



# **EROSION AND LANDFORM EVOLUTION SIMULATIONS TO SUPPORT WASTE LANDFORM DESIGN: GOONYELLA RIVERSIDE MINE COMPLEX**

September 2024



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## 1 SUMMARY

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For waste landforms at Goonyella Riverside Mine Complex (GRM), Landloch Pty Ltd has completed:

- a) Initial WEPP runoff/erosion model simulations;
- b) Derivation of parameters for the SIBERIA landform evolution model; and
- c) Landform evolution simulations for 3-D waste landforms provided by BMA.

Erodibility data for materials considered in WEPP simulations were sourced from previous erodibility studies that assessed GRM materials and from direct measurement of materials from GRM, and included:

- Clay topsoil;
- Clay topsoil mixed with fresh Permian waste; and
- Fresh Permian waste.

WEPP simulations were carried out for the following batter slope geometries:

- 500m long, at 30% gradient;
- 600m long at 25% gradient;
- 750m long at 20% gradient;
- 1,000m long, at 15% gradient; and
- 1,000m long, at 10% gradient.

Each of these batter slope geometries were sheeted with:

- Clay soil with vegetation groundcover levels of 0–90%;
- Clay soil mixed with fresh Permian waste with vegetation groundcover levels of 0–70%; and
- Fresh Permian waste with vegetation groundcover levels of 0–50%.

In deriving and applying SIBERIA parameters, it was assumed that the:

- Clay topsoil mixed with fresh Permian waste with vegetation groundcover levels of 50% will be used for outward-facing batters with 15% gradient on:
  - Goonyella;
  - Airstrip; and
  - Broadmeadow/Isaac.
- Fresh Permian waste with vegetation groundcover levels of 30% will be used for inward-facing (low wall) batters with 30% gradient on:
  - Goonyella;
  - Airstrip; and
  - Broadmeadow/Isaac.

It is considered that these simulations address all options being considered for GRM.

SIBERIA model output showed batter slopes erode at rates below target levels in all cases. Some gully erosion is predicted to occur after 300 years for the clay topsoil mixed with fresh Permian waste and the fresh Permian waste covered slopes, when used on the Goonyella and Broadmeadow/Isaac landforms.

In these circumstances, given the material underlying these surfaces is likely to be the more erosion-resistant fresh Permian waste, the risk of exposing problematic (more erodible) materials over the long-term via gully erosion and not achieving the post-mining land use is considered low. However, gully erosion should be monitored and assessed by an appropriately qualified person as part of the rehabilitation monitoring and maintenance process. Gully erosion was not predicted to occur for the Airstrip landform after 300 years.

## 2 INTRODUCTION

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### 2.1 Overview

Landloch has been engaged by BMA to carry out specific specialist studies for soils and capping, and landform design, to provide information for the subsequent compilation of transitional Progressive Rehabilitation and Closure Plans (PRC Plans) for its existing operational coal assets located within the Bowen Basin.

This report considers the design of stable waste landforms on the Goonyella Riverside Mine Complex (GRM). GRM includes the Goonyella Riverside mine and the Broadmeadow underground mine.

### 2.2 Objectives of landform design

A key requirement of landform design is to demonstrate that the rehabilitated landform shapes can confidently be expected to be erosionally stable over the long term, while also supporting the target Post Mining Land Use (PMLU). As part of that requirement, this landform study reports:

- Materials to be used in landform rehabilitation and their erodibility;
- Erosion assessments for a range of material and slope profile options, considering interactions between soil erodibility, rainfall erosivity, and landform height, gradient and vegetation groundcover. These assessments aim to identify options that will achieve acceptable erosion rates over a 100-year period; and
- Landform evolution simulations using the SIBERIA landform evolution model (LEM) to assess stability of 3-dimensional (3-D) rehabilitation landform designs over a period of 300 years.

## 3 LANDFORM STUDY METHODS

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The landform study consisted of four stages:

- a) Sourcing and review of erosion model and LEM input data and information;
- b) Simulations of runoff and erosion for a range of landform batter options using the WEPP (Water Erosion Prediction Project) model (Flanagan and Livingston 1995);
- c) Derivation of input parameters for the SIBERIA LEM (Willgoose *et al.* 1989); and
- d) LEM simulations using SIBERIA for 3-D landform shapes provided by BMA.

### 3.1 Data sources

Information on the soil and waste types present at GRM were sourced from:

- Data collected as part of the development of this report;
- Landloch's GRM material characterisation study report (Landloch 2024);
- Landloch's assessment of GRM's rocky Permian wastes (unpublished data); and
- Historical erodibility testing of GRM's soils (Sheridan 2001).



### 3.2 Topsoils

The GRM material characterisation study report (Landloch 2024) assessed the properties of 27 topsoil stockpiles. This material represents the soil available for use in rehabilitation at GRM.

Clay topsoils account for 80% of samples assessed across the GRM topsoil stockpiles. They are concentrated in the northern, eastern, and southern areas of the mine. Generally, the clay soil samples have similar properties, but occasional minor inclusions of loams were noted at some stockpiles. This is likely a result of topsoils from minor texture contrast or Kandosol soil units being stripped with the more dominant clays.

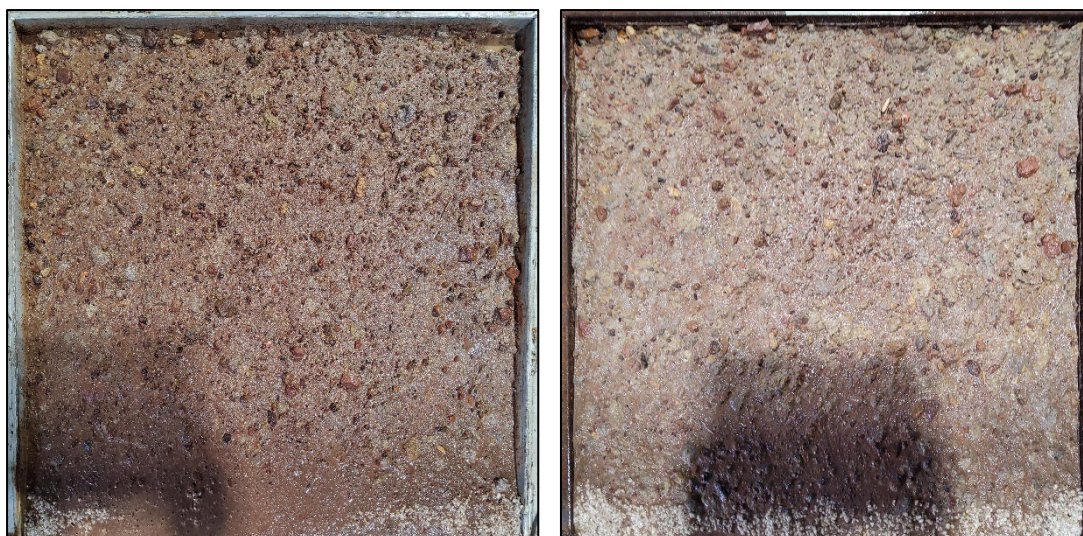
Loam topsoils account for 20% of samples assessed across the GRM topsoil stockpiles. They are scattered around the south and south-west portion of the mine. These materials have been recovered from a variety of soil types, but have similar physical soil properties once stockpiled, so have been grouped together to aid their management.

Given the dominance of the clay topsoil at GRM, only the clay topsoil was considered further for erodibility testing of the soils.

A summary of the properties of the available soil types is given in Table 1. The table includes data from the assessment of stockpiled soils (Landloch 2024) and data from the assessment of a clay topsoil subjected to erodibility testing as part of this project. The data shows that the clay soils for which WEPP erodibility parameters are available are consistent with the properties of the stockpiled clay soils and hence can be used to model long-term erosion potential for GRM. Figure 1 shows the clay topsoil tested immediately after exposure to high intensity simulated rain. Erodibility data for a clay soil was also available from Sheridan (2001). These data sources were incorporated to produce an aggregated erodibility parameter dataset for the clay topsoils.

**Table 1:** Properties of soils at GRM as reported in Landloch (2024) and measured as part of this study.

| Analysis                                    | Clay Topsoil<br>(Landloch 2024) | Clay Topsoil<br>(GRM_TS_004) | Loam Topsoil<br>(Landloch 2024) |
|---------------------------------------------|---------------------------------|------------------------------|---------------------------------|
| pH <sub>w</sub> (pH Units)                  | 7.7–9.0                         | 8.8                          | 6.5–8.3                         |
| EC <sub>1:5</sub> (dS/m)                    | <1.0                            | 0.8                          | <0.2                            |
| ECEC (meg/100g)                             | 5.6–20                          | 11                           | 1.9–7.9                         |
| Exchangeable sodium<br>percentage (ESP) (%) | 5.8–22                          | 19                           | 1.5–7.1                         |
| Clay content (%)                            | >35                             | 53                           | >35                             |
| Rock content (%)                            | <30                             | 8                            | <20                             |



**Figure 1:** Test plots immediately following application of simulated rain to a clay topsoil. GRM\_TS\_004 Plot 1 (left) and Plot 2 (right).

### 3.3 Wastes

Waste materials at GRM include sandstone, mudstone/siltstone, and tertiary materials.

Sandstone wastes account for a large proportion of the fresh Permian wastes and tend to be reasonably consistent in their characteristics given the range of strata locations and proximity to carbonaceous layers. Fresh Permian wastes are considered most suitable for placement close to the final rehabilitated surface for use as a secondary growth media. They also have the potential to be used as a rock armour to increase batter slope resistance to erosion and to stabilise steeper areas.

Weathered Permian wastes tend to vary in properties depending on the degree of weathered inclusions. They are considered suitable as a secondary growth media but should be capped with a suitable quality topsoil to prevent its exposure at the final rehabilitated surface. If exposed, this material will be susceptible to erosion due to its tendency to rapidly weather and disperse. Tertiary wastes are a highly weathered and contain small portions of fragile (low durability) rock. As a result, their placement close to the final rehabilitated surface is not recommended. Assessment of erodibility of the wastes only considered fresh Permian wastes because the weathered Permian and Tertiary wastes are not recommended to be placed close to the final rehabilitation surface.

A summary of the properties of the fresh Permian wastes are given in Table 2. Data from the GRM material characterisation study (Landloch 2024) and an assessment of the rocky Permian wastes done as part of this study are provided. The data shows that fresh Permian waste for which erodibility parameters are available are consistent with the properties reported more broadly for the same material (Landloch 2024). Hence, they can be used to model long-term erosion potential for GRM. This data was aggregated to produce a single erodibility parameter dataset for the fresh Permian waste. Figure 2 shows the Permian wastes tested immediately after exposure to high intensity simulated rain.

**Table 2:** Properties of Permian wastes at GRM as reported in Landloch (2024) and measured as part of this study.

| Analysis                   | Sandstone Permian Spoil<br>(Landloch 2024) | Fresh Permian Waste<br>(This Study) |
|----------------------------|--------------------------------------------|-------------------------------------|
| pH <sub>w</sub> (pH Units) | 8.3–9.9                                    | 9.4–9.6                             |
| EC <sub>1:5</sub> (dS/m)   | <0.8                                       | <1.0                                |
| ECEC (meg/100g)            | 8–24                                       | 7.4–11                              |
| ESP (%)                    | 6–36                                       | 25–26                               |
| Clay content (%)           | 10–35                                      | 23–28                               |
| Rock content (%)           | >50                                        | 66–73                               |



**Figure 2:** Test plots immediately following application of simulated rain to a Permian waste. R14\_002 (left) and AH003\_02 (right).

### 3.4 Summary

Clay soil and fresh Permian wastes are available for use at the surface of rehabilitated waste landforms. Erosion modelling of the landforms at GRM assumed different surface materials as follows:

- Clay topsoil mixed with fresh Permian waste will be used for outward-facing batters on:
  - Goonyella;
  - Airstrip; and
  - Broadmeadow/Isaac.
- Fresh Permian waste will be used for inward facing (low wall) batters on:
  - Goonyella;
  - Airstrip; and
  - Broadmeadow/Isaac.

A mixture of fresh Permian waste with the clay soil was found to be more suitable than topsoil alone, given the high erodibility measured for the clay topsoils at GRM.



## 3.5 WEPP simulations

### 3.5.1 Parameters used

Erodibility parameters for WEPP runoff/erosion simulations have been determined experimentally for clay topsoil and fresh Permian waste. These parameters include:

- Effective hydraulic conductivity;
- Interrill erodibility;
- Rill erodibility; and
- Critical flow shear stress for initiation of rilling.

### 3.5.2 Slope, materials, and vegetation groundcover options

Initial WEPP simulations were carried out for:

- Batter slopes 500m long, at 30% gradient, surfaced with:
  - Clay soil with vegetation groundcover levels of 0–90%;
  - Fresh Permian waste with vegetation groundcover levels of 0–30%; and
  - Clay soil mixed with Fresh Permian wastes with vegetation cover levels of 0–70%.
- Batter slopes 600m long, at 25% gradient, surfaced with:
  - Clay soil with vegetation groundcover levels of 0–90%;
  - Fresh Permian waste with vegetation groundcover levels of 0–30%; and
  - Clay soil mixed with Fresh Permian wastes with vegetation cover levels of 0–70%.
- Batter slopes 750m long, at 20% gradient, surfaced with:
  - Clay soil with vegetation groundcover levels of 0–90%;
  - Fresh Permian waste with vegetation groundcover levels of 0–30%; and
  - Clay soil mixed with Fresh Permian wastes with vegetation cover levels of 0–70%.
- Batter slopes 1,000m long, at 15% gradient, surfaced with:
  - Clay soil with vegetation groundcover levels of 0–90%;
  - Fresh Permian waste with vegetation groundcover levels of 0–30%; and
  - Clay soil mixed with Fresh Permian wastes with vegetation cover levels of 0–70%.
- Batter slopes 1,000m long, at 10% gradient, surfaced with:
  - Clay soil with vegetation groundcover levels of 0–90%;
  - Fresh Permian waste with vegetation groundcover levels of 0–30%; and
  - Clay soil mixed with Fresh Permian wastes with vegetation cover levels of 0–70%.

In considering clay topsoil mixed with fresh Permian waste, input parameters used the hydraulic conductivity of the soil and the critical flow shear stress of the fresh Permian waste (consistent with Landloch's unpublished data for such mixtures).

### ***3.5.3 Vegetation groundcover impacts***

Impacts of vegetation groundcover on infiltration rates were estimated using the relationship reported by Kato *et al.* (2009), and direct impacts of vegetation groundcover on erosion rates were estimated using Cover (C) factors for the Revised Universal Soil Loss Equation (RUSLE) (Renard *et al.* 1993) listed in Rosewell (1993).

Vegetation groundcover levels of 30% for relatively low fertility fresh Permian waste, and 50% for soil/fresh waste mixtures, and 70% for the more fertile clay soils were adopted in erosion simulations.

This report details materials and the associated vegetation groundcover levels for the representative materials available at the time of sampling. The modelled vegetation groundcover levels are conservative. This study was designed to support the total groundcover levels in the EA acceptance criteria and is not intended to prescribe exact vegetation groundcover levels.

### ***3.5.4 Assumptions with respect to effects of cover on erosion***

Points to be noted:

- a) In considering "vegetation groundcover" this report specifically considers contact cover of vegetation on the soil surface. Practically, this means a combination of grass cover and anchored (not readily moved) surface litter.
- b) The vegetation groundcover levels can be varied in the modelling. Rock groundcover for the material tested is accounted for within the parameters used in the WEPP simulations.
- c) Different materials with higher rock groundcover, require lower levels of vegetation groundcover.
- d) Total groundcover (vegetation groundcover plus rock groundcover combined) limits erosion.

### ***3.5.5 Climate***

All simulations used a synthetic 100-year climate file prepared to match all relevant characteristics of Moranbah climate.

### ***3.5.6 Key assumptions – landforms and vegetation***

The simulations are based on two key assumptions:

- a) There will be no uncontrolled discharge of runoff from landform tops onto outer batter slopes; and
- b) The assumed vegetation groundcover levels will be achieved sustainably, with those levels being set as triggers for investigation and remedial action should monitoring indicate that they are not being achieved.

It should be recognised there are also underlying assumptions of good rehabilitation practice such that:

- There will not be discharges of concentrated flows onto any batter slopes at any point of their rehabilitation;
- Batter slopes will not be formed with significant flow-concentrating profiles (e.g. variations in surface elevation such that there is cross-slope concentration of flow into consistent depressions running downslope);
- Any cross-slope ripping will be carried out strictly on the contour; and
- Soil management (including stripping, stockpiling, replacement, amendment, and fertilisation) will be carried out effectively to maximise early and continuing plant growth.

### *3.5.7 Soil loss targets*

This study used runoff, and erosion modelling to identify landform options that would erode at rates low enough to provide long-term erosional stability. Effectively, the landforms are planned to be consistent with tolerable rates of soil loss. Wischmeier and Smith (1978) defined tolerable soil loss for cropland as, "the maximum rate of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely."

A value of 11.2t/ha/y averaged over an area of interest is often cited as a tolerable soil loss rate, but that value was derived by US soil conservation agencies for deep, fertile cultivated soils, and has little relevance to most rehabilitated minesites. Using similar criteria to those applied for crop land, a lower soil loss tolerance value of 4.5t/ha/y was developed by US agencies for erosion of rangeland soils and shallow cultivated soils (Wight and Siddoway 1979).

Lower tolerance values are relevant to rangeland and minesite situations, as not only are the soils shallower and more susceptible to fertility decline, but the lack of regular tillage or disturbance means that any rills or points of scour that form are more likely to extend and develop into gullies over time. These are typically of concern for minesite landforms where there is no bedrock layer at depth to limit long-term depths of incision.

For that reason, a key priority in setting a tolerable erosion target is the prevention of significant rill or gully development. On that basis, for slopes where long-term erosion risk (for a range of reasons) is considered high, a maximum rate of erosion of 5t/ha/y at any point on the batter slopes being modelled has commonly been applied by Landloch on the basis that; at this rate rilling is largely if not completely absent.

Typically, the high risk category includes slopes where the overall landform height is >50m, and situations where – due to rainfall limitations and/or soil fertility concerns – vegetation growth is unlikely to rapidly colonise and stabilise any rills that form.

As the landforms at GRM are planned to be considerably higher than 50m, the adopted target erosion value for this assessment is a maximum at any point of the outer batter slopes of 5t/ha/y. However, for low wall slopes that drain to pits, there are no potential off-site impacts of erosion, and planned PMLU is typically native vegetation. For those situations, a slightly higher erosion target (a maximum of 10t/ha/y) has been adopted.

The elimination of rilling reduces the potential for channelised flow to form gullies, and experience to date with a large number of waste landforms designed by Landloch has shown that the target soil loss values adopted have achieved acceptable levels of stability to erosion.

### 3.6 Derivation of SIBERIA parameters

To run SIBERIA, the parameters  $\beta_1$ ,  $m_1$ ,  $n_1$ ,  $\beta_3$ , and  $m_3$  are usually needed. However, if the batter area to be modelled is identical to the batter for which erosion data are available for calibration,  $m_3$  and  $\beta_3$  can be taken as 1.0 and a value for  $n_1$  of 1.5 can be adopted for situations where slope gradient does not affect slope erodibility (Willgoose, pers. comm.). Therefore, the two key parameters that require derivation are  $\beta_1$  and  $m_1$ .

The  $\beta_1$  parameter can be considered a "rate parameter", as it primarily controls the rate of sediment movement. The  $m_1$  parameter can be considered as primarily controlling slope length responses. However, in practice, there is interaction between all the parameters with the result that a large number of parameter sets will all show the same rate of erosion though some aspects of the pattern of erosion that is predicted will vary. It is for this reason that, where possible, fixed values of  $n_1$  and  $m_3$  are adopted – thereby reducing the difficulty of deriving parameter values.

Input parameters for SIBERIA are typically derived by fitting the various model equations to time series data of runoff and erosion. To generate the necessary data, Landloch has developed method that involves:

- a) Run the WEPP model to generate data sets of runoff and erosion for slopes consistent with the proposed landforms and for materials of interest using site specific climate data.
- b) Analyse the WEPP output to derive the required SIBERIA input parameters.

This approach ensures that SIBERIA parameters are effectively benchmarked to the WEPP output, and thereby, effectively based on measured erodibility parameters for site materials and on site climate.

## 4 RESULTS OF WEPP SIMULATIONS

Simulations considered slope lengths of 500m and 1,000m. The target erosion rate for modelling outward-facing batters (clay topsoil) is an average annual rate of 5t/ha/y. The target erosion rate for modelling inward-facing batters (low walls, fresh Permian waste) is an average annual rate of 10t/ha/y.

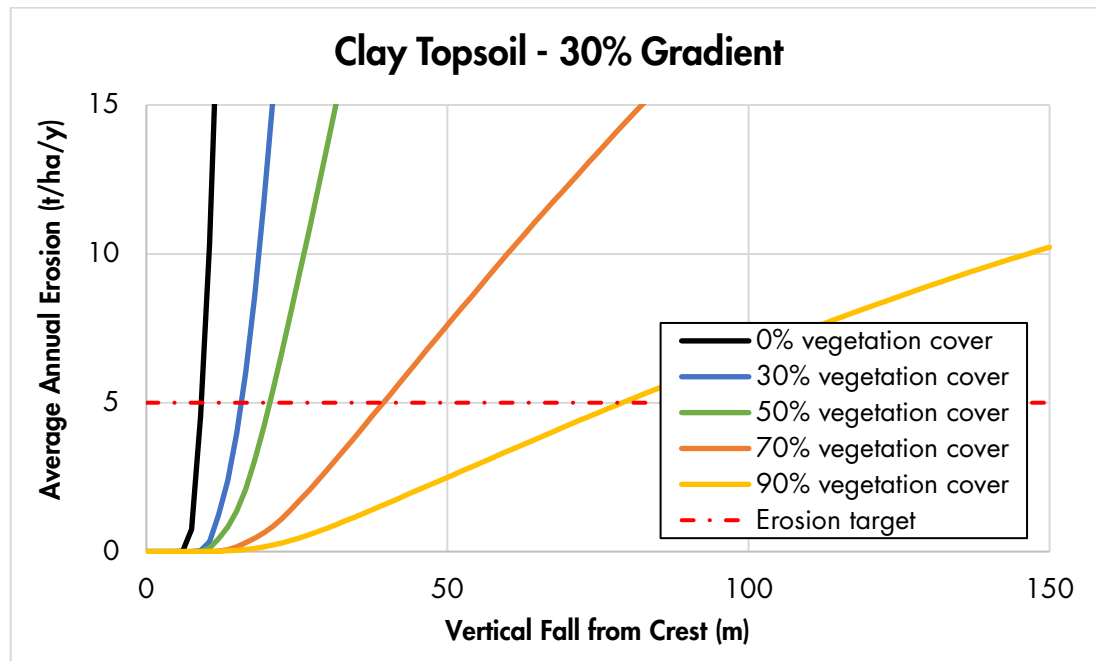
### 4.1 Slopes surfaced with vegetated clay topsoil

For the clay topsoil modelled, long-term WEPP erosion simulations indicate that gradients of >15% would require very high vegetation groundcover levels (>90%) (Figures 3–6). Slopes using clay topsoils are predicted to be erosionally stable only when gradients of

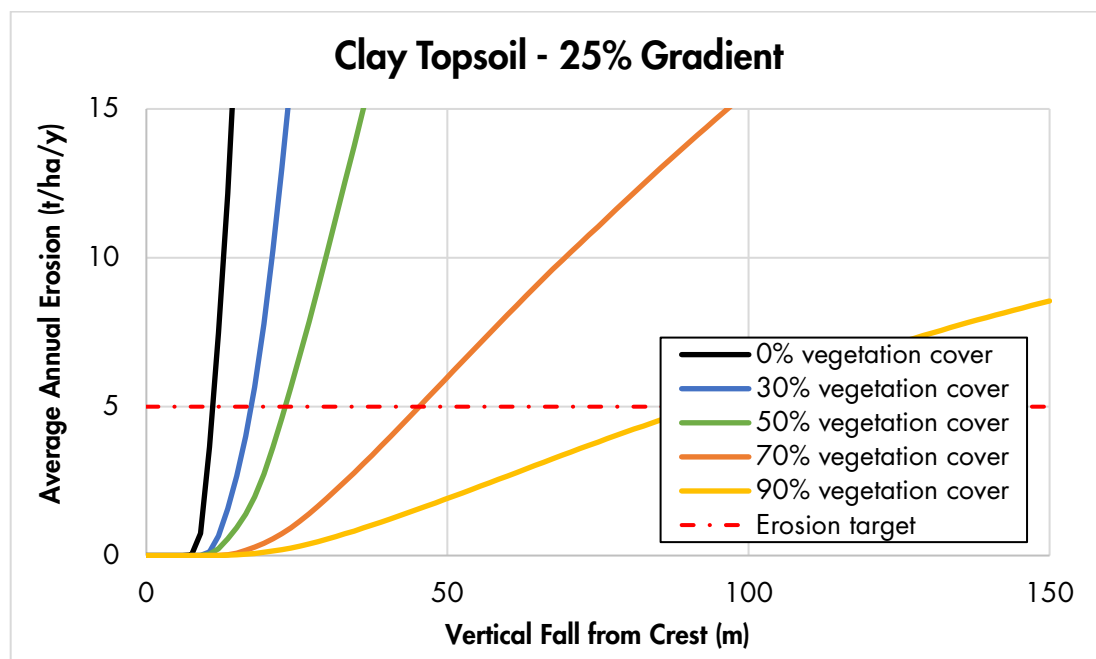


10% or less are adopted for slope lengths up to 1,000m, and when vegetation groundcover levels of 90% are achieved (Figure 7), for slope lengths less than 1,000m.

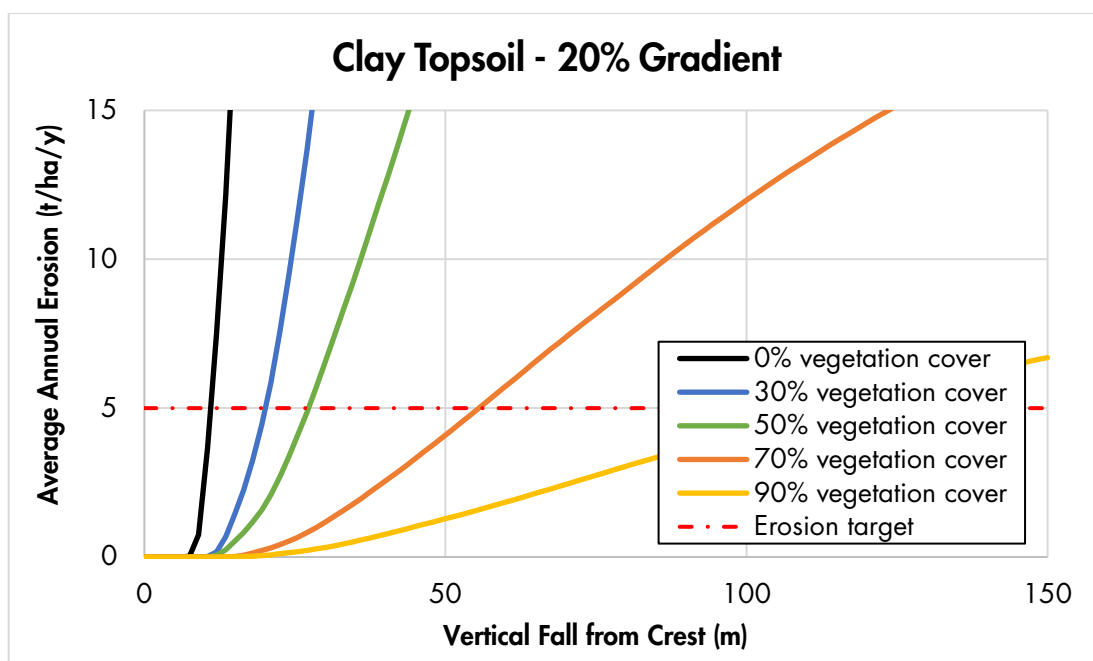
These results indicate that the clay topsoil are GRM is highly erodible. Erosion of a clay soil mixed with rock was considered as a means of maintaining soil as the primary growth media while also increasing the erosion resistance of the rehabilitation surface.



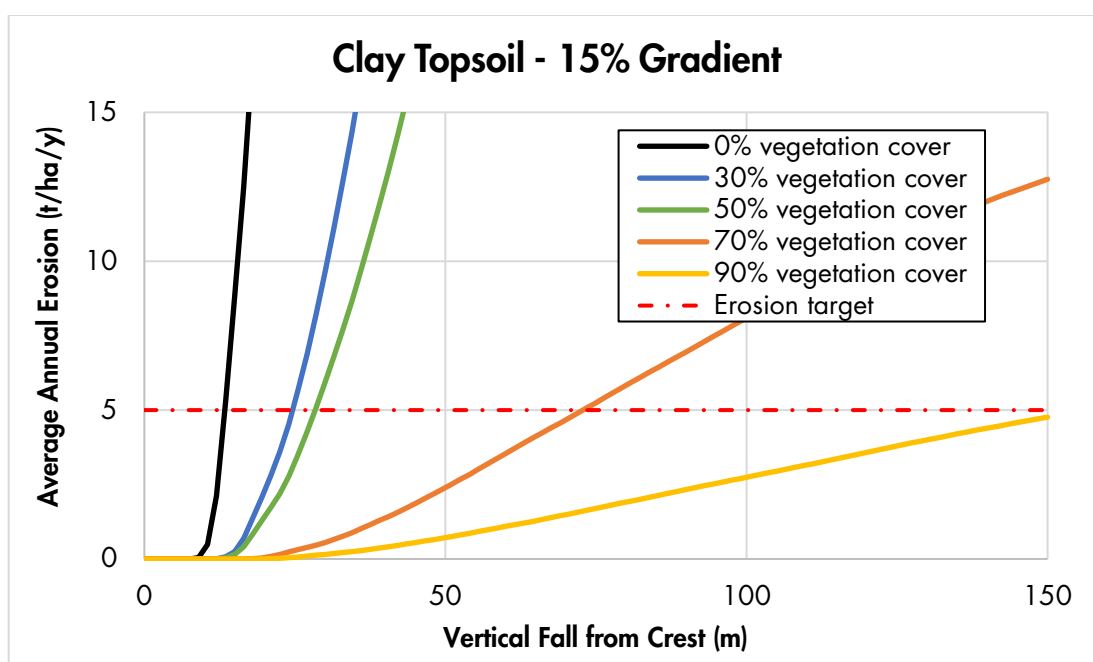
**Figure 3:** Predicted erosion rates on 30% gradient outward-facing slope sheeted with clay topsoil.



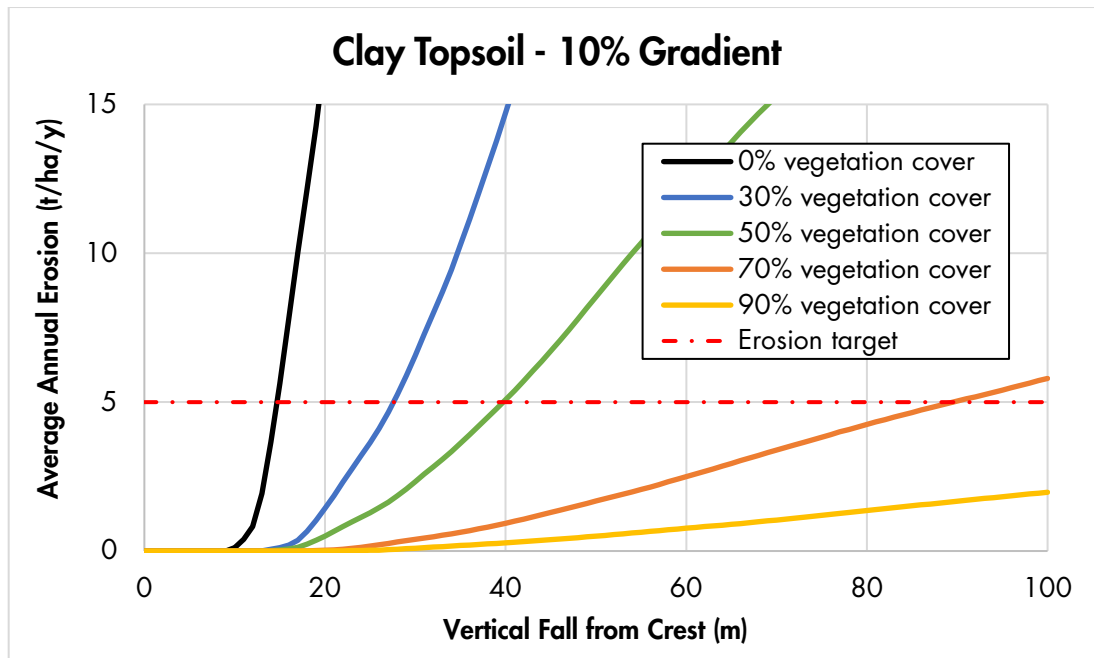
**Figure 4:** Predicted erosion rates on a 25% gradient outward-facing slope sheeted with clay topsoil.



**Figure 5:** Predicted erosion rates on a 20% gradient outward-facing slope sheeted with clay topsoil.



**Figure 6:** Predicted erosion rates on 15% gradient outward-facing slope sheeted with clay topsoil.

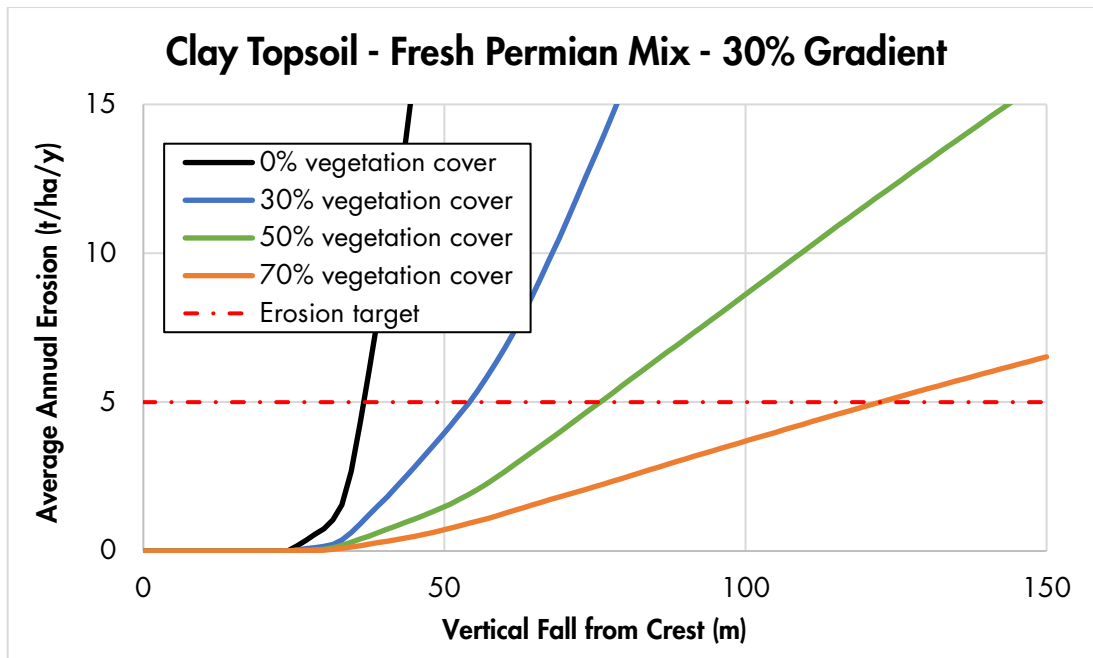


**Figure 7:** Predicted erosion rates on a 10% gradient outward-facing slope sheeted with clay topsoil.

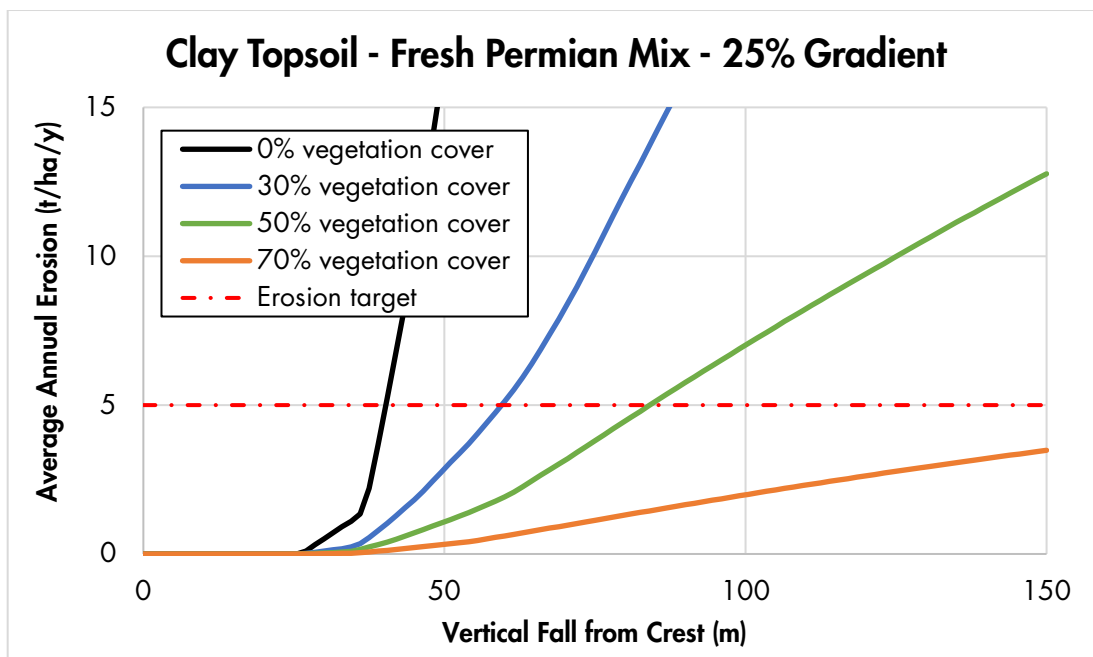
## 4.2 Slopes surfaced with vegetated clay topsoil/fresh waste mixture

For the modelled clay topsoil mixed with fresh Permian waste, long-term WEPP erosion simulations indicate that gradients of 30% would require very high vegetation groundcover levels (>70%) (Figure 8). Slopes with gradients of 20–30% would also require high vegetation groundcover levels (>70%) (Figures 9–10), for slope lengths less than 1,000m. Slopes using clay topsoils mixed with fresh Permian waste are predicted to be erosionally stable only when gradients of 15% or less are adopted for slope lengths up to 1,000m, and when vegetation groundcover levels of 50% or greater are achieved (Figures 11–12).

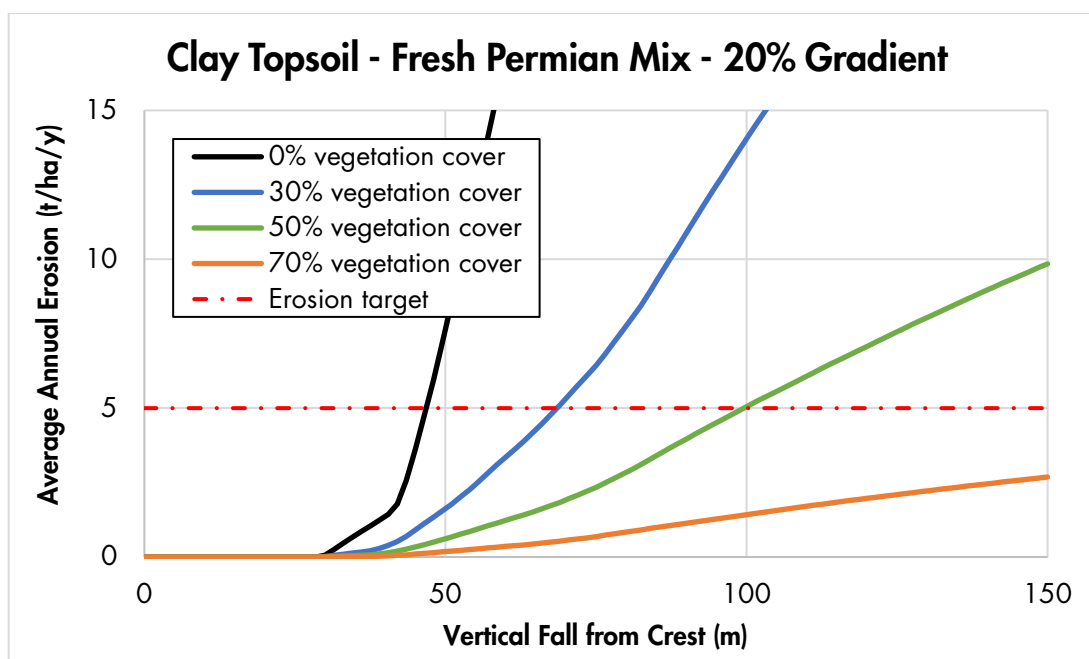
The results indicate that incorporating Permian waste into the surface of the outward-facing slopes reduces the required vegetation groundcover compared to soils alone.



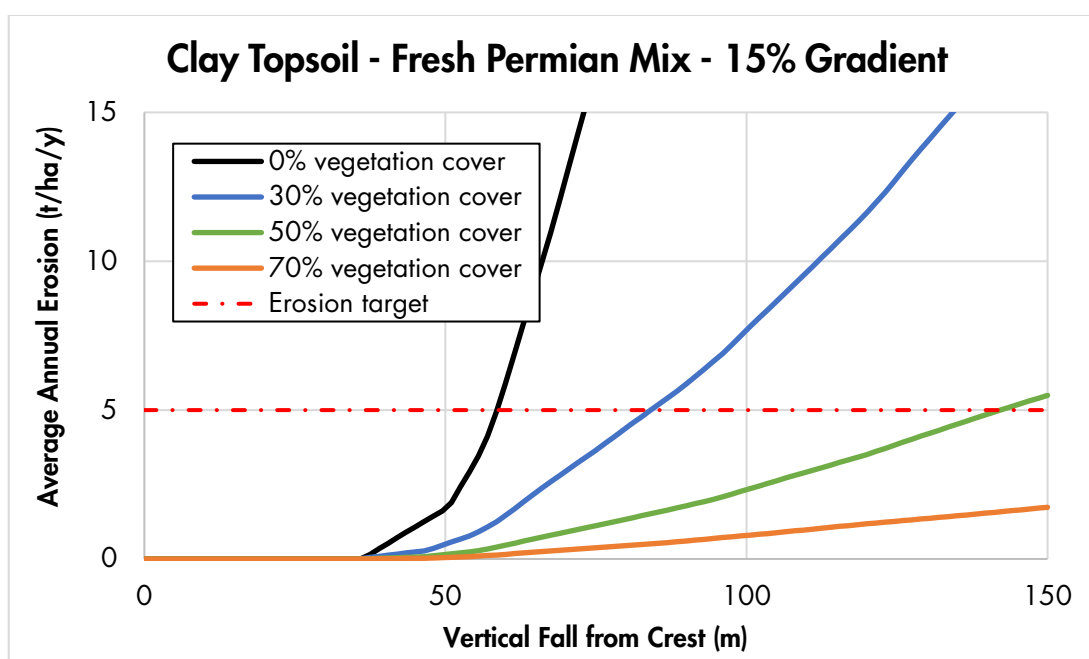
**Figure 8:** Predicted erosion rates on 30% gradient outward-facing slope sheeted with clay topsoil mixed with fresh Permian waste.



**Figure 9:** Predicted erosion rates on 25% gradient outward-facing slope sheeted with clay topsoil mixed with fresh Permian waste.

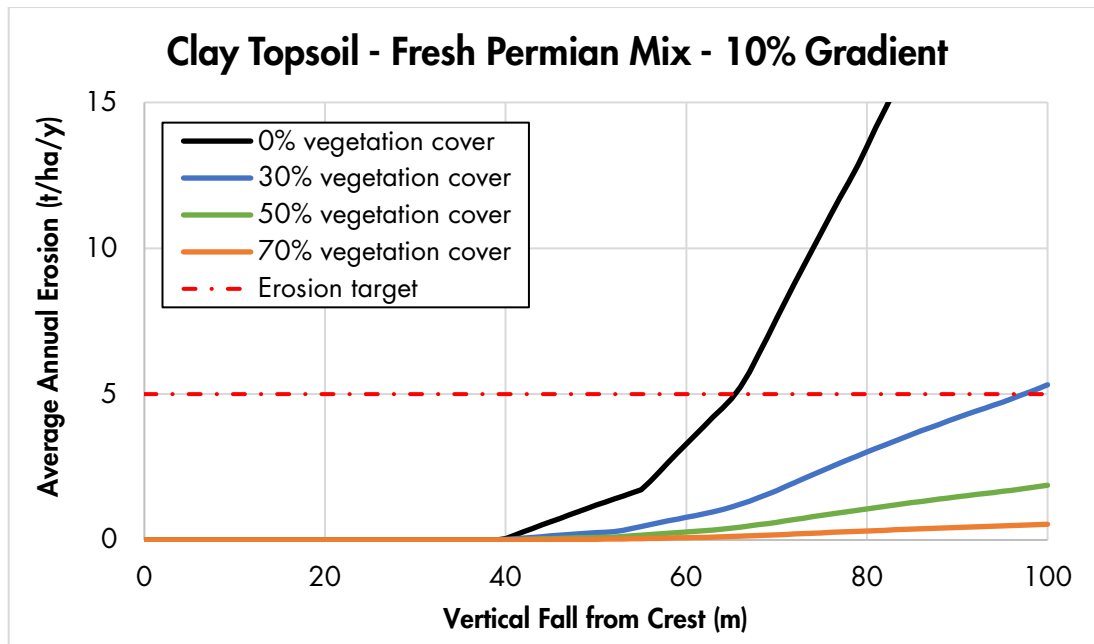


**Figure 10:** Predicted erosion rates on 20% gradient outward-facing slope sheeted with clay topsoil mixed with fresh Permian waste.



**Figure 11:** Predicted erosion rates on 15% gradient outward-facing slope sheeted with clay topsoil mixed with fresh Permian waste.

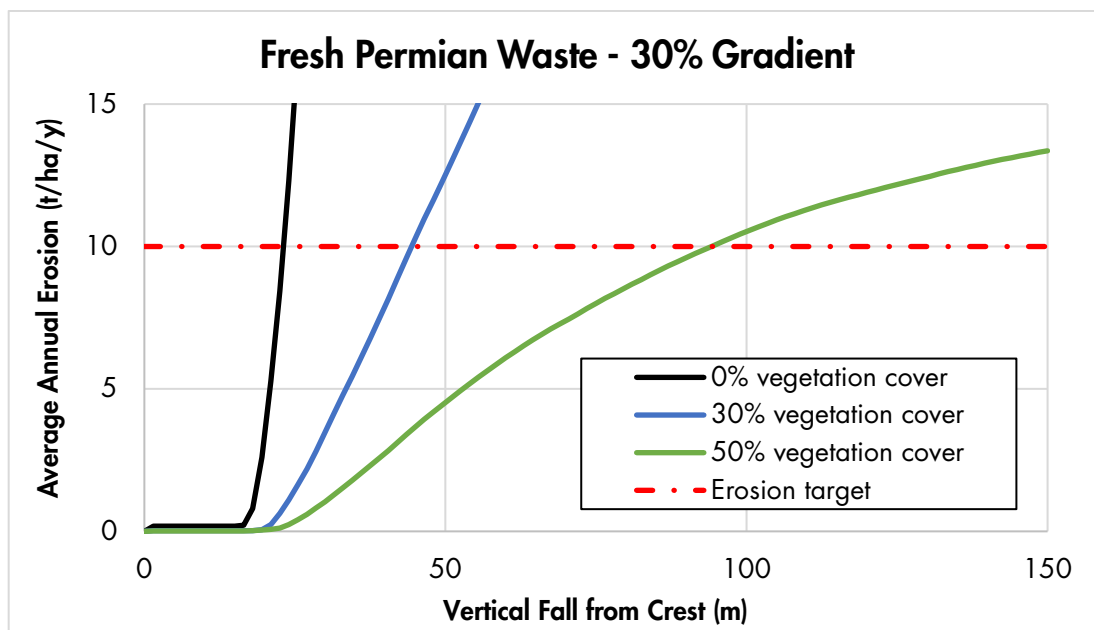




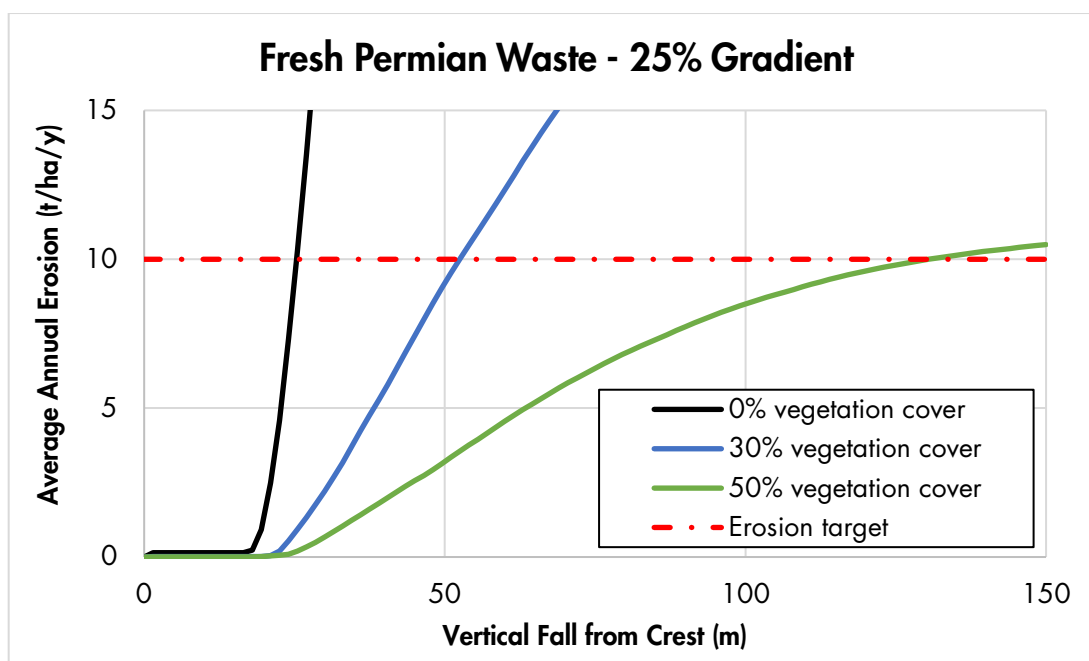
**Figure 12:** Predicted erosion rates on 10% gradient outward-facing slope sheeted with clay topsoil mixed with fresh Permian waste.

### 4.3 Slope surfaced with vegetated Permian waste

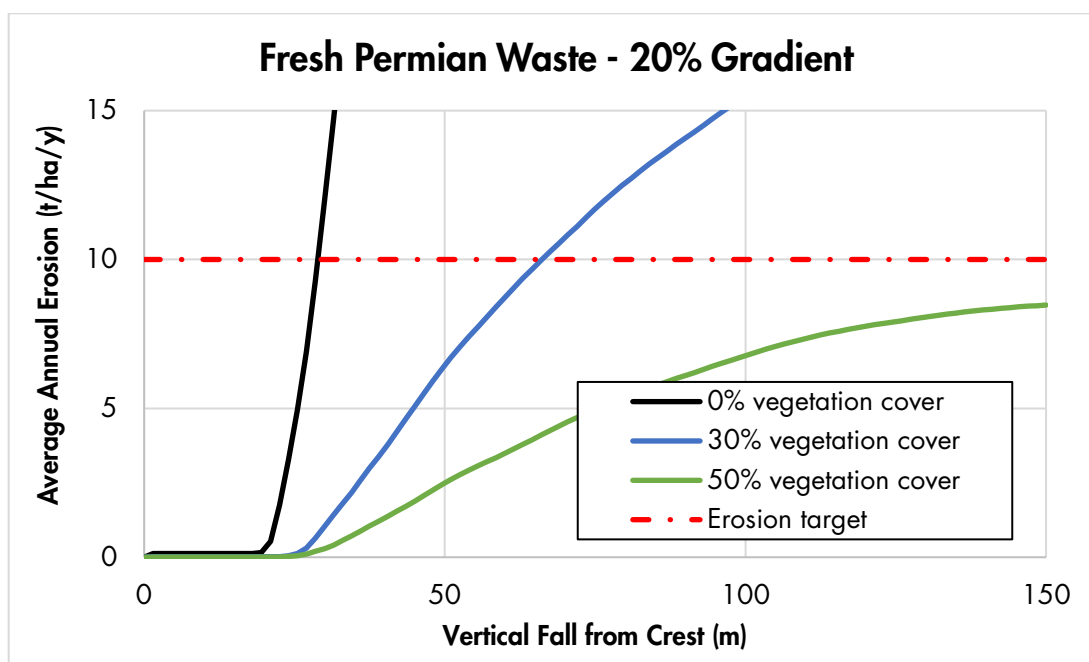
For the fresh Permian waste modelled, simulations indicate that slopes with gradients of 15–30% are predicted to be stable for a vegetation groundcover level of >50% (Figures 13–16) and slopes with gradients of 10% are predicted to be stable for a vegetation groundcover level of >30% (Figure 17). The results also indicate that using Permian waste on the outward-facing slopes would reduce the vegetation groundcover requirements compared to soils alone.



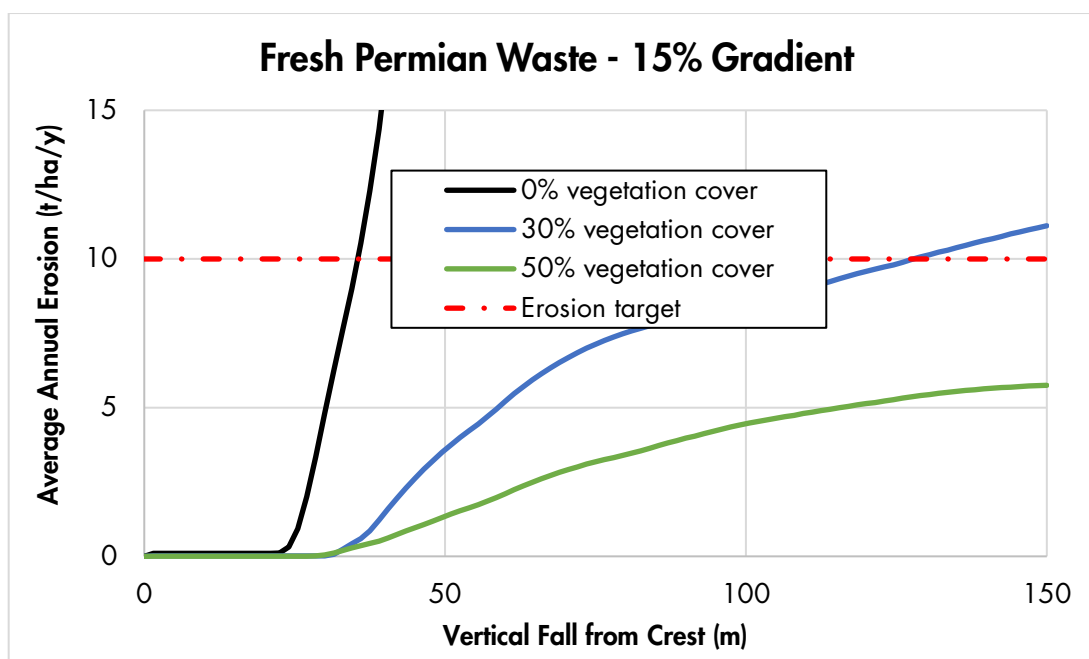
**Figure 13:** Predicted erosion rates on a 30% gradient inward-facing slope sheeted with fresh Permian waste.



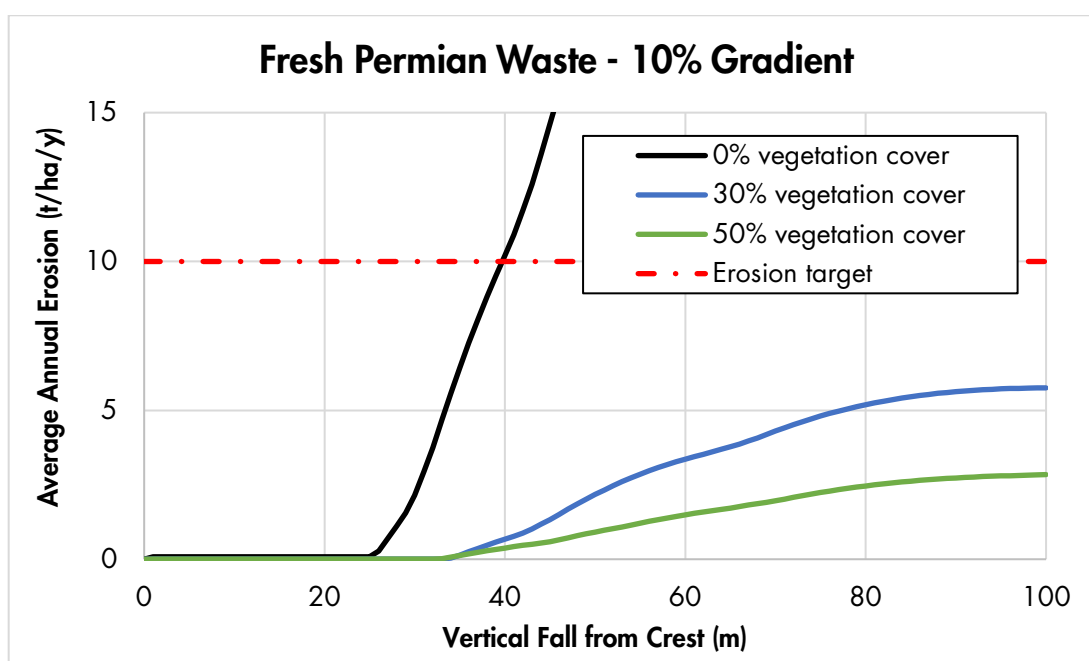
**Figure 14:** Predicted erosion rates on a 25% gradient inward-facing slope sheeted with fresh Permian waste.



**Figure 15:** Predicted erosion rates on a 20% gradient inward-facing slope sheeted with fresh Permian waste.



**Figure 16:** Predicted erosion rates on a 15% gradient inward-facing slope sheeted with fresh Permian waste.



**Figure 17:** Predicted erosion rates on a 10% gradient inward-facing slope sheeted with fresh Permian waste.

## 4.4 Summary

Based on the erosion modelling results, it was concluded that use of vegetated clay soil mixed with fresh Permian waste and fresh Permian waste surfaces can be erosionally stable. Given this finding, SIBERIA landform evolution modelling used the following for the Goonyella, Airstrip, and Broadmeadow/Isaac landforms:

- Clay topsoil mixed with fresh Permian waste with vegetation groundcover levels of 50% for outward-facing batters with 15% gradient, and
- Fresh Permian waste with vegetation groundcover levels of 30% for inward-facing (low wall) batters with 30% gradient.

## 5 SIBERIA MODEL SETUP

### 5.1 Parameters

SIBERIA model parameters derived from WEPP simulations are shown in Table 3. As noted previously (Section 3.5.3), the vegetation groundcover levels assumed are conservative, with some variation to account for lower fertility of the wastes.

It should be noted that the method of deriving parameters attempts to ensure that the  $m_1$  parameter is optimised so that SIBERIA simulations show a similar impact of slope length to that predicted by WEPP. However, because the two models use different methods to consider impacts of slope length, it is not reasonable to expect complete agreement between the two models over the full range of slope lengths considered.

**Table 3:** Estimated SIBERIA parameters.

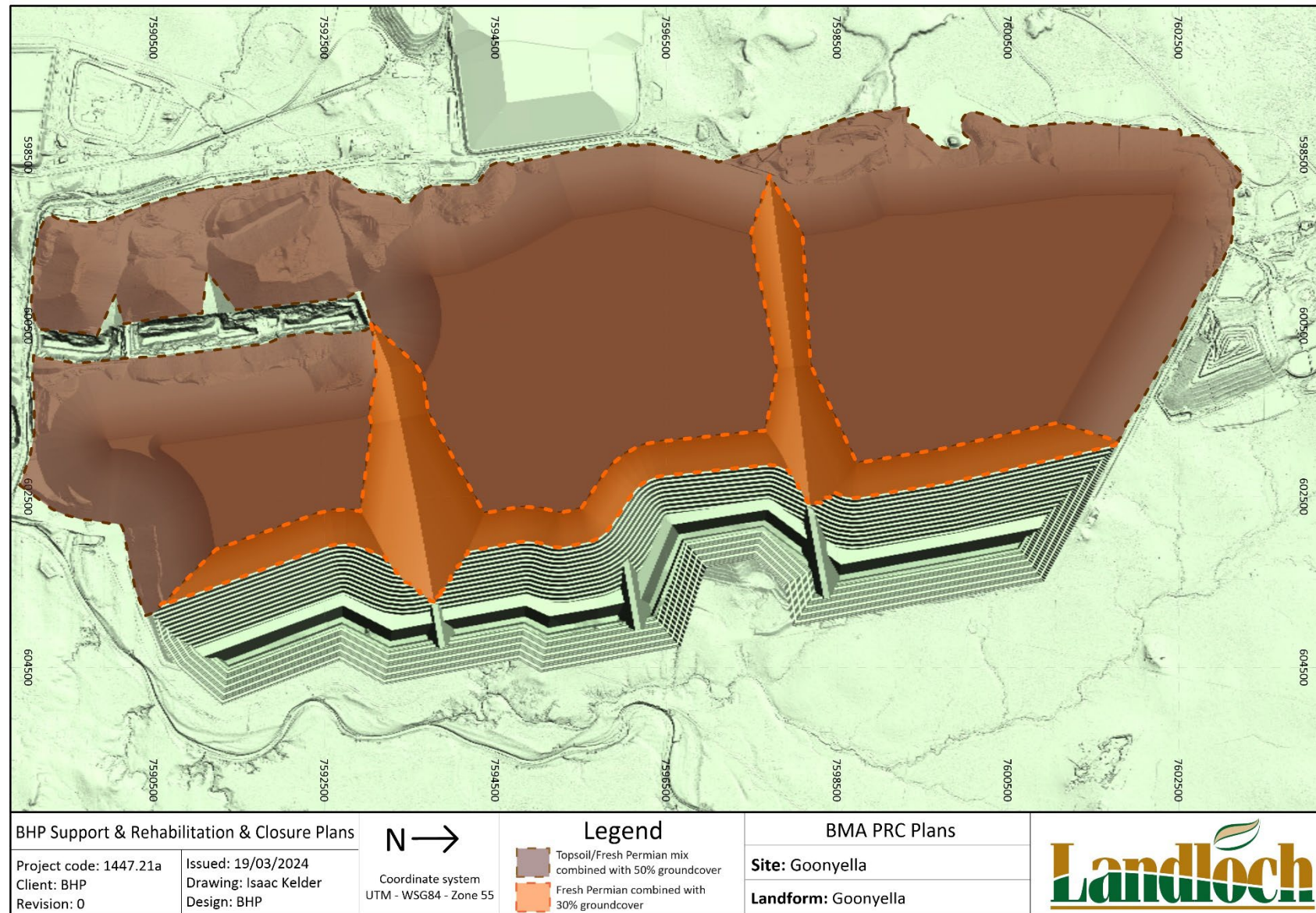
| Material                               | Vegetation Groundcover (%) | $m_1$  | $\beta_1$ | $n_1$ |
|----------------------------------------|----------------------------|--------|-----------|-------|
| Clay topsoil – fresh Permian waste mix | 50                         | 1.3285 | 0.00103   | 1.5   |
| Fresh Permian waste                    | 30                         | 1.1952 | 0.00105   | 1.5   |

### 5.2 Elevation models

Proposed 3-D final landform design files for GRM were provided by BMA. The landforms modelled included:

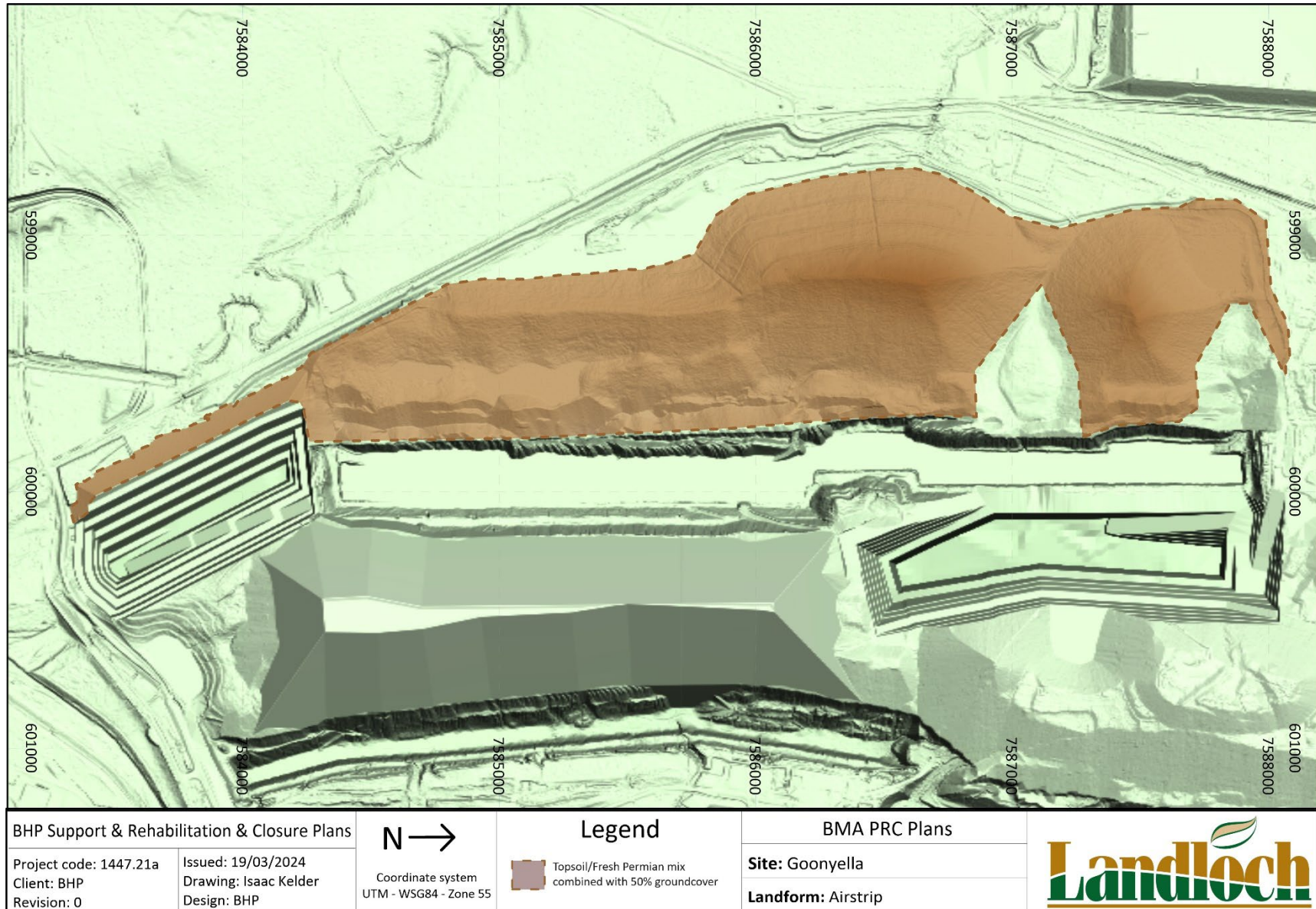
- Goonyella;
- Airstrip; and
- Broadmeadow/Isaac.

These landforms were designed on the basis of WEPP model runoff/erosion results for potential surface materials to be applied (Figures 18–20). These figures also show the regions in which different surface materials and vegetation groundcover levels were applied.



**Figure 18:** Goonyella rehabilitation landform.





**Figure 19:** Airstrip rehabilitation landform.





**Figure 20:** Broadmeadow/Isaac rehabilitation landform.

## 6 LANDFORM EVOLUTION MODEL OUPUTS

Using input parameters derived for the materials to be used on the landforms, the SIBERIA model was run for 300 years, with outputs provided between 50 years and 300 years. At each output year, visualisations of the rate of erosion and gully development are provided, along with a table that includes rates for each material on the landform. Rates of gully depth that exceeds 0.3m are highlighted in the visualisations. Visualisations for 300 years are shown below. However, all visualisations (50, 100, 200, and 300 years) are provided in Appendix A.

### 6.1 Goonyella landform

Rehabilitation of the Goonyella landform is planned to use vegetated clay topsoil combined with fresh waste rock on the outward-facing slopes and vegetated fresh Permian waste on the inward-facing (low wall) slopes (Figure 18). SIBERIA modelling has assumed a vegetation groundcover of 50% for the outward-facing heavy clay topsoil surfaces and 30% for the inward-facing Permian waste surfaces.

Predicted erosion rates shown in Table 4 indicate that at a vegetation groundcover level of 50%, predicted erosion rates of the outward-facing batter slopes are below the target level of 5t/ha/y for the entire simulation period. If vegetation groundcover of the inward-facing batters is 30% (or greater), then erosion rates of these batters are also predicted to be below the target rate (10t/ha/y). This indicates lower vegetation groundcover levels can meet the target erosion rate.

The results also indicate that using Permian waste on the outward-facing slopes would improve erosional performance and reduce the vegetation groundcover required compared to the soil mix.

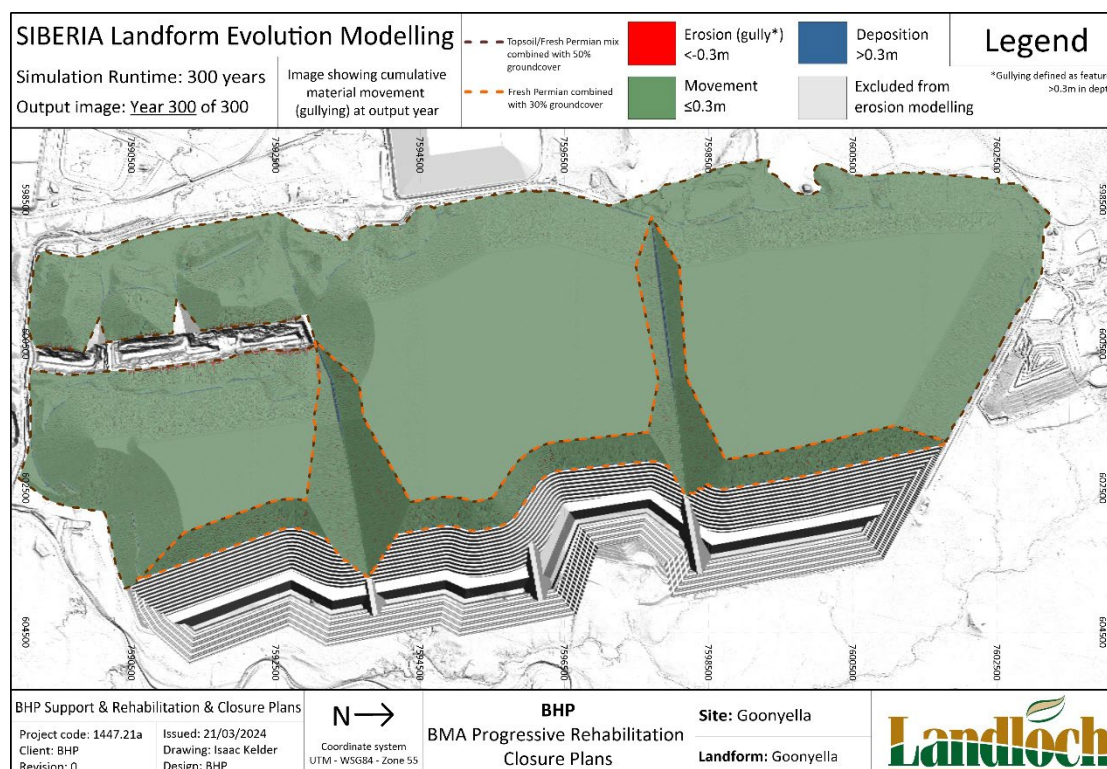
**Table 4:** Predicted erosion rates and gully depths for the Goonyella landform.

| Simulation year                                                         | Maximum gully depth (m) | Average annual erosion (t/ha/y) | Cumulative erosion (mm) |
|-------------------------------------------------------------------------|-------------------------|---------------------------------|-------------------------|
| Clay topsoil - Fresh Permian waste mix, with 50% vegetation groundcover |                         |                                 |                         |
| 50                                                                      | -                       | 3.1                             | 12                      |
| 100                                                                     | -                       | 2.6                             | 22                      |
| 200                                                                     | -                       | 2.6                             | 32                      |
| 300                                                                     | 0.3                     | 2.6                             | 42                      |
| Fresh Permian waste with 30% vegetation groundcover                     |                         |                                 |                         |
| 50                                                                      | -                       | 4.2                             | 16                      |
| 100                                                                     | -                       | 4.2                             | 32                      |
| 200                                                                     | -                       | 4.1                             | 48                      |
| 300                                                                     | 0.3                     | 3.9                             | 63                      |

Figure 21 shows SIBERIA output after 300 years of simulation. The SIBERIA output indicates that the Goonyella landform is not prone to significant levels of gully erosion if the surface conditions (material type and vegetation groundcover levels) are achieved.



Some gully erosion is predicted to occur after 300 years for both the vegetated clay topsoil combined with fresh waste rock surfaces and the vegetated fresh Permian waste covered surfaces. However, given the underlying secondary growth media material is likely to be erosion-resistant fresh Permian waste, the risk of exposing problematic (more erodible) materials and for erosion to accelerate over the long-term is considered low. Gully erosion should be monitored as part of the rehabilitation monitoring process and remediated if assessed as required by an appropriately qualified person to achieve the post-mining land use.



**Figure 21:** Predicted erosion and deposition depths of the Goonyella rehabilitation landform after 300 years.

## 6.2 Airstrip landform

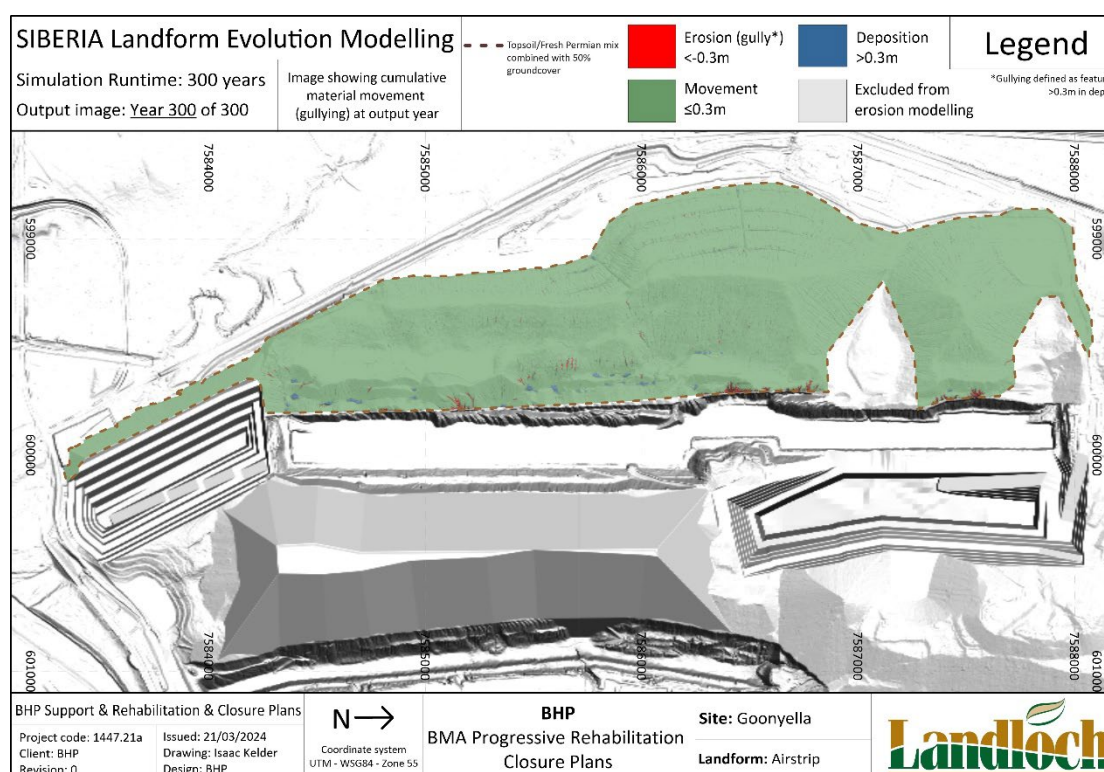
Rehabilitation of the Airstrip landform has used vegetated clay topsoil combined with fresh waste rock on all slopes (Figure 19). SIBERIA modelling has assumed a vegetation groundcover of 50% for these surfaces.

Predicted erosion rates shown in Table 5 indicate that at a vegetation groundcover level of 50%, predicted erosion rates of the batter slopes will be below the target level of 5t/ha/y. This indicates lower vegetation groundcover levels can meet the target erosion rate.

**Table 5:** Predicted erosion rates and gully depths for the Airstrip landform.

| Simulation year                                                         | Maximum gully depth (m) | Average annual erosion (t/ha/y) | Cumulative erosion (mm) |
|-------------------------------------------------------------------------|-------------------------|---------------------------------|-------------------------|
| Clay topsoil - Fresh Permian waste mix, with 50% vegetation groundcover |                         |                                 |                         |
| 50                                                                      | -                       | 2.1                             | 8                       |
| 100                                                                     | -                       | 1.6                             | 14                      |
| 200                                                                     | -                       | 1.4                             | 20                      |
| 300                                                                     | -                       | 1.3                             | 25                      |

Figure 22 shows SIBERIA output after 300 years of simulation. The SIBERIA output indicates that the Airstrip landform is not prone to significant levels of gully erosion if the surface conditions (material type and vegetation groundcover levels) are achieved. Some rill erosion is predicted to occur in areas where the slope interacts with the final void.



**Figure 22:** Predicted erosion and deposition depths of the Airstrip rehabilitation landform after 300 years.

### 6.3 Broadmeadow/Isaac landform

Rehabilitation of the Broadmeadow/Isaac landform is planned to use vegetated clay topsoil combined with fresh waste rock on the outward-facing slopes and vegetated fresh Permian waste on the inward-facing (low wall) slopes (Figure 20). SIBERIA modelling has assumed a vegetation groundcover of 50% for the outward-facing surfaces and 30% for the inward-facing surfaces.

Predicted erosion rates shown in Table 6 indicate that at a vegetation groundcover level of 50%, predicted erosion rates of the outward-facing batter slopes are below the target

level (5t/ha/y). If vegetation groundcover of the inward-facing batters is 30% or greater, batter slope erosion rates are also predicted to be below the target rate (10t/ha/y). This indicates lower vegetation groundcover levels can meet the target erosion rate.

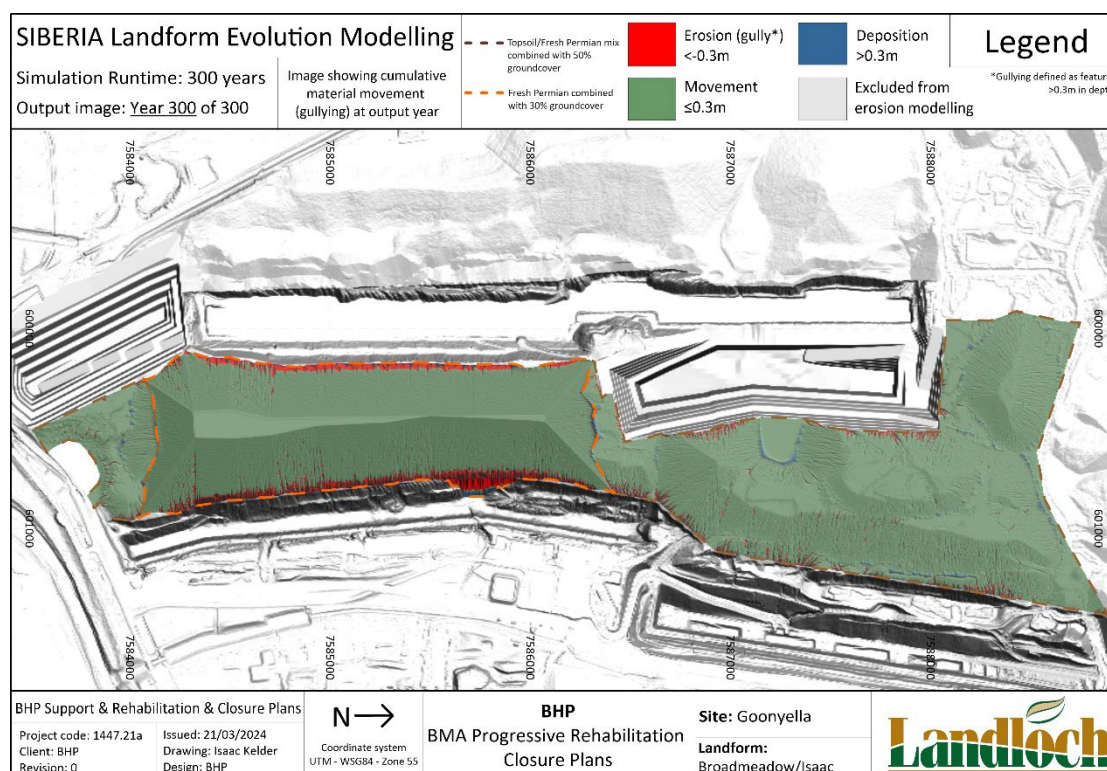
The results also indicate that using Permian waste into the surface of the outward-facing slopes would improve erosional performance and reduce the vegetation groundcover required compared to the soil mix.

Figure 23 shows SIBERIA output after 300 years of simulation. The SIBERIA output indicates that the Broadmeadow/Isaac landform is not prone to significant levels of gully erosion if the surface conditions (material type and vegetation groundcover levels) are achieved. Some gully erosion is predicted to occur after 300 years for both the vegetated clay topsoil combined with fresh waste rock surfaces and the vegetated fresh Permian waste covered surfaces. This occurs at the interface between a new dump area and existing surface. The result is an artefact of the elevations within 3-D design file supplied; in reality this transition area will be smoother than modelled and this area is not likely to erode at rates that would increase the risk of rill or gully erosion. However, given the underlying secondary growth media material is likely to be erosion-resistant fresh Permian waste, the risk of exposing problematic (more erodible) materials and for erosion to accelerate over the long-term is considered low. Gully erosion should be monitored as part of the rehabilitation monitoring process and remediated if assessed as required by an appropriately qualified person to achieve the post-mining land use.

**Table 6:** Predicted erosion rates and gully depths for the Broadmeadow/Isaac landform.

| Simulation year                                                         | Maximum gully depth (m) | Average annual erosion (t/ha/y) | Cumulative erosion (mm) |
|-------------------------------------------------------------------------|-------------------------|---------------------------------|-------------------------|
| Clay topsoil - Fresh Permian waste mix, with 50% vegetation groundcover |                         |                                 |                         |
| 50                                                                      | -                       | 4.0                             | 16                      |
| 100                                                                     | -                       | 2.8                             | 26                      |
| 200                                                                     | -                       | 2.3                             | 35                      |
| 300                                                                     | 0.3                     | 2.1                             | 43                      |
| Fresh Permian waste with 30% vegetation groundcover                     |                         |                                 |                         |
| 50                                                                      | -                       | 6.4                             | 24                      |
| 100                                                                     | -                       | 5.4                             | 45                      |
| 200                                                                     | -                       | 5.3                             | 65                      |
| 300                                                                     | 0.3                     | 5.3                             | 86                      |





**Figure 23:** Predicted erosion and deposition depths of the Broadmeadow/Isaac rehabilitation landform after 300 years.

## 7 WATER MANAGEMENT

Water management recommendations for waste landforms at GRM are summarised as:

- No construction of permanent berms or graded banks and rock chutes on batter slopes. Temporary berms are to be used only where considered absolutely essential.
- Prevention of discharge from the relatively small areas of level dump tops onto the dump slopes is critical.

Simulations of runoff and erosion indicate that – once vegetation is established – there is no requirement for installation of berms or graded banks to reduce slope length and erosion risk. It is anticipated that batter slope rehabilitation will be carried out progressively, working gradually up from the bottom of the slope, so that there will be increasing vegetation groundcover on lower sections of a slope as the works gradually (over a number of years) move towards the top of the landform.

It should be noted that – on well-vegetated surfaces – annual rainfall excess on average will be 2–5% of annual rainfall, so preventing water discharge onto the slopes results in only a very small increase in the amount of water retained on the land surface and made available for vegetation growth. It is also noted that the quite small increase in drainage to depth that will be caused by retention of runoff on the tops of the landforms will be insignificant.

## 8 CONCLUSIONS

---

Both runoff/erosion simulations using the WEPP model and landform evolution simulations using the SIBERIA model indicate that the proposed waste landforms at GRM can be expected to be stable over the long term (up to 300 years) provided the correct surface materials and the required levels of vegetation groundcover for those materials are achieved.

This report details materials and associated vegetation groundcover levels for the representative materials available at the time of sampling. The modelled vegetation groundcover levels are conservative. The modelling detailed in this report is intended to support the total groundcover levels in the EA acceptance criteria and is not intended to prescribe exact vegetation groundcover levels.

Water management recommendations for the site include the prevention of discharge from the small areas of level dump tops onto the slopes and avoidance of any permanent bunds or rock chutes on batter slopes.

## REFERENCES

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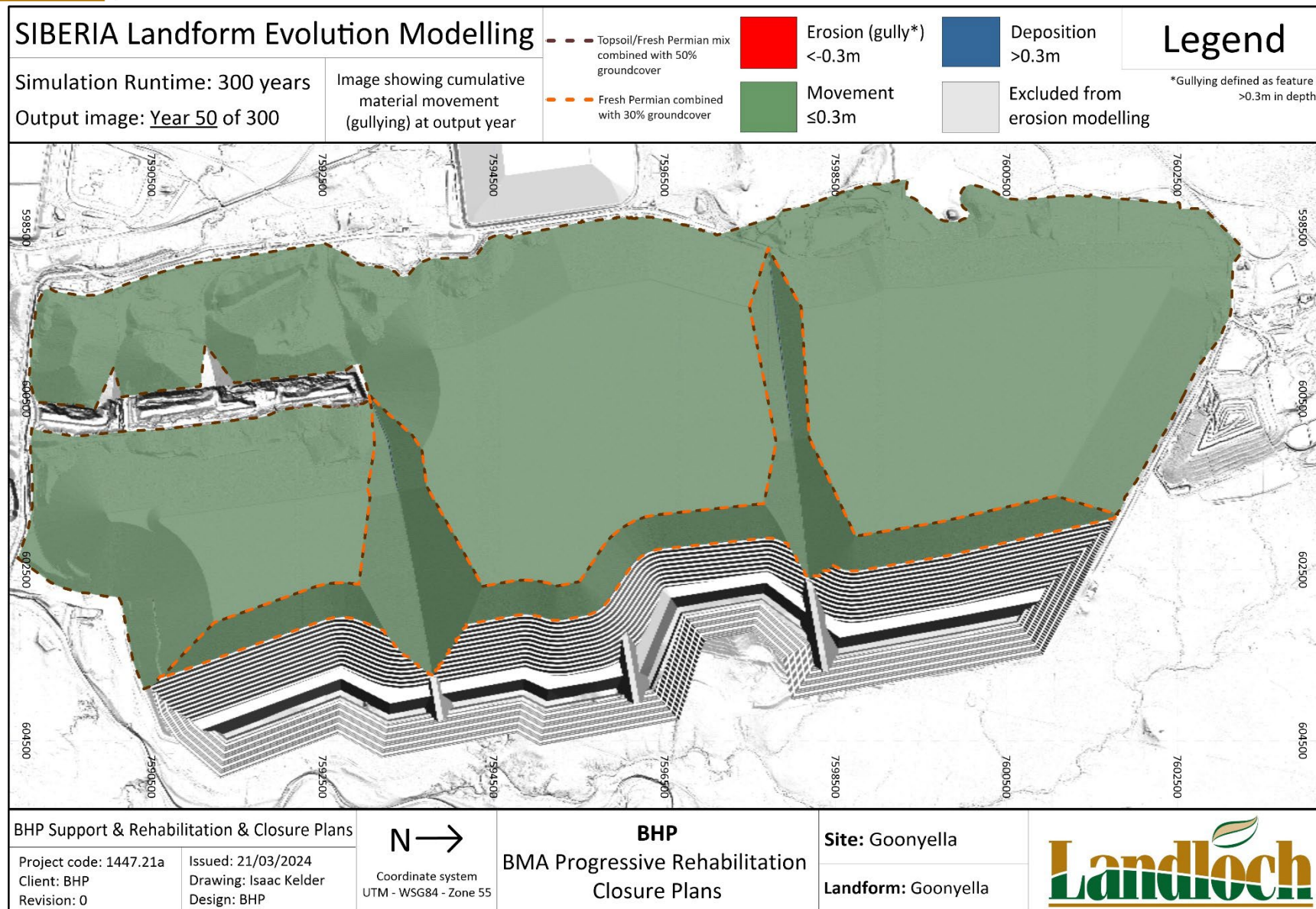
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## APPENDIX A: SIBERIA VISUALISATIONS

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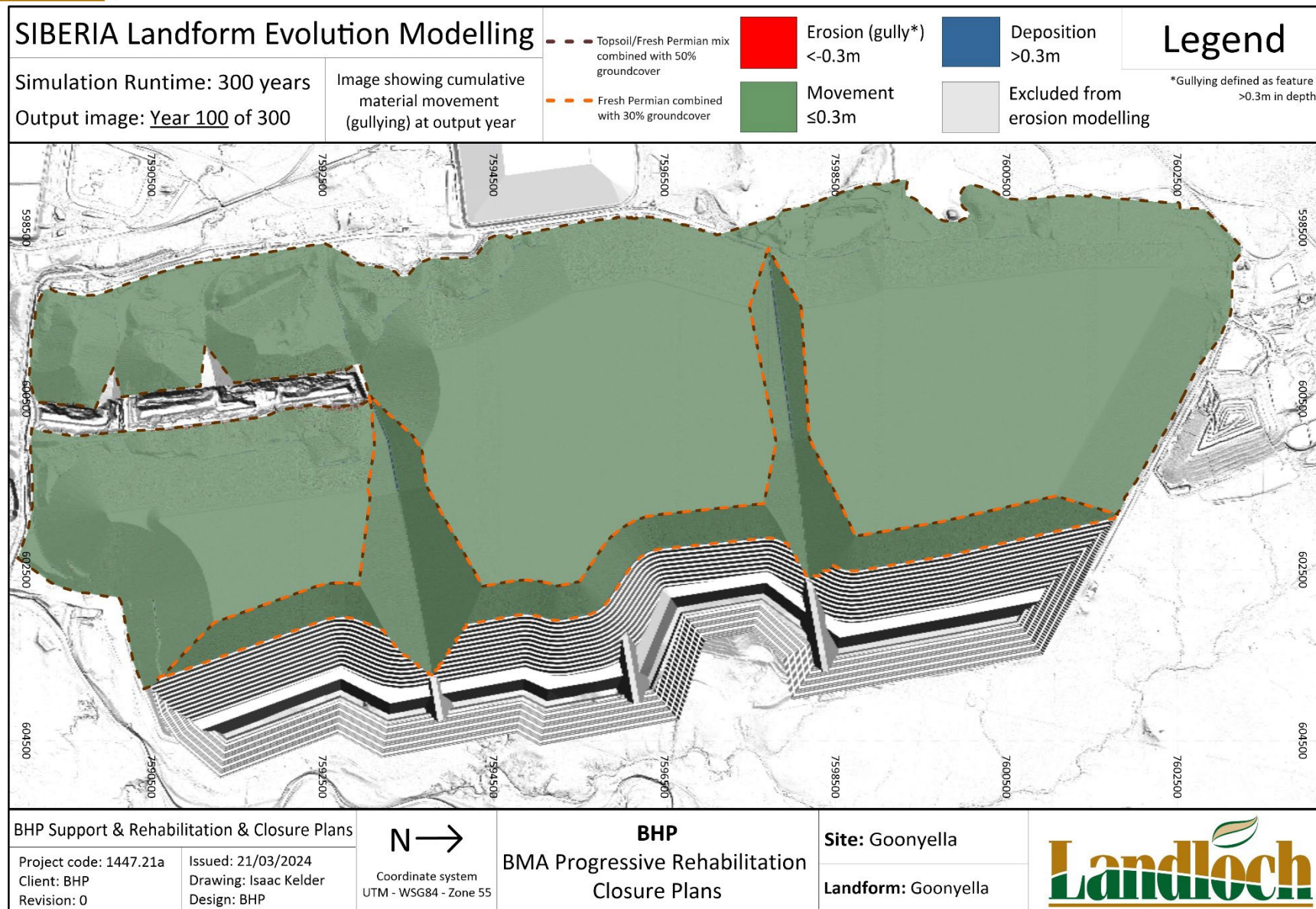
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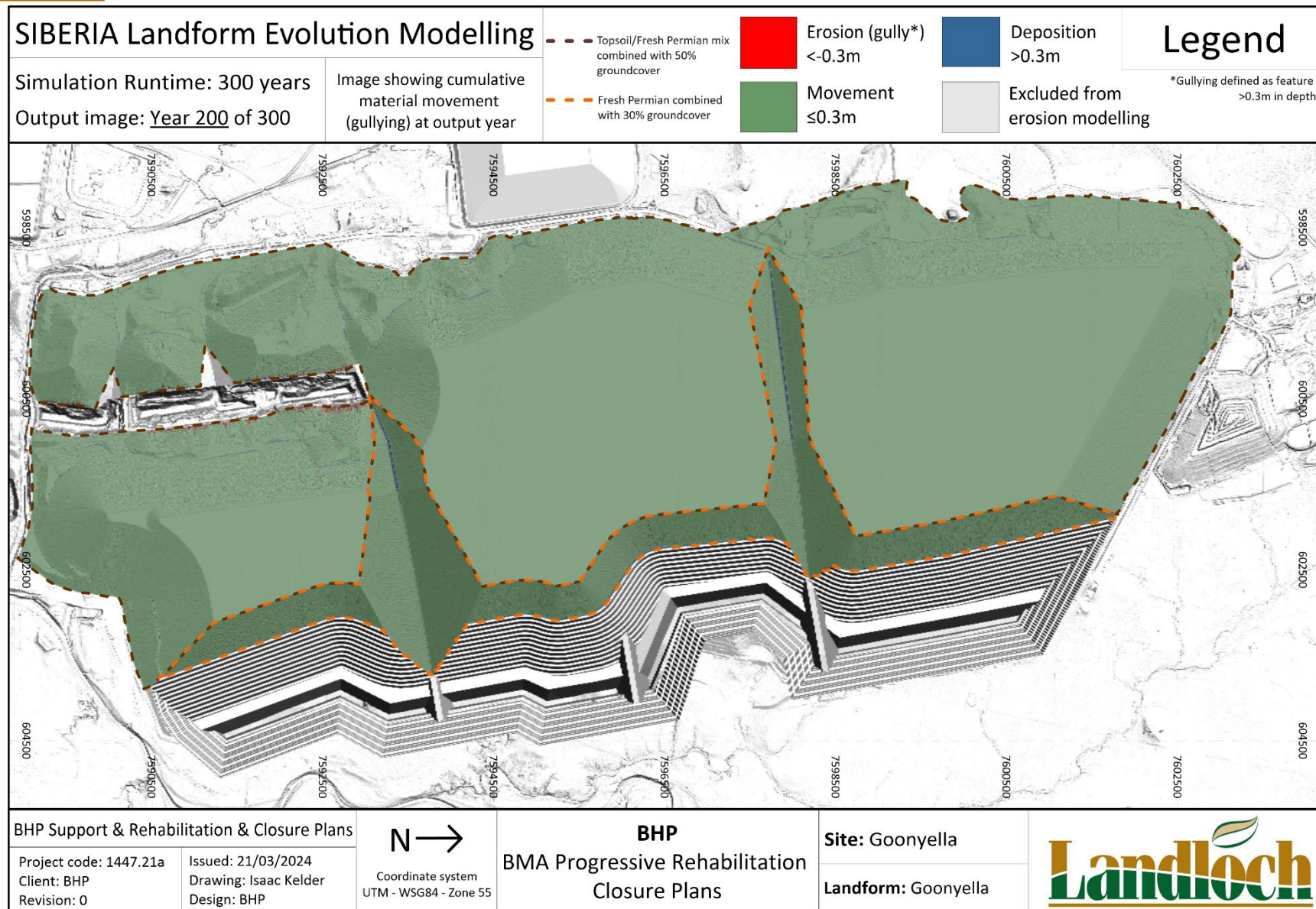


**Figure A-1:** Predicted erosion and deposition depths of the Goonyella rehabilitation landform after 50 years.



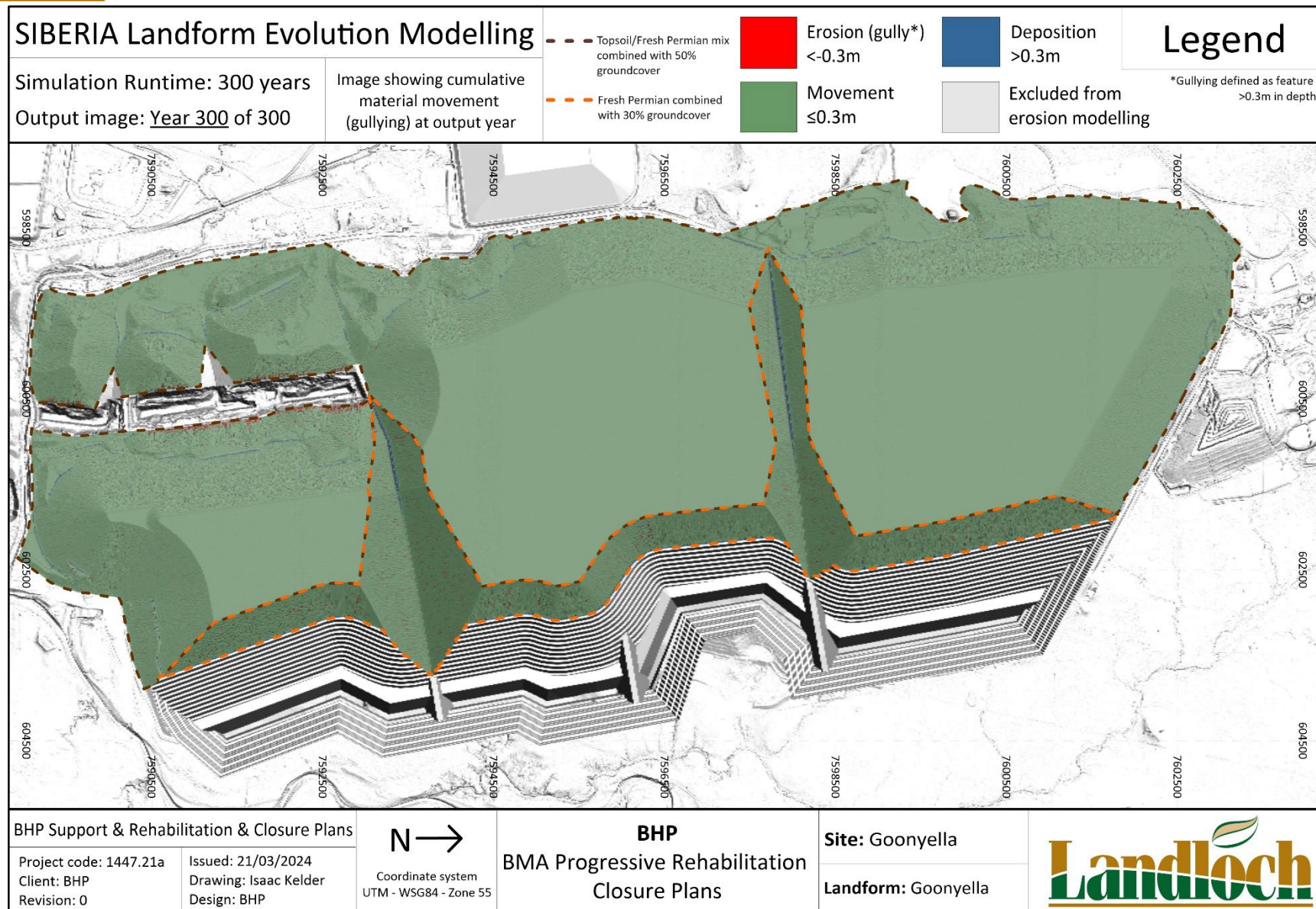


**Figure A-2:** Predicted erosion and deposition depths of the Goonyella rehabilitation landform after 100 years.

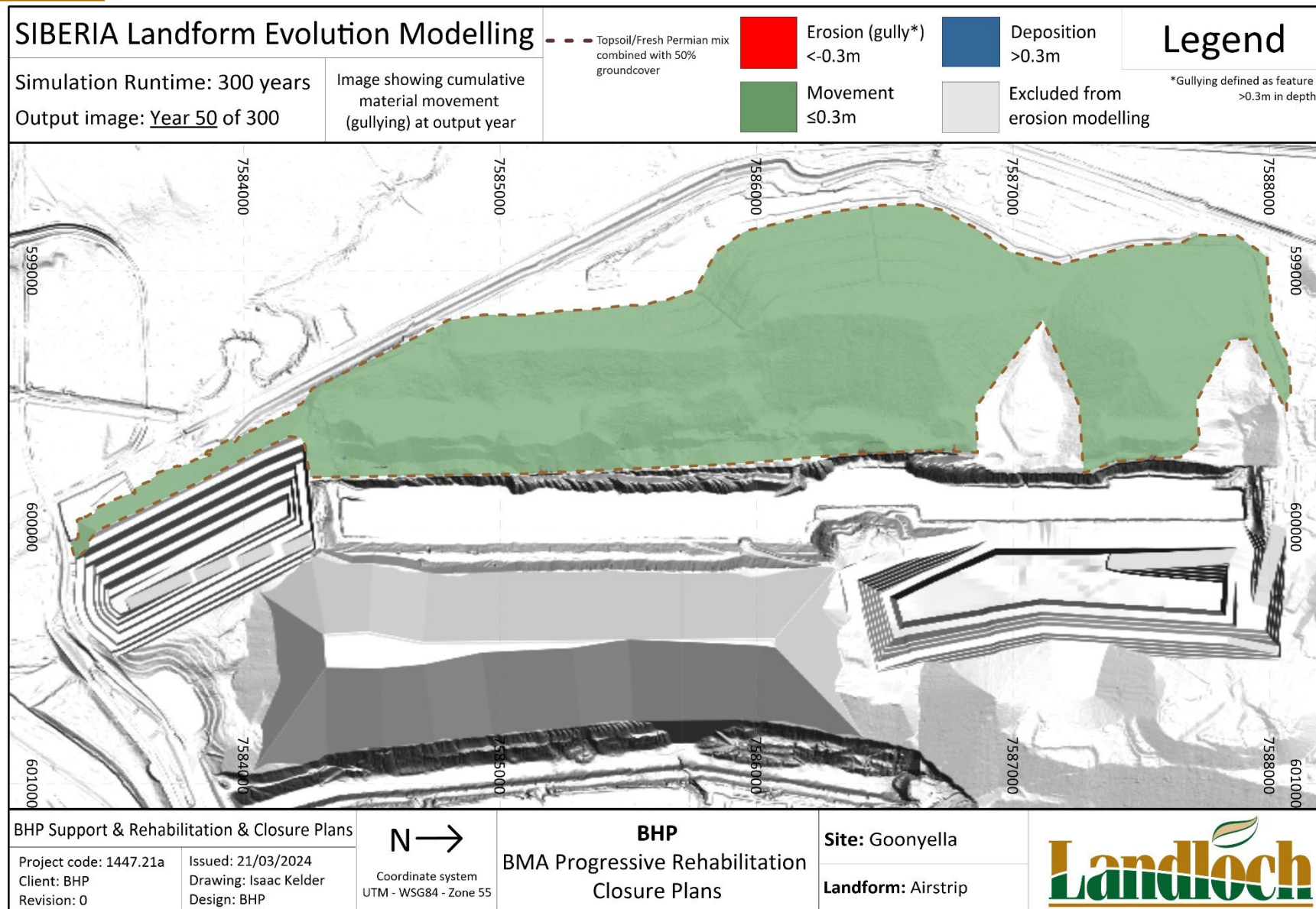


**Figure A-3:** Predicted erosion and deposition depths of the Goonyella rehabilitation landform after 200 years.



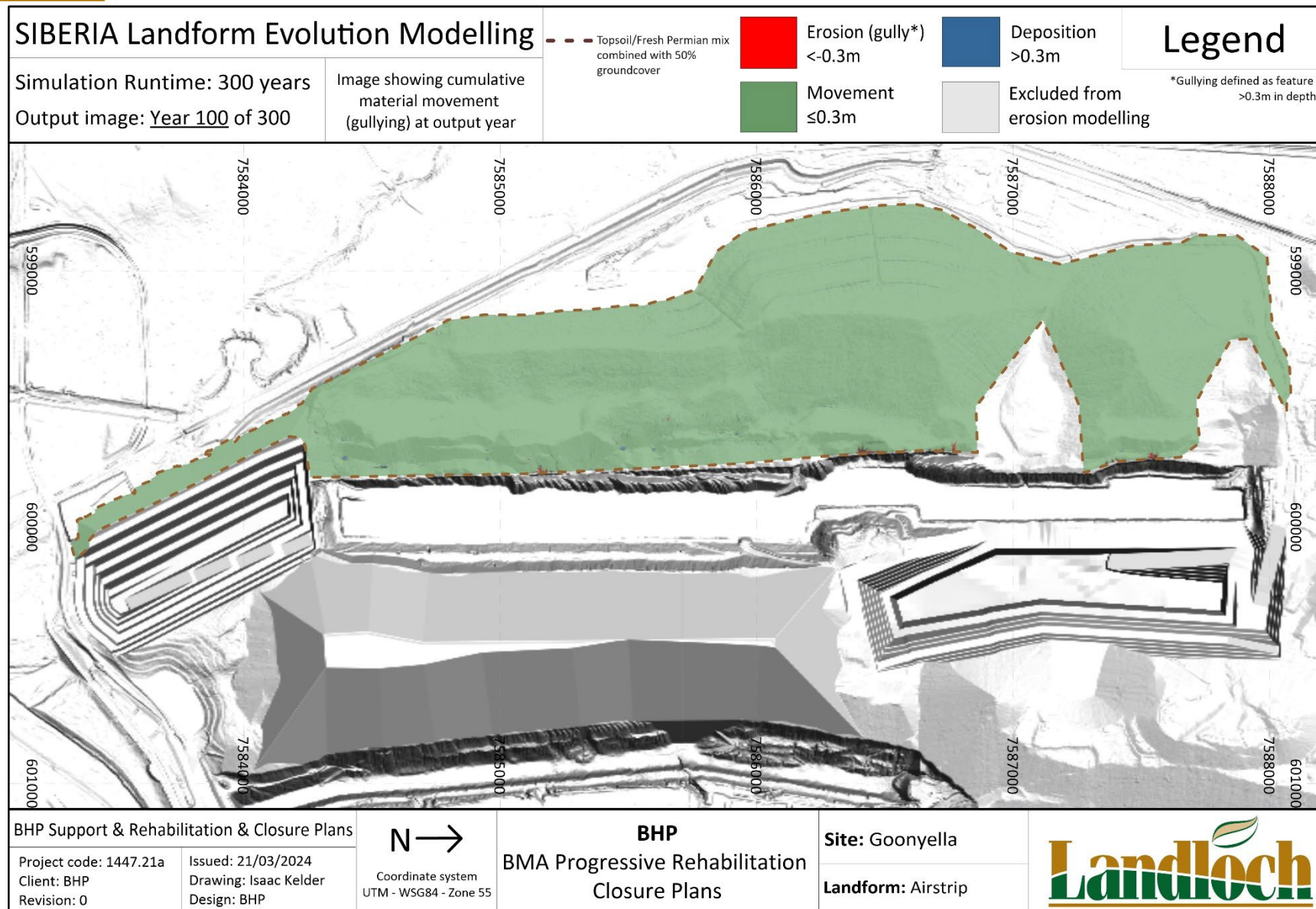


**Figure A-4:** Predicted erosion and deposition depths of the Goonyella rehabilitation landform after 300 years.



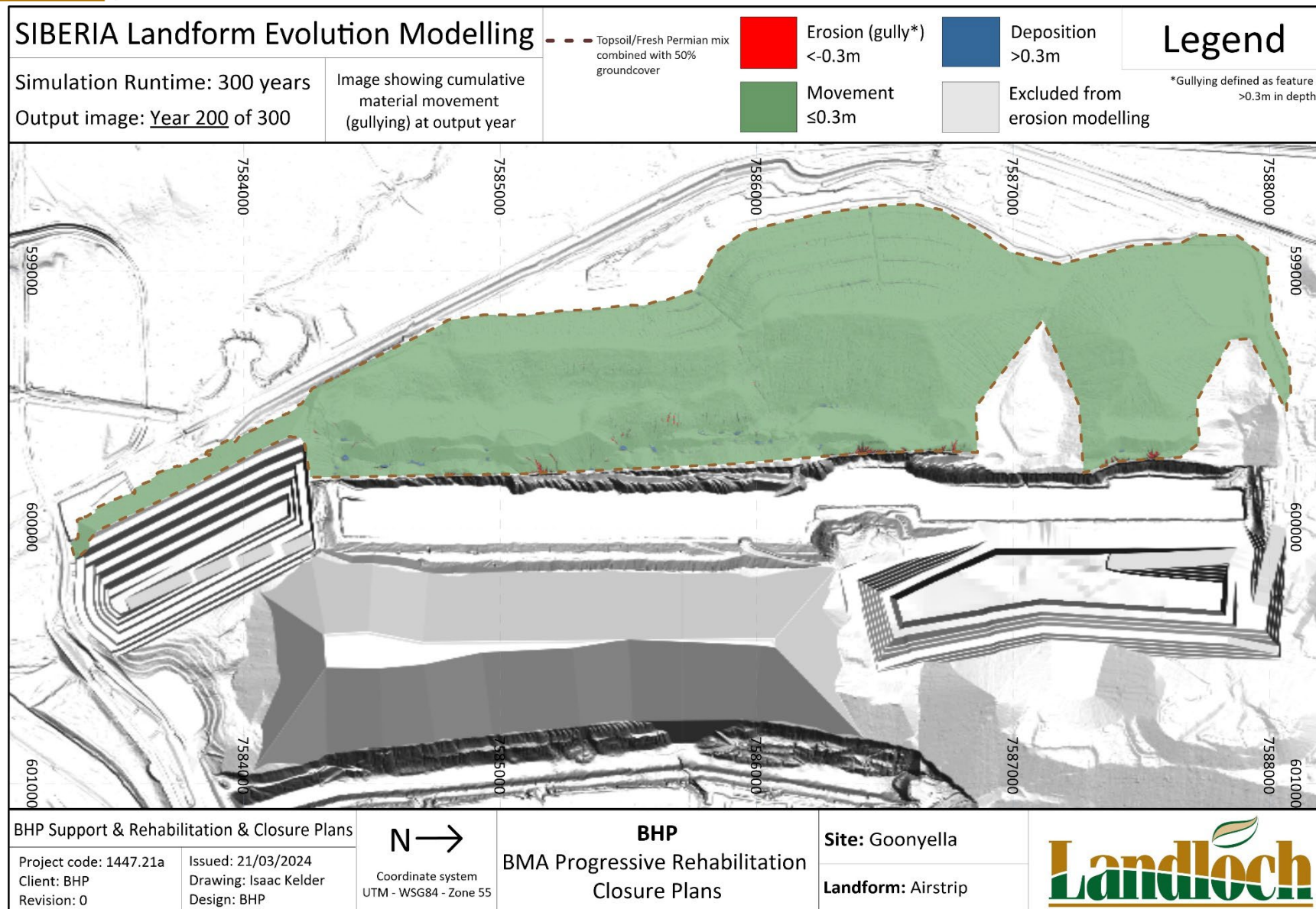
**Figure A-5:** Predicted erosion and deposition depths of the Airstrip rehabilitation landform after 50 years.



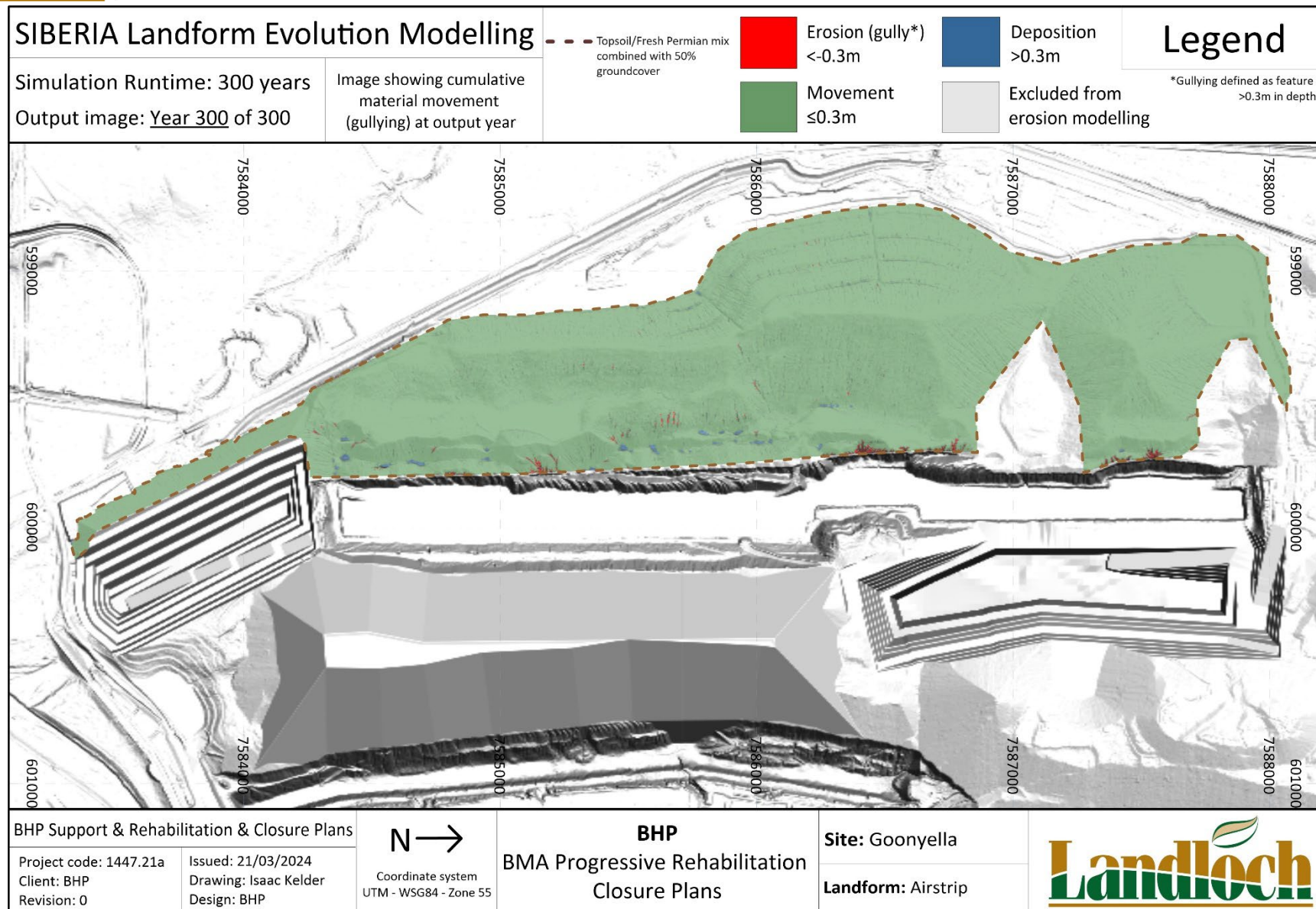


**Figure A-6:** Predicted erosion and deposition depths of the Airstrip rehabilitation landform after 100 years.



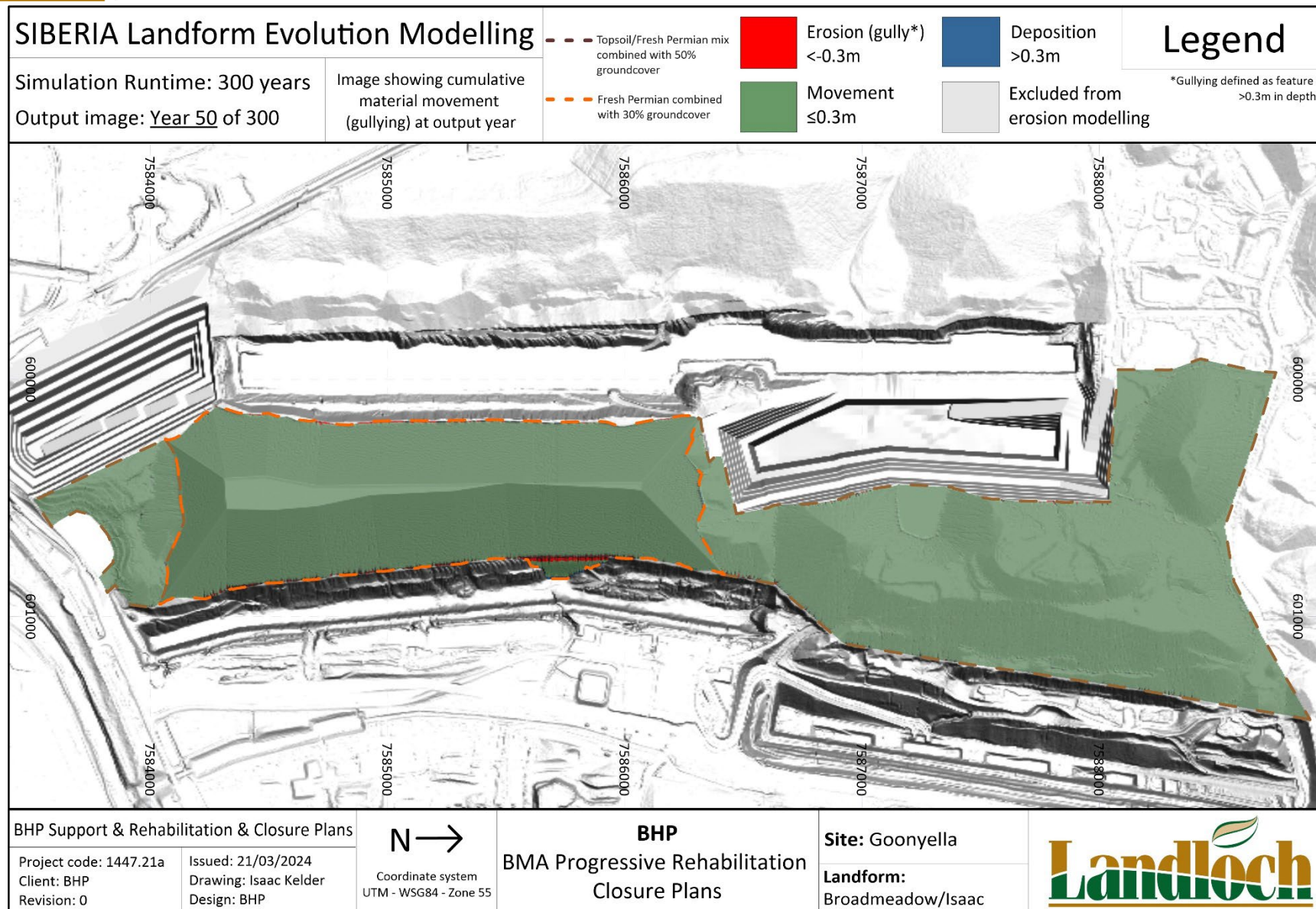


**Figure A-7:** Predicted erosion and deposition depths of the Airstrip rehabilitation landform after 200 years.

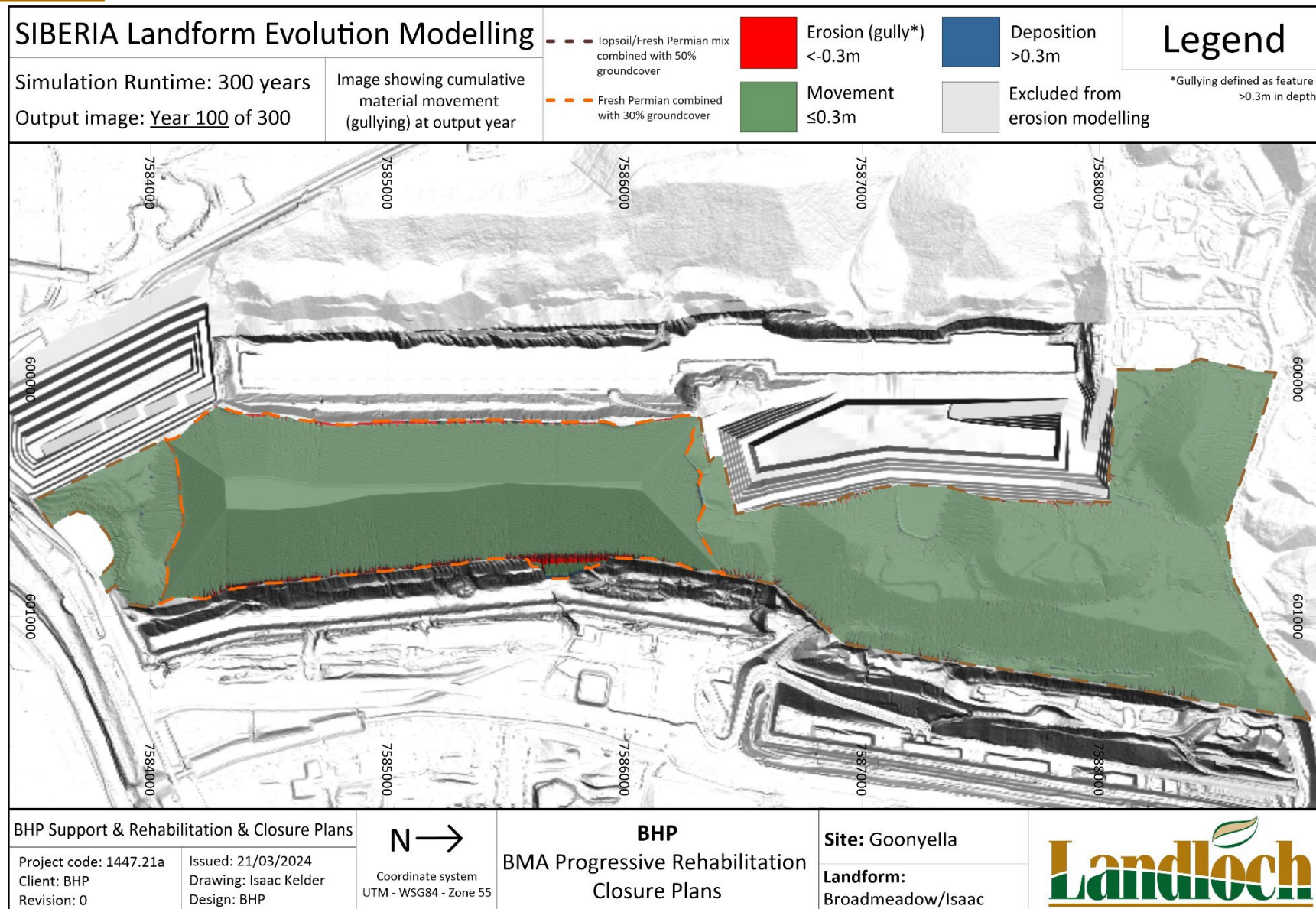


**Figure A-8:** Predicted erosion and deposition depths of the Airstrip rehabilitation landform after 300 years.



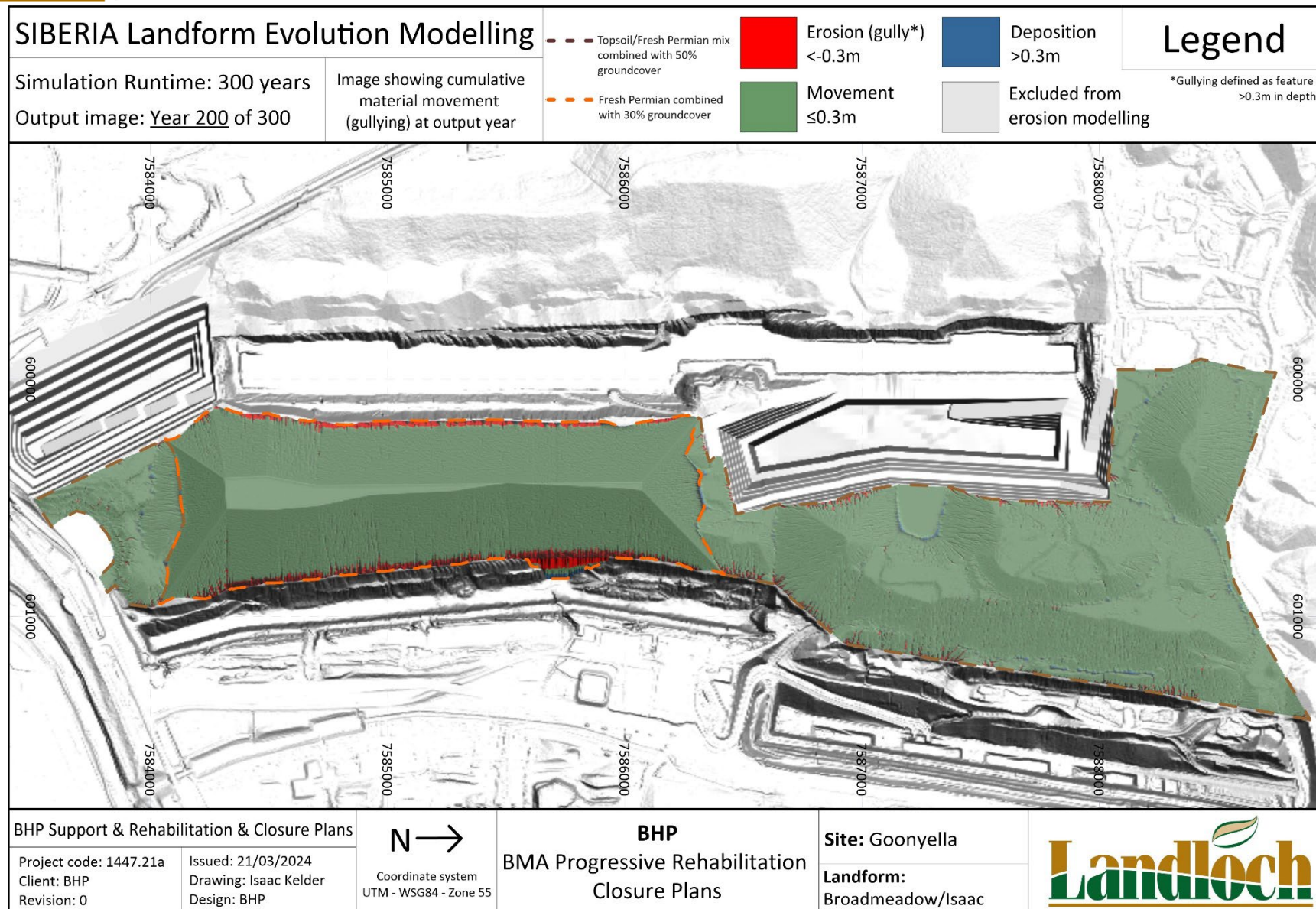


**Figure A-9:** Predicted erosion and deposition depths of the Broadmeadow/Isaac rehabilitation landform after 50 years.

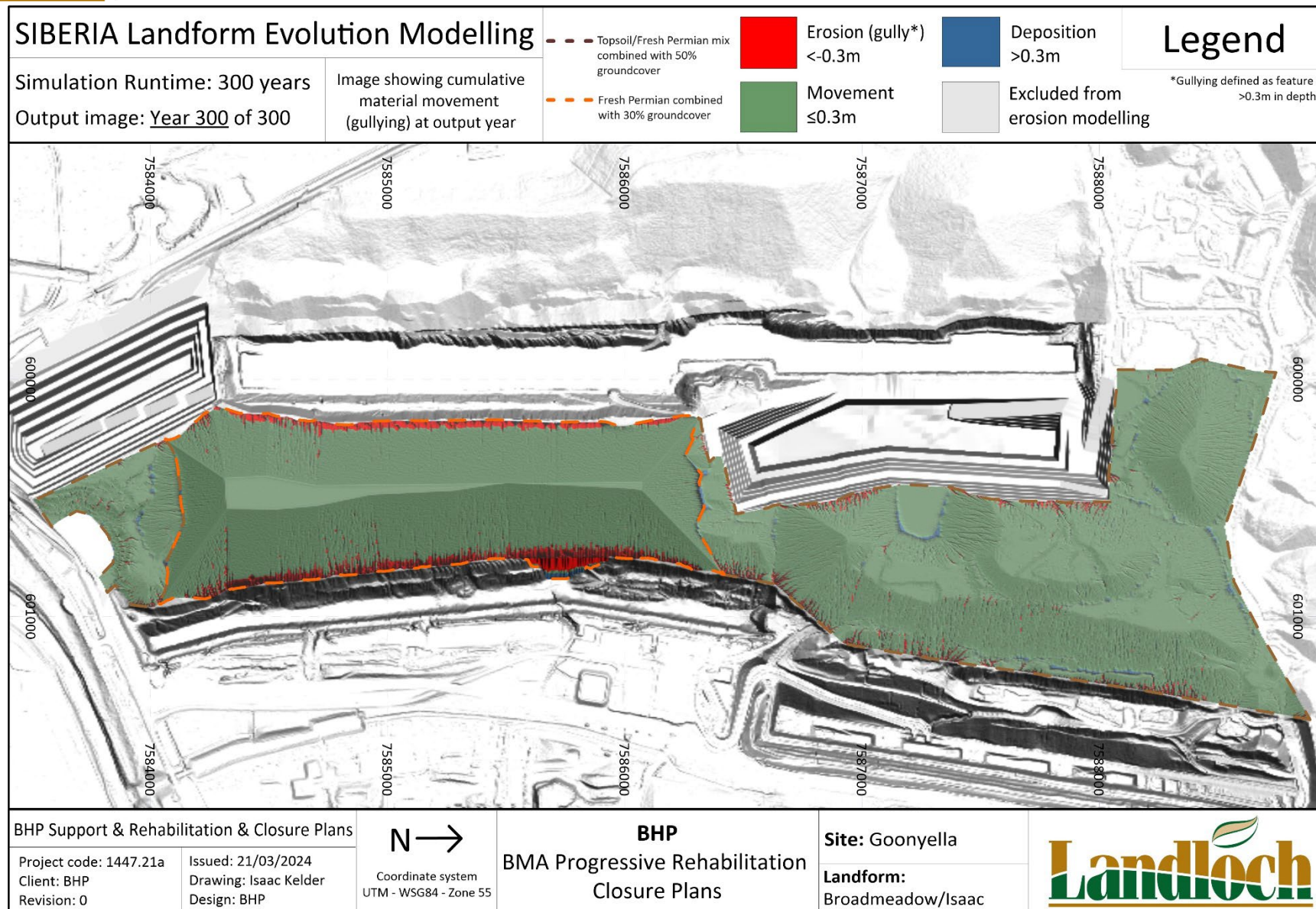


**Figure A-10:** Predicted erosion and deposition depths of the Broadmeadow/Isaac rehabilitation landform after 100 years.





**Figure A-11:** Predicted erosion and deposition depths of the Broadmeadow/Isaac rehabilitation landform after 200 years.



**Figure A-12:** Predicted erosion and deposition depths of the Broadmeadow/Isaac rehabilitation landform after 300 years.



# BMA

## PRCP Concept Design Report

Isaac River Diversion

QC1000\_051-REP-004-3

29 OCTOBER 2024



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**Signatures:**






Sifa



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# 1. INTRODUCTION

## 1.1 Context

The purpose of this report is to detail the concept design developed for the closure and ultimate relinquishment of the Isaac River Diversion which satisfies the conditions under Environmental Authority (EA) EPML00853413. The watercourse diversion is required to achieve a state of dynamic equilibrium enabling its relinquishment in the post closure landform of the Goonyella Riverside Mine (GRM).

The long-term performance of the diversion under both operating and closure scenarios is assessed within the following objectives, based on requirements from relevant licences and approvals:

- The diversion demonstrates to be in a safe, stable, non-polluting, and self-sustaining state (As per EA requirements outlined in Section 3.3).
- Rehabilitation requirements (acceptance criteria) include goals, objectives and acceptance criteria for the post mining land use of the 'Watercourse' which is applicable for the watercourse diversion.
- Achieves the key outcomes identified in the Department of Natural Resources, Mines and Energy (DNRME) *Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000 (DNRME, 2019)*.

This report details the design requirements for the rehabilitation of the diversion for incorporation into the Progressive Rehabilitation and Closure Plan (PRCP) for GRM as described in the Queensland Department of Environment and Science (DES) *Guideline: Progressive rehabilitation and closure plans (ESR/2019/4964, Version 3- 4 April 2023)*.

## 1.2 Purpose and Scope

The scope of work for each diversion is comprised of two stages:

- Stage 1: Options identification, assessment and selection.
- Stage 2: Concept Design on the preferred option outcome from Stage 1.

The purpose of this document is to outline the concept design developed for the preferred diversion option (outcome from Stage 1) to achieve a state of dynamic equilibrium resulting in a relinquishable state for the diversion. The following methodology was utilised:

- A desktop geomorphic assessment of the Isaac River was undertaken using historical aerial imagery and survey to identify options for the closure alignment.
- Review of existing flood studies to determine peak flow rates for design flow events to assess hydraulic performance.
- Hydraulic assessment of the diversion option against the criteria in the *DNRME 2019 Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000 (DNRME, 2019)*.
- Develop concept design sketches and watercourse diversion spatial polygons for presentation in the PRCP.
- Develop concept design report summarising the design and key information required for inclusion in the PRCP.

## 1.3 Design Process

### 1.3.1 Concept Design Considerations

The design is concept only, and not at functional level which would be required for approval and construction. The concept design is developed exclusively for PRCP purposes within the limitations of the PRCP, with only permanent design options considered.

To progress the concept design to a functional design level, detailed site-specific information is required including:

- Soil surveys and geotechnical studies.
- Material characterisation for use in erosion protection cover (i.e. rock sizing and composition).
- Site specific revegetation studies.



## 2. OVERVIEW

### 2.1 Location

The Isaac River flows south along the eastern boundary of GRM, approximately 25 km north of Moranbah within the Bowen Basin. The river has a large catchment area that includes multiple tributaries amounting to a drainage sub-basin covering 22,324 km<sup>2</sup>. It eventually discharges into the Mackenzie River and ultimately the Fitzroy River.

The Isaac River was diverted between 1985 and 1987 on the GRM and Broadmeadow Mine (BRM) mining operations leases to allow access to coal deposits by open cut mining. The diversion begins over the top of where longwall LW 105 of BRM was mined in 2011. The diversion replaced approximately 9 km of river channel with 7.7 km of diversion channel including two drop structures, each around 2 m in height. The drop structures were designed to control bed grade due to the decreased length. Both structures have failed since construction with the upstream drop structure replaced in 2020 and the downstream drop structure now redundant (Nelly Group Engineering, 2021). The diversion has 8 longwalls subsiding much of the upstream half of the diversion.

### 2.2 Pre-Mining Condition

Prior to mining, the predominant land use was agriculture. The upstream catchment area is shared with two other coal mines (North Goonyella and Burton), while several other coal mines are located downstream, along significant tracts of the Isaac River watercourse. This channel bed width is comparable with the pre-development bed width as well as the bed widths upstream and downstream, however the diversion design had steeper banks, did not include benches, and lacked geomorphic variability seen in the natural/pre-development river reach which resulted in a reduced overall waterway area. The pre-mining natural upstream, downstream and diversion reaches have been described as follows:

- **Upstream reach** – The Isaac River flowed southwest passing through cattle grazing vegetation and continues to have multiple tributaries flowing into it.
- **Downstream reach** – The downstream reach banks have been described as comprising highly erodible tertiary sediments, however the channel banks were noted as generally stable, with attached benches and thick obliquely deposited mud drapes which have contributed to stability (Alluvium, 2009).
- **Diversion reach (pre-mining)** – The length of Isaac River that was diverted between 1985 and 1987 consisted of an irregularly meandering, moderately sinuous, low gradient channel. Channel dimensions were largely consistent with the upstream and downstream reaches, with benches present throughout. Inset floodplains were prevalent throughout the reach, allowing flows to break out of the main channel more frequently. Further, bank full height was lower than the current diversion and the floodplain adjoining the channel was generally >500 m on both sides of the channel, allowing flows to spread across a very large area. This would have reduced flow hydraulic values within the channel (in comparison with the current diversion) in larger events. An Ortho-DEM was developed using aerial imagery from 1975 to confirm the length of the original section of Isaac River that was diverted (Advisian, 2020). This data calculated a length of approximately 8.97 km, which is 1.3 km longer than the current diversion. Therefore, the diversion channel was constructed with a bed gradient that is steeper than the original section of river diverted.

### 2.3 Current Conditions

A monitoring program for the Isaac River diversion was initiated in 2007 with the last major monitoring was completed in 2021 by Alluvium. As part of the major monitoring report, the latest condition of the Isaac River diversion has been described at the time of writing as follows (Alluvium, 2022):

- Upstream of the diversion, there have been significant changes to the in-channel vegetation since baseline monitoring. There were larger layers of shrub woody vegetation in the mobile bed sediments that have since been removed by large flow events in early 2008 to 2013. The bed width of the upstream reach is comparable to pre-development widths. The main detractor from condition is the aggradation of the stream bed with high sediment inputs from reaches further upstream. Banks are generally stable across these reaches, there are local instances of bank erosion, one notable site between U7 and U8. The channel bed is bedrock controlled in this area and the low flow

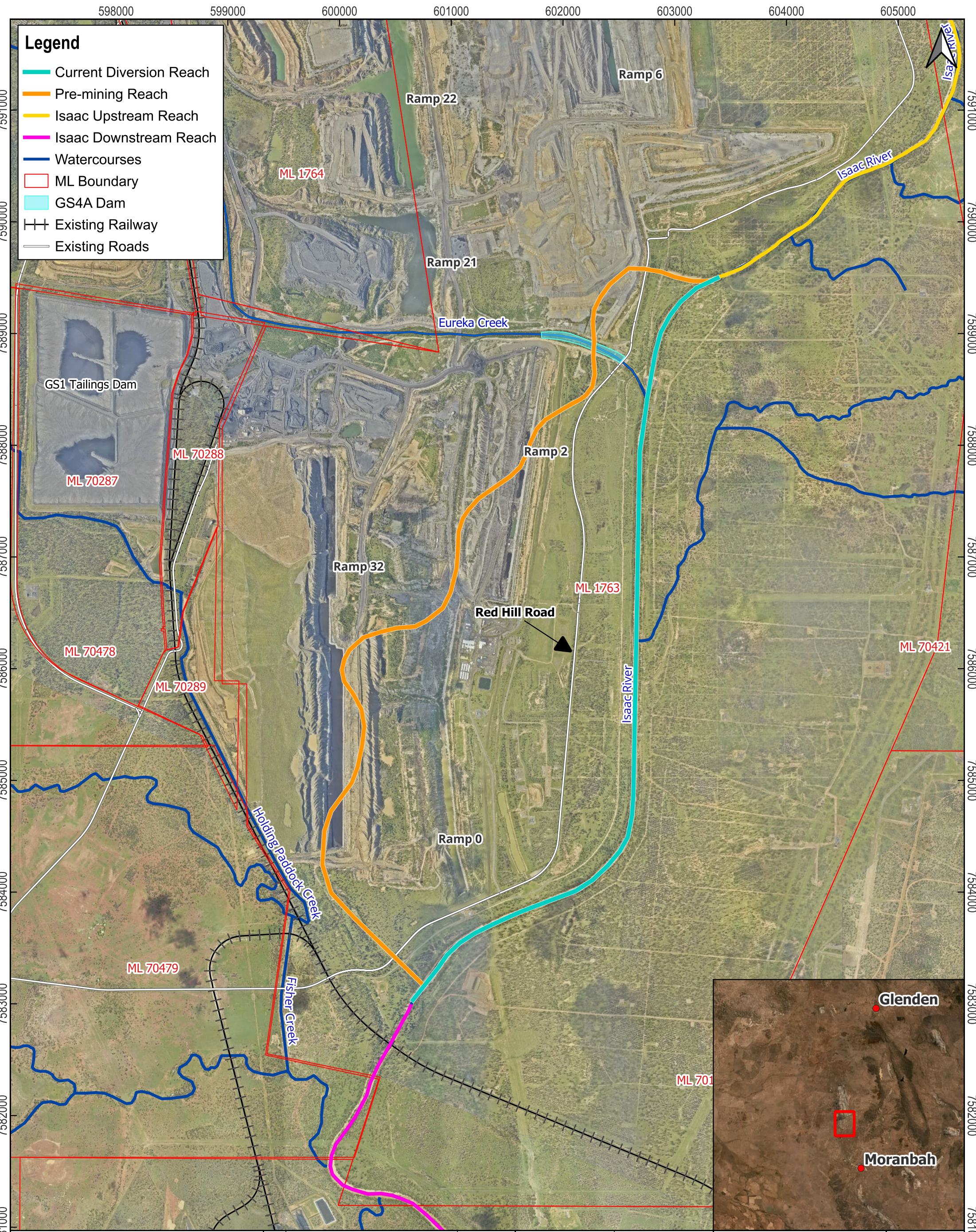
channel has migrated across the rock bar into the bank. Other instances of bank erosion are where the channel impinges on the terrace creating a near vertical scarp, however these are often eroding at low rates due to the more consolidated nature of the Tertiary sediments.

- The downstream reach continued to be in moderate to good condition. The main detractors in the IDC score were primarily due to excess sediment inputs aggrading the stream bed resulting in a reduction of morphologic diversity and suppressed native riparian vegetation. Subsidence influences on bedload sediment transport, both upstream and downstream of this reach were not yet apparent.

The results of the IDC assessment for the GRM and BRM Isaac River diversion monitoring reaches for 2021 showed the diversion reach to be in moderate condition overall with lower IDC and geomorphic and riparian indices than the upstream and downstream reaches. Since baseline monitoring in 2007, the diversion reach IDC has shown a slow and steady improving condition trajectory. This will largely be attributable to maturing vegetation on the bank attached benches in-channel and the morphologic diversity such as pools created by subsidence. The diversion bank did not include benches and lacked geomorphic variability seen in the pre-development river reach which resulted in a reduced overall waterway area.

The current location of the upstream, downstream and diversion reaches of Isaac River are shown in Figure 2.1.





**BMA PRCP GRM Isaac River Diversion**

Figure 2.1  
Location of Isaac River Diversion

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## 3. BASIS FOR CONCEPT DESIGN

There are currently two recognised guidelines for design of watercourse diversions within Queensland:

- *Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000 (Department of Natural Resources, Mines and Energy (DNRME), 2019).*
- *Criteria for functioning river landscape units in mining and post mining landscapes (Australian Coal Association Research Program (ACARP), 2014).*

Both the DNRME and ACARP Guidelines were developed based on previous research completed by ACARP in the early 2000s which included assessment of existing diversion performance and the development of design and rehabilitation criteria for watercourse diversions.

### 3.1 DNRME Guidelines

#### 3.1.1 Diversion Design Outcome Requirements (Permanent Watercourse Diversions)

The diversion design outcome requirements are nominated by DNRME for permanent watercourse diversions and have been used to develop the design for the Isaac River diversion:

- Outcome 1 – The permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.
- Outcome 2 – The permanent watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.
- Outcome 3 – The hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.
- Outcome 4 – The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising any impacts on upstream and downstream reaches.
- Outcome 5 – The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

#### 3.1.2 Design Criteria

DNRME recommend the following design criteria in development of permanent watercourse diversions and have been considered in development of the Isaac River diversion:

- The watercourse diversion should tie-in with the existing or receiving watercourse within the resource tenure boundary.
- The stability and performance of a watercourse diversion is assisted by vegetation within the watercourse diversion and adjoining floodplain and does not include artificial structures for grade control that requires ongoing maintenance.
- The channel capacity must be at least equivalent to the natural stream channel capacity existing in that vicinity.
- The length of the channel should be equivalent to the length of the watercourse it replaces.
- Bed grade/slope should be equivalent to the existing watercourse.
- Batter slopes should be designed to maintain stability through different substrates.

The DNRME Guideline also nominates a set of hydraulic design criteria which have been adapted from the original ACARP research. These hydraulic design criteria were developed based on assessment of existing Bowen Basin streams and watercourse diversions and are considered reflective of stable hydraulic conditions for ephemeral systems in central Queensland. The hydraulic design criteria are summarised in Table 3.1 and include the following:

- Shear stress which is a function of discharge, flow depth and hydraulic gradient and represents the tractive force acting on sediment particles and is used to determine the threshold of motion for sediment. High shear stress provides an indication of potential erosion in cohesive sediments or movement of non-cohesive sediments. It also provides a measure of the ability of vegetation to withstand flow.
- Stream power which is a function of hydraulic gradient, flow width and flow rate and represents the energy available to do work on the channel. High stream power values generally result in elevated erosion potential.



- Velocity which is a function of flow rate and cross-sectional area and is a simplified measure of erosion potential. Generally higher velocities result in higher erosion potential; however, stream power and shear stress are more reliable indicators of erosion and sediment transport potential.

**TABLE 3.1: DNRME 2019 HYDRAULIC DESIGN CRITERIA**

| Design Flow Event                               | Stream Power (W/m <sup>2</sup> ) | Velocity (m/s) | Shear Stress (N/m <sup>2</sup> ) |
|-------------------------------------------------|----------------------------------|----------------|----------------------------------|
| 39% AEP (previously 2-year ARI) - no vegetation | <35                              | <1.0           | <40                              |
| 39% AEP (previously 2-year ARI) - vegetated     | <60                              | <1.5           | <40                              |
| 2% AEP (previously 50-year ARI)                 | <150                             | <2.5           | <80 <sup>1</sup>                 |

<sup>1</sup> DNRME values are extracted from ACARP 2002, however the value reported for the 2% AEP shear stress (<50 N/m<sup>2</sup>) in the DNRME 2014 is incorrect. The ACARP value of <80 N/m<sup>2</sup> has been adopted.

The DNRME hydraulic design criteria summarised in Table 3.1 were adopted as the basis for the concept design. The ACARP value described in Section 3.2 are provided for information only. The ACARP values were referenced when considering stable stream powers and shear stresses during the vegetation establishment phase of the construction.

## 3.2 ACARP Guidelines

ACARP (2014) outlined several approaches to the design of diversion channel dimensions, including:

- The analogous approach, where channel dimensions are selected from a reference reach.
- The hydraulic geometry approach, where dimensions are determined from regression relationships; and
- The analytical approach, where equations are used to calculate continuity, hydraulic resistance, and sediment transport and channel characteristics are determined from field inspection of a reference reach.

In addition to the analogous approach, ACARP (2014) also provides guidance on alluvial channel design parameters which were adapted from ACARP (2002). These hydraulic parameters are intended to be representative of stable watercourses within the Bowen Basin and are summarised in Table 3.2.

**TABLE 3.2: ACARP 2014 ALLUVIAL CHANNEL DESIGN PARAMETERS**

| Stream Type        | Sediment Scenario | Stream Power 39% AEP (W/m <sup>2</sup> ) | Stream Power 2% AEP (W/m <sup>2</sup> ) |
|--------------------|-------------------|------------------------------------------|-----------------------------------------|
| Alluvial           | Supply limited    | 15-35                                    | 50-100                                  |
|                    | Transport limited | 35-60                                    | 80-150                                  |
| Bedrock controlled | n/a               | 50-100                                   | 100-350                                 |

ACARP (2014) also provides recommendations on shear stress thresholds for vegetation used as part of rehabilitation activities. These thresholds are summarised in Table 3.3.

**TABLE 3.3: ACARP 2014 RECOMMENDED VEGETATION SHEAR STRESS THRESHOLDS**

| Vegetation Type                                             | Design Shear Stress (N/m <sup>2</sup> ) |
|-------------------------------------------------------------|-----------------------------------------|
| Buffel grass ( <i>Cenchrus ciliaris</i> )                   | 40                                      |
| Structurally diverse suite of established native vegetation | 120                                     |

## 4. OPTIONS IDENTIFICATION

Engeny identified three potential options for the diversion as part of stage 1 (summarised below in Table 4.1). The following constraints were also considered during the development of the concept design:

- Geomorphic features of the pre mining drainage path.
- Upstream and downstream channel geometry and grade.
- Remaining within the mining lease (ML) boundary.
- Impacts to, and from, the final landform.
- Impacts to surrounding drainage paths and catchments.
- Permanent options only.

The objective was to identify suitable options for the rehabilitation of the diversion, and select a preferred option informed by multi-criteria analysis (MCA) to progress to concept design.

Each option was defined with a concept cross section and longitudinal profile. Civil earthworks modelling was undertaken to confirm the following:

- Alignment of the diversion options.
- The need for potential flood levees (during operations).
- Final landform reconfiguration.
- Reinstatement of the floodplain.
- Proposed tie-in locations to the existing waterway.
- Development of a Class 5 capital cost estimate for construction.

The options identification also included assessment of key risks and opportunities regarding construction staging, potential for impacts to downstream infrastructure and post mining land-use risks in the context of closure.

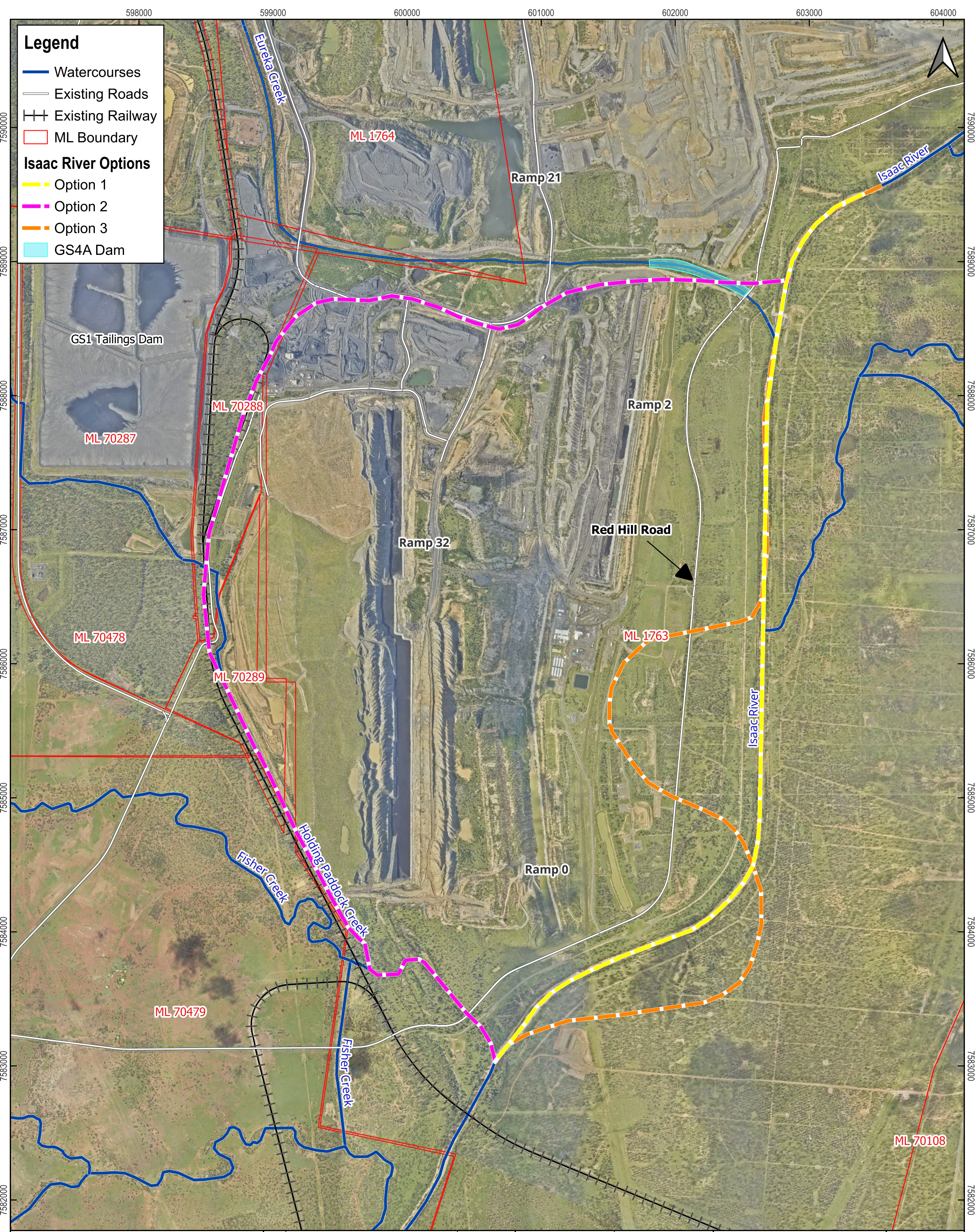
The three options assessed are shown in Figure 4.1 and summarised in Table 4.1.

**TABLE 4.1: OPTIONS IDENTIFICATION DETAILS**

| Statistic                                                           | Option 1                                                                                                                                                                                                                                                                                                                        | Option 2                                                                                                                                                                                                                                                                                                                | Option 3                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description                                                         | Retain existing diversion alignment (7.7 km).<br>Diversion grade is approximately 0.12%.                                                                                                                                                                                                                                        | Western Route passing through Holding Paddock Creek diversion.<br>Diversion channel significantly longer (10 km).<br>Approximately half of the diversion route is located in an area already disturbed.<br>The intent of this option is to divert Fisher Creek, HPC and Eureka Creek altogether along with Isaac River. | Combination of mid and lower meander.<br>Retain the existing diversion alignment and add meander west and east of the existing diversion to add further geomorphic diversity to the Isaac River and return the pre-mining reach length.<br>Diversion length 8.7 km (similar to the pre-mining length). |
| Likelihood that diversion will achieve state of dynamic equilibrium | Low – has an alignment with a length (7.7 km) shorter than the pre-mining alignment. Isaac River is currently performing below license conditions due to the drop structures which could not be retained in closure. Further remediation works are to be completed to return the Isaac River to a state of dynamic equilibrium. | Lowest – has an alignment with a length (10 km) longer than the pre-mining alignment. Substantial difference in grade (0.08%). Option 2 will include two catchments and crosses the planned R32 South void.                                                                                                             | High – has an alignment with a length (8.7km) and grade (0.10%) similar to the pre-mining alignment.                                                                                                                                                                                                   |
| Order of magnitude cost estimate*                                   | \$5 M                                                                                                                                                                                                                                                                                                                           | \$152 M                                                                                                                                                                                                                                                                                                                 | \$98 M                                                                                                                                                                                                                                                                                                 |
| Ability to isolate diversion from flows during establishment period | No – Will be constructed on the existing diversion alignment.                                                                                                                                                                                                                                                                   | Yes – The entirety of the diversion can be constructed offline from the existing diversion.                                                                                                                                                                                                                             | Partially – Option 3 cuts across the existing alignment. It is possible but there is some engineering risk.                                                                                                                                                                                            |

\* Option 1 estimates are based solely on direct diversion cut requirement costs. Option 2 & 3 are adopted from the 'Isaac River Diversion Pre-IPS report' by Advisian in May 2020, and the material volume and costs associated with the option have been adopted from the report.





**BMA PRCP GRM Isaac River  
Diversion**

**Figure 4.1  
Isaac River Diversion Realignment  
Options**

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# 5. OPTIONS ANALYSIS

## 5.1 Multi-Criteria Analysis Framework

A high-level multi-criteria analysis (MCA) was undertaken to rank the identified options for individual criteria as per Figure 5.1 below and determine a preferred option. The weighting of each criterion was determined and agreed upon with a BMA and Engeny collaborative decision group. The individual weightings are summarised in Table 5.1. Based on the score for each criterion against each option, a preferred option is identified.

|                   |                          |                        |                |                        |                          |
|-------------------|--------------------------|------------------------|----------------|------------------------|--------------------------|
| <b>-3</b>         | <b>-2</b>                | <b>-1</b>              | <b>0</b>       | <b>1</b>               | <b>2</b>                 |
| <b>Fatal Flaw</b> | <b>Strongly Negative</b> | <b>Mildly Negative</b> | <b>Neutral</b> | <b>Mildly Positive</b> | <b>Strongly Positive</b> |

**Figure 5.1: Ranking Scores for MCA**

**TABLE 5.1: WEIGHTING FOR INDIVIDUAL SCREENING CRITERIA**

| Criteria                                                            | Weight |
|---------------------------------------------------------------------|--------|
| Likelihood that diversion will achieve state of dynamic equilibrium | 50%    |
| Order of magnitude cost estimate                                    | 30%    |
| Ability to isolate diversion from flows during establishment period | 20%    |

## 5.2 Multi-Criteria Analysis

The MCA resulted in Option 3 to be carried forward into concept design as a preferred option, since it scored highest out of the two options and resulted in the lowest relative risk (see Table 5.2). Refer to Appendix A for the detailed MCA and scoring.

**TABLE 5.2: MULTI-CRITERIA ANALYSIS OUTCOMES**

| Item                   | Option 1     | Option 2     | Option 3    |
|------------------------|--------------|--------------|-------------|
| Overall Weighted Score | -0.4         | -1.7         | 1.2         |
| Relative Risk          | Neutral Risk | Highest Risk | Lowest Risk |
| Fatal Flaw             | No           | Yes          | No          |

## 6. CONCEPT DESIGN

### 6.1 Design Parameters and Plan

Table 6.1 details the parameters for each outcome in Section 3, forming the design plan for the permanent diversion, aligning with DNRME and ACARP Guideline requirements.

**TABLE 6.1: DNRME AND ACARP PARAMETERS ADOPTED**

| DNRME Parameters (DNRME, 2019)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Equivalent ACARP Parameters (ACARP, 2014)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>Outcome 1 –</i><br/>The design plan should include a detailed description of:<br/>a) the location, function, and description of geomorphic features within the proposed watercourse diversion as well as a revegetation and vegetation management plan.</p>                                                                                                                                                                                                                                                               | <p><i>Outcome 1 –</i><br/>Geomorphic and riparian vegetation features of the diverted watercourse and connecting reaches (minimum of 1 km upstream and downstream of proposed tie ins). Vegetation characteristics along the proposed optional watercourse diversions should also be noted. <input checked="" type="checkbox"/></p>                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <p><i>Outcome 2 –</i><br/>The design plan should include a detailed description of:<br/>a) the development and calibration, or sensitivity analysis, of the hydrologic model, including the referencing of methodologies used to generate flood frequency analysis. <input checked="" type="checkbox"/><br/>b) any design implications and construction processes that necessitate a lateral disconnectivity of sub-surface flow between the watercourse and an adjacent final void (if proposed). <input type="checkbox"/></p> | <p><i>Outcome 2 –</i><br/>Summary of hydrological characteristics including surface water-groundwater interactions and water use. Flow changes along the reach should also be clearly noted. <input checked="" type="checkbox"/></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p><i>Outcome 3 –</i><br/>The design plan should include hydraulic modelling results (benchmarked against guideline values for stream power, shear stress and velocity adopted from ACARP, 2002) and analysis identifying depth of inundation. The design plan should include a floodplain of sufficient capacity.</p>                                                                                                                                                                                                          | <p><i>Outcome 3 –</i><br/>Summary of hydraulic characteristics along the waterway length. <input checked="" type="checkbox"/><br/>Longitudinal section of stream power with standard cross section increments. A higher frequency of cross sections is required at stream junctions and bifurcations. <input checked="" type="checkbox"/><br/>A table summarising stream powers (in channel and floodplain) at each cross section is also required, along with statistics for the reach. This specifically includes the reach minimum, low quartile, median, mean, upper quartile and maximum values<sup>2</sup>. <input type="checkbox"/><br/><sup>2</sup>Only mean stream power values were calculated for comparison with the adopted criteria.</p> |
| <p><i>Outcome 4 –</i><br/>The design plan should include a sediment transport analysis that identifies how the watercourse diversion will manage erosion or deposition events such that they are consistent with the existing sediment regime.</p>                                                                                                                                                                                                                                                                              | <p><i>Outcome 4 –</i><br/>Sedimentation characteristics. Where the existing reach is aggrading, degrading, or is in equilibrium. Note presence of sediment sources (e.g., main channel bed or bank instabilities, floodplain contributions) and sinks (e.g., flood outs or sediment splays along low gradient sections of the reach, and infilling pools). <input checked="" type="checkbox"/></p>                                                                                                                                                                                                                                                                                                                                                     |
| <p><i>Outcome 5 –</i><br/>The design plan should include the specification of spoil placement and sequencing and the settlement process and timing of operation that will ensure the watercourse diversion, once constructed, operates in a stable manner.</p>                                                                                                                                                                                                                                                                  | <p><i>Outcome 5 –</i><br/>Interaction between watercourse diversion options and mine infrastructure (pipes, pits, culverts, access, etc.) and planning over the life of mine. <input checked="" type="checkbox"/></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

It is important to note only benchmark values for shear stress and velocity were adopted from DNRME, 2019. Stream power benchmark values were adopted from ACARP, 2014 due to it being a more contemporary standard that considers impacts of sediment transport.

### 6.2 Concept Design Diversion Alignment

Option 3 was identified to be the preferred option alignment using the MCA. The option was further refined to optimise the earthworks. The current length of the diversion is approximately 7.7 km, whereas the pre-mining length for the same reach was approximately 8.97 km. The proposed diversion is designed to be approximately 8.7 km in length. The full concept drawing package for the permanent Isaac River diversion is included in Appendix E and the interaction of the design with the PRCP landform is in Appendix F.

## 6.3 Channel Geometry and Grade

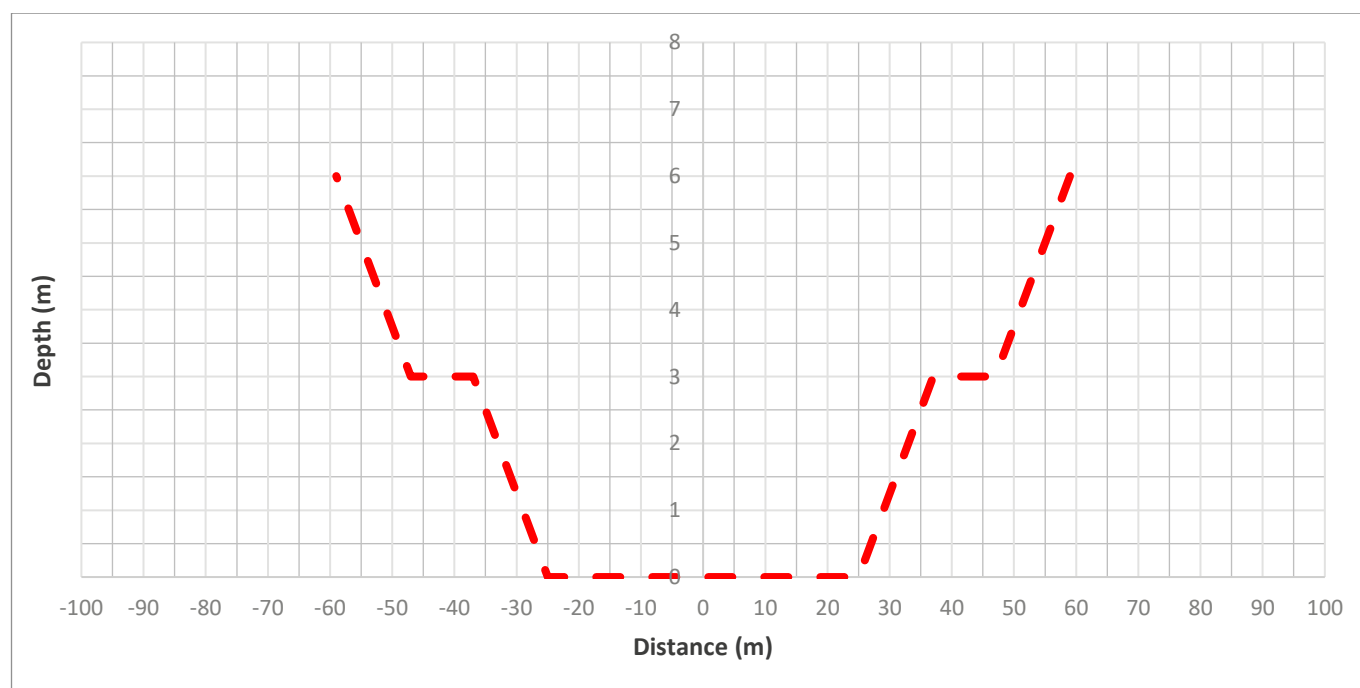
Table 6.2 summarises the selected typical channel cross-section for the concept design. These dimensions are adopted based on the geomorphology assessment done by Hydrobiology in 2019, which identified the average geomorphic characteristics of the upstream, diversion, and downstream reaches of the Isaac River (Hydrobiology, 2019).

Figure 6.1 shows the adopted cross-section for the for the proposed alignment. The concept design drawings in Appendix E show the typical cross sections, longitudinal profile, and footprint of the proposed channel works.

**TABLE 6.2: DETAILED CHANNEL CROSS SECTION GEOMETRY FOR CONCEPT DESIGN**

| Channel Geometry  | Suggested Quantity | Adopted Quantity | Comments                                                                                                                                                                                                         |
|-------------------|--------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Channel Bed Width | 50 – 60 m          | 50 m             |                                                                                                                                                                                                                  |
| Bench Width       | 10 – 20 m          | 10 m             |                                                                                                                                                                                                                  |
| Channel Depth     | 8 – 10 m           | 3 m              | Consistent depth of low flow channel at 3 m.                                                                                                                                                                     |
| Batter Slope      | 1:3 – 1:5          | 1V:4H            | For both the low flow channel and high flow channel batters. The batters will be covered with topsoil, hydromulch and hydroseed (Appendix E) to ensure stability and prompt revegetation of the channel batters. |

The concept design does not seek to change the vertical grade. The current diversion closely approximates the pre-mining conditions for the Isaac River. The grade of the proposed diversion is 0.1%, which is the same as the existing grade of the current diversion. The proposed diversion is approximately 8.7 km in length, which is a 3% reduction from the pre-mining length. The reduced length in the channel is not expected to adversely impact sediment transport/deposition within the channel. A longitudinal section for the diversion alignment is included in the concept design drawings in Appendix E.

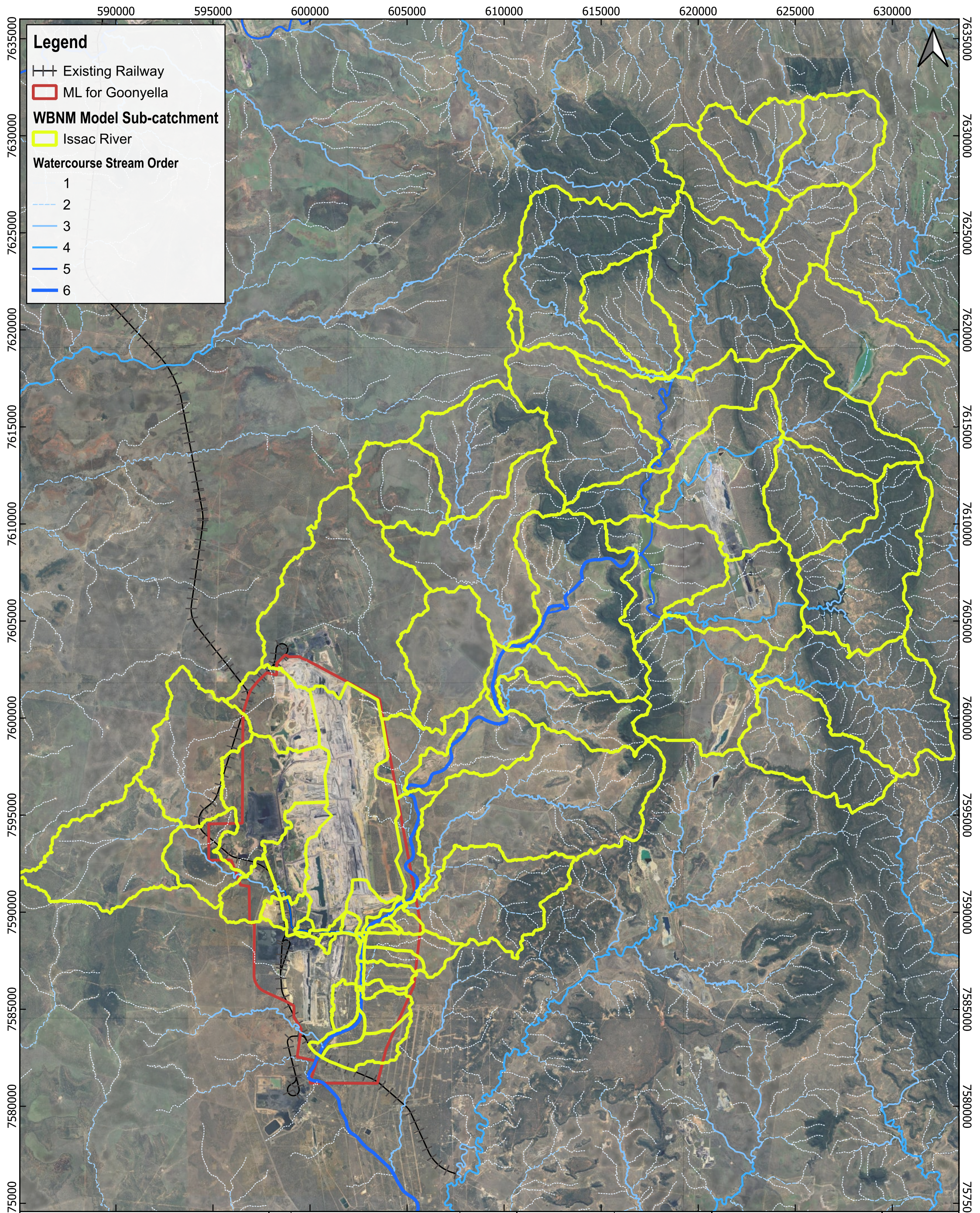


**Figure 6.1: Design Channel Cross Section of Isaac River**

## 6.4 Hydrology

A hydrologic model of Isaac River (concept design) was developed using WBNM software. The model was used to estimate flows for the 1 in 1000-year flood event. Peak flows for frequent events (39% AEP and 2% AEP) for the Isaac River proposed diversion was estimated using the ACARP (2002) method. The details of the hydrologic model development are presented in Appendix B. The Isaac River catchment is presented in Figure 6.2.





**Legend**

Existing Railway

ML for Goonyella

**WBNM Model Sub-catchment**

Issac River

**Watercourse Stream Order**

1

2

3

4

5

6

BMA PRCP GRM Isaac River

Diversion

Figure 6.2

Catchment Map

| REV. | DETAILS | DATE |
|------|---------|------|
| 0    |         |      |
|      |         |      |
|      |         |      |
|      |         |      |

|                |                  |
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| DRAWN: CH      | CHECKED: BK      |
| APPROVED: BK   | DATE: 24/07/2024 |
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024 km

Scale @ A3: 1:170,000

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## 6.4.1 Frequent Events

Peak flows for frequent events (39% AEP and 2% AEP) for the Isaac River diversion (concept design) and significant tributaries were estimated using the ACARP (2002) methods. The flow estimation details using the ACARP (2002) methods are included in Appendix B2. Table 6.3 summarises the total Isaac River diversion design flow downstream of the channel design.

The ACARP (2002) assessment included a regional flood frequency analysis for a selection of gauged catchments in the Bowen Basin region. From this, a method was developed to estimate flood magnitudes for ungauged catchments, based on catchment area and rainfall intensity. The calculated flood magnitudes for the 39% and 2% AEP events were then used to determine diversion design limits for shear stress, stream power and velocity. This approach has been adopted to determine the flows within the proposed Isaac River diversion concept design and has been compared to the ACARP (2002) diversion channel design parameters.

**TABLE 6.3: ISAAC RIVER DIVERSION DESIGN FLOWS**

| Rainfall Event       | Diversion Channel Design Flows (ACARP, 2002) m <sup>3</sup> /s |
|----------------------|----------------------------------------------------------------|
| 2% AEP (50-year ARI) | 2736.46                                                        |
| 39% AEP (2-year ARI) | 390.16                                                         |

## 6.4.2 Rare Events

The interaction of a 0.1% AEP flood event and the PRCP closure landform was assessed to inform the interaction between the diversion and final voids landform. Peak flows for 0.1 % for the Isaac River diversion (concept design) and significant tributaries were estimated using the WBNM software (refer to Appendix B1). The 0.1% peak flow rate at the end of the diversion is 5291 m<sup>3</sup>/s.

# 6.5 Hydraulics

## 6.5.1 Frequent Events

A two-dimensional TUFLOW flood model was developed to assess the compliance with the DNRME and ACARP hydraulic performance criteria for the 39% and 2% AEP events. The model simulated both the diversion design channel and the upstream reach, extending approximately 9.5 km upstream of the design. The extents and depths of the 39% and 2% AEP flooding are depicted in Figure 6.3 and Figure 6.4.

Average values were derived from the TUFLOW model for the stream powers, stream velocity and shear stress in the 39% and 2% AEP events (refer to Table 6.4). The proposed diversion values have been compared to the DNRME (2019) diversion channel design parameters. The detailed results for the DNRME guideline design criteria (stream power, velocity, and shear stress) as they vary along the length of the channel are presented graphically in Appendix D.

**TABLE 6.4: DIVERSION DESIGN CRITERIA COMPARED TO DNRME (2019) GUIDELINE PARAMETERS**

| Design Criteria                  | 39% AEP (2-year ARI) |                               | 2% AEP (50-year ARI) |                               |
|----------------------------------|----------------------|-------------------------------|----------------------|-------------------------------|
|                                  | Diversion            | DNRME Design Parameter (2019) | Diversion            | DNRME Design Parameter (2019) |
| Stream Power (W/m <sup>2</sup> ) | 38.7                 | <60                           | 131.7                | <150                          |
| Stream Velocity (m/s)            | 1.77                 | <1.5                          | 2.46                 | <2.5                          |
| Shear Stress (N/m <sup>2</sup> ) | 21.8                 | <40                           | 54.3                 | <80 <sup>1</sup>              |

<sup>1</sup> DNRME values are extracted from ACARP 2002, however the value reported for the 2% AEP shear stress (<50 N/m<sup>2</sup>) in the DNRME 2014 is incorrect. The ACARP value of <80 N/m<sup>2</sup> has been adopted.

It can be seen from Table 6.4 that all the average diversion hydraulic results are below design parameters for both the 39% AEP and 2% AEP storm events except for the 39% AEP velocity.

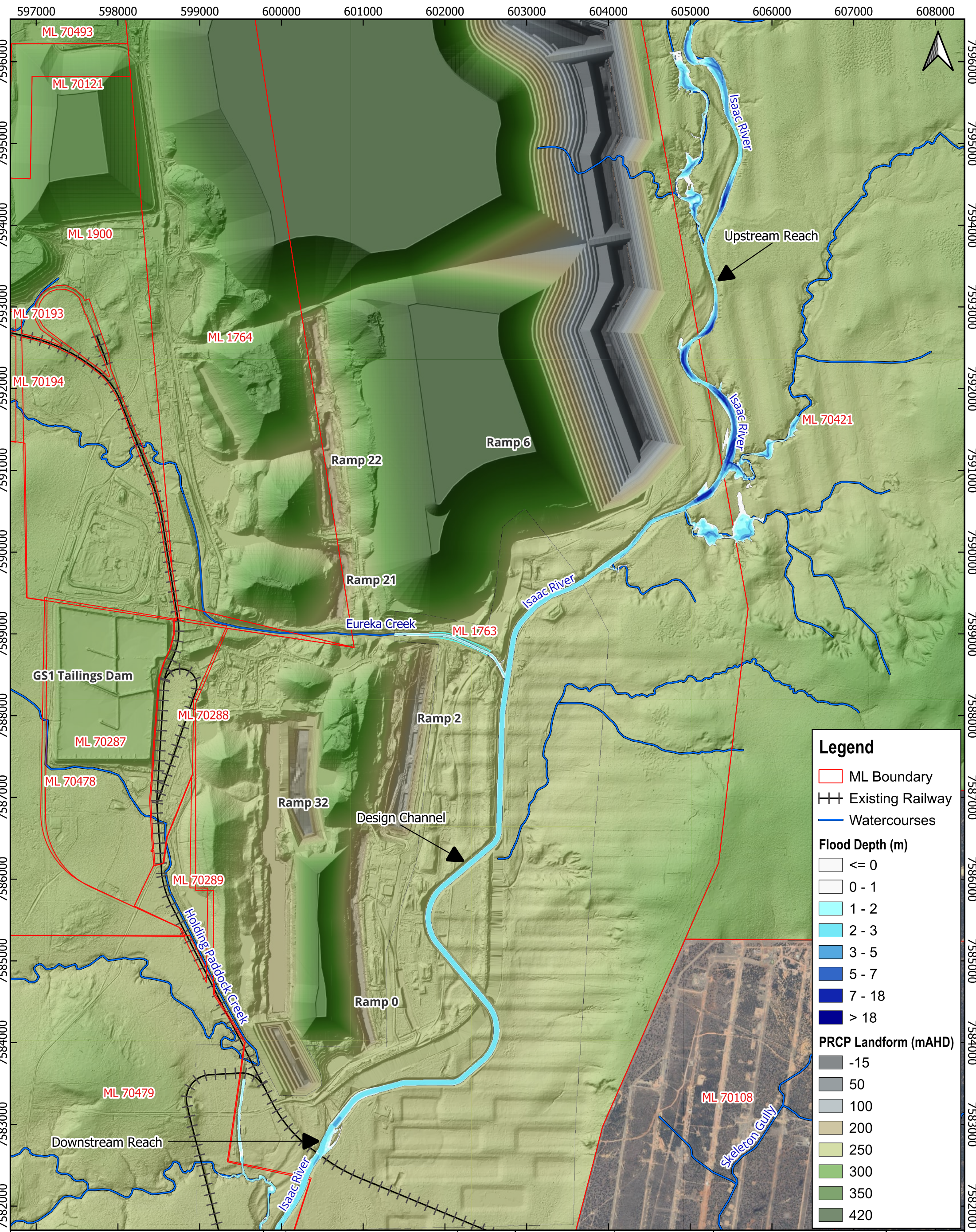
The modelled velocity is generally consistent with the velocities observed in the upstream and downstream reaches with the velocity exceeding the threshold values due to the large capacity of the channel with no floodplain engagement which would be typically for smaller capacity watercourses throughout the Bowen Basin from which the threshold values were derived.

## 6.5.2 Rare Events

The TUFLOW flood model was also developed to assess the interaction between the diversion and final voids landform for the 0.1% AEP event. The extents and depths of the 0.1% AEP flooding are depicted in Figure 6.5.

The results indicate that the concept diversion design does not interact with any final voids. However, there is a high possibility of interaction from the upstream reaches of the diversion design. Additionally, the 0.1% AEP flood event shows flows to the Ramp 0 and Ramp 2, located west of the diversion. It's important to note that these results are based on landform version 2. However, the latest landform version 2.3 includes flood protection measures that mitigate this risk.





**BMA PRCP GRM Isaac River  
Diverison**

**Figure 6.3  
39% AEP Flood Event with PRCP  
Landform 2**

| REV. | DETAILS | DATE |
|------|---------|------|
| 0    |         |      |
|      |         |      |
|      |         |      |

|                |                  |
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| DRAWN: CH      | CHECKED: BK      |
| APPROVED: BK   | DATE: 24/07/2024 |
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Scale @ A3: 1:41,000

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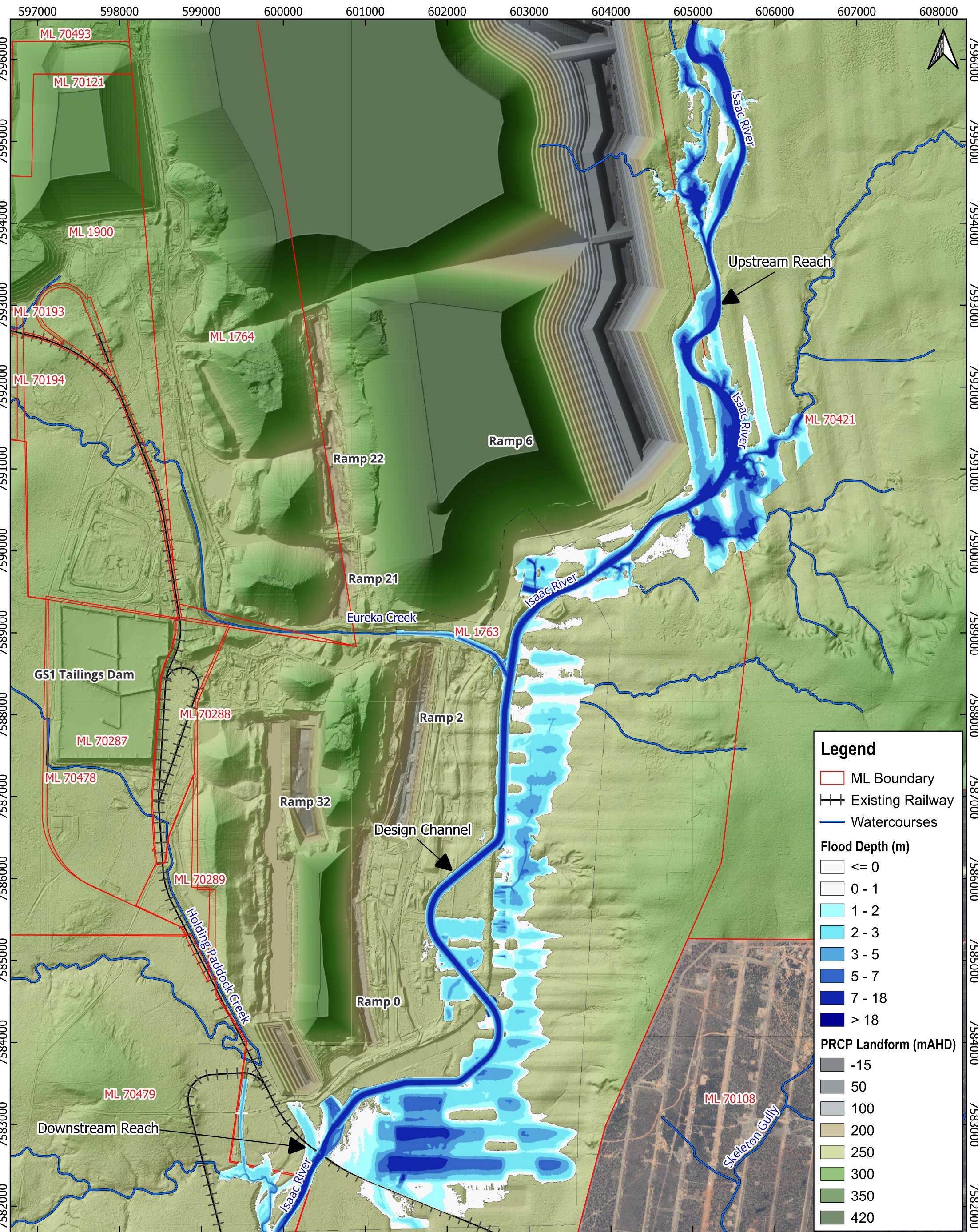
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**BMA PRCP GRM Isaac River  
Diversion**

**Figure 6.4  
2% AEP Flood Event with PRCP  
Landform 2**

| REV. | DETAILS | DATE |
|------|---------|------|
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| APPROVED: BK | DATE: 24/07/2024 |

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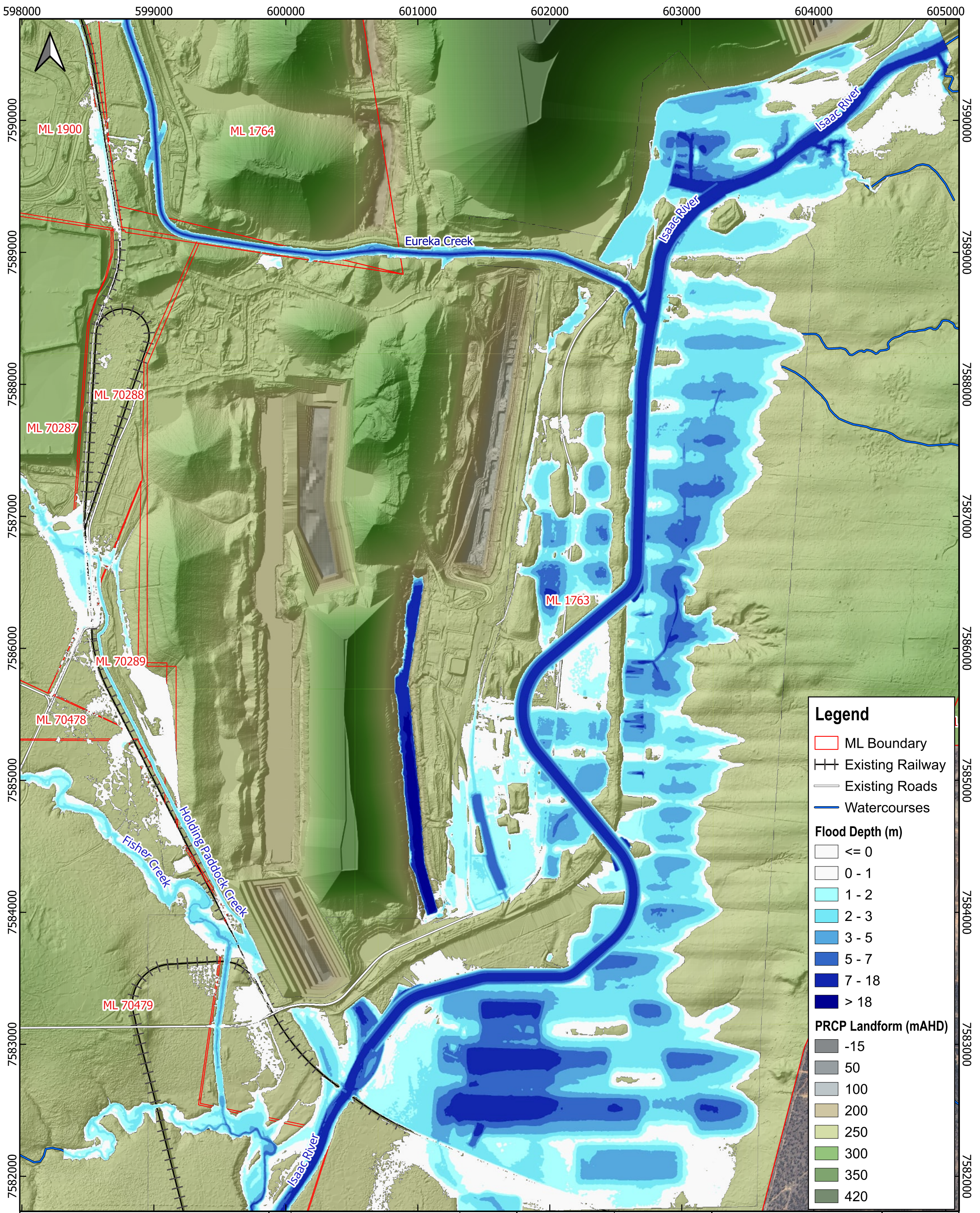
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**Legend**

ML Boundary

Existing Railway

Existing Roads

Watercourses

**Flood Depth (m)**

<= 0

0 - 1

1 - 2

2 - 3

3 - 5

5 - 7

7 - 18

> 18

**PRCP Landform (mAHD)**

-15

50

100

200

250

300

350

420

BMA PRCP GRM Isaac River  
Diversi

Figure 6.5  
0.1% AEP Flood Event with PRCP  
Landform 2

| REV. | DETAILS | DATE |
|------|---------|------|
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## 6.6 Risks and Mitigation Measures

Table 6.5 summarises the main risks for the diversion design and its ability to achieve a state of dynamic equilibrium suitable for relinquishment. The consequence and likelihood matrix utilised for this risk assessment align with BHP Global Standard – Risk Management.

**TABLE 6.5: DIVERSION RISKS AND MITIGATION MEASURES**

| Risks                                                                                                                                      | Likelihood      | Consequences | Risk Rating and Score | Mitigation Measures                                                                                                                                                                                                                                                          | Residual Likelihood | Residual Consequences | Residual Risk Rating and Score |
|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------|--------------------------------|
| Damage to new diversion channel due to frequent (up to 20% AEP / 5 year ARI) flood events. Diversion alignment unable to be taken offline. | Likely          | 2            | 30                    | Diversion channel constructed during dry season.<br><br>Detailed revegetation plan to be implemented to promote rapid establishment. Seed mix to include fast establishing species to rapidly stabilise diversion.                                                           | Likely              | 1                     | 10                             |
| Damage to the new diversion channel due to extreme/rare (0.1% AEP / 1000 year ARI) flood event (mainly overland flow and bank erosion).    | Unlikely        | 2            | 3                     | Revegetation plan to include large species capable of withstanding shear stresses associated with rare events.                                                                                                                                                               | Highly Unlikely     | 2                     | 0.9                            |
| Construction program impacted by frequent flow event (up to 20% AEP / 5 year ARI). Diversion unable to be taken offline.                   | Probable        | 1            | 3                     | Diversion construction to be timed to minimise risk of large flows while still maintaining enough watering to promote vegetation establishment and growth.<br><br>Potential to construct upstream detention to minimise the peak flows if allowed by existing water licence. | Likely              | 1                     | 10                             |
| Constructability of diversion channel – encountering bedrock, material availability and access.                                            | Unlikely        | 2            | 3                     | Geotechnical and soil investigations as part of functional design.                                                                                                                                                                                                           | Highly Unlikely     | 1                     | 0.3                            |
| Flood ingress into final voids.                                                                                                            | Likely          | 2            | 30                    | Final landform design to provide flood protection to ensure no flooding ingress in 0.1% AEP flood with 1.0 m freeboard.                                                                                                                                                      | Highly Unlikely     | 2                     | 0.9                            |
| Upstream rehabilitation of mining areas unsatisfactory leading to increase sediment loads to the final diversion channel.                  | Highly Unlikely | 2            | 0.9                   | Additional upstream controls could be considered during functional design. Offline flow through sediment basins during vegetation establishment phase of rehabilitated catchments reporting to the Eureka Diversion.                                                         | Likely              | 2                     | 30                             |

## 6.7 Additional Design and Construction Considerations

### 6.7.1 Surface Water Infrastructure

The final landform will be designed to ensure flood protection to final voids to mitigate this risk. Final voids are to be offset from the Isaac River by a sufficient distance to limit seepage into the voids. The PRCP landform (Version 2) shows flows to the Ramp 0 and Ramp 2, located west of the diversion. However, the latest iteration of the landform (Version 2.3) effectively addresses this risk, providing sufficient distance from the Isaac River to prevent seepage into the voids. The PRCP landform (Version 2.3) will be implemented to ensure that the 0.1% AEP flood event does not contribute to external inflows into the void. Additionally, the design will guarantee the flood protection of final voids located north-west upstream of the concept design, incorporating a sufficient buffer between the upstream reach and the final voids (refer to the PRCP for flood mitigation details). The overall intent for the flood protection landform will not require ongoing maintenance to maintain function.

### 6.7.2 Soils

The channel bed and banks are expected to be comprised largely of the surrounding soils, which potentially include dispersive sandy to loamy duplex soils. Erosion of the diversion channel is a key risk to the diversion not achieving a state of dynamic equilibrium. Key actions which should be undertaken in detailed design and construction to further quantify and mitigate this risk include:

- A detailed soil survey should be conducted in the functional design stage to determine characteristics of topsoil and subsoil within the diversion alignment.
- The detailed engineering in functional design should specify requirements for cover materials, including rock and rock mulch, to protect diversion batters from erosion.
- Temporary erosion sediment controls should be designed to minimise risk of erosion until vegetation establishment. This plan should be developed and approved by an appropriately qualified person informed by site specific soils data.
- An appropriately qualified person to assess the growth media for the diversion banks and recommend required ameliorants, fertilisers and surface treatments. Excess supply of sediment from upstream and adjacent mining activities (spoil dumps, haul roads, coal stockpiles etc.) can impact vegetation establishment within the new diversion. Controls should be established to reduce sediment influx from surrounding landforms during the establishment of the diversion channel.

### 6.7.3 Revegetation

Hydraulic modelling has demonstrated that the 39% AEP average velocity (1.77 m/s) is slightly above the DNRME guideline value of 1.5 m/s for a stable channel with vegetation and 1 m/s for a stable channel without vegetation (refer Table 3.2). Additionally, the 39% AEP average shear stress of 38.7 N/m<sup>2</sup> is slightly above the DNRME guideline value of 35 N/m<sup>2</sup> for a stable channel with no vegetation (refer Table 3.2). Effective revegetation will be crucial for the long-term stability of the diversion reach. A detailed revegetation plan should be developed as part of the function design for Isaac River as it will be critical to prevent uncontrolled erosion in the early years following construction.

The revegetation for the diversion should be done in accordance with the revegetation plan informed by baseline vegetation surveys. The plan should:

- Specify the method for revegetation considering direct seeding, mulch blanket, direct planting etc. and be informed by the erosion potential, expected velocities of flows and the cover material in selecting the appropriate method.

The watercourse revegetation species should be based on selecting key framework trees, woody understory and groundcover species associated with the predominant natural watercourse regional ecosystems occurring upstream and/or downstream of the site as prescribed in the GRM Progressive Rehabilitation and Closure Plan (PRCP).

- Revegetation design should focus on re-establishing riparian vegetation for upper banks, mid banks and lower bank (including bank toe) revegetation zones.
- Include geomorphic and vegetation features like those in the local landscape.
- Consider irrigation and other controls required to promote vegetation establishment in response to changing climatic conditions.
- Achieve sufficient ground cover to mitigate erosion risk on beds and banks.



- Maintain a sediment transport regime that does not directly impact on upstream and downstream reaches.
- Not require ongoing maintenance.

#### 6.7.4 Monitoring and Maintenance

Monitoring and maintenance of the diversion during the operational phase should be conducted in accordance with BMAs watercourse diversion monitoring program and following construction and rehabilitation of the new diversion alignment, it will be required to be conducted in accordance with the PRCP. The monitoring and maintenance of the diversion during the establishment phase should be done routinely and consider the following (at least):

- Identifying introduced species and weeds for control.
- Success of vegetation establishment and identifying the need for subsequent seeding or planting.
- Climatic conditions which may impact the success of vegetation establishment (i.e., drought).
- Unplanned events which may impact the success of vegetation establishment (i.e., bushfire).
- Monitoring for erosion of beds and banks.
- Sediment transport under low flow conditions to ensure no excess sedimentation.
- Success of temporary erosion and sediment control measures.

The frequency of inspections should be aligned to risk (i.e. increase where control implementation is not suitable), and following periods of high flow in the diversion.

## 7. CONCLUSION

The existing diversion is experiencing increasing bank erosion, lack of geomorphic and vegetation features like those in the local landscape, sediment aggradation and sediment deposition downstream.

The concept design has been developed to meet the requirements of the PRCP and achieve a state of dynamic equilibrium enabling its relinquishment in the post closure landform of GRM.

Three options for rehabilitation of the diversion were identified and assessed using the BMA MCA outlined in Section 5. The selected option to proceed with the concept design was Option 3. This option retains the existing diversion alignment but meanders west and east of the existing diversion to add further geomorphic diversity to the Isaac River and return the pre-mining reach length. Maintenance and rehabilitation of the existing diversion is to be conducted along the channel. The final concept design, typical cross sections and longitudinal section are presented in Appendix E.

The highest risk to successful performance of the diversion is vegetation failure and subsequent erosion of the banks and bed of the diversion. It is noted that the 39% AEP (2yr ARI) stream power and velocities exceed the DNRME design criteria for stability if the channel remains unvegetated. Given that the alignment is unable to be taken offline during construction, it will be critical that vegetation of the channel be established following construction to minimise erosion risk during frequent events. The concept design could be optimised in detailed design to further reduce the stream power and velocities in conjunction with a planned diversion revegetation strategy.

The latest PRCP landform (Version 2.3) has been designed to effectively provide flood protection for Ramp 0 and Ramp 2, ensuring that the 0.1% AEP flood event does not contribute to additional external inflows into the void. Additionally, the latest iteration of the landform ensures flood protection for the final voids located northwest and upstream of the concept design, maintaining a sufficient buffer between the upstream reach and the final voids.



## 8. QUALIFICATIONS

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

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# APPENDIX A: MULTI-CRITERIA ANALYSIS DETAILS



Multi-Criteria Analysis - Isaac River Diversion

Project: PRCP GRM Diversions

Workshop Date:

|            |                   |                 |         |                 |                   |
|------------|-------------------|-----------------|---------|-----------------|-------------------|
| -3         | -2                | -1              | 0       | 1               | 2                 |
| Fatal Flaw | Strongly Negative | Mildly Negative | Neutral | Mildly Positive | Strongly Positive |

| Criteria                                                            | Assumptions/Considerations                                                                                                                                    | Weight | Option 1 | Option 2 | Option 3 | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------|----------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Likelihood that diversion will achieve state of dynamic equilibrium | Considers the difference between diversion length and grade to natural stream length and grade. Ideally diversion length/grade = natural stream length/grade. | 50%    | -2       | -3       | 2        | Option 1: Has an alignment with a length (7.7 km) shorter than the pre-mining alignment. However, Isaac river is currently performing below license conditions due to the drop structures which could not be retained in closure. Further remediation works are to be completed to return the river to a state of dynamic equilibrium.<br>Option 2: Has an alignment with a length (10 km) longer than the pre-mining alignment. Substantial Difference in grade (0.08%). Option 2 will include two catchments and crosses the planned R32 South void.<br>Option 3: Has an alignment with a length (8.7km) and grade (0.10%) similar to the pre-mining alignment. |
| Order of magnitude cost estimate                                    | Assumes \$10/m3 of cut.                                                                                                                                       | 30%    | 2        | -2       | 0        | Option 1 estimates are based solely on direct diversion cut requirement costs. Option 2 & 3 are adopted from the ‘Isaac River Diversion Pre-IPS report’ by Advisian in May 2020, and the material volume and costs associated with the option have been adopted from the report.                                                                                                                                                                                                                                                                                                                                                                                  |
| Ability to isolate diversion from flows during establishment period | Diversion can be isolated from flows if it is constructed offline of the existing diversion.                                                                  | 20%    | 0        | 2        | 1        | Option 1: Will be constructed on the existing diversion alignment.<br>Option 2: The entire of the diversion can be constructed offline from the existing diversion.<br>Option 3: Option 3 cuts across the existing alignment. It is possible but there is some engineering risk.                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                     | Overall Weighted Score                                                                                                                                        |        | -0.4     | -1.7     | 1.2      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

|                                         |              |              |             |
|-----------------------------------------|--------------|--------------|-------------|
| Is there a Fatal Flaw?<br>Relative Risk | No           | Fatal Flaw   | No          |
|                                         | Neutral Risk | Highest Risk | Lowest Risk |



---

# APPENDIX B: HYDROLOGIC MODEL DEVELOPMENT

The bottom half of the page features a series of four thick, white, wavy lines that sweep from the bottom left towards the right, creating a sense of movement and depth against the solid teal background.

## B.1 Hydrologic Model Setup - WBNM

The WBNM (Watershed Bound Network Model) runoff routing software (2021 version) was used to develop the hydrology model. WBNM automatically calculates catchment routing based on the sub-catchment area, pervious/impervious areas and parameters, and the sub-catchment flow paths.

### B.1.1 Catchment Inputs

The hydrological model includes the total catchment for the Isaac River (inclusive of Eureka, HPC, and Fisher creeks) extending downstream past the Goonyella mine, covering a total area of approximately 1180 km<sup>2</sup>. Sub-catchment delineation for GRM was developed using the PRCP landform (Version 2) topography displayed in Figure F.1. The final landform topography data did not extend over a portion of the hydraulic model assessment area. Additional Shuttle Radar Topographic Mission (SRTM) topography data was used to complete the model topography required

Three open water bodies are located in the upper catchment: Lake Elphinstone, Teviot Dam and Burton Gorge Dam. Lake Elphinstone is a natural lake formed behind the Carborough Range whereas Teviot Dam and Burton Gorge Dam are man-made structures that supply water to Burton and North Goonyella mines in the upper catchment.

The design life of the Teviot Creek Dam and Burton Gorge Dam, as part of mining closure operations, could impact design flow estimates. For this study, the WBNM model did not include the Burton Gorge Dam, Teviot Dam, and Lake Elphinstone located upstream of the study area, considering a worst-case scenario.

Figure B.1 provides the sub-catchment extents used for the WBNM.

### B.1.2 Model Parameters

The final landform is proposed to be rehabilitated; therefore, the hydrology model has assumed no impervious surfaces remain and a 0% impervious fraction (Fi) for all catchments including the remaining spoil areas and voids.

The default routing parameter of 1, pervious lag parameter of 1.8 and impervious lag parameter of 0.1 have been adopted for the WBNM.

### B.1.3 Design Rainfall

The 0.1% AEP (1000yr) was sourced using the Australian Rainfall and Runoff 2019 IFD generation tool available on the Bureau of Meteorology (BoM) website ([www.bom.gov.au](http://www.bom.gov.au)), at Latitude 21.6652 (S), Longitude 148.0792 (E). Aerial Reduction Factors (ARFs) have been used for all design events to convert point rainfall estimates to areal rainfall estimates.

### B.1.4 Temporal Patterns

Design events (1% - 0.1% AEP) have utilised the 'East Coast North' areal temporal patterns, as the total catchment area for the model exceeds 75 km<sup>2</sup>. All ten temporal patterns were simulated for storm durations ranging from the 3 hours to 168 hours.

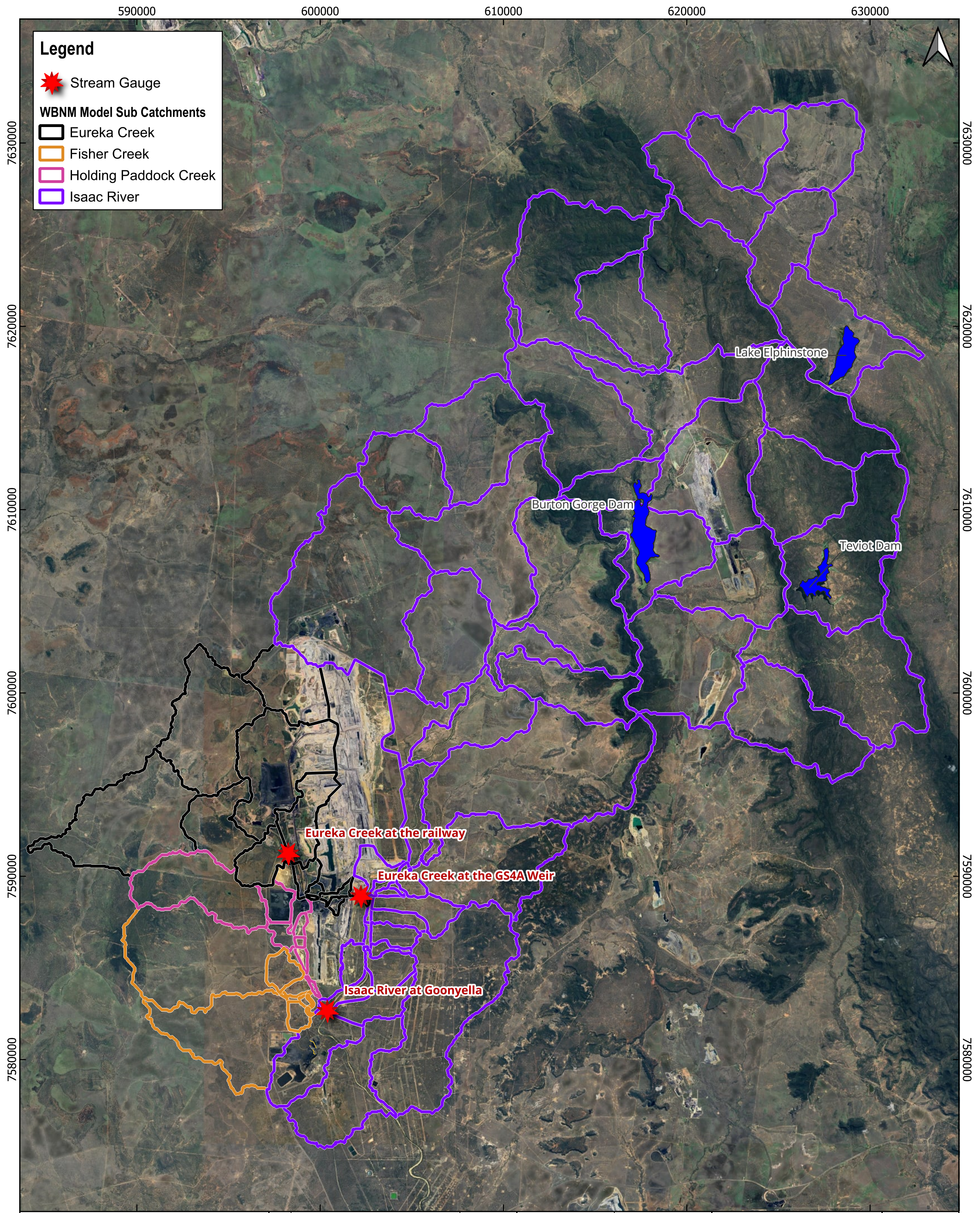
### B.1.5 Design Rainfall Losses

The initial and continuing losses obtained from the ARR Datahub for Isaac River catchment to Goonyella gauge are 36 mm and 2.7 mm/h, respectively.

The adopted design rainfall losses were selected to achieve the best match between the XP-RAFTS design discharges with the design discharges estimated by the FFA at the Isaac River Goonyella gauge. The following is of note:

- For the 50%, 20%, 10%, 5%, 2% and 1% AEP events, the default ARR initial losses of 36 mm and continuing losses of 2.7 mm/h were adopted, respectively. The initial loss will decrease for larger events as the catchment is likely to be more saturated prior to the design rainfall burst.
- For the 0.1% AEP design event, a conservative 0 mm initial loss was adopted. A continuing loss of 2.5 mm/h was adopted as per the flood assessment done by WRM in 2019 (WRM, 2019 ).





**BMA PRCP GRM Isaac River  
Diversion**

Figure B.1  
WBNM Hydrologic Model Layout

| REV. | DETAILS | DATE |
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| APPROVED: BK   | DATE: 01/08/2024 |
| GENERAL NOTES: |                  |

024 km

Scale @ A3: 1:180,000

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## B.1.6 Model Validation

The 50%, 20%, 10%, 5%, 2% and 1% AEP peak flows estimated from the hydrology model were validated using the following methods:

- **Regional Flood Frequency Estimation Model (RFFE)** - is a recommended peak flow validation method from the ARR 2019 guidelines (Ball, et al., 2019). The RFFE provides peak flow estimations based on the catchment area and a catchment shaping factor, determined using the catchment centroid and outlet coordinates. The RFFE peak flow estimates were calculated using the ARR RFFE Model online tool (<http://rffe.arr-software.org/>).
- **Flood Frequency Analysis (FFA)** - provides peak flow estimates for different AEPs by developing a fitted distribution from recorded peak flows from historical flood events.

A flood frequency analysis (FFA) of recorded flows at the Isaac River Goonyella Gauge was conducted by Engeny in 2021. The FFA results were used for validation in the Isaac River Flood Model, completed by Engeny in March 2021. The analysis focused on peak annual discharges (from October to September) recorded at the Isaac River at Goonyella (130414A) streamflow gauge by Queensland's Department of Natural Resources Mines and Energy (DNRME) between 1982 and 2020. A Log Pearson Type 3 (LPIII) distribution was applied to the annual maximum series of peak flows from the gauge (Engeny, 2021).

- **Peak flow estimates from previous flood studies** –
  - A hydrologic modelling of the Isaac River catchment including the Grosvenor Mine (GRV) and Moranbah North Mine (MNM) using the XPRAFTS runoff-routing model was developed to estimate the 39%, 10%, 5%, 2%, 1%, 0.2% and 0.1% annual exceedance probability (AEP) and probable maximum flood (PMF) design discharges for the Isaac River and its tributaries (Engeny, 2021). The estimated peak flows at the Isaac River at Goonyella Streamflow Gauge were compared to the WBNM and RFFE peak flows (refer to Figure B.2 ). It is to be noted that the Burton Gorge Dam, Teviot Dam and Lake Elphinstone upstream of the study area were modelled as detention basins in the XPRAFTS model.
  - Design peak discharges in the Isaac River at Goonyella, Eureka Creek upstream of the railway and Eureka Creek at the GS4A for the 10%, 5%, 2%, 1%, 0.1% were estimated using the XP-RAFTS model by WRM in 2019. These flows were compared to the WBNM model design peak discharges at these three gauge locations.

## B.1.7 Model Validation Results

Table B.1 shows the WBNM estimated design discharges at the Isaac River at Goonyella, Eureka Ck at the Railway and Eureka Ck at the GS4A for design events between 10% to 0.1% AEP, and the comparison to the WRM design discharges. A visual comparison of the WBNM design peak discharges at the Isaac River streamflow gauge (130414A) against the flood frequency distribution curve, XP-RAFTS estimated peak flows by Engeny in 2021 and RFFE is provided in Figure B.2.

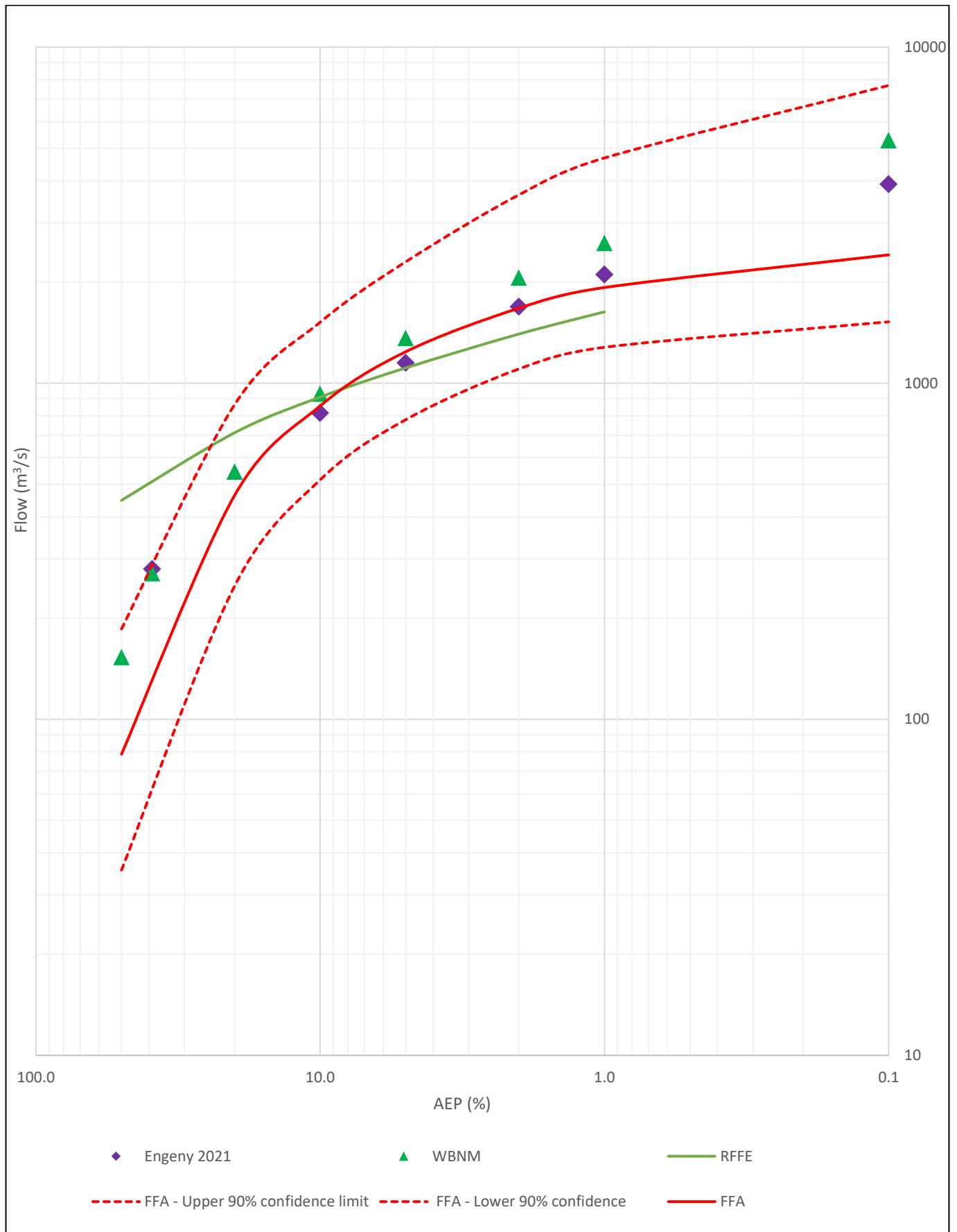
Validation of the design hydrology peak flow estimates indicates the following.

- **Isaac River Gauge**
  - Modelled peak flows for all design events are higher (3%-26%) than the LPIII expected quantile from the FFA. This is expected considering the exclusion of Burton Gorge Dam, Teviot Dam and Lake Elphinstone (Figure B.2).
  - Modelled peak flows compared to the RFFE method were higher for events rarer than the 10% AEP and lower for events more frequent than the 10% AEP. This irregularity is not concerning as the RFFE can provide irregular results if catchment characteristics are mostly different from the nearby gauged waterways used to derive the RFFE. Additionally, the Isaac gauge catchment (1071.21 km<sup>2</sup>) is outside the RFFE recommended catchment size of 0.5-1000 km<sup>2</sup>, hence results have lower accuracy (Figure B.2).
  - WBNM estimated peak flows for all design events are higher (11%-28%) than the WRM 2019 flood modelling report (Table B.1).
- **Eureka Ck Gauge**
  - WBNM estimated peak flows for all design events are higher (10%-37%) than the WRM 2019 flood modelling report. This is expected considering the 37% increase of the Eureka catchment (Table B.1).



**TABLE B.1: COMPARISON OF WBNM DESIGN DISCHARGES TO THE WRM 2019 FLOWS**

|                             |                                   | WRM (2019) Peak Discharge (m3/s) | WRM (2019) Critical duration (hours) | WBNM Peak Discharge (m3/s) | WBNM Critical duration (hours) | Difference (%) |
|-----------------------------|-----------------------------------|----------------------------------|--------------------------------------|----------------------------|--------------------------------|----------------|
| Isaac River at Goonyella    | Catchment Area (km <sup>2</sup> ) | -                                |                                      | 1071.12 km <sup>2</sup>    |                                | -              |
|                             | Design event (AEP%)               |                                  |                                      |                            |                                |                |
|                             | 10                                | 830                              | 18 hr                                | 932                        | 18 hr                          | 11%            |
|                             | 5                                 | 1167                             | 18 hr                                | 1363                       | 18 hr                          | 14%            |
|                             | 2                                 | 1707                             | 18 hr                                | 2061                       | 18 hr                          | 17%            |
|                             | 1                                 | 2079                             | 24 hr                                | 2616                       | 18 hr                          | 21%            |
|                             | 0.1                               | 3808                             | 24 hr                                | 5291                       | 18 hr                          | 28%            |
| Eureka Creek at the railway | Catchment Area (km <sup>2</sup> ) | 76.4 km <sup>2</sup>             |                                      | 113.78 km <sup>2</sup>     |                                | 33%            |
|                             | Design event (AEP%)               |                                  |                                      |                            |                                |                |
|                             | 10                                | 140                              | 6 hr                                 | 159                        | 18 hr                          | 12%            |
|                             | 5                                 | 180                              | 6 hr                                 | 217                        | 18 hr                          | 17%            |
|                             | 2                                 | 256                              | 6 hr                                 | 299                        | 18 hr                          | 14%            |
|                             | 1                                 | 299                              | 6 hr                                 | 374                        | 18 hr                          | 20%            |
|                             | 0.1                               | 499                              | 6 hr                                 | 692                        | 12 hr                          | 28%            |
| Eureka Creek at the GS4A    | Catchment Area (km <sup>2</sup> ) | 80.7 km <sup>2</sup>             |                                      | 129.05 km <sup>2</sup>     |                                | 37%            |
|                             | Design event (AEP%)               |                                  |                                      |                            |                                |                |
|                             | 10                                | 147                              | 6 hr                                 | 163                        | 18 hr                          | 10%            |
|                             | 5                                 | 189                              | 6 hr                                 | 225                        | 18 hr                          | 16%            |
|                             | 2                                 | 267                              | 6 hr                                 | 320                        | 18 hr                          | 17%            |
|                             | 1                                 | 311                              | 6 hr                                 | 400                        | 18 hr                          | 22%            |
|                             | 0.1                               | 521                              | 6 hr                                 | 728                        | 18 hr                          | 28%            |



**FIGURE B.2: COMPARISON OF WBNM DESIGN DISCHARGES TO THE FFA AND RFFE DESIGN DISCHARGES TO THE ISAAC RIVER GAUGE**



## B.2 Hydrologic Model Setup - ACARP

Peak flows for frequent events (39% AEP and 2% AEP) for the Isaac River diversion (concept design) and significant tributaries were estimated using the ACARP (2002) methods. The ACARP (2002) assessment included a regional flood frequency analysis for a selection of gauged catchments in the Bowen Basin region. From this, a method was developed to estimate flood magnitudes for ungauged catchments, based on catchment area and rainfall intensity.

Table B.2 summarises the estimated design flows of Isaac River and its tributaries using the ACARP (2002) method. These design flows were subsequently applied as steady state inflow boundaries in the TufLOW model to determine diversion design limits for shear stress, stream power and velocity. Figure C.2 shows the location of the applied design flows in the TufLOW model.

**TABLE B.2: DESIGN FLOWS OF ISAAC RIVER AND ITS TRIBUTARIES USING THE (ACARP, 2002) METHOD**

| Isaac River & Tributaries | 2% AEP (50-year ARI) Design Flow (m <sup>3</sup> /s) | 39% AEP (2-year ARI) Design Flow (m <sup>3</sup> /s) |
|---------------------------|------------------------------------------------------|------------------------------------------------------|
| Isaac River               | 165.54                                               | 1542.25                                              |
| Eureka Creek              | 275.4                                                | 53.8                                                 |
| Goonyella Creek           | 48.68                                                | 291.65                                               |
| Twelve Mile Creek         | 36.22                                                | 195.06                                               |
| Unnamed Gully             | 23.82                                                | 110.28                                               |
| Platypus Creek            | 22.74                                                | 103.55                                               |
| HPC & Fisher Creek        | 39.34                                                | 218.26                                               |
| <b>Total</b>              | <b>390.16</b>                                        | <b>2736.46</b>                                       |

---

# APPENDIX C: HYDRAULIC MODEL DEVELOPMENT





## C.1 Model Extent and Topography

The hydraulic model utilised the TUFLOW HPC solver. The Digital Elevation Model (DEM) used in the hydraulic model was based on the most recent PRCP landform (Version 2) provided by BHP.

A grid cell size of 4 m was selected for the TUFLOW model, which is suitable for representing the width of the diversion across multiple modelling cells. To enhance the resolution of sub-grid scale features, an SGS (Sub-Grid Scale) sample distance of 2 m was implemented.

The selected extent for the model is from upstream of where Isaac design starts to downstream of Isaac River in the extent of the ML Goonyella Riverside. The modelling layout is shown in Figure C.1 and Figure C.2.

The proposed diversion design option was included in the model using design tins produced by 12D and merging it to the PRCP landform (Version 2).

## C.2 Hydraulic Roughness

The hydraulic roughness has been selected based on the inspection of aerial imagery and expected treatments within the diversion. As per the MCA workshop, roads will be removed as part of the closure, including the GS4A dam. The GS1 tailings dam will be rehabilitated. The rail, which is not owned by BMA and goes to Moranbah North, was considered in the base land use mapping of the site. The adopted Manning's 'n' roughness values are summarized in Table C.1 below.

**TABLE C.1: ADOPTED MANNING'S N ROUGHNESS**

| Land Use                                               | Manning's 'n' |
|--------------------------------------------------------|---------------|
| Railway                                                | 0.015         |
| Dense Vegetation                                       | 0.080         |
| Eureka Creek Design Channel                            | 0.050         |
| Isaac Constructed Channel (Bed)                        | 0.027         |
| Isaac Constructed Channel (Right and left Bank)        | 0.050         |
| Existing Watercourses (Isaac River Tributaries)        | 0.030         |
| Existing Isaac River Bed (Upstream & Downstream Reach) | 0.027         |

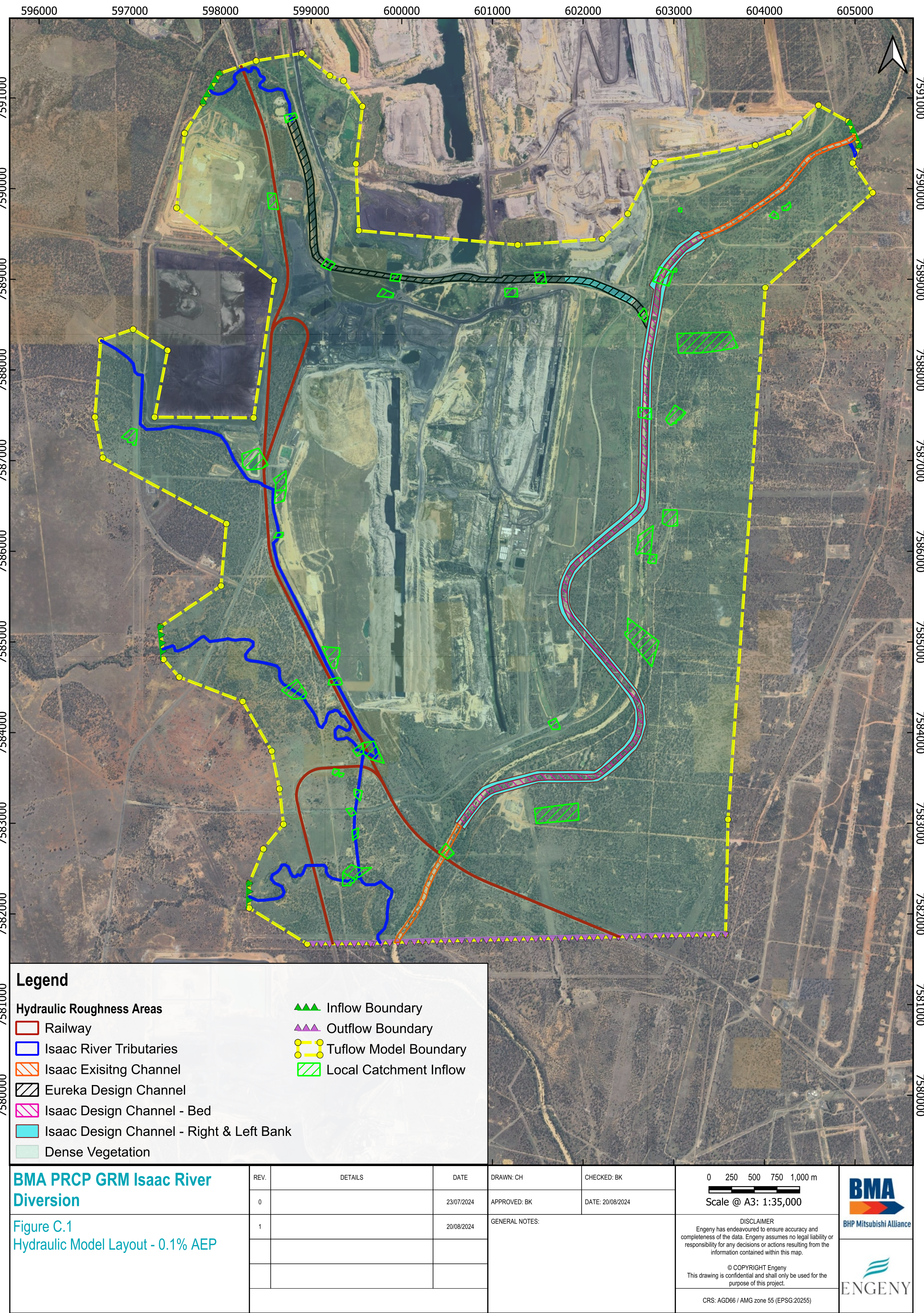
## C.3 Model Inflows and Boundary Conditions

Boundary conditions are required in the model to define hydrology inflows, flow leaving the model domain and interfaces between the one dimensional and two-dimensional model domains. The following boundary conditions used in the models are:

- Upstream: The upstream boundary condition used a combination of 'SA' and 'BC' type boundaries, allocating flow to the defined model grid cells based on the design hydrograph from the hydrologic model (flow per unit of time) input. Total inflow hydrographs were applied to Isaac River at the upstream boundary.
- Downstream: Three normal depth outflow boundaries were adopted with a hydraulic grade based on the Isaac River channel grade at the downstream extent of the model. The boundary was located a sufficient distance downstream to not influence the flood behaviour near the areas of interest.

Peak flows as estimated by the WBNM hydrologic model (only for 0.1% AEP event) have been applied at various locations dependent on the diversion being assessed. The location of the model inflows (0.1% AEP) can also be seen in Figure C.1. As mentioned in section 6.4.1, for the 39% and 2% AEP event, constant ACARP flows were applied throughout the diversion as shown in Figure C.2.





**Legend**

**Hydraulic Roughness Areas**

Railway

Isaac River Tributaries

Isaac Existing Channel

Eureka Design Channel

Isaac Design Channel - Bed

Isaac Design Channel - Right & Left Bank

Dense Vegetation

Inflow Boundary

Outflow Boundary

Tuflow Model Boundary

Local Catchment Inflow

**BMA PRCP GRM Isaac River Diversion**

Figure C.1  
Hydraulic Model Layout - 0.1% AEP

| REV. | DETAILS | DATE       |
|------|---------|------------|
| 0    |         | 23/07/2024 |
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GENERAL NOTES:

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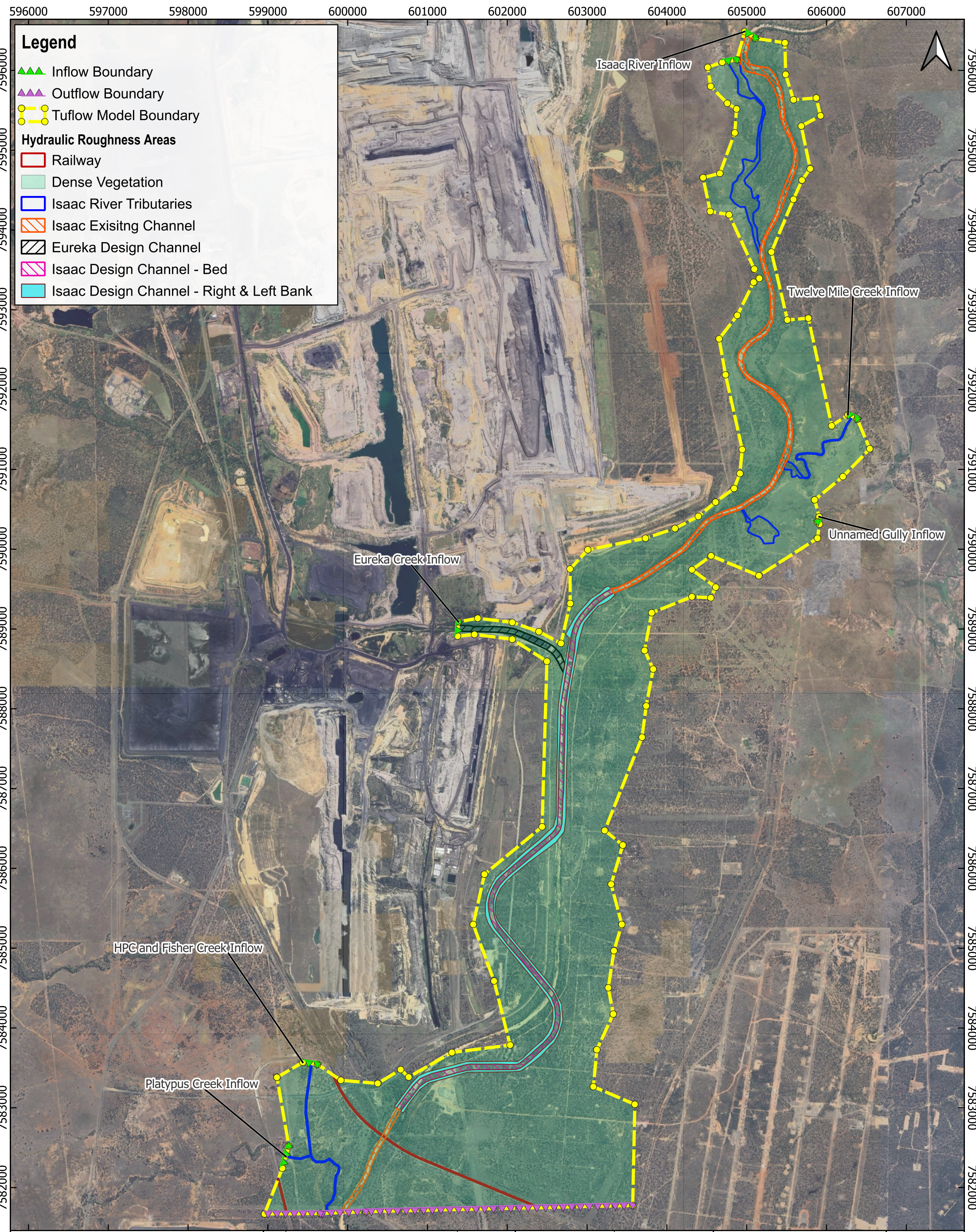
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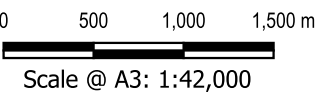




**BMA PRCP GRM Isaac River  
Diversion**

**Figure C.2**  
**Hydraulic Model Layout - 39 and 2%  
AEP**

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# APPENDIX D: HYDRAULIC PARAMETER MODELLING RESULT





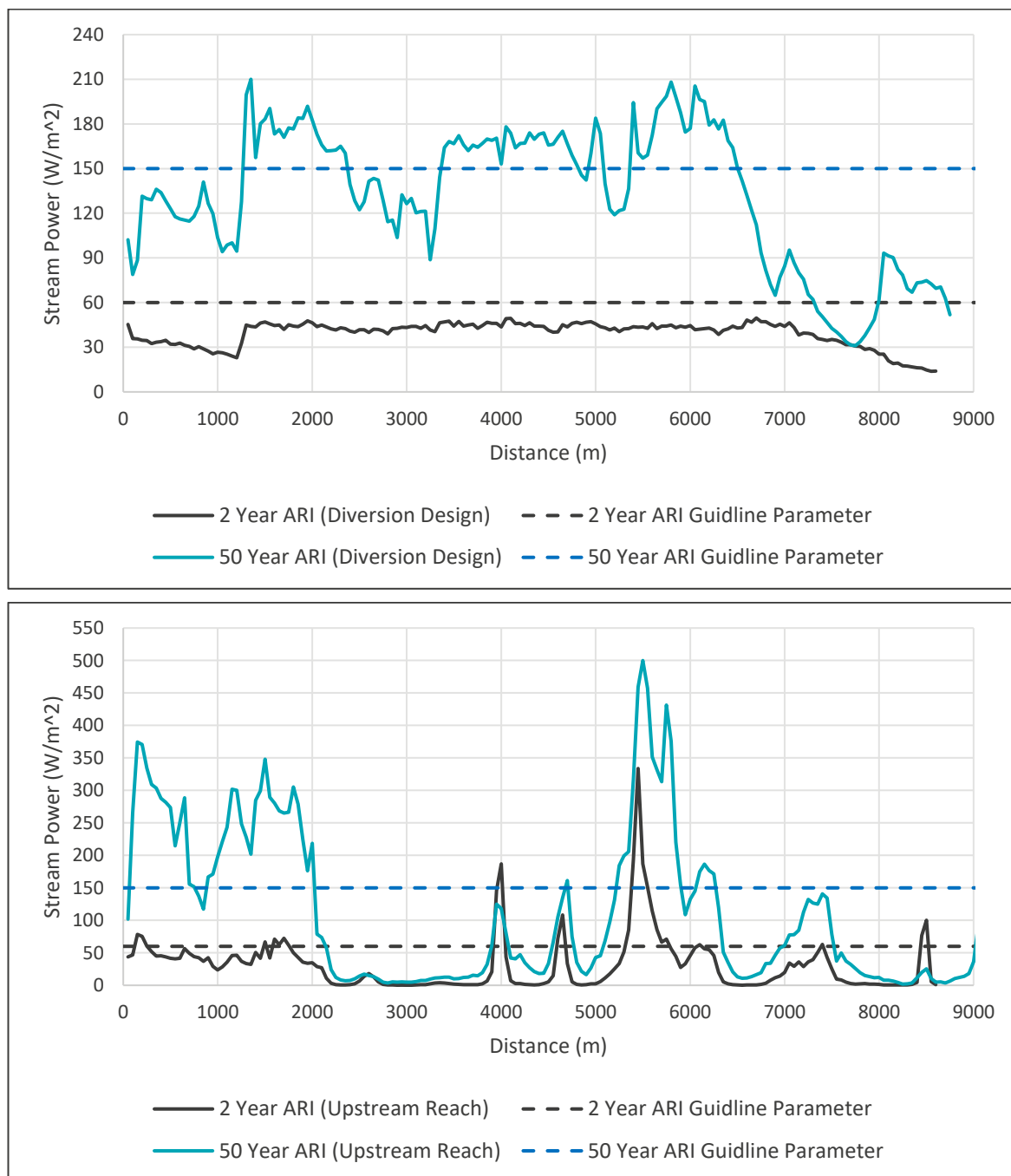


FIGURE D.1: STREAM POWER TUFLOW MODEL RESULTS (DIVERSION DESIGN AND UPSTREAM REACH)

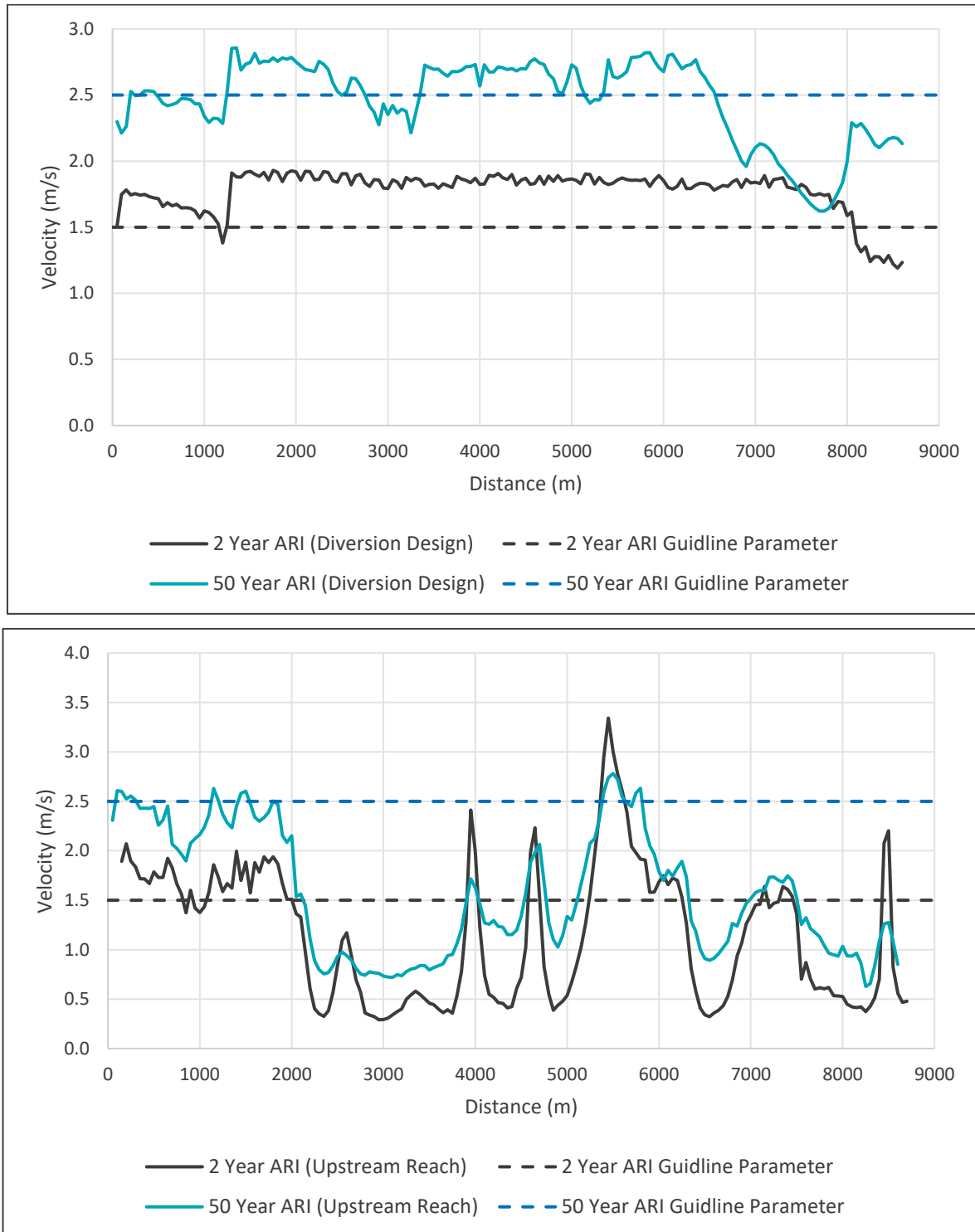


FIGURE D.2: VELOCITY TUFLOW MODEL RESULTS (DIVERSION DESIGN AND UPSTREAM REACH)



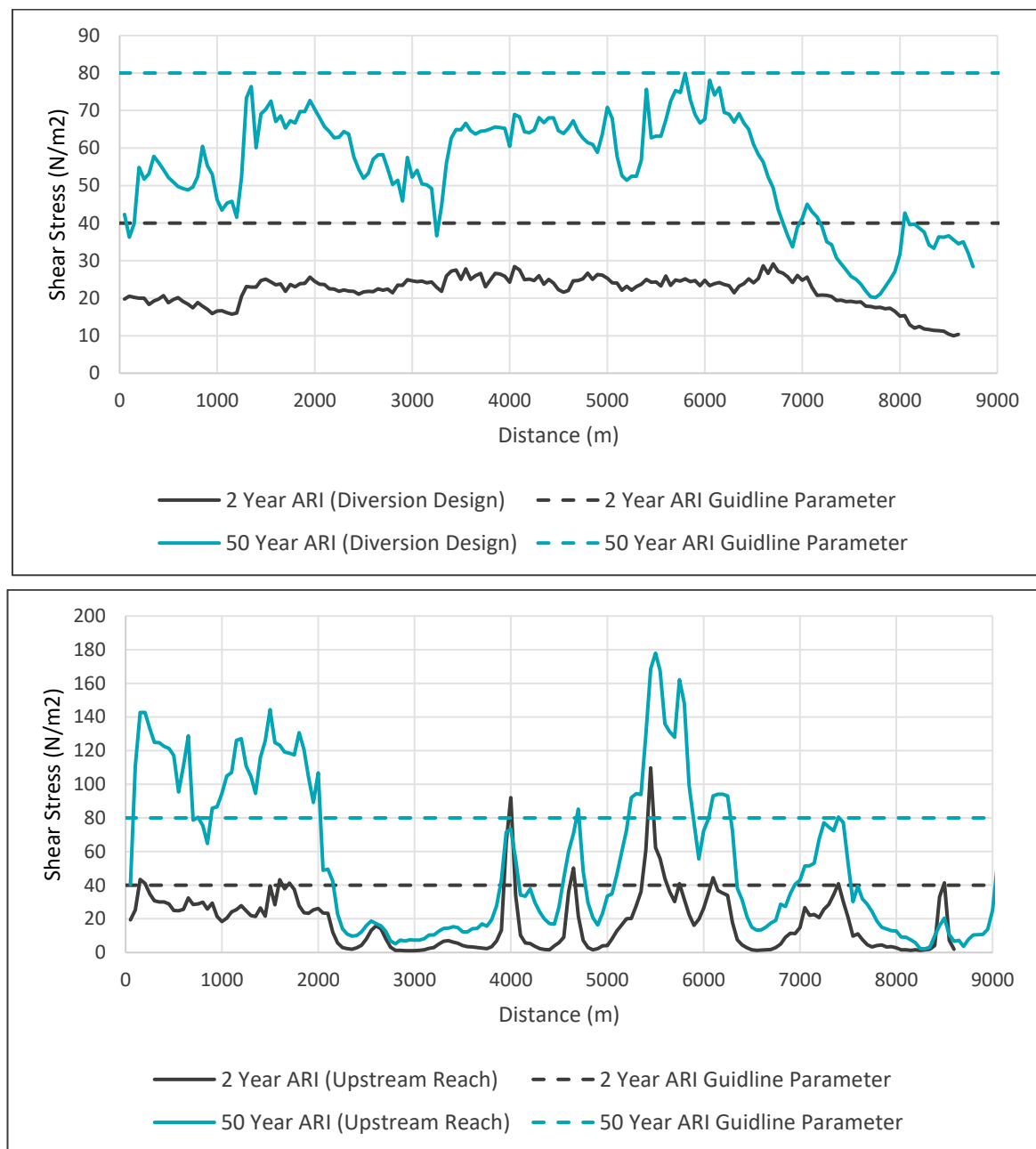


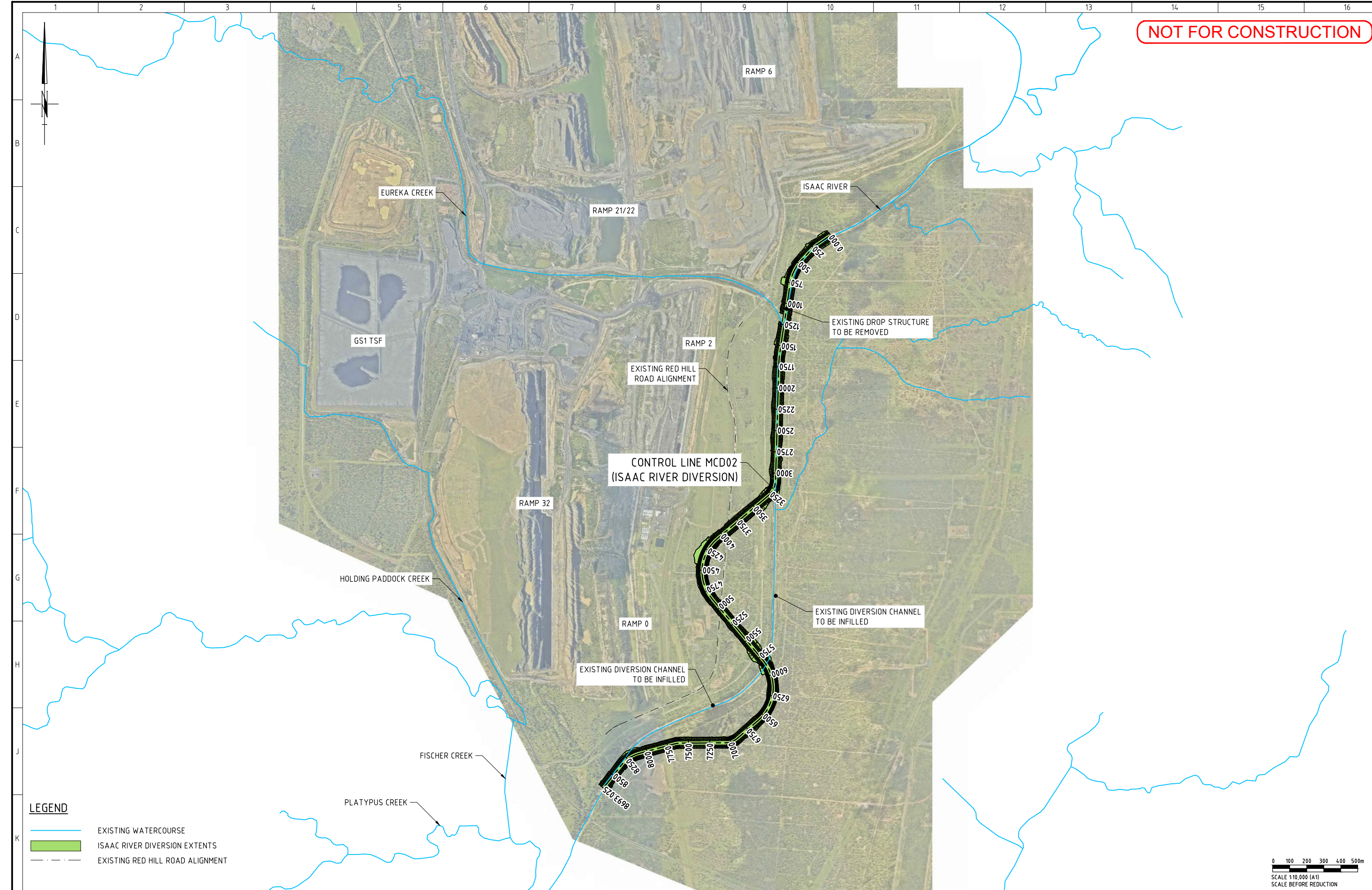
FIGURE D.3: SHEAR STRESS TUFLOW MODEL RESULTS (DIVERSION DESIGN AND UPSTREAM REACH)

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# APPENDIX E: PREFERRED OPTION CONCEPT DESIGN DRAWINGS







NOT FOR CONSTRUCTION

LEGEND

- EXISTING WATERCOURSE
- ISAAC RIVER DIVERSION EXTENTS
- EXISTING RED HILL ROAD ALIGNMENT

VENDOR DRG NUMBER  
QC1000-051-DWG-0101



| REVISION |      | REFERENCE DRAWINGS |       |
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| SIGNATURE        | DATE | RPEQ ENGINEER | SIGNATURE  |
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| ENGINEER         |      | EQUIPMENT TAG |            |
| ENG. CHK (QA)    |      |               |            |
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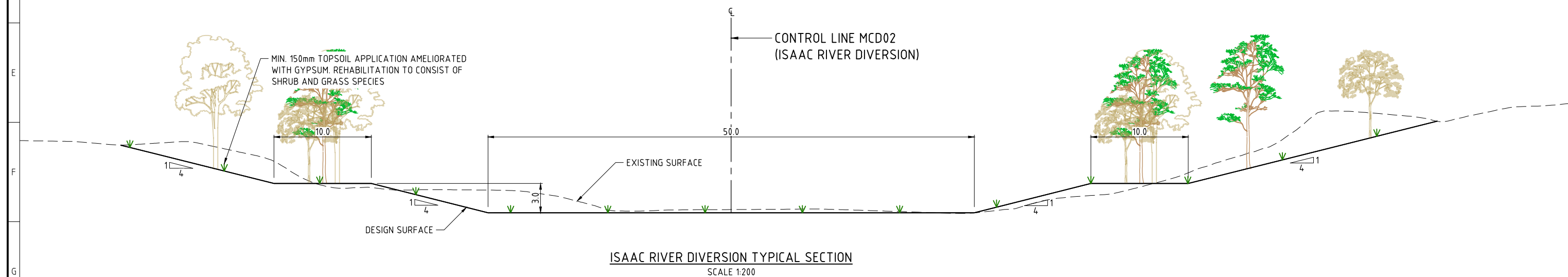
GOONYELLA MINE  
PRCP ISAAC RIVER DIVERSION  
GENERAL ARRANGEMENT PLAN

STATUS: NOT FOR CONSTRUCTION - FOR DISCUSSION

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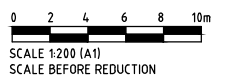


## ISAAC RIVER DIVERSION TYPICAL SECTION

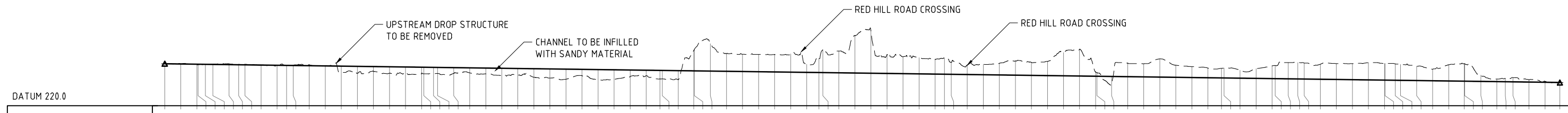
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———— DESIGN SURFACE

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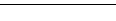
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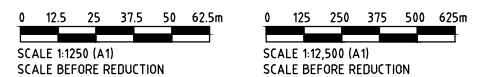
SCALE 1:12500 HORZ.

SCALE 1:1000 VERT.

LEGEND

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| VENDOR LOGO<br> |  |  |  |  |  |  |  |  |  |                                       |  |  |               |  |      |                                                                         |  |  |  | DRAWN            |  |  | SIGNATURE     | DATE | RPEQ ENGINEER |  |                                                                       |  |  |  |
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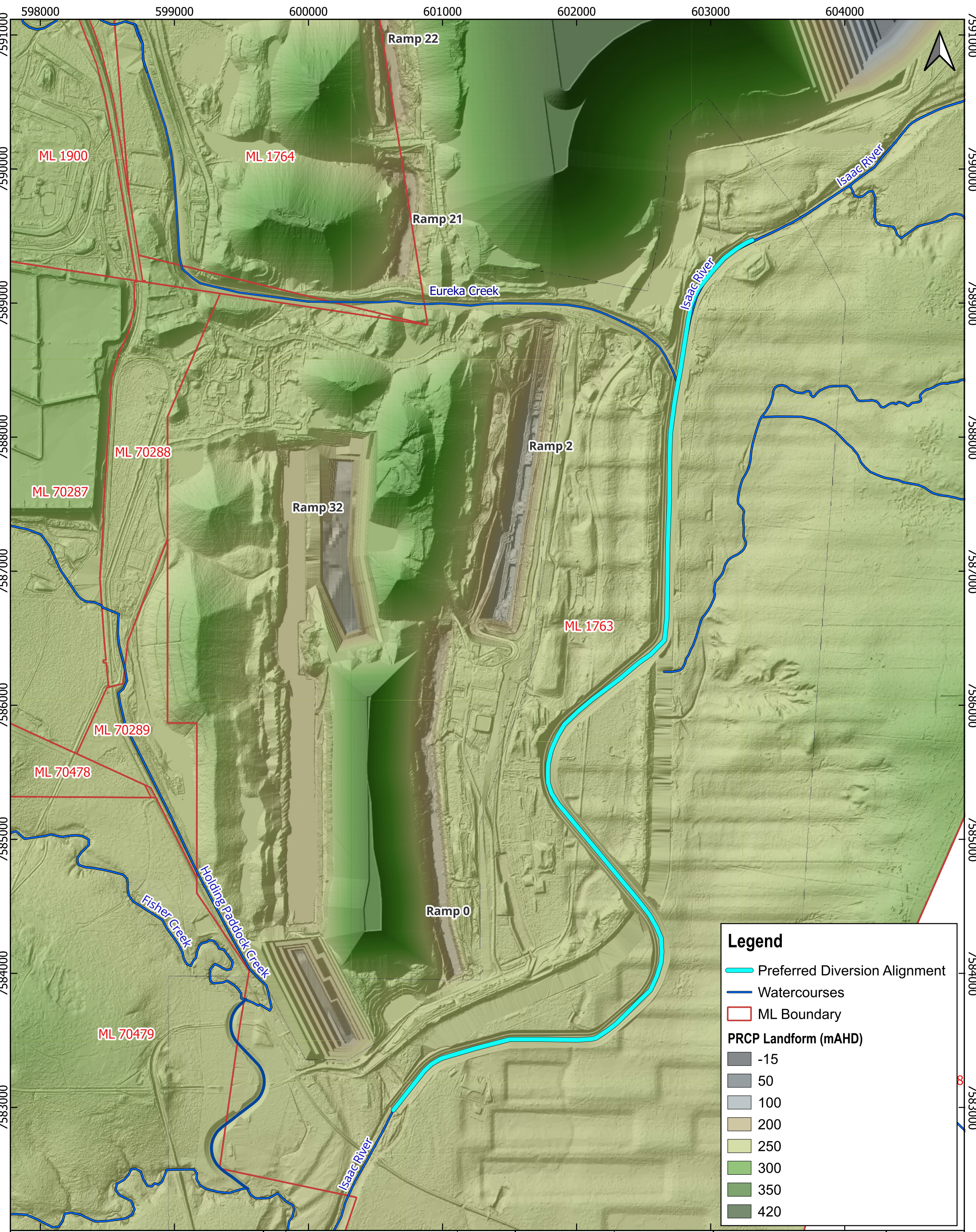


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# APPENDIX F: CONCEPT DESIGN WITH PRCP LANDFORM (VERSION 2) INTERACTION







**BMA PRCP GRM Isaac River  
Diversion**

**Figure F.1  
Isaac River Concept Design with PRCP  
Landform 2**

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# BMA

## PRCP Concept Design Report

Fisher Creek Diversion

QC1000\_051-REP-002-2

30 SEPTEMBER 2024



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| Rev | Date       | Description      | Author                          | Reviewer    | Project Mgr.  | Approver    |
|-----|------------|------------------|---------------------------------|-------------|---------------|-------------|
| 0   | 24/07/2024 | Issue for Review | Christian Hansen & Sean Willmet | Ben Kiernan | Ryan Kinnealy | Ben Kiernan |
| 1   | 14/08/2024 | Issue for Review | Christian Hansen & Sean Willmet | Ben Kiernan | Ryan Kinnealy | Ben Kiernan |
| 2   | 30/09/2024 | Client Issue     | Christian Hansen & Sean Willmet | Ben Kiernan | Ryan Kinnealy | Ben Kiernan |

**Signatures:**



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# 1. INTRODUCTION

## 1.1 Context

The purpose of this report is to detail the concept design developed for the closure and ultimate relinquishment of the Fisher Creek Diversion to comply with the conditions under EA EPML00853413. The diversion was authorised through the *Central Queensland Coal Associates Agreement Act 1968* (CQCAA Act). Therefore, the diversion is required to achieve a state of dynamic equilibrium enabling its relinquishment in the post closure landform of the Goonyella Riverside Mine (GRM).

The long-term performance of the diversion under both operating and closure scenarios is assessed within the following objectives, based on requirements from relevant licences and approvals:

- The diversion demonstrates to be in a safe, stable, non-polluting, and self-sustaining state (As per Environmental Authority requirements outlined in Section 3.3).
- Rehabilitation requirements (acceptance criteria) include goals, objectives and acceptance criteria for the post mining land use of the 'Watercourse' which is applicable for the watercourse diversion.
- Achieves the key outcomes identified in the Department of Natural Resources, Mines and Energy (DNRME) *Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000* (DNRME, 2019).

This report details the design requirements for the rehabilitation of the diversion for incorporation into the Progressive Rehabilitation and Closure Plan (PRCP) for GRM as described in the Queensland Department of Environment and Science (DES) *Guideline: Progressive rehabilitation and closure plans* (ESR/2019/4964, Version 3- 4 April 2023).

## 1.2 Purpose and Scope

The scope of work for each diversion is comprised of two stages:

- Stage 1: Options identification, assessment and selection.
- Stage 2: Concept Design on the preferred option outcome from Stage 1.

The purpose of this document is to outline the concept design developed for the preferred diversion option (outcome from Stage 1) to achieve a state of dynamic equilibrium resulting in a relinquishable state for the diversion. The following methodology was conducted:

- A desktop geomorphic assessment of the creek was undertaken using historical aerial imagery and survey to identify options for the closure alignment.
- Review of existing flood studies to determine peak flow rates for design flow events to assess hydraulic performance.
- Hydraulic assessment of the diversion option against the criteria in the *DNRME 2019 Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000* (DNRME, 2019).
- Develop concept design sketches and watercourse diversion spatial polygons for presentation in the PRCP.
- Develop concept design report summarising the design and key information required for inclusion in the PRCP.

## 1.3 Design Process

### 1.3.1 Concept Design Considerations

The design is concept only, and not at functional level which would be required for approval and construction. The concept design is developed exclusively for PRCP purposes within the limitations of the PRCP, with only permanent design options considered.

To progress the concept design to a functional design level, detailed site-specific information is required including:

- Soil surveys and geotechnical studies.
- Material characterisation for use in erosion protection cover (i.e. rock sizing and composition).
- Site specific revegetation studies.



## 2. OVERVIEW

### 2.1 Location

Fisher Creek is a tributary of the Isaac River hydrologically connected to Holding Paddock (upstream) and Platypus Creek (downstream). The creek is located approximately 25 km north of Moranbah and is part of the Fitzroy River Basin within the Bowen Basin geological formation. The location within the Queensland region is shown in Figure 2.1. The upstream catchment covers an area of approximately 64 km<sup>2</sup> and flows through open woodlands across gently sloping plains with cattle grazing vegetation. The upstream reach flows along the southwestern border of the Goonyella Riverside Mine (GRM) Mining Lease (ML 1763) towards the diversion reach which crosses a road and railway south of the mine.

### 2.2 Pre-Mining Condition

Fisher Creek was previously a direct tributary of the Isaac River and was independent of Platypus Creek, flowing eastward, upstream of the Goonyella rail bridge with the pre-mining reach shown in Figure 2.1. After the Holding Paddock Creek was diverted into Fisher Creek during the 1980's as part of the mining development, Fisher Creek was then diverted into Platypus Creek just downstream of the two creeks.

- **Upstream reach** – Based on historical imagery and the latest diversion monitoring report (Alluvium, 2021), Fisher Creek had three tributaries prior to the Holding Paddock Creek diversion. The reach has been subject to heavy cattle grazing which has limited vegetation regrowth; however, remnant vegetation was continuous and more dense pre-mining activity.
- **Diversion reach** – The diversion reach originally flowed directly into the Isaac River passing through grazing vegetation. Vegetation has been cleared and thinned since mining activities have begun adjacent to the reach.
- **Downstream reach** – As the diversion flows directly into Platypus Creek and originally the Isaac River, there is no defined Fisher Creek downstream reach.

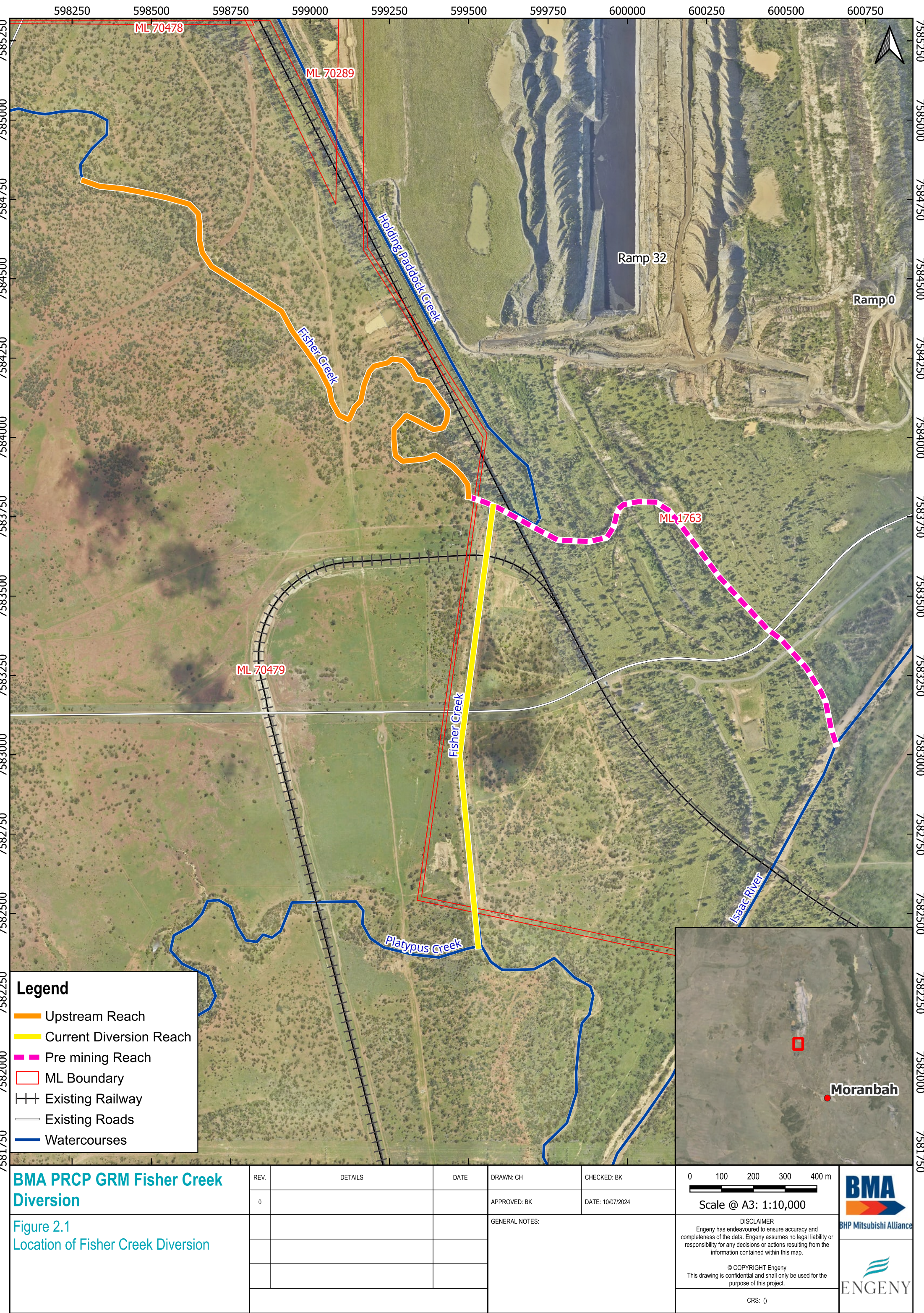
### 2.3 Current Conditions

Monitoring of the Fisher Creek diversion has been undertaken since baseline monitoring in 2009. The last major monitoring effort at the time of writing was conducted in 2020 (Alluvium, 2021) and the Fisher Creek diversion has been described in the report as follows:

- The upstream reach has continued to remain mostly static in geomorphic conditions. The riparian condition has deteriorated due to drought stress and cattle grazing which resulted in reduced ground cover. Where the bank remains stable, there is good vegetation cover however, excess sediment inputs from further upstream are smothering the bed where some morphologic diversity remains. As the catchment has effectively doubled by the Holding Paddock Creek (HPC) diversion, the reach has undergone erosional adjustments but has since recovered partly due to the high sediment inputs.
- The diversion reach discharges directly into Platypus Creek which has been considered the downstream reach of the diversion. The geomorphic condition of Platypus Creek has deteriorated significantly over time with extreme bank erosion and mass failures due to cattle grazing, vegetation clearing in the sodic soils, and increased flow rates and durations as a result of the increased catchment area from the diversion works. Severe bank erosion has occurred where vegetation has been cleared along the entire reach. The extent of groundcover has not improved since baseline monitoring and while trees and shrubs have increased in density, they are still sparse and the overall riparian condition has shown only minor improvement. A large rock chute approximately 100m upstream of the confluence between Fisher and Platypus Creeks has also been constructed in 2012 to stabilise a large erosion head originating from a failed drop structure at the Platypus Creek confluence.

The upstream and diversion reaches of the Fisher Creek diversion at the GRM are shown in Figure 2.1.





Legend

- Upstream Reach
- Current Diversion Reach
- Pre mining Reach
- ML Boundary
- Existing Railway
- Existing Roads
- Watercourses

BMA PRCP GRM Fisher Creek Diversion

Figure 2.1  
Location of Fisher Creek Diversion

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## 3. BASIS FOR CONCEPT DESIGN

There are currently two recognised guidelines for design of watercourse diversions within Queensland:

- *Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000 (Department of Natural Resources, Mines and Energy (DNRME), 2019).*
- *Criteria for functioning river landscape units in mining and post mining landscapes (Australian Coal Association Research Program (ACARP), 2014).*

Both the DNRME and ACARP Guidelines were developed based on previous research completed by ACARP in the early 2000s which included assessment of existing diversion performance and the development of design and rehabilitation criteria for watercourse diversions.

The DNRME and ACARP Guidelines have both been used to inform the basis of design for the diversion, as summarised in Table 3.1.

**TABLE 3.1: DNRME AND ACARP GUIDELINES USED FOR DESIGN BASIS**

| Guideline | Design Parameter                                                                                                      |
|-----------|-----------------------------------------------------------------------------------------------------------------------|
| DNRME     | Diversion Design Outcomes and Design Recommendations<br><br>Velocity, shear stress, stream power (39% AEP) guidelines |
| ACARP     | General Design Process<br><br>Stream power (2% AEP event Guideline)                                                   |

### 3.1 DNRME Guidelines

#### 3.1.1 Diversion Design Outcome Requirements (Permanent Watercourse Diversions)

The diversion design outcome requirements are nominated by DNRME for permanent watercourse diversions and have been used to develop the design for Fisher Creek diversion:

- Outcome 1 – The permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.
- Outcome 2 – The permanent watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.
- Outcome 3 – The hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.
- Outcome 4 – The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising any impacts on upstream and downstream reaches.
- Outcome 5 – The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

#### 3.1.2 Design Criteria

DNRME recommend the following design criteria in development of permanent watercourse diversions and have been considered in development of the Fisher Creek diversion:

- The watercourse diversion should tie-in with the existing or receiving watercourse within the resource tenure boundary.
- The stability and performance of a watercourse diversion is assisted by vegetation within the watercourse diversion and adjoining floodplain and does not include artificial structures for grade control that requires ongoing maintenance.
- The channel capacity must be at least equivalent to the natural stream channel capacity existing in that vicinity.
- The length of the channel should be equivalent to the length of the watercourse it replaces.
- Bed grade/slope should be equivalent to the existing watercourse.
- Batter slopes should be designed to maintain stability through different substrates.

The DNRME Guideline also nominates a set of hydraulic design criteria which have been adapted from the original ACARP research. These hydraulic design criteria were developed based on assessment of existing Bowen Basin streams and watercourse diversions and are considered reflective of stable hydraulic conditions for ephemeral systems in central Queensland. The hydraulic design criteria are summarised in Table 3.2 and include the following:

- Shear stress which is a function of discharge, flow depth and hydraulic gradient and represents the tractive force acting on sediment particles and is used to determine the threshold of motion for sediment. High shear stress provides an indication of potential erosion in cohesive sediments or movement of non-cohesive sediments. It also provides a measure of the ability of vegetation to withstand flow.
- Stream power which is a function of hydraulic gradient, flow width and flow rate and represents the energy available to do work on the channel. High stream power values generally result in elevated erosion potential.
- Velocity which is a function of flow rate and cross-sectional area and is a simplified measure of erosion potential. Generally higher velocities result in higher erosion potential; however, stream power and shear stress are more reliable indicators of erosion and sediment transport potential.

**TABLE 3.2: DNRME 2019 HYDRAULIC DESIGN CRITERIA**

| Design Flow Event                               | Stream Power (W/m <sup>2</sup> ) | Velocity (m/s) | Shear Stress (N/m <sup>2</sup> ) |
|-------------------------------------------------|----------------------------------|----------------|----------------------------------|
| 39% AEP (previously 2-year ARI) - No Vegetation | <35                              | <1.0           | <40                              |
| 39% AEP (previously 2-year ARI) - Vegetated     | <60                              | <1.5           | <40                              |
| 2% AEP (previously 50-year ARI)                 | <150                             | <2.5           | <80 <sup>1</sup>                 |

<sup>1</sup> DNRME values are extracted from ACARP 2002, however the value reported for the 2% AEP shear stress (<50 N/m<sup>2</sup>) in the DNRME 2014 is incorrect. The ACARP value of <80 N/m<sup>2</sup> has been adopted.

The DNRME hydraulic design criteria summarised in Table 3.2 were adopted as the basis for the concept design. The ACARP value described in Section 3.2 are provided for information only. The ACARP values were referenced when considering stable stream powers and shear stresses during the vegetation establishment phase of the construction.

## 3.2 ACARP Guidelines

ACARP (2014) outlined several approaches to the design of diversion channel dimensions, including:

- The analogous approach, where channel dimensions are selected from a reference reach.
- The hydraulic geometry approach, where dimensions are determined from regression relationships; and,
- The analytical approach, where equations are used to calculate continuity, hydraulic resistance, and sediment transport and channel characteristics are determined from field inspection of a reference reach.

In addition to the analogous approach, ACARP (2014) also provides guidance on alluvial channel design parameters which were adapted from ACARP (2002). These hydraulic parameters are intended to be representative of stable watercourses within the Bowen Basin and are summarised in Table 3.3.



**TABLE 3.3: ACARP 2014 ALLUVIAL CHANNEL DESIGN PARAMETERS**

| Stream Type        | Sediment Scenario | Stream Power 39% AEP (W/m <sup>2</sup> ) | Stream Power 2% AEP (W/m <sup>2</sup> ) |
|--------------------|-------------------|------------------------------------------|-----------------------------------------|
| Alluvial           | Supply limited    | 15-35                                    | 50-100                                  |
|                    | Transport limited | 35-60                                    | 80-150                                  |
| Bedrock Controlled | n/a               | 50-100                                   | 100-350                                 |

ACARP (2014) also provides recommendations on shear stress thresholds for vegetation used as part of rehabilitation activities. These thresholds are summarised in Table 3.4.

**TABLE 3.4: ACARP 2014 RECOMMENDED VEGETATION SHEAR STRESS THRESHOLDS**

| Vegetation Type                                             | Design Shear Stress (N/m <sup>2</sup> ) |
|-------------------------------------------------------------|-----------------------------------------|
| Buffel grass ( <i>Cenchrus ciliaris</i> )                   | 40                                      |
| Structurally diverse suite of established native vegetation | 120                                     |

## 4. OPTIONS IDENTIFICATION

Engeny identified two potential options for the diversion as part of stage 1 (summarised below in Table 4.1). The following criteria were also considered during the development of the concept design:

- Geomorphic features of the pre mining drainage path.
- Upstream and downstream channel geometry and grade.
- Remaining within the ML boundary.
- Impacts to, and from, the final landform.
- Impacts to surrounding drainage paths and catchments.
- Permanent options only.

The objective was to identify suitable options for the rehabilitation of the diversion, and select a preferred option informed by multi-criteria analysis (MCA) to progress to concept design.

Each option was defined with a concept cross section and longitudinal profile. Civil earthworks modelling was undertaken to confirm the following:

- Alignment of the diversion options.
- The need for potential flood levees (during operations).
- Final landform reconfiguration.
- Reinstatement of the floodplain.
- Proposed tie-in locations to the existing waterway.
- Development of a Class 5 capital cost estimate for construction.

The options identification also included assessment of key risks and opportunities regarding construction staging, potential for impacts to downstream infrastructure and post mining land-use risks in the context of closure.

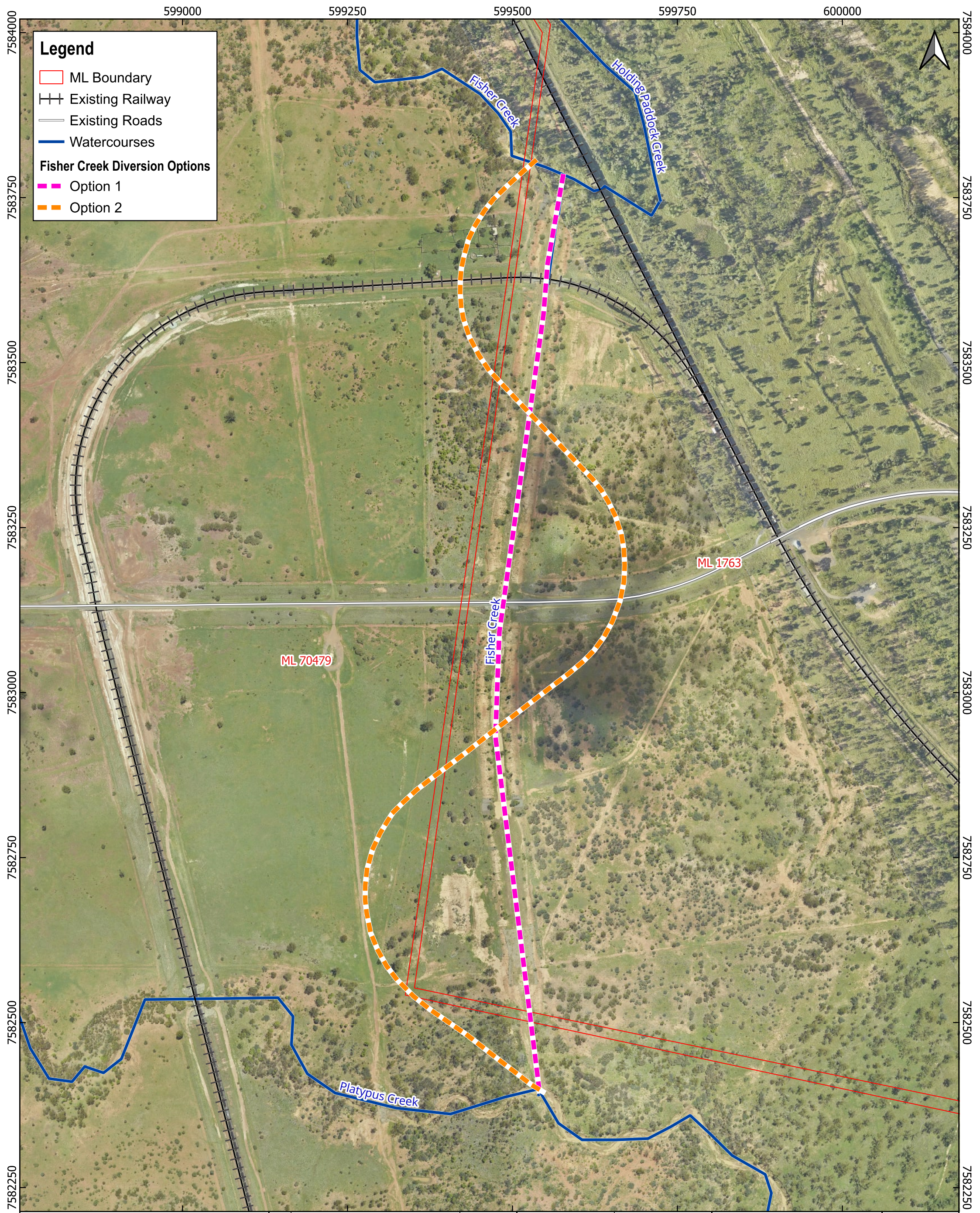
The three options assessed are shown in Figure 4.1 and summarised in Table 4.1.

**TABLE 4.1: OPTIONS IDENTIFICATION DETAILS**

| Statistic                                                           | Option 1                                                                                                                                                                                                                                                   | Option 2                                                                                                                                                                                                              |
|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description                                                         | Retain existing diversion alignment, the total length of the diversion is approximately 1500m                                                                                                                                                              | Meanders to the east of the existing diversion. The diversion crosses Red Hill Road and Goonyella Hay Point Railway between Holding Paddock and Platypus creek. Total length of the diversion is approximately 1800m. |
| Likelihood that diversion will achieve state of dynamic equilibrium | Low – has an alignment with a length (1.4 km) and grade (0.39%) similar to the pre-mining alignment. However, Option 1 has drop structure; Creek deteriorating. Further remediation works to be completed to return creek to state of dynamic equilibrium. | High – has an alignment with a length (1.8 km) and grade (0.28%) similar to the pre-mining alignment.                                                                                                                 |
| Order of magnitude cost estimate*                                   | \$1.0 M                                                                                                                                                                                                                                                    | \$6.9 M                                                                                                                                                                                                               |
| Ability to isolate diversion from flows during establishment period | No – will be constructed on the existing diversion alignment                                                                                                                                                                                               | Yes – option 2 cuts across the existing alignment at two separate locations. It is possible but there is some engineering risk.                                                                                       |

\* Costs estimated based on average \$10/m<sup>3</sup>.





**BMA PRCP GRM Fisher Creek Diversion**

Figure 4.1  
Fisher Creek Diversion Realignment Options

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## 5. OPTIONS ANALYSIS

### 5.1 Multi-Criteria Analysis Framework

A high-level multi-criteria analysis (MCA) was undertaken to rank the identified options for individual criteria as per Figure 5.1 below and determine a preferred option. The weighting of each criterion was determined and agreed upon with a BMA and Engeny collaborative decision group. The individual weightings are summarised in Table 5.1. Based on the score for each criterion against each option, a preferred option is identified.

|                   |                          |                        |                |                        |                          |
|-------------------|--------------------------|------------------------|----------------|------------------------|--------------------------|
| <b>-3</b>         | <b>-2</b>                | <b>-1</b>              | <b>0</b>       | <b>1</b>               | <b>2</b>                 |
| <b>Fatal Flaw</b> | <b>Strongly Negative</b> | <b>Mildly Negative</b> | <b>Neutral</b> | <b>Mildly Positive</b> | <b>Strongly Positive</b> |

**Figure 5.1: Ranking Scores for MCA**

**TABLE 5.1: WEIGHTING FOR INDIVIDUAL SCREENING CRITERIA**

| Criteria                                                            | Weight |
|---------------------------------------------------------------------|--------|
| Likelihood that diversion will achieve state of dynamic equilibrium | 50%    |
| Order of magnitude cost estimate                                    | 30%    |
| Ability to isolate diversion from flows during establishment period | 20%    |

### 5.2 Multi-Criteria Analysis

The MCA resulted in Option 2 to be carried forward into concept design as a preferred option, since it scored highest out of the two options and resulted in the lowest relative risk (see Table 5.2). Refer to Appendix A for the detailed MCA and scoring.

**TABLE 5.2: MULTI-CRITERIA ANALYSIS OUTCOMES**

| Item                   | Option 1     | Option 2    |
|------------------------|--------------|-------------|
| Overall Weighted Score | -0.4         | 1.2         |
| Relative Risk          | Neutral Risk | Lowest Risk |
| Fatal Flaw             | No           | No          |



# 6. CONCEPT DESIGN

## 6.1 Design Parameters and Plan

Table 6.1 details the parameters for each outcome in Section 3, forming the design plan for the permanent diversion, aligning with DNRME and ACARP Guideline requirements.

**TABLE 6.1: DNRME AND THE AUSTRALIAN COAL ASSOCIATION RESEARCH PROGRAM (ACARP) PARAMETERS ADOPTED**

| DNRME Parameters (DNRME, 2019)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Equivalent ACARP Parameters (ACARP, 2014)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>Outcome 1 –</i></p> <p>The design plan should include a detailed description of:</p> <p>a) the location, function, and description of geomorphic features within the proposed watercourse diversion as well as a revegetation and vegetation management plan.</p>                                                                                                                                                                                                                                                                                                                                                                                           | <p><i>Outcome 1 –</i></p> <p>Geomorphic and riparian vegetation features of the diverted watercourse and connecting reaches (minimum of 1 km upstream and downstream of proposed tie ins). Vegetation characteristics along the proposed optional watercourse diversions should also be noted. <input checked="" type="checkbox"/></p>                                                                                                                                                                                                                                                                                                                                                                                   |
| <p><i>Outcome 2 –</i></p> <p>The design plan should include a detailed description of:</p> <p>a) the development and calibration, or sensitivity analysis, of the hydrologic model, including the referencing of methodologies used to generate flood frequency analysis<sup>1</sup></p> <p>b) any design implications and construction processes that necessitate a lateral disconnectivity of sub-surface flow between the watercourse and an adjacent final void (if proposed).</p> <p><sup>1</sup> A hydrologic model for the southern extent of GRM inclusive of Fisher Creek was originally developed as part of the Eureka Flood Study (Engeny, 2024).</p> | <p><i>Outcome 2 –</i></p> <p>Summary of hydrological characteristics including surface water-groundwater interactions and water use. Flow changes along the reach should also be clearly noted. <input checked="" type="checkbox"/></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <p><i>Outcome 3 –</i></p> <p>The design plan should include hydraulic modelling results (benchmarked against guideline values for stream power, shear stress and velocity adopted from ACARP, 2002) and analysis identifying depth of inundation. The design plan should include a floodplain of sufficient capacity.</p>                                                                                                                                                                                                                                                                                                                                         | <p><i>Outcome 3 –</i></p> <p>Summary of hydraulic characteristics along the waterway length. Longitudinal section of stream power with standard cross section increments. A higher frequency of cross sections is required at stream junctions and bifurcations. <input checked="" type="checkbox"/></p> <p>A table summarising stream powers (in channel and floodplain) at each cross section is also required, along with statistics for the reach. This specifically includes the reach minimum, low quartile, median, mean, upper quartile and maximum values<sup>2</sup>. <input type="checkbox"/></p> <p><sup>2</sup> Only mean stream power values were calculated for comparison with the adopted criteria.</p> |
| <p><i>Outcome 4 –</i></p> <p>The design plan should include a sediment transport analysis that identifies how the watercourse diversion will manage erosion or deposition events such that they are consistent with the existing sediment regime.</p>                                                                                                                                                                                                                                                                                                                                                                                                             | <p><i>Outcome 4 –</i></p> <p>Sedimentation characteristics. Where the existing reach is aggrading, degrading, or is in equilibrium. Note presence of sediment sources (e.g., main channel bed or bank instabilities, floodplain contributions) and sinks (e.g., flood outs or sediment splays along low gradient sections of the reach, and infilling pools). <input checked="" type="checkbox"/></p>                                                                                                                                                                                                                                                                                                                    |
| <p><i>Outcome 5 –</i></p> <p>The design plan should include the specification of spoil placement and sequencing and the settlement process and timing of operation that will ensure the watercourse diversion, once constructed, operates in a stable manner.</p>                                                                                                                                                                                                                                                                                                                                                                                                 | <p><i>Outcome 5 –</i></p> <p>Interaction between watercourse diversion options and mine infrastructure (pipes, pits, culverts, access, etc.) and planning over the life of mine <input checked="" type="checkbox"/></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

It is important to note only benchmark values for shear stress and velocity were adopted from DNRME (2019). Stream power benchmark values were adopted from ACARP (2014) due to it being a more contemporary standard that considers impacts of sediment transport.

## 6.2 Concept Design Diversion Alignment

The alignment of Option 2 was determined to be the preferred option using the MCA. Option 1 was not chosen due to the high grade of the existing diversion (0.39%) predicted to not be able to perform within the hydraulic design criteria even with remediation works. Option 2 was further refined to closely match the pre-mining grade and compliance with the hydraulic design criteria. The full concept drawing package for the permanent Fisher Creek diversion is included in Appendix E and the interaction of the design with the PRCP landform 2 in Appendix F.

## 6.3 Channel Geometry and Grade

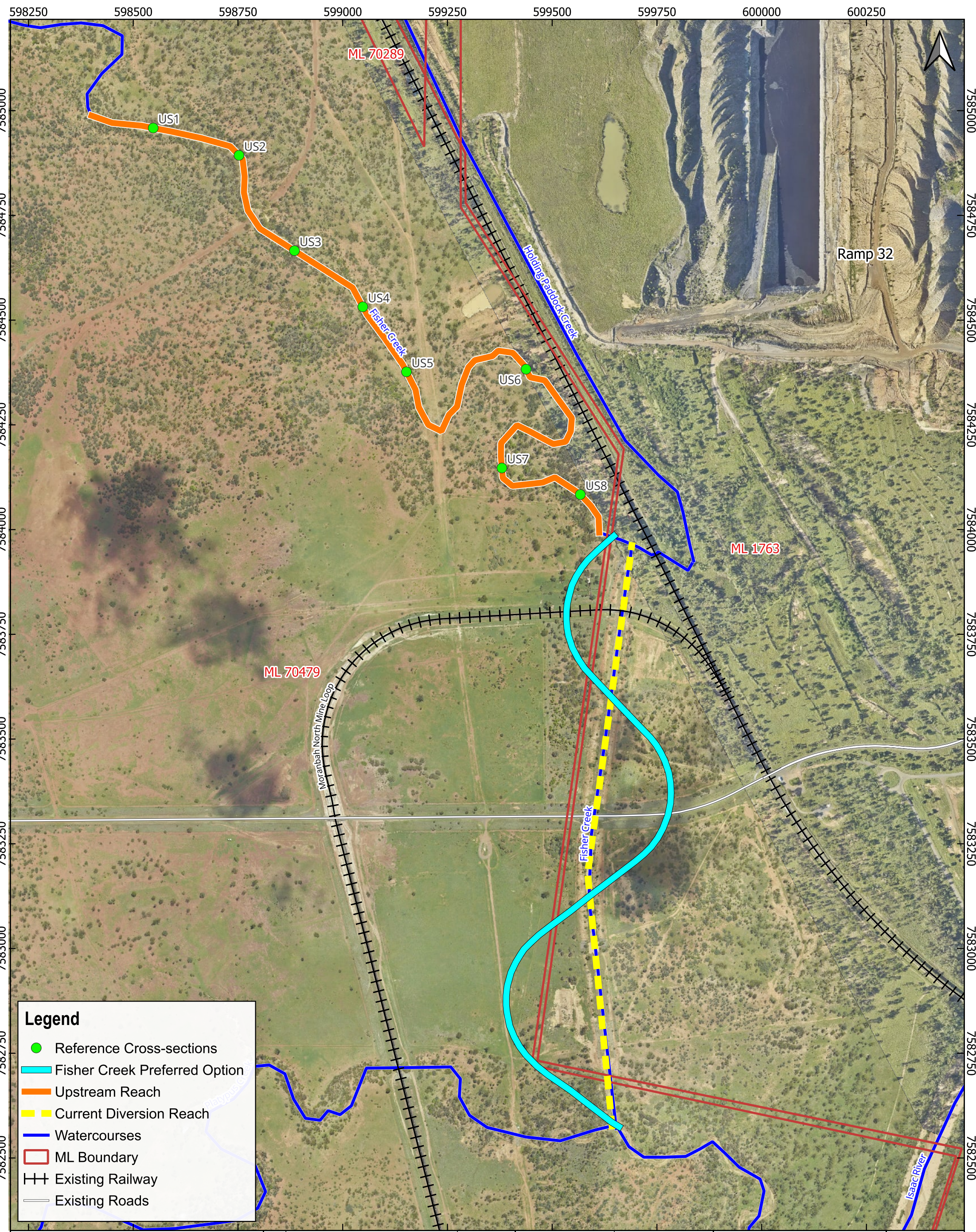
The location of the reference cross sections is shown in Figure 6.1. The typical upstream channel cross sections are presented in Figure 6.2. These dimensions were based on the average natural downstream channel geometry and grade as assessed in the options identification phase.

Table 6.2 summarises the typical channel cross section selected for the concept design. The concept design drawings in Appendix E show the typical cross sections, longitudinal profile, and footprint of the proposed channel works.

**TABLE 6.2: DETAILED CHANNEL CROSS SECTION GEOMETRY FOR CONCEPT DESIGN**

| Channel Geometry  | Quantity                                              | Comments                                                                                                                                                                                                                          |
|-------------------|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Channel Bed Width | 9.5 m                                                 | Based on current upstream Fisher Creek representative cross sections and additional catchment area inflows from Holding Paddock Creek factored into the downstream diversion cross section                                        |
| Bench Width       | 4 m                                                   |                                                                                                                                                                                                                                   |
| Channel Depth     | 2 m                                                   | Consistent depth of low flow channel at 2 m                                                                                                                                                                                       |
| Batter Slope      | 1V:5H (Low Flow Channel)<br>1V:6H (High Flow Channel) | Based on the existing upstream Fisher Creek representative cross sections.<br>The batters will be covered with topsoil, hydromulch and hydroseed (Appendix E) to ensure stability and prompt revegetation of the channel batters. |





**BMA PRCP GRM Fisher Creek Diversion**

**Figure 6.1**  
Location of Reference Cross-Sectional Areas

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| APPROVED: BK | DATE: 17/07/2024 |

GENERAL NOTES:

0100200 m

Scale @ A3: 1:8,000

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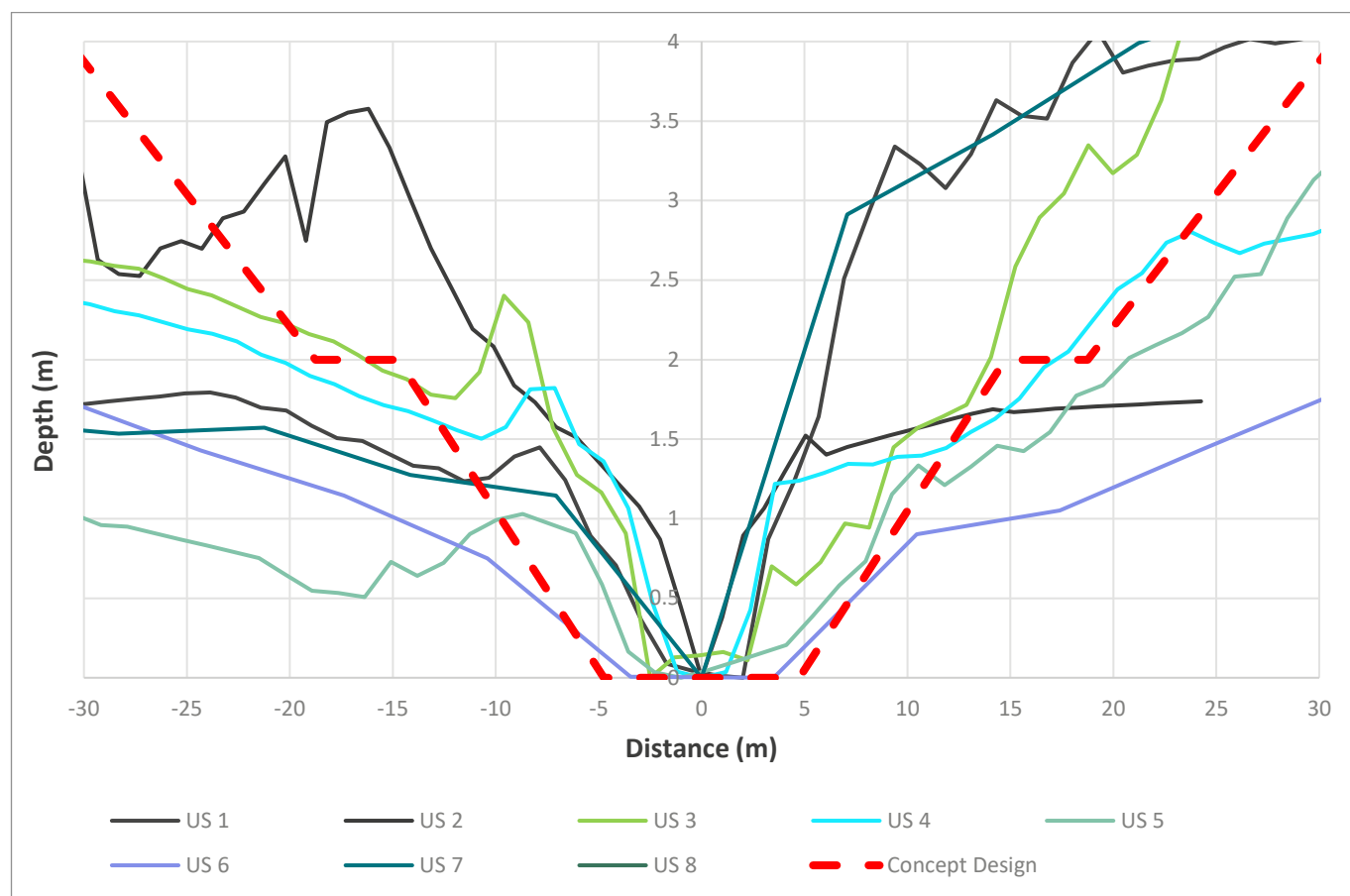
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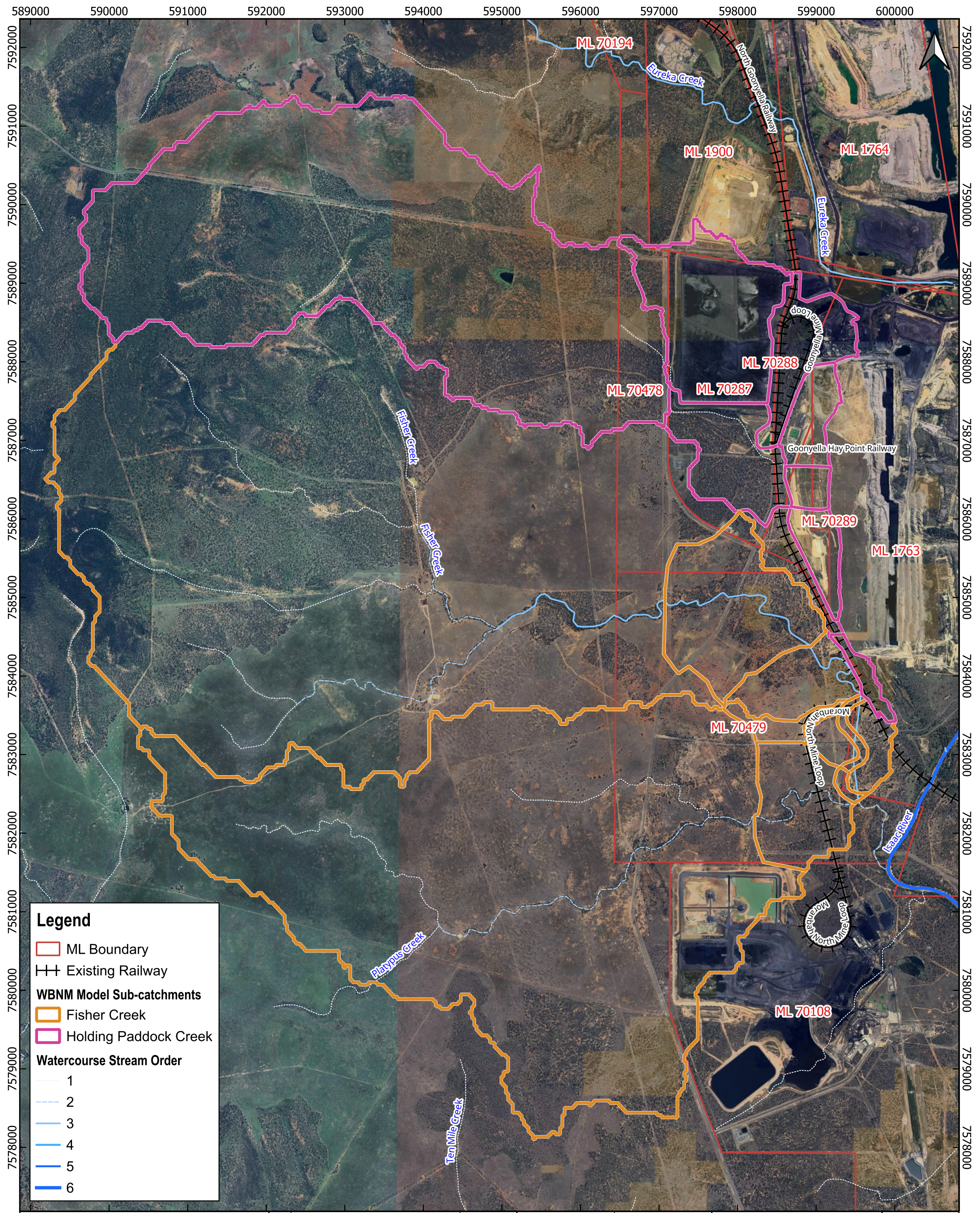
**Figure 6.2: Typical Upstream Channel Cross Section of Fisher Creek**

The concept design seeks to change the vertical grade, which is reduced from 0.39% in the existing diversion to a grade of 0.28%, with the new diversion design attributed to the more natural sinuosity adopted which is closer to the original pre-mining length. The current length of the diversion is approximately 1400m, the pre-mining length for the same reach was approximately 1500m. The new diversion design has a length of approximately 1800m and joins into Platypus Creek as opposed to the Isaac River which is depicted in the original pre-mining alignment. A longitudinal section for the diversion alignment is included in the concept design drawings in Appendix E.

## 6.4 Hydrology

A hydrologic model for the southern extent of GRM inclusive of Fisher Creek was developed for the Eureka Creek Diversion using WBNM software and was validated against the Isaac River Gauge. This model was also used for the Fisher Creek (concept design) to estimate flows for the 0.1% AEP (1 in 1000 year) flood event. The details of the hydrologic model development are presented in Appendix B. Peak flows for frequent events (39%AEP and 2%AEP) for the Fisher Creek diversion were estimated using the ACARP (2002) method and are presented in Table 6.3. The Fisher Creek catchment is presented in Figure 6.3.





**BMA PRCP GRM Fisher Creek  
Diversion**

**Figure 6.3  
Catchment Map**

| REV. | DETAILS                                 | DATE | DRAWN: CH      | CHECKED: BK      |
|------|-----------------------------------------|------|----------------|------------------|
| 1    | Catchment Map of Fisher Creek Diversion |      | APPROVED: BK   | DATE: 12/08/2024 |
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### 6.4.1 Frequent Events

Peak flows for frequent events (39% AEP and 2% AEP) for the Fisher Creek diversion (concept design) were estimated using the ACARP (2002) methods and are presented in Table 6.3. The ACARP (2002) assessment included a regional flood frequency analysis for a selection of gauged catchments in the Bowen Basin region. From this, a method was developed to estimate flood magnitudes for ungauged catchments, based on catchment area and rainfall intensity. The calculated flood magnitudes for the 39% and 2% AEP events were then used to determine diversion design limits for shear stress, stream power and velocity to provide a conservative estimate. This approach has been adopted to determine the flows within the proposed Fisher Creek diversion concept design and have been compared to the ACARP (2002) diversion channel design parameters. The diversion channel design flows were calculated based on the catchment area and rainfall intensities of both the Fisher Creek and Holding Paddock Creek catchments due to both watercourses entering the upstream section of the Fisher Creek Diversion. Alongside this the ACARP flows for both Platypus Creek and the Isaac River were also calculated and used in the hydraulic model due to their tailwater effects influencing the Fisher Creek diversion.

**TABLE 6.3: ACARP DESIGN FLOWS**

| Rainfall Event       | Peak Catchment Design Flows (ACARP, 2002) m <sup>3</sup> /s |                       |                |             |
|----------------------|-------------------------------------------------------------|-----------------------|----------------|-------------|
|                      | Fisher Creek                                                | Holding Paddock Creek | Platypus Creek | Isaac River |
| 2% AEP (50-year ARI) | 73                                                          | 53                    | 55             | 1174        |
| 39% AEP (2-year ARI) | 35                                                          | 27                    | 28             | 267         |

### 6.4.2 Rare Events

The interaction of a 0.1% AEP flood event and the PRCP landform 2 has been assessed as part of the rehabilitation flood modelling completed for the PRCP. This informs the interaction between the diversion and final voids landform. The 0.1% AEP peak flow rate at the end of the diversion is estimated at 438m<sup>3</sup>/s.

## 6.5 Hydraulics

A two-dimensional TUFLOW flood model was developed to assess the compliance with the DNRME and ACARP hydraulic performance criteria for the 39% and 2% AEP events.

Average values were derived from the TUFLOW model for the stream powers, stream velocity and shear stress in the 39% and 2% AEP event (refer to Table 6.4). The proposed diversion values have been compared to the DNRME (2019) diversion channel design parameters. The detailed results for the DNRME guideline design criteria (stream power, velocity, and shear stress) as they vary along the length of the channel are presented graphically in Appendix D.

**TABLE 6.4: DIVERSION DESIGN CRITERIA COMPARED TO DNRME (2019) GUIDELINE PARAMETERS**

| Design Criteria                  | 39% AEP (2-year ARI) |                               | 2% AEP (50-year ARI) |                               |
|----------------------------------|----------------------|-------------------------------|----------------------|-------------------------------|
|                                  | Diversion            | DNRME Design Parameter (2019) | Diversion            | DNRME Design Parameter (2019) |
| Stream Power (W/m <sup>2</sup> ) | 28.46                | <60                           | 36.60                | <150                          |
| Stream Velocity (m/s)            | 0.84                 | <1.5                          | 0.99                 | <2.5                          |
| Shear Stress (N/m <sup>2</sup> ) | 24.20                | <40                           | 28.67                | <80 <sup>1</sup>              |

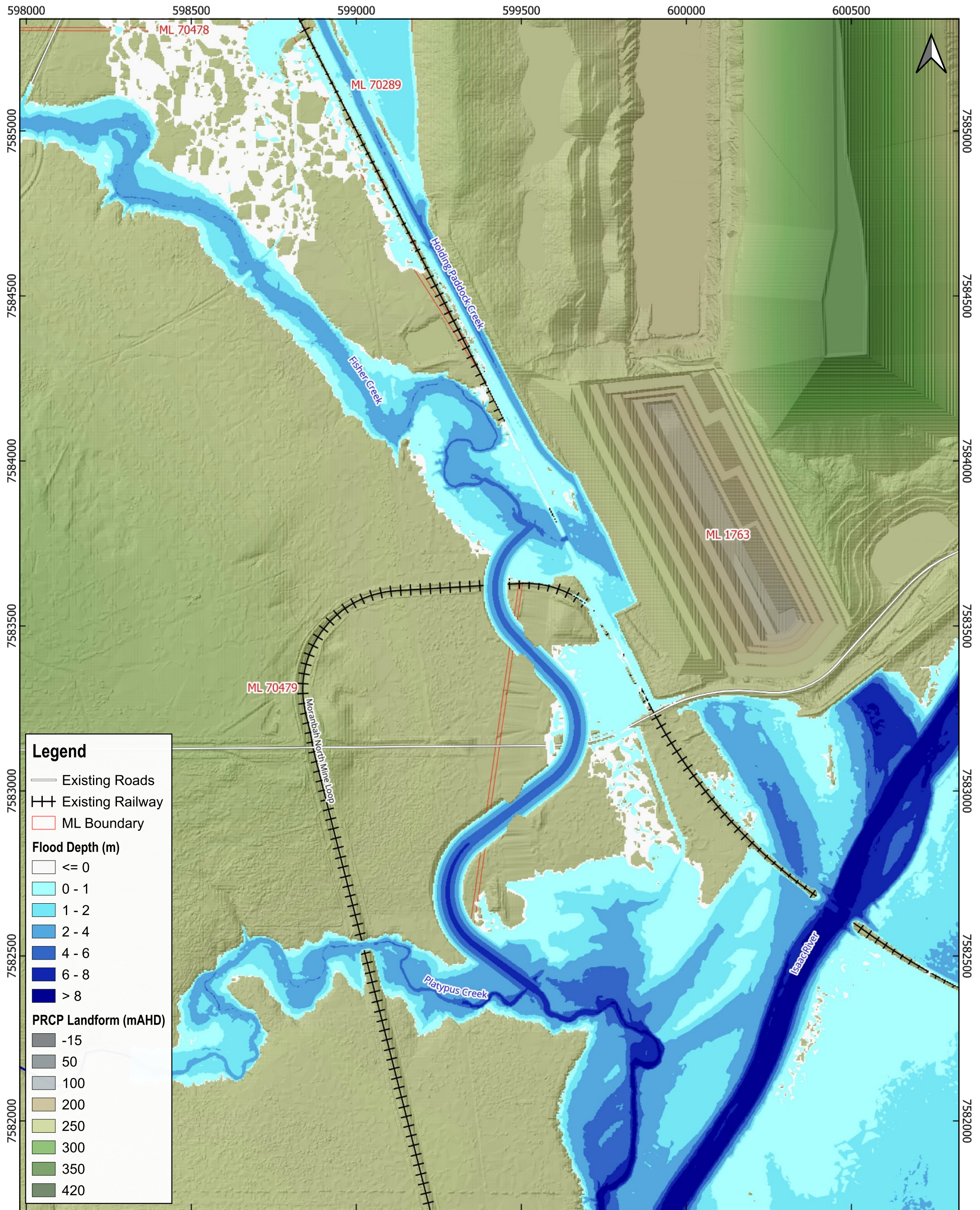
<sup>1</sup> DNRME values are extracted from ACARP 2002, however the value reported for the 2% AEP shear stress (<50 N/m<sup>2</sup>) in the DNRME 2014 is incorrect. The ACARP value of <80 N/m<sup>2</sup> has been adopted.



It can be seen from Table 6.4 that all the average diversion hydraulic results are below the design parameters for both the 39% AEP and 2% AEP events. Moreover, 39% AEP (2yr ARI) stream power and velocities meet the DNRME design criteria for stability if the channel remains unvegetated. The detailed results for the DNRME guideline design criteria (stream power, velocity, and shear stress) as they vary along the length of the channel are presented graphically in Appendix D.

The extents and depths of the 0.1% AEP design flood event with the PRCP landform 2 and concept diversion design are depicted in Figure 6.4. The result shows that there is no risk of flood ingress to any final voids.



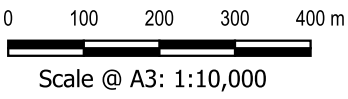


BMA PRCP GRM Fisher Creek  
Diverison

Figure 6.4  
0.1% AEP Flood Event with PRCP  
Landform 2

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## 6.6 Risks and Mitigation Measures

Table 6.5 summarises the main risks for the diversion design and its ability to achieve a state of dynamic equilibrium suitable for relinquishment. The consequence and likelihood matrix utilised for this risk assessment align with the BHP Global Standard- Risk Management.

**TABLE 6.5: DIVERSION RISKS AND MITIGATION MEASURES**

| Risks                                                                                                                                  | Likelihood      | Consequences | Risk Rating and Score | Mitigation Measures                                                                                                                                                                                                                                                                          | Residual Likelihood | Residual Consequences | Residual Risk Rating and Score |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------|--------------------------------|
| Damage to new diversion channel due to frequent (up to 20% AEP / 5 year ARI) flood events.                                             | Probable        | 2            | 9                     | <p>Diversion channel constructed during dry season.</p> <p>Majority of diversion able to be constructed while offline.</p> <p>Detailed revegetation plan to be implemented to promote rapid establishment. Seed mix to include fast establishing species to rapidly stabilise diversion.</p> | Unlikely            | 1                     | 1                              |
| Damage to the new diversion channel due to extreme/rare (0.1% AEP / 1000 year ARI) flood event (mainly overland flow and bank erosion) | Highly Unlikely | 2            | 0.9                   | <p>Revegetation plan to include large species capable of withstanding shear stresses associated with rare events.</p>                                                                                                                                                                        | Highly Unlikely     | 2                     | 0.9                            |
| Construction program impacted by frequent flow event (up to 20% AEP / 5 year ARI).                                                     | Unlikely        | 1            | 1                     | <p>Diversion construction to be timed to minimise risk of large flows while still maintaining enough watering to promote vegetation establishment and growth.</p> <p>Majority of diversion able to be constructed while offline.</p>                                                         | Unlikely            | 1                     | 1                              |
| Constructability of diversion channel – encountering bedrock, material availability and access                                         | Unlikely        | 2            | 3                     | <p>Geotechnical and soil investigations as part of functional design.</p>                                                                                                                                                                                                                    | Highly Unlikely     | 1                     | 0.3                            |
| Flood ingress into final voids                                                                                                         | Highly Unlikely | 2            | 0.9                   | <p>Final landform design to provide flood protection to ensure no flooding ingress in 0.1% AEP flood with 1.0 m freeboard</p>                                                                                                                                                                | Highly Unlikely     | 2                     | 0.9                            |
| Upstream rehabilitation of mining areas unsatisfactory leading to increase sediment loads to the final diversion channel               | Unlikely        | 2            | 3                     | <p>Additional upstream controls could be considered during functional design. Offline flow through diversion from upstream watercourses (Fisher Creek and Holding Paddock Creek) could report to the Fisher Diversion</p>                                                                    | Unlikely            | 2                     | 3                              |

## 6.7 Additional Design and Construction Considerations

### 6.7.1 Infrastructure

The section of Red Hill Road impacted by the concept diversion design will be removed and given a post-mining land use (PMLU) at closure and as such will not affect the concept diversion design.

### 6.7.2 Soils

The channel bed and banks are expected to be comprised largely of the surrounding soils, which potentially include dispersive sandy to loamy duplex soils. Erosion of the diversion channel is a key risk to the diversion not achieving a state of dynamic equilibrium. Key actions which should be undertaken in detailed design and construction to further quantify and mitigate this risk include:

- A detailed soil survey should be conducted in the functional design stage to determine characteristics of topsoil and subsoil within the diversion alignment.
- The detailed engineering in functional design should specify requirements for cover materials, including rock and rock mulch, to protect diversion batters from erosion.
- Temporary erosion sediment controls should be designed to minimise risk of erosion until vegetation establishment. This plan should be developed and approved by an appropriately qualified person informed by site specific soils data.
- An appropriately qualified person to assess the growth media for the diversion banks and recommend required ameliorants, fertilisers and surface treatments.
- Excess supply of sediment from upstream and adjacent mining activities (spoil dumps, haul roads, coal stockpiles etc.) can impact vegetation establishment within the new diversion. Controls should be established to reduce sediment influx from surrounding landforms during the establishment of the diversion channel.

### 6.7.3 Revegetation

Hydraulic modelling has demonstrated that the design criteria values for stream power, stream velocity and shear stress for both 39% AEP and 2% AEP storm events, are within the ACARP (2002) diversion channel design parameters (refer Table 3.2). Effective revegetation will be crucial for the long-term stability of the diversion reach. A detailed revegetation plan should be developed as part of the functional design for Fisher Creek as it will be critical to prevent uncontrolled erosion in the early years following construction.

The revegetation for the diversion should be done in accordance with the revegetation plan informed by baseline vegetation surveys. The plan should:

- Specify the method for revegetation considering direct seeding, mulch blanket, direct planting etc. and be informed by the erosion potential, expected velocities of flows and the cover material in selecting the appropriate method.

The watercourse revegetation species should be based on selecting key framework trees, woody understorey and groundcover species associated with the predominant natural watercourse regional ecosystems occurring upstream and/or downstream of the site as prescribed in the Goonyella Riverside Mine Progressive Rehabilitation and Closure Plan.

- Revegetation design should focus on re-establishing riparian vegetation for upper banks, mid banks and lower bank (including bank toe) revegetation zones.
- Include Geomorphic and vegetation features like those in the local landscape.
- Consider irrigation and other controls required to promote vegetation establishment in response to changing climatic conditions.
- Achieve sufficient ground cover to mitigate erosion risk on beds and banks.
- Maintain a sediment transport regime that does not directly impact on upstream and downstream reaches.
- Not require ongoing maintenance.



#### 6.7.4 Monitoring and Maintenance

Monitoring and maintenance of the diversion during the operational phase should be conducted in accordance with BMAs watercourse diversion monitoring program and following construction and rehabilitation of the new diversion alignment is required to be conducted in accordance with the PRCP. The monitoring and maintenance of the diversion during the establishment phase should be done routinely and consider the following (at least):

- Identifying introduced species and weeds for control.
- Success of vegetation establishment and identifying the need for subsequent seeding or planting.
- Climatic conditions which may impact the success of vegetation establishment (i.e., drought).
- Unplanned events which may impact the success of vegetation establishment (i.e., bushfire).
- Monitoring for erosion of beds and banks.
- Sediment transport under low flow conditions to ensure no excess sedimentation.
- Success of temporary erosion and sediment control measures.

The frequency of inspections should be aligned to risk (i.e. increase where control implementation is not suitable), and also following periods of high flow in the diversion.

## 7. CONCLUSION

The existing diversion is experiencing increasing bank erosion, lack of geomorphic and vegetation features like those in the local landscape, sediment aggradation and sediment deposition downstream.

The concept design has been developed to meet the requirements of the PRCP and achieve a state of dynamic equilibrium enabling its relinquishment in the post closure landform of GRM.

Two options for rehabilitation of the diversion were identified and assessed using the BMA Multi-Criteria Analysis outlined in Section 5. Option 2 was selected to proceed as the preferred concept design as it has a grade similar to the pre-mining alignment which is required for hydraulic performance criteria compliance. The final concept design, typical cross sections and longitudinal section are presented in Appendix E.

The concept design demonstrates that the watercourse diversion will satisfy the closure objectives identified in the guidelines, for PRCP purposes.



## 8. QUALIFICATIONS

- (a) In preparing this document, including all relevant calculation and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.
- (b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.
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- (g) This Report does not provide legal advice.

## 9. REFERENCES

- ACARP. (2014). *Criteria for functioning river landscape units in mining and post mining landscapes*, ACARP Project C20017. Alluvium Consulting.
- Alluvium Consulting. (2021). *Fisher Creek Diversion Operations Monitoring 2020 - Goonyella Riverside Mine*.
- DES. (2024). *Environmental Authority EPML00853413*.
- DES. (2023). *Guideline: Progressive rehabilitation and closure plans (ESR/2019/4964)*.
- DNRME. (2019). *Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000, OSW/2019/4599, Version 2.00*.
- Engeny. (2016). *Fischer Creek Diversion Major Monitoring Assessment*.
- WRM. (2019, August 2). *Goonyella and Broadmeadow Hydraulic Assessment*.



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# APPENDIX A: MULTI-CRITERIA ANALYSIS DETAILS



Multi-Criteria Analysis - Fisher Creek Diversion

Project: PRCP GRM Diversions  
Workshop Date:

|            |                   |                 |         |                 |                   |
|------------|-------------------|-----------------|---------|-----------------|-------------------|
| -3         | -2                | -1              | 0       | 1               | 2                 |
| Fatal Flaw | Strongly Negative | Mildly Negative | Neutral | Mildly Positive | Strongly Positive |

| Criteria                                                            | Assumptions/Considerations                                                                                                                                    | Weight | Option 1 | Option 2 | Comments                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Likelihood that diversion will achieve state of dynamic equilibrium | Considers the difference between diversion length and grade to natural stream length and grade. Ideally diversion length/grade = natural stream length/grade. | 50%    | -2       | 2        | Option 1: Has an alignment with a length (1.4 km) and grade (0.39%) similar to the pre-mining alignment. However, Option 1 has drop structure; Creek deteriorating. Further remediation works to be completed to return creek to state of dynamic equilibrium.<br>Option 2: Has an alignment with a length (1.8 km) and grade (0.3%) similar to the pre-mining alignment |
| Order of magnitude cost estimate                                    | Assumes \$10/m3 of cut.                                                                                                                                       | 30%    | 2        | 0        | Compared based on direct diversion cut requirement costs only.                                                                                                                                                                                                                                                                                                           |
| Ability to isolate diversion from flows during establishment period | Diversion can be isolated from flows if it is constructed offline of the existing diversion.                                                                  | 20%    | 0        | 1        | Option 1: Will be constructed on the existing diversion alignment<br>Option 2: Cuts across the existing alignment at two separate locations. It is possible but there is some engineering risk.                                                                                                                                                                          |
| Overall Weighted Score                                              |                                                                                                                                                               |        | -0.4     | 1.2      |                                                                                                                                                                                                                                                                                                                                                                          |

|                        |              |             |
|------------------------|--------------|-------------|
| Is there a Fatal Flaw? | No           | No          |
| Relative Risk          | Neutral Risk | Lowest Risk |



---

# APPENDIX B: HYDROLOGIC MODEL DEVELOPMENT



## HYDROLOGIC MODEL SETUP

The WBNM (Watershed Bound Network Model) runoff routing software (2021 version) was used to develop the hydrology model. WBNM automatically calculates catchment routing based on the sub-catchment area, pervious/impervious areas and parameters, and the sub-catchment flow paths.

### Catchment Inputs

Sub-catchment delineation for GRM was developed using the PRCP landform (Version 2) topography displayed in Figure B.1. The hydrological model includes the total catchment for the Isaac River (inclusive of Eureka, HPC, and Fisher creeks) extending downstream past the Goonyella mine, covering a total area of approximately 1180 km<sup>2</sup>.

Three open water bodies are located in the upper catchment: Lake Elphinstone, Teviot Dam and Burton Gorge Dam. Lake Elphinstone is a natural lake formed behind the Carborough Range whereas Teviot Dam and Burton Gorge Dam are man-made structures that supply water to Burton and North Goonyella mines in the upper catchment.

The design life of the Teviot Creek Dam and Burton Gorge Dam, as part of mining closure operations, could impact design flow estimates. For this study, the WBNM model did not include the Burton Gorge Dam, Teviot Dam, and Lake Elphinstone located upstream of the study area, considering a worst-case scenario.

Figure B.1 provides the sub-catchment extents used for the WBNM.

### Model Parameters

The final landform is proposed to be rehabilitated; therefore, the hydrology model has assumed no impervious surfaces remain and a 0% impervious fraction (Fi) for all catchments including the remaining spoil areas and voids.

The default routing parameter of 1, pervious lag parameter of 1.8 and impervious lag parameter of 0.1 have been adopted for the WBNM.

### Design Rainfall

The 0.1% AEP (1000yr) was sourced using the Australian Rainfall and Runoff 2019 IFD generation tool available on the Bureau of Meteorology (BoM) website ([www.bom.gov.au](http://www.bom.gov.au)), at Latitude 21.6652 (S), Longitude 148.0792 (E). Aerial Reduction Factors (ARFs) have been used for all design events to convert point rainfall estimates to areal rainfall estimates.

### Temporal Patterns

Design events (1% - 0.1% AEP) have utilised the 'East Coast North' areal temporal patterns, as the total catchment area for the model exceeds 75 km<sup>2</sup>. All ten temporal patterns were simulated for storm durations ranging from the 3 hours to 168 hours.

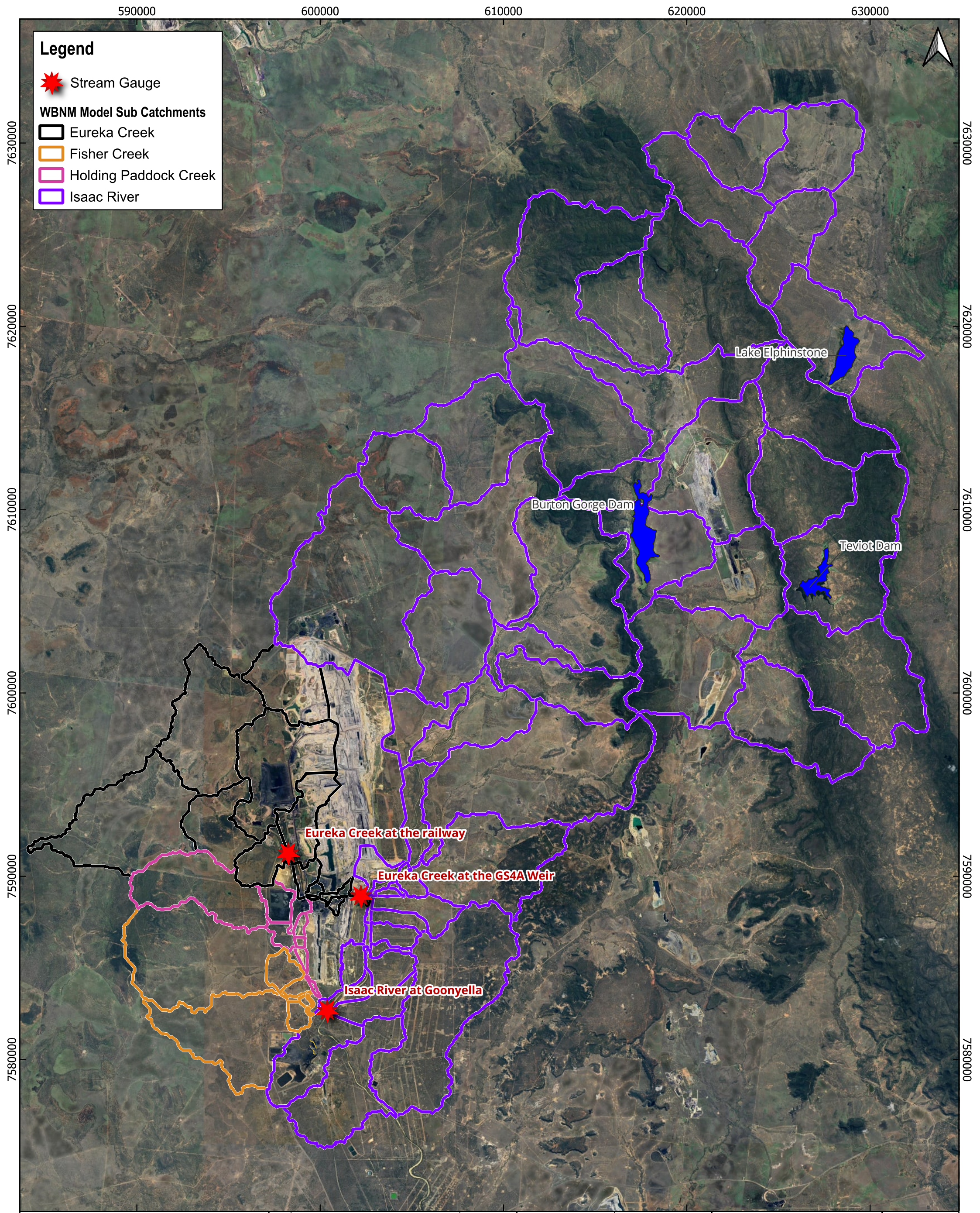
### Design Rainfall Losses

The initial and continuing losses obtained from the ARR Databank for Isaac River catchment to Goonyella gauge are 36 mm and 2.7 mm/h, respectively.

The adopted design rainfall losses were selected to achieve the best match between the XP-RAFTS design discharges with the design discharges estimated by the FFA at the Isaac River Goonyella gauge. The following is of note:

- For the 50%, 20%, 10%, 5%, 2% and 1% AEP events, the default ARR initial losses of 36 mm and continuing losses of 2.7 mm/h were adopted, respectively. The initial loss will decrease for larger events as the catchment is likely to be more saturated prior to the design rainfall burst.
- For the 0.1% AEP design event, a conservative 0 mm initial loss was adopted. A continuing loss of 2.5 mm/h was adopted as per the flood assessment done by WRM in 2019 (WRM, 2019 ).





**Legend**

 Stream Gauge

**WBNM Model Sub Catchments**

 Eureka Creek

 Fisher Creek

 Holding Paddock Creek

 Isaac River

**BMA PRCP GRM Fisher Creek  
Diversion**

Figure B.1  
WBNM Hydrologic Model Layout

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## MODEL VALIDATION

The 50%, 20%, 10%, 5%, 2% and 1% AEP peak flows estimated from the hydrology model were validated using the following methods:

- **Regional Flood Frequency Estimation Model (RFFE)** - is a recommended peak flow validation method from the ARR 2019 guidelines (Ball, et al., 2019). The RFFE provides peak flow estimations based on the catchment area and a catchment shaping factor, determined using the catchment centroid and outlet coordinates. The RFFE peak flow estimates were calculated using the ARR RFFE Model online tool (<http://rffe.arr-software.org/>).
- **Flood Frequency Analysis (FFA)** - provides peak flow estimates for different AEPs by developing a fitted distribution from recorded peak flows from historical flood events.

There is no gauge station for Fisher Creek, while the Eureka Creek gauges (Eureka Creek at the railway and GS4A) had an insufficient monitoring duration to conduct a reliable Flood Frequency Analysis (FFA). As a result, the FFA for the nearby Isaac River at the Goonyella gauge, located 7 km downstream of Eureka, was used for validation purposes. This analysis was completed as part of the Isaac River Flood Model by Engeny in March 2021.

Isaac River FFA was undertaken on the peak annual (water year from October to September) discharges recorded at Isaac River at Goonyella (130414A) streamflow gauge by Queensland Department of Natural Resources Mines and Energy (DNRME) between 1982 and 2020. A Log Pearson Type 3 (LPIII) distribution was fitted to an annual maximum series of peak flows from the gauge (Engeny, 2021). To adapt the Isaac River FFA to Eureka Creek (as there was no gauge station data for Fisher Creek nor was it covered as part of the WRM 2019 flood modelling report), peak flows were scaled based on the catchment area using the QRT method. The formula used for this adjustment is:

$$Q_u = \left( \frac{A_u}{A_g} \right)^n Q_g$$

Where,

$Q_u$  is the estimated peak flow for the ungauged catchment.

$A_u$  is the area for the ungauged catchment.

$A_g$  is the catchment area for the stream gauging station.

$Q_g$  is the peak flow for the gauging station determined from the flood frequency analysis.

The exponent  $n$  has been determined from the regional flood frequency regression analysis (RFFE) undertaken by the Queensland Department of Transport and Main Roads (Palmen & Weeks, 2008).

- **Peak flow estimates from previous flood studies –**
  - A hydrologic modelling of the Isaac River catchment including the Grosvenor Mine (GRV) and Moranbah North Mine (MNM) using the XPRAFTS runoff-routing model was developed to estimate the 39%, 10%, 5%, 2%, 1%, 0.2% and 0.1% annual exceedance probability (AEP) and probable maximum flood (PMF) design discharges for the Isaac River and its tributaries (Engeny, 2021). The estimated peak flows at the Isaac River at Goonyella Streamflow Gauge were compared to the WBNM and RFFE peak flows (refer to Figure B.2 ). It is to be noted that The Burton Gorge Dam, Teviot Dam and Lake Elphinstone upstream of the study area were modelled as detention basins in the XPRAFTS model.
  - Design peak discharges in the Isaac River at Goonyella, Eureka Creek upstream of the railway and Eureka Creek at the GS4A for the 10%, 5%, 2%, 1%, 0.1% were estimated using the XP-RAFTS model by WRM in 2019. These flows were compared to the WBNM model design peak discharges at these three gauge locations.



## Model Validation Results

Table B.1 shows the WBNM estimated design discharges at the Isaac River at Goonyella, Eureka Ck at the Railway and Eureka Ck at the GS4A for design events between 10% to 0.1% AEP, and the comparison to the WRM design discharges. This was due to there being no WRM design discharges for Fisher Creek. A visual comparison of the WBNM design peak discharges at the Isaac River streamflow gauge (130414A) against the flood frequency distribution curve, XP-RAFTS estimated peak flows by Engeny in 2021 and RFFE is provided in Figure B.2.

Validation of the design hydrology peak flow estimates indicates the following.

- **Isaac River Gauge**

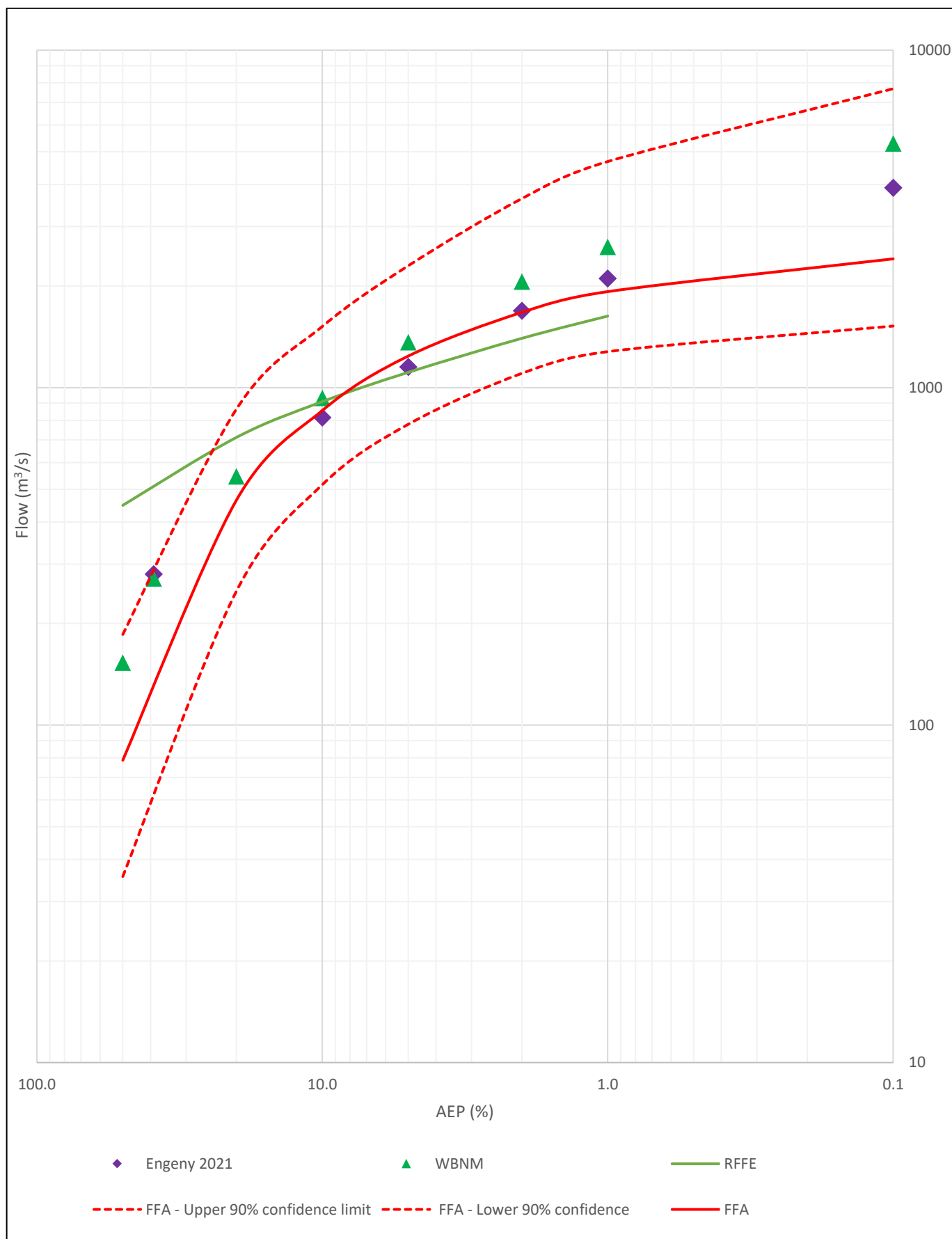
- Modelled peak flows for all design events are higher (3%-26%) than the LPIII expected quantile from the FFA. This is expected considering the exclusion of Burton Gorge Dam, Teviot Dam and Lake Elphinstone (Figure B.2).
- Modelled peak flows compared to the RFFE method were higher for events rarer than the 10% AEP and lower for events more frequent than the 10% AEP. This irregularity is not concerning as the RFFE can provide irregular results if catchment characteristics are mostly different from the nearby gauged waterways used to derive the RFFE. Additionally, the Issac gauge catchment (1071.21 km<sup>2</sup>) is outside the RFFE recommended catchment size of 0.5-1000 km<sup>2</sup>, hence results have lower accuracy (Figure B.2).
- WBNM estimated peak flows for all design events are higher (11%-28%) than the WRM 2019 flood modelling report (Table B.1).

- **Eureka Ck Gauge**

- WBNM estimated peak flows for all design events are higher (10%-37%) than the WRM 2019 flood modelling report. This is expected considering the 37% increase of the Eureka catchment (Table B.1).

**TABLE B.1: COMPARISON OF WBNM DESIGN DISCHARGES TO THE WRM 2019 FLOWS**

|                             |                                   | WRM (2019) Peak Discharge (m3/s) | WRM (2019) Critical duration (hours) | WBNM Peak Discharge (m3/s) | WBNM Critical duration (hours) | Difference (%) |
|-----------------------------|-----------------------------------|----------------------------------|--------------------------------------|----------------------------|--------------------------------|----------------|
| Isaac River at Goonyella    | Catchment Area (km <sup>2</sup> ) | -                                |                                      | 1071.12 km <sup>2</sup>    |                                | -              |
|                             | Design event (AEP%)               |                                  |                                      |                            |                                |                |
|                             | 10                                | 830                              | 18 hr                                | 932                        | 18 hr                          | 11%            |
|                             | 5                                 | 1167                             | 18 hr                                | 1363                       | 18 hr                          | 14%            |
|                             | 2                                 | 1707                             | 18 hr                                | 2061                       | 18 hr                          | 17%            |
|                             | 1                                 | 2079                             | 24 hr                                | 2616                       | 18 hr                          | 21%            |
|                             | 0.1                               | 3808                             | 24 hr                                | 5291                       | 18 hr                          | 28%            |
| Eureka Creek at the railway | Catchment Area (km <sup>2</sup> ) | 76.4 km <sup>2</sup>             |                                      | 113.78 km <sup>2</sup>     |                                | 33%            |
|                             | Design event (AEP%)               |                                  |                                      |                            |                                |                |
|                             | 10                                | 140                              | 6 hr                                 | 159                        | 18 hr                          | 12%            |
|                             | 5                                 | 180                              | 6 hr                                 | 217                        | 18 hr                          | 17%            |
|                             | 2                                 | 256                              | 6 hr                                 | 299                        | 18 hr                          | 14%            |
|                             | 1                                 | 299                              | 6 hr                                 | 374                        | 18 hr                          | 20%            |
|                             | 0.1                               | 499                              | 6 hr                                 | 692                        | 12 hr                          | 28%            |
| Eureka Creek at the GS4A    | Catchment Area (km <sup>2</sup> ) | 80.7 km <sup>2</sup>             |                                      | 129.05 km <sup>2</sup>     |                                | 37%            |
|                             | Design event (AEP%)               |                                  |                                      |                            |                                |                |
|                             | 10                                | 147                              | 6 hr                                 | 163                        | 18 hr                          | 10%            |
|                             | 5                                 | 189                              | 6 hr                                 | 225                        | 18 hr                          | 16%            |
|                             | 2                                 | 267                              | 6 hr                                 | 320                        | 18 hr                          | 17%            |
|                             | 1                                 | 311                              | 6 hr                                 | 400                        | 18 hr                          | 22%            |
|                             | 0.1                               | 521                              | 6 hr                                 | 728                        | 18 hr                          | 28%            |



**FIGURE B.2: COMPARISON OF WBNM DESIGN DISCHARGES TO THE FFA AND RFFE DESIGN DISCHARGES TO THE ISAAC RIVER GAUGE**



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# APPENDIX C: HYDRAULIC MODEL DEVELOPMENT



## MODEL EXTENT AND TOPOGRAPHY

The hydraulic model utilised the TUFLOW HPC solver. The Digital Elevation Model (DEM) used in the hydraulic model was based on the most recent PRCP landform (Version 2) provided by BHP.

A grid cell size of 4 m was selected for the TUFLOW model, which is suitable for representing the width of the diversion across multiple modelling cells.

The selected extent for the Fisher Creek TUFLOW model covers upstream of where Eureka Creek starts to the Isaac River, downstream of where Holding Paddock Creek, Fisher Creek, and Platypus Creek join into the Isaac River from the west which are all in the extent of the ML Goonyella Riverside. This was chosen to maintain a consistent modelling extent for the 0.1%AEP runs for all the GRM diversions across each of the hydraulic models. The modelling layout is shown in Figure C.1 and Figure C.2.

The proposed diversion design option was included in the model using design tins produced by 12D and merging it to the PRCP landform (Version 2).

## HYDRAULIC ROUGHNESS

The hydraulic roughness has been selected based on the inspection of aerial imagery and expected treatments within the diversion as well as historical investigations into hydraulic roughness values for existing watercourse channels at GRM. The rail, which is not owned by BMA and goes to Moranbah North, was considered in the base land use mapping of the site. The adopted Manning's 'n' roughness values are summarized in TABLE C.1 below.

**TABLE C.1: ADOPTED MANNING'S N ROUGHNESS**

| Land Use                                                | Manning's 'n' |
|---------------------------------------------------------|---------------|
| Railway                                                 | 0.015         |
| Constructed Channel                                     | 0.050         |
| Dense Vegetation                                        | 0.080         |
| Isaac River Existing Channel                            | 0.020         |
| Platypus Creek Existing Channel                         | 0.030         |
| Holding Paddock Creek and Fisher Creek Existing Channel | 0.050         |

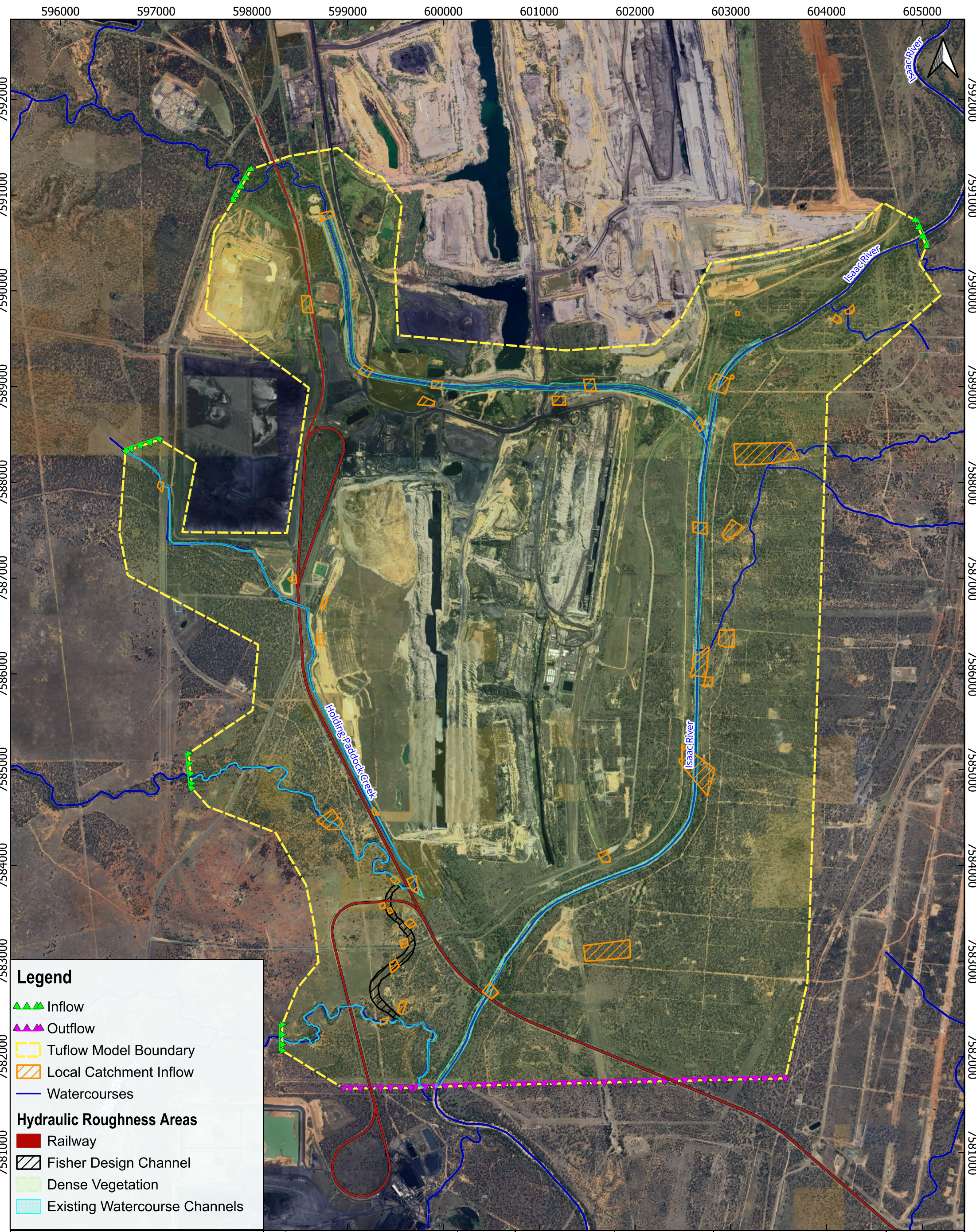
## MODEL INFLOWS AND BOUNDARY CONDITIONS

Boundary conditions are required in the model to define hydrology inflows, flow leaving the model domain and interfaces between the one dimensional and two-dimensional model domains. The following boundary conditions used in the models are:

- **Upstream:** The upstream boundary condition used a combination of 'SA' and 'BC' type boundaries, allocating flow to the defined model grid cells based on the design hydrograph from the hydrologic model (flow per unit of time) input. Total inflow hydrographs were applied to Fisher Creek, Isaac River, Holding Paddock Creek and Platypus Creek at the upstream boundaries.
- **Downstream:** A normal depth outflow boundary was adopted with a hydraulic grade based on the Isaac River channel grade at the downstream extent of the model. The boundary was located a sufficient distance downstream to not influence the flood behaviour near the areas of interest.

Peak flows as estimated by the WBNM hydrologic model (only for 0.1% AEP event) have been applied at various locations dependent on the diversion being assessed. The location of the model inflows (0.1% AEP) can also be seen in Figure C.1. As mentioned in section 6.4.1, for the 39% and 2% AEP event, constant ACARP flows were applied throughout the diversion as shown in Figure C.2.





**Legend**

- Inflow
- Outflow
- Tuflow Model Boundary
- Local Catchment Inflow
- Watercourses

**Hydraulic Roughness Areas**

- Railway
- Fisher Design Channel
- Dense Vegetation
- Existing Watercourse Channels

**BMA PRCP GRM Fisher Creek Diversion**

**Figure C.1**  
Hydraulic Model Layout - 0.1% AEP

| REV. | DETAILS | DATE | DRAWN: CH      | CHECKED: BK      |
|------|---------|------|----------------|------------------|
| 1    |         |      | APPROVED: BK   | DATE: 13/08/2024 |
|      |         |      | GENERAL NOTES: |                  |
|      |         |      |                |                  |
|      |         |      |                |                  |

05001,000 m

Scale @ A3: 1:35,000

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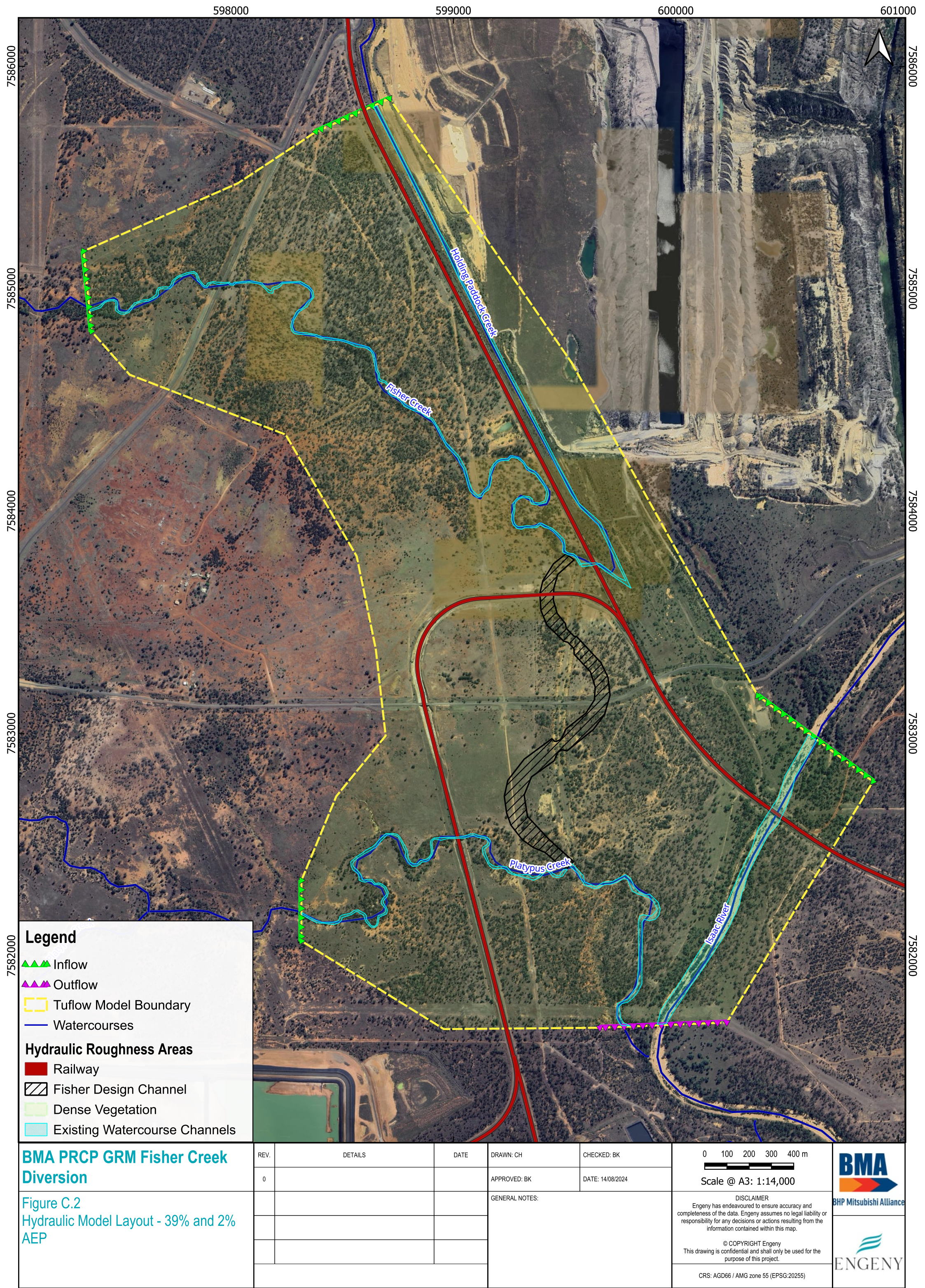
CRS: AGD66 / AMG zone 55 (EPSG:20255)

BMA

BHP Mitsubishi Alliance

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# APPENDIX D: HYDRAULIC PARAMETER MODELLING RESULT



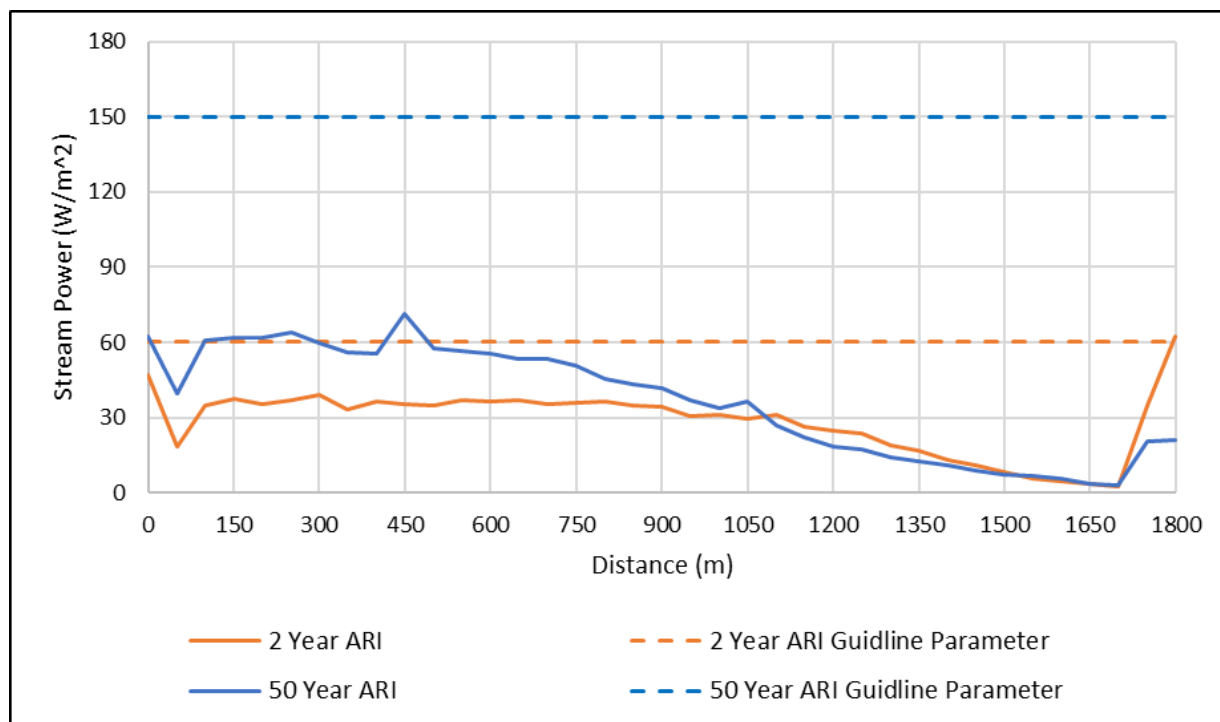


FIGURE D.1: STREAM POWER TUFLOW MODEL RESULTS

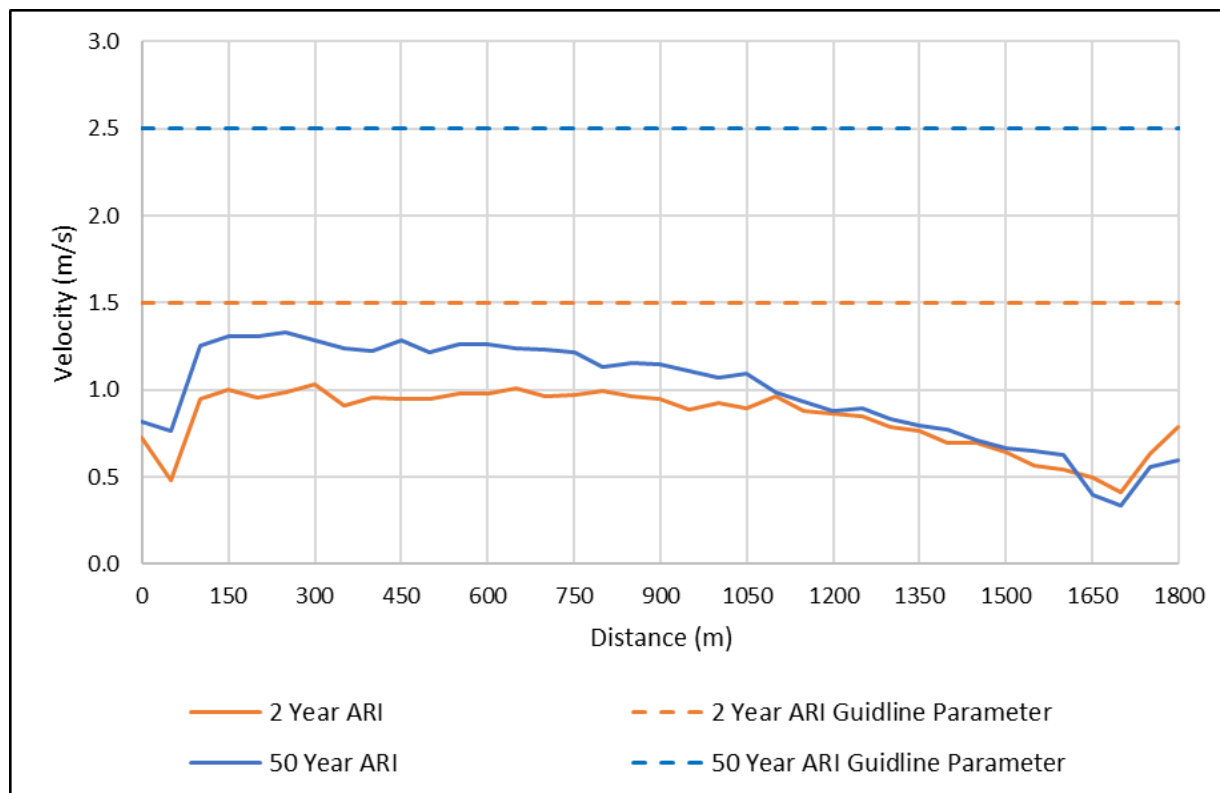


FIGURE D.2: VELOCITY TUFLOW MODEL RESULTS



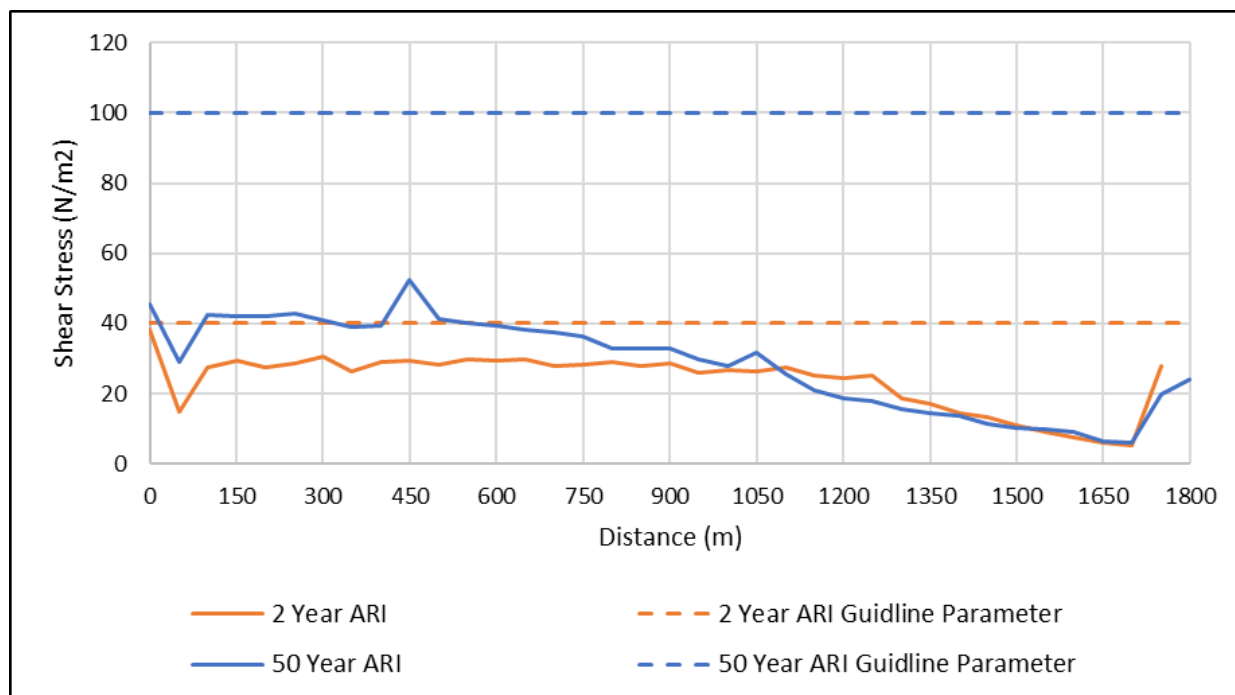


FIGURE D.3: SHEAR STRESS TUFLOW MODEL RESULTS

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# APPENDIX E: PREFERRED OPTION CONCEPT DESIGN DRAWINGS



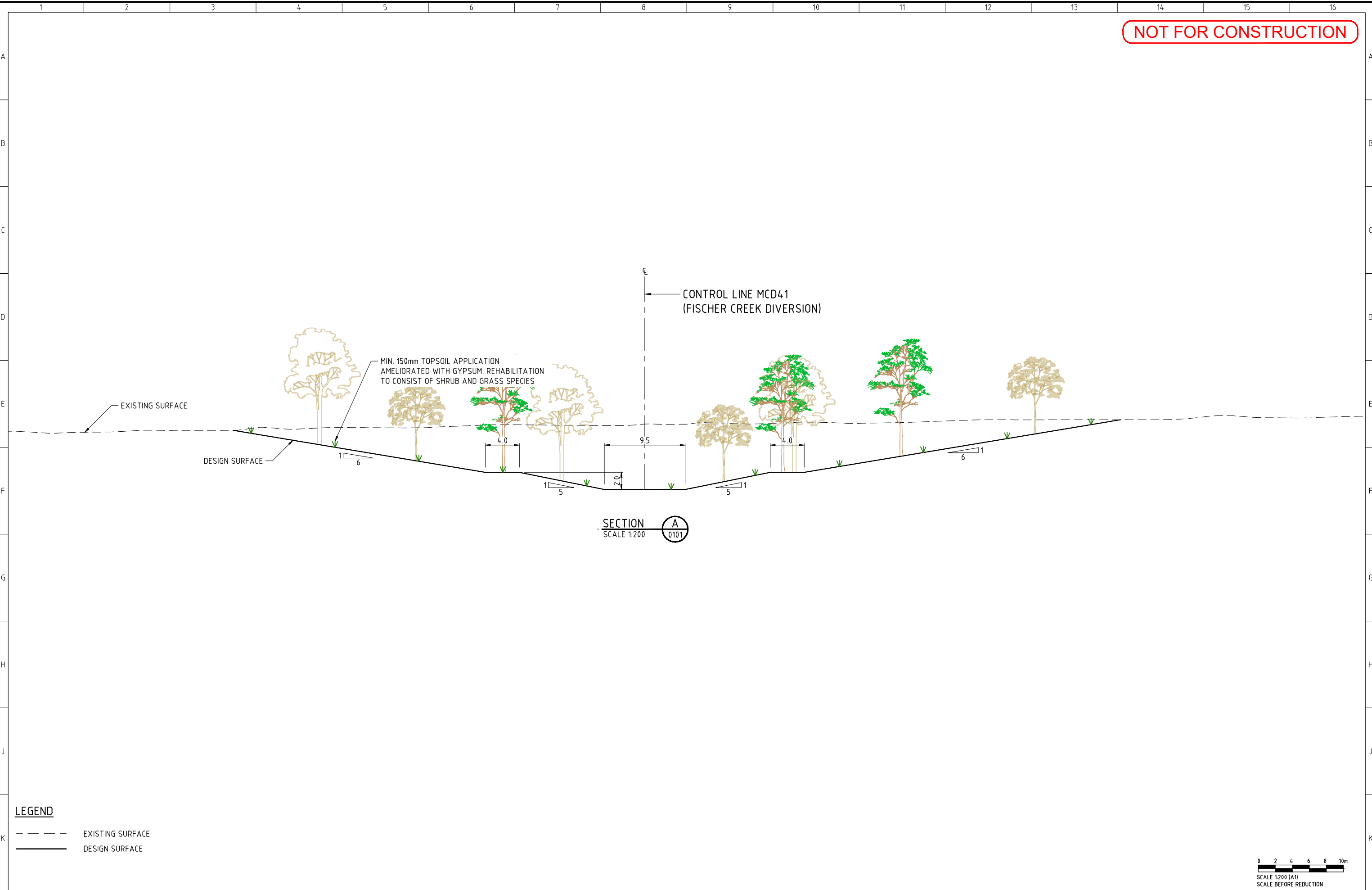


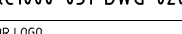
( NOT FOR CONSTRUCTION

[illegible]



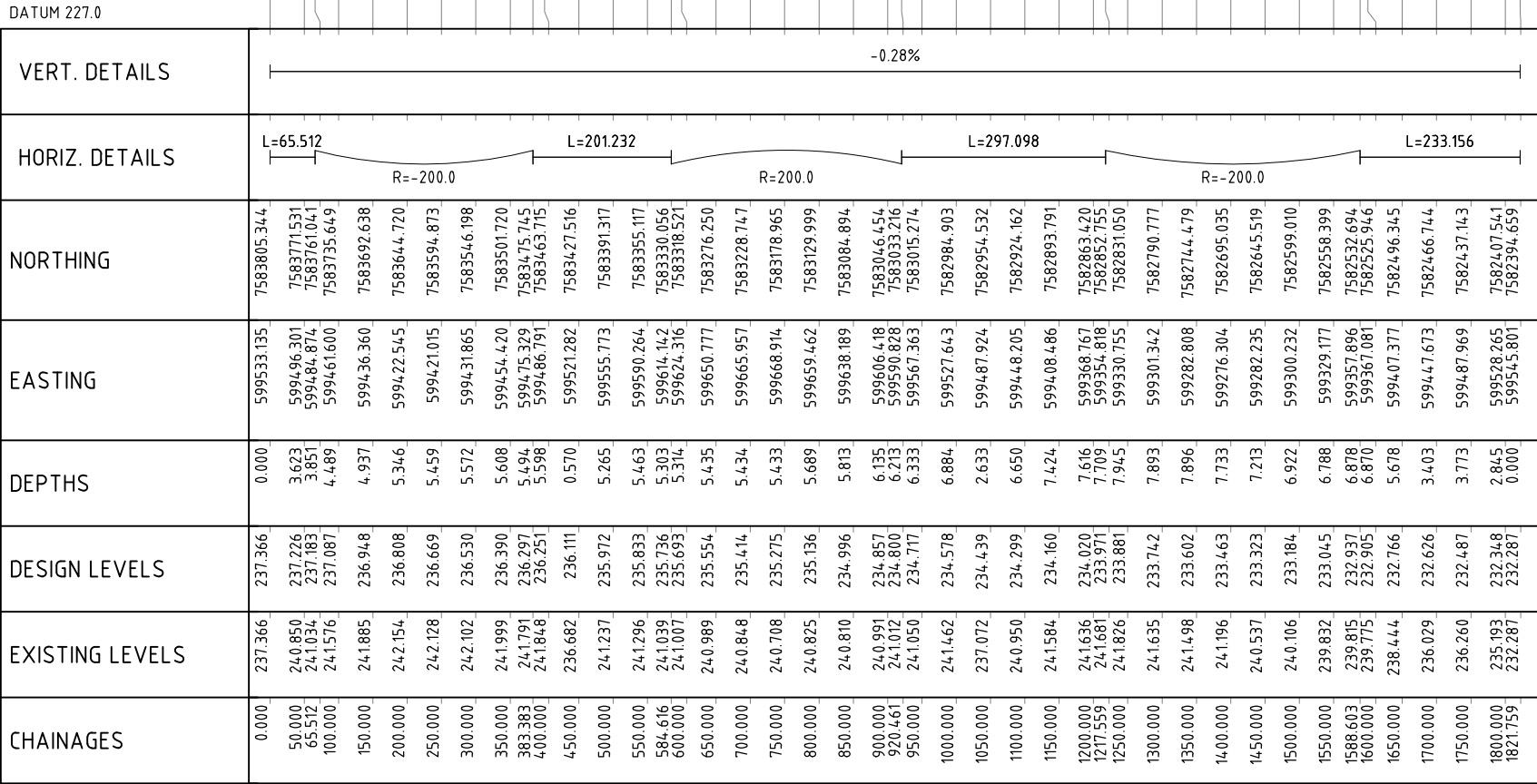
NOT FOR CONSTRUCTION



|                                                                                                    |   |               |   |   |               |   |      |          |    |                                                                                                                  |    |                  |      |    |               |  |            |  |                                                                                |                |  |          |
|----------------------------------------------------------------------------------------------------|---|---------------|---|---|---------------|---|------|----------|----|------------------------------------------------------------------------------------------------------------------|----|------------------|------|----|---------------|--|------------|--|--------------------------------------------------------------------------------|----------------|--|----------|
| VENDOR DRG NUMBER<br>QC1000-051-DWG-0201                                                           |   |               |   |   |               |   |      |          |    | UNCONTROLLED IF PRINTED OR DOWNLOADED                                                                            |    | VENDOR APPROVALS |      |    | RPEQ APPROVAL |  | BMA REVIEW |  | GOONYELLA MINE<br>PRCP FISCHER CREEK DIVERSION<br>TYPICAL SECTIONS AND DETAILS |                |  | Sht      |
| VENDOR LOGO<br> |   |               |   |   |               |   |      |          |    | <br>BHP Mitsubishi Alliance |    | SIGNATURE        | DATE |    | RPEQ ENGINEER |  | SIGNATURE  |  |                                                                                |                |  | Sht Size |
|                                                                                                    |   | DRAWN         |   |   | RPEQ No.      |   | DATE | A1       |    |                                                                                                                  |    |                  |      |    |               |  |            |  |                                                                                |                |  |          |
|                                                                                                    |   | DRN. CHK      |   |   | PROJECT No.   |   |      | Scale    |    |                                                                                                                  |    |                  |      |    |               |  |            |  |                                                                                |                |  |          |
|                                                                                                    |   | ENGINEER      |   |   | EQUIPMENT TAG |   |      | -        |    |                                                                                                                  |    |                  |      |    |               |  |            |  |                                                                                |                |  |          |
|                                                                                                    |   | ENG. CHK (QA) |   |   |               |   |      | Rev. No. |    |                                                                                                                  |    |                  |      |    |               |  |            |  |                                                                                |                |  |          |
|                                                                                                    |   |               |   |   |               |   |      |          |    |                                                                                                                  |    | APPROVED         |      |    |               |  | DATE       |  | DRG. No.                                                                       | LEGACY DRG No. |  | A        |
|                                                                                                    |   |               |   |   |               |   |      |          |    |                                                                                                                  |    |                  |      |    |               |  |            |  | STATUS: NOT FOR CONSTRUCTION - FOR REVIEW                                      |                |  |          |
| 1                                                                                                  | 2 | 3             | 4 | 5 | 6             | 7 | 8    | 9        | 10 | 11                                                                                                               | 12 | 13               | 14   | 15 | 16            |  |            |  |                                                                                |                |  |          |



NOT FOR CONSTRUCTION



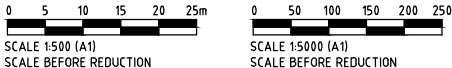
CONTROL LINE MCD01 (FISHER CREEK DIVERSION)

SCALE 1:5000 HORIZ

SCALE 1:500 VERT

### LEGEND

— — — — — EXISTING SURFACE  
————— DESIGN SURFACE

[illegible]

AD FILE: QC1000-051-DWG-0301.dwg

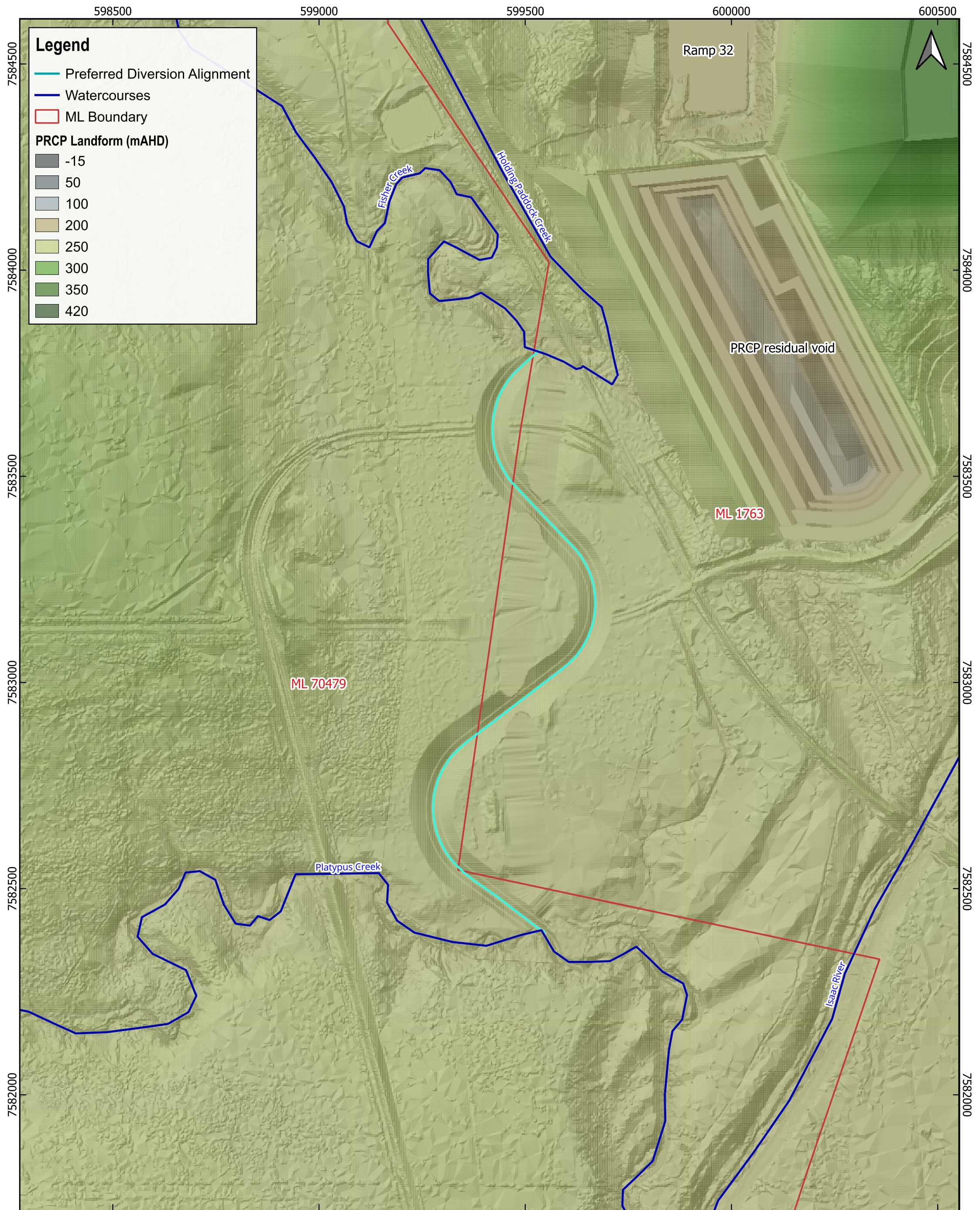
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# APPENDIX F: CONCEPT DESIGN WITH PRCP LANDFORM 2 INTERACTION







**BMA PRCP GRM Fisher Creek Diversion**

**Figure F.1**  
**Fisher Creek Concept Design with PRCP Landform 2**

| REV. | DETAILS          | DATE       | DRAWN: CH      | CHECKED: BK      |
|------|------------------|------------|----------------|------------------|
| 0    | Issue for review | 04/09/2024 | APPROVED: BK   | DATE: 24/09/2024 |
|      |                  |            | GENERAL NOTES: |                  |
|      |                  |            |                |                  |
|      |                  |            |                |                  |

0 100 200 m  
Scale @ A3: 1:8,000

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Goonyella Riverside and Broadmeadow Mine PRCP  
Risk Assessment

| Risk Event                                                                                                                                               | Scenario # | Scenario                                 | Causes<br>(related to risk event)                                                                                                                                                                                                                                                                                                                                                                                                                        | Impact Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Highest<br>MFL Level | Mitigating Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Highest<br>Severity | Preventative Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Likelihood Basis<br>(chance of the impact at the severity,<br>taking into account the effectiveness of<br>the preventative controls)                                                                                       | Likelihood | Likelihood | RRR |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|-----|
| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU1      | Landform failure                         | 1. Erosional instability<br>2. Geotechnical instability<br>3. Incorrect geotechnical assessment<br>4. Differential settlement (spoil and backfilled dams)<br>5. Insufficient materials to achieve design (rock, growth media)<br>6. Unsuitable materials used on final landform surface<br>7. Flooding/unplanned inundation<br>8. Not achieving design<br>9. Selection of inappropriate PMLU<br>10. Greater than modelled subsidence impacts             | - Erosion<br>- Growth media loss<br>- Failure of vegetation<br>- Slumping and settlement<br>- Mass movement of landform<br>- Surface cracking                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 4                    | - Monitoring of landform stability and rehabilitation success to be undertaken post rehabilitation<br>- Subsidence monitoring<br>- Identify requirements for rectification works.<br>- Complete maintenance                                                                                                                                                                                                                                                                                                                                                                                                                   | 2                   | - Ongoing materials characterisation<br>- Selective handling of materials for placement<br>- Review the topsoil and rock material balance periodically during operations to ensure sufficient volumes for the rehabilitation needs.<br>- No permanent berms or water management on spoil dump slopes<br>- Landform surrounding the spoil dumps and voids to be reshaped to be free-draining where required to prevent impacts<br>- Groundcover including vegetation to provide erosion resistance<br>- Compliance to plan<br>- Sufficient cover over rejects and tailings<br>- Growth media assessment to determine amelioration and fertiliser requirements<br>- Progressive operational subsidence management to repair initial cracks and drainage to reduce ponding to acceptable limits after initial subsidence<br>- Final subsidence rehabilitation to repair final cracks and drainage to reduce inundation/ponding to acceptable limits after final subsidence<br>- Suitable revegetation species in subsidence ponded areas<br>- Flooding of underground workings                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | With all controls in place, including ongoing monitoring and maintenance, landform failure on a large scale for this landform is unlikely                                                                                  | Unlikely   | 0.1        | 3   |
| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU2      | Alteration of hydrogeological conditions | 1. Release of contaminants to groundwater<br>2. Change in groundwater flow, recharge and/or discharge characteristics resulting in changes to the hydrogeological system<br>3. Drawdown and alteration of groundwater flow due to void lakes acting as a sink driven by evaporation from the lakes<br>4. Maintaining dewatered conditions within aquifers<br>5. Change of aquifer availability/properties resulting from resource removal and subsidence | - Groundwater chemistry altered rendering it not suitable for extraction and/or to support the PMLU, or reduction of groundwater quality within the Isaac alluvials<br>- Groundwater quality not supporting the establishment/maintenance of Environmental Values and Water Quality Objectives for the basins in which the site is located<br>- Unfavourable Geochemical or contaminants reporting to shallow and deep groundwater systems<br>- Reduction of groundwater height within surrounding extraction bores<br>- Degradation of terrestrial and aquatic groundwater dependant ecosystems (GDEs)<br>- Dewatering of coal seams and other lithologies that have potential for AMD generation resulting in transport of contaminant of concern to ground and groundwater resources | 5                    | - Assessment and remediation of impacted material, where appropriate<br>- Development and approval of a Site Management Plan to assist with on-going management and restriction to future land use activities where appropriate<br>- Implementation of management controls and monitoring programs outlined in an approved Site Management Plan<br>- Re-establishment of impacted ecosystems<br>- Decommissioning of impacted supply bores and re-instatement in suitable location<br>- Regular updating of groundwater models to continue to improve the understanding of groundwater and the affects from mining operations | 3                   | - All imported hazardous materials are to be stored and used in accordance with relevant standards and removed from site on completion of mining<br>- Appropriate management, placement, and monitoring of waste (spoil, tailings, rejects) during operations<br>- Contaminated land investigation to be undertaken at the completion of operations to identify contamination that has the potential to cause impacts to groundwater<br>- Implementation of remediation and/or management plans as required to reduce potential groundwater impact risks<br>- Mine affected water dams to be decommissioned (including investigation for potential contamination and groundwater impacts)<br>- Groundwater monitoring to be undertaken in accordance with EA/PRCP conditions<br>- Future tailings disposal options to be assessed for potential release of contaminants to waters including groundwater and control/approvals put in place<br>- Installation of relevant groundwater monitoring bores<br>- Analysis of data and development of site-specific groundwater quality limits<br>- Revisiting and updating the groundwater models every five years (commencing from 2050)<br>- Residual void catchments to be designed and created to establish sinks that provide for the collection of seepage from former operational areas, tailing storage facilities and spoil dumps<br>- Landforms constructed to minimise the potential for flooding of the residual voids<br>- Landforms designed to minimise contaminant generation and transport<br>- Modelling of groundwater and fate and transport to understand the impacts associated with landforms/activities | With all controls in place, including ongoing monitoring and maintenance, failure to attain a stable condition for land described as the post-mining land use is unlikely due to alternation of hydrogeological conditions | Unlikely   | 0.1        | 10  |



Goonyella Riverside and Broadmeadow Mine PRCP  
Risk Assessment

| Risk Event                                                                                                                                               | Scenario # | Scenario                                               | Causes<br>(related to risk event)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Impact Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Highest<br>MFL Level | Mitigating Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Highest<br>Severity | Preventative Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Likelihood Basis<br>(chance of the impact at the severity,<br>taking into account the effectiveness of<br>the preventative controls)                                                                                                             | Likelihood | Likelihood | RRR |
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| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU3      | Alteration of surface water systems                    | 1. Release of contaminants to surface water resources<br>2. Changes to alignments and ecosystems of drainage lines and watercourses<br>3. Changes to hydraulic flows<br>4. Changes to flood patterns/distribution<br>5. Alteration of surface water infiltration rates<br>6. Surface water flows over unvegetated/disturbed soils where rehabilitation has not re-established<br>7. Overland discharges from neighbouring landforms and rehabilitated areas<br>8. Watercourses and drainage lines not attaining successful rehabilitated state<br>9. Changes to surface water flows due to subsidence<br>10. Changes in vegetation due to ponding | - Surface water chemistry altered rendering it not suitable for PMLU<br>- Degradation of ecosystems and land uses connected to surface water flows and floodplains on and down gradient of the mine<br>- Sedimentation of downstream surface water drainage lines resulting in changes to their hydraulic properties and impacting ecosystems<br>- Surface water quality not supporting the establishment/maintenance of Environmental Values and Water Quality Objectives for the basins in which the mine is located<br>- Accelerated erosion rates from surface water flows in disturbed areas and degraded ecosystems<br>- Reduction in rehabilitation success rates due to reduced surface water quality<br>- Alteration of soil properties associated with contaminants/inundation, including erodibility and geotechnical qualities<br>- Alteration in vegetation due to change in in surface run off<br>- Vegetation failure due to inundation in subsidence areas<br>- Increased weed establishment and growth in subsidence inundation areas<br>- Reduction in land capability of PMLU in subsidence ponded areas (woodland habitat and/or grazing) | 4                    | - Surface water monitoring data to be collected in accordance with the EA. If impacts are identified, further investigations will be undertaken to determine appropriate remedial measures<br>- Any loss of hazardous contaminants that cause contaminated land/environmental harm will be reported and investigated as appropriate<br>- Remedial works will be undertaken where releases from site result in impacts to surface waters, which may include alteration of the landforms, implementation of a Site Management Plan, implementation of additional controls/measures that reduce the potential for surface water impacts and/or re-establishment of impacted ecosystems where appropriate<br>- Subsidence monitoring and rectification works<br>- Undertake maintenance of rehabilitation and subsidence areas | 3                   | - All imported hazardous materials to be stored and used in accordance with relevant standards and removed from site on completion of operations<br>- Appropriate management, placement, and monitoring of waste (spoil, tailings, rejects) during operations<br>- Surface water monitoring to be undertaken in accordance with EA conditions<br>- Installation of monitoring equipment at the relevant surface water monitoring locations<br>- Analysis of data and development of site-specific surface water quality limits for relevant watercourses<br>- Rehabilitation and monitoring of disturbed reaches of watercourses undertaken<br>- Mine affected water dams to be decommissioned and areas rehabilitated<br>- A contaminated land investigation will be undertaken at the completion of operations and remediation works undertaken as appropriate<br>- Landforms constructed to minimise the potential for flooding of the residual voids<br>- Tailings and other waste disposal facilities appropriately covered<br>- Progressive operational subsidence management<br>- Final landform that limits the inundation/ponding of water to acceptable limits within subsidence areas to enable surface water movement to Isaac River at mine closure | With all controls in place, including ongoing monitoring and maintenance, failure to attain a stable condition for land described as the post-mining land use is unlikely due to alternation of surface water conditions                         | Unlikely   | 0.1        | 10  |
| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU4      | Watercourse diversion not achieving closure objectives | 1. Hydrologic characteristics of surface water and groundwater systems not representative of natural reaches<br>2. Hydraulic characteristics not representative of natural reaches<br>3. Geomorphic instability (bank erosion)<br>4. Sediment transport regime is not in equilibrium with and/or representative of the natural reaches<br>5. Poor riparian vegetation diversity and cover<br>6. High percentage of weeds/ invasive species<br>7. Poor water quality from runoff from surrounding landforms and rehabilitated areas<br>8. Failure of landforms impacting the performance of the diversion<br>9. Subsidence impacts to watercourse  | - Sediment regime impacts within diversion/subsided areas and downstream reaches resulting in changes to hydraulic properties<br>- Surface water chemistry altered rendering it not suitable for PMLU<br>- Degradation of downstream ecosystems and land uses connected to surface water flows and floodplains<br>- Surface water quality not supporting the establishment/maintenance of Environmental Values and Water Quality Objectives for the basins in which the mine is located<br>- Accelerated rates of erosion and instability of the diversion or watercourse banks causing landform instability, damage to rehabilitation areas and alteration of watercourse hydraulics<br>- Changes to environmental flows and flood regimes impacting on surrounding land users and environmental receptors                                                                                                                                                                                                                                                                                                                                                   | 5                    | - Surface water and watercourse monitoring data to be collected. If impacts are identified, further investigations will be undertaken to determine appropriate remedial measures<br>- Rehabilitated landforms that do not attain a stable state to be investigated, repaired, revegetated and/or redesigned                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3                   | - Watercourse diversion monitoring to relevant IDC standard and maintenance during the operational phase<br>- Monitoring and maintenance of subsidence impacted areas as per EA during operations<br>- Diversion remediation designs in accordance with the DNRME 2019 hydraulic design criteria for permanent diversions<br>- Diversion design to include growth media assessment and revegetation species aligned to growth media, landforms and PMLU<br>- Mine infrastructure that interacts with the watercourses during operations will be removed prior to closure (e.g. culverts)<br>- Rehabilitation of surrounding landforms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | With all controls in place, including ongoing monitoring and maintenance, inability of watercourses to meet closure objectives is probable as a stable condition has not been achieved and attainment of a stable condition will be challenging. | Probably   | 0.3        | 3   |

Goonyella Riverside and Broadmeadow Mine PRCP  
Risk Assessment

| Risk Event                                                                                                                                               | Scenario # | Scenario                                                                                             | Causes<br>(related to risk event)                                                                                                                                                                                                                                                                                                                                                                                                                        | Impact Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Highest<br>MFL Level | Mitigating Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Highest<br>Severity | Preventative Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Likelihood Basis<br>( <i>chance of the impact at the severity,<br/>taking into account the effectiveness of<br/>the preventative controls</i> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Likelihood | Likelihood | RRR |
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| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU5      | Contaminated land impacting on environmental receptors, rehabilitation and attainment of PMLUs       | 1.Discharges and accumulation of hazardous contaminants (including emerging contaminants) from operational activities.<br>2. Licensed activities such as disposal of tailing, rejects, general and other wastes.                                                                                                                                                                                                                                         | - Contaminants present within soil or water resulting in an unacceptable risk to the environment or PMLU<br>- Alteration of soil chemistry that impacts on structural characteristics<br>- Contaminants reducing the soil suitability for rehabilitation species<br>- Requirement for on-going management and restriction of land uses                                                                                                                                                                                                                                                                                                                                                                     | 4                    | - Investigate and remediate contamination incidents<br>- Implement a Site Management Plan to manage impacts, where required<br>- Removal of primary or secondary sources<br>- Restrict site usage<br>- Undertake ongoing monitoring to manage contaminated land risks                                                                                                                                                                                                                                                                                                                                                                              | 3                   | - Management of operational activities to limit any potential contamination, all stored hazardous materials and infrastructure, that have a reasonable potential to release contaminants, will be appropriately recycled or disposed<br>- Cleaning up of spills upon identification<br>- Contaminated land investigation to be undertaken prior to closure and areas of contamination remediated and/or managed as appropriate<br>- On-going surface water and groundwater monitoring providing an indication of contamination<br>- Shallow rooted species for PMLUs with higher risk of contamination to allow for capping or other engineered controls.<br>- Create landforms that include strong groundwater sinks to manage migration of contaminants off site | The contaminated land investigation and remediation/management works will aim to render the site suitable for the intended PMLUs and reduce the potential for any environmental harm. With operational sources of hazardous materials removed from site, tailings facilities capped and contained, any landfill materials capped and managed, the likelihood of contaminated land impacts preventing attainment of closure criteria is probable. Leachate from tailings is occurring and will be on-going. Lanfill is poorly understood.<br><br>Due to the age, duration and nature of the heavy industrial site use, remediation/management are anticipated to be required to render the site suitable for the intended PMLUs and reduce the potential for environmental harm post-mining | Probably   | 0.3        | 30  |
| Stable condition for land described as a post-mining land (reference PDM EA Table E1 - cattle grazing, woodland habitat and watercourse) is not achieved | PMLU6      | Flooding influences on rehabilitation and final landforms                                            | 1. Water inundation of landforms<br>2. Saturation of materials within landforms<br>3. Velocities of floodwaters on rehabilitated landforms<br>4. Inaccurate modelling<br>5. Surface inundation due to subsidence                                                                                                                                                                                                                                         | - Reduction in geotechnical stability of landforms causing failure of the landforms<br>- Erosion of landform and sedimentation<br>- Mobilisation of any contaminants contained within the landforms and impacts to downstream water and groundwater quality<br>- Alteration of terrestrial ecology through introduction of weeds, sedimentation, or damage to select rehabilitation species<br>- Introduction of weeds and impacts to rehabilitation vegetation establishment<br>- Loss of flood waters/environmental flows to residual voids<br>- Vegetation failure in subsidence inundated areas<br>- Reduction in land capability of PMLU in subsidence ponded areas (woodland habitat and/or grazing) | 3                    | - Assessment of landform failure and required rectification works upon safe access to site immediately after the flood event. Assessment to include identification of measures that would limit potential for on-going impacts.<br>- Re-engineering of landforms to mitigate future failures followed by re-construction of landforms, and rehabilitation works.<br>- Assessment of downstream impacts and undertake remediation/rehabilitation as required to re-establish drainage line hydraulics and ecosystems in liaison with the administering authority.<br>- Monitoring of landform stability and rehabilitation success to be undertaken | 2                   | - Removal of infrastructure from watercourses<br>- Decommissioning of dams<br>- Remediation of contaminated material where required<br>- Design of landforms within flood extents that are stable and able to withstand flooding and water velocities<br>- Establishment of vegetation suitable for the environment and reduces erosion risks<br>- Progressive operational subsidence management to repair initial cracks and drainage to reduce inundation/ponding to acceptable limits after initial subsidence and final subsidence rehabilitation after final subsidence<br>- Suitable revegetation species in subsidence ponded areas<br>- Subsidence monitoring                                                                                              | Flood modelling indicates post-mining landform design does not result in inundation of residual voids and velocities outside of the watercourses and diversions are unlikely to impact rehabilitated landforms. Preventative controls include decommissioning of dams and culverts that could contribute to, or impact flood conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Unlikely   | 0.1        | 3   |
| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU7      | Rehabilitated landforms result in alteration of flood hydrology upstream and downstream              | 1. Changes to drainage network hydraulics.<br>2. Artificial landforms and subsidence areas reducing or increasing flood extent and changing velocities/flows.<br>3. Changes to vegetation cover and soil type which alter runoff and infiltration rates.                                                                                                                                                                                                 | - Increasing/decreasing of flood extents, frequency and severity<br>- Degradation of ecosystems due to altered flows, flood extent, duration or frequency<br>- Infrastructure damage<br>- Health and safety risks to on-site and off-site land users associated with increased flood heights, velocities and frequency                                                                                                                                                                                                                                                                                                                                                                                     | 4                    | - Due to the off-site nature of the impacts, which occur during significant flood events, available mitigating controls at the time of the impact are limited due to safety and accessibility restrictions. After flooding has reseeded, landform design and alteration could be undertaken to reduce possible future events.                                                                                                                                                                                                                                                                                                                      | 3                   | - Removal of infrastructure that would adversely interfere with stream hydraulics (e.g. culverts) and decommissioning of dams<br>- Establishment of landforms that are stable and provide appropriate level of flood protection to the residual voids<br>- Undertake monitoring and maintenance works where required to maintain landforms<br>- Rehabilitated landforms to limit inundation/ponding to acceptable limits<br>- Monitoring of subsidence and rectification works as required                                                                                                                                                                                                                                                                         | With preventative controls implemented, identified impacts associated with alteration of flood hydrology are probable due to loss of flows associated with subsidence and residual void catchments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Probably   | 0.3        | 30  |
| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU8      | Insufficient or inappropriate growth media and rock resources required for rehabilitation activities | 1. Insufficient growth media and rock quantities of suitable quality<br>2. Unstable/unsuitable material (erosive, dispersive, saline materials)<br>3. Weed infestation (soil is already infested with weed seeds)<br>4. Insufficient placement depth and surface treatment<br>5. Incorrect growth media and rock characterisation and amelioration<br>6. Inappropriate topsoil and rock stockpiling and management<br>7. Selection of inappropriate PMLU | - Erosion<br>- Growth media loss<br>- Topsoil deficit<br>- Failure of vegetation (poor vegetation growth or incorrect vegetation affecting PMLU)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 4                    | - Monitoring of rehabilitation success to confirm stability and identify requirements for rectification works.<br>- Repair erosion areas, retest growth media and revegetate.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 2                   | - Topsoil surveys and mapping<br>- Review the topsoil, growth media and rock resources periodically during operations to ensure sufficient volumes for the rehabilitation needs.<br>- Final landform design based on available materials.<br>- Undertake rehabilitation planning and preparation in accordance with the specific requirements for growth media, rock, seed and management for the PMLU<br>- Management of topsoil and rock stockpiles and application during rehabilitation<br>- Growth media assessment to determine ameliorant and physical treatments<br>- Amelioration and physical treatments applied as per assessment<br>- Selective handling of materials for placement<br>- Compliance to plan                                            | With all controls in place, including ongoing monitoring and maintenance, insufficient or inappropriate growth media and rock for use on rehabilitation is unlikely                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Unlikely   | 0.1        | 3   |



Goonyella Riverside and Broadmeadow Mine PRCP  
Risk Assessment

| Risk Event                                                                                                                                               | Scenario # | Scenario                                             | Causes<br>(related to risk event)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Impact Description                                                                                                                                                                                                                                                                                                                                                                                  | Highest<br>MFL Level | Mitigating Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                | Highest<br>Severity | Preventative Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Likelihood Basis<br>(chance of the impact at the severity,<br>taking into account the effectiveness of<br>the preventative controls)                                                                                          | Likelihood | Likelihood | RRR |
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| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU9      | Insufficient management of mineral waste             | 1. Poor material characterisation<br>2. Geochemistry not correctly defined for materials stored in permanent landforms (ie tailings, rejects, spoil) leading to an incorrect assessment of their potential for AMD and salinity generation and transport.<br>3. Inappropriate placement of adverse material<br>4. Poor landform execution<br>5. Inappropriate management strategy/cover<br>6. Generation and release of AD/SD/NMD and salinity from coal during operation accumulating in groundwater, surface water, soils | - Release of contaminants to surface and groundwater from rehabilitated landforms.<br>- Vegetation failure<br>- Water cannot be used by end user                                                                                                                                                                                                                                                    | 5                    | - Monitoring of rehabilitation success to confirm stability and identify requirements for rectification works.<br>- Maintenance and rectification works undertaken<br>- Goonyella residual void is acting as sinks for groundwater therefore capturing potential AMD / salinity impacted seepage from TSF/spoil piles/reject stockpiles<br>- Spoil materials have excess buffering capacity (ie. acid neutralising capacity in excess of acid generating capacity) | 1                   | - Material characterisation during operations (outcomes stored into Geological database) in line with BHP Materials Management Standard<br>- Ongoing sampling of tailings and rejects from processing plant<br>- Appropriate material placement and selective handling during operations<br>- Remove and / or cover tailings and rejects<br>- Detailed cover design for tailings and rejects completed prior to installation<br>- Install tailings and rejects cover as per detailed design<br>- Appropriate water quality monitoring for surface and groundwater to enable tracking of processes affecting water quality during operation and into closure<br>- Undertaking appropriate fate and transport modelling during operations, pending of risk profile of landform | With all controls in place, including ongoing monitoring and maintenance, insufficient management of mineral waste is unlikely                                                                                                | Unlikely   | 0.1        | 1   |
| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU10     | Failure of, or inappropriate engineered cover design | 1. Poor material characterisation<br>2. Geochemistry not correctly defined for materials stored in permanent landforms (ie tailings, rejects, spoil) leading to an incorrect assessment of their potential for AMD and salinity generation and transport.<br>3. Erosional instability<br>4. Geotechnical instability<br>5. Insufficient materials to achieve cover design<br>6. Unsuitable materials used on cover design<br>7. Not achieving design                                                                        | - Release of contaminants to surface and/or groundwater from rehabilitated landforms.<br>- Vegetation failure<br>- Erosion                                                                                                                                                                                                                                                                          | 5                    | - Surface water and groundwater monitoring data to be collected in accordance with the EA. If impacts are identified, further investigations will be undertaken to determine appropriate remedial measures<br>- Rehabilitation monitoring and identification of maintenance<br>- Complete maintenance                                                                                                                                                              | 2                   | - Material characterisation during operations (outcomes stored into Geological database) in line with BHP Materials Management Standard<br>- Ongoing sampling of tailings and rejects from processing plant<br>- Tailings and rejects material appropriately disposed on-site<br>- In-situ geochemical and geotechnical monitoring of landforms<br>- Surface and groundwater monitoring<br>- Detailed cover design completed prior to installation<br>- Installation of cover conducted in accordance with cover design<br>- Documented compliance to plan                                                                                                                                                                                                                   | With all controls in place, including ongoing monitoring and maintenance, failure of cover is unlikely                                                                                                                        | Unlikely   | 0.1        | 3   |
| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU11     | Inadequate and/or inappropriate revegetation         | 1. Unfavourable climatic conditions and/or weather events<br>2. Incorrect species mix<br>3. Poor seed quality<br>4. Weed contaminated seed<br>5. Poor quality growth media or seed bed preparation<br>6. Erosion<br>7. Land contaminants<br>8. Subsidence related ponding causing vegetation dieback and loss of                                                                                                                                                                                                            | - Exposed soils due to poor vegetation establishment and growth, resulting in enhanced erosion rates.<br>- Increased weed establishment and growth.<br>- Reduction in land capability of PMLU (woodland habitat and/or grazing)<br>- Need for ongoing corrective action - soil sampling and analysis, amelioration and re-vegetation.<br>- Reduced fauna habitat due to loss of existing vegetation | 3                    | - Monitoring of rehabilitation<br>- Monitoring of subsidence areas and repair of surface cracks<br>- Rectification works undertaken e.g. repair erosion areas or ponded areas, retest materials, review seed mix and revegetate                                                                                                                                                                                                                                    | 1                   | - Growth media assessment to determine ameliorant and physical treatments<br>- Amelioration and physical treatments applied as per assessment<br>- Management of seed selection, provenance and quality<br>- Plant at optimal time of year<br>- Revegetation species aligned to growth media, landforms, subsidence and PMLU<br>- Progressive operational subsidence management to repair initial cracks and drainage to reduce ponding to acceptable limits after initial subsidence and final rehabilitation after final subsidence                                                                                                                                                                                                                                        | With all controls in place, including revegetating with species aligned to growth media, landforms, subsidence and PMLUs, as well as ongoing monitoring and maintenance, inadequate or inappropriate revegetation is unlikely | Unlikely   | 0.1        | 1   |
| Stable condition for land described as a post-mining land (reference PMLU table E1 - cattle grazing, woodland habitat, water course) use is not achieved | PMLU12     | Deterioration of built infrastructure conditions     | 1. Potential soil contamination around mine industrial areas<br>2. Inadequate sealing of surface underground infrastructure (shaft, holes, etc)                                                                                                                                                                                                                                                                                                                                                                             | - Reduced soil fertility to support PMLU land capability<br>- Potential contamination of surface water runoff affecting integrity of local catchments.<br>- Inability to achieve PMLU                                                                                                                                                                                                               | 2                    | - Undertake a preliminary contaminated land assessment prior to the completion of the approved activities, identify if any areas require a further Detailed Site Investigation and remediation plan developed if required<br>- Conduct ongoing maintenance<br>- Mapping of below ground infrastructure remaining at closure                                                                                                                                        | 1                   | - Clean up and remediate contamination during operational period.<br>- Surface infrastructure not being retained on-site to be decommissioned and removed, and underlying land rehabilitated<br>- Undertake contaminated land assessment and remediation/management where required post mining<br>- Capping and sealing of surface underground infrastructure (shaft, holes etc)                                                                                                                                                                                                                                                                                                                                                                                             | With all controls in place, including ongoing monitoring and maintenance, deterioration of built infrastructure is unlikely                                                                                                   | Unlikely   | 0.1        | 1   |

Goonyella Riverside and Broadmeadow Mine PRCP  
Risk Assessment

| Risk Event                                                                                       | Scenario # | Scenario                                                                 | Causes<br>(related to risk event)                                                                                                                                                                                                                                          | Impact Description                                                                                                                                                                                                                                                                                                                                                                                      | Highest<br>MFL Level | Mitigating Controls                                                                                                      | Highest<br>Severity | Preventative Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Likelihood Basis<br>(chance of the impact at the severity,<br>taking into account the effectiveness of<br>the preventative controls)                                                           | Likelihood | Likelihood | RRR |
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| NUMAs do not achieve safe, structurally stable condition or cause environmental harm off tenure. | NUMA1      | Void walls do not achieve geotechnical stability                         | 1. Geotechnical instability<br>2. Geochemical instability<br>3. Increase/decrease in predicted void water levels<br>4. Incorrect geotechnical assessment                                                                                                                   | - Failure of void walls leads to instability beyond NUMA extent                                                                                                                                                                                                                                                                                                                                         | 4                    | - Geotechnical monitoring<br>-AQP completing designs and assessments<br>- Identify requirements for rectification works. | 1                   | - Geotechnical assessment and final void wall design<br>- Pit floor treatments as required to improve low wall stability.<br>- Geotechnical monitoring during operations<br>- Updated geotechnical assessment to be completed as mining approaches final limits and wall design and NUMA extent adjusted if required<br>- NUMA extents designed at the required FoS limit<br>- Bunding or equivalent landform, fencing and signage placed at FoS limit<br>- Install physical barrier to underground access points<br>- Compliance to plan | With all controls in place, including ongoing monitoring and maintenance, wall failure beyond the NUMA limit is unlikely                                                                       | Unlikely   | 0.1        | 1   |
| NUMAs do not achieve safe, structurally stable condition or cause environmental harm off tenure. | NUMA2      | Uncontrolled access to NUMA                                              | 1. Inappropriate design, management and construction of safety bund or equivalent landform<br>2. Inadequate/poorly maintained fencing and signage                                                                                                                          | - Unmanaged access to NUMA by people or livestock                                                                                                                                                                                                                                                                                                                                                       | 4                    | - Compliance checks as part of monitoring                                                                                | 1                   | - Safety bunding or equivalent landform, fencing and signage placed at FoS limit, where required to prevent access<br>- Geotech modelling completed to determine FoS limit<br>- Install physical barrier to underground access points<br>- Compliance to plan                                                                                                                                                                                                                                                                             | With all controls in place, including ongoing monitoring and maintenance, failure of bunding, fencing and signage is unlikely                                                                  | Unlikely   | 0.1        | 1   |
| NUMAs do not achieve safe, structurally stable condition or cause environmental harm off tenure. | NUMA3      | Uncontrolled flooding into voids                                         | 1. Flood mitigation is not installed or incorrect construction<br>2. Incorrect flood modelling<br>3. Climate change impacts are different to those used to inform landform design                                                                                          | - Uncontrolled capture of flood waters<br>- Altered/changed alignment of watercourses and drainage lines<br>- Removal of downstream environmental flows<br>- Filling of residual void with water and interconnecting groundwater units<br>- Geotechnical instability of residual void<br>- Contamination of clean surface water flows, within residual void<br>- Contamination of groundwater resources | 4                    | - Compliance checks as part of monitoring                                                                                | 2                   | - Flood modelling<br>- Void flood mitigation designed to correct flood event<br>- Void flood mitigation (partial backfill and/or landforms) installed<br>- Compliance to plan                                                                                                                                                                                                                                                                                                                                                             | With all controls in place, including ongoing monitoring and maintenance, uncontrolled flooding into the voids is unlikely                                                                     | Unlikely   | 0.1        | 3   |
| NUMAs do not achieve safe, structurally stable condition or cause environmental harm off tenure. | NUMA4      | Water in the void causes environmental harm outside of the mining tenure | 1. Groundwater outflow seepage not identified by groundwater modelling<br>2. Lack of groundwater quality data to support water quality assessment<br>3. Overtopping or interconnection of the void lake with shallow groundwater water units<br>4. Flooding of underground | - Reduction in surface and/or groundwater quality beyond the mining leases<br>- Degradation of GDEs<br>- Changes to the chemistry of shallow groundwater units<br>- Groundwater extraction/use off site impacted                                                                                                                                                                                        | 5                    | - Groundwater monitoring<br>- Water quality monitoring<br>- AQP design for flooding                                      | 3                   | - Up to date groundwater and void lake water balancemodelling<br>- Void flood mitigation designed to correct flood event<br>- Void flood mitigation (partial backfill and/or landforms) installed<br>- Containment of potential sediment as a result of erosion from the low-wall within the residual void<br>- Landform design to enable to ensure inward hydraulic gradient towards Goonyella residual void.<br>- Compliance to plan                                                                                                    | With all controls in place, including ongoing monitoring and maintenance, any water in voids causing environmental harm outside of mining tenure will be managed through engineering controls. | Unlikely   | 0.1        | 10  |



# Permit

**Environmental Protection Act 1994**

## Environmental authority EPML00853413

*This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.*

**Environmental authority number: EPML00853413**

**Environmental authority takes effect on 26 February 2024**

### Environmental authority holder(s)

| Name(s)                                 | Registered address                                          |
|-----------------------------------------|-------------------------------------------------------------|
| QCT MINING PTY. LTD.                    | Level 16 480 Queen Street BRISBANE CITY QLD 4000 Australia  |
| QCT Resources Pty Limited               | Level 16, 480 Queen Street BRISBANE CITY QLD 4000           |
| QCT INVESTMENT PTY. LTD.                | Level 16 480 Queen Street BRISBANE CITY QLD 4000 Australia  |
| BHP COAL PTY LTD                        | Level 14, 480 Queen Street BRISBANE CITY QLD 4000 Australia |
| BHP Queensland Coal Investments Pty Ltd | Level 14, 480 Queen Street BRISBANE CITY QLD 4000           |
| Mitsubishi Development Pty Ltd          | Level 16, 480 Queen Street BRISBANE CITY QLD 4000           |
| Umal Consolidated Pty Ltd               | Level 14, 480 Queen Street BRISBANE CITY QLD 4000           |

### Environmentally relevant activity and location details

| Environmentally relevant activity/activities                                                                                                                                              | Location(s)                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Schedule 3 13: Mining black coal                                                                                                                                                          | ML70287 ML70494 ML1763 ML70288 ML70469 ML70421 ML70478 ML70479 ML70468 ML1802 ML70121 ML70493 ML1764 ML70289 ML70194 ML1900 ML700003 ML70193 |
| Ancillary 08 - Chemical Storage 3: Storing more than 500 cubic metres of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c) | ML70468 ML1802 ML70121 ML70493 ML1764 ML70289 ML70194 ML1900 ML700003 ML70287 ML70193 ML70494 ML1763 ML70288 ML70469 ML70421 ML70479 ML70478 |

**Permit**

**Environmental authority EPML00853413**  
**Goonyella Riverside and Broadmeadow Mine**

| <b>Environmentally relevant activity/activities</b>                                                                                                                                        | <b>Location(s)</b>                                                                                                                                               |
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| Ancillary 31 - Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000t                                           | ML70468 ML1802 ML70121 ML70493<br>ML1764 ML70289 ML70194 ML1900<br>ML700003 ML70193 ML70287 ML70479<br>ML70494 ML1763 ML70288 ML70469<br>ML70421 ML70478 ML70479 |
| Ancillary 56 - Regulated Waste Storage Receiving and storing regulated waste                                                                                                               | ML70289 ML70194 ML1900 ML700003<br>ML70193 ML70287 ML70494 ML1763<br>ML70288 ML70469 ML70421 ML70478<br>ML1764 ML70479 ML70468 ML1802<br>ML70121 ML70493         |
| Ancillary 60 - Waste disposal 2: Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1)(b) (h) more than 200,000t                   | ML1763                                                                                                                                                           |
| Ancillary 63 - Sewage Treatment 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (c) more than 1,500 but not more than 4,000EP | ML1802 ML70121 ML70493 ML1764<br>ML70289 ML70194 ML1900 ML700003<br>ML70193 ML70287 ML70494 ML1763<br>ML70288 ML70469 ML70421 ML70478<br>ML70468                 |

### **Additional information for applicants**

#### Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

#### Contaminated land

It is a requirement of the EP Act that an owner or occupier of contaminated land give written notice to the administering authority if they become aware of the following:

- the happening of an event involving a hazardous contaminant on the contaminated land (notice must be given within 24 hours); or
- a change in the condition of the contaminated land (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the contaminated land (notice must be given within 20 business days) that is causing, or is reasonably likely to cause, serious or material environmental harm.



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For further information, including the form for giving written notice, refer to the Queensland Government website [www.qld.gov.au](http://www.qld.gov.au), using the search term 'duty to notify'.

**Take effect**

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

- a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority-on the nominated day; or
- b) if the authority states a day or an event for it to take effect-on the stated day or when the stated event happens; or
- c) otherwise- one the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Planning Act 2016* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading information or operating without a valid environmental authority.

Juliana Mccosker  
Department of Environment and Science  
Delegate of the administering authority  
*Environmental Protection Act 1994*

**Enquiries:**  
Business Centre (Coal)  
Department of Environment and Science  
PO Box 3028  
EMERALD QLD 4720  
Phone: (07) 4987 9320  
Email: CRMining@des.qld.gov.au

**Date Issued: 26 February 2024**

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#### Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

#### Other permits required

This permit only provides an approval under the *Environmental Protection Act 1994*. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site. For example, this may include permits / approvals with your local Council (for planning approval), the Department of Transport and Main Roads (to access state controlled roads), the Department of Natural Resources, Mines and Energy (to clear vegetation), and the Department of Agriculture and Fisheries (to clear marine plants or to obtain a quarry material allocation).



Conditions of environmental authority

| Schedule A: General |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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| Condition number    | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| A1                  | This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| A2                  | <p><b>Prevent and /or minimise likelihood of environmental harm</b></p> <p>In carrying out the environmentally relevant activities, the environmental authority holder must take all reasonable and practicable measures to prevent and/or to minimise the likelihood of environmental harm being caused. Any environmentally relevant activity, that, if carried out incompetently, or negligently, may cause environmental harm, in a manner that could have been prevented, shall be carried out in a proper manner in accordance with the conditions of this environmental authority.</p>                                                                                        |
| A3                  | <p><b>Maintenance of measures, plant and equipment</b></p> <p>The environmental authority holder must ensure:</p> <ul style="list-style-type: none"> <li>a) that all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority are installed;</li> <li>b) that such measures, plant and equipment are maintained in a proper condition;</li> <li>c) that such measures, plant and equipment are operated in a proper manner; and</li> <li>d) that all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.</li> </ul> |
| A4                  | <p><b>Monitoring and records</b></p> <p>Except where specified otherwise in another condition of this environmental authority, all monitoring records and reports required by this environmental authority must be kept for a period of not less than <b>five (5) years</b>.</p>                                                                                                                                                                                                                                                                                                                                                                                                     |
| A5                  | Monitoring and determinations required under any condition of this environmental authority must be conducted by an appropriately qualified person(s).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| A6                  | Upon request from the administering authority, copies of monitoring results, records, registers, management plans and reports required by the conditions of this environmental authority must be made available and provided to the administering authority within <b>ten (10) business days</b> or an alternative timeframe agreed between the administering authority and the environmental authority holder.                                                                                                                                                                                                                                                                      |
| A7                  | <p><b>Notification of emergencies, incidents and exceptions</b></p> <p>The environmental authority holder must notify the administering authority by written notification within <b>twenty-four (24) hours</b> after becoming aware of any emergency or incident that results in the release of contaminants not in accordance, or reasonably expected to be not in accordance, with the conditions of this environmental authority.</p>                                                                                                                                                                                                                                             |

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| A8  | <p>Within <b>ten (10) business days</b> following the initial notification under condition <b>A7</b>, or the receipt of monitoring results associated with the notification made under condition <b>A7</b>, whichever is the latter, the environmental authority holder must provide further written advice to the administering authority, including the following:</p> <ul style="list-style-type: none"> <li>a) results and interpretation of any samples taken and analysed;</li> <li>b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and</li> <li>c) proposed actions to prevent a recurrence of the emergency or incident.</li> </ul>                |
| A9  | <p><b>Complaints</b></p> <p>The environmental authority holder must record all environmental complaints received about the mining activities, including:</p> <ul style="list-style-type: none"> <li>a) name, address and contact number for of the complainant;</li> <li>b) time and date of complaint;</li> <li>c) reasons for the complaint;</li> <li>d) investigations undertaken;</li> <li>e) conclusions formed;</li> <li>f) actions taken to resolve the complaint, including the use of appropriate dispute resolution if required;</li> <li>g) any abatement measures implemented; and</li> <li>h) person responsible for resolving the complaint.</li> </ul>                                   |
| A10 | <p>A register of alternative arrangements must be established and maintained by the environmental authority holder. The register must include:</p> <ul style="list-style-type: none"> <li>a) the location to which the alternative arrangement applies;</li> <li>b) the period of the alternative arrangement;</li> <li>c) details about the particular environmental nuisance impact or impacts the arrangement is for; and</li> <li>d) details about the mitigation measures, where relevant.</li> </ul>                                                                                                                                                                                              |
| A11 | <p><b>Monitoring on request</b></p> <p>When requested by the administering authority, the environmental authority holder must investigate any nuisance, or contaminant release, or environmental harm, or complaint that is neither frivolous nor vexatious in the opinion of the authorised person, by:</p> <ul style="list-style-type: none"> <li>a) undertaking the monitoring specified by the administering authority;</li> <li>b) undertaking the monitoring in the timeframe nominated or agreed to by the administering authority;</li> <li>c) completing an analysis and interpretation of the monitoring results; and</li> <li>d) implementing abatement measures, where required.</li> </ul> |



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| A12 | The results of the investigation undertaken in accordance with condition <b>A11</b> must be provided to the administering authority within <b>twenty (20) business days</b> of completion of the monitoring timeframe in accordance with condition <b>A11(b)</b> , or a longer timeframe agreed to by the administering authority. |
| A13 | No mining to be undertaken on ML70478 and ML70479.                                                                                                                                                                                                                                                                                 |

| Schedule B: Air  |                                                                                                                                                                                                                                                                                                             |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Condition number | Condition                                                                                                                                                                                                                                                                                                   |
| B1               | <b>Odour nuisance</b><br><br>The release of noxious or offensive odour or any other noxious or offensive airborne contaminant resulting from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.                                                    |
| B2               | If the administering authority determines odour released from the mining activities to constitute an environmental nuisance, the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance. |
| B3               | <b>Dust nuisance</b><br><br>The release of dust or particulate matter or both resulting from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.                                                                                                    |



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| B4 | <p>Monitoring of dust and particulate matter resulting from the mining activities, undertaken in accordance with condition <b>A11</b>, must be carried out at a place relevant to the potentially affected sensitive place or commercial place and must not exceed the following levels when measured at any sensitive place or commercial place:</p> <ul style="list-style-type: none"> <li>a) dust deposition, measured as total insoluble matter, of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 <i>Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method</i>.</li> <li>b) a concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of either: <ul style="list-style-type: none"> <li>i. Australian Standard AS3580.9.6 <i>Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM10 high volume sampler with size selective inlet – Gravimetric method</i>; or</li> <li>ii. Australian Standard AS3580.9.8 <i>Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM10 continuous direct mass method using a tapered element oscillating microbalance analyser</i>; or</li> <li>iii. Australian Standard AS3580.9.9 <i>Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM10 low volume sampler – Gravimetric method</i>; or</li> <li>iv. Australian Standard AS3580.9.11 <i>Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM10 beta attenuation monitors</i>.</li> </ul> </li> <li>c) a concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a 1 year averaging time, when monitored in accordance with the most recent version of either: <ul style="list-style-type: none"> <li>i. Australian Standard AS3580.9.3 <i>Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – Total suspended particulate matter (TSP) – High volume sampler gravimetric method</i>; or</li> <li>ii. any alternative method of monitoring TSP that may be permitted by the Air Quality Sampling Manual as published from time to time by the administering authority.</li> </ul> </li> </ul> <p><i>NOTE: Exceedances due to events that cannot be managed by the environmental authority holder, such as bushfires, fuel reduction burning for fire management purposes or dust storms, would not be considered to be in breach of condition <b>B4</b> if the environmental authority holder can demonstrate that the exceedance was caused by such events.</i></p> |
| B5 | <p>If monitoring, undertaken in accordance with condition <b>A11</b>, indicates exceedance of the relevant limits in condition <b>B4</b>, the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| Schedule C: Noise and Vibration |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Condition number                | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| C1                              | <b>Noise nuisance</b><br>Noise from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| C2                              | Noise is not considered an environmental nuisance under condition <b>C1</b> if monitoring shows that noise does not exceed the limits in <b>Table C1 (Noise Limits)</b> , at any sensitive place or commercial place.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| C3                              | <b>Noise monitoring</b><br>Noise monitoring, undertaken in accordance with condition <b>A11</b> , must comply with the most recent version of the administering authority's <i>Noise Measurement Manual</i> , and must include the following descriptors, characteristics and conditions: <ul style="list-style-type: none"> <li>a) <math>L_{A10}</math>, adj, 10 mins;</li> <li>b) <math>L_{A1}</math>, adj, 10 mins;</li> <li>c) the level and frequency of occurrence of impulsive or tonal noise;</li> <li>d) atmospheric conditions including wind speed and direction;</li> <li>e) effects due to extraneous factors such as traffic noise; and</li> <li>f) location, date and time of recording.</li> </ul> |
| C4                              | If monitoring, undertaken in accordance with condition <b>A11</b> , indicates exceedance of the relevant limits in <b>Table C1 (Noise Limits)</b> , the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.                                                                                                                                                                                                                                                                                                                                                                                 |

**Table C1 (Noise Limits)**

| Noise Level<br>dB(A)     | Monday to Saturday  |                          |                        | Sundays and Public Holidays |                          |                        |
|--------------------------|---------------------|--------------------------|------------------------|-----------------------------|--------------------------|------------------------|
|                          | Day<br>(7am to 6pm) | Evening<br>(6pm to 10pm) | Night<br>(10pm to 7am) | Day<br>(9am to 6pm)         | Evening<br>(6pm to 10pm) | Night<br>(10pm to 9am) |
| <b>Sensitive Place</b>   |                     |                          |                        |                             |                          |                        |
| $L_{A10}$ , adj, 10 mins | B/g + 5             | B/g + 5                  | B/g + 0                | B/g + 5                     | B/g + 5                  | B/g + 0                |
| $L_{A1}$ , adj, 10 mins  | B/g + 10            | B/g + 10                 | B/g + 5                | B/g + 10                    | B/g + 10                 | B/g + 5                |
| <b>Commercial Place</b>  |                     |                          |                        |                             |                          |                        |
| $L_{A10}$ , adj, 10 mins | B/g + 10            | B/g + 10                 | B/g + 5                | B/g + 10                    | B/g + 10                 | B/g + 5                |
| $L_{A1}$ , adj, 10 mins  | B/g + 15            | B/g + 15                 | B/g + 10               | B/g + 15                    | B/g + 15                 | B/g + 10               |



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| C5  | <b>Vibration nuisance</b><br>Vibration from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| C6  | Vibration is not considered an environmental nuisance under condition <b>C5</b> if monitoring shows that vibration does not exceed the limits specified in <b>Table C2 (Vibration Limits)</b> .                                                                                                                                                                                                                                                                                                                                                                                                      |
| C7  | <b>Airblast overpressure nuisance</b><br>The airblast overpressure level from blasting operations on the mining leases must not cause an environmental nuisance, at any sensitive place or commercial place.                                                                                                                                                                                                                                                                                                                                                                                         |
| C8  | Airblast overpressure is not considered an environmental nuisance under condition <b>C7</b> if monitoring shows that airblast overpressure does not exceed the levels specified in <b>Table C3 (Airblast Overpressure Level)</b> .                                                                                                                                                                                                                                                                                                                                                                   |
| C9  | <b>Vibration and/or airblast overpressure monitoring</b><br>Vibration and/or airblast overpressure monitoring, undertaken in accordance with condition <b>A11</b> , must comply with the most recent version of the administering authority's <i>Noise Measurement Manual</i> , and must include the following descriptors, characteristics and conditions:<br>a) location of the blast(s) within the mining area (including which bench level);<br>b) atmospheric conditions including temperature, relative humidity and wind speed and direction; and<br>c) location, date and time of recording. |
| C10 | If monitoring, undertaken in accordance with condition <b>A11</b> , indicates exceedance of the relevant limits in <b>Table C2 (Vibration Limits)</b> or <b>Table C3 (Airblast Overpressure Level)</b> , the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.                                                                                                                                                                                                              |
| C11 | The environmental authority holder cannot undertake any blasting on ML70478 and ML70479.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

**Table C2 (Vibration Limits)**

| Location                            | Vibration Measured                                                                                                                             |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Sensitive place or commercial place | 5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time. |

**Table C3 (Airblast Overpressure Level)**

| Location                            | Airblast Overpressure Measured                                                                                              |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Sensitive place or commercial place | 115 dB (Linear peak) for nine (9) out of ten (10) consecutive blasts and not greater than 120 dB (Linear peak) at any time. |

| Schedule D: Waste |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| Condition number  | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| D1                | <p><b>Waste management</b></p> <p>A Waste Management Plan must be developed by an appropriately qualified person and implemented. The Waste Management Plan must include, but is not limited to:</p> <ul style="list-style-type: none"> <li>a) a description of the mining activities that may generate waste;</li> <li>b) a description of all waste activities being carried out;</li> <li>c) the location/s (including GPS coordinates) of where all waste activities are, or have been, carried out, including: <ul style="list-style-type: none"> <li>i. the type of waste disposed of, treated, or reprocessed; and</li> <li>ii. the volume of waste disposed of, treated, or reprocessed;</li> </ul> </li> <li>d) identification of the potential risks to the environment from all waste activities carried out;</li> <li>e) control measures to be implemented to minimise the potential for environmental harm associated with carrying out of the waste activities, including but not limited to: <ul style="list-style-type: none"> <li>i. segregation of the wastes;</li> <li>ii. storage of the wastes;</li> <li>iii. transport of the wastes; and</li> <li>iv. monitoring and reporting matters concerning the wastes;</li> </ul> </li> <li>f) how the waste will be managed with in accordance with the waste management hierarchy (that is, avoid, reuse, recycling, energy recovery, disposal);</li> <li>g) the hazardous characteristics of the wastes generated including disposal procedures for hazardous wastes;</li> <li>h) procedures for reprocessing waste in accordance with condition <b>D4</b>;</li> <li>i) procedures for managing accidents, spills and other incidents;</li> <li>j) the indicators or other criteria on which the performance of the waste management plan will be assessed;</li> <li>k) staff training; and</li> <li>l) reference to the Groundwater Monitoring and Management Program for the general waste landfill.</li> </ul> |
| D2                | <p>The environmental authority holder must submit the Waste Management Plan required by condition <b>D1</b> to the administering authority prior to commencing a new process, or varying an existing process, for reprocessing any waste.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| D3                | <p><b>Waste receipt</b></p> <p>The only waste permitted to be received is:</p> <ul style="list-style-type: none"> <li>a) the types of waste specified in conditions <b>D5</b> to <b>D8</b> (inclusive); and</li> <li>b) sewage and sludge for treatment in accordance with <b>Schedule H: Sewage Treatment</b>; and</li> <li>c) from a BHP Billiton Mitsui Coal (BMC) or BHP Mitsubishi Alliance (BMA) site in Queensland.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |



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| D4 | <p><b>Waste reprocessing</b></p> <p>The only waste permitted to be reprocessed is:</p> <ul style="list-style-type: none"> <li>a) spoil or overburden;</li> <li>b) vegetation;</li> <li>c) water or sediment containing hydrocarbons;</li> <li>d) fuels, oils, lubricants and coolants;</li> <li>e) bulk rubber;</li> <li>f) inert waste;</li> <li>g) poly-pipe and other plastic;</li> <li>h) fibreglass;</li> <li>i) treated and untreated timber; and</li> <li>j) asphalt.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| D5 | <p><b>Waste disposal</b></p> <p>Unless otherwise specified in conditions <b>D6</b> to <b>D8</b> (inclusive), waste, other than spoil or overburden or vegetation removed as part of the mining activity, must not be disposed of within the mining leases listed on this environmental authority and must be taken to a facility that is lawfully allowed to accept such waste under the provisions of the <i>Environmental Protection Act 1994</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| D6 | <p>The following types of waste are permitted to be disposed of within the specified features for the waste type:</p> <ul style="list-style-type: none"> <li>a) rejects and sediment containing hydrocarbons: <ul style="list-style-type: none"> <li>i. in spoil emplacements; and</li> <li>ii. in regulated structures in accordance with <b>Schedule G: Structures</b> of this environmental authority; and</li> <li>iii. in pits or voids; and</li> <li>iv. in dedicated rejects emplacements; and</li> </ul> </li> <li>b) tailings and water or sediment containing hydrocarbons: <ul style="list-style-type: none"> <li>i. in regulated structures in accordance with <b>Schedule G: Structures</b> of this environmental authority; and</li> <li>ii. in pits or voids that are not regulated structures, provided a consequence category assessment in accordance with condition <b>G1</b> has been completed.</li> </ul> </li> </ul> |

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| D7 | <p>The following types of waste are permitted to be disposed of within the mining leases listed on this environmental authority:</p> <ul style="list-style-type: none"><li>a) bulk rubber;</li><li>a) inert waste;</li><li>b) poly-pipe and other plastic;</li><li>c) fibreglass;</li><li>d) treated and untreated timber;</li><li>e) asphalt; and</li><li>f) asbestos.</li></ul> <p>These types of waste may be disposed of:</p> <ul style="list-style-type: none"><li>a) in pits or voids;</li><li>b) in spoil emplacements; and</li><li>c) left insitu below ground level.</li></ul> |
| D8 | <p>General waste can only be disposed of into the general waste landfill on ML1763 and identified in <b>Figure 1 (General Waste Landfill Location)</b>, which must be operated in accordance with the Waste Management Plan as described by condition <b>D1</b>.</p>                                                                                                                                                                                                                                                                                                                    |



| Schedule E: Land |                                                                                                                                                                                                                                                                             |
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| Condition number | Condition                                                                                                                                                                                                                                                                   |
| E1               | <b>Topsoil</b><br>Topsoil must be strategically stripped ahead of mining in accordance with a Topsoil Management Plan.                                                                                                                                                      |
| E2               | A topsoil inventory, which identifies the topsoil requirements for rehabilitation and availability of suitable topsoil on site, must be provided with any Estimated Rehabilitation Cost application.                                                                        |
| E3               | <b>Rehabilitation landform criteria</b><br>Unless otherwise permitted under the conditions of this environmental authority, all areas significantly disturbed by mining activities must be rehabilitated in accordance with <b>Table E1 (Rehabilitation Requirements)</b> . |

**Table E1 (Rehabilitation Requirements)**

| Post Mining Land Use | Goal                                            | Objective                                                                                                                       | Indicator                                      | Acceptance Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cattle grazing       | Safe to humans and wildlife                     | Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use | Hazard assessment                              | No significant difference                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                      | Stable                                          | Rehabilitation is geotechnically stable                                                                                         | Factor of safety                               | ≥1.5                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                      |                                                 | Rehabilitation is erosionally stable                                                                                            | Extent, slope gradient and groundcover         | 1. Groundcover >50%<br>2. 70% of slopes ≤20%                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                      | Non-polluting                                   | Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters                             | pH<br>EC<br>Turbidity                          | Not significantly different to upstream values                                                                                                                                                                                                                                                                                                                                                                                                                |
|                      |                                                 | Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater                                    | EC                                             | Not significantly different to:<br>(a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or,<br>(b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.                                                                                                                                                                                                  |
|                      | Able to sustain the agreed post-mining land use | Rehabilitation is suitable for sustainable cattle grazing                                                                       | Land suitability assessment for cattle grazing | Land suitability class ≤3 or not different from pre-mining class if ≥4. Assessment completed in accordance with <i>LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland)</i> unless otherwise agreed in writing between the administering authority and the environmental authority holder. |
|                      |                                                 |                                                                                                                                 | Leucaena stem density                          | <250 stems >2m height per ha (1 per 40m <sup>2</sup> ), mean total area                                                                                                                                                                                                                                                                                                                                                                                       |

# Environmental authority EPML00853413

## Goonyella Riverside and Broadmeadow Mine

| Post Mining Land Use | Goal                                            | Objective                                                                                                                       | Indicator                                                                     | Acceptance Criteria                                                                                                                                                                                                                                                                                |
|----------------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dryland cropping     | Safe to humans and wildlife                     | Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use | Hazard assessment                                                             | No significant difference                                                                                                                                                                                                                                                                          |
|                      | Stable                                          | Rehabilitation is geotechnically stable                                                                                         | Factor of safety                                                              | ≥1.5                                                                                                                                                                                                                                                                                               |
|                      |                                                 | Rehabilitation is erosionally stable                                                                                            | Percentage of cultivation at >1% slope gradient with functional contour banks | 100% of rehabilitated areas                                                                                                                                                                                                                                                                        |
|                      | Non-polluting                                   | Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters                             | pH<br>EC<br>Turbidity                                                         | Not significantly different to upstream values                                                                                                                                                                                                                                                     |
|                      |                                                 | Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater                                    | EC                                                                            | Not significantly different to:<br>(a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or,<br>(b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.                                       |
|                      | Able to sustain the agreed post-mining land use | Rehabilitation is suitable for sustainable dryland cropping                                                                     | Land suitability assessment for dryland cropping                              | Land suitability class ≤3 or not different from pre-mining class if ≥4. Assessment completed in accordance with the <i>Regional Land Suitability Frameworks for Queensland 2013</i> unless otherwise agreed in writing between the administering authority and the environmental authority holder. |
| Woodland habitat     | Safe to humans and wildlife                     | Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use | Hazard assessment                                                             | No significant difference                                                                                                                                                                                                                                                                          |
|                      | Stable                                          | Rehabilitation is geotechnically stable                                                                                         | Factor of safety                                                              | ≥1.5 unless an alternative is justified by an appropriately qualified person                                                                                                                                                                                                                       |
|                      |                                                 | Rehabilitation is erosionally stable                                                                                            | Groundcover (steep slopes, >15%)                                              | 80%                                                                                                                                                                                                                                                                                                |
|                      |                                                 |                                                                                                                                 | Groundcover (lesser slopes, ≤15%)                                             | 50%                                                                                                                                                                                                                                                                                                |
|                      | Non-polluting                                   | Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters                             | pH<br>EC<br>Turbidity                                                         | Not significantly different to upstream values                                                                                                                                                                                                                                                     |
|                      |                                                 | Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater                                    | EC                                                                            | Not significantly different to:<br>(a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or,<br>(b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.                                       |
|                      | Able to sustain the agreed post-                | Native bushland characteristics                                                                                                 | Species richness<br>Trees<br>Shrubs<br>Grasses                                | ≥2<br>≥3<br>≥4                                                                                                                                                                                                                                                                                     |



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| Post Mining Land Use | Goal                                            | Objective                                                                                                                                      | Indicator                                                     | Acceptance Criteria                                                                                                                                                                                                                                          |
|----------------------|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      | mining land use                                 |                                                                                                                                                | Tree canopy cover                                             | ≥16%                                                                                                                                                                                                                                                         |
| Water Storage        | Safe to humans and wildlife                     | Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use                | Hazard assessment                                             | No significant difference                                                                                                                                                                                                                                    |
|                      | Stable                                          | Rehabilitation is geotechnically stable                                                                                                        | Factor of Safety                                              | ≥1.5                                                                                                                                                                                                                                                         |
|                      |                                                 | Rehabilitation is erosionally stable (banks and immediate surrounds)                                                                           | Groundcover                                                   | >50%                                                                                                                                                                                                                                                         |
|                      | Non-polluting                                   | Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters                                            | pH<br>EC<br>Turbidity                                         | Not significantly different to upstream values                                                                                                                                                                                                               |
|                      |                                                 | Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater                                                   | EC                                                            | Not significantly different to:<br>(a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or,<br>(b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines. |
|                      | Able to sustain the agreed post-mining land use | Rehabilitation retains water that is a potential resource for cattle grazing, with quality according to ANZECC guidelines version October 2000 | TDS<br>Calcium<br>Magnesium<br>Nitrate<br>Nitrite<br>Sulphate | ≤5,000mg/L<br>≤1,000mg/L<br>≤2,000mg/L<br>≤400mg/L<br>≤30mg/L<br>≤1,000mg/L                                                                                                                                                                                  |
| Watercourse          | Safe to humans and wildlife                     | Safety hazards are not significantly different to surrounding unmined landscapes subject to the same land use                                  | Hazard assessment                                             | No significant difference                                                                                                                                                                                                                                    |
|                      | Stable                                          | Rehabilitation is erosionally stable                                                                                                           | Geomorphic index (IDC method)                                 | Greater or equal to upstream or downstream values.                                                                                                                                                                                                           |
|                      | Non-polluting                                   | Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters                                            | pH<br>EC<br>Turbidity                                         | Not significantly different to upstream values                                                                                                                                                                                                               |
|                      | Able to sustain the agreed post-mining land use | Riparian vegetation                                                                                                                            | Riparian vegetation index (IDC method)                        | Greater or equal to upstream or downstream values.                                                                                                                                                                                                           |

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|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E4 | Progressive rehabilitation must commence within <b>two (2) years</b> when areas become available within the mining leases.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| E5 | <p>Complete an investigation into rehabilitation of disturbed areas and submit a report to the administering authority proposing acceptance criteria for Department review and comment. The investigation report must be reviewed and updated every <b>three (3) years</b>, commencing on <b>30 June 2008</b>. The Rehabilitation Management Plan must include, at a minimum:</p> <ul style="list-style-type: none"> <li>a) map existing areas of rehabilitation;</li> <li>b) develop design objectives for rehabilitation of disturbed areas and post mining land uses across the mine;</li> <li>c) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation;</li> <li>d) detail rehabilitation methods applied to areas;</li> <li>e) contain landform design criteria including end of mine design;</li> <li>f) detail how landform design will be consistent with the surrounding topography;</li> <li>g) identify success criteria for areas and itemize revegetation criteria;</li> <li>h) explain planned native vegetation rehabilitation areas and corridors;</li> <li>i) identify at least a minimum of three (3) reference and three (3) rehabilitation sites to be used to develop rehabilitation success criteria;</li> <li>j) describe rehabilitation indicators and the monitoring program to be used;</li> <li>k) develop a contingency plan for rehabilitation maintenance or redesign;</li> <li>l) describe end of mine landform design plan and post mining land uses across the mine; and</li> <li>m) include a cost benefit analysis / triple bottom line assessment (or an alternative assessment method) of the proposed final landform design criteria and alternatives.</li> </ul> |
| E6 | <p><b>Residual void outcome</b></p> <p>Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |



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|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E7 | <p>Complete an investigation into residual voids and submit a report to the administering authority proposing acceptance criteria to meet the outcomes in condition <b>E6</b> and landform design criteria in <b>Table E2 (Rehabilitation Design Parameters)</b> and must be reviewed and updated every <b>three (3) years</b>, commencing on <b>30 June 2008</b>. The investigation must include the following, at a minimum:</p> <ul style="list-style-type: none"> <li>a) a study of options available for minimising final void area and volume;</li> <li>b) a void hydrology study, addressing the long-term water balance in the voids, connections to groundwater resources and water quality parameters in the long term;</li> <li>c) a pit wall stability study, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events;</li> <li>d) a hydrological study into the long-term risk of the Isaac River / final void interaction, including erosion of the banks and spoil and extreme hydrological events, and the consequences of such interaction to the long-term stability of the final voids;</li> <li>e) a study of void capability to support native flora and fauna;</li> <li>f) proposal/s for end of mine void rehabilitation success criteria and final void areas and volume; and</li> <li>g) the recommendations of these studies are to be followed during the life of the mine, and will include detailed research and modelling.</li> </ul> |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Table E2 (Landform Design Parameters)**

| Rehabilitation Area                                     | Design Criteria          | Qualifications                                                                                       |
|---------------------------------------------------------|--------------------------|------------------------------------------------------------------------------------------------------|
| Final high walls:<br>Competent rock<br>Incompetent rock | <65° slope<br><17° slope | Competency certified by an appropriately qualified professional accredited by a credible third party |
| Low walls                                               | <17° slope               | Angle of repose / benched / graded                                                                   |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E8  | <p><b>Preventing contaminant release to land</b></p> <p>Contaminants must not be released to land in manner that constitutes a nuisance, material harm or serious environmental harm.</p>                                                                                                                                                                                                                                           |
| E9  | <p><b>Storage and handling of chemicals and flammable or combustible liquids</b></p> <p>All chemicals and flammable or combustible liquids must be stored and handled in accordance with the most recent version of an Australian Standard where such is applicable. Where no relevant Australian Standard exists, store such materials within an effective on-site containment system.</p>                                         |
| E10 | <p><b>Infrastructure</b></p> <p>All infrastructure, constructed by or for the environmental authority holder during the mining activities including water storage structures, must be removed from the site prior to surrender, except where agreed in writing by the post mining landowner/ landholder.</p> <p><i>NOTE: This is not applicable where the landowner/ landholder is also the environmental authority holder.</i></p> |

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|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E11 | <p><b>Exploration</b></p> <p>The environmental authority holder must rehabilitate in accordance with this environmental authority, any disturbance from mining activities which were undertaken under:</p> <ul style="list-style-type: none"> <li>a) this environmental authority; or</li> <li>b) any other environmental authority that applied to the land that is the subject of this environmental authority.</li> </ul>                                                                                                                                   |
| E12 | <p><b>Subsidence</b></p> <p>The post mining land use for areas affected by subsidence as a result of underground mining, except for watercourse subsidence that is subject to <b>Schedule H: Watercourse Subsidence</b>, must be:</p> <ul style="list-style-type: none"> <li>a) if agricultural land use prior to mining – agricultural land use; or</li> <li>b) if a land use other than agricultural use – the same land use as existed prior to mining.</li> </ul>                                                                                          |
| E13 | <p>Subsidence management procedures must be developed and implemented during the continuation of the environmental authority, except for watercourse subsidence that is subject to <b>Schedule H: Watercourse Subsidence</b>. The subsidence management strategies must be detailed in the Subsidence Management Plan and must at a minimum include:</p> <ul style="list-style-type: none"> <li>a) subsidence modelling prior to mining;</li> <li>b) rehabilitation methodology; and</li> <li>c) land management practices pre and post subsidence.</li> </ul> |
| E14 | No subsidence permitted on ML70478 and ML70479.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| E15 | <p><b>Impacts to Prescribed Environmental Matters</b></p> <p>No impact on State Significant Biodiversity Values (SSBV) or Matters of State Environmental Significance (MSES) on ML70478 and ML70479.</p>                                                                                                                                                                                                                                                                                                                                                       |
| E16 | Impacts to Matters of State Environmental Significance (MSES) on ML1763 that are associated with Red Hill Mine are only authorised to occur in accordance with the conditions of the Red Hill Mine Environmental Authority EPML03337715.                                                                                                                                                                                                                                                                                                                       |



| Schedule F: Water |                                                                                                                                                                                                                                                                                  |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Condition number  | Condition                                                                                                                                                                                                                                                                        |
| F1                | <b>Contaminant Release</b><br>Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the mining activities, except as permitted under the conditions of this environmental authority. |
| F2                | Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in <b>Table F1 (Mine Affected Water Release Points)</b> .                                        |
| F3                | The release of mine affected water to internal water management infrastructure that is installed and operated in accordance with a Water Management Plan that complies with conditions <b>F28</b> to <b>F29</b> inclusive is permitted.                                          |

**Table F1 (Mine Affected Water Release Points)**

| Release Point (RP) | Easting (GDA94) | Northing (GDA94) | Mine Affected Water Source and Location | Monitoring Point           | Receiving Waters Description |
|--------------------|-----------------|------------------|-----------------------------------------|----------------------------|------------------------------|
| RP1                | 602621          | 7588947          | GS4a Dam (Eureka Creek)                 | Upstream of spillway (MP1) | Isaac River                  |

|    |                                                                                                                                                                                                                                                                                                                                 |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F4 | The release of mine affected water to waters in accordance with condition <b>F2</b> must not exceed the release limits stated in <b>Table F2 (Mine Affected Water Release Limits)</b> when measured at the monitoring points specified in <b>Table F1 (Mine Affected Water Release Points)</b> for each quality characteristic. |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Table F2 (Mine Affected Water Release Limits)**

| Quality Characteristic                              | Release Limit                  | Monitoring Frequency                                                                                                                                                                                                                          |
|-----------------------------------------------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Electrical Conductivity ( $\mu\text{S}/\text{cm}$ ) | 10,000                         | Real time telemetry for EC and pH with grab samples at commencement and weekly thereafter when safe to do so and access permits<br><br>Daily grab samples if telemetry not available (the first sample must be taken as soon as practicable)^ |
| pH (pH units)                                       | 6.5 (minimum)<br>9.0 (maximum) |                                                                                                                                                                                                                                               |
| Sulphate ( $\text{SO}_4^{2-}$ ) (mg/L)              | N/A (correlated with EC)       | Commencement of release and weekly thereafter during release when safe to do so and access permits                                                                                                                                            |

NOTES: ^ Generally during daylight hours only

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F5 | <p>The release of mine affected water to waters from the release points must be monitored at the locations specified in <b>Table F1 (Mine Affected Water Release Points)</b> for each quality characteristic and at the frequency specified in <b>Table F2 (Mine Affected Water Release Limits)</b> and <b>Table F3 (Release Contaminant Trigger Investigation Levels)</b>.</p> <p><i>NOTE: the administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event condition F5 is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations. When there no temporary safe or practical access to the monitoring point, a representative alternative site or monitoring point can be used.</i></p> |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Table F3 (Release Contaminant Trigger Investigation Levels)**

| Quality Characteristic           | Trigger Level (µg/L) | Comment of Trigger Level                                                                                                            | Monitoring Frequency                                                                                 |
|----------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Aluminium                        | 1530                 | Based on 80th percentile of 4 background sites and comparison with upstream values.                                                 | Commencement of release and weekly thereafter during release, when safe to do so and access permits. |
| Chromium                         | 3                    | Based on 80th percentile of 4 background sites and comparison with upstream values.                                                 |                                                                                                      |
| Copper                           | 3                    | Based on 80th percentile of 4 background sites and comparison with upstream values.                                                 |                                                                                                      |
| Iron                             | 970                  | Based on 80th percentile of 4 background sites and comparison with upstream values.                                                 |                                                                                                      |
| Nickel                           | 11                   | For aquatic ecosystem protection, based on SMD guideline                                                                            |                                                                                                      |
| Zinc                             | 8                    | For aquatic ecosystem protection, based on SMD guideline                                                                            |                                                                                                      |
| Molybdenum                       | 34                   | For aquatic ecosystem protection, based on low reliability guideline                                                                |                                                                                                      |
| Selenium                         | 10                   | For aquatic ecosystem protection, based on LOR for ICPMS                                                                            |                                                                                                      |
| Uranium                          | 1                    | For aquatic ecosystem protection, based on LOR for ICPMS                                                                            |                                                                                                      |
| Vanadium                         | 10                   | For aquatic ecosystem protection, based on LOR for ICPMS                                                                            |                                                                                                      |
| Nitrate                          | 1100                 | For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN                                                  |                                                                                                      |
| Petroleum hydrocarbons (C6-C9)   | 50                   | Based on LOR for P&T/GC/FID/MSD                                                                                                     |                                                                                                      |
| Petroleum hydrocarbons (C10-C36) | 200                  | Based on LOR for C15-C28 fraction using GC/FID                                                                                      |                                                                                                      |
| Total Nitrogen                   | 500                  | For aquatic ecosystem protection, based on Isaac River Sub-basin Environmental Values and Water Quality Objectives (September 2011) |                                                                                                      |
| Total Phosphorus                 | 50                   | For aquatic ecosystem protection, based on Isaac River Sub-basin Environmental Values and Water Quality Objectives (September 2011) |                                                                                                      |

**NOTES:**

1. All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.
3. SMD – slightly moderately disturbed level of protection, guideline refers ANZECC & ARMCANZ (2000).
4. LOR – typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.



|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| F6  | <p>If quality characteristics of the release exceed any of the trigger levels specified in <b>Table F3 (Release Contaminant Trigger Investigation Levels)</b> during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in <b>Table F3 (Release Contaminant Trigger Investigation Levels)</b> and:</p> <ul style="list-style-type: none"> <li>(1) where the trigger values are not exceeded then no action is to be taken; or</li> <li>(2) where the downstream results exceed the trigger values specified in <b>Table F3 (Release Contaminant Trigger Investigation Levels)</b> for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites and; <ul style="list-style-type: none"> <li>(a) if the result is less than the background monitoring site data, then no action is to be taken; or</li> <li>(b) if the result is greater than the background monitoring site data, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining: <ul style="list-style-type: none"> <li>i. details of the investigations carried out; and</li> <li>ii. actions taken to prevent environmental harm.</li> </ul> </li> </ul> </li> </ul> <p><i>NOTE: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with condition <b>F6(2)(b)</b>, no further reporting is required for subsequent trigger events for that quality characteristic.</i></p> |
| F7  | <p>If an exceedance in accordance with condition <b>F6(2)(b)</b> is identified, the environmental authority holder must notify the administering authority within <b>twenty-four (24) hours</b> of receiving the result.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| F8  | <p><b>Mine Affected Water Release Events</b></p> <p>The environmental authority holder must ensure a stream flow gauging station(s) is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in <b>Table F4 (Mine Affected Water Release During Flow Events)</b>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| F9  | <p>Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition <b>F2</b> must only take place during periods of natural flow events in accordance with the receiving water flow criteria for discharge specified in <b>Table F4 (Mine Affected Water Release During Flow Events)</b> for the release point(s) specified in <b>Table F1 (Mine Affected Water Release Points)</b>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| F10 | <p>Notwithstanding condition <b>F9</b>, releases from RP1 may occur during periods of no flow in the Isaac River, provided:</p> <ul style="list-style-type: none"> <li>a) a surface flow has been recorded in Eureka Creek at Monitoring Point 2 within the <b>twenty-four (24) hour</b> period prior to release; and</li> <li>b) the release serves only to allow for the total volume of inflow into GS4a Dam resulting from natural flows in Eureka Creek to be conveyed through GS4a Dam into the Isaac River during periods of no flow in the Isaac River.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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| F11 | <p>The 80<sup>th</sup> percentile of electrical conductivity (EC) values recorded at the downstream monitoring points listed in <b>Table F6 (Receiving Waters Upstream Background and Downstream Monitoring Points)</b> must not exceed 2000uS/cm at any time during the release influence period. The 80<sup>th</sup> percentile must be calculated using all EC values recorded by the monitoring station during the release influence period.</p> <p><i>Note: The release influence period is the period during which the downstream monitoring points are influenced by mine affected water includes both the duration of release and any lag time between release point/s and downstream monitoring points</i></p> |
| F12 | The daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring points in <b>Table F1 (Mine Affected Water Release Points)</b> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| F13 | Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

**Table F4 (Mine Affected Water Release During Flow Events)**

| Receiving waters | Release Point (RP) | Gauging Station   | Gauging Station Easting (GDA94) | Gauging Station Northing (GDA94) | Receiving Water Flow Criteria for Discharge* (m³/s) | Receiving Water Flow Recording Frequency^ |
|------------------|--------------------|-------------------|---------------------------------|----------------------------------|-----------------------------------------------------|-------------------------------------------|
| Isaac River      | RP1                | Upper Isaac River | 605183                          | 7596105                          | ≥ 3                                                 | Daily                                     |

^ Assumes access to real time telemetry monitoring is available. Where real time telemetry is not available, daily records will be calculated.

# When the downstream flow gauge falls below the minimum flow trigger, the 6 week tail flow period commences. Tail flow restricted by trigger limits in receiving waters (**Table F5**).

\* Receiving water minimum flow requirements at the time of commencement apply to the entire release event, where the release period changes.

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F14 | <p><b>Notification of release event</b></p> <p>The environmental authority holder must notify the administering authority via WaTERS as soon as practicable and no later than <b>twenty-four (24) hours</b> after commencing to release mine affected water to the receiving environment. The release commencement notification must include the submission of written advice to the administering authority of the following information:</p> <ul style="list-style-type: none"> <li>a) release commencement date and time;</li> <li>b) expected release cessation date and time;</li> <li>c) release point(s);</li> <li>d) release rate;</li> <li>e) receiving water(s) including the natural flow rate; and</li> <li>f) any details (including available data) regarding likely impacts on the receiving water(s).</li> </ul> |
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| F15 | <p>The environmental authority holder must notify the administering authority via WaTERS as soon as practicable and no later than <b>twenty-four (24) hours</b> after cessation of a release event notified under condition <b>F14</b>. The release cessation notification must include the submission of written advice to the administering authority of the following information:</p> <ul style="list-style-type: none"> <li>a) release cessation date and time;</li> <li>b) receiving water(s) including the natural flow rate; and</li> <li>c) volume of water released.</li> </ul> <p><i>NOTE: Successive or intermittent releases occurring within <b>twenty-four (24) hours</b> of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with conditions <b>F14</b> and <b>F15</b> and <b>F16</b>, provided the relevant details of the release are included within the notification provided in accordance with conditions <b>F14</b> and <b>F15</b> and <b>F16</b>.</i></p> |
| F16 | <p>Within <b>twenty-eight (28) days</b> of notification under condition <b>F15</b>, the environmental authority holder must provide the administering authority via WaTERS the following information in writing:</p> <ul style="list-style-type: none"> <li>a) confirmation of: <ul style="list-style-type: none"> <li>i. the release commencement date and time;</li> <li>ii. the release cessation date and time;</li> <li>iii. receiving water(s) including the natural flow rate;</li> <li>iv. volume of water released;</li> </ul> </li> <li>b) all in-situ and laboratory water quality monitoring results;</li> <li>c) details regarding the compliance of the release with the conditions of <b>Schedule F: Water</b> of this environmental authority (i.e. contamination limits, natural flow, discharge volume);</li> <li>d) whether the release of water resulted in any impacts to the receiving environment; and</li> <li>e) any other matter(s) pertinent to the water release event.</li> </ul>                                                                                     |
| F17 | <p><b>Notification of release event exceedance</b></p> <p>If the release limits defined in <b>Table F2 (Mine Affected Water Release Limits)</b> are exceeded, the environmental authority holder must notify the administering authority within <b>twenty-four (24) hours</b> of receiving the results.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| F18 | <p>The environmental authority holder must, within <b>twenty-eight (28) days</b> of the notification provided in accordance with condition <b>F17</b>, provide a report to the administering authority via WaTERS detailing:</p> <ul style="list-style-type: none"> <li>a) the reason for the release;</li> <li>b) the location of the release;</li> <li>c) the total volume of the release and which (if any) part of this volume was non-compliant;</li> <li>d) the total duration of the release and which (if any) part of this period was non-compliant;</li> <li>e) all water quality monitoring results;</li> <li>f) any general observations;</li> <li>g) all calculations; and</li> <li>h) any other matters pertinent to the water release event.</li> </ul>                                                                                                                                                                                                                                                                                                                             |

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| F19 | <p><b>Receiving Environment Monitoring and Contaminant Trigger Levels</b></p> <p>The quality of the receiving waters must be monitored at the locations specified in <b>Table F6 (Receiving Water Upstream Background and Downstream Monitoring Points)</b> for each quality characteristic and at the monitoring frequency stated in <b>Table F5 (Receiving Waters Contaminant Trigger Levels)</b> and <b>Table F3 (Release Contaminant Trigger Investigation Levels)</b>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| F20 | <p>If quality characteristic(s) of the receiving water at the downstream monitoring point exceed any of the trigger levels specified in <b>Table F5 (Receiving Waters Contaminant Trigger Levels)</b> during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and:</p> <ol style="list-style-type: none"> <li>(1) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken; or</li> <li>(2) where the downstream results exceed the upstream results, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining: <ol style="list-style-type: none"> <li>(a) details of the investigations carried out; and</li> <li>(b) actions taken to prevent environmental harm.</li> </ol> </li> </ol> <p><i>NOTE: Where an exceedance of a trigger level has occurred and is being investigated in accordance with F20(2) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.</i></p> |

**Table F5 (Receiving Waters Contaminant Trigger Levels)**

| Quality Characteristic                              | Trigger Level            | Monitoring Frequency                                                                                                                                                                                                                      |
|-----------------------------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| pH<br>(pH units)                                    | 6.5 to 9.0               | Real time telemetry for EC and pH with grab samples at commencement and weekly thereafter when safe to do so and access permits<br>Daily grab samples if telemetry not available (the first sample must be taken as soon as practicable)^ |
| Electrical Conductivity<br>(µS/cm)                  | 2000 – cease the release |                                                                                                                                                                                                                                           |
| Sulphate (SO <sub>4</sub> <sup>2-</sup> )<br>(mg/L) | 1000                     | Commencement of release and weekly thereafter during release when safe to do so and access permits^                                                                                                                                       |

NOTES: ^ Generally during daylight hours only

**Table F6 (Receiving Waters Upstream Background and Downstream Monitoring Points)**

| Monitoring Point<br>(MP)                                  | Receiving Waters Location Description                | Easting<br>(GDA94) | Northing<br>(GDA94) |
|-----------------------------------------------------------|------------------------------------------------------|--------------------|---------------------|
| <b>Upstream Background Monitoring Points <sup>a</sup></b> |                                                      |                    |                     |
| MP2                                                       | Eureka Creek upstream                                | 595792             | 7592251             |
| MP3                                                       | Isaac River upstream of confluence with Eureka Creek | 604898             | 7590685             |
| <b>Release Point Monitoring Points</b>                    |                                                      |                    |                     |
| MP1                                                       | Eureka Creek Diversion (GS4a Dam)                    | 602621             | 7588947             |
| <b>Downstream Monitoring Points</b>                       |                                                      |                    |                     |
| MP4                                                       | Isaac River downstream (Railway Bridge)              | 600545             | 7582923             |

NOTES: (a) The data from background monitoring points must not be used where they are affected by releases from other mines.



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| F21 | <p><b>Receiving Environment Monitoring Program (REMP)</b></p> <p>The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site.</p> <p>For the purposes of the REMP, the receiving environment is the waters of the Isaac River and connected or surrounding waterways within <b>ten (10) kilometres</b> downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| F22 | <p>The REMP must:</p> <ul style="list-style-type: none"> <li>a) assess the condition or state of receiving waters, including upstream conditions, spatially within the REMP area, considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g. seasonality);</li> <li>b) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected;</li> <li>c) include monitoring from background reference sites (e.g. upstream or background) and downstream sites from the release (as a minimum, the locations specified in <b>Table F6 (Receiving Water Upstream Background and Downstream Monitoring Points)</b>);</li> <li>d) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the <i>Queensland Water Quality Guidelines 2009</i>. This should include monitoring during periods of natural flow irrespective of mine or other discharges;</li> <li>e) include monitoring and assessment of dissolved oxygen saturation, temperature and all water quality parameters listed in <b>Table F2 (Mine Affected Water Release Limits)</b> and <b>Table F3 (Release Contaminant Trigger Investigation Levels)</b>;</li> <li>f) include, where appropriate, monitoring of metals/metalloids in sediments (in accordance with ANZECC &amp; ARMCANZ 2000, BATLEY and/or the most recent version of AS5667.1 Guidance on Sampling of Bottom Sediments);</li> <li>g) include, where appropriate, monitoring of macroinvertebrates in accordance with the AusRivas methodology,</li> <li>h) apply procedures and/or guidelines from ANZECC &amp; ARMCANZ 2000 and other relevant guideline documents;</li> <li>i) describe sampling and analysis methods and quality assurance and control; and</li> <li>j) incorporate stream flow and hydrological information in the interpretations of water quality and biological data.</li> </ul> |
| F23 | <p>A report outlining the findings of the REMP, including all monitoring results and interpretations in accordance with conditions <b>F21</b> and <b>F22</b> must be prepared annually. This report must include the following:</p> <ul style="list-style-type: none"> <li>a) an assessment of background reference water quality;</li> <li>b) the condition of downstream water quality compared against water quality objectives; and</li> <li>c) the suitability of current discharge limits to protect downstream environmental values.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

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| F24 | <p><b>Water reuse</b></p> <p>Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party for the purpose of:</p> <ul style="list-style-type: none"> <li>a) supplying stock water subject to compliance with the quality release limits specified in <b>Table F7 (Stock Water Release Limits)</b>; or</li> <li>b) supplying irrigation water subject to compliance with quality release limits in <b>Table F8 (Irrigation Water Release Limits)</b>; or</li> <li>c) supplying water for construction and/or road maintenance in accordance with the conditions of this environmental authority.</li> </ul> |
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**Table F7 (Stock Water Release Limits)**

| Quality Characteristic  | Units    | Minimum | Maximum |
|-------------------------|----------|---------|---------|
| pH                      | pH units | 6.5     | 8.5     |
| Electrical Conductivity | µS/cm    | N/A     | 5000    |

**Table F8 (Irrigation Water Release Limits)**

| Quality Characteristic  | Units    | Minimum | Maximum                                                                                         |
|-------------------------|----------|---------|-------------------------------------------------------------------------------------------------|
| pH                      | pH units | 6.5     | 8.5                                                                                             |
| Electrical Conductivity | µS/cm    | N/A     | Site specific value determined in accordance with ANZECC & ARMCANZ (2000) Irrigation Guidelines |

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| F25 | <p>Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as dams or tanks, for the purpose of supplying water to any operation licensed for either ERA13 (mining black coal) or ERA31 (mineral processing). The volume, pH and electrical conductivity of water transferred must be monitored and recorded.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| F26 | <p>If the responsibility for mine affected water is given or transferred to another person in accordance with conditions <b>F24</b> or <b>F25</b>:</p> <ul style="list-style-type: none"> <li>a) the responsibility for the mine affected water must only be given or transferred in accordance with a written agreement (the third party agreement); and</li> <li>b) the third party agreement must include a commitment from the person utilising the mine affected water to use it in such a way as to prevent environmental harm or public health incidents and specifically make the persons aware of the General Environmental Duty (GED) under section 319 of the <i>Environmental Protection Act 1994</i>, environmental sustainability of the water disposal and protection of environmental values of waters; and</li> <li>c) the third party agreement must be signed by both parties to the agreement.</li> </ul> |



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| F27 | <p><b>Water general</b></p> <p>All determinations of water quality and biological monitoring must be:</p> <ul style="list-style-type: none"> <li>a) performed by a person or body possessing appropriate experience and qualifications to perform the required measurements;</li> <li>b) made in accordance with methods prescribed in the latest edition of the administering authority's <i>Monitoring and Sampling Manual</i>;</li> <li>c) collected from the monitoring locations identified within this environmental authority, within ten hours of each other where possible;</li> <li>d) carried out on representative samples; and</li> <li>e) analysed at a laboratory accredited (e.g. NATA) for the method of analysis being used.</li> </ul> <p><i>Note: Condition F27 requires the Monitoring and Sampling Manual to be followed and where it is not followed because of exceptional circumstances this should be explained and reported with the results.</i></p>                                                                                                                                                                         |
| F28 | <p><b>Water Management Plan</b></p> <p>A Water Management Plan must be developed by an appropriately qualified person(s) and implemented for all mining activities. The Water Management Plan must address, the following:</p> <ul style="list-style-type: none"> <li>a) provide for effective management of actual and potential environmental impacts resulting from water management associated with the mining activity carried out under this environmental authority; and</li> <li>b) be developed in accordance with administering authority's guideline <i>Preparation of water management plans for mining activities</i> and include: <ul style="list-style-type: none"> <li>i. a study of the source of contaminants;</li> <li>ii. a water balance model for the site;</li> <li>iii. a water management system for the site;</li> <li>iv. measures to manage and prevent saline drainage;</li> <li>v. measures to manage and prevent acid rock drainage;</li> <li>vi. contingency procedures for emergencies; and</li> <li>vii. a program for monitoring and review of the effectiveness of the Water Management Plan.</li> </ul> </li> </ul> |
| F29 | <p>The Water Management Plan must be reviewed each calendar year by an appropriately qualified person(s).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| F30 | <p><b>Stormwater and water sediment controls</b></p> <p>An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| F31 | <p>Stormwater, other than mine affected water, is permitted to be released to waters from:</p> <ul style="list-style-type: none"> <li>a) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition <b>F30</b>; and</li> <li>b) water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with conditions <b>F28</b> to <b>F29</b> inclusive, for the purpose of ensuring water does not become mine affected water.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

**Permit**  
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| RR1 | Conditions F21 to F23 do not apply if the environmental authority holder is a participant of the FRREMP.                                                                                                                                                                                                                |
| RR2 | The environmental authority holder must notify the administering authority in a written statement within twenty (20) business days of ceasing to be a participant of the FRREMP. The written statement must detail how the environmental authority holder is going to fulfil the requirements of conditions F21 to F23. |



| Schedule G: Structures |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| Condition number       | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| G1                     | <p><b>Assessment of consequence category</b></p> <p>The consequence category of any structure must be assessed by a suitably qualified and experienced person, in accordance with the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i>, at the following times:</p> <ul style="list-style-type: none"> <li>a) prior to the design and construction of the structure, if it is not an existing structure; or</li> <li>b) prior to any change in its purpose or the nature of its stored contents.</li> </ul> |
| G2                     | A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.                                                                                                                                                                                                                                                                                                                                                                                                          |
| G3                     | Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i> .                                                                                                                                                                                                                                                                                                                 |
| G4                     | <p><b>Design and construction of a regulated structure</b></p> <p>Conditions <b>G5</b> to <b>G9</b> inclusive do not apply to existing structures.</p> <p><i>NOTE: Construction of a dam includes modification of an existing dam – see definitions.</i></p>                                                                                                                                                                                                                                                                                                                             |
| G5                     | <p>All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i>.</p> <p><i>NOTE: Certification of design and construction may be undertaken by different persons.</i></p>                                                                                                                                                                |
| G6                     | Construction of a regulated structure is prohibited unless the environmental authority holder has submitted a consequence category assessment report and certification to the administering authority has been certified by a suitably qualified and experienced person for the design and design plan and the associated operating procedures in compliance with the relevant condition of this environmental authority.                                                                                                                                                                |
| G7                     | Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i> , and must be recorded in the Register of Regulated Structures.                                                                                                                                                                                                                                 |

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| G8  | <p>Regulated structures must:</p> <ul style="list-style-type: none"> <li>a) be designed and constructed in accordance with and conform to the requirements of the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i>;</li> <li>b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: <ul style="list-style-type: none"> <li>viii. floodwaters from entering the regulated dam from any watercourse or drainage line; and</li> <li>ix. wall failure due to erosion by floodwaters arising from any watercourse or drainage line.</li> </ul> </li> <li>c) for regulated dams associated with a failure to contain – seepage, have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.</li> </ul>                                                                                                                  |
| G9  | <p>Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that:</p> <ul style="list-style-type: none"> <li>a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; and</li> <li>b) construction of the regulated structure is in accordance with the design plan.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| G10 | <p><b>Operation of a regulated structure</b></p> <p>Operation of a regulated structure, except for an existing structure, is prohibited unless the environmental authority holder has submitted to the administering authority:</p> <ul style="list-style-type: none"> <li>a) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with condition <b>G6</b>;</li> <li>b) a set of 'as constructed' drawings and specifications;</li> <li>c) certification of those 'as constructed drawings and specifications' in accordance with condition <b>G9</b>;</li> <li>d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan;</li> <li>e) the requirements of this environmental authority relating to the construction of the regulated structure have been met;</li> <li>f) the environmental authority holder has entered the details, required under this environmental authority, into the Register of Regulated Structures; and</li> <li>g) there is a current operational plan for the regulated structures.</li> </ul> |



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| G11 | <p>For existing structures that are regulated structures:</p> <p>a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the environmental authority holder must submit to the administering authority within <b>twelve (12) months</b> of the commencement of this condition a copy of the certified system design plan including that structure; and</p> <p>b) there must be a current operational plan for the existing structures.</p> |
| G12 | Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.                                                                                                                                                                                                                                                                |
| G13 | <p><b>Mandatory Reporting Level</b></p> <p>Conditions <b>G14</b> to <b>G17</b> inclusive only apply to regulated structures which have not been certified as low consequence category for 'failure to contain – overtopping'.</p>                                                                                                                                                                                                                                                                                                                                          |
| G14 | The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that, during routine inspections of that dam, it is clearly observable.                                                                                                                                                                                                                                                                                                                                                                                                            |
| G15 | The environmental authority holder must, as soon as practical and within <b>forty-eight (48) hours</b> of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.                                                                                                                                                                                                                                                                                                                                            |
| G16 | The environmental authority holder must immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.                                                                                                                                                                                                                                                                                                                                                                                   |
| G17 | The environmental authority holder must record any changes to the MRL in the Register of Regulated Structures.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| G18 | <p><b>Design Storage Allowance</b></p> <p>The environmental authority holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to <b>1 July</b> of each year.</p>                                                                                                                                                                                                              |
| G19 | By <b>1 November</b> of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).                                                                                                                                                                                                                                                                                                 |
| G20 | The environmental authority holder must notify the administering authority as soon as possible and within <b>forty-eight (48) hours</b> of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on <b>1 November</b> of any year.                                                                                                                                                                                                                                                   |

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| G21 | The environmental authority holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on <b>1 November</b> of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.                                                                                                                                                                                                                                                                                                                                 |
| G22 | <b>Annual inspection report</b><br>Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| G23 | At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure.                                                                                                                                                                                                                                                                                                                                                 |
| G24 | The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i> .                                                                                                                                                                                                                                                                                                                                                                                                                |
| G25 | The environmental authority holder must:<br>a) within <b>twenty (20) business days</b> of receipt of the annual inspection report, provide to the administering authority:<br>i. the recommendations section of the annual inspection report; and<br>ii. if applicable, any actions being taken in response to those recommendations; and<br>b) if, following receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the environmental authority holder, provide this to the administering authority within <b>ten (10) business days</b> of receipt of the request.                       |
| G26 | <b>Transfer arrangements</b><br>The environmental authority holder must provide a copy of any reports, documentation and certifications prepared under this environmental authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.                                                                                                                                                                                                                                                                                                        |
| G27 | <b>Decommissioning and rehabilitation</b><br>Dams must not be abandoned but be either:<br>a) decommissioned and rehabilitated to achieve compliance with condition <b>G28</b> ; or<br>b) be left in-situ for a beneficial use(s) provided that:<br>i. it no longer contains contaminants that will migrate into the environment; and<br>ii. it contains water of a quality that is demonstrated to be suitable for its intended beneficial use(s); and<br>iii. the administering authority, the environmental authority holder and the landholder agree in writing that the dam will be used by the landholder following the cessation of the environmentally relevant activity(ies). |



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| G28 | <p>After decommissioning, all significantly disturbed land caused by the carrying out of the environmentally relevant activity(ies) must be rehabilitated to meet the following final acceptance criteria:</p> <ul style="list-style-type: none"> <li>a) the landform is safe for humans and fauna;</li> <li>b) the landform is stable with no subsidence or erosion gullies for at least three (3) years;</li> <li>c) any contaminated land (e.g. contaminated soils) is remediated and rehabilitated</li> <li>d) not allowing for acid mine drainage; or</li> <li>e) there is no ongoing contamination to waters (including groundwater);</li> <li>f) rehabilitation is undertaken in a manner such that any actual or potential acid sulphate soils on the area of significant disturbance are treated to prevent or minimise environmental harm in accordance with the <i>Instructions for the treatment and management of acid sulfate soils (2001)</i>;</li> <li>g) all significantly disturbed land is reinstated to the pre-disturbed soil suitability class;</li> <li>h) for land that is not being cultivated by the landholder: <ul style="list-style-type: none"> <li>i. groundcover, that is not a declared pest species is established and self-sustaining</li> <li>ii. vegetation of similar species richness and species diversity to pre-selected analogue sites is established and self-sustaining, and</li> <li>iii. the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance caused by carrying out the mining activity(ies).</li> </ul> </li> <li>i) for land that is to be cultivated by the landholder, cover crop is revegetated, unless the landholder will be preparing the site for cropping within 3 months of mining activities being completed.</li> </ul> |
| G29 | <p><b>Register of Regulated Structures</b></p> <p>A Register of Regulated Structures must be established and maintained by the environmental authority holder for each regulated structure.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| G30 | The environmental authority holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated structure is submitted to the administering authority.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| G31 | The environmental authority holder must make a final entry of the required information in the Register of Regulated Structures once compliance with condition <b>G10</b> and <b>G11</b> has been achieved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| G32 | The environmental authority holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| G33 | All entries in the Register of Regulated Structures must be approved by the chief executive officer for the environmental authority holder, or their delegate, as being accurate and correct.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| G34 | The environmental authority holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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| G35 | <p><b>Transitional arrangements</b></p> <p>All existing structures that have not been assessed in accordance with either, the Manual or the former <i>Manual for Assessing Hazard Categories and Hydraulic Performance of Dams</i>, must be assessed and certified in accordance with the Manual within <b>six (6) months</b> of amendment of the environmental authority adopting this schedule.</p>                                                                          |
| G36 | <p>All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in <b>Table G1 (Transitional Requirements for Existing Structures)</b>, depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure.</p>                                                                                                                |
| G37 | <p><b>Table G1 (Transitional Requirements for Existing Structures)</b> ceases to apply for a structure once any of the following events has occurred:</p> <ul style="list-style-type: none"> <li>a) it has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or</li> <li>b) it has been decommissioned; or</li> <li>c) it has been certified as no longer being assessed as a regulated structure.</li> </ul> |
| G38 | <p>Certification of the transitional assessment required by <b>G35</b> and <b>G36</b> (as applicable) must be provided to the administering authority within <b>six (6) months</b> of amendment of the environmental authority adopting this schedule.</p>                                                                                                                                                                                                                     |

**Table G1 (Transitional Requirements for Existing Structures)**

| Transition period required for existing structures to achieve the requirements of the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i> |                                                                                                                         |                                                                                                                          |                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Compliance with Criteria                                                                                                                                                                                            | High                                                                                                                    | Significant                                                                                                              | Low                                                                            |
| >90% and a history of good compliance performance in last 5 years                                                                                                                                                   | No transition required                                                                                                  | No transition required                                                                                                   | No transitional conditions apply. Review consequence assessment every 7 years. |
| >70% to ≤90%                                                                                                                                                                                                        | Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases. | Within 10 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases. | No transitional conditions apply. Review consequence assessment every 7 years. |
| >50 to ≤70%                                                                                                                                                                                                         | Within 5 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.  | Within 7 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.   | Review consequence assessment every 7 years.                                   |
| ≤50%                                                                                                                                                                                                                | Within 5 years or as per compliance requirements (e.g. TEP timing)                                                      | Within 5 years or as per compliance requirements (e.g. TEP timing)                                                       | Review consequence assessment every 5 years.                                   |



| Schedule H: Sewage Treatment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Condition number             | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| H1                           | <p><b>Treated sewage effluent</b></p> <p>The cumulative total daily peak design capacity of the sewage treatment plant/s must not exceed 4000 equivalent persons (EP). Small package plants and/or septic systems, each with a daily peak design capacity less than 21EP, are not included in the cumulative total daily peak design capacity.</p>                                                                                                                                                                                                                                                                              |
| H2                           | <p>Treated sewage effluent must not be directly released from the sewage treatment plant/s to any waters.</p> <p><i>Note: 'waters' does not include structures associated with the mine affected water management system.</i></p>                                                                                                                                                                                                                                                                                                                                                                                               |
| H3                           | <p>Treated sewage effluent may be:</p> <ul style="list-style-type: none"> <li>a) released to the mine affected water management system for mixing with other mine affected water;</li> <li>b) released to land via a sub-surface infiltration trench;</li> <li>c) irrigated or sprayed for dust suppression or firefighting or evaporation; or</li> <li>d) removed as waste.</li> </ul>                                                                                                                                                                                                                                         |
| H4                           | <p>Treated sewage effluent that is released in accordance with condition <b>H3(a)</b> and has mixed with other mine affected water must be managed as mine affected water in accordance with the conditions of this environmental authority.</p>                                                                                                                                                                                                                                                                                                                                                                                |
| H5                           | <p>Treated sewage effluent that is released in accordance with condition <b>H3(b)</b> or <b>H3(c)</b> must be carried out in a manner such that:</p> <ul style="list-style-type: none"> <li>a) vegetation is not damaged;</li> <li>b) there is no surface ponding of effluent; and</li> <li>c) there is no run-off of treated sewage effluent to waters.</li> </ul>                                                                                                                                                                                                                                                             |
| H6                           | <p>Treated sewage effluent released in accordance with condition <b>H3(a)</b> or <b>H3(b)</b> or <b>H3(c)</b> from any sewage treatment plant that has a daily peak design capacity of greater than 21EP must be monitored:</p> <ul style="list-style-type: none"> <li>a) at the point where the treated sewage effluent is released from the sewage treatment plant/s;</li> <li>b) for the quality characteristics specified in <b>Table H1 (Treated Sewage Effluent Monitoring Requirements)</b>; and</li> <li>c) at the frequency specified in <b>Table H1 (Treated Sewage Effluent Monitoring Requirements)</b>.</li> </ul> |

**Table H1 (Treated Sewage Effluent Monitoring Requirements)**

| Quality Characteristic                        | Units              | Monitoring Frequency |
|-----------------------------------------------|--------------------|----------------------|
| 5-day Biochemical Oxygen Demand (uninhibited) | mg/L               | Monthly              |
| pH                                            | pH units           | Monthly              |
| Thermotolerant coliforms                      | Colonies per 100mL | Monthly              |
| Total nitrogen                                | mg/L               | Monthly              |
| Total phosphorus                              | mg/L               | Monthly              |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H7 | <p>If treated sewage effluent is being released in accordance with condition <b>H3(c)</b>:</p> <p>a) the results of monitoring in accordance with condition <b>H6</b> must not exceed the release limits specified in <b>Table H2 (Treated Sewage Effluent Contaminant Release Limits)</b>; and</p> <p>b) the release must not cause spray drift or over spray to any sensitive place or commercial place.</p> |
| H8 | <p>If the release limits specified in <b>Table H2 (Treated Sewage Effluent Contaminant Release Limits)</b> are exceeded in accordance with condition <b>H7(a)</b>, the environmental authority holder must notify the administering authority in accordance with conditions <b>A7</b> and <b>A8</b>.</p>                                                                                                       |

**Table H2 (Treated Sewage Effluent Contaminant Release Limits)**

| Quality Characteristic                                                                       | Release Limit | Units              | Limit Type |
|----------------------------------------------------------------------------------------------|---------------|--------------------|------------|
| 5-day Biochemical Oxygen Demand (uninhibited)                                                | 50            | mg/L               | Maximum    |
| pH                                                                                           | 6.0 to 9.0    | pH units           | Range      |
| Thermotolerant coliforms, based on the average of a minimum number of five samples collected | 1000          | Colonies per 100mL | Maximum    |



| Schedule I: Groundwater |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Condition number        | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| I1                      | <p><b>Groundwater Monitoring and Management Program</b></p> <p>A Groundwater Monitoring and Management Program to detect and manage risk from the landfill authorised by condition <b>D8</b> must be developed, documented and implemented by an appropriately qualified person prior to the landfill receiving waste.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| I2                      | <p>The Groundwater Monitoring and Management Program required by condition <b>I2</b> must:</p> <ul style="list-style-type: none"> <li>a) identify potential sources of contamination to groundwater from the landfill;</li> <li>b) ensure that all potential groundwater impacts due to the landfill are identified, mitigated and monitored;</li> <li>c) document sampling and monitoring methodology;</li> <li>d) ensure that adequate groundwater monitoring and data analysis is undertaken to achieve the following objectives: <ul style="list-style-type: none"> <li>i. detect any impacts to groundwater levels due to the landfill;</li> <li>ii. detect any impacts to groundwater quality due to the landfill; and</li> <li>iii. determine trends in groundwater quality;</li> </ul> </li> <li>e) include an appropriate quality assurance and quality control program;</li> <li>f) include a conceptual groundwater model;</li> <li>g) be provided to the administering authority for review at least <b>six (6) weeks</b> before being finalised; and</li> <li>h) include a review process to identify required improvements to the program and address any comments provided by the administering authority.</li> </ul> |
| I3                      | <p>The construction, maintenance and decommissioning of groundwater monitoring bores must be undertaken in a manner that:</p> <ul style="list-style-type: none"> <li>a) prevents contaminants entering the groundwater;</li> <li>b) ensures the integrity of the bores to obtain representative groundwater samples from the target aquifer; and</li> <li>c) maintains the hydrogeological environment within the aquifer.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| I4                      | <p>A bore drill log must be kept for each reference, compliance and observation groundwater monitoring bore which includes:</p> <ul style="list-style-type: none"> <li>a) bore identification reference and geographic coordinate location;</li> <li>b) specific construction information including but not limited to depth of bore, depth and length of casing, depth and length of screening and bore sealing details;</li> <li>c) standing groundwater level and water quality parameters including physical parameters and results of laboratory analysis for the possible trigger parameters;</li> <li>d) lithological data, stratigraphic interpretation by an appropriately qualified person to identify important features associated with groundwater monitoring; and</li> <li>e) target aquifer formation of the bore.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                         |





| Schedule J: Watercourse Subsidence |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Condition number                   | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| J1                                 | <p><b>Authorised subsidence</b></p> <p>Subject to the conditions of this environmental authority, specifically conditions <b>J1</b> to <b>J14</b> inclusive, the environmental authority holder is authorised to subside the Isaac River within ML1763, as depicted in <b>Figure 2 (Authorised Subsidence Extent)</b>. This subsidence is authorised to occur as a result of underground longwall mining activities.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| J2                                 | <p>This environmental authority does not authorise the use of top coal caving (or thick seam mining) methods where it would result in subsidence of the bed or banks of the Isaac River.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| J3                                 | <p><b>Subsidence Management Plan</b></p> <p>A Subsidence Management Plan must be developed to the satisfaction of the administering authority, in accordance with the administering authority's guideline "Watercourse Subsidence – Central Queensland Mining Industry" or any subsequent versions, or any other relevant guideline as directed by the administering authority. The Subsidence Management Plan must include at least the following components:</p> <ul style="list-style-type: none"> <li>a) the condition of the existing watercourse (including a baseline assessment);</li> <li>b) the objectives and outcomes of the subsidence management plan;</li> <li>c) a risk assessment that identifies all potential impacts on the watercourse and associated floodplain resulting from subsidence of the watercourse;</li> <li>d) the measures to be implemented to avoid, minimise and mitigate each potential impact;</li> <li>e) a monitoring, maintenance and evaluation program that: <ul style="list-style-type: none"> <li>i. details the level of effectiveness of the measures using indicators and success criteria;</li> <li>ii. includes the annual review of success and appropriateness of measures; and</li> <li>iii. details how improvements will be implemented where success criteria are not met.</li> </ul> </li> <li>f) consideration of cumulative impacts on the Isaac River from upstream activities;</li> <li>g) consideration of impacts on groundwater as a result of subsidence of the watercourse;</li> <li>h) a rehabilitation plan for subsided areas of the Isaac River including: <ul style="list-style-type: none"> <li>i. rehabilitation objectives;</li> <li>ii. completion criteria; and</li> <li>iii. schedule for progressive rehabilitation; and</li> </ul> </li> <li>i) an action plan to address the outcomes and recommendations from annual inspections.</li> </ul> |
| J4                                 | <p>The Subsidence Management Plan must be assessed and certified by an independent, third party, suitably qualified and experienced person, that the plan is compliant in all respects with this environmental authority.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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| J5  | <p>Subsidence of the Isaac River within longwall panel LW11 onwards must not commence until:</p> <ul style="list-style-type: none"> <li>a) the administering authority has received a copy of the certified subsidence management plan; and</li> <li>b) the subsidence management plan has been implemented.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| J6  | The administering authority may, within <b>twenty-eight (28) days</b> of receiving the certified Subsidence Management Plan as required by condition <b>J5</b> , provide comments in respect to the submitted plan.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| J7  | All comments made by the administering authority under condition <b>J6</b> must be considered and incorporated into the Subsidence Management Plan within <b>twenty-eight (28) days</b> of receipt of the comments, and the plan be re-submitted to the administering authority.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| J8  | <p><b>Annual inspection</b></p> <p>Each subsided longwall panel and the full extent of the Isaac River must be inspected annually by a suitably qualified and experienced person in accordance with the following minimum requirements:</p> <ul style="list-style-type: none"> <li>a) report on the condition of the bed and banks of the watercourse;</li> <li>b) report on ground cover (%) and pasture biomass (kg/ha) in the riparian zone;</li> <li>c) a comparison of the bed depths, and bank widths from the previous inspection, to determine the overall soil loss from the subsided areas of the Isaac River, and the mitigation measures to be implemented to minimise further soil loss;</li> <li>d) assess the structural, geotechnical and hydraulic adequacy of the subsided longwall panels;</li> <li>e) assess the adequacy of all mitigation measures with respect to the subsidence management plan and any previous annual inspection; and,</li> <li>f) detail any recommended mitigation measures or rehabilitation requirements to be undertaken.</li> </ul> |
| J9  | After each annual inspection, a copy of a report including any recommendations, certified by an independent, third party, suitably qualified and experienced person, must be provided to the administering authority within <b>two (2) months</b> of completion.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| J10 | Any recommended mitigation measure, as identified in the annual inspection, must be implemented prior to <b>1 November</b> of the year that the recommendation was given, unless otherwise agreed to by the administering authority.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| J11 | If the mitigation measures recommended in the annual inspections are not implemented, no further subsidence of the Isaac River is permitted until the measures are completed, unless otherwise agreed to by the administering authority.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| J12 | The Subsidence Management Plan must be reviewed and updated to address any recommendations detailed in the annual inspection reports.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |



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| J13 | <p><b>Rehabilitation of watercourse subsidence</b></p> <p>All areas of the Isaac River that have been affected by subsidence must be rehabilitated to a standard consistent with items a) through e) below, and certified by a suitably qualified person;</p> <ul style="list-style-type: none"><li>a) incorporate pre-existing natural features of the watercourse (including geomorphic and vegetation);</li><li>b) attain the pre-existing hydrologic characteristics of surface water and groundwater systems for the area in which the watercourse is located;</li><li>c) attain the hydraulic characteristics of the watercourse that are equivalent to other local watercourses, and are suitable for the subsided areas of the Isaac River, without using artificial structures that require on-going maintenance;</li><li>d) attain sediment transport and water quality regimes that allow the watercourse to be self-sustaining, while minimising any impacts to upstream and downstream water quality, geomorphology and/or vegetation; and</li><li>e) attain equilibrium and functionality in all substrate conditions at the location of the watercourse.</li></ul> |
| J14 | <p>Rehabilitation of the subsided areas of the Isaac River must be undertaken progressively in accordance with the Subsidence Management Plan.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

**END OF CONDITIONS**

# Environmental authority EPML00853413

## Goonyella Riverside and Broadmeadow Mine

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### Definitions

Key terms and/or phrases used in this document are defined in this section. Environmental authority holders should note that where a term is not defined, the definition in the *Environmental Protection Act 1994*, its regulations or environmental protection policies must be used. If a word remains undefined it has its ordinary meaning.

**Acceptance criteria** means the measures by which the actions implemented to rehabilitate the land are deemed to be complete. The acceptance criteria indicate the success of the rehabilitation outcome or remediation of areas which have been significantly been disturbed by the mining activities. Acceptance criteria may include information regarding:

- a) vegetation establishment, survival and succession;
- b) vegetation productivity, sustained growth and structure development;
- c) fauna colonisation and habitat development;
- d) ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes;
- e) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;
- f) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;
- g) resilience of vegetation to disease, insect attack, drought and fire; and
- h) vegetation water use and effects on ground water levels and catchment yields.

**Acid rock drainage** means any contaminated discharge emanating from a mining activity formed through a series of chemical and biological reactions, when geological strata is disturbed and exposed to oxygen and moisture as a result of mining activity.

**Administering authority** is the agency or department that administers the environmental authority provisions under the *Environmental Protection Act 1994*.

**Airblast overpressure** means energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

**Alternative arrangement** in relation to a sensitive place or a commercial place, means:

- a) A written agreement:
  - i. between the environmental authority holder and a third party;
  - ii. that identifies a particular type(s) of environmental nuisance;
  - iii. about the way in which the particular environmental nuisance impact(s) will be dealt with;
  - iv. at a particular location; and
  - v. for a defined period of time.
- b) An alternative arrangement must make clear to the third party that by entering in to the agreement that:
  - i. their place will be excluded as a sensitive place or commercial place; and
  - ii. the consequences of exclusion as a sensitive place or commercial place.

Note: An alternative arrangement may include, but is not limited to, details of the nuisance abatement measures to be implemented, provision of alternative accommodation, or agreement between the parties that the location will not be considered a sensitive place or commercial place for the purposes of the Environmental Authority, for the duration of the alternative arrangement. The written agreement may be in any form, with some examples being a lease, or an agistment, or a conduct and compensation agreement under the *Mineral Resources Act 1989*.

**Annual exceedance probability or AEP** means the probability that at least one event in excess of a particular magnitude will occur in any given year.



**Annual inspection report** means an assessment prepared by a suitably qualified and experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan):

- a) against recommendations contained in previous annual inspections reports;
- b) against recognised dam safety deficiency indicators;
- c) for changes in circumstances potentially leading to a change in consequence category;
- d) for conformance with the conditions of this authority;
- e) for conformance with the 'as constructed' drawings;
- f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the dam (or network of linked containment systems); and
- g) for evidence of conformance with the current operational plan.

**ANZECC** means the Australian and New Zealand Guidelines for Fresh Marine Water Quality 2000

**Appropriately qualified person** means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.

**Assessed or assessment** by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

- a) exactly what has been assessed and the precise nature of that determination;
- b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;
- c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
- d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

**Associated works** in relation to a dam, means:

- a) operations of any kind and all things constructed, erected or installed for that dam; and
- b) any land used for those operations.

**Authority** means an environmental authority or a development approval.

**Bed and banks** for a waters, river, creek, stream, lake, lagoon, pond, swamp, wetland or dam means land over which the water of the waters, lake, lagoon, pond, swamp, wetland or dam normally flows or that is normally covered by the water, whether permanently or intermittently; but does not include land adjoining or adjacent to the bed and banks that is from time to time covered by floodwater.

**Beneficial use** in respect of dams means that the current or proposed owner of the land on which a dam stands, has found a use for that dam that is:

- a) of benefit to that owner in that it adds real value to their business or to the general community;
- b) in accordance with relevant provisions of the *Environmental Protection Act 1994*;
- c) sustainable by virtue of written undertakings given by that owner to maintain that dam; and
- d) the transfer and use have been approved or authorised under any relevant legislation.

**Biosolids** means the treated and stabilised solids from sewage.

**Blasting** means the use of explosive materials to fracture:

- a) rock, coal and other minerals for later recovery; or
- b) structural components or other items to facilitate removal from a site or for reuse.

**Bulk rubber** means tyres, conveyor belt, and other similar rubber waste.

**Certification** in relation to regulated structures, means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* or this environmental authority, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A)).

**Certifying, certify or certified** have a corresponding meaning as 'certification' in relation to regulated structures.

**Chemical** means:

- a) an agricultural chemical product or veterinary chemical product within the meaning of the *Agricultural and Veterinary Chemicals Code Act 1994 (Commonwealth)*; or
- b) a dangerous good under the dangerous goods code; or
- c) a lead hazardous substance within the meaning of the *Workplace Health and Safety Regulation 1997*; or
- d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers' Advisory Council and published by the Commonwealth; or
- e) any substance used as, or intended for use as:
  - i. a pesticide, insecticide, fungicide, herbicide, rodenticide, nematocide, miticide, fumigant or related product; or
  - ii. a surface active agent, including, for example, soap or related detergent; or
  - iii. a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or
  - iv. a fertiliser for agricultural, horticultural or garden use; or
- f) a substance used for, or intended for use for:
  - i. mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or
  - ii. manufacture of plastic or synthetic rubber.



**Commercial place** means:

- a) A work place that is used as:
  - i. an office; or
  - ii. a place of business; or
  - iii. a place used for commercial purposes.
- b) Despite paragraph (a), the following places are not commercial places:
  - i. subject to paragraph (c), a place that is the subject of an alternative arrangement; or
  - ii. places that are part of the mining activity; or
  - iii. employees accommodation or public roads; or
  - iv. a property owned or leased by one or more of the environmental authority holders, or a related company, whether or not it is subject to an alternative arrangement.
- c) A place that is the subject of a current alternative arrangement in relation to a particular type(s) of environmental nuisance, is not a commercial place for the purposes of that type(s) of environmental nuisance, however remains a commercial place for the purpose of other types of environmental nuisances.

**Consequence** in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.

**Consequence category** means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*.

**Construction or constructed** in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a design plan.

**Contaminate** means to render impure by contact or mixture.

**Contaminated** means the substance has come into contact with a contaminant.

**Contaminant** can be

- a) a gas, liquid or solid; or
- b) an odour; or
- c) an organism (whether alive or dead), including a virus; or
- d) energy, including noise, heat, radioactivity and electromagnetic radiation; or
- e) a combination of contaminants.

**Control measure** means any action or activity that can be used to prevent or eliminate a hazard or reduce it to an acceptable level.

**Dam** means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works.

**Dam crest volume** means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).

**Design plan** is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

**Design storage allowance or DSA** means an available volume, estimated in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an annual exceedance probability (AEP) specified in that Manual.

**Designer** for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

**Disturbance** of land includes:

- a) compacting, removing, covering, exposing or stockpiling of earth;
- b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion;
- c) carrying out mining within a watercourse, waterway, wetland or lake;
- d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls;
- e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be removed after the mining activity has ceased; or
- f) releasing of contaminants into the soil, or underlying geological strata.

However, the following areas are not included when calculating areas of disturbance:

- a) areas off lease (e.g. roads or tracks which provide access to the mining lease);
- b) areas previously disturbed which have achieved the rehabilitation outcomes;
- c) by agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions);
- d) areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be left by agreement with the landowner; or
- e) disturbance that pre-existed the grant of the tenure.

**Dwelling** means any of the following structures or vehicles that is principally used as a residence:

- a) a house, unit, motel, nursing home or other building or part of a building; or
- b) a caravan, mobile home or other vehicle or structure on land; or
- c) a water craft in a marina.

**Effluent** means treated waste water released from sewage treatment plants.

**Emergency action plan** means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to downstream communities and the implementation of protection measures. The plan must require dam owners to annually update contact.

**End of pipe** means the location at which water is released to waters or land.

**Environmental authority** means an environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994*.

**Environmental authority holder** means the holder of this environmental authority.

**Environmentally relevant activity** means an environmentally relevant activity as defined under section 18 of the *Environmental Protection Act 1994*.



**EPBC** means the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

**ERC decision** means a decision made by the administering authority under section 300 of the *Environmental Protection Act 1994* about the estimated rehabilitation cost for a resource activity.

**ERC period** for the estimated rehabilitation cost for a resource activity, means:

- a) if a PRCP schedule applies for the activity, the period of between 1 and 5 years stated in the application for an ERC decision under section 298(2)(b); or
- b) if the activity is a petroleum activity that is an ineligible ERA, other than a petroleum activity to which a plan of operations applies, or the activity relates to a 1923 Act petroleum tenure granted under the *Petroleum Act 1923*, the period of between 1 and 5 years stated in the ERC decision about the estimated rehabilitation cost; or
- c) if a plan of operations applies for the activities, the plan period for the plan of operations; or
- d) otherwise, the total period during which the resource activity is likely to be carried out under the environmental authority for the activity.

**Estimated rehabilitation cost (ERC)** for a resource activity, see section 300(2) of the *Environmental Protection Act 1994*.

**Existing authority** has the meaning in section 94 of the *Environmental Offsets Act 2014*.

**Existing structure** means a structure that was in existence prior to 24 October 2014.

**Extreme storm storage** means a storm storage allowance determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority.

**Floodwater** means water overflowing, or that has overflowed, from waters, river, creek, stream, lake, pond, wetland or dam onto or over riparian land that is not submerged when the watercourse or lake flows between or is contained within its bed and banks.

**Flowable substance** means matter or a mixture of materials that can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

**Foreseeable future** is the period used for assessing the total probability of an event occurring. Permanent structures and ecological sustainability should be expected to still exist at the end of a 150 year foreseeable future with an acceptable probability of failure before that time.

**FRREMP** means a Fitzroy Basin Receiving Environment Monitoring Program for the region in which the EA is located, that has been endorsed in writing by the administering authority.

**General waste** means waste other than regulated waste.

**Hazardous waste** means a substance, whether liquid, solid or gaseous that, if improperly treated, stored, disposed of or otherwise managed, is likely to cause environmental harm.

**Holder**, for a mining tenement, means a holder of the tenement under the *Mineral Resources Act 1989*, and the holder of the associated environmental authority under the *Environmental Protection Act 1994*.

**Hydraulic performance** means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*.

**Inert waste** means bricks, pavers, ceramics, concrete, glass, steel, or similar waste that does not biodegrade or decompose.

**Infrastructure** means water storage dams, roads and tracks, buildings and other structures built for the purpose of mining activities but does not include other facilities required for the long-term management of mining impacts or the protection of potential resources. Such other facilities include dams, waste rock dumps, voids, or ore stockpiles and buildings as well as other structures whose ownership can be transferred and which have a residual beneficial use for the next owner of the mining leases or the background land owner.

**LA<sub>10</sub>, adj, 10 mins** means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10 minute measurement period, using Fast response.

**LA<sub>1</sub>, adj, 10 mins** means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10 minute measurement period, using Fast response.

**Lake** includes:

- a) lagoon, swamp or other natural collection of water, whether permanent or intermittent; and
- b) the bed and banks and any other element confining or containing the water.

**Land** in the “land schedule” of this document means land excluding waters and the atmosphere.

**Land use** describes the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

**Landfill** means land used as a waste disposal site for lawfully putting solid waste on the land.

**Levee** means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of water or flowable substances at any other times.

**Low consequence dam** means any dam that is not a high or significant consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014)* (EM635).

**Mandatory reporting level or MRL** means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014)* (EM635) published by the administering authority.

**Manual** means the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014)* (EM635) published by the administering authority.

**Matters of state environmental significance or MSES** has the meaning in schedule 2 of the *Environmental Offsets Regulation 2014*.

**Maximum extent of impact** means the total, cumulative, residual extent and duration of impact to a prescribed environmental matter that will occur over a project's life after all reasonable avoidance and reasonable on-site mitigation measures have been, or will be, undertaken.

**mbgl** means metres below ground level.

**mg/L** means milligrams per litre.

**Mechanically reprocessing waste** includes mechanically crushing, milling, grinding, shredding or sorting waste, whether or not for the purpose of recycling the waste.



**Mine affected water** means the following types of water:

- a) pit water, tailings dam water, processing plant water;
- b) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the *Environmental Protection Regulation 2008* if it had not formed part of the mining activity;
- c) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage runoff containing sediment only, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;
- d) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;
- e) groundwater from the mine's dewatering activities; or
- f) a mix of mine affected water (under any of paragraphs (a) to (e)) and other water.

**Mineral** means a substance which normally occurs naturally as part of the earth's crust or is dissolved or suspended in water within or upon the earth's crust and includes a substance which may be extracted from such a substance, and includes:

- a) clay if mined for use for its ceramic properties, kaolin and bentonite;
- b) foundry sand;
- c) hydrocarbons and other substances or matter occurring in association with shale or coal and necessarily mined, extracted, produced or released by or in connection with mining for shale or coal or for the purpose of enhancing the safety of current or future mining operations for coal or the extraction or production of mineral oil there from;
- d) limestone if mined for use for its chemical properties;
- e) marble;
- f) mineral oil or gas extracted or produced from shale or coal by in situ processes;
- g) peat;
- h) salt including brine;
- i) shale from which mineral oil may be extracted or produced;
- j) silica, including silica sand, if mined for use for its chemical properties; or
- k) rock mined in block or slab form for building or monumental purposes;

But does not include:

- a) living matter;
- b) petroleum within the meaning of the *Petroleum Act 1923*;
- c) soil, sand, gravel or rock (other than rock mined in block or slab form for building or monumental purposes) to be used or to be supplied for use as such, whether intact or in broken form; or
- d) water.

**Mining activities** means the activities:

- a) authorised as per the definition in section 110 of the *Environmental Protection Act 1994*; and
- b) all environmentally relevant activities authorised under this environmental authority; and
- c) waste activities.

**Modification or modifying** (see definition of 'construction').

**Natural flow** means the flow of water through waters caused by nature.

**Notice of election** has the meaning in section 18(2) of the *Environmental Offsets Act 2014*.

**Noxious** means harmful or injurious to health or physical wellbeing.

**Offensive** means causing reasonable offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

**Operational plan** includes:

- a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA allowance); and
- b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

**Participant of the FRREMP** means an environmental authority holder that is identified as a current participant by the organisation carrying out the Regional REMP.

**Peak particle velocity or ppv** means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mm/s).

**Prescribed environmental matters** has the meaning in section 10 of the *Environmental Offsets Act 2014*, limited to the matters of State environmental significant listed in schedule 2 of the *Environmental Offsets Regulation 2014*.

**Protected area** means

- a) a protected area under the *Nature Conservation Act 1992*; or
- b) a marine park under the *Marine Parks Act 1992*; or
- c) a World Heritage Area.

**Progressive rehabilitation** means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation as mining operations are ongoing.

**Receiving environment**, in relation to an activity that causes or may cause environmental harm, means the part of the environment to which the harm is, or may be, caused. The receiving environment includes (but is not limited to):

- a) a watercourse;
- b) groundwater;
- c) land; and
- d) sediments.

**Receiving waters** means the waters into which this environmental authority authorises releases of mine affected water.

**Reference site (or analogue site)** may reflect the original location, adjacent area or another area where rehabilitation success has been completed for a similar biodiversity. Details of the reference site may be as photographs, computer generated images and vegetation models etc.

**Register of Regulated Structures** includes:

- a) date of entry in the register;
- b) name of the dam, its purpose and intended/actual contents;
- c) the consequence category of the dam as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*;
- d) dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the dam;
- e) name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;
- f) for the regulated dam, other than in relation to any levees –
  - i. the dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;
  - ii. coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area
  - iii. dam crest volume (megalitres);
  - iv. spillway crest level (metres AHD).
  - v. maximum operating level (metres AHD);
  - vi. storage rating table of stored volume versus level (metres AHD);
  - vii. design storage allowance (megalitres) and associated level of the dam (metres AHD);
  - viii. mandatory reporting level (metres AHD);
- g) the design plan title and reference relevant to the dam;
- h) the date construction was certified as compliant with the design plan;
- i) the name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;
- j) details of the composition and construction of any liner;
- k) the system for the detection of any leakage through the floor and sides of the dam;
- l) dates when the regulated dam underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;
- m) dates when recommendations and actions arising from the annual inspection were provided to the administering authority; and
- n) dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

**Regulated dam** means any dam in the significant or high consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority.

**Regulated structure** includes land-based containment structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity.

**Regulated waste** is defined in the *Environmental Protection Regulation 2008*.

**Rehabilitation** means the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.



**Rejects** means:

- a) breaker rejects; or
- b) coarse rejects; or
- c) mid/fine size rejects; or
- d) tailings that have been dewatered; or
- e) any combination of rejects (under any of paragraphs a to d).

**Representative** means a sample set that covers the variance in monitoring or other data due to either natural changes or operational phases of the mining activities.

**Reprocessing** includes:

- a) recycling; or
- b) mechanical treatment; or
- c) thermal treatment; or
- d) biological treatment; or
- e) chemical treatment.

**Residual void** means an open pit resulting from the removal of ore and/or waste rock that will remain following the cessation of all mining activities and completion of rehabilitation processes.

**Resource activity** is an activity that involves

- a) a geothermal activity; or
- b) a GHG storage activity; or
- c) a mining activity; or
- d) a petroleum activity.

**Saline drainage** is the movement of waters, contaminated with salt(s), as a result of the mining activity.

**Scheme fund** means the scheme fund established under section 24 of the *Mineral and Energy Resources (Financial Provisioning) Act 2018*.

**Self-sustaining** means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.

**Sensitive place** means:

- a) Any of the following:
  - i. a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or
  - ii. a motel, hotel or hostel; or
  - iii. an educational institution; or
  - iv. a medical centre or hospital; or
  - v. a protected area; or
  - vi. a public park or gardens.
- b) Despite paragraph (a), the following places are not sensitive places:
  - i. subject to paragraph (c), a place that is the subject of an alternative arrangement; or
  - ii. a mining camp (i.e. accommodation and ancillary facilities for mine employees or contractors or both, associated with the mine the subject of the environmental authority), whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the environmental authority holders for the mining project, or a related company; or
  - iii. a property owned or leased by one or more of the environmental authority holders, or a related company, whether or not it is subject to an alternative arrangement.
- c) A place that is the subject of a current alternative arrangement in relation to a particular type(s) of environmental nuisance, is not a sensitive place for the purposes of that type(s) of environmental nuisance, however remains a sensitive place for the purpose of other types of environmental nuisances.

**Sewage** means the used water of persons to be treated at a sewage treatment plant.

**Significant residual impact** has the meaning in section 8 of the *Environmental Offsets Act 2014*.

**Spillway** means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges from the dam, normally under flood conditions or in anticipation of flood conditions.

**Stable** in relation to land, means land form dimensions are or will be stable within tolerable limits now and in the foreseeable future. Stability includes consideration of geotechnical stability, settlement and consolidation allowances, bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.

**Stormwater** means all surface water runoff from rainfall.

**Structure** means dam or levee.

**Suitably qualified and experienced person** in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002*, and has demonstrated competency and relevant experience:

- a) for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design.
- b) for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design or engineering hydrology.

**Suitably qualified and experienced person** in relation to watercourse subsidence means one who holds relevant professional qualifications to the satisfaction of the administering authority and the administering authority is satisfied that person has knowledge, suitable experience and demonstrated expertise in relevant fields, as set out below:

- a) knowledge of engineering principles related to the structures, hydrology, hydraulics and environmental impact of watercourse subsidence; and
- b) a total of five years of suitable experience and demonstrated expertise in the following categories:
  - i. hydrology with particular reference to flooding, estimation of extreme storms or water management;
  - ii. hydraulics with particular reference to sediment transport and deposition and erosion control;
  - iii. hydrogeology with particular reference to seepage, groundwater.

**System design plan** means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

**Tailings** means fines from mineral processing that have not been dewatered.

**The Act** means the *Environmental Protection Act 1994*.

**Void** means any constructed, open excavation in the ground.

**Waste** as defined in section 13 of the *Environmental Protection Act 1994*.

**Waste activities** means receiving, storing, disposing, treating, or reprocessing wastes, and does not include composting.

**Waste and resource management hierarchy** has the meaning given by section 9 of the *Waste Reduction and Recycling Act 2011*.

**Water quality** means the chemical, physical and biological condition of water.

**Watercourse** has the meaning in Schedule 4 of the *Environmental Protection Act 1994* and means a river, creek or stream in which water flows permanently or intermittently:

- a) in a natural channel, whether artificially improved or not; or
- b) in an artificial channel that has changed the course of the watercourse.

Watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing water.

**Waters** includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

**WaTERS** means the Water Tracking and Electronic Reporting System.

**Wet season** means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination, this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

**µg/L** means micrograms per litre.

**µS/cm** means microsiemens per centimetre.

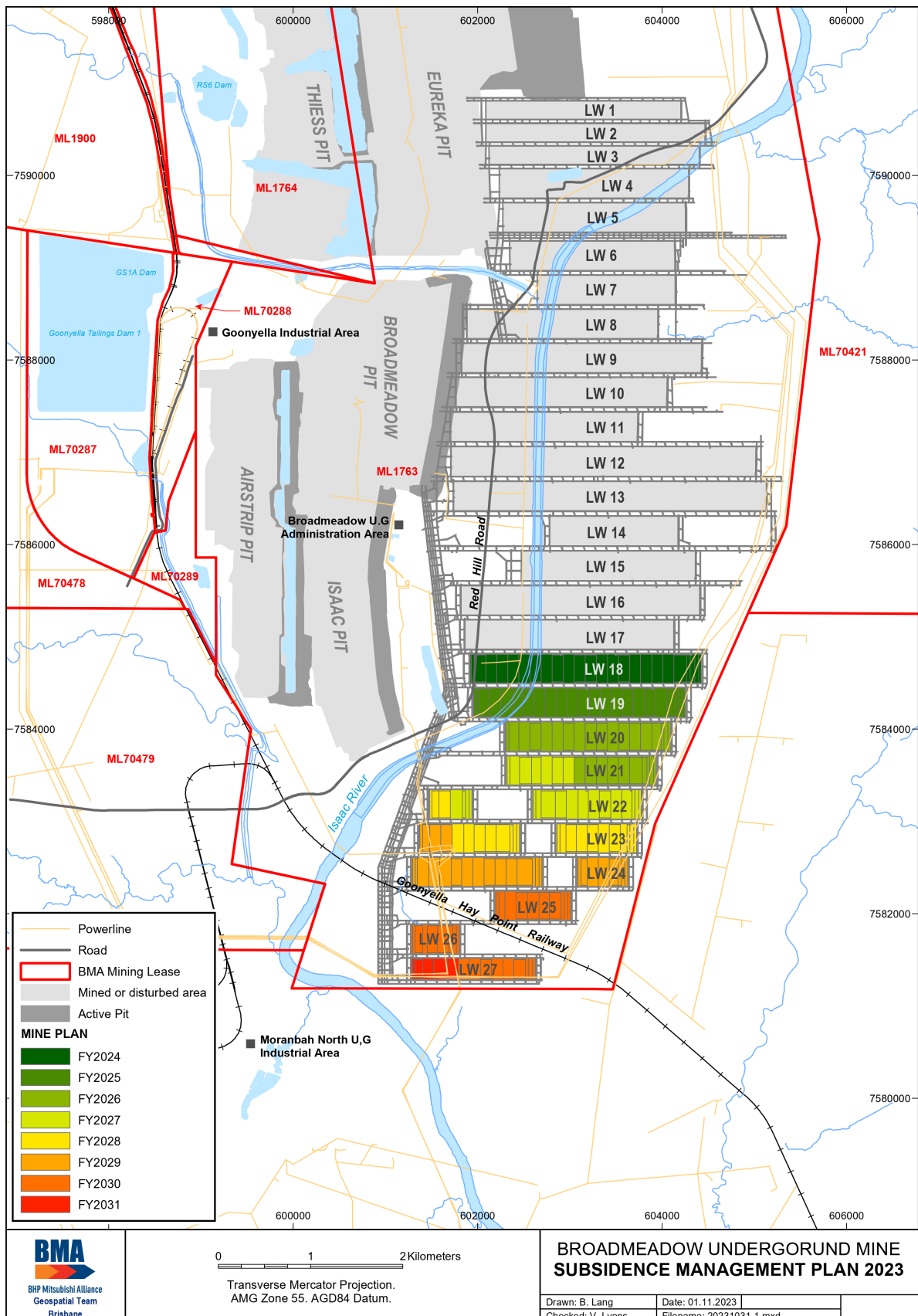
## END OF DEFINITIONS



Figure 1 (General Waste Landfill Location)



**Figure 2 (Authorised Subsidence Extent)**



**END OF ENVIRONMENTAL AUTHORITY**



# Notice

## *Environmental Protection Act 1994*

### **Progressive rehabilitation and closure plan transition notice**

*This statutory notice is issued by the administering authority<sup>1</sup> under section 754 of the Environmental Protection Act 1994 to advise you that you must submit a proposed Progressive rehabilitation and closure plan (PRC plan).*

BHP Coal Pty Ltd  
Level 14, 480 Queen Street,  
Brisbane City, QLD 4000

Craig.lockhart@bhp.com; Trudy.mazucco@bhp.com

Attention: Craig Lockhart & Trudy Mazucco

Our reference: EPML00853413

### **Transition Notice for a PRC plan**

#### **1 Environmental authority details**

Environmental authority EPML00853413 dated 25 June 2020 issued to BHP Coal Pty Ltd, Mitsubishi Development Pty Ltd, QCT MINING PTY. LTD., Umal Consolidated Pty Ltd, QCT INVESTMENT PTY. LTD., BHP Queensland Coal Investment Pty Ltd and QCT Resources Pty Limited.

Land description: ML1763, ML1764, ML1802, ML1900, ML700003, ML70121, ML70193, ML70194, ML70287, ML70288, ML70289, ML70421, ML70468, ML70469, ML70478, ML70479, ML70493 and ML70494

#### **2 Required action**

The holder(s) of environmental authority EPML00853413 must submit a proposed PRC plan that meets the requirements in sections 126C and 126D of the *Environmental Protection Act 1994*, pursuant to section 754 of the *Environmental Protection Act 1994*. The holder(s) must submit the proposed PRC plan to the administering authority, by **29 November 2024**.

#### **3 Transitional provisions**

Pursuant to the transitional provisions in section 754(3) of the *Environmental Protection Act 1994*, the holder(s) of the environmental authority are not required to comply with the requirements under section 126C(1)(g) or (h), or 126D(2) or (3) of the *Environmental Protection Act 1994* if –

<sup>1</sup> The Department of Environment and Science is the administering authority under the *Environmental Protection Act 1994*.

## Progressive rehabilitation and closure plan transition notice

- (a) an outcome for the land has been identified under a land outcome document; and
- (b) the outcome for the land is the same as, or substantially similar to, the outcome for the land if it were a non-use management area under a PRCP schedule.

A land outcome document is defined under section 750 of the *Environmental Protection Act 1994*.

Section 126C(1)(g) or (h), or 126D(2) of the *Environmental Protection Act 1994* require reasons and evidence to be provided to support a proposed non-use management area.

Section 126D(3) of the *Environmental Protection Act 1994* provides for any void that is contained wholly or partly in a flood plain to be rehabilitated to a stable condition.

In accordance with section 754(4) of the *Environmental Protection Act 1994*, if a land outcome document does not state sufficient detail to identify either the location or area of the land to which the outcome relates, the proposed PRC plan must state—

- (a) if the area is not identified — how the total area of the land to which the outcome relates will be minimised; and
- (b) if the location is not identified — how the mining environmental authority holder will ensure the location of the land to which the outcome relates minimises risks to the environment.

### 4 Supporting information

As detailed in section 2 of this notice, your PRC plan and associated PRCP schedule is required to address the relevant legislative requirements.

Please refer to the guideline Progressive Rehabilitation and Closure Plans (ESR/2019/4964) for more information about the requirements of the PRC plan and associated PRCP schedule, and the assessment process.

### 5 Consultation

The administering authority recommends that you request a pre-lodgement meeting to discuss the requirements of the proposed PRC plan in more detail. To request a pre-lodgement meeting, please complete and lodge the form 'Application for pre-lodgement services' (ESR/2015/1664) to arrange a meeting.

Should you have any questions in relation to this notice, contact Business Centre Coal via the below details.



Signature

13/12/2021

Date

Chris Wake  
Department of Environment and Science  
Delegate of the administering authority  
*Environmental Protection Act 1994*

**Enquiries:**  
Coal Business Centre  
Department of Environment and Science  
PO Box 3028, Emerald QLD 4720  
Phone: (07) 4987 9320  
Email: CRMining@des.qld.gov.au

## Memorandum

**Date** 29 November 2021  
**To** Chris Wake, Manager Environmental Services, Department of Environment and Science  
**From** Trudy Mazucco, Principal Closure Planning Minerals Australia  
**CC** Craig Lockhart, Manager Closure Planning Minerals Australia  
**Subject** Progressive Rehabilitation and Closure Plan – Goonyella Riverside / Broadmeadow Mine Complex (v2)

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### Purpose

The purpose of this memo is to provide context and background information for the purpose of completing a Progressive Rehabilitation and Closure Plan (PRC Plan) and associated PRCP Schedule for the Environmental Authority (EA) noted below (Goonyella Riverside / Broadmeadow Mine Complex). This information is intended to facilitate the issuing of a notification for the PRC Plan and associated PRCP Schedule for this EA.

**Environmental Authority Number:** EPML00853413 (19 December 2019)

**Environmental Authority Holders:** BHP Billiton Mitsubishi Alliance (BMA) equity holding, comprising:

- QCT Mining Pty Ltd
- QCT Resources Pty Ltd
- QCT Investments Pty Ltd
- BHP Coal Pty Ltd
- BHP Queensland Coal Investments Pty Ltd
- Mitsubishi Development Pty Ltd
- Umal Consolidated Pty Ltd



| PRCP Requirement    | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                     |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
|                     | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Post-2024 submission considerations |
| Introduction        | <p>The Goonyella Riverside Mine Complex (GRBM Complex) comprises the open cut Goonyella Mine (GRM) and the underground longwall Broadmeadow Mine (BRM). The mine is located 30km north of the town of Moranbah, Queensland.</p> <p>Environmentally relevant activities are authorised on mining leases (MLs) ML1763, ML1764, ML1802, ML1900, ML70121, ML70193, ML70194, ML70287, ML70288, ML70289, ML70468, ML70469, ML70478, ML70479, ML70493, ML70494, and ML700003.</p> <p>Mining operations commenced at Goonyella in 1971 and the mine merged with the Riverside Mine in 1989.</p>                                                                                                                                                                                                                                     | -                                   |
| Project Planning    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                     |
| Project description | <p>GRM is a conventional open cut strip mine with a north-south coal seam strike. Mining involves the removal and stockpiling of topsoil, drilling and blasting of overburden, and use of draglines and truck/shovel to remove the overburden to expose the coal seams (Goonyella Upper, Goonyella Middle and Goonyella Lower).</p> <p>The underground operations at BRM utilise longwall mining. Mining operations commenced with access from the GRM Eureka Pit, with current access from Broadmeadow Pit. Access to future underground panels may be established from other GRM pits.</p> <p>Product coal is transported by rail to the Hay Point Coal Terminal for export.</p> <p>Mining activities primarily occur within ML1763, with a small portion of mining occurring on the south-eastern portion of ML1764.</p> | -                                   |
| Mining activities   | <p>The current mining activities at GRBM include:</p> <ul style="list-style-type: none"> <li>• Open cut mining (GRM);</li> <li>• Underground mining (BRM);</li> <li>• Spoil dumps and reject dumps;</li> <li>• Tailings storage facilities (TSFs);</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | -                                   |

| PRCP Requirement        | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                     |
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|                         | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Post-2024 submission considerations |
|                         | <ul style="list-style-type: none"> <li>• Two coal handling and preparation plants (CHPPs);</li> <li>• Mine water dams;</li> <li>• Coal stockpile areas;</li> <li>• Run-of-mine (ROM) area; and</li> <li>• Haul roads and laydown areas.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                     |
| Existing rehabilitation | Rehabilitation has been completed routinely at GRBM each year.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -                                   |
| PMLUs                   | <p>The predominant pre-mining land uses at GRBM were cattle grazing and woodland.</p> <p>As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, BHP has transitional arrangements for GRBM for the post-mining land uses (PMLUs) listed in Table E1 of the EA, which include:</p> <ul style="list-style-type: none"> <li>• Cattle grazing;</li> <li>• Dryland cropping;</li> <li>• Woodland habitat;</li> <li>• Water storage; and</li> <li>• Watercourse.</li> </ul> <p>The completion criteria in Table E1 will also be transitioned to milestone criteria in the PRC Plan. The location, extent and viability of these PMLUs will be detailed in the PRC Plan.</p> | -                                   |
| NUMAs                   | <p>As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, BHP has transitional arrangements for residual voids as NUMAs for GRM.</p> <p>Void wall stability will determine the extent of a NUMA as it may extend past the mined void crest if necessary to allow for management of wall instability. This will be detailed in the PRC Plan for GRM.</p> <p>As the EA does not state the area or location of the proposed NUMAs, the PRC Plan will include detail on how the total area of land as NUMAs will be minimised, as well as how the location will minimise risk to environment, as required in the guideline.</p>                                           | -                                   |

| PRCP Requirement                          | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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|                                           | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Post-2024 submission considerations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                           | The PRC Plan will also demonstrate how environmental harm will be managed beyond the transitioned NUMAs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Voids in floodplains                      | As the location and size of the transitioned NUMAs are not identified in land outcome documents, flood modelling in accordance with the <i>BHP PRCP Flood Modelling Position – 23072020 memo</i> will be completed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Community consultation                    | As a transition site, there is no requirement for community consultation prior to submission of PRC Plan. However, BHP will follow an engagement plan over the life of the operation, in line with current internal stakeholder engagement frameworks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Rehabilitation and Management Methodology |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Hydrogeology                              | <p>GRBM comprises deep voids, and underground workings which extend under the Isaac River. The groundwater regime in the mine area comprises Quaternary alluvial aquifers associated with the creeks and rivers in the area, Tertiary sediment and basalt aquifers, and Permian sedimentary rock aquifers. The aquifers generally yield low flow volumes of poor quality groundwater and generally have limited beneficial use in the area.</p> <p>GRBM is a large, complicated hydrogeological site, with limited groundwater data and no current groundwater model.</p> <p>To allow the delivery of the PRC plan in November 2024 the PRC plan groundwater assessment and modelling work will need to commence by mid-2023, which will also represents the cut-off date for the collection of additional groundwater data.</p> <p>The reduced timeline, will limit BMA's capacity to collect additional site-specific information to close out data gaps. This is particularly relevant where shallow groundwater is hosted in alluvial and tertiary geology. Historical limited groundwater data collection for the site has been focused on the Permian geological units and as such only limited information is held characterising shallower groundwater units.</p> <p>To achieve the proposed timelines, groundwater inputs into the PRC plan will rely more heavily on available regional models, data sharing agreements, existing data held for the sites and more conservative assumptions/uncertainty analysis.</p> <p>The delivery of the PRC plan in November 2024 will not provide for:</p> <ul style="list-style-type: none"> <li>Closing out any data gaps/uncertainties identified during the assessment of groundwater;</li> </ul> | <p>As documented in the DES memo Groundwater Scope of Work to Satisfy PRCP requirements, dated 25 September 2020, it is noted that delivery of the PRCP on 1 November 2024 will be based on the groundwater data held at the time. Additional groundwater data may be required post-2024 to assess seasonal trends, provide greater data definition, and to reduce uncertainties.</p> <p>The delivery of a PRCP for GRBM by 1 November 2024 will need to rely on the initial rounds of contaminated land investigations. These initial rounds of investigation are unlikely to achieve delineation of plumes and coverage across the entire mine site. This will limit the understanding of contaminant fate-and-transport modelling. Contaminated land investigations will be on-going post-2024 based on potential risks identified.</p> |



| PRCP Requirement          | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                 |
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|                           | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Post-2024 submission considerations                                                                                                                                                                                                                                             |
|                           | <ul style="list-style-type: none"> <li>Completion of contaminated land investigation data sets that will allow for predictive modelling of contaminant transport;</li> <li>Collection of complete data sets for all shallow/confined groundwaters to provide confirmation of existence, condition and depth; and</li> <li>Modelling to higher levels of resolution if required/relevant for specific locations to inform other technical studies.</li> </ul>                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                 |
| Flooding                  | <p>The GRBM Complex is located within the headwaters of the Isaac-Connors sub-catchment of the greater Fitzroy Basin. The Isaac River is the main watercourse traversing the mine site. The Isaac River and tributaries (Eureka, Goonyella, Cleanskin, Platypus, Holding Paddock, Fischer and Ceil Creeks) in and around the GRBM Complex are ephemeral.</p> <p>As per the <i>BHP PRCP Flood Modelling Position – 23072020</i> memo, BHP will use a risk-based approach to flood modelling. Where the risk-based approach identifies a flood modelling requirement, the modelling will be completed using criteria identified as appropriate for the location.</p> | -                                                                                                                                                                                                                                                                               |
| Soil and capping material | <p>As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, the soil and capping assessment at GRBM will include:</p> <ul style="list-style-type: none"> <li>Topsoil quality, quantity, treatments and management;</li> <li>Availability, quality and quantity of any other capping material required; and</li> <li>Strategies to address any deficits including development of alternative growth media to support appropriate PMLUs.</li> </ul>                                                                                                                                                                                           | As contaminated land detailed site investigations and fate-and-transport modelling for the entire site are unlikely to be completed by 1 November 2024, this will impact the level of certainty on site-wide capping material balances.                                         |
| Waste characterisation    | <p>Mine waste at GRBM includes:</p> <ul style="list-style-type: none"> <li>Overburden / interburden;</li> <li>Coarse rejects; and</li> <li>Tailings.</li> </ul> <p>Historic geochemical and physical (for sodicity and dispersivity) characterisation test work will represent the bulk of the data utilised to assess the geochemical risk posed by key mine waste domain and landforms.</p>                                                                                                                                                                                                                                                                      | On-going contaminated land investigations are envisaged to be required post-2024, which may impact on the understanding of impacts associated with waste materials. Therefore, additional data collected as part of the contaminated land investigations may require updates to |

| PRCP Requirement | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                    |
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|                  | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Post-2024 submission considerations                                                                                                                                                                                                                                                                                                                |
|                  | <p>As detailed in <i>BHP PRCP Geochem DES Update 26082020</i>, site specific and data collected from other BHP sites extracting coal from the Moranbah Coal Measures (<i>PRCP memos – comments and feedback 25092020</i>) will be used to assist with defining the environmental geochemical properties of key material domains at GRBM.</p> <p>In addition to the historic samples listed in <i>BHP PRCP Geochem DES Update 26082020</i>, the following additional data are currently available:</p> <ul style="list-style-type: none"> <li>• Core drilling of 6 holes (totalling 1277m) completed in October 2021. Overburden and seam samples currently being collected for analysis in early 2022. Estimate minimum 850 samples. These data were not included in the <i>BHP PRCP Geochem DES Update 26082020</i>.</li> <li>• 159 tailings and rejects samples collected from drilling conducted at the GS1 TSF in 2021. These data were not included in the <i>BHP PRCP Geochem DES Update 26082020</i>.</li> <li>• 127 tailings and rejects samples collected from drilling conducted at the RS1 TSF in 2021. These data were not included in the <i>BHP PRCP Geochem DES Update 26082020</i>.</li> <li>• 26 coarse reject samples from GY and RV CHPPs + ongoing routine sample collection. Commenced July 2021. These data were not included in the <i>BHP PRCP Geochem DES Update 26082020</i>.</li> <li>• 110 tailings samples from GY and RV CHPPs + ongoing routine sample collection. Commenced February 2017.</li> <li>• Ongoing tailings and reject sampling testing will be conducted to augment geochemical knowledge for these materials type (<i>BHP PRCP Geochem DES Update 26082020</i>).</li> </ul> <p>Sample prep and analytical tests varied slightly between the different sampling programs (and between drill-hole samples vs reject samples). However, the fundamental geochemical and physical (i.e. sodicity and dispersivity) characterisation methodology was the same or similar between programs. Therefore, all data is relevant and will be used in the assessment.</p> <p>Lab-work generally undertaken in stages:</p> <ul style="list-style-type: none"> <li>• Stage 1 (screening – typically all samples): pH &amp; EC (1:5 water extracts on pulps); total sulfur (S); acid neutralising capacity (ANC).</li> </ul> | <p>the interpretations made as part of the waste characterisations studies.</p> <p>Groundwater data gaps may not be closed out for PRCP submission on 1 November 2024. Therefore, source, pathway and receptor linkages associated with waste characterisation studies may need to be updated on closing out of any hydrogeological data gaps.</p> |

| PRCP Requirement                        | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                    |                |                 |                        |                                         |                                                               |                                                                                                                                                                                                                                                                                                    |               |                                                                 |                                                                                                             |      |                                                        |                                                                                                                                           |               |                                                                                       |                                                                                      |
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|                                         | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Post-2024 submission considerations                                                                                                                                                                                                                                                                |                |                 |                        |                                         |                                                               |                                                                                                                                                                                                                                                                                                    |               |                                                                 |                                                                                                             |      |                                                        |                                                                                                                                           |               |                                                                                       |                                                                                      |
|                                         | <ul style="list-style-type: none"> <li>Stage 2 (typically selected samples): sulfur speciation; net acid generation (NAG); total metals; soluble metals (1:5 water extracts on pulps); exchangeable cations; Emerson Aggregate.</li> <li>Stages 3+ (selected samples): acid buffering characterisation curves (ABCC); Extended Boil NAG; Sequential NAG; Kinetic-NAG; Quantitative XRD; OxCon; free draining column leach tests.</li> </ul> <p>Historic and new data for all mine waste will be reinterpreted to provide a consistent understanding and definition of the geochemical and physical risk (i.e. AMD and salinity/dispersivity, as applicable) across key material domains including pit wall geochemical stability.</p> <p>One of the outcomes of the geochemical and physical characterisation will be a classification system that will confidently identify beneficial and problematic waste from a chemical and physical stability perspective.</p> <p>The PRC Plan will detail the waste categories to ensure problematic waste, based on both chemical and physical behaviour, is managed at GRBM. Conceptual waste categories at GRBM are shown in the table below but modification may be made in the PRC Plan submission once the final assessments have been completed:</p> <table border="1"> <thead> <tr> <th>Waste Category</th><th>Characteristics</th><th>Recommended Management</th></tr> </thead> <tbody> <tr> <td>Tertiary/<br/>Weathered<br/>Permian waste</td><td>Non-carbonaceous<br/><br/>Fine textured, often saline and sodic</td><td> <ul style="list-style-type: none"> <li>Place on lower slopes or not on the outside of higher slope dumps where possible</li> <li>If used on the outside of the landforms, ameliorants to be considered for sodic materials to limit dispersion and landforms to be designed accordingly</li> </ul> </td></tr> <tr> <td>Permian waste</td><td>Non-carbonaceous<br/><br/>Rockier, lower in salinity and sodicity</td><td> <ul style="list-style-type: none"> <li>Place on the outside of higher slope dumps where possible</li> </ul> </td></tr> <tr> <td>Rock</td><td>Non-carbonaceous<br/><br/>Basalt and competent sandstone</td><td> <ul style="list-style-type: none"> <li>Can be used on outside slopes to achieve steeper, more stable landforms (rock mulching)</li> </ul> </td></tr> <tr> <td>AMD potential</td><td>Coaly and carbonaceous material (carbonaceous overburden/ interburden, thin partings)</td><td> <ul style="list-style-type: none"> <li>Co-mingle dumping with other waste</li> </ul> </td></tr> </tbody> </table> <p>A risk based approach will be used to determine what work is required to characterise existing waste dumps if issues are identified.</p> |                                                                                                                                                                                                                                                                                                    | Waste Category | Characteristics | Recommended Management | Tertiary/<br>Weathered<br>Permian waste | Non-carbonaceous<br><br>Fine textured, often saline and sodic | <ul style="list-style-type: none"> <li>Place on lower slopes or not on the outside of higher slope dumps where possible</li> <li>If used on the outside of the landforms, ameliorants to be considered for sodic materials to limit dispersion and landforms to be designed accordingly</li> </ul> | Permian waste | Non-carbonaceous<br><br>Rockier, lower in salinity and sodicity | <ul style="list-style-type: none"> <li>Place on the outside of higher slope dumps where possible</li> </ul> | Rock | Non-carbonaceous<br><br>Basalt and competent sandstone | <ul style="list-style-type: none"> <li>Can be used on outside slopes to achieve steeper, more stable landforms (rock mulching)</li> </ul> | AMD potential | Coaly and carbonaceous material (carbonaceous overburden/ interburden, thin partings) | <ul style="list-style-type: none"> <li>Co-mingle dumping with other waste</li> </ul> |
| Waste Category                          | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Recommended Management                                                                                                                                                                                                                                                                             |                |                 |                        |                                         |                                                               |                                                                                                                                                                                                                                                                                                    |               |                                                                 |                                                                                                             |      |                                                        |                                                                                                                                           |               |                                                                                       |                                                                                      |
| Tertiary/<br>Weathered<br>Permian waste | Non-carbonaceous<br><br>Fine textured, often saline and sodic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>Place on lower slopes or not on the outside of higher slope dumps where possible</li> <li>If used on the outside of the landforms, ameliorants to be considered for sodic materials to limit dispersion and landforms to be designed accordingly</li> </ul> |                |                 |                        |                                         |                                                               |                                                                                                                                                                                                                                                                                                    |               |                                                                 |                                                                                                             |      |                                                        |                                                                                                                                           |               |                                                                                       |                                                                                      |
| Permian waste                           | Non-carbonaceous<br><br>Rockier, lower in salinity and sodicity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>Place on the outside of higher slope dumps where possible</li> </ul>                                                                                                                                                                                        |                |                 |                        |                                         |                                                               |                                                                                                                                                                                                                                                                                                    |               |                                                                 |                                                                                                             |      |                                                        |                                                                                                                                           |               |                                                                                       |                                                                                      |
| Rock                                    | Non-carbonaceous<br><br>Basalt and competent sandstone                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <ul style="list-style-type: none"> <li>Can be used on outside slopes to achieve steeper, more stable landforms (rock mulching)</li> </ul>                                                                                                                                                          |                |                 |                        |                                         |                                                               |                                                                                                                                                                                                                                                                                                    |               |                                                                 |                                                                                                             |      |                                                        |                                                                                                                                           |               |                                                                                       |                                                                                      |
| AMD potential                           | Coaly and carbonaceous material (carbonaceous overburden/ interburden, thin partings)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>Co-mingle dumping with other waste</li> </ul>                                                                                                                                                                                                               |                |                 |                        |                                         |                                                               |                                                                                                                                                                                                                                                                                                    |               |                                                                 |                                                                                                             |      |                                                        |                                                                                                                                           |               |                                                                                       |                                                                                      |



| PRCP Requirement | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                         |
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|                  | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Post-2024 submission considerations                                                                                                                                                                                                                                                                                     |
| Landform design  | The main structures of the GRBM final landform include spoil dumps, rejects dumps, final voids, tailings storage facilities and subsidence. The PRC Plan will include the detail for landform design as per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | As contaminated land detailed site investigations and fate-and-transport modelling for the entire site are unlikely to be completed by 1 November 2024, this will impact the level of certainty on site-wide remediation requirements and closure-related landform designs.                                             |
| Cover design     | A risk-based approach will be used to determine areas that may require a cover design.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | As contaminated land detailed site investigations and fate-and-transport modelling for the entire site are unlikely to be completed by 1 November 2024, this will impact the level of certainty on site-specific cover designs.                                                                                         |
| Water management | <p>Water management planning will integrate the results of other technical studies such as contaminated land, waste characterisation, TSF closure, diversions, groundwater assessments and landform design, to provide an understanding of the post mining water management requirements and potential risks. Water management planning will identify requirements for any ongoing dewatering or treatment and how this is to be achieved.</p> <p>The design of the final landforms will include, where required, infiltration and seepage intervention and collection controls, where these measures are deemed to be required.</p> <p>There are four creek diversions at GRBM:</p> <ul style="list-style-type: none"> <li>• Isaac River Creek;</li> <li>• Eureka Creek Holding;</li> <li>• Holding Paddock Creek; and</li> <li>• Fischer Creek.</li> </ul> <p>The creek diversions undergo routine monitoring as part of the operations, and this monitoring will be completed throughout the LoA as part of the operations and closure. The PRC Plan will define the approval regime and status of each diversion i.e. temporary or permanent. In addition, BHP will assess the performance of all watercourse diversions and this assessment will be used to inform subsequent relinquishment and final landform outcomes for each diversion. Forward work plan based on the outcomes of the assessment of the watercourse diversion will be included in the PRCP schedule.</p> | On-going contaminated land investigations are envisaged to be required post-2024, which may impact on the understanding of sources, pathways, receptors and their potential linkages. Water management considerations within the 2024 PRC plan will be based on available information and take a conservative approach. |

| PRCP Requirement | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                     |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                  | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Post-2024 submission considerations                                                                                                                                                                                                                                                 |
| Revegetation     | <p>The PRC Plan will include the detail for revegetation as per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>.</p> <p>The Revegetation Plan will be consistent with the revegetation planning requirements of the PRCP guideline and existing BHP rehabilitation management plans. The Revegetation Plan will describe the works for establishing and managing the revegetation as it relates to the intended PMLUs as listed in Table E1 of the EA (e.g. cattle grazing, woodland habitat, watercourses, water storage and dryland cropping).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | -                                                                                                                                                                                                                                                                                   |
| TSFs             | <p>Current GRBM TSFs include: GS1 TSF, RS1 TSF, Ramp 32 and Dragline 5 TSF. These facilities comprise the following:</p> <ul style="list-style-type: none"> <li>Central decant turkey's nest dams (RS1 and GS1): these are above ground facilities with partial or complete perimeter embankments (RS1 is bounded by a waste dump of coarse rejects on its western side). These facilities have a central decant using an embankment or pontoon-mounted pump. In addition to requiring additional fill materials to promote drainage to the external embankments, softer tailings in the vicinity of the central decant will result in differential settlement that will require additional fill materials to maintain the drainage.</li> <li>In-pit TSF (Ramp 32): this is a disused mining void that has been partially filled with tailings. The relatively level pit floor will result in small differential settlement.</li> <li>In-void TSF (Dragline 5): this is a disused mining void that has been partially filled with tailings. The relatively level pit floor will result in small differential settlement.</li> </ul> <p>The PRC Plan will include the detail for TSFs as per the <i>BHP Coal Tailings PRCP Final 30062020 memo</i>. This includes site and material characterisation which will inform conceptual closure designs of TSFs where applicable. The closure design schedule will be driven by availability and risk profile of individual facilities.</p> | -                                                                                                                                                                                                                                                                                   |
| Voids            | <p>Voids at GRM are progressively backfilled with overburden and mine waste as mining advances during the operational stage. At closure, only the final voids (location of final cuts) will remain. BHP will use a risk-based approach to assess representative final voids at GRM. The PRC Plan will include the detail for voids as per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>.</p> <p>Void closure planning relating to water resources will include:</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | As previously mentioned, contaminated land detailed site investigations and fate-and-transport modelling for the entire site is unlikely to be completed by 1 November 2024. As the results of these investigations may impact on the water quality within the void, the void water |

| PRCP Requirement   | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Post-2024 submission considerations                                                                                                                                                                                                                                                                                                                                      |
|                    | <ul style="list-style-type: none"> <li>An update of the hydrogeological model where appropriate;</li> <li>Void water balance;</li> <li>Void water quality prediction for electrical conductivity;</li> <li>Hydrologic conceptual site model; and</li> <li>A risk based approach to assess the potential impacts of flooding and the need for any additional flood modelling.</li> </ul>                                                                                                           | <p>quality predictions may be incomplete and require additional development post-PRC Plan and Schedule submission.</p> <p>Where void hydrology is impacted by shallower groundwaters, for which limited data is currently held, amendment of the Void Closure Plan may be required upon collection of additional data and any updating of the hydrogeological model.</p> |
| Underground mining | The requirements of the PRCP Guideline will be compiled for the BRM workings.                                                                                                                                                                                                                                                                                                                                                                                                                     | Ongoing groundwater data collection and any update to the hydrogeological model undertaken after 1 November 2024 may improve the understanding of hydrogeological conditions. Therefore, updates to the underground mining PRCP considerations may be required post-2024.                                                                                                |
| Infrastructure     | <p>The main on-site infrastructure at GRBM includes: CHPPs, train load-out facility, permanent and temporary buildings, bitumen roads and car parks, mine industrial area (MIA) (workshops, sheds etc.), ROM pad and coal stockpiles (conveyors, stackers, etc.) and water dams.</p> <p>As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, all required information on decommissioning or retainment of infrastructure will be included as part of the PRC Plan.</p> | -                                                                                                                                                                                                                                                                                                                                                                        |
| Risk assessment    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                          |
| Risk assessment    | To be completed as part of the PRC Plan.                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Due to the limited datasets pertaining to the hydrogeological and contaminated land outcomes, the level of certainty of occurrence of potential risk events identified as part of the 1 November 2024                                                                                                                                                                    |



| PRCP Requirement                                                                                                             | BHP information submission for review                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                              | 29 November 2024 submission                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Post-2024 submission considerations                                                                                                                                                                                                            |
|                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | GRBM submission, and their potential consequences and required controls and/or mitigations will only be at a conceptual level of understanding. Ongoing data collection and analysis after 1 November 2024 will enable improved risk analysis. |
| Rehabilitation trials and monitoring and maintenance                                                                         | <p>Rehabilitation trials will be undertaken, if required, to verify alternate rehabilitation treatments such as alternative growth media and landform requirements. Where appropriate, concepts requiring further investigation in a trial will be included in the PRC Plan.</p> <p>Monitoring and maintenance will be based on current BHP processes. As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, all required information will be included.</p> | -                                                                                                                                                                                                                                              |
| PRCP Schedule                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                |
| Rehabilitation milestones, and milestone criteria                                                                            | To be completed based on the content of the PRC Plan.                                                                                                                                                                                                                                                                                                                                                                                                                                 | -                                                                                                                                                                                                                                              |
| PRCP Submission                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                |
| <p>As discussed with the DES team on Monday, 29 November 2021:</p> <p><b>GRBM PRCP submission date: 29 November 2024</b></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                |

**Recommendations**

Review and consider the above information as a basis for PRCP compilation for the GRBM complex.

Yours sincerely

**Trudy Mazucco**  
**Principal Closure Planning**  
Trudy.mazucco@bhp.com

Appendix 1: Goonyella Riverside / Broadmeadow Mine Complex: Supporting Maps

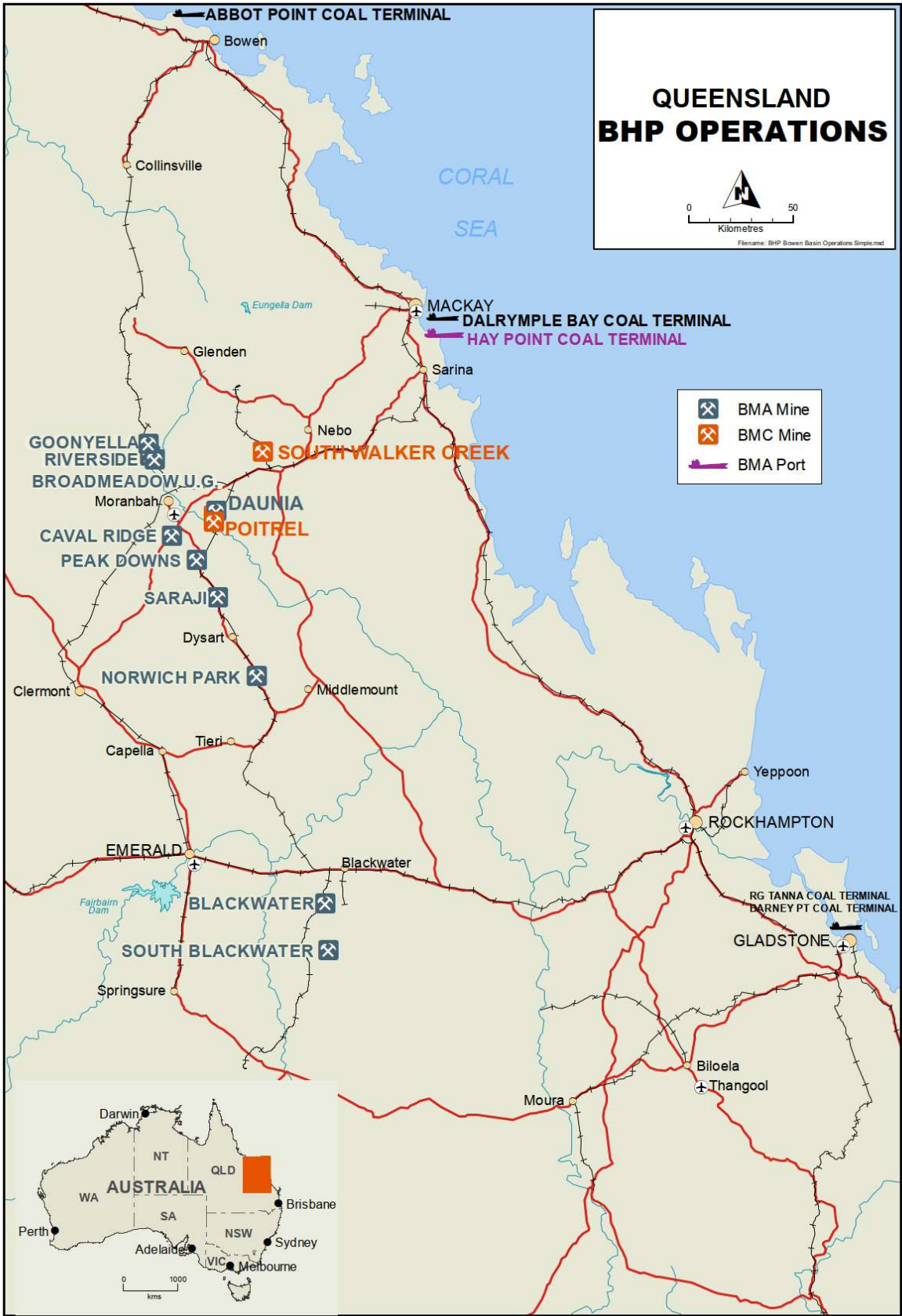
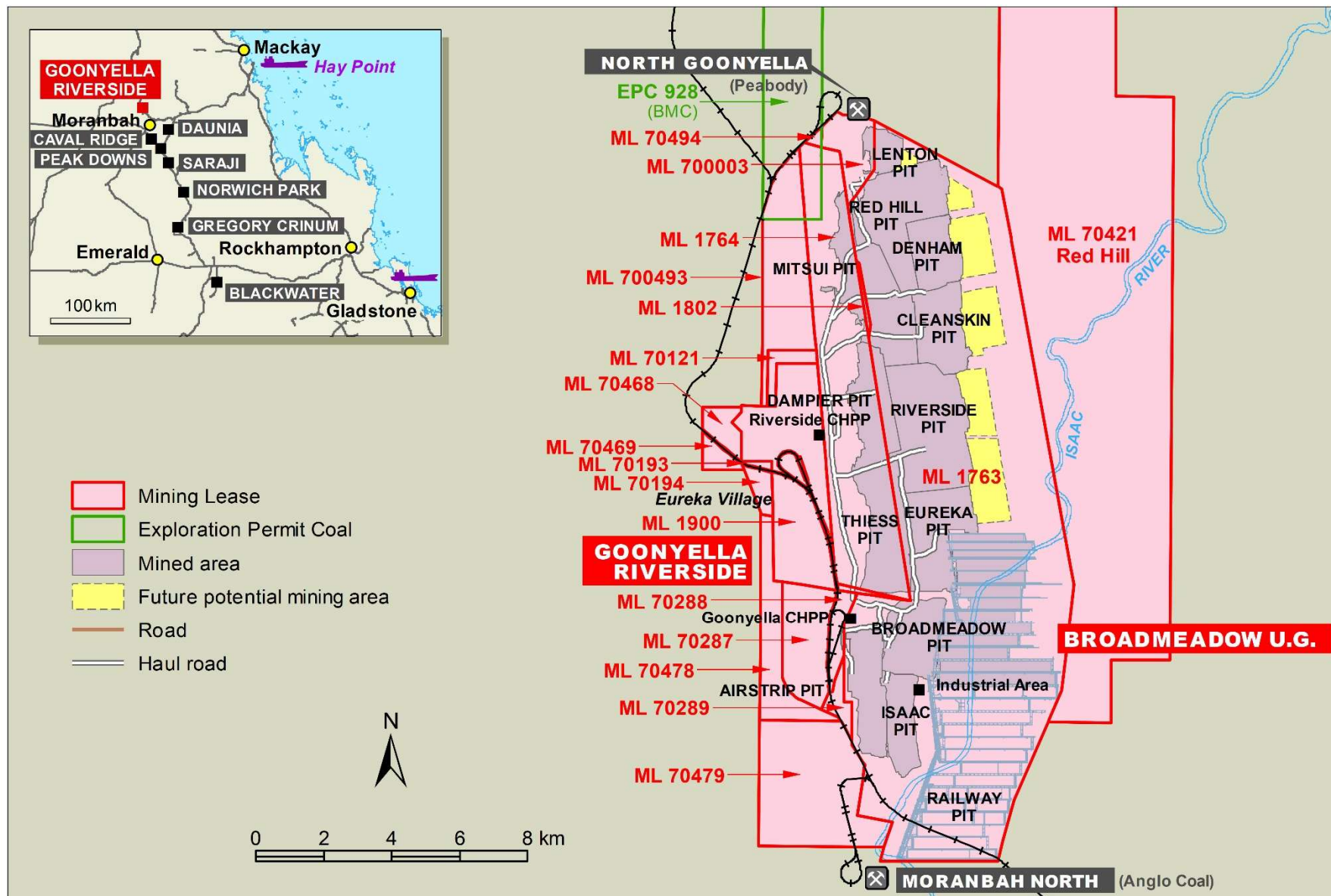


Figure 1: BHP Operations in Queensland





**Figure 2: GRBM Complex mining tenements and operational land**