



REPORT

EVOLUTION MINING LTD

**Mount Rawdon Operations –
Progressive Rehabilitation and
Closure Planning – Hydraulic
Assessment**

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CONTENTS

1	INTRODUCTION	1
1.1	Background and Purpose	1
1.2	Site Watercourses/Drainage Setting	2
1.3	Scope of Work	3
1.4	Methodology	3
1.5	Structure of Report	4
2	HYDROLOGIC ASSESSMENT	5
2.1	General	5
2.2	Coincident Flooding Scenarios	5
2.3	Probable Maximum Precipitation	5
2.4	Rare Precipitation Estimation	7
2.5	Regional Flood Frequency Estimate	9
3	HYDRAULIC ASSESSMENT.....	11
3.1	Model Overview	11
3.2	Model Domain	11
3.3	Digital Elevation Model	12
3.3.1	Base Topography	12
3.3.2	TSF Closure Surface	15
3.3.3	TSF Closure Spillway	15
3.3.4	Pit Abandonment Bund	16
3.3.5	South Dam Fill Area	16
3.3.6	Southern Diversion Drain	16
3.4	Grid Size Selection and Time Step	17
3.5	Boundary Conditions	17
3.6	Surface Roughness	20
3.7	Sensitivity Analysis	22
4	RESULTS	23
4.1	Introduction	23
4.2	TSF	24
4.3	West Dam	25
4.4	South Dam Fill Area Dam	28
4.5	Southern Diversion Drain	28
4.6	Pit Bund	28
4.7	Perry River Dam	30
4.8	Retained Dams	30
4.9	Tributaries	32
4.10	Sensitivity Analysis	34
5	PRCP INPUTS AND DISCUSSION	36
5.1	General	36
5.2	The South Dam, Process Water Dam and the MIA	36
5.3	Pit	36
5.4	TSF	37
5.5	West Dam and Retained Dams	37
5.6	Perry River Dam	38
6	SUMMARY AND CONCLUSIONS.....	39
	REFERENCES	40



TABLES

TABLE 1: COINCIDENT FLOODING SCENARIOS	5
TABLE 2: GSDM FACTORS FOR PMP ESTIMATE	6
TABLE 3: PMP DEPTH ESTIMATE	7
TABLE 4: RARE RAINFALL DEPTH ESTIMATES [3]	8
TABLE 5: RFFE RESULT SUMMARY – PERRY RIVER	9
TABLE 6: TSF CLOSURE SPILLWAY DETAILS.....	16
TABLE 7: PIT ABNDONMENT BUND DETAILS.....	16
TABLE 8: SOUTH DAM FILL AREA	16
TABLE 9: SOUTHERN DIVERSION DRAIN DETAILS.....	17
TABLE 10: BOUNDARY CONDITIONS	19
TABLE 11: DAM INITIAL WATER LEVELS	19
TABLE 12: MANNINGS 'N' ROUGHNESS COEFFICIENT.....	21
TABLE 13: TSF RESULTS.....	24
TABLE 14: WEST DAM RESULTS	26
TABLE 15: SOUTH DAM FILL AREA RESULTS.....	28
TABLE 16: SOUTHERN DIVERSION DRAIN RESULTS	28
TABLE 17: PIT BUND RESULTS.....	29
TABLE 18: PERRY RIVER DAM RESULTS.....	30
TABLE 19: SEDIMENT DAM 3 RESULTS.....	30
TABLE 20: WD1, WD2, WD3 AND WD4 RESULTS.....	31
TABLE 21: DOWNSTREAM TRIBUTARIES RESULTS – SWINDON CREEK	32
TABLE 22: DOWNSTREAM TRIBUTARIES RESULTS – RAWDON CREEK	32
TABLE 23: DOWNSTREAM TRIBUTARIES RESULTS – TWELVE MILE CREEK	33
TABLE 24: DOWNSTREAM TRIBUTARIES RESULTS – MINGHAM CREEK	33
TABLE 25: SENSITIVITY ANALYSIS RESULTS – PMF EVENT	35

DIAGRAMS

DIAGRAM 1: SITE LOCATION	1
DIAGRAM 2: SITE TRIBUTARIES AND INFRASTRUCTURE	2
DIAGRAM 3: PMP DEPTH ESTIMATE.....	6
DIAGRAM 4: PERRY RIVER CATCHMENT.....	10
DIAGRAM 5: TUFLOW MODEL DOMAIN	12
DIAGRAM 6: LIDAR AND SRTM DATA EXTENTS.....	13
DIAGRAM 7: POST CLOSURE FEATURES	15
DIAGRAM 8: BOUNDARY LOCATIONS	18
DIAGRAM 9: PERRY RIVER DAM INITAIL WATER LEVEL EXTENTS.....	20
DIAGRAM 9: MANNINGS ROUGHNESS.....	21



DIAGRAM 10: RESULTS REPORTING LOCATIONS.....	23
DIAGRAM 11: TSF SPILLWAY PMP RESULTS	25
DIAGRAM 12: WEST DAM, SOUTH DAM AREA AND SOUTHERN DIVERION DRAIN PMP RESULTS	27

FIGURES

FIGURE 001 – PROBABLE MAXIMUM FLOOD– MAXIMUM FLOOD DEPTHS
FIGURE 002 – PROBABLE MAXIMUM FLOOD – MAXIMUM FLOOD VELOCITY
FIGURE 003 – 0.1 % AEP – MAXIMUM FLOOD DEPTHS
FIGURE 004 – 0.1 % AEP – MAXIMUM FLOOD VELOCITY
FIGURE 005 – 1 % AEP – MAXIMUM FLOOD DEPTHS
FIGURE 006 – 1 % AEP – MAXIMUM FLOOD VELOCITY

APPENDICES

APPENDIX A – GSDM PROBABLE MAXIMUM PRECIPITATION CALCULATIONS
APPENDIX B – GRID SIZE SENSITIVITY

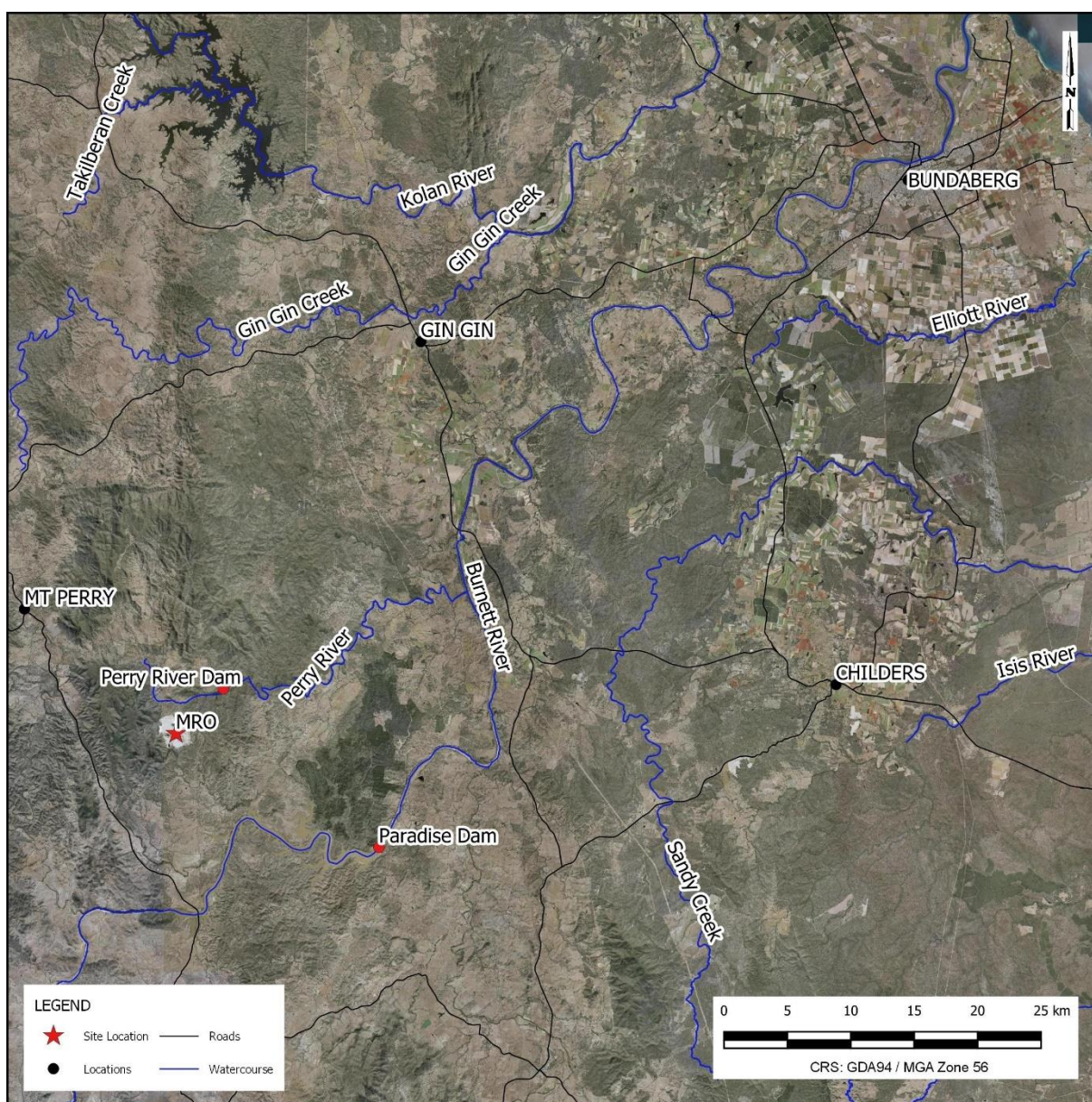


1 INTRODUCTION

1.1 Background and Purpose

Evolution Mining Ltd (Evolution) owns and operates the Mt Rawdon Operation (MRO), which spans nine (9) mining leases in the Wide Bay-Burnett region of Queensland. The MRO is located approximately 14 km southeast of Mt Perry, and approximately 73 km southwest of Bundaberg, as shown on **DIAGRAM 1**. Most of the MRO site drains north towards the Perry River. The remainder of the site drains south, via Mingham Creek, to the Burnett River, as shown on **DIAGRAM 2**. The Burnett River is impounded by Paradise Dam, approximately 18 km southeast of the site, as shown on **DIAGRAM 1**. Paradise Dam does not have any impact on the hydraulic regimes at the MRO site.

DIAGRAM 1: SITE LOCATION



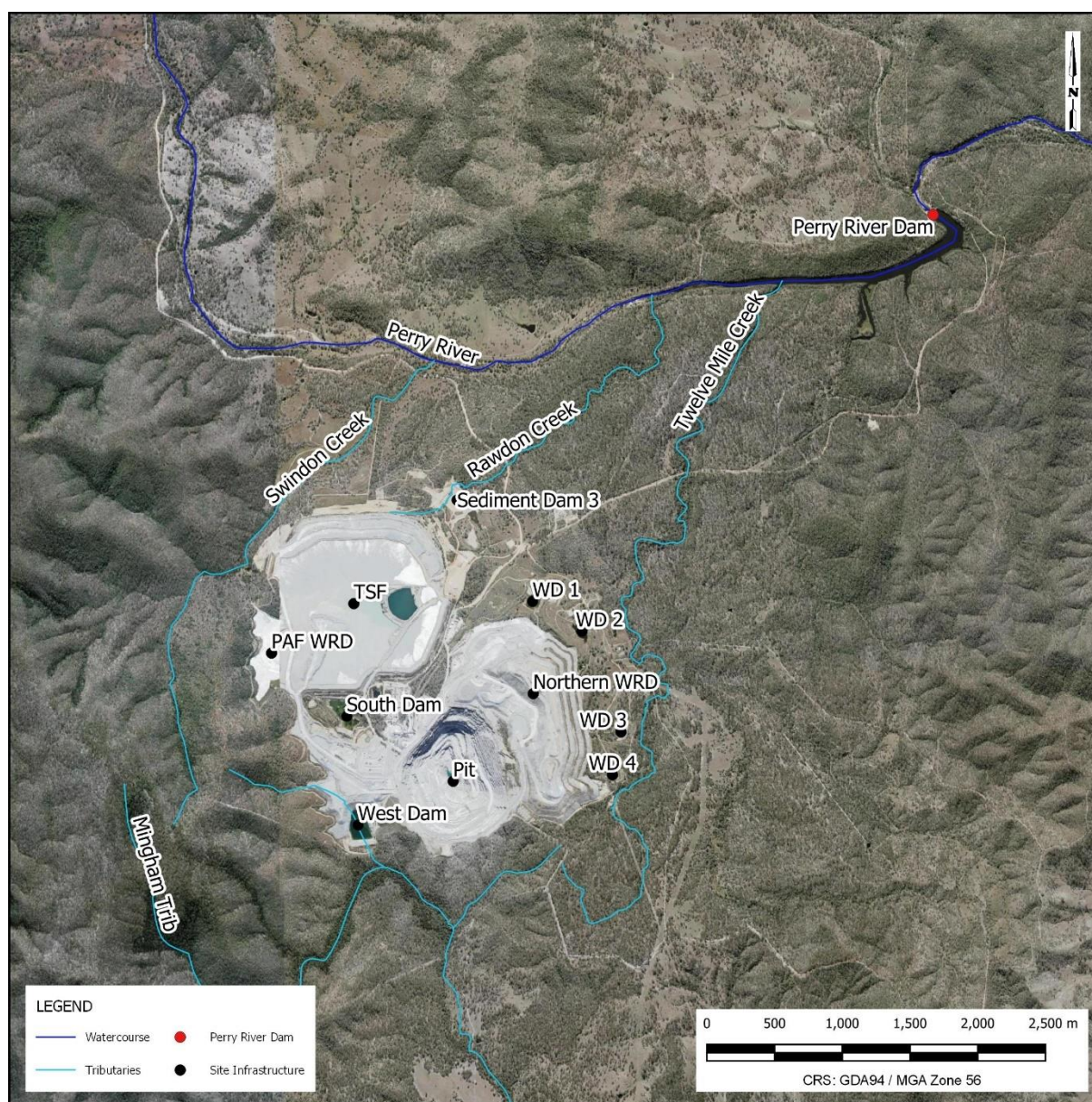
The purpose of this report is to develop a flood profile for the MRO site as part of the Progressive Closure and Rehabilitation Plan (PCRP). The flood profile will be developed for the Probable Maximum Flood, 1:1,000 and 1:100 Annual Exceedance Probability (AEP) design storm events.



1.2 Site Watercourses/Drainage Setting

The MRO is located approximately 2 km south of the Perry River. Swindon Creek conveys flows from the catchment to the west of the Tailings Storage Facility (TSF) north towards the Perry River. Rawdon Creek and Twelve Mile Creek convey flows from the catchments downstream of the TSF and east of the Northern Waste Rock Dump (WRD) respectively, north towards the Perry River. Mingham Creek receives flows from 'Mingham Trib', 'Mingham Trib West' and 'Mingham Trib East' south towards the Burnett River. The locations of these tributaries are depicted on **DIAGRAM 2**, along with key existing mine infrastructure. The West Dam, Sediment Dam 3, WD1, WD2, WD3 and WD4 are to be retained for erosion and sediment control purposes post closure. Currently, WD1, WD2, WD3 and WD4 receive mine impacted runoff from the Northern WRD. Under post closure conditions, the dams will continue to receive runoff from the Northern WRD, however the Northern WRD will be capped and rehabilitated, such that surface runoff will no longer be mine impacted.

DIAGRAM 2: SITE TRIBUTARIES AND INFRASTRUCTURE





The Perry River has been impounded by the Perry River Dam (PRD) approximately 4.5 km to the northeast of the site. Flows from the Perry River enter the Burnett River approximately 21 km east of the PRD. The Perry River and the Burnett River are in the Burnett River Basin. The Burnett River discharges into the Coral Sea at Burnett Heads, approximately 13 km northeast of Bundaberg.

1.3 Scope of Work

The following scope of work is required by Evolution to complete their PRCP submission.

- To provide a flood risk profile for the site under post closure conditions
- To provide flood mapping to show water depths and velocities on the final landform design.

The flood risk profile for the TSF and the Pit at MRO was required to be developed in accordance with the PRCP guidelines [1]. In consultation with Evolution, it was agreed to model the following events:

- Probable Maximum Flood (PMF) resulting from the Probable Maximum Precipitation (PMP);
- 1:1,000 AEP (0.1% AEP); and
- 1:100 AEP (1% AEP) storm events.

Australian Rainfall and Runoff (ARR) [2] was utilised to develop the rainfall estimates for input into a TUFLOW hydraulic model.

1.4 Methodology

The methodology adopted to achieve the scope of works for the PRCP flood study consists of the following three tasks.

- Hydrologic assessment of the site and upstream catchments. This will include:
 - Estimation of site rainfall for the 0.1% AEP, 1% AEP and 5% AEP events from the Bureau of Meteorology (BoM) datasets;
 - Estimation of Probable Maximum Precipitation; and,
 - Regional Flood Frequency Estimates for peak discharge in the Perry River.
- Hydraulic modelling of the site and upstream catchments. This will include:
 - Setting up a Digital Elevation Model (DEM) of the site that conceptually represents the post closure site conditions;
 - Estimation of surface roughness conditions;
 - Application of direct rainfall over the model domain with RFFE flows at the upstream inflow location;
 - Undertaking grid size sensitivity testing;
 - Undertaking model sensitivity testing for rainfall and surface roughness variations; and
 - Producing mapping of flood depths and velocities for the modelled storm events.
- Preparation of a report to present the results of the modelling for inclusion in Evolution's PRCP submission.



1.5 Structure of Report

The structure of the report, to address the above scope of works, is as follows.

- Section 2** Details the hydrologic estimations undertaken for the site. This section includes the inputs and outcomes of the rainfall estimation process for the PMP, 0.1% AEP and 1% AEP design events and the Regional Flood Frequency Estimate (RFFE) for the Perry River.
- Section 3** Details the development of the TUFLOW hydraulic model utilised for estimating the response of the site to the hydrographs determined in **Section 2.0**.
- Section 4** This section presents and discusses the hydraulic modelling results of the post closure conditions.
- Section 5** This section discusses relevant results to inform the PCRPs planning and design.
- Section 6** Provides a summary and conclusions from the hydraulic assessment.



2 HYDROLOGIC ASSESSMENT

2.1 General

As the MRO site is located at the upper extents of Swindon Creek, Rawdon Creek, Twelve Mile Creek and Mingham Creek, it will not receive flows from any external or upstream catchments. Direct rainfall was applied to the hydraulic model grid so a one dimensional hydrologic model was not required to estimate any other inflows to the hydraulic model domain.

2.2 Coincident Flooding Scenarios

The Perry River Dam (PRD) impounds flows from an upstream catchment area of approximately 97 km². The travel length from the upstream catchment to the PRD headwall is approximately 18 km. Swindon Creek has a flow length of approximately 4.6 km to its junction with the Perry River. Due to this difference in travel length, and therefore time of concentration, it is anticipated that the peak flows from the upstream Perry River catchment would arrive at the confluence with Swindon Creek after the peak flows from Swindon Creek, Rawdon Creek and Twelve Mile Creek catchments.

If the same magnitude event in the local MRO catchment and the regional Perry River catchment were modelled, the combined magnitude of the modelled event would be greater than that in either the local or regional events for the reason stated above. It is good practice to assume that coincident flood scenarios apply in this case to avoid over design or over estimation of flood levels. Coincident flood event scenarios for the local MRO site and the Perry River catchments have been applied, as detailed in **TABLE 1**.

TABLE 1: COINCIDENT FLOODING SCENARIOS

MRO Site Rainfall Event	Perry River Rainfall Event
PMP	1 % AEP (1:100 AEP)
0.1 % AEP (1:1,000 AEP)	1 % AEP (1:100 AEP)
1 % AEP (1:100 AEP)	5 % AEP (1:20 AEP)

The input hydrology for the PMP, 1:1,000, 1:100 and 1:20 AEP events was developed in accordance with Australian Rainfall & Runoff guidelines [2]. The different methodologies used to estimate the hydrology are detailed in **Sections 2.3, 2.4 and 2.5**.

2.3 Probable Maximum Precipitation

The Probable Maximum Precipitation (PMP) for the site has been assessed in accordance with Australian Rainfall and Runoff (2019) [2]. The site is located in the generalised tropical storm coastal zone and therefore the Generalised Short Duration Method (GSDM) [3] was adopted for event durations between 0.25 hrs and 6 hrs.

The GSDM requires catchment factors to be applied to the initial rainfall depth to estimate the PMP for the site. The site specific values of the catchment factors utilised in deriving the PMP estimates are summarised in **TABLE 2**. A summary of the GSDM PMP calculations is provided in **Appendix A**.



TABLE 2: GSDM FACTORS FOR PMP ESTIMATE

Parameter	Value
Duration Limit	0.25 - 6 hours
Proportion Smooth	0.0
Proportion Rough*	1.0
Mean elevation at site (m AHD)	140
Elevation Adjustment Factor (EAF)	1.0
Moisture Adjustment Factor (MAF)	0.860

*Rough terrain is classified as that in which elevation changes of 50 m or more within horizontal distances of 400 m are common [1].

These factors were applied to generate the PMP depths for 0.25 hr to 6 hr durations, as shown on **DIAGRAM 3** and in **TABLE 3**.

DIAGRAM 3: PMP DEPTH ESTIMATE

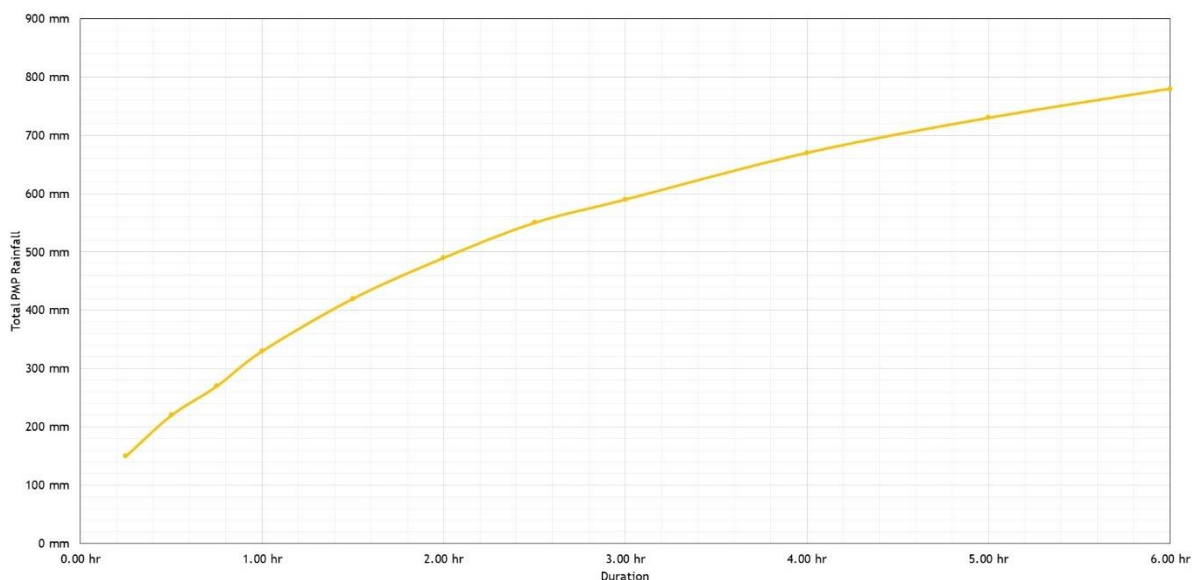




TABLE 3: PMP DEPTH ESTIMATE

Duration (hr)	Total Rainfall Depth (mm)
0.25	150
0.5	220
0.75	270
1.0	330
1.5	420
12.0	490
2.5	550
3.0	590
4.0	670
5.0	730
6.0	780

2.4 Rare Precipitation Estimation

Rare precipitation events are defined as events with an AEP equal to or greater than the 5% AEP event. Rainfall estimates for the 1% and 0.1% AEP storm events for the MRO site were obtained from the Bureau of Meteorology's 'Design Rainfall Data System' [4]. The rainfall depths for these events are summarised in **TABLE 4**.

**TABLE 4: RARE RAINFALL DEPTH ESTIMATES [4]**

Duration	Rainfall Depth (mm)		
	5% AEP	1% AEP	0.1% AEP
1 min	5.1	6.59	9.44
2 min	8.76	11.4	16.5
3 min	12.3	16	23
4 min	15.5	20.1	28.9
5 min	18.5	23.9	34.3
10 min	30.2	39	55.7
15 min	38.6	49.8	71.2
20 min	45	58.1	83.2
25 min	50.2	64.9	93
30 min	54.4	70.6	101
45 min	64.1	83.7	120
1 hour	71	93.3	134
1.5 hour	80.8	107	154
2 hour	88	118	169
3 hour	98.7	134	191
4.5 hour	111	151	216
6 hour	120	165	236
9 hour	136	188	268
12 hour	149	207	295
18 hour	170	238	339
24 hour	187	262	376
30 hour	202	283	411
36 hour	215	300	440
48 hour	236	329	483
72 hour	264	367	535
96 hour	282	390	562
120 hour	291	402	576
144 hour	295	408	582
168 hour	295	409	582

Each duration event is further divided into an ensemble of ten temporal patterns (TP), as detailed in the Australian Rainfall and Runoff (ARR) Datahub [2]. The variations in the temporal patterns account for rainfall patterns not being uniform for their duration, with periods of more intense and less intense rainfall occurring within a single rainfall event. Rainfall hyetograph estimates from **TABLE 3** and **TABLE 4** were applied directly to the hydraulic model as rain on grid. This is discussed further in **Section 3.2**.



2.5 Regional Flood Frequency Estimate

The Regional Flood Frequency Estimator (RFFE) utilises the data from 853 gauged catchments across Australia and utilises Log Pearson Type 3 distributions to estimate flows based on records in similar catchments. It is understood that the RFFE provides a less accurate estimation of peak discharge in a watercourse than would be obtained from the development of a hydrologic model. In this case, the estimates of peak discharge in the Perry River were used to investigate whether the river had any backwater impacts on the local discharges from the MRO site rather than for modelling of the Perry River. To represent the impact and risk of coincident flooding from the Perry River, flood discharge estimates were included in the hydraulic model as inflows at the upstream boundary in the TUFLOW hydraulic model. [5]. The estimates were made at the location immediately upstream of the confluence with Swindon Creek, indicated as Catchment Outlet on **DIAGRAM 4**.

In the absence of LiDAR data for the wider area external to the MRO site, the upstream catchment area and characteristics for the Perry River were derived from 30 m gridded SRTM data [6].

Due to the distance from the MRO site to the Perry River, it was considered there would be little impact on the site. This was tested by using the mean discharge and 95th percentile flow estimates. It was observed there was no impact to the MRO site from flooding in the Perry River.

The peak flow estimates for the Perry River are summarised in **TABLE 5**.

TABLE 5: RFFE RESULT SUMMARY – PERRY RIVER

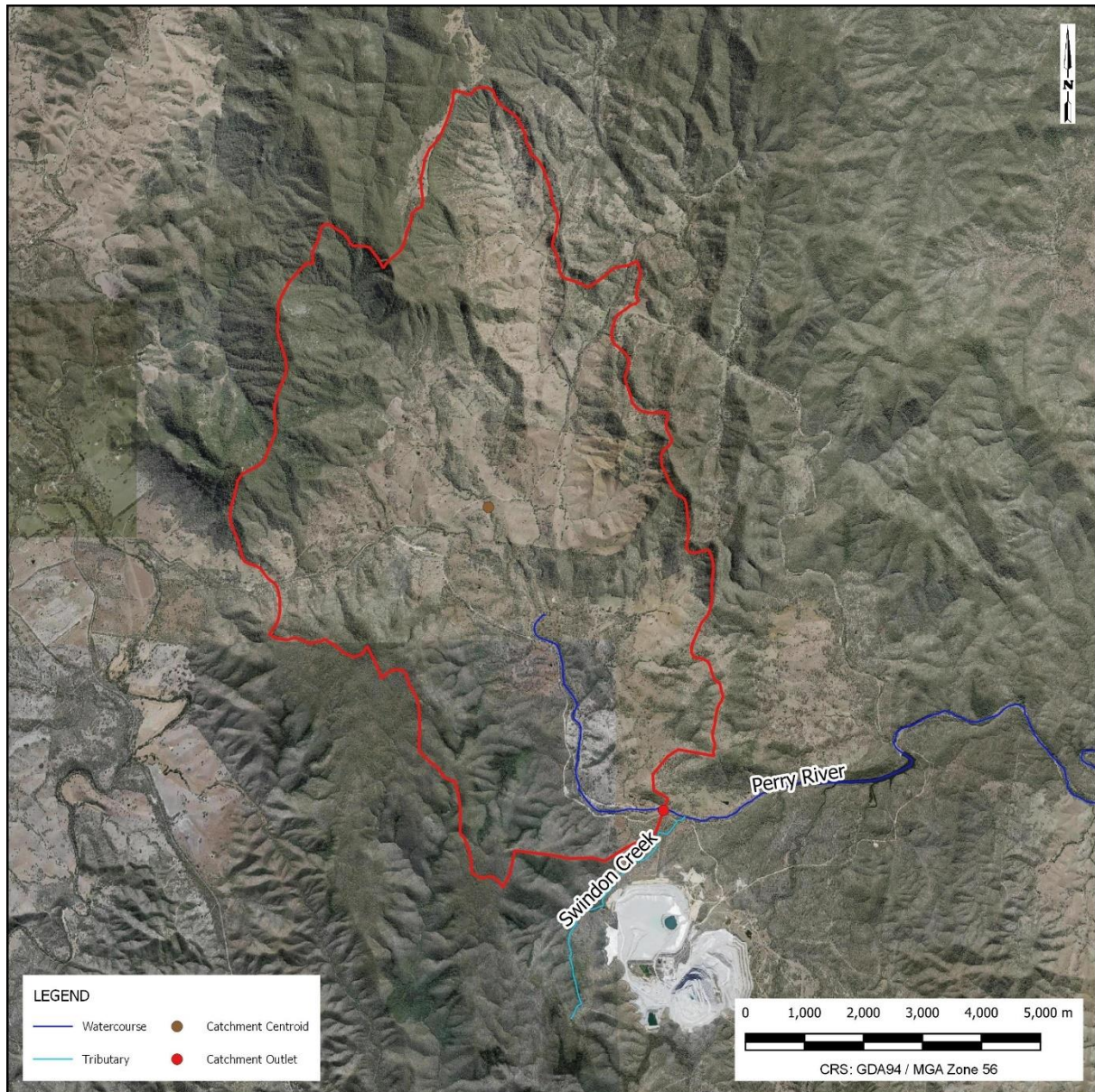
AEP (%)	Mean Discharge (m ³ /s)
50	41.3
20	105
10	172
5	261
2	421
1	581

The RFFE estimates peak flows only and does not generate or estimate flow hydrographs. While generally considered to be a validation tool, as mentioned above, the RFFE estimate was adopted to calculate the extent of impacts to the MRO site due to the presence of the impounded lake behind the Perry River Dam and the potential interaction on the flow regimes of Swindon Creek, Rawdon Creek and Twelve Mile Creek. As such, the application of the peak discharge in the Perry River as a steady state condition was considered conservative and appropriate for the required purpose.

The catchment boundary, outlet location and centroid location for the Perry River upstream of Swindon Creek are shown on **DIAGRAM 4**.



DIAGRAM 4: PERRY RIVER CATCHMENT





3 HYDRAULIC ASSESSMENT

3.1 Model Overview

Hydraulic analysis of the study area has been undertaken using the two dimensional (2D) finite difference program TUFLOW, which is an industry accepted software package highly suited to the investigation of flood behaviour in complex flow scenarios. The model can simulate unsteady hydrodynamic flow in two dimensions on a rectilinear grid, as well as a one-dimensional unsteady hydrodynamic flow through waterway structures, such as culverts. The model is based on a robust finite difference solution scheme that is able to compute both sub-critical and supercritical flow regimes. The selected hydraulic solver for the 2D model was the HPC scheme.

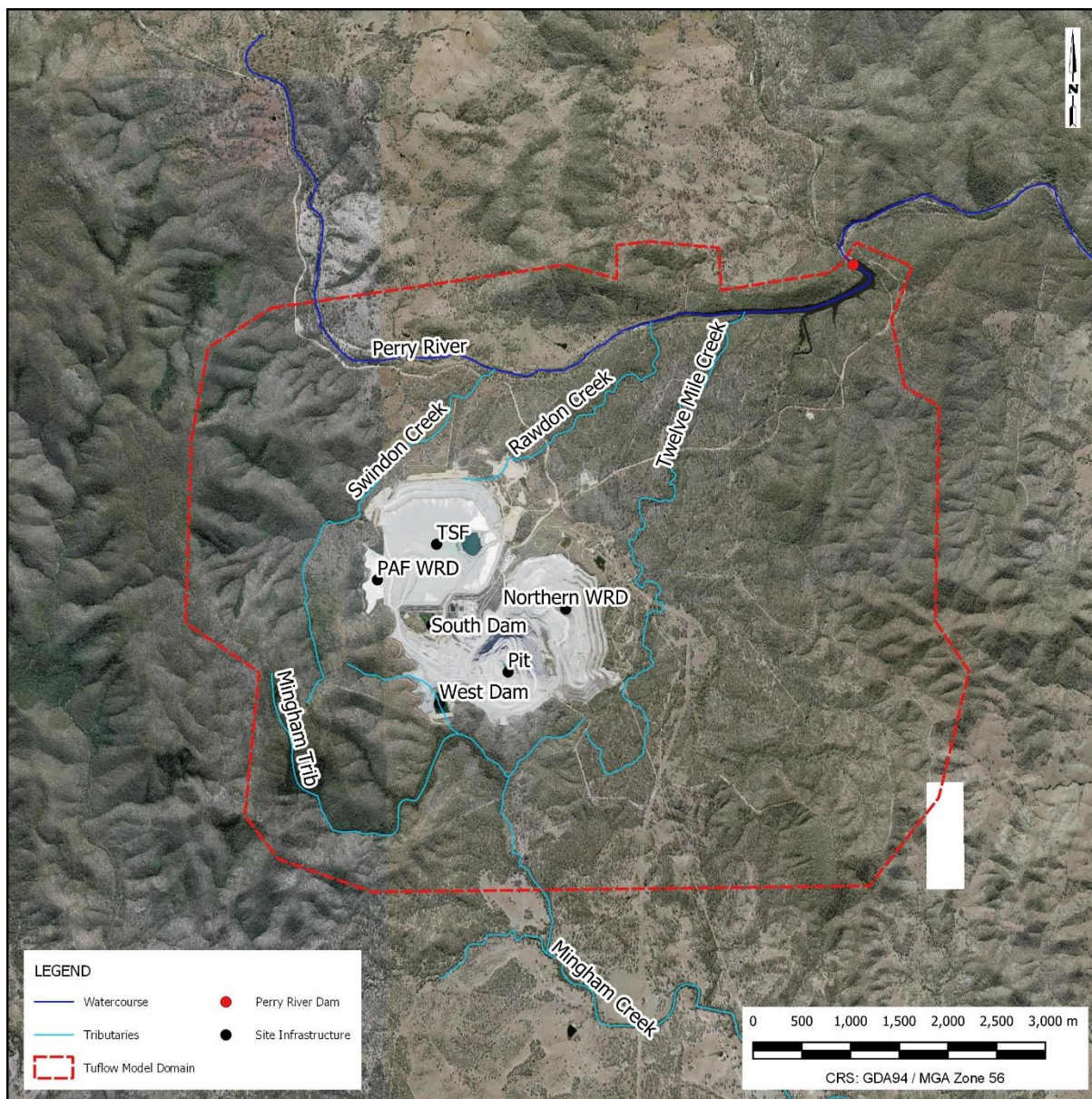
3.2 Model Domain

The TUFLOW model was set up to quantify the impacts of the PMP, 0.1% AEP and 1% AEP design storms. The model domain is depicted on **DIAGRAM 5** and includes the following structures and areas that will remain in the post-closure conditions.

- TSF (Post closure surface and spillway)
- Pit (including a 2 m abandonment bund around the crest)
- Northern WRD and the potentially acid forming (PAF) WRD
- South Dam and West Dam

In conjunction with the site extents, the model domain includes Swindon Creek, Rawdon Creek and Twelve Mile Creek, which all flow north towards the Perry River, as well as Mingham Creek, which flows south towards the Burnett River.

DIAGRAM 5: TUFLOW MODEL DOMAIN



3.3 Digital Elevation Model

3.3.1 Base Topography

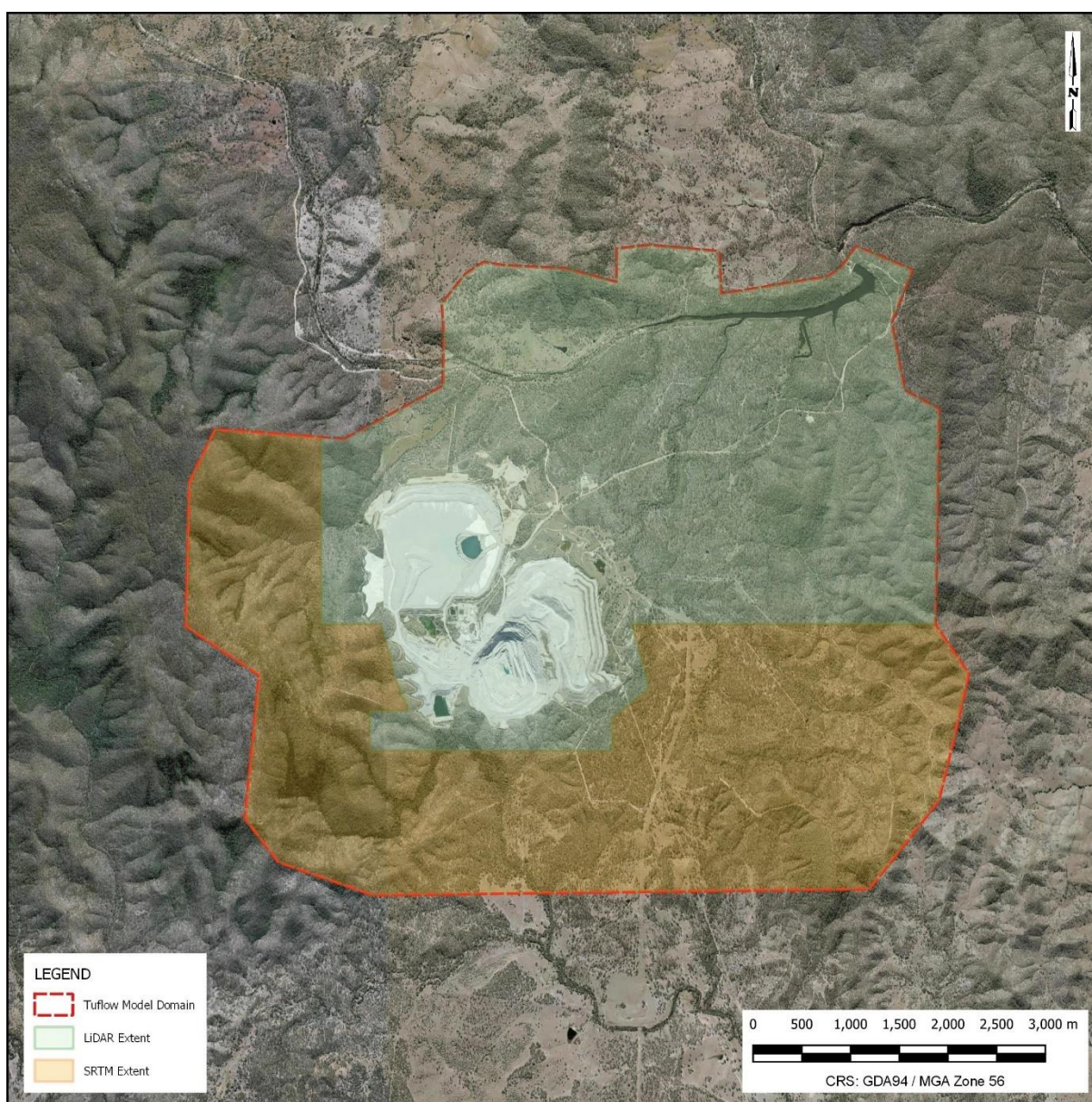
The topographical base for the TUFLOW model was developed from a series of regional survey and site specific LiDAR datasets. The site survey datasets were resampled into Digital Elevation Models (DEMs). The following datasets were input into the topographical model.

- Hydro Enforced 1 Second DEM [6]
- Perry River Dam Grid [7]
- Site Survey 1 March 2021 [8]
- Site Survey 7 March 2021 [9]
- Site Survey 10 February 2021 [10]
- Site Survey 23 February 2021 [11]

- Site Survey October 2020 [12]
- Site Survey 13 March 2018 [13]

The quality of the LiDAR datasets is substantially higher than that of the SRTM dataset. Consequently, the DEM area based on SRTM topography will create ‘modelling noise’ in the modelled depths and velocities. The inclusion of SRTM data in the model was to allow for the runoff from upstream areas of Swindon Creek and Mingham Creek to be incorporated into the model. With the exception of the results reported in Mingham Creek, all detailed assessments on the MRO site and its downstream areas were based upon LiDAR topographic data. The extents of the LiDAR and SRTM datasets within the modelling domain are depicted on **DIAGRAM 6**.

DIAGRAM 6: LIDAR AND SRTM DATA EXTENTS



In addition to the base LiDAR and SRTM datasets, the following topographic elements were included to represent the post closure site conditions at the concept stage.

- The TSF embankment was raised to a crest level of 198 m AHD at the western extents, rising to 211 m AHD at the eastern extents to represent the conceptual closure conditions of the embankment.

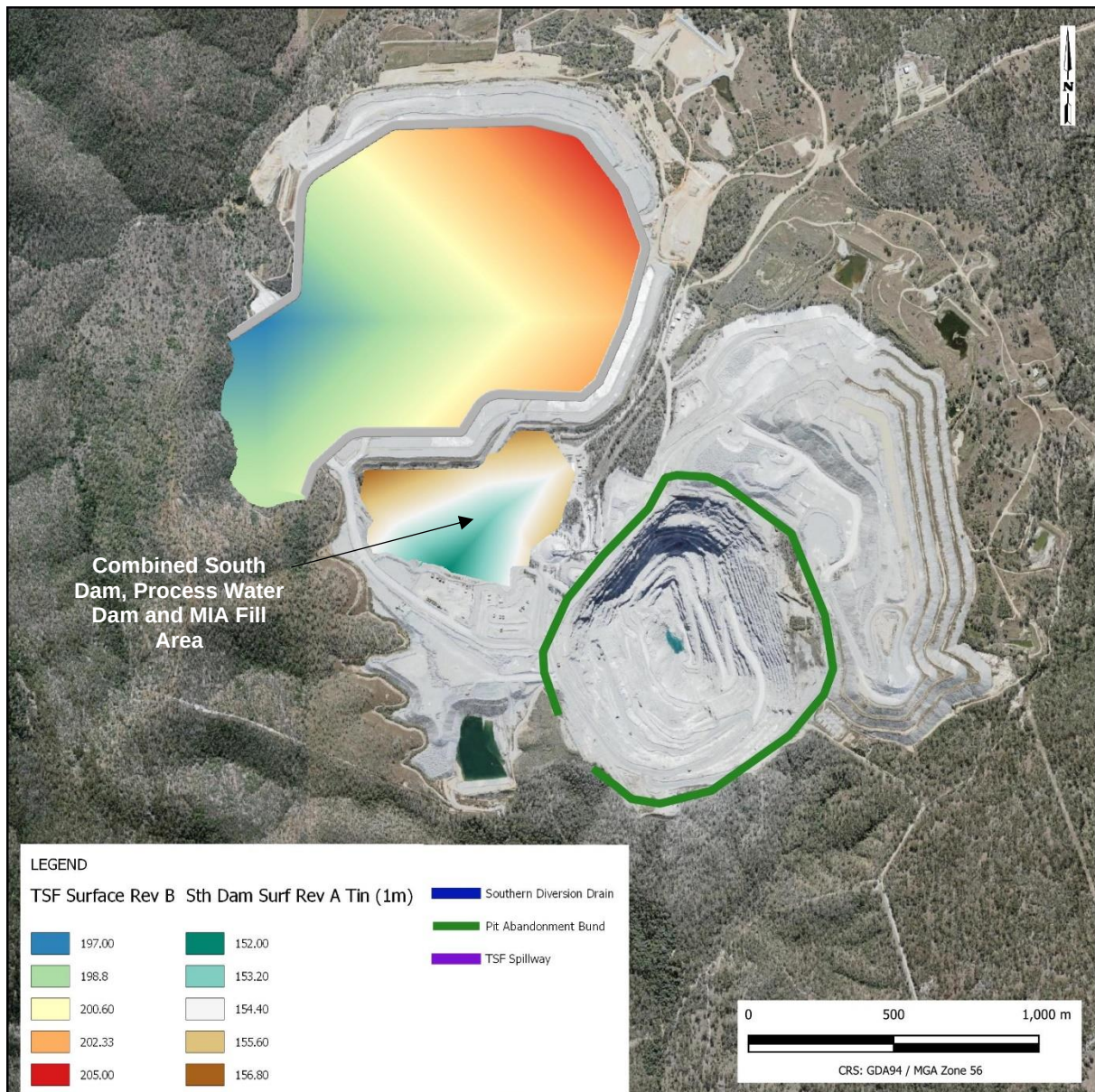


- The TSF closure surface incorporated a 0.5% shedding profile to the closure spillway at its western extent. The eastern elevation is at approximately 206.0 m AHD, falling to 197 m AHD at the spillway location.
- The TSF Closure Spillway arrangement, located at the western edge of the TSF, is discussed in **Section 3.3.3**.
- The combined area of the South Dam, Process Water Dam and the mine infrastructure area (MIA) will be filled with NAF rock to a minimum level of 152 m AHD to allow flows to discharge south towards the West Dam.
- A Pit Abandonment Bund, at least 2 m high, surrounding the Pit.
- A Southern Diversion Drain conveying flows from the South Dam filled area to the West Dam.

Closure capping surface alignments of the WRDs have not been incorporated in the hydraulic model at this stage in the design process.

The locations of the TSF Embankment, TSF Closure Surface, TSF Closure Spillway, South Dam Fill Area, Pit Abandonment Bund and South Diversion Drain are shown on **DIAGRAM 7**.

DIAGRAM 7: POST CLOSURE FEATURES



The sizing and geometric parameters of these features are detailed in the sub-sections below.

3.3.2 TSF Closure Surface

The levels of the conceptual closure surface for the TSF were based on the TSF embankment being raised to 198 m AHD at the location of the spillway, with the surface starting at 197 m AHD, increasing to 206 m AHD at the eastern TSF extents. This surface incorporated a 0.5% longitudinal grade draining towards the east, in conjunction with a 0.5% longitudinal surface from the north and south embankments towards the centre. This is depicted on **DIAGRAM 7**. In addition to the TSF Surface, a bund is to be constructed on the western edge of the TSF to direct all runoff towards the spillway. This bund is to be constructed to a minimum elevation of 200 m AHD.

3.3.3 TSF Closure Spillway

The TSF closure spillway has been sized to convey PMP flows. It is proposed to incorporate a spillway on the western embankment based on the details listed in **TABLE 6**.



TABLE 6: TSF CLOSURE SPILLWAY DETAILS

Parameter	Value
Upstream Invert Level	197.0 m AHD
Downstream Invert Level	196.65 m AHD
Base Width	50.0 m
Side Slopes	1 (V) :1 (H)
Length	35 m
Depth at Upstream Face	1 m
Longitudinal Grade	1 %

3.3.4 Pit Abandonment Bund

The Pit Abandonment Bund has been sized with the parameters listed in **TABLE 7**. The conceptual bund has been designed in accordance with DIR (1997) [14], and was sized to prevent unintentional access of the abandoned pit void by humans.

TABLE 7: PIT ABNDONMENT BUND DETAILS

Parameter	Value
Crest Width	5 m
Minimum Height	2 m
Batter Slopes	1 (V) :2 (H)

3.3.5 South Dam Fill Area

The area that is currently occupied by the South Dam, Process Water Dam and MIA is to be filled and shaped so that any surface runoff will drain south towards the Southern Diversion Drain and West Dam. The minimum fill levels are listed in **TABLE 8**.

TABLE 8: SOUTH DAM FILL AREA

Parameter	Value
Minimum Upstream Fill Level	154.74 m AHD
Minimum Downstream Fill Level	152.0 m AHD
Longitudinal Grade	0.5%

3.3.6 Southern Diversion Drain

The Southern Diversion Drain has been sized to convey PMP flows from the South Dam Fill Area to the West Dam. The diversion drain is to be constructed through the existing formation between the South Dam and West Dam. It is proposed to construct the diversion drain based on the details listed in **TABLE 9**.



TABLE 9: SOUTHERN DIVERSION DRAIN DETAILS

Parameter	Value
Upstream Invert Level	152.0 m AHD
Downstream Invert Level	147.5 m AHD
Base Width	10 m
Side Slopes	1 (V) : 2 (H)
Length	450 m
Longitudinal Grade	1 %

3.4 Grid Size Selection and Time Step

The choice of grid cell size is important to ensure that the final solution converges with accuracy whilst saving simulation time. This is done by running the model with a number of grid cell sizes and selecting the largest cell size that provides results that match the smaller grid sizes. In this project, the TUFLOW hydraulic model was run to assess the sensitivity to grid size on water surface elevations for four different grid sizes:

- 20 m x 20 m (20 m grid);
- 15 m x 15 m (15 m grid);
- 10 m x 10 m (10 m grid); and
- 5 m x 5 m (5 m grid).

Based upon the results of the model runs, it was determined that that 15 m grid size was most appropriate. A full discussion of the grid size selection is included in **Appendix B**. Based upon the grid size of 15 m, an initial time step of 7.5 seconds was selected.

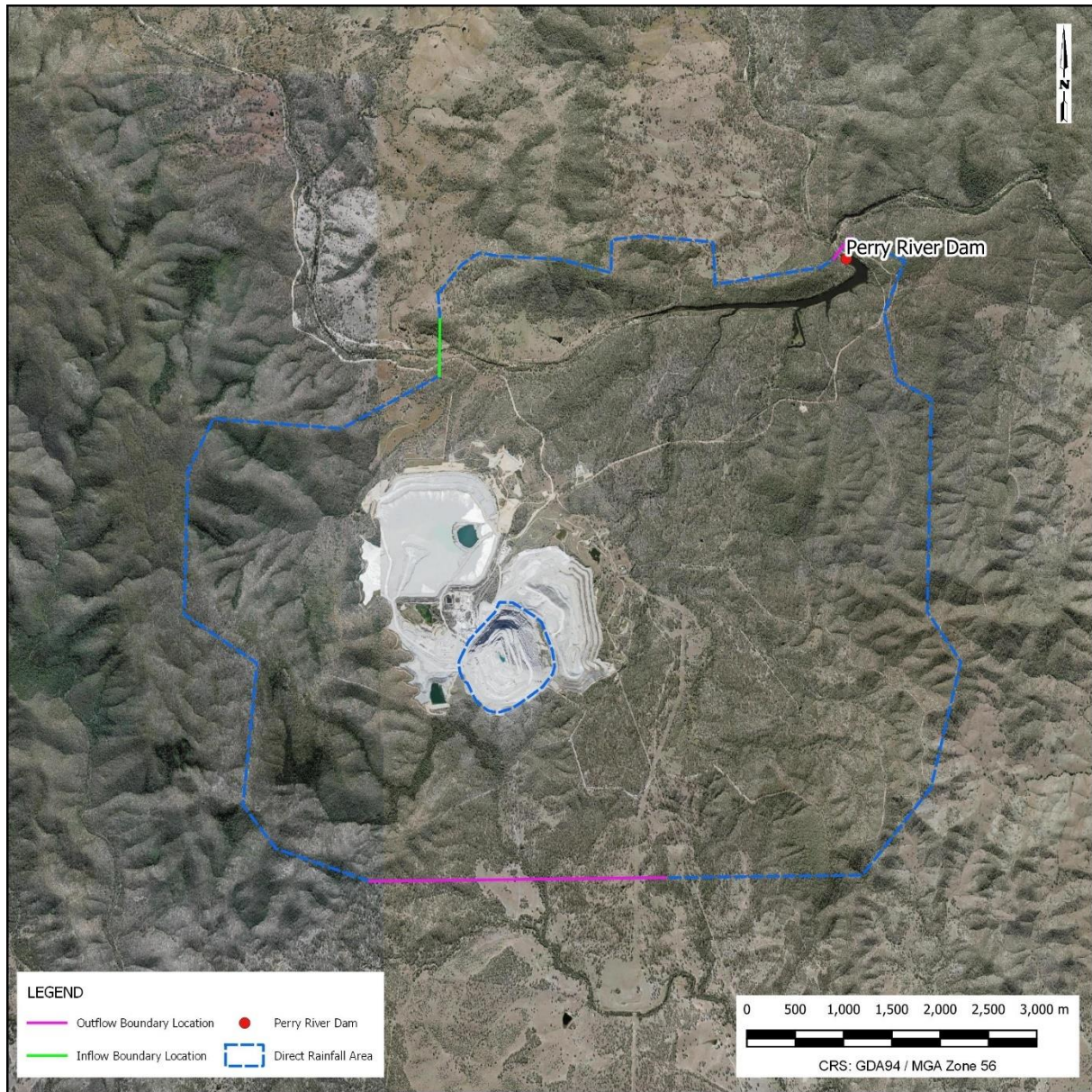
3.5 Boundary Conditions

As detailed in **Section 2.5**, RFFE flows form the upstream inflow boundary for the Perry River in the model domain. The location of upstream flow is depicted on **DIAGRAM 8** and the steady state flows are provided in **TABLE 10**. To allow the full steady state flow conditions to develop in the Perry River before the storm flows from the MRO occurred, a lag time was applied to the direct rainfall over the model domain. The lag time applied to the application of the direct rainfall was 3 hours.

The perimeter of the model had a boundary condition applied to allow rainfall to exit the model. This was done to ensure the model does not allow for the ponding of water at the model's edges. This boundary is not shown on **DIAGRAM 8** for clarity. Boundary conditions at the outflow locations on the Perry River (downstream of the Perry River Dam) and Mingham Creek assumed a normal depth based on bed slopes of 1.2% and 2% respectively.



DIAGRAM 8: BOUNDARY LOCATIONS



**TABLE 10: BOUNDARY CONDITIONS**

MRO Site Rainfall Event	Perry River RFFE Event	Perry River RFFE Estimate (m ³ /s)
PMP	1 % AEP Mean Flow	581
0.1 % AEP	1 % AEP Mean Flow	581
0.1 % AEP Sensitivity	1% AEP 95 th Percentile Flow	2320
1 % AEP	5% AEP Mean Flow	261

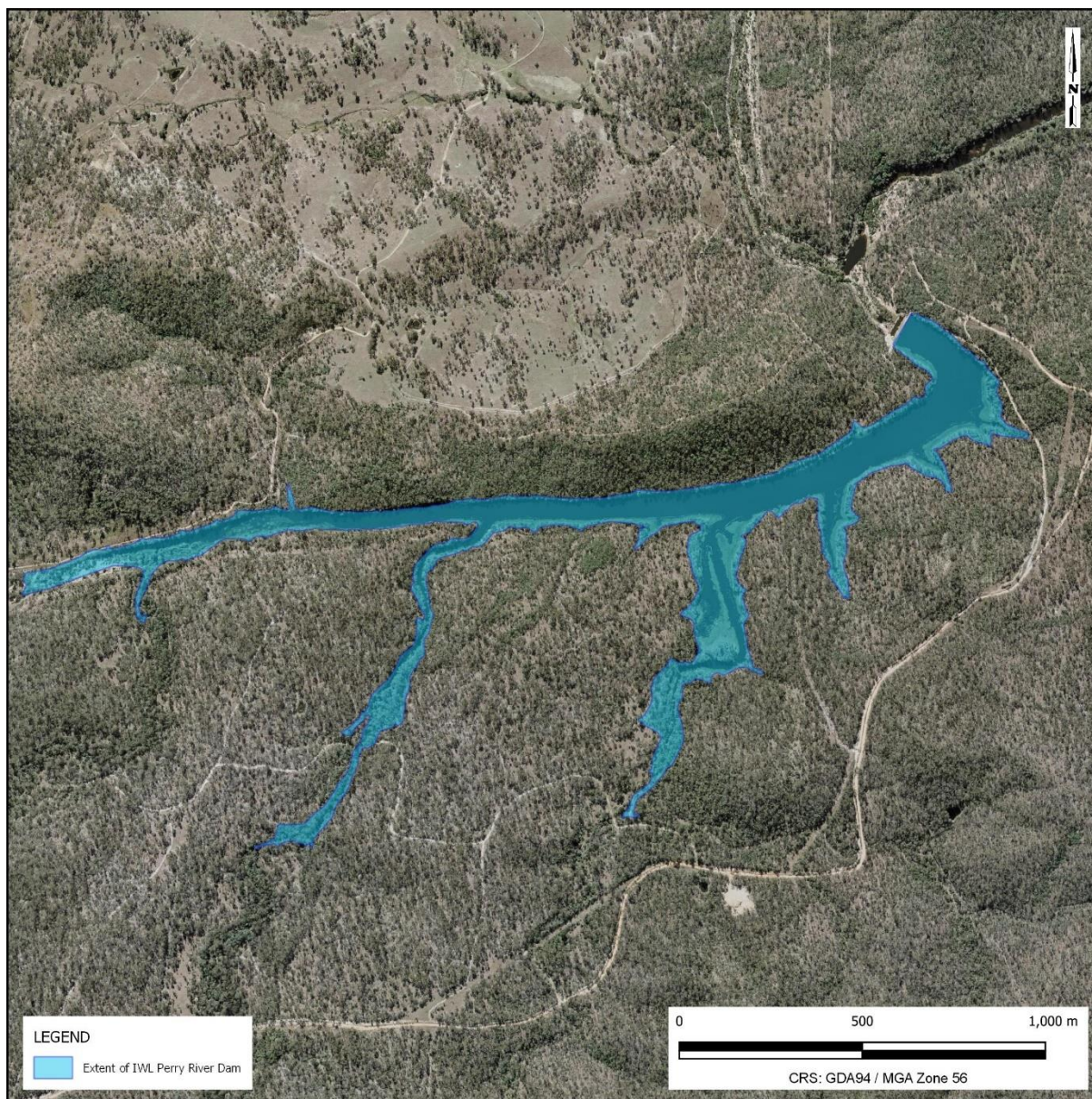
In addition to the model boundaries, the dams that are to be retained on site, in conjunction with the Perry River Dam, were set to full supply level so that any inflows to the dam from the upstream catchment would result in the dam spilling. This was based on the conservative assumption that there will have been wet weather preceding the design storm events so that the dams would already be full. The Perry River Dam has a full supply level (FSL) of 98.0 m AHD, which extends up the Twelve Mile Creek and Rawdon Creek tributaries. As such, it has been assumed that any flows entering the dam do not activate friction at the creek bed, but flow across upper layers of water in the dam. The Perry River Dam does not have an emergency spillway; the embankment crest of the dam forms a broad crested weir configuration for the spillway.

The adopted initial water levels (IWLs) are detailed in **TABLE 11**. The extents of the adopted IWL in the Perry River Dam is depicted on **DIAGRAM 9**.

TABLE 11: DAM INITIAL WATER LEVELS

Site Rainfall Event	Initial Water Level (m AHD)
Perry River Dam	98.0
Sediment Dam 3 (SD3)	119.1
WD 1	126.7
WD 2	120.0
WD 3	125.1
WD 4	134.4
West Dam	123.8

DIAGRAM 9: PERRY RIVER DAM INITAIL WATER LEVEL EXTENTS



3.6 Surface Roughness

The Manning's 'n' surface roughness coefficient was used to describe the surface conditions within the model domain. Manning's 'n' roughness coefficients were assigned to the model domain based on land use type and characteristics, as depicted on **DIAGRAM 10**. Selection of the coefficient values was made considering the apparent roughness of surfaces based upon inspection of available aerial imagery and assumption of the proposed surface conditions post closure. The reference values detailed in Innovyze (2019) [15] were utilised to represent natural channels and post closure site conditions. The main flow regime in a direct rainfall model is overland flow, which results in higher Manning's 'n' values than in river channels and floodplains. A default surface roughness of $n = 0.4$ was adopted for non-mine impacted areas. A description of each adopted Manning's 'n' coefficients is provided in **TABLE 12**.

DIAGRAM 10: MANNINGS ROUGHNESS

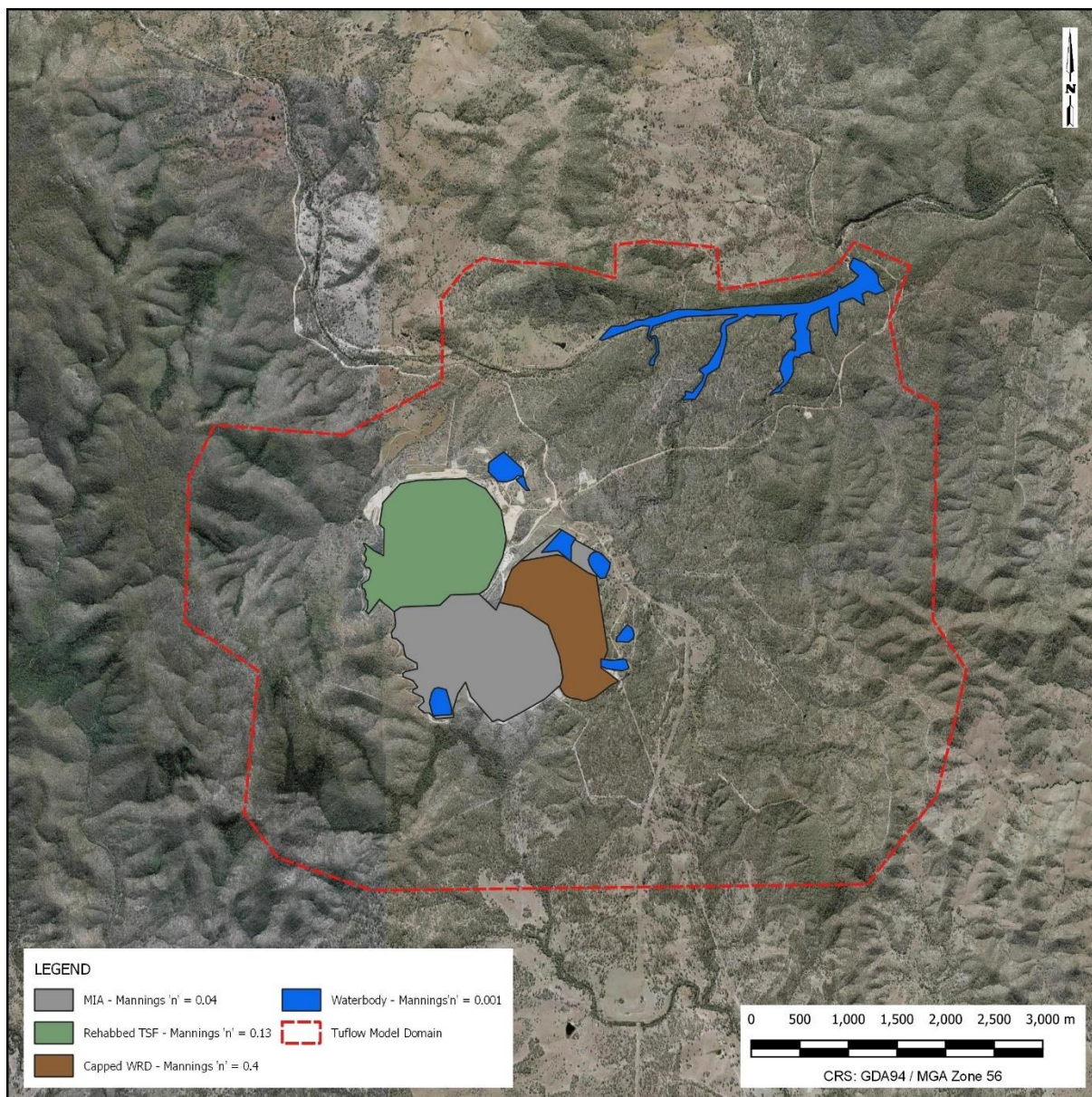


TABLE 12: MANNINGS 'n' ROUGHNESS COEFFICIENT

Mannings 'n' coefficient	Description
0.001	Still water/dams
0.04	Areas of sparse vegetation, with exposed rocky surfaces
0.13	Areas of short to medium grasses and short scrubby vegetation
0.40	Light underbrush of grasses and vegetation. Tall canopy above.



3.7 Sensitivity Analysis

A sensitivity analysis was undertaken for the TSF closure conditions to understand the model's response to changes in values of key parameters, such as changes in rainfall estimates and surface roughness. This provides an improved understanding of the potential impacts in the uncertainties in estimation of these parameters. The following sensitivity scenarios were assessed:

- A $\pm 20\%$ change in rainfall depths to account for the uncertainty in the estimated rainfall and those associated with climate change impacting extreme rainfall events.
- A $\pm 20\%$ change in assumed Manning's 'n' roughness coefficients. In general, higher roughness coefficients reduce flow velocities and therefore increase modelled flood depths. Lower roughness coefficients have a converse effect.



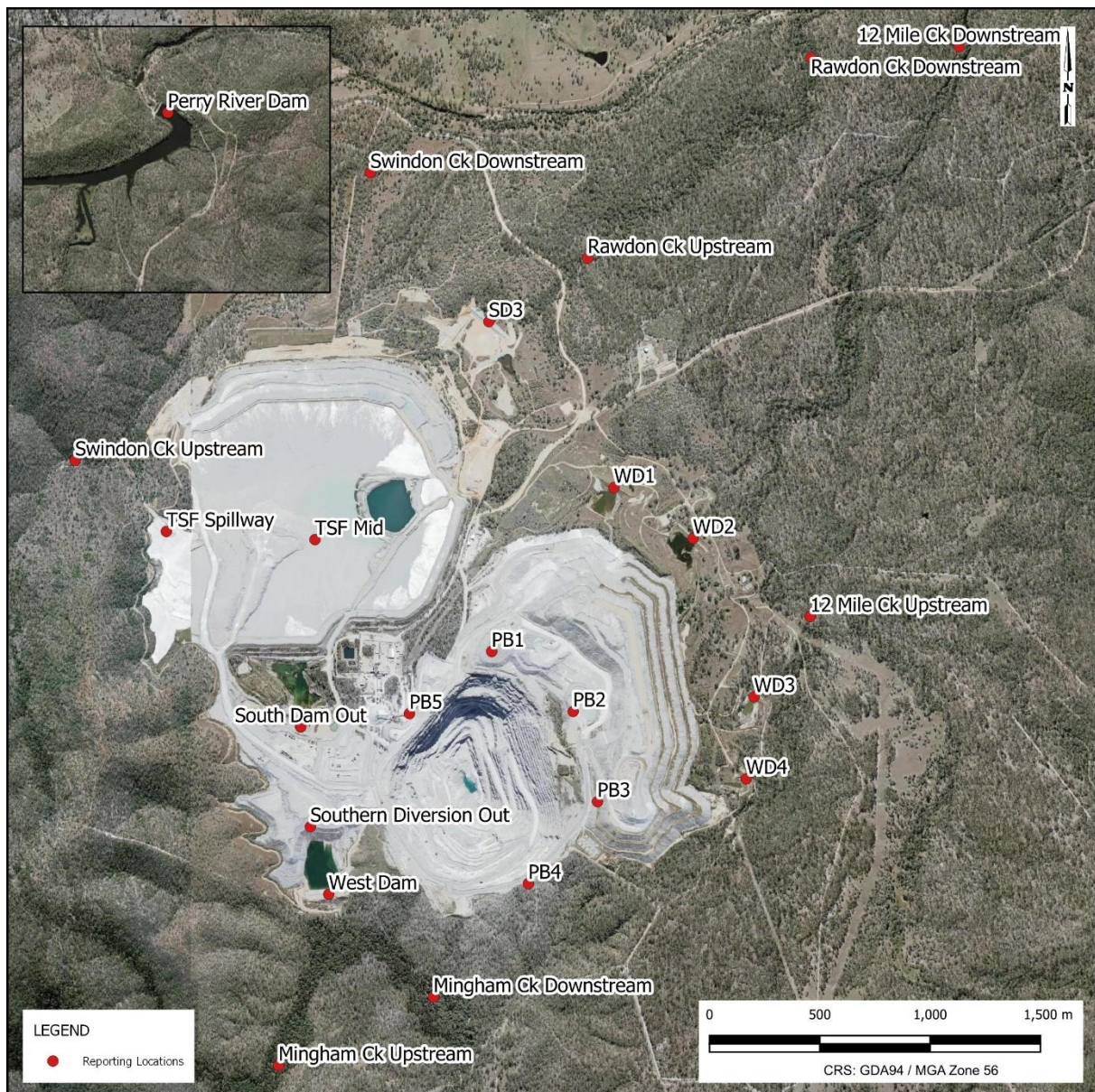
4 RESULTS

4.1 Introduction

The results of the TUFLOW model showing maximum water depths and velocities are shown on **Figure 001 to Figure 006**.

A summary of the results of flooding on the post closure conditions of the TSF, West Dam, South Dam Fill Area, Southern Diversion Drain, Pit Bund, Perry River Dam, retained dams on site and the downstream tributaries are summarised below. The locations at which results are reported are depicted on **DIAGRAM 11**.

DIAGRAM 11: RESULTS REPORTING LOCATIONS





4.2 TSF

The maximum recorded flow rates, depths and velocities in the TSF spillway and in the middle of the TSF closure surface are summarised in **TABLE 13**. PMF flood depths are depicted on **DIAGRAM 11** and on **Figure 001**. Upon discharging from the TSF, flows enter Swindon Creek. The PMF rainfall event produces the highest water surface elevation, peak flow rate and peak velocity in the TSF. As rainfall depth decreases in conjunction with the decreasing extremity of the storm event (0.1% AEP and 1% AEP), the modelled depths, flow rates and velocities also decrease, as expected.

The results also indicate that there is a fall in water surface elevation across the TSF closure surface. The maximum velocities across the TSF closure surface are less than 0.6 m/s, so erosion of emerging vegetation is unlikely to occur in extreme rainfall events.

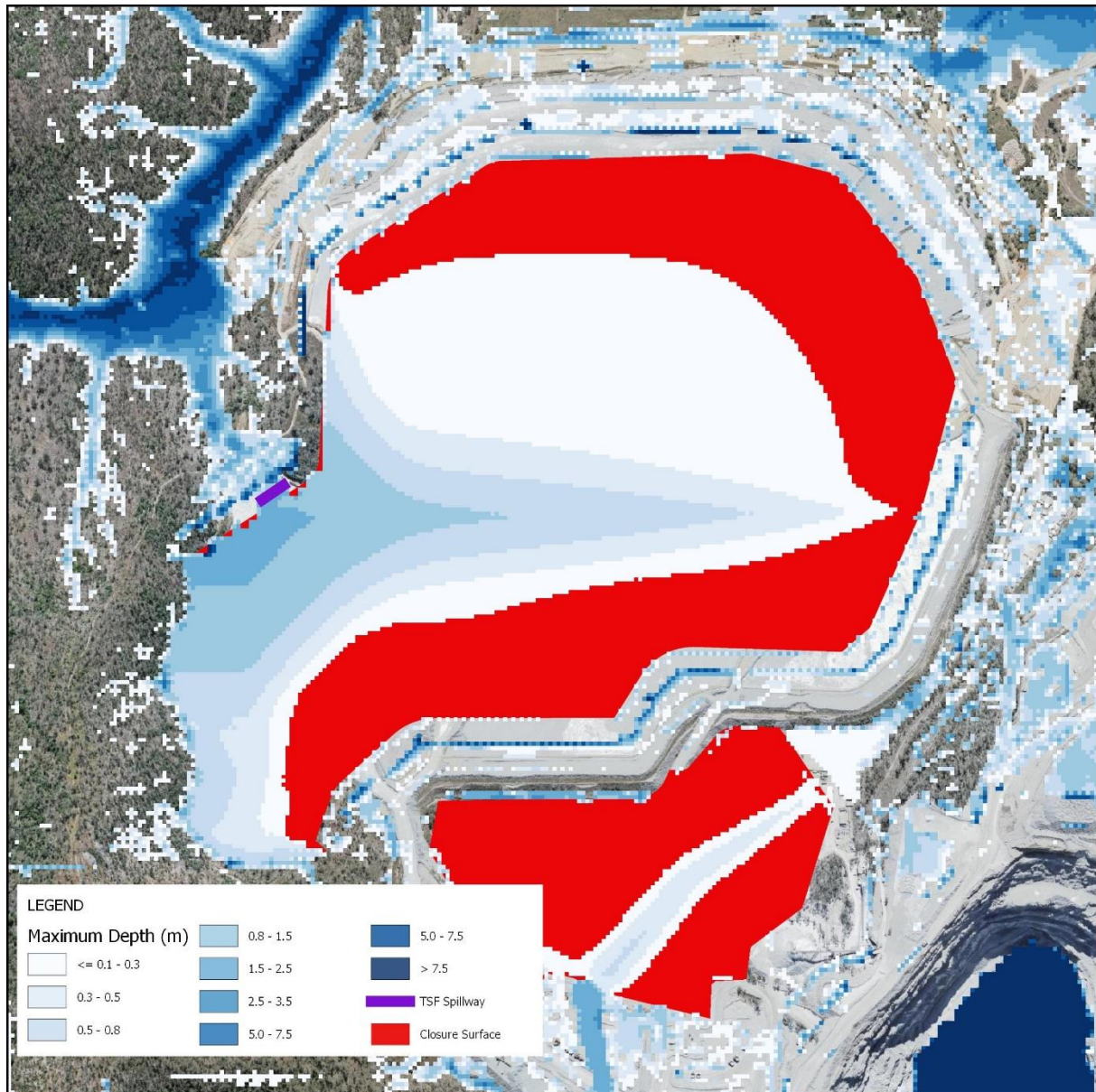
TABLE 13: TSF RESULTS

Location	Parameter	PMF	0.1% AEP	1% AEP
TSF Spillway	Peak Flow Rate (m ³ /s)	99.9	24.6	17.2
	TSF Embankment Level (m AHD)	200.0	200.0	200.0
	Spillway Elevation (m AHD)	197.0	197.0	197.0
	Spillway Maximum Water Surface Elevation (m AHD)	199.04	198.21	198.05
	Spillway Maximum Flood Depth (m)	2.04	1.21	1.05
	Spillway Flow Velocity (m/s)	0.9	0.5	0.5
	Critical Storm Duration and Temporal Pattern	90 min	360 min TP07	360 min TP07
TSF Mid	TSF Surface Maximum Water Surface Elevation (m AHD)	201.25	200.92	200.87
	TSF Surface Maximum Flood Depth (m)	0.65	0.32	0.27
	TSF Surface Flow Velocity (m/s)	0.4	0.3	0.2
	Critical Storm Duration and Temporal Pattern	60 min	360 min TP07	360 min TP07

As can be seen the above, the PMF rainfall event produces the highest water surface elevation, peak flow rate and peak velocity. As the applied rainfall depth decreases in conjunction with the reduced storm risk (0.1% AEP and 1% AEP), the modelled depths, flow rates and velocities also decrease, as expected.

There is a fall in water surface elevation across the TSF closure surface. The maximum velocities across the TSF closure surface are less than 0.6 m/s in the PMF storm event and less than 0.3 m/s in the 1% AEP design storm event, so erosion of emerging vegetation is unlikely to occur in extreme rainfall events. The peak velocities in are shown on **Figures 002, 004 and 006**.

DIAGRAM 12: TSF SPILLWAY PMF MAXIMUM FLOOD DEPTH RESULTS



4.3 West Dam

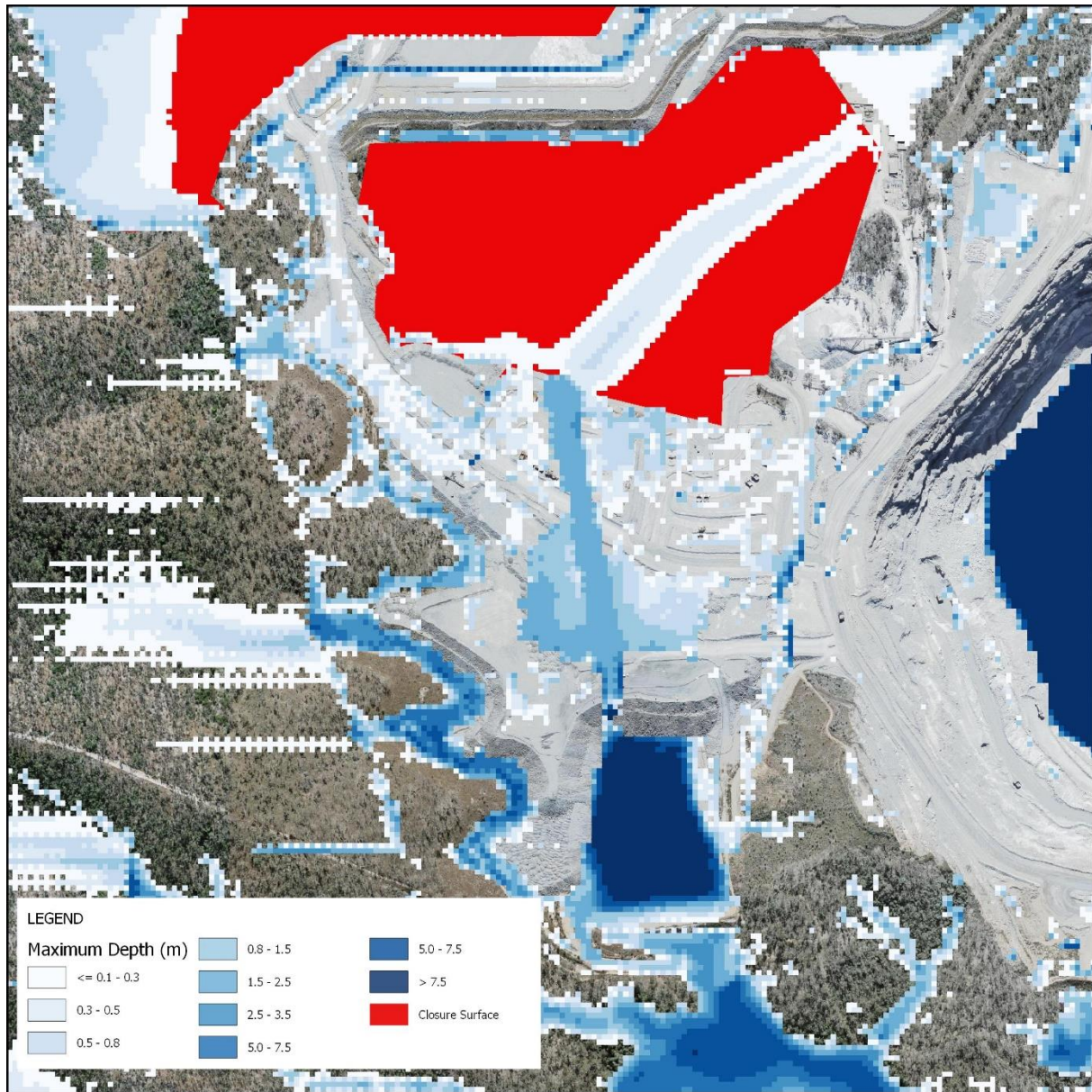
The maximum recorded flow rates, water surface elevations and velocities over the West Dam embankment are summarised in **TABLE 14**. PMF flood depths are depicted on **DIAGRAM 13**.



TABLE 14: WEST DAM RESULTS

	PMF	0.1% AEP	1% AEP
Peak Flow Rate (m ³ /s)	120.1	27.6	18.0
Embankment Crest Level (m AHD)	123.80	123.80	123.80
Maximum Water Surface Elevation (m AHD)	124.41	123.93	123.83
Maximum Flood Depth over embankment (m)	0.61	0.13	0.03
Maximum Velocity over embankment (m/s)	3.1	2.0	0.9
Critical Storm Duration and Temporal Pattern	90 min	360 min TP07	360 min TP07

**DIAGRAM 13: WEST DAM, SOUTH DAM AREA AND SOUTHERN DIVERION DRAIN PMF
MAXIMUM FLOOD DEPTH RESULTS**



As can be seen in **TABLE 14**, the PMF rainfall event produces the largest flood depth and velocity over the West Dam embankment. As rainfall depth decreases in conjunction with the return period (0.1% AEP and 1% AEP), the modelled depths and velocities also decrease, as expected.



4.4 South Dam Fill Area Dam

The maximum recorded flow rates, water surface elevations and velocities at the downstream location of the South Dam Fill Area are summarised in **TABLE 15**. PMF flood depths are depicted on **DIAGRAM 13**.

TABLE 15: SOUTH DAM FILL AREA RESULTS

	PMF	0.1% AEP	1% AEP
Peak Flow Rate (m ³ /s)	51.4	7.1	4.7
Fill Area Elevation at South Dam Out (m AHD)	152.0	152.0	152.0
Maximum Water Surface Elevation at South Dam Out (m AHD)	152.68	152.40	152.36
Maximum Flood Depth (m)	0.68	0.40	0.36
Maximum Velocity (m/s)	1.5	0.8	0.7
Critical Storm Duration and Temporal Pattern	60 min	270 min TP04	270 min TP04

As can be seen the above, the PMF rainfall event produces the highest water depth and velocity at the downstream end of the South Dam Fill Area. As rainfall depth decreases in conjunction with the return period (0.1% AEP and 1% AEP), the modelled depths and velocities also decrease, as expected.

4.5 Southern Diversion Drain

The maximum recorded flow rates, water surface elevations and velocities at the outlet of the Southern Diversion Drain are summarised in **TABLE 16**. PMF flood depths are depicted on **DIAGRAM 13**.

TABLE 16: SOUTHERN DIVERSION DRAIN RESULTS

	PMF	0.1% AEP	1% AEP
Peak Flow Rate (m ³ /s)	70.9	10.1	6.6
Diversion Drain Outlet Level (m AHD)	150.0	150.0	150.0
Diversion Drain Crest Level at Outlet (m AHD)	154.3	154.3	154.3
Maximum Water Surface Elevation at Outlet (m AHD)	152.21	150.58	150.47
Maximum Flood Depth at Outlet (m)	2.21	0.58	0.47
Maximum Velocity at Outlet (m/s)	1.1	0.6	0.6
Critical Storm Duration and Temporal Pattern	90 min	270 min TP04	270 min TP04

4.6 Pit Bund

The maximum recorded water surface elevations adjacent to the Pit Bund at locations PB1, PB2, PB3, PB4 and PB5 are summarised in **TABLE 17**. The locations of the reference points are provided on **DIAGRAM 11**.

**TABLE 17: PIT BUND RESULTS**

Location	Parameter	PMF	0.1% AEP	1% AEP
PB1	Ground Elevation Level (m AHD)	184.22	184.22	184.22
	Maximum Water Surface Elevation (m AHD)	184.89	184.39	184.24
	Bund Elevation (m AHD)	186.22	186.22	186.22
	Freeboard (m)	1.33	1.83	1.98
	Critical Storm Duration and Temporal Pattern	120 min	20 min TP02	20 min TP02
PB2	Ground Elevation Level (m AHD)	210.84	210.84	210.84
	Maximum Water Surface Elevation (m AHD)	211.02	210.98	210.96
	Bund Elevation (m AHD)	212.84	212.84	212.84
	Freeboard (m)	1.82	1.86	1.88
	Critical Storm Duration and Temporal Pattern	120 min	25 min TP02	25 min TP02
PB3	Ground Elevation Level (m AHD)	202.95	202.95	202.95
	Maximum Water Surface Elevation (m AHD)	203.92	203.42	202.99
	Bund Elevation (m AHD)	204.95	204.95	204.95
	Freeboard (m)	1.03	1.53	1.96
	Critical Storm Duration and Temporal Pattern	180 min	20 min TP02	20 min TP02
PB4	Ground Elevation Level (m AHD)	152.68	152.68	152.68
	Maximum Water Surface Elevation (m AHD)	153.93	153.92	153.88
	Bund Elevation (m AHD)	154.68	154.68	154.68
	Freeboard (m)	0.75	0.76	0.80
	Critical Storm Duration and Temporal Pattern	120 min	20 min TP02	20 min TP02
PB5	Ground Elevation Level (m AHD)	155.60	155.60	155.60
	Maximum Water Surface Elevation (m AHD)	155.72	155.69	155.64
	Bund Elevation (m AHD)	157.60	157.60	157.60
	Freeboard (m)	1.88	1.91	1.96
	Critical Storm Duration and Temporal Pattern	15 min	20 min TP02	20 min TP02

As can be seen in **TABLE 17**, the Pit Bund has sufficient height to ensure no ingress of surface runoff into the pit under post-closure conditions. The freeboard at locations PB1, PB2, PB3 and PB5 exceeds 1 m in the PMF event. At PB4 there is freeboard of 0.75 m in the PMF event. While this may indicate hydraulic overdesign of the Pit Bund, the primary purpose of the Pit Bund is to prevent unintended human access to the pit void during closure conditions, therefore, it is not recommended to design a Pit Bund height of less than 2 m in the detailed design stage.



4.7 Perry River Dam

The maximum recorded flow rates, water surface elevations and velocities at the Perry River Dam embankment crest are summarised in **TABLE 18**.

TABLE 18: PERRY RIVER DAM RESULTS

	PMF	0.1% AEP	1% AEP
PRD Embankment Crest Level (m AHD)	98.0	98.0	98.0
Spillway Elevation (m AHD)	98.0	98.0	98.0
Maximum Water Surface Elevation (m AHD)	104.60	102.60	101.21
Maximum Flood Depth (m)	6.60	4.60	3.21
Maximum Flow Velocity (m/s)	2.7	1.9	1.0
Critical Storm Duration and Temporal Pattern	240 min	720 min TP08	720 min TP08

As can be seen in **TABLE 18**, during the 1% AEP event, the Perry River Dam has a modelled flood depth of 3.21 m, increasing to 6.6 m in the modelled PMF event. The broad crest of the Perry River Dam forms the spillway, so that any flows passing over the crest will extend up to 145 m in width during the modelled PMF flood event.

The Perry River Dam was constructed to provide a process water source for the MRO operations. The dam was not designed to control downstream releases to the Perry River; the crest level was set to provide sufficient storage volume and so is lower than the 1% AEP level, as can be seen in **TABLE 18**.

4.8 Retained Dams

The maximum recorded flow rates, water surface elevations and velocities at the Sediment Dam 3 embankment crest are summarised in **TABLE 19**. The maximum recorded flow rates, water surface elevations and velocities at the embankment crests of WD1, WD2, WD3 and WQ4 are summarised in **TABLE 20**.

TABLE 19: SEDIMENT DAM 3 RESULTS

	PMF	0.1% AEP	1% AEP
Peak Flow Rates (m ³ /s)	82.6	27.6	25.6
Embankment Level (m AHD)	119.1	119.1	119.1
Maximum Water Surface Elevation (m AHD)	120.36	119.53	119.52
Maximum Flood Depth (m)	1.26	0.43	0.42
Maximum Flow Velocity (m/s)	3.4	2.7	1.6
Critical Storm Duration and Temporal Pattern	120 min	360 min TP07	360 min TP07

As can be seen in **TABLE 19**, Sediment Dam 3 overtops during flood events equal to and greater than the 1% AEP event. During the 1% AEP flood event, the maximum flood depth over the crest is 0.42 m, increasing to 1.26 m in the PMF flood event.

**TABLE 20: WD1, WD2, WD3 AND WD4 RESULTS**

Dam Number	Parameter	PMF	0.1% AEP	1% AEP
WD1	Peak Flow Rates (m ³ /s)	82.0	26.1	24.0
	Embankment Level (m AHD)	126.7	126.7	126.7
	Maximum Water Surface Elevation (m AHD)	127.83	127.38	127.28
	Maximum Flood Depth (m)	1.13	0.68	0.58
	Maximum Flood Velocity (m/s)	1.2	1.0	1.0
	Critical Storm Duration and Temporal Pattern	90 min	360 min TP07	360 min TP07
WD2	Peak Flow Rates (m ³ /s)	20.5	3.7	2.6
	Embankment Level (m AHD)	120.0	120.0	120.0
	Maximum Water Surface Elevation (m AHD)	120.52	120.09	120.05
	Maximum Flood Depth (m)	0.52	0.09	0.05
	Maximum Flood Velocity (m/s)	0.7	0.3	0.1
	Critical Storm Duration and Temporal Pattern	120 min	360 min TP07	360 min TP07
WD3	Peak Flow Rates (m ³ /s)	13.3	4.7	1.7
	Embankment Level (m AHD)	125.1	125.1	125.1
	Maximum Water Surface Elevation (m AHD)	125.39	125.21	125.18
	Maximum Flood Depth (m)	0.29	0.11	0.08
	Maximum Flood Velocity (m/s)	1.5	0.8	0.5
	Critical Storm Duration and Temporal Pattern	25 min	270 min TP04	270 min TP04
WD4	Peak Flow Rates (m ³ /s)	2.3	1.7	1.7
	Embankment Level (m AHD)	134.4	134.4	134.4
	Maximum Water Surface Elevation (m AHD)	134.41	134.41	134.41
	Maximum Flood Depth (m)	0.01	0.01	0.01
	Maximum Flood Velocity (m/s)	0.5	0.3	0.2
	Critical Storm Duration and Temporal Pattern	25 min	20 min TP02	20 min TP02

The maximum WSE in WD4 appears to be similar in all storm events. The small flow rates over the 150 m length broad crested weir has little measurable impact on observed water surface elevations.



4.9 Tributaries

The maximum recorded flow rates, water surface elevations and velocities in the downstream tributaries are summarised in **TABLE 21** to **TABLE 24**.

TABLE 21: TRIBUTARIES RESULTS – SWINDON CREEK

	PMF	0.1% AEP	1% AEP
Peak Downstream Flow Rates (m ³ /s)	446.3	99.4	72.0
Upstream Maximum Water Surface Elevation (m AHD)	149.03	145.42	144.90
Upstream Bed Elevation (m AHD)	141.39	141.39	141.39
Downstream Maximum Water Surface Elevation (m AHD)	117.64	115.55	113.67
Downstream Bed Elevation (m AHD)	110.71	110.71	110.71
Upstream Maximum Flow Depth (m)	7.64	5.54	3.51
Downstream Maximum Flow Depth (m)	6.93	4.03	2.96
Upstream Maximum Velocity (m/s)	1.2	0.9	0.8
Downstream Maximum Velocity (m/s)	0.6	0.4	0.5
Critical Storm Duration and Temporal Pattern	60 min	360 min TP07	360 min TP07

TABLE 22: TRIBUTARIES RESULTS – RAWDON CREEK

	PMF	0.1% AEP	1% AEP
Peak Downstream Flow Rates (m ³ /s)	63.5	14.0	12.6
Upstream Maximum Water Surface Elevation (m AHD)	114.27	112.32	112.31
Upstream Bed Elevation (m AHD)	110.85	110.85	110.85
Downstream Maximum Water Surface Elevation (m AHD)	104.74	103.15	101.48
Downstream Bed Elevation (m AHD)	99.67	99.67	99.67
Upstream Maximum Flow Depth (m)	3.42	1.47	1.46
Downstream Maximum Flow Depth (m)	5.05	3.48	1.81
Upstream Maximum Velocity (m/s)	0.5	0.1	0.1
Downstream Maximum Velocity (m/s)	2.6	0.8	2.3
Critical Storm Duration and Temporal Pattern	180 min	360 min TP07	360 min TP07

**TABLE 23: TRIBUTARIES RESULTS – TWELVE MILE CREEK**

	PMF	0.1% AEP	1% AEP
Peak Downstream Flow Rates (m³/s)	416.6	91.8	56.0
Upstream Maximum Water Surface Elevation (m AHD)	116.70	114.57	113.98
Upstream Bed Elevation (m AHD)	111.22	111.22	111.22
Downstream Maximum Water Surface Elevation (m AHD)	103.97	102.46	101.13
Downstream Bed Elevation (m AHD)	99.68	99.68	99.68
Upstream Maximum Flow Depth (m)	5.48	3.35	2.76
Downstream Maximum Flow Depth (m)	4.29	2.78	1.45
Upstream Maximum Velocity (m/s)	0.6	0.4	0.3
Downstream Maximum Velocity (m/s)	3.1	1.5	1.5
Critical Storm Duration and Temporal Pattern	180 min	720 min TP08	720 min TP08

TABLE 24: DOWNSTREAM TRIBUTARIES RESULTS – MINGHAM CREEK

	PMF	0.1% AEP	1% AEP
Peak Downstream Flow Rates (m³/s)	355.6	90.0	57.9
Upstream Maximum Water Surface Elevation (m AHD)	117.20	115.90	115.45
Upstream Bed Elevation (m AHD)	113.72	113.72	113.72
Downstream Maximum Water Surface Elevation (m AHD)	101.27	99.46	98.93
Downstream Bed Elevation (m AHD)	96.85	96.85	96.85
Upstream Maximum Flow Depth (m)	3.48	2.18	1.73
Downstream Maximum Flow Depth (m)	4.42	2.61	2.08
Upstream Maximum Velocity (m/s)	0.6	0.5	0.4
Downstream Maximum Velocity (m/s)	0.9	0.6	0.5
Critical Storm Duration and Temporal Pattern	60 min	360 min TP07	360 min TP07

As can be seen in **TABLE 21** to **TABLE 24**, the modelled results in the downstream tributaries produce the largest peak flow rates, flood depths and flood velocities in the PMF event, as expected. These results should be read in conjunction with **Figure 001** to **Figure 006**.

In Swindon Creek, that maximum WSE varies by approximately 3 m between the 1% AEP and PMF events. With the variation in peak flow rate between the events, this indicates that the creek extends into its floodplain along its entire length. With the exception of the PMF event, the peak velocities in the creek do not exceed 1 m/s in the modelled storm events.

In Rawdon Creek there is a similar pattern of flooding to Swindon Creek, however the results indicate that the creek channel contains most the flood flow with little overbank flooding in the extreme flood events. Rawdon Creek has the smallest catchments of the four creeks modelled, which is reflected in the peak flow rates.

Twelve Mile Creek has the largest catchment area of the modelled creeks, and this is reflected in the modelled peak flow rates. The PMF flood event has a peak flow rate approximately 4.5 times greater than the 0.1% AEP event.

From the results, Mingham Creek has a large floodplain and velocities less than 1 m/s in all modelled events.



4.10 Sensitivity Analysis

A sensitivity analysis was undertaken for the TSF and the MRO site. Due to the distance of the MRO site and TSF from the Perry River, sensitivity testing of the flow rates in the Perry River was not undertaken, except to assess whether the flood levels in the Perry River impacted the upstream water surface elevations at the upstream MRO site, which they did not.

A comparison of peak water surface elevation (WSE), flood depths and velocities at the middle of the TSF Surface, Swindon Creek, Rawdon Creek and Mingham Creek are summarised in **TABLE 25**.

As can be seen in **TABLE 25**, the waterways adjacent to the MRO site are sensitive to variations in applied rainfall depth and surface roughness. Changes in the rainfall depth applied to the model have similar increases and decreases for the 20% increases and decreases. Increases in the surface roughness have approximately three times the impact on flood depth in the watercourses as decreasing the roughness.

The TSF closure surface is also subject to variations in maximum water surface elevation, with increases in rainfall depth having approximately double the impact of decreases in rainfall depth. Increases in the surface roughness on the TSF have a far greater impact on flood depth than decreases. Overall, a 20% increase in assumed roughness results in larger variations than the 20% increase in rainfall depth. The sensitivity modelling indicated that changes in rainfall depth or surface roughness had little to no measurable impact on velocities across the surface.

From the results, it can be taken that the model is sensitive to changes in both applied rainfall depth and surface roughness, with the greatest impacts being made by increases in the surface roughness coefficients.

If further modelling is to be undertaken, it is recommended that photographs of site conditions in the creeks and an understanding likely surface treatments to the overland flow areas are used to reassess surface roughness estimates at the closure site.

**TABLE 25: SENSITIVITY ANALYSIS RESULTS – PMF EVENT**

Location	Sensitivity Scenario	Peak WSE (m AHD)	Change in Peak WSE (m AHD)	Flood Depth (m)	Change in Depth (m)	Flow Velocity (m/s)	Change in Velocity (m/s)
TSF Surface	Base Model	201.25	-	0.65	-	0.4	-
	+ 20% Rainfall Depth	201.31	0.06	0.71	0.06	0.4	0.0
	- 20 % Rainfall Depth	201.19	-0.06	0.59	-0.06	0.3	-0.1
	+ 20% Mannings 'n'	201.35	0.10	0.75	0.10	0.4	0.0
	- 20 % Mannings 'n'	201.22	-0.03	0.62	-0.03	0.4	0.0
Swindon Creek	Base Model	147.66		5.55		1.0	
	+ 20% Rainfall Depth	148.66	1.00	6.56	1.00	1.1	0.1
	- 20 % Rainfall Depth	146.60	-1.06	4.49	-1.06	0.8	-0.2
	+ 20% Mannings 'n'	149.18	1.52	7.08	1.52	1.0	0.0
	- 20 % Mannings 'n'	147.16	-0.50	5.05	-0.50	1.1	0.1
Rawdon Creek	Base Model	114.99		4.29		0.5	
	+ 20% Rainfall Depth	115.69	0.70	4.99	0.70	0.6	0.1
	- 20 % Rainfall Depth	114.30	-0.69	3.60	-0.69	0.5	0.0
	+ 20% Mannings 'n'	115.98	0.99	5.28	0.99	0.5	0.0
	- 20 % Mannings 'n'	114.73	-0.25	4.04	-0.25	0.6	0.1
Mingham Creek	Base Model	100.58		4.15		0.8	
	+ 20% Rainfall Depth	101.29	0.71	4.86	0.71	0.9	0.1
	- 20 % Rainfall Depth	99.83	-0.75	3.40	-0.75	0.7	-0.1
	+ 20% Mannings 'n'	101.64	1.06	5.22	1.06	0.8	0.0
	- 20 % Mannings 'n'	100.24	-0.34	3.81	-0.34	0.9	0.1



5 PRCP INPUTS AND DISCUSSION

5.1 General

With reference to the PRCP Guidelines [1], a key focus of this flood risk assessment was to identify two aspects of closure planning:

- ensuring that any residual voids are not located wholly or partly in the food plain (defined as the 0.1% AEP flood extent).
- Assess the flood risk to any remaining infrastructure.

Detailed below is a discussion on the flood risk profile for the infrastructure on site that is to be retained, which includes:

- South Dam, Process Water Dam and the MIA
- Pit
- TSF
- West Dam
- Sediment Dam 3, WD1, WD2, WD3 and WD4
- Perry River Dam

A discussion of the impacts to the infill areas and the infrastructure that will remain on site is provided in the following sections.

5.2 The South Dam, Process Water Dam and the MIA

The area of the South Dam, Process Water Dam, and MIA is to be filled to restore hydraulic connectivity with Mingham Creek. A Southern Diversion Drain will be constructed to convey flows from this area to the West Dam. Summaries of the flood profiles for the South Dam Filled Area and Southern Diversion Drain are presented in **TABLE 15** and **TABLE 16**, respectively.

5.3 Pit

When assessed against the PRCP Guidelines [1], the pit void has been determined not to be located in the extents of the PMF or 0.1% AEP flood plain of either Rawdon Creek or Twelve Mile Creek.

It is proposed that a 2 m high abandonment bund be constructed around the pit crest to prevent the ingress of surface runoff from upstream catchments. The flood modelling presented in **Section 4.6** indicated that a diversion drain will be required on the upstream side of the abandonment bund to divert runoff away from the pit void to either Twelve Mile Creek or Rawdon Creek. Flows to the south of the pit will discharge to Mingham Creek.

Any rainfall over the pit surface will be retained within the pit void and will evaporate during the dry season.

By diverting flows away from the pit to Twelve Mile Creek and Rawdon Creek, the pit abandonment bund and diversion drain will partially restore the pre-mining hydraulic regime. Flows south towards Mingham Creek will be restored to pre-mining conditions as the natural ridge skirted the southern extent of the pit.

The upstream extents of Rawdon Creek and Twelve Mile Creek are located within the area of pit void. The pit void has a storage volume such that it is unlikely to fill and spill and so rainfall falling within the pit will be removed from the local watercourse network.

The design of the required abandonment bund and the associated diversion drain will be undertaken at the future detailed design phase.



5.4 TSF

Post closure, the TSF will be retained, although the surface will be capped and graded to ensure the surface is free draining to the closure spillway on the western edge. This conceptual design incorporates a 0.5% gradient on the self-shedding surface and a modified embankment on the downstream face. The embankment will be modified with a shallower gradient on the downstream face for post closure stability. A closure spillway (sized for PMF flows) will be incorporated to ensure the following occurs:

- Prevention of water ponding against the upstream face of the embankment;
- Prevention of flow over the top of the embankment; and
- To ensure all flows from the TSF are conveyed to Swindon Creek.

The flood modelling results presented in **Section 4.2** demonstrated that the proposed spillway design (**TABLE 6**) will be suitable to safely convey design storm events up to and including the PMF. Flooding from Rawdon Creek and Mingham Creek does not extend to the TSF embankment.

All surface runoff from the TSF will enter Swindon Creek, which restores the pre-mining hydraulic regime.

The exact location and configuration of the closure spillway will be set during the detailed design phase. A summary of the flood profile in the TSF spillway and surface is provided in **TABLE 13**.

5.5 West Dam and Retained Dams

Post closure, the West Dam and retained dams (Sediment Dam 3, WD1, WD2, WD3 and WD4) will be used for passive sediment and erosion control purposes. The flood modelling presented in **Section 4.8** indicates that all the structures will overtop in events equal to and greater than the 1% AEP storm event. It is possible that overtopping of the retained dams would occur in storm events more frequent than the 1% AEP, but these have not been assessed in this project.

The West Dam will receive flows from the South Dam Fill Area via the Southern Diversion Drain. Flows from the West Dam will enter Mingham Creek. The flood profile for the West Dam is summarised in



TABLE 14.

Sediment Dam 3 receives flows from a portion of the TSF embankment face, but not from the TSF closure spillway. Flows from Sediment Dam 3 enter Rawdon Creek. The flood profile for Sediment Dam 3 is summarised in **TABLE 19**.

WD1, WD2, WD3 and WD4 all receives flows form the Northern WRD. All flow that overtop these dam embankments will enter the Perry River via Twelve Mile Creek. The flood profiles for the WD1, WD2, WD3 and WD4 are summarised in **TABLE 20**

The overtopping of these retained dams will not impact the TSF or Pit. It is expected that sediment will gradually accumulate within the dams such that the dams will not have a functional storage volume.

Flows from the retained dams will enter the downstream tributaries to the Perry River or Mingham Creek, maintaining the pre-mining hydraulic regime.

5.6 Perry River Dam

Post closure, the Perry River Dam will be retained. Due to its configuration, the embankment crest is also the emergency spillway. As such, the Perry River Dam will overtop in storm events between the 1% AEP and the PMF. The flood risk profile at the Perry River Dam is summarised in **TABLE 18**.



6 SUMMARY AND CONCLUSIONS

ATCW were commissioned by Evolution to prepare a flood risk profile for the MRO site to meet the requirements of the PRCP guidelines at closure. The PRCP requires flood risk assessments for two aspects of closure: to identify whether any mine voids will remain in the floodplain post-closure; and to assess the flood risk to remaining infrastructure.

To prepare the flood risk profiles, hydraulic analysis of the site was undertaken using the two dimensional (2D) finite difference program TUFLOW. ARR [2] guidelines were utilised to develop the hydrology inputs to the hydraulic model. It is understood that Evolution intends to rehabilitate the site to the pre-mining topography as far as is practically possible.

As a result of this hydraulic analysis, flood risk profiles were developed for key infrastructure that will remain at the MRO site. Flood mapping was generated for maximum flood depths and maximum velocities for the PMF, 0.1% AEP and 1% AEP design storm events and is presented in **Figures 001 to 006**.

Hydraulic analysis indicated that the pit will not be impacted by flows from upstream catchments due to the construction of a 2 m high abandonment bund. The pit is not located within the extents of the floodplains of Rawdon Creek, Twelve Mile Creek or Mingham Creek.

The TSF is to be capped and rehabilitated, with its surface shedding to the closure spillway that has been designed to convey flows up to the PMF event.

The South Dam area is to be filled, with a diversion drain constructed to convey flows to the West Dam, which will assist in restoring the pre-mining hydraulic regime at the site.

The West Dam and other retained dams will all experience overtopping during PMF, 0.1% AEP and 1% AEP flow conditions. The overtopping flood depths and flood velocities will not cause significant impacts to these structures.

The Perry River Dam will continue to be overtopped in events greater than the 1% event.

Hydraulic analysis indicated that the modelled maximum flood depths and maximum flood velocities will not result in significant impacts to the TSF closure surface or embankment, Northern WRD or the filled area of the current South Dam. The hydraulic analysis indicated that the West Dam will overtop, however, the maximum flood depths and maximum flood velocity of overtopping flows will not result in significant impacts to the West Dam. All other areas of the site (except for the pit void) drain freely to Swindon Creek, Rawdon Creek, Twelve Mile Creek and Mingham Creek. No other structures experience significant impacts from flooding in the modelled post-closure scenario.

The pre-mining flow regimes to the local watercourses across the MRO site have been maintained in the post closure design, as far as practicable. The exception to this is the pit void where rainfall falling over its surface will be retained and will evaporate in dryer months.

Detailed design of the following elements will be required at a future stage:

- TSF Closure Spillway
- TSF Closure Surface
- South Dam Fill Area
- Southern Diversion Drain
- Pit Abandonment Bund
- Northern WRD capping surface and profile



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- [1] Department of Environment and Science (2021), 'Guideline Progressive rehabilitation and closure plans (PRC plans)', ESR/2019/4964, March 2021, version 2.00.
- [2] Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia
- [3] Bureau of Meteorology (2003), 'The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method', Bureau of Meteorology, Melbourne, Australia, June 2003
- [4] Bureau of Meteorology (2019), 'Design Rainfall Data System', Commonwealth of Australia.
- [5] Rahmen A, Haddad, K (2021), 'Regional Flood Frequency Estimation Model,' Accessed 15 April 2021, <https://rffe.arr-software.org/> .
- [6] Geoscience Australia (2021), 'Shuttle Radar Topographic Mission – Hydro_Enforced_1_second_DEM', Accessed 09 April 2021, <https://elevation.fsdg.org.au/> .
- [7] Evolution Mining Limited (2018), Perry River Dam Grid.
- [8] Evolution Mining Limited, (2021a), Site Survey 1 March 2021.
- [9] Evolution Mining Limited (2021b), Site Survey 7 March 2021.
- [10] Evolution Mining Limited (2021c), Site Survey 10 February 2021.
- [11] Evolution Mining Limited (2021d), Site Survey 23 February 2021.
- [12] Evolution Mining Limited (2020a), Site Survey October 2020.
- [13] Evolution Mining Limited (2018), Site Survey 13 March 2018.
- [14] Department of Industry and Resources, (1997), 'Safety Bund Walls Around Abandoned Open Pit Mines Guideline', Document Number ZMA048HA, Version 1.0.
- [15] Innovyze (2019), 'Manning's n Roughness Coefficients – Open Channel', October 2019.

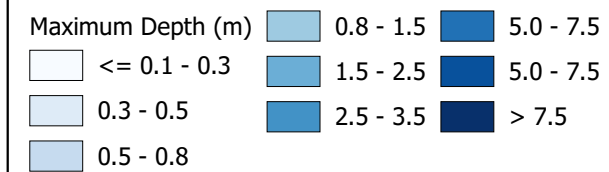
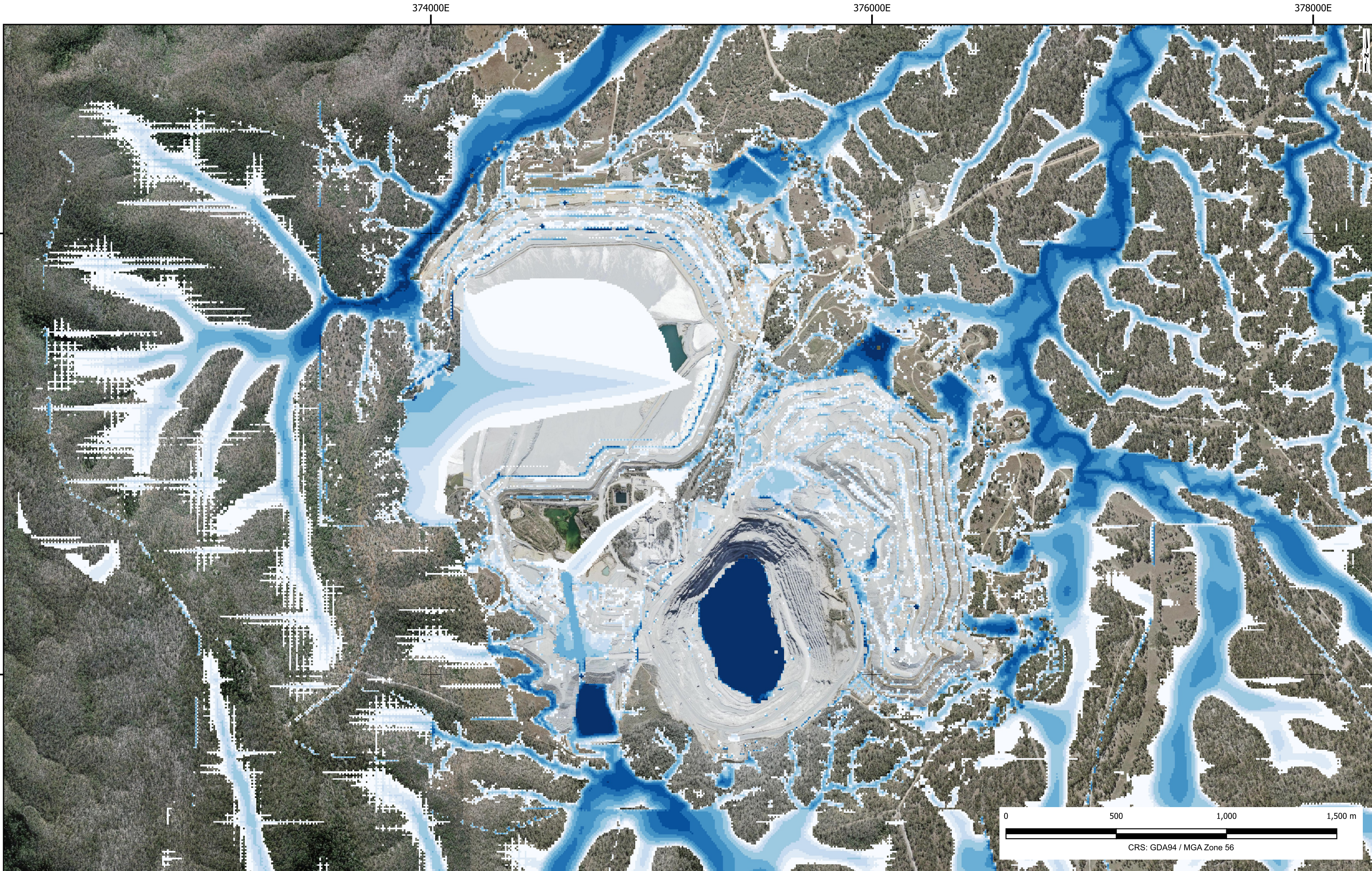


CONDITIONS OF REPORT

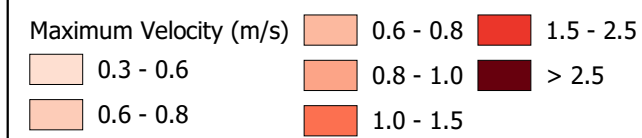
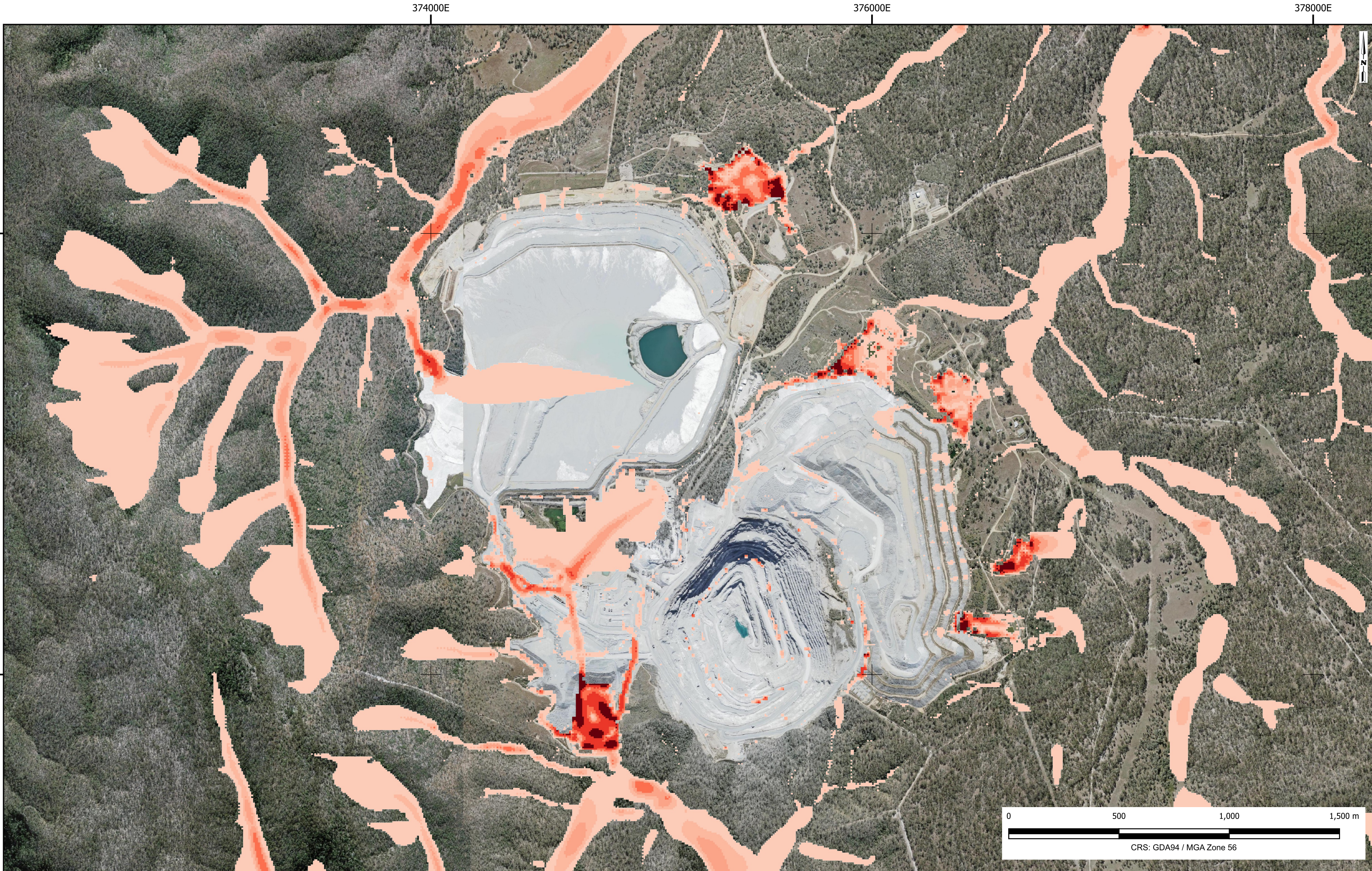
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FIGURES



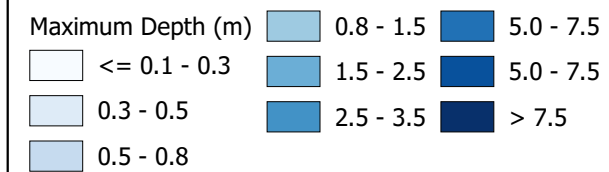
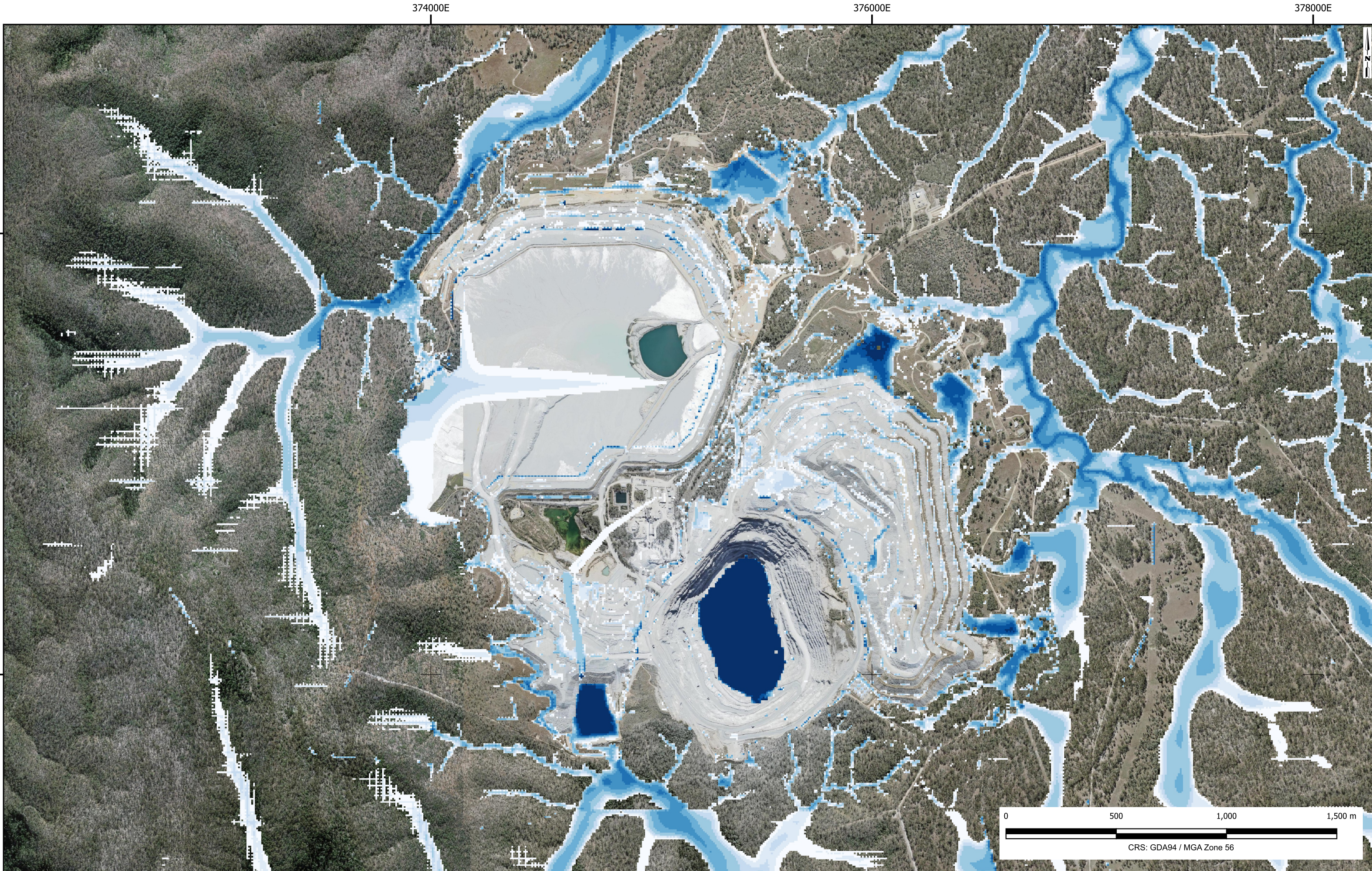
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MOUNT RAWDON OPERATIONS
PROBABLE MAXIMUM FLOOD - MAXIMUM FLOOD DEPTH



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PROBABLE MAXIMUM FLOOD - MAXIMUM FLOOD VELOCITY



FIGURE 002
111359.83
DATE: 2022-12-08



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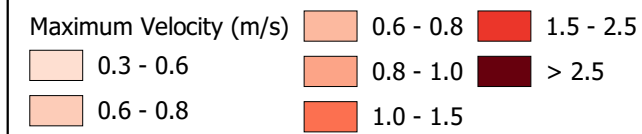
0.1% ANNUAL EXCEEDANCE PROBABILITY - MAXIMUM FLOOD DEPTH



FIGURE 003

111359.83

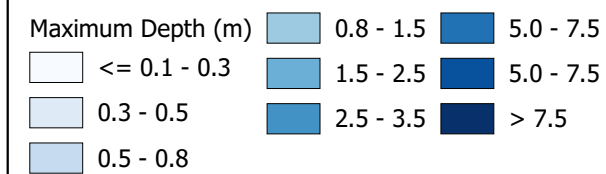
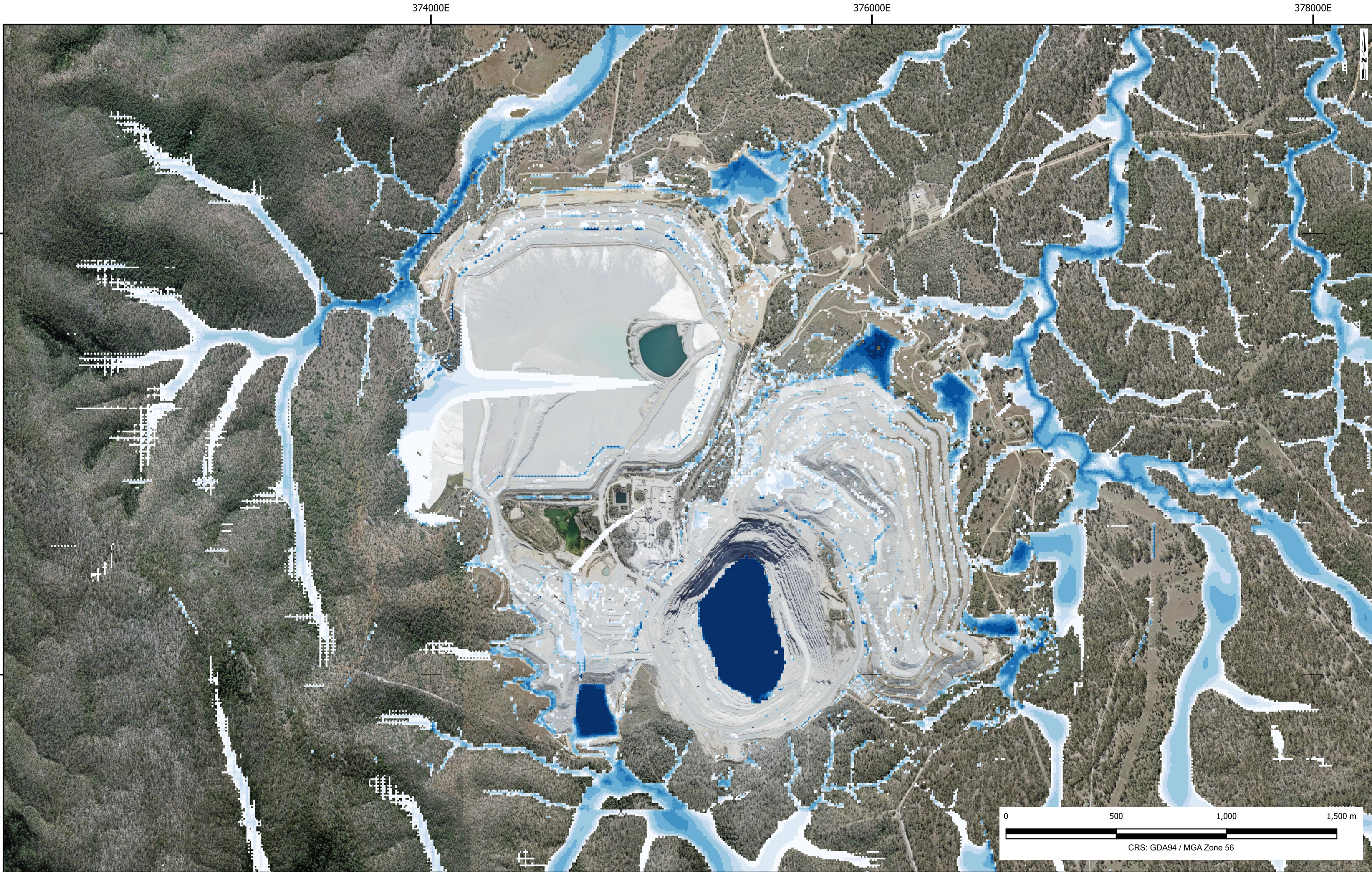
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0.1% ANNUAL EXCEEDANCE PROBABILITY - MAXIMUM FLOOD VELOCITY



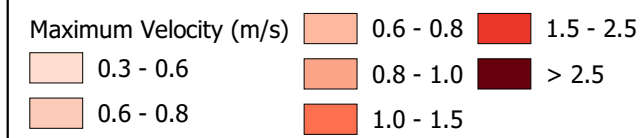
FIGURE 004
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MOUNT RAWDON OPERATIONS
1.0% ANNUAL EXCEEDANCE PROBABILITY - MAXIMUM FLOOD DEPTH



FIGURE 005
111359.83
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1.0% ANNUAL EXCEEDANCE PROBABILITY - MAXIMUM FLOOD VELOCITY



FIGURE 006
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APPENDICES



APPENDIX A – GSDM PROBABLE MAXIMUM PRECIPITATION CALCULATIONS

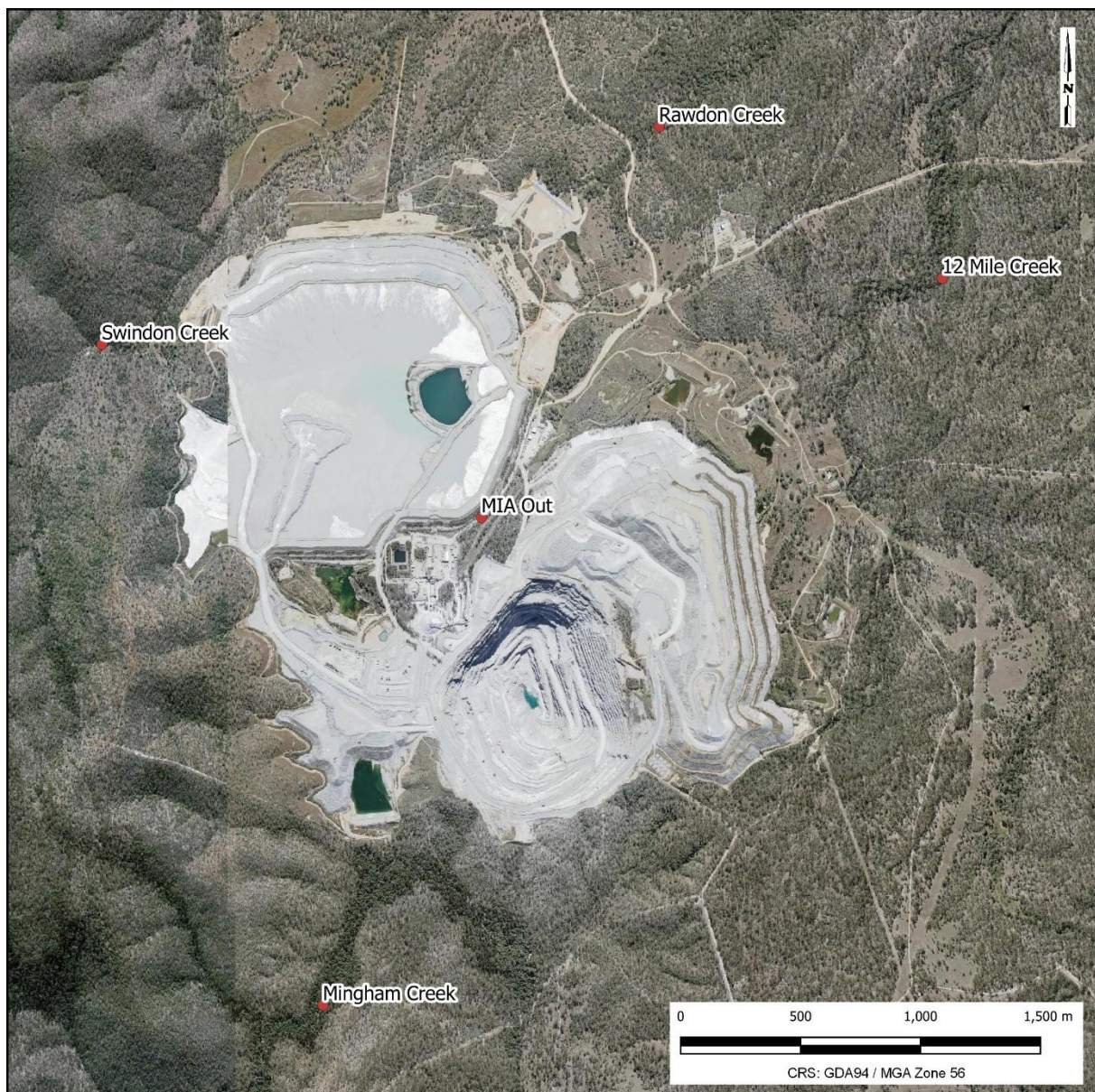
APPENDIX B – GRID SIZE SENSITIVITY

In order to determine the most appropriate grid cell size, the model was run to assess the sensitivity to grid size on water surface elevations for four different grid sizes:

- 20 m x 20 m (20 m grid)
- 15 m x 15 m (15 m grid)
- 10 m x 10 m (10 m grid)
- 5 m x 5 m (5 m grid)

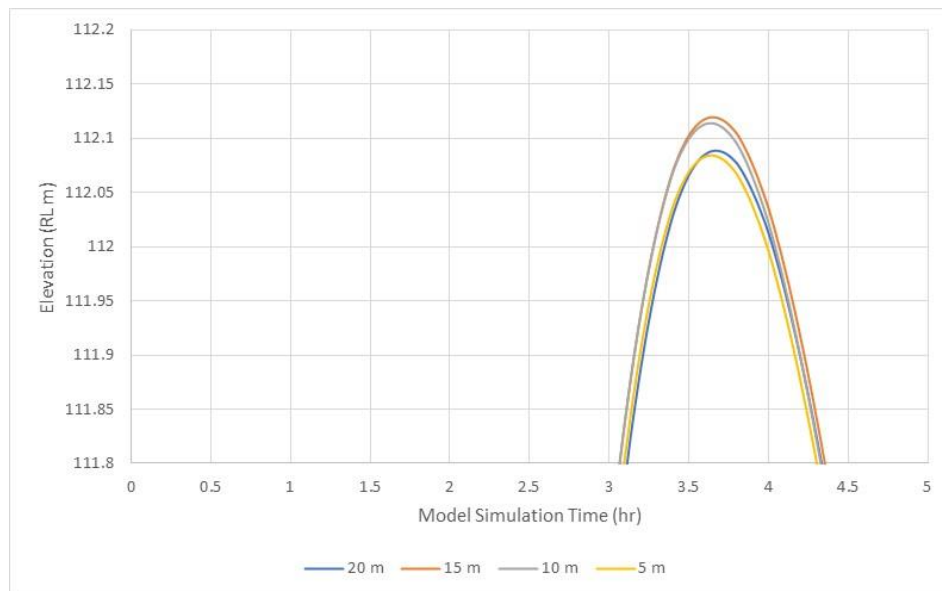
The locations at which grid sensitivity was assessed are shown on **DIAGRAM B1**. The sensitivity was based upon the PMP duration that produced the maximum water surface elevations at the sensitivity locations. The PMP durations that resulted in maximum water surface elevations varied between the 1 hour and 4 hour events. The same duration event was assessed at each location to ensure an appropriate comparison.

DIAGRAM B1: MODEL SENSITIVITY ANALYSIS LOCATIONS



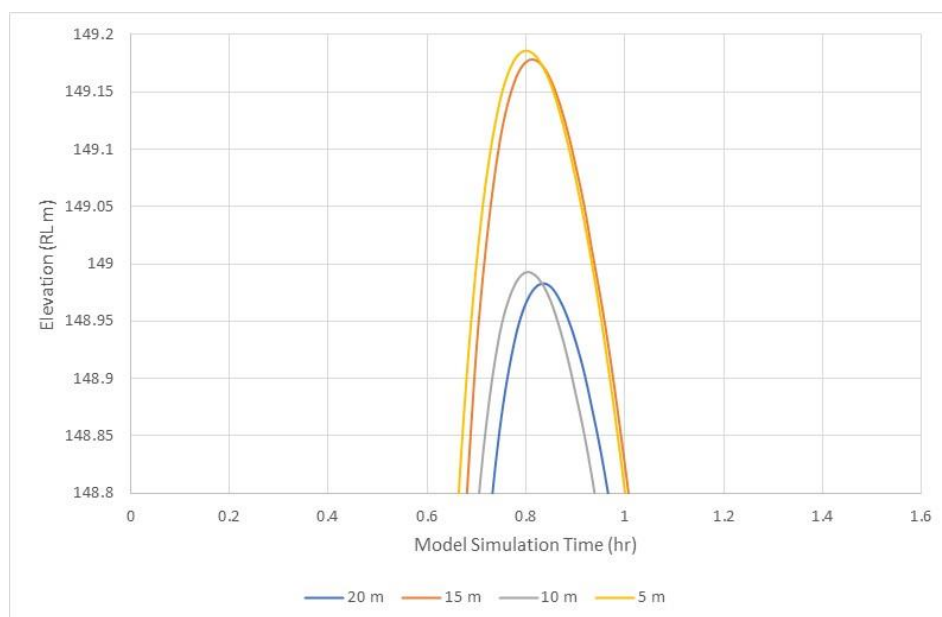
The water levels at Twelve Mile Creek, Swindon Creek, Rawdon Creek, Mingham Creek and MIA Out are shown on **DIAGRAM B2**, **DIAGRAM B3**, **DIAGRAM B4**, **DIAGRAM B5** and **DIAGRAM B6** respectively.

DIAGRAM B2: TWELVE MILE CREEK PEAK WATER SURFACE ELEVATION



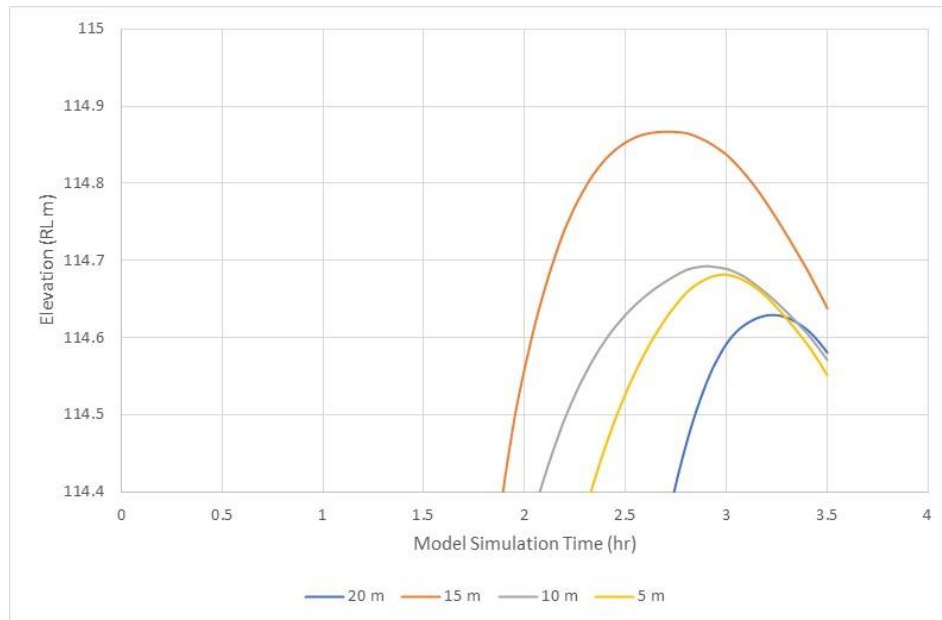
As can be seen in **DIAGRAM B2**, the peak water surface elevation at Twelve Mile Creek is produced in the model run on the 15 m grid. The 10 m grid produces a similar peak water surface elevation. It is noted the maximum difference in elevation between the modelled water surface elevation is 35 mm. Therefore the 15 m grid or 10 m grid would be suitable for full assessment.

DIAGRAM B3: SWINDON CREEK PEAK WATER SURFACE ELEVATION



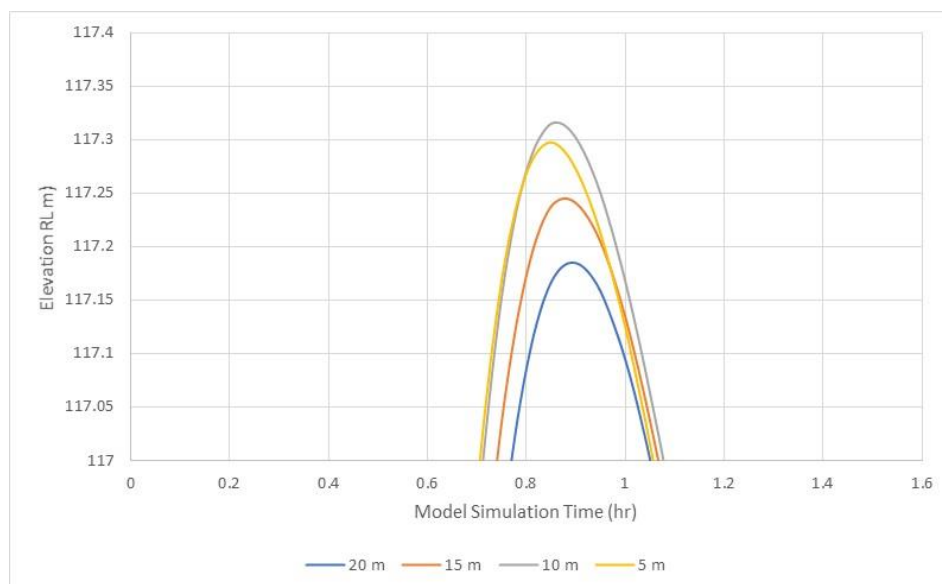
As can be seen in **DIAGRAM B3**, the peak water surface elevation at Swindon Creek is produced in the model run on the 5 m grid. It is noted the 5 m grid produces a similar peak water surface elevation in the 15 m grid. It is noted the difference between the 5 m grid and 15 m grid is less than 10 mm. Due to this small difference, it was determined the 5 m or 15 m grid would be suitable for detailed assessment.

DIAGRAM B4: RAWDON CREEK PEAK WATER SURFACE ELEVATION



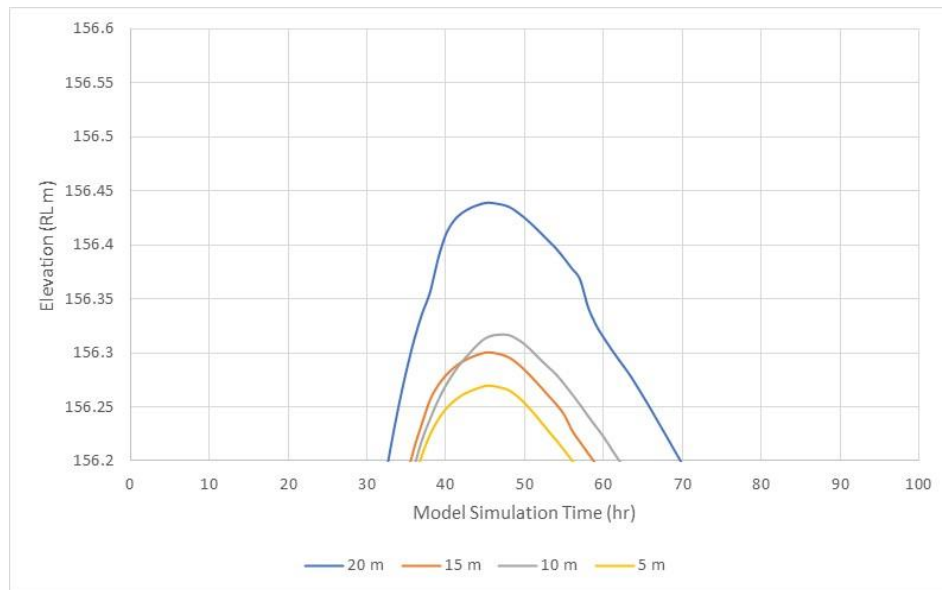
As can be seen in **DIAGRAM B4**, the peak water surface elevation at Rawdon Creek is produced in the model run on the 15 m grid. It is noted the maximum difference in elevation between the modelled water surface elevation is 230 mm. It was determined the 15 m grid would be suitable for detailed assessment.

DIAGRAM B5: MINGHAM CREEK PEAK WATER SURFACE ELEVATION



As can be seen in **DIAGRAM B5**, the peak water surface elevation at Mingham Creek is produced in the model run on the 10 m grid. It is noted the maximum difference in elevation between the modelled water surface elevation run on the 15 m grid is 70 mm.

DIAGRAM B6: MIA OUT PEAK WATER SURFACE ELEVATION



As can be seen in **DIAGRAM B6**, the peak water surface elevation at MIA Out is produced in the model run on the 20 m grid. It is noted this value is approximately 130 mm higher than the 15 m grid.

Due to the variation in peak results produced by the various grid sizes, based the overall results of the 16m grid providing higher levels, and higher convergence of results, it was determined the 15 m grid was the most suitable for detailed assessment as it produced results that were validated by 10 m x