FINAL REPORT

KARARA IRON ORE PROJECT MINE LIFE EXTENSION PROJECT - SURFACE WATER HYDROLOGY ASSESSMENT

PREPARED FOR KARARA MINING LTD

3 July 2024

REVISION: B

Stantec

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Karara Mining Ltd

Karara Iron Ore Project Mine Life Extension Project - Surface Water Hydrology Assessment

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1. Introduction

1.1 Background and Objectives

Karara is the largest mining operation and the first major magnetite mine in the Mid-West. The operation is located 200 km south-east of Geraldton and includes a large open pit mine, ore processing and beneficiation plant, logistics networks, and other mine-related infrastructure.

Karara Mining Ltd (KML) requires a surface water hydrology assessment to support approvals for the Karara Iron Ore Project (KIOP) Mine Life Extension (MLE) project, which mainly consists of extensions to the Waste Rock Dump (WRD), Tailings Storage Facility (TSF), and associated infrastructure for life of mine (LoM) operations. In addition, mine closure assessments are required for the Blue Hills North and Terapod rehabilitated areas of the Mungada Iron Ore Project (MIOP), part of which forms the KIOP Mine Life Extension (MLE) Project and supports ongoing mine operations at KIOP. Assessments are also required for the Yandanooka Borefield and Pipeline and the Syncline Turner Haul Road.

This report details the surface water hydrology assessment for the areas outlined above, including the identification of current flood risks and the provision of recommended mitigation measures. This assessment includes baseline and LoM scenarios for KIOP, the Yandanooka Borefield, and the Syncline Turner Haul Road; closure conditions are assessed at KIOP and MIOP.

Figure 1-1 shows the relative locations of the assessed areas. Contributing catchment areas associated with the KIOP and MIOP areas are illustrated in Figure 1-2.

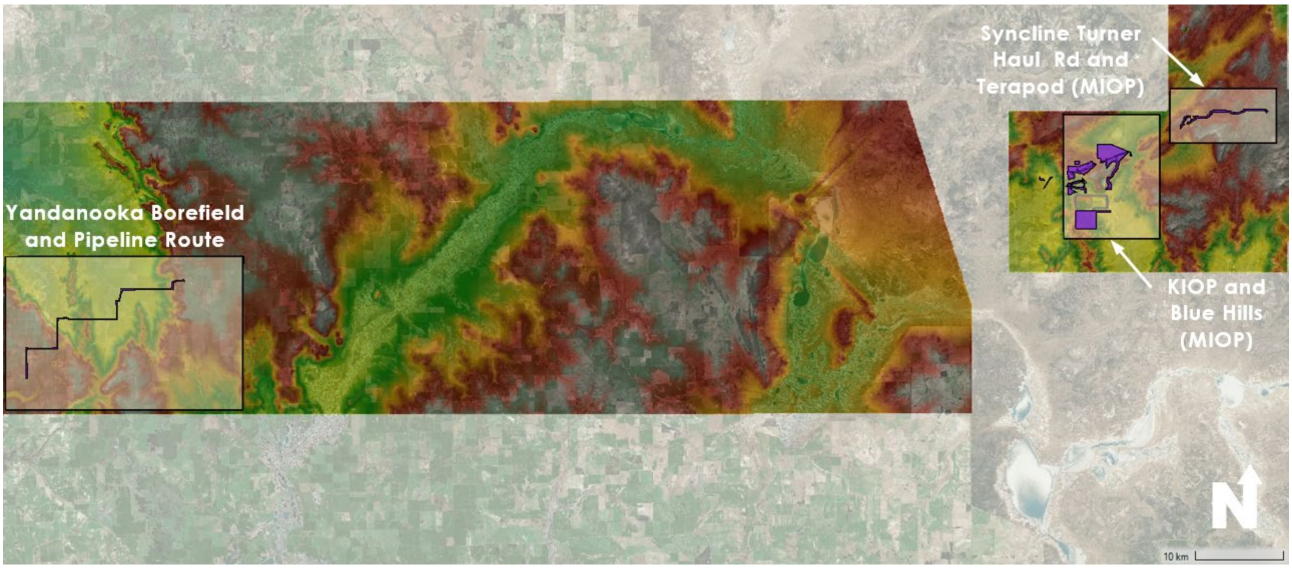

Figure 1-1 Assessed Areas

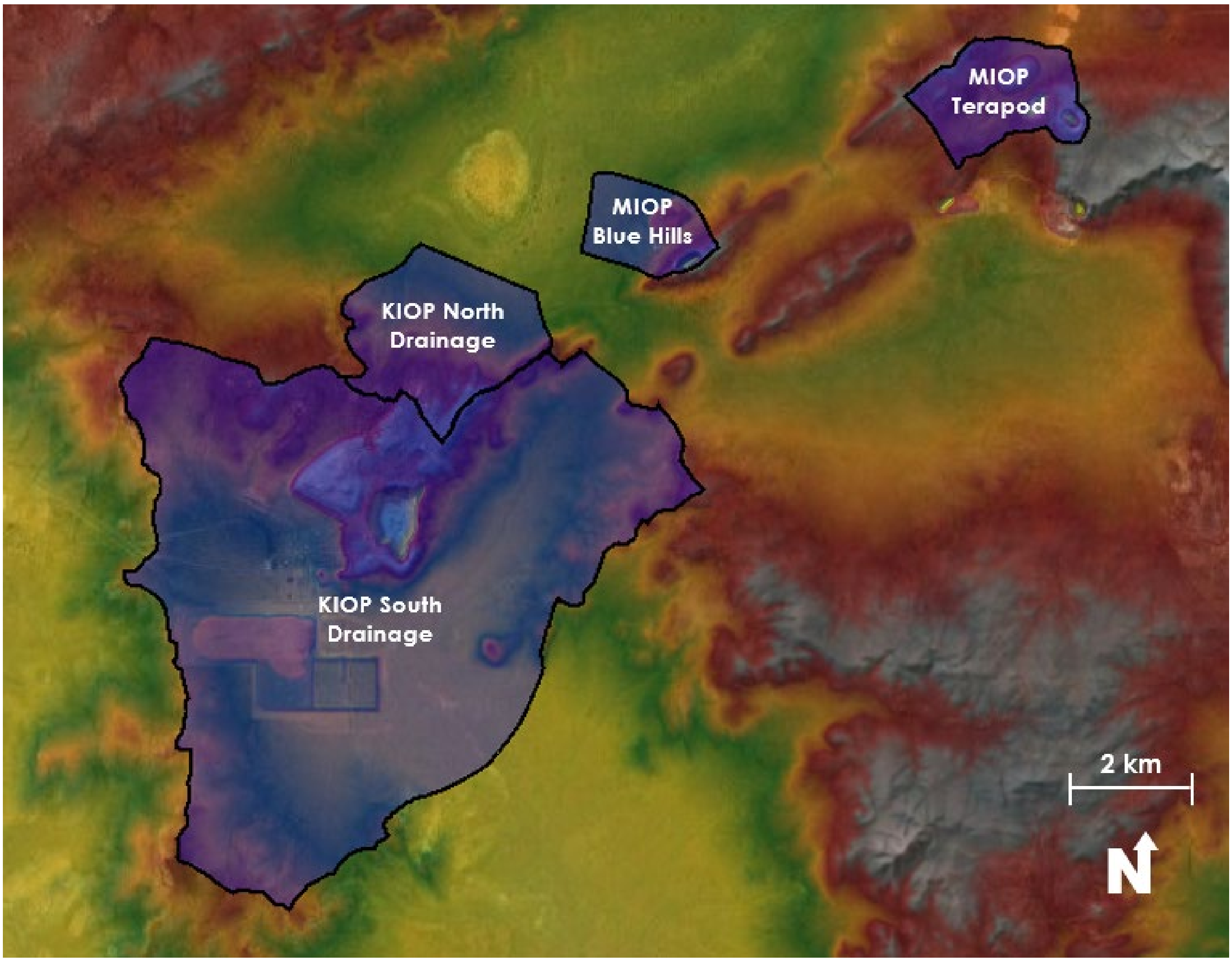

Figure 1-2 KIOP and MIOP Catchments

1.2 Data Sources

The surface water hydrology modelling in this report is based on background data provided by KML. A desktop review was conducted to extract relevant information from the provided reports, computational models, and geospatial data. The following data sources were used in this study:

- 1m x 1m digital elevation model (DEM) in Geo TIFF format covering all KIOP and MIOP catchments
- 20cm x 20cm DEM in Geo TIFF format covering a portion of the Karara catchment and all features within the Terapod, Blue Hills, and Mungada areas
- Life of mine plan features “Karara Nov 21.dxf” and “Section 38 Proposed Disturbance Areas.shp”
- Perimeter of the TSF “Dry_Stack_TSF_Toe.shp” and “DesignLifts_NoExpansion.shp”
- Abandonment bund alignment “Stage_8_abandonment_bund_v3.dxf”

The following software applications were used in the development and presentation of hydrological and hydraulic models in this assessment:

- XPRAFTS Version 2018.1.2
- Australian Rainfall and Runoff Regional Flood Frequency Estimation (RFFE) 2016 V1
- HEC-RAS Version 6.4

The following hydrological reports were made available for review and for the provision of background details. Full citation details are provided in Section 8.

- Karara Stage 2A TSF Flood Modelling and Drainage Assessment (Advision, 2017)
- Karara TSF Expansion Drainage Assessment (Advision, 2017)

- Karara Stage 4 Mining Proposal Flood Modelling and Drainage Assessment (Advisian, 2018)
- Mungada Ridge Hematite Project Surface Water Management (Coffey, 2007)
- Karara Surface Water Management Review and Assessment (MWH, 2012)
- Karara Iron Ore Project Surface Water Baseline and Impact Assessment (MWH, 2008)

1.3 Scenarios

The modelling in this report is based on three scenarios:

- *Baseline (KIOP)*. This scenario uses 2021 terrain data and culvert survey data, modified to reflect TSF2B earthworks.
- *Life of Mine (KIOP)*. The Life of Mine (LoM) scenario updates the baseline model with the November 2023 mine plan, including updated landforms and diversions.
- *Closure (KIOP and MIOP)*. This scenario updates the LoM model with the railway embankment at KIOP breached. For MIOP, where mining operations have ceased, 2021 terrain surfaces are used to reflect the closure condition.

1.4 Methodology and Assumptions

Precipitation hyetographs were applied using rainfall-runoff modelling (XPRAFTS). Critical-duration temporal patterns were developed in accordance with Australian Rainfall and Runoff (ARR2019) methodologies (Ball et. al., 2019). Surface water runoff was assessed using 2D rain-on-grid hydraulic modelling with HEC-RAS software (USACE 2023).

Although some pits in the mine plan include existing or proposed abandonment bunds, the bunds have not been designed to retain water, and runoff draining toward the bunds is assumed to empty to the pit. All waste rock landforms are assumed to be water retaining at KIOP, in that the rainfall will be managed on the landforms without significant contribution to downstream peak flow rates. Runoff on landforms will be managed through a combination of profiling to keep water away from slopes; crest, toe and cell bunding; and deep ripping to encourage infiltration.

2. Hydrology

2.1 Hydrological Setting

2.1.1 Climate

The KIOP and MIOP projects are located in an area that is subject to an arid climate with hot summers and cold winters. Temperature variations in the region can be large, with the average daily maximum temperatures rising to 37 degrees in summer and dropping to a minimum of 6 degrees in winter.

Continuous meteorological data is available from the Bureau of Meteorology (BoM) Morawa Station (BoM Site No. 008093) from 1925 to 2005 and from Morowa Airport Station (BoM Site No. 008296) from 1997 to 2024. Morowa is located approximately 85 km west of the mine site area. A summary of temperature averages at Morawa Airport Station for an elevation of 271 m AHD is provided in Table 2.1.

Table 2.1: Summary of Morawa Airport Station Temperature Statistics (1997 – 2024)

Mean Daily Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max (^{0}C)	37.5	37	33.5	28.9	24.0	20.1	18.9	20.4	23.4	28.3	32.2	35.5	28.3
Min (^{0}C)	19.8	20.4	18.3	14.4	10.3	7.5	6.2	6.6	7.9	11.1	14.5	17.6	12.9

Daily rainfall data is available at Karara Mine from April 2011 to present. Daily data is also available from Karara Station (BoM Station No. 010195) between 1991 and 2021. Karara Station is relatively close to the project area (approximately 9 km southwest of the mine site) at an elevation of 320 m AHD.

Average annual rainfall in the region varies from 280-400 mm. Rain is expected to occur in the winter months, mainly from May to August, with July being the wettest month of the year. Most of the winter rain results from the passage of cold fronts. These fronts may associate with cloud bands from the northwest, which may enhance the totals. Mean annual rainfall for the date ranges detailed above is 305 mm at Karara Station and 284 mm at Morowa Airport.

Pan evaporation is almost an order of magnitude greater than average rainfall in the vicinity of the mine site, exceeding average rainfall in every month of the year.

Additional details on the regional climate and hydrologic setting are included in the Surface Water Baseline and Impact Assessment (MWH, 2008) and other hydrological reports referenced in Section 1.2.

2.1.2 Regional Catchment

The KIOP and MIOP are located within the internally draining Yarra Yarra catchment basin. The irregular surface flow is directed to a chain of several thousand ephemeral salt lakes and samphire-covered claypans. The drainage lines are poorly defined in the catchment, and ponding typically follows wet periods.

2.2 Rainfall Estimation

Rainfall depths for events up to 1:2,000 Annual Exceedance Probability (AEP) were taken from the 2016 Bureau of Meteorology Intensity-Frequency-Duration (IFD) data for KIOP, MIOP, the Syncline Turner Haul Road, and the Yandanooka borefield pipeline alignment. The 2016 precipitation values are the most up-to-date IFD curves as of the date of this report.

The Probable Maximum Precipitation (PMP) design rainfall was estimated using the methodology described in the Generalised Short-Duration Method (BoM, 2003a) for storm durations up to 6 hours and the Revised Generalised Tropical Storm Method (BoM, 2003b) for storms duration from 24 hours and longer. A summary of estimated PMP design rainfall depths is provided in Table 2-2 below.

Design rainfall depths for the 1:10,000 AEP events were derived by interpolating between the 1:1,000 and 1:2,000 AEP values and the PMP values. The interpolation procedure is described in Book 8 Section 3.5.2 of the Australian Rainfall and Runoff (ARR) guideline (Ball et al, 2019). A frequency curve is plotted using a log-normal scale through the derived rainfall totals (i.e. 1:1,000 AEP, 1:2,000 AEP and the PMP), and the 1:10,000 AEP rainfall is read off the curve.

Areal Reduction Factors (ARFs) were estimated using methodology described in Book 2 Chapter 4 of the ARR guideline (Ball et al, 2019). The South-West Western Australia region and conservatively half of the total catchment area (i.e. 23.8 km^2) was adopted to estimate the ARF values. The estimated rainfall depths are summarised in Table 2-2 for storm durations ranging from 1 to 72 hours. Critical-duration storm events (those resulting in runoff with the highest peak discharge) range from 4 to 12 hours for the Karara plant site catchment.

Table 2-2: Summary of Estimated Rainfall Depths for 1 to 72-hour Storm Durations

Duration (hours)	Total Rainfall Depth (mm)			
	1:100 AEP	1:1,000 AEP	1:10,000 AEP	PMP
1	44	66	96	330
1.5	51	76	112	430
2	56	83	121	500
3	64	93	134	600
4	70	103	151	690
5	76	113	164	760
6	82	121	179	810
12	103	153	223	820
24	125	191	279	830
72	167	276	450	1290

The Rangelands West and West Flatlands temporal patterns were taken from ARR (Ball et al, 2019) for the 1% AEP event. The Average Temporal patterns for the 1:1,000 AEP to PMP events were obtained from the GSDM and GTSMR guidelines. Figure 2-1 shows the depth-frequency-duration curves for the KIOP and MIOP project areas, and Figure 2-2 shows the intensity-frequency-duration curves. Figure 2-3 and Figure 2-4 show the precipitation data for the Yandanooka area. Gridded rainfall results show an average variation of approximately 2% across the KIOP, MIOP, and Syncline Turner Haul Road areas; a single set of IFD values based on the centroid of the catchments was applied for these areas. Precipitation in the Yandanooka area differs substantially from the remaining areas, and separate IFD values were applied for Yandanooka.

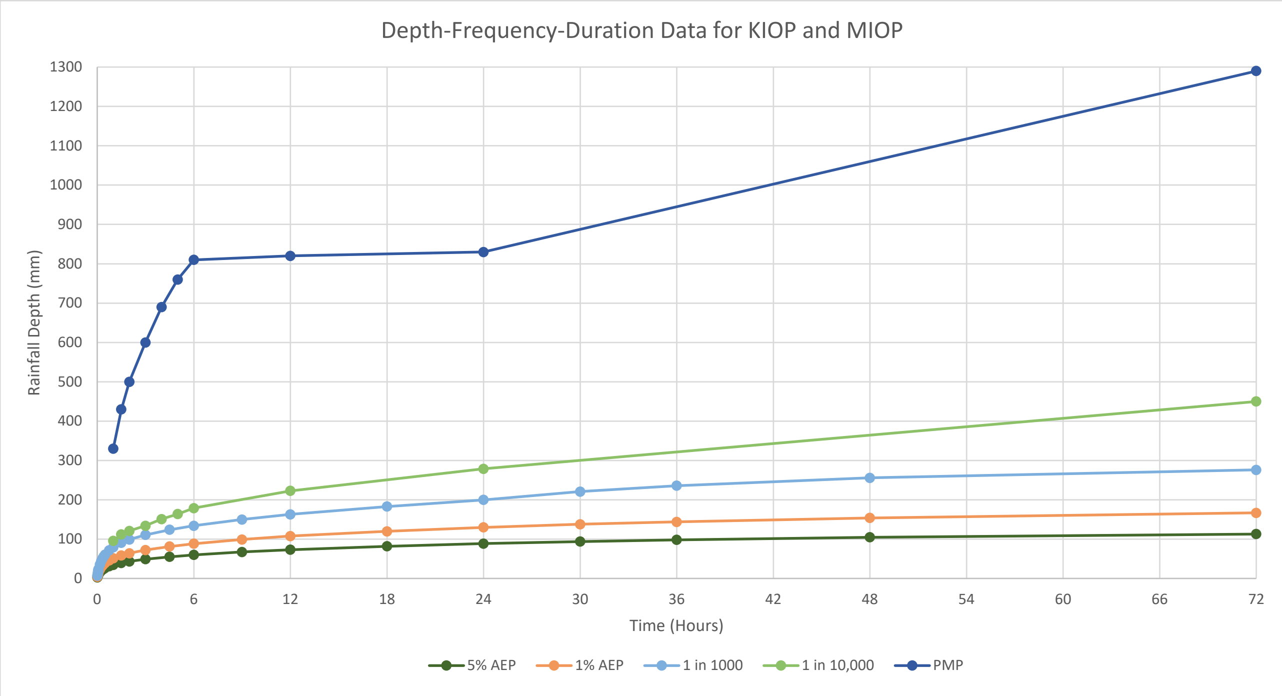

Figure 2-1 Depth-Frequency-Duration Curves for KIOP and MIOP

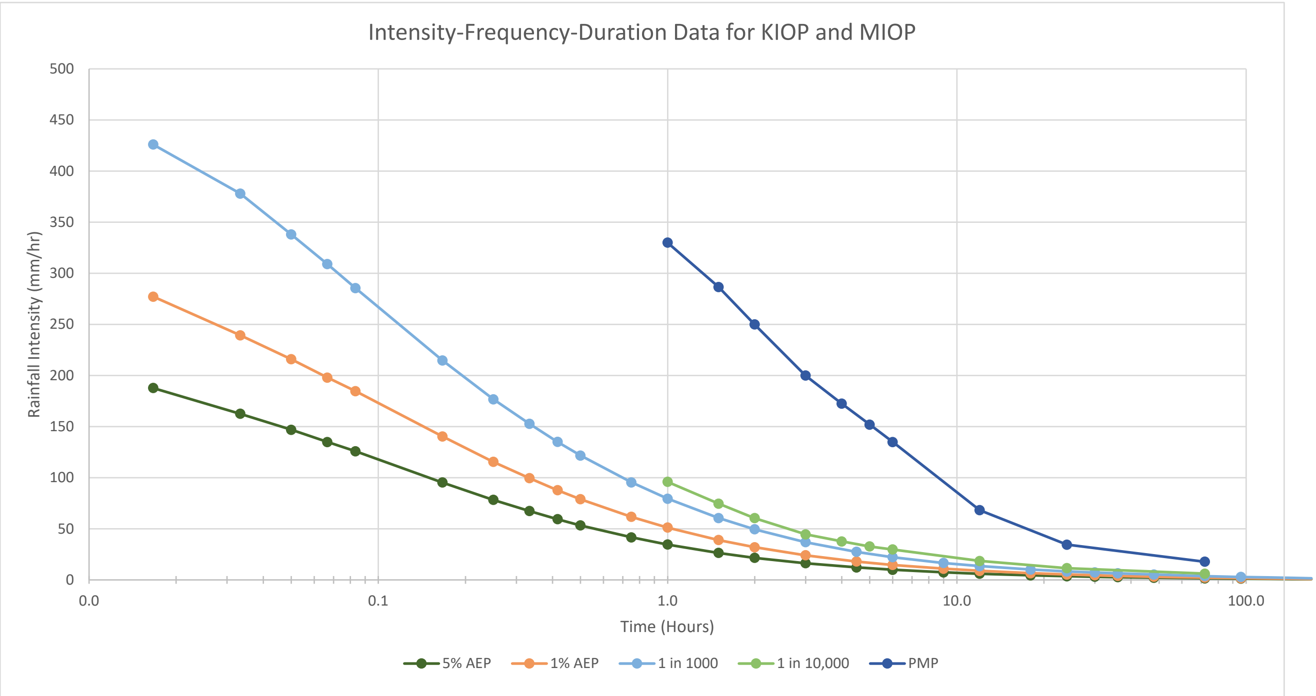

Figure 2-2 Intensity-Frequency-Duration Curves for Karara

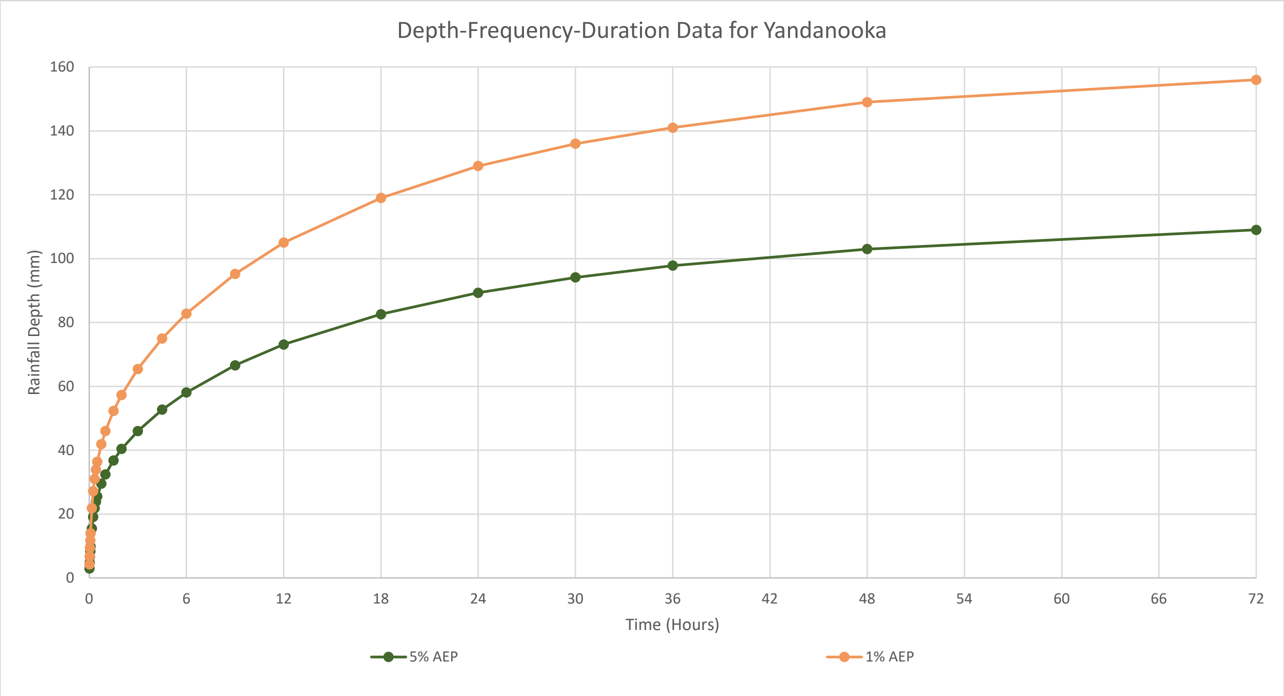

Figure 2-3 Depth-Frequency-Duration Curves for Yandanooka

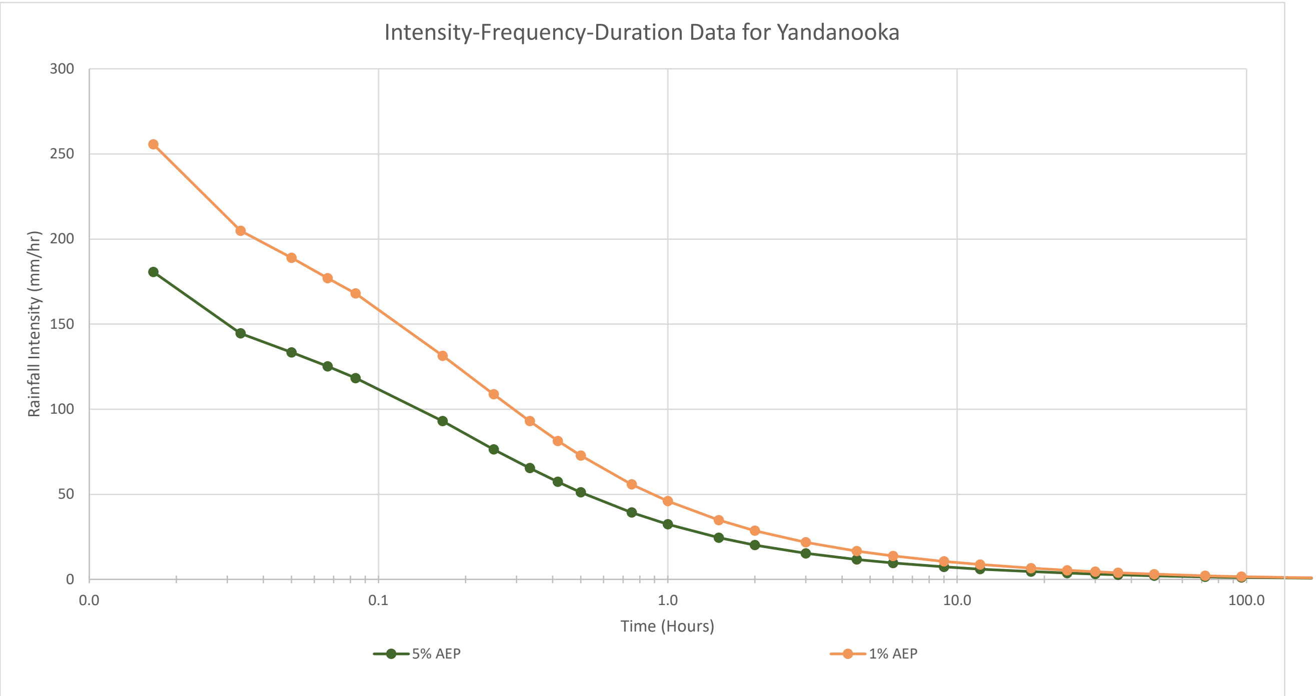

Figure 2-4 Intensity-Frequency-Duration Curves for Yandanooka

2.3 Rainfall-Runoff Routing

There are no Department of Water and Environmental Regulation (DWER) flow gauges in the vicinity of the KIOP and MIOP site areas. In the absence of catchment runoff records, a runoff-routing model (XPRAFTS) was developed to estimate runoff in the KIOP catchment. These results were used as a comparison with the HEC-RAS direct precipitation hydraulic modelling results for KIOP and MIOP.

The catchment boundaries for catchments flowing toward the KIOP mine site were derived using the available topographic data. The catchment outlet was defined at the hydraulic modelling flow validation location; the sub-catchment boundaries, catchment outlet location, and associated areas are presented in Figure 2-5.

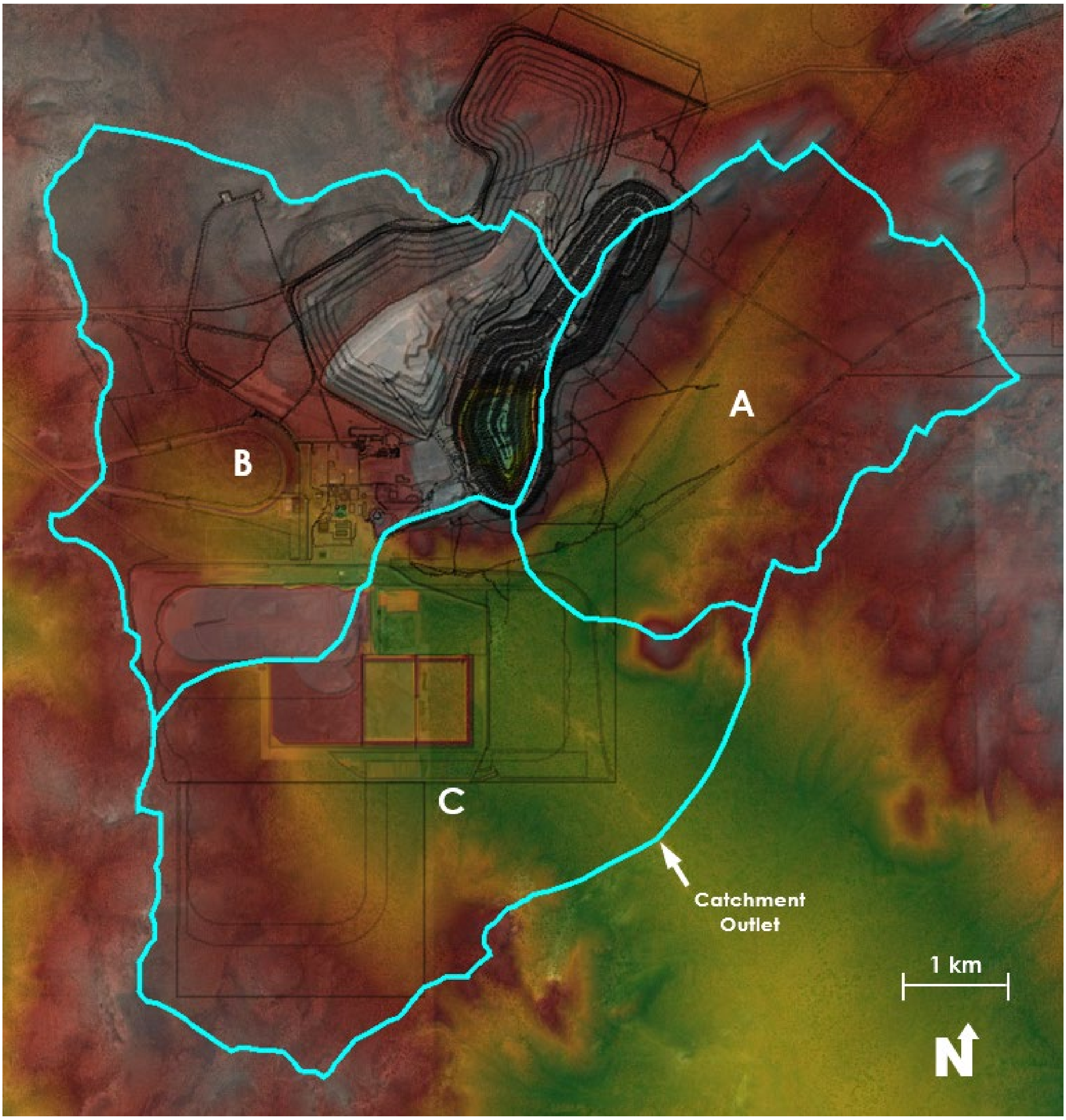

Figure 2-5 Hydrologic Model Layout

The XPRAFTS rainfall-runoff routing model (Version 2018.1.2) was used to estimate baseline runoff for the KIOP South catchment. XPRAFTS is a general runoff and streamflow routing program used to calculate flood hydrographs from rainfall and other catchment related inputs. Based on similar catchment characteristics and land cover, XPRAFTS results are used to inform the selection of parameters for rain-on-grid hydraulic modelling of all assessed catchments, including KIOP North and MIOP catchments.

XPRAFTS modelling allows for the catchment characteristics to be represented using catchment area, catchment average slope, impervious fraction, PERN (similar to the Manning's roughness coefficient), and rainfall losses. The adopted PERN value (0.05) was selected based on the review of aerial photography. The lag time between sub-catchments was estimated by assuming average flow velocity of 1 m/s. The adopted parameters in the XPRAFTS model are provided in Table 2-3.

Table 2-3: Karara XPRAFTS Model Inputs

	Sub-catchment Nam		
Parameter	A	B	C
Catchment area (km^2)	13.53	15.70	18.41
Slope (%)	1.81	1.34	0.87
Lag time to D/S node (min)	47	63	0

ARR Data Hub results are presented in Appendix B. Infiltration data (initial and continuing loss rates) are not available for the project area through the ARR Data Hub due to extreme variability in soil conditions and a lack of available calibration data in the region. Given ARR 2019 does not include current guidance for loss rates in the region, assumed infiltration rates were based on previous hydrology reports as listed in Section 1.2, which cite Table 3.3 in Book 2 Section 3 of ARR (Pilgrim et al, 1987). The initial loss data for 1:1,000 AEP and 1:10,000 AEP were interpolated between 1% AEP and PMP (using an equivalent 1:10,000,000 AEP) in accordance with the methodology described in Book 8 Section 4.3 ARR (Ball et al, 2019). The adopted losses in XPRAFTS model are provided in Table 2-4. The adopted precipitation values in this report do not include uplift for climate change; interim climate change guidance currently under review by DCCEEW (2024) recommends accounting for non-stationarity in extreme events. If adopted, the precipitation values in this report should be revisited.

Table 2-4: Adopted Losses in XPRAFTS The Model

Design Event	Initial Loss (mm)	Continuing Loss (mm/hr)
1% AEP (1:100)	38.0	3
1:1,000 AEP	30.4	3
1:10,000 AEP	22.8	3
PMF	0	1

2.4 Hydrologic Model Validation

In the absence of hydrological model calibration, a Regional Flood Frequency Estimation (RFFE) procedure was performed to validate the 1% AEP peak flow at the catchment outlet. Results are included in Appendix C. The input data adopted to produce the RFFE model is summarised in Table 2-5. The estimated peak flow for the Karara catchment using the RFFE model is shown in Figure 2-6.

The modelling results indicated a reasonable agreement between the estimated 1% AEP peak flows using XPRAFTS (78 m^3/s) and the RFFE model (67 m^3/s). The estimated peak flow using the XPRAFTS model is assumed to be more representative of local conditions than the RFFE model results due to the limited calibration data which was available to develop the RFFE model parameters in remote areas of Australia such as Karara.

Table 2-5: RFFE Input Data

Parameter	Value
Catchment Area (km^2)	47.6
Latitude (Outlet)	-29.2195
Longitude (Outlet)	116.789
Latitude (Centroid)	-29.1946
Longitude (Centroid)	116.77

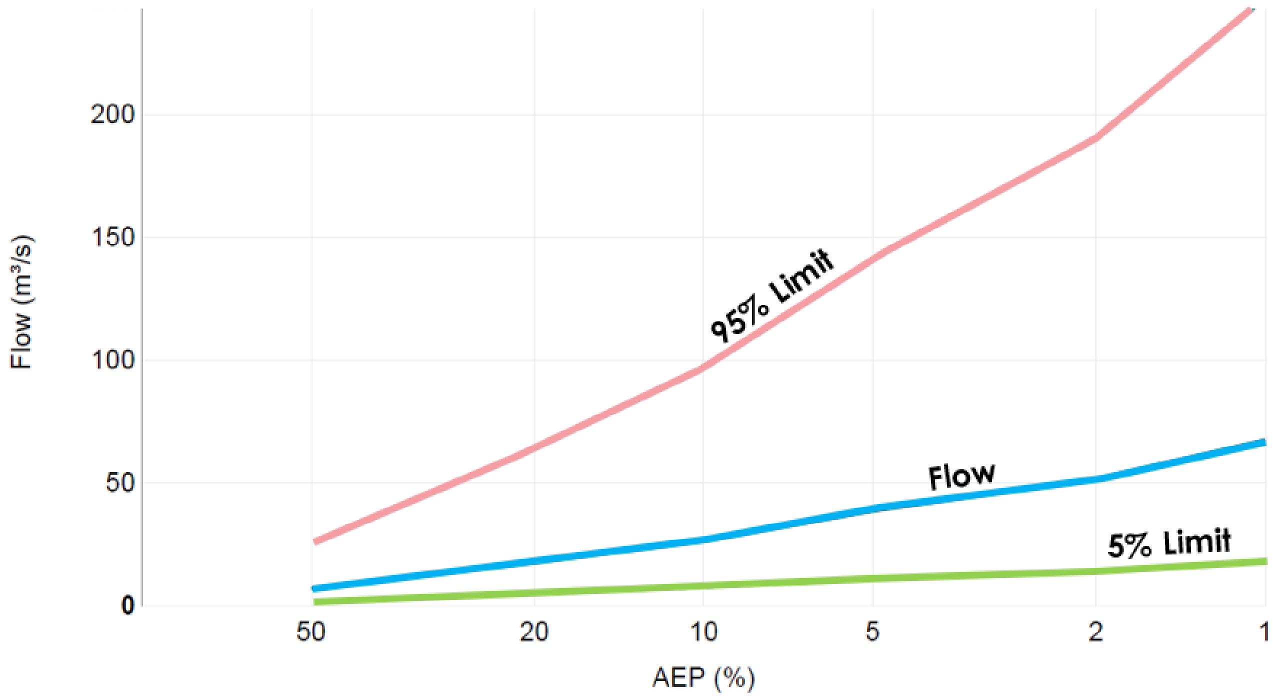

Figure 2-6 Estimated Peak Flow for Various Design Events using RFFE Model

2.5 Hydrologic Model Results

The XPRAFTS model was used to estimate preliminary flows at the catchment outlet for the 1% AEP, 1:1,000 AEP, 1:10,000 AEP and PMF events. The resulting critical durations (the rainfall duration resulting in the highest peak discharge rate) range from 4 to 12 hours. The peak flow rates at the catchment outlet are summarised in Table 2-6.

The estimated peak flow using the West Flatlands temporal pattern for the 1% AEP design event was adopted as it resulted in a more conservative peak flow. The flow hydrographs at the catchment outlet are illustrated in Figure 2-7. These flow rates are used for validation of applied catchment parameters in the rain-on-grid hydraulic model developed for KIOP and MIOP.

Table 2-6: Peak Flow at the Catchment Outlet

Design Event	Peak Flow (m^3/s)	Critical Duration (hr)
1: 100 AEP	78.3[1]	9
1: 1,000 AEP	229	12
1:10,000 AEP	404	12
PMF	2397	4

[1] Maximum of estimated peak flow using Rangelands West (72.1 m^3/s) and West Flatlands (78.3 m^3/s) temporal patterns

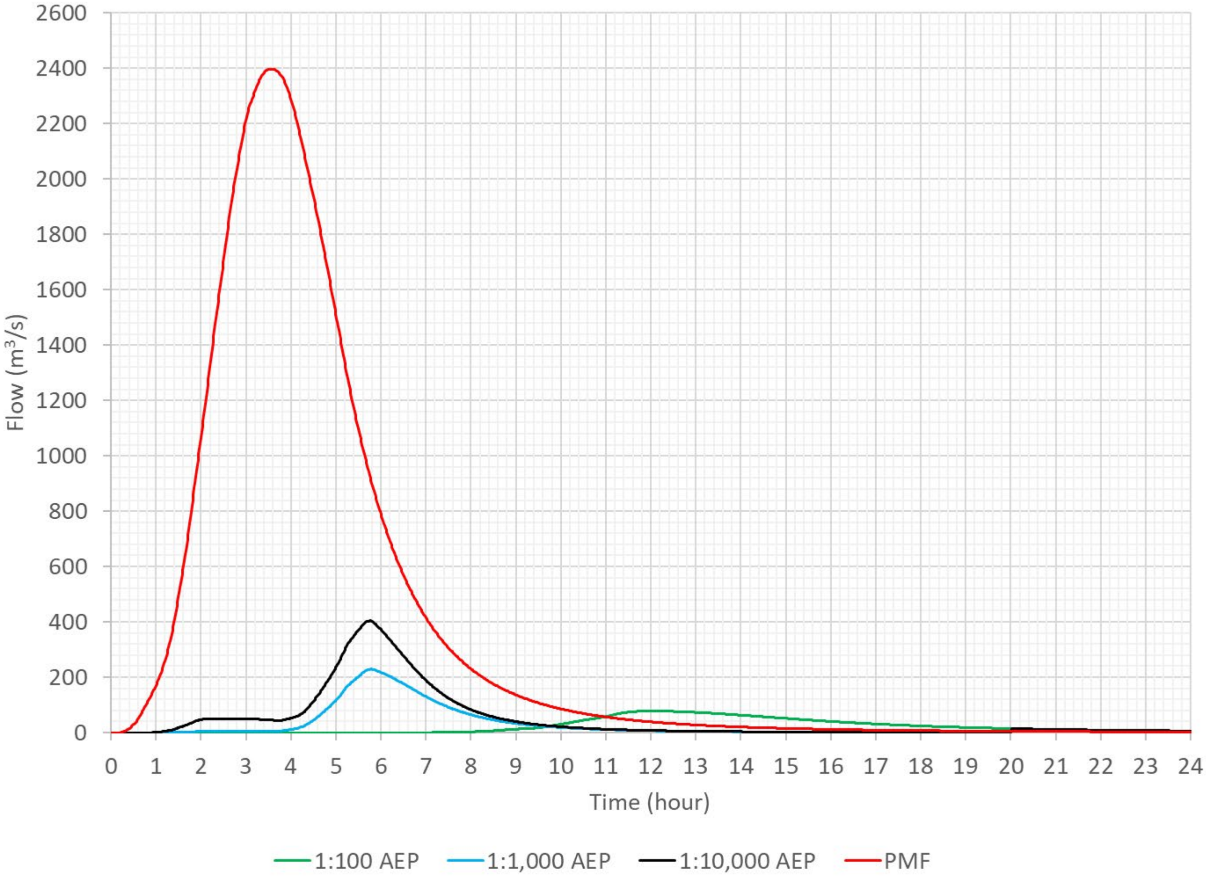

Figure 2-7 XP-RAFTS Flow Hydrographs at the Catchment Outlet

3. Hydraulic Model Development

Direct precipitation (or rain-on-grid) models were set up for the baseline condition, operational Life of Mine (LoM) condition, and closure condition in HEC-RAS 2D Version 6.4 using the input parameters defined in the following sections.

3.1 Terrain

The underlying terrain for the HEC-RAS models were compiled from the 20 cm by 20 cm Digital Elevation Models (DEMs), supplemented with the 1 m by 1 m resolution DEM where the finer resolution coverage was incomplete. The DEMs are based on smoothed photogrammetry from 5 cm and 20 cm multi-spectral imagery data acquired by KML in 2021. Areas outside the LiDAR coverage area were incorporated from publicly available SRTM (satellite-based) terrain data with an approximate resolution of 30 m by 30 m. Some discrepancies occur along the interfaces between terrain surfaces, and the DEMs were smoothed along a corridor using the HEC-RAS terrain modification tool to facilitate flow across the interface. The Yandanooka Borefield and Pipeline area utilises a DEM compiled from Department of Primary Industries and Regional Development 5 m contour data (DPIRD, 2000).

3.2 Precipitation and Loss Rates

Rainfall hyetographs and loss rates were adopted based on the critical-duration XP-RAFTS input described above, with losses subtracted from the rainfall to generate rainfall excess for application as a model boundary condition.

3.3 Computational Grid Size

A computational grid size of 20 metres was applied to the 120 km^2 KIOP 2D flow area, covering the catchment areas draining toward the KIOP site. Break lines were added along embankment crests, drain centrelines, bunds, benches, and roadways with resolutions varying from 5 to 10 metres as illustrated in Figure 3-1. HEC-RAS recognises the sub-grid resolution of the terrain data, which varies up to 0.2 metres where applicable.

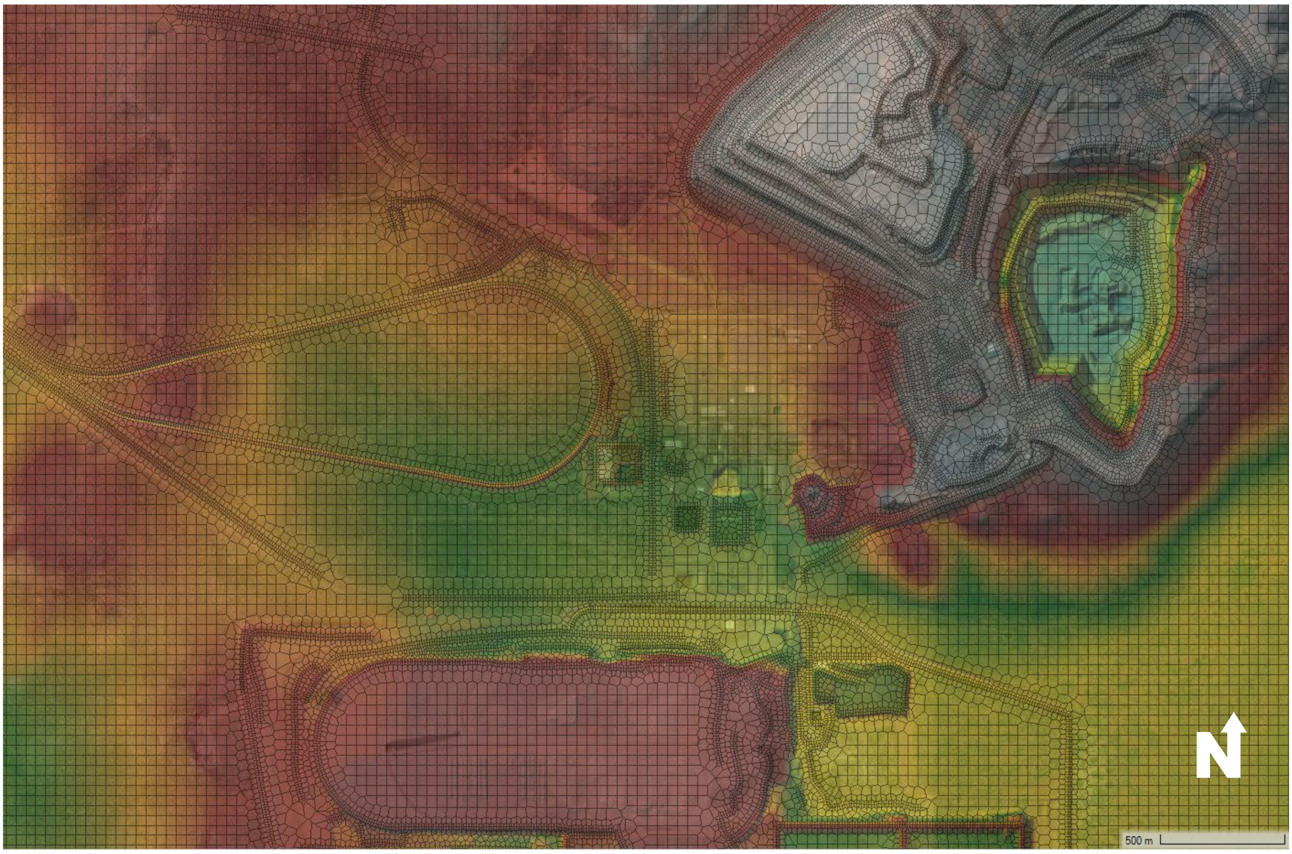

Figure 3-1 KIOP Computational Grid Example

A 10m x 10m grid was applied to the MIOP and Syncline Turner Haul Road areas, and a 50m x 50m computational grid was assigned to the Yandanooka Borefield area.

3.4 Culverts

Fifteen (15) sets of culverts were incorporated into the model based on survey data provided by KML. The relative locations of the modelled culverts are shown as blue polylines in Figure 3-2. Any existing culverts that are not modelled are assumed to be blocked under design flow conditions.

Figure 3-2 Modelled Culvert Locations

3.5 Timestep and Simulation Window

An adaptive time step was applied to the model. The resulting timesteps varied from 1-5 seconds. A 24-hour simulation window was applied to capture the recession of peak flows throughout the modelled area.

3.6 Mannings Roughness Coefficient

Non-vegetated, engineered diversion channels and catch drains were assigned Mannings roughness coefficients ranging from 0.04 to 0.06, and sheet flow areas were assigned a roughness coefficient of 0.08. A roughness coefficient of 0.2 was applied to the proposed top-soil stockpile areas.

3.7 Outflow

The 2D model extents and flow directions are shown in Figure 3-3. Normal depth energy gradients were applied at outflow locations, with the assigned slope matching the bed slope of existing drainage paths. Slopes vary from approximately 0.1% to 1%. Several internally draining basins are apparent in the available topographic data; basins were assumed to be dry at the commencement of the modelled precipitation events.

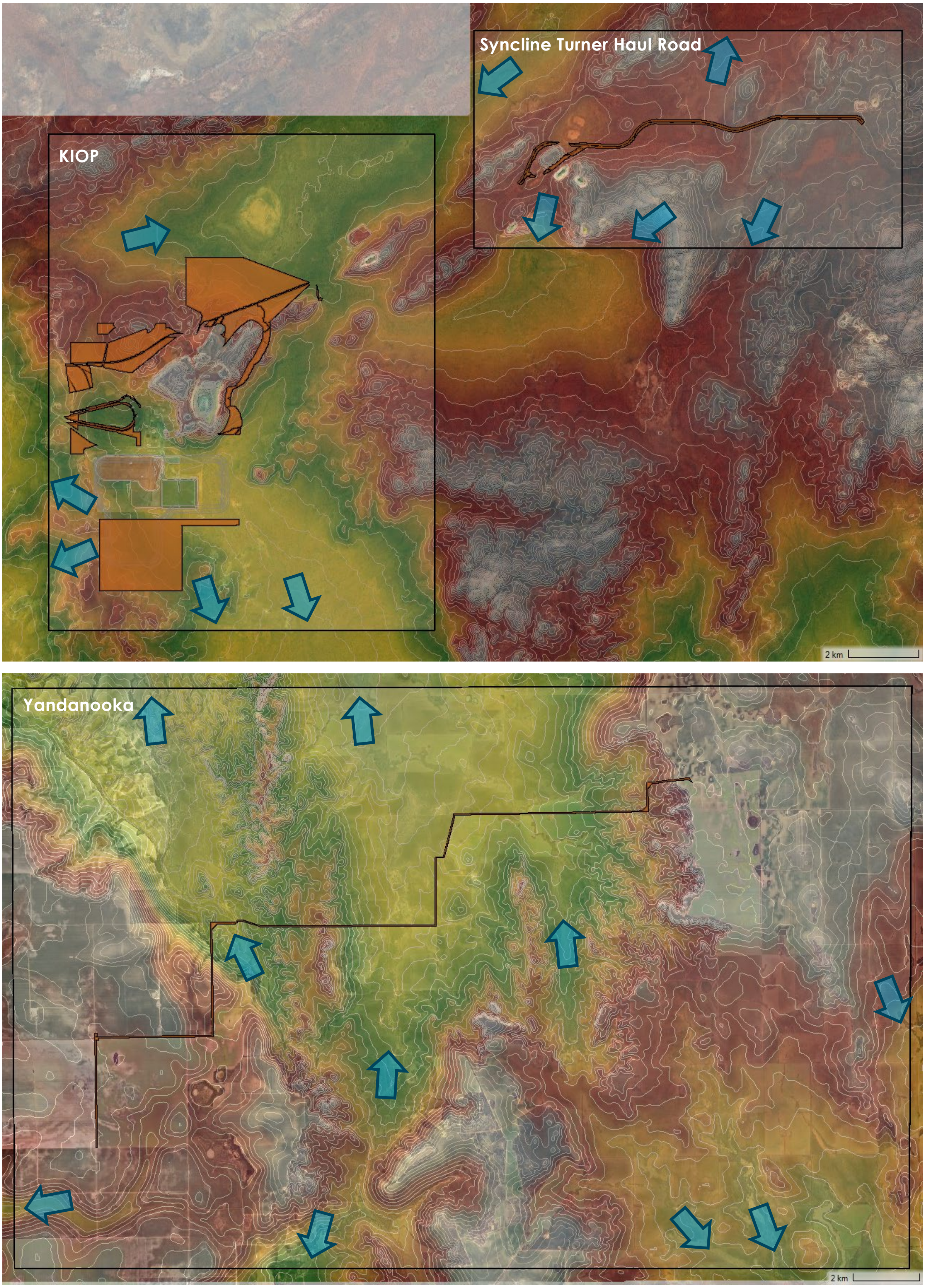

Figure 3-3 2D Flow Areas with Flow Directions

3.8 Calculation Options and Tolerances

The full momentum shallow water equation set was adopted for the model runs. All remaining coefficients, options, tolerances, and model settings apply default program settings.

3.9 Summary of Parameters and Simulation

Table 3-1 summarises the model parameters used for the selected model runs. In addition, sensitivity runs were applied to selected models in order to optimise grid size, timesteps, and boundary condition locations as well as to determine confidence bands around the presented results.

Table 3-1: Summary of Model Parameters

Model Parameter	Value
Precipitation	ARR 2019 temporal patterns
Outflow Boundary Condition	0.1% - 1% normal depth slope
Simulation Window	24 hours
Computational Time Step	1-5 seconds
Computational Mesh Grid	2-20 metres
Roughness (channels and floodplains)	0.04 – 0.06
Roughness (sheet flow and topsoil areas)	0.08 – 0.2
Roughness (culverts)	0.023
Equation Set	Full Momentum Shallow Water Equation
DEM Grid Resolution	0.2-5 metres

Table 3-2 summarises the model runs along with the underlying terrain features and flood events applied to each model run.

Table 3-2: Summary of model runs

Area	Scenario	Flood Event				
		5% AEP	1% AEP	1 in 1,000 AEP	1 in 10,000 AEP	PMF
Karara (KIOP)	Baseline[1]	X	X			X
Karara (KIOP)	LoM[2]	X	X			X
Karara (KIOP)	Closure[3]		X	X	X	X
Terapod (MIOP)	Closure[4]		X			X
Blue Hills (MIOP)	Closure[4]		X			X
1. Baseline condition uses 2021 50cm DEM LiDAR terrain with first lift of dry stack TSF and existing culverts/drains based on 2020 survey data						
2. Life of Mine condition uses baseline terrain/culverts/drains + future WRD, TSF, roads, toe bund, stockpile areas, and diversion						
3. Mine site closure is Life of Mine terrain with rail embankment breach and culverts removed						
4. MIOP sites apply baseline 2020-2021 terrain as the closure condition						

4. Results

4.1 Flood Depths, Inundation Extents, and Peak Velocities

Maximum flood depths, inundation extents, and peak velocities are shown in Appendix D for the fourteen model runs summarised in Table 3-2. Results are shown with a 10 cm threshold for display. The depth results show substantial ponding behind the rail loop culverts and where the existing and proposed drain meet the natural drainage path. Velocity results indicate some areas with potential erosion as described below.

4.2 Water Surface Elevation and Velocity Profiles

Figure 4-1 shows the alignment of the main drainage line extending across the site in the Baseline Condition model runs. Figure 4-2 shows the alignment of the LoM and Closure Condition drain.

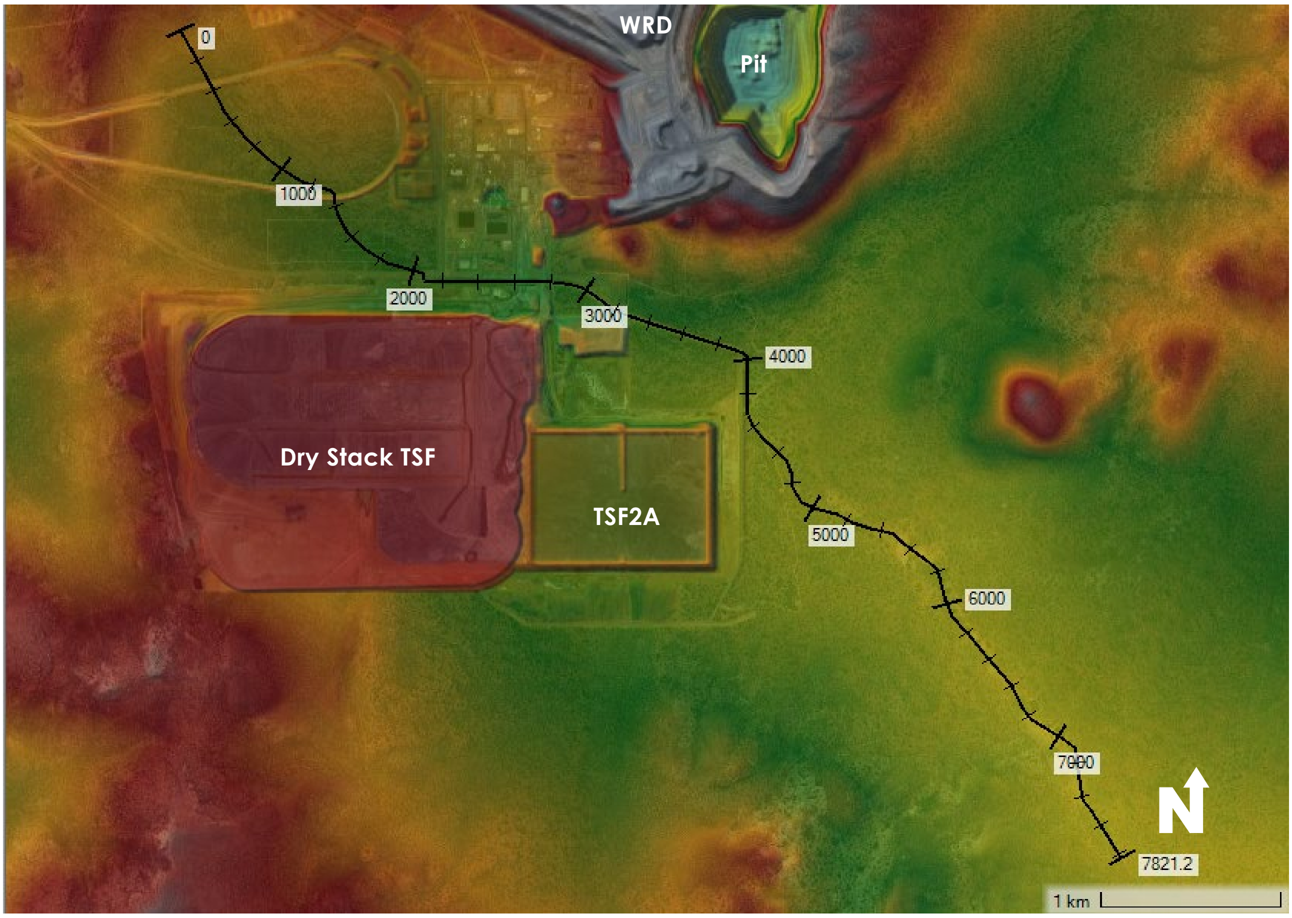

Figure 4-1 Profile Alignment and Chainage along Existing Drain

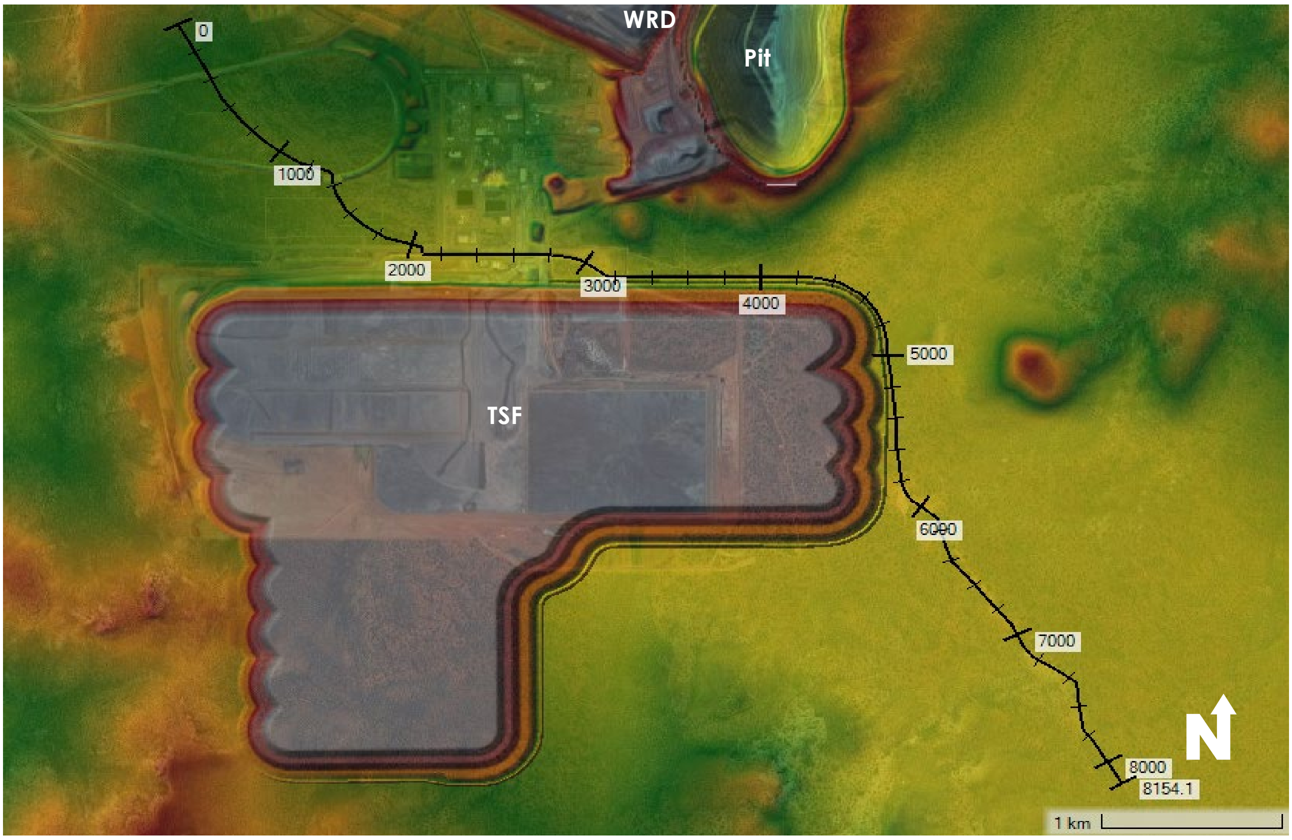

Figure 4-2 Profile Alignment and Chainage along Proposed Drain

Figure 4-3 and Figure 4-4 show the maximum water surface elevation (WSE) and peak velocity profiles measured along the drain alignment for Baseline Conditions. Figure 4-5 and Figure 4-6 show the water surface elevation and velocity profiles for the LoM scenario, and Figure 4-7 and Figure 4-8 reflect the Closure Condition.

The KIOP water surface elevation profiles provide indicative guidance for bund heights, with freeboard applied above the hydraulic gradient.

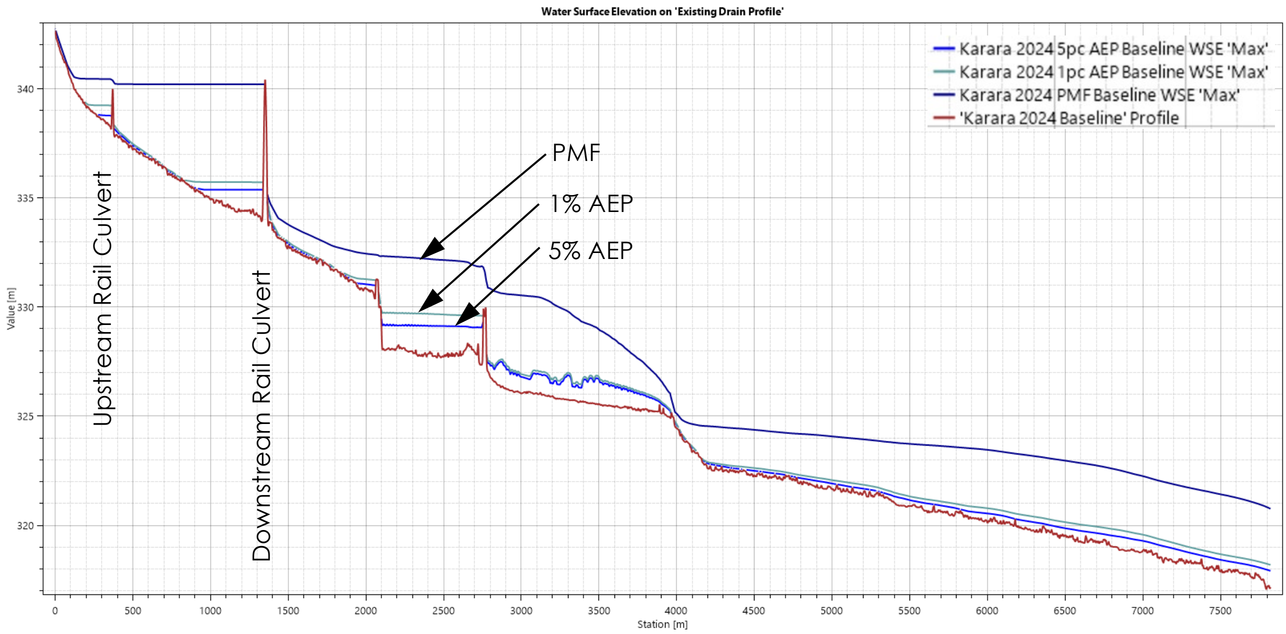

Figure 4-3 Maximum Water Surface Elevation Profiles for Baseline Runs along Existing Drain Alignment

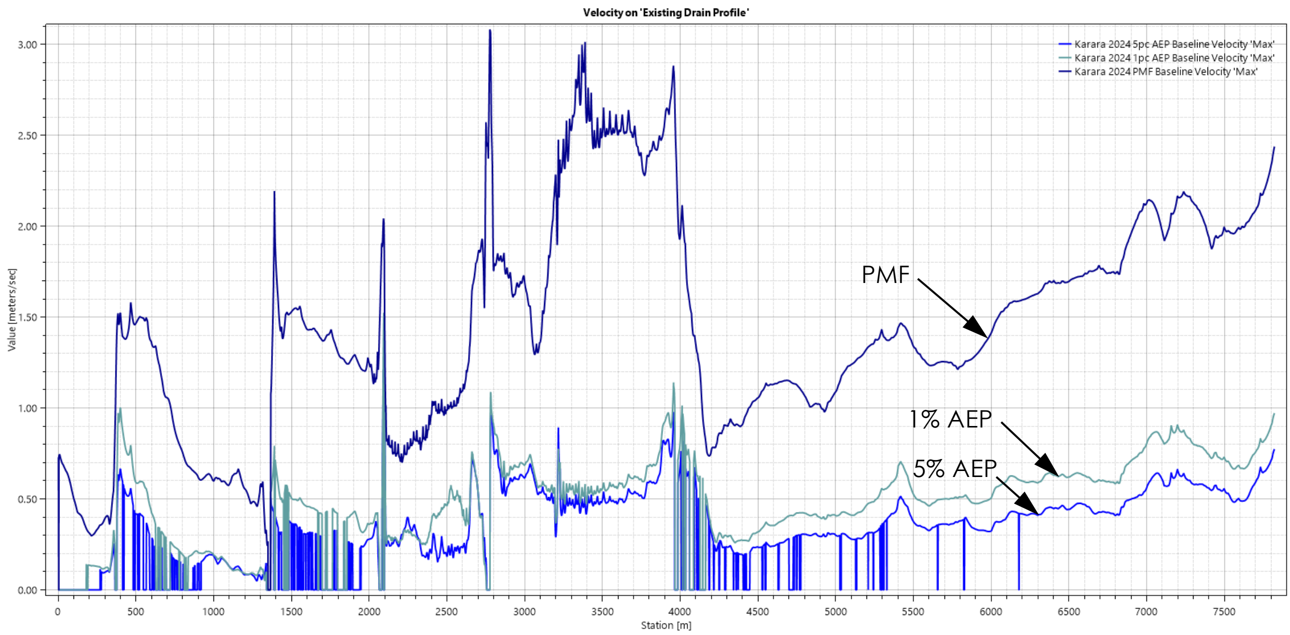

Figure 4-4 Maximum Velocity Profiles for Baseline Runs along Existing Drain Alignment

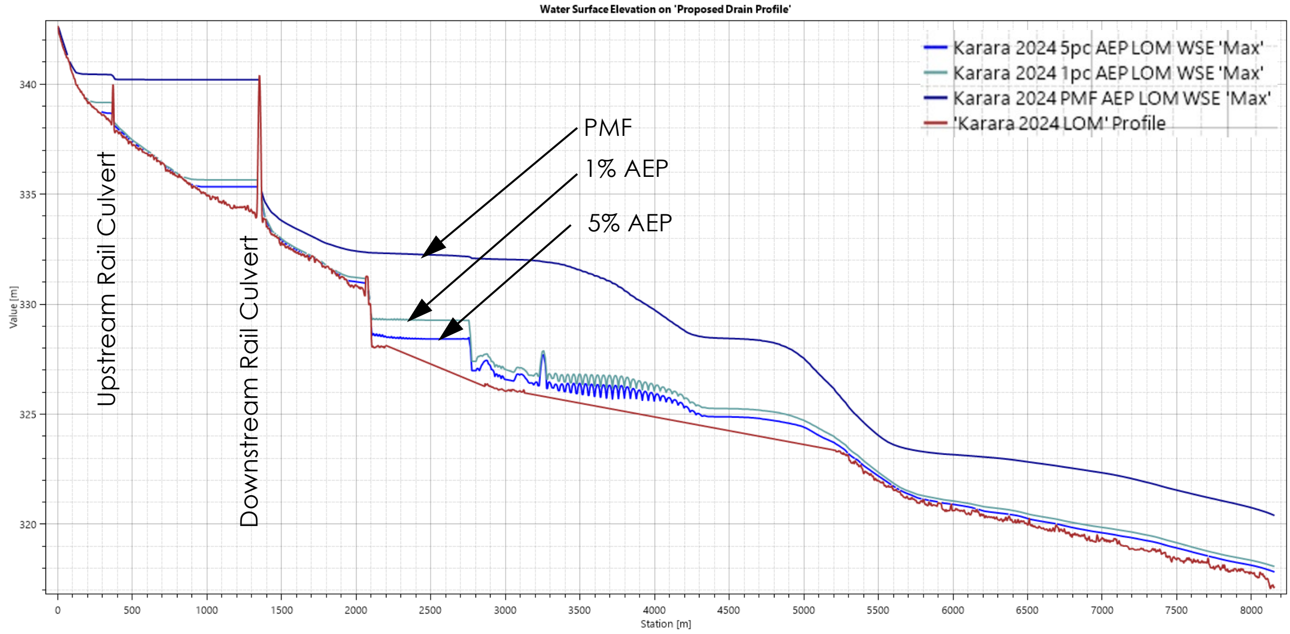

Figure 4-5 Maximum Water Surface Elevation for LoM along Proposed Drain Alignment

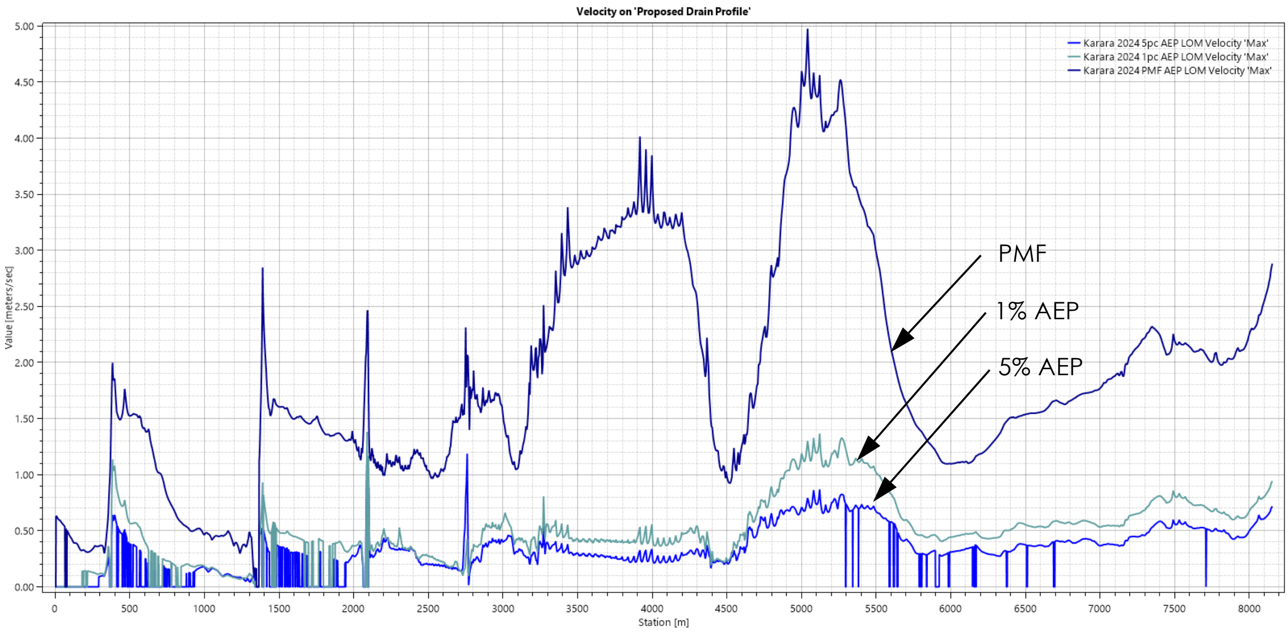

Figure 4-6 Maximum Velocity for LoM along Proposed Drain Alignment

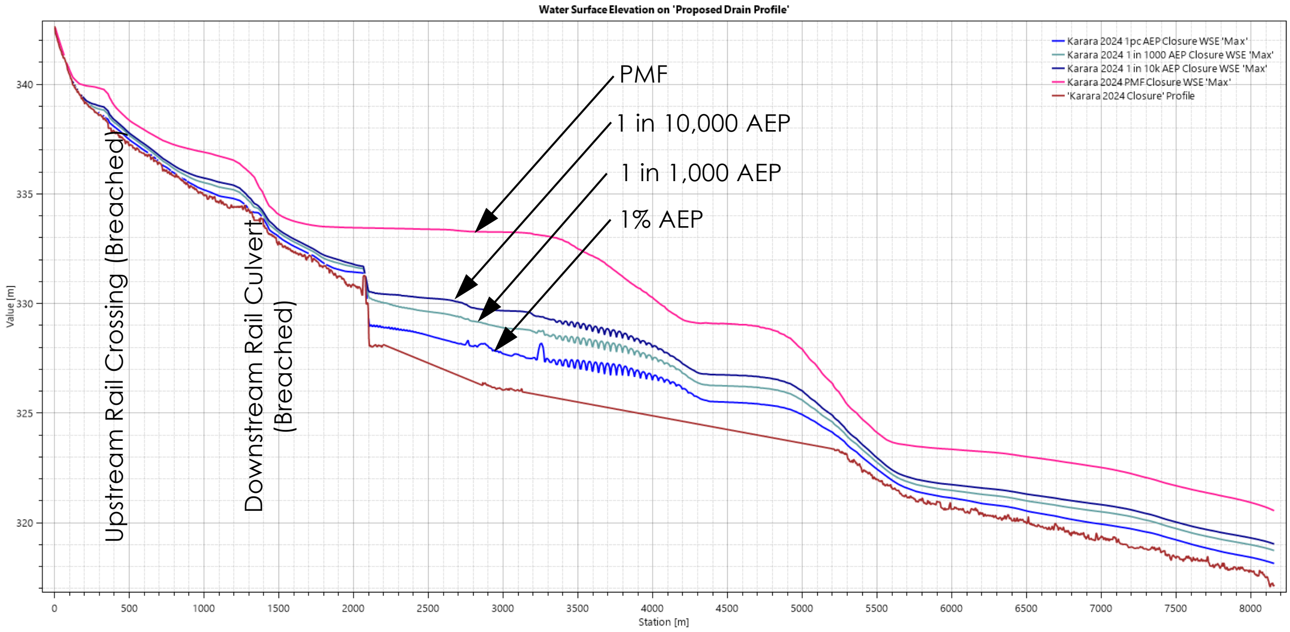

Figure 4-7 Maximum water surface elevation for closure along proposed drain alignment

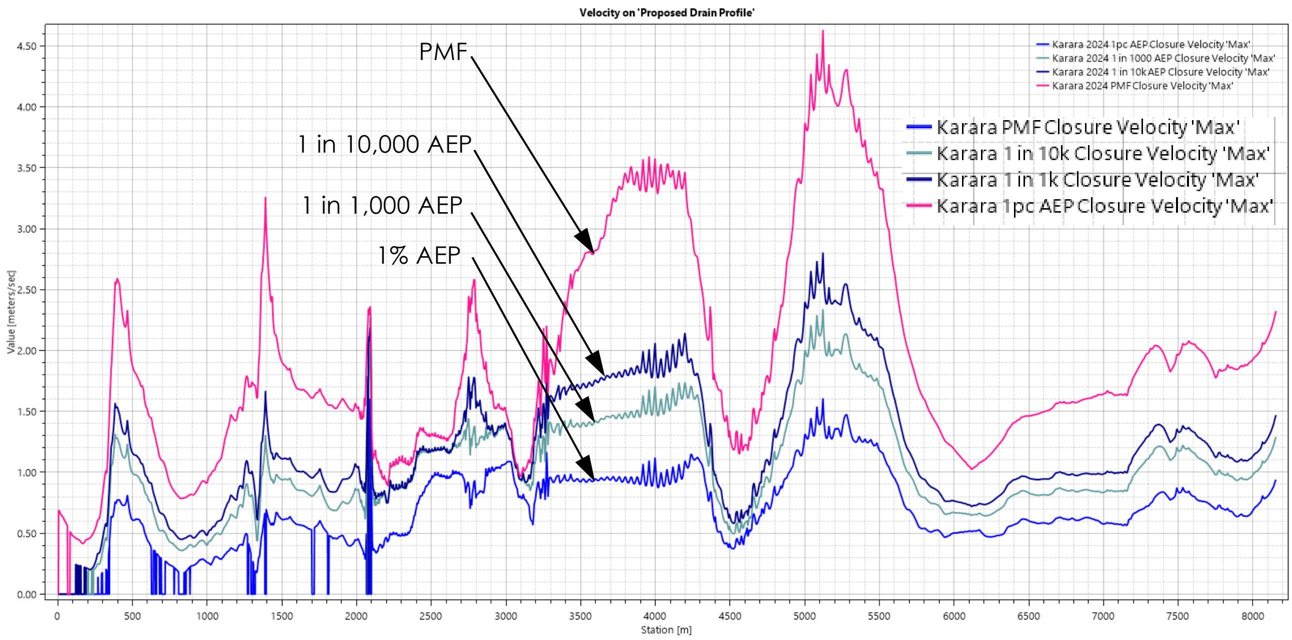

Figure 4-8 Maximum velocity for closure along proposed drain alignment

4.3 Pit Filling

Appendix E shows the impacts of a 72-hour PMF precipitation event on pit lake levels at KIOP and MIOP. The results indicate that sufficient freeboard is present in the pit walls to prevent overtopping.

5. Impacts

5.1 Impacted Areas

As shown in the inundation maps in Appendix D, the modelling results were used to predict areas where ponding is expected to occur following rainfall under LoM and Closure Conditions.

Figure 5-1 highlights areas where ponding occurs along the roadway adjacent to the proposed LoM waste rock landform expansion in the 5% AEP event. The PMF event is shown for the closure condition in Figure 5-2. The baseline and LoM ground profiles and 5% AEP water surface elevation profiles are shown in Figure 5-3, with corresponding peak velocities shown in Figure 5-4. In the concentrated flow areas highlighted in the figures, lateral drains, bunds, floodway crossings, culverts, or a combination of culverts and floodway crossings will be implemented to facilitate drainage, minimise downtime, and reduce the risks of erosion and sedimentation.

Figure 5-5 highlights areas where ponding occurs along the southern TSF expansion in the 5% AEP event. The PMF event is shown for the closure condition in Figure 5-6. The ground profile and 5% AEP water surface elevation profiles are shown in Figure 5-7, with corresponding peak velocities shown in Figure 5-8. In the ponded areas highlighted in the figures, placement of a sump is recommended to prevent standing water against the toe of the embankment.

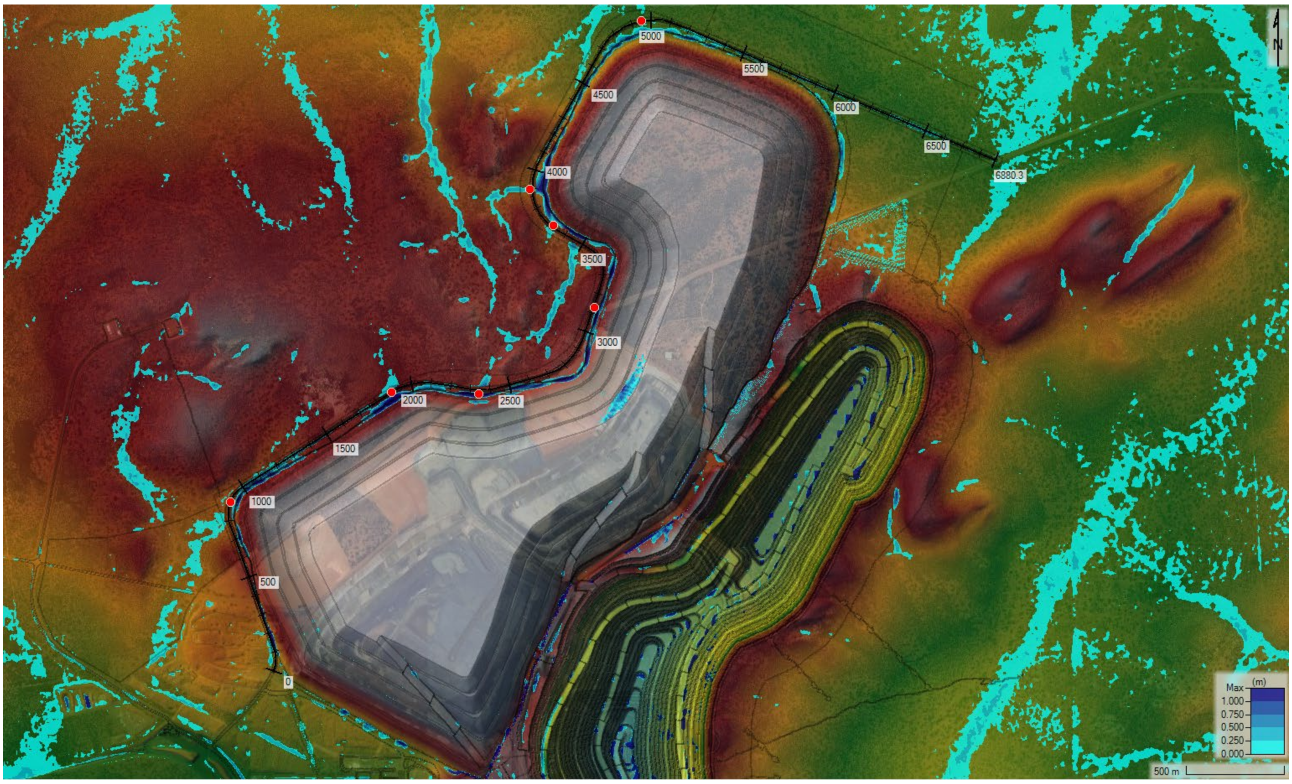

Figure 5-1 Northern Ponding Areas in 5% AEP LOM Scenario

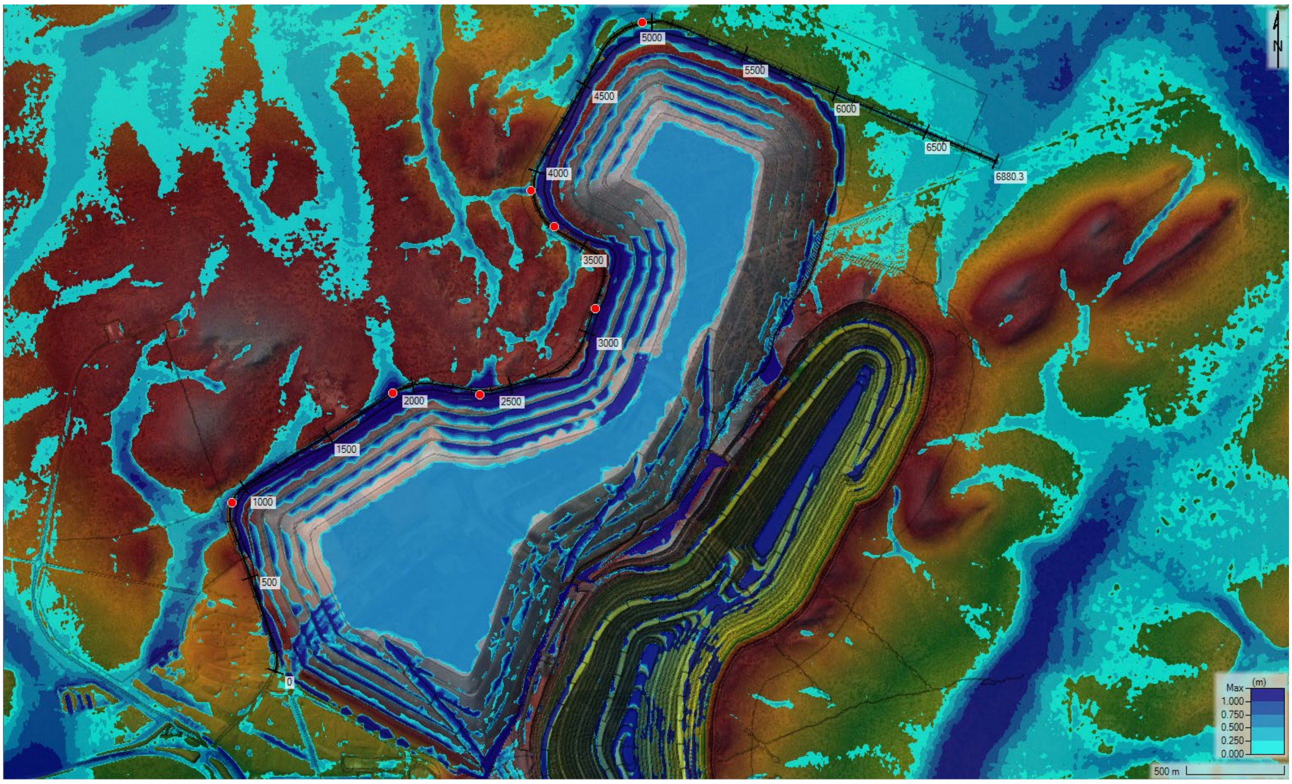

Figure 5-2 Northern Ponding Areas in PMF Closure Scenario

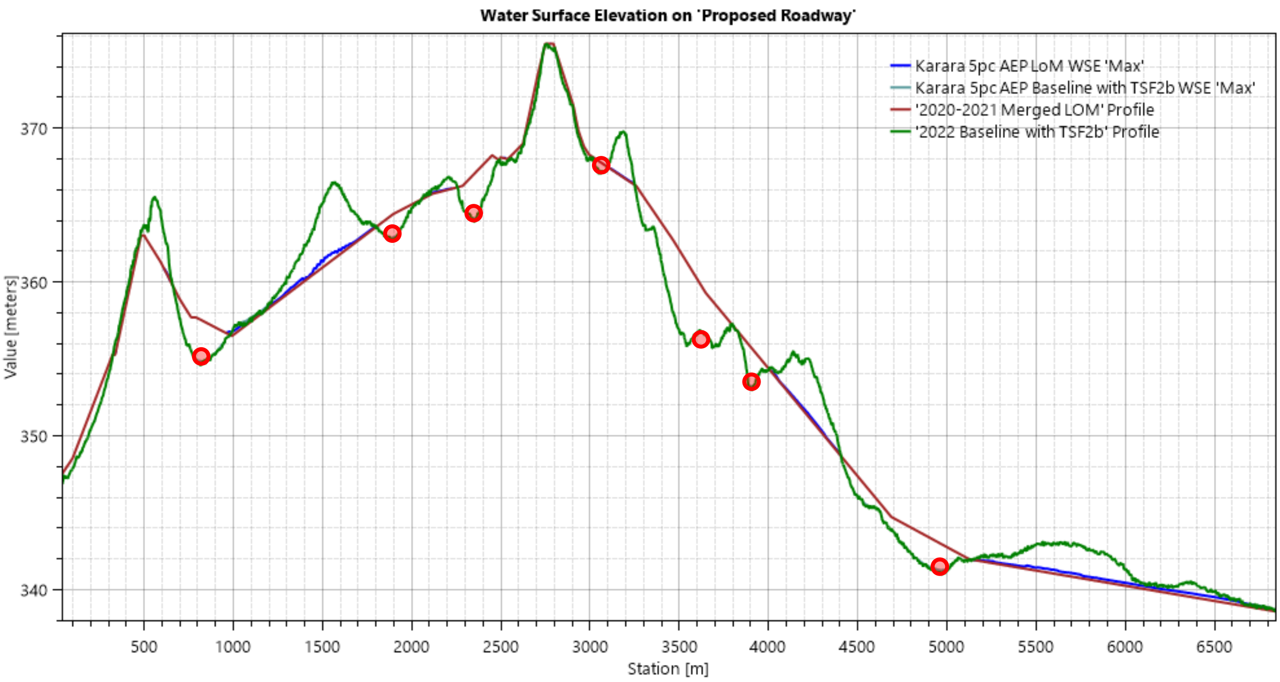

Figure 5-3 5% AEP Water Surface Elevation Profile for Baseline and LoM Condition along Roadway

Figure 5-4 5% AEP Maximum Velocity Profile for Baseline and LoM Condition along Roadway

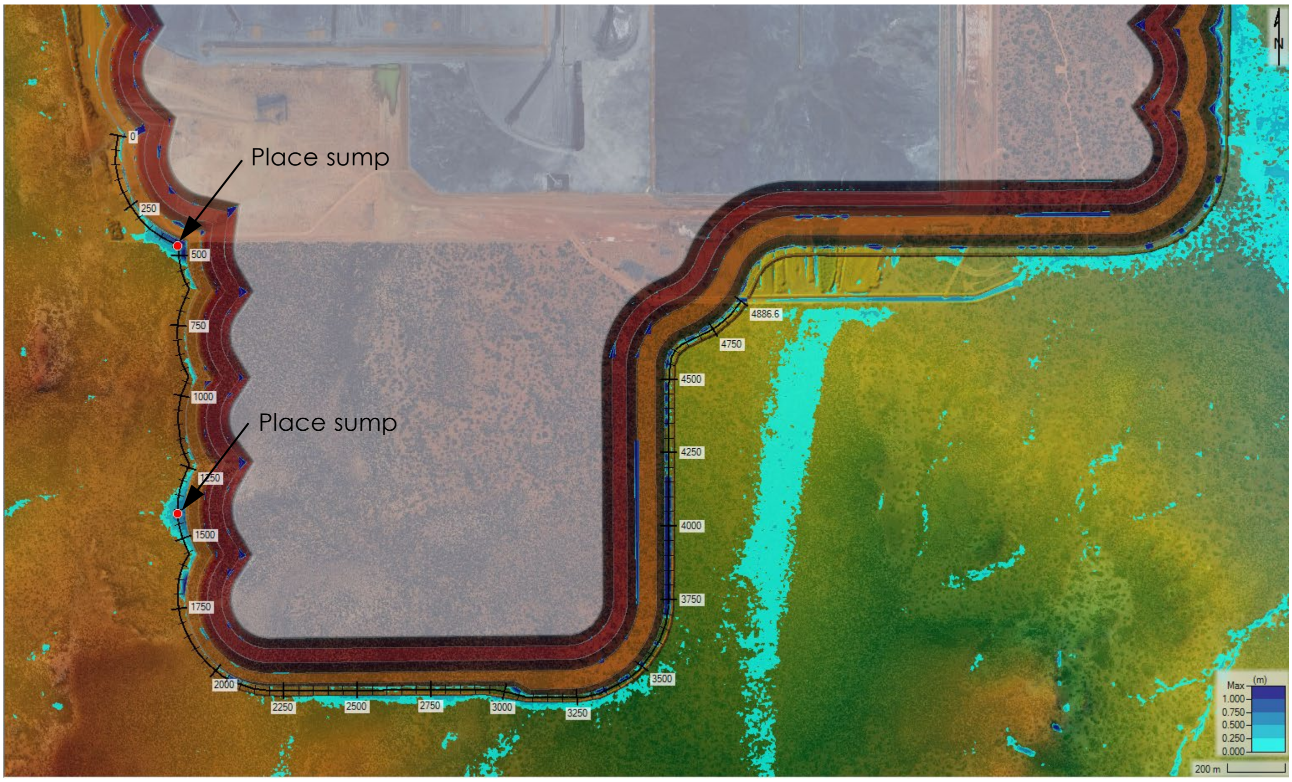

Figure 5-5 Ponding Areas in 5% AEP LoM Scenario for TSF Expansion

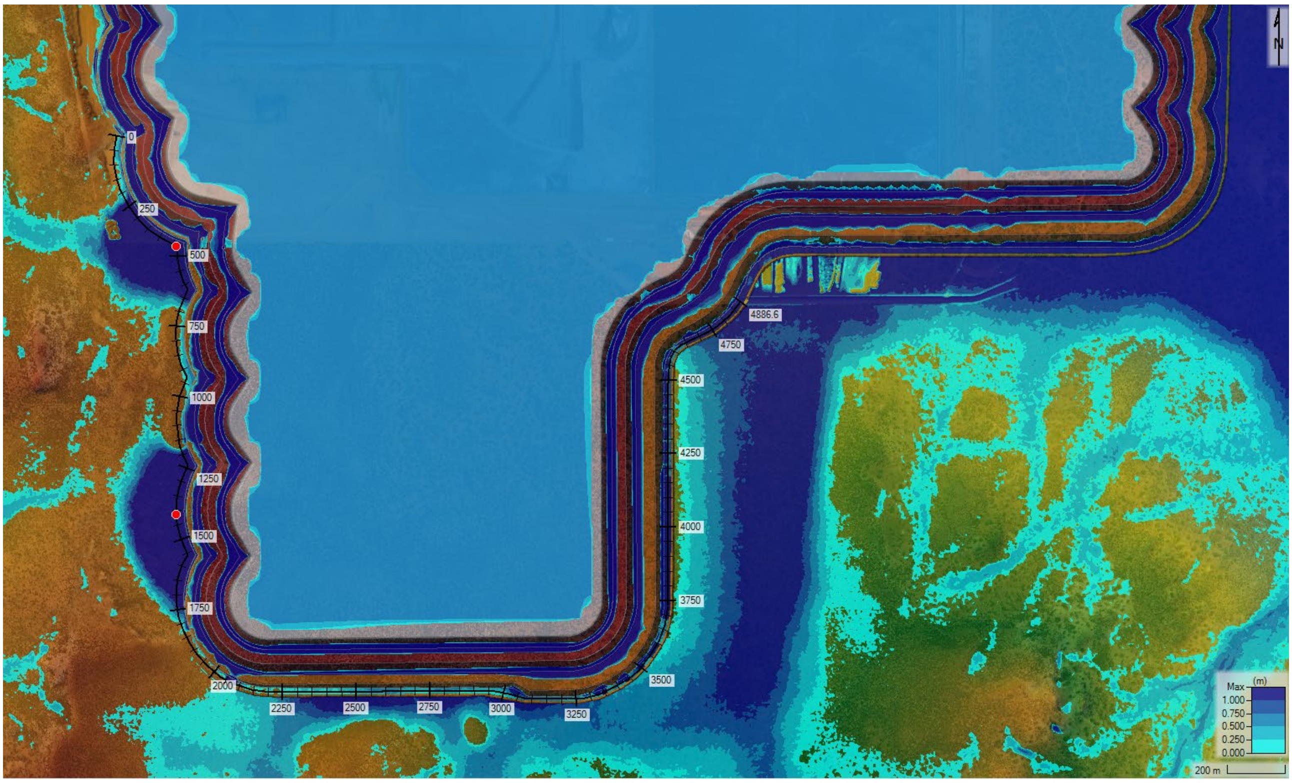

Figure 5-6 Ponding Areas in PMF Closure Scenario for TSF Expansion

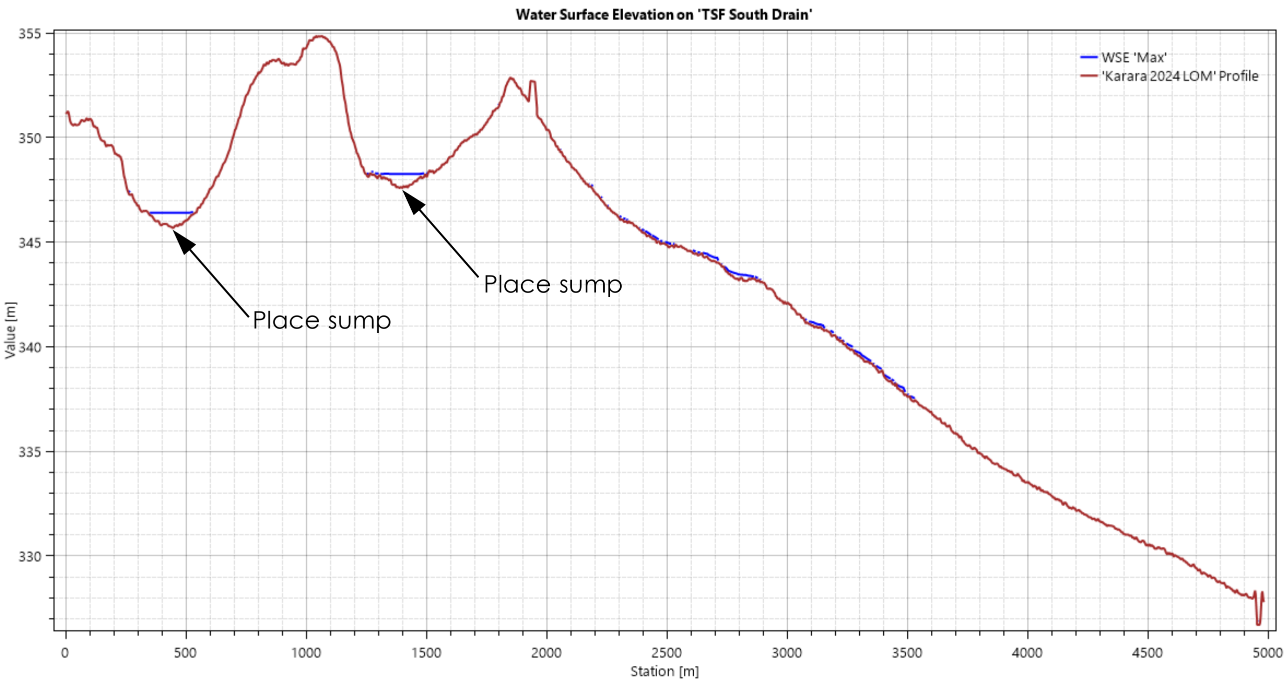

Figure 5-7 5% AEP Maximum Water Surface Elevation Profile for LoM Condition along Toe Drain

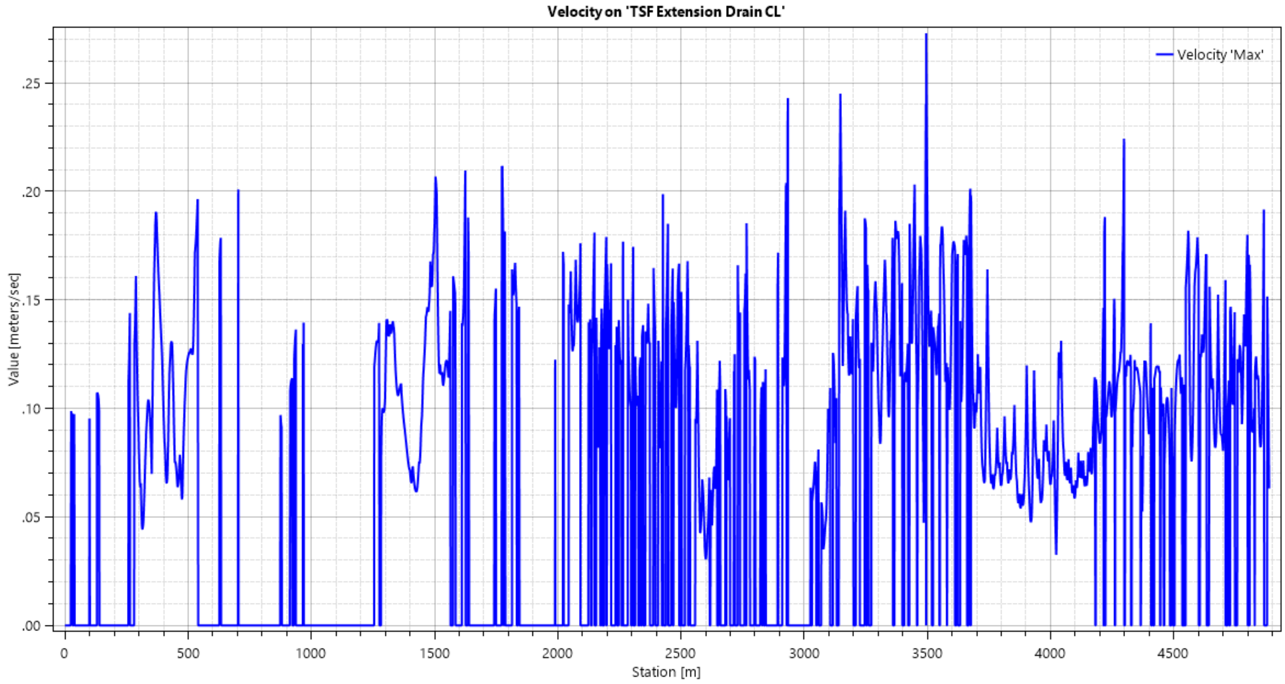

Figure 5-8 5% AEP Maximum Velocity Profile for LoM Condition along Toe Drain

5.2 Hydrograph Peaks and Flow Volume

Figure 5-9 compares Baseline, Life of Mine (LoM), and Closure Condition runoff hydrographs at the outflow. As indicated by the hydrographs, the proposed LoM features, and stockpile areas provide some flow attenuation and peak flow reduction relative to the Baseline Condition.

For Closure scenarios in which the rail embankment is breached, upstream flows are increased relative to the LoM Condition. Discharge hydrographs measured downstream of the KIOP site indicate an overall reduction in peak discharge rate and corresponding flow widths and depths. Afflux maps showing increases and decreases in flow depths are included in Appendix D.

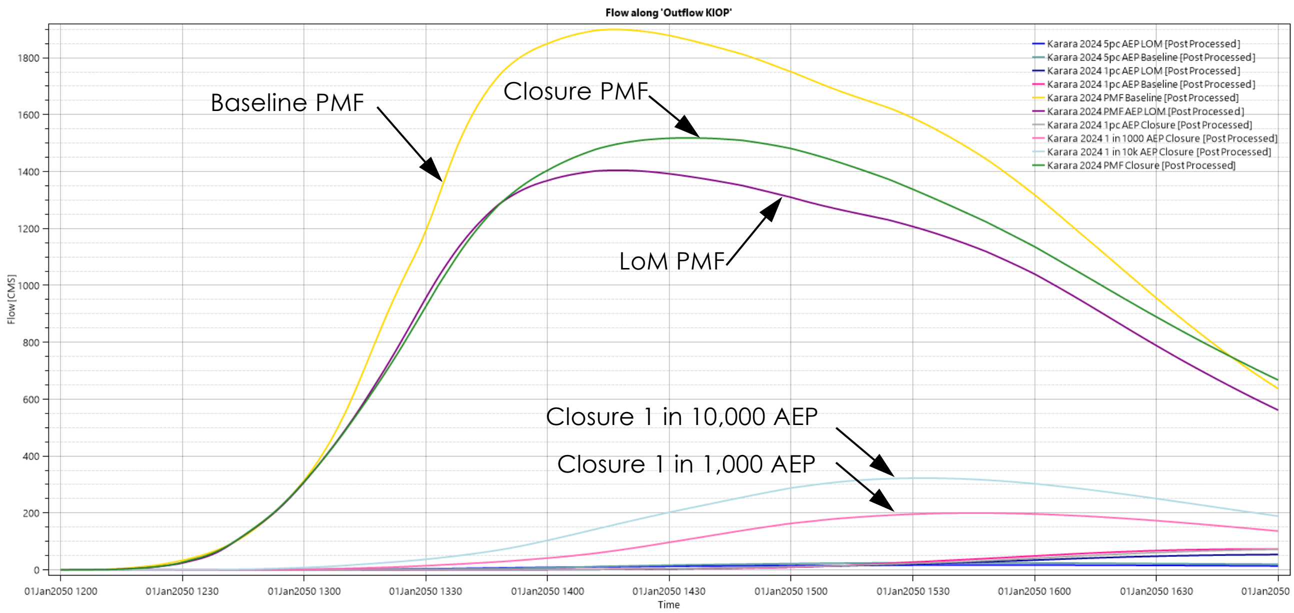

Figure 5-9 Comparison of Peak Flow Hydrographs

5.3 Diversion

The LoM plan and closure plan includes a diversion drain and bund around the eastern end of the TSF, designed to prevent inundation and erosion of the toe of the landforms. The LoM drain is retained in the closure plan. Bund levels would need to be increased for closure conditions to the levels indicated in Figure 4-7. Rock armouring is required for scour protection as described below.

5.4 Syncline Turner Haul Road

The proposed life of mine plan includes maintenance of the Syncline Turner haul road, located in the northeast of the development envelope. Figure 5-10 shows the maximum inundation depths in the 5% AEP event along the disturbance footprint for the roadway corridor. Figure 5-11 shows 1% AEP inundation depths. Figure 5-12 shows the centreline alignment and chainage reference for profile figures. Figure 5-13 shows the maximum water surface elevation profiles for the 5% AEP and 1% AEP events. The figures show flow crossing at Chainage 2000, 4100, 7200, 9300, and 9900. Maximum 1% AEP flow depths are less than 1m.

Maintenance activities do not include significant earthworks, and the existing drainage along the roadway is to remain in place. Impacts to upstream and downstream flow regimes related to the maintenance activities are not expected to be significant in terms of flow retention or concentration. Standard erosion and sediment control measures should be adopted during maintenance activities.

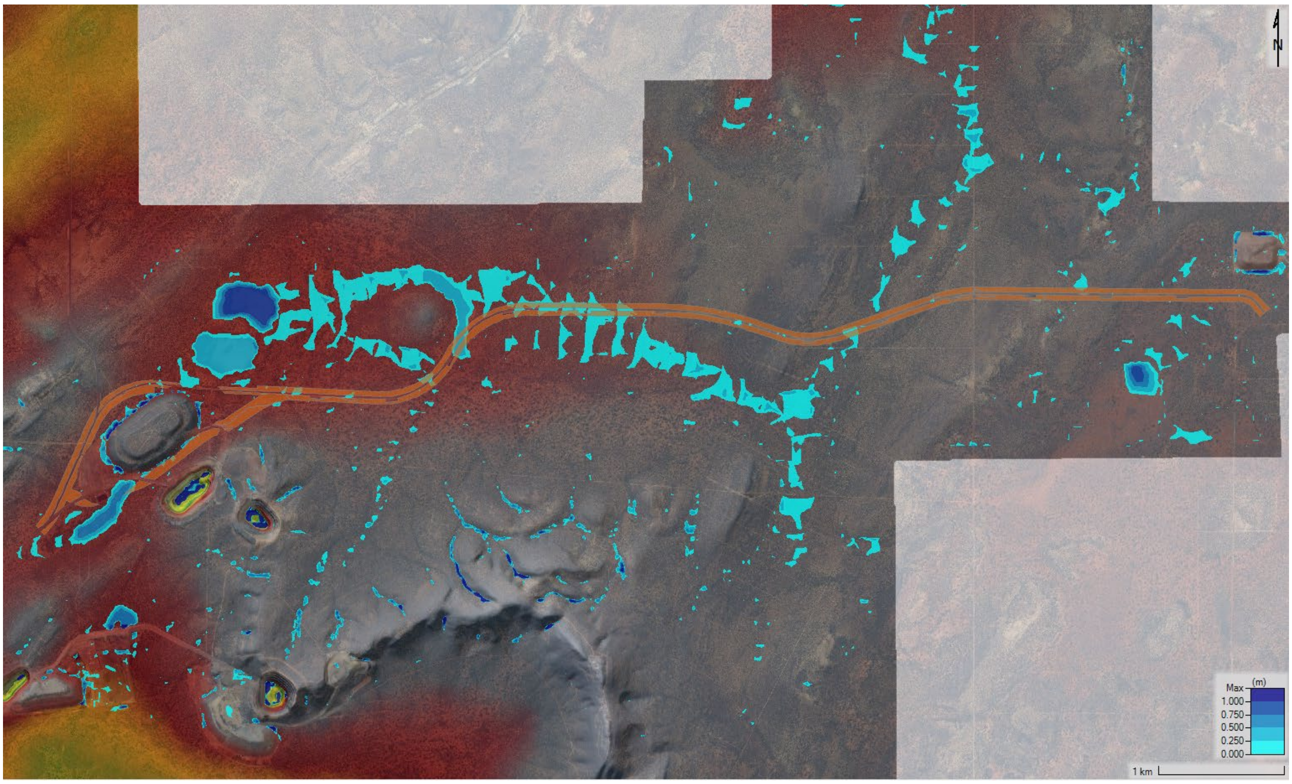

Figure 5-10 5% AEP maximum inundation along haul road

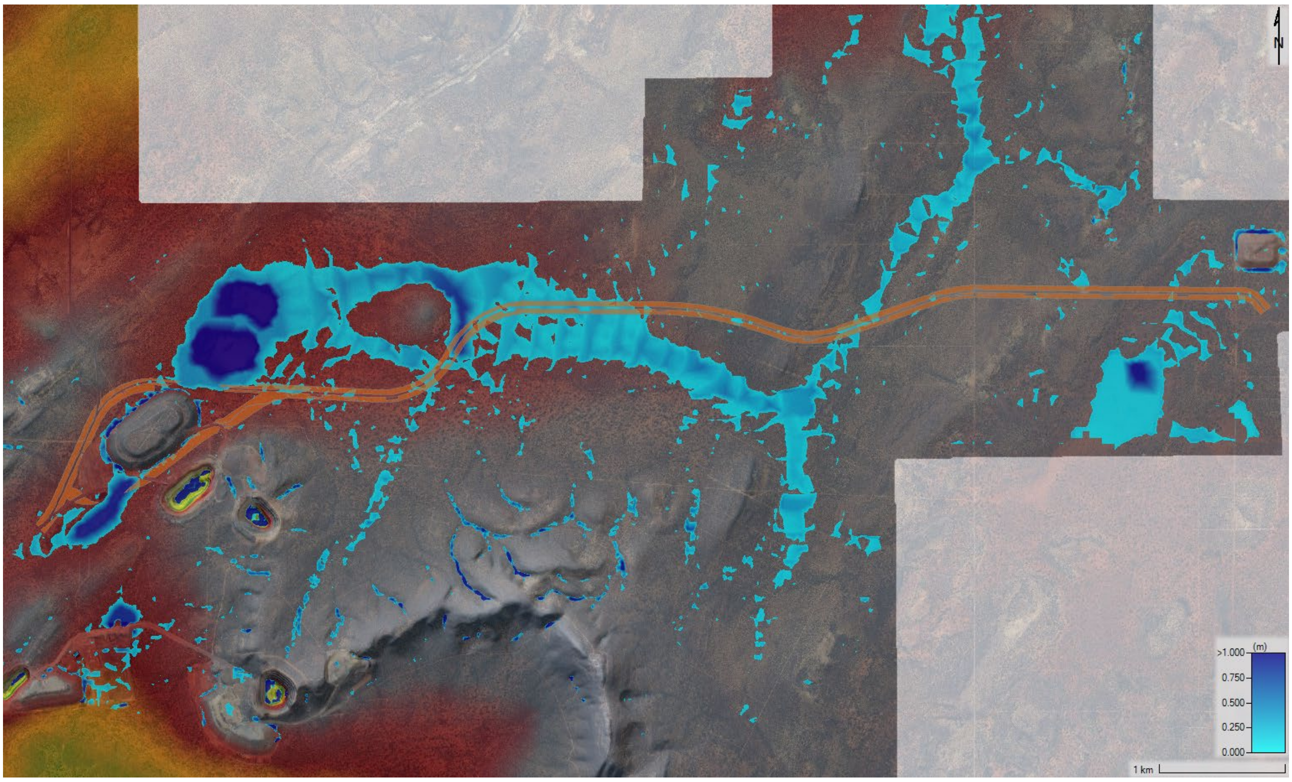

Figure 5-11 1% AEP maximum inundation along haul road

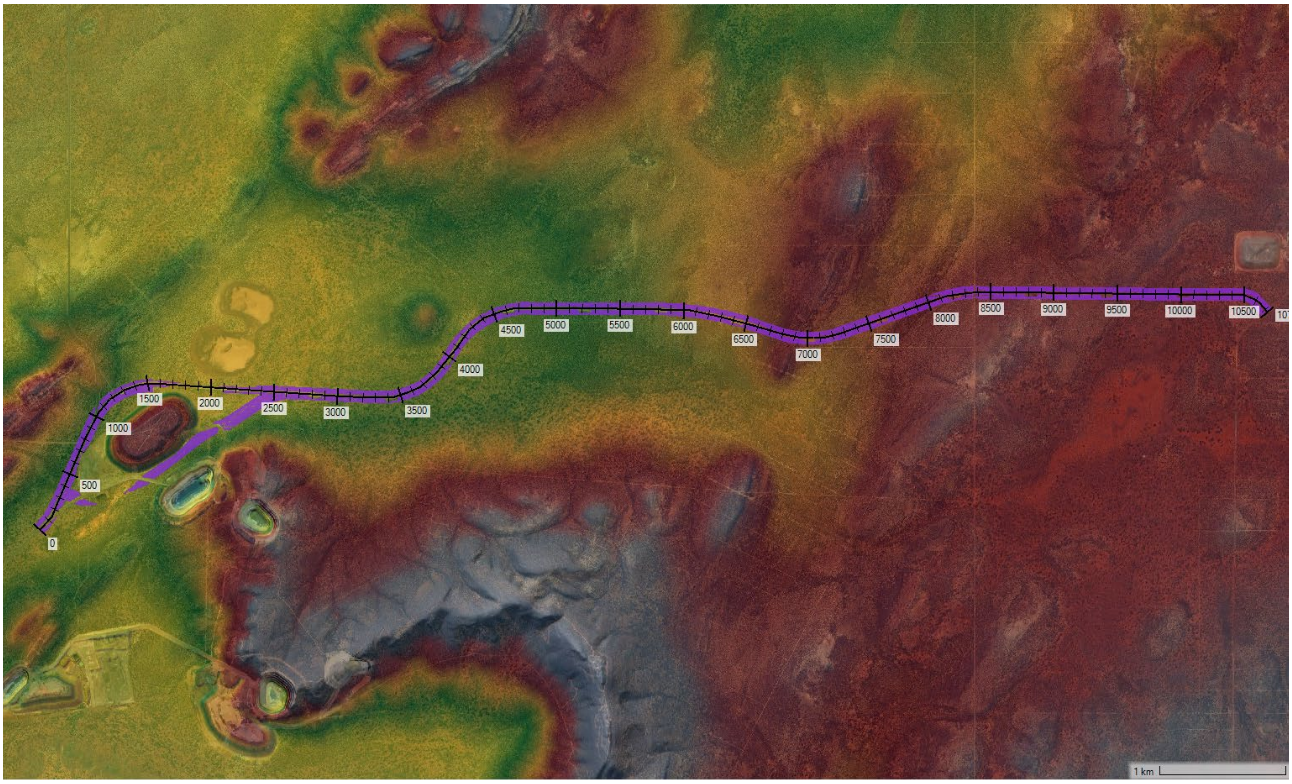

Figure 5-12 Roadway chainage reference for profile figures

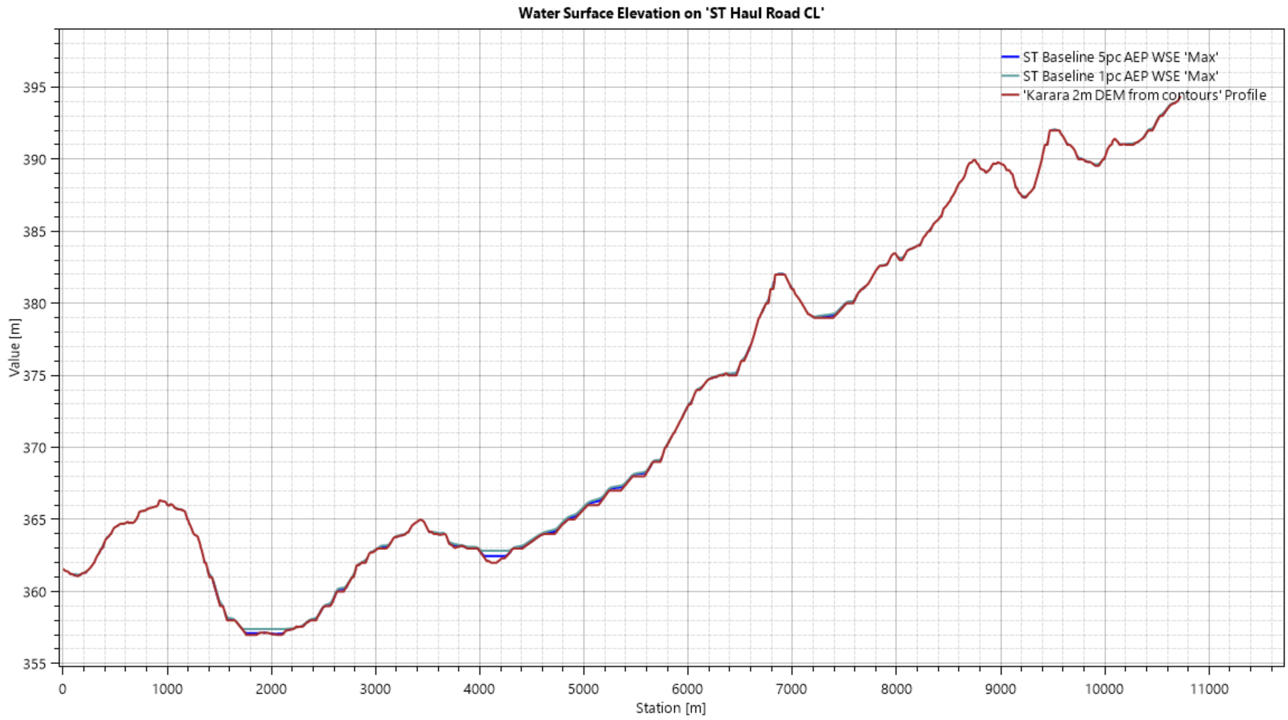

Figure 5-13 5% AEP and 1% AEP maximum water surface elevation profiles along haul road

5.5 Yandanooka Borefield and Water Pipeline

The KIOP MLE Project includes a buried water pipeline and pipeline maintenance and access routes extending to the Yandanooka borefield located approximately 100 km west of the mine site. Figure 5-14 shows the narrow disturbance corridor along the pipeline route. Figure 5-15 shows the alignment and chainage reference for profile figures along with the 5% AEP maximum inundation depths. Figure 5-16 shows the 1% AEP inundation. Figure 5-17 shows the ground profile and maximum water surface elevation profiles for the 5% AEP and 1% AEP events.

The buried pipeline is not expected to impede surface water flows, and maintenance access will generally follow existing tracks. Burial depths will account for potential scour along concentrated flow paths indicated in the figures. Impacts to upstream and downstream flow regimes related to the maintenance corridor are not expected to be significant.

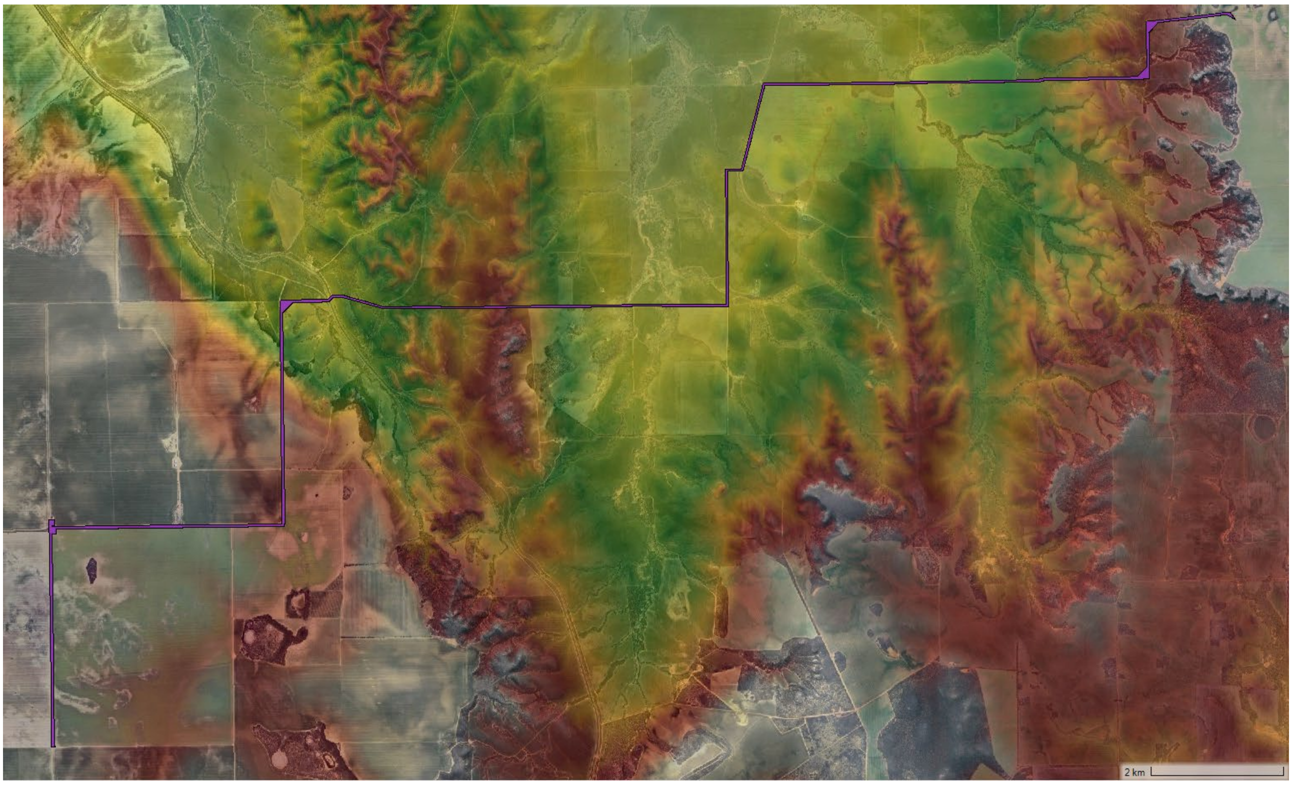

Figure 5-14 Disturbance area along for pipeline route

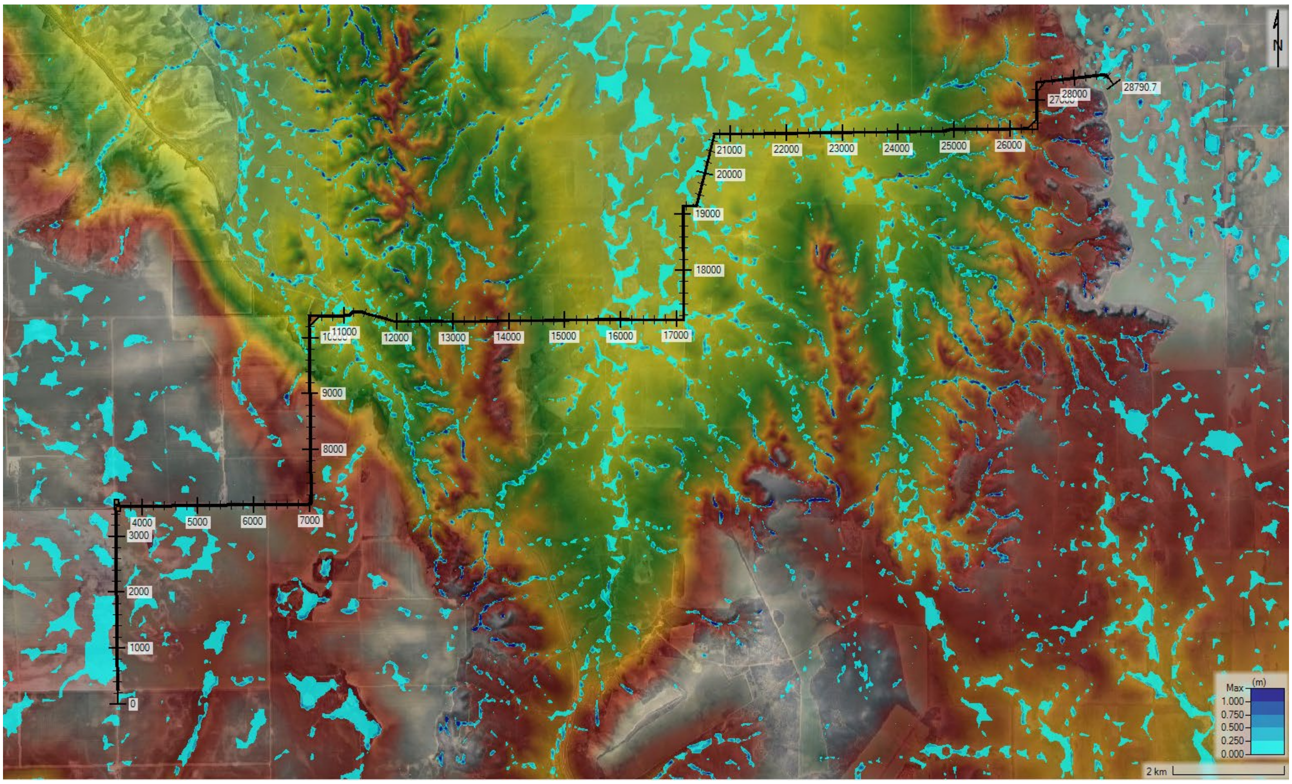

Figure 5-15 5% AEP maximum inundation along pipeline route

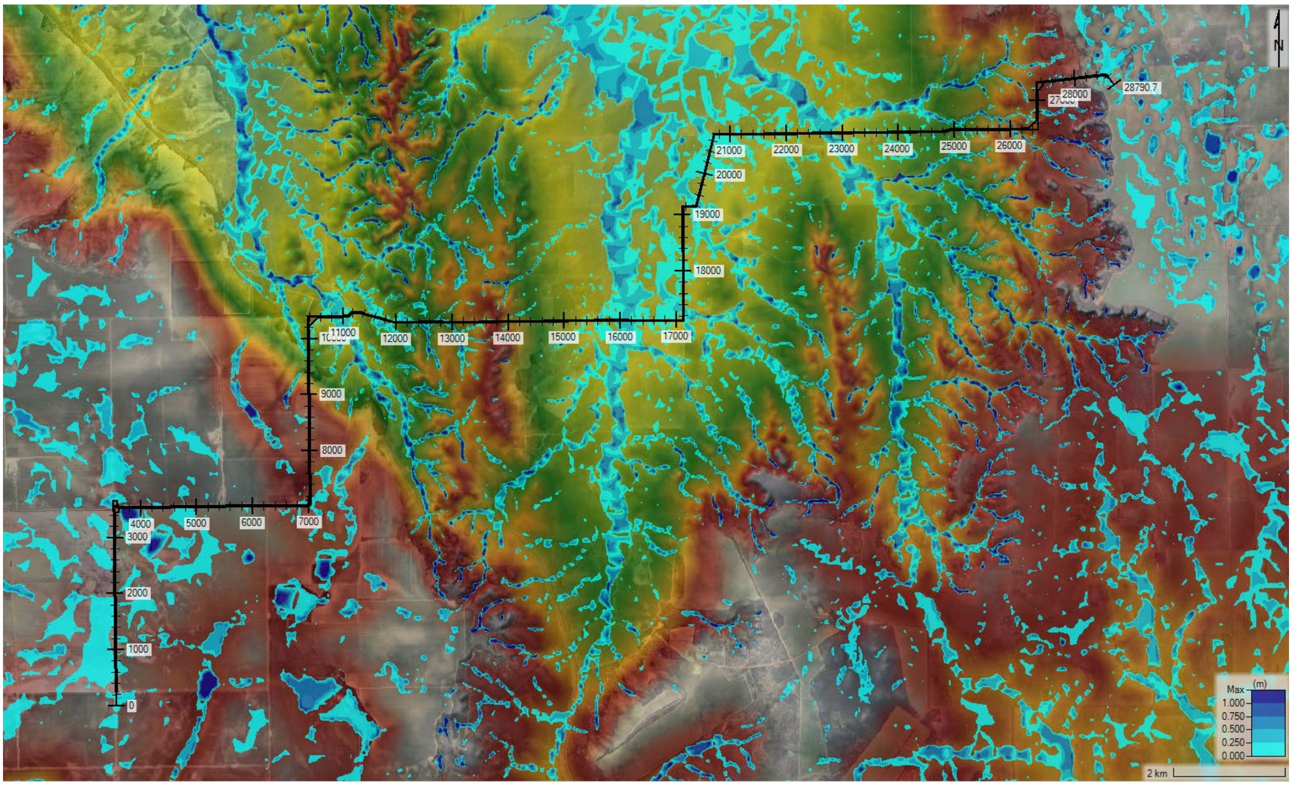

Figure 5-16 1% AEP maximum inundation along pipeline route

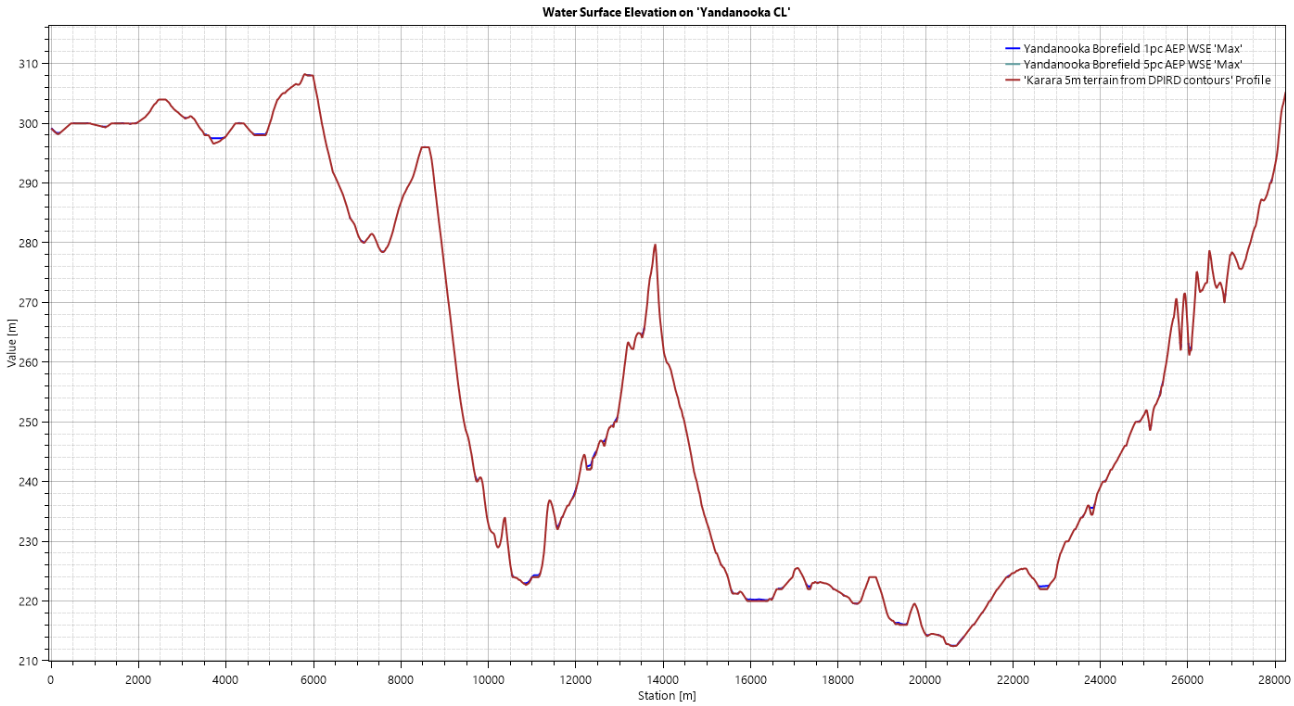

Figure 5-17 5% AEP and 1% AEP maximum water surface elevation profiles along pipeline route

6. Scour Assessment

6.1 Recommended Rock Armour Protection

The maximum velocity maps shown in Appendix D indicate areas in red where velocities exceed 2 m/s. Velocities along the diversion are generally less than 2 m/s in the 1% AEP event, meeting the criteria for unlined channels. Placement of Facing Class rock may be warranted along the embankments where flows enter the channel. Additional areas of periodic maintenance may be identified during future survey or construction activities.

Velocities along the main diversion drain exceed 2 m/s in the 1 in 1,000, 1 in 10,000, and PMF events. Table 6-1 below shows an excerpt from MRWA's Floodway Design Guide (MRWA 2006), which in turn is derived from 1994 Austroads tables and highlights the recommended rock class and section thicknesses associated with specified velocity ranges. Table 6-2 shows the equivalent classes from Specification 406 for rock protection (MRWA 2017). Figure 6-1 shows the tabulated values graphically.

Although the class of rock protection is listed as "None" for velocities less than 2 m/s, this table refers to Facing Class and larger rock sizes. Localised, concentrated flow paths along the embankment slope will likely exceed these thresholds, albeit with very shallow flow depths. Localised application of Type A rock is recommended following an examination of the competence of bank materials following excavation.

A capping layer of coarse, angular gravels and cobbles may be beneficial along the excavated banks where loose materials are encountered. The capping layer would resist localised rilling and gullying from direct rainfall as well as erosion related to floodwaters that enter the channel from the overbanks. Vegetation and cohesion will increase the allowable threshold over time following initial construction. Culverts require standard inlet and outlet protection.

Table 6-1: Rock Protection (from Table 3.11, Austroads 2023, Table 5.1, MRWA 2006)

Velocity (m/s)	Class of rock protection (tonne)	Section thickness, *T* (m)
< 2	None	–
2.0–2.6	Facing	0.50
2.6–2.9	Light	0.75
2.9–3.9	¼	1.00
3.9–4.5	½	1.25
4.5–5.1	1.0	1.60
5.1–5.7	2.0	2.00
5.7–6.4	4.0	2.50
> 6.4	Special	–

Table 6-2: Standard Classes of Rock Slope Protection (from Table 406.1, MRWA 2017)

Rock Class	Rock Size (m) *	Approximate Rock Mass (kg)	Percentage of Rock Larger than Rock Size in the Second Column	Typical Use (Examples Only)
Type A	0.20 0.10 0.075		0 50 90	Catchpit Surrounds
Type B1	0.30 0.20 0.10		0 50 90	Culvert Outlets
Type B (Facing)	0.40 0.30 0.15	100 35 2.5	0 50 90	Culvert Outlets
Light	0.55 0.40 0.20	250 100 10	0 50 90	Floodway Batters
Quarter Tonne	0.75 0.55 0.30	500 250 35	0 50 90	Floodway Batters
One Tonne	1.15 0.90 0.55	2000 1000 250	0 50 90	Floodway Batters
Two Tonne	1.45 1.15 0.75	4000 2000 500	0 50 90	Floodway Batters
Rock Pitching	0.40 x 0.40 x 0.20 0.15 x 0.15 x 0.15		60 100	Landscaped Slopes (Typically Limestone)

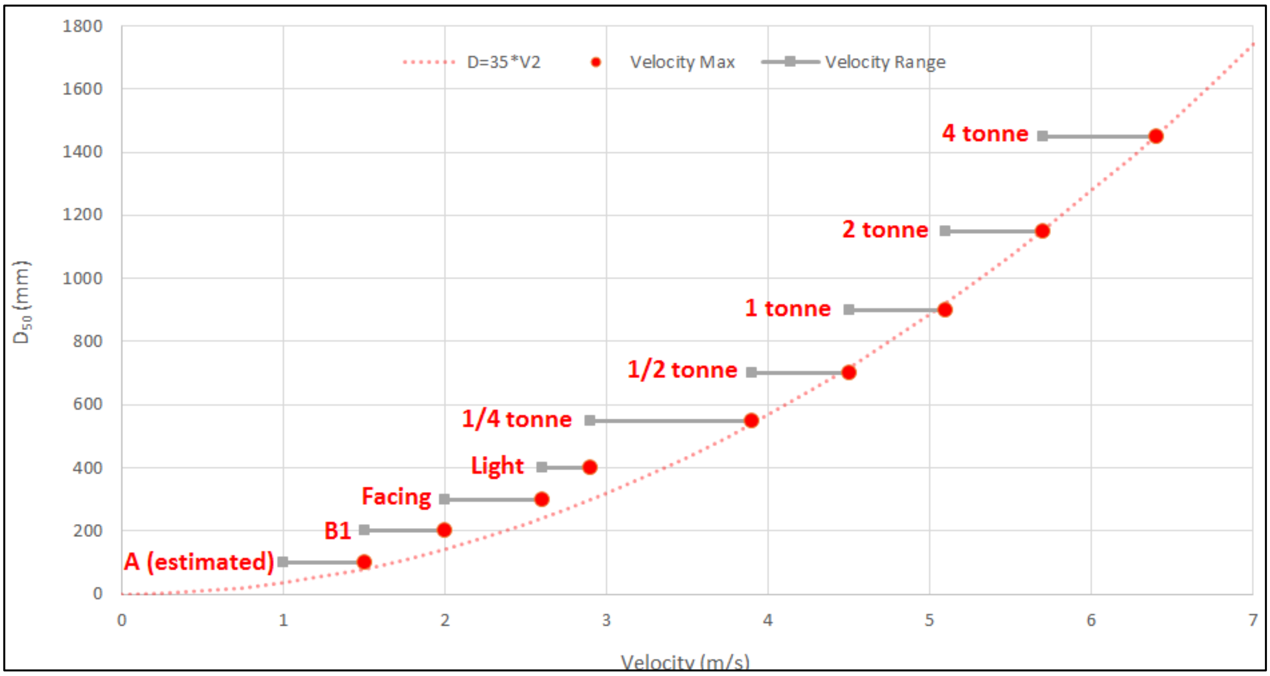

Figure 6-1 Velocity vs. Median Stone Size (based on Austroads 2023)

7. Conclusions and Recommendations

The inundation and velocity maps shown in Appendix D indicate areas of ponding and potential scour. The results have been applied to determine new or increased bund heights and armour rock requirements for LoM and closure drain and bund designs as reflected in the mine plan.

7.1 Life of Mine

It is recommended that a new diversion drain and bund are designed in order to prevent toe erosion along waste rock landforms and embankment slopes throughout the LoM. All runoff from direct rainfall on fill slopes should be managed for sedimentation prior to discharge into the downstream environment.

A series of culverts and/or floodways are required to facilitate drainage and prevent erosion of the proposed roadway around the waste rock landform. Sumps are recommended in the depressions along the western side of the proposed TSF expansion.

Ongoing monitoring and maintenance of drains and bunds is recommended before each wet season and after each flood event to check for any localised scour, deposition, bank migration or vertical head cuts, with mitigation measures implemented based on the monitoring results.

The proposed LoM landforms at KIOP result in some peak flow attenuation and reduction in downstream runoff volumes under each of the modelled LoM flood events.

The proposed mine plan includes maintenance of the Syncline Turner haul road, located in the northeast of the development envelope. Maintenance activities do not include significant earthworks, and existing drainage measures along the roadway are to remain in place. Impacts to upstream and downstream flow regimes related to the maintenance activities are not expected to be significant in terms of flow retention or concentration. Standard erosion and sediment control measures should be adopted during maintenance activities.

The proposed mine plan also includes a buried water pipeline and pipeline maintenance and access routes extending to the Yandanooka borefield located approximately 100km west of the mine site. The buried pipeline is not expected to impede surface water flows, and maintenance access will generally follow existing tracks. Burial depths will account for potential scour along concentrated flow paths indicated in the hydraulic results. Impacts to upstream and downstream flow regimes related to the pipeline maintenance corridor are not expected to be significant, provided standard erosion and sediment control measures are adopted during construction and maintenance activities.

7.2 Closure

As shown in Appendix E, the modelling indicates that KIOP and MIOP pits are unlikely to overtop in flood events up to the 72-hour PMF event.

It is recommended that diversion drains and bunds are upgraded at closure in order to prevent toe erosion along post-closure landforms without active management. The closure scenario includes removal of the railway embankment where it intercepts flow paths. Placement of abandonment bunds and rehabilitation of fill slopes are recommended for closure pits and landforms.

The presence of pits and proposed closure landforms results in some peak flow attenuation and reduction in downstream runoff volumes under each of the modelled closure flood events.

8. References

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19. U.S. Army Corps of Engineers, 2016. HEC-RAS, River Analysis System, User’s Manual, Version 5.0, Hydrologic Engineering Center, Davis, California, September.

Appendices

Appendix A Precipitation Hyetographs

Applied precipitation hyetographs are shown below for critical-duration rainfall events based on XPRAFTS modelling:

1% AEP

Time (Hours)	Rainfall (mm)
0.5	7.3
1.0	10.3
1.5	14.9
2.0	19.8
2.5	21.2
3.0	24.9
3.5	29.6
4.0	36.1
4.5	43.9
5.0	47.8
5.5	49.6
6.0	59.7
6.5	66.3
7.0	73.6
7.5	86.0
8.0	91.0
8.5	92.5
9.0	93.6

1 in 1,000 AEP

Time (Hours)	Rainfall (mm)
1.5	10.1
3.0	28.3
4.5	3.8
6.0	3.7
7.5	2.4
9.0	43.6
10.5	56.3
12.0	4.7

1 in 10,000 AEP

Time (Hours)	Rainfall (mm)
1.5	14.7
3.0	41.3
4.5	5.6
6.0	5.4
7.5	3.6
9.0	63.6
10.5	82.1
12.0	6.9

PMP

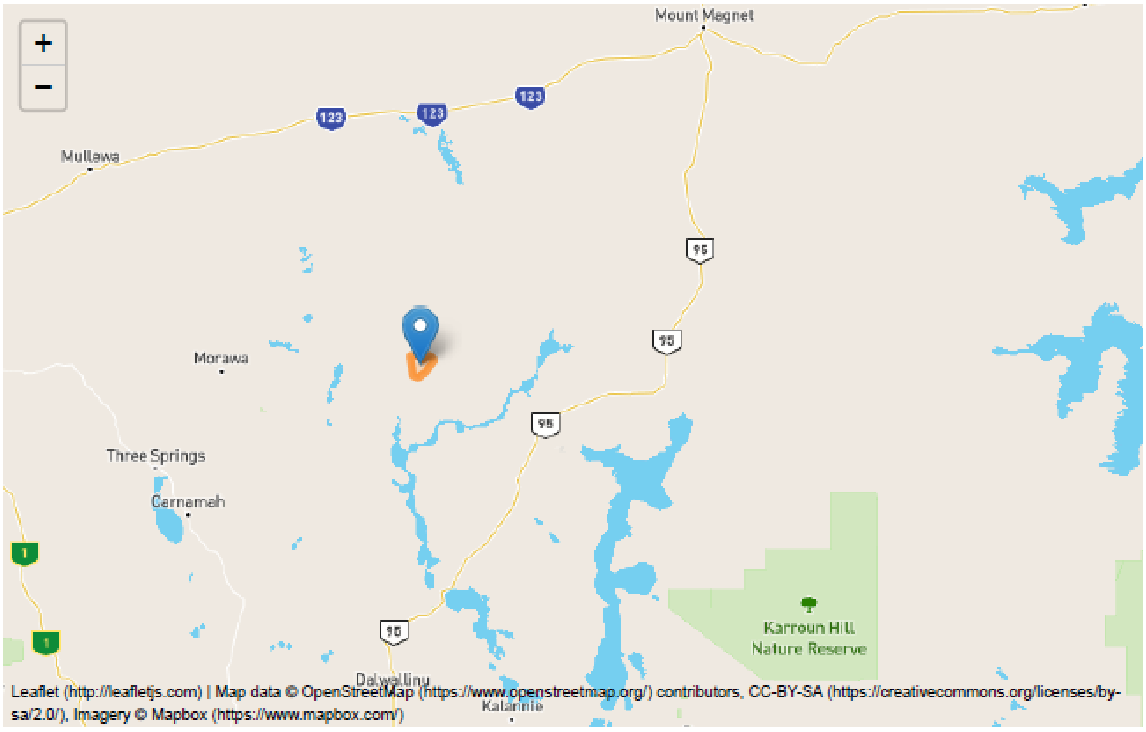
Time (Hours)	Rainfall (mm)
0.2	27.6
0.4	41.4
0.6	55.2
0.8	48.3
1.0	48.3
1.2	48.3
1.4	48.3
1.6	41.4
1.8	48.3
2.0	34.5
2.2	41.4
2.4	34.5
2.6	34.5
2.8	34.5
3.0	27.6
3.2	20.7
3.4	20.7
3.6	13.8
3.8	13.8
4.0	6.9

Appendix B ARR Data Hub Results

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	116.77
Latitude	-29.195
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Interim Climate Change Factors	show
Baseflow Factors	show



Leaflet (http://leafletjs.com) | Map data © OpenStreetMap (https://www.openstreetmap.org/) contributors, CC-BY-SA (https://creativecommons.org/licenses/by-sa/2.0/), Imagery © Mapbox (https://www.mapbox.com/)

River Region

Division	South West Coast
River Number	14
River Name	Moore-Hill Rivers
Shape Intersection (%)	100.0

Layer Info

Time Accessed	29 March 2021 12:53PM
Version	2016_v1

ARF Parameters

$$ARF = Min\left\{1, \left[1 - a\left(Area^b - c\log_{10}Duration\right)Duration^{-d} + eArea^f Duration^g\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**Shape Intersection (%)**
SW WA	0.183	0.259	0.271	0.33	3.85e-06	0.41	0.55	0.00817	-0.00045	100.0

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26 \text{ x } 10^{-3} \text{ x } Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141 \text{ x } Area^{0.213} \text{ x } 10^{-0.021\frac{(Duration-180)^2}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

Layer Info

Time Accessed	29 March 2021 12:53PM
Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

Storm Initial Losses (mm)	NaN
Storm Continuing Losses (mm/h)	NaN

Layer Info

Time Accessed	29 March 2021 12:53PM
Version	2016_v1

Temporal Patterns | Download (.zip) (static/temporal_patterns/TP/Rwest_FLTwest.zip)

code	Rwest_FLTwest
Label	Rangelands West And Flatlands
Shape Intersection (%)	100.0

Layer Info

Time Accessed	29 March 2021 12:53PM
Version	2016_v2

Areal Temporal Patterns | Download (.zip) (./static/temporal_patterns/Areal/Areal_Rwest_FLTwest.zip)

code	Rwest_FLTwest
arealabel	Rangelands West And Flatlands
Shape Intersection (%)	100.0

Layer Info

Time Accessed	29 March 2021 12:53PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-29.1946172246&longitude=116.769861399&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	29 March 2021 12:53PM

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	1.1 (0.077)	2.9 (0.130)	4.1 (0.145)	5.2 (0.151)	4.9 (0.111)	4.6 (0.089)
90 (1.5)	1.1 (0.069)	3.1 (0.122)	4.4 (0.137)	5.7 (0.144)	7.1 (0.142)	8.1 (0.138)
120 (2.0)	0.9 (0.047)	2.5 (0.088)	3.6 (0.100)	4.6 (0.106)	6.0 (0.110)	7.1 (0.111)
180 (3.0)	0.2 (0.010)	2.0 (0.062)	3.2 (0.079)	4.3 (0.088)	5.3 (0.086)	6.0 (0.083)
360 (6.0)	0.0 (0.000)	0.7 (0.018)	1.2 (0.024)	1.6 (0.027)	1.7 (0.022)	1.8 (0.020)
720 (12.0)	0.0 (0.000)	0.1 (0.002)	0.2 (0.002)	0.2 (0.003)	0.7 (0.008)	1.1 (0.011)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.3 (0.003)	0.6 (0.005)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	29 March 2021 12:53PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

	RCP 4.5	RCP6	RCP 8.5
2030	**0.758 (3.8%)**	0.675 (3.3%)	**0.782 (3.9%)**
2040	**0.970 (4.8%)**	0.868 (4.3%)	**1.132 (5.7%)**
2050	**1.179 (5.9%)**	1.094 (5.5%)	**1.501 (7.6%)**
2060	**1.370 (6.9%)**	1.332 (6.7%)	**1.900 (9.7%)**
2070	**1.526 (7.7%)**	1.564 (7.9%)	**2.342 (12.1%)**
2080	**1.631 (8.3%)**	1.769 (9.0%)	**2.839 (14.9%)**
2090	**1.667 (8.5%)**	1.929 (9.9%)	**3.404 (18.1%)**

Layer Info

Time Accessed	29 March 2021 12:53PM
Version	2019_v1
Note	ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

Baseflow Factors

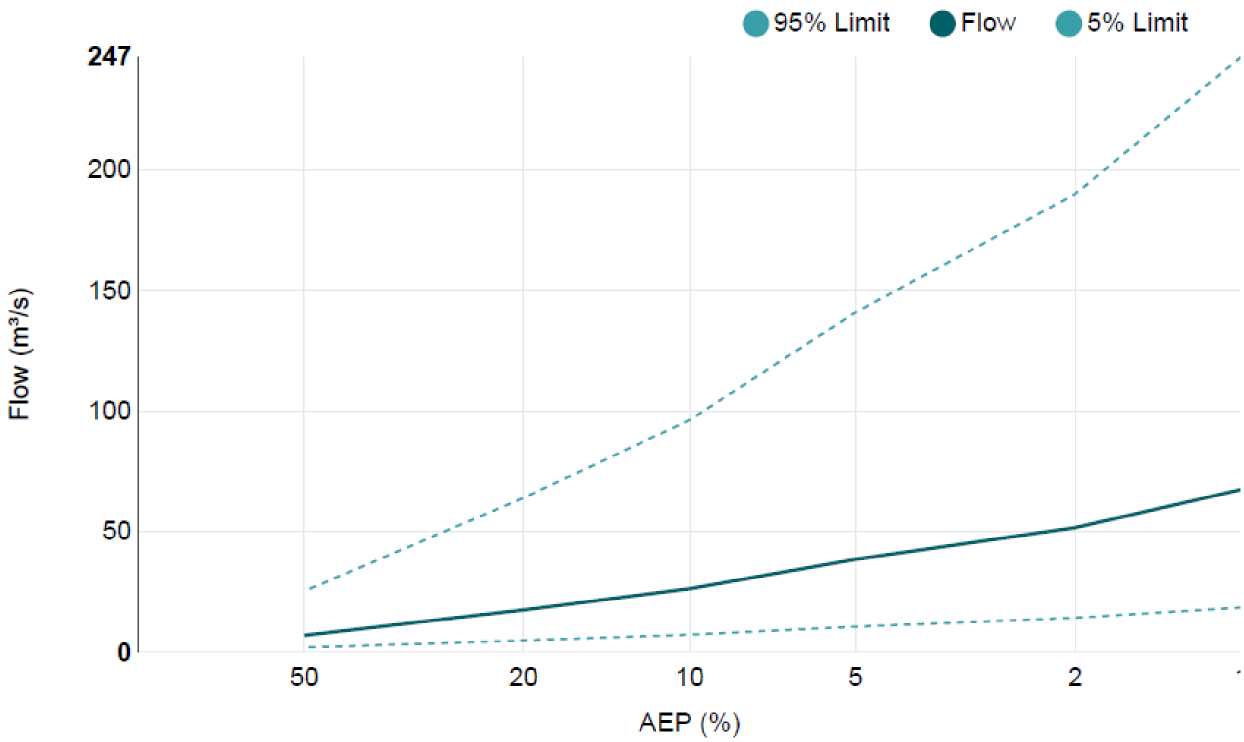
Downstream	8005
Area (km2)	29680.490763
Catchment Number	8064
Volume Factor	0.088178
Peak Factor	0.028405
Shape Intersection (%)	92.2

Layer Info

Time Accessed	29 March 2021 12:53PM
Version	2016_v1

Appendix C Regional Flood Frequency Estimation

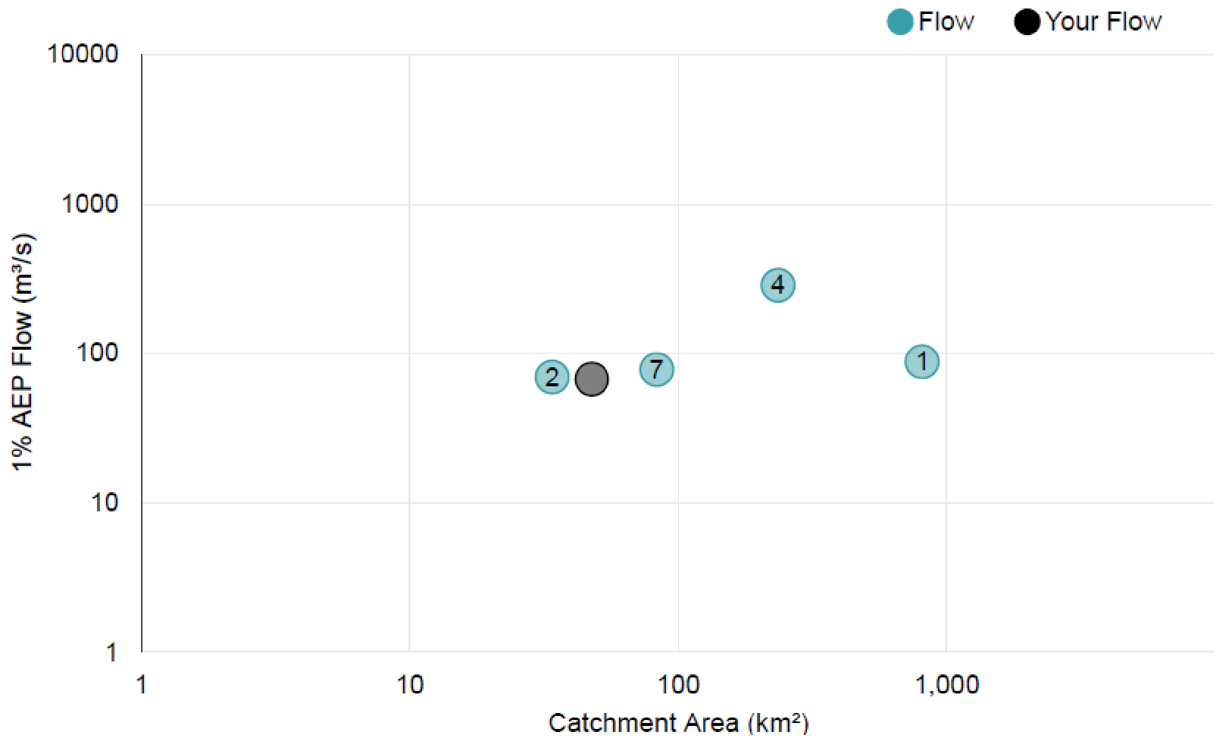
Results | Regional Flood Frequency Estimation Model



*The catchment has unusual shape. Results have lower accuracy and may not be directly applicable in practice.

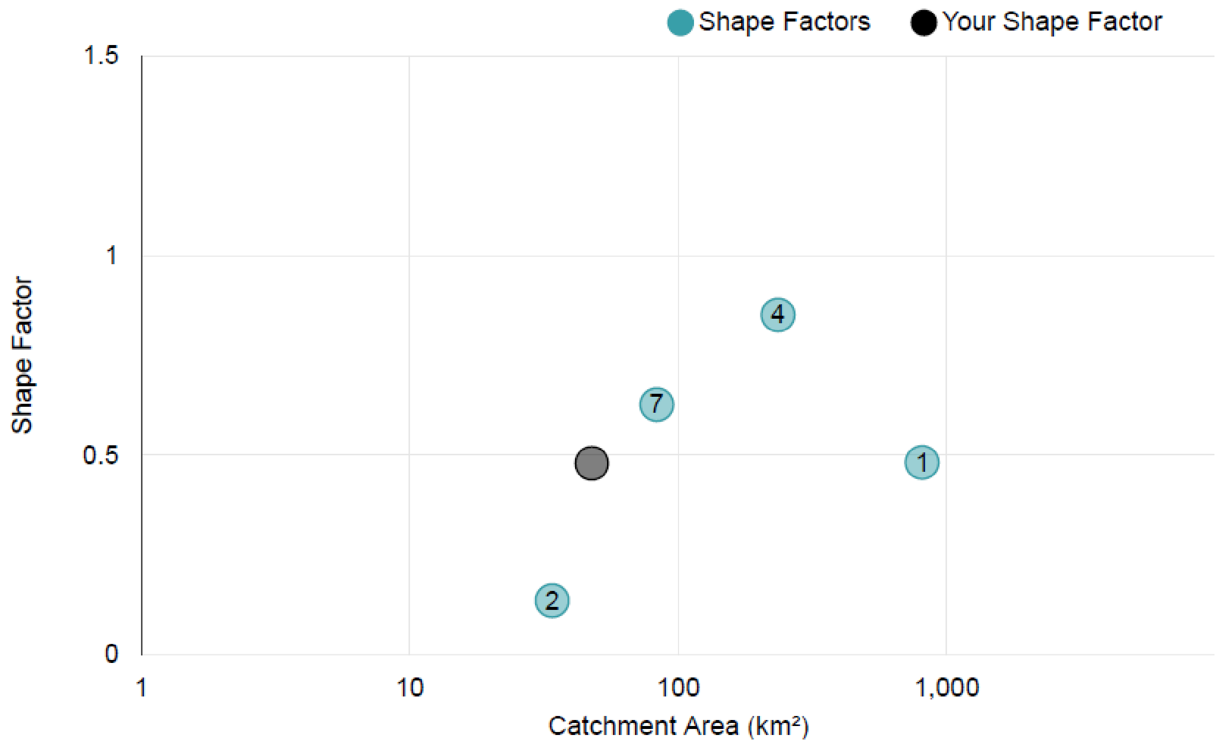
AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	6.96	1.93	25.3
20	17.5	4.84	64.0
10	26.3	7.24	96.3
5	38.5	10.6	141
2	51.6	14.2	190
1	67.4	18.5	247

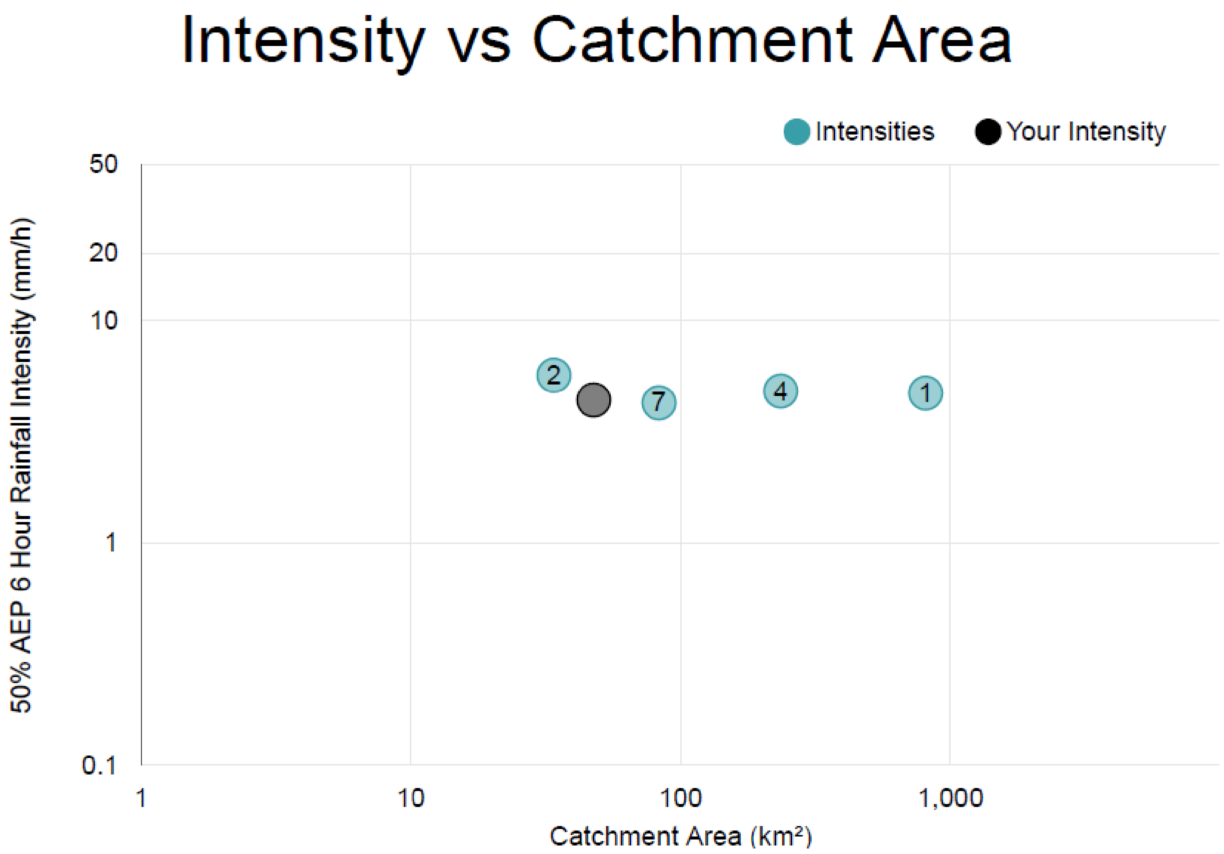
1% AEP Flow vs Catchment Area

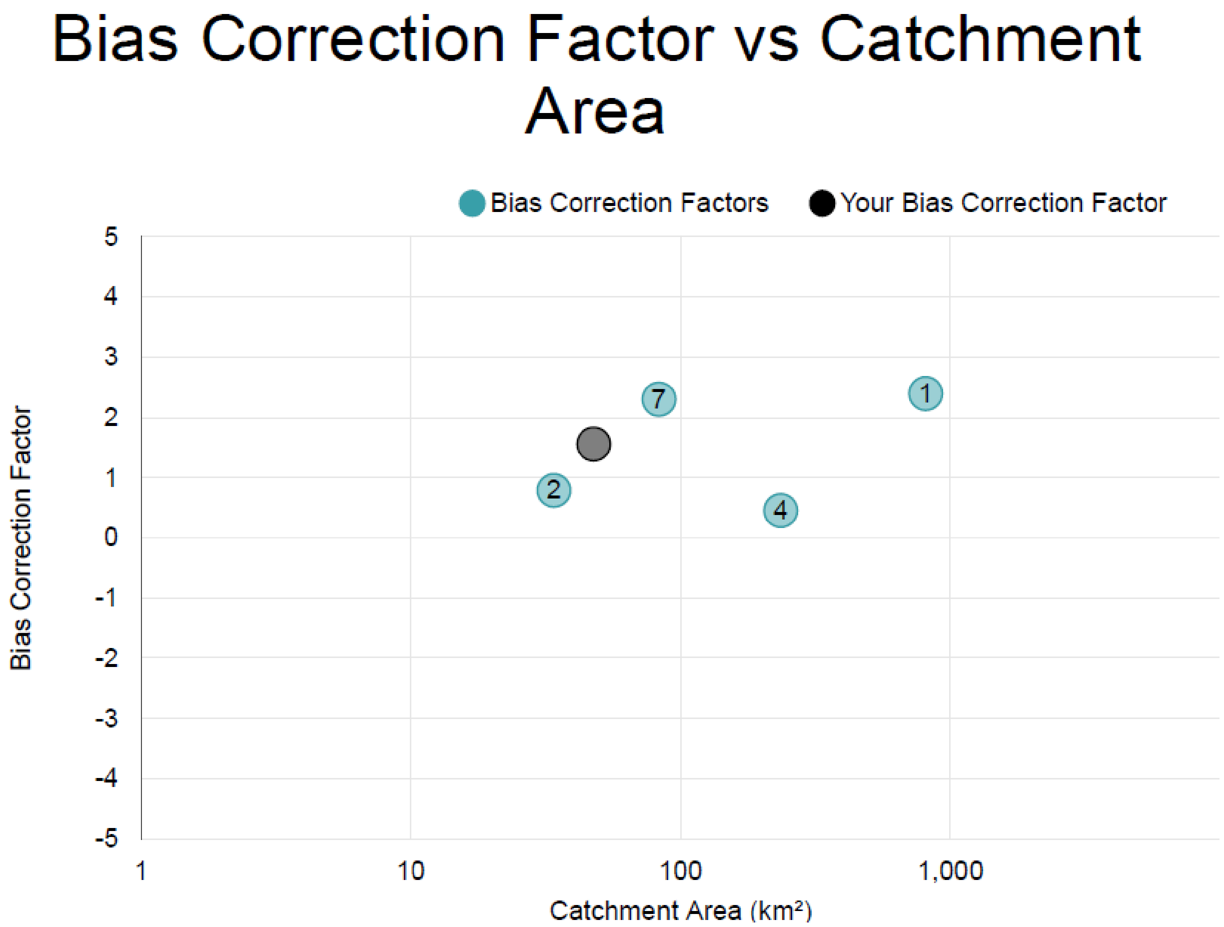


Shape Factor vs Catchment Area

Note: This region does not use shape factors

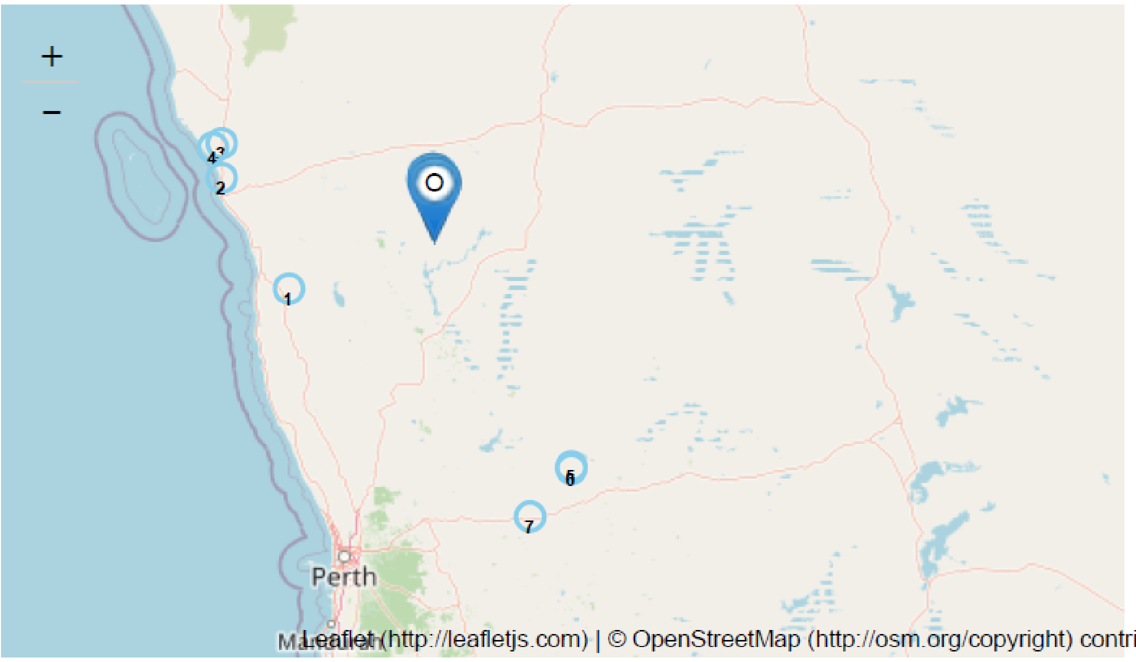



Intensity vs Catchment Area
Intensities
Your Intensity
50% AEP 6 Hour Rainfall Intensity (mm/h)
50
20
10
1
0.1
2
7
4
1
1
10
100
1,000
Catchment Area (km²)


Bias Correction Factor vs Catchment Area
Bias Correction Factors
Your Bias Correction Factor
Bias Correction Factor
5
4
3
2
1
0
-1
-2
-3
-4
-5
7
1
2
4
1
10
100
1,000
Catchment Area (km²)

Input Data

Date/Time	2022-02-11 03:18
Catchment Name	Karara
Latitude (Outlet)	-29.2195
Longitude (Outlet)	116.789
Latitude (Centroid)	-29.1946
Longitude (Centroid)	116.77
Catchment Area (km^2)	47.6
Distance to Nearest Gauged Catchment (km)	151.86
50% AEP 6 Hour Rainfall Intensity (mm/h)	4.393369
2% AEP 6 Hour Rainfall Intensity (mm/h)	12.580598
Rainfall Intensity Source (User/Auto)	Auto
Region	Fringe - Pilbara & Arid and Semi-arid
Region Version	RFFE Model 2016 v1
Region Source (User/Auto)	Auto
Shape Factor	0.48*
Interpolation Method	Natural Neighbour
Bias Correction Value	1.555



Method by Dr Ataur Rahman and Dr Khaled Haddad from Western Sydney University for the Australian Rainfall and Runoff Project. Full description of the project can be found at the project page (http://arr.ga.gov.au/revision-projects/project-list/projects/project-5) on the ARR website. Send any questions regarding the method or project here (mailto:admin@arr-software.org).

ENGINEERS AUSTRALIA (http://www.engineersaustralia.org.au)

WESTERN SYDNEY UNIVERSITY (http://www.uws.edu.au)

Appendix D Inundation, Velocity, and Afflux Maps

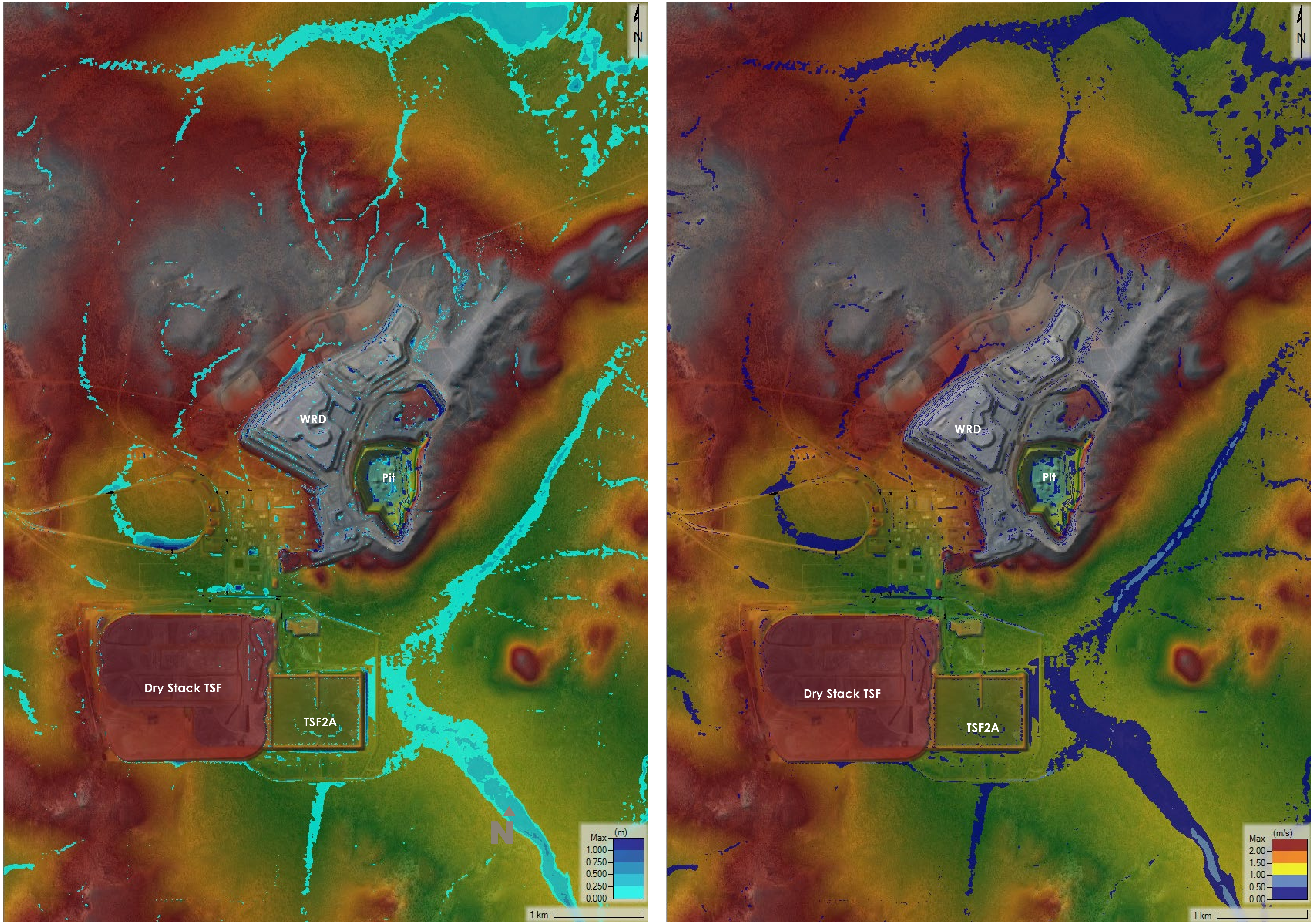


Figure D-1 KIOP Baseline 5% AEP Max Depth (left) and Max Velocity (right)

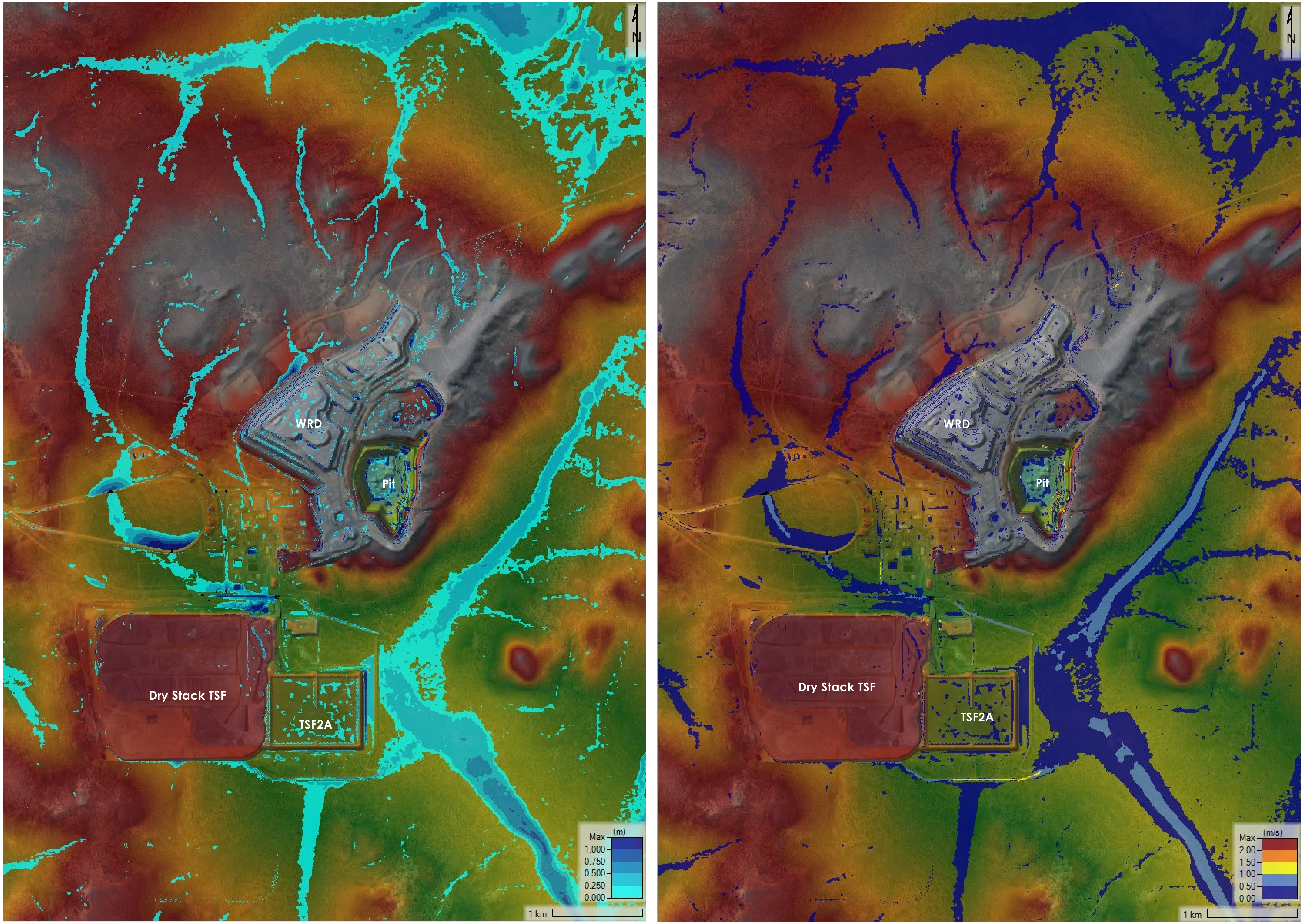


Figure D-2 KIOP Baseline 1% AEP Max Depth (left) and Max Velocity (right)

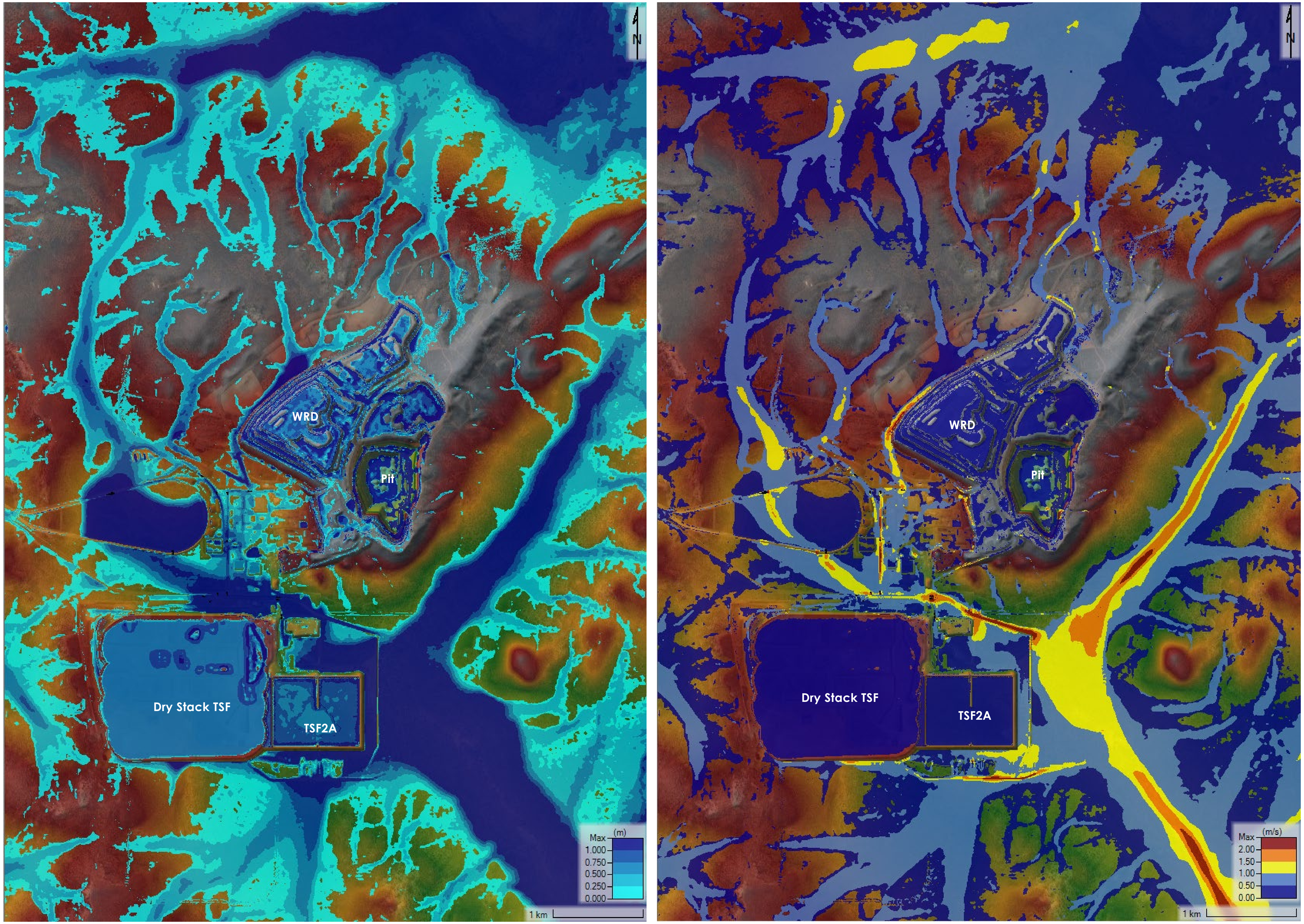


Figure D-3 KIOP Baseline PMF Max Depth (left) and Max Velocity (right)

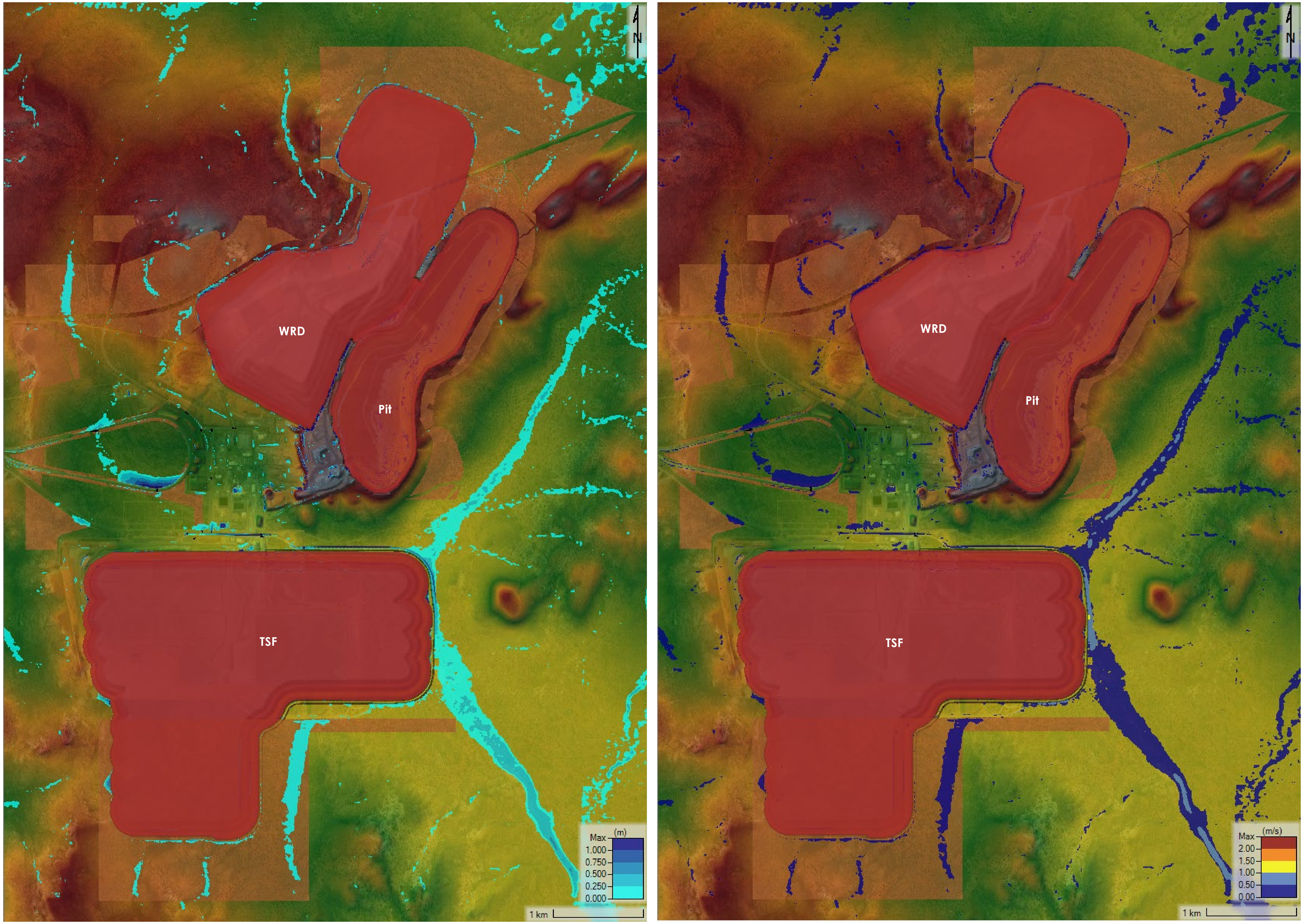


Figure D-4 KIOP Life of Mine 5% AEP Max Depth (left) and Max Velocity (right)

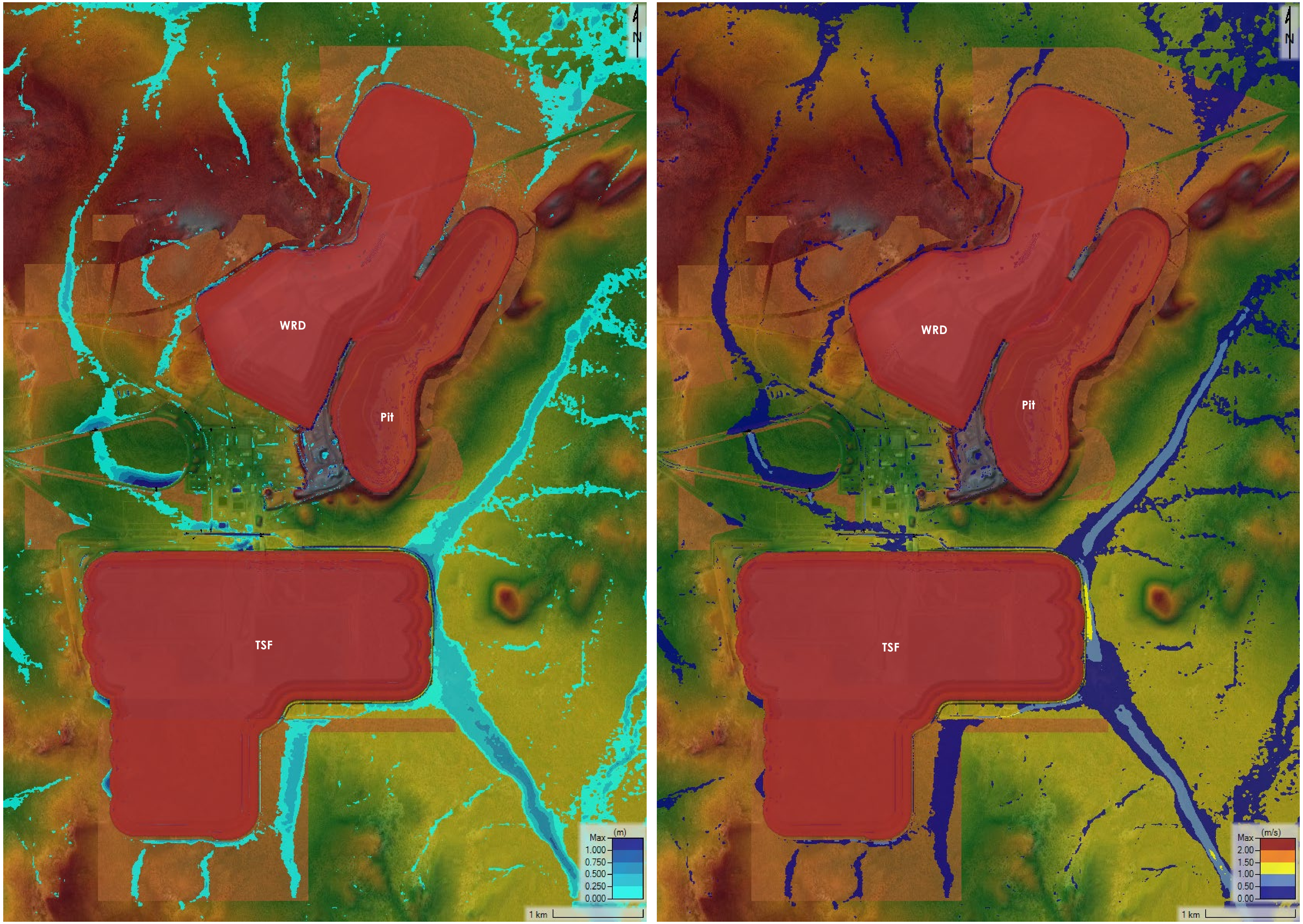


Figure D-5 KIOP Life of Mine 1% AEP Max Depth (left) and Max Velocity (right)

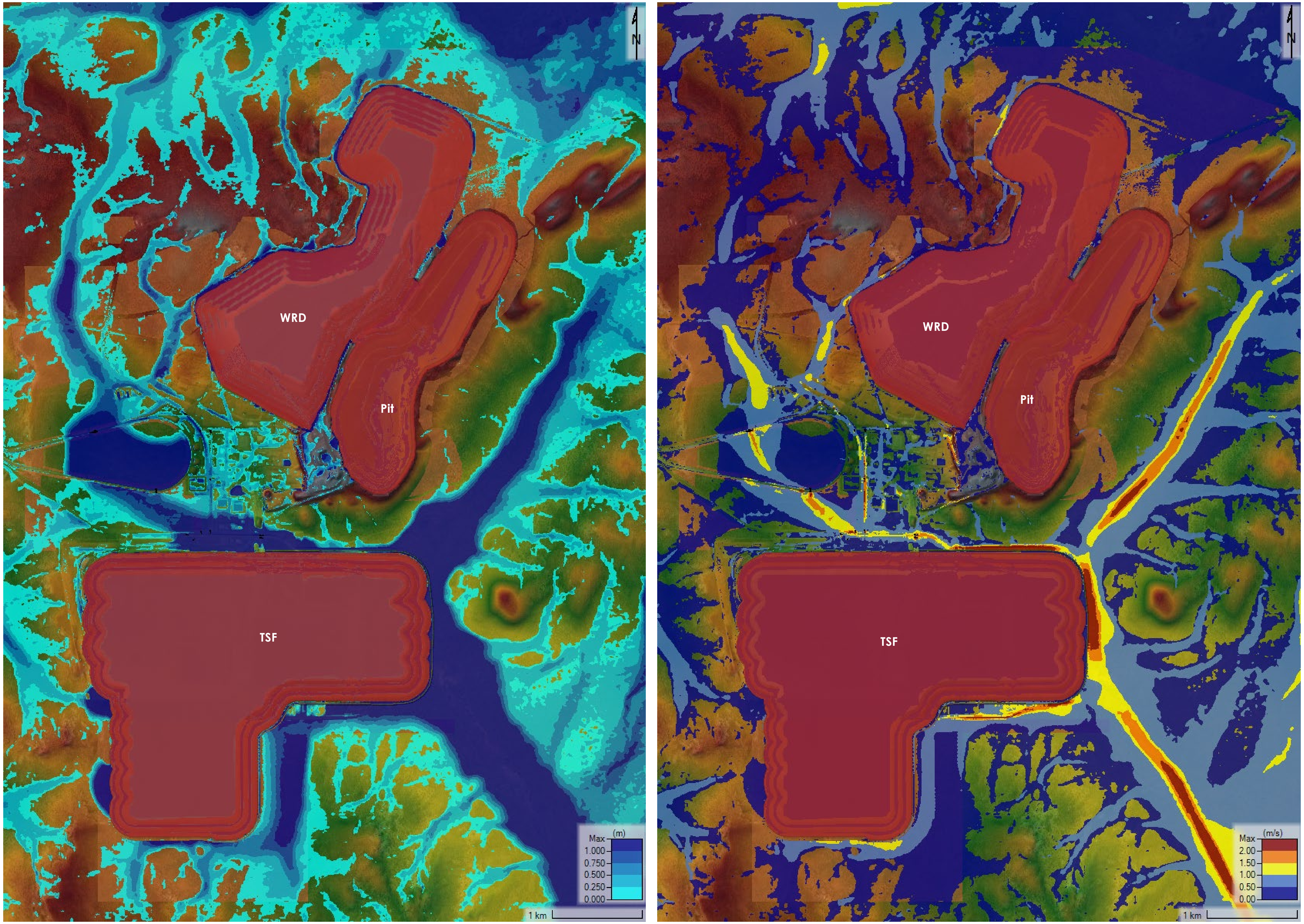


Figure D-6 KIOP Life of Mine PMF Max Depth (left) and Max Velocity (right)

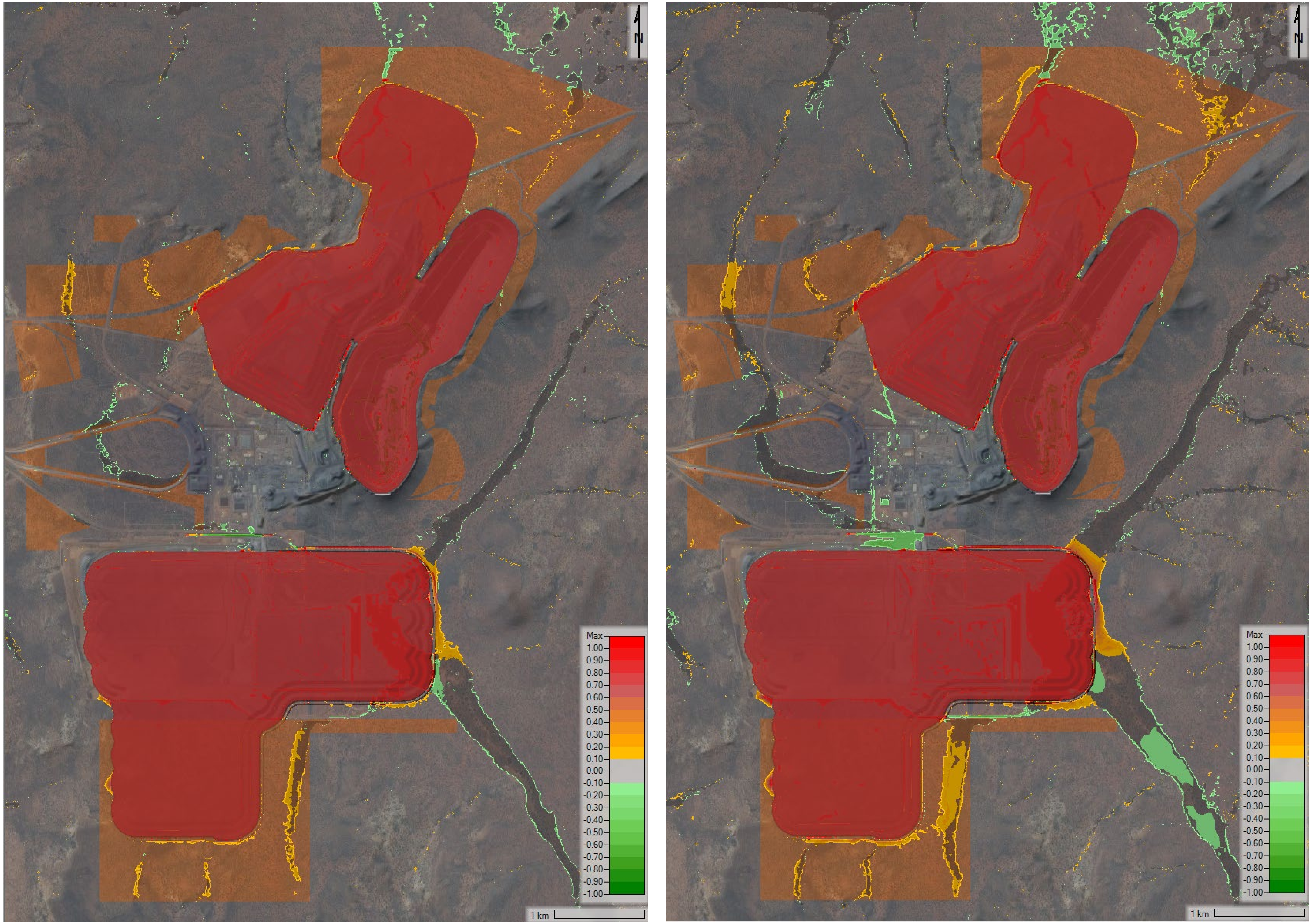


Figure D-7 KIOP Maximum Life of Mine vs. Baseline Afflux for 5% AEP (left) and 1% AEP (right)

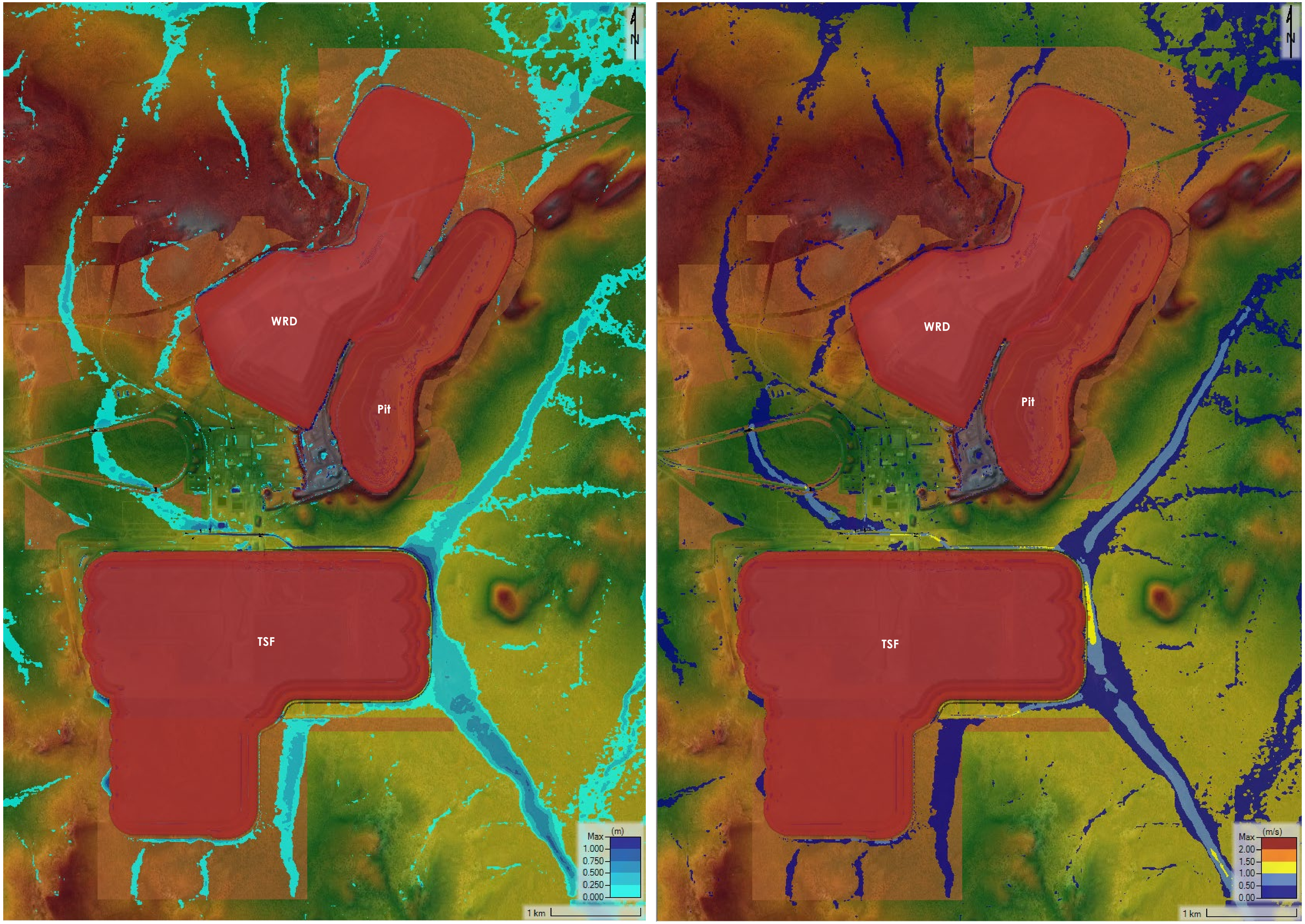
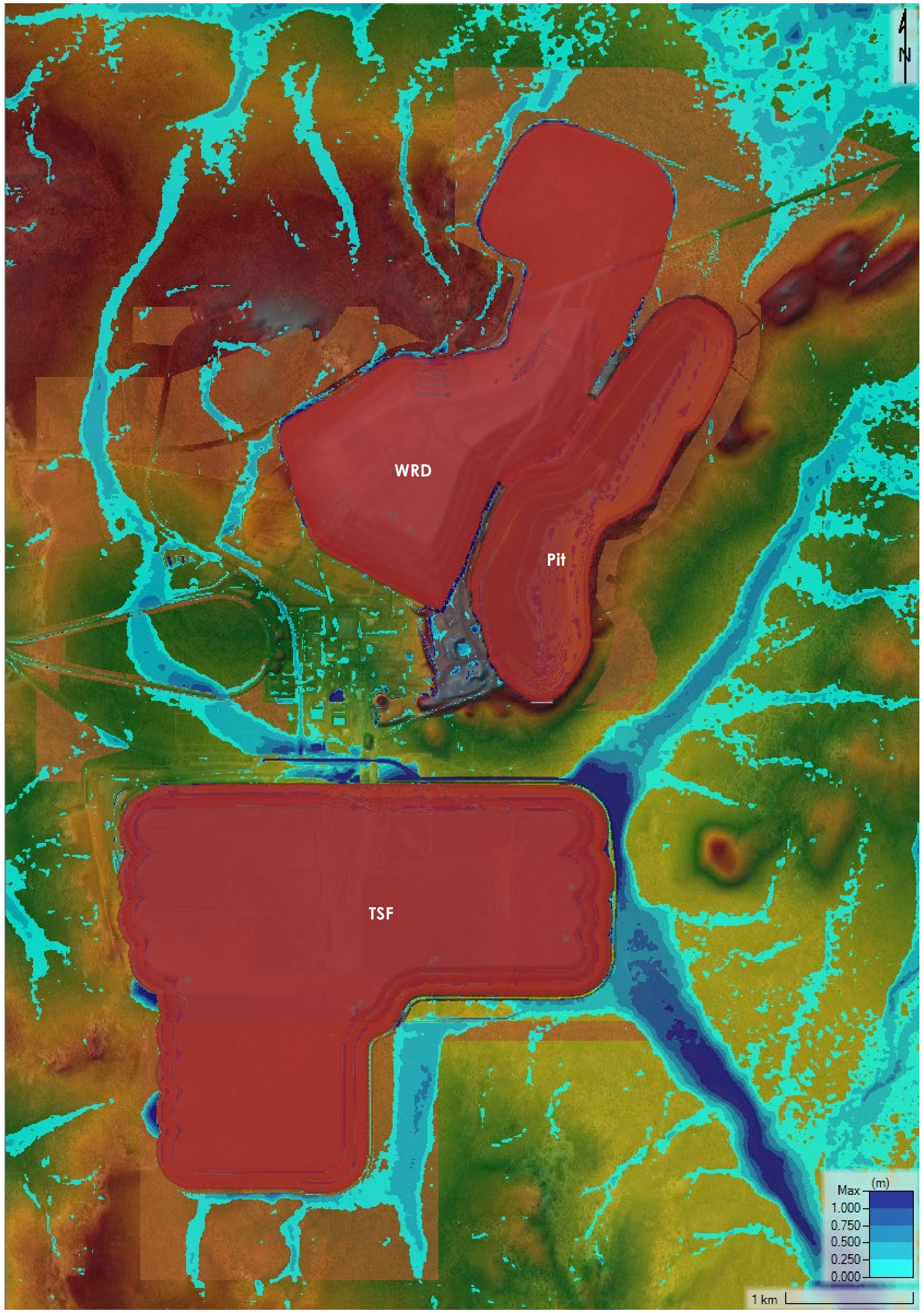


Figure D-8 KIOP Closure 1% AEP Max Depth (left) and Max Velocity (right)



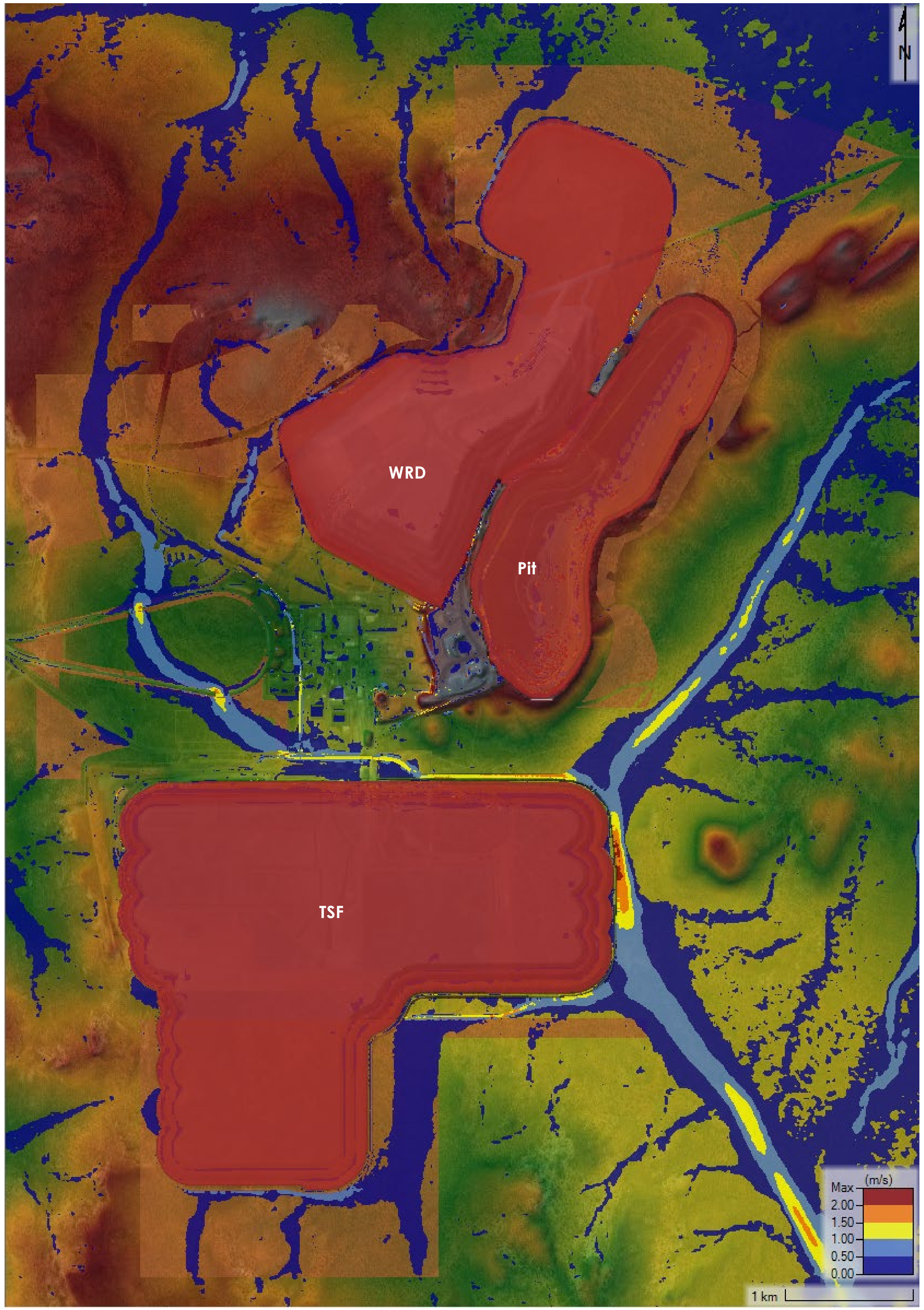


Figure D-9 KIOP Closure 1 in 1,000 AEP Max Depth (left) and Max Velocity (right)

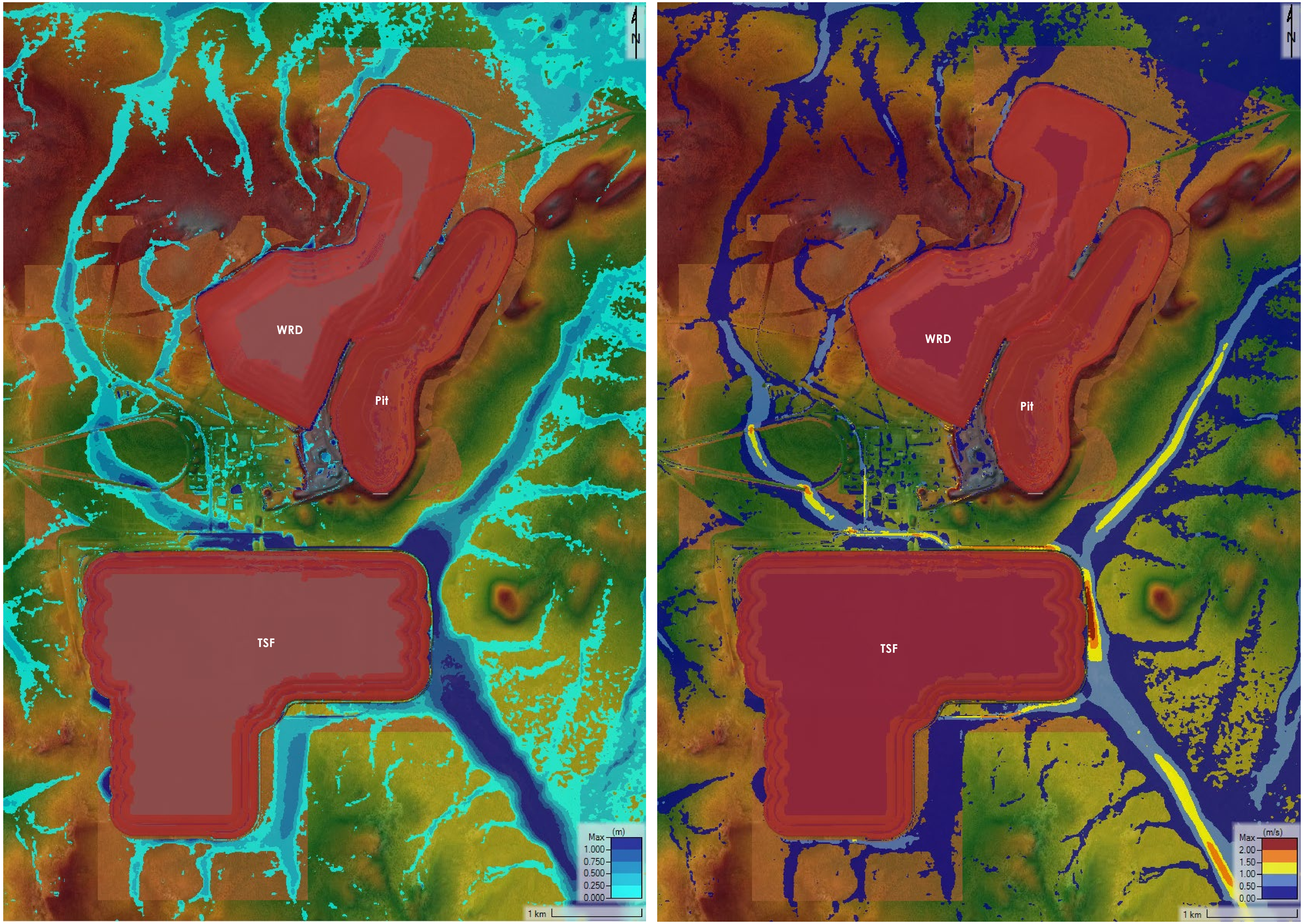


Figure D-10 KIOP Closure 1 in 10,000 AEP Max Depth (left) and Max Velocity (right)

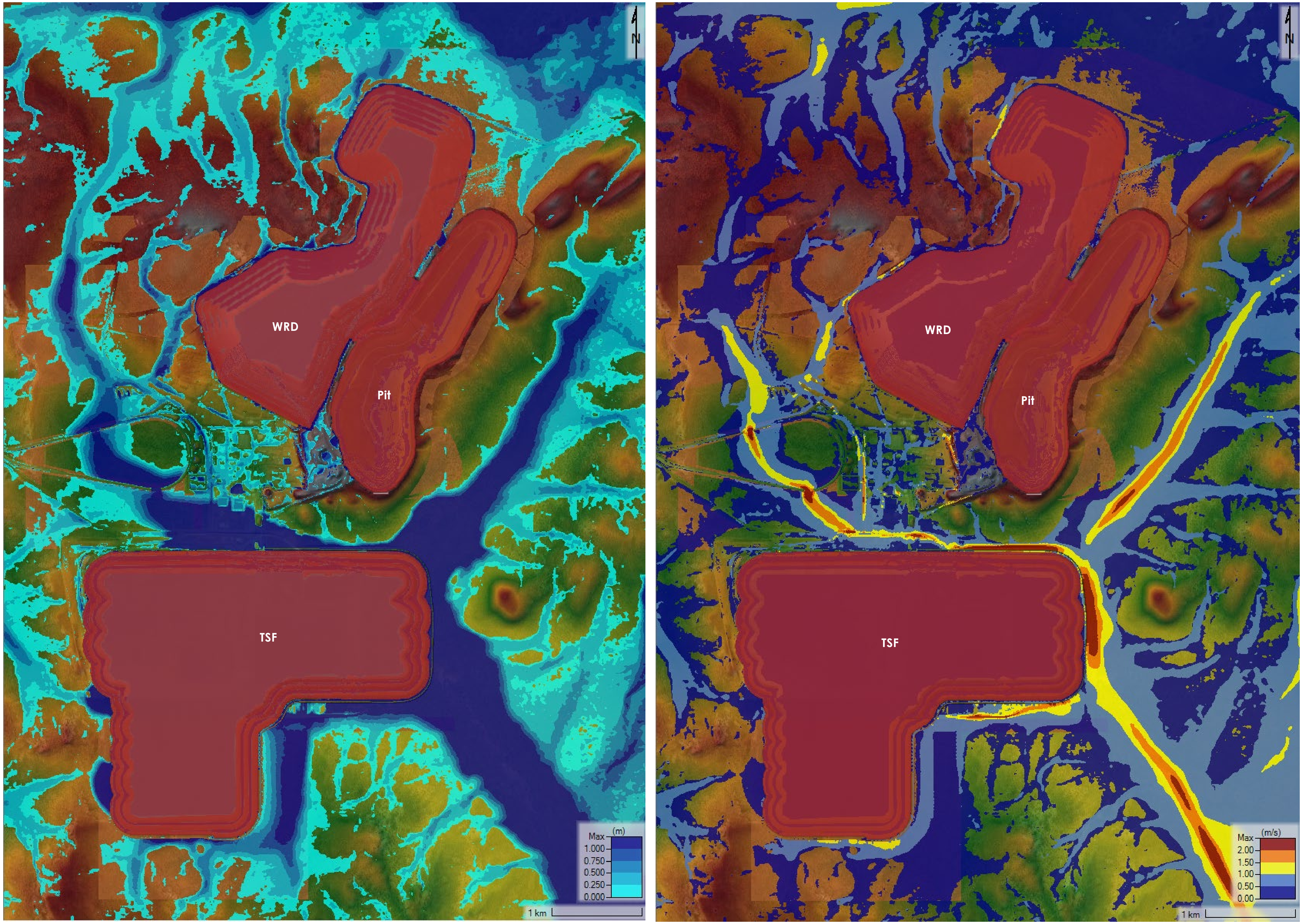


Figure D-11 KIOP Closure PMF Max Depth (left) and Max Velocity (right)

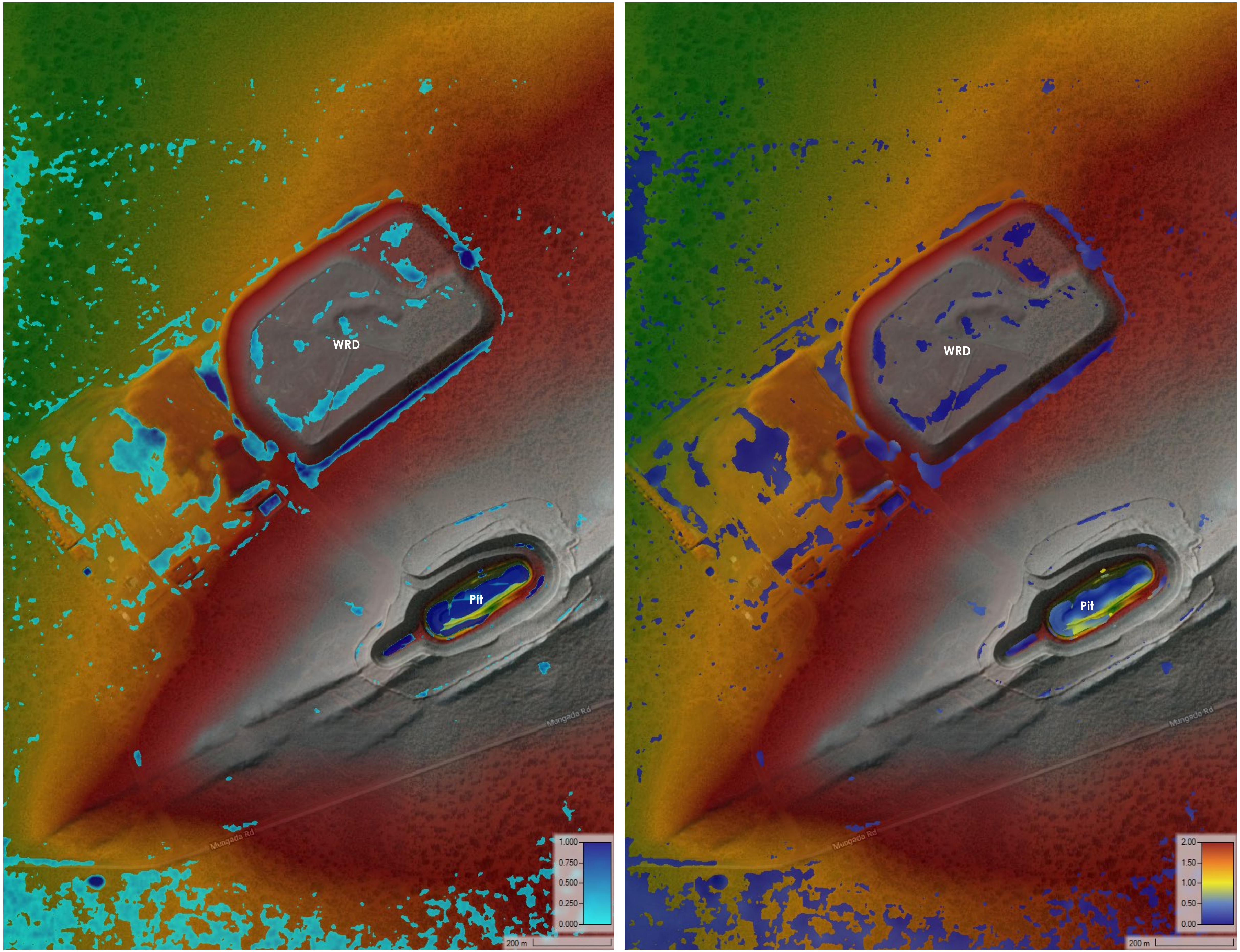
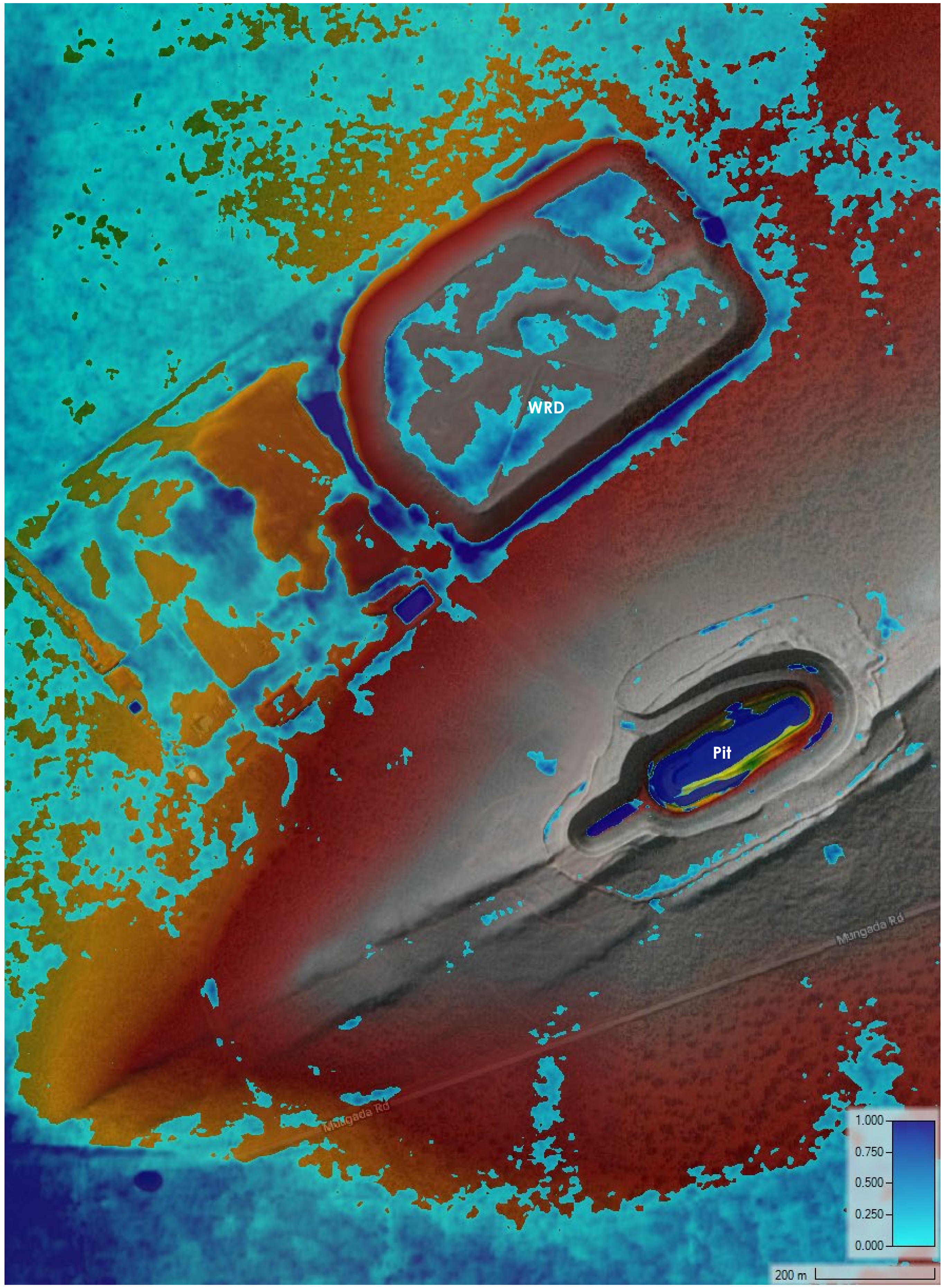


Figure D-12 Blue Hills (MIOP) 1% AEP Max Depth (left) and Max Velocity (right)



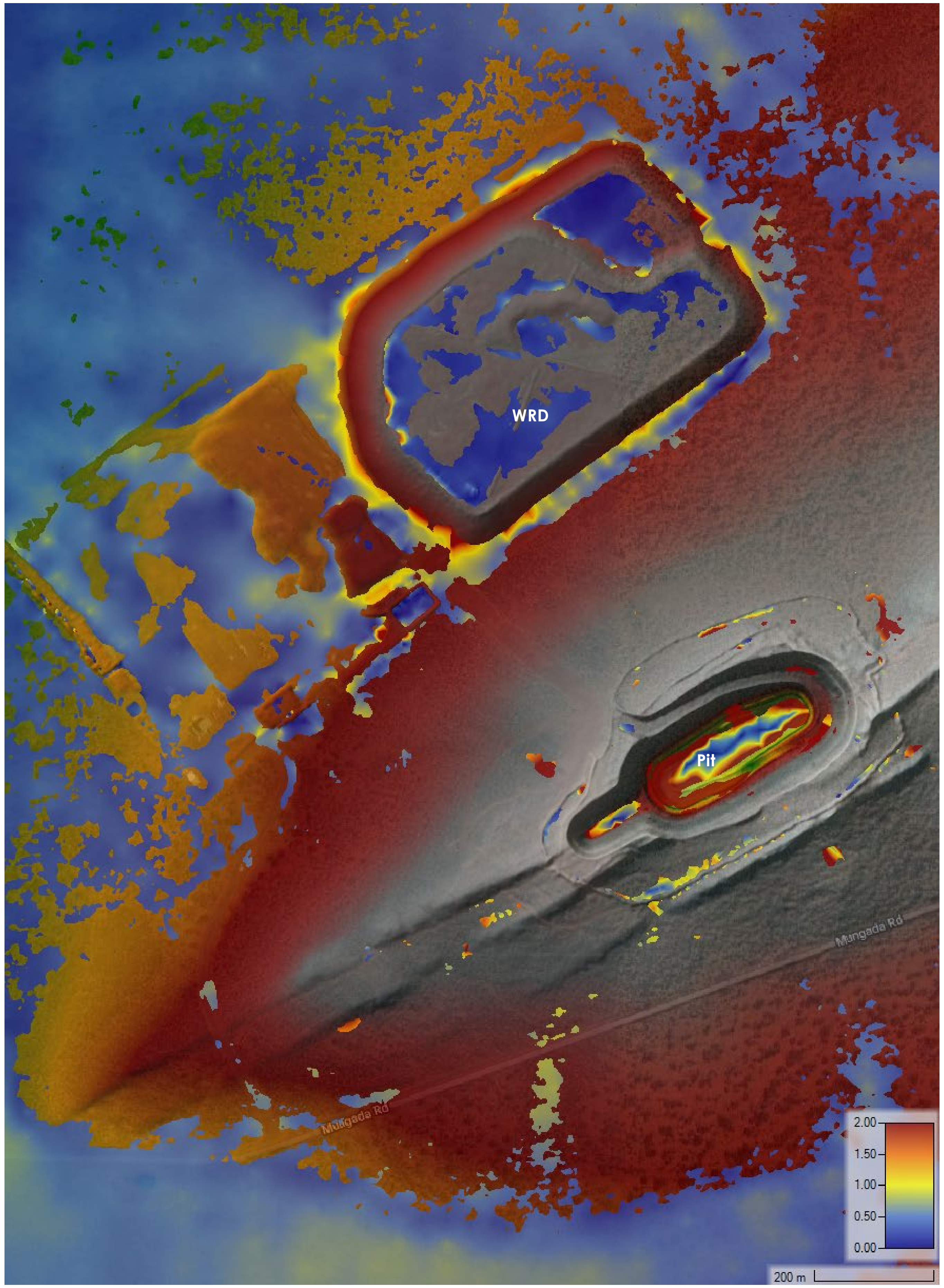


Figure D-13 Blue Hills (MIOP) PMF Max Depth (left) and Max Velocity (right)

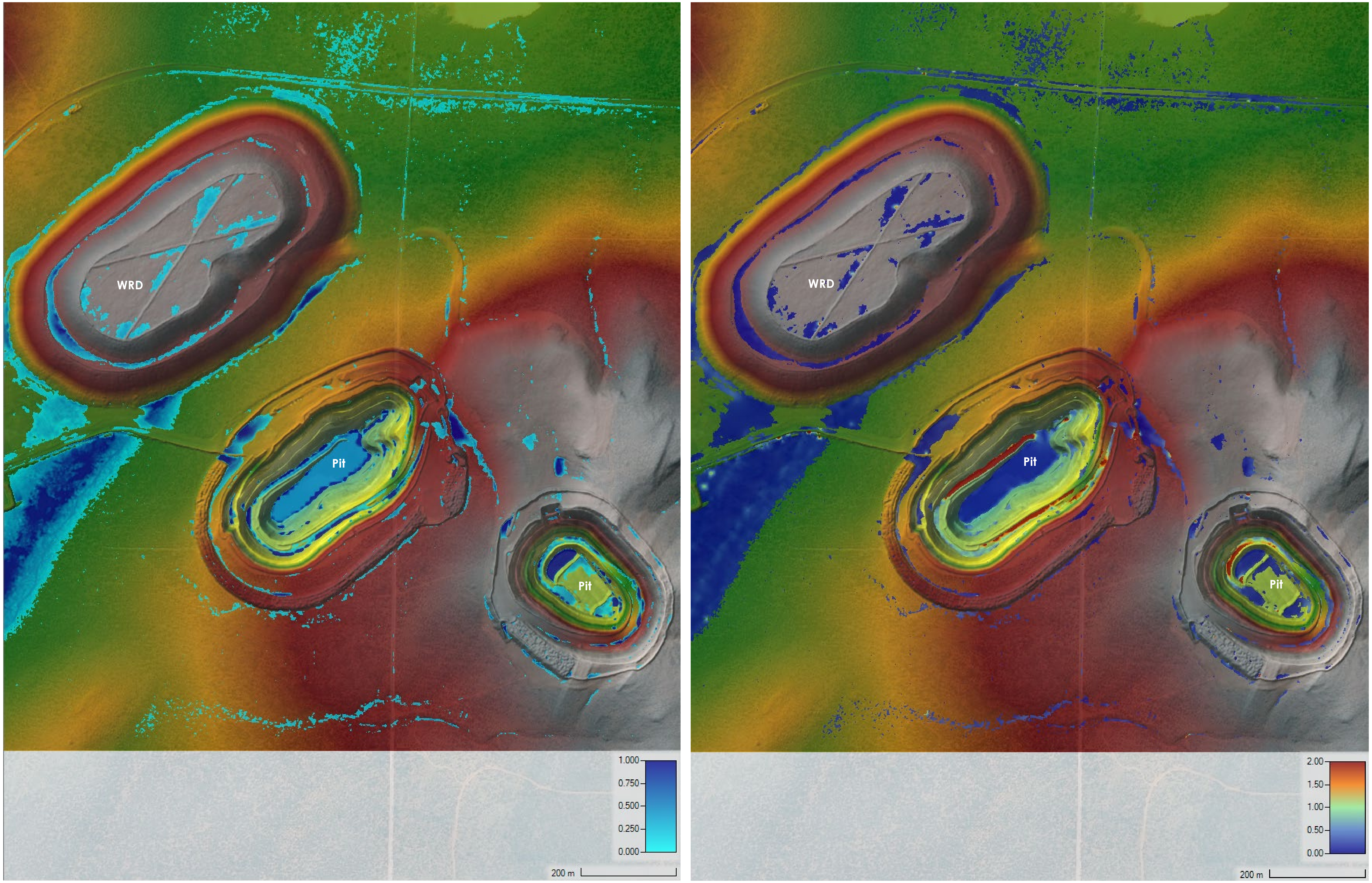


Figure D-14 Terapod (MIOP) 1% AEP Max Depth (left) and Max Velocity (right)

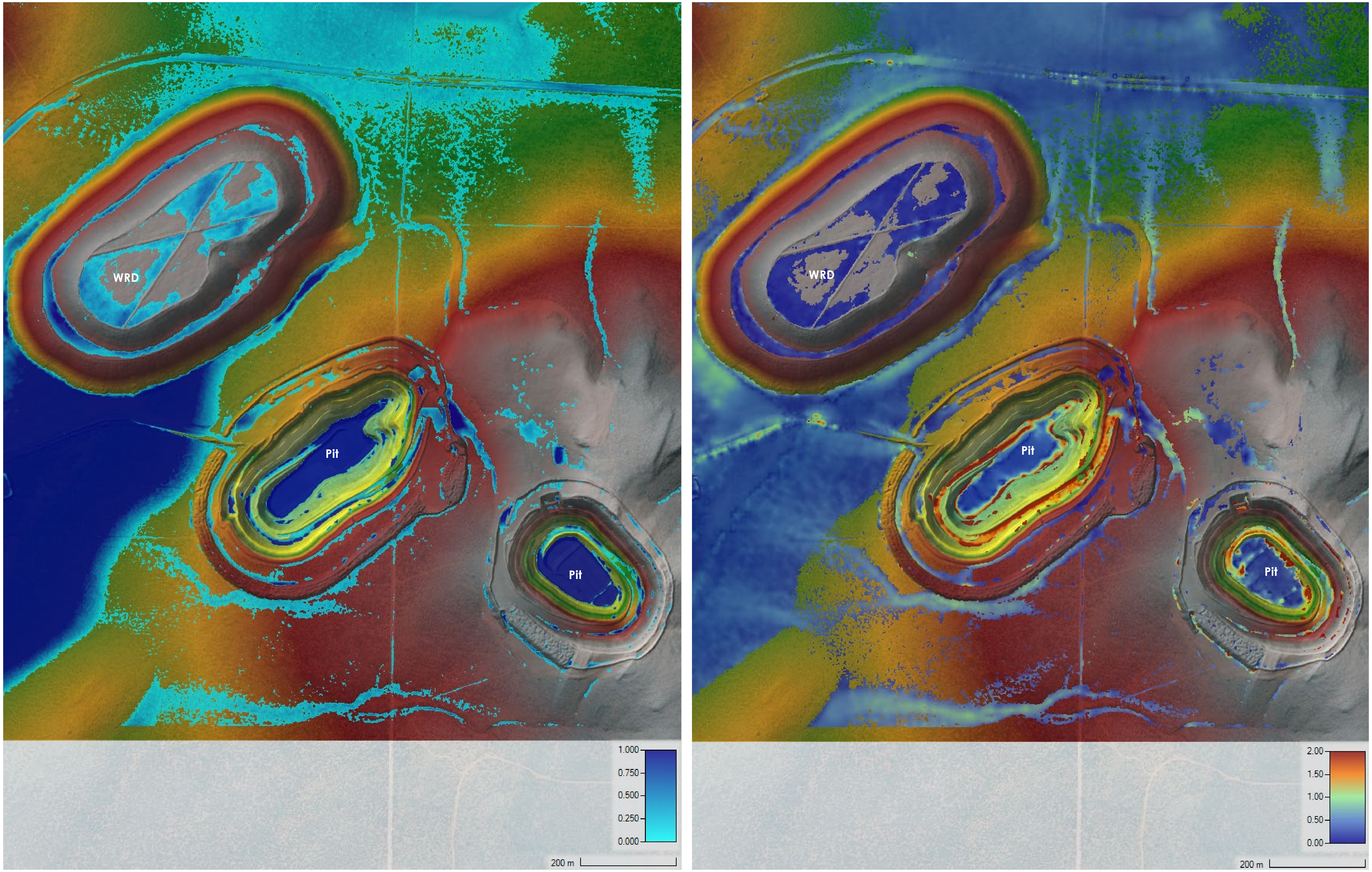
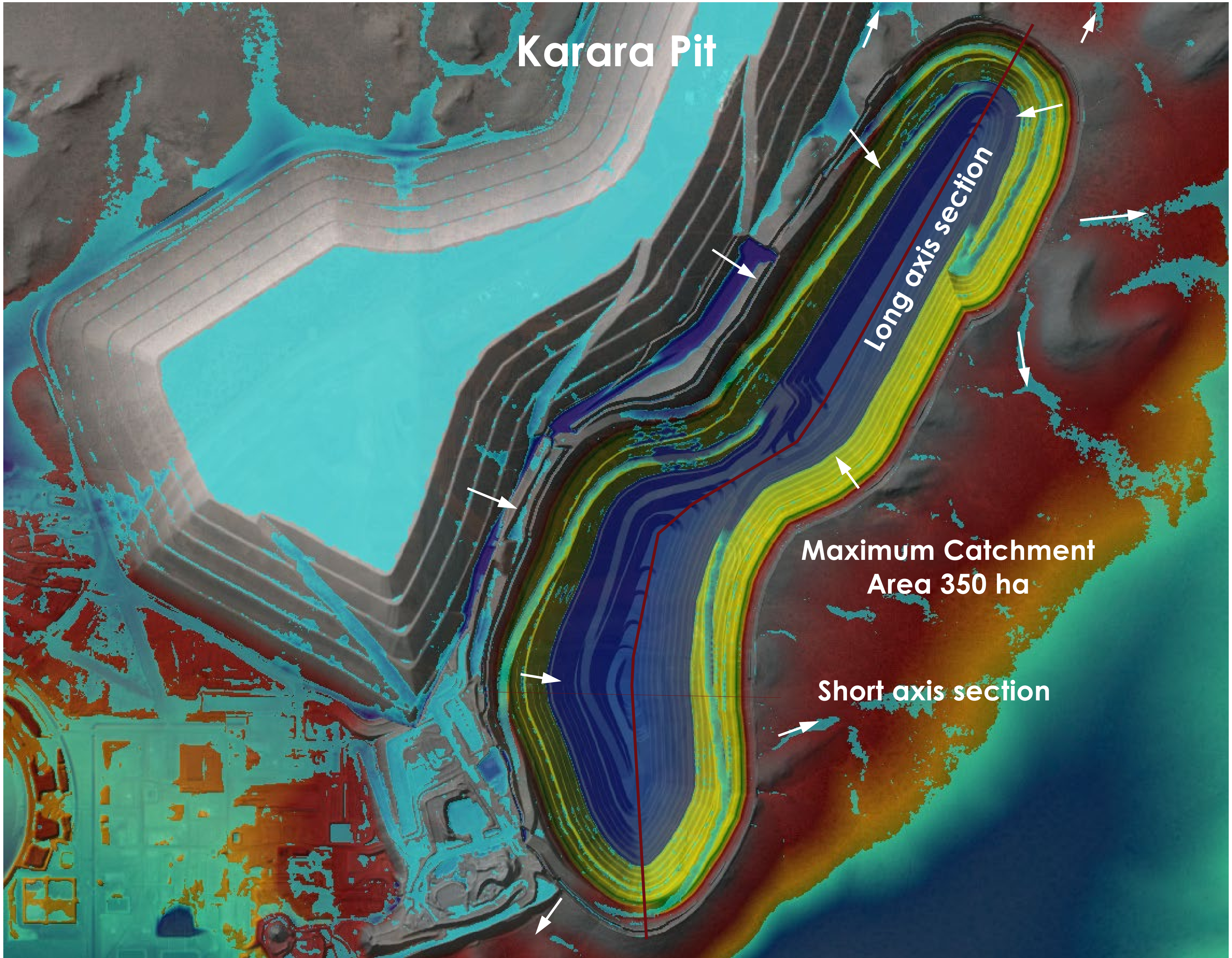
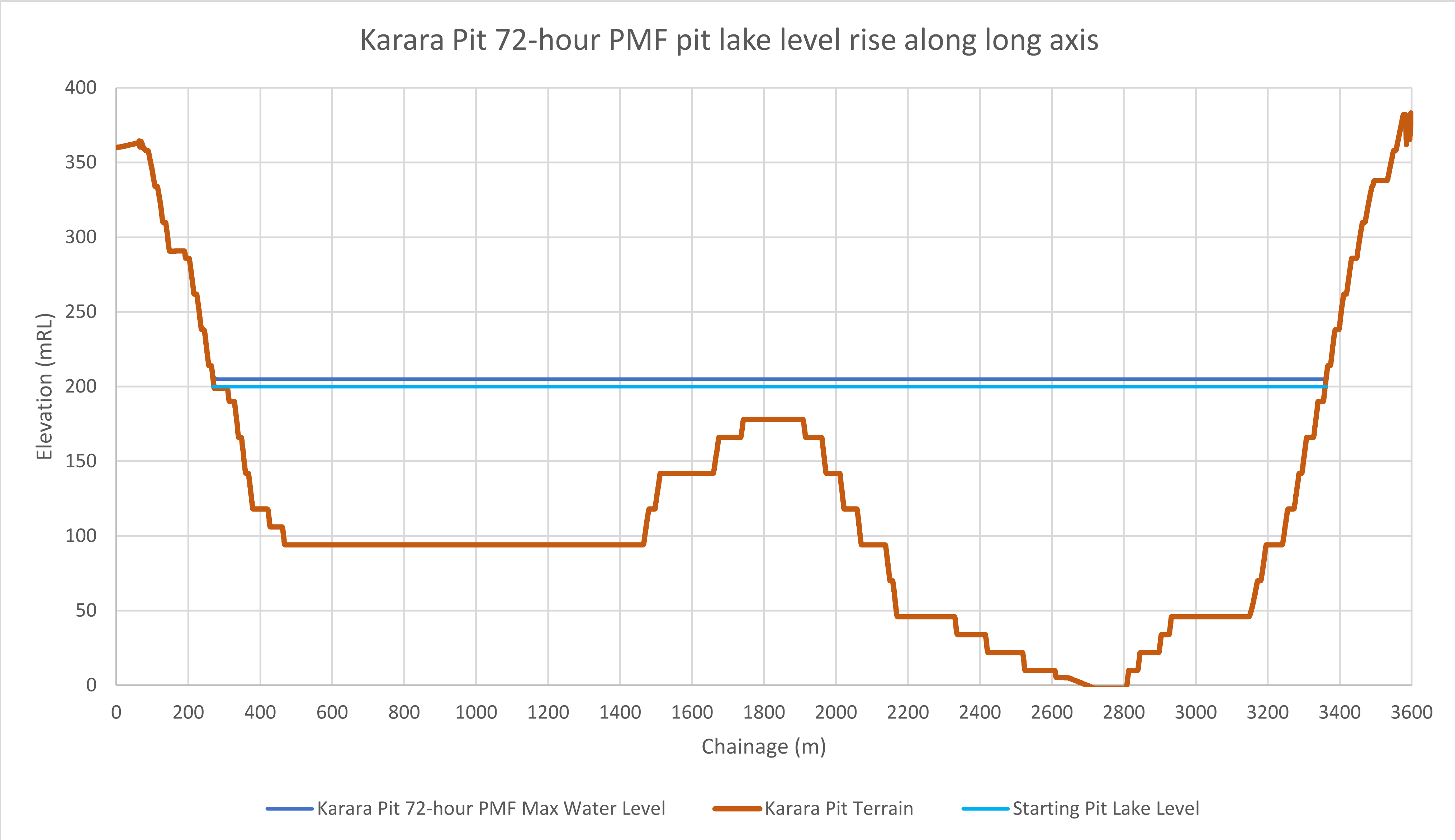


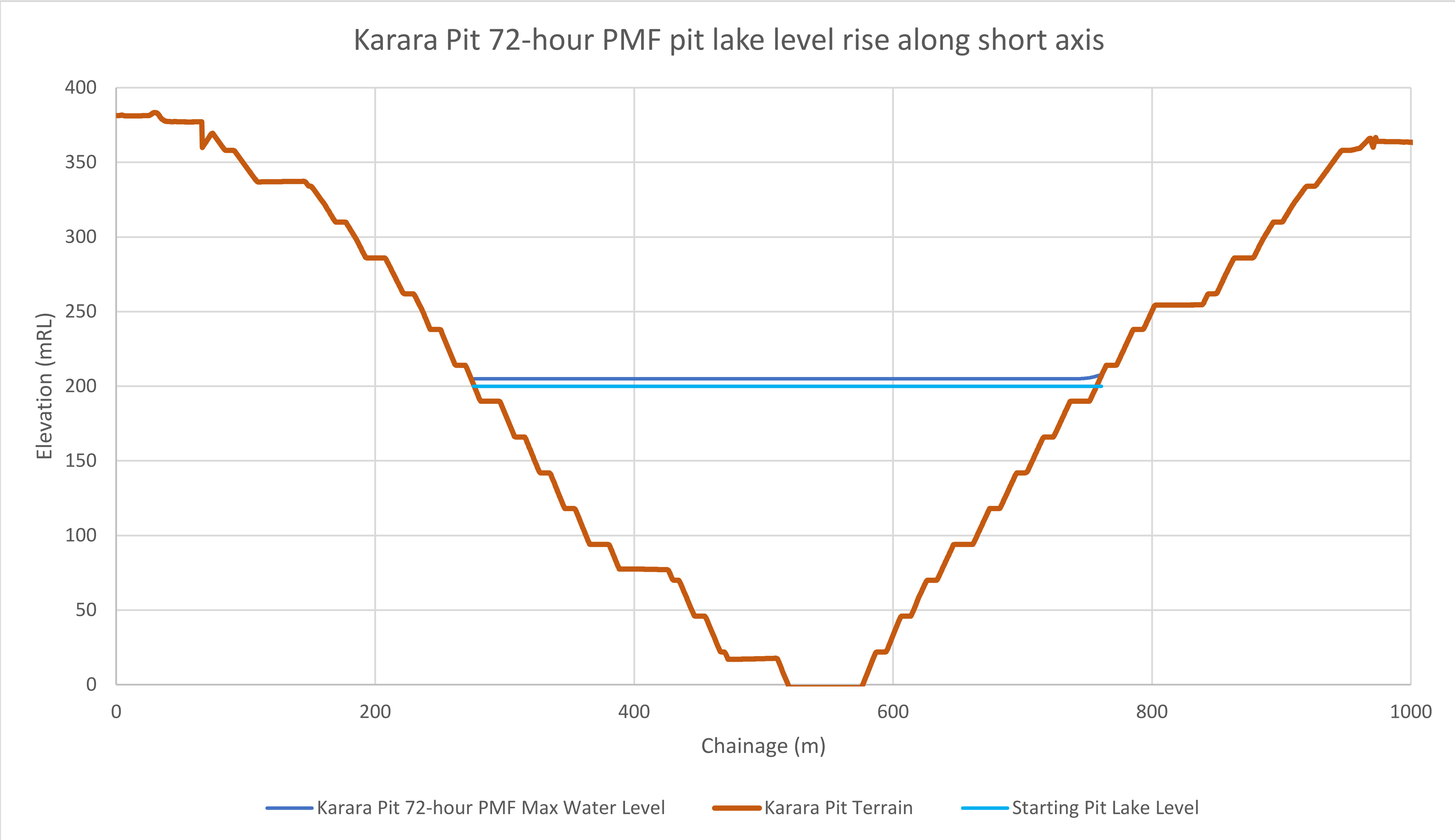
Figure D-15 Terapod (MIOP) Closure PMF Max Depth (left) and Max Velocity (right)

Appendix E Change in Pit Lake Level with PMF

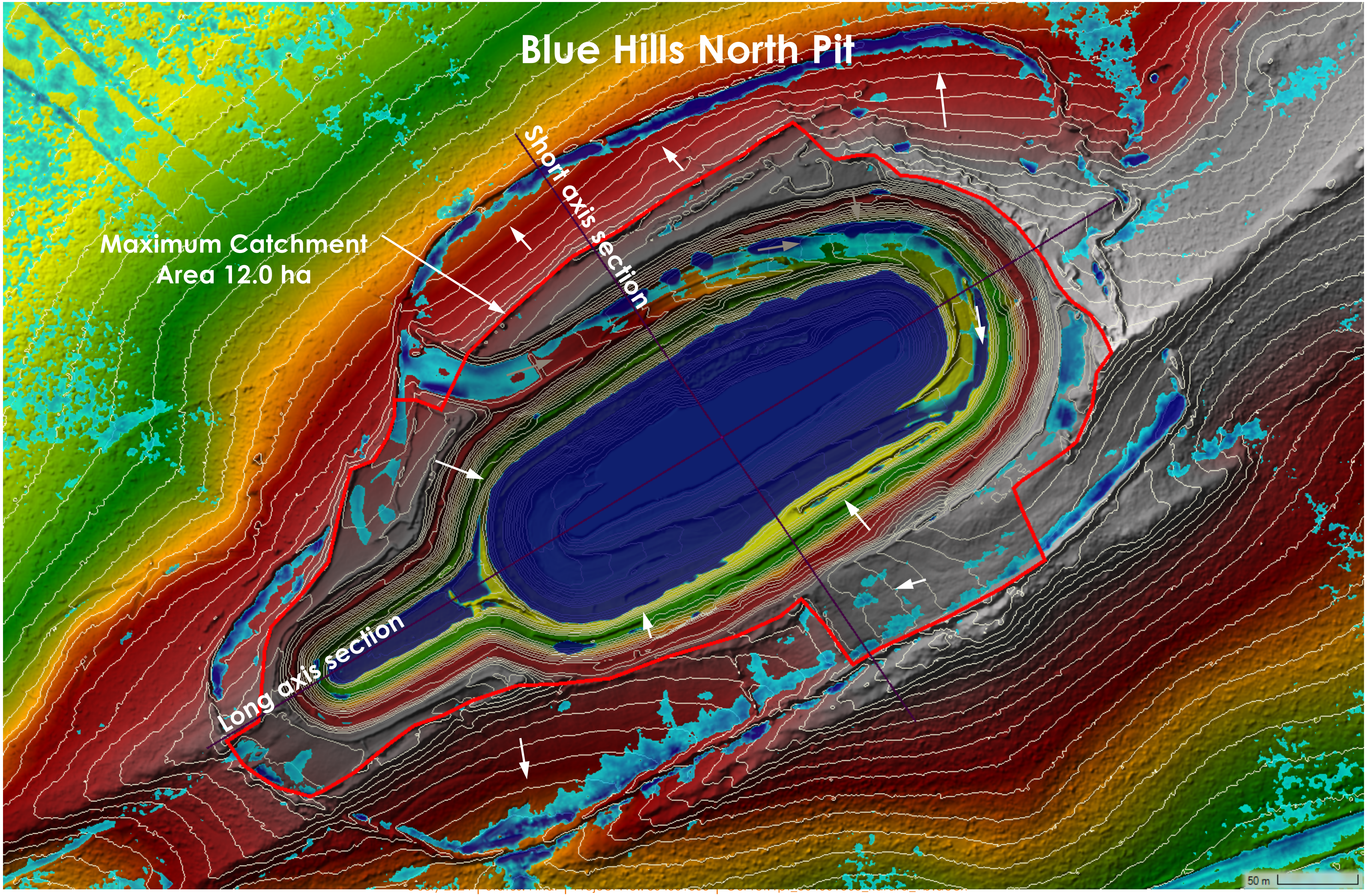

Karara Pit
Long axis section
Maximum Catchment Area 350 ha
Short axis section

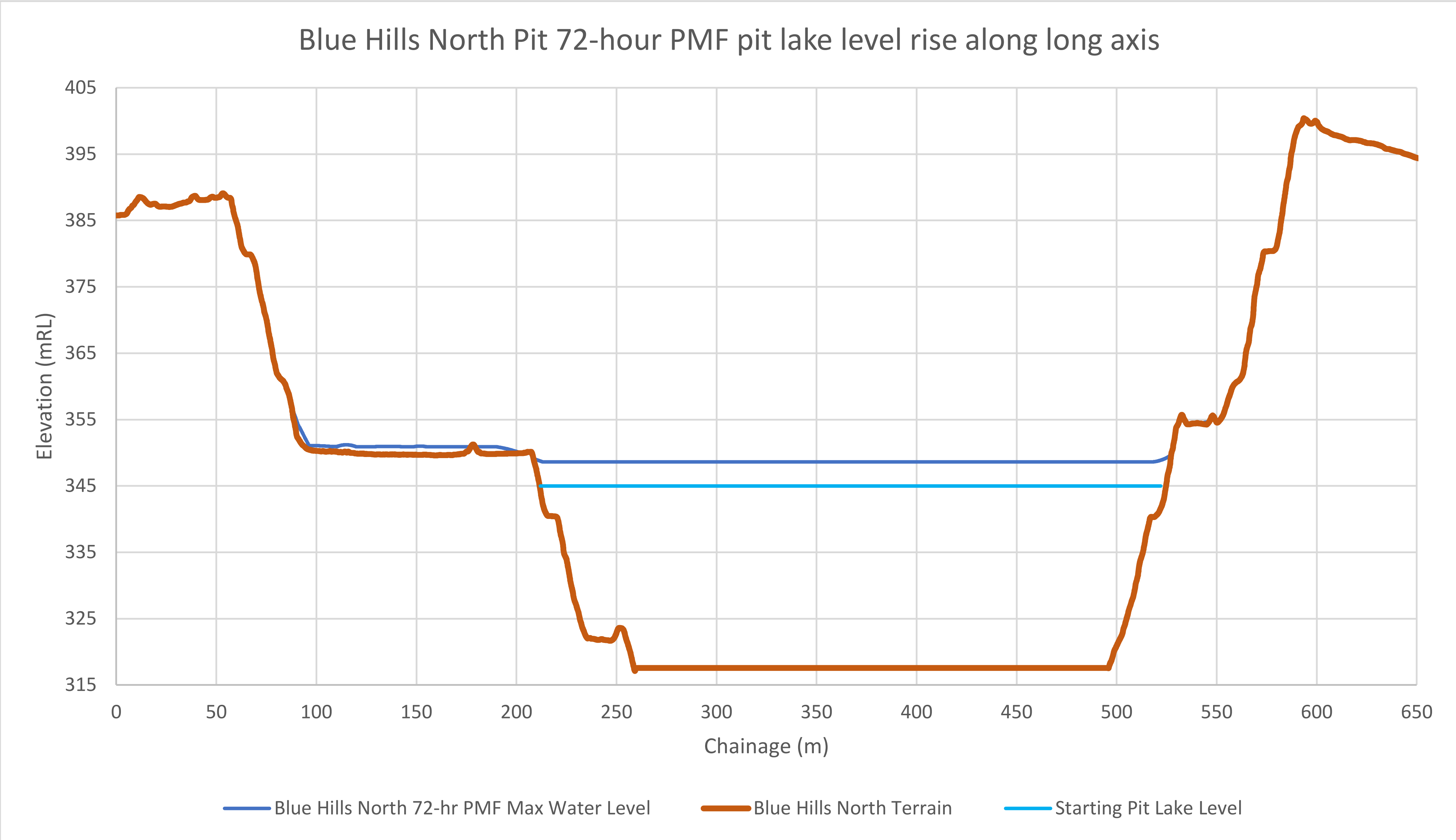


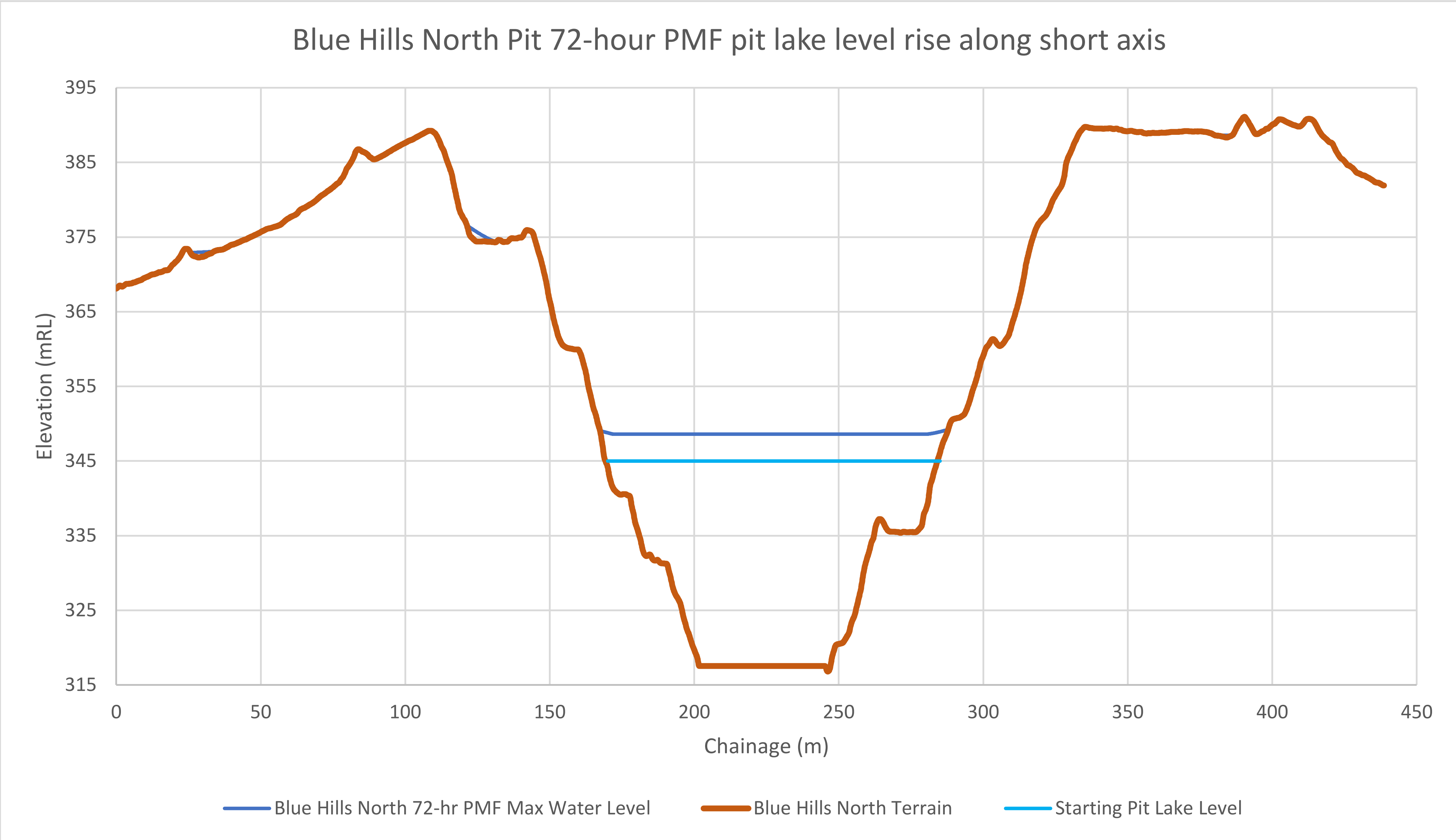
Karara Pit 72-hour PMF pit lake level rise along long axis
400
350
300
250
200
150
100
50
0
Elevation (mRL)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
Chainage (m)
Karara Pit 72-hour PMF Max Water Level
Karara Pit Terrain
Starting Pit Lake Level

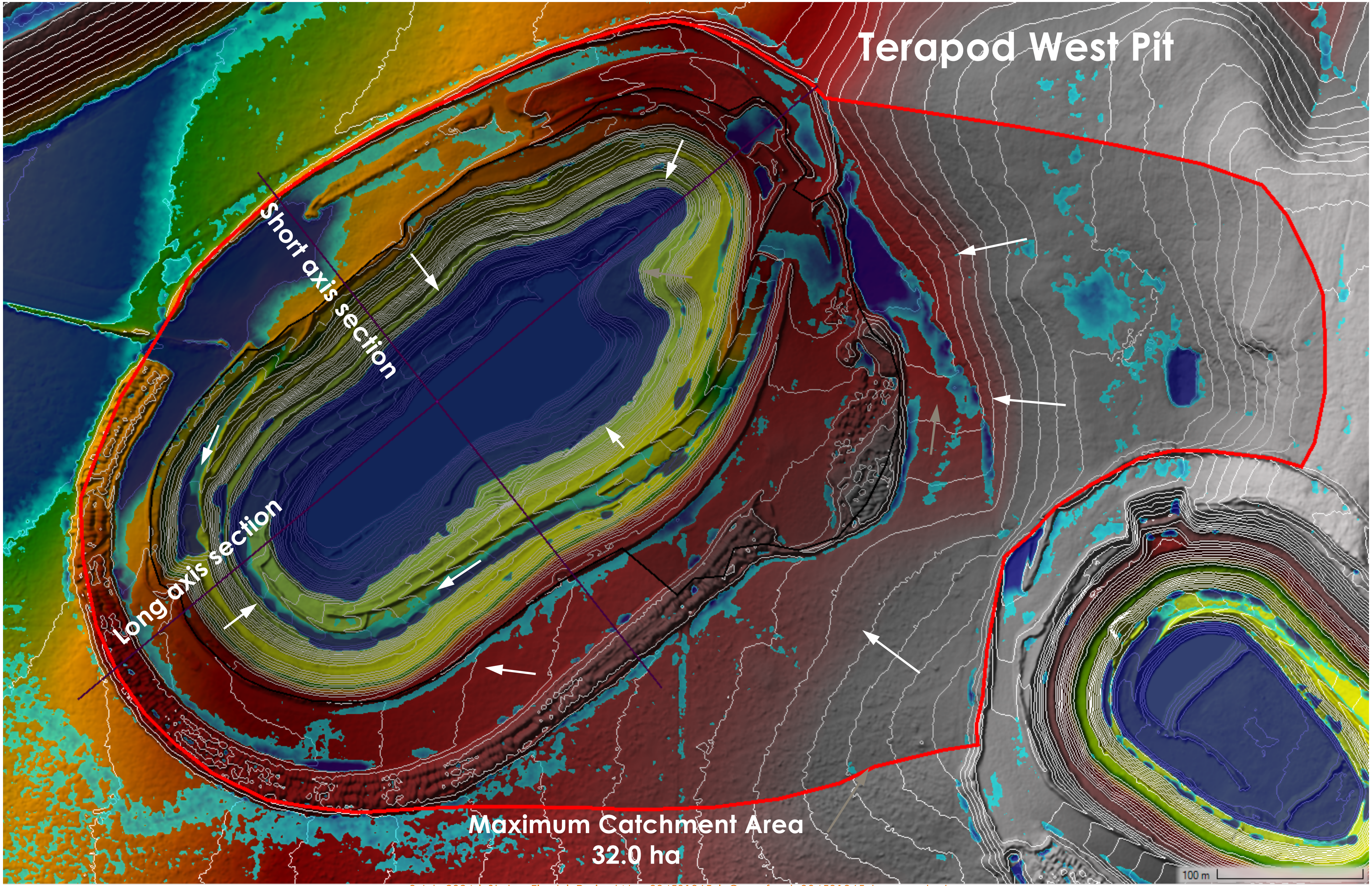


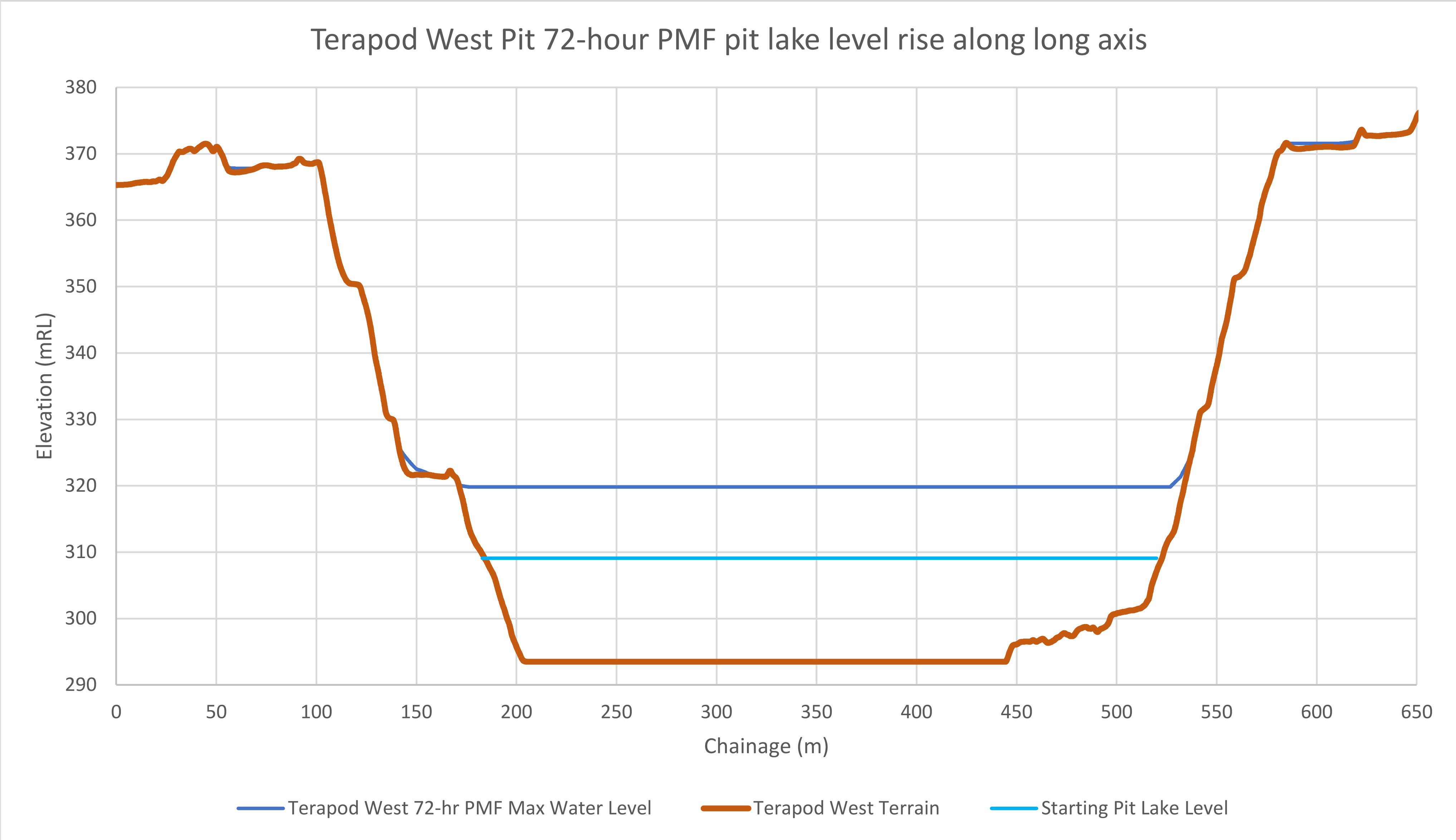
Karara Pit 72-hour PMF pit lake level rise along short axis
400
350
300
250
200
150
100
50
0
Elevation (mRL)
0
200
400
600
800
1000
Chainage (m)
Karara Pit 72-hour PMF Max Water Level
Karara Pit Terrain
Starting Pit Lake Level


Blue Hills North Pit
Maximum Catchment Area 12.0 ha
Short axis section
Long axis section
50 m

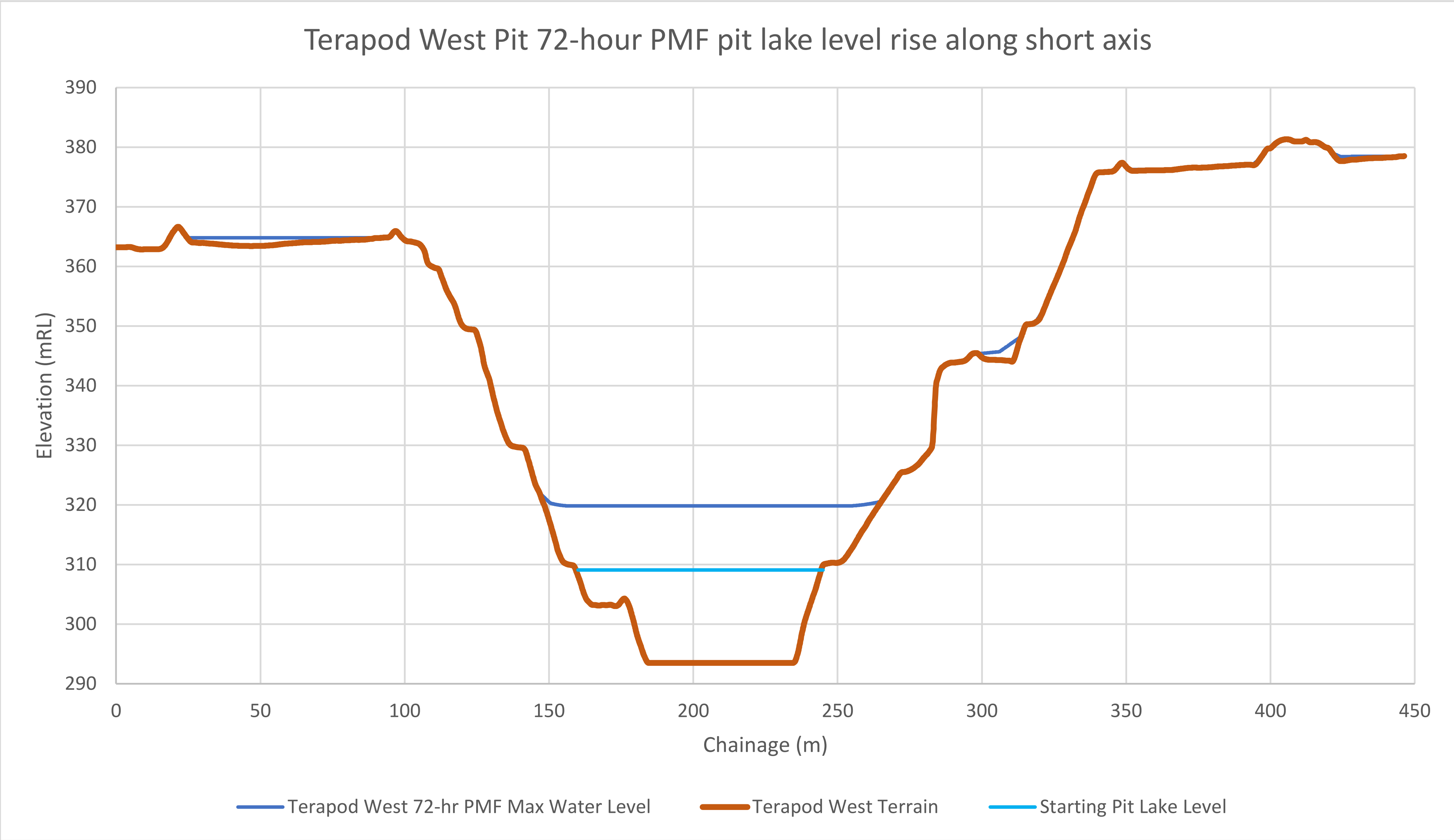

Blue Hills North Pit 72-hour PMF pit lake level rise along long axis
405
395
385
375
365
355
345
335
325
315
Elevation (mRL)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
Chainage (m)
Blue Hills North 72-hr PMF Max Water Level
Blue Hills North Terrain
Starting Pit Lake Level

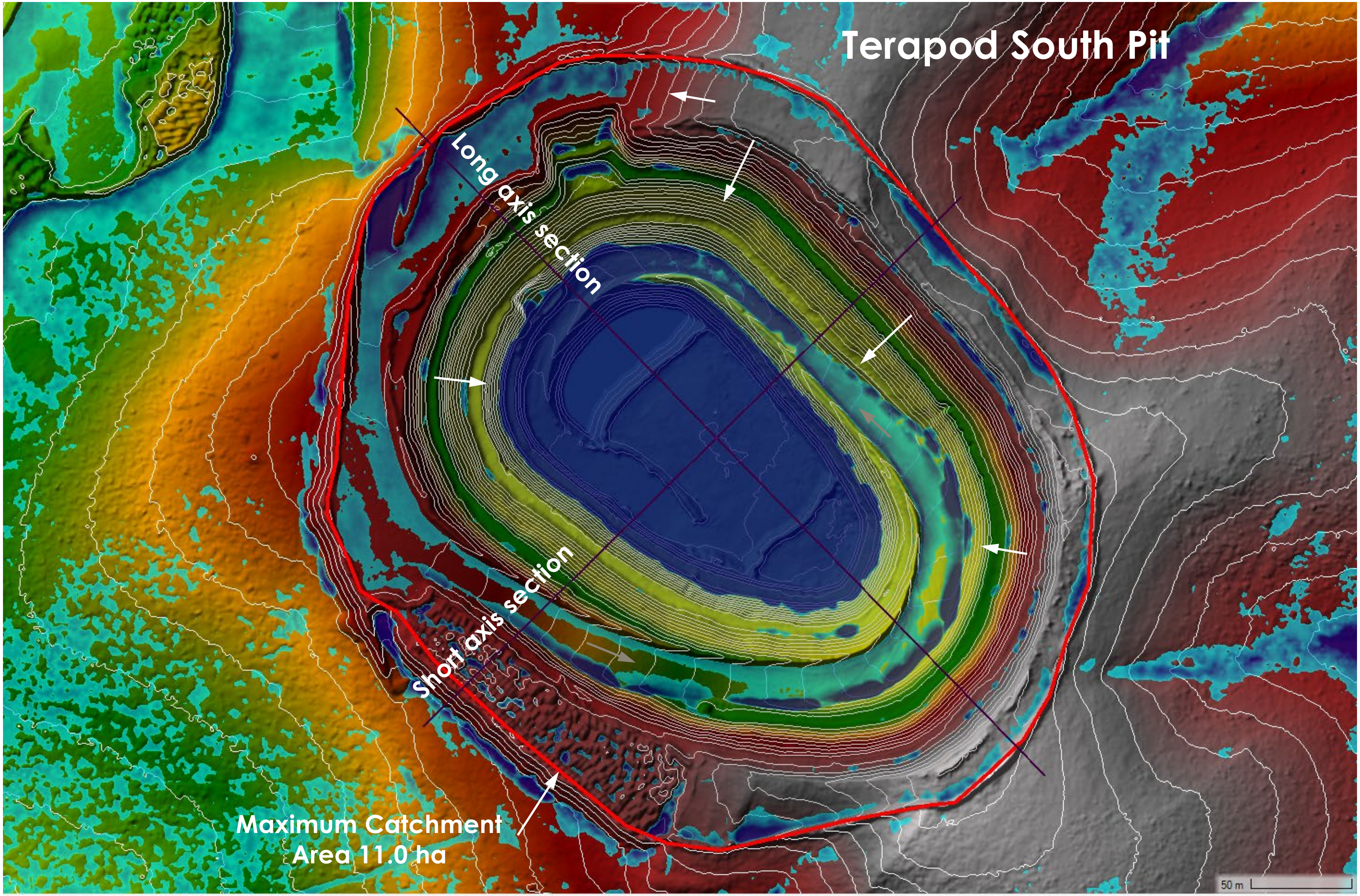

Blue Hills North Pit 72-hour PMF pit lake level rise along short axis
Elevation (mRL)
395
385
375
365
355
345
335
325
315
0
50
100
150
200
250
300
350
400
450
Chainage (m)
Blue Hills North 72-hr PMF Max Water Level
Blue Hills North Terrain
Starting Pit Lake Level

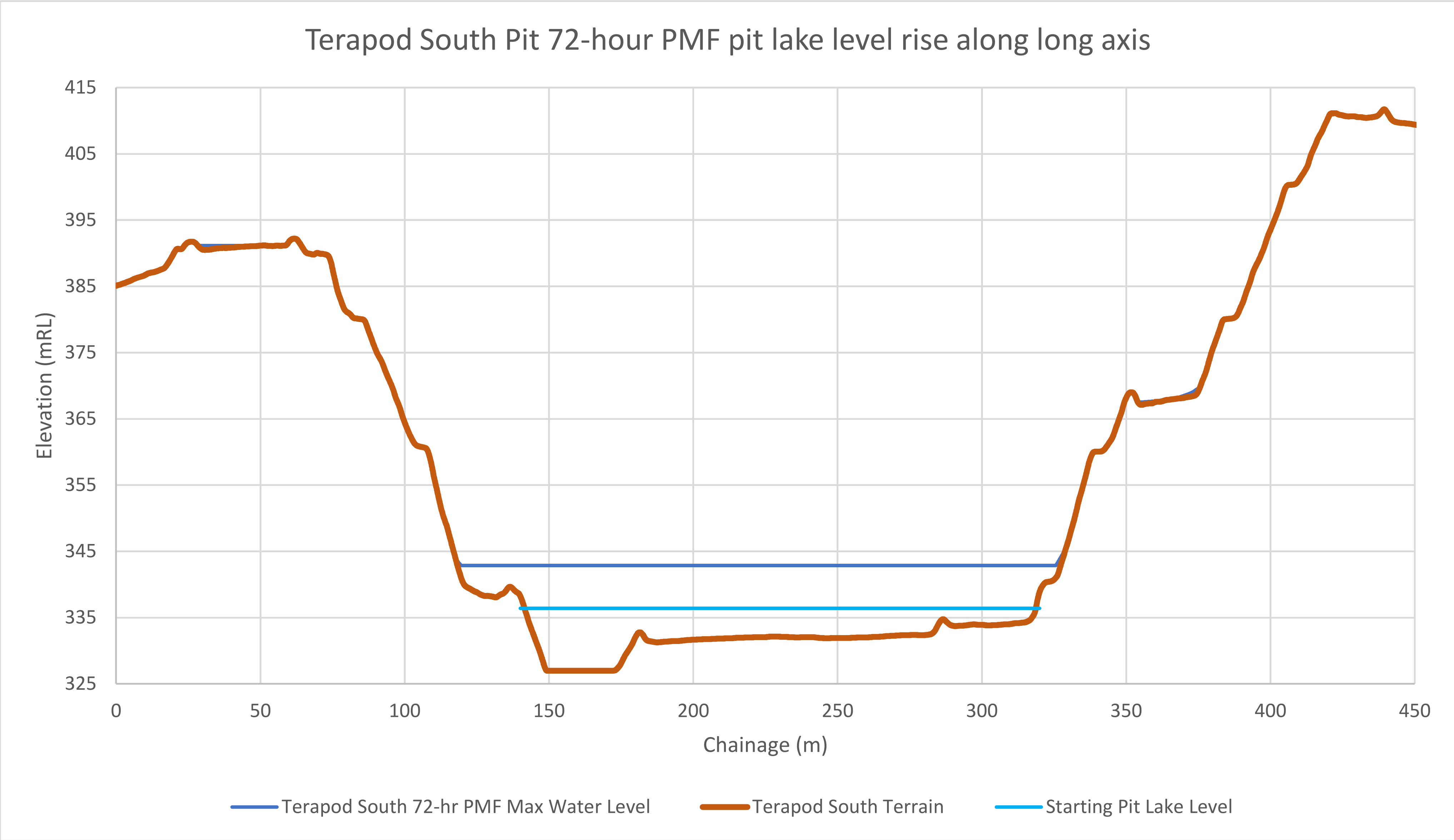

Terapod West Pit
Short axis section
Long axis section
Maximum Catchment Area
32.0 ha
100 m

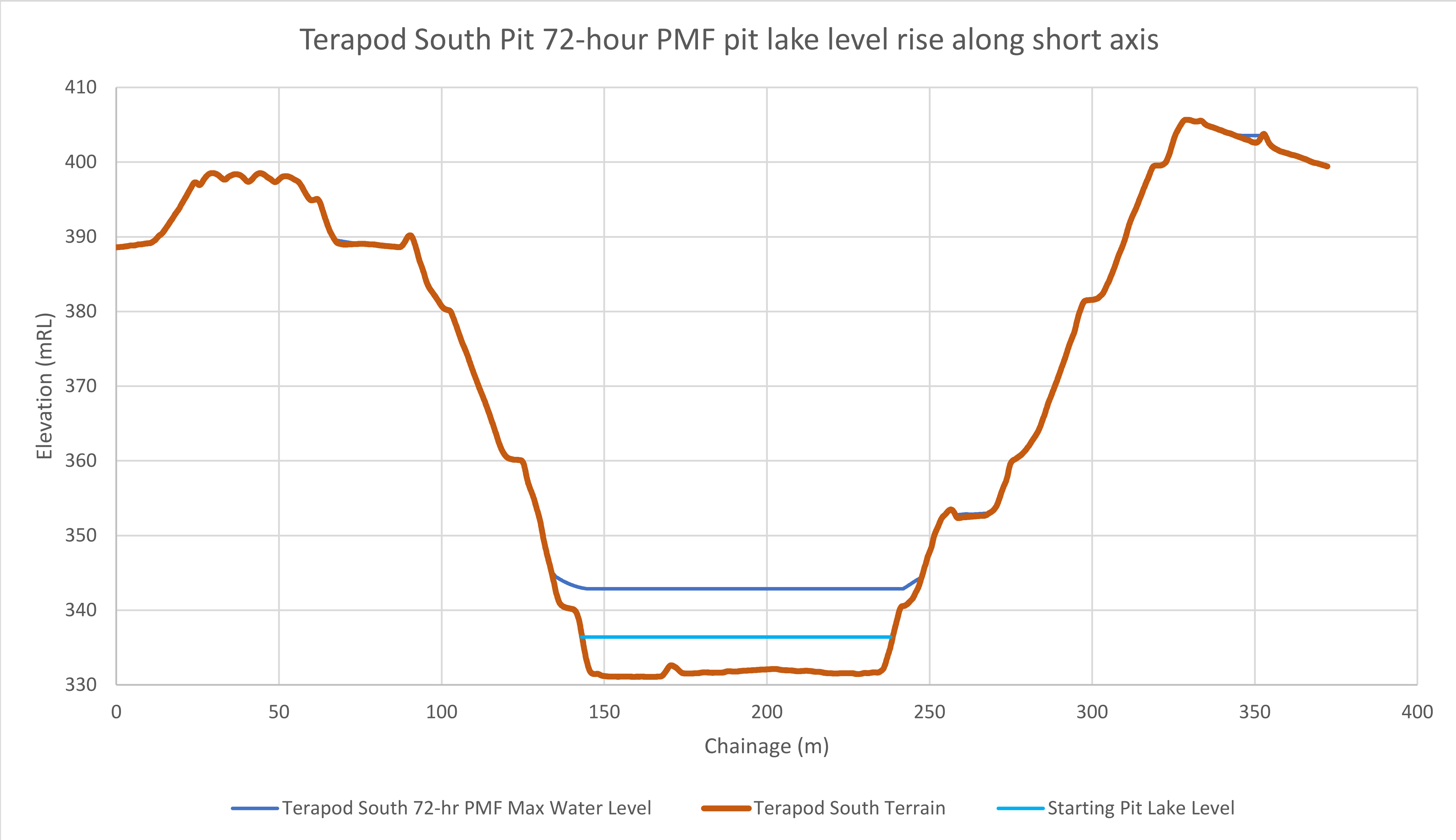


Terapod West Pit 72-hour PMF pit lake level rise along long axis
380
370
360
350
340
330
320
310
300
290
Elevation (mRL)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
Chainage (m)
Terapod West 72-hr PMF Max Water Level
Terapod West Terrain
Starting Pit Lake Level


Terapod West Pit 72-hour PMF pit lake level rise along short axis
390
380
370
360
350
340
330
320
310
300
290
Elevation (mRL)
0
50
100
150
200
250
300
350
400
450
Chainage (m)
Terapod West 72-hr PMF Max Water Level
Terapod West Terrain
Starting Pit Lake Level


Terapod South Pit
Long axis section
Short axis section
Maximum Catchment
Area 11.0 ha
50 m


Terapod South Pit 72-hour PMF pit lake level rise along long axis
415
405
395
385
375
365
355
345
335
325
Elevation (mRL)
0
50
100
150
200
250
300
350
400
450
Chainage (m)
Terapod South 72-hr PMF Max Water Level
Terapod South Terrain
Starting Pit Lake Level



Terapod South Pit 72-hour PMF pit lake level rise along short axis
410
400
390
380
370
360
350
340
330
Elevation (mRL)
0
50
100
150
200
250
300
350
400
Chainage (m)
Terapod South 72-hr PMF Max Water Level
Terapod South Terrain
Starting Pit Lake Level

Perth

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