APPENDIX K

BP33 Underground Mine Flood Modelling Study (WRM, 2025)

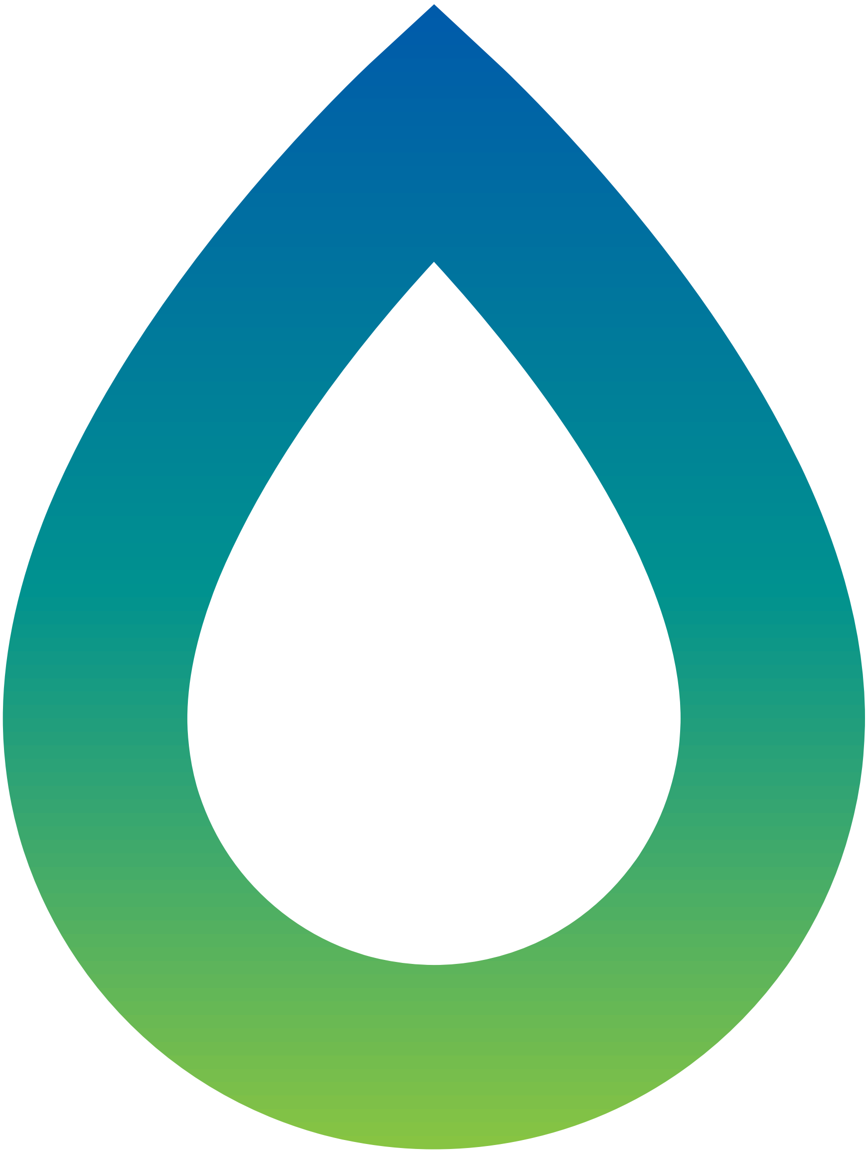
BP33 UNDERGROUND MINE

Flood study

Lithium Developments (Grants NT) Pty Ltd

3 October 2025

1727-27-I_DRAFT



DETAILS

Report Title	BP33 Underground mine, Flood study
Client	Lithium Developments (Grants NT) Pty Ltd

THIS REVISION

Report Number	1727-27-I_DRAFT
Date	3 October 2025
Author	JL/KO
Reviewer	JO

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1 INTRODUCTION

1.1 BACKGROUND

The BP33 Underground Mine (BP33) forms a part of the greater Finniss Lithium Project (the Project), which currently encompasses both BP33 underground mine operation and the adjacent Grants operation. The Project is managed by Lithium Developments (Grants NT) Pty Ltd (LD) with construction currently ongoing. This flood study focuses on the internal catchments of the site as well as the tributaries external to the site.

BP33 is located approximately 6 km south of the Grants operations in the Northern Territory, approximately 20 km southwest of Darwin and 20 km west of Berry Springs. A locality plan of BP33 is shown in Figure 1.1.

1.2 PURPOSE AND SCOPE

The purpose of the BP33 flood study is to:

- Understand the currently developed conditions flooding characteristics in the vicinity of BP33 and the receiving tributaries (Drainage Line BP1); and
- Understand the local flooding characteristics of the internal catchments and assess the flood immunity of the Box Cut.

WRM have previously completed existing conditions flooding assessment in the vicinity of BP33 and drainage line BP1. Further details of the hydrological and hydraulic model developments as well as the results under existing conditions are documented in *BP33 Underground Mine – Flood Study Report, Ref 1727-22-B1 dated 17 July 2024 (WRM, 2024)*.

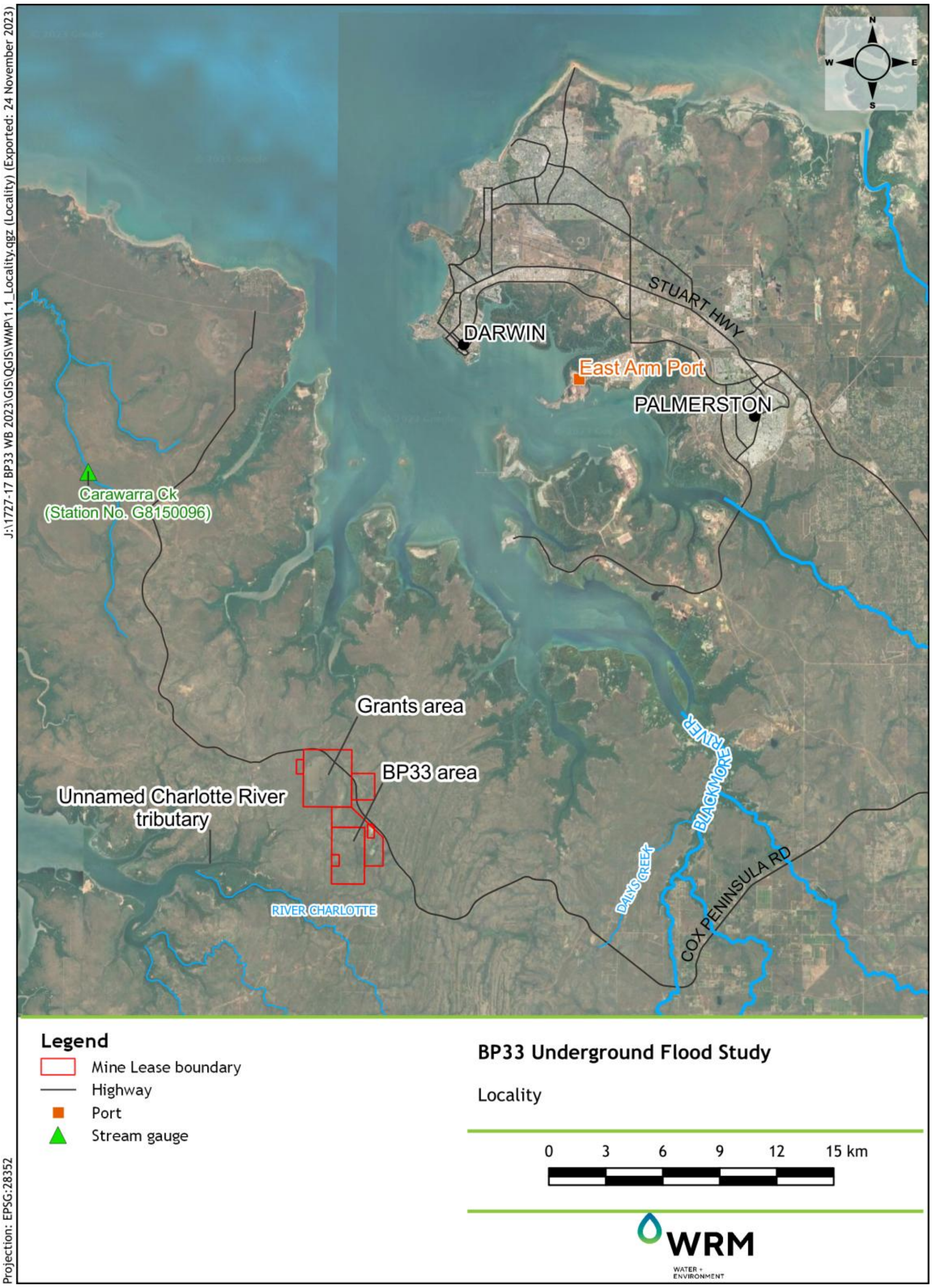

Figure 1.1 Project locality

2 DRAINAGE CHARACTERISTICS

2.1 GENERAL

Figure 2.1 shows the local catchments and drainage features in the vicinity of the BP33 area. There are two unnamed tributaries that drain through the vicinity of the BP33 area, Drainage Line BP1 and the overland flowpath. The unnamed tributaries are located within the Charlotte River catchment, which discharges into Bynoe Harbour. The Charlotte River is located approximately 3 km to the southwest of BP33.

2.2 EXTERNAL CATCHMENTS

2.2.1 Drainage Line BP1

Drainage Line BP1 has a catchment area of approximately 359 ha to the downstream Mine Lease boundary. Of this catchment area, approximately 94 ha is upstream of OHD. The catchment is mostly natural with some grassed areas that were cleared by preliminary exploration activities. The channel is poorly defined, particularly in the upper section of the reach. The channel banks are vegetated with grasses, shrubs and small trees. There are three arms of Drainage Line BP1:

- The central drainage line which is named as Drainage Line BP1;
- The waterway to the east where overflows from the Observation Hill Dam (OHD) discharge into Drainage Line BP1; and
- A local north-western overland flow path which crosses the BP33 site area before discharging into Drainage Line BP1.

2.3 INTERNAL CATCHMENTS

2.3.1 Sediment Basin 1

Sediment Basin 1 (SB1) has an upstream catchment area of approximately 22.3 ha to the outlet of the sediment basin. The catchment receives mostly catchment runoff from the box-cut stockpile area, and the infrastructure/contractor pads to the north. Runoff would generally be picked up by the sediment drains located on the eastern side of the site.

2.3.2 Sediment Basin 2

Sediment Basin 2 (SB2) has an upstream catchment area of approximately 16 ha to the outlet of the sediment basin. The catchment is mostly catchment runoff from the Waste Rock Stockpile Area and the laydown areas which are located on the western side of the site. Runoff would generally be picked up by the perimeter drain and sediment drains that encompasses the western and southern side of the site.

2.3.3 Box Cut

The Box Cut area has a self-contained catchment area with no upstream catchments draining to it. The catchment area to the Box Cut is approximately 3.2 ha. Water that accumulates in the Box-Cut is a result of direct rainfall.

2.3.4 Clean water diversion

The clean water diversion drain is an existing diversion drain which diverts upper natural catchment away from the mining infrastructure. The clean water diversion drain diverts the natural catchment runoff to the east, to Drainage Line BP1.

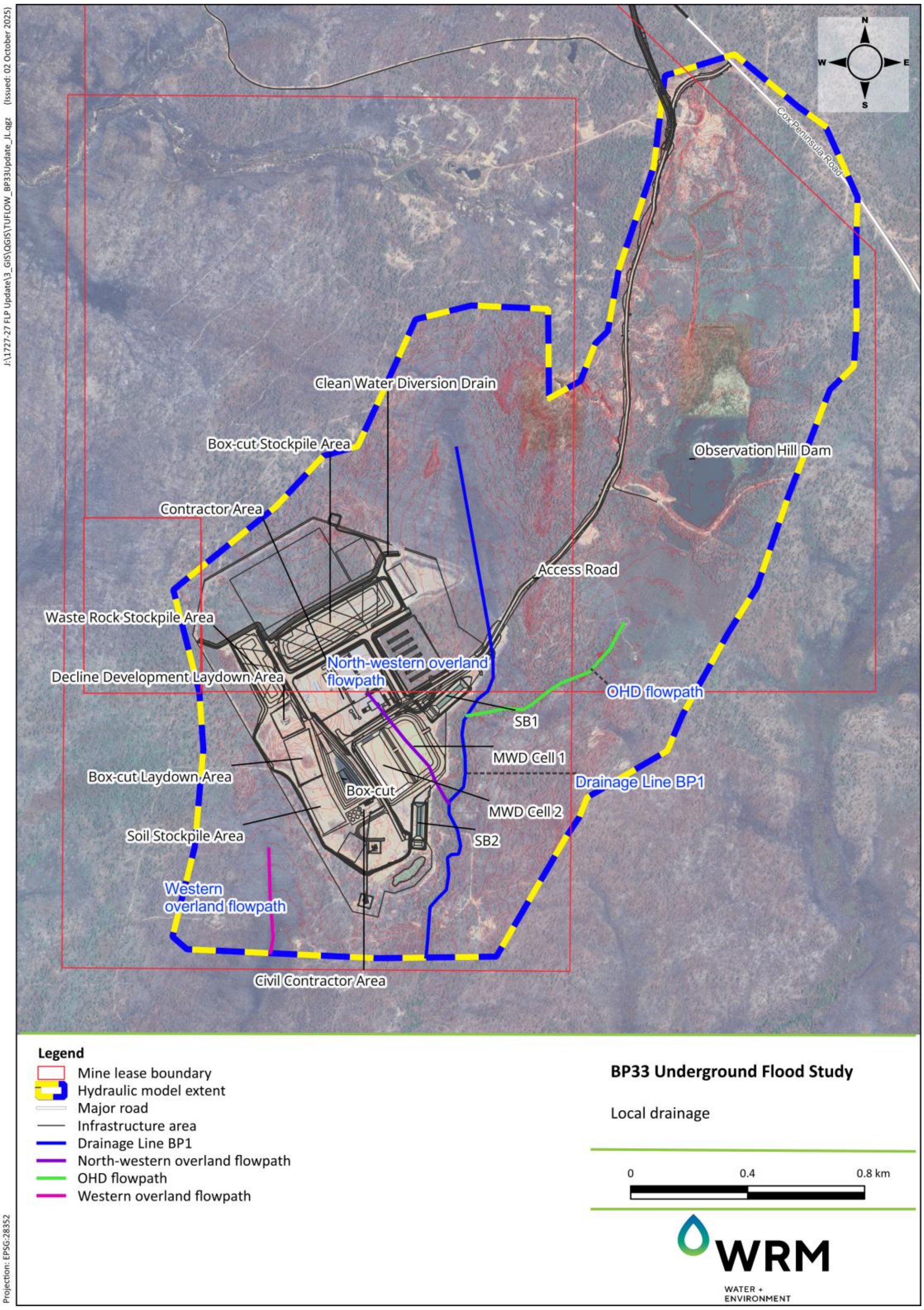

Figure 2.1 Local drainage network

3 HYDROLOGICAL MODELLING

3.1 OVERVIEW

The URBS hydrologic model (Caroll, 2021) was used to estimate design flood discharges for the catchments external to the site under developed conditions. For the internal catchments, a Rain-on-Grid (ROG) or direct rainfall TUFLOW model was developed and is detailed in Section 4.2.

URBS is a runoff-routing computer model that uses a network of conceptual storages to represent the routing of rainfall excess through a catchment. URBS has been extensively used throughout Australia by many, including by the Bureau of Meteorology (BoM) for flood forecasting on major river systems.

The URBS model was used in the “split mode” which enables the separate simulation of catchment and channel routing. Adopted rainfall losses are subtracted from the total rainfall hyetograph to obtain rainfall excess. The rainfall excess is then routed through conceptual catchment storage to determine the local runoff hydrograph for each sub-catchment. Full details of the URBS model and its features are given in the URBS v6.60 User Manual (Carroll, 2021).

Further details of the modelling methodology and model configuration for developed conditions are provided below.

3.2 METHODOLOGY

A hydrologic model was developed for developed conditions using the URBS runoff-routing software package. The 2021 version of URBS, which includes an implementation of the ARR 2019 guidelines, was used.

There was no publicly available recorded streamflow data in the drainage lines that cross the proposed Project area to calibrate the model. As a result, the URBS design discharges estimated for the Project were previously validated against the 10% AEP and 1% AEP design flood events. Validation of the hydrology model is documented in *BP33 Underground Mine – Flood Study Report, Ref 1727-22-B1 dated 17 July 2024 (WRM, 2024)*.

Design discharges were determined using the ensemble methodology defined in Australian Rainfall & Runoff (Ball et al., 2019). An ensemble of 10 temporal patterns is modelled for each storm duration to derive a range of estimated peak discharges for the 1% AEP and 0.1% AEP events. The storm duration with the highest median peak discharge of the ensemble is selected and the temporal pattern that produces the peak discharge just above the ensemble median is used for design event modelling. Design flood hydrographs were then estimated using the validated URBS model were adopted as inflows in the hydraulic model.

3.3 DESIGN RAINFALL INTENSITIES

Design rainfall intensities for the Project URBS model for all design events and durations from 15 minutes to 12 hours were obtained from the Commonwealth Bureau of Meteorology (BOM) Design Rainfall Data System (http://www.bom.gov.au/water/designRainfalls/revised-ifd/). Table 3.1 shows the adopted design rainfall depths.

Table 3.1 Adopted design rainfall intensities, AEPs for 1% and 0.1%, durations from 15 minutes to 12 hours

Duration	Design rainfall intensities (mm/hr) by AEP	
	1%	0.1%
15 min	198	311
20 min	175	276
25 min	158	248
30 min	144	226
45 min	116	181
1 hour	98.0	153
1.5 hour	76.6	119
2 hours	64.0	99.9
3 hours	49.6	77.7
4.5 hours	38.7	60.8
6 hours	32.5	51.3
9 hours	25.7	40.7
12 hours	21.9	34.7

3.4 MODEL CONFIGURATION

3.4.1 Spatial configuration

Figure 3.1 shows the URBS model configuration for developed conditions. The model covers an area of 4.0 km^2 and consists of 19 sub-catchments, ranging in size from 0.05 km^2 to 0.43 km^2. Out of those 19 sub-catchments, 4 sub-catchments were delineated to represent the mining infrastructure area or internal catchments. Data based on the latest available topography was provided by the client with approximately 1 m grid resolution were used to delineate the sub-catchment draining to the study area.

Design flood hydrographs estimated for the external catchments using the validated URBS model were adopted as inflows in the hydraulic model under developed conditions. For internal catchments, the hydraulic model adopted inflows from the ROG TUFLOW model outputs. Further details of the ROG TUFLOW model development are provided in Section 4.2.

3.4.2 Sub-catchment parameters

Table 3.2 shows the URBS modelling parameters used. Characteristics for each sub-catchment are shown in Table 3.3 which includes catchment slope, catchment area, imperviousness and urbanisation. Catchment slopes and area were determined based on available topographic data.

Table 3.2 URBS parameters

URBS Parameter	Adopted Value
Model type	Split
Alpha (Channel Lag Parameter)	0.2
Beta (Catchment Lag Parameter)	3.5
m (Catchment non-linearity)	0.6
n (Channel routing exponent 1/(km/h))	1.0
USES	L, U, I, CS

Table 3.3 URBS sub-catchment parameters under developed conditions

Sub-catchment ID	Area (km^2)	Catchment Slope (%)	Impervious (%)	Urbanisation
GL_01	0.07	7%	0.0	0.0
GL_03	0.34	3%	0.0	0.0
GL_06	0.18	5%	0.0	0.0
GL_07	0.19	3%	0.0	0.0
GL_10	0.19	9%	0.0	0.0
GL_11	0.32	6%	0.0	0.0
GL_13	0.36	3%	0.0	0.0
GL_17	0.19	3%	0.0	0.0
GL_36	0.21	5%	0.0	0.0
GL_37	0.26	4%	0.0	0.0
GL_42	0.09	9%	0.0	0.0
GL_43	0.45	5%	0.0	0.0
GL_44	0.41	5%	0.0	0.0
GL_67	0.10	3%	0.0	0.0
GL_68	0.23	2%	53.9	1
GL_69	0.15	4%	19.2	0.38
GL_70	0.05	2%	75.7	1
GL_71	0.07	2%	20.7	0.51

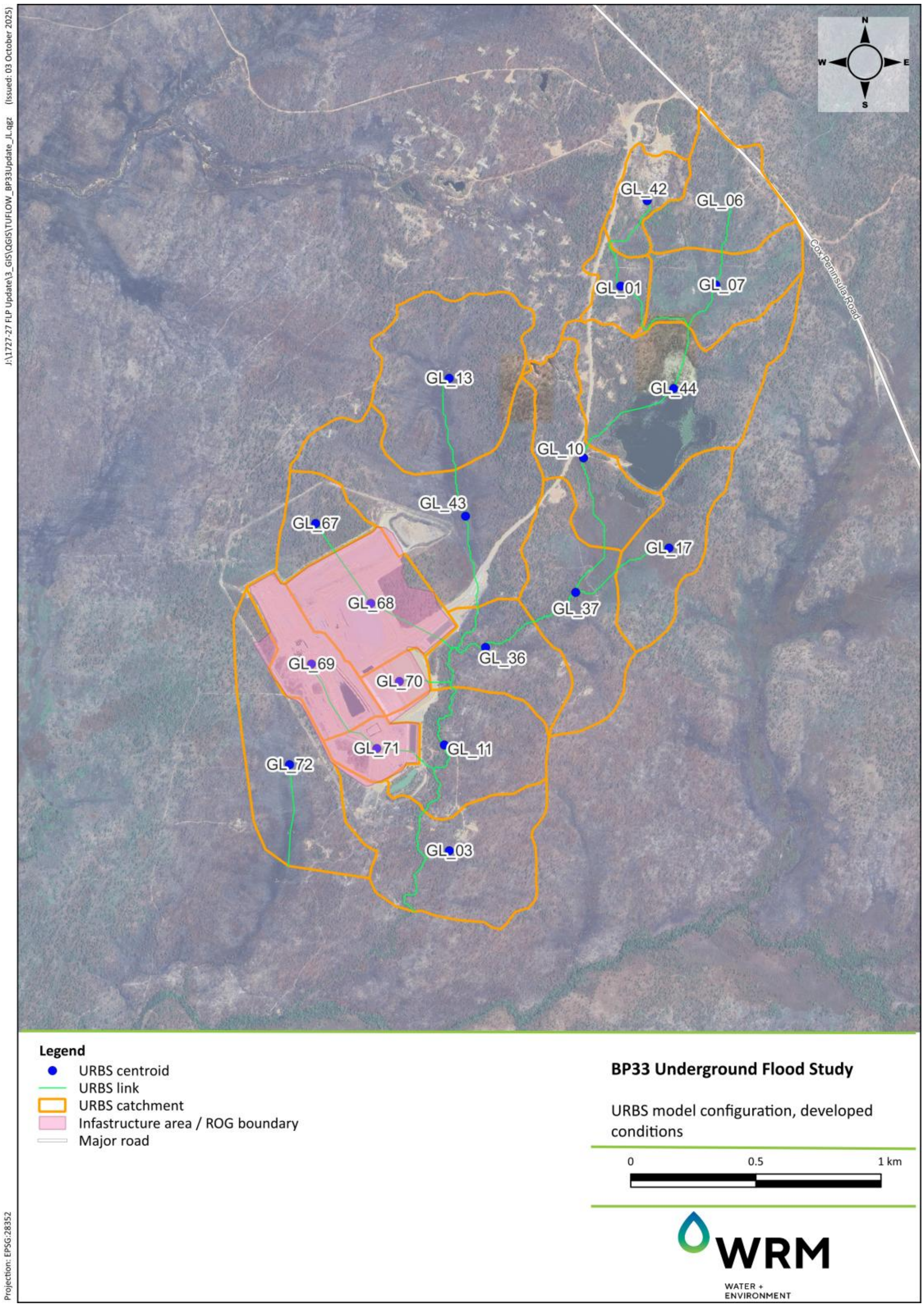

Figure 3.1 URBS configuration, developed conditions

3.4.3 Temporal patterns

Temporal patterns were obtained from the ARR data hub based on a point location at the centroid of the catchment. As per ARR guidelines, 10 temporal patterns which result in 10 design storms for each duration for each AEP were used. The URBs model was run for all 10 temporal patterns for various storm durations for the 1% and 0.1% AEP events. The critical storm duration was identified as the duration which produce the highest median peak discharge from the 10 design storms for each storm duration.

3.4.4 Design rainfall losses

URBS Initial Loss (IL) and Continuing Loss (CL) values were varied to each design event to find the values of losses necessary to reconcile URBS estimates of peak flood discharges at GL_43 and GL_11 for 10%, 1% AEP and 0.1% AEP against the Rational Method peak, which were detailed in WRM report (2024). The adopted IL and CL for the two design events are shown in Table 3.4.

Table 3.4 Adopted IL and CL rates

Design Event (AEP %)	Initial Loss (mm)	Continuing Loss (mm/hr)
10	10.0	2.0
1	2.0	2.0
0.1	1.1	2.0

3.5 HYDROLOGIC MODEL VALIDATION

The BP33 URBS model was validated against the Rational Method (RM) peak discharge estimates under existing conditions at GL_43 and GL_11 catchments and was detailed in WRM report (2024).

The RM estimates of peak flood discharges for all design events were obtained at sub-catchment GL_43 and GL_11, located at the upstream of BP33 URBS model or upstream of the proposed infrastructure area of BP33 Mine Lease. A total area of 79.23 ha and 337.54 ha drains to GL_43 and GL_11 respectively.

Table 3.5 shows the percentage difference between URBS and Rational Method peak discharges in GL_43 and GL_11 for all design events. The URBS model results in catchment GL_43 and GL_11 shows are within 10% and 3% of the Rational Method results which shows a good agreement across the two methodologies.

Table 3.5 URBS model validation results

AEP (%)	URBS peak discharge (m^3/s)	RM peak discharge (m^3/s)	Difference to RM
Catchment to GL_43			
10	8.7	8.0	9.4%
1	13.2	13.0	1.6%
Catchment to GL_11			
10	34.7	34.9	-0.5%
1	56.3	57.6	-2.2%

3.6 REPRESENTATIVE TEMPORAL PATTERNS

The validated URBS model was used to estimate design discharges for external catchments based on the ARR 2019 guidelines (Ball et al, 2019). Design discharge hydrographs were produced for the 1% AEP and 0.1% AEP design events, for a range of storm durations from 15 minutes to 12 hours. An ensemble of 10 temporal patterns was applied for each duration. At the reporting locations (sub-catchment GL_43 and GL_11), the critical duration design storm that had been validated was identified.

At the reporting location (sub-catchment GL_11 and GL_43), the critical duration design storm that had been validated was identified. Table 3.5 shows the developed conditions critical storm durations at GL_11 and GL_43 for 1% AEP and 0.1% AEP design events.

Table 3.6 shows the representative temporal pattern hydrographs which were selected for use in the TUFLOW hydraulic model. The representative design temporal patterns were adopted based on an assessment of the URBS critical duration design storms at the GL_11 and GL_43 catchments.

Table 3.6 URBS critical durations at the external catchments

AEP (%)	Critical duration	
	GL_11	GL_43
1	2 hours	1 hour
0.1	2 hours	4.5 hours

Table 3.7 Representative design temporal patterns

Duration	Representative temporal pattern	
	1% AEP	0.1% AEP
15 min	7	8
30 min	7	9
1 hour	9	5
1.5 hour	3	4
2 hour	7	7
3 hour	2	9
4.5 hour	10	10
6 hour	8	8

4 HYDRAULIC MODELLING

4.1 OVERVIEW

The two-dimensional TUFLOW hydrodynamic model (BMT, 2023) was used to simulate the flow behaviour of the infrastructure area and unnamed tributaries (Drainage Line BP1) in the vicinity of the Project including flood extents, levels, depths and velocities.

The WRM (2024) hydraulic model was updated to include BP33 under developed conditions, which includes a clean water diversion drain, several sediment basins, internal drainage at the site and an access road to the east of BP33 which connects to Cox Peninsula Road.

The results of the developed conditions hydraulic model were used to determine the catchment flow behaviour at both the infrastructure area and drainage line BP1. Further details of the modelling methodology and model configuration are provided below.

4.2 METHODOLOGY

A TUFLOW two-dimensional hydrodynamic model was used to estimate the flooding characteristics (extents, levels, depths and velocities) for the study area. TUFLOW represents hydraulic behaviour on a fixed grid by solving the full two-dimensional depth-averaged momentum and continuity equations for free surface flow. The model automatically calculates breakout points and flow directions within the study area. An adaptive time step is used by the computational engine to maintain simulation stability. All hydraulic modelling was undertaken using the TUFLOW Build 2023-03-AB HPC-GPU solver.

For this study, the hydraulic model was developed using two model inflow methodologies. This included local and total inflow polygons which were adopted from the validated URBS hydrologic model for external catchments located outside the infrastructure area, and a ROG model to assess the local drainage risks within the BP33 operational area.

The hydraulic model was run for the 1% AEP and 0.1% AEP design flood events for developed conditions. The model results were used to assess the predicted flood extents, depths, velocities and levels at the BP33 area and drainage line BP1.

4.3 MODEL CONFIGURATION

4.3.1 Topographic data

The hydraulic model included the following model topographies in the following priority order:

- 2025 LiDAR dataset, covering the infrastructure area and was provided by Core Lithium and acquired on 22 September 2025;
- Access road into BP33 infrastructure area design surface and was provided by JBU on October 2023;
- 2023 LiDAR dataset, covering the infrastructure area and adjacent upstream areas, and was provided by JBU and acquired on 20 September 2023; and
- 2021 LiDAR dataset, covering the remaining area within the adopted hydraulic model boundary. Areas where there was a significant elevation difference between the 2025 and 2021 datasets were adjusted vertically (using the TUFLOW model) to ensure a smooth transition between the two surfaces.

Figure 4.1 shows the topographic data used in the hydraulic model.

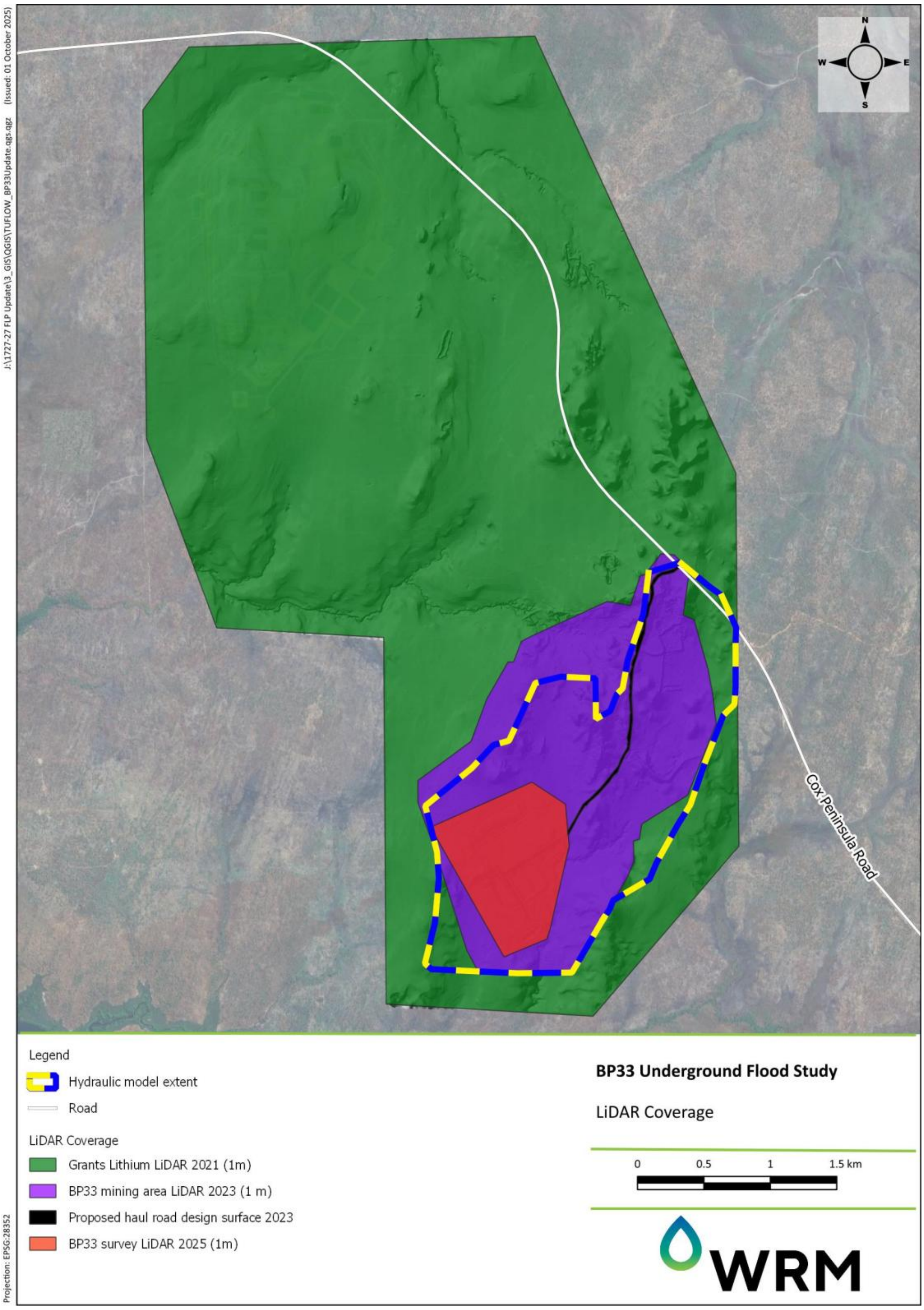

Figure 4.1 Topographic data extents

4.3.2 Model extent and spatial configuration

The TUFLOW model extent covers an area of about 398.65 ha and includes the infrastructure area as well as the external catchments that will drain through Drainage Line BP1. From the most upstream area, the model extends approximately 3.1 km to the south as shown in Figure 4.2.

The model uses a 2 m cell size (i.e. 2 m x 2 m cells). The 2 m cell size was adopted as it ensured a good representation of major drainage features, road embankments and unnamed channels or gullies.

Initial water levels were set based on the spillway levels for the sediment basins. This would simulate the worst-case scenario where there is no available storage in the sediment basins to store site runoff and would run directly off-site and into Drainage Line BP1.

4.3.3 Inflow and outflow boundaries

For external catchments, design discharge hydrographs produced by the URBS model were applied to the TUFLOW model as inflow hydrographs as shown in Figure 4.2, using the 'Surface Area' (SA) inflow approach. The SA inflow approach was used to apply local external catchment inflows along a flow path that were produced by an URBS model for developed conditions.

The ROG hydraulic model was also undertaken within the code boundary of the BP33 infrastructure area. Rainfall within this area was directly applied to each grid cell within the ROG model extent using an input rainfall hyetograph (described in Section 4.3.4)

The adopted downstream model boundaries are located far enough downstream to ensure results at the BP33 Mine Lease area are not impacted by boundary effects. There were two downstream outflows boundaries in this model. All downstream boundaries were described as non-tidally affected (clear of the Timor Sea). Hence, a 'normal flow' type boundary condition for each downstream model boundary was adopted based on the downstream channel slope. Figure 4.2 shows the location of the inflow and outflow boundaries for developed conditions.

4.3.4 Adopted Mannings 'n' roughness and rainfall losses

The rainfall initial and continuing losses were applied within the TUFLOW ROG model according to different land use types. The TUFLOW model also uses Manning's 'n' values to represent hydraulic resistance across the whole TUFLOW model area. The adopted Manning's 'n' values and rainfall losses corresponding to each land use type are shown in Table 4.1. The classification of land use areas for hydraulic modelling was based on aerial imagery. The adopted land use mapping under developed conditions is shown in Figure 4.3.

Table 4.1 Adopted Manning's 'n' values

Land use description	Manning's 'n' coefficient	Initial loss (mm)	Continuing loss (mm/hr)
Road	0.025	3	0.6
Waste rock dump	0.050	13.5	2.3
Cleared	0.030	10.5	1.8
Drain	0.022	3	0.6
Dense vegetation	0.090	15	2.5

4.3.5 Hydraulic structures

The hydraulic model incorporates a total of 10 culverts within the BP33 area under developed conditions. Of these, one culvert is located at the access road floodway, while the remaining nine are situated within the BP33 site, as shown in Figure 4.2.

Details of these culverts are presented in Table 4.2, based on the site layout provided by Core Lithium on 30 September 2025 and high resolution aerial imagery supplied by Core Lithium on 22 September 2025. High resolution aerial imagery was flown in September 2025 and represents the current developed conditions more accurately.

Table 4.2 Cross road culvert details in the BP33 area, developed conditions

Culvert ID	Material	Dimensions (no. of barrels @ dia)	US IL (mAHD)	DS IL (mAHD)
C-1	CSP	2 @ 0.9 m	21.66	21.52
C-2	CSP	2 @ 0.9 m	20.97	20.58
C-3	CSP	2 @ 1.5 m	18.55	18.23
C-4	CSP	2 @ 1.5 m	18.07	17.78
C-5x	CSP	2 @ 0.3 m	22.03	21.93
C-6X	CSP	0 @ 0.9 m	17.32	17.30
C-7	BlackMax Polypropylene	2 @ 0.6 m	23.97	23.43
C-8X	BlackMax Polypropylene	2 @ 0.6 m	20.68	19.87
C-9X	CSP	1 @ 0.6 m	16.90	16.20
C-10X	CSP	1 @ 0.3 m	23.05	22.22

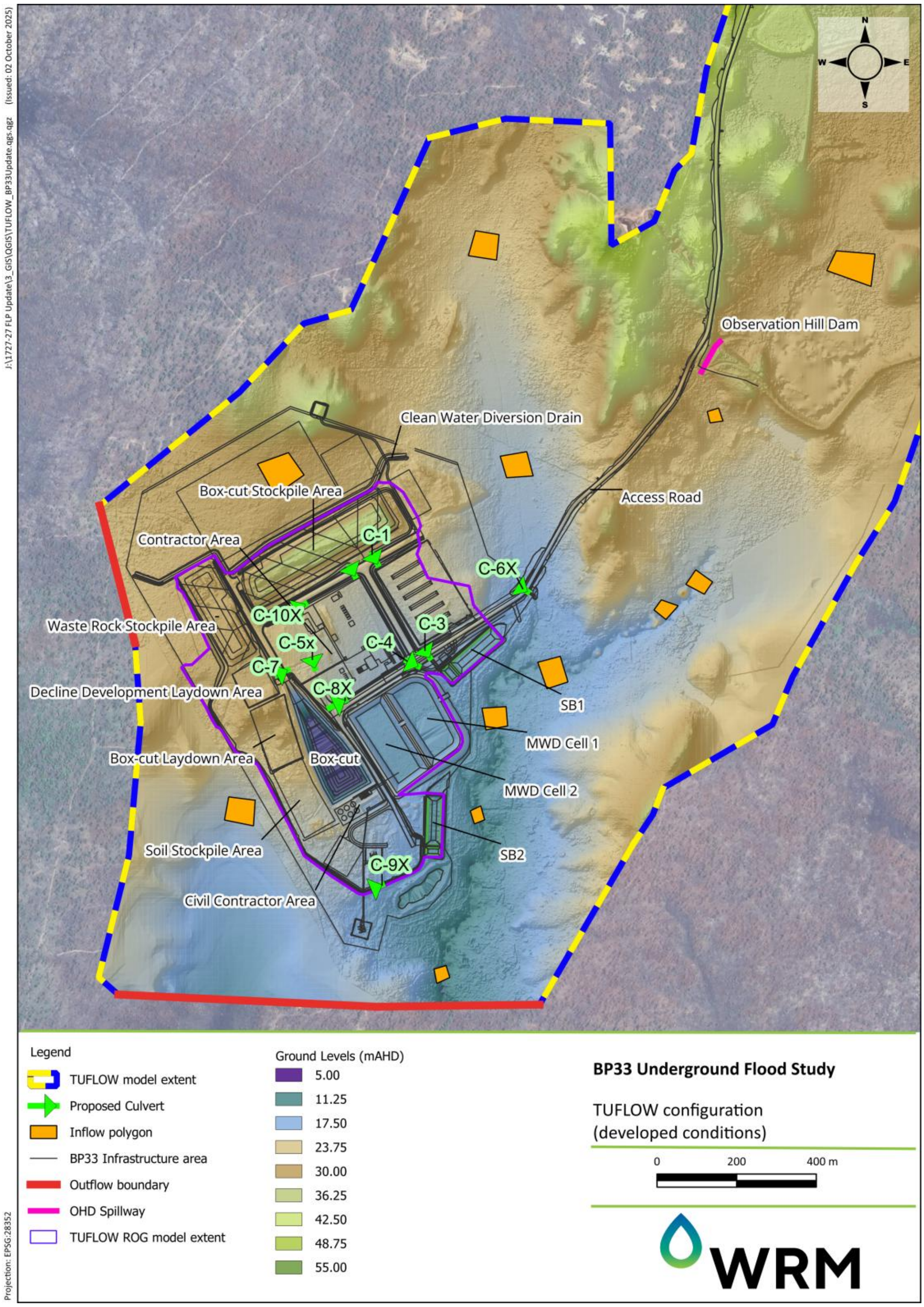

Figure 4.2 TUFLOW configuration, developed conditions

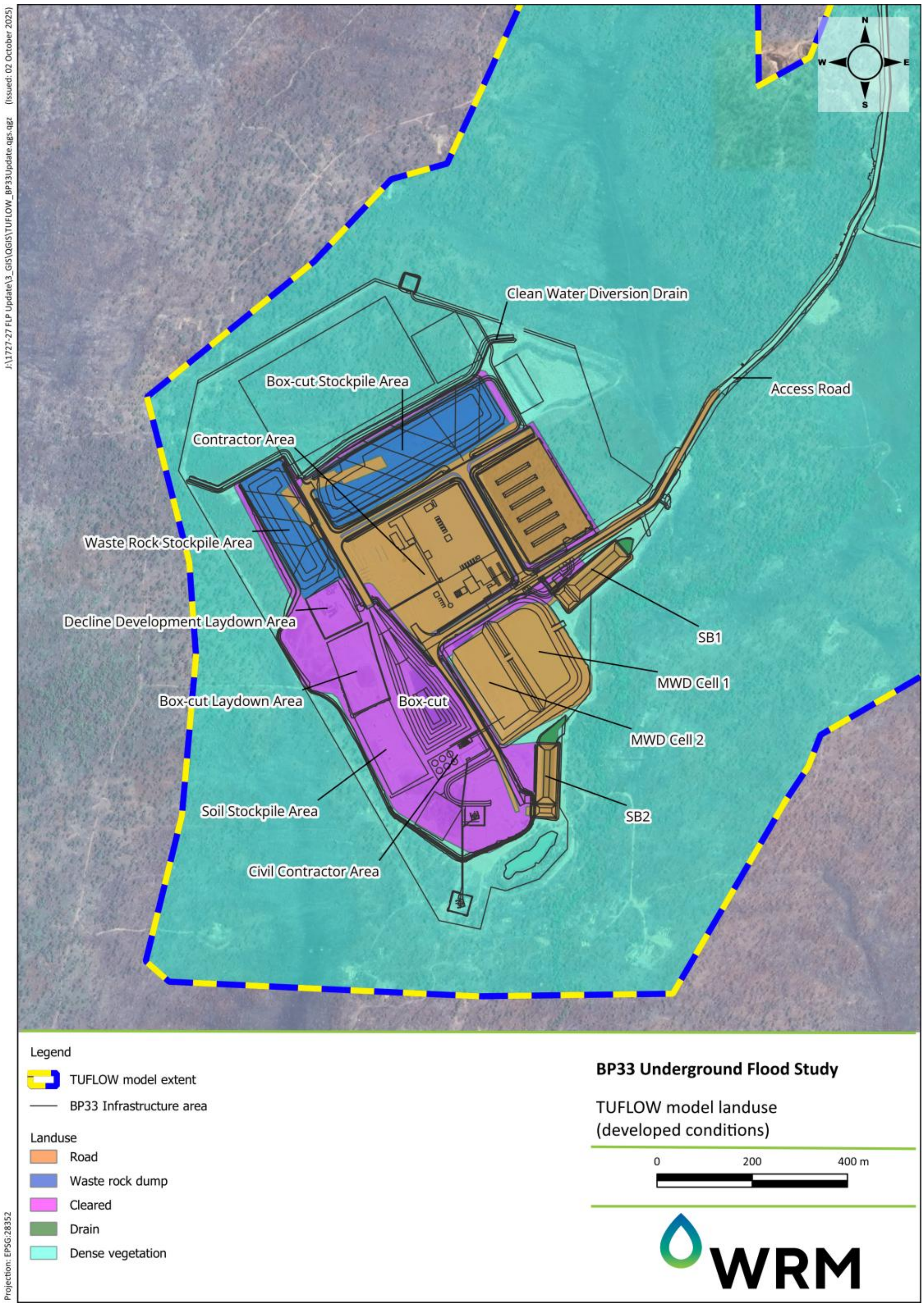

Figure 4.3 TUFLOW model land use mapping, developed conditions

4.4 DEVELOPED HYDRAULIC MODEL VALIDATION

Table 4.3 shows the percentage difference between the TUFLOW and Rational Method (RM) peak discharges at Culvert C-7 catchment for 1% AEP under developed conditions. Figure 4.4 shows the validation catchment to Culvert C-7. A percentage impervious of 10% was assumed in the RM calculations. Model results show good agreement across two methodologies. The TUFLOW model results are all within 1.5% of Rational method.

Table 4.3 Validation results between hydraulic model and RM under developed conditions

AEP (%)	URBS peak discharge (m^3/s)	RM peak discharge (m^3/s)	Difference to RM
Catchment to culvert C-7			
1	0.88	0.89	-1.1%

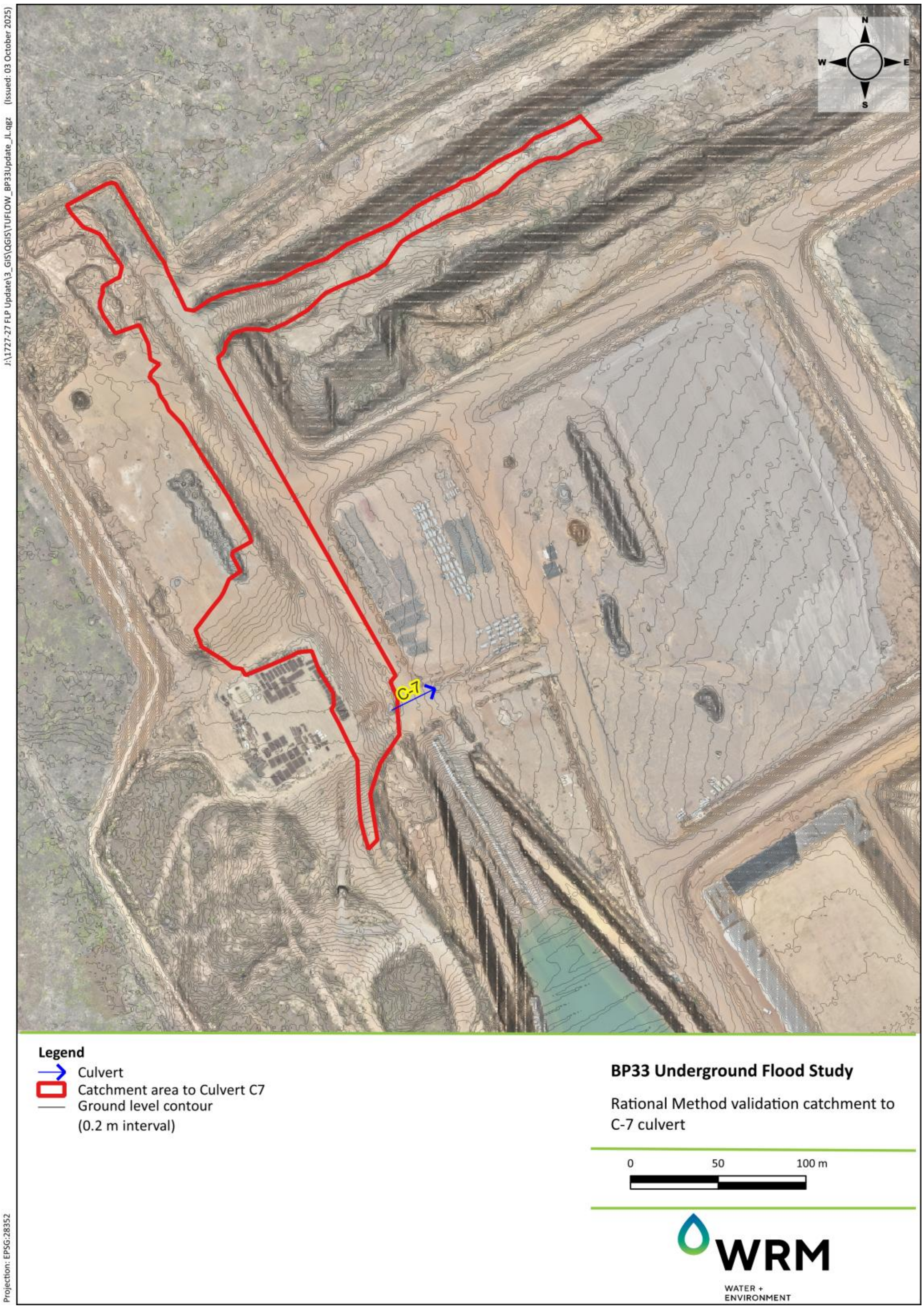

Figure 4.4 Rational Method validation catchment to Catchment C-7

5 FLOOD MODELLING ASSESSMENT

5.1 OVERVIEW

The existing drainage features and infrastructure area were assessed using hydrologic (URBS) and hydraulic (TUFLOW) models to assess the flooding characteristics at and in the vicinity of BP33 site.

The TUFLOW model was used to estimate predicted peak flood extents, levels, depths, and velocities for the 1% (1 in 100) and 0.1% (1 in 1,000) AEP design flood events.

Figure A.1 to Figure A.2 in Appendix A show the predicted peak flood extents, levels and depths for developed conditions for the 1% and 0.1% AEP events respectively.

Figure A.3 to Figure A.4 in Appendix A show the predicted peak flood velocities for developed conditions for the 1% and 0.1% AEP events respectively.

5.2 DEVELOPED CONDITIONS FLOODING

Table 5.1 shows the road immunity against the modelled design events at each key crossing locations within the BP33 area for developed conditions, as well as the range of overtopping depths (i.e., event from the road starts to be overtopped to the biggest event within the modelled design events, which is the 0.1% AEP). The crossing locations are shown in Figure A.1 to Figure A.4 in Appendix A. The following is of note:

- Culverts C-1, C-2, C-3, C-8X and C-10X have sufficient capacity to convey the predicted 1% AEP and 0.1% AEP design flows; and
- Culverts C-5X, C-7 and C-9X do not have sufficient capacity to convey the predicted 1% AEP and 0.1% AEP design flows. However, the crossings remain trafficable during a 1% AEP for larger vehicles (e.g. 4WDs) with overtopping depths ranging from:
    - 0.07 m (at culvert C-7) to 0.25 m (at culvert C-9X) for 1% AEP; and
    - 0.10 m (at culvert C-7) to 0.28 m (at culvert C-9X) for 0.1% AEP.
- Culvert C-7 (located at the ramp into the box cut) has insufficient capacity and would require an increased capacity to prevent inundation of the road. Site have advised that they have 1.2 m x 0.6 m RCBCs available to upgrade this crossing. Based on a 1% AEP design flow of 0.89 m^3/s, one (1) x 1.2 m x 0.6 m RCBC crossing would be sufficient to convey the 1% AEP design flow. Notwithstanding, runoff which overtops the internal haul road at C-7 would flow eastwards to the internal drain which connects to culvert C-5X and away from the BP33 Box Cut for both the 1% AEP and 0.1% AEP design events.
- The sediment drains from C-7 to C-5X and C-5X to C-8X have insufficient capacity to contain the 1% AEP and 0.1% AEP and have high velocities that would require scour protection to limit erosion along the drain.
- Culvert C-6X (located at the access road floodway) predominantly functions as a low-flow culvert for the more frequent flood events. For the rarer and more extreme events, the access road to the site functions as a floodway. Depths on the access road for the 1% AEP is around 0.40 m. While this depth of water will prevent access to the site, it is likely to close the road for only a short period following intense rainfall.
- The current internal drainage (as of September 2025) prevents any overflows from the internal drains to the box-cut for both design events. Catchment runoff inundation that is shown in the Box Cut is caused by direct rainfall.

- The southeastern portion of the contractor area is inundated for both design events with depths of up to 0.49 m and 0.83 m during 1% AEP and 0.1% AEP respectively.

- Table 5.2 shows the overtopping depth at all reporting locations which are shown in Figure A.1 to Figure A.4 in Appendix A for all design events. The following is of note:
    - A total of 8 locations have been identified along the perimeter sediment drain at the BP33 infrastructure area where overflows occur.
        - Of this, 1 reporting location (i.e., RL02) refers to overflows from external catchment runoff to internal catchment for the 0.1% AEP design event with a shallow depth of around 0.01 m; and
        - The remaining 7 reporting locations refer to overflows from internal catchment runoff to the external catchment. Overflow at RL05 only occurred during 0.1% AEP design event with a depth of up to 0.04 m. Overflows at RL01, RL03, RL04 and RL06 to RL08 occurred for both design events with maximum depths of up to 0.25 m at RL04 for 1% AEP and up to 0.31 m for 0.1% AEP.
- The predicted 1% AEP and 0.1% AEP flood levels at the drainage line BP1 and western overland flow path do not interact with any of the infrastructure locations and sediment dams at BP33 site.
- It is recommended to apply or to maintain erosion protection measures (eg, check dams and rock protection) to avoid erosion risks at the following locations:
    - Upstream and downstream culvert aprons;
    - Sediment basins spillways;
    - Sediment drains that have elevated velocities which include:
        - the sediment drain surrounding the Box-Cut stockpile to culvert C-1;
        - the sediment drain from culvert C-1 to culvert C-3;
        - the sediment drain from culvert C-2 to culvert C-4;
        - the sediment drain from culvert C-3 to Sediment Basin 1 (SB1);
        - the sediment drain from culvert C-4 to Sediment Basin 1 (SB1); and
        - the sediment drain from culvert C-7 to culvert C-5x.
    - Upstream and downstream of the sediment drain entrances and exits; and
    - Upstream and downstream batters of Culvert C-6 floodway crossing.

Table 5.1 Road immunity as well as overtopping depth at each culvert within the BP33 area for developed conditions

Structure crossing ID	Developed conditions	
	Road immunity	Range of overtopping depth
C-1	0.1% AEP	Not overtopped
C-2	0.1% AEP	Not overtopped
C-3	0.1% AEP	Not overtopped
C-4	0.1% AEP	Not overtopped
C-5X	<1% AEP	1% AEP to 0.1% AEP (0.13 m to 0.16 m)
C-6X	<1% AEP	1% AEP to 0.1% AEP (0.40 m to 0.52 m)
C-7	<1% AEP	1% AEP to 0.1% AEP (0.07 m to 0.10 m)
C-8X	0.1% AEP	Not overtopped
C-9X	<1% AEP	1% AEP to 0.1% AEP (0.25 m to 0.28 m)
C-10X	0.1% AEP	Not overtopped

Table 5.2 Overtopping depth at each of the reporting location for all design events

Reporting ID	Overtopping depth (m)		Comment
	1% AEP	0.1% AEP	
RL01	0.14	0.20	Internal catchment overflowing to external catchment
RL02	Not overtopped	0.01	External catchment overflowing to internal catchment
RL03	0.45	0.51	Internal catchment overflowing to external catchment
RL04	0.25	0.28	Internal catchment overflowing to external catchment
RL05	Not overtopped	0.04	Internal catchment overflowing to external catchment
RL06	0.08	0.11	Internal catchment overflowing to external catchment
RL07	0.24	0.31	Internal catchment overflowing to external catchment
RL08	0.03	0.10	Internal catchment overflowing to external catchment

6 CONCLUSION

WRM undertook a Drainage Line BP1 and internal catchment flood assessment to assess the BP33 flood risk for infrastructure and mining areas for developed conditions. Outcomes of the flood study generally shows that the current internal drainage is satisfactory to prevent any internal catchment overflows to the Box Cut. The external flood path at Drainage Line BP1 does not impact the Box Cut.

The model results show:

- Culverts C-1, C-2, C-3, C8X, and C-10X have sufficient capacities to convey both the 1% AEP and 0.1% AEP design flows.
- Culverts C-5X, C-7, and C-9X do not have sufficient capacities to convey the 1% and 0.1% AEP design flows, with depths reaching up to 0.25 m and 0.28 m respectively. However, the crossings remain trafficable during a 1% AEP for larger vehicles (e.g. 4WDs).
- Culvert C-7 (located at the ramp into the box cut) has insufficient capacity and would require an increased capacity to prevent inundation of the road. Site have advised that they have 1.2 m x 0.6 m RCBCs available to upgrade this crossing. Based on a 1% AEP design flow of 0.89 m^3/s, one (1) x 1.2 m x 0.6 m RCBC crossing would be sufficient to convey the 1% AEP design flow. Notwithstanding, the current internal drainage of the site prevents any overflows from the drains to the box-cut area for both the 1% AEP and 0.1% AEP design events. Catchment runoff that is shown in the Box Cut is caused by direct rainfall.
- Flood depths at the access road to the site (where culvert C-6X is located) reach up to 0.40 m in the 1% AEP and 0.52 m in the 0.1% AEP design flood events. Culvert C-6X acts as a low-flow pipe culvert for the more frequent events. For the rarer and more extreme events, the access road floodway will be active. While these depths of water will prevent access to the site, it is likely to close the road for only a short period following intense rainfall.
- The southeastern portion of the contractor area is subject to inundation during both design events, with inundation depths of up to 0.49 m (1% AEP) and 0.83 m (0.1% AEP).
- The sediment drains from C-7 to C-5X and C-5X to C-8X have insufficient capacity to contain the 1% AEP and 0.1% AEP and have high velocities that would require scour protection to limit erosion along the drain.
- Eight (8) overflow locations have been identified along the perimeter sediment drain. One location (i.e., RL02) shows external-to-internal catchment overflow during the 0.1% AEP event with a shallow depth of around 0.01 m, while the other seven locations show internal-to-external overflows, with depths of up to 0.25 m and 0.31 m for the 1% and 0.1% AEP events respectively.
- The predicted flood levels for both design events at drainage line BP1 and the western overland flow path do not impact any infrastructure or the box cut at BP33.
- It is recommended to apply or to maintain erosion protection measures to avoid erosion risks at the following locations:
    - Upstream and downstream culvert aprons;
    - Sediment basins spillways;
    - Sediment drains that have elevated velocities which include:
        - the sediment drain surrounding the Box-Cut stockpile to culvert C-1;
        - the sediment drain from culvert C-1 to culvert C-3;
        - the sediment drain from culvert C-2 to culvert C-4;

        - the sediment drain from culvert C-3 to Sediment Basin 1 (SB1);
        - the sediment drain from culvert C-4 to Sediment Basin 1 (SB1); and
        - the sediment drain from culvert C-7 to culvert C-5x.
    - Upstream and downstream of the sediment drain entrances and exits; and
    - Upstream and downstream batters of Culvert C-6 floodway crossing.

7 REFERENCES

Ball et al, 2019	‘Australian Rainfall and Runoff: A Guide to Flood Estimation’, Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), © Commonwealth of Australia (Geoscience Australia), 2019.
BMT, 2023	*TUFLOW (software), BMT, version 2023-03-AB, 2023.*
Carroll, 2021	URBS (Unified River Basin Simulator): A Rainfall Runoff Routing Model for Flood Forecasting & Design (Version 6.6) D.G. Carroll, 2021
WRM, 2024	BP33 Underground Mine – Flood study assessment report, WRM Water & Environment Pty Ltd, Report Ref. 1727-22-B1, 17 July 2024.

APPENDIX A DESIGN FLOOD MAPS

A.1 PEAK FLOOD EXTENTS, DEPTHS AND LEVELS

Figure A.1 to Figure A.2 show the predicted peak flood extents, depths and levels for 1% AEP and 0.1% AEP for developed conditions.

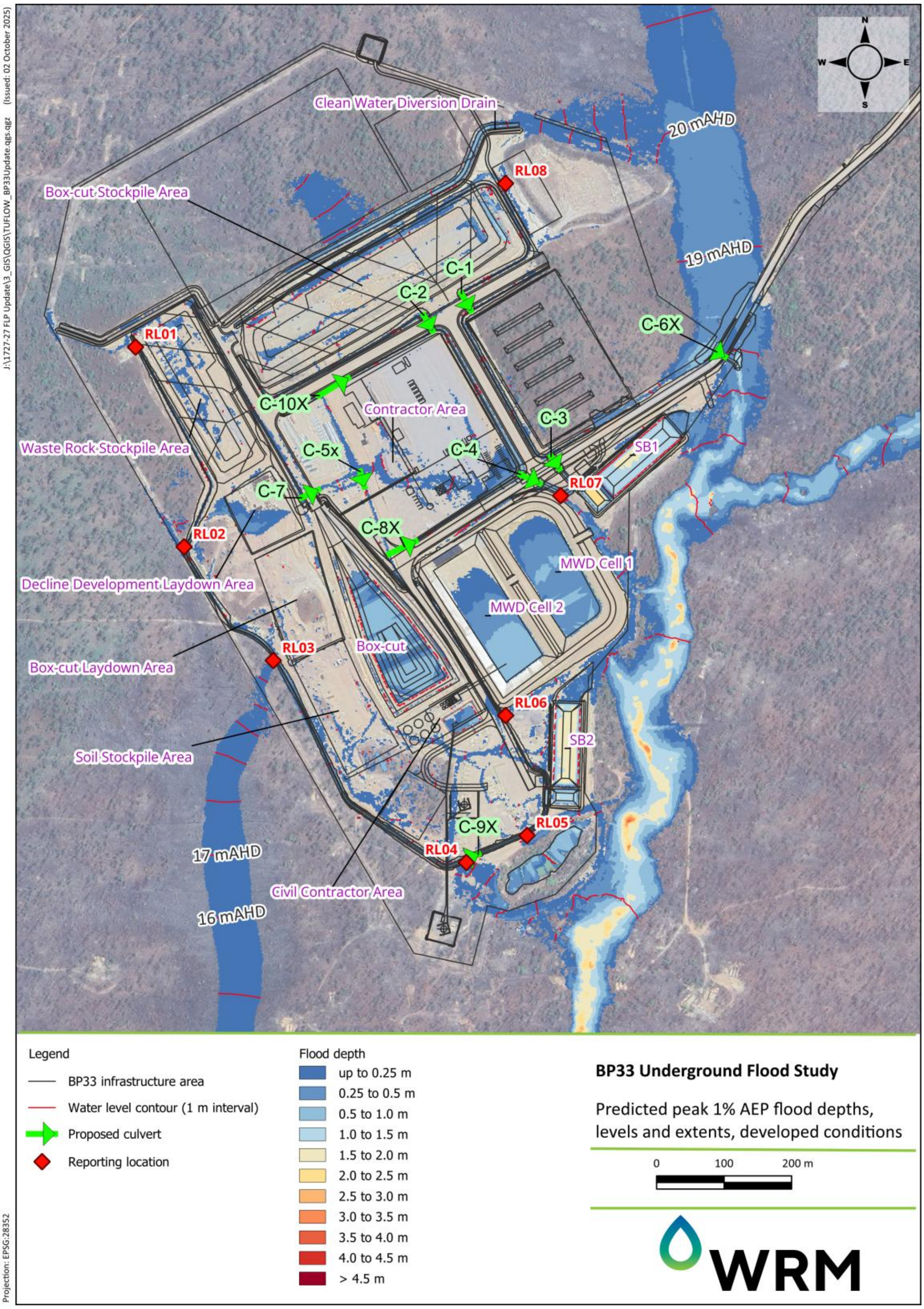

Figure A.1 Peak flood extents, levels & depths, 1% AEP, developed conditions

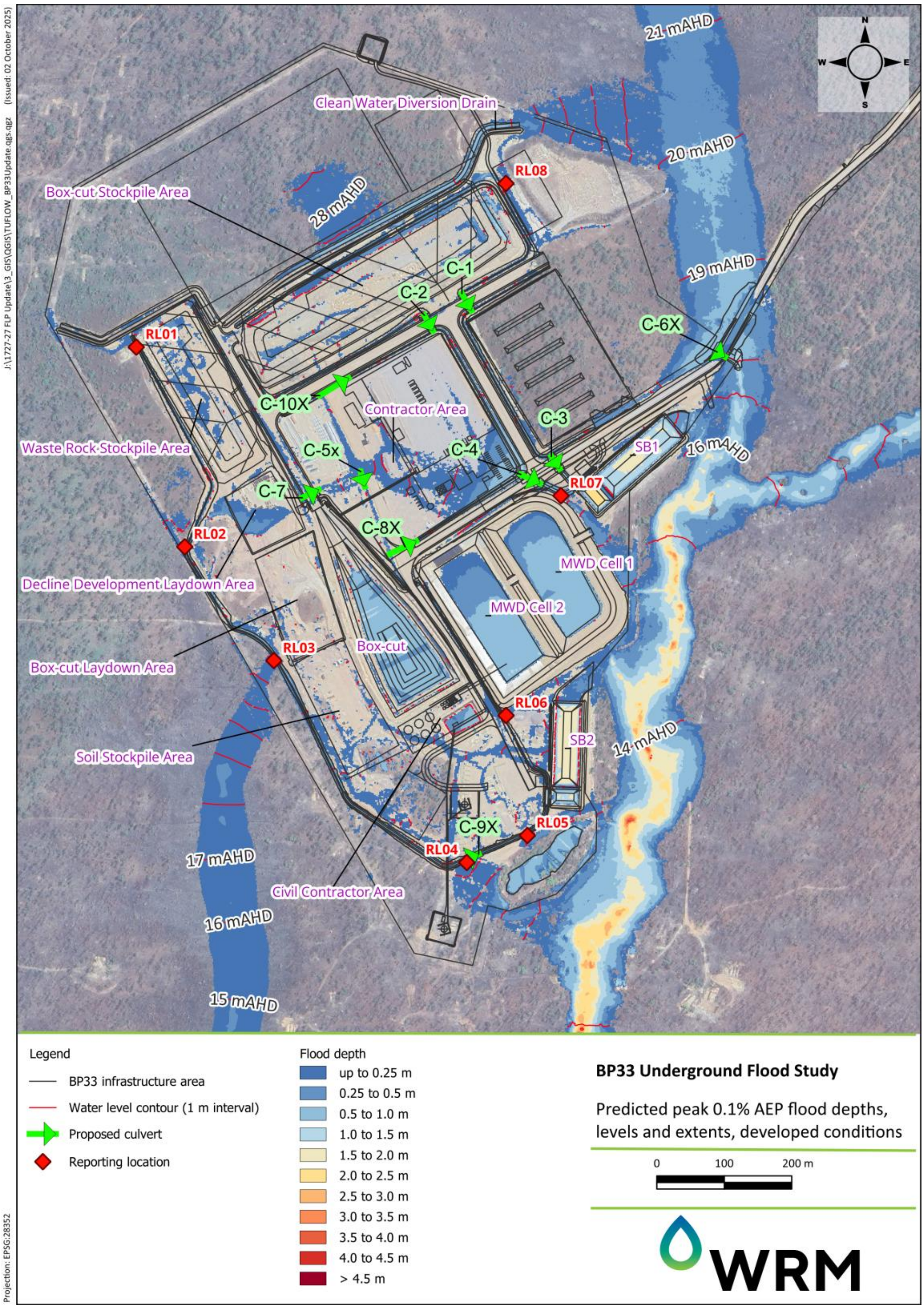

Figure A.2 Peak flood extents, levels & depths, 0.1% AEP, developed conditions

A.2 PEAK FLOOD VELOCITIES

Figure A.3 to Figure A.4 show the predicted peak flood velocities for 1% AEP and 0.1% AEP for developed conditions.

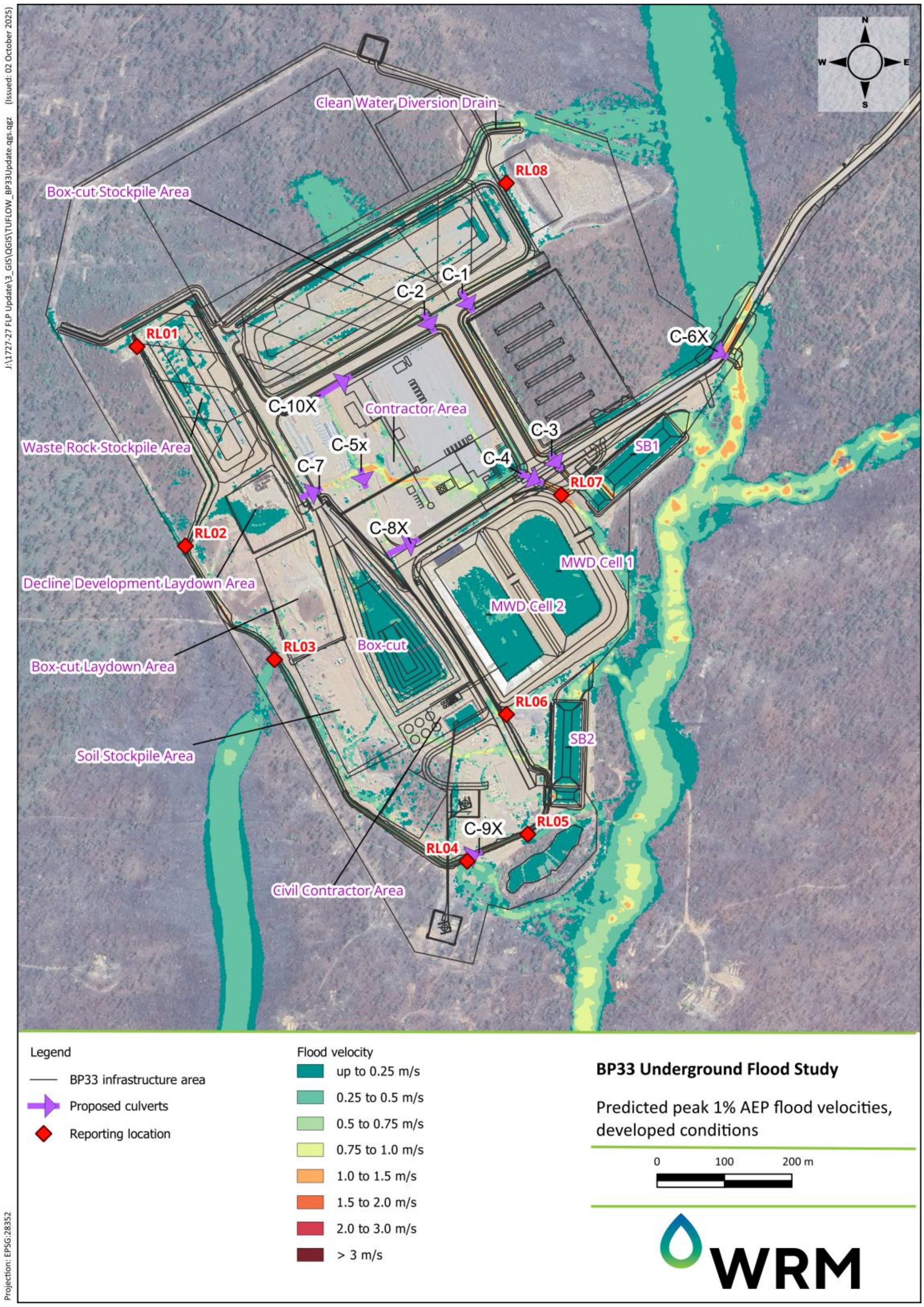

Figure A.3 Peak flood velocities, 1% AEP, developed conditions

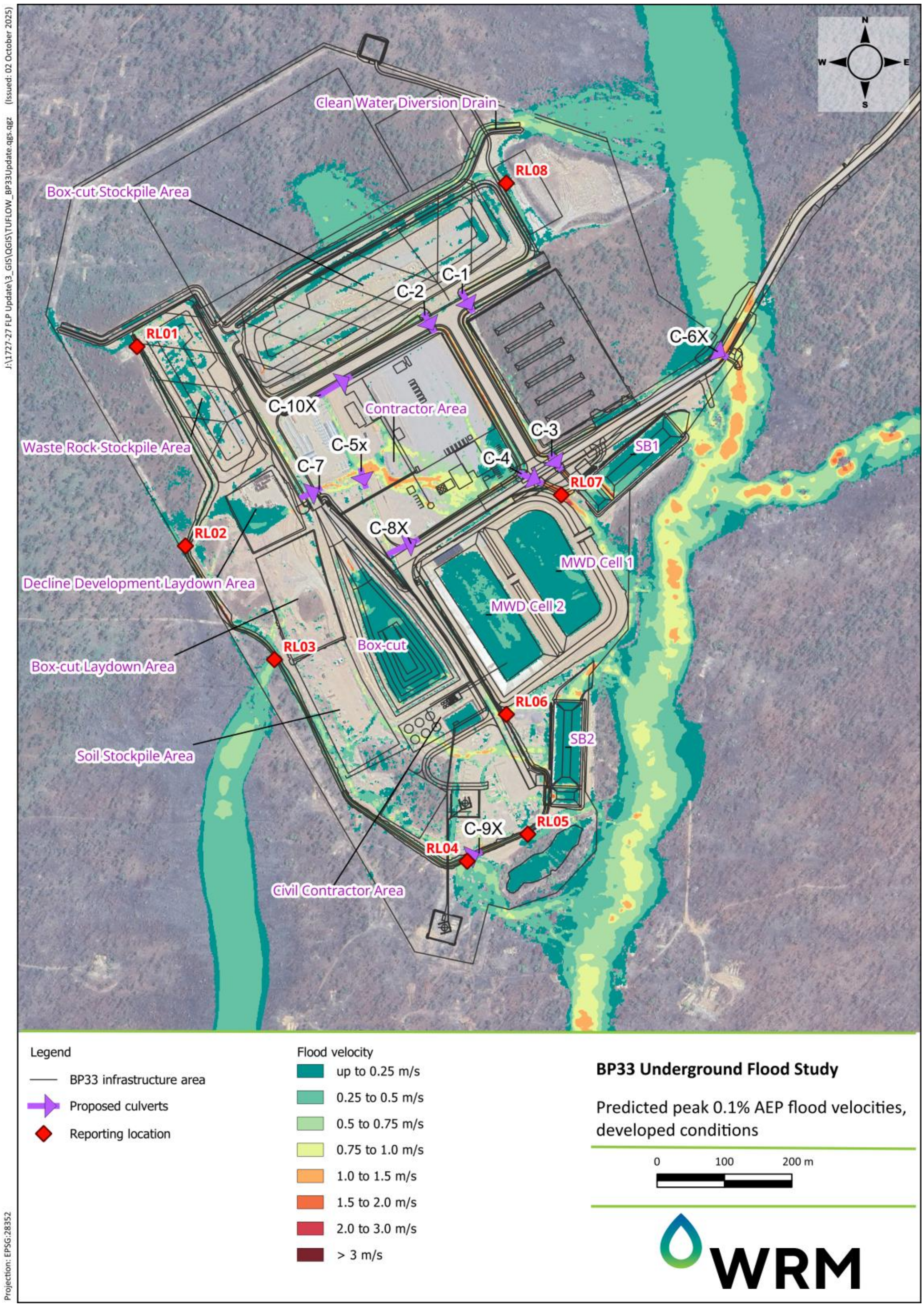

Figure A.4 Peak flood velocities, 0.1% AEP, developed conditions