# Appendix D – Tahmoor Coal – Flood Impact Assessment

# Tahmoor Coal

## Flood Impact Assessment: LW31-37

Tahmoor Coal Pty Ltd

1072-02-B, 3 December 2014

| | |
|---|---|
| **Report Title** | Tahmoor Coal<br>Flood Impact Assessment: LW31-37 |
| **Client** | Tahmoor Coal Pty Ltd |
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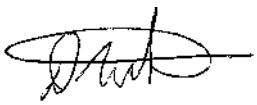

David Newton
**Principal Engineer**

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# 1 Introduction

## 1.1 PROJECT OVERVIEW

Tahmoor Coal operates an underground coal mine located near the townships of Tahmoor and Picton in the Southern Highlands of New South Wales (NSW). Continuation of mining operations requires the development of Longwall Panels 31 to 37 (shown in Figure 1.1) which will result in the subsidence beneath Stonequarry, Cedar, Matthews and Redbank Creeks. The potential impacts of developing the longwall panels will be managed through various management plans, including a subsidence management plan.

## 1.2 PROJECT SCOPE

To assist in the development of the subsidence management plan, WRM Water & Environment Pty Ltd (WRM) was commissioned by Tahmoor Coal Pty Ltd (TC) to assess the impacts on existing flood levels caused by the subsidence associated with the mining of longwall panels 31 to 37 (LW31 to LW37). Detailed hydrologic and hydraulic modelling has been undertaken to quantify these impacts.

The flood impact assessment methodology was based on the development of a runoff routing model (XP-RAFTS) to estimate design flood discharges and a two-dimensional hydraulic model (TUFLOW) to estimate design flood levels, extents, depths and velocities for existing and post-subsidence conditions.

## 1.3 REPORT STRUCTURE

This report details the methodology and results of the flood impact assessment. The report is structured as follows:

- Section 2 describes the background information and drainage characteristics of the catchments in the vicinity of LW31 to LW37.
- Section 3 describes the development and verification of the hydrologic model and the estimation of design flood discharges.
- Section 4 describes the development of the hydraulic model used in the study and the estimation of design flood extents, depths and velocities.
- Section 5 presents the hydraulic model results for existing and post-subsidence conditions.
- Section 6 presents a summary of findings.

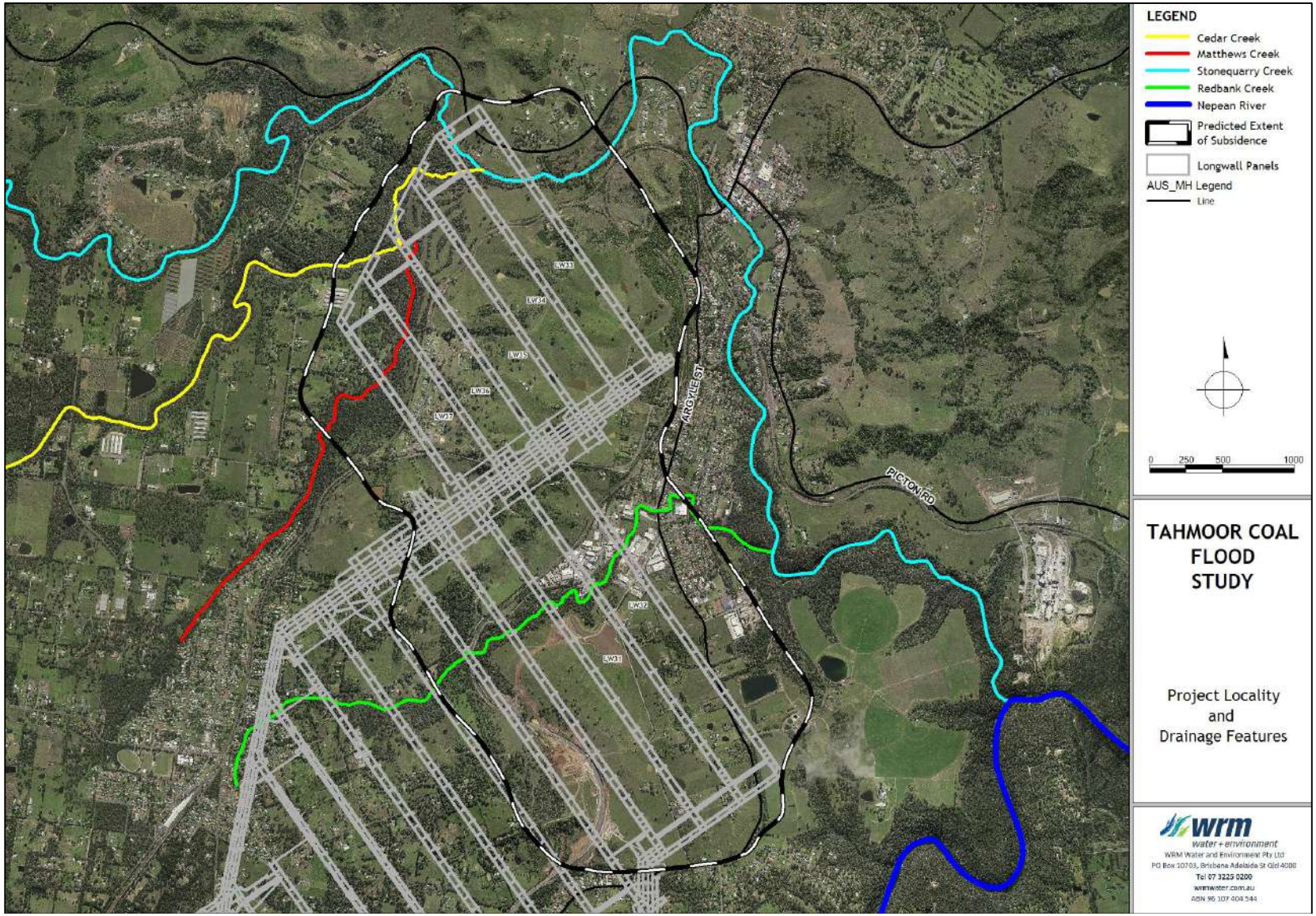



**Figure 1.1 – Tahmoor Coal, Project Locality and Drainage Features**

# 2 Background Information

## 2.1 DRAINAGE CHARACTERISTICS

The Project area is located between the towns of Tahmoor and Picton, approximately 66 km south-west of Sydney. Stonequarry Creek, Cedar Creek, Matthews Creek and Redbank Creek, which all traverse the Project area, are tributaries of the Nepean River. For the purposes of this investigation, the Project area has been divided into two catchment areas, referred to as the Matthews Creek catchment and Redbank Creek.

### 2.1.1 Matthews Creek catchment

The Matthews Creek catchment includes the Cedar Creek, Matthews Creek and Stonequarry Creek catchments. Stonequarry Creek flows roughly west to east before turning south and flowing through the town of Picton to join the Nepean River. Cedar and Matthews Creeks also flow west to east before joining Stonequarry Creek approximately 1.5 km north-west of Picton.

The Matthews Creek total catchment, which has an area of approximately 43 $km^2$, originates approximately 8.9 km south-west of the junction of the three creeks. The catchment is largely undeveloped or agricultural land, although it does include a small portion of the township of Thirlmere to the south (see Figure 2.1).

### 2.1.2 Redbank Creek catchment

Redbank Creek flows roughly west to east through the township of Thirlmere before joining Stonequarry Creek just south of Picton, approximately 2.5 km upstream of the junction with the Nepean River.

The Redbank Creek total catchment covers an area of approximately 8 $km^2$ and incorporates areas of both Thirlmere and Picton townships. The remainder of the catchment is undeveloped or agricultural land as shown in Figure 2.1.

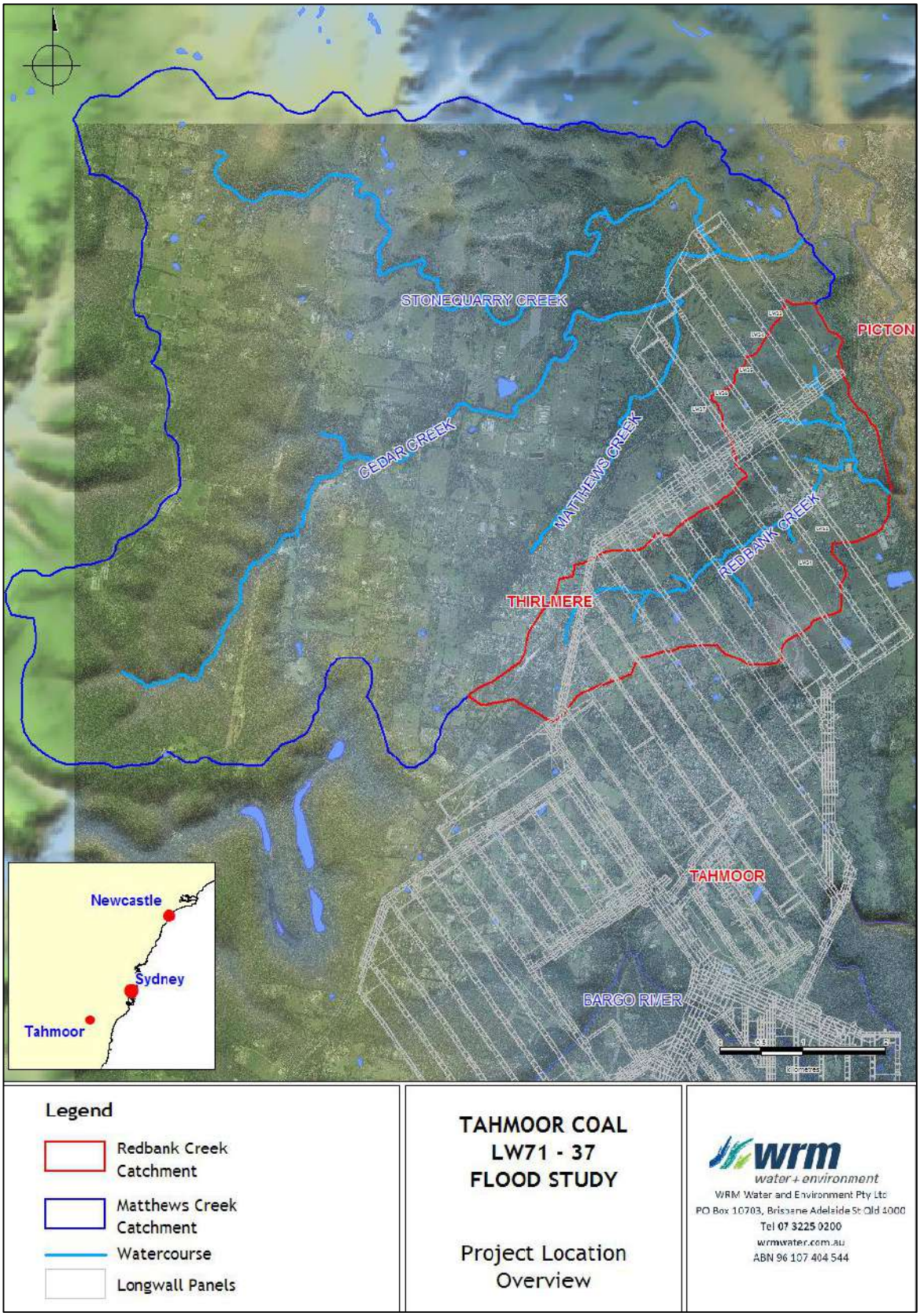



**Figure 2.1 – Project area overview**

## 2.2 TOPOGRAPHIC DATA

Topographic aerial survey data for the study area was provided by Mine Subsidence Engineering Consultants (MSEC). The aerial laser scanning (ALS) data, which was obtained from a fixed wing aircraft in June 2013, was supplied as a digital elevation model (DEM) with a grid size of 2.0 m. Predicted subsidence levels were also supplied for LW22 – LW30 and LW31 – LW37. The ground elevation data utilised for the existing (pre-LW31 – LW37 subsidence) incorporates existing subsidence from LW22 – LW30. It should be noted that LW32A has been excluded from this assessment.

## 2.3 PREVIOUS STUDIES

Two flood investigations have been recently undertaken in the vicinity of the project area:

- *Myrtle and Redbank Creeks Flood Study,* undertaken by Hughes Trueman Pty Ltd for Xtrata Coal Tahmoor, 2009; and
- *Stonequarry Creek: 2D Modelling and Climate Change Assessment,* undertaken by WorleyParsons for Wollondilly Shire Council, 2011.

The Hughes Trueman report includes an analysis of Redbank Creek using a steady-state one-dimensional HEC-RAS hydraulic model. The hydrology was based on a Rational Method calculation for the catchment.

The WorleyParsons report encompasses the Picton region with the hydraulic model boundary commencing downstream of the area of interest for this investigation.

Relevant information from the Hughes Trueman and the WorleyParsons studies was compared to the results of this investigation.

# 3 Hydrologic model development

## 3.1 OVERVIEW

Flood discharges within the Matthews Creek and Redbank Creek catchments were estimated using the XP-RAFTS runoff-routing software package (XP Software, 2013). The Matthews Creek and Redbank Creek catchment boundaries and the XP-RAFTS model subcatchments are shown in Figure 3.1 and Figure 3.2, respectively.

## 3.2 MODEL PARAMETERS

The Matthews Creek and Redbank Creek XP-RAFTS subcatchment boundaries were delineated using the available topographic data. Catchment development conditions and land use allocations were based on aerial photographs. The models were configured based on the following assumptions:

- Catchment slopes were determined from supplied topographic data;
- An impervious fraction of 40% and 10% was adopted for developed and undeveloped land use, respectively. Where subcatchments contained both land uses types, a value was determined based on the proportion of each land use within the subcatchment;
- PERN 'n' values of 0.04 and 0.08 were adopted for developed and undeveloped land use, respectively. Where subcatchments contained both land uses types, a value was determined based on the proportion of each land use within the subcatchment;
- Initial and continuing losses (IL & CL) were determined for each subcatchment based on the relationship with fraction impervious shown in Table 3.1;
- An areal reduction factor of 1.0 was adopted for all events; and
- A global 'Bx' factor of 1.0 and 1.2 was adopted for the Matthews Creek and Redbank Creek models, respectively.

**Table 3.1 – Initial and continuing losses**

| Fraction Impervious (%) | Initial Loss (mm) | Continuing Loss (mm/h) |
|---|---|---|
| 15 | 15.0 | 2.5 |
| 15 to 35 | 11.25 | 1.88 |
| 35 | 7.5 | 1.25 |

### 3.2.1 Subcatchments

The arrangement of subcatchments within the Matthews Creek and Redbank Creek catchments is shown in Figure 3.1 and Figure 3.2 respectively. Full details of adopted subcatchments parameters are provided in Appendix A.

### 3.2.2 Routing links

The arrangement of routing links within the Matthews Creek and Redbank Creek catchments is shown in Figure 3.1 and Figure 3.2 respectively. A channel routing 'X' factor of 0.25 was adopted for all routing links in both models. Channel routing 'K' values were calculated based on link length and assuming an average flow velocity of 1.5m/s. Full details of adopted routing link parameters are provided in Appendix A.

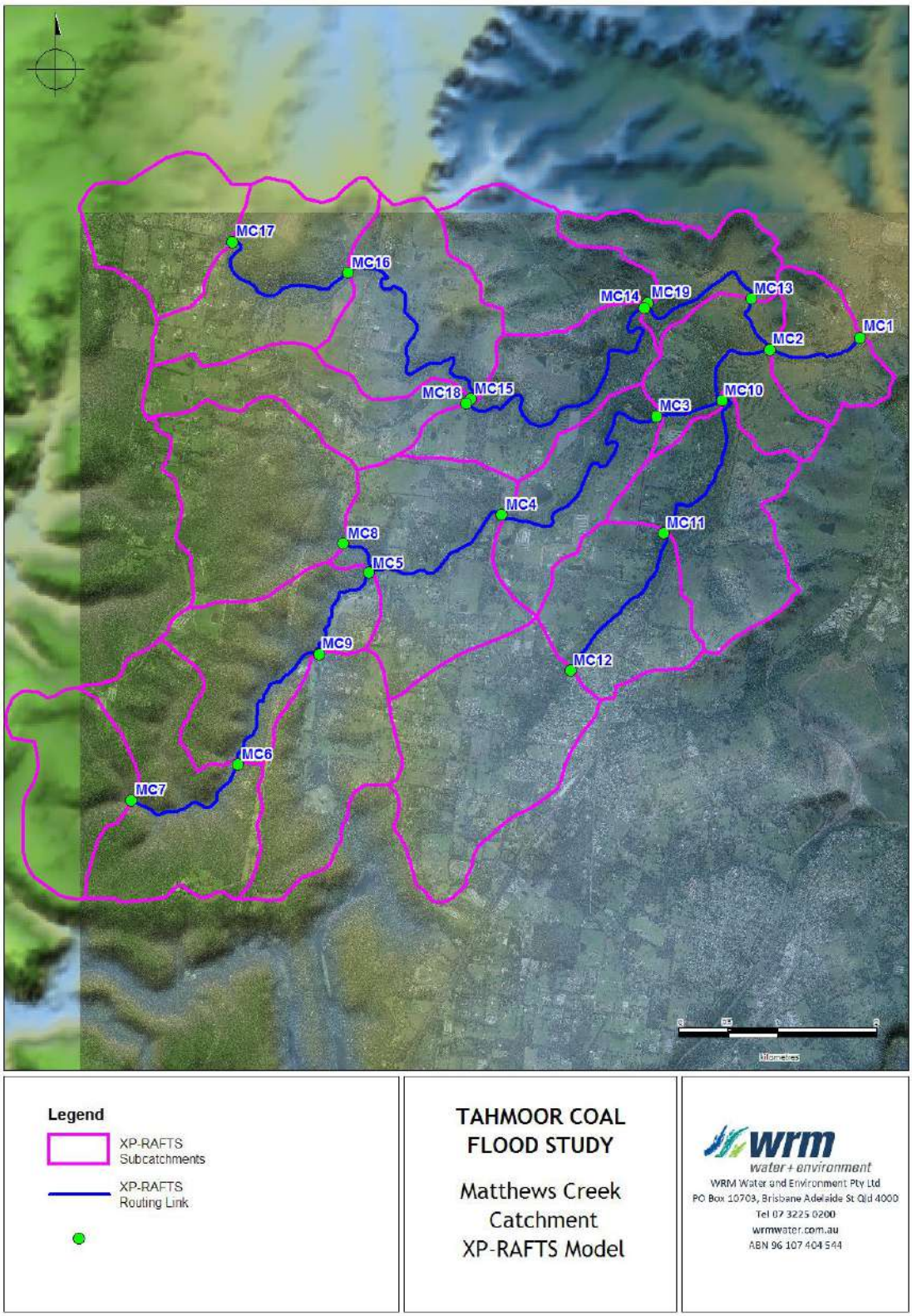



**Figure 3.1 – Matthews Creek XP-RAFTS model configuration**

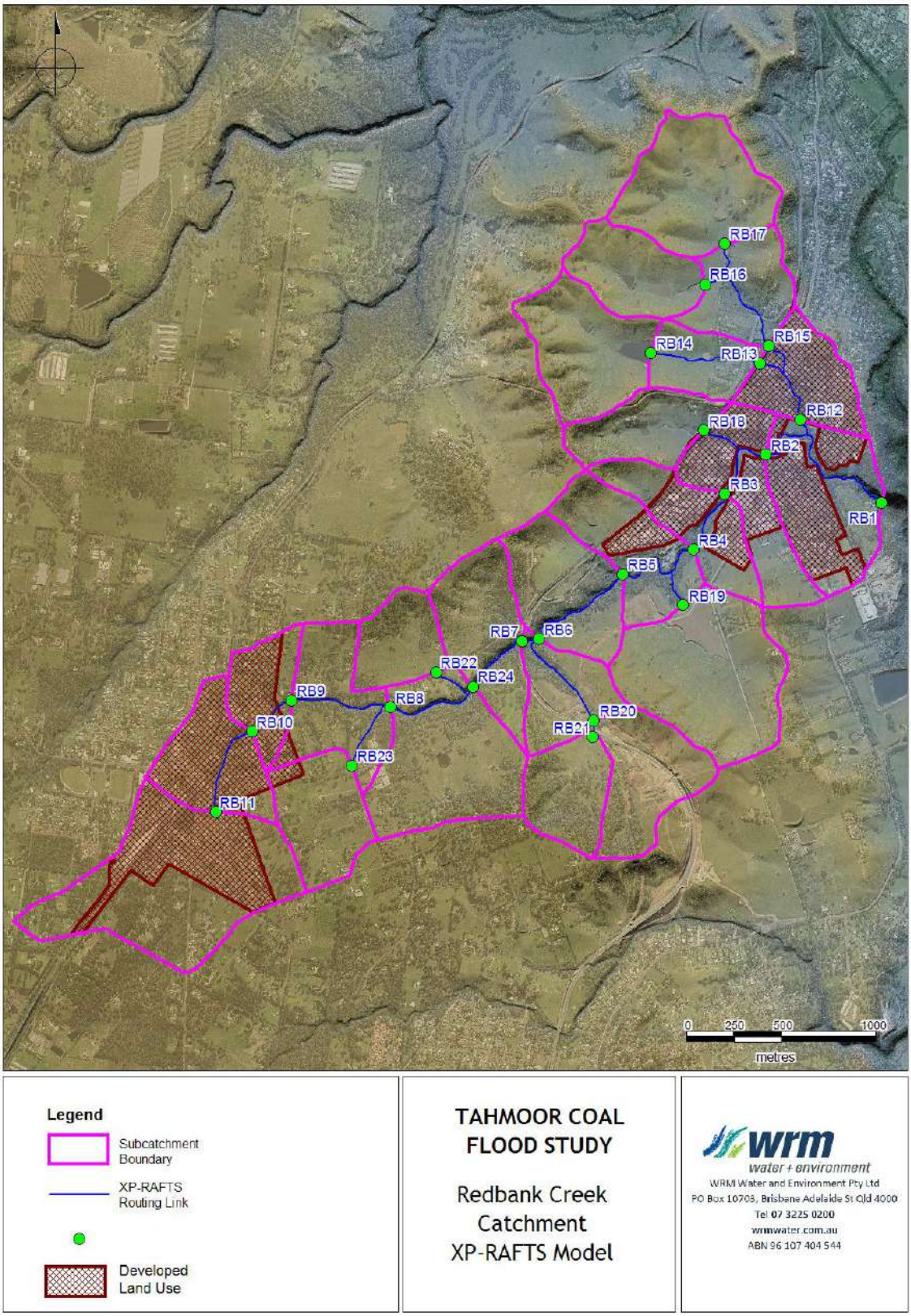



**Figure 3.2 – Redbank Creek XP-RAFTS model configuration**

## 3.3 ESTIMATION OF DESIGN DISCHARGES

### 3.3.1 Methodology

The Matthews Creek and Redbank Creek XP-RAFTS models were used to estimate design discharges for the 1% AEP event, using design rainfall intensities. Estimates of peak design discharges were then validated against Rational Method estimates of peak design discharge for a number of key locations.

### 3.3.2 Design rainfall data

Design rainfall data was obtained from the Bureau of Meteorology (BOM) AR&R 1987 IFD tool (BOM, 2014). Table 3.2 shows the design rainfall intensities adopted.

**Table 3.2 – Adopted design rainfall intensities**

| Duration | 1% AEP Design Intensity (mm/h) | |
|---|---|---|
| (min) | Redbank Creek Catchment | Matthews Creek Catchment |
| 5 | 222 | 218 |
| 10 | 171 | 167 |
| 20 | 124 | 120 |
| 30 | 101 | 97.2 |
| 60 | 68.6 | 66.1 |
| 120 | 45.6 | 44.0 |
| 180 | 35.7 | 34.4 |
| 360 | 23.5 | 22.7 |

### 3.3.3 Design discharges and critical durations

To identify critical storm durations for flooding in the Redbank Creek and Matthews Creek catchments, the XP-RAFTS models were run for a range of storm durations from 15-minutes to 72-hours for the 1% AEP design event. The Matthews Creek catchment was found to have a critical duration of 6 hours, while the Redbank Creek catchment was found to have a critical duration of 2 hours.

### 3.3.4 Rational Method validation

Design discharges estimated by XP-RAFTS were validated against Rational Method discharges for the following locations (refer Figure 3.1 and Figure 3.2):

- MC1, MC3, MC11 and MC 13 for the Matthews Creek catchment; and
- RB1, RB2, RB12 and RB24 for the Redbank Creek catchment.

In addition to validation against the Rational Method estimates, XP-RAFTS design discharge estimates were also compared to design discharges from previous flood studies of the same catchments. Table 3.3 shows the comparison of XP-RAFTS estimates, Rational Method estimates and previous flood study estimates of peak design discharges.

Comparison of Rational Method and XP-RAFTS peak design discharge estimates showed that XP-RAFTS model estimates were generally within 20% of Rational Method estimates for both Matthews Creek and Redbank Creek, with the exception of location RB2 which was within 26%. It should be noted that the Rational Method for Eastern New South Wales (Pilgrim, 1998) makes no allowance for variations in catchment slope or degree of development. Results for both models compared favourably against previous flood studies. As such, the XP-RAFTS model peak design discharges have been adopted for this study.

**Table 3.3 – Comparison of XP-RAFTS and Rational Method 1% AEP peak discharges**

| Reporting Location | Rational Method ($m^3/s$) | XP-RAFTS ($m^3/s$) | Difference (%) | Previous Study ($m^3/s$) |
|---|---|---|---|---|
| MC1 (Catchment outlet) | 276 | 319 | -15% | 300 [a,b] |
| MC3 | 138 | 143 | -4% | - |
| MC11 | 57.3 | 47.0 | 18% | - |
| MC13 | 118 | 105 | 11% | - |
| RB1 (Catchment outlet) | 77.9 | 95.0 | -22% | - |
| RB2 | 58.9 | 74.0 | -26% | 73.1 [c] |
| RB12 | 24.7 | 21.3 | 14% | - |
| RB24 | 32.9 | 35.7 | -9% | 36.4 [c] |

a. Stonequarry Creek 2D Modelling and Climate Change Assessment (Worley Parsons, 2011)

b. Approximate value estimated from hydrograph figure as an exact value was not reported.

c. Myrtle and Redbank Creeks Flood Study – Final Report (Hughes Trueman, 2009)

# 4 Hydraulic model development

## 4.1 OVERVIEW

The TUFLOW hydrodynamic model (WBM, 2010) was used to simulate the existing and post-subsidence conditions flow behaviour in the Matthews Creek and Redbank Creek catchments. TUFLOW represents hydraulic conditions 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.

## 4.2 MODEL EXTENT

Separate TUFLOW models were developed to estimate flood depths and extents in the Matthews Creek and Redbank Creek catchments. The configuration of each model is shown in Figure 4.1 and Figure 4.2. The Redbank Creek TUFLOW model, which used a 1 second time step, extends from approximately 0.4 km upstream of the Railway Culvert to approximately 0.35 km upstream of the confluence of Redbank and Stonequarry Creeks. The Matthews Creek TUFLOW model, which was simulated using the TUFLOW GPU Solver, used a variable time step determined by the modelling software package. The Matthews Creek TUFLOW model extends from approximately 1.6 km upstream of the confluence of Matthews and Cedar Creek to immediately upstream of the Barkers Lodge Road Bridge over Stonequarry Creek. Both models were developed using a 1 m grid.

## 4.3 ADOPTED BED ROUGHNESS

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance (notionally channel or floodplain roughness). No calibration data is available for the study areas. Therefore Manning's 'n' values were based on the guidelines given in Chow (1959). Discrete regions of continuous vegetation types and land uses were mapped, and an appropriate roughness value assigned to each region. Vegetation and land use mapping was undertaken using aerial photography and is shown in Figure 4.1 and Figure 4.2. The Manning's 'n' values applied to the Redbank Creek model were:

- Creek Channel: 'n' = 0.07
- Thick vegetation: 'n' = 0.09
- Roads: 'n' = 0.02
- Urban Drainage Channel: 'n' = 0.06
- Default: 'n'= 0.05

The Manning's 'n' values applied to the Matthews Creek catchment model were:

- Creek Channel: 'n' = 0.08
- Thick vegetation: 'n' = 0.09
- Waterbodies: 'n' = 0.045
- Default: 'n' = 0.06

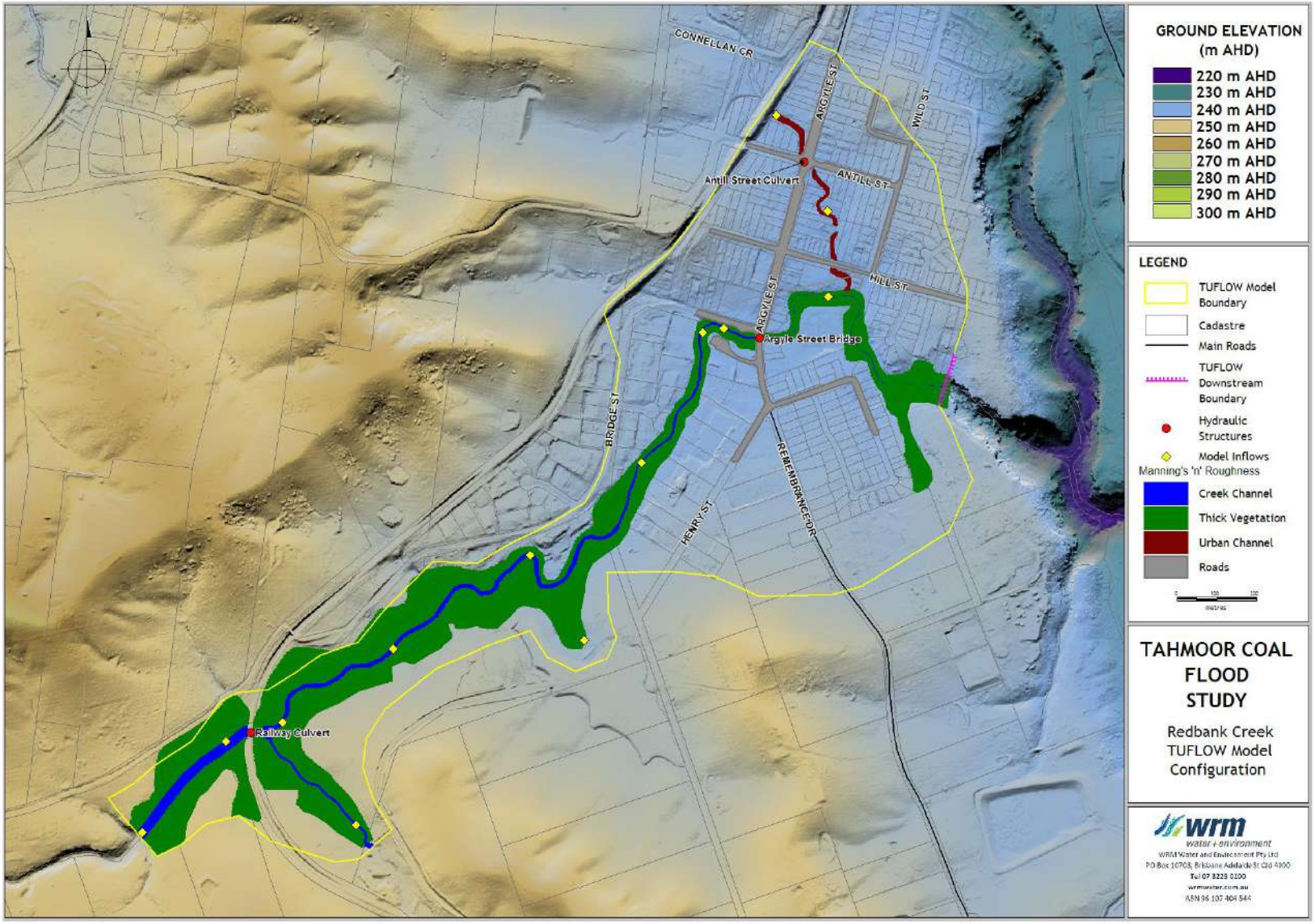



**Figure 4.1 – Redbank Creek TUFLOW Model Configuration**

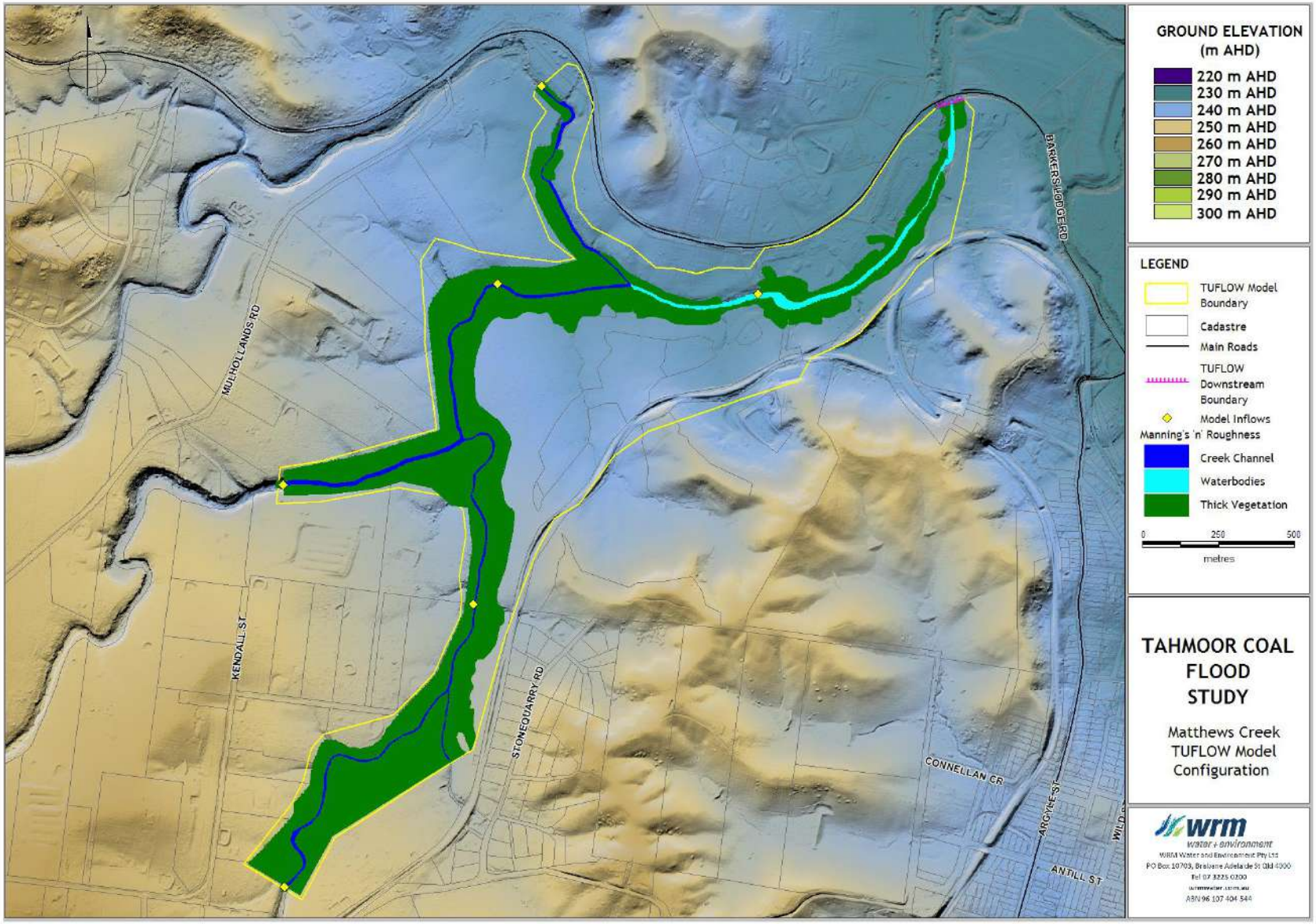



**Figure 4.2 – Matthews Creek TUFLOW Model Configuration**

## 4.4 BOUNDARY CONDITIONS

The downstream boundary in the Redbank Creek TUFLOW model is located approximately 0.7 km downstream of the Argyle Street crossing of Redbank Creek. A normal depth flood slope of 0.005 m/m was applied to the Redbank Creek model as the downstream tailwater boundary. This boundary condition was based on flood gradients that were representative of the bed slopes at the model boundaries.

A HT (water level) Boundary was used as the downstream boundary in the Matthews Creek TUFLOW model immediately upstream of the Barkers Lodge Road crossing of Stonequarry Creek. As outlined in the TUFLOW GPU model release notes, using this type of boundary and applying a level that is below the lowest ground elevation along the boundary results in the model being forced to adopt normal flow conditions and water is able to exit the model.

Design discharge hydrographs extracted from the XP-RAFTS hydrologic model were adopted as inflows at the TUFLOW model boundaries as shown in Figure 4.1 and Figure 4.2.

## 4.5 HYDRAULIC STRUCTURES

The Redbank Creek TUFLOW model includes three hydraulic structures which are shown in Figure 4.1. These structures were included in the TUFLOW model as 1D hydraulic structures (Railway and Antill Street culverts) and as a layered 2D-flow constriction (Argyle Street Bridge). The arrangement of the Antill Street culvert (2 No. 2.1 m x 1.2 m) and the Argyle Street Bridge structure, shown in Figure 4.3 and Figure 4.4, respectively, was determined following an inspection of the Project area.

The configuration of the Railway culvert (see Figure 4.5 ) was obtained from design drawing supplied by the client. This structure is a brick-lined culvert approximately 60 m long and is currently being reinforced against potential subsidence impacts.

There are no hydraulic structures within the Matthews Creek catchment modelling area.

## 4.6 POST-SUBSIDENCE TOPOGRAPHY

The ground levels within the existing case hydraulic models were amended to include the proposed post-subsidence ground elevations. The post-subsidence topographic data for LW31 to LW37 was supplied by MSEC and excludes LW32A. Figure 4.6 and Figure 4.7 show the location of the predicted subsidence in relation to the TUFLOW model boundaries.

The adopted hydrology, Manning's 'n' values and tailwater conditions for the post-subsidence models were identical to those included in the existing scenario models.

Figure 4.3 – Photograph showing the Antill Street culvert

Figure 4.4 – Photograph showing the Argyle Street Bridge

**Figure 4.5 – Photograph showing the Railway Culvert**

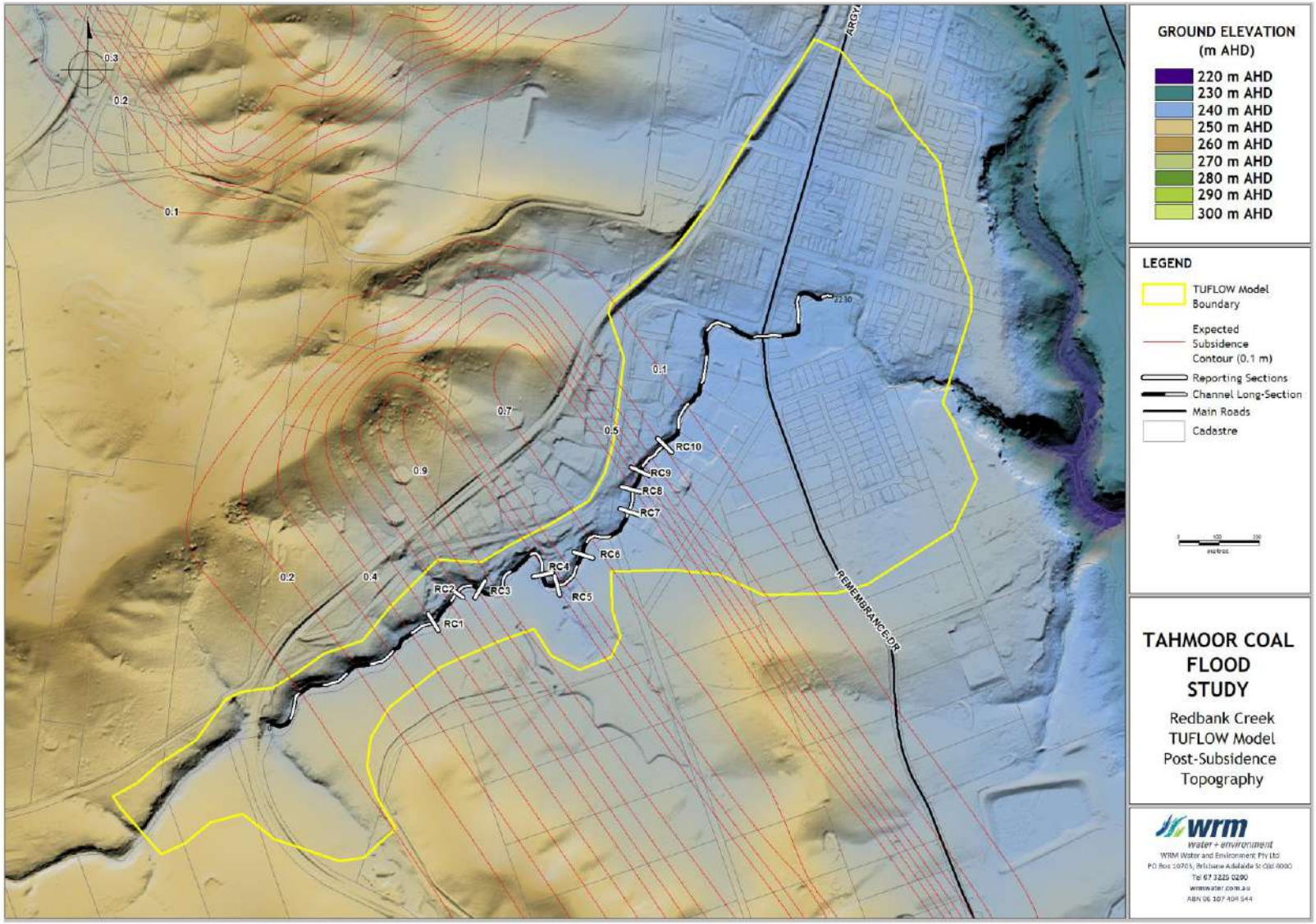



**Figure 4.6 – Predicted Subsidence, Redbank Creek TUFLOW Model**

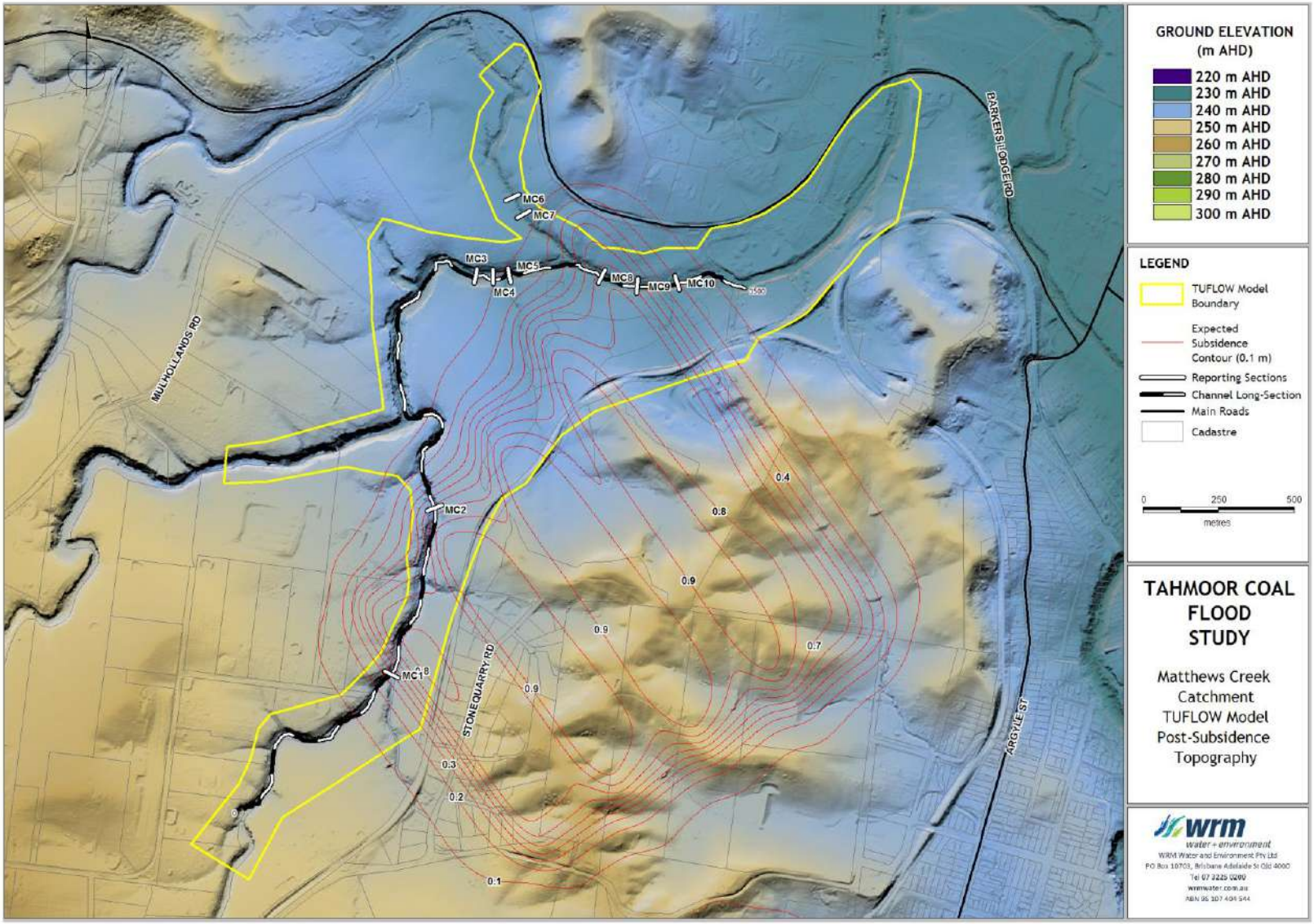



**Figure 4.7 – Predicted Subsidence, Matthews Creek Catchment TUFLOW Model**

# 5 Hydraulic Modelling Results

## 5.1 OVERVIEW

The TUFLOW model was used to determine design flood levels, depths, extents and velocities in Redbank Creek and in the Matthews Creek catchment for the 1% AEP design flood for the existing conditions. The 1% AEP design event was subsequently simulated for the post-subsidence conditions. Plans showing the depth, extent and velocity under existing conditions for the 1% AEP design event are presented in Appendix B. Plans showing the depth, extent and velocity under post-subsidence conditions for the 1% AEP design event are presented in Appendix C.

## 5.2 EXISTING CONDITIONS MODEL RESULTS

### 5.2.1 Redbank Creek

Flooding in Redbank Creek is typically contained in the creek channel with the exception of overbank flow located in the north-eastern extent of the hydraulic model downstream of the Antill Street culvert and in the vicinity of the Argyle Street Bridge. Depths in these areas range between 0.2 m and 1.0 m. Depths in the creek channel are significant in places with flood depths in excess of 4.0 m located downstream of the Argyle Street bridge.

Stream velocities in Redbank Creek are high (point velocities greater than 2.5 m/s) during the 1% AEP design event. The velocities in the overbank flow path downstream of Antill Street and in the vicinity of the Argyle Street Bridge are slightly lower (less than 2.0 m/s).

### 5.2.2 Matthews Creek

Flooding in the Matthews Creek catchment is contained within the Matthews Creek, Cedar Creek and Stonequarry Creek channels with depths typically in excess of 4.0 m in numerous locations. Stream velocities are very high with point velocities in excess of 3.5 m/s in the section of Stonequarry Creek near of the downstream boundary.

## 5.3 POST-SUBSIDENCE MODEL RESULTS

Plans showing the design depth, flood extent and velocity under post-subsidence conditions for the 1% AEP design event are presented in Appendix C. Plans showing the change in the 1% AEP flood levels and stream velocities due to the inclusion of the predicted LW31 to LW37 subsidence are presented in Appendix D.

An analysis of the impacts caused by the predicted subsidence indicates that a reduction in flood level occurs in both the Redbank Creek and Matthews Creek catchment modelling areas. Changes in water level typically reflect the change in ground elevations caused by the subsidence with a maximum reduction in water level of -0.97 m in the Redbank Creek model and -0.75 m in the Matthews Creek catchment model.

The impact of the subsidence caused by the mining of LW31 to LW37 does not result in an increase in flood levels in the Redbank Creek and Matthews Creek catchment modelling areas.

A comparison between water levels and ground elevations for the existing and post-subsidence condition models is shown in Figure 5.1 and Figure 5.2. The chainages shown in these figures correspond to the long-sections shown in Figure 4.6 and Figure 4.7.

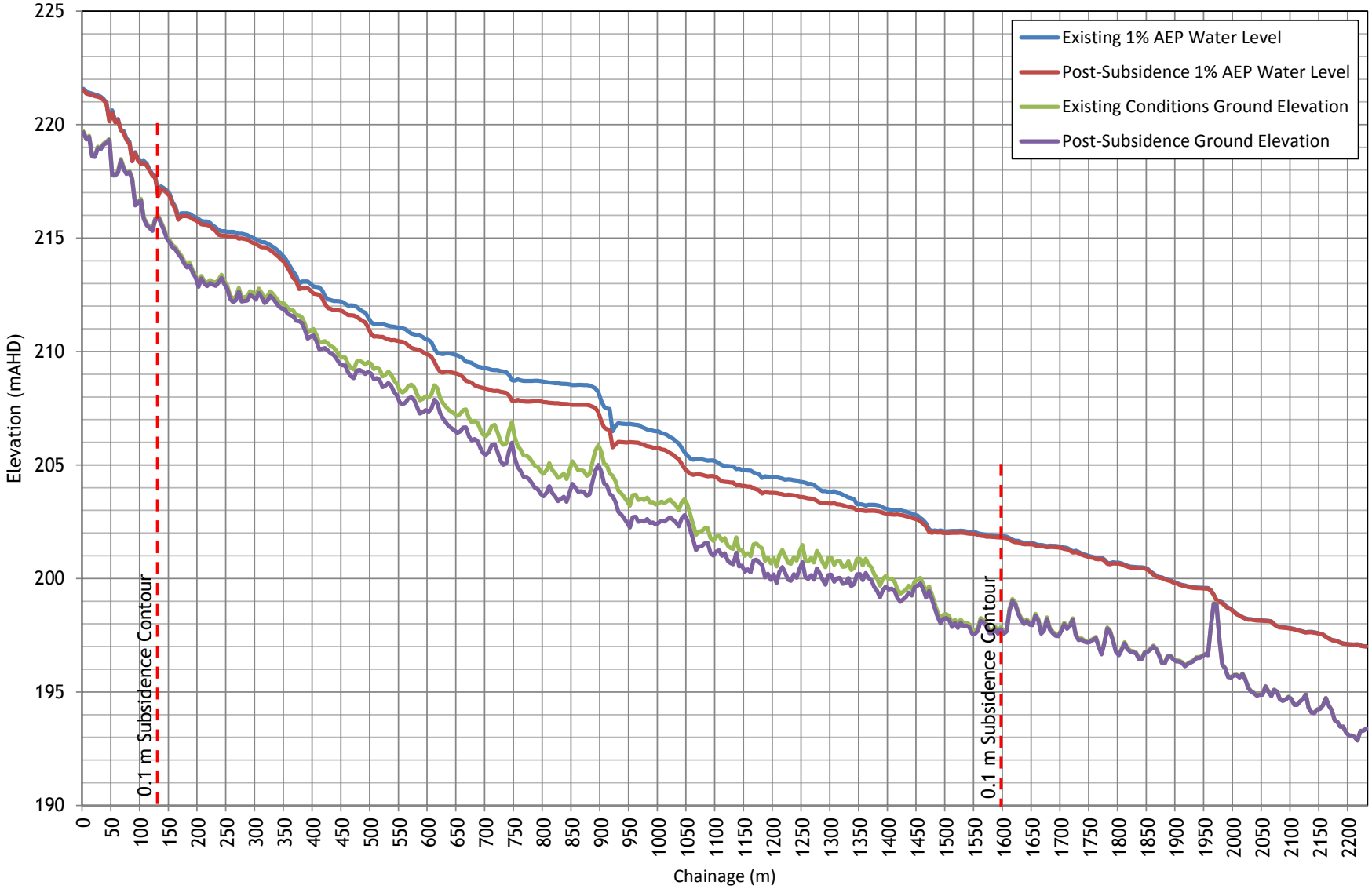



**Figure 5.1 – Comparison of water levels and ground elevations, Redbank Creek model**

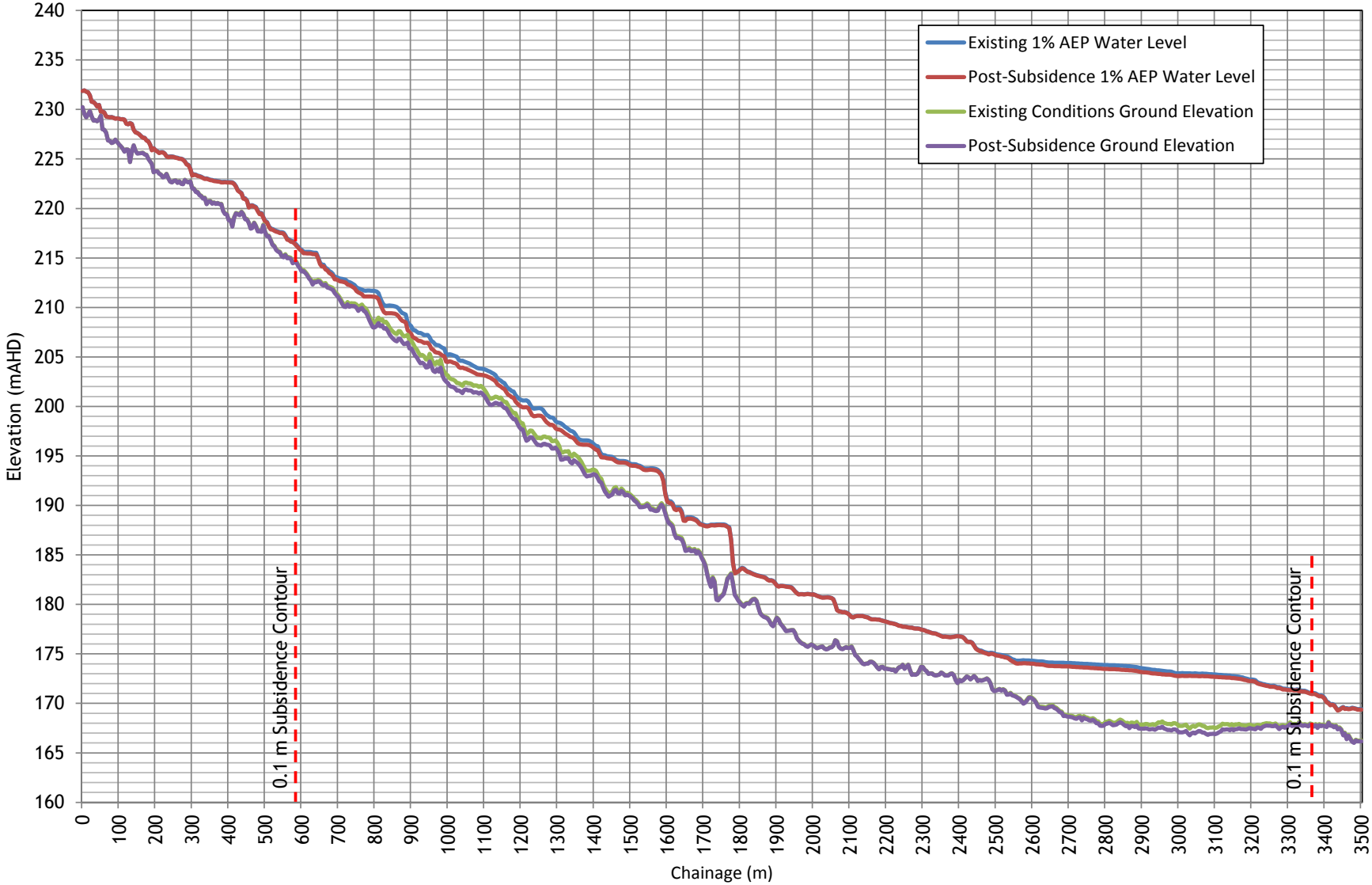



**Figure 5.2 - Comparison of water levels and ground elevations, Matthews Creek catchment model**

The impact of the predicted subsidence on stream velocities indicates a maximum reduction in point velocities of 0.92 m/s and a maximum increase of 0.77 m/s in the Redbank Creek model and a maximum reduction in point velocity of 0.58 m/s and a maximum increase in point velocity of 0.65 m/s occurring within the Matthews Creek catchment modelling area. A comparison of averaged stream velocities at various cross section locations (see Figure 4.6 and Figure 4.7) is shown in Table 5.1 and Table 5.2. This comparison indicates that the change in average stream velocities is relatively minor within both modelling areas.

**Table 5.1 - Comparison of average stream velocities, Redbank Creek model**

| Reporting Location | Existing Conditions (m/s) | Post-Subsidence Conditions (m/s) | Difference (m/s) |
|---|---|---|---|
| RC1 | 1.86 | 1.98 | 0.12 |
| RC2 | 1.21 | 1.51 | 0.30 |
| RC3 | 1.35 | 1.52 | 0.17 |
| RC4 | 1.47 | 1.41 | -0.07 |
| RC5 | 1.63 | 1.55 | -0.08 |
| RC6 | 1.67 | 1.70 | 0.04 |
| RC7 | 1.74 | 1.48 | -0.26 |
| RC8 | 1.05 | 0.91 | -0.14 |
| RC9 | 1.46 | 1.30 | -0.16 |
| RC10 | 1.50 | 1.45 | -0.05 |

**Table 5.2 - Comparison of average stream velocities, Matthews Creek catchment model**

| Reporting Location | Existing Conditions (m/s) | Post-Subsidence Conditions (m/s) | Difference (m/s) |
|---|---|---|---|
| MC1 | 1.51 | 1.74 | 0.23 |
| MC2 | 2.76 | 2.48 | -0.28 |
| MC3 | 2.73 | 2.97 | 0.24 |
| MC4 | 1.69 | 1.82 | 0.13 |
| MC5 | 1.16 | 1.25 | 0.09 |
| MC6 | 1.64 | 1.86 | 0.22 |
| MC7 | 1.58 | 1.92 | 0.34 |
| MC8 | 2.11 | 1.89 | -0.22 |
| MC9 | 1.74 | 1.63 | -0.11 |
| MC10 | 2.52 | 2.42 | -0.11 |

# 6 Summary

The subsidence caused by the mining of LW31 to LW37 will impact flood levels and velocities along Matthews Creek, Redbank Creek, Cedar Creek and Stonequarry Creek which traverse the Project area.

Hydrologic (XP-RAFTS) and hydraulic (TUFLOW) models were used to estimate design flood discharges, flood levels, depths, velocities and extents in the vicinity of the Project area for the 1% AEP design event for existing and post-subsidence conditions.

The results of the flood modelling are summarised as follows:

- Flows are generally contained within the channels of Matthews Creek, Redbank Creek, Cedar Creek and Stonequarry Creek with depths in excess of 4.0 m in the main channels;
- Overbank flow occurs in the Redbank Creek model in the vicinity of the Argyle Street Bridge and downstream of the Antill Street culvert. Depths in these areas range between 0.2 m and 1.0 m;
- Stream velocities in the main channels are relatively high (point velocities greater than 2.0 m/s and 3.5 m/s in Redbank Creek and in the Matthews Creek catchment, respectively). The velocity in the overbank flow areas is slightly lower (less than 2.0 m/s);
- An analysis of the impacts caused by the predicted subsidence on water levels and stream velocities in Redbank Creek and the Matthews Creek catchment indicates that a localised change in flood levels and stream velocities occurs during the 1% AEP design event. These localised changes are confined to the creek channels with a maximum reduction in water level of -0.97 m in the Redbank Creek model and -0.75 m in the Matthews Creek catchment model;
- The impact of the subsidence caused by the mining of LW31 to LW37 does not result in an increase in flood levels in the Redbank Creek and Matthews Creek catchment modelling areas;
- Changes to stream velocity are localised with a maximum reduction in point velocities of 0.92 m/s and a maximum increase of 0.77 m/s in the Redbank Creek model and a maximum reduction in point velocity of 0.58 m/s and a maximum increase in point velocity of 0.65 m/s in the Matthews Creek catchment modelling area; and
- A comparison of cross-section averaged stream velocities at various locations indicates that the change in average stream velocities is relatively minor in both modelling areas. There is a maximum increase of 0.3 m/s and a maximum decrease of -0.26 m/s occurring in the Redbank Creek modelling area representing a change in velocity of the order of 24% and 14%, respectively.
- A maximum increase of 0.34 m/s and a maximum decrease of -0.28 m/s occurs in the Matthews Creek catchment modelling area, representing a change in velocity of the order of 21% and 10%, respectively.

# 7 References


| | |
|---|---|
| BMT WBM (2010) | *'TUFLOW User Manual - GIS Based 2D/1D Hydrodynamic Modelling'*, BMT WBM Pty Ltd, February 2011. |
| Chow (1959) | *'Open Channel Hydraulics'*, written by V.T. Chow, McGraw-Hill Book Company, NY, 1959. |
| Hughes Trueman (2009) | *'Myrtle and Redbank Creeks Flood Study'*, Report prepared by Hughes Trueman for Xtrata Coal Tahmoor, May 2009. |
| Pilgrim (1998) | *'Australian rainfall & Runoff – A Guide to Flood Estimation'*, Book IV, Section 1, Revised Edition, Institution of Engineers Australia, 1998. |
| WorleyParsons (2011) | *'Stonequarry Creek, 2D Modelling and Climate Change Assessment'*, Report prepared by WorleyParsons for Wollondilly Shire Council, July 2011. |
| XP Software (2013) | *'XP-RAFTS User Manual'*, XP Software, 2013. |

# Appendix A XP-RAFTS model parameters

## A1 Matthews Creek catchment model

Table A.1 – Matthews Creek XP-RAFTS subcatchments parameters

| Node | Area (ha) | Slope (%) | Fraction Impervious (%) | PERN 'n' |
|---|---|---|---|---|
| MC1 | 121.9 | 4.1 | 10 | 0.08 |
| MC2 | 176.7 | 3.4 | 10 | 0.08 |
| MC3 | 179.0 | 4.1 | 10 | 0.08 |
| MC4 | 303.2 | 1.3 | 10 | 0.08 |
| MC5 | 246.5 | 2.4 | 10 | 0.08 |
| MC6 | 288.4 | 3.6 | 10 | 0.08 |
| MC7 | 180.8 | 7.7 | 10 | 0.08 |
| MC8 | 303.6 | 4.2 | 10 | 0.08 |
| MC9 | 233.8 | 2.3 | 10 | 0.08 |
| MC10 | 258.8 | 4.3 | 10 | 0.08 |
| MC11 | 202.8 | 4.5 | 10 | 0.08 |
| MC12 | 352.1 | 2.5 | 10 | 0.08 |
| MC13 | 143.9 | 2.7 | 10 | 0.08 |
| MC14 | 218.3 | 2.5 | 10 | 0.08 |
| MC15 | 247.9 | 1.2 | 10 | 0.08 |
| MC16 | 250.4 | 3.3 | 10 | 0.08 |
| MC17 | 177.0 | 4.2 | 10 | 0.08 |
| MC18 | 182.8 | 2.8 | 10 | 0.08 |
| MC19 | 189.1 | 3.6 | 10 | 0.08 |

Table A.2 – Matthews Creek XP-RAFTS routing link parameters

| Link | Length (m) | Channel Routing K (hr) | Channel Routing X |
|---|---|---|---|
| MC7 - MC6 | 1419 | 0.26 | 0.25 |
| MC6 - MC5 | 2681 | 0.50 | 0.25 |
| MC9 - MC5 | 1142 | 0.21 | 0.25 |
| MC5 - MC4 | 1670 | 0.31 | 0.25 |
| MC8 - MC4 | 2080 | 0.39 | 0.25 |
| MC12 - MC11 | 1775 | 0.33 | 0.25 |
| MC4 - MC3 | 2638 | 0.49 | 0.25 |
| MC11 - MC10 | 1798 | 0.33 | 0.25 |
| MC3 - MC2 | 1636 | 0.30 | 0.25 |
| MC10 - MC2 | 997 | 0.18 | 0.25 |
| MC13 - MC2 | 632 | 0.12 | 0.25 |
| MC2 - MC1 | 1004 | 0.19 | 0.25 |
| MC14 - MC13 | 1474 | 0.27 | 0.25 |
| MC19 - MC13 | 1482 | 0.27 | 0.25 |
| MC18 - MC14 | 3204 | 0.59 | 0.25 |
| MC15 - MC14 | 3221 | 0.60 | 0.25 |
| MC17 - MC16 | 1755 | 0.32 | 0.25 |
| MC16 - MC15 | 2879 | 0.53 | 0.25 |

# A2 Redbank Creek catchment model

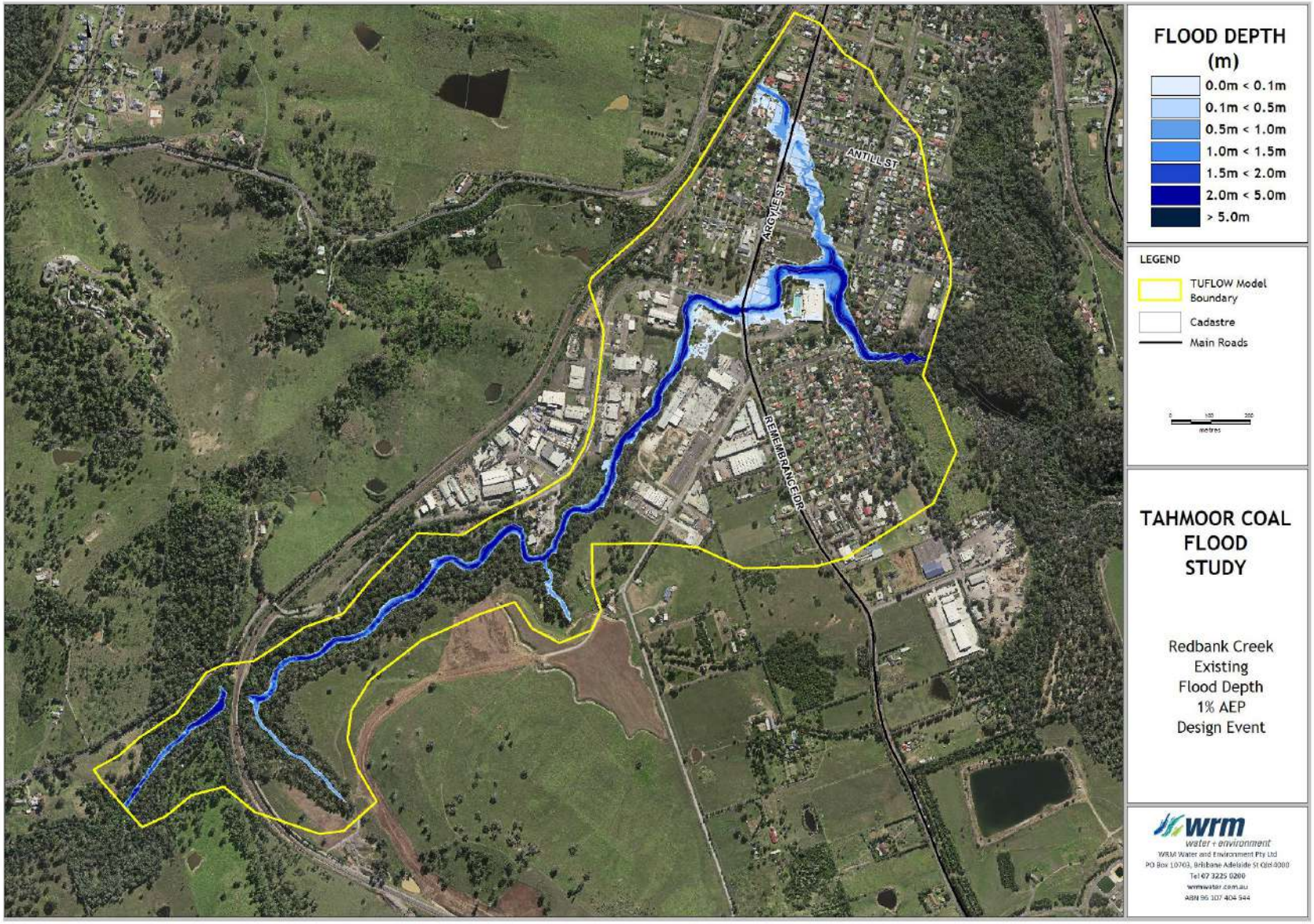
Table A.3 – Redbank Creek XP-RAFTS subcatchments parameters

| Node | Area (ha) | Slope (%) | Fraction Impervious (%) | PERN 'n' |
|---|---|---|---|---|
| RB1 | 42.44 | 7.8 | 27.3 | 0.06 |
| RB2 | 32.32 | 2.3 | 29.1 | 0.05 |
| RB3 | 26.88 | 4.6 | 23.0 | 0.06 |
| RB4 | 32.13 | 3.3 | 14.5 | 0.07 |
| RB5 | 34.48 | 5.1 | 10.0 | 0.08 |
| RB6 | 21.87 | 4.1 | 10.0 | 0.08 |
| RB7 | 33.02 | 6.7 | 10.0 | 0.08 |
| RB8 | 32.26 | 3.7 | 11.2 | 0.08 |
| RB9 | 18.39 | 3.2 | 32.4 | 0.05 |
| RB10 | 28.85 | 1.9 | 37.5 | 0.04 |
| RB11 | 76.21 | 1.4 | 23.0 | 0.06 |
| RB12 | 25.15 | 2.4 | 40.0 | 0.04 |
| RB13 | 17.56 | 2.7 | 10.2 | 0.08 |
| RB14 | 36.66 | 3.0 | 10.0 | 0.08 |
| RB15 | 25.34 | 2.8 | 10.2 | 0.08 |
| RB16 | 25.78 | 3.8 | 10.0 | 0.08 |
| RB17 | 44.38 | 4.1 | 10.0 | 0.08 |
| RB18 | 23.19 | 4.8 | 10.3 | 0.08 |
| RB19 | 58.17 | 4.0 | 10.0 | 0.08 |
| RB20 | 31.43 | 3.9 | 10.0 | 0.08 |
| RB21 | 22.4 | 4.5 | 10.0 | 0.08 |
| RB22 | 19.3 | 5.9 | 10.0 | 0.08 |
| RB23 | 27.62 | 3.8 | 11.6 | 0.08 |
| RB24 | 52.63 | 5.0 | 10.0 | 0.08 |
| RB1 | 42.44 | 7.8 | 27.3 | 0.06 |

Table A.4 – Redbank Creek XP-RAFTS routing link parameters

| Link | Length (m) | Channel Routing K (hr) | Channel Routing X |
|---|---|---|---|
| RB10 - RB9 | 272 | 0.05 | 0.25 |
| RB11 - RB10 | 506 | 0.09 | 0.25 |
| RB12 - RB1 | 721 | 0.13 | 0.25 |
| RB13 - RB12 | 423 | 0.08 | 0.25 |
| RB14 - RB13 | 603 | 0.11 | 0.25 |
| RB15 - RB12 | 471 | 0.09 | 0.25 |
| RB16 - RB15 | 566 | 0.1 | 0.25 |
| RB17 - RB15 | 645 | 0.12 | 0.25 |
| RB18 - RB2 | 360 | 0.07 | 0.25 |
| RB19 - RB4 | 380 | 0.07 | 0.25 |
| RB2 - RB1 | 947 | 0.18 | 0.25 |
| RB20 - RB6 | 582 | 0.11 | 0.25 |
| RB21 - RB20 | 85 | 0.02 | 0.25 |
| RB22 - RB24 | 256 | 0.05 | 0.25 |
| RB23 - RB8 | 399 | 0.07 | 0.25 |
| RB24 - RB7 | 373 | 0.07 | 0.25 |
| RB3 - RB2 | 399 | 0.07 | 0.25 |
| RB4 - RB3 | 353 | 0.07 | 0.25 |
| RB5 - RB4 | 558 | 0.1 | 0.25 |
| RB6 - RB5 | 592 | 0.11 | 0.25 |
| RB7 - RB6 | 92 | 0.02 | 0.25 |
| RB8 - RB24 | 509 | 0.09 | 0.25 |
| RB9 - RB8 | 536 | 0.1 | 0.25 |

# Appendix B Existing Conditions Model Results


FLOOD DEPTH (m)
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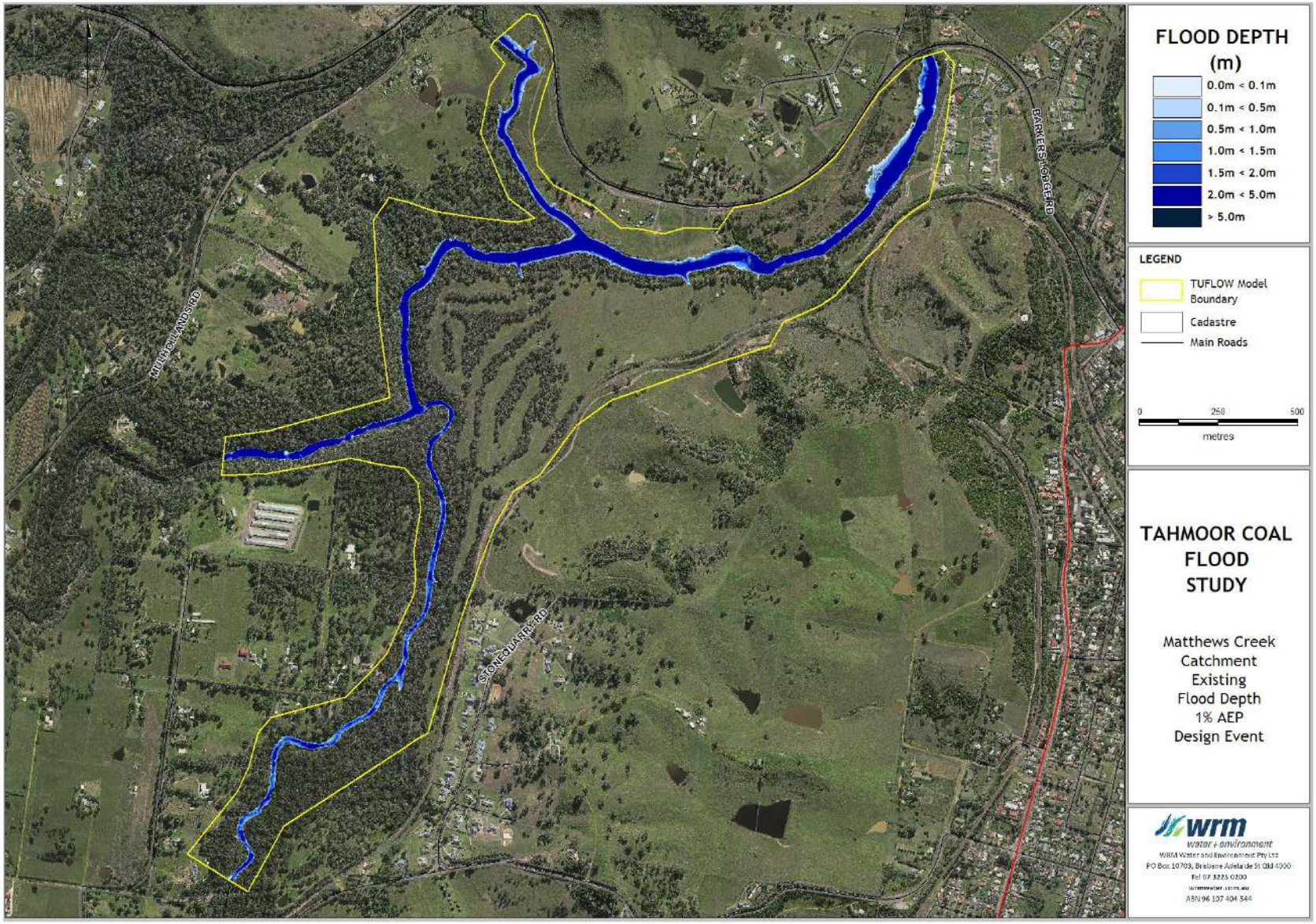
0.1m < 0.5m
0.5m < 1.0m
1.0m < 1.5m
1.5m < 2.0m
2.0m < 5.0m
> 5.0m
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
ANTILL ST
ARGYLE ST
REMEMBRANCE DR
TAHMOOR COAL FLOOD STUDY
Redbank Creek
Existing
Flood Depth
1% AEP
Design Event
wrm
water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 544

VELOCITY
(m/s)
0.0m/s < 0.5m/s
0.5m/s < 1.0m/s
1.0m/s < 1.5m/s
1.5m/s < 2.0m/s
2.0m/s < 2.5m/s
2.5m/s < 3.0 m/s
3.0m/s < 3.5m/s
3.0m/s < 4.0m/s
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
metres
ANTILL ST
ARGYLE ST
REMEMBRANCE DR
TAHMOOR COAL FLOOD STUDY
Redbank Creek
Existing
Flood Velocity
1% AEP
Design Event
wrm
water + environment
WRM Water and Environment Pty Ltd
PO Box 10763, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 544

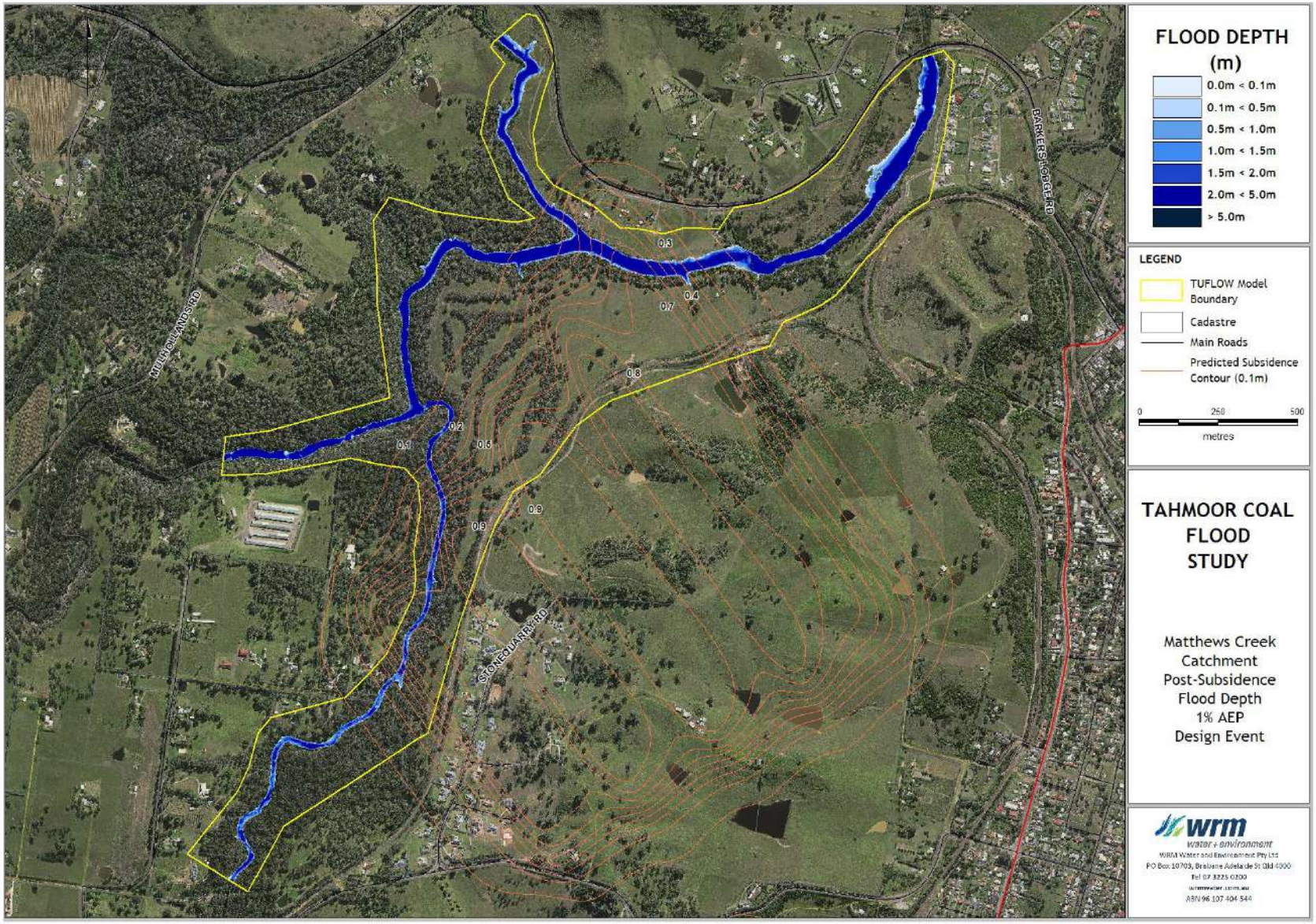

FLOOD DEPTH
(m)
0.0m < 0.1m
0.1m < 0.5m
0.5m < 1.0m
1.0m < 1.5m
1.5m < 2.0m
2.0m < 5.0m
> 5.0m
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
0
250
500
metres
TAHMOOR COAL FLOOD STUDY
Matthews Creek Catchment
Existing Flood Depth
1% AEP Design Event
wrm
water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 548
MILLHOLLANDS RD
STONEQUARRY RD
BARKERS LODGE RD

VELOCITY
(m/s)
0.0m/s < 0.5m/s
0.5m/s < 1.0m/s
1.0m/s < 1.5m/s
1.5m/s < 2.0m/s
2.0m/s < 2.5m/s
2.5m/s < 3.0 m/s
3.0m/s < 3.5m/s
3.0m/s < 4.0m/s
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
0
250
500
metres
TAHMOOR COAL FLOOD STUDY
Matthews Creek Catchment
Existing Flood Velocity
1% AEP Design Event
wrm water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 548
MILLHOLLANDS RD
STONEQUARRY RD
BARKERS LODGE RD

# Appendix C Post-Subsidence Model Results

FLOOD DEPTH (m)
0.0m < 0.1m
0.1m < 0.5m
0.5m < 1.0m
1.0m < 1.5m
1.5m < 2.0m
2.0m < 5.0m
> 5.0m
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
Predicted Subsidence Contour (0.1m)
ANTILL ST
ARGYLE ST
REMEMBRANCE DR
0.1
0.4
0.7
0.8
0.7
0.9
0.3
0.2
TAHMOOR COAL FLOOD STUDY
Redbank Creek
Post-Subsidence
Flood Depth
1% AEP
Design Event
wrm
water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 944

VELOCITY
(m/s)
0.0m/s < 0.5m/s
0.5m/s < 1.0m/s
1.0m/s < 1.5m/s
1.5m/s < 2.0m/s
2.0m/s < 2.5m/s
2.5m/s < 3.0 m/s
3.0m/s < 3.5m/s
3.0m/s < 4.0m/s
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
Predicted Subsidence Contour (0.1m)
metres
TAHMOOR COAL FLOOD STUDY
Redbank Creek
Post-Subsidence
Flood Velocity
1% AEP
Design Event
ANTILL ST
ARGYLE ST
REMEMBRANCE DR
0.1
0.2
0.3
0.4
0.6
0.7
0.8
0.9
wrm
water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 544


FLOOD DEPTH (m)
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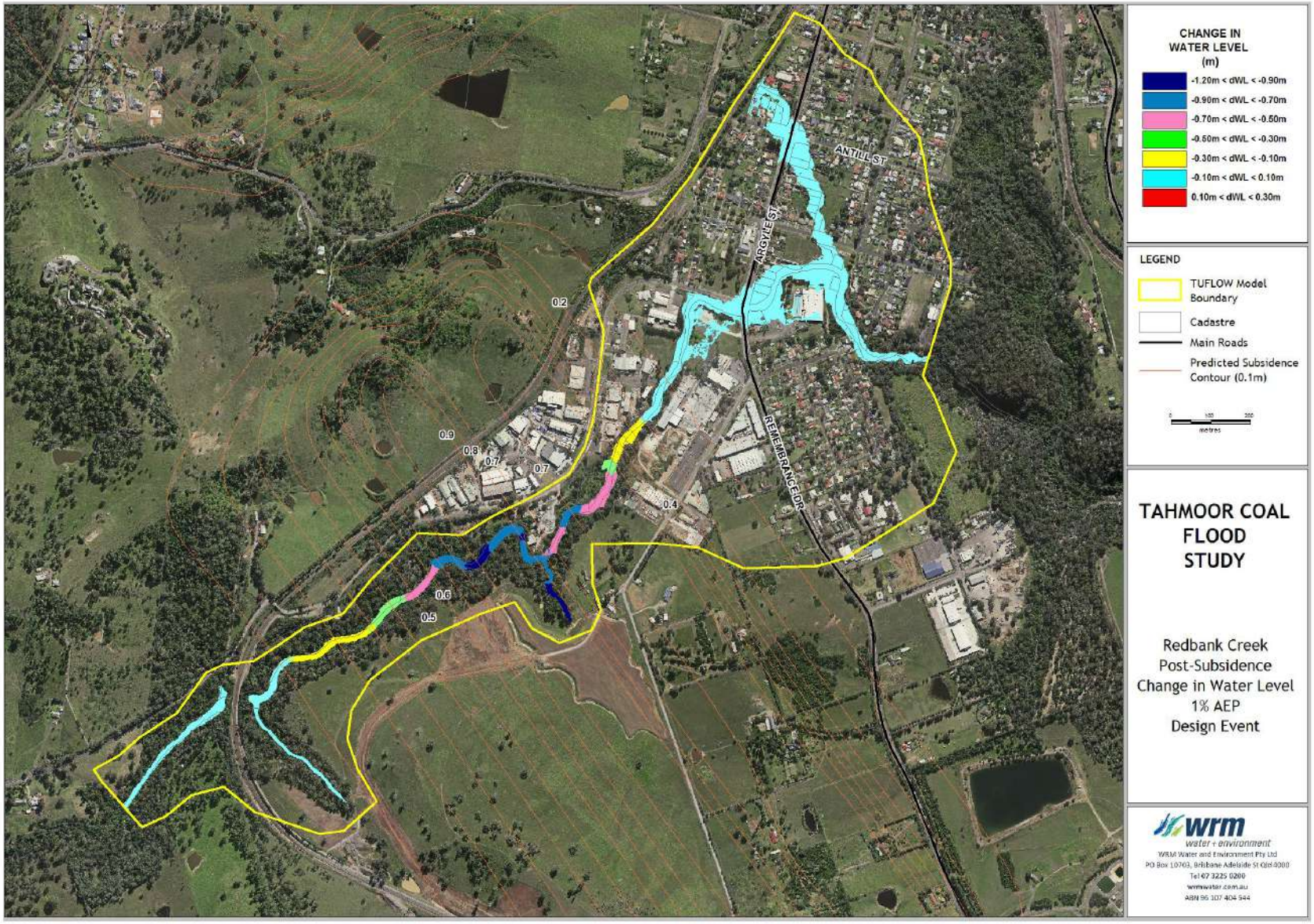
0.1m < 0.5m
0.5m < 1.0m
1.0m < 1.5m
1.5m < 2.0m
2.0m < 5.0m
> 5.0m
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
Predicted Subsidence Contour (0.1m)
0
250
500
metres
TAHMOOR COAL FLOOD STUDY
Matthews Creek Catchment
Post-Subsidence Flood Depth
1% AEP Design Event
wrm water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 548
MILLHOLLANDS RD
STONEQUARRY RD
BARKERS LODGE RD
0.1
0.2
0.3
0.4
0.5
0.7
0.8
0.9

VELOCITY
(m/s)
0.0m/s < 0.5m/s
0.5m/s < 1.0m/s
1.0m/s < 1.5m/s
1.5m/s < 2.0m/s
2.0m/s < 2.5m/s
2.5m/s < 3.0 m/s
3.0m/s < 3.5m/s
3.0m/s < 4.0m/s
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
Predicted Subsidence Contour (0.1m)
0
250
500
metres
TAHMOOR COAL FLOOD STUDY
Matthews Creek Catchment
Post-Subsidence
Flood Velocity
1% AEP
Design Event
wrm
water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 548
MULHOLLANDS RD
STONEQUARRY RD
PARKERS LODGE RD
0.1
0.2
0.3
0.4
0.5
0.7
0.8
0.9

# Appendix D Post-Subsidence Impacts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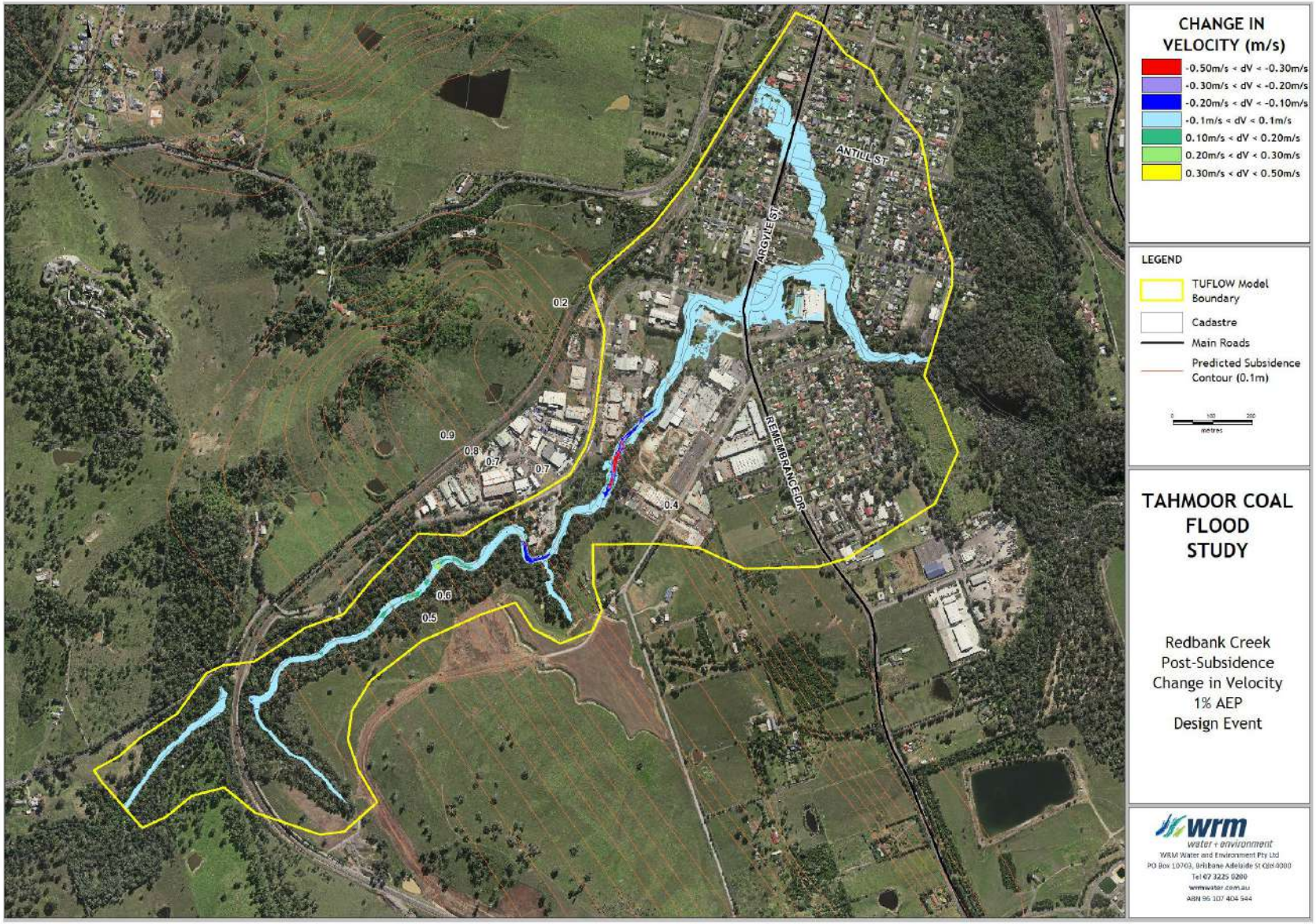
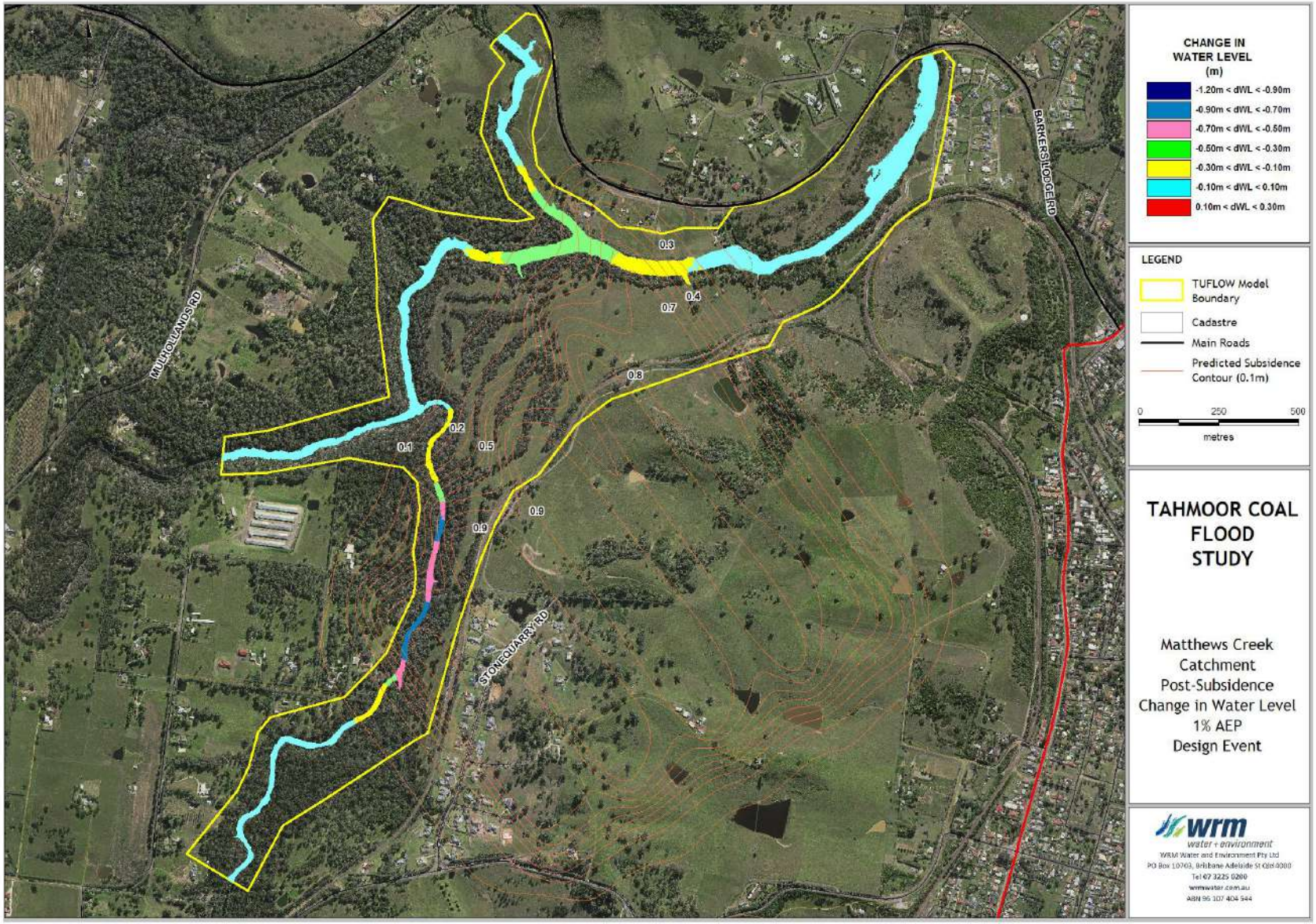
-0.50m < dWL < -0.30m
-0.30m < dWL < -0.10m
-0.10m < dWL < 0.10m
0.10m < dWL < 0.30m
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
Predicted Subsidence Contour (0.1m)
metres
TAHMOOR COAL FLOOD STUDY
Redbank Creek
Post-Subsidence
Change in Water Level
1% AEP
Design Event
ANTILL ST
ARGYLE ST
REMEMBRANCE DR
0.2
0.9
0.8
0.7
0.7
0.4
0.6
0.5
wrm
water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 544


CHANGE IN VELOCITY (m/s)
-0.50m/s < dV < -0.30m/s
-0.30m/s < dV < -0.20m/s
-0.20m/s < dV < -0.10m/s
-0.1m/s < dV < 0.1m/s
0.10m/s < dV < 0.20m/s
0.20m/s < dV < 0.30m/s
0.30m/s < dV < 0.50m/s
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
Predicted Subsidence Contour (0.1m)
metres
TAHMOOR COAL FLOOD STUDY
Redbank Creek
Post-Subsidence
Change in Velocity
1% AEP
Design Event
ANTILL ST
ARGYLE ST
REMEMBRANCE DR
0.2
0.9
0.8
0.7
0.7
0.4
0.6
0.5
wrm
water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 544


CHANGE IN WATER LEVEL (m)
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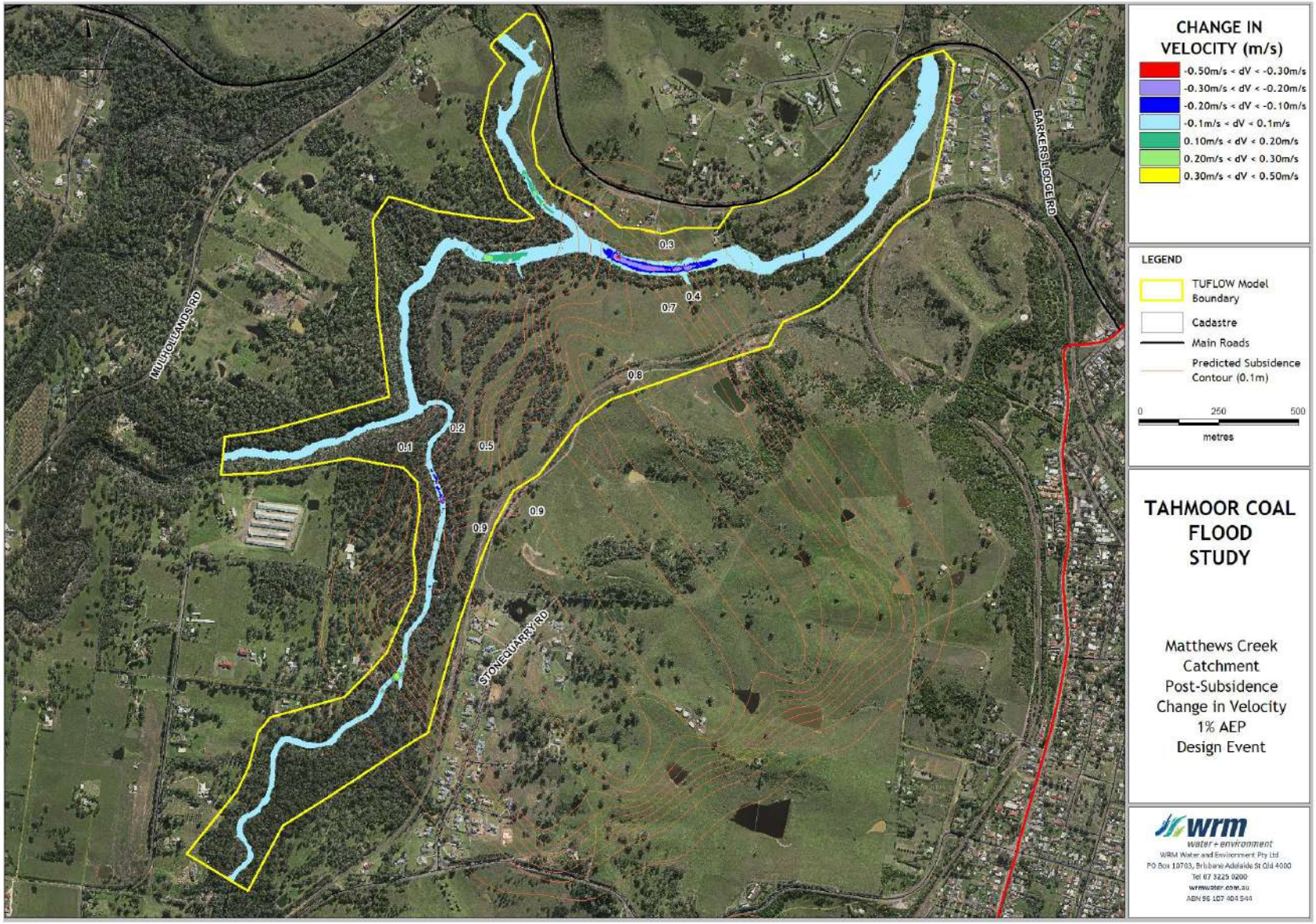
-0.70m < dWL < -0.50m
-0.50m < dWL < -0.30m
-0.30m < dWL < -0.10m
-0.10m < dWL < 0.10m
0.10m < dWL < 0.30m
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
Predicted Subsidence Contour (0.1m)
0
250
500
metres
TAHMOOR COAL FLOOD STUDY
Matthews Creek Catchment
Post-Subsidence
Change in Water Level
1% AEP
Design Event
wrm
water + environment
WRM Water and Environment Pty Ltd
PO Box 10763, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 544
MULHOLLANDS RD
BARKERS LODGE RD
STONEQUARRY RD
0.1
0.2
0.3
0.4
0.5
0.7
0.8
0.9
0.9


CHANGE IN VELOCITY (m/s)
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-0.30m/s < dV < -0.20m/s
-0.20m/s < dV < -0.10m/s
-0.1m/s < dV < 0.1m/s
0.10m/s < dV < 0.20m/s
0.20m/s < dV < 0.30m/s
0.30m/s < dV < 0.50m/s
LEGEND
TUFLOW Model Boundary
Cadastre
Main Roads
Predicted Subsidence Contour (0.1m)
0
250
500
metres
TAHMOOR COAL FLOOD STUDY
Matthews Creek Catchment Post-Subsidence Change in Velocity 1% AEP Design Event
wrm water + environment
WRM Water and Environment Pty Ltd
PO Box 10703, Brisbane Adelaide St Qld 4000
Tel 07 3225 0200
wrmwater.com.au
ABN 96 107 404 544
MULHOLLANDS RD
BARKERS LODGE RD
STONEQUARRY RD
0.1
0.2
0.3
0.4
0.5
0.7
0.8
0.9
0.9