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Huntlee Subdivision – Modification 20

Stormwater & Flood Management Strategy

for Huntlee Pty Ltd

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1. Introduction

Northrop Consulting Engineers have been engaged by Huntlee Pty Ltd to prepare an overview of the Stormwater and Flood Management Strategy adopted across the Huntlee Stage 1 Project Area in support of DA Modification 20.

Modification 20 proposes lot layout amendments through the subdivision of Town Centre Substages 1-5 and subdivision of Substages 13-16. In addition to the allotment changes, amendments to the adjoining roads, relocation of the urban town centre square and a small increase to the total public open space are proposed under Modification 20.

The changes occur over 5 main areas as identified below within Figure 1 and Figure 2. All 5 areas fall within sub-catchments of Tributary 2 and in terms of Stormwater have been previously covered by the approval within the '*Trunk Stormwater and Flooding Assessment*' published August 2012 prepared by Worley Parsons.

The following report intends to outline the changes that are required to the previously adopted Stormwater and Flood Management Strategy brought about due to the changes proposed by Modification 20 and how they are to be appropriately managed.

1.1 Legislation, Policies and Guidelines

This assessment has been prepared with consideration to the following legislation, policies and guidelines.

- Cessnock Local Environmental Plan (LEP) 2011.
- Cessnock City Council Development Control Plan (2018), specifically Part E17 – Huntlee.
- Australian Rainfall and Runoff 2019 (AR&R 2019).
- NSW Flood Prone Land Policy
- NSW Government Floodplain Development Manual (NSW Government, 2005)
- Water Management Act 2000 (NSW Government, 2000)
- NSW MUSIC Modelling Guidelines 2015 (BMT WBM)
- The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method (BOM, 2003)

1.2 Relevant Reports and Documents

This study has been prepared with consideration given to the following reports:

1. Huntlee Project Trunk Stormwater and Flooding Assessment prepared by Worley Parsons and dated by August 2012, herein referred to as "The Original Report (WorleyParsons, 2012)".
2. Greta Flood Study Final Report prepared by WMA Water and completed in February 2019.
3. Online Stormwater Detention Basin 3 for Huntlee Urban Release Area – Tributary Two (Revision C) prepared by Northrop Consulting Engineers and dated the 7th of July 2021.

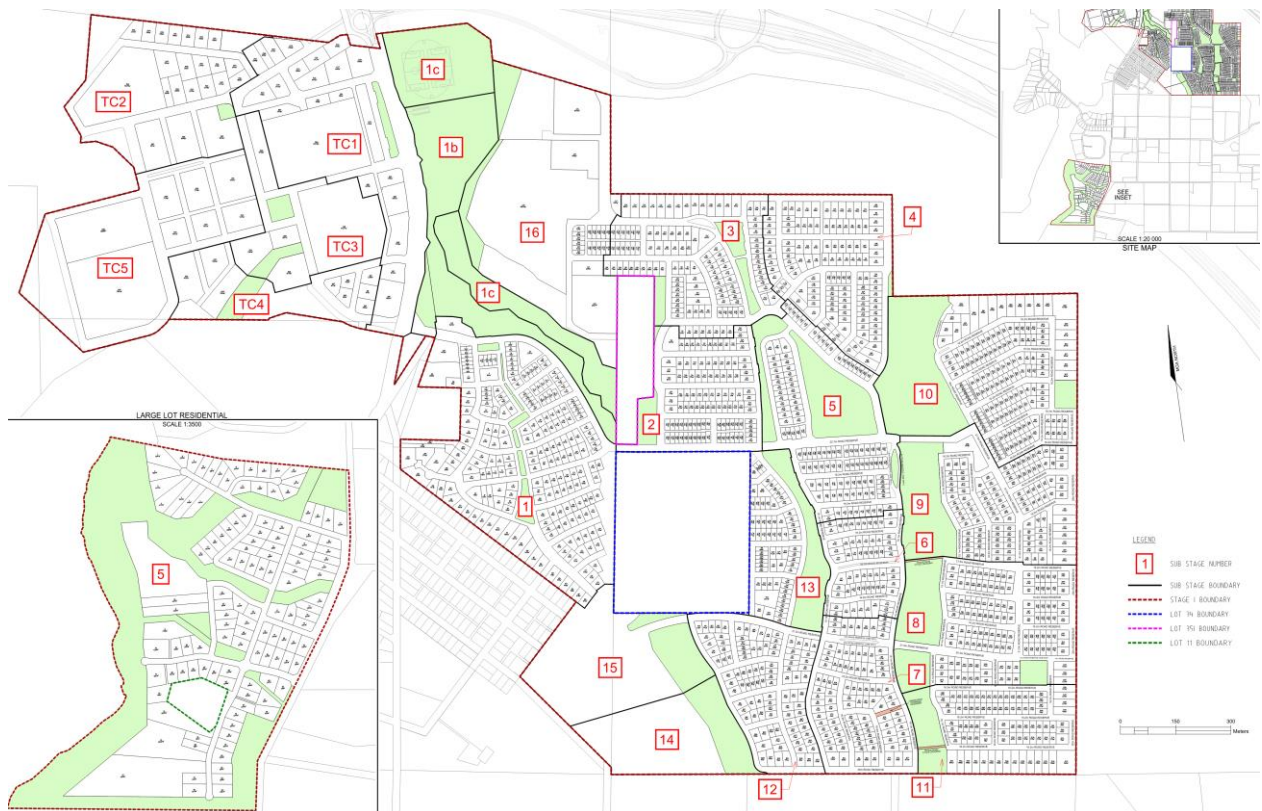


Figure 1: Stage 1 Project Area Current Masterplan Layout

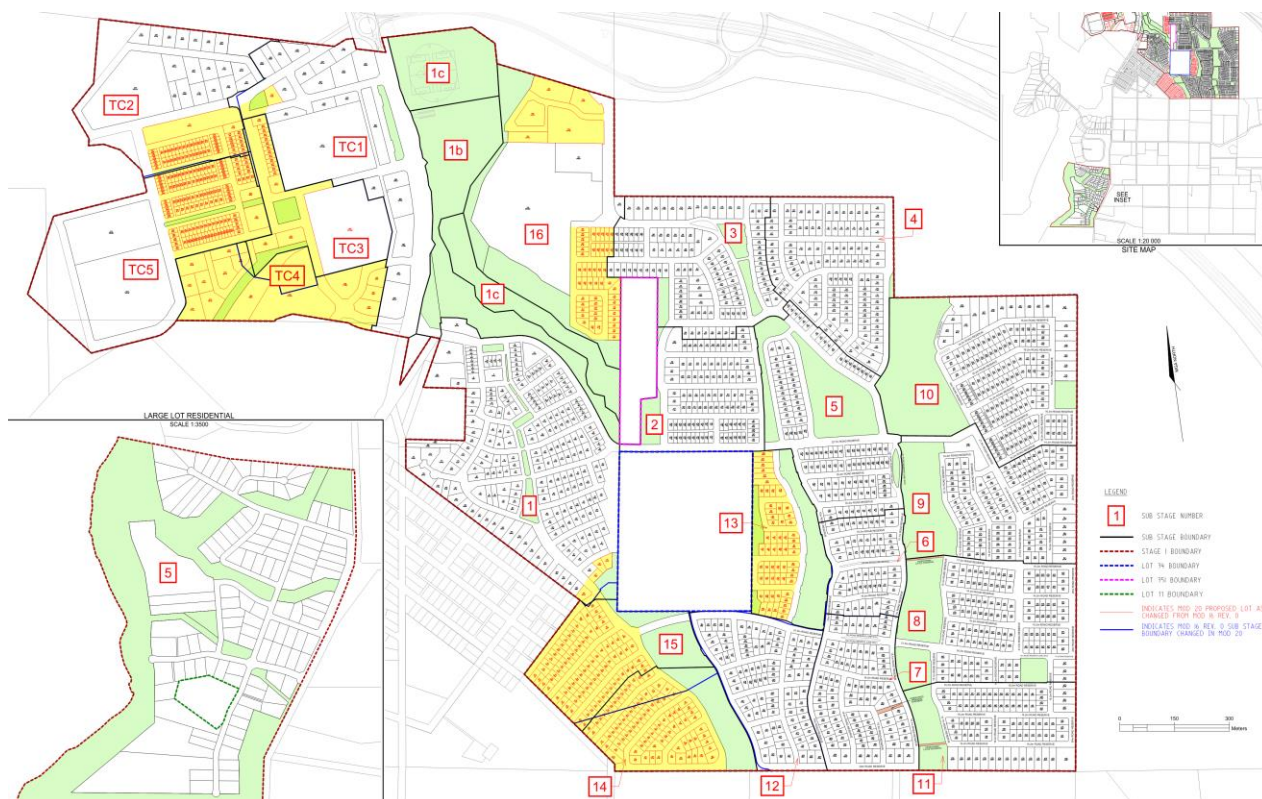


Figure 2: Stage 1 Project Area Masterplan Layout Proposed Under MOD 20

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2. Project Background

2.1 Huntlee Urban Release Area

The Huntlee Project is a major Urban Release Area (URA) in the Hunter region which will provide housing for approximately 20,000 people accommodated within up to 7,300 dwellings. The site covers approximately 1609ha and incorporates land designated for both urban and conservation purposes.

The site is located 20km north of Cessnock, 25km southwest of Singleton and approximately 500m south of Branxton. Generally, the site is bound by the Main North Railway and Hunter Expressway to the north and east, the existing North Rothbury village to the south and the Black Creek floodplain to the west.

In 2013 the Huntlee Development Control Plan (DCP) was adopted by the Director-General of the Department of Planning and Infrastructure pursuant to the provisions of Section 74C of the Environmental Planning and Assessment Act, 1979 (the Act). Figure 3 below shows an extract from the DCP illustrating the extent of the Huntlee Project Area and respective LGA's.

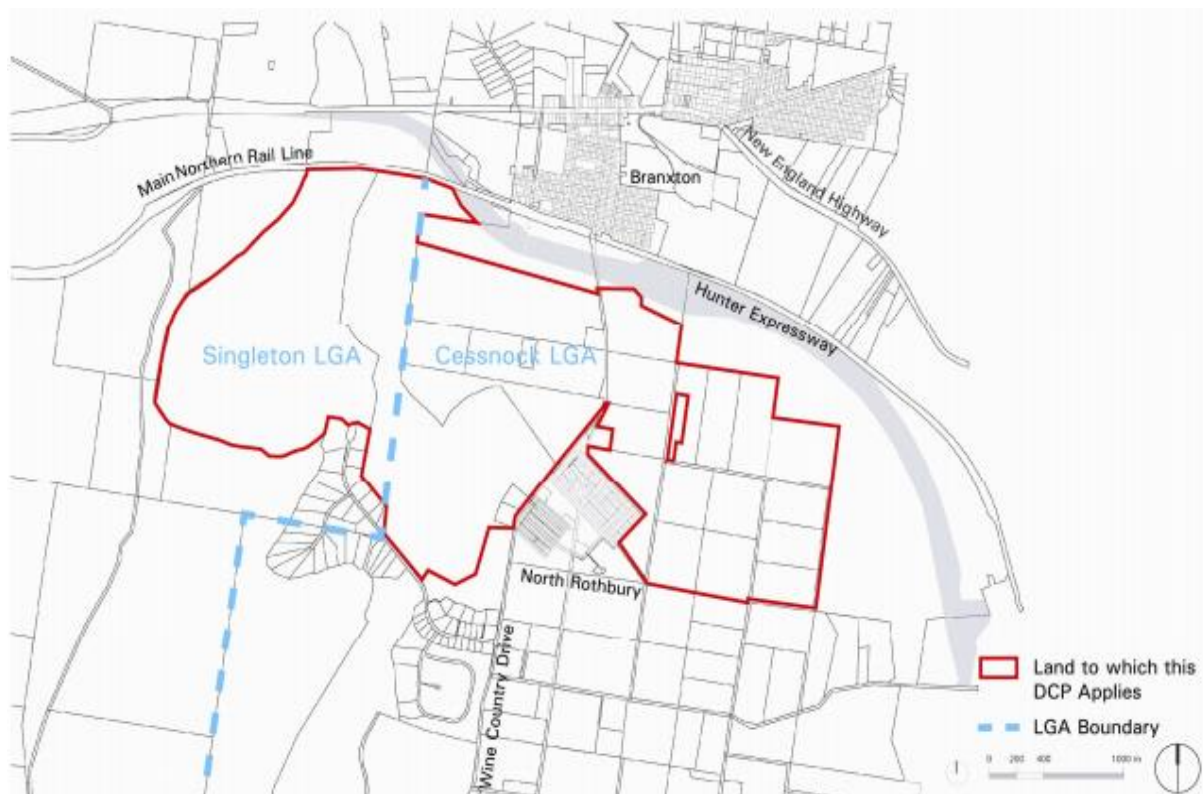


Figure 3: Extract from Huntlee DCP 2013

2.2 Stage 1 Project Area

The Stage 1 Project Area covers approximately 360ha of the Huntlee URA. Stage 1 was granted approval in 2013 and is now well into the construction phase with over 500 dwellings already occupied. The Stage 1 Project Area in context of the overall Huntlee development framework is shown below in Figure 4.

The Stage 1 development includes the first residential village (approximately 1,500 dwellings) extending northeast of the existing North Rothbury township, approximately 50 hectares of the Town Centre, a new school and approximately 120 large residential lots off Wine Country Drive.

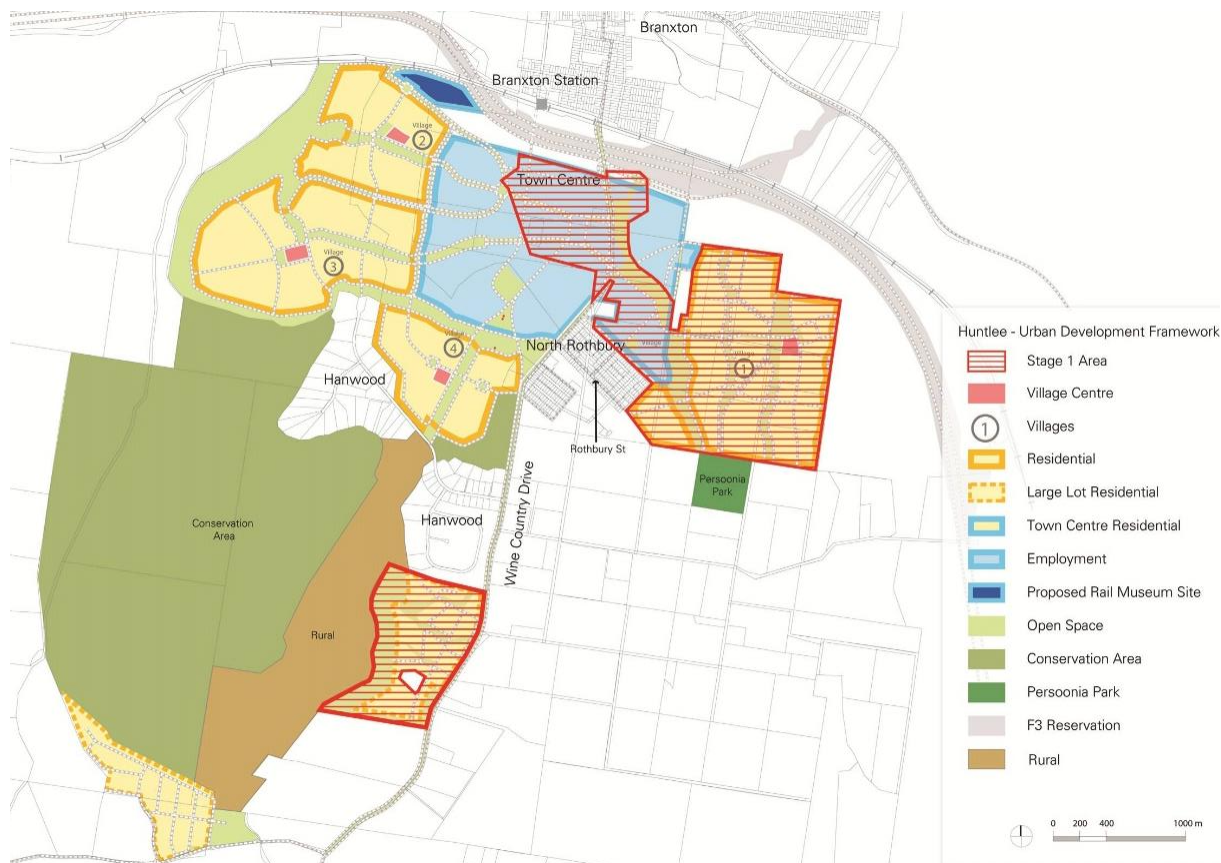


Figure 4: Stage 1 Project Area within Overall Huntlee Development Framework

2.3 Stormwater Management Strategy

Huntlee is located within the catchments of the Black and Anvil Creeks, both of which are tributaries of the Hunter River. Anvil Creek is located to the north-east of the site with two of its minor tributaries extending within the Stage 1 development boundary. In its pre-developed state land within the Stage 1 Project Area consisted mainly of grazing pasture and sparse bushland. The land is characterised by gently undulating slopes with average grades ranging from 5-10%.

Stormwater management for the Stage 1 Project Area was based on the Concept Stormwater Mitigation Strategy prepared by Worley Parsons as presented in the report '*Trunk Stormwater and Flooding Assessment*' published August 2012. The strategy proposed regional online detention basins and offline sub catchment water quality facilities. Figure 5 illustrates the locations of the main regional detention basins proposed under the Original Strategy (WorleyParsons, 2012). As depicted two online regional detention facilities were proposed within the Tributary 2 catchment.

As noted in the introduction all changes to the development layout proposed in this Modification are located in the Tributary 2 catchment.

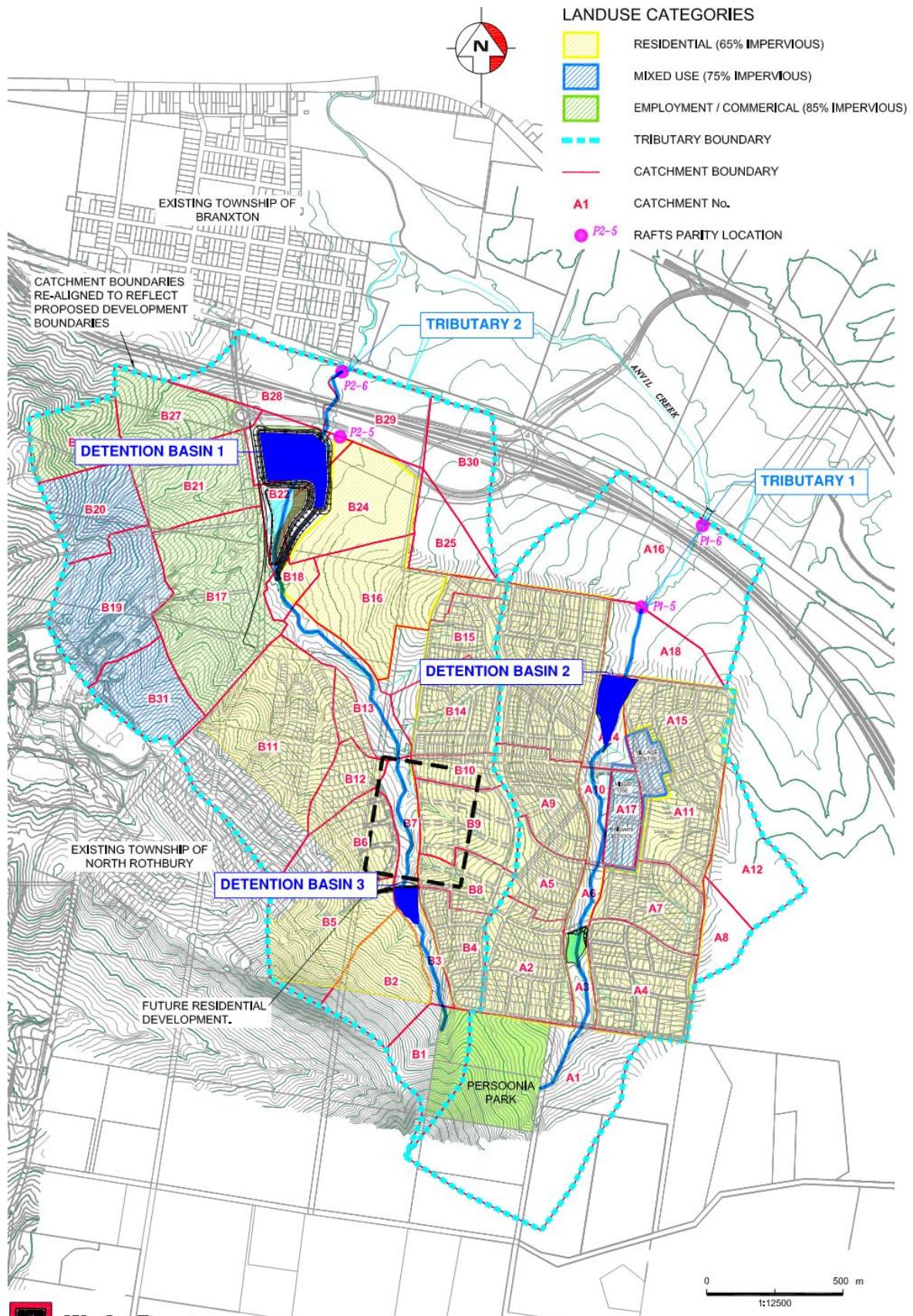


Figure 5: Huntlee Project 'Trunk Stormwater and Flooding Assessment' (Worley Parsons, 2012)

In 2017 Northrop Consulting Engineers were engaged to prepare a catchment and hydraulic analysis for Tributary 2 to progress the detailed design of the regional detention facilities, in accordance with the Stage 1 Development Approval. At the time of writing this report Detention Basin 3 was well into its construction phase with completion anticipated early 2022. Detention Basin 1 is currently progressing through the detailed design phases with construction anticipated to commence by the end of 2022.

2.4 Amendments Proposed Under Modification 20

As noted above, modification 20 proposes amendments across 5 main areas, refer **Error! Reference source not found.** below.



Figure 6: Main Areas of Change Proposed Under MOD 20

The implications of these amendments on stormwater design can be summarised as follows.

- Area 1 – Changes across Area 1 encompass further subdivision of Town Centre Substages 1-5 and transition of a number of allotments from commercial to residential. The approved stormwater strategy has assumed an 85% developed impervious fraction across this area. Ultimately runoff from the impacted sub-catchments will be conveyed east across Wine Country Drive into offline water quality facilities before discharging into Online Detention Basin 1. Adoption of the 85% impervious fraction was intended to represent commercial lots typical of a town centre development. Given all proposed residential lots are less than 400m², retention of the 85% impervious fraction is considered appropriate. As such no changes to the Stormwater Management Strategy are proposed to accommodate layout amendments across Area 1.
- Area 2 – Changes across Area 2 encompass further subdivision of Substage 16. The existing stormwater strategy has assumed an 85% developed impervious fraction across this area to reflect the mix-use zoning. Ultimately runoff from the impacted sub-catchments will be conveyed west into offline water quality facilities before discharging into Online Detention Basin 1. Given no change of use, retention of the 85% impervious fraction has been considered appropriate and no changes to the stormwater strategy are proposed across Area 2.

- Area 3 – Changes across Area 3 also encompass further subdivision of Substage 16. The existing stormwater strategy has assumed a 65% developed impervious fraction across this area to reflect the residential zoning. Ultimately runoff from the impacted sub-catchments will be conveyed west into offline water quality facilities before discharging into Online Detention Basin 1. Given no change of use or increase in development footprint retention of the 65% impervious fraction is considered appropriate and no changes to the stormwater strategy are proposed across Area 3.
- Area 4 – Changes across Area 4 encompass layout amendments across Substages 1 and 13. The existing stormwater strategy has assumed a 65% developed impervious fraction across these areas to reflect the residential zoning. Ultimately runoff from the impacted sub-catchments will be conveyed to offline water quality facilities and offline detention facilities before discharging across the Lot 34 site boundary. Mitigation facilities will be designed to ensure all water quality and quantity objectives are met prior to discharge. Therefore the only update to the stormwater strategy will be the location and size of the end of line facilities now being positioned upstream of the lot 34 site boundary.
- Area 5 – Changes across Area 5 encompass layout amendments across Substage 14 and 15. The approved stormwater strategy has assumed a 65% developed impervious fraction across this area to reflect the residential zoning. Ultimately runoff from the impacted sub-catchments will be conveyed to offline water quality facilities before discharging into Online Detention Basin 3. Again, given no change of use or increase in development footprint no changes to the stormwater strategy are proposed across Area 5.

As such the only significant deviation included in Modification 20 when compared to the Original Report (WorleyParsons, 2012) is the incorporation of stormwater management devices specifically for Substage 13 (refer Figure 2) which will remain upstream of lot 34. This is due to this substage draining directly into land held under separate private ownership that will not be developed by Huntlee Pty Ltd. As a result, separate offline mitigation facilities to meet both stormwater quality and quantity requirements at the boundary of Substage 13 are proposed as part of this Modification. This change has been required as runoff from this substage was not previously addressed by the Original Report (WorleyParsons, 2012).

The sections below intend to outline the updated/refined modelling approach adopted by the current Stormwater Management Strategy for reference when undertaking review of Modification 20. It is noted that the information below is provided for Modification 20 assessment purposes only and will be further refined and assessed as part of the Detailed Design and Construction Certificate approval process.

Specifically, the below aims to detail how modelling has been used to:

- Calculate catchment runoff and peak flow rates in the pre- and post-developed scenarios. 2D modelling in line with AR&R2019 is proposed as opposed to 1D AR&R1987 methodologies which the existing approval is based. This is to bring the Strategy in line with current industry best practice.
- Determine the detention volumes required to ensure no worsening upstream or downstream impact using updated stormwater modelling practices.
- Confirm flood inundation extents to inform spatial planning and future on lot development using updated stormwater modelling practices.
- Assess the effectiveness of the proposed treatment train to meet pollutant removal efficiency targets to mitigate impacts upon downstream environments using updated stormwater modelling practices and having due regard for updated topography / catchment extents.

3. Methodology

This report has been split into two major sections: one for Water Quantity and the second for Water Quality. The study methodology for each section is summarised below.

3.1 Water Quantity

Stormwater quantity modelling has been prepared using the XP-STORM hydrological and one-dimensional hydraulic software package, featuring the two-dimensional TUFLOW hydrodynamic engine.

The water quantity investigation has adopted the following methodology:

- Desktop review of previous investigations and available information including design plans, LiDAR and survey data, stormwater infrastructure information and land use classifications.
- Preparation of an Existing Case one-dimensional XP-STORM hydrological and 1D hydraulic model.
- Modification of the Existing Case one-dimensional XP-STORM hydrological and 1D hydraulic model to include the proposed development.
- Design of stormwater detention basins to limit developed case peak flow discharge to pre-developed levels
- Conversion of the Existing and Developed Case XP-STORM models to a combined 1D/2D hydrological and hydraulic model to confirm design flood levels and extents.
- The results of the assessment are presented herein including flood depth and elevation figures.

The XP-STORM model setup, parameters and results are presented in the Water Quantity section of this report.

3.2 Water Quality

Stormwater quality modelling has been performed using the Model for Urban Stormwater Conceptualisation (MUSIC). The proposed strategy is based on the NSW MUSIC Modelling Guidelines (BMT WBM, 2015) and was developed through the following methodology.

- Desktop review of available information including previous reports prepared for the study area.
- Delineation of water quality catchments and land use based on the masterplan layout and site grading.
- Development of a MUSIC model and inclusion of current best practice stormwater treatment devices in accordance with the latest NSW MUSIC Modelling Guidelines (BMT WBM, 2015);
- Review the performance of the proposed treatment train strategy with respect to Council's pollutant removal efficiency targets outlined in the Huntlee DCP 2018.

The MUSIC model setup, parameters and results are presented in the Water Quality section of this report.

4. Water Quantity

3.1. Hydrological Model Parameters

Stormwater modelling for Tributary 2 has been updated using the XP-STORM hydrological and one-dimensional hydraulic software package, featuring the two-dimensional TUFLOW hydrodynamic engine. The following provides a summary of the parameters used in the development of the one and two-dimensional models.

The Laurenson hydrological model, coupled with the Initial and Continuing Loss model has been used for this study. As per the latest AR&R 2019 guidelines, initial loss, continuing loss, pre-burst rainfall and storm burst rainfall portions of the design storm events have been considered as part of this study as shown in the below Figure 7.

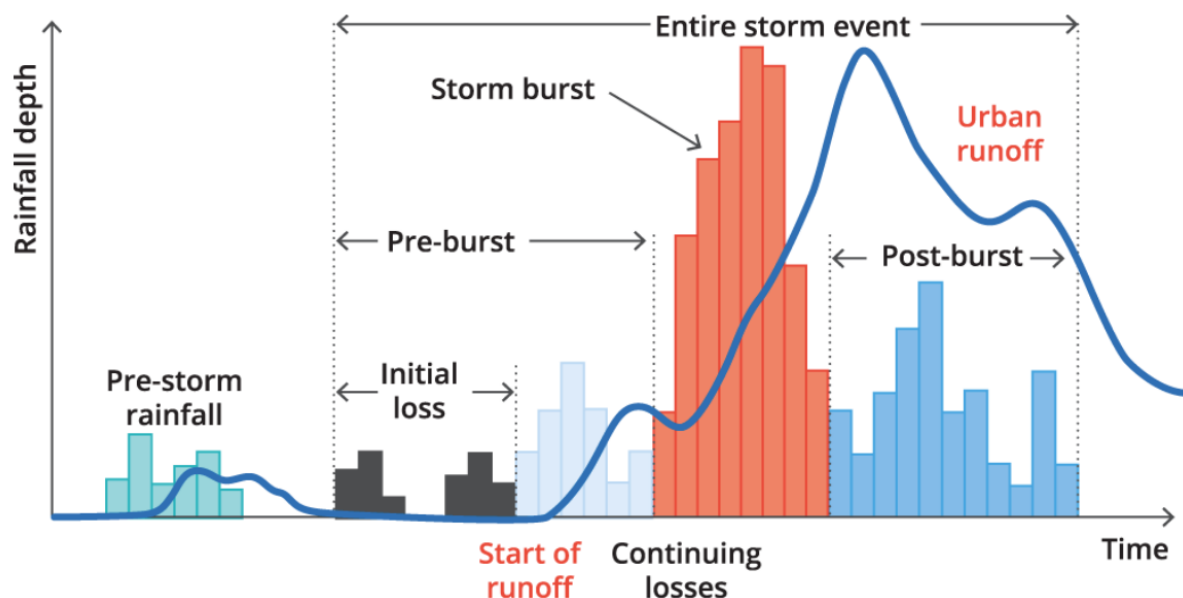


Figure 7: Rainfall Runoff in Urban Catchments (ARR 2019 Figure 9.6.4)

The input data for the Laurenson hydrological model used in this study includes sub-catchment data, design rainfall, temporal patterns, pre-burst rainfall and the initial and continuing losses. These are summarised in the report sections below.

It is noted that Tributary 2 is included as part of the Greta Flood Study (WMA Water, 2019). A similar modelling methodology has been adopted herein with exception of the use of the Median Pre-Burst Depths as discussed below.

4.1.1. Sub-Catchment Properties

Sub-catchments have been digitised using a combination of LiDAR, aerial imagery, design drawings and design surfaces. Sub-catchments are shown in **Figures A1** and **A2** of Appendix A. The following Table 1 and Table 2 present the existing and developed case catchment properties, respectively.

It is noted that catchments upstream of Lot 34 have been assumed existing as part of the regional modelling. This has been performed assuming detention, which limits developed case runoff to pre-developed conditions, will be proposed upstream of Lot 34.

In accordance with the assumptions made by the regional catchment modelling presented herein, detailed modelling has now been undertaken for Basin 3. This modelling is presented in the Online Stormwater Detention Basin 3 for Huntlee Urban Release Area – Tributary Two report (Northrop, 2021) which confirms the detention is proposed in this area. A copy of the report is provided within Appendix D. At the time of preparation of this study, Basin 3 was under construction.

Table 1: Existing Case Catchment Properties (Refer to Figure A1 of Appendix A)

Catchment Reference	Area (ha)	Impervious (%)	Slope (%)	Catchment Reference	Area (ha)	Impervious (%)	Slope (%)
C01	9.56	0.0	9.9	C22	3.73	0.0	4.9
C02	10.69	0.0	8.9	C23	1.25	60.0	7.3
C03	2.59	0.0	2.2	C24	7.13	18.9	6.0
C04	5.75	0.0	5.2	C25	11.06	0.0	4.9
C05	15.58	5.4	7.5	C26	6.06	15.4	4.7
C06	2.38	60.0	7.7	C27	15.40	0.0	4.9
C07	11.07	0.0	5.6	C28	5.75	0.0	3.2
C08	5.00	0.0	1.7	C29	1.77	24.0	7.6
C09	6.08	0.0	4.7	C30	6.17	0.0	4.9
C10	9.95	0.0	4.2	C31	10.08	0.0	5.4
C11	2.79	0.0	5.5	C32	12.34	0.0	3.9
C12	4.17	60.0	8.5	C33	6.91	0.0	5.0
C13	6.53	0.0	5.3	C34	9.59	0.0	4.4
C14	1.51	0.0	4.7	C35	17.09	12.3	1.1
C15	2.25	0.0	4.1	C36	9.79	0.0	3.9
C16	5.41	60.0	5.7	C37	23.89	0.0	4.1
C17	5.46	0.0	6.0	C38	7.01	0.0	5.1
C18	5.11	0.0	3.7	C39	7.43	23.2	1.4
C19	6.16	0.0	1.3	C40	2.70	5.0	1.1
C20	8.88	0.0	4.6	C41	28.07	20	2.5
C21	10.48	0.0	4.4				

Table 2: Developed Case Catchment Properties (Refer to Figure A2 of Appendix A)

Catchment Reference	Area (ha)	Impervious (%)	Slope (%)	Catchment Reference	Area (ha)	Impervious (%)	Slope (%)
C01	9.56	0.0	9.9	C26	5.88	65.0	4.4
C02	10.69	0.0	8.9	C27	5.16	65.0	4.6
C03	3.15	0.0	2.2	C28	6.53	85.0	3.0
C04	7.63	0.0	5.2	C29	4.23	85.0	6.0
C05	15.74	5.3	7.5	C30	15.30	85.0	4.6
C06	2.38	60.0	7.7	C31	3.39	85.0	5.0
C07	5.52	65.0	5.6	C32	2.47	85.0	4.7
C08	1.87	0.0	2.0	C33	3.04	0.0	1.5
C09	4.42	65.0	4.7	C34	10.53	85.0	3.9
C10	10.11	65.0	4.2	C35	5.89	65.0	4.5
C11	1.73	65.0	5.5	C36	12.49	85.0	4.9
C12	2.07	0.0	1.7	C37	11.38	85.0	4.9
C13	1.83	65.0	5.4	C38	2.78	0.0	1.0
C14	0.84	65.0	1.7	C39	11.03	85.0	5.1
C15	2.47	65.0	5.0	C40	15.16	85.0	3.9
C16	4.17	60.0	8.5	C41	7.19	85.0	5.0
C17	6.78	65.0	5.3	C42	6.13	85.0	4.4
C18	1.56	65.0	3.6	C43	8.88	0.0	1.0
C19	2.61	65.0	2.5	C44	2.97	5.0	1.1
C20	5.41	60.0	5.7	C45	6.48	85.0	5.0
C21	5.78	65.0	6.0	C46	8.60	0.0	5.0
C22	5.19	65.0	3.1	C47	7.01	0.0	5.1
C23	2.88	5.0	4.4	C48	3.35	0.0	3.6
C24	2.86	0.0	1.3	C49	7.43	23.2	1.4
C25	12.02	65.0	4.1	C50	28.07	20.0	2.5

4.1.2. Burst Rainfall

The latest AR&R 2019 intensity-frequency-duration (IFD) rainfall depths have been obtained from the Bureau of Meteorology (BOM) for a location over the subject site. The latest AR&R 2019 temporal patterns for the “East-Coast South” region were applied to the 50%, 20%, 10%, 5% and 1% AEP design storm depths. For this study, storm durations ranging from 10 minutes to 24 hours were considered to determine the critical event.

The Generalised Short Duration Method (GSDM) and procedures outlined in the Publication “*The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method*” (BOM, 2003) were used to develop design storm depths and patterns for the Probable Maximum Flood (PMF). The following Table 3 presents the Intensity-Frequency-Duration (IFD) rainfall depths adopted by the study.

Table 3: Rainfall Intensity-Frequency-Duration Depths

Duration	50% AEP (mm)	20% AEP (mm)	10%AEP (mm)	5% AEP (mm)	1%AEP (mm)	PMP (mm)
10-min	10.8	16.1	19.5	23.1	32.5	N/A
15-min	13.6	20.2	24.5	29	40.8	170
20-min	15.8	23.2	28.1	33.2	46.7	N/A
25-min	17.6	25.6	30.9	36.5	51.1	N/A
30-min	19.0	27.5	33.2	39.2	54.7	240
45-min	22.2	31.8	38.4	45.2	62.4	300
1-hour	24.7	35.0	42.1	49.4	68.0	350
1.5-hour	28.2	39.7	47.7	55.9	76.3	460
2-hour	31.0	43.5	52.1	61.0	83.1	530
3-hour	35.4	49.5	59.3	69.4	94.6	650
4.5-hour	40.7	56.8	68.1	79.8	109	N/A
6-hour	45.0	63	75.8	88.9	123	N/A
9-hour	52.3	73.6	88.8	105	146	N/A
12-hour	58.5	82.5	99.9	118	166	N/A
18-hour	68.3	97.2	118	141	199	N/A
24-hour	76.2	109	133	159	226	N/A

4.1.3. Losses and Roughness

The latest AR&R 2019 storm losses have been used for this study and were obtained from the AR&R Data Hub. Storm losses provided by the ARR Data Hub are intended for rural catchments only and as such have been reduced for the urban areas as summarised in the below Table 4. Raw data provided by the AR&R Datahub is provided in Appendix B.

Table 4: Initial and Continuing Losses

Landuse	Initial Loss (mm)	Contuing Loss (mm/hr)	Roughness
Rural Pervious (ARR Data Hub)	18.0	2.0	N/A
Pervious (Rural)	18.0	2.0	0.050
Impervious (Rural)	10.8	0.8	0.015
Pervious (Urban)	10.8	0.8	0.035
Impervious (Urban)	1.0	0.0	0.015

The latest AR&R 2019 guidelines have also introduced an updated philosophy with respect to modelling urban impervious areas with consideration to Directly Connected and In-Directly Connected Impervious Areas (DCIA & ICIA). Recommendations presented in AR&R 2019 suggests that initial losses for ICIA areas are to consider a reduction factor in the order of 60-80% to represent the potential for additional losses as ICIA areas pass across pervious surfaces. These reduction factors have also been applied to both the impervious (Rural) and Pervious (Urban) portions of the catchment to remain conservative.

The hydraulic roughness values used in this study are also similar to what was used for the existing case catchments in the Original Report (WorleyParsons, 2012).

Initial Losses during the PMF have been reduced to zero, conservatively assuming fully wet antecedent conditions prior to the occurrence of the PMF. Furthermore, the typical Laurenson storage non-linearity exponent of -0.285 was used for the 20% to 1% AEP, however, was modified to -0.001 during the PMF to represent a linear catchment response during extreme events.

4.1.4. Pre-Burst Rainfall

Since the preparation of the Greta Flood Study (WMA Water, 2019) the NSW Office of Environment and Heritage (OEH) commissioned a review of the nationally derived losses and pre-burst for catchments over NSW. As a result, the latest NSW-Specific Transformational pre-burst depths have been used in lieu of the median pre-burst depths considered by the Greta Flood Study (WMA Water, 2019).

The latest NSW-Specific Transformational pre-burst rainfall depths presented in Table 5 below were added to the design rainfall events and distributed evenly over three timesteps prior to the burst of the design storm events. The 60-minute pre-burst rainfall has been used for storm durations less than 60 minutes in accordance with the latest AR&R 2019 guidance.

Table 5: Transformational Pre-burst Rainfall Depths (ARR Data Hub)

Duration	50% AEP (mm)	20% AEP (mm)	10% AEP (mm)	5% AEP (mm)	1% AEP (mm)
1-hour	1.3	6.8	7.1	6.2	11.0
1.5-hour	5.0	8.3	8.1	6.3	9.0
2-hour	0	5.7	7.2	7.4	11.6
3-hour	1.8	6.7	7.9	8.3	12.9
6-hour	3.2	7.4	7.6	9.0	13.7
12-hour	2.8	6.9	7.3	8.3	13.7
18-hour	0.8	5.7	6.3	8.4	14.7
24-hour	0	3.6	4.5	6.0	13.2

The NSW-Specific Transformational pre-burst rainfall depths are used in lieu of directly applying the NSW Probability Neutral Burst Initial Loss. This results in the same rainfall excess being applied to the model as outlined below.

The ARR Data Hub provides NSW-Specific Transformational pre-burst rainfall is added to each storm event over several timesteps prior to the burst. Resultant Probability Neutral Burst initial rainfall losses

are then determined by the difference between the Transformational pre-burst rainfall and the Storm Losses presented in the above Table 5 and Table 4 respectively.

This calculation is summarised overleaf.

$$\text{Burst Initial Loss (Probability Neutral IL)} = \text{Storm Initial Loss (Table 4) - NSW Specific Transformational Pre-burst Rainfall (Table 5)}$$

For example, the NSW Probability Neutral Burst Initial Loss for the 1% AEP - 60-minute storm duration is presented in Attachment B as 7.0mm. This is applied in XP-RAFTS to Rural Pervious catchments through the below equation.

$$7.0\text{mm (Rural NSW Probability Neutral IL)} = 18\text{mm (Rural Storm Loss)} - 11.0\text{mm (Transformational Pre-Burst)}$$

Through this methodology, the NSW Probability Neutral Burst Initial Losses and design storm losses presented in the Greta Flood Study (WMA Water, 2019) have been adopted as part of this study.

4.2. Hydraulic Model

4.2.1. Two-Dimensional Model Grid Extents and Size

A grid size of 3m x 3m was adopted for the two-dimensional model to adequately represent flows over spillways and through overland flow paths. A timestep of one second was used and the model was run of up to three hours for the 20%, 10%, 5% and 1% AEP while a six-hour model run time was adopted for the PMF.

The two-dimensional grid extent is shown in the attached Figures A3 and A4 of Appendix A. The grid extends beyond North Rothbury to the south, follows the Tributary-two creek line and terminates to the north of the Main Northern Railway to the north of the Hunter Expressway.

4.2.2. Terrain

Terrain data used includes a combination of LiDAR elevation data, detailed survey and design surfaces developed using the 12D. Some additional modifications have also been made by manually entering elevation strings and polygons into the XP-STORM software.

Terrain data for the existing and developed case scenarios are presented in Figures A1 and A2 of Appendix A respectively.

4.2.3. Boundary Conditions

Flows derived from the 1D network have been applied directly to the two-dimensional grid via a series of one-dimensional nodes.

An outlet head boundary has been entered in the two-dimensional model approximately 35m downstream of the Main Northern Railway as shown in Figures A5 and A6 of Appendix A. A “free outfall” tailwater condition has been considered for all events with the greatest tailwater control for the basin expected to be derived by the capacity of the culverts and spill elevation of the WCD Link Road/ Hunter Expressway as well as the Main Northern Railway.

4.2.4. Catchment Roughness

Catchment roughness was based on a review of hydraulic literature, aerial imagery and observations made during a site visit. Figure A3 of Appendix A presents the catchment roughness and values adopted for the Existing case while Figure A4 presents the values adopted for the developed case scenario.

4.2.5. Hydraulic Structures

Existing case hydraulic structures are based on the information provided in the aforementioned studies and design plans and are presented in Figure A5 of Appendix A. These hydraulic structures are also summarised in the following Table 6.

Table 6: Existing Case Culverts (Refer to Figure A5 for Locations)

Location	Type/Size (m)	Number of	Upstream Invert (mAHD)	Downstream Invert (mAHD)
Wine Country Drive	1.2m RCP	1	37.75	37.33
Wine Country Drive	0.6m RCP	3	39.80	39.56
Wine Country Drive	0.6m RCP	3	41.45	40.75
Wine Country Drive Link Road	0.6m RCP	3	39.89	38.81
Wine Country Drive Link Road/Expressway	1.8m High x 2.4m Wide RCBC	3	32.64	31.27
Wine Country Drive Link Road	1.05m RCP	1	34.80	34.44
Wine Country Drive Link Road	0.9m RCP	1	47.75	47.28
Main Northern Railway	1.5m High x 1.7m Wide Arch	1	30.242	30.092
	2.0m CMP	1	30.777	30.630
	0.9m RCP	1	30.244	30.092

Similarly, the developed case hydraulic structures are presented in Figure A6 of Appendix A. These hydraulic structures are summarised in Table 7 below. Overflow spill weir properties for the developed case scenarios are also summarised in Table 7 below.

Table 7: Developed Case Culverts (Refer to A6 for Locations)

Location	Type/Size (m)	Number of	Upstream Invert (mAHD)	Downstream Invert (mAHD)
Wine Country Drive	0.825m RCP	1	47.69	43.73
Wine Country Drive	1.05m RCP	1	40.32	38.60
	0.675m RCP	1	40.32	38.84
Wine Country Drive	1.2m High x 2.1m Wide RCBC	1	37.63	36.60
Wine Country Drive	1.65m RCP	1	38.37	36.60
Triton Boulevard	0.6m RCP	3	39.89	38.81
Splitter (Pond)	1.2m High x 1.5m Wide RCBC	1	38.30	37.90
Splitter (Detention)	1.2m High x 2.7m Wide RCBC	2	38.78	38.6
Retention Pond	0.9m RCP	5	35.80	35.60
Detention Basin	1.2m High x 3.0m Wide RCBC	1	34.60	33.90

Table 8: Developed Case Weir Properties

Location	Length (m)	Elevation (m AHD)
Access Track (Splitter)	23.5	41.3
Pond Weir	80	38.0
Detention Basin Weir	30	37.8

4.2.6. Blockage

Blockage has been based on the procedure presented in the latest ARR 2019 guidelines with the exception of varied blockage with respect to return interval. As an alternative the “AEP 5% - AEP 0.5%” grouping has been used for all return intervals. In this case, varying blockage based on return interval is expected to provide little benefit during both the, minor events (i.e. less than the 5% AEP); where a higher blockage is assumed; and significant events (i.e. the PMF) where flows are largely controlled by the Wine Country Drive Link Road and the Hunter Expressway.

Given the proposed culverts are online, there is the potential for blockage at the upstream locations to influence flows at the downstream infrastructure. Noting that there are two critical design locations namely, the access track and the detention basin, the following three blockage scenarios have been considered.

- Design Scenario 1 – Worst Case Downstream Pre to Post Comparison:
 - 0% blockage on Basin outlet.

- 0% blockage on Splitter culvers.
- Design Scenario 2 – Detention Basin Design Blockage:
 - 15% blockage on Basin outlet.
 - 0% blockage on Splitter culvers.
- Design Scenario 3 – Access Track/ Splitter Design Blockage:
 - 0% blockage on Basin outlet.
 - 15% blockage on Splitter culverts.

The results for each of the three above design blockage scenarios have been combined to produce an envelope of all blockage scenarios.

Zero percent blockage has been considered for existing and previously designed culverts (i.e. the Wine Country Drive Link Road/ Expressway and Triton Boulevard culverts) to avoid artificial detention throughout the catchment.

4.2.7. Critical Duration

Storm durations ranging from the 10-minute to 24-hour duration have been considered for the 20% to 1% AEP design storm events. All ten temporal patterns for each storm duration have been considered with the “Ensembles in Hydrology and Hydraulics” methodology discussed in ARR 2019 used for this study.

For the 20% AEP to the 1% AEP design storm events, a minimum of the top three critical duration ensembles identified across the catchment, as determined by the one-dimensional model were then passed into the two-dimensional model. The durations that produced the largest median peak flow value and water levels were considered the critical ensemble.

For the PMF, all events ranging from the 15-minute to 6-hour duration were modelled in the two-dimensional model.

4.3. Results

4.3.1. Critical Duration

The ensembles that were passed to the two-dimensional model for each blockage scenario are summarised in the below Table 9. It is noted that all ten temporal patterns for each duration have been passed into the two-dimensional model.

Table 9: Critical Durations Ensembles Passed to the Two-Dimensional Model

Ensemble	20% AEP (mm)	10% AEP (mm)	5% AEP (mm)	1% AEP (mm)
1	45-minute	45-minute	45-minute	25-minute
2	1-hour	1-hour	1-hour	45-minute
3	1.5-hour	1.5-hour	1.5-hour	1-hour
4	N/A	N/A	N/A	1.5-hour

The results presented herein are an envelope of the duration ensembles presented in Table 9 above that produced the maximum median result. An envelope of the results for the PMF have also been presented herein.

4.3.2. Existing Case Flood Behaviour

The existing case model setup is presented in Figure A3 and A5 of Appendix A. Existing conditions are based on pre-2014 catchment conditions where upgrades to Wine Country Drive and development in the upper reaches of the catchment (other than North Rothbury) have not yet been introduced. The Hunter Expressway and Wine Country Drive Link Road have been included in the existing scenario.

The existing case flood depth and elevation contours for the 20%, 10%, 5%, 1% AEP and PMF design storm events are presented in Figures C1 to C5 of Appendix A. Flows derived by the upstream catchment travel in a northerly direction through Tributary-two and towards Wine Country Drive Link Road and the Hunter Expressway.

During events up to and including the 1% AEP, flows travel beneath Wine Country Drive Link Road and the Hunter Expressway via three 1.8m high x 2.4m wide Reinforced Concrete Box Culverts (RCBC). Runoff then continues in a northerly direction before passing beneath the Main Northern Railway through a combination of a 1.5m High x 1.7m Wide Arch culvert, a 2.0m Corrugated Metal Pipe (CMP) and a 900mm Reinforced Concrete Pipe (RCP).

Given the magnitude of flows during the PMF, the capacity of the below ground network beneath Wine Country Drive Link Road/Hunter Expressway and the Main Northern Railway is exceeded, with water levels and peak flows largely controlled by spill over the crest of Wine Country Drive Link Road and the Main Northern Railway.

4.3.3. Developed Case Flood Behaviour

The developed case flood depth and elevation contours for the 20%, 10%, 5%, 1% AEP and PMF design storm events at Basin 1 is presented in Figures D1 – D5 of Appendix A. Similarly, CSK01 presented in Appendix C presents the flood extents through the remainder of Tributary 2.

A summary of peak flood levels at Basin 1 during the 1% AEP are presented in the following Table 10 and Figure D4 of Appendix A respectively.

Table 10 - 1% AEP Modelled Water Levels (Refer to Figures C4 and D4 for locations)

Location	Existing (m AHD)		Developed (m AHD)	
	Median	Maximum	Median	Maximum
Upstream of WCD Link Road	36.13	36.37	35.34	35.49
Detention Basin	-	-	38.40	38.42
Retention Pond	-	-	38.42	38.45
Upstream of Access Track	-	-	41.70	41.73

A comparison of the developed case peak flood levels and the minimum road sag level in Wine Country Drive suggests a minimum of 950mm freeboard is available during the 1% AEP design storm event.

4.3.4. Pre to Post Peak Flow Comparison

A peak flow comparison has been prepared to assess the performance of the proposed detention basins. The 20%, 10%, 5% and 1% AEP results are presented below in Table 11. The comparison is based the peak flows passing through the culverts beneath Wine Country Drive and the Hunter Expressway. The un-blocked scenario has been considered as it is expected to produce the highest peak flow and water level downstream of the proposed basin.

Table 11: Pre to Post Developed Peak Flow Comparison (Unblocked)

Design Storm	Existing		Developed		Difference (m ³ /s)
	Event	Flow (m ³ /s)	Event	Flow (m ³ /s)	
20% AEP	90min_TP2	18.0	90min_TP5	13.6	-4.4
10% AEP	90min_TP7	23.3	90min_TP10	15.8	-7.5
5% AEP	90min_TP7	29.7	90min_TP3	17.7	-12.0
1% AEP	60min_TP2	43.1	60min_TP8	33.6	-9.5

The results of the peak flow comparison suggests the proposed detention basin currently exceeds its requirement to limit developed case runoff to that of the existing case.

4.3.5. Frequent Flows

The Huntlee Stage 1 Subdivision and Works Conditions of approval (MP 10-0137), in particular item C14 - Part D recommends more frequent events such as the 39.4% AEP (or 2yr ARI) design storm event be considered as part of the assessment. Review of more frequent events is important as numerous terrestrial and aquatic life rely on both frequent and infrequent flows to supply and resupply waterways, pools and riffles within natural creeks and fluvial floodplains.

To maintain the natural drainage regime during the 39.4% AEP, the access track, proposed as part of the Ultimate Scenario, has been designed to split high and low flows between the Retention/Detention facilities. The intent of the splitter is to direct frequent flows from the upstream catchment into the downstream reaches of creek rather than being contained within the proposed retention pond. As such, flows less than or equal to the 39.4% AEP are directed through the detention basin and downstream rather than through the retention pond.

A comparison of the peak flow through the downstream culverts beneath Wine Country Drive and the Hunter Expressway during the 39.4% AEP is presented in Table 12 below. The results demonstrate that the existing case flows during the 39.4% AEP can be maintained post-development.

Table 12 - Comparison of the 39.4% AEP Peak Flow at the Culverts Beneath WCD and the Hunter Expressway

Design Storm	Existing		Developed		Difference (m ³ /s)
	Event	Flow (m ³ /s)	Event	Flow (m ³ /s)	
39.4% AEP	90min_TP8	10.95	90min_TP5	9.97	-0.98

Although the developed case peak flows during the 39.4% AEP may be less than that of the existing case, the introduction of impervious surfaces has the potential to change the volume of flow discharging downstream. As such, a comparison of the hydrographs for the critical existing case

event (i.e. the 90-minute Temporal Pattern 8) during the 39.4% AEP is shown in Figure 8 below. The comparison has been reported at the location through the culverts beneath Wine Country Drive and the Hunter Expressway.

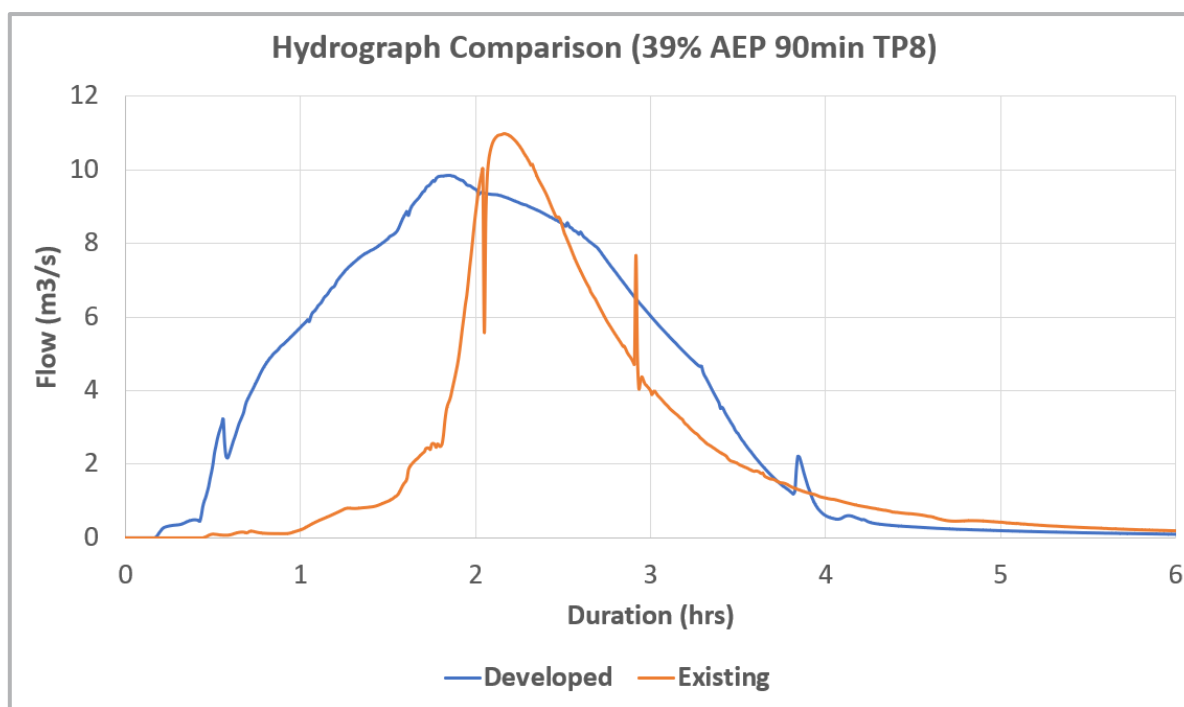


Figure 8: Comparison of Existing and Developed (Ultimate) Case Hydrographs (39.4% AEP 90min TP8)

Although the peak flow may be less, the hydrographs presented in Figure 8 demonstrate a much wider hydrograph shape during the developed case suggesting the volume of runoff is larger than that of the existing case. A direct comparison of the volume of runoff for the critical existing case event has also been prepared as shown in Table 13 below. The results are consistent with the observations made in Figure 8 whereby, Table 13 shows an increase in the volume of runoff discharged downstream. As a result, the volume of runoff provided to re-stock the downstream waterways, pools and riffles is expected to be maintained.

Table 13: Comparison of the 39.4% AEP Runoff Volume Through the Culverts Beneath Wine Country Drive and the Hunter Expressway

Design Storm	Existing		Developed		Difference (%)
	Event	Volume (m ³)	Event	Volume (m ³)	
39.4% AEP	90min_TP8	48,760	90min_TP8	81,060	+66.2%

It is noted that water quality devices have been assumed full prior to the occurrence of the storm burst presented in the above results. This is considered a reasonable assumption particularly with the flow systems reticulation network introduced across the Huntlee URA, negating the requirement for re-use tanks, as well as the potential for wet antecedent conditions, such as those presented as "Pre-Storm Rainfall" in Figure 7 above.

The results presented above suggest that the existing case peak flow conditions can be maintained post-development while, no loss in the volume of runoff released downstream is expected during the 39.4% AEP design storm event.

4.3.6. Detention Volume

A comparison between the detention volume presented in the Original Report (WorleyParsons, 2012) and the currently proposed detention volume is presented in the below Table 14. As previously mentioned, the design for Basin 3 has not been performed as part of this investigation with the volume extracted from the Online Stormwater Detention Basin 3 for Huntlee Urban Release Area – Tributary Two report (Northrop, 2021).

Table 14: Detention Volume Comparison

Scenario	WorleyParsons (2012) (m ³)	Northrop (m ³)	Difference (m ³)	Difference (%)
Basin 1	71,000	77,400	+6,400	9.0
Basin 3	10,000	10,500	+500	5.0
Total	81,000	87,900	+6,900	8.5

The results presented in the above Table 14 suggests the current strategy proposes approximately 6,900m³ more detention volume when compared to the Original Report (WorleyParsons, 2012).

The difference is expected to be due to the use of the latest AR&R 2019 data and methodologies as well as some slight amendments to the layout and terrain since the preparation of the Original Report (WorleyParsons, 2012).

It is noted that the volume for Basin 1 is expected to vary as it progresses through the detailed design phases. The intent of the basin is to ensure developed case peak flow does not exceed existing case conditions, generally as presented in Table 11.

The resulting flood extents anticipated across the post developed site following the construction of online detention basins 1 and 3 are illustrated on the figure provided within Appendix C.

5. Water Quality

4.4. Stormwater Quality Philosophy and Targets

In accordance with the mitigation strategy prepared in the Original Report (WorleyParsons, 2012), stormwater quality is proposed to be managed through a treatment train approach to meet pollutant removal efficiency targets outlined in the Huntlee DCP 2018. These targets have been reproduced in Table 15 below.

Table 15: Pollutant Removal Efficiency Targets

Pollutant	Treatment Efficiency Target
Total Suspended Solids (TSS)	85% reduction in pollutant loads
Total Nitrogen (TN)	45% retention of average annual load.
Total Phosphorous (TP)	45% retention of average annual load.

Across the Tributary 2 catchment treatment trains consisting of offline Gross Pollutant Traps (GPT's) and biofiltration basins are generally proposed. The only exception to this is the Town Centre sub-catchments which are to discharge from the GPT's into an offline pond / constructed wetland system east of Wine Country Drive.

4.5. MUSIC Model

To ensure that the Mod 20 layout can still be serviced by the current strategy, Stormwater quality modelling has been undertaken using the Model for Urban Stormwater Improvement and Conceptualization (MUSIC) V6. MUSIC serves as a planning and decision support system that is used to estimate the efficiency of SQIDs at capturing common stormwater pollutants (i.e. Total Suspended Solids (TSS), Total Nitrogen (TN), Total Phosphorus (TP) and Gross Pollutants (GP)) from stormwater runoff. Modelling involves the use of historical or synthesized long-term rainfall data and algorithms that can simulate the performance of stormwater treatment measures to determine stormwater pollution control.

4.5.1. Model Parameters

In order to establish a MUSIC model, rainfall and evaporation records in the vicinity of the Huntlee site were sought. In addition, the catchment had to be categorised based on its final land use.

To develop a model that could comprehensively assess the performance of the proposed stormwater management plan and to be consistent with the Original Report (WorleyParsons, 2012), 6-minute pluviograph data from the BoM station 061174, located in Millfield, was used. As per the Original Report (WorleyParsons, 2012), rainfall between 1969 and 1973 was used for all MUSIC water quality simulations. This period is reported to represent '5 consecutive years of approximate average rainfall'.

Monthly areal potential evapotranspiration (PET) rates for the site were established from PET data provided by the Climate Atlas of Australia (BoM). The monthly average PET adopted by the MUSIC model are shown in Table 16.

The catchment was split into two primary land use categories being 'Residential' to represent the lower density residential areas (65% impervious), and 'Commercial' to represent the higher density commercial areas (75-85% impervious). The upstream catchment to the site was modelled using the 'Revegetated Land' node with a 100% pervious percentage. All public open parklands have also been modelled using the 'Revegetated Land' node with a 10% impervious percentage.

Table 16: Average Evaporation and Potential Evapotranspiration at Huntlee

Month	Average Monthly Evaporation [^] (mm/month)	Areal Potential Evapotranspiration (mm/month)
January	180	170
February	175	140
March	125	130
April	100	90
May	90	65
June	80	60
July	75	50
August	90	70
September	120	90
October	140	120
November	180	150
December	200	165

[^] Evaporation from Class evaporation pan

The Base and Storm Flow concentration parameters for the different land uses have been adopted from the 2015 NSW MUSIC Modelling Guidelines. Parameters for the source node inputs used are summarised in Table 17 to Table 20.

Table 17: Concentration Parameters for TSS (Tables 5-6 and 5-7 NSW MUSIC Modelling Guidelines)

Total Suspended Solids	Concentration Parameter	Residential	Commercial
Base Flow	Mean (log mg/L)	1.20	1.20
	Std Dev (log mg/L)	0.17	0.17
Storm Flow	Mean (log mg/L)	2.150	2.150
	Std Dev (log mg/L)	0.320	0.320

Table 18: Concentration Parameters for TP (Tables 5-6 and 5-7 NSW MUSIC Modelling Guidelines)

Total Phosphorus	Concentration Parameter	Residential	Commercial
Base Flow	Mean (log mg/L)	-0.850	-0.850
	Std Dev (log mg/L)	0.190	0.190
Storm Flow	Mean (log mg/L)	-0.600	-0.600
	Std Dev (log mg/L)	0.250	0.250

Table 19: Concentration parameters for TN (Tables 5-6 and 5-7 NSW MUSIC Modelling Guidelines)

Total Nitrogen	Concentration Parameter	Residential	Commercial
Base Flow	Mean (log mg/L)	0.110	0.110
	Std Dev (log mg/L)	0.120	0.120
Storm Flow	Mean (log mg/L)	0.300	0.300
	Std Dev (log mg/L)	0.190	0.190

Table 20: Rainfall-Runoff Parameters (Table 5-5 NSW MUSIC Modelling Guidelines)

Property	Rainfall-Runoff Parameter	Residential	Road Reserve
Impervious Areas	Rainfall Threshold (mm/day)	1	1.5
	Soil Storage Capacity (mm)	88	88
	Initial Storage (% of Capacity)	25	25
Pervious Areas	Field Capacity (mm)	70	70
	Infiltration Capacity Coefficient –a	180	180
	Infiltration Capacity Exponent –b	3	3
Ground Water	Initial Depth (mm)	10	10
	Daily Recharge Rate (%)	25	25
	Daily Baseflow Rate (%)	25	25
	Daily Deep Seepage Rate (%)	0	0

4.6. Treatment Devices

The following treatment devices have been incorporated into the Tributary 2 model.

- Gross Pollutant Trap (GPT) – The published removal treatment efficiencies for the proprietary GPTs have been utilised within the MUSIC model to simulate the removal of coarse sediment and litter at the end of line locations. Each unit will be required to treat approximately half of the 1EY peak flow rate. The modelling utilises a MUSIC node supplied by Humes for the GPT. Research presented in Australian Runoff Quality (Engineers Australia 2006) suggests that roughly 1m³/ hectare/ year of gross pollutants and sediment could be expected from a typical residential catchment. GPT units have been appropriately selected for each sub-catchment ensuring sufficient storage capacity to allow bi-annual cleanout
- Bio-filtration Basin – Bioretention systems are effective at removing suspended pollutants from stormwater. The stormwater ponds on the surface of the bioretention basin and slowly filters through the soil media. This filter area retains the pollutants through fine filtration, absorption and some biological uptake from plant roots. The soil media also allows for the

growth of plants. Treated stormwater is collected at the base of the system via a network of perforated pipes located within the gravel drainage layer which is then discharged into outlet pits. Parameters for the bioretention basin were adopted in accordance with the “NSW MUSIC Modelling Guidelines” (BMT WBM, 2015).

- Pond / Constructed Wetland – Constructed wetland systems are shallow, extensively vegetated water bodies that use enhanced sedimentation, fine filtration and biological uptake processes to remove pollutants from stormwater. Water levels rise during rainfall events and outlets are configured to slowly release flows, typically over two to three days, back to dry weather water levels. Parameters for the wetland were adopted in accordance with the “NSW MUSIC Modelling Guidelines” (BMT WBM, 2015).

4.7. MUSIC Model Results

The results calculated by the MUSIC model are shown in Table 21 below. The table shows pollutant load and removal efficiencies for the developed site across the entire catchment. As summarised the calculated pollutant removal adequately achieves the targets outlined in the Huntlee DCP 2013.

Table 21: Pollutant Removal Efficiency Results

Parameter	Source Load	Residual Load	% Reduction
TSS (kg/yr)	213000	30300	86
TP (kg/yr)	343	103	70
TN (kg/yr)	2550	1120	56
GP (kg/yr)	38100	858	98

5. Conclusion

With reference to the hydrologic and hydraulic study undertaken it has been demonstrated that the stormwater strategy adequately ensures no net increase in peak flows downstream during storm events up to the 1% AEP.

Through the introduction of two on-line regional detention basins, adverse effects of the proposed development have been mitigated on the downstream properties and regional hydrology. Additional interim basins are expected to be required along the eastern boundary of Lot 34 to ensure peak runoff through the privately owned property are not made worse.

Through the incorporation of offline water quality treatment devices, the impact of development on downstream receiving waters and environments will be mitigated.

The proposed Stormwater & Flood Management Strategy remains generally consistent with the previously approved strategy, presented in the *"Huntlee Project Trunk Stormwater and Flooding Assessment"* prepared by Worley Parsons in 2012. In addition, the proposal fits in with the site wide concepts for the Huntlee development such that spatial, servicing and landscaping requirements can be met.

We trust this meets your requirements, however, should you require anything further, please do not hesitate to contact the undersigned.

Prepared:



Brittany Balcombe

Civil | Environmental Engineer
BEng (Environmental)

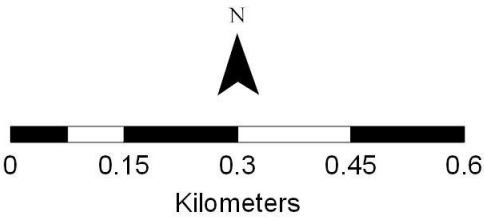
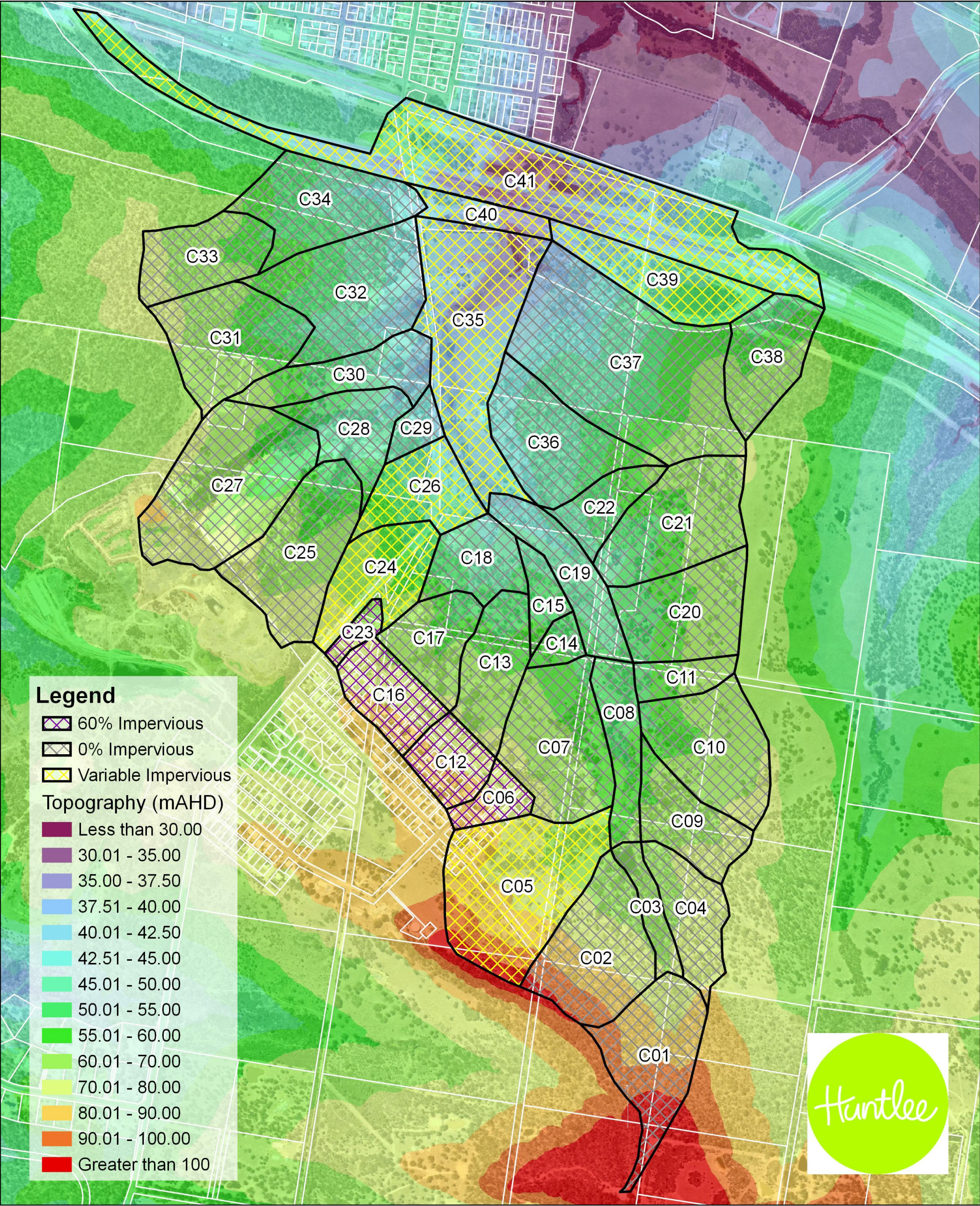
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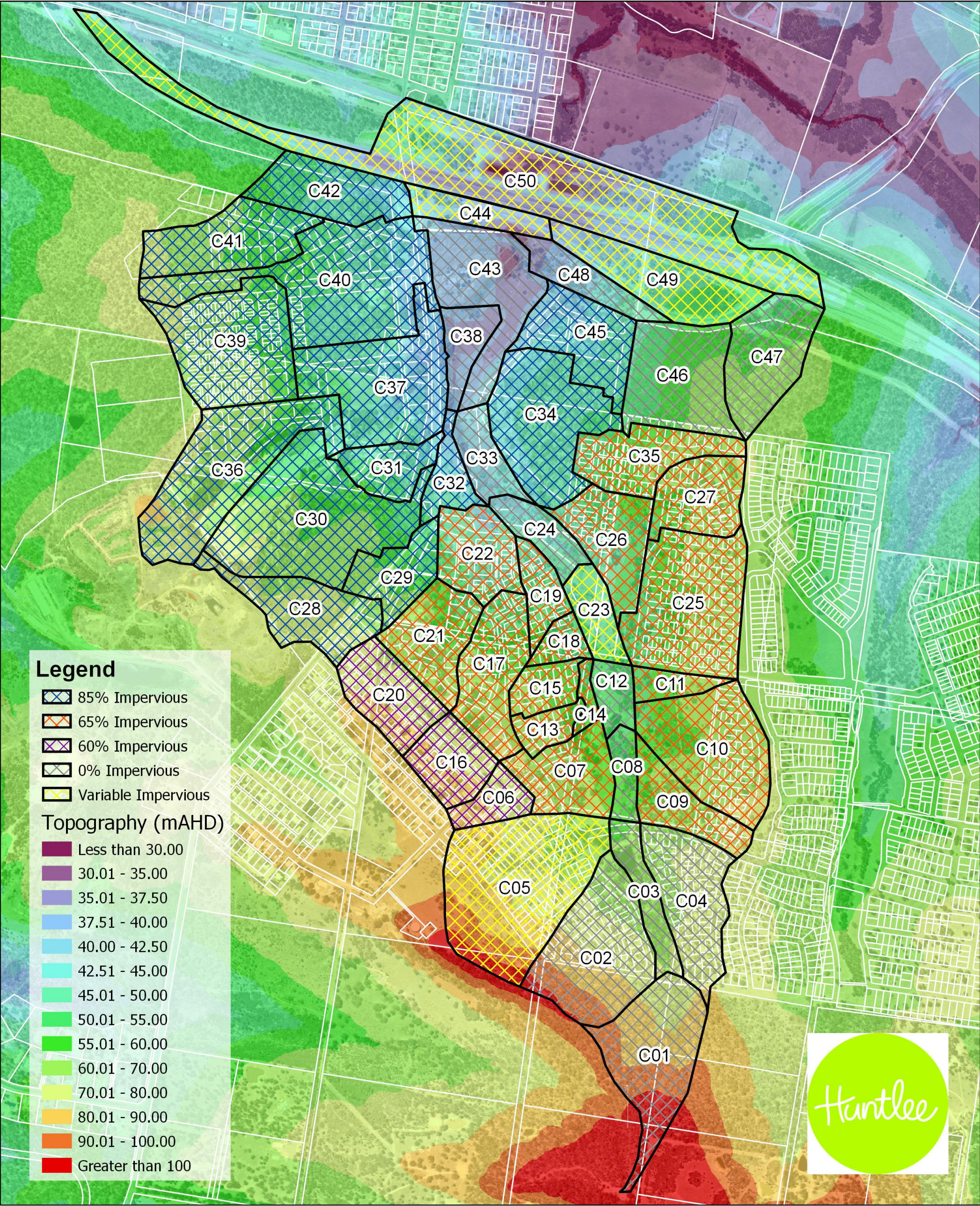
Appendix A – Flood Figures



Huntlee Mod 20 (NL150007)

Existing Scenario
Catchments and Topography

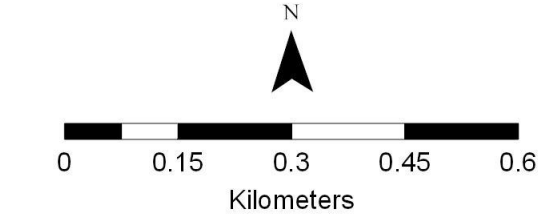
Figure A1 [A]

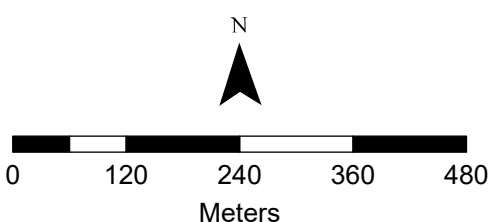
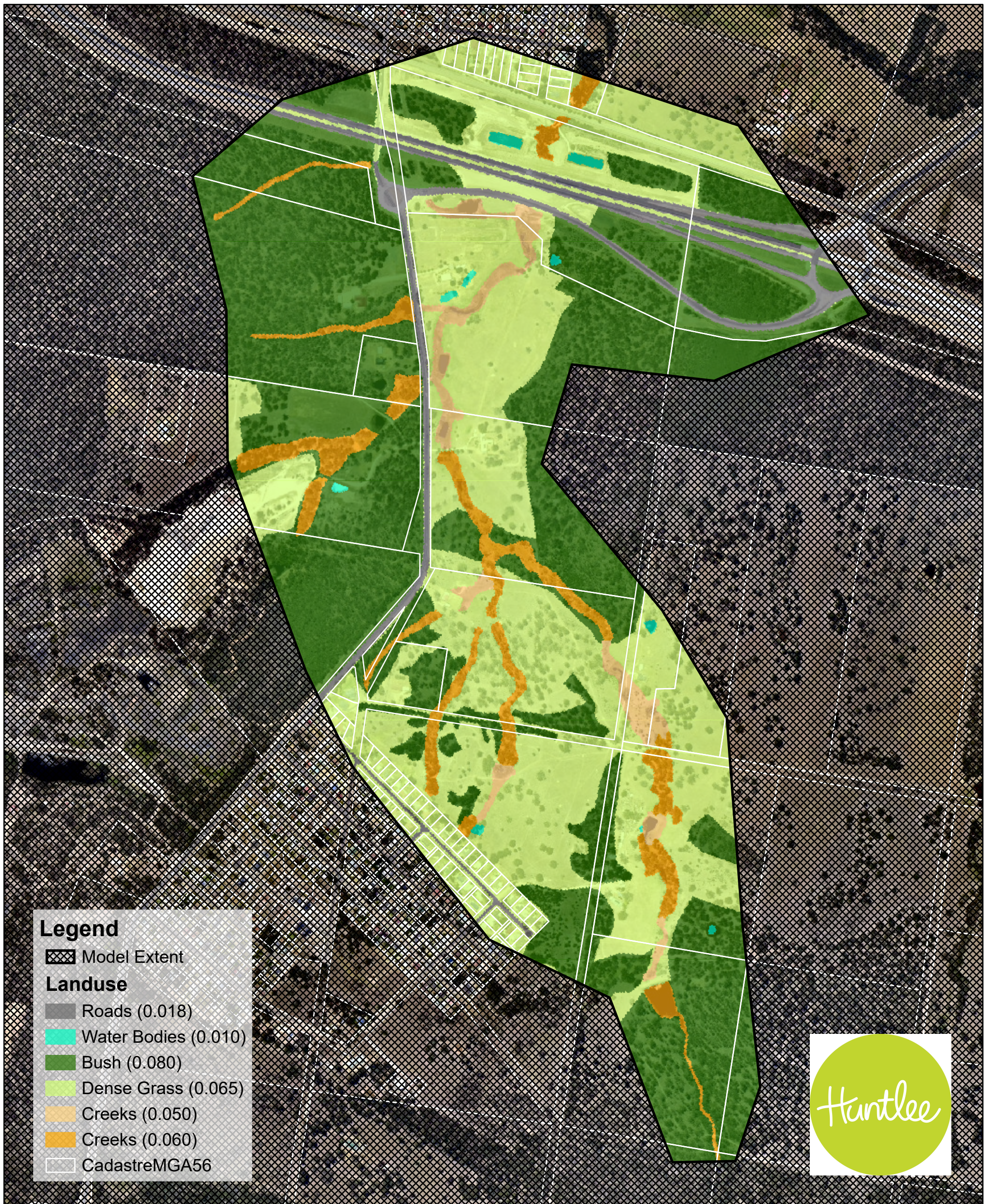


Huntlee Mod 20 (NL150007)

Developed Scenario
Catchments and Topography

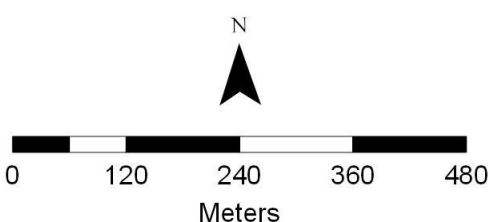
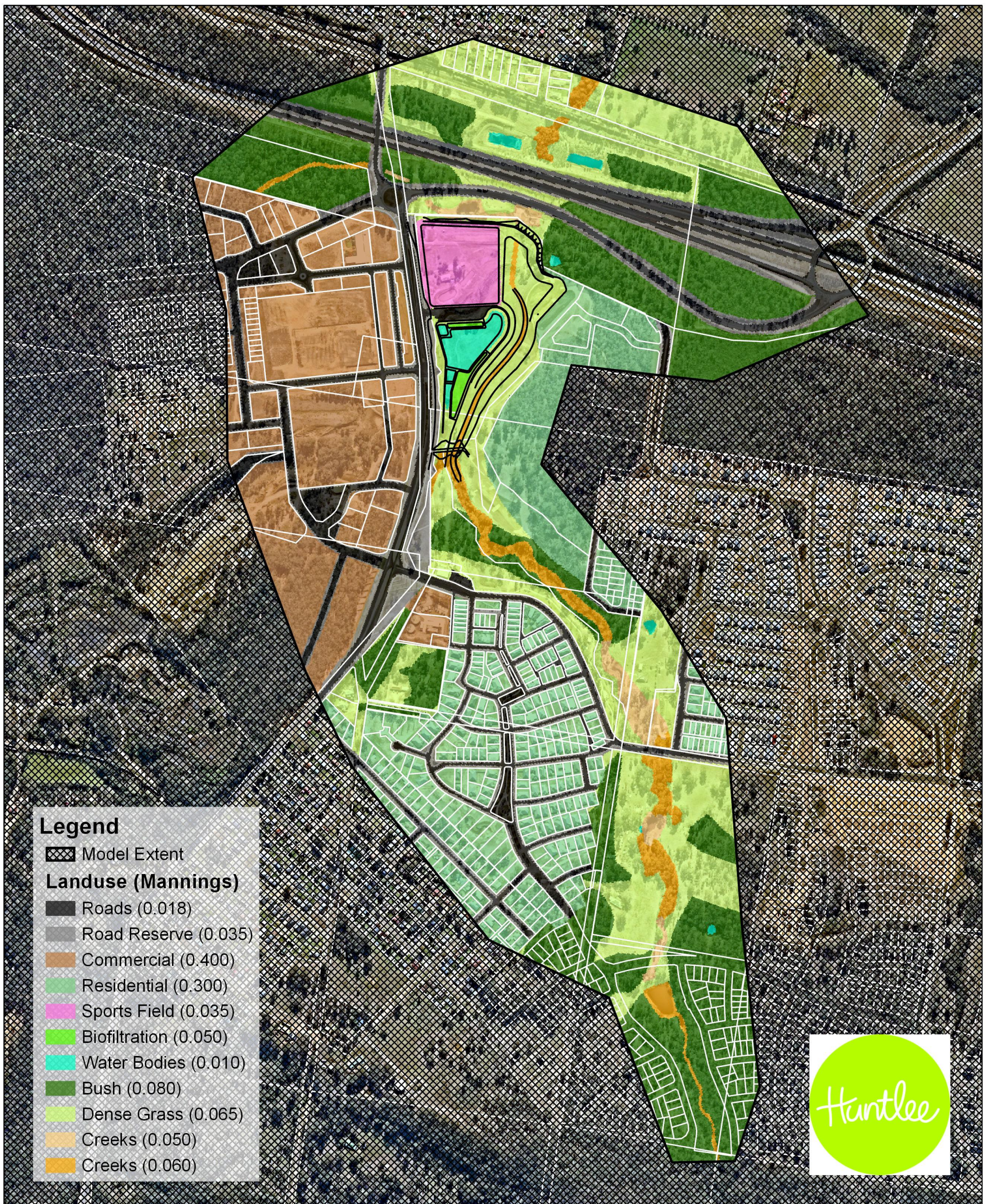
Figure A2 [A]





Huntlee Mod 20 (NL150007)
Existing Scenario
Landuse and Surface Roughness

Figure A3 [A]



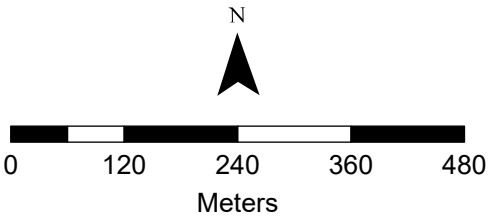
Huntlee Mod 20 (NL150007)
Developed Scenario
Landuse and Surface Roughness

Figure A4 [A]



Legend

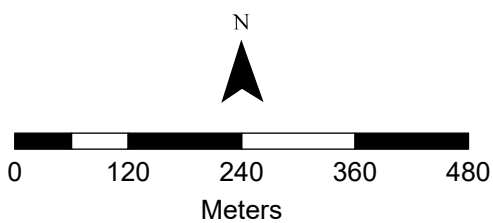
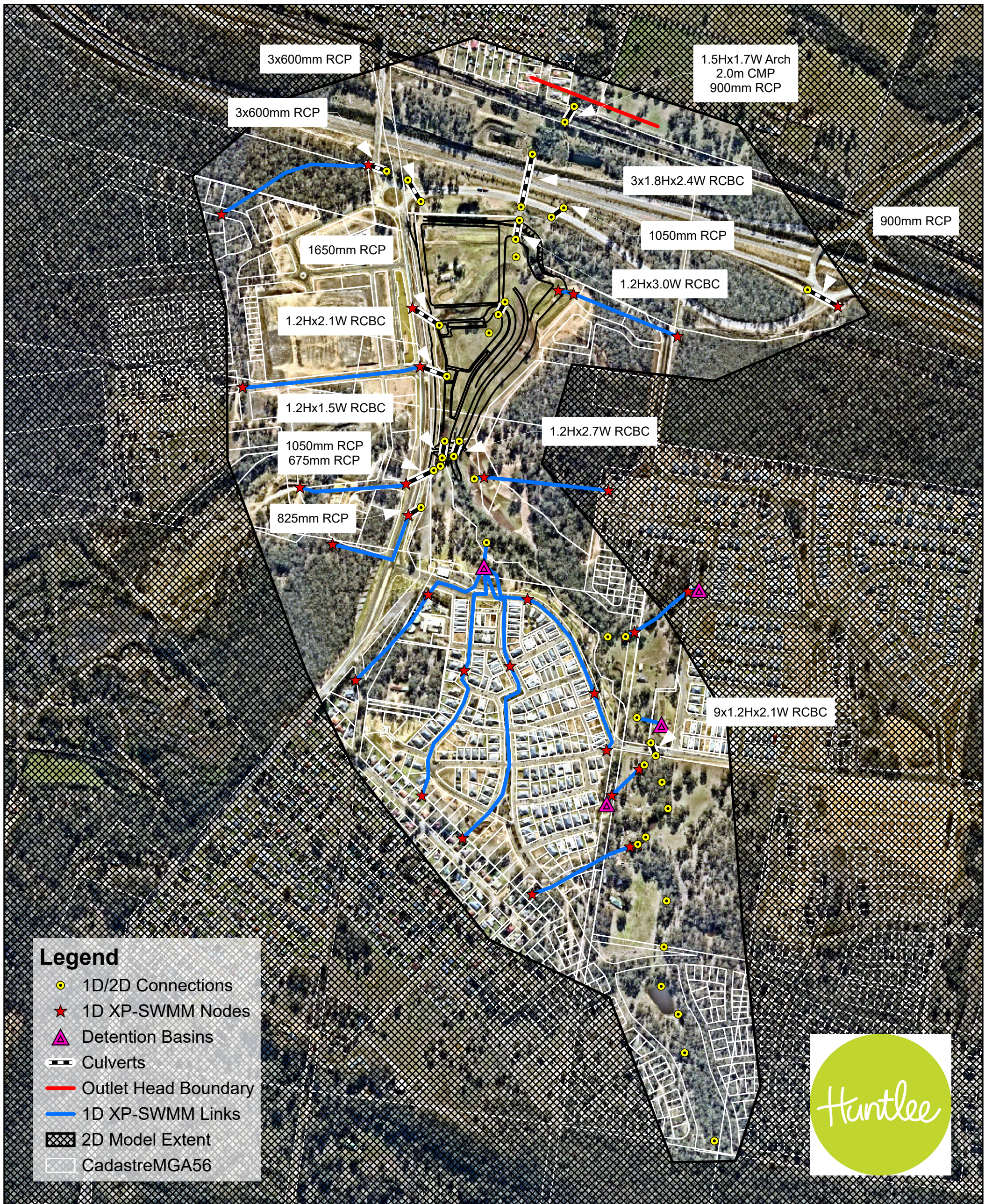
- 1D/2D Connections
- ★ 1D XP-SWMM Nodes
- Outlet Head Boundary
- 1D XP-SWMM Links
- Culverts
- ▨ 2D Model Extent



Huntlee Mod 20 (NL150007)

Existing Scenario
1D/2D Model Setup

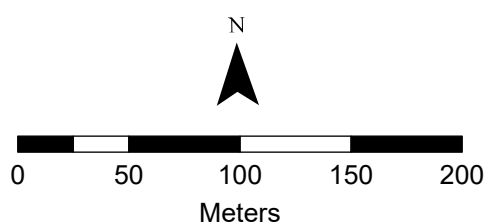
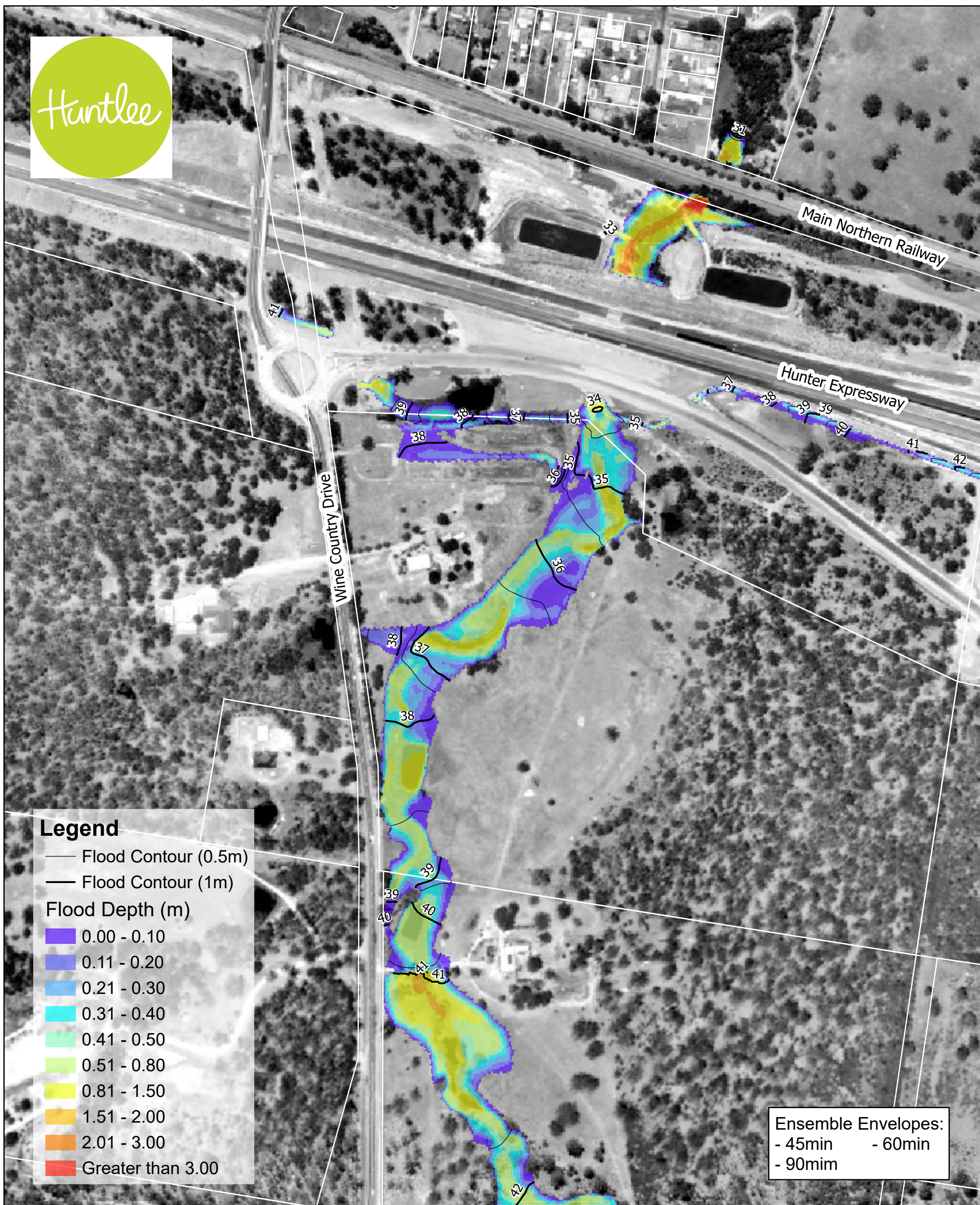
Figure A5 [A]



Huntlee Mod 20 (NL150007)

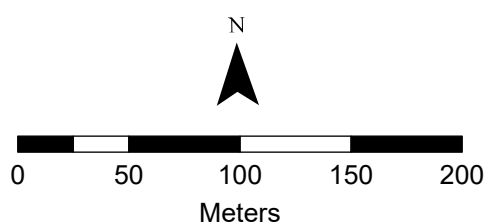
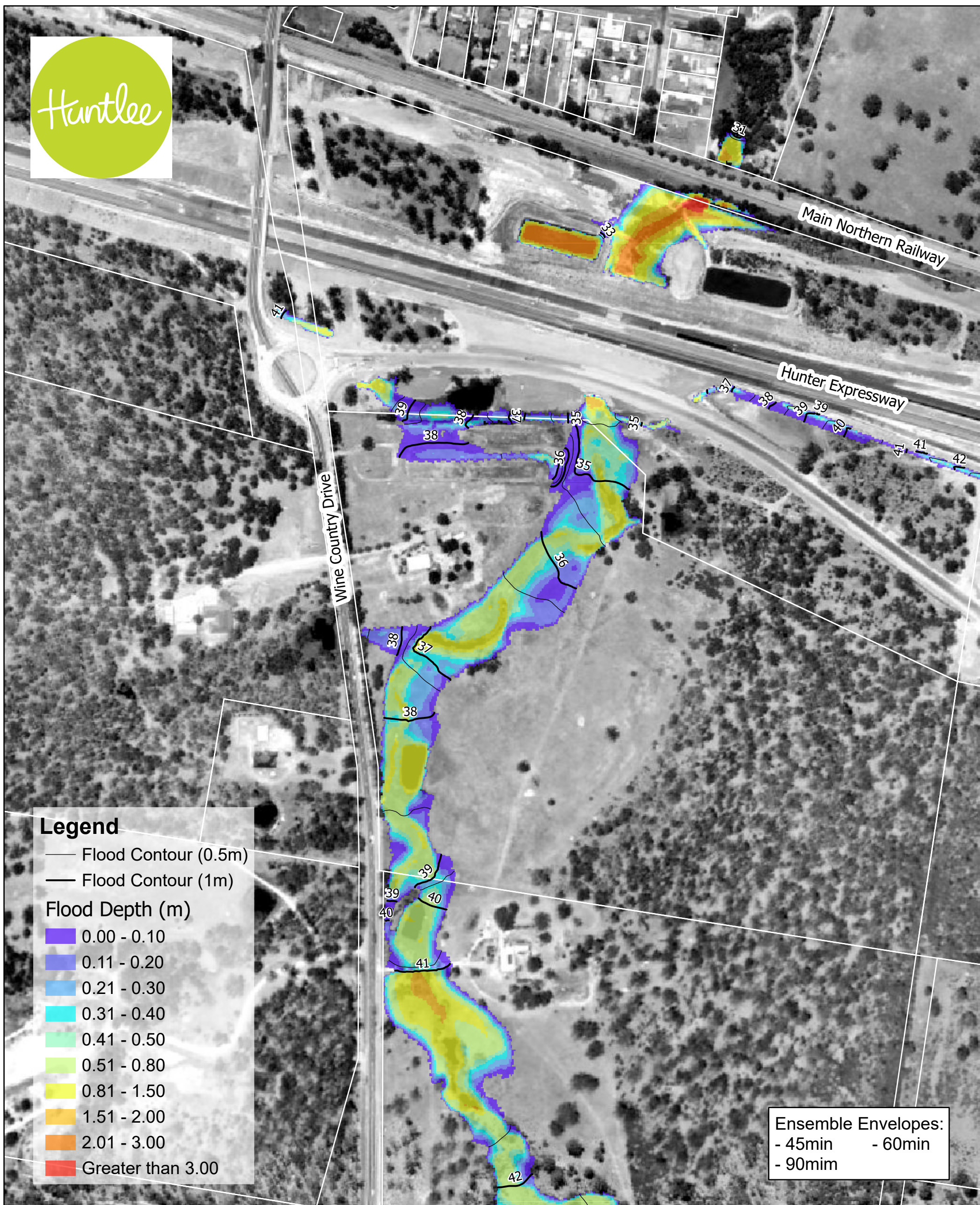
Developed Scenario
1D/2D Model Setup

Figure A6 [A]



Huntlee Mod 20 (NL150007)
 Existing Scenario
 20% AEP Flood Depth and Elevation

Figure C1 [A]

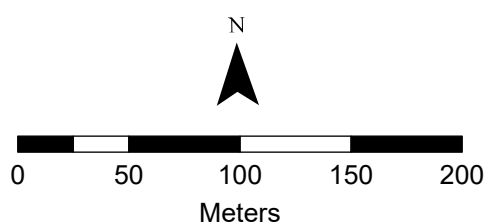
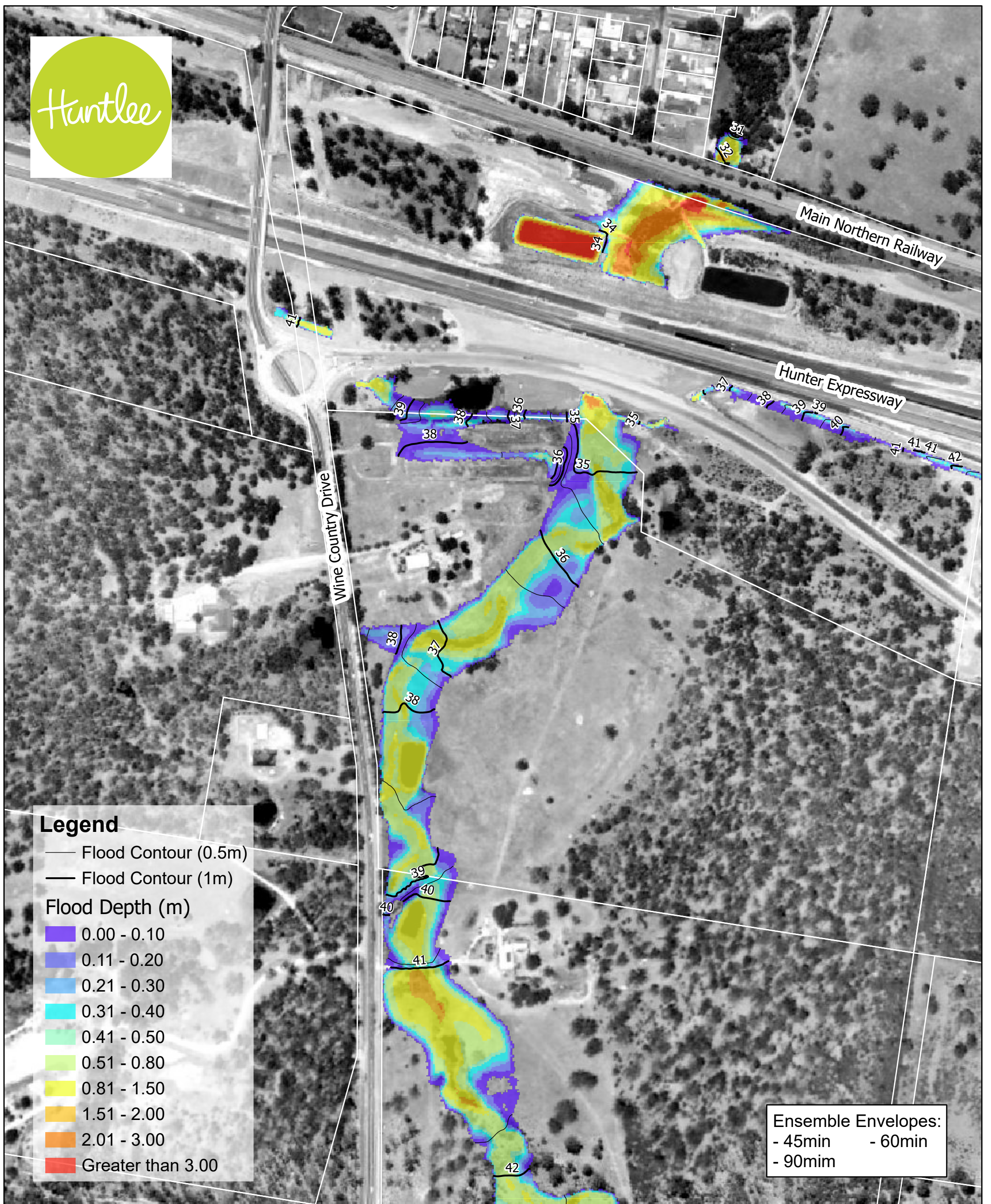


Huntlee Mod 20 (NL150007)

Existing Scenario

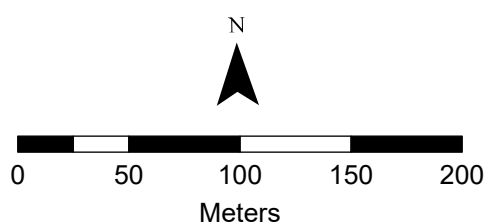
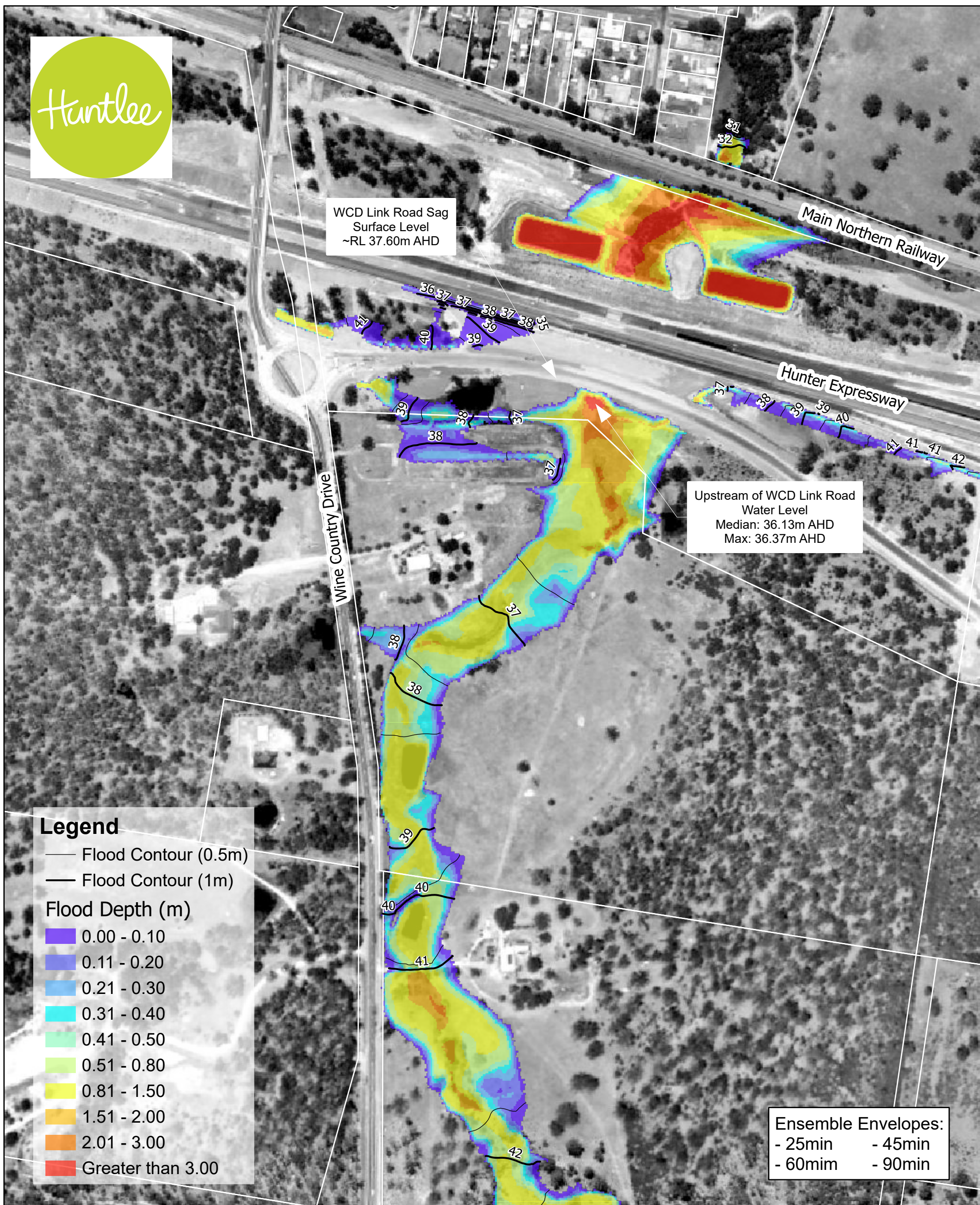
10% AEP Flood Depth and Elevation

Figure C2 [A]



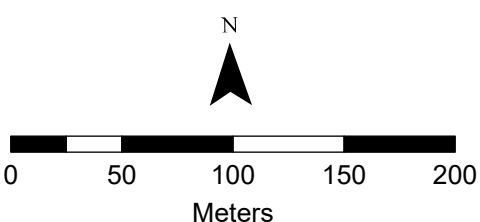
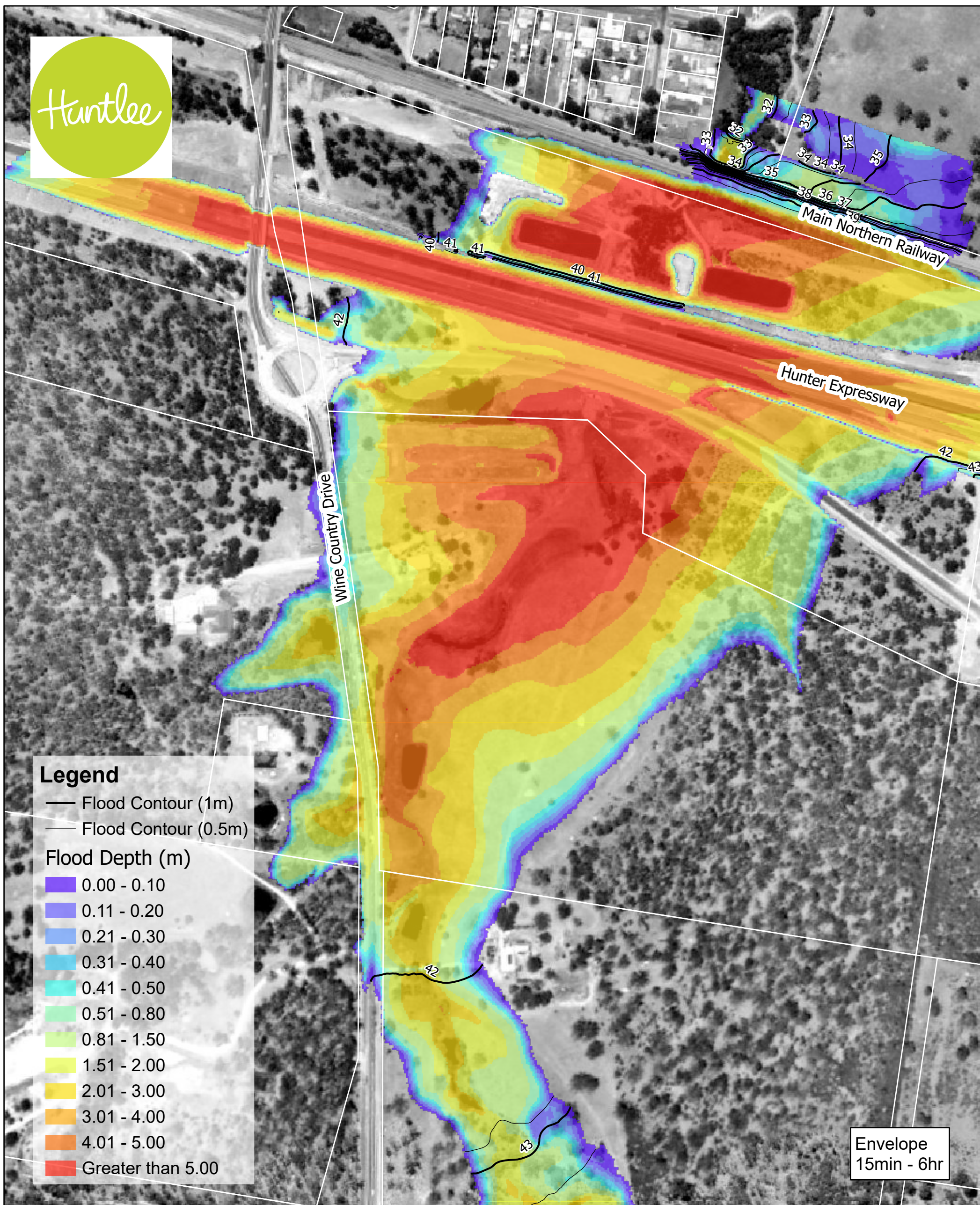
Huntlee Mod 20 (NL150007)
 Existing Scenario
 5% AEP Flood Depth and Elevation

Figure C3 [A]



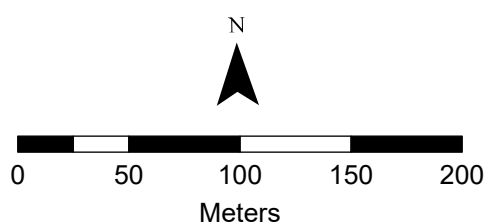
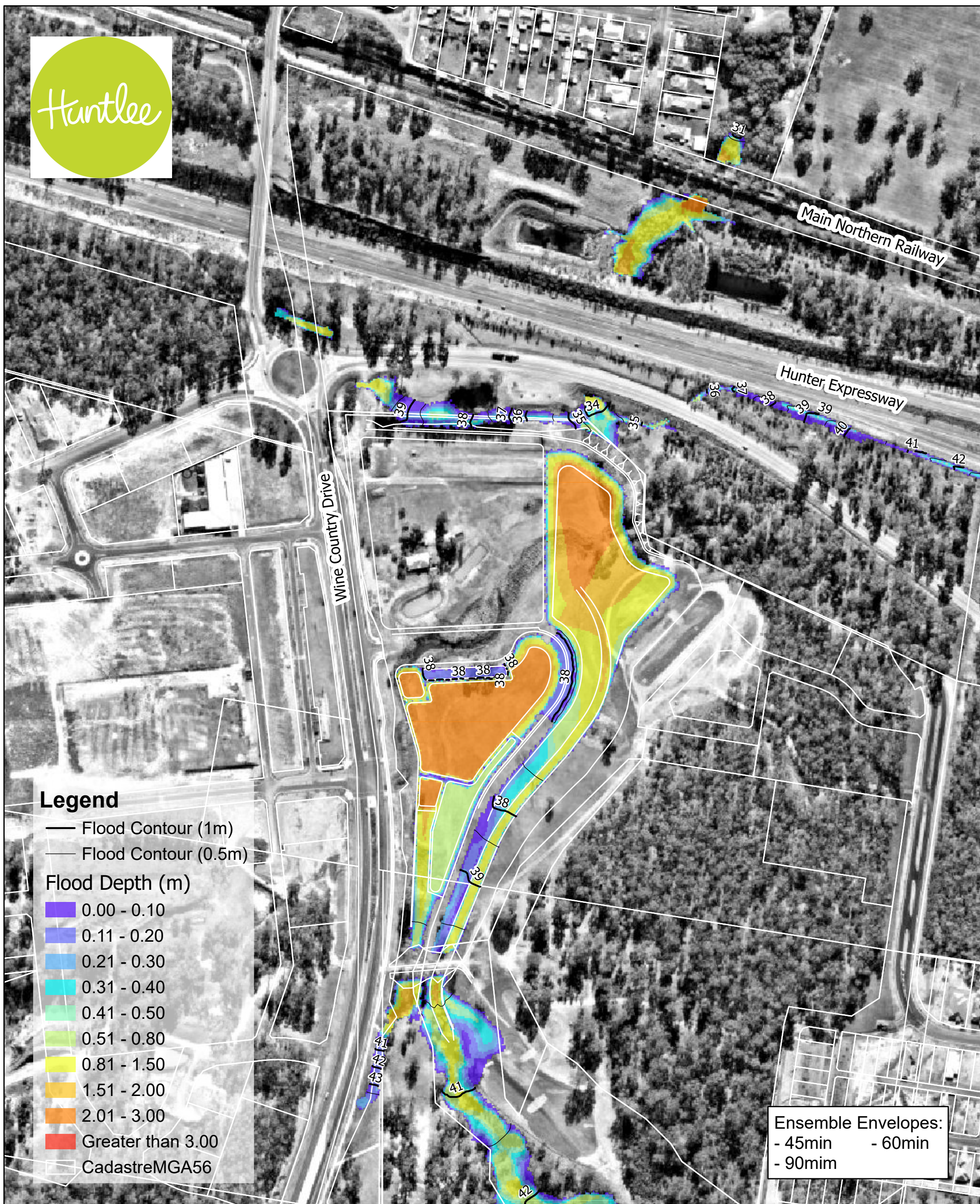
Huntlee Mod 20 (NL150007)
Existing Scenario
1% AEP Flood Depth and Elevation

Figure C4 [B]



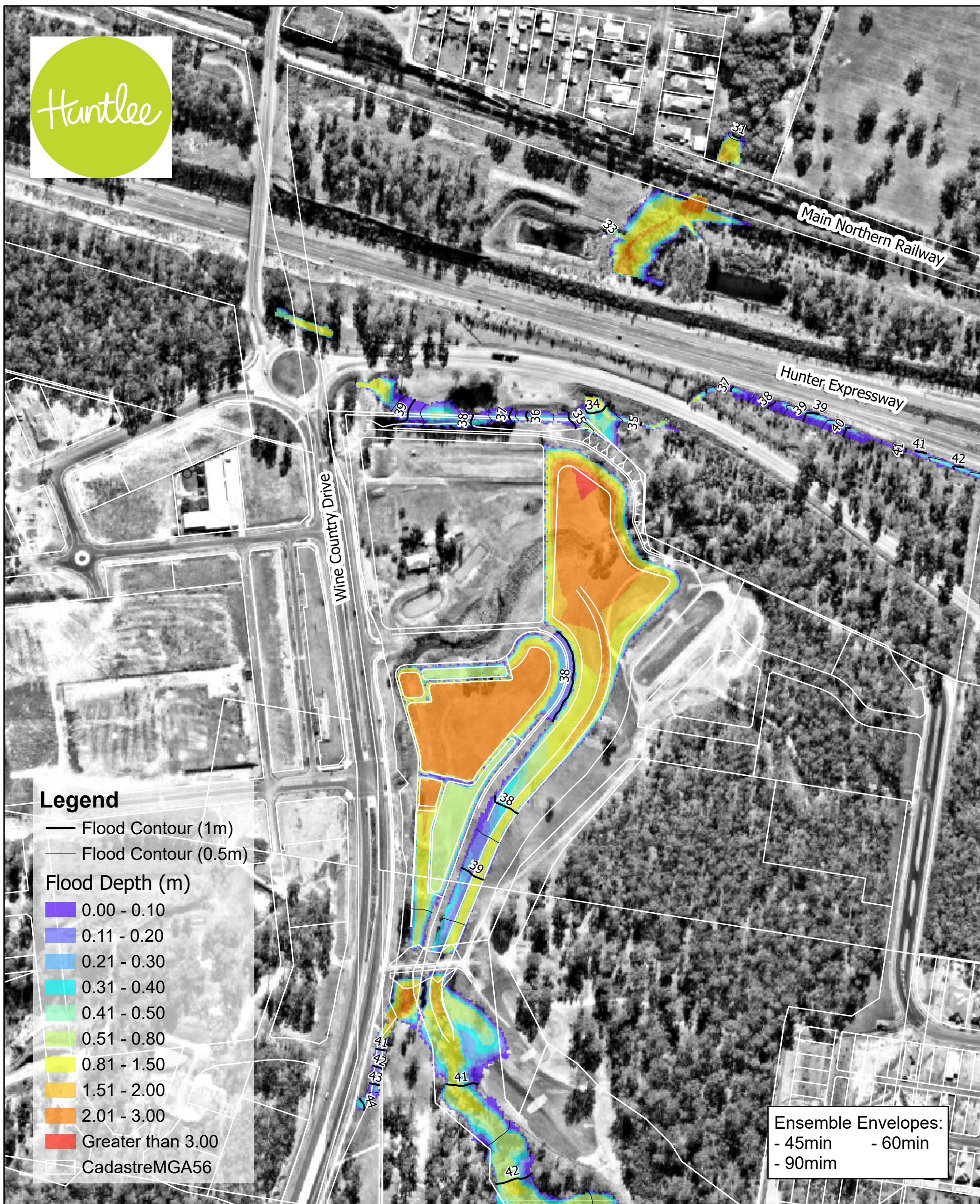
Huntlee Mod 20 (NL150007)
Existing Scenario
PMF Flood Depth and Elevation

Figure C5 [A]



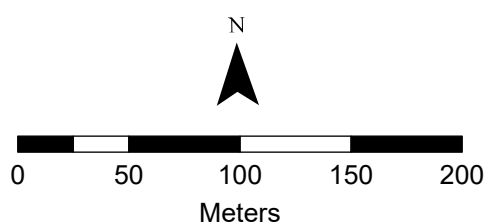
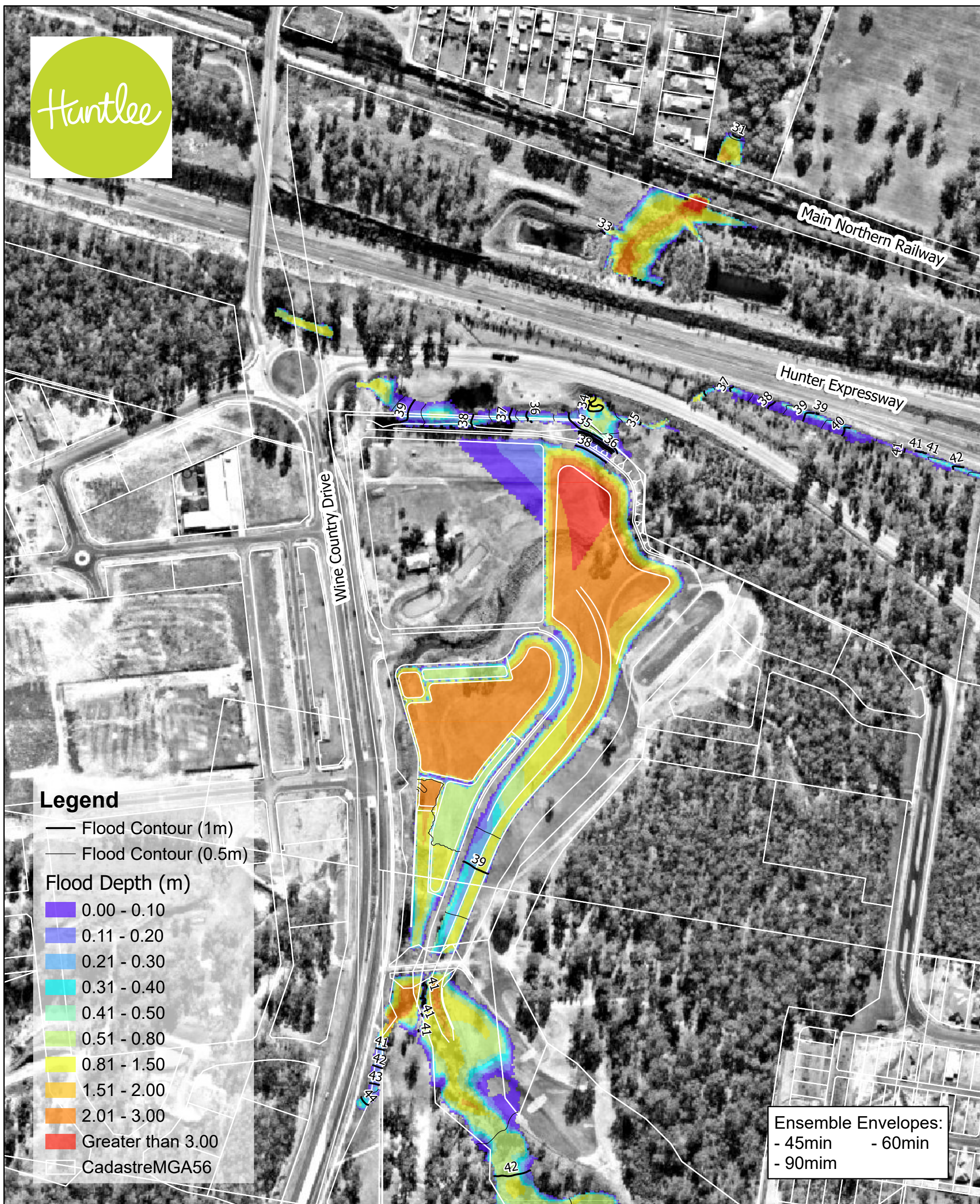
Huntlee Mod 20 (NL150007)
 Developed Scenario
 20% AEP Flood Depth and Elevation

Figure D1 [A]



Huntlee Mod 20 (NL150007)
Developed Scenario
10% AEP Flood Depth and Elevation

Figure D2 [A]

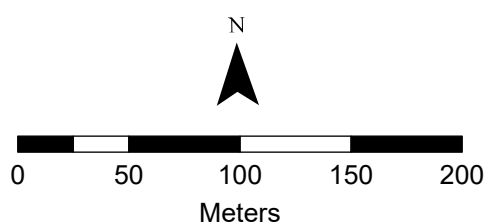
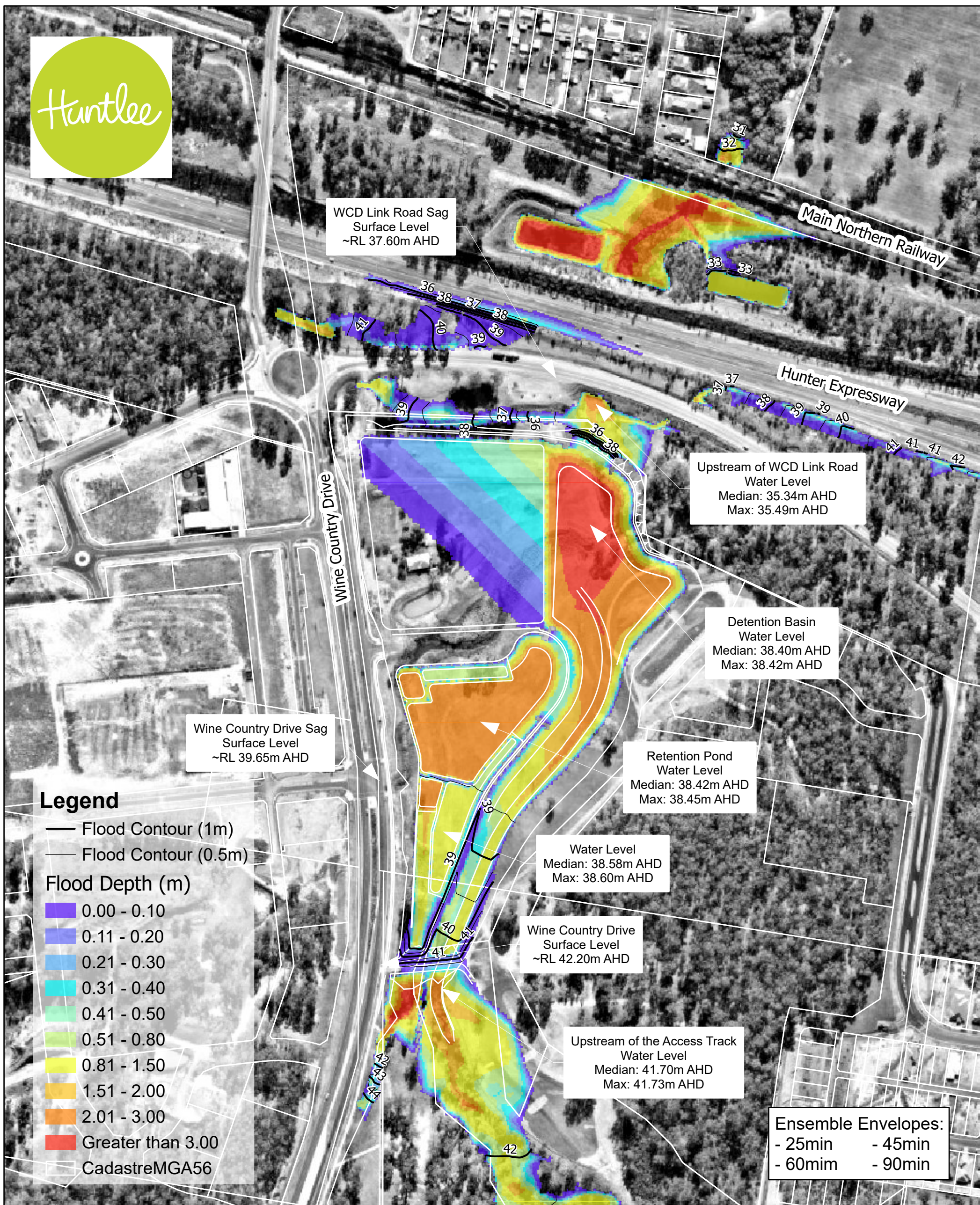


Huntlee Mod 20 (NL150007)

Developed Scenario

5% AEP Flood Depth and Elevation

Figure D3 [A]

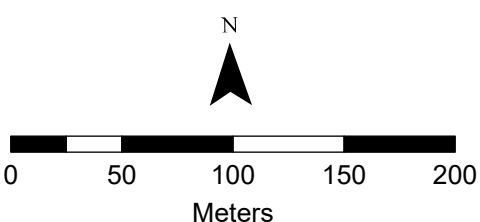
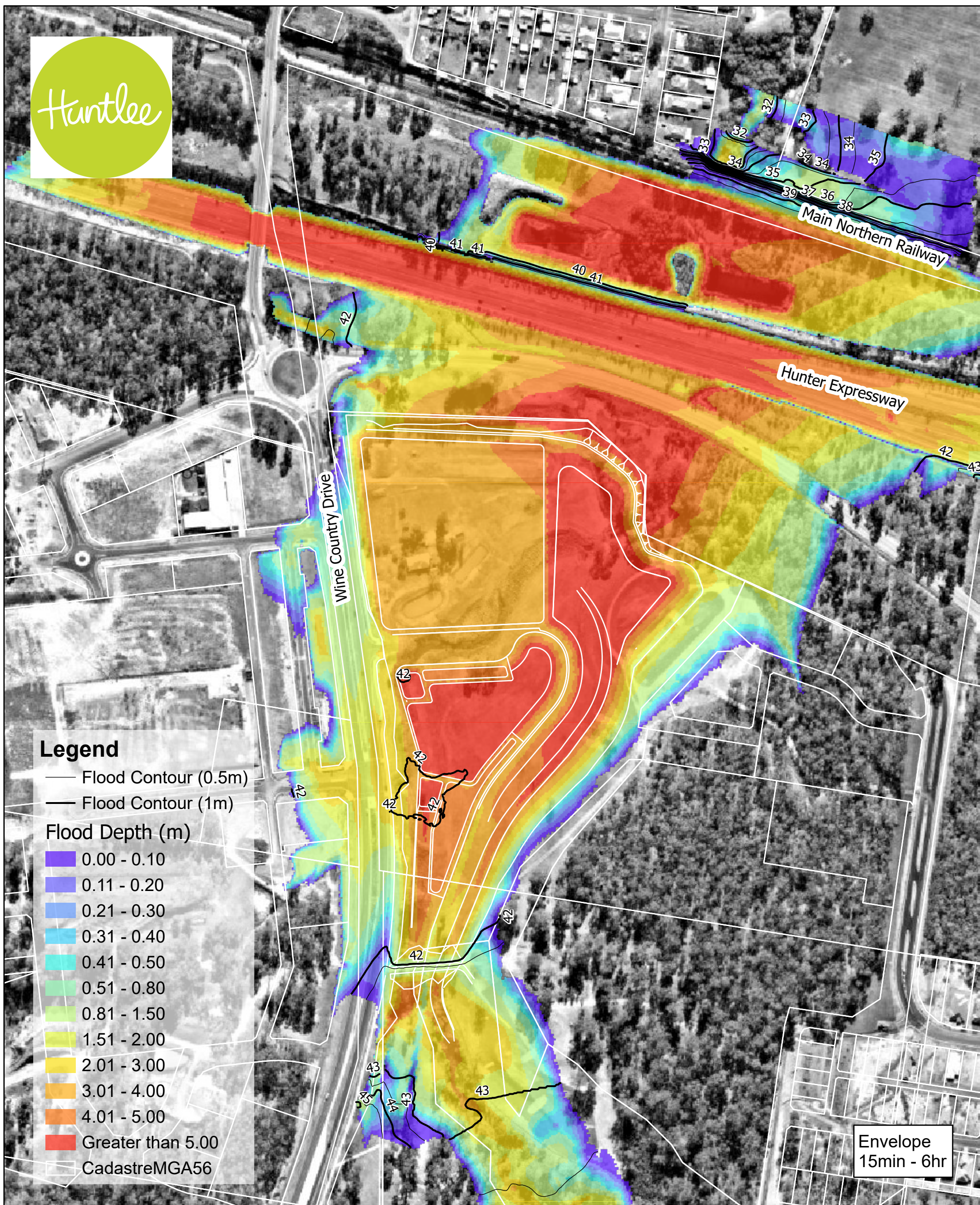


Huntlee Mod 20 (NL150007)

Developed Scenario

1% AEP Flood Depth and Elevation

Figure D4 [B]



Huntlee Mod 20 (NL150007)
Developed Scenario
PMF Flood Depth and Elevation

Figure D5 [A]

Appendix B – ARR DataHub Data

Results - ARR Data Hub
[STARTTXT]

Input Data Information
[INPUTDATA]
Latitude,-32.681200
Longitude,151.357500
[END_INPUTDATA]

River Region
[RIVREG]
Division,South East Coast (NSW)
River Number,10
River Name,Hunter River
[RIVREG_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v1
[END_RIVREG]

ARF Parameters
[LONGARF]
Zone,SE Coast
a,0.06
b,0.361
c,0.0
d,0.317
e,8.11e-05
f,0.651
g,0.0
h,0.0
i,0.0
[LONGARF_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v1
[END_LONGARF]

Storm Losses
[LOSSES]
ID,29260.0
Storm Initial Losses (mm),18.0
Storm Continuing Losses (mm/h),2.0
[LOSSES_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v1
[END_LOSSES]

Temporal Patterns
[TP]
code,ECsouth
Label,East Coast South
[TP_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v2
[END_TP]

Areal Temporal Patterns
[ATP]
code,ECsouth
arealabel,East Coast South
[ATP_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v2
[END_ATP]

Median Preburst Depths and Ratios
[PREBURST]

min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),0.5 (0.020),0.7 (0.021),0.9 (0.022),1.1 (0.022),1.6 (0.028),2.1 (0.031)
90 (1.5),2.8 (0.097),1.9 (0.049),1.4 (0.029),0.9 (0.015),0.8 (0.012),0.7 (0.010)
120 (2.0),0.0 (0.001),0.7 (0.015),1.1 (0.021),1.5 (0.025),1.5 (0.021),1.5 (0.019)
180 (3.0),0.4 (0.013),1.3 (0.027),1.9 (0.032),2.5 (0.036),2.0 (0.024),1.7 (0.018)
360 (6.0),2.2 (0.048),4.2 (0.067),5.6 (0.074),6.9 (0.078),9.2 (0.085),10.9 (0.089)
720 (12.0),3.7 (0.064),7.7 (0.094),10.4 (0.104),12.9 (0.109),14.4 (0.100),15.6 (0.094)
1080 (18.0),0.5 (0.007),6.5 (0.066),10.4 (0.088),14.2 (0.101),15.1 (0.088),15.8 (0.080)
1440 (24.0),0.0 (0.000),4.6 (0.042),7.7 (0.057),10.6 (0.067),12.1 (0.062),13.3 (0.059)
2160 (36.0),0.0 (0.000),1.2 (0.009),1.9 (0.012),2.7 (0.014),5.7 (0.025),8.0 (0.030)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.2 (0.001),0.3 (0.001)
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)
[PREBURST_META]
Time Accessed,12 March 2021 01:20PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST]

10% Preburst Depths
[PREBURST10]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
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)
[PREBURST10_META]
Time Accessed,12 March 2021 01:20PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST10]

25% Preburst Depths
[PREBURST25]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1080 (18.0),0.0 (0.000),0.1 (0.001),0.1 (0.001),0.1 (0.001),0.1 (0.000),0.0 (0.000)
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)
[PREBURST25_META]
Time Accessed,12 March 2021 01:20PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST25]

75% Preburst Depths
[PREBURST75]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),14.0 (0.553),12.3 (0.351),11.2 (0.266),10.1 (0.205),14.3 (0.239),17.3 (0.255)
90 (1.5),30.1 (1.047),21.3 (0.536),15.5 (0.325),9.9 (0.177),10.3 (0.154),10.6 (0.139)
120 (2.0),7.3 (0.230),12.8 (0.295),16.5 (0.316),20.0 (0.328),23.8 (0.326),26.7 (0.321)
180 (3.0),12.3 (0.343),23.8 (0.481),31.4 (0.530),38.8 (0.559),35.3 (0.424),32.7 (0.346)
360 (6.0),18.4 (0.404),31.7 (0.504),40.6 (0.536),49.0 (0.552),54.3 (0.505),58.3 (0.475)
720 (12.0),19.0 (0.322),32.4 (0.393),41.4 (0.414),49.9 (0.423),49.1 (0.341),48.5 (0.293)
1080 (18.0),14.0 (0.204),29.4 (0.303),39.7 (0.335),49.5 (0.352),53.3 (0.309),56.2 (0.283)
1440 (24.0),6.7 (0.087),19.2 (0.176),27.5 (0.207),35.5 (0.224),43.8 (0.224),50.1 (0.222)
2160 (36.0),3.4 (0.038),9.2 (0.072),13.1 (0.084),16.8 (0.090),29.3 (0.127),38.6 (0.145)

2880 (48.0),1.2 (0.012),4.0 (0.029),5.9 (0.034),7.7 (0.037),15.5 (0.061),21.3 (0.072)
4320 (72.0),0.0 (0.000),0.7 (0.004),1.1 (0.006),1.6 (0.007),5.5 (0.019),8.5 (0.026)

[PREBURST75_META]

Time Accessed,12 March 2021 01:20PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST75]

90% Preburst Depths

[PREBURST90]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),39.4 (1.559),36.2 (1.035),34.1 (0.811),32.1 (0.650),59.0 (0.989),79.1 (1.164)
90 (1.5),66.4 (2.310),60.9 (1.532),57.2 (1.200),53.7 (0.961),64.5 (0.960),72.6 (0.952)
120 (2.0),26.0 (0.825),51.2 (1.178),67.9 (1.303),83.9 (1.376),86.0 (1.175),87.6 (1.054)
180 (3.0),38.2 (1.064),55.9 (1.131),67.7 (1.142),79.0 (1.138),92.6 (1.112),102.9 (1.088)
360 (6.0),55.7 (1.226),68.6 (1.089),77.1 (1.018),85.3 (0.960),105.8 (0.984),121.1 (0.988)
720 (12.0),46.8 (0.796),69.6 (0.844),84.7 (0.848),99.2 (0.840),93.0 (0.645),88.4 (0.534)
1080 (18.0),37.1 (0.539),66.6 (0.685),86.1 (0.728),104.9 (0.746),106.3 (0.616),107.4 (0.540)
1440 (24.0),31.1 (0.405),52.5 (0.481),66.7 (0.500),80.3 (0.505),99.6 (0.510),114.1 (0.506)
2160 (36.0),11.3 (0.128),29.0 (0.228),40.6 (0.260),51.8 (0.277),72.4 (0.315),87.9 (0.331)
2880 (48.0),13.3 (0.137),25.0 (0.178),32.7 (0.189),40.2 (0.194),57.5 (0.226),70.5 (0.240)
4320 (72.0),13.7 (0.125),15.0 (0.094),15.8 (0.081),16.5 (0.071),27.2 (0.095),35.2 (0.107)

[PREBURST90_META]

Time Accessed,12 March 2021 01:20PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST90]

Interim Climate Change Factors

[CCF]

,RCP 4.5,RCP6,RCP 8.5

2030,0.869 (4.3%),0.783 (3.9%),0.983 (4.9%)
2040,1.057 (5.3%),1.014 (5.1%),1.349 (6.8%)
2050,1.272 (6.4%),1.236 (6.2%),1.773 (9.0%)
2060,1.488 (7.5%),1.458 (7.4%),2.237 (11.5%)
2070,1.676 (8.5%),1.691 (8.6%),2.722 (14.2%)
2080,1.810 (9.2%),1.944 (9.9%),3.209 (16.9%)
2090,1.862 (9.5%),2.227 (11.5%),3.679 (19.7%)

[CCF_META]

Time Accessed,12 March 2021 01:20PM

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.

[END_CCF]

Probability Neutral Burst Initial Loss

[BURSTIL]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0
60 (1.0),16.6,11.1,10.8,11.7,10.4,6.9
90 (1.5),12.9,9.6,9.8,11.6,11.0,8.9
120 (2.0),18.2,12.2,10.7,10.5,9.5,6.3
180 (3.0),16.1,11.2,10.0,9.6,9.4,5.0
360 (6.0),14.7,10.5,10.3,8.9,8.5,4.2
720 (12.0),15.1,11.0,10.6,9.6,10.3,4.2
1080 (18.0),17.1,12.2,11.6,9.5,11.6,3.2
1440 (24.0),19.4,14.3,13.4,11.9,12.1,4.7
2160 (36.0),23.1,18.1,17.5,17.6,15.6,6.9
2880 (48.0),23.7,20.1,19.7,22.3,17.1,8.9
4320 (72.0),24.3,21.8,22.3,24.9,20.1,15.1

[BURSTIL_META]

Time Accessed,12 March 2021 01:20PM

Version,2018_v1

Note,As this point is in NSW the advice provided on losses and pre-burst on the [NSW Specific Tab](#) of the ARR Data Hub is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

[END_BURSTIL]Transformational Pre-burst Rainfall

[PREBURST_TRANS]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0

60 (1.0),1.3,6.8,7.1,6.2,7.5,11.0
90 (1.5),5.0,8.3,8.1,6.3,6.9,9.0
120 (2.0),0.0,5.7,7.2,7.4,8.4,11.6
180 (3.0),1.8,6.7,7.9,8.3,8.5,12.9
360 (6.0),3.2,7.4,7.6,9.0,9.4,13.7
720 (12.0),2.8,6.9,7.3,8.3,7.6,13.7
1080 (18.0),0.8,5.7,6.3,8.4,6.3,14.7
1440 (24.0),0.0,3.6,4.5,6.0,5.8,13.2
2160 (36.0),0.0,0.0,0.4,0.3,2.3,11.0
2880 (48.0),0.0,0.0,0.0,0.0,0.8,9.0
4320 (72.0),0.0,0.0,0.0,0.0,0.0,2.8

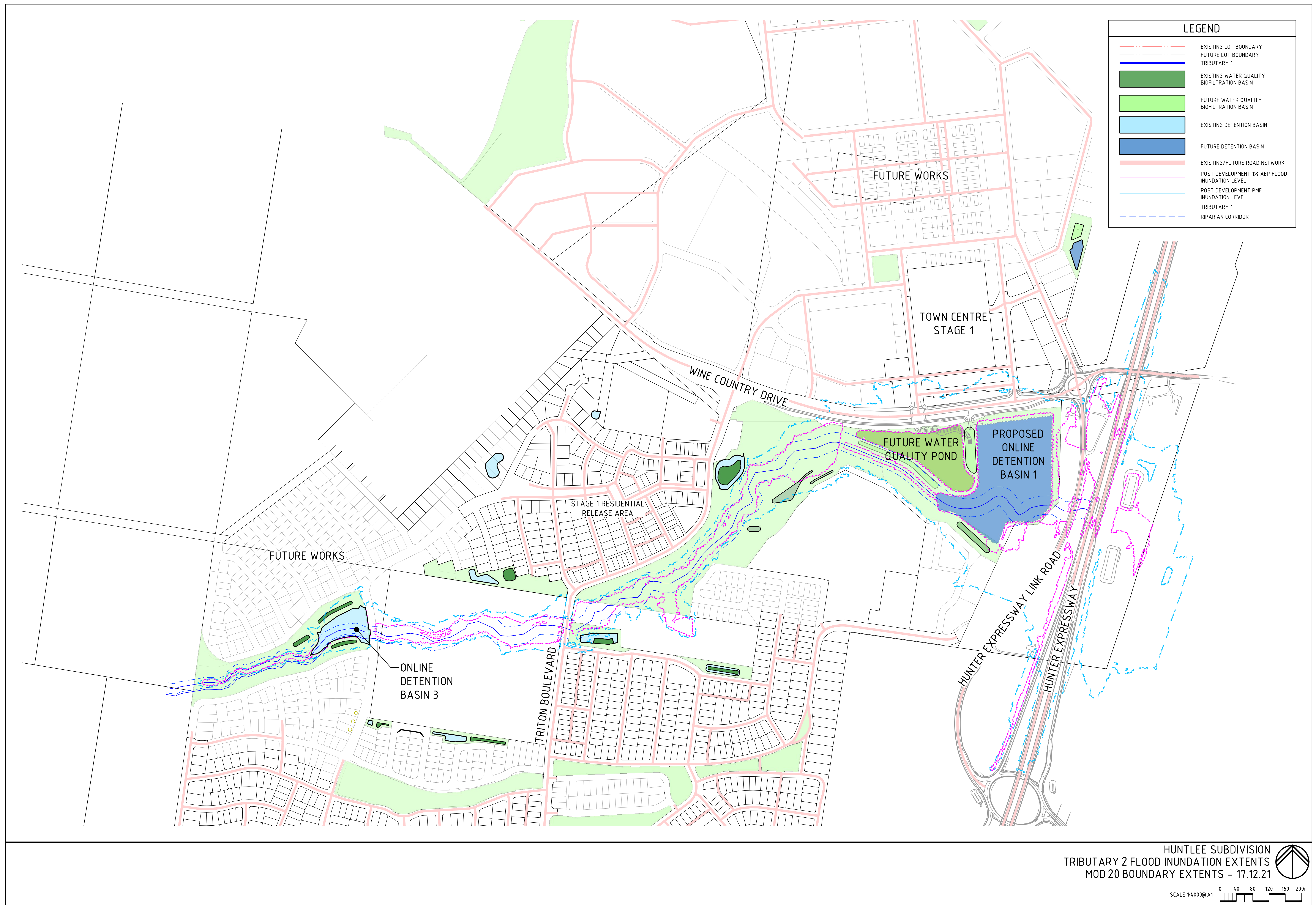
[PREBURST_TRANS_META]

The tranformational pre-burst is intended for software suppliers in the NSW area and is simply the Initial Loss - Burst Initial Loss. It is not appropriate to use these values if considering a calibrated initial loss.

[END_PREBURST_TRANS]

[ENDTXT]

Appendix C – Tributary 2 Flood Extents



Appendix D – Online Detention Basin 3 Design Report



Online Stormwater Detention Basin 3

for

Huntlee Urban Release Area – Tributary-Two

for LWP Property Group

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		Date
Prepared by	RB	07/07/2021
Checked by	BB	07/07/2021
Admin	HB	07/07/2021

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Huntlee Urban Release Area – Tributary-Two

Project Ref: NL151661_E14 [C]

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C	For Approval	R Batirov	B Balcombe	07/07/2021

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The report is based on generally accepted practices and standards applicable to the scope of work at the time it was prepared. No other warranty, express or implied, is made as to the professional advice included in this report.

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1. Introduction

This report has been prepared by Northrop Consulting Engineers seeking recommendation from the NSW Natural Resources Access Regulator (NRAR) formerly NSW Office of Water (NOW) in relation to the stormwater detention strategy proposed to mitigate the effects of the subdivision works on Tributary 2 within Stage 1 of the Huntlee Major Project Area.

Under delegation of the Minister for Planning and Infrastructure Stage 1 of the Huntlee Subdivision was granted approval on 14 September 2011 pursuant to section 75J of the Environmental Planning Assessment Act 1979 and the referred conditions.

Specifically, in relation to Stormwater Detention section **C14** outlines the following requirements:

- a) Mitigation measures shall be undertaken in accordance with the 'Trunk Stormwater and Flooding Assessment' report (Worley Parsons August 2012) and the Statement of Commitments, prior to the issue of a construction certificate at each substage, including:
 - i) bio-retention gardens.
 - ii) Swales.
 - iii) on-line detention basins.
 - iv) rainwater tanks on each lot.
 - v) CRZs, APZs and other measures as required under Water Management Act 2000.
 - vi) vegetation buffers.
 - vii) decommission existing farm dams.
 - viii) rehabilitation of any degraded riparian corridors which are proposed to be retained on site to the satisfaction of the Certifying Authority.
- b) Prior to construction of any online stormwater detention structures, detailed designs should be prepared to **the satisfaction of the NSW Office of Water (NOW)**. These designs should demonstrate consistency with the NOW guidelines for controlled activities.
- c) The vegetated riparian zone (VRZ) setbacks should comply with the 'Guidelines for Riparian Corridors on Waterfront land' (NSW Office of Water, 2012).
- d) Permanent Waterbody 1 shall be primarily for stormwater detention and shall be designed so as not to capture any runoff from the third order watercourse during low flow events, environmental flows to be maintained. Detailed design of Permanent Waterbody 1 shall be prepared for and endorsed by the NSW Office of Water prior to construction commencing. The design should demonstrate that the diversion results in a stream that remains hydrologically and geomorphically stable and ensures:
 - i) the stream grade through the diversion is consistent with the existing stream grade.
 - ii) the ongoing stability of the stream bed and banks.
 - iii) the introduction of appropriate riparian vegetation along the diversion.
 - iv) design structures so that they retain 2 year recurrence interval criteria to ensure low to medium flows are not impeded by flood detention structures.
 - v) new detention structures should achieve no increase in peak flows from design floods.

- e) On completion of the construction of permanent water bodies and or stormwater detention basins, the applicant must provide “as constructed” surveys to the Department of Planning and Infrastructure and NSW Office of Water.

This report intends to act on condition b) by gaining support for the work done to date in relation to the Stormwater Detention Strategy and receive concurrence confirming NRAR’s satisfaction with the detailed design. It is noted that the subject structure of this report is not the “Permanent Waterbody” noted in condition d).

2. Project Background

2.1 Huntlee Urban Release Area

The Huntlee Project is a major Urban Release Area (URA) in the Hunter region which will provide housing for approximately 20,000 people accommodated within up to 7,300 dwellings. The site covers approximately 1609ha and incorporates land designated for both urban and conservation purposes.

The site is located 20km north of Cessnock, 25km southwest of Singleton and approximately 500m south of Branxton. Generally, the site is bound by the Main North Railway and Hunter Expressway to the north and east, the existing North Rothbury village to the south and the Black Creek floodplain to the west. Figure 1 below shows an extract from the DCP illustrating the extent of the Huntlee Project Area and respective LGA's.

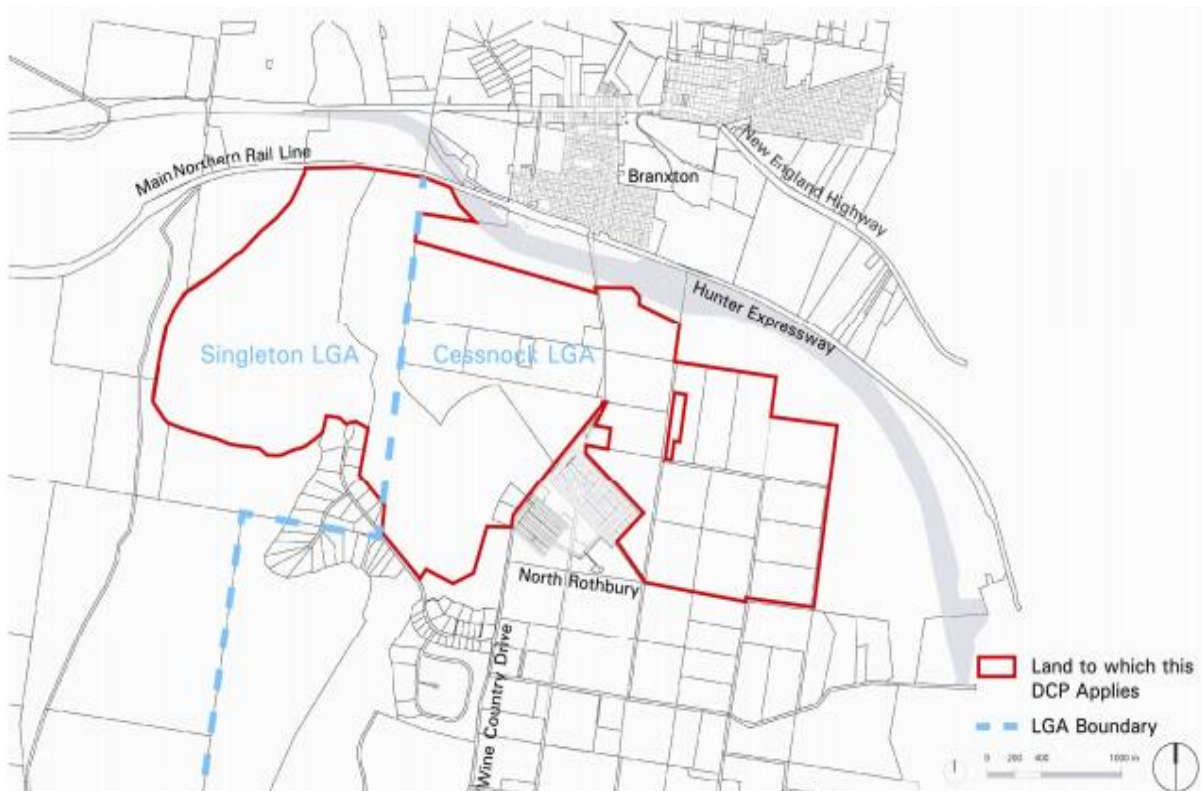


Figure 1: Extract from Huntlee DCP 2013

2.2 Stage 1 Project Area

The Stage 1 Project Area covers approximately 360ha of the Huntlee URA. Stage 1 was granted approval in 2013 and is now well into the construction phase with over 500 dwellings already occupied. The Stage 1 Project Area in context of the overall Huntlee development framework is shown below in Figure 2. The Stage 1 development includes the first residential village (approximately 1,500 dwellings) extending north east of the existing North Rothbury township, approximately 50 hectares of the Town Centre, a new school and approximately 120 large residential lots off Wine Country Drive.

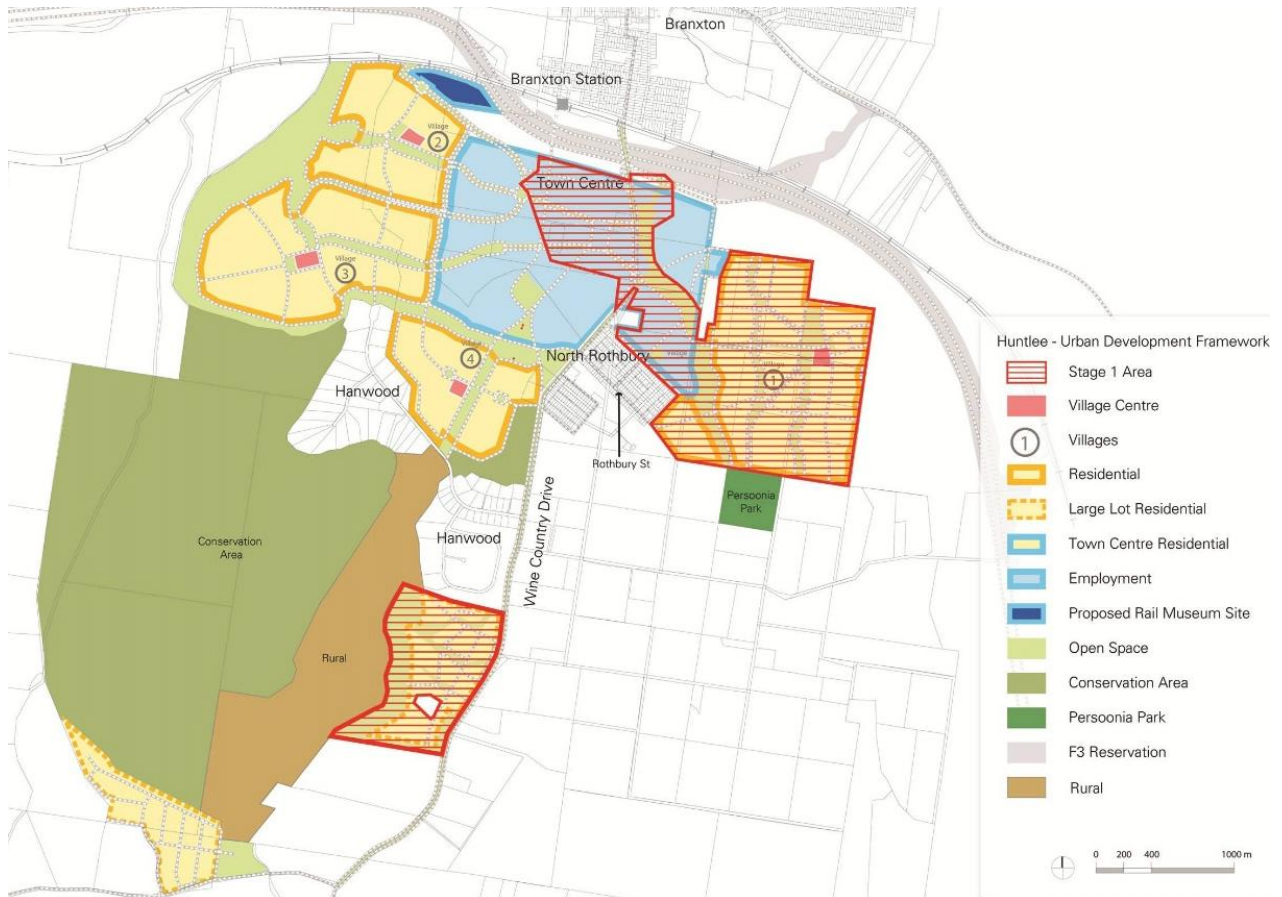


Figure 2: Stage 1 Project Area within Overall Huntlee Development Framework

2.3 Site Description

The existing undeveloped site consists mainly of grazing pasture and sparse bushland. The land is characterised by gently undulating slopes with average grades ranging from 5-10%. The site is located within the catchments of the Black and Anvil Creeks, which are both tributaries of the Hunter River. The Anvil Creek is located to the north-east of the site with two of its minor tributaries extending within the Stage 1 Project Area.

2.4 Stormwater Management Strategy

In relation to stormwater management, development within the Stage 1 Project Area is governed by the Worley Parsons 2012 report '*Trunk Stormwater and Flooding Assessment*'. An extract from the report depicting the overall site wide strategy is provided below in **Figure 3**.

The strategy proposes regional online detention of both minor tributaries, subsequently identified as Tributaries 1 and 2. Online detention facilities for the eastern watercourse, Tributary 1, were completed in 2017.

Huntlee Pty Ltd is now seeking to progress with provision of the Tributary 2 Online Detention Basin 3. The report sections below intend to outline the catchment and hydraulic analysis undertaken for Tributary 2, resultant detention basin sizing and proposed culvert crossing configuration.

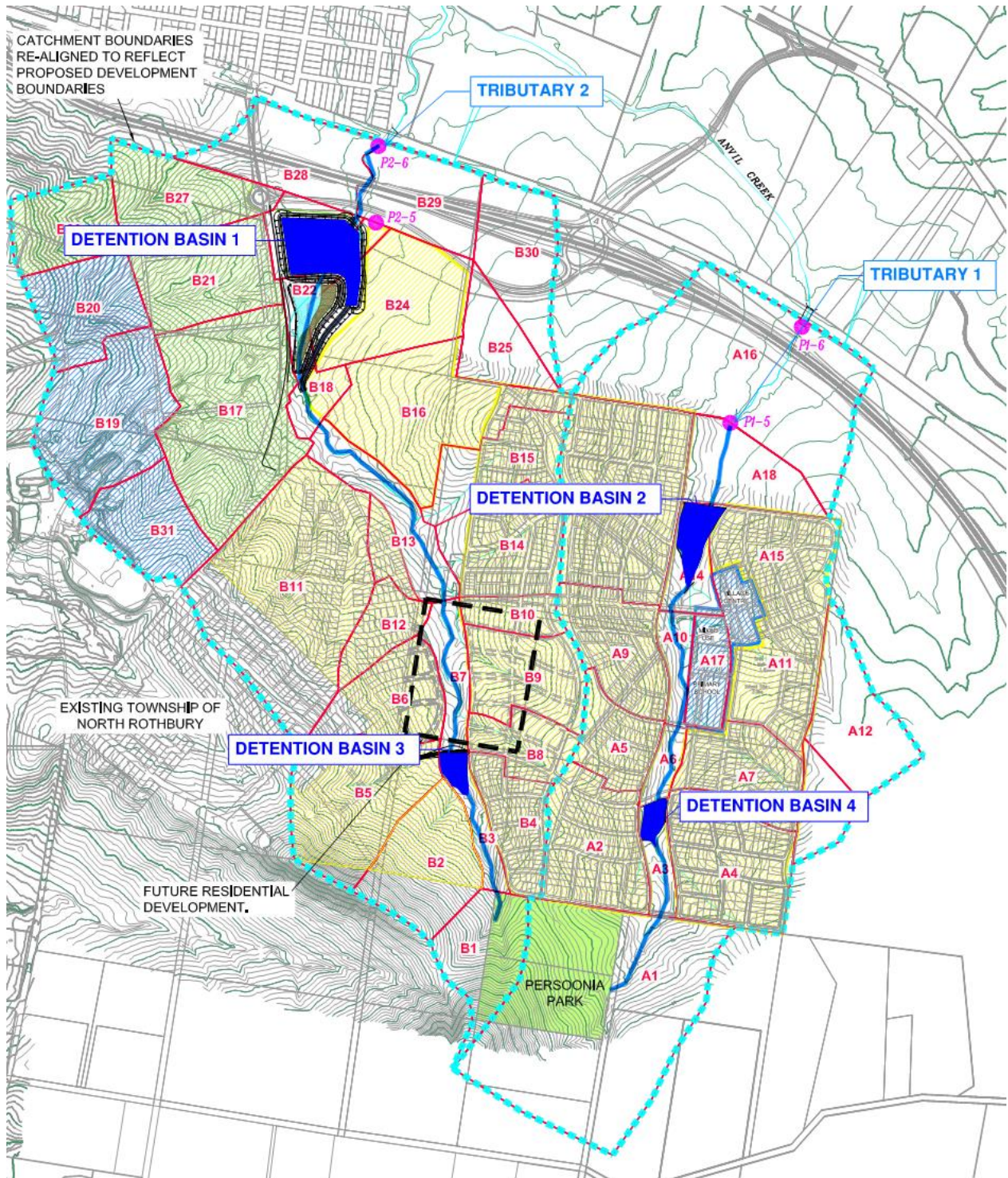


Figure 3: Huntlee Project 'Trunk Stormwater and Flooding Assessment' (Worley Parsons, August 2012)

3. Investigation Objectives

The aim of the investigation is to develop a concept design for the proposed Tributary 2 online Detention Basin 3. This basin, shown in the context of the current masterplan layout is illustrated in Figure 4 overleaf.

Specifically, the investigation has focused on the following objectives:

- The determination of catchment runoff and peak flow rates for a number of durations up to and including the 1% Annual Exceedance Probability (AEP) rainfall event.
- Detention design to ensure no worsening impact on upstream or downstream landowners.
- Determination of the inundation extent to allow the spatial, servicing, and landscaping requirements in the vicinity of the tributary crossing and detention to be generally confirmed.

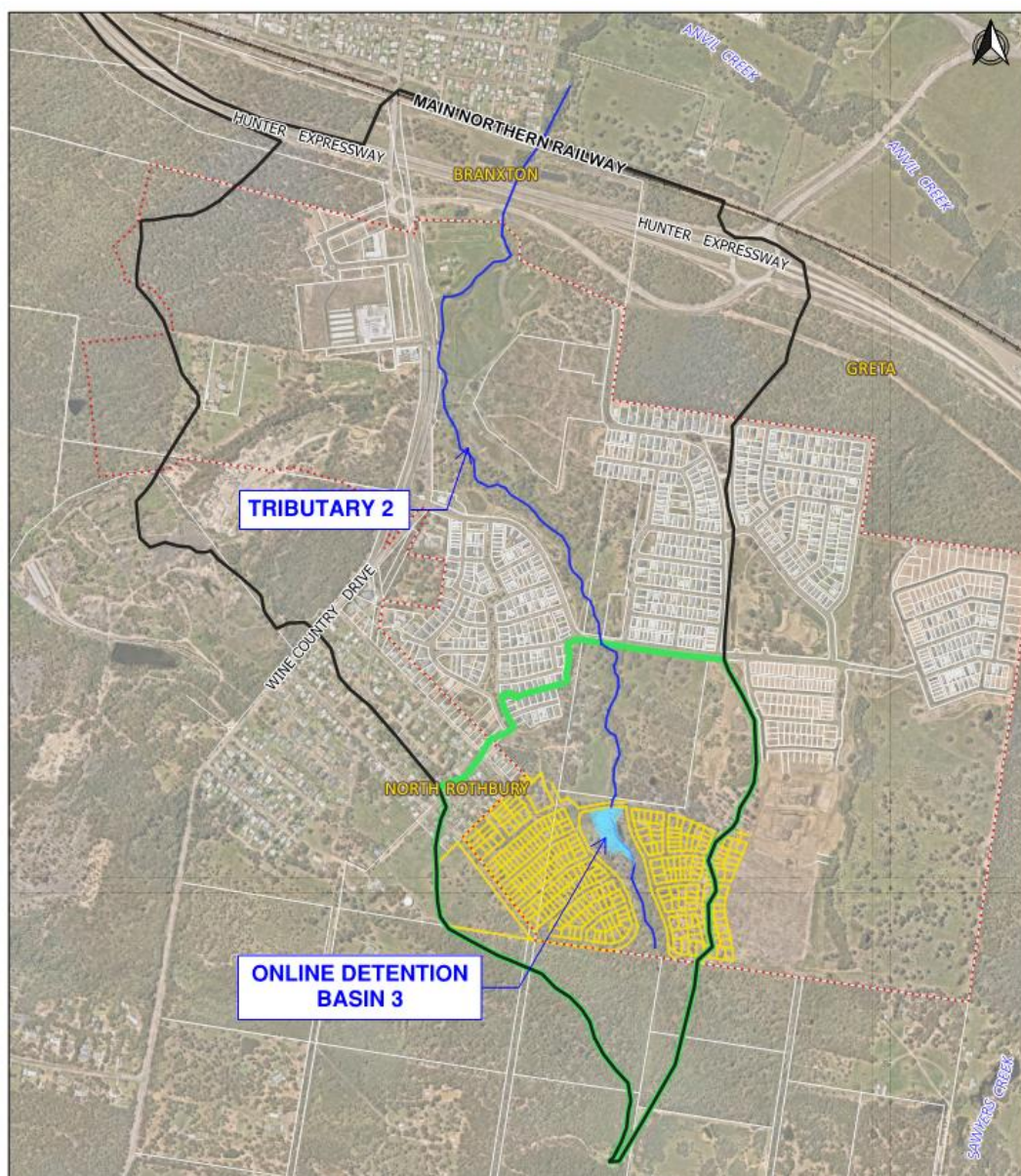


Figure 4: Tributray 2 Online Detention Basin 3

4. Methodology

The investigation has adopted the following methodology:

- Desktop review of previous investigations and available information including design plans, LiDAR and survey data, stormwater infrastructure information and land use classifications.
- Preparation of an Existing Case one-dimensional XP-STORM hydrological and 1D hydraulic model.
- Modification of the Existing Case one-dimensional XP-STORM hydrological and 1D hydraulic model to include the development.
- Conversion of the Existing and Developed Case XP-STORM models to a combined 1D/2D hydrological and hydraulic model to confirm design flood levels and extents.
- The results of the assessment are presented herein including pre to post peak flow comparisons downstream of the proposed detention basin and flood depth and elevation figures.

This study has been prepared with consideration given to the following guidelines and reports:

- Australian Rainfall and Runoff 2019 (AR&R 2019).
- NSW Government Floodplain Development Manual (NSW Government, 2005).
- Huntlee Project Trunk Stormwater and Flooding Assessment prepared by Worley Parsons and dated by August 2012.
- Greta Flood Study Final Report prepared by WMA Water and completed in February 2019.

5. Model Parameters

Modelling has been undertaken using the XP-STORM hydrological and one-dimensional hydraulic software package, featuring the two-dimensional TUFLOW hydrodynamic engine. The following provides a summary of the parameters used in the development of the one and two-dimensional models.

5.1. Hydrological Model

The Laurenson hydrological model, coupled with the Initial and Continuing Loss model has been used for this study. As per the latest AR&R 2019 guidelines, initial loss, continuing loss, pre-burst rainfall and storm burst rainfall portions of the design storm events have been considered as part of this study as shown in the below **Figure 5**.

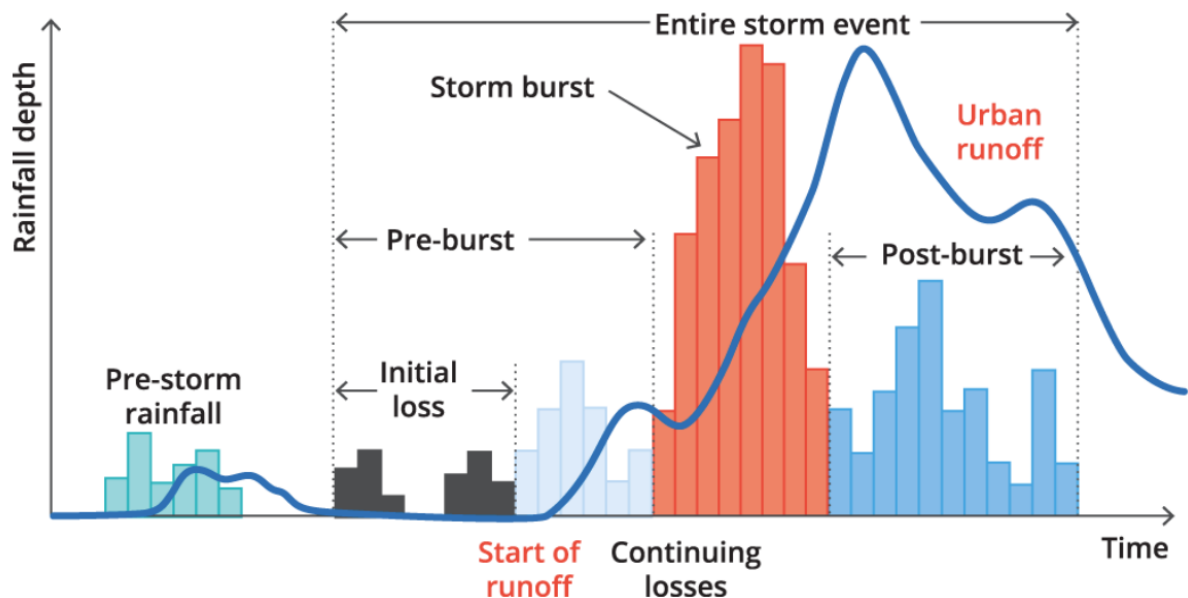
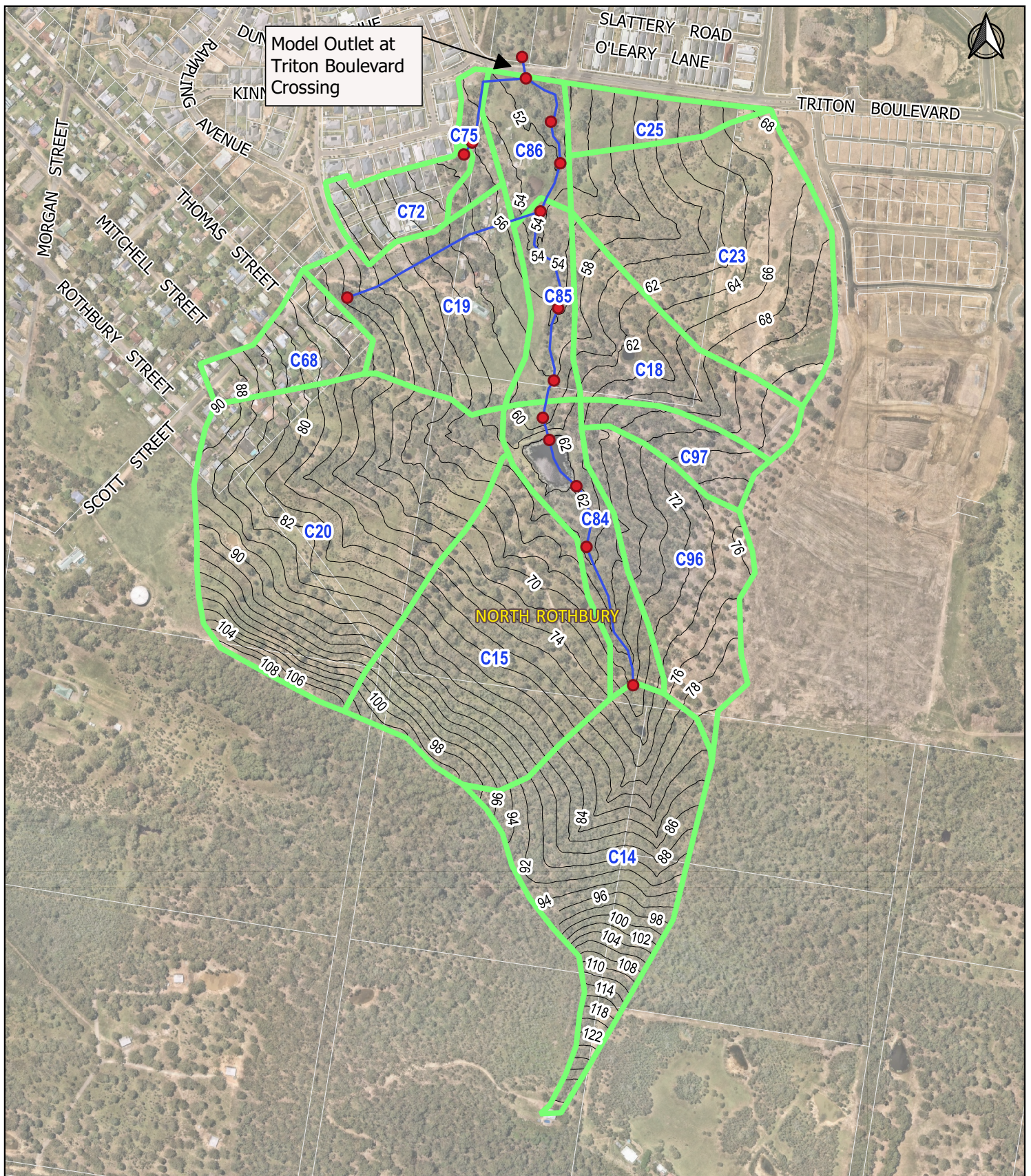


Figure 5 - Rainfall Runoff in Urban Catchments (ARR 2019 Figure 9.6.4)

The input data for the Laurenson hydrological model used in this study includes sub-catchment data, design rainfall, temporal patterns, pre-burst rainfall and the initial and continuing losses. These are summarised in the report sections below.

5.1.1. Sub-Catchment Properties

Sub-catchments have been digitised using a combination of LiDAR, aerial imagery and previous design drawings and surfaces. Sub-catchments are shown in **Figures 6** (Existing) and **7** (Proposed) overleaf.



Legend

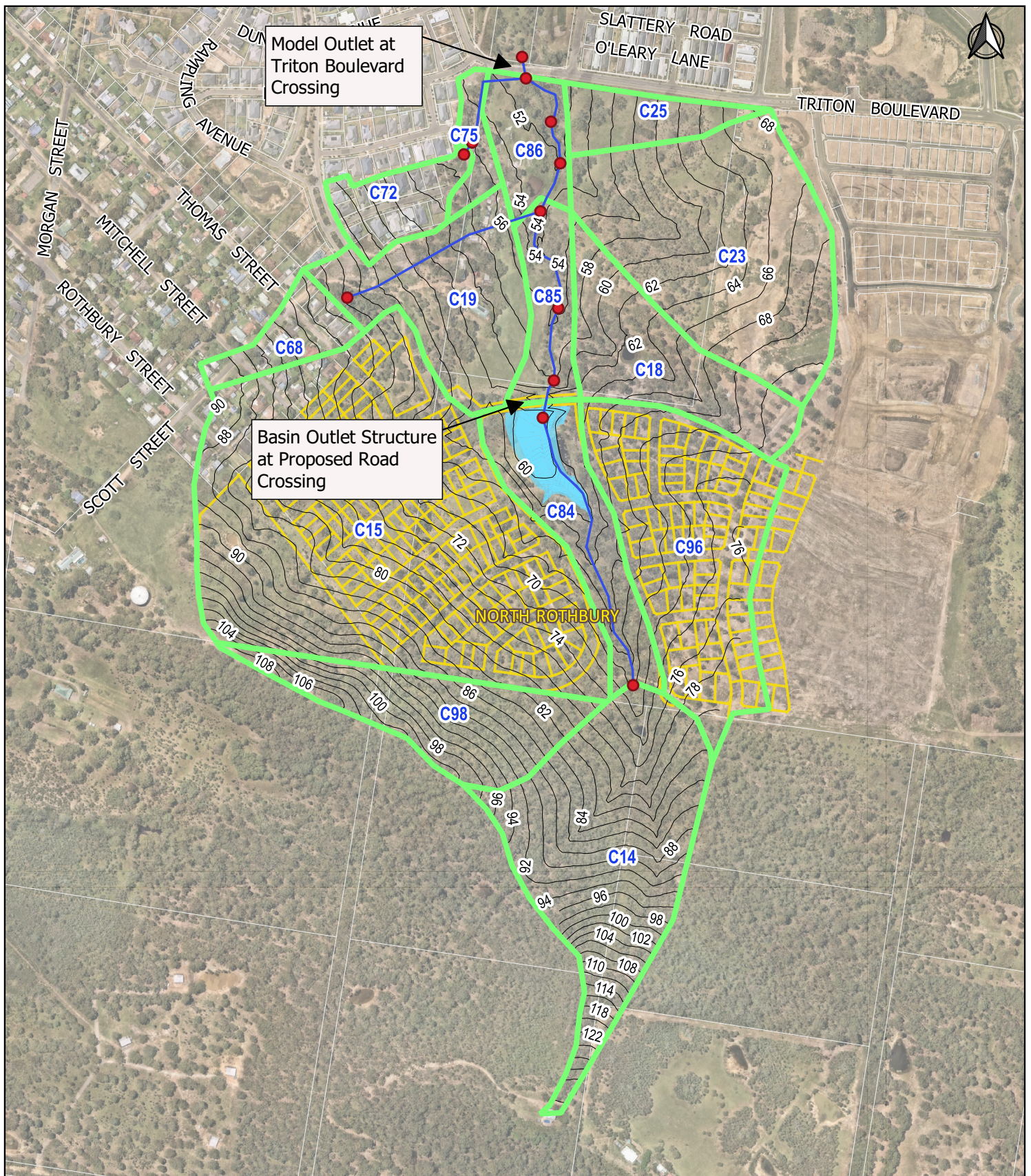
- Nodes
- Links
- ▭ Subcatchments
- 5m Contours
- Cadastre

0 100 200 Metres
1:7,500

Figure 6[A]
XP-Storm 1D Model Layout
Existing Conditions

Huntlee T2 Basin 3





Legend

- Nodes
- Links
- ▭ Subcatchments
- 5m Contours
- Cadastre
- ▭ Proposed Detention Basin
- ▭ Proposed Lot Layout

0 100 200 Metres
1:7,500

Figure 7[B]
XP-Storm 1D Model Layout
Developed Conditions

Huntlee T2 Basin 3



Tables 1 and 2 below present the existing and proposed case catchment properties, respectively.

Table 1 - Existing Case Catchments and Characteristics

Catchment Reference	Area (ha)	Impervious (%)	Slope (%)	Catchment Reference	Area (ha)	Impervious (%)	Slope (%)
C14	9.56	0	5.9	C72	1.83	65	3.8
C15	10.36	0	5.9	C75	0.84	0	2.9
C18	4.50	0	4.0	C84	3.46	0	5.1
C19	6.12	0	4.3	C85	2.12	0	4.1
C20	14.92	5	6.0	C86	2.07	0	3.2
C23	10.11	0	3.2	C96	5.75	0	3.7
C25	1.73	0	3.6	C97	1.80	0	3.4
C68	2.38	60	4.6				

Table 2 - Developed Case Catchments and Characteristics

Catchment Reference	Area (ha)	Impervious (%)	Slope (%)	Catchment Reference	Area (ha)	Impervious (%)	Slope (%)
C14	9.56	0	5.9	C72	1.83	65	3.8
C15	21.64	65	5.6	C75	0.84	0	2.9
C18	4.50	0	4.0	C84	4.12	0	5.0
C19	5.33	0	4.3	C85	2.12	0	4.1
C23	10.11	0	3.2	C86	2.07	0	3.2
C25	1.73	0	3.6	C96	8.59	65	3.5
C68	1.55	60	4.6	C98	4.59	0	7.9

5.1.2. Burst Rainfall

The latest AR&R 2019 intensity-frequency-duration (IFD) rainfall depths have been obtained from the Bureau of Meteorology (BOM) for a location over the subject site. The latest AR&R 2019 temporal patterns for the “East-Coast South” region were applied to the 50%, 20%, 10%, 5% and 1% AEP design storm depths. For this study, storm durations ranging from 10 minutes to 24 hours were considered to determine the critical event.

The Generalised Short Duration Method (GSDM) and procedures outlined in the Publication “*The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method*” (BOM, 2003) were used to develop design storm depths and patterns for the Probable Maximum Flood (PMF).

The following **Table 3** presents the Intensity-Frequency-Duration (IFD) rainfall depths adopted by the study.

Table 3 - Rainfall Intensity-Frequency-Duration Depths

Duration	50% AEP (mm)	20% AEP (mm)	10%AEP (mm)	5% AEP (mm)	1%AEP (mm)	PMP (mm)
10-min	10.8	16.1	19.5	23.1	32.5	N/A
15-min	13.6	20.2	24.5	29	40.8	170
20-min	15.8	23.2	28.1	33.2	46.7	N/A
25-min	17.6	25.6	30.9	36.5	51.1	N/A
30-min	19.0	27.5	33.2	39.2	54.7	240
45-min	22.2	31.8	38.4	45.2	62.4	300
1-hour	24.7	35.0	42.1	49.4	68.0	350
1.5-hour	28.2	39.7	47.7	55.9	76.3	460
2-hour	31.0	43.5	52.1	61.0	83.1	530
3-hour	35.4	49.5	59.3	69.4	94.6	650
4.5-hour	40.7	56.8	68.1	79.8	109	N/A
6-hour	45.0	63	75.8	88.9	123	N/A
9-hour	52.3	73.6	88.8	105	146	N/A
12-hour	58.5	82.5	99.9	118	166	N/A
18-hour	68.3	97.2	118	141	199	N/A
24-hour	76.2	109	133	159	226	N/A

5.1.3. Losses and Roughness

The latest AR&R 2019 storm losses have been used for this study and were obtained from the AR&R Data Hub. Storm losses provided by the ARR Data Hub are intended for Rural catchments only and as such have been reduced for the urban areas as summarised in the below **Table 4**.

Table 4 - Initial and Continuing Losses

Landuse	Initial Loss (mm)	Contuing Loss (mm/hr)	Roughness
Rural Pervious (ARR Data Hub)	18.0	2.0	N/A
Pervious (Rural)	18.0	2.0	0.050
Impervious (Rural)	10.8	0.8	0.015
Pervious (Urban)	10.8	0.8	0.035
Impervious (Urban)	1.0	0.0	0.015

It is noted that the subject site is included as part of the Greta Flood Study (WMA Water, 2019). A similar modelling methodology has been adopted herein with exception of the use of the Median Pre-Burst Depths as discussed below.

The latest AR&R 2019 guidelines have also introduced an updated philosophy with respect to modelling urban impervious areas with consideration to Directly Connected and In-Directly Connected Impervious Areas (DCIA & ICIA). Recommendations presented in AR&R 2019 suggests that initial losses for ICIA areas are to consider a reduction factor in the order of 60-80% to represent the potential for additional losses as ICIA areas pass across pervious surfaces. These reduction factors have also been applied to both the impervious (Rural) and Pervious (Urban) portions of the catchment to remain conservative.

The roughness values used are also similar to what was used for the existing case catchments in the original Huntlee Project Trunk Stormwater and Flooding Assessment for Stage one prepared by Worley Parsons in 2012

Initial Losses during the PMF have been reduced to zero, conservatively assuming fully wet antecedent conditions prior to the occurrence of the PMF. Furthermore, the typical Laurenson storage non-linearity exponent of -0.285 was used for the 20% to 1% AEP, however, was modified to -0.001 during the PMF to represent a linear catchment response during extreme events.

5.1.4. Pre-Burst Rainfall

Since the preparation of the Greta Flood Study (WMA Water, 2019) the NSW Office of Environment and Heritage (OEH) commissioned a review of the nationally derived losses and pre-burst for catchments over NSW. As a result, the latest NSW-Specific Transformational pre-burst depths have been used in lieu of the median pre-burst depths considered by the Greta Flood Study (WMA Water, 2019).

The latest NSW-Specific Transformational pre-burst rainfall depths presented in **Table 5** below were added to the design rainfall events and distributed evenly over three timesteps prior to the burst of the design storm events. The 60-minute pre-burst rainfall has been used for storm durations less than 60 minutes in accordance with the latest AR&R 2019 guidance.

Table 5 - Transformational Pre-burst Rainfall Depths (ARR Data Hub)

Duration	50% AEP (mm)	20% AEP (mm)	10% AEP (mm)	5% AEP (mm)	1% AEP (mm)
1-hour	1.3	6.8	7.1	6.2	11.0
1.5-hour	5.0	8.3	8.1	6.3	9.0
2-hour	0	5.7	7.2	7.4	11.6
3-hour	1.8	6.7	7.9	8.3	12.9
6-hour	3.2	7.4	7.6	9.0	13.7
12-hour	2.8	6.9	7.3	8.3	13.7
18-hour	0.8	5.7	6.3	8.4	14.7
24-hour	0	3.6	4.5	6.0	13.2

The NSW-Specific Transformational pre-burst rainfall depths are used in lieu of directly applying the NSW Probability Neutral Burst Initial Loss. This results in the same rainfall excess being applied to the model as outlined below.

The ARR Data Hub provides NSW-Specific Transformational pre-burst rainfall which as mentioned above, is added to each storm event over several timesteps prior to the burst. Resultant Probability Neutral Burst initial rainfall losses are then determined by the difference between the Transformational pre-burst rainfall and the Storm Losses presented in **Tables 4** above.

This calculation is summarised overleaf.

$$\text{Burst Initial Loss (Probability Neutral IL)} = \text{Storm Initial Loss (Table 4)} - \text{NSW Specific Transformational Pre-burst Rainfall (Table 5)}$$

For example, the NSW Probability Neutral Burst Initial Loss for the 1% AEP - 60-minute storm duration is presented in Attachment B as 7.0mm. This is applied in XP-RAFTS to Rural Pervious catchments through the below equation.

$$7.0\text{mm (Rural NSW Probability Neutral IL)} = 18\text{mm (Rural Storm Loss)} - 11.0\text{mm (Transformational Pre-Burst)}$$

Through this methodology, the NSW Probability Neutral Burst Initial Losses and design storm losses presented in the Greta Flood Study (WMA Water, 2019) have been adopted as part of this study.

5.2. Hydraulic Model

5.2.1. One-Dimensional Model Setup

The 1D XP-Storm model setup for both the existing and developed case models are presented in Figures 6[A] and 7[A], respectively. The constructed models incorporate one-dimensional hydrodynamic links and nodes. The links are linear features and represent hydraulic routing (open channels and culverts) between the nodes. The nodes are entered as a point feature and include sub-catchment runoff inflows, storage basins and a connection between the links.

The model outlet is located at the existing Triton Boulevard culvert crossing. Downstream backwater condition has been set as a “free outfall” and used for all modelled flood events.

5.2.2. Two-Dimensional Model Setup

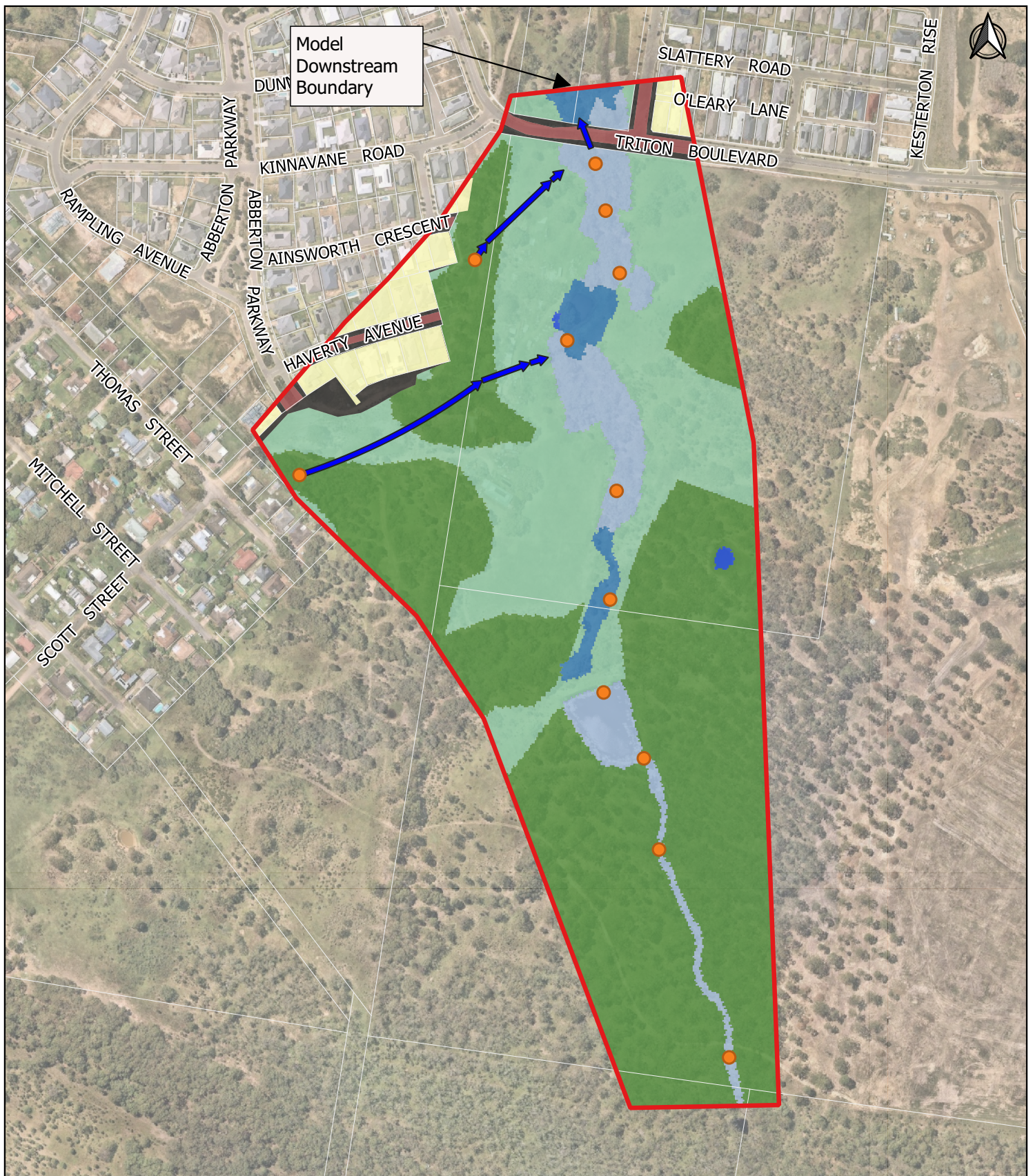
A grid size of 2m x 2m was adopted for the two-dimensional model to adequately represent flows over spillways and through overland flow paths. The two-dimensional grid extent is shown in the Figures 8[A] and 9[A] overleaf for both the existing and developed scenarios, respectively.

Terrain data used in the development of the model includes a combination of LiDAR elevation data, detailed topographic survey and design surfaces. Some additional modifications have also been made by manually entering elevation strings and polygons into the XP-STORM software.

An outlet head boundary has been entered in the two-dimensional model approximately 20 metres downstream of Triton Boulevard culvert crossing (refer to Figures 8[A] and 9[A]). A “free outfall” tailwater condition has been considered for all events.

Flows derived from the 1D network have been applied directly to the two-dimensional grid via a series of one-dimensional nodes.

Catchment roughness was based on a review of hydraulic literature, aerial imagery and observations made during a site visit. Adopted catchment roughness's in both the existing and developed case scenarios have been summarised in the legends of Figures 8[A] and 9[A] respectively.



Legend

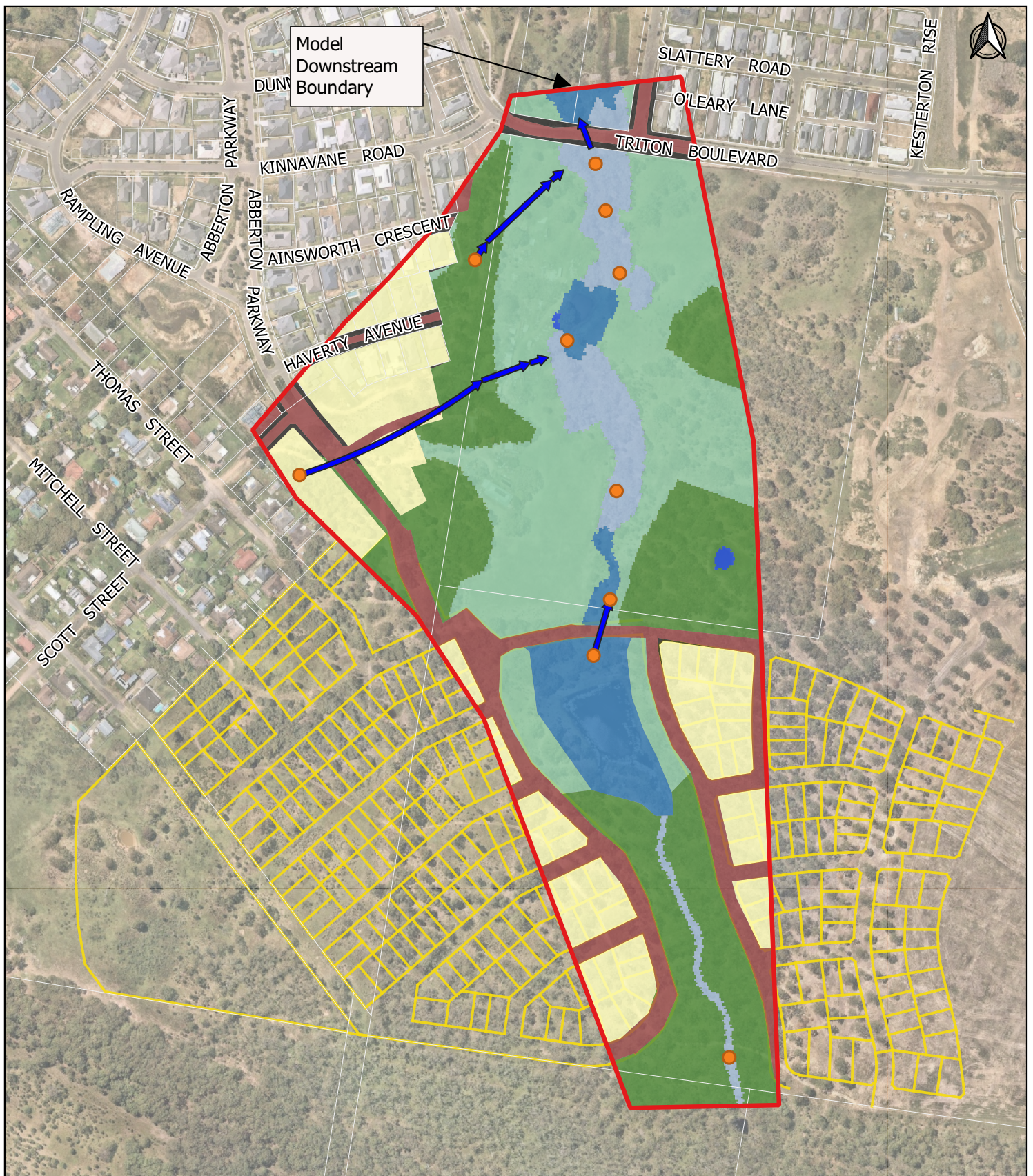
- | | |
|-------------------|----------------------|
| Cadastre | Landuse (Roughness) |
| 2D_GridExtent | Bush (0.080) |
| Catchment Inflows | Creeks (0.050) |
| 1D Structures | Creeks (0.060) |
| | Dense Grass (0.065) |
| | Residential (0.300) |
| | Road Reserve (0.035) |
| | Roads (0.018) |
| | Water Bodies (0.010) |

0 100 200 Metres
1:5,000

Figure 8[A]
TUFLOW 2D Model Setup
Existing Conditions

Huntlee T2 Basin 3





Legend

- | | |
|---------------------|----------------------|
| Cadastre | Landuse (Roughness) |
| 2D_GridExtent | Bush (0.080) |
| Catchment Inflows | Creeks (0.050) |
| 1D Structures | Creeks (0.060) |
| Proposed Lot Layout | Dense Grass (0.065) |
| | Residential (0.300) |
| | Road Reserve (0.035) |
| | Roads (0.018) |
| | Water Bodies (0.010) |

0 100 200 Metres
1:5,000

Figure 9[A]
TUFLOW 2D Model Setup
Developed Conditions

Huntlee T2 Basin 3



5.2.3. Hydraulic Structures

The modelled hydraulic structures (culverts) in both the existing and proposed cases are summarised in Table 6 below.

Table 6 – Modelled Hydraulic Structures (Culverts)

Scenario	Location	Size/Type	Number of	Upstream Invert (mAHD)	Downstream Invert (mAHD)	Road Spill Crest Level (mAHD)
Existing	Triton Boulevard	H1200mm x W2100mm RCBC	9	49.70	49.60	52.49
Proposed	Triton Boulevard	H1200mm x W2100mm RCBC	9	49.70	49.60	52.49
Proposed	Detention Basin	525 mm RCP (Low Flow)	3	58.57	58.43	62.21
		900 mm RCP (High Flow)	4	59.60	59.46	

5.2.4. Blockage

The following design blockage factors have been applied to the proposed detention basin outlet structure:

- Low flow pipes – 50% blockage; and
- High flow pipes – 15% blockage.

An un-blocked scenario has also been considered when reviewing the pre-to-post peak flow for the proposed basin. The above design blockage has been considered for the definition of maximum design flood depths and elevations within the basin.

A zero percent blockage factor has been considered for the Triton Boulevard culvert crossing downstream during both the existing and developed scenarios. Blockage at this structure is not expected to induce tailwater effects at the proposed basin as the invert of the proposed basin is sited approximately six metres above the spill crest of Triton Boulevard.

5.2.5. Critical Duration

Storm durations ranging from the 10-minute to 24-hour durations have been considered for the 20% to 1% AEP design storm events. All ten temporal patterns for each storm duration have been considered with the “Ensembles in Hydrology and Hydraulics” methodology discussed in AR&R 2019 used for this study. The durations that produced the largest median peak flow value and water levels were considered the critical ensemble.

For the 20% AEP to the 1% AEP design storm events, a top critical duration ensemble identified across the catchment, as determined by the one-dimensional model were then passed into the two-dimensional model.

For the PMF, all events ranging from the 15-minute to the 3-hour duration were modelled in the two-dimensional model.

6. Results

6.1. Existing vs. Proposed Peak Flow Comparison

The results from the one-dimensional stormwater detention assessment for both the developed case blocked and unblocked scenarios are summarised below in the following **Tables 7** and **8**.

Table 7 – Pre to Post (unblocked) Peak Flow Comparison

Design Storm Event	Existing		Post-Developed (unblocked)		Difference (m ³ /s)
	Critical Storm (duration/pattern)	Peak Flow (m ³ /s)	Critical Storm (duration/pattern)	Peak Flow (m ³ /s)	
50% AEP	1.5hr 8	2.03	1.5hr 5	1.99	-0.04
20% AEP	45min 7	4.09	45min 9	4.03	-0.06
10% AEP	1hr 6	5.76	1hr 7	5.18	-0.58
5% AEP	1hr 6	7.23	1hr 6	6.19	-1.04
1% AEP	25min 1	11.68	45min 9	9.17	-2.51

Table 8 – Pre to Post (blocked) Peak Flow Comparison

Design Storm Event	Existing		Post-Developed (blocked)		Difference (m ³ /s)
	Critical Storm (duration/pattern)	Peak Flow (m ³ /s)	Critical Storm (duration/pattern)	Peak Flow (m ³ /s)	
50% AEP	1.5hr 8	2.03	1.5hr 8	2.03	-0.00
20% AEP	45min 7	4.09	45min 9	3.97	-0.12
10% AEP	1hr 6	5.76	1hr 7	5.13	-0.63
5% AEP	1hr 6	7.23	1hr 6	5.51	-1.72
1% AEP	25min 1	11.68	45min 2	7.78	-3.90

The results presented above indicate that the proposed detention basin effectively attenuates runoff from the development areas for events up to and including the 1% AEP.

6.2. Flood Depth and Elevation

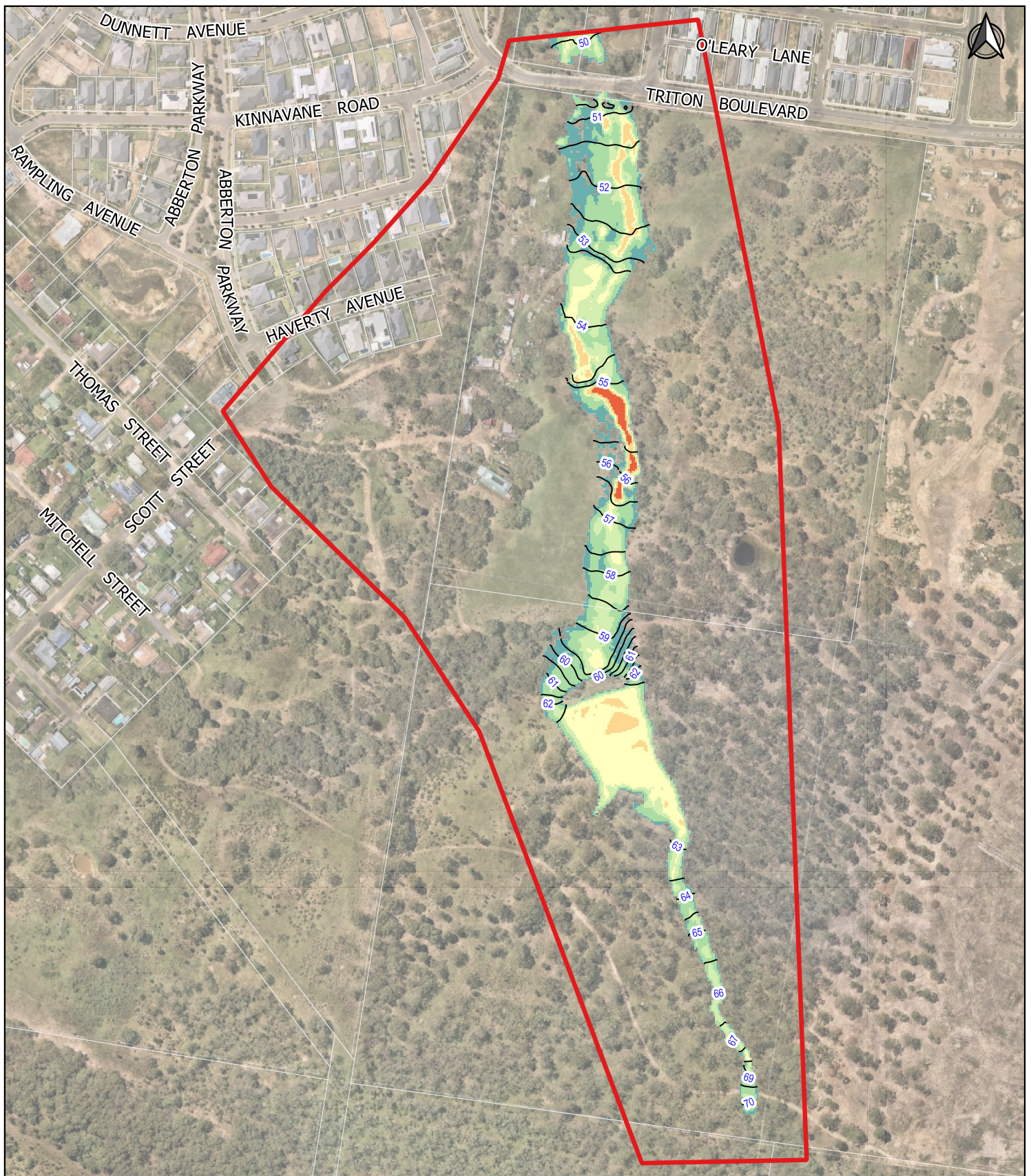
The 1% AEP and PMF design storm events were run in the two-dimensional model for both the existing and developed case (blockage) scenarios. The resultant flood depth and elevation contours are presented in the following Figures 10[A] to 13[A]. For the 1% AEP, the critical events specified in the above Table 8 were run in the two-dimensional model, while events ranging from the 15-minute to 3 hour durations were run and enveloped to produce the maximum flood depth for the PMF.

The following **Table 9** presents the maximum modelled water elevation and storage capacity of the proposed detention basin for 1% AEP and PMF design storm events. The design blockage scenario has been considered for the estimation of the water level and volumes.

Table 9 – Peak Water Elevation and Storage Volume (Design Blockage)

Scenario	Water Elevation (m AHD)	Storage Volume (m ³)
1% AEP	61.26	10,500
PMF	62.84	30,900

The above Table 9 shows a volume of approximately 10,500m³ during the 1% AEP design storm event. This is generally consistent with the 10,000m³ specified in the original Trunk Stormwater and Flooding Assessment report (Worley Parsons August 2012). The slight difference in volume is expected to be the results of a slightly different development case layout and the use of the latest Australian Rainfall and Runoff (2019) guidelines.



Legend

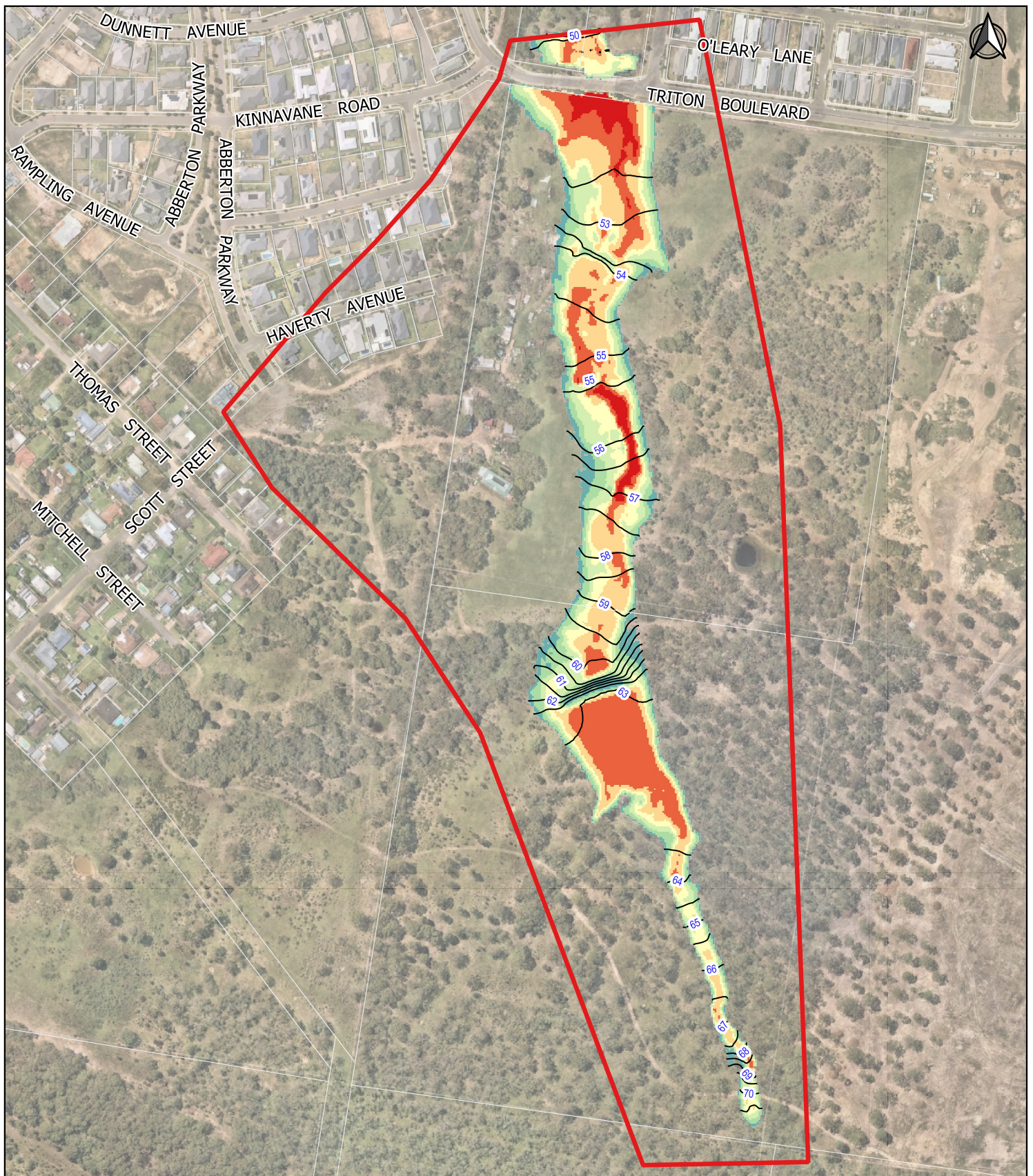
 	2D Model Extent	Depth (m)
 	Cadastral	 < 0.01
	Contour 0.5m	 0.01 - 0.10
		 0.10 - 0.30
		 0.30 - 0.50
		 0.50 - 0.70
		 0.70 - 1.00
		 1.00 - 1.50
		 1.50 - 3.00

0 90 180 Metres
1:4,500

Figure 10[A]
1% AEP Flood Event
25min Critical Duration
Flood Depth and Elevation
Existing Conditions

Huntlee T2 Basin 3





Legend

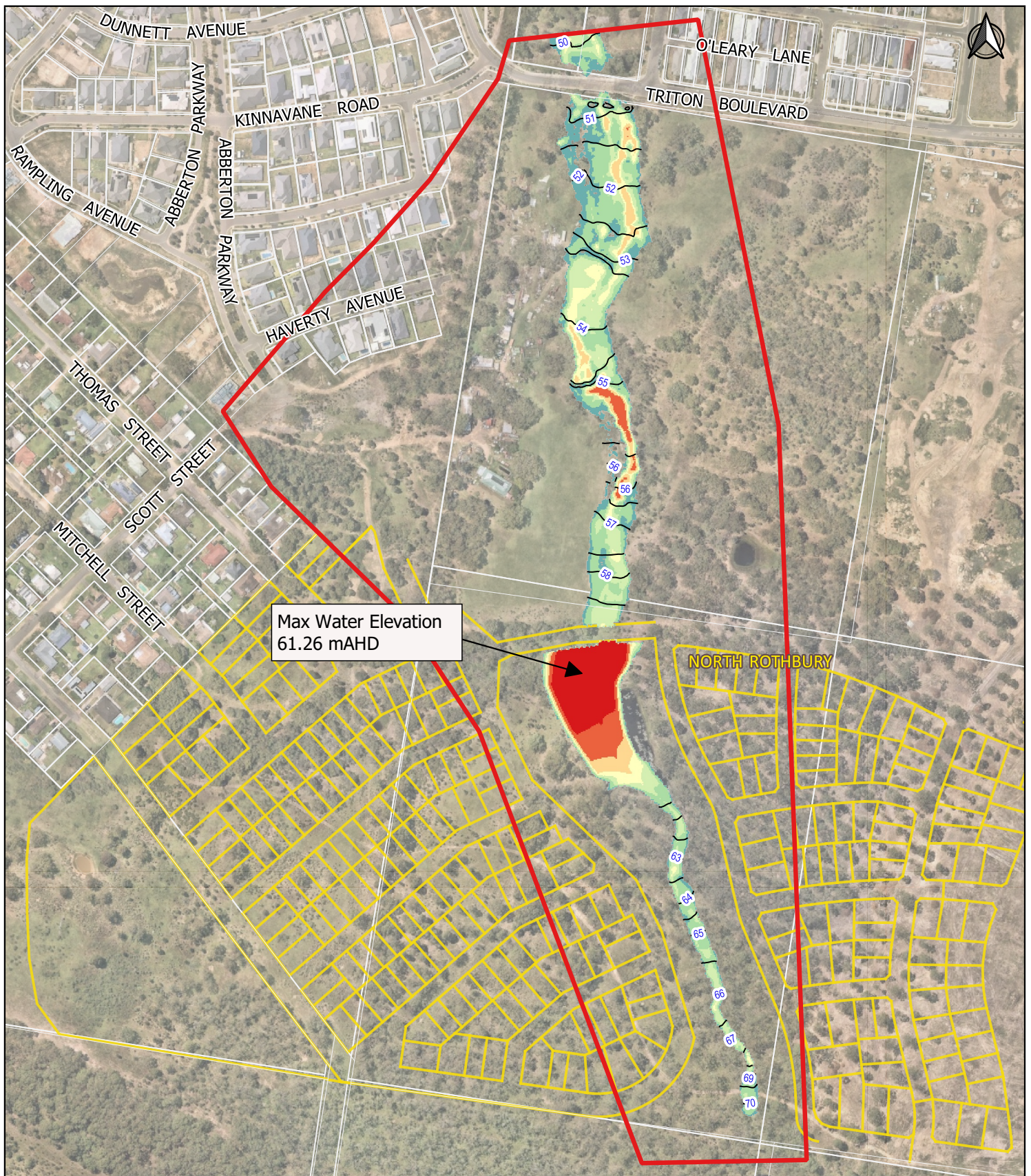
 	2D Model Extent	Depth (m)
	Cadastral	 < 0.01
	Contour (0.5m)	 0.01 - 0.10
		 0.10 - 0.30
		 0.30 - 0.50
		 0.50 - 0.70
		 0.70 - 1.00
		 1.00 - 1.50
		 1.50 - 3.00

0 90 180 Metres
1:4,500

Figure 11[B]
PMF Event
Critical Envelope
Flood Depth and Elevation
Existing Conditions

Huntlee T2 Basin 3





Legend

- 2D Model Extent
- Cadastre
- 0.5m Contour (mAHD)
- Proposed Lot Layout

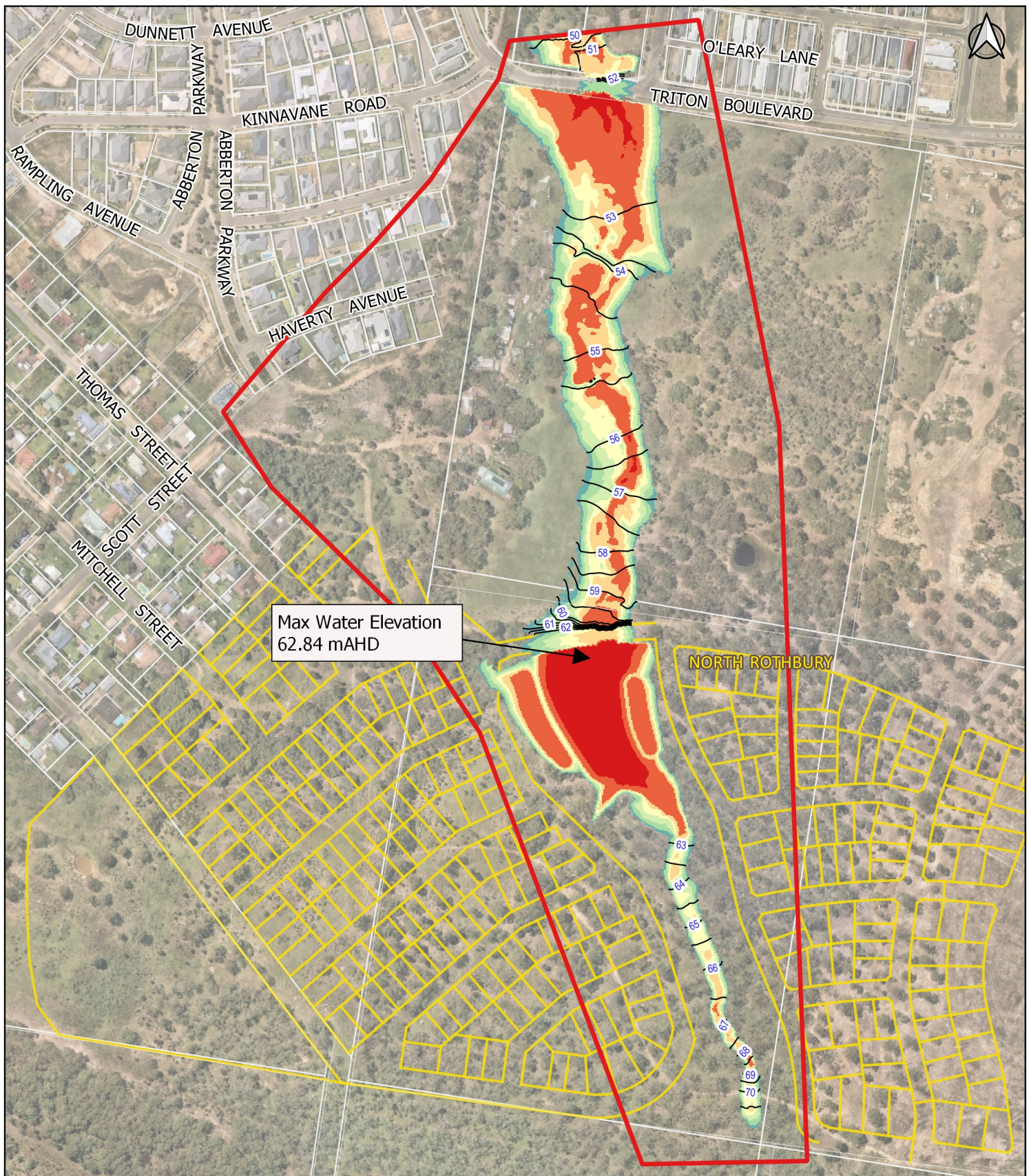
Depth (m)	
	< 0.01
	0.01 - 0.10
	0.10 - 0.30
	0.30 - 0.50
	0.50 - 0.70
	0.70 - 1.00
	1.00 - 1.50
	1.50 - 3.00

0 90 180 Metres
1:4,500

Figure 12[B]
1% AEP Flood Event
45min Critical Duration
Flood Depth and Elevation
Developed Conditions

Huntlee T2 Basin 3





Legend

- ▬ 2D Model Extent
- ▬ Cadastre
- ▬ 0.5m Contour (mAHD)
- ▬ Proposed Lot Layout

Depth (m)	
▬	< 0.01
▬	0.01 - 0.10
▬	0.10 - 0.30
▬	0.30 - 0.50
▬	0.50 - 0.70
▬	0.70 - 1.00
▬	1.00 - 2.00
▬	2.00 - 5.00

0 90 180 Metres
1:4500

Figure 13[B]
PMF Event
Critical Envelope
Flood Depth and Elevation
Developed Conditions

Huntlee T2 Basin 3



7. Basin Design

The proposed detention basin is to be designed in accordance with NRAR's Guidelines for Instream Works on Waterfront Land. This guideline outlines that all proposed works within a watercourse should protect and enhance the following:

- Water flow.
- Water quality.
- Stream ecology.
- Existing riparian vegetation.

In addition to these, impacts on the hydrologic, hydraulic and geomorphic functions of a watercourse should be minimised along with the construction footprint and extent of disturbance.

In consideration of these design requirements the proposal intends to minimise modification to the existing profile of Tributary 2 by maintaining the natural channel profile up and downstream of the proposed basin headwall. It is noted however that as part of these works an existing farm dam is to be decommissioned in accordance with development consent condition C14-(a)vii).

This design aims to minimise the impact on the existing riparian vegetation and stream morphology. The culvert outlet configuration proposed allows stormwater flows to be maintained providing protection and enhancement to the stream ecology. Riprap of natural indigenous rock is proposed at the inlet and outlet structures as opposed to other 'less natural' energy dissipaters.

The detailed design drawings indicate the proposed location of the online detention basin and provide details on the control structures. The detailed design drawings also indicate the extent of inundation in a 1% AEP design storm post developed event and the pre-developed natural flow extent.

As part of the broader subdivision's Concept Mitigation Strategy offline water quality treatment devices will be included to ensure pollutant load reduction targets are met to the authority's satisfaction.

7.1. Scour Protection

In accordance with NRAR's requirements, rock riprap has been provided upstream and downstream of the outlet control structures.

The rock riprap provided downstream of the outlet has been sized using the published material produced by 'Catchments and Creeks Pty Ltd' namely 'Rock Sizing for Multi-Pipe & Culvert Outlets (November 2014). Based on the outlet flowrate and velocity (obtained from the XP-STORM model), and pipe diameter, the size of the rock its required thickness and footprint was determined.

Pipe Outlet Riprap:

Equivalent Pipe Diameter – 2.09m

Total Q_{max} (1% AEP, no blockage) = 9.17m³/s

V_{max} high flow outlet (1% AEP) = 3.2m/s

V_{max} low flow outlet (1% AEP) = 4.8m/s

d₅₀ Rock Size = 600mm at 1100mm deep

Rock Apron Length (minimum) = 11m

8. Conclusion

The design methodology and results for the proposed Huntlee Tributary-Two stormwater detention basin 3 has been discussed in this report. The detention basin wall and outlet control structure will be constructed at the proposed road crossing to minimise the loss of riparian vegetation. The proposed detention basin has active storage volume of approximately of 10,500 cubic metres which is similar to the volume presented in the 'Trunk Stormwater and Flooding Assessment' report (Worley Parsons August 2012).

It has been demonstrated that the proposed concept adequately ensures no net increase in peak flows during storm events up to the 1% AEP. In doing so the strategy also mitigates the adverse effects of the proposed development on up and downstream properties and the regional hydrology. In addition to this the proposal fits in with the site wide concepts for the Huntlee development such that spatial, servicing and landscaping requirements can be met.

In accordance with condition b) of the approval granted by the Minister for Planning and Infrastructure Huntlee Pty Ltd are now seeking NRAR's concurrence/ satisfaction for the design of the online detention system to support a Construction Certificate for the works.

Appendix A – Detailed Engineering Plans

Appendix B – ARR Data Hub Data

Results - ARR Data Hub
[STARTTXT]

Input Data Information
[INPUTDATA]
Latitude,-32.681200
Longitude,151.357500
[END_INPUTDATA]

River Region
[RIVREG]
Division,South East Coast (NSW)
River Number,10
River Name,Hunter River
[RIVREG_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v1
[END_RIVREG]

ARF Parameters
[LONGARF]
Zone,SE Coast
a,0.06
b,0.361
c,0.0
d,0.317
e,8.11e-05
f,0.651
g,0.0
h,0.0
i,0.0
[LONGARF_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v1
[END_LONGARF]

Storm Losses
[LOSSES]
ID,29260.0
Storm Initial Losses (mm),18.0
Storm Continuing Losses (mm/h),2.0
[LOSSES_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v1
[END_LOSSES]

Temporal Patterns
[TP]
code,ECsouth
Label,East Coast South
[TP_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v2
[END_TP]

Areal Temporal Patterns
[ATP]
code,ECsouth
arealabel,East Coast South
[ATP_META]
Time Accessed,12 March 2021 01:20PM
Version,2016_v2
[END_ATP]

Median Preburst Depths and Ratios
[PREBURST]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.5 (0.020),0.7 (0.021),0.9 (0.022),1.1 (0.022),1.6 (0.028),2.1 (0.031)
90 (1.5),2.8 (0.097),1.9 (0.049),1.4 (0.029),0.9 (0.015),0.8 (0.012),0.7 (0.010)
120 (2.0),0.0 (0.001),0.7 (0.015),1.1 (0.021),1.5 (0.025),1.5 (0.021),1.5 (0.019)
180 (3.0),0.4 (0.013),1.3 (0.027),1.9 (0.032),2.5 (0.036),2.0 (0.024),1.7 (0.018)
360 (6.0),2.2 (0.048),4.2 (0.067),5.6 (0.074),6.9 (0.078),9.2 (0.085),10.9 (0.089)
720 (12.0),3.7 (0.064),7.7 (0.094),10.4 (0.104),12.9 (0.109),14.4 (0.100),15.6 (0.094)
1080 (18.0),0.5 (0.007),6.5 (0.066),10.4 (0.088),14.2 (0.101),15.1 (0.088),15.8 (0.080)
1440 (24.0),0.0 (0.000),4.6 (0.042),7.7 (0.057),10.6 (0.067),12.1 (0.062),13.3 (0.059)
2160 (36.0),0.0 (0.000),1.2 (0.009),1.9 (0.012),2.7 (0.014),5.7 (0.025),8.0 (0.030)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.2 (0.001),0.3 (0.001)
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)

[PREBURST_META]

Time Accessed,12 March 2021 01:20PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST]

10% Preburst Depths

[PREBURST10]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
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)

[PREBURST10_META]

Time Accessed,12 March 2021 01:20PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST10]

25% Preburst Depths

[PREBURST25]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1080 (18.0),0.0 (0.000),0.1 (0.001),0.1 (0.001),0.1 (0.001),0.1 (0.000),0.0 (0.000)
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)

[PREBURST25_META]

Time Accessed,12 March 2021 01:20PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST25]

75% Preburst Depths

[PREBURST75]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),14.0 (0.553),12.3 (0.351),11.2 (0.266),10.1 (0.205),14.3 (0.239),17.3 (0.255)
90 (1.5),30.1 (1.047),21.3 (0.536),15.5 (0.325),9.9 (0.177),10.3 (0.154),10.6 (0.139)
120 (2.0),7.3 (0.230),12.8 (0.295),16.5 (0.316),20.0 (0.328),23.8 (0.326),26.7 (0.321)
180 (3.0),12.3 (0.343),23.8 (0.481),31.4 (0.530),38.8 (0.559),35.3 (0.424),32.7 (0.346)
360 (6.0),18.4 (0.404),31.7 (0.504),40.6 (0.536),49.0 (0.552),54.3 (0.505),58.3 (0.475)
720 (12.0),19.0 (0.322),32.4 (0.393),41.4 (0.414),49.9 (0.423),49.1 (0.341),48.5 (0.293)
1080 (18.0),14.0 (0.204),29.4 (0.303),39.7 (0.335),49.5 (0.352),53.3 (0.309),56.2 (0.283)
1440 (24.0),6.7 (0.087),19.2 (0.176),27.5 (0.207),35.5 (0.224),43.8 (0.224),50.1 (0.222)
2160 (36.0),3.4 (0.038),9.2 (0.072),13.1 (0.084),16.8 (0.090),29.3 (0.127),38.6 (0.145)

2880 (48.0),1.2 (0.012),4.0 (0.029),5.9 (0.034),7.7 (0.037),15.5 (0.061),21.3 (0.072)
4320 (72.0),0.0 (0.000),0.7 (0.004),1.1 (0.006),1.6 (0.007),5.5 (0.019),8.5 (0.026)

[PREBURST75_META]

Time Accessed,12 March 2021 01:20PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST75]

90% Preburst Depths

[PREBURST90]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),39.4 (1.559),36.2 (1.035),34.1 (0.811),32.1 (0.650),59.0 (0.989),79.1 (1.164)
90 (1.5),66.4 (2.310),60.9 (1.532),57.2 (1.200),53.7 (0.961),64.5 (0.960),72.6 (0.952)
120 (2.0),26.0 (0.825),51.2 (1.178),67.9 (1.303),83.9 (1.376),86.0 (1.175),87.6 (1.054)
180 (3.0),38.2 (1.064),55.9 (1.131),67.7 (1.142),79.0 (1.138),92.6 (1.112),102.9 (1.088)
360 (6.0),55.7 (1.226),68.6 (1.089),77.1 (1.018),85.3 (0.960),105.8 (0.984),121.1 (0.988)
720 (12.0),46.8 (0.796),69.6 (0.844),84.7 (0.848),99.2 (0.840),93.0 (0.645),88.4 (0.534)
1080 (18.0),37.1 (0.539),66.6 (0.685),86.1 (0.728),104.9 (0.746),106.3 (0.616),107.4 (0.540)
1440 (24.0),31.1 (0.405),52.5 (0.481),66.7 (0.500),80.3 (0.505),99.6 (0.510),114.1 (0.506)
2160 (36.0),11.3 (0.128),29.0 (0.228),40.6 (0.260),51.8 (0.277),72.4 (0.315),87.9 (0.331)
2880 (48.0),13.3 (0.137),25.0 (0.178),32.7 (0.189),40.2 (0.194),57.5 (0.226),70.5 (0.240)
4320 (72.0),13.7 (0.125),15.0 (0.094),15.8 (0.081),16.5 (0.071),27.2 (0.095),35.2 (0.107)

[PREBURST90_META]

Time Accessed,12 March 2021 01:20PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST90]

Interim Climate Change Factors

[CCF]

,RCP 4.5,RCP6,RCP 8.5

2030,0.869 (4.3%),0.783 (3.9%),0.983 (4.9%)
2040,1.057 (5.3%),1.014 (5.1%),1.349 (6.8%)
2050,1.272 (6.4%),1.236 (6.2%),1.773 (9.0%)
2060,1.488 (7.5%),1.458 (7.4%),2.237 (11.5%)
2070,1.676 (8.5%),1.691 (8.6%),2.722 (14.2%)
2080,1.810 (9.2%),1.944 (9.9%),3.209 (16.9%)
2090,1.862 (9.5%),2.227 (11.5%),3.679 (19.7%)

[CCF_META]

Time Accessed,12 March 2021 01:20PM

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.

[END_CCF]

Probability Neutral Burst Initial Loss

[BURSTIL]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0
60 (1.0),16.6,11.1,10.8,11.7,10.4,6.9
90 (1.5),12.9,9.6,9.8,11.6,11.0,8.9
120 (2.0),18.2,12.2,10.7,10.5,9.5,6.3
180 (3.0),16.1,11.2,10.0,9.6,9.4,5.0
360 (6.0),14.7,10.5,10.3,8.9,8.5,4.2
720 (12.0),15.1,11.0,10.6,9.6,10.3,4.2
1080 (18.0),17.1,12.2,11.6,9.5,11.6,3.2
1440 (24.0),19.4,14.3,13.4,11.9,12.1,4.7
2160 (36.0),23.1,18.1,17.5,17.6,15.6,6.9
2880 (48.0),23.7,20.1,19.7,22.3,17.1,8.9
4320 (72.0),24.3,21.8,22.3,24.9,20.1,15.1

[BURSTIL_META]

Time Accessed,12 March 2021 01:20PM

Version,2018_v1

Note,As this point is in NSW the advice provided on losses and pre-burst on the [NSW Specific Tab](#) of the ARR Data Hub is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

[END_BURSTIL]Transformational Pre-burst Rainfall

[PREBURST_TRANS]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0

60 (1.0),1.3,6.8,7.1,6.2,7.5,11.0
90 (1.5),5.0,8.3,8.1,6.3,6.9,9.0
120 (2.0),0.0,5.7,7.2,7.4,8.4,11.6
180 (3.0),1.8,6.7,7.9,8.3,8.5,12.9
360 (6.0),3.2,7.4,7.6,9.0,9.4,13.7
720 (12.0),2.8,6.9,7.3,8.3,7.6,13.7
1080 (18.0),0.8,5.7,6.3,8.4,6.3,14.7
1440 (24.0),0.0,3.6,4.5,6.0,5.8,13.2
2160 (36.0),0.0,0.0,0.4,0.3,2.3,11.0
2880 (48.0),0.0,0.0,0.0,0.0,0.8,9.0
4320 (72.0),0.0,0.0,0.0,0.0,0.0,2.8

[PREBURST_TRANS_META]

The tranformational pre-burst is intended for software suppliers in the NSW area and is simply the Initial Loss - Burst Initial Loss. It is not appropriate to use these values if considering a calibrated initial loss.

[END_PREBURST_TRANS]

[ENDTXT]

Appendix C – Hydraulic Results

[illegible][illegible]