Stormwater Management Strategy

For

Wine Country Drive – Large Lot Residential Subdivision

For

Huntlee Urban Release Area

for Huntlee Pty Ltd

Report Document Control

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Contents

1. Introduction

Northrop Consulting Engineers have been engaged by Huntlee Pty Ltd to prepare a Concept Stormwater Management Strategy for the proposed 113 large lot rural residential subdivision off Wine Country Drive (WCD) as part of the Huntlee Urban Release Area (URA). Positioned on Lot 10, DP 1105639, the subdivision forms part of the overall Stage 1 Huntlee Project Area.

This report has been prepared to support the modification application to convey the concept stormwater management philosophy adopted for the revised subdivision layout.

1.1 Project Background

1.1.1 Huntlee Urban Release Area

The Huntlee Project is a major URA in the Hunter region which will provide housing for approximately 20,000 people accommodated within up to 7,300 dwellings. The project will deliver a new town comprising of a commercial centre, residential precincts, open spaces, recreation areas, conservation reserves and supporting employment lands.

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). The DCP applies to all development on the land in Zone R1 General Residential, Zone R2 Low Density Residential and Zone B4 Mixed Use within the Huntlee site and is to be used to assess all development applications.

Figure 1 below shows an extract from the DCP illustrating the extent of the Huntlee Project Area and respective LGA's.

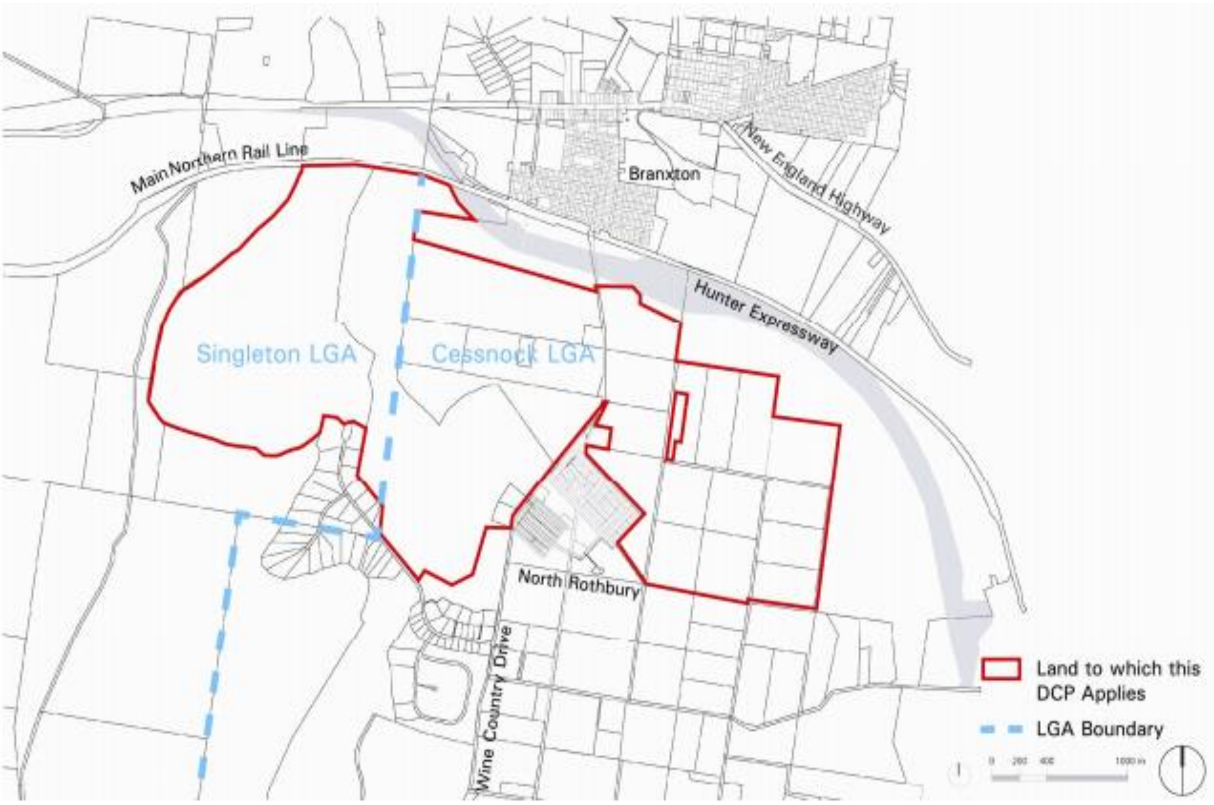


Figure 1: Extract from Huntlee DCP 2013

1.1.2 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 approximately 175 dwellings already occupied. The Stage 1 Project Area in context of the overall Huntlee development framework is shown below in **Figure 2.**

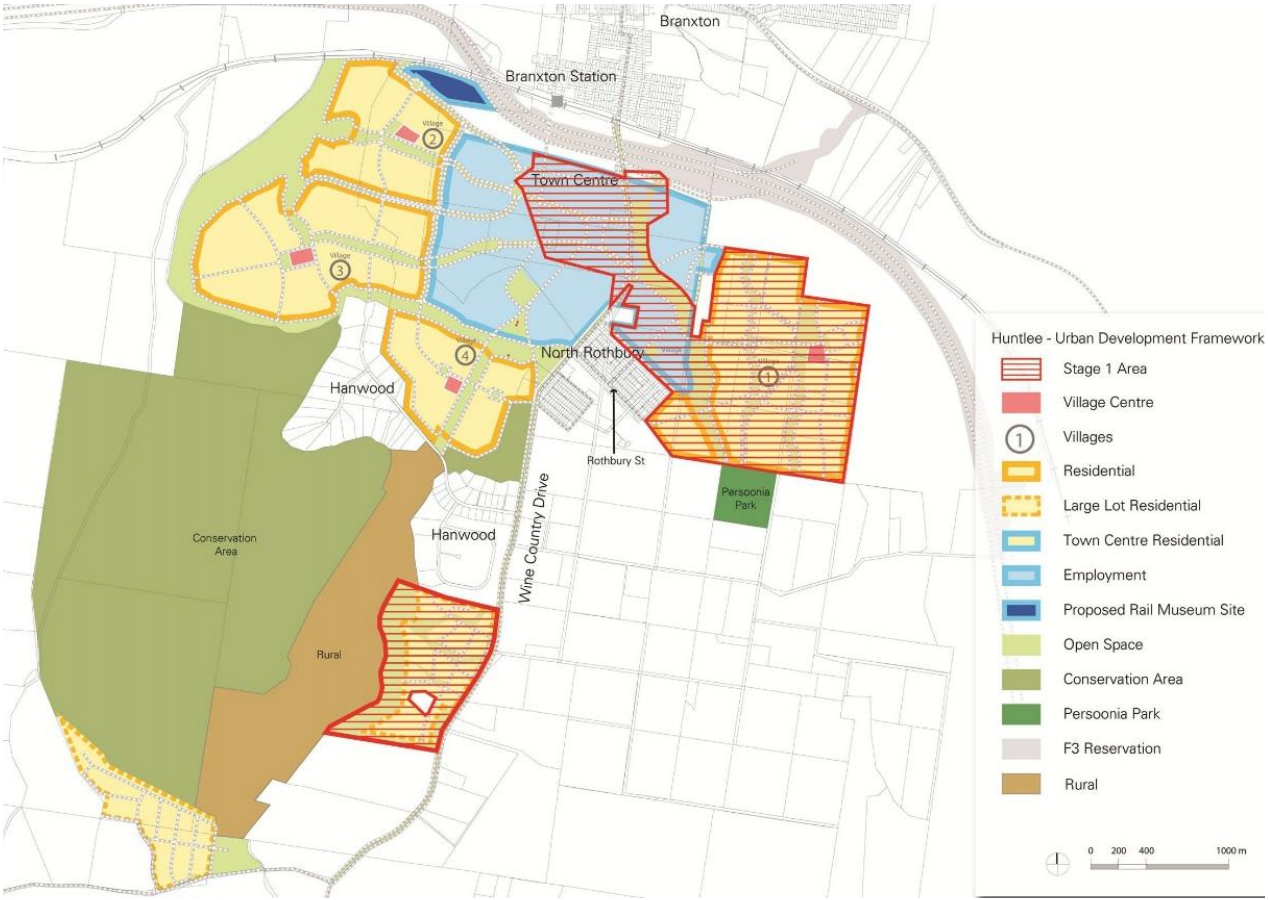


Figure 2: Stage 1 Project Area within Overall Huntlee Development Framework

The Stage 1 Project Area includes the first residential village extending north east of the existing North Rothbury township, approximately 50ha of the Town Centre and approximately 80ha of large residential lots located off WCD to the south of the Town Centre within the suburb of Rothbury (hereby referred to as ‘the Site’).

1.2 Proposed Development and Current Approval Modification

The large lot subdivision is proposing to deliver a rural-residential style development with lot sizes ranging from approximately 2000m^2 up to over 7ha. Wide road reserves and low densities across the site will be in keeping with the surrounding developments and properties. Given the size of the individual allotments public open space within the development will be minimal.

This modification is seeking approval to amend the proposed subdivision layout to better consider site access, onsite flooding, riparian offsets and asset protection zones. Accordingly, this report is seeking to update the proposed Stormwater Management Strategy and confirm requirements for future onsite development in accordance with the revised layout. Specifically, under the modification for the Site this report will supersede the current approved stormwater strategy *Trunk Stormwater and Flooding Assessment* - Stage *1 Project Application* prepared by WorleyParsons in 2012.

2. Stormwater Management

2.1 Stormwater Management Objectives

Urbanised development often results in significant modification to soils, topography, impervious percentages and vegetation. Surface water runoff volumes and pollutant concentrations from urban catchments are typically above pre-developed states and without management have the potential to convey increased runoff volumes and pollutant loads to downstream receiving waters. Unmanaged these increases can have detrimental impacts on stream stability, environmental ecology and flooding.

To mitigate the potentially detrimental effects of urbanisation upon the catchment a Stormwater Management Plan will be implemented across the site. The principles of the proposed stormwater management strategy have been derived from the riparian, flood and water cycle controls identified under Section 3 of the 2013 Huntlee DCP. The DCP states that development is to incorporate the principles of Water Sensitive Urban Design (WSUD).

To deliver a Stormwater Management Plan which achieves the principles of WSUD the following objectives have been set:

- Identify the riparian corridors within the site through categorisation of the tributaries in accordance with DPI Water's 'Guideline for Riparian Corridors on Waterfront Land' requirements.
- Determine the 1% AEP flood inundation extents along the identified tributaries within the site boundary to inform flood planning for the development.
- Minimise the potential impact of local and downstream flooding by ensuring no net increase in peak flows during events up to the 1% AEP storm in receiving waterways.
- Mitigate the impacts of urban development on stormwater quality through integrated management of land and water resources incorporating best practice stormwater management, to reach the nominated pollutant load reduction targets.

2.2 Approved Stormwater Management Strategy

The Stormwater Strategy approved under the Stage 1 Development Application was based upon the *Trunk Stormwater and Flooding Assessment* - Stage *1 Project Application* prepared by WorleyParsons in 2012. Under this strategy management of rural residential style lots was to be largely undertaken through the adoption of onsite measures. Table *6.2-Potential Stormwater Management Solutions for Various Land Uses* specifically identified the following for rural residential areas:

- *Rural residential and large lot residential areas lend themselves to complete on-lot management of stormwater. This can be achieved through rainwater tanks for roofed areas and by allowing runoff from other impervious surfaces (and any overflow from rainwater tanks) to infiltrate in vegetated areas. Roadways can be effectively treated using roadside swales and bio-retention areas. (Trunk Stormwater and Flooding Assessment* - Stage *1 Project Application,* Worley Parsons 2012).

Landscaping features such as contour banks and 'soak-a-ways' were also identified as suitable source controls for rural residential lots where runoff from impervious surfaces can be directed onto grassed areas and slowly infiltrated.

2.3 Proposed Stormwater Management Strategy

The strategy outlined by the Worley Parsons 2012 report is to be largely adopted by the revised lot layout. With a proposed minimum lot size in excess of 2000m^2 and relatively flat natural surface grades, on lot measures including rainwater harvesting tanks and landscaping features encouraging infiltration are considered appropriate for the site. Treatment and conveyance of runoff from the road reserve via vegetated swales and biofiltration basins have also been considered appropriate for the revised layout.

The report sections below aim to identify the Site's existing riparian and onsite flooding constraints, review the sites requirement for onsite detention and outline the proposed stormwater mitigation measures to be adopted under the revised management strategy.

3 Site Characteristics

3.1 Existing Site Description

The Site is located approximately 1.6km south of the existing North Rothbury township. Covering a total area of approximately 82.3ha the Site is bordered to the east by WCD, west by Black Creek, south by existing rural development and north by future lots within the Hanwood rural residential subdivision. An aerial depiction of the site in its existing state is provided below in **Figure 3.**

The Site is predominately cleared grazing land with the exception of some areas of sparse bushland mostly located along the boundary and drainage lines. The average surface slopes across the proposed subdivision are approximately 2% with only small areas of minor localised regrading for diversion swales, farm dams and the like evident. The site falls in a north westerly direction towards Black Creek. Black Creek is a significant feature of the Cessnock LGA, with a large proportion of the City's population living within its catchment.

Figure 3: Existing Site (Source: https://maps.six.nsw.gov.au/)

3.2 Available Topographic Data

Due to the size of the Site, detailed survey has not been undertaken at this stage of the development. It is understood that detailed survey of the development area will be undertaken on a stage by stage basis during the detailed design phase. For this reason, Light Detection and Ranging (LiDAR) aerial survey has been used for the purpose of this assessment. It is noted that the accuracy of the ground information obtained from LiDAR survey can be adversely affected by the nature and density of vegetation, the presence of steeply varying terrain, the vicinity of buildings and/or the presence of water. The accuracy is typically plus or minus 0.15 m for clear terrain. As this assessment has been undertaken to inform the concept planning of the proposal the level of accuracy provided by the LiDAR data has been considered acceptable. It is however recommended that detailed survey be used to undertake future detailed designs.

3.3 Existing Catchment

3.3.1 Black Creek

The entire catchment of Black Creek is approximately 307km^2 and extends from the Broken Back Range in the west to the Cessnock State Forest in the east. Within the lower reaches, the network runs through large areas of agriculture land and is therefore subject to a significant volume of licensed water extraction for irrigation purposes. Within the subject Site, Black Creek is characterised by an almost flat bed that maintains permanent flows.

The Black Creek catchment has an extensive flooding history with significant events recorded in 1927, 1949, 1974, 1977, 2007 and most recently in 2015. A Council commissioned flood study from Nulkaba to Branxton published by WMA Water was released in 2015. The study recommends the outcomes of the assessment be used by Council as a planning tool to mitigate flood risk to future development in the catchment. In accordance with this recommendation, development within the Site will be governed by the Black Creek flood inundation levels obtained from Cessnock City Council.

3.3.2 Existing Onsite Watercourses and Riparian Corridors

Natural drainage across the Site is characterised by three tributaries, including Dominicks Creek to the north, which conveys runoff in a westerly direction to Black Creek. These tributaries convey runoff from significant upstream rural catchments which have been depicted below in **Figure 4.** The central and southern watercourses are unnamed and thus for the purposes of this report have been referred to as Tributaries 1 and 2 respectively.

Each of the existing watercourses entering site have been classified in accordance with the Strahler method. The classifications have been summarised in **Table 1**, it is noted that Dominicks Creek and Tributary 1 combine near the north western corner of the site forming a 3rd order water course prior to crossing the boundary.

Table 1: Entering Watercourse Classification

Water Course	Sub-Catchment Area (ha)	Strahler Order
Black Creek	-	4th
Dominicks Creek	218	2nd
Tributary 1	89	2nd
Tributary 2	490	2nd

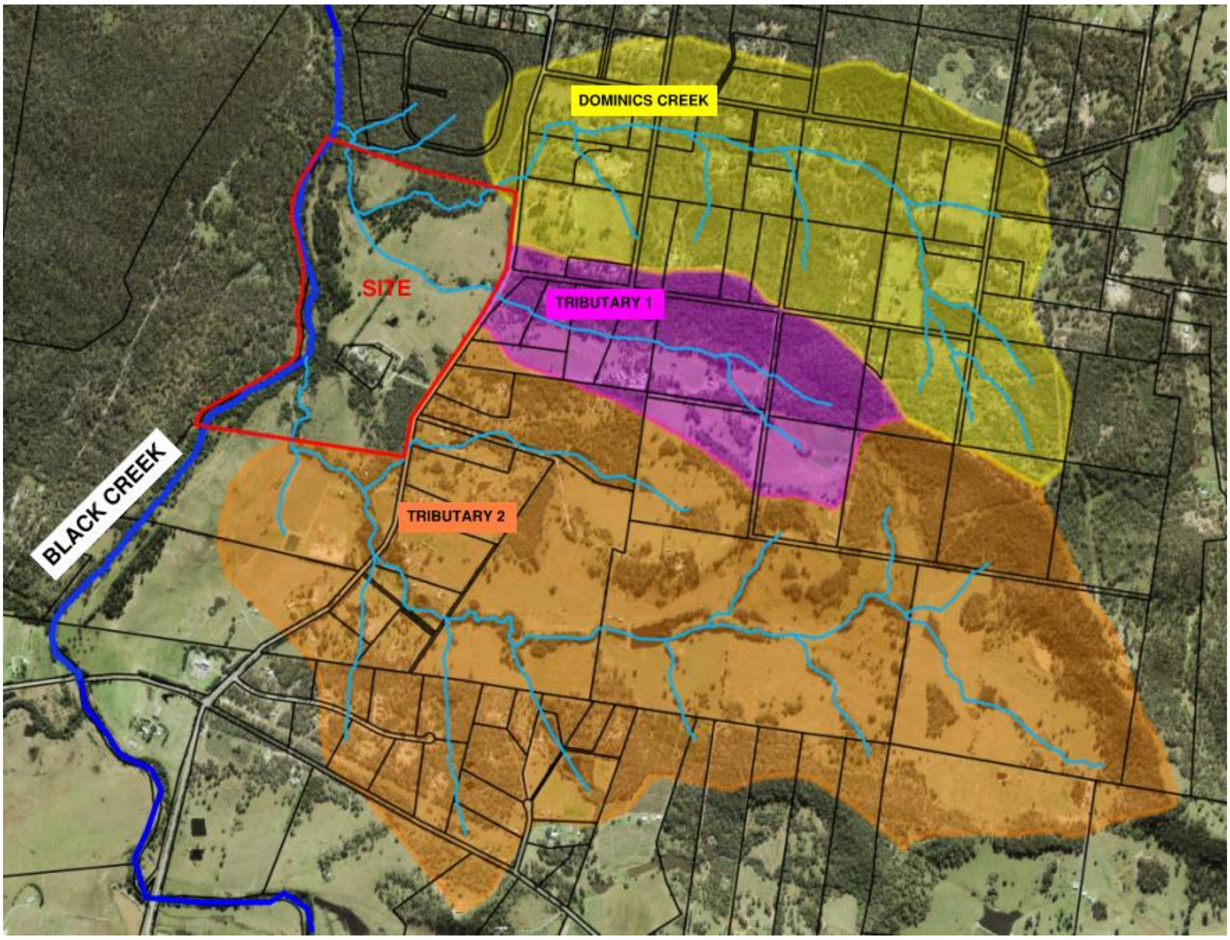


Figure 4: Upstream Watercourses & Sub-Catchments

Designated riparian corridors are to be established along each of the identified watercourses to determine development offsets in accordance with the original stormwater management objectives outlined by the Worley Parsons strategy. Riparian corridors play a vital ecological role providing a transition zone between the terrestrial environment on land and the aquatic environment within a waterbody. In accordance with the NSW Department of Planning, Industry and Environment (DPIE) Water requirements, riparian corridors are to be established based on watercourse order to determine the 'Vegetated Riparian Zone' and average channel width. Table 2 summarises the adopted total riparian corridor widths for each water course order.

Table 2: Adopted Riparian Corridor Widths

Watercourse Order	Vegetated Riparian Zone Width Each Side of Watercourse (m)	Average Channel Width (m)	Total Riparian Corridor Width (m)
1st	10	0-1	20-21
2nd	20	5	45
3rd	30	10	70
4th	40	15	95

All riparian corridors have been depicted on the 'Concept Stormwater Management Plan' provided within Appendix B.

4 Onsite Flooding & Detention Assessment

Development offset from Black Creek has been determined by the flood inundation levels provided by CCC. To understand the flooding constrains across the remainder of the Site resulting from the 3 defined watercourses, further study has been undertaken. The study has also sort to investigate the pre and post developed runoff flow rates to assess the requirement for onsite detention.

4.1 Methodology

The following methodology has been undertaken for the assessment:

- Review of available information including the proposed development layout, LiDAR elevation data, Aerial Imagery and Cadastre.
- Construction of a one-dimensional XP-RAFTS model to estimate peak flows derived by the waterways to the east of WCD and through the subject site.
- Modification of the one-dimensional XP-RAFTS model to include the proposed development.
- Comparison of the peak flow derived by the pre and post developed catchments during the 20%, 10%, 5% and 1% AEP with consideration given to the likely timing of the peak from the nearby Black Creek catchment.
- Construction of a two-dimensional HEC-RAS model to determine the flood extents through the subject site during both the 1% AEP and PMF design storm events for both the existing and developed case scenarios.

As noted above, flows and flooding of the subject site derived from the upstream Black Creek catchment have not been assessed as part of this study. This information has been obtained from the Black Creek Flood Study – Stage 2 (Nulkaba to Branxton) prepared by WMA Water in December 2015 as provided by Council.

4.2 Hydrological Model Parameters

The hydrological model was developed in XP-RAFTS using Laurenson Hydrology. As per the latest Australian Rainfall and Runoff Guidelines (ARR 2019); initial loss, continuing loss and pre-burst rainfall portions of the design storm events have been considered as part of this study as shown in the below **Figure 5.**

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, each of which have been summarised in the report sections below.

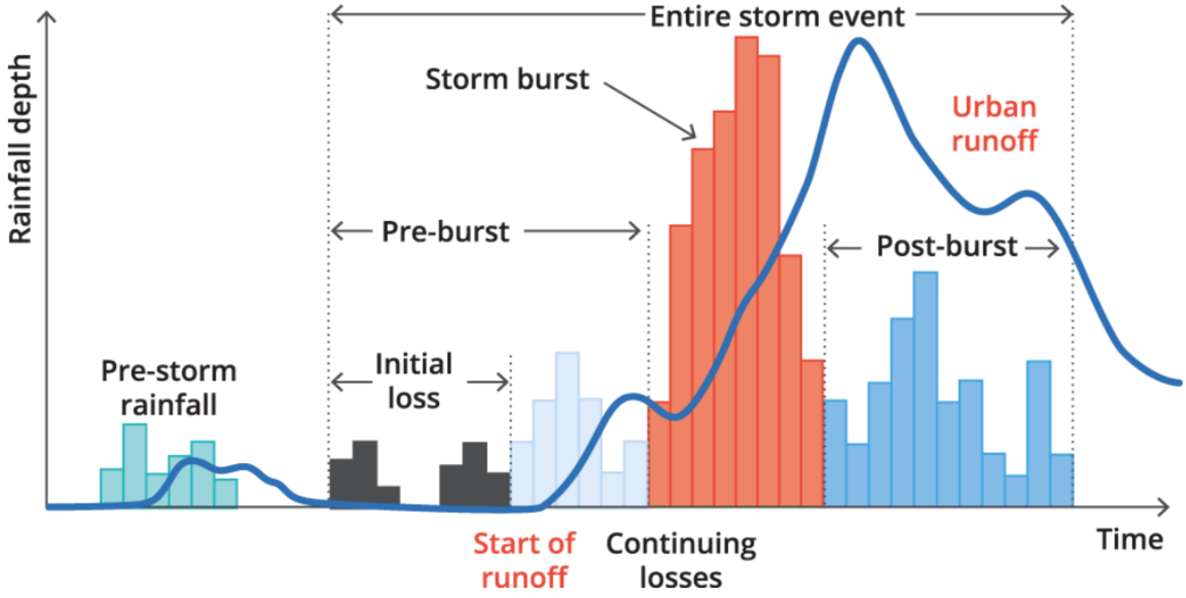


Figure 5 - Conceptual Design Storm Pattern (ARR 2019 Figure 9.6.4)

4.2.1 Sub-Catchment Properties

Sub-catchments have been digitised using a combination of LiDAR, Aerial imagery and Cadastral data. Appendix A - Figure 1 presents the sub-catchments considered as part of the study while the below **Table 3** presents the sub-catchment properties.

Catchment slope has been determined individually for each sub-catchment, while impervious percentages for rural areas have been estimated from review of aerial imagery.

Table 3 - Modelled Existing Case Sub-Catchment Properties

Catchment Reference	Area (ha)	Impervious (%)	Slope (%)
C01	144.20	3.0	5.25
C02	44.68	1.0	6.21
C03	184.40	0.0	5.42
C04	71.8	3.0	3.24
C05	46.04	3.0	4.22
C06	14.38	2.0	3.35
C07	64.48	3.0	3.63
C08	194.99	5.0	2.88
C09	30.37	4.0	2.05
C10	17.76	7.0	2.03
C11	22.16	5.0	1.66
C12	35.50	4.0	1.29
C13	27.60	3.0	1.99

The developed case catchments remain the same as presented in Table 3 above, with an increased impervious percentage over the developed catchments. A typical 45% impervious fraction has been adopted over the developed areas of the catchment.

4.2.2 Rainfall

The latest rainfall depths have been obtained from the Bureau of Meteorology (BOM) for a location over the catchment centroid. The latest ARR 2019 temporal patterns for the “East-Coast South” region was applied to the 20%, 10%, 5% and 1% AEP design storm depths. To remain conservative, Areal Reduction Factors have not been considered as part of this study.

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).

4.2.3 Pre-Burst Rainfall

The Transformational Pre-Burst depths have been added to the design rainfall events and distributed evenly over three timesteps prior to the burst of the design storm events. As recommended by the latest ARR 2019 guidelines, the 60min pre-burst depths have been used for storm durations that are less than 60 minutes.

4.2.4 Losses and Roughness

The latest ARR 2019 storm losses have been used for this study and were obtained from the ARR Data Hub. Storm losses provided by the ARR Data Hub are intended for Rural catchments. With the intended land-use for the proposed developed to be rural residential, additional reductions to the pervious initial losses have not been made as shown in the below Table 4**.** Modelled continuing losses have been reduced by a factor of 0.4 in accordance with the advice provided in the latest Department of Primary Industry and Environment (DPIE) guidelines.

The typical Laurenson storage non-linearity exponent of -0.285 was used for the 20% to 1% AEP design storm events and was modified to -0.001 during the PMF to represent a linear catchment response during more significant events.

Table 4 - Modelled Hydrologic Losses and Roughness Parameters

Land-use	Initial Loss (mm)	Continuing Loss (mm/hr)	Roughness
Rural Pervious (ARR Data Hub)	37.0	3.3	N/A
Modelled Pervious (Upstream)	37.0	1.32	0.060
Modelled Pervious (Developed Areas)	37.0	1.32	0.045
Modelled Impervious	1.5	0.0	0.015

4.2.5 Hydraulic Model Parameters

The two-dimensional (2D) model used for this study is HEC-RAS 2D developed by the U.S Army Corps of Engineers. HEC-RAS 2D is capable of performing two-dimensional shallow water flow equations including the 2D Saint Venant and Momentum equations. It is considered suitable for the purposes of this study.

4.2.6 Terrain Data

The terrain data used for the two-dimensional model is the 2011 LiDAR elevation data obtained from the ELVIS – Elevation and Depth – Foundation Spatial Data website and made available for use by the NSW Government. It is noted no changes to the topography have been made between the Existing and Developed case scenarios.

4.2.7 Catchment Roughness

Catchment roughness was based on review of hydraulic literature and aerial imagery. The below **Table 5** presents the hydraulic roughness used across the two-dimensional model.

Table 5 - Modelled Hydraulic Roughness Parameters

Land use Type	Roughness (Manning's)
Buildings	0.900
Black Creek	0.030
Drainage Channels	0.040
Forest	0.090
Grass/Pasture/Cultivated Land	0.045
Water Bodies	0.020
Sealed Roads	0.015
Unsealed Roads	0.022

4.2.8 Mesh Extent, Size and Timestep

The two-dimensional grid used extends from Wine Country Drive in the east, Black Creek to the west and approximately 250m north and 800m south of the subject site.

A maximum three-metre mesh cell size has been used which was considered a suitable size for the purposes of this study. An adaptive timestep was used with a maximum Courant number of 0.9. The adaptive timestep enables more efficient model run times while, still maintaining a high degree of accuracy.

4.2.9 Boundary Conditions

Seven inflow boundaries are included in the model as shown in Appendix A - Figure 1. One inflow for each of the six tributaries upstream of the subject site (Inflows A to F in Appendix A - Figure 1), and another in Black Creek upstream of the subject site have been included in the 2D model. Flows derived by the subject site have been entered at the inflow boundaries on the upstream end of the site which is considered conservative.

Bank-full flow conditions have been used in Black Creek for both the 1% AEP and PMF design storm events while inflows for each of the eastern tributaries have been extracted from the one-dimensional

XP-RAFTS model. An outlet head boundary with an elevation of 32.0m AHD is located in Black Creek, downstream of the subject site for both the 1% AEP and PMF. This effectively represents a free-outfall tail-water condition for flows through the tributaries through the subject site.

4.2.10 Hydraulic Structures

Hydraulic structures have not been considered in the one and two-dimensional modelling. This is considered conservative as detention upstream of the Wine Country Drive is ignored, resulting in higher peak flows through the Site.

4.3 Critical Duration

The critical duration was determined in XP-RAFTS with storm durations ranging from 10-minutes to the 72-hours considered for the 20%, 10%, 5% and 1% AEP design storm events. For events more frequent than the PMF, the duration that produced the highest median peak flow through Dominick's Creek and the adjacent un-named creeks was considered the critical duration. The duration that produced the maximum peak flow was considered the critical event for the PMF. This methodology is consistent with the recommendations in ARR 2019.

4.4 Results

4.4.1 Detention

The XP-RAFTS model has been used to review the pre-developed and post-developed peak flow rates for the subject site. Previous discussions with Cessnock City Council has identified a preference to limit open space areas as part of the proposed development and as such, an investigation for the suitability of stormwater detention has been performed as part of this study.

The following three site discharge points have been identified (refer to Appendix A – Figure 1 for locations):

- Discharge Point I: Downstream of C09 (includes flow from C10 and upstream).
- Discharge Point II: Downstream of C11.
- Discharge Point III: Downstream of C12 (includes flow from C13 and upstream).

The pre-developed and post developed critical duration and peak flow results for these three main discharge points are presented in the below Table 6, Table 7 and Table 8.

Table 6 - Pre to Post Comparison Discharge Point I (Downstream of C09)

Storm Event	Pre-Developed Critical Event	Pre-Developed Flow (m^3/s)	Post-Developed Critical Event	Post-Developed Flow (m^3/s)	Difference (m^3/s)
20% AEP	1.5 hour_TP8	14.30	1.5 hour_TP8	14.08	-0.22
10% AEP	1.5 hour_TP6	18.85	3 hour_TP4	18.59	-0.26
5% AEP	3 hour_TP4	23.29	2 hour_TP3	23.18	-0.11
1% AEP	1 hour_TP2	38.70	1 hour_TP2	37.97	-0.73

Table 7 – Pre to Post Comparison Discharge Point II (Downstream of C11)

Storm Event	Pre-Developed Critical Event	Pre-Developed Flow (m^3/s)	Post-Developed Critical Event	Post-Developed Flow (m^3/s)	Difference (m^3/s)
20% AEP	1.5 hour_TP8	1.59	1.5 hour_TP1	2.26	0.67
10% AEP	1.5 hour_TP6	2.10	15 min_TP4	2.67	0.57
5% AEP	2 hours_TP7	2.59	15 min_TP4	3.16	0.57
1% AEP	1 hour_TP7	4.35	1.5 hour_TP10	4.89	0.54

Table 8 – Pre to Post Comparison Discharge Point III (Downstream of C12)

Storm Event	Pre-Developed Critical Event	Pre-Developed Flow (m^3/s)	Post-Developed Critical Event	Post-Developed Flow (m^3/s)	Difference (m^3/s)
20% AEP	3 hour_TP6	15.79	3 hour_TP6	15.68	-0.11
10% AEP	3 hour_TP6	22.89	3 hour_TP6	22.72	-0.17
5% AEP	3 hour_TP9	28.70	3 hour_TP9	28.46	-0.24
1% AEP	2 hour_TP8	43.65	2 hour_TP8	43.26	-0.39

The results presented in the above Table 6 and Table 8 suggest peak flow rates are reduced downstream of sub-catchments C09 and C12 with no mitigation proposed. This is expected to be due to the timing between the peak of the upstream regional catchments and discharge from the development site. Runoff derived by the developed areas responds quickly and is released before the peak of the upstream catchment passes through the subject site. As a result, the peak from the upstream catchment is reduced.

The above Table 7 suggests that an increase in peak flow is observed immediately downstream of sub-catchment C11. This is expected to be due to the size of the upstream catchment being much smaller than the other two (total being C06 and C11 only). The smaller catchment size has a faster response time which coincides with the discharge from the developed catchments.

To review the potential impact the proposed development may have on the regional event, a comparison of the overall discharge from the site, with all three discharge points combined, has been prepared. The Black Creek Flood Study – Stage 2 (Nulkaba to Branxton) prepared by WMA Water in December 2015 suggests the critical event in the lower reaches of Black Creek is the 36-hour duration. A comparison of the pre-developed and post-developed results from the XP-RAFTs model during the 36hr is presented in the below Figure 6 and Figure 7.

The results shown in the Figure 6 and Figure 7 demonstrate that a decrease is expected downstream of the subject site during the regional event critical duration. This is expected to be due to the early response from the developed catchment as shown in Figure 6. Figure 7 also shows a decrease in the tail of the local catchment hydrograph. This is important to recognise as it is likely, due to the size of the regional Black Creek catchment, that the coincidence of the local catchment and the peak of the Black Creek catchment will occur during the tail of the local catchment.

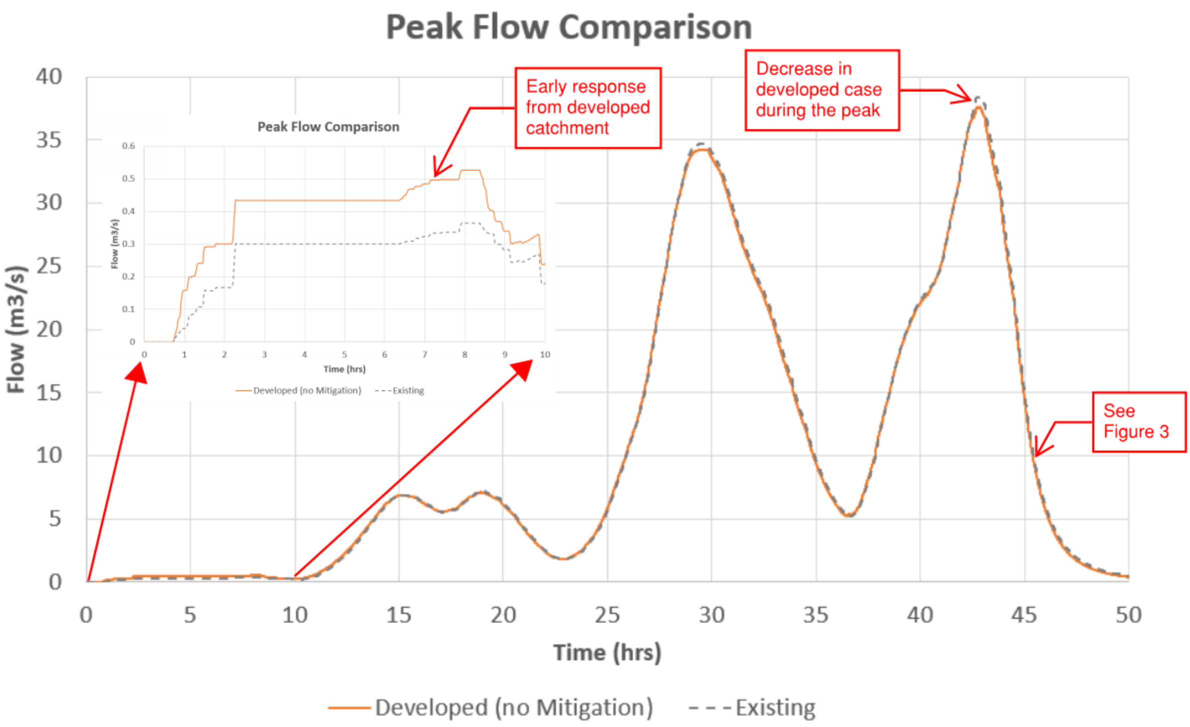


Figure 6 – XP-RAFTS Pre and Post Developed peak flow comparison – Local Catchment (Combined Site Discharge – 1% AEP 36hr Temporal Pattern 5)

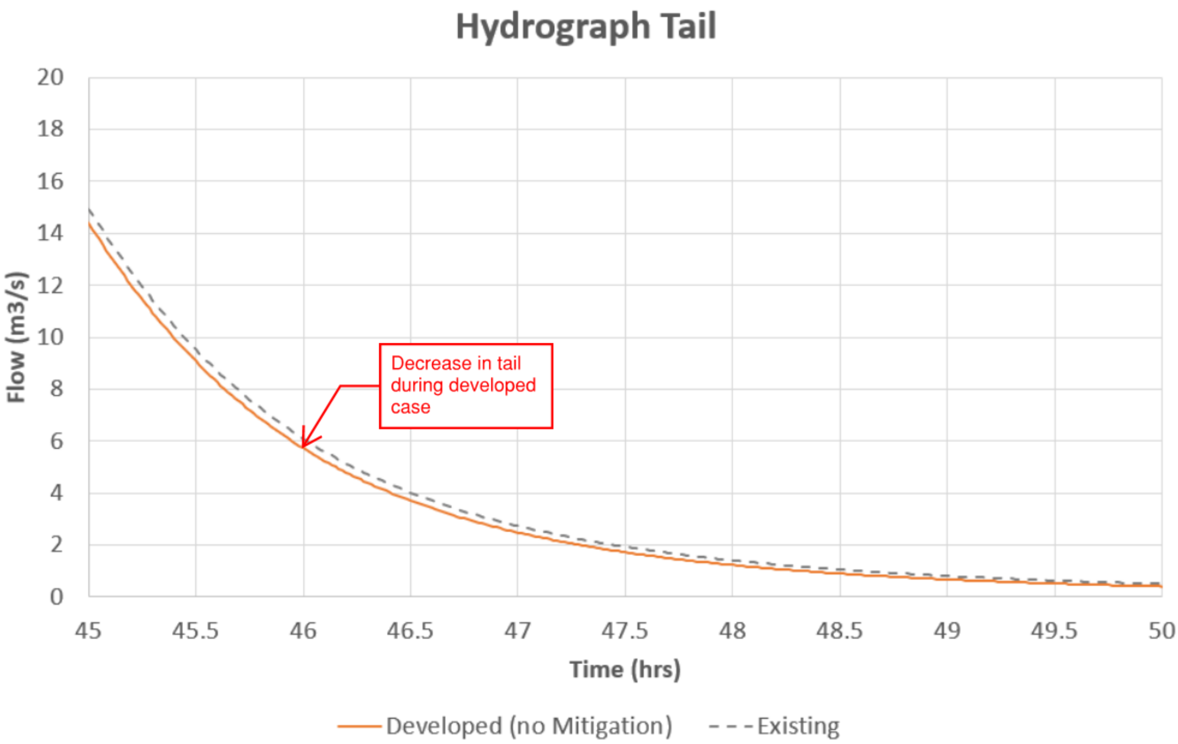


Figure 7 – XP-RAFTS Pre and Post Developed peak flow comparison – Local Catchment Tail-Only (Combined Site Discharge – 1% AEP 36hr Temporal Pattern 5)

The results presented above show that although there may be a minor increase in the peak flow from the subject site downstream of catchment C11 (during short duration events), an overall decrease is observed in the peak during the critical regional event. As such, a minor decrease in the flood level is expected downstream of the subject site during a regional Black Creek flood event, and as such onsite detention measures are not considered appropriate for the proposed development.

4.4.2 Flooding

Flow derived by the XP-RAFTS model has been applied directly to the two-dimensional grid at the locations shown in Figure 1 within Appendix A. Figures 2 to 5 within Appendix A present the existing case flood depth, elevation and velocity through the subject site for both the 1% AEP and PMF design storm events.

Similarly, Figures 6 to 9 within Appendix A present the developed case flood depth, elevation and velocity through the subject site for both the 1% AEP and PMF design storm events. The 1% AEP regional flood extent presented in the Black Creek Flood Study – Stage 2 (Nulkaba to Branxton) prepared by WMA Water in December 2015 has also been included in the figures.

The results show some sections of the development are expected to be impacted by the 1% AEP particularly downstream of inflows E and F. In these locations the flood inundation extents are largely contained within the proposed riparian corridors with only minor encroachments extending beyond. In location D entering upstream runoff is to be conveyed within the road reserve. All future on lot development will be restricted to areas above the 1% AEP with habitable dwellings to adopt minimum freeboard levels in accordance with CCC requirements.

5 Stormwater Quality Assessment

In order to minimise any adverse impacts upon the ecology and health of the downstream watercourses, stormwater treatment devices have been incorporated into the design of the development.

5.1 Methodology

The performance of the proposed stormwater management strategy has been assessed using the conceptual computer software MUSIC (Version 6.2). MUSIC serves as a planning and decision support system that is used to estimate the efficiency of Stormwater Quality Improvement Devices (SQIDs) at capturing common stormwater pollutants including Total Suspended Solids, Total Nitrogen, Total Phosphorous and Gross Pollutants 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.

5.2 Stormwater Quality Philosophy and Targets

Stormwater quality is proposed to be managed through a treatment train approach to meet pollutant removal efficiency targets outlined in the Huntlee DCP 2013. These targets have been reproduced in **Table 9** below.

Table 9: 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.

5.3 Treatment Train Assessment

5.3.1 Model Parameters

In order to establish a MUSIC model, rainfall and evaporation records in the vicinity of the Huntlee site were sought. To develop a model that could comprehensively assess the performance of the proposed stormwater management plan and to be consistent with the *Trunk Stormwater and Flooding Assessment* undertaken by Worley Parsons, 6-minute pluviograph data from the BoM station 061174, located in Millfield, was used. As per the Worley Parsons study, 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 10.**

Table 10: 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

It is noted that as development is to be restricted to areas above the 1%AEP modelling has only considered the developable land above this inundation level. A total impervious percentage of 45% was adopted for the lot areas above the 1% AEP, 67% of which was modelled as roof area with the remaining 33% modelled as hardstand. A total impervious percentage of 65% was adopted for the street and verge areas. To reflect this the catchment was split into three primary land use categories being ‘Rural-Residential’, ‘Residential – Roof’ and ‘Road Reserve’.

The Base and Storm Flow concentration parameters for the different land uses have been adopted from the NSW MUSIC Modelling Guidelines, 2015. Parameters for the source node inputs used are summarised in Tables 11 to 14.

Table 11: Concentration Parameters for TSS (Tables 5-6 and 5-7 NSW MUSIC Modelling Guidelines)

Total Suspended Solids	Concentration Parameter	Residential	Sealed Road
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	2.430
	Std Dev (log mg/L)	0.320	0.320

Table 12: Concentration Parameters for TP (Tables 5-6 and 5-7 NSW MUSIC Modelling Guidelines)

Total Phosphorus	Concentration Parameter	Residential	Sealed Road
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)	-0.60	-0.300
	Std Dev (log mg/L)	0.25	0.250

Table 13: Concentration parameters for TN (Tables 5-6 and 5-7 NSW MUSIC Modelling Guidelines)

Total Nitrogen	Concentration Parameter	Residential	Sealed Road
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)	0.30	0.340
	Std Dev (log mg/L)	0.19	0.190

Table 14: 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
Pervious Areas	Soil Storage Capacity (mm)	88	88
	Initial Storage (% of Capacity)	25	25
	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

5.3.2 Modelled Treatment Train

The proposed treatment measures to be adopted across the site have been summarised below. In conjunction with the practical constraints of the proposed development layout and riparian corridors, device positions were governed by the provision of access for maintenance.

- **Rainwater Harvesting Tanks**

Rainwater harvesting tanks connected to individual roof areas have been proposed as the primary source control. Harvested water shall be reused onsite through non-potable internal and external connections. The adoption of rainwater tanks will not only effectively reduce the demand on the potable water supply but also reduce the volume of runoff from each dwelling effectively reducing the size of downstream controls. By removing the 'first flush' of rainfall through proprietary fittings, the tanks will aid in the removal of debris, sediment and attached nutrients collected on roof areas.

Reuse tanks with a minimum volume of 10kL have been modelled which were considered appropriate given the size of the individual allotments. With a piped inter-allotment drainage network not considered necessary for the development density or style, tank overflows are anticipated to discharge via grass swales to level spreaders as required to return concentrated runoff to sheet flow.

- **Landscaping Features**

Landscape features such as contour banks and soak-a-ways have also been considered as source controls across the site. Landscape design promoting slow infiltration of impervious surfaces could easily be accommodated across the rural style lots. Such features have therefore been modelled as buffer strips downstream of all rural residential catchments. Buffers represent vegetated areas such as backyards and roadside grass strips which act to filter sheet flow runoff from areas such as driveways prior to discharging to downstream receiving waters.

- **Vegetated Swales**

Vegetated grass swales have been proposed to provide primary treatment to runoff from road reserve areas. Vegetation within the swales will aid in the removal of gross pollutants, coarse sediment and suspended solids. Swales shall also be adopted as conveyance measures to direct runoff from road reserves to the downstream receiving waters within dedicated drainage easements.

- **Biofiltration Basins**

Three biofiltration basins have been proposed across the site to provide end-of-line secondary treatment. Collected stormwater runoff is to pond within the basins and infiltrate through a porous filter media which supports nutrient removing plant species. Infiltrated stormwater is captured in a subsurface drain and discharged back to the main stormwater line. Stormwater will enter these basins via a riprap-lined weir designed to dissipate energy. A high flow bypass will be provided to prevent scour damage in higher intensity rainfall events.

The proposed location and approximate sizing of these biofiltration basins has been depicted on the 'Concept Stormwater Management Plan' provided within Appendix B.

Figure 8 below shows the nodal representation of the modelled treatment train in MUSIC.

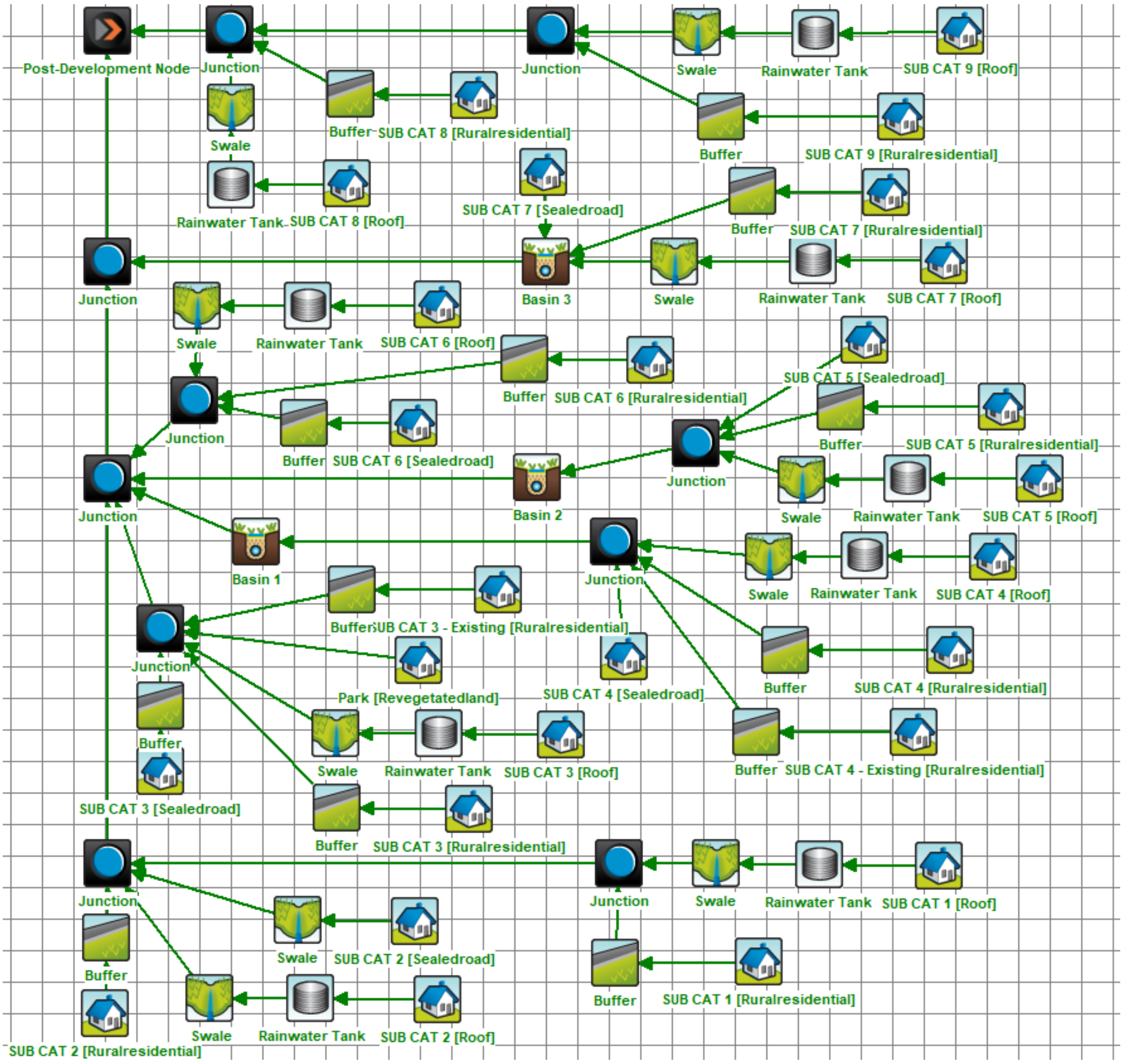


Figure 8: Schematic of MUSIC model

5.3.3 MUSIC Model Results

The results calculated by the MUSIC model are shown in **Table 15** 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 15: Pollutant Removal Efficiency Results

Parameter	Source Load	Residual Load	% Reduction
TSS (kg/yr)	14000	2090	85
TP (kg/yr)	33.8	13.3	61
TN (kg/yr)	299	149	50
GP (kg/yr)	4640	1010	78

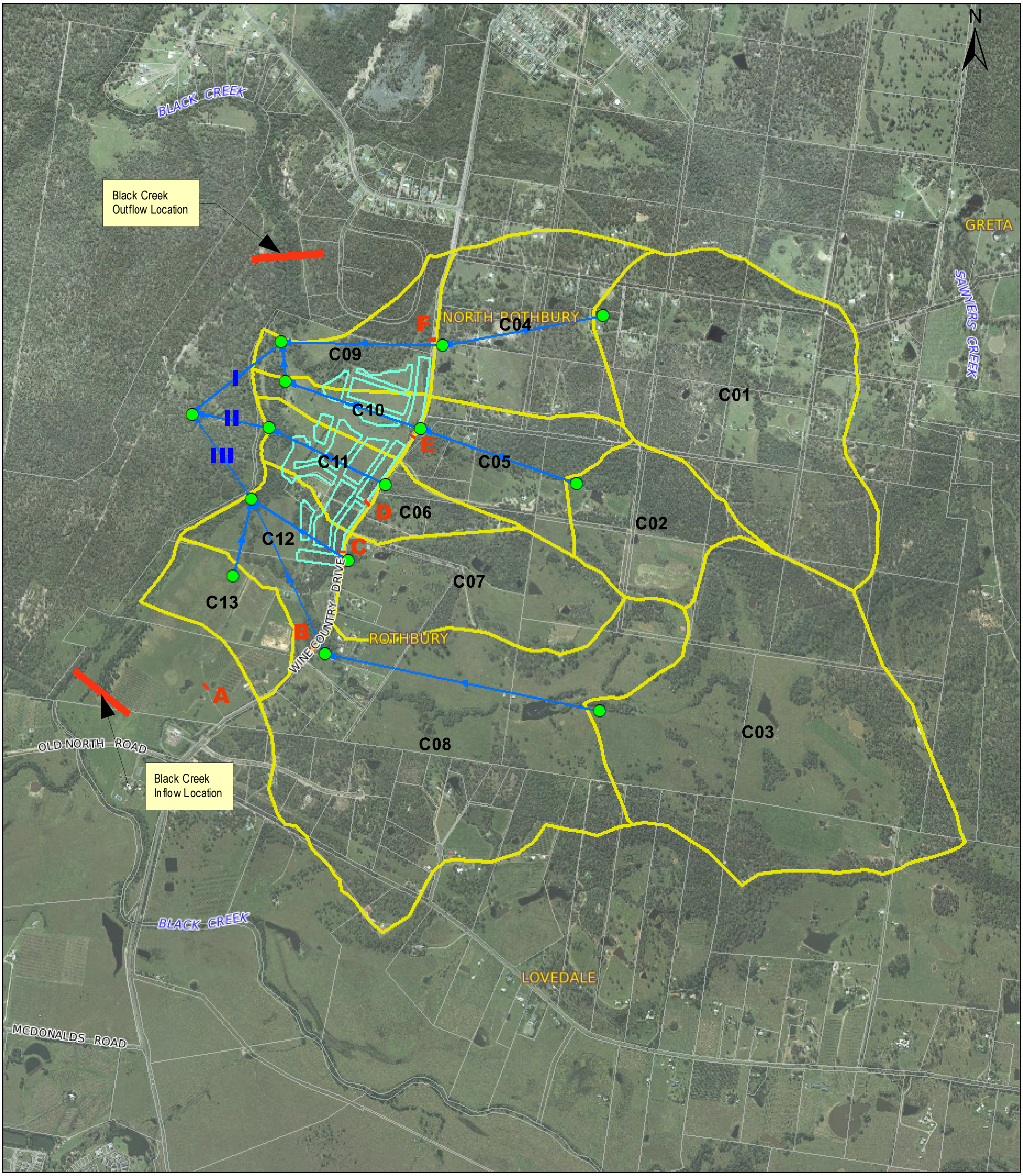
6 Conclusion

The proposed Stormwater Management Strategy prepared to reflect the revised subdivision layout is considered to effectively meet the objectives of the 2013 Huntlee DCP and is therefore recommended for adoption.

In summary the following conclusions can be drawn:

- Riparian corridors are to be established over the natural watercourses which exist across the Site to ensure development buffers are adopted by future on lot development.
- Flood inundation extents for the 1% AEP across the Site have been provided to inform flood planning of future development. Development envelops are to be provided above the 1% AEP flood level with appropriate freeboard to be adopted for habitable dwellings.
- Assessment of the pre and post developed flow regimes has been undertaken, concluding that onsite detention will not be required to mitigate runoff from the future development with no significant adverse impact on the existing flood behaviour anticipated during the regional flood event.
- The impact of the urban development on stormwater quality is to be mitigated through the incorporation of source and end-of-line treatment controls to reach the nominated pollutant load reduction targets.

Appendix A - Flood Study Figures



Legend

- Hydraulic Model Inflows/Outflow
- RAFTS Model Nodes
- RAFTS Model Links
- Proposed Lots
- Subcatchments
- Cadastre

0 315 630 1,260
Meters 1:25,000

Figure 1[A]

Hydrological Model Sub Catchments

Data Source: LPI

NL200554 - Huntlee

NORTHROP

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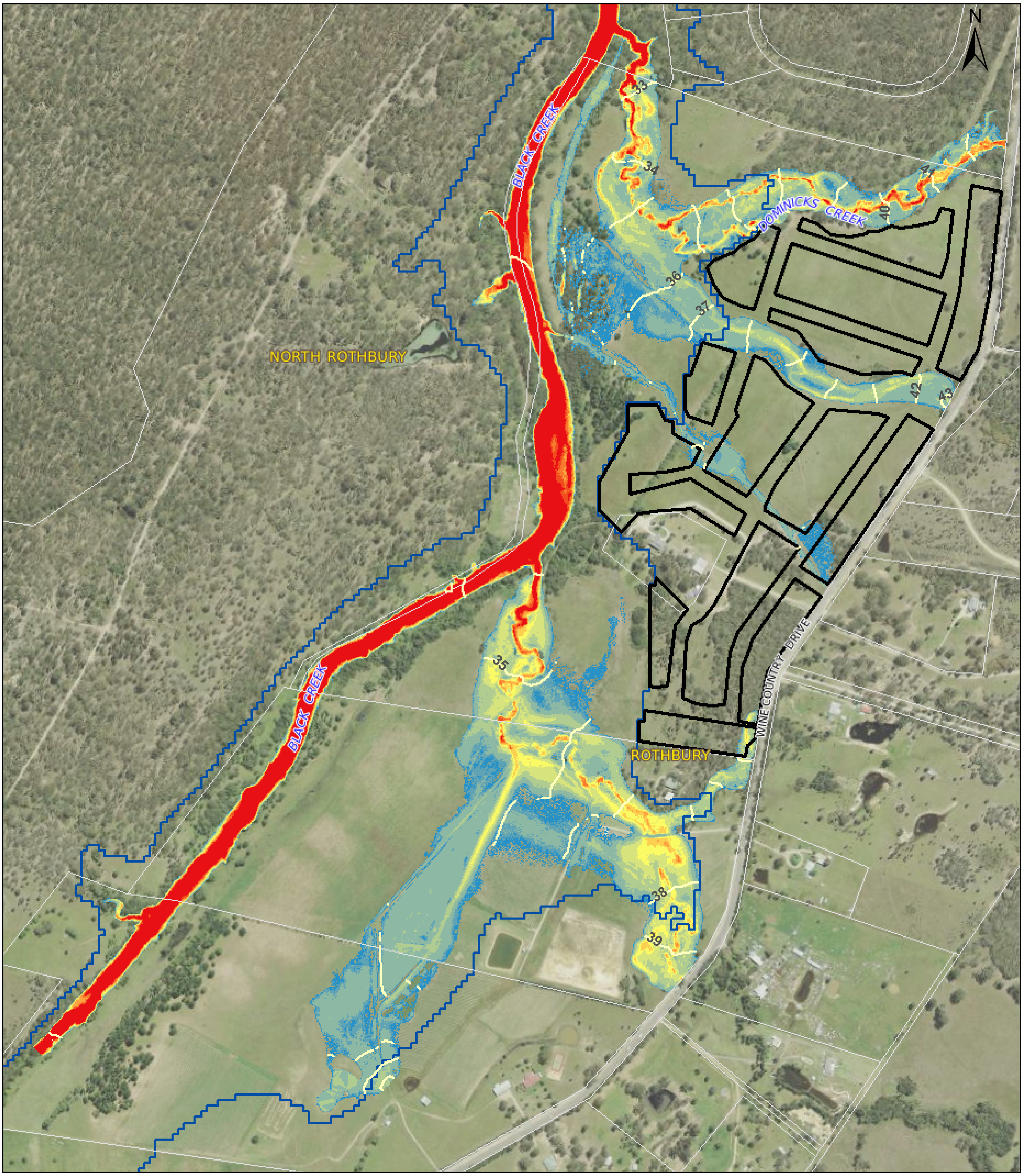

Legend

- Water Levels
- Proposed Lots
- Cadastre
- Black Creek 1% AEP Flood Extent

Depth(m)

- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 2

0 115 230 460 Meters 1:9,156

Figure 2[A]

Existing Scenario Depth & Elevation
1% AEP Flood Event, Local Catchments

Data Source: LPI

NL200554 - Huntlee

NORTHROP

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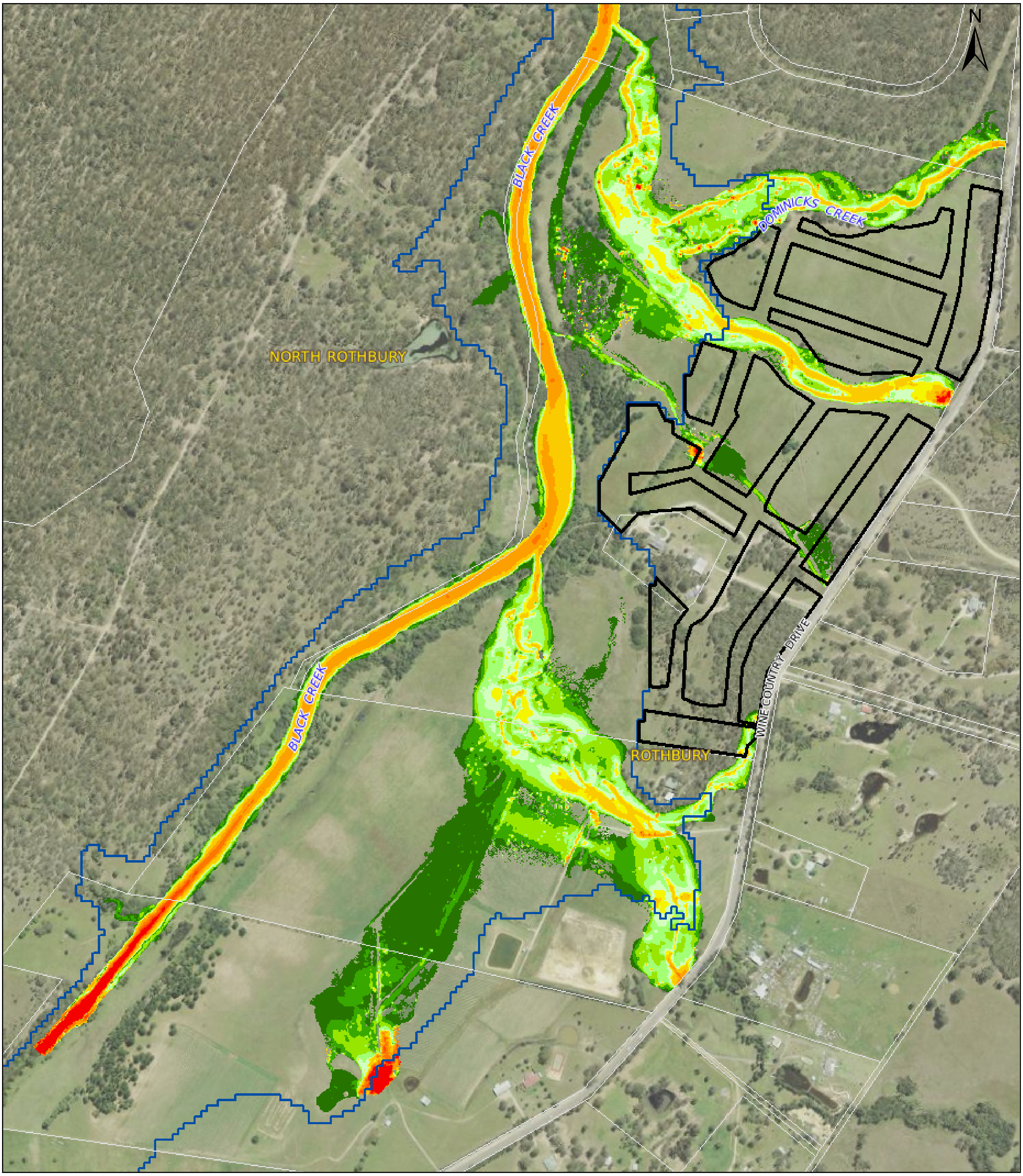

Legend

- Proposed Lots
- Cadastre
- Black Creek 1% AEP Flood Extent

Velocity(m/s)

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00
- 1.01 - 1.20
- 1.21 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00

0 115 230 460 Meters 1:9,156

Figure 3[A]

Existing Scenario Velocity
1% AEP Flood Event, Local Catchments

Data Source: LPI

NL200554 - Huntlee

NORTHROP

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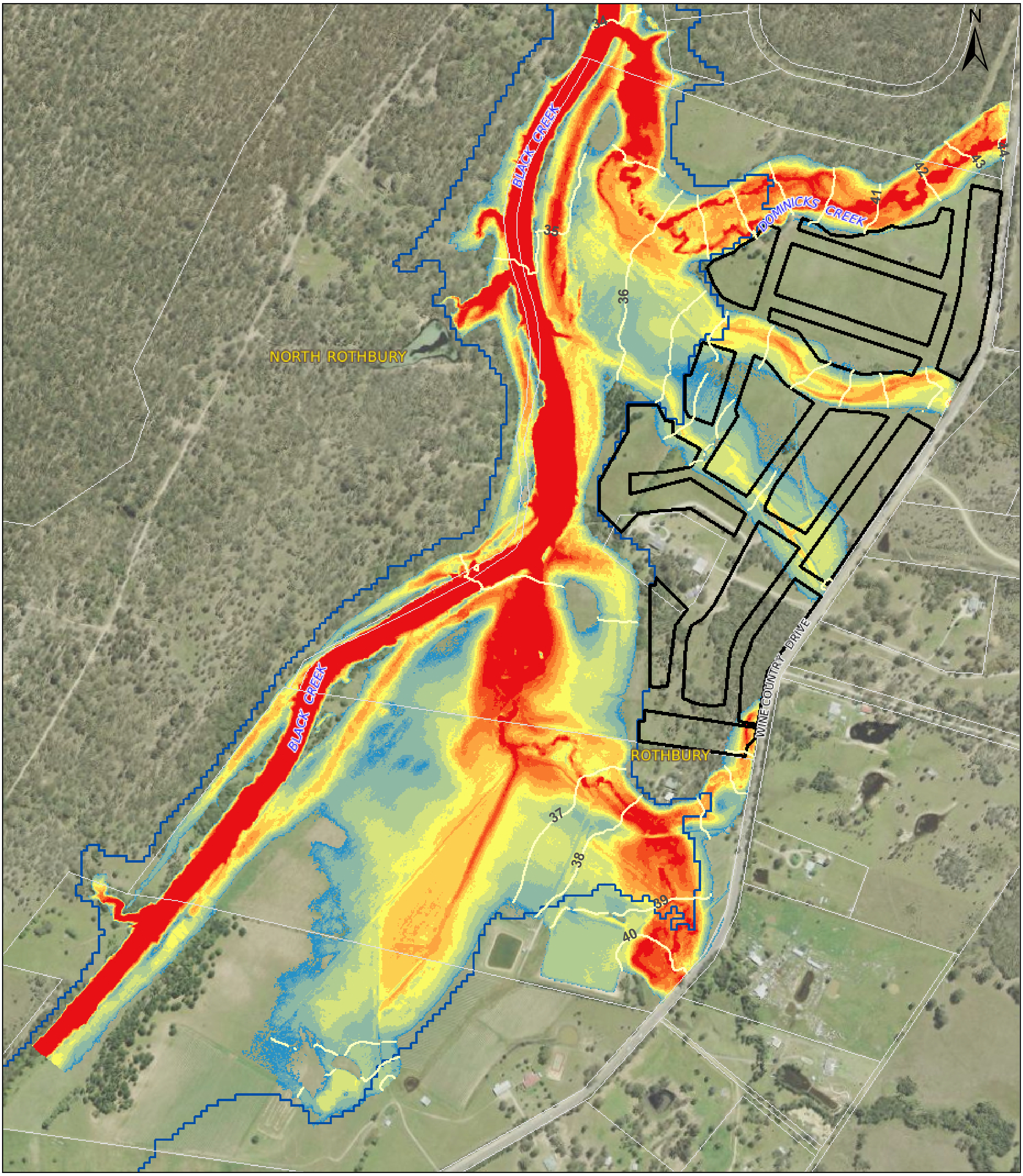

Legend

- Water Levels
- Proposed Lots
- Cadastre
- Black Creek 1% AEP Flood Extent

Depth(m)

- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 2

0 115 230 460 Meters 1:9,156

Figure 4[A]

Existing Scenario Depth & Elevation PMF Flood Event, Local Catchments

Data Source: LPI

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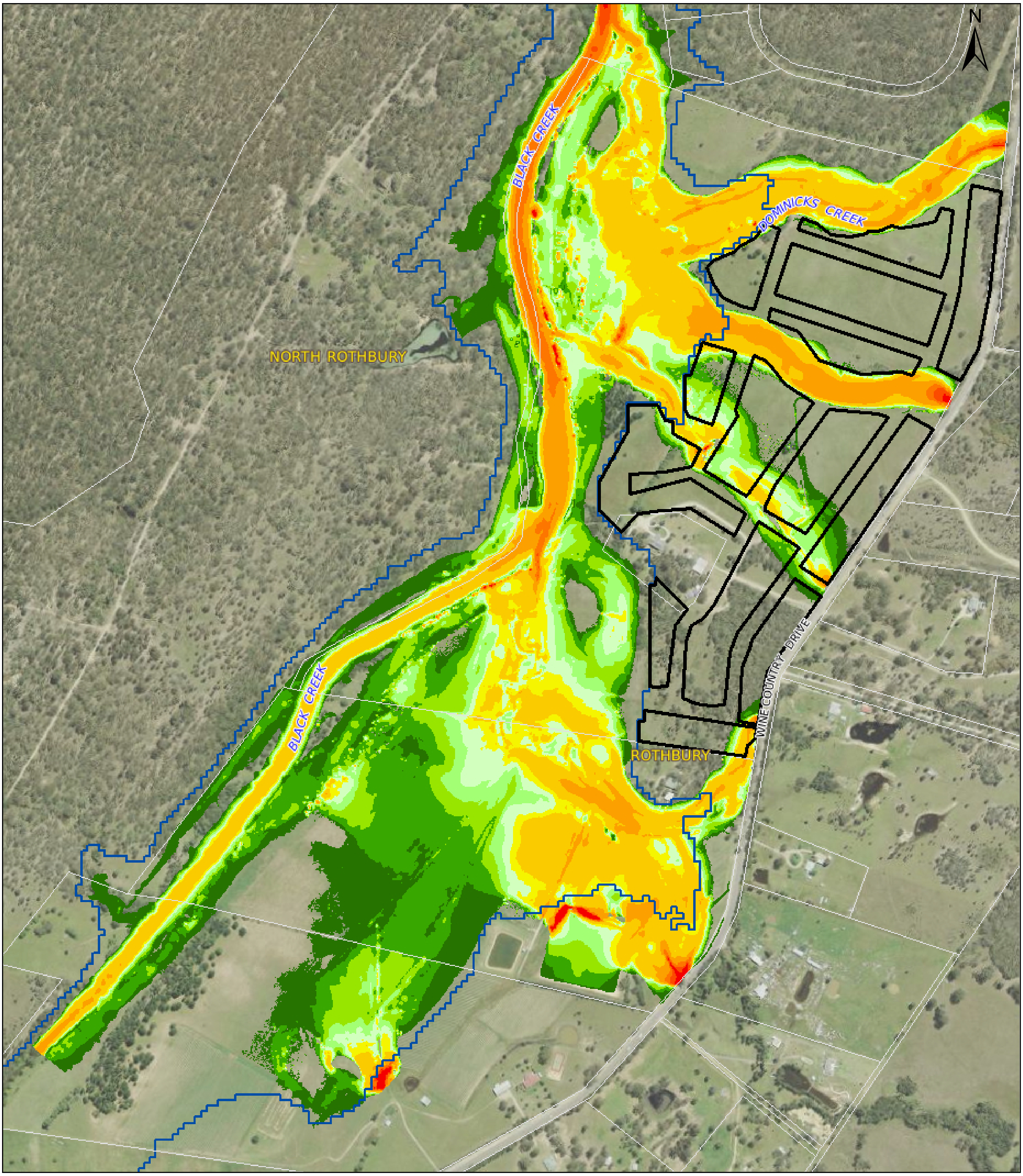
NL200554 - Huntlee

NORTHROP



Legend

- Proposed Lots
- Cadastre
- Black Creek 1% AEP Flood Extent

Velocity(m/s)

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00
- 1.01 - 1.20
- 1.21 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00

0 115 230 460
Meters 1:9,156

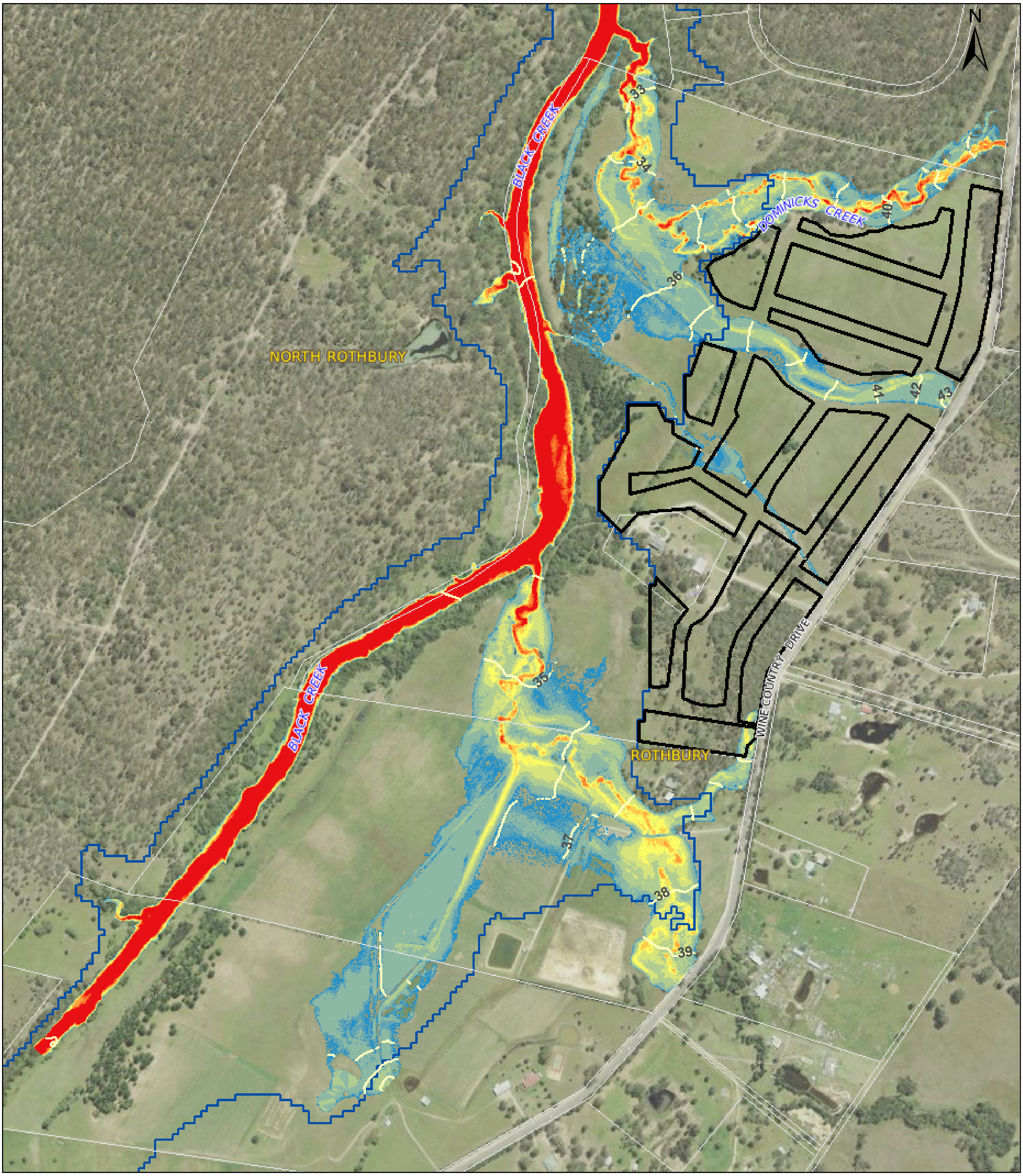
Figure 5[A]

Existing Scenario Velocity
PMF Flood Event, Local Catchments

NL200554 - Huntlee

NORTHROP

Data Source: LPI
24/03/2020 D:\jobs\HUNTLEE\HECRAS\Figures\ArcMap\NL_huntlee_F005.mxd



Legend

- Water Levels
- Proposed Lots
- Cadastre
- Black Creek 1% AEP Flood Extent

Depth(m)

0.02 - 0.05	0.7 - 0.9
0.05 - 0.1	0.9 - 1.1
0.1 - 0.3	1.1 - 1.3
0.3 - 0.5	1.3 - 1.5
0.5 - 0.7	1.5 - 1.7
	1.7 - 2

0 115 230 460 Meters 1:9,156

Figure 6[A]

Developed Scenario Depth & Elevation
1% AEP Flood Event, Local Catchments

NL200554 - Huntlee

NORTHROP

Data Source: LPI

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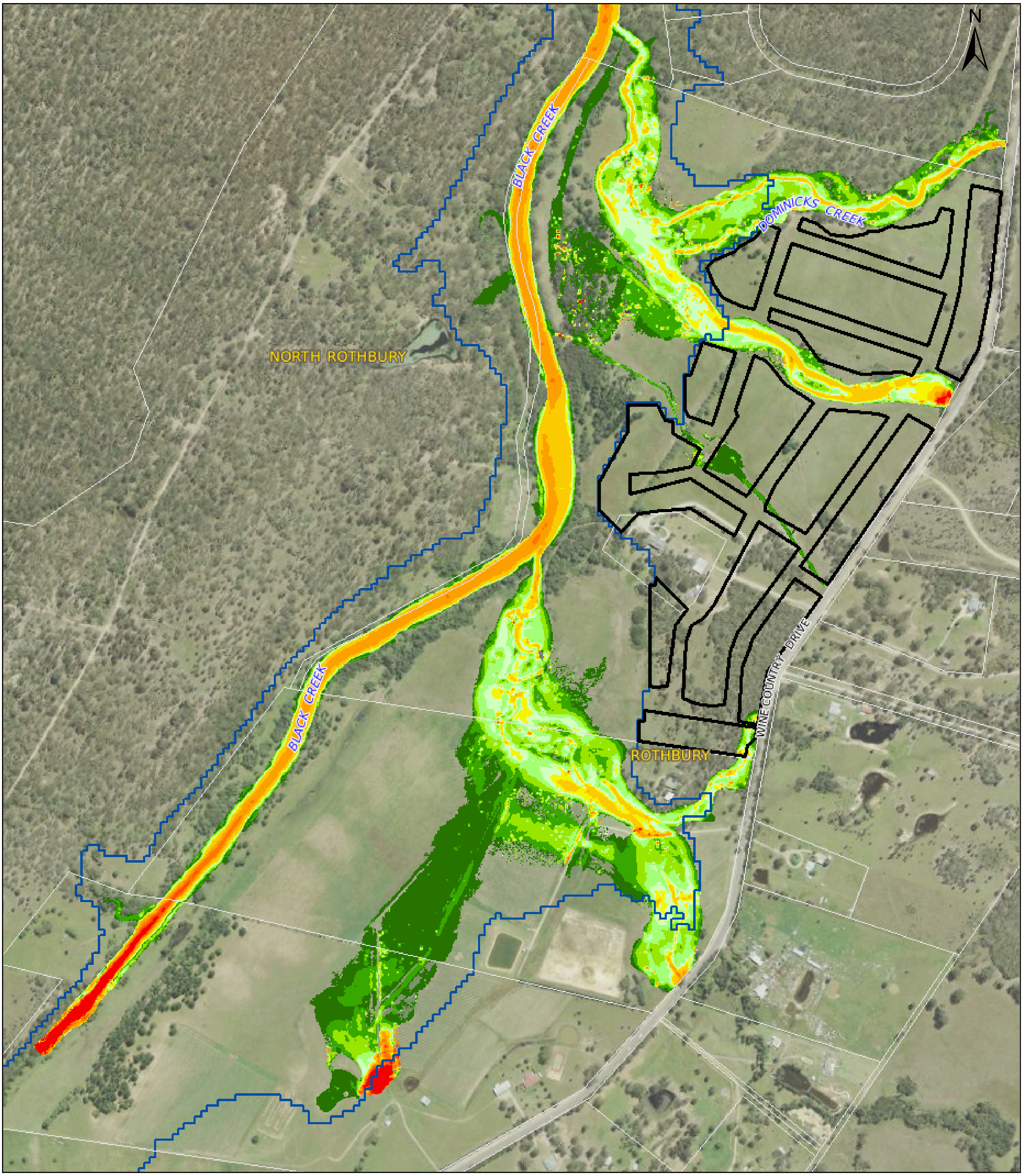

Legend

- Proposed Lots
- Cadastre
- Black Creek 1% AEP Flood Extent

Velocity(m/s)

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00
- 1.01 - 1.20
- 1.21 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00

0 115 230 460 Meters 1:9,156

Figure 7[A]

Developed Scenario Velocity
1% AEP Flood Event, Local Catchments

Data Source: LPI

NL200554 - Huntlee

NORTHROP

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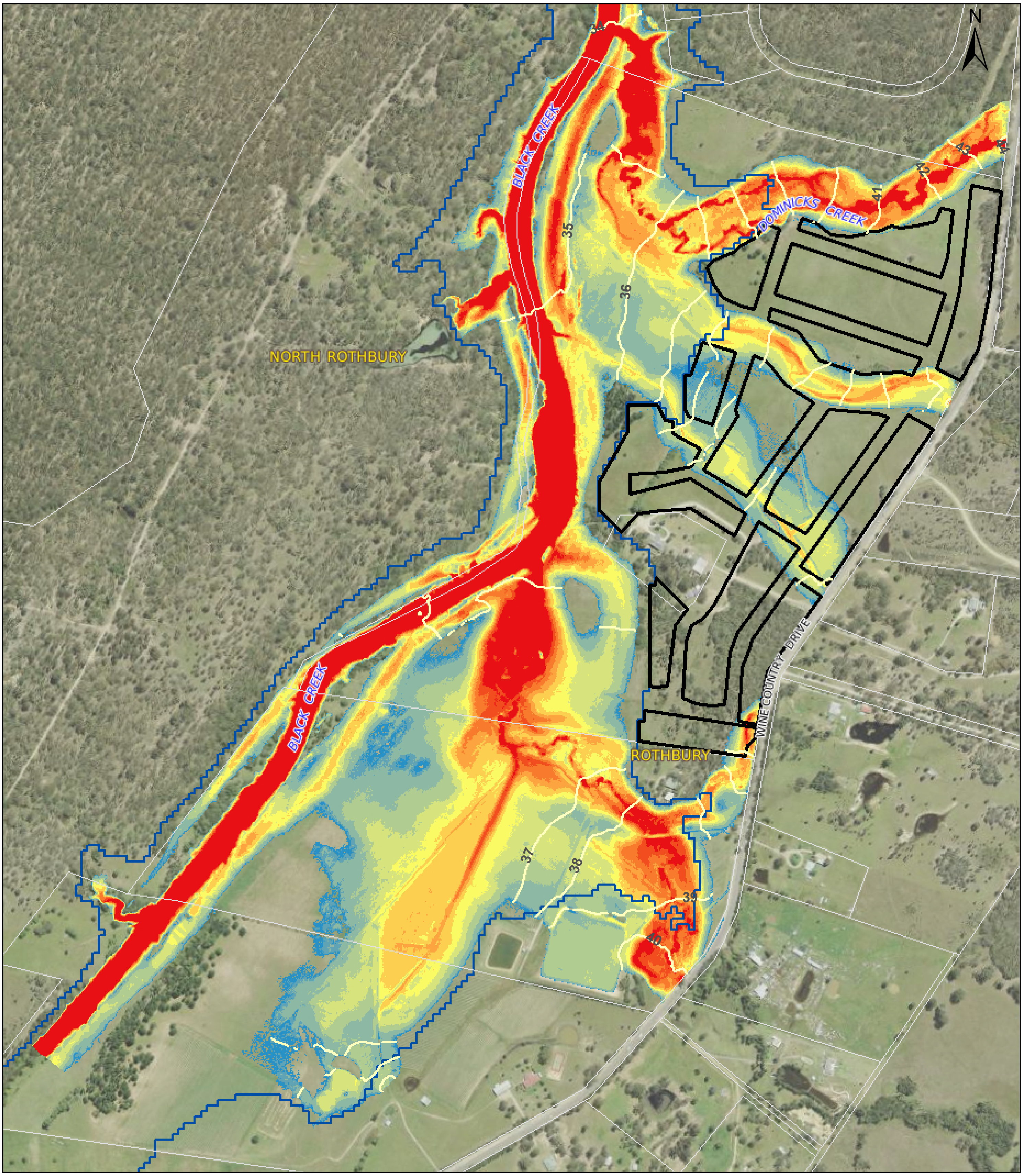


Legend

- Water Levels
- Proposed Lots
- Cadastre
- Black Creek 1% AEP Flood Extent

Depth(m)

- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 2

0 115 230 460 Meters 1:9,156

Figure 8[A]

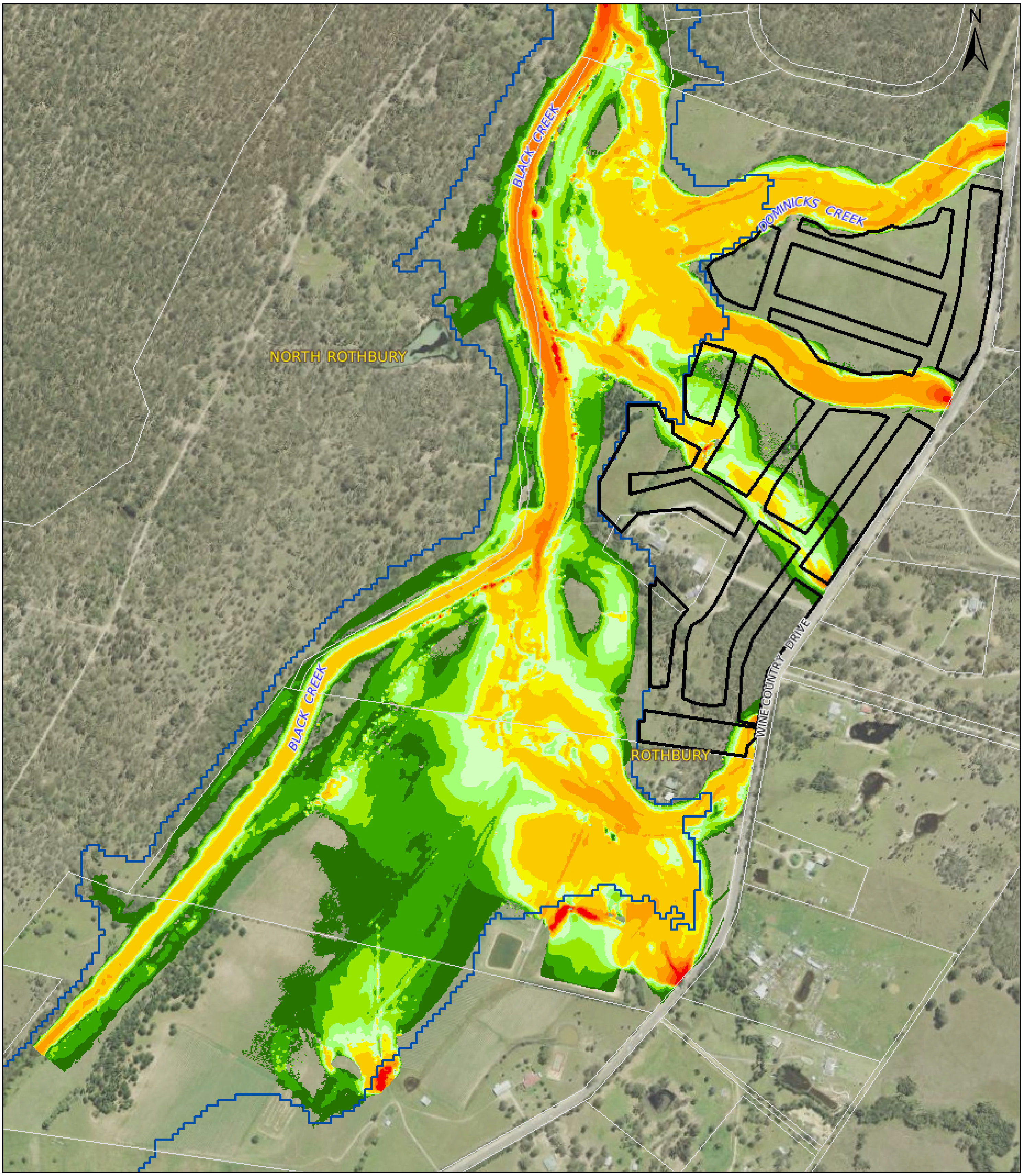
Developed Scenario Depth & Elevation
PMF Flood Event, Local Catchments

Data Source: LPI

24/03/2020 D:\jobs\HUNTLEE\HECRAS\Figures\ArcMap\NL_huntlee_F008.mxd

NL200554 - Huntlee

NORTHROP



Legend

- Proposed Lots
- Cadastre
- Black Creek 1% AEP Flood Extent

Velocity(m/s)

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00
- 1.01 - 1.20
- 1.21 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00

0 115 230 460 Meters 1:9,156

Figure 9[A]

Developed Scenario Velocity
PMF Flood Event, Local Catchments

Data Source: LPI

23/03/2020 D:\jobs\HUNTLEE\HECRAS\Figures\ArcMap\NL_huntlee_F009.mxd

NL200554 - Huntlee

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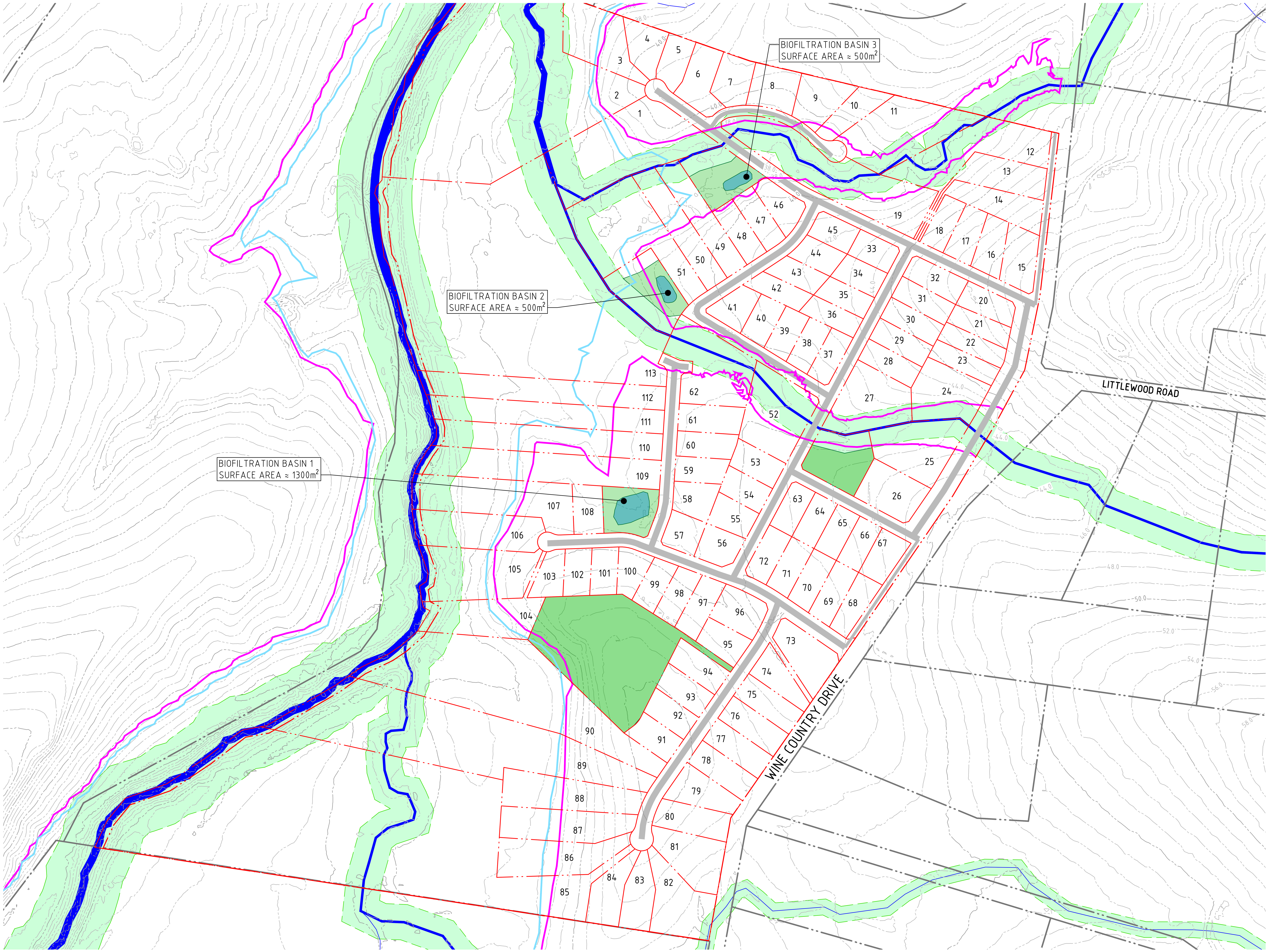
Appendix B - Concept Stormwater Management Plan



LEGEND

- PROPOSED LOT BOUNDARY LINE
- EXISTING BOUNDARY LINE
- PROPOSED ROADS
- 100 YEAR FLOODING LEVEL
- 20 YEAR FLOODING LEVEL
- EXISTING CONTOURS
- RIPARIAN CORRIDOR
- CREEK ALIGNMENT

DRAWN: J.KIND
DESIGNED: B.BALCOMBE
JOB MANAGER: B.BALCOMBE
VERIFIER: B.CLARK

NOT FOR CONSTRUCTION

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	ISSUED FOR INFORMATION	JK		BB	28.02.20
2	ISSUED FOR INFORMATION	JK		BB	23.03.20
A	ISSUED FOR APPROVAL	WC	BC	BB	15.06.20

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PROJECT
CONCEPT STORMWATER MANAGEMENT STRATEGY

DRAWING TITLE
CIVIL ENGINEERING PACKAGE
CONCEPT STORMWATER PLAN

JOB NUMBER: **NL200554**
DRAWING NUMBER: **CSK01.01**
REVISION: **A**
DRAWING SHEET SIZE = A1