REPORT

Boyuan Bringelly Pty Ltd

South Creek West Cobbitty Sub-Precinct 5

Water Cycle Management Report

April 2024

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Version control

Issue	Author	Reviewer	Approver	Date approved
A - First Draft	Troy McLeod	David Crompton	David Crompton	25/09/2021
B - Second Draft	Troy McLeod	David Crompton	David Crompton	1/10/2021
C - Third Draft	Troy McLeod	David Crompton	David Crompton	15/6/2022
D – Final Draft	Troy McLeod	Sabina Lohani	Sabina Lohani	15/12/2022
E – Final	Ahmad Albaba	Troy McLeod	David Johnson	26/04/2024

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1. EXECUTIVE SUMMARY

As part of the ongoing development of the South Creek West (SCW) Precinct it is proposed to rezone a 303 hectare (ha) parcel of land in Cobbitty, located within the Camden Local Government Area (LGA). The proposed South Creek West Cobbitty Sub-Precinct 5 (Precinct 5) has frontages to The Northern Road and is situated immediately upstream of the recently released Lowes Creek Maryland Precinct. Precinct 5 is predominantly rural farmland but also includes the currently under construction service station at the intersection of The Northern Road and Marylands Link Road 1.

J. Wyndham Prince Pty Ltd have prepared the Cobbitty Sub-Precinct 5 Water Cycle Management Strategy (WCMS) report to support the proposed rezoning of the BHL land holdings within Precinct 5. The BHL land holdings comprises of 173 ha of land and incorporates Lots 2 & 4 in DP 1216380, Lot 2 in DP 1241819 and Lot 500 in DP 1231858 as shown in Appendix A. The WCMS report presents background details on the planning proposal for the Precinct, hydrologic, hydraulic and water quality analysis, riparian corridor assessment and includes consideration of existing ecological constraints.

Our assessment demonstrates that the proposed five (5) detention basins located throughout the Precinct with a total storage of approximately 77,000 m^3 will ensure that peak post-development discharges are restricted to less than the pre-development levels at all key comparison locations. The strategy includes one (1) online wet basin, one (1) offline dry detention basin, three (3) formal online dry detention basins and some minor informal basins where cycleways and pathways cross the drainage corridors.

Water quality will be managed by a variety of controls which include on-lot rainwater tanks, gross pollutant traps, bio-retention rain gardens and ornamental ponds in order to deliver Council's required water quality objectives. Medium and high-density residential areas, together with industrial and commercial areas and the local school are proposed to manage their own water quality needs onsite.

Twelve (12) bio-retention raingardens are proposed to be located within Precinct 5 to manage stormwater quality runoff before discharge to the adjoining precinct. one (1) ornamental pond/waterbody is also proposed as part of the water quality strategy. Proprietary (vortex style) GPTs are also proposed to be located at each discharge point of the subdivision.

The WCMS report provides a hydraulic assessment of Precinct 5. The assessment defined the flood behaviour within the Precinct providing information on flood depths, flood levels and flood hazards for the 50% AEP, 20% AEP, 5% AEP, 1% AEP and Probable Maximum Flood (PMF) events. The flood impact maps (refer to Appendix C) show that there will be acceptable impacts external to Precinct 5. Further discussion on the suitability of these impacts is provided in Section 7.5.

The Stormwater Management Strategy proposed for the SCW Cobbitty Sub-Precinct 5 is therefore functional; it delivers the required technical performance, lessens environmental degradation and pressure on downstream ecosystems and infrastructure and provides for a 'soft' sustainable solution for water cycle management within the Precinct.

The findings/recommendations/conclusions of this report remain relevant, providing a holistic assessment of the precinct to inform future development on the subject site. It is intended this report will be updated to reflect the refined ILP and any comments received following public exhibition.

2. BACKGROUND

2.1. Overview

The South Creek West Land Release Area (SCWLA) release area forms part of the South West Growth Area (SWGA). Given the scale of the release area, the Department of Planning, Industry and Environment (DPIE) divided SCW into five distinct precincts numbered 1 – 5. The land to which this Planning Proposal relates to is referred to as Cobbitty Sub-Precinct 5, also known as Precinct 5. It totals approximately 303 hectares and has been characterised by rural residential and agricultural land uses and activities.

The Precinct was released by the Minister for Planning on 24 November 2017 for urban development. The release formally commenced the rezoning process for land within the precinct, including the subject site.

Precinct 5 is located within the south-west portion of SCWLA within the suburb of Cobbitty in the Camden LGA. The Precinct adjoins the Lowes Creek Maryland Precinct, which has recently been rezoned to the north, the Pondicherry precinct to the east which is in the process of being rezoned and the growing town centre and suburbs of Oran Park to the south.

Plate 2-1 illustrates the site boundaries of Precinct 5 and SCWLA.

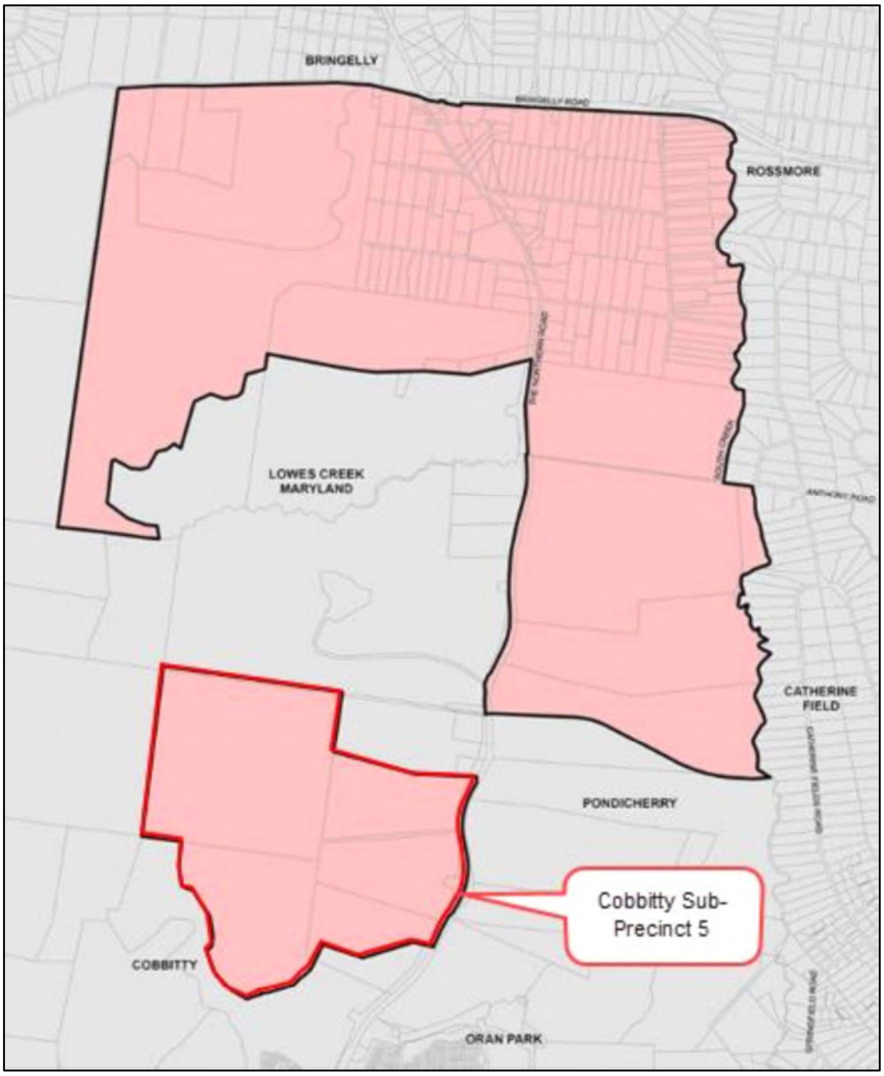


Plate 2-1 – South Creek West Land Release Area

2.2. Existing Site

The existing site comprises of a number of large lot rural residential dwellings and farm sheds. The site consists of a number of watercourses and farm dams and is bisected by a powerline easement. An overview of the existing site is shown on Plate 2-2.

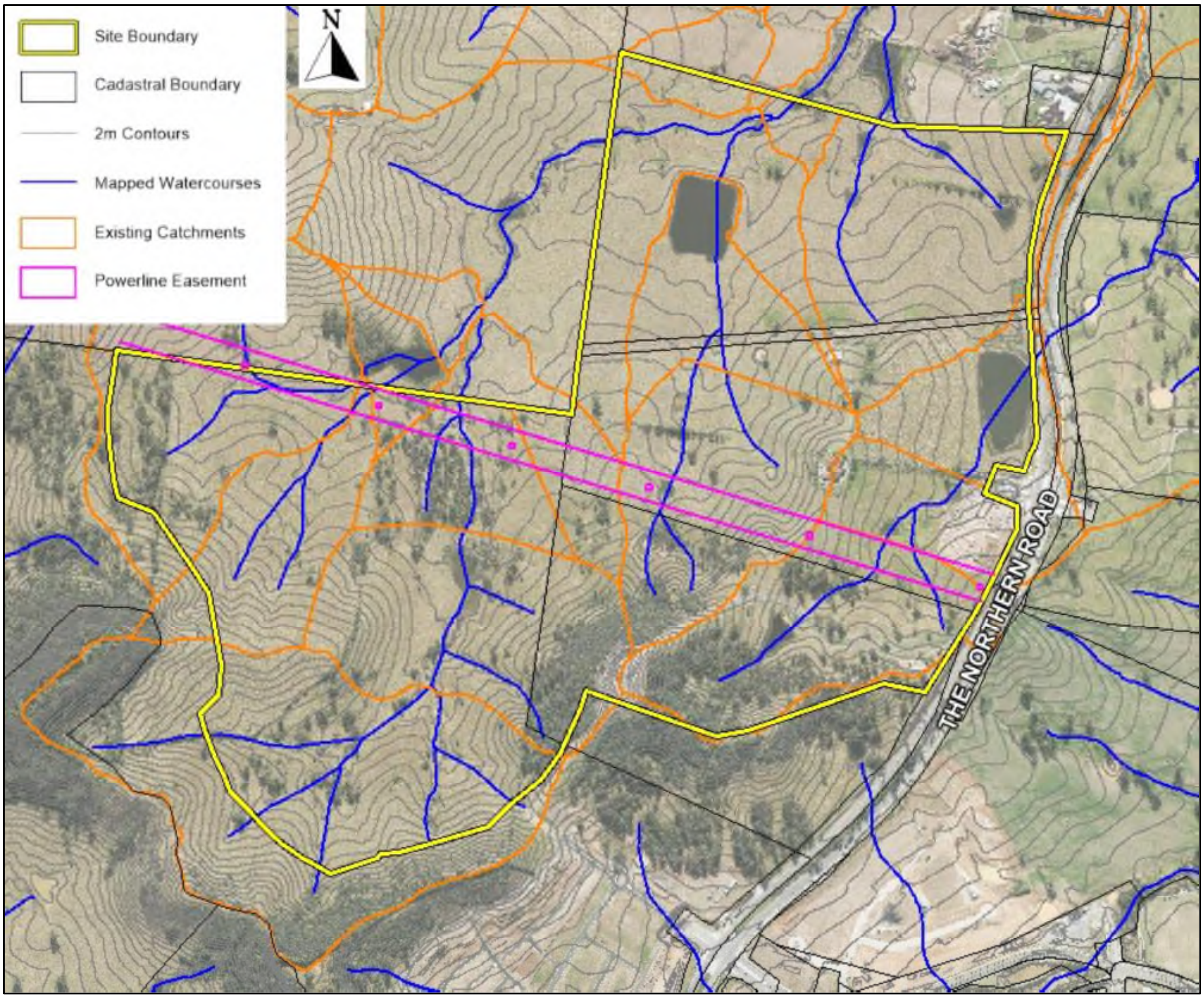


Plate 2-2 – Existing Site

2.3. Objective

The objective of this study is to prepare a WCMS that supports the rezoning of the BHL land holdings within the South Creek West Cobbitty Sub-Precinct 5 for urban development. The study includes an assessment of flooding impact within the site, together with the stormwater quantity and quality management required to ensure that there are no adverse impacts external to the site.

2.4. Proposed Development

The ILP has been prepared to support the planning proposal and precinct rezoning and has been informed by extensive specialist consultant studies. The site will comprise approximately 3,800 dwellings and a population of 12,000 people within a thriving community supported by:

- Easy access to jobs in the Western Sydney Aerotropolis
- Local shops, community uses and services, and proximity to the Oran Park Town Centre
- Open space, including sporting fields and local parks
  - Open space typologies also include creeks, grasslands, playgrounds, and other nature-based recreations areas
- Pedestrian and cycling connections including a central green corridor
- Prominent creeks and riparian areas that retain water in the local environment
- Integrated stormwater and services infrastructure that improve local amenity

An Indicative Layout Plan (ILP) of Cobbitty Precinct 5 (BHL Land Holdings) is shown in Plate 2-3 and is provided in Appendix A.

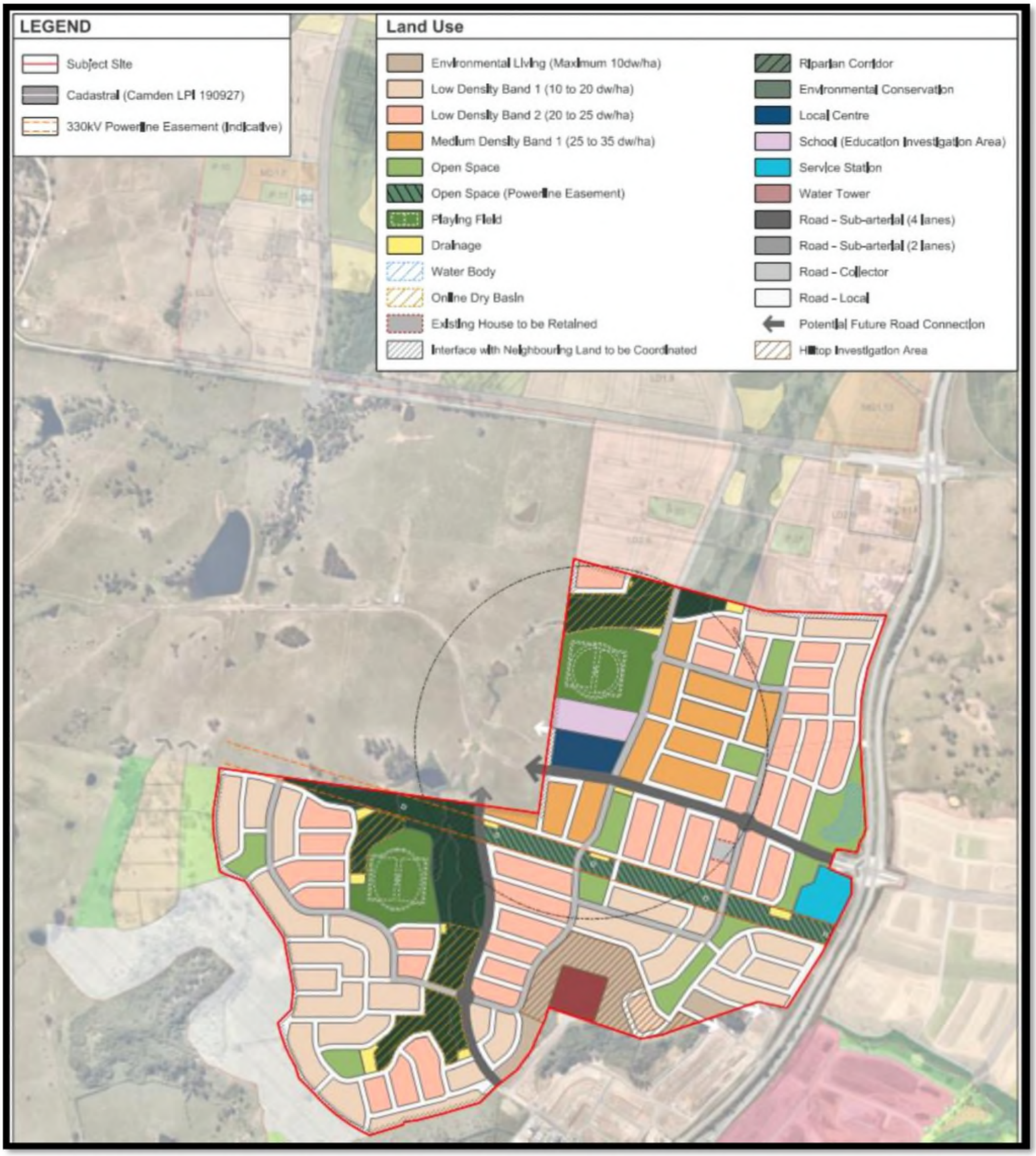


Plate 2-3 – Cobbitty Precinct 5 ILP – BHL Land Holdings (Rev N, Design + Planning 26/03/2024)

3. PREVIOUS STUDIES AND RELEVANT GUIDELINES

The following control documents have been considered in the development of the Water Cycle Management Strategy for the SCW Cobbitty Sub-Precinct 5:

- Camden Council Development Control Plan (DCP) (2019);
- Oran Park Precinct Growth Centres Development Control Plan (DCP, 2016); and
- Camden Council Draft Engineering Design Specification (2019).

A review of other investigations in the vicinity of the Precinct 5 together with Council advice is summarised in the following sections.

3.1. Lowes Creek Maryland Precinct WCMS (Cardno, 2018)

Cardno prepared the Lowes Creek Maryland Water Cycle Management Strategy (LCM WCMS) report in September 2018 for the Department of Planning to support the proposed rezoning of approximately 531 ha of land immediately to the north of Precinct 5. The LCM WCMS report included hydrologic analysis, water quality analysis and riparian corridor assessment.

The report demonstrated that six (6) offline and two (2) online detention basins would ensure that peak post-development flows are restricted to less than the existing flow at all key comparison locations. A number of gross pollutant traps, together with 21 bioretention rain gardens, deliver the required water quality outcomes for the Precinct.

3.2. Meeting with Camden Council (March 2020)

The project team met with Camden Council on 9 March 2020 to discuss the proposed rezoning and gain an appreciation of Council's expectations for the Precinct 5 rezoning.

Council noted that the Water Cycle Management brief was no longer valid and needed to be updated. Importantly, the Upper South Creek (USC) Flood model has been updated to reflect Australian Rainfall & Runoff (AR&R) 2019 procedures and now considers existing farm dams at full supply level. Council subsequently supplied the updated USC hydrology and flood model for use in the Precinct 5 rezoning assessment.

Discussion regarding playing fields serving a dual purpose as detention basins and open space was discussed Council subsequently provided the newly endorsed *Dedication of Constrained Lands Policy* which potentially permits the dual use of open space. While the current study has avoided the use of playing fields as basins, this may be a future option pending Natural Resources Access Regulator (NRAR) advice on online basins within the riparian corridor. Council noted a preference for online detention basins to blend into the environment, with gentle batters and no walls or pit/pipe outlet structures.

Council also confirmed that cut/fill on the site is okay, as long as there are no flood impacts. Catchments in the order of 20 – 25 ha were suggested before formal trunk drainage is required and Council indicated that smaller catchments would be preferred due to drainage issues on other Precincts where trunk drainage was not provided. Therefore, road and drainage capacity is to form part of the design considerations post rezoning.

With regard to Water Sensitive Urban Design (WSUD), Council advised that their preference is for vortex style GPTs and standard Growth Centres stormwater quality controls. It was agreed that modelling is to be undertaken using MUSIC software.

Regional flood evacuation is not necessary, however emergency management for the proposed development for events up to the PMF are to be considered together with the consideration of climate change, consistent with the updated USC flood model needs to be assessed.

3.3. Upper South Creek Flood Study (WMA Water, 2020)

As part of the consultation with Council, it was confirmed that the USC model had been updated to align with the AR&R 2019 procedures. The formal report is still in draft form and at the time of writing this report has not been made available. However, the XP-RAFTS hydrologic and TUFLOW hydraulic models together with a draft user guide were provided to consultants working in the Camden Council LGA so that rezoning assessments can use the latest study information.

Council facilitated a presentation by WMA Water on 28 April 2020 to a number of consultants, including J. Wyndham Prince, on the use of the model; a number of questions were raised regarding catchment and model parameters. Importantly, it was identified that the spatially varying rainfall within the XP-RAFTS model was incorrectly applying the 'mid' rainfall data across the entire model and not the 'west' and 'east' data where appropriate. As the TUFLOW hydraulic model utilises inflow hydrographs from the XP-RAFTS hydrologic model, this incorrect rainfall data has implications for the broader flood model. Council confirmed that for Precinct 5 the 'west' rainfall data supplied with the USC model is to be used. WMA Water indicated that the modelling would need to be updated and would be re-issued. An updated model was made available in July 2021 (ref: 210201_USC_Regional_Flood_Model.zip), and has been used to inform the Precinct 5 assessments.

3.4. Environment and Heritage Group Comments on Planning Proposal (DPE, 2022)

The Environment and Heritage Group (EHG) within the Department of Planning and Environment (DPE) provided comments and recommendations on the Cobbitty Sub-Precinct 5 Planning Proposal in June 2022. Specific comments were provided relating to the hydrological and flooding assessments in the Water Cycle Management Report (JWP, 1 October 2021). The general recommendations in the EHG review are summarised and responded to below.

EHG generally opposes the online basins which are proposed to be located in the C2 Environmental Conservation area. They note that the basin construction and operation could be detrimental to the existing Cumberland Plain Woodland (CPW) within the riparian corridor. The devices that are proposed within C2 zoned areas are the dry detention basin B4 and the waterbody/pond WB2. Note that online dry basin B1 is no longer part of this planning proposal.

The online dry detention basin B4 is online to a 1st order watercourse. Detention is permitted online to 1st order watercourses as detailed in NRAR's Guideline for Controlled Activities on Waterfront Land (2018). The waterbody WB2 is online to a 3rd order watercourse in the location of an existing farm dam. The waterbody will improve the local amenity in the area and continue to provide a habitat for native flora and fauna. The future detailed design of the waterbody will aim to avoid the limited CPW and other vegetation in the area. The waterbody will manage peak flows from the surrounding urban catchments and reduce flows and velocities being delivered to the more dense vegetation immediately downstream.

The EHG consider the flood impact assessment undertaken in the Water Cycle Management Report to be reasonable. However, it is noted that future considerations and liaison with Dam Safety NSW will be required to provide management of risks associated with potential dam failure.

3.5. Review of Flood Assessment (WMA Water, 2024)

WMA Water undertook a review of the South Creek West Cobbitty Sub-Precinct 5 Water Cycle Management Report (JWP, 1 October 2021) on behalf of Camden Council. The response to the comments were provided in the updated Water Cycle Management Report (JWP, 15 December 2022). Prior to this, WMA Water provided comments on the response provided in the Water Cycle Management Report (JWP, 15 December 2022) and made recommendations regarding the flood modelling that was undertaken which have been addressed in this updated report as detailed in Table 3-1.

Table 3-1 – Response to WMA Water Review

Review Section	Issue identified by WMA Water	Response (JWP, 15 December 2022)	WMA Water comment	Response (JWP 26 April 2024)
4.3.1. Trimmed Model	The use of a trimmed model does not provide an indication of potential flood impacts further downstream where these tributaries join major creeks (such as Lowes Creek and South Creek)	The model has been extended to include the confluence of the sites tributaries with Lowes Creek. In addition, we have prepared a comparison of flow hydrographs at the downstream model boundary between the Upper South Creek model as received and the amended developed conditions model. Refer to Section 7 for updated flood modelling details and hydrograph comparison.	The model should extend all the way to Bringelly Road.	Hydrograph comparisons are provided at the downstream trimmed model extent for the 1% AEP to ensure that flow behaviour/timings are unchanged post development. We believe that this should be sufficient to inform Councils merit assessment and the full USC model can be rerun at development application stage, if required.
4.3.2. Surface Roughness for Creek Corridor	There is an inconsistency in the adopted Manning's 'n' roughness values for the creek corridor that has not been justified	The surface roughness under developed conditions assumes revegetation of the riparian corridor. This is to reflect the likely vegetation to be introduced as part of the vegetation management plan (VMP) and to be maintained in perpetuity. Refer to Section 7.3.2 for details.	Adequate if justified.	Resolved.
4.3.3. Large Western Farm Dam	There is a large western farm dam that has been removed from the pre-development conditions model. The active storage that it provides in the existing conditions has not been accounted for. If this was included in the existing conditions model, then it would provide additional benefit downstream that should be matched with the proposed basins.	The property in which the large western farm dam is located is no longer part of this planning proposal and therefore, has been reverted to existing conditions in the flood modelling (consistent with the USC modelling).	Exclusion of this dam from the precinct footprint resolves issue.	Resolved.

Review Section	Issue identified by WMA Water	Response (JWP, 15 December 2022)	WMA Water comment	Response (JWP 26 April 2024)
4.3.4. Proposed Development Plans	No details of the proposed basins were provided (as drawings or in the Water Cycle Management Report), and hence the basin representations in the TUFLOW model could not be verified.	Preliminary concept designs have been prepared and can be seen in Appendix B. Additional detail regarding basin top water levels and proposed outlets has also been provided in the hydrological modelling Section 6.	Drawings of basins included in Appendix B. Basin details now included in report. Although contained in the hydrology section, these will be compared with what is implemented in the TUFLOW model in subsequent reviews.	We note that the conversion of WB2 to a dry basin will mean that the concept design drawing for this device will be outdated. This means that the representation of this device in the TUFLOW model will be coarse (without 3D design).
4.3.5. Blockage	Design blockage not assessed in basin modelling.	As WMA Water suggests, this can be considered at future detailed design stages.	Noted that this will be undertaken at future design stages.	Resolved.
5.2. Review Outcomes	Peak flows/hydrograph plots to be provided downstream of the site (for pre and post dev conditions) from the TUFLOW model. Details of the basin configurations should be documented.	Hydrograph plots at the downstream TUFLOW model boundary are provided in Section 7. Preliminary design concepts for all basins have been prepared along with the additional detail regarding basin top water levels and outlet designs in Section 6.	Hydrograph plots provided of 1% AEP event only. 20% AEP and 5% AEP events should also be provided.	Additional hydrographs to be provided in lieu of extended model.
6.1. Offline Dry Detention Basins	Representation of basins in XP-RAFTS is simplistic and not enough detail is provided to verify suitability of modelling.	Stage storage relationships have been derived from the preliminary concepts and used to inform the XP-RAFTS basin modelling.	Basin stage-storage curves should be a reasonable representation of the basin. Low flow outlets should specify culvert configurations or detail the derivation of stage-discharge curves. Spillways should be reasonable sizes. Subject to review of updated modelling.	Outlet sizes would be specified in revised modelling/reporting with the relevant development applications.

Review Section	Issue identified by WMA Water	Response (JWP, 15 December 2022)	WMA Water comment	Response (JWP 26 April 2024)
6.2. Online Dry Detention Basins	Basin B4 is not represented in the TUFLOW model.	Basin B4 has been added to the TUFLOW model.	Noted as rectified, subject to review of updated modelling.	Resolved.
6.3. Online Wet Detention Basins	Online wet detention basins are not modelled as 'wet' basins, and the volume stored in the 1% AEP event is approximately 20% larger than that reported.	Initial water levels have been incorporated in the TUFLOW modelling for both of the waterbodies. TUFLOW detention volumes should be recorded above these levels. The updated TUFLOW modelling has incorporated concept design surfaces to provide more accurate reflection of the likely basin landforms. Refer to Section 7.3.2 for flood modelling details.	Noted as rectified, subject to review of updated modelling.	Resolved.
6.4. Basin Depths	Basin representation differences between XP-RAFTS and TUFLOW resulting in different peak depths. Basin B1 depths are up to 3.6m which would create a dam safety risk requiring DSNSW consultation.	This was rectified through the preparation of the preliminary concepts for all basins which were included in the developed conditions modelling.	Noted as rectified, subject to review of updated modelling.	Resolved.
6.5. Road Crossings	No road crossings have been included and no justification as to why this is the case was provided.	Road crossing designs can be determined and assessed at future design stages. The culvert crossings will be sized to provide 1% AEP flood immunity plus freeboard.	Noted that this will be undertaken at future design stages.	Resolved. Note that the road crossings will be added in the modelling and reporting at the development application stage for the project.

4. RIPARIAN CORRIDOR ASSESSMENT

Ecological Australia Pty Ltd (ELA) has undertaken a desktop riparian watercourse study in support of the Precinct planning process and have ground-truthed a number of watercourses where access was available. A number of watercourses within the catchment are mapped as 1st order watercourses and are considered unlikely to be considered a "River" under the Act based on field inspection. Further consultation with the Natural Resources Access Regulator (NRAR) will be undertaken to confirm ELA's assessments. An overview of the stream classification within the site is provided Plate 4-1. A number of mapped watercourses on the eastern portion of the Precinct are not considered to be rivers under the Act. Further support to the removal of these watercourses is provided in ELA's report.

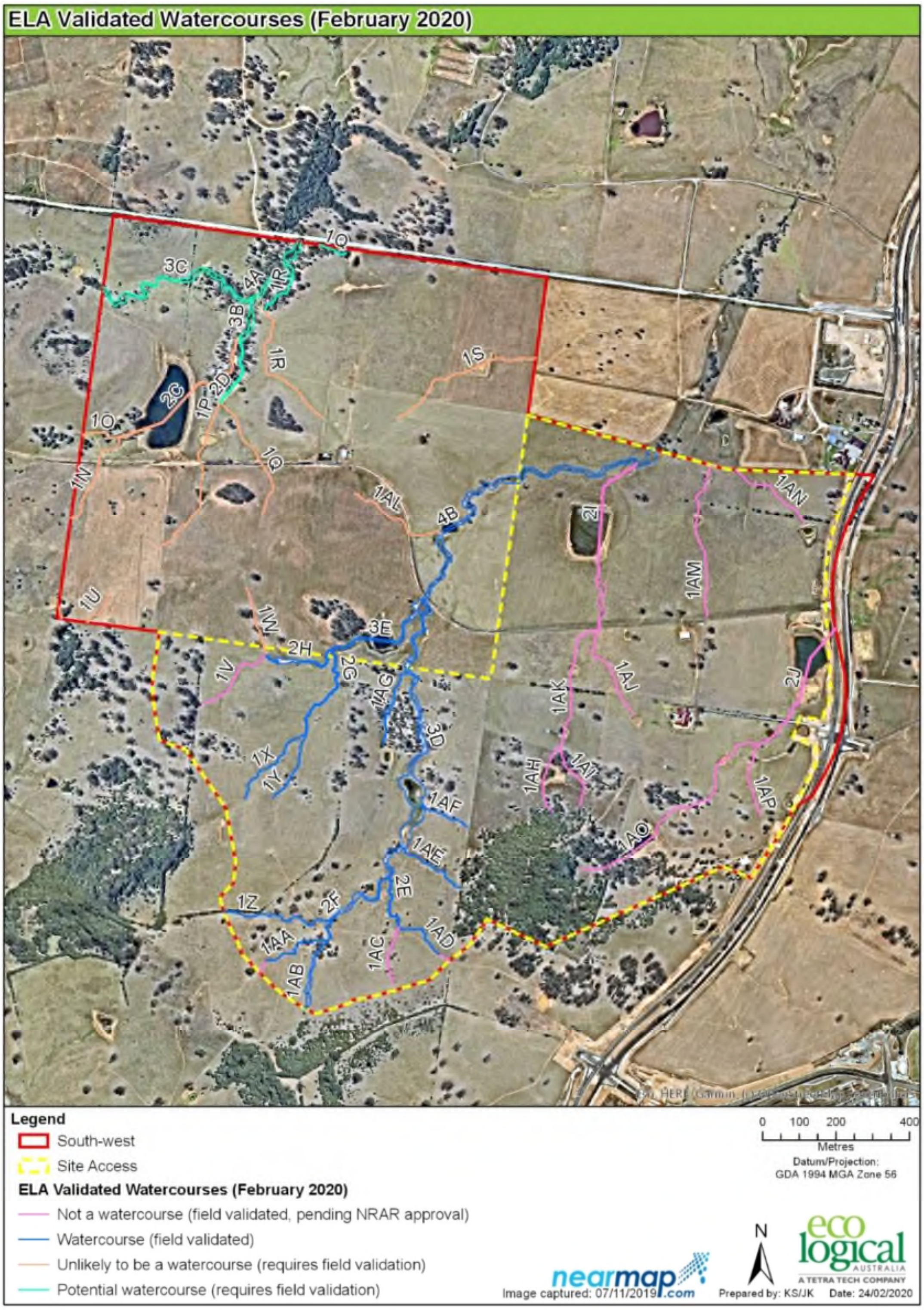


Plate 4-1 – Riparian Mapping (ELA, Feb 2020)

5. WATER QUALITY ASSESSMENT

The stormwater quality analysis for this study was undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). This water quality modelling software was developed by the Cooperative Research Centre (CRC) for Catchment Hydrology which is based at Monash University and was first released in July 2002. Version 6.3 was adopted for this study.

The model provides a number of features relevant for the Precinct:

- It is able to model the potential nutrient reduction benefits of gross pollutant traps, constructed wetlands, grass swales, bio-retention systems, sedimentation basins, infiltration systems, ponds and it incorporates mechanisms to model stormwater re-use as a treatment technique.
- It provides mechanisms to evaluate the attainment of water quality objectives.

The modelling was undertaken to ensure that Camden Council's stormwater quality objectives are met.

5.1. Modelling Inputs and Assumptions

In accordance with the meeting held with Council on 9 March 2020, we have prepared the MUSIC model using MUSIC-Link functionality to ensure that Council's modelling requirements are adhered to. We have also referenced Camden Council's Draft Engineering Design Specification (2019).

The target pollutant removal rates for this development as required in the Growth Centres DCP are shown in Table 5-1.

Table 5-1 –Pollutant Reduction Targets

Pollutant	Reduction Target	Ideal Outcome
Total Suspended Solids (TSS)	85%	95%
Total Phosphorous (TP)	65%	95%
Total Nitrogen (TN)	45%	85%
Gross Pollutants (GP)	90%	100%

A stream erosion index assessment is also required to ensure that the duration of post-development stream forming flows are no greater than 3.5 - 5.0 times the duration of pre-development stream forming flows, with an ideal outcome of 1.0.

The MUSIC Modelling has used a series of default Camden Council MUSIC-Link and assumed parameters. Details are provided in Appendix E.

As the development grading within Precinct 5 is unknown at this stage, we have modelled an indicative 10 ha low-density residential catchment and a typical 10 ha medium density catchment to inform the anticipated size of the regional devices. An average density of 20 dwellings per hectare has been calculated for the typical 10 ha low density catchment, and 30 dwellings per hectare for the typical 10 ha medium density catchment.

Table 5-2 and Table 5-3 provide details of the assumed breakdown of a typical 10 ha low-density and medium density residential catchments, respectively.

Table 5-2 – Typical 10 ha Low-density Residential Catchment Breakdown

Landuse		% Lot	Area (ha)	% Catchment	% Impervious
Lots	Roof to Tank	30%	1.80	60%	75%
	Roof Bypass Tank	30%	1.80		
	Driveways	10%	0.60		
	Other Impervious	5%	0.30		
	Pervious Areas	25%	1.50		
Roads			3.00	30%	90%
Open Space			1.00	10%	30%
Total			**10.00**	**100%**	**75%**

Table 5-3 – Typical 10 ha medium -density Residential Catchment Breakdown

Landuse		% Lot	Area (ha)	% Catchment	% Impervious
Lots	Roof	60%	3.84	64%	80%
	Driveways	10%	0.64		
	Other Impervious	10%	0.64		
	Pervious Areas	20%	1.28		
Roads			3.00	30%	90%
Open Space			0.60	6%	30%
Total			**10.00**	**100%**	**80%**

An overview of the indicative model layout is shown in Plate 5-1. Note that both bioretention raingardens and ponds form part of the water quality strategy for the site; both of which have been tested for the 10 ha Low Density Catchment.

Source nodes labelled with "MD" represent the Medium Density Catchment and "LD" represent the Low Density Catchment.

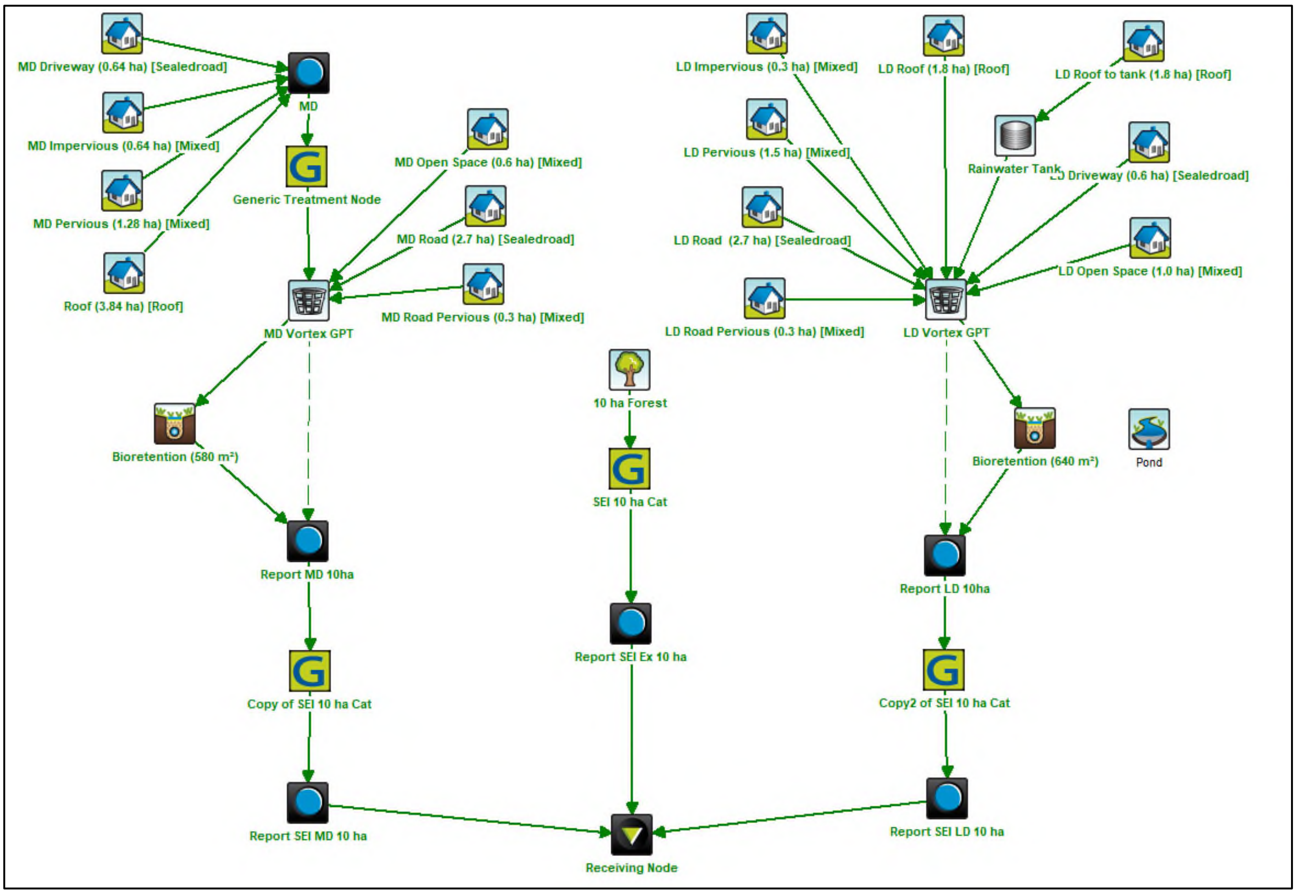


Plate 5-1 – MUSIC Model Overview (110628-02 MU1.sqz)

5.2. Water Quality Management Measures

It is proposed that stormwater quality in Precinct 5 be managed using a treatment train approach. Further details on land use assumptions and parameters are provided in Appendix D. A proposed treatment train of water quality devices has been identified to achieve the target pollutant removals.

- Rainwater harvesting and re-use of residential roof runoff of by utilising rainwater tanks;
- Gross Pollutant Traps (GPT) to pre-treat runoff prior to discharge into bioretention gardens;
- Bioretention Raingardens which will receive flows from the GPTs;
- Ornamental Lakes / Ponds; and
- On-lot treatment devices for Medium and High-Density zoned land, school sites, together with industrial and commercial areas.

The indicative location of water quality devices are shown in Figure 5-01 in Appendix C.

Further details regarding the rainwater tank, Gross Pollutant Traps, Bioretention Raingarden and Pond parameters are provided in Appendix D.

5.3. Modelling Results

The MUSIC model was run using the stochastically generated estimated pollution loads from the source catchments. The pollutant reductions achieved for the proposed water quality treatment of a typical 10 ha low density residential catchment is provided in Table 5-4 for raingarden treatment and Table 5-5 for pond treatment.

Table 5-4 – Summary of MUSIC Model Results for Typical 10 ha Low Density Residential Catchment – Raingarden Treatment

Pollutant	Total Developed Source Nodes	Total Residual Load from Site	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(%)	(%)
TSS	10000	1460	85.0%	85.4%
TP	20.6	7.10	65.0%	65.5%
TN	134	67.3	45.0%	49.8%
Gross Pollutants	1460	14.1	90.0%	99.0%
Raingarden Properties				
Media Bed area (m²)	640			
Total Area Managed (ha)	10.00			
Raingarden (% Managed Cat)	0.64%			

Table 5-5 – Summary of MUSIC Model Results for Typical 10 ha Low Density Residential Catchment – Pond Treatment

Pollutant	Total Developed Source Nodes	Total Residual Load from Site	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(%)	(%)
TSS	10000	1370	85.0%	86.3%
TP	20.6	6.87	65.0%	66.7%
TN	134	72.7	45.0%	45.7%
Gross Pollutants	1460	0.0	90.0%	100.0%
Pond Properties				
Surface Area (m²)	4,000			
Permanent Volume (m³)	8,000			
Total Area Managed (ha)	10.00			
Pond (% Managed Cat)	4.00%			

Similarly, the pollutant reductions achieved for the proposed water quality treatment of a typical 10 ha medium density residential catchment is provided in Table 5-6.

Table 5-6 – Summary of MUSIC Model Results for Typical 10 ha Medium Density Residential Catchment

Pollutant	Total Developed Source Nodes (kg/yr)	Total Residual Load from Site (kg/yr)	Target Reduction Required (%)	Total Reduction Achieved (%)
TSS	10500	1570	85.0%	85.0%
TP	21.2	7.19	65.0%	66.1%
TN	140	65.4	45.0%	53.3%
Gross Pollutants	1540	11.3	90.0%	99.3%
Raingarden Properties				
Media Bed area (m^2)	580			
Total Area Managed (ha)	10.00			
Raingarden (% Managed Cat)	0.58%			

The indicative size of the regional bio-retention devices are provided in Table 5-7 which have been determined by conservatively adopting 0.64% of catchment for all areas and adopting ponds/waterbodies sized at 4% of contributing catchment. Please refer to Figure 5-01 in Appendix C for the bioretention device catchment areas and device locations.

Table 5-7 – Water Quality Device Sizes

Raingarden/ Wetland ID	Cat Area (ha)	Area Treated On Lot (ha)	Device Sizing: % of Catchment	Device Sizing: Treatment Area (m^2)	Device Sizing: Footprint (m^2)
RG1	12.8		0.64%	820	1,230
RG2	13.9		0.64%	890	1,335
RG3	5.0		0.64%	320	480
RG4	29.3		0.64%	1,880	2,820
RG5	10.0		0.64%	650	975
RG7	16.0		0.64%	1,030	1,545
RG8	28.4	13.9	0.64%	930	1,395
RG9	1.3		0.64%	90	135
RG10	15.0	0.4	0.64%	940	1,410
RG11	16.8		0.64%	1,080	1,620
RG12	8.3		0.64%	540	810
RG13	9.3	0.6	0.64%	560	840
WB1	13.7	1.8	4.00%	4,750	5,938

* School, local centre, service station and medium density residential areas are assumed to have on lot treatment.
* The footprint of the raingardens is assumed to be 50% larger than the filter area and the footprint of the waterbodies is assumed to be 25% larger than the treatment area to allow for batters and curtilage in the design.
* The on lot treatment area is subtracted from the overall catchment area in the calculation of the device sizing.

Based on experience in other Growth Centre Precincts, the land take required for stand-alone bio-retention rain gardens is approximately 150% of the bio-retention media bed area. This accounts for the required Extended Detention Zone (EDZ), batters, maintenance access tracks and retaining walls/transition to the surrounding terrain.

A Camden Council MUSIC-Link report is provided in Appendix E.

5.4. Stream Erosion Index

A Stream Erosion Index (SEI) assessment has been undertaken to ensure that the proposed typical bio-retention devices reduce the duration of post-development stream forming flows to no greater than 3.5-5 times the duration of pre-development stream forming flows. The methodology used to determine the SEI within this report complies with the NSW MUSIC Modelling Guide (2015).

A forest node has been used to represent the site under existing conditions and the rainfall-runoff/soil parameters remain consistent with Council's MUSIC-Link parameters.

As there are no stream gauge records available for the site, the critical flow has been adopted as 50% of the 50% AEP, 540-minute duration storm flows determined using XP-RAFTS hydrologic software. A summary table of the SEI assessment and results for a typical 10 ha low-density residential catchment is provided in Table 5-8.

Table 5-8 – SEI Assessment for Typical 10 ha Low Density Residential Catchment

	XP-Rafts 50% AEP		Stream Erosion Index		
Assessment Location	**Q_2 (m^3/s)**	**Q_{crit} (m^3/s)**	**Pre Dev Outflow (ML/yr)**	**Post Dev Outflow (ML/yr)**	**SEI**
Report SEI Low 10ha - Raingarden	0.191	0.096	5.97	12.7	2.1
Report SEI Low 10ha - Pond	0.191	0.096	5.97	6.89	1.2

Similarly, a summary table of the SEI assessment and results for a typical 10 ha medium density residential catchment is provided in Table 5-9.

Table 5-9 – SEI Assessment for Typical 10 ha Medium Density Residential Catchment

	XP-Rafts 50% AEP		Stream Erosion Index		
Assessment Location	**Q_2 (m^3/s)**	**Q_{crit} (m^3/s)**	**Pre Dev Outflow (ML/yr)**	**Post Dev Outflow (ML/yr)**	**SEI**
Report SEI Med 10ha	0.191	0.096	5.97	16.1	2.7

The SEI results indicate that the proposed stormwater quality treatment train, when sized to achieve pollution reduction targets, will ensure that the duration of post development stream forming flows would be no greater than the limit of 3.5 times the duration of existing conditions stream forming flows. Notwithstanding, at the design stage, all development applications should undertake an SEI assessment to confirm that the statutory SEI requirements are achieved.

5.5. Construction Stage

Erosion and sediment control measures are to be implemented during the construction phase in accordance with the requirements of Council and the guidelines set out by Landcom (the "Blue Book" 2004).

As the operation of 'bio-retention' (raingarden) water quality treatment systems are sensitive to the impact of sedimentation, construction phase controls should generally be maintained until the majority of site building works (approximately 80%) are complete.

5.6. Long Term Management

Regular maintenance of the stormwater quality treatment devices is required to control weeds, remove rubbish and monitor plant establishment and health. Some sediment build-up may occur on the surface of the raingardens and may require removal to maintain the high standard of stormwater treatment. Regular management and maintenance of the water quality control systems will ensure long-term, functional stormwater treatment. It is strongly recommended that a site-specific Operation and Maintenance (O & M) Manual is prepared for the system as part of future Development Applications. The O & M manual will provide information on the Best Management Practices (BMP's) for the long-term operation of the treatment devices. The manual will provide site-specific management procedures for:

- Maintenance of the GPT structures including rubbish and sediment removal;
- Management of the raingarden including plant monitoring, replanting guidelines, monitoring and replacement of the filtration media and general maintenance (i.e. weed control, sediment removal); and
- Indicative costing of maintenance over the life of the device.

6. WATER QUANTITY ASSESSMENT

The hydrologic analyses for Precinct 5 was undertaken utilising AR&R 2019 methodologies within XP-RAFTS hydrologic modelling software. XP-RAFTS is a non-linear runoff routing model that generates runoff hydrographs from rainfall data. The objective of the hydrologic analysis was to determine the requirement and size of detention basins needed to restrict peak post-development to existing flows at all key locations.

XP-RAFTS models have been created to represent both "Existing" and "Developed" site conditions and are based on the Upper South Creek (USC) XP-RAFTS hydrologic models prepared by WMA Water in February 2021. It is important to note that an issue relating to the spatially varying rainfall data and variation in some of the catchment areas utilised in the USC hydrologic model was identified as part of this assessment. Camden Council advised that the 'west' rainfall data is to be utilised for Precinct 5, and the catchment areas should reflect calculated spatial areas.

The USC XP-RAFTS model was prepared for the much broader USC floodplain, with catchments varying in size from 0.1 ha to 668.4 ha. To ensure that basins were sized to attenuate flows within Precinct 5, catchments have been split where necessary to allow flow reporting at key locations (refer Plate 6-1), particularly basin outlets and receiving catchments immediately downstream of the Precinct.

Our approach as part of this Precinct planning process is to 'book end' the assessment requirements by determining the detention volumes required to manage the 50% AEP and 1% AEP storm events. Intermediate storm events are then assessed in the flood assessment described in Section 7.

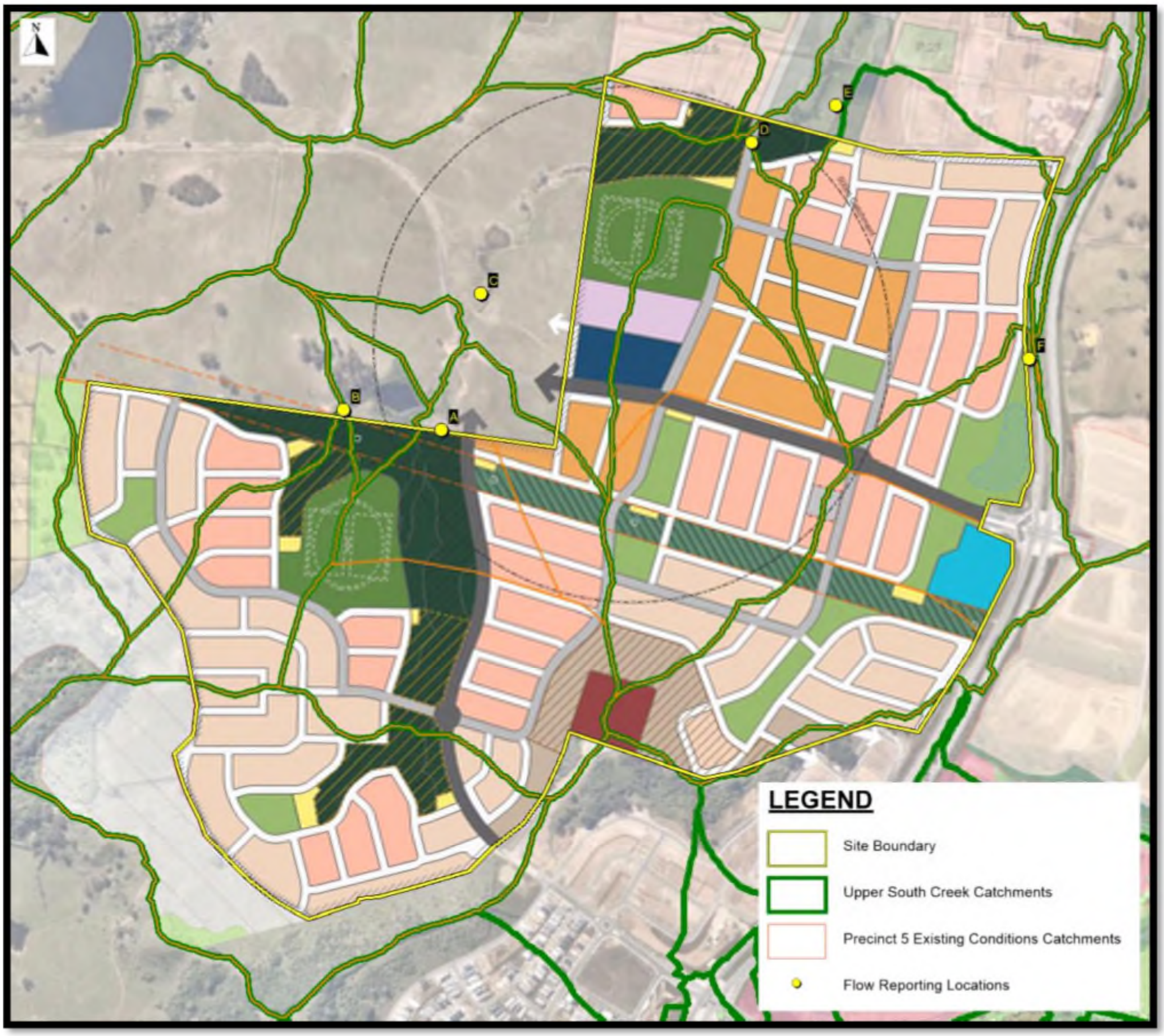


Plate 6-1 – XP-RAFTS Catchments and Reporting Locations

6.1. Existing Site Condition

The XP-RAFTS model from the USC Flood Study by WMA Water, February 2021 was adopted as the 'base case' model for the hydrologic assessment. Refer to Plate 6-2 for an illustration of the model layout. The existing conditions catchment plan is provided in Figure 6-01 in Appendix C.

In order to create the site-specific "Existing" conditions model for Precinct 5 the WMA, February 2021 XP-RAFTS model was amended with the following changes:

- Catchment 1057 has been split (with "a", "b" and "c" suffix) to create a comparison location at the proposed basin WB2;
- Catchments 1458, 1026 and 997 were split to create comparison locations at the Precinct boundary;
- Catchment 997 was further split at upstream locations to allow for further flow interrogations;
- All catchment areas have been updated to reflect calculated areas (spherical); and
- Model parameters for all new catchments have been kept consistent with the calibrated model provided by WMA Water. This includes adopting existing initial and continuing loss, vectored slopes and assumed fraction imperviousness.

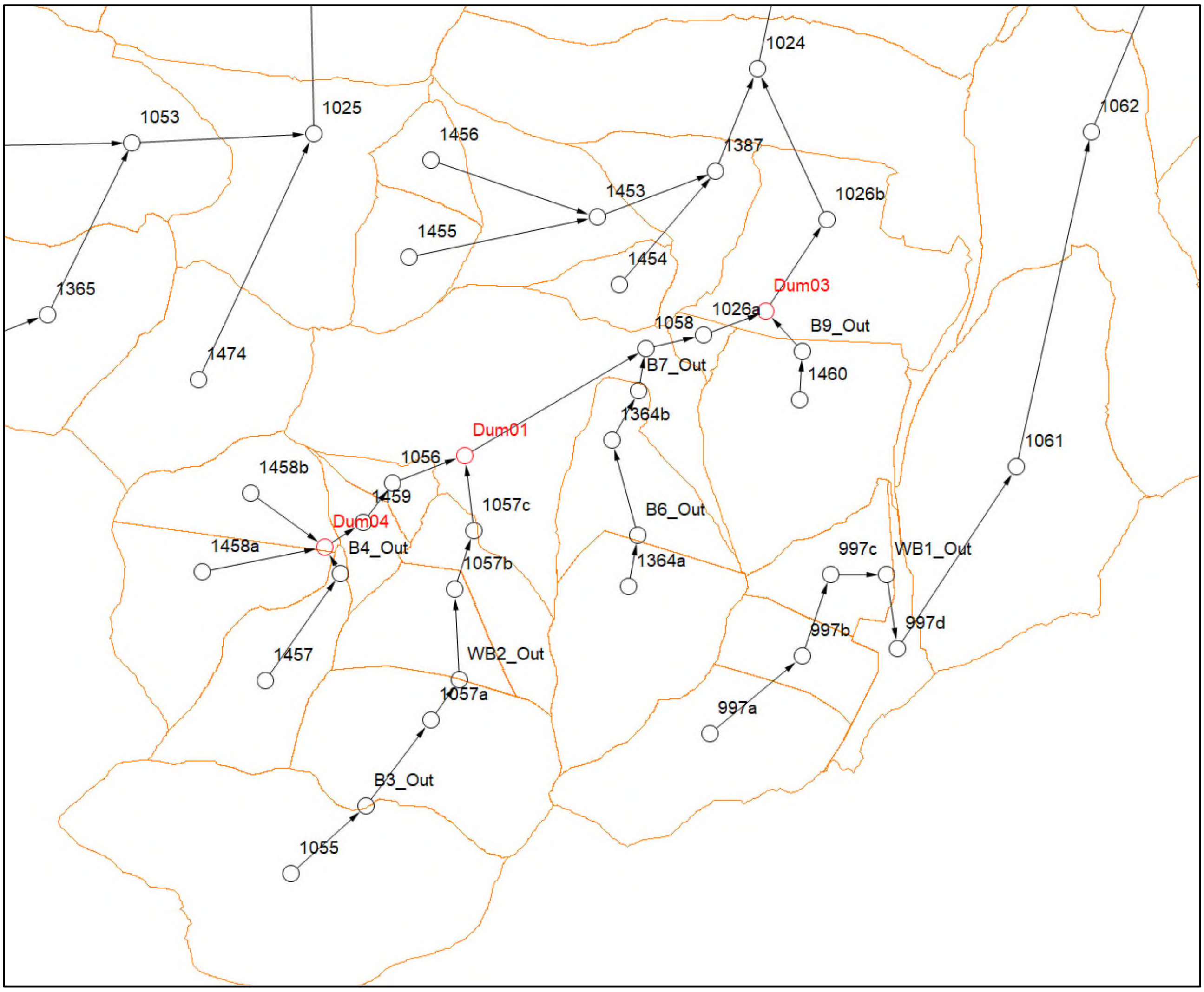


Plate 6-2 – Existing Conditions XP-RAFTS Catchments Model Layout (EX_010_~AEP~_~DURN~.xp)

6.2. Developed Site Conditions

A "Developed" site conditions model has been created by updating the existing site conditions model to represent the ILP land users. Refer to Plate 6-3 for model layout and Figure 6-02 for the developed catchment plan in Appendix C.

The developed condition model was established by updating existing condition model with the following changes:

- The existing catchment delineation will be generally be retained. The only exceptions are:
  - Catchment 1057a was further split to ("d" suffix) to estimate the developed flow into Basin B2.
  - Catchment 1058 was split to create a comparison location at the development edge;
  - Catchment 1364b was adjusted to suit the ILP layout.

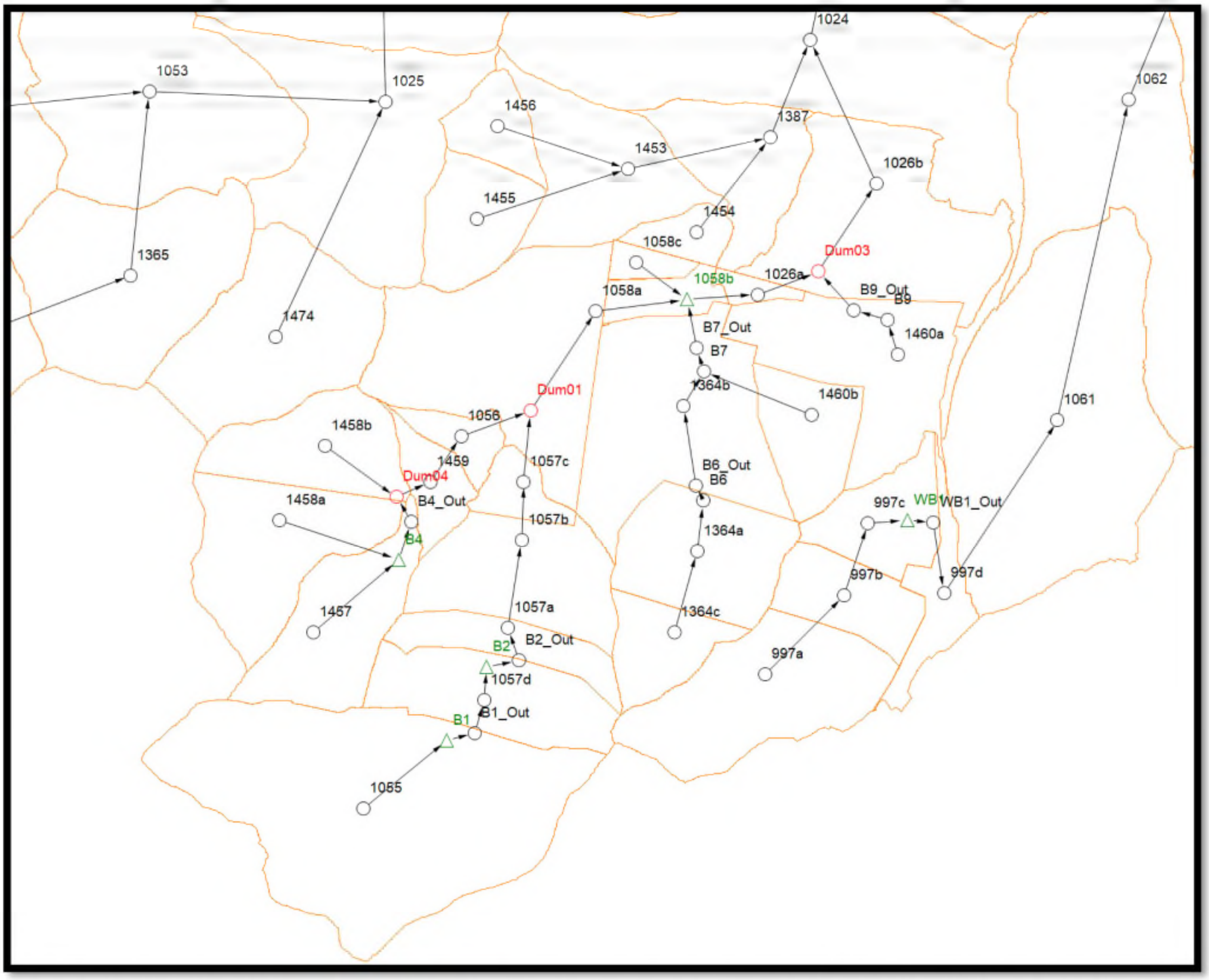


Plate 6-3 – Developed Conditions XP-RAFTS Catchments Model Layout (DEV_016_~AEP~_~DURN~.xp)

- In accordance with Council guidelines, fraction impervious values were applied based on the proposed land-use zoning within the ILP. Details of the percentage impervious applied to the model are shown in Table 6-1;
- Developed conditions catchments have been increased in area by 5% to ensure that there is some flexibility in the final catchment arrangement as the design of the Precinct evolves.

Table 6-1 – Developed Conditions Fraction Impervious

Landuse	% Impervious
Residential - Low Density 1	75
Residential - Low Density 2	80
Residential - Medium Density	85
Roads	90
Industrial / Commercial	90
School	50
Active Open Space	30
Riparian Corridor	10
Basins / SP2 Drainage	75
Existing Conditions Area	0

- Detention basins have been incorporated to attenuate developed conditions flows for the 50% AEP and 1% AEP flood events to ensure that acceptable peak flows are discharged at the Precinct boundary;
- Lag links within the riparian corridor and catchment slopes have been maintained as per the existing conditions; and
- Mannings 'n' of 0.025 and 0.015 has been adopted for pervious and impervious catchment areas respectively within Precinct 5.

6.3. Detention Basins

The proposed detention management strategy will consist of a series of basins and waterbodies strategically positioned throughout the site. The strategy includes one (1) offline dry basin, three (3) online dry basins and one (1) online wet basin in Precinct 5. Plate 6-4 provides an overview of the proposed basin locations. The reporting locations generally represent Precinct boundary locations where the existing terrain naturally grades into surrounding properties.

The catchments discharging to the proposed basins assume that the nearby road networks within the subdivision will be designed to allow both minor (piped) and major (overland) flows to discharge to the basin.

The detention basins in the XP-Rafts model use stage-storage relationships derived from the estimated footprint of each basin in accordance with the ILP. The basin outlets have been configured to ensure 0.5 m freeboard to the likely road, and adjoining urban development is available. Refinement of both the detention storage arrangement and basin outlet configuration will be required to support the future design phases of the Precinct.

Stage-discharge relationships have been used to represent the detention basin outlets. The proposed detention basin outlets are detailed in Table 6-2. A number of additional informal basins will also be created at locations where cycleways and pathways cross the drainage corridors. These have not been formally modelled at this stage but where appropriate will be included within the relevant modelling and reporting at DA stage of the project. The modelling of these is more relevant within the TUFLOW for smaller storm events rather than the 1% AEP storms.

Table 6-2 – Basin Outlet Details

Basin ID	Outlet Details
B1	Low Level Outlet - 750mm RCP U/S Invert 103, 20m long at 2% grade
	High Level Outlet - 23m weir at RL 104.05
B2	Low Level Outlet - 750mm RCP U/S Invert 102, 20m long at 2% grade
	High Level Outlet - 23m weir at RL 103
B4	Low Level Outlet - 2 x 450mm RCP U/S Invert 100.0, 30m long at 4% grade
	High Level Outlet - 10m weir at RL 101.4
B7	Low Level Outlet - 2 x 0.6H x 0.75W RCPC U/S Invert 85.1, 20m long at 2.8% grade
	High Level Outlet - 50m weir at RL 88.05
WB1	Low Level Outlet - 0.9m x 0.9m pit at RL 99.1 together with 1 x 375mm RCP U/S Invert 96.8, 40m long at 2% grade
	High Level Outlet - 15m weir at RL 100.1

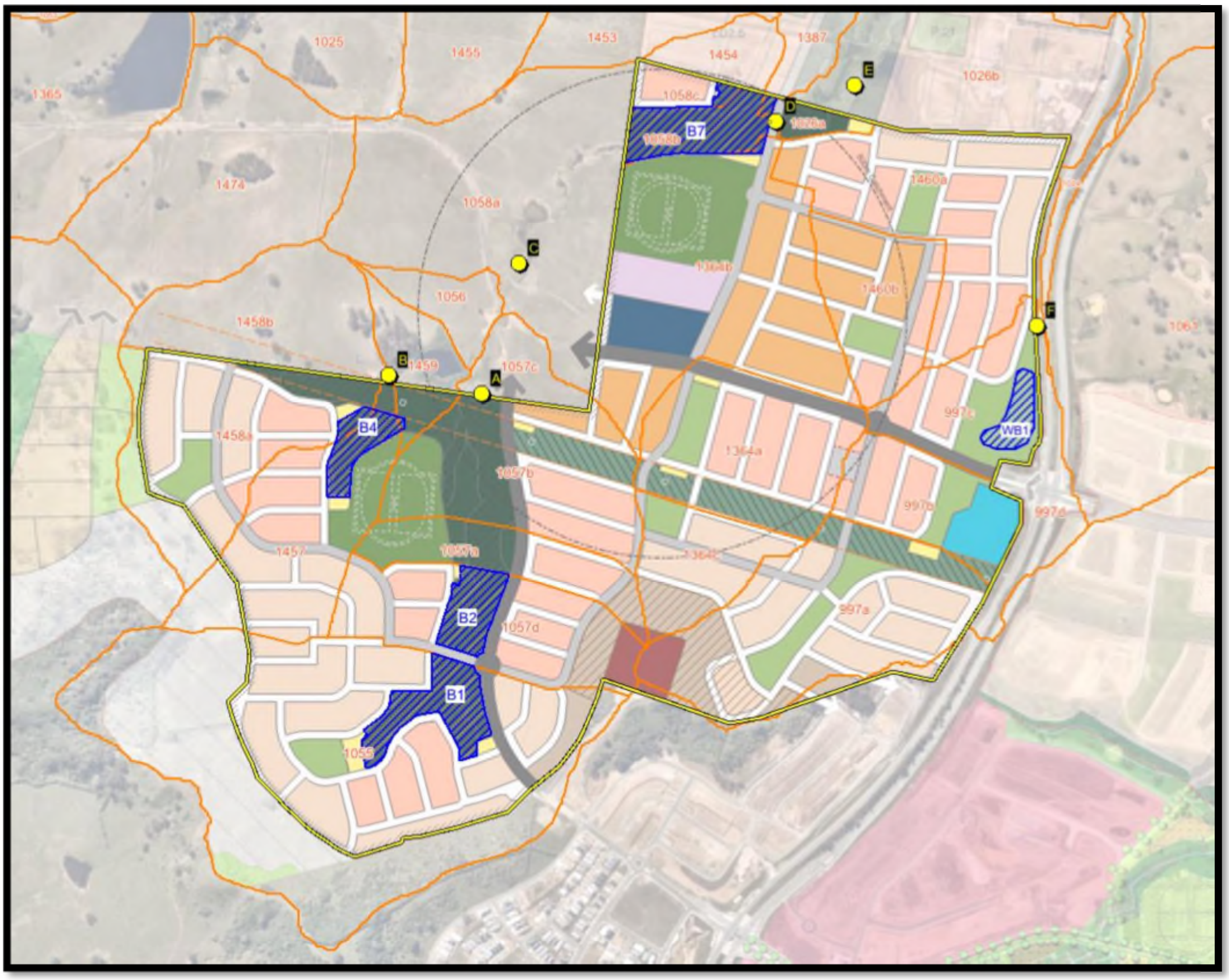


Plate 6-4 – Proposed Detention Basin Locations

6.4. Results

The existing and developed conditions catchment peak flow for the 50% and 1% AEP storm events were derived from the XP-RAFTS model. The storm durations as specified in the USC model user guide were assessed. Table 6-3 shows a comparison between existing ("Ex") and developed ("Dev") condition peak flows with the proposed detention basin at each of the key comparison locations shown in Plate 6-4.

Table 6-3 – Comparison of Existing and Developed Flows

Report Location	XP-RAFTS Node	50% AEP					20% AEP					1% AEP				
		Ex	Durn	Dev	Durn	Dev/Ex	Ex	Durn	Dev	Durn	Dev/Ex	Ex	Durn	Dev	Durn	Dev/Ex
A	1057b	1.40	1440	1.33	30	0.95	2.08	1440	1.86	30	0.89	6.50	360	5.21	720	0.80
B	Dum04	0.76	1440	0.71	1440	0.93	1.12	1440	0.94	1440	0.84	4.01	30	3.92	360	0.98
C	Dum01	2.43	1440	1.97	1440	0.81	3.62	1440	2.79	1440	0.77	11.45	360	10.99	360	0.96
D	1026a	3.73	1440	2.96	540	0.79	5.57	1440	4.08	540	0.73	17.12	360	14.79	360	0.86
E	Dum03	4.15	1440	3.47	30	0.84	6.20	1440	4.50	540	0.73	18.89	360	16.11	360	0.85
F	WB1_Out	0.62	1440	0.57	540	0.92	0.93	1440	0.60	540	0.65	2.91	360	2.88	360	0.99

It is important to note that the primary function of the XP-RAFTS model was to provide indicative detention storage requirements and to provide inflow hydrographs for use in the TUFLOW hydraulic model. The TUFLOW hydraulic model described in Section 7 provides a more accurate reflection of flow routing and confirms that there are no adverse flood impacts in the receiving catchments.

The summary of the preliminary detention volumes required at each basin to ensure that post developed flows do not exceed pre-developed flows are provided in Table 6-4.

Table 6-4 – Summary of Proposed Detention Volumes

Basin ID	Volume (m^3)	1% AEP TWL	1% AEP Depth
B1	19,955	104.20	1.20
B2	11,675	103.17	1.17
B4	7,864	101.64	1.64
B7	24,331	88.29	3.19
WB1	12,981	100.30	1.20

The hydrological modelling result shows that the proposed five (5) detention basins within Precinct 5 will ensure that post-development flows do not exceed existing flows at all key comparison locations for events up to and including the 1% AEP storm event. The hydraulic impacts within the Precinct detailed in Section 7.

7. FLOOD IMPACT ASSESSMENT

The USC TUFLOW hydraulic model was updated by WMA Water in February 2021 to reflect the AR&R 2019 procedures. At the time of writing this report, only the user guide associated with the model has been provided, as such it is not possible to provide a detailed model review.

J. Wyndham Prince has been provided both the USC TUFLOW model and results for comparison purposes. As discussed in Section 6 of this report, some issues relating to catchment areas and rainfall data were identified which will have flow on effect for the hydrographs adopted in the TUFLOW hydraulic modelling. The USC TUFLOW mode has been used as a base model to inform the Precinct 5 modelling.

7.1. Available Data

The following data was used to inform the flood modelling:

- Hydrology model (XPRAFTS) used for stormwater management strategy (Section 6);
- Upper South Creek TUFLOW flood model (WMA, February 2021);
- The Draft Indicative Layout Plan – BHL Land Holding Cobbitty dated 26/03/2024 supplied by Design + Planning (Appendix A); and
- Aerial photography of the site recorded by Metromap, 2021.

7.2. Events and Durations

The TUFLOW model was run in model build 2018-03-AE_isp for the events and durations in Table 7-1 in accordance with the USC model user guide (WMA, 2020).

Table 7-1 Modelled TUFLOW Events and Durations

	Duration	Temporal Pattern
50% AEP 20% AEP	30m	9
	540m	5
	1440m	6
5% AEP	60m	6
	360m	1
	1080m	6
1% AEP	30m	1
	360m	5
	720m	8
PMF	60m	n/a
	120m	
	240m	

7.3. Existing Conditions Model

To establish an existing condition model of the Precinct, the following amendments were made:

- Re-run the USC flood model to confirm that flood results provided by Council are replicated;
- The USC model has been trimmed to focus on Precinct 5, adopting HQ slope boundaries where necessary to reflect the hydraulic grade of the broader model flood results;
- Initial water levels were then added to the farm dams in the vicinity of the Precinct to reflect the full supply level in the dams which were omitted in the Council model;
- The model was then run with inflow hydrographs that were generated in the edited XP-Rafts models discussed in Section 6 of this report. An existing conditions hydrograph was also moved downstream of the large western farm dam within the Precinct. This model has then been adopted as the base conditions that the proposed development model has been compared against.

All of the above listed amendments have been tested against the preceding model results to provide an incremental understanding of the impacts of each change. Refer to Section 7.3.1 for details of the validation process.

An existing conditions TUFLOW model setup plan, together with a Manning's 'n' roughness plan are provided in Figure 7-01 and 7-02 respectively in Appendix C.

7.3.1 Model Validation

Four (4) model validation runs were completed to enable comparison to the USC WMA, February 2021 TUFLOW model results provided by Council.

Validation 1 – Replicate Council Model Results

The peak 1% AEP storm was run and compared with the gridded results provided by Council. Plate 7-1 below provides a flood level difference map which confirms that there are no measurable flood level differences and, therefore, the USC results have been successfully replicated.

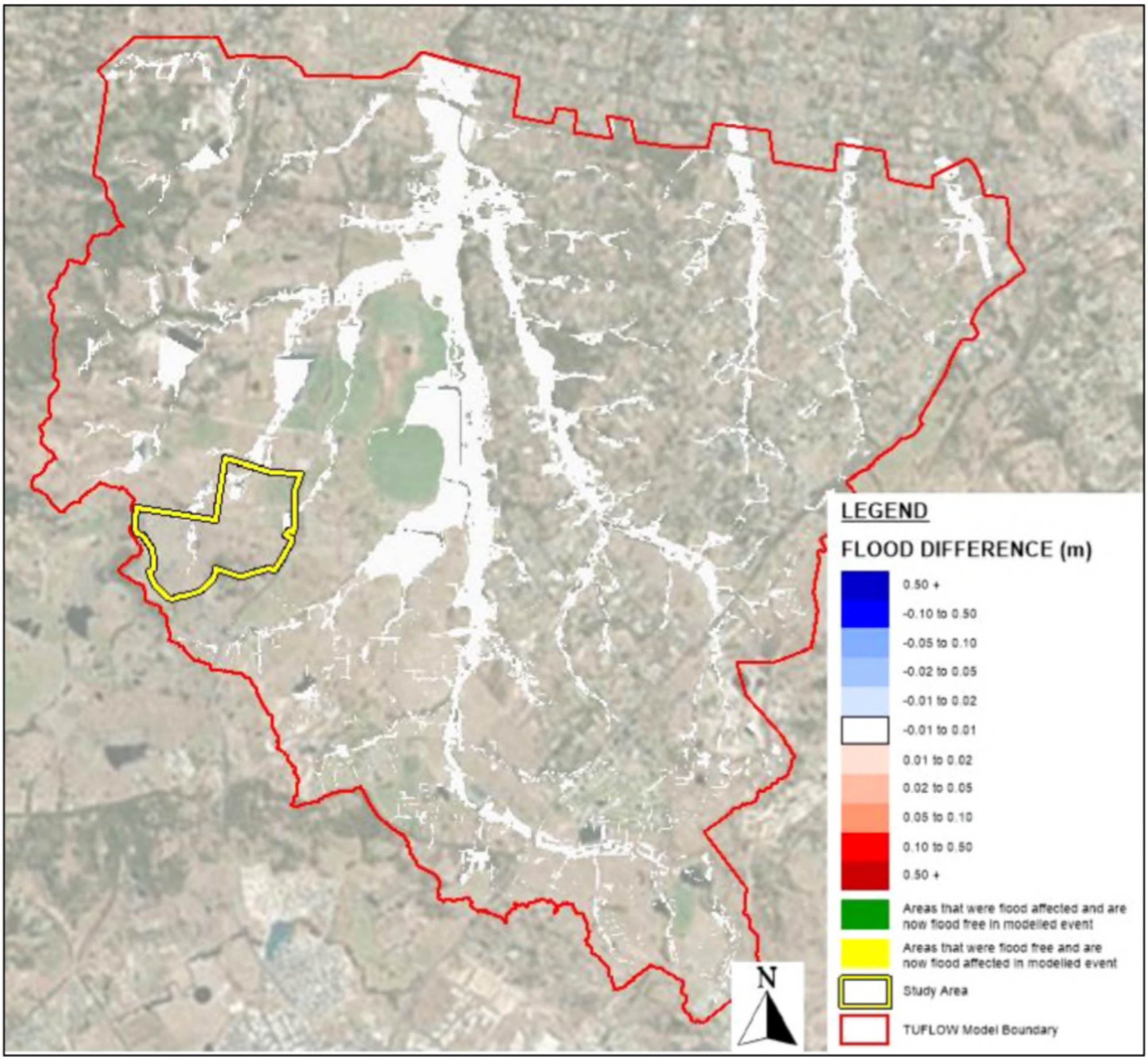


Plate 7-1 – Validation 1 – Peak 1% AEP Flood Comparison

Validation 2 – Compare trimmed model with Council results

The USC model was then trimmed to a suitable extent to assess the Precinct 5 rezoning. The peak 1% AEP flood results for the trimmed model have also been compared with the peak 1% AEP results provided by Council. The flood difference map shown in Plate 7-2 confirms that, with the exception of the downstream boundary location, there are no observable flood level differences within and in the vicinity of the Precinct. Given that the location of the flood level difference at the boundary location is approximately 3 km from the Precinct, the adopted boundary conditions will not influence flood levels within the area of interest.

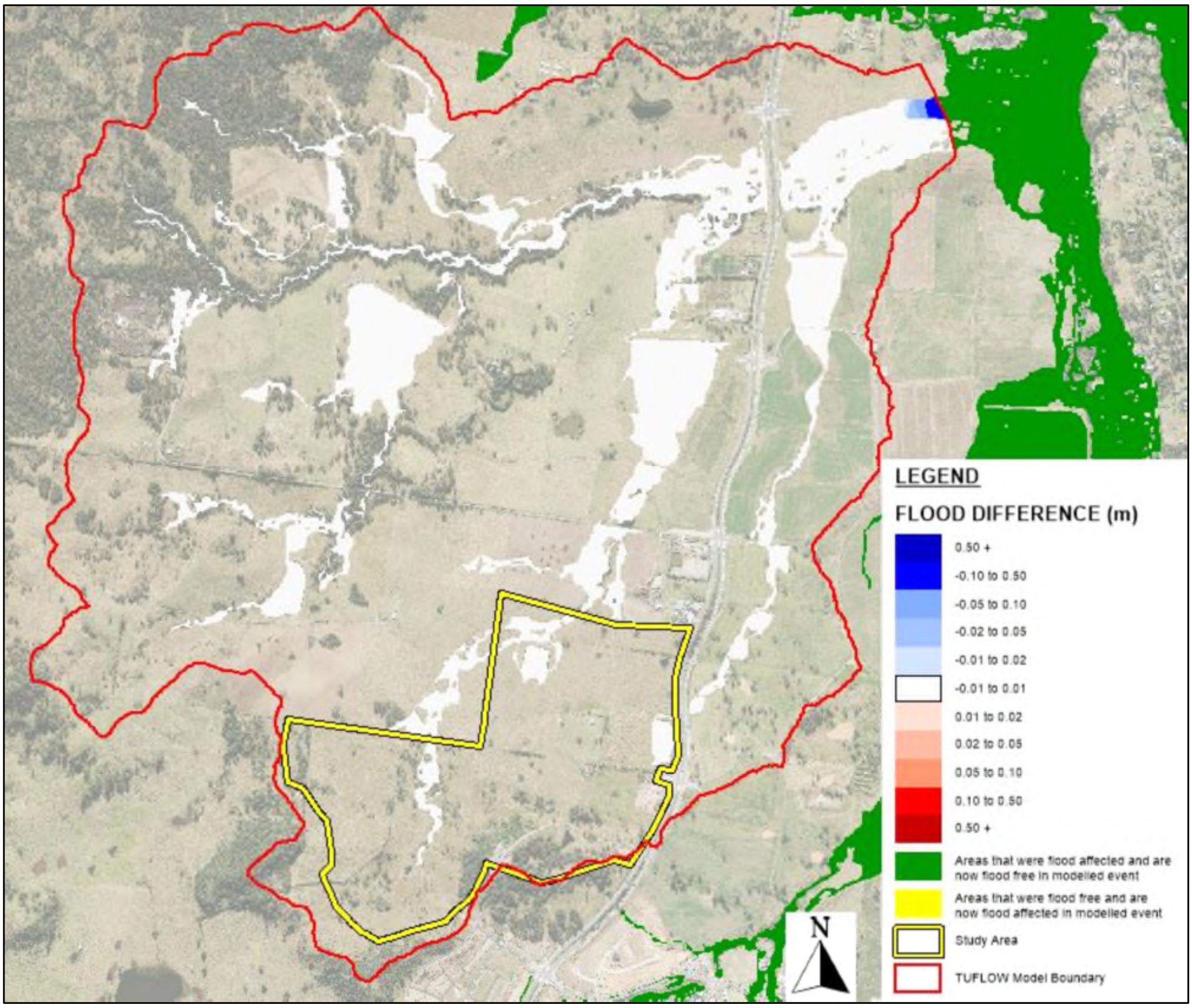


Plate 7-2 – Validation 2 – Peak 1% AEP Flood Comparison

Validation 3 – Compare farm dams filled model with Council Results

The Council provided USC model only considered the three (3) large downstream farm dams to be at full supply level. This was updated to include all other farm dams within the vicinity of the Precinct or immediately downstream. Given that these initial water levels have been added to the farm dams some differences between Council's model are again anticipated. The flood difference map in Plate 7-3 reflects the peak 1% AEP results for this model compared with the trimmed USC model (Validation 2). Flood level increases within the creek corridors through the Precinct and downstream are a result of a reduction in the available passive storage due to the existing farm dams being filled and not associated with the development of Precinct 5.

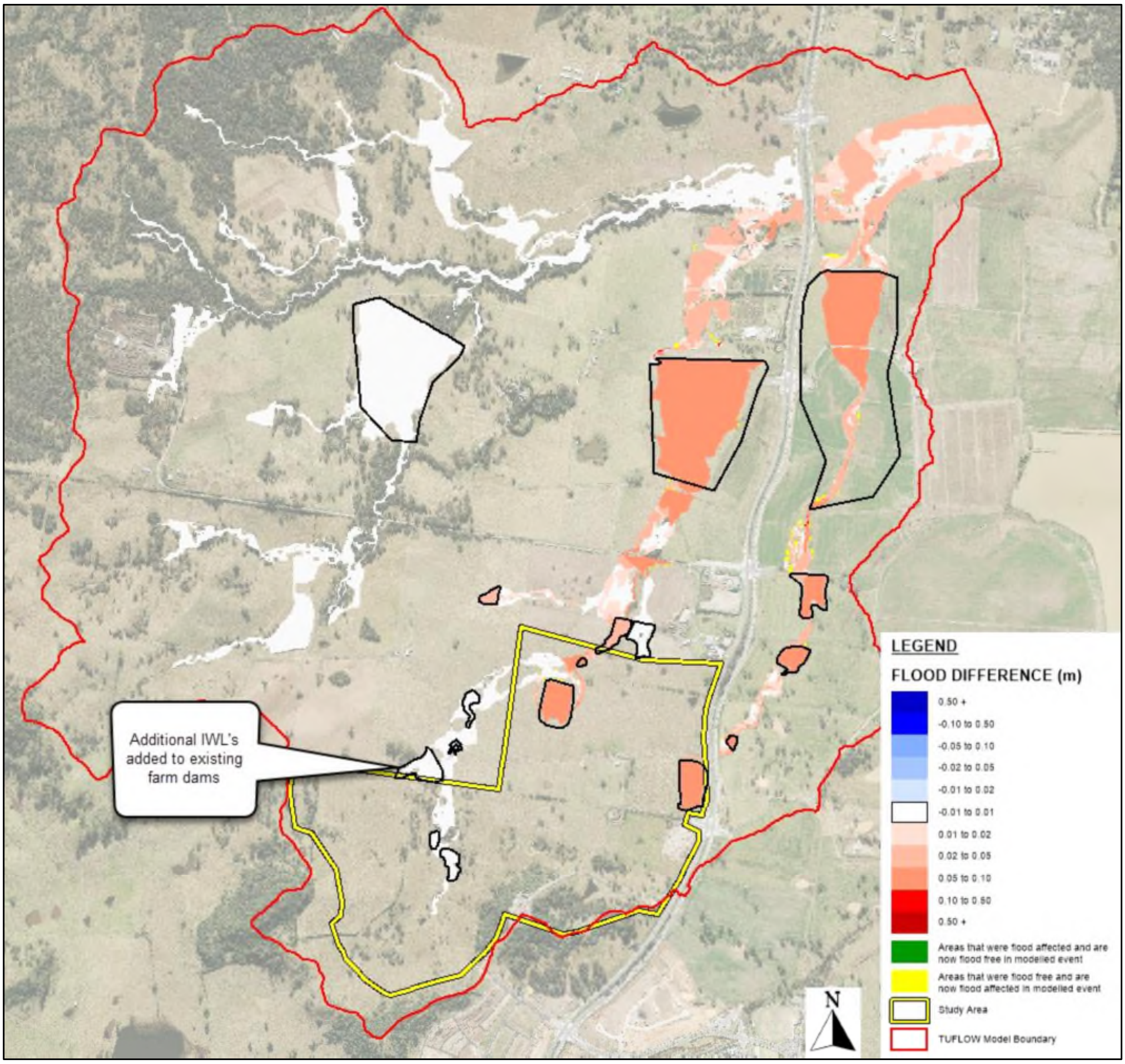


Plate 7-3 – Validation 3 – Peak 1% AEP Flood Comparison

Validation 4 – Compare updated hydrology model with Council Results

The updated existing conditions hydrology model (as described in Section 6) was used to inform the hydrograph inputs. The flood difference map in Plate 7-4 presents the comparison of the peak 1% AEP results against the results described in Validation 3. The minor changes that can be seen within the Precinct are expected and are due to the shifts/splits in catchment boundaries to inform the basin modelling described in Section 6.

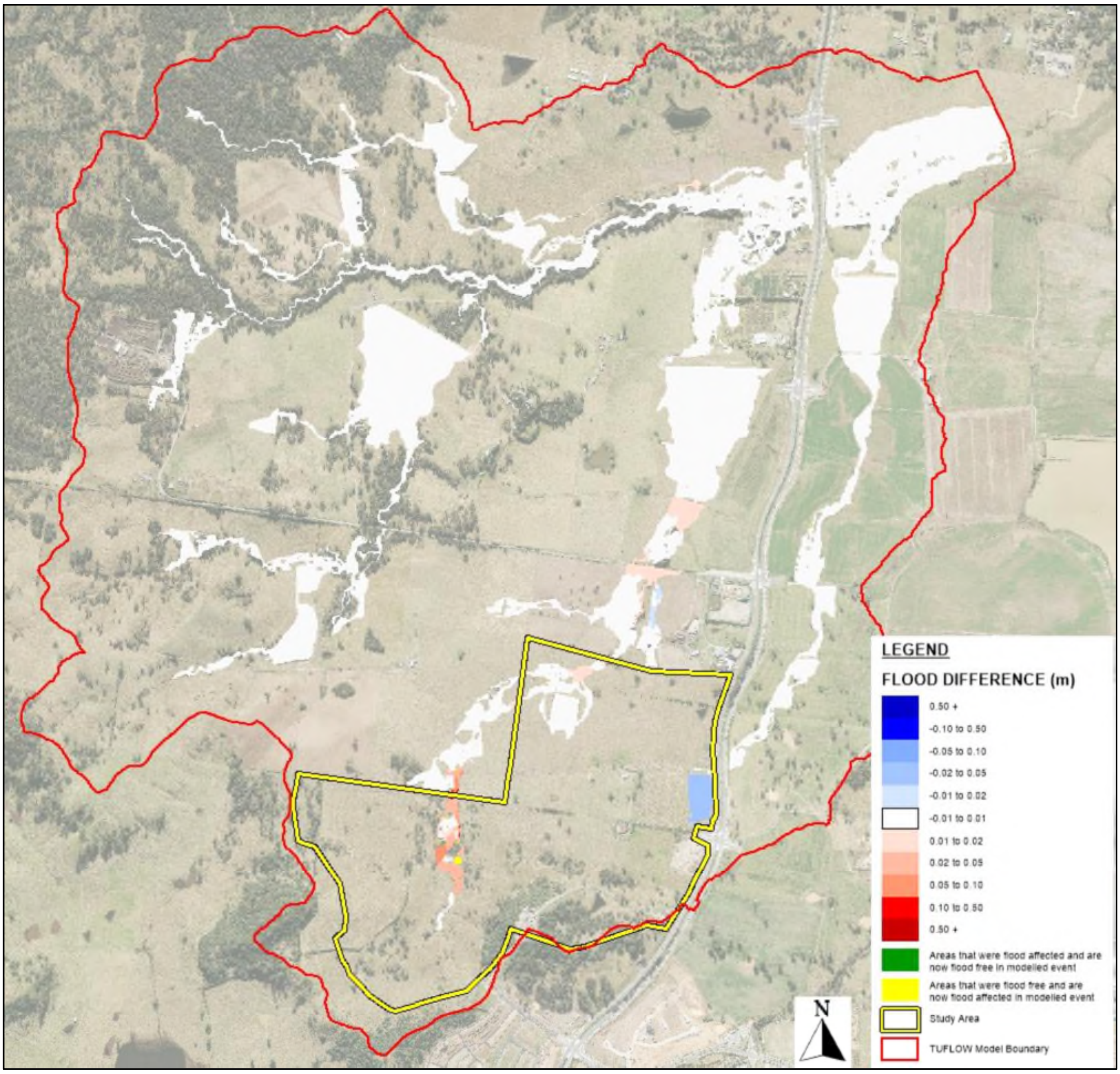


Plate 7-4 – Validation 4 – Peak 1% AEP Flood Comparison

Validation 4 has been used to assess the development impact and the performance of the detention/flood strategy for Precinct 5.

7.3.2 Developed Condition Model

An assessment of the developed condition was undertaken by amending the existing condition model with the preliminary concept landforms for each of the proposed detention basins. The developed, unmitigated flows from XP-RAFTS model were applied to the anticipated discharge locations to the corridors and basins to assess the performance of all basins.

A drainage swale has been included in the developed model to the immediate west of the northern playing fields to allow the existing flow path in this area to continue to drain to the north.

The ILP was used to update the land use for the proposed development model (Appendix A). The roughness value adopted for the proposed land-use external to the Precinct are consistent with the values adopted in the USC WMA, February 2021 flood model, while manning's values within the Precinct have been updated to reflect the future land uses. The surface roughness under developed conditions assumes revegetation of the riparian corridor. This is to reflect the likely vegetation to be introduced as part of the vegetation management plan (VMP) and to be maintained in perpetuity. Table 7-2 provides details of Manning's 'n' values adopted within the model.

Table 7-2 – Roughness Value

Mannings Roughness n	
Landuse	**Value**
Bare Earth	0.02
Maintained Grass/Parks/Ovals	0.03
Floodplain Grass/Pasture	0.04
Light Vegetation	0.045
Medium Vegetation	0.06
Dense Vegetation	0.08
Dense Riparian Vegetation	0.12
Creeks and Open Waterbodies	0.03
Roads	0.02
Road Corridor	0.035
Paved Areas	0.02
Low Density Residential	0.045
Medium Density Residential	0.06
Industrial/Commercial/Schools	0.03
Railway	0.06
Cobbitty Low Density Residential	0.1
Cobbitty Medium Density Residential	0.2
Cobbitty High Density Residential/Commercial/Industrial	0.3
Cobbitty Riparian Corridor	0.12 < 0.5m depth
	0.03 < 1.0m depth

Initial water levels have been incorporated in the TUFLOW modelling for the proposed permanent waterbody. TUFLOW detention volumes should be recorded above these levels. The updated TUFLOW modelling has incorporated concept design for (B4 and WB1) together with amending the surface using a (2d_zsh) layer to provide more accurate reflection to the likely basin landforms.

Future road crossings have not been included in the developed conditions modelling at this stage. Road crossing designs can be determined and assessed at future detailed design stages. The culvert crossings will be sized to provide 1% AEP flood immunity plus freeboard. Cycleway and pathway crossings of the corridor have not been included at this point. Specific details can be included in the development application stage once the precise locations are confirmed. The inclusion of these roads and cycleways crossings will provide extra detention particularly for small storm events.

A developed conditions TUFLOW model setup plan, together with a Manning's 'n' roughness plan are provided in Figure 7-03 and 7-04 respectively in Appendix C.

The TUFLOW model was assessed for a series of AEPs and storm durations to understand the impacts that the proposed development may have on the receiving catchments.

7.4. Discussion of Results

7.4.1 Existing Scenario Flood Behaviour

The existing conditions flood depth and level results for the 50% 20%, 5% and 1% AEP events, together with the PMF are shown on Figures 7-05, 7-08, 7-11, 7-14 and 7-17 in Appendix C, respectively.

Flooding within the central riparian corridor is generally contained within the creek lines, except for existing farm dam locations where flood extents increase due to the spillway embankments and find alternate overland routes back to the watercourse.

The existing conditions flood depths and extents generally reflect well-defined watercourses through, and adjacent to, Precinct 5.

7.4.2 Developed Scenario Flood Behaviour

The developed conditions flood depth and level results for the 50%, 20%, 5% and 1% AEP events, together with the PMF are shown on Figures 7-06, 7-09, 7-12, 7-15 and 7-18 in Appendix C, respectively.

Flood extents external to the site are generally consistent with existing conditions.

Flood extents are contained within the central riparian corridor up to the 1% AEP, with no evidence of 1% AEP flows entering developable areas. Flood hazard mapping presented in Figure 7-19 in Appendix B indicates that there are no unsafe areas within the proposed urban portion of Precinct 5.

7.5. Flood Impact Assessment

Flood difference mapping for the 50%, 20%, 5% and 1% AEP events are presented on Figures 7-07, 7-10, 7-13 and 7-16 in Appendix C, respectively.

Generally, there are no adverse flood level impacts external to Precinct 5 in events greater than the 50% AEP event. However, in the 50% AEP there are some minor impacts seen downstream in the large farm dam in the future Lowes Creek Maryland Precinct. This is due to the large amount of passive storage the dam provides (created by its large footprint and controlled weir outlet). The large dam highlights the volume change that occurs in the 50% AEP event at the model boundary which is created by the reduced initial rainfall losses under developed conditions. This effect is only prevalent in the 50% AEP as the larger events are less influenced by the change in rainfall loss parameters. We note that the large farm dam will be removed as part of the downstream LCM development which will in turn remove this minor impact.

Local flood level increases within Precinct 5 due to the proposed development are to be expected, and the results confirm that the proposed detention basins within the Precinct appropriately manage flows back to existing conditions at the Precinct boundary.

7.6. Hydrograph Comparison

Comparisons of hydrographs have been made between existing conditions and developed conditions at the downstream boundary of the TUFLOW model. The comparisons have been made in the 1% AEP event for all assessed durations to ensure that no significant timing changes have occurred at the peak of the storm events which could contribute to an impact downstream of the model boundary. The location at which the comparisons have been made is shown in Plate 7-5.

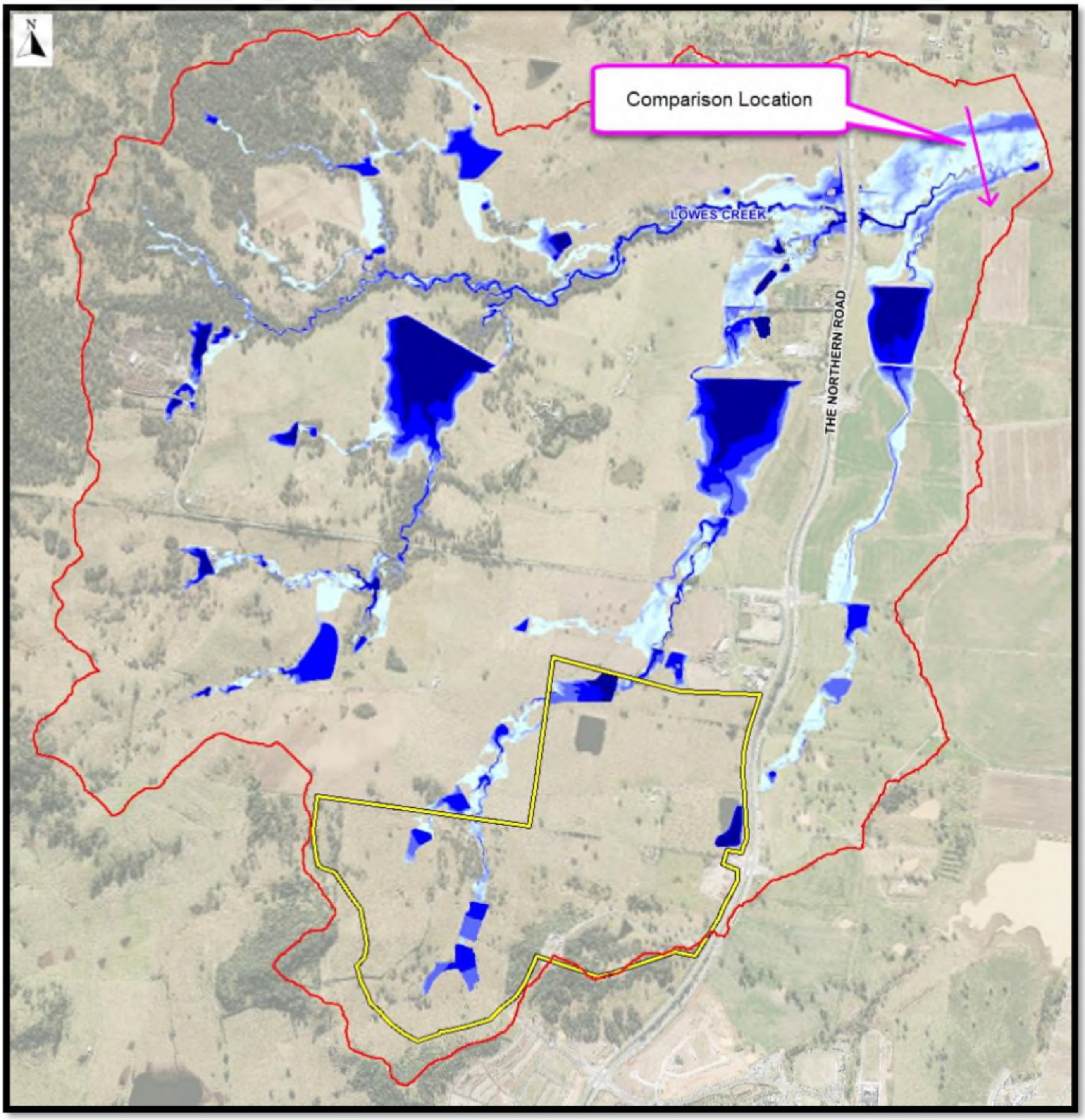


Plate 7-5 – Hydrograph Comparison Location

The 1% AEP hydrograph comparisons are presented in the graph in Plate 7-6. The comparisons have been made between the Council USC model conditions, the updated Cobbitty existing conditions and the Cobbitty developed conditions.

The graph generally shows that some volume increases have occurred as a result of the existing conditions model updates. Specifically, this is due to the addition of initial water levels (IWL) to the farm dams in the vicinity of the precinct. This is detailed in Section 7.3.1. The graphs also show that there are no changes to the hydrograph behaviour as a result of the proposed development. And therefore, it is not expected that the development will have any impacts beyond the boundary of the model.

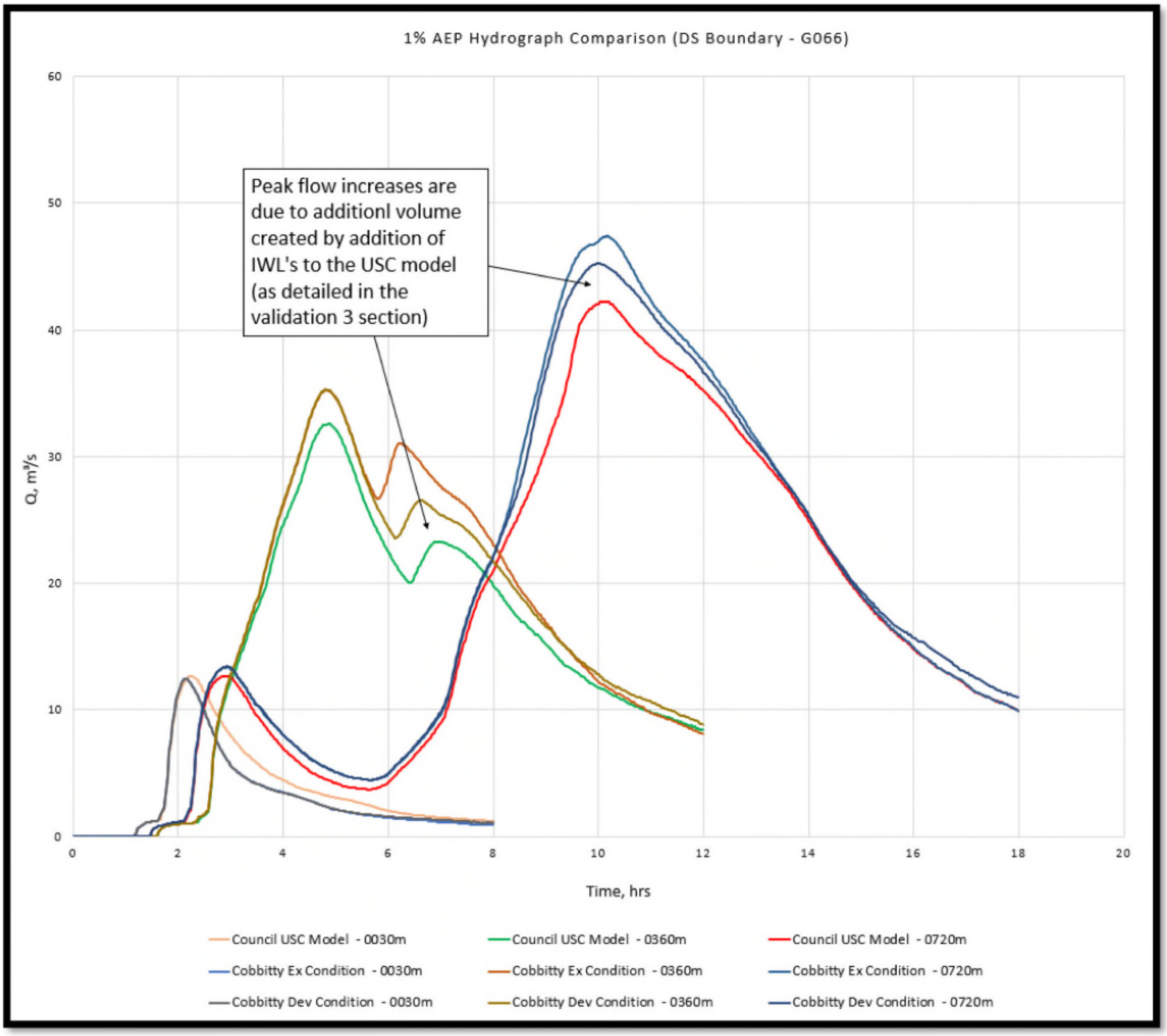


Plate 7-6 – 1% AEP Hydrograph Comparisons

7.7. Climate Change Sensitivity

The 1% AEP developed conditions flood behaviour shown in Figure 7-15 is contained within the riparian corridor and the preliminary surface grading of the Precinct ensuring that a minimum of 0.5 m freeboard achieved to the adjacent development.

Future assessments will consider a climate change sensitivity assessment as part of the full suite of events and durations to be run in accordance with the USC model guide to support future development applications. Notwithstanding, given that the PMF results indicate minimal encroachment on lots and that the PMF is not influenced by the impacts of climate change, it is unlikely that a climate change sensitivity assessment will have a greater impact on the developable portion of the Precinct. Thus, the need for a sperate climate change assessment is not seen as required at this time.

8. GLOSSARY

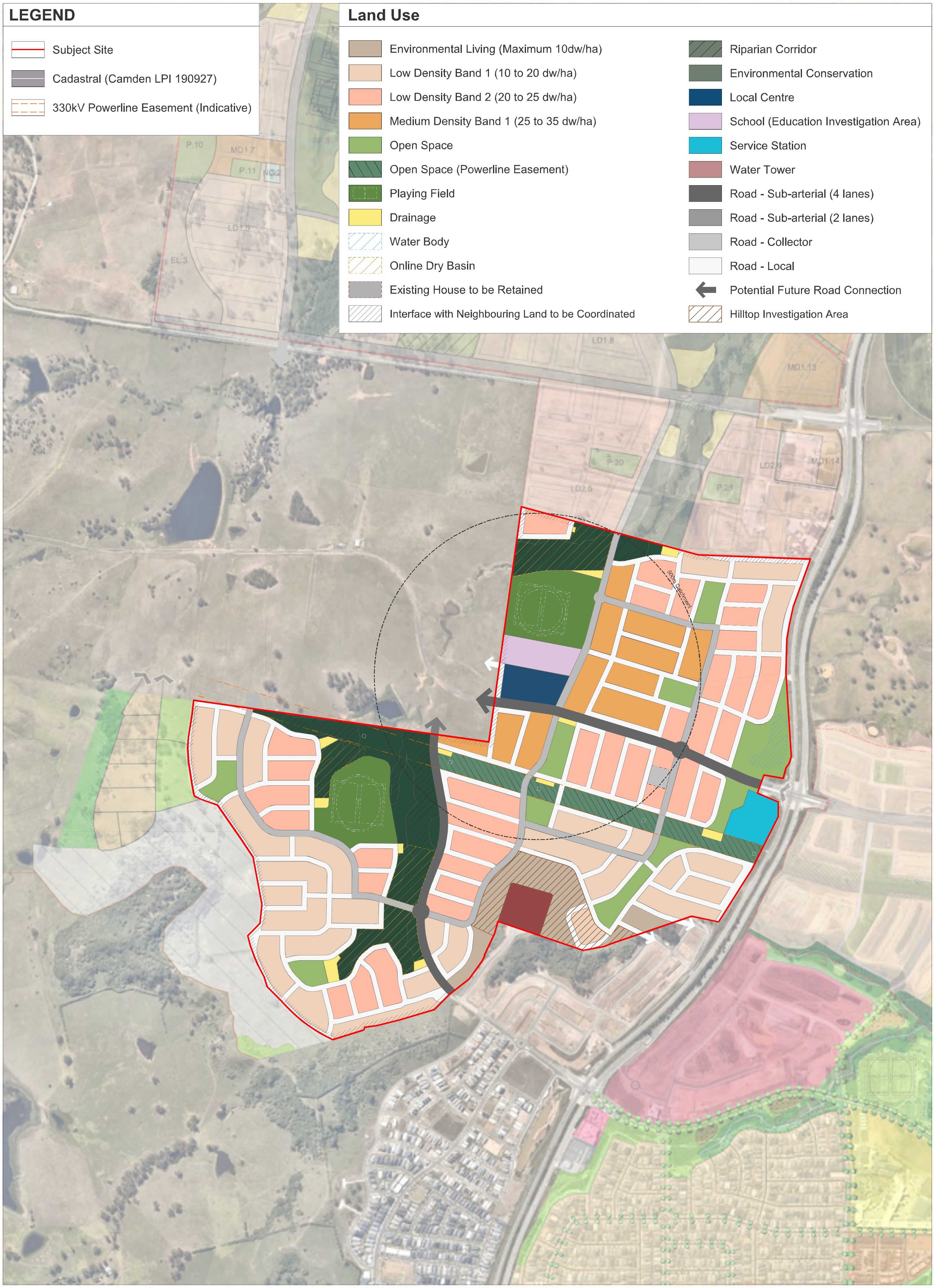
Term	Definition
Annual Exceedance Probability (AEP)	The chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring annually. Normally expressed as a percentage.
Australian Rainfall and Runoff (AR&R)	Refers to the current edition of Australian Rainfall and Runoff published by the Institution of Engineers, Australia.
Exceedances per Year (EY)	The number of times a year that statistically a storm flow is exceeded.
Floodplain Planning Level (FPL)	The FPL is a height used to set floor levels for property development in flood-prone areas. It is generally defined as the 1% AEP flood level plus 0.5m freeboard.
Floodplain Development Manual (FDM) and Guidelines (April 2005)	The FDM is a document issued by the Department of Environment Climate Change and Water (DECCW) that provides a strategic approach to floodplain management. The guidelines have been issued by the NSW Department of Planning (DoP) to clarify issues regarding the setting of FPL's. This document is also the framework for the development of Floodplain Risk Management Studies and Plans.
Hydrograph	Is a graph that shows how the stormwater discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
J. Wyndham Prince Pty Ltd (JWP)	Consulting Civil Infrastructure Engineers and Project Managers undertaking these investigations
MUSIC	A modelling package designed to help urban stormwater professionals visualise possible strategies to tackle urban stormwater hydrology and pollution impacts. MUSIC stands for Model for Urban Stormwater Improvement Conceptualisation and has been developed by the Cooperative Research Centre (CRC),
Peak Discharge	Is the maximum stormwater runoff that occurs during a flood event
Probable Maximum Flood (PMF)	The greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.

Term	Definition
TUFLOW	A computer program that provides two-dimensional (2D) and one dimensional (1D) solutions of the free surface flow equations to simulate flood and tidal wave propagation. It is specifically beneficial where the hydrodynamic behaviour, estuaries, rivers, floodplains and urban drainage environments have complex 2D flow patterns that would be awkward to represent using traditional 1D network models.
XP-RAFTS	Is a runoff routing model that uses the Laurenson non-linear runoff routing procedure to develop a sub catchment stormwater runoff hydrograph from either an actual event (recorded rainfall time series) or a design storm utilising Intensity-Frequency-Duration data together with dimensionless storm temporal patterns as well as standard AR&R 1987 data.

9. REFERENCES

1. DCP 2019. *Camden Development Control Plan*, Camden Council 2019.
2. DCP 2016. *Oran Park Precinct Growth Centres Development Control Plan*, Department of Planning, NSW Government 2016.
3. CC, 2019. *Camden Council Draft Engineering Design Specification*, Camden Council 2019.
4. CRCCH, (2005) - CRC For Catchment Hydrology (2005). *MUSIC Model for Urban Stormwater Improvement Conceptualisation*, User Guide Version 3.
5. BMTWBM (2015). *Draft NSW MUSIC Modelling Guidelines*
6. Willing & Partners Pty. Ltd. (1996). *Runoff Analysis & Flow Training Simulation*. Addendum, Version 5.0
7. Willing & Partners Pty. Ltd. (1994). *Runoff Analysis & Flow Training Simulation*. Detailed Documentation and User Manual, Version 4.0

APPENDIX A – SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5 ILP



Draft Indicative Layout Plan - BHL Land Holding

COBBITTY

NORTH

50 0 100 200 300 400 500 metres

Ref:BHLCO-2-001a-2	Date: 26/3/2024	Revision: N	Scale: 1:5,000@A1

Note: All areas and dimensions subject to detailed survey

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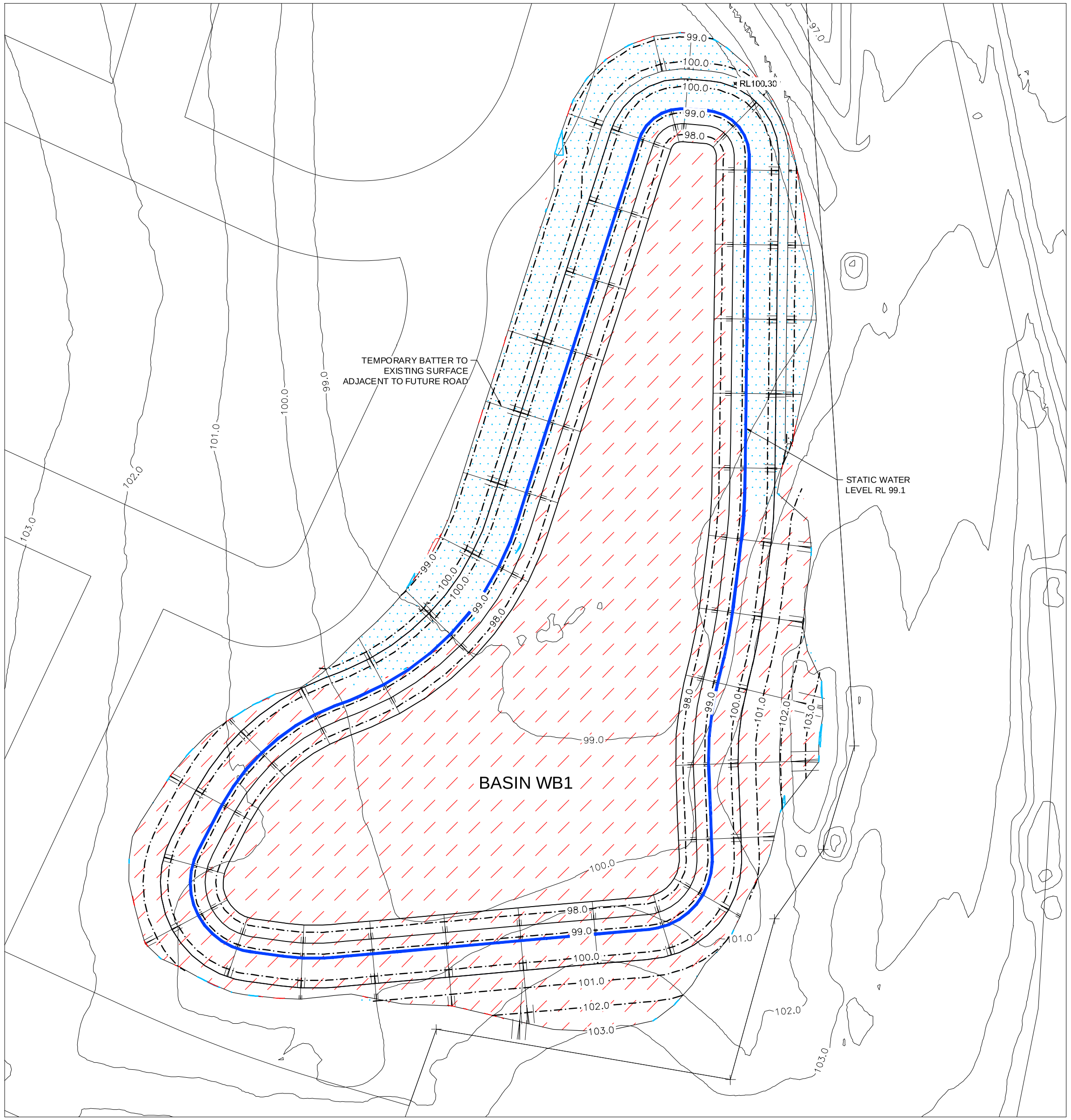
APPENDIX B – PRELIMINARY CONCEPT PLANS



BASIN WB1

(blue line)	STATIC WATER LEVEL
——100.0——	EXISTING SURFACE CONTOURS & LEVELS
—·—100.0·—·—	DESIGN SURFACE CONTOURS & LEVELS
(dotted fill)	EXTENT OF FILL = 2,500m^3
(hatched)	EXTENT OF CUT = 17,500m^3

INVERT RL 97.52

PERMENANT POOL VOLUME = 11,850m^3

STATIC WATER LEVEL RL 99.1

DETENTION VOLUME = 13,000m^3

TOP WATER LEVEL RL 100.3

1:500 (AT A1)
1:1000 (AT A3)

10 0 10 20 30 40 50
METRES

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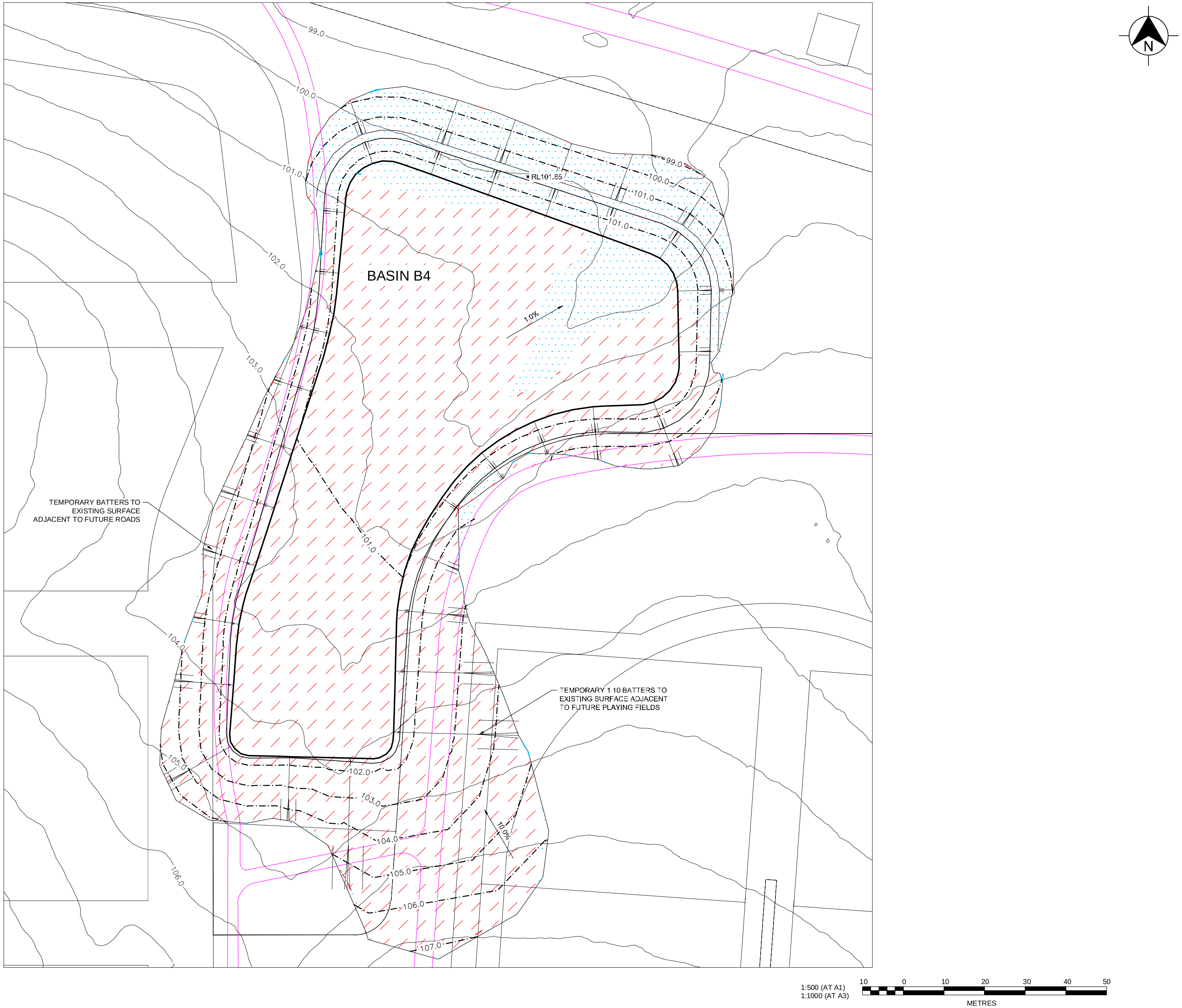
SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN WB1 CONCEPT DESIGN

110628-02-SK02

28/10/2022



BASIN B4

100.0 (solid line)	EXISTING SURFACE CONTOURS & LEVELS
100.0 (dash-dot line)	DESIGN SURFACE CONTOURS & LEVELS
(dotted fill)	EXTENT OF FILL = 2,400m^3
(hatched fill)	EXTENT OF CUT = 13,300m^3

INVERT RL 100.0

DETENTION VOLUME = 7,900m^3

TOP WATER LEVEL RL 101.65

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SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN B4 CONCEPT DESIGN

110628-02-SK04
25/11/2022

APPENDIX C – FIGURES

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LEGEND

- Site Boundary
- Assumed Raingarden Catchments
- Indicative Basin Footprint
- Indicative Raingarden Footprint
- Indicative Pond Footprint
- Future Culvert Crossing
- Pedestrian Link
- RG1 19.2 ha — Catchment ID, Area

NOTES

- Raingarden locations within riparian corridor subject to offest requirements and flood constraints

N

0 240
metres
Scale 1:6,000 @ A3

Projection: GDA 1994 MGA Zone 56

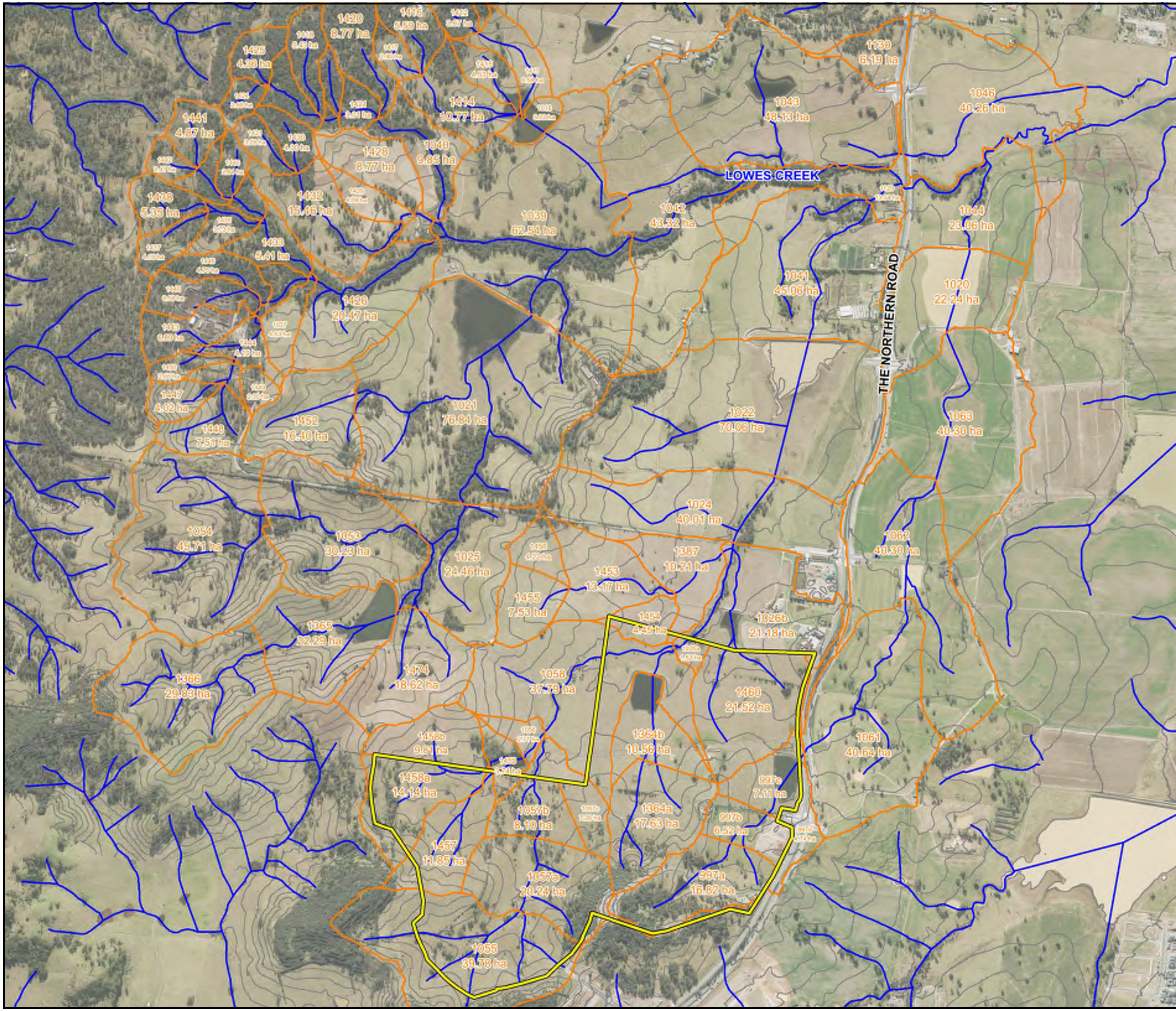
Figure 5-01

South Creek West
Cobbitty Sub-Precinct 5

Developed Conditions
Water Cycle Management Plan

Date: 15/04/2024
Issue: G

Filename: "J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report\110628-02_Fig5-01_DEV_WQCP_G.WOR"



LEGEND

- Site Boundary
- Existing Conditions Catchment
- 1075a 16.38 ha — Catchment ID Area
- Watercourse
- 5m Contours

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-01

South Creek West Cobbitty Sub-Precinct 5

Existing Conditions Catchment Plan

Date: 13/12/2022

Issue B

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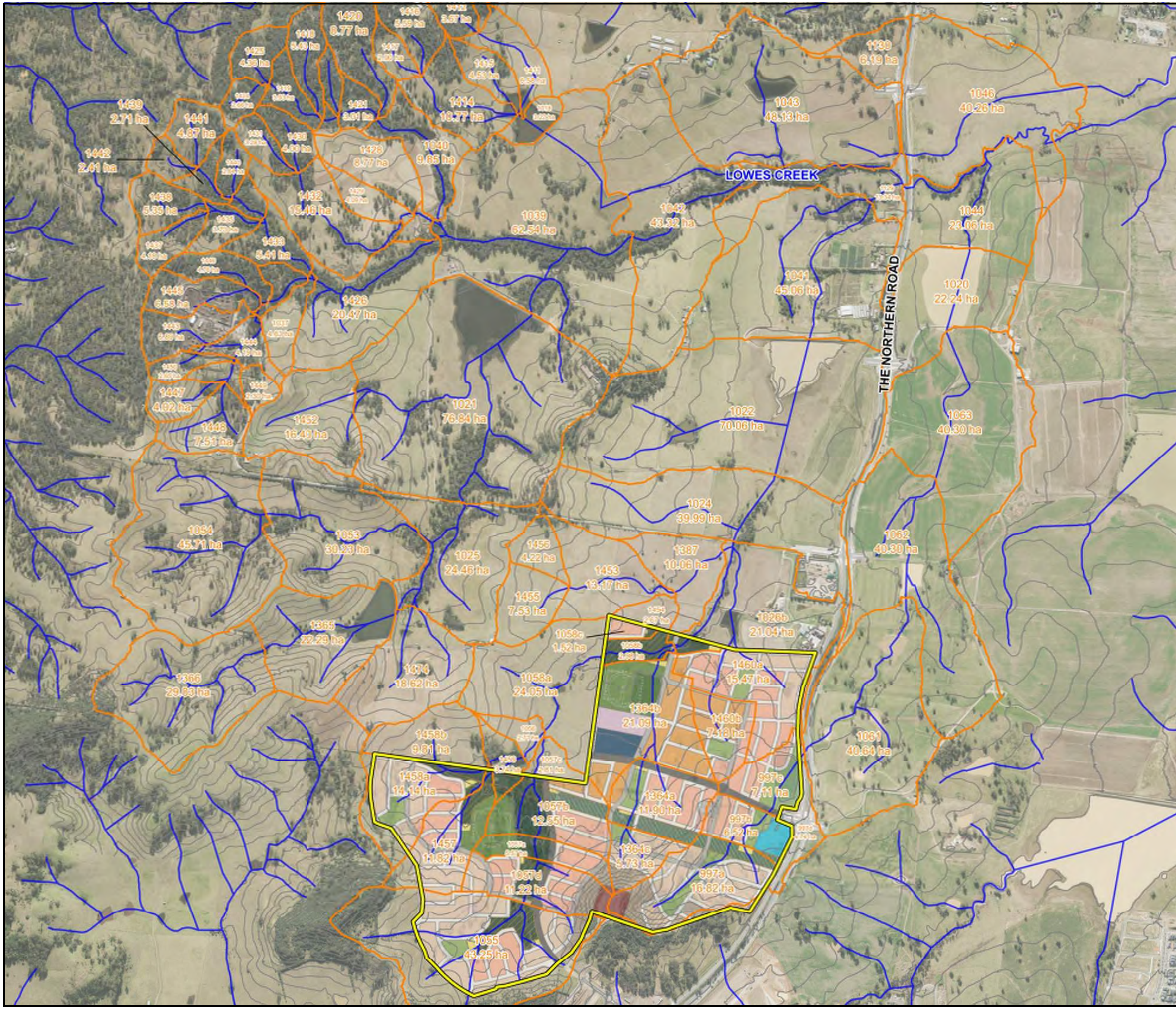

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LEGEND

- Site Boundary
- Developed Conditions Catchment
- 1075a 16.38 ha — Catchment ID Area
- Watercourse
- 5m Contours

N

0 600 metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-02

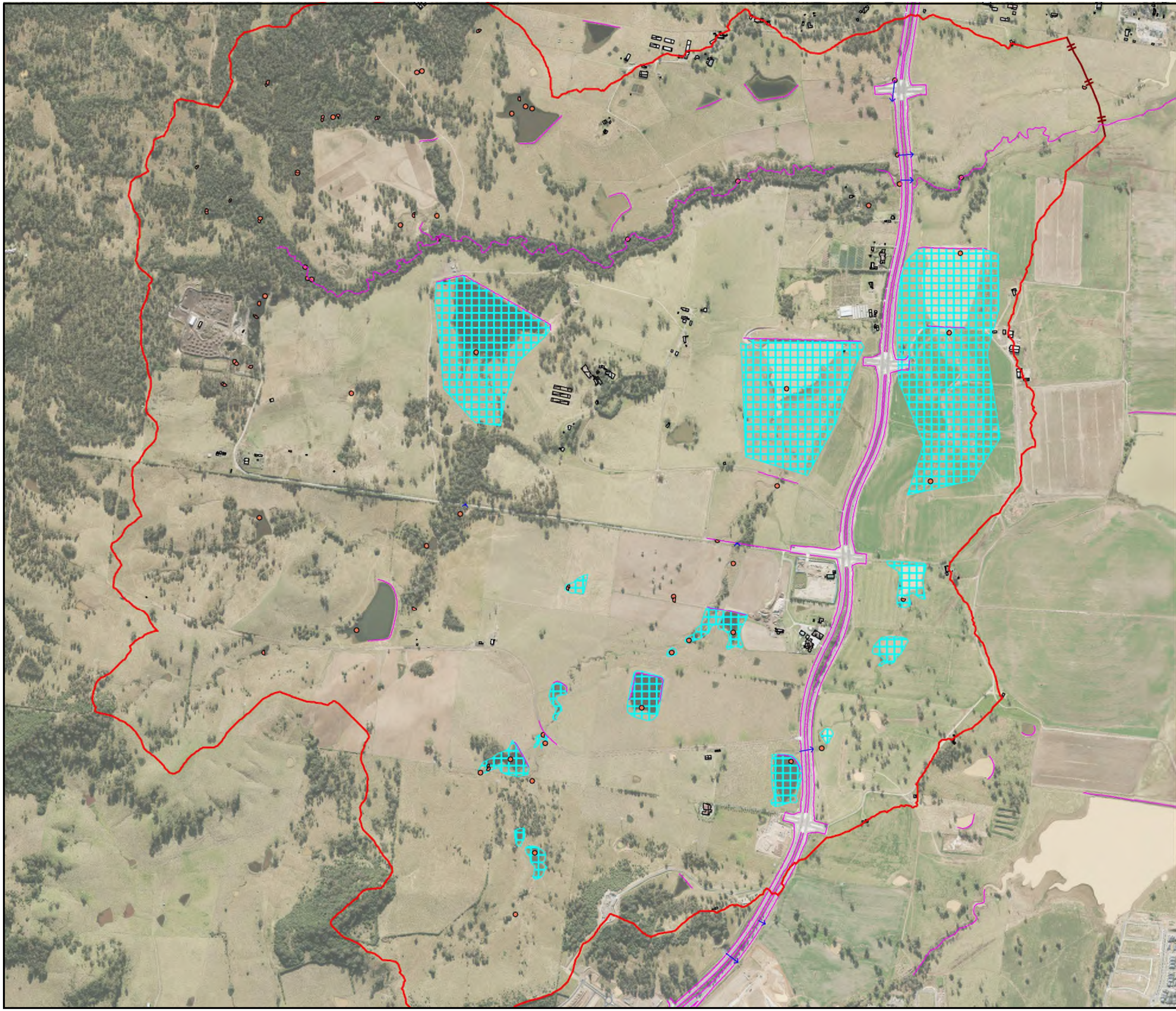
South Creek West Cobbitty Sub-Precinct 5

Developed Conditions Catchment Plan

Date: 15/04/2024

Issue D

Filename: "J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report\110628-02_Fig6-02_DEV_CP_C.WOR"



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LEGEND

TUFLOW MODEL ELEMENTS

- TUFLOW Model Boundary
- IWL Initial Water Level Area
- Building Block
- HQ Slope Boundary
- Terrain Modification (Z Shape)
- 1D NWK Culvert
- 2D SX Connection (Point)
- SA Catchment Inflow Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-01

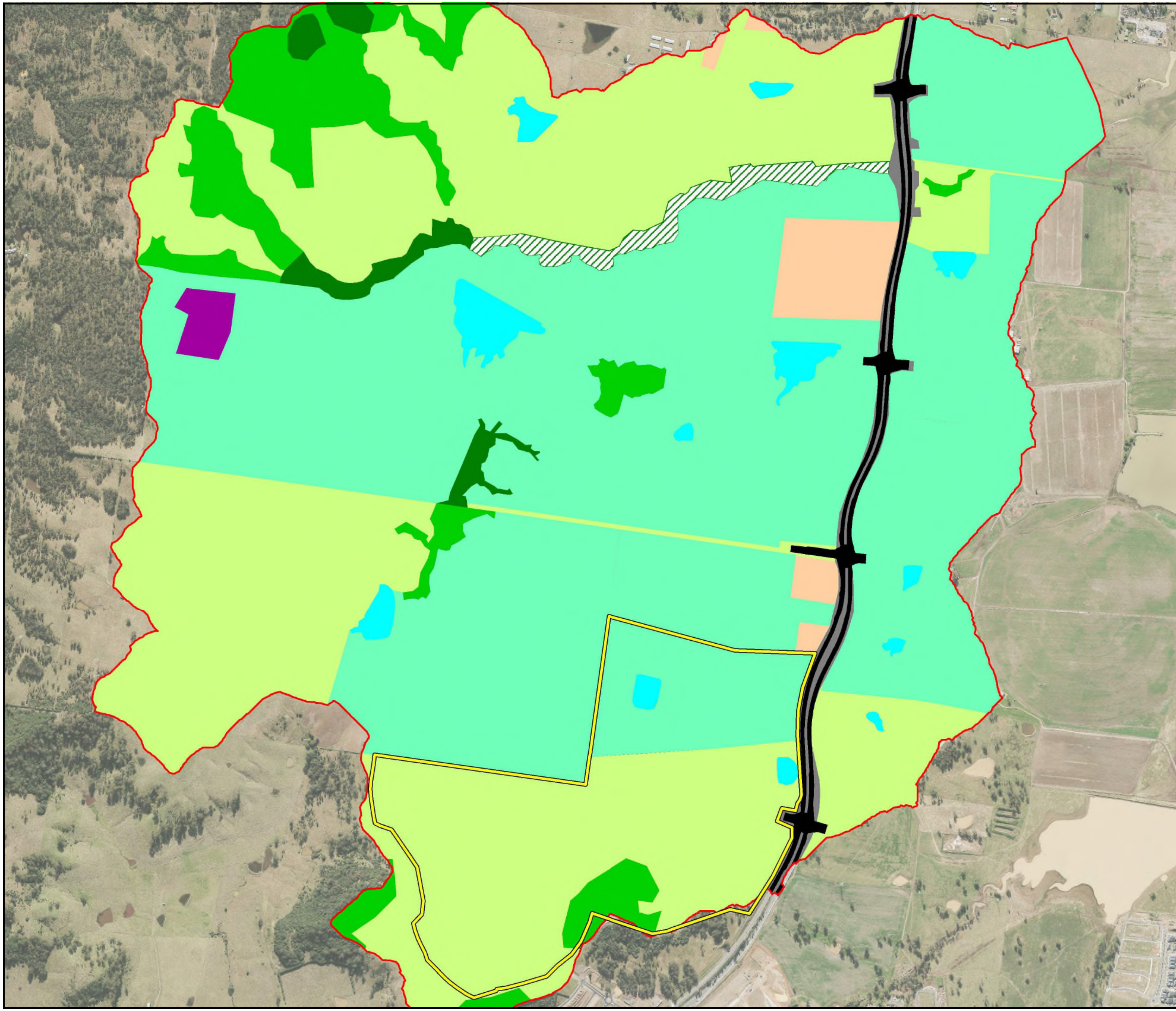
South Creek West
Cobbitty Sub-Precinct 5

Existing Conditions
TUFLOW Setup

Sate: 13/12/2022

Issue C

Filename: "J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report\110628-02_Fig7-01_EX_TFS_C.WOR"



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LEGEND

MANNINGS VALUE

- Bare Earth
- Creeks and Open Water
- Paved Areas
- Road Corridor
- Roads
- Low Density Residential (Rural)
- Industrial/Commercial/Schools
- Light Vegetation
- Floodplain Grass / Pasture (Default)
- Medium Vegetation
- Dense Vegetation
- Dense Riparian Vegetation
- Site Boundary
- TUFLOW Model Boundary

N

0 480
metres
Scale 1:12,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-02

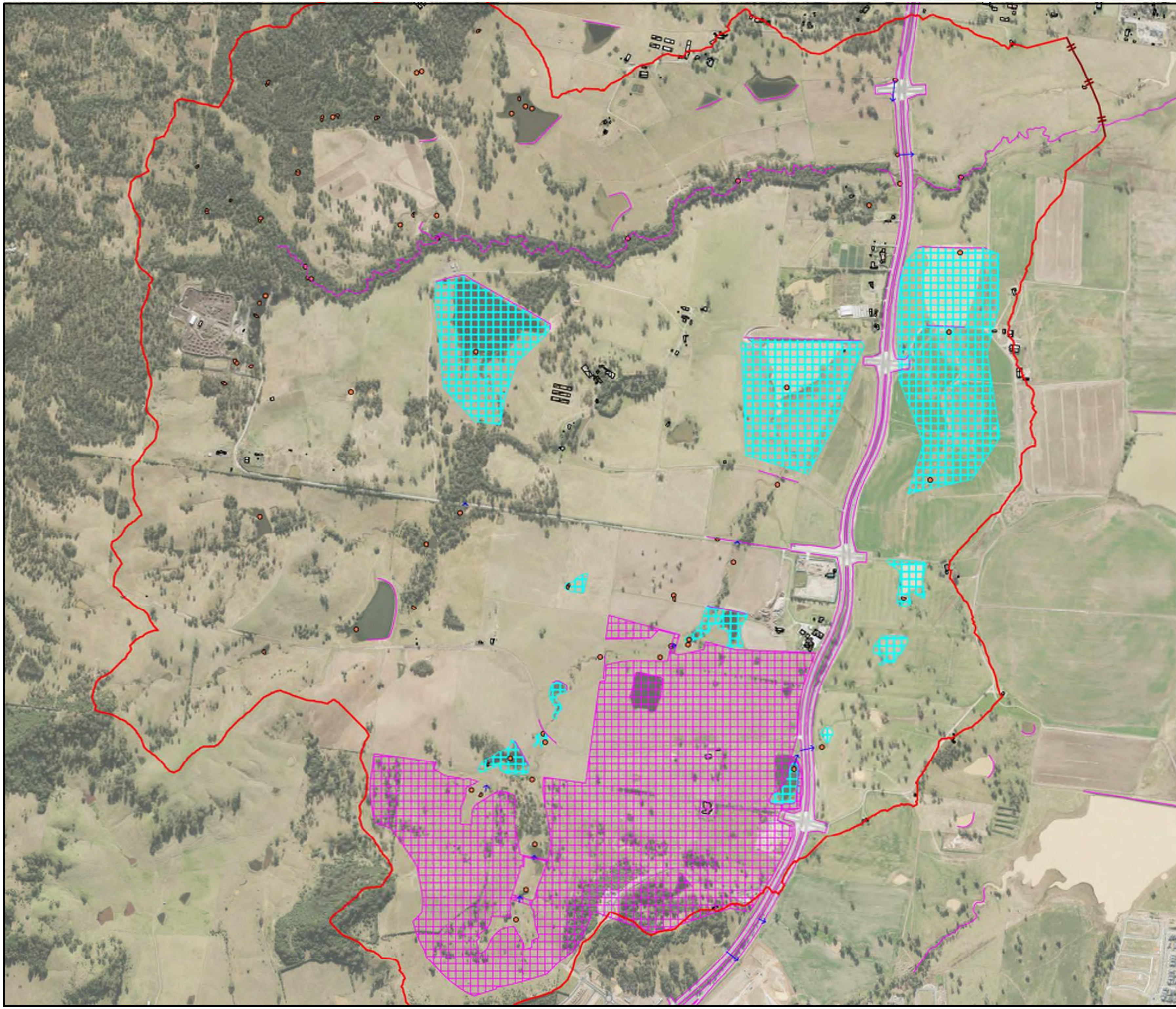
South Creek West Cobbitty Sub-Precinct 5

Existing Conditions TUFLOW Mannings

Sate: 14/12/2022

Issue C

Filename: "J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report\110628-02_Fig7-02_EX_TFM_C.WOR"



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LEGEND

TUFLOW MODEL ELEMENTS

- TUFLOW Model Boundary
- IWL Initial Water Level Area
- Building Block
- HQ Slope Boundary
- Terrain Modification (Z Shape)
- Terrain Modification (Z Shape)
- 1D NWK Culvert
- 2D SX Connection (Point)
- SA Catchment Inflow Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-03

South Creek West
Cobbitty Sub-Precinct 5

Developed Conditions
TUFLOW Setup

Sate: 15/04/2024

Issue D

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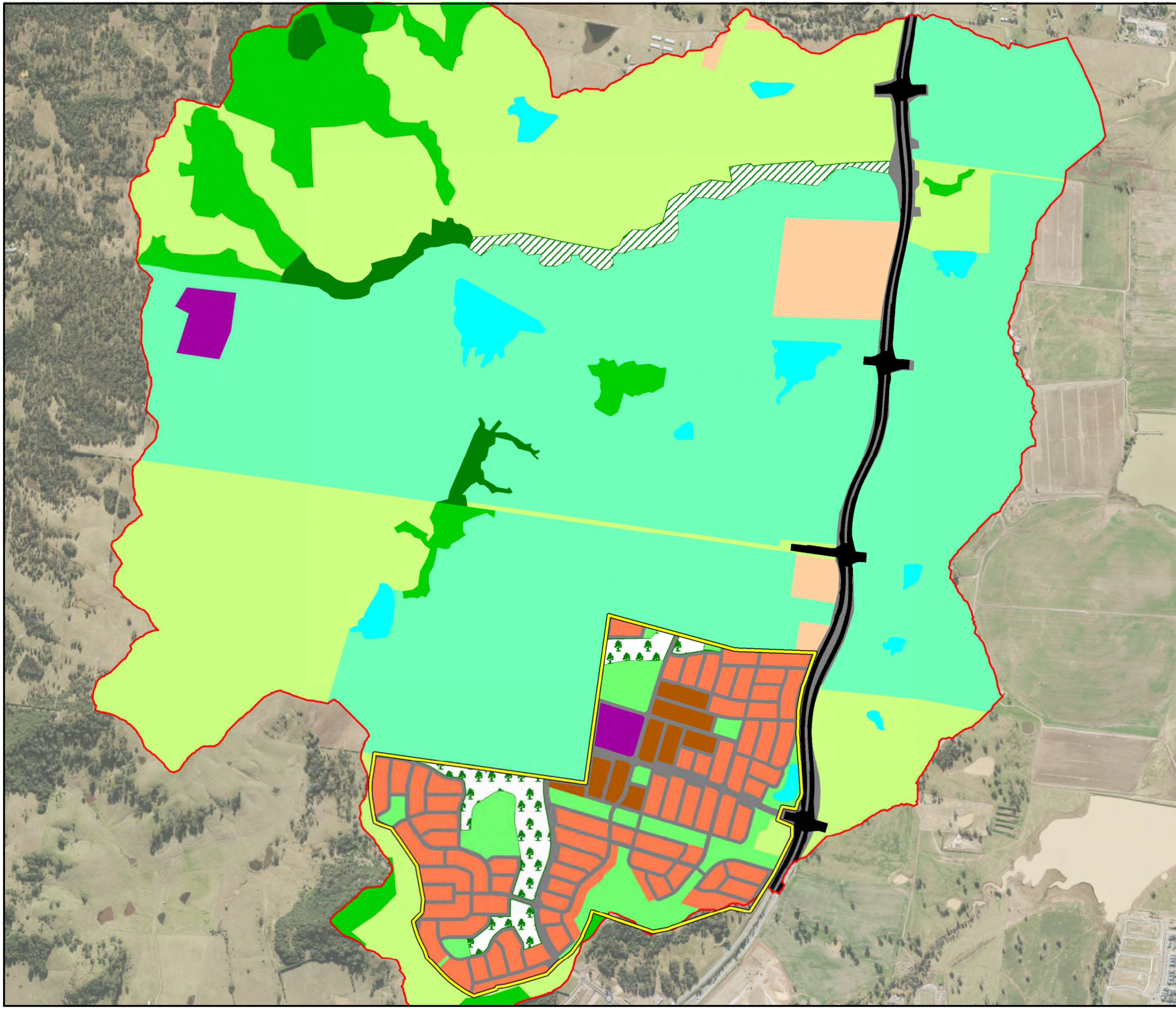

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LEGEND

MANNINGS VALUE

- Bare Earth
- Creeks and Open Water/Basins
- Paved Areas
- Road Corridor
- Roads
- Low Density Residential (Rural)
- Cobbitty Low Density Residential
- Cobbitty Medium Density Residential/School
- Cobbitty High Density Residential/Commericial/School
- Industrial/Commercial/Schools
- Light Vegetation
- Floodplain Grass/Pasture (Default)
- Maintained Grass/Parks/Ovals
- Medium Vegetation
- Dense Vegetation
- Dense Riparian Vegetation
- Cobbitty Riparian Corridor
- Site Boundary
- TUFLOW Model Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-04

South Creek West Cobbitty Sub-Precinct 5

Developed Conditions TUFLOW Mannings

Sate: 15/04/2024

Issue D

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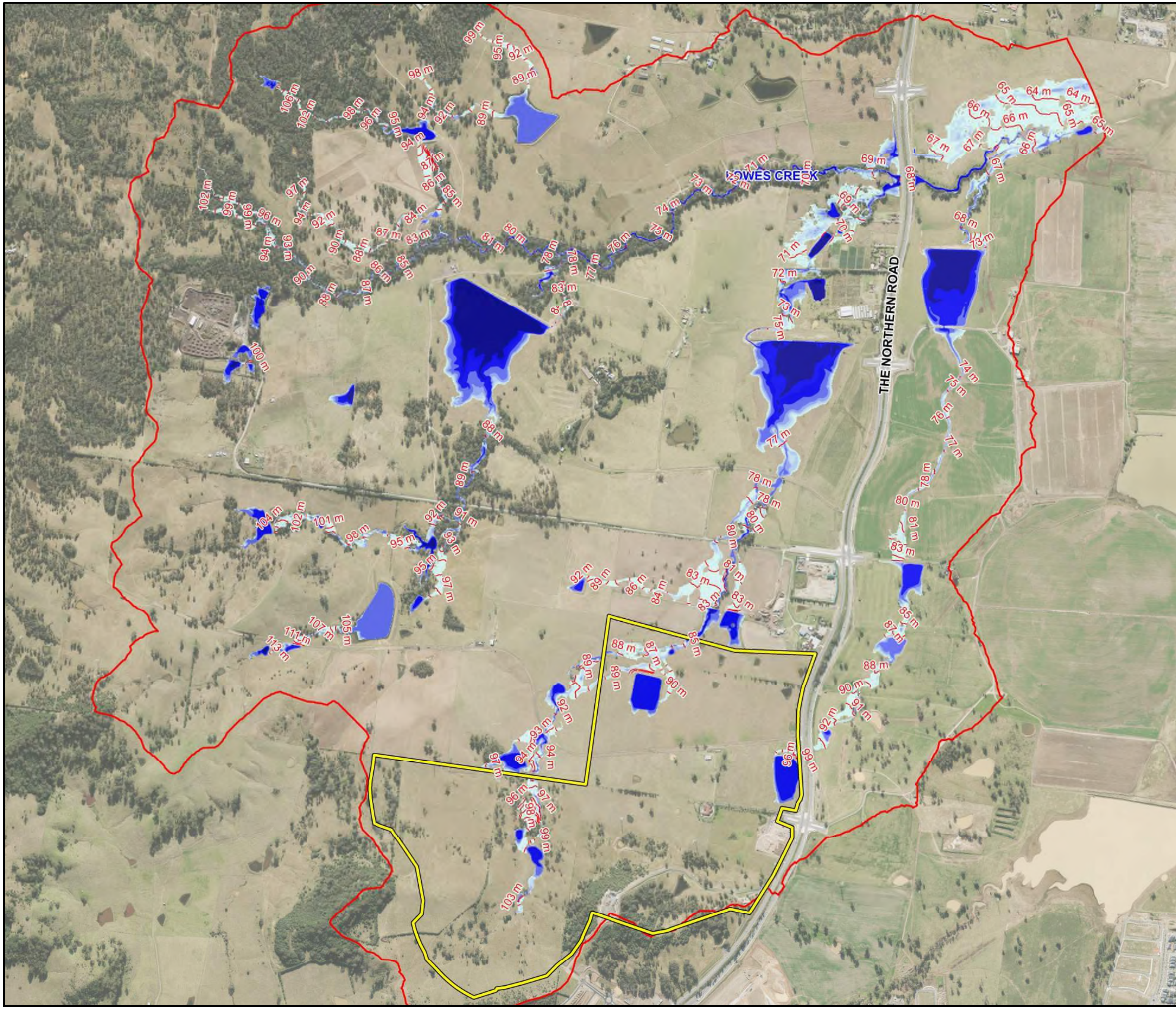

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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 — 1.0 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 — 600 metres

Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-05

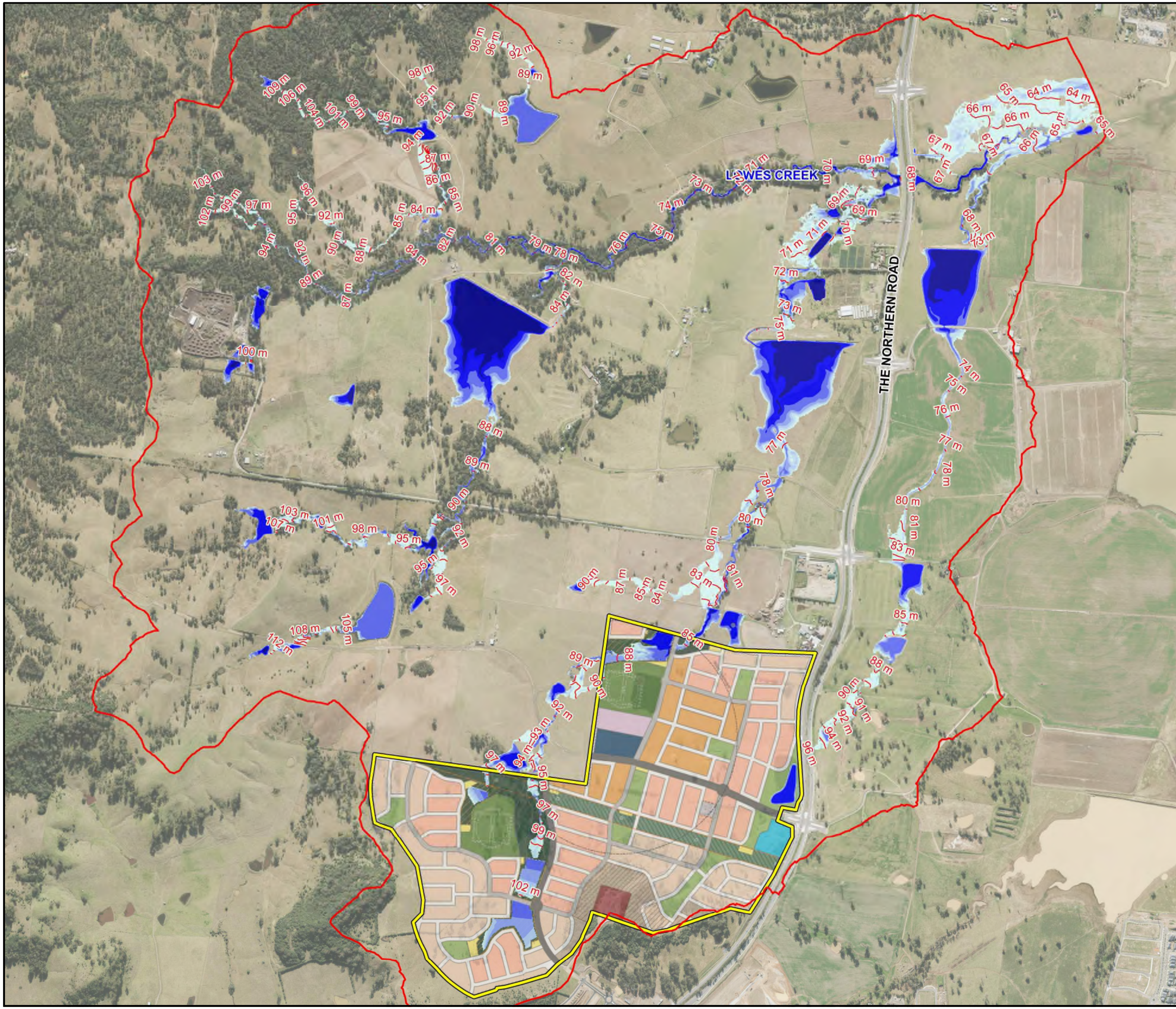
South Creek West
Cobbitty Sub-Precinct 5

50% AEP
Existing Conditions
Flood Depths and Levels

Date: 14/12/2022

Issue: C

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-05_EX11_50pc_DEP_C.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 1.0 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 600 metres

Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-06

South Creek West Cobbitty Sub-Precinct 5

50% AEP
Developed Conditions
Flood Depths and Levels

Date: 15/04/2024

Issue: E

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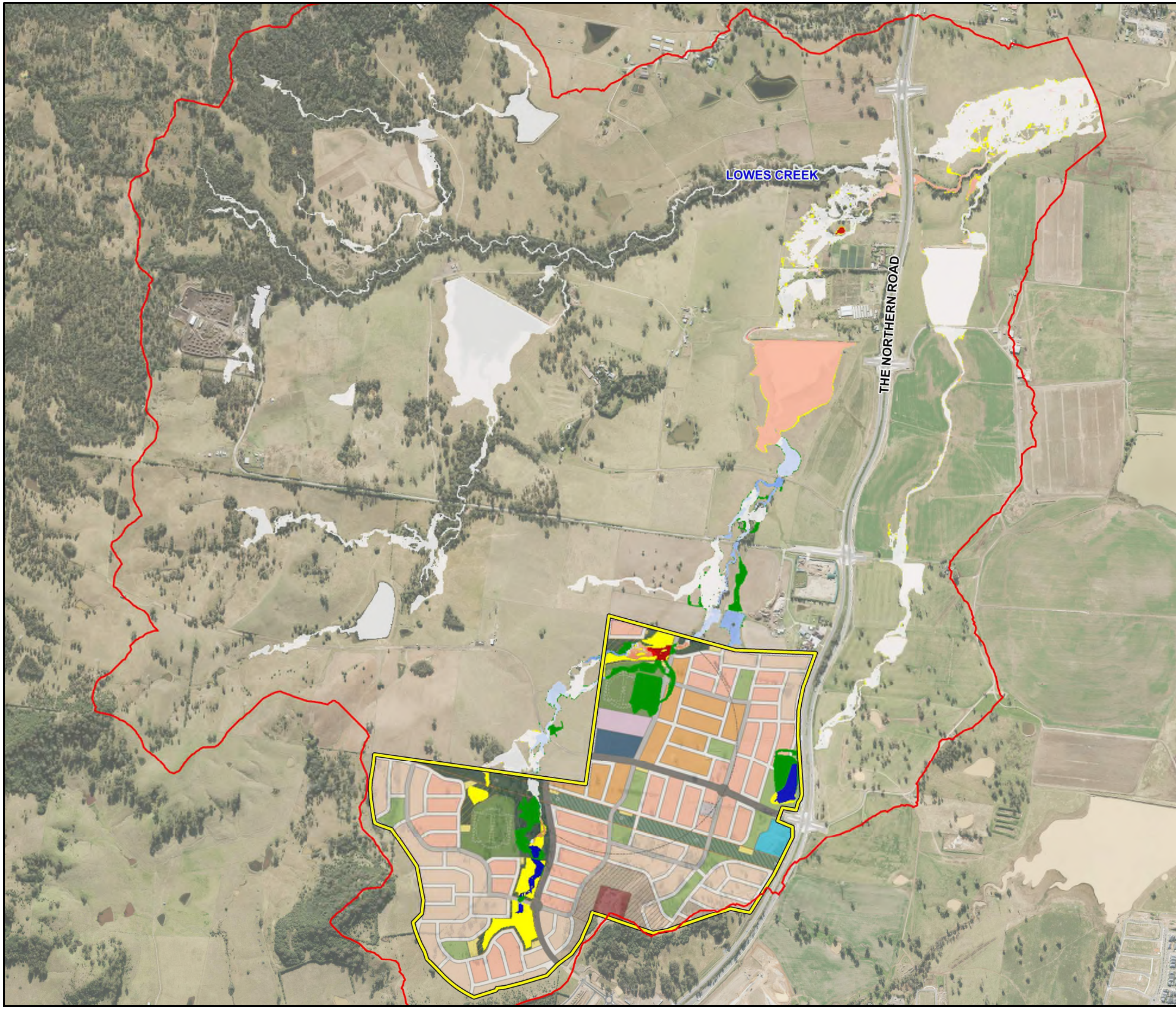

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LEGEND

FLOOD DIFFERENCE (m)

- < -0.50
- -0.30 to 0.50
- -0.10 to 0.30
- -0.05 to 0.10
- -0.03 to 0.05
- -0.03 to 0.03
- 0.03 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- > 0.50
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- Study Area
- TUFLOW Model Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

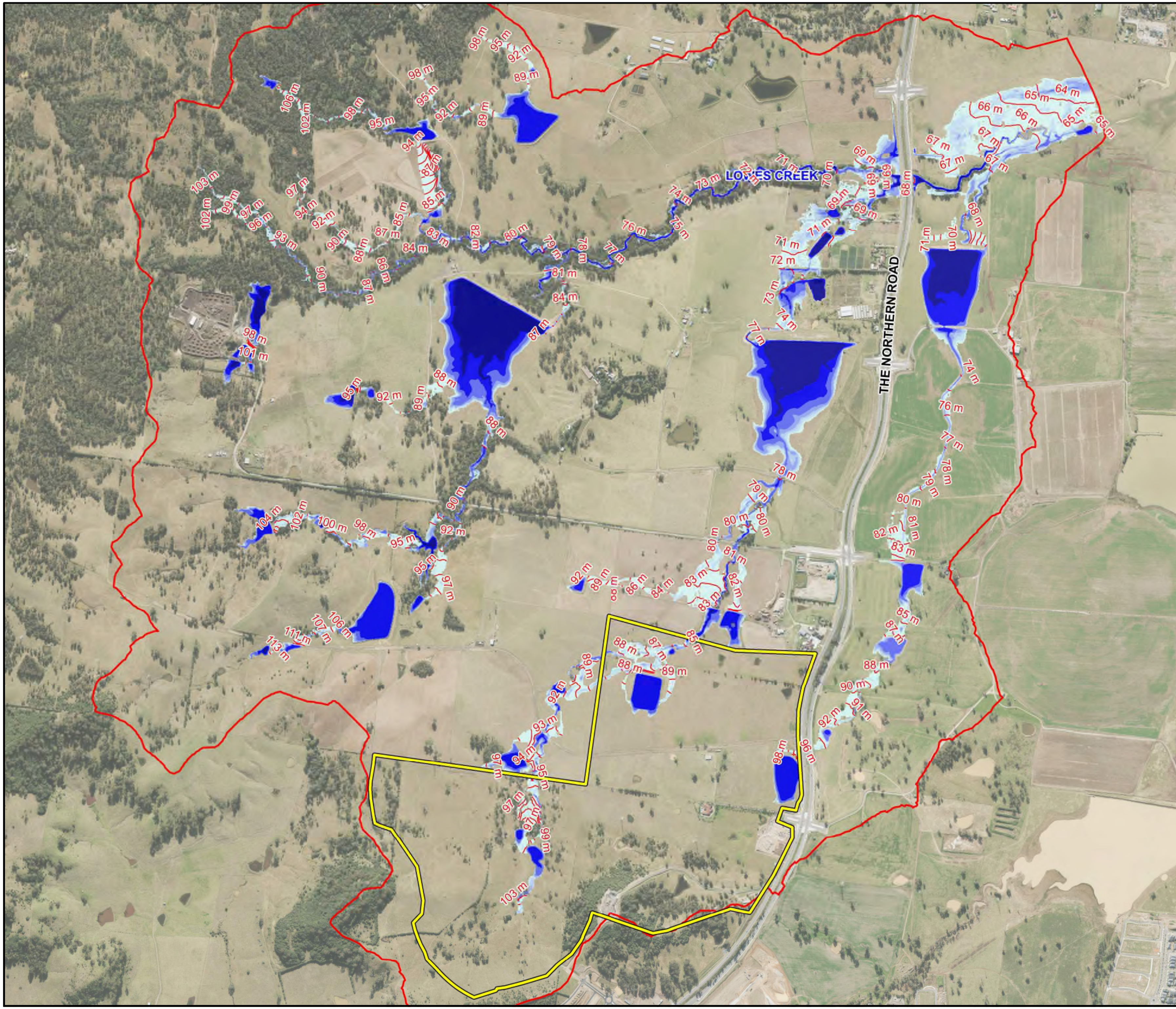
Figure 7-07

South Creek West
Cobbitty Sub-Precinct 5

50% AEP
Developed - Existing
Flood Difference

Date: 15/04/2024 Issue: E

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-07_DEV06-EX11_50pc_DIFF_E.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 1.0 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 600 metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-08

South Creek West
Cobbitty Sub-Precinct 5

20% AEP
Existing Conditions
Flood Depths and Levels

Date: 14/12/2022 Issue: C

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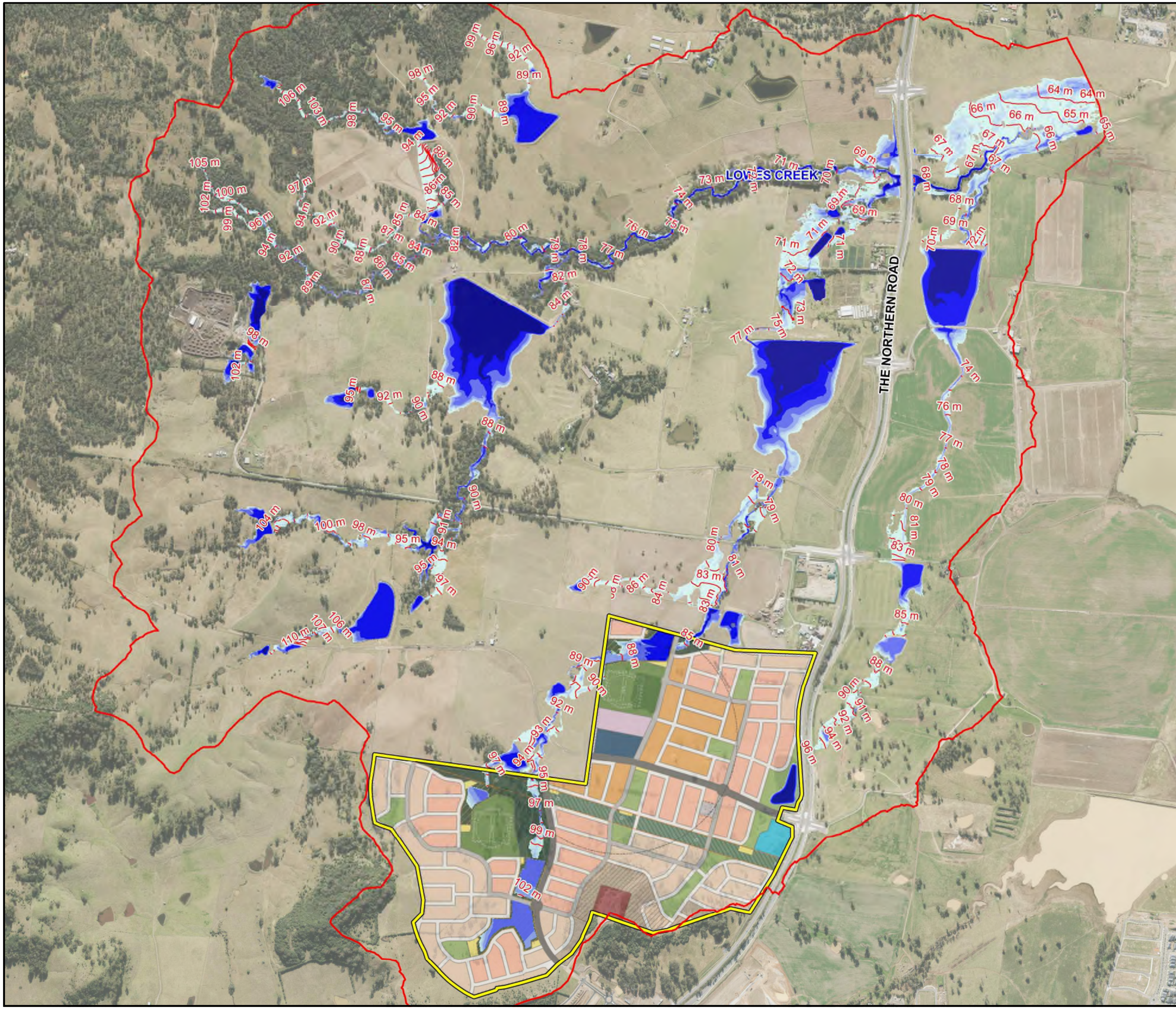

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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 1.0 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

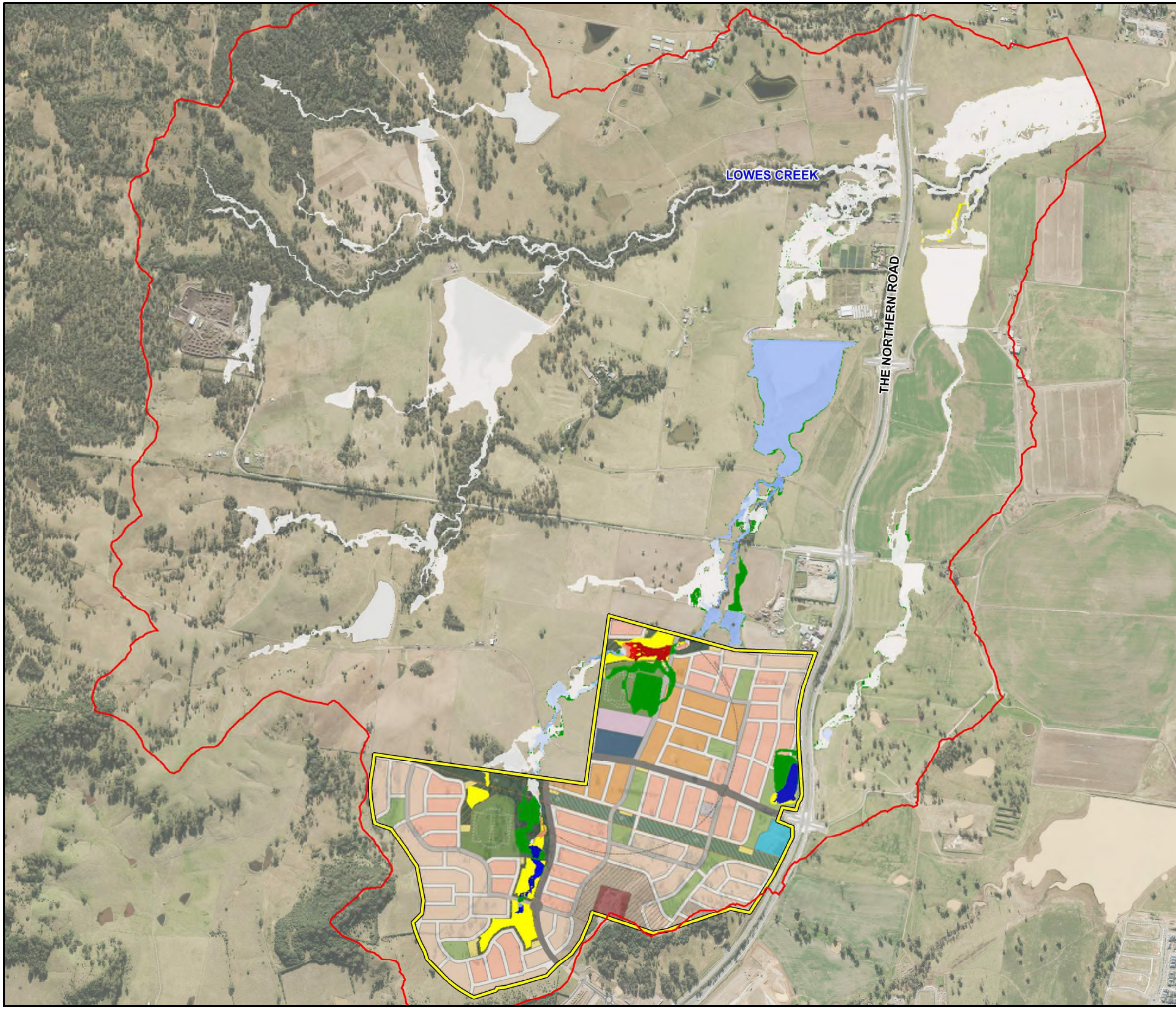
Figure 7-09

South Creek West
Cobbitty Sub-Precinct 5

20% AEP
Developed Conditions
Flood Depths and Levels

Date: 15/04/2024 Issue: E

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-09_DEV06_20pc_DEP_E.wor



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LEGEND

FLOOD DIFFERENCE (m)

- < -0.50
- -0.30 to 0.50
- -0.10 to 0.30
- -0.05 to 0.10
- -0.03 to 0.05
- -0.03 to 0.03
- 0.03 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- > 0.50
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- Study Area
- TUFLOW Model Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-10
South Creek West Cobbitty Sub-Precinct 5

20% AEP
Developed - Existing
Flood Difference

Date: 15/04/2024 Issue: E

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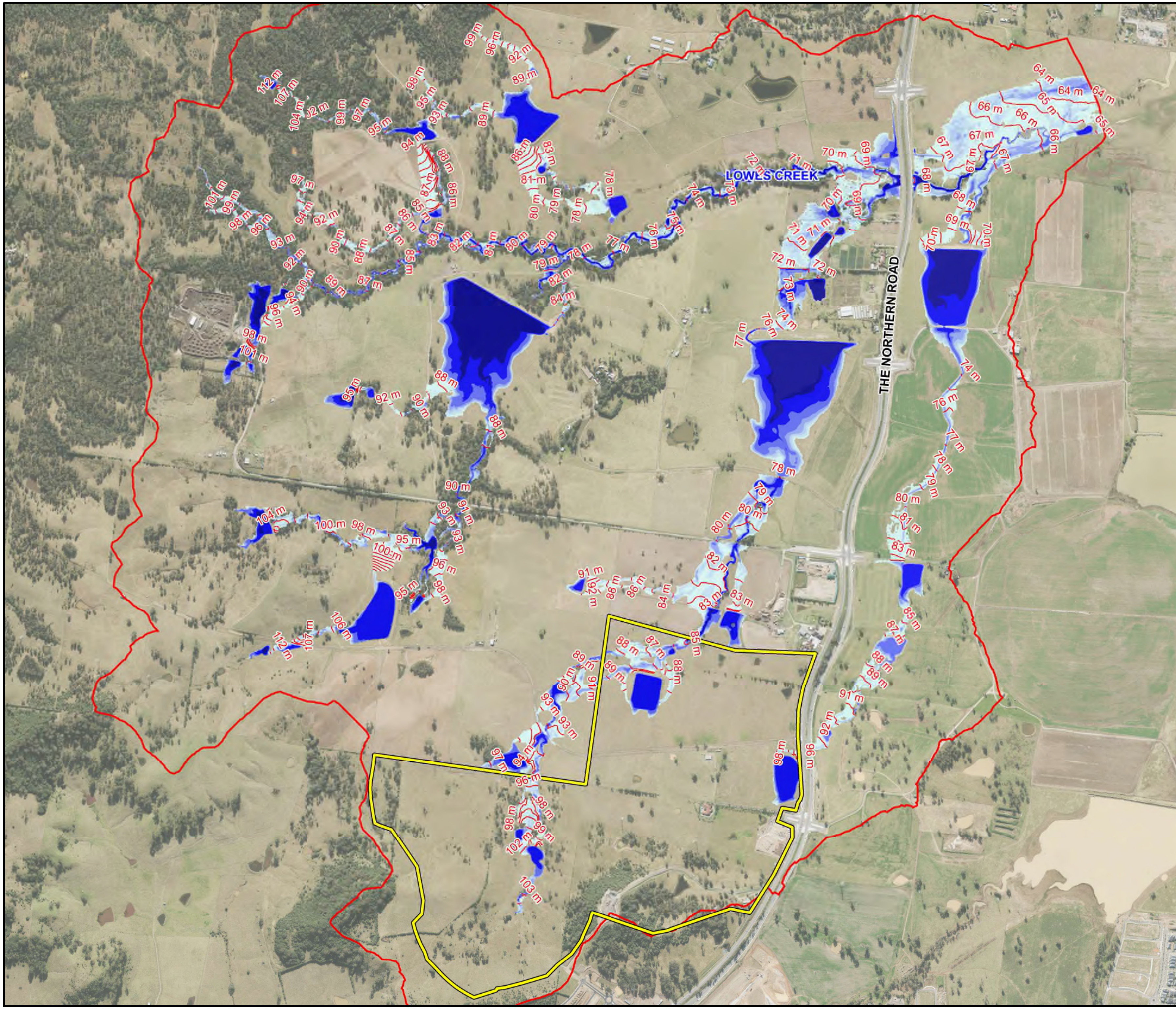

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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 1.0 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 600 metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-11

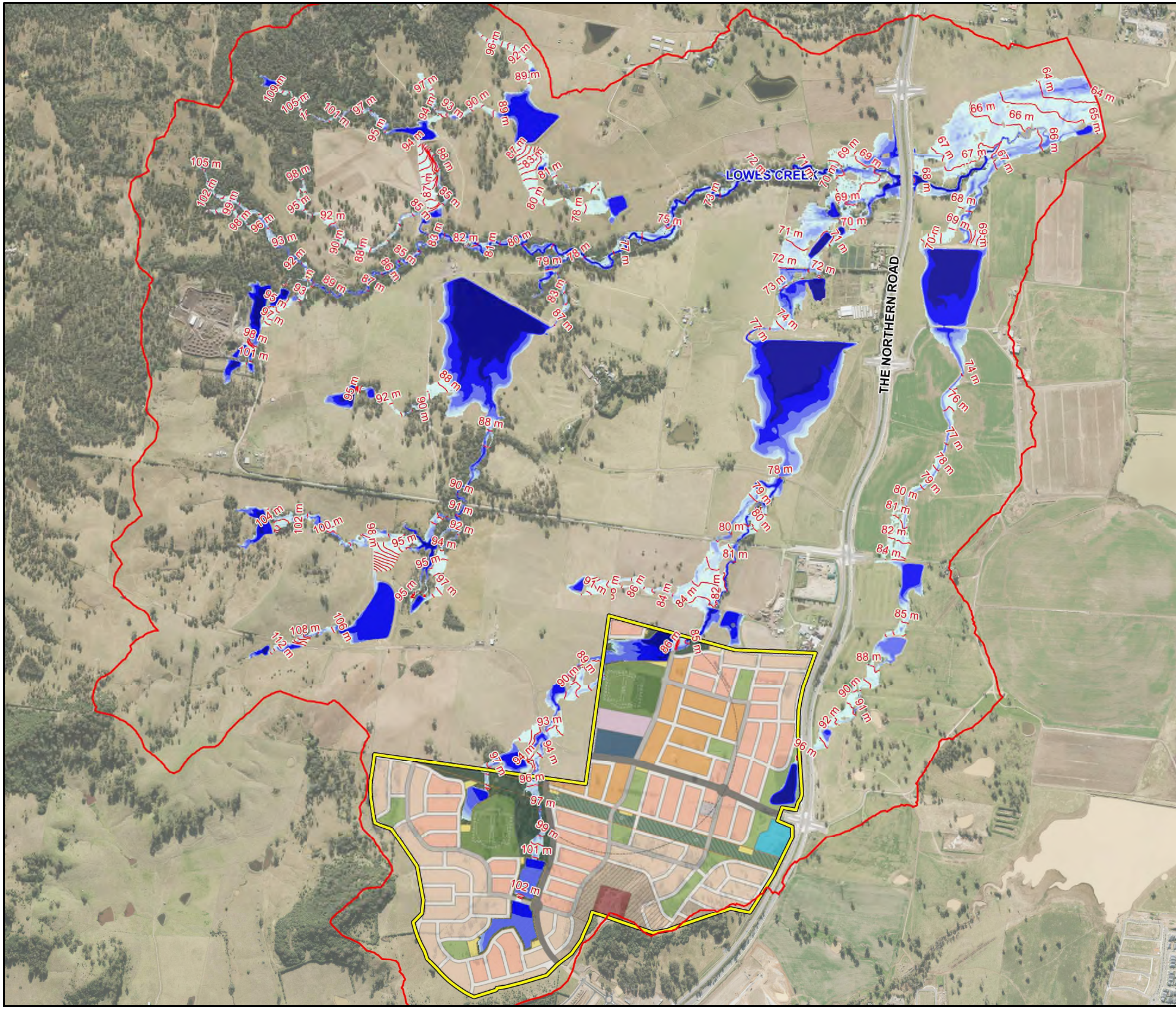
South Creek West
Cobbitty Sub-Precinct 5

5% AEP
Existing Conditions
Flood Depths and Levels

Date: 14/12/2022

Issue: C

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-11_EX11_05pc_DEP_C.wor



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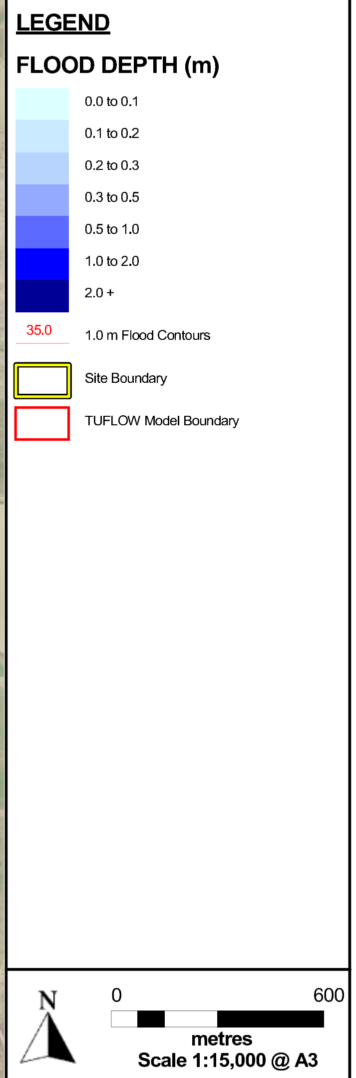


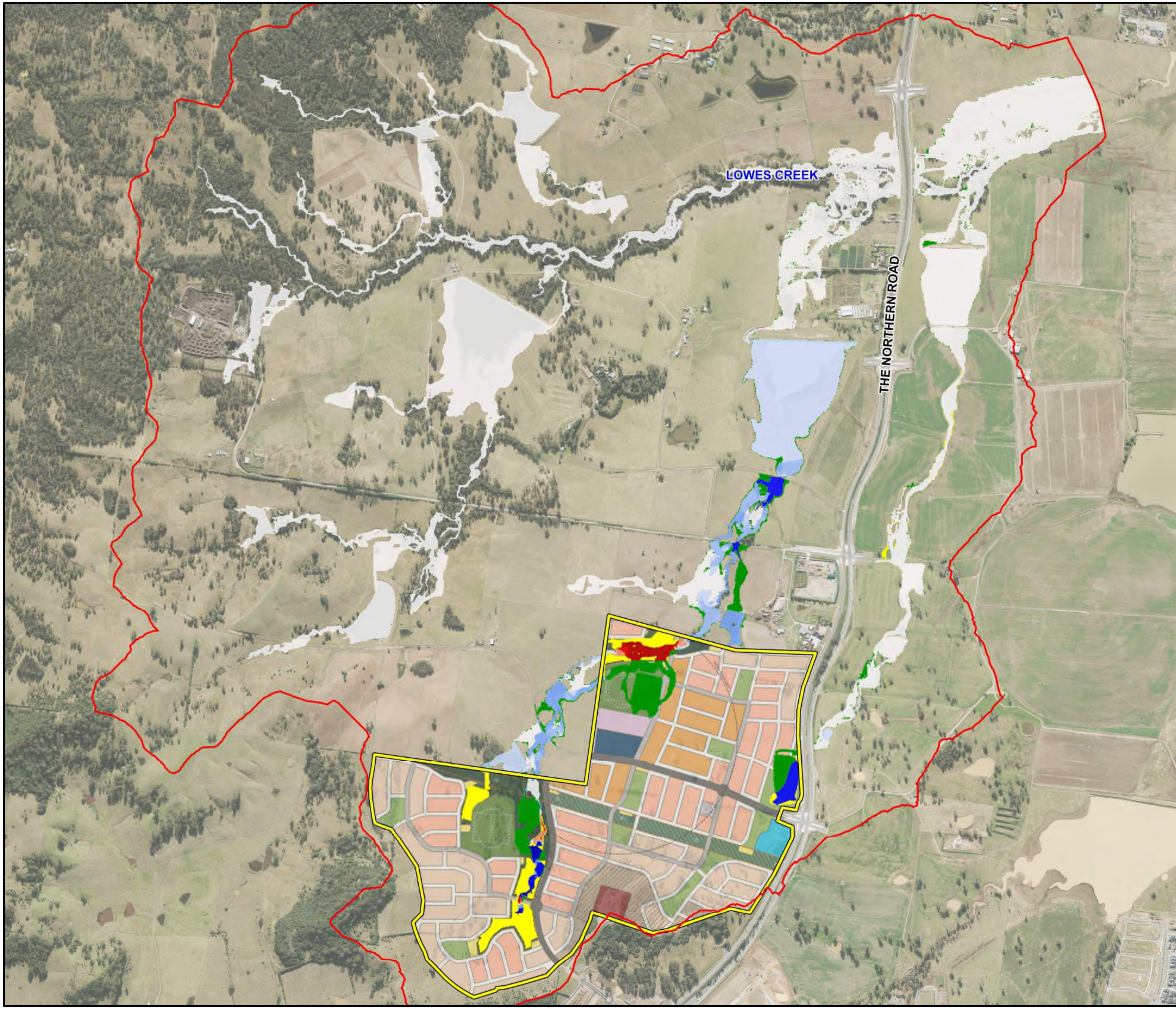
Projection: GDA 1994 MGA Zone 56

Figure 7-12
South Creek West Cobbitty Sub-Precinct 5

5% AEP
Developed Conditions
Flood Depths and Levels

Date: 15/04/2024 Issue: E

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-12_DEV06_05pc_DEP_E.wor



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LEGEND

FLOOD DIFFERENCE (m)

- < -0.50
- -0.30 to 0.50
- -0.10 to 0.30
- -0.05 to 0.10
- -0.03 to 0.05
- -0.03 to 0.03
- 0.03 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- > 0.50
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- Study Area
- TUFLOW Model Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

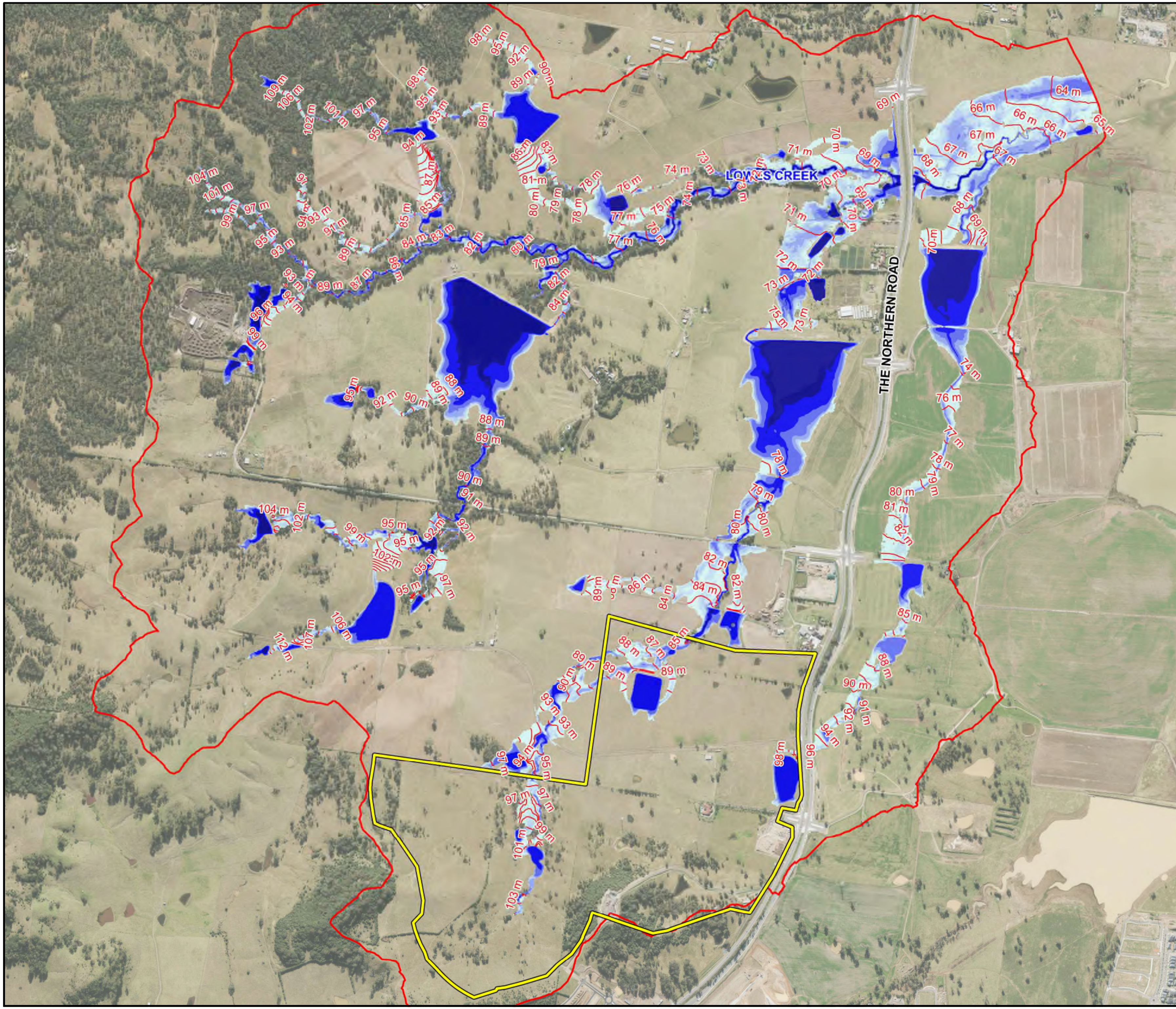
Figure 7-13

South Creek West Cobbitty Sub-Precinct 5

5% AEP
Developed - Existing
Flood Difference

Date: 15/04/2024 Issue: E

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-13_DEV06-EX11_05pc_DIFF_E.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 1.0 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-14

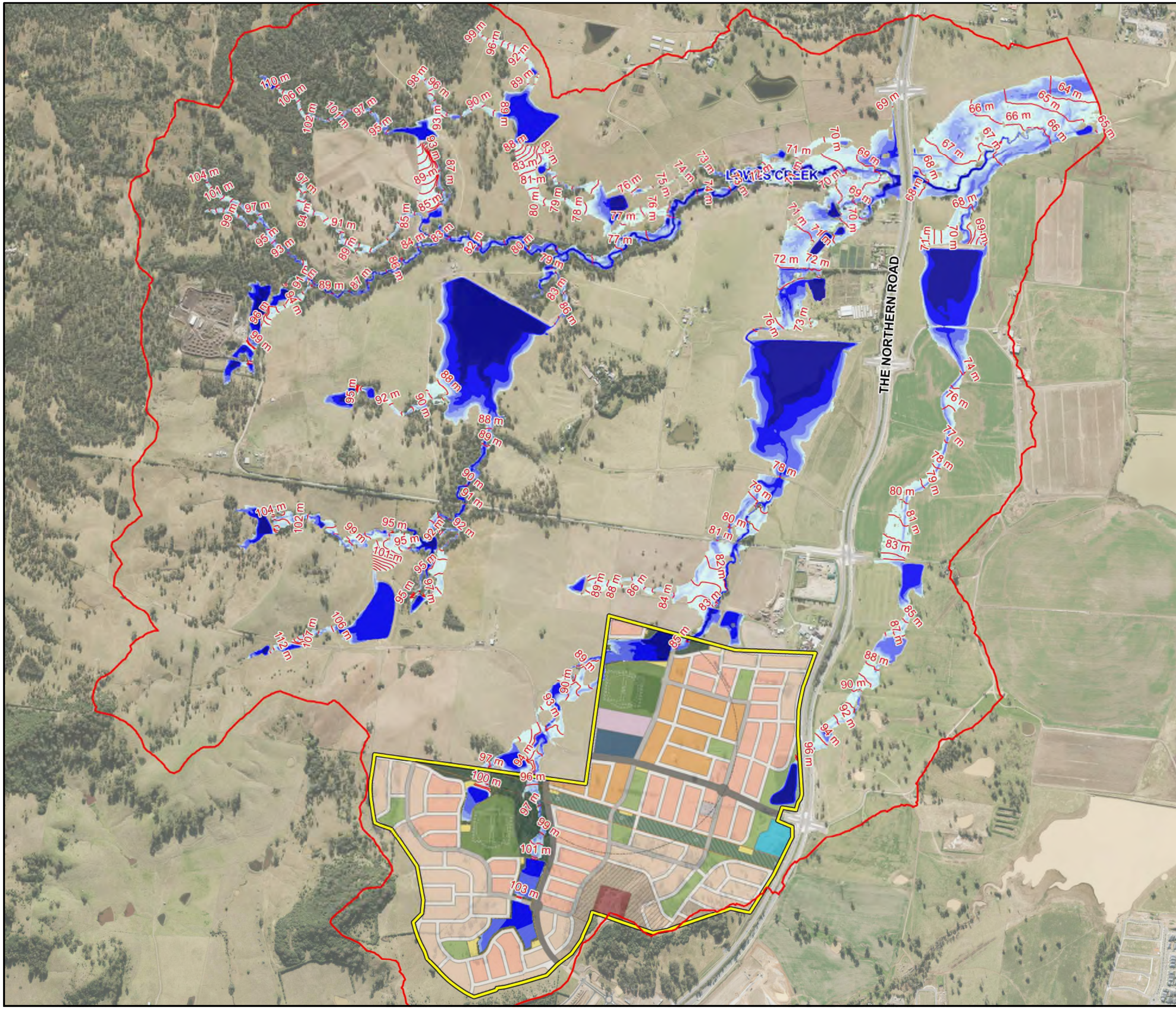
South Creek West
Cobbitty Sub-Precinct 5

1% AEP
Existing Conditions
Flood Depths and Levels

Date: 14/12/2022

Issue: C

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-14_EX11_01pc_DEP_C.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 1.0 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 600 metres

Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-15

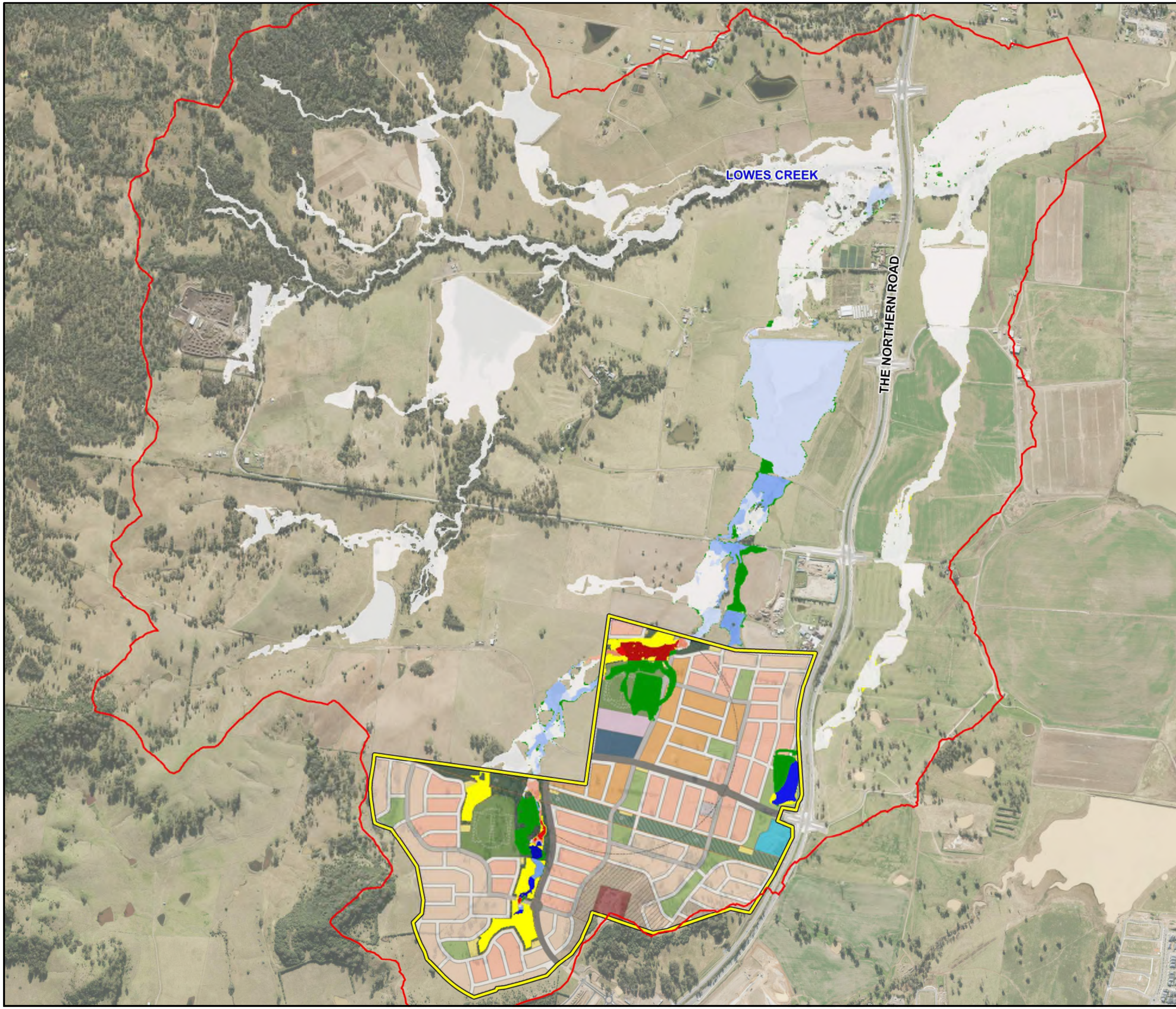
South Creek West Cobbitty Sub-Precinct 5

1% AEP Developed Conditions Flood Depths and Levels

Date: 15/04/2024

Issue: E

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-15_DEV06_01pc_DEP_E.wor



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LEGEND

FLOOD DIFFERENCE (m)

- < -0.50
- -0.30 to 0.50
- -0.10 to 0.30
- -0.05 to 0.10
- -0.03 to 0.05
- -0.03 to 0.03
- 0.03 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- > 0.50
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- Study Area
- TUFLOW Model Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-16

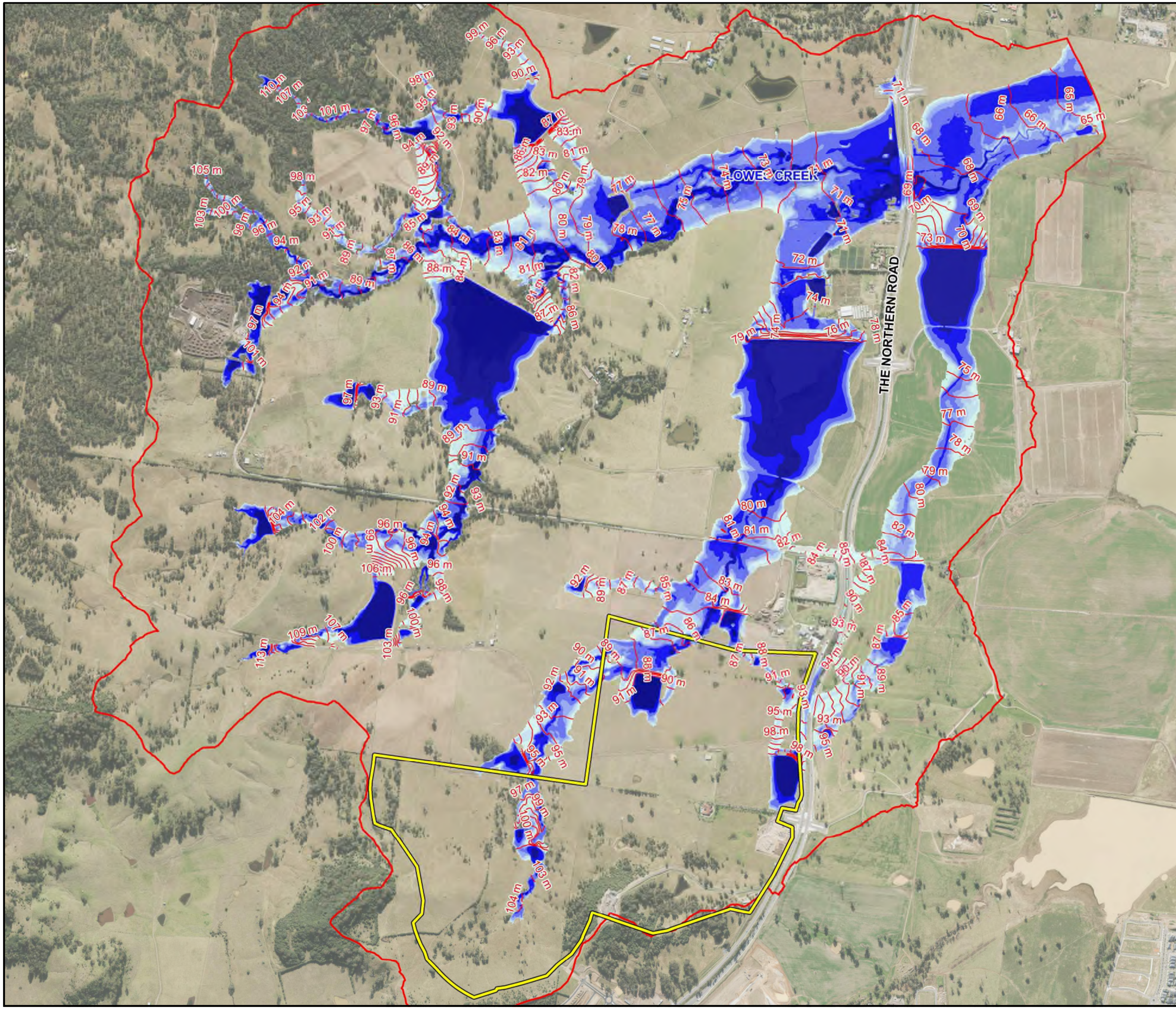
South Creek West
Cobbitty Sub-Precinct 5

1% AEP
Developed - Existing
Flood Difference

Date: 15/04/2024

Issue: E

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-16_DEV06-EX11_01pc_DIFF_E.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 1.0 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N
0 — 600 metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

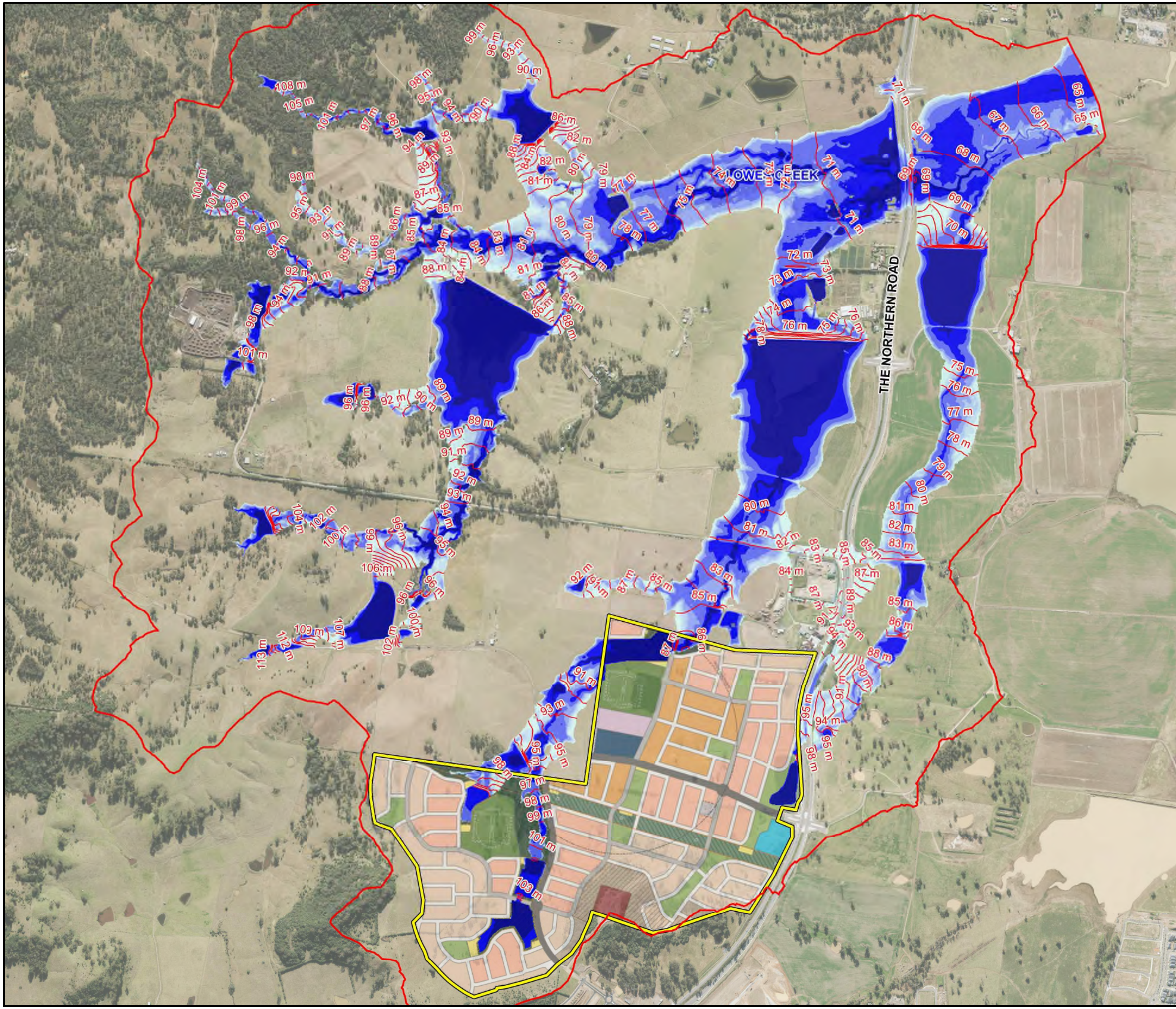
Figure 7-17

South Creek West
Cobbitty Sub-Precinct 5

Probable Maximum Flood
Existing Conditions
Flood Depths and Levels

Date: 14/12/2022 Issue: C

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-17_EX11_PMF_DEP_C.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 1.0 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 — 600 metres

Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-18

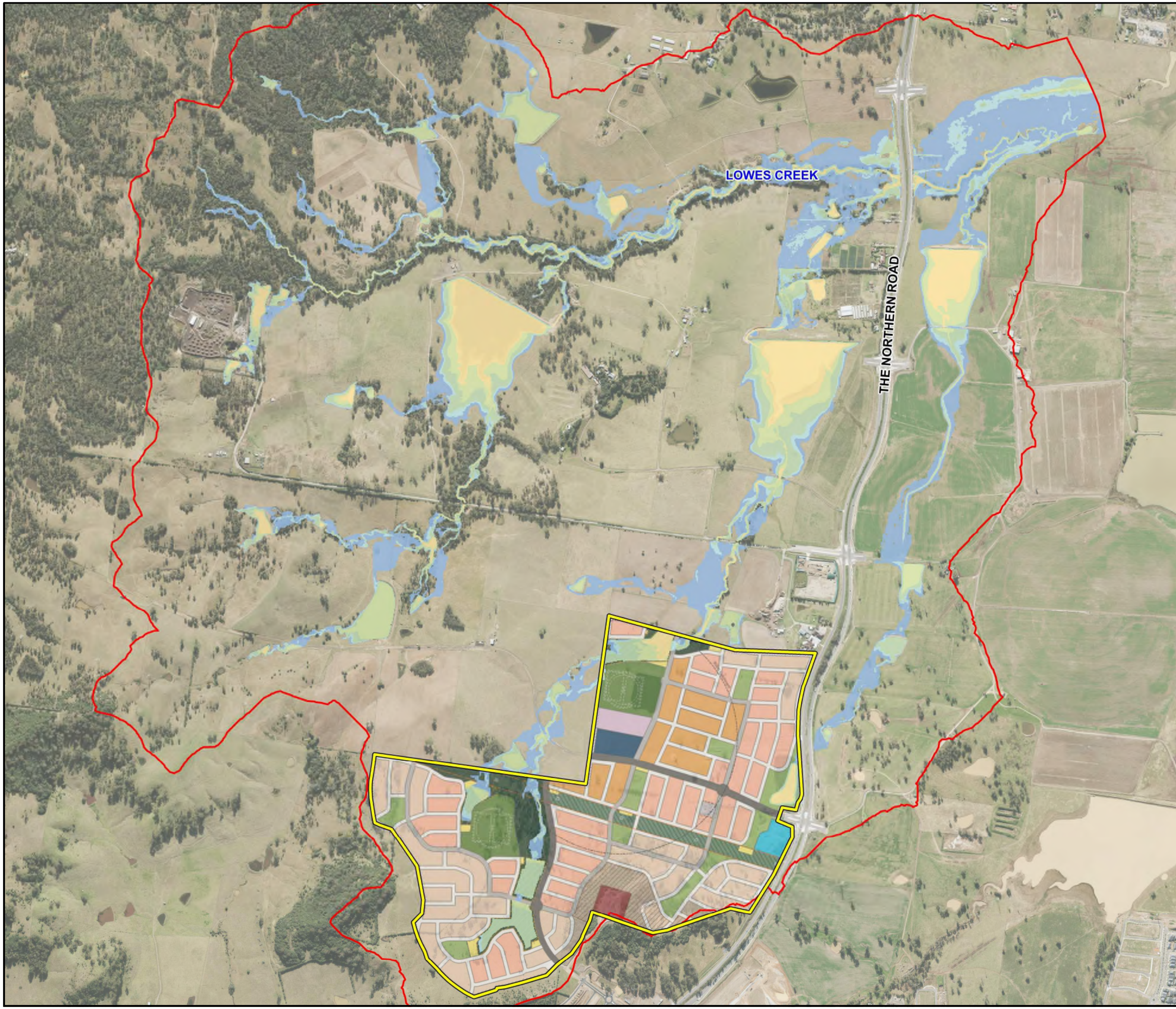
South Creek West Cobbitty Sub-Precinct 5

Probable Maximum Flood Developed Conditions Flood Depths and Levels

Date: 15/04/2024

Issue: D

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-18_DEV06_PMF_DEP_D.wor



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LEGEND

FLOOD HAZARD

- H1 - Generally safe.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4- Unsafe for people and vehicles.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to failure.
- Site Boundary
- TUFLOW Model Boundary

N

0 600
metres
Scale 1:15,000 @ A3

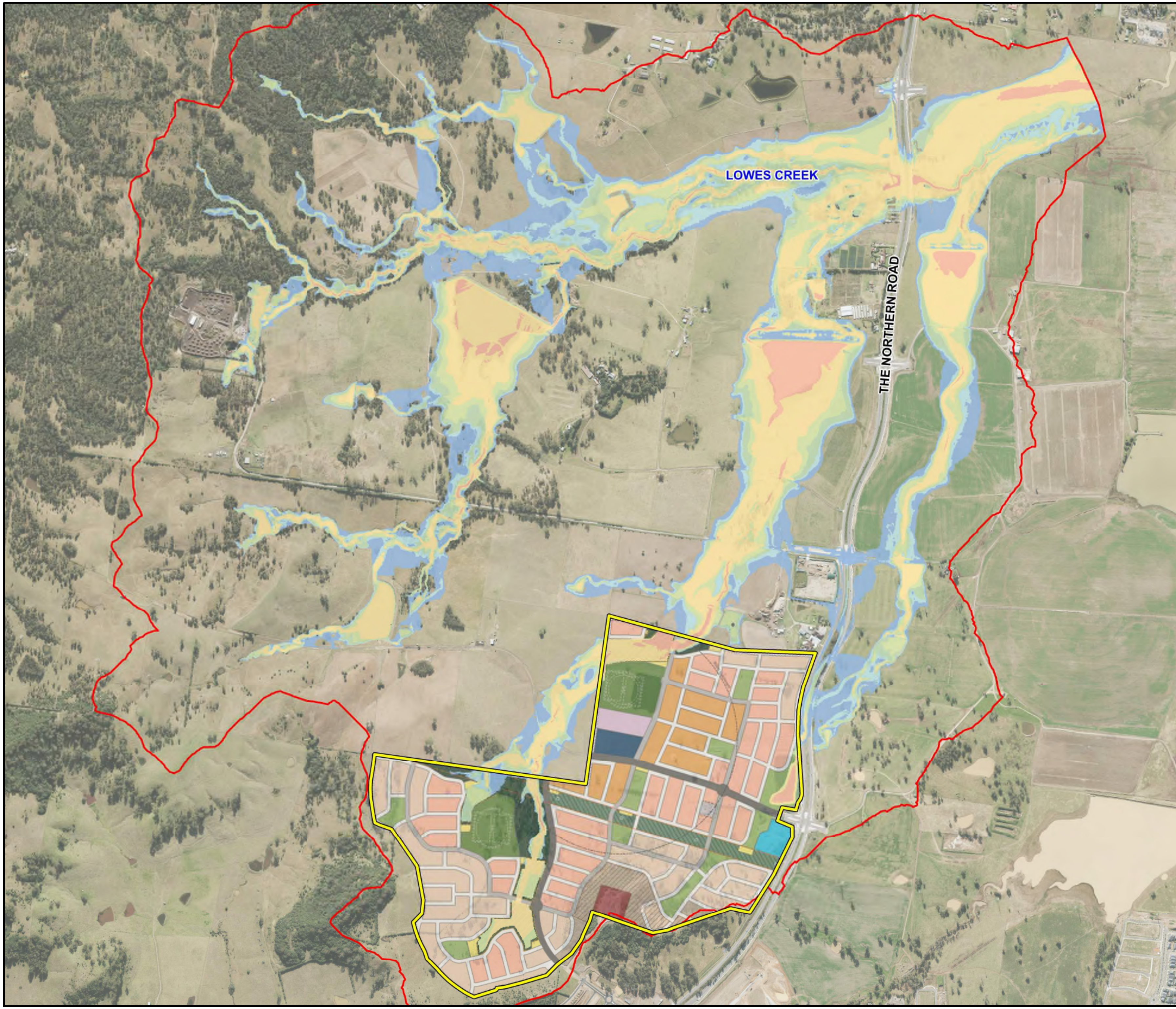
Projection: GDA 1994 MGA Zone 56

Figure 7-19
South Creek West
Cobbitty Sub-Precinct 5

1% AEP
Developed Conditions
Flood Hazard

Date: 15/04/2024 Issue: D

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-19_DEV06_01pc_HAZ_D.wor



J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

LEGEND

FLOOD HAZARD

- H1 - Generally safe.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4- Unsafe for people and vehicles.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to failure.
- Site Boundary
- TUFLOW Model Boundary

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-20

South Creek West
Cobbitty Sub-Precinct 5

Probable Maximum Flood
Developed Conditions
Flood Hazard

Date: 15/04/2024 Issue: D

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev E\110628-02_Fig7-20_DEV06_PMF_HAZ_D.wor

APPENDIX D – MUSIC MODEL DATA

Modelling Inputs and Assumptions

The MUSIC Modelling has used a series of default Camden Council MUSIC-Link assumptions and parameters. Details are provided below.

- The water quality treatment approach reflects the treatment of Cobbitty Sub-Precinct 5 only;
- An indicative MUSIC model catchment plan assumes existing conditions catchment delineation will generally be maintained in the Precinct grading and is shown in Figure 5-01 in Appendix B;
- R3, R4, school, industrial and commercial areas are assumed to provide on-lot stormwater quality treatment measures that achieve statutory pollutant removal targets prior to discharge to the regional system, however public roads within these land use areas (assumed to be 30% of the catchment within these on-lot treatment areas) are to be catered for in regional devices;
- The proposed low density residential development has a lot mix of normal residential to large-lot residential including medium density residential, as such, lot area with an average of 75% impervious is assumed overall within the precinct;
- Camden Council DCP requires a minimum 30% landscaped area for both low and medium density lots, however, a slightly higher 80% impervious has been adopted for the medium density development, consistent with Camden Council Engineering Guidelines (CC, 2009).
- The MUSIC model catchments have been split into the roof, road, urban previous and urban impervious.

Water Quality Management Measures

Details of the parameters used in the rainwater tanks, gross pollutant traps, bioretention raingardens and ponds are provided below.

Rainwater Tank

Rainwater tanks were modelled for Precinct 5 based on the following design assumptions:

- All low-density residential developments are expected to incorporate rainwater tanks to comply with BASIX guidelines. Therefore, a standard 3 kL tank with a surface area of 1.7 m² per tank has been adopted.
- 50% of the roof areas from these lots will be directly connected to rainwater tanks;
- Rainwater tank re-use of 50 kL/y/dwelling for landscape irrigation and a daily use of 0.15 kL/day/dwelling for internal use is conservatively adopted on the NSW MUSIC Modelling Guidelines (BMTWBM 2015) for a typical 3 person household with rainwater plumbed for washing machine and toilet flushing. See Plate C-1 below extracted from the NSW MUSIC Modelling Guidelines (BMTWBM 2015);

Table 6-1 Typical Water Demands for Single Dwellings (derived from data provided by Sydney Water, 2015)

Water Use	Single dwellings (litres/day/dwelling)					
	Number of occupants					
	1	2	3	3.05	4	5
Indoor Uses						
Toilets	27	54	80	82	107	134
Toilets + Washing Machine	58	115	173	176	231	289
Toilets + Washing Machine + Hot Water	106	212	318	324	425	531
All uses	162	325	487	495	649	812
Outdoor Uses						
All uses	151	151	151	151	151	151

Plate C-1 – Rainwater Tank Re-use rates, (Table 6-1, NSW MUSIC Modelling Guidelines (BMTWBM, 2015))

Gross Pollutant Traps

Gross Pollutant Traps (GPTs) have been provided to filter stormwater prior to discharge into the bioretention raingardens. A vortex style GPT node has been adopted in MUSIC as per Council's request within the Precinct.

The expected pollutant removal rates adopted within the model is provided in Table C-1. Such devices may include proprietary GPTs such as a Humeceptor or CDS unit (or equivalent). For the purposes of MUSIC modelling it was assumed that the GPTs will be located upstream of the bioretention raingardens and ponds.

Table C-1 – GPT Input Parameters

Pollutant	Input	Output
TSS (mg/L)	0	0
	75	75
	1000	300
TP (mg/L)	0	0
	0.5	0.5
	10	7
TN (mg/L)	0	0
	50	50
GP (kg/ML)	0	0
	100	2

A 4 EY (3 month ARI) treatable flow rate has been adopted as the capture of flow volumes greater than this did not provide any significant increase in performance.

A high flow bypass link within the MUSIC model reflects flows in excess of the treatable flow bypassing both the bio-retention raingarden and GPT. The final hydraulic arrangement for each device will be subject to a detailed design process to support the future development application.

Bioretention Raingarden

The design parameters adopted for the bioretention raingarden are shown in Table C-2. The filter media receives flow having firstly being treated by the GPT at each outlet. Bioretention raingarden systems are proposed in 16 locations across Precinct 5 to achieve the statutory pollutant reduction targets. The bio-retention raingardens will also attenuate first flush flows to reduce the risk of stream erosion within the watercourses.

Table C-2 – Bioretention Raingarden Input Parameters

Raingarden Parameter	10 ha Low Density Catchment	10 ha Medium Density Catchment
High Flow Bypass (m^3/s)	100	
Extended Detention Basin (m)	0.3	
Surface Area (m^2)	704	638
Filter Area (m^2)	640	580
Filter Depth	0.5	
Unlined Filter Media Perimeter (m)	0.01	
Saturated Hydraulic Conductivity (mm/h)	100	
TN Content of Filter Media (mg/kg)	750	
Orthophosphate Content of Filter Media (mg/kg)	40	
Exfiltration Rate (mm/hr)	0	
Overflow Weir Width (m)	Varies (target 0.10 m - 0.15m weir depth)	
Base Lined	Yes	
Vegetated with effective Nutrient removal Plants	Yes	
Underdrain Present	Yes	
Submerged Zone with Carbon Present	No	

Treatment Pond

The design parameters adopted for the treatment ponds are shown in Table C-3. These ponds are proposed in two (2) locations across the Precinct and will receive flows from the development after first being treated by the GPT at each outlet. The pond will also attenuate first flush flows to reduce the risk of stream erosion within the watercourses.

Table C-3 – Bioretention Raingarden Input Parameters

Pond Parameter	Value
High Flow Bypass (m^3/s)	100
Surface Area (m^2)	4000
Extended Detention Depth (m)	0.3
Permanent Pool Volume (m^3)	8000
Initial Volume (m^3)	8000
Exfiltration Rate (mm/hr)	0
Evaporative Loss as % of PET	100
Equivalent Pipe Diameter (mm)	200
Overflow Weir Width (m)	10
Notional Detention Time (hrs)	6.53

On-lot Treatment

All medium and high density residential development, together with commercial/industrial and school developments are assumed to provide on-lot stormwater quality treatment to achieve the required statutory pollution reduction targets of 85% (TSS), 65% (TP), 45% (TN) and 90% Gross pollutants prior to discharge to the public street drainage system.

It is anticipated that these on-lot devices could comprise proprietary stormwater quality management devices or traditional bio-retention raingardens.

A generic node reflecting on-lot pollutant reductions is incorporated in the MUSIC model. It is important to note that the SEI requirements are comfortably met in the regional devices, and therefore no on-lot SEI assessment is deemed necessary.

MUSIC MODELLING WORKSHEET
South Creek West - Bringelly Precinct Rezoning Assessment

	Catchment Division						Node Inputs: Catchment Split Road/Roof/Impervious/Pervious						
Catchment	**Total Catchment Area (ha)**	**R2 Lot Area (ha)**	**No. Lots**	**Avg Lot Size (m²)**	**Road Reserve Area (ha)**	**Active Open Space**	**Road (ha)**	**Driveways (ha)**	**R2 Roof to Tank (ha)**	**R2 Roof Bypass (ha)**	**Other Impervious (ha)**	**Pervious Areas (ha)**	**Effective % Impervious**
Typical 10 ha Low-Density	10.000	6.000	120	500	3.000	1.000	2.700	0.600	1.800	1.800	0.600	2.500	75%
Typical 10 ha Medium-Density	10.000	6.400	192	333	3.000	0.600	2.700	0.640	--	3.840	0.820	2.000	80%

	Node Inputs: Rainwater Tanks					
Catchment	**Hi Flow Bypass**	**Equivalent Pipe dia (mm)**	**Daily Demand (kL)**	**Annual Demand (kL/yr)**	**Total Tank Volume (m^3)**	**Tank Surface Area (m^2)**
Typical 10 ha Low-Density	0.39300	548	18.0	6000	288.0	204.0

	R2 Lots	
Overflow Pipe Diameter	50	mm
PET - Rain for landscape area	50	kL/year/dwelling
Assumed Daily Demand	150	L/day
Adopted Tank Size	3	kL
Assumed 80% is useable (w/o topups)	80	%
Useable tank	2.4	kL
Tank Surface Area per Dwelling	1.7	m^2
I5min/1yr	78.6	mm/hr

Input
MUSIC Input

		Treatable Flow Calculation				
	Cat. Area (ha)	**Tc* (min)**	**%Imperv.**	**1yr Flow (m^3/s)**	**3mth Flow (m^3/s)**	**6mth Flow (m^3/s)**
GPT Treatable flow (low density)	10.000	8.5	75%	1.125	0.585	0.821
GPT Treatable flow (medium density)	10.000	8.5	80%	1.164	0.605	0.850

APPENDIX E –MUSIC-LINK REPORT

MUSIC-*link* Report

Project Details		Company Details	
Project:	SCW Cobbitty Sub-Precinct 5	**Company:**	JWP
Report Export Date:	24/09/2021	**Contact:**	Troy McLeod
Catchment Name:	110628-02 MU1	**Address:**	77 Union Road, Penrith NSW
Catchment Area:	10ha	**Phone:**	47203392
Impervious Area*:	150.0%	**Email:**	tmcleod@jwprince.com.au
Rainfall Station:	67035 LIVERPOOL(WHITLAM		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1985 - 31/12/1994 11:54:00 PM		
Mean Annual Rainfall:	783mm		
Evapotranspiration:	1261mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.34		
Study Area:	Camden City Council		
Scenario:	Camden City Council		

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Report LD 10ha	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	12.8%	Bio Retention Node	2	Urban Source Node	15
TSS	85.3%	Rain Water Tank Node	1	Forest Source Node	1
TP	65.7%	Pond Node	1		
TN	49.9%	GPT Node	2		
GP	99%	Generic Node	4		

Comments

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention (580 m�)	Hi-flow bypass rate (cum/sec)	None	None	100
Bio	Bioretention (580 m�)	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention (640 m�)	Hi-flow bypass rate (cum/sec)	None	None	100
Bio	Bioretention (640 m�)	PET Scaling Factor	2.1	2.1	2.1
Forest	10 ha Forest	Area Impervious (ha)	None	None	0
Forest	10 ha Forest	Area Pervious (ha)	None	None	10
Forest	10 ha Forest	Total Area (ha)	None	None	10
GPT	LD Vortex GPT	Hi-flow bypass rate (cum/sec)	None	99	0.585
GPT	MD Vortex GPT	Hi-flow bypass rate (cum/sec)	None	99	0.605
Pond	Pond	% Reuse Demand Met	None	None	0
Rain	Rainwater Tank	% Reuse Demand Met	None	None	46.10
Receiving	Receiving Node	% Load Reduction	None	None	74.3
Receiving	Receiving Node	GP % Load Reduction	90	None	99.2
Receiving	Receiving Node	TN % Load Reduction	45	None	79.6
Receiving	Receiving Node	TP % Load Reduction	65	None	83.7
Receiving	Receiving Node	TSS % Load Reduction	85	None	88.5
Urban	LD Driveway (0.6 ha)	Area Impervious (ha)	None	None	0.6
Urban	LD Driveway (0.6 ha)	Area Pervious (ha)	None	None	0
Urban	LD Driveway (0.6 ha)	Total Area (ha)	None	None	0.6
Urban	LD Impervious (0.3 ha)	Area Impervious (ha)	None	None	0.3
Urban	LD Impervious (0.3 ha)	Area Pervious (ha)	None	None	0
Urban	LD Impervious (0.3 ha)	Total Area (ha)	None	None	0.3
Urban	LD Open Space (1.0 ha)	Area Impervious (ha)	None	None	0.301
Urban	LD Open Space (1.0 ha)	Area Pervious (ha)	None	None	0.698
Urban	LD Open Space (1.0 ha)	Total Area (ha)	None	None	1
Urban	LD Pervious (1.5 ha)	Area Impervious (ha)	None	None	0
Urban	LD Pervious (1.5 ha)	Area Pervious (ha)	None	None	1.5
Urban	LD Pervious (1.5 ha)	Total Area (ha)	None	None	1.5
Urban	LD Road (2.7 ha)	Area Impervious (ha)	None	None	2.7
Urban	LD Road (2.7 ha)	Area Pervious (ha)	None	None	0
Urban	LD Road (2.7 ha)	Total Area (ha)	None	None	2.7
Urban	LD Road Pervious (0.3 ha)	Area Impervious (ha)	None	None	0
Urban	LD Road Pervious (0.3 ha)	Area Pervious (ha)	None	None	0.3
Urban	LD Road Pervious (0.3 ha)	Total Area (ha)	None	None	0.3
Urban	LD Roof (1.8 ha)	Area Impervious (ha)	None	None	1.8
Urban	LD Roof (1.8 ha)	Area Pervious (ha)	None	None	0
Urban	LD Roof (1.8 ha)	Total Area (ha)	None	None	1.8
Urban	LD Roof to tank (1.8 ha)	Area Impervious (ha)	None	None	1.8
Urban	LD Roof to tank (1.8 ha)	Area Pervious (ha)	None	None	0
Urban	LD Roof to tank (1.8 ha)	Total Area (ha)	None	None	1.8

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	MD Driveway (0.64 ha)	Area Impervious (ha)	None	None	0.64
Urban	MD Driveway (0.64 ha)	Area Pervious (ha)	None	None	0
Urban	MD Driveway (0.64 ha)	Total Area (ha)	None	None	0.64
Urban	MD Impervious (0.64 ha)	Area Impervious (ha)	None	None	0.64
Urban	MD Impervious (0.64 ha)	Area Pervious (ha)	None	None	0
Urban	MD Impervious (0.64 ha)	Total Area (ha)	None	None	0.64
Urban	MD Open Space (0.6 ha)	Area Impervious (ha)	None	None	0.178
Urban	MD Open Space (0.6 ha)	Area Pervious (ha)	None	None	0.421
Urban	MD Open Space (0.6 ha)	Total Area (ha)	None	None	0.6
Urban	MD Pervious (1.28 ha)	Area Impervious (ha)	None	None	0
Urban	MD Pervious (1.28 ha)	Area Pervious (ha)	None	None	1.28
Urban	MD Pervious (1.28 ha)	Total Area (ha)	None	None	1.28
Urban	MD Road (2.7 ha)	Area Impervious (ha)	None	None	2.7
Urban	MD Road (2.7 ha)	Area Pervious (ha)	None	None	0
Urban	MD Road (2.7 ha)	Total Area (ha)	None	None	2.7
Urban	MD Road Pervious (0.3 ha)	Area Impervious (ha)	None	None	0
Urban	MD Road Pervious (0.3 ha)	Area Pervious (ha)	None	None	0.3
Urban	MD Road Pervious (0.3 ha)	Total Area (ha)	None	None	0.3
Urban	Roof (3.84 ha)	Area Impervious (ha)	None	None	3.84
Urban	Roof (3.84 ha)	Area Pervious (ha)	None	None	0
Urban	Roof (3.84 ha)	Total Area (ha)	None	None	3.84

Only certain parameters are reported when they pass validation