Water Cycle Management Strategy Report

Mirvac Homes (NSW) Pty Limited and
Vianello Holdings Pty Limited

Glenmore Park Stage 3 (GP3)

April 2022

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TABLE OF CONTENTS

PLATES

TABLES

APPENDICES

1. EXECUTIVE SUMMARY

J. Wyndham Prince has been engaged by Mirvac Homes (NSW) Pty Ltd (Mirvac) and Vianello Holdings Pty Ltd (Vianello) to prepare a Water Cycle Management Strategy Report in support of the proposed rezoning of a 205-ha parcel of land at The Northern Road, Mulgoa. The Glenmore Park Stage 3 (GP3) site is located within the Penrith Local Government Area (LGA). This report details the procedures used and presents the results of investigations to support the rezoning and future development applications to be submitted to Penrith City Council (Council).

This Water Cycle Management Strategy (WCMS) presents background and details of the planning proposal for the GP3 rezoning, hydrologic analysis, water quality analysis, riparian corridor assessment and ecological assessment. An initial WCMS was previously submitted to Council (JWP, 24 March 2020, ref: 110474-02-Rpt1_E) which resulted in a series of comments and requests for information that have subsequently been addressed in this revised report. Key updates include transitioning the hydrologic model to ARR 2019 methodologies, the preparation of a 1D/2D flood model of the site in TUFLOW, preparation of a detailed water quality model of the proposed development in MUSIC and the preparation of concept design plans for a selection of devices across the site. In addition to this, NSW Government's Cumberland Plain Conservation Plan (CPCP) has been considered to inform the GP3 Master Plan.

The revised modelling and overall Water Cycle Management Strategy is based on the revised Master Plan and preliminary gradings that have been undertaken by ADW Johnson (for the Mirvac landholdings) and J. Wyndham Prince (for the Vianello landholdings).

Results demonstrate that the proposed five (5) detention basins located throughout the site with a total storage of approximately 39,000 m³ will ensure that peak post-development discharges in storm events up to and including the 1% AEP are restricted to less than the pre-development levels at all key comparison locations. The strategy includes one (1) "dry" detention basin and four (4) "wet" detention basins co-located with open water bodies.

The Water Cycle Management Strategy also provides a flood impact assessment of the GP3 precinct. The assessment defines the flood behaviour within the Precinct providing information on the flood depths, levels, and hazards for 20% AEP, 1% AEP and PMF events. The flood impact maps show that in the 20% AEP and 1% AEP events, the development of GP3 results in some localised impacts within the Mulgoa Nature Reserve downstream which are restricted to the existing flood extents. Further investigations to reduce these impacts will be undertaken in the post exhibition phase of the rezoning.

Water quality will be managed by on-lot rainwater tanks, gross pollutant traps, raingardens and permanent ponds in order to deliver the required water quality outcomes for the site. A total of nine (9) raingardens and four (4) permanent ponds are proposed across the site. The anticipated total bio-retention raingarden area is 11,420 m² and the anticipated total pond surface area is 23,720 m².

Concept designs have been prepared for a selection of devices across the site to give an indication of the stormwater infrastructure design outcomes that can be expected. The concept designs are provided in Appendix A. For an overview of the Water Cycle Management Plan refer to Figure 1-1 in Appendix B.

The Water Cycle Management Strategy proposed for Glenmore Park Stage 3 is functional; delivers the required technical performance; lessens environmental degradation and pressure on downstream ecosystems and infrastructure and provides for a 'soft' sustainable solution for stormwater management within the precinct.

2. BACKGROUND

2.1. Site

The Glenmore Park Stage 3 site is located within the Penrith City Council Local Government area and consists of approximately 205 ha of land located at The Northern Road, Mulgoa. The site is bound to the north by the existing Glenmore Park Stage 2 development, The Northern Road to the east, Chain-O-Ponds Road to the south and Mulgoa Nature Reserve to the west.

The site includes a number of minor Mulgoa Creek tributaries that traverse the site before discharging to Mulgoa Nature Reserve as well as a number of existing farm dams. The site is predominantly used for agricultural purposes with an undulating terrain and variations in height from RL 91 m to RL 47 m.

Refer to Plate 2-1 below for further detail of the site.

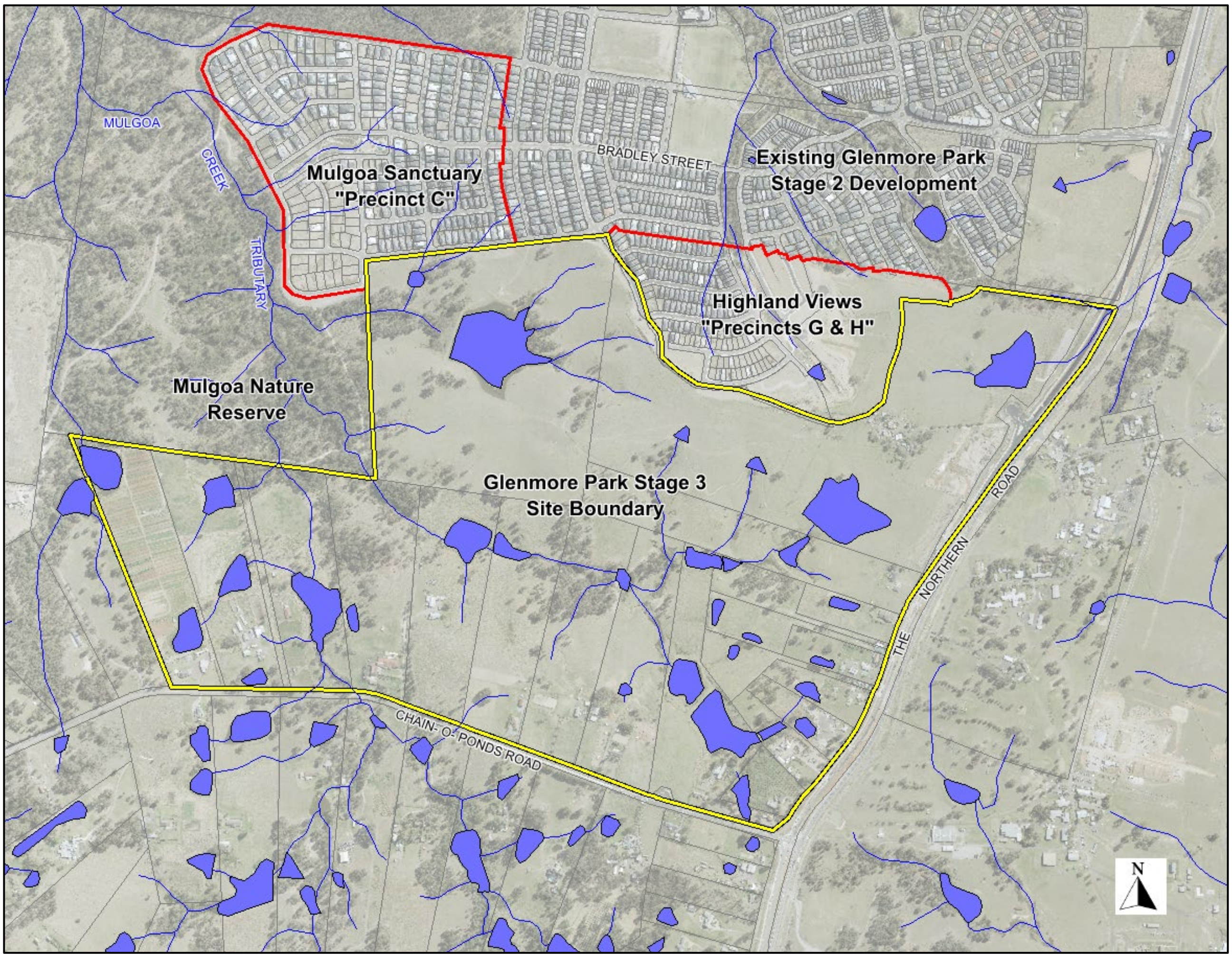

Plate 2-1 – Existing Site

There are a series of significant upstream catchments, ranging in size from 1 ha to 10 ha, that are conveyed via watercourses (unnamed tributaries) through the subject site before discharging to Mulgoa Creek along the northern boundary. It is proposed that a number of tributaries that traverse the site will be maintained as fully functional riparian corridors.

The Vianello portion of land is currently zoned as RU2 Rural Landscape under the Penrith Local Environmental Plan (2010), while the remaining portion of land under control of Mirvac and others is zoned RU2 Rural Landscape and E3 Environmental Management. Refer to Plate 2-2 below for details.

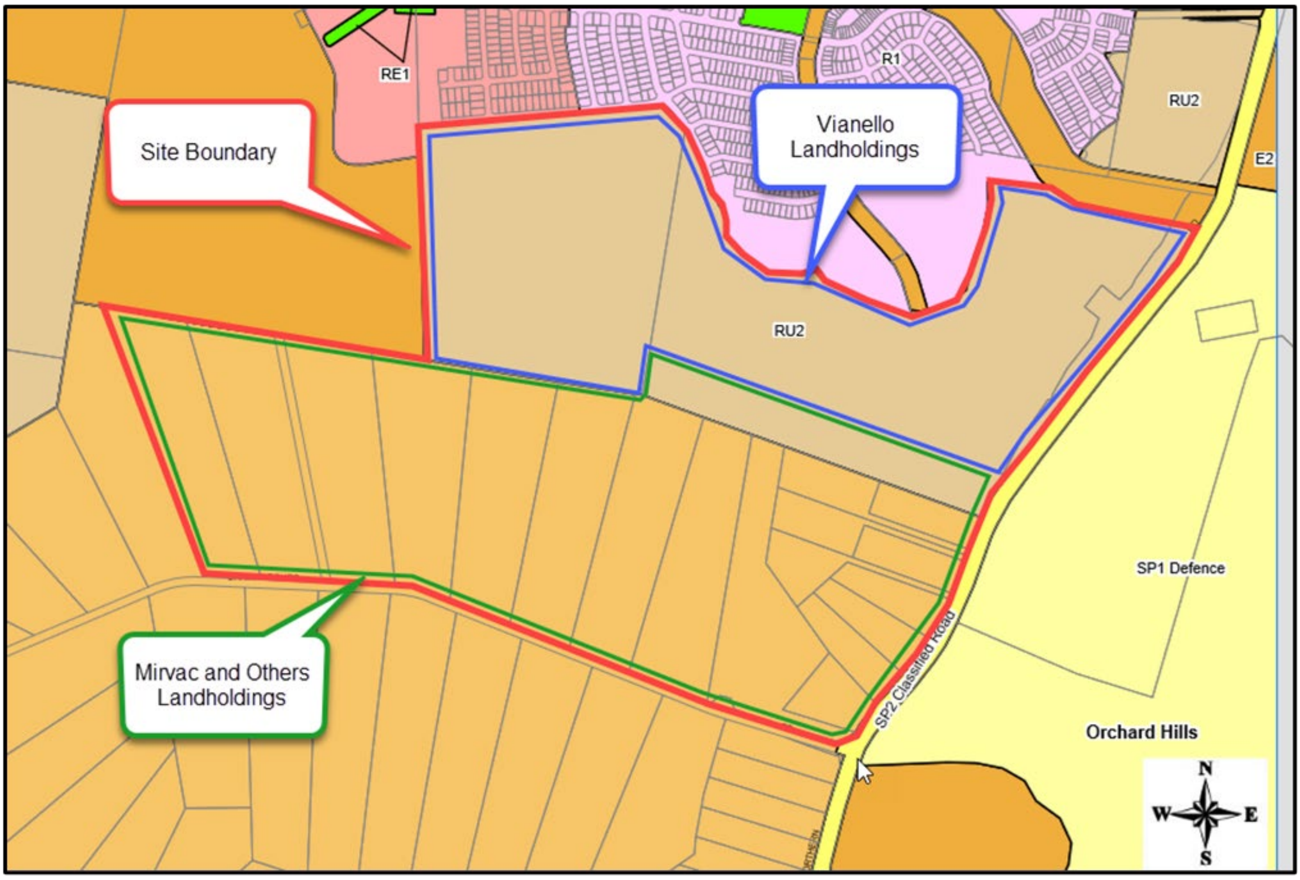

Plate 2-2 – Existing Zoning

2.2. Objective

The objective of this study is to support the rezoning application for GP3 by expanding on the previously submitted stormwater strategy, addressing the items raised by Council, and includes an assessment of flooding within and surrounding the subject site, water quality assessment and concept design preparation. This assessment will ensure compliance with Council's development standards and policies.

2.3. Proposed Development

The Planning Proposal submitted to Council on 21 May 2018 supports an amendment to the Penrith Local Environmental Plan (LEP) 2010 to rezone a 205-ha parcel of land at The Northern Road, Mulgoa to accommodate a new residential development.

The Planning Proposal is supported by a Masterplan, which represents the overall planning framework and preferred outcome for the Glenmore Park Stage 3. The Masterplan includes the following significant features:

- Residential development with associated road infrastructure
- School site
- Mixed use / commercial areas
- Passive / Active Open Space Area throughout the masterplan

Five (5) stormwater detention basins will be provided at strategic locations throughout the development to mitigate peak flows resulting from urbanisation of the catchment to less than (or equal to) existing conditions.

Some riparian corridors which bisect the site are proposed to be maintained and enhanced to be a functioning riparian corridor, while others are proposed to be removed with the support of Natural Resources Access Regulator (NRAR). The Cumberland Plain Conservation Plan is also a key constraint that has been considered in the proposed Master Plan. Various water quality devices are also proposed throughout the development to minimise the impact on the environment and deliver PCC's water quality objectives. Refer to Plate 2-3 for the Masterplan for the site.

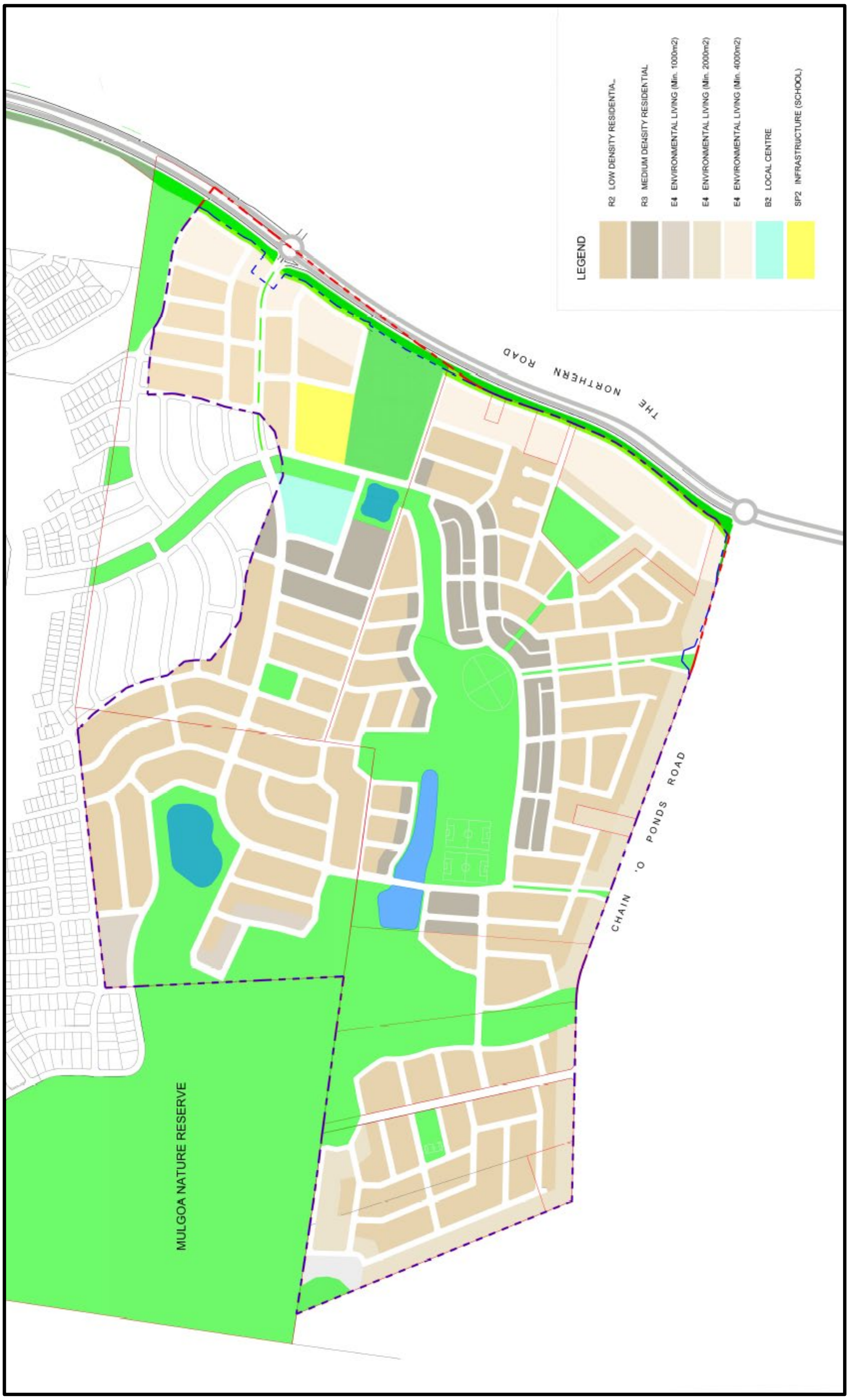

Plate 2-3 – GP3 Master Plan (Mirvac, 4 April 2022, Rev F)

3. PREVIOUS STUDIES

3.1. Stormwater Management Strategy – Glenmore Park Stage 2 (2005)

This report (JWP, 2005) was previously prepared to support the master planning and rezoning process and presents the results of the investigations undertaken in developing a Stormwater Management Strategy that incorporated the principles of Water Sensitive Urban Design (WSUD) to integrate with and support the development planning process for the Glenmore Park Stage 2 Release Area.

The water quality strategy proposed in this investigation allowed for the provision of bio-retention raingardens sized at 1% of the catchment area. The modelling also included rainwater tanks on each residential allotment; however, these were modelled as a pond node due to the rainwater tank node not being included in earlier versions of the MUSIC water quality modelling software. The results of the modelling showed that the treatment train was adequate to achieve the applicable water quality targets at the time, with scope to be refined in subsequent investigations.

The strategy also allowed for the provision of detention storage to restrict 1 EY (Exceedances per Year) post development peak flows to predevelopment levels for local catchments within Glenmore Park Stage 2 (consistent with the requirements of the Glenmore Park Stage 2 DCP). Detention incorporated within the existing Blue Hills Wetland provides adequate storage to restrict post development flows to predevelopment levels for all storms up to and including the 1% AEP storms for the Surveyors Creek catchment of Glenmore Park Stage 2.

Results of the strategy indicate that there is no net increase in stormwater discharge rates at the downstream end of the Mulgoa Creek Tributary, and therefore no detention storage has been provided for storm events in excess of the 1 EY.

3.2. Penrith Overland Flow Flood “Overview Study” (2006)

In August 2006, Cardno Lawson Treloar Pty Ltd (Cardno) prepared the Overland Flow Study for Penrith City Council. The study formed the first stage to inform a series of flood assessments across the LGA. It identified 40 creek systems and their catchment areas that will ultimately require further studies.

As part of the study, two-dimensional (2D) hydraulic (SOBEK) modelling was completed to determine flood behaviour for the entire LGA. This model was not informed by traditional methods of hydrological modelling. Instead, design rainfall time-series were applied directly on the model grid as input. The resulting flood extents were used to identify properties affected by overland flooding.

The 1% AEP flood extents defined in this study were used to identify the flooding constraints affecting the Glenmore Park Stage 3 site.

Plate 3-1 shows extracts of Council’s flood maps which shows the extents of 5% AEP (20-year ARI), 1% AEP (100 year ARI) and PMF overland flooding across the existing site.

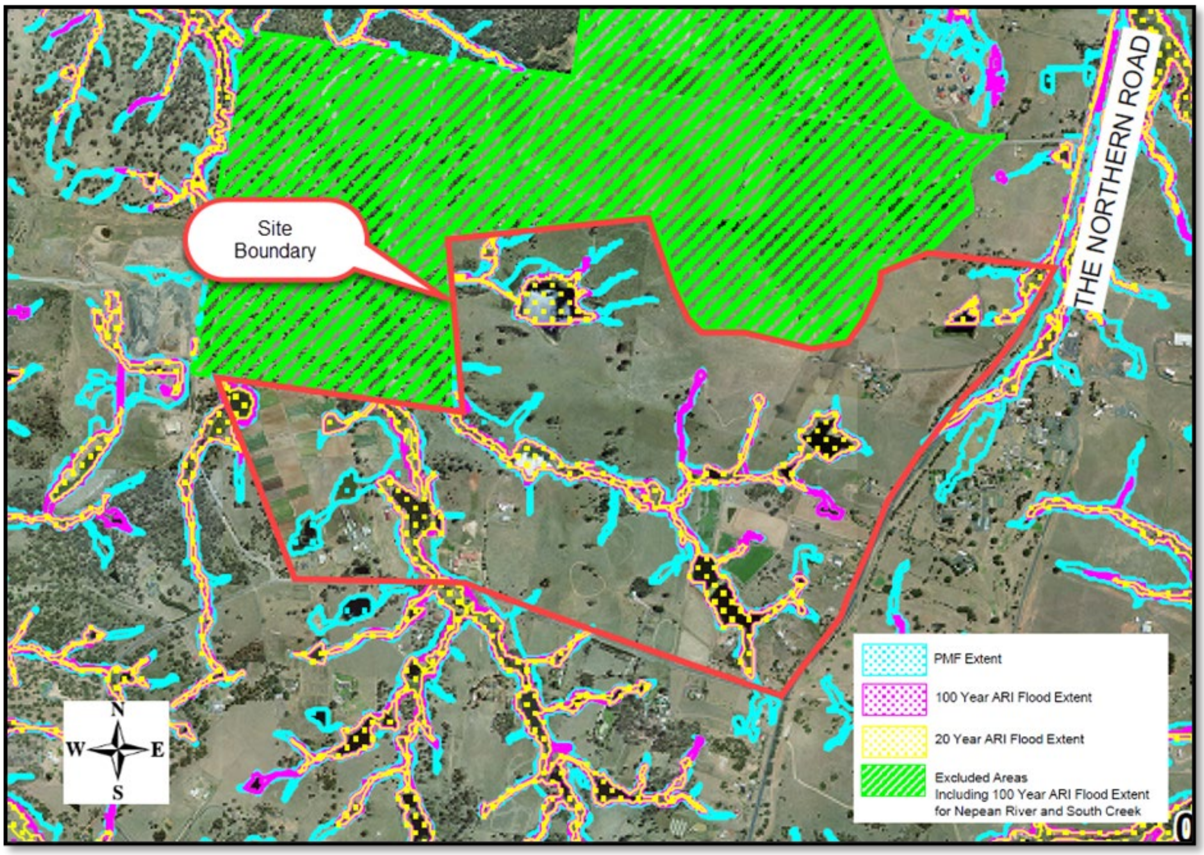

Plate 3-1 – Flooding Across GP3 Site (Cardno, 2006)

3.3. Glenmore Park Stage 2 – Stormwater Management Strategy Addendum Report – Revised Water Quality Modelling & Stream Erosion Index Assessment (2010)

In 2010, J. Wyndham Prince completed the “Glenmore Park Stage 2 – Stormwater Management Strategy Addendum Report – Revised Water Quality Modelling & Stream Erosion Index Assessment” (Addendum Report) for the Landowners Group. This assessment revised the previous strategy for the Glenmore Park Stage 2 Release Area (JWP, 2005) to address updates to the development layout, PCC’s design requirements and MUSIC modelling software.

Results of this investigation showed that the provision of Gross Pollutant Traps (GPTs) and raingardens within the development will ensure that the post development stormwater discharges will meet the DCP’s water quality objectives for Glenmore Park Stage 2. The inclusion of rainwater tanks as an additional node in the new MUSIC model has allowed raingarden areas derived in the 2005 study to be reduced from 1% to 0.55% relative to the catchments they service.

3.4. Glenmore Park Stage 2 Precinct C – Stormwater Management Strategy (2017)

This report (JWP 2017) was prepared to support Development Applications for bulk earthworks, subdivision and development within Precinct C at Glenmore Park Stage 2. The strategy has been prepared to conform with the statutory requirements and industry best practice for stormwater management.

The Stormwater Management Strategy comprises of a treatment train consisting of on lot treatment, street level treatment and subdivision/development treatment measures. The structural elements proposed for the development include proprietary GPT units, three (3) detention basins and three (3) bio-retention systems (raingardens). Refer to Plate 3-2 below.

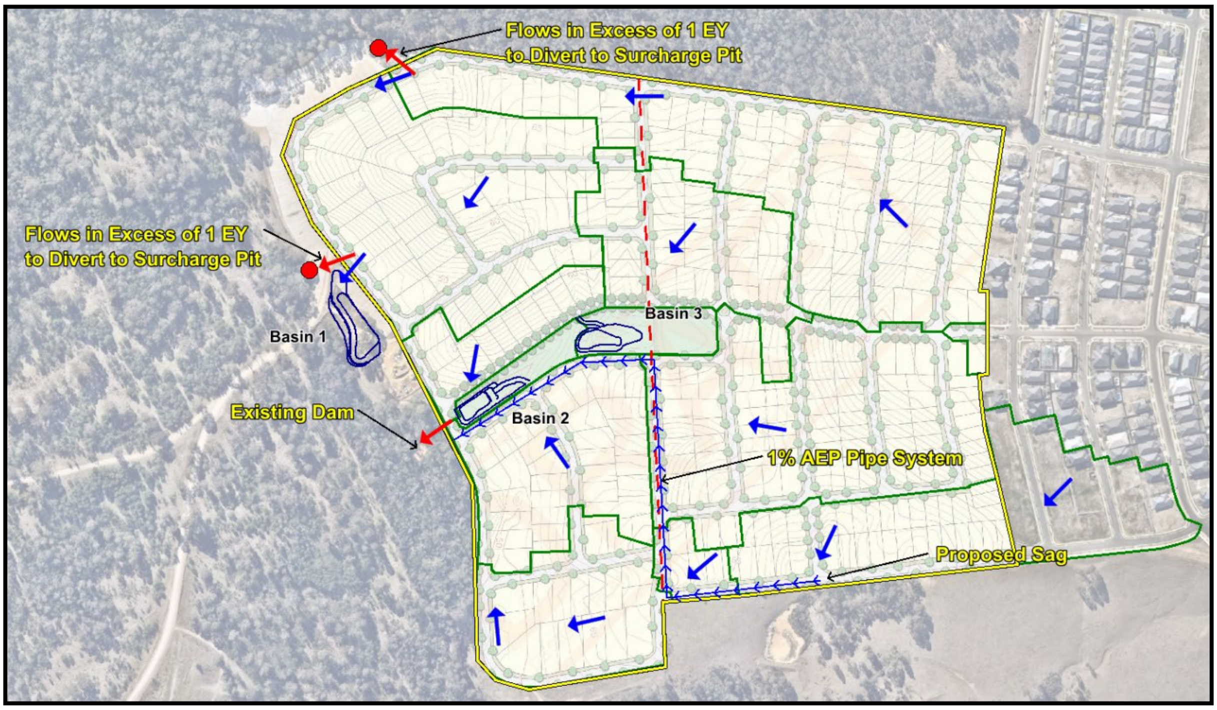

Plate 3-2 – Stormwater Management Strategy – Precinct C

The proposed strategy for the developed site provides a basis for the detailed design and development of the site to ensure that the environmental, urban amenity, engineering and economic objectives for stormwater management and site are achieved.

4. DEVELOPMENT GUIDELINES AND CONSTRAINTS

The following guidelines were considered in developing the Water Cycle Management Strategy for the Glenmore Park Extension Planning Proposal site.

4.1. Penrith City Council Water Sensitive Urban Design Policy (2017)

Penrith City Council's WSUD Policy (PCC, adopted 2013, reviewed 2017) identifies the following objectives for consideration with regard to stormwater management:

- Protect and enhance natural water systems such as creeks and rivers in the Penrith LGA.
- Treat urban stormwater to meet water quality objectives for reuse and/or discharge to receiving waters.
- Match the natural water runoff regime as closely as possible (where appropriate).
- Reduce potable water demand through water efficient fittings and appliances, rainwater harvesting and water reuse.
- Minimise wastewater generation and treatment of wastewater to a standard suitable for effluent reuse opportunities.
- Integrate stormwater management into the landscape so as to maximise the visual and recreational amenity of urban development.
- Provide objectives and controls for specific WSUD elements including water conservation, stormwater quality and waterway stability management.

This document nominates the pollutant load reductions as follows:

- **Gross Pollutants:** 90% reduction in the post development mean annual load greater than 5mm
- **Total Suspended Solids:** 85% reduction in the post development mean annual load
- **Total Phosphorus:** 60% reduction in the post development mean annual load
- **Total Nitrogen:** 45% reduction in the post development mean annual load

This policy is supported by Penrith City Council's "WSUD Technical Guidelines" (PCC, 2015), which sets out the key parameters that are required to be used in sizing all Stormwater Treatment Measures in MUSIC.

4.2. Penrith City Council Development Control Plan (2014)

The Penrith City Council Development Control Plan (Part C3 – Water Management) (PCC, 2014) identifies the following objectives for consideration with regard to water management:

- Adopt an integrated approach that takes into account all aspects of the water cycle in determining impacts and enhancing water resources;
- Promote sustainable practices in relation to the use of water resources for human activities;
- Minimise water consumption for human uses by using best practice site planning, design and water efficient appliances;
- Address water resources in terms of the entire water catchment;
- Protect water catchments and environmental systems from development pressures and potential pollution sources;
- Protect and enhance natural watercourses, riparian corridors and wetlands;
- Integrate water management with stormwater, drainage and flood conveyance requirements; and
- Utilise principles of Water Sensitive Urban Design in designing new developments or infill development in existing areas.

4.3. Cooling the City Strategy (2015)

Penrith City Council has developed the Cooling the City Strategy, in 2015 that identifies strategies to cool the city and region in a way that improves liveability and prioritises protection from heat for people and communities based on the research undertaken within Penrith LGA. This strategy identified a range of opportunities that could be considered to cool the city to have the greatest impact and includes:

- Green Infrastructure;
- Water Sensitive Urban Design (WSUD);
- Increased Albedo / Reflectivity;
- Policy & Planning
- Community Engagement.

The research also demonstrated water either on the surface or stored in the soil profile, tree cover, and ground cover that is permeable and grassed are significantly cooler than others. The foundation of urban heat mitigation is the retention of water in the landscape. WSUD includes technologies such as water efficient fittings and appliances, rainwater tanks to reduce potable water consumption and costs, bio retention systems (rain gardens), swales, wetlands, proprietary devices and other approved site-specific measures to reduce pollution from stormwater entering local waterways which together can influence air temperature and surface temperature.

4.4. Penrith City Council Stormwater Drainage Guidelines for Building Developments (2020)

The Penrith City Council Stormwater Drainage Guidelines for Building Developments (PCC, adopted 2016, reviewed 2020) identifies the following objectives for consideration with regard to stormwater drainage:

- Minimise any adverse impacts and prevent damage to the built and natural environment as a result of stormwater runoff from building developments;
- Manage the quantity of stormwater runoff generated by building developments;
- Protect the existing public stormwater drainage assets;
- Minimise the impacts of flooding (mainstream and local) to the built and natural environment;
- Manage risk to lives and property from the impacts of stormwater and flooding;
- Ensure the design and construction of the stormwater drainage systems for building developments can be economically maintained;
- Provide uniform specification and technical requirements in design and construction of stormwater drainage systems for building developments within the Penrith City Council Local Government Area (LGA); and
- Have uniform approach and ensure consistency in the assessment of stormwater drainage systems for building developments.

4.5. Guidelines for controlled activities on waterfront land – Riparian corridors (NRAR, 2018)

In May 2018, the Natural Resources Access Regulator (NRAR) released guidelines for riparian corridors on waterfront land. New rules regarding controlled activities within riparian corridors have been established that provide more flexibility in how riparian corridors can be used. These guidelines have been adopted in developing the riparian corridor strategy for the Glenmore Park Stage 3 Planning Proposal.

As part of the guidelines, water courses orders have been classified under the Strahler System using current 1:25,000 topographic maps. The Strahler System classification methodology, corresponding riparian corridor widths and riparian corridor matrix are shown on Plate 4-1, Table 4-1 and 4-2, respectively.

The various watercourses within the existing site include 1st to 4th order water courses.

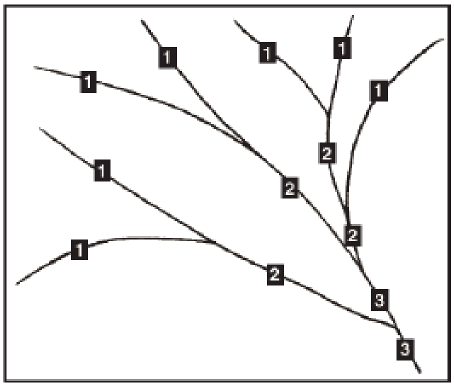

Plate 4-1 – The Strahler System (NRAR)

Table 4-1 – Recommended Riparian Corridor Widths (NRAR)

Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 metres + channel width
2nd order	20 metres	40 metres + channel width
3rd order	30 metres	60 metres + channel width
4th order and greater (includes estuaries, wetlands and parts of rivers influence by tidal waters)	40 metres	80 metres + channel width

Note: Where a watercourse does not exhibit the features of a defined channel with bed and banks, the NRAR may determinethat the watercourse is not waterfront land for the purposes of the WM Act.

Table 4-2 – Riparian Corridor Matrix (NRAR)

Stream order	Vegetated riparian zone(VRZ)	RC offsetting for non-RC users	Cycleways andpaths	Detention basins		Stormwater outlet structures and essential services	Stream realignment	Road crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10 m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
2nd	20 m	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
3rd	30 m	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes
4th	40 m	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes

4.6. Cumberland Plain Conservation Plan (DPIE, 2022)

As part of the NSW Government's commitment to providing the Western Parkland City, the Department of Planning, Industry and Environment has prepared a Cumberland Plain Conservation Plan (CPCP) in order to protect Western Sydney's biodiversity and support its growth to 2056 and beyond (NSW, Planning Portal, 2022).

The following future development areas are covered by the CPCP

- Greater Macarthur Growth Area

- Greater Penrith to Eastern Creek Investigation Area (GP3 forms part of this area)
- Western Sydney Aerotropolis
- Wilton Growth Area.

The full extent of the CPCP is provided below in Plate 4-2.

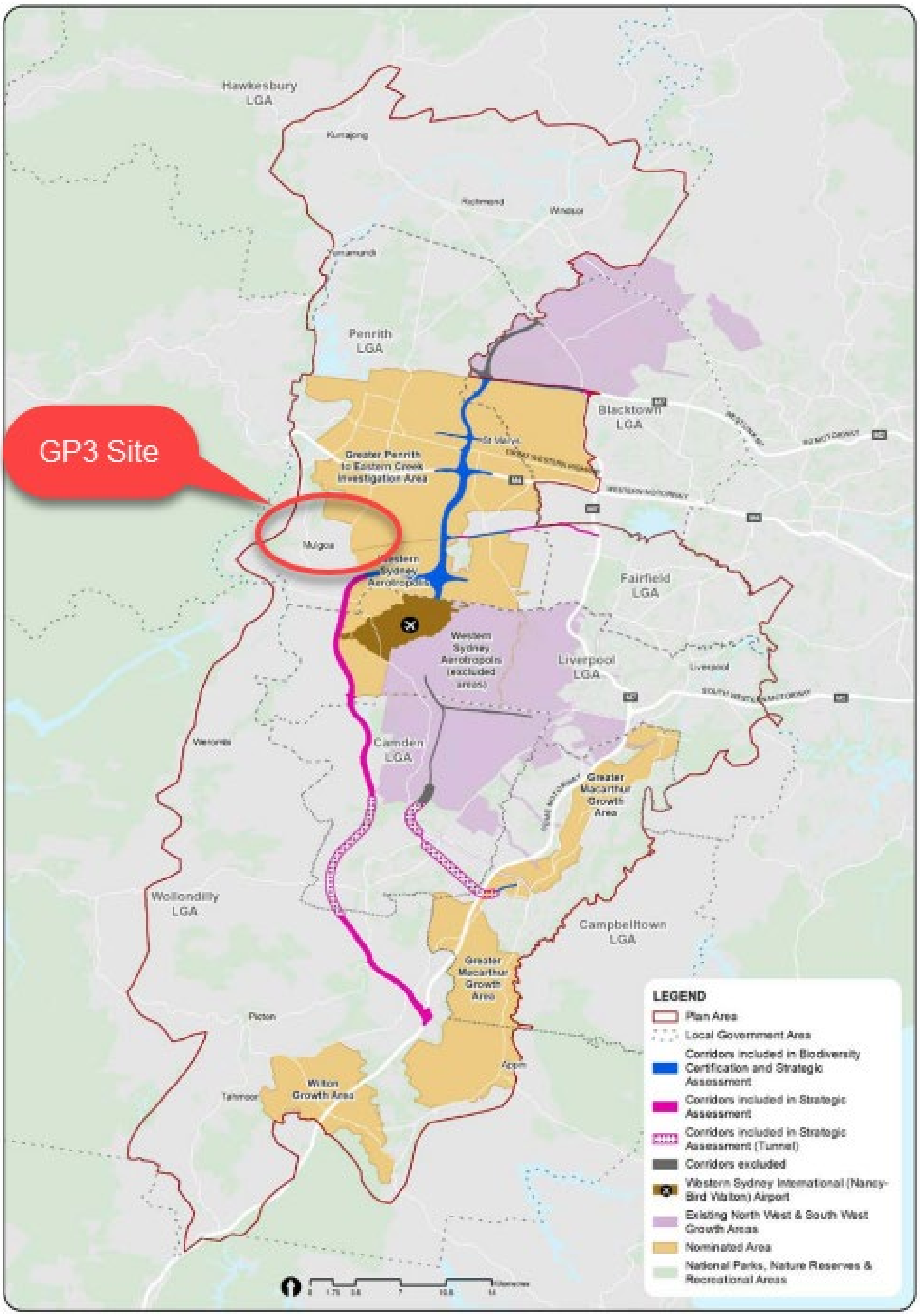

Plate 4-2 – Cumberland Plain Conservation Plan (DPIE)

The CPCP constraints within GP3 has been used to inform the masterplan development.

The CPCP will be a key constraint in developing GP3 and the required water management devices will need to consider the CPCP constraints and adjoining riparian corridors. Concept designs for the water quality devices adjoining these corridors will be undertaken post-exhibition.

5. HYDROLOGIC ASSESSMENT

The hydrologic analysis for the site at Glenmore Park Stage 3 was undertaken using the rainfall-runoff flood routing model XP-RAFTS (2018). This assessment has adopted the methodologies outlined in the Australian Rainfall and Runoff (ARR) 2019 guidelines (formerly ARR 2016).

In order to address these requirements, hydrologic modelling for the 20% AEP, 1% AEP and PMF storm events for a range of durations and temporal patterns has been undertaken and a basin strategy has been developed.

The details of the key stormwater infrastructure are shown on the concept plans in Appendix A.

5.1. Hydrologic Parameters

The ARR Data Hub provides guidance on the loss parameters for pervious catchments for this locality. The overall storm loss suggested by ARR Data Hub is 46 mm which has then been factored by 60% due to the urban nature of the surrounding catchment consistent with advice in ARR 2016 Book 5 section 3.5.3.2.1. Refer to Table 5-1 for details of the loss parameters used in the assessment.

Table 5-1 – Initial / Continuing Loss

Catchment Conditions	Initial Loss (mm)	Continuing Loss (mm/hr)
Pervious	27.6	2.5
Impervious	1	0

The Manning's roughness parameters used in this assessment are based on industry best practice and experience in similar catchments in the Penrith LGA. Refer to Table 5-2 for details of the Manning's roughness parameters used in the assessment.

Table 5-2 – Manning's Roughness 'n'

Conditions	Manning's Value
Existing (Rural) Pervious	0.040
Urban Pervious	0.025
Impervious	0.015

The rainfall data used in this assessment was adopted from the Bureau of Meteorology (BOM) 'Design Rainfall Data System' (downloaded on 9 November 2021). Details of the IFD data used in the XP-RAFTS modelling is provided in Appendix C along with the ARR Data Hub summary.

5.2. Existing Conditions

Sub-catchment areas contributing to the drainage system were established through a combination of LiDAR contour data obtained from the NSW Spatial Information Exchange, detailed site survey obtained for portions of the site and catchment information gathered from surrounding studies / developments.

The XP-RAFTS model includes catchments upstream of the site and extends approximately 500 m to the north-west of the site into Mulgoa Nature Reserve. The model also includes catchments to the east of the site adjacent to the new Northern Road alignment.

Model development of the "existing" site conditions included the following assumptions:

- Link lagging between sub-catchments was adopted throughout the hydrological model. Given the site and upstream catchment is largely pasture grass, the lag times adopted have been based on a flow velocity of 1 m/s. Following an initial run of the hydraulic model, the hydrologic lag links were then adjusted to the velocities from the hydraulic model at various points in the catchment. The hydraulic model shows that velocities are generally in the range of 1-1.5 m/s.

- Fraction impervious values for each catchment have been measured to reflect impervious surfaces such as buildings, pavement and permanent farm dams based on the available aerial imagery.

Refer to Plate 5-1 for the existing model layout and Figure 5-1 for the existing catchment plan.

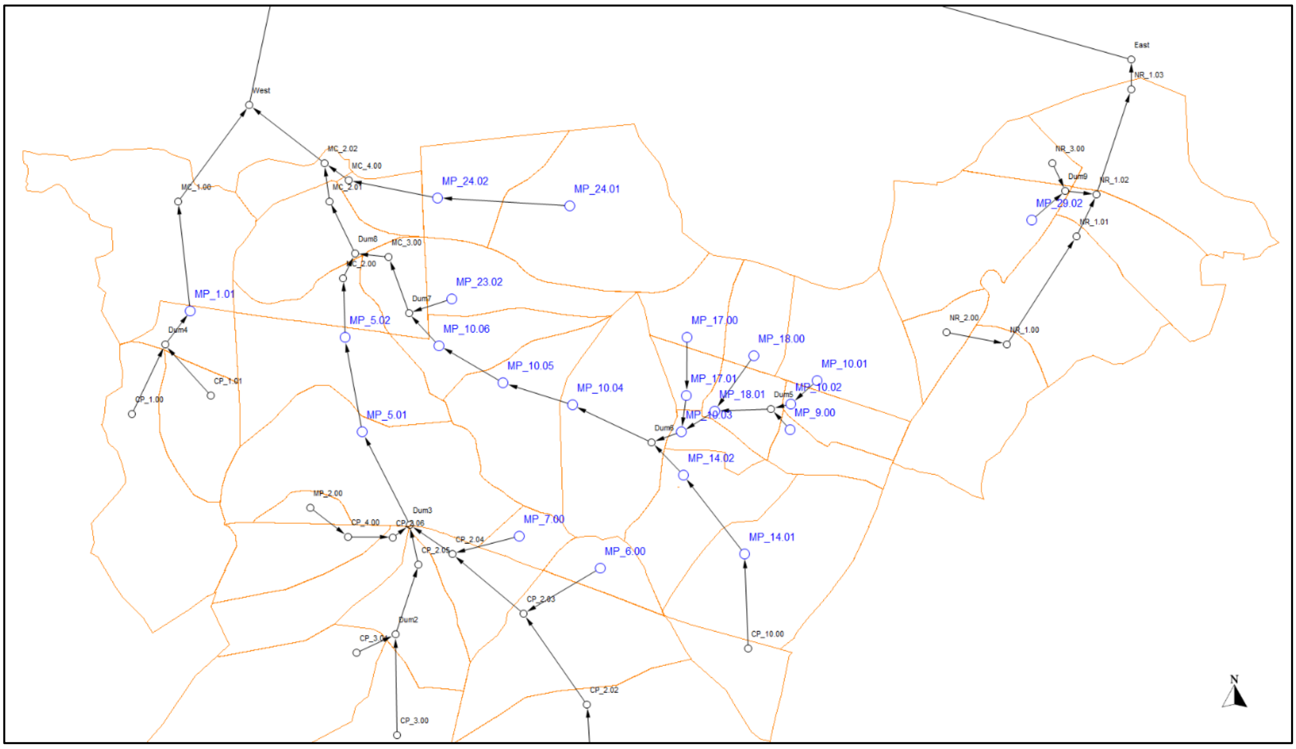

Plate 5-1 – Existing Conditions XP-Rafts Layout

(Ref: 110474_Ex_003.xp)

5.3. Developed Site Conditions

The developed case sub-catchment areas contributing to the drainage system were maintained to be the same as the existing case catchment boundaries outside the site. Developed catchment boundaries within the Glenmore Park Stage 3 site were adjusted to represent the proposed preliminary gradings.

Final catchment boundaries and areas contributing to each detention basin and water quality device will be updated and confirmed as part of future development applications. However, preliminary developed case catchment extents are shown on Figure 5-2.

Model development of the “developed” site conditions included the following assumptions:

- Sub-catchments within the site boundary were updated based on the indicative road network and anticipated regrading of the site.
- In accordance with Council guidelines, a fraction impervious of 80% impervious has been applied to each developed condition catchment across GP3. This is consistent with the fraction impervious for residential development including half road as outlined in Councils ‘Design Guidelines for Engineering Works for Subdivisions and Developments’ (2013). Riparian corridors have been assumed to be 5% impervious and external catchments have been left consistent with existing conditions assumptions.
- Developed lag links have generally been kept consistent with existing lag assumptions in the creek lines. An increase flow velocity of 1.5 – 2.5 m/s dependant on the grade of the sub-catchment has been applied for developed subdivision catchments.

It is noted that portions of the northern Vianello catchments have been diverted to the east, along the internal landholder boundary, to be managed in consolidated detention basin VB4. This allows for the delivery of total flow from these catchments to be at or below existing conditions levels at the site, corridor and landholder boundaries. To achieve this, minor (piped) flows are proposed to be delivered south across the landholder boundary into Mirvac's portions of the development at existing flowrates up to the likely street drainage capacity. All flows in excess of the existing condition flow regime are diverted for detention management.

A catchment diversion has also been adopted at the southern boundary of the site and involves diverting catchments MP_6.00 and MP_7.00 (see Figure 5-2) to the corridor to the west. The proposed culvert in this area will be required to cater for approximately 4-5 m³/s of flow and will be in the order of a 1.5 m x 1.2 m box culvert. Further details of this arrangement and hydraulic modelling can be provided at the detailed design stages of the development.

Refer to Plate 5-2 for the developed model layout.

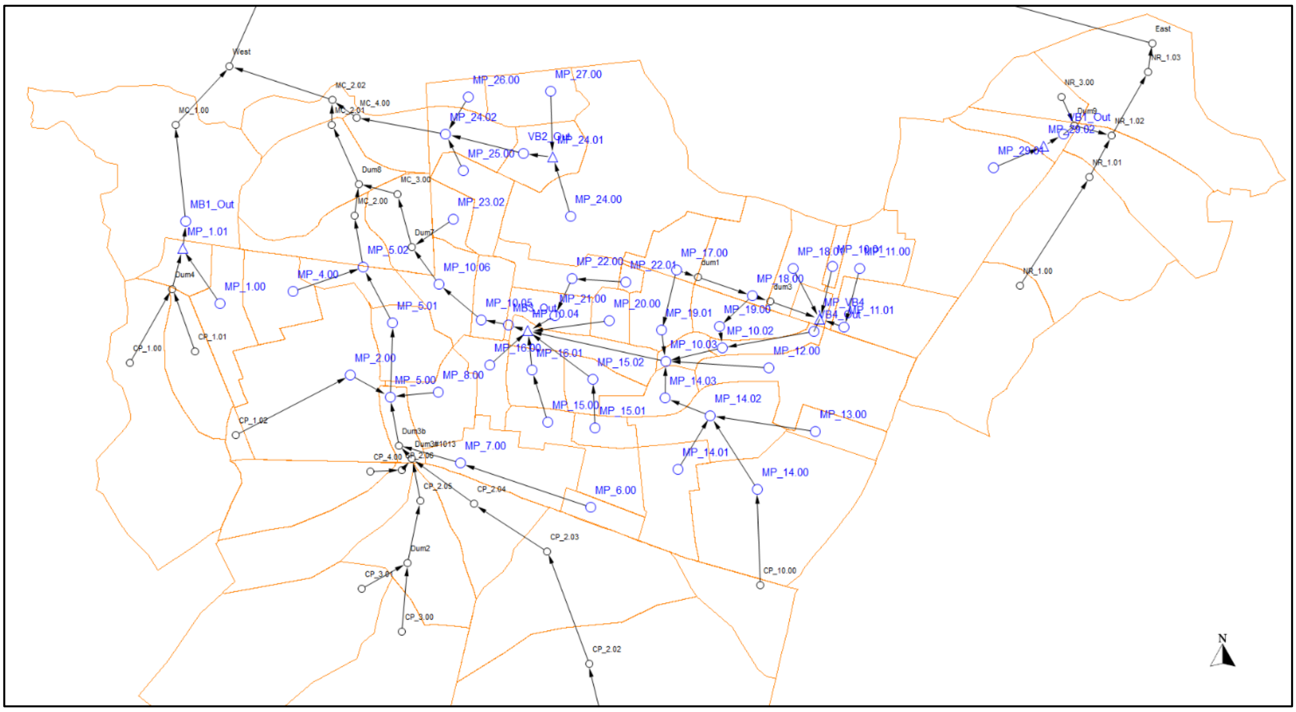

Plate 5-2 – Developed Conditions XP-Rafts Layout

(Ref: 110474_Dev_004.xp)

5.4. Proposed Detention Basins

Five (5) detention basins are proposed within the Glenmore Park Stage 3 Planning Proposal development to attenuate stormwater runoff discharging from the site. The proposed detention basins will adopt outlet arrangements suitable to ensure that at the discharge locations from the site, peak flows under developed conditions are equal to or less than existing conditions for both the 20% and 1% AEP storm events.

For the proposed locations of the detention basins and the flow comparison locations, refer to Plate 5-3. For further detail of the indicative arrangement of the basins refer to the Water Cycle Management Plan, (Figure 1-1) or the concept plans in Appendix A.

Four (4) detention basins are proposed to be "wet" detention basins located over permanent waterbodies within the site to enhance the local amenity and assist in the management of the "urban heat effect". The other (1) "dry-bed" detention basin is proposed as part of the Water Cycle Management Strategy and will provide passive open space for the community.

It is also noted that the surrounding road drainage network will be required to be designed to allow for minor (piped) flows and major (overland) flows to drain to the basins.

Basins that have been concept designed have been represented in the model using stage-storage relationships derived from 12d design modelling. Basins without concept designs have been represented using a storage applied at a maximum detention depth of 1-1.5 m for the 1% AEP storm event. Custom stage-discharge relationships have been derived for each basin to ensure flow management is achieved.

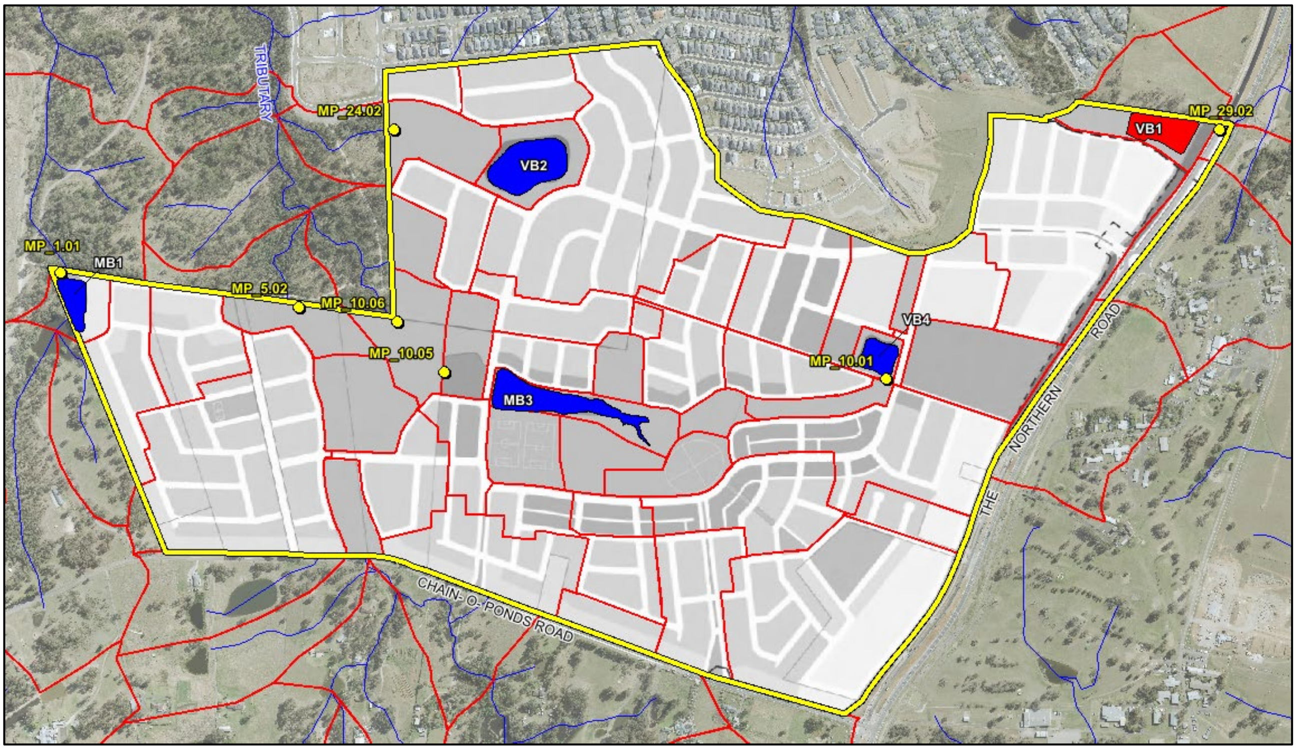

Plate 5-3 – XP-Rafts Comparison Locations

5.5. Results

Discharge estimates were derived for both the “existing” and “developed” catchments for the 20% AEP and 1% AEP events. A range of storm durations from 10 minutes to 24 hours were analysed to determine the peak mean duration/temporal pattern consistent with ARR 19 methodologies. Table 5-3 below shows a comparison between “existing” and “developed” peak flows at each of the key comparison locations shown on Plate 5-3.

It is noted that a number of local sub-catchments in the Glenmore Park Stage 3 site will discharge undetained across the site boundary into Mulgoa Nature Reserve land. Although this will increase local sub-catchment flows, peak flows at the discharge locations of the site to Mulgoa Creek Tributary will not increase.

Table 5-3 – Peak Mean Flow Estimates

Comparison Node	ARR 2019					
	20% AEP			1% AEP		
	Existing Flow (m³/s)	Developed Flow (m³/s)	Dev/Ex	Existing Flow (m³/s)	Developed Flow (m³/s)	Dev/Ex
MP_1.01	1.81	1.52	0.84	6.02	6.00	1.00
MP_5.02	13.63	11.69	0.86	36.58	34.93	0.95
MP_10.01	0.86	0.83	0.97	2.49	2.46	0.99
MP_10.05	6.03	6.05	1.00	19.45	19.02	0.98
MP_10.06	6.29	6.17	0.98	20.99	19.22	0.92
MP_24.02	2.01	1.95	0.97	6.41	6.19	0.97
MP_29.02	0.91	0.84	0.93	3.08	2.90	0.94

Table 5-4 below includes a summary of the detention volumes required at each basin to ensure that developed flows do not exceed existing flows. Refer to Plate 5-3 for basin locations.

Table 5-4 – Summary of Detention Volumes

Basin	Storage Required (m³)	Stage Used (m)
MB1	2,140	1.03
MB3	15,620	1.56
VB1	4,960	1.10
VB2	9,890	0.99
VB4	6,140	1.02

Further detailed modelling of these basins will be undertaken to support any future Development Application (DA) to Council.

5.6. Discussion of Modelling Results

Results of the hydrological modelling show that the proposed five (5) detention basins within the development site will ensure that post-development flows do not exceed existing flows at the key comparison locations for events up to and including the 1% AEP storm event.

The modelling, therefore, demonstrates that the proposed stormwater management strategy supports the proposed planning proposal and will ensure that there are no adverse impacts upon surrounding properties. The modelling of the basin outlets will be optimised at the future detailed design stages to provide more efficient water quantity management outcomes while still achieving pre-post flow targets.

6. HYDRAULIC MODELLING

A fully dynamic one and two dimensional (1D/2D) hydraulic model has been prepared to inform the flood impact assessment for Glenmore Park Stage 3. The TUFLOW modelling is used to confirm the basin performance of the “online” basin MB3 and ensure there are no impacts of the proposed development to the neighbouring environment. The 20% AEP, 1% AEP and PMF events were modelled for the critical peak mean storm durations as determined in the hydrological model.

6.1. Available Data

The following data was used to inform the modelling:

- Hydrology models (XP-Rafts) prepared for this Water Cycle Management Strategy using ARR 2019 methodologies;
- Digital Elevation Model (DEM) obtained from the NSW Government Spatial Services website;
- Detailed site survey for the existing creeks within the Mirvac portion of the site;
- Design information for the RMS upgrade of the Northern Road, including culvert crossing sizes and DEM;
- Approximate road crossing information at Chain O Ponds Road obtained via ground truthing during a site inspection;
- Preliminary gradings prepared by ADW Johnson (for the Mirvac landholdings) and J. Wyndham Prince (for the Vianello landholdings);
- Concept designs for key stormwater infrastructure within the site;
- Aerial imagery for the site recorded by MetroMap, 2021.

6.2. TUFLOW Model Development

The hydraulic (TUFLOW) model has been developed to assess the behaviour and extent of flooding in the vicinity of GP3. A map showing the main features adopted in the TUFLOW model is provided in Figures 6-1 (existing conditions) and 6-2 (developed conditions) in Appendix B. The assessment has been undertaken using the 2020-10-AB TUFLOW build using the heavily parallelised computation (HPC) methodology.

6.2.1 Model Domain

The model extent encompasses the development and contributing catchments to the south and extends into Mulgoa Nature Reserve in the west and beyond The Northern Road in the east where the subject site discharges.

6.2.2 Grid Size

A grid size of 3 m x 3 m was adopted for the purpose of this assessment. This resolution of the model grid provides a balance between an accurate definition of the catchment and minimises model run times. Given the intent of the flood modelling, a 3 m x 3 m cell size is considered fit for purpose for this rezoning assessment.

6.2.3 Terrain

The underlying digital elevation model (DEM) is based on LiDAR data captured in 2019 by NSW Government Spatial Services and detailed site survey obtained for the creeks and dams within Mirvac’s landholdings. This was combined with design data of the RMS The Northern Road upgrade, forming the 'existing surface'.

The preliminary design surfaces and concept designs were added to the 'existing surface' to form the 'design surface'.

6.2.4 Material Roughness

Material roughness parameters have been set up in the model based on cadastral boundary information in the catchment and aerial imagery. Pervious open space areas have been divided based on the density of vegetation present and farm dams have been assumed to contain permanent water to the spillway levels. Rural buildings have also been represented with a higher manning's to reflect the obstructions to flow.

Under developed conditions, the urban residential areas have been divided into lots and road corridors to provide the level of detail necessary for the purposes of this assessment. For details of the adopted roughness values refer to Table 6-1 below. A map showing materials roughness adopted in the TUFLOW model is provided in Figure 6-3 and 6-4 in Appendix B.

Table 6-1 – Material Roughness, 'n', Parameters

Mannings Roughness, n	Landuse
0.3	Residential areas – high density
0.1	Residential areas – low density
0.3	Industrial/commercial
0.035	Open pervious areas, minimal vegetation (grassed)
0.06	Open pervious areas, moderate vegetation(shrubs)
0.1	Open pervious areas, thick vegetation (trees)
0.03	Waterways/channels – minimal vegetation
0.045	Waterways/channels – vegetated
0.015	Concrete lined channels
0.02	Paved roads/car park/driveways
0.02	Lakes (no emergent vegetation)
0.06	Wetlands (emergent vegetation)
0.02	Estuaries/Oceans

6.2.5 Flow Hydrographs and Boundary Conditions

Flow hydrographs extracted from the XP-RAFTS hydrological model were applied to represent flows entering the model from local catchments within the model extent. The peak mean flows at critical locations throughout the site have been examined to determine a suitable suite of durations and temporal patterns to assess in the model. The adopted durations and temporal patterns are summarised in Table 6-2 below.

Table 6-2 – Modelled Events, Durations and Temporal Patterns

Event	Duration	Temporal Pattern
20% AEP	60 min	8
	120 min	6
	120 min	8
	360 min	10
1% AEP	45 min	6
	45 min	8
	60 min	2
	60 min	8
PMF	15 min	GSDM method adopted
	30 min	
	45 min	
	60 min	

Flow hydrographs have been applied as "Source Area" (SA) inputs and flow versus time (QT) inflow boundaries.

Under existing conditions, it should be noted that total hydrographs have been applied in the creek upstream of basin MB3 and in the creek downstream of basin MB1. This is to remove the influence of passive storages and attenuation that the large existing farm dams provide in both the south eastern portion of the site (downstream of Chain O Ponds Road) and in the western corner of the site (at MB1).

Under developed conditions, basin outflows are applied downstream of each basin to reflect the attenuation that has been modelled in the hydrological model. The exception to this is basin MB3 which has been modelled in the TUFLOW model with an appropriately sized outlet arrangement. A total hydrograph has also been used to represent the delivery of flows to the main corridor to the west of catchments MP_6.00 and MP_7.00 via a culvert arrangement as detailed in Section 5.3.

A water level versus flow (HQ) downstream boundary with a 1% slope was used as the downstream boundary of the model.

6.2.6 Initial Water Level

Farm dams throughout the model extent have been assumed to be at full supply level at the beginning of the storm events to reflect antecedent rainfall in the catchment.

6.2.7 Pipe (1D) Networks

1D Pipe Networks have been used within the model to reflect the various road crossings at Chain O Ponds Road and The Northern Road. Culvert sizes at Chain O Ponds Road have been obtained via ground truthing during a site visit while culvert sizes at The Northern Road have been obtained from RMS design plans (GHD, 2017).

In addition to road crossings, the basin MB1 and MB3 outlets (in the developed conditions) have been modelled using a 1D network arrangement and has been sized to match the outlet that informed the hydrology modelling. A 1D network has also been used to convey flows from catchment CP_10.00 (see Figure 5-2) through the proposed development.

6.3. Discussion of Results

6.3.1 Existing Scenario Flood Behaviour

The existing condition flood depth and level results for the 20% AEP, 1% AEP and PMF event are shown on Figures 6-5, 6-8 and 6-11 in Appendix B respectively. The 20% and 1% AEP flood extents are generally similar, with flows appearing well contained within the existing well-defined watercourses.

In 20% AEP event (Figure 6-5), flood depths within the watercourses both within and upstream of the site are generally in the order of 0.5 m to 1.0 m, and greater than 2 m within existing farm dams online to the main watercourses. In the lower reaches, flood depths generally up to 1.0 m are observed in the main water courses in the 20% AEP event, with isolated pockets of flood depth greater than 2.0 m.

In 1% AEP event (Figure 6-8), flood depths within the watercourses both within and upstream of the site are generally similar to the 20% AEP event, however isolated of flood depths in the order of 1.0 m to 2.0 m are now observed. In the lower reaches, flood depths generally up to 2.0 m are observed in the main water courses, increasing to greater than 2.0 m toward the model outlet.

Based on site observations and available lidar data, it appears that the existing 2 x 1800 mm RCP crossing of Chain of Ponds Road (upstream of the future western channel) hold permanent water due to the embankment of a downstream dam being higher than the culvert inverts.

The PMF flood extents shown in (Figure 6-11) are much broader than the 1% AEP event, however it is noted that flows are contained within well-defined watercourses. Broadscale flood depths in the order of 1.0 to 2.0 m occur in the upper reaches, and greater than 2.0 m in the lower reaches which are to be expected in this extreme event.

6.3.2 Developed Scenario Flood Behaviour

The developed conditions flood depth and level results for the 20% AEP, 1% AEP and PMF event are shown on Figures 6-6, 6-9 and 6-12 in Appendix B respectively. Flood extents external to the site are generally consistent with existing conditions.

In 20% AEP event (Figure 6-6), flood depths within the channel in the western portion of the site are generally in the order of 0.5 m to 1.0 m, with isolated pockets of flood depth greater than 1.0 m. Flood depths in the main corridor upstream of Basin MB3 range from 0.1 m to 2.0 m in deeper existing pools.

In 1% AEP event (Figure 6-9), flood depths within the channel in the western portion of the site are generally in the order of 1.5 m. Flood depths in the main corridor upstream of Basin MB3 are generally similar to the 20% AEP event, however the extent of deeper water is slightly increased. A pipe system reflects flow from upstream catchments to the south of the site safely conveyed through the development to the main corridor, with no overland flow observed.

In the PMF event (Figure 6-12), flood depths greater than 2.0 m are observed within the main corridor and western channel, with some encroachment on perimeter roads and lots evident. It is noted that the preliminary trunk pipe system (2 x 1200 mm RCPs) through the south-eastern portion of the site appears to have PMF capacity, as no flows are evident on the subdivision. However, the future drainage design will need to carefully consider the practicality of pit depths and capacities. A balance may need to be found between managing some PMF flow in a pipe and some safe overland flow through the street drainage network in the south eastern portion of the site to the main corridor.

It is important to note that a climate change assessment has not been undertaken at this stage. However, given that the PMF is generally well contained within the corridor, it is anticipated that a 1% AEP climate change scenario is unlikely to affect the proposed lots greater than PMF event affectation.

6.3.3 Flood Impact Assessment

Flood difference mapping for the 20% and 1% AEP event are shown on Figures 6-7 and 6-10 in Appendix B respectively.

Generally, there are no flood impacts external to the site in the 20% and 1% AEP events. There are some minor localised flood level increases (within the existing extents of flooding) that can be seen downstream of basin VB2 in the 20% AEP event. There are also some minor flood impacts downstream of basin MB3 in the 1% AEP event which stretch into the Mulgoa Nature Reserve downstream of the site. In both situations, the flood level increases are in the order of 20-40mm and dissipate once the flows reach the confluence with the main Mulgoa Creek Tributary. Further modelling will need to be undertaken during the post exhibition / development application phase of the project to ensure that these minor impacts are mitigated.

Local flood level increases due to the proposed development upstream of basins within the site are to be expected, as are areas along the western channel where existing flooded areas are now lifted and still wet (i.e., the design flood depths are appropriate, the flood level increase is due to a surface amendment).

6.3.4 Flood Hazard

The 20% AEP existing and developed flood hazard mapping shown of Figures 6-13 to 6-18 indicate that there are no adverse changes in Flood Hazard external to the site in all modelled events. Within the site, high hazard up to a H6 category (unsafe for people, vehicles and buildings) are evident within the watercourses and basins, which is to be expected. Appropriate flood warning signage will need to be provided in these areas as part of the future construction designs of these areas/devices.

7. WATER QUALITY ASSESSMENT

7.1. Modelling Inputs and Assumptions

MUSIC modelling for GP3 has been undertaken using MUSIC 6.3. The modelling has considered the Penrith City Council WSUD Technical Guidelines (PCC, 2020) and Council Standard Engineering Guidelines.

The MUSIC model catchments have been split into various source nodes (i.e. roof, road, urban pervious and impervious) and the details on the catchment area and land use assumptions are provided in Appendix D.

The pollutant reduction targets for this development are detailed in Table 7-1 below as depicted in PCC's WSUD Technical Guidelines.

Table 7-1 – Pollutant Reduction Targets

Pollutant	Reduction Targets
Gross Pollutants	90%
Total Suspended Solids (TSS)	85%
Total Phosphorus (TP)	60%
Total Nitrogen (TN)	45%

The MUSIC modelling has assumed the following in the determination of the results:

- The proposed development has a lot mix of normal and medium density residential. As outlined in PCC's Standard Engineering Guidelines, these lot types have an overall impervious percentage of 75% and 85% respectively.
- Roof areas for normal lots are assumed to cover 60% of the lot area.
- Roof areas for medium density lots are assumed to cover 75% of the lot area.
- Commercial areas - 100% impervious.
- Road reserve - 95% impervious.
- Riparian corridor - 5% impervious.
- Active open space - 50% impervious.
- Passive open space - 10% impervious.
- School - 75%.
- It is understood that the average R2 lot size across GP3 is approximately 400 m². As such, it has been assumed that all R2 lots will have rainwater tanks. It is understood that the average R3 lot size will be only 200 m², therefore, rainwater tanks have not been modelled for the R3 lots.
- Normal lots that have rainwater tanks are assumed to capture 50% of the roof area with the other 50% to bypass.
- It is assumed that commercial areas will provide on-lot treatment which has been modelled using a generic treatment node set to achieve reduction targets locally. The ultimate treatment train can be determined as part of a future development application.

Further details on the assumed parameters are provided in Appendix D.

7.2. Water Quality Management Measures

It is proposed that stormwater quality in the GP3 precinct be managed using a treatment train approach. A proposed treatment train of water quality devices has been identified to achieve the target pollutant removals. This includes a combined system of rainwater tanks, Gross Pollutant Traps (GPT), bio-retention raingardens and permanent water bodies (ponds). The proposed treatment train consists of:

- Rainwater harvesting and re-use of residential roof runoff of by utilising on-lot rainwater tanks;

- Rainwater harvesting and re-use of catchment flows discharging to the proposed sporting fields;
- On-lot treatment for commercial lots;
- Gross Pollutant Traps (GPT) to pre-treat runoff prior to discharge into bioretention raingardens and ponds;
- Bioretention Raingarden which will receive flows from the GPTs; and
- Permanent water bodies (ponds) which will receive flows from the GPTs.

The indicative location of bioretention raingardens, ponds and other key devices are shown in Figure 7-1 in Appendix B.

7.2.1 Rainwater Tanks

On-lot rainwater tanks were modelled for the development based on the following design assumptions:

- All normal residential (R2) lots are assumed to have a rainwater tank;
- 50% of the roof areas from these lots will be captured by the rainwater tanks;
- 3.0kL rainwater tanks will be provided on each lot, with 2.4kL re-usable storage above top-up.
- Rainwater tank re-use of 0.10kL/day internal use and 50kL/year as PET-Rain (in accordance with PCC WSUD Technical Guidelines, 2020).

Additional details on the rainwater tank sizing are provided in Appendix D. It is noted that any OSD that the rainwater tanks may provide have been ignored in the formal OSD modelling assessment detailed in Section 5.

A rainwater storage tank is also proposed to be located at the proposed sporting fields to capture stormwater runoff to be reused for irrigation. This tank assumed the following design assumptions:

- 1000 kL storage capacity;
- 25 mm/week irrigation demand.

7.2.2 Gross Pollutant Traps

The GPTs have been provided to filter stormwater prior to discharge into the drainage system, bioretention raingarden devices and ponds. The expected pollutant removal rates adopted within the model is provided in Table 7-2. A generic vortex style GPT node has been adopted in MUSIC to provide flexibility in the detailed design and allow for a specific product to be selected at a later stage. The GPT node has adopted a reduction in gross pollutants, total phosphorus (TP), total suspended solids (TSS) and no additional removal of total nitrogen (TN). For the purposes of achieving the water quality targets, it has been assumed in the MUSIC model that the GPTs are located upstream of the bioretention raingarden and ponds.

Table 7-2 - GPT Input Parameters

<table>
<tr><th>Pollutant</th><th>Input</th><th>Output</th></tr>
<tr><td rowspan="3">TSS (mg/L)</td><td>0</td><td>0</td></tr>
<tr><td>75</td><td>75</td></tr>
<tr><td>1000</td><td>300</td></tr>
<tr><td rowspan="3">TP (mg/L)</td><td>0</td><td>0</td></tr>
<tr><td>0.5</td><td>0.5</td></tr>
<tr><td>10</td><td>7</td></tr>
<tr><td rowspan="2">TN (mg/L)</td><td>0</td><td>0</td></tr>
<tr><td>50</td><td>50</td></tr>
<tr><td rowspan="2">Gross Pollutant (kg/ML)</td><td>0</td><td>0</td></tr>
<tr><td>100</td><td>2</td></tr>
</table>

7.2.3 Ponds

Permanent water bodies (ponds) are designed to have permanent water storage that promotes a Hydraulic Residence Time (HRT) of sufficient length to promote the appropriate pollutant removal mechanisms. The ponds are to receive flows having firstly being treated by the GPTs and/or raingarden devices. The design parameters adopted for the ponds are shown in Table 7-3.

Table 7-3 - Pond Input Parameters

Parameters	Permanent Pond ID			
	MB1	VB2	VB4	MB3
Surface Area(sq.m)	2,000	10,000	5,179	6,540
Extended Detention Depth (m)	0.3	0.3	0.3	0.3
Permanent pool volume (cu.m)	2,000	37,000	7,200	7,830
Initial Volume (cu.m)	2,000	37,000	7,200	7,830
Exfiltration Rate (mm/hr)	0.03	0.03	0.03	0.03

7.2.4 Bioretention Raingardens

The bioretention raingardens are to receive and treat the run-off flows through the filter media bed after being firstly treated by the GPT. Numerous bioretention raingardens have been proposed across the development in order to achieve the pollutant reduction targets outlined in PCC's WSUD Technical Guidelines (PCC, 2020). The devices will also attenuate first flush flows to reduce the risk of stream erosion within the watercourse. The design parameters adopted for the bioretention raingardens are shown in Table 7-4.

Table 7-4 - Bioretention Raingarden Input Parameters

Parameters	Raingarden ID								
	RG A	RG B	RG C	RG D	RG E	RG F	RG G	RG H	RG J
Low flow by-pass (cu.m/s)	0	0	0	0	0	0	0	0	0
High Flow by-pass (cu.m/s)	100	100	100	100	100	100	100	100	100
Extended Detention Depth (m)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Filter Area (sq.m)	400	200	2,000	1,100	4,000	720	500	1,000	1,500
Saturated Hydraulic Conductivity (mm/hr)	125	125	125	125	125	125	125	125	125
Filter Depth (m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
TN Content (mg/kg)	800	800	800	800	800	800	800	800	800
Orthophosphate Content (mg/kg)	40	40	40	40	40	40	40	40	40
Exfiltration Rate (mm/hr)	0	0	0	0	0	0	0	0	0
Base Lined	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Underdrain Present	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Submerged Zone	No	No	No	No	No	No	No	No	No

7.3. Modelling Results

The proposed treatment train devices have ensured the pollutant reduction targets that are detailed in PCC's WSUD Technical Guidelines (PCC, 2020) have been achieved. A summary of the MUSIC model results at the total receiving node of the model are provided in Table 7-5.

Table 7-5 - Summary of MUSIC Model Results

Pollutant	Total Developed Source Loads	Total Residual Load from Site	Total Reduction Achieved	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(kg/yr)	(%)	(%)
TSS	135000	18900	116100	85.0%	86.0%
TP	266	83.9	182	60.0%	68.5%
TN	1880	869	1011	45.0%	53.8%
Gross Pollutants	22400	208	22192	90.0%	99.1%

(Ref: 110474-02-MU02.sqz)

Key reporting locations have also been assessed at the discharge points of the site to ensure that pollutant reduction targets are being achieved downstream of each treatment train. Further details of these results can be found in Appendix D. Refer to Plate 7-1 for context of MUSIC reporting locations, raingardens and catchments and Figure 7-1 in Appendix B for further detail.

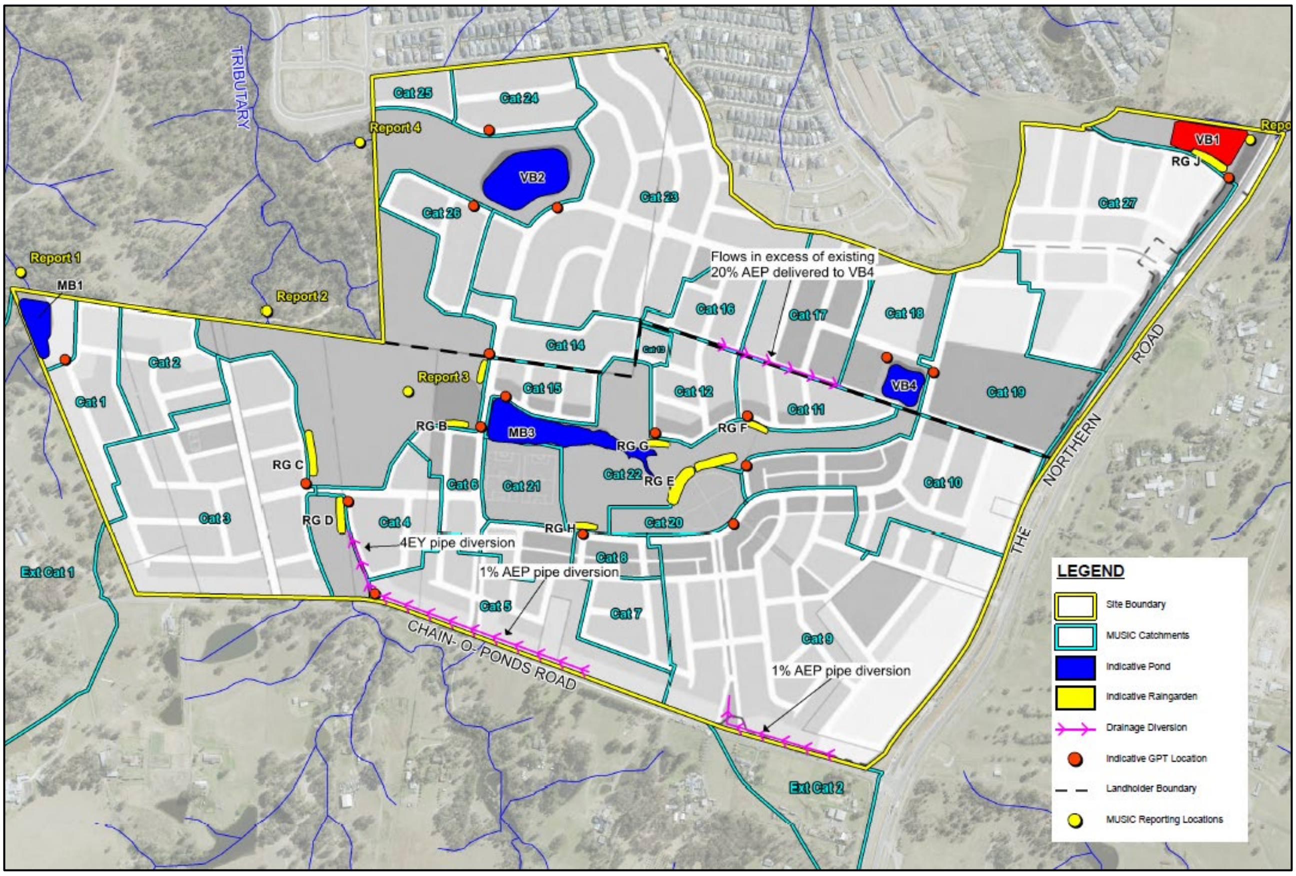

Plate 7-1 – MUSIC Catchments and Reporting Locations

7.4. Stream Erosion Index

The stream erosion index (SEI) assessment has been undertaken as outlined in PCC's WSUD Technical Guidelines (PCC, 2020). The SEI assessment is to ensure that the duration of post-development stream forming flows are no greater than 3.5 times the duration of the pre-development stream forming flows. The methodology to determine the SEI complies with the NSW MUSIC Modelling Guidelines (2015).

A rural residential source node has been used to represent the site under existing conditions. The flows for the existing and developed conditions have been calculated (refer to Table 7-6) and a SEI at each discharge location was determined. A summary of the SEI assessment and results are provided in Table 7-7.

Table 7-6 – Determination of Stream Forming Flow

	Determination of Critical Flow						
Assessment Location	Area (km^2)	$t_c = 0.76A^{0.38}$ (hour)	t_c (minutes)	I_2 (mm/hr)	C_2	Q_2 (m^3/s)	Q_{crit} (m^3/s)
Report 1	0.29	0.48	29	44.0	0.44	1.58	0.79
Report 2	0.33	0.50	30	43.5	0.44	1.75	0.87
Report 3	1.03	0.77	46	35.2	0.44	4.47	2.24
Report 4	0.29	0.47	28	44.0	0.44	1.57	0.79
Report 5	0.15	0.37	22	51.1	0.44	0.97	0.48

Table 7-7 – SEI Results Summary

Assessment Location	Stream Erosion Index		
	Pre Dev Outflow (ML/yr)	Post Dev Outflow (ML/yr)	SEI
Report 1	5.03	4.90	1.0
Report 2	5.71	13.50	2.4
Report 3	21.60	23.80	1.1
Report 4	4.98	5.21	1.0
Report 5	2.29	5.08	2.2

7.5. Permanent Water Body Management Strategy

The concept design plans in Appendix A, which include permanent water bodies (ponds) MB1, MB3 and VB4, have been designed to consider the Royal Life Saving Guidelines (2004) and should ensure the safety of anyone who may enter them.

Algal management is a key consideration to ensure the pond water remains clean, clear and healthy. Waterbodies particularly throughout Western Sydney can become thermally stratified when two (2) distinct temperature layers form. In the summer months, algal blooms often occur in the warm stable conditions of the upper layer. Increasing the movement of water that circulates between the shallower and deeper layers of the pond reduces the difference in temperature, oxygen and nutrients between the two layers. An aerator can be used within the pond to achieve the required water circulation and can also add an additional aesthetic appeal to the area. The high pumping rate/circulation rate of an aerator breaks down the thermal stratification, mixing the cooler deep-water layer with the warmer surface water layer. This in turn distributes oxygen to all parts of the lake which assists in the breakdown of the algae chain. To determine the recommended number of aeration units for a pond, the general sizing guideline is 1.5HP per 4000m^2 is suggested.

A depiction of a water aeration device that can be used within each pond is provided in Plate 7-1.

Plate 7-2 - Aeration Device

Source: www.otterbineaustralia.com.au

7.6. Construction Stage

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

Bioretention raingardens are well known to be sensitive to the impact of sedimentation. Hence, various sediment control devices and basins will need to be implemented during the construction phase. The bioretention raingardens should only be constructed when the majority of the works (approximately 80%) are complete.

7.7. 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 recommended that a site-specific operation and maintenance manual is prepared for the long-term management of the treatment devices. The manual will provide site specific management procedures for:

- Management of the bioretention raingarden including the plant monitoring, replanting guidelines, monitoring and replacement of the filtration media and general maintenance (i.e. weed control, sediment removal).
- Management of permanent water systems including replanting guidelines. A separate algal control strategy may be needed in order to ensure the long-term viability of the waterbodies.
- Maintenance of the GPT devices including rubbish and sediment removal.
- Indicative costing of maintenance over the life of the device.

8. GLOSSARY

Term	Definition
Airborne Laser Survey (ALS)	Is a technique for obtaining a definition of the surface elevation (ground, buildings, power lines, trees, etc.) by pulsing a laser beam at the ground from an airborne vehicle (generally a plane) and measuring the time taken for the laser beam to return to a scanning device fixed to the plane. The time taken is a measure of the distance which, when ground-truthed, is generally accurate to ± 150mm.
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.
Dam Crest Flood (DCF)	The flood event where a dam embankment is first overtopped.
Dam Safety Committee (DSC)	A NSW statutory body aligned with Department of Primary Industries. Its function is to ensure the safety of dams within NSW.
Digital Terrain Model (DTM)	Is a spatially referenced three-dimensional (3D) representation of the ground surface represented as discrete point elevations where each cell in the grid represents an elevation above an established datum.
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.
Floodplain Storage Areas	Parts of a floodplain that are important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.
Floodway	The areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Hyetograph	The distribution of rainfall over time.
Hydrograph	Is a graph that shows how the stormwater discharge changes with time at any particular location.

Term	Definition
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
Potential Loss of Life (PLL)	Potential Loss of Life assessment
Population at Risk (PAR)	Population at risk assessment
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.
Triangular Irregular Network (TIN)	A technique used in the created DTM by developing a mass of interconnected triangles. For each triangle, the ground level is defined at each of the three vertices, thereby defining a plane surface over the area of the triangle
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

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Penrith City Council, 2020, 'Stormwater Drainage Guidelines for Building Developments'

APPENDIX A – CONCEPT DESIGN PLANS

PLAN
SCALE 1:5000

1:5000 (AT A1)
1:10000 (AT A3)
100 50 0 50 100 150 200 250 300 350 400 450 500
METRES

DRAFT ISSUE ONLY
PRELIMINARY DESIGNS SUBJECT TO CHANGE

	AMENDMENT	DES	DRN	CKD	APR	DATE
C	ADDED MB1 TO LOCALITY PLAN	CC/JCA	CC/JCA	DC	DC	12/04/22
B	ISSUE FOR REVIEW	CC/JCA	CC/JCA	DC	MS	08/04/22
A	ISSUE FOR REVIEW	CC/JCA	JCA/NM	DC	MS	22/12/21

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GP3 MULGOA PLANNING PROPOSAL
BASIN AND RAINGARDEN CONCEPT

LOCALITY PLAN & INDEX

PROJECT No: 110474-02
SHEET No: SK100

AZIMUTH: M.G.A. | DATUM: A.H.D. | ORIGIN: | PLAN No: 110474-02-SK100 | C

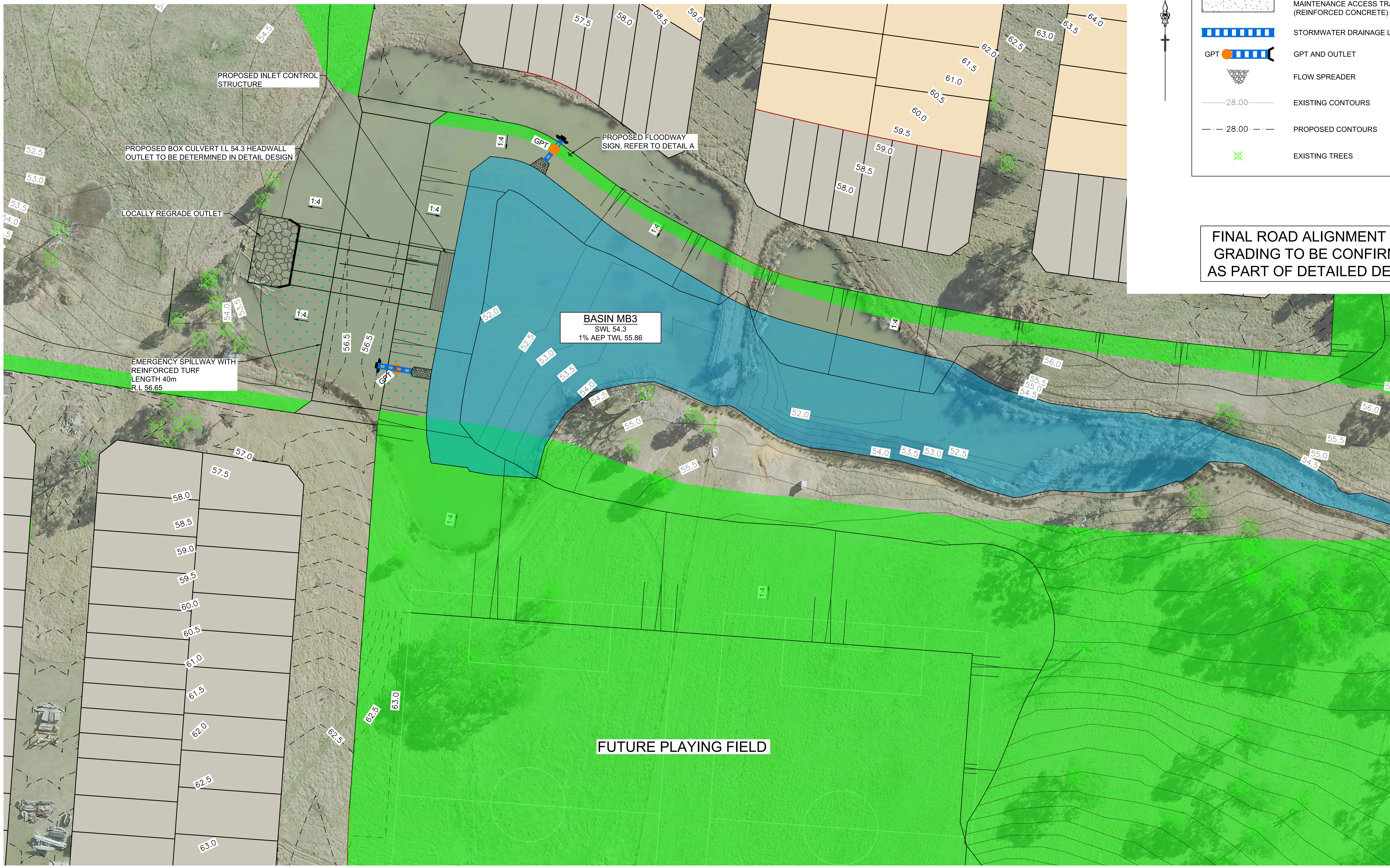
Plotted: 13 April , 2022 6:19:39 PM File Name: J:\110474 - Mulgoa Planning Proposal\CD\SK\110474-02-SK100.dwg

BASIN SUMMARY TABLE	
BASIN NAME	MB3
POND STORAGE (m^3)	7,830

LEGEND

- ROCK SCOUR PROTECTION
- PERMANENT WATER
- MAINTENANCE ACCESS TRACK (REINFORCED CONCRETE)
- STORMWATER DRAINAGE LINE
- GPT — GPT AND OUTLET
- FLOW SPREADER
- 28.00 — EXISTING CONTOURS
- 28.00 — PROPOSED CONTOURS
- EXISTING TREES

FINAL ROAD ALIGNMENT AND GRADING TO BE CONFIRMED AS PART OF DETAILED DESIGN



PLAN
SCALE 1:500

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

DETAIL A
FLOODWAY SIGN
NTS

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PRELIMINARY DESIGNS SUBJECT TO CHANGE

	AMENDMENT	DES	DRN	CKD	APR	DATE
C	ADDED MASTERPLAN HATCH & AERIAL	CC/JCA	CC/JCA	DC	DC	12/04/22
B	ISSUE FOR REVIEW	CC/JCA	CC/JCA	DC	MS	08/04/22
A	ISSUE FOR REVIEW	CC/JCA	JCA/NM	DC	MS	22/12/21

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GP3 MULGOA PLANNING PROPOSAL
BASIN AND RAINGARDEN CONCEPT
DETAIL PLAN MB3

PROJECT No: 110474-02
SHEET No: SK101

AZIMUTH: M.G.A. | DATUM: A.H.D. | ORIGIN: | PLAN No: 110474-02-SK101 | C

Plotted: 13 April , 2022 6:21:46 PM File Name: J:\110474 - Mulgoa Planning Proposal\CD\SK110474-02-SK101.dwg

PLAN
SCALE 1:1000

LEGEND

- ROCK SCOUR PROTECTION
- PERMANENT WATER
- MAINTENANCE ACCESS TRACK (REINFORCED CONCRETE)
- STORMWATER DRAINAGE LINE
- GPT — GPT AND OUTLET
- FLOW SPREADER
- EXISTING TREES

FINAL ROAD ALIGNMENT AND GRADING TO BE CONFIRMED AS PART OF DETAILED DESIGN

1:1000 (AT A1)
1:2000 (AT A3)
20 10 0 10 20 30 40 50 60 70 80 90 100
METRES

DRAFT ISSUE ONLY
PRELIMINARY DESIGNS SUBJECT TO CHANGE

	AMENDMENT	DES	DRN	CKD	APR	DATE
C	ADDED MASTERPLAN HATCH & AERIAL	CC/JCA	CC/JCA	DC	DC	12/04/22
B	ISSUE FOR REVIEW	CC/JCA	CC/JCA	DC	MS	08/04/22
A	ISSUE FOR REVIEW	CC/JCA	JCA/NM	DC	MS	22/12/21

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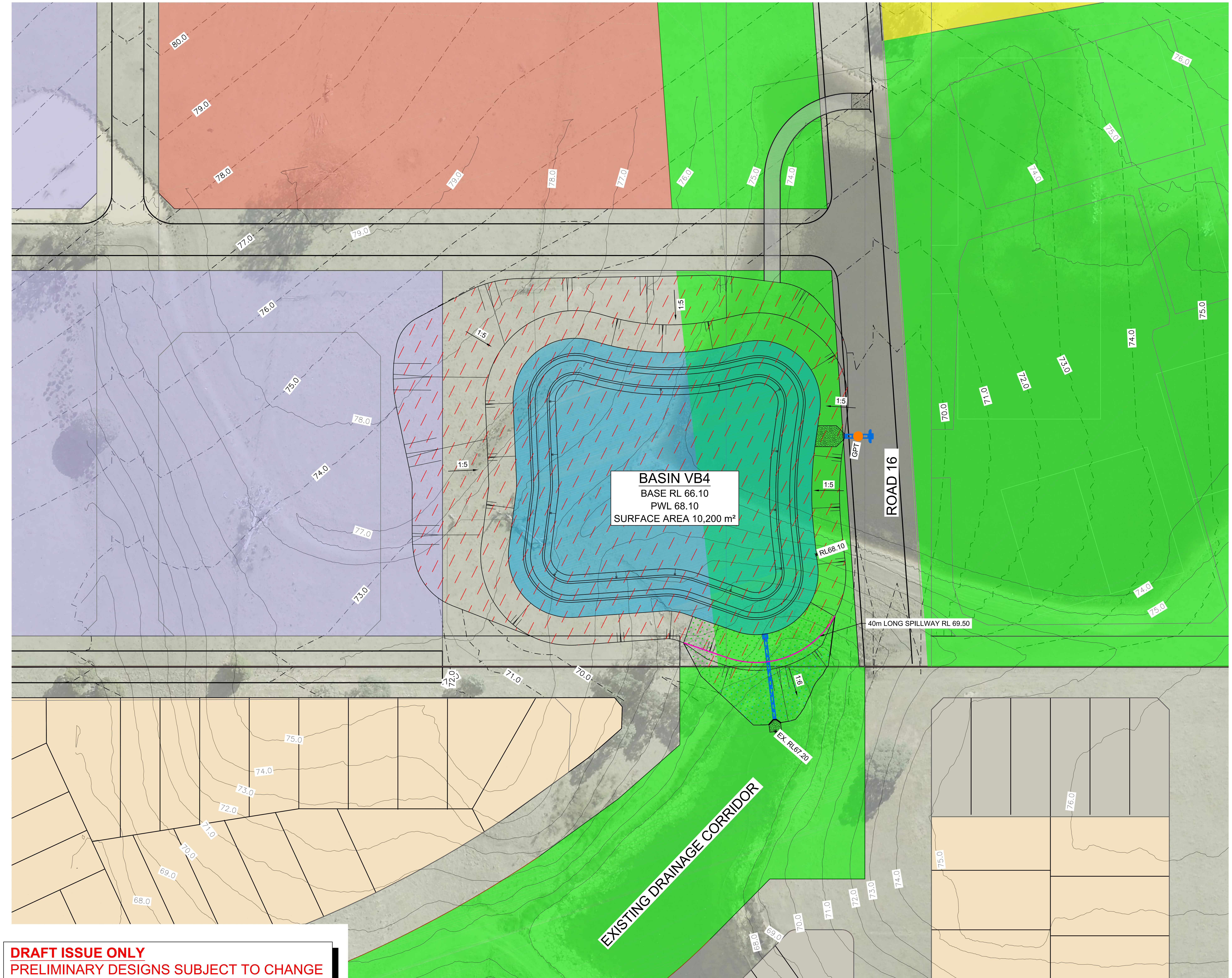
GP3 MULGOA PLANNING PROPOSAL
BASIN AND RAINGARDEN CONCEPT
CHANNEL & RAINGARDEN LAYOUT PLAN

PROJECT No: 110474-02
SHEET No: SK105

AZIMUTH: M.G.A. | DATUM: A.H.D. | ORIGIN: | PLAN No: 110474-02-SK105 | C

Plotted: 13 April , 2022 6:22:23 PM File Name: J:\110474 - Mulgoa Planning Proposal\CD\SK\110474-02-SK105.dwg



LEGEND

- EXTENT OF CUT
- EXTENT OF FILL
- ROCK SCOUR PROTECTION
- 4m WIDE MAINTENANCE ACCESS TRACK (CRUSHED SANDSTONE)
- REINFORCED TURF
- 4m WIDE MAINTENANCE ACCESS TRACK (REINFORCED CONCRETE)
- STORMWATER DRAINAGE LINE
- GPT — GPT AND OUTLET
- FLOW SPREADER
- 60.00 — EXISTING CONTOURS
- 60.00 — PROPOSED CONTOURS

BASIN SUMMARY TABLE	
BASIN NAME	VB4
POND STORAGE (m^3)	8,250

FINAL ROAD ALIGNMENT AND GRADING TO BE CONFIRMED AS PART OF DETAILED DESIGN

1:250 (AT A1)
1:500 (AT A3)
5 0 5 10 15 20 25
METRES

DRAFT ISSUE ONLY
PRELIMINARY DESIGNS SUBJECT TO CHANGE

	AMENDMENT	DES	DRN	CKD	APR	DATE
A	ISSUE FOR REVIEW	CC/JCA	JCA/NM	DC	MS	22/12/21

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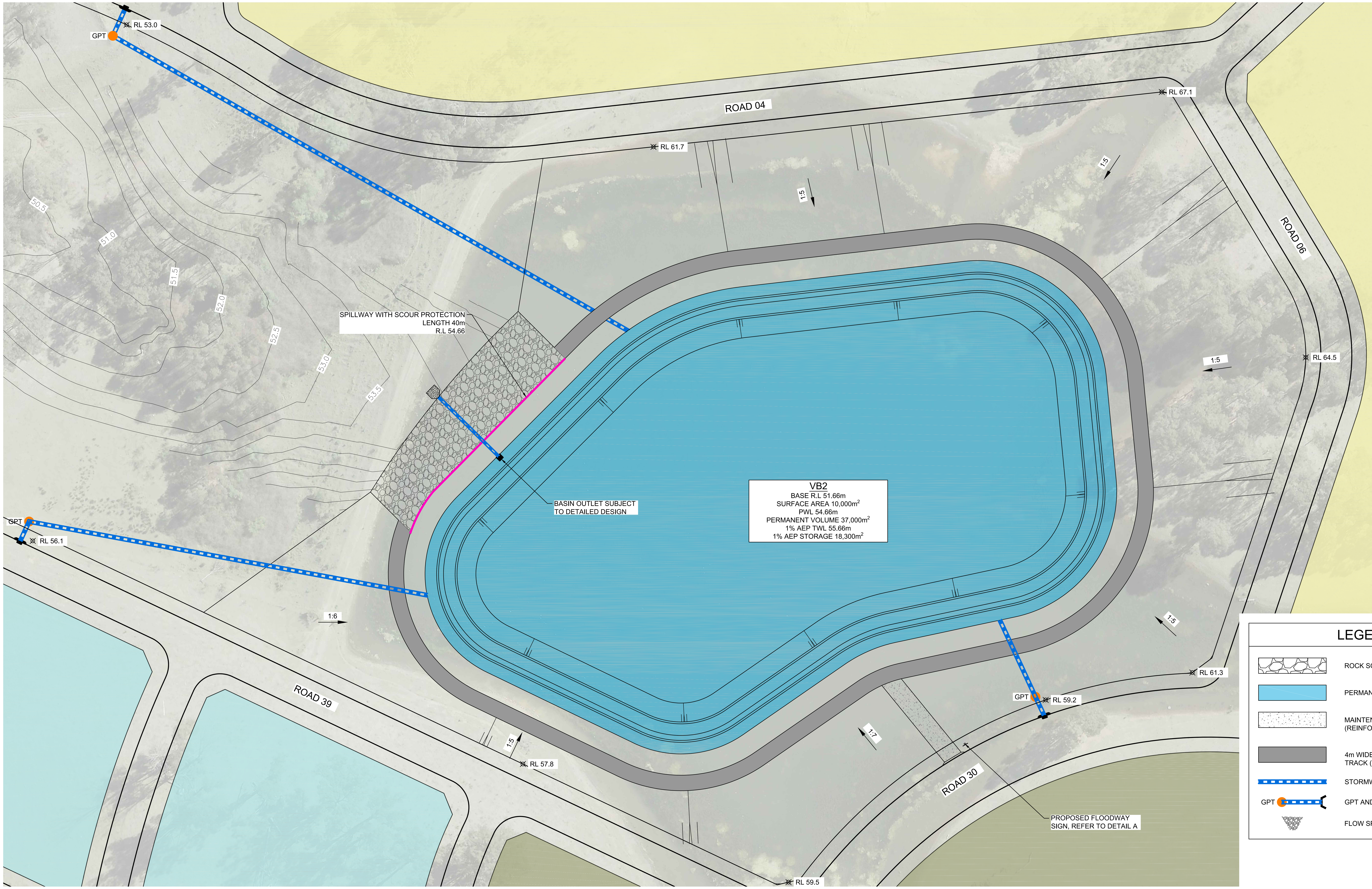
GP3 MULGOA PLANNING PROPOSAL
BASIN AND RAINGARDEN CONCEPT

DETAIL PLAN VB4

PROJECT No: 110474-02
SHEET No: SK111

AZIMUTH: M.G.A. DATUM: A.H.D. ORIGIN:
PLAN No: 110474-02-SK111 A

Plotted: 13 April , 2022 3:12:56 PM File Name: J:\110474 - Mulgoa Planning Proposal\CD\SK110474-02-SK111.dwg



DETAIL A
FLOODWAY SIGN
NTS

LEGEND

	ROCK SCOUR PROTECTION
	PERMANENT WATER
	MAINTENANCE ACCESS TRACK (REINFORCED CONCRETE)
	4m WIDE MAINTENANCE ACCESS TRACK (CRUSHED SANDSTONE)
	STORMWATER DRAINAGE LINE
GPT	GPT AND OUTLET
	FLOW SPREADER

FINAL ROAD ALIGNMENT AND GRADING TO BE CONFIRMED AS PART OF DETAILED DESIGN

DRAFT ISSUE ONLY
PRELIMINARY DESIGNS SUBJECT TO CHANGE

PLAN
SCALE 1:500

1:500 (AT A1)
1:1000 (AT A3)
10 0 10 20 30 40 50
METRES

A	ISSUE FOR REVIEW	CC/JCA	JCA	DC	MS	08/04/22
	AMENDMENT	DES	DRN	CKD	APR	DATE

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GP3 MULGOA PLANNING PROPOSAL
BASIN AND RAINGARDEN CONCEPT

DETAIL PLAN VB2

PROJECT No: 110474-02
SHEET No: SK120

AZIMUTH: M.G.A. | DATUM: A.H.D. | ORIGIN: | PLAN No: 110474-02-SK120 | A

Plotted: 13 April , 2022 6:22:50 PM File Name: J:\110474 - Mulgoa Planning Proposal\CD\SK\110474-02-SK120.dwg

DETAIL A
FLOODWAY SIGN
NTS

LEGEND

- ROCK SCOUR PROTECTION
- PERMANENT WATER
- MAINTENANCE ACCESS TRACK (REINFORCED CONCRETE)
- 4m WIDE MAINTENANCE ACCESS TRACK (CRUSHED SANDSTONE)
- STORMWATER DRAINAGE LINE
- GPT GPT AND OUTLET
- FLOW SPREADER
- E2 ENVIRONMENTAL CONSERVATION

DRAFT ISSUE ONLY
PRELIMINARY DESIGNS SUBJECT TO CHANGE

PLAN
SCALE 1:500

1:500 (AT A1)
1:1000 (AT A3)
10 0 10 20 30 40 50
METRES

FINAL ROAD ALIGNMENT AND GRADING TO BE CONFIRMED AS PART OF DETAILED DESIGN

	AMENDMENT	DES	DRN	CKD	APR	DATE
B	AMENDED BASIN DETAIL LEVELS AND HATCH	CC/JCA	CC/JCA	DC	DC	12/04/22
A	ISSUE FOR REVIEW	CC/JCA	JCA	DC	DC	11/04/22

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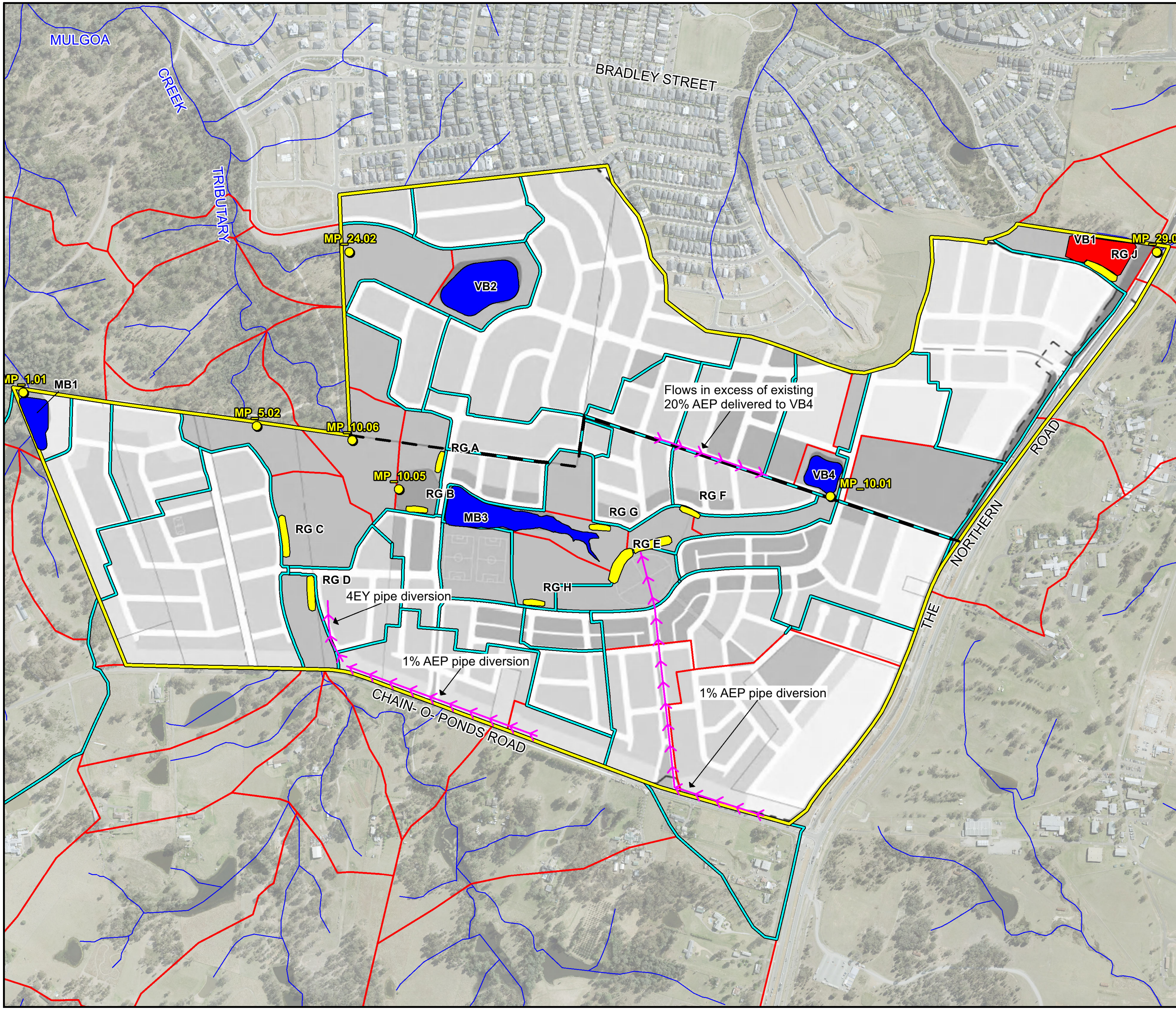
GP3 MULGOA PLANNING PROPOSAL
BASIN AND RAINGARDEN CONCEPT
DETAIL PLAN MB1

AZIMUTH: M.G.A. DATUM: A.H.D. ORIGIN:

PROJECT No: 110474-02
SHEET No: SK130
PLAN No: 110474-02-SK130 B

Plotted: 13 April , 2022 6:29:34 PM File Name: J:\110474 - Mulgoa Planning Proposal\CD\SK110474-02-SK130.dwg

APPENDIX B - FIGURES



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LEGEND

- Site Boundary
- MUSIC Catchments
- XP-RAFTS Catchments
- Indicative Detention Basin (over pond)
- Indicative Detention Basin (dry bed)
- Indicative Raingarden
- Drainage Diversion
- Comparison Node
- Landholder Boundary

N

0 320
metres
Scale 1:8,000 @ A3

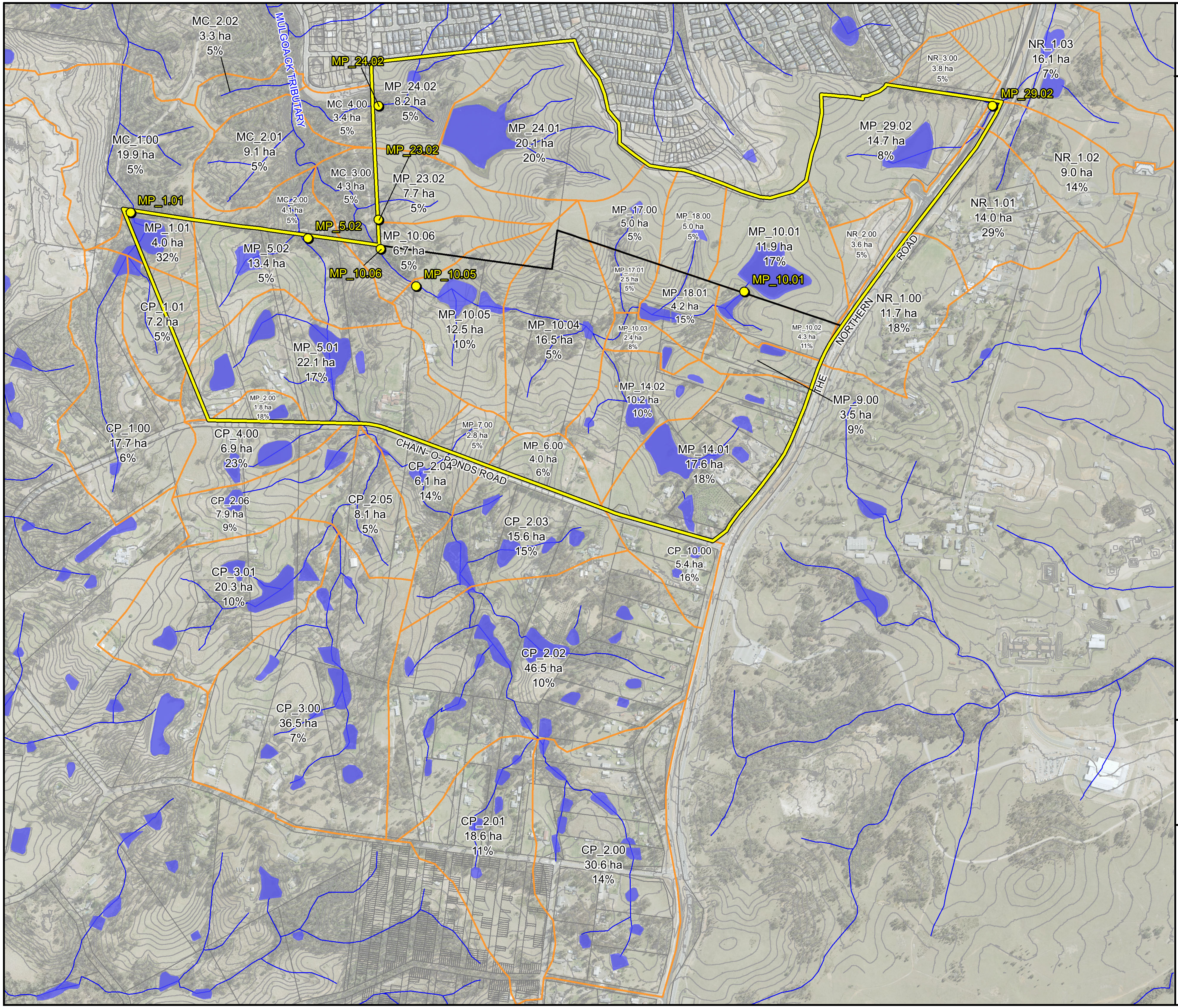
Projection: GDA 1994 MGA Zone 56

Figure 1-1
Glenmore Park Stage 3

Water Cycle Management Plan

Date: 13/04/2022 Issue: C

Filename: "J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig1-1_WCMP_C.WOR"



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LEGEND

- Site Boundary
- XP-RAFTS Catchments
- MP_1.01 4.0 ha 32% — XP-Rafts ID, Area and % Impervious
- 2m LIDAR Contours
- Landholder Division
- Watercourse
- Existing Farm Dam

N

0 420
metres
Scale 1:10,500 @ A3

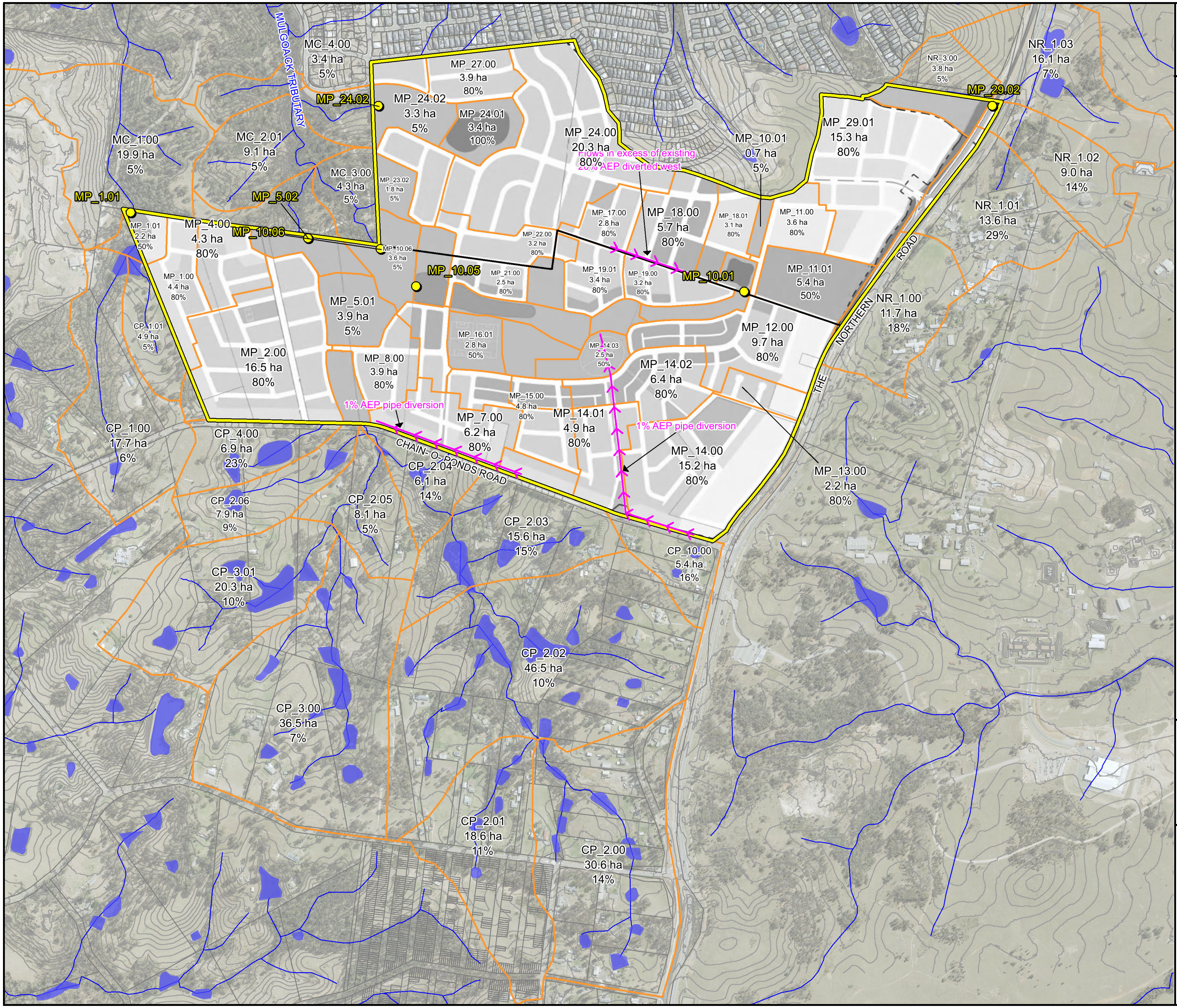
Projection: GDA 1994 MGA Zone 56

Figure 5-1

Glenmore Park Stage 3

XP-Rafts Catchment Plan
Existing Conditions

Date: 22/12/2021 Issue: A



Filename: "J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig5-2_DEV Catchments_C.WOR"

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LEGEND

- Site Boundary
- XP-RAFTS Catchments
- MP_1.01 4.0 ha 32% — XP-Rafts ID, Area and % Impervious
- 2m LIDAR Contours
- Landholder Division
- Watercourse
- Existing Farm Dam

N

0 420 metres
Scale 1:10,500 @ A3

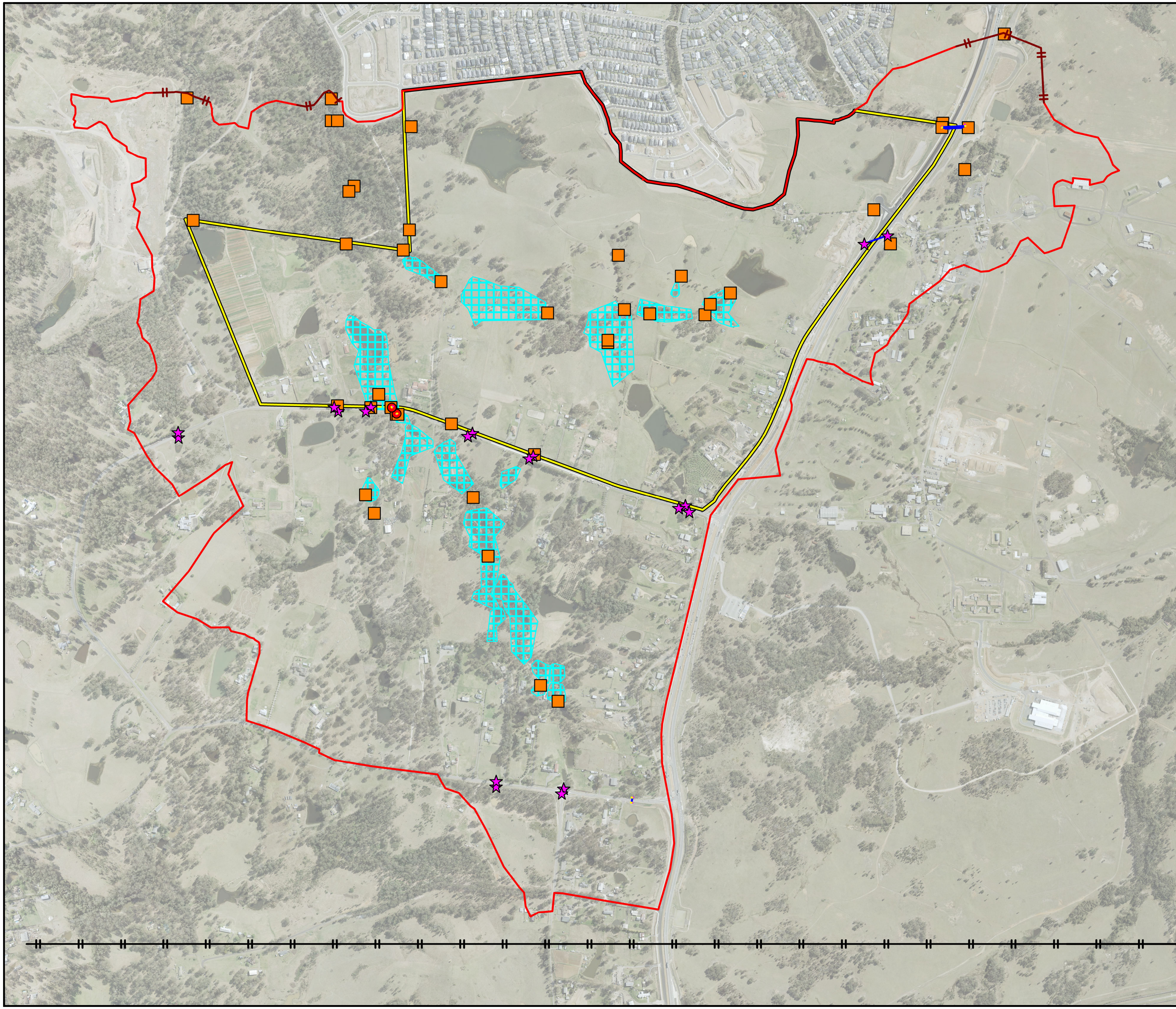
Projection: GDA 1994 MGA Zone 56

Figure 5-2

Glenmore Park Stage 3

XP-Rafts Catchment Plan Developed Conditions

Date: 13/04/2022 Issue: C



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Projection: GDA 1994 MGA Zone 56

Figure 6-1

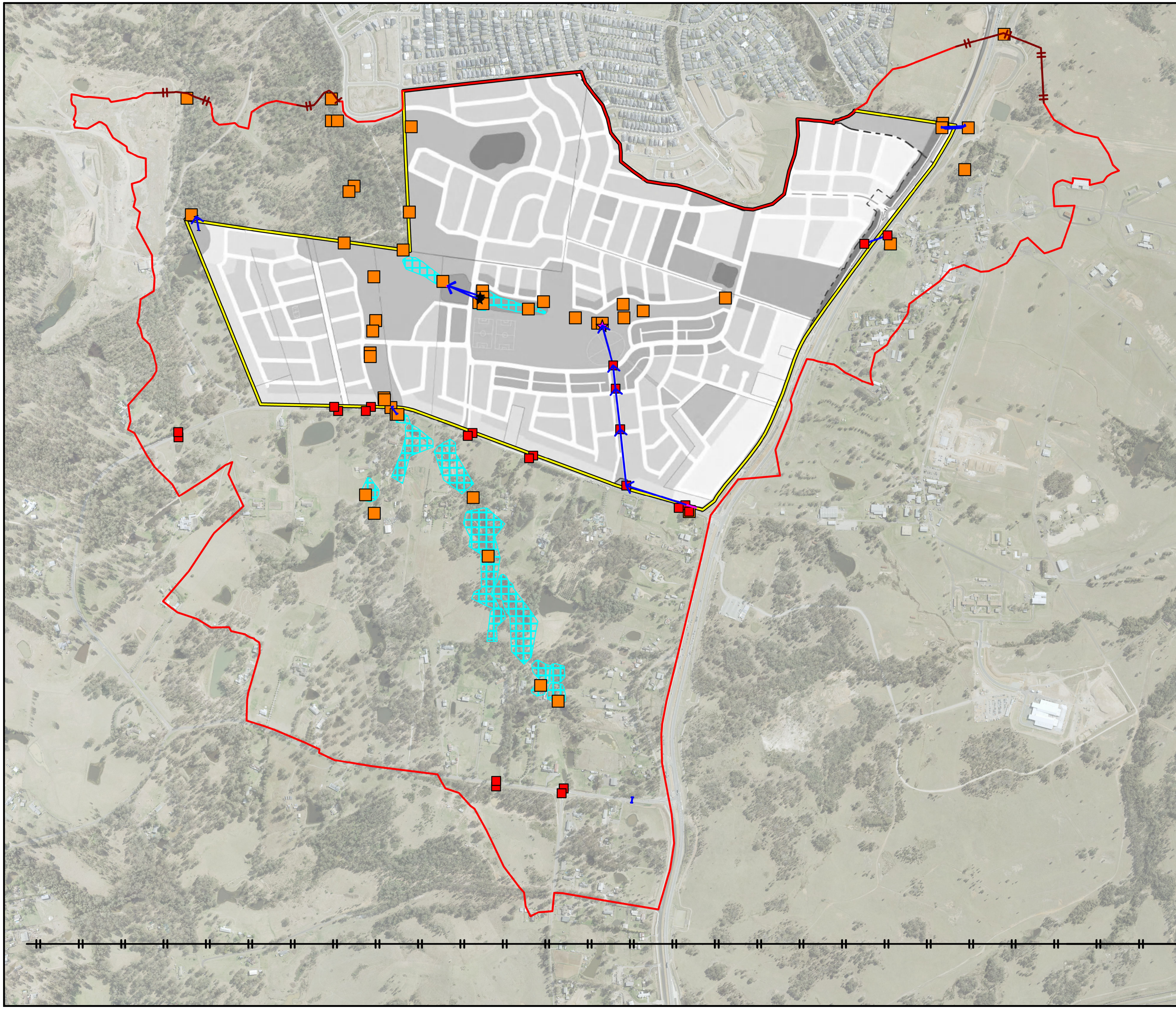
Glenmore Park Stage 3

Existing Conditions TUFLOW Setup

Date: 13/04/2022

Issue: C

Filename: "J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-1_EX03_TFS_C.wor"



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LEGEND

TUFLOW MODEL ELEMENTS

- TUFLOW Model Boundary
- SA Catchment Inflow Location
- IWL Initial Water Level Area
- 2d LOC Line
- HQ Slope Boundary
- 1D NWK Culvert
- Connection Line (CN)
- 2D SX Connection (Line)
- 2D SX Connection (Point)
- 1D IWL Initial Water Level (Point)
- 1D NWK Pit
- Site Boundary

N

0 480
metres
Scale 1:12,000 @ A3

Projection: GDA 1994 MGA Zone 56

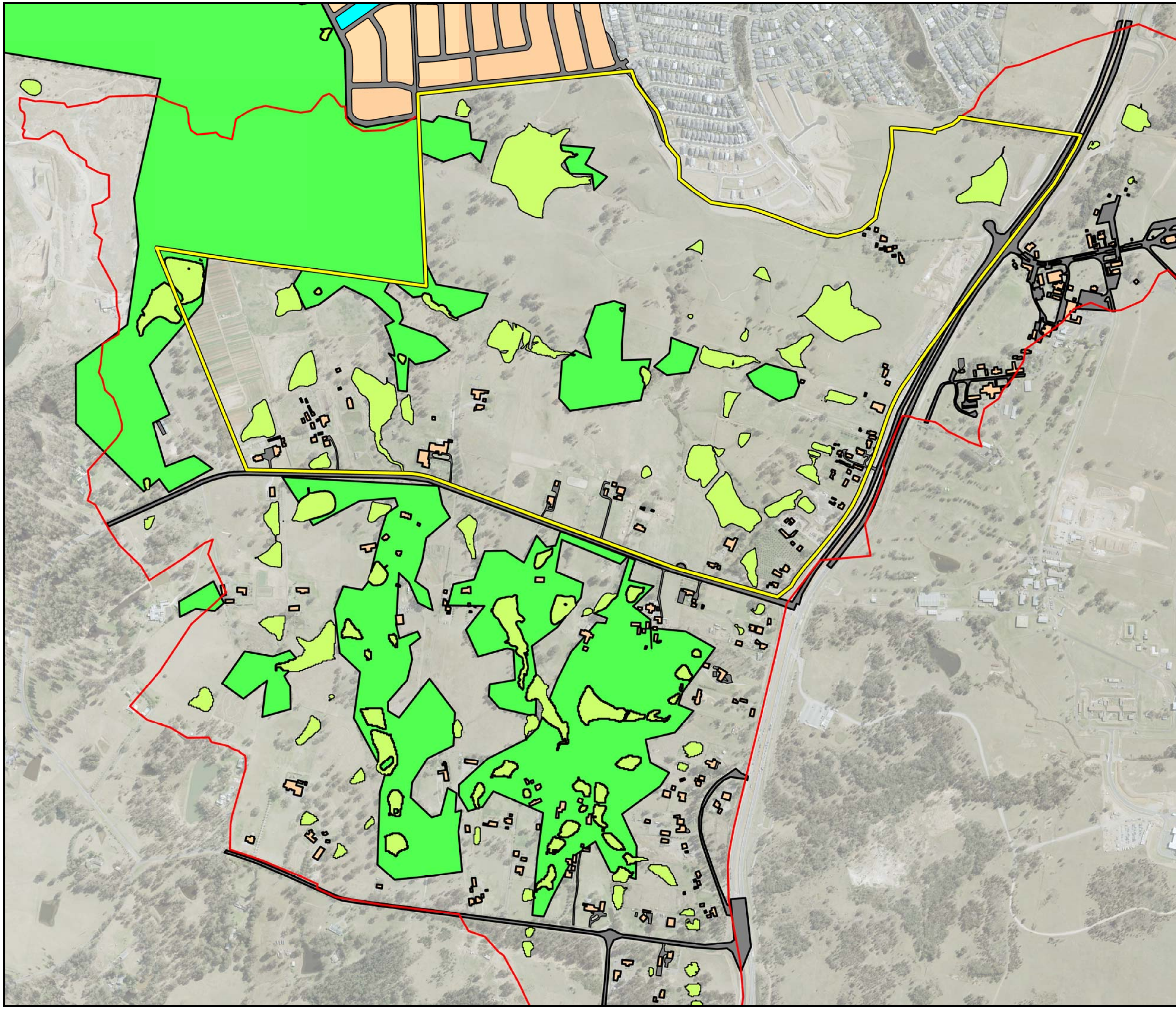
Figure 6-2

Glenmore Park Stage 3

Developed Conditions
TUFLOW Setup

Date: 13/04/2022 Issue: C

Filename: "J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-2_DEV02_TFS_C.wor"



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LEGEND

MANNINGS VALUE

- 0.020 Roads
- 0.100 Urban Residential
- 0.020 Lakes (No Emergent Veg)
- 0.060 Medium Vegetation
- 0.045 Vegetated Waterway/Channel
- Site Boundary
- TUFLOW Model Boundary

N

0 400
metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-3

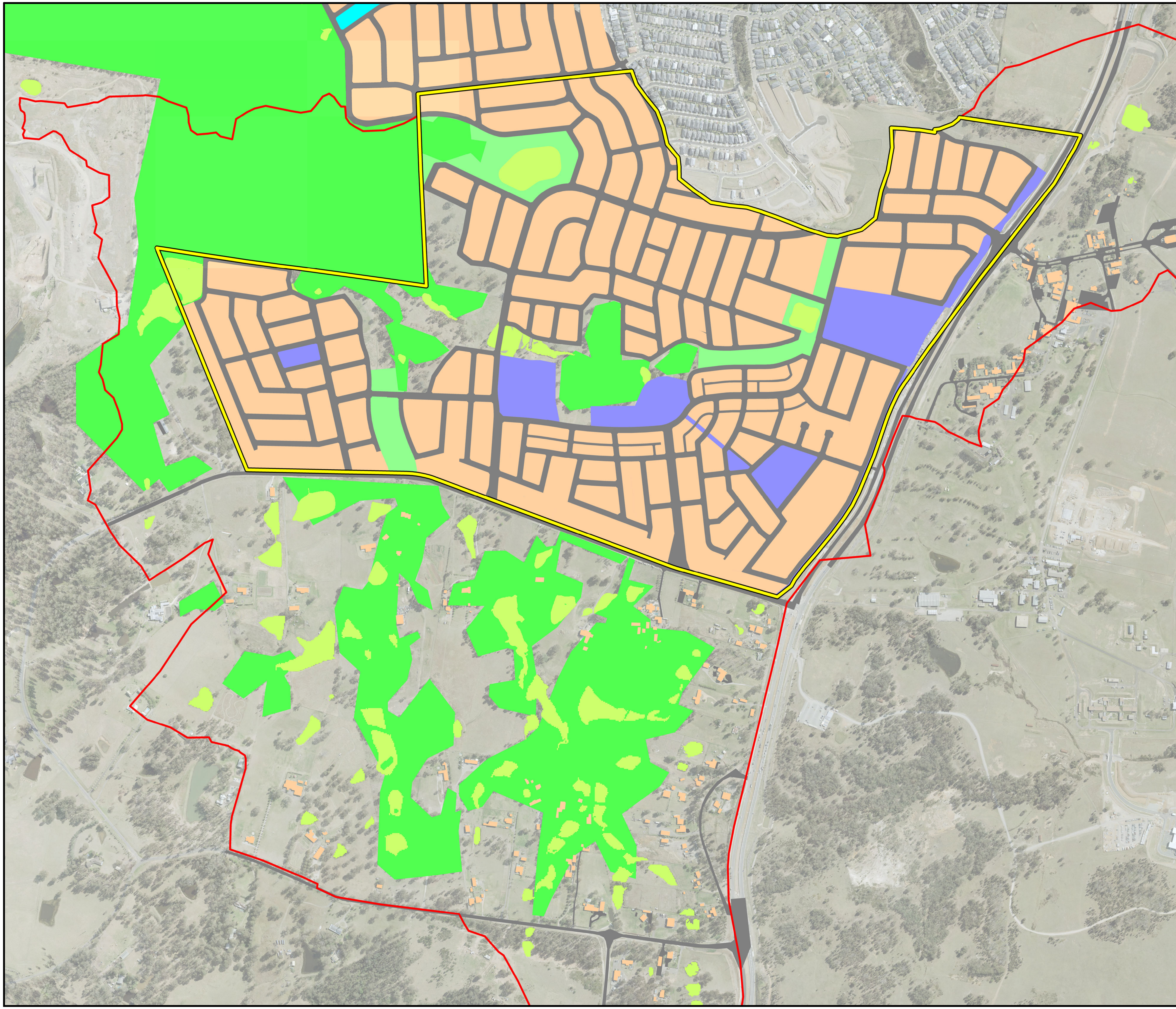
Glenmore Park Stage 3

Existing Conditions
TUFLOW Mannings

Date: 23/12/2021

Issue: A

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report\110474-02_Fig6-3_EX02__TFM_A.wor



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LEGEND

MANNINGS VALUE

- 0.020 Roads
- 0.100 Urban Residential
- 0.020 Lakes (No Emergent Veg)
- 0.045 Light Vegetation
- 0.060 Medium Vegetation
- 0.030 Vegetated Waterway/Channel (Minimal Vegetation)
- 0.045 Vegetated Waterway/Channel
- Site Boundary
- TUFLOW Model Boundary

N

0 400
metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-4

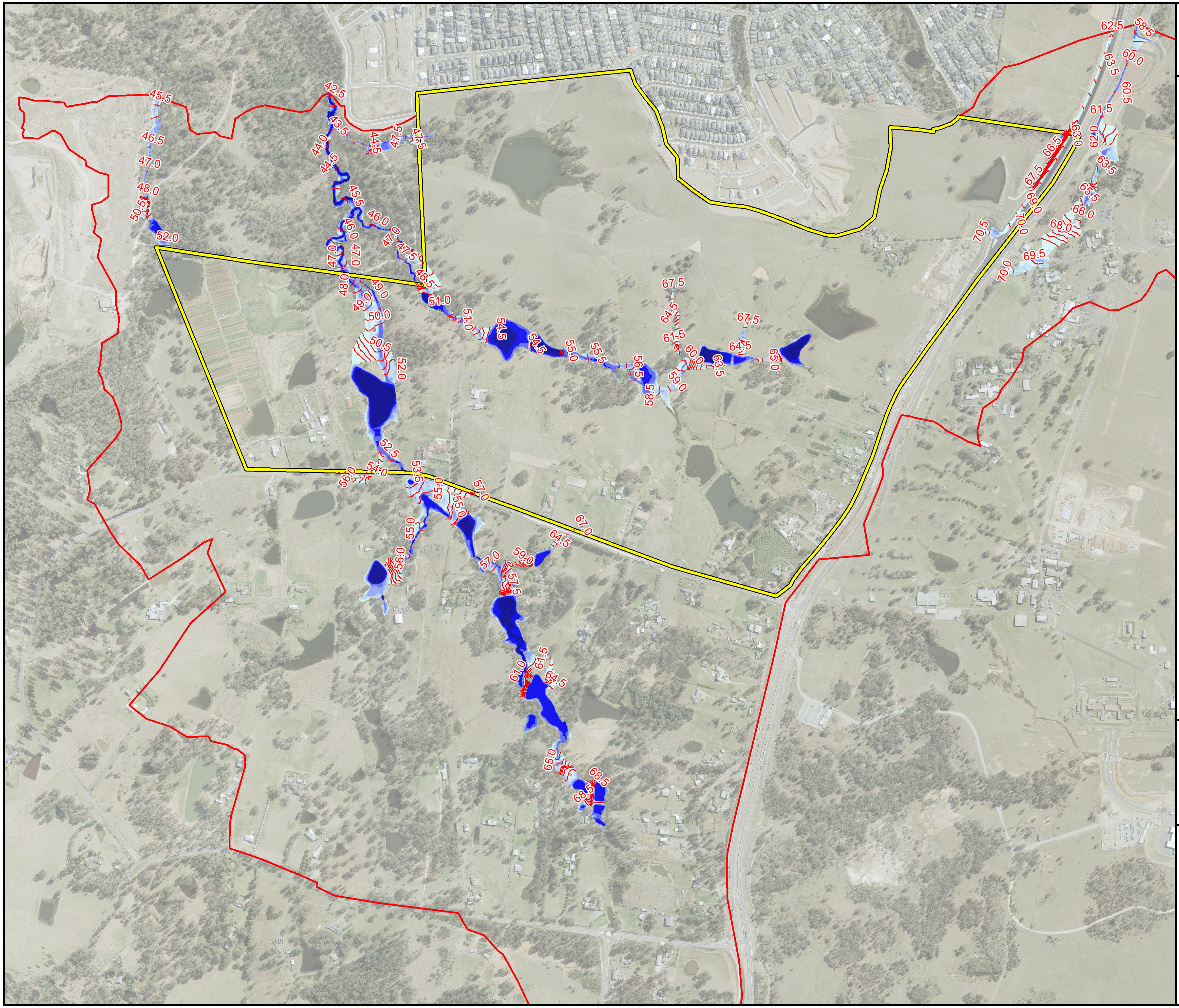
Glenmore Park Stage 3

Developed Conditions
TUFLOW Mannings

Date: 12/04/2022

Issue: B

Filename: "J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report B\110474-02_Fig6-4_DEV02_TFM_B.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 +

55.0 — 0.5 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 — 400 metres

Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

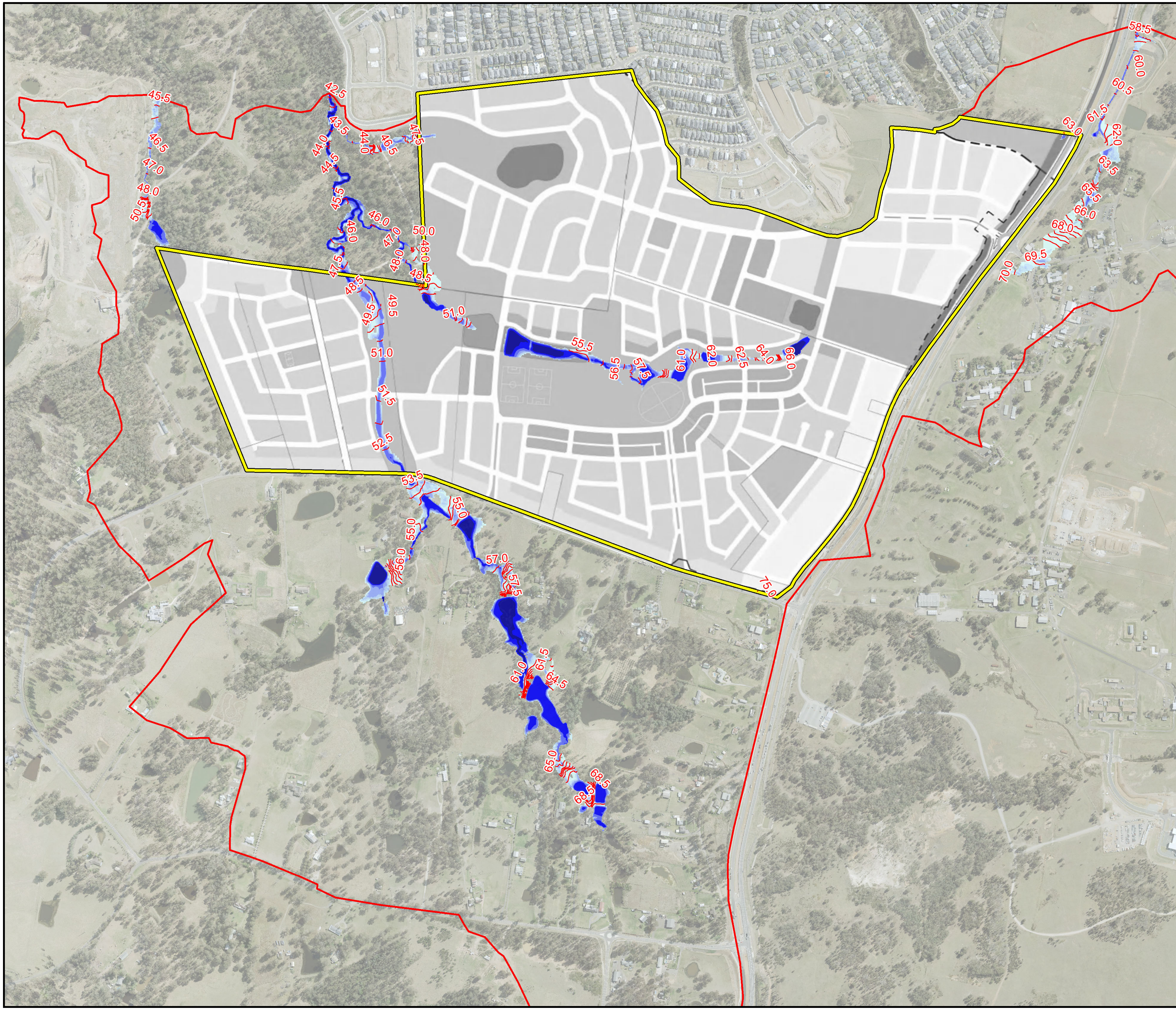
Figure 6-5

Glenmore Park Stage 3

20% AEP
Existing Conditions
Flood Depths and Levels

Date: 13/04/2022 | Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-5_EX04_20pc_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 +

55.0 0.5 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 400
metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-6

Glenmore Park Stage 3

20% AEP
Developed Conditions
Flood Depths and Levels

Date: 13/04/2022 Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-6_DEV03_20pc_DEP_C.wor

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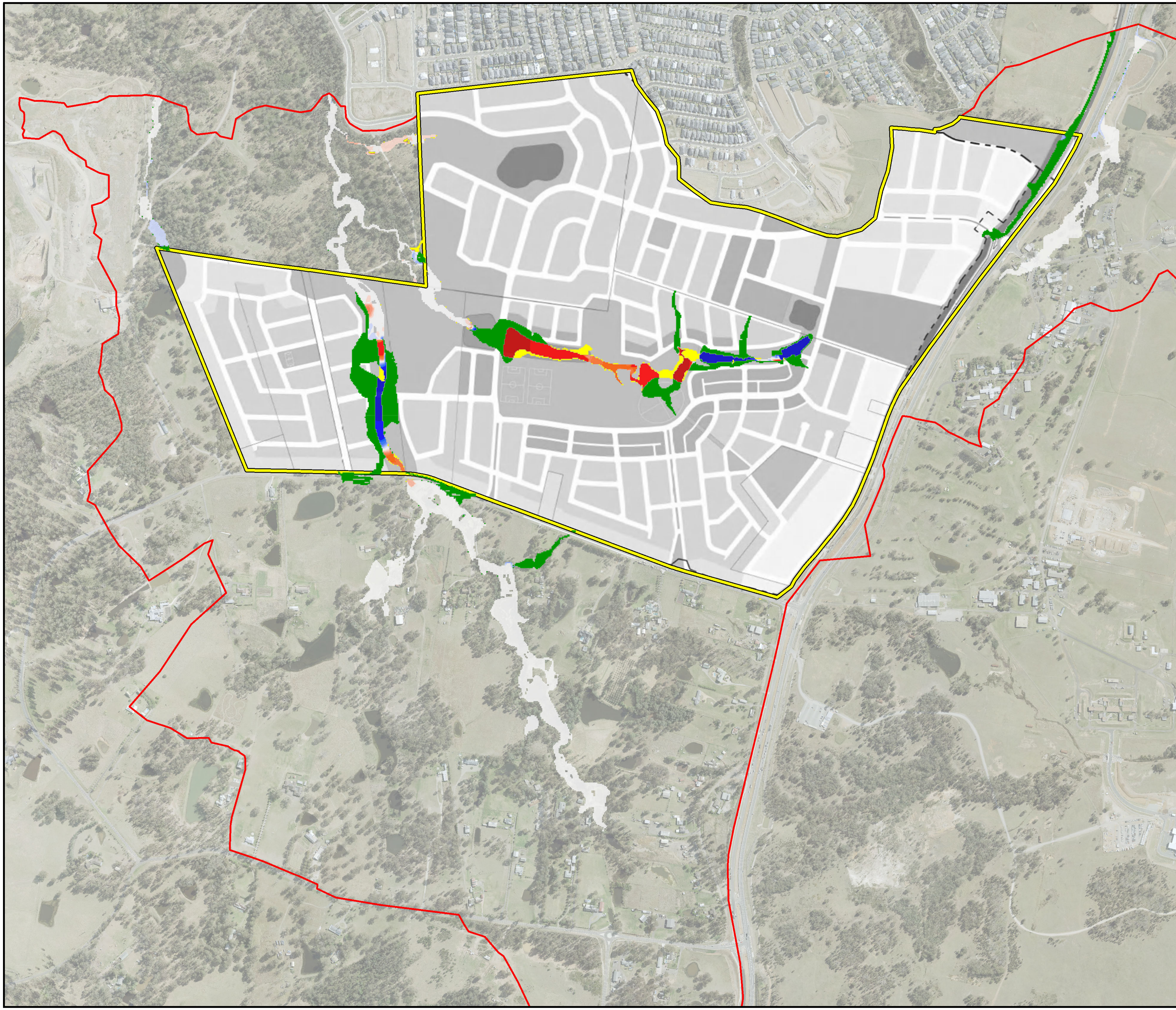

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LEGEND

FLOOD DIFFERENCE (m)

- 0.50 +
- -0.20 to 0.50
- -0.15 to 0.20
- -0.10 to 0.15
- -0.08 to 0.10
- -0.06 to 0.08
- -0.04 to 0.06
- -0.02 to 0.04
- -0.02 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.15
- 0.15 to 0.20
- 0.20 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
- Site Boundary
- TUFLOW Model Boundary

N

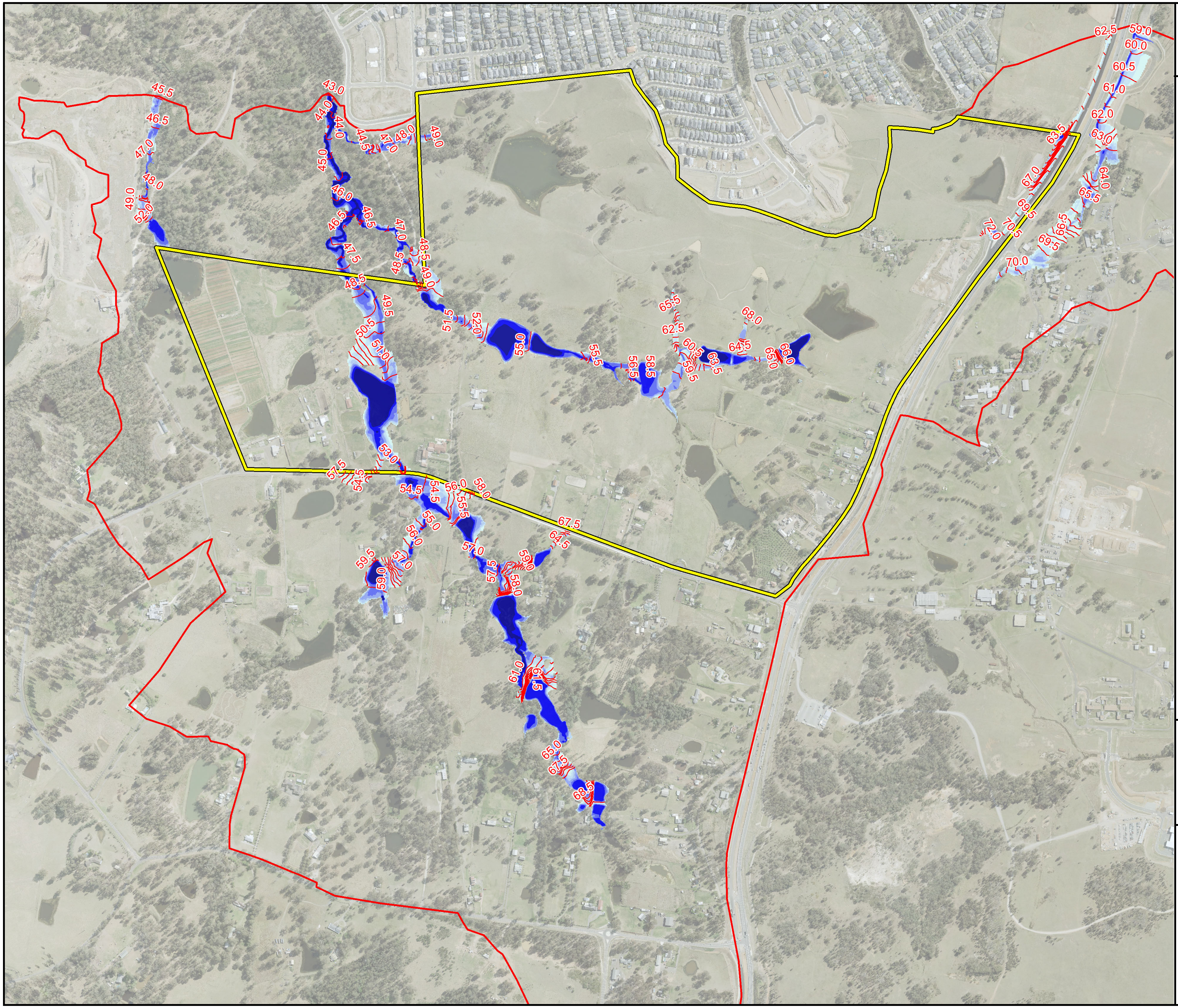
0 400
metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-7
Glenmore Park Stage 3

20% AEP
Developed - Existing
Flood Difference

Date: 13/04/2022 Issue: C



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& PROJECT MANAGERS

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 +

55.0 — 0.5 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 — 400
metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

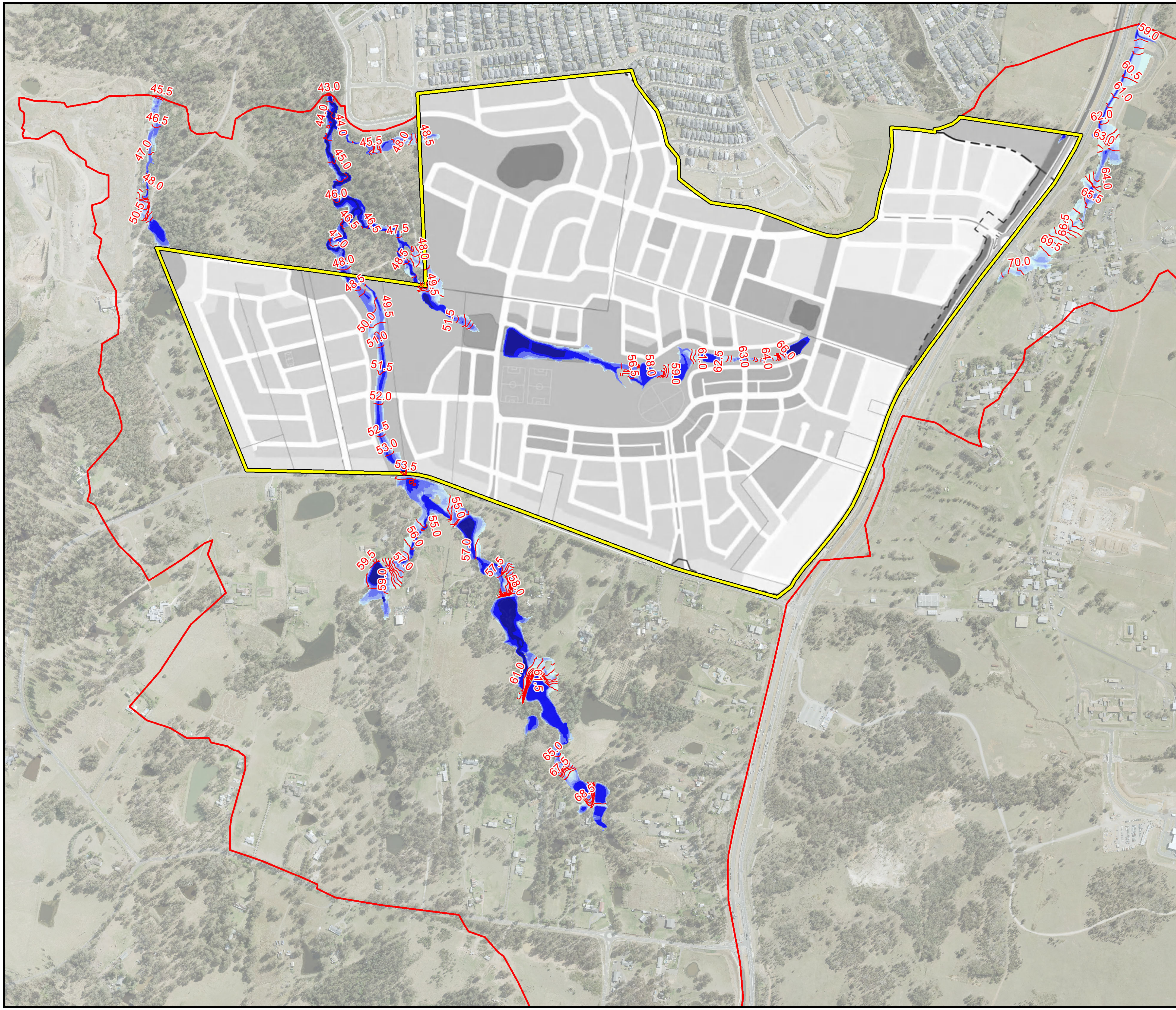
Figure 6-8

Glenmore Park Stage 3

1% AEP
Existing Conditions
Flood Depths and Levels

Date: 13/04/2022 Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-8_EX04_1pc_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 +
- 55.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 400 metres

Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-9

Glenmore Park Stage 3

1% AEP
Developed Conditions
Flood Depths and Levels

Date: 13/04/2022 Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-9_DEV03_1pc_DEP_C.wor

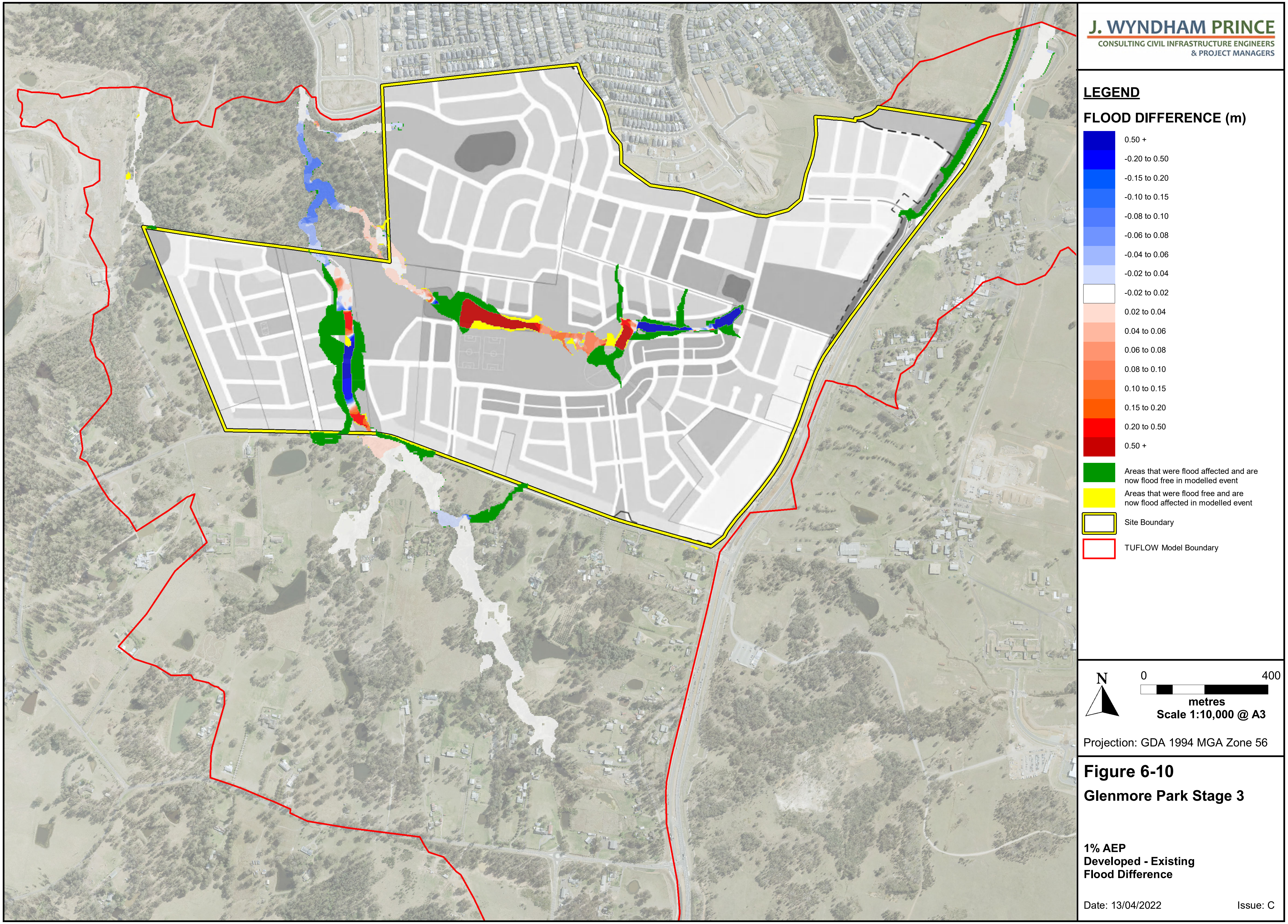


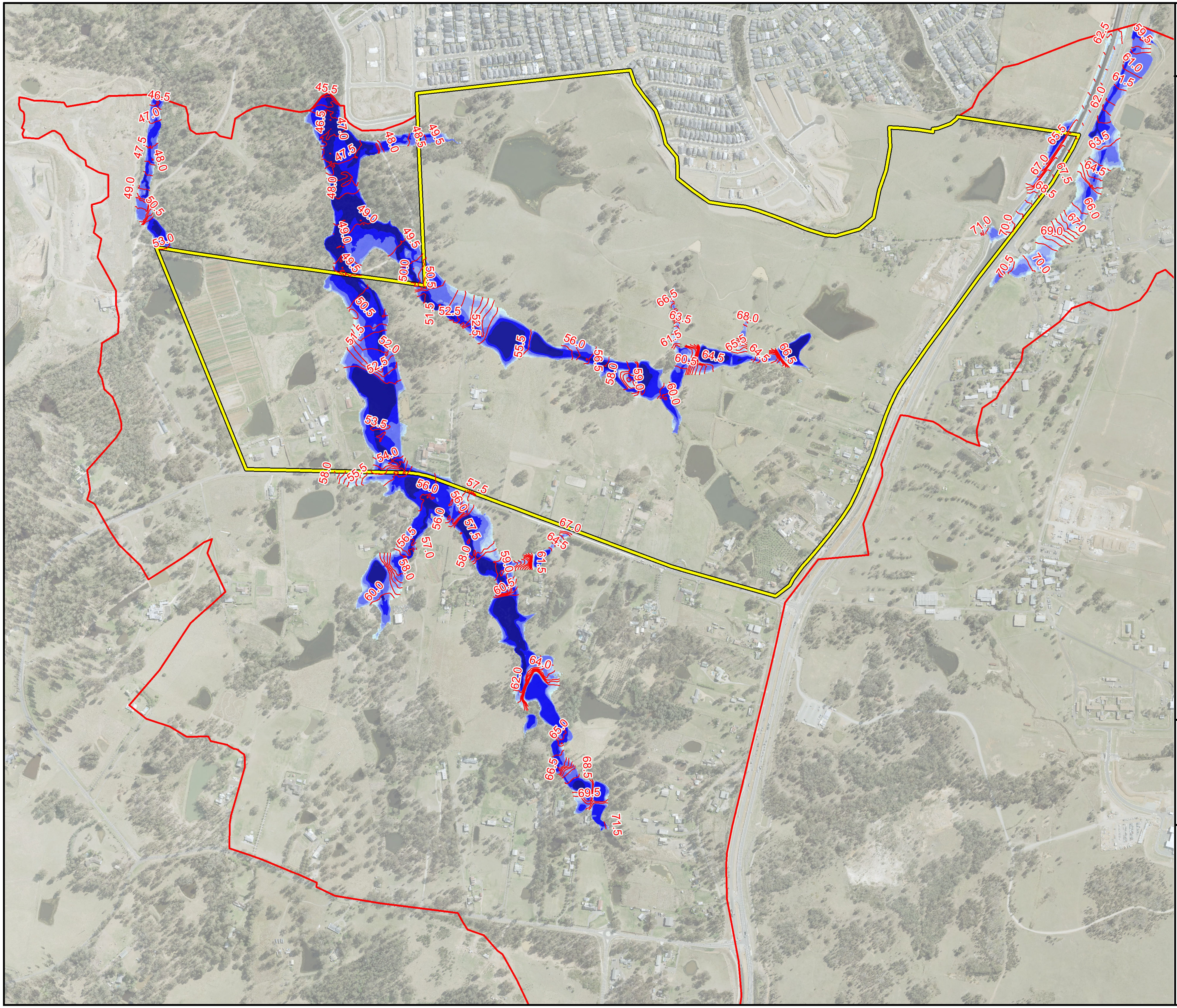
Figure 6-10
Glenmore Park Stage 3

1% AEP
Developed - Existing
Flood Difference

Date: 13/04/2022

Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-10_DEV03-EX04_1pc_FDM_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 +

55.0 — 0.5 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 — 400 metres
Scale 1:10,000 @ A3

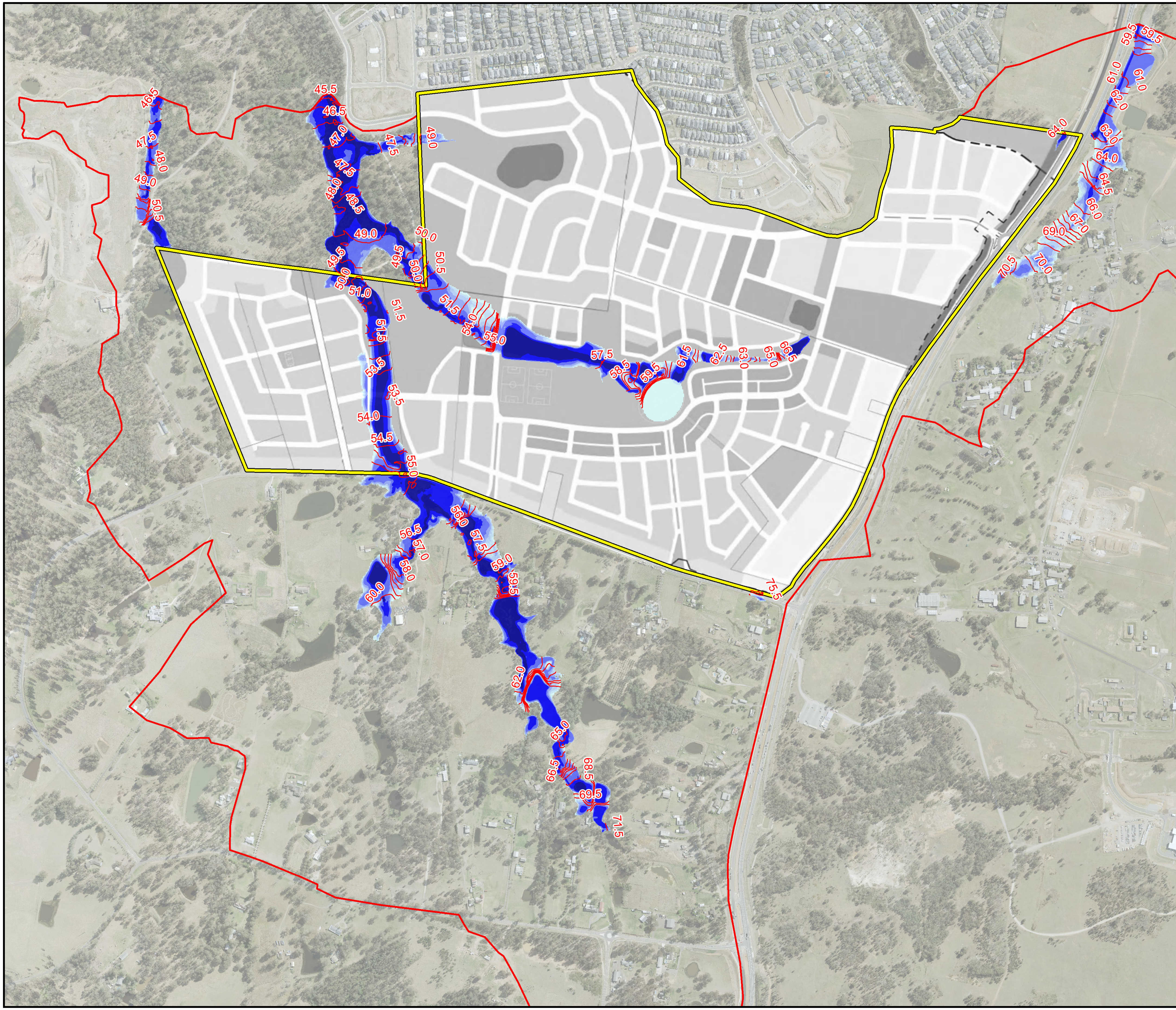
Projection: GDA 1994 MGA Zone 56

Figure 6-11
Glenmore Park Stage 3

PMF
Existing Conditions
Flood Depths and Levels

Date: 13/04/2022 Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-11_EX04_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 +
- 55.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 400
metres
Scale 1:10,000 @ A3

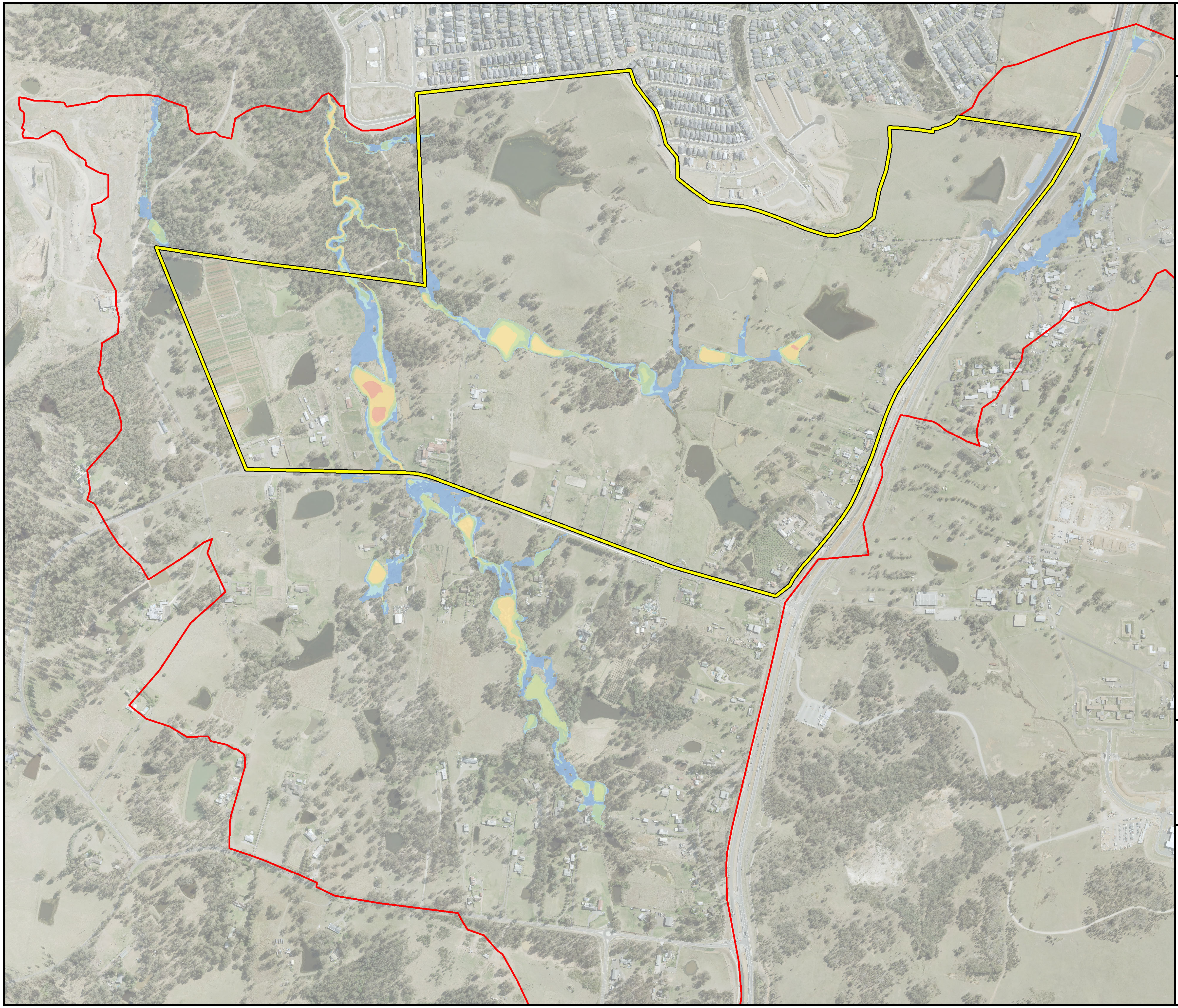
Projection: GDA 1994 MGA Zone 56

Figure 6-12
Glenmore Park Stage 3

PMF
Developed Conditions
Flood Depths and Levels

Date: 13/04/2022 Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-12_DEV03_PMF_DEP_C.wor



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& 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

0 400
metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

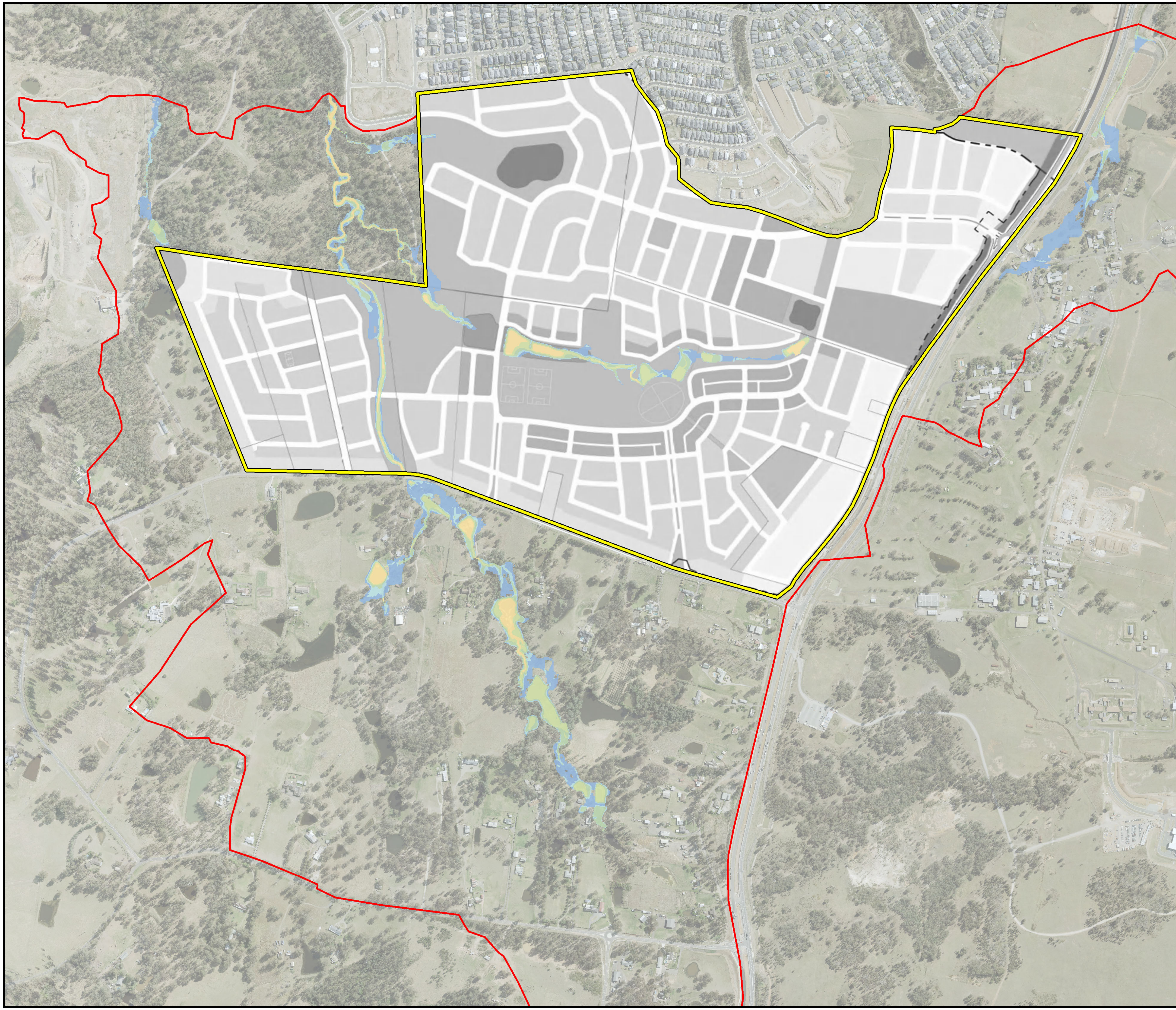
Figure 6-13

Glenmore Park Stage 3

20% AEP
Existing Conditions
Flood Hazard

Date: 13/04/2022 Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-13_EX04_20pc_HAZ_C.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

0 400
metres
Scale 1:10,000 @ A3

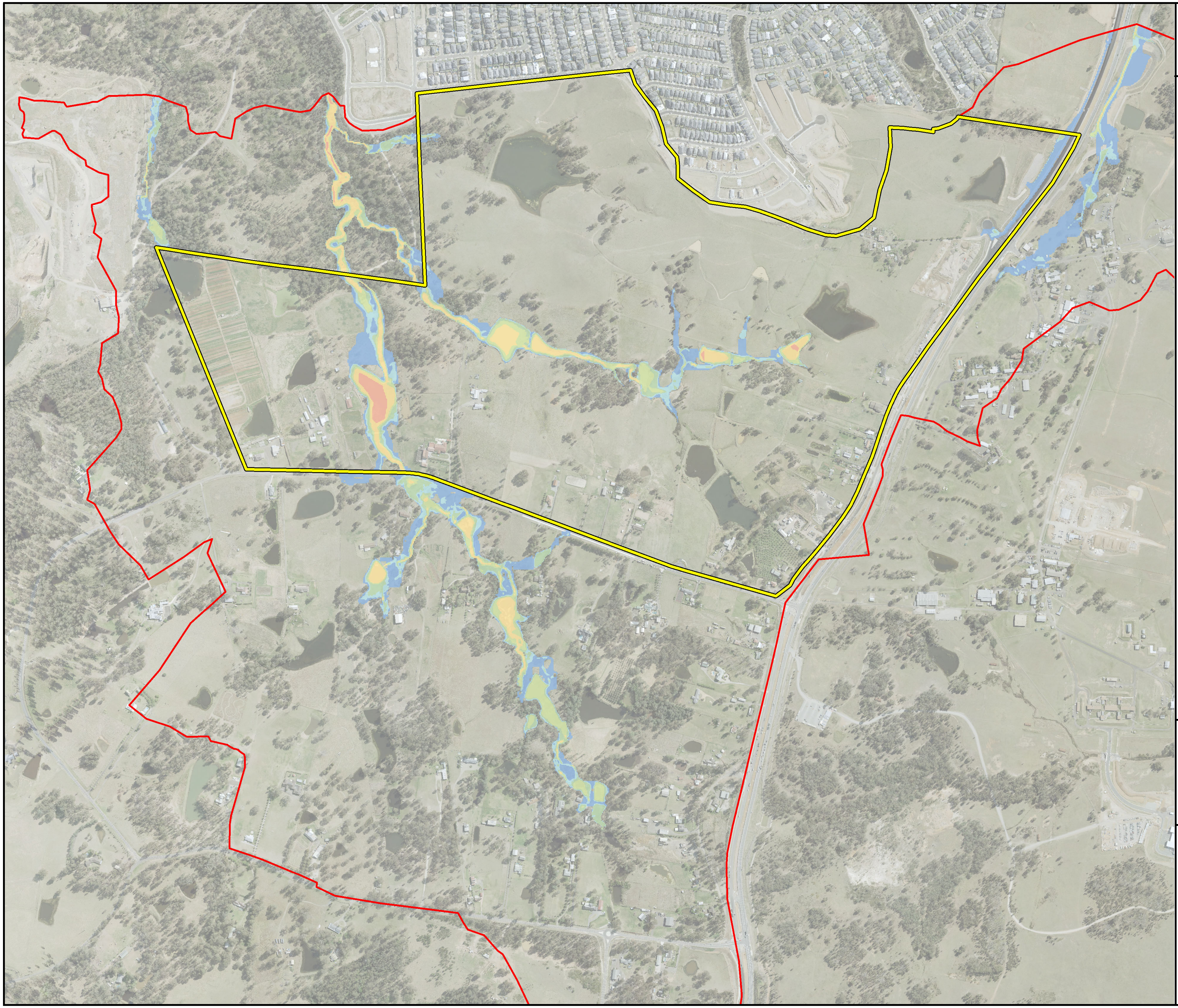
Projection: GDA 1994 MGA Zone 56

Figure 6-14
Glenmore Park Stage 3

20% AEP
Developed Conditions
Flood Hazard

Date: 13/04/2022 Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-14_DEV03_20pc_HAZ_C.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

0 400
metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

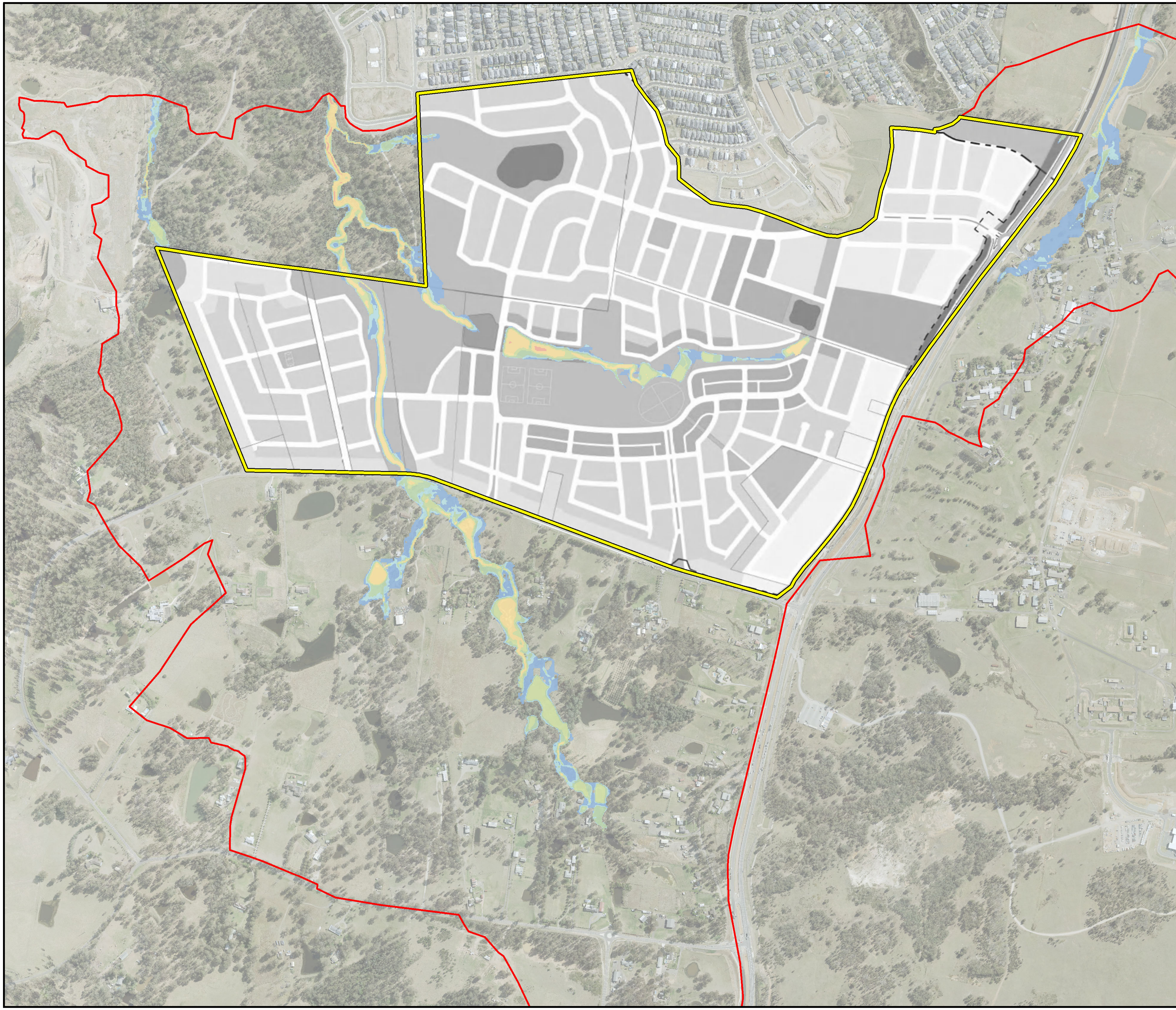
Figure 6-15

Glenmore Park Stage 3

1% AEP
Existing Conditions
Flood Hazard

Date: 13/04/2022 Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-15_EX04_1pc_HAZ_C.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

0 400
metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

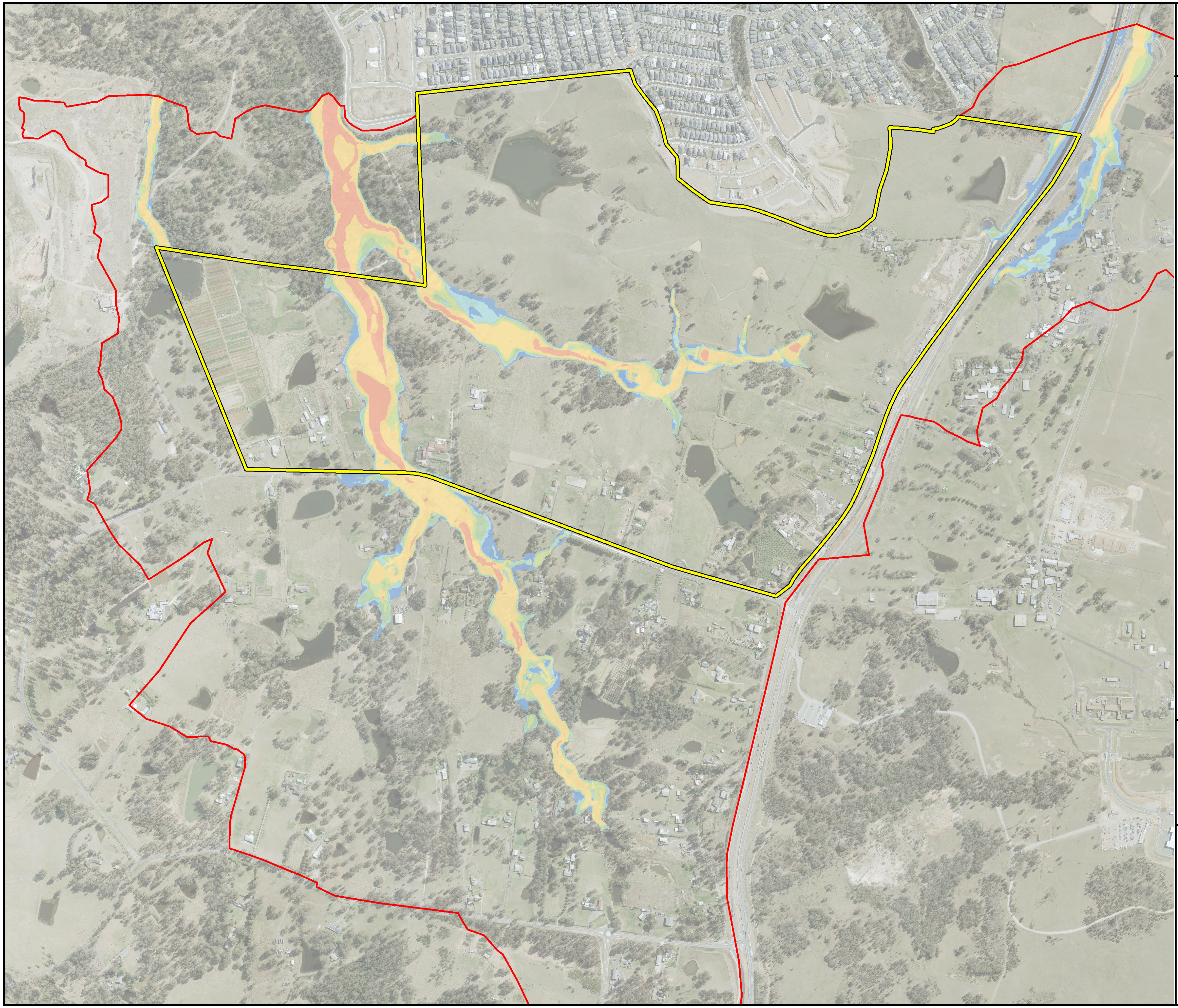
Figure 6-16

Glenmore Park Stage 3

1% AEP
Developed Conditions
Flood Hazard

Date: 13/04/2022 Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-16_DEV03_1pc_HAZ_C.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

0 400
metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

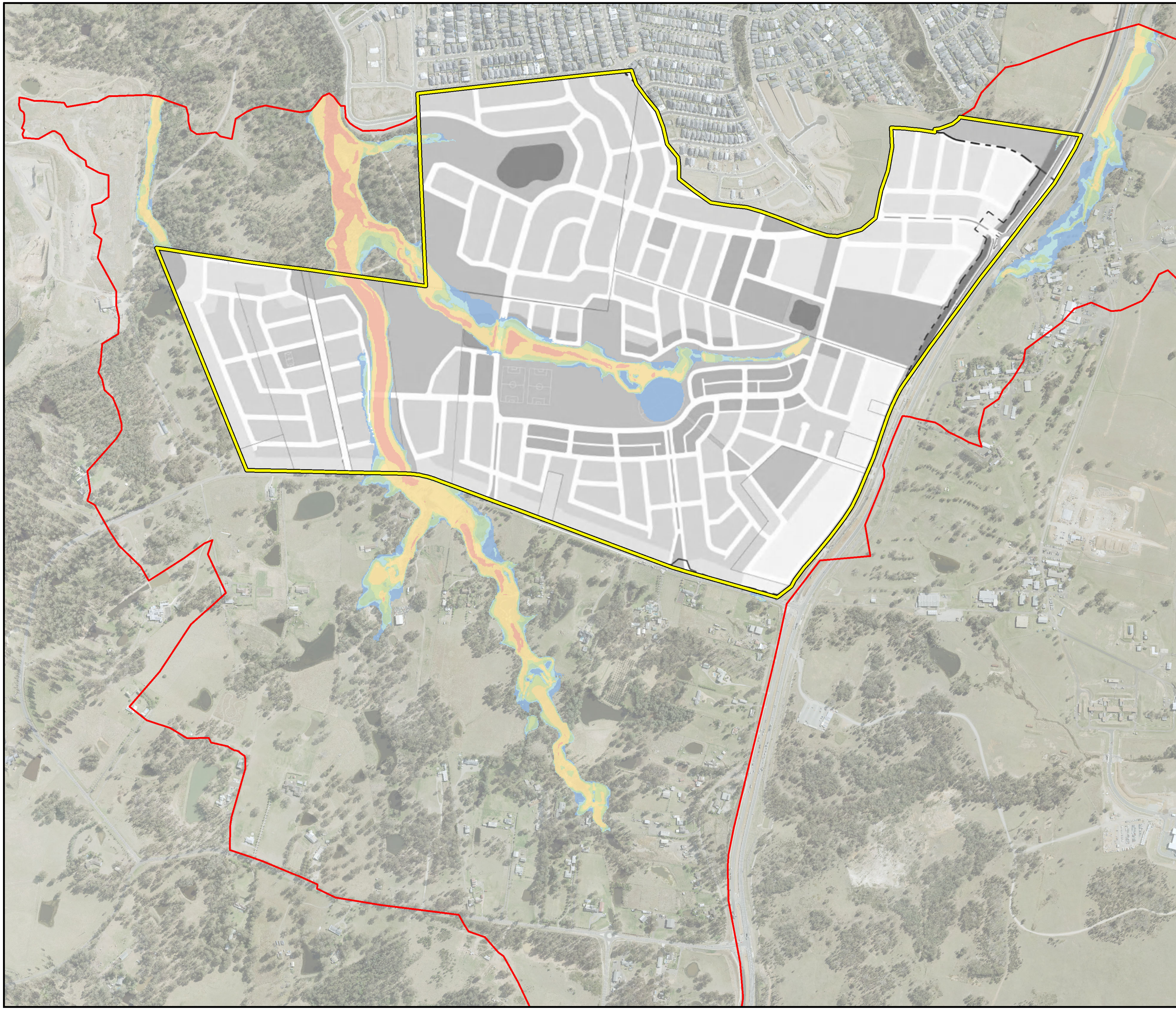
Figure 6-17
Glenmore Park Stage 3

PMF
Existing Conditions
Flood Hazard

Date: 13/04/2022

Issue: C

Filename: J:\110474 - Mulgoa Planning Proposal\02-SWMS\MapInfo\Figures\Report C\110474-02_Fig6-17_EX04_PMF_HAZ_C.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

0 400 metres
Scale 1:10,000 @ A3

Projection: GDA 1994 MGA Zone 56

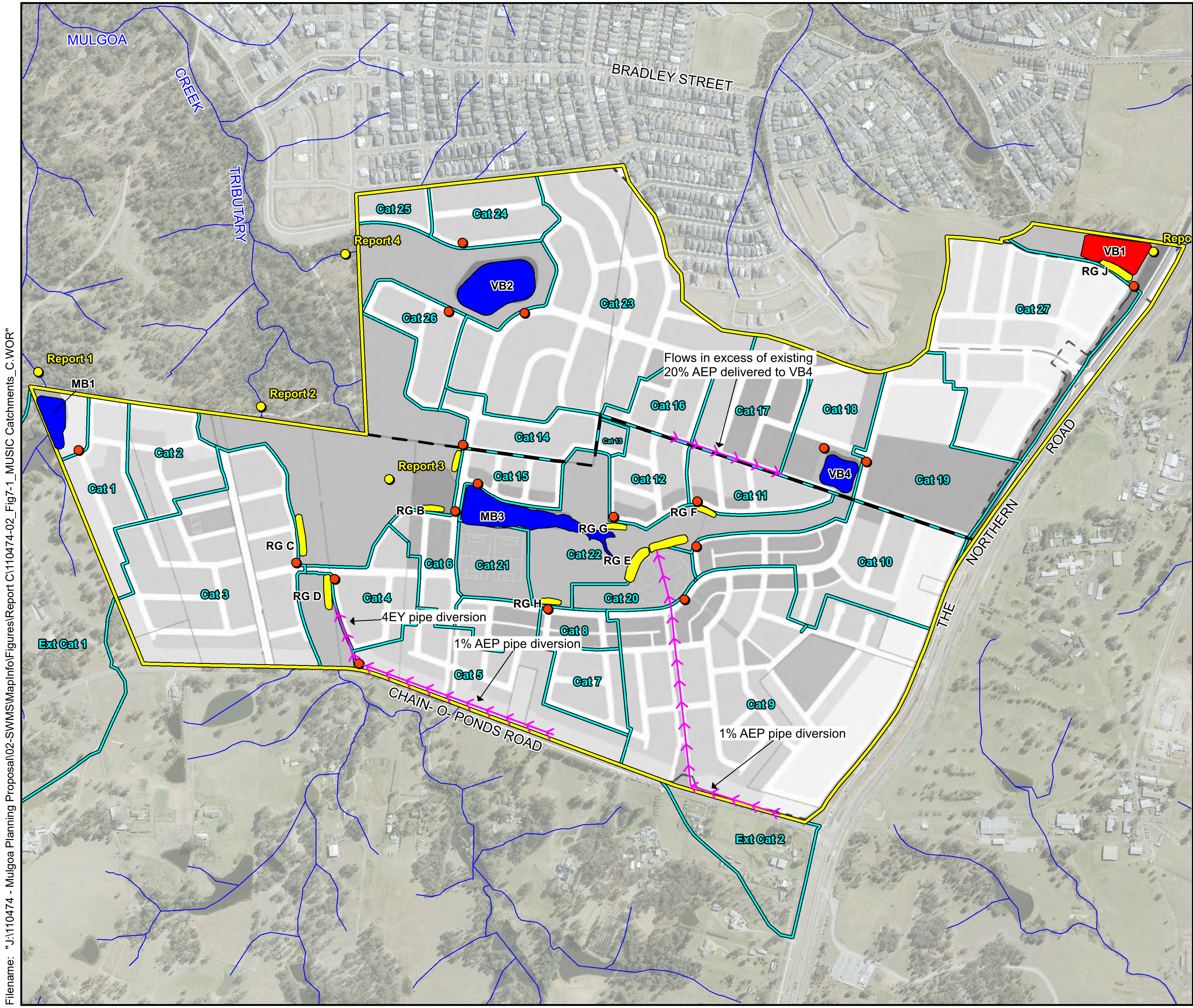
Figure 6-18

Glenmore Park Stage 3

PMF
Developed Conditions
Flood Hazard

Date: 13/04/2022

Issue: C



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LEGEND

- Site Boundary
- MUSIC Catchments
- Indicative Pond
- Indicative Raingarden
- Drainage Diversion
- Indicative GPT Location
- Landholder Boundary
- MUSIC Reporting Locations

Projection: GDA 1994 MGA Zone 56

Figure 7-1

Glenmore Park Stage 3

MUSIC Catchment Plan

Date: 13/04/2022

Issue: C

APPENDIX C – XP-RAFTS IFD & ARR DATA HUB SUMMARY

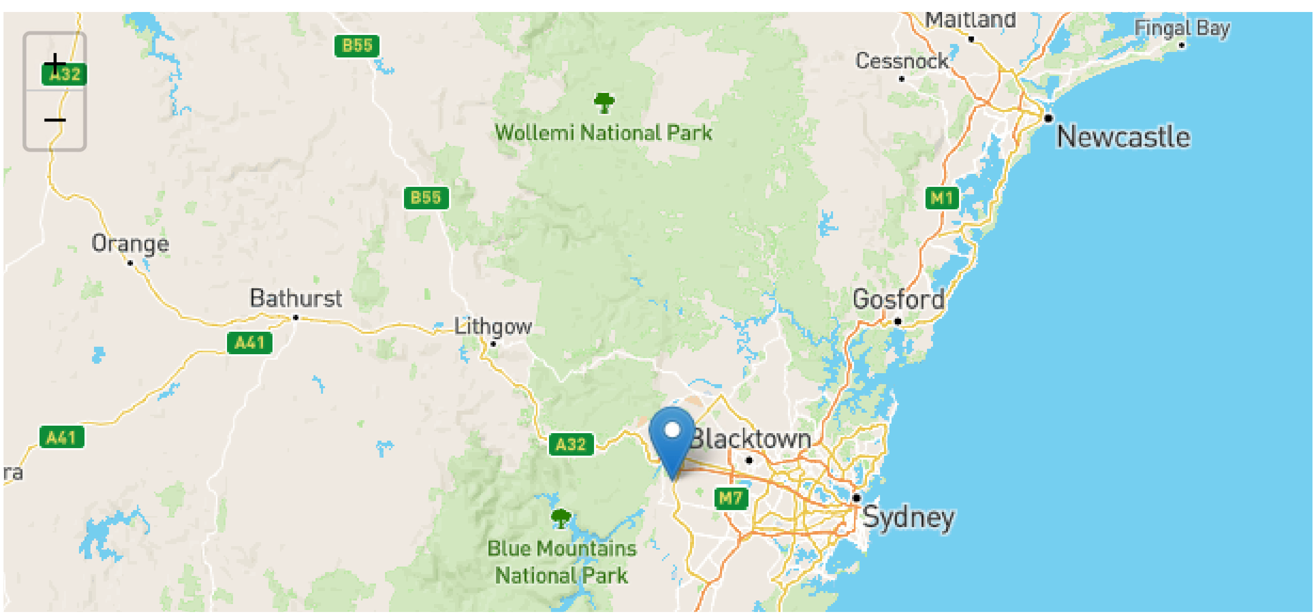
IFD Design Rainfall Depth (mm)
Issued: 9-Nov-21
Location Label:
Requested coordinate: Latitude -33.8177 Longitude 150.678
Nearest grid cell: Latitude 33.8125 (S) Longitude 150.6875 (E)

		Annual Exceedance Probability (AEP)						
Duration	**Duration in min**	**63.20%**	**50%**	**20%**	**10%**	**5%**	**2%**	**1%**
1 min	1	1.98	2.27	3.21	3.87	4.53	5.43	6.15
2 min	2	3.22	3.65	5.06	6.06	7.07	8.46	9.61
3 min	3	4.48	5.09	7.08	8.49	9.92	11.9	13.5
4 min	4	5.64	6.43	8.99	10.8	12.6	15.1	17.1
5 min	5	6.69	7.65	10.7	12.9	15.1	18.1	20.5
10 min	10	10.6	12.2	17.4	21	24.6	29.5	33.3
15 min	15	13.3	15.3	21.7	26.3	30.8	36.9	41.7
20 min	20	15.2	17.5	24.9	30	35.2	42.2	47.7
25 min	25	16.7	19.2	27.2	32.9	38.5	46.2	52.2
30 min	30	17.9	20.6	29.2	35.2	41.2	49.4	55.9
45 min	45	20.8	23.7	33.4	40.1	47	56.3	63.8
1 hour	60	22.9	26	36.4	43.7	51.1	61.3	69.4
1.5 hour	90	26.1	29.6	40.9	49	57.3	68.7	77.9
2 hour	120	28.7	32.4	44.6	53.3	62.2	74.6	84.7
3 hour	180	33	37.1	50.7	60.6	70.7	84.8	96.2
4.5 hour	270	38.3	43	58.7	70	81.7	98	111
6 hour	360	42.8	48.2	65.7	78.5	91.6	110	125
9 hour	540	50.6	57.1	78.3	93.6	109	131	149
12 hour	720	57.2	64.7	89.4	107	125	150	170
18 hour	1080	68	77.5	108	131	153	184	207
24 hour	1440	76.7	88	124	150	176	211	239
30 hour	1800	83.9	96.7	138	167	196	235	265
36 hour	2160	90	104	150	181	214	256	288
48 hour	2880	99.7	116	168	205	241	289	325
72 hour	4320	113	132	193	236	278	332	374
96 hour	5760	121	141	207	253	299	357	401
120 hour	7200	126	147	215	262	310	370	414
144 hour	8640	129	151	219	267	315	375	420
168 hour	10080	132	153	220	267	315	376	420

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	150.678
Latitude	-33.818
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Interim Climate Change Factors	show
Probability Neutral Burst Initial Loss (./nsw_specific)	show



Data

River Region

Division	South East Coast (NSW)
River Number	12
River Name	Hawkesbury River

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2016_v1

ARF Parameters

$$ARF = Min\left\{1, \left[1 - a\left(Area^b - c\log_{10}Duration\right)Duration^{-d} + eArea^f Duration^g\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	a	b	c	d	e	f	g	h	i
SE Coast	0.06	0.361	0.0	0.317	8.11e-05	0.651	0.0	0.0	0.0

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26 \text{ x } 10^{-3} \text{ x } Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141 \text{ x } Area^{0.213} \text{ x } 10^{-0.021\frac{(Duration-180)^2}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

Layer Info

Time Accessed	09 November 2021 02:06PM

Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

Note: As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. The continuing storm loss information from the ARR Datahub provided below should only be used where relevant under the loss hierarchy (level 5) and where used is to be multiplied by the factor of 0.4.

ID	21179.0
Storm Initial Losses (mm)	46.0
Storm Continuing Losses (mm/h)	3.4

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2016_v1

Temporal Patterns | Download (.zip) (static/temporal_patterns/TP/ECsouth.zip)

code	ECsouth
Label	East Coast South

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2016_v2

Areal Temporal Patterns | Download (.zip) (./static/temporal_patterns/Areal/Areal_ECsouth.zip)

code	ECsouth
arealabel	East Coast South

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-33.8177&longitude=150.678&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	09 November 2021 02:06PM

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	1.7 (0.066)	1.4 (0.038)	1.2 (0.026)	0.9 (0.018)	2.6 (0.043)	3.9 (0.056)
90 (1.5)	0.6 (0.019)	1.0 (0.023)	1.2 (0.025)	1.5 (0.026)	1.1 (0.016)	0.9 (0.011)
120 (2.0)	0.0 (0.000)	0.2 (0.004)	0.3 (0.006)	0.4 (0.007)	1.2 (0.017)	1.9 (0.022)
180 (3.0)	1.7 (0.046)	3.2 (0.062)	4.1 (0.068)	5.0 (0.071)	3.6 (0.042)	2.5 (0.026)
360 (6.0)	3.8 (0.080)	10.9 (0.166)	15.6 (0.199)	20.1 (0.219)	17.5 (0.159)	15.5 (0.125)
720 (12.0)	1.5 (0.023)	5.8 (0.065)	8.6 (0.080)	11.3 (0.090)	16.8 (0.112)	21.0 (0.123)
1080 (18.0)	1.4 (0.018)	6.3 (0.058)	9.5 (0.073)	12.6 (0.082)	15.9 (0.087)	18.4 (0.089)
1440 (24.0)	0.0 (0.000)	4.1 (0.033)	6.8 (0.045)	9.4 (0.053)	11.4 (0.054)	13.0 (0.054)
2160 (36.0)	0.0 (0.000)	2.1 (0.014)	3.5 (0.020)	4.9 (0.023)	5.7 (0.022)	6.3 (0.022)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.5 (0.002)	0.8 (0.003)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	09 November 2021 02:06PM

Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2018_v1

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

25% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	16.8 (0.646)	16.9 (0.464)	16.9 (0.388)	17.0 (0.332)	21.4 (0.349)	24.7 (0.356)
90 (1.5)	12.8 (0.434)	16.2 (0.395)	18.4 (0.374)	20.5 (0.357)	19.4 (0.282)	18.5 (0.238)
120 (2.0)	9.3 (0.288)	20.3 (0.455)	27.5 (0.516)	34.4 (0.553)	30.8 (0.413)	28.1 (0.331)
180 (3.0)	27.4 (0.738)	36.4 (0.718)	42.5 (0.701)	48.2 (0.682)	44.4 (0.523)	41.5 (0.431)
360 (6.0)	21.4 (0.444)	40.4 (0.614)	53.0 (0.675)	65.0 (0.710)	76.0 (0.691)	84.2 (0.675)
720 (12.0)	30.1 (0.465)	36.1 (0.404)	40.1 (0.374)	43.9 (0.350)	56.5 (0.376)	66.0 (0.387)
1080 (18.0)	22.4 (0.289)	33.8 (0.312)	41.4 (0.317)	48.6 (0.318)	55.0 (0.299)	59.7 (0.288)
1440 (24.0)	14.4 (0.164)	25.0 (0.201)	32.0 (0.213)	38.8 (0.220)	41.1 (0.194)	42.8 (0.179)
2160 (36.0)	11.5 (0.111)	17.7 (0.119)	21.9 (0.120)	25.8 (0.121)	34.8 (0.136)	41.5 (0.144)
2880 (48.0)	3.7 (0.032)	5.4 (0.032)	6.5 (0.032)	7.6 (0.031)	12.4 (0.043)	16.0 (0.049)
4320 (72.0)	0.0 (0.000)	0.4 (0.002)	0.7 (0.003)	1.0 (0.004)	7.9 (0.024)	13.1 (0.035)

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	42.3 (1.622)	47.2 (1.297)	50.4 (1.154)	53.6 (1.048)	80.4 (1.313)	100.5 (1.448)
90 (1.5)	36.6 (1.240)	56.2 (1.373)	69.1 (1.410)	81.5 (1.423)	72.6 (1.057)	65.9 (0.846)
120 (2.0)	54.1 (1.672)	91.9 (2.063)	117.0 (2.194)	141.0 (2.265)	127.7 (1.711)	117.7 (1.390)
180 (3.0)	54.0 (1.455)	85.1 (1.678)	105.8 (1.746)	125.6 (1.776)	116.7 (1.376)	110.0 (1.143)
360 (6.0)	51.5 (1.070)	82.5 (1.255)	103.0 (1.313)	122.7 (1.340)	134.4 (1.223)	143.2 (1.149)
720 (12.0)	52.0 (0.803)	75.2 (0.842)	90.7 (0.846)	105.4 (0.841)	119.2 (0.792)	129.6 (0.761)
1080 (18.0)	47.1 (0.607)	64.9 (0.599)	76.8 (0.588)	88.1 (0.576)	104.1 (0.567)	116.1 (0.560)
1440 (24.0)	31.0 (0.352)	44.2 (0.356)	53.0 (0.353)	61.5 (0.348)	75.5 (0.357)	86.1 (0.361)
2160 (36.0)	38.1 (0.366)	44.6 (0.298)	48.9 (0.270)	53.0 (0.248)	72.7 (0.284)	87.4 (0.303)
2880 (48.0)	23.1 (0.199)	22.2 (0.132)	21.6 (0.105)	21.0 (0.087)	50.7 (0.176)	73.0 (0.224)
4320 (72.0)	6.0 (0.045)	19.3 (0.100)	28.2 (0.120)	36.7 (0.132)	38.5 (0.116)	39.9 (0.107)

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

	RCP 4.5	RCP6	**RCP 8.5**
2030	**0.869 (4.3%)**	0.783 (3.9%)	**0.983 (4.9%)**
2040	**1.057 (5.3%)**	1.014 (5.1%)	**1.349 (6.8%)**
2050	**1.272 (6.4%)**	1.236 (6.2%)	**1.773 (9.0%)**
2060	**1.488 (7.5%)**	1.458 (7.4%)	**2.237 (11.5%)**
2070	**1.676 (8.5%)**	1.691 (8.6%)	**2.722 (14.2%)**
2080	**1.810 (9.2%)**	1.944 (9.9%)	**3.209 (16.9%)**
2090	**1.862 (9.5%)**	2.227 (11.5%)	**3.679 (19.7%)**

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2019_v1
Note	ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	**50.0**	**20.0**	**10.0**	**5.0**	**2.0**	**1.0**
60 (1.0)	26.3	18.4	16.6	16.7	15.3	12.2
90 (1.5)	29.8	20.2	17.2	16.7	15.5	15.0
120 (2.0)	32.6	17.6	15.4	14.7	13.3	12.7
180 (3.0)	31.6	16.6	14.4	14.3	13.5	10.1
360 (6.0)	31.0	17.7	15.0	13.5	11.5	7.0
720 (12.0)	31.5	21.8	20.4	19.0	16.9	9.3
1080 (18.0)	33.7	24.5	23.0	21.5	18.6	11.4
1440 (24.0)	38.3	29.9	28.0	27.6	24.7	15.8
2160 (36.0)	39.3	32.7	31.7	32.4	27.9	13.6
2880 (48.0)	44.4	38.9	38.9	42.9	34.4	17.1
4320 (72.0)	48.3	42.1	40.8	45.4	37.8	25.5

Layer Info

Time Accessed	09 November 2021 02:06PM
Version	2018_v1
Note	As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

Download TXT (downloads/411f8dd7-0fb5-43e5-a4ba-647ce25bd86a.txt)

Download JSON (downloads/1870b270-e655-4c73-8e40-d9e1d7284fdc.json)

Generating PDF... (downloads/3cfdfd15-bfcc-4f5d-8d48-caeb9c147519.pdf)

APPENDIX D – MUSIC PARAMETERS, RESULTS & MUSIC-LINK REPORT

MUSIC Catchment Breakdown

110474 - MUSIC MODELLING WORKSHEET
Mulgoa GP3

		Catchment Division											Node Inputs						
														Standard (Normal)					
Catchment	Total Catchment Area (ha)	School	Passive Openspace	Active Openspace	Riparian Corridor	Local centre	Road	R2 Lot Area	R2 Lot area with RWT %	R2 Lot Area with RWT (ha)	R2 Lot Area with no RWT	R3 Lot Area	Road (ha)	Roof to Tank (ha)	Roof Bypass (ha)	Urban Impervious (ha)	Urban Pervious (ha)	Commercial (ha)	Total Area modelled (ha) (check)
Cat 1	4.36	0	0	0			1.18	3.18	100%	3.18	0.00	0	1.18	0.95	0.95	0.48	0.80	0.00	4.36
Cat 2	4.27	0.00	0.00	0.00			1.08	3.19	100%	3.19	0.00	0.00	1.08	0.96	0.96	0.48	0.80	0.00	4.27
Cat 3	16.46	0.00	0.00	0.55			4.60	11.31	100%	11.31	0.00	0.00	4.60	3.39	3.39	1.97	3.10	0.00	16.46
Cat 4	3.94	0.00	0.00	0.00			1.20	2.66	100%	2.66	0.00	0.08	1.20	0.80	0.86	0.41	0.68	0.00	3.94
Cat 5	7.91	0.00	0.00	0.00			1.20	6.71	100%	6.71	0.00	0.00	1.20	2.01	2.01	1.01	1.68	0.00	7.91
Cat 6	2.58	0.00	0.00	0.00			1.07	0.68	100%	0.68	0.00	0.83	1.07	0.20	0.83	0.19	0.29	0.00	2.58
Cat 7	4.77	0.00	0.00	0.00			1.89	2.25	100%	2.25	0.00	0.63	1.89	0.67	1.14	0.40	0.66	0.00	4.77
Cat 8	1.58	0.00	0.00	0.00			0.69	0.00	100%	0.00	0.00	0.89	0.69	0.00	0.67	0.09	0.13	0.00	1.58
Cat 9	28.73	0.00	0.89	1.74			7.78	16.45	100%	16.45	0.00	1.88	7.78	4.93	6.34	3.62	6.07	0.00	28.73
Cat 10	9.74	0.00	0.19	0.00			2.85	4.46	100%	4.46	0.00	2.24	2.85	1.34	3.02	0.91	1.62	0.00	9.74
Cat 11	3.22	0.00	0.00	0.00			1.10	1.81	100%	1.81	0.00	0.31	1.10	0.54	0.78	0.30	0.50	0.00	3.22
Cat 12	3.40	0.00	0.00	0.00			1.28	1.68	100%	1.68	0.00	0.43	1.28	0.50	0.83	0.30	0.48	0.00	3.40
Cat 13	0.47	0.00	0.00	0.00			0.14	0.34	100%	0.34	0.00	0.00	0.14	0.10	0.10	0.05	0.08	0.00	0.47
Cat 14	3.23	0.00	0.00	0.00			1.16	2.06	100%	2.06	0.00	0.00	1.16	0.62	0.62	0.31	0.52	0.00	3.23
Cat 15	2.51	0.00	0.00	0.00			1.14	0.93	100%	0.93	0.00	0.45	1.14	0.28	0.61	0.18	0.30	0.00	2.51
Cat 16	2.84	0.00	0.00	0.00			0.96	1.88	100%	1.88	0.00	0.00	0.96	0.56	0.56	0.28	0.47	0.00	2.84
Cat 17	5.65	0.00	0.00	0.00			1.58	1.45	100%	1.45	0.00	2.63	1.58	0.43	2.41	0.48	0.76	0.00	5.65
Cat 18	4.88	0.00	1.67	0.00		1.90	0.52	0.00	100%	0.00	0.00	0.79	0.52	0.00	0.59	0.25	1.62	1.90	4.88
Cat 19	8.93	2.00	0.15	5.03			1.19	0.55	100%	0.55	0.00	0.00	1.19	0.17	0.17	4.11	3.29	0.00	8.93
Cat 20	2.53	0.00	0.00	2.53			0.00	0.00	100%	0.00	0.00	0.00	0.00	0.00	0.00	1.27	1.27	0.00	2.53
Cat 21	2.77	0.00	0.00	2.77			0.00	0.00	100%	0.00	0.00	0.00	0.00	0.00	0.00	1.38	1.38	0.00	2.77
Cat 22	9.74	0.00	0.00	0.00	9.74		0.00	0.00	100%	0.00	0.00	0.00	0.00	0.00	0.00	0.49	9.25	0.00	9.74
Cat 23	20.31	0.00	0.00	0.00			5.52	14.79	100%	14.79	0.00	0.00	5.52	4.44	4.44	2.22	3.70	0.00	20.31
Cat 24	3.92	0.00	0.00	0.00			0.89	3.03	100%	3.03	0.00	0.00	0.89	0.91	0.91	0.45	0.76	0.00	3.92
Cat 25	1.39	0.00	0.00	0.00			0.35	1.04	100%	1.04	0.00	0.00	0.35	0.31	0.31	0.16	0.26	0.00	1.39
Cat 26	3.36	0.00	0.00	0.00			1.28	2.07	100%	2.07	0.00	0.00	1.28	0.62	0.62	0.31	0.52	0.00	3.36
Cat 27	15.31	0.00	1.02	0.00			4.27	10.02	100%	10.02	0.00	0.00	4.27	3.01	3.01	1.61	3.43	0.00	15.31
Ext Cat 1	24.77	0.00	0.00	0.00			0.00	0.00	100%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.77
Ext Cat 2	5.45	0.00	0.00	0.00			0.00	0.00	100%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.45
Total	209.02																		

MUSIC Rainwater Tank Inputs

				RAINWATER TANK						
					High Flow By-pass			Overflow Pipe Dia	PET - RAIN	
Catchment	**Lots**	**Equivalent Pipe Area (m^2)**	**Equivalent Pipe radius (m)**	**Total Area of Roof to Tank (ha)**	**1yr flow on roof (m^3/s)**	**Total Tank Volume (m^3)**	**Tank Surface Area (m^2)**	**Equivalent Pipe dia (mm)**	**Annual Demand (kL/yr)**	**Daily Demand (kL/day)**
Cat 1	80	0.156	0.223	0.95	0.20	191	149	446	3979	8.0
Cat 2	80	0.157	0.223	0.96	0.20	192	150	447	3990	8.0
Cat 3	283	0.555	0.420	3.39	0.71	679	530	841	14137	28.3
Cat 4	66	0.130	0.204	0.80	0.17	159	125	408	3323	6.6
Cat 5	168	0.329	0.324	2.01	0.42	403	315	648	8394	16.8
Cat 6	17	0.033	0.103	0.20	0.04	41	32	206	848	1.7
Cat 7	56	0.110	0.187	0.67	0.14	135	105	375	2809	5.6
Cat 8	0	0.000	0.000	0.00	0.00	0	0	0	0	0.0
Cat 9	411	0.807	0.507	4.93	1.03	987	771	1014	20556	41.1
Cat 10	111	0.219	0.264	1.34	0.28	267	209	528	5571	11.1
Cat 11	45	0.089	0.168	0.54	0.11	109	85	336	2262	4.5
Cat 12	42	0.082	0.162	0.50	0.10	101	79	324	2098	4.2
Cat 13	8	0.016	0.072	0.10	0.02	20	16	145	420	0.8
Cat 14	52	0.101	0.180	0.62	0.13	124	97	359	2580	5.2
Cat 15	23	0.045	0.120	0.28	0.06	56	43	240	1156	2.3
Cat 16	47	0.092	0.171	0.56	0.12	113	88	343	2348	4.7
Cat 17	36	0.071	0.150	0.43	0.09	87	68	301	1810	3.6
Cat 18	0	0.000	0.000	0.00	0.00	0	0	0	0	0.0
Cat 19	14	0.027	0.093	0.17	0.03	33	26	186	694	1.4
Cat 20	0	0.000	0.000	0.00	0.00	0	0	0	0	0.0
Cat 21	0	0.000	0.000	0.00	0.00	0	0	0	0	0.0
Cat 22	0	0.000	0.000	0.00	0.00	0	0	0	0	0.0
Cat 23	370	0.726	0.481	4.44	0.92	888	693	962	18492	37.0
Cat 24	76	0.149	0.218	0.91	0.19	182	142	435	3791	7.6
Cat 25	26	0.051	0.128	0.31	0.07	62	49	255	1301	2.6
Cat 26	52	0.102	0.180	0.62	0.13	124	97	360	2593	5.2
Cat 27	251	0.492	0.396	3.01	0.63	601	470	791	12526	25.1

PET - Rain for landscape area	50	kL/year/dwelling
Assumed Daily Demand	100	L/day
Adopted Tank Size	3	kL
Assumed 80% is useable (w/o topups)	80	%
Useable tank	2.4	kL
Assumed Tank height	1.6	m
I5min/1yr	75	mm/hr

MUSIC Modelling Parameters

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

Table D1 – Rainfall-Runoff Parameters for Penrith

Impervious Area Parameters	
Rainfall threshold (mm)	1.4
Pervious Area Parameters	
Soil Storage Capacity (mm)	105
Initial Storage (% of capacity)	30
Field Capacity (mm)	70
Infiltration Capacity Coefficient - a	150
Infiltration Capacity Coefficient - b	3.5
Groundwater Properties	
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	10
Daily Deep Seepage Rate (%)	0

Table D2 – Source Node Parameters

Surface Type	**TSS**		**TP**		**TN**	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Storm Flow						
Roof	1.3	0.32	-0.89	0.25	0.3	0.19
Road	2.43	0.32	-0.3	0.25	0.34	0.19
Impervious	2.15	0.32	-0.6	0.25	0.3	0.19
Pervious	2.15	0.32	-0.6	0.25	0.3	0.19
Base Flow						
Roof	-	-	-	-	-	-
All Surfaces	1.2	0.17	-0.85	0.19	0.11	0.12

MUSIC Modelling Results

A series of MUSIC reporting locations have been used to ensure that the development is achieving pollutant reduction targets at each receiving creek. The results at each location are reported below. Details of the reporting locations can be seen in Figure 7-1.

Table D3 – Report 1 – Summary of MUSIC Results

Pollutant	**Total Developed Source Loads**	**Total Reduction Required**	**Total Source Loads**	**Total Residual Load from Site**	**Total Reduction Achieved**	**Target Reduction Required**	**Total Reduction Achieved**
	(kg/yr)	**(kg/yr)**	**(kg/yr)**	**(kg/yr)**	**(kg/yr)**	**(%)**	**(%)**
TSS	3320	2822	7780	3430	4350	85.0%	131.0%
TP	7	4	15	9	6	60.0%	90.2%
TN	49	22	111	84	27	45.0%	55.1%
Gross Pollutants	585	527	891	0	891	90.0%	152.3%

Note that reporting location 1 includes external existing catchments which are not required to be treated by the proposed device in this location (pond MB1). Therefore, a load-based calculation has been used to isolate the load reduction that is required for the developed catchment and ensure that the treatment train achieves this reduction.

Table D4 – Report 2 – Summary of MUSIC Results

Pollutant	Total Developed Source Loads (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Target Reduction Required (%)	Total Reduction Achieved (%)
TSS	23200	3360	19840	85.0%	85.5%
TP	48	15.3	33	60.0%	68.3%
TN	359	152	207	45.0%	57.7%
Gross Pollutants	4330	126	4204	90.0%	97.1%

Table D5 – Report 3 – Summary of MUSIC Results

Pollutant	Total Developed Source Loads (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Target Reduction Required (%)	Total Reduction Achieved (%)
TSS	74300	10800	63500	85.0%	85.5%
TP	143	46.0	97	60.0%	67.8%
TN	984	466	518	45.0%	52.6%
Gross Pollutants	11600	11	11589	90.0%	99.9%

Table D6 – Report 4 – Summary of MUSIC Results

Pollutant	Total Developed Source Loads (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Target Reduction Required (%)	Total Reduction Achieved (%)
TSS	22000	2580	19420	85.0%	88.3%
TP	45	13.4	31	60.0%	70.0%
TN	321	158	163	45.0%	50.8%
Gross Pollutants	3900	14	3886	90.0%	99.6%

Table D7 – Report 5 – Summary of MUSIC Results

Pollutant	Total Developed Source Loads (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Target Reduction Required (%)	Total Reduction Achieved (%)
TSS	11800	1720	10080	85.0%	85.4%
TP	23	7.0	16	60.0%	70.2%
TN	164	68	96	45.0%	58.4%
Gross Pollutants	1950	57	1893	90.0%	97.1%

PENRITH CITY COUNCIL

music link

MUSIC-*link* Report

Project Details		Company Details	
Project:	Glenmore Park Stage 3 MU02	**Company:**	J. Wyndham Prince
Report Export Date:	12/04/2022	**Contact:**	David Crompton
Catchment Name:	110474-02-MU02	**Address:**	77 Union Road, Penrith NSW
Catchment Area:	28.74ha	**Phone:**	47203340
Impervious Area*:	77.48%	**Email:**	DCrompton@jwprince.com.au
Rainfall Station:	67113 PENRITH		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1999 - 31/12/2008 11:54:00 PM		
Mean Annual Rainfall:	691mm		
Evapotranspiration:	1158mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.34		
Study Area:	Penrith		
Scenario:	Penrith Development		

* 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: Junction	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	10.6%	Pond Node	4	Urban Source Node	132
TSS	2.12%	Rain Water Tank Node	23		
TP	5.37%	Bio Retention Node	9		
TN	10.6%	Generic Node	13		
GP	21.8%	GPT Node	21		

Comments

80% rainwater tank reuse rates will be achieved under BASIX requirements for residential lots.

Failing results are in the pre development node and therefore should be ignored.

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	Copy of Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	RG C	PET Scaling Factor	2.1	2.1	2.1
Bio	RG D	PET Scaling Factor	2.1	2.1	2.1
Bio	RG E	PET Scaling Factor	2.1	2.1	2.1
GPT	Cat 1 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.196
GPT	Cat 10 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.383
GPT	Cat 11 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.412
GPT	Cat 12 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.301
GPT	Cat 14 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.188
GPT	Cat 15 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.131
GPT	Cat 18 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.198
GPT	Cat 19 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.311
GPT	Cat 2 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.192
GPT	Cat 23 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.686
GPT	Cat 24 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.182
GPT	Cat 25 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.076
GPT	Cat 26 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.159
GPT	Cat 27 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.583
GPT	Cat 3 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.58
GPT	Cat 4 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.184
GPT	Cat 5 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.32
GPT	Cat 6 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.135
GPT	Cat 7 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.22
GPT	Cat 8 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.091
GPT	Cat 9 Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	1.011
Pond	Cat 1 Pond	% Reuse Demand Met	None	None	0
Pond	Cat 20 Pond	% Reuse Demand Met	None	None	0
Pond	MB3 Pond	% Reuse Demand Met	None	None	0
Pond	VB4 Pond	% Reuse Demand Met	None	None	0
Pre	Pre-Development Node	% Load Reduction	None	None	80.6
Pre	Pre-Development Node	TN % Load Reduction	45	None	78
Pre	Pre-Development Node	TP % Load Reduction	60	None	77.1
Receiving	Receiving Node	% Load Reduction	None	None	16.4
Receiving	Receiving Node	GP % Load Reduction	90	None	99.1
Receiving	Receiving Node	TN % Load Reduction	45	None	53.7

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Node Type	Node Name	Parameter	Min	Max	Actual
Receiving	Receiving Node	TP % Load Reduction	60	None	68.4
Receiving	Receiving Node	TSS % Load Reduction	85	None	86
Urban	Cat 1 50% Bypass Urban	Area Impervious (ha)	None	None	0.95
Urban	Cat 1 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 1 50% Bypass Urban	Total Area (ha)	None	None	0.95
Urban	Cat 1 Impervious	Area Impervious (ha)	None	None	0.48
Urban	Cat 1 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 1 Impervious	Total Area (ha)	None	None	0.48
Urban	Cat 1 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 1 Pervious	Area Pervious (ha)	None	None	0.8
Urban	Cat 1 Pervious	Total Area (ha)	None	None	0.8
Urban	Cat 1 Urban	Area Impervious (ha)	None	None	0.95
Urban	Cat 1 Urban	Area Impervious (ha)	None	None	1.119
Urban	Cat 1 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 1 Urban	Area Pervious (ha)	None	None	0.060
Urban	Cat 1 Urban	Total Area (ha)	None	None	0.95
Urban	Cat 1 Urban	Total Area (ha)	None	None	1.18
Urban	Cat 10 50% Bypass Urban	Area Impervious (ha)	None	None	3.02
Urban	Cat 10 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 10 50% Bypass Urban	Total Area (ha)	None	None	3.02
Urban	Cat 10 Impervious	Area Impervious (ha)	None	None	0.91
Urban	Cat 10 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 10 Impervious	Total Area (ha)	None	None	0.91
Urban	Cat 10 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 10 Pervious	Area Pervious (ha)	None	None	1.62
Urban	Cat 10 Pervious	Total Area (ha)	None	None	1.62
Urban	Cat 10 Urban	Area Impervious (ha)	None	None	1.34
Urban	Cat 10 Urban	Area Impervious (ha)	None	None	2.703
Urban	Cat 10 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 10 Urban	Area Pervious (ha)	None	None	0.146
Urban	Cat 10 Urban	Total Area (ha)	None	None	1.34
Urban	Cat 10 Urban	Total Area (ha)	None	None	2.85
Urban	Cat 11 50% Bypass Urban	Area Impervious (ha)	None	None	0.78
Urban	Cat 11 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 11 50% Bypass Urban	Total Area (ha)	None	None	0.78
Urban	Cat 11 Impervious	Area Impervious (ha)	None	None	0.3
Urban	Cat 11 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 11 Impervious	Total Area (ha)	None	None	0.3
Urban	Cat 11 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 11 Pervious	Area Pervious (ha)	None	None	0.5

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat 11 Pervious	Total Area (ha)	None	None	0.5
Urban	Cat 11 Urban	Area Impervious (ha)	None	None	0.54
Urban	Cat 11 Urban	Area Impervious (ha)	None	None	1.043
Urban	Cat 11 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 11 Urban	Area Pervious (ha)	None	None	0.056
Urban	Cat 11 Urban	Total Area (ha)	None	None	0.54
Urban	Cat 11 Urban	Total Area (ha)	None	None	1.1
Urban	Cat 12 50% Bypass Urban	Area Impervious (ha)	None	None	0.83
Urban	Cat 12 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 12 50% Bypass Urban	Total Area (ha)	None	None	0.83
Urban	Cat 12 Impervious	Area Impervious (ha)	None	None	0.3
Urban	Cat 12 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 12 Impervious	Total Area (ha)	None	None	0.3
Urban	Cat 12 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 12 Pervious	Area Pervious (ha)	None	None	0.48
Urban	Cat 12 Pervious	Total Area (ha)	None	None	0.48
Urban	Cat 12 Urban	Area Impervious (ha)	None	None	0.5
Urban	Cat 12 Urban	Area Impervious (ha)	None	None	1.214
Urban	Cat 12 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 12 Urban	Area Pervious (ha)	None	None	0.065
Urban	Cat 12 Urban	Total Area (ha)	None	None	0.5
Urban	Cat 12 Urban	Total Area (ha)	None	None	1.28
Urban	Cat 13 50% Bypass Urban	Area Impervious (ha)	None	None	0.1
Urban	Cat 13 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 13 50% Bypass Urban	Total Area (ha)	None	None	0.1
Urban	Cat 13 Impervious	Area Impervious (ha)	None	None	0.05
Urban	Cat 13 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 13 Impervious	Total Area (ha)	None	None	0.05
Urban	Cat 13 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 13 Pervious	Area Pervious (ha)	None	None	0.08
Urban	Cat 13 Pervious	Total Area (ha)	None	None	0.08
Urban	Cat 13 Urban	Area Impervious (ha)	None	None	0.1
Urban	Cat 13 Urban	Area Impervious (ha)	None	None	0.132
Urban	Cat 13 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 13 Urban	Area Pervious (ha)	None	None	0.007
Urban	Cat 13 Urban	Total Area (ha)	None	None	0.1
Urban	Cat 13 Urban	Total Area (ha)	None	None	0.14
Urban	Cat 14 50% Bypass Urban	Area Impervious (ha)	None	None	0.62
Urban	Cat 14 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 14 50% Bypass Urban	Total Area (ha)	None	None	0.62

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat 14 Impervious	Area Impervious (ha)	None	None	0.31
Urban	Cat 14 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 14 Impervious	Total Area (ha)	None	None	0.31
Urban	Cat 14 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 14 Pervious	Area Pervious (ha)	None	None	0.52
Urban	Cat 14 Pervious	Total Area (ha)	None	None	0.52
Urban	Cat 14 Urban	Area Impervious (ha)	None	None	0.62
Urban	Cat 14 Urban	Area Impervious (ha)	None	None	1.100
Urban	Cat 14 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 14 Urban	Area Pervious (ha)	None	None	0.059
Urban	Cat 14 Urban	Total Area (ha)	None	None	0.62
Urban	Cat 14 Urban	Total Area (ha)	None	None	1.16
Urban	Cat 15 50% Bypass Urban	Area Impervious (ha)	None	None	0.61
Urban	Cat 15 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 15 50% Bypass Urban	Total Area (ha)	None	None	0.61
Urban	Cat 15 Impervious	Area Impervious (ha)	None	None	0.18
Urban	Cat 15 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 15 Impervious	Total Area (ha)	None	None	0.18
Urban	Cat 15 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 15 Pervious	Area Pervious (ha)	None	None	0.3
Urban	Cat 15 Pervious	Total Area (ha)	None	None	0.3
Urban	Cat 15 Urban	Area Impervious (ha)	None	None	0.28
Urban	Cat 15 Urban	Area Impervious (ha)	None	None	1.081
Urban	Cat 15 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 15 Urban	Area Pervious (ha)	None	None	0.058
Urban	Cat 15 Urban	Total Area (ha)	None	None	0.28
Urban	Cat 15 Urban	Total Area (ha)	None	None	1.14
Urban	Cat 16 50% Bypass Urban	Area Impervious (ha)	None	None	0.56
Urban	Cat 16 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 16 50% Bypass Urban	Total Area (ha)	None	None	0.56
Urban	Cat 16 Impervious	Area Impervious (ha)	None	None	0.28
Urban	Cat 16 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 16 Impervious	Total Area (ha)	None	None	0.28
Urban	Cat 16 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 16 Pervious	Area Pervious (ha)	None	None	0.47
Urban	Cat 16 Pervious	Total Area (ha)	None	None	0.47
Urban	Cat 16 Urban	Area Impervious (ha)	None	None	0.56
Urban	Cat 16 Urban	Area Impervious (ha)	None	None	0.910
Urban	Cat 16 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 16 Urban	Area Pervious (ha)	None	None	0.049

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat 16 Urban	Total Area (ha)	None	None	0.56
Urban	Cat 16 Urban	Total Area (ha)	None	None	0.96
Urban	Cat 17 50% Bypass Urban	Area Impervious (ha)	None	None	2.41
Urban	Cat 17 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 17 50% Bypass Urban	Total Area (ha)	None	None	2.41
Urban	Cat 17 Impervious	Area Impervious (ha)	None	None	0.48
Urban	Cat 17 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 17 Impervious	Total Area (ha)	None	None	0.48
Urban	Cat 17 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 17 Pervious	Area Pervious (ha)	None	None	0.76
Urban	Cat 17 Pervious	Total Area (ha)	None	None	0.76
Urban	Cat 17 Urban	Area Impervious (ha)	None	None	0.43
Urban	Cat 17 Urban	Area Impervious (ha)	None	None	1.498
Urban	Cat 17 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 17 Urban	Area Pervious (ha)	None	None	0.081
Urban	Cat 17 Urban	Total Area (ha)	None	None	0.43
Urban	Cat 17 Urban	Total Area (ha)	None	None	1.58
Urban	Cat 18 Bypass Urban	Area Impervious (ha)	None	None	0.59
Urban	Cat 18 Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 18 Bypass Urban	Total Area (ha)	None	None	0.59
Urban	Cat 18 Impervious	Area Impervious (ha)	None	None	0.25
Urban	Cat 18 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 18 Impervious	Total Area (ha)	None	None	0.25
Urban	Cat 18 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 18 Pervious	Area Pervious (ha)	None	None	1.62
Urban	Cat 18 Pervious	Total Area (ha)	None	None	1.62
Urban	Cat 18 Urban	Area Impervious (ha)	None	None	0.493
Urban	Cat 18 Urban	Area Impervious (ha)	None	None	1.9
Urban	Cat 18 Urban	Area Pervious (ha)	None	None	0.026
Urban	Cat 18 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 18 Urban	Total Area (ha)	None	None	0.52
Urban	Cat 18 Urban	Total Area (ha)	None	None	1.9
Urban	Cat 19 50% Bypass Urban	Area Impervious (ha)	None	None	0.17
Urban	Cat 19 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 19 50% Bypass Urban	Total Area (ha)	None	None	0.17
Urban	Cat 19 Impervious	Area Impervious (ha)	None	None	4.11
Urban	Cat 19 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 19 Impervious	Total Area (ha)	None	None	4.11
Urban	Cat 19 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 19 Pervious	Area Pervious (ha)	None	None	3.29

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat 19 Pervious	Total Area (ha)	None	None	3.29
Urban	Cat 19 Urban	Area Impervious (ha)	None	None	1.128
Urban	Cat 19 Urban	Area Impervious (ha)	None	None	0.17
Urban	Cat 19 Urban	Area Pervious (ha)	None	None	0.061
Urban	Cat 19 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 19 Urban	Total Area (ha)	None	None	1.19
Urban	Cat 19 Urban	Total Area (ha)	None	None	0.17
Urban	Cat 2 50% Bypass Urban	Area Impervious (ha)	None	None	0.96
Urban	Cat 2 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 2 50% Bypass Urban	Total Area (ha)	None	None	0.96
Urban	Cat 2 Impervious	Area Impervious (ha)	None	None	0.48
Urban	Cat 2 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 2 Impervious	Total Area (ha)	None	None	0.48
Urban	Cat 2 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 2 Pervious	Area Pervious (ha)	None	None	0.8
Urban	Cat 2 Pervious	Total Area (ha)	None	None	0.8
Urban	Cat 2 Urban	Area Impervious (ha)	None	None	0.96
Urban	Cat 2 Urban	Area Impervious (ha)	None	None	1.024
Urban	Cat 2 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 2 Urban	Area Pervious (ha)	None	None	0.055
Urban	Cat 2 Urban	Total Area (ha)	None	None	0.96
Urban	Cat 2 Urban	Total Area (ha)	None	None	1.08
Urban	Cat 20 Impervious	Area Impervious (ha)	None	None	1.27
Urban	Cat 20 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 20 Impervious	Total Area (ha)	None	None	1.27
Urban	Cat 20 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 20 Pervious	Area Pervious (ha)	None	None	1.27
Urban	Cat 20 Pervious	Total Area (ha)	None	None	1.27
Urban	Cat 21 Impervious	Area Impervious (ha)	None	None	1.38
Urban	Cat 21 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 21 Impervious	Total Area (ha)	None	None	1.38
Urban	Cat 21 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 21 Pervious	Area Pervious (ha)	None	None	1.38
Urban	Cat 21 Pervious	Total Area (ha)	None	None	1.38
Urban	Cat 22 Impervious	Area Impervious (ha)	None	None	0.49
Urban	Cat 22 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 22 Impervious	Total Area (ha)	None	None	0.49
Urban	Cat 22 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 22 Pervious	Area Pervious (ha)	None	None	9.25
Urban	Cat 22 Pervious	Total Area (ha)	None	None	9.25

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat 23 50% Bypass Urban	Area Impervious (ha)	None	None	4.44
Urban	Cat 23 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 23 50% Bypass Urban	Total Area (ha)	None	None	4.44
Urban	Cat 23 Impervious	Area Impervious (ha)	None	None	2.22
Urban	Cat 23 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 23 Impervious	Total Area (ha)	None	None	2.22
Urban	Cat 23 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 23 Pervious	Area Pervious (ha)	None	None	3.7
Urban	Cat 23 Pervious	Total Area (ha)	None	None	3.7
Urban	Cat 23 Urban	Area Impervious (ha)	None	None	4.44
Urban	Cat 23 Urban	Area Impervious (ha)	None	None	5.235
Urban	Cat 23 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 23 Urban	Area Pervious (ha)	None	None	0.284
Urban	Cat 23 Urban	Total Area (ha)	None	None	4.44
Urban	Cat 23 Urban	Total Area (ha)	None	None	5.52
Urban	Cat 24 50% Bypass Urban	Area Impervious (ha)	None	None	0.91
Urban	Cat 24 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 24 50% Bypass Urban	Total Area (ha)	None	None	0.91
Urban	Cat 24 Impervious	Area Impervious (ha)	None	None	0.45
Urban	Cat 24 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 24 Impervious	Total Area (ha)	None	None	0.45
Urban	Cat 24 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 24 Pervious	Area Pervious (ha)	None	None	0.76
Urban	Cat 24 Pervious	Total Area (ha)	None	None	0.76
Urban	Cat 24 Urban	Area Impervious (ha)	None	None	0.91
Urban	Cat 24 Urban	Area Impervious (ha)	None	None	0.844
Urban	Cat 24 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 24 Urban	Area Pervious (ha)	None	None	0.045
Urban	Cat 24 Urban	Total Area (ha)	None	None	0.91
Urban	Cat 24 Urban	Total Area (ha)	None	None	0.89
Urban	Cat 25 50% Bypass Urban	Area Impervious (ha)	None	None	0.31
Urban	Cat 25 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 25 50% Bypass Urban	Total Area (ha)	None	None	0.31
Urban	Cat 25 Impervious	Area Impervious (ha)	None	None	0.16
Urban	Cat 25 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 25 Impervious	Total Area (ha)	None	None	0.16
Urban	Cat 25 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 25 Pervious	Area Pervious (ha)	None	None	0.26
Urban	Cat 25 Pervious	Total Area (ha)	None	None	0.26
Urban	Cat 25 Urban	Area Impervious (ha)	None	None	0.31

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat 25 Urban	Area Impervious (ha)	None	None	0.331
Urban	Cat 25 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 25 Urban	Area Pervious (ha)	None	None	0.018
Urban	Cat 25 Urban	Total Area (ha)	None	None	0.31
Urban	Cat 25 Urban	Total Area (ha)	None	None	0.35
Urban	Cat 26 50% Bypass Urban	Area Impervious (ha)	None	None	0.62
Urban	Cat 26 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 26 50% Bypass Urban	Total Area (ha)	None	None	0.62
Urban	Cat 26 Impervious	Area Impervious (ha)	None	None	0.31
Urban	Cat 26 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 26 Impervious	Total Area (ha)	None	None	0.31
Urban	Cat 26 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 26 Pervious	Area Pervious (ha)	None	None	0.52
Urban	Cat 26 Pervious	Total Area (ha)	None	None	0.52
Urban	Cat 26 Urban	Area Impervious (ha)	None	None	0.62
Urban	Cat 26 Urban	Area Impervious (ha)	None	None	1.214
Urban	Cat 26 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 26 Urban	Area Pervious (ha)	None	None	0.065
Urban	Cat 26 Urban	Total Area (ha)	None	None	0.62
Urban	Cat 26 Urban	Total Area (ha)	None	None	1.28
Urban	Cat 27 50% Bypass Urban	Area Impervious (ha)	None	None	3.01
Urban	Cat 27 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 27 50% Bypass Urban	Total Area (ha)	None	None	3.01
Urban	Cat 27 Impervious	Area Impervious (ha)	None	None	1.61
Urban	Cat 27 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 27 Impervious	Total Area (ha)	None	None	1.61
Urban	Cat 27 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 27 Pervious	Area Pervious (ha)	None	None	3.43
Urban	Cat 27 Pervious	Total Area (ha)	None	None	3.43
Urban	Cat 27 Urban	Area Impervious (ha)	None	None	3.01
Urban	Cat 27 Urban	Area Impervious (ha)	None	None	4.049
Urban	Cat 27 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 27 Urban	Area Pervious (ha)	None	None	0.220
Urban	Cat 27 Urban	Total Area (ha)	None	None	3.01
Urban	Cat 27 Urban	Total Area (ha)	None	None	4.27
Urban	Cat 3 50% Bypass Urban	Area Impervious (ha)	None	None	3.39
Urban	Cat 3 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 3 50% Bypass Urban	Total Area (ha)	None	None	3.39
Urban	Cat 3 Impervious	Area Impervious (ha)	None	None	1.97
Urban	Cat 3 Impervious	Area Pervious (ha)	None	None	0

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat 3 Impervious	Total Area (ha)	None	None	1.97
Urban	Cat 3 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 3 Pervious	Area Pervious (ha)	None	None	3.1
Urban	Cat 3 Pervious	Total Area (ha)	None	None	3.1
Urban	Cat 3 Urban	Area Impervious (ha)	None	None	3.39
Urban	Cat 3 Urban	Area Impervious (ha)	None	None	4.362
Urban	Cat 3 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 3 Urban	Area Pervious (ha)	None	None	0.237
Urban	Cat 3 Urban	Total Area (ha)	None	None	3.39
Urban	Cat 3 Urban	Total Area (ha)	None	None	4.6
Urban	Cat 4 50% Bypass Urban	Area Impervious (ha)	None	None	0.86
Urban	Cat 4 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 4 50% Bypass Urban	Total Area (ha)	None	None	0.86
Urban	Cat 4 Impervious	Area Impervious (ha)	None	None	0.41
Urban	Cat 4 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 4 Impervious	Total Area (ha)	None	None	0.41
Urban	Cat 4 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 4 Pervious	Area Pervious (ha)	None	None	0.68
Urban	Cat 4 Pervious	Total Area (ha)	None	None	0.68
Urban	Cat 4 Urban	Area Impervious (ha)	None	None	0.8
Urban	Cat 4 Urban	Area Impervious (ha)	None	None	1.138
Urban	Cat 4 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 4 Urban	Area Pervious (ha)	None	None	0.061
Urban	Cat 4 Urban	Total Area (ha)	None	None	0.8
Urban	Cat 4 Urban	Total Area (ha)	None	None	1.2
Urban	Cat 5 50% Bypass Urban	Area Impervious (ha)	None	None	2.01
Urban	Cat 5 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 5 50% Bypass Urban	Total Area (ha)	None	None	2.01
Urban	Cat 5 Impervious	Area Impervious (ha)	None	None	1.01
Urban	Cat 5 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 5 Impervious	Total Area (ha)	None	None	1.01
Urban	Cat 5 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 5 Pervious	Area Pervious (ha)	None	None	1.68
Urban	Cat 5 Pervious	Total Area (ha)	None	None	1.68
Urban	Cat 5 Urban	Area Impervious (ha)	None	None	2.01
Urban	Cat 5 Urban	Area Impervious (ha)	None	None	1.138
Urban	Cat 5 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 5 Urban	Area Pervious (ha)	None	None	0.061
Urban	Cat 5 Urban	Total Area (ha)	None	None	2.01
Urban	Cat 5 Urban	Total Area (ha)	None	None	1.2

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat 6 50% Bypass Urban	Area Impervious (ha)	None	None	0.83
Urban	Cat 6 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 6 50% Bypass Urban	Total Area (ha)	None	None	0.83
Urban	Cat 6 Impervious	Area Impervious (ha)	None	None	0.19
Urban	Cat 6 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 6 Impervious	Total Area (ha)	None	None	0.19
Urban	Cat 6 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 6 Pervious	Area Pervious (ha)	None	None	0.29
Urban	Cat 6 Pervious	Total Area (ha)	None	None	0.29
Urban	Cat 6 Urban	Area Impervious (ha)	None	None	0.2
Urban	Cat 6 Urban	Area Impervious (ha)	None	None	1.014
Urban	Cat 6 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 6 Urban	Area Pervious (ha)	None	None	0.055
Urban	Cat 6 Urban	Total Area (ha)	None	None	0.2
Urban	Cat 6 Urban	Total Area (ha)	None	None	1.07
Urban	Cat 7 50% Bypass Urban	Area Impervious (ha)	None	None	1.14
Urban	Cat 7 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 7 50% Bypass Urban	Total Area (ha)	None	None	1.14
Urban	Cat 7 Impervious	Area Impervious (ha)	None	None	0.4
Urban	Cat 7 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 7 Impervious	Total Area (ha)	None	None	0.4
Urban	Cat 7 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 7 Pervious	Area Pervious (ha)	None	None	0.66
Urban	Cat 7 Pervious	Total Area (ha)	None	None	0.66
Urban	Cat 7 Urban	Area Impervious (ha)	None	None	0.67
Urban	Cat 7 Urban	Area Impervious (ha)	None	None	1.792
Urban	Cat 7 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 7 Urban	Area Pervious (ha)	None	None	0.097
Urban	Cat 7 Urban	Total Area (ha)	None	None	0.67
Urban	Cat 7 Urban	Total Area (ha)	None	None	1.89
Urban	Cat 8 Bypass Urban	Area Impervious (ha)	None	None	0.67
Urban	Cat 8 Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 8 Bypass Urban	Total Area (ha)	None	None	0.67
Urban	Cat 8 Impervious	Area Impervious (ha)	None	None	0.09
Urban	Cat 8 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 8 Impervious	Total Area (ha)	None	None	0.09
Urban	Cat 8 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 8 Pervious	Area Pervious (ha)	None	None	0.13
Urban	Cat 8 Pervious	Total Area (ha)	None	None	0.13
Urban	Cat 8 Urban	Area Impervious (ha)	None	None	0.654

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat 8 Urban	Area Pervious (ha)	None	None	0.035
Urban	Cat 8 Urban	Total Area (ha)	None	None	0.69
Urban	Cat 9 50% Bypass Urban	Area Impervious (ha)	None	None	6.34
Urban	Cat 9 50% Bypass Urban	Area Pervious (ha)	None	None	0
Urban	Cat 9 50% Bypass Urban	Total Area (ha)	None	None	6.34
Urban	Cat 9 Impervious	Area Impervious (ha)	None	None	3.62
Urban	Cat 9 Impervious	Area Pervious (ha)	None	None	0
Urban	Cat 9 Impervious	Total Area (ha)	None	None	3.62
Urban	Cat 9 Pervious	Area Impervious (ha)	None	None	0
Urban	Cat 9 Pervious	Area Pervious (ha)	None	None	6.07
Urban	Cat 9 Pervious	Total Area (ha)	None	None	6.07
Urban	Cat 9 Urban	Area Impervious (ha)	None	None	4.93
Urban	Cat 9 Urban	Area Impervious (ha)	None	None	7.379
Urban	Cat 9 Urban	Area Pervious (ha)	None	None	0
Urban	Cat 9 Urban	Area Pervious (ha)	None	None	0.400
Urban	Cat 9 Urban	Total Area (ha)	None	None	4.93
Urban	Cat 9 Urban	Total Area (ha)	None	None	7.78
Urban	Existing Cat - Report 1	Area Impervious (ha)	None	None	0
Urban	Existing Cat - Report 1	Area Pervious (ha)	None	None	29.13
Urban	Existing Cat - Report 1	Total Area (ha)	None	None	29.13
Urban	Existing Cat - Report 2	Area Impervious (ha)	None	None	0
Urban	Existing Cat - Report 2	Area Pervious (ha)	None	None	32.59
Urban	Existing Cat - Report 2	Total Area (ha)	None	None	32.59
Urban	Existing Cat - Report 3	Area Impervious (ha)	None	None	0
Urban	Existing Cat - Report 3	Area Pervious (ha)	None	None	103
Urban	Existing Cat - Report 3	Total Area (ha)	None	None	103
Urban	Existing Cat - Report 4	Area Impervious (ha)	None	None	0
Urban	Existing Cat - Report 4	Area Pervious (ha)	None	None	28.98
Urban	Existing Cat - Report 4	Total Area (ha)	None	None	28.98
Urban	Existing Cat - Report 5	Area Impervious (ha)	None	None	0
Urban	Existing Cat - Report 5	Area Pervious (ha)	None	None	15.31
Urban	Existing Cat - Report 5	Total Area (ha)	None	None	15.31
Urban	Ext Cat 1	Area Impervious (ha)	None	None	1.213
Urban	Ext Cat 1	Area Pervious (ha)	None	None	23.55
Urban	Ext Cat 1	Total Area (ha)	None	None	24.77
Urban	Ext Cat 2	Area Impervious (ha)	None	None	0.862
Urban	Ext Cat 2	Area Pervious (ha)	None	None	4.587
Urban	Ext Cat 2	Total Area (ha)	None	None	5.45

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PENRITH
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Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	99	100
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	99	100
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	99	100
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	99	100
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	99	100
Bio	Copy of Bioretention	Hi-flow bypass rate (cum/sec)	None	99	100
Bio	RG C	Hi-flow bypass rate (cum/sec)	None	99	100
Bio	RG D	Hi-flow bypass rate (cum/sec)	None	99	100
Bio	RG E	Hi-flow bypass rate (cum/sec)	None	99	100
Pre	Pre-Development Node	GP % Load Reduction	90	None	0
Pre	Pre-Development Node	TSS % Load Reduction	85	None	75.3
Rain	Cat 1 Rainwater Tank	% Reuse Demand Met	80	None	41.30
Rain	Cat 10 Rainwater Tank	% Reuse Demand Met	80	None	41.63
Rain	Cat 11 Rainwater Tank	% Reuse Demand Met	80	None	41.63
Rain	Cat 12 Rainwater Tank	% Reuse Demand Met	80	None	41.4227
Rain	Cat 13 Rainwater Tank	% Reuse Demand Met	80	None	41.98
Rain	Cat 14 Rainwater Tank	% Reuse Demand Met	80	None	41.46
Rain	Cat 15 Rainwater Tank	% Reuse Demand Met	80	None	41.85
Rain	Cat 16 Rainwater Tank	% Reuse Demand Met	80	None	41.5757
Rain	Cat 17 Rainwater Tank	% Reuse Demand Met	80	None	41.5751
Rain	Cat 19 Rainwater Tank	% Reuse Demand Met	80	None	41.594
Rain	Cat 2 Rainwater Tank	% Reuse Demand Met	80	None	41.5516
Rain	Cat 23 Rainwater Tank	% Reuse Demand Met	80	None	41.50
Rain	Cat 24 Rainwater Tank	% Reuse Demand Met	80	None	41.6711
Rain	Cat 25 Rainwater Tank	% Reuse Demand Met	80	None	41.33
Rain	Cat 26 Rainwater Tank	% Reuse Demand Met	80	None	41.39
Rain	Cat 27 Rainwater Tank	% Reuse Demand Met	80	None	41.5542
Rain	Cat 3 Rainwater Tank	% Reuse Demand Met	80	None	41.4471
Rain	Cat 4 Rainwater Tank	% Reuse Demand Met	80	None	41.7797
Rain	Cat 5 Rainwater Tank	% Reuse Demand Met	80	None	58.26
Rain	Cat 6 Rainwater Tank	% Reuse Demand Met	80	None	41.40
Rain	Cat 7 Rainwater Tank	% Reuse Demand Met	80	None	41.53
Rain	Cat 9 Rainwater Tank	% Reuse Demand Met	80	None	41.4777
Rain	Rainwater Tank	% Reuse Demand Met	80	None	16.09

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