SOUTH CREEK WEST SUB-PRECINCT 5 PLANNING PROPOSAL

MERIT ASSESSMENT FOR ONLINE DRY BASINS

COBBITTY

SEPTEMBER 2024

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CONTENTS

APPENDICES

1 COBBITTY SUB-PRECINCT 5

1.1 Purpose of this Report

This report has been prepared in relation to a rezoning proposal for land situated in Cobbitty, within Sub-Precinct 5 of the South Creek West Precinct, forming part of the South West Growth Area. The Planning Proposal seeks approval to amend the *State Environmental Planning Policy (Precincts – Western Parkland City) 2021* (Parkland City SEPP) for the site located on the western side of The Northern Road and positioned between the zoned precincts of Oran Park to the south and the Lowes Creek Maryland to the north. The rezoning process, which has been ongoing for several years, has been guided by an Indicative Layout Plan (ILP) informed by comprehensive on-site investigations and specialist background studies.

To enable the Planning Proposal process to progress to completion, it is necessary to seek concurrence and approval from the *Department of Climate Change, Energy, the Environment and Water* (DCCEEW) formerly the *Natural Resource Access Regulator* (NRAR) on the method for managing stormwater within the Precinct which includes land containing a riparian corridor.

The report is focused on the proposal to provide several online dry basins within portions of the sites riparian corridors. The report provides an assessment against the Objects and Principles of the *Water Management Act 2000* as the key NSW legislation governing the management of the State's water resources and a merit assessment against the *Guidelines for Riparian Corridors on Waterfront Land* (the Guidelines) (*Natural Resource Access Regulator* now the *Department of Climate Change, Energy, the Environment and Water*) (DCCEEW).

This review and assessment focuses on five main elements in justifying the proposal for online dry basins and has been informed with assistance from Stormwater Engineers (JWP) and Ecologists (Eco Logical Australia):

- The economic use of land to deliver on the Government directives for new housing;
- Net beneficial biodiversity outcomes;
- Marginal additional flooding impact relative to what would occur from the required road and pedestrian crossings alone;
- Other online basins in the locality including lower portions of the same creekline;
- Government return on major infrastructure investment, including rail, road, sewer and water infrastructure.

This review has determined the future development as envisaged through the ILP will achieve the principles of ecological sustainable development and deliver the optimum social, economic and environmental outcome which is fully compliant with the 'Objects and Principles' of the *Water Management Act 2000* (WM Act), while also worthy of approval considering the provided merit assessment against the Guidelines.

1.2 Property Details

The property details for the Precinct 5 Planning Proposal are detailed below and shown in Figure 1.

- Lot 2, 4 and part Lot 3 DP1216380
- Lot 500 DP1231858
- Lot 4 DP1273487

Figure 1: Rezoning Property Details

1.3 Regional and Local Context

Cobbitty is located within Camden Local Government Area in South West Sydney, approximately 50km from the Sydney CBD, 16km from the Western Sydney Airport and Aerotropolis, 14km from the Campbelltown CBD and 5km from the Narellan Town Centre. The subject site forms part of the South Creek West Land Release Area in the South West Growth Area, and is identified as Sub-Precinct 5.

The site is located on the western side of The Northern Road with the Lowes Creek Maryland Precinct to the north, the Pondicherry Precinct to the east and the developing areas of Oxley Ridge and Arcadian Hills to the south. The site is ideally located for urban development as envisaged.

The site is well serviced by major transport infrastructure including the adjoining The Northern Road and nearby Camden Valley Way to the east. The extension of Gregory Hills Drive also provides a direct regional road link to Campbelltown Train Station and the northbound entry to the Hume Highway. The South West Rail Link is also now operational with Leppington Station situated approximately 7.5km north east of the site accessed via Camden Valley Way.

Sydney Water infrastructure works are constructing two water reservoirs on the southern ridgeline within the property. Additionally, a sewer pump station is under construction at the junction of South Creek and Lowes Creek. Both infrastructure projects will provide essential services to support the site's development.

The site and surrounding region has in the past been used predominantly for agricultural purposes. However since the establishment of the South West Growth Area in 2005, the surrounding area has seen significant change with the area being pivotal to the State Governments long term strategy to manage urban growth and development in the Sydney Metropolitan Region.

1.4 Existing Site Characteristics

The site is zoned RU1 Primary Production under the Camden Local Environmental Plan 2010 and has functioned as a rural property for decades. It is predominantly cleared of significant vegetation, consisting mainly of exotic pasture grasses with no ecological value.

Although the land is bio-certified under the Western Parkland City SEPP, several scattered clusters of remnant Cumberland Plain Woodland remain across the site, varying in both size and quality.

The site’s topography is shaped by a ridgeline along the southern boundary, sloping northwards and westward, forming a natural amphitheatre to the north and east. A major ridgeline outside the site, to the southwest, rises to a high point of 164m, creating a natural barrier between the site and the Denbigh heritage homestead and its curtilage. Within the site, a minor ridgeline peaks at 154m, where Sydney Water is constructing a water reservoir.

The lower areas of the site are defined by two main creek corridors that flow northward, traversing the Lowes Creek Maryland precinct before joining Lowes Creek, a tributary of South Creek, which lies east of The Northern Road. Multiple farm dams are scattered along the creek lines, both within the site and downstream.

These creek lines have been modified from their natural state due to activities such as dam construction, crossings, removal of native riparian vegetation for agriculture, and increased sediment and nutrient transport.

2 PLANNING POLICIES AND FRAMEWORK

The below briefly outlines the relevant planning policies and framework needing consideration when seeking to rezone land within the South West Growth Area. Additional justifications and assessment of those are provided in section *4.0 Merrit Assessment* and *5.0 Statutory Planning Assessment*.

2.1 National Housing Accord

The National Housing Accord has set a target to build 1.2 million new homes over 5 years commencing mid-2024. This has been backed by the National Cabinet who has endorsed the Commonwealth providing $3.5 billion in payments to state, territory and local governments to support the delivery of new homes towards this target.

Camden's five year target is set at 10,200 dwellings with financial incentives linked to help fund the delivery of infrastructure including roads, open spaces and community facilities.

Located within the South West Growth Area, the site is ideally situated to assist Camden Council in achieving their target with the rezoning to contribute approximately 2,312 dwellings over the life of the project.

2.2 Western Parkland City Blueprint

The Western Parkland City Blueprint establishes a set of short and medium-term priorities for government, to guide investment towards 2036. It's a companion piece to the Economic Development Roadmap – Phase 1 (Roadmap), and will guide the investment and decision making of the Western Parkland City Authority.

The Blueprint sets out a vision made up of themes of green, connected and advanced. These themes are underpinned by a series of directions and priorities. The directions that are of relevance to the biodiversity and water cycle management aspects of the Planning Proposal include:

- **Improve the city's amenity:** The Planning Proposal includes the provision of various parklands and open space that are co-located with the retained riparian corridors. Tree cover is enhanced through the open space and the requirement for tree planting and water sensitive urban design throughout the public domain and road verges.
- **Support integrated water cycle management:** The Planning Proposal will facilitate the delivery of an integrated water cycle management system, including one wet and several dry basins and an integrated offline water quality treatment train ensuring all stormwater is cleaned to the relevant standards prior to entering the natural creek system.
- **Protect and enhance biodiversity and the natural environment:** The ILP retains significant amounts of high biodiversity value vegetation, particularly around the riparian corridor, despite the site being entirely biodiversity certified. The riparian corridor and vegetation will be co-located with open space, and will be an integrated part to the future community through the provision of active transport networks and the inherent amenity benefits.
- **Strengthen resilience to climate change and natural hazards:** The site today is comprised mostly of exotic pasture grasses with no ecological value. By establishing connected biodiversity corridors and significant native public domain tree canopy, the site will be transformed into a resilient and sustainable future community
- **Plan and deliver active transport connections:** The ILP is underpinned by an active transport network that is co-located with open space and the riparian corridors.
- **Enable integrated delivery:** The Planning Proposal will facilitate the concurrent delivery of housing, alongside public utilities, community and transport infrastructure, water cycle management facilities and biodiversity corridors.
- **Strengthen connection to Country:** Where possible the design of the ILP and Planning Proposal has considered the now finalised Designing with Country Framework. This is evident in the retention of ridgelines and enhancement of environmental corridors with tangible connections for community enjoyment. This is despite the framework having been initiated and finalised after the design of the ILP and submission of the Planning Proposal.

The Planning Proposal contributes significantly to the Western Parkland City vision by activating a key precinct within the South west Growth Centre that will address the above directions, and help achieve the planning prioritise for the area.

2.3 State Environmental Planning Policy (Precincts – Western Parkland City) 2021

The Western Parkland City SEPP contains planning provisions for Precincts within the Western Parkland City, including the South West Growth Area in which Cobbitty is located.

The aims of the SEPP are to:

(a) to co-ordinate the release of land for residential, employment and other urban development in the South West Growth Centre, the Wilton Growth Area and the Greater Macarthur Growth Area,
(b) to enable the Minister from time to time to designate land in growth centres as ready for release for development,
(c) to provide for comprehensive planning for growth centres,
(d) to enable the establishment of vibrant, sustainable and liveable neighbourhoods that provide for community well-being and high quality local amenity,
(e) to provide controls for the sustainability of land in growth centres that has conservation value,
(f) to provide for the orderly and economic provision of infrastructure in and to growth centres,
(g) to provide development controls in order to protect the health of the waterways in growth centres,
(h) to protect and enhance land with natural and cultural heritage value,
(i) to provide land use and development controls that will contribute to the conservation of biodiversity.

Further the Western Parkland City SEPP outlines development controls for:

- determining development applications (DA's) prior to and after the finalisation of the Precinct Planning Process;
- flood prone land and major creeks lands;
- clearing native vegetation; and
- cultural heritage landscape areas.

The Planning Proposal has sought amendments to the SEPP to establish the future zoning and development provisions for the site. Specifically, the proposal seeks to zone the land in accordance with the *Western Parkland City SEPP, Appendix 5 Camden Growth Centres Precinct Plan* and will include *C2 Environmental Conservation* zoning along with *Riparian Protection Area* and *Native Vegetation Retention Area* mapping of the riparian corridors. These provisions will ensure the long term protection and enhancement of the riparian corridors through the development process and future community enjoyment.

2.4 Water Management Act 2000

The key NSW legislation governing the management of the State's water resources is the WM Act. The main objective of the WM Act is to manage NSW water in a sustainable and integrated manner that will benefit both present and future generations. The WM Act is administered by DCCEEW and establishes an approval regime for activities within waterfront land, defined as the land 40m from the highest bank of a river, lake or estuary.

2.5 Guidelines for Riparian Corridors on Waterfront Land

DCCEEW, has *Guidelines for Controlled Activity Approvals*, including in-stream works, laying pipes and cables, outlet structures, riparian corridors, vegetation management and watercourse crossings. The Guidelines provide essential information on how to safeguard the state's water resources and stay compliant when carrying out activities that require a controlled activity approval.

The Guidelines for Controlled Activities on Waterfront Land — Riparian Corridors (NRAR, 2018) provides a standardised assessment matrix for Riparian Corridors, with widths based on the Strahler stream order system. Where a proposal does not conform with the Guidelines, a merit assessment pathway is required to ensure the proposal meets the requirements of the WM Act.

The ILP seeks to provide three online dry basins within 2^{nd}, 3^{rd} and 4^{th} order streams as part of a holistic urban design, stormwater and biodiversity strategy for the site. Locating online basins within 3^{rd} and 4^{th} order streams is inconsistent with the assessment matrix provided within the Guidelines and therefore requires a merit assessment for review by DEECCW.

This report has been prepared to provide evidence that a thorough review has been conducted of the site conditions, environmental factors and government policy which when combined and on merit justify the proposed online dry detention basins. The report concludes that the proposed online dry basins are best placed to achieve the principles of ecologically sustainable development and deliver the optimum social, economic and environmental outcomes which are fully compliant with the Objects and Principles of the WM Act.

2.6 Greener Places, Healthier Waterways: A Vision for the Camden Green and Blue Grid

Camden Council's *Greener Places, Healthier Waterways A Vision for the Camden Green and Blue Grid* sets the long-term strategic vision to create greener places and healthier waterways across the Camden area. It outlines Council's approach for joining and enhancing green open spaces, biodiversity corridors, riparian areas, and natural bushland (the Green Grid) using creeks, rivers and lakes (the Blue Grid) as the spine for these connections.

The objective of the strategy is to encourage the development of sustainable, healthy and livable communities which are integrated with natural environment. This is to be achieved through the long-term aspirational goals of the policy, which seek to:

- improve and retain remnant vegetation, particularly along waterways;
- reconnect and protect biodiversity corridors;
- provide recreational trails for community enjoyment, healthy living and engagement;
- provide urban green links promoting walking and cycling;
- ensure constrained easement and flood prone land is utilised as green recreational spaces;
- use native trees within streets and urban areas;
- ensure river walks are extended along the main waterways of the Nepean River, South Creek, Cobbitty Creek and Bringelly Creek; and
- ensure water sensitive urban design principles are promoted, monitored and enhanced.

The Planning Proposal aligns with the policy's goals by preserving pockets of remnant native vegetation within designated environmental corridors. These areas will be enhanced through revegetation and eventually reconnected to the broader local and regional biodiversity networks, addressing the site's current lack of ecological connectivity. Additionally, pedestrian and cycling paths will be incorporated into the riparian buffers, seamlessly blending these natural corridors with the future community and promoting healthy living principles. Further, the principles of water sensitive urban design are promoted through the proposal, with all water quality, detention and flooding objectives achieved.

3 PROPOSED INDICATIVE LAYOUT PLAN

The ILP has been shaped by the below site-specific design considerations and the South West Growth Area Structure Plan, combined with fundamental urban design concepts to create a refined and cohesive plan for shaping a future community:

- Create a new local centre combined with a new primary school to establish a community focal point.
- Provide opportunities for a diverse mix of housing types, with medium density housing located around the local centre and major open space amenity.
- Integrate the development with the existing Oxley Ridge and Oran Park Precinct to the south and west and the upcoming Lowes Creek Maryland Precinct to the north.
- Retain key creek lines and capitalise on the opportunity to create a central green link and smaller green links throughout the precinct.
- Retain existing significant vegetation and enhance local biodiversity.
- Improve water quality, water flow and the health of riparian corridors.
- Manage and retain views within and beyond the site.
- Provide movement links between the Oran Park Precinct and Lowes Creek Maryland Precinct, creating a meaningful urban road network.
- Utilise landscaping and topography on the eastern boundary to manage noise.
- Promote pedestrian and cycle linkages.

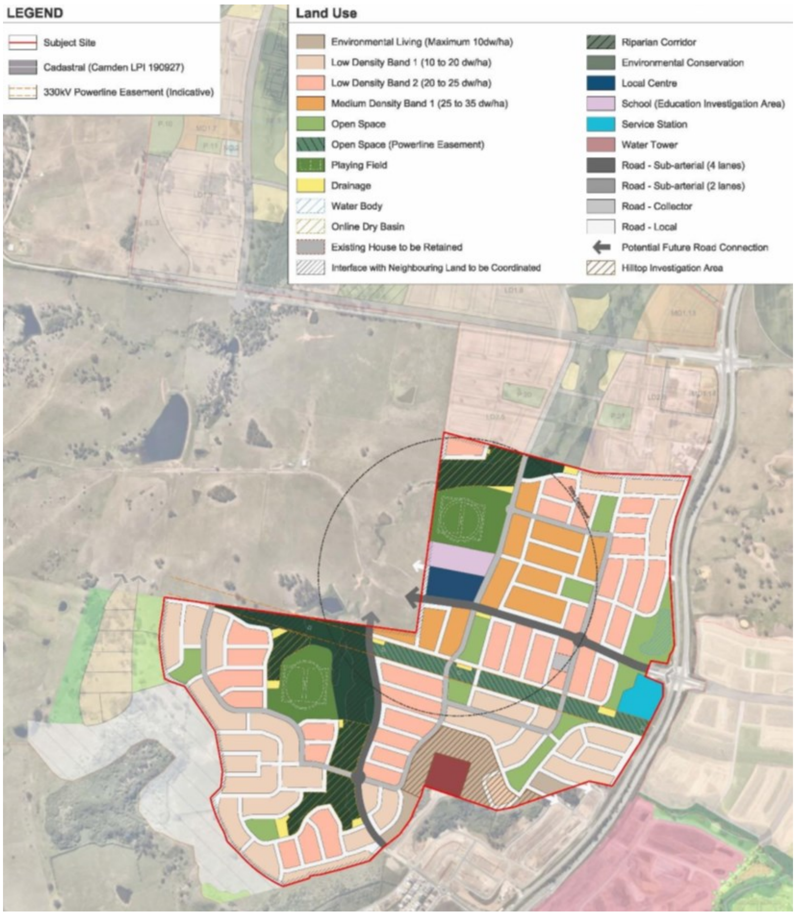


Figure 2: Cobbitty ILP (Design+Planning)

3.1 Proposed Riparian Corridors

Eco Logical Australia (ELA) were engaged as part of the planning proposal process to undertake the riparian corridor assessment including Strahler stream order classification and field validation, which took place on the 19-20 February 2020.

The results of this assessment are shown in Figure 3 below, with the report provided as Appendix 1.

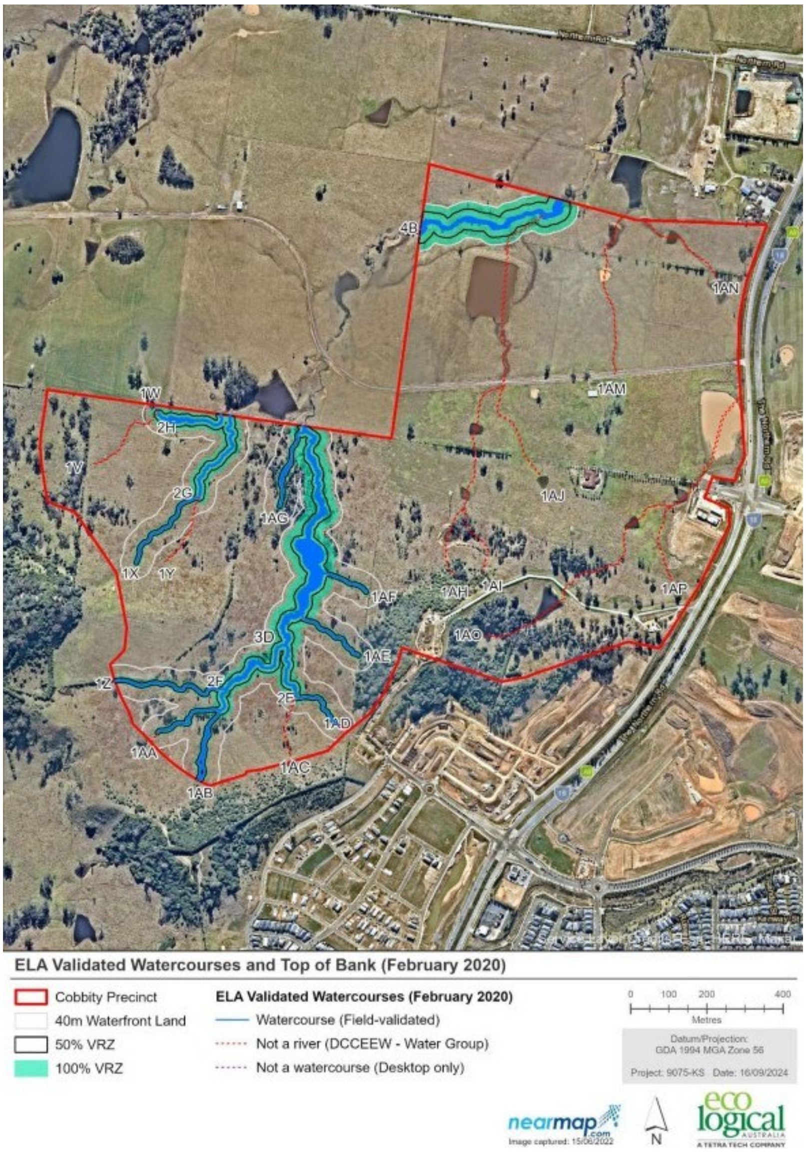


Figure 3: ELA Field Validated Watercourses Map and Top of Bank (February 2020)

An offsetting exercise was then conducted to ensure the connectivity, values and function of the riparian corridors were retained when designed and delivered in the context of a future urban environment. The offsetting was conducted in accordance with the averaging rule of the Guidelines and is shown in Figure 4 below and included as Appendix 2. The offsetting included removal of several 1st Order streams to ensure a logical residential network could evolve adjoining a larger main corridor which includes the validated 2nd and 3rd Order streams.

The offsetting has been conducted to retain the total area of validated riparian corridor, with the impact area not exceeding the offset area.

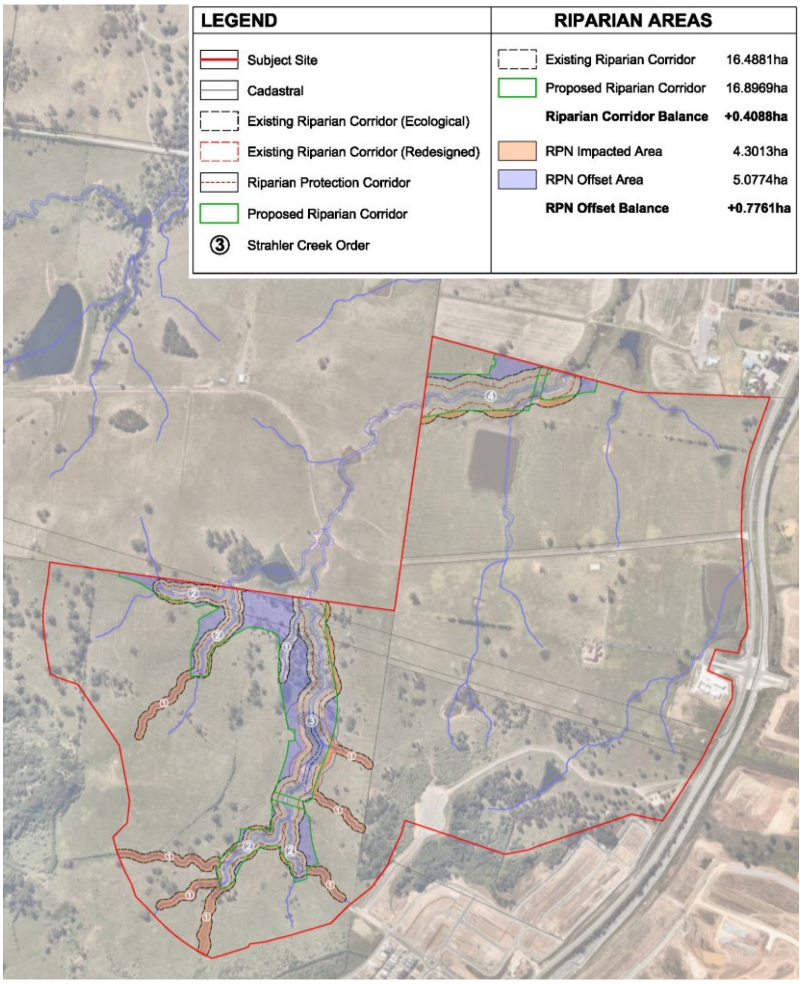


Figure 4: Riparian Calculation Plan (Design+Planning)

3.2 Proposed Online Dry Basins

The location of the proposed online dry basins are detailed on the ILP and sited within 2nd, 3rd and 4th Order streams, refer Figure 5 below.

The proposed online basins within the 2nd Order streams are permitted in accordance with the riparian corridor matrix contained within the Guidelines. All basins are proposed as dry basins, with all water quality to be conducted off line and outside the boundaries of the defined riparian corridors (shown yellow on the ILP).

Figure 5: Online basin locations (Design+Planning)

The online basins requiring merit assessment are situated within the 3rd and 4th Order Streams. These basins are utilising areas that accommodate road and pedestrian crossings, with the latter positioned north of the basin on the 3rd Order stream. These sites have been selected as suitable for online dry basins due to the natural inundation expected from the construction of these crossings.

The road network has been carefully planned to minimize riparian crossings, thereby preserving the natural hydrology of the creeks and maintaining biodiversity connectivity as much as possible.

Some cut and fill earthworks are required to these basin areas due in part to the construction of the road and pedestrian crossings. Some minor earthworks are also proposed to ensure the detention requirements of the site are met and overland flow is not directed onto the adjoining landowner to the north.

3.3 Existing Vegetation

The biodiversity assessment of the site was also conducted by Eco Logical Australia who observed the creek lines in the study area to have been altered from their natural state due to works along the creek (creation of dams and crossings), removal of native riparian vegetation to facilitate agricultural land uses, increases in sediment and nutrient transport through the system and various other factors.

The sites vegetation categorise are identified in Figure 6, which also shows the vegetation in the context of the ILP determined riparian corridors and open spaces.

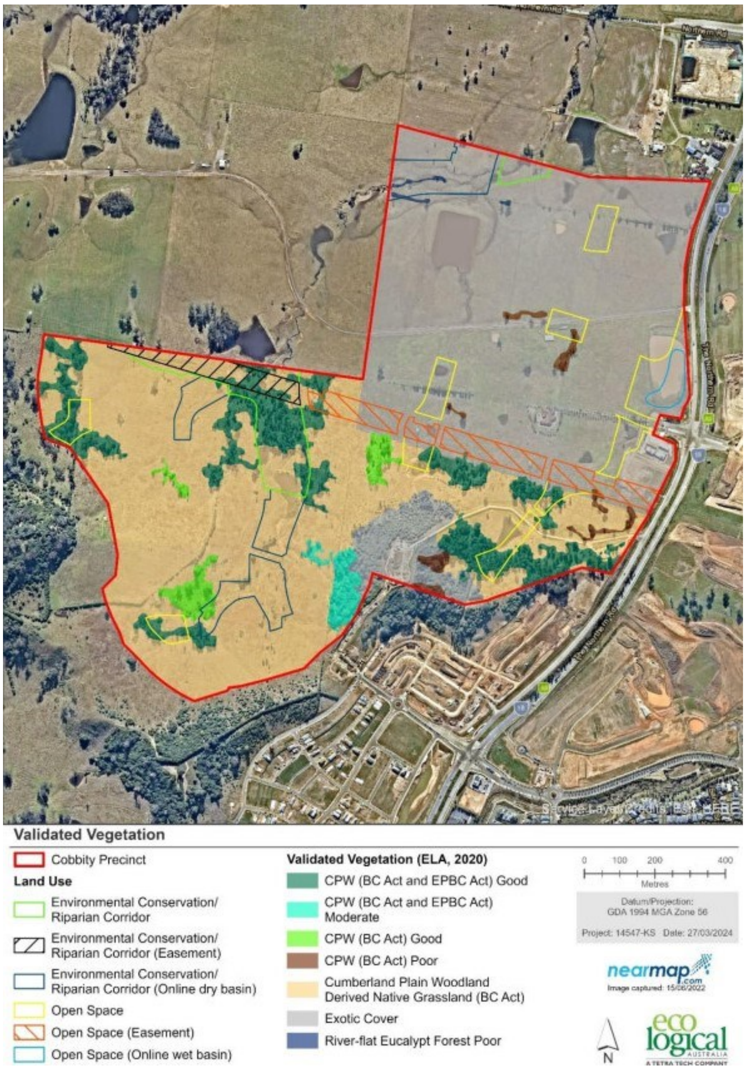


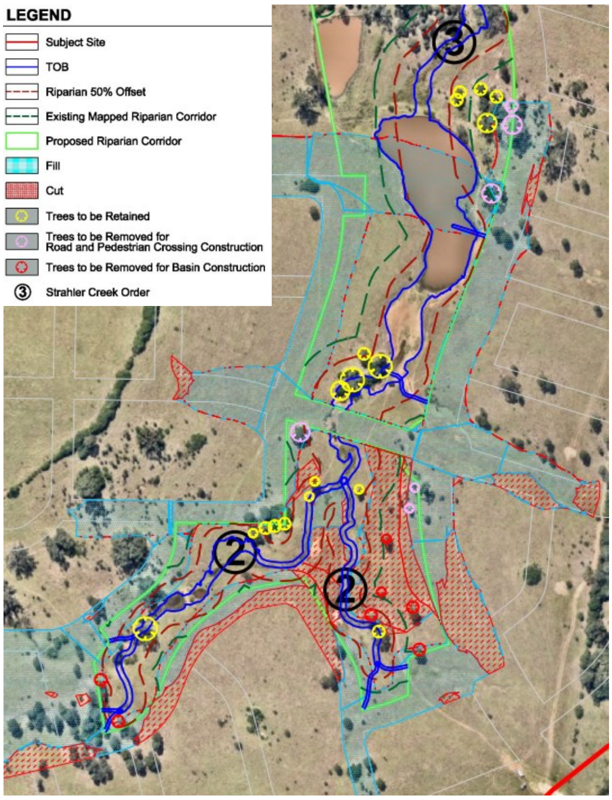
Figure 6: Validated Vegetation (ELA)

The riparian vegetation throughout the site varies in quality. In the south-western extent of the site, where most creeks met the definition of a river, riparian condition was highly modified and generally poor, with limited shrubs or canopy cover. The central creek system of 2F and 3D (refer Figure 3), had the highest quality riparian vegetation, with good quality Cumberland Plain Woodland present (Figure 6) particularly in the north. The proposed location of online basins has considered the sites high quality vegetation and instead positioned them in areas containing modified forms due to existing farm dams and little existing vegetation.

The extracts below (Figure 7) show the proposed basin locations inclusive of cut and fill earthworks extents and trees to be removed or retained. While some trees will require removal either due to the road construction or the basin works, these are sporadic paddock trees and not identified as Existing Native Vegetation (ENV) for the purposes of SEPP Mapping.

Other than one tree the earthworks for the basins will have no impact on the existing native vegetation in the 3rd and 4th order streams, though some tree removal is required in the 2nd order stream to create the detention capacity needed for the site drainage. All tree removal and earthworks will be further refined at DA stage with the view to reduce the works within the corridor including loss of trees as much as possible. This will be achieved through revised batter slopes and introduction of retaining walls.

Lastly and significantly the corridor will be revegetated and maintained as a fully functioning riparian corridor drastically improving the existing on site conditions and ensuring the urban development process contributes to the enhancement of local biodiversity.



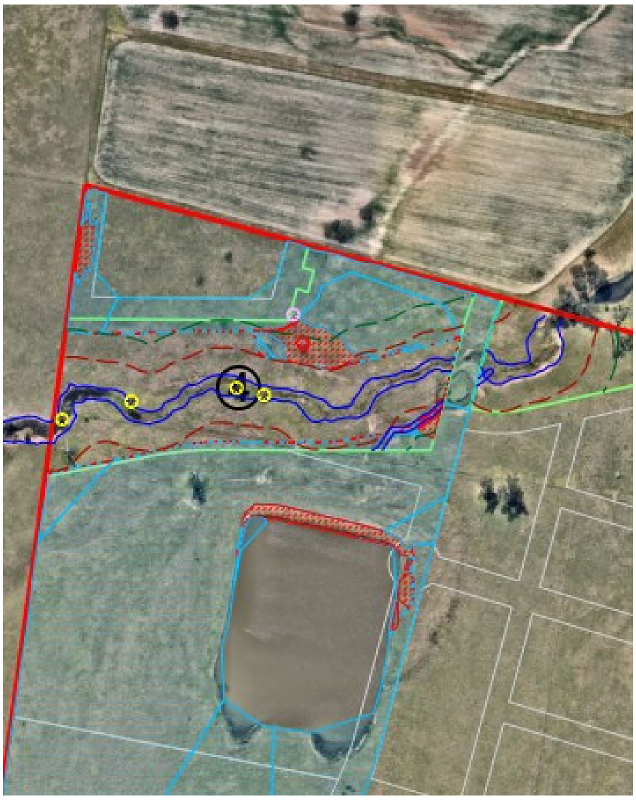


Figure 7: Existing Vegetation Impacts

4 MERIT ASSESSMENT

This section provides a comprehensive merit assessment of the proposed online dry detention basins within Cobbitty Sub-Precinct 5. The assessment evaluates the balance between urban development and environmental conservation, focusing on the key elements required to justify the integration of stormwater management infrastructure into riparian corridors. By examining the need for new housing, the potential biodiversity benefits, flood management implications, and government return on infrastructure investments, this merit assessment illustrates how the proposal aligns with the principles of ecologically sustainable development. The assessment draws on detailed analysis from stormwater engineers and ecologists, ensuring that the project not only meets regulatory requirements but also delivers optimal social, environmental, and economic outcomes for the future community.

4.1 The Need for New Housing

It is well documented that Sydney, like much of Australia, is currently experiencing a 'Housing Crisis.' This crisis has led both State and Federal Governments to prioritise housing policies aimed at alleviating the pressures of affordability, particularly for first home buyers. With escalating property prices and constrained supply, innovative solutions which balance the urgent need for housing with the protection of environmental assets should be pursued.

One such solution is the co-location of online dry detention basins within riparian corridors, which offers a dual benefit. By integrating stormwater management infrastructure into natural ecosystems, the project ensures the ecological integrity of the riparian corridors while promoting economically sustainable land use. This approach optimises land use efficiency, reduces the urban footprint, and creates a synergy between urban development and environmental protection.

Importantly, the riparian biodiversity and ecological outcomes will not be harmed by this co-location. In fact, through the rehabilitation of the corridors with native, endemic species, the project supports the health of the riparian ecosystem. The online dry detention basins will not only manage stormwater but also contribute to maintaining water quality, reducing flood risks, and preserving natural hydrological cycles. This co-location provides an innovative model of urban infrastructure that balances both housing needs and environmental stewardship.

In addressing Sydney's housing demands, it is critical to pursue sustainable development practices that provide affordable housing while safeguarding ecological assets. The co-location of detention basins within riparian corridors ensures that urban growth is compatible with environmental protection, delivering long-term benefits for both the community and the natural landscape. This integrated approach helps foster a more resilient, liveable city while alleviating the housing shortage in a sustainable and responsible manner.

4.2 Net Beneficial Biodiversity Outcomes

The co-location of online dry detention basins within riparian corridors presents a valuable opportunity to achieve net beneficial biodiversity outcomes through the thoughtful integration of urban infrastructure and ecological systems.

The rehabilitation of riparian corridors with native, endemic species suited to both the local and basin environments will enhance biodiversity by restoring habitats that have previously been degraded. Strategically planting these species within the detention basins and along the riparian corridors creates a more supportive environment for local wildlife, including birds, amphibians, and invertebrates. This increase in habitat availability fosters a more resilient and diverse ecosystem within the urban landscape.

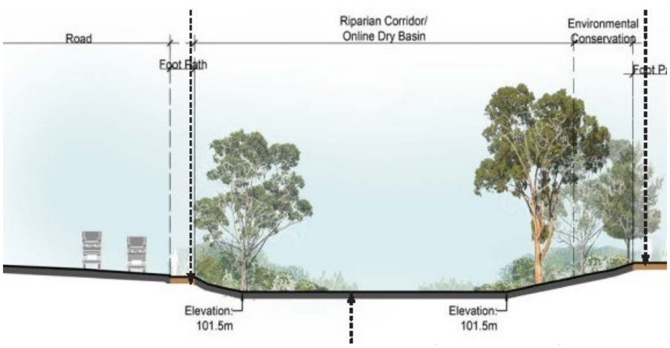


Figure 8: Combined Riparian Corridor and Online Basin (Urbis)

A holistic Water Cycle Management Strategy (WCMS) plays a crucial role in managing urban stormwater by capturing runoff and controlling its release into the riparian corridor. The proposal includes the use of gross pollutant traps and bioretention rain gardens located outside the riparian corridor to allow sediments and pollutants to settle. This approach improves the quality of water entering the natural system, benefiting aquatic species and supporting a healthier riparian ecosystem. The proposal ensures that the ecological health of the corridor remains unaltered by the co-location of detention aspects within the riparian corridor.

The design of the online dry basins mitigates erosion risks in riparian zones by controlling water flow during peak storm events. This reduction in erosion preserves soil stability and protects the structural integrity of habitats within the corridor, which is particularly important for species that rely on stable ground for nesting or foraging. The controlled release of stormwater maintains natural flow regimes, which are critical for the lifecycle of various aquatic species and riparian plants.

Moreover, co-locating these basins within riparian corridors enhances climate resilience. By preserving and enhancing green spaces, the project supports microclimate regulation, benefiting sensitive species. Additionally, the corridors serve as natural ecological links between fragmented habitats, facilitating species movement and promoting genetic diversity—key factors in maintaining robust biodiversity. Importantly, none of these ecological processes are harmed by the co-location of dry basins within the riparian corridors.

The combination of flood mitigation, habitat restoration, and improved water quality provides long-term ecological benefits. As native species become established and ecological processes stabilise, the riparian corridors are expected to see an increase in both species richness and ecological function. This represents a net positive outcome for biodiversity within the urban setting and is further supported by the co-location of the dry detention basins.

In summary, the co-location of online dry detention basins within riparian corridors not only meets practical urban infrastructure needs but also delivers significant biodiversity benefits. The integration of ecological principles in the urban design ensures that these areas contribute to the long-term health and resilience of local ecosystems.

4.3 Marginal Additional Flooding Impacts

The proposed online dry detention basins are strategically located upstream of two riparian road crossings and a pedestrian crossing. In the urban design process, efforts have been made to limit the number of riparian crossings due to their impacts on the natural flow functions of the creek. By minimising these crossings, the design aims to preserve the ecological integrity and hydraulic dynamics of the riparian environment as much as possible.

However, these crossings and the associate 1% AEP culverts, inherently alter the natural flow of water, creating upstream inundation as detailed below (Figure 9).

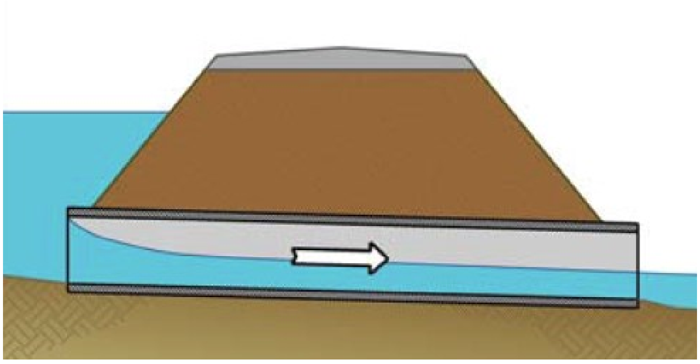


Figure 9: Typical culvert operation at peak stormwater events showing upstream inundation

These impacts create opportunities for enhanced sustainability outcomes through the natural integration of basins with these riparian crossings. Importantly, the analysis of this proposal indicates the additional flooding impacts, shown dark blue in Figure 10 resulting from the co-location of the basins are minimal and well within acceptable thresholds. The road and pedestrian crossings already contribute to altered hydraulic conditions, meaning the proposed basins do not significantly exacerbate existing flooding scenarios. Instead, they are designed to complement and manage the stormwater runoff generated by these crossings, thereby enhancing flood resilience in the area and effectively contributing to economical and sustainable land use.

By capturing and retaining runoff, the online dry basins mitigate peak flow rates during storm events, helping to stabilise downstream water levels. This function not only addresses local flooding concerns but also ensures that any marginal additional impacts are managed effectively, contributing to a net benefit for the riparian corridor and surrounding areas.

Furthermore, the design of the basins considers existing flood patterns and incorporates best practices in stormwater management to minimise potential adverse effects. As a result, the basins enhance the overall functionality of the riparian corridor while maintaining natural flood dynamics to the greatest extent possible.

In conclusion, the marginal additional flooding impacts associated with the proposed online dry detention basins are negligible compared with the existing conditions created by the road and pedestrian crossings. This thoughtful integration of infrastructure supports both flood management goals and ecological integrity within the riparian corridor.

To further illustrate these findings, J. Wyndham Prince has produced several diagrams in their analysis that depict the flood extents resulting from development, the duration of inundation for these flood extents, and the comparable existing flood extents. These diagrams cover all storm events requested by Council as part of their flood modelling assessment, including the 50%, 20%, and 1% AEP events. Additionally, cross sections, including cut-and-fill analysis, have been provided, focusing on the 1% AEP storm event, which represents the worst-case scenario.

This information is included in the WCM Report produced by J. Wyndham Prince, attached as Appendix 3. An overlay plan has also been developed to quantify the ultimate differences in flood extents, comparing the effects of the riparian crossings alone to those with the addition of the proposed co-located detention basins. This plan, shown as Figure 10, supports this report’s conclusions that the additional flooding impacts of incorporating the basins with the riparian crossings are marginal.

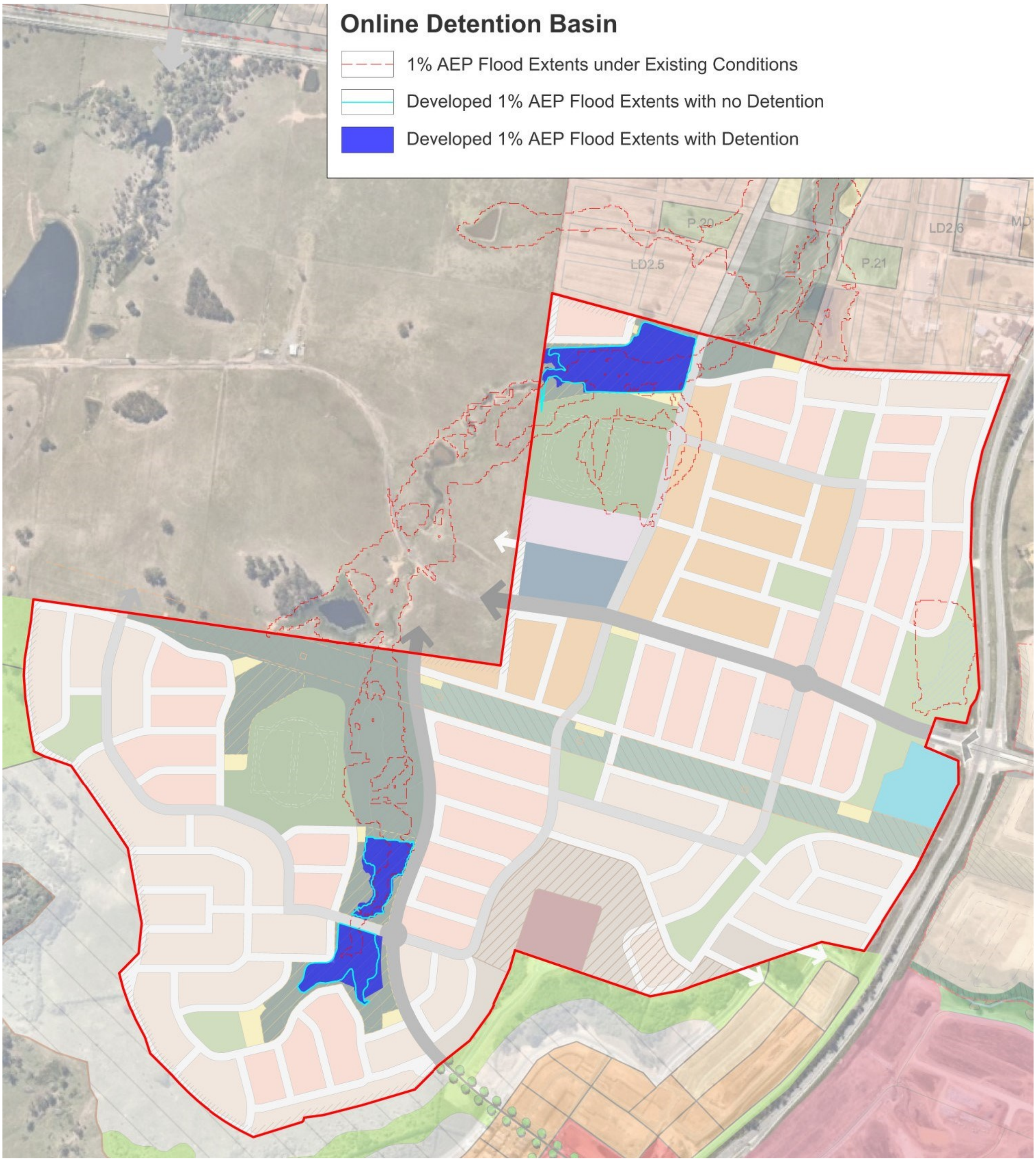


Figure 10: Comparison of 1% AEP flood extents formed at the riparian crossings with and without detention

4.4 Government Return on Investment

To support the population growth within the South West Growth Area, both State and Federal Governments have committed substantial funding towards critical infrastructure projects within the region. Investments in transport networks, including the Western Sydney Airport and the South West Rail Link, are pivotal in improving connectivity and accessibility. These projects not only facilitate the movement of people but also enhance the efficiency of goods transport, ultimately stimulating local economies and attracting businesses to the area.

The development of essential services, such as schools, healthcare facilities, and community amenities, has also been prioritised to ensure new residents have access to high-quality services. Funding for the New Western Sydney Schools Program aims to accommodate the educational needs of a growing population, while the expansion of health services, including upgrades to local hospitals, addresses the increasing demand for healthcare in the region.

The strategic integration of online dry detention basins within riparian corridors not only enhances stormwater management but also facilitates efficient land development. These basins are designed as multifunctional assets that manage stormwater runoff, reduce flooding risks, and preserve ecological integrity while maximising the utility of available land. Moreover, this co-location can significantly reduce the long-term asset costs for Camden Council. By effectively managing stormwater within the riparian corridors, the burden of maintaining separate stormwater infrastructure is alleviated, minimising maintenance and operational expenses over time.

Furthermore, this approach aligns with broader policy objectives of sustainable urban development. By utilising land resources judiciously and ensuring infrastructure is well-planned and implemented, government investment can yield substantial returns—both financial and social. This integrated strategy supports the vision of creating thriving, dynamic communities that meet the needs of residents while contributing to the overall economic prosperity of greater Sydney and New South Wales.

In conclusion, the South West Growth Area exemplifies how strategic government investment in infrastructure, combined with the co-location of detention basins and riparian corridors, can facilitate efficient land development, generate the best return on public funds, and reduce long-term asset costs for Camden Council—all while laying the foundation for sustainable, liveable communities.

4.5 Local Riparian Precedent

4.5.1 Lowes Creek Maryland

Sub-Precinct 5 is adjoined by Lowes Creek Maryland directly to the north. The former NSW Department of Planning coordinated the urban design and planning for the site, culminating in the rezoning in February 2022. The design incorporates two online detention basins, strategically positioned over existing farm dams. These basins are located on Strahler categorised 4th order streams and notably the eastern online basin aligns with the same creekline and is directly downstream of the online basins proposed in Sub-Precinct 5, refer Figures 11, 12 and 13 below.

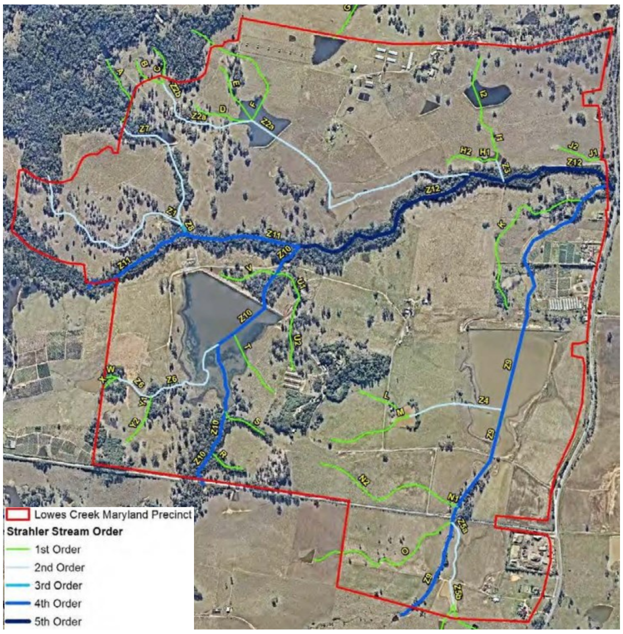


Figure 11: Lowes Creek Maryland Precinct Planning Strahler Stream Order Classification (ELA 2018)

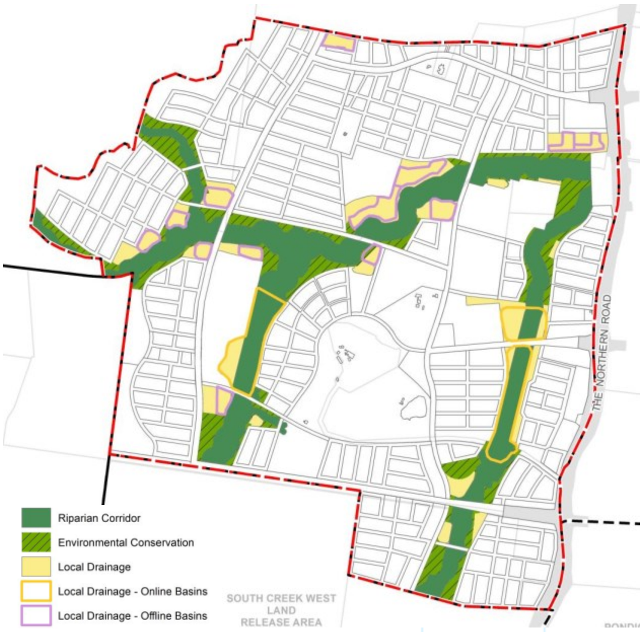


Figure 12: Lowes Creek Maryland Growth Centre DCP, Figure 2-3 Key Elements of Water Cycle Management and Ecology Strategy (DoPIE)

The Lowes Creek Maryland precedent illustrates a collaborative approach among all levels of government regarding the concept of online detention basins when they are planned and designed appropriately. As outlined in this report, the urban design process has prioritised limiting the number of riparian crossings to preserve the ecological integrity and hydrological dynamics of the riparian environment. However, these crossings create opportunities to co-locate the basins, resulting in only marginal additional flooding impacts. This thoughtful integration of infrastructure effectively supports both flood management goals and the ecological integrity of the riparian corridor.

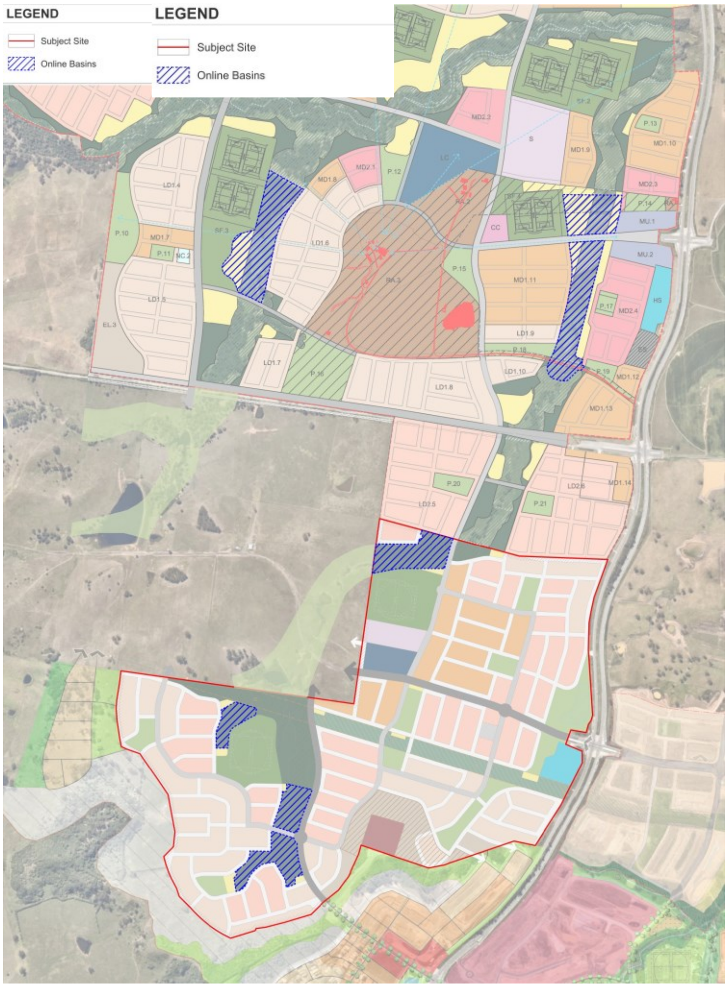


Figure 13: Combined proposed Sub-Precinct 5 ILP with Lowes Creek Maryland showing online basins

4.5.2 Gregory Hills

The Gregory Hills precedent offers a constructed example within the Camden LGA of a fully functioning riparian corridor with co-located online detention basins. As illustrated in Figure 14 below, Basins 1 and 2 incorporate online detention with a controlled outlet, a low-flow channel, a basin bed with a carefully selected planting regime, and fully vegetated buffers. These buffers include low and mid-storey vegetation as well as a significant tree canopy supporting a diverse ecosystem. The street view image provided (Figure 15), further highlights this integration. Notably, the design also utilises a pedestrian bund as part of the controlled outlet within the basins, a feature that is similarly employed in the Sub-Precinct 5 context.

The Gregory Hills precedent demonstrates a successful implementation of online detention basins within a riparian corridor, with the vegetation thriving and appropriately selected for the basin context. This serves as a tangible and local example of how stormwater management infrastructure can be integrated into a natural setting while maintaining ecological function and supporting riparian health.

Figure 14: Gregory Hills online dry basins aerial image (Nearmap, image dated 15 June 2023)

Figure 15: Corner of Kavanagh Street and Wallarah Circuit (Google Maps)

5 STATUTORY PLANNING ASSESSMENT

5.1 Water Management Act 2000

The below assessment of the proposal against the Objects and Principles of the WM Act is provided to demonstrate compliance with this important policy framework.

	Clause	Comment
Clause 3 – OBJECTS		
(a)	to apply the principles of ecologically sustainable development, and	Ecologically sustainable development (ESD) is a key concept in urban design and planning. The proposed Water Cycle Management Strategy (WCMS) integrates economic, environmental, and social considerations to meet the needs of the current generation without compromising the ability of future generations to meet theirs. This approach considers existing conditions such as farm dams, vegetation, topography, detention requirements for future upstream developments, and applicable government policies and directives. The riparian corridor will be transformed into a valuable ecological asset, promoting biodiversity while serving as a central component of the WCMS. The proposed basin strategy will provide adequate detention storage to ensure that post-development peak discharges are lower than pre-development levels, improving the site's resilience to major rainfall events. The WCMS will manage water quality through multiple controls, including on-lot rainwater tanks, gross pollutant traps, and bio-retention raingardens. In addition, the restoration and revegetation of the riparian corridor, guided by a future vegetation management plan (VMP) aligned with the basin strategy, will significantly enhance the health of the riparian ecosystem. The active transport network within the precinct will be integrated with the riparian corridor, generating social benefits by encouraging community engagement. The corridor's aesthetic and recreational value also supports the principles of ESD by providing visual appeal, a connection to nature, and urban heat island mitigation, contributing to the well-being of future residents. Lastly, by combining complementary land uses, the site can be developed in the most effective and efficient manner while respecting its unique characteristics and achieving the principles of ESD.
(b)	to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and	The aim of the proposed WCMS is to restore the degraded riparian corridor into a community asset which promotes biological diversity and manages the quantity and quality of water through the catchment. The WCMS will allow for the protection and rehabilitation of the riparian corridors, which are currently in poor condition, unmaintained and contain large amounts of exotic flora. The proposed online basins make use of the proposed road and pedestrian crossings and existing topography of the creeks and overbanks, minimising the extent of regrading works required and additional peak water levels. The online basins have also been located in areas with little existing vegetation ensuring disturbance of existing native vegetation is minimised. The revegetation of the corridor with native riparian species in accordance with a compatible VMP will enhance the ecosystem, increase biological diversity and improve water quality.
(c)	to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including— (i) benefits to the environment, and (ii) benefits to urban communities, agriculture, fisheries, industry and recreation, and (iii) benefits to culture and heritage, and	The proposed WCMS creates opportunities for placemaking, cultural enrichment, and community building, while maximising the potential for environmental restoration and the promotion of biodiverse ecosystems. By integrating positive ecological outcomes within an urban framework, the WCMS embodies the principles of ecologically sustainable development, ultimately leading to social, economic, and environmental benefits.

	(iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,	The online-dry basins will be preserved as natural riparian corridors and rehabilitated with native endemic species suited to the basin environment. This co-location of complementary land uses ensures both ecological integrity and efficient, economically sustainable land use. Restoring the creek corridors will have a lasting positive impact on Aboriginal people, honouring their spiritual and social customs. Currently under private ownership with limited ecological value, the corridors will be restored to their native condition and dedicated to public ownership, enabling broader community access and fostering a deeper connection to Country for all.
(d)	to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,	Through Council, community will play an important role in the management of the riparian corridors and WCMS into the future. Through building positive relationships between community and the creeks, a strong sense of place is established leading to a strong sense of community ownership and pride.
(e)	to provide for the orderly, efficient and equitable sharing of water from water sources,	Water sharing is not proposed as part of the WCMS.
(f)	to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,	The rezoning process for the site has reviewed and assessed all matters of environmental significance including the land, its soil, its native vegetation and its native fauna with protection measures implemented where required as part of that process. These include both SEPP and DCP provisions to inform and direct future Development Applications.
(g)	to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,	Water usage is not proposed and would be subject to the required environmental assessments and regulatory requirements if proposed in the future.
(h)	to encourage best practice in the management and use of water.	The WCMS proposes an online detention system, with water quality management to be undertaken in separate stand-alone raingardens outside the corridor. This mirrors the normal water cycle management processes required through the Guidelines, the Growth Centres DCP and Council policies and ensures the water is treated and cleaned prior to discharge into the online system. The detention capacity of the basins and the controlled outlets will ensure no aggravation of downstream flooding impacts.

	Clause	Comment
Clause 5 – WATER MANAGEMENT PRINCIPLES		
(1)	The principles set out in this section are the water management principles of this Act.	
(2)	Generally — (a) water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and (b) habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and (c) the water quality of all water sources should be protected and, wherever possible, enhanced, and (d) the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and (e) geographical and other features of Aboriginal significance should be protected, and (f) geographical and other features of major cultural, heritage or spiritual significance should be protected, and	(a) The WCMS seeks to protect and rehabilitate the riparian corridors, which have been heavily degraded by waterway modifications, vegetation clearing, agricultural uses and the introduction of exotic flora. (b) This principle relates primarily to the protection of existing values. The riparian corridors on site are mostly in poor health, devoid of fauna and contain few areas of quality habitat. The corridors, including the online basins will be full restored to a functioning riparian corridor with biological diversity, significantly improving the overall health of the ecosystem. (c) The WCMS inclusive of GPT's and bio-retention raingardens will ensure the urban runoff is treated and cleaned prior to discharge into the natural riparian environment. All water quality devices will be positioned outside the extents of the riparian corridors. The restoration of the riparian corridors and the removal of incompatible agricultural land use will also have a significant improvement on the water quality entering the natural riparian environment. (d) Any license proposed in the future, would be subject to the required environmental assessments and regulatory requirements. (e) An Aboriginal assessment has been undertaken as part of the rezoning for the site, with protection measures to be implemented as needed subject to that process. (f) The rezoning process has reviewed and assess all geographical and other features of major cultural, heritage or spiritual significance with protection measures implemented where required. This includes protection of riparian corridors, ridgetops and areas of existing native vegetation.

	(g) the social and economic benefits to the community should be maximised, and (h) the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements.	(g) The social and economic benefits to the community will be maximized by delivering a drainage system that aligns with both biodiversity and riparian objectives in its location, form, and function. The design preserves online dry basins as natural riparian corridors, rehabilitating them with native, endemic species suited to the basin environment. By co-locating these complementary land uses, the project ensures ecological integrity while promoting economically sustainable land use. The social benefits include enhanced aesthetic value and improved ecological outcomes, contributing to community well-being. On the economic side, efficient land use ensures the desired development outcomes are achievable within an increasingly complex industry that demands a balance between environmental stewardship and adequate return on investment and which can take years to come to fruition. (h) The delivery of the WCMS will provide opportunity to monitor the assets over time to provide insight into the success and identify changes to management regimes as needed.
(3)	In relation to water sharing — (a) sharing of water from a water source must protect the water source and its dependent ecosystems, and (b) sharing of water from a water source must protect basic landholder rights, and (c) sharing or extraction of water under any other right must not prejudice the principles set out in paragraphs (a) and (b).	Water sharing is not proposed as part of the proposal. If water extraction was to be proposed in the future, this would be subject to the required environmental assessments and regulatory requirements.
(4)	In relation to water use — (a) water use should avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land should be rehabilitated, and (b) water use should be consistent with the maintenance of productivity of land in the long term and should maximise the social and economic benefits to the community, and (c) the impacts of water use on other water users should be avoided or minimised.	Water use is not proposed as part of the proposal. If water use was to be proposed in the future, such as irrigation of public reserves by Council, this would be subject to the required environmental assessments and regulatory requirements.
(5)	In relation to drainage management — (a) drainage activities should avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land should be rehabilitated, and (b) the impacts of drainage activities on other water users should be avoided or minimised.	J. Wyndham Prince are the project engineers and have undertaken the required drainage management modelling to inform the WCMS design and detention requirements. The catchments discharging to the proposed basins assume the nearby road networks within the subdivision will be designed to allow both minor (piped) and major (overland) flows to discharge to the basin. Further, the WCMS will rectify the land degradation currently experienced on site and through the protection and rehabilitation of the riparian corridor and floodway. The provision of controlled outlets for the online basins also ensures water is not held in the environment in the way the existing farm dams operate. Instead, the controlled outlets will allow low flows to continue entering creek at a rate which does not exceed the pre-development scenario. Accordingly, impacts on other water users within the catchment will be avoided.
(6)	In relation to floodplain management — (a) floodplain management must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and	(a) The floodplain within the site has been significantly impacted by modification of the land, farm dams, agricultural land uses and vegetation clearing. Accordingly, the WCMS will allow for rehabilitation of the flood plain through water quality management devices, revegetation and stormwater detention. (b) The proposed works will not result in any detrimental impacts to other water uses within the catchment. Following the completion of works, the quality of water will be enhanced, benefiting downstream water users. (c) The WCMS includes the provision of adequate storage within the detention basins, ensuring flood level increases due to the proposed development are

	(b) the impacts of flood works on other water users should be avoided or minimised, and (c) the existing and future risk to human life and property arising from occupation of floodplains must be minimised.	managed back to existing conditions. There will be no residential development located within the floodplains defined through the development process.
(7)	In relation to controlled activities — (a) the carrying out of controlled activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and (b) the impacts of the carrying out of controlled activities on other water users must be avoided or minimised.	The proposed WCMS seeks to restore the riparian corridor to a natural state to manage runoff and erosion, improve water quality and enhance biological diversity. Whilst some disturbance of the existing environment is expected during construction, the existing environment is already in a degraded form with little biodiversity benefit. Erosion and sediment control measures will be implemented during works in accordance with Council requirements and the guidelines set out in the *Blue Book* (2004). This will ensure the water quality and health of the broader catchment is not impacted.
(8)	In relation to aquifer interference activities — (a) the carrying out of aquifer interference activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and (b) the impacts of the carrying out of aquifer interference activities on other water users must be avoided or minimised.	The proposed WCMS does not constitute aquifer interference activities.

5.2 Guidelines for Riparian Corridors on Waterfront Land

5.2.1 What is a Riparian Corridor?

The *Guidelines for Riparian Corridors on Waterfront Land* define a riparian corridor as the "transition zone between the terrestrial environment and the river or watercourse (aquatic environment)." These corridors play a crucial role in maintaining ecological health, and the guidelines highlight the importance of protecting, restoring, and rehabilitating watercourses to ensure their vital functions.

The Planning Proposal and WCMS have thoroughly considered the essential functions of riparian corridors to ensure they are preserved during the development of the precinct and the co-location of detention basins. Key functions include:

- **Providing bed and bank stability and reducing bank and channel erosion:** Riparian corridors enhance the structural integrity of watercourses by stabilising soils and slowing water flow, thus minimising erosion risks. The proposed corridors will be revegetated according to a detailed VMP, ensuring the integration of detention basins will not compromise these stability objectives but rather enhance them.
- **Protecting water quality by trapping sediment, nutrients, and contaminants:** While the online dry detention basins will be integrated with the creek system, primary water quality treatment will occur outside the riparian corridor. This approach protects the corridor's role as a natural habitat while maximising the effectiveness of upstream treatment systems.
- **Providing a diversity of habitats for flora and fauna:** Riparian corridors support a rich variety of life by offering habitats for terrestrial, riparian, and aquatic species. The co-location of detention basins enhances habitat diversity, creating additional opportunities for wildlife while promoting ecological connectivity.
- **Providing connectivity between wildlife habitats:** Riparian corridors serve as essential ecological linkages, allowing wildlife movement between fragmented habitats. The proposed basins will maintain this connectivity, ensuring the corridor remains a viable passage for various species.

- **Conveying flood flows and controlling the direction of flood flows:** The strategic placement of detention basins within the riparian corridor enhances its ability to manage floodwaters effectively. The design will ensure that flood extents and inundation periods are only marginally different from typical road crossings, supporting both flood management and ecological integrity.
- **Providing an interface or buffer between developments and waterways:** The co-location of detention basins within the riparian corridor establishes a critical buffer that protects water quality by filtering runoff from urban areas before it enters the creek.
- **Providing passive recreational uses:** The design enhances opportunities for passive recreation, such as walking and birdwatching, by integrating landscaped areas with native vegetation. This not only enriches the recreational experience but also fosters community engagement with the environment.

Through these considerations, the proposed development aims to harmonise urban infrastructure with the natural functions of riparian corridors, ensuring ecological integrity and sustainability.

5.3 SEPP & DCP Provisions

The Parkland City SEPP and Camden Growth Centres DCP contain objectives, provisions and controls which will set the framework for the orderly development of the site as envisaged through the rezoning process. This includes provisions relating to riparian corridors, native vegetation and ecology, flooding and water cycle management.

Through the process of refining the riparian and drainage designs the proposal has evolved from what was originally submitted to Council as part of the Planning Proposal. This includes acknowledgement that the SEPP Riparian Protection Area mapping is required over the entire area of riparian corridor within the Precinct, inclusive of the Native Vegetation Protection overlay as determined through the ELA biodiversity site investigations studies. Those maps are provided as Figures 16 and 17 below and included as Appendix 4.

Changes to the Growth Centre DCP or the South Creek West Sub Precinct 5 schedule are not required with the riparian areas already defined in the various figures and sections as *Environmental Conservation.*

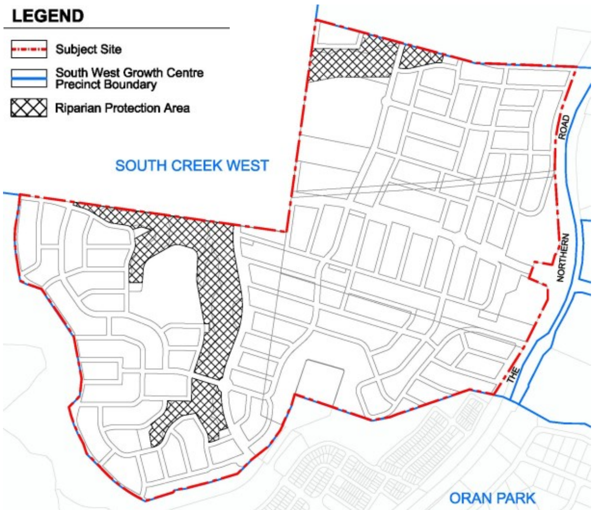


Figure 16: Proposed Parkland City SEPP Riparian Protection Area Map

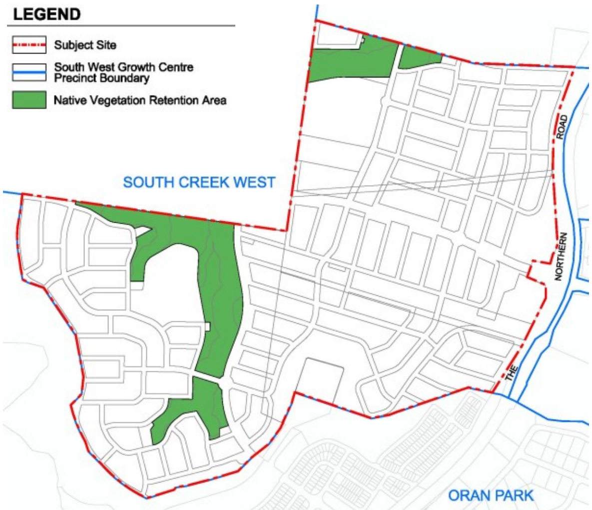


Figure 17: Proposed Parkland City SEPP Native Vegetation Retention Area Map

6 CONCLUSION

The Cobbitty Sub-Precinct 5 rezoning proposal demonstrates a balanced approach to sustainable urban development. Through the co-location of online dry detention basins within riparian corridors, the project optimises land use efficiency while ensuring environmental protection. The proposal delivers essential housing that aligns with regional growth strategies, addressing Sydney's housing crisis while preserving natural ecosystems.

The integration of stormwater management within riparian corridors supports the principles of the *Water Management Act 2000*, ensuring minimal additional flood risks, improved water quality, and enhanced biodiversity. Furthermore, the proposal capitalises on government investments in regional infrastructure, ensuring long-term economic and social benefits.

This assessment concludes that the rezoning proposal and the construction of online dry basins will deliver a net-positive environmental and economic outcome, making it a sustainable solution to support Camden's growth objectives while maintaining ecological integrity. Consideration of the merits presented is requested from Camden Council and DCCEEW leading ultimately to the rezoning of the land for the intended urban development.

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APPENDICES

Appendix 1	South Creek West (South West) Precinct Riparian Assessment (Eco Logical Australia)
Appendix 2	Riparian Calculation Plan (Design+Planning)
Appendix 3	South Creek West Cobbitty Sub-Precinct 5 Water Cycle Management Report (J. Wyndham Prince)
Appendix 4	Amended Proposed SEPP Maps

South Creek West (South West) Precinct Riparian Assessment

JJ Cobbitty

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DOCUMENT TRACKING

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Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Description
AHCVV	Additional High Conservation Value Vegetation
BC Act	NSW *Biodiversity Conservation Act 2016*
BOM	Bureau of Meteorology
DA	Development Application
DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DPE	Department of Planning and Environment
DPI Fisheries	NSW Department of Primary Industries - Fisheries
EHG	Environment and Heritage Group
ELA	Eco Logical Australia Pty Ltd
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FM Act	NSW *Fisheries Management Act 1994*
GDE	Groundwater Dependent Ecosystem
ILP	Indicative Layout Plan
LGA	Local Government Area
RC	Riparian corridor
SCW	South Creek West
SEPP	State Environmental Planning Policy
SWGA	South West Growth Area
VRZ	Vegetated riparian zone
WM Act	NSW *Water Management Act 2000*

Executive Summary

Eco Logical Australia Pty Ltd (ELA) was engaged by JJ Cobbitty to undertake a Riparian Assessment for Precinct Planning of the South Creek West (South West) precinct, 'Precinct 5'. The aim of this report is to identify key riparian constraints to assist design of an Indicative Layout Plan (ILP).

ELA field-validated watercourses and riparian zones along watercourses within the precinct. Ten 1st order watercourses and two 2nd order watercourses did not have a defined bed or bank and represent overland flow paths rather than 'rivers' as defined by the *Water Management Act 2000* (WM Act). The NSW Department of Climate Change, Energy, the Environment and Water – Water Group (DCCEEW – Water Group) would determine if these can be removed from the map and therefore not need to be retained in the Precinct Plan as part of their formal review of the proposal.

Seven 1st and four 2nd order reaches that did meet the definition of a river were in poor condition, with ephemeral or intermittent flow only and limited habitat features. The 3rd and 4th order watercourses were in moderate to good condition, with larger pools, aquatic vegetation, and instream features. The 3rd and 4th order watercourses are mapped as key fish habitat, and are classed as Type 2, Class 2 waterways in terms of their key fish habitat sensitivity. Riparian habitat was generally poor, lacking canopy and mid-storey cover. Along the primary creek line, which flows through the centre of the study area, there was good condition Cumberland Plain Woodland which provides good habitat, bank stabilisation and shade for the creek. Based on field validation, there is a total of 16.48 ha of riparian zone on the site, assuming a Vegetated Riparian Zone (VRZ) around each existing on-line farm dam.

An Indicative Layout Plan has been prepared that provides 16.89 ha of riparian area, including three on-line stormwater basins to detain and slowly release water during periods of high rainfall. The proposal seeks to remove and subsequently offset the seven 1st order validated watercourses, and replace the on-line dam on the central 3rd order watercourse with a vegetated base-flow channel. The proposed riparian corridor would be revegetated, rehabilitated and managed under a Vegetation Management Plan developed at the Development Application stage. Overall, the proposal is generally consistent with the NSW DPI Fisheries Policy and Guidelines for Fish Conservation and Management under the *Fisheries Management Act 1994* through the removal of the on-line dam which would restore fish passage in key fish habitat, and ensure the riparian corridor functions as a natural system through revegetation in lieu of a 50 m riparian buffer, as recommended by the guidelines for Type 2, Class 2 waterways. Under the DPI Fisheries guidelines, a bridge, arch structure, box culvert and ford are the preferred crossing types for the road crossings across Class 2 key fish habitat, in that order. Consistency with these guidelines in regard to road crossings would be determined at the Development Application or detailed design stage.

The proposal is also generally consistent with the DCCEEW Guidelines for Controlled Activities on Waterfront Land under the *Water Management Act 2000* through the 1:1 offset of any encroachment into the existing riparian corridor, assuming removal of the on-line dam, with fully-structured riparian vegetation to be implemented and managed under a Vegetation Management Plan. Inconsistencies with the DCCEEW riparian guidelines include removal of seven validated 1st order watercourses, and installation of dry on-line basins on 3rd and 4th order watercourses. However, the on-line basins are proposed to be dry and fully vegetated, with an equivalent Vegetated Riparian Zone calculated from the top of the bank of the base-flow channel proposed through the centre of the basins, Moreover, the proposal seeks to meet the objectives under the *Water Management Act 2000*, through protecting and enhancing riparian vegetation, improving the quality and health of the retained watercourses, reducing erosion, improving bank stabilisation, and improving public access to the watercourses and connection to green space. Under the DCCEEW riparian guidelines, permitted road crossing types include a culvert or a bridge over the 3rd and 4th order watercourses. Consistency with these crossing guidelines would be determined at the Development Application stage.

This report recommends that the protection and management of the riparian zone be achieved through:

- The use of a C2 Environmental Conservation zone
- The use of the Riparian Protection map in the *State Environmental Planning Policy (Precincts – Western Parkland City) 2021*, linked to the Camden Growth Centres Precincts Development Control Plan (DCP) clauses relating to water cycle management and native vegetation.
- Preparation and implementation of Vegetation Management Plans (VMPs) concurrently with development of land adjoining the riparian corridor. The VMPs are to be consistent with the objectives of the C2 zone, DCCEEW *Guidelines for Vegetation Management Plans on Waterfront Land*, and should allow for recreation infrastructure that does not have a significant impact on riparian values.
- Vegetation management to be generally in accordance with the Vegetation Management Strategy contained in this report.
- Where possible, major riparian zones should be in public ownership so that public access for recreation is possible.

1. Introduction

1.1 Description of the project

Eco Logical Australia Pty Ltd (ELA) was engaged by JJ Cobbitty to undertake a Riparian Land Assessment for Precinct Planning of the South Creek West (SCW) Cobbitty Sub-Precinct 5. It accompanies a Planning Proposal for a proposed amendment to the *State Environmental Planning Policy (Precincts – Western Parkland City) 2021* (Western Parkland City SEPP) for the study area located along the Northern Road and which forms part of Cobbitty Sub-Precinct 5, in the SCW Land Release Area (Figure 1).

SCW forms part of the South West Growth Area (SWGA). Given the scale of the release area, the Department of Planning and Environment (DPE) divided it into five distinct precincts numbered 1 – 5. The land to which this Planning Proposal relates to is referred to as Cobbitty Sub-Precinct 5, also known as Precinct 5. It totals approximately 303 ha and has been characterised by rural residential and agricultural land uses and activities. The Planning Proposal applies to a 172.74 ha portion of Precinct 5, defined as the study area in this report.

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

Precinct 5 is located within the south-west portion of the South Creek West Land Release (SCWLA) area within the suburb of Cobbitty in the Camden Local Government Area (LGA). The Precinct adjoins the Lowes Creek Maryland Precinct, which has recently been rezoned to the north, the Pondicherry precinct to the east which is in the process of being rezoned and the growing town centre and suburbs of Oran Park to the south (Figure 1).

The aim of this assessment is to identify key riparian features and constraints of the site to inform the rezoning process, as well as to provide recommendations with respect to aquatic ecosystem management in alignment with key legislation, planning instruments and guidelines, outlined in Section 2.

Specific objectives of this project are to:

- Undertake a Riparian Corridors Assessment to inform the precinct planning process and development of the Indicative Layout Plan (ILP).
- Work in collaboration with the Water Cycle Management Service Provider, to map riparian corridors using the Strahler system and provide recommendations and planning controls for riparian lands.
- Work in collaboration with the Water Cycle Management Service Provider to identify suitable locations for stormwater management such as detention basins, stormwater outlet structures and constructed wetlands.

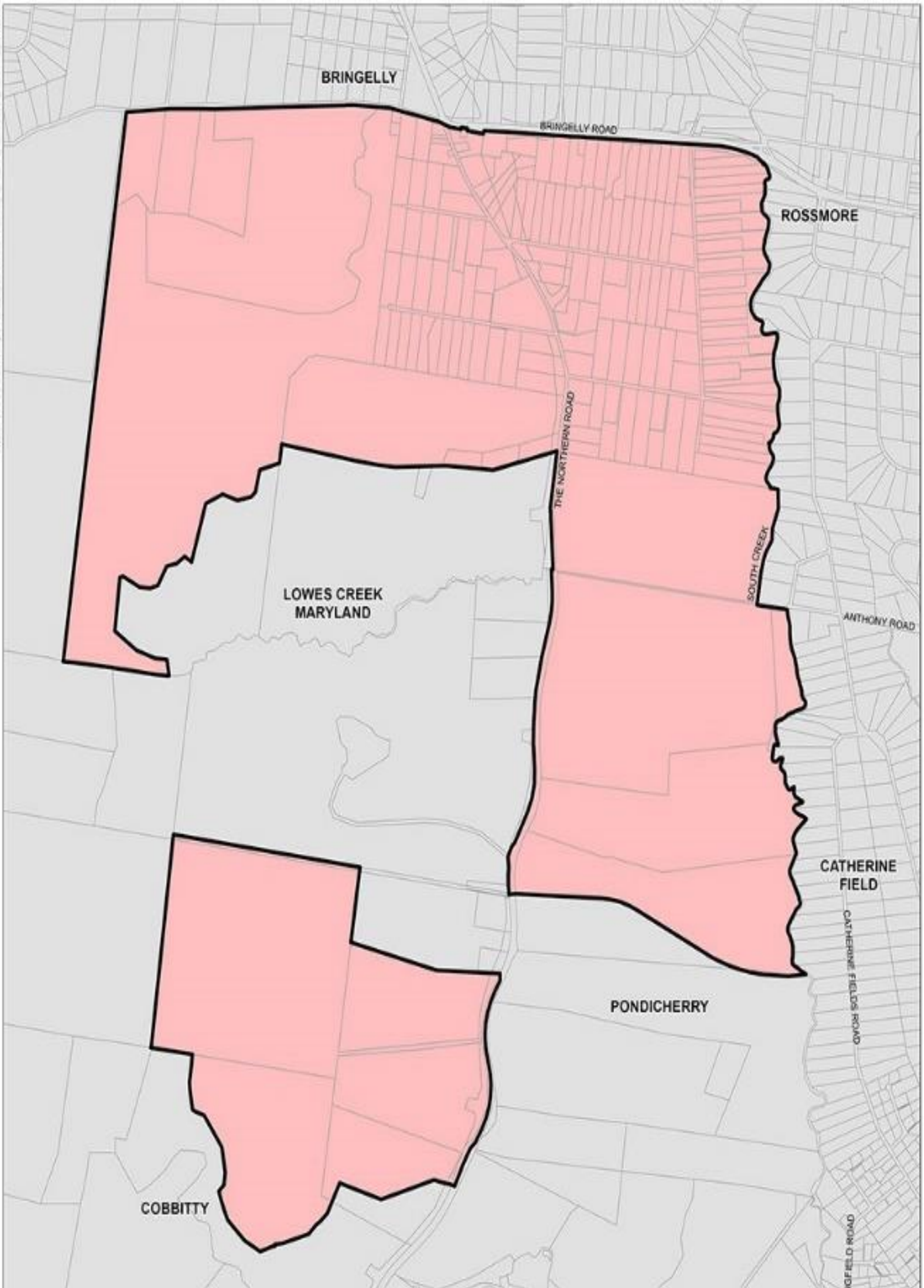


Figure 1: South Creek West release area

1.2 Study area and context

The study area is located within the suburb of Cobbitty in Camden LGA and is situated within the Hawkesbury-Nepean catchment (Figure 2). The study area contains numerous unnamed tributaries of Lowes Creek which flows west-to-east into Wianamatta-South Creek, northeast of the study area. These middle and lower reaches of the Hawkesbury-Nepean catchment are generally highly impacted and degraded, both directly through waterway modifications and indirectly through adjacent land-use practises. Hydrological and sediment regimes have been dramatically altered due to vegetation clearance and increasing urbanisation. Increasing impervious surfaces in the catchment are causing changes to hydrology which has greatly altered the geomorphology and ecology of the watercourses. In the opinion of NSW DPI Fisheries, removal of large woody debris from NSW rivers and streams and degradation of native riparian vegetation are considered key threatening processes which adversely affect threatened species populations or ecological communities, or could cause species, populations or ecological communities in NSW that are not threatened to become threatened. Protection of riparian values at the planning proposal stage is vital not only for the hydrological function of the watercourses on site, but also for the protection of ecological values and potential threatened species habitat which may be present on site.

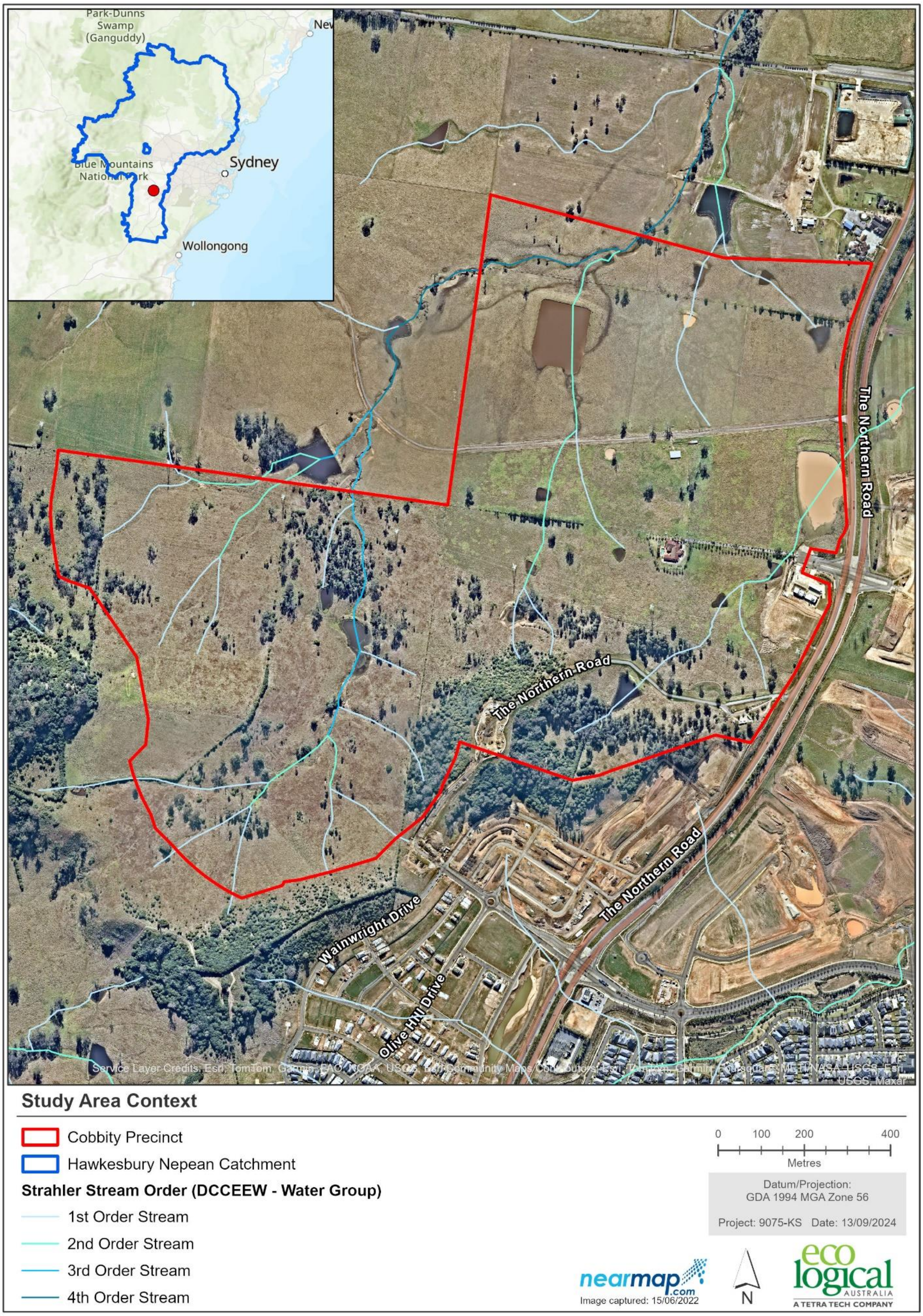


Figure 2: Location of the study area

1.3 Proposal

JJ Cobbitty, as the major landholder in the precinct, seeks to initiate the preparation of a planning proposal for the rezoning of Precinct 5 in accordance with the proposed Draft ILP (Figure 3). This is to facilitate the orderly redevelopment of Precinct 5 into a residential community.

The intended outcome of this Planning Proposal is to amend the current *State Environmental Planning Policy (Precincts – Western Parkland City) 2021* to facilitate the urban development of Precinct 5 as part of the South West Growth Centre as envisaged in the Greater Sydney Commission’s Regional Plan and District Plan.

The Draft ILP has been prepared to support the planning proposal and precinct rezoning and has been informed by extensive specialist consultant studies. The site will comprise approximately 2,312 dwellings and a population of approximately 7,056 people within a thriving community supported by:

- 19.97 ha of active and passive open space
- A thriving local centre
- Prominent creeks and riparian areas that retain water in the local environment
- Protection of ridgelines, creeks, and views through Connecting with Country design principles
- Integrated stormwater and services infrastructure that improve local amenity

The proposed new planning controls comprise amendments to *State Environmental Planning Policy (Precincts – Western Parkland City) 2021* and associated environmental planning instruments including the rezoning of the precinct to reflect land uses shown in the Draft ILP.

This Planning Proposal also seeks to introduce a site-specific Schedule to the *Camden Growth Centre Precincts Development Control Plan* to support the Precincts development in accordance with the Draft ILP and supporting technical investigations.

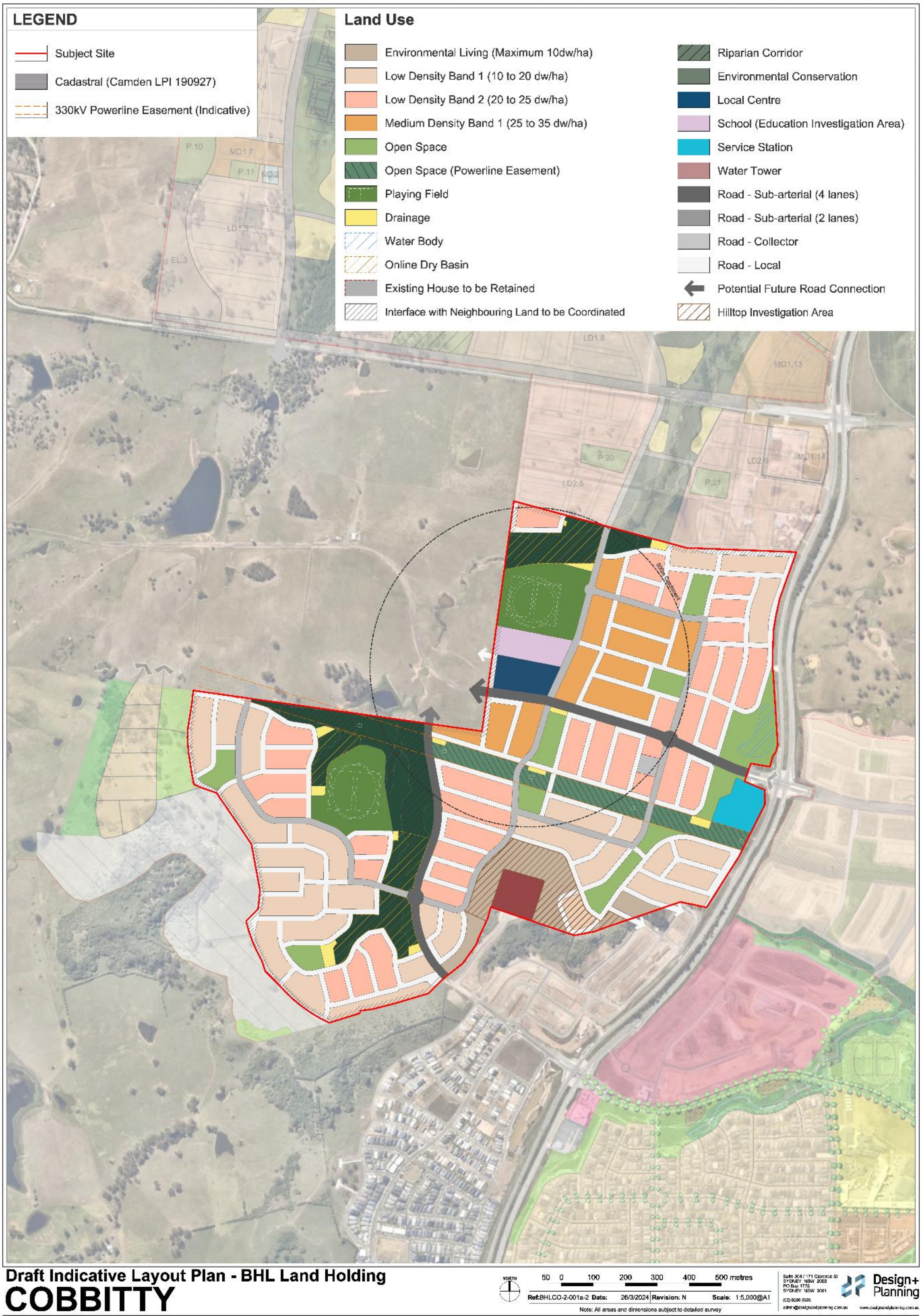


Figure 3: Draft Indicative Layout Plan (ILP)

1.4 Background

Following an extensive review by Council (and the APP Group) and the Local Planning Panel, the planning proposal and Biodiversity Assessment have been amended to reflect feedback from the Environment and Heritage Group (EHG) and enable Council endorsement for its progression to gateway. This report addresses the comments and feedback received from EHG, Council and the Local Planning Panel (Table 1).

Table 1: Response to EHG comments

EHG Comment	Response
The need to relocate proposed detention basins outside of the proposed C2 Zone/riparian corridors and limit proposed drainage works within the C2 zone.	The current ILP has removed the previously proposed online wet basin within the Riparian Corridor, and this has been replaced by an online dry basin. The ILP will allow for protected and rehabilitated watercourses to be established, which will improve their current condition, as currently they receive no observable maintenance and exotic flora species dominate some areas of the Riparian Corridor. Watercourse protection will also allow for an improvement in water quality within the precinct, as revegetation and weed control would create stable beds and banks and a buffer between residential areas and the watercourse. Although the *Controlled Activities – Guidelines for Riparian Corridors on Waterfront Land* (DPE 2022), do not allow for online dry basins on 3rd and 4th order watercourses, it is noted that: • **All basins will be dry and vegetated:** The Riparian Corridor will be revegetated to a full-structured vegetation community (Cumberland Plain Woodland or River-flat Eucalypt Forest), with some areas having a greater dominance of species which tolerate longer periods of inundation. This has been reflected in the relevant flood modelling in Appendix A undertaken by JWP (2024), where a Manning's n value of 0.12 has been assumed. Manning's n typically ranges from 0.01 in smooth concrete channels with no obstructions to 0.10 in streams with large amounts of large woody debris and vegetation that impedes flow (Land & Water Australia 2009). • **All basins will be for temporary flood detention only:** Basin inundation times are provided by JWP (2024) in Appendix A. In the 50% AEP storm event, the maximum inundation time is 24-36 hours for a small area upstream of the culverts. • **The basins will have an equivalent Vegetated Riparian Zone (VRZ) for the corresponding watercourse:** The existing VRZ area across the site is 16.89 ha, assuming a 10 m-wide watercourse and associated VRZ through the centreline of the existing farm dam on the 3rd order watercourse. The area of VRZ proposed to be retained under the ILP is 16.90 ha. This basin would have a Manning's n value of 0.1, Sydney Water describes riparian/stream vegetation with an n value between 0.05 – 0.1 as "Grass and/or weeds more than twice the height of flow depth; or dense, strong reed growth; or significant shrub growth within the channel; or significant inflexible vegetation within channel" (Sydney Water 2024). When combined with trees that are tolerant of periodic inundation, the basins would provide riparian functions and meet the requirements of a VRZ. Basin vegetation would be managed and maintained under a VMP, to be prepared at the DA stage. • **The basins will not be used for water quality treatment purposes:** Water quality management will be undertaken in separate stand-alone devices outside the outer 50% VRZ. The online basins are proposed for water retention only. It is also noted that the Drainage Areas shown within the ILP (Figure 3) have not been counted towards the native vegetation retention values. Further, any road crossings within the Riparian Corridor would adhere to the DCCEEW guidelines for watercourse crossings on waterfront land (DPE 2022).

2. Statutory framework

An array of strategic plans, legislation, policies, and guidelines apply to the planning and management of biodiversity issues within the study area. This information was reviewed and used to identify priority issues and approaches for the study area and are summarised below.

2.1 Statutory framework

Table 2 summarises the relevant legislation and policies that apply to the study area, which are required to be considered.

Table 2: Statutory framework and relevance to this study

Act	Relevance
	Commonwealth
Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)	On 28 February 2012, the Commonwealth Minister for the Environment announced the program of development related activities within the Growth Centres that had been approved under the Growth Centres Strategic Assessment. (This was the second stage of the approval of the Strategic Assessment of the Growth Centres under the Commonwealth EPBC Act). Specifically, *"All actions associated with the development of the Western Sydney Growth Centres as described in the Sydney Region Growth Centres Strategic Assessment Program Report (Nov 2010) have been assessed at the strategic level and approved regarding their impact on the following matters of national environmental significance (MNES):* • *World Heritage Properties* • *National Heritage Places,* • *Wetlands of International Importance,* • *Listed threatened species, populations, and communities, and* • *Listed migratory species."* This approval essentially means that the Commonwealth is satisfied that the conservation and development outcomes that will be achieved through development of the Growth Centres Precincts will satisfy their requirements for environmental protection under the EPBC Act. Therefore, provided development activity proceeds in accordance with the Growth Centres requirements (such as the Biodiversity Certification Order, the Western Parkland City SEPP and Development Control Plans (DCPs), Growth Centres Development Code etc), then there is no requirement to assess the impact of development activities on MNES and hence no requirement for referral of activities to the Commonwealth. The requirement for assessment and approval of threatened species and endangered ecological communities and the other MNES issues listed above under the EPBC Act has now been "turned off" by the approval of the Strategic Assessment.
	State
Biosecurity Act 2015 (Biosecurity Act)	The *Noxious Weed Act 1993* was repealed and replaced with the Biosecurity Act. Under the Biosecurity Act all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable. Specific legal requirements apply to State determined priorities under the *Greater Sydney Regional Strategic Weed Management Plan 2017-2022*. Weeds listed as 'other weeds of regional concern' warrant resources for local control or management programs and are a priority to keep out of the region. Inclusion in this list may assist Local Control Authorities and/or land managers to prioritise action in certain circumstances where it can be demonstrated the weed poses a threat to the environment, human health, agriculture etc.

Act	Relevance
Fisheries Management Act 1994 (FM Act)	The *Fisheries Management Act 1994* (FM Act) governs the management of fish and their habitat in NSW. The FM Act applies to fish and marine vegetation and requires a separate assessment from the NSW *Biodiversity Conservation Act 2016* (BC Act), which only relates to terrestrial animals and plants. The objectives of the FM Act are to conserve fish stocks and key fish habitats, conserve threatened species, populations and ecological communities of fish and marine vegetation and to promote ecologically sustainable development. The FM Act also regulates activities involving dredging and/or reclamation of aquatic habitats, obstruction of fish passage, harming marine vegetation and use of explosives within a waterway. Any activity that will block fish passage, involve dredging or reclamation of channel bed or banks or involve use of explosives in the waterway within key fish habitat, will require a permit under Part 7 of this Act.
Water Management Act 2000 (WM Act)	The *Water Management Act 2000* control the extraction of water, the use of water, the construction of works such as dams and weirs and the carrying out of activities in or near water sources in New South Wales. 'Water sources' are defined very broadly and include any river, lake, estuary, place where water occurs naturally on or below the surface of the ground and coastal waters. The relevant objectives of this act are to: *a. Apply the principles of ecologically sustainable development* *b. Protection, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality* *c. Recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including benefits to:* *i the environment, and* *ii urban communities, agriculture, fisheries, industry and recreation, and* *iii culture and heritage, and* *iv the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water.* The NSW Department of Climate Change, Energy, the Environmental and Water (DCCEEW) – Water Group administers licencing and approvals for controlled activities on 'waterfront land', which is defined as the land 40 m from the highest bank of a river, lake or estuary published on the Department's website (Water Management (General) Regulation 2018 hydroline spatial data 1.0), known as the 'hydroline'. Apart from the exceptions stated in Schedule 4, Part 2 of the Water Management (General) Regulation 2018, controlled activities are: • the construction of buildings or carrying out of works; • the removal of material or vegetation from land by excavation or any other means; • the deposition of material on land by landfill or otherwise; or • any activity that affects the quantity or flow of water in a water source. It is an offence to carry out a controlled activity on waterfront land except in accordance with an approval. Waterfront land exists within 40 m of the top of bank of each validated watercourse within the study area, and relevant riparian buffers apply in accordance with the *Guidelines for Controlled Activities on waterfront land—Riparian corridors* (DPE 2022), the 'DCCEEW guidelines'.
State Environmental Planning Policy (Biodiversity and Conservation) 2021 *(Biodiversity and Conservation SEPP)*	The development site is located within the Hawkesbury-Nepean catchment in accordance with Chapter 6 of Biodiversity and Conservation SEPP. Therefore, general development controls under Division 2 (clauses 6.6 – 6.10) apply: • Water quality and quantity – the effect on the quality of water entering a natural waterbody will be as close as possible to neutral or beneficial, and, the impact on water flow in a natural waterbody will be minimised. • Aquatic ecology – the development is to have minimal impacts, whether direct, indirect or cumulative, to adjacent and downstream waterbodies and wetlands. • Flooding – the development, if flooded, is not to release pollutants or obstruct natural flows to nearby wetlands and riverine ecosystems. • Recreation and public access – foreshore access is not to cause an adverse impact on natural waterbodies, watercourses, wetlands or riparian vegetation.

Act	Relevance
	• Total catchment management – the consenting authority must consult with downstream Councils before granting development consent.

2.2 Strategic plans

Table 3 summarises the relevant strategic assessments that apply to the study area, which should be considered within the Planning Proposal.

Table 3: Strategic plans and relevance to this study

Strategic Plan	Biodiversity / Sustainability Objectives
The Greater Sydney Region Plan, *A Metropolis of Three Cities* (Greater Sydney Commission, 2018)	The Greater Sydney Region Plan, *A Metropolis of Three Cities* (Greater Sydney Commission, 2018) is built on a vision of three cities where most residents live within 30 minutes of their jobs, education and health facilities, services, and great places. To meet the needs of a growing and changing population the vision seeks to transform Greater Sydney into a metropolis of three cities: • The Western Parkland City. • The Central River City. • The Eastern Harbour City. The Plan includes directions and objectives for liveability and sustainability, productivity, and infrastructure within Greater Sydney, including two sustainability objectives, which are most relevant to this study, being: • The coast and waterways are protected and healthier. • A cool and green parkland city in the South Creek corridor; and • the Green Grid links parks, open spaces, bushland and walking and cycling paths. The Plan is supported by five District Plans, which provide greater details regarding conservation objectives, including the Western Sydney District Plan.
Our Greater Sydney 2056 – Western Sydney District Plan (Greater Sydney Commission, 2018)	The Western Sydney District Plan is a 20-year plan to manage economic, social, and environmental growth and provides a guide for implementing the Greater Sydney Region Plan at a district level. The Plan outlines two relevant sustainability planning priorities, which coincide and build on the objectives listed within the Greater Sydney Region Plan, being: • Protecting and improving the health and enjoyment of the district's waterways. • Creating a Parkland City urban structure and identity, with South Creek as a defining spatial element.
Greener Places - An Urban Green Infrastructure Design Framework for New South Wales (Government Architect NSW, 2020) and Draft Greener Places Design Guide (Government Architects NSW, 2020)	Greener Places is a design framework to guide the planning, design, and delivery of green infrastructure in urban areas across NSW. It aims to create a healthier, more liveable, and sustainable urban environment by improving community access to recreation and exercise, supporting walking, and cycling connections and improving the resilience of urban areas. The Draft Greener Places Design Guide framework provides information on how to design, plan, and implement green infrastructure in urban areas throughout NSW. The draft guide provides a consistent methodology to help State and local government, and industry create a network of green infrastructure. This study focuses on one of the three major components of the green infrastructure network, being bushland and waterways. Five key strategies have been developed to connect, protect, restore, enhance, and create urban habitat as an integral part of how urban areas are planned, constructed, and maintained, which include: • protect and conserve ecological values; • restore disturbed ecosystems to enhance ecological value and function; • create new ecosystems; • connect people to nature; and • connect urban habitats.

2.3 Relevant guidelines

2.3.1 Guidelines for Controlled Activities on Waterfront Land – Riparian Corridors

The NSW DCCEEW – Water Group *Guidelines for Controlled Activities on waterfront land—Riparian corridors* (DCCEEW guidelines) published in May 2022 outlines the need for a Vegetated Riparian Zone (VRZ) adjacent to the channel to provide a transition zone between the terrestrial environment and watercourse (DPE 2022). This vegetated zone helps maintain and improve the ecological functions of a watercourse whilst providing habitat for terrestrial flora and fauna. The VRZ plus the channel (bed and banks of the watercourse to the highest bank) constitute the 'riparian corridor' (RC) (Figure 4). To be consistent with the DCCEEW guidelines, VRZ widths should be based on watercourse order as classified under the Strahler system of ordering watercourses and using Hydroline Spatial Data which is published on the department's website (Table 4).

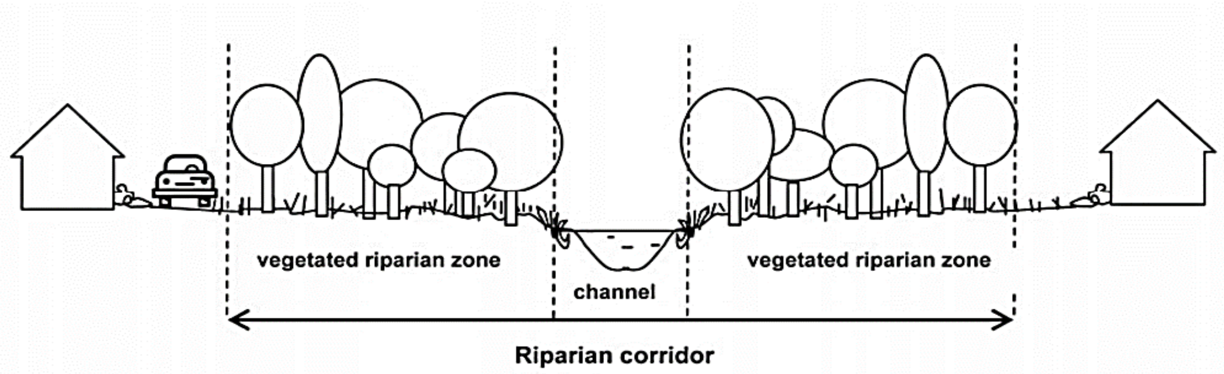


Figure 4: Vegetated riparian corridor widths relative to Strahler stream order (DPE 2022)

Table 4: Recommended riparian corridor widths relative to Strahler stream order (DPE 2022)

Watercourse Type	VRZ Width (Each Side of Watercourse)	Total Riparian Corridor Width
1st order	10 m	20 m + channel width
2nd order	20 m	40 m + channel width
3rd order	30 m	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 m	80 m + channel width

Certain works are permissible within the riparian zone if specific design criteria are met (Table 5). Non-riparian uses in the outer 50% of the VRZ are permitted as long as compensation (1:1 offset) is achieved within the site using the 'averaging rule' (Figure 5 and key below).

Table 5: Riparian corridor (RC) matrix of permissible use (DPE 2022)

Stream Order	Vegetated Riparian Zone (VRZ)	RC Offsetting for Non-RC Uses	Cycle ways and Paths	Detention Basins		Stormwater Outlet Structures and Essential Services	Stream Realignment	Road Crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10 m	●	●	●	●	●	●	●		
2nd	20 m	●	●	●	●	●		●		
3rd	30 m	●	●	●		●			●	●
4th +	40 m	●	●	●		●			●	●

Key to riparian corridor matrix

***Stream* order**: *The watercourse order as classified under the Strahler system based on Hydroline Spatial Data published on the Department's website*[1] *when zoomed in at a scale of 2 km or less. A stream may separate and then converge—this is called a 'braided stream'. A braided stream retains the same stream order throughout the braid, as though it were a single stream. For the riparian guidelines, stream order is fixed and is not to be altered if an upstream hydroline is not considered waterfront land.*

Vegetated riparian zone (VRZ)*: The required width of the VRZ measured from the top of the high bank on each side of the watercourse.*

Riparian corridor (RC) off-setting for non RC uses*: Non-riparian uses, such as bushfire Asset Protection Zones, roads and urban development are allowed within the outer 50% of the VRZ, so long as offsets are provided in accordance with the averaging rule as seen in Figure 5.*

Cycleways and paths*: Cycleways or paths no wider than four metres total disturbance footprint can be built in the outer 50% of the VRZ.*

Detention basins*: Detention basins can be built in the outer 50% of the VRZ or online where indicated. Offline detention basins do not need to be offset so long as there is an equivalent VRZ for the corresponding watercourse and they are built in compliance with the department's Guidelines for watercourse crossings and Guidelines for in-stream works. If a proposed basin will not have an equivalent VRZ for the corresponding watercourse, it may still be built in the outer 50% of the VRZ but must be offset. Online basins must:*

- *be dry and vegetated*
- *be for temporary flood detention only with no permanent water holding*
- *have an equivalent VRZ for the corresponding watercourse order*
- *not be used for water quality treatment purposes.*

Stormwater outlet structures and essential services*: Stormwater outlets or essential services are allowed in the RC. Works for essential services on a fourth order or greater stream are to be undertaken by directional drilling or tied to existing crossings.*

Stream realignment*: Indicates that a watercourse may be realigned.*

Road crossings*: Indicates permitted road crossing methods. Also refer to DPI Fisheries policy and guidelines for fish friendly waterway crossings (Fairfull 2013).*

[1] https://www.industry.nsw.gov.au/water/licensing-trade/hydroline-spatial-data

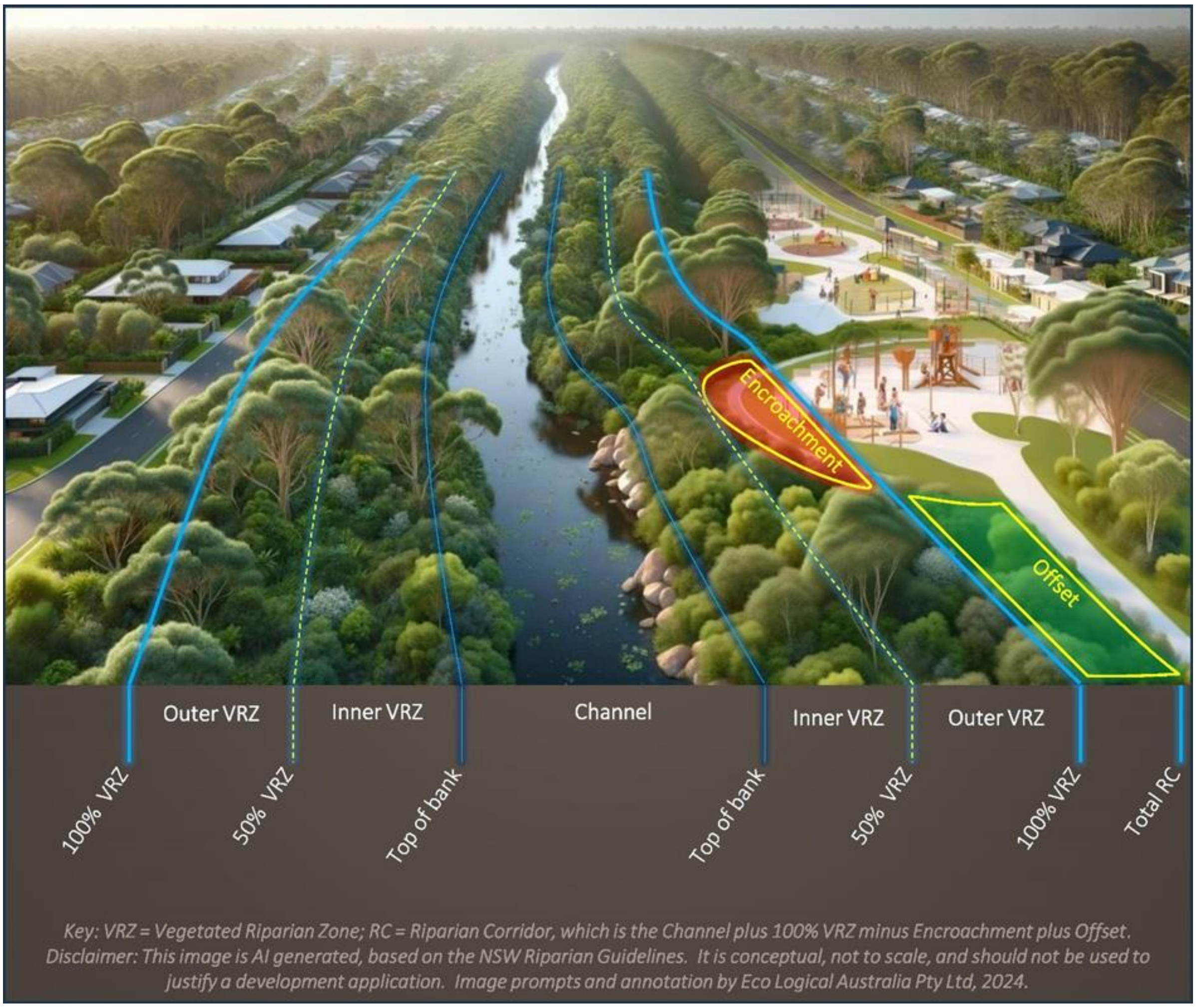


Figure 5: Riparian 'averaging rule' for offsetting encroachment into the outer 50% of the VRZ (adapted from DPE 2022)

2.3.2 Policy and Guidelines for Fish Habitat Conservation and Management

The NSW DPI Policy and guidelines for fish habitat conservation and management (Fairfull, 2013) (Fisheries guidelines) is a supplementary document that outlines the requirements and obligations under the FM Act and the *Fisheries Management (General) Regulation 2010* and were developed to maintain and enhance fish habitat and assist in the protection of threatened species. The Fisheries guidelines provides a definition of key fish habitat and provides guidance for assigning a classification of waterways for fish passage, which informs the types of infrastructure suitable for the creek line (Table 6) and sensitivity of the key fish habitat present (Table 7), which determines the potential disturbance and offsetting required for development. Specific policy and guidelines applicable to particular waterway classifications and key fish habitat sensitivity types are highlighted in Table 8.

Table 6: Classification of waterways for fish passage and crossing type (Fairfull 2013)

Classification	Characteristics of waterway class and preferred crossing type
CLASS 1 Major key fish habitat	• Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g., river or major creek), habitat of a threatened or protected fish species or 'critical habitat'. • Bridge, arch structure, or tunnel. • Bridges are preferred to arch structures.
CLASS 2 Moderate key fish habitat	• Non-permanently flowing (intermittent) stream, creek, or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pool or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present. • Bridge, arch structure, culvert [1] or ford. • Bridges are preferred to arch structures, box culverts and fords (in that order).
CLASS 3 Minimal key fish habitat	• Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g., fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats. • Culvert [2] or ford. • Box culverts are preferred to fords and pipe culverts (in that order).
CLASS 4 Unlikely key fish habitat	• Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or freestanding water or pools post rain events (e.g., dry gullies or shallow floodplain depressions with no aquatic flora present). • Culvert [3], causeway or ford. • Culverts and fords are preferred to causeways (in that order).

Key to crossing type

[1] High priority given to the 'High Flow Design' procedures presented for the design of these culverts—refer to the "Design Considerations" section of Fairfull and Witheridge 2003.

[2] Minimum culvert design using the 'Low Flow Design' procedures; however, 'High Flow Design' and 'Medium Flow Design' should be given priority where affordable—refer to the "Design Considerations" section of Fairfull and Witheridge (2003).

[3] Fish friendly waterway crossing designs possibly unwarranted. Fish passage requirements should be confirmed with NSW DPI.

As noted in Fairfull and Witheridge 2003, there are additional factors that must be taken into consideration by those involved in waterway crossing design and construction, including public safety, social and budgetary constraints. Each crossing is therefore assessed by NSW DPI on a case-by-case basis.

Table 7: Key fish habitat types (Fairfull 2013)

Key fish habitat and associated sensitivity classification scheme (for assessing potential impacts of certain activities and developments on key fish habitat types)	
TYPE 1 – Highly sensitive key fish habitat	• *Posidonia australis* (strapweed). • *Zostera*, *Heterozostera, Halophila and Ruppia* species of seagrass beds >5 m^2 in area. • Coastal saltmarsh >5 m^2 in area. • Coral communities. • Coastal lakes and lagoons that have a natural opening and closing regime (i.e., are not permanently open or artificially opened or are subject to one off unauthorised openings). • Marine Park, an aquatic reserve or intertidal protected area. • Coastal wetlands mapped under the *State Environmental Planning Policy (Resilience and Hazards) 2021*, wetlands recognised under international agreements (e.g., Ramsar, JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia. • Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 m in length, or native aquatic plants. • Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act. • Mound springs.
TYPE 2 – Moderately sensitive key fish habitat	• *Zostera, Heterozostera, Halophila and Ruppia* species of seagrass beds <5 m^2 in area. • Mangroves. • Coastal saltmarsh <5 m^2 in area. • Marine macroalgae such as *Ecklonia* and *Sargassum* species. • Estuarine and marine rocky reefs. • Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (e.g., managed in line with an entrance management program). • Aquatic habitat within 100 m of a marine park, an aquatic reserve or intertidal protected area. • Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna. • Freshwater habitats and brackish wetlands, lakes, and lagoons other than those defined in TYPE 1. • Weir pools and dams up to full supply level where the weir or dam is across a natural waterway.
TYPE 3 – Minimally sensitive key fish habitat may include:	• Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna. • Coastal and freshwater habitats not included in TYPES 1 or 2. • Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation.

Table 8: Policy and guidelines for riparian and freshwater aquatic vegetation (Fairfull 2013)

Policy	
1)	NSW DPI will generally not approve or support works that may harm freshwater aquatic vegetation (TYPE 1 and 2 habitats – see Table 7), unless adequate mitigation, rehabilitation and/or demonstrated compensation measures are in place (see section 3.3 of Fairfull 2013).
2)	NSW DPI will generally require riparian buffer zones to be established and maintained for developments or activities in or adjacent to TYPE 1 or 2 habitats or CLASS 1-3 waterways. Riparian buffer zones shall be measured from the top of the bank/drainage depression along CLASS 1 to 3 waterways (see Table 6). Please note that this policy does not apply to developments involving maintenance to existing, or construction of new roads or bridges crossing a waterway, but may apply to developments involving roads that are adjacent to, but not crossing a waterway (e.g. new subdivisions, rezoning proposals involving new access roads, new road developments along a new alignment).
3)	NSW DPI will require the design of riparian buffer zones to incorporate the maintenance of lateral connectivity between aquatic and riparian habitat. Installation of infrastructure, terraces, retaining walls, cycle ways, pathways and grass verges within the riparian buffer zone shall be avoided or minimised.
4)	NSW DPI will generally support proposals that aim to remove willows or other exotic trees or other weeds from the watercourse, followed by rehabilitation with native species. Willows and other exotic trees should only be removed from the stream where stream stability is not unduly compromised.
Guidelines	
a)	NSW DPI will assess the width of the riparian buffer zone based on the habitat TYPE and waterway CLASS (see Table 6 and Table 7), the possible extent of the disturbance and the susceptibility of the riverbank to erosion. As a guide the following are recommended: • TYPE 1, CLASS 1: 100 metres • TYPE 2, CLASS 2-3: 50 metres • TYPE 3, CLASS 3-4: 10-50 metres For guidelines on designing filter strips for this purpose (including appropriate widths) please refer to Prosser and Karssies (2001). Advice on protecting aquatic macrophytes in wetlands and shallow lakes can be obtained from Bailey et al. (2002).
b)	Riparian buffer zones should be clearly delineated (e.g. fences or other markers) and well managed to avoid degradation (e.g. weed and stock access management).
c)	Developments should ensure that existing native riparian vegetation is retained to the greatest extent possible in an undamaged and unaltered condition. Revegetation of disturbed areas with local native species should also be considered as part of development controls (e.g. stabilisation of sediment, sediment filters during and post-construction) and mitigation measures. Monitoring should be undertaken to ensure successful establishment of vegetation in these areas
d)	Where establishment or rehabilitation of a riparian zone is required, the rehabilitation strategy should include native in-stream vegetation (macrophytes) and snags where appropriate.
e)	Mitigation or rehabilitation measures for developments should include weed control.
f)	Willow control guidelines can be accessed at www.weeds.org.au/WoNS/willows/

2.3.3 Wetlands Management Policy 2010

The NSW Wetlands Management Policy (DECCW 2010) aims to provide for the protection, ecologically sustainable use, and management of NSW wetlands. Wetlands include lakes, lagoons, estuaries, rivers, floodplains, swamps, bogs, billabongs, marshes, coral reefs, and seagrass beds. Wetlands within the study area occur within the riparian corridor.

3. Methods

3.1 Desktop review

A review of the following data, background literature and relevant planning instruments and strategic documents was undertaken:

- NSW *Fisheries Management Act 1994*; Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update) (Fairfull 2013); key fish habitat mapping
- NSW *Water Management Act 2000* and Guidelines for controlled activities on waterfront land – Riparian corridors (DPE 2022)
- Water Management (General) Regulation 2018 hydroline spatial data 1.0
- Bureau of Meteorology (BOM) Groundwater Dependent Ecosystems (GDE) Atlas
- NSW River styles database (DPE 2023).

3.2 River validation and top of bank mapping

The Strahler stream order classification was extracted from the *Water Management (General) Regulation 2018* hydroline spatial data 1.0, known as the 'hydroline'. Top of bank was estimated using aerial photographs and 0.5 m contours before being field validated on 19th and 20th of February 2020 by two aquatic ecologists, using a GPS enabled tablet. A 'river', as termed in the WM Act, is a watercourse shown on the state hydroline map and one that has a defined bed, bank and evidence of geomorphic processes (erosion and deposition). A river may generally have some aquatic habitat features, either ephemeral or permanent, and may be discontinuous along its length. A watercourse may have portions of its length that do not display evidence of a river but if there are defining features upstream of that reach, then it must be classed as a river for its full length (as measured down from the uppermost part that has defining characteristics). Under the DCCEEW riparian guidelines, should a watercourse not be defined as a river, then the downstream Strahler stream order cannot be altered. That is, the Strahler stream order is a fixed calculation from the state hydroline map, regardless of whether the river exists, or has been engineered, or is proposed to be engineered (i.e. piped or filled for development).

Each watercourse that met the definition of a 'river' under the WM Act was assigned the appropriate riparian corridor width in accordance with the Strahler stream order. Riparian widths were then applied using ArcGIS Pro. Creeks bordering the site were assessed where possible to determine if their riparian buffers would encroach into the study area. Due to access constraints, any reaches which did not exhibit geomorphic features of a 'river' within the study area but have a hydroline which begins outside of the study area, were subject to desktop-only assessment.

3.3 Condition assessment

The watercourses and riparian zones were visually assessed for ecological value regarding physical form, benthic substrate, fish habitat, instream woody debris and vegetation condition.

The condition assessment was undertaken to recognise key components of watercourse health and function. The level of assessment conducted was chosen to assist with future management of watercourse and riparian environments within the study area by highlighting current values, threats and limits to potential improvements along the watercourse. All dams were inspected for habitat, with time spent listening for frogs and observing birds at each.

4. Results

4.1 Desktop review

The study area consists of nineteen 1st order, six 2nd order, one 3rd order and one 4th order watercourse (Figure 6). Key fish habitat (KFH) exists within the study area along the unnamed 3rd order watercourse running south-to-north within the western half of the study area, as well as further downstream where this creek intersects with the northern study area boundary as a 4th order watercourse (Figure 6). The river style of the watercourse comprised of reach 3D and 4B is a laterally unconfined, continuous channel with low sinuosity and a fine-grained bed, assessed in 2020 (DPE 2023).

See Section 4.4 for groundwater dependent ecosystems (GDEs) and the Biodiversity Assessment (ELA 2024) for the likelihood of occurrence of FM Act listed threatened aquatic threatened species, communities or populations.

4.2 River validation and top of bank

The *Guidelines for Riparian Corridors on Waterfront Land* (DPE 2022) acknowledge that some hydrolines on topographic maps may not meet the definition of a 'river' under the WM Act. This is generally the case where there is no defined bed or bank and no evidence of channelised flow or geomorphic processes such as erosion and deposition. As highlighted in Appendix B, field survey concluded that 11 1st order watercourses and two 2nd order watercourses do not meet the definition of a 'river' for the purposes of the WM Act, as they do not exhibit evidence of geomorphic processes such as erosion or deposition in the form of bed and banks (Figure 7). Due to access constraints, the upstream portion of reach 1W, which extends beyond the study area, was assessed via desktop methods only and requires further validation. Where a watercourse had defined bed and banks upstream, the downstream mapped watercourse was classified as a 'river', regardless of the presence or absence of bed and banks. Watercourses which met the definition of a 'river' under the WM Act are highlighted in Figure 7, along with their respective vegetated riparian zones (VRZs) as per the DCCEEW riparian guidelines (Table 4). Waterfront land exists within 40 m of the top of bank of each of these validated watercourses. Total riparian corridor area, assuming an equivalent VRZ around the central online dam, is 17.47 ha. See Appendix B for a description of each reach and watercourse validation rationale.

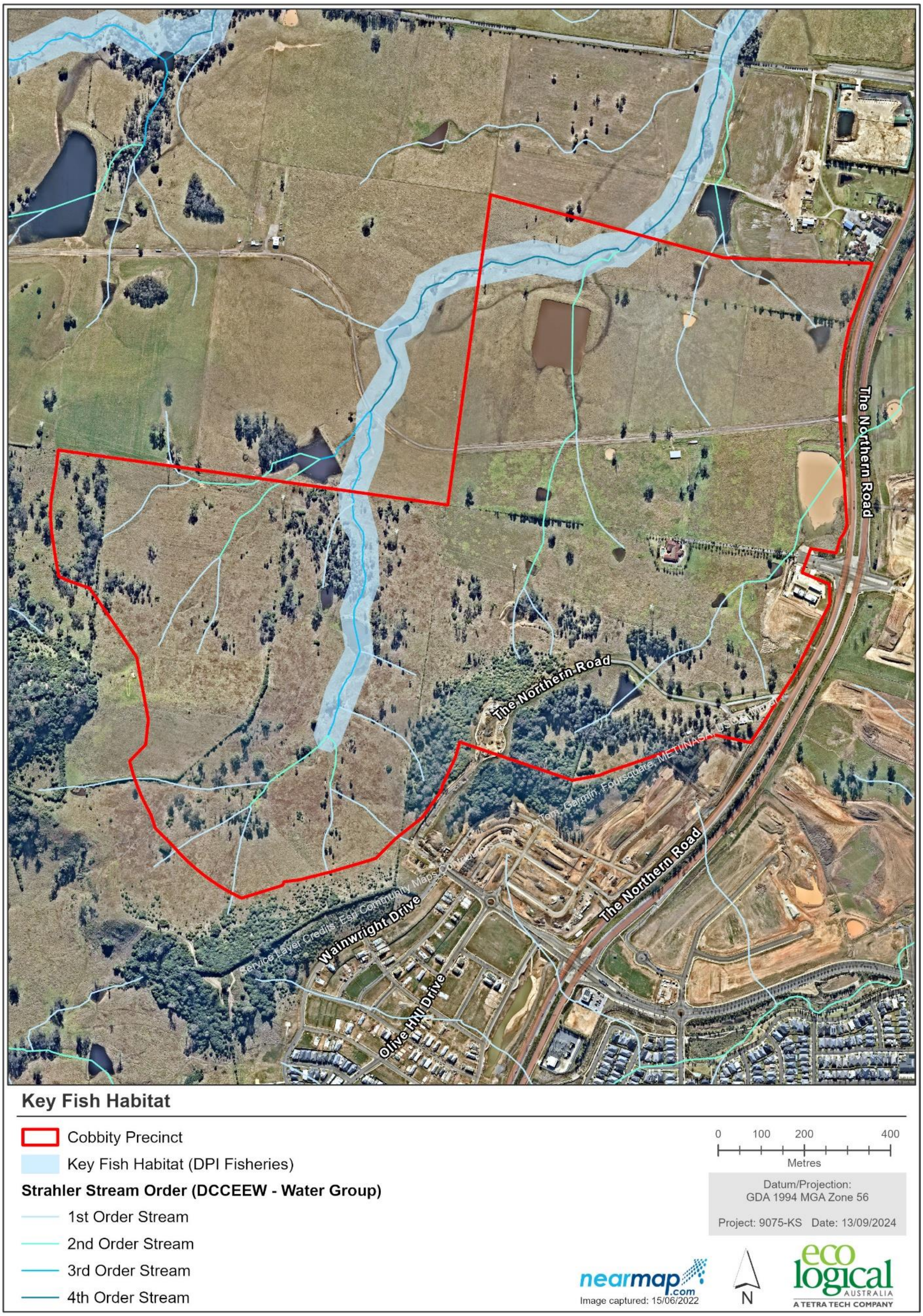


Figure 6: Key fish habitat and state hydroline mapping within the study area

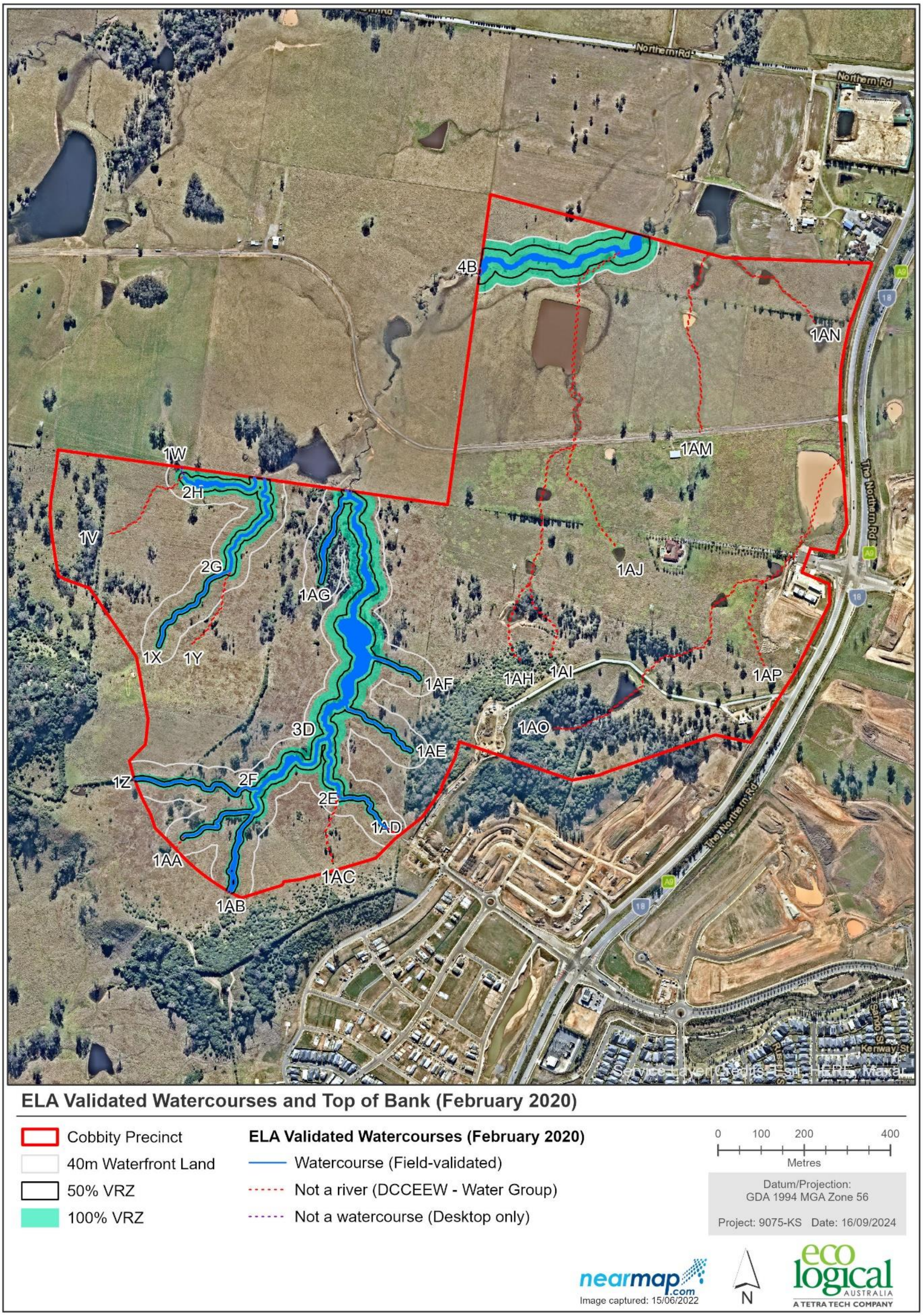


Figure 7: Watercourse validation and riparian corridors

4.3 Aquatic and riparian habitat condition assessment

The creek lines in the study area have been altered from their natural state due to works along the creek (creation of dams and crossings), removal of native riparian vegetation to facilitate agricultural land uses, increases in sediment and nutrient transport through the system and various other factors.

Nonetheless, all tributaries have value as a component of the catchment and riparian corridors that exist in the region. Where present, the tributaries of each creek also provide instream habitat for local fish species, aquatic macrophytes and aquatic macroinvertebrates all of which contribute to local ecosystem health. Programs that encourage improvements in these ecosystem values would be crucial to improving the condition of downstream environments.

For each reach, a condition of good, moderate, or poor was applied based on the:

- Stream shape and size
- Frequency of flow (ephemeral or perennial)
- Presence of aquatic habitat (pools, riffles, snags, vegetation)
- Potential for threatened or protected fish species or fauna
- Connection with other habitats.

Watercourses in good condition had clearly defined bed and banks with intermittent to semi-permanent water in pools with aquatic vegetation present. Snags were present, with good fish habitat. Watercourses in moderate condition had clearly defined bed and banks with ephemeral or intermittent water after a rain event. Aquatic vegetation may or may not be present, with less in stream features such as snags. These creeks would provide fish passage during rain events and refuge for fauna such as turtles. Poor condition watercourses had poor or no defined bed and banks and were typically a dry gully or depression, lacking aquatic vegetation with no habitat for fish or other fauna. A description of the condition of each reach is presented in Appendix B. Dams were present throughout the site and have been described in Appendix B. Overall, dams provided habitat for fish, frogs, turtles, and wader birds.

The riparian vegetation throughout the site varied in quality. Throughout the north-eastern extent of the site, the vegetation was pasture with scattered poor condition Cumberland Plain Woodland (Figure 8). In the south-western extent of the site, where most creeks met the definition of a river, riparian condition was highly modified and generally poor, with limited shrubs or canopy cover. The dominant vegetation was derived native grassland. The central creek system of 2F and 3D, had the highest quality riparian vegetation, with good quality Cumberland Plain Woodland present (Figure 8). These areas were characterised by a canopy dominated by *Eucalyptus tereticornis* (Forest Red Gum) and *Eucalyptus moluccana* (Grey Box). The open midstorey was dominated by exotic species *Lycium ferocissimum* (African Boxthorn) and *Olea europaea* subsp. *cuspidata* (African Olive), with scattered *Lantana camara* (Lantana) and *Gomphocarpus fruticosus* (Narrow-leaved Cotton Bush) in some areas. The groundcover was dominated by a large number of native grasses and forbs, including *Microlaena stipoides* (Weeping Grass), *Bothriochloa macra* (Red Grass), *Einadia hastata* (Berry Saltbush) and more. Exotic groundcover species were also present, though to a significantly lesser extent, and included *Eragrostis curvula* (African Lovegrass), *Setaria parviflora* and *Sida acuta* (Spinyhead Sida).

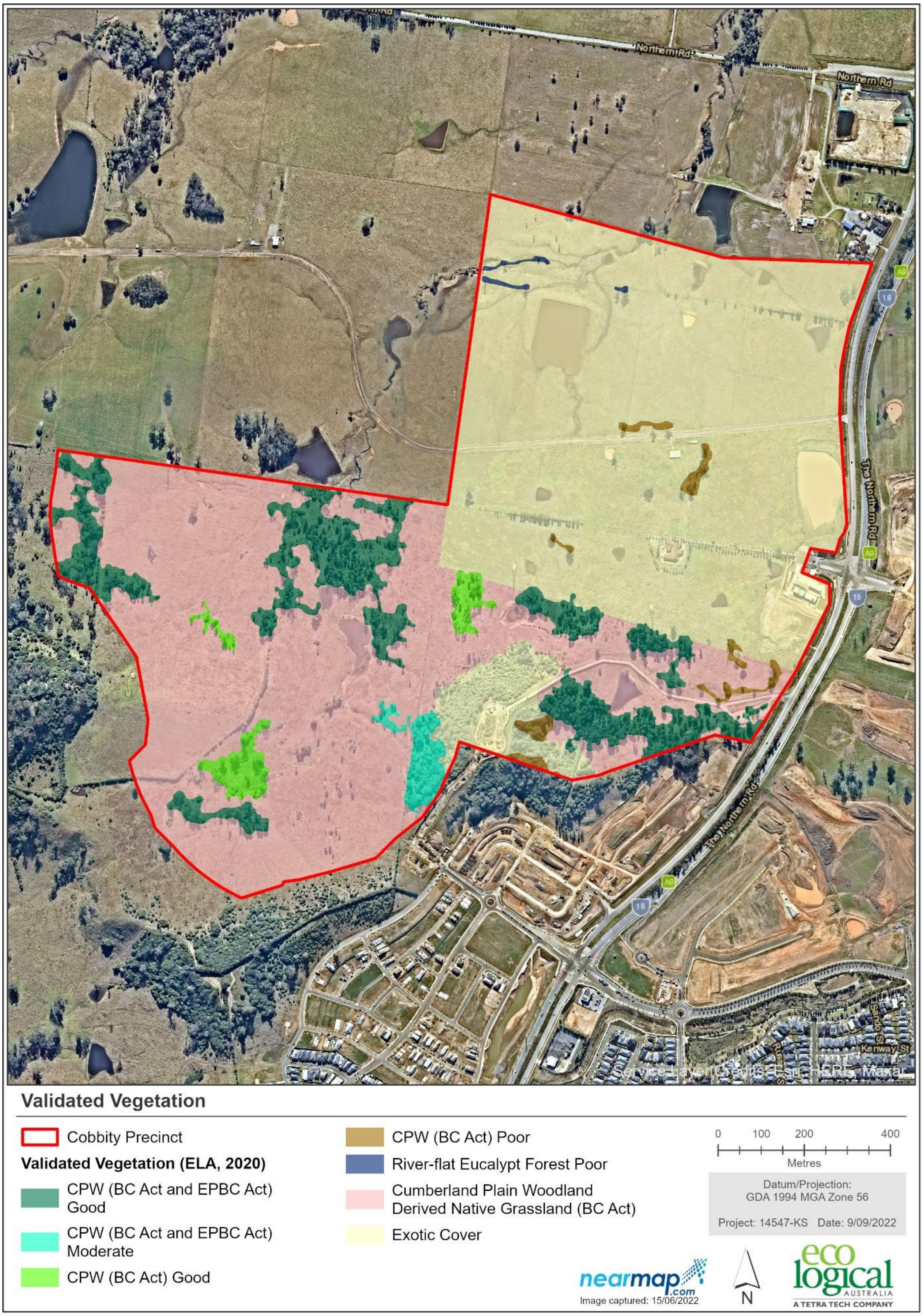


Figure 8: Validated vegetation communities and condition

4.4 Groundwater Dependant Ecosystems

One terrestrial groundwater dependent ecosystem (GDE), Cumberland Shale Hills Woodland, has a high potential of occurrence within the south-eastern corner of the study area, and no aquatic GDEs are mapped within the study area (Figure 9). Validated vegetation mapping in the Biodiversity Assessment (ELA 2024) indicates the presence of Cumberland Plain Woodland/Cumberland Plain Shale Woodlands and Cumberland Plain Woodland Derived Native Grassland in the location of the mapped terrestrial GDE (Figure 9). Definitive determination regarding the reliance on groundwater would require a hydrological survey to determine the level of the groundwater table.

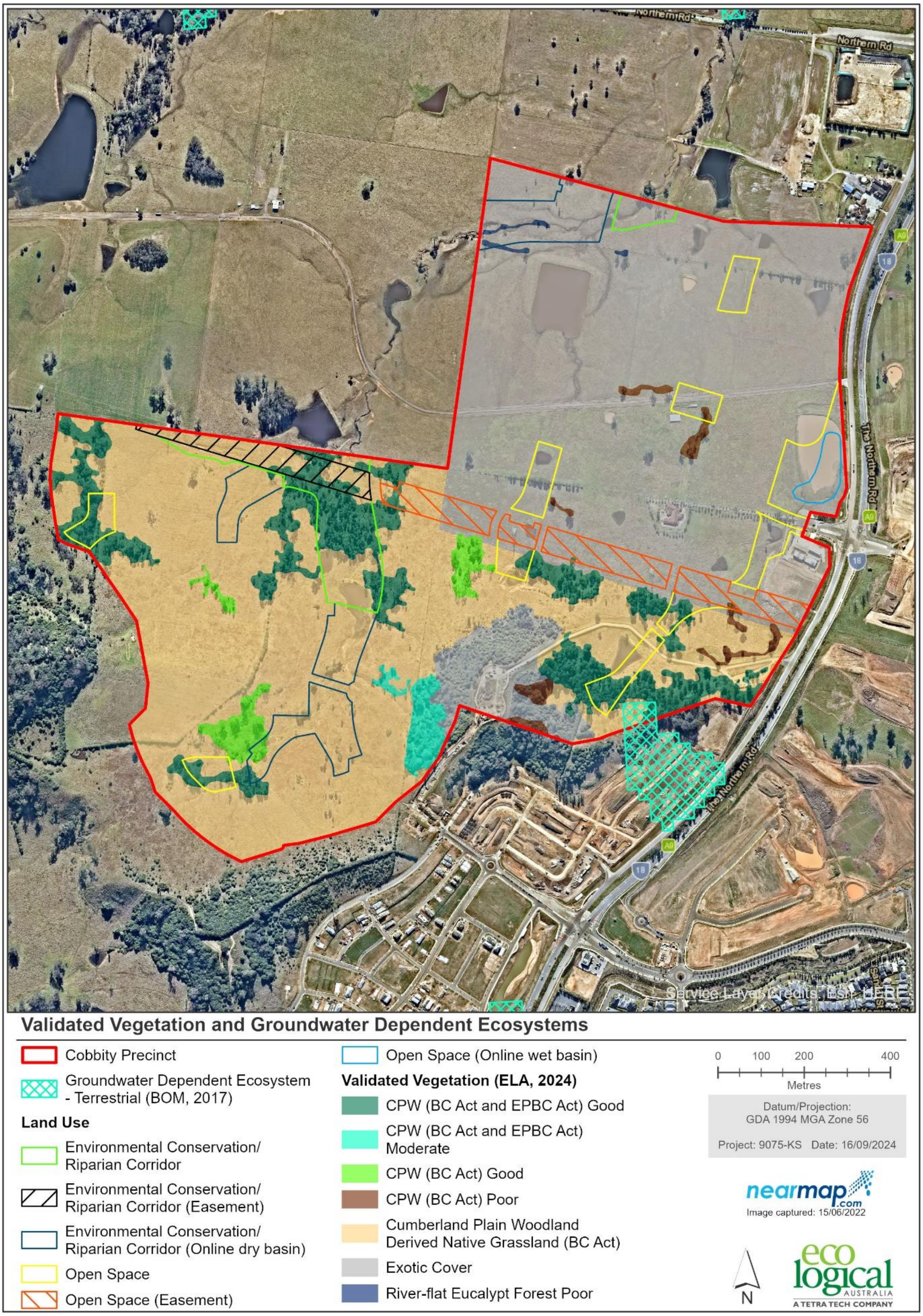


Figure 9: Groundwater dependent ecosystems within the study area

5. Riparian assessment

5.1 Indicative layout plan in relation to watercourses and riparian corridors

As outlined within the Western City District Plan (Greater Sydney Commission, 2018), improving sustainability is at the forefront of future strategic planning and development. Such improvements are focused on incorporating natural landscape features into the urban environment and protecting and managing natural systems. It is recognised that all aspects of sustainability rely on maintaining and managing green infrastructure such as waterways and remnant patches of native vegetation. Therefore, optimising and protecting existing riparian assets will be essential in ensuring the ongoing health and sustainability of the Cobbity Sub-Precinct 5.

An ILP has been developed which proposes to retain 16.90 ha of riparian corridor which was in moderate to good condition at the time of the survey and has the highest recovery potential (Figure 3; Figure 10).

The primary creek corridor, consisting of reaches 1AG, 2E, 2F and 3D in the centre of the site has been proposed to be retained and rehabilitated, in addition to the 2nd order creeks to the west, reach 2G and 2H, and the 4th order creek along the northern boundary of the study area, reach 4B. The ILP proposes removal and subsequent offset of seven 1st order watercourses which meet the definition of a 'river' under the WM Act, in addition to the removal of the online dam along reach 3D (Figure 11), which would restore a more natural hydrological regime along the watercourse through creation of a base-flow channel and restoration of the riparian corridor. The ILP also proposes the installation of three dry, vegetated online basins. The proposed ILP will therefore provide an opportunity to:

- Improve the necessary health and quality of the existing waterways and riparian corridors within the Precinct
- Improve public access to, and along, the riparian corridors, providing connected green space
- Protect and enhance flora, fauna, and urban bushland
- Reduce erosion and sedimentation and improve bank stabilisation
- Provide riparian vegetation buffers, allowing the recovery and reinstatement of more natural conditions within currently highly modified waterways
- Allow for the safe conveyance of floodwater.

Assuming the dam to be removed would be replaced with a 10 m-wide base-flow channel and appropriate VRZ, the total existing riparian area equates to 16.48 ha. Accounting for removal of the seven validated 1st order watercourses and encroachment of the ILP into the riparian corridor in certain areas, the total riparian corridor delivered in the ILP is 16.89 ha with a balance of +0.4088 ha. Proposed encroachment is 4.30 ha, and proposed offsets are 5.07 ha (Figure 11). Therefore, the proposal adheres to the 'averaging rule' and 1:1 compensation required by the DCCEEW riparian guidelines, assuming removal of the online dam.

Removal of watercourses which meet the definition of a 'river' under the WM act has occurred in other precincts, usually where:

- The river is a first-order watercourse.
- The river is in a degraded or poor condition and doesn't provide any important habit linkages

- The loss of riparian zone is offset by the increase of riparian zone in the remaining watercourses at a ratio of 1:1.

Further, the proposal would improve the structure and integrity of vegetation within the proposed riparian corridor, defined in Figure 11, and support Connecting to Country objectives through the preservation of ridgelines, views, and waterways. Restoration of the riparian zone would be achieved through the Riparian Management Strategy outlined in Section 5.5, and future Vegetation Management Plans (VMPs) to be prepared at the Development Application (DA) stage. These measures would be focused on improving the riparian areas which have limited native vegetation, and protecting and improving areas of intact native vegetation which will contribute to broader landscape connectivity, in conjunction with the Landscape Masterplan (Urbis 2024). ‘Nature trails’ and footpaths proposed within the riparian corridor by the Landscape Masterplan are permitted within the riparian corridor under the DCCEEW riparian guidelines, provided they do not encroach on the inner 50% VRZ and have a total disturbance footprint width of less than 4 m (Table 5).

Permissible road crossing types under the DCCEEW guidelines for watercourse crossings on waterfront land (DPE 2022) for the 3rd and 4th order watercourses in the study area include a culvert or a bridge (Table 5). Provided a culvert or a bridge is proposed over the 3rd and 4th order watercourses within the study area at the DA stage, the proposal is consistent with the DCCEEW guidelines for road crossings. See section 5.4 for permissible crossing types under the DPI Fisheries guidelines.

Where proposed works are inconsistent with the *Guidelines for Controlled Activities on Waterfront Land* (DPE 2022), the principles of the WM Act can guide activities that are to take place on waterfront land and be used to provide a merit-based assessment of the proposed development.

The principles set out in this section are the water management principles of the WM Act described below:

Generally:

a. *water sources, floodplains, and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and*
b. *habitats, animals, and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and*
c. *the water quality of all water sources should be protected and, wherever possible, enhanced, and*
d. *the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and*
e. *geographical and other features of Aboriginal significance should be protected, and*
f. *geographical and other features of major cultural, heritage or spiritual significance should be protected, and*
g. *the social and economic benefits to the community should be maximised, and*
h. *the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements.*

In relation to controlled activities:

a. the carrying out of controlled activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and

b. *the impacts of the carrying out of controlled activities on other water users must be avoided or minimised.*

The ILP allows for protected and rehabilitated riparian corridors to be established. Under the Riparian Management Strategy and future VMPs, these vegetated channels will become protected waterways within the precinct which will improve their current condition, as currently they receive no observable maintenance and exotic flora species dominate some areas of the riparian buffer. Watercourse protection also allows for an improvement in water quality within the precinct, as revegetation and weed control would create stable beds and banks and a buffer between residential areas and the watercourse.

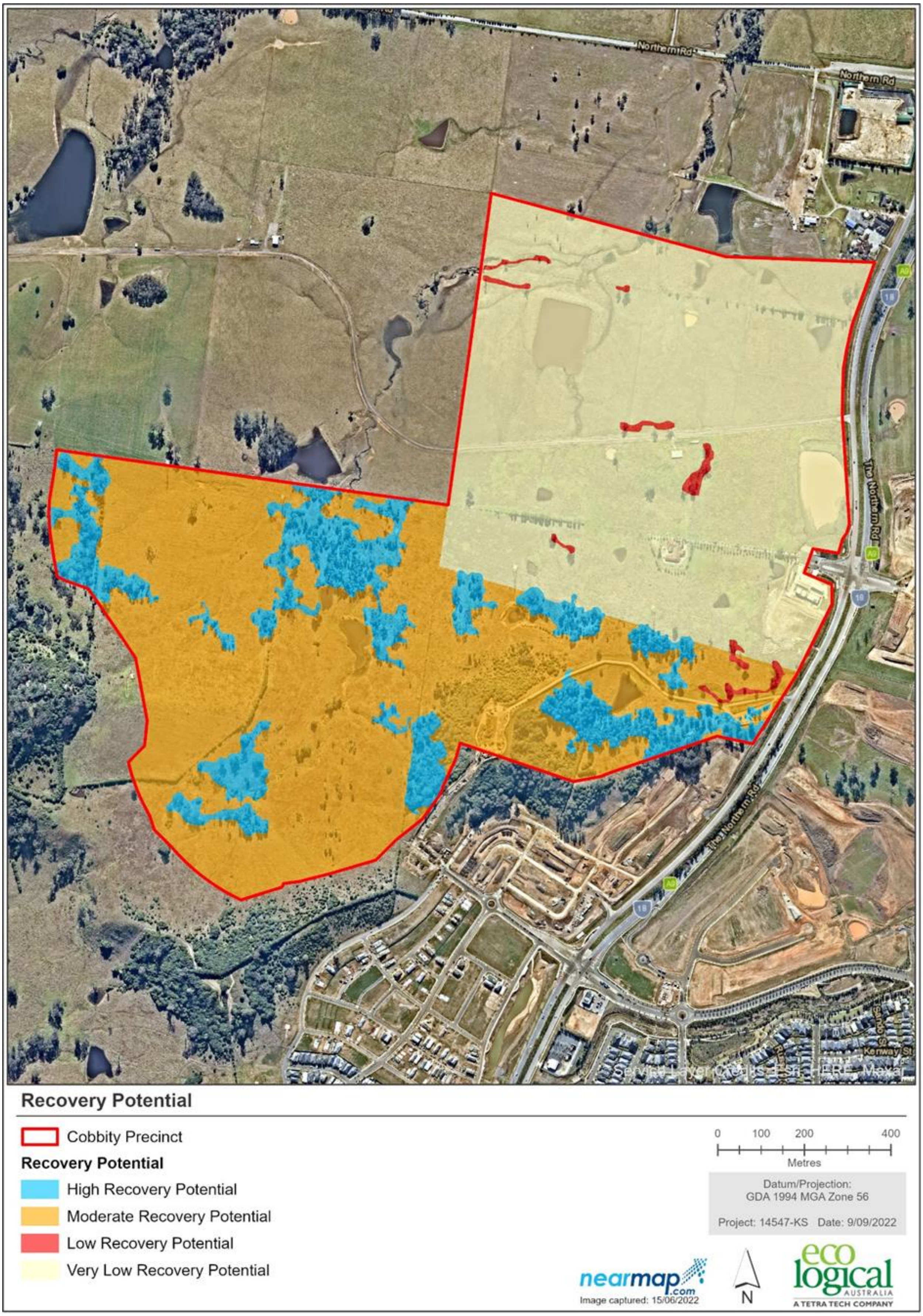


Figure 10: Recovery potential of vegetation within the study area

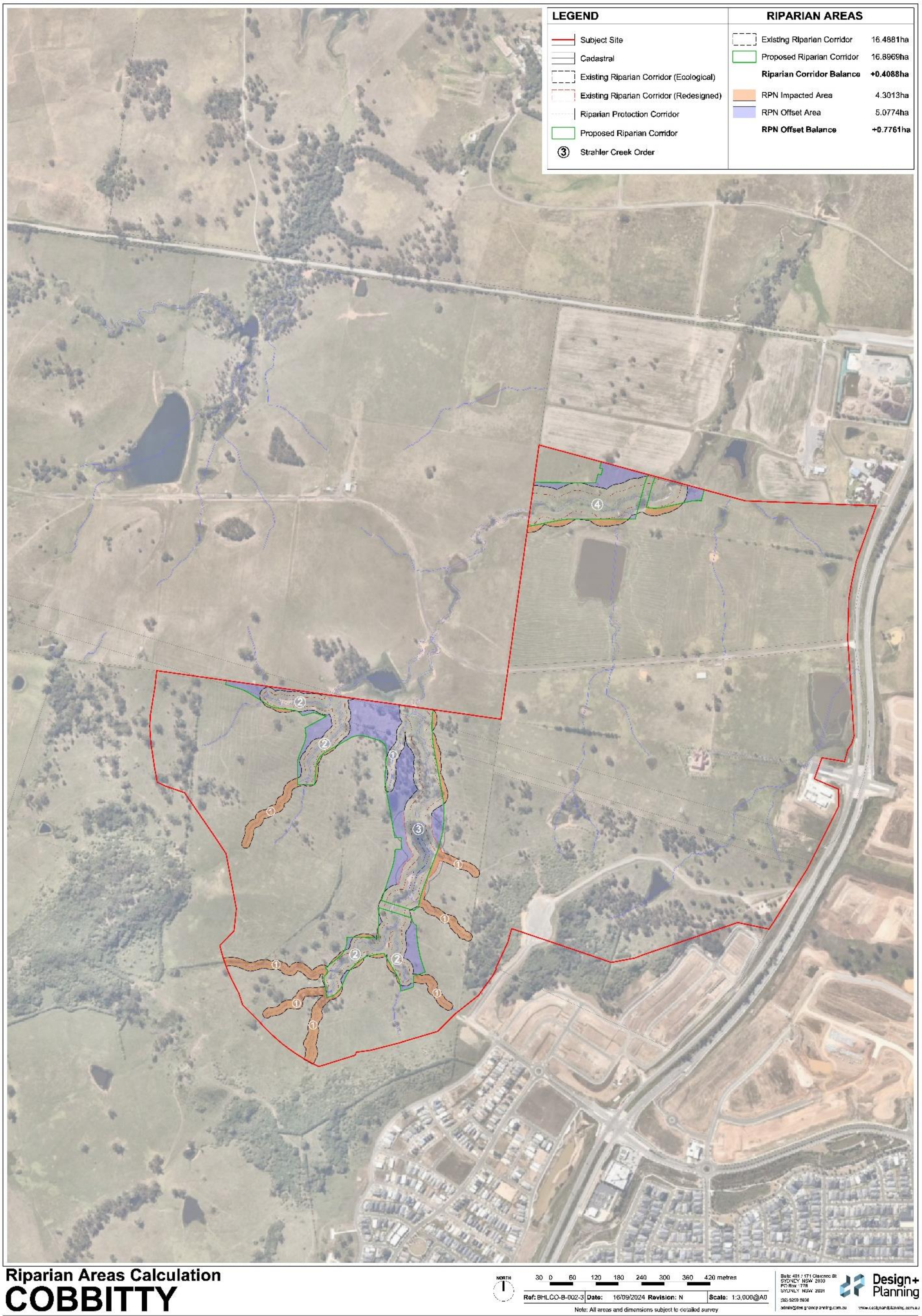


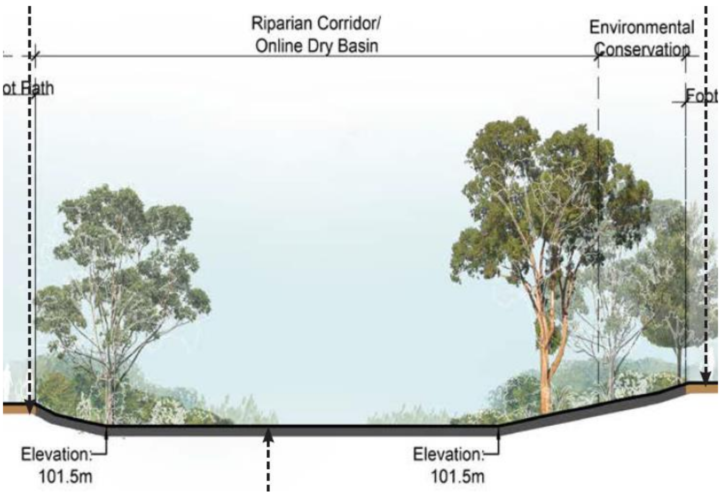
Figure 11: Encroachment of the proposed ILP into the riparian corridor and proposed areas for offset

5.2 Online basins

The proposal includes three online, dry, vegetated basins within the riparian corridor (Figure 12). Each have had inundation times modelled for 50%, 20% and 1% AEP events, presented in Appendix A (JWP 2024). The DCCEEW riparian guidelines do not provide for online dry basins on 3rd or 4th order watercourses, nor do they provide for online basins without an equivalent VRZ. However, the proposed basins do provide some ecological merit. These areas would be revegetated to a full-structured vegetation community (Cumberland Plain Woodland or River-flat Eucalypt Forest). In areas of prolonged inundation times (24-36 hours), species selection would be based on species which are tolerant of such inundation. This has been reflected in the relevant flood modelling undertaken by JWP (2024) in Appendix A, where a Mannings Value of 0.12 has been assumed.

Further, although the basins are proposed on a 3rd and 4th order watercourse, the requirements outlined in Table 2 of the *Guidelines for Controlled Activities on Waterfront Land* (DPE 2022) have been addressed in Table 9 to further justify this proposal.

Table 9: DCCEEW riparian guidelines requirements for online basins

Requirement	Comment
Online detention basins must be dry and vegetated.	The proposed dry detention basins will be fully vegetated, as indicated by the Landscape Masterplan below (Urbis 2024).  *Vegetated riparian corridor within an online dry basin, adapted from the Landscape Masterplan (Urbis 2024; Cobbitty Creek Parklands Central Section A)* The online basins would be designed and managed as a fully-structured riparian corridor under a VMP to be developed at the DA stage. The hydraulic model prepared by JWP (2024) allows for a fully structured riparian corridor to form part of the new development with a Manning's n value of 0.12 for flood levels less than 0.5 m deep and 0.03 for flood levels greater than 0.5 m deep when it is likely that shrub and grass vegetation would fold over and offer limited resistance. The maximum depth of water in a basin (i.e. the difference between the creek invert and the top of bank) is as follows: • Basin 1: 3.0m • Basin 2: 5.0m • Basin 7: 3.3m. These maximum depths would only be for small areas and for short periods. The time of inundation is shown in the figures in the Water Cycle Management

Requirement	Comment
	Strategy (JWP, 2024). These are extracted and provided in Appendix B of this report. The VMP to be prepared at DA stage will require selection of species that are tolerant of inundation within certain parts of the basins, such as a greater use of native grasses and rushes in areas of longest inundation, then Casuarinas and Melaleucas in areas that are frequently inundated.
Online detention basins must be for temporary flood detention only, with no permanent water holding.	Basin inundation times are demonstrated in Appendix A (from JWP 2024). Overall maximum holding time is 36.4 hours above RL 101.5 m AHD for a 20% AEP event in basin 1 and 2, with no permanent water holding proposed.
Online detention basins must have an equivalent VRZ for the corresponding watercourse order.	Although no equivalent VRZ is proposed when measured from the edge of the basin, the proposed dry online basins would contain a base-flow channel (assumed top of bank for VRZ buffering) and operate as a functional riparian corridor with fully structured vegetation. The modelled Manning's n value for the basin when dry or less than 0.5 m depth is 0.12 (JWP 2024). Sydney Water describes riparian/stream vegetation with an n value between 0.05 – 0.1 as "Grass and/or weeds more than twice the height of flow depth; or dense, strong reed growth; or significant shrub growth within the channel; or significant inflexible vegetation within channel" (Sydney Water 2024). When combined with trees that are tolerant of periodic inundation, the basins would provide functions expected under the WM Act, and meet the requirements of a VRZ. Basin vegetation would be managed and maintained under a VMP, to be prepared at the DA stage. Moreover, the ILP proposes 1:1 offset of encroachments and removal of creeks which meet the definition of a 'river' under the WM Act. The maximum static water level of the basins for a 1% AEP event is highlighted in Figure 12, assuming a Manning's n value of 0.12.
Online detention basins must not be used for water quality treatment purposes.	Water quality management will be undertaken in separate stand-alone devices outside the outer 50% VRZ (Figure 12). The online basins are proposed for water retention only.

In general, the ILP is consistent with the objectives of the WM Act and aims to apply the principles of ecological development by rehabilitating areas with the highest recovery potential to restore natural ecological processes along the primary watercourse whilst considering the hydrological context of the broader catchment. Although basins are located on 3rd and 4th order watercourses, the basins would maintain and restore ecological and hydrological function of the watercourses by functioning as a riparian corridor for the base-flow channel with fully-structured riparian vegetation established and managed under a VMP, developed at the DA stage. Therefore, the VRZ for basins has been measured from the low flow top of bank, rather than edge of basin.

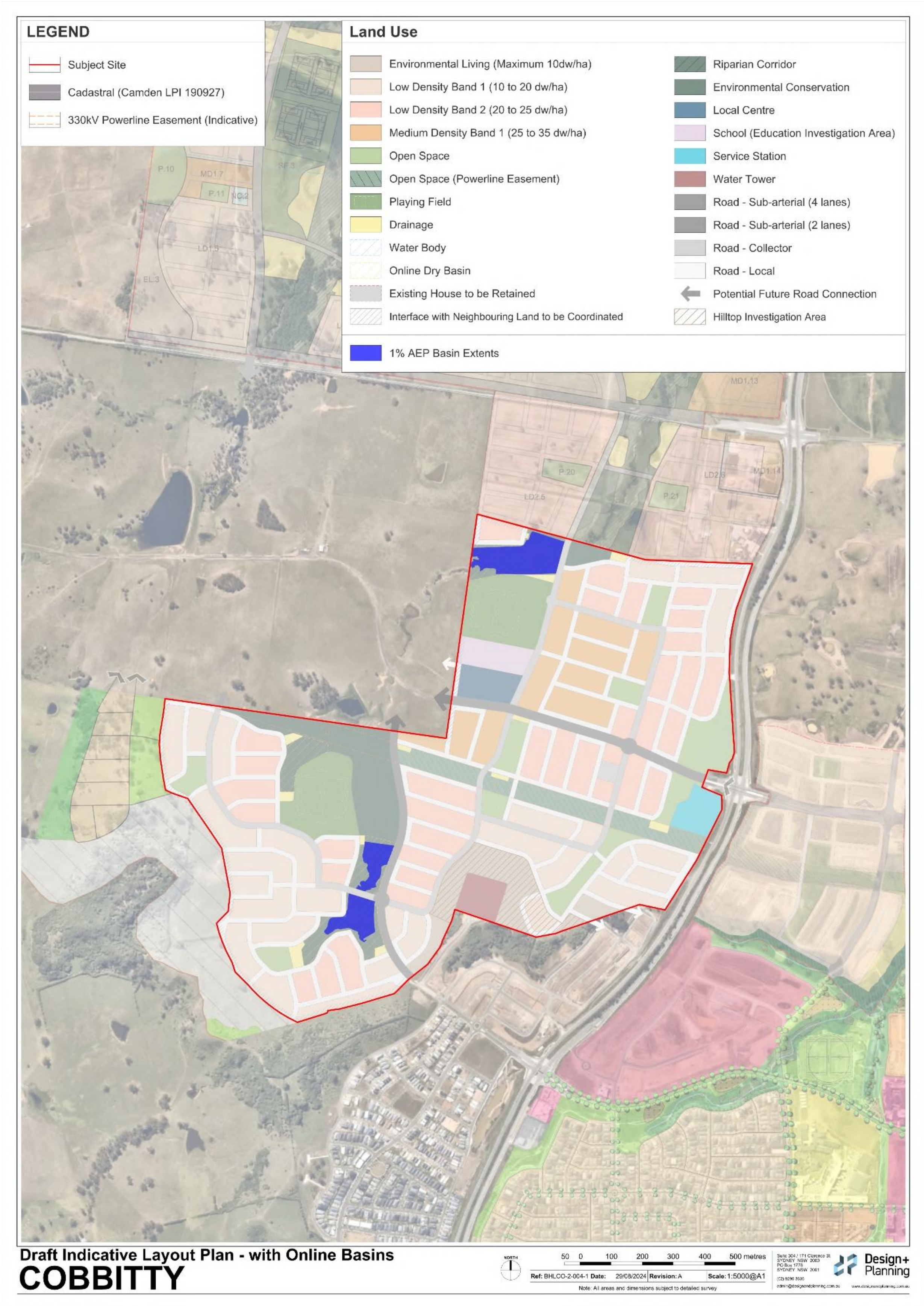


Figure 12: Indicative layout plan within online basins and riparian corridor (Design and Planning, Revision A)

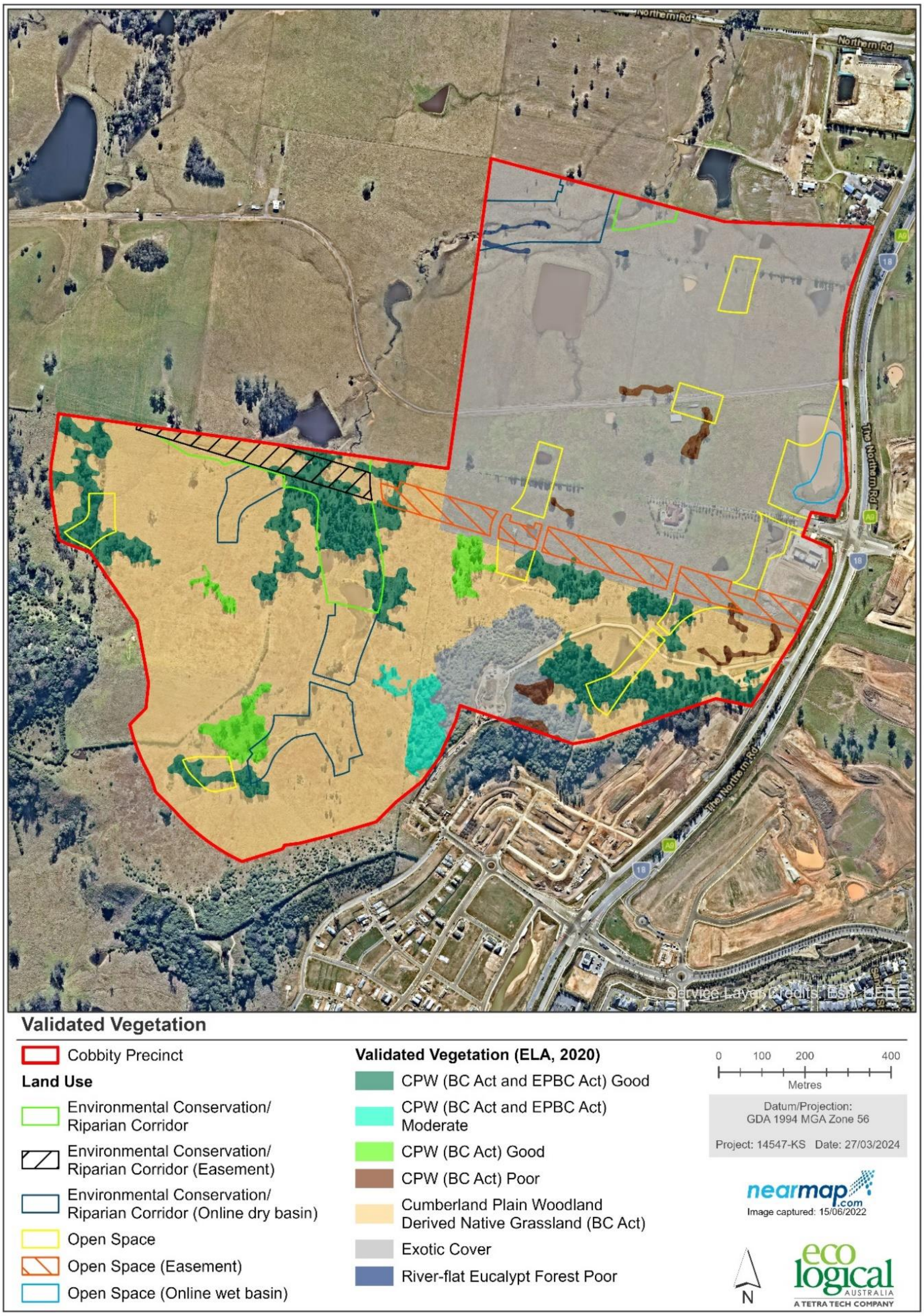


Figure 13: Indicative Layout Plan and existing native vegetation

5.3 Groundwater Dependant Ecosystems

Field survey confirmed no BOM-mapped aquatic GDEs were present on site. The mapped terrestrial GDE is present in the south-eastern corner of the study area, based on field-validated vegetation mapping (Figure 9). In lieu of an extensive groundwater assessment, groundwater is unlikely to be a significant constraint to the development. Provided that water cycle management measures are implemented in the design, changes to spatial and temporal flows are likely to be minimal and not significantly affect the groundwater table.

5.4 Aquatic ecology

KFH exists along the central 3rd order watercourse and further downstream where it intersects the northern portion of the study area as a 4th order creek. This watercourse may be classified as Class 2 – Moderate key fish habitat and Type 2 – Moderately sensitive key fish habitat due the intermittently flowing and semi-permanent to permanent nature of the watercourse, presence of snags, clearly defined banks and sparse aquatic vegetation as described in Appendix B. As such, the preferred crossing type for the 3rd and 4th order waterway crossings under the Fisheries guidelines with respect to waterway classification is, in order of preference, bridges, arch structures, box culverts and fords. The proposed road crossings over the 3rd and 4th order watercourse would adhere to the design requirements outlined in Fairfull and Witheridge (2003) to meet fish passage policy and guidelines, ensuring the proposal does not create any barriers to fish passage. Moreover, the proposed removal of the online dam and replacement with a base-flow channel would restore fish passage within the reach. The overall consistency of the crossing design with fish passage requirements under the Fisheries guidelines would be determined at the DA or detailed design stage.

DPI Fisheries also recommend a riparian buffer zone 50 metres from the top of bank for Type 2 Class 2 waterways. Where the proposed works encroach on the VRZ required under the WM Act, 1:1 offsetting is proposed in addition to full revegetation and rehabilitation of the riparian corridor under a VMP. Therefore, the condition of the riparian corridor would be improved from its pre-development state, which includes negligible to sparse riparian vegetation (Appendix B). Overall, the proposal is generally consistent with the policies and guidelines for protecting urban riparian vegetation, as it seeks to ensure the riparian corridor functions as a ‘natural’ system through revegetation.

See the Biodiversity Assessment (ELA 2024) for the likelihood of occurrence of threatened aquatic species, communities or populations listed under the FM Act.

5.5 Riparian Management Strategy and recommendations

The subject site is dominated by Cumberland Plain Woodland in varying conditions with large patches of Derived Native Grassland. The subject site also contains large areas of Exotic Cover at the northern extent of the subject site. Areas of River-Flat Eucalypt Forest are comparatively minimal and limited in location along few watercourses.

While all the Cumberland Plain Woodland within the subject site meets the description of the critically endangered ecological community listed under the BC Act, most of the remnants do not meet the definition of the federally listed Cumberland Plain Shale Woodland and Shale Gravel Transition Forest. Large patches of Cumberland Plain Woodland are present along the main creek lines of the site and should be retained and rehabilitated as part of the ILP. The overarching riparian management strategy outlines future restoration potential of native vegetation along riparian zones in the precinct with broad objectives to re-establish characteristic diversity of indigenous plants and communities whilst reducing exotic weed cover.

5.5.1 Averaging rule

As discussed in Section 5.1, DCCEEW's guidelines provide an Averaging Rule, which allows non-riparian works / activities to be carried out within the outer riparian corridor provided that the average width of the riparian zone can be achieved over the length of the watercourse within the development site. Under this rule, the outer 50% of the riparian corridor may be used for development lots, infrastructure, etc., provided that an equivalent area connected to the riparian corridor is offset on the site. The inner 50% must be protected and fully revegetated.

The future riparian management areas are based on the locations of existing riparian corridors, that have the highest likelihood of full rehabilitation but may vary be varied in the future subject to detailed designs. As such, the riparian rehabilitation areas may be subject to change following detailed design.

5.5.2 Recovery potential

Recovery potential relates to the degree, manner, and pace of an area to recovery after disturbance or stress and is impacted by factors including vegetation composition, structure, and function of remaining vegetation, biodiversity, and presence of key weed species. A moderate to good recovery potential allows the land to be managed for an improvement in the condition of the remnant vegetation and to increase linkages (wildlife corridor) between extant stands of vegetation.

With appropriate management actions, areas identified as having a moderate recovery potential would improve the condition of threatened species habitat and ecosystem connectivity within the precinct. Management actions would need to be on-going and facilitate the natural regeneration of the over-storey and/or regeneration of native species (grasses, herbs, and forbs) in the seed bank.

The following four classes of recovery potential have been identified within the subject site (Figure 10):

- High Recovery Potential: Native vegetation mapped as areas which generally have native canopy cover of greater than 10% and contained native species in each structural layer.
- Moderate Recovery Potential: Other areas of native vegetation with some canopy, less structural complexity, and a higher level of weed infestation or ongoing disturbance.

- Low Recovery Potential: Areas which show some potential for natural regeneration. Some native species present in some structural layers, very high level of weed infestations, not all structural layers present.
- Very Low Recovery Potential: All other areas including cleared and heavily cultivated and/or pasture improved areas.

Areas along the central creek line have moderate to high recovery potential which indicates that rehabilitating the riparian corridor along the central and north-western creek lines has a high feasibility. The recommended areas of rehabilitation target the watercourses that already have moderate to good condition vegetation established for example around 2F and 3D. Vegetating along these watercourses and linking the isolated vegetation patches would allow for an improvement in wildlife corridors and overall creek condition. This would incidentally facilitate the recovery of the creek systems to a functioning natural waterway.

5.5.3 Management zones

The area of the riparian corridor proposed to be retained and managed within the ILP is approximately 16.90 ha. The rehabilitation works for the riparian corridor will be focused on weed control, assisted regeneration and revegetation. The riparian corridor consists of three management zones as identified below and in Figure 14.

- Zone 1: Rehabilitation and Weed Management
- Zone 2: Revegetation
- Zone 3: Revegetation (Groundcover and Mid-Storey Species).

An assessment of the native resilience and weed densities was conducted during field surveys. The vegetation within the riparian corridor is generally in poor to moderate condition with high weed densities in the ground layers. Areas of exotic pasture will require maintenance to prevent the continued incursion of weeds into the riparian corridor. This will best be achieved by regular mowing or ongoing weed control along the interface of the riparian corridor and proposed developable areas.

The key management priorities and required management actions for revegetation are:

- Target removal of priority and environmental weeds
- Control of exotic grasses and other exotic species
- Tubestock planting following weed control in areas of low resilience (either fully structured, ground cover only or wetland species based on locations shown in Figure 14).
- Monitor native vegetation and weed densities.
- Species selection will be based on Riverflat Eucalypt Forest, but with particular attention paid to the proposed period of inundation as shown in Appendix B.

The key management priorities and required management actions for rehabilitation and weed management are:

- Target removal of priority and environmental weeds
- Control of exotic grasses and other exotic species
- Monitor native vegetation and weed densities.

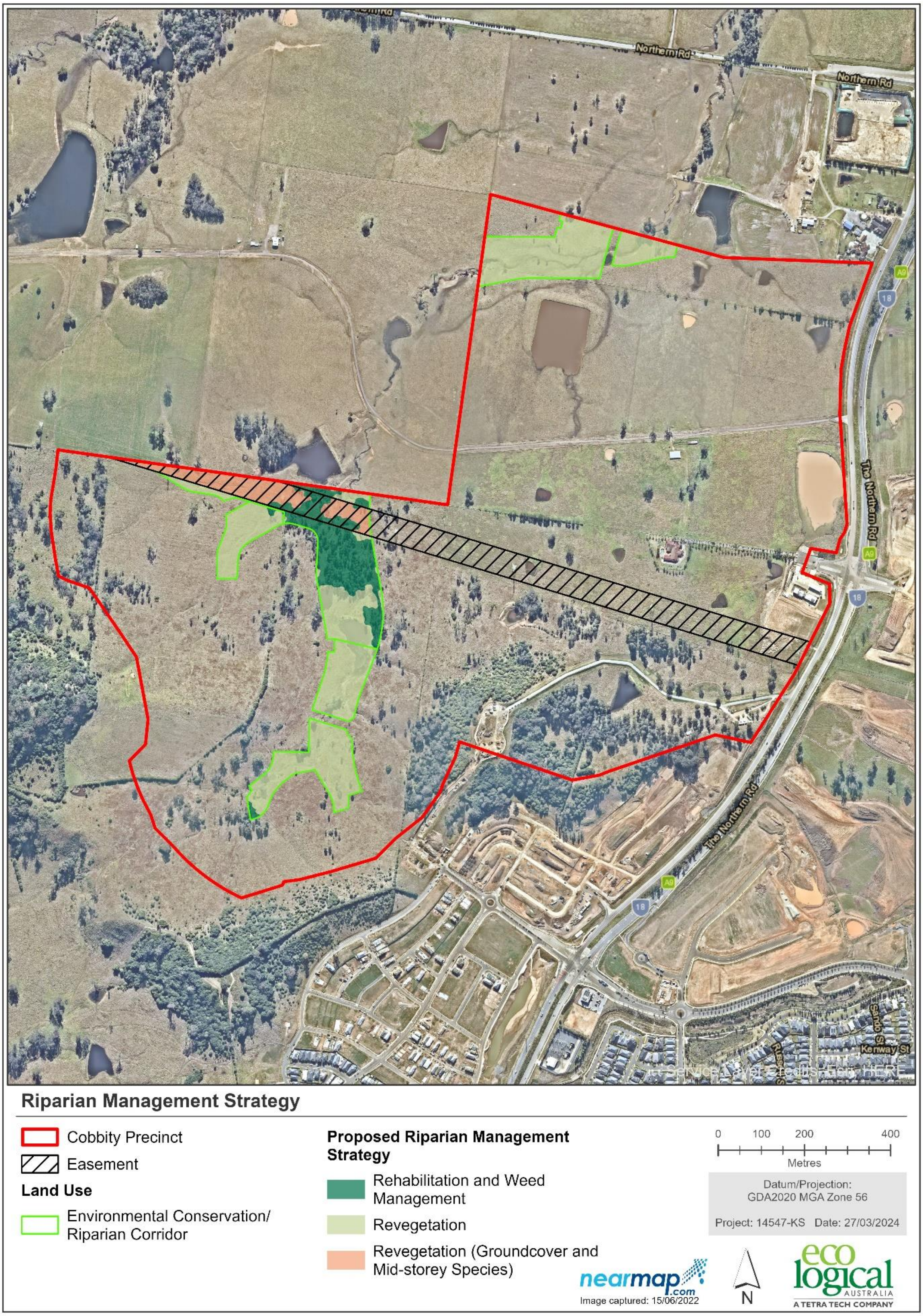


Figure 14: Indicative riparian management zones

5.5.4 SEPP and DCP provisions

Major riparian corridors should be zoned C2 Environmental Conservation under the Growth Centres SEPP as this provides clear objectives for the protection and management of the riparian corridor. The permissible uses within the Environmental Conservation zones are shown below.

Zone	Permitted without consent	Permitted with consent	Prohibited
Environmental Conservation	Nil	Drainage; Earthworks; Environmental facilities; Environmental protection works; Flood mitigation works; Information and education facilities; Kiosks; Recreation areas; Roads; Signage; Waterbodies (artificial)	Business premises; Hotel or motel accommodation; Industries; Multi dwelling housing; Recreation facilities (major); Residential flat buildings; Restricted premises; Retail premises; Seniors housing; Service stations; Warehouse or distribution centres; Any development not specified in item 2 or 3

Where multiple land uses are proposed, for example public access for recreation, other land use zones may be appropriate such as RE1 Public Recreation, as long as the management regime for the land has a primary objective of environmental protection. However, the proponent is proposing to zone riparian corridors and adjacent accessible areas as C2 with hatching on the riparian corridors to identify where the corridor must be maintained for conservation purposes.

The riparian areas should also be subject to the Camden City Council Growth Centres Precincts DCP clauses that relate to Water Cycle Management (2.3.2) and Native Vegetation and Ecology (2.3.5). The clauses are triggered by including the riparian areas on the Western Parkland City SEPP Riparian Protection Area map. The DCP (section 2.3.5) has controls specifically for the Riparian Protection Areas which should apply to the South Creek West precinct:

- *Within land that is in a Riparian Protection Area, native vegetation is to be conserved and managed in accordance with the Guidelines for riparian corridors on waterfront land prepared by the NSW Office of Water*.

The conservation and management regime for the vegetation should be described in a Vegetation Management Plan that has been prepared to be consistent with the zone objectives, the above guidelines and Landscape plans prepared for the development.

Where public access for recreation is proposed, public ownership of riparian lands is likely to be the best solution. Discussion with local government regarding the infrastructure and vegetation management in the riparian zone is recommended.

An assessment under the Biodiversity and Conservation SEPP is provided below for controls on development generally (Table 10), which is applicable to development in the Hawkesbury-Nepean catchment.

Table 10: Impact assessment for controls on development generally under Part 6 of the Biodiversity and Conservation SEPP

Item	Impact assessment
Clause 6.6 Water quality and quantity	*(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied the development ensures—* *(a) the effect on the quality of water entering a natural waterbody will be as close as possible to neutral or beneficial.* The proposed revegetation, rehabilitation and management of the riparian corridor under a VMP prepared at the DA stage is anticipated to have a beneficial effect on the watercourse during the operational phase of the development. Potential adverse effects on the watercourse during the construction phase would be mitigated through the implementation of a Construction Environmental Management Plan (CEMP), also prepared at the DA stage. *(b) the impact on water flow in a natural waterbody will be minimised.* The proposed works include the removal of the online dam on the 3rd order creek and construction of a base-flow channel, allowing for the reinstatement of natural flow.
Clause 6.7 Aquatic ecology	*(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied of the following—* *(a) the direct, indirect or cumulative adverse impact on terrestrial, aquatic or migratory animals or vegetation will be kept to the minimum necessary for the carrying out of the development.* A CEMP prepared at the DA stage would include mitigation measures to ensure the proposed works would not have a direct, indirect or cumulative adverse impact on flora or fauna. See the Biodiversity Assessment for the potential impacts of construction and operation on terrestrial biodiversity (ELA 2024). The proposed rehabilitation of the riparian corridor under a VMP would have a positive impact on aquatic ecology throughout the operational phase of the development, relative to the current aquatic and riparian condition of the watercourses (Section 4.3). Revegetation of the riparian corridor would increase aquatic habitat values in KFH through improved shading and bank stability, introduction of snags, increased native leaf litter as food for macroinvertebrates, and improvement in nutrient cycling and water quality. Moreover, the removal of the online dam on the 3rd order watercourse would remove a barrier for fish passage. *(b) the development will not have a direct, indirect or cumulative adverse impact on aquatic reserves.* The proposal is located approximately 38 km west of the nearest aquatic reserve, and would not have an adverse impact on the reserve. *(c) if a controlled activity approval under the Water Management Act 2000 or a permit under the Fisheries Management Act 1994 is required in relation to the clearing of riparian vegetation—the approval or permit has been obtained.* The requirement for approval or permit will be addressed as part of future integrated development applications. *(d) the erosion of land abutting a natural waterbody or the sedimentation of a natural waterbody will be minimised.* Erosion mitigation measures during construction would be addressed in a CEMP to be prepared at the DA stage. The proposal includes retaining walls within the riparian corridor abutting the online detention basins for the prevention of erosion during high-flow events throughout the proposal's operational stage. *(e) the adverse impact on wetlands that are not in the coastal wetlands and littoral rainforests area will be minimised.* Under the NSW Wetlands Management Policy 2010, the watercourse within the study area is broadly classed as a wetland, as are all ephemeral and perennial watercourses in NSW. See responses a-d above.

Clause 6.8 Flooding	*(2) Development consent must not be granted to development on flood liable land in a regulated catchment unless the consent authority is satisfied the development will not—* *(a) if there is a flood, result in a release of pollutants that may have an adverse impact on the water quality of a natural waterbody.* A Water Cycle Management study is in preparation (JWP 2024) to demonstrate compliance with water quality targets set out within the Camden City Council Growth Centres Precincts DCP. *(b) have an adverse impact on the natural recession of floodwaters into wetlands and other riverine ecosystems.* The proposal site does not lie between a watercourse and any flood dependent ecosystems. There are no wetlands mapped downstream.
Clause 6.9 Recreation and public access	*(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied of the following—* *(a) the development will maintain or improve public access to and from natural waterbodies for recreational purposes, including fishing, swimming and boating, without adverse impact on natural waterbodies, watercourses, wetlands or riparian vegetation.* Public access to the watercourses would be greatly improved relative to current public accessibility. As per the Landscape Masterplan (Urbis 2024), nature trails, boardwalks and bridges are proposed within the riparian corridor.
Clause 6.10 Total catchment management	*In deciding whether to grant development consent to development on land in a regulated catchment, the consent authority must consult with the council of each adjacent or downstream local government area on which the development is likely to have an adverse environmental impact.* This is the responsibility of council.

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Appendix A – Online basin inundation modelling (JWP 2024)

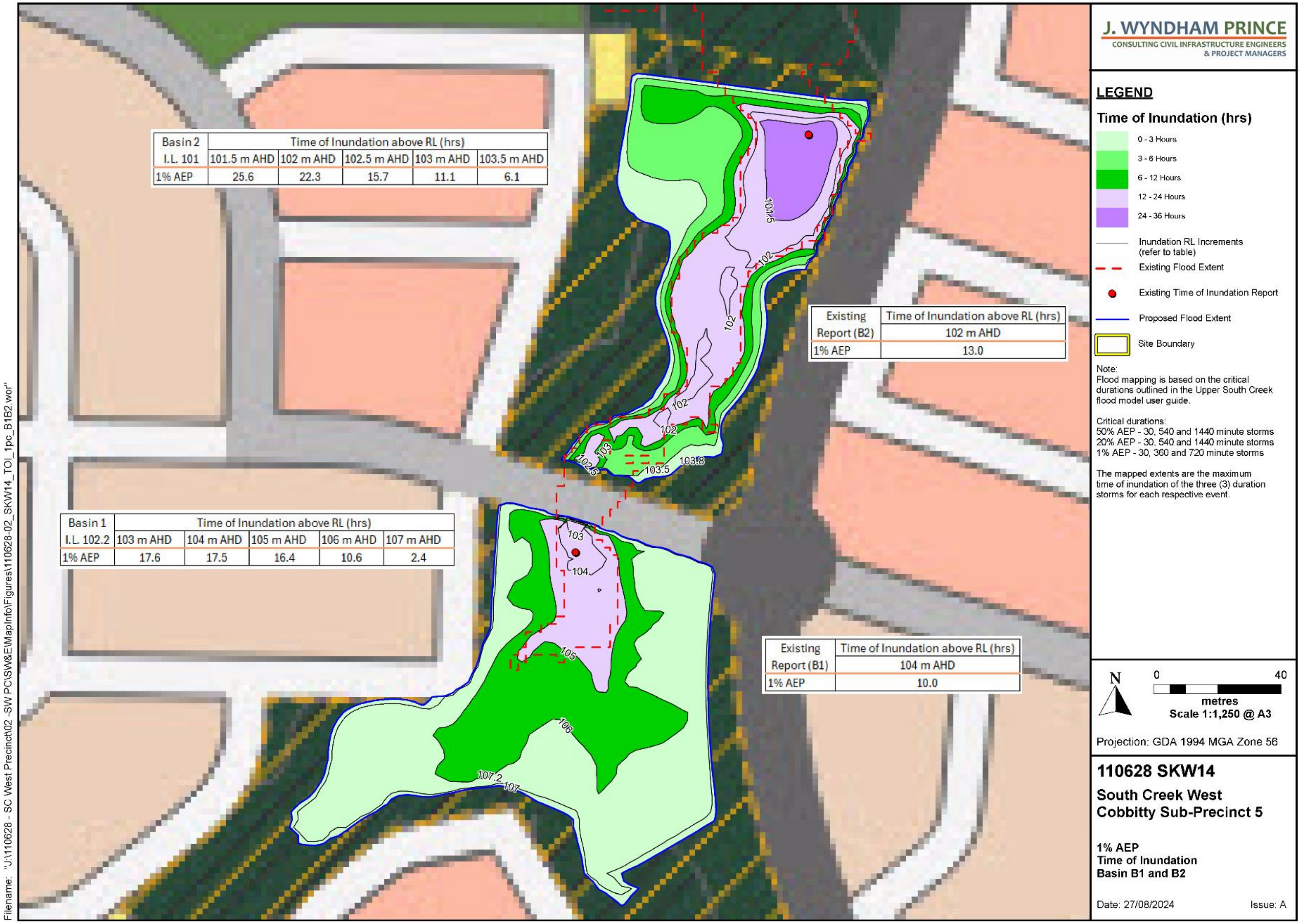


Figure 15: Basin 1 and basin 2 inundation time for 1% AEP event (JWP 2024)

Basin 2	Time of Inundation above RL (hrs)				
I.L. 101	101.5 m AHD	102 m AHD	102.5 m AHD	103 m AHD	103.5 m AHD
20% AEP	36.4	32.8	9.4	3.8	n/a

Existing Report (B2)	Time of Inundation above RL (hrs)
	102 m AHD
20% AEP	15.0

Basin 1	Time of Inundation above RL (hrs)				
I.L. 102.2	103 m AHD	104 m AHD	105 m AHD	106 m AHD	107 m AHD
20% AEP	28.5	28.3	26.6	5.2	n/a

Existing Report (B1)	Time of Inundation above RL (hrs)
	104 m AHD
20% AEP	7.6

Figure 16: Basin 1 and basin 2 inundation time for 20% AEP event (JWP 2024)

Basin 2	Time of Inundation above RL (hrs)				
I.L. 101	101.5 m AHD	102 m AHD	102.5 m AHD	103 m AHD	103.5 m AHD
50% AEP	36.1	32.4	4.1	n/a	n/a

Existing Report (B2)	Time of Inundation above RL (hrs)
	102 m AHD
50% AEP	7.7

Basin 1	Time of Inundation above RL (hrs)				
I.L. 102.2	103 m AHD	104 m AHD	105 m AHD	106 m AHD	107 m AHD
50% AEP	26.5	23.9	12.8	2.2	n/a

Existing Report (B1)	Time of Inundation above RL (hrs)
	104 m AHD
50% AEP	3.2

Figure 17: Basin 1 and basin 2 inundation time for 50% AEP (JWP 2024)

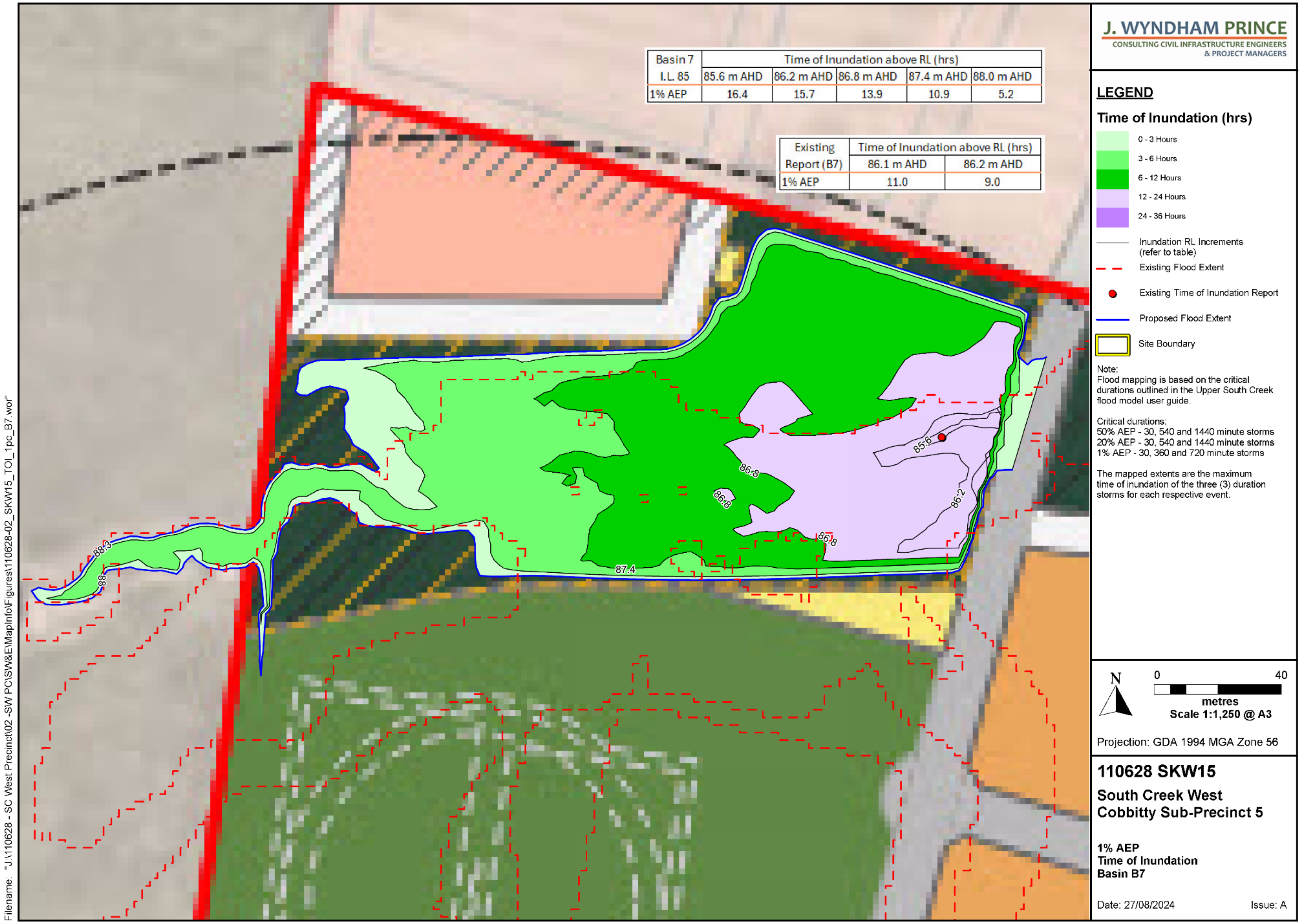
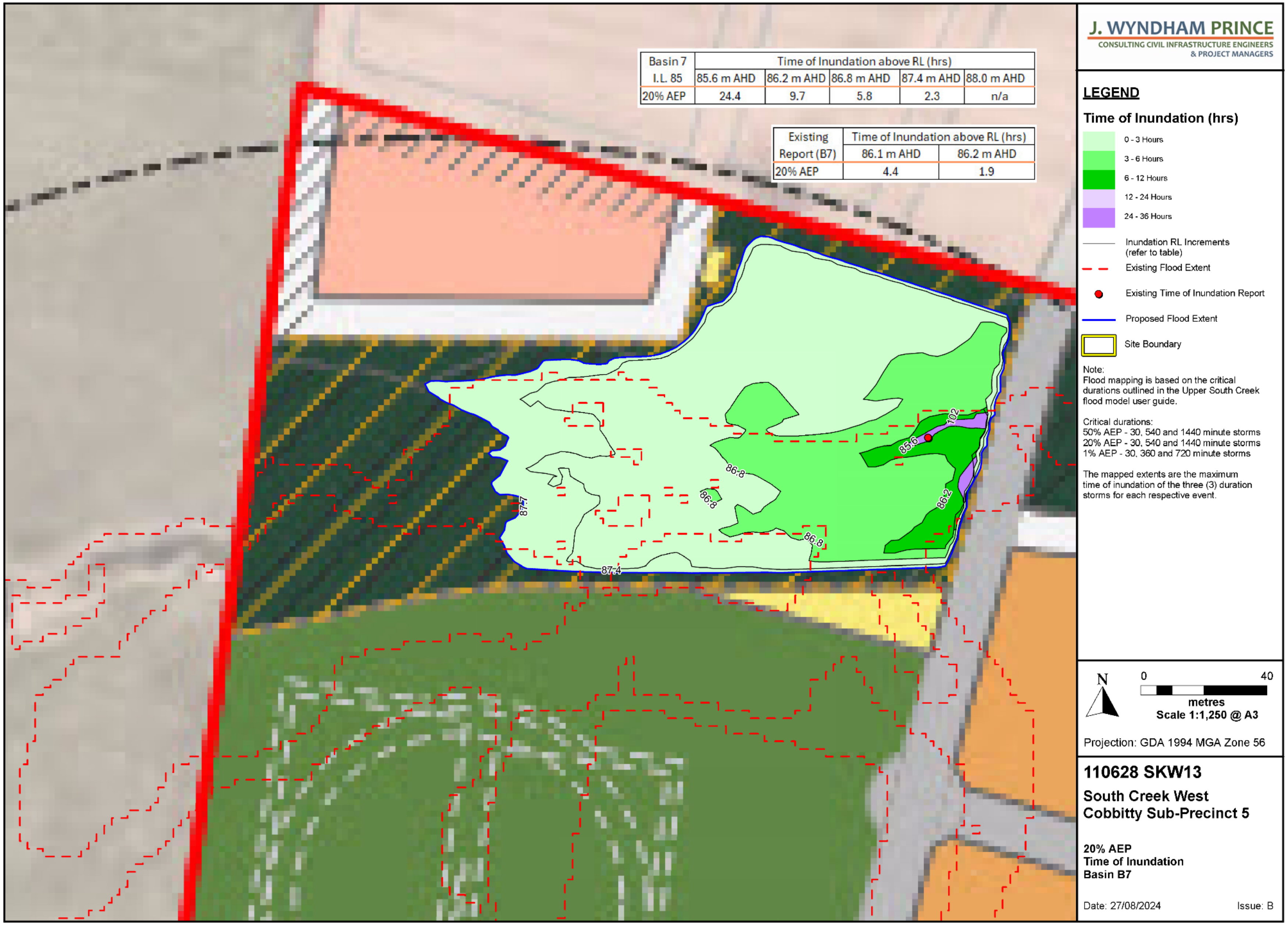


Figure 18: Basin 7 inundation time for 1% AEP event (JWP 2024)

Filename: "J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\110628-02_SKW13_TOI_20pc_B7.wor"



Basin 7	Time of Inundation above RL (hrs)				
I.L. 85	85.6 m AHD	86.2 m AHD	86.8 m AHD	87.4 m AHD	88.0 m AHD
20% AEP	24.4	9.7	5.8	2.3	n/a

Existing	Time of Inundation above RL (hrs)	
Report (B7)	86.1 m AHD	86.2 m AHD
20% AEP	4.4	1.9

Figure 19: Basin 7 inundation time for 20% AEP (JWP 2024)

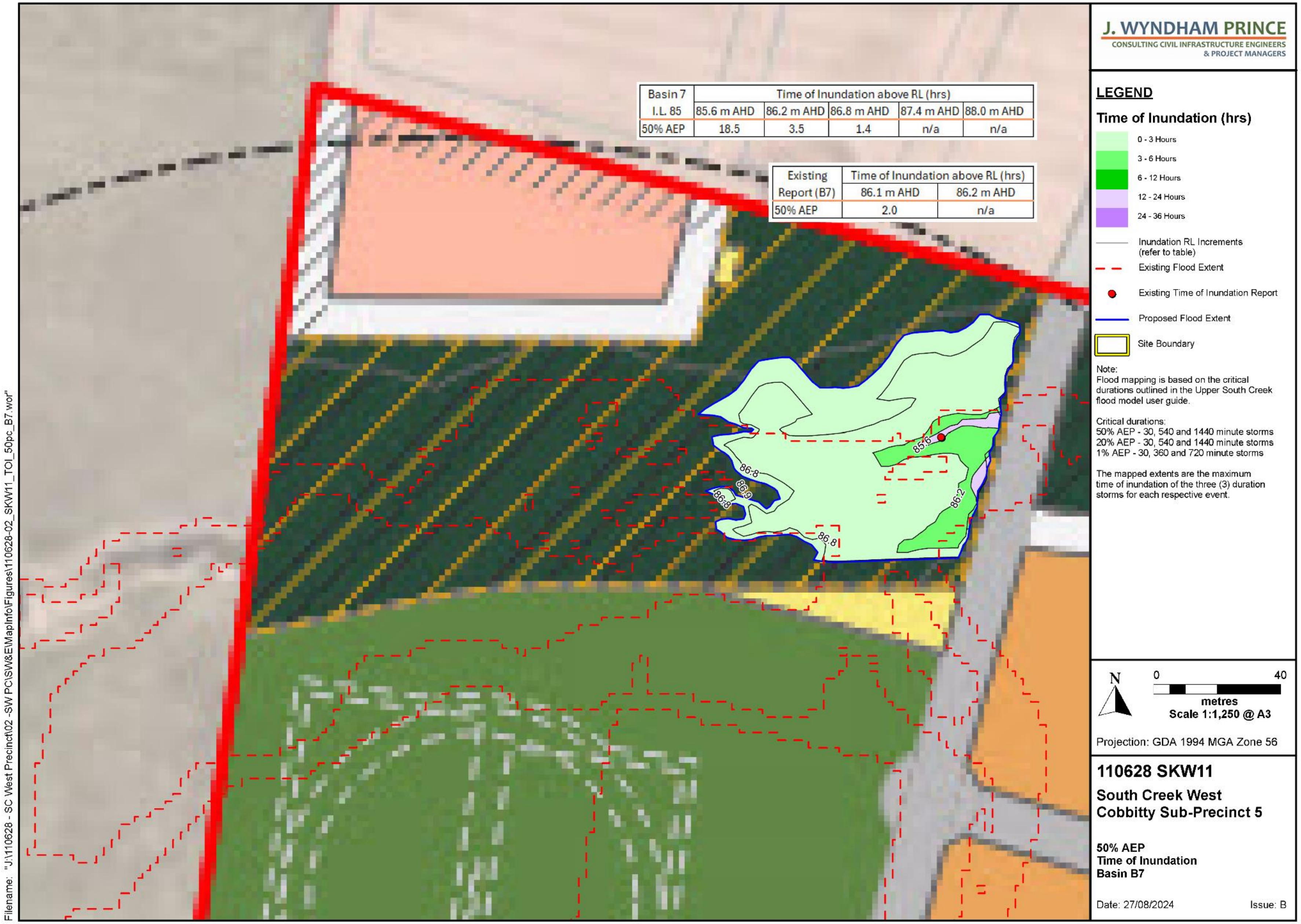


Figure 20: Basin 7 inundation time for 50% AEP event (JWP 2024)

Appendix B – Reach descriptions

B1 First order watercourses

Reach descriptions for first-order creeks are detailed in Table 11.

Table 11: First order reach descriptions

Reach	Proposed WM Act Status (pending DCCEEW – Water Group approval)	Description	Condition	Photo facing upstream	Photo facing downstream
1AA	River	The channel was defined upstream, 1 m with 0.5 high banks that were grassed and gently sloped. The riparian vegetation was mainly absent, except for pasture grasses and scattered African Olive shrubs. Moving downstream, the channel dispersed into overland flow, before becoming defined again at the start of the small patch of native vegetation predominately juvenile *E. tereticornis*. The bed was bare, with a clay silt benthic substrate. Small turbid pools were present at the low points. Flood debris was evident at the base of riparian vegetation. No aquatic vegetation was observed.	Poor	 Upstream section  Channel through vegetated riparian zone	 Upstream section – sparse riparian vegetation  Flood debris on up sides of tree trunks

1AB	River	The channel began upstream with a small head cut and defined exposed channel for 40 m before becoming overland flow with no defined bed or banks. There was no aquatic vegetation present, and the bed was a course clay. The riparian vegetation was African Olive shrubs, and a pasture grasses.	Poor	 Head cut upstream  Overland flow only	 Channel meandering through olives  Overland flow only
1AC	Not a 'river'	No defined bed or banks. Overland flow at a low point only.	Poor		

1AD	River	Channel 0.5 – 1 m upstream, beginning with a narrow-incised channel before widening downstream with gently sloped grassed banks. The channel was dry with no aquatic vegetation present. There was a small head cut present at the confluence with 1AC. Riparian vegetation was pasture grasses only, no shrubs or trees were present.	Poor		
1AE	River	Channel varied between 0.5 – 1.5 m wide. Upstream, the channel was shallow with gently sloped banks. Water was present, in long narrow pools. No aquatic vegetation was observed. The channel was vegetated with grass and sedges. Upstream of the confluence with the dam, the channel was deeply eroded with a 1.5 m vertical head cut. One turtle was observed at the confluence. The riparian vegetation along the length of the channel was a mix of native and exotic grasses. *Bursaria spinosa* and Cotton Bush were present in the wider riparian area.	Moderate		
1AF	River	Channel approximately 0.5 m wide, with gently sloping grassed banks. Ephemeral creek, with no water at the time of survey. Riparian vegetation was pasture grass only, no trees or shrubs. Scattered *Eucalyptus moluccana* were observed in the broader riparian zone.	Poor		

1AG	River	Partly dry, ephemeral channel approximately 5 m wide with eroded banks and intermittent standings of water. Some aquatic vegetation including *Juncus* sp. observed along the channel and banks.	Poor		
1AH	Not a 'river'	No defined bed or banks. Overland flow at a low point only.	Poor		
1AI	Not a 'river'	No defined bed or banks. Overland flow at a low point only.	Poor		

1AJ	Not a 'river'	No defined bed or banks. Overland flow at a low point only.	Poor		
1AM	Not a 'river'	No defined bed or banks. Overland flow at a low point only.	Poor		
1AN	Not a 'river'	No defined bed or banks. Overland flow at a low point only.	Poor		

1AO	Not a 'river'	No defined bed or banks. Overland flow at a low point only.	Poor		
1AP	Not a 'river'	No defined bed or banks. Overland flow at a low point only.	Poor		
1V	Not a 'river'	No defined bed or banks. Overland flow at a low point only.	Poor		

1W	Not a 'river' (desktop only – requires field validation)	No defined bed or banks. Overland flow at a low point only. Upstream of site boundary was not validated.	Poor		
1X	River	Channel was defined approximately 100 m downstream from start of Strahler mapping. The banks were 0.5 m wide, with shallow pools of clear water present. The channel then dispersed downstream, becoming overland flow, until it was mapped to flow offsite.	Poor		
1Y	Not a 'river'	No defined bed or banks. Overland flow at low point only.	Poor		

1Z	River	At the upstream extent of the creek, there was an eroded head cut with a small tannin stained pool of water and vegetation that differed to the surrounding pasture grasses. Downstream, the channel dispersed into overland flow, and a single turtle was observed in the grass. The channel developed definition approximately halfway to the confluence with 2F. The channel was 1 m wide, with sloped grassy beds. Water was pooled in at the low points and woody debris was scattered throughout the reach. Riparian vegetation throughout was pasture grasses, patches of African Olive and scattered *Eucalyptus* sp. The creek had some shading, where vegetation was present. One Common Eastern Froglet was heard calling.	Moderate	 Head cut at upstream extent  Channel disperses into overland flow  Defined channel  Pooling water in channel

B2 Second order watercourses

REACH 2E

The channel began with a headcut at the confluence of 1AC and 1AD. The channel was 1 m wide, with intermittent pools of water, which had an oily sheen on the surface. No aquatic macrophytes were observed in these pools. Scattered African Olive shrubs lined the channel and the remaining riparian vegetation consisted of pasture grass with no native tree species observed. The channel stopped after 50 m, dispersing into overland flow with no defined bed or banks to direct flow. Approximately 60 m downslope, the channel became defined with a clear eroded headcut. Downstream the channel was 2 m wide, with slumping banks vegetated with grass. Water was present, in depressions in the channel. There was no difference in the vegetation in the channel to the riparian zone. No trees or shrubs were present. No frogs, fish or wader birds were observed using the watercourse. The condition of 2E was moderate.


Upstream – pools of water with sheen


Facing downstream – channel disappears


Defined headcut that begins channel downstream


Banks slumping with pasture in channel

REACH 2F

Channel began at the confluence of 1AA and 1AB, the banks were both vertical with undercutting erosion. The channel widened into a pool approximately 7 m wide and 10 m wide, with shallow clear water. An eastern long-necked turtle was observed in the pool. Juncus and *Persicaria decipiens* (Slender Knotweed) were present along the edge and shallows of the pool. Algae covered grass was present in the centre. Moving downstream, the channel narrowed to between 1.5 m and 2.5 m wide, with tannin-stained water and no aquatic macrophytes. The right bank was consistently steeper than the left, which had less gradient. Both banks were vegetated with pasture. The channel meandered through the paddock, with few shrubs or trees present, before joining 2E upstream of a dam. Woody debris was present throughout and there was potential fish habitat throughout the reach. The condition of 2F was good.

Upstream pool with aquatic macrophytes, turtle and Juncus.

Narrower channel with tannin-stained water

REACH 2G

The mapped channel began at the confluence of 1X and 1Y. There was no defined channel for the extent of the reach. No defined bed or banks were observed, or geomorphic processes. The reach has been mapped as a creek however, as there was a channel defined upstream along watercourse 1X. Riparian vegetation was pasture grasses only, no shrubs or trees were present. The condition of this watercourse was poor.

Facing upstream

Facing downstream

REACH 2H

2H begins at the confluence of 1V and 1W. At the confluence of the two first-order creeks, the channel was not defined. The channel began at the top of the first dam, which was dry at the time of the survey. Scattered Juncus lined the dam, however, there was no aquatic vegetation present in the dam. The second dam had clear water, with submerged grass. Juncus lined the edge of the dam. Downstream of the dams, the channel became overland flow with no defined geomorphic processes. There was a headcut at the boundary of the site, which defined the upstream extent of the dam downstream. There was limited variation along the watercourse, with no snags or boulders present. Turbid water was present in this headcut. No aquatic vegetation was observed in the surveyed reach, no frogs were heard, and no aquatic fauna was observed. The overall condition was moderate.

Facing upstream – confluence of first-orders

Facing downstream – dry dam

Facing upstream at second dam – clear water

Facing downstream – channel disperses into grass

REACH 2I

The mapped channel began at the confluence of 1AI and 1AH. There was no defined channel for the extent of the reach. No defined bed or banks were observed, or geomorphic processes. Riparian vegetation was pasture grasses only, no shrubs or trees were present. This watercourse was in poor condition.

Representative upstream and downstream photos of overland flow

REACH 2J

The mapped channel began at the confluence of 1AP and 1AO. There was no defined channel for the extent of the reach, only overland flow at a low point. No defined bed or banks were observed, or geomorphic processes. Riparian vegetation was pasture grasses only, no shrubs or trees were present. This watercourse was in poor condition.


Representative upstream and downstream photos of overland flow

B3 Third order watercourses

REACH 3D

The third-order creek began at the confluence of 2E and 2F, slightly upstream of the large dam. The channel was 2 m wide with gently sloping banks and no riparian trees or shrubs, before entering the dam, at a severely eroded 2 m drop off. Downstream of the dam, the channel was up to 5 m wide and well defined with long, wide pools present throughout which had turbid water and no aquatic macrophytes. Water was also present in other low-lying depressions. Sedges including *Juncus* sp. were observed in wet areas. Banks transitioned from gently sloping with grassy vegetation upstream to bare, steep and undercut downstream. The riparian corridor downstream of the dam had a native canopy with *Eucalyptus tereticornis* and *Angophora* spp. with exotic African Olive dominating the shrub layer. Ground cover was typical pasture grasses. Although no aquatic vegetation was present, there was woody debris throughout to diversify flow after rain. Pools and runs provided habitat for fish, frogs and wader birds. The overall condition was good.

Facing upstream to confluence *of second-orders*

Channel joins dam at large eroded feature

Downstream of dam – facing upstream large wide

Facing downstream – gently sloped grassy banks

Bare banks with undercutting

Long pool present at downstream extent of channel

B4 Fourth order watercourses

REACH 4B

The downstream extent of this fourth order was field-validated. At the upstream extent of the surveyed reach, the channel was evident as 3 m wide and over 1 m deep. Snags and the native aquatic plants *Typha orientalis* (Cumbungi) and Slender Knotweed were present. Birds including *Anas superciliosa* (Pacific Black Duck), *Egretta novaehollandiae* (White-faced Heron) and *Egretta pacifica* (White-necked Heron) were observed using the pool. *Limnodynastes tasmaniensis* (Spotted Marsh Frog) was also heard calling. The left bank was severely eroded, near vertical and bare. The right bank had less gradient and was vegetated by grass. Riparian vegetation was mostly absent, with two large *Melaleuca styphelioides* the only trees observed. The channel meandered downstream, with narrow runs widening into larger pools and low lying saturated grassy depressions. Both banks were vegetated by grass only and were eroded on the out bends. Water in the pools was mostly stagnant with a thick oily sheen. There was evidence of cattle tracking through the creek. At the downstream extent, where the creek flowed outside the study area, was a long deep pool, with clear water. The fence line was filled with debris, damming the pool upstream. Many snags were present. The banks were high, approximately 1.5 m, and bare. There was a small, vegetated area with *Melaleuca* sp. and *Angrophora* sp. surrounding the creek. The roots of some trees were evident sticking out of the eroded banks. *Limnodynastes peronii* (Striped Marsh Frog) and Spotted Marsh Frog were heard calling along the entire reach and frog eggs were observed in many of the pools. The overall condition was good.

Upstream where creek enters site – long clear pool

Facing downstream – sparse riparian vegetation

Centre of surveyed reach – run of shallow water

Runs flowing into pools with stagnant water

Downstream pool with debris along the fence line of property

B5 Dams

Table 12: Habitat observed at dams during field survey

Reach	Dam Number*	Description	Aquatic Fauna Observed	Aquatic Flora Observed	Representative Photo
1AN	1	Dam nearing capacity, fringing vegetation was good frog habitat.	*Crinia signifera* (Common Eastern Froglet), *Tachybaptus novaehollandiae* (Australasian Grebe)	*Ludwigia peploides* (Water Primrose), *Ottelia ovalifolia* (Swamp Lily), Juncus	
1AN	2	Dam nearing capacity, fringing vegetation, water was clear and shallow.	No fauna observed	Scattered Juncus	

Reach	Dam Number*	Description	Aquatic Fauna Observed	Aquatic Flora Observed	Representative Photo
1AM	1	Dam nearing capacity, eroded bank, water was clear with tannins.	2 turtles	Scattered Juncus	
1AM	2	Dam nearing capacity, eroded bank, water was clear with tannins.	2 turtles	Fringing Juncus	
1AO	1	Clear deep water, dam was full with submerged terrestrial vegetation.	4 turtles, Australasian Grebe, White-faced Heron, *Chenonetta jubata* (Australian Wood Duck)	Fringing Juncus	

Reach	Dam Number*	Description	Aquatic Fauna Observed	Aquatic Flora Observed	Representative Photo
1AO	2	Clear, shallow water. Dam was nearing capacity with submerged terrestrial vegetation.	No fauna observed	No flora observed	
1AO	3	Dam was deep with turbid water and grassy banks.	No fauna observed	Water Primrose, *Eleocharis* sp. (Bulrush), Juncus, Swamp Lily	
1AJ	1	Water was clear and dam was nearing capacity.	3 Turtles, 1 Common Eastern Froglet	Fringing Juncus	

Reach	Dam Number*	Description	Aquatic Fauna Observed	Aquatic Flora Observed	Representative Photo
1AH	1	Water was shallow and extremely turbid. A large tunnel had eroded through the dam wall and there were big rills eroding on the upstream side.	5 Turtles, Australasian Grebe, White-faced Heron, Striped Marsh Frog	Cumbungi in centre of dam, fringing Juncus.	
2I	1	Water was turbid, with grass the only fringing vegetation.	Australian Wood Duck, Australasian Grebe, 2 Turtles	Cumbungi	
2I	2	Water was less turbid than dam 1, grass only fringing vegetation.	No fauna observed	No flora observed	

Reach	Dam Number*	Description	Aquatic Fauna Observed	Aquatic Flora Observed	Representative Photo
2I	3	Very large dam, reaching capacity. Water was turbid and submerging terrestrial vegetation.	Australian Wood Ducks, Australasian Grebe, Pacific Black Duck, White-faced Heron, 3 Turtles	No flora observed	
2I	4	Dam walls were very steep, with dam almost at capacity with clear water. Grass was only fringing vegetation.	3 Turtles	No flora observed	
2H	1	Dam was almost dry, with a clay capped silty benthic substrate.	No fauna observed	No flora observed	

Reach	Dam Number*	Description	Aquatic Fauna Observed	Aquatic Flora Observed	Representative Photo
2H	2	Dam had clear, shallow water. Terrestrial grass was submerged.	No fauna observed	No flora observed	
3D	1	Very large dam, with a narrow eroding upstream extent that was dry. The wide downstream extent had turbid water with submerged terrestrial vegetation.	1 Turtle, White-faced Heron	Sparse Swamp Lily, Fringing Juncus	 

**dams are numbered in order along creek: upstream to downstream*

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Riparian Areas Calculation

COBBITTY

Ref: BHLCO-B-002-3	Date: 16/09/2024	Revision: N	Scale: 1:3,000@A0

Note: All areas and dimensions subject to detailed survey

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REPORT

JJ Cobbitty Development Pty Ltd

South Creek West

Cobbitty Sub-Precinct 5

Water Cycle Management Report

September 2024

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
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Version control

Issue	Author	Reviewer	Approver	Date approved
A - First Draft	Troy McLeod	David Crompton	David Crompton	25/09/2021
B - Second Draft	Troy McLeod	David Crompton	David Crompton	1/10/2021
C - Third Draft	Troy McLeod	David Crompton	David Crompton	15/6/2022
D – Final Draft	Troy McLeod	Sabina Lohani	Sabina Lohani	15/12/2022
E – Final	Ahmad Albaba	Troy McLeod	David Johnson	26/04/2024
F - Gateway	Troy McLeod	Sabina Lohani	Sabina Lohani	13/09/2024

TABLE OF CONTENTS

PLATES

TABLES

APPENDICES

1. EXECUTIVE SUMMARY

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

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

Our assessment demonstrates that the proposed five (5) detention basins located throughout the Precinct with a total storage of approximately 80,200 m^3 will ensure that peak post-development discharges are restricted to less than the pre-development levels at all key comparison locations.

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

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

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

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

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

2. BACKGROUND

2.1. Overview

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

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

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

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

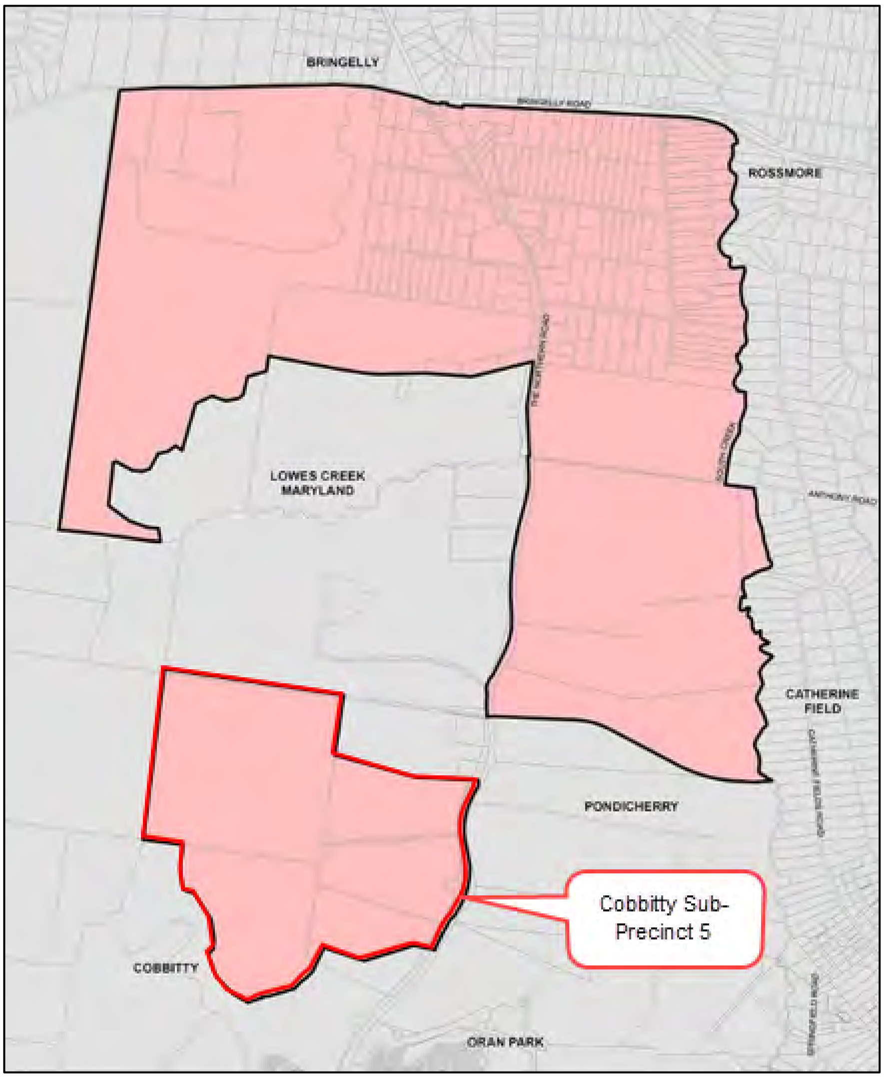

Plate 2-1 – South Creek West Land Release Area

2.2. Existing Site

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

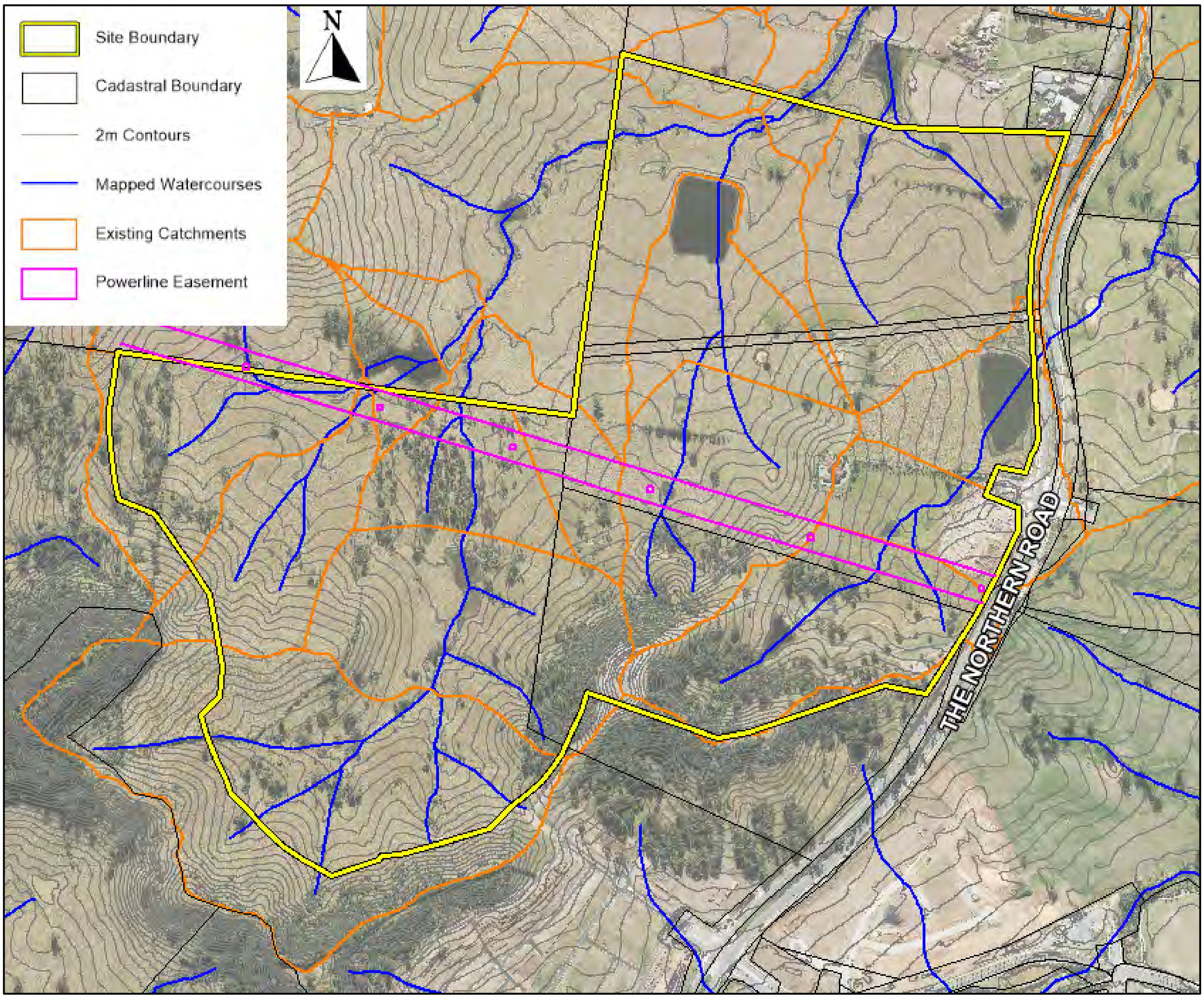

Plate 2-2 – Existing Site

2.3. Objective

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

2.4. Proposed Development

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

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

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

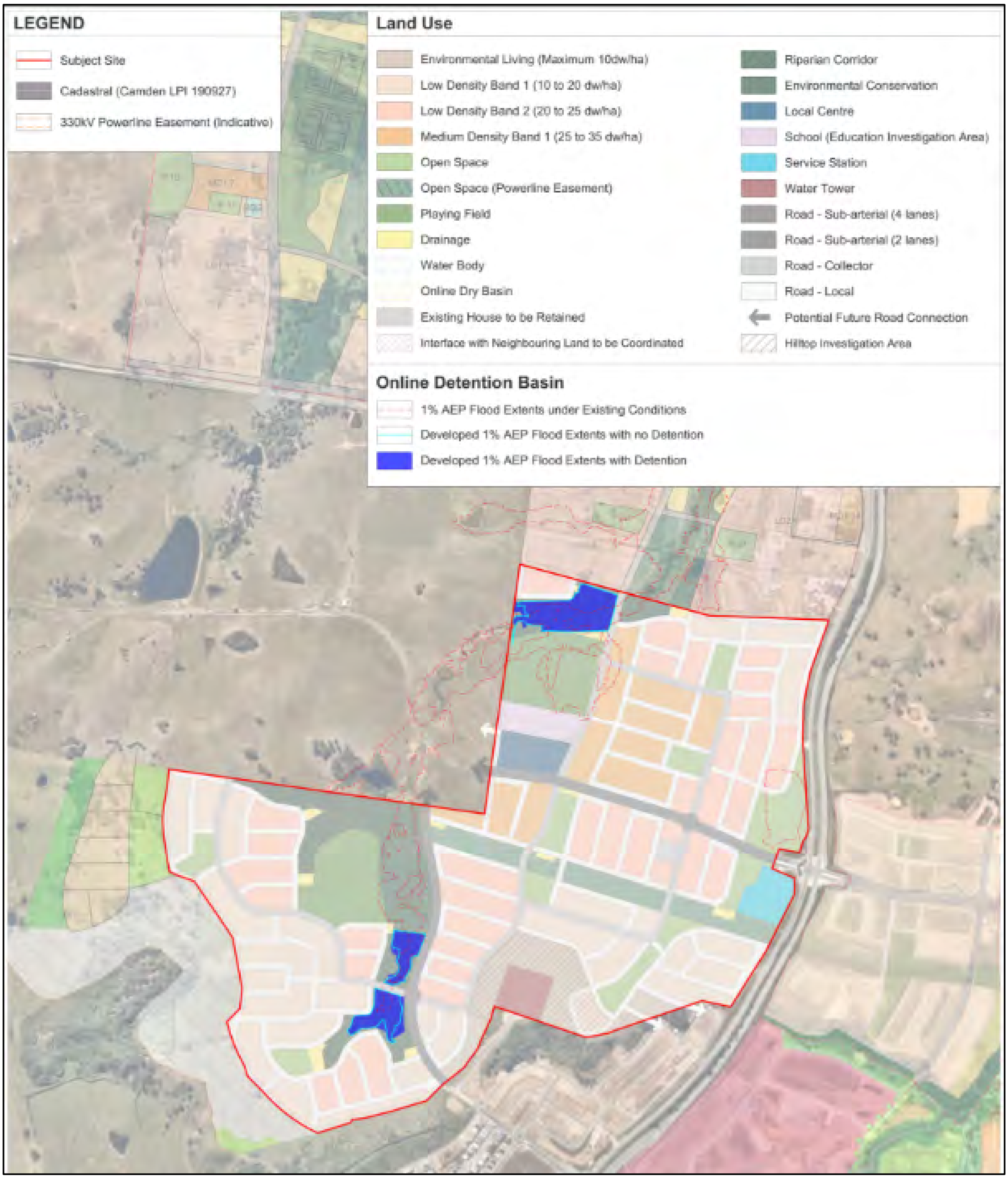

Plate 2-3 – Cobbitty Draft ILP with Online Basins (Rev B, Design + Planning 6/09/2024)

3. PREVIOUS STUDIES AND RELEVANT GUIDELINES

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

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

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

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

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

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

3.2. Meeting with Camden Council (March 2020)

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

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

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

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

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

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

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

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

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

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

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

EHG generally opposes the online basins which are proposed to be located in the C2 Environmental Conservation area. They note that the basin construction and operation could be detrimental to the existing Cumberland Plain Woodland (CPW) within the riparian corridor. The devices that are proposed within C2 zoned areas are the dry detention basins B1, B2, B4 and B7.

The online dry detention basins B4 and B1 are online to 1st order and 2nd order watercourses, respectively. Detention is permitted online to 1st order and 2nd order watercourses as detailed in NRAR's Guideline for Controlled Activities on Waterfront Land (2018). The online dry detention basins B2 and B7 are online to a 3rd order and 4th order watercourse, respectively. Basins B1, B2 and B7 are proposed to be natural storage areas that are created by embankments that would otherwise be required to facilitate the urban development. The B1 and B7 storage areas are situated upstream of road crossings while B2 storage area is situated upstream of a pedestrian link that crosses the C2 corridor. The basin inverts are proposed to remain as natural riparian corridors that will be revegetated and rehabilitated as part of the development. Some minor regrading works are proposed in basins B1 and B7 in order to achieve the necessary detention storages, however, these are mostly clear of existing stands of CPW. Detailed time of inundation mapping has been produced as an output of the flood modelling detailed within this report. Refer to Section 7 for further details.

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

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

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

Table 3-1 – Response to WMA Water Review

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

Review Section	Issue identified by WMA Water	Response (JWP, 15 December 2022)	WMA Water comment	Current Response
4.3.4. Proposed Development Plans	No details of the proposed basins were provided (as drawings or in the Water Cycle Management Report), and hence the basin representations in the TUFLOW model could not be verified.	Preliminary concept designs have been prepared and can be seen in Appendix B. Additional detail regarding basin top water levels and proposed outlets has also been provided in the hydrological modelling Section 6.	Drawings of basins included in Appendix B. Basin details now included in report. Although contained in the hydrology section, these will be compared with what is implemented in the TUFLOW model in subsequent reviews.	Additional concept designs have been prepared for basins B1, B2 and B7 which supplement the previous designs prepared for B4 and WB1. Concept design surfaces have been used in the developed conditions TUFLOW model.
4.3.5. Blockage	Design blockage not assessed in basin modelling.	As WMA Water suggests, this can be considered at future detailed design stages.	Noted that this will be undertaken at future design stages.	Resolved.
5.2. Review Outcomes	Peak flows/hydrograph plots to be provided downstream of the site (for pre and post dev conditions) from the TUFLOW model. Details of the basin configurations should be documented.	Hydrograph plots at the downstream TUFLOW model boundary are provided in Section 7. Preliminary design concepts for all basins have been prepared along with the additional detail regarding basin top water levels and outlet designs in Section 6.	Hydrograph plots provided of 1% AEP event only. 20% AEP and 5% AEP events should also be provided.	A hydrograph plot has been provided at a location downstream of the site which assesses the 1% AEP flows in Councils USC model, the updated existing conditions model and the developed conditions model.

Review Section	Issue identified by WMA Water	Response (JWP, 15 December 2022)	WMA Water comment	Current Response
6.1. Offline Dry Detention Basins	Representation of basins in XP-RAFTS is simplistic and not enough detail is provided to verify suitability of modelling.	Stage storage relationships have been derived from the preliminary concepts and used to inform the XP-RAFTS basin modelling.	Basin stage-storage curves should be a reasonable representation of the basin. Low flow outlets should specify culvert configurations or detail the derivation of stage-discharge curves. Spillways should be reasonable sizes. Subject to review of updated modelling.	The concept basin designs have informed the stage-storage curves in XP-RAFTS. Basin outlet details are provided in Table 6-2 which have been reflected in both XP-RAFTS and TUFLOW as stage-discharge relationships.
6.2. Online Dry Detention Basins	Basin B4 is not represented in the TUFLOW model.	Basin B4 has been added to the TUFLOW model.	Noted as rectified, subject to review of updated modelling.	All basins are represented in the TUFLOW model.
6.3. Online Wet Detention Basins	Online wet detention basins are not modelled as 'wet' basins, and the volume stored in the 1% AEP event is approximately 20% larger than that reported.	Initial water levels have been incorporated in the TUFLOW modelling for both of the waterbodies. TUFLOW detention volumes should be recorded above these levels. The updated TUFLOW modelling has incorporated concept design surfaces to provide more accurate reflection of the likely basin landforms. Refer to Section 7.3.2 for flood modelling details.	Noted as rectified, subject to review of updated modelling.	Resolved.

Review Section	Issue identified by WMA Water	Response (JWP, 15 December 2022)	WMA Water comment	Current Response
6.4. Basin Depths	Basin representation differences between XP-RAFTS and TUFLOW resulting in different peak depths. Basin B1 depths are up to 3.6m which would create a dam safety risk requiring DSNSW consultation.	This was rectified through the preparation of the preliminary concepts for all basins which were included in the developed conditions modelling.	Noted as rectified, subject to review of updated modelling.	Resolved.
6.5. Road Crossings	No road crossings have been included and no justification as to why this is the case was provided.	Road crossing designs can be determined and assessed at future design stages. The culvert crossings will be sized to provide 1% AEP flood immunity plus freeboard.	Noted that this will be undertaken at future design stages.	All road crossings (and pedestrian crossings) have been included in the flood modelling and are used as basin embankments.

4. RIPARIAN CORRIDOR ASSESSMENT

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

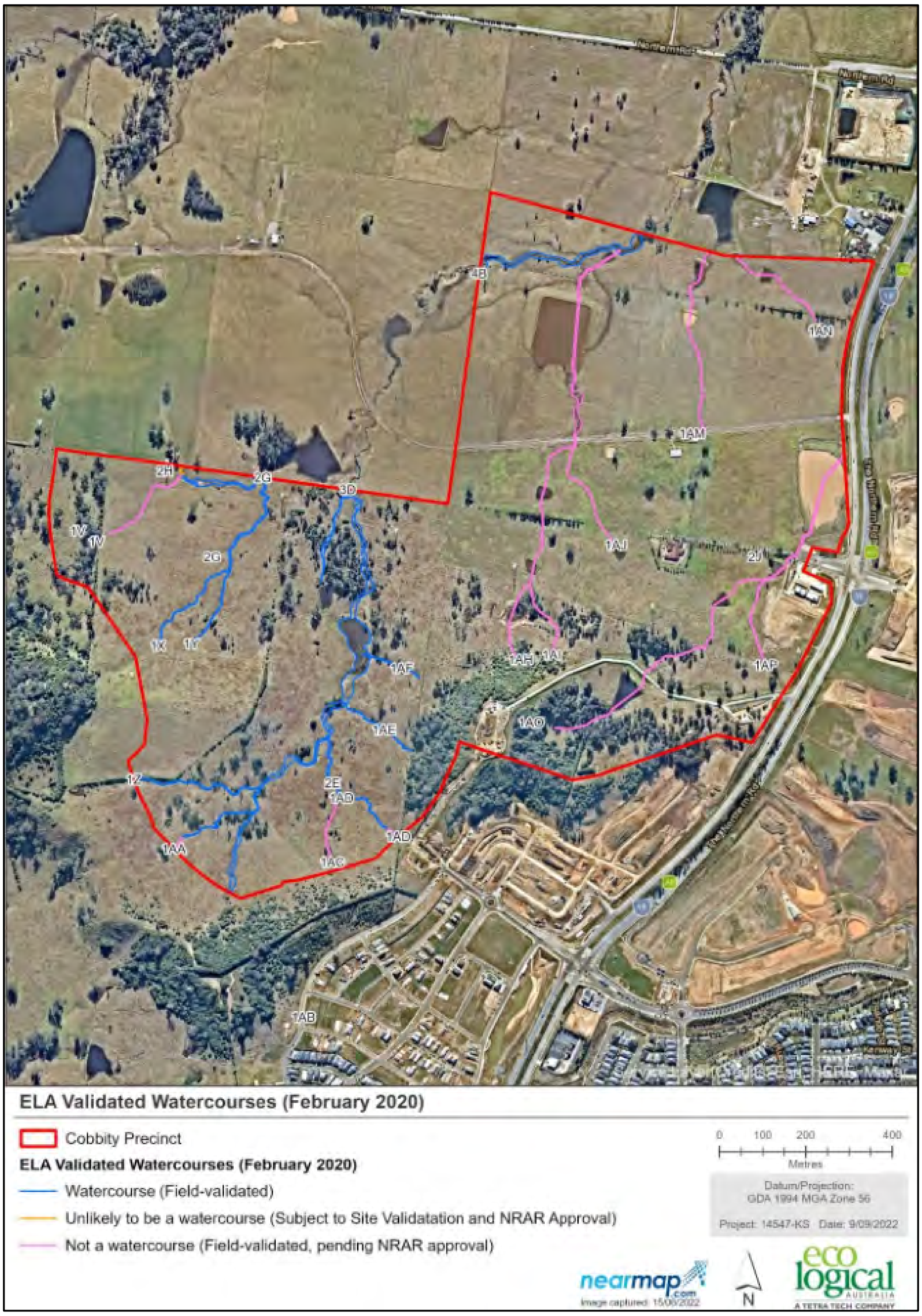

Plate 4-1 – Riparian Mapping (ELA, Feb 2020)

5. WATER QUALITY ASSESSMENT

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

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

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

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

5.1. Modelling Inputs and Assumptions

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

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

Table 5-1 –Pollutant Reduction Targets

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

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

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

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

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

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

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

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

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

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

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

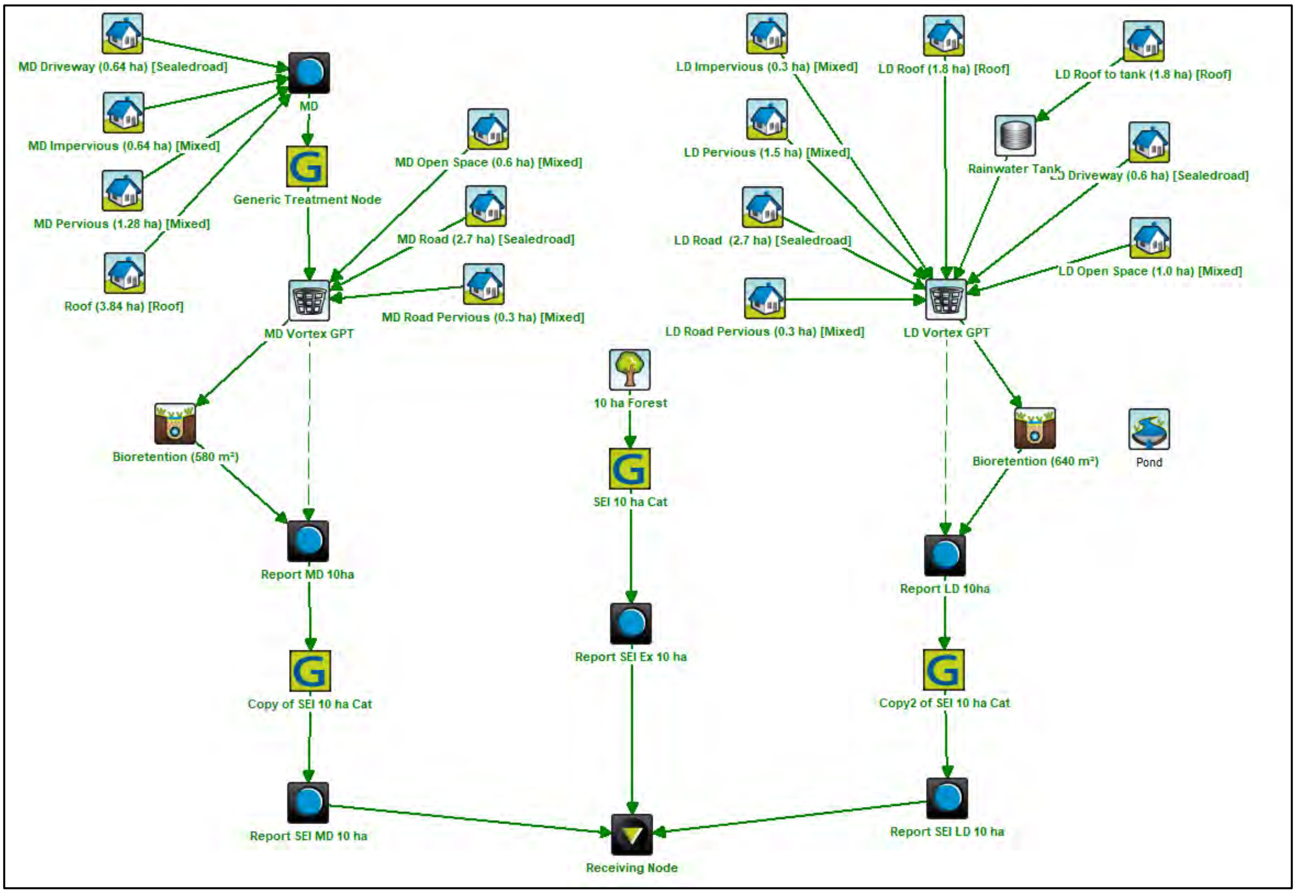

Plate 5-1 – MUSIC Model Overview (110628-02 MU1.sqz)

5.2. Water Quality Management Measures

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

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

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

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

5.3. Modelling Results

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

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

Pollutant	Total Developed Source Nodes	Total Residual Load from Site	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(%)	(%)
TSS	10000	1460	85.0%	85.4%
TP	20.6	7.10	65.0%	65.5%
TN	134	67.3	45.0%	49.8%
Gross Pollutants	1460	14.1	90.0%	99.0%
Raingarden Properties				
Media Bed area (m^2)	640			
Total Area Managed (ha)	10.00			
Raingarden (% Managed Cat)	0.64%			

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

Pollutant	Total Developed Source Nodes	Total Residual Load from Site	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(%)	(%)
TSS	10000	1370	85.0%	86.3%
TP	20.6	6.87	65.0%	66.7%
TN	134	72.7	45.0%	45.7%
Gross Pollutants	1460	0.0	90.0%	100.0%
Pond Properties				
Surface Area (m^2)	4,000			
Permanent Volume (m^3)	8,000			
Total Area Managed (ha)	10.00			
Pond (% Managed Cat)	4.00%			

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

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

Pollutant	Total Developed Source Nodes (kg/yr)	Total Residual Load from Site (kg/yr)	Target Reduction Required (%)	Total Reduction Achieved (%)
TSS	10500	1570	85.0%	85.0%
TP	21.2	7.19	65.0%	66.1%
TN	140	65.4	45.0%	53.3%
Gross Pollutants	1540	11.3	90.0%	99.3%
Raingarden Properties				
Media Bed area (m²)	580			
Total Area Managed (ha)	10.00			
Raingarden (% Managed Cat)	0.58%			

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

Table 5-7 – Water Quality Device Sizes

Raingarden/ Wetland ID	Cat Area (ha)	Area Treated On Lot (ha)	Device Sizing: % of Catchment	Device Sizing: Treatment Area (m²)	Device Sizing: Footprint (m²)
RG1	12.8		0.64%	820	1,230
RG2	13.9		0.64%	890	1,335
RG3	5.0		0.64%	320	480
RG4	29.3		0.64%	1,880	2,820
RG5	10.0		0.64%	650	975
RG7	16.0		0.64%	1,030	1,545
RG8	28.4	13.9	0.64%	930	1,395
RG9	1.3		0.64%	90	135
RG10	15.0	0.4	0.64%	940	1,410
RG11	16.8		0.64%	1,080	1,620
RG12	8.3		0.64%	540	810
RG13	9.3	0.6	0.64%	560	840
WB1	13.7	1.8	4.00%	4,750	5,938

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

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

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

5.4. Stream Erosion Index

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

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

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

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

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

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

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

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

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

5.5. Construction Stage

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

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

5.6. Long Term Management

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

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

6. WATER QUANTITY ASSESSMENT

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

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

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

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

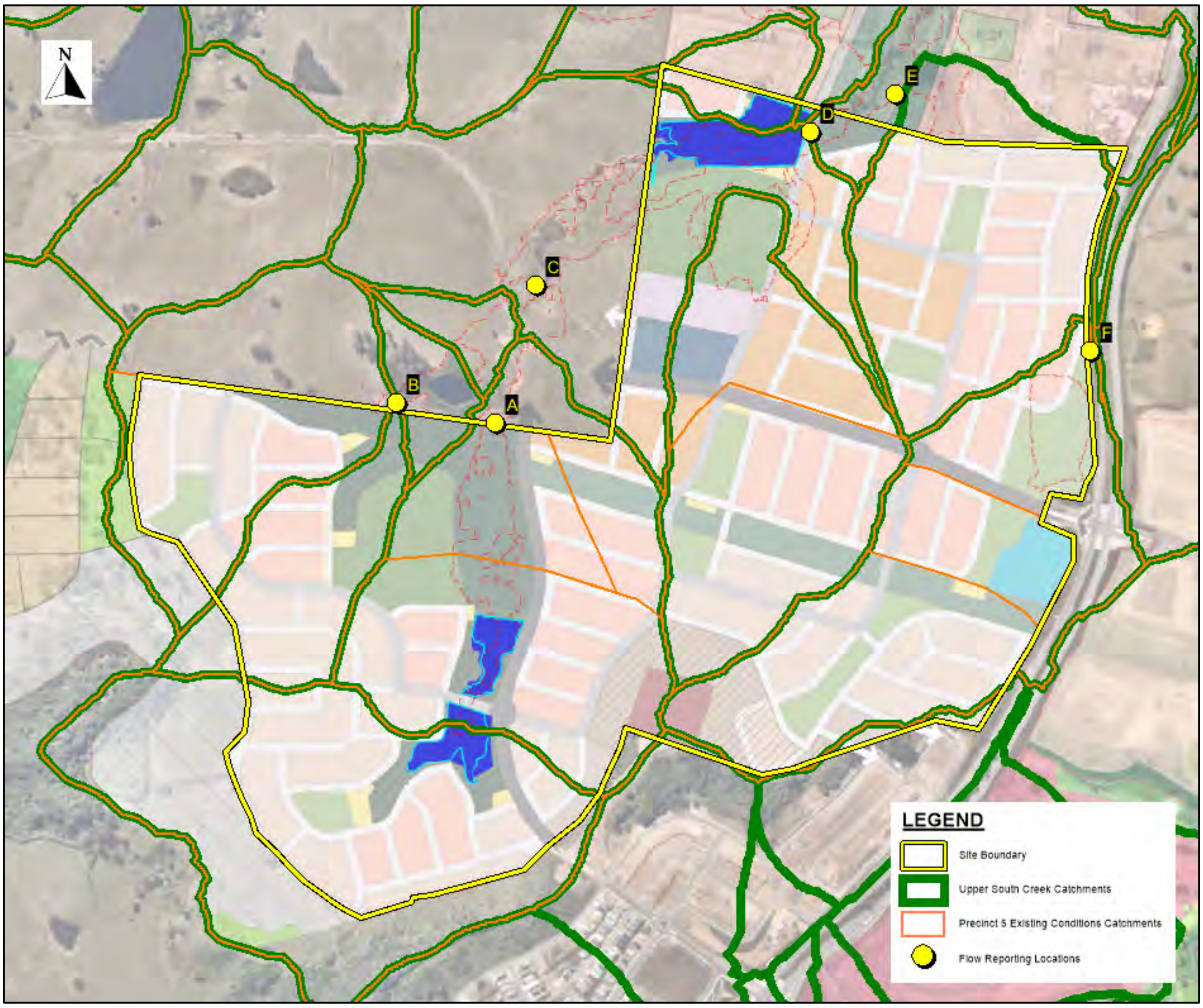

Plate 6-1 – XP-RAFTS Catchments and Reporting Locations

6.1. Existing Site Condition

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

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

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

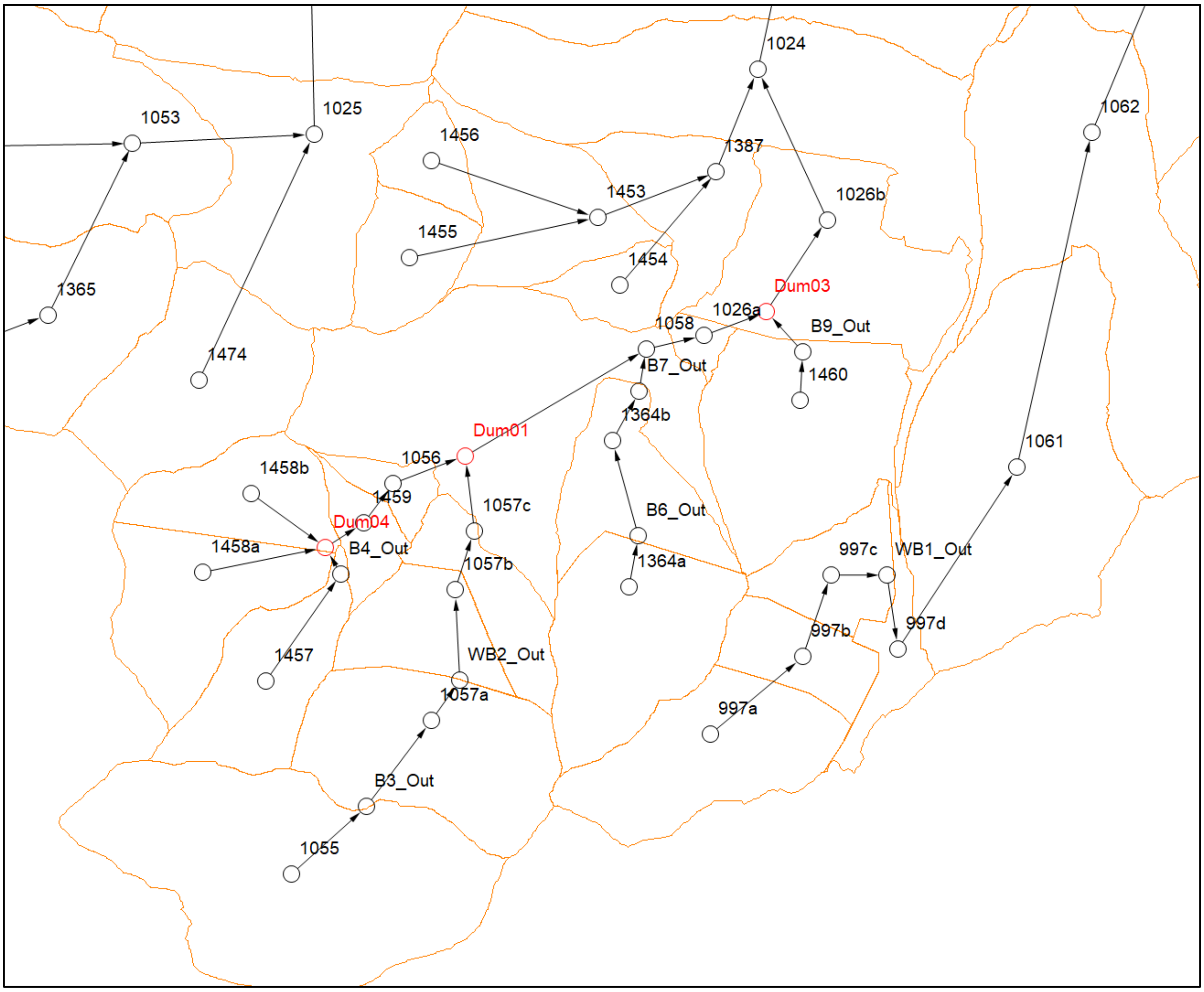

Plate 6-2 – Existing Conditions XP-RAFTS Catchments Model Layout (EX_010_~AEP~_~DURN~.xp)

6.2. Developed Site Conditions

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

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

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

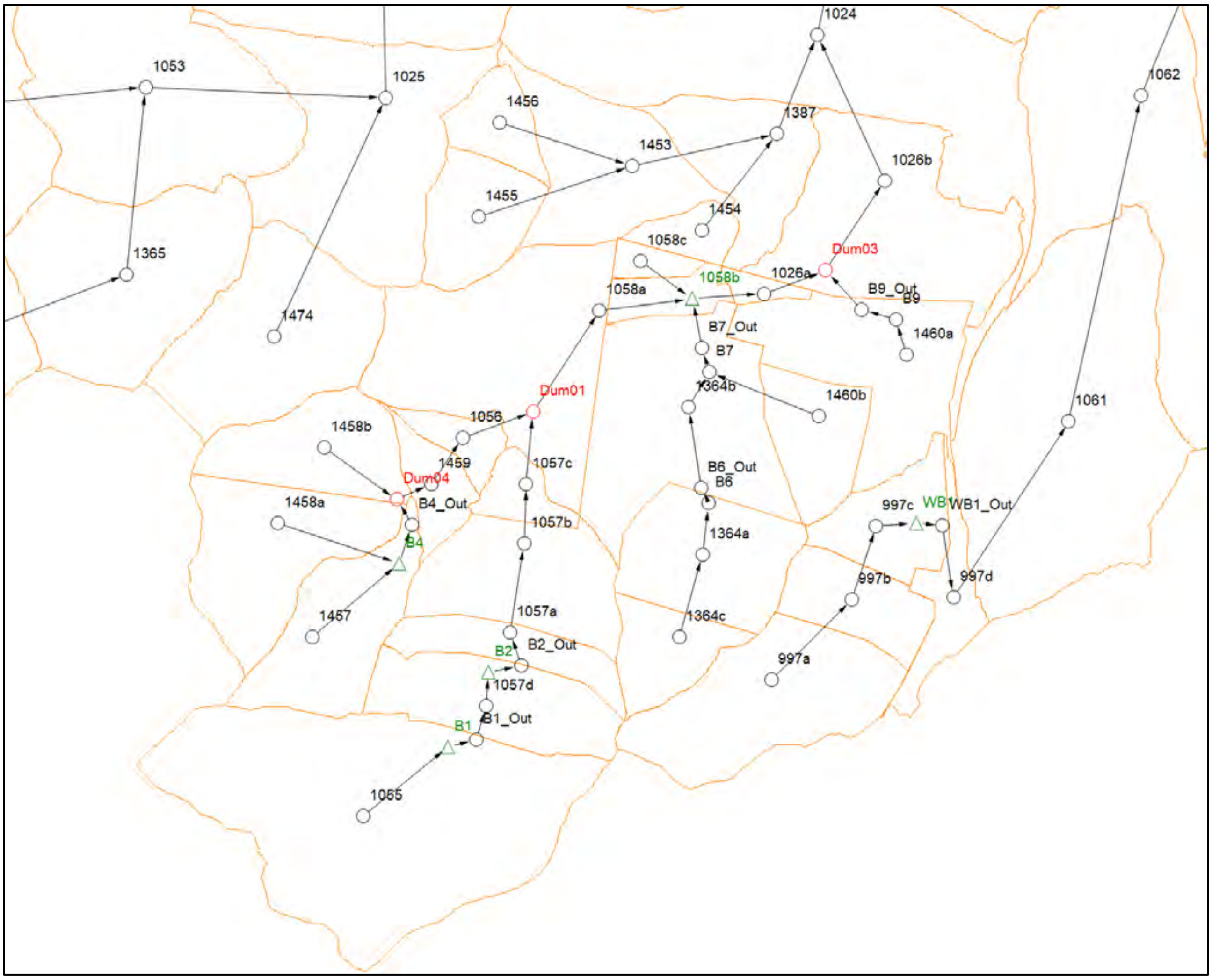

Plate 6-3 – Developed Conditions XP-RAFTS Catchments Model Layout (DEV_018_~AEP~_~DURN~.xp)

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

Table 6-1 – Developed Conditions Fraction Impervious

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

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

6.3. Detention Basins

The proposed detention management strategy will consist of a series of basins and waterbodies strategically positioned throughout the site. The strategy includes five (5) detention devices, including one (1) wet basin (situated above a permanent pond) and four (4) dry bed basins. Plate 6-4 provides an overview of the proposed basin locations. The reporting locations generally represent Precinct boundary locations where the existing terrain naturally grades into surrounding properties.

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

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

Stage-discharge relationships have been used to represent the detention basin outlets. The proposed detention basin outlets are detailed in Table 6-2.

Table 6-2 – Basin Outlet Details

Basin ID	Outlet Details
B1	Low Level Outlet - 300mm RCP U/S Invert 102.2, 20m long at 0.5% grade
	Mid Level Pit - 1.2m x 1.2m pit at RL 105.9 with 0.5m orifice control at invert
	High Level Outlet - 23m weir at RL 107
B2	Low Level Outlet - 225mm RCP U/S Invert 101, 50m long at 0.5% grade
	Mid Level Pit 1 - 1.2m x 1.2m pit at RL 102.3 with 0.5m orifice control at invert
	Mid Level Pit 2 - 1.2m x 1.2m pit at RL 103 with 0.4m orifice control at invert
	High Level Outlet - 25m weir at RL 103.6
B4	Low Level Outlet - 2 x 450mm RCP U/S Invert 100.0, 30m long at 4% grade
	High Level Outlet - 10m weir at RL 101.4
B7	Low Level Outlet - 2 x 0.6H x 0.75W RCBC U/S Invert 85, 20m long at 0.3% grade
	High Level Outlet - 50m weir at RL 88.05
WB1	Low Level Outlet - 0.9m x 0.9m pit at RL 99.1 together with 1 x 375mm RCP U/S Invert 96.8, 40m long at 2% grade
	High Level Outlet - 15m weir at RL 100.1

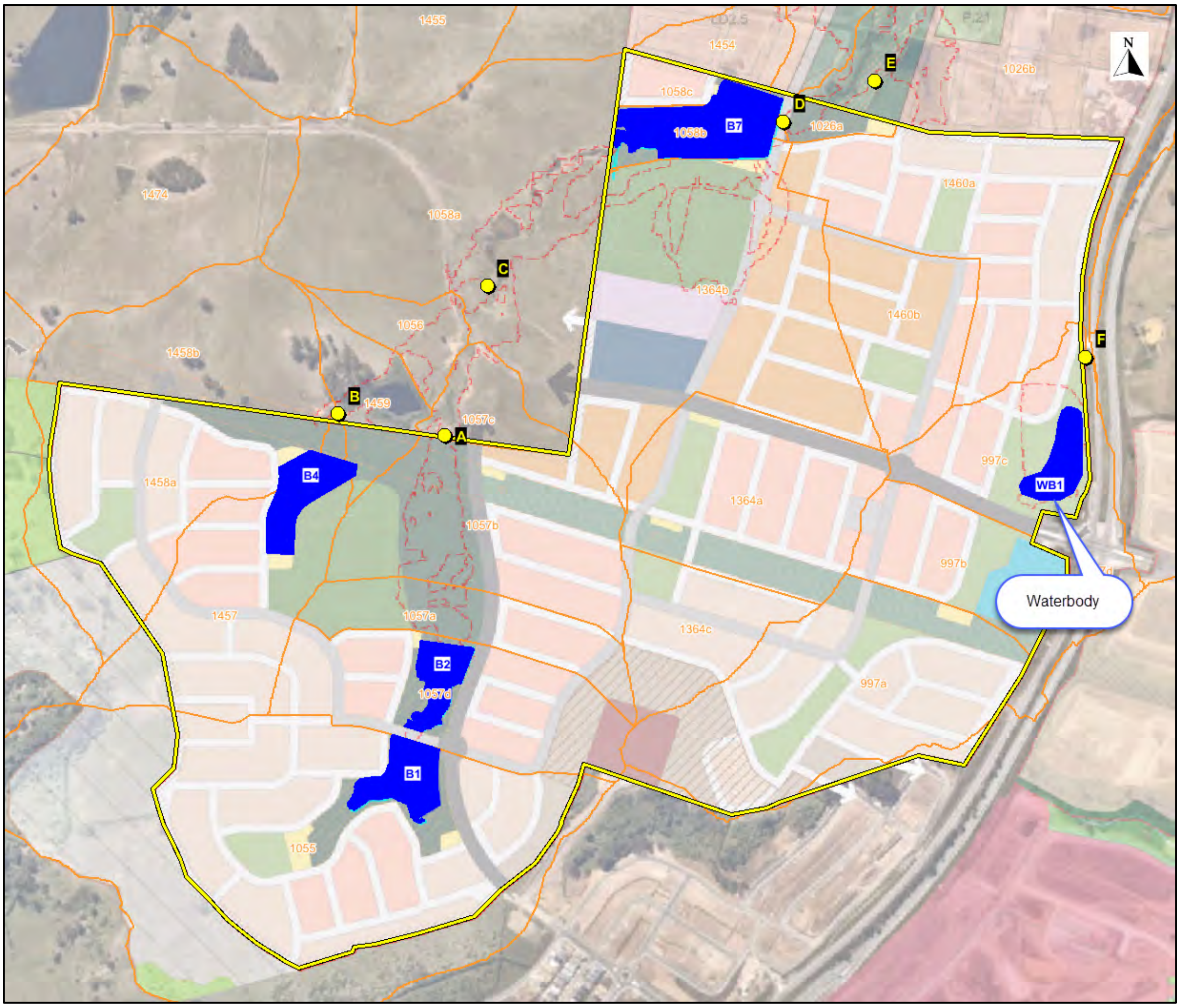

Plate 6-4 – Proposed Detention Basin Locations

6.4. Results

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

Table 6-3 – Comparison of Existing and Developed Flows

Report Location	XP-RAFTS Node	50% AEP					20% AEP					1% AEP				
		Ex	Durn	Dev	Durn	Dev/Ex	Ex	Durn	Dev	Durn	Dev/Ex	Ex	Durn	Dev	Durn	Dev/Ex
A	1057b	1.40	1440	1.39	30	0.99	2.08	1440	1.96	1440	0.94	6.50	360	5.86	360	0.90
B	Dum04	0.76	1440	0.72	1440	0.95	1.12	1440	0.95	1440	0.85	4.01	30	3.88	360	0.97
C	Dum01	2.43	1440	2.06	1440	0.85	3.62	1440	3.19	1440	0.88	11.45	360	10.38	360	0.91
D	1026a	3.73	1440	3.29	540	0.88	5.57	1440	4.08	540	0.73	17.12	360	15.82	360	0.92
E	Dum03	4.15	1440	3.83	30	0.92	6.20	1440	4.50	540	0.73	18.89	360	16.77	360	0.89
F	WB1_Out	0.62	1440	0.57	540	0.92	0.93	1440	0.60	540	0.65	2.91	360	2.88	360	0.99

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

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

Table 6-4 – Summary of Proposed Detention Volumes

Basin ID	Volume (m^3)	1% AEP TWL	1% AEP Depth
B1	16,015	107.15	4.95
B2	11,258	103.76	2.76
B4	7,839	101.64	1.64
B7	32,031	88.31	3.31
WB1	12,981	100.30	1.20

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

6.5. Concept Design

Preliminary concept designs have been prepared for basins B1, B2 and B7 which are located online to the riparian corridor. Each of these basins consists of an embankment created as part of the urban fabric of the development and which would be otherwise be required to deliver the development. These are in the form of road crossings and pedestrian crossings/links. The basins make use of the existing topography of the creeks and overbanks and require minimal regrading works to deliver the necessary detention volumes.

A series of concept design plans have been prepared which illustrate the cut and fill zones required to deliver the basins. The cut and fill zones are generally outside of existing stands of trees. Refer to Appendix B for the concept plans.

7. FLOOD IMPACT ASSESSMENT

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

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

7.1. Available Data

The following data was used to inform the flood modelling:

- Hydrology model (XPRAFTS) used for stormwater management strategy (Section 6);
- Upper South Creek TUFLOW flood model (WMA, February 2021);
- The Draft Indicative Layout Plan – with Online Basins Cobbitty dated 6/09/2024 supplied by Design + Planning (Appendix A); and
- Aerial photography of the site recorded by Metromap, 2024.

7.2. Events and Durations

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

Table 7-1 Modelled TUFLOW Events and Durations

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

7.3. Existing Conditions Model

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

- Re-run the USC flood model to confirm that flood results provided by Council are replicated;
- Initial water levels were then added to the farm dams in the vicinity of the Precinct to reflect the full supply level in the dams which were omitted in the Council model;
- The model was then run with inflow hydrographs that were generated in the edited XP-Rafts models discussed in Section 6 of this report. This model has then been adopted as the base conditions that the proposed development model has been compared against.

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

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

7.3.1 Model Validation

Three (3) model validation runs were completed to enable comparison to the USC WMA, February 2021 TUFLOW model results provided by Council.

Validation 1 – Replicate Council Model Results

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

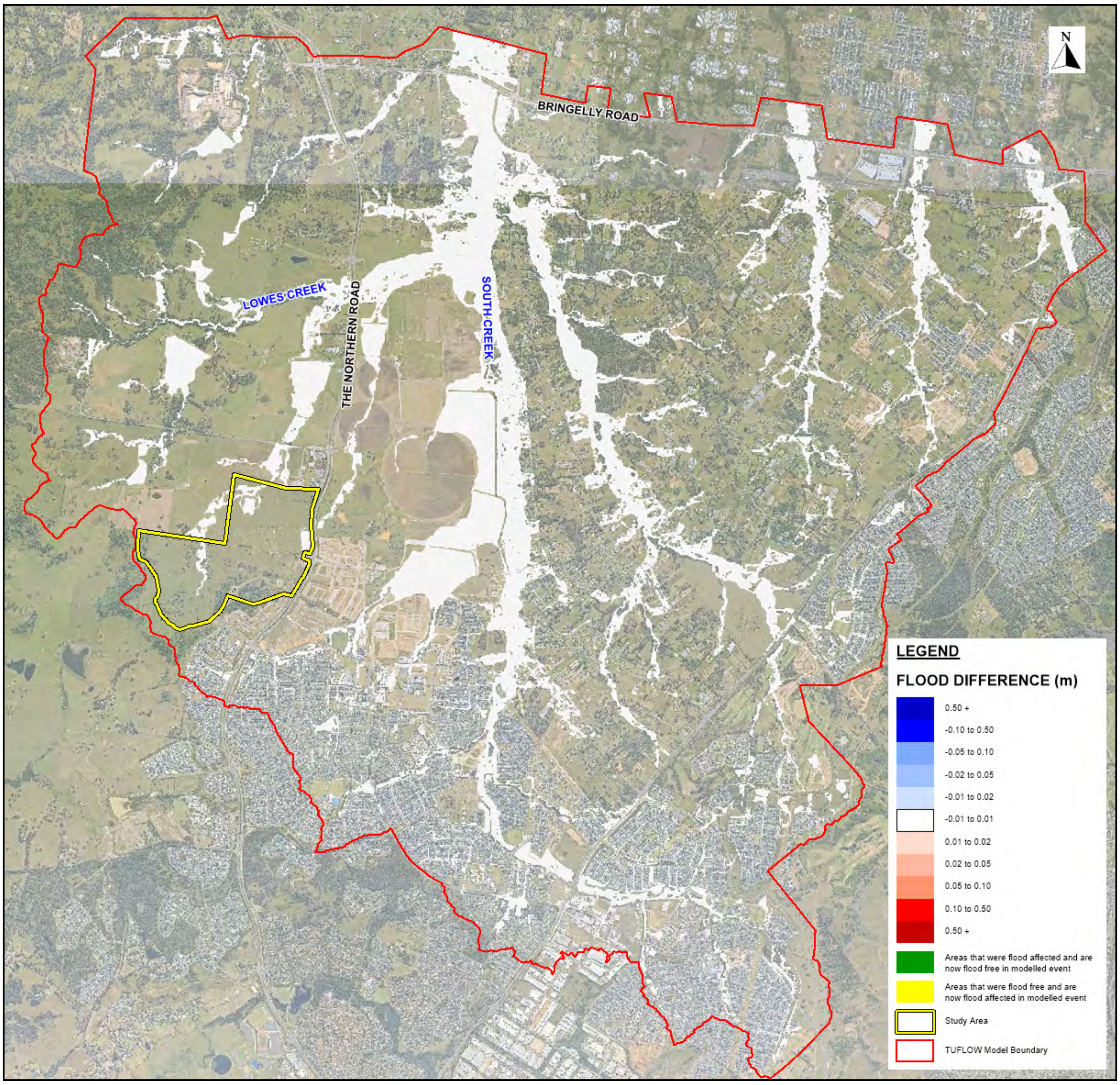

Plate 7-1 – Validation 1 – Peak 1% AEP Flood Comparison

Validation 2 – Compare farm dams filled model with Council Results

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

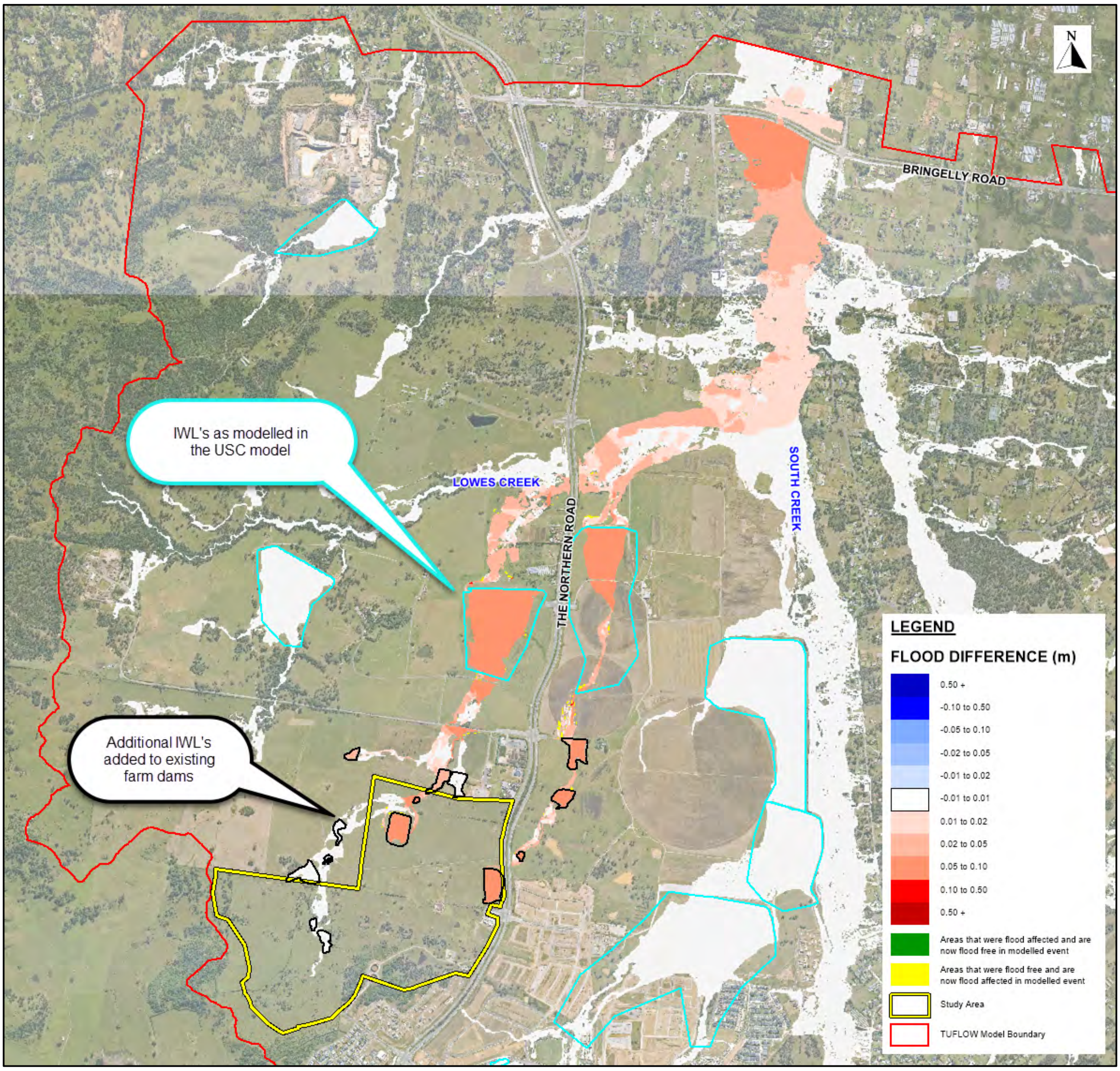

Plate 7-2 – Validation 2 – Peak 1% AEP Flood Comparison

Validation 3 – Compare updated hydrology model with Council Results

The updated existing conditions hydrology model (as described in Section 6) was used to inform the hydrograph inputs. The flood difference map in Plate 7-3 presents the comparison of the peak 1% AEP results against the results described in Validation 2. The minor changes that can be seen within the Precinct are expected and are due to the shifts/splits in catchment boundaries to inform the basin modelling described in Section 6.

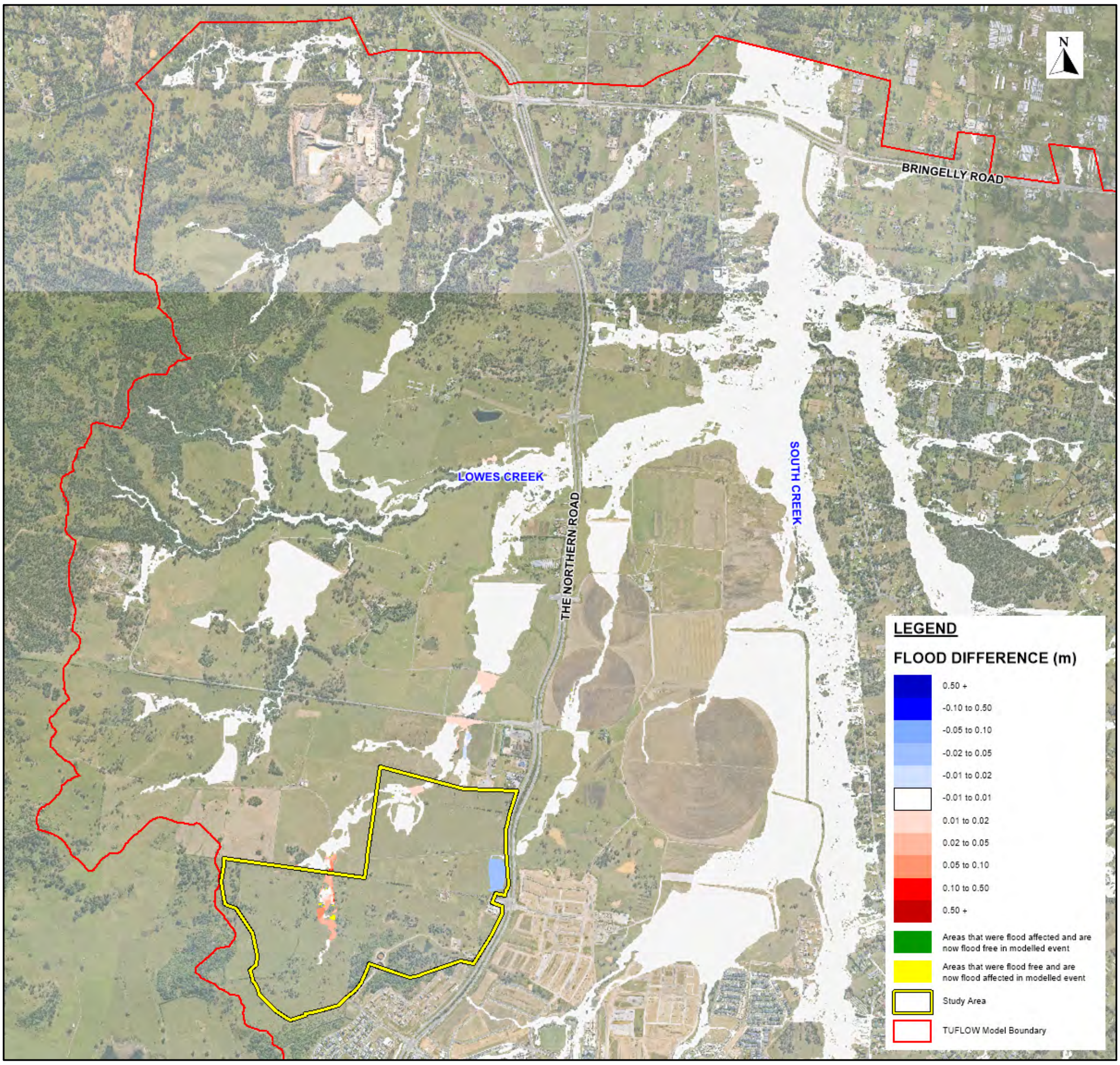

Plate 7-3 – Validation 3 – Peak 1% AEP Flood Comparison

Validation 3 has been used to assess the development impact and the performance of the detention/flood strategy for Precinct 5.

7.3.2 Developed Condition Model

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

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

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

Table 7-2 – Roughness Value

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

Initial water levels have been incorporated in the TUFLOW modelling for the proposed permanent waterbody. The TUFLOW detention volume for the waterbody should be recorded above this level. The updated TUFLOW modelling has incorporated concept design surfaces for all basins including the proposed road crossings and pedestrian crossing.

The basin outlets have been sized to provide 1% AEP flood immunity plus freeboard to the road crossing and pedestrian crossing crest levels.

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

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

7.4. Discussion of Results

7.4.1 Existing Scenario Flood Behaviour

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

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

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

7.4.2 Developed Scenario Flood Behaviour

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

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

Flood extents are contained within the central riparian corridor up to the 1% AEP, with no evidence of 1% AEP flows entering developable areas. Flood hazard mapping presented in Figure 7-19 and 7-20 in Appendix C indicates that there are no unsafe areas within the proposed residential areas of Precinct 5.

7.5. Flood Impact Assessment

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

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

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

7.6. Hydrograph Comparison

Comparisons of hydrographs have been made between existing conditions and developed conditions at the downstream reach of Lowes Creek. The comparisons have been made in the 1% AEP event for all assessed durations to ensure that no significant timing changes have occurred at the peak of the storm events which could contribute to an impact downstream of the model boundary. The location at which the comparisons have been made is shown in Plate 7-4.

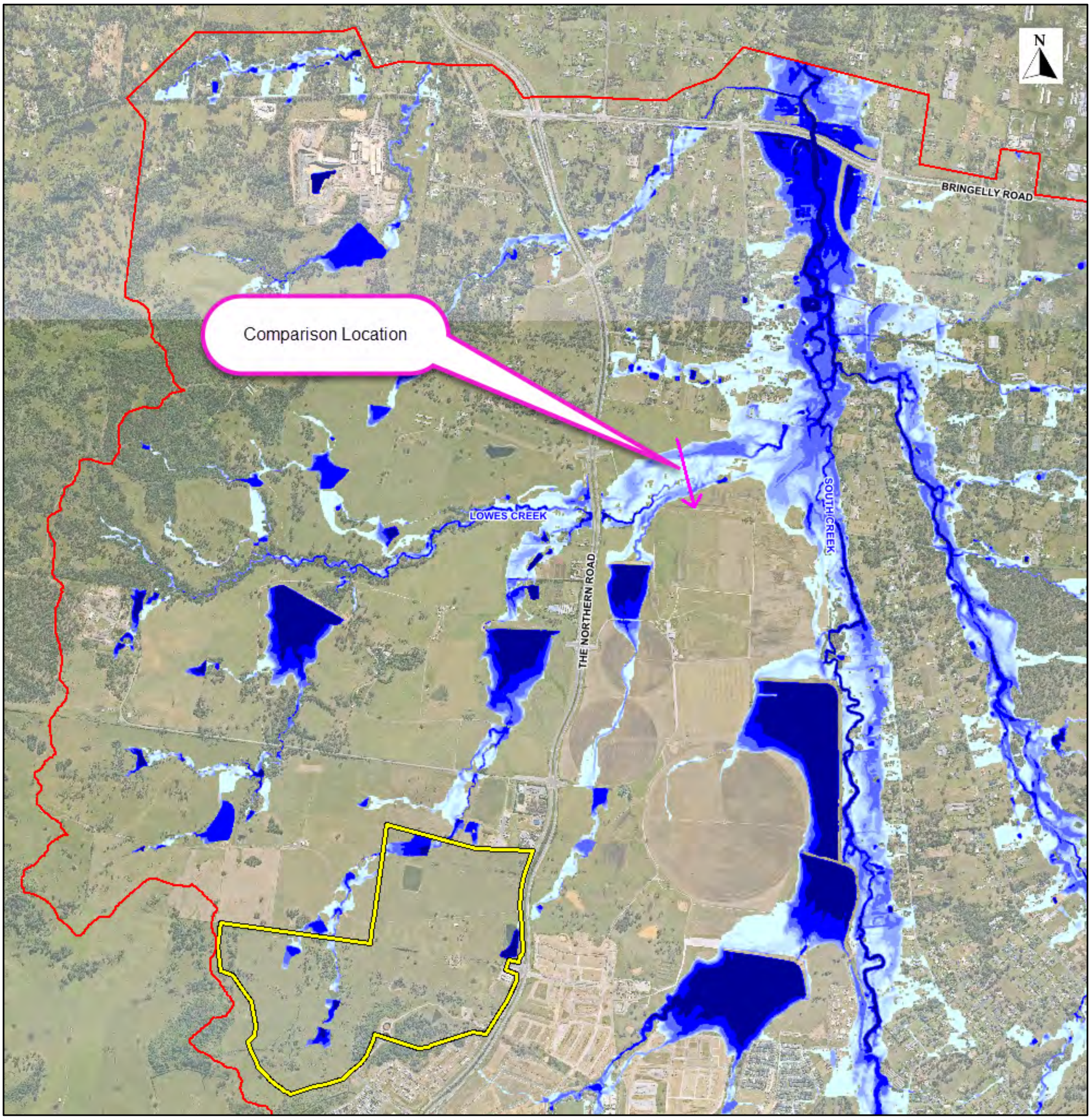

Plate 7-4 – Hydrograph Comparison Location

The 1% AEP hydrograph comparisons are presented in the graph in Plate 7-5. The comparisons have been made between the Council USC model conditions, the updated Cobbitty existing conditions and the Cobbitty developed conditions.

The graph generally shows that some volume increases have occurred as a result of the existing conditions model updates described in the model validation process. Specifically, this is due to the addition of initial water levels (IWL) to the farm dams in the vicinity of the precinct. This is detailed in Section 7.3.1. The graphs also show that there are no changes to the hydrograph behaviour as a result of the proposed development.

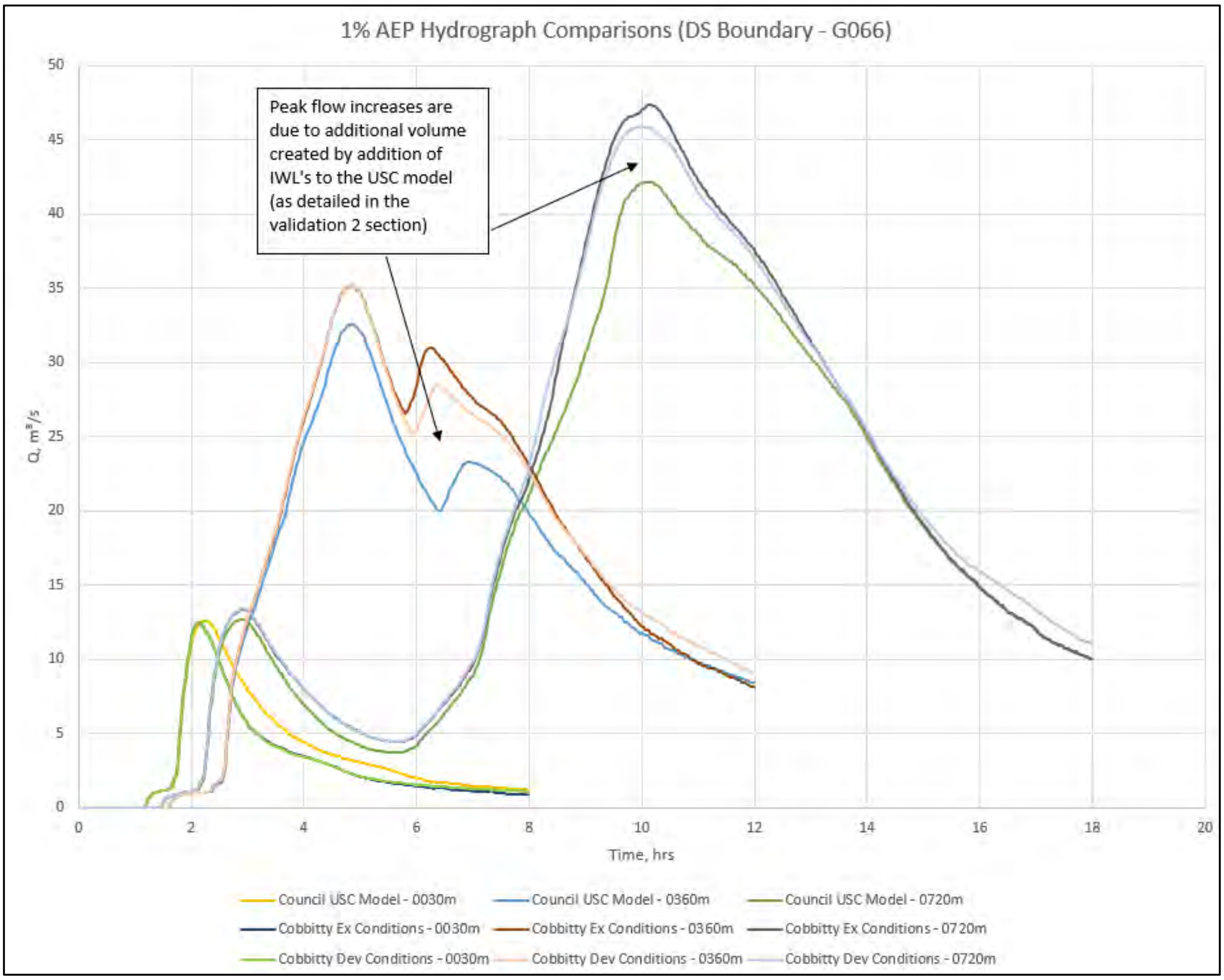

Plate 7-5 – 1% AEP Hydrograph Comparisons

7.7. Climate Change Sensitivity

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

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

7.8. Time of Inundation Mapping

A series of time of inundation maps have been prepared to illustrate the periods (in hours) of inundation that basins B1, B2 and B7 are subject to at various (depth) intervals. This has been assessed for the 50% AEP, 20% AEP and the 1% AEP storm events.

This mapping has informed an assessment from Ecological Australia on the suitability and resilience of vegetation within the inundation areas. Refer to the Ecological Australia September 2024 report for further details on the outcomes.

Refer to Figures 7-21 to 7-26 in Appendix C for the time of inundation mapping.

8. GLOSSARY

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

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

9. REFERENCES

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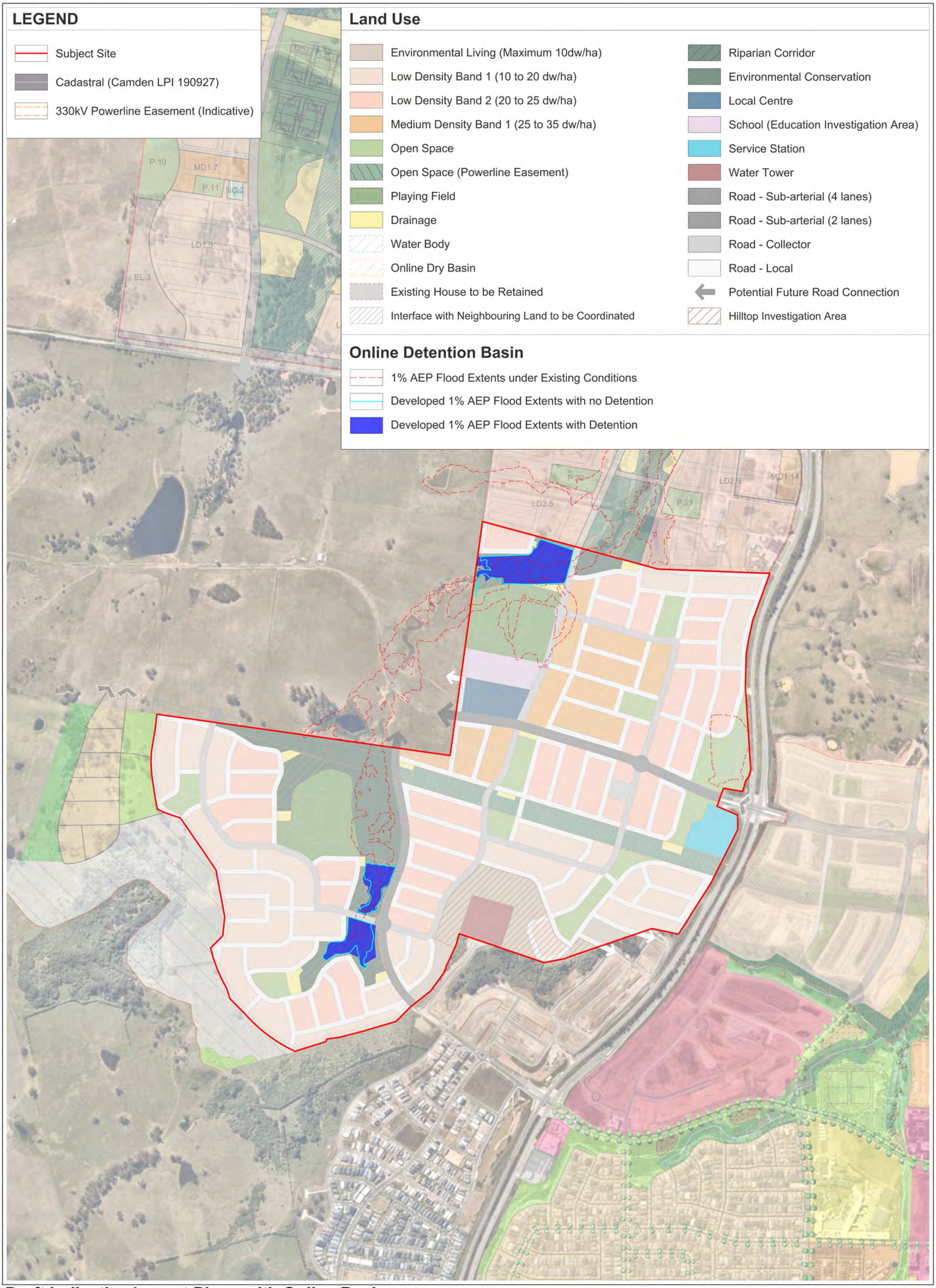
5. BMTWBM (2015). *Draft NSW MUSIC Modelling Guidelines*
6. Willing & Partners Pty. Ltd. (1996). *Runoff Analysis & Flow Training Simulation*. Addendum, Version 5.0
7. Willing & Partners Pty. Ltd. (1994). *Runoff Analysis & Flow Training Simulation*. Detailed Documentation and User Manual, Version 4.0

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



Draft Indicative Layout Plan - with Online Basins

COBBITTY

NORTH

50 0 100 200 300 400 500 metres

Ref: BHLCO-2-004-1 | Date: 06/09/2024 | Revision: B | Scale: 1:5000@A1

Note: All areas and dimensions subject to detailed survey

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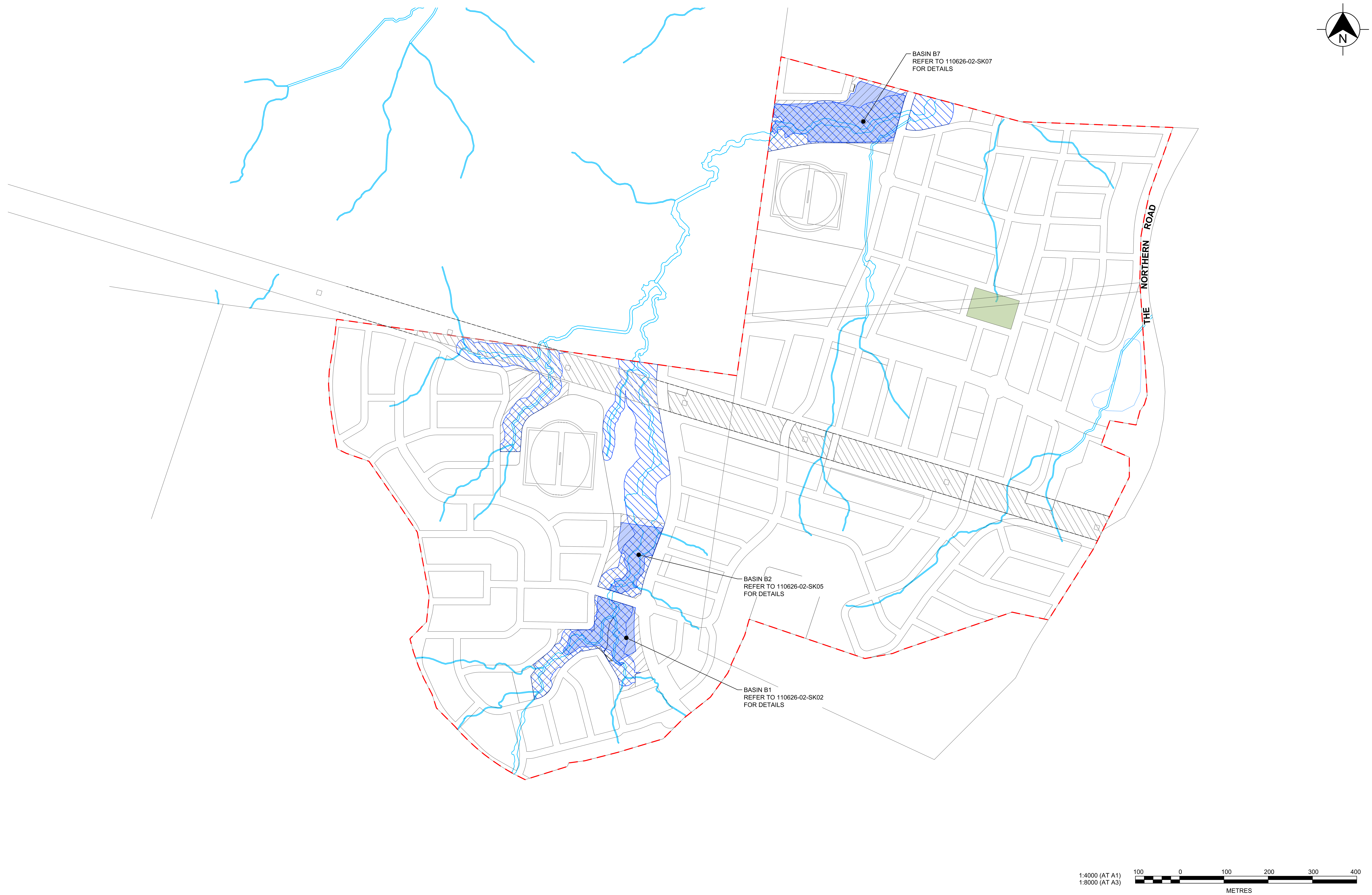
APPENDIX B – PRELIMINARY CONCEPT PLANS



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SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

DEVELOPMENT AND BASIN LAYOUT PLAN

110628-02-SK01

21/08/2024

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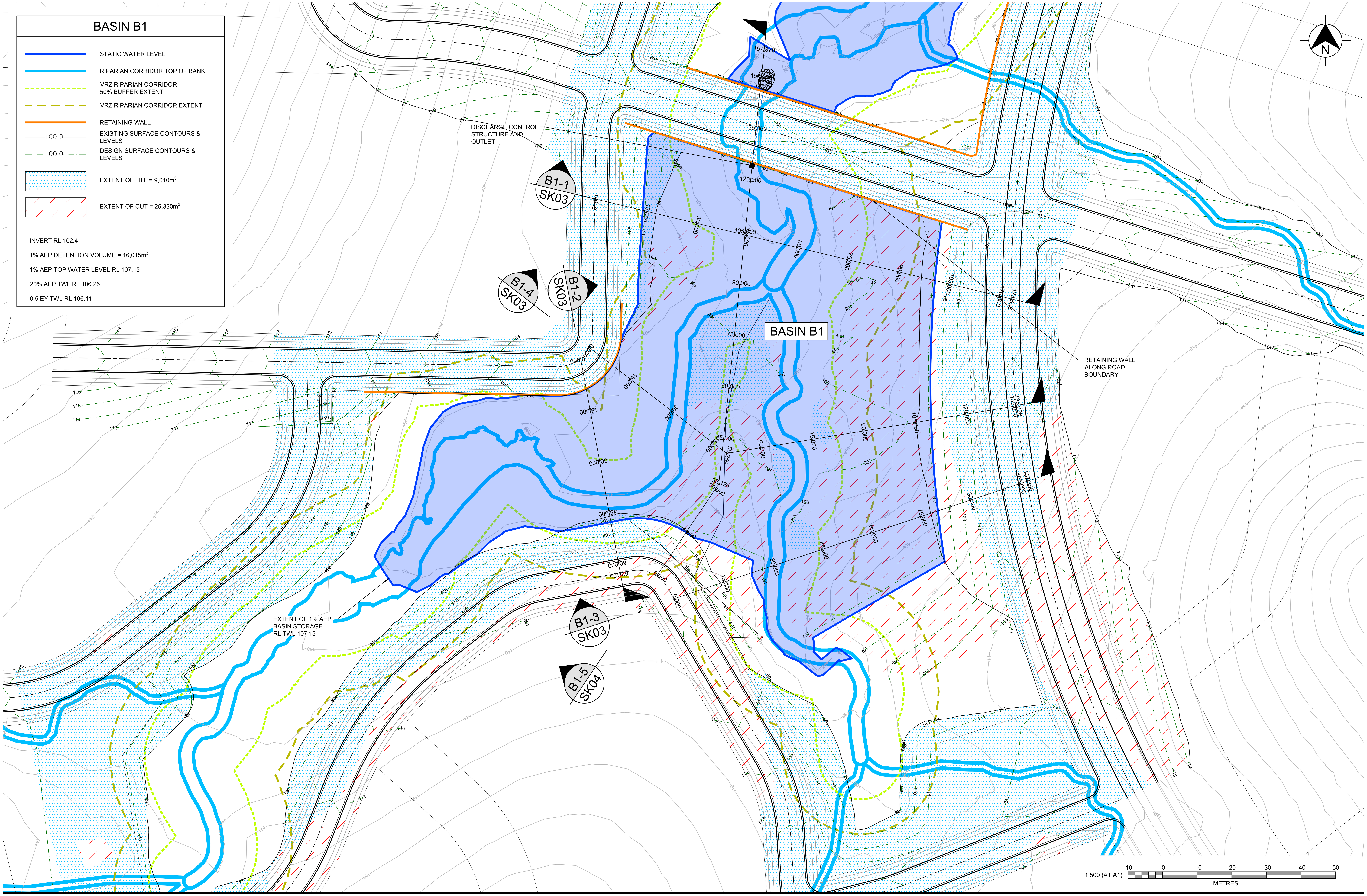

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SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN B1 CONCEPT DESIGN

110628-02-SK02

21/08/2024

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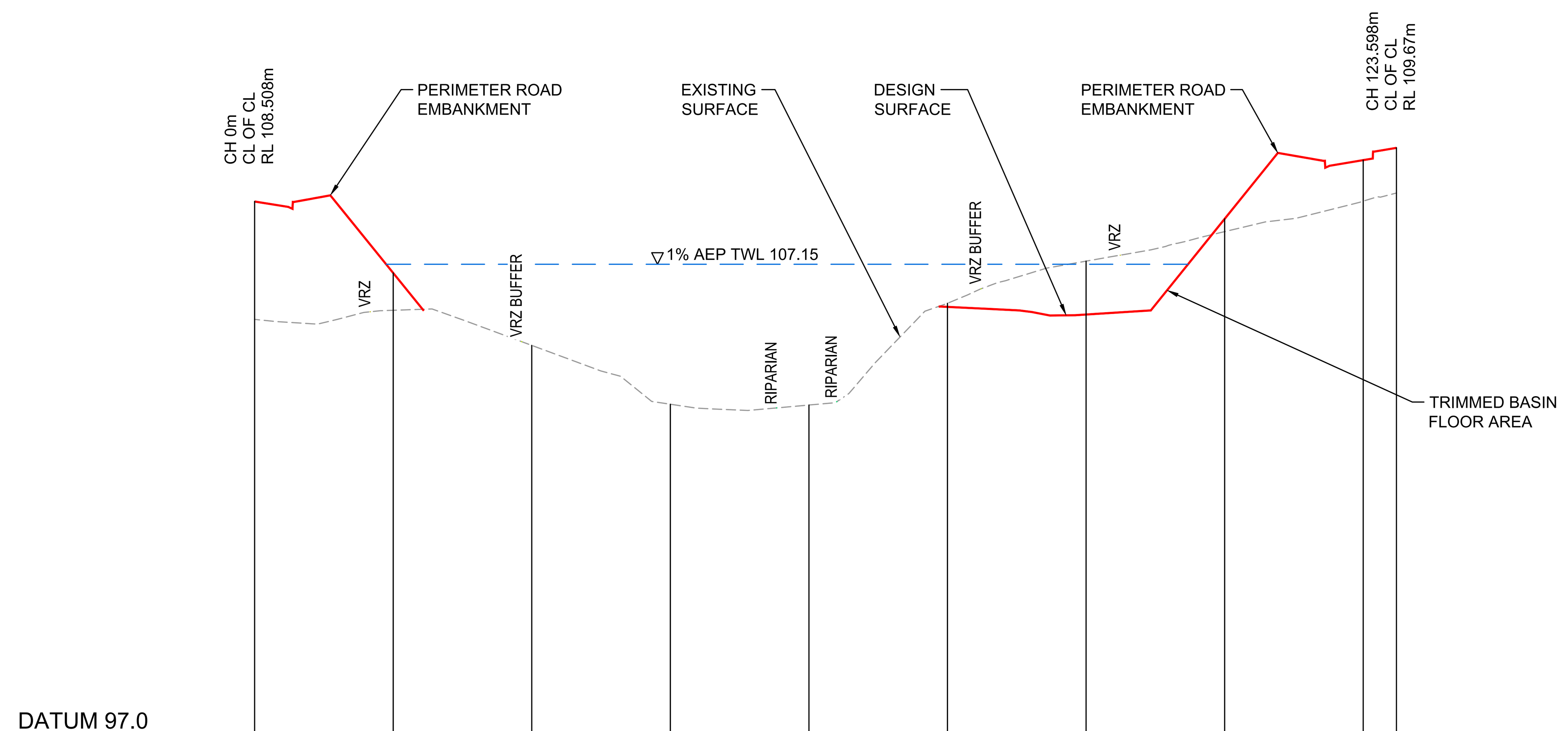
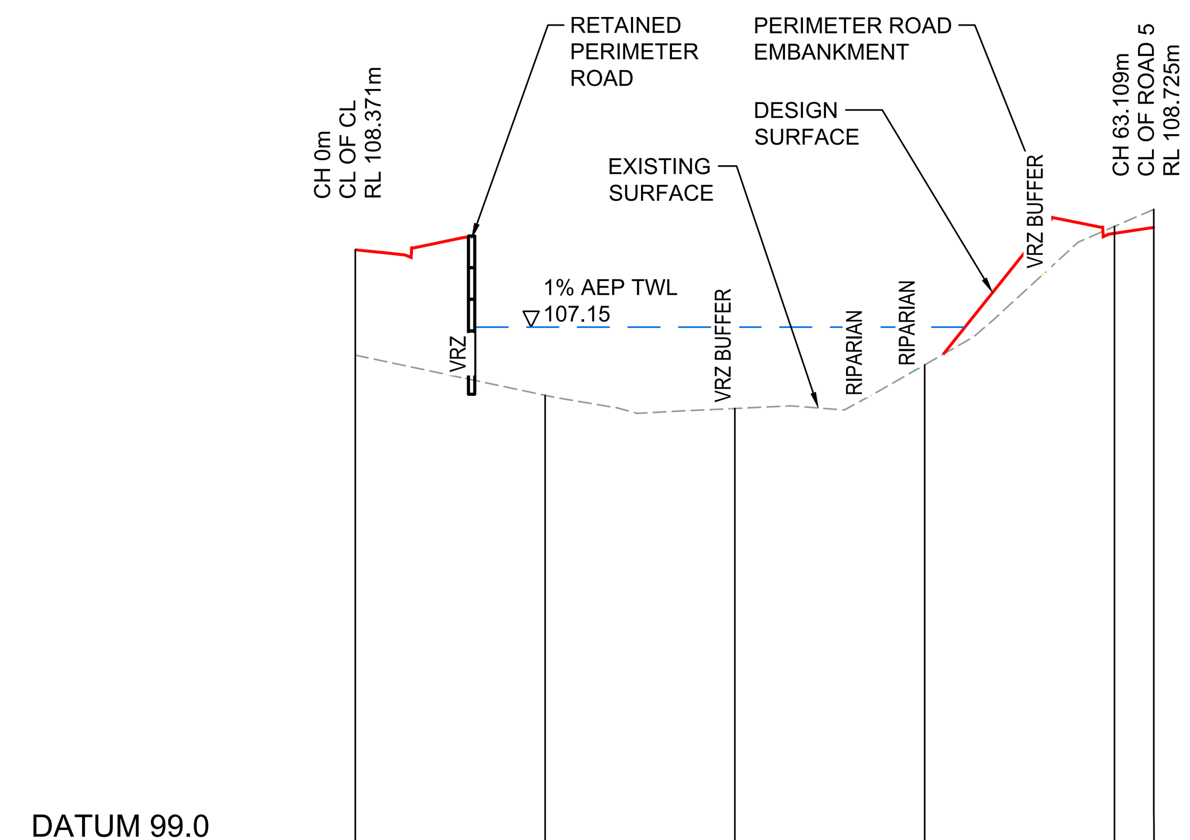


DESIGN SURFACE	108.508	106.962				106.228	106.062	108.132	109.404	109.670
EXISTING SURFACE	105.957	106.154	105.394	104.121	104.103	106.306	107.218	107.857	108.517	108.693
CHAINAGE	0.000	15.000	30.000	45.000	60.000	75.000	90.000	105.000	120.000	123.598

LONGITUDINAL SECTION B1-1

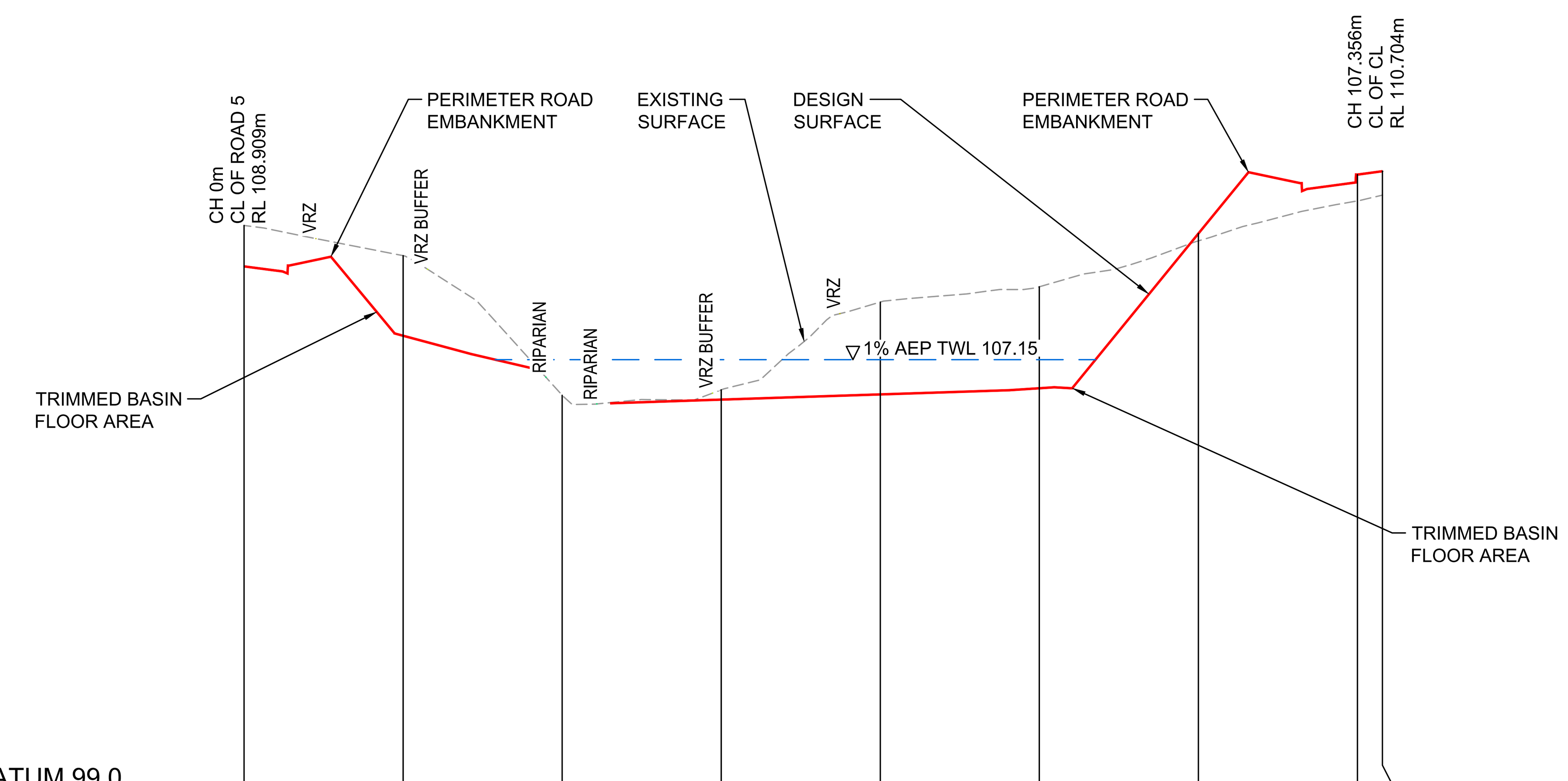
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



DESIGN SURFACE	108.371				108.631	108.725
EXISTING SURFACE	106.707	106.073	105.865	106.554	108.741	109.010
CHAINAGE	0.000	15.000	30.000	45.000	60.000	63.109

LONGITUDINAL SECTION B1-2

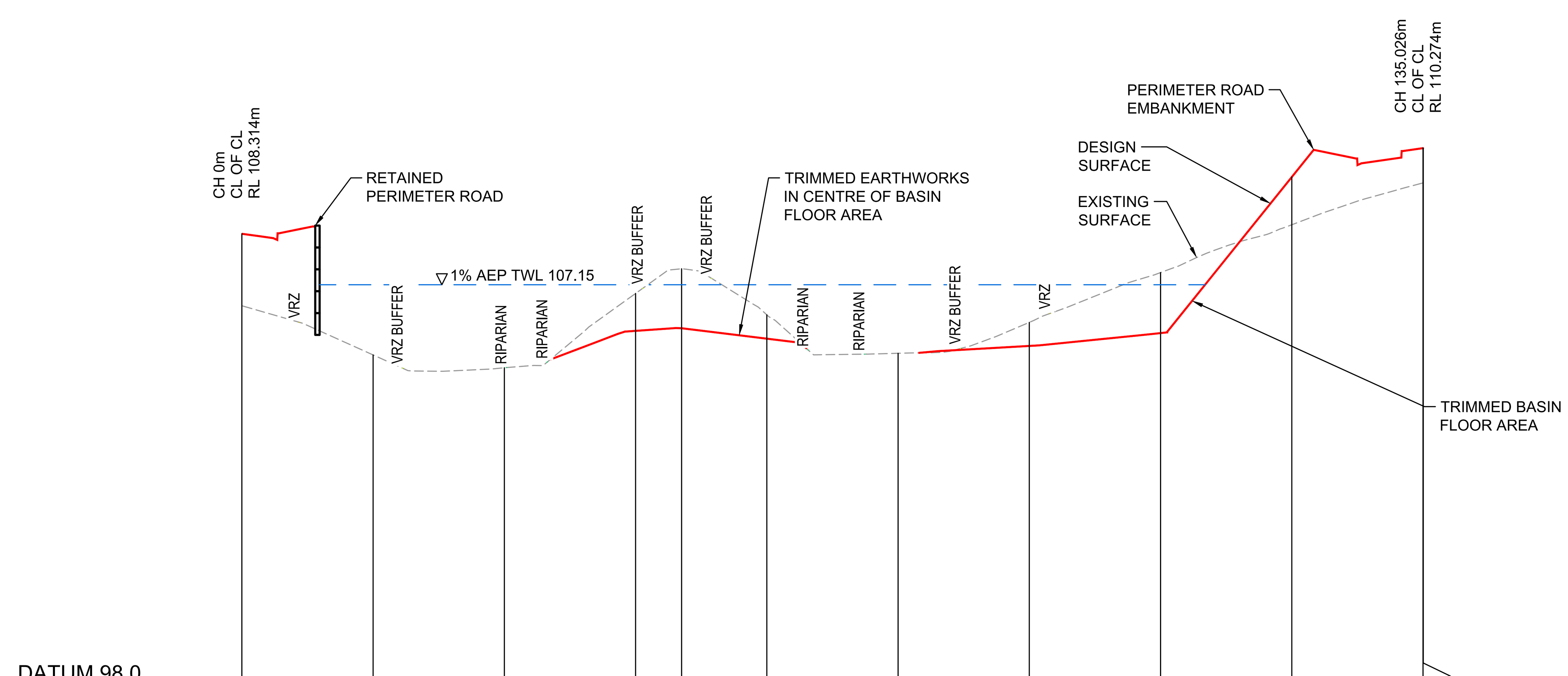
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



DESIGN SURFACE	108.909	107.601		106.396	106.494	106.611	109.528	110.641	110.704
EXISTING SURFACE	109.681	109.111	106.478	106.581	108.236	108.525	109.390	110.144	110.253
CHAINAGE	0.000	15.000	30.000	45.000	60.000	75.000	90.000	105.000	107.356

LONGITUDINAL SECTION B1-3

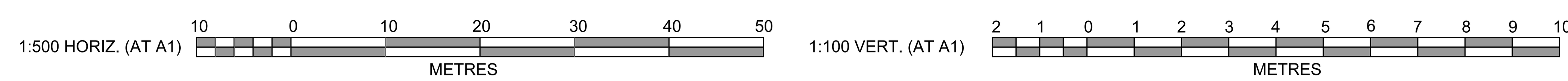
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



DESIGN SURFACE	108.314			106.095	106.155	105.916		105.750	106.044	109.613	110.273	110.274
EXISTING SURFACE	106.669	105.544	105.251	106.951	107.514	106.461	105.582	106.289	107.428	108.521	109.478	109.480
CHAINAGE	0.000	15.000	30.000	45.000	50.259	60.000	75.000	90.000	105.000	120.000	135.000	135.026

LONGITUDINAL SECTION B1-4

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



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SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN B1 SECTIONS SHEET 1

110628-02-SK03
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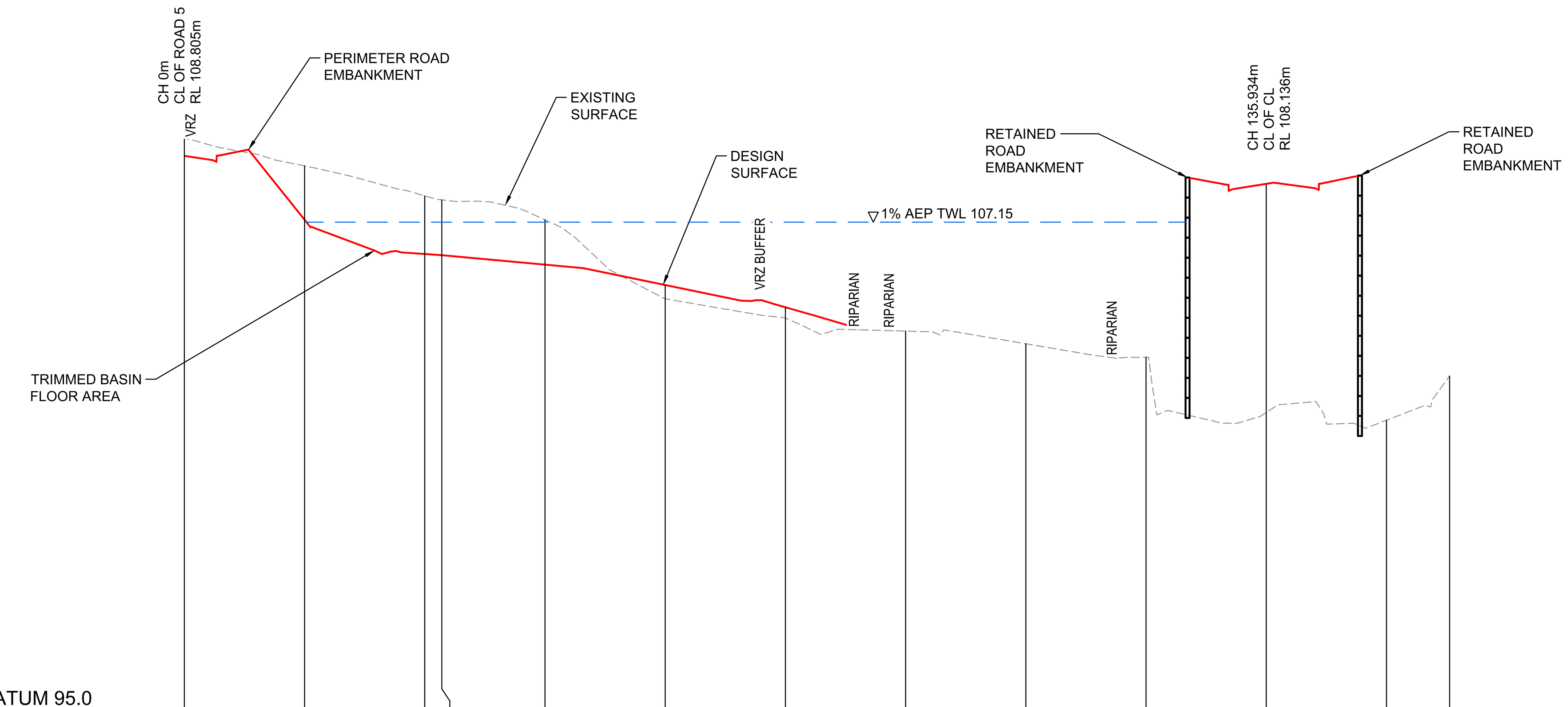

DATUM 95.0

DESIGN SURFACE	108.805	107.210	106.355	106.326	106.090	105.581	105.026				108.107		
EXISTING SURFACE	109.246	108.556	107.806	107.706	107.207	105.241	104.756	104.431	104.115	103.778	102.399	102.206	103.310
CHAINAGE	0.000	15.000	30.000	32.124	45.000	60.000	75.000	90.000	105.000	120.000	135.000	150.000	157.878

LONGITUDINAL SECTION B1-5

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

1:500 HORIZ. (AT A1) 10 0 10 20 30 40 50 METRES

1:100 VERT. (AT A1) 2 1 0 1 2 3 4 5 6 7 8 9 10 METRES

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SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN B1 SECTIONS SHEET 2

110628-02-SK04
21/08/2024
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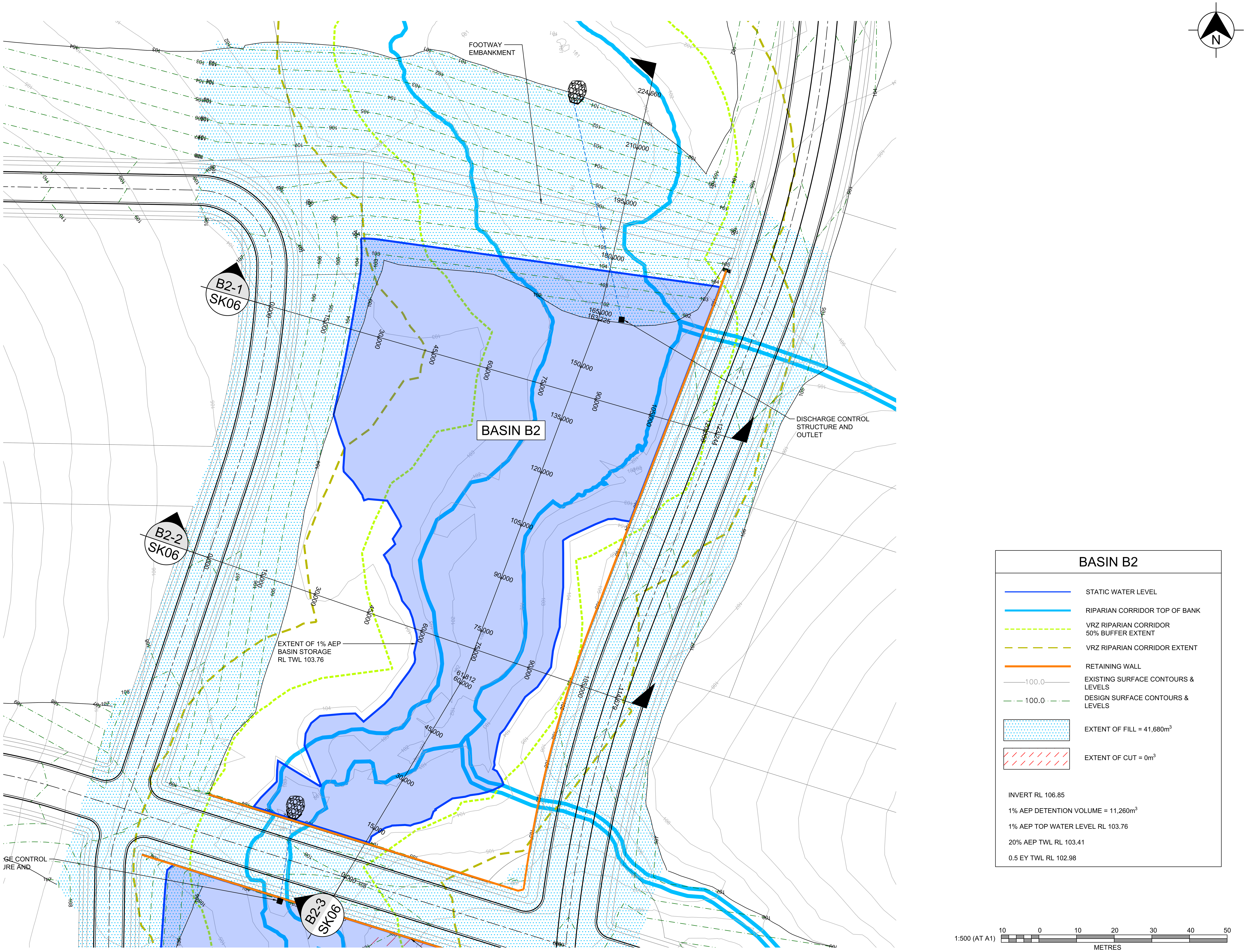

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SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN B2 CONCEPT DESIGN

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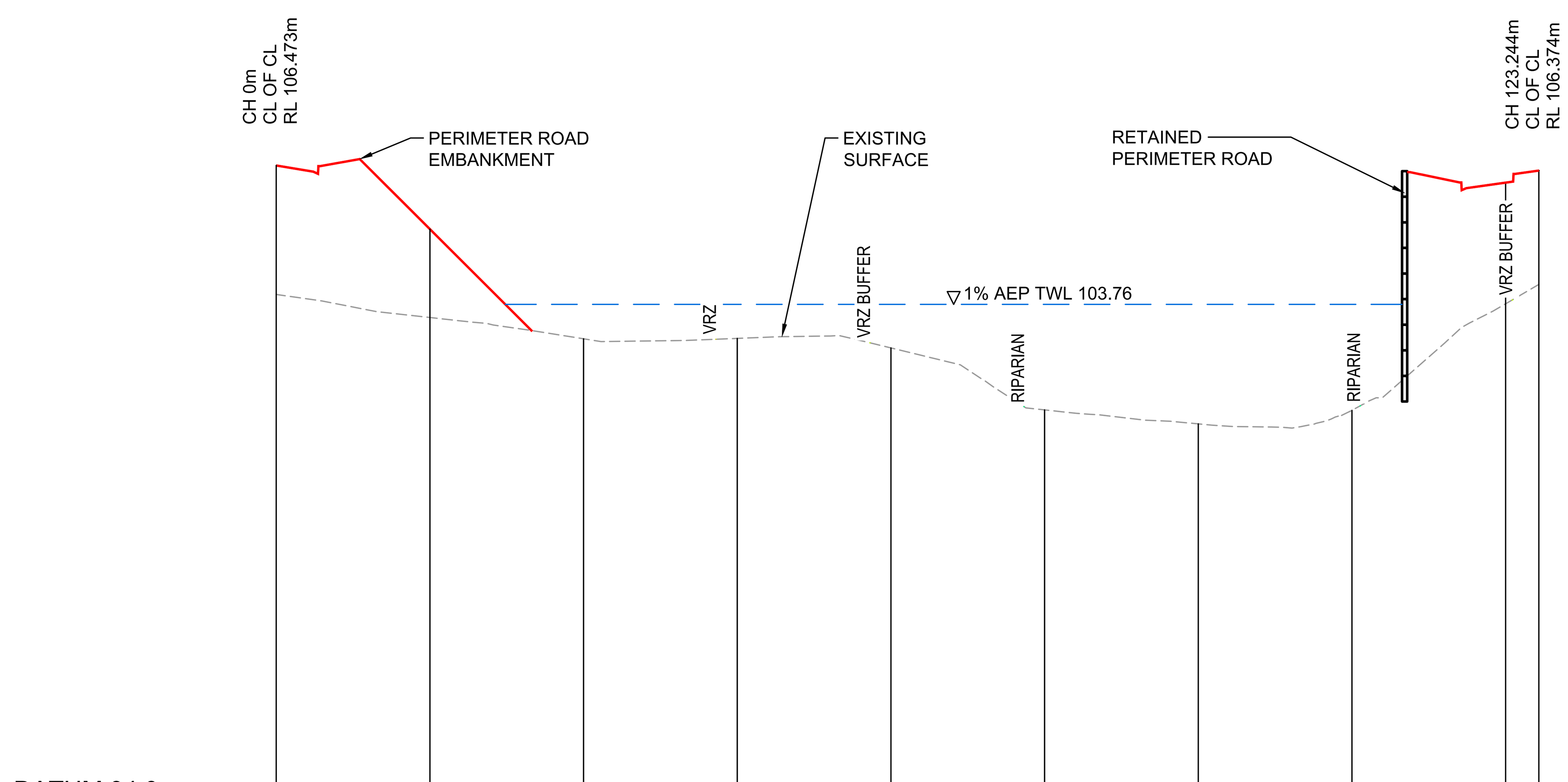
A

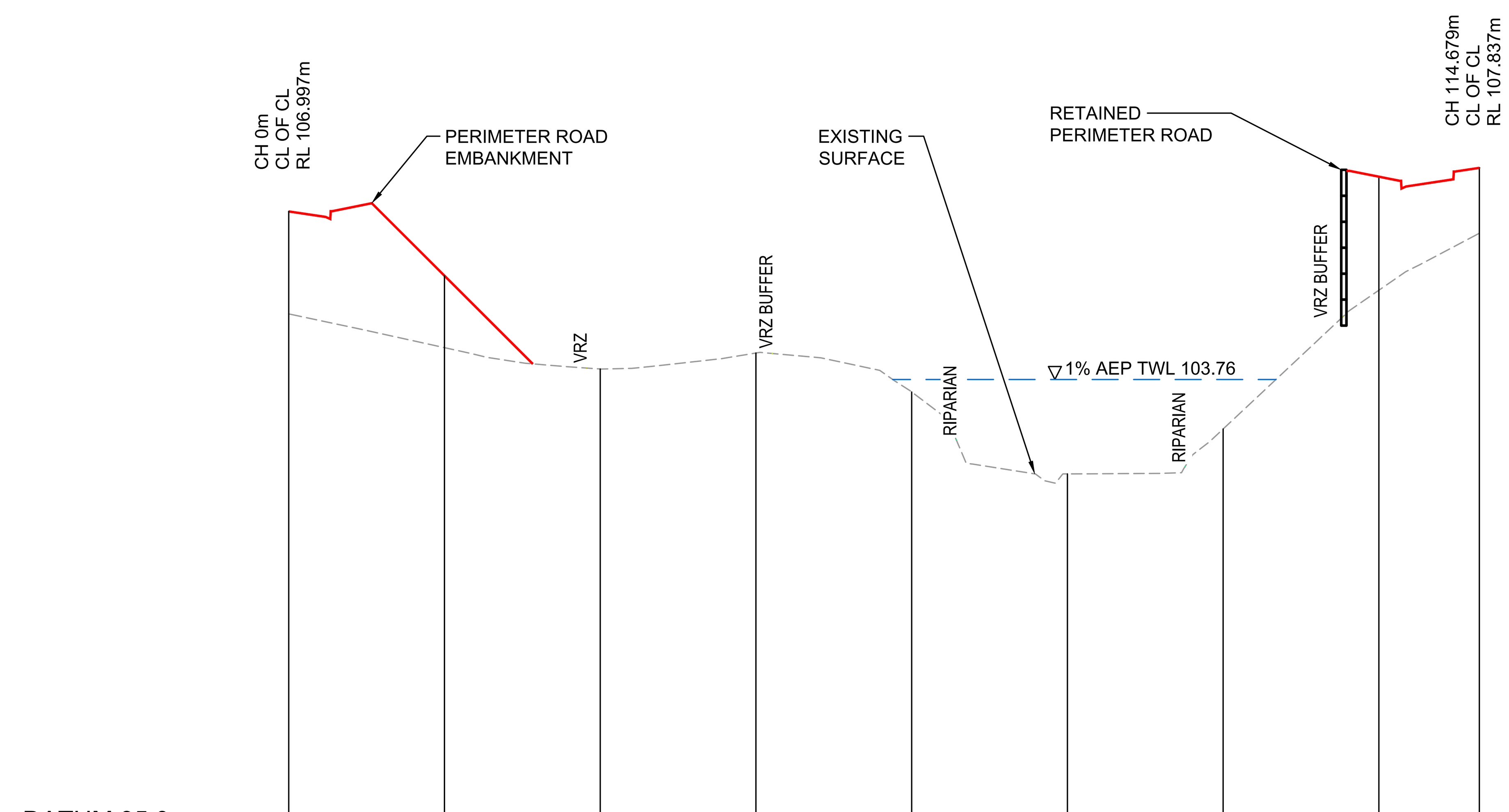


DATUM 94.0

DESIGN SURFACE	106.473	105.230							106.138	106.374
EXISTING SURFACE	103.954	103.504	103.088	103.095	102.909	101.699	101.426	101.690	103.772	104.150
CHAINAGE	0.000	15.000	30.000	45.000	60.000	75.000	90.000	105.000	120.000	123.244

LONGITUDINAL SECTION B2-1

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

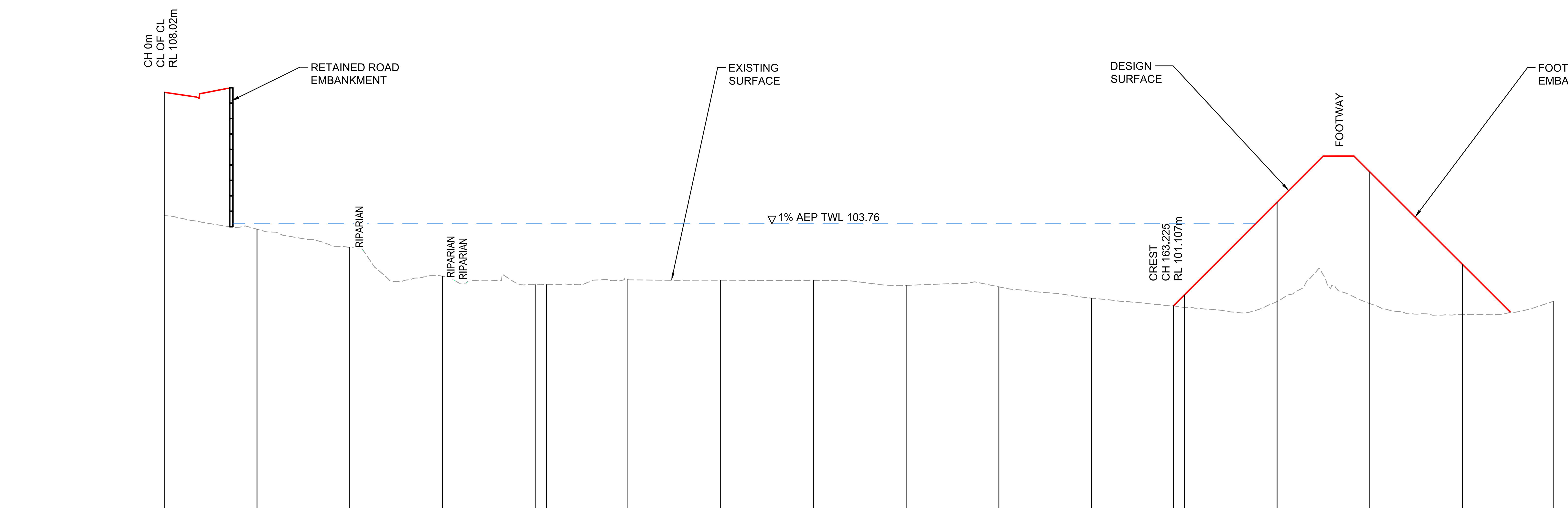


DATUM 95.0

DESIGN SURFACE	106.997	105.759						107.667	107.836
EXISTING SURFACE	105.023	104.374	103.962	104.270	103.520	101.942	102.806	105.479	106.577
CHAINAGE	0.000	15.000	30.000	45.000	60.000	75.000	90.000	105.000	114.679

LONGITUDINAL SECTION B2-2

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

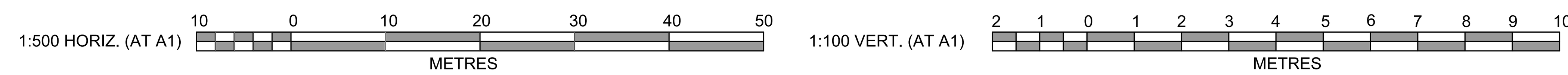


DATUM 94.0

DESIGN SURFACE	108.020												101.107	101.462	104.465	105.443	102.446	
EXISTING SURFACE	104.029	103.587	103.000	102.067	101.791	101.790	101.957	101.937	101.927	101.769	101.722	101.355	101.107	101.054	101.249	101.179	100.824	101.247
CHAINAGE	0.000	15.000	30.000	45.000	60.000	61.812	75.000	90.000	105.000	120.000	135.000	150.000	163.225	165.000	180.000	195.000	210.000	224.660

LONGITUDINAL SECTION B2-3

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



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SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN B2 SECTIONS

110628-02-SK06
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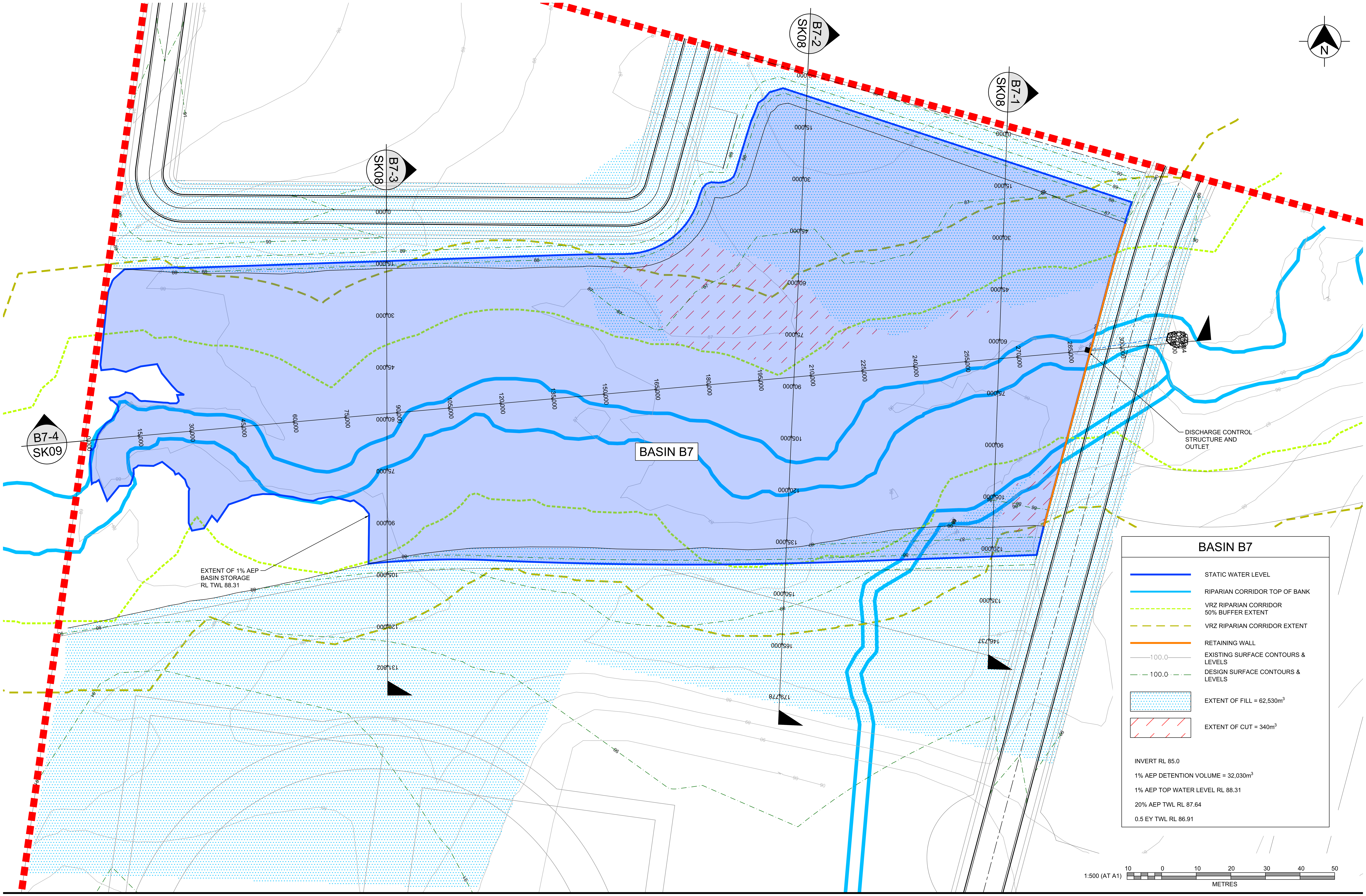

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SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN B7 CONCEPT DESIGN

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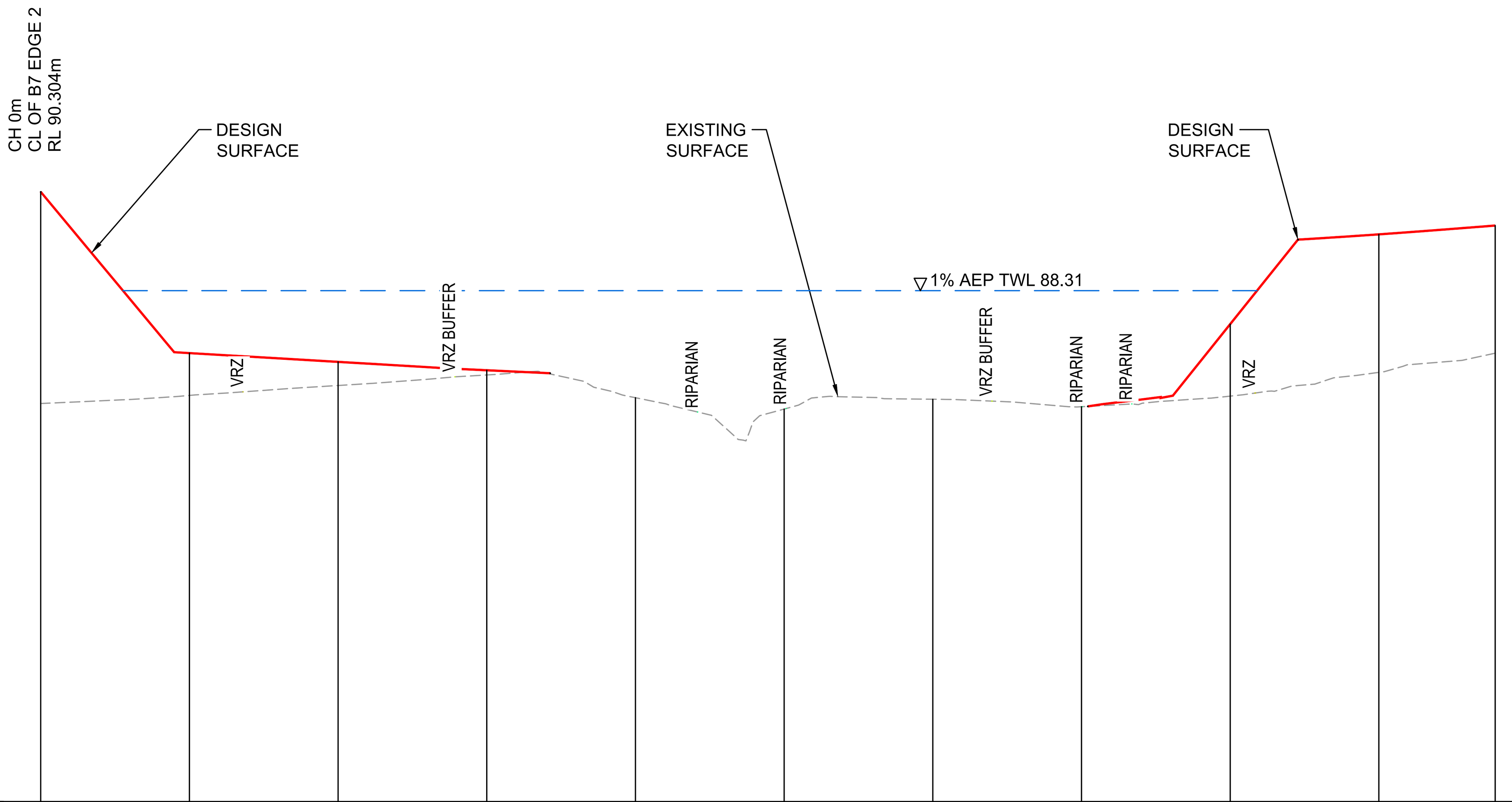
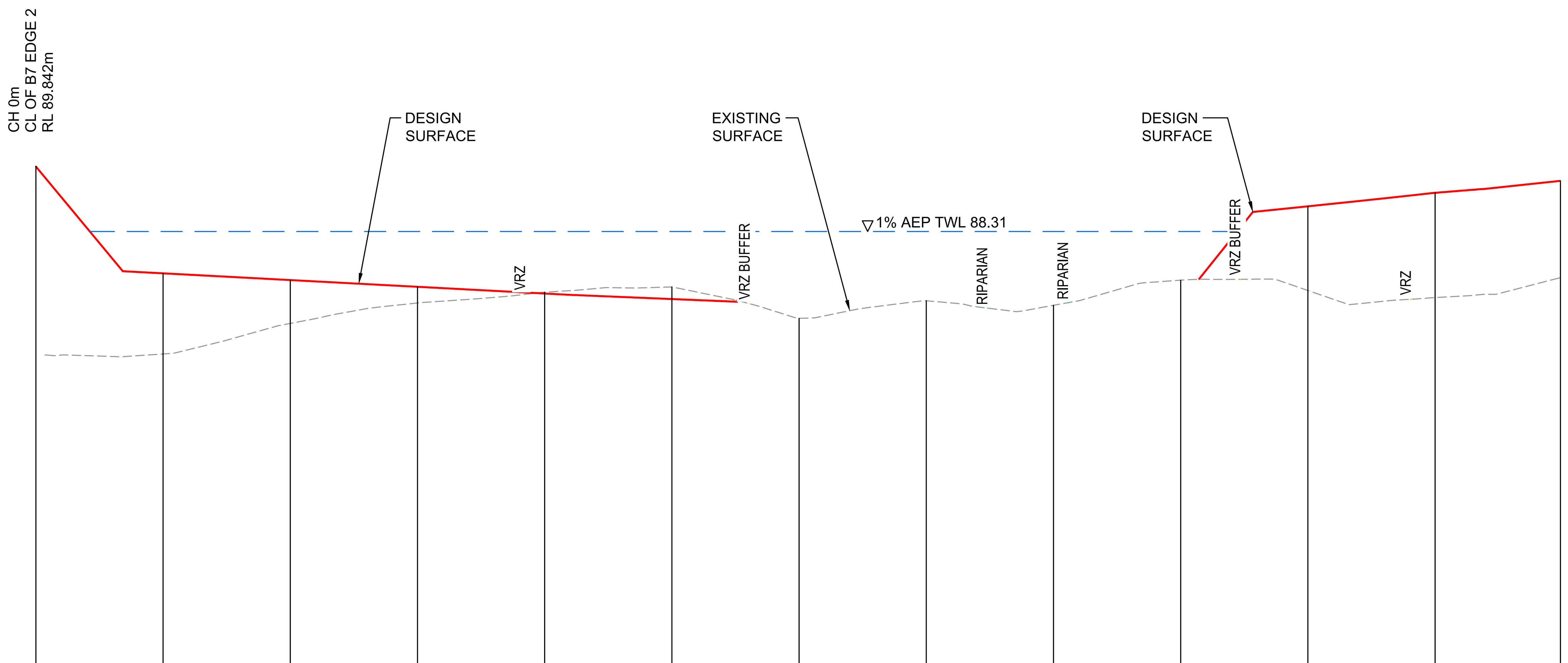
A



DATUM 78.0

DESIGN SURFACE	90.304	87.050	86.873	86.704					87.634	89.447	89.624
EXISTING SURFACE	86.032	86.196	86.396	86.608	86.150	85.921	86.118	85.967	86.182	86.661	87.048
CHAINAGE	0.000	15.000	30.000	45.000	60.000	75.000	90.000	105.000	120.000	135.000	146.737

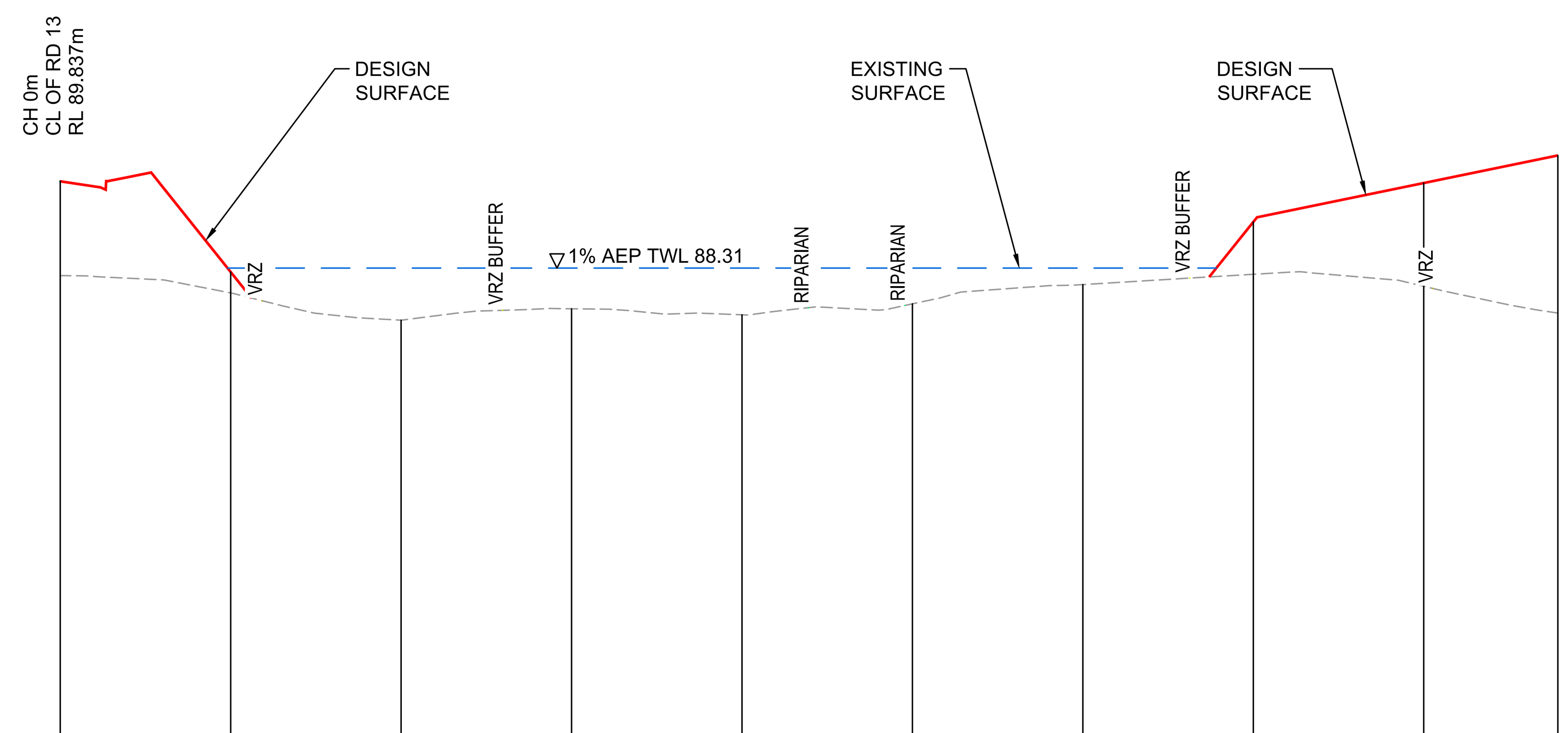
LONGITUDINAL SECTION B7-1
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



DATUM 78.0

DESIGN SURFACE	89.842	87.322	87.163	87.004	86.846	86.716					88.903	89.221	89.504
EXISTING SURFACE		85.419	86.140	86.622	86.876	87.000	86.259	86.675	86.567	87.160	86.916	86.750	87.220
CHAINAGE	0.000	15.000	30.000	45.000	60.000	75.000	90.000	105.000	120.000	135.000	150.000	165.000	179.778

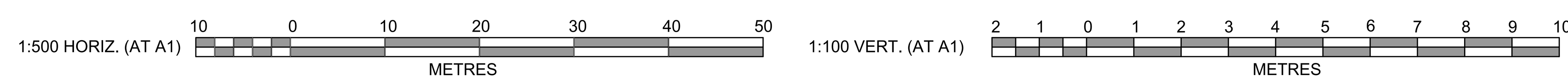
LONGITUDINAL SECTION B7-2
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



DATUM 80.0

DESIGN SURFACE	89.837	88.241						89.122	89.807	90.292
EXISTING SURFACE	88.178	87.873	87.393	87.594	87.488	87.681	88.020	88.201	87.990	87.519
CHAINAGE	0.000	15.000	30.000	45.000	60.000	75.000	90.000	105.000	120.000	131.802

LONGITUDINAL SECTION B7-3
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



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SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN B7 SECTIONS SHEET 1

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21/08/2024
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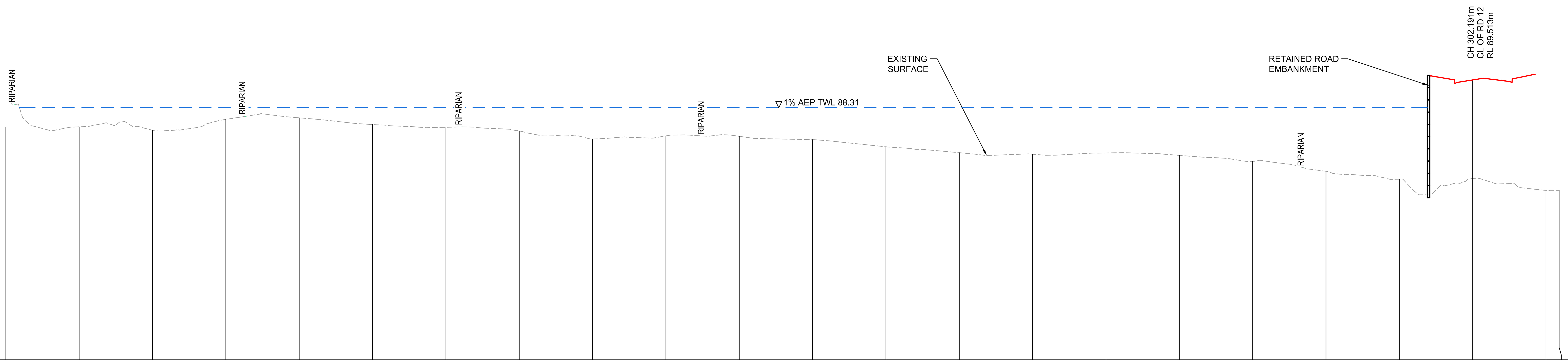

DATUM 78.0

DESIGN SURFACE												
EXISTING SURFACE		87.526	87.385	87.830	87.895	87.619	87.509	87.360	87.028	87.156	87.139	87.002
CHAINAGE	0.000	15.000	30.000	45.000	60.000	75.000	90.000	105.000	120.000	135.000	150.000	165.000

DESIGN SURFACE									89.444		
EXISTING SURFACE	86.710	86.469	86.408	86.458	86.359	86.117	85.710	85.386	85.412	84.926	84.928
CHAINAGE	180.000	195.000	210.000	225.000	240.000	255.000	270.000	285.000	300.000	315.000	317.684

LONGITUDINAL SECTION B7-4

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

1:500 HORIZ. (AT A1) 10 0 10 20 30 40 50 METRES

1:100 VERT. (AT A1) 2 1 0 1 2 3 4 5 6 7 8 9 10 METRES

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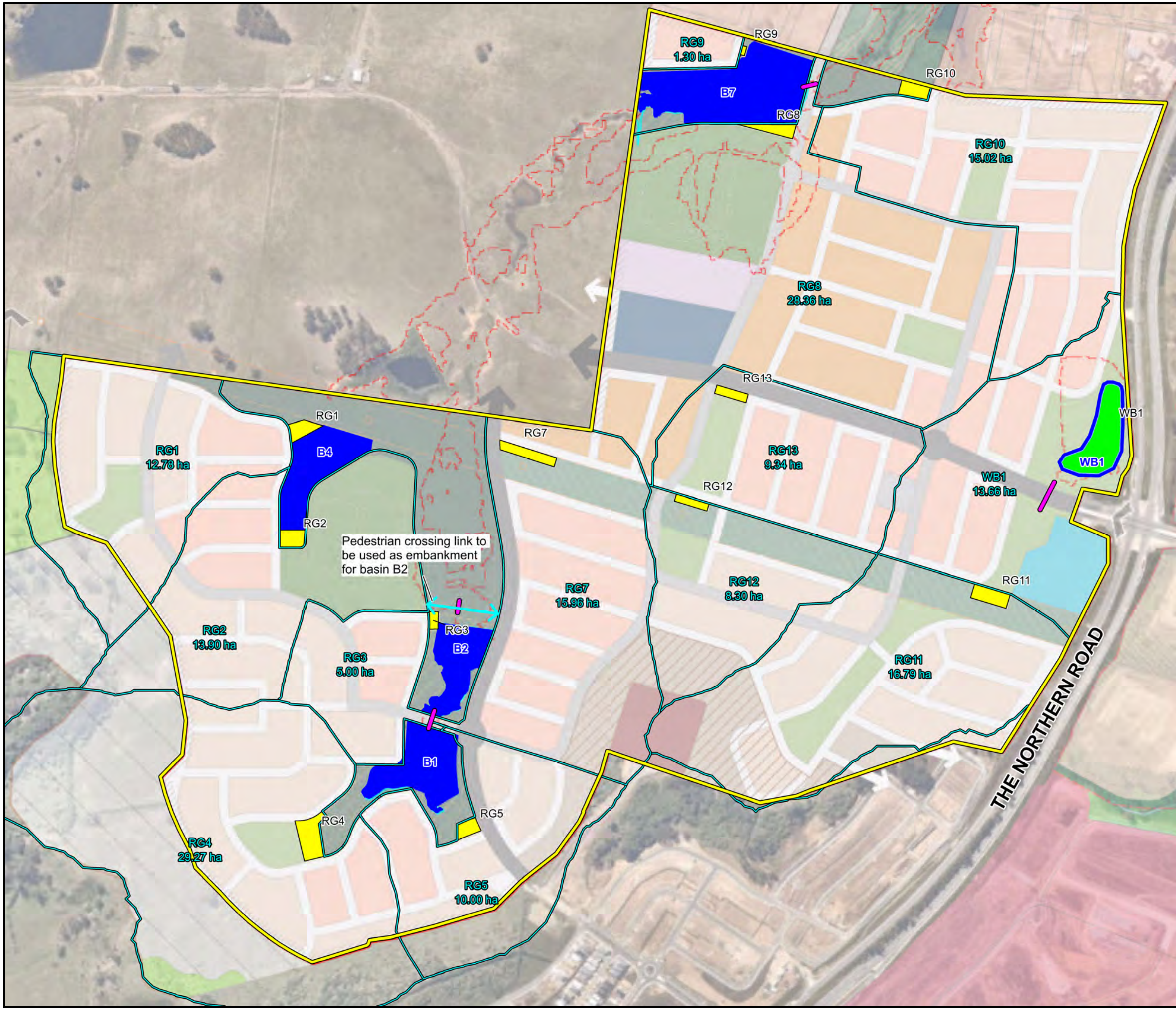
SOUTH CREEK WEST, COBBITTY SUB-PRECINCT 5

BASIN B7 SECTIONS SHEET 2

110628-02-SK09
21/08/2024
A

APPENDIX C – FIGURES



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LEGEND

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

NOTES

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

N

0 240
metres
Scale 1:6,000 @ A3

Projection: GDA 1994 MGA Zone 56

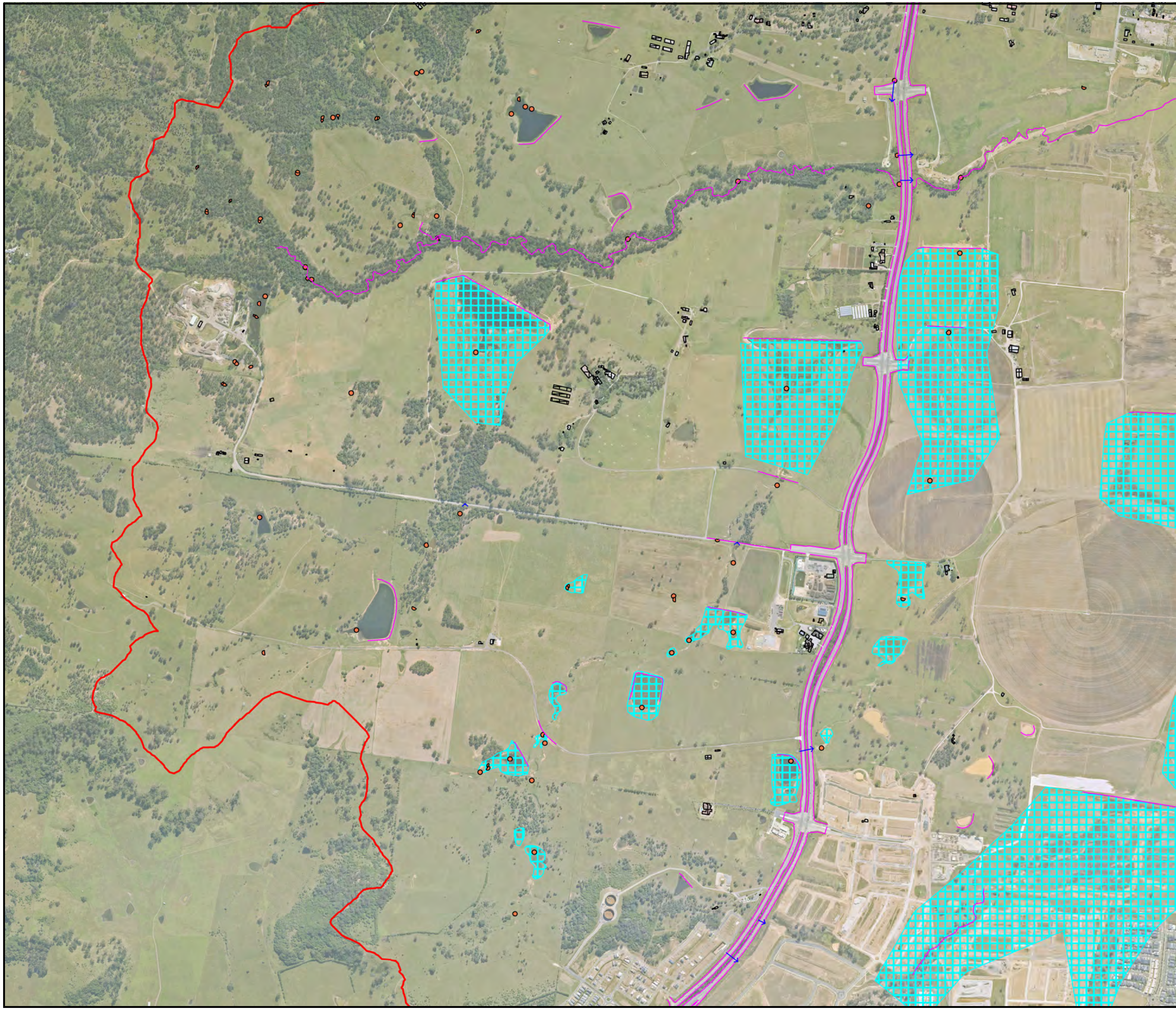
Figure 5-01

South Creek West
Cobbitty Sub-Precinct 5

Developed Conditions
Water Cycle Management Plan

Date: 12/09/2024 Issue: H

Filename: "J:\110628 - SC West Precinct02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig5-01_DEV_WQCP_H.WOR"



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LEGEND

TUFLOW MODEL ELEMENTS

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

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-01

South Creek West
Cobbitty Sub-Precinct 5

Existing Conditions
TUFLOW Setup

Date: 13/09/2024 Issue D

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

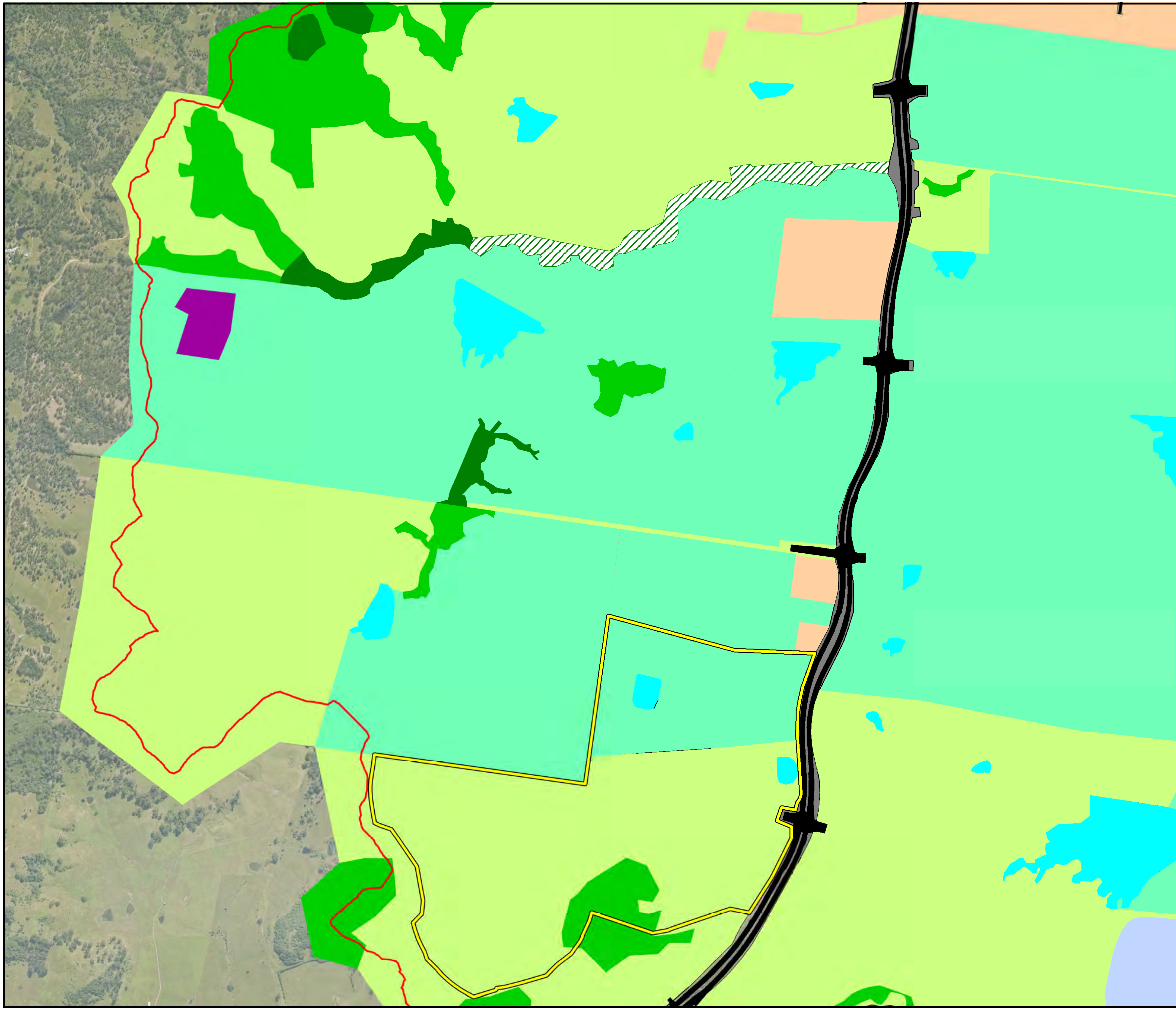
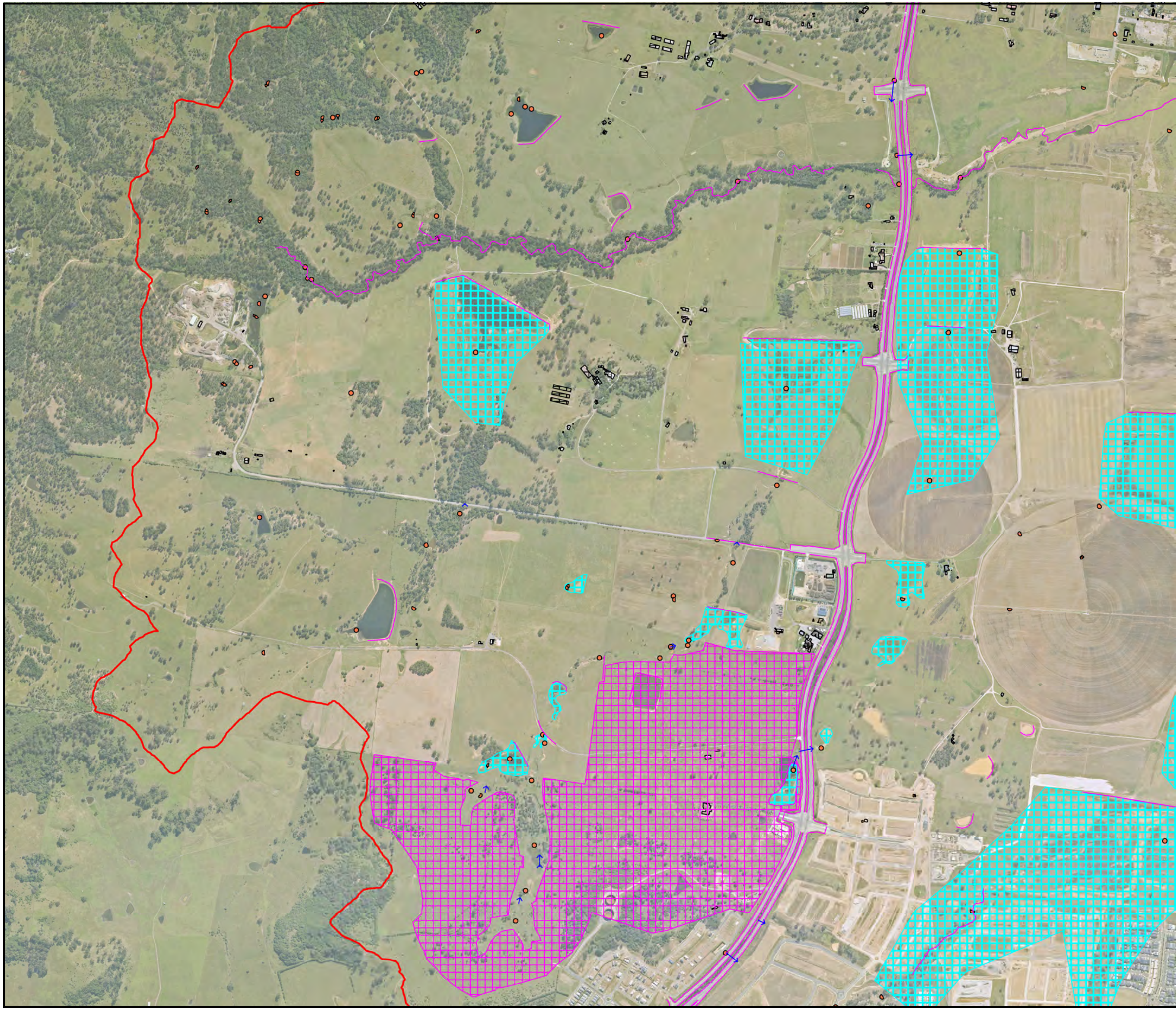


Figure 7-02

South Creek West
Cobbitty Sub-Precinct 5

Existing Conditions
TUFLOW Mannings

Date: 13/09/2024 Issue D



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LEGEND

TUFLOW MODEL ELEMENTS

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

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-03

South Creek West Cobbitty Sub-Precinct 5

Developed Conditions TUFLOW Setup

Date: 13/09/2024

Issue E

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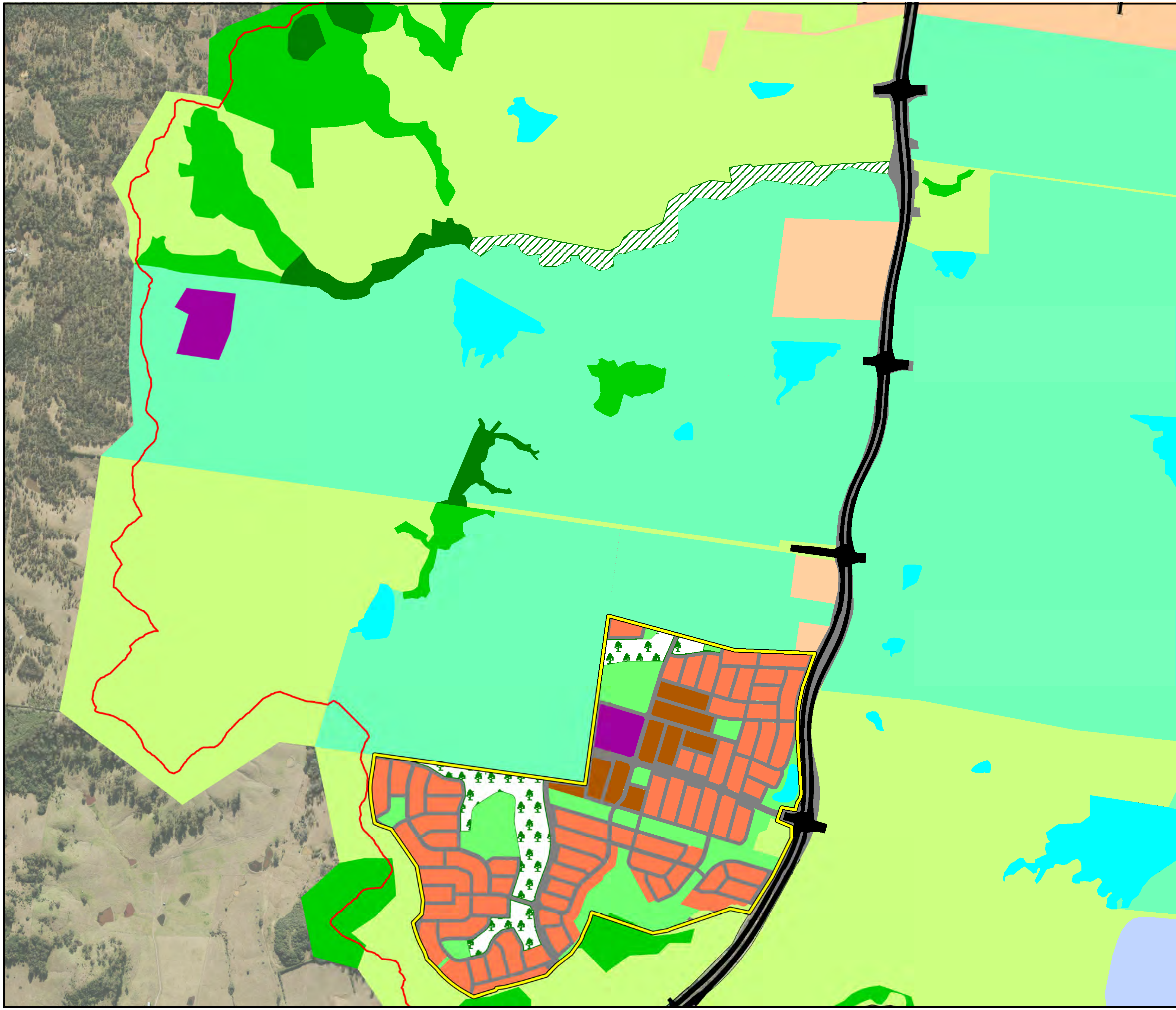

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LEGEND

MANNINGS VALUE

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

N

0 600
metres
Scale 1:15,000 @ A3

Projection: GDA 1994 MGA Zone 56

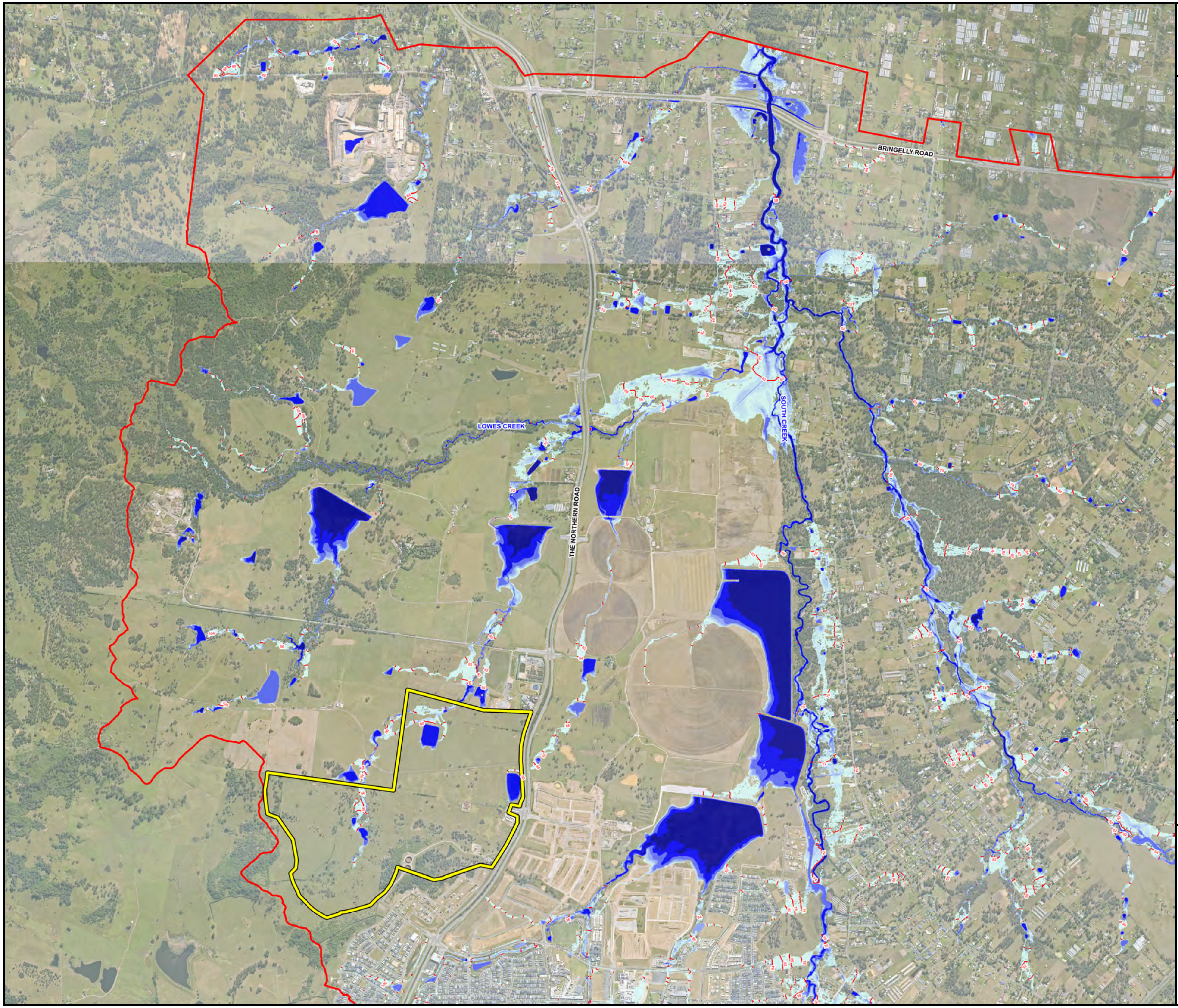
Figure 7-04

South Creek West
Cobbitty Sub-Precinct 5

Developed Conditions
TUFLOW Mannings

Date: 13/09/2024 Issue E

Filename: "J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-04_DEV_TFM_E.WOR"



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LEGEND

FLOOD DEPTH (m)

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

35.0 2.0 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

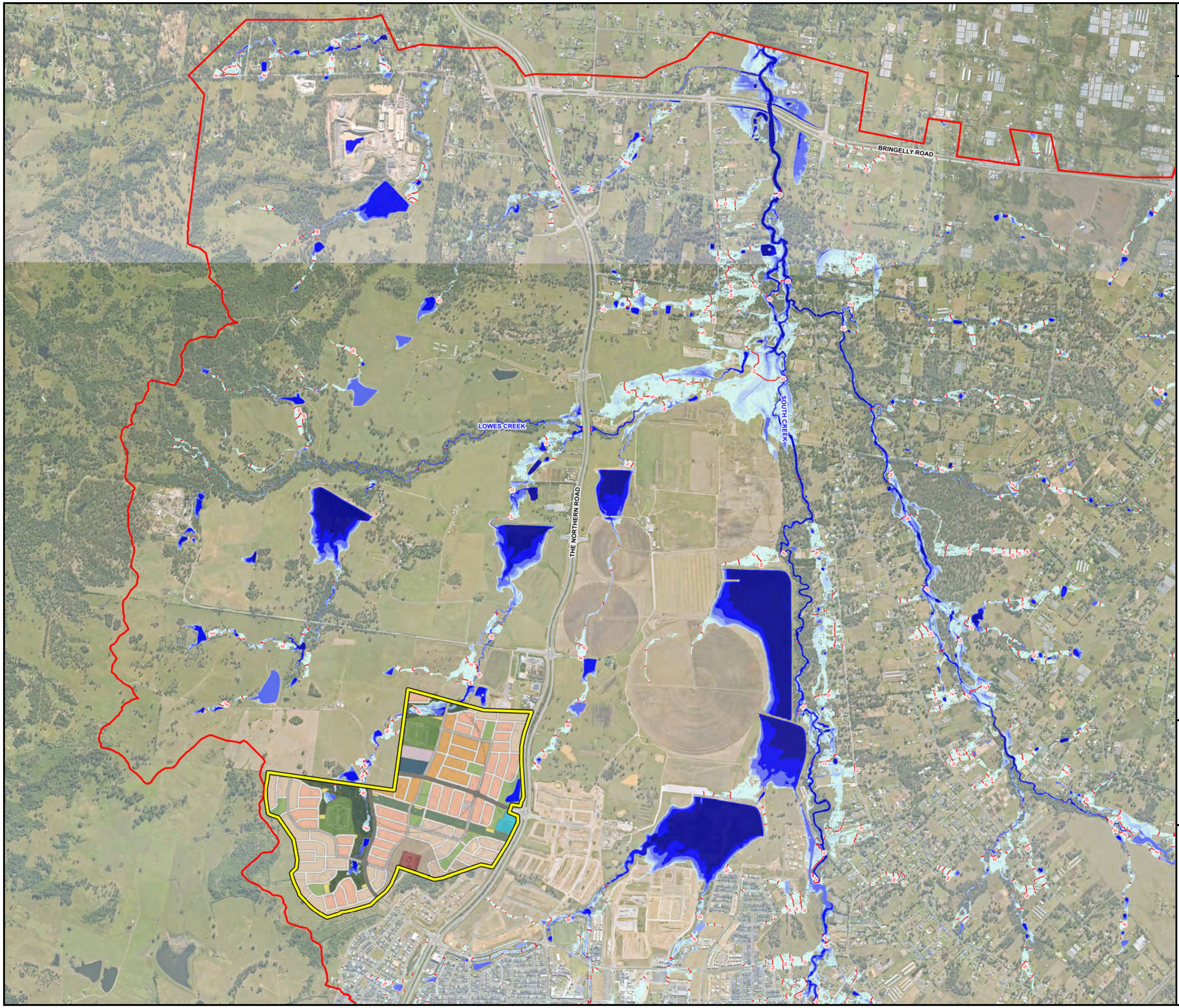
Figure 7-05

South Creek West
Cobbitty Sub-Precinct 5

50% AEP
Existing Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: D

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-05_EX13_50pc_DEP_D.wor



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LEGEND

FLOOD DEPTH (m)

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

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

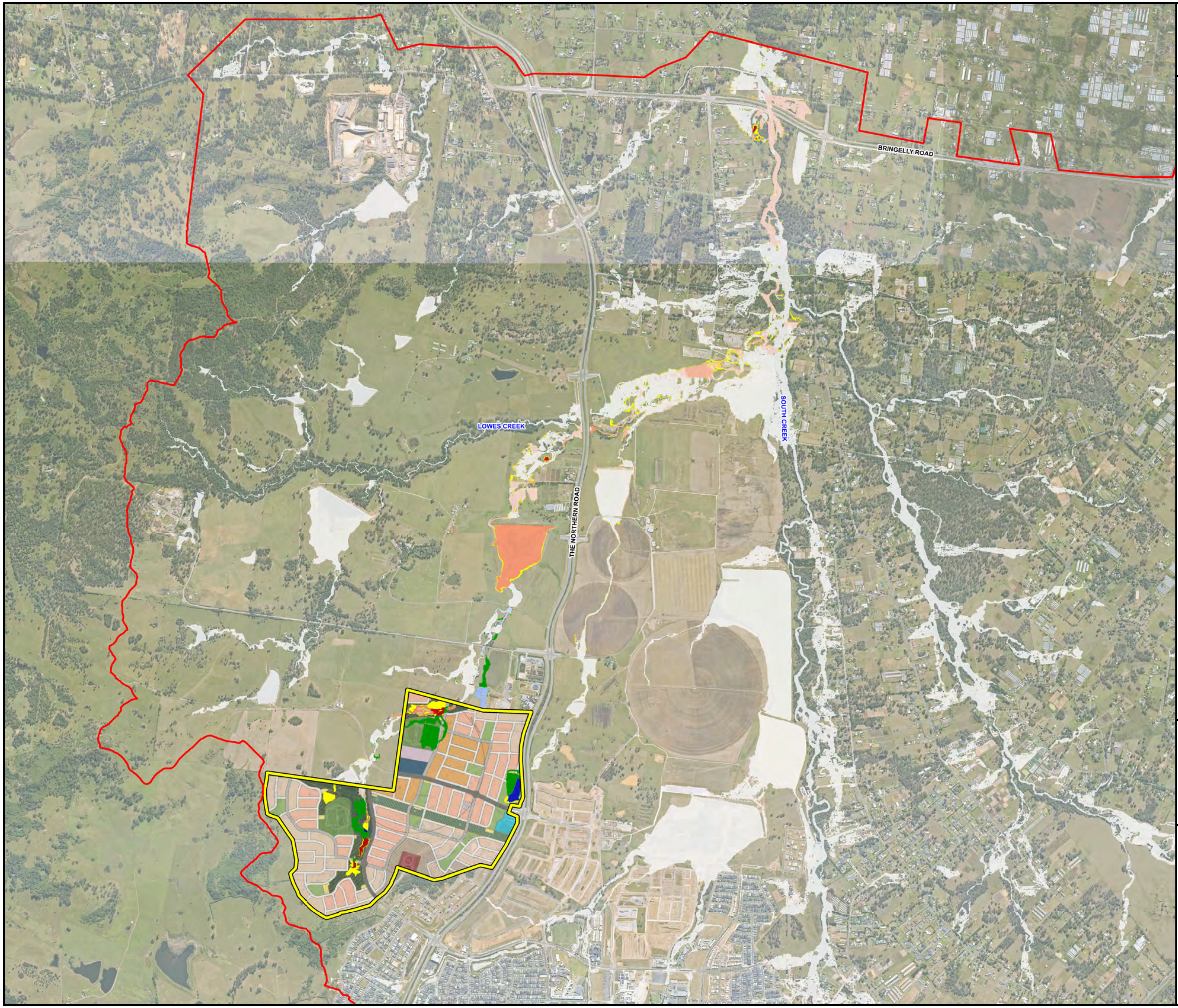
Figure 7-06

South Creek West Cobbitty Sub-Precinct 5

50% AEP
Developed Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: F

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-06_DEV08_50pc_DEP_F.wor



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LEGEND

FLOOD DIFFERENCE (m)

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

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

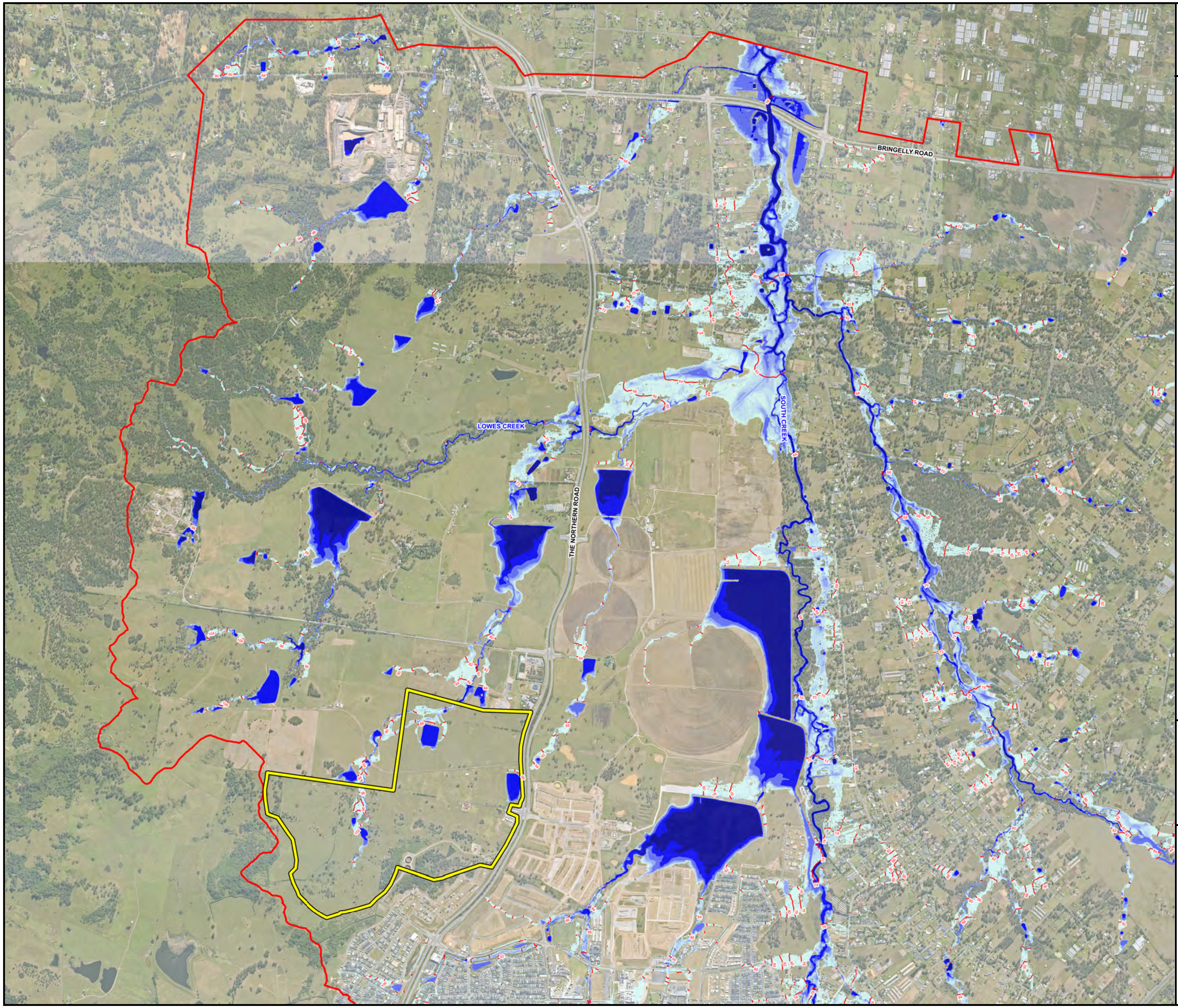
Figure 7-07

South Creek West
Cobbitty Sub-Precinct 5

50% AEP
Developed - Existing
Flood Difference

Date: 6/09/2024 Issue: F

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-07_DEV08-EX13_50pc_DIFF_F.wor



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LEGEND

FLOOD DEPTH (m)

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

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

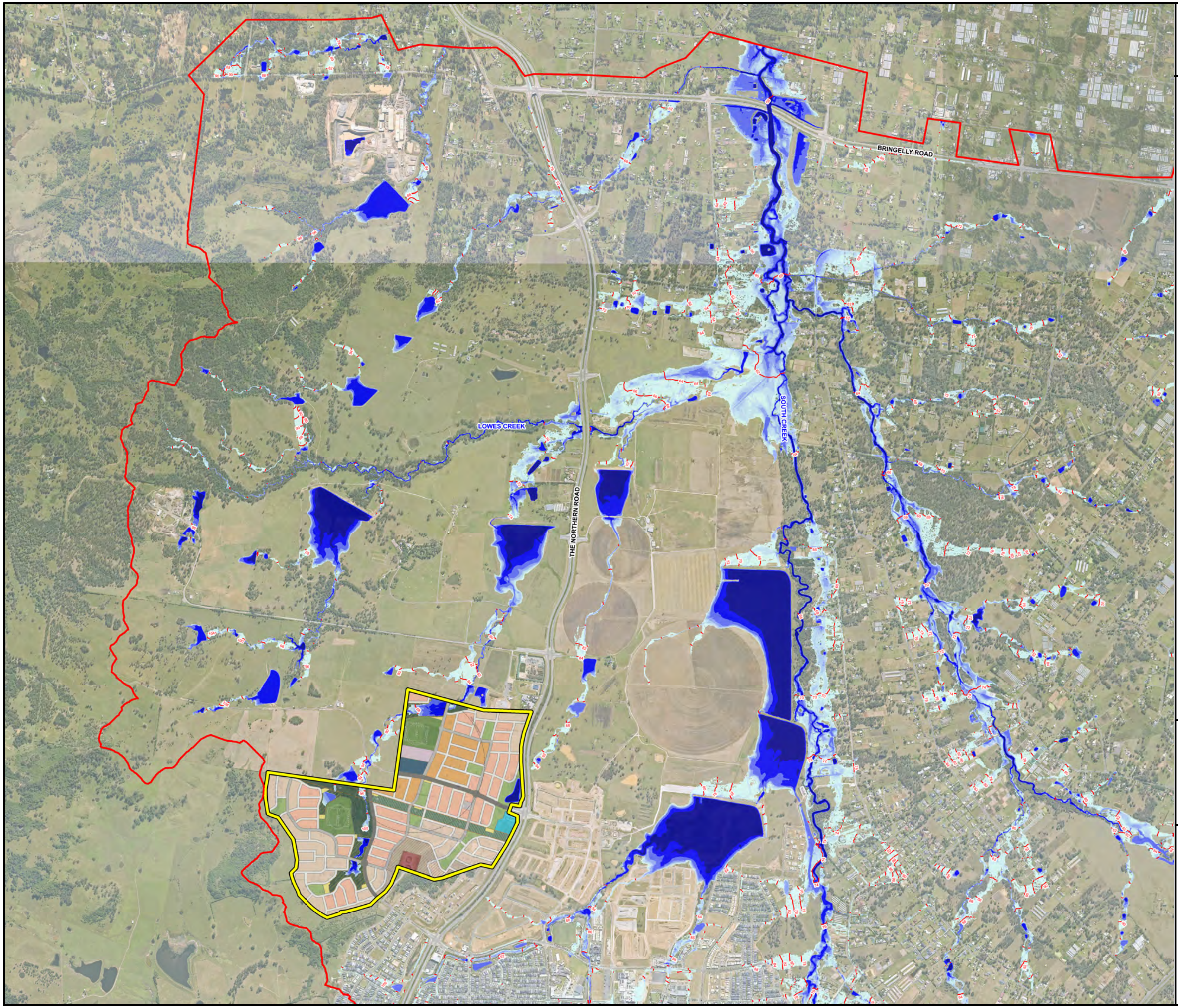
Figure 7-08

South Creek West
Cobbitty Sub-Precinct 5

20% AEP
Existing Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: D

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-08_EX13_20pc_DEP_D.wor



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LEGEND

FLOOD DEPTH (m)

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

35.0 — 2.0 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 — 1000 metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

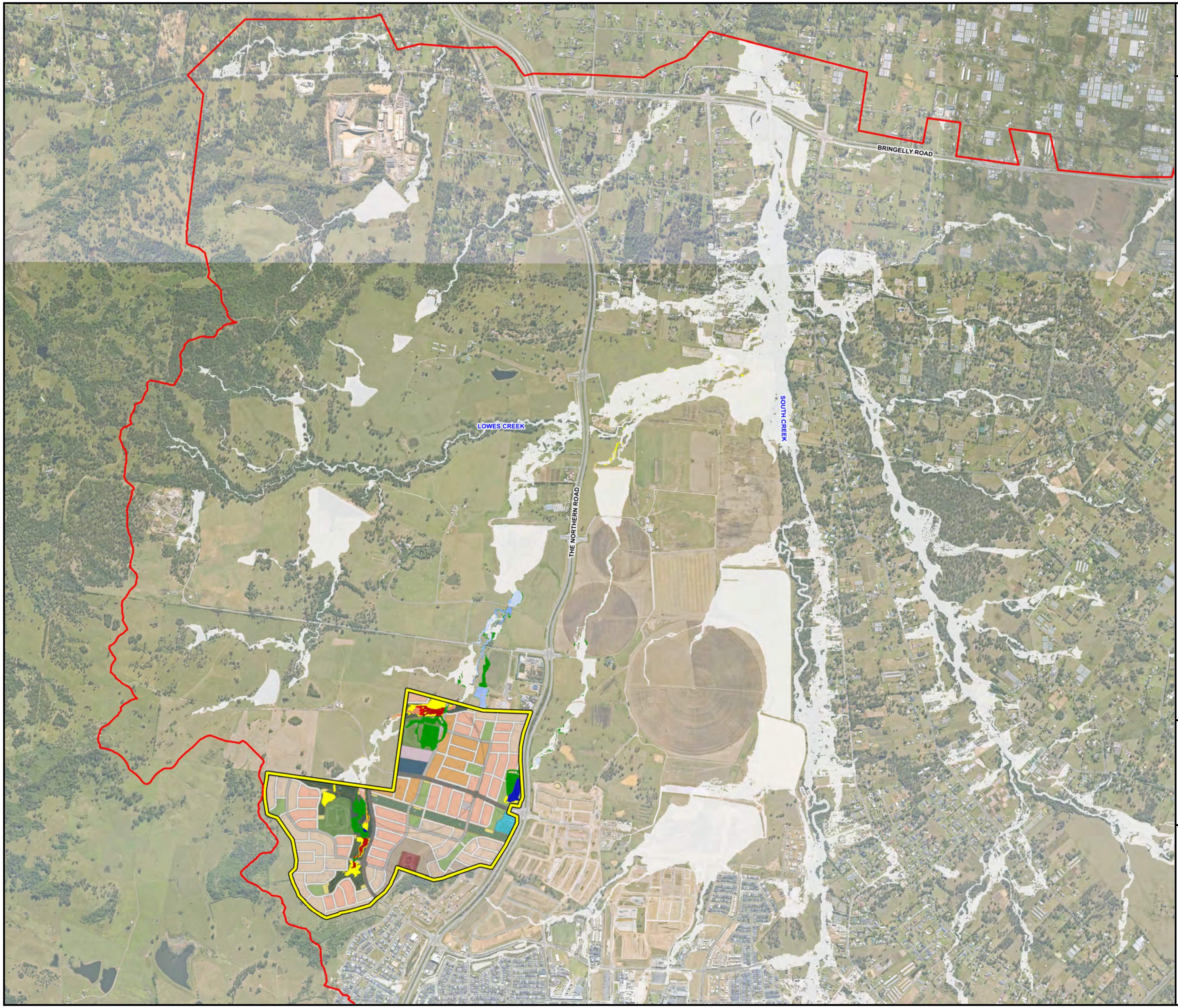
Figure 7-09

South Creek West Cobbitty Sub-Precinct 5

20% AEP
Developed Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: F

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-09_DEV08_20pc_DEP_F.wor



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LEGEND

FLOOD DIFFERENCE (m)

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

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

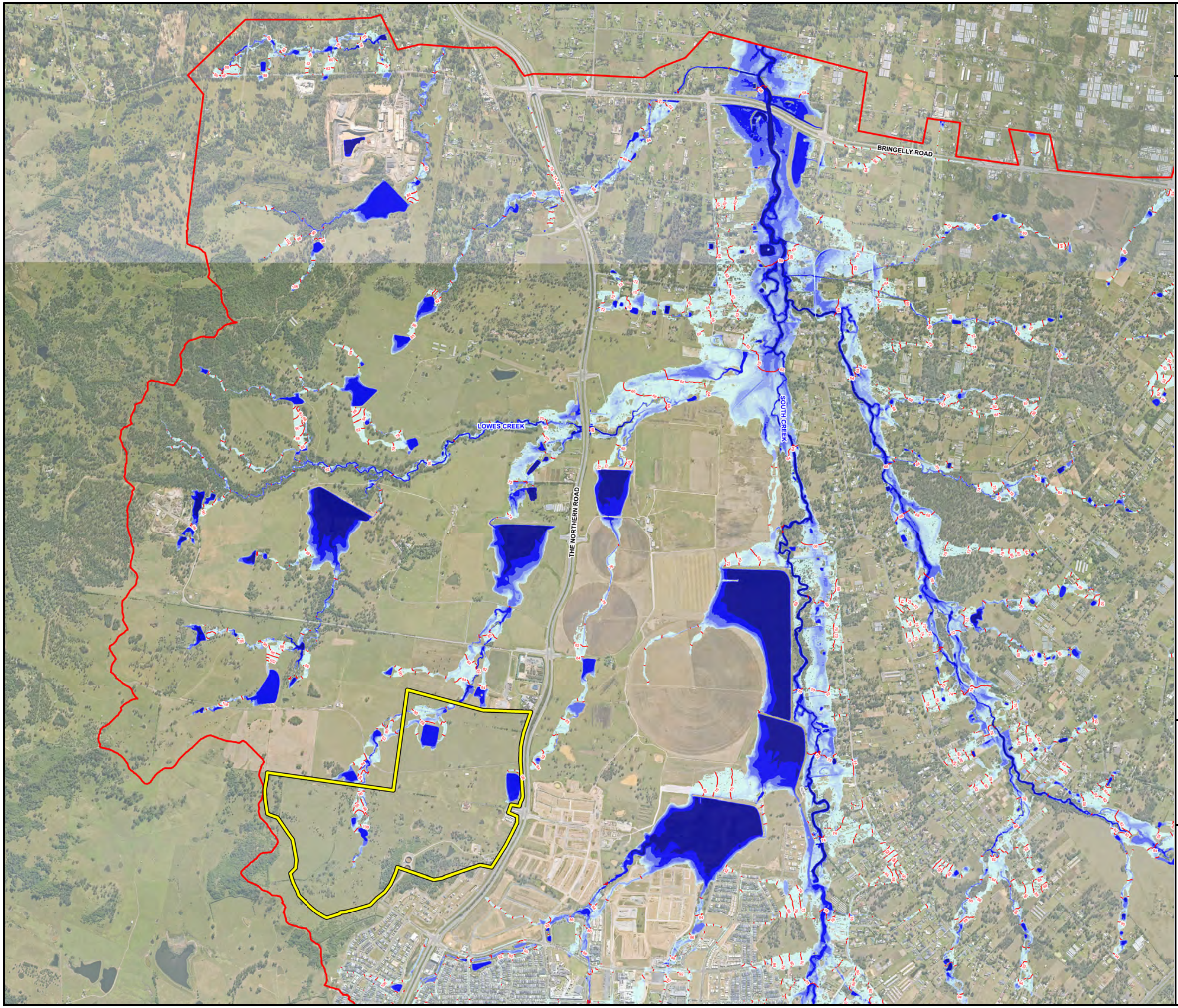
Figure 7-10

South Creek West
Cobbitty Sub-Precinct 5

20% AEP
Developed - Existing
Flood Difference

Date: 6/09/2024 Issue: F

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-10_DEV08-EX13_20pc_DIFF_F.wor



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LEGEND

FLOOD DEPTH (m)

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

N

0 — 1000 metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

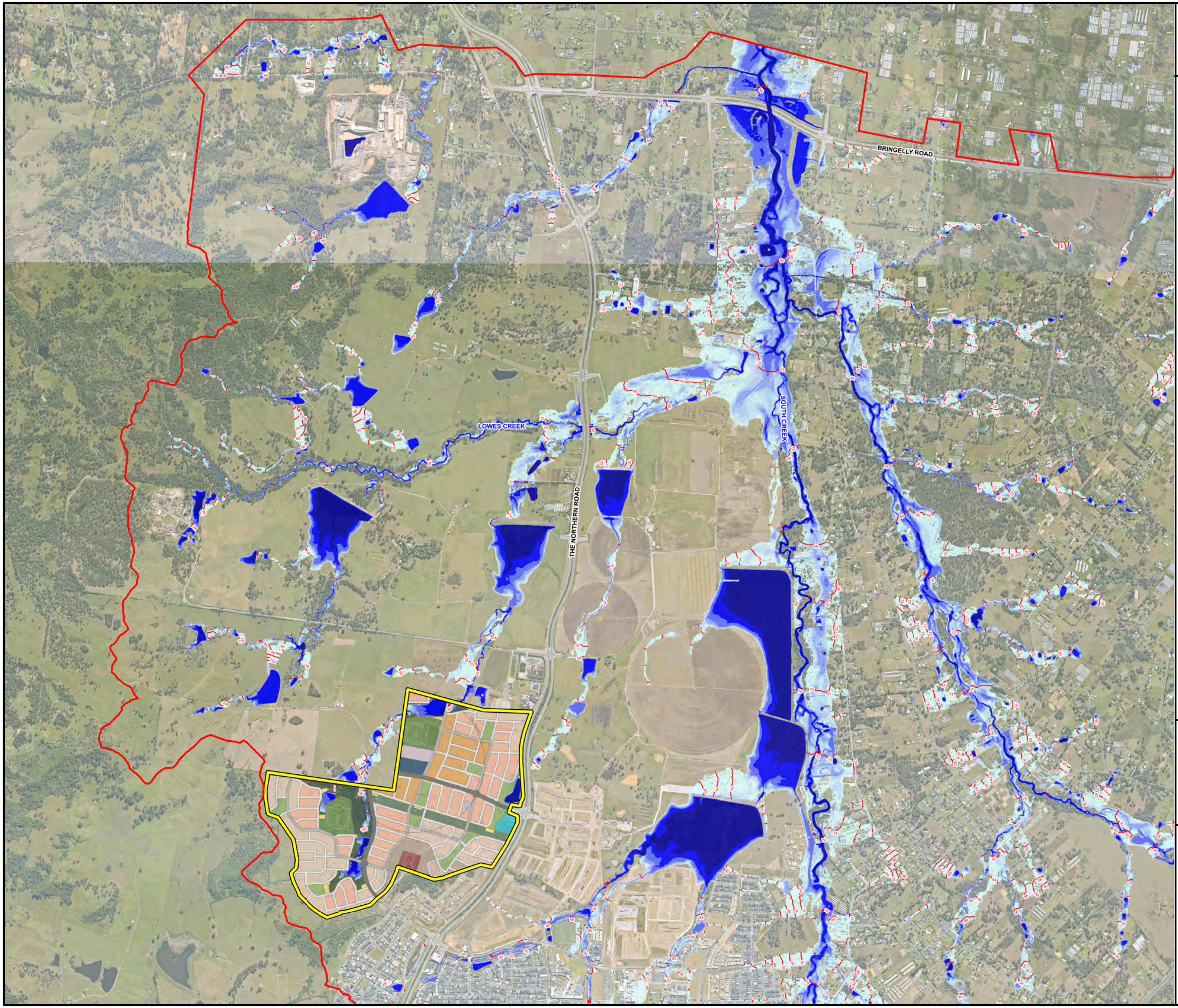
Figure 7-11

South Creek West
Cobbitty Sub-Precinct 5

5% AEP
Existing Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: D

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-11_EX13_05pc_DEP_D.wor



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LEGEND

FLOOD DEPTH (m)

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

35.0 2.0 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-12

South Creek West
Cobbitty Sub-Precinct 5

5% AEP
Developed Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: F

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-12_DEV08_05pc_DEP_F.wor

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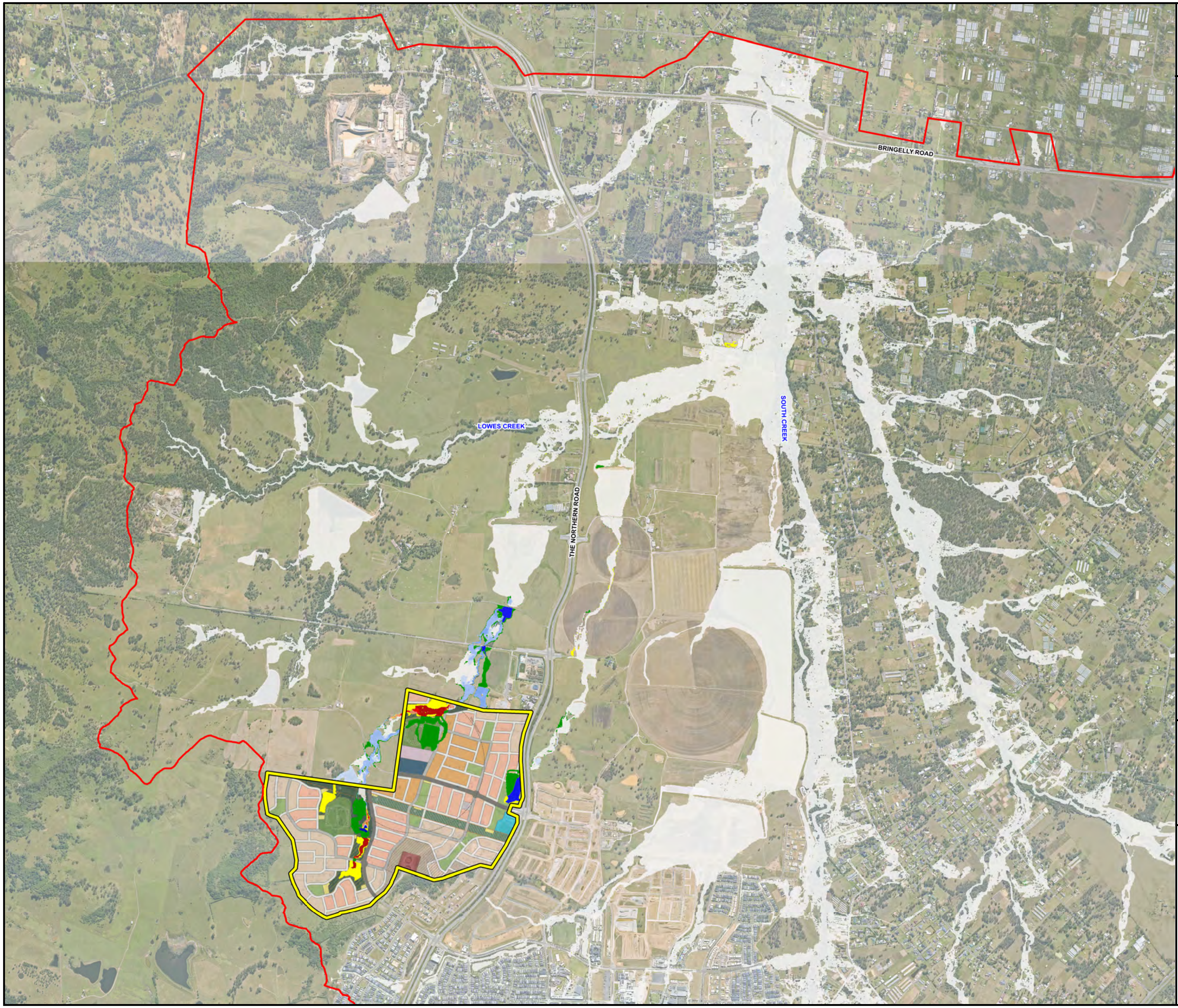

LEGEND

FLOOD DIFFERENCE (m)

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

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-13

South Creek West Cobbitty Sub-Precinct 5

5% AEP
Developed - Existing
Flood Difference

Date: 6/09/2024 Issue: F

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-13_DEV08-EX13_05pc_DIFF_F.wor

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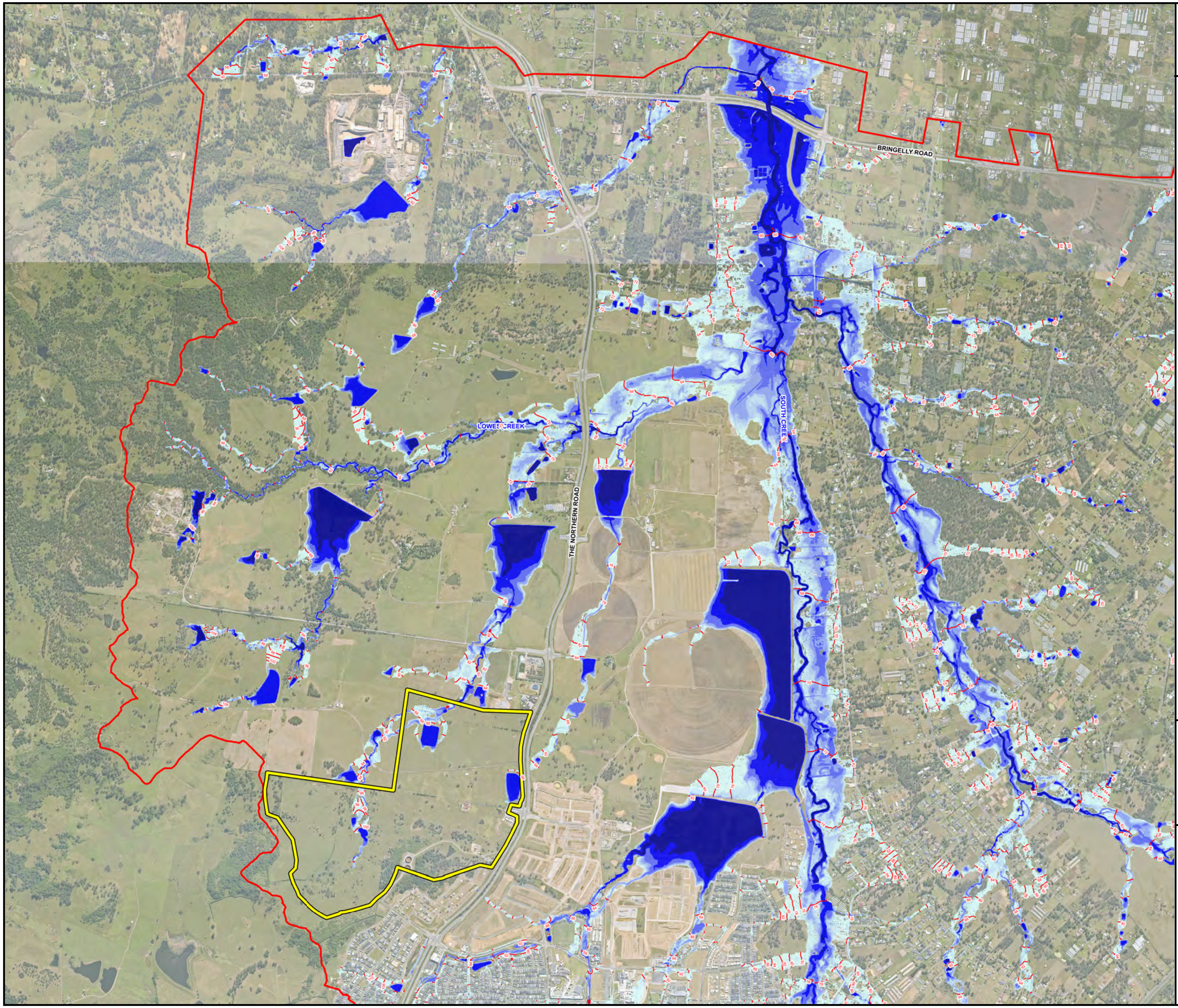

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LEGEND

FLOOD DEPTH (m)

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

N

0 1000
metres
Scale 1:25,000 @ A3

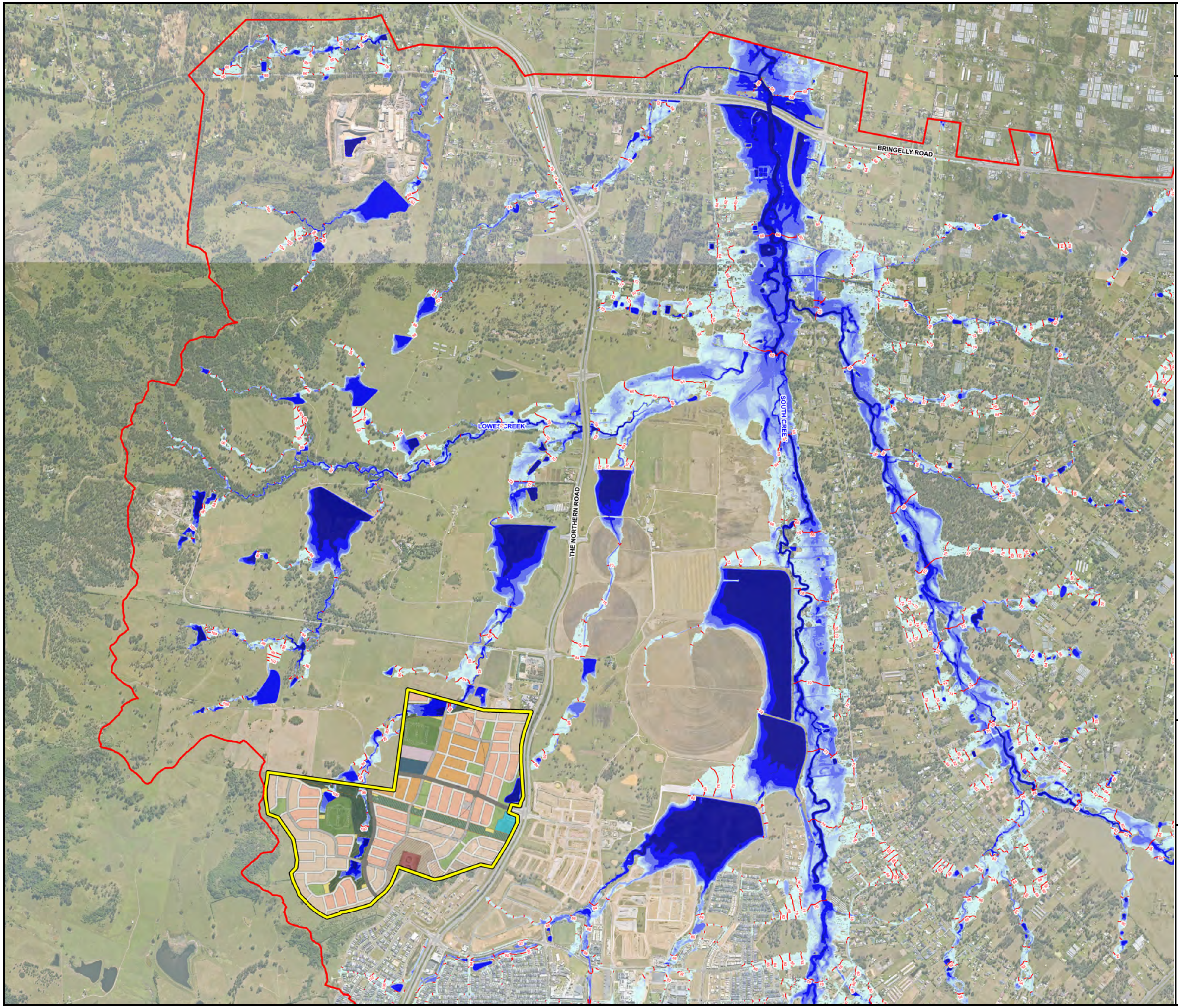
Projection: GDA 1994 MGA Zone 56

Figure 7-14

South Creek West Cobbitty Sub-Precinct 5

1% AEP
Existing Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: D



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LEGEND

FLOOD DEPTH (m)

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

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

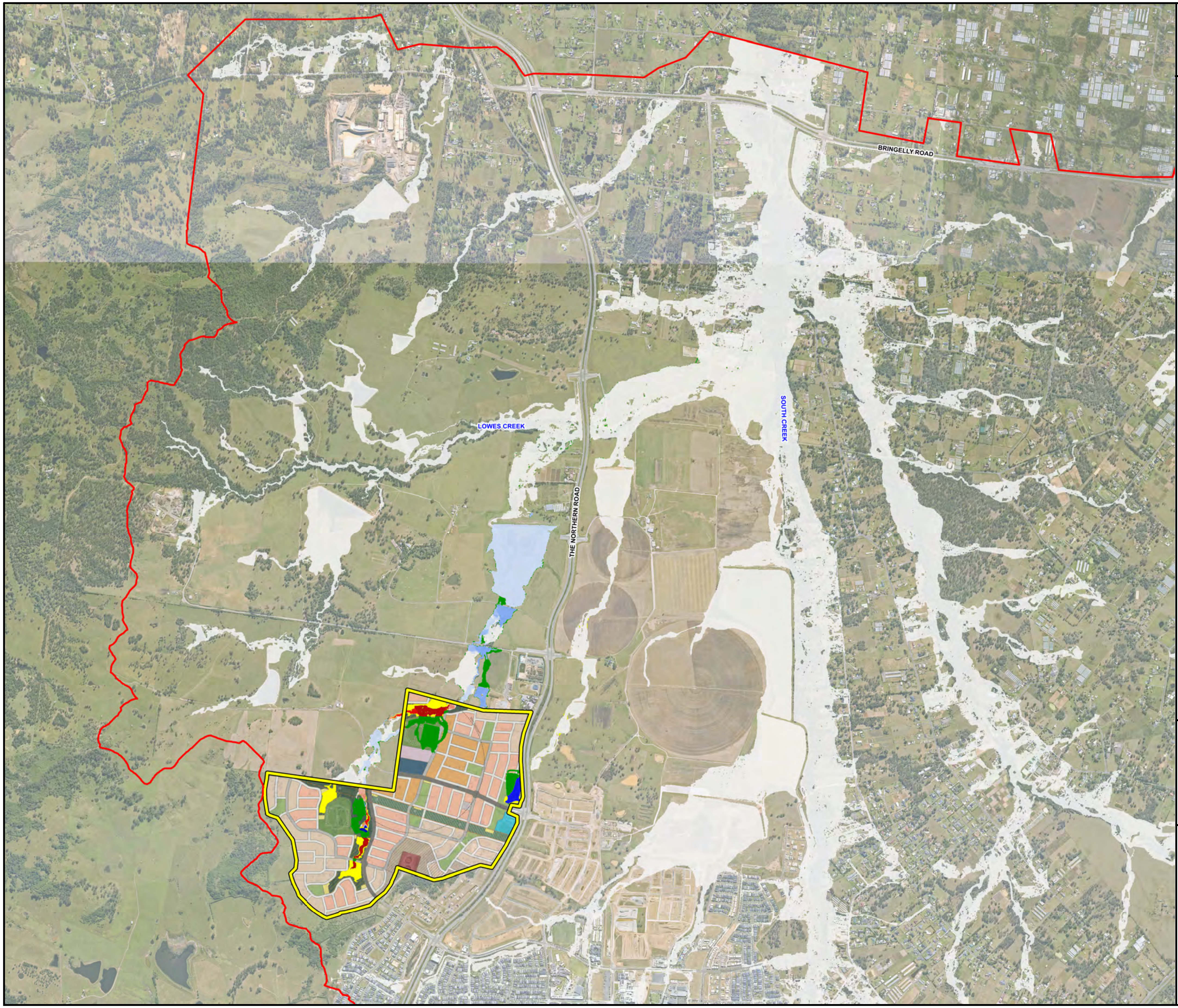
Figure 7-15

South Creek West Cobbitty Sub-Precinct 5

1% AEP
Developed Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: F

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-15_DEV08_01pc_DEP_F.wor



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LEGEND

FLOOD DIFFERENCE (m)

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

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

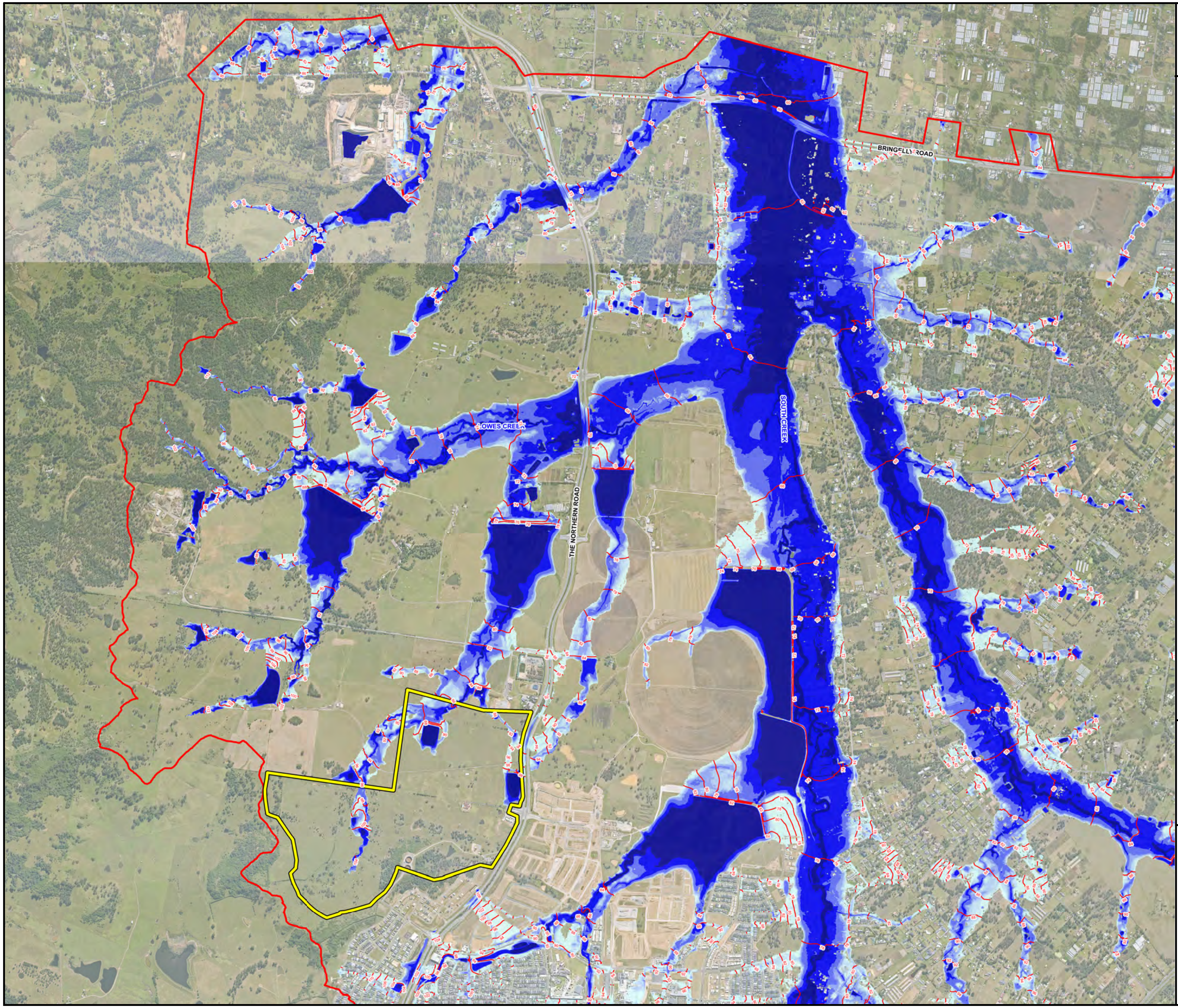
Figure 7-16

South Creek West Cobbitty Sub-Precinct 5

1% AEP
Developed - Existing
Flood Difference

Date: 6/09/2024 Issue: F

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-16_DEV08-EX13_01pc_DIFF_F.wor



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LEGEND

FLOOD DEPTH (m)

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

35.0 2.0 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-17

South Creek West
Cobbitty Sub-Precinct 5

Probable Maximum Flood
Existing Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: D

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-17_EX13_PMF_DEP_D.wor

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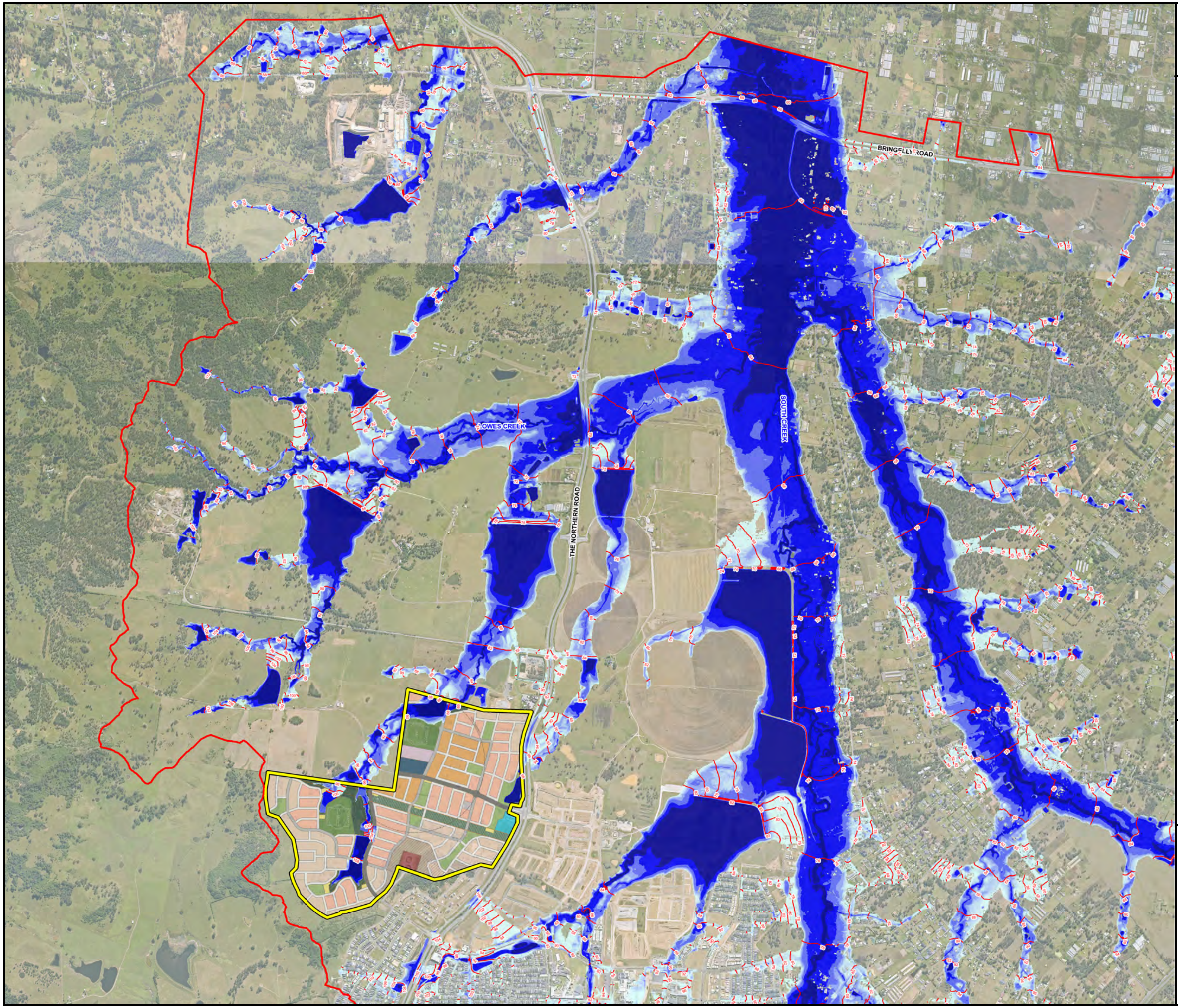

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LEGEND

FLOOD DEPTH (m)

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

N

0 1000
metres
Scale 1:25,000 @ A3

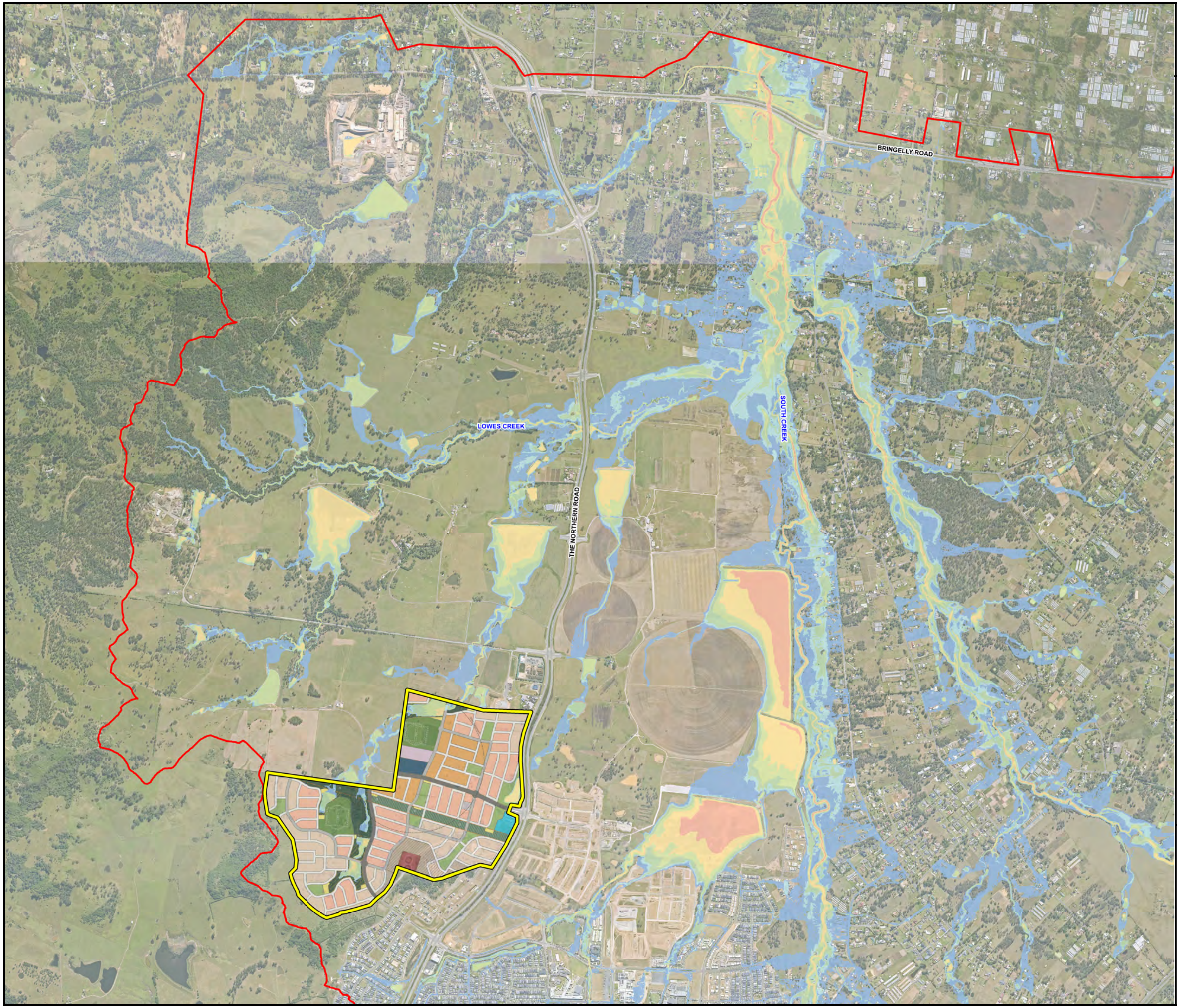
Projection: GDA 1994 MGA Zone 56

Figure 7-18

South Creek West Cobbitty Sub-Precinct 5

Probable Maximum Flood
Developed Conditions
Flood Depths and Levels

Date: 6/09/2024 Issue: E



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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 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

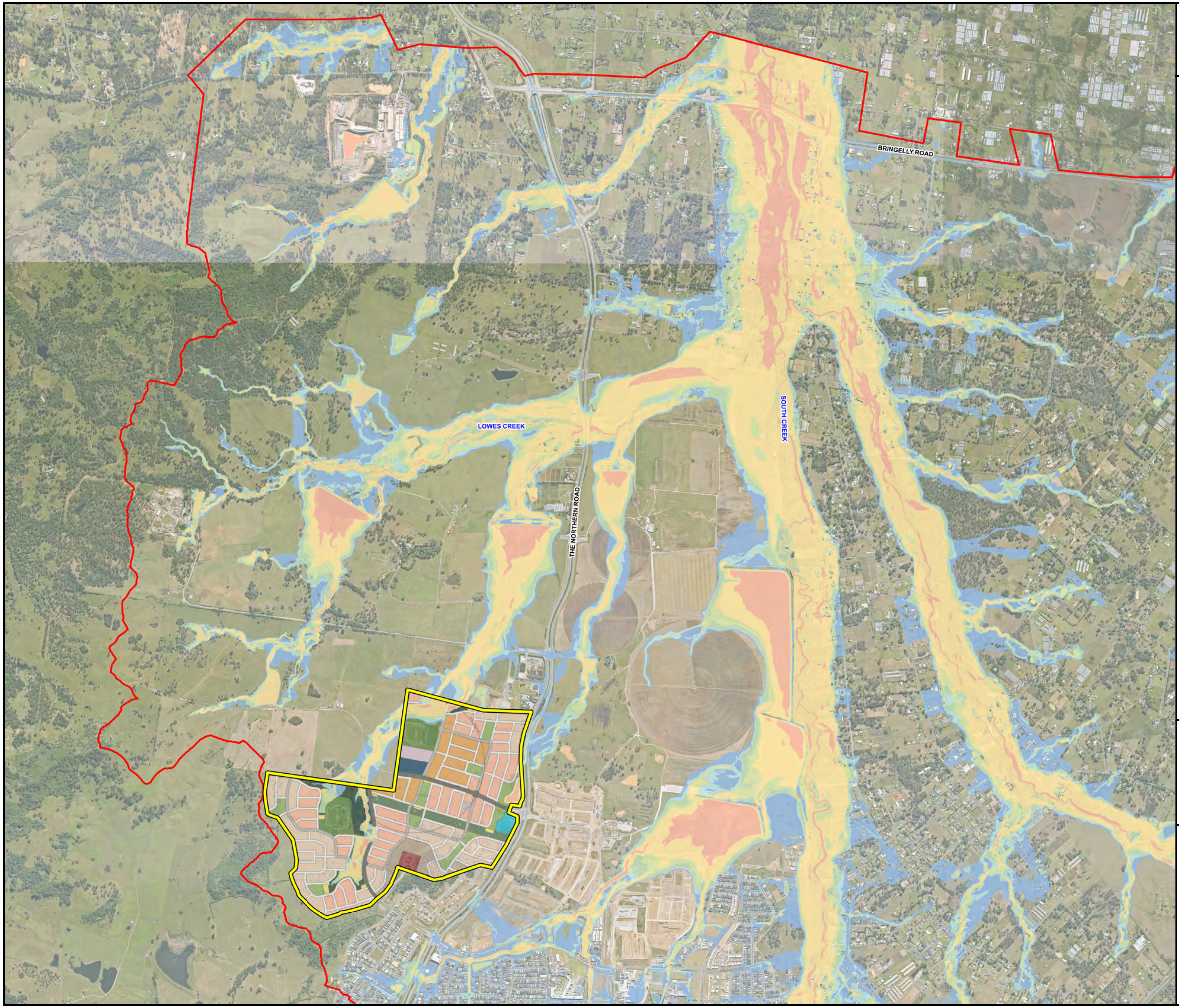
Figure 7-19

South Creek West Cobbitty Sub-Precinct 5

1% AEP Developed Conditions Flood Hazard

Date: 6/09/2024 Issue: E

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-19_DEV08_01pc_HAZ_E.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 1000
metres
Scale 1:25,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-20

South Creek West Cobbitty Sub-Precinct 5

Probable Maximum Flood
Developed Conditions
Flood Hazard

Date: 6/09/2024 Issue: E

Filename: J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-20_DEV08_PMF_HAZ_E.wor

Basin 2	Time of Inundation above RL (hrs)				
I.L. 101	101.5 m AHD	102 m AHD	102.5 m AHD	103 m AHD	103.5 m AHD
50% AEP	36.1	32.4	4.1	n/a	n/a

Existing Report (B2)	Time of Inundation above RL (hrs)
	102 m AHD
50% AEP	7.7

Basin 1	Time of Inundation above RL (hrs)				
I.L. 102.2	103 m AHD	104 m AHD	105 m AHD	106 m AHD	107 m AHD
50% AEP	26.5	23.9	12.8	2.2	n/a

Existing Report (B1)	Time of Inundation above RL (hrs)
	104 m AHD
50% AEP	3.2

Filename: "J:\110628 - SC West Precinct02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-21_TOI_50pc_B1B2.wor"

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LEGEND

Time of Inundation (hrs)

- 0 - 3 Hours
- 3 - 6 Hours
- 6 - 12 Hours
- 12 - 24 Hours
- 24 - 36 Hours
- Inundation RL Increments (refer to table)
- Existing Flood Extent
- Existing Time of Inundation Report
- Proposed Flood Extent
- Site Boundary

Note:
Flood mapping is based on the critical durations outlined in the Upper South Creek flood model user guide.

Critical durations:
50% AEP - 30, 540 and 1440 minute storms
20% AEP - 30, 540 and 1440 minute storms
1% AEP - 30, 360 and 720 minute storms

The mapped extents are the maximum time of inundation of the three (3) duration storms for each respective event.

N

0 40
metres
Scale 1:1,250 @ A3

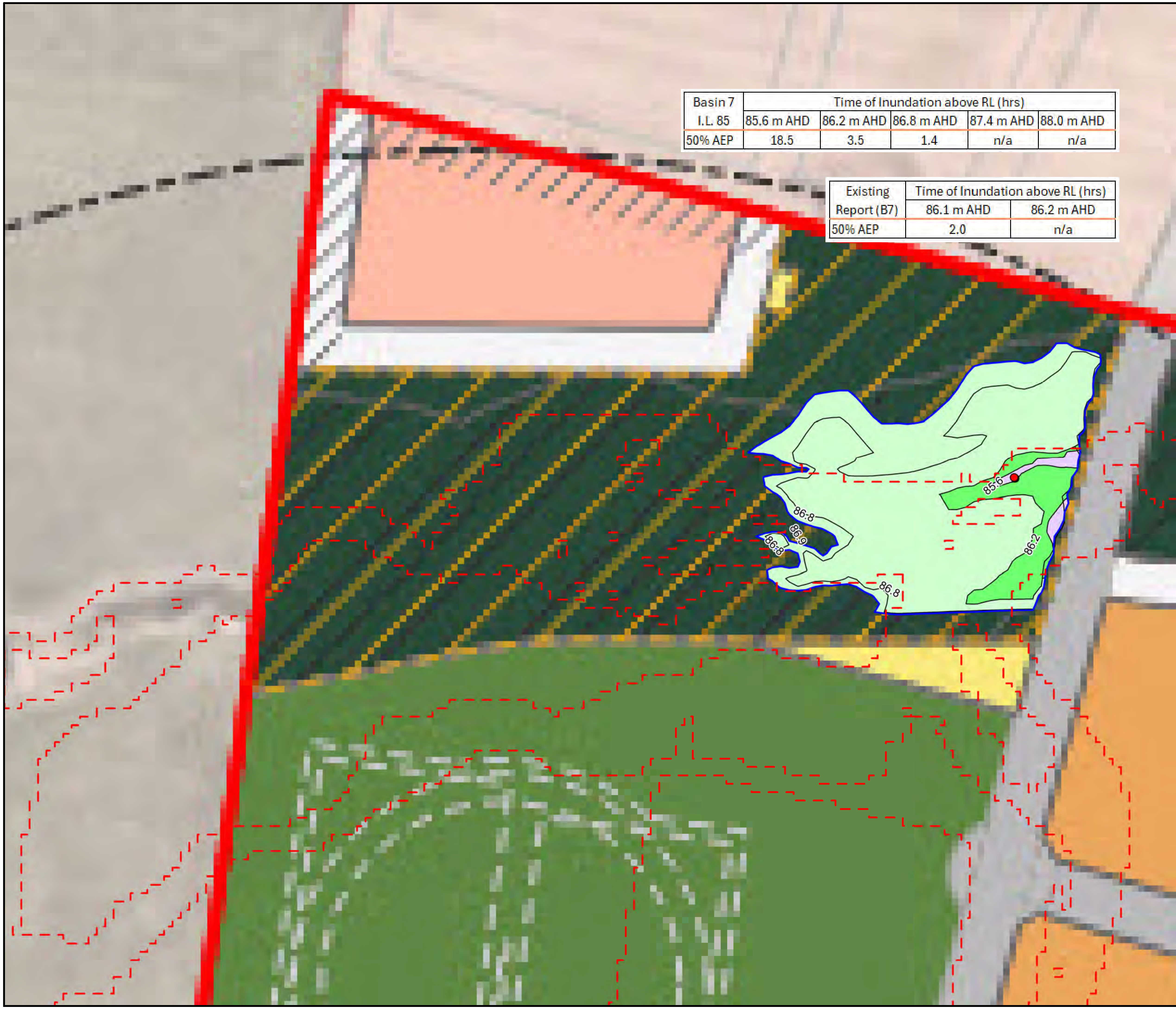
Projection: GDA 1994 MGA Zone 56

Figure 7-21

South Creek West
Cobbitty Sub-Precinct 5

50% AEP
Time of Inundation
Basin B1 and B2

Date: 13/09/2024 Issue: A



Basin 7	Time of Inundation above RL (hrs)				
I.L. 85	85.6 m AHD	86.2 m AHD	86.8 m AHD	87.4 m AHD	88.0 m AHD
50% AEP	18.5	3.5	1.4	n/a	n/a

Existing Report (B7)	Time of Inundation above RL (hrs)	
	86.1 m AHD	86.2 m AHD
50% AEP	2.0	n/a

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LEGEND

Time of Inundation (hrs)

- 0 - 3 Hours
- 3 - 6 Hours
- 6 - 12 Hours
- 12 - 24 Hours
- 24 - 36 Hours
- Inundation RL Increments (refer to table)
- Existing Flood Extent
- Existing Time of Inundation Report
- Proposed Flood Extent
- Site Boundary

Note:
Flood mapping is based on the critical durations outlined in the Upper South Creek flood model user guide.

Critical durations:
50% AEP - 30, 540 and 1440 minute storms
20% AEP - 30, 540 and 1440 minute storms
1% AEP - 30, 360 and 720 minute storms

The mapped extents are the maximum time of inundation of the three (3) duration storms for each respective event.

N

0 40
metres
Scale 1:1,250 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-22

South Creek West Cobbitty Sub-Precinct 5

50% AEP
Time of Inundation
Basin B7

Date: 13/09/2024 Issue: A

Filename: "J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-22_TOI_50pc_B7.wor"

Basin 2	Time of Inundation above RL (hrs)				
I.L. 101	101.5 m AHD	102 m AHD	102.5 m AHD	103 m AHD	103.5 m AHD
20% AEP	36.4	32.8	9.4	3.8	n/a

Existing Report (B2)	Time of Inundation above RL (hrs)
	102 m AHD
20% AEP	15.0

Basin 1	Time of Inundation above RL (hrs)				
I.L. 102.2	103 m AHD	104 m AHD	105 m AHD	106 m AHD	107 m AHD
20% AEP	28.5	28.3	26.6	5.2	n/a

Existing Report (B1)	Time of Inundation above RL (hrs)
	104 m AHD
20% AEP	7.6

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LEGEND

Time of Inundation (hrs)

- 0 - 3 Hours
- 3 - 6 Hours
- 6 - 12 Hours
- 12 - 24 Hours
- 24 - 36 Hours
- Inundation RL Increments (refer to table)
- Existing Flood Extent
- Existing Time of Inundation Report
- Proposed Flood Extent
- Site Boundary

Note:
Flood mapping is based on the critical durations outlined in the Upper South Creek flood model user guide.

Critical durations:
50% AEP - 30, 540 and 1440 minute storms
20% AEP - 30, 540 and 1440 minute storms
1% AEP - 30, 360 and 720 minute storms

The mapped extents are the maximum time of inundation of the three (3) duration storms for each respective event.

N

0 40
metres
Scale 1:1,250 @ A3

Projection: GDA 1994 MGA Zone 56

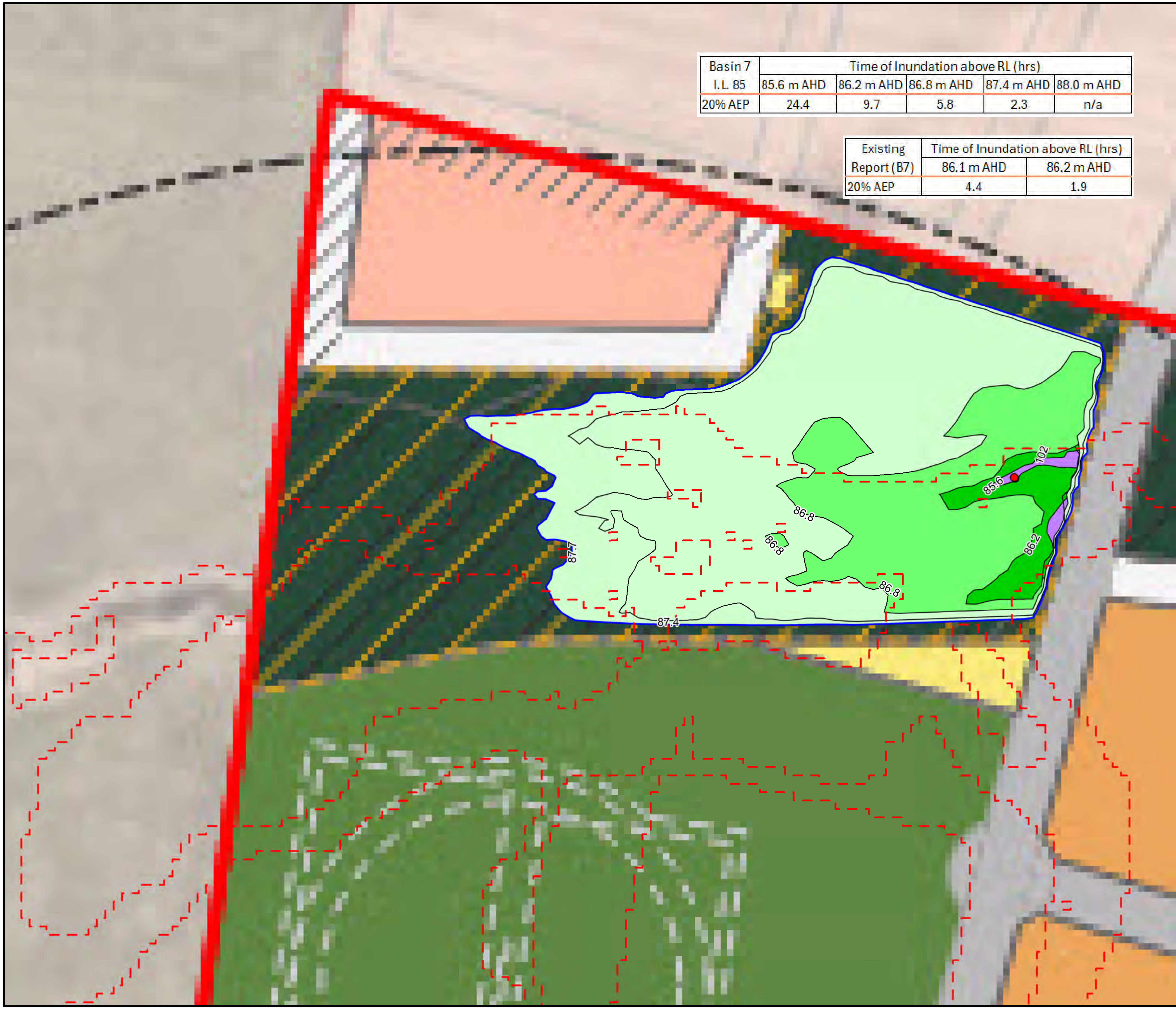
Figure 7-23

South Creek West
Cobbitty Sub-Precinct 5

20% AEP
Time of Inundation
Basin B1 and B2

Date: 13/09/2024 Issue: A

Filename: "J:\110628 - SC West Precinct02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-23_TOI_20pc_B1B2.wor"



Basin 7	Time of Inundation above RL (hrs)				
I.L. 85	85.6 m AHD	86.2 m AHD	86.8 m AHD	87.4 m AHD	88.0 m AHD
20% AEP	24.4	9.7	5.8	2.3	n/a

Existing	Time of Inundation above RL (hrs)	
Report (B7)	86.1 m AHD	86.2 m AHD
20% AEP	4.4	1.9

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& PROJECT MANAGERS

LEGEND

Time of Inundation (hrs)

- 0 - 3 Hours
- 3 - 6 Hours
- 6 - 12 Hours
- 12 - 24 Hours
- 24 - 36 Hours
- Inundation RL Increments (refer to table)
- Existing Flood Extent
- Existing Time of Inundation Report
- Proposed Flood Extent
- Site Boundary

Note:
Flood mapping is based on the critical durations outlined in the Upper South Creek flood model user guide.

Critical durations:
50% AEP - 30, 540 and 1440 minute storms
20% AEP - 30, 540 and 1440 minute storms
1% AEP - 30, 360 and 720 minute storms

The mapped extents are the maximum time of inundation of the three (3) duration storms for each respective event.

N

0 40
metres
Scale 1:1,250 @ A3

Projection: GDA 1994 MGA Zone 56

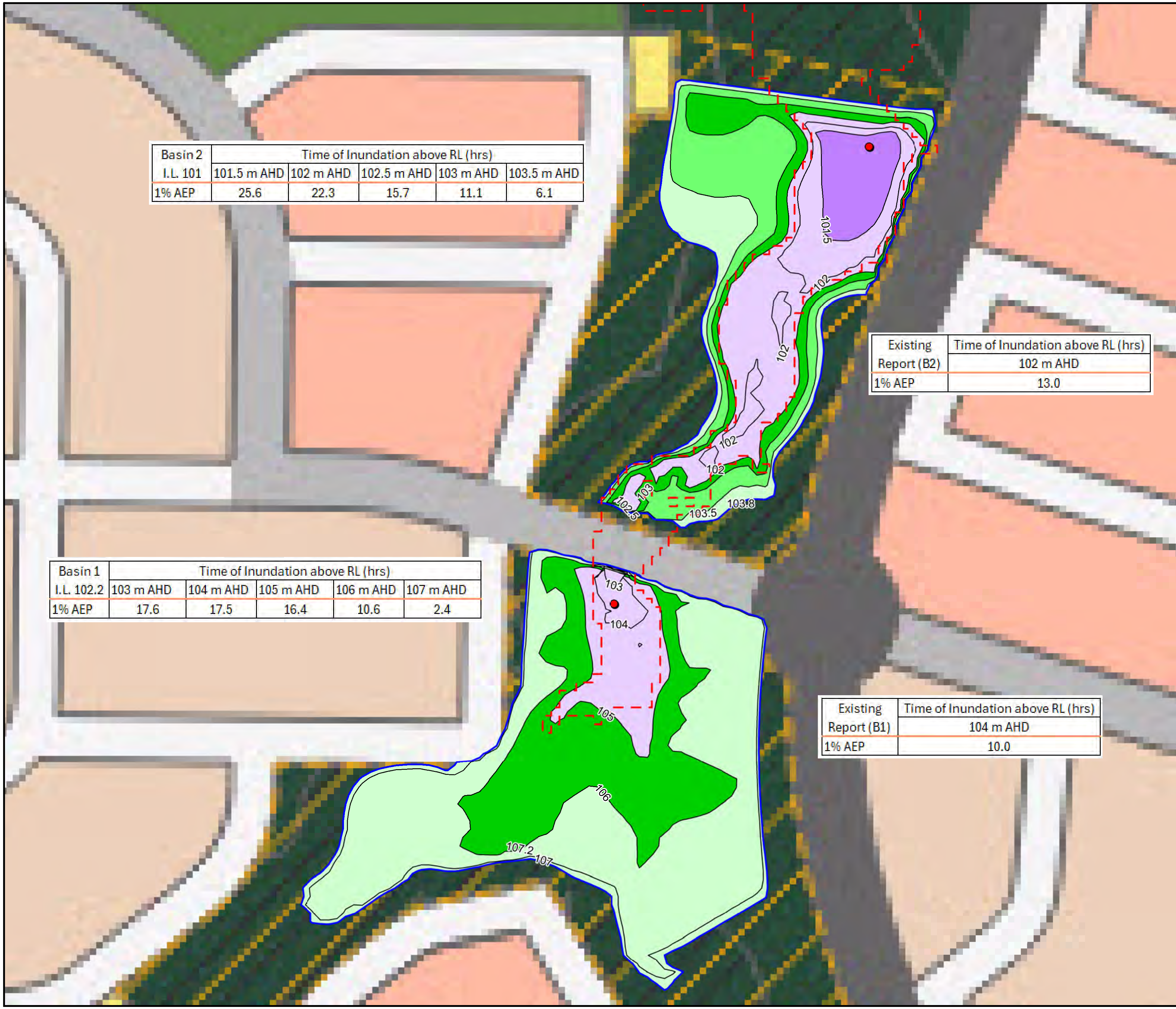
Figure 7-24

South Creek West
Cobbitty Sub-Precinct 5

20% AEP
Time of Inundation
Basin B7

Date: 13/09/2024 Issue: A

Filename: "J:\110628 - SC West Precinct02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-24_TOI_20pc_B7.wor"



Basin 2	Time of Inundation above RL (hrs)				
I.L. 101	101.5 m AHD	102 m AHD	102.5 m AHD	103 m AHD	103.5 m AHD
1% AEP	25.6	22.3	15.7	11.1	6.1

Existing Report (B2)	Time of Inundation above RL (hrs)
	102 m AHD
1% AEP	13.0

Basin 1	Time of Inundation above RL (hrs)				
I.L. 102.2	103 m AHD	104 m AHD	105 m AHD	106 m AHD	107 m AHD
1% AEP	17.6	17.5	16.4	10.6	2.4

Existing Report (B1)	Time of Inundation above RL (hrs)
	104 m AHD
1% AEP	10.0

Filename: "J:\110628 - SC West Precinct02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-25_TOI_1pc_B1B2.wor"

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LEGEND

Time of Inundation (hrs)

- 0 - 3 Hours
- 3 - 6 Hours
- 6 - 12 Hours
- 12 - 24 Hours
- 24 - 36 Hours
- Inundation RL Increments (refer to table)
- Existing Flood Extent
- Existing Time of Inundation Report
- Proposed Flood Extent
- Site Boundary

Note:
Flood mapping is based on the critical durations outlined in the Upper South Creek flood model user guide.

Critical durations:
50% AEP - 30, 540 and 1440 minute storms
20% AEP - 30, 540 and 1440 minute storms
1% AEP - 30, 360 and 720 minute storms

The mapped extents are the maximum time of inundation of the three (3) duration storms for each respective event.

N

0 40 metres
Scale 1:1,250 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-25

South Creek West Cobbitty Sub-Precinct 5

1% AEP
Time of Inundation
Basin B1 and B2

Date: 13/09/2024 Issue: A

Basin 7	Time of Inundation above RL (hrs)				
I.L. 85	85.6 m AHD	86.2 m AHD	86.8 m AHD	87.4 m AHD	88.0 m AHD
1% AEP	16.4	15.7	13.9	10.9	5.2

Existing	Time of Inundation above RL (hrs)	
Report (B7)	86.1 m AHD	86.2 m AHD
1% AEP	11.0	9.0

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LEGEND

Time of Inundation (hrs)

- 0 - 3 Hours
- 3 - 6 Hours
- 6 - 12 Hours
- 12 - 24 Hours
- 24 - 36 Hours
- Inundation RL Increments (refer to table)
- Existing Flood Extent
- Existing Time of Inundation Report
- Proposed Flood Extent
- Site Boundary

Note:
Flood mapping is based on the critical durations outlined in the Upper South Creek flood model user guide.

Critical durations:
50% AEP - 30, 540 and 1440 minute storms
20% AEP - 30, 540 and 1440 minute storms
1% AEP - 30, 360 and 720 minute storms

The mapped extents are the maximum time of inundation of the three (3) duration storms for each respective event.

N
0 40
metres
Scale 1:1,250 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-26

South Creek West
Cobbitty Sub-Precinct 5

1% AEP
Time of Inundation
Basin B7

Date: 13/09/2024 Issue: A

Filename: "J:\110628 - SC West Precinct\02 -SW PC\SW&E\MapInfo\Figures\Report Rev F\110628-02_Fig7-26_TOI_1pc_B7.wor"

APPENDIX D – MUSIC MODEL DATA

Modelling Inputs and Assumptions

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

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

Water Quality Management Measures

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

Rainwater Tank

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

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

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

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

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

Gross Pollutant Traps

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

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

Table C-1 – GPT Input Parameters

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

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

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

Bioretention Raingarden

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

Table C-2 – Bioretention Raingarden Input Parameters

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

Treatment Pond

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

Table C-3 – Bioretention Raingarden Input Parameters

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

On-lot Treatment

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

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

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

MUSIC MODELLING WORKSHEET
South Creek West - Bringelly Precinct Rezoning Assessment

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

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

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

Input
MUSIC Input

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

APPENDIX E –MUSIC-LINK REPORT

MUSIC-*link* Report

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

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

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

Comments

Passing Parameters

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

Only certain parameters are reported when they pass validation

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

Only certain parameters are reported when they pass validation

Native Vegetation Protection Map

COBBITTY

NORTH

40 0 80 160 240 320 400 metres

Ref: BHLCO-13-007a-2	Date: 23/09/2024	Revision: B	Scale: 1:4,000@A1

Note: All areas and dimensions subject to detailed survey

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Riparian Protection Area Map

COBBITTY

Ref: BHLCO-13-005a-2 | Date: 20/09/2024 | Revision: B | Scale: 1:4,000@A1

Note: All areas and dimensions subject to detailed survey

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