

Civil, Flooding and Stormwater

Macquarie Park Innovation Precinct

Prepared for Department of Planning and Environment / 6 October 2023

221883

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1.0 Executive Summary

Taylor Thomson Whitting (TTW) have been engaged by the Department of Planning and Environment (DPE) to offer civil engineering and flooding advice for a proposed master plan covering the Macquarie Park Innovation Precinct (MPIP). The MPIP site is bounded by the M2 Motorway to the north and east, Epping Road to the south, and Shrimptons Creek to the west. The site area is approximately 185 hectares and mostly developed with B3, B7 and RE1 zoning classification.



Figure 1.1: Site Map

This report will cover existing flood conditions, opportunities for the provision of watercourse restoration options including water quantity and quality devices, as well as the realignment of existing road networks and pedestrian pathways. Detailed flood planning levels for a range of development types have also been summarised per requirements outlined by City of Ryde Council within their Development Control Plan (DCP) 2014. Information provided in this report aligns with the Macquarie Park Innovation Precinct's Place Strategy (August 2022) and Strategic Infrastructure and Services Assessment (September 2022).

1.1 Summary of Key Recommendations

In developing this report, it has been identified that master planning of the Macquarie Park Innovation Precinct will be defined by the following civil design considerations.

- Introduction of precinct wide green spacing Water Sensitive Urban Design (WSUD) principles including a substantial increase to deep zone planting and existing tree canopy of proposed streetscapes.
- Integration of a 20.0m Riparian zone and associated WSUD solutions surrounding the existing Shrimptons Creek perennial stream.
- Implementation of deep planting and bioretention waterfeatures associated with the developed gullies and creek areas of Industrial Creek and Porters Creek to alleviate flooding extents generated during the 1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) events.
- Flood Planning Levels (FPL) are to be taken as the 1% AEP and associated with an applicable freeboard as defined by City of Ryde Council in the DCP (2014) and associated Stormwater Technical Manual (2014).
- Additionally, Critical and Sensitive Uses and Facilities as well as entrance to carparking below the surrounding FPL will instead require an FPL or protection against the PMF flood level. A summary of variable Flood Planning Levels for specific development types is further discussed in Section 4.0 of this report.
- Roadways and pedestrian shared zones are to be designed in accordance with Council's DCP, standard drawings and Public Domain Technical Manual, Transport for NSW (TfNSW) standards, Austroads Guide to Road Design, and Australian Standard (AS) 2890.5 On-Street Parking.
- Where the realignment of existing road networks and public domain works is proposed, it is recommended that existing kerblines and alignments are maintained where applicable to reduce the impact to inground services including water, sewer, gas, electrical, and telecommunication services housed within the public domain.
- The extent and location of inground services will need to be considered prior to the integration of tree plantings or allocation of deep soil planting zones.

2.0 Existing Conditions

A Before You Dig Australia (BYDA) enquiry has been made to support the development of this master plan and ensure that the extent of known existing subterranean services have been satisfactorily identified to aid govern in future planning opportunities. Assets belonging to AARNet, Ausgrid, Aussie Broadband, City of Ryde Council, FibreconX, Jemena Gas North, NBN, Nextgen, Optus, Superloop, Sydney Metro, Sydney Water, Telstra, TPG, Transgrid, TfNSW, Verizon Business, and Vocal Communications have all been identified within proximity to the proposed extent of plans.

The Sydney Metro line currently bisects the proposed study site from the south-east to the north-west and is predominantly situated beneath the existing Waterloo Road. An overview of the alignment of this system is provided in **Figure 2.1** below.



Figure 2.1: Extent of Sydney Metro Line through proposed site.

Telecommunication, sewerage, stormwater, gas, and electrical services are all prominent within the scope of works and are primarily associated within the public domain as well as existing developments. This document has been prepared in consultation with the Macquarie Park Innovation Precinct – Utilities Report prepared by Arcadis which has identified and assessed existing utility services constraints, opportunities and capacity as part of the MPIP proposal. Please refer to the Utilities Report prepared by Arcadis for information regarding existing and proposed inground service assets.

2.1 Existing Flooding Conditions

Bewsher Consulting have conducted a flood risk management study and plan on behalf of the City of Ryde Council for the Macquarie Park Catchment and summarised the outcomes in the Macquarie Park Floodplain Risk Management Study and Plan (Bewsher, 2011). As part of the study, Bewsher have developed a 2D hydraulic (TUFLOW) model for the Industrial Creek Catchment simulating the impact of different flood events. The entire study area spans 1,558 hectares and is mostly developed.

Council's 100-year Average Recurrence Interval (ARI) design rainfall information for a range of storm durations up to twelve hours were imported into DRAINS to generate the series of corresponding runoff hydrographs. Those storm durations which generated flows close to peak flow values were then imported into TUFLOW and the flood surfaces compared to determine which duration produced the highest flood levels. This exercise found that the two-hour storm was overwhelmingly the critical duration for the Mars, Shrimptons, Industrial, Porters and Lane Cove catchments while the critical storm duration for the river at and downstream of Fullers Bridge was nine hours. The flood map presented in this report is a combination of the two-hour storm flood levels along the local catchments draining to the river and the nine-hour storm levels for the river itself.

In both the 100-year ARI and PMF conditions, the site area is flood affected. Valley-like troughs drain north-east across the Macquarie Park precinct towards the Lane Cove River. In terms of the site, two major overland flow streams occur along Shrimptons Creek and near the eastern boundary starting at the intersection of Epping Road and Lane Cove Road. Overland flow is generally conveyed within the road system in most sections but does appear to get quite severe at the northern boundary.

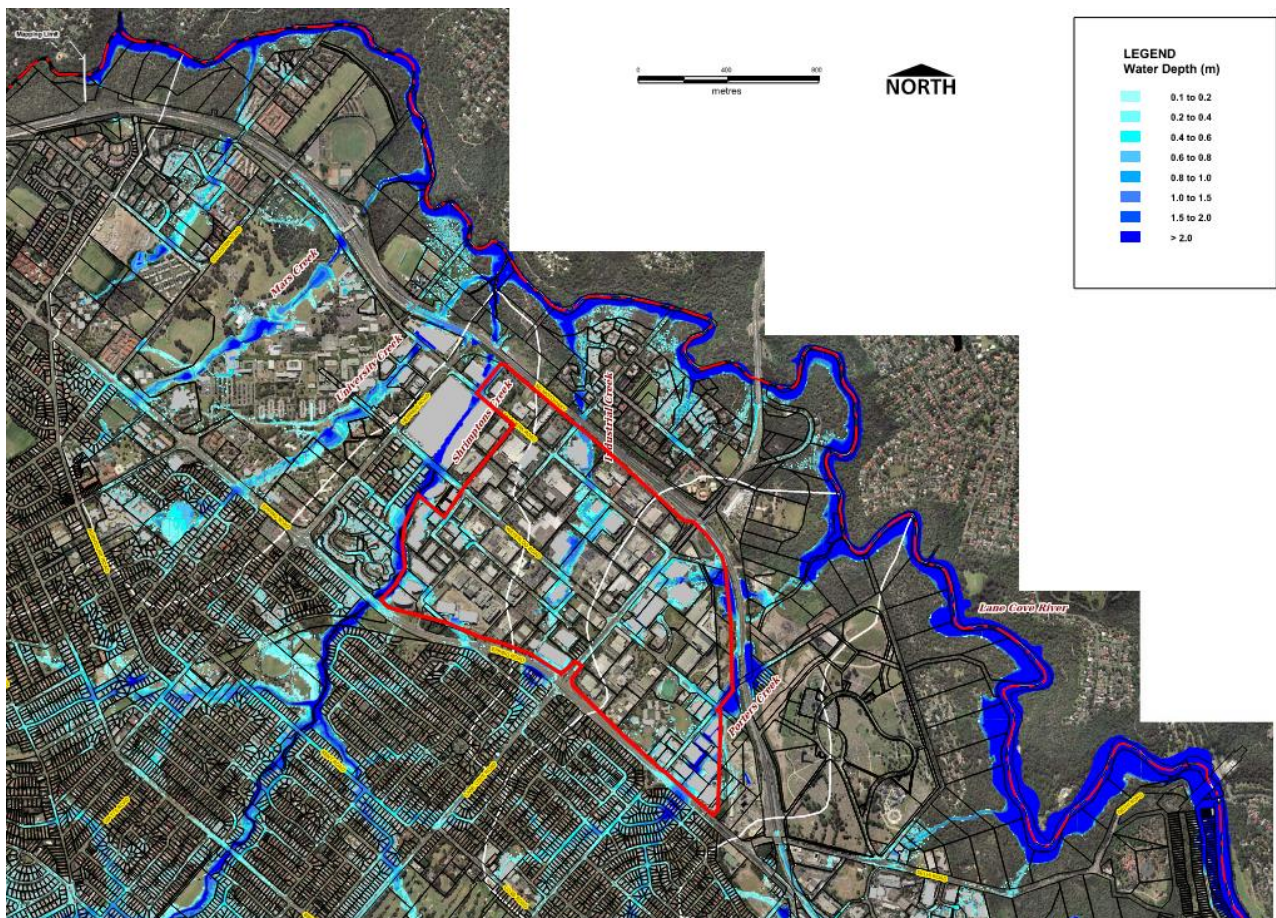


Figure 2.2: City of Ryde PMF Flood Map

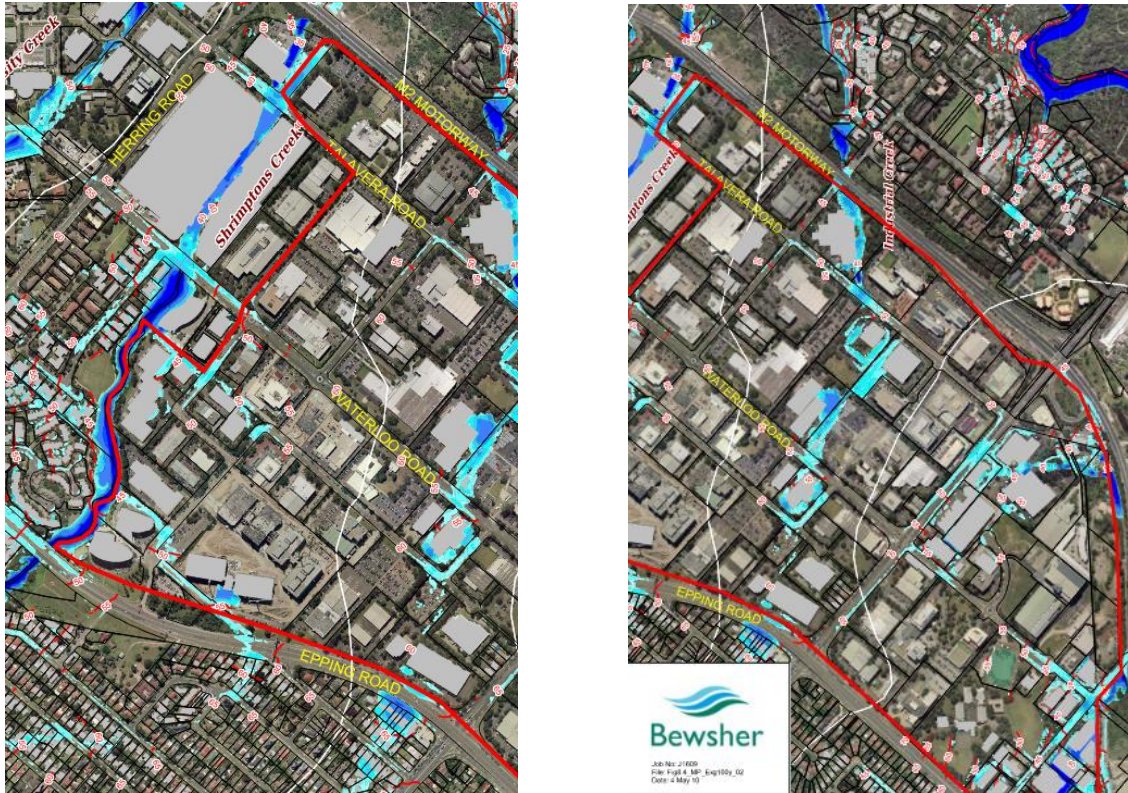


Figure 2.3: City of Ryde 100 Year ARI Flood Map

A previous stormwater and flood assessment for a nearby site shows the existing drainage pit and pipe network which overlaps with the eastern section of the current site. There is a strong correlation between the pipe network and the flood mapping indicating that inundation of the existing system is evident. Flooding from the south-east intersection of the site aligns with the direction of the pipe network.

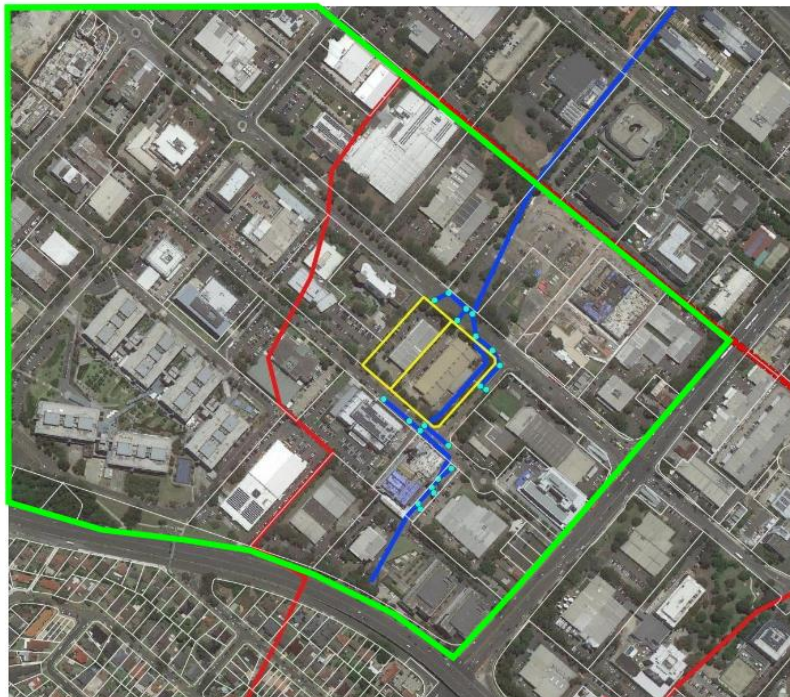


Figure 2.4: Existing Pipe Network

3.0 Public Domain Works

Master planning of the precinct involves restructuring of existing transport routes to increase user amenity and promote active transport options. Works will include integration of enhanced deep planting zones and areas, increased street planting, introduction of WSUD principles, and increased canopy cover.

3.1 Waterloo Road Green Corridor

Under existing conditions, Waterloo Road carries a high volume of traffic with limited crossing opportunities for pedestrians. There are narrowing sections of median approaching vehicular intersections with minimum planting within the public realm. Mature trees are located within the existing median and neighbouring lot boundaries. There are extensive in-ground services located within the street and public realm of Waterloo Road including electrical, telecommunications, gas, water, sewer, and stormwater lines and pits.

Development of the Waterloo Road Green Corridor will focus on the development of a green spine through the city centre and offer passive recreational space and public access opportunities. Proposed changes include:

- Median alignment with mature existing trees retained where applicable.
- New street planting within the public realm.
- New 2-way cycle path on south side of road corridor and separate pedestrian footpath to reduce commuter conflict.
- Shared path retained on north side of the road corridor as well as additional footpath width.

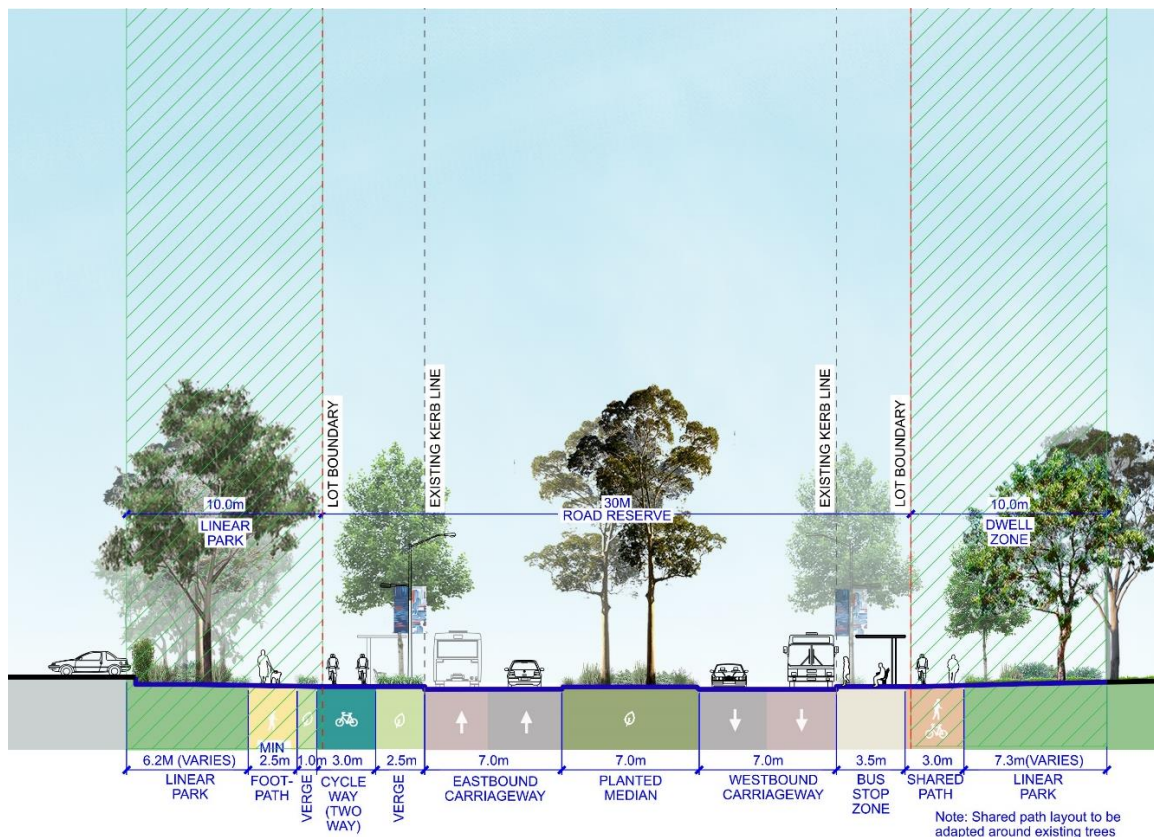


Figure 3.1: Proposed Waterloo Road Typical Cross-Section

The existing median varies along the length of Waterloo Road and averages about 7.5m which is in excess of the 7.0m as proposed in the Green Corridor plans. Reconstruction of the median kerblines and removal of small plantings may be required as part of the proposed works. Impacts to existing mature trees should be considered to ensure these trees are not negatively impacted by realignment of this kerblines. Future plantings will need to consider the extensive in ground services present within Waterloo Road. Alignment of the footpath and shared path alignment is noted to be routed around existing trees.

3.2 Secondary Circulation Routes

The scope of the master plan report includes development of local streets with a width of 20.0m to 25.0m. Roadways typically have a wide carriageway with additional width for street parking. Surrounding developments vary but typically consist of large buildings or medium to high density residential buildings. Example roadways include the existing Lyonpark Road located to the entrance of the precinct. There are existing in-ground services located within the street and public realm of Waterloo Road including electrical, telecommunications, gas, water, sewer, and stormwater lines and pits.

Proposed changes to secondary circulation routes include:

- Blistering existing parking lanes with deep soil zones to accommodate additional large street tree cover.
- Increased footpath width where appropriate.
- Implementation of separate cycleway or shared path where appropriate.
- Incorporation of WSUD features incorporated in kerb and tree blisters.
- Upgraded paving, lighting, and signage.

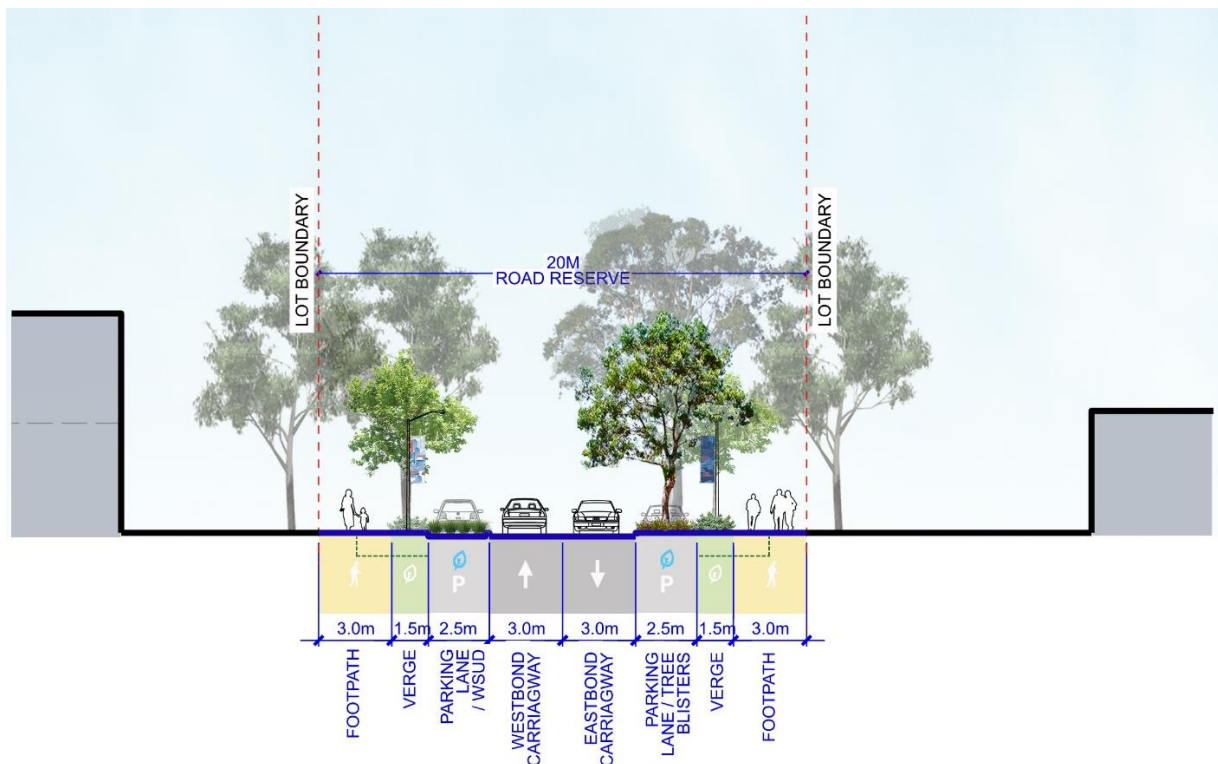


Figure 3.2: Proposed 20.0m Secondary Circulation Route Typical Cross-Section

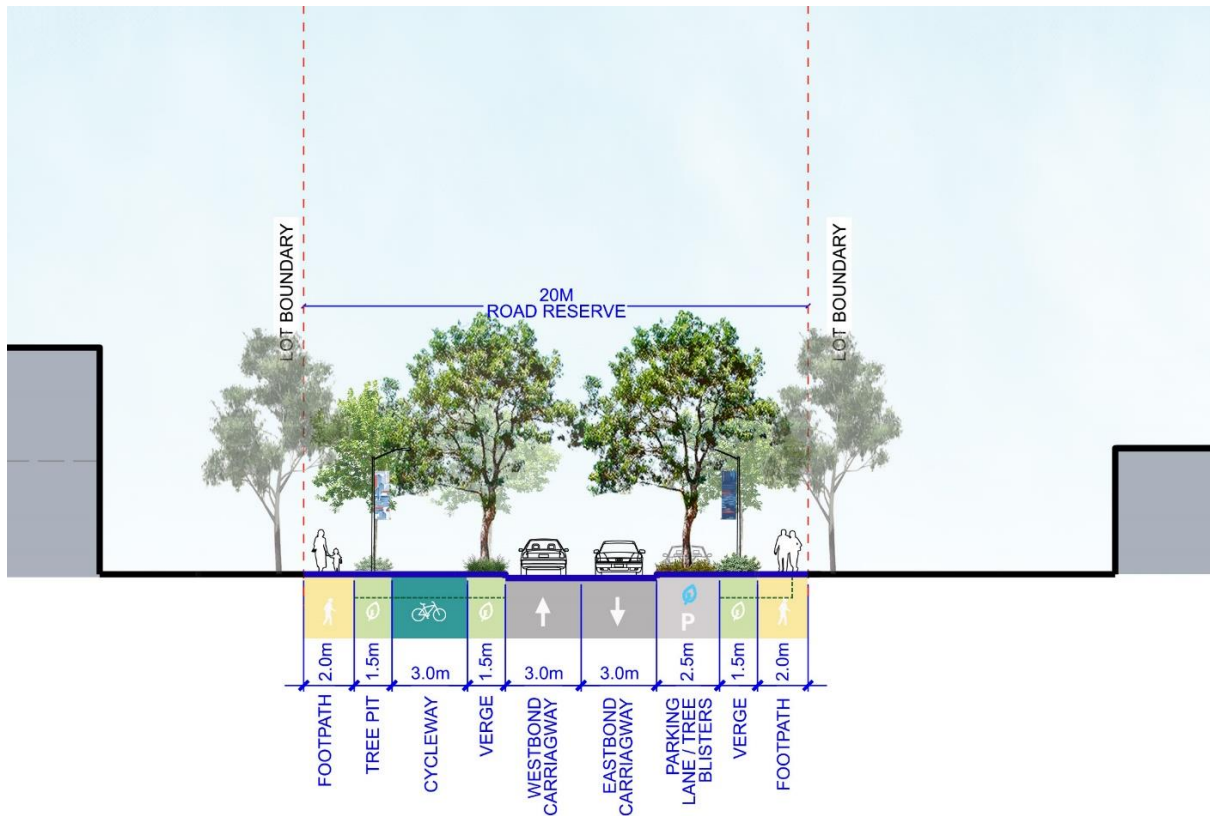


Figure 3.3: Proposed 20.0m Secondary Circulation Route with Separate Cycleway Typical Cross-Section

The proposed works along Lyonpark Road (Green Boulevard) are restricted by existing mature trees along both northbound and southbound kerblines as well as existing infrastructure including parking meters and street signage. Other secondary streets generally align with existing kerb and gutter lines and may be restricted by existing infrastructure such as street signage. The incorporation of street blistering to create WSUD deep planting zones is recommended to improve precinct stormwater quality and quantity discharge. Deep planting zones and new trees will need to consider the extent of existing in ground services including telecommunications, electrical, water and gas lines and pits. There is the possibility of a 5.0m extension beyond the site boundary on the northbound side to incorporate additional planting and a dedicated footpath zone.

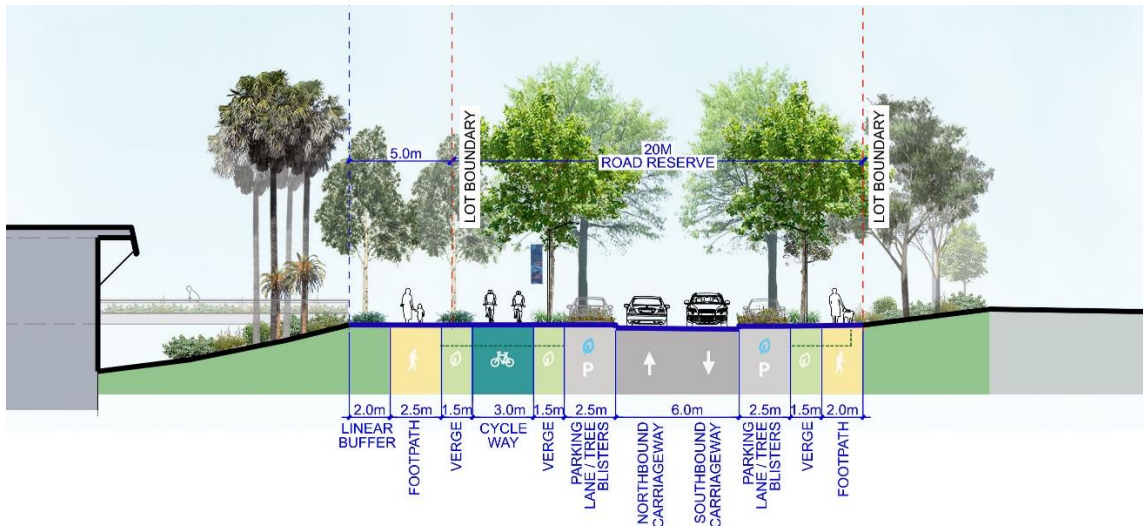


Figure 3.4: Proposed Secondary Green Boulevard (Lyonpark Road) Typical Cross-Section

3.3 Local Streets

The scope of the master plan report includes development of local streets with a width of 14.5m. Proposed works will prioritise pedestrian movements through the application of slow speed environments to encourage walkability. Proposed changes will include:

- Street parking to be implemented on one side of the laneway only.
- Blistering existing parking lanes with deep soil zones to accommodate additional large street tree cover.
- Incorporation of WSUD features incorporated in kerb and tree blisters.

As with the proposal for secondary circulation routes, the incorporation of street blistering to create WSUD deep planting zones is recommended to improve precinct stormwater quality and quantity discharge. Although less prominent on local streets, consideration of all existing in ground services including telecommunications, electrical, gas, sewer, water and stormwater lines and pits will need to be considered when identifying opportunities for deep planting zones and associated WSUD developments.

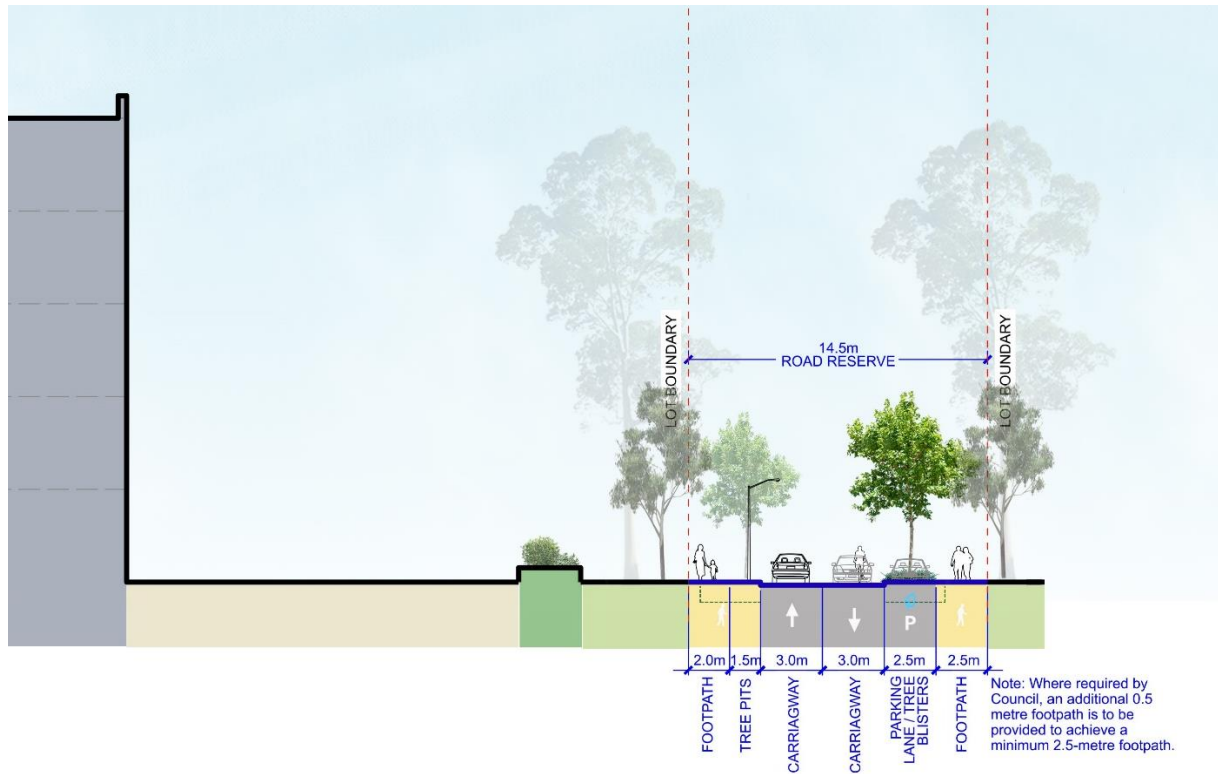


Figure 3.5: Proposed 14.5m Local Street Typical Cross-Section

3.4 Cycleways

The proposal includes a new pedestrian and cycleway link between Lyonpark Road and Khartoum Road. This will not be trafficable by vehicles and will allow vital connections for active transport. The scope of proposed works includes:

- Extension of the wider active transport network and links with separate cycleways.
- Connectivity to encourage active transport options through the precinct.
- Increased pedestrian amenity through application of tree-lined corridor with shaded canopy.

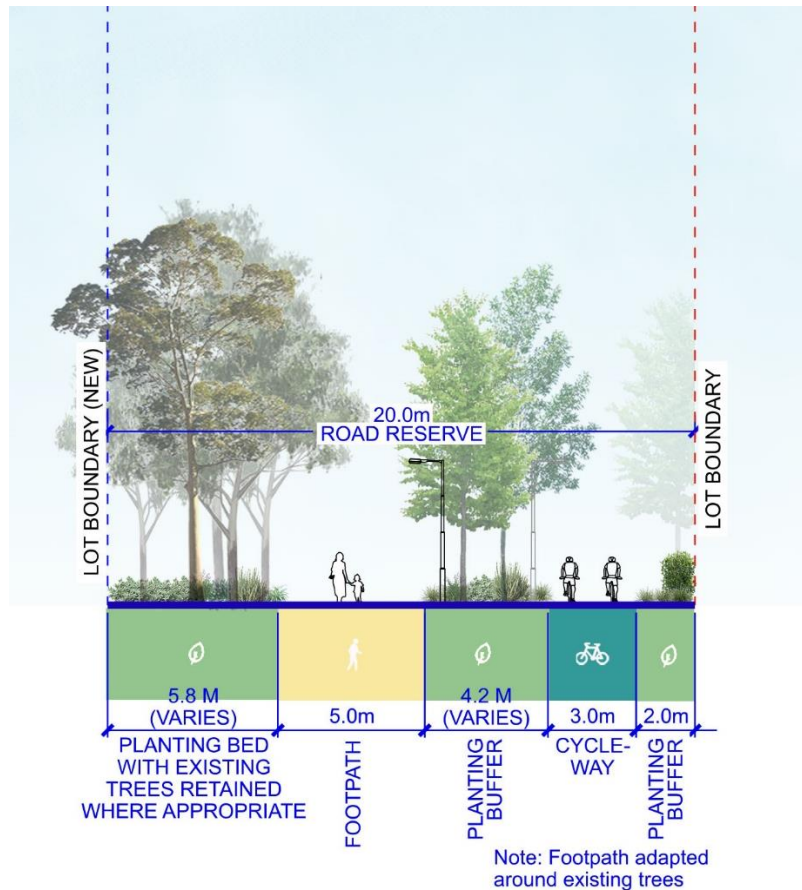


Figure 3.6: Proposed 20.0m Green Boulevard Reserve Typical Cross-Section

The existing route predominately consists of impervious hardstand such as driveway pavement. Implementation of a tree lined corridor with extensive planting zones will therefore be beneficial for incorporation of WSUD principles. Existing in ground services including telecommunications, electrical, sewer, water and stormwater have been identified within the vicinity of the proposed laneway and therefore proposed deep planting zones will need to consider the impacts of inground services.

4.0 Watercourse Restoration

Section 6.5 of the stormwater management technical manual within the City of Ryde Council 2014 DCP stipulates the following for riparian zones:

Riparian zones must not be subject to developments (erection of structures or fill) without the specific consent of the Council. For non-perennial watercourses, the riparian zone consists of 5 metres either side of the top of the bank. For perennial watercourses, the riparian zone is 20 metres either side from the top of the bank or within the 100-year flood plain – whichever is greater. This must be calculated by a consultant engineer.

Retaining and restoring natural watercourses achieves the following benefits:

- Stream stabilisation, by reducing the velocity of stormwater, stream bank erosion and sedimentation of waterways.
- Increased water infiltration and groundwater recharge, resulting in a reduction in the amount of stormwater and flooding incidence.
- Improved water quality, because vegetation acts a filter, reducing pollutant and nutrient levels.

The site falls within several identified catchments of local tributaries of the Lane Cove River located to the north and east of site beyond the M2 motorway. Waterways identified within the scope of works are Shrimptons Creek, Industrial Creek, and Porters Creek as demonstrated in **Figure 4.1**. Due to development within the area, large runs of these rivers have been developed and therefore no longer appear to be exposed to the sky and are instead routed through culverts or pipes for the majority of their run within the study area.

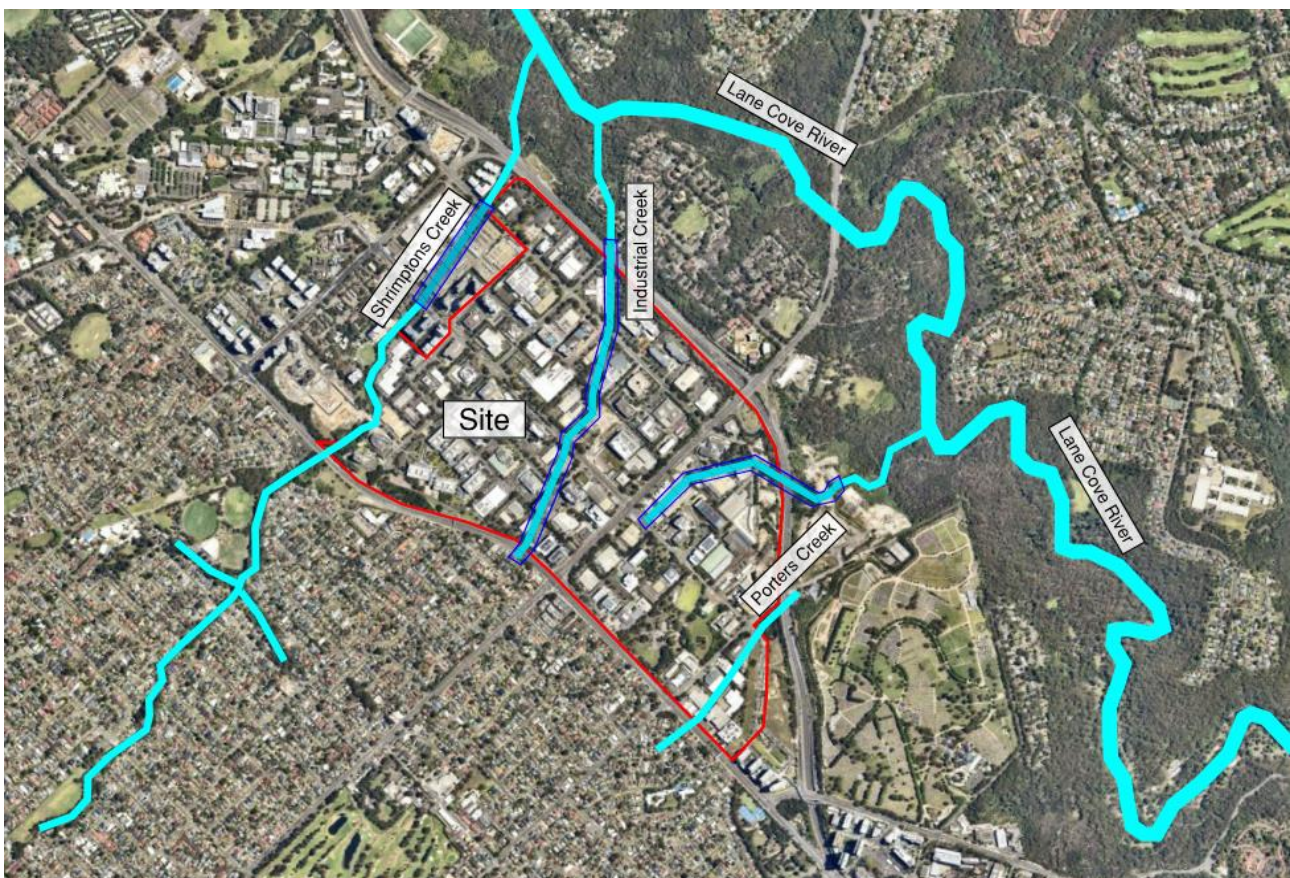


Figure 4.1: Identified Creek Lines based on aerial study and mapping by Bewsher Consulting Pty Ltd

The developed nature of Industrial Creek and Porters Creek indicate that any opportunity for watercourse restoration will primarily be associated with Shrimptons Creek. As a second order perennial stream, a 20m vegetated riparian zone will be required either side of the creek to fall in line with recommendations provided in the City of Ryde DCP (2014). Realignment of the stream is not permitted within any sections of the stream bounded by the proposed site boundary, although the development of infrastructure comprising of cycleways, pathing, detention basins, storm water outlets, essential services, and any form of road crossing is permitted.

Restoration of the Shrimptons Creek watercourse could include opportunities for the provision of a 20m riparian zone as well as WSUD principles, predominantly zoning for water detention basins and siting of biofiltration and constructed wetland systems. Adoption of these options will involve the purchase of property surrounding Shrimptons Creek and it is recommended that highly pervious land such as parks and playing fields be investigated for integrated for these purposes over already developed land. Potential zoning of the riparian zone and opportunities for watercourse restoration has been included in **Figure 4.2** below.

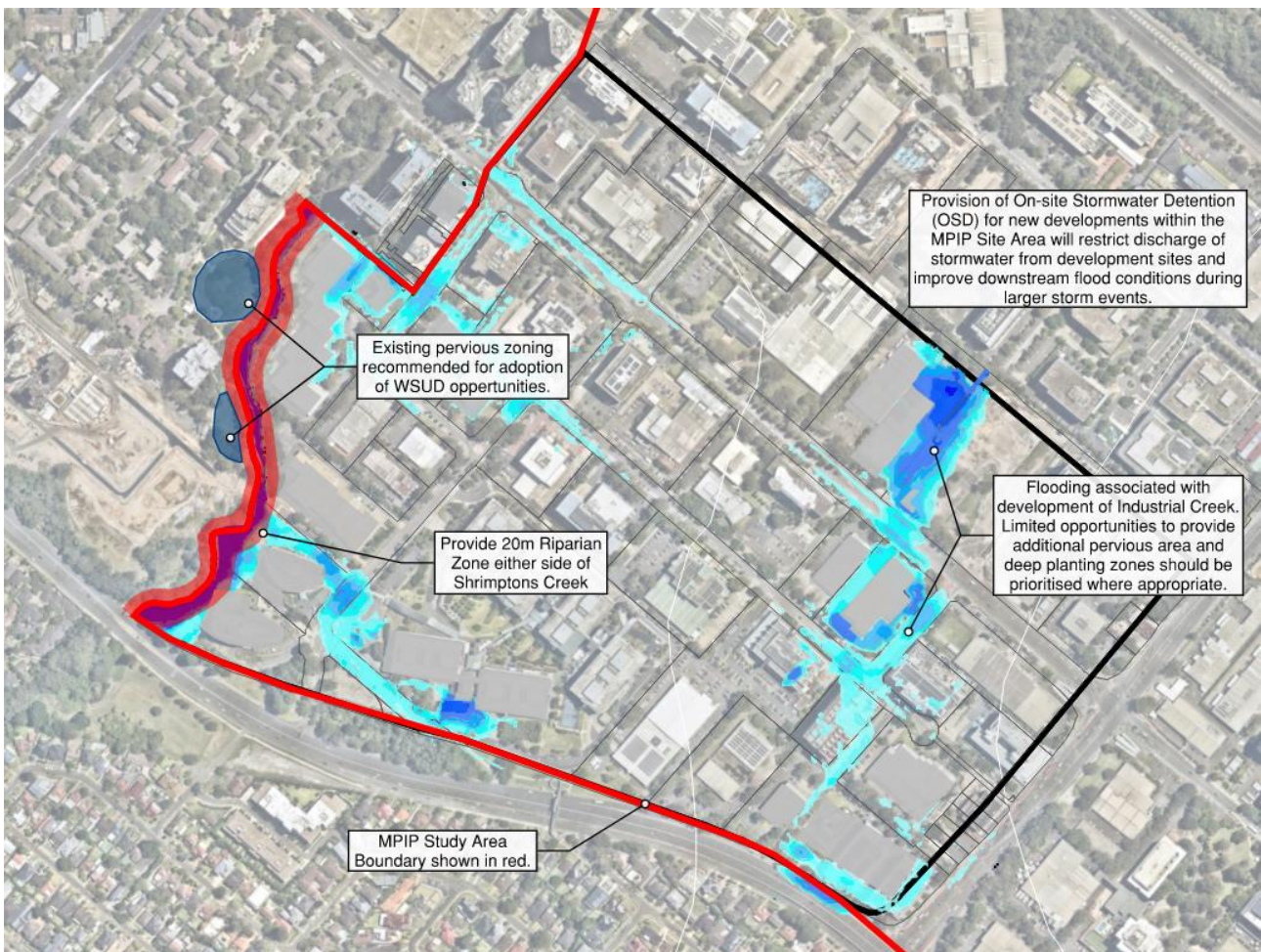


Figure 4.2: Spatial recommendations for stormwater treatment, detention, and riparian zoning.

Proposed WSUD principles for the Master plan includes a substantial increase to deep zone planting and existing tree canopy to alliviate stormwater quantity and stormwater quality impacts from increased development. Increased pervious area such as those along Waterloo Road and Lyonpark Road will reduce the rate stormwater is conveyed from the precinct to local watercourses and would be enhanced by increased planting within the public domain. Further implementation of kerb blistering to secondary circulation routes and local roads will further increase percentage of pervious area and aid in restricting the stormwater quality and stormwater quantity discharge.

Proposed green spacing closely aligns with identified creek lines as outlined below. As existng flooding during both the 1%AEP and PMF are heavily associated with these developed gullies and creek lines, the proposed intergration of WSUD solutions including bioretention and infiltration oppertunities will likely aid with improving flood conditions within the MPIP once implemented. Further oppertunities for green space should be prioritised where possible to enhance WSUD opportunities.

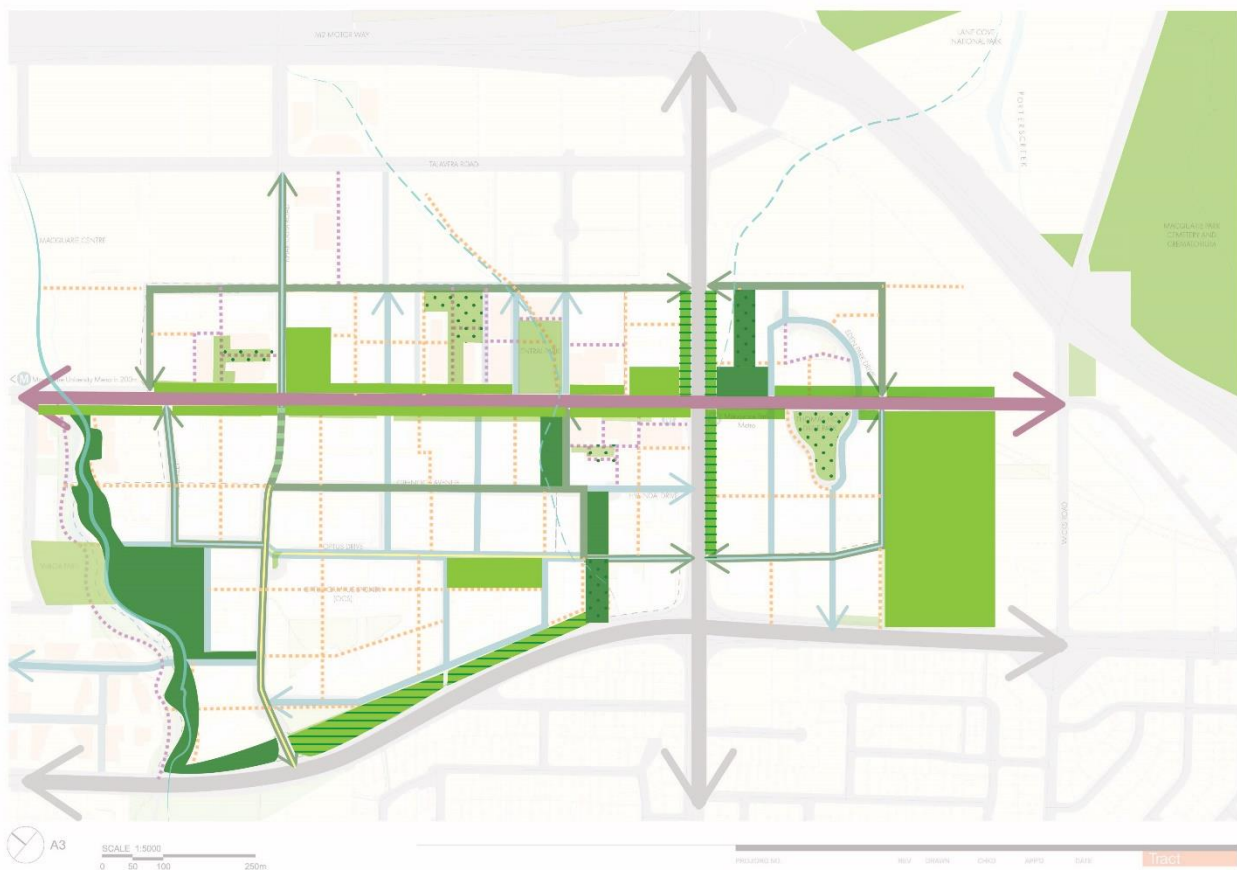


Figure 4.3: Proposed Precinct Green Spacing Network and Associated Watercourses

TTW have previously implemented stormwater quantity measures on a local watercourse within close proximity to Shrimptons Creek situated within the Macquarie University Campus as outlined in **Figure 4.4**. The extent of works consists of a series of detention basins used to control stormwater runoff from inundating the downstream river system which reduces flooding and water inundation issues and represents an indication of what future water restoration efforts along the alignment of Shrimptons Creek could look like. It should be stressed that the provision of land needed to zone potential WSUD devices will likely be restricted within proximity of Shrimptons Creek due to extensive existing development and therefore reclamation of viable land should be prioritised to ensure restoration solutions may be properly zoned.



Figure 4.4: Existing detention basins within close proximity of Shrimptons Creek and Site

5.0 Flooding Design

The City of Ryde DCP (2014) outlines flood levels as the 100-year ARI (Annual Recurrence Interval) storm event in accordance with advice provided in the NSW Floodplain Development Manual (2005). Flood Planning Levels (FPL) required for developments within City of Ryde Council are therefore equal to the level of the 100-year ARI flood level plus the following freeboard requirements based on flooding and overland flow for different categories of developments provided in **Table 5.1** below as outlined in the City of Ryde Development Control Plan (2014).

Table 5.1: Freeboard Requirements (City of Ryde DCP, 2014)

Drainage System/ Overland Flow	Residential			Industrial/ Commercial	
	Land Level ^(b)	Habitable Floor Level	Non-Habitable Level ^(c)	Land Level ^(b)	Floor Level
Surface Drainage/ adjoining ground level ^(a)	-	.15m	-	-	.15m
Public drainage infrastructure, creeks and open channels	0.5m	0.5m	0.1m	0.3m	0.3m
Flooding and Overland Flow (Overland Flow Precincts and Low Risk)	N/A	0.3m	0.15m	N/A	0.3m
Flooding and Overland Flow (Medium Risk and greater)	N/A	0.5m	0.3m	N/A	-
Onsite Detention ^(d)	N/A	0.2m	0.1m	N/A	0.2m
Road Drainage Minor Systems (Gutter and pipe flow)		0.15m below top of grate			
Road Drainage		Refer to Figure 2-1.			
Detention Basins ⁽⁴⁾		The top water level shall be designed to be 0.5m below top of embankment (100yr ARI)			

Schedule 2 of the DCP defines the following development types provided in **Table 5.2** below where additional flood planning requirements may be required depending on the flood risk associated with site based on the velocity and flow of water. City of Ryde outline the following flood risk categories.

- High Flood Risk is land with a potentially catastrophic damage to property and life as well as evacuation problems. Most development is restricted within this category.
- Medium Flood Risk is land with the potential of flood damage and public safety but can be addressed through the application of appropriate measures including flood planning requirements.
- Low Flood Risk is land below the PMF but outside of High and Medium Flood Risk Areas.
- Overland Flow Precincts receive shallow inundation following significant storm events.

Table 5.2: Development Types (City of Ryde DCP, 2014)

CRITICAL USES AND FACILITIES	SENSITIVE USES AND FACILITIES	RESIDENTIAL
Emergency services facilities; administration building or public administration building that may provide an important contribution to the notification or evacuation of the community during flood events (e.g. SES headquarters and Police Stations); Hospitals.	Community facility; telecommunications facility; Institutions; Educational establishments; Liquid fuel depot; Public utility undertaking (including electricity generating works and utility installations) which are essential to evacuation during periods of flood or if affected would unreasonably affect the ability of the community to return to normal activities after flood events, residential care facility, school and seniors housing.	Attached dwelling, backpackers' accommodation; bed and breakfast accommodation; boarding house; caravan park (with permanent occupants); child care centre; dual occupancy; dwelling; dwelling house; exhibition home; group home; home-based child care centre; home business; home industry; home occupancy; home occupation (sex services); hostel; hotel or motel accommodation; moveable dwelling; multi dwelling housing; neighbourhood shop; permanent group home; residential accommodation; residential flat building; secondary dwelling; semi detached
COMMERCIAL OR INDUSTRIAL	RECREATION AND NON - URBAN	CONCESSIONAL
Air transport facility; airport; amusement centre; brothel; bulky goods premises; business premises; caravan park; community facility (other than critical and sensitive uses and facilities); correctional centre; crematorium; depot; entertainment facility; exhibition village; food and drink premises; freight transport facility; function centre; funeral chapel; funeral home; hazardous industry; hazardous storage establishment; health care professional; health consulting rooms; health services facility; heavy industry; heliport; highway service centre; industrial retail outlet; industry; liquid fuel depot;	Animal boarding or training establishment; biosolid waste application; biosolids treatment facility; boat launching ramp; boat repair facility; boat shed; caravan park (with non- permanent occupants); charter and tourism boating facility; environmental facility; environmental protection works; extensive agriculture; extractive industry; information and education facility; horticulture; kiosk; landscape and garden supplies; marina; mine; mining; moveable dwelling; port facilities; public utility undertaking (other than critical uses or facilities); recreation area; recreation	Alterations and additions to freestanding/ dual occupancy residential dwellings. Work sheds, non-habitable outbuildings, Change of use of office/ industrial space.

Floor Planning Levels for all development types sited within the City of Ryde may therefore be summarised by values provided in **Table 5.3** below.

Table 5.3: Summary of Flood Planning Levels and Freeboard Requirements

Development type	Floor Planning Level	Freeboard	Notes
Critical Uses and Facilities	PMF	NA	City of Ryde will not permit development of Critical Uses and Facilities on land subject to major overland flow or land subject to floodwaters.
Sensitive Uses and Facilities	PMF	NA	All floor levels must be no lower than the PMF level. Development in High and Medium flood risk areas is not permitted.
Residential	100-year ARI	500mm <i>(Above 100-year ARI)</i> 150mm <i>(Above Ground FL)</i>	Completed works must be capable of withstanding the force of flood water, debris, and buoyancy to the 100-year ARI.
Commercial or Industrial	100-year ARI	300mm <i>(Above 100-year ARI)</i> 150mm <i>(Above Ground FL)</i>	Applicable to low flood risk areas. Developments are generally not accepted by Council in high flood risk precincts.
Recreation and Non-Urban	100-year ARI	Refer TABLE 4.1	Floor planning levels of habitable and non-habitable areas are required to comply with the freeboard requirements provided in TABLE 5.1 .
Concessional	100-year ARI	Refer TABLE 4.1	Floor planning levels of habitable and non-habitable areas are required to comply with the freeboard requirements provided in TABLE 5.1 .
Carparking Areas	100-year ARI <i>(where above adjacent floor levels)</i> PMF <i>(basement parking and where below adjacent floor levels)</i>	NA <i>(open and basement parking only)</i> 150mm <i>(Above adjacent floor levels but enclosed only)</i>	Basement parking and parking below adjacent floor levels are required to provide a bunded crest to the PMF. Provision of restraints and barriers to the 100-year ARI flood is required to prevent vehicles leaving site for large open parking areas exceeding 10 car spaces.

6.0 Stormwater

The proposed site is highly developed and is comprised mostly of impervious surfacing including roadways, roofing, and pavement. These existing conditions increase the rate in which stormwater and accumulated pollutant loads are discharged to local watercourses, inundating downstream systems.

6.1 Stormwater Quantity

The City of Ryde DCP (2014), Part 8.2: Stormwater Management Technical Manual stipulates that proposed development requires an onsite detention OSD incorporated prior to the off-site discharge point. Provision of OSD within new development lots will aid in restricting the inundation of existing watercourses and aid in restricting the impacts of flooding to downstream developments.

6.1.1 Onsite Stormwater Detention (OSD)

Section 1.4.2 of the Ryde stormwater management technical manual outlines the following general OSD requirements:

- The OSD system should be located prior to the point of discharge, generally in the lowest point of the site and located in a common area to facilitate access. This can possibly include a car park, open space area or even roof top areas where no underground storage is possible.
- As much as possible of the site area is to drain through the OSD system(s). A portion of the impervious area may discharge directly to Council's system if it cannot be drained to the storage facility, provided the PSD is reduced and SSR is increased to compensate for the smaller catchment.
- The maximum desirable extent of impervious bypassing the OSD system is 25% of the total impervious site area.
- Where it is proposed for the site to discharge to the kerb and gutter, the PSD shall be restricted to 30 L/s.
- A positive covenant must be executed and registered against the title of the lots containing OSD systems to require maintenance of the system. This positive covenant must be on any linen plans for subdivision of the development. If no subdivision is proposed, the covenant shall be prepared prior to finalisation of the development.

OSD Design – Detailed Method:

As this development does not fit the criteria for the simplified design method, it therefore requires the detailed method. Section 1.4.4 outlines of the Ryde stormwater management technical manual outlines the requirements of the detailed method:

- OSD design must ensure the level of stormwater discharged from the area of development must not exceed the peak stormwater discharge arising from the post-developed works during a 5-year ARI storm event.
- To restrict post development flows to pre-development levels a detention basin for the design storms will be required to be modelled.
- In cases where the site proposes discharge to the kerb and gutter, the point of discharge is to be limited to 30 L/s.
- If the rate of discharge from the outlet of the OSD system is affected by tail water conditions from the receiving system, then full hydraulic calculations will be required in accordance with Section 5 of the manual.

6.2 Stormwater Quality

WSUD stormwater quality annual pollutant load reduction targets should be adopted for all new developments in line with the City of Ryde DCP (2014), Part 8.2: Stormwater Management Technical Manual. These rates recommended to be adopted are provided in **Table 6.1** below.

Table 6.1: Stormwater Quality Requirements (City of Ryde DCP, 2014)

Pollutant	WSUD Stormwater Quality Performance Target
Gross Pollutants	90%
Total Suspended Solids	85%
Total Phosphorus	60%
Total Nitrogen	45%

6.2.1 Water Sensitive Urban Design (WSUD)

WSUD opportunities for the precinct are summarised in **Table 6.2** below. Zoning for the implementation of precinct wide water quality measures, primarily bioretention systems and constructed wetlands will need to be adopted early to ensure that land can be reclaimed by Council for the purpose of zoning and constructing the necessary area of works.

Table 6.2: Summary of Physical Constraints affecting WSUD measures:

WSUD Measure	Steep site	Shallow bedrock	Acid Sulfate Soils	Low permeability soil (eg. Clay)	High permeability soil (eg. sand)	High water table	High sediment input	Land availability
Swales and buffer strips	C	D	D	✓	✓	D	D	C
Bioretention Swales	C	C	C	✓	✓	C	D	C
Sedimentation basins	C	✓	✓	✓	✓	D	✓	C
Bioretention basins	C	D	D	✓	✓	C	C	C
Constructed wetlands	C	D	C	✓	D	D	D	C
Infiltration measures	C	C	C	C	✓	C	C	C
Sand filters	D	✓	✓	✓	✓	D	C	✓
Aquifer storage and recovery	C	C	C	C	✓	C	C	C

C – Constraint may preclude use; D – Constraint may be overcome through appropriate design;

✓ - Generally not a constraint

7.0 Summary of Policy Recommendations

Although the surrounding area is highly developed, several opportunities for watercourse restoration are present within the scope of works outlined by the proposed master plan. Options include the provision of a 20m riparian zone and development of detention and water quality infrastructure such as bioretention within land bounded by Shrimptons creek, increased opportunity for WSUD area including deep plantings and extended tree canopy cover and increased green spacing around identified developed gullies and creek areas such as Industrial Creek and Porters Creek. Further opportunities for WSUD principles should be prioritised where applicable to enhance user amenity of precinct development.

Flood planning levels are defined by City of Ryde Council in the DCP (2014) and associated Stormwater Technical Manual (2014). Where applicable, flood levels are to be taken as the 100-year ARI and associated with an applicable freeboard as discussed in Section 4.0 of this report. Several development types including Critical and Sensitive Uses and Facilities as well as entrance to carparking below the surrounding floor planning level will require flood planning levels or protection against the PMF respectively. A summary of flood planning levels is provided below. Please refer to Section 4.0 of this report for a full definition of flood planning advice.

Development type	Floor Planning Level	Freeboard
Critical Uses and Facilities	PMF	NA
Sensitive Uses and Facilities	PMF	NA
Residential	100-year ARI	500mm <i>(Above 100-year ARI)</i> 150mm <i>(Above Ground FL)</i>
Commercial or Industrial	100-year ARI	300mm <i>(Above 100-year ARI)</i> 150mm <i>(Above Ground FL)</i>
Recreation and Non-Urban	100-year ARI	Refer TABLE 5.3
Concessional	100-year ARI	Refer TABLE 5.3
Carparking Areas	100-year ARI <i>(where above adjacent floor levels)</i> PMF <i>(basement parking and where below adjacent floor levels)</i>	NA <i>(open and basement parking only)</i> 150mm <i>(Above adjacent floor levels but enclosed only)</i>

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