



Robert **Bird** Group

North Ryde Station Precinct M2 Site

State Significant Development Civil Design Report

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1.0 Introduction

1.1 Background

This report has been prepared in support of State Significant Development SSD-5093 for Stage 1 Preliminary Works including superlot subdivision, civil infrastructure and public domain works and other associated works on the M2 site.

The M2 Site forms part of the North Ryde Station Precinct. The North Ryde Station Precinct comprises the Station Site North, Station Site South, and the M2 Site and is divided by the M2 Motorway and Delhi Road.

The subject site (the site subject to this State Significant Development Application) is principally the M2 Site. The subject site is owned by UrbanGrowth NSW.

The M2 Site is legally described as Lot 101 DP 1131776. The M2 Site is bounded by the M2 Motorway to the east, Epping Road to the south west, Delhi Road to the south and by Wicks Road to the north. Access to the site for construction of the ECRL was established via a construction access point from the M2 on ramp and an access driveway from Wicks Road. The M2 Site has a total site area of 91,530m². The land generally slopes down to the north, towards Wicks Road. The northern portion of the site also contains a small creek known as Porters Creek.

1.2 Document Scope

This Civil Design Report has been prepared by Robert Bird Group (RBG) who are engaged by Urban Growth NSW (UG NSW) to provide civil engineering design in respect of the M2 Site, being part of the North Ryde Station Urban Activation Precinct (UAP). This report has been prepared to support a State Significant Development Application (SSDA) for the M2 Site, it provides a summary of the proposed civil works associated with the development including:

- Site Preparation Works:
 - Bulk earthworks; and
 - Site re-grading
- Works associated with roads and intersections:
 - Design of internal roads; and
 - External intersection upgrades
- Upgrade of pedestrian pathway and cycle way networks
- Drainage and Water Sensitive Urban Design (WSUD)
- Services reticulation

Reference is made throughout the report to the Civil design drawings, which are provided under separate cover.

1.3 References and Inputs

Referenced documents include:

- North Ryde Station, Stormwater Management Plan (SWMP), RBG, May 2014.
- Flood Assessment, Emergency Vehicle Access via Wicks Road and Waterloo Road and Justification for no On-Site Detention, Cardno, April 2014
- Report on Preliminary Geotechnical Investigation, Douglas Partners, April 2014
- Phase 1 Contamination Report, Douglas Partners, April 2014
- Remediation Action Plan, Douglas Partners, April 2014
- Topographical Survey, Project Surveyors, May 2014
- TIDC Development Sites Report of Impacts on Epping to Chatswood Rail Line, Doc# PR_6437, August 2008;
- TIDC ECRL Underground Infrastructure Guidelines, May 2008;

- North Ryde Station Precinct Development Control Plan, 4 December 2013 (DCP 2013)
- City of Ryde Development Control Plan 2010 (DCP 2010)
- Macquarie Park Floodplain Risk Management Study & Plan, April 2010 (Bewsher 2010).
- Macquarie Park Floodplain Risk Management Study & Plan, February 2011 (Bewsher 2011).
- Australian Human Rights Commission – Accessible Bus Stop Guidelines (2010)

1.4 Existing Site Description and Conditions

The M2 Site is located within the City of Ryde local government area and is bound by the M2 Motorway to the east, Delhi Road to the south, Epping Road to the south-west, Wicks Road to the north, and low rise commercial/industrial buildings to the west. Refer Figure 1 for an aerial image of the site. The area is an irregular shaped land parcel covering approximately 9.15ha and is about 600m long and 90m wide. Site levels slope down to the north with a difference in level of approximately 28m, which is an average slope of about 5%.

At the time of this report, the site was being utilised by Leighton Contractors and the Epping to Thornleigh Third Track (ETTT) Alliance as a works compound. There is an access road running north south on the western side of the site, with entry/exit at the intersection of Wicks Road and Waterloo Road. Temporary construction access has also been provided from the M2 Motorway on-ramp to the east of the site. There are site sheds and parking areas to the south with stockpiles of excavated material occupying the centre of the site. A large concrete lined water settling basin is located at the lower levels of the worked area and appears to be maintained to treat runoff from the construction site.

Bushland occupies the northern part of the site. Porters Creek runs parallel to Wicks Road at the northern end of the site within the bushland area. The Epping to Chatswood Railway Line (ECRL) tunnels pass under the southern end of the site. The approximate alignment of the ECRL is indicated in Figure 1.



Figure 1 – Aerial Site Image

Utilities

Survey and Dial-Before-You-Dig (DBYD) information indicate the presence of gas, electricity, telecommunications, sewer, water and stormwater present along the Wicks Road and Epping Road corridors adjacent to the site. A high pressure gas main traverses the site diagonally from Wicks Road to the M2 Motorway site boundary, where it continues south, parallel to but outside the site limits. This gas main is not critical to the supply of the site and discussions are underway with the service provider, Jemena, regarding possible relocation of this main. Refer to the site survey plans in the Civil Engineering drawings for the location of known existing services.

Existing Structures

The Site includes an area of land acquired from Lot 2 (DP 528488) which fronts Epping Road and is currently occupied by a building (North Ryde Smash Repairs). The M2 Site includes only the eastern portion of this land parcel, however, which does not include the existing building. The demolition of the building is not part of the proposed works.

There is an existing cross drainage culvert in Porters Creek under the access road at the northern end of the site which runs parallel to Wicks Road. The culvert is to be removed and replaced as part of the proposed works.

Epping to Chatswood Rail Line

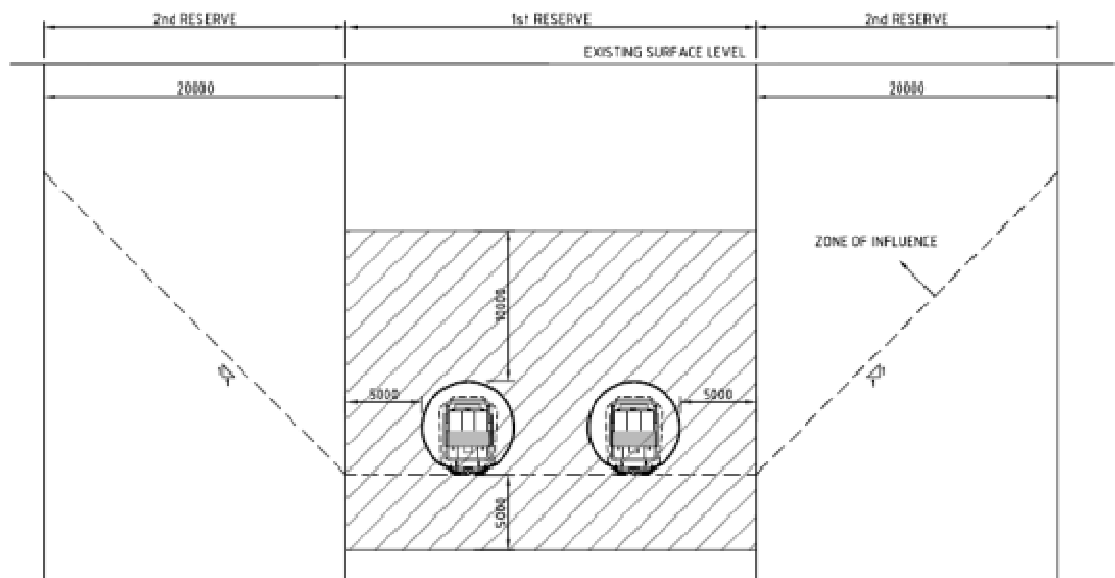
Twin tunnels forming part of the Epping to Chatswood Rail Line (ECRL), are located below the Site and provide development constraints that are to be considered.

ECRL Underground Infrastructure Protection (ECRL UIP) Guidelines, Report # 20007300/ PO-4532, dated 06 May 2009, Revision 4, provides the protection requirements and constraints on construction activities and building development in the vicinity of the ECRL. Specifically:

- Section 3.1 describes the 'Reserve Zones';
- Drawing (PRL GD 02467-02604) details the extents of the reserve zones; and
- Section 3.4 provides details of Development Guidelines. The guidelines limit excavations, footings and foundations within the zones and provide advice as to when detailed geotechnical evaluations need to be undertaken for certain construction activities.

Typically the reserve corridor is 70m wide, consisting of a 30m wide (typical) '1st Reserve' located over the ECRL tunnels, with a further 40m comprising the remaining '2nd Reserve Zone' (20m either side of the 1st Reserve). The Reserve zones are shown on the Civil Engineering, Bulk Earthworks design drawing (C-O-2-01).

The 1st Reserve is also defined vertically to extend 10m above the crown of the tunnels. The ECRL UIP Guidelines Drawings PRL GD 02475-02477 provide longitudinal sections of the alignment across the development, and details of the depth from existing ground level to 1st reserve zone can be identified. A typical section through the tunnel showing the extent of the 1st and 2nd Reserve Zones is shown in Figure 2.



**Figure 2 – Typical Section through ECRL running tunnels
(Sourced from the ECRL Protection Guidelines PRL-GD-02600-1.)**

The ECRL UIP Guidelines highlight that construction within the First Reserve zone, directly over or within 5m horizontally of the tunnels should be limited to shallow excavations and light loadings (maximum 3m deep excavations and maximum 150kPa bearing pressure footings). Development in this zone which could result in higher loads would require a detailed analysis of impacts of the proposed construction. The Second Reserve zones extend to 20m horizontally either side of the first reserve and to a depth indicated by the zone of influence shown in Figure 2. Development inside the Second Reserve will also be constrained, but to a lesser degree. It is noted that deep foundations can be located in the Second Reserve subject to founding below the zone of influence and de-bonding of the pile. The net effect of any construction in either of the reserve zones must not adversely affect the ECRL.

Further information on ECRL infrastructure and constraints to development are provided in the following reports:

- TIDC Development Sites Report of Impacts on Epping to Chatswood Rail Line, Doc# PR_6437, August 2008;
- TIDC ECRL Underground Infrastructure Guidelines, Doc#20007300/PO-4532, May 2008.

Geotechnical

A preliminary geotechnical investigation and report has been undertaken by Douglas Partners, (April 2014). The purpose of the geotechnical investigation is to advise on ground conditions for structural and civil works. Specifically, the following has been addressed:

General:	Reactivity of the soil; Standard of compaction of fill encountered; Advice on site trafficability during construction; Depth to rock; Salinity of the soil;
Structural:	Soil bearing parameters for pad and strip footings and bored piers; Soil stiffness parameters for slab on ground under wheel and racking loads;
Civil:	Design parameters for embankment stabilisation and/or retaining walls; Design parameters for pavement design; Safe batter slopes (temporary and permanent).

The geotechnical report provides a Geotechnical Model, which is presented as Table 1 below. The model indicates deep filling overlying silty clay, with shale, siltstone and sandstone below. Extremely low to medium strength rock was encountered at relatively shallow depths. Medium to high strength bedrock was encountered at depths of 10m to 40m.

Table 1 M2 Site Geotechnical Model (Douglas Partners 2014)

Unit	Material	Description
1	Filling	Deep filling was encountered in the majority of the borehole locations across the M2 site to depths of 1.0m to 3.0m.
2	Silty Clay	Hard silty clay identified at several borehole locations, to depths of 1.9m and 2.2m (up to 1.9m thick).
3	Shale, Siltstone and Sandstone (Mittagong Formation)	Extremely low to very low strength shale and siltstone to depths of 3.0m to 3.7m was encountered in boreholes at the southern end of the site.
		Low to medium strength siltstone to depths of 5.1m to 6.0m in boreholes at the very south of the site.
		Extremely low to low strength, fine grained sandstone to depths of 2.1m to 4.25m.
4	Sandstone (Hawkesbury Sandstone)	Medium to high strength sandstone, moderately to slightly fractured to unbroken with depth, was proven to depths of 9.55m to 41m. Some very low strength bands were encountered at various depths.

The report also noted that historical documents reference a decline and shaft, which were large open excavations during the construction of the ECRL to facilitate the entry of equipment. It has been reported that the decline had rock bolts installed as temporary support when it was an open excavation and the excavation has been backfilled with a concrete plug and filling. For buildings over the decline, special attention will be required on the foundations so that they are not affected by the decline.

2.0 Civil Works Design

The civil design consists of the following elements:

- Site preparation and clearing;
- Erosion and sediment control;
- Earthworks;
- Roads and pavements;
- Utility services; and
- WSUD and stormwater drainage.

2.1 Site Preparation and Clearing

Site preparation will generally consist of the following:

- Detailed site services investigation confirming location of all utility assets, establishment of construction management plans, including addressing any requirements set forth by Transport NSW for protection of ECRL assets (refer ECRL UIP Guidelines);
- Implementation of site specific environmental and construction management plans i.e. establish site compound, install sediment and erosion control devices, etc;
- Site clearing and demolition of redundant structures and utilities; and
- Stripping of any vegetation and unsuitable material for disposal at an appropriate disposal facility or by redistribution on site. Stockpiling of materials deemed suitable for reuse i.e. milled pavements for reuse as fill material

The existing site access road and culvert will require progressive demolition to facilitate the proposed construction of the roads and stormwater drainage. Service relocations will be required to facilitate the construction of the Epping Road and Wicks Road intersections.

2.2 Erosion and Sediment Control

A preliminary erosion and sediment control plan has been prepared for the Site based on existing survey data and geotechnical information. Reference is made to the Landcom guideline, Managing Urban Stormwater Runoff: Soils and Construction ('the Blue Book').

The Preliminary Geotechnical Report indicates that "*natural site soils are of high plasticity clays with a relatively high potential for movement with changes in moisture content*". As such, Type F soil category has been adopted for design (as defined in the Blue Book).

The erosion and sediment control measures for the site are staged in accordance with the anticipated development stages:

1. Bulk Earthworks and removal of excess cut material;
2. Construction of roads and public domain works; and
3. Development of individual allotments.

The erosion and sediment control measures proposed for the M2 Site include:

- Sediment basins with sediment storage volume and "clean water channel" catch drains for discharge into Porters Creek;
- Sediment fences around stockpiles and construction zones where soils are exposed;
- Catch drains/bunds to collect construction site runoff and convey flows to the sediment basin; and
- Sediment protection devices on existing and proposed inlet pits i.e. filter socks.

Vehicular access shall be provided to all sediment basins to enable regular maintenance and sediment removal. Soil management measures shall be in accordance with City of Ryde Council DCP 2010 Part 4.5 Section 6.3.4.

Refer to the North Ryde Station Precinct Stormwater Management Plan, RBG, May 2013 for further details.

2.3 Earthworks

2.3.1 Codes, Guidelines and Specifications

The earthworks design of the project will be carried out in accordance with the relevant local, state and national design guidelines and Australian Standard Codes of Practice including but not limited to the following:

- AS 1289 Methods of Testing Soils For Engineering Purposes;
- AS 3798 Guidelines on Earthworks for Commercial and Residential Developments;
- AS 4678 Earth Retaining Structures
- Managing Urban Stormwater: Soils and Construction, Landcom ('The Blue Book'); and
- ECRL Underground Infrastructure Protection Guidelines.

Table 2 provides preliminary geotechnical design criteria adopted for developing site grading and earthworks. Refer the Douglas Partners 'Report on Preliminary Geotechnical Investigation for M2 Site, Delhi Road, North Ryde' April 2014, for detailed requirements for site preparation and earthworks.

Table 2 Preliminary Geotechnical Parameters – Earthworks	
Parameter	Design Criteria
Earthworks	
Interface batters on graded lots	Minimum grade – 1% (100:1) Maximum grade – 25% (4:1)
Excavation batters (H:V) (for batter heights up to 2m)	Uncontrolled Fill or Silty Clay - 1.5:1 (temporary); 2.5:1 (permanent) Stiff / Hard Silty Clay – 1:1 (temporary); 2:1 (permanent) Low Strength Rock – 0.75:1 (temporary); 1:1 (permanent) Med – High Strength Rock – vertical (temporary); 0.75:1 (permanent)
Fill	300mm thick layers compacted at 98% SMDD up to 500mm below proposed subgrade level. 500mm below proposed subgrade levels to be compacted to 100% SMDD. Moisture content to be controlled within optimum < 2%

2.3.2 Earthworks Strategy

The earthworks proposal is intended to provide a suitably graded site for future development, whilst minimising the quantum of excess material which will be required to be removed from site and the cost of disposing of waste materials. A preliminary cut and fill analysis has been undertaken for the proposed earthworks – Refer to Civil Engineering design drawings C-0-2-01 and C-0-2-02. A total cut volume of 55,850 m³ and fill volume of 22,200m³ is estimated from the model.

From the above calculation, an excess of 33,650 m³ of material has been estimated to require removal off the site. It is anticipated that the exported material will consist of Virgin Excavated

Natural Material (VENM). This will be achieved by stripping any non-VENM (including topsoil and fill) from the road reserves and public open spaces, which will be sorted and stockpiled on site. The required volume of VENM will be removed from these areas to other development sites. Stockpiled material which is suitable for use as structural fill (including milled pavements, fill and crushed sandstone) will then be used to replace the VENM removed from the road reserves prior to construction of the road. Other materials will be redistributed around the site in accordance with the grading plan. It is noted that the estimated earthworks volumes above do not include any bulking of materials during excavation or for multiple handling of materials as described above.

2.4 Roads and Pavements

2.4.1 Codes and Specifications

The roadworks design of the project will be carried out in accordance with the relevant local, state and national design guidelines and Australian Standard Codes of Practice including but not limited to the following:

- AS1428 Design for Access and Mobility
- AS 1742 Manual of Uniform Traffic Control Devices Parts 1 to 15
- AS 2890 Parking Facilities, Parts 1 and 2
- AUSTROADS Guide to Road Design Parts 1 to 8
- AUSTROADS Guide to geometric design of Rural Roads
- AUSTROADS Guide to Traffic Engineering Practice Parts 1 to 14 (SAA HB69)
- AUSTROADS Vehicle Turning Templates
- AUSTROADS Pavement Design – A Guide to the Structural Design of Road Pavements
- AUSTROADS APRG Report No.21 - A guide to the design of new pavements for light traffic
- RMS Road Design Guide
- RMS Delineation Guidelines
- RMS Guide to Signs and Markings
- RMS Shared Zone Policy and Guidelines
- Cement & Concrete Association of Australia: Industrial Floors and Pavements: Guidelines for Design Construction and Specification.
- NSW Department of Planning – North Ryde Precinct Development Control Plan 4 December 2013.
- Australian Human Rights Commission – Accessible Bus Stop Guidelines (2010)
- City of Ryde Council
 - Council Development Control Plan 2010 – Parts 8.3. 9.2
 - Environmental Standards Development Criteria, Section 4, Public Civil Works (draft)

2.4.2 Design Criteria

The following design criteria have been adopted for the road design:

Table 3 Roads and Pavement Design Criteria	
Parameter	Design Criteria
Roads	
Road Classifications	<u>Spine Street</u> - Collector with buses <u>Park Street, Plaza Street, Retail Street</u> – Local Access, with buses considered for clockwise circulation only. Crossovers and Driveway Access (heavy duty crossing)
Design Vehicle	12.5m bus for proposed bus route (clockwise circulation within site) 12.5m heavy rigid vehicle (HRV) accessing Lot 104 from Spine Street. 8.8m medium rigid truck for all other movements.
Design Speeds	Design – 50KPH
Design Traffic Loading (Equivalent Standard Axle)*	Spine Street – 3.0×10^6 ESAs Park Street, Plaza Street, Retail Street – 8.7×10^5 ESAs
Pavement Design Life	40 Years
Design Subgrade California Bearing Ratio (CBR)	CBR 5**

* As provided by the Traffic Engineer. Assumptions as follows:
- Austroads Guide to Pavement Technology Part 2: Pavement Structural Design (2012)
- 5% heavy vehicles, 1% annual growth, 2.1 axle groups per heavy vehicle, 0.6 ESA/HVAG

** As nominated in the Preliminary Geotechnical Report

2.4.3 Design Gradients

The design gradients for roads and footpaths shall be in accordance with the Ryde City Council Environmental Standards Development Criteria, Section 4, Public Civil Works (draft).

Refer to Civil Engineering drawings for design grading.

2.4.4 Materials

Pavement materials shall be in accordance with the Ryde City Council Environmental Standards Development Criteria, Section 4, Public Civil Works (draft). Refer to the Civil Engineering drawings for typical construction details.

2.4.5 Roads and Pavement Proposal

The road design includes internal roads and intersections with existing roads external to the site. These are described in further detail below (to be read in conjunction with the design drawings):

Spine Street:

The Spine Street is a 520m long collector road which will provide all vehicular access to the site via Epping Road to the south and the Wicks Road and Waterloo Road intersection to the north. Spine Street is typically 6.5m wide (two lanes), with additional 2.5m parking lanes on each side for on-street parking and is to be surfaced with asphaltic concrete. Roadside footpaths are provided, other than where a detached shared use path is provided in public open space (Lot 111) on the eastern side of the road. The total road reserve width is generally 17.5m.

The road is generally crowned at 3% crossfall to direct surface water to dish drains on either side (separating the traffic lanes from the parking bays). 3% superelevation has been provided at the

two bends (both 90m radius) in line with AUSTROADS standards. Spine Street has a maximum longitudinal gradient of 7%.

A bus stop will be provided in each direction with suitable turning space and tactile indicators for disabled users, albeit the road longitudinal gradient does not allow for these stops to be fully compliant with the Accessible Bus Stop Guidelines which are aligned to the Disability Discrimination Act (DDA).

Spine Street has two internal road intersections and access to residential development lots are provided as vehicular crossovers. Where development lots are separated from the Spine Street carriageway by the public open space (Lot 111), driveway crossovers will be constructed from the road carriageway to the development lot boundaries. It is proposed that the crossovers are located within the road reserve rather than crossing the public open space.

Park Street / Plaza Street / Retail Street

Park Street, Plaza Street and Retail Street join together to form a two way loop road.

Park Street is 170m long and joins Spine Street to Plaza Street. The road is 6.5m wide (two lanes), will have 2.5m wide parking lanes and will be surfaced with asphaltic concrete. A 4m wide shared use path on the northern side, and a 2m footpath on the southern side will be provided to give a total road reserve width of 17.5m. Park Street has a maximum longitudinal grade of 4.5% to the west, reducing to 2% in the eastern portion.

Plaza Street is 70m long and joins Park Street to Retail Street with right-angle bends at either end. The road 9.75m wide, consisting of two general traffic lanes and a bus lane. Plaza Street is proposed to have 2.5m wide footpaths on each side to give a total road reserve width of 14.75m. The road crossfall is designed to slope westwards to assist drainage but has relatively flat longitudinal grades of 1%. Plaza Street will have a natural stone pavement (granite cobbles or similar - refer to Landscape Architect details). A single DDA compliant bus stop will be provided on the eastern side of the road noting that buses will be required to use the loop road in a clockwise direction.

Retail Street is 140m long and is located within the proposed 'mixed use' zoned area of the site (between Lots 104 and 105). The 6.5m wide road has 2.5m wide parking lanes and 4m wide footpaths on each side to give a total road reserve width of 19.5m. It has a longitudinal gradient of 1.5% to the east increasing to 5% where it intersects with Spine Street. Retail Street will have an asphaltic concrete surface.

Future Connecting Road

Provision has been made in the design for a potential future connecting road to be constructed within Lot 109 to connect Spine Street (via the industrial land to the west of the Site) to Wicks Road. Lot 109 is 17.5m wide, consistent with other road reserves in the proposal, to allow for a road and intersection to be designed in the future. It should be noted however, that this road does not form part of this SSD application.

2.4.6 Intersections

Wicks Road / Waterloo Road:

The Spine Street will join the existing priority T-intersection of Wicks Road and Waterloo Road to form a four-way intersection. It is proposed that the new intersection will be controlled by traffic signals including controlled crossings for pedestrians and cyclists (providing continuity of the existing cycle paths to those provided within the site). In order to provide the number of traffic lanes required from the TMAP report, part of Wicks Road will be widened on the north western side, and will be regraded to remove a localised low point. It is anticipated that the Wicks / Waterloo intersection will be the main vehicular ingress and will be the only vehicular egress from the site.

Epping Road:

Entry to the site will be provided from the southbound carriageway of Epping Road between the Wicks Road and Delhi Road intersections. A deceleration lane will be formed by elongating the existing service lane providing access to the existing retail outlets on Epping Road. This intersection will only provide for left turns into the site. As such, the section of Spine Street joining Epping Road will be one-way (northbound only) up to the proposed vehicular entry to Lot 104.

It is further proposed that the existing Epping Road service lane will be narrowed with kerb blisters to provide a continuous width of approximately 3.5m. Footpaths will be modified to suit these modifications. The existing bus stop will be relocated to the closest suitable alternative point and will be DDA compliant, with the exception of being on a steeper than desirable longitudinal gradient. Alternative locations have been considered, however moving the stop further to the west to the nearest point where the road is at the maximum desirable gradient would put the relocated bus stop within 200m of an existing stop further to the west and would reduce accessibility to the existing retail on Epping Road and to the M2 Site.

Pedestrian facilities:

Pedestrian footpaths and crossings will be provided within the site. Additionally, the existing footpath along the northern side of Epping Road, which is narrow and in poor repair will be reconstructed and widened as part of the works.

2.4.7 Parking and Signage

On-street parking is proposed to be provided on Spine Street, Park Street and Retail Street. Refer to the signs and line-marking drawings in Appendix A for proposed parking layouts.

Sign design will be coordinated with street lighting poles where possible to avoid signage clutter in the footway.

2.5 Utility Services

The Site will be supplied with electricity, potable water, sewer, gas and telecommunications services in accordance with the relevant authority requirements. Street lighting will be provided for the roads and public open spaces in accordance with City of Ryde Council standards. All services will be located within the road reserve verges and footpaths, except for sewerage, which is proposed to be located in the public open space (Lot 111) and along the western site boundary.

Some lead-in works to augment existing services adjoining the Site are required. This is addressed under separate cover from this report.

2.6 WSUD and Stormwater Drainage

2.6.1 Codes and Specifications

The stormwater design of the project will be carried out in accordance with the relevant local, state and national design guidelines (where not over-ridden by Ryde City Council requirements) and Australian Standard Codes of Practice including but not limited to the following:

- AS 3500.3.1 National Plumbing and Drainage Part 3.1:
Stormwater Drainage – Performance Requirements
- AS 3500.3.2 National Plumbing and Drainage Part 3.2:
Stormwater Drainage – Acceptable Solutions
- Australian Rainfall and Runoff (AR&R)
- Landcom WSUD guidelines

- City of Ryde Council
 - Development Control Plan 2010
 - North Ryde Station Precinct – Development Control Plan 2013
 - Environmental Design Guidelines – Civil Works (draft)
 - Engineering Standard Details

2.6.2 Design Criteria

The following design criteria have been adopted for stormwater design:

Table 4 Stormwater Drainage Design Criteria	
Parameter	Design Criteria
Drainage	
Drainage design	Rational Method in accordance with Australian Rainfall & Runoff (AR&R)
Minor Design Storm – network design	M2 Site – 20 YR ARI storm event (Council standard is 50 YR ARI, however it has been agreed previously that 20 year ARI is appropriate in a masterplanned and controlled development of this nature). 100 YR ARI storm event has been adopted for network design in the area adjacent to Porters Creek to minimise overland flow affecting the Wicks Road / Waterloo Road Intersection.
Major Design Storm - overland flow	100 YR ARI storm event
Pipe Sizing	Minimum diameter - 375mm Minimum grade 0.5%. Maximum grade to be selected to comply with maximum velocities (as below).
Pipe Velocities	Minimum 0.8 m/s. Preferred Minimum 1.0 m/s Maximum 7.0 m/s. Preferred Maximum 5.0 m/s
Water Quality*	90% reduction of Gross Pollutants 85% reduction of Total Suspended Solids 65% reduction of Total Phosphorus 45% reduction of Total Nitrogen

* In accordance with the City of Ryde DCP (2010) and Landcom WSUD guidelines

Refer to the RBG Stormwater Management Plan for details of the Water Sensitive Urban Design (WSUD) and stormwater management strategy.

The principles for the site stormwater management are summarised as follows:

- The proposed design does not include On-Site Detention (OSD) for the road reserve and public open spaces, based on the findings of the Cardno study. OSD will also not be required for private allotments unless the proposed development exceeds the maximum impervious ratio which has been defined for each type of land use.
- Public domain (parks and road reserve) runoff shall be directed to WSUD elements, specifically bio-retention tree pits or rain gardens. WSUD elements shall provide treatment to meet best practice water quality targets. Subsoil and overflow connections shall be provided from WSUD elements to the in-ground drainage network;
- Development lot proposals will be required to demonstrate that they meet the appropriate water quality objectives.

2.7 Flood Risk

The *Macquarie Park Floodplain Risk Management Study & Plan* by Bewsher Consulting, April 2010 (Bewsher 2010 Report) provides flood mapping for Porters Creek and Lane Cove catchments, including flood levels and extents. The Bewsher 2010 Report was sourced from the City of Ryde Council website.

The Bewsher Report indicated localised flooding risk to the north of the site in the bushland adjacent to Porters Creek (proposed bushland reserve, Lot 101) and along the western site boundary. An inter-allotment stormwater drainage pipe and overland flow path within a drainage easement will be provided along the western boundary, which will outfall into Porters Creek, east of the Spine Road culvert and will alleviate potential flooding in the western allotments.

The bushland reserve (Lot 101) adjoining Porters Creek will be subject to a minor increase in the flood level. However, it has been established by the Cardno study that there is no adverse affect to adjoining or downstream properties.

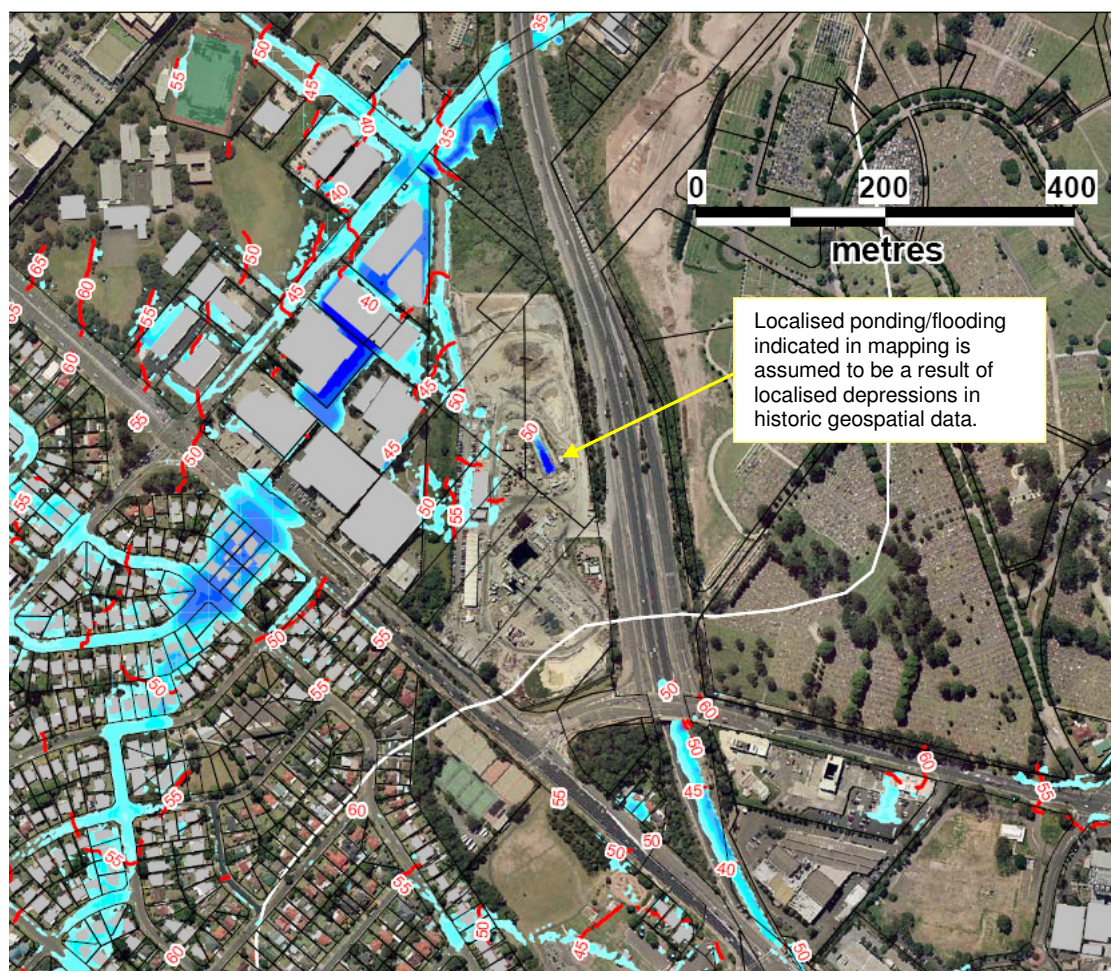


Figure 2.1 - Extract from Figure 8.5 Simulation of 100 Year ARI Flood (Bewsher 2010 Report)

3.0 Safety In Design

An initial Safety In Design (SID) risk assessment was carried out by RBG on 1 April 2014, based on the architectural layout for the site and the initial civil design drawings and sketches. The assessment utilised the RBG standard SID toolkit which identified a number of standard hazards associated with civil engineering projects and prompted the designers to consider specific examples of hazards which exist in the context of the project during construction, use, maintenance and decommissioning. Mitigation measures were considered for each hazard and risk scores were assigned based on a combination of the likelihood that the hazard will cause harm and the most probable severity of harm. Hazards were then categorised as low, moderate, significant or extreme based on their risk score.

Three non-standard hazards have been identified relating to the civil design for the Site and are detailed below. It should be noted that the concept design has not been subject to a Road Safety Audit at this stage.

3.1 Conflicts at ‘Mews Road’ Driveway Crossovers

The residential allotments on the eastern side of the Spine Street (Lots 201 to 204) are accessed via four driveway crossovers adjoining the Public Open Space (Lot 111), which are expected to link to future ‘Mews Roads’ and parking facilities within the allotments. Each allotment is likely to generate significant traffic movements, whilst the Public Open Space is intended to attract pedestrian and cyclist use generating the potential for conflicts between users in these areas.

Measures considered in concept design: A roadside footpath has not been provided, but a shared path has been provided within the Public Open Space. Where the shared path and driveway crossovers intersect, surfacing materials will indicate continuity of the shared path and therefore highlight the requirement for vehicles to give way to cyclists and pedestrians. The shared path crossings will be a minimum of 5.0m from the Spine Street carriageway to maximise visibility and give space for a vehicle turning off the Spine Street to wait for pedestrians and cyclists to cross without impeding Spine Street traffic. Signs will be provided on Spine Street to warn drivers of the potential for cyclists and pedestrians crossing the driveway crossovers.

Further measures required at detail design: The concept design should be subject to a Road Safety Audit and findings incorporated into the detail design.

3.2 Access to Lot 104 from Spine Street

For safety reasons, the Epping Road end of the Spine Street can only be used by vehicular traffic for entry to the site, ie left turn only from Epping Road to Spine Street. The mixed use allotment (Lot 104) at the southern end of the site is to be provided with access to and from the section of Spine Street which requires one-way access from the south (Epping Road) and two-way access to the north. Noting that these access points could be used in the future for access to car parks or loading bays, the above requirements could potentially create confusion about whether vehicles are able to access Epping Road from Spine Street.

Measures considered in concept design: The arrangement of the Lot 104 driveway crossovers from Spine Street has been designed to allow entry by large vehicles (up to 12.5m trucks) from both south (Epping Road) and north directions, with channelised turning lanes. The arrangement provides a physical restriction to deter southbound vehicles from continuing past the lot entry and attempt to illegally gain access to Epping Road. This is to be reinforced use of ‘no entry’ signs. Vehicles exiting Lot 104 will be required to turn right onto Spine Street northbound, which will also be enforced using signage.

Further measures required at detail design: The concept design, including all proposed signage should be subject to a Road Safety Audit and findings incorporated into the detail design.

3.3 Roadside Hazard Assessment

The roadside environment will consist of street furniture (including sign posts and lighting poles), landscaping, structures and buildings. The placement of standard street furniture within the road reserve is consistent with the speed environment (50km/h speed limit) and does not present a

significant or unusual hazard. Future buildings will be subject to standard set back requirements and are also not considered to require any protection measures.

A culvert headwall discharging to Porters Creek is proposed to be constructed adjoining Spine Street at the northern end of the site. The headwall will be a minimum of 7.3m set back from the road carriageway and is approximately 10m long with a maximum vertical face height of up to 4.0m. The vertical drop and potentially high flows of water within Porters Creek would present hazards to an errant vehicle which leaves the Spine Street.

Measures considered in concept design: The use of crash barriers to prevent errant vehicles from accidentally being propelled over the culvert headwall has been considered against the RTA Austroads Guide Supplement (RTA/11.097). The 4m vertical drop to water has a maximum severity index of 7.5. The number of collisions per year has been calculated as 0.021 based on the road geometry (including the curvature of the road and the width of the verge) as the designed verge width provides an opportunity for the majority of errant vehicles to stop or steer back to the road before impacting the hazard. The combination of severity index and frequency of collisions categorises this hazard as being 'low risk'.

An independent check has been carried out against the 'Clear Zone' methodology described in Austroads Guide to Road Design (Part 6: Roadside Design, Safety and Barriers), which calculates a clear zone of 6.75m for the intended road geometry. The clear zone is the area adjacent to the traffic lanes which should not contain unprotected significant hazards.

Due to the low risk of errant vehicles driving over the headwall, it is not proposed to provide a crash barrier in this location.

Further measures required at detail design: The concept design should be subject to a Road Safety Audit and findings incorporated into the detail design.



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