

Macquarie Centre Redevelopment Stage 1 Concept DA

Flooding and Stormwater Management Report

December 2015

AMP Capital

Mott MacDonald

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Contents

Chapter	Title	Page
1	Introduction	1
2	Design Criteria	3
2.1	Council documentation	3
2.2	Water sensitive urban design	3
2.3	Floodplain risk management	3
3	Source Data	4
3.1	Council Data	4
3.2	Survey	4
3.3	Other data	4
3.3.1	Current Architectural Drawings	4
3.3.2	Information on Previous works	4
4	Existing Site Condition	5
5	Stormwater Management	6
5.1	Water Quantity	6
5.1.1	Existing System	6
5.1.2	Proposed System	8
5.1.3	On Site Stormwater Detention Basin (OSD)	10
6	Flood Risk	11
7	Water Quality	13
7.1	Water Quality Objective	13
7.1.1	Potential water quality improvement devices	13
7.2	MUSIC Model, Parameters, and Methodology	14
7.3	Proposed Treatment	16
7.4	Water Quality Analysis Results	17
7.5	Water re-use	18
8	Summary	19

Figures

Figure 4.1:	Site Location	5
Figure 5.1:	Existing catchment delineation	7
Figure 5.2:	Proposed catchment delineation	9
Figure 6.1:	Entry Ramp Locations	12
Figure 7.1:	Pre Development Music Model	16
Figure 7.2:	Post Development Music Model	17

Tables

Table 1.1: Overview of Indicative Mix of Land Uses 1
Table 1.2: Shrimptons Creek Levels Adjacent Macquarie Centre 2
Table 3.1: Site Survey 4
Table 3.2: Details of Previous Works 4
Table 6.1: Minimum Basement Entry Ramp Levels 11
Table 7.1: Site Area Breakdown for Water Quality Modelling 15
Table 7.2: Development Classification of Music Nodes 15
Table 7.3: Music Model Results 18
Table 7.4: Rainwater Tank Parameters 18

1 Introduction

This report has been prepared on behalf of AMP Capital (AMPC) in support of a Stage 1 Development Application (DA) for the mixed use redevelopment of Macquarie Shopping Centre (Macquarie Centre). The Stage 1 DA seeks concept approval for the redevelopment of Macquarie Centre by establishing:

- Building envelopes and design parameters for future development on the site, including the proposed uses within the podium and tower components.
- The distribution of floor space across the site.
- Future pedestrian and vehicle connections to and within the site.

This report supports the proposed future redevelopment of the Macquarie Centre in relation to flooding and stormwater management.

The Stage 1 DA seeks concept approval for the mixed use redevelopment of Macquarie Centre under s.83B of the *Environmental Planning & Assessment Act* 1979. The first stage will seek concept approval only for:

- Mixed use development to enable a range of land uses. The final mix of land uses will be subject to and determined under the relevant Stage 2 detailed DAs.
- Building envelopes for the proposed basement, expanded podium and tower forms.
- The four tower envelopes fronting Herring Road will have maximum heights ranging from 90m and 120m above existing ground level. The building envelope for Tower 1 is of sufficient dimensions to accommodate alternate tower forms.
- Maximum additional gross floor area (GFA) of 148,000sqm.
- The new retail podium along Herring Road will replace the existing structure. This will provide an active frontage with separate pedestrian entries to Herring Road and the creation of a vibrant atrium space.
- The creation of 'Station Plaza' between the train station and shopping centre, framed by active uses and a landmark building known as the "Shard".
- The building envelopes for the proposed basement and upper levels of the expanded podium will accommodate a maximum of 2,175 additional car spaces.
- New vehicle and pedestrian access points.

The Stage 1 DA does not seek approval for

- Any works, including demolition, excavation, construction and public domain improvements.
- The final arrangement of land uses.
- Layout, mix and number of residential units.
- A specific number of car spaces (as this will be determined having regard to the final mix of land uses).
- The design of the building exteriors including facades and roofs.
- Public domain and landscape design.

Such approvals will be sought via subsequent development applications following receipt of development consent for the Stage 1 DA. The overview of the indicative mix of land uses within the proposed building envelopes is identified in Table 1.1 below:

Table 1.1: Overview of Indicative Mix of Land Uses

Component	Proposed
Basement	Loading docks, car parking and associated vehicle circulation, waste rooms, utilities, future connection to existing train station (subject to consent from RailCorp) and retail premises.
Podium	Retail premises, commercial premises, food and drink premises, entertainment facilities (indoor), recreation area, car parking and associated vehicle circulation, community uses (subject to further discussions with

Component	Proposed
	Council) and communal open space associated with the towers.
Tower 1	Mixed use development comprising commercial premises and/or residential accommodation and/or serviced apartments above a retail podium.
Towers 2, 3 and 4	Mixed use development comprising residential accommodation and/or services apartments above a retail podium.

Source: Urbis support documentation for the Macquarie Centre Redevelopment

The existing stormwater system was reviewed for the proposed redevelopment. Based on the findings of Bewsher's report titled *Macquarie Park Floodplain Risk Management Study and Plan (September 2010)* and other works Mott MacDonald has completed in the area; we understand the subject site to be flood affected by the adjacent Shrimptons Creek.

A review of the Ryde City Council flood maps has indicated the following flood levels are relevant to the subject site:

Table 1.2: Shrimptons Creek Levels Adjacent Macquarie Centre

Location	20% AEP Level	1% AEP Level	PMF Level
Talavera Road D/S	37.50	37.80	38.50
Waterloo Road D/S	41.20	41.00	41.30
Waterloo Road U/S	42.10	42.15	42.20

Source: Bewsher Macquarie Park Floodplain Risk Management Study and Plan for Ryde City Council (The above levels are based on a culvert blocked scenario)

This report will address the immediate flooding issues associated with the proposed development. The analysis will be used to demonstrate the re-development presents no adverse impact on the flooding conditions of adjacent sites.

The scope of this report is to:

- Analyse the extent and impact of flooding within the site in a pre-to-post scenario and confirm if the existing stormwater system has sufficient capacity to convey runoff from the proposed re-development;
- Demonstrate that the necessary requirements associated with floodplain risk management principles have been identified and that the proposed development complies with these requirements; and
- Analyse the existing stormwater system and note changes needed in order to meet the requirements of Ryde City Council's Development Control Plan.
- Determine the water quality impacts and propose an appropriate arrangement of water quality features as required to achieve pre-post improvement in water quality discharge from site.
- Optimise the water-balance on site, through analysis and recommendations on the use of rainwater tanks for water reuse.

2 Design Criteria

The following documentation was used to guide the analysis of the water-cycle management for the proposed Macquarie Centre redevelopment.

2.1 Council documentation

- Council's Requirements for Stormwater Management are set out in Section 8.2 of the Development Control Plan 2014 (DCP2014).
- Council's Requirements for water quality are set out in Water Sensitive Urban Design Guidelines (adopted 26 May 2015).
- Council's Stormwater and Floodplain Management Technical Manual

2.2 Water sensitive urban design

- DECC NSW Managing Urban Stormwater: Soils and Construction Volume 2
- Engineers Australia Australian Runoff Quality A guide to Water Sensitive Urban Design
- LANDCOM NSW Managing Urban Storm Water: Soils and Construction Vol 1

2.3 Floodplain risk management

- The NSW government's guidelines; Floodplain Development Manual (2005), and the Practical Consideration of Climate Change (2007).
- Engineers Australia Australian Rainfall and Runoff A Guide to Flood Estimation

3 Source Data

3.1 Council Data

The following Council documentation was obtained through the Ryde City Council website, and through direct consultation with Council Officers:

- Extracts from Council's stormwater pipe database for part of Waterloo, Herring and Talavera road reserves;
- *Macquarie Park Floodplain Risk Management Study and Plan* (Bewsher 2010), adopted by Council;
- City of Ryde DCP (2014); and
- City of Ryde WSUD Guidelines (May 2015).

3.2 Survey

The survey information below provided by AMP was used to compile the base scenario for the investigation.

Table 3.1: Site Survey

By	Date of Survey	Description	Drawing Reference
William L. Backhouse Pty Ltd	Oct 2015	Preliminary survey for Macquarie Centre	CH4090A3

3.3 Other data

3.3.1 Current Architectural Drawings

Allen Jack and Cottier Architects provided copies of architectural concept drawings DA0000 Rev 1 to DA3103 Rev 1 dated 26 November 2015. Additional information on the composition of each proposed tower has been provided to estimate the future demands of the development.

3.3.2 Information on Previous works

Mott Macdonald has completed previous investigations into drainage and flooding in the vicinity. Listed below are examples of previous work with immediate relevance to the current proposal. Some of these findings have been used in the preparation of these works.

Table 3.2: Details of Previous Works

Title	By	Date	Description
Macquarie Centre Extension Interim Local Stormwater Drainage Report	Mott MacDonald	June 2010	Investigation of local drainage issues
Macquarie Centre Carpark Flood Protection Investigation Report	Mott MacDonald	Jan 2014	Eastern carpark and Link road investigation

4 Existing Site Condition

Macquarie Centre is approximately 11.25 hectares in area and is located at the corner of Waterloo Road, Herring Road and Talavera Road, Macquarie Park. The site is legally described as Lot 100 in DP 1190494.

The site is bound by Herring Road to the north west, Talavera Road to the north east, commercial uses to the south east and Waterloo Road to the south west. Located within the Macquarie Park Corridor, the site has excellent access to public transport, situated immediately adjacent the Macquarie University Railway Station and the Herring Road Bus Station. Located between the M2 Hills Motorway and Epping Road, the site also enjoys excellent vehicle connectivity.

Macquarie Centre was originally constructed in 1981. The centre has undergone various stages of redevelopment and extensions. A major refurbishment occurred in 2000, 2003 and most recently in 2014, creating a fresh food court, David Jones expansion, addition of second full line supermarket (Coles), a value supermarket (Aldi), with new speciality food and convenience stores. Today Macquarie Centre is the largest shopping centre in NSW and the 8th largest shopping centre in Australia and includes a wide range of retail, entertainment and service offerings.

The shopping centre currently spans five levels accommodating 368 stores, including major retailers such as David Jones, Myer, Target, Big W, Aldi, Coles and Woolworths. The centre also houses a large number of mini major international retails stores including H&M, Zara, Uniqlo, Forever 21, GAP and Sephora. A number of entertainment offerings exist in the centre including a cinema complex and ice skating rink. The site currently has a gross floor area of 170,850m^2 and accommodates 4,755 car spaces.

The site is subject to flooding constraints due to the immediate proximity to the Shrimptons Creek flow regime. The section of creek line under the Macquarie Centre has been replaced with a large box culvert system. The box culvert system runs from Waterloo Road under the main carpark access road (Link Road) to Talavera Road. Several side lines draining the Commercial buildings and carparks connect to this culvert. Historical records show that the creek has on occasion flooded along this road through Macquarie Centre. The proposed major civil works are predominantly to the west of the box culvert, with modifications to the east of the culvert only occurring on the upper floor levels of the existing structures.

Figure 4.1: Site Location

Source: *Six maps* Imagery (2015)

5 Stormwater Management

5.1 Water Quantity

The catchments surrounding the subject site contributing runoff to Shrimptons Creek are managed with the major/minor approach to stormwater drainage. The piped system within the Council Roads is suitable for the hydraulic load from minor events, with Average Recurrence Intervals (ARI) of up to 20 years. The major event flows result in a drowned pipe network, with significant flow paths associated with each of Waterloo, Talavera and Link road reserves.

5.1.1 Existing System

Catchments

The existing catchments of the formal drainage infrastructure at the site comprise approximately 2.6 ha of predominantly impervious area (95%). The catchment break-up was determined based on field inspection, survey information and Council's records of stormwater assets. The catchments are shown on Figure 5.1 below.

Figure 5.1: Existing catchment delineation

Source: *Mott MacDonald Hydraulic Model* (2015)

Hydraulic Model

The hydraulic model used in analysis of the site was built upon survey data, Council database information on drainage infrastructure and observations of conditions on site. DRAINS software was used to perform the hydraulic calculations to determine the capacity of the piped system and performance of overland flow channels through design rainfall events. The existing piped system generally meets the requirements of

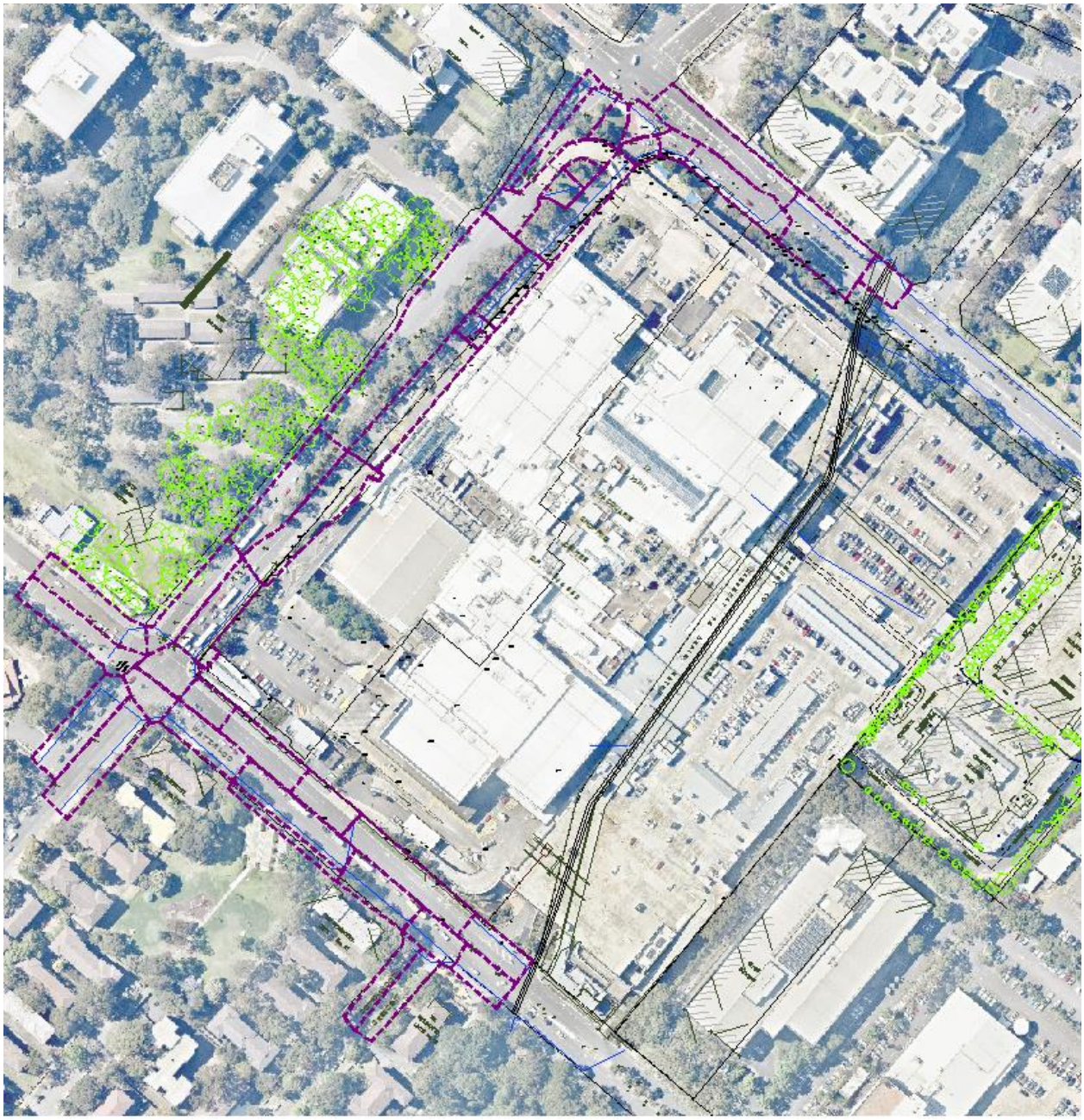
Council for piped flow, however in some areas the pit inlet capacity is considered to restrict the performance of the minor system.

5.1.2 Proposed System

Catchments

The catchment breakup for the site based on the concept Architectural Plans is shown on Figure 5.2 below. The impervious area is reduced in the proposal such from 95% in the existing case to approximately 90% through the provision of landscaped areas. With the kerb and gutter modifications required for the proposed case, an increase in the number of inlet pits is recommended. The full scope of pipe modifications and provision of new pits is subject to the condition of the existing pipes. This is to be confirmed in the detailed design stage with further survey of the existing piped system.

Figure 5.2: Proposed catchment delineation



Source: *Mott MacDonald Hydraulic Model* (2015)

Hydraulic Model

The hydraulic model built for the existing scenario was modified to determine the necessary piped infrastructure to inform the civil design of the site and surrounding Council Roads. Current connections of site catchments directly to the large culvert beneath Link Road were maintained in the proposed case, assuming catchment runoff from the site is accommodated by existing piped connections beneath Macquarie Centre.

5.1.3 On Site Stormwater Detention Basin (OSD)

Local context

Through analysis of the current flow regime at the Macquarie Centre; survey and Council records were inspected to gather information on the existing stormwater infrastructure. The available documentation of existing stormwater infrastructure on the site did not reveal any current provisions for On-Site Stormwater Detention.

Based on the concept proposal as documented in the Architectural plans, impervious areas on-site will be reduced with the redevelopment of the Macquarie Centre.

Regional context

Considering the flow management of the Shrimptons Creek catchment in its entirety, the critical point in terms of the providing drainage infrastructure to minimise flood risk is the drainage culvert between Waterloo and Talavera Roads. In this location the Shrimptons Creek channel is constricted by the existing Link Road, limiting the flow capacity of the channel. Located towards the lower extremity of the catchment with respect to this critical point, it is considered that the provision of on-site detention could potentially worsen the peak flows by attenuation of local site flows to coincide with the peak runoff from the larger upstream Shrimptons Creek catchment.

Recommendation

As stormwater detention is not required to manage the peak flows in the proposed case with respect to the existing scenario, and the provision of detention could worsen flooding through the coincidence of flood peaks, it is recommended that no stormwater detention facilities be installed as part of the Macquarie Centre redevelopment.

6 Flood Risk

The subject site and surrounding areas within Council road reserves are exposed to the major flow regime of Shrimptons Creek presenting flood risk to people and vehicles. The wider catchment of Shrimptons Creek from upstream of Waterloo Road contributes runoff from approximately 550 ha of predominantly residential land, with significant portions of mixed, business park and commercially zoned land. The published flood study *Macquarie Park Floodplain Risk Management Study and Plan* (Bewsher, 2010) indicates the predicted flood response to major storm events in the vicinity of the site. Based on review of this flood study, areas of Waterloo Road and Talavera Road pose significant risk to both people and vehicles in major flood events.

Mott Macdonald has performed an analysis of the Macquarie Centre concept proposal to identify key elements of the design to be considered for potential flood risk. Basement carpark entry levels were assessed through 1d flow path analysis to determine minimum levels such that each entry will not be susceptible inundation for all storm events up to and including the PMF.

Flood warning and evacuation

The existing carpark and loading dock areas with access from Link Road, Waterloo Road and Talavera Roads are exposed to inundation during major flood events. The proposed basement carpark in the western portion of the site is essentially an extension of the existing carpark with entry of the southern end of Link Road. It is recommended that the flood warning and evacuation measures in place for these existing carparks shall be expanded to cover the new carpark.

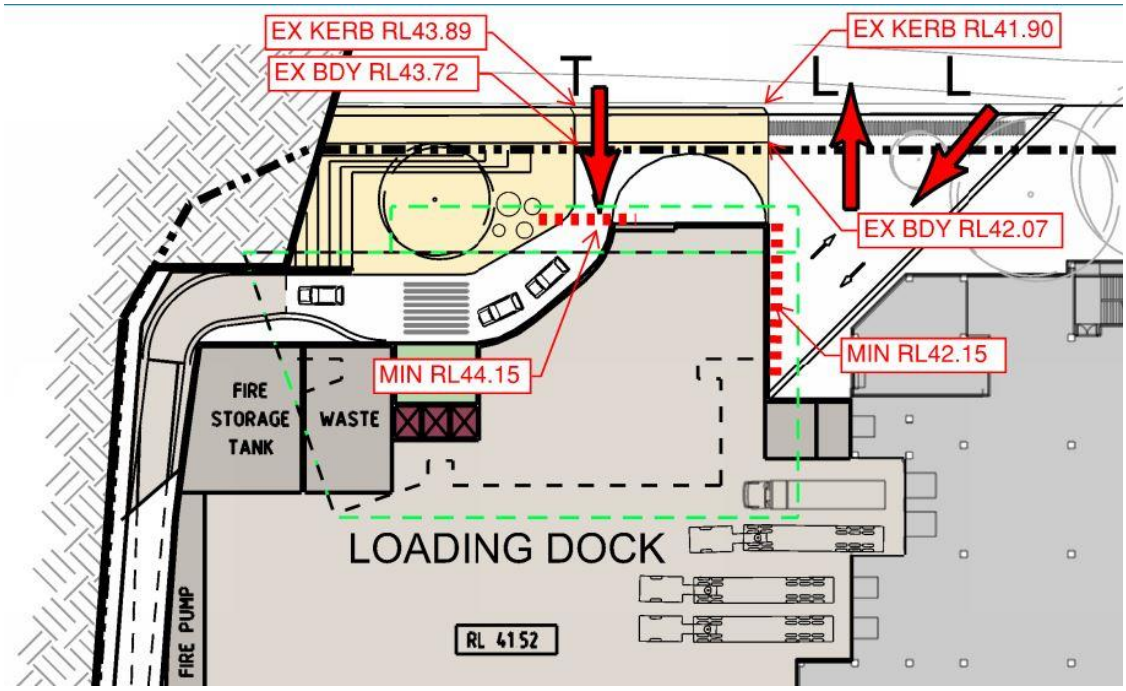
Flood hazard elimination

To eliminate flood hazards in underground structures, the following levels in Table 6.1 can be adopted as the minimum ramp levels for the following underground entrances. The levels for the Northern Tower Carpark and Loading Dock entry ramps are indicated in plan on Figure 6.1 following.

Table 6.1: Minimum Basement Entry Ramp Levels

Basement Carpark	Entry ramp location	Minimum Level (m AHD)	Flood protection level
Western Carpark below the Macquarie Centre redevelopment	Northern Tower Carpark ramp entry at Talavera Road	44.15	PMF, 100yr + freeboard
	Northern Loading Dock ramp entry at Talavera Road	42.15	PMF, 100yr + freeboard
	Southern ramp entry from existing carpark	40.50	PMF, culvert blockage
Central Carpark and Loading Dock adjacent Link Road	Northern Loading Dock entry at Talavera Road	NA	Ramp protection not practical

Figure 6.1: Entry Ramp Locations



Source: Architectural Level 1 Plan extract

It should be noted that the above level of 40.50m for the southern ramp entry is not achieved for the existing carpark at the south, adjacent Waterloo Road. As discussed above, the proposed carpark beneath Macquarie Centre is an extension from an existing carpark subject to flooding. Access ramps meeting the above minimum level is an option to consider in order to manage the flood inundation hazard. This option should be considered with regard to the likelihood of extreme events and the effectiveness of the flood warning and evacuation plan developed for the site.

Residual flooding issues

Depending on the ramp arrangements and basement carpark levels with respect to the above minimum ramp levels, flood waters entering underground carparks may need to be captured and pumped out. Whilst potential connections to the downstream system exist within the extent of the site, any pumped system will require periodical maintenance.

Existing flood hazard measures

Previous modifications to existing carparks made to reduce flood hazards will be maintained through the Macquarie Centre redevelopment. Vehicle barriers installed to prevent vehicle transportation by flows during major events will be replaced with new barriers to suit the proposed access arrangements for carparks and loading docks.

7 Water Quality

A review has been undertaken to assess the effects of the proposed re-development works on the level of stormwater quality leaving the site. Further assessment has also been undertaken to explore options with providing rainwater tanks as part of the proposed development and are discussed further below.

7.1 Water Quality Objective

The proposed re-development area forms a smaller part of the overall Macquarie Centre Site. The existing site is comprised of a number of parking facilities, general retail areas and is largely developed. The proposed re-development generally replaces large portions of these existing hardstand areas with new buildings as such the site works have been assessed to ensure no worsening of both stormwater runoff and water quality.

To demonstrate compliance with these objectives, treatment removal loads were analysed from pre to post development scenarios using MUSIC (Model for Urban Stormwater Improvement Conceptualisation) Version 6.1 software. Model development and results are discussed in section 7.4.

7.1.1 Potential water quality improvement devices

The following list of custom in-situ and proprietary devices can be implemented to reduce pollutants from the site runoff. To achieve the optimum performance a number of devices can be used in sequence to form a treatment train to remove pollutants as necessary.

Rainwater Tanks

Rainwater tanks are sealed tanks designed to retain rainwater collected from roofs for subsequent re-use on site. In developing a MUSIC model for the proposed site, a portion of roof water from the buildings would be modelled to discharge directly to rainwater harvesting tanks. Water demand rates for the development are then defined based on assumed re-use rates in order to attain the most efficient water usage on site.

Bioretention Swale

Bioretention swales can be installed to treat surface runoff from the site catchments. Bioretention systems typically contain an extended detention zone above a filter layer in the order of 100-300mm in depth and can contain water tolerant plant species to facilitate additional nutrient removal. Sediments and attached pollutants (including nutrients, metals and other soluble pollutants) are removed via filtration through the vegetative surface layer and filter media below.

Gross Pollutant Traps

Surface inlet pits within proposed hardstand areas of the site can be provided with pit inserts including oil absorbent media. The pit inserts sit beneath the stormwater pit grates and collect gross pollutants and

larger sediments. Similarly, inserts can be located at each downpipe / rainwater tank connection to treat runoff from the new roofed areas prior to re-use or discharge to the site trunk pit and pipe network. Many proprietary products are available such as the Enviropod by Stormwater360 which quotes the following removal rates in combination with Stormfilter cartridges:

- Suspended Solids, 54%
- Phosphorus, 30%
- Nitrogen, 21%
- Gross Pollutants, 100%

Filtration devices

Filtration devices are provided as an end of line treatment device to treat stormwater runoff from the proposed development. These systems target a full range of pollutants including total suspended solids, soluble heavy metals, oil and grease, and total nutrients. Proprietary products are generally scalable such that the appropriate runoff flow can be effectively treated. An example of a cartridge filter device is the StormFilter by Stormwater360. Each StormFilter cartridge has a treatable flow rate of 1~1.6L/s and is designed to capture and treat the “first flush” volume of a rainfall event. Supplied product information on the removal rates for pollutants is as follows:

- Suspended Solids, 73.5%
- Phosphorus, 49%
- Nitrogen, 32%
- Gross pollutants, 95%

7.2 MUSIC Model, Parameters, and Methodology

A water quality modelling tool, MUSIC was utilised to simulate urban stormwater systems operating at a range of temporal and spatial scales. MUSIC models the total amounts of gross pollutants and nutrients produced within various types of catchments. It allows the user to simulate the removal rates expected when implementing removal filters to reduce the increased gross pollutant and nutrient levels created by the proposed development.

The following methodology and parameters were incorporated in the MUSIC modeling:

- The MUSIC model was created to assess the effectiveness of water quality improvement devices which are proposed as part of the proposed development;
- In accordance with Council’s requirements, pluviograph data from 066037 Sydney Airport AMO (1988-1998) 6 minute interval was utilised within the model;
- Average Potential Evapotranspiration (PET) data for Sydney Region has been used in MUSIC;
- Two MUSIC models were setup to represent the pre-development site and post-developed site. From the concept architectural plans the site was then categorised into the following areas:
  - Roof;
  - Landscape areas; and
  - Road area.

Table 7.1: Site Area Breakdown for Water Quality Modelling

Site	Categories	Area (Ha)
Pre-Development	Roof area	1.79
	Landscape	0.13
	Road	0.70
Total Area (Pre-developed)		**2.62**
Post-Development	Roof Area	1.40
	Landscape Area	0.28
	Hardstand	0.51
	Road	0.43
Total Area (Developed)		**2.62**

The catchments of the pre and post development sites were determined through examination of the concept architectural plans. The layout of the model for the pre and post development scenarios is indicated in Figure 7.1 and Figure 7.2 respectively.

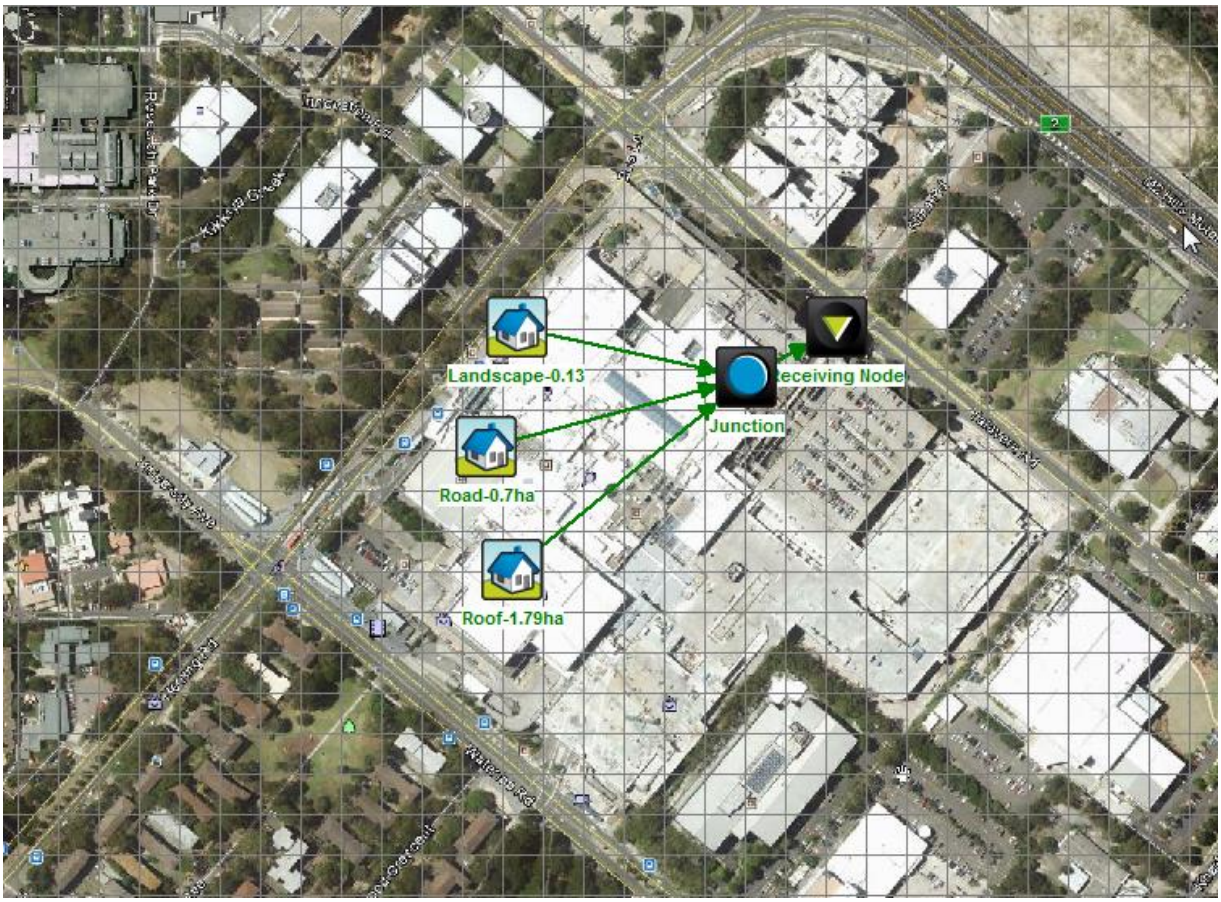
Pollutant concentration parameters used within the model were based on the recommended model defaults for different land use categories as specified in Council's MUSIC modelling guideline. These are summarised in the following table:

Table 7.2: Development Classification of Music Nodes

MUSIC Node	Category
Roof	"Roof Area"
Road	Road Area"
Hardstand	"Impervious Area"
Landscaping	"Pervious Area"

Source: City of Ryde Council's MUSIC Modelling Handbook (2009).

Figure 7.1: Pre Development Music Model



Source: Mott MacDonald Water Quality Analysis (2015)

7.3 Proposed Treatment

Upon analysis of the proposal, new landscaped areas within the site boundary will increase the natural filtration of runoff prior to entering the drainage system. Due to this increase in pervious areas the post-developed scenario is anticipated to have no negative impact on discharge water quality from the site. The increased provision of roof areas as opposed to road areas contributes to an improved water-cycle management strategy. The results of the pre-post assessment are provided below in Section 7.4.

Figure 7.2: Post Development Music Model

Source: Mott MacDonald water quality analysis 2015

7.4 Water Quality Analysis Results

Results of the MUSIC analysis indicate that the increase of pollution load from the proposed development without a pollutant treatment control is negligible in comparison with the pre-development site. This result is expected since the impervious percentage of the site area will be reduced through the provision of landscaped areas at the Herring Road level of the development as such no additional water quality treatment devices are proposed for the re-development works.

The provision of a rainwater tank discussed below in section 7.5; whilst not part of the stormwater quality treatment train, will also have a positive effect on pollution removal. Further consideration may be given to providing trash screens and GPT's within the drainage network during the detailed design phase of the project.

Table 7.3: Music Model Results

Pollutant	Pre-Development measures (kg/yr)	Post-Development with no WSUD measures (kg/yr)	Decrease in pollution Rate (%)
Total Suspended Solids	2,700	2,700	0
Phosphorus	6.39	5.95	6
Nitrogen	53	50.4	5
Gross Pollutants	603	566	6

7.5 Water re-use

Rainwater tanks are sealed tanks designed to retain rainwater collected from roofs for subsequent re-use on site. In developing the MUSIC model for the proposed site, a portion of roof water from the new buildings has been modelled to discharge directly to rainwater harvesting tanks. Water demand rates for the development have been defined based on assumed re-use rates in order to attain the most efficient water usage on site. The proposed development consists of 4 towers, including one commercial and three residential use.

A preliminary analysis based on estimated water demand indicates that rainwater storage totalling 50kL should be satisfactory:

- Site suppression= assumed 4 hours 12 times a year using 5m^3/h=240 kL/yr
- Irrigation = assumed 2,000m2 irrigation area at 0.01 kL/week/m2 = 1040kL/yr scaled by daily PET – Rain and distributed across the tanks.

In order to meet 90% reliability of satisfying the irrigation demand for reusable water on-site the rainwater tank was configured with the following parameters within the Music model.

Table 7.4: Rainwater Tank Parameters

Irrigation Area	Irrigation Requirement	Daily Demand	PET
2800m^2	10mm/m^2/week	3.9 kL/day	1040 kL/yr

8 Summary

The Macquarie Centre redevelopment as proposed by AMP Capital can be constructed in line with Council standards and relevant guidelines. The following list summarises the flooding and stormwater management issues to be addressed in detailed design.

Piped Drainage System

The existing piped drainage system in the road reserves surrounding the site is generally in accordance with Council's major/minor approach to drainage of urban areas. The proposed development will involve the addition of pit inlet capacity where kerb and gutter works will be completed. Depending on the existing condition of the piped stormwater infrastructure, some upgrades/replacement of Council drainage will be required.

Flood Risk

Existing flooding conditions in the vicinity of the site will be maintained with the redevelopment of Macquarie Centre. The proposal does not impact significantly on any major flow paths, and flood risk to people and vehicles across the site and surrounds is not worsened. In the event of major flooding, flood storage is not adversely affected by the proposal.

Water Quality

With the proposed changes in previous areas associated with the provision of landscaped areas, water quality improvement devices are not needed to improve water quality of site runoff.

Water re-use

The opportunity to re-use clean runoff from the roof structures on site provides better sustainability outcomes for the site. The management of water quality is also boosted with the incorporation of rainwater tanks as the clean water is separated from flows which transport pollutants.

Basement Carparks

Where it is practical, basement entry ramps will be provided to eliminate flood hazards. Where basement carpark levels are proposed to match in with existing carparks on site, the flood hazard management systems in place for the existing carparks shall extent to cover proposed carparks.