MOTT MACDONALD

SPG Bennett's Green

Stormwater Management Report

July 2018

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Contents

1 Introduction

Mott MacDonald has been commissioned by Blueprint to prepare a Stormwater Management report for the proposed development identified as Lot 1 DP1214343 Pacific Highway, Bennetts Green. This report will be lodged with Lake Macquarie City Council to support a Section 96 application for this development and details the modelling procedures and results obtained in developing the proposed water cycle management plan. A previous DA (DA/251/2013) was lodged for the site, however, due to an update to the site layout, a Section 96 application is required.

The advice outlined in this report and documented on Mott MacDonald drawings MMD-382538-C-DR-00-S96-0001 to 0221, aims to address the following engineering components:

- Understand the existing stormwater flow conditions for the site and determine requirements for post-development flows from regulatory authorities;
- Design a stormwater pipe network to convey flows throughout the site to appropriate discharge points including connecting to the existing network, where applicable;
- Assess the safety of the overland flows throughout the site; and
- Identify appropriate measures to satisfy Council's water quality and quantity requirements and determine the location and land area required to implement the measures.

The following analyses have taken into consideration the economical, engineering, environmental and social aspects of the works throughout the implementation of appropriate stormwater controls and best management practices.

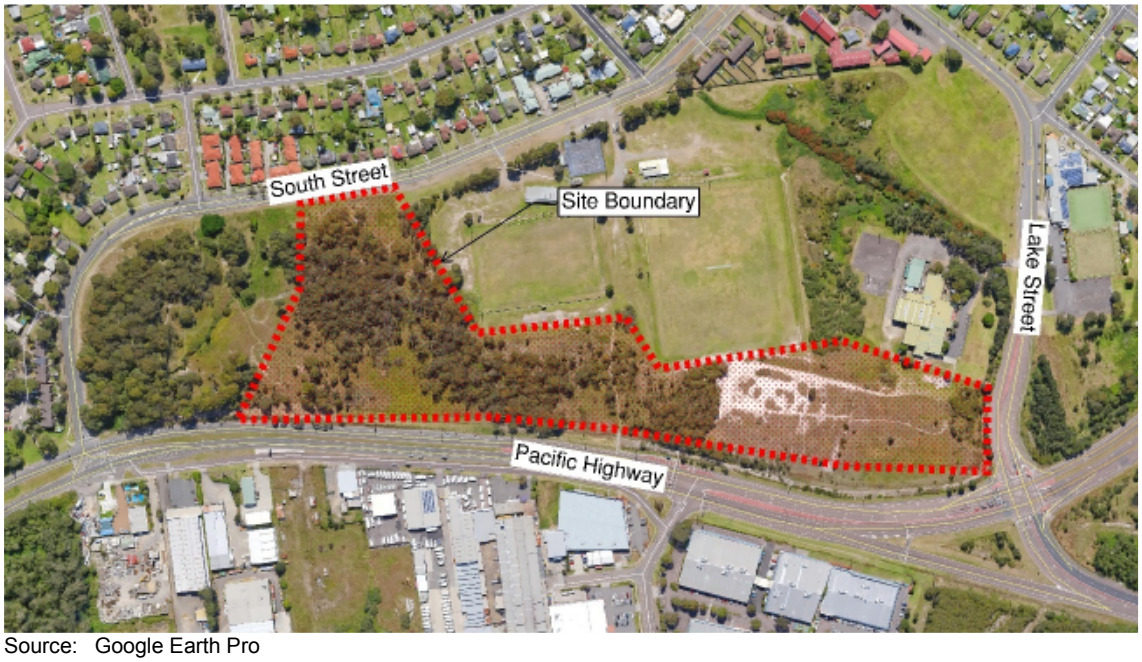
2 The Physical Environment

2.1 Site Description and Proposed Works

The subject site is located approximately 14km to the south west of the Newcastle at 20 Pacific Highway, Bennetts Green, and falls within the Lake Macquarie City Council local government area (LGA). The development site covers an of approximately 7.97 Ha and forms part of the Newcastle metropolitan area. The existing site, which is predominately vacant with dense vegetation and trees, falls generally towards an existing swale to the south, draining along Pacific Highway. The proposed site is bound by:

- Existing sporting grounds to the north west;
- Lake Street to the north;
- Pacific Highway and an industrial area to the east; and
- Existing residential land to the south and west.

Figure 1: Existing Site



Source: Google Earth Pro

The proposed works consists of the creation of a new home improvement centre (Bunnings Warehouse) as well as 3 separate buildings making up 12 tenancies including Anaconda, Spotlight, a fast food restaurant and a service station. Detailed site survey indicates that there is an existing drainage channel along the eastern boundary of the site with the Pacific Highway which is to be the proposed discharge point for stormwater flows generated by the proposed development.

As per the *Jewells Wetland Flood Study* (2013) prepared by BMT WBM for Lake Macquarie Council, we also note that the subject site is located in a flood affected area. A summary of the

existing flood conditions as well as the proposed flood management strategies for the site is included in Section 4.5 of this Report.

2.2 Data

2.2.1 Topography

Topographic information for the site was obtained from detailed survey data completed by Lockley Land Title Solutions.

2.2.2 Rainfall Data

2.2.2.1 Intensity-Frequency-Duration (IFD)

IFD data obtained from Council's Handbook on Drainage Design Guidelines was utilised for this subject site.

Table 1: Rainfall Intensities for Lake Macquarie City Council

DURATION	5 YEAR	10 YEAR	20 YEAR	100 YEAR
5 mins	140.63	158.37	181.91	236.01
10 mins	108.04	121.79	140.01	181.94
15 mins	90.42	102.00	117.33	152.63
20 mins	78.87	89.02	102.44	133.37
30 mins	64.20	72.52	83.51	108.86
45 mins	51.57	58.30	67.18	87.68
1 hour	43.85	49.61	57.19	74.72
1.5 hours	34.14	38.64	44.57	58.28
2 hours	28.49	32.25	37.21	48.68
3 hours	22.00	24.92	28.77	37.67

Source: Lake Macquarie Council's Handbook on Drainage Design Guidelines

Table 2: IFD Polynomial Coefficients

ARI	a	b	c	d	e	f	g
5 year	3.7761122	-0.5897489	-0.0391105	0.0073409	0.0014211	-0.0001706	-0.0000469
10 year	3.8993162	-0.5880349	-0.0393949	0.0072956	0.0014641	-0.0001673	-0.0000485
20 year	4.0415185	-0.5866177	-0.0396301	0.0072581	0.0014997	-0.0001645	-0.0000498
100 year	4.3086945	-0.5839552	-0.0400719	0.0071876	0.0015666	0.0001594	-0.0000522

Source: Lake Macquarie Council's Handbook on Drainage Design Guidelines

3 Design Controls and Guidelines

3.1 Lake Macquarie City Council Development Control Plans

An integral part of the Development Application process, Development Control Plans (DCP), provides the necessary controls for the development of the site. Relevant Lake Macquarie Council DCPs include:

- Engineering Design Guidelines – July 2016
- Handbook on Drainage Design Guidelines – December 2013
- Water Cycle Management Guidelines – June 2013

3.1.1 Lake Macquarie City Council – Engineering Design Guidelines – July 2016

Council's *Engineering Design Guidelines* provide a quality management system for the execution and recording of the design processes.

3.1.2 Lake Macquarie City Council – Handbook On Drainage Design Guidelines – December 2013

Council's *Handbook on Drainage Design Guidelines* set out the requirements for the design of stormwater drainage for urban and rural areas. The Design Guidelines outline a broad strategy for the design and development of land within the LGA including:

- Providing clear guidelines for the requirements of stormwater drainage and civil works;
- Ensuring that developments meet all relevant standards for the disposal of stormwater and that developments do not increase the hazard to persons or property; and
- Catering for minor and major stormwater systems.

The policy also provides detailed requirements for the hydrologic and hydraulic design and analyses of the proposed water management system including standard calculation factors.

3.1.3 Lake Macquarie City Council – Water Cycle Management Guidelines – June 2013

Council's Water Cycle Management Guidelines outlines a broad strategy for the implementation of WSUD principles within the LGA.

3.2 Australia Rainfall Runoff – Volume 1 (2001)

Prepared by Engineers Australia, Australian Rainfall and Runoff – A Guide to Flood Estimation was written to "provide Australian designers with the best available information on design flood

estimation". It contains procedures for estimating stormwater runoff for a range of catchments and rainfall events and design methods for urban stormwater drainage systems.

According to the document, good water management Master Planning should take into account:

- Hydrological and hydraulic processes;
- Land capabilities;
- Present and future land sues;
- Public attitudes and concerns;
- Environmental matters;
- Costs and finances; and
- Legal obligations and other aspects.

3.3 NSW Floodplain Development Manual

The recommendations detailed in this report are made in line with the FDM guidelines on floodplain risk management. Reference to flood hazard is built upon the established hydraulic categorisation of overland flow paths provided in the FDM guideline and summarised in the velocity-depth product graph below.

Figure 2: Hazard Categorisation

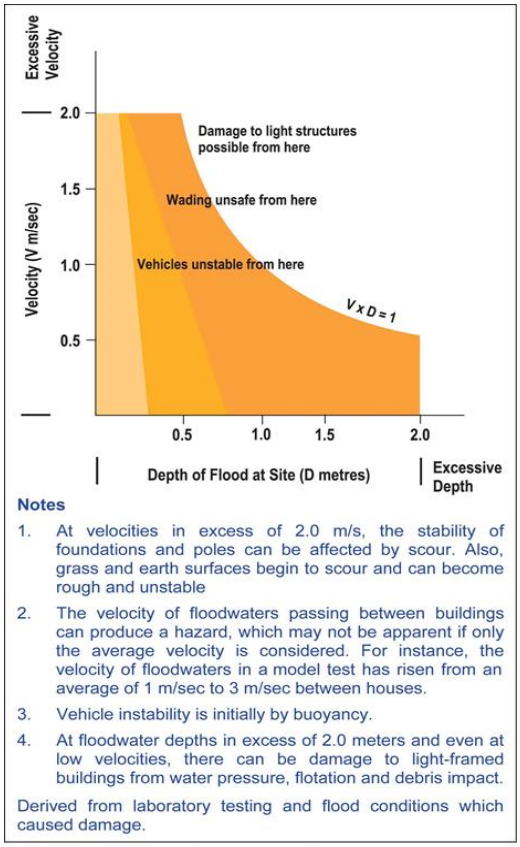


FIGURE L1 - Velocity & Depth Relationships
Source: NSW Floodplain Development Manual, 2005

4 Stormwater Management

4.1 Water Quantity Management

4.1.1 Stormwater Drainage

The major/minor approach to stormwater drainage is the reocgnised concept for urban catchments within the Lake Macquarie City Council local government area. For the purposes of this report, DRAINS software is used to calculate flows exiting the site for the proposed scenario. The minor drainage system will be designed to contain stormwater flows from the minor (20yr ARI) storm event within a below ground pit and pipe network.

The major drainage system incorporates overland flow routes through proposed road, hardstand and landscaped areas and is assessed against the 100 year ARI design storm event. In accordance with council's requirements, the major drainage system is to be designed in a manner that ensures that personal safety is not compromised. As such, all overland flow routes for the site are to be designed so that the maximum velocity x depth product shall not exceed $0.4m^2/s$ in accordance with Council's guidelines.

4.1.2 Detention Tanks

Detention Tanks are used in stormwater management to restrict stormwater flows at times of high discharge at the outlet. The aim of this is to limit downstream flows to existing levels in order to reduce the risk of flooding downstream of the site. The storage volume is typically located below ground with discharges controlled using an outlet and orifice to contain the minor storm.

According to Council's Handbook for Drainage Design Guidelines, the following On-Site Detention (OSD) requirements for the proposed development:

- Inflows shall be based on runoff from the developed site. A 1 in 20 year average recurrence interval storm shall be adopted for inflow calculations (Q^{20}_{dev}); and
- The maximum outflow from the basin shall be computed on a 1 in 5 year average recurrence interval storm, based on runoff from the undeveloped site (Q^{5}_{und}).

Separate stormwater networks including detention tanks have been provided for each lot to manage post-developed flows in accordance with Council requirements and to mirror the existing flow regime.

4.2 Water Quantity Modelling

A hydrological model of the catchment was formulated using the DRAINS software package and was analysed to assess the performance of the site stormwater network. The DRAINS program typically performs design and analysis calculations for urban stormwater systems and models the flood behaviour on both rural and urban catchments.

The user data inputs required by DRAINS include catchment areas, time of concentration, pervious and impervious areas, IFD rainfall intensities and flow path roughness. Modelling is performed through the development of a network of pipes, pits and nodes to represent both the proposed and existing scenarios on site.

4.2.1 Model Parameters

In order to assess the performance of the proposed site pit and pipe network, a DRAINS model was established with the input parameters, described below:

4.2.1.1 Hydrological Model

- Paved (impervious) area depression storage = 1 mm
- Supplementary area depression storage = 0 mm
- Grassed (pervious) area depression storage = 5 mm
- Soil type = 3

DRAINS user guide describes soil type 3 as follows:

> *Type 3 (or C) slow infiltration rates (may have layers that impede downward movement of water).*

4.2.1.2 Rainfall Data

Table 3: DRAINS AMC Numbers

AMC Number	Description	Total Rainfall in 5 days preceding the storm (mm)
1	Completely Dry	0
2	Rather Dry	0 to 12.5
3	Rather Wet	12.5 to 25
4	Saturated	Over 25

AMC = 3 will generate higher runoff rates due to lower infiltration to soil compared to lower AMC numbers, therefore aiding in a conservative approach to inlet structure, pipe and stormwater detention design.

- Design storms using IFD data obtained from Council's *Handbook for Drainage Design Criteria* were entered into DRAINS for the following durations for the 5 year, 10 year 20 year and 100 year ARI storm events:
  - *Storm Durations: 5, 10, 15, 20, 25, 30, 45, 60, 90, 120, 180 minute.*

4.2.2 Existing System

The existing site naturally grades to the north eastern boundary of the site towards the intersection of Lake Street and Pacific Highway. There is a grassed swale adjacent to the eastern boundary of the site which runs parallel with Pacific Highway, falling towards Lake Street. From the intersection, the swale travels west along Lake Street. The total catchment area being conveyed downstream to the site in the current scenario is approximately 7.97Ha. Existing upstream catchments of approximately 2.06Ha will generate runoff for the site from the sporting grounds to the west. This gives a total catchment size of 10.03Ha.

In order to calculate the Permissible Site Discharge rates from the pre-developed site, nodes were included in the DRAINS model to represent the existing catchment scenario as described above. These nodes were then assigned a sub-catchment (including area, flow path length, slope, roughness, pervious and impervious areas, and the like) which is representative of the

total existing area which lies within the catchment boundary. By keeping areas consistent, the pre-post discharge rates of the main catchments can then be directly compared. It should be noted that the upstream flows have not been considered when calculating the Permissible Site Discharge. They have however been considered when designing the pit and pipe network in the minor and major storm event. In accordance with Council's guidelines, existing catchments have been assumed to be 100% pervious and have been assessed using the 5yr ARI storm event in order to calculate the Permissible Site Discharge.

Figure 3: Lot Catchments

4.2.3 Proposed System

The DRAINS model for the proposed scenario was developed based on the following methodology:

- A concept pit and pipe network has been developed for the proposed siteworks (refer to Mott MacDonald drawings MMD-382538-C-DR-00-S96-0110 to 0114 for details). Here, four (4) separate outlets have been proposed from the site to convey runoff to the existing drainage channel along the Pacific Highway to mirror the existing flow regime;
- For the major system (100 year ARI storm event), a conservative blockage factor of 50% has been applied to all stormwater pits within the development area in accordance with general engineering practice;
- The upstream catchment drainage through the development from the sporting grounds were also considered in the model. An impervious fraction of 0% has been adopted for the catchment;
- Below ground detention tanks have also been incorporated into the model to control flows from the site to each discharge point in accordance with Council's

requirements. The locations of the tanks have been proposed in order to maximise collection of upstream flows and allow easy access for maintenance;

- Tailwater levels at the discharge to the existing downstream drainage channel have been set based on the following:
  - E10 = top of pipe obvert in accordance with general engineering practice;
  - A14 = top of pipe obvert in accordance with general engineering practice;
  - H9 = top of pipe obvert in accordance with general engineering practice;
  - T6 = existing downstream flood levels in Lake Street as provided by Council (refer to email correspondence in Appendices for details):
    - 20yr ARI storm event at RL 16.05m AHD
    - 100yr ARI storm event at RL 16.10m AHD

Figure 4: DRAINS Model

Source: Pit and Catchment Labels have not been shown for clarity

4.2.4 DRAINS Results

Iterations were performed in the DRAINS model to determine the size of the proposed piped network and the respective OSD in order to satisfy major/minor system requirements in accordance with Lake Macquarie City Council standards.

Results indicate that the major / minor system requirements are satisfied at all proposed pits in the development area and that the piped system sufficiently conveys minor storm flows with safe provision for major system flows.

4.2.4.1 On-Site Detention

The proposed tanks have the following parameters:

- Each lot has been designed to have 1 detention tank. Lot 1 however has allowed for 2 due to the site being split into 2 separate sub catchments. As such, 4 detention tanks have been proposed for this design;
- Each tank has been situated in order to allow for maximum flows and ease of maintenance;

- The Permissible Site Discharge (PSD) for the minor storm event for each lot has been calculated using the 5 year ARI storm assuming an impervious fraction of 0%. The results are provided in Table 4:

Table 4: Minor Storm Permissible Site Discharge

Discharge location	PSD (m^3/s)
A9 (Lot 1)	0.461
E10 (Lot 1)	0.200
H9 (Lot 2)	0.552
T16 (Lot 3)	0.557

While the pipe network has been sized to account for flows collected from upstream of the site, the OSD tanks have not been designed to allow for these flows. As such, the PSD for each catchment will only take the site into its calculation. To account for this, flows from OSD tank A9 have been calculated at the discharge from the tank, not from the discharge point from the site.

- Discharge is controlled via an orifice plate in OSD tanks A9, E7 and S4. These are installed at the outlet of the discharge control pit in order to satisfy pre-post conditions. Pre-post conditions were maintained in tanks H6 and T10 without the use of orifice plates.

Table 5: Orifice Plate Diameter

OSD Tank	Diameter (mm)
A9	609
E7	290
S4	130

Results of the DRAINS analysis are summarised in the following table:

Table 6: DRAINS Pre-Post Comparison – A9

ARI Event	Permissible Site Discharge (m^3/s)	Post-Developed Peak Discharge with no OSD (m^3/s)	Post-Developed Peak Discharged with OSD (m^3/s)	Tank TWL (AHD)	Tank Storage Volume (m^3)
20 year	0.461	0.984	0.408	RL20.48	724
100 year	1.12	1.163	0.507	RL20.79	952

Table 7: DRAINS Pre-Post Comparison – E10 (Tank E7)

ARI Event	Permissible Site Discharge (m^3/s)	Post-Developed Peak Discharge with no OSD (m^3/s)	Post-Developed Peak Discharged with OSD (m^3/s)	Tank TWL (AHD)	Tank Storage Volume (m^3)
20 year	0.200	0.491	0.136	RL19.68	366
100 year	0.526	0.573	0.157	RL19.92	459

Table 8: DRAINS Pre-Post Comparison – H9 (Tank H5)

ARI Event	Permissible Site Discharge (m^3/s)	Post-Developed Peak Discharge with no OSD (m^3/s)	Post-Developed Peak Discharged with OSD (m^3/s)	Tank TWL (AHD)	Tank Storage Volume (m^3)
20 year	0.552	0.846	0.541	RL19.09	373
100 year	1.10	1.054	0.637	RL19.37	425

Table 9: DRAINS Pre-Post Comparison – T10 (Tanks S4 and T9)

ARI Event	Permissible Site Discharge (m^3/s)	Post-Developed Peak Discharge with no OSD (m^3/s)	Post-Developed Peak Discharged with OSD (m^3/s)	Tank TWL (AHD)	Tank Storage Volume (m^3)
20 year	0.557	1.06	0.503	S4 = RL18.39 T9 = RL 17.09	S4 = 185 T9 = 273
100 year	1.18	1.381	1.16	S4 = RL19.07 T9 = RL 17.48	S4 = 257 T9 = 366

Results of the DRAINS analysis indicates that the OSD tanks provide sufficient flow retardation and attenuation to ensure that the downstream peak post-developed discharges do not exceed those of the pre-developed scenario for the worst case storm duration. It should be noted that the OSD tank storage volumes above indicate the volume of stormwater detained by the tank, not the total volume of the tank.

4.3 Water Quality Management

The stormwater management systems for the site shall comply with Lake Macquarie City Council's Water Cycle Management Guidelines. Council's guidelines require improved water quality of the stormwater flow from the developed site prior to discharge into the authorities' drainage system. The Council's target water quality pollutant removal rates are summarised below:

1. *Reduction in average annual total suspended solids (SS) export load of 80%*
2. *Reduction annual average total phosphorus (TP) export load of 45%*
3. *Reduction in annual average total nitrogen (TN) export load of 45%*

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) software.

4.3.1 Proposed Treatments

4.3.1.1 HumeGard® Gross Pollutant Trap (GPT)

For primary treatment of the stormwater runoff, a HumeGard® Gross Pollutant Trap is to be provided. The HumeGard is a pollution control device specifically designed to remove gross pollutants and coarse sediments in residential and commercial developments. The MUSIC node from Hume's was used for this model with the input data as summarised below.

Table 10: HumeGard® GPT MUSIC Input Parameters

Pollutant	Input	Output	Adopted Rate
Suspended Solids (mg/L)	500	295	41%
Phosphorus (mg/L)	5	3.3	34%
Nitrogen (mg/L)	5	3.8	24%

Source: *Music Modelling Guidelines*

4.3.1.2 Jellyfish

The JellyFish® filter is to be provided to be used as a final treatment device for stormwater runoff from the proposed development. Using filtration cartridges the JellyFish® filter is able to capture a high level of stormwater pollutants including total suspended solids, total nitrogen, total phosphorous, total copper and total zinc. In developing the MUSIC model for the proposed development, the following JellyFish® cartridge systems by Stomwater360 have been proposed as an end-of-line treatment prior to discharge.

Table 11: Jellyfish® Filter Types

Catchment	Unit ID	Treatable Flow Rate (L/s)
E7 (Lot 1)	JF2250-5-1	27.5
A9 (Lot 1)	JF2250-11-2	60
H6 (Lot 2)	JF2250-9-2	50
T10 (Lot 3)	JF3250-17-3	92.5

Source: Stormwater360

The position of the JellyFish® system has been proposed to maximise flows and allow easy access for maintenance. The MUSIC nodes from Stormwater360 was used for this model with the input data as summarised below.

Table 12: JellyFish® Filter MUSIC Input Parameters

Pollutant	Input	Output	Adopted Rate
Suspended Solids (mg/L)	200	22	89%
Phosphorus (mg/L)	0.4	0.14	65%
Nitrogen (mg/L)	7	3.2	54%

Source: *Music Modelling Guidelines*

4.3.1.3 Enviropods

Several surface inlet pits within the proposed Lot 1 and Lot 3 areas have been designed to be provided with enviropod pit inserts including oil absorbent media. The pit inserts will be beneath the stormwater pit grates and will collect gross pollutants, sediments, oils and grease.

Table 13: EnviroPod® Filter MUSIC Input Parameters

Pollutant	Input	Output	Adopted Rate
Suspended Solids (mg/L)	1000	460	46%
Phosphorus (mg/L)	1.80	0.45	25%
Nitrogen (mg/L)	9.2	1.7	18%

Source: *Music Modelling Guidelines*

4.3.1.4 Rainwater Tanks

Rainwater tanks have been utilised as a means of water reuse within the precinct. Stormwater that discharges directly from roofed areas is generally considered 'clean' water, with the roof water from the buildings modelled to discharge directly to a rainwater harvesting tank. These tanks are to store water for re-use associated with the site. Rainwater tanks have been sized to in accordance with Council's water quality treatment requirements. A minimum of 80% of total rainwater reuse has been assumed for the site.

The following estimated water demand rates have been applied in developing the proposed MUSIC model:

Lot 1A:

- Toilets = 1.6kL/day based on 0.1kL/day/toilet;

Lot 1B:

- Toilets = accounted for in re-use for Lot 1A for Bunnings Building;
- Landscaping = assumed 730m^2 irrigation area (50% of total nursery area) at 0.4kL/yr/m2 = 292kL/yr scaled by PET – rain (Note: rainwater re-use for Lot 1B supplied from rainwater tank for Lot 1A);

Lot 2:

- Toilets = 1.6kL/day based on 0.1kL/day/toilet;
- Landscaping = assumed 615m^2 irrigation area (50% of soft landscaping) at 0.4kL/yr/m2 = 246kL/yr scaled by PET – rain.

Lot 3:

- Toilets = 1.6kL/day based on 0.1kL/day/toilet;
- Landscaping = assumed 635m^2 irrigation area (50% of soft landscaping) at 0.4kL/yr/m2 = 254kL/yr scaled by PET – rain.

4.4 Water Quality Modelling

Treatment removal loads were analysed for the interim scenario using MUSIC (Model for Urban Stormwater Improvement Conceptualisation) Version 6 software. A water quality modeling 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.

4.4.1 MUSIC Model – Parameters and Methodology

In order to assess the effectiveness of the stormwater quality systems that are to be included as part of the subdivision, a MUSIC model was created using the follow parameters and methodology:

4.4.1.1 Developed Site

The following methodology and parameters were incorporated into the MUSIC modelling for the post-developed site:

- The Lake Macquarie City Council North Region MUSIC link was used for the MUSIC model;
- The post-developed site was consolidated into four main sub-catchment areas (Lot 1A, Lot 1B, Lot 2 and Lot 3) based on the proposed drainage system and the Lot layouts. The areas are as follows:

Table 14: Area Breakdown per MUSIC Sub-Catchment

MUSIC Sub-Catchment	Area (Ha)
Lot 1A	1.225
Lot 1B	2.324
Lot 2	1.980
Lot 3	2.443
Total	**7.972**

- Bypass areas have been based on areas which will not be treated by the GPT and Jellyfish® treatment train provided. Enviropods have been utilised as an alternative treatment for the road bypass areas;
- Catchments were then separated into “Road” and “Lot” areas based on the proposed lot layout received from Blueprint. As no landscaping plan has been established, both “Road” and “Roof” areas have adopted a 100% fraction impervious. “Bypass” areas in each lot have been further separated into “Landscaped”, “Roof” and “Road” areas. Table 15 below outlines the adopted areas for each sub-catchment;

Table 15: MUSIC Catchment Breakdown

MUSIC Sub-Catchment	Roof to Rainwatwer Tank (Ha)	Roof (Ha)	Hardstand / Carpark (Ha)	Bypass – Hardstand / Carpark (Ha)	Bypass – Landscaped (Ha)	Total Area (Ha)
Lot 1A	0.667	-	0.431	0.073	0.054	**1.225**
Lot 1B	-	0.961	1.252	-	0.111	**2.324**
Lot 2	0.264	0.334	1.259	-	0.123	**1.980**
Lot 3	0.375	0.421	1.439	0.081	0.127	**2.443**
Total	**1.306**	**1.716**	**4.381**	**0.154**	**0.415**	**7.972**

- Lot 3’s Bypass area has been separated to account for flows that will be captured by Enviropods;
- Rainwater tanks have been proposed to collect flows from roofed areas with the following tank sizes:

Table 16: Rainwater Tank Sizes

Rainwater Tank	Lot	Size (kL)
RWT 1	Lot 1A	50
RWT 2	Lot 2	50
RWT 3	Lot 3	50
Total		**150**

- The pollutant concentration parameters used within the model were based on the recommended model defaults for different land use categories. These are summarised in the following tables;

Table 17: Post Development Areas – MUSIC Node Classification

MUSIC Node	Classification
Roof	"Roof"
Road	"Sealedroad"
Landscaping	"Mixed"

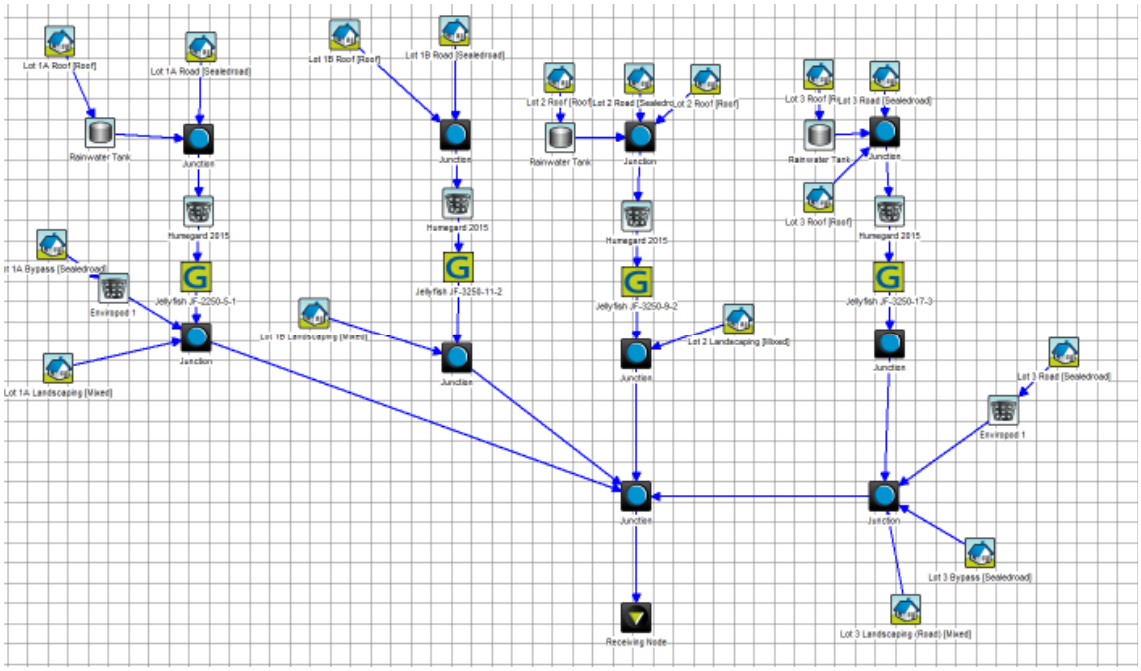
Table 18: MUSIC Node – Rainfall Runoff Parameters

Classification		TSS		TP		TN	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
"Roof"	**Base Flow**	1.10	0.17	-0.82	0.19	0.32	0.12
	Storm Flow	1.30	0.32	-0.89	0.25	0.30	0.19
"Road"	**Base Flow**	1.20	0.17	-0.85	0.19	0.11	0.12
	Storm Flow	2.43	0.32	-0.30	0.25	0.34	0.19
"Mixed"	**Base Flow**	1.20	0.17	-0.85	0.19	0.11	0.12
	Storm Flow	2.15	0.32	-0.60	0.25	0.30	0.19

- The soil properties for the pervious areas of the catchment were defined based on the recommended default parameters provided by Council.

A treatment train was designed to incorporate a series of treatment nodes including GPTs, Jellyfish® Filter, Enviropods and rainwater tanks. The effectiveness of the proposed treatments is summarised in Section 4.4.2 below.

Figure 5: MUSIC Model



4.4.2 MUSIC Results

Table 19: MUSIC Model Results

Pollutant	Post-Developed Pollutant Load with no WSUD measures (kg/yr)	Post-Developed Pollutant Load with WSUD measures (kg/yr)	Removal Rate (Post-Developed Scenario)	Target Removal Rate
Total Suspended Solids	13,300	2,690	79.9%	80%
Total Phosphorus	25.1	8.7	65.4%	45%
Total Nitrogen	141	61.6	56.4%	45%
Gross Pollutants	1,640	34.6	97.9%	-

Results of the MUSIC analysis indicate that, by including the nominated treatment train as described in this report, the post-developed water quality improvement objectives set out in Council's DCP are achieved for suspended solids, phosphorus, and nitrogen.

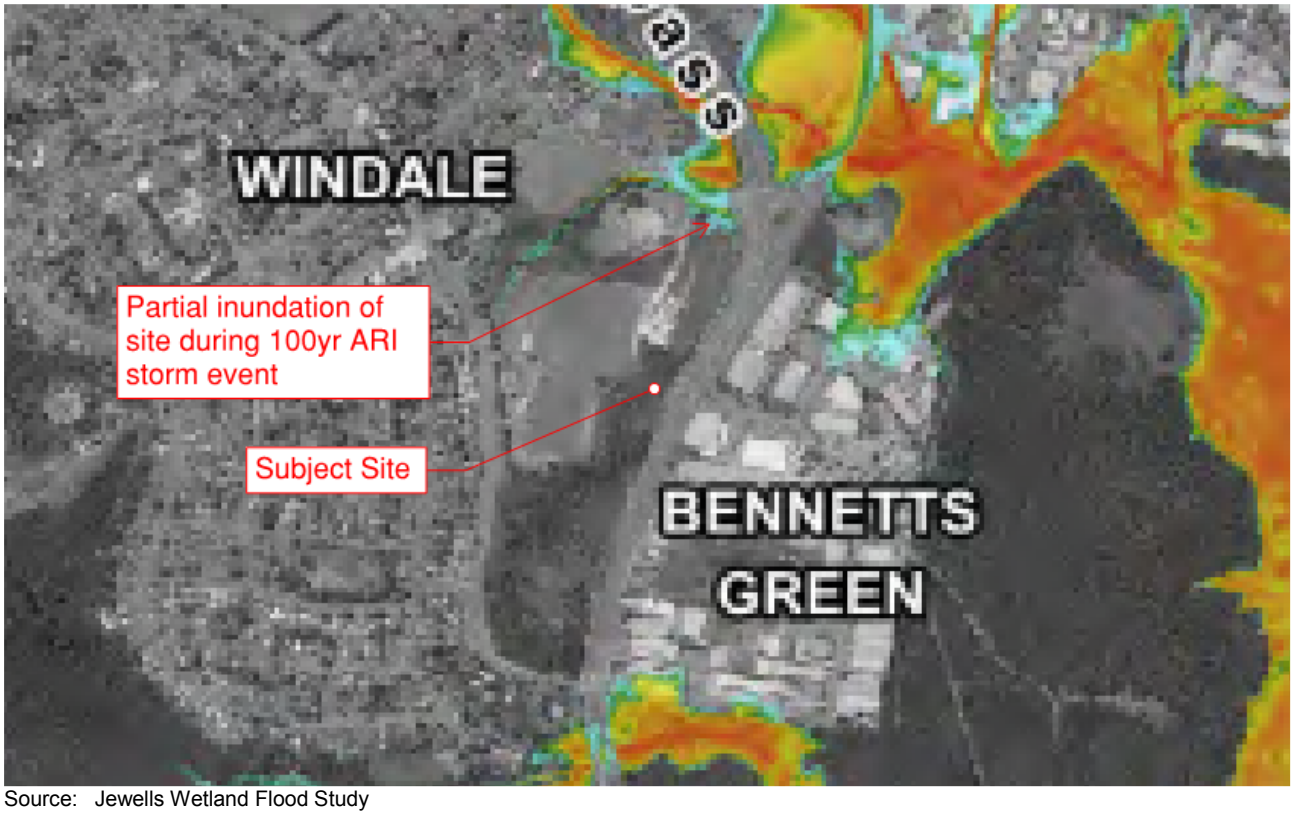
A copy of the MUSIC link report is also included in Appendix E for reference.

4.5 Flooding

As specified in the *Jewells Wetland Flood Study* (2013), it is understood that the subject site is located in a flood affected area. Based on a desktop review of the results of the Flood Study, we note the following with respect to the existing flooding conditions for the local catchment:

- The Flood Maps included in the report indicate that the northern portion of the subject site at the intersection of Lake Street and the Pacific Highway is partially inundated by flood waters in the 100yr ARI storm event. Here, the flood hazard within the site boundary is classified as “Low Risk” and “Flood Fringe”, with flows contained to the northern boundary of the site;

Figure 6: Existing Flood Extents – 100yr ARI



Source: Jewells Wetland Flood Study

- Based on a combination of feedback from Lake Macquarie Council and the results of the Flood Study, we note the following peak flood levels at key locations within the site:
  - Intersection of Lake Street / Pacific Highway:
    - 20yr ARI = RL 16.57m AHD
    - 100yr ARI = RL 16.81m AHD
  - Proposed stormwater outlet T6 to existing drainage channel in Lake Street:
    - 20yr ARI = RL 16.05m AHD
    - 100yr ARI = RL 16.10m AHD.

A preliminary assessment of the proposed works has been carried out with results indicating that the development will have a negligible effect on the overall flooding of the local catchment. This includes:

- **Floor Levels:**

  The lowest finished floor level for the new commercial tenancies on the site is RL 19.40m AHD which allows for sufficient freeboard to the peak 1 in 100yr ARI flood level of RL 16.81m AHD in accordance with Council requirements;

- **Flood Affectation:**

  As stated above, based on the results of the Jewells Wetland Flood Study, we note that the flood hazard classification within the subject site is “Low Risk” and “Flood Fringe”. Works within the flood zone are restricted to minor filling at the northern boundary to lift the level of the carpark above the peak flood levels, with a flood protection wall / bund also proposed along the boundary with Lake Street to provide freeboard during the 100yr ARI flood event.

  The NSW Floodplain Development Manual classifies flood fringe areas as “*the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and / or flood levels*.”

  Based on the above, it is understood that the proposed development within the flood zone will have a negligible impact on flood levels and flows within the local catchment.

- **Flood Flows:**

  As discussed in section 4.3 of this Report, the development is to include provision of adequately sized OSD facilities to restrict peak flows downstream of the site to Council requirements; and

- **Car Parking and Driveway Access**
  - All carparking spaces within the development area either located above the peak 1 in 20yr ARI flood level or have been provided with sufficient protection; and
  - Lake Street to the north of the site is fully inundated during flood events, with the depth at the site boundary at the new driveway access approximately 0.2m in the 1 in 20yr ARI storm. In order to manage access to and from the site during a flood event and potential evacuation if required, a site- specific Flood Management Plan has been prepared - refer to Appendix D for details.

Appendices

A. Council Correspondence

Reilly, Dean K

From: Brian Gibson <BrianGibson@lakemac.nsw.gov.au>
Sent: 23 May 2018 11:27
To: Reilly, Dean K
Cc: Alison Brown; Matthew Skerrett; Edward Green; Ruth Hallett
Subject: RE: Bennetts Green - DA/251/2013/A & DA/1188/2017 & DA/1191/2017
Attachments: Bennetts Green.jpg

Hi Dean

Thank you for the information yesterday.

A review of the requirements listed (DA/1191/2017, Engineering – Stormwater Management (a, b &c)) in Council's RFI dated 10 May 2018 was undertaken following receipt of your information.

It has been identified flood levels provided by Council in the "Property Flooding Information Summary" have been picked up from the higher areas of the site further to the east towards the intersection with the Pacific Highway. Council apologises for any inconvenience in this regard.

Council has reviewed the flood levels relative to the proposed discharge location T11 and can confirm:

a. The location of the peak 100yr ARI Flood Level as listed in the "Property Flooding Information Summary" relative to the proposed discharge location T11 is RL16.1
b. Attached is a screen shot from the Council Flood Model at the proposed discharge point T11 to confirm the peak 20 yr and 100yr ARI TWL at this location. Please note that the light blue line shows the 1 in 20 year flood level and the dark blue line shows the 1 in 100 year flood level.

Therefore the requirements listed under DA/1191/2017, Engineering – Stormwater Management (a, b & c) in Council's recent RFI are to be reviewed in light of the revised flood level.

Please advise if this outcome is satisfactory in terms of tomorrow's meeting.

Regards,

Brian Gibson
Senior Development Planner

P: 02 4921 0388
E: briangibson@lakemac.nsw.gov.au

126-138 Main Road Speers Point NSW 2284
Box 1906 HRMC NSW 2310

lakemac.com.au

From: Reilly, Dean K [mailto:Dean.Reilly@mottmac.com]
Sent: Tuesday, 22 May 2018 4:41 PM
To: Brian Gibson; Ruth Hallett
Cc: Alison Brown; Matthew Skerrett; Edward Green
Subject: HPRM: RE: Bennetts Green - DA/251/2013/A & DA/1188/2017 & DA/1191/2017

Hi Ruth / Brian,

The main item we wish to clarify with Council at the meeting is the design tailwater level to be adopted at the proposed outflow (T11) to the existing swale in Lake Street. As per Item 35 in Council's RFI#2 for DA/1191/2017

Property Flooding Information Summary

Print Download PDF

Property Flooding Information Summary for Lot 1 DP 1214343, 20 Pacific Highway, Bennetts Green

Summary generated: 3:31 PM on 15/05/2018

The following information is provided from the records of the Council pursuant to the Local Government Act 1993, in response to your request for details of the possible effects on the specified property (Lot) from flooding, tidal inundation, and predicted sea level rises. For detailed, survey-verified flood information you can apply for a Flood Certificate or Flood / Tidal Inundation certificate (charges apply).

Lot information

Lot details	Lot 1 DP 1214343
Minimum Ground Level	15.49 mAHD
Maximum Ground Level	26.18 mAHD
Flood Hazard Classification	Flood Control Lot - High Hazard

The **Jewells Wetland Flood Study 2013** indicates the following flood information for Lot 1 DP 1214343.

Source of flooding	Catchment	
Flood Level (5%)	Max level: 16.57 mAHD	
Flood Level (1%)	Max level: 16.81 mAHD	
Probable Maximum Flood (PMF)	Max level: 18.92 mAHD	
Flood Planning Level	17.31 mAHD	

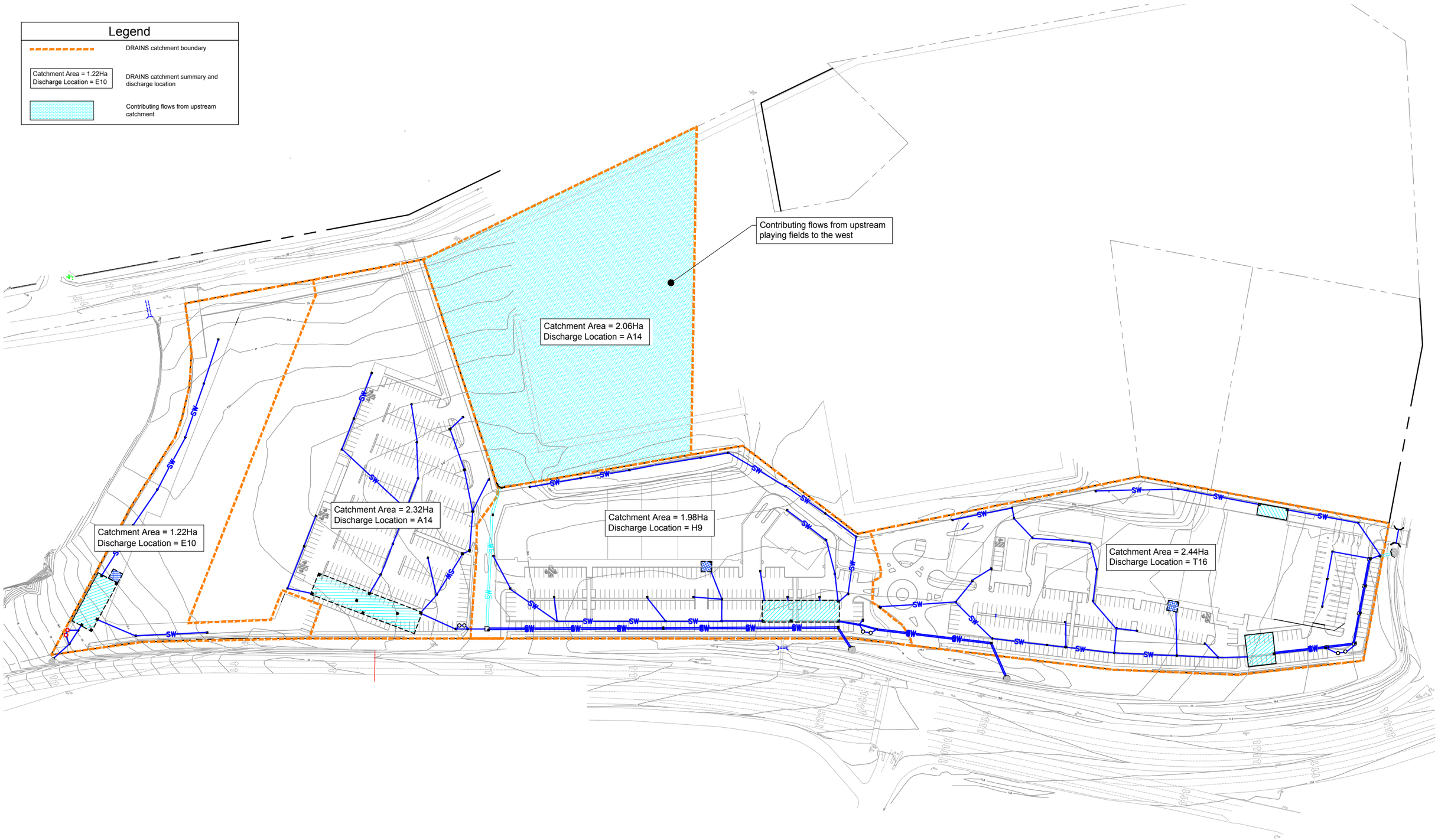
Please note

B. DRAINS Catchment Plan

D08960689

Legend

- DRAINS catchment boundary
- Catchment Area = 1.22Ha / Discharge Location = E10 — DRAINS catchment summary and discharge location
- Contributing flows from upstream catchment



Re-Issued for Approval

Rev	Date	Drawn	Description	Ch'k'd	App'd
P5	02.07.2018	GAP	Re-Issued for Approval	DR	BS
P4	19.12.2017	DRC	Re-Issued for Approval	DR	BS
P3	04.07.2017	JN	Re-Issued for Section 96 Approval	JG	X
P2	23.06.2017	DRC	Issued for Section 96 Approval	JG	X
P1	31.05.2017	DRC	Issued for Section 96 Approval	JG	X

1:1000 0 50m 100m

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Title
Spotlight Property Group
Bennetts Green, Pacific Highway
Civil Works
DRAINS Catchment Plan

Designed	A.Singh		Eng check	D. Reilly	
Drawn	D.Chapman		Coordination	J. Gilligan	
Dwg check	A.Singh		Approved	B.Soo	
Scale at A1	Status		Rev	Security	
1:1000	PRE		P5	STD	

Drawing Number
MMD-382538-C-DR-00-S96-0180

P:\Sydney\Projects\382xxx\382538 Blueprint Windale\04 Working\01 CAD\Civil\Drawings\MMD-382538-C-DR-00-S96-0180.dwg Jul 3, 2018 - 11:44AM mr55920

C. MUSIC Catchment Plan

D08960689

Re-Issued for Approval

Rev	Date	Drawn	Description	Ch'k'd	App'd
P5	02.07.2018	GAP	Re-Issued for Approval	DR	BS
P4	19.12.2017	DRC	Re-Issued for Approval	DR	BS
P3	04.07.2017	JN	Re-Issued for Section 96 Approval	JG	X
P2	23.06.2017	DRC	Issued for Section 96 Approval	JG	X
P1	31.05.2017	DRC	Issued for Section 96 Approval	JG	X

1:1000 0 50m 100m

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Title
Spotlight Property Group
Bennetts Green, Pacific Highway
Civil Works
MUSIC Catchment Plan

Designed	A.Singh		Eng check	D. Reilly	
Drawn	D.Chapman		Coordination	J. Gilligan	
Dwg check	A.Singh		Approved	B.Soo	
Scale at A1	Status		Rev		Security
1:1000	PRE		P5		STD

Drawing Number
MMD-382538-C-DR-00-S96-0181

D. Flood Management Plan

D.1 Background

Council has advised that this property is subject to flooding in a 1% Annual Exceedance Probability (AEP) (1 in 100 year ARI) storm event. The Probable Maximum Flood (PMF) is the highest flood level that is ever likely to occur, however it is extremely rare. Relevant levels are:

Peak Flood Levels (intersection lake Street / Pacific highway)

- 5% AEP Flood Level = RL 16.57m AHD
- 1% AEP Flood Level = RL 16.81m AHD
- PMF Flood Level = RL 18.92m AHD

Flood Levels at Driveway entrance off Lake Street

- 5% AEP Flood Level = RL 16.05m AHD
- 1% AEP Flood Level = RL 16.10m AHD

Tenancies T6-T8

- Building Floor Level = RL 19.40m AHD
- Undercroft carpark = RL16.40m AHD

The above levels give an indication of how the various floods will impact this property. A Flood Evacuation procedure is provided below and shall be implemented in the event of an extreme flood event in order to provide sufficient time for evacuation to a suitable safe point.

D.2 General Information

- The property is situated in a “flood fringe” area and is affected by flood waters from Lake Street / Pacific Highway during extreme events.
- During a 5% AEP flood event, Lake Street will be flooded. Traveling through floodwaters on foot or in a vehicle can be very dangerous as obstructions can be hidden under the floodwaters, or you could be swept away, even in a car. **All staff and patrons are advised to follow instructions from the senior on-site managers for directions to evacuation points and safe areas. No attempt should be made to exit via Lake Street.**
- If there is time prior to evacuation gather medicines, food, mobile phones, first aid kit, special papers and any small valuables into a bag in one location,
- The loop road to the west and carpark to the south are the primary evacuation routes from all carpark and building areas across Tenancies T6-T8. This loop road exits to the Pacific Highway further to the south outside the flood zone.
- It is important to note that the driveway access to the site off Lake Street does become blocked by flooding for the 5% AEP and larger events in the vicinity of the site boundary. Early detection is subsequently essential in order to allow sufficient time for the evacuation of the undercroft carpark.

- Flood depth markers and signage are to be provided within the undercroft carpark and at the driveway entrance to the site from Lake Street which may become flooded.
  - During an evacuation, the on-site manager will be responsible for monitoring the flood depth markers and gauges during the evacuation of the undercroft carpark. In the event that the driveway entrance becomes inundated to a depth of 0.2m (i.e via ponding) then it is deemed untrafficable and no longer safe to pass.
  - Patrons will instead be instructed to relocate to ground floor level of Tenancies T6-T8.
  - Do not evacuate the building at this time and wait until the flood recedes. Remember floodwaters are much deeper and run much faster outside.
- The on-site manager shall coordinate all evacuation proceeding on the site.
- In the case of a medical or other life threatening emergency ring 000 as normal, but explain about the flooding.
- A laminated copy of this flood plan should be permanently attached (glued) adjacent to the exits on the Ground floor of Tenancies T6-T8.
- This flood management plan should be reviewed every 5 years, particularly with the potential sea level rise due to the greenhouse effect and included in all inductions.

D.3 Procedure

The following staged evacuation procedure shall be implemented for the safe evacuation of pedestrians and vehicles above the PMF.

Numerous safe points above the PMF are available and include:

1. Ground Floor Level of Tenancies T6-T8
2. Tenancies T1-T5
3. High levels of site further to the south

Evacuation procedures to these safe points shall be enforced by the On-Site Manager and include the following steps:

- Depth gauges to be provided along the entry driveway from Lake Street with depth alert alarms.
- Once the flood levels in Lake Street have reached a ponded depth of RL 16.00m AHD at the driveway entrance, a siren will sound to inform the senior On-site Manager.
- The Senior On-site Manager will then authorize for the Lake Street access to be closed so vehicles may not leave onto Lake Street. The emergency exit further to the south along the Pacific Highway shall be put into operartion.
- The On-site Manager will then alert all staff and pedestrians to move their vehicles from the undercroft carpark and lower lying carpark areas (fronting Tenancy T8) to the carpark / loading areas further to the south at Tenancies T6-T7 or the Loading Dock pavement area to the rear of Tenancies T6-T8 whilst it is still safe to do so and prior to the access driveway and loop road becoming inundated. Patrons shall then either **seek shelter at either one of the Safe Points 1 to 3 listed above.**
- The Senior On-site Manager must monitor the flood depth markers along the loop road during the evacuation of both the undercroft carpark and low-lying carpark to

ensure that the depth of flooding does not exceed 200mm (vehicles are deemed to be unstable for flood depths >= 200mm). If this does occur, then the following must occur:

- Patrons to be advised that the loop road is blocked and subsequently directed back to carpark fronting Tenancies T6-T7 which is located above the PMF flood level;
- Patrons instructed to seek shelter within **Ground Level of Tenancies T6-T8 (Safe Point 1).**
- Do not evacuate the building at this time and wait until the flood recedes. Remember floodwaters are much deeper and run much faster outside.

E. MUSIC-link Report

LAKE MACQUARIE CITY COUNCIL

MUSIC-*link* Report

Project Details		Company Details	
Project:	Bennetts Green	**Company:**	Mott MacDonald
Report Export Date:	03/07/2018	**Contact:**	
Catchment Name:	180629 382538 Bennets Green MUSIC Model	**Address:**	
Catchment Area:	7.922ha	**Phone:**	
Impervious Area*:	94.76%	**Email:**	
Rainfall Station:			
Modelling Time-step:	6 Minutes		
Modelling Period:	01/01/1999 - 31/12/2008 23:54:00		
Mean Annual Rainfall:	902mm		
Evapotranspiration:	1408mm		
MUSIC Version:	6.2.1		
MUSIC-link data Version:	6.22		
Study Area:	North Region		
Scenario:	North Region		

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

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Receiving Node	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	3.42%	Rain Water Tank Node	3	Urban Source Node	17
TSS	79.9%	Generic Node	4		
TP	65.4%	GPT Node	6		
TN	56.4%				
GP	97.9%				

Comments

Total TSS removal at 79.9% which is considered satisfactory.

Re-use for rainwater tank for Lot 2 slightly less than 80%, however, minimum 80% re-use target achieved for whole site when accounting for all three tanks.

LAKE MACQUARIE CITY COUNCIL

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
GPT	Enviropod 1	Hi-flow bypass rate (cum/sec)	None	None	0.18
GPT	Enviropod 1	Hi-flow bypass rate (cum/sec)	None	None	0.02
GPT	Humegard 2015	Hi-flow bypass rate (cum/sec)	None	None	100
GPT	Humegard 2015	Hi-flow bypass rate (cum/sec)	None	None	100
GPT	Humegard 2015	Hi-flow bypass rate (cum/sec)	None	None	100
GPT	Humegard 2015	Hi-flow bypass rate (cum/sec)	None	None	100
Rain	Rainwater Tank	% Reuse Demand Met	80	None	82.07
Rain	Rainwater Tank	% Reuse Demand Met	80	None	84.59
Receiving	Receiving Node	% Load Reduction	None	None	3.42
Receiving	Receiving Node	GP % Load Reduction	70	None	97.9
Receiving	Receiving Node	TN % Load Reduction	45	None	56.4
Receiving	Receiving Node	TP % Load Reduction	45	None	65.4
Urban	Lot 1A Bypass	Area Impervious (ha)	None	None	0.073
Urban	Lot 1A Bypass	Area Pervious (ha)	None	None	0
Urban	Lot 1A Bypass	Total Area (ha)	None	None	0.073
Urban	Lot 1A Landscaping	Area Impervious (ha)	None	None	0
Urban	Lot 1A Landscaping	Area Pervious (ha)	None	None	0.054
Urban	Lot 1A Landscaping	Total Area (ha)	None	None	0.054
Urban	Lot 1A Road	Area Impervious (ha)	None	None	0.381
Urban	Lot 1A Road	Area Pervious (ha)	None	None	0
Urban	Lot 1A Road	Total Area (ha)	None	None	0.381
Urban	Lot 1A Roof	Area Impervious (ha)	None	None	0.667
Urban	Lot 1A Roof	Area Pervious (ha)	None	None	0
Urban	Lot 1A Roof	Total Area (ha)	None	None	0.667
Urban	Lot 1B Landscaping	Area Impervious (ha)	None	None	0
Urban	Lot 1B Landscaping	Area Pervious (ha)	None	None	0.111
Urban	Lot 1B Landscaping	Total Area (ha)	None	None	0.111
Urban	Lot 1B Road	Area Impervious (ha)	None	None	1.252
Urban	Lot 1B Road	Area Pervious (ha)	None	None	0
Urban	Lot 1B Road	Total Area (ha)	None	None	1.252
Urban	Lot 1B Roof	Area Impervious (ha)	None	None	0.961
Urban	Lot 1B Roof	Area Pervious (ha)	None	None	0
Urban	Lot 1B Roof	Total Area (ha)	None	None	0.961
Urban	Lot 2 Landscaping	Area Impervious (ha)	None	None	0
Urban	Lot 2 Landscaping	Area Pervious (ha)	None	None	0.123
Urban	Lot 2 Landscaping	Total Area (ha)	None	None	0.123
Urban	Lot 2 Road	Area Impervious (ha)	None	None	1.259
Urban	Lot 2 Road	Area Pervious (ha)	None	None	0
Urban	Lot 2 Road	Total Area (ha)	None	None	1.259
Urban	Lot 2 Roof	Area Impervious (ha)	None	None	0.264

Only certain parameters are reported when they pass validation

LAKE MACQUARIE CITY COUNCIL

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Lot 2 Roof	Area Impervious (ha)	None	None	0.334
Urban	Lot 2 Roof	Area Pervious (ha)	None	None	0
Urban	Lot 2 Roof	Area Pervious (ha)	None	None	0
Urban	Lot 2 Roof	Total Area (ha)	None	None	0.264
Urban	Lot 2 Roof	Total Area (ha)	None	None	0.334
Urban	Lot 3 Bypass	Area Impervious (ha)	None	None	0.081
Urban	Lot 3 Bypass	Area Pervious (ha)	None	None	0
Urban	Lot 3 Bypass	Total Area (ha)	None	None	0.081
Urban	Lot 3 Landscaping (Road)	Area Impervious (ha)	None	None	0
Urban	Lot 3 Landscaping (Road)	Area Pervious (ha)	None	None	0.127
Urban	Lot 3 Landscaping (Road)	Total Area (ha)	None	None	0.127
Urban	Lot 3 Road	Area Impervious (ha)	None	None	1.147
Urban	Lot 3 Road	Area Impervious (ha)	None	None	0.292
Urban	Lot 3 Road	Area Pervious (ha)	None	None	0
Urban	Lot 3 Road	Area Pervious (ha)	None	None	0
Urban	Lot 3 Road	Total Area (ha)	None	None	1.147
Urban	Lot 3 Road	Total Area (ha)	None	None	0.292
Urban	Lot 3 Roof	Area Impervious (ha)	None	None	0.375
Urban	Lot 3 Roof	Area Impervious (ha)	None	None	0.421
Urban	Lot 3 Roof	Area Pervious (ha)	None	None	0
Urban	Lot 3 Roof	Area Pervious (ha)	None	None	0
Urban	Lot 3 Roof	Total Area (ha)	None	None	0.375
Urban	Lot 3 Roof	Total Area (ha)	None	None	0.421

Only certain parameters are reported when they pass validation

LAKE MACQUARIE CITY COUNCIL

Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Rain	Rainwater Tank	% Reuse Demand Met	80	None	78.7387
Rain	Rainwater Tank	Threshold Hydraulic Loading for C** (m/yr)	0	0	3500
Rain	Rainwater Tank	Threshold Hydraulic Loading for C** (m/yr)	0	0	3500
Rain	Rainwater Tank	Threshold Hydraulic Loading for C** (m/yr)	0	0	3500
Rain	Rainwater Tank	Total Nitrogen - C** (mg/L)	0	0	1.4
Rain	Rainwater Tank	Total Nitrogen - C** (mg/L)	0	0	1.4
Rain	Rainwater Tank	Total Nitrogen - C** (mg/L)	0	0	1.4
Rain	Rainwater Tank	Total Phosphorus - C** (mg/L)	0	0	0.13
Rain	Rainwater Tank	Total Phosphorus - C** (mg/L)	0	0	0.13
Rain	Rainwater Tank	Total Phosphorus - C** (mg/L)	0	0	0.13
Rain	Rainwater Tank	Total Suspended Solids - C** (mg/L)	0	0	12
Rain	Rainwater Tank	Total Suspended Solids - C** (mg/L)	0	0	12
Rain	Rainwater Tank	Total Suspended Solids - C** (mg/L)	0	0	12
Receiving	Receiving Node	TSS % Load Reduction	80	None	79.9

Only certain parameters are reported when they pass validation