REPORT

Lot 1006 Boolaroo (Weemala)

Concept Stormwater Management Plan & Water Sensitive Urban Design Strategy

Client: Hunter Development Brokerage Pty Ltd

Reference: PA2519

Status: Final/P01.02

Date: 24 November 2020

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Enhancing Society Together

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1 Introduction

Royal HaskoningDHV (RHDHV) was engaged by Hunter Development Brokerage (HDB) to prepare a Concept Stormwater Management Plan (SMP) and Water Sensitive Urban Design (WSUD) Strategy for the residential subdivision proposed at Lot 1006, Boolaroo (herein referred to as the subject site).

The subject site is located in the suburb of Boolaroo, NSW within the Lake Macquarie City Local Government Area (LGA).

A number of consultants were previously engaged by Pasminco Cockle Creek Smelter Pty Ltd, developers and more recently, the Hunter and Central Coast Development Corporation (HCCDC) to prepare stormwater assessments of Developable Lands for the Pasminco/Boolaroo Precinct, namely:

- **GCA Pty Ltd, May 2016** – Bunderra Subdivision Development Application, Main Road, Boolaroo - Stormwater DA Report for Pasminco Cockle Creek Smelter Pty Ltd, Revision: 3.
- **Engeny, November 2016** – Superlot DA, Main Road - Stormwater Master Plan, Rpt No. M7134_001
- **Engeny, July 2018** – Weemala Stage 1 – Detailed Design Stormwater Management Plan, Rpt No. N1100_009, and
- **Lyndsay & Dynan, June 2020** – Cockle Creek Redevelopment - Stormwater Management Strategy, Project No.00015361 – Hunter & Central Coast Development Corporation.

These previous stormwater assessments reviewed the existing topographic conditions and stormwater management systems, assessed the impact of the proposed ultimate development on the catchment and resulting changes to stormwater runoff, and presented several stormwater basins to be implemented across the subject site. Since then, at least one subdivision (Lot 50) and some of the basins have been constructed.

The previous investigations included a range of technical studies that include information to assist in preparing a SMP and WSUD Strategy. Based on the above plans and strategies, previous outcomes are consolidated into a tangible set of proposed stormwater control measures for the proposed development.

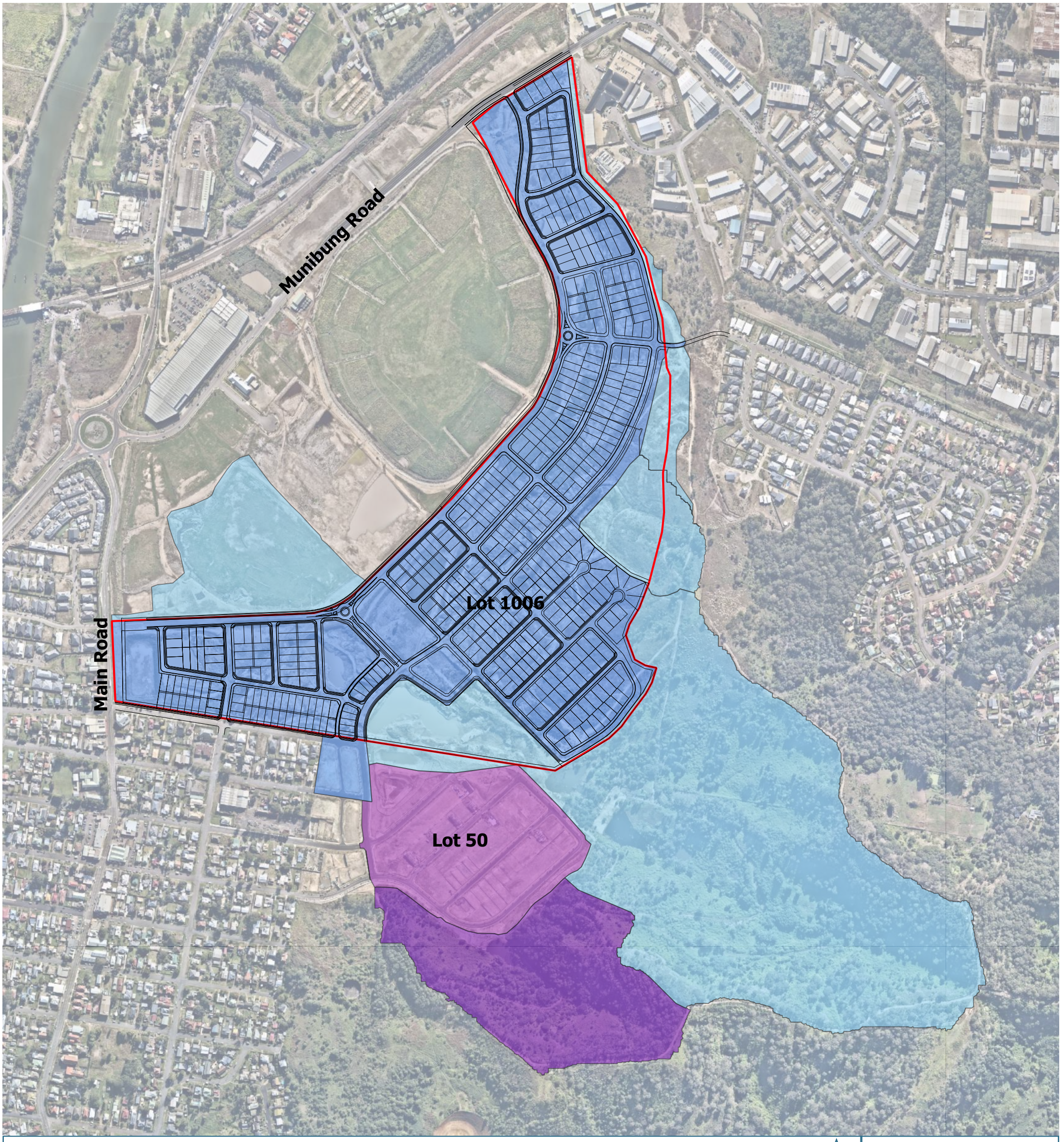
The following report was prepared based on existing site plans, aerial photos, and project development details as well as a site visit attended by RHDHV staff on the 2 September 2020. The scope of this investigation was to consolidate the stormwater and WSUD investigations to allow for a Development Application (DA) submission concerning the proposed residential subdivision development.

2 Description of the Proposed Development

The proposed residential development (Weemala at the Lake) is located at the intersection of Main Road and Munibung Road, Boolaroo. The development is to occur within Lot 1006, which covers approximately 59 ha. Lot 1006 is bounded by Main Road to the west, Munibung Road to the north, and existing residential development to the south. A steep undeveloped area is located to the east of the proposed development, which drains through the site towards Main Road. A recently constructed residential subdivision (Lot 50) also drains to the north and into the proposed development area.

The development proposal incorporates 511 residential lots to be released in stages. The majority of residential lots are suitable for single detached dwellings although some higher density residential housing is also to be provided. Conventional pit and pipe drainage with kerb and gutter are proposed to manage stormwater from residential lots and roads. Open space areas are to be provided around a large waterbody/constructed wetland/detention basin near the boundary between Lot 1006 and Lot 50. Footpath and cycleways are to provide a connection between the open space area and the surrounding residential development. Higher density residential housing is proposed around the open waterbody/wetland.

A map of the proposed development and the external catchments is shown on **Figure 2-1**. Potential development incorporating up to four large residential lots may occur on the eastern side of Lot 1006 but for this assessment was assumed to be undeveloped.



PROJECT: HDB - Weemala SMP

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Figure 2-1 Proposed Development (Lot 1006) and External Catchment

0 250 500 750 1000 m

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Legend:

- Developed Catchment
- Undeveloped Catchment
- Lot 50 - Developed Catchment
- Lot 50 - Undeveloped Catchment
- Lot 1006 Boundary

COORDINATE SYSTEM: Datum GDA94; Projection: MGA Zone 56 | DATE: 20/11/2020 | SCALE: 1:7000 | REVISION: C

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3 Expected Changes to Catchment Hydrology

The proposed residential development will increase the extent of impervious surfaces and formalised piped drainage systems. These alterations, if unmitigated, are expected to result in the following hydrologic changes:

- Increases in runoff volumes and peak flow rates from the developed area. Broadly, this will (if unmitigated) increase stormwater flooding risks in downstream areas.
- Increased potential for stormwater pollution due to higher runoff volumes and pollutant generation potential associated with the increase of impervious areas and change in surface type/land use.

The magnitude of these hydrologic changes will be a function of the relative change in the impervious fraction between existing and developed conditions.

The total catchment area for the site and upstream contributing catchment area is 126.9 ha with an internal (Lot 1006) catchment of 52.3 ha. Therefore, external catchment comprising the “Lot 50 subdivision” and the surrounding undeveloped catchment to the south-east of the site total some 74.6 ha. The subject site was divided into three stormwater management sub-catchment areas coinciding with three proposed treatment basins within the subject site.

The impervious fractions for existing and proposed site conditions were calculated based on a review of aerial photography, and the proposed development plans provided by HDB. The impervious fraction was determined based on proposed surface types. The impervious fraction of the residential development proposed within Lot 1006 was estimated to be approximately 70%. The overall impervious fraction for the proposed development including external catchment areas was estimated to be 45%.

Figure 2-1 shows the extent of the above-mentioned stormwater management sub-catchment areas. These sub-catchment areas are applied to the stormwater management calculations that are documented in **Section 5**.

4 Stormwater Management Guidelines, Objectives and Targets

4.1 Assessment objectives

The objective of this stormwater assessment is to establish stormwater management requirements for the ultimate development proposed within the subject site. The stormwater requirements have been established on the basis that no further development within the site occurs.

To calculate stormwater requirements such as detention storage volumes, existing conditions refer to undeveloped site conditions. Proposed site conditions include both the proposed development within Lot 1006 as well as the adjacent Lot 50 subdivision situated to the south of the subject site.

This approach was applied as the stormwater management system for any future development may be integrated with the Lot 50 stormwater management system located upstream of the subject site.

4.2 Relevant guidelines and targets

4.2.1 Lake Macquarie City Council guidelines

Lake Macquarie Development Control Plan 2014 – Revision 23, April 2020

This guideline was published by Lake Macquarie City Council (LMCC) in April 2020 and outlines Council's requirements and advice on the lodgement requirements for DA's for residential developments.

Details of the stormwater management systems and the measures proposed to mitigate the effects of stormwater quantity and quality impacts on adjoining or downstream sites are to be provided following Council's Water Cycle Management Guidelines. RHDHV has considered the stormwater management requirements that are specified in the guideline during the preparation of the conceptual stormwater management plan. Specifically, the objectives of stormwater management are to:

- ensure that the development does not adversely affect water quality or availability
- ensure that watercourses and riparian vegetation are maintained to mitigate sedimentation and keep good water quality in downstream waterways
- minimise adverse impacts on downstream environments or nearby land due to increased development
- incorporate WSUD techniques into all new developments, and
- minimise the volume and rate of stormwater leaving a development site.

Stormwater management objectives from this guideline are summarised in **Table 4-1**, which establishes recommended stormwater management objectives for the subject site.

Water Cycle Management Guidelines – Revision 2, June 2013

The water cycle management guidelines were published by LMCC in 2013 and provides direction on how to achieve the water management objectives as outlined in Council's Development Control Plan (DCP). These guidelines provide practical advice for implementing Water Cycle Management (WCM) principles and explore practical water management options for residents, Council, developers and business. The guidelines also provide recommended stormwater modelling approaches and parameters. Stormwater management objectives from this guideline are summarised in **Table 4-1**, which establishes recommended stormwater management objectives for the subject site.

Engineering Design Guidelines, July 2016

The engineering design guidelines were published by LMCC in 2016. Section 0074 Stormwater drainage (Design) provides stormwater drainage systems design and documentation to meet the following requirements:

- reduce the frequency of flooding of private and public buildings in flood-prone areas
- control of surface flows to prescribed velocity/depth limits
- control of surface flows to minimise the effect on pedestrians and traffic in more frequent stormwater conditions
- within each catchment, retention of incident rainfall and runoff consistent with the planned use of the area
- conformance with the Australian Rainfall & Runoff (ARR) 'major/minor' system concept
- a constant average recurrence interval (ARI) for existing and reconstructed works, and
- adoption of WSUD principles.

Specifically, the guidelines assist with the planning and design of stormwater drainage using WSUD principles including on-site detention (OSD), capture and use of stormwater as an alternative source of water to conserve potable water, use of vegetation for filtering purposes, water-efficient landscaping, protection of water-related environmental, recreational and cultural values, localised water harvesting for re-use, and localised wastewater treatment systems.

Handbook on Drainage Design Guidelines, December 2013

The handbook on drainage design guidelines was published by LMCC in 2013, and states that it must be read in conjunction with the following:

- Lake Macquarie Development Control Plan 2014 (DCP 2014) – *now superseded (April 2020)*
- Section 0074 Stormwater Drainage (Design) of Part 1 of the Engineering Guidelines
- Part 3 of the Engineering Guidelines (Stormwater Quality Improvement Device Guidelines), and
- The drainage drawings of Part 6 of the Engineering Guidelines (Engineering Standard Drawings)

The handbook provides the requirements and guidance for the drainage of public assets or infrastructure that will become a public asset. Specifically, the document includes reference to the site discharge index (SDI)[1], general principles and requirements for on-site stormwater management and alternate discharge options.

Stormwater Quality Improvement Devices (SQID) Guidelines, December 2013

The stormwater quality improvement devices (SQID) guidelines were published by LMCC in 2013. These guidelines were prepared to assist development applicants with identifying and arranging appropriate SQID's to incorporate into their development. These guidelines should be considered along with Council's requirements for stormwater management that are specified in the Water Cycle Management Guidelines (WCMGs).
The proposed development type and scale determines whether SQIDs are required for a particular development. The WCMGs outline the type and scale of development that requires a development

[1] *Defined as the ratio of the impermeable area that drains directly (DC) to a drainage system to the total site area (S). DCP 2014 sets a performance criteria of 0.1 (10%) for the maximum allowable SDI. On this basis, 90% of stormwater runoff from any site must be managed through suitably designed stormwater source controls.*

applicant to prepare a WCMP. The WCMGs reflect the requirements of Council's DCP 2014 and LEP 2014 that are relevant to the provision of SQIDs within development.

4.2.2 Industry guidelines

Australian Runoff Quality

Australian Runoff Quality (ARQ) is an industry guideline document published in 2005 by the Institution of Engineers Australia (IEAust). The document provides guidance on all aspects of WSUD, including preventative measures, source controls, conveyance controls and end of pipe controls.

Australian Rainfall and Runoff

Australian Rainfall and Runoff (IEAust, 2019) (or AR&R 2019) refers to a series of documents and data that has been prepared by the Institution of Engineers, Australia and the Bureau of Meteorology. AR&R 2019 was prepared to provide designers with the best available information on design flood estimation and is widely accepted as a design guideline for all flood and stormwater-related investigation and design in Australia.

Stormwater Bioretention Systems – Adoption Guidelines

The Adoption Guidelines for Stormwater Biofiltration Systems were developed by the Facility for Advancing Water Biofiltration in 2009. This guideline contains design recommendations for biofiltration systems.

4.3 Recommended stormwater management objectives

Table 4-1 provides a summary of the stormwater management objectives that are specified in the LMCC guidelines for stormwater system design, OSD design and stormwater quality treatment. These objectives were applied to establish stormwater management requirements for the subject site.

LMCC DCP 2014 and the Water Cycle Management Guidelines were adopted to assess stormwater quality pollutant reduction targets for post-construction stormwater runoff and are presented in **Table 4-1**.

Table 4-1: Proposed stormwater management objectives for development with the subject site

Guideline Objectives	Summary
Minor stormwater system criteria (piped network)	• RHDHV have generally adopted the 10-year ARI event as the design criteria for the minor piped drainage system. However, in certain parts of the site where overland gap flows (i.e. 100-year ARI minus 10-year ARI flows) needs to be directed towards the detention basins against the natural falls, then RHDHV have increased the trunk drainage network size to closer to the 20-year ARI capacity, to maximise the amount of overland flow entering the detention basins. • For the south-western (main) catchment discharging under Main Road – a pre-determined outlet discharge rate of 6.5 m^3/s (via the existing Ø1200 RCP and 1800w x 600h RCBC) has been applied for the 10-year event. The minor system is to achieve this discharge rate during the 10-year ARI event in addition to being sufficiently sized to capture approximately the 20-year ARI event, as outlined above. • Otherwise parity[2] with peak flow rates at other outlet locations for the undeveloped catchment condition. • Flows above the 20-year ARI event shall be diverted to the basins via the road network and associated overland flow paths. For parts of the upper catchment to Basin A, some of the catchment can't physically drain to Basin A. Therefore, the trunk drainage capacity has been increased to the 20-year ARI event to ensure sufficient flow is directed to the basin. • Approximately the 20-year ARI event has been adopted for the sizing of the pipe network in some areas of the site to reduce the overland flows produced during the 100-year ARI event. This will help maintain a safe Velocity-Depth product for the gap flows. Note gap flows are defined as the excess stormwater flows produced during the 100-year event not captured by the minor stormwater system. i.e. the overland flows within the developed catchment (100-year minus 10 or 20-year ARI event).
Major stormwater system criteria (overland flows)	• The major stormwater management system has been designed to cater for the 100-year ARI event. • The major stormwater management system incorporates the road network and designated overland flow routes to direct the 'gap flow' to the basins (where possible). • All basins to have sufficient capacity to accommodate the 100-year ARI critical duration storm. • For south-western (main) catchment discharging under Main Road – a predetermined outlet discharge rate of 8.6 m^3/s (via the existing Ø1200 RCP and 1800w x600h RCBC) has been applied for the 100-year event • Otherwise parity with undeveloped conditions at other outlet locations.[2] • Velocity-Depth (VD) product of overland flows ≤0.4 m^2/s for the 100-year ARI event • Subdivision house pads that are located in proximity to overland flow paths are to be set at a level such that sufficient freeboard above the 100-year ARI flood levels is provided following the LMCC DCP (2014/2020).

[2] *Required detention volume was estimated to achieve parity with pre-developed conditions, although it is noted that there may be additional capacity within the downstream drainage and detention system that may enable higher discharge rates to occur (to be confirmed with LMCC). If this is the case, the Basin C detention requirements may be reduced.*

Guideline Objectives Summary	
Detention storage requirements	• To be provided to mitigate any increase in peak flows associated with re-development. • Detention storage volumes and outlet controls sized to reduce peak flow from the proposed development site to satisfy the minor/major design criteria defined outlined above.

Stormwater quality	• Water quality controls are designed to achieve the following pollutant load reductions for the subject site:
	  ○ 80% reduction in the average annual load of TSS
	  ○ 45% reduction in the average annual load of TP
	  ○ 45% reduction in the average annual load of TN.

5 Conceptual Stormwater Management Plan

5.1 Overview

The development proposal will increase the area of roof, road pavement and other paved landscaping surfaces within the subject site. This will result in an increase in stormwater runoff volumes and peak flow rates compared to existing conditions with a related reduction in evapotranspiration and groundwater recharge volumes. These changes have the potential (without mitigation) to result in stormwater quantity and quality impacts on the local receiving environment.

A conceptual SMP is presented in the following sections, which includes:

- the general arrangement of stormwater management measures expected at the subject site
- details of the relationship between the development layout, stormwater drainage system and detention storages, and
- WSUD options for stormwater quantity and quality control following LMCC's Development Control Plan (DCP) 2014/2020.

Specifically, the WSUD Strategy seeks to provide the following (LMCC, 2016):

- Identify management strategies for land and water use and practices
- Link water quantity controls with water quality controls
- Integrate permanent stormwater management features into the overall development
- Identify legal point(s) of discharge
- identify pollutants of concern and their sources for both the construction and operational phases of development
- Identify an optimum combination of structural and non-structural Stormwater Quality Best Management Practices to limit the pollutant export potential of the site for both the construction and operational phases of development, and
- Outline maintenance requirements.

The SMP makes recommendations on stormwater management and sets objectives for the development of the subject site. The SMP is informed by a stormwater drainage system design and analysis program (DRAINS) to estimate the detention storage requirements for the developable area consistent with LMCC's stormwater management requirements (refer **Table 4-1**). Detention volume requirements were estimated for three dual-purpose storages which are to manage the peak flow rate of stormwater leaving the subject site during large infrequent storm events (e.g. 10-year ARI storm and greater). The basins would also incorporate either constructed wetland or bio-retention features to provide a stormwater quality treatment function for the small frequent rainfall events (e.g. up to the 1-year ARI storm). Additional WSUD features proposed include rainwater tanks on all new dwellings (to reduce potable water demands, and to reduce stormwater runoff volumes), and gross pollutant traps upstream of any discharge points from residential areas into the proposed basins (these are proposed to capture gross pollutants such as litter and leaf matter, plus hydrocarbons, as well as coarse sediment).

A conceptual WSUD strategy is presented consistent with recommended stormwater quality targets to mitigate potential stormwater quality impacts. The Model for Stormwater Urban Improvement Conceptualisation (MUSIC) was used to demonstrate the quality of stormwater from the development that can be appropriately managed within the subject site.

The WSUD strategy targets load reductions of common stormwater pollutants (total suspended solids, total nitrogen, total phosphorus and gross pollutants). The WSUD Strategy includes a concept plan to illustrate how the water quality requirements are to be addressed showing the indicative size and location of stormwater quality control measures at the subject site.

5.2 Stormwater quantity

5.2.1 Trunk drainage system

A piped stormwater drainage system will be established to manage stormwater runoff from future development in the subject site. It is expected that the piped drainage system will be integrated with the road network and will connect into the proposed basins via the GPT devices. Treated stormwater will then be discharged into the existing stormwater drainage system downstream of the site.

The trunk drainage system will need to be designed to meet the design objectives for the minor and major stormwater system that are provided in **Table 4-1**. Notably, the minor (piped) stormwater system will be required to not only achieve the discharge requirements for the 10-year ARI event but also (in some areas) capture and convey approximately the 20-year event to the basins to minimise the 'gap flow'. The capacity of the piped network is required to be increased to reduce gap flows during the major (100-year ARI) event such that they remain within the acceptable limits as specified within LMCC's Engineering Design Guidelines (2016), and to ensure that sufficient flow arrives into the basins to allow attenuation to occur. These gap flows are to be conveyed to the basins via the road network and designated overland flow routes i.e. the major stormwater system. To facilitate this, RHDHV has prescribed sags points and crests to be included within the civil design, further details of these will be provided as part of the detailed design package.

With the increased capacity of the piped network, during the 100-year ARI event, overland flows on Fotheringham Road are expected to remain within 1 to 1.5 m^3/s within each half-road (each side of the road). Given the grade and width of the Fotheringham Road, this volume of flow should not exceed the prescribed Velocity x Depth product of 0.4 m^2/s, as per LMCC DCP requirements. **Figure 5-2** shows the peak flow rates and expected flow path of the overland flows.

With the increased capacity of the piped network, the risk of blockage is expected to be low as all inflows into the trunk drainage will be through either kerb inlet or grated inlet pits, which will prevent large debris entering the piped drainage system. A coarse Debris Control Screen is proposed at the upstream end of the developed area, to prevent large debris (such as tree branches/shopping trolleys) from entering Basin A, and potentially blocking the proposed outlet control structure.

5.2.2 Stormwater detention

Section 3 established that the proposed residential development will increase the impervious fraction from pre-existing undeveloped conditions to approximately 45%. Increased imperviousness will increase both peak flow rates and runoff volumes from the development area, potentially increasing stormwater flood risk in downstream areas. Stormwater detention storage is proposed to mitigate those hydrologic changes.

Detention storage volumes were calculated using the DRAINS hydrologic and hydraulic modelling software. DRAINS was applied to calculate runoff hydrographs from the combined stormwater management areas (total area of 132.1 ha) as depicted in **Figure 5-1**. Associated hydrologic parameters are provided in **Appendix B**.

The DRAINS model was applied to simulate the 10-year ARI, 20-year ARI (minor) and 100-year ARI (major) design storm events. A full range of storm durations was assessed using the ensemble storm method (AR&R 2019). Detention storage volumes and nominal low and high outflow rates were established to achieve pre-determined peak flow rates at legal points of discharge for the 10-year ARI and 100-year ARI design storm events. The 3-hour duration event was identified to be the governing duration for the proposed development and its surrounding catchment. Shorter duration design events will be utilised for the sizing of trunk piped drainage systems throughout the sub-division.

Pre and post-development assessment is not required for Catchments A and Catchment B (those areas reporting to Basin B), because the post developed scenario simply needs to satisfy the discharge requirements for the minor and major events as stated in **Table 4-1**, due to the pre-existing (undersized) piped drainage outlets from Basin B. However, for Basin C the estimated existing conditions (undeveloped) peak flow rates for the 10-year ARI and 100-year ARI events for the critical duration event are provided in **Table 5-1**. Detention basin C was sized such that the post developed conditions were at parity with the predeveloped site conditions.

Table 5-1: Peak flow analysis for Basin C

ARI (years)	Modelled Peak Flow (m^3/s)		
	Existing Conditions	Development Conditions (no OSD)	Development Conditions (with OSD)
10	3.4	5.3	2.9
100	7.6	9.6	6.8

Table 5-2 and **Table 5-3** provide a summary of the detention basin performance for the 10-year and 100-year ARI design events respectively. The detention volume requirement is inclusive of both Lot 50 and the proposed development within the subject site (i.e. Lot 1006).

Table 5-2: Required Detention Basin parameters for the 10-year ARI event

Storage	Detention Volume Requirement (m^3)	Outflow Rate (m^3/s)	Peak Water Level (m)	Surface Area (m^2)
Basin A	34 230	3.2	26.45	16 700
Basin B	9 810	5.6	9.23	6 600
Basin C	1 170	2.9	21.45	1 750

Table 5-3: Required Detention Basin parameters for the 100-year ARI event

Storage	Detention Volume Requirement (m^3)	Outflow Rate (m^3/s)	Peak Water Level (m)	Surface Area (m^2)
Basin A	63 100	4.5	28.08	21 000
Basin B	14 900	8.4	9.96	7 500
Basin C	2 300	6.8	21.99	2 500

Additionally, it should be noted that the peak water level achieved in Basin A during a 100-year ARI event is 28.08 m and the spillway to Basin A is located at approximately 29.9 m. The resulting freeboard during a 100-year ARI event is approximately 1.8 m which is sufficient to accommodate this event with a 50% outlet blockage scenario.

5.3 Stormwater quality

5.3.1 Water quality control options

Water quality controls are required to improve the quality of stormwater runoff from the development area. **Table 4-1** established that water quality controls are to be designed to achieve the following pollutant load reductions:

- 80% reduction in average annual load of total suspended solids (TSS)
- 45% reduction in average annual load of total phosphorus (TP), and
- 45% reduction in average annual load of total nitrogen (TN).

A stormwater detention system is not to be regarded as a “source control” when calculating the site drainage index (SDI). The following controls can also be deployed in residential lots to assist meeting the above-mentioned pollutant load reductions (by reducing the effective impervious area within the site):

- Porous paving (note: not accepted by Council within public open space areas)
- Grading of hardstand areas toward grass of soft landscaping areas to reduce directly connected impervious area
- Infiltration devices, and
- Rainwater tanks and associated water re-use.

The following water quality treatment controls arranged in a ‘treatment train’ are considered to be capable of meeting the abovementioned pollutant load reductions:

- Rainwater harvesting (via rainwater tanks)
- Gross pollutant traps
- Bioretention basins, and
- Constructed wetland.

5.3.2 Effectiveness of stormwater quality controls

A conceptual WSUD strategy was modelled (refer to **Appendix C**) using the MUSIC model to estimate the treatment effectiveness of water quality controls in addressing the stormwater quality targets outlined in **Table 4-1**. The concept for the proposed residential development should accommodate conventional pit and pipe drainage for the conveyance of stormwater runoff from roads, residential lots, and other development areas to the stormwater treatment measures. The effectiveness of water quality controls was assessed based on the following assumptions:

- All building roof areas could be directed to a rainwater tank located within each lot.
- An average occupancy rate of residential households is three.
- Average typical potable water use for a household is around 200 L/person/day. Toilet flushing and clothes washing has a relatively constant demand throughout the year and typically accounts for around 20% and 12% of household water use respectively (Sydney Water, 2019).

- Average outdoor water use is around 20% of annual household water use. The distribution of the annual outdoor water demand is greatest during the warmer months and least during the cooler months (i.e. scales according to the daily PET and rainfall).
- A GPT could be installed immediately upstream of the bioretention basins and constructed wetland.
- A bioretention system or constructed wetland could be constructed into the base of the stormwater basins to provide final treatment prior to discharge from the subject site.
- Stormwater outflows from Basin A are to bypass Basin B bioretention as these flows have already been treated for water quality, refer **Figure 5-3**.

The size and configuration of the stormwater quality treatment measures modelled are summarised in **Table 5-5**.

Mean annual pollutant loads and treatment effectiveness for the subject site is shown in **Table 5-4**. The results demonstrate that Council's stormwater quality targets could be achieved for the site using a combination of the abovementioned water quality control options.

Table 5-4: Mean annual pollutant load and treatment effectiveness

Parameter	Mean Annual Load and Treatment Effectiveness		
	Source	Residual	% Reduction
Flow (ML/yr)	354	305	14
Total Suspended Solids (kg/yr)	36 700	6 290	83
Total Phosphorus (kg/yr)	80.1	32.9	59
Total Nitrogen (kg/yr)	648	303	53

Table 5-5: Summary of stormwater treatment measures

Stormwater Treatment Measure	Potential Configuration
Constructed wetland – Basin A	Surface area = 9 000 m^2 Extended detention depth = 0.75 m Permanent pool volume = 6 750 m^3 Exfiltration rate = 0 mm/hr Evaporative loss as % of PET = 125% Equivalent outlet pipe diameter = 135 mm
Bioretention basin – Basin B	Surface area = 1 800 m^2 Extended detention depth = 0.30 m Total biofilter area = 1 350 m^2 Biofilter depth = 0.50 m Saturated hydraulic conductivity = 200 mm/hr TN content of filter media = 800 mg/kg Orthophosphate content of filter media = 55 mg/kg Exfiltration rate = 0mm/hr
Bioretention basin – Basin C	Surface area = 1 000 m^2 Extended detention depth = 0.30 m Total biofilter area = 700 m^2 Biofilter depth = 0.50 m Saturated hydraulic conductivity = 200 mm/hr TN content of filter media = 800 mg/kg Orthophosphate content of filter media = 55 mg/kg Exfiltration rate = 0mm/hr
Gross Pollutant Trap (HumeGuard or similar)	Number of GPTs = 3 High flow by-pass = 0.035 m^3/s Flow reduction = 0% TSS concentration reduction = 50% TP concentration reduction 40% TN concentration reduction = 26%
Rainwater tanks/basement storage	Number of tanks = 511 (one per residential lot) Individual tank properties: *Volume below overflow pipe = 3 kL* *Depth above overflow = 0.2 m* *Surface area = 1.5 m^2* *Initial volume = 1.5 kL* *Overflow pipe diameter = 100 mm* *Max drawdown height = 2 m* Re-use demand for each tank: Constant daily demand Outdoor water use (distribution PET-Rain)

5.4 Other engineering works and catchment treatment

A summary of the Stormwater Management Plan and WSUD Strategy is shown in **Figure 5-3**. Concept plan and section details of Basin A and Basin B outlet control structure are provided on **Figure 5-4** to **Figure 5-6**.

Other engineering works that would be required to manage stormwater to achieve the outcomes are as follows:

- Piped trunk drainage systems design to 10-year ARI capacity and in some instances to a 20-year ARI capacity to direct sufficient stormwater runoff to the proposed basins.
- Overland flow paths (generally utilising proposed roadways) to act as overland flow paths for major storm events (maximum velocity-depth criteria to be 0.4 m^2/s for the 100-year ARI major storm event).
- Subdivision house pads that are located in proximity to overland flow paths are to be set at a level such that sufficient freeboard above the 100-year ARI flood levels is provided following the LMCC DCP (2014/2020).
- Significant excavation and earthworks within the footprint of Basin A to achieve the required surface areas, volumes and stable batters to provide a constructed wetland and detention storage basin. The main basin water retaining embankment is to be designed by a suitably qualified civil/geotechnical engineer using appropriate imported clean low permeability clay fill. An appropriate spillway shall be sized and incorporated into the embankment design to allow the safe discharge of stormwater in the event of either blockage of the piped outlet, or for events above the 100-year ARI event.
- Outlet discharge pipeline between Basin A and Basin B, a Ø1050 RCP will be required to control flows from Basin A into Basin B such that the Basin B discharge requirements can be satisfied. The hydraulic grade-line of this pipeline shall be carefully checked against the proposed finished surface topography to ensure that it does not become overly pressurised. Should minor pressurisation of this main be determined, then appropriate controls (such as no further connections to this pipe from the surrounding development area, and lock-down solid manhole covers) shall be integrated into the design. It is expected that with careful control, pressurisation of this main will not be necessary.
- A coarse Debris Control Screen shall be installed at the upstream end of Basin A to intercept large woody debris from the upstream catchment. This is to lessen the risk of blockages at the Basin A outlet (i.e. pipe connecting Basin A and B). A floating boom and grated screen are to be installed around the Basin A outlet structure to intercept vegetation, gross pollutants or other surface debris generated inside the basin.
- Details around the basin maintenance and access points are to be provided within detailed design plans as follows:
    - Maintenance access tracks with a minimum width of 2.5 m are to be provided around the perimeter of Basin A, with a maximum longitudinal slope of 1V:8H.
    - Batters to have a maximum slope of 1V:4H where maintenance access is required.
    - Access tracks to all inlet and outlet headwalls to be provided (minimum width of 1.2 m)
    - GPT access pads as per LMCC standard drawing EGSD-424.
- Upslope diversion drains are required to intercept runoff from the external catchment areas upstream of the subject site. The diversion drains in combination with an increase in the capacity

of the pit and pipe network (up to 20-year ARI capacity), are to be used to convey the intercepted overland flows to the basins.

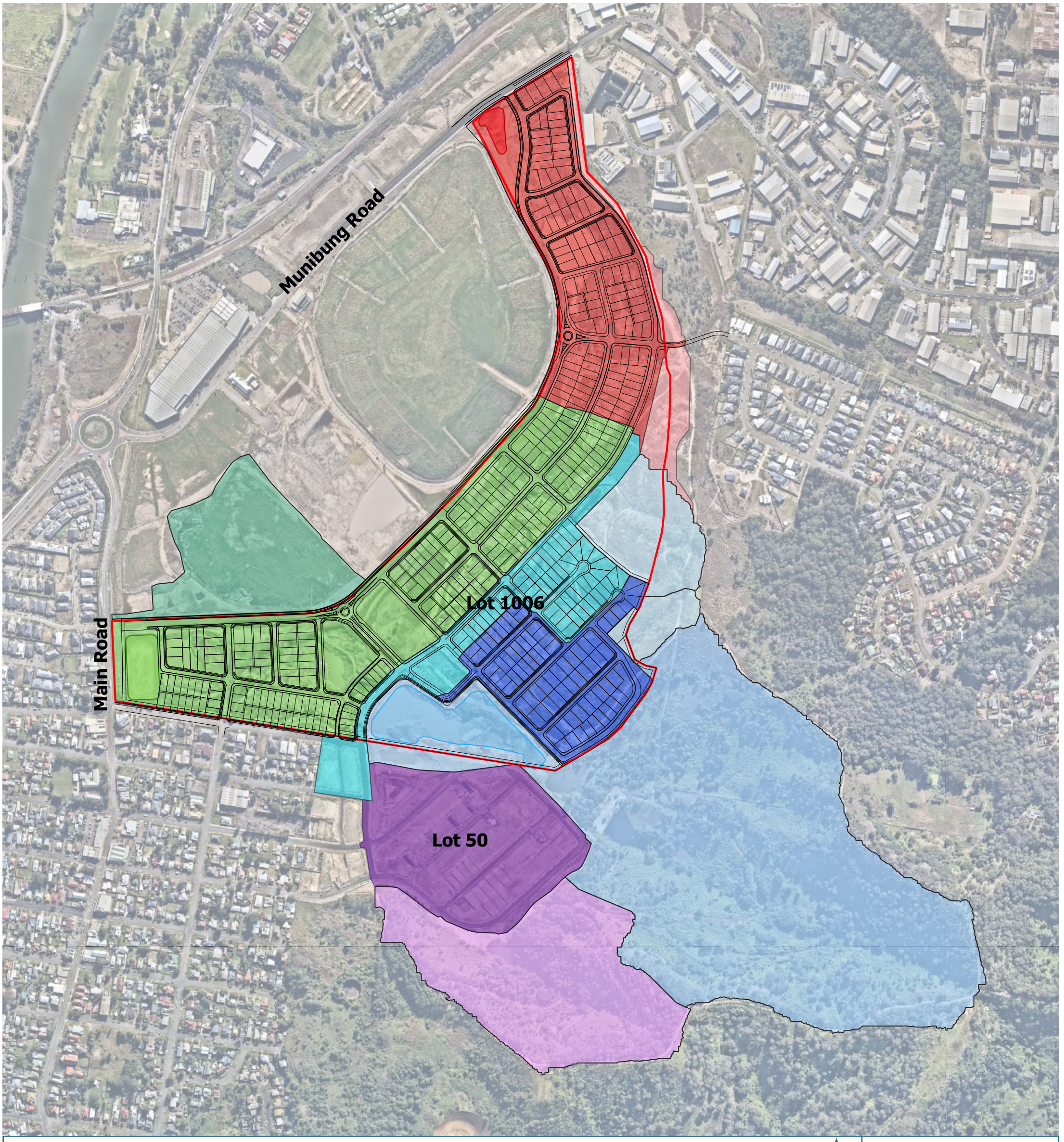
- Bioretention and subsoil drainage to be installed in the base of Basin B; the subsoil drainage is to be connected into the existing stormwater outlet pit, invert level RL 6.20 m (as per GCA design). Upstream invert level of the subsoil drainage will be approximately 800 mm below the existing basin invert level.
- A concrete-lined V-drain is to be installed around the downstream perimeter of the bioretention system for Basin C. This is to collect low flows treated by the bioretention system and provide a connection with the basin outlet structure.
- A new outlet control structure is required in Basin C to satisfy the minor/major discharge criteria (i.e. parity with pre-existing conditions). This structure as depicted in **Figure 5-6** is to be in addition to the existing 2xØ1200 RCPs and would include the construction of a grated concrete weir (length of 7.5 m) with a low-level orifice outlet (800 mm diameter) situated at the invert of the basin (RL 19.915 m) and high flow weir level of RL 21.5m.
- Additional excavation (in the order of 1 500 m^3) is also required within the invert of Basin C to provide an increased storage capacity of 2 300m^3.
- RHDHV has prescribed several amendments to the road design to enable the direction of overland flows into the appropriate basins. These amendments are to be included within the detailed design plan set but are generally as follows:
    - Creation of sag points adjacent to Basins A, B and C.
    - Moving road crests and adjusting cross fall to direct flow but also delineate catchments.
    - Installation of a speed bump (in combination with a sag point) on Fotheringham Road to further encourage flow into Basin B.
    - As outlined above, these measures in combination with increasing parts of the piped drainage network to the 20-year ARI capacity, are sufficient to ensure that the peak discharge rates leaving the site meet parity with existing conditions and that 100-year ARI overland flows do not exceed safe conditions (i.e. maximum 0.4 m^2/s in a 100-year ARI event in accordance with LMCC guidelines).

5.5 Dam safety assessments

RHDHV has consulted with Dam Safety NSW (DSNSW) and their initial advice is that:

- there will be a need to undertake dam safety assessments (DSAs) of Basins A, B and C to determine which, if any, of the three proposed detention basins will require a declaration under the Dam Safety Regulation (2019).
- individual DSA's are required for all of the dams
- DSAs will be used to determine the Consequence Categories (CC) of Basins A, B and C, and
- a precipitating failure also needs to be considered in the case of Basin A cascading into Basin B.

The DSAs will be undertaken concurrently with the detailed drainage design, and at this stage, it is highly likely that Basin A will be referred to Dam Safety NSW.



PROJECT: HDB - Weemala SMP

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Figure 5-1 Combined Stormwater Management Areas

0 250 500 750 1000 m

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Legend:

- Lot 1006 Boundary
- Cat A - Undeveloped, OLF to A
- Cat A - Undevelped, Piped to A
- Cat A - Developed, Lot 50 Basin spills to A
- Cat A - Undeveloped, Lot 50 Basin spills to A
- Cat A - Developed, Minor & Major to A
- Cat A - Developed, Minor to A Major to B
- Cat B - Developed, Minor & Major to B
- Cat B - Undeveloped, Minor & Major to B
- Cat C - Developed, Minor & Major to C
- CatC - Undeveloped, Minor & Major to C

COORDINATE SYSTEM: Datum GDA94; Projection: MGA Zone 56 | DATE: 19/11/2020 | SCALE: 1:7000 | REVISION: A

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Munibung Road

Main Road

Lot 50

2.90 m^3/s

1.36 m^3/s

1.79 m^3/s

2.64 m^3/s

0.66 m^3/s

0.44 m^3/s

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Figure 5-2 Estimated Peak Overland Flows During the 100-year ARI Event

0 250 500 750 1000 m

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Legend:

- Lot 1006 Boundary
- Cat A - Undeveloped, OLF to A
- Cat A - Undevelped, Piped to A
- Cat A - Developed, Lot 50 Basin spills to A
- Cat A - Undeveloped, Lot 50 Basin spills to A
- Cat A - Developed, Minor & Major to A
- Cat A - Developed, Minor to A Major to B
- Cat B - Developed, Minor & Major to B
- Cat B - Undeveloped, Minor & Major to B
- Cat C - Developed, Minor & Major to C
- CatC - Undeveloped, Minor & Major to C
- Overland Flows

COORDINATE SYSTEM: Datum GDA94; Projection: MGA Zone 56 | DATE: 24/11/2020 | SCALE: 1:5000 | REVISION: A

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PROJECT: HDB - Weemala SMP

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Figure 5-3 Stormwater Management Plan & WSUD Strategy

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0 250 500 750 1000 m

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Legend:

- Existing Basin B
- Basin B Bioretention
- Basin A
- Basin A Wetland
- Basin C
- Basin C Bioretention
- Roads
- Lot 1006 Boundary
- Catch Drain Sags
- Weir & Orifice
- GPT + Outlet
- 1050RCP
- Debris Screen
- Concrete Dish Drain
- Floating Boom
- Basin B Bioretention Bypass
- Catch Drains

COORDINATE SYSTEM: Datum GDA94; Projection: MGA Zone 56 | DATE: 18/11/2020 | SCALE: 1:5000 | REVISION: C

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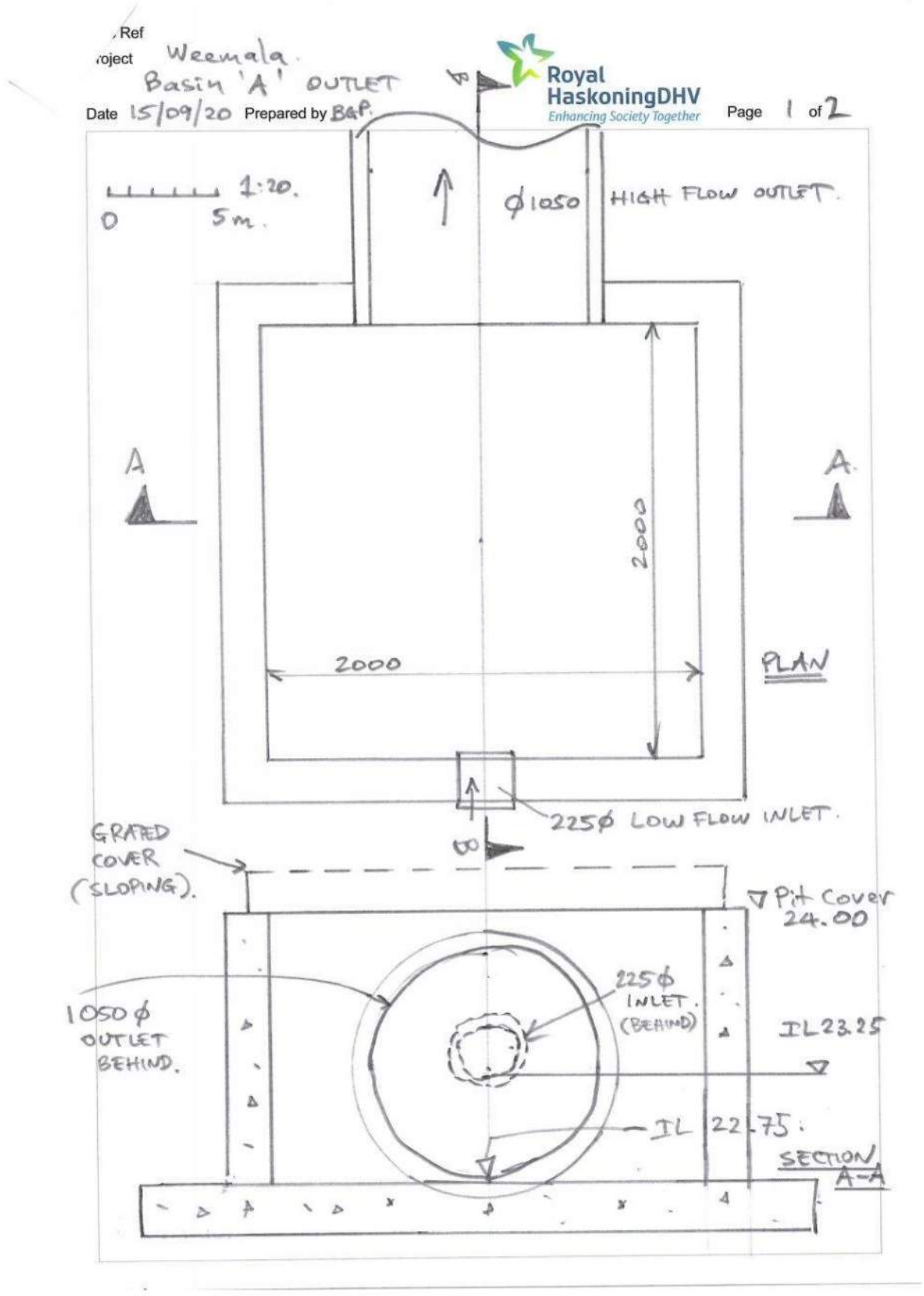


Figure 5-4: Plan and Section A-A of Basin A Outlet Control Structure

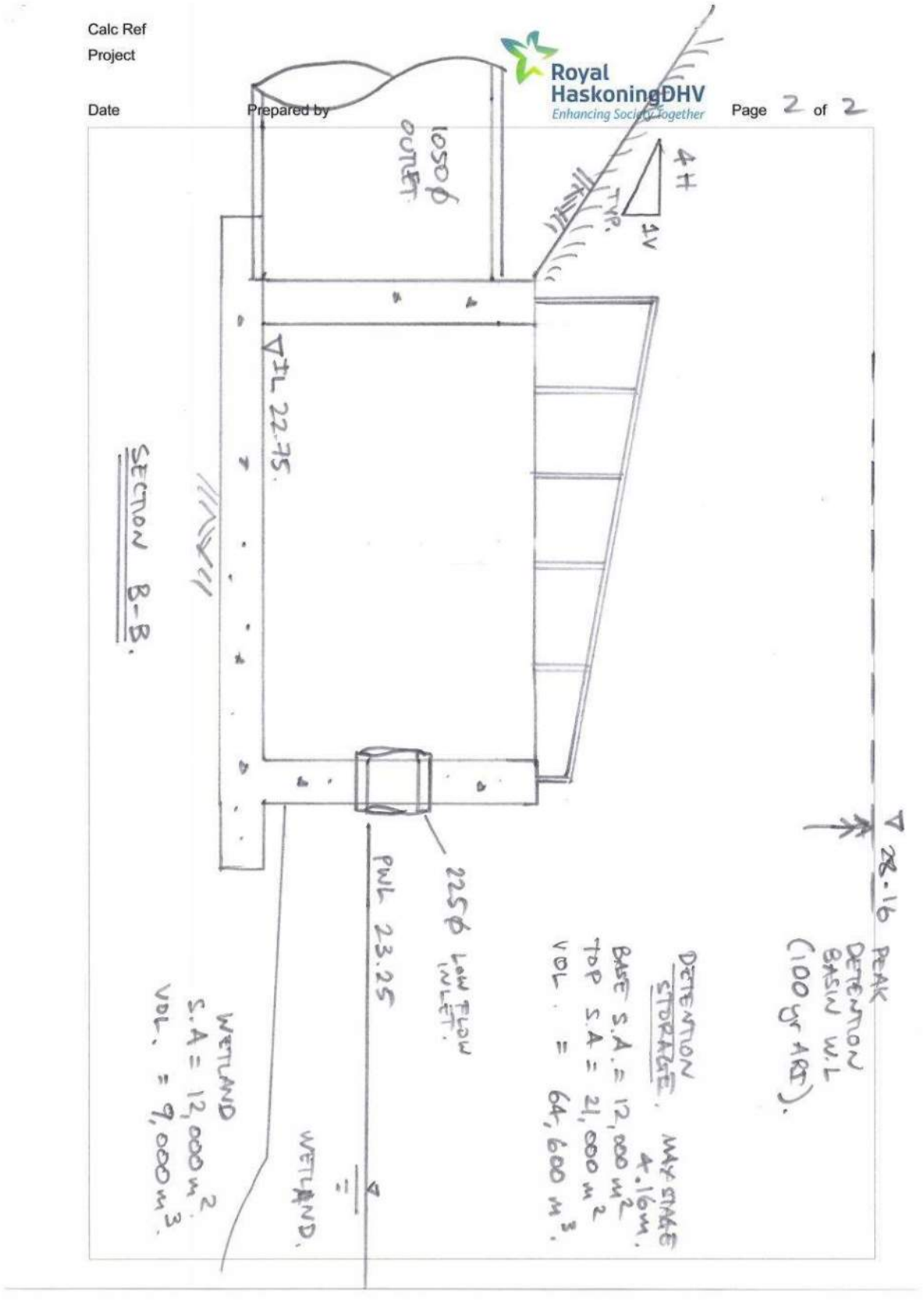


Figure 5-5: Section B-B of Basin A Outlet Control Structure

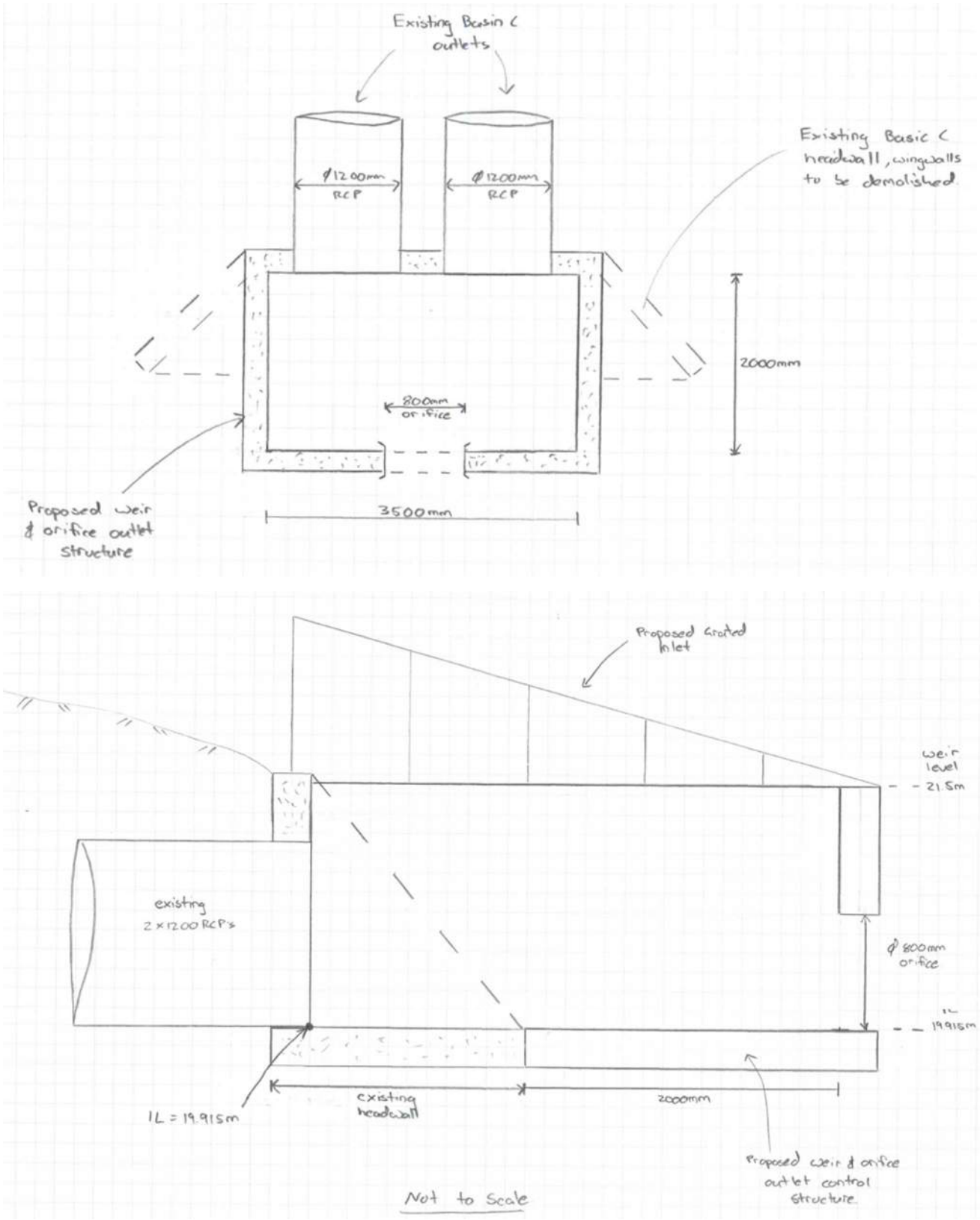


Figure 5-6: Plan and section of Basin C Outlet Control Structure

6 Conclusion

A piped stormwater drainage system would need to be established to manage stormwater runoff from the future development site and connected with the existing and proposed stormwater management basins. Some modifications to the existing drainage system may be required to accommodate future stormwater detention and water quality treatment requirements (e.g. an alternate inlet/outlet arrangement to the existing detention storage facilities, GPT's upstream of basin storages). The stormwater drainage system would need to be integrated with the future detention storage and water quality treatment controls identified for the site. Treated stormwater would ultimately discharge into the existing stormwater drainage system located downstream of the subject site.

The combined detention storage requirements for the site is estimated to be 80 300 m^3, which takes into account WSUD philosophies to reduce directly connected impervious areas and provide beneficial open space and soft landscaping areas where possible. Additionally, some civil works and drainage modifications are required to the existing basins and outlet structures. Basin A will be a large and deep storage and further investigations into the hydraulic performance of this basin are recommended to confirm its operational performance. This would include the consideration of various basin outlet blockage conditions (e.g. partially or fully blocked) as well as the hazard potential of overland flows resulting from basin spills during extreme rainfall events. Careful hydraulic design of the proposed DN1050 pipe connecting Basin A to Basin B will also be required at the detailed design stage.

As outlined in this report, modifications to the road geometries have been combined with an increase in the minor piped drainage system capacity up to a 20-year ARI capacity (i.e. above the LMCC requirement of 10-year ARI) to ensure that sufficient overland flow can enter Basin A, and to ensure that overland flows in the 100-year ARI event do not exceed LMCC requirements of 0.4 m^2/s.

Water quality treatment controls would need to be integrated into the future development to satisfy LMCC's mean annual pollutant load reduction targets of 80%, 45% and 45% for TSS, TP and TN respectively. Conceptual stormwater quantity and quality modelling indicate that the above targets could be achieved for the developed site condition using rainwater tanks, a large constructed wetland, two bioretention basins, and underground propriety stormwater treatment systems (such as HumeGuard GPTs immediately upstream of the storages). We note that stormwater outflows from Basin A are to bypass Basin B bioretention as these flows have already been treated for water quality, refer **Figure 5-3**.

7 References

Institution of Engineers Australia, 1987. 'Australian Rainfall and Runoff – A Guide to Flood Estimation'.

Institution of Engineers Australia, 2005. 'Australian Runoff Quality'

Landcom, 2011. Residential density guide for Landcom project teams, available: https://www.landcom.com.au/assets/Publications/Statement-of-Corporate-Intent/8477325cc1/Density-Guide-Book.pdf [accessed: 7 July 2020].

LMCC, 2013a. Handbook on Drainage Design Guidelines, December 2013.

LMCC, 2013b. Stormwater Quality Improvement Devices Guidelines, December 2013.

LMCC, 2014a. Lake Macquarie Development Control Plan 2014 – Revision 23 Part 3 – Development within Residential Zones Adopted by Council 27 April 2020.

LMCC, 2014b. Water Cycle Management Guidelines – Revision 2, June 2013

LMCC, 2016. Engineering Design Guidelines, July 2016.

New South Wales Government, 2004. Managing Urban Stormwater: Soils and Construction, 4th Edition, March 2004. ISBN 0-9752030-3-7.

New South Wales Government, 2005. 'Floodplain Development Manual – The Management of Flood Liable Land'.

Sydney Water, 2019. Water Conservation Report | 2018-2019. Report prepared by Sydney Water, December 2019. SW 82 12/19.

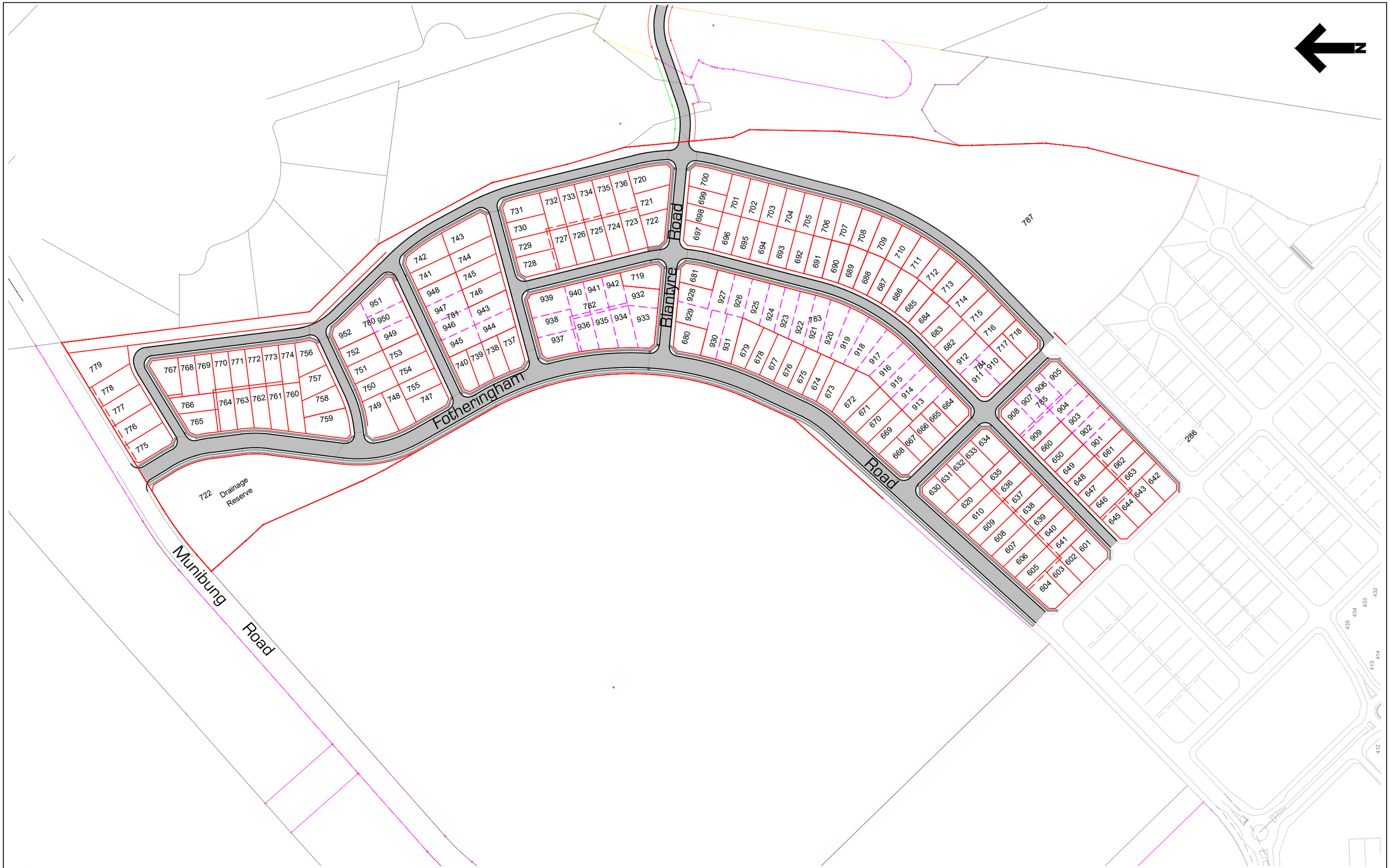
8 Glossary

100-year event	An event that occurs on average once every 100 years. Also known as a 1% AEP event. See annual exceedance probability (AEP) and average recurrence interval (ARI).
2-year event	An event that occurs on average once every 2 years. Also known as a 50% AEP event. See annual exceedance probability (AEP) and average recurrence interval (ARI).
Afflux	The change in water level from existing conditions resulting from a change in the watercourse or floodplain – e.g. construction of a new bridge.
Annual Exceedance Probability (AEP)	Measured as a percentage and a term used to describe the size of an event. AEP is the long term probability between events of a certain magnitude. For example, a 1% AEP event is one that has a 1% probability of occurring in any given year. The AEP is closely related to the ARI.
Australian Height Datum	A common national plane of level approximately equivalent to the height above sea level. All water levels presented in this report have been provided in metres AHD.
Australian Rainfall and Runoff (AR&R)	Engineers Australia publication pertaining to rainfall and flooding investigations in Australia.
Average daily flowrate	The value (which can also be expressed in m^3/s) determined from measured or modelled daily flows (typically expressed in ML/day). It represents the average flow rate over 24 hours and is different to peak or instantaneous daily flow.
Average Recurrence Interval (ARI)	Measured in years and a term used to describe event size. It is a means of describing how likely an event is to occur in a given year. For example, a 100-year ARI event is one that occurs or is exceeded on average once every 100 years.
Calibration	The adjustment of model configuration and key parameters to best fit an observed data set.
Concentration	The amount or mass of a substance present in a given volume or mass of sample usually expressed as milligram per litre (water sample) or micrograms per kilogram (sediment sample).
Conceptual model	A simplified and idealised representation of the physical hydrologic setting and the understanding of the essential flow and water quality processes of the system.

Design flood event	A hypothetical flood representing a specific likelihood of occurrence (for example the 100yr ARI or 1% AEP flood).
Detention storage	The dedicated area set aside for the temporary storage of stormwater during large rainfall events.
Development	Existing or proposed works that may or may not impact upon flooding. Typical works are filling of land, and the construction of roads, floodways and buildings.
Digital Elevation Model	A digital representation of ground surface topography or terrain.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving, for example, metres per second (m/s).
DRAINS	Stormwater Drainage System design and analysis program widely used in Australia.
Drinking water	A common name utilised for potable water.
Flood	Relatively high river or creek flows, which overtop the natural or artificial banks, and inundate floodplains and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
Hydraulic conductivity	The rate at which water of a specified density and kinematic viscosity can move through a permeable medium.
Hydraulic head	A specific measurement of water pressure above a datum. It is usually measured as a water surface elevation, expressed in units of length. The hydraulic head can be used to determine a hydraulic gradient between two or more points.
Flood source	The source of the floodwaters. In this assessment, urban stormwater from the local catchment is the primary source of floodwaters.
Floodway	A flow path (sometimes artificial) that carries significant volumes of floodwaters during a flood.
Freeboard	A factor of safety usually expressed as a height above the adopted flood level thus determining the flood planning level. Freeboard tends to compensate for factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels.
Hydraulic	The term given to the study of water flow in creeks, rivers, estuaries and coastal systems. Deals with practical applications (such as the transmission of energy or the effects of flow) of liquid (such as water) in motion.

Hydrograph	A graph showing how a river or creek's discharge changes with time.
Hydrologic	The term given to the study of the rainfall-runoff process in catchments.
Hyetograph	A graph showing the depth of rainfall over time.
Intensity Frequency Duration (IFD) Curve	A statistical representation of rainfall showing the relationship between rainfall intensity, storm duration and frequency (probability) of occurrence.
MUSIC	Model for Urban Stormwater Improvement Conceptualisation predicts the performance of stormwater quality management systems. It is intended to help organisations plan and design (at a conceptual level) appropriate urban stormwater management systems for their catchments.
Overland flows	Surface runoff flows that migrates to the receiving environment when an area is over irrigated beyond its hydraulic capacity limits.
Pluviometer	A rainfall gauge capable of continuously measuring rainfall intensity.
Probable maximum flood (PMF)	An extreme flood deemed to be the maximum flood likely to occur.
Riparian	The interface between land and waterway. Literally means "along the river margins".
Runoff	The amount of rainfall from a catchment that ends up as flowing water in the river or creek.
Stage	See flood level.
Stage hydrograph	A graph of water level over time.
TN	Total Nitrogen, the sum of all forms of nitrogen in surface waters comprising a dissolved component (nitrate, nitrite), ammonia and ammonium, and an organic component (organic nitrogen).
Topography	The shape of the surface features of the land.
TP	Total Phosphorus, the sum of all forms of phosphorus in surface waters comprising soluble and particulate fractions of organic and inorganic phosphorus.
TSS	Total Suspended Solids, the total quantity measurement of solid material per unit volume of water. Units commonly expressed as mg/L.
Water quality	A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Appendix A: Proposed Development Layout



NOTE: ALL DIMENSIONS, AREAS, LOT NUMBERS EASEMENTS & NUMBER OF LOTS ARE SUBJECT TO THE APPROVAL OF COUNCIL & OTHER AUTHORITIES AND TO THE FINAL SURVEY & LINEN PLAN AND SHOULD BE CONSIDERED AS CONCEPTUAL ONLY. DO NOT RELY ON THE INFORMATION IN THIS PLAN FOR ANY PURCHASE, DISPOSAL OR OTHER MATTER.

Revision B 15/9/2020
Scale 1:5000 @ A3
20041

Weemala - DA 2 (North)
Overall Plan - Subdivision Layout
Main Road Boolaroo

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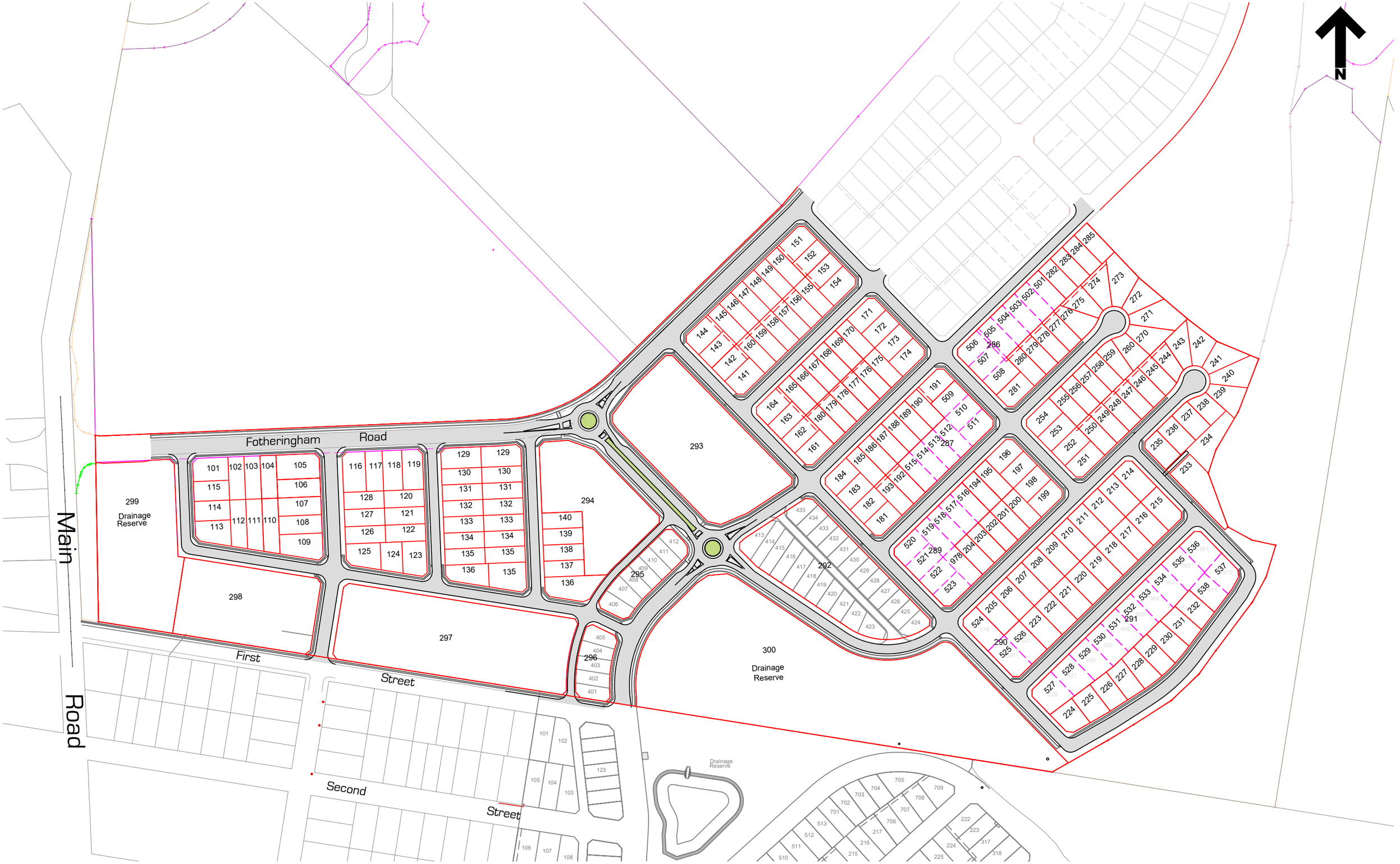

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Revision B 15/09/2020
Scale 1:3000 @ A3
Job No. 20041

Weemala - DA 1 (South)
Overall Plan - Subdivision Layout
Main Road Boolaroo

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Appendix B: DRAINS Model Results

10yr ARI Event

DRAINS results prepared from Version 2020.05

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surfa Flow Arriv (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N92921	9.26		0.771				
All to A - 5	57.46		0.529		1.54	0.011	Inlet Capacity
All to A - 4	57.02		0.529		1.48	0.011	Inlet Capacity
All to A - 3	56.56		0.529		1.44	0.011	Inlet Capacity
All to A - 2	56.08		0.529		1.42	0.011	Inlet Capacity
All to A - 1	55.59		0.529		1.41	0.011	Inlet Capacity
Junction Pit	26.45		0		1.35		None
All to B - 0	26.59		0.985		1.41	0.118	Inlet Capacity
All to B - 1	23.79		0.985		1.21	0.118	Inlet Capacity
All to B - 2	21.42		0.985		1.08	0.118	Inlet Capacity
All to B - 3	20.12		0.985		0.88	0.118	Inlet Capacity
All to B - 4	19.2		0.985		0.8	0.118	Inlet Capacity
All to B - 5	16.28		0.985		0.72	0.118	Inlet Capacity
All to B - 6	13.37		0.985		0.63	0.118	Inlet Capacity
All to B - 7	9.32		0.985		0.68	0.118	Inlet Capacity
All to C - 4	25.04		1.11		1.46	0.15	Inlet Capacity
C Sag	22.72	24	1.765	42.9	0.98	0.764	Inlet Capacity
All to C - 1	25.36		1.11		1.44	0.15	Inlet Capacity
All to C - 2	24.22		1.11		1.18	0.15	Inlet Capacity
All to C - 3	23.73		1.11		0.97	0.15	Inlet Capacity
Catch Drain Inlet	41.06	44.31	0.86	44.8	2.94		Inlet Capacity
Major to B - 1	41.02		0.649		1.98	0.034	Inlet Capacity
Catch Drain Inlet 2	41.57	44.31	0.86	44.8	2.43		Inlet Capacity
Major to B - 4	41.42		0.649		1.58	0.034	Inlet Capacity
Major to B - 3	41.35		0.649		1.65	0.034	Inlet Capacity
Major to B - 2	41.23		0.649		1.77	0.034	Inlet Capacity

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Piped Undeveloped	0.749	0	0.749	0	9.19	0	10% AEP, 15 min burst, Storm 6
Cat Lot50 Undeveloped	2.637	0	2.637	0	16.16	0	10% AEP, 20 min burst, Storm 10
OLF Undeveloped	11.592	0	11.592	0	9.19	0	10% AEP, 15 min burst, Storm 6
Catchment C Un-Dev	3.365	0	3.365	0	14.15	0	10% AEP, 20 min burst, Storm 8
IKEA	0.724	0	0.724	0	54.06	0	10% AEP, 1 hour burst, Storm 8
Piped Undeveloped 2	0.749	0	0.749	0	9.19	0	10% AEP, 15 min burst, Storm 6
Cat All to A - 5	0.508	0.138	0.373	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat All to A - 4	0.508	0.138	0.373	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat All to A - 3	0.508	0.138	0.373	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat All to A - 2	0.508	0.138	0.373	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat All to A - 1	0.508	0.138	0.373	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat BB0	0.957	0.219	0.747	2.44	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat BB1	0.957	0.219	0.747	2.44	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat BB2	0.957	0.219	0.747	2.44	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat BB3	0.957	0.219	0.747	2.44	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat BB4	0.957	0.219	0.747	2.44	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat BB5	0.957	0.219	0.747	2.44	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat BB6	0.957	0.219	0.747	2.44	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat BB7	0.957	0.219	0.747	2.44	8.15	2.34	10% AEP, 10 min burst, Storm 7
Catchment C Dev 4	1.067	0.218	0.85	2.89	7.56	2.34	10% AEP, 10 min burst, Storm 7
Catchment C Dev 5	1.067	0.218	0.85	2.89	7.56	2.34	10% AEP, 10 min burst, Storm 7
Catchment C Dev 1	1.067	0.218	0.85	2.89	7.56	2.34	10% AEP, 10 min burst, Storm 7
Catchment C Dev 2	1.067	0.218	0.85	2.89	7.56	2.34	10% AEP, 10 min burst, Storm 7
Catchment C Dev 3	1.067	0.218	0.85	2.89	7.56	2.34	10% AEP, 10 min burst, Storm 7
Cat Major to B - 1	0.622	0.169	0.457	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat Lot50 Developed	3.79	1.043	2.78	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat Major to B - 4	0.622	0.169	0.457	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat Major to B - 3	0.622	0.169	0.457	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7
Cat Major to B -2	0.622	0.169	0.457	1.91	8.15	2.34	10% AEP, 10 min burst, Storm 7

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
IKEA Pipe	0.723	0.71	9.259	9.234	10% AEP, 1 hour burst, Storm 4
A4	0.495	1.14	57.456	57.02	10% AEP, 10 min burst, Storm 7
A3	0.986	1.38	57.02	56.564	10% AEP, 10 min burst, Storm 7
A2	1.476	1.54	56.564	56.085	10% AEP, 10 min burst, Storm 7
A1	2.01	1.78	56.085	55.587	10% AEP, 10 min burst, Storm 8
Cat A Trunk Line 2.1	2.219	1.79	55.587	26.446	10% AEP, 10 min burst, Storm 7
Cat A Trunk Line 3	4.471	0.44	26.446	26.446	10% AEP, 15 min burst, Storm 6
Pipe A to B	3.23	5.32	25.786	9.684	10% AEP, 1 hour burst, Storm 4
BB0	0.805	1.51	26.587	23.787	10% AEP, 10 min burst, Storm 7
BB1	1.535	1.8	23.787	21.42	10% AEP, 10 min burst, Storm 7
BB2	2.277	2.16	21.42	20.122	10% AEP, 10 min burst, Storm 7
BB3	3.027	2.61	19.971	19.2	10% AEP, 10 min burst, Storm 7
BB4	3.746	2.83	19.071	16.284	10% AEP, 10 min burst, Storm 7
BB5	4.433	3.02	16.158	13.367	10% AEP, 10 min burst, Storm 7
BB6	5.171	3.22	13.244	9.32	10% AEP, 15 min burst, Storm 6
BB7	6.027	2.53	9.252	9.234	10% AEP, 15 min burst, Storm 6
C4	0.895	1.66	25.04	22.716	10% AEP, 10 min burst, Storm 7
C5	4.598	3.07	22.678	21.454	10% AEP, 10 min burst, Storm 5
C1	0.894	1.59	25.357	24.221	10% AEP, 10 min burst, Storm 7
C2	1.746	2.23	24.117	23.733	10% AEP, 10 min burst, Storm 7
C3	2.583	2.69	23.549	22.716	10% AEP, 10 min burst, Storm 7
Connecter	0.728	0.71	41.058	41.018	10% AEP, 15 min burst, Storm 6
Cat A Trunk Line 1	3.639	2.63	41.018	26.446	10% AEP, 15 min burst, Storm 9
Existing Outlet Lot50	3.078	4.16	29.722	27.409	10% AEP, 30 min burst, Storm 4
Connecter 2	0.728	1.37	41.571	41.416	10% AEP, 15 min burst, Storm 6
AB3	1.223	0.94	41.361	41.354	10% AEP, 15 min burst, Storm 6
AB2	1.72	1.37	41.247	41.234	10% AEP, 15 min burst, Storm 6
AB1	2.243	2.1	41.044	41.018	10% AEP, 10 min burst, Storm 3

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Catch to Pipe	0.749	0.733	0.473	0.233	0.8	1.86	3.45	10% AEP, 15 min burst, Storm 6
Catch Drain Cat Lot50	2.637	2.637	0.497	0.389	1.69	3.11	4.35	10% AEP, 20 min burst, Storm 10
OLF	11.592	11.329	4.004	0.554	0.95	14.43	1.71	10% AEP, 15 min burst, Storm 6
Combined 1200 and RCB	5.611	5.611	3.644	0.6	3.12	1.8	5.2	10% AEP, 1 hour burst, Storm 3
Catch to Pipe 2	0.749	0.733	0.473	0.233	0.8	1.86	3.45	10% AEP, 15 min burst, Storm 6
Cat A Minor Roads - 5	0.011	0.011	0.64	0.038	0.05	0.44	1.36	10% AEP, 10 min burst, Storm 7
Cat A Minor Roads - 4	0.011	0.011	0.661	0.038	0.05	0.44	1.36	10% AEP, 10 min burst, Storm 7
Cat A Minor Roads - 3	0.011	0.011	0.665	0.038	0.05	0.44	1.32	10% AEP, 10 min burst, Storm 7
Cat A Minor Roads - 2	0.011	0.011	0.685	0.038	0.05	0.44	1.32	10% AEP, 10 min burst, Storm 7
Cat A Minor Roads - 1	0.011	0.011	0.687	0.039	0.05	0.45	1.28	10% AEP, 10 min burst, Storm 7
Basin A OLF	0	0	0.788	0	0	0	0	
major FH0.1	0.118	0.117	0.751	0.078	0.11	2.41	1.44	10% AEP, 10 min burst, Storm 7
major FH1.1	0.118	0.117	0.751	0.078	0.11	2.41	1.44	10% AEP, 10 min burst, Storm 7
major FH2.1	0.118	0.117	0.751	0.078	0.11	2.41	1.44	10% AEP, 10 min burst, Storm 7
major FH3.1	0.118	0.117	0.751	0.078	0.11	2.41	1.44	10% AEP, 10 min burst, Storm 7
major FH4.1	0.118	0.117	0.751	0.078	0.11	2.41	1.44	10% AEP, 10 min burst, Storm 7
major FH5.1	0.118	0.117	0.751	0.078	0.11	2.41	1.44	10% AEP, 10 min burst, Storm 7
major FH6.1	0.118	0.117	0.751	0.078	0.11	2.41	1.44	10% AEP, 10 min burst, Storm 7
major FH7.1	0.118	0.117	0.751	0.078	0.11	2.41	1.44	10% AEP, 10 min burst, Storm 7
C4 to Sag	0.15	0.149	0.379	0.109	0.13	2.79	1.24	10% AEP, 10 min burst, Storm 7
To Basin C	0.764	0.76	0	0.055	0.09	12.21	1.69	10% AEP, 10 min burst, Storm 7
Orifce + Weir	2.924	2.924	1.199	0.469	1.46	2	3.11	10% AEP, 20 min burst, Storm 7
C1 - Sag	0.15	0.149	0.275	0.122	0.12	3.2	0.95	10% AEP, 10 min burst, Storm 7
C2 - Sag	0.15	0.149	0.262	0.123	0.11	3.26	0.92	10% AEP, 10 min burst, Storm 7
C3 - Sag	0.15	0.149	0.262	0.123	0.11	3.26	0.92	10% AEP, 10 min burst, Storm 7
B-1 to FH	0.034	0.034	0.514	0.05	0.11	0.8	2.19	10% AEP, 10 min burst, Storm 7
Trap Spillway	0	0	1.96	0	0	0	0	
B-4 to FH	0.034	0.034	0.514	0.05	0.11	0.8	2.19	10% AEP, 10 min burst, Storm 7
B-3 to FH	0.034	0.034	0.514	0.05	0.11	0.8	2.19	10% AEP, 10 min burst, Storm 7
B-2 to FH	0.034	0.034	0.514	0.05	0.11	0.8	2.19	10% AEP, 10 min burst, Storm 7
To Basin B	0.528	0.528	0	0.051	0.07	11.8	1.31	10% AEP, 15 min burst, Storm 9
major FH1	0.215	0.213	0.338	0.128	0.15	3.41	1.2	10% AEP, 10 min burst, Storm 7
major FH2	0.225	0.224	0.327	0.131	0.15	3.52	1.18	10% AEP, 10 min burst, Storm 7
major FH3	0.268	0.267	0.453	0.124	0.2	3.3	1.6	10% AEP, 15 min burst, Storm 6
major FH4	0.338	0.334	0.293	0.159	0.18	4.8	1.11	10% AEP, 15 min burst, Storm 6
major FH5	0.402	0.392	0.383	0.153	0.22	4.44	1.46	10% AEP, 15 min burst, Storm 6
major FH6	0.444	0.434	0.453	0.147	0.26	4.07	1.76	10% AEP, 15 min burst, Storm 9
major FH7	0.488	0.488	0.459	0.154	0.27	4.51	1.73	10% AEP, 15 min burst, Storm 9
Cat A Minor Road - 3	0.013	0.012	0.687	0.041	0.05	0.48	1.34	10% AEP, 10 min burst, Storm 7

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin B	9.23	9809.4	5.611	0	5.611
Basin A	26.45	34228.6	3.23	3.23	0
Basin C	21.45	1161.5	2.924	0	2.924
Lot 50 Basin	30.24	2891.5	3.078	3.078	0

100yr ARI Event

DRAINS results prepared from Version 2020.05

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfa Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N92921	10.12		1.924				
All to A - 5	57.52		1.071		1.48	0.105	Inlet Capacity
All to A - 4	57.11		1.071		1.39	0.105	Inlet Capacity
All to A - 3	56.68		1.071		1.32	0.105	Inlet Capacity
All to A - 2	56.24		1.071		1.26	0.105	Inlet Capacity
All to A - 1	55.76		1.071		1.24	0.105	Inlet Capacity
Junction Pit	28.08		0		0		Outlet System
All to B - 0	26.74		2.017		1.26	0.384	Inlet Capacity
All to B - 1	24.02		2.017		0.98	0.384	Inlet Capacity
All to B - 2	21.71		2.017		0.79	0.384	Inlet Capacity
All to B - 3	20.54		2.017		0.46	0.384	Inlet Capacity
All to B - 4	19.69		2.017		0.31	0.384	Inlet Capacity
All to B - 5	16.76		2.017		0.24	0.384	Inlet Capacity
All to B - 6	13.79		2.017		0.21	0.384	Inlet Capacity
All to B - 7	10		2.017		0	1.444	Outlet System
All to C - 4	25.2		2.319		1.3	0.455	Inlet Capacity
C Sag	23.13	24	5.269	42.9	0.57	2.903	Inlet Capacity
All to C - 1	25.53		2.319		1.27	0.455	Inlet Capacity
All to C - 2	25.04		2.319		0.36	0.455	Inlet Capacity
All to C - 3	24.52		2.319		0.18	0.455	Inlet Capacity
Catch Drain Inlet	41.38	44.86	1.869	240	2.62		Inlet Capacity
Major to B - 1	41.35		1.312		1.65	0.166	Inlet Capacity
Catch Drain Inlet 2	42.07	44.86	1.869	240	1.93		Inlet Capacity
Major to B - 4	42.02		1.312		0.98	0.166	Inlet Capacity
Major to B - 3	41.93		1.312		1.07	0.166	Inlet Capacity
Major to B - 2	41.71		1.312		1.29	0.166	Inlet Capacity

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Piped Undeveloped	1.636	0	1.636	0	6.9	0	1% AEP, 10 min burst, Storm 1
Cat Lot50 Undeveloped	6.182	0	6.182	0	12.29	0	1% AEP, 15 min burst, Storm 8
OLF Undeveloped	25.337	0	25.337	0	6.9	0	1% AEP, 10 min burst, Storm 1
Catchment C Un-Dev	7.565	0	7.565	0	10.77	0	1% AEP, 15 min burst, Storm 2
IKEA	1.924	0	1.924	0	40.77	0	1% AEP, 45 min burst, Storm 8
Piped Undeveloped 2	1.636	0	1.636	0	6.9	0	1% AEP, 10 min burst, Storm 1
Cat All to A - 5	0.911	0.234	0.677	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat All to A - 4	0.911	0.234	0.677	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat All to A - 3	0.911	0.234	0.677	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat All to A - 2	0.911	0.234	0.677	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat All to A - 1	0.911	0.234	0.677	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat BB0	1.734	0.372	1.362	1.98	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat BB1	1.734	0.372	1.362	1.98	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat BB2	1.734	0.372	1.362	1.98	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat BB3	1.734	0.372	1.362	1.98	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat BB4	1.734	0.372	1.362	1.98	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat BB5	1.734	0.372	1.362	1.98	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat BB6	1.734	0.372	1.362	1.98	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat BB7	1.734	0.372	1.362	1.98	6.58	1.89	1% AEP, 10 min burst, Storm 7
Catchment C Dev 4	1.915	0.444	1.62	2.34	6.11	1.89	1% AEP, 10 min burst, Storm 1
Catchment C Dev 5	1.915	0.444	1.62	2.34	6.11	1.89	1% AEP, 10 min burst, Storm 1
Catchment C Dev 1	1.915	0.444	1.62	2.34	6.11	1.89	1% AEP, 10 min burst, Storm 1
Catchment C Dev 2	1.915	0.444	1.62	2.34	6.11	1.89	1% AEP, 10 min burst, Storm 1
Catchment C Dev 3	1.915	0.444	1.62	2.34	6.11	1.89	1% AEP, 10 min burst, Storm 1
Cat Major to B - 1	1.117	0.287	0.83	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat Lot50 Developed	6.832	1.772	5.06	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat Major to B - 4	1.117	0.287	0.83	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat Major to B - 3	1.117	0.287	0.83	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7
Cat Major to B -2	1.117	0.287	0.83	1.54	6.58	1.89	1% AEP, 10 min burst, Storm 7

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
IKEA Pipe	1.924	1.7	10.115	9.958	1% AEP, 45 min burst, Storm 6
A4	0.806	1.31	57.519	57.112	1% AEP, 10 min burst, Storm 7
A3	1.613	1.58	57.112	56.68	1% AEP, 10 min burst, Storm 7
A2	2.419	1.78	56.68	56.236	1% AEP, 10 min burst, Storm 7
A1	3.23	1.94	56.236	55.76	1% AEP, 10 min burst, Storm 3
Cat A Trunk Line 2.1	3.931	2.21	55.737	28.084	1% AEP, 10 min burst, Storm 7
Cat A Trunk Line 3	7.907	0.72	28.084	28.084	1% AEP, 10 min burst, Storm 4
Pipe A to B	4.461	4.98	27.389	10.049	1% AEP, 2 hour burst, Storm 2
BB0	1.344	1.75	26.737	24.024	1% AEP, 10 min burst, Storm 7
BB1	2.641	2.49	23.912	21.715	1% AEP, 10 min burst, Storm 7
BB2	3.943	2.88	21.607	20.538	1% AEP, 10 min burst, Storm 7
BB3	5.255	3.24	20.254	19.687	1% AEP, 10 min burst, Storm 7
BB4	6.554	3.59	19.391	16.762	1% AEP, 10 min burst, Storm 7
BB5	8.261	4.14	16.521	13.789	1% AEP, 10 min burst, Storm 4
BB6	9.656	4.67	13.586	10	1% AEP, 10 min burst, Storm 3
BB7	10.8	3.62	9.963	9.958	1% AEP, 10 min burst, Storm 3
C4	1.455	2.03	25.17	23.132	1% AEP, 10 min burst, Storm 7
C5	6.477	3.57	22.884	21.987	1% AEP, 10 min burst, Storm 4
C1	1.455	1.91	25.503	25.042	1% AEP, 10 min burst, Storm 7
C2	2.924	1.99	24.744	24.524	1% AEP, 10 min burst, Storm 7
C3	4.309	3.23	23.863	23.132	1% AEP, 10 min burst, Storm 7
Connecter	1.123	0.74	41.356	41.345	1% AEP, 15 min burst, Storm 10
Cat A Trunk Line 1	6.353	3.23	41.318	28.084	1% AEP, 10 min burst, Storm 3
Existing Outlet Lot50	4.104	3.1	30.453	28.084	1% AEP, 25 min burst, Storm 3
Connecter 2	1.141	0.85	42.043	42.024	1% AEP, 10 min burst, Storm 4
AB3	2.025	1.11	41.931	41.926	1% AEP, 10 min burst, Storm 7
AB2	2.953	1.64	41.726	41.715	1% AEP, 10 min burst, Storm 7
AB1	3.903	2.56	41.364	41.345	1% AEP, 10 min burst, Storm 7

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Catch to Pipe	1.636	1.634	0.473	0.313	1.31	2.5	4.18	1% AEP, 10 min burst, Storm 1
Catch Drain Cat Lot50	6.182	6.161	0.497	0.536	2.89	4.28	5.39	1% AEP, 15 min burst, Storm 8
OLF	25.337	25.296	4.004	0.858	1.89	16.86	2.2	1% AEP, 10 min burst, Storm 1
Combined 1200 and RCB	8.436	8.436	3.644	0.6	4.69	1.8	7.81	1% AEP, 1 hour burst, Storm 2
Catch to Pipe 2	1.636	1.634	0.473	0.313	1.31	2.5	4.18	1% AEP, 10 min burst, Storm 1
Cat A Minor Roads - 5	0.105	0.103	0.64	0.078	0.16	1.74	2.03	1% AEP, 10 min burst, Storm 7
Cat A Minor Roads - 4	0.105	0.103	0.661	0.079	0.16	1.76	2	1% AEP, 10 min burst, Storm 7
Cat A Minor Roads - 3	0.105	0.103	0.665	0.079	0.16	1.78	1.96	1% AEP, 10 min burst, Storm 7
Cat A Minor Roads - 2	0.105	0.103	0.685	0.08	0.15	1.8	1.92	1% AEP, 10 min burst, Storm 7
Cat A Minor Roads - 1	0.105	0.103	0.717	0.08	0.15	1.8	1.92	1% AEP, 10 min burst, Storm 7
Basin A OLF	0	0	2.291	0	0	0	0	
major FH0.1	0.384	0.384	2.347	0.12	0.21	4.32	1.76	1% AEP, 10 min burst, Storm 7
major FH1.1	0.384	0.384	2.347	0.12	0.21	4.32	1.76	1% AEP, 10 min burst, Storm 7
major FH2.1	0.384	0.384	2.347	0.12	0.21	4.32	1.76	1% AEP, 10 min burst, Storm 7
major FH3.1	0.384	0.384	2.347	0.12	0.21	4.32	1.76	1% AEP, 10 min burst, Storm 7
major FH4.1	0.384	0.384	2.347	0.12	0.21	4.32	1.76	1% AEP, 10 min burst, Storm 7
major FH5.1	0.384	0.384	2.347	0.12	0.21	4.32	1.76	1% AEP, 10 min burst, Storm 7
major FH6.1	0.384	0.384	2.347	0.12	0.21	4.32	1.76	1% AEP, 10 min burst, Storm 7
major FH7.1	1.444	1.443	2.347	0.183	0.44	7.55	2.4	1% AEP, 2 hour burst, Storm 9
C4 to Sag	0.455	0.454	2.34	0.161	0.23	4.93	1.44	1% AEP, 10 min burst, Storm 1
To Basin C	2.903	2.877	0.611	0.103	0.26	17.01	2.51	1% AEP, 10 min burst, Storm 7
Orifce + Weir	6.769	6.769	1.199	0.852	3.38	2	3.97	1% AEP, 25 min burst, Storm 7
C1 - Sag	0.455	0.454	2.579	0.179	0.2	5.98	1.1	1% AEP, 10 min burst, Storm 1
C2 - Sag	0.455	0.454	2.459	0.182	0.19	6.14	1.06	1% AEP, 10 min burst, Storm 1
C3 - Sag	0.455	0.454	2.459	0.182	0.19	6.14	1.06	1% AEP, 10 min burst, Storm 1
B-1 to FH	0.166	0.164	0.514	0.083	0.23	1.91	2.73	1% AEP, 10 min burst, Storm 7
Trap Spillway	2.598	2.598	1.96	0.302	0.76	4.31	2.52	1% AEP, 25 min burst, Storm 3
B-4 to FH	0.166	0.164	0.514	0.083	0.23	1.91	2.73	1% AEP, 10 min burst, Storm 7
B-3 to FH	0.166	0.164	0.514	0.083	0.23	1.91	2.73	1% AEP, 10 min burst, Storm 7
B-2 to FH	0.166	0.164	0.514	0.083	0.23	1.91	2.73	1% AEP, 10 min burst, Storm 7
To Basin B	2.639	2.636	0.499	0.109	0.23	17.54	2.12	1% AEP, 10 min burst, Storm 1
major FH1	1.032	1.021	2.494	0.213	0.35	7.16	1.62	1% AEP, 10 min burst, Storm 7
major FH2	1.29	1.283	2.539	0.229	0.39	7.57	1.71	1% AEP, 10 min burst, Storm 7
major FH3	1.491	1.486	2.092	0.218	0.48	7.29	2.22	1% AEP, 10 min burst, Storm 7
major FH4	1.794	1.789	2.701	0.261	0.46	8.38	1.77	1% AEP, 10 min burst, Storm 7
major FH5	2.052	2.047	2.329	0.251	0.55	8.12	2.21	1% AEP, 10 min burst, Storm 7
major FH6	2.249	2.244	2.092	0.245	0.62	7.98	2.55	1% AEP, 10 min burst, Storm 7
major FH7	2.466	2.466	2.085	0.251	0.67	8.12	2.66	1% AEP, 10 min burst, Storm 4
Cat A Minor Road - 3	0.444	0.441	0.717	0.128	0.32	3.41	2.46	1% AEP, 10 min burst, Storm 7

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin B	9.96	14897.7	8.436	0	8.436
Basin A	28.08	63066.7	4.461	4.461	0
Basin C	21.99	2264	6.769	0	6.769
Lot 50 Basin	30.9	5475.7	6.702	4.104	2.598

Appendix C: Stormwater Quantity and Quality Modelling (MUSIC)

MUSIC Model Configuration

Model description

Stormwater quality modelling was undertaken to estimate the hydrology and load of common stormwater pollutants (i.e. TSS, TP and TN) generated by the site. MUSIC modelling was undertaken to estimate continuous hydrology and runoff water quality for the DGL site. MUSIC includes algorithms to evaluate the hydrology and concentrations/loads from urban catchments and estimate the performance of stormwater management measures at capturing these pollutants. MUSIC was designed to continuously simulate urban stormwater systems over a range of temporal and spatial scales utilising historically representative rainfall data.

MUSIC is considered within the industry to be an appropriate conceptual design tool for the analysis of runoff water quality in the urban environment. The hydrologic algorithm in MUSIC simplifies the rainfall-runoff processes and requires the input of the following variables to perform the hydrological assessment:

- Rainfall data (time steps varying from 6 minutes to 1 day)
- Areal potential evapotranspiration (PET) rates
- Catchment parameters (area, % impervious and pervious areas)
- Impervious and pervious area parameters (rainfall threshold, soil and groundwater parameters)
- Storm event and base flow stormwater (event mean) pollutant concentrations.

MUSIC can be applied for comparison of alternative scenarios that adopt the same base inputs. Although the magnitude of the estimates may not be equivalent to actual site conditions (due to limitations in available data for a particular site), the relative differences between scenarios are expected to be appropriate for decision making.

The MUSIC modelling approach applied to estimate stormwater runoff and pollutant loads for the local catchment is described in the following sections.

Delineation of surface types and area

Surface types and areas were mapped in a GIS-based on 2020 Nearmap aerial image of the development site and design drawings of the proposed residential development layout provided by HDB.

Rainfall and PET

The MUSIC meteorological template includes the rainfall and areal potential evapotranspiration data. It forms the basis for the hydrologic calculations within MUSIC. To simulate the performance of stormwater quality treatment measures, MUSIC requires the input of data from a representative continuously recording rainfall station (pluviograph).

The sub-daily rainfall and average monthly areal potential evapotranspiration (PET) rates were obtained from the MUSIC-Link data Version 6.3 for Lake Macquarie City Council for the northern region (LMCC North catchments 1999-2008 6 min.mlb).

Model time step

A 6-minute time step was adopted to simulate water quality and characterise pollutant loads across the site.

Site parameters

Source nodes, linked to varying surface types, were utilised for the development of the MUSIC Model; namely: Urban-Roof, Urban-Sealed Road, Urban-Mixed. The area and percentage imperviousness of the sources nodes used to represent the major surfaces across the site were estimated from the subdivision layout for Lot 1006 provided by HDB.

Rainfall-runoff parameters

Modelling of the rainfall-runoff process in MUSIC requires the definition of one impervious surface parameter and eight pervious surface parameters. The rainfall-runoff parameters were defined using MUSIC-Link data Version 6.31 for Lake Macquarie City Council for the northern region. The impervious surface parameter (rainfall threshold) was adjusted for major surfaces as follows:

- Building roofs – 1 mm (accounts for small depression store on the roof area and first flush device)
- Sealed road – 1.5 mm
- Landscaped and open space – 1 mm

Runoff quality parameters

The MUSIC stormwater constituent pollutant concentrations were adopted from those provided by MUSIC Link data detailed above.

Treatment nodes

Treatment nodes were configured to represent the type and size of treatment measures outlined by the conceptual stormwater management plan and WSUD strategy identified for the developed site. The treatment measures were represented within the MUSIC model using the parametrisation outlined in **Table C-1**.

Table C-1: Treatment node parameters

Stormwater Treatment Measure	Modelled Configuration
Constructed wetland – Basin A	Surface area = 9 000 m^2 Extended detention depth = 0.75 m Permanent pool volume = 6 750 m^3 Exfiltration rate = 0 mm/hr Evaporative loss as % of PET = 125% Equivalent outlet pipe diameter = 135 mm
Bioretention basin – Basin B	Surface area = 1 800 m^2 Extended detention depth = 0.30 m Total biofilter area = 1 350 m^2 Biofilter depth = 0.50 m Saturated hydraulic conductivity = 200 mm/hr TN content of filter media = 800 mg/kg Orthophosphate content of filter media = 55 mg/kg Exfiltration rate = 0mm/hr
Bioretention basin – Basin C	Surface area = 1 000 m^2 Extended detention depth = 0.30 m Total biofilter area = 700 m^2 Biofilter depth = 0.50 m Saturated hydraulic conductivity = 200 mm/hr TN content of filter media = 800 mg/kg Orthophosphate content of filter media = 55 mg/kg Exfiltration rate = 0mm/hr
Gross Pollutant Trap	Number of GPTs = 3 High flow by-pass = 0.035 m^3/s Flow reduction = 0% TSS concentration reduction = 49% TP concentration reduction 40% TN concentration reduction = 25%
Rainwater tanks/basement storage	Number of tanks = 511 (one per residential lot) Individual tank properties: *Volume below overflow pipe = 3 kL* *Depth above overflow = 0.2 m* *Surface area = 1.5 m^2* *Initial volume = 1.5 kL* *Overflow pipe diameter = 100 mm* *Max drawdown height = 2 m* Re-use demand for each tank: *Constant daily demand* Outdoor water use (distribution PET-Rain)

The arrangement of source nodes and treatment nodes for the subject site is shown in **Figure C-1**.

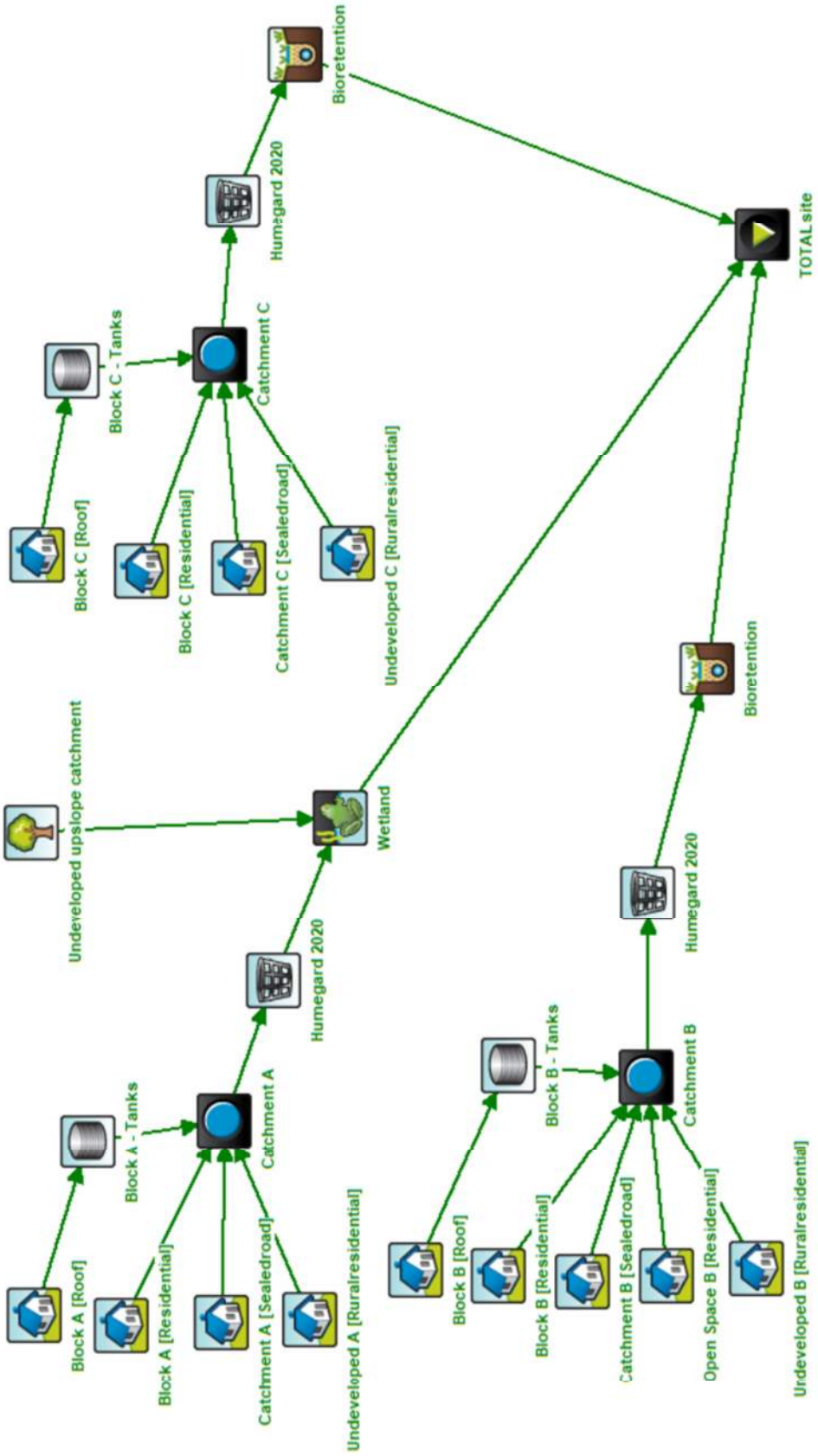

Figure C-1: MUSIC Model Schematisation

Appendix D: MUSIC-Link Report

LAKE MACQUARIE CITY COUNCIL

MUSIC-*link* Report

Project Details		Company Details	
Project:	Lot 1006 Boolaroo (Weemala on the Lake)	**Company:**	Royal HaskoningDHV
Report Export Date:	23/11/2020	**Contact:**	Luke Kidd
Catchment Name:	LMCC_MUSIC_Link_v6.3_Weemala_003	**Address:**	
Catchment Area:	101.41ha	**Phone:**	0249269521
Impervious Area*:	24.57%	**Email:**	luke.kidd@rhdhv.com
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:	6.3.0		
MUSIC-link data Version:	6.33		
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: TOTAL site	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	13.8%	Rain Water Tank Node	3	Urban Source Node	13
TSS	82.9%	Wetland Node	1	Forest Source Node	1
TP	58.9%	Bio Retention Node	2		
TN	53.2%	GPT Node	3		
GP	100%				

Comments

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	None	1.5
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	None	1.5
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Forest	Undeveloped upslope catchment	Area Impervious (ha)	None	None	0
Forest	Undeveloped upslope catchment	Area Pervious (ha)	None	None	42.3
Forest	Undeveloped upslope catchment	Total Area (ha)	None	None	42.3
GPT	Humegard 2020	Hi-flow bypass rate (cum/sec)	None	None	100
GPT	Humegard 2020	Hi-flow bypass rate (cum/sec)	None	None	100
GPT	Humegard 2020	Hi-flow bypass rate (cum/sec)	None	None	100
Rain	Block A - Tanks	% Reuse Demand Met	80	None	80.15
Rain	Block B - Tanks	% Reuse Demand Met	80	None	80.52
Rain	Block C - Tanks	% Reuse Demand Met	80	None	81.92
Receiving	TOTAL site	% Load Reduction	None	None	13.8
Receiving	TOTAL site	GP % Load Reduction	70	None	100
Receiving	TOTAL site	TN % Load Reduction	45	None	53.2
Receiving	TOTAL site	TP % Load Reduction	45	None	58.9
Receiving	TOTAL site	TSS % Load Reduction	80	None	82.9
Urban	Block A	Area Impervious (ha)	None	None	4.8
Urban	Block A	Area Impervious (ha)	None	None	0.262
Urban	Block A	Area Pervious (ha)	None	None	0
Urban	Block A	Area Pervious (ha)	None	None	4.837
Urban	Block A	Total Area (ha)	None	None	4.8
Urban	Block A	Total Area (ha)	None	None	5.1
Urban	Block B	Area Impervious (ha)	None	None	6.96
Urban	Block B	Area Impervious (ha)	None	None	0.375
Urban	Block B	Area Pervious (ha)	None	None	0
Urban	Block B	Area Pervious (ha)	None	None	6.904
Urban	Block B	Total Area (ha)	None	None	6.96
Urban	Block B	Total Area (ha)	None	None	7.28
Urban	Block C	Area Impervious (ha)	None	None	4.16
Urban	Block C	Area Impervious (ha)	None	None	0.204
Urban	Block C	Area Pervious (ha)	None	None	0
Urban	Block C	Area Pervious (ha)	None	None	4.075
Urban	Block C	Total Area (ha)	None	None	4.16
Urban	Block C	Total Area (ha)	None	None	4.28
Urban	Catchment A	Area Impervious (ha)	None	None	2.51
Urban	Catchment A	Area Pervious (ha)	None	None	0
Urban	Catchment A	Total Area (ha)	None	None	2.51
Urban	Catchment B	Area Impervious (ha)	None	None	3.45

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Catchment B	Area Pervious (ha)	None	None	0
Urban	Catchment B	Total Area (ha)	None	None	3.45
Urban	Catchment C	Area Impervious (ha)	None	None	2.2
Urban	Catchment C	Area Pervious (ha)	None	None	0
Urban	Catchment C	Total Area (ha)	None	None	2.2
Urban	Open Space B	Area Impervious (ha)	None	None	0
Urban	Open Space B	Area Pervious (ha)	None	None	2.18
Urban	Open Space B	Total Area (ha)	None	None	2.18
Urban	Undeveloped A	Area Impervious (ha)	None	None	0
Urban	Undeveloped A	Area Pervious (ha)	None	None	11
Urban	Undeveloped A	Total Area (ha)	None	None	11
Urban	Undeveloped B	Area Impervious (ha)	None	None	0
Urban	Undeveloped B	Area Pervious (ha)	None	None	1.31
Urban	Undeveloped B	Total Area (ha)	None	None	1.31
Urban	Undeveloped C	Area Impervious (ha)	None	None	0
Urban	Undeveloped C	Area Pervious (ha)	None	None	3.88
Urban	Undeveloped C	Total Area (ha)	None	None	3.88
Wetland	Wetland	% Reuse Demand Met	None	None	0

Only certain parameters are reported when they pass validation