Our Ref: 82017142:02
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19 March 2019

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TECHNICAL MEMORANDUM – TALLAWARRA LAND WATER QUALITY REQUIREMENTS

1 Introduction

Cardno (NSW/ACT) Pty Ltd (Cardno) has been engaged by Bridgehill (Tallawarra) Pty Ltd to undertake preliminary stormwater water quality investigations in support of a response to submissions report for a Section 75W modification to concept approval for Tallawarra Lands. A plan detailing the proposed modification has been enclosed with this letter.

This technical memorandum is to address matters raised by Council and other agencies not previously addressed that pertain to water quality requirements of the proposed expansion of development footprint and increase in residential yield. Specifically, the comments addressed in this memorandum were raised in an e-mail correspondence from Michelle Niles (NSW Planning and Environment) dated 6th November 2018 and are as follows:

- Any approval should include clear stormwater quality targets to ensure the water quality of Lake Illawarra and include requirements for auditing during construction and long term stormwater quality monitoring.
- Use of crown land for stormwater management is not supported and this aspect should be removed from the drainage assessment.
- Further assessment of water quality impacts should be undertaken to determine how the proposed development densities and boundaries, as modified, will influence the water quality of receiving waters and estuary health of Lake Illawarra.

Additionally, this memorandum outlines the proposed stormwater quality improvement assets required to meet stormwater quality targets with the proposed modifications to the Tallawarra Lands concept approval.

2 Stormwater Targets for Tallawarra Lands

The following was noted by the Department of Industry in a letter to Michelle Niles (reference: OUT 18/9945 Attachment A) dated 24th July 2018 regarding the adoption of stormwater quality targets for the proposed Tallawarra Lands modification:

- The stormwater water quality performance targets proposed for this development are to be those detailed in the Wollongong City Council's (WCC) Local Environment Plan (LEP) and Development Control Plan (DCP).
- Chapter E15 of the DCP specifies reduction loads of;
    - Total Nitrogen (TN) – 45%
    - Total Phosphorous (TP) – 60%
    - Total Suspended Solids (TSS) – 85%
    - Gross Pollutants (GP) – 90%
- [T]hese levels "may be adjusted by Council, at its discretion, as a part of the WSUD Strategy Development. This is particularly applicable to developments located in sensitive catchments (e.g. Lake Illawarra Catchment)"
- To ensure that the water quality improvements that have been achieved in Lake Illawarra are not compromised or reversed the department recommends that the reduction targets be adjusted in accordance with the provisions of the DCP and the sensitivity of Lake Illawarra

The previously approved Tallawarra Lands Concept Plan (Appendix 11 – Drainage Assessment BMT WBM 2010) adopted the following stormwater targets to be achieved through conceptual water quality modelling using the software MUSIC (Model for Urban Stormwater Improvement Conceptualisation) by comparing pollutant loads with and without the incorporation of increased stormwater quality improvement assets:

- Total Nitrogen (TN) – 45% to 50%
- Total Phosphorous (TP) – 60% to 65%
- Total Suspended Solids (TSS) – 85% to 90%
- Gross Pollutants (GP) – 90% - 95%

This approach conforms to the current requirement of WCC DCP 2009 - Chapter E15 – Water Sensitive Urban Design (WSUD). The lower target of the above range represents WCC's current targets while the upper end of the range was proposed by BMT WBM after discussion with WCC and represents a target suitable for a sensitive catchment that also ensures the sustainability of ongoing operation and maintenance.

Cardno considers that the upper threshold proposed by WBM BMT satisfies the recommendations by Department of Industry and recommends that these targets continue to be used for the proposed modification to the Tallawarra Lands Concept Approval.

3 The Use of Crown Land for Stormwater Management

The previously approved Tallawarra Lands Concept Plan (Appendix 11 – Drainage Assessment BMT WBM 2010) proposed two water quality assets, BB-N3 and BB-N4, to be constructed in Crown Land as part of the North Shore Precinct WSUD strategy (refer Figure 5-9).

The Department of Industry letter (reference: OUT 18/9945) attachment B notes that "the proponent should be aware that in designing stormwater flows and structures, that the adjoining Crown land is not to be used for the collection, filtration or distribution of stormwater". It is noted that this advice should have been raised in the previous submission as it is now contrary to the approved concept plan.

Cardno's update to the stormwater concept plan proposes that the two basins (BB-N3 and BB-N4) can be combined and relocated within the development boundary (refer to enclosed WSUD layout plan) however due to the nature of the adjoining Crown Land, it will be necessary to pass stormwater outlets (post-treatment stormwater distribution) though this land to reach Lake Illawarra. Cardno considers that this approach will minimise the use of Crown Land to manage stormwater and satisfy the Department of Industry recommendations.

4 Further Assessment of Water Quality Impacts

The Department of Industry letter (reference: OUT 18/9945) recommends that "[a]ny approval should include a requirement for a long term stormwater quality monitoring program to test and verify the performance of the stormwater controls to be developed at the detailed design phase" and that "[i]n addition, a requirement for independent auditing of the performance of water quality controls used during the construction phase of the development should be included."

Cardno proposes that a condition for a long term stormwater quality monitoring program to be submitted as a part of Construction Certification and for independent construction phase water quality auditing be added to the Development Application Consent Conditions for the Tallawarra Lands development.

5 Proposed WSUD Concept

Cardno have conducted conceptual water quality modelling using the software MUSIC to determine WSUD requirements for the Tallawarra Lands development that would meet the water quality criteria outlined in Section 2 of this letter. Details of the MUSIC model setup and assumptions as well as a catchment plan and a figure showing the indicative locations and sizes of these assets has been enclosed with this letter.

Modelling results are included in the table below demonstrating that the proposed WSUD treatment train is capable of meeting the water quality targets proposed in Section 2.

Pollutant Load Reductions for Lake Illawarra discharge

Pollutant	Proposed Scenario Pollutant Load (kg/yr)	Residual Pollutant Load (kg/yr)	Total Pollutant Load Reduction (%)	Target Reduction (%)
TSS	87,600	6,970	92	90
TP	121	40.6	66.6	65
TN	975	483	50.5	50
GP	14,900	32.3	99.8	95

We trust that the information submitted satisfactorily addresses matters raised by Council and other agencies not previously addressed that pertain to water quality requirements for the response to submissions report for a Section 75W modification to concept approval for Tallawarra Lands. Should you require anything further, please contact the undersigned.

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Enc: Section 75W Modification Layout Plan
MUSIC modelling summary
MUSIC Catchment – Central Precinct
MUSIC Catchment – Northern Precinct

MUSIC Modelling Summary

Adopted WSUD Measures

The treatment train proposed for the Tallawarra Lands development is shown on the MUSIC catchment layouts for the Central and Northern Precinct, enclosed with this letter (**Figure 1-1** and **Figure 1-2**). The treatment train consists of rainwater tanks (RWTs), gross pollutant traps (GPTs), and a mixture of constructed wetlands and bio-retention basins to meet water quality requirements. Additionally, a vegetated swale is proposed for the parkland of the central precinct. Inlet ponds will be incorporated onto all bio-retention basins and constructed wetlands to protect these assets from high velocity ponds and high sediment loading and to minimise ongoing maintenance. A table outlining the function of each of these assets in included below.

Proposed Treatment Measures

Treatment Measures	Purpose	Comment
Rainwater Tank	Reduction of runoff and associated pollutants	Assumed for all lots to achieve BASIX targets, and form part of the treatment train in reducing runoff and associated pollutants.
Gross Pollutant Trap	Removal of coarse pollutants and litter	Decrease loadings of coarse particulates and improve the amenity of the bioretention basins.
Vegetated Swale	Conveyance and reduction of runoff and associated pollutants	Provided to offer stormwater conveyance and treatment as an alternative to underground piped systems through the central parkland.
Sedimentation Pond	Removal of coarse to medium sized sediments.	Promotes the settlement of sediments and also reducing flow velocities, helping to protect and minimise maintenance of downstream assets.
Bioretention Basin	Removal of fine suspended solids and associated contaminants, as well as some soluble contaminants.	End of line component of the WSUD treatment train to reduce TSS, TN and TP loads. Consists of vegetated sand filter with a basin.
Constructed Wetland	Removal of fine suspended solids and associated contaminants, as well as soluble contaminants.	End of line component of WSUD treatment train to reduce TSS, TN and TP loads.

Modelling Approach

The water quality software package MUSIC v6.2.0 was used to optimise the configuration of the various WSUD measures identified above and to ensure water quality objectives are met.

MUSIC was used to predict pollutant loads under the post-development conditions and estimate the reduction in pollution resulting from the proposed treatment train. This estimation is based on a range of project-specific input data including daily rainfall, monthly evapotranspiration rates, and sub-catchment characteristics. The WSUD treatment train proposed for the development area is illustrated in **Figure 1-3**.

Modelling Inputs and Parameters

Rainfall and Evapotranspiration

Rainfall data was obtained from the Bureau of Meteorology (BoM) for Port Kembla. A 5-year rainfall dataset was used from the period 2005-2009 by which a continuous 6-minute time-step simulation was run. Evapotranspiration data was similarly sourced from BoM.

Catchment Land Use Characteristics

The impervious area for each sub-catchment was assessed based on land use. Each sub-catchment was divided into areas representing lots, road reserve, parkland, commercial zones and industrial areas. A summary of adopted impervious fractions is included in the table below.

A total 60% impervious area was adopted for light residential (RES_L) areas in accordance with WCC DCP (2009) Chapter E14. The residential area representing lots was further divided into roof area and yard area. The roofs were assigned an area of 225 m^2 representing the average roof size for the proposed lots, and were modelled as 100% impervious. The roof area was subtracted from the total residential urban area, with the remaining impervious area used to estimate the impervious cover of the yard area. The roof area was further subdivided with 75% of roof area being directed to the proposed RWTs and the remaining 25% bypassing the tank.

The road and park areas were calculated directly from the concept plans The road area was assumed to be 95% impervious while the park area was assumed to be 25% in accordance with WCC DCP (2009) Chapter E14. The commercial and industrial areas were assumed be 100% impervious in accordance with WCC DCP (2009) Chapter E14.

Impervious areas used in MUSIC model

Land Use (MUSIC Source Node Type)	Impervious Area (%)
Urban Roof (Roof)	100%
Light Residential (Normal Residential)	60%
Sealed Road Reserve (Sealed road)	95%
Commercial Area (Commercial)	100%
Industrial Area (Industrial)	100%

Runoff Generation

Infiltration and soil moisture storage parameters are required by MUSIC in the generation of runoff volumes from the various sub-catchments. Input data was taken from the Tallawarra Lands Concept Plan (Appendix 11 – Drainage Assessment BMT WBM 2010). A summary of the adopted parameters is included in the table below.

MUSIC Rainfall-Runoff Parameters (BMT WBM, 2010)

Impervious Area Parameters	
Rainfall Threshold (roofs, mm)	1.0
Rainfall Threshold (road pavement, mm)	2.0
Rainfall Threshold (mixed urban surfaces, mm)	1.4
Pervious Area Parameters	
Soil Storage Capacity (mm)	155
Initial Storage (% of capacity)	30
Field Capacity (mm)	95
Infiltration Capacity Coefficient – a	150
Infiltration Capacity Exponent – b	3.5

Groundwater Properties	
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	10
Daily Deep Seepage Rate (%)	0

Pollutant Concentrations

The adopted parameters to stochastically generate pollutant concentrations in the MUSIC modelling are summarised in the table below. Input data for the Commercial, Industrial, and Residential land use type were taken from the Tallawarra Lands Concept Plan (Appendix 11 – Drainage Assessment BMT WBM 2010) while the Roof and Sealed Road land use data values are based on a comprehensive review of urban catchments by Fletcher et al. (2004).

Adopted Pollutant Model Parameters (BMT WBM, 2010)

Land Use	Flow Conditions	TSS Mean (log mg/L)	TSS SD (log mg/L)	TP Mean (log mg/L)	TP SD (log mg/L)	TN Mean (log mg/L)	TN SD (log mg/L)
Commercial	Base flow	1.20	0.17	-0.85	0.19	0.11	0.12
	Storm flow	2.15	0.32	-0.6	0.25	0.30	0.19
Industrial	Base flow	1.20	0.17	-0.85	0.19	0.11	0.12
	Storm flow	2.15	0.32	-0.6	0.25	0.30	0.19
Residential	Base flow	1.20	0.17	-0.85	0.19	0.11	0.12
	Storm flow	2.15	0.32	-0.6	0.25	0.30	0.19
Roof	Base flow	0	0	0	0	0	0
	Storm flow	1.30	0.32	-0.89	0.25	0.30	0.19
Sealed 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

Rainwater Tanks

Considering the NSW Government BASIX requirements, a 3,000L rainwater tank has been adopted for all allotments. A surface area of 1.4m² was adopted for each tank, assuming a base diameter of 1.35m. Surface areas and volumes were collated into a single rainwater tank treatment node for each catchment as per the MUSIC modelling guidelines. The roof areas were separated into two nodes, one representing 75% area directed to the rainwater tank Treatment Nodes in the MUSIC model, the other representing the estimated 25% of roof area that would bypass the rainwater tanks. This approach accounts for residents disconnecting their rainwater tanks. Reuse rates were set to 300 L/day to represent water reuse for toilet flushing and outdoor use such as garden watering.

GPTs

GPTs have been modelled in MUSIC assuming a generic GPT pollutant removal performance. The modelling input parameters for removal efficiencies of TSS, TP, TN and GP were adopted as 70%, 30%, 12%, 95%, respectively.

Bioretention Basin

The bioretention basins were modelled using the 'Bioretention' treatment node in the MUSIC model. A total of five bioretention basins have been included in the treatment train with the filter surface area ranging from 100 m^2 to 800 m^2. The footprints for the basins are shown on **Figure 1-1** and **Figure 1-2**. An extended detention depth of 0.3m was adopted. A saturated hydraulic conductivity of 180 mm/hr was adopted for the sand filter, which is representative of sandy loam filter media. A filter depth of 500mm was adopted with an orthophosphate content of 40 µg/kg representing a low phosphorous media.

Sedimentation Basin

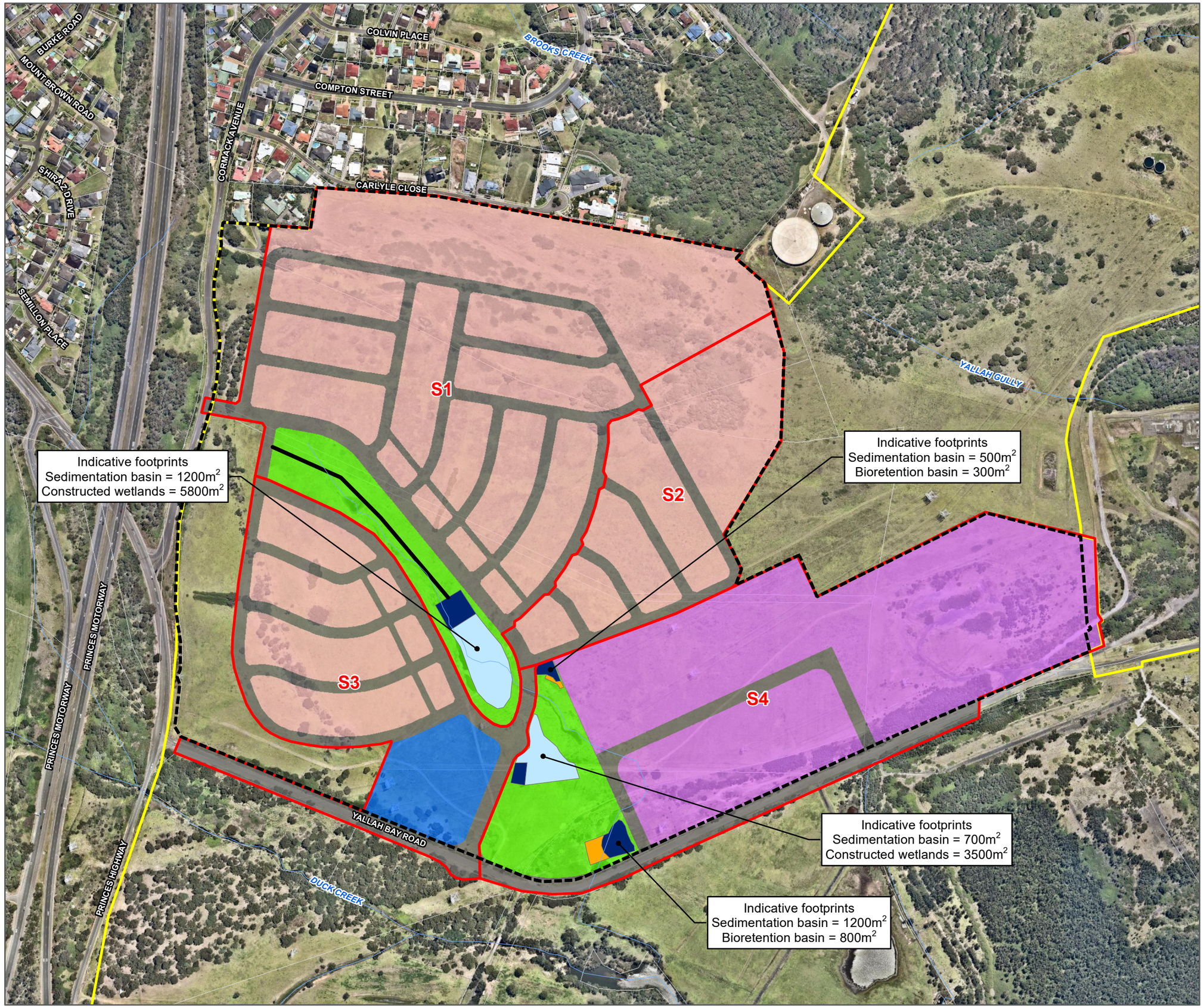
A total of five sedimentation basins were modelled as inlet basins for either bioretention or wetland nodes. The surface of area of the basins ranged from 300 m^2 to 1200 m^2. The footprints for the basins are shown on **Figure 1-1** and **Figure 1-2**. An extended detention depth of 0.5 m was adopted. Filter media for the basin is based on fine sand giving a particle size of 125 microns. A capture efficiency of 90% and a clean out frequency of 10 years were assumed.

Constructed Wetland

The constructed wetlands were modelled using the 'Wetland' treatment nodes in the MUSIC model. The proposed wetlands will cover an area of 5800 m^2 and 3500 m^2 in the southern section of the subdivision. These footprints can be seen in **Figure 1-1** and **Figure 1-2**. The proposed permanent pool volumes of the wetlands are 2320m^3 and 1400 m^3 respectively. Both wetland nodes have an extended detention depth of 0.3 m.

Vegetated Swale

The vegetated swale was modelled using the 'Swale' treatment node in the MUSIC model. The asset has a length of 300 m and depth of 0.5 m. The base width and top width are 1 m and 5 m respectively. The bed slope has been designed at 4.5% with a vegetation height of 0.25 m.



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MUSIC Catchments - Central Precinct

TALLAWARRA LANDS

Legend

- Concept Plan Boundary
- Proposed Superlot Boundary
- Watercourses (LPI)
- Swale
- Cadastre (DFSI-SS, 2018)
- Music Catchments
- Wetlands
- Bioretention Basin
- Sedimentation Basin

Impervious Type

- Commercial
- Industrial
- Parkland
- Residential
- Road

FIGURE 1-1

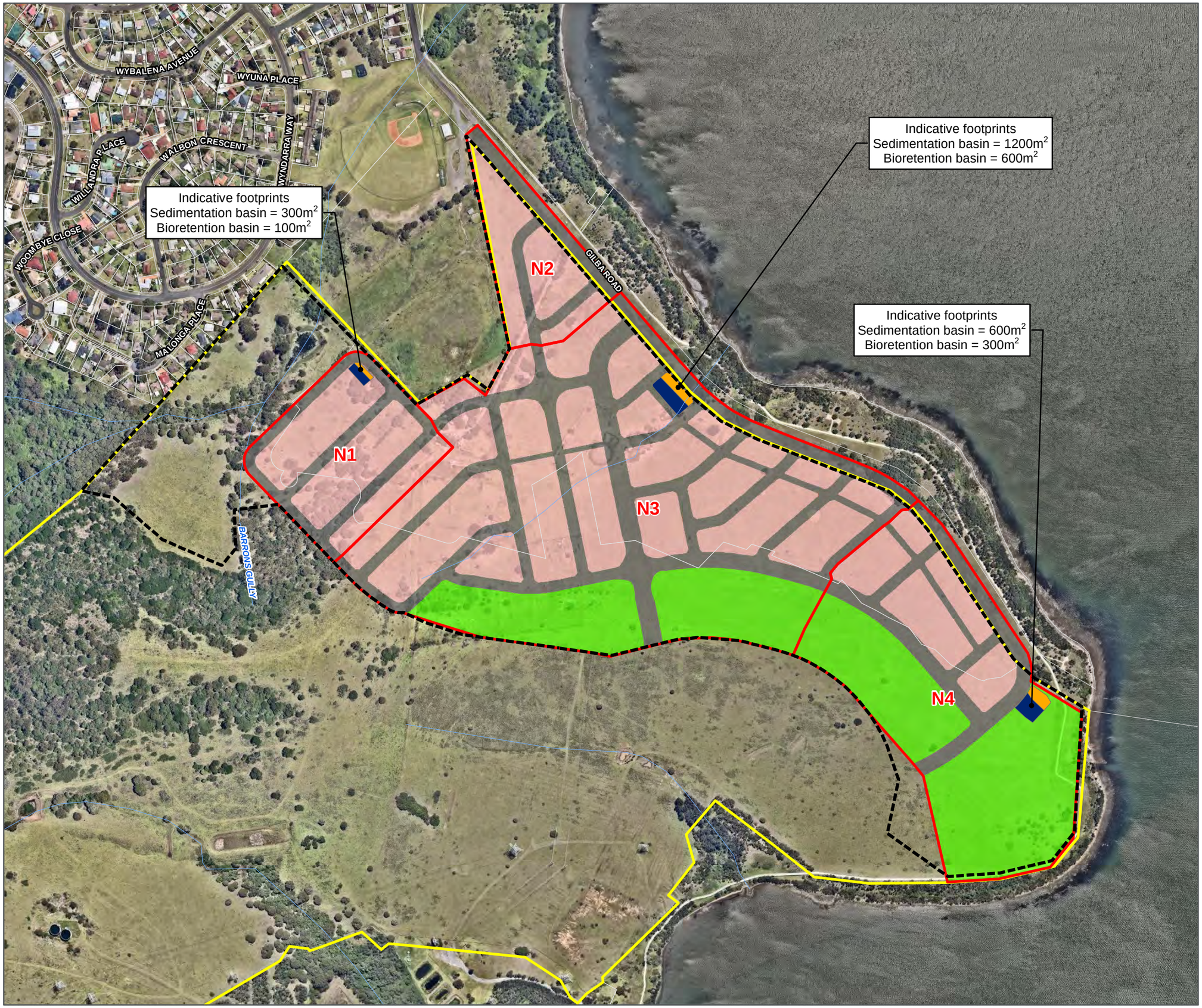
1:5,000 Scale at A3

Metres

0 50 100 150 200

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-01-21 | Project: 8201714201
Coordinate System: GDA 1994 MGA Zone 56
Map: 82017142-01-GS-072-MUSICCatchment_Central.mxd 01
Aerial imagery supplied by nearmap (July, 2018)



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MUSIC Catchments - Northern Precinct

TALLAWARRA LANDS

Legend

- Concept Plan Boundary
- Proposed Superlot Boundary
- Watercourses (LPI)
- Cadastre (DFSI-SS, 2018)
- Music Catchments
- Bioretention Basin
- Sedimentation Basin

Impervious Type

- Parkland
- Residential
- Road

FIGURE 1-2

1:5,000 Scale at A3

Metres

0 50 100 150 200

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-03-18 | Project: 8201714201
Coordinate System: GDA 1994 MGA Zone 56
Map: 82017142-01-GS-071-MUSICCatchment_North.mxd 03
Aerial imagery supplied by nearmap (December, 2018)

Figure 1-3 Proposed WSUD Treatment Train