



# Riverstone East Stage 3

## Water Cycle Management Strategy Report



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*Cover image: View of First Ponds Creek crossing of Windsor Road (looking downstream)*

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## Executive Summary

The Riverstone East Precinct has been identified for future homes and jobs growth as part of Sydney's North West Growth Area (NWGA). Stages 1 and 2 of the Precinct were re-zoned to support residential development in 2016, with Stage 3 being the only remaining stage yet to be re-zoned. The Rouse Hill Regional Park is located within the Stage 3 precinct but will not be rezoned as part of the subject planning proposal.

Rhelm has undertaken a water cycle management assessment based upon the Indicative Layout Plan (ILP) developed by Hatch/Roberts Day (Revision E, dated 01/09/23) (the exhibited ILP) and the updated ILP by Hatch/Roberts Day (Revision H, dated 21/11/24).

This assessment addresses:

- Stormwater quality management,
- Stormwater quantity management, and
- Riparian corridors.

### **Site Overview**

The Precinct is located in the Blacktown City Council local government area (LGA) and comprises a 378 ha area of land between the Riverstone Stages 1 and 2 Precincts and Windsor Road.

In its current state, the Precinct is predominantly comprised of sparsely vegetated rural land zoned RU4 – Primary Production. The site is traversed by a number of watercourses and overland flow paths draining north-east to Killarney Chain of Ponds and north-west towards First Ponds Creek. Both Killarney Chain of Ponds and First Ponds Creek flow to Wianamatta-South Creek just upstream of its confluence with the Hawkesbury-Nepean River (*Dyarubbin*).

### **Data and Literature Review**

A comprehensive data and literature review was undertaken to collate the available data relevant to the study, and to review applicable design guidelines to inform the development of the water cycle management strategy. The review considered data from:

- Blacktown City Council,
- Department of Planning and Environment (now Department of Planning, Infrastructure and Housing and the Department of Climate Change, Environment, Energy and Water),
- Bureau of Meteorology, and
- Technical reports and models relevant to the Precinct.

### **Stormwater Quality Management**

An existing scenario MUSIC model was established to define baseline stormwater volumes and pollutant loading of site discharge for comparison against post-development conditions as part of a neutral or beneficial effect on water quality (NorBE) assessment.

A stormwater treatment train comprising the following features was established to manage the pollutant loading from the fully developed site under the adopted development scenario:

- Rainwater tanks,
- Grassed swales,



- Gross pollutant traps,
- Sediment basins,
- Bioretention basins,
- Constructed wetlands, and
- Stormwater harvesting ponds.

Results of the MUSIC modelling indicate that whilst not fully achieving NorBE, the proposed treatment train sufficiently reduces pollutant loads to a level that is consistent with the objectives of the *State Environmental Planning Policy (Biodiversity and Conservation)* 2021. The proposed treatment strategy also achieves the minimum pollutant reduction targets stipulated in the *Growth Centres Development Control Plan* (DCP) 2010 (updated in 2021) but does not meet those from the *Technical guidance for achieving Wianamatta-South Creek stormwater management targets* (Wianamatta-South Creek Guidelines) (DPE, 2022). Additional on-lot treatment for medium and high-density residential zones would be required to achieve the pollutant reduction targets from the Wianamatta-South Creek Guidelines (DPE, 2022).

### **Stormwater Quantity Management**

The primary stormwater quantity management objective for the Precinct is to mimic natural hydrology as much as practical, both for design storm events and environmental flow conditions.

An on-site detention basin strategy was developed to mitigate the increase in site flows associated with higher imperviousness of the developed catchment, with the performance of the proposed basins assessed using the XP-RAFTS hydrologic model and TUFLOW hydraulic model developed for the *Flood Impact and Risk Assessment* (Rhelm, 2024). The detention basins have been co-located with regional water quality treatment basins where possible in order to minimise land take. No detention has been proposed for the First Ponds Creek catchment based on the outcomes of regional flood modelling as part of the *First Ponds Creek Flood Assessment* (CSS, 2021) and the companion study to this water cycle management strategy, being the *Riverstone East Stage 3 Flood Impact and Risk Assessment* (Rhelm, 2024).

In summary, flood modelling results revealed that the proposed basins successfully reduce post-development flows to pre-development levels for the Killarney Chain of Ponds catchments.

The site Stream Erosion Index (SEI) was calculated using the results of the XPRAFTS and MUSIC models and was found to meet the required 3.5:1 ratio in the Growth Centres DCP 2010 for all key discharge locations.

MUSIC water balance modelling for selected wet, dry and average rainfall years was undertaken to determine the reliability of proposed stormwater harvesting measures at meeting predicted demands. Results of this assessment found that proposed harvesting measures will meet over 70% of stormwater re-use demands in average rainfall years and over 50% of demands in dry years.

Flow durations curves were produced for the existing and post-development site, as well as a natural site of equivalent area, for comparison against the flow duration targets stipulated in the Wianamatta-South Creek Guidelines (DPE, 2022). Despite not meeting the Wianamatta-South Creek flow duration targets, the post-development curves were found to mimic that of a natural catchment.



***Morphology and Design Riparian Channels***

The locality was characterised historically by a chain of ponds morphology. However, most ponds have either been removed or converted into farm dams. Where channels are present, these were found to be generally poorly defined across the Precinct and lacking in vegetation coverage. As such, vegetated engineered creek channels and associated riparian areas have been proposed for the site first order watercourses to assist in achieving both flood conveyance and biodiversity objectives.



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- A – Concept Water Cycle Management Design Drawings (Prepared by Enspire Solutions)
- B – MUSIC-Link Report



## Acronyms and Abbreviations

AHD	Australian Height Datum
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BCC	Blacktown City Council
BoM	Bureau of Meteorology
DCCEEW	Department of Climate Change, Environment, Energy and Water (NSW)
DCP	Development Control Plan
DPE	Department of Planning and Environment (now DPHI and DCCEEW)
DPIE	Department of Planning, Industry and Environment (now DPHI and DCCEEW)
DPHI	Department of Planning, Housing and Infrastructure
Ha	Hectares
IFD	Intensity-Frequency-Duration
ILP	Indicative Layout Plan
LEP	Local Environment Plan
LGA	Local Government Area
LiDAR	Light Detention and Ranging
m <sup>2</sup>	Square metres
m <sup>3</sup>	Cubic metres
kL	Kilolitres
ML	Megalitres
m/s	Metres per second
m <sup>3</sup> /s	Cubic metres per second
mAHD	metres to Australian Height Datum
mm	Millimetres
m/s	Metres per second
NoRBE	Neutral or Beneficial Effect
NSW	New South Wales
OEH	Office of Environment and Heritage (now DCCEEW)
OSD	On Site Detention
VRZ	Vegetated Riparian Zone
WSUD	Water sensitive urban design



# 1 Introduction

The Riverstone East Precinct has been identified for future homes and jobs growth as part of Sydney's North West Growth Area (NWGA). Stages 1 and 2 of the Precinct were re-zoned to support residential development in 2016, with Stage 3 being the only remaining stage yet to be re-zoned. The Rouse Hill Regional Park is located within the Stage 3 precinct but will not be rezoned as part of the subject planning proposal.

Rhelm Pty Ltd (Rhelm), supported by Enspire Solutions (Enspire) have been engaged by the Department of Planning, Housing and Infrastructure (DPHI) to prepare a water cycle management strategy to inform the development of a Precinct Plan and development guidelines for Riverstone Stage 3 (the Precinct).

This assessment addresses:

- Stormwater quality management,
- Stormwater quantity management, and
- Riparian corridors.

The area to the west of First Ponds Creek (referred to as the Junction Road site) has not been included in the analysis as the proposed land use will generally remain similar to existing in this area. The small area of proposed low density residential will be subject to Council's water cycle management controls and has not been considered as part of the regional stormwater management strategy described in this report.

## 1.1 Study Area

The Precinct comprises a 378 ha area of land bounded by Windsor Road to the north-east, Tallawong Precinct to the south and the Stage 2 Precinct to the west (bounded by First Ponds Creek). The entirety of the Precinct is located within the Blacktown City Council local government area (LGA).

The Precinct contains a number of watercourses, the most significant being Killarney Chain of Ponds (a tributary of Wianamatta-South Creek and the Dyarubbin-Hawkesbury Nepean River system) which drains in a northerly direction through the southern portion of the Precinct. Other major watercourses include First Ponds Creek which runs along the western boundary of the site. Both Killarney Chain of Ponds and First Ponds Creek drain to sets of culverts crossing Windsor Road and form a confluence approximately 530m north of the site (within the Box Hill Precinct).

The Precinct also contains a number of waterbodies (possible remnant chain of pond features, which is the historic morphologic character of the creeks of the locality, these are now mostly farm dams) located along watercourses and overland flow paths. The most significant dams are those located on the AJ Bush and Sons site (1106 Windsor Road) and along the downstream tributary of First Ponds Creek. None of these waterbodies or dams were identified as declared dams by Dam Safety NSW under the *Dam Safety Regulation*, 2019 as at April 2023.

The study area and relevant waterway features are shown in **Figure 1-1**.

## 1.2 Report Structure

The report is structured as follows:

- Data Review (**Section 2**)
- Development Controls and Guidelines (**Section 3**)



- Catchment and Meteorological Characteristics (**Section 4**)
- Indicative Layout Plan (**Section 5**)
- Stormwater Quality Management (**Section 6**)
- Stormwater Quantity Management (**Section 7**)
- Riparian Corridors (**Section 8**)
- Conclusion and Recommendations (**Section 9**).

This report should be read in conjunction with the *Riverstone Stage 3 – Flood Impact and Risk Assessment* (Rhelm, 2024) which details the hydrologic and hydraulic modelling methodology and outcomes.

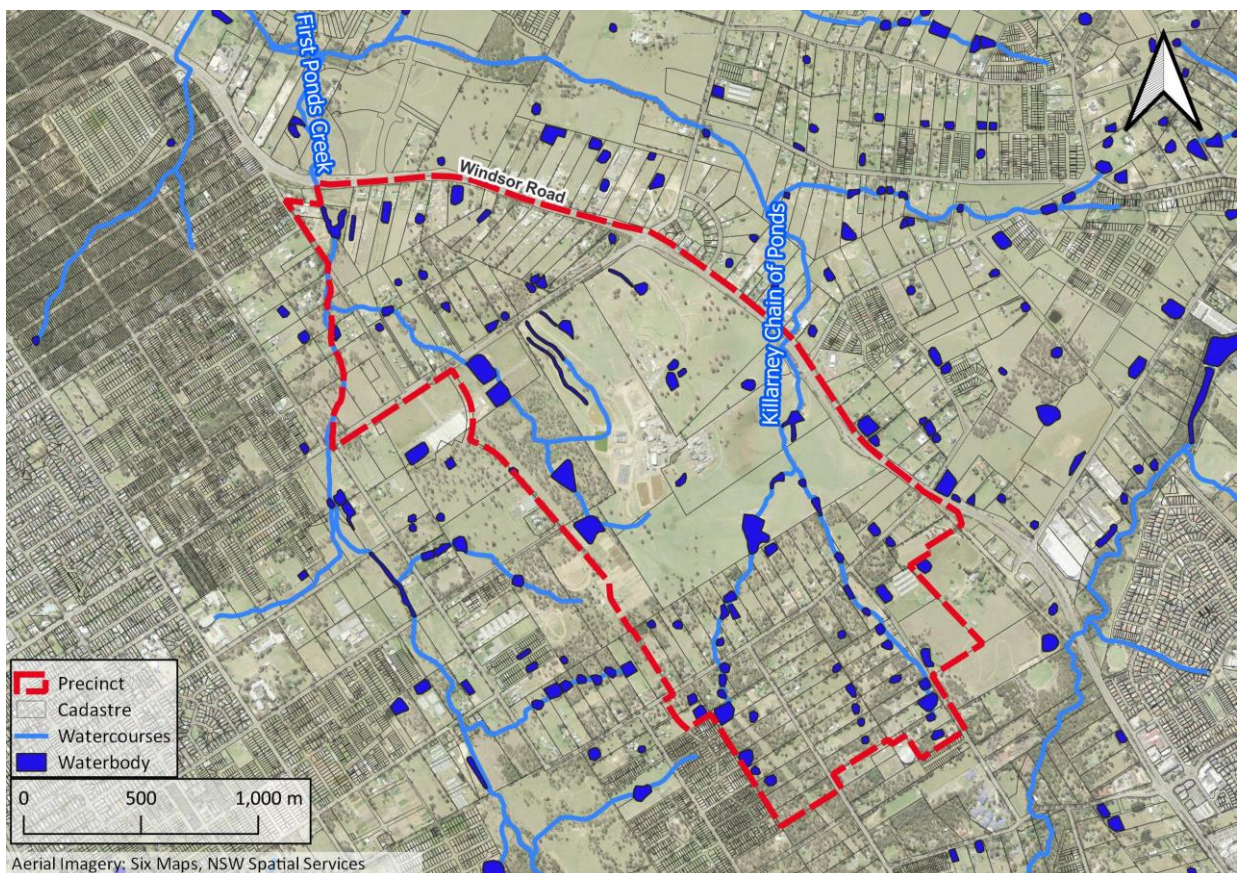


Figure 1-1 Study Area



## 2 Data Review

### 2.1 Site Inspection

A site tour/inspection was undertaken on 16 March 2023 to gain an appreciation of the character of the study area. Given the scale of the Precinct, the tour was largely conducted via bus and thus detailed inspection of key site features relevant to water cycle management (such as watercourses and waterbodies) was limited.

A further site inspection was undertaken on 5 May 2023 to confirm the details of accessible cross drainage structures across the Precinct.

### 2.2 Previous Water Cycle Management Studies and Reports

Previous studies undertaken for the locality relevant to the water cycle management strategy are summarised below.

#### 2.2.1 Alex Avenue and Riverstone Precincts – Water Sensitive Urban Design and Flooding Report (GHD, 2008)

The Growth Centres Commission (GCC) engaged GHD to undertake a flooding and water sensitive urban design (WSUD) assessment in support of a planning proposal to rezone the 1,600 ha Riverstone and Alex Avenue precincts (located to the west of the Riverstone Stage 3 precinct).

Key objectives of the water cycle management component were to suitably manage the quantity and quality of stormwater runoff from the development via reducing post-development flows to pre-development levels and adopting the following stormwater management targets:

- 85% reduction in total suspended solids (TSS)
- 65% reduction in total phosphorus (TP)
- 45% reduction in total nitrogen (TN)
- 90% reduction in gross pollutants
- Stream erosion index of 3.5-5.

On-site detention targets were achieved via both regional detention basins and lot-scale detention assumptions to attenuate runoff from the developed catchments. XP-RAFTS hydrologic modelling software was used to compare pre and post-development flowrates and develop permissible site discharge (PSD) and minimum required storage volumes at key discharge points.

A stormwater treatment train comprising of gross pollutant traps, grassed swales, regional bioretention basins (co-located in detention basins) and public wetlands was established to treat developed runoff. MUSIC software was used to assess the effectiveness of proposed treatment measures and demonstrate compliance with reduction targets and stream flow index (SEI) requirements.

#### 2.2.2 Post Exhibition Flooding and Water Cycle Management (incl. Climate Change impact on Flooding (GHD, 2010)

This study was commissioned as an update to the *Alex Avenue and Riverstone Precincts – Water Sensitive and Urban Design and Flooding* (GHD, 2008).

Key updates from the GHD (2008) study included rationalisation of the riparian corridors and consolidation of a number of detention/bioretention basins to maximise developable land and produce an improved economic outcome. This included an integrated analysis of the Riverstone and Riverstone



East precincts, with the nomination of a number of online basins along First Ponds Creek. Modelling and mapping was updated to reflect the design changes in the post-development scenario.

This study also included the assessment of climate change impacts on detention basins via increasing 1% AEP design rainfalls by 20% to account for potential increases in rainfall intensity.

### 2.2.3 Water Cycle Management Report (Mott MacDonald, 2015)

This flooding and water cycle management assessment was commissioned in support of the rezoning of the 656 Ha Riverstone East site, inclusive of the Stage 3 precinct.

Similar to the GHD (2008) study, the objective of the on-site detention strategy was to reduce post-development flows to pre-development levels for a full range of design storm events up to and including the 1% AEP. This was achieved through a network of both offline and online detention basins, inclusive of two basins along First Ponds Creek which accept flows from both the Riverstone and Riverstone East precincts. Hydrologic modelling to determine basin volumes was determined using XP-RAPTS software, with impacts on flooding confirmed in a TUFLOW hydraulic model of the study area.

The same stormwater pollutant reduction targets as those in GHD (2008) were adopted in the Mott Macdonald (2015) study. A stormwater treatment train comprising rainwater tanks, grassed swales, gross pollutant traps and regional bioretention basins was proposed to manage the quality of stormwater discharging from the Riverstone East Precinct. Proposed bioretention basins include both offline basins adjacent to the riparian corridors and online basins on first order streams, co-located within detention basins. MUSIC modelling was undertaken to demonstrate compliance with the water quality targets.

### 2.2.4 Water Cycle Management Report Post Exhibition (Mott MacDonald, 2016)

Following public exhibition of the Mott MacDonald (2015) report, the flooding and water cycle management assessment was updated to address comments received during exhibition. This included some adjustments to the base case hydrologic model assumptions and refinements to the on-site detention basin design. No major changes were made to the WSUD strategy; however, proposed conveyance swales were removed from the MUSIC model.

The modelling and drawing series/mapping were updated to reflect the changes made from the 2015 study.

## 2.3 Waterway Health Data

### 2.3.1 Waterway Health Ratings

A spatial data file (reference 'Waterway quality health grades.shp') containing waterway health ratings at two locations along First Ponds Creek was provided by Blacktown City Council to inform this strategy. The locations are as follows:

- Location 1 – upstream of Gordon Road
- Location 2 – downstream of Windsor Road.

Data collected at these locations are not considered a direct indicator of discharge quality from the Precinct as Location 1 is upstream of the Precinct and the portion of the Precinct catchment draining to Location 2 only constitutes a small portion of the overall catchment. However, ratings obtained from the digital spatial data provided by Council have been reproduced in **Table 2-1** as an indicator of overall water quality in First Ponds Creek.



Table 2-1 Waterway Health Ratings

Location	Rating*			
	2019-2020	2019-2020	2020-2021	2021-2022
Location 1	C	C	C	D
Location 2	C	C	D	C

\* **Rating score guide:** –**A - Excellent:** Water quality indicators are within guideline limits more than 90% of the time. Diverse waterbug community with species sensitive to pollution present. Good riparian vegetation with native plant diversity and coverage. –**B - Good:** Water quality indicators are within guideline limits 85% of the time. Moderately diverse waterbug community with some pollution sensitive species not present. Riparian vegetation has moderate native plant diversity and coverage, with some weed infestations. –**C - Fair:** Water quality indicators are within guideline limits 70% of the time. Waterbug community only contains pollution tolerant species. Riparian vegetation is lacking native diversity and coverage, and weeds are likely to be present and possibly dominating. –**D - Poor:** Water quality indicators are within guideline limits less than 50% of the time. Waterbug community only contains pollution tolerant species. Riparian vegetation is lacking native plant diversity, and weeds are most likely to be dominating.

## 2.3.2 Rapid Riparian Assessment

Digital spatial data files containing riparian corridor condition classifications at selected locations from a 2015 survey (file reference ‘Rapid Riparian Assessment 2015.shp’) and 2020 survey (file reference ‘Rapid Riparian Assessment 2020.shp’) were provided by Blacktown City Council.

Classifications from the 2020 assessment are shown in **Figure 2-1**. Two locations are within the Precinct on a tributary of First Ponds Creek, showing a Fair and Poor condition.

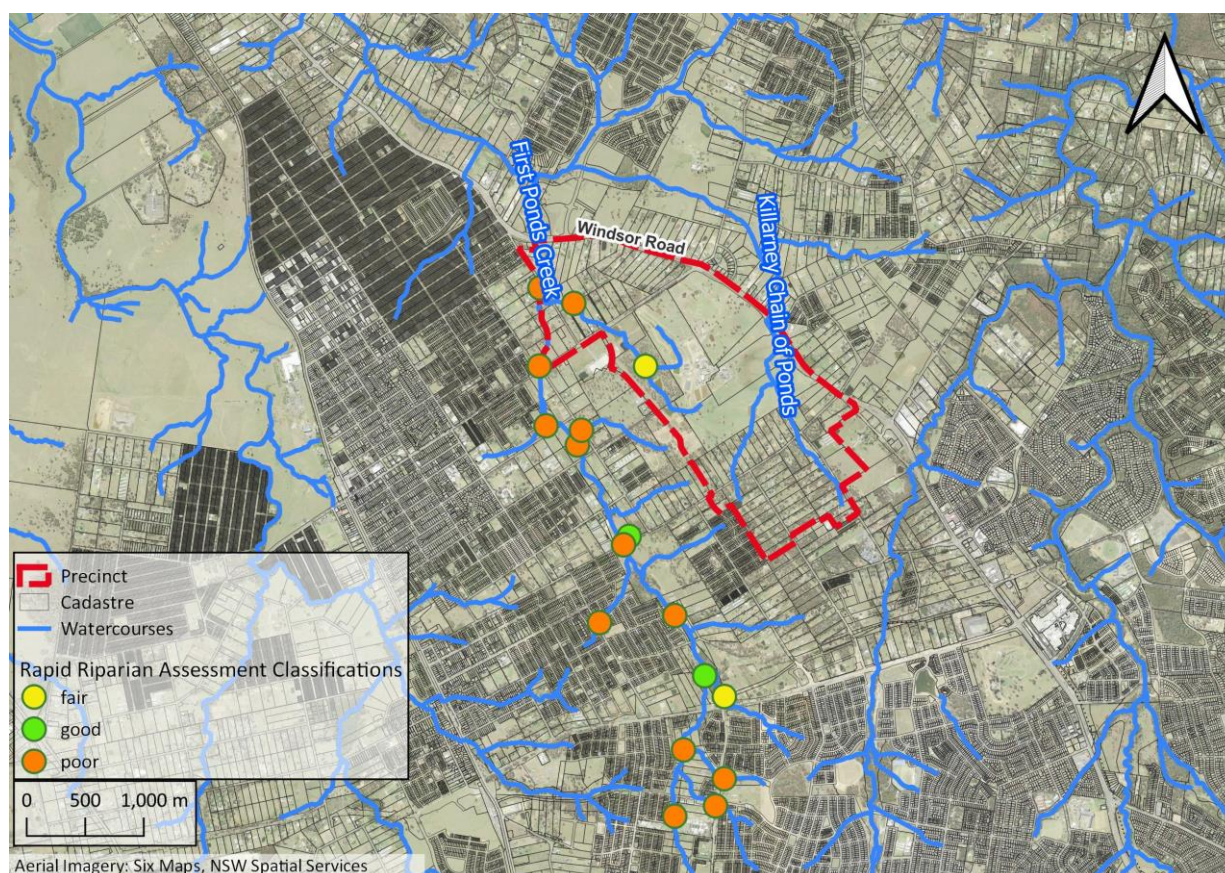


Figure 2-1 Rapid Riparian Assessment Classifications (Source: Blacktown City Council)



## 2.4 Existing Models/Modelling Data

A summary of available water cycle management models/modelling data relevant to the Precinct and how this data has been used in the assessment is provided in **Table 2-2**.

**Table 2-2 Available Models/Modelling Data**

Data Source	Data Type	Relevance to the Assessment
<i>First Ponds Creek Flood Assessment</i> (CSS, 2021)	XP-RAFTS Model	<p>XP-RAFTS models for the existing (file reference 'First Ponds Creek - existing combined model-20191017.xp') and developed (file reference 'first ponds creek developed_2021.xp') scenario have been provided by Council for use in the assessment.</p> <p>These models cover both the First Ponds Creek and Killarney Chain of Ponds catchments and have been used for preliminary sizing of proposed detention basins and calculation of design flowrates for proposed stormwater treatment measures.</p>
<i>Water Cycle Management Report – Riverstone East</i> (Mott MacDonald, 2015)	XP-RAFTS Model	<p>XP-RAFTS models for the existing (file reference '141127 Ex-MM Riverstone East, 100yr - 0.04 0.025.xp') and developed (file reference '150107 Pr-MM Riverstone East, 100yr - 0.035 0.015 - Online basins w NWRL-Basin 1 change - Copy.xp') scenarios have been provided.</p> <p>This model utilises ARR1987 hydrologic procedures and does not contain sufficient sub-catchment delineation in the Alex Avenue precinct. As such, the CSS (2021) model has been used in preference to this model for the assessment.</p>
	MUSIC Model	<p>A post-development MUSIC model covering the entire Riverstone East site (inclusive of Stage 3) has been provided.</p> <p>This model has not been used in the assessment due to the availability of base meteorological data and node parameters in Council's MUSIC-Link template and the adoption of a different stormwater treatment strategy compared to Mott MacDonald (2016).</p>
<i>Water Cycle Management Report – Riverstone East</i> (Mott MacDonald, 2016)	12D Design Strings	<p>Basin and channel design strings associated with the Mott MacDonald (2016) assessment have been provided. These have not been used as the design of these features has changed substantially in the updated assessment.</p>



### 3 Development Controls and Guidelines

The subject site is located within the North West Priority Growth Area (NWGA) and therefore development at the site is expected to be regulated in the future under the *State Environmental Planning Policy (Precincts—Central River City) 2021* (noting that other portions of the Riverstone East area are regulated under Appendix 11 of the SEPP). The *Blacktown City Council Growth Centre Precincts Development Control Plan* (2010) which was amended in 2021 is also expected to apply. The SEPP is an environmental planning instrument (EPI) which designates land uses and development in the study area, while the DCP regulates development with specific guidelines and parameters.

Being a tributary of the Hawkesbury-Nepean system, which is identified as a ‘regulated catchment’, the site falls under the provisions of the *State Environmental Planning Policy (Biodiversity and Conservation) 2021*. The DPHI Policy team has confirmed the applicability of the SEPP (Biodiversity and Conservation) 2021.

The site is also located in the Wianamatta-South Creek catchment where stormwater management plans for development are required to comply with *Technical guidance for achieving Wianamatta-South Creek stormwater management targets* (Wianamatta-South Creek Guidelines) (DPE, 2022). The related provisions of the Wianamatta-South Creek Guidelines (DPE, 2022) as they apply to the Precinct as concurrent design objectives have been considered, with the adopted stormwater management targets (refer **Section 6.1**) being the greater of the two standards with respect to beneficial outcomes for receiving waters.

#### 3.1 State Environmental Planning Policy (Precincts—Central River City) 2021

Part 3.5 of the Precincts—Central River City SEPP 2021 provides a number of clauses regarding development on flood prone and major creeks land; however, this SEPP has no directly relevant clauses relating to water-cycle management.

#### 3.2 State Environmental Planning Policy (Biodiversity and Conservation) 2021

Part 6.6 of the SEPP (Biodiversity and Conservation) 2021 applies to development within regulated catchments in NSW. Clauses relevant to water cycle management are reproduced below.

##### 6.6 Water quality and quantity

(1) In deciding whether to grant development consent to development on land in a regulated catchment, the consent authority must consider the following—

- (a) whether the development will have a neutral or beneficial effect on the quality of water entering a waterway,
- (b) whether the development will have an adverse impact on water flow in a natural waterbody,
- (c) whether the development will increase the amount of stormwater run-off from a site,
- (d) whether the development will incorporate on-site stormwater retention, infiltration or reuse,
- (e) the impact of the development on the level and quality of the water table,
- (f) the cumulative environmental impact of the development on the regulated catchment,
- (g) whether the development makes adequate provision to protect the quality and quantity of ground water.

(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied the development ensures—

- (a) the effect on the quality of water entering a natural waterbody will be as close as possible to neutral or beneficial, and



*(b) the impact on water flow in a natural waterbody will be minimised.*

### 3.3 Blacktown Local Environment Plan 2015

Whilst the LEP does not directly apply to the Precinct as the SEPP (Precincts—Central River City) 2021 is the relevant EPI, clauses relating to water cycle management have been reproduced below for information purposes.

#### 7.3 Riparian land and watercourses

*(1) The objectives of this clause are as follows—*

- (a) water quality within watercourses,*
- (b) the stability of the bed and banks of watercourses,*
- (c) aquatic and riparian habitats,*
- d) ecological processes within watercourses and riparian areas.*

*(2) This clause applies to the following land—*

- (a) land that is a watercourse,*
- (b) land that is within 40 metres of the top of the bank of a watercourse.*

*(3) In deciding whether to grant development consent for development on land to which this clause applies, the consent authority must consider—*

*(a) whether or not the development is likely to have any adverse impact on the following—*

- (i) the water quality and flows within the watercourse,*
- (ii) aquatic and riparian species, habitats and ecosystems of the watercourse,*
- (iii) the stability of the bed and banks of the watercourse,*
- (iv) the free passage of fish and other aquatic organisms within or along the watercourse,*
- (v) any future rehabilitation of the watercourse and riparian areas, and*
- (b) whether or not the development is likely to increase water extraction from the watercourse, and*
- (c) any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.*

*(4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that—*

- (a) the development is designed, sited and will be managed to avoid any significant adverse environmental impact, or*
- (b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or*
- (c) if that impact cannot be minimised—the development will be managed to mitigate that impact.*

### 3.4 Blacktown City Council Growth Centre Precincts Development Control Plan (2010)

Section 2.3.1 of the Blacktown City Council Growth Centre Precincts DCP (2010, updated in 2021) provides water cycle management related development objectives and controls for the precinct. These are reproduced below.

#### Objectives

*(a) to manage the flow of stormwater from urban parts of the Precinct to replicate, as closely as possible, pre-development flows;*

#### Controls - General

*3. Stormwater is to be managed primarily through the street network in accordance with Council's Water Sensitive Urban Design Development Control Plan.*



4. Roads on primary drainage lines shown on the Key elements of the water cycle management and ecology strategy figure, in the relevant Precinct Schedule, are to be constructed in the locations shown, and are to be designed in accordance with specifications of Council in relation to management of stormwater flows and quality.

- prevent damage by stormwater to the built and natural environment,
- reduce nuisance flows to a level which is acceptable to the community,
- provide a stormwater system which can be economically maintained and which uses open space in a compatible manner,
- minimise urban water run-off pollutants to watercourses, and

8. Where practical, development shall attenuate up to the 50% AEP peak flow for discharges into the local tributaries, particularly Category 1 and 2 creeks. This will be achieved using detention storage within water quality features and detention basins.

9. The developed 1% AEP peak flow is to be reduced to pre-development flows through the incorporation of stormwater detention and management devices.

11. The trunk stormwater system is to be constructed and maintained by Council in accordance with the Riparian and Water Cycle Management Strategy at Appendix B, and to achieve water quality targets set by the Department of Environment, Climate Change and Water in Table 2-1.

Water quality and stream erosion targets specified in Table 2-1 of the Growth Centre Precincts DCP (2010) are reproduced below.

Stormwater management objective:

- 85% reduction in TSS
- 65% reduction in TP
- 45% reduction in TN
- 90% reduction in gross pollutants
- Stream erosion control ratio of 3.5-5.0:1

An 'ideal' stormwater outcome is also reported as an aspirational target:

- 95% reduction in TSS
- 95% reduction in TP
- 85% reduction in TN
- 100% reduction in gross pollutants
- Stream erosion control ratio of 1:1.

The ideal stormwater outcome identified in the DCP is very challenging to achieve and beyond the targets set for the wider catchment (see **Section 3.6**).

### 3.5 WSUD Developer Handbook – MUSIC Modelling and Design Guideline (2020)

Blacktown City Councils WSUD Developer Handbook – MUSIC Modelling and Design Guideline (2020) details the requirements for water quality modelling for the Precinct. This guideline has been utilised for modelling and design assumptions in the water cycle management assessment.

### 3.6 Wianamatta-South Creek Stormwater Management Guidelines (2022)

Chapter 1 of the Wianamatta-South Creek Guidelines (DPE, 2022) presents two operational water quality target options for proposed development within the Wianamatta-South Creek catchment. These targets are as follows:



Option 1 – annual load reduction:

- 90% reduction in TSS
- 80% reduction in TP
- 65% reduction in TN
- 90% reduction in gross pollutants

Option 2 – allowable mean annual load:

- <80kg/ha/year of TSS
- <0.3kg/ha/year of TP
- <3.5kg/ha/year of TN
- <16kg/ha/year of gross pollutants

In addition to water quality targets, the Wianamatta-South Creek Guidelines (DPE, 2022) provide two stormwater flow target options. These are as follows:

Option 1 – mean annual runoff volume (MARV):

- $MARV \leq 2$  ML/ha/y at the point of discharge to the local waterway
- 90%ile flow of 1,000–5,000 L/ha/day at the point of discharge to the local waterway
- 50%ile flow of 5-100 L/ha/day at the point of discharge to the local waterway
- 10%ile flow of 0 L/ha/day at the point of discharge to the local waterway

Option 2 – flow percentiles:

- 95%ile flow of 3,000–15,000 L/ha/day at the point of discharge to the local waterway
- 90%ile flow of 1,000–5,000 L/ha/day at the point of discharge to the local waterway
- 75%ile flow of 100–1,000 L/ha/day at the point of discharge to the local waterway
- 50%ile flow of 5-100 L/ha/day at the point of discharge to the local waterway
- Cease to flow to be between 10% and 30% of the time.

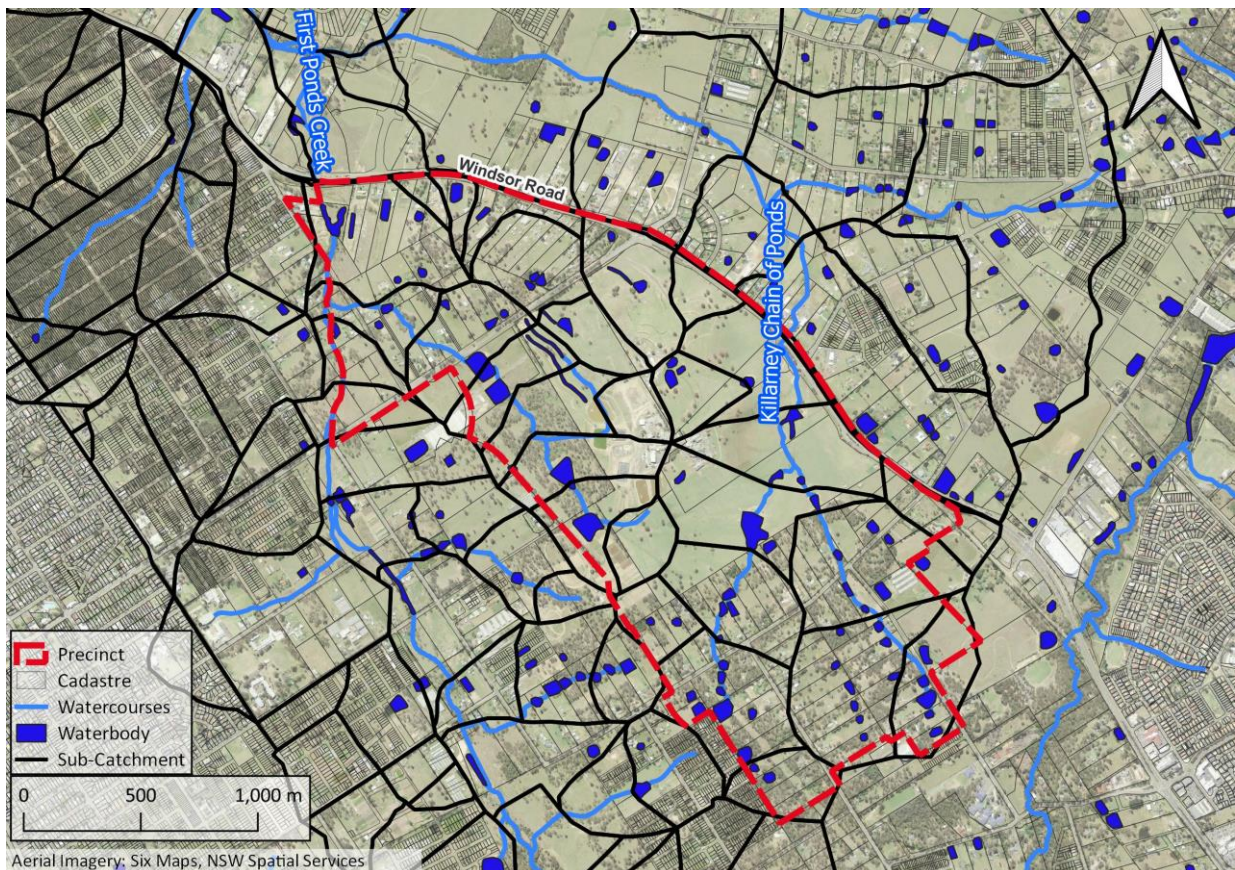
The practicality of meeting these flow duration objectives was explored as part of the water cycle management assessment and is discussed in **Section 7.5**.



## 4 Catchment and Meteorological Characteristics

### 4.1 Catchment Mapping

Sub-catchment mapping has been completed across the precinct as part of the development of Council's XP-RAFTS hydrologic models of the First Ponds Creek and Killarney Chain of Ponds catchments. Baseline sub-catchment mapping across the study area (prior to the recent development of the Riverstone and Box Hill precincts) is shown in **Figure 4-1**.

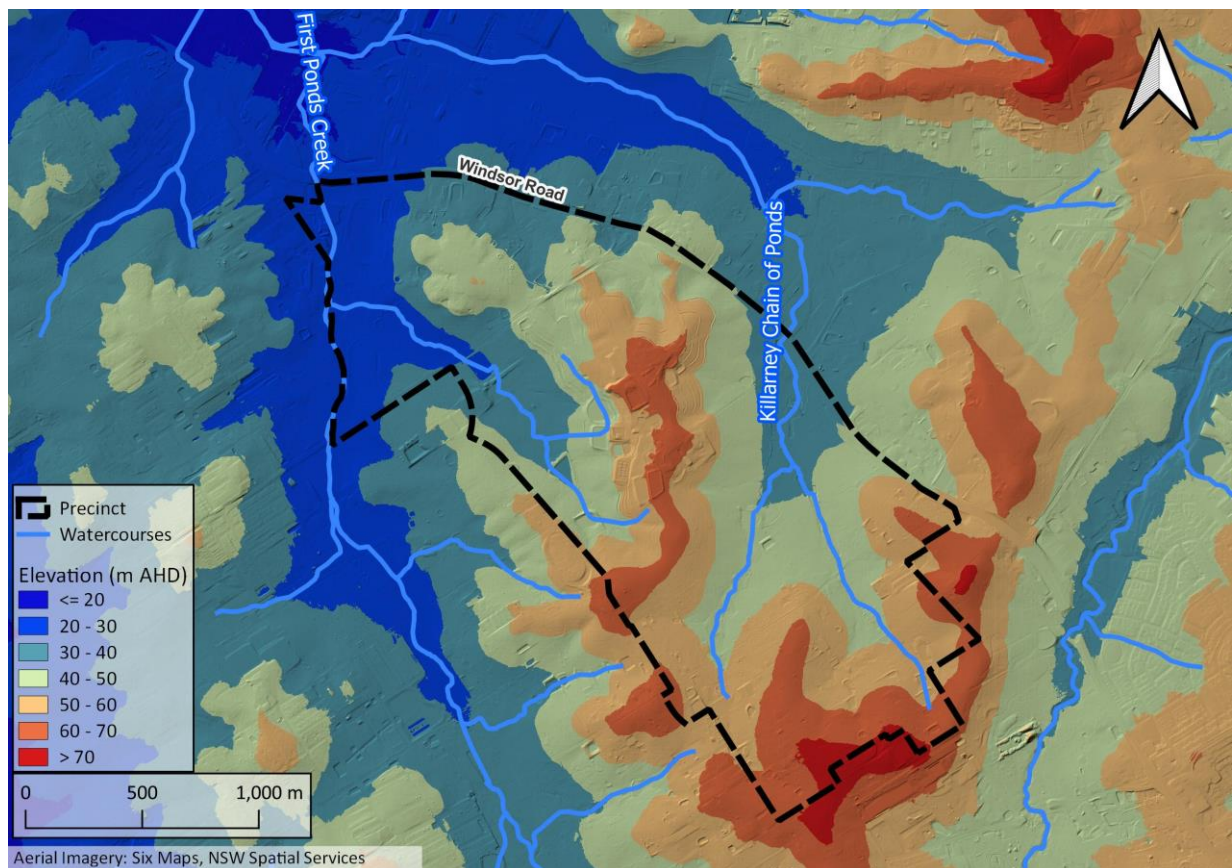


**Figure 4-1 Precinct Sub-Catchment Mapping**

### 4.2 Topography and Drainage

The site grades to the north-east towards Killarney Chain of Ponds and north-west towards First Ponds Creek, with moderate slopes in the range of 1-10% observed across the majority of the site. **Figure 4-2** shows the topography of the Precinct and surrounds based on 2019 LiDAR data.



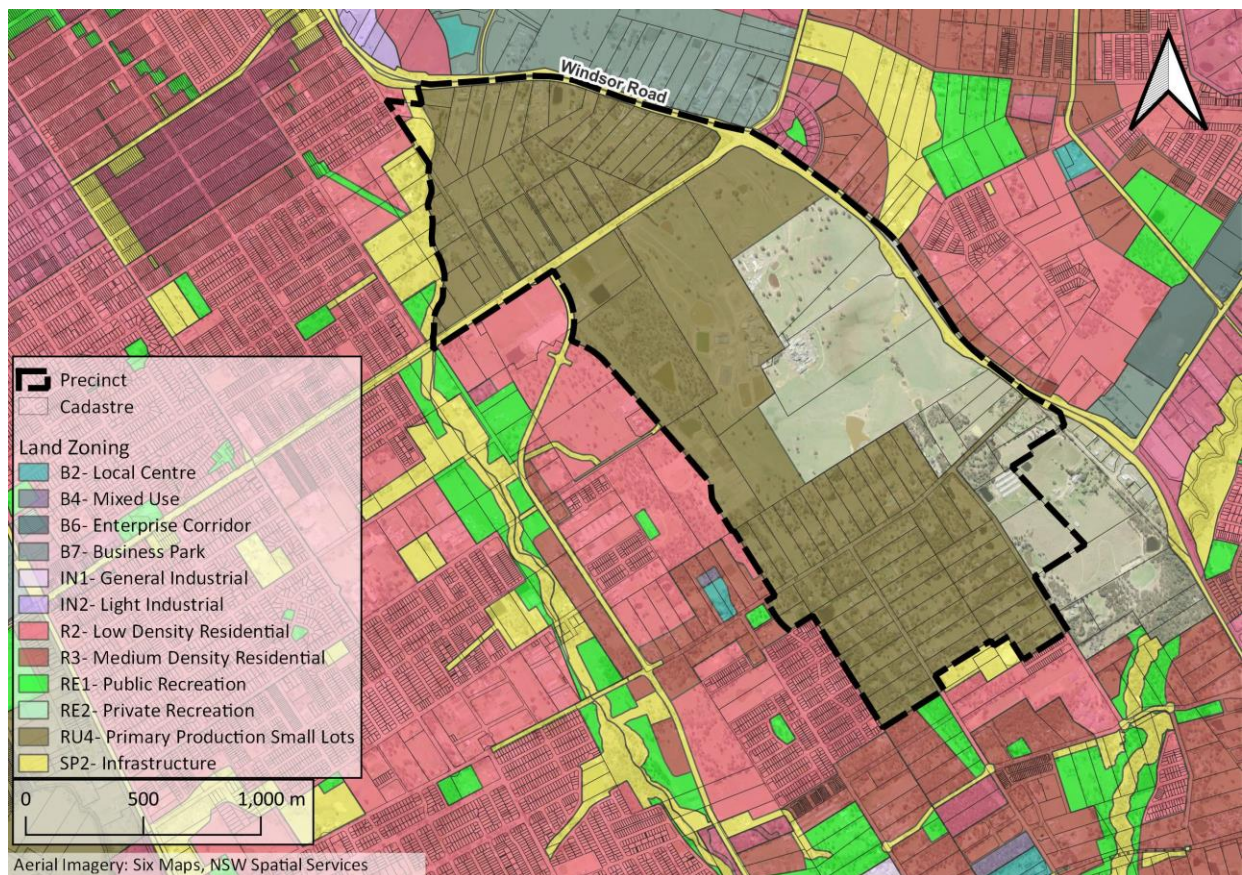


**Figure 4-2 Precinct Topography**

## 4.3 Land Use

The site is predominantly comprised of sparsely vegetated rural land zoned RU4 – Primary Production. The proposed Rouse Hill Regional Park is located in the south-eastern portion of the site where the current land use is also rural in nature, with a lower percentage of vegetation coverage than the remainder of the site. Existing land use information across the study area has been sourced from the Blacktown LEP 2015 and is shown in **Figure 4-3**.





**Figure 4-3 Existing Land Zoning**

### 4.4 Soils

DPIE's mapped soil landscapes (eSPADE) cover the study area and indicate a Blacktown soil landscape across the majority of the Precinct. This soil landscape is characterised by loam topsoils underlain by clay loam and light to medium clay. A hydrologic soil group of C (slow infiltration) covers the majority of the Precinct, with some Group D (very slow infiltration) soils present around the major drainage lines.

### 4.5 Rainfall

Daily rainfall data relevant to the study area has been sourced from the Richmond – UWS Hawkesbury meteorological station (Station 067021). This station is located approximately 15km from the Precinct and contains the longest timeseries of recorded rainfall data of the nearby stations (139 years).

Rainfall statistics for this gauge from BoM are summarised in **Table 4-1**. These statistics show that:

- Mean annual rainfall is 804 mm
- Annual rainfall has ranged from 268 – 1718 mm
- Highest daily rainfall recorded was 309 mm in May 1889.



**Table 4-1 Monthly Climate Statistics for Station 067021 (Source: BoM, Accessed 2 August 2023)**

Statistic Element (for Years 1881- 2023)	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Mean rainfall (mm)	96.5	94.5	94	67.3	55.9	60.5	45.6	42	42.1	57.4	73.6	75.1	804
Highest rainfall (mm)	375.7	442.4	569	338.9	529	360.6	285.6	465.3	180.1	217.8	449.6	327	1718.2
Date of Highest rainfall	1972	1990	2022	1946	1889	1950	1904	1986	1892	2004	1961	1947	1950
Lowest rainfall (mm)	7.4	3	3	1.6	1.1	0.8	0	0	0	1.3	2.5	0	268
Date of Lowest rainfall	1929	1939	1965	1980	2008	1883	1972	1946	1957	1968	1915	2019	1944
Decile 1 monthly rainfall (mm)	21.6	11	17.4	11.6	7.5	5.3	5.2	4	8.4	12.7	14.8	14.2	527.4
Decile 5 (median) monthly rainfall (mm)	74.2	74.3	66.5	50.7	30.6	38.6	27.8	24	33.4	43.5	66.2	55.6	796
Decile 9 monthly rainfall (mm)	188	190.1	188.6	131.7	121.3	152	108	86.2	86.2	127.4	139	158.2	1076
Highest daily rainfall (mm)	198.6	175.2	209	160	309.4	101.6	138.4	210	103.4	94.8	131.8	88.1	309.4
Date of Highest daily rainfall	11/01/1949	10/02/1992	4/03/2022	16/04/1946	28/05/1889	1/06/1897	27/07/1952	6/08/1986	2/09/1970	20/10/1987	18/11/1961	10/12/1920	28/05/1889
Mean number of days of rain	11.2	11.2	11.5	9.7	9	10	8.4	7.9	8.2	9.1	10.2	10.2	116.6
Mean number of days of rain $\geq 1$ mm	7.7	7.5	7.8	6.3	5.5	5.7	4.6	4.8	5.3	6.1	7.2	7.3	75.8
Mean number of days of rain $\geq 10$ mm	2.6	2.7	2.5	1.8	1.3	1.6	1.1	1.1	1.1	1.7	2.4	2.3	22.2
Mean number of days of rain $\geq 25$ mm	1	1	1	0.6	0.4	0.6	0.4	0.3	0.2	0.5	0.7	0.7	7.4

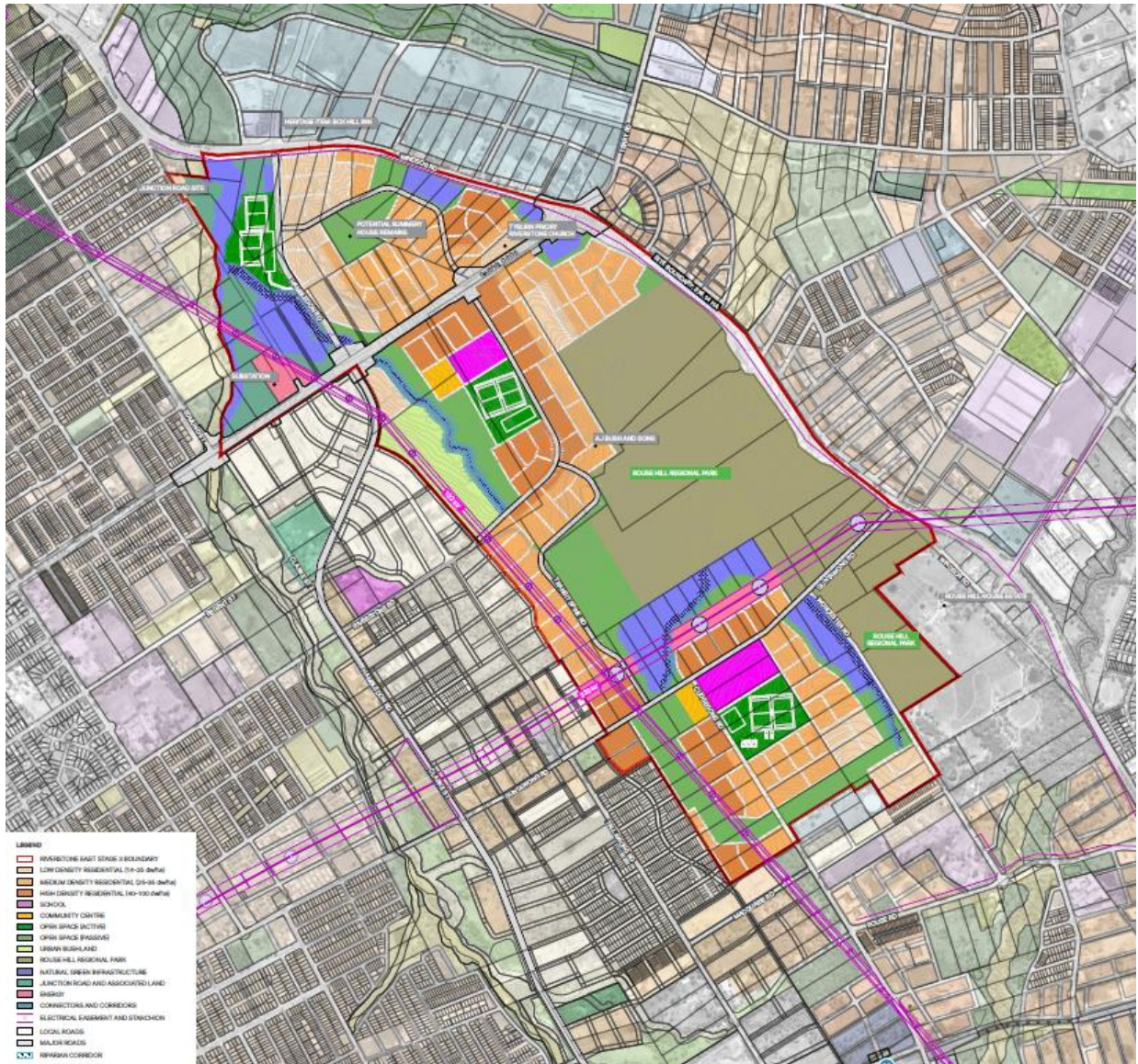


## 5 Indicative Layout Plan

### 5.1 Exhibited ILP

An Indicative Layout Plan (ILP) has been developed by Hatch/Roberts Day (Revision E, dated 01/09/23) with consideration to the outcomes of baseline constraints analysis (including water cycle management) and an Enquiry by Design (EBD) workshop. This ILP has been used as a basis for post-development land use characteristics adopted in the water cycle management assessment.

The exhibited ILP is shown in **Figure 5-1**.



**Figure 5-1 Indicative Layout Plan (Source: Hatch/Roberts Day, 2023)**

### 5.2 Post-Exhibition Updates

Following public exhibition in early 2024, minor updates to the ILP were made based on feedback received on the exhibited layout (**Figure 5-1**). Notable changes included a reconfiguration of the public open space and transit spine road alignment north of Garfield Road East. The updated ILP (Revision H, dated 21/11/24) is shown in **Figure 5-2**.



The updated ILP was reviewed in relation to changes that may impact the water cycle management strategy, such as catchment imperviousness and space allocations for stormwater management measures. It was found that the ILP update resulted in a change in impervious area of less than 1% from an overall catchment perspective. This is not expected to produce any material changes to catchment hydrology or pollutant generation and thus updates to the water quantity and quality modelling were not considered necessary. There is sufficient space allocation for stormwater management measures in the Revision H layout such that minor overlaps between proposed stormwater basins and roadways could be addressed via adjustments to the shape of basins during future design stages.

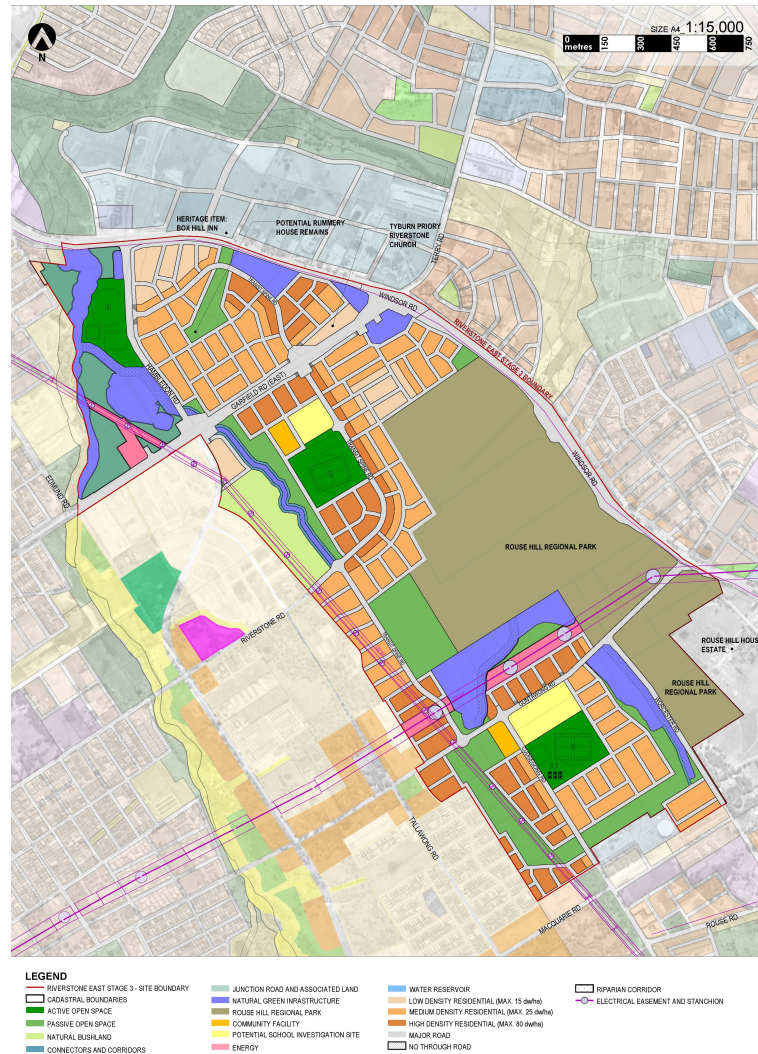


Figure 5-2 Updated Indicative Layout Plan (Source: Hatch/Roberts Day, 2025)



## 6 Stormwater Quality Management

### 6.1 Stormwater Quality Targets

As outlined in **Section 3**, a number of different stormwater quality targets apply to the Precinct. A summary of these different stormwater targets and their applicability to the Precinct stormwater management strategy is provided in **Table 6-1**.

**Table 6-1 Summary of Range of Stormwater Quality Targets**

Target	Applicability to the Assessment
<p>BCC Growth Centres DCP minimum reduction targets of:</p> <ul style="list-style-type: none"> <li>85% reduction in TSS</li> <li>65% reduction in TP</li> <li>45% reduction in TN</li> <li>90% reduction in gross pollutants</li> </ul>	<p>These are the considered the minimum requirement in terms of pollutant reduction targets applicable to the Precinct.</p>
<p>BCC Growth Centres DCP aspirational reduction targets of:</p> <ul style="list-style-type: none"> <li>95% reduction in TSS</li> <li>95% reduction in TP</li> <li>85% reduction in TN</li> <li>100% reduction in gross pollutants</li> </ul>	<p>Although a desirable outcome in terms of catchment water quality, compliance with these targets is not mandated in the BCC Growth Centres DCP and is not considered economically viable given the quantum of stormwater management measures required to reduce pollutant loads by the target percentages.</p>
<p>Wianamatta-South Creek Guidelines (DPE, 2022) reduction targets of:</p> <ul style="list-style-type: none"> <li>90% reduction in TSS</li> <li>80% reduction in TP</li> <li>65% reduction in TN</li> <li>90% reduction in gross pollutants</li> </ul> <p>These reduction targets were found to be more achievable for the subject site than the allowable mean annual load option (refer <b>Section 3.6</b>) in the Wianamatta-South Creek Guidelines (DPE, 2022).</p>	<p>These have been adopted as the target reduction in pollutant loading in the development of the Precinct water cycle management strategy. However, strict compliance with these targets is not considered essential given that catchment runoff will only pass through a small (1km) length of Wianamatta-South Creek before discharging to the Dyarubbin-Hawkesbury Nepean River.</p>
<p>Neutral or beneficial effect (NorBE) on water quality compared to existing conditions. The <i>Using MUSIC in the Sydney Drinking Water Catchment</i> (Water NSW, 2023) guidelines suggest aiming for the following MUSIC modelling results to demonstrate this will be achieved:</p> <ul style="list-style-type: none"> <li>10% reduction in TSS, TP and TN compared to existing conditions</li> <li>Post-development pollutant concentrations less than pre-development for 50-98% of the time</li> </ul> <p>The additional reductions in pollutant loading are to account for uncertainties inherent in MUSIC modelling.</p>	<p>Achieving NorBE is necessary for compliance with the SEPP (Biodiversity and Conservation) 2021 (refer <b>Section 3.2</b>).</p> <p>Applying the 10% reduction in loads compared to existing is considered overly conservative for the subject assessment given the significant level of conservativeness in developed site imperviousness assumptions (refer <b>Section 6.4.1</b>).</p>



## 6.2 Existing Scenario MUSIC Modelling

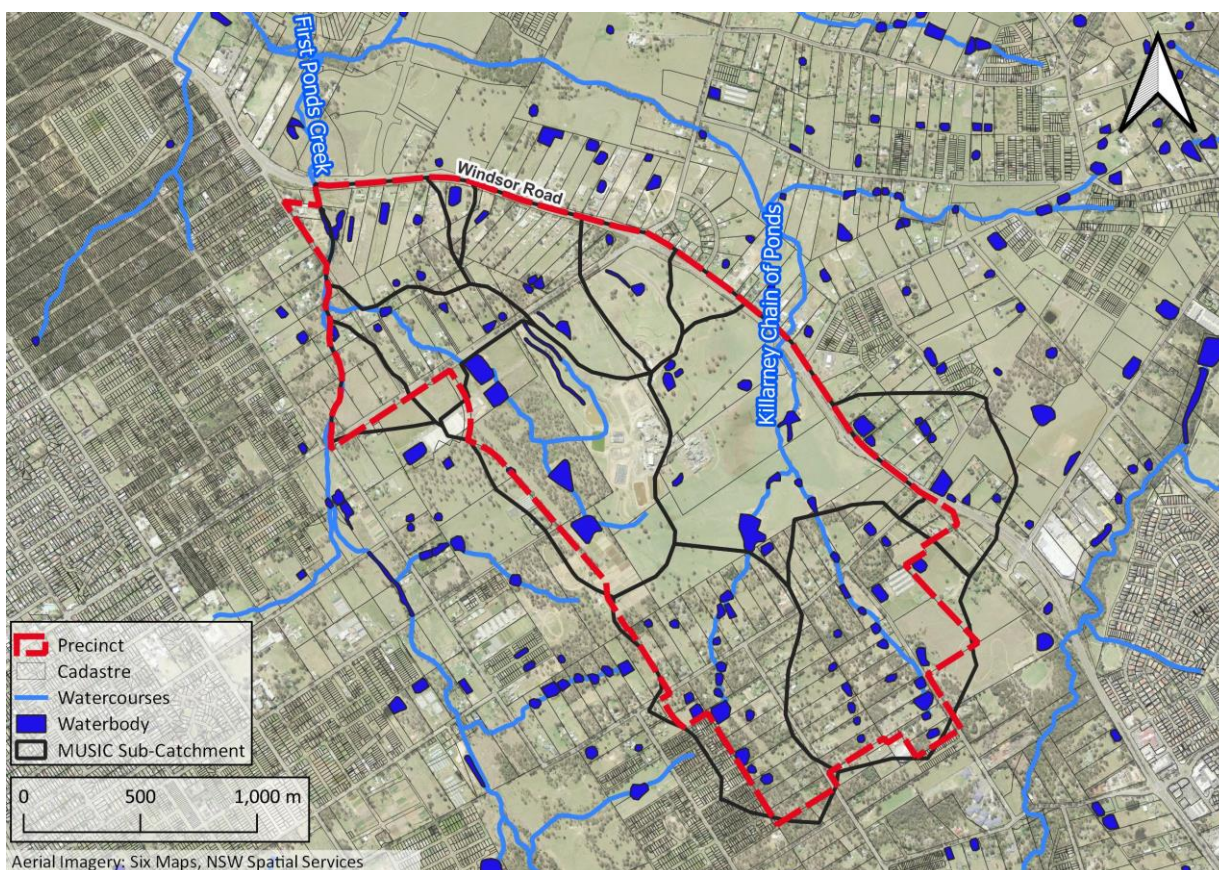
A base case MUSIC model (version 6.3.0) was established to quantify existing pollutant loading from the Precinct and upstream catchments for the purpose of the NorBE assessment. Details of the base case MUSIC modelling are provided in the following sections.

### 6.2.1 Sub-Catchment Delineation

MUSIC sub-catchments upstream and within the site were delineated using the hydrologic model sub-catchment delineation from Council's existing scenario XP-RAFTS model of Killarney Chain of Ponds and First Ponds Creek.

MUSIC modelling does not benefit from the same level of sub-catchment delineation as is typically required for design event hydrologic/flood modelling. As such, sub-catchments were consolidated around major drainage lines and equated to a total of 12 in the base case model.

**Figure 6-1** shows the sub-catchment delineation adopted in the base case MUSIC model. Note that some areas outside of the Precinct are located within the catchments for analysis.



**Figure 6-1 MUSIC Sub-Catchments – Existing Scenario**

### 6.2.2 Base Information

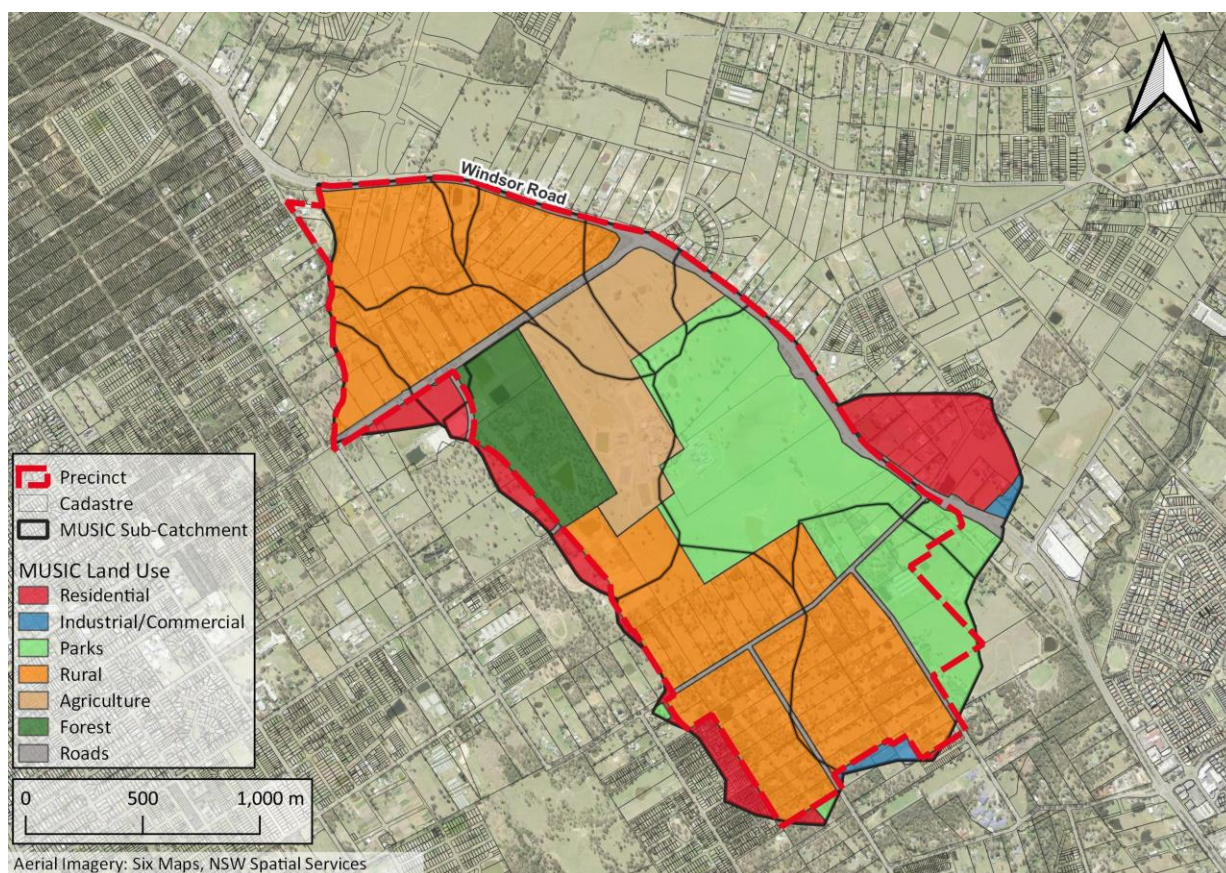
Base meteorological data from Council's MUSIC-link (version 6.34) was adopted for the purpose of the water quality assessment. This utilises 6-minute rainfall pluviograph data from the Liverpool (Whitlam Centre) meteorological station (Station 067035) over a 9-year period from 1967 to 1976. This station is approximately 30km south of the Precinct and reported a MAR of 857 over the analysed time period.



The MUSIC-link base meteorological data also includes monthly average potential evapotranspiration (PET) data which equates to an annual rate of 1261mm/year.

### 6.2.3 Source Nodes

Source node types within each sub-catchment were defined based on land use zoning, aerial imagery and site observations (**Figure 6-2**). BCC's default MUSIC source nodes and parameters were adopted where appropriate. Alternate source node parameters from the NSW MUSIC Modelling Guidelines (BMT WBM, 2015) were used where no BCC nodes were available for the land use type (e.g. agricultural). Source node parameters for the existing scenario land use types are summarised in **Table 6-2**.



**Figure 6-2 MUSIC Land Use – Existing Scenario**



Table 6-2 Adopted MUSIC Source Node Parameters

		Land Use						
		Residential	Industrial/ Commercial	Parks	Rural	Agriculture	Forest	Roads
Percentage Impervious		85	90	5	5	5	0	85
Impervious Area Properties								
Rainfall Threshold (mm/day)		1.4						
Pervious Area Properties								
Soil Storage Capacity (mm)		170						
Initial Storage (% of Capacity)		30						
Field Capacity (mm)		70						
Infiltration Capacity Coefficient – a		210						
Infiltration Capacity Coefficient – b		4.7						
Groundwater Properties								
Initial Depth (mm)		10						
Daily Recharge Rate (%)		50						
Daily Baseflow Rate (%)		4						
Daily Deep Seepage Rate (%)		0						
Total Suspended Solids Generation (log mg/L)								
Base Flow	Mean	1.20	1.20	1.20	1.15	1.30	0.78	1.20
	Std Dev	0.17	0.17	0.17	0.17	0.13	0.13	0.17
Storm Flow	Mean	3.00	3.00	3.00	1.95	2.15	1.60	2.43
	Std Dev	0.32	0.32	0.32	0.32	0.31	0.20	0.32
Total Phosphorus Generation (log mg/L)								
Base Flow	Mean	-0.85	-0.85	-0.85	-1.22	-1.05	-1.22	-0.85
	Std Dev	0.19	0.19	0.19	0.19	0.13	0.13	0.19
Storm Flow	Mean	-0.30	-0.30	-0.30	-0.66	-0.22	-1.10	-0.30
	Std Dev	0.25	0.25	0.25	0.25	0.30	0.22	0.25
Total Nitrogen Generation (log mg/L)								
Base Flow	Mean	0.11	0.11	0.11	-0.05	0.04	-0.52	0.11
	Std Dev	0.12	0.12	0.12	0.12	0.13	0.13	0.12
Storm Flow	Mean	0.30	0.30	0.30	0.30	0.48	-0.05	0.34
	Std Dev	0.19	0.19	0.19	0.19	0.26	0.24	0.19



## 6.2.4 Treatment Nodes

### 6.2.4.1 Ponds

Pond treatment nodes sourced from BCC’s MUSIC nodes were used to represent the likely degree of treatment provided by the existing farm dams within the study area. Given the significant quantity and spread of farm dams throughout the study area, it was assumed that each sub-catchment area would be treated by 50% of the combined pond area within each MUSIC sub-catchment. Each pond was assumed to have an average depth of 1m and a nominally small hydraulic residence time close to 0.

### 6.2.4.2 Generic Treatment Nodes

Generic treatment nodes were used to represent the assumed local stormwater treatment for new residential areas external to the Precinct where runoff would bypass the locations of regional treatment measures previously nominated in Mott MacDonald (2016). Treatment percentages were set to achieve BCC’s minimum reduction targets (refer **Section 6.1**) for these areas.

## 6.2.5 Results

**Table 6-3** summarises the results of the MUSIC water quality assessment for the existing scenario, including the percentage reduction compared to untreated catchment runoff.

**Table 6-3 Existing Scenario Pollutant Loads**

Pollutant	Catchment (un-treated) Loads (kg/yr)	Catchment Outflow Loads (kg/yr)	Percentage Reduction %
Total Suspended solids (TSS)	178,000	60,400	66.1
Total Phosphorus (TP)	361	189	47.7
Total Nitrogen (TN)	2,450	1,780	27.5
Gross Pollutants	17,700	1,390	92.1

## 6.3 Stormwater Management Strategy

A stormwater treatment train was developed to target typical pollutants associated with urban runoff including gross pollutants, suspended sediment (TSS), nutrients (nitrogen and phosphorus) and hydrocarbons. In addition to stormwater treatment, the stormwater management strategy includes stormwater harvesting measures for the capture and re-use of stormwater to reduce potable water demands across the Precinct.

Features of the proposed treatment train are summarised in **Table 6-4**. **Figure 6-3** shows the location of proposed regional treatment basins.

Concept design drawings of proposed stormwater management measures are attached in **Appendix A**.

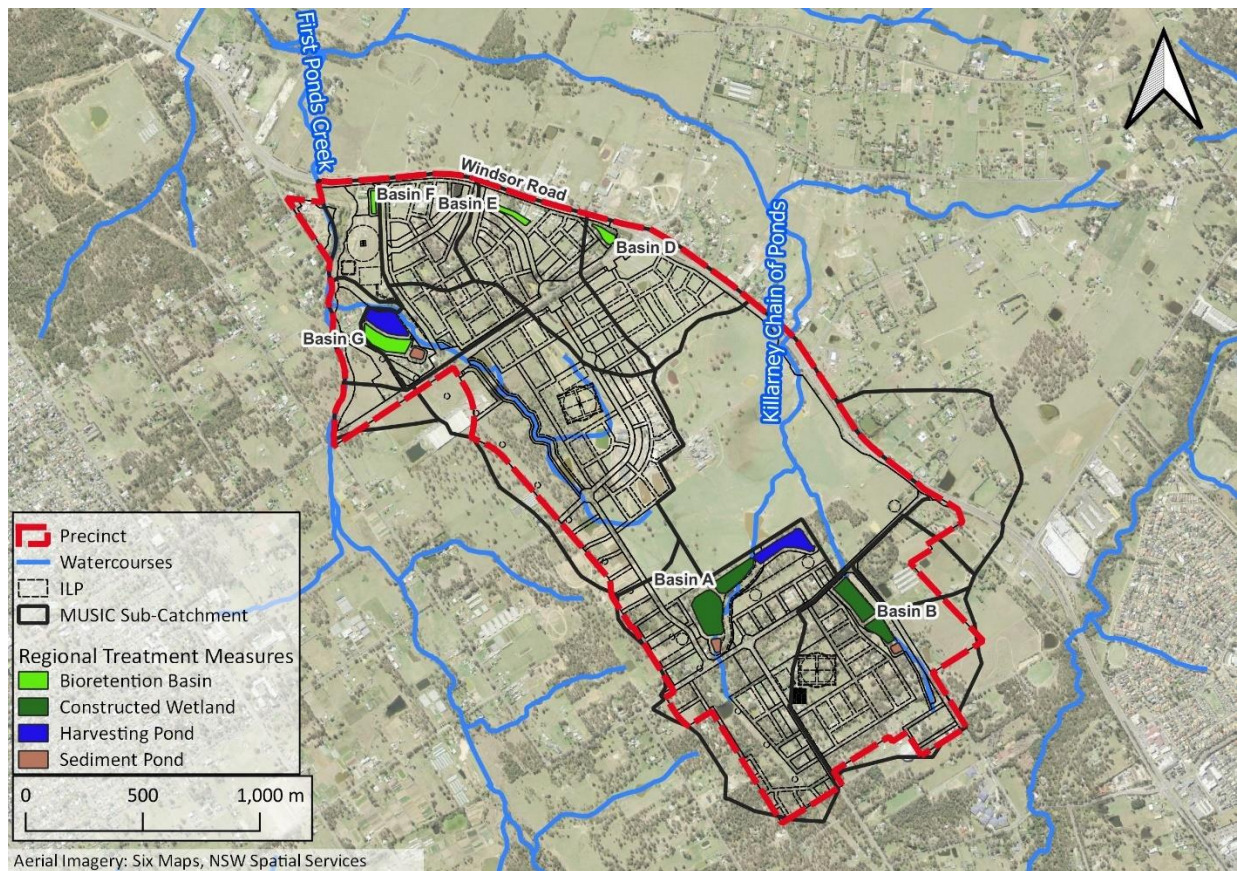


Table 6-4 Proposed Stormwater Treatment Train

Treatment Measures		Description <sup>1</sup>
On-lot measures	Rainwater tanks	Rainwater tanks are proposed on each new allotment to capture rainwater for internal and external re-use.
	Grassed swales	Grassed swales are proposed to treat runoff from public open space and sporting field areas, reducing the reliance on end of line treatment measures.
At-source measures	Gross pollutant traps (GPTs)	GPTs are proposed on the downstream end of Precinct stormwater drainage lines prior to discharging to riparian corridors or direct to regional treatment measures. These are primary treatment measures targeting gross pollutants and coarse sediment. The GPTs will also contain oil baffles to capture hydrocarbons and satisfy Section 11.6.1 of Council's WSUD Developer Handbook – MUSIC Modelling and Design Guideline (2020).
	Sediment ponds	Sediment ponds are proposed as a secondary treatment measure for the two Killarney Chain of Ponds tributaries and First Ponds Creek tributary, targeting coarse to medium sediment.
	Constructed wetlands	Constructed wetlands are proposed as tertiary treatment measures for the two Killarney Chain of Ponds tributaries, targeting finer sediment and nutrients. In addition to a stormwater treatment function, the wetlands will provide significant ecological benefits via creating a habitat for a range of fauna.
	Bioretention basins	Bioretention basins are proposed as tertiary treatment measures for the First Ponds Creek tributary and major Precinct drainage lines, targeting finer sediment and nutrients. For portions of the site where on-site detention is required, bioretention basins will be co-located within detention basins to minimise land take.
End of line measures	Harvesting ponds	Stormwater harvesting ponds are proposed at the downstream end of the major site catchments (First Ponds Creek and Killarney Chain of Ponds tributaries) and will be the main source of water for landscape irrigation of public open space and sporting fields within the Precinct. The proposed harvesting scheme will reduce stormwater runoff volumes discharging from the Precinct will also reduce the reliance on potable water servicing.  Recycled water servicing from the Rouse Hill Water Recycling Plant was considered but ultimately set aside due to the ability of the proposed stormwater harvesting measures to provide a reliable water supply (refer <b>Section 7.4</b> ) and additional stormwater infrastructure requirements to provide an equivalent level of treatment without the proposed harvesting scheme in place.

<sup>1</sup> Refer Section 6.4.3 for performance assumptions made for each measure





**Figure 6-3 Regional Treatment Measures**

### 6.4 Post-Development (ILP) Scenario MUSIC Modelling

#### 6.4.1 Sub-Catchment Delineation

Similarly to the base case MUSIC model, the sub-catchment delineation for the post-development model with the ILP as proposed in **Section 5** is a consolidated version on the delineation from the corresponding XP-RAFTS model, equating to a total of 13 MUSIC sub-catchments. The sub-catchment delineation adopted in the post-development MUSIC model is included in **Figure 6-3**.

#### 6.4.2 Source Nodes

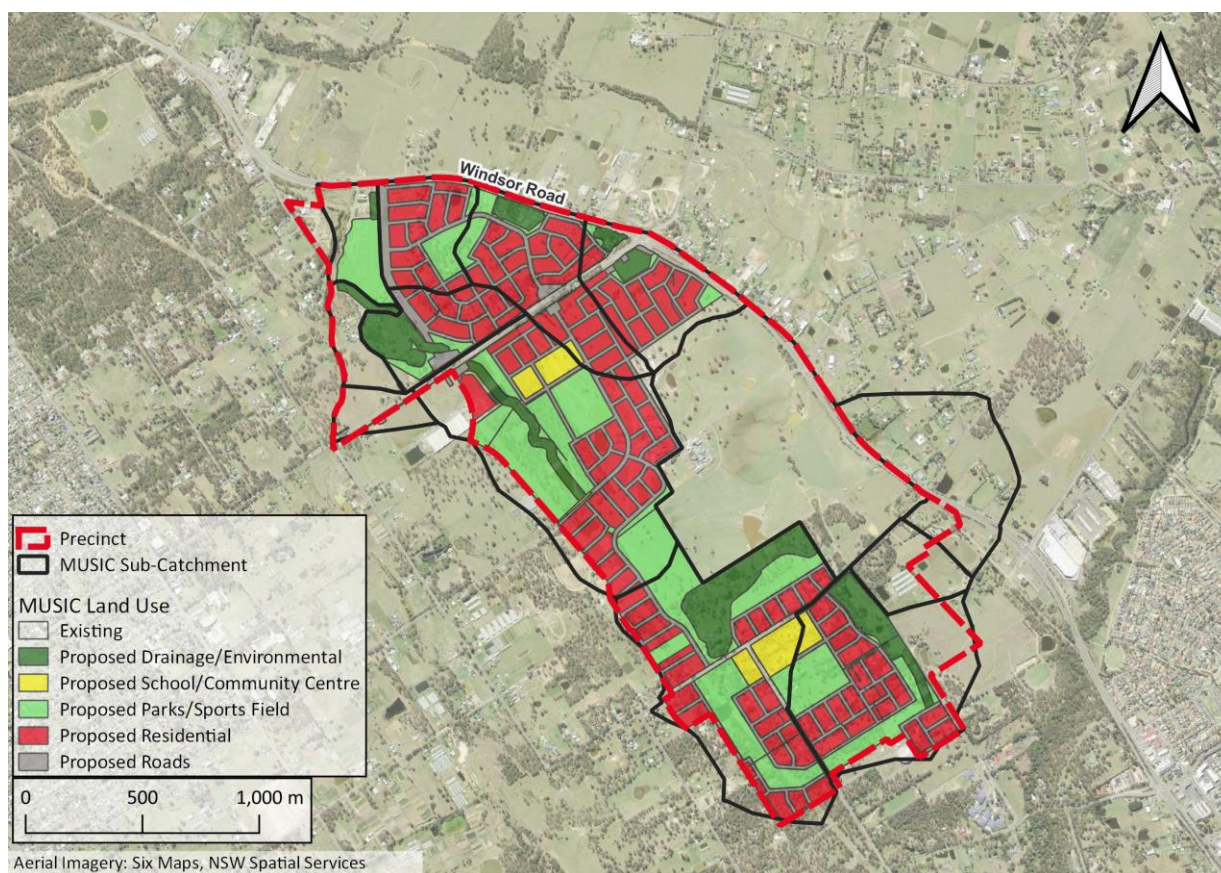
Source nodes representing post-development land uses were obtained from BCC's default MUSIC nodes. The post-development land use is shown in **Figure 6-4**.

For proposed residential and community centre/school areas, the land use was split into roof, driveway and landscaping areas. **Table 6-5** shows the surface type split for these land uses.

Percentage impervious values were assigned in accordance with the recommended values in the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020). These values are considered conservative given the impervious fraction used in MUSIC modelling is typically based on effective impervious area (EIA) rather than total impervious area (TIA). The adopted percentage imperviousness for post-development land use types is shown in **Table 6-6**.

As outlined in **Section 5.2**, the updated ILP does not represent a material change in the catchment conditions and therefore the analysis associated with the exhibited ILP information is reported here.





**Figure 6-4 MUSIC Land Use - Post-Development Scenario**

**Table 6-5 Post-Development Land Use Split**

Land Use	Source Node Type (% of total area)			
	BCC Roof Area	BCC Road Areas (driveways)	BCC Other Impervious Areas	BCC Pervious Areas
Residential	60	10	15	15
School/Community Centre	30	10	10	50



**Table 6-6 Post-Development Source Nodes and Imperviousness**

Land Use	Source Node Type	Percentage Impervious
Proposed Residential	As per <b>Table 6-5</b>	85
Proposed School/Community Centre	As per <b>Table 6-5</b>	50
Proposed Parks/Sports Field	Residential	20 <sup>2</sup>
Proposed Roads	Sealed road	95
Proposed Drainage/Environmental	Forest	5

### 6.4.3 Treatment Nodes

Seven treatment node types have been included in the MUSIC models to represent elements of the treatment train:

- Rainwater Tanks,
- Swales,
- Continuous Deflective Separation (CDS) GPTs,
- Sediment Basins,
- Bioretention,
- Ponds (wetlands), and
- Ponds (harvesting).

It is assumed that farm dams within the Precinct will be remediated and filled as part of the development and thus have been excluded for the portions of the MUSIC model where development is proposed.

#### 6.4.3.1 Rainwater Tanks

Default rainwater tank treatment nodes were used in the post-development MUSIC model. Adopted residential rainwater tank assumptions are as follows:

- Tank sizing of 4kL per allotment, modelled at 90% of the total volume in MUSIC to allow for air space and sedimentation,
- Tanks assumed to receive 100% of roof runoff from each dwelling, and
- Assumed rainwater re-use rates of:
  - Internal re-use rate of 0.1kL/day/lot
  - External re-use rate of 25kL/year/lot

DCP controls will be required to enforce the minimum rainwater tank volumes and contributing roof area assumptions. Multiple slimline tanks may be required to capture runoff from the entire roof area.

#### 6.4.3.2 Swales

Swale treatment nodes were obtained from BCC's default MUSIC nodes. Swales have been proposed as an at-source treatment measure for public open space and sporting fields, with an assumed length of 200m per hectare of public open space/sporting field. This has been modelled as 100m/ha to allow for distributed catchment inflows along the length of the swales.

Key swale parameters are summarised in **Table 6-7**.

<sup>2</sup> This is lower than the 50% recommended in the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020). A SEPP/DCP clause will be required to enforce a maximum 20% imperviousness for public open space areas.



Table 6-7 Swale Parameters

Parameter	
Low Flow Bypass (m <sup>3</sup> /s)	0
Bed Slope (%)	0.5
Base Width (m)	1
Top Width (m)	5
Depth (m)	0.4
Vegetation Height (m)	0.05
Exfiltration Rate (mm/hr)	0

#### 6.4.3.3 CDS GPTs

CDS GPT treatment nodes were obtained from BCC's default MUSIC nodes. A single CDS node was used for each major post-development sub-catchment to represent the aggregate of GPTs located at the outlet of individual stormwater drainage lines into riparian corridors or treatment basins. The high flow bypass rate has been set at the 4EY flowrate for each sub-catchment.

Key GPT parameters are summarised in **Table 6-8**.

Table 6-8 CDS GPT Parameters

CDS GPT		
	Input (mg/L)	Output (mg/L)
Low Flow Bypass (m <sup>3</sup> /s)	0	
High Flow Bypass (m <sup>3</sup> /s)	4EY flowrate	
Total Suspended Solids	0	0
	75	75
	1000	300
Total Phosphorous	0	0
	0.5	0.5
	10	7
Total Nitrogen	0	0
	50	50
Gross pollutants	0	0
	100	2

#### 6.4.3.4 Sediment Basins

Sediment basin nodes were obtained from BCC's default MUSIC nodes and used to represent the corresponding portions of Basins A, B and G (**Figure 6-3**). The surface area of each basin was calculated in accordance with Section 11.3.1 of the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020). Modelled volumes are based on the upper 2/3 of the permanent water depth to account for sedimentation in the base. High flow bypass rates were set at either the 4EY design flowrate or the flowrate required to keep velocities in downstream wetlands (**Section 6.4.3.6**) sufficiently low.

Key sediment basin parameters are summarised in **Table 6-9**.



Table 6-9 Sediment Basin Parameters

Parameter	Basin A	Basin B	Basin G
Low Flow Bypass (m <sup>3</sup> /s)		0	
High Flow Bypass (m <sup>3</sup> /s)	1.35	1.35	3.6
Surface Area (m <sup>2</sup> )	1,823	1,489	2,207
Extended Detention Depth (m)		0.35	
Permanent Pool Volume (m <sup>3</sup> )	1,411	1,162	1,775
Exfiltration Rate (mm/hr)		0	
Evaporative Loss as % of PET		75	
Notional Detention Time (hrs)	5.71	4.67	6.92

#### 6.4.3.5 Bioretention

Default bioretention treatment nodes were used to represent the regional bioretention basins in the post-development MUSIC model, with the sizing and parameterisation based on Section 11.8 of the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020). High flow bypass has been set at the 4EY flow.

Key bioretention basin parameters are summarised in **Table 6-10**.

Table 6-10 Bioretention Parameters

Parameter	Basin D	Basin E	Basin F	Basin G
Upstream Catchment Area (Ha)	24.7	30.4	17.6	92.9
Low Flow Bypass (m <sup>3</sup> /s)		0		
High Flow Bypass (m <sup>3</sup> /s)	1.3	2.0	1.2	3.6
Filter Area (m <sup>2</sup> )	3,065	2,958	1,927	10,000
Filter Depth (m)		0.8		
Extended Detention Depth (m)	0.3	0.3	0.3	0.3
Saturated Hydraulic Conductivity (mm/hr)		100		
TN Content of Filter Media (mg/kg)		800		
Orthophosphate Content of Filter Media (mg/kg)		40		
Lined Base		Yes		
Vegetated with Effective Nutrient Removal Plants		Yes		

#### 6.4.3.6 Ponds (wetlands)

Given the macrophyte zone overflow will be located at the downstream end of the two proposed constructed wetlands (Basins A and B), pond treatment nodes with k and C\* values adjusted to match those of a wetland were used in lieu of the default wetland nodes where the overflow is assumed to be located upstream of the macrophyte zone. The high flow bypass rate for the wetlands has been set at a



value to limit design velocities to a maximum of 0.05m/s in the shallow marsh zones in the 4EY event as opposed to conveying full 4EY flows through the macrophyte zone. The modelled permanent pool volume accounts for 10% of the macrophyte zone volume being occupied by stored sediment.

Key wetland parameters are summarised in **Table 6-11**.

**Table 6-11 Wetland Parameters**

Parameter	Basin A	Basin B
Upstream Catchment Area (Ha)	59.7	49.3
Low Flow Bypass (m <sup>3</sup> /s)	0	
High Flow Bypass (m <sup>3</sup> /s)	1.35	1.35
Surface Area (m <sup>2</sup> )	29,022	19,487
Extended Detention Depth (m)	0.35	
Permanent Pool Volume (m <sup>3</sup> )	10,188	6,932
Exfiltration Rate (mm/hr)	0	
Evaporative Loss as % of PET	125	
Notional Detention Time (hrs)	5	61.1

#### 6.4.3.7 Ponds (harvesting)

Default pond treatment nodes were used to represent the stormwater harvesting components of Basins A and G. The k and C\* values for these ponds have been set to 0 (no treatment) given their main function as harvesting/re-use measures and location at the downstream end of the treatment train. The modelled re-use rates have been based on an assumed irrigation rate of 0.4kL/year over 80% of pervious open space/sporting field areas (17.9 Ha for Basin A and 24.4 Ha for Basin G).

Key harvesting pond parameters are summarised in **Table 6-12**.

**Table 6-12 Wetland Pond Harvesting Parameters**

Parameter	Basin A	Basin G
Upstream Catchment Area (Ha)	119.3	92.9
Low Flow Bypass (m <sup>3</sup> /s)	0	
High Flow Bypass (m <sup>3</sup> /s)	100	3.6
Surface Area (m <sup>2</sup> )	15,435	11,908
Extended Detention Depth (m)	1.1	0.35
Permanent Pool Volume (m <sup>3</sup> )	17,359	15,005
Exfiltration Rate (mm/hr)	0	
Evaporative Loss as % of PET	75	
Notional Detention Time (hrs)	2.38	5.97
Re-use Rate (kL/year)	71,729	97,456



## 6.4.4 Results

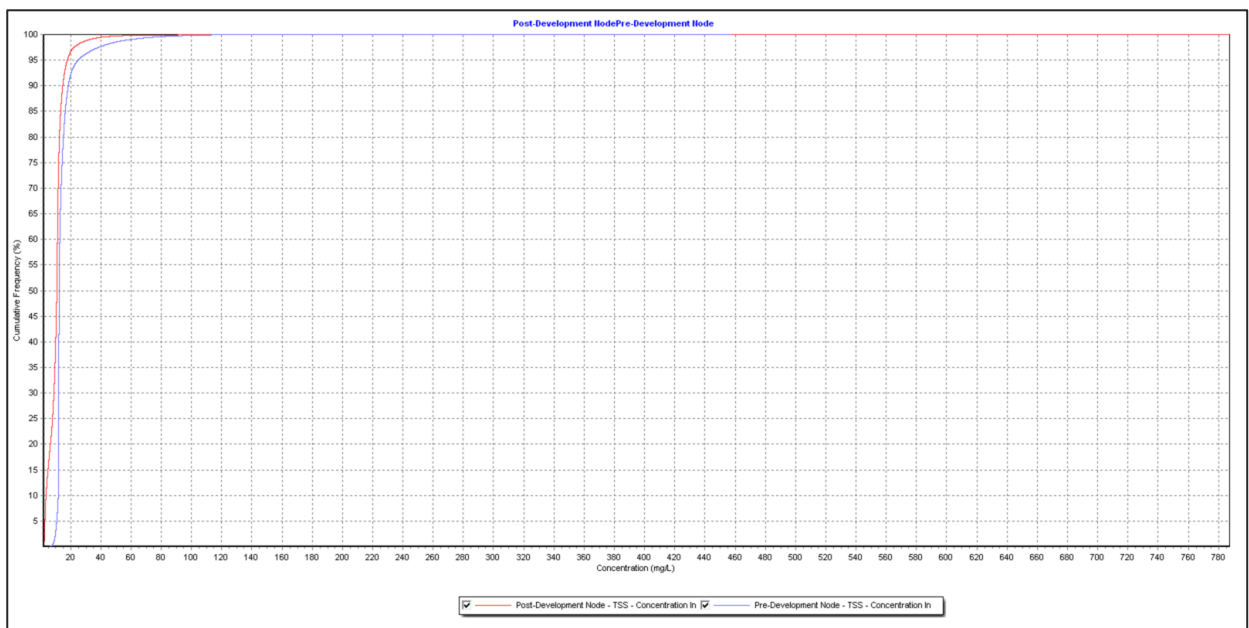
### 6.4.4.1 NorBE Assessment

**Table 6-13** shows existing and post-development pollutant loading for the purpose of the NorBE assessment.

A comparison of the existing and post-development TSS, TP and TN concentrations for runoff-generating events is provided in **Figure 6-5** to **Figure 6-7**.

**Table 6-13 Existing vs Post-Development Load Comparison (NorBE Assessment)**

Pollutant	Existing Outflow Loads (kg/yr)	Post-Development Outflow Loads (kg/yr)	Percentage Reduction/Increase %
Total Suspended solids (TSS)	60,400	47,300	-21.7
Total Phosphorus (TP)	189	186	-1.6
Total Nitrogen (TN)	1,780	1,920	+7.9
Gross Pollutants	1,390	371	-73.3



**Figure 6-5 Existing vs Post-Development Concentration Comparison – TSS**



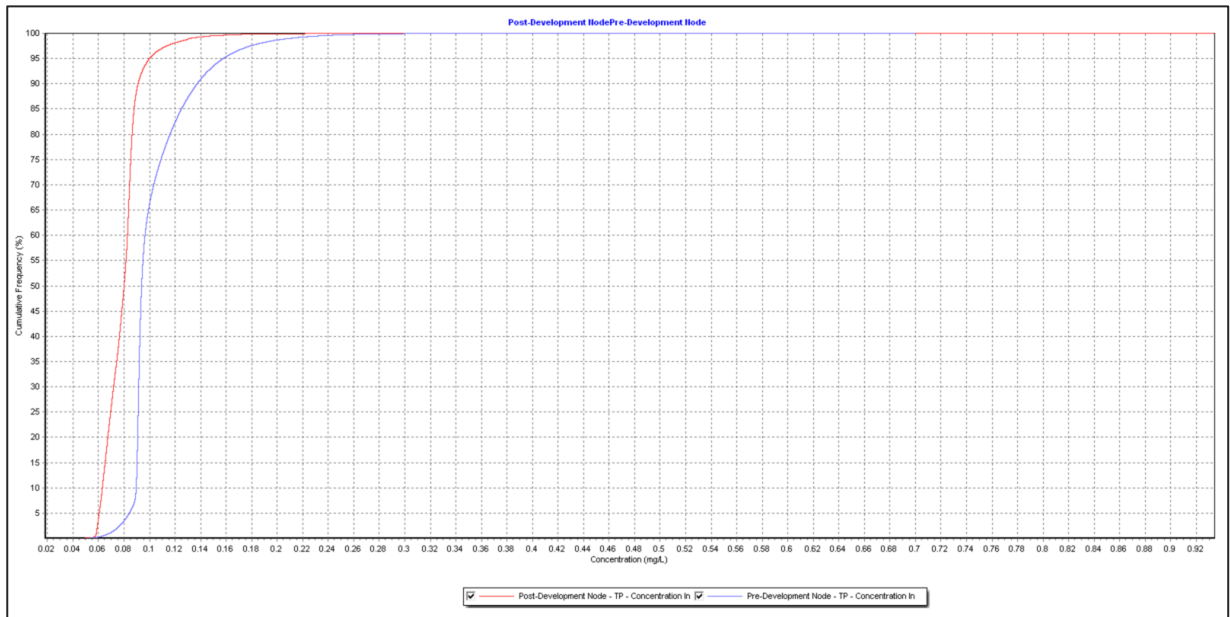


Figure 6-6 Existing vs Post-Development Concentration Comparison – TP

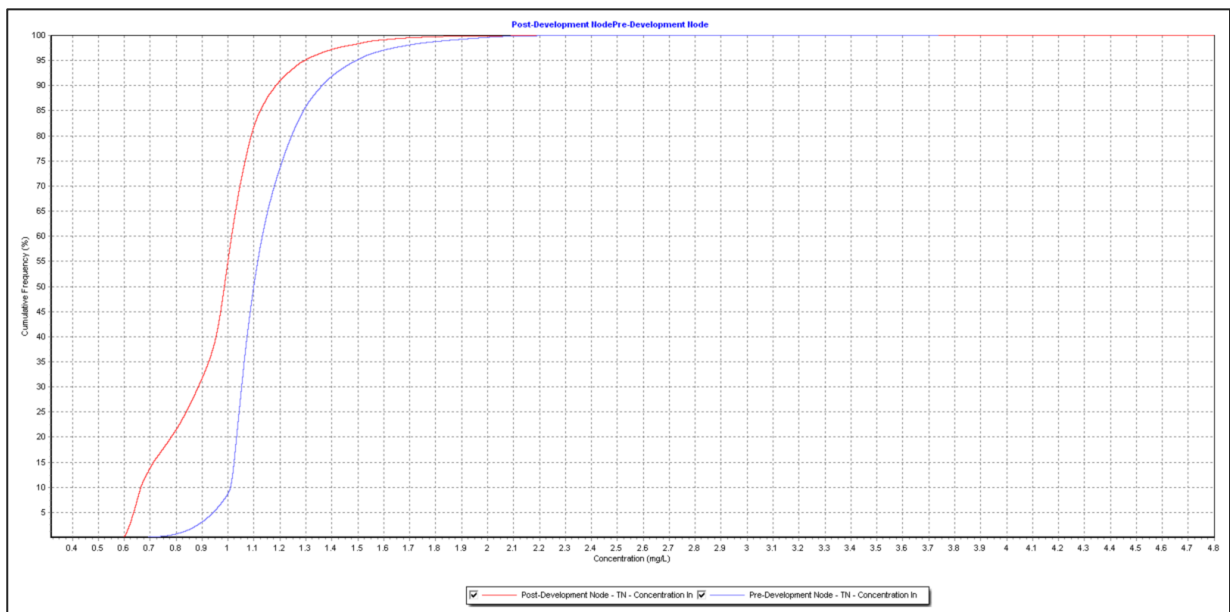


Figure 6-7 Existing vs Post-Development Concentration Comparison – TN

The results presented in **Table 6-13** show that the post-development TN loads are higher than those that would be required to meet the NorBE criteria stipulated in the *Using MUSIC in the Sydney Drinking Water Catchment* (Water NSW, 2023). **Figure 6-5** to **Figure 6-7** show that post-development TSS, TP and TN concentrations are less than pre-development levels for the 50<sup>th</sup> to 95<sup>th</sup> percentile runoff generating events demonstrating compliance with the NorBE concentration targets in the *Using MUSIC in the Sydney Drinking Water Catchment* (Water NSW, 2023).

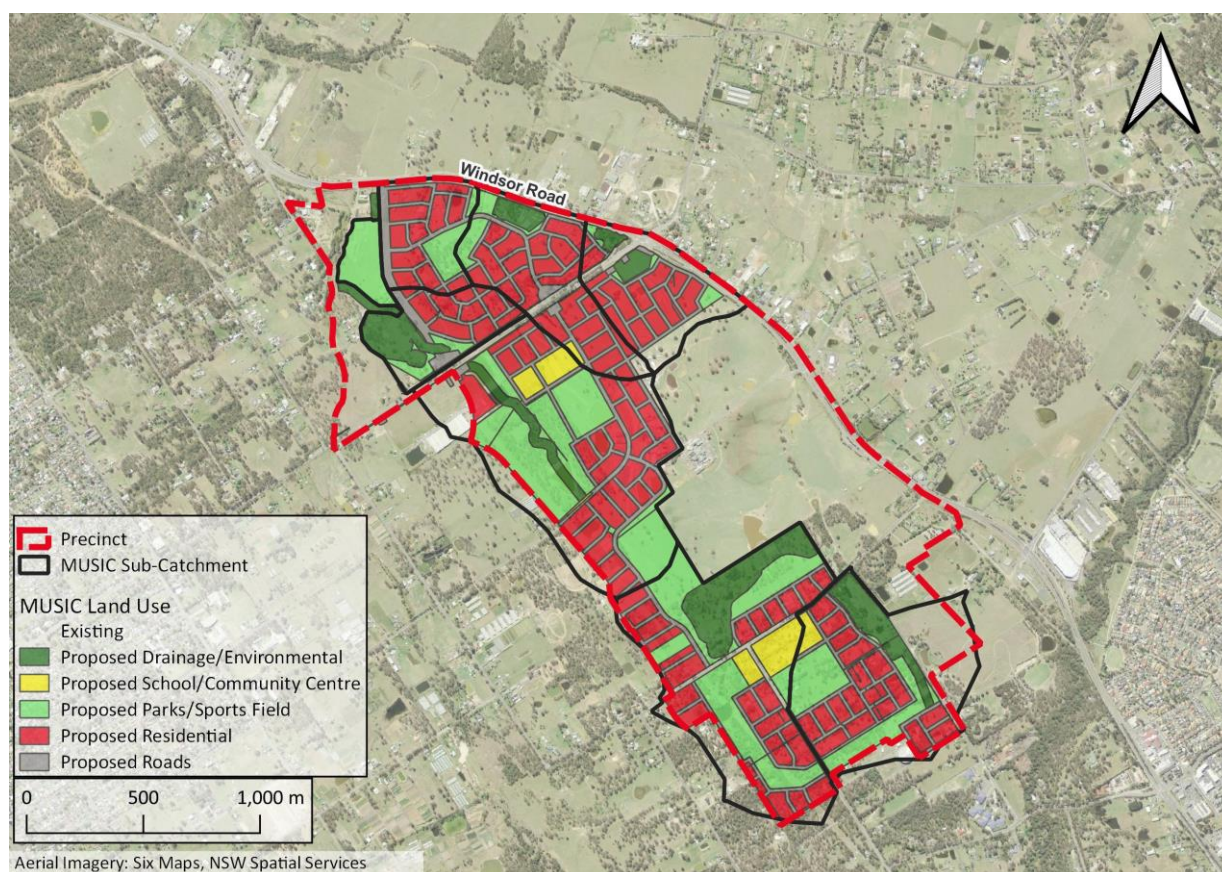


Although not achieving NorBE from a pollutant loading perspective, the slight increases in would not be expected to adversely impact downstream waterway health as increases in TN compared to the existing scenario are only minor (approximately 8%) and do not correspond with an increase in nitrogen concentration. The achieved water quality outcomes are thus considered to be consistent with Part 6.6 – Clause 2 (a) of the SEPP (Biodiversity and Conservation) 2021.

### 6.4.4.2 Pollutant Load Reductions

For the purpose of assessing post-development pollutant load reductions compared to an un-treated scenario, sub-catchments where land use will not change substantially as a result of the proposed development (such as Rouse Hill Regional Park) were removed from the model. The MUSIC sub-catchments for this scenario are shown in **Figure 6-8**.

The results of the percentage reduction-based assessment presented in **Table 6-14**.



**Figure 6-8 MUSIC Sub-Catchments – Percentage Reduction-Based Assessment**

**Table 6-14 Post-Development Pollutant Load Reductions (BCC/Wianamatta Assessment)**

Pollutant	Post-Development Un-Treated Loads (kg/yr)	Post-Development Outflow Loads (kg/yr)	Percentage Reduction %
Total Suspended solids (TSS)	298,000	35,100	88.2
Total Phosphorus (TP)	566	147	74.1
Total Nitrogen (TN)	3,590	1,560	56.4



Pollutant	Post-Development Un-Treated Loads (kg/yr)	Post-Development Outflow Loads (kg/yr)	Percentage Reduction %
Gross Pollutants	37,600	89	99.8

The MUSIC results shown in **Table 6-14** indicate the proposed treatment train achieves compliance with BCC’s minimum reduction targets but does not achieve the Wianamatta-South Creek reduction targets. Additional on-lot tertiary treatment measures such as membrane filters or bioretention systems would be required to achieve these reduction targets. This could be provided for medium and high- density residential zones in accordance with Section 11.1 of the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020).

A MUSIC-Link report for the post-development MUSIC modelling has been attached in **Appendix B**.



## 7 Stormwater Quantity Management

### 7.1 Stormwater Quantity Objectives

Stormwater detention objectives for the Precinct are to reduce post-development flows to less than or equal to pre-development flows design storm events ranging from the 50% AEP up to and including the 1% AEP.

Objectives for environmental flows are to mimic existing site runoff volumes and durations as much as practical.

### 7.2 Regional Detention Assessment

#### 7.2.1 Basin Design

A regional detention basin strategy was developed to mitigate the increase in site flows associated with higher imperviousness of the developed catchment. Proposed detention basins were sized using the XP-RRAFTS hydrologic model and TUFLOW hydraulic model developed for the *Flood Impact and Risk Assessment* (Rhelm 2023).

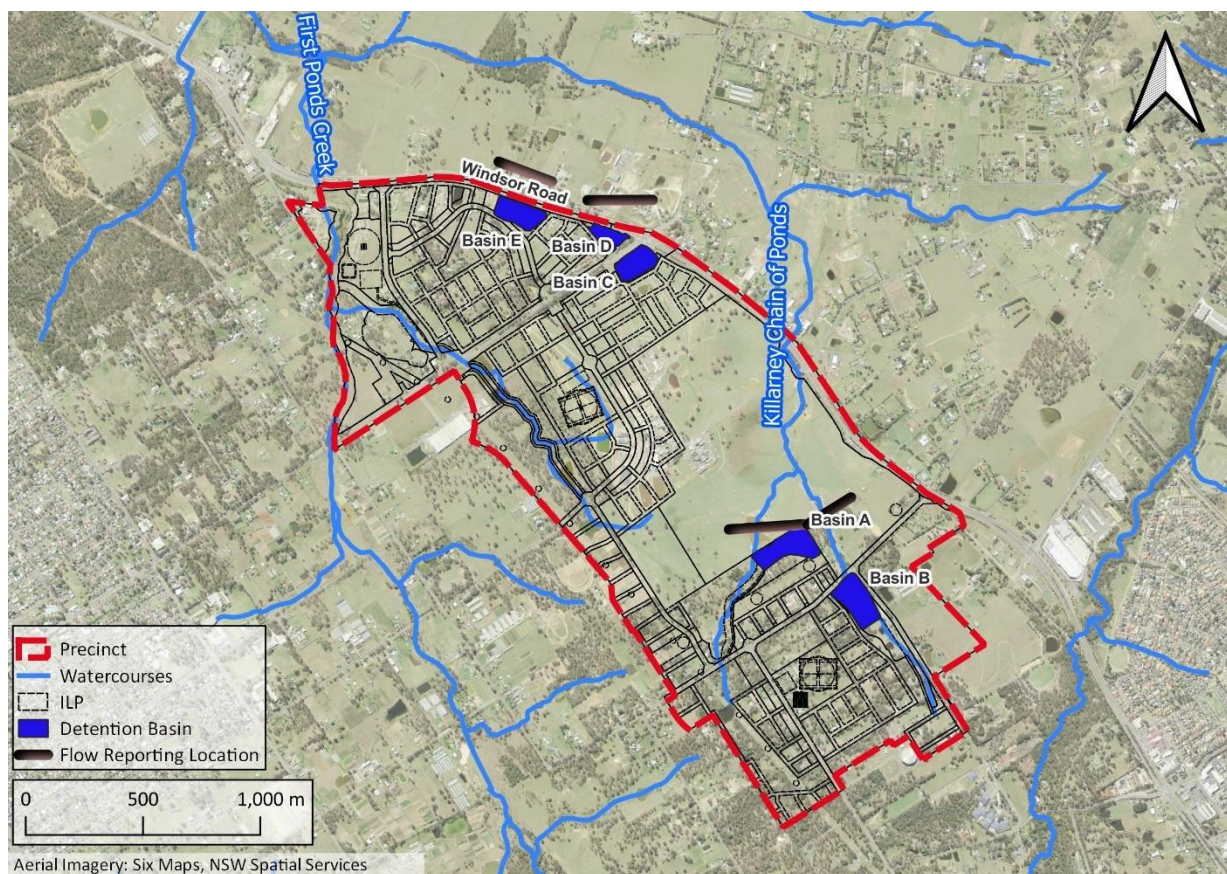
For the Killarney Chain of Ponds catchment, detention basins have been located online of the two first order watercourses draining to the Rouse Hill Regional Park and at major topographical low points along the north-eastern Precinct boundary. For the First Ponds Creek catchment, the *First Ponds Creek Flood Assessment* (CSS, 2021) and *Riverstone East Stage 3 Flood Impact and Risk Assessment* (Rhelm, 2024) indicate that flows and flood levels are generally lower in the fully developed state of the catchment than the base case condition (circa 2010), with the exception of more frequent events such as the 20% AEP. As such, no detention has been proposed for the site catchments draining to First Ponds Creek. Further discussion and flood impact mapping is provided in the *Riverstone East Stage 3 Flood Impact and Risk Assessment* (Rhelm, 2024).

Proposed basin design parameters/assumptions are as follows:

- Primary outlet pipes sized to convey 50% AEP flows,
- Secondary outlet weir to convey 1% AEP flows,
- Maximum 1.5m depth above the invert of primary outlet pipes/culverts in a 1% AEP event,
- Minimum 0.5m freeboard to top of embankment levels in a 1% AEP event,
- Maximum 1m storage depth over wetland planting in a 1% AEP event,
- Maximum 0.8m storage depth over bioretention filters in a 1% AEP event,
- Extended detention depth excluded in detention storage calculations,
- Typical 1V:5H batter/embankment slopes for maintainability and safe emergency egress,
- Maximum batter/embankment slopes of 1V:4H,
- Minimum 1% base slope to promote drainage, and
- 4m wide berm width with a maintenance access road around the basin perimeter.

**Figure 7-1** shows the location of proposed detention basins across the Precinct and flow reporting locations downstream of the basins. **Table 7-1** summarises key design features of each basin.





**Figure 7-1 Detention Basin Locations**

**Table 7-1 Detention Basin Properties**

Detention Basin	Primary Outlet	Secondary Outlet	1% AEP Storage (m <sup>3</sup> )
A	0.9 diameter RCP	40m wide weir	24,960
B	1.05 diameter RCP (wetland) 1.2W x 0.9H RCBC (riparian corridor)	15m wide weir	6,280
C	0.9 diameter RCP	2 x 1200sq pit	7,520
D	0.525 diameter RCP	10m wide weir	4,190
E	0.675 diameter RCP	10m wide weir	9,570

### 7.2.2 Results

Flows were extracted from the existing and post-development TUFLOW model at the locations shown in **Figure 7-1** to assess the performance of the proposed basins at reducing post-development flows to pre-development levels across the Killarney Chain of Ponds catchment.

The results of the detention assessment for a range of storm events from the 50% to 1% AEP are shown in **Table 7-2**.



**Table 7-2 Pre and Post-Development Flow Comparison**

Location	Pre-Development Flow (m3/s)				Post-Development Flow (m3/s)			
	50% AEP	10% AEP	5% AEP	1% AEP	50% AEP	10% AEP	5% AEP	1% AEP
Basin A	1.20	2.55	4.35	9.70	1.22	3.39	5.69	9.03
Basin B	2.12	6.80	9.36	15.48	1.84	6.07	7.45	10.49
Basin D	0.75	1.85	2.62	3.85	0.62	1.27	1.47	2.45
Basin E	0.99	2.40	3.19	5.02	0.91	1.59	2.40	3.83

The results shown in **Table 7-2** suggest the proposed detention basins generally reduce post-development flows to pre-development levels for design storm events ranging from the 50% AEP to the 1% AEP. The exception to this is Basin A where the low flow diversion from Basin B results in higher flows immediately downstream for the 10% AEP, 10% AEP and 5% AEP events. Flood impact mapping indicates that this altered flow distribution does not produce a significant flood level increase at the confluence of the two Killarney Chain of Ponds tributaries.

### 7.3 Stream Erosion Index

The stream erosion index (SEI) is the ratio of post-development flow to pre-development flow above the ‘stream-forming flowrate’ and relates to the additional erosion that can be caused by increased runoff from developed catchments. This has been calculated as follows:

- The existing 50% AEP total flow at key site discharge locations was estimated using existing scenario XP-RAFTS model results from the *Flood Impact and Risk Assessment* (Rhelm, 2024).
- The critical flow was calculated at 25% of the 50% AEP flow.
- Results of the base case and post-development MUSIC models were interrogated to determine the average annual volume of runoff for events where flows exceed the critical flow.
- The ratio of resultant post-development annual volume was compared to the existing scenario to determine the SEI.

The stream erosion indices at key discharge locations are shown in **Table 7-3**.

**Table 7-3 Stream Erosion Index**

Location	SEI	Comment
Downstream Basin A/B	0.31	SEI meets the ‘ideal’ 1:1 ratio in the Growth Centres DCP 2010.
Downstream Basin D	2.29	SEI meets the maximum 3.5:1 ratio in the Growth Centres DCP 2010.
Downstream Basin E	2.19	SEI meets the maximum 3.5:1 ratio in the Growth Centres DCP 2010.
Downstream Basin F	1.80	SEI meets the maximum 3.5:1 ratio in the Growth Centres DCP 2010.
Downstream Basin G	1.03	SEI meets the maximum 3.5:1 ratio in the Growth Centres DCP 2010.

### 7.4 Water Balance Assessment

A water balance assessment has been undertaken using the post-development MUSIC model described in **Section 6.4** to determine the reliability of proposed stormwater harvesting measures at meeting predicted demands across varying climatic conditions. For this assessment, daily rainfall data from the Richmond – UWS Hawkesbury meteorological station (Station 067021) was analysed over a 123-year



period from 1900 to 2023. This meteorological data set was used in preference to the stations nominated in the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020) due to the close proximity to the site as well as the length of the data series and coverage of a wider variety of climatic conditions, including the millennium drought and 2022 floods.

Rainfall depths for wet (90<sup>th</sup> percentile), dry (10<sup>th</sup> percentile) and average (50<sup>th</sup> percentile) rainfall years were obtained from Bureau of Meteorology statistics for Station 067021 (**Table 7-4**), with results from representative years extracted from the timeseries for the purpose of the water balance assessment.

**Table 7-4 Wet, Dry and Average Year Rainfall Depths**

	Wet Year	Dry Year	Average Year
<b>Rainfall (mm)</b>	1076	527	796
<b>Representative Year</b>	1989	2006	1970

Results of the MUSIC water balance assessment for the two proposed stormwater harvesting ponds (Basins A and G) and combined rainwater tanks for the Basin A catchment are summarised in **Table 7-5**. This includes re-use demands and deficits for the representative wet, dry and average rainfall years.

**Table 7-5 Water Balance Results**

	Basin A			Basin G			Rainwater Tanks (Basin A)		
	Wet Year	Dry Year	Average Year	Wet Year	Dry Year	Average Year	Wet Year	Dry Year	Average Year
<b>Re-Use Requested (ML/yr)<sup>3</sup></b>	63.7	79.1	67.5	86.5	107.4	91.7	36.2	39.5	37.0
<b>Re-Use Supplied (ML/yr)</b>	63.7	71.2	64.4	85.3	87.4	87.5	29.7	23.4	28.4
<b>Deficit (ML/yr)</b>	0.0	7.9	3.1	1.2	20.0	4.2	6.5	16.1	8.6
<b>% Re-use Demand Met</b>	100	90.0	95.3	98.7	81.3	95.4	82.0	59.1	76.6

The results shown in **Table 7-5** suggest that the proposed stormwater harvesting basins will provide a reliable source of water for irrigation of public open space areas and the rainwater tanks will meet the majority of lot-scale re-use demands. The dry year results also suggest that the proposed harvesting measures will provide the majority of re-use demands under projected climate change conditions where annual rainfall totals are expected to decrease.

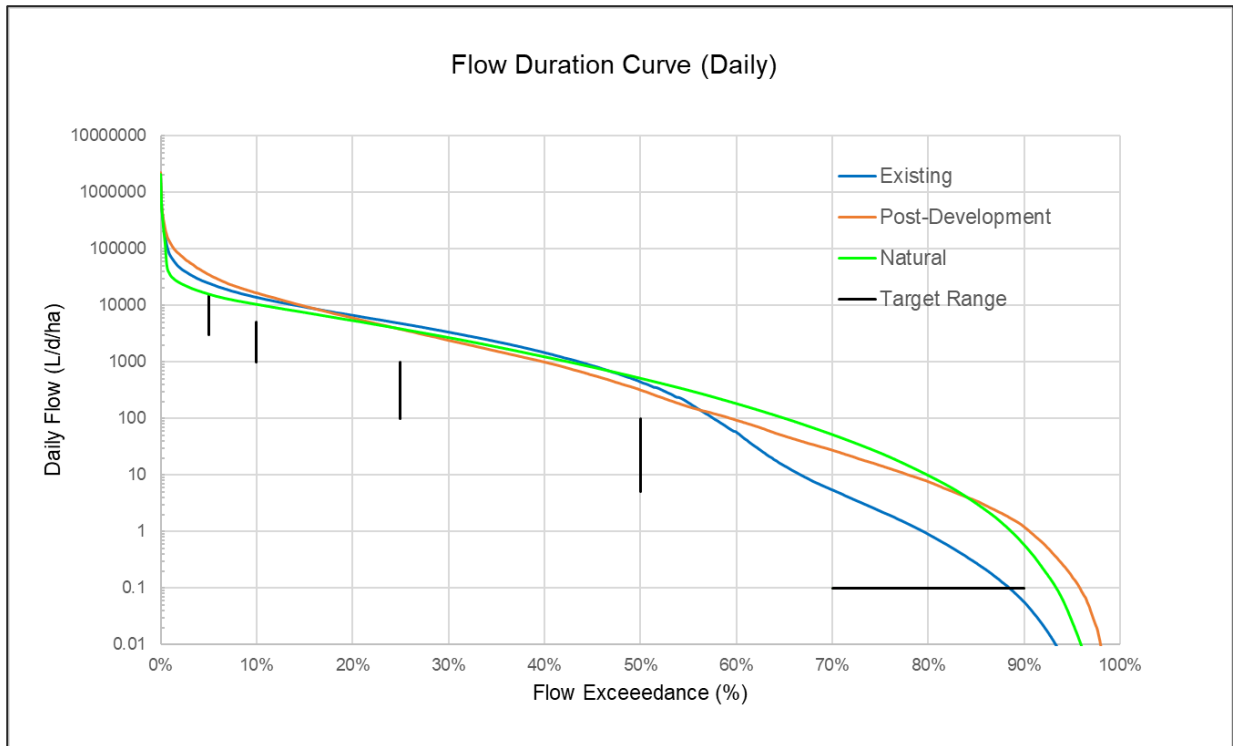
## 7.5 Flow Duration Assessment

Flow duration curves were generated for the existing and post-development MUSIC models using the same daily rainfall data as the water balance assessment (**Section 7.4**). Flow duration curves were also generated for a natural catchment of equivalent area but with zero imperviousness. **Figure 7-2** shows a

<sup>3</sup> The average external re-use rate is scaled based on daily PET – rainfall and thus varies based on the rainfall patterns of a particular year.



comparison of the generated curves with the flow duration targets from the Wianamatta-South Creek Guidelines (DPE, 2022).



**Figure 7-2 Flow Duration Curve Comparison**

**Figure 7-2** shows that the flow duration curve for the overall site discharge is above the range required in the Wianamatta-South Creek Guidelines (DPE, 2022), including the curve from the natural/undeveloped catchment scenario.

The flow duration curve of the developed site is similar that of the existing site and of a natural catchment with an equivalent area and is therefore considered to meet the hydrological objectives for the development.



## 8 Riparian Corridors

### 8.1 Riparian Corridor Objectives

The core objectives for riparian corridors are:

- Land should be set aside for the provision of riparian corridors and establish formal creeks where they are currently ill-defined.
- Corridors provide an opportunity to better control flood flows that currently extend beyond existing top of banks.
- Riparian corridors should perform a broad range of environmental functions including:
  - Water quality improvements – shading of creeks reduces water temperature, vegetation provides an additional filter for surface flows discharged to the watercourses
  - Wildlife corridor – a linkage for fauna to utilise.

### 8.2 Requirements under the Water Management Act (2000)

DCCEEW (formerly DPE-Water and prior to that the Natural Resource Access Regulator) is responsible for matters under the *Water Management Act, 2000* (WM Act) and associated regulation. The management of development on waterfront land (being that land within 40 m of the top of the highest bank of an identified waterway) is the subject of Part 3 of the WM Act.

In support of this Act, there are *Guidelines for Riparian Corridors* (DPE Water, 2018). These guidelines describe the use of the ‘Strahler’ system for stream ordering to identify the width of riparian corridor (referred to as vegetated riparian zone or VRZ) that is required to be associated with an identified waterway. Schedule 2 of the WM (General) Regulation (2018) indicates that Strahler stream ordering should be undertaken using the hydroline dataset, being an online geographical information system.

VRZ requirements are specified in Table 1 of DPE Water (2018) and reproduced in **Table 8-1**.

**Table 8-1 Recommended Riparian Corridor Widths (Source: DPE Water, 2018)**

Watercourse type	VRZ width (each side of watercourse)	Total RC width
<b>1st order</b>	10 metres	20 metres + channel width
<b>2nd order</b>	20 metres	40 metres + channel width
<b>3rd order</b>	30 metres	60 metres + channel width
<b>4th order and greater</b>	40 metres	80 metres + channel width

*Note: Where a watercourse does not exhibit the features of a defined channel with bed and banks, DPE Water may determine that the watercourse is not waterfront land for the purposes of the WM Act.*

### 8.3 Riparian Corridor Design

A waterway and riparian corridor concept design was prepared using general natural channel design principles with the intention to meet the objectives listed in **Section 8.1**.

A cross section of the concept developed is shown in **Figure 8-1**. **Figure 8-2** shows the extent of the proposed riparian corridors based on the Strahler stream order and noting that the northern mapped watercourse extending from the A J Bush and Sons site would be eligible for declassification based on a review of LiDAR topographical data.

The design cross section for waterways has the following key features:

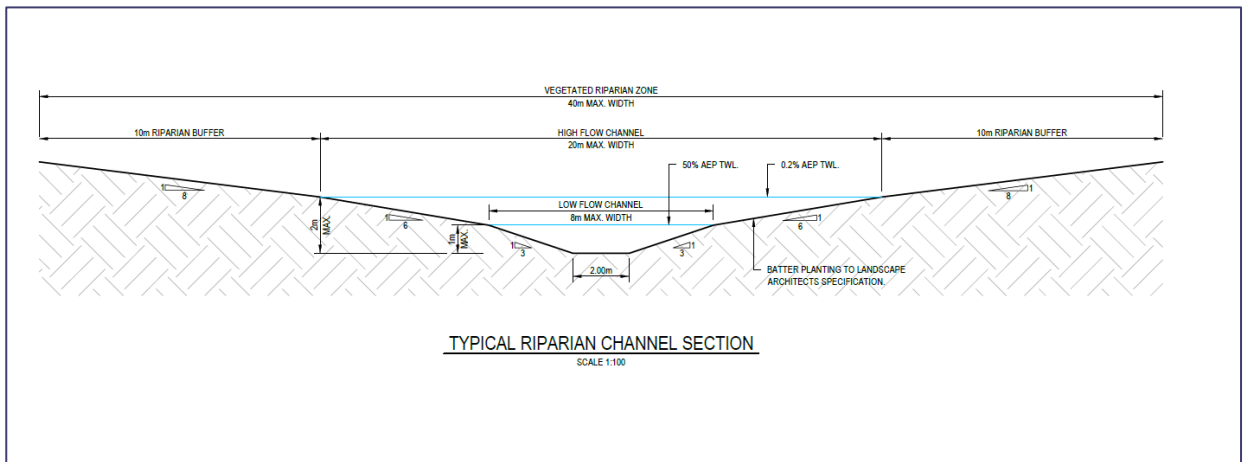
- Retention of existing watercourse bed levels where possible
- Low flow channel to convey 50% AEP flows – 1:3 bank slopes with a 2m bed width and 1m depth.



- High-flow channel component to convey flows up to the 0.2% AEP – 1:6 bank slopes.
- Freeboard component to assist in conveying PMF flows and provide 0.5m freeboard above 0.2% AEP flood levels – 1:8 bank slopes.

It has been assumed that the corridor would be vegetated with appropriate local plant species at a relatively dense planting scale to achieve biodiversity and flood hydraulics objectives.

Note that no corridor design or works are proposed for First Ponds Creek itself (for example as a half creek corridor) given the creek forms the Precinct north-western boundary. It has been assumed that this reach of the creek and its riparian area (being that portion located within the Precinct) would be the subject of a vegetation management plan.



**Figure 8-1 Concept Riparian Corridor Cross Section**



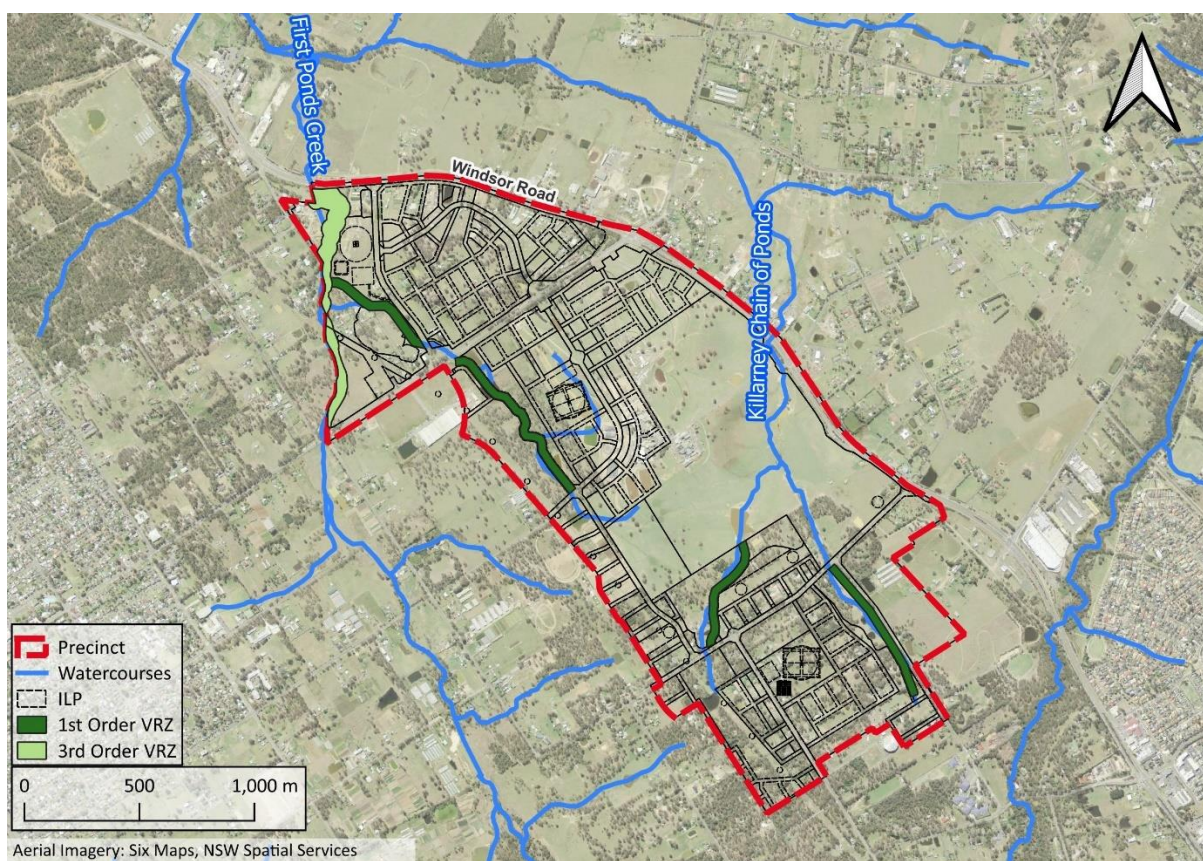


Figure 8-2 Proposed Riparian Corridors



## 9 Conclusion

A water cycle management strategy has been developed for the proposed re-zoning and development of per the Riverstone East Stage 3 Precinct.

Hydrologic, hydraulic and water quality modelling undertaken as part of the assessment revealed that stormwater quality, quantity and waterway health objectives can be achieved for the Precinct with the implementation of the following strategy:

- Provision of a suitably sized stormwater treatment train including lot scale and regional treatment measures to manage pollutant loading from the developed site. Additional on-lot treatment for medium and high-density residential zones would be required to achieve the pollutant reduction targets from the Wianamatta-South Creek Guidelines (DPE, 2022),
- Implementation of a stormwater harvesting system comprising lot scale rainwater tanks and regional harvesting ponds to reduce site discharge volumes and reliance on potable water,
- Provision of regional detention basins to limit post-development flows to pre-development levels for the Killarney Chain of Ponds catchments, and
- Establishment of defined riparian channels with appropriate planting to achieve both flood control and biodiversity functions.



## 10 References

Catchment Simulation Solutions (2021) *First Ponds Creek Flood Assessment*, Prepared for Blacktown City Council, Draft.

DPE (2022) *Technical guidance for achieving Wianamatta-South Creek stormwater management targets*, September 2022.

GHD (2008) *Alex Avenue and Riverstone Precincts – Water Sensitive Urban Design and Flooding Report*, Prepared for the Greater Cities Commission.

GHD (2010) *Alex Avenue and Riverstone Precincts – Post Exhibition Flooding and Water Cycle Management (incl. Climate Change impact on Flooding)*, Prepared for the Department of Planning and Environment.

Mott Macdonald (2015) *Water Cycle Management Report – Riverstone East*, Prepared for the Department of Planning.

Mott Macdonald (2016) *Water Cycle Management Report – Riverstone East*, Prepared for the Department of Planning.

Water NSW (2023) *Using MUSIC in Sydney Drinking Water Catchment – A Water NSW Current Recommended Best Practice*, February 2023.





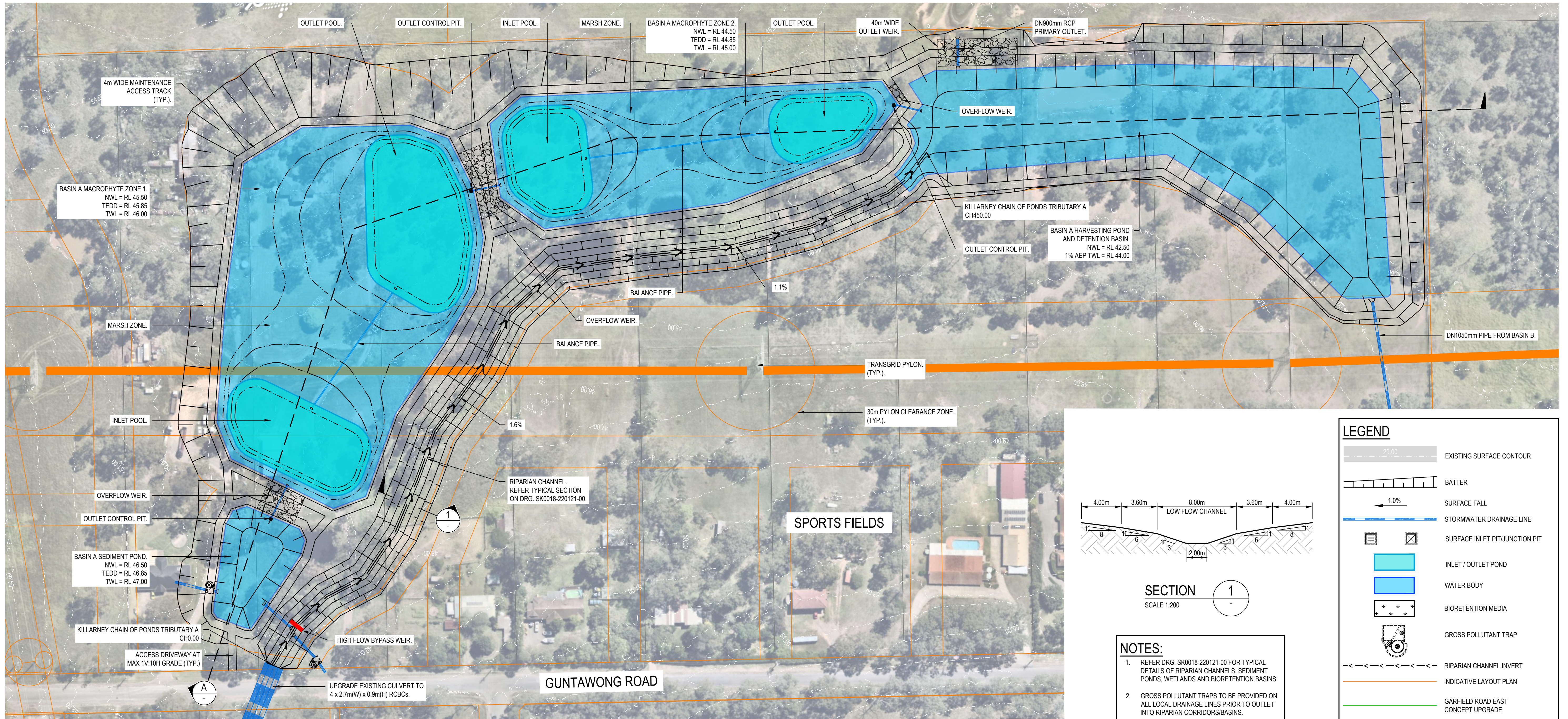
## Appendix A

Concept Water Cycle Management  
Drawings

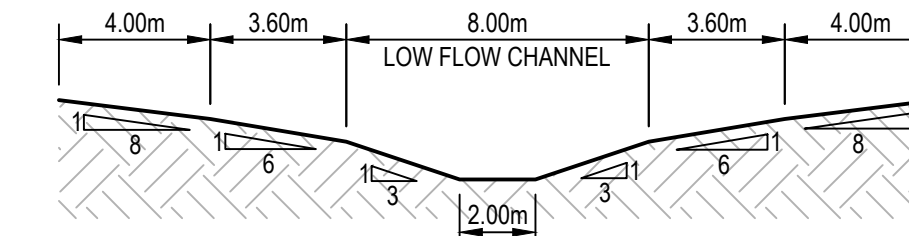








SITE PLAN  
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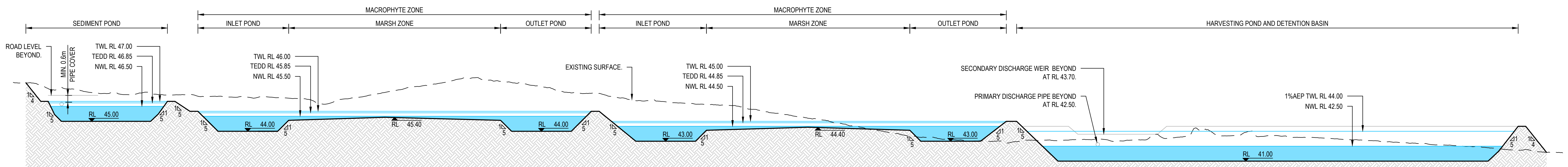
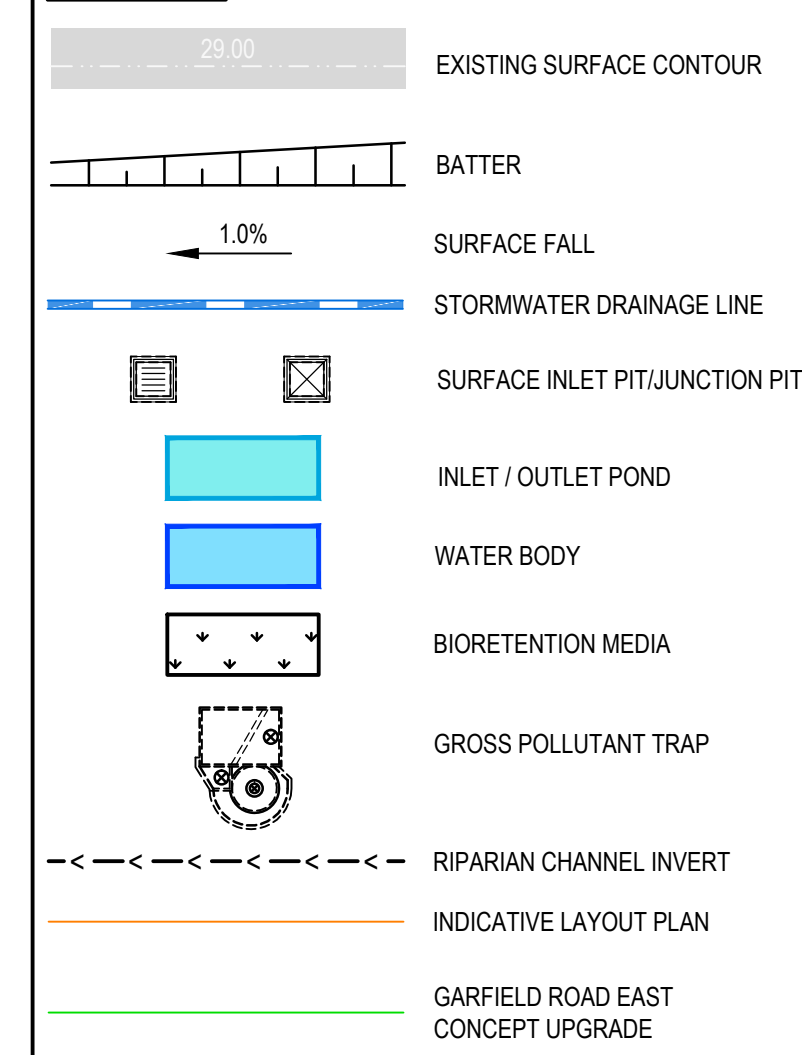


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NOTES:

1. REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
2. GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.

LEGEND



SECTION A  
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2	8/09/2023	ISSUED FOR INFORMATION	SHH	JPS	LCC	CEV
1	8/08/2023	ISSUED FOR COORDINATION	SHH	JPS	LCC	CEV

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Title	Project Number/Drawing Number	Revision
WATER CYCLE MANAGEMENT STRATEGY BASIN A & KILLARNEY CHAIN OF PONDS TRIBUTARY A	SK0011-220121-00	4

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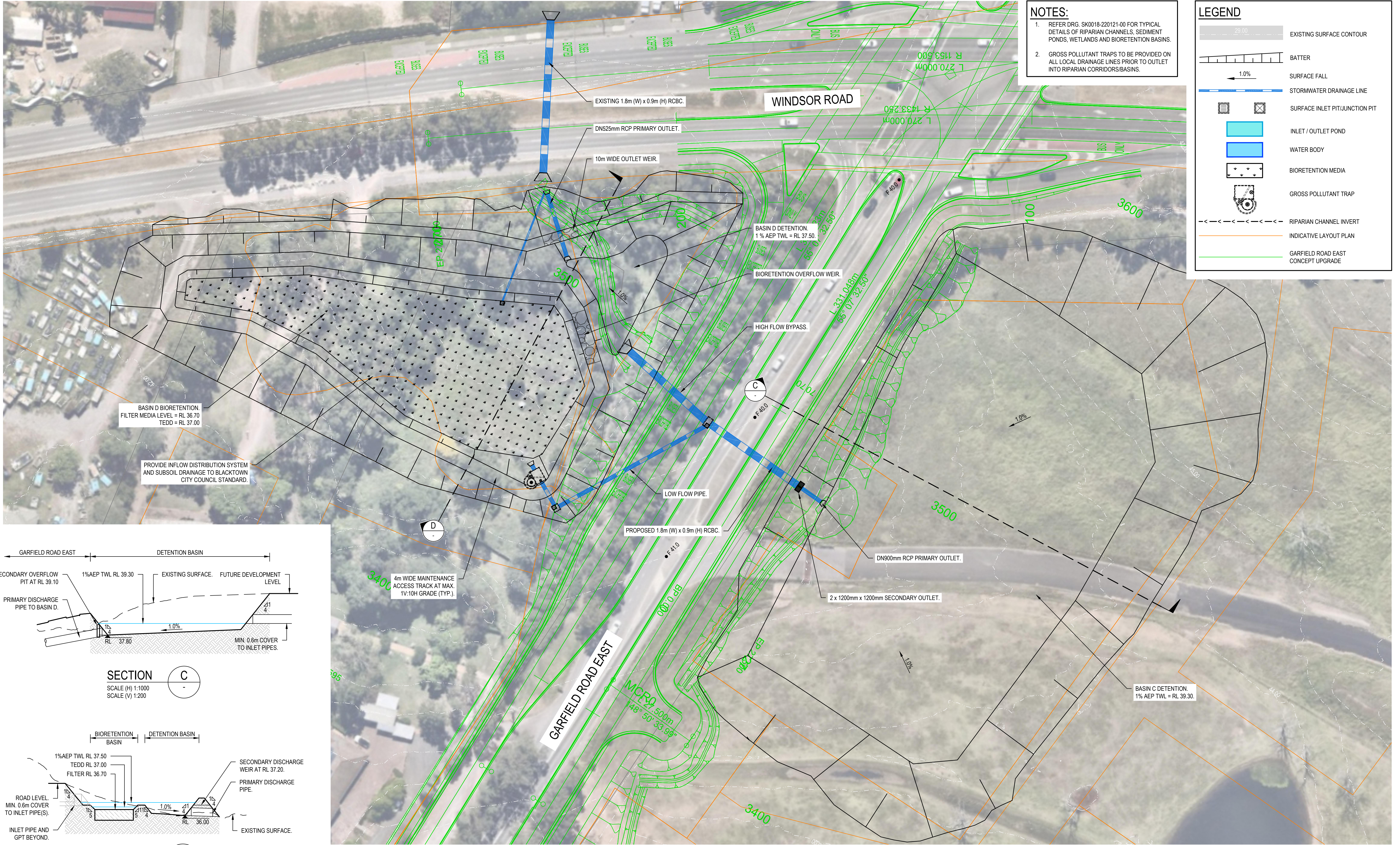
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DATE PLOTTED: 15 September 2023 3:04 PM BY: SHAWN HOYONG
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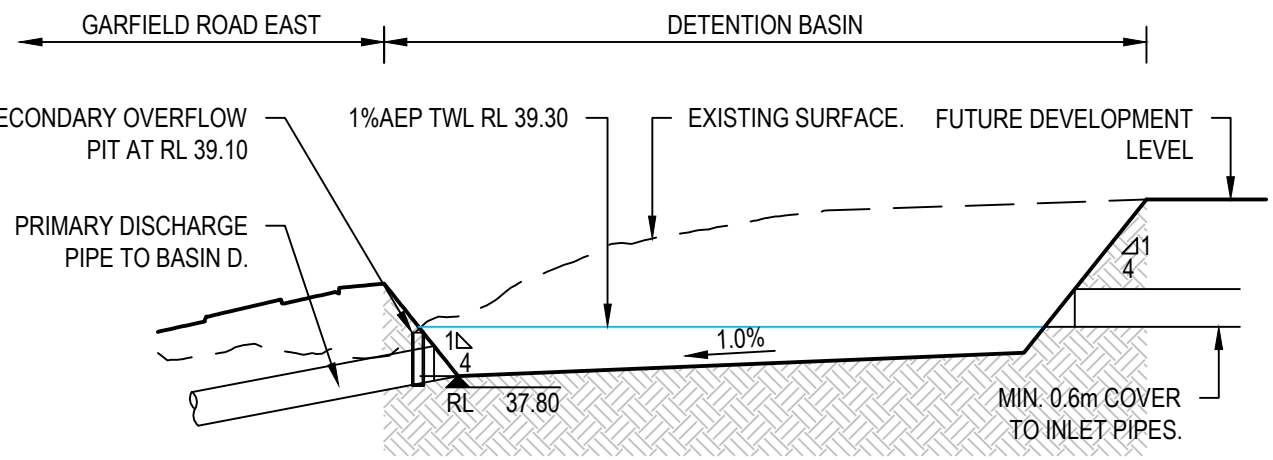




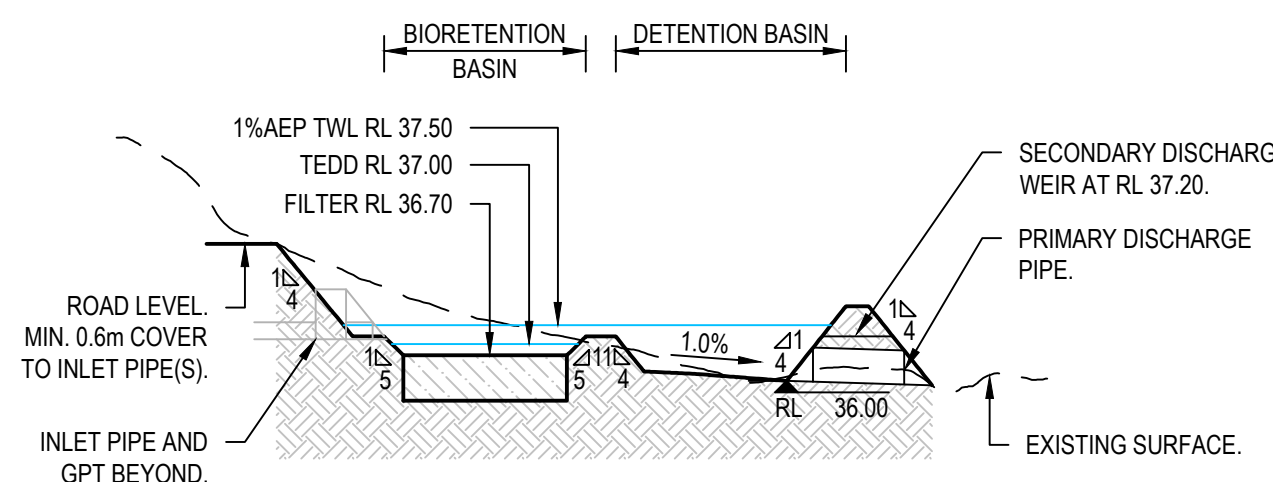
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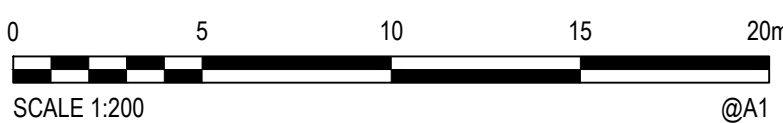
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- BATTER
- SURFACE FALL
- STORMWATER DRAINAGE LINE
- SURFACE INLET PIT/JUNCTION PIT
- INLET / OUTLET POND
- WATER BODY
- BIORETENTION MEDIA
- GROSS POLLUTANT TRAP
- RIPARIAN CHANNEL INVERT
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE



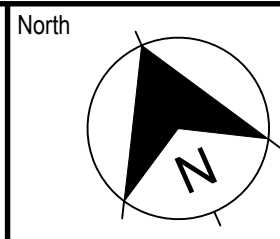
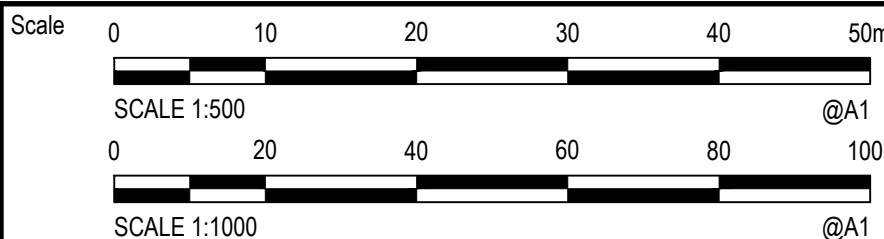
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SCALE (V) 1:200



**SECTION D**  
SCALE (H) 1:1000  
SCALE (V) 1:200



**SITE PLAN**  
SCALE 1:500



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Project  
**RIVERSTONE EAST STAGE 3**

Title  
**WATER CYCLE MANAGEMENT STRATEGY  
BASIN C AND BASIN D**

Scale  
**AS SHOWN**

Date  
**08/08/2023**

Size  
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Datum  
**MGA94**

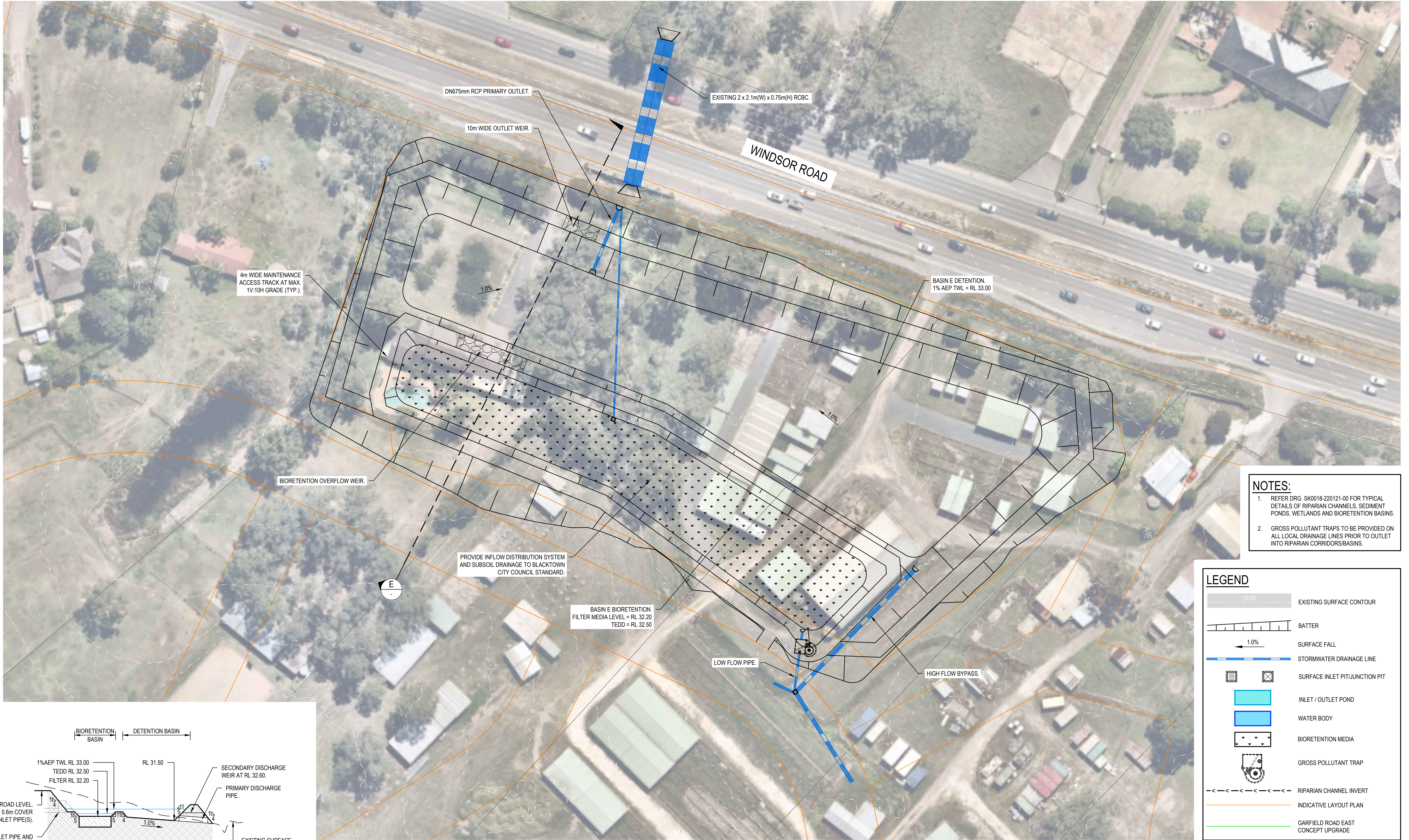
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Revision  
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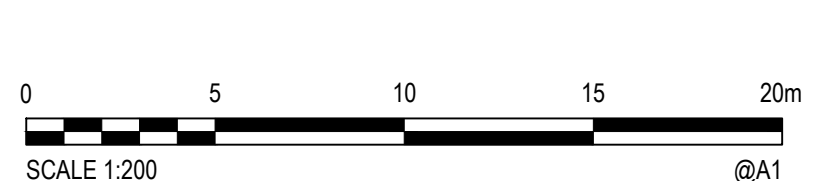
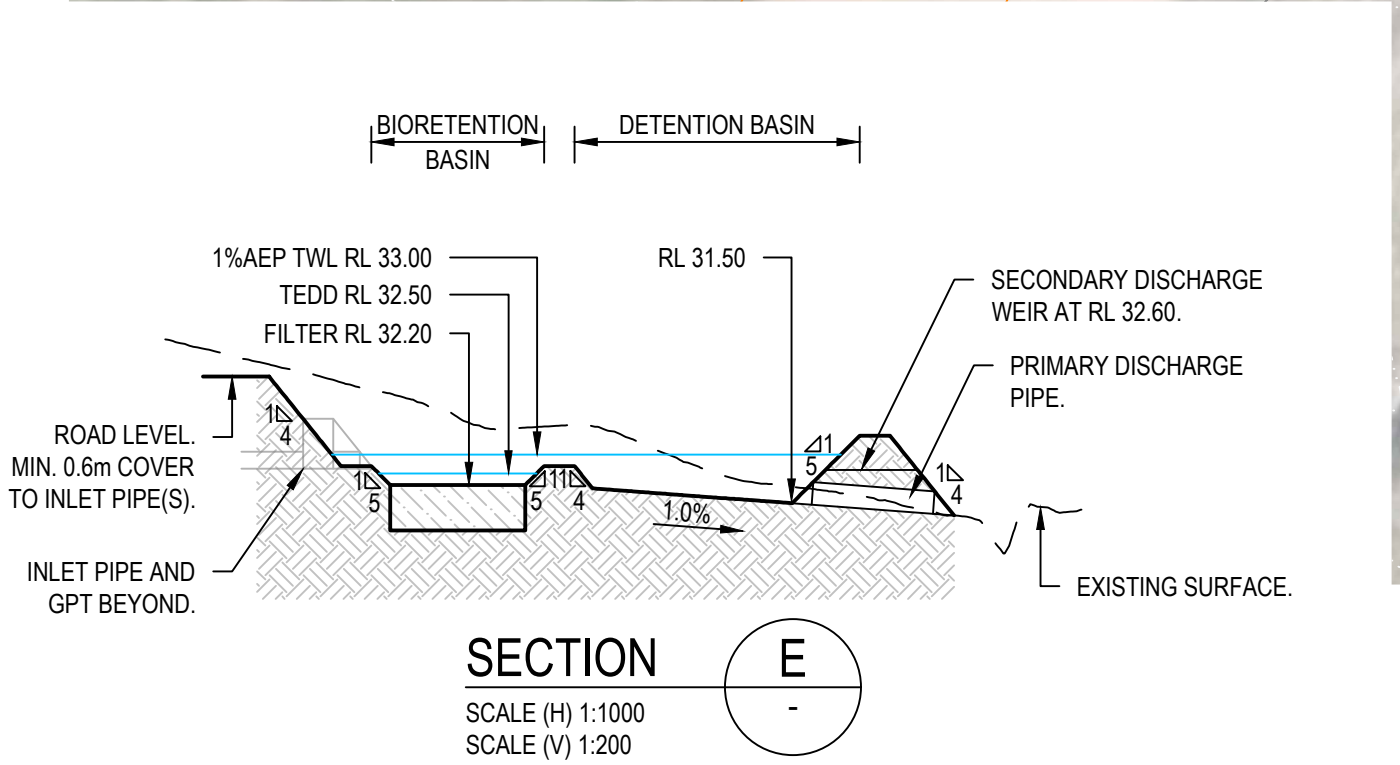




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  - GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.

**LEGEND**

- EXISTING SURFACE CONTOUR
- BATTER
- SURFACE FALL
- STORMWATER DRAINAGE LINE
- SURFACE INLET PIT/JUNCTION PIT
- INLET / OUTLET POND
- WATER BODY
- BIORETENTION MEDIA
- GROSS POLLUTANT TRAP
- RIPARIAN CHANNEL INVERT
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE



REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
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1	8/08/2023	ISSUED FOR COORDINATION	SHH			CEV

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Project RIVERSTONE EAST STAGE 3	Scale AS SHOWN Date 08/08/2023	Status <b>FOR INFORMATION ONLY</b> NOT TO BE USED FOR CONSTRUCTION
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Revision <b>4</b>
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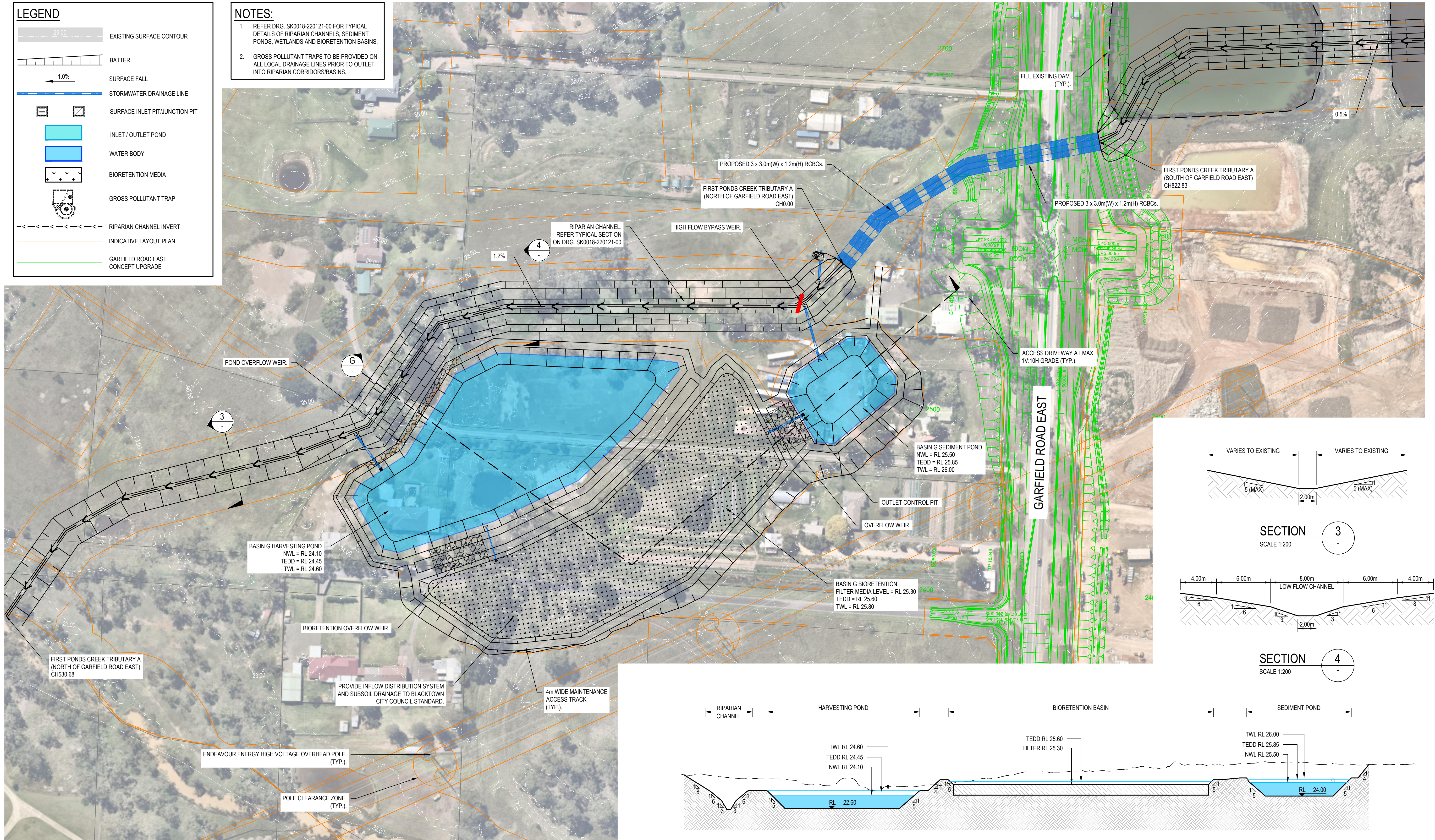


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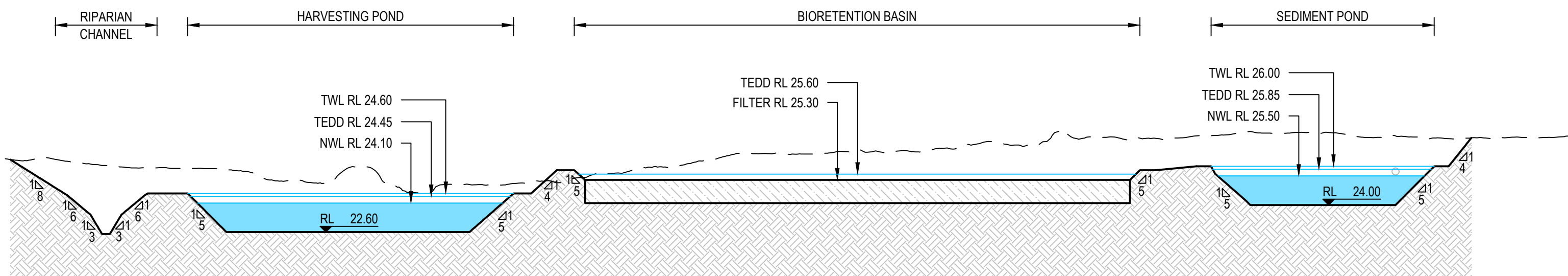
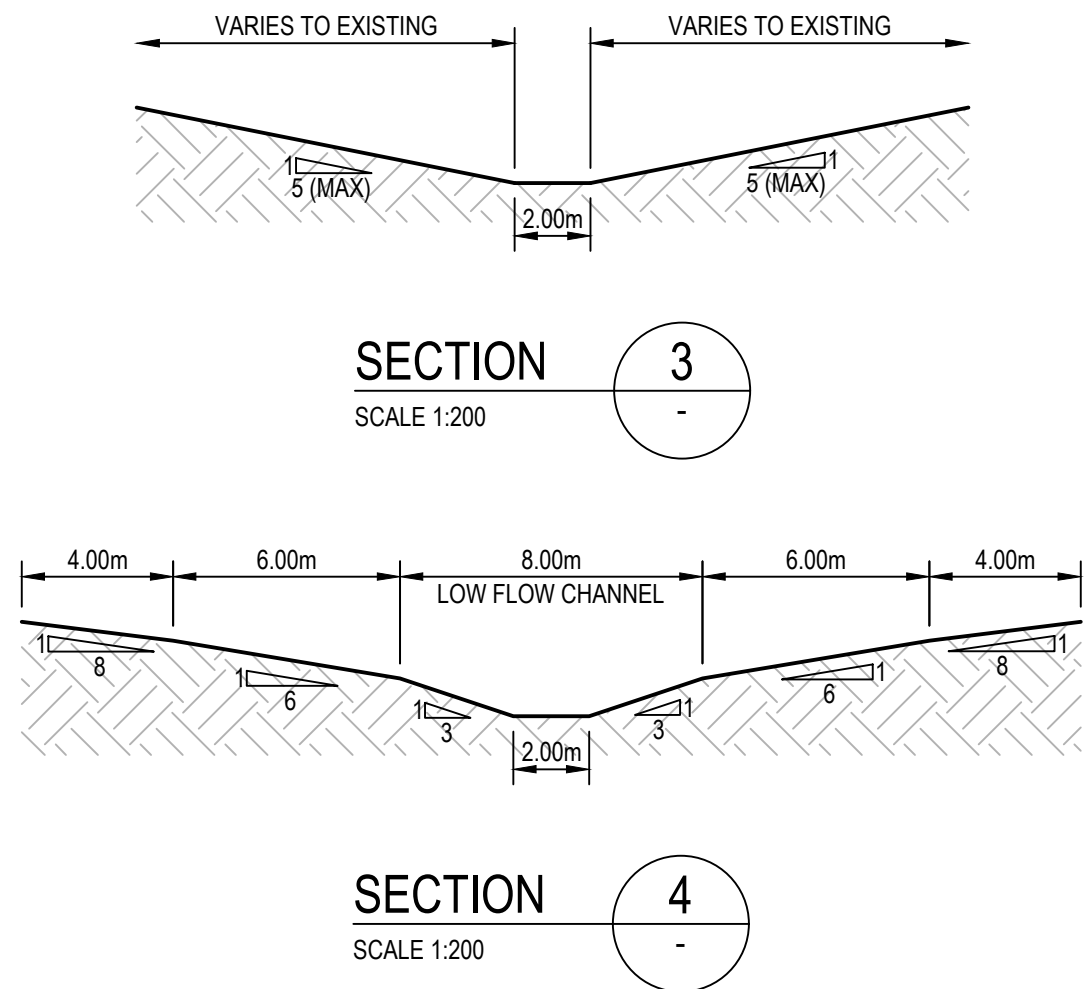
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- WATER BODY
- BIORETENTION MEDIA
- GROSS POLLUTANT TRAP
- RIPARIAN CHANNEL INVERT
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE

**NOTES:**

- REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
- GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.



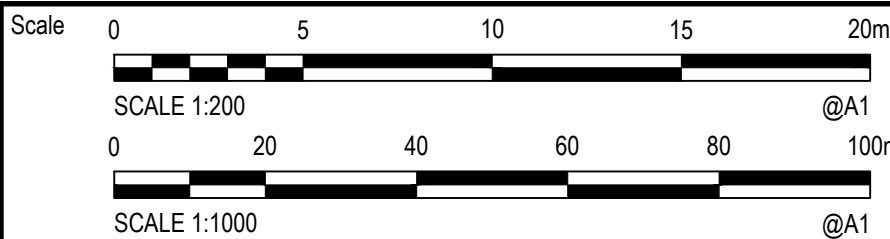
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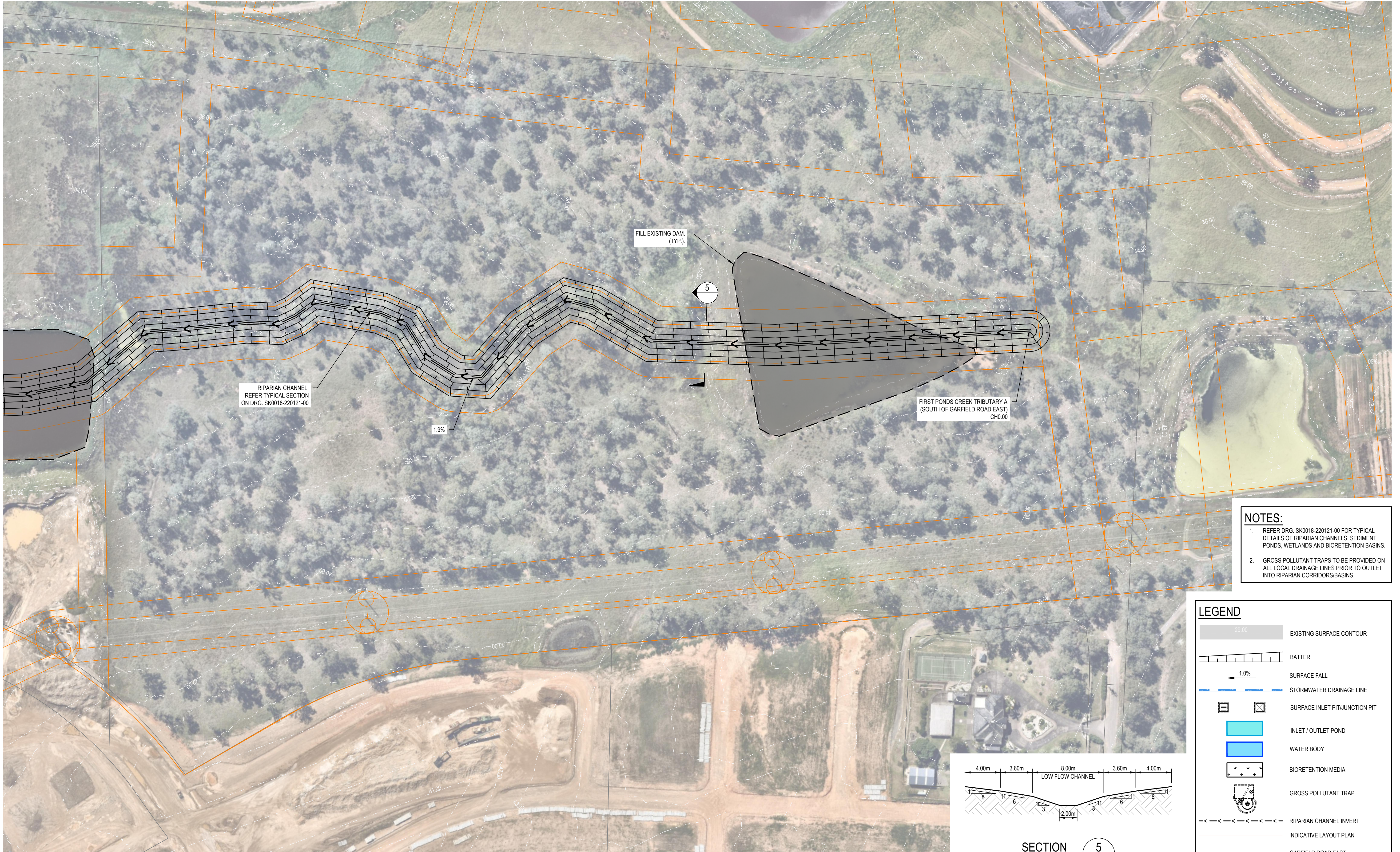
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Project  
RIVERSTONE EAST  
STAGE 3  
  
Title  
WATER CYCLE MANAGEMENT STRATEGY  
BASIN G & FIRST PONDS CREEK TRIBUTARY A  
SHEET 01

Scale  
AS SHOWN  
Date  
08/08/2023  
Size  
A1  
Datum  
MGA94

Status  
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Project Number/Drawing Number  
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Revision  
**4**

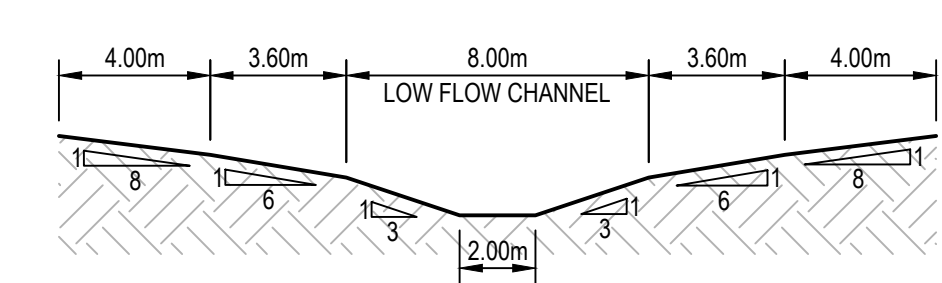




- NOTES:**
1. REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
  2. GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.

**LEGEND**

	EXISTING SURFACE CONTOUR
	BATTER
	SURFACE FALL
	STORMWATER DRAINAGE LINE
	SURFACE INLET PIT/JUNCTION PIT
	INLET / OUTLET POND
	WATER BODY
	BIORETENTION MEDIA
	GROSS POLLUTANT TRAP
	RIPARIAN CHANNEL INVERT
	INDICATIVE LAYOUT PLAN
	GARFIELD ROAD EAST CONCEPT UPGRADE



**SITE PLAN**  
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North	

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Project  
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STAGE 3  
  
Title  
WATER CYCLE MANAGEMENT STRATEGY  
BASIN G & FIRST PONDS CREEK TRIBUTARY A  
SHEET 02

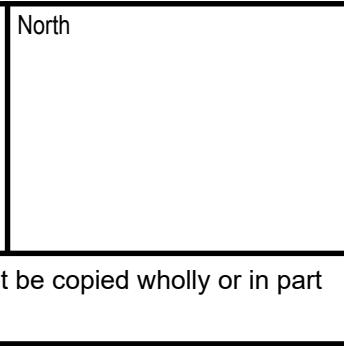
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Status  
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Project Number/Drawing Number  
**SK0017-220121-00**  
Revision  
**4**





Client	
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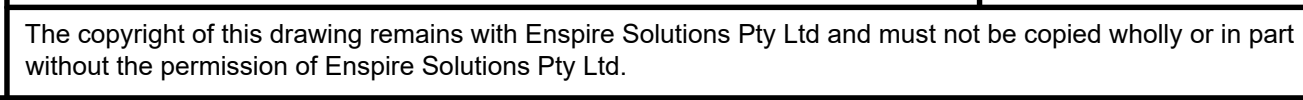
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Title	WATER CYCLE MANAGEMENT STRATEGY TYPICAL DETAILS

DATE PLOTTED: 15 September 2023 8:49 AM BY : SHAWN HOTONG





Client	
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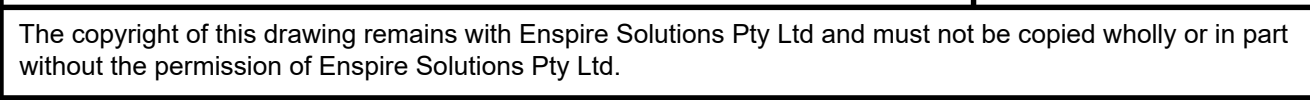








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## Appendix B

MUSIC-Link Report



## MUSIC-*link* Report

Project Details		Company Details
<b>Project:</b>	Riverstone East Stage 3 WCM	<b>Company:</b>
<b>Report Export Date:</b>	14/09/2023	<b>Contact:</b>
<b>Catchment Name:</b>	j1809_music_dev_08	<b>Address:</b>
<b>Catchment Area:</b>	436.783ha	<b>Phone:</b>
<b>Impervious Area*:</b>	53.49%	<b>Email:</b>
<b>Rainfall Station:</b>	67035 LIVERPOOL(WHITLAM	
<b>Modelling Time-step:</b>	6 Minutes	
<b>Modelling Period:</b>	1/01/1967 - 31/12/1976 11:54:00 PM	
<b>Mean Annual Rainfall:</b>	857mm	
<b>Evapotranspiration:</b>	1261mm	
<b>MUSIC Version:</b>	6.3.0	
<b>MUSIC-link data Version:</b>	6.34	
<b>Study Area:</b>	Blacktown	
<b>Scenario:</b>	Blacktown Development	

\* 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: Post-Development Node	Reduction	Node Type	Number	Node Type	Number
<b>Flow</b>	23.6%	Pond Node	8	Urban Source Node	82
<b>TSS</b>	86.5%	Rain Water Tank Node	10	Forest Source Node	10
<b>TP</b>	71.8%	Sedimentation Basin Node	3		
<b>TN</b>	54%	Bio Retention Node	4		
<b>GP</b>	99.2%	Swale Node	9		
		Generic Node	2		
		GPT Node	6		

### Comments

Refer to Section 6 of the Water Cycle Management Assessment (Rhelm, 2023) for commentary on deviations from BCC standard source and treatment node parameters



## Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	None	1.3
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	None	1.2
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	None	2
Bio	Bioretention	Hi-flow bypass rate (cum/sec)	None	None	3.6
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention	PET Scaling Factor	2.1	2.1	2.1
Forest	CA02-Drainage/Environmental	Area Impervious (ha)	None	None	0.088
Forest	CA02-Drainage/Environmental	Area Pervious (ha)	None	None	1.709
Forest	CA02-Drainage/Environmental	Total Area (ha)	None	None	1.798
Forest	CA05-Drainage/Environmental	Area Impervious (ha)	None	None	0.091
Forest	CA05-Drainage/Environmental	Area Pervious (ha)	None	None	1.924
Forest	CA05-Drainage/Environmental	Total Area (ha)	None	None	2.016
Forest	CA16-Drainage/Environmental	Area Impervious (ha)	None	None	0.249
Forest	CA16-Drainage/Environmental	Area Pervious (ha)	None	None	5.265
Forest	CA16-Drainage/Environmental	Total Area (ha)	None	None	5.515
Forest	CA16-Drainage/Environmental Bypass	Area Impervious (ha)	None	None	0.187
Forest	CA16-Drainage/Environmental Bypass	Area Pervious (ha)	None	None	3.954
Forest	CA16-Drainage/Environmental Bypass	Total Area (ha)	None	None	4.142
Forest	CA19-Drainage/Environmental	Area Impervious (ha)	None	None	0.176
Forest	CA19-Drainage/Environmental	Area Pervious (ha)	None	None	3.721
Forest	CA19-Drainage/Environmental	Total Area (ha)	None	None	3.898
Forest	CA19-Drainage/Environmental Bypass	Area Impervious (ha)	None	None	0.066
Forest	CA19-Drainage/Environmental Bypass	Area Pervious (ha)	None	None	1.399
Forest	CA19-Drainage/Environmental Bypass	Total Area (ha)	None	None	1.466
Forest	CF02B-Drainage/Environmental	Area Impervious (ha)	None	None	0.019
Forest	CF02B-Drainage/Environmental	Area Pervious (ha)	None	None	0.387
Forest	CF02B-Drainage/Environmental	Total Area (ha)	None	None	0.407
Forest	CF06-Drainage/Environmental	Area Impervious (ha)	None	None	0.223
Forest	CF06-Drainage/Environmental	Area Pervious (ha)	None	None	4.708
Forest	CF06-Drainage/Environmental	Total Area (ha)	None	None	4.932
Forest	CF07-Drainage/Environmental	Area Impervious (ha)	None	None	0.158
Forest	CF07-Drainage/Environmental	Area Pervious (ha)	None	None	3.086
Forest	CF07-Drainage/Environmental	Total Area (ha)	None	None	3.245
Forest	CF13-Drainage/Environmental	Area Impervious (ha)	None	None	0.059
Forest	CF13-Drainage/Environmental	Area Pervious (ha)	None	None	1.062
Forest	CF13-Drainage/Environmental	Total Area (ha)	None	None	1.122
GPT	CDS 3030	Hi-flow bypass rate (cum/sec)	None	None	2.3
GPT	CDS 3030	Hi-flow bypass rate (cum/sec)	None	None	2.5

Only certain parameters are reported when they pass validation



Node Type	Node Name	Parameter	Min	Max	Actual
GPT	CDS 3030	Hi-flow bypass rate (cum/sec)	None	None	3.6
GPT	CDS 3030	Hi-flow bypass rate (cum/sec)	None	None	1.2
GPT	CDS 3030	Hi-flow bypass rate (cum/sec)	None	None	2
GPT	CDS 3030	Hi-flow bypass rate (cum/sec)	None	None	1.3
Pond	CA07-Pond	% Reuse Demand Met	None	None	0
Pond	CA11-Pond	% Reuse Demand Met	None	None	0
Pond	CA16 Wetland	% Reuse Demand Met	None	None	0
Pond	CA18-Pond	% Reuse Demand Met	None	None	0
Pond	CA19 Wetland	% Reuse Demand Met	None	None	0
Pond	CF13-Pond	% Reuse Demand Met	None	None	0
Pond	Storage Pond	% Reuse Demand Met	None	None	92.872
Pond	Storage Pond	% Reuse Demand Met	None	None	90.85
Post	Post-Development Node	% Load Reduction	None	None	23.6
Post	Post-Development Node	GP % Load Reduction	90	None	99.2
Post	Post-Development Node	TN % Load Reduction	45	None	54
Post	Post-Development Node	TP % Load Reduction	65	None	71.8
Post	Post-Development Node	TSS % Load Reduction	85	None	86.5
Sedimentation	Blacktown Only Sedimentation Basin	Exfiltration Rate (mm/hr)	0	0	0
Sedimentation	Blacktown Only Sedimentation Basin	Exfiltration Rate (mm/hr)	0	0	0
Sedimentation	Blacktown Only Sedimentation Basin	Exfiltration Rate (mm/hr)	0	0	0
Sedimentation	Blacktown Only Sedimentation Basin	High Flow Bypass Out (ML/yr)	None	None	16.42
Sedimentation	Blacktown Only Sedimentation Basin	High Flow Bypass Out (ML/yr)	None	None	28.8717
Sedimentation	Blacktown Only Sedimentation Basin	High Flow Bypass Out (ML/yr)	None	None	22.70
Sedimentation	Blacktown Only Sedimentation Basin	Notional Detention Time (hrs)	None	None	4.67
Sedimentation	Blacktown Only Sedimentation Basin	Notional Detention Time (hrs)	None	None	5.71
Sedimentation	Blacktown Only Sedimentation Basin	Notional Detention Time (hrs)	None	None	6.92
Swale	Blacktown Only Swale 2020	Bed slope	0.005	0.01	0.005
Swale	Blacktown Only Swale 2020	Bed slope	0.005	0.01	0.005
Swale	Blacktown Only Swale 2020	Bed slope	0.005	0.01	0.005
Swale	Blacktown Only Swale 2020	Bed slope	0.005	0.01	0.005
Swale	Blacktown Only Swale 2020	Bed slope	0.005	0.01	0.005
Swale	Blacktown Only Swale 2020	Bed slope	0.005	0.01	0.005
Swale	Blacktown Only Swale 2020	Bed slope	0.005	0.01	0.005
Swale	Blacktown Only Swale 2020	Bed slope	0.005	0.01	0.005
Swale	Blacktown Only Swale 2020	Bed slope	0.005	0.01	0.005
Urban	CA02-Driveways	Area Impervious (ha)	None	None	1.6
Urban	CA02-Driveways	Area Pervious (ha)	None	None	0
Urban	CA02-Driveways	Total Area (ha)	None	None	1.6
Urban	CA02-Msc Impervious	Area Impervious (ha)	None	None	2.368
Urban	CA02-Msc Impervious	Area Pervious (ha)	None	None	0

Only certain parameters are reported when they pass validation



Node Type	Node Name	Parameter	Min	Max	Actual
Urban	CA02-Misc Impervious	Total Area (ha)	None	None	2.368
Urban	CA02-Misc Pervious	Area Impervious (ha)	None	None	0
Urban	CA02-Misc Pervious	Area Pervious (ha)	None	None	2.499
Urban	CA02-Misc Pervious	Total Area (ha)	None	None	2.499
Urban	CA02-New Roads	Area Impervious (ha)	None	None	7.263
Urban	CA02-New Roads	Area Pervious (ha)	None	None	0.404
Urban	CA02-New Roads	Total Area (ha)	None	None	7.668
Urban	CA02-Park/Sports Field	Area Impervious (ha)	None	None	0.530
Urban	CA02-Park/Sports Field	Area Pervious (ha)	None	None	2.126
Urban	CA02-Park/Sports Field	Total Area (ha)	None	None	2.657
Urban	CA02-Parks	Area Impervious (ha)	None	None	0.025
Urban	CA02-Parks	Area Pervious (ha)	None	None	0.503
Urban	CA02-Parks	Total Area (ha)	None	None	0.529
Urban	CA02-Resi_Roof	Area Impervious (ha)	None	None	9.209
Urban	CA02-Resi_Roof	Area Pervious (ha)	None	None	0
Urban	CA02-Resi_Roof	Total Area (ha)	None	None	9.209
Urban	CA02-Roads	Area Impervious (ha)	None	None	1.775
Urban	CA02-Roads	Area Pervious (ha)	None	None	0.324
Urban	CA02-Roads	Total Area (ha)	None	None	2.1
Urban	CA05-Driveways	Area Impervious (ha)	None	None	0.874
Urban	CA05-Driveways	Area Pervious (ha)	None	None	0
Urban	CA05-Driveways	Total Area (ha)	None	None	0.874
Urban	CA05-Misc Impervious	Area Impervious (ha)	None	None	1.311
Urban	CA05-Misc Impervious	Area Pervious (ha)	None	None	0
Urban	CA05-Misc Impervious	Total Area (ha)	None	None	1.311
Urban	CA05-Misc Pervious	Area Impervious (ha)	None	None	0
Urban	CA05-Misc Pervious	Area Pervious (ha)	None	None	1.311
Urban	CA05-Misc Pervious	Total Area (ha)	None	None	1.311
Urban	CA05-New Roads	Area Impervious (ha)	None	None	4.512
Urban	CA05-New Roads	Area Pervious (ha)	None	None	0.251
Urban	CA05-New Roads	Total Area (ha)	None	None	4.764
Urban	CA05-Park/Sports Field	Area Impervious (ha)	None	None	0.237
Urban	CA05-Park/Sports Field	Area Pervious (ha)	None	None	0.927
Urban	CA05-Park/Sports Field	Total Area (ha)	None	None	1.165
Urban	CA05-Parks	Area Impervious (ha)	None	None	0.163
Urban	CA05-Parks	Area Pervious (ha)	None	None	3.174
Urban	CA05-Parks	Total Area (ha)	None	None	3.338
Urban	CA05-Roads	Area Impervious (ha)	None	None	3.944
Urban	CA05-Roads	Area Pervious (ha)	None	None	0.720
Urban	CA05-Roads	Total Area (ha)	None	None	4.665

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	CA05-Roof	Area Impervious (ha)	None	None	5.245
Urban	CA05-Roof	Area Pervious (ha)	None	None	0
Urban	CA05-Roof	Total Area (ha)	None	None	5.245
Urban	CA07- Roads	Area Impervious (ha)	None	None	5.059
Urban	CA07- Roads	Area Pervious (ha)	None	None	0.924
Urban	CA07- Roads	Total Area (ha)	None	None	5.984
Urban	CA07-Parks	Area Impervious (ha)	None	None	3.667
Urban	CA07-Parks	Area Pervious (ha)	None	None	71.19
Urban	CA07-Parks	Total Area (ha)	None	None	74.86
Urban	CA11-Business park	Area Impervious (ha)	None	None	1.037
Urban	CA11-Business park	Area Pervious (ha)	None	None	0.115
Urban	CA11-Business park	Total Area (ha)	None	None	1.153
Urban	CA11-Parks	Area Impervious (ha)	None	None	0.293
Urban	CA11-Parks	Area Pervious (ha)	None	None	5.694
Urban	CA11-Parks	Total Area (ha)	None	None	5.988
Urban	CA11-Residential	Area Impervious (ha)	None	None	20.49
Urban	CA11-Residential	Area Pervious (ha)	None	None	3.567
Urban	CA11-Residential	Total Area (ha)	None	None	24.06
Urban	CA11-Roads	Area Impervious (ha)	None	None	2.476
Urban	CA11-Roads	Area Pervious (ha)	None	None	0.452
Urban	CA11-Roads	Total Area (ha)	None	None	2.929
Urban	CA16- Residential	Area Impervious (ha)	None	None	5.628
Urban	CA16- Residential	Area Pervious (ha)	None	None	0.979
Urban	CA16- Residential	Total Area (ha)	None	None	6.608
Urban	CA16-Driveways	Area Impervious (ha)	None	None	2.156
Urban	CA16-Driveways	Area Pervious (ha)	None	None	0
Urban	CA16-Driveways	Total Area (ha)	None	None	2.156
Urban	CA16-Msc Impervious	Area Impervious (ha)	None	None	3.02
Urban	CA16-Msc Impervious	Area Pervious (ha)	None	None	0
Urban	CA16-Msc Impervious	Total Area (ha)	None	None	3.02
Urban	CA16-Msc Pervious	Area Impervious (ha)	None	None	0
Urban	CA16-Msc Pervious	Area Pervious (ha)	None	None	4.733
Urban	CA16-Msc Pervious	Total Area (ha)	None	None	4.733
Urban	CA16-New Roads	Area Impervious (ha)	None	None	8.036
Urban	CA16-New Roads	Area Pervious (ha)	None	None	0.447
Urban	CA16-New Roads	Total Area (ha)	None	None	8.484
Urban	CA16-Park/Sports Field	Area Impervious (ha)	None	None	2.844
Urban	CA16-Park/Sports Field	Area Pervious (ha)	None	None	11.39
Urban	CA16-Park/Sports Field	Total Area (ha)	None	None	14.243
Urban	CA16-Park/Sports Field Bypass	Area Impervious (ha)	None	None	0.816

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	CA16-Park/Sports Field Bypass	Area Pervious (ha)	None	None	3.271
Urban	CA16-Park/Sports Field Bypass	Total Area (ha)	None	None	4.088
Urban	CA16-Parks	Area Impervious (ha)	None	None	0.040
Urban	CA16-Parks	Area Pervious (ha)	None	None	0.778
Urban	CA16-Parks	Total Area (ha)	None	None	0.819
Urban	CA16-Resi Roof	Area Impervious (ha)	None	None	10.36
Urban	CA16-Resi Roof	Area Pervious (ha)	None	None	0
Urban	CA16-Resi Roof	Total Area (ha)	None	None	10.36
Urban	CA16-Roads	Area Impervious (ha)	None	None	2.117
Urban	CA16-Roads	Area Pervious (ha)	None	None	0.387
Urban	CA16-Roads	Total Area (ha)	None	None	2.505
Urban	CA16-School Roof	Area Impervious (ha)	None	None	1.285
Urban	CA16-School Roof	Area Pervious (ha)	None	None	0
Urban	CA16-School Roof	Total Area (ha)	None	None	1.285
Urban	CA18-Parks	Area Impervious (ha)	None	None	0.576
Urban	CA18-Parks	Area Pervious (ha)	None	None	11.19
Urban	CA18-Parks	Total Area (ha)	None	None	11.769
Urban	CA18-Roads	Area Impervious (ha)	None	None	0.442
Urban	CA18-Roads	Area Pervious (ha)	None	None	0.080
Urban	CA18-Roads	Total Area (ha)	None	None	0.523
Urban	CA19- Resi Roof	Area Impervious (ha)	None	None	7.59
Urban	CA19- Resi Roof	Area Pervious (ha)	None	None	0
Urban	CA19- Resi Roof	Total Area (ha)	None	None	7.59
Urban	CA19-Driveways	Area Impervious (ha)	None	None	1.37
Urban	CA19-Driveways	Area Pervious (ha)	None	None	0
Urban	CA19-Driveways	Total Area (ha)	None	None	1.37
Urban	CA19-Industrial	Area Impervious (ha)	None	None	2.017
Urban	CA19-Industrial	Area Pervious (ha)	None	None	0.225
Urban	CA19-Industrial	Total Area (ha)	None	None	2.243
Urban	CA19-Msc Impervious	Area Impervious (ha)	None	None	2.003
Urban	CA19-Msc Impervious	Area Pervious (ha)	None	None	0
Urban	CA19-Msc Impervious	Total Area (ha)	None	None	2.003
Urban	CA19-Msc Pervious	Area Impervious (ha)	None	None	0
Urban	CA19-Msc Pervious	Area Pervious (ha)	None	None	2.425
Urban	CA19-Msc Pervious	Total Area (ha)	None	None	2.425
Urban	CA19-New Roads	Area Impervious (ha)	None	None	6.671
Urban	CA19-New Roads	Area Pervious (ha)	None	None	0.371
Urban	CA19-New Roads	Total Area (ha)	None	None	7.043
Urban	CA19-Park/Sports Field	Area Impervious (ha)	None	None	1.971
Urban	CA19-Park/Sports Field	Area Pervious (ha)	None	None	7.716

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	CA19-Park/Sports Field	Total Area (ha)	None	None	9.688
Urban	CA19-Parks	Area Impervious (ha)	None	None	0.512
Urban	CA19-Parks	Area Pervious (ha)	None	None	9.953
Urban	CA19-Parks	Total Area (ha)	None	None	10.466
Urban	CA19-Residential	Area Impervious (ha)	None	None	0.157
Urban	CA19-Residential	Area Pervious (ha)	None	None	0.027
Urban	CA19-Residential	Total Area (ha)	None	None	0.185
Urban	CA19-Roads	Area Impervious (ha)	None	None	1.790
Urban	CA19-Roads	Area Pervious (ha)	None	None	0.327
Urban	CA19-Roads	Total Area (ha)	None	None	2.118
Urban	CA19-School Roof	Area Impervious (ha)	None	None	0.316
Urban	CA19-School Roof	Area Pervious (ha)	None	None	0
Urban	CA19-School Roof	Total Area (ha)	None	None	0.316
Urban	CF02_A-Driveways	Area Impervious (ha)	None	None	0.811
Urban	CF02_A-Driveways	Area Pervious (ha)	None	None	0
Urban	CF02_A-Driveways	Total Area (ha)	None	None	0.811
Urban	CF02_A-Misc Impervious	Area Impervious (ha)	None	None	1.217
Urban	CF02_A-Misc Impervious	Area Pervious (ha)	None	None	0
Urban	CF02_A-Misc Impervious	Total Area (ha)	None	None	1.217
Urban	CF02_A-Misc Pervious	Area Impervious (ha)	None	None	0
Urban	CF02_A-Misc Pervious	Area Pervious (ha)	None	None	1.217
Urban	CF02_A-Misc Pervious	Total Area (ha)	None	None	1.217
Urban	CF02_A-New Roads	Area Impervious (ha)	None	None	5.445
Urban	CF02_A-New Roads	Area Pervious (ha)	None	None	0.303
Urban	CF02_A-New Roads	Total Area (ha)	None	None	5.749
Urban	CF02_A-Park/Sports Field	Area Impervious (ha)	None	None	0.580
Urban	CF02_A-Park/Sports Field	Area Pervious (ha)	None	None	2.381
Urban	CF02_A-Park/Sports Field	Total Area (ha)	None	None	2.962
Urban	CF02_A-Roads	Area Impervious (ha)	None	None	0.656
Urban	CF02_A-Roads	Area Pervious (ha)	None	None	0.119
Urban	CF02_A-Roads	Total Area (ha)	None	None	0.776
Urban	CF02_A-Roof	Area Impervious (ha)	None	None	4.867
Urban	CF02_A-Roof	Area Pervious (ha)	None	None	0
Urban	CF02_A-Roof	Total Area (ha)	None	None	4.867
Urban	CF02_B-Park/Sports Field	Area Impervious (ha)	None	None	1.076
Urban	CF02_B-Park/Sports Field	Area Pervious (ha)	None	None	4.414
Urban	CF02_B-Park/Sports Field	Total Area (ha)	None	None	5.491
Urban	CF02_B-Roads	Area Impervious (ha)	None	None	0.447
Urban	CF02_B-Roads	Area Pervious (ha)	None	None	0.081
Urban	CF02_B-Roads	Total Area (ha)	None	None	0.529

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	CF02_B-Rural	Area Impervious (ha)	None	None	0.206
Urban	CF02_B-Rural	Area Pervious (ha)	None	None	3.797
Urban	CF02_B-Rural	Total Area (ha)	None	None	4.004
Urban	CF06-Driveways	Area Impervious (ha)	None	None	0.591
Urban	CF06-Driveways	Area Pervious (ha)	None	None	0
Urban	CF06-Driveways	Total Area (ha)	None	None	0.591
Urban	CF06-Misc Impervious	Area Impervious (ha)	None	None	0.887
Urban	CF06-Misc Impervious	Area Pervious (ha)	None	None	0
Urban	CF06-Misc Impervious	Total Area (ha)	None	None	0.887
Urban	CF06-Misc Pervious	Area Impervious (ha)	None	None	0
Urban	CF06-Misc Pervious	Area Pervious (ha)	None	None	0.887
Urban	CF06-Misc Pervious	Total Area (ha)	None	None	0.887
Urban	CF06-New Roads	Area Impervious (ha)	None	None	3.954
Urban	CF06-New Roads	Area Pervious (ha)	None	None	0.220
Urban	CF06-New Roads	Total Area (ha)	None	None	4.175
Urban	CF06-Park/Sports Field	Area Impervious (ha)	None	None	0.342
Urban	CF06-Park/Sports Field	Area Pervious (ha)	None	None	1.374
Urban	CF06-Park/Sports Field	Total Area (ha)	None	None	1.717
Urban	CF06-Roads	Area Impervious (ha)	None	None	0.621
Urban	CF06-Roads	Area Pervious (ha)	None	None	0.113
Urban	CF06-Roads	Total Area (ha)	None	None	0.735
Urban	CF06-Roof	Area Impervious (ha)	None	None	3.548
Urban	CF06-Roof	Area Pervious (ha)	None	None	0
Urban	CF06-Roof	Total Area (ha)	None	None	3.548
Urban	CF06-Rural	Area Impervious (ha)	None	None	0.033
Urban	CF06-Rural	Area Pervious (ha)	None	None	0.613
Urban	CF06-Rural	Total Area (ha)	None	None	0.647
Urban	CF07- Roads	Area Impervious (ha)	None	None	2.755
Urban	CF07- Roads	Area Pervious (ha)	None	None	0.503
Urban	CF07- Roads	Total Area (ha)	None	None	3.259
Urban	CF07-Driveways	Area Impervious (ha)	None	None	2.28
Urban	CF07-Driveways	Area Pervious (ha)	None	None	0
Urban	CF07-Driveways	Total Area (ha)	None	None	2.28
Urban	CF07-Misc Impervious	Area Impervious (ha)	None	None	3.287
Urban	CF07-Misc Impervious	Area Pervious (ha)	None	None	0
Urban	CF07-Misc Impervious	Total Area (ha)	None	None	3.287
Urban	CF07-Misc Pervious	Area Impervious (ha)	None	None	0
Urban	CF07-Misc Pervious	Area Pervious (ha)	None	None	4.484
Urban	CF07-Misc Pervious	Total Area (ha)	None	None	4.484
Urban	CF07-New Road	Area Impervious (ha)	None	None	10.98

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	CF07-New Road	Area Pervious (ha)	None	None	0.612
Urban	CF07-New Road	Total Area (ha)	None	None	11.601
Urban	CF07-Park/Sports Field	Area Impervious (ha)	None	None	4.806
Urban	CF07-Park/Sports Field	Area Pervious (ha)	None	None	19.25
Urban	CF07-Park/Sports Field	Total Area (ha)	None	None	24.06
Urban	CF07-Parks	Area Impervious (ha)	None	None	0.031
Urban	CF07-Parks	Area Pervious (ha)	None	None	0.619
Urban	CF07-Parks	Total Area (ha)	None	None	0.651
Urban	CF07-Resi Roof	Area Impervious (ha)	None	None	12.081
Urban	CF07-Resi Roof	Area Pervious (ha)	None	None	0
Urban	CF07-Resi Roof	Total Area (ha)	None	None	12.081
Urban	CF07-Residential	Area Impervious (ha)	None	None	7.470
Urban	CF07-Residential	Area Pervious (ha)	None	None	1.300
Urban	CF07-Residential	Total Area (ha)	None	None	8.771
Urban	CF07-School Roof	Area Impervious (ha)	None	None	0.996
Urban	CF07-School Roof	Area Pervious (ha)	None	None	0
Urban	CF07-School Roof	Total Area (ha)	None	None	0.996
Urban	CF13- Roads	Area Impervious (ha)	None	None	0.016
Urban	CF13- Roads	Area Pervious (ha)	None	None	0.002
Urban	CF13- Roads	Total Area (ha)	None	None	0.019
Urban	CF13-New Roads	Area Impervious (ha)	None	None	0.036
Urban	CF13-New Roads	Area Pervious (ha)	None	None	0.002
Urban	CF13-New Roads	Total Area (ha)	None	None	0.039
Urban	CF13-Park/Sports Field	Area Impervious (ha)	None	None	0.002
Urban	CF13-Park/Sports Field	Area Pervious (ha)	None	None	0.009
Urban	CF13-Park/Sports Field	Total Area (ha)	None	None	0.012
Urban	CF13-Rural	Area Impervious (ha)	None	None	0.346
Urban	CF13-Rural	Area Pervious (ha)	None	None	6.372
Urban	CF13-Rural	Total Area (ha)	None	None	6.719
Urban	CF17- Roads	Area Impervious (ha)	None	None	1.242
Urban	CF17- Roads	Area Pervious (ha)	None	None	0.226
Urban	CF17- Roads	Total Area (ha)	None	None	1.469
Urban	CF17-New Roads	Area Impervious (ha)	None	None	0.244
Urban	CF17-New Roads	Area Pervious (ha)	None	None	0.013
Urban	CF17-New Roads	Total Area (ha)	None	None	0.258
Urban	CF17-Residential	Area Impervious (ha)	None	None	1.906
Urban	CF17-Residential	Area Pervious (ha)	None	None	0.331
Urban	CF17-Residential	Total Area (ha)	None	None	2.238
Urban	CF17-Rural	Area Impervious (ha)	None	None	0.148
Urban	CF17-Rural	Area Pervious (ha)	None	None	2.730

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	CF17-Rural	Total Area (ha)	None	None	2.879

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### Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Forest	CA02-Drainage/Environmental	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CA02-Drainage/Environmental	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CA02-Drainage/Environmental	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52
Forest	CA02-Drainage/Environmental	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13
Forest	CA02-Drainage/Environmental	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	0.78
Forest	CA02-Drainage/Environmental	Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.17	0.17	0.13
Forest	CA02-Drainage/Environmental	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.34	-0.05
Forest	CA02-Drainage/Environmental	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CA02-Drainage/Environmental	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CA02-Drainage/Environmental	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CA02-Drainage/Environmental	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Forest	CA05-Drainage/Environmental	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CA05-Drainage/Environmental	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CA05-Drainage/Environmental	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52
Forest	CA05-Drainage/Environmental	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13
Forest	CA05-Drainage/Environmental	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	0.78
Forest	CA05-Drainage/Environmental	Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.17	0.17	0.13
Forest	CA05-Drainage/Environmental	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.34	-0.05
Forest	CA05-Drainage/Environmental	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CA05-Drainage/Environmental	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CA05-Drainage/Environmental	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CA05-Drainage/Environmental	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Forest	CA16-Drainage/Environmental	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CA16-Drainage/Environmental	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CA16-Drainage/Environmental	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52
Forest	CA16-Drainage/Environmental	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13
Forest	CA16-Drainage/Environmental	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	0.78
Forest	CA16-Drainage/Environmental	Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.17	0.17	0.13
Forest	CA16-Drainage/Environmental	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.34	-0.05
Forest	CA16-Drainage/Environmental	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CA16-Drainage/Environmental	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CA16-Drainage/Environmental	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CA16-Drainage/Environmental	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Forest	CA16-Drainage/Environmental Bypass	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CA16-Drainage/Environmental Bypass	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CA16-Drainage/Environmental Bypass	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52
Forest	CA16-Drainage/Environmental	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13

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Forest	CA16-Drainage/Environmental Bypass	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.34	-0.05
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Node Type	Node Name	Parameter	Min	Max	Actual
Forest	CA16-Drainage/Environmental Bypass	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CA16-Drainage/Environmental Bypass	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CA16-Drainage/Environmental Bypass	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CA16-Drainage/Environmental Bypass	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Forest	CA19-Drainage/Environmental	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CA19-Drainage/Environmental	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CA19-Drainage/Environmental	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52
Forest	CA19-Drainage/Environmental	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13
Forest	CA19-Drainage/Environmental	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	0.78
Forest	CA19-Drainage/Environmental	Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.17	0.17	0.13
Forest	CA19-Drainage/Environmental	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.34	-0.05
Forest	CA19-Drainage/Environmental	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CA19-Drainage/Environmental	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CA19-Drainage/Environmental	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CA19-Drainage/Environmental	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Forest	CA19-Drainage/Environmental Bypass	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CA19-Drainage/Environmental Bypass	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CA19-Drainage/Environmental Bypass	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52
Forest	CA19-Drainage/Environmental Bypass	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13
Forest	CA19-Drainage/Environmental Bypass	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	0.78
Forest	CA19-Drainage/Environmental Bypass	Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.17	0.17	0.13
Forest	CA19-Drainage/Environmental Bypass	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.34	-0.05
Forest	CA19-Drainage/Environmental Bypass	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CA19-Drainage/Environmental Bypass	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CA19-Drainage/Environmental Bypass	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CA19-Drainage/Environmental Bypass	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Forest	CF02B-Drainage/Environmental	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CF02B-Drainage/Environmental	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CF02B-Drainage/Environmental	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52
Forest	CF02B-Drainage/Environmental	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13

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Forest	CF02B-Drainage/Environmental	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CF02B-Drainage/Environmental	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CF02B-Drainage/Environmental	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CF02B-Drainage/Environmental	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Forest	CF06-Drainage/Environmental	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CF06-Drainage/Environmental	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CF06-Drainage/Environmental	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52

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Node Type	Node Name	Parameter	Min	Max	Actual
Forest	CF06-Drainage/Environmental	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13
Forest	CF06-Drainage/Environmental	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	0.78
Forest	CF06-Drainage/Environmental	Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.17	0.17	0.13
Forest	CF06-Drainage/Environmental	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.34	-0.05
Forest	CF06-Drainage/Environmental	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CF06-Drainage/Environmental	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CF06-Drainage/Environmental	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CF06-Drainage/Environmental	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Forest	CF07-Drainage/Environmental	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CF07-Drainage/Environmental	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CF07-Drainage/Environmental	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52
Forest	CF07-Drainage/Environmental	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13
Forest	CF07-Drainage/Environmental	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	0.78
Forest	CF07-Drainage/Environmental	Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.17	0.17	0.13
Forest	CF07-Drainage/Environmental	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.34	-0.05
Forest	CF07-Drainage/Environmental	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CF07-Drainage/Environmental	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CF07-Drainage/Environmental	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CF07-Drainage/Environmental	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Forest	CF13-Drainage/Environmental	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.52
Forest	CF13-Drainage/Environmental	Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.12	0.13
Forest	CF13-Drainage/Environmental	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.52
Forest	CF13-Drainage/Environmental	Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.19	0.13
Forest	CF13-Drainage/Environmental	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	0.78
Forest	CF13-Drainage/Environmental	Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.17	0.17	0.13
Forest	CF13-Drainage/Environmental	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.34	-0.05
Forest	CF13-Drainage/Environmental	Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.19	0.24
Forest	CF13-Drainage/Environmental	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.3	-1.1
Forest	CF13-Drainage/Environmental	Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.25	0.22
Forest	CF13-Drainage/Environmental	Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.32	0.32	0.2
Pond	CA16 Wetland	Evaporative Loss as % of PET	75	75	125
Pond	CA16 Wetland	Number of CSTR Cells	2	2	4
Pond	CA16 Wetland	Total Nitrogen - k (m/yr)	40	40	150
Pond	CA16 Wetland	Total Phosphorus - C* (mg/L)	0.09	0.09	0.06
Pond	CA16 Wetland	Total Phosphorus - k (m/yr)	300	300	1000
Pond	CA16 Wetland	Total Suspended Solids - C* (mg/L)	12	12	6

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Node Type	Node Name	Parameter	Min	Max	Actual
Pond	CA19 Wetland	Total Phosphorus - C* (mg/L)	0.09	0.09	0.06
Pond	CA19 Wetland	Total Phosphorus - k (m/yr)	300	300	1000
Pond	CA19 Wetland	Total Suspended Solids - C* (mg/L)	12	12	6
Pond	CA19 Wetland	Total Suspended Solids - k (m/yr)	400	400	1500
Pond	Storage Pond	Extended detention depth (m)	0.25	1	1.1
Pond	Storage Pond	Total Nitrogen - C* (mg/L)	1	1	0
Pond	Storage Pond	Total Nitrogen - C* (mg/L)	1	1	0
Pond	Storage Pond	Total Nitrogen - k (m/yr)	40	40	0
Pond	Storage Pond	Total Nitrogen - k (m/yr)	40	40	0
Pond	Storage Pond	Total Phosphorus - C* (mg/L)	0.09	0.09	0
Pond	Storage Pond	Total Phosphorus - C* (mg/L)	0.09	0.09	0
Pond	Storage Pond	Total Phosphorus - k (m/yr)	300	300	0
Pond	Storage Pond	Total Phosphorus - k (m/yr)	300	300	0
Pond	Storage Pond	Total Suspended Solids - C* (mg/L)	12	12	0
Pond	Storage Pond	Total Suspended Solids - C* (mg/L)	12	12	0
Pond	Storage Pond	Total Suspended Solids - k (m/yr)	400	400	0
Pond	Storage Pond	Total Suspended Solids - k (m/yr)	400	400	0
Rain	Rainwater Tank	% Reuse Demand Met	80	None	74.6742
Rain	Rainwater Tank	% Reuse Demand Met	80	None	74.4292
Rain	Rainwater Tank	% Reuse Demand Met	80	None	74.6734
Rain	Rainwater Tank	% Reuse Demand Met	80	None	74.4556
Rain	Rainwater Tank	% Reuse Demand Met	80	None	74.48
Rain	Resi Rainwater Tank	% Reuse Demand Met	80	None	74.69
Rain	Resi Rainwater Tank	% Reuse Demand Met	80	None	74.58
Rain	School Rainwater Tank	% Reuse Demand Met	80	None	36.58
Rain	School Rainwater Tank	% Reuse Demand Met	80	None	35.81
Rain	School Rainwater Tank	% Reuse Demand Met	80	None	34.06
Urban	CA02-Resi_Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.11
Urban	CA02-Resi_Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.85
Urban	CA02-Resi_Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.2
Urban	CA05-Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.11
Urban	CA05-Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.85
Urban	CA05-Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.2
Urban	CA16-Resi Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.11
Urban	CA16-Resi Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.85
Urban	CA16-Resi Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.2
Urban	CA16-School Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.11
Urban	CA16-School Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.85
Urban	CA16-School Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.2
Urban	CA19- Resi Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.11

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	CA19- Resi Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.85

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Urban	CF12-School Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.2
Urban	CF02_A-Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.11
Urban	CF02_A-Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.85
Urban	CF02_A-Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.2
Urban	CF02_B-Rural	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.05
Urban	CF02_B-Rural	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.22
Urban	CF02_B-Rural	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.15
Urban	CF06-Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.11
Urban	CF06-Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.85
Urban	CF06-Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.2
Urban	CF06-Rural	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.05
Urban	CF06-Rural	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.22
Urban	CF06-Rural	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.15
Urban	CF07-Resi Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.11
Urban	CF07-Resi Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.85
Urban	CF07-Resi Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.2
Urban	CF07-School Roof	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.11
Urban	CF07-School Roof	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.85
Urban	CF07-School Roof	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.2
Urban	CF13-Rural	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.05
Urban	CF13-Rural	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.22
Urban	CF13-Rural	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.15
Urban	CF17-Rural	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	-0.05
Urban	CF17-Rural	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-1.22
Urban	CF17-Rural	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.15

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