



O'Connell Street, Cadden

Stormwater Management Strategy Report Stages 2 to 4

Legacy Property
October 2016





Quality
Safety
Environment

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

O'Connell Street, Caddens – Stormwater Management Strategy – Stages 2 to 4

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1 INTRODUCTION

J. Wyndham Prince Pty Ltd (JWP) have been engaged by *Legacy Property* to prepare a Stormwater Management Strategy (SWMS) report to support the approval of Stages 2 to 4 for the proposed subdivision at O'Connell Street, Caddens.

The overall development includes approximately 550 lots across a total of six (6) stages. In July, 2016 a Development Application (DA) was submitted to Penrith City Council (Council) and approved for 99 lots within Stage 1. The current DA submission for Stages 2 to 4 includes a further 257 lots, with consideration also being given to the future arrangement of Stages 5 to 6.

This report details the proposed Stormwater Management Strategy which will ensure that both water quantity and water quality are managed prior to discharge from Stages 2 to 4 in accordance with Penrith City Council's guidelines and policy documents.

The proposed works are detailed on engineering design drawings 110358/DA200 to 110358/DA227, which should be read in conjunction with this report.

1.1 Previous Studies and Reports

Several hydrological studies have previously been undertaken for the catchments in the immediate vicinity of the subject site. These are summarised below.

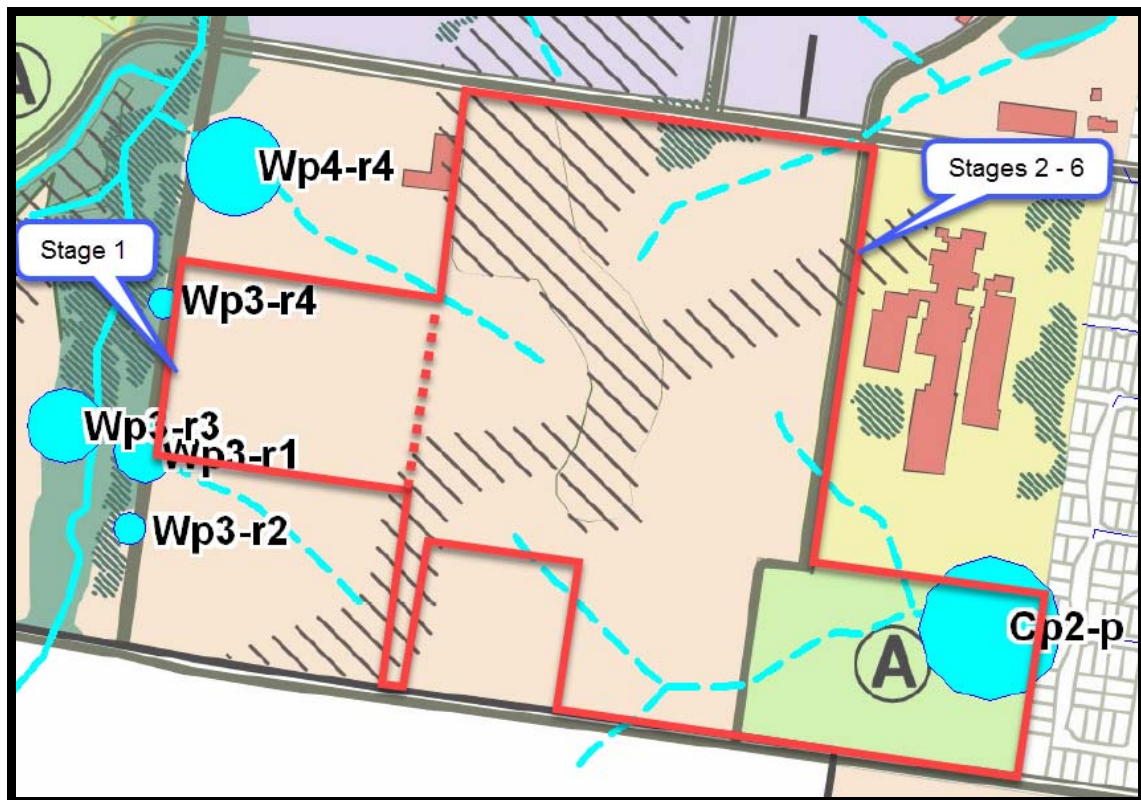
1.1.1 *WELL Precinct – Hydrology and Catchment Management Study (Cardno, 2006)*

The Werrington Enterprise Living and Learning (WELL) Precinct covers approximately 670 hectares and includes the Caddens Release area. The *WELL Precinct – Hydrology and Catchment Management Study (2006)* was undertaken by Cardno/Willing on behalf of Penrith City Council.

The purpose of the study was to provide input for planning of the WELL Precinct, by identifying the basic water quality and quantity management principles and key management issues.

It is noted that the study was undertaken at a strategic level, and indicated that the results in the report are subject to review during future, more detailed planning investigations.

This strategy included regional basins across the WELL Precinct with several located in the vicinity of the current development. Refer to Plate 1.1 which also includes the approximate site boundary for the current development.



**Plate 1.1 – Caddens Release Area Basins (with current stage boundary overlay)
(Extract: Cardno, 2006 Report)**

1.1.2 Caddens Release Area – Catchment Management, Hydrology and Water Quality Report

In 2007, Hughes Trueman were commissioned by Landcom to prepare a *Catchment Management, Hydrology and Water Quality Report* to assist with the rezoning and masterplanning infrastructure investigation for the Caddens release area at Penrith. The report built upon the *WELL Precinct – Hydrology and Catchment Management Study (2006)* by Cardno and subsequently the report (HT, 2007) developed water management strategies for the Caddens release area.

Regional detention basins were re-sized across the Caddens release area with volumes significantly reduced from those defined in the WELL Precinct study (Cardno, 2006).

Hughes Trueman provided discussion that a) the basin sizes are significantly smaller than the sizing put forth by Cardo (2006) b) the basin sizing by Cardno was not based upon hydrologic modelling; and c) the Upper Parramatta River Catchment Trust method adopted by Cardno may overestimate the required basin sizes.

1.1.3 Stormwater Management Strategy Report – Stage 1 (JWP, 2016)

In July 2016, J. Wyndham Prince prepared the “*Stormwater Management Strategy – Stage 1 Report*” to support of Stage 1 works (99 lot subdivision) fronting O’Connell Lane.

The report presented a stormwater strategy surrounding “Basin A” to ensure that peak post development flows do not exceed pre development flows at key locations. The strategy encompassed “Basin A” (constructed by others) as follows:

- Detention Basin with total active storage of 3790 m³
- Total Raingarden filter bed area of 1250 m².

Results demonstrated that the existing “Basin A” would receive flows both from Stage 1 and the adjacent development to the south which fronts Caddens Road to achieve Council’s stormwater requirements.

2 THE EXISTING SITE

The overall site is located wholly within the Penrith Local Government Area within the *Werrington Enterprise Living and Learning* (WELL) Precinct. The current zoning is "R1" General Residential.

The total site area (Stages 1 to 6) is approximately 38 ha and is predominantly rural grazing land. A number of dwellings and farm sheds are currently located on the site.

Stages 2 to 4 covers approximately 21.8 ha of the overall site and is bisected by a natural crestline. The terrain naturally grades into an adjacent property (future subdivision) to the north – west, O'Connell Street to the north and to Vivaldi Street to the south – east. Refer to Plate 2.1.

The eastern portion of the site is drained via an existing 1650 mm dia pipe and easement into Vivaldi Street before ultimately draining to the east. Refer to Plate 2.1.

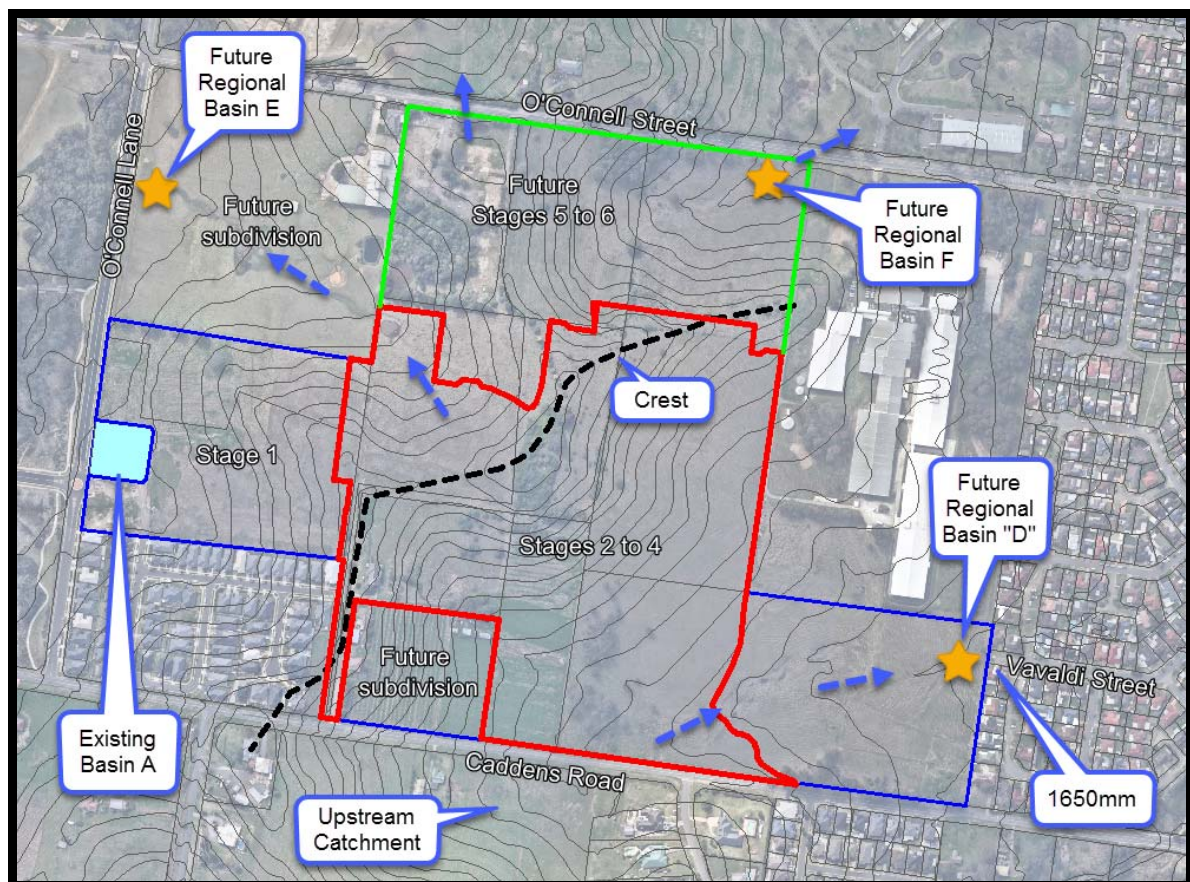


Plate 2.1 - Existing Site

Regional detention Basin 'A' shown in Plate 2.1 has been constructed as part of the adjacent Caddens development and also manages flows from Stage 1.

The other regional detention basins "D", "E" and "F" which were identified across the Caddens release area are shown on the Penrith Local Environmental Plan (Caddens) 2009 land-zoning map are also included on Plate 2.1.

Previous consultation with Penrith City Council has identified that there is no longer provision for delivery of stormwater infrastructure under the WELL section 94 contributions plan. J. Wyndham Prince understand that it is Council's desire that the regional basins still be constructed, however they require interim detention devices to be designed as permanent structures as the development of the Precinct proceeds.

The current Local Environment Plan from Council is shown on Plate 2.2 below. An “SP2 Stormwater System” land zoning is dedicated in the eastern portion of the site.

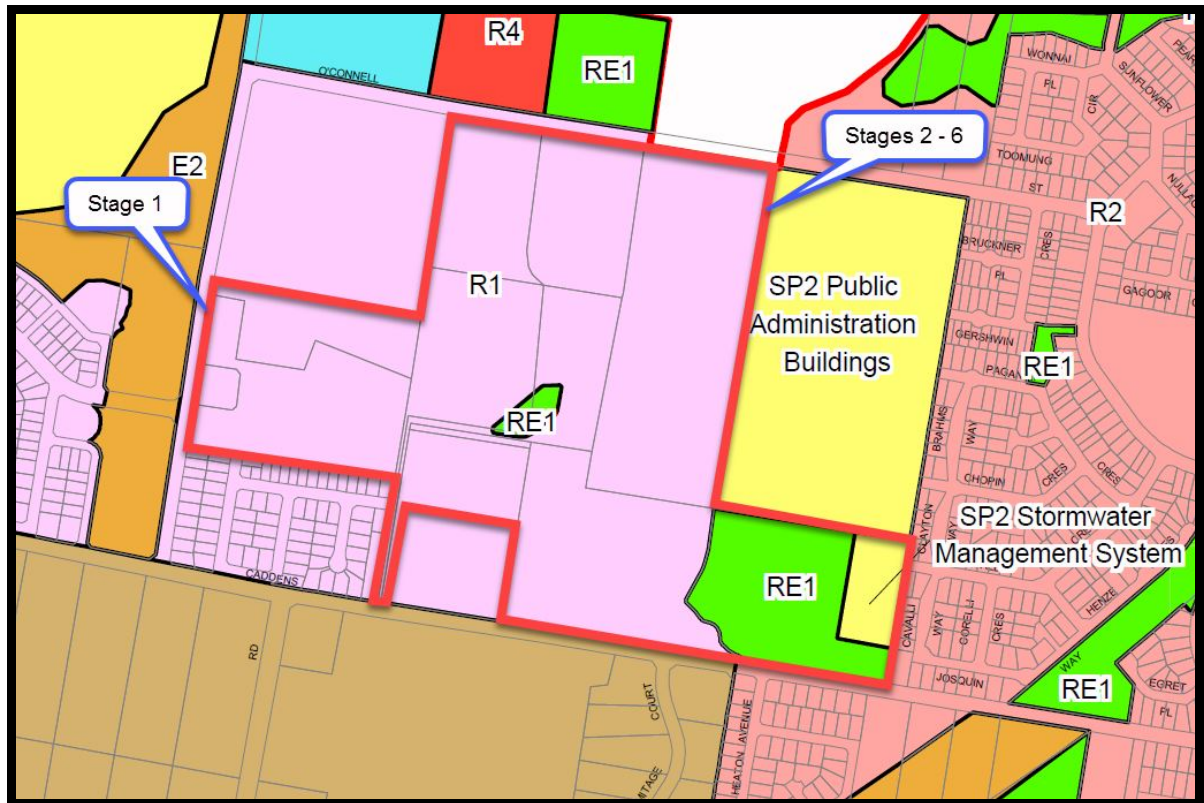


Plate 2.2 – Local Environment Plan
 (Source: Penrith City Council LEP 201) dated 14 October 2016)

3 PROPOSED DEVELOPMENT

The overall development includes approximately 550 lots across six (6) stages. In July 2016, DA12/1193 was submitted to Council (and approved) for the construction of 99 lots within Stage 1. The current Stage 2 to 4 DA submission now includes a further 257 lots, with consideration given to the future arrangement of Stages 5 to 6 (194 lots). Refer to Plate 3.1.

Stages 2 to 4 will include the creation of 257 residential lots, two (2) open space parks, road network together with associated street drainage and stormwater management controls.

The proposed development will include a series of co-located raingarden / detention basins to manage stormwater quality and quantity. These include:

- **Basin "B"** - located within Stage 4, the basin will attenuate and treat runoff prior to discharging overland to the adjacent property to the north – west (future subdivision). It is noted that this flowpath naturally occurs under existing catchments.
- **Basin "C"** – constructed as part of the future Stage 5 works, the basin will manage those catchments draining to the north prior to discharge to O'Connell Street. A separate DA will be made to Council for this management device in due course.
- **Basin "D"** - located in the eastern side of the park being proposed within Stage 2 (in the SP2 land). Flows will be attenuated and treated prior to discharge into the existing 1650 mm dia pipe which connects the subject site, through a drainage easement and along Vivaldi Street to the east.

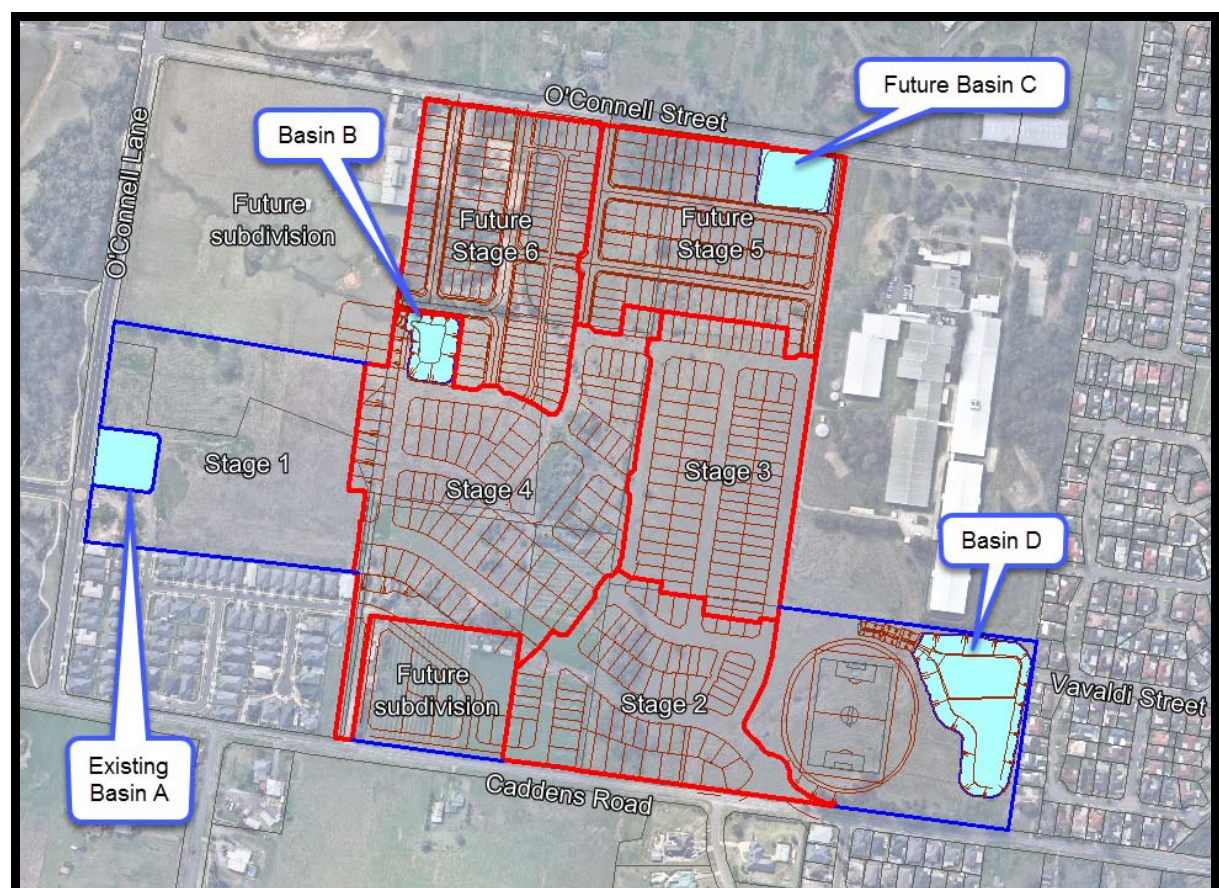


Plate 3.1 - Proposed Development

4 DEVELOPMENT CONTROLS AND GUIDELINES

The following control documents have been considered in the development of the Stormwater management strategy for the Stages 2 to 4 of the O'Connell Street development:

- Penrith City Council DCP 2014
- Penrith City Council Engineering design guidelines for subdivisions
- Penrith City Council WSUD Policy (2013)
- Penrith City Council WSUD Technical Guidelines (2015)

5 WATER QUANTITY ANALYSIS

Two (2) detention basins (Basins “B” and “D”) are proposed to manage stormwater runoff from Stages 2 to 4 of the O’Connell Street development. A third detention basin (Basin “C”) will be constructed at a later date to support the future Stage 5 and 6 works.

Existing and developed catchment plans are presented on Figures 1 and 2 in Appendix A. The total “developed” catchment area directed to Basin “D” includes 21.2 ha of proposed residential development along with external catchments of 8.8 ha and 1.1 ha.

The total “developed” catchment area directed to Basin “B” includes 5.75 ha of proposed residential development area from Stage 4 and future Stage 6.

A hydrological assessment has been undertaken using XP-RAFTS to determine the necessary detention volumes to ensure post development flows do not exceed existing condition flows exiting the subject site.

A water quality assessment was also undertaken to determine the treatment that is required to manage urban runoff from the O’Connell Street Stages 2 to 4 development, refer to Section 6 of this report for the water quality assessment.

Refer to XP-RAFTS layouts in Appendix B for further details of the hydrological modelling.

5.1 Discharge Estimates (Basin B)

Basin “B” is designed to manage stormwater runoff from Stage 4 and part of future Stage 6. The basin is located adjacent to the western boundary and receives flows via the proposed pipe system and low points in the surrounding roads.

The outlet from Basin “B” will discharge to the west via a level spreader to ensure there is no concentration of flows. It is anticipated that when the future subdivision to the west is constructed, lots will be elevated up to the proposed road level, which will allow the emergency spillway to drain to the roadway. A raingarden is also located in the base for water quality treatment. Details of Basin B are included on drawing 110358/DA222.

Discharge estimates were derived for both the “existing” and “developed” catchments for the 1%, 20% and 50% AEP events. A range of storm durations from 10 minutes to 24 hours were analysed to determine the critical storm duration.

Table 5.1 to 5.3 below shows a comparison between pre and post development discharges at the Basin B outlet and just downstream (including a bypass catchment of 0.23 ha). Refer to Plate 5.1 for comparison locations. Refer to Plate 5.1

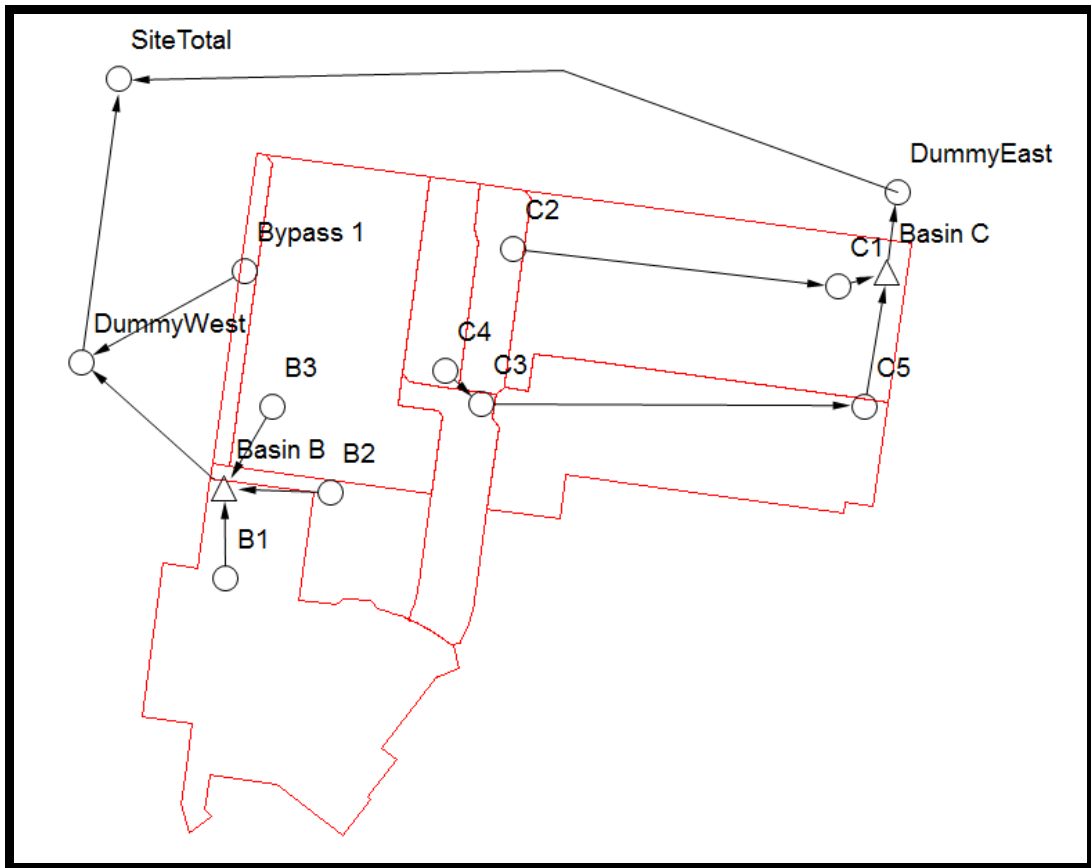


Plate 5.1 – XP-RAFTS Developed Layout (Northern)

Table 5.1 - Pre & Post Development Discharges at Basin B outlet

AEP	Existing (m ³ /s)	Post - Development (m ³ /s)	Post / Pre ratio
50%	0.57	0.50	0.88
20%	0.92	0.71	0.77
1%	2.00	1.79	0.90

Table 5.2 - Pre & Post Development Discharges at Dummy West (including bypass catchment at western boundary)

AEP	Existing (m ³ /s)	Post - Development (m ³ /s)	Post / Pre ratio
50%	0.57	0.55	0.96
20%	0.92	0.74	0.80
1%	2.00	1.85	0.93

The performance of Basin B is also provided in Table 5.3 below.

Table 5.3 - Basin "B" Performance

Basin B Performance						
AEP	Peak Inflow	Storm Duration	Peak Outflow	Storm Duration	Storage Used	Top Water Level
	(m ³ /s)	(min)	(m ³ /s)	(min)	(m ³)	RL (m)
50%	1.24	90	0.50	90	553	58.22
20%	1.67	90	0.71	90	782	58.37
1%	2.77	90	1.79	90	1287	58.66

Source: 110358_RA1_Dev (North).xp

5.2 Discharge Estimates (Basin D)

Basin "D" is designed to manage stormwater runoff from Stages 2, 3 and 4 as well as the "future subdivision" near Road 18 and 19. Two (2) external catchments "Ex Cat 5" and "Ex Cat 7" also enter the basin, but are considered as undeveloped.

The basin is located in the eastern side of the proposed park (in the SP2 land). Flows will be attenuated and treated prior to discharge into the existing 1650 mm dia pipe which connects the subject site, through a drainage easement and along Vivaldi Street to the east.

The basin design has considered freeboard to the existing residential properties to the east and includes a raingarden for water quality in the base. Details of Basin D are included on drawing 110358/DA223.

Discharge estimates were derived for both the "existing" and "developed" catchments for the 1%, 20% and 50% AEP events. A range of storm durations from 10 minutes to 24 hours were analysed to determine the critical storm duration.

Tables 5.4 to 5.6 below shows a comparison between pre and post development discharges at the Basin D outlet and just downstream. Refer to Plate 5.2 for comparison locations.

Legacy Property has made allowance in the size of detention basin "D" to cater for the future 2 Ha subdivision within the Caddens area. This is not strictly required, as this area does not form part of Legacy Property's development, however represents approximately 12 % of the total development area being managed within detention basin "D". It is understood Legacy Property may seek a Section 94 offset for this proportion of the total detention basin cost.

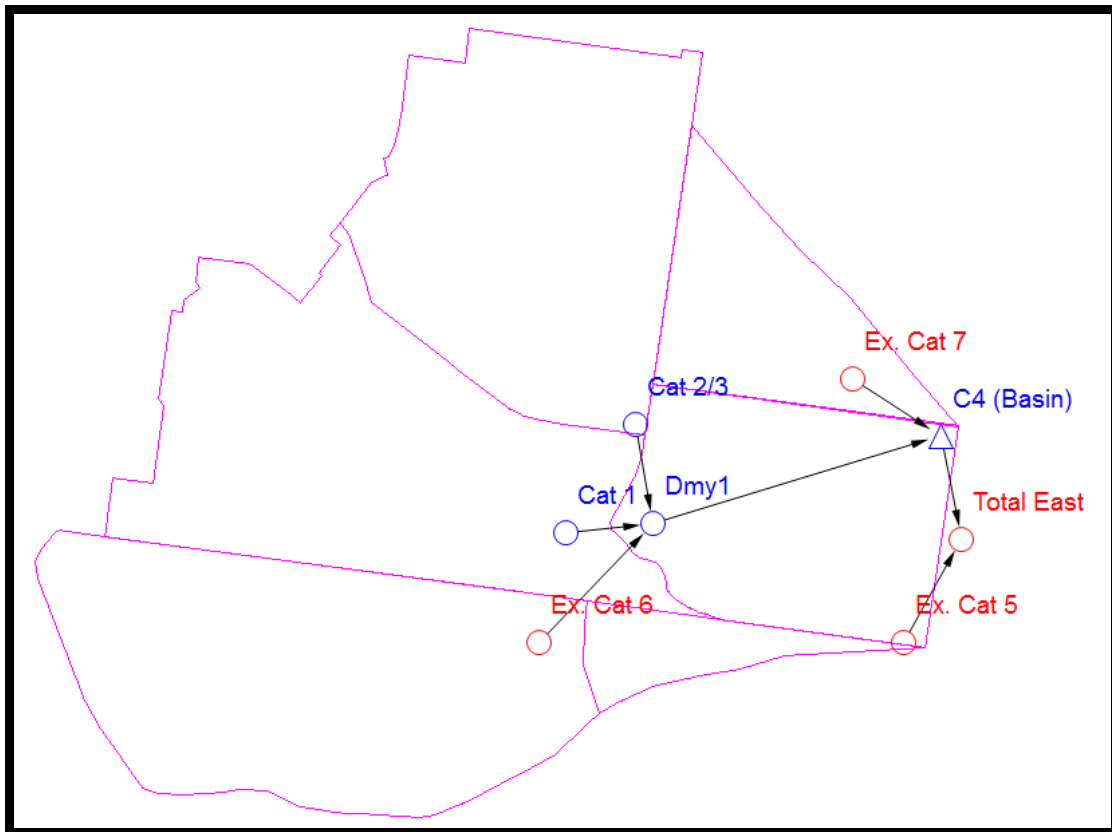


Plate 5.2 – XP-RAFTS Developed Layout (Southern)

Table 5.4 - Pre & Post Development Discharges at Basin D outlet

AEP	Existing (m ³ /s)	Post - Development (m ³ /s)	Post / Pre ratio
50%	2.39	2.32	0.97
20%	3.92	3.45	0.88
1%	8.70	7.74	0.89

Table 5.5 - Pre & Post Development Discharges at Total East

AEP	Existing (m ³ /s)	Post - Development (m ³ /s)	Post / Pre ratio
50%	2.5	2.38	0.95
20%	4.0	3.52	0.87
1%	8.9	7.94	0.89

The performance of Basin D is also provided in Table 5.6 below.

Table 5.6 - Basin "D" Performance

Basin D Performance						
AEP	Peak Inflow	Storm Duration	Peak Outflow	Storm Duration	Storage Used	Top Water Level
	(m ³ /s)	(min)	(m ³ /s)	(min)	(m ³)	RL (m)
50%	5.03	90	2.32	120	3126	36.22
20%	7.06	90	3.45	120	4238	36.36
1%	12.58	90	7.74	120	6904	36.67

Source: 110358_RA4 Dev (South).xp

5.3 Discussion of Modelling Results

The results of the hydrological modelling show that the proposed detention basins "B" and "D" will ensure that post-development flows do not exceed pre-development flows at key comparison locations for the 1%, 20% and 50% AEP storm events.

6 WATER QUALITY ANALYSIS

6.1 Modelling Inputs and Assumptions

The MUSIC modelling for the Stage 2 to 6 development was undertaken using MUSIC Version 6.1 and in accordance with Penrith City Council's WSUD Design Policy (PCC, 2013a) and Technical Guidelines (PCC, 2015). This water quality modelling software was developed by the Cooperative Research Centre (CRC) for Catchment Hydrology, which is based at Monash University and was first released in July 2002.

In accordance with PCC's Water Sensitive Urban Design Technical Guidelines (2015), sub-catchments have been split into roof, road, urban pervious and urban impervious. The target pollutant removal rates for this development are 85% Suspended Solids (TSS), 60% Total Phosphorus (TP) and 45% Total Nitrogen (TN).

A proposed treatment train of water quality devices has been identified to achieve the target pollutant removals. This includes a combined system of rainwater tanks, Gross Pollutant Traps (GPT) and bio-retention raingardens.

The *MUSIC* Modelling has assumed the following in determination of results:

- Residential catchment 85% impervious overall;
- Roof area cover 75% of lots;
- Road reserve 95% impervious;
- Open Space 50% impervious;
- 3.0 kL rainwater tanks on each lot, 2.4 kL re-usable storage above top-up;
- Rainwater tank re-use has been assumed as follows:
 - 0.08 kL/day internal use per lot; and
 - 25 kL/year PET rain.

Further details on the MUSIC modelling parameters, Gross Pollutant Trap and the Bio-retention Rain garden are provided in Appendix C.

6.2 MUSIC Model Layout

The catchment plan for Stages 2 to 6 has been split into three (3) distinct sub-catchments, each being serviced by a treatment train that will incorporate gross pollutant traps upstream of a common bio-retention raingarden devices. A catchment plan is included in Appendix A.

There are two (2) external catchments which enter the subject site from surrounding areas. This includes a large undeveloped catchment (8.8 Ha) to the south of Caddens Road and a smaller catchment (3 Ha) just to the north of Basin D. These external catchments have been considered in the model as forest nodes due to the undeveloped nature.

There is a small portion of development (rear of lots) which will bypass the Basin B. The strategy has overcompensated for this area.

The required device size parameters are summarised in Table 6.2, and the layout of the MUSIC model is shown in Appendix A. Further details are included in Appendix C.

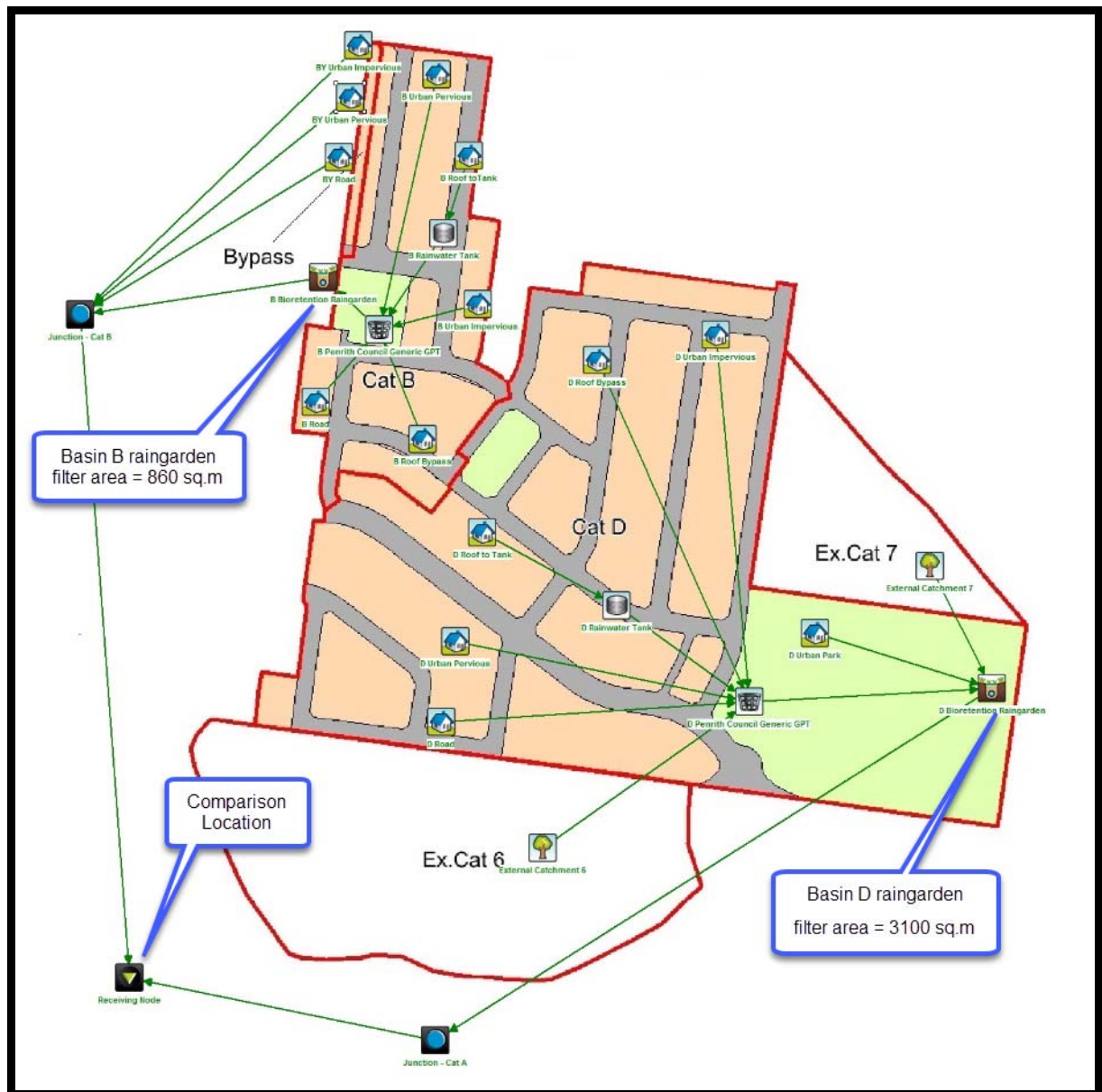


Plate 6.1 – MUSIC Model Layout (110358 MU4.sqz)

6.3 Modelling Results

The combined performance of the proposed water quality management strategy for Stages 2 and 4 is summarised below in Table 6.1.

Table 6.1 - Summary of MUSIC Results (Stages 2 to 4)

Pollutant	Total Developed Source Nodes	Minimum Reduction Required	Total Residual Load from Site	Total Reduction Achieved	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)	(%)	(%)
TSS	22300	18955	3350	18950	85.0%	85.0%
TP	44.7	29.1	13.2	31.5	65.0%	70.5%
TN	334	150.3	134	200.0	45.0%	59.9%
Gross Pollutants	3930	3537	135	3795	90.0%	96.6%

The results indicate that the proposed treatment system that includes on-lot rainwater tanks, gross pollutant traps and bio-retention raingardens will provide adequate treatment removal in accordance with Council’s WSUD Policy (PCC, 2013a). Minimum raingarden sizes are summarised in Table 6.2.

Table 6.2 - Summary of Minimum Raingarden Sizes

Basin	Filter Area (m ²)	Percentage of Catchment
B	860	1.5%
D	3100	1.4%

A *MUSIC-LINK* report was generated which demonstrates that the *MUSIC* modelling achieves Penrith City Council's water quality targets. A copy of this report is provided in Appendix C.

7 SUMMARY

This report details the investigations and presents the results of the Stormwater Management Strategy to support the Stage 2 to 4 DA for the proposed subdivision at O'Connell Street, Caddens.

The proposed stormwater management strategy for the development of Stages 2 to 4 will consist of:

- Detention Basin "B" with a total active storage of approximately 1300 m³
- Detention Basin "D" with total active storage of 6950 m³
- Raingarden filter bed area within Basin "B" of 860 m²
- Raingarden filter bed area within Basin "D" of 3100 m²

Results demonstrate that the proposed detention basins will ensure that peak post development discharges are restricted to less than the pre development levels at all key comparison locations. Water quality will be managed by on-lot rainwater tanks, gross pollutant trap and rain gardens co-located within detention basins. The proposed works are provided on engineering design drawing set 110358/DA200 to 110358/DA227.

The proposed Stormwater Management Strategy for Stages 2 to 4 of the O'Connell Street, Caddens development provides a basis for the detailed design and development of the Construction Certificate drawings to ensure that the environmental, urban amenity, engineering and economic objectives for stormwater management and site discharge are achieved.

We see that this stormwater strategy provides the necessary modelling to support approval for the Stage 2 to 4 DA. If you require any additional information, please do not hesitate to contact the undersigned on (02) 4720 3340.

Yours faithfully

J. WYNDHAM PRINCE



DAVID CROMPTON

Manager – Stormwater and Environment

8 REFERENCES

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APPENDIX A – Figures



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LEGEND

- XP-RAFTS Catchments (North)
- XP-RAFTS Catchments (North-West)
- XP-RAFTS Catchments (South)
- Basin
- Future Development
- ▲ XP-RAFTS Node/Basin
- XP-RAFTS Link
- Cat 1 XP-RAFTS Catchment Name

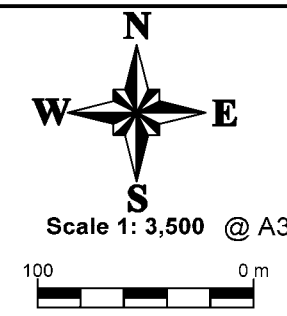
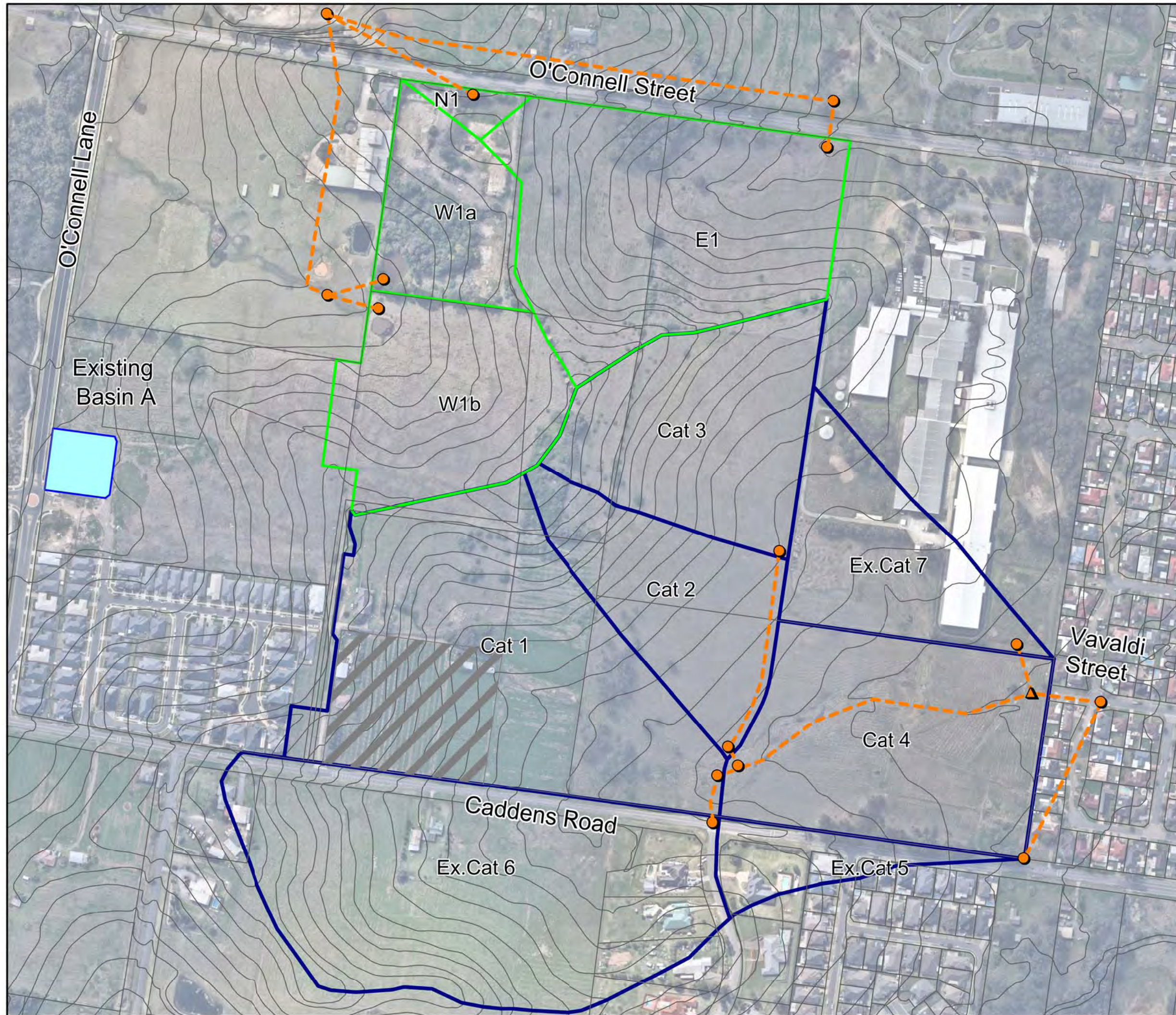


Figure 1
Stages 2 to 4
O'Connell Street
Caddens

Existing
Catchment Plan

File Name: 110358 Figure 1
 Date : 21/10/2016 Issue : A





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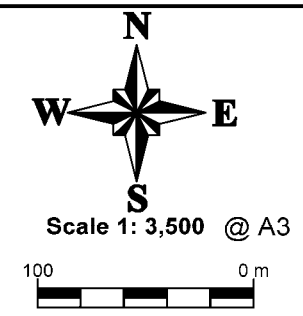
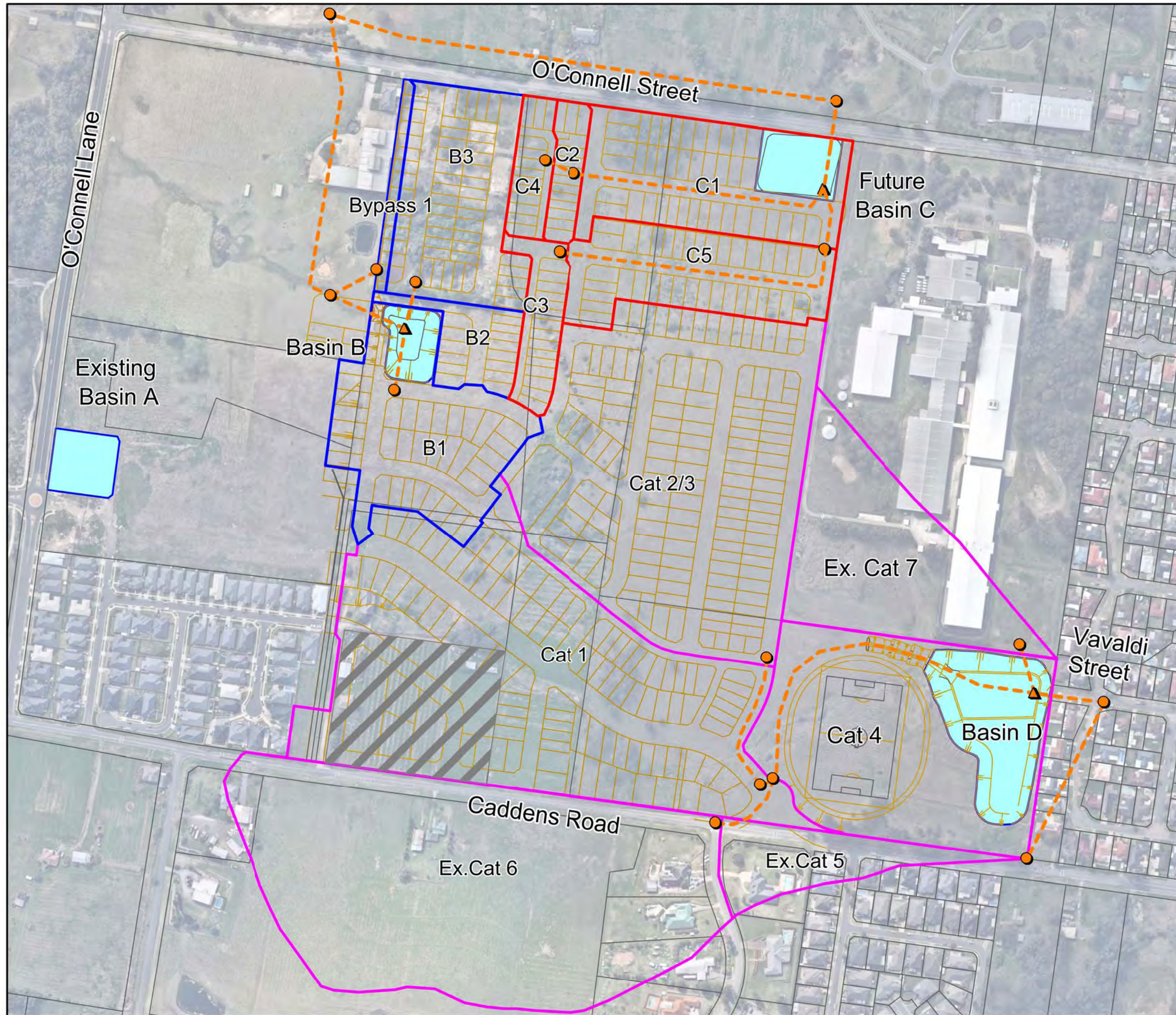


Figure 2
Stages 2 to 4
O'Connell Street
Caddens

Developed
Catchment Plan

File Name: 110358 Figure 2
Date : 21/10/2016 Issue : A





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LEGEND

-  MUSIC Catchment Boundary
-  Residential Lots
-  Road Reserve
-  Open Space
-  Future Development

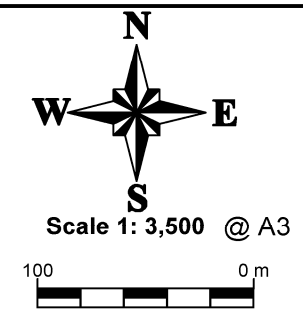
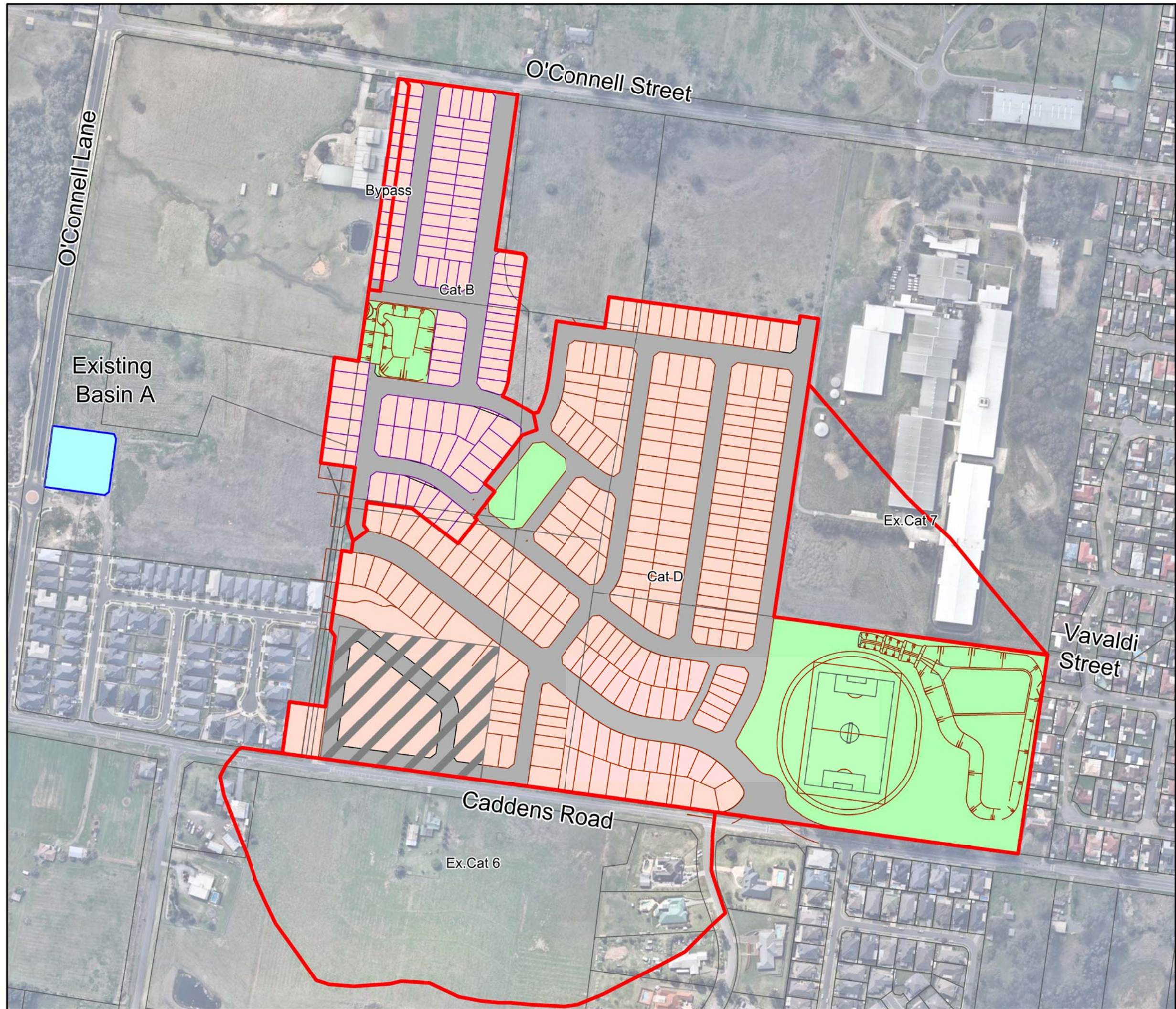


Figure 3
Stages 2 to 4
O'Connell Street
Caddens

MUSIC

Catchment Plan

File Name: 110358 Figure 3
 Date : 25/10/2016 Issue : B



LEGACYPROPERTY

J. WYNDHAM PRINCE

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LEGEND

-  MUSIC Catchment Boundary
-  Residential Lots
-  Road Reserve
-  Open Space
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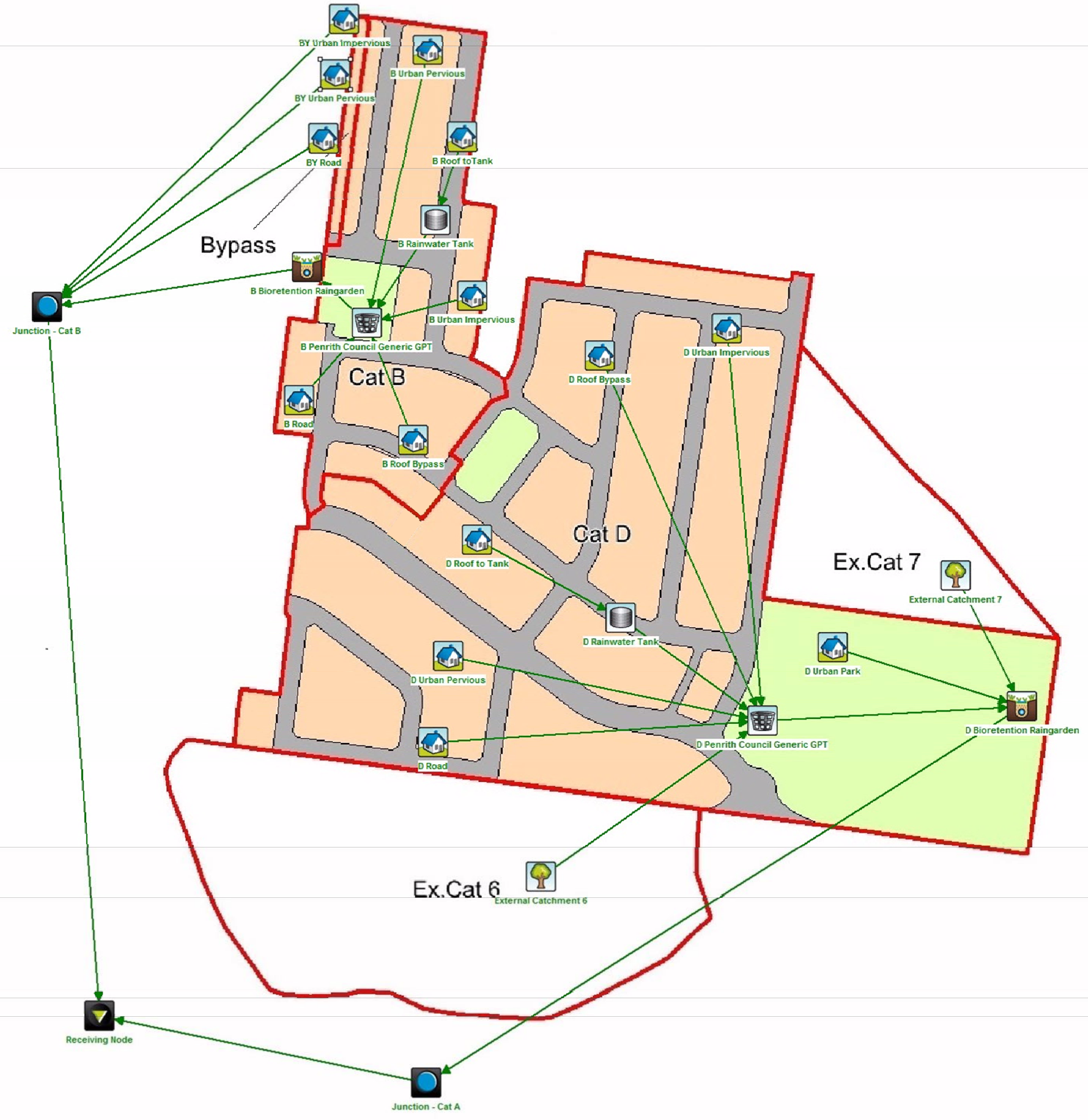
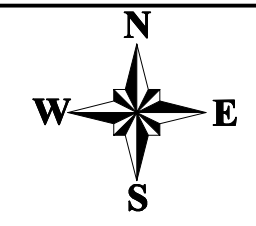


Figure 4
Stages 2 to 4
O'Connell Street
Caddens

MUSIC Catchment Plan

File Name: 110358 Figure 4
Date : 25/10/2016 Issue : B

APPENDIX B – XP RAFTS Input Details

RAFTS INPUT PARAMETERS

Table B 1 - Initial / Continuing Loss

Initial/ Continuing Losses		
Loss	Pervious Catchment	Impervious Catchment
Initial Loss	10.0	1.0
Continuing Loss	2.5	0.0

Table B 2 - Adopted PERNS

Catchment Condition	Adopted PERNS
Rural Pervious	0.05
Urban Pervious	0.025
Urban Impervious	0.015

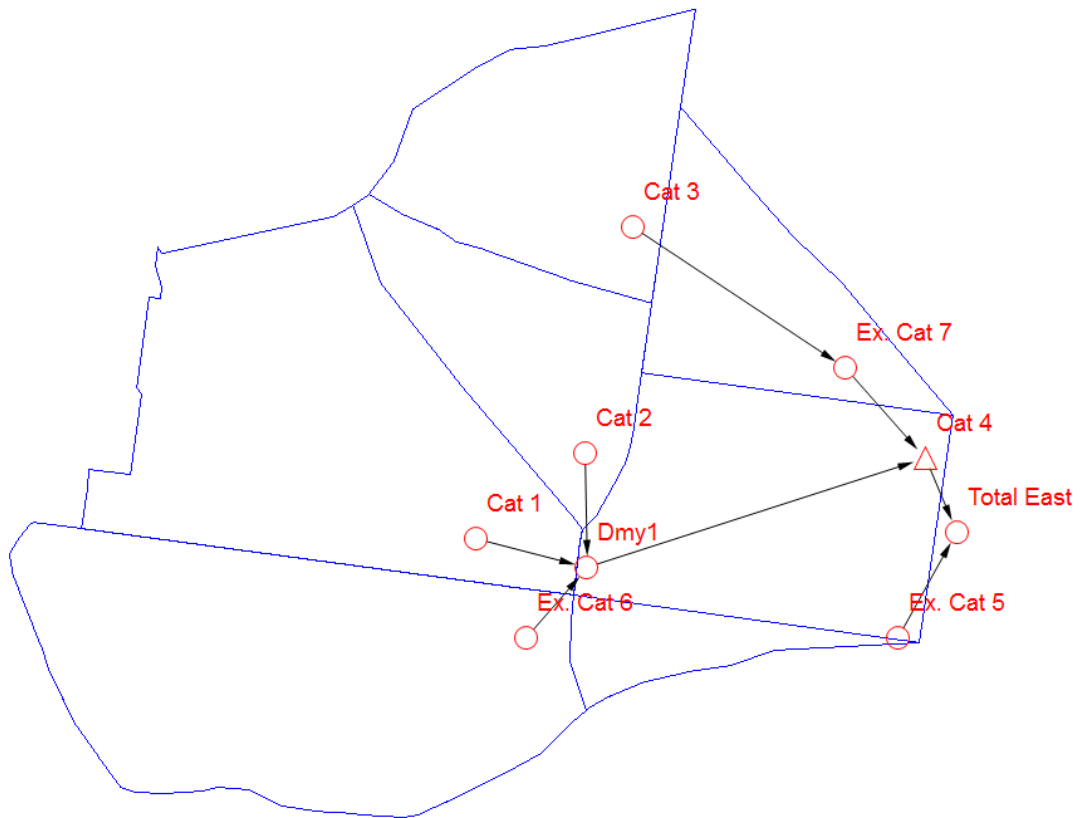


Plate B.1 – XP-RAFTS Layout Existing (Southern portion of site)

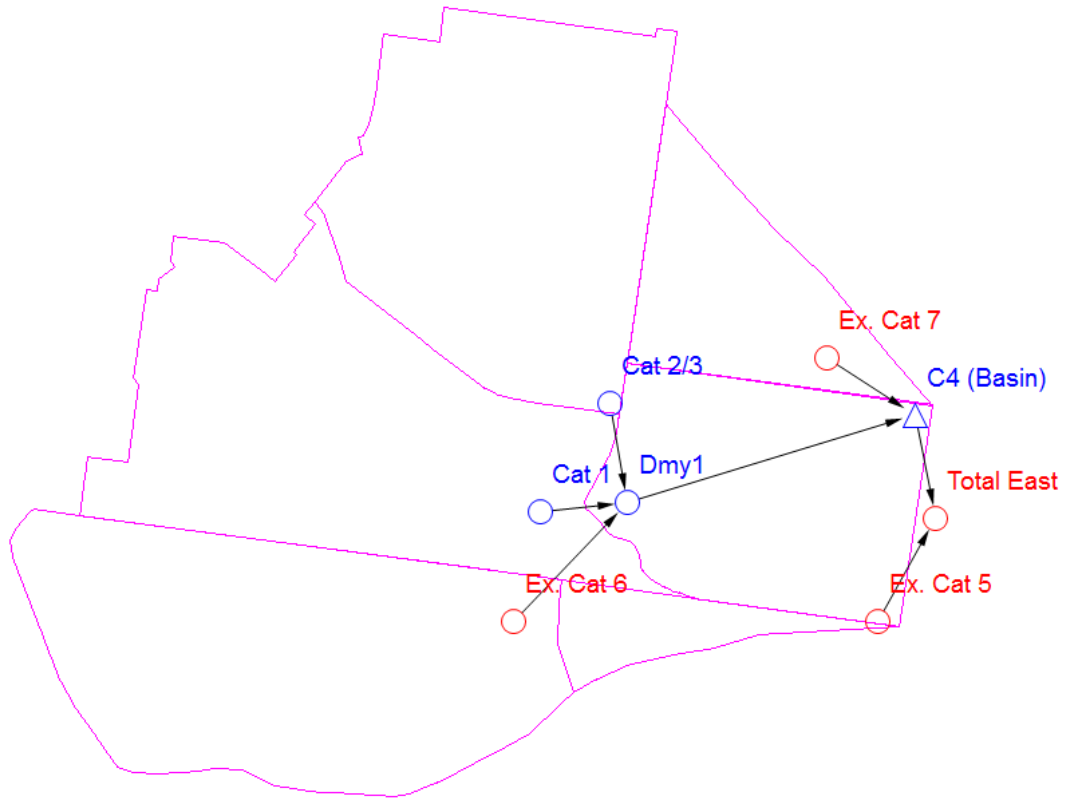


Plate B.2 – XP-RAFTS Layout Developed (Southern portion of site)

Table B 3 – SOUTHERN PORTION OF SITE

XP-RAFTS Model - Southern Portion of Site												
Existing												
Catchment Name	Area (Ha)	Fraction Impervious	Slope				Area (Ha)		Links			
			U/S Level	D/ S Level	Length	Catchment Slope	Impervious	Pervious	Name	Length	Link time at 2m/s	
Cat 1	8.2	5	69.4	43.2	433	6%	0.4	7.8	dmy 2 - out	300	2.5	
Cat 2	3.3	5	73	42.4	340	9%	0.2	3.1	dmy 1 - out	350	2.9	
Cat 3	4.2	5	71.5	46.8	246	10%	0.2	4.0				
Cat 4	5.5	5	45.7	37	350	2%	0.3	5.2				
Ex.Cat 5	1.1	85	51.8	37.3	471	3%	1.0	0.2				
Ex.Cat 6	8.8	15	73.5	45.7	305	9%	1.3	7.5				
Ex.Cat 7	3.1	20	52	37.8	394	4%	0.6	2.5				
Total	34.3											
Developed												
Catchment Name	Area (Ha)	Fraction Impervious	Slope				Area (Ha)		Links			
			U/S Level	D/ S Level	Length	Catchment Slope	Impervious	Pervious	Name	Length	Link time (min) at 2m/s	
Cat 1	8.8	85	67	43.8	434	5%	7.5	1.3	Ex Cat 6 - dummy	95	0.8	
Cat 2/3	7.8	85	67.6	44.6	623	4%	6.6	1.2	Cat 2/3 - dummy	94	0.8	
Cat 4	5.1	50	41.5	37.9	358	1%	2.56	2.56	dummy to outlet	358	3.0	
Ex.Cat 5	1.1	85	51.8	37.3	471	3%	1.0	0.2				
Ex.Cat 6	8.8	15	73.5	45.7	305	9%	1.3	7.5				
Ex.Cat 7	3.1	20	52	37.8	394	4%	0.6	2.5				
Total	34.80											

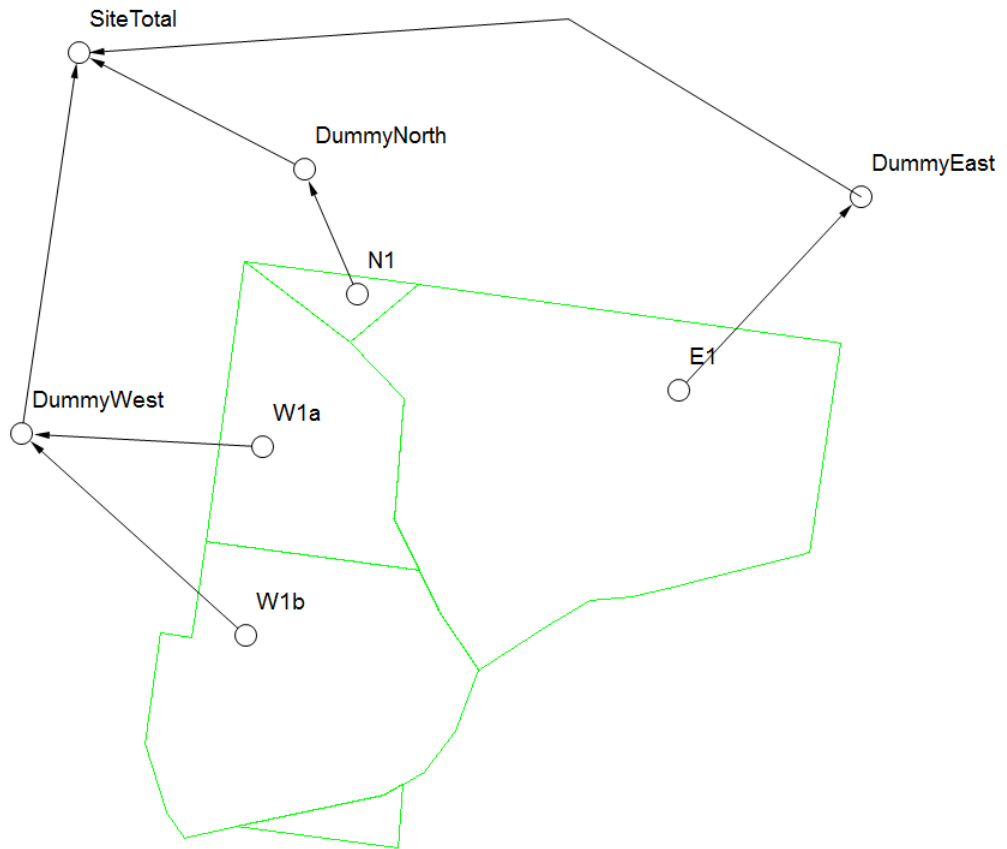


Plate B.3 – XP-RAFTS Layout Existing (Northern portion of site)

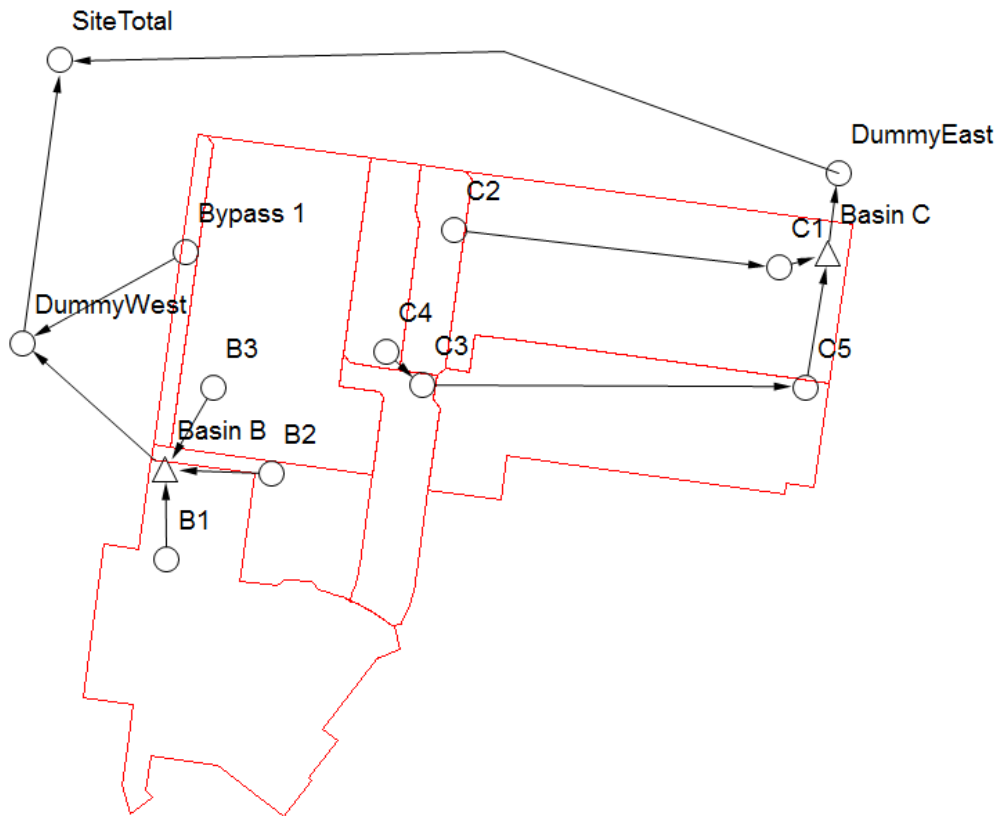


Plate B.4 – XP-RAFTS Layout Developed (Northern portion of site)

Table B 4 – NORTHERN PORTION OF SITE

XP-RAFTS Model - Northern Portion of Site											
Existing											
Catchment Name	Area (Ha)	Fraction Impervious	Slope				Area (Ha)		Links		
			U/S Level	D/ S Level	Length	Catchment Slope	Impervious	Pervious	Name	Length	Link time at 2m/s
N1	0.30	40	68	64.94	50	6.1%	0.12	0.18	dmy 2 - out	300	2.5
W1a	2.24	40	68	56.39	180	6.5%	0.89	1.34	dmy 1 - out	350	2.9
W1b	3.74	5	73	56.05	218	7.8%	0.19	3.55			
E1	6.54	5	71.49	43.65	383	7.3%	0.33	6.21			
Total	12.8										
Developed											
Catchment Name	Area (Ha)	Fraction Impervious	Slope				Area (Ha)		Links		
			U/S Level	D/ S Level	Length	Catchment Slope	Impervious	Pervious	Name	Length	Link time (min) at 2m/s
Bypass	0.23	85				4%	0.20	0.03			
B1	2.73	75	69.8	60.3	230	4%	2.05	0.68	C5-C1	49	0.4
B2	0.69	85	66.2	58.1	180	5%	0.59	0.10			
B3	2.33	85	65.1	58.1	283	2%	1.98	0.35			
C1	2.71	75	61	50.3	255	4%	2.03	0.68			
C2	0.42	85	64.4	61.2	36	9%	0.36	0.06			
C3	0.66	85	66.2	62.4	176	2%	0.56	0.10			
C4	0.50	85	64.9	62.9	135	1%	0.43	0.08			
C5	2.01	85	64.7	51.8	334	4%	1.71	0.30			
Total	12.28										

APPENDIX C – MUSIC Modelling Parameters and Report

110358 - MUSIC MODELLING WORKSHEET
O'CONNELL LANE - STAGES 2 - 4

Catchment	Catchment Division				Node Inputs						check	RG Size (ha)	RG Size (% cat)
	Total Catchment Area (ha)	Residential Lot Area (ha)	Road (incl. Reserve) Area (ha)	Open Space	Road (ha)	Roof to Tank (ha)	Roof Bypass (ha)	Urban Impervious	Urban Pervious	Forest			
Catchment D	22.12	11.369	5.252	5.504	5.252	4.263	4.263	3.889	4.457	0.000	22.12	0.33187	1.50%
Catchment B	5.75	3.416	1.822	0.516	1.822	1.281	1.281	0.600	0.770	0.000	5.75	0.08631	1.50%
External Cat 6	8.81	0.000	0.000	8.806	0.000	0.000	0.000	0.000	0.000	8.806	8.81	Part of D	
External Cat 7	3.08	0.000	0.000	3.083	0.000	0.000	0.000	0.000	0.000	3.083	3.08	Part of D	
Bypassing	0.23	0.216	0.012	0.000	0.012	0.000	0.000	0.184	0.032	0.000	0.23	Assumed Not Treated	

O'Connell Lane bypassing - assumed not to be part of treatable flows
Assumed external catchments remain undeveloped, yet remain part of this assessment

Flow to GPT/Raingarden

	Area (ha)	1yr Flow (m³/s)	3mth Flow (m³/s)
Catchment D + Cat 6 - park	25.82	1.66	0.86
Catchment D + Cat 6 & 7(ext)	34.01	2.05	1.07
Catchment B	5.75	0.49	0.26
O'Connell Lane	Assumed Not Treated		

Section of Cat D that does not go through GPT:

Catchment	Total	Urban Impervious	Urban Pervious
Park	5.11	2.56	2.56
remainder	17.01	1.33	1.90

RAINWATER TANK

Catchment	Lots	Equivalent Pipe Area (m²)	Equivalent Pipe radius (m)	Equivalent Pipe dia (mm)	Total Area of Roof to Tank (Ha)	1yr flow on roof (m³/s)	Daily Demand (kL)	Annual Demand (kL/yr)	Total Tank Volume (m³)	Tank Surface Area (m²)	Overflow Pipe Dia	High Flow By-pass	Daily Demand	PET - RAIN	Tank Surface Area
Catchment D	222	0.436	0.372	745	4.263	0.888	17.76	5550	532.8	416.25					
Catchment B	103	0.202	0.254	507	1.281	0.267	8.24	2575	247.2	193.13					
Catchment C	122	0.239	0.276	552	1.571	0.327	9.76	3050	292.8	228.75					
Bypassing	0	0.000	0.000	0	0.000	0.000	0	0	0.0	0.00					

*Backyard only
Captured - 447 lots only, including Existing development, excluding external catchment
Bypassing - Backyard portion of lots assumed not to have rainwater tanks with backyard flows draining to X street

Basin 'A' Raingarden Design Parameters	Value
Catchment Area (ha)	10.37
High Flow Bypass (3 month ARI) (m³/s)	0.45
Extended Detention Depth (m)	0.3
Raingarden Storage Surface Area (m²)	1250
Filter Depth (m)	0.5

PET - Rain for landscape area	25 kL/year/dwelling
Assumed Daily Demand	80 L/day
Adopted Tank Size	3 kL
Assumed 80% is useable (w/o topups)	80 %
Useable tank	2.4 kL
Assumed Tank height	1.6 m
15min/1yr	75 mm/hr

Input
MUSIC Input

MUSIC-*link* Report

Project Details		Company Details	
Project:	110358 OConnel Lane Caddens	Company:	J Wyndham Prince
Report Export Date:	21/10/2016	Contact:	David Crompton
Catchment Name:	110358_MU3	Address:	580 High Street, Penrith NSW
Catchment Area:	39.989ha	Phone:	02 4720 3340
Impervious Area*:	56.25%	Email:	DCrompton@jwprince.com.au
Rainfall Station:	67113 PENRITH		
Modelling Time-step:	6 Mminutes		
Modelling Period:	1/01/1999 - 31/12/2008 11:54:00 PM		
Mean Annual Rainfall:	691mm		
Evapotranspiration:	1158mm		
MUSIC Version:	6.1.0		
MUSIC-link data Version:	6.0		
Study Area:	Penrith		
Scenario:	Penrith 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: Receiving Node	Reduction	Node Type	Number	Node Type	Number
Flow	12.9%	Bio Retention Node	2	Urban Source Node	14
TSS	85%	Rain Water Tank Node	2	Forest Source Node	2
TP	69.9%	GPT Node	2		
TN	59.5%				
GP	96.6%				

Comments

GPT removal of TSS TP and TN is a modeling abnormality that is being investigated

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	B Bioretention Raingarden	Hi-flow bypass rate (cum/sec)	None	99	0.26
Bio	B Bioretention Raingarden	PET Scaling Factor	2.1	2.1	2.1
Bio	D Bioretention Raingarden	Hi-flow bypass rate (cum/sec)	None	99	1.07
Bio	D Bioretention Raingarden	PET Scaling Factor	2.1	2.1	2.1
Forest	External Catchment 6	Area Impervious (ha)	None	None	0
Forest	External Catchment 6	Area Pervious (ha)	None	None	8.806
Forest	External Catchment 6	Total Area (ha)	None	None	8.806
Forest	External Catchment 7	Area Impervious (ha)	None	None	0
Forest	External Catchment 7	Area Pervious (ha)	None	None	3.083
Forest	External Catchment 7	Total Area (ha)	None	None	3.083
GPT	B Penrith Council Generic GPT	Hi-flow bypass rate (cum/sec)	None	99	0.26
GPT	D Penrith Council Generic GPT	Hi-flow bypass rate (cum/sec)	None	99	0.86
Receiving	Receiving Node	% Load Reduction	None	None	12.9
Receiving	Receiving Node	GP % Load Reduction	90	None	96.6
Receiving	Receiving Node	TN % Load Reduction	45	None	59.5
Receiving	Receiving Node	TP % Load Reduction	60	None	69.9
Receiving	Receiving Node	TSS % Load Reduction	85	None	85
Urban	B Road	Area Impervious (ha)	None	None	1.725
Urban	B Road	Area Pervious (ha)	None	None	0.096
Urban	B Road	Total Area (ha)	None	None	1.822
Urban	B Roof Bypass	Area Impervious (ha)	None	None	1.281
Urban	B Roof Bypass	Area Pervious (ha)	None	None	0
Urban	B Roof Bypass	Total Area (ha)	None	None	1.281
Urban	B Roof to Tank	Area Impervious (ha)	None	None	1.281
Urban	B Roof to Tank	Area Pervious (ha)	None	None	0
Urban	B Roof to Tank	Total Area (ha)	None	None	1.281
Urban	B Urban Impervious	Area Impervious (ha)	None	None	0.6
Urban	B Urban Impervious	Area Pervious (ha)	None	None	0
Urban	B Urban Impervious	Total Area (ha)	None	None	0.6
Urban	B Urban Pervious	Area Impervious (ha)	None	None	0
Urban	B Urban Pervious	Area Pervious (ha)	None	None	0.77
Urban	B Urban Pervious	Total Area (ha)	None	None	0.77
Urban	BY Road	Area Impervious (ha)	None	None	0.011
Urban	BY Road	Area Pervious (ha)	None	None	0.000
Urban	BY Road	Total Area (ha)	None	None	0.012
Urban	BY Urban Impervious	Area Impervious (ha)	None	None	0.183
Urban	BY Urban Impervious	Area Pervious (ha)	None	None	0
Urban	BY Urban Impervious	Total Area (ha)	None	None	0.183
Urban	BY Urban Pervious	Area Impervious (ha)	None	None	0
Urban	BY Urban Pervious	Area Pervious (ha)	None	None	0.032

Only certain parameters are reported when they pass validation

NOTE: A successful self-validation check of your model does not constitute an approved model by Penrith City Council
MUSIC-*link* now in MUSIC by eWater – leading software for modelling stormwater solutions

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	BY Urban Pervious	Total Area (ha)	None	None	0.032
Urban	D Road	Area Impervious (ha)	None	None	5.014
Urban	D Road	Area Pervious (ha)	None	None	0.237
Urban	D Road	Total Area (ha)	None	None	5.252
Urban	D Roof Bypass	Area Impervious (ha)	None	None	4.263
Urban	D Roof Bypass	Area Pervious (ha)	None	None	0
Urban	D Roof Bypass	Total Area (ha)	None	None	4.263
Urban	D Roof to Tank	Area Impervious (ha)	None	None	4.263
Urban	D Roof to Tank	Area Pervious (ha)	None	None	0
Urban	D Roof to Tank	Total Area (ha)	None	None	4.263
Urban	D Urban Impervious	Area Impervious (ha)	None	None	1.33
Urban	D Urban Impervious	Area Pervious (ha)	None	None	0
Urban	D Urban Impervious	Total Area (ha)	None	None	1.33
Urban	D Urban Park	Area Impervious (ha)	None	None	2.542
Urban	D Urban Park	Area Pervious (ha)	None	None	2.568
Urban	D Urban Park	Total Area (ha)	None	None	5.111
Urban	D Urban Pervious	Area Impervious (ha)	None	None	0
Urban	D Urban Pervious	Area Pervious (ha)	None	None	1.9
Urban	D Urban Pervious	Total Area (ha)	None	None	1.9

Only certain parameters are reported when they pass validation

Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
GPT	B Penrith Council Generic GPT	TN % Load Reduction	0	0	-0.00
GPT	B Penrith Council Generic GPT	TP % Load Reduction	0	0	-0.00
GPT	B Penrith Council Generic GPT	TSS % Load Reduction	0	0	-0.00
GPT	D Penrith Council Generic GPT	TN % Load Reduction	0	0	-0.00
GPT	D Penrith Council Generic GPT	TP % Load Reduction	0	0	-0.01
GPT	D Penrith Council Generic GPT	TSS % Load Reduction	0	0	-0.00

Only certain parameters are reported when they pass validation

NOTE: A successful self-validation check of your model does not constitute an approved model by Penrith City Council
MUSIC-*link* now in MUSIC by eWater – leading software for modelling stormwater solutions