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Water Cycle Managment Report for Proposed Castlereagh Tourism Development at 39-65 Old Castlereagh Road, Castlereagh NSW 2749

Prepared For: Morson Group

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DOCUMENT HISTORY

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1. Content of this report have been based on available information as noted in the report and its appendices, thus this report should be read in conjunction with the referenced reports.
2. The limitations present in any of the referenced reports will be inherent in this report.
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1. INTRODUCTION

Smart Structures Australia has been engaged by Morson Group to provide Stormwater Engineering consultancy services for the proposed mixed-use tourism development at 39-65 Old Castlereagh Road, Castlereagh NSW 2749. This report has been prepared for the Development Application in support of the proposed Stormwater management component of the works.

The purpose of this report is to evaluate the quantity and quality of stormwater associated with the proposed development to demonstrate that an appropriate stormwater management strategy has been adopted to satisfy council's requirements.

2. SCOPE OF WORK

The proposed Castlereagh Tourism Development comprises the construction of followings;

- Construction of a mixed-use tourism development including a 7-storey hotel, 6000 m² indoor recreation facility with 2 drive-thru restaurants, 5,500 m² club, and 555 car parking spaces across under croft and multi-storey car park structures. Refer to architectural plans prepared by Morson Group for details.

- Associated stormwater drainage management network.

The following reports, guideline and information were used in the stormwater quality and quantity analysis and in the report compilation.

- Penrith Lakes Development Control PLAN 2021-Stage 1
- Penrith City Council's Stormwater Drainage Guidelines for Building 2016,
- Penrith City Council's WSUD technical Guidelines 2014
- Australian Rainfall and Runoff 2019
- Australian Standards 3500.3:2021

3. SITE CHARACTERISTICS

3.1 Property Detail

The site has a primary frontage to Old Castlereagh Road to the west and comprises three existing residential lots, Lot 12, Lot 14, and Lot 16, with single-storey dwellings and associated outbuildings. The remainder of the site is predominantly undeveloped, featuring open grassed areas with gentle slopes, established tree lines along the northern and southern boundaries, and an existing drainage line along the northern edge adjoining a landscaped reserve, as shown in Figure 1.

Figure 1: site locality plan

The proposed development occupies an area of approximately 2.74 ha and involves the construction of a mixed-use tourism precinct comprising a 7-storey hotel, a 6,000 m² indoor recreation facility incorporating two drive-thru restaurants, and a 5,500 m² club. The development also includes provision for 555 car parking spaces accommodated within under croft and multi-storey car park structures, along with associated stormwater drainage, and services infrastructure works as illustrated in Figure 2.

The proposed development is proposed to be completed in three separate stages known as Stage 1, Stage 2 and Stage 3.refer to stormwater drawings for staging details.

Figure 2: Proposed Development

3.2 Topography

The existing site covers an area of approximately 2.74 hectares and is predominantly undeveloped. The topography features a gentle slope falling from south to north, supporting natural overland flow across the site. This grading influences site drainage and guides runoff towards the northern boundary. Refer to the locality plan in Figure 1.

4. STORMWATER MANAGEMENT

The Penrith Lakes Water Management Plan: Stage 2 outlines the strategy for completing and operating the Penrith Lakes Scheme, a large-scale environmental rehabilitation and urban development project located in Castlereagh, within the Penrith Local Government Area. The proposed development is within the bounds of the Penrith Lakes Scheme.

The objective of this section is to demonstrate the civil works and stormwater management strategy necessary to comply with the requirements of the Penrith Lakes Scheme Water Management Plan (Stage 2), which guides stormwater quality and quantity outcomes for developments located within the Scheme area. The strategy supports the proposed Development Application by ensuring stormwater runoff is appropriately treated through measures consistent with the Scheme's integrated treatment train approach, including gross pollutant traps, On-site detention tanks, and WSUD principles, prior to discharge into the adjacent lake system.

4.1 Pre-Development condition and drainage system

Based on the feature survey information, the site is currently in a predominantly undeveloped state, with residential dwellings located on each existing lot. Stormwater runoff from the site is conveyed via an existing drainage line situated along the northern boundary, adjacent to the landscape reserve and lake. This drainage corridor collects runoff from the site and directs it through a culvert outlet into the adjacent lake system, forming part of the broader Penrith Lakes Scheme. The natural grading of the site from south to north facilitates efficient drainage toward this outlet point.

4.2 Proposed Stormwater Management Strategy

The proposed development entails the systematic collection and treatment of stormwater runoff generated from both roof and impervious surface areas. Roof runoff from the proposed buildings will be directed into rainwater tanks, which are intended to supply non-potable demands such as toilet flushing, irrigation, and general outdoor use. Surface runoff from proposed hardstand areas will be captured through a new below-ground drainage network, which is designed to manage stormwater from 1% AEP storm event conveyed via a sufficient below ground drainage network.

Collected runoff will then be directed to a below-ground on-site detention (OSD) system, which is designed to attenuate peak flows to pre-development levels in accordance with Council requirements. From the OSD system, stormwater will be conveyed to a filtration unit for the removal of pollutants prior to discharge. Treated flows will then be directed to a diversion pit, which will ultimately connect to the existing drainage infrastructure located along the northern boundary, ensuring seamless integration with the broader Penrith Lakes Scheme stormwater network.

4.3 Hydrology and Hydraulics

The intensity-frequency-duration (IFD) data of the site's specific location was extracted from Penrith City Council's Stormwater Drainage Specification for Building Developments as shown in Figure 4.

DESIGN RAINFALL INTESNSITY FOR PENRITH

Duration Hr Min	Annual Exceedance Probability (AEP) 100% (mm/h)	50% (mm/h)	20% (mm/h)	10% (mm/h)	5% (mm/h)	2% (mm/h)	1% (mm/h)
0 5	74.51	96.49	125.86	143.36	166.29	196.42	219.79
0 6	69.67	90.24	117.91	134.33	155.84	184.27	206.25
0 7	65.72	85.12	111.26	126.75	147.02	173.89	194.63
0 8	62.38	80.79	105.57	120.25	139.45	164.94	184.59
0 9	59.49	77.04	100.63	114.60	132.87	157.12	175.82
0 10	56.95	73.75	96.27	109.62	127.08	150.23	168.09
0 11	54.69	70.81	92.39	105.19	121.92	144.10	161.21
0 12	52.66	68.18	88.91	101.22	117.29	138.61	155.04
0 13	50.82	65.79	85.76	97.62	113.11	133.64	149.46
0 14	49.14	63.61	82.89	94.35	109.31	129.12	144.40
0 15	47.60	61.61	80.26	91.35	105.83	125.00	139.77
0 16	46.18	59.77	77.85	88.59	102.63	121.20	135.52
0 17	44.87	58.07	75.61	86.05	99.68	117.70	131.60
0 18	43.65	56.49	73.54	83.69	96.94	114.46	127.97
0 19	42.51	55.01	71.61	81.49	94.39	111.44	124.59
0 20	41.45	53.63	69.81	79.43	92.01	108.63	121.44
0 22	39.51	51.13	66.53	75.71	87.70	103.52	115.73
0 24	37.79	48.90	63.63	72.40	83.87	99.01	110.67
0 26	36.25	46.91	61.04	69.45	80.45	94.97	106.16
0 28	34.86	45.11	58.70	66.79	77.38	91.34	102.10
0 30	33.60	43.48	56.58	64.38	74.59	88.05	98.42
0 35	30.91	39.99	52.05	59.23	68.62	81.01	90.55
0 40	28.71	37.15	48.35	55.01	63.75	75.26	84.13
0 45	26.87	34.77	45.26	51.50	59.68	70.46	78.76
0 50	25.30	32.74	42.63	48.51	56.21	66.37	74.19
0 55	23.96	31.00	40.37	45.92	53.22	62.84	70.24
1 00	22.78	29.48	38.38	43.67	50.60	59.75	66.79

Duration Hr Min	Annual Exceedance Probability (AEP) 100% (mm/h)	50% (mm/h)	20% (mm/h)	10% (mm/h)	5% (mm/h)	2% (mm/h)	1% (mm/h)
1 30	17.95	23.23	30.23	34.37	39.81	47.00	52.52
2 00	15.12	19.56	25.43	28.89	33.46	39.47	44.10
2 30	13.23	17.11	22.22	25.22	29.19	34.42	38.44
3 00	11.86	15.33	19.88	22.56	26.10	30.76	34.35
2 30	10.81	13.97	18.10	20.53	23.74	27.97	31.22
3 00	9.97	12.88	16.69	18.92	21.87	25.75	28.74
3 30	10.81	13.97	18.10	20.53	23.74	27.97	31.22
4 00	9.97	12.88	16.69	18.92	21.87	25.75	28.74
4 30	9.29	12.00	15.53	17.60	20.35	23.95	26.72
5 00	8.71	11.26	14.56	16.51	19.07	22.44	25.04
5 30	8.41	10.87	14.05	15.93	18.40	21.66	24.16
6 00	7.80	10.08	13.03	14.77	17.06	20.07	22.40
8 00	6.54	8.45	10.93	12.40	14.33	16.86	18.82
10 00	5.70	7.37	9.54	10.83	12.53	14.76	16.48
12 00	5.08	6.57	8.54	9.70	11.23	13.25	14.80
18 00	3.91	5.08	6.65	7.60	8.83	10.47	11.73
24 00	3.23	4.20	5.56	6.38	7.44	8.87	9.97
36 00	2.42	3.17	4.28	4.95	5.82	7.01	7.91
48 00	1.96	2.58	3.52	4.10	4.86	5.88	6.67
60 00	1.64	2.18	3.00	3.52	4.18	5.09	5.79
72 00	1.42	1.89	2.62	3.08	3.68	4.48	5.11

Figure 4: IFD Design Rainfall Intensity (mm/hr)- Extracted from Penrith City Council's Stormwater Drainage Specification for Building Developments

5. STORMWATER QUALITY

The proposed water quality strategy for the site, which meets all the requirements and target sets by the Penrith Lakes DCP, are described in detail below.

Rainwater tanks and filtration system are selected as the primary WSUD treatment measures for the proposed site to reduce pollutant loads due to the proposed development in accordance with the requirements of the Penrith Lakes DCP, Chapter 3.2.

The key pollutant reduction targets are summarised in the table below.

Table 7: Stormwater Runoff Pollutant Reduction Targets

Pollutant	Reduction Target
Gross Pollutants	90% reduction in the mean annual load
Total Suspended Solids	85% reduction in the mean annual load
Total Phosphorus	65% reduction in the mean annual load
Total Nitrogen	45% reduction in the mean annual load

5.1 Proposed Filtration System

The proposed filtration system includes three key components designed to ensure effective stormwater management and pollutant removal.

- OceanGuard Baskets
- Rainwater tanks
- Filter system (Psorb Stormfilters)

The site is divided into three catchments, each serviced by a dedicated system of rainwater tanks, OceanGuard gross pollutant baskets, and proprietary stormwater filtration units (Psorb StormFilters). For non-roof areas, including landscaped spaces, hardstand surfaces, and driveways, runoff is initially directed to Ocean Guard baskets. These baskets are designed to remove large debris and gross pollutants from the stormwater. Following the initial treatment in the Ocean Guard baskets, the runoff undergoes further treatment through storm filters. These filters are designed to remove finer sediments and contaminants, ensuring that the stormwater meets above mentioned targets before draining to the discharge point. Furthermore, Runoff from hardstand areas that cannot be treated effectively—referred to as bypass areas—also passes through the Ocean Guard baskets before being discharged to the final discharge point.

5.2 Proposed Rainwater Tanks

Stormwater runoff generated from roof areas is directed to dedicated rainwater tanks. These tanks are designed to collect and store rainwater for various non-potable uses, including outdoor water reuse, toilet flushing, and irrigation. To appropriately size the tanks and ensure that reuse demands are met, efficiency curves have been developed for each lot. These curves assess the relationship between harvested rainwater volumes and estimated non-potable water demands across a range of tank capacities.

The proposed development comprises three catchments belonging to three stages, two of which are primarily occupied by recreation facilities, and the third by a hotel, considered a commercial use. Roof runoff from all buildings will be directed to rainwater tanks. For the third catchment, rainwater reuse is limited to non-potable supply within common area toilets and the irrigation of surrounding landscaped areas. For the recreational facility lots, reuse is proposed for toilet flushing and irrigation. To ensure accurate estimation of reuse demands and support robust water balance calculations, the reuse rates have been based on the Penrith city council's WSUD technical guidelines 2014. According to Section 4.5 of this guide:

- For internal reuse in industrial/business developments (including accessible toilets), an allowance of **0.1 kL/day per toilet or urinal** has been adopted.
- For irrigation of landscaped areas only allow **0.4 kL/year/m²** as PET-Rain for sprinkler systems and **0.3 kL/year/m²** for subsurface irrigation. For bioretention filter areas only allow 0**.4 kL/year/m²** as PET-Rain (subsurface irrigation only).

To support stormwater quality improvement and meet Council's reuse targets, multiple rainwater tanks are proposed across the site. The rainwater reuse system is integrated with the overall stormwater management strategy, including on-site detention and treatment prior to final discharge into the existing drainage network along the northern boundary. Refer to the table below for proposed tank capacities and corresponding demand satisfaction estimates.

Table 8: Summery of RWT sizes and details

Location	Volume (KL)	Number Of Toilets	Landscape Area for Irrigation (m^2)	% Of Demand Met
Catchment1	200.65	25	2,705.41	80.26
Catchment2	222.34	31	2,763.79	80.54
Catchment3	200.67	13	2,635.81	71.30

Tables and diagrams are provided in appendix E.

Water quality model for subject site established using MUSIC (Ver 6.3.0) to evaluate pollutant loadings from post developed catchment nodes being as roof areas, commercial lots impervious areas and commercial lots pervious areas, driveway and parking areas.

MUSIC Model results show that adopted target reductions are achieved via implementation of rainwater tanks and separate filtration systems for each catchment. The effectiveness of the treatment devices and measures proposed in the above section has been modelled using MUSIC with the overall treatment train efficiency results shown in Table 9 below.

Table 9: Treatment Train Efficiencies

Indicator	Percentage of Pollutant Reduction Achieved	Targets
Gross Pollutants	96.9 %	90%
Total Suspended Solids	85 %	85%
Total Phosphorus	72.3%	65%
Total Nitrogen	71.3%	45%

Refer to Appendix C for further details on MUSIC model results.

6. STORMWATER QUANTITY

Based on the Penrith lakes Development Control Plan 2014, Chapter 3.2, control 5, Adequate stormwater systems must be designed and constructed to ensure that, development does not increase stormwater peak flows in any downstream area, for all rainfall events up to the 1% AEP event. Therefore, to size the OSD system, the primary objective is to match post-development peak flow for the 5,10,20 and 100-year ARI rain events as closely as possible to pre-development condition for the site.

6.1 Drainage Network

The proposed drainage system has been designed to fully capture and convey all runoff generated during the 1% AEP storm event. Stormwater from the entire development will be directed through the underground network to the On-Site Detention (OSD) systems, ensuring that no overflow occurs under 1% AEP conditions.

6.2 Stormwater Quantity Management System

As discussed in Section 4.2, multiple On-Site Detention (OSD) systems have been designed to limit peak outflows from the proposed development to pre-development levels. These systems have been configured for each catchment to attenuate discharge flows from impervious areas, pervious areas, and driveways. The design ensures that post-development flows do not exceed pre-development flows for the 20% AEP, 10% AEP, 5% AEP, and 1% AEP storm events.

As outlined in Section 3.2, the existing site features a gentle slope from south to north, naturally directing surface runoff toward the northern boundary, where an existing drainage line adjoins the landscape reserve and the adjacent lake system.

In the proposed post-development scenario, the site will be divided into three distinct catchments corresponding with three stages of development, each corresponding to one of the proposed developments. Each catchment will be independently serviced by a dedicated on-site detention (OSD) system designed to manage stormwater quantity by attenuating peak flows to pre-development levels. Following detention, stormwater from each OSD system will be conveyed to a corresponding filtration system to address water quality objectives. Treated runoff will then be directed to a diversion pit, which will connect to the nearest existing stormwater pit located along the northern boundary of each lot. These discharge points ultimately form part of the broader drainage network and will contribute to the Penrith Lakes system, ensuring compliance with both Council and Penrith Lakes Scheme requirements.

The Impervious fractions for existing and proposed scenarios are provided in the table below:

Table 3: Pre-Development catchment analysis

Pre Development Catchment Analysis		
description	**Area (m2)**	**Impervious Area %**
Catchment 1	9,145.20	24
Catchment 2	10,666.00	2
Catchment 3	7,576.50	10
Total Site Area	27,387.70	11

Table 4: Post-Development catchment analysis

Post Development Catchment Analysis				
description	**Total site area (m2)**	**Area draining to basin**	**Area bypassing basin**	**Impervious Area %**
Catchment 1	9,145.2	7,951.20	1,194	80
Catchment 2	10,666	9,183.15	1,482.85	82
Catchment 3	7,576.5	4,820.24	267.10 (Excluding the overland flow path area*)	95 (Excluding the overland flow path area*)

**Note: As identified in the flood study, a portion of Catchment 3 is designated as an overland flow path during the 1% AEP flood event and this area has been excluded from the imperviousness percentage calculations. Refer to the stormwater drawings for the extent of the overland flow path and to Section 7 for further flood-related details.*

Figure 5: Internal Catchment plans and corresponding OSD tanks

Discharges from each OSD tank will be controlled with a dual low flow orifice and high flow overflow weir fitted within the OSD system (Refer to civil drawings details plans). This combination is to optimise outflow rate during various stormwater events and to ensure outflow is limited to the flows in pre-development condition which is aligned with the objectives set out in DCP.

To analyse the characteristics of stormwater flows and to determine the appropriate volume for each OSD tank, hydrology and hydraulics models were established for the proposed stormwater drainage network, for 20% AEP,10% AEP, 5% AEP and 1% AEP storm events using DRAINS model, in accordance with the Penrith Lakes DCP and Penrith City Council's stormwater Drainage Guidelines.

7.3 DRAINS Modelling

DRAINS is an Australian made software program used for designing and analysing stormwater drainage systems and catchments, which widely utilised in the Australian market and recognised by various authorities across Australia.

For urban catchment analysis, DRAINS uses the Horton / ILSAX Hydrological modelling and the time-area routing procedure to convert rainfall hyetographs to runoff hydrographs. Also, Kinematic Wave Equation is used to estimate Times of Concentration for respective sub-catchments with specific flow path lengths, surface roughness, rainfall intensity and surface slope.

DRAINS modelling indicates that, with the implementation of the proposed OSD tanks, peak discharge flows from the commercial developments and associated driveways, will be limited to below discharge rates in pre-development conditions during all storm events.

Table 5: Summery of OSD components

Name/location	Volume Required (m3)	Low Flow Orifice Size(mm)	High Flow Orifice Size(mm)	1% AEP Top Water Level (m AHD)
Catchment 1 OSD	175.50	250	450	24.56
Catchment 2 OSD	268.60	215	505	23.72
Catchment 3 OSD	140.20	195	375	23.84

Refer tables below for pre and post developed peak flow with implementation of OSD tanks.

Table 6: Post and Pre developed peak flows

Pre & Post Development Peak Flow Rates (L/s)					
	Name/Location	20% AEP	10% AEP	5% AEP	1% AEP
Post- Developed Peak Flow (m3/s)	Catchment 1	84	121	177	273
	Catchment 2	65	89	140	260
	Catchment 3	61	78	102	207
Pre- Developed Peak Flow (m3/s)	Catchment 1	98	132	177	277
	Catchment 2	66	105	146	262
	Catchment 3	61	92	125	211

Models and Results from the DRIANS provided in appendix A.

7. FLOODING

The subject site is impacted by both local (overland) and reginal (riverine) flooding sources. A detailed assessment of flooding has been conducted in a separate report prepared by Water Technology Consultants, Ref No:24050074_M01V01_Flood_ Assessment.

8. EROSION AND SEDIMENT CONTROL PLAN

Prior to the demolition stage and before any construction can take place, erosion and sediment control measures must be set in place. The measures that have been proposed are as follows:

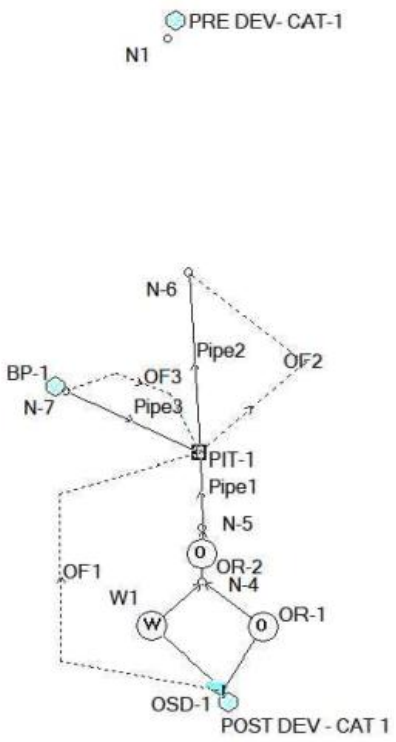
- Site security fence surrounding the site
- Sedimentation fences around downstream areas, surrounding disturbed areas and any soil stockpiles
- Geotextile filter fabric sediment traps
- Temporary site access cattle grid
- Sedimentation basin in excavated areas
- Pump and filtration system
- Haybales through which the pumped-out water will be discharged as a secondary method of filtration

Refer to Erosion and Sediment control plans prepared as part of Civil drawings for proposed development for further details.

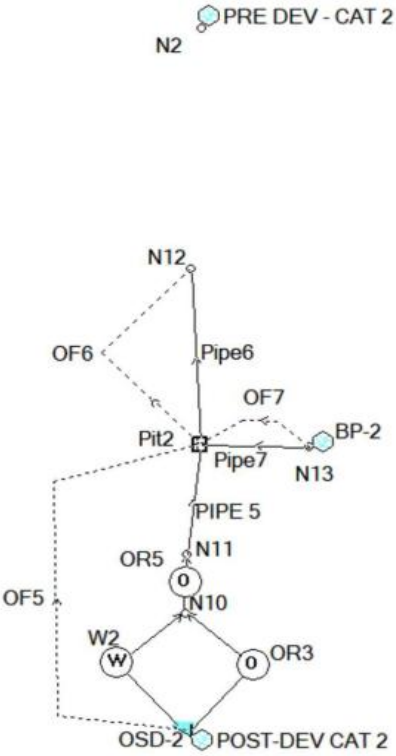
9. APPENDICES

APPENDIX A: DRAINS MODELS AND DRAINS RESULTS

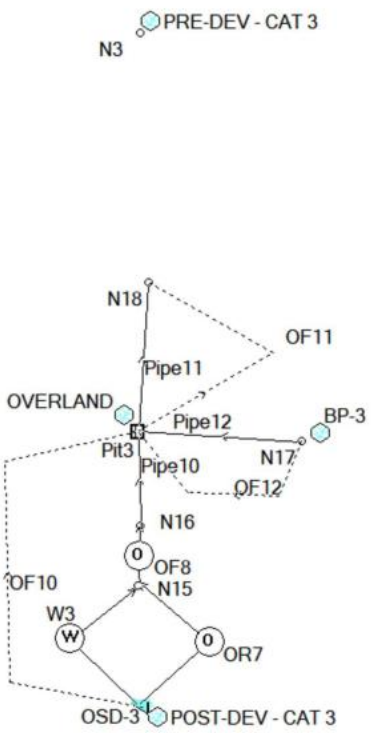
DRAINS MODEL:



CATCHMENT 1 (STAGE 1)
DRAINS MODEL

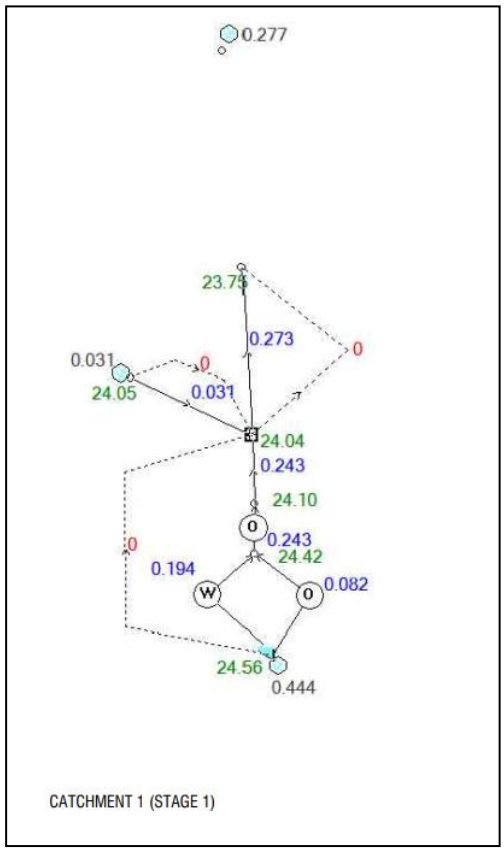


CATCHMENT 2 (STAGE 2)
DRAINS MODEL

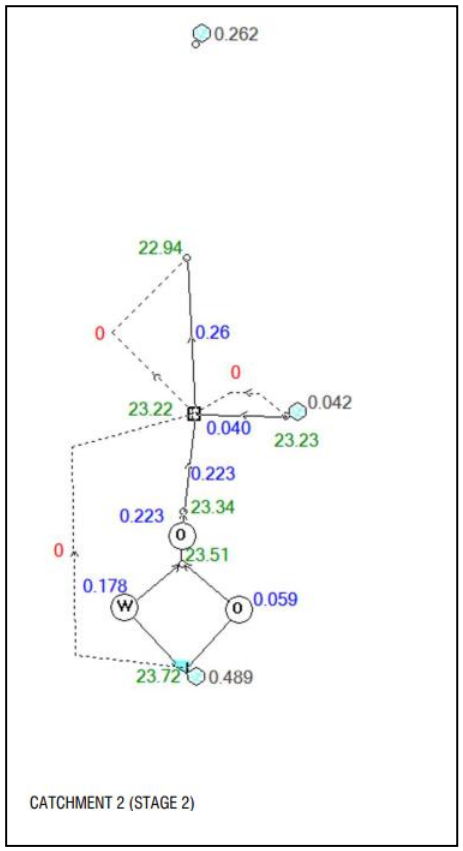


CATCHMENT 3 (STAGE 3)
DRAINS MODEL

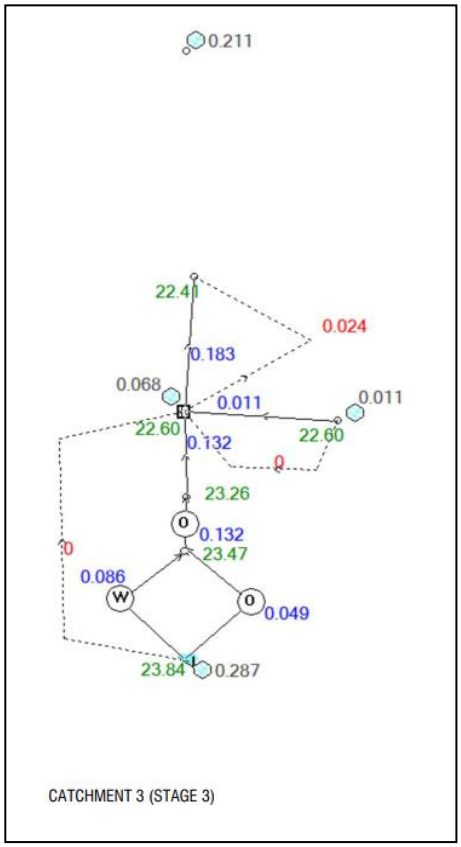
DRAINS Result (1% AEP)



CATCHMENT 1 (STAGE 1)

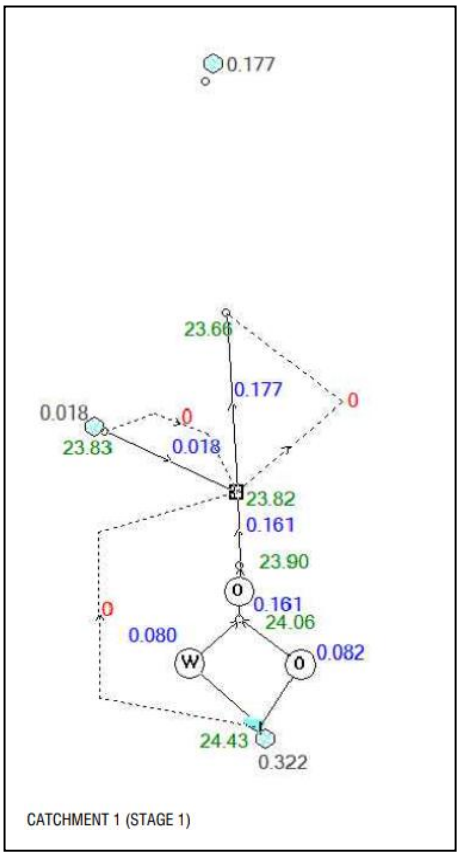


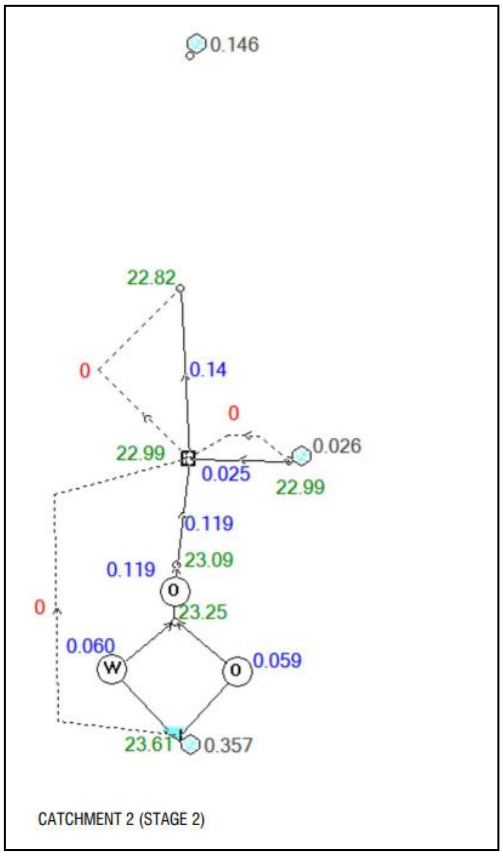
CATCHMENT 2 (STAGE 2)

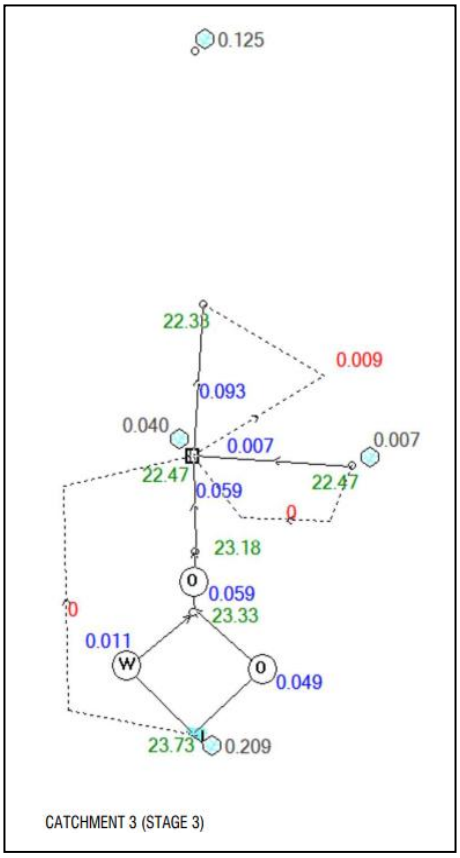


CATCHMENT 3 (STAGE 3)

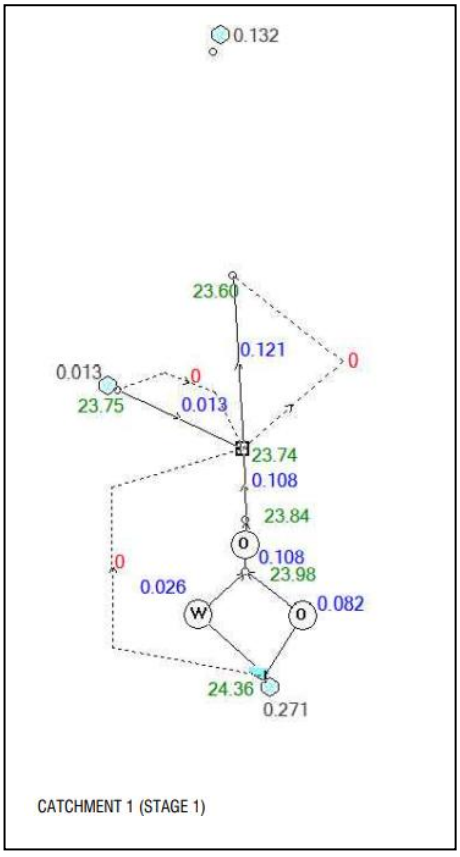
DRAINS Result (5% AEP)

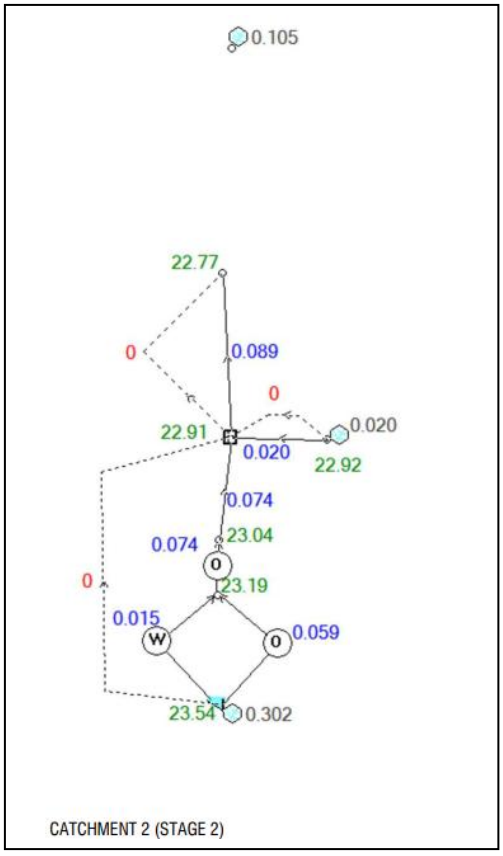


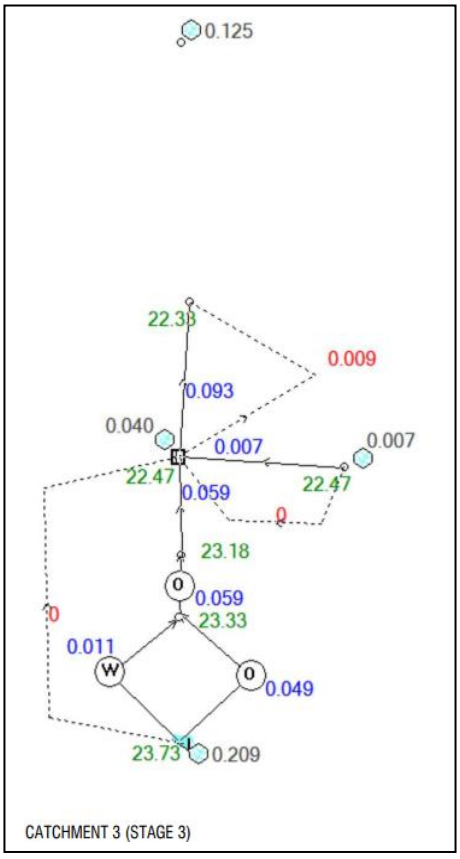




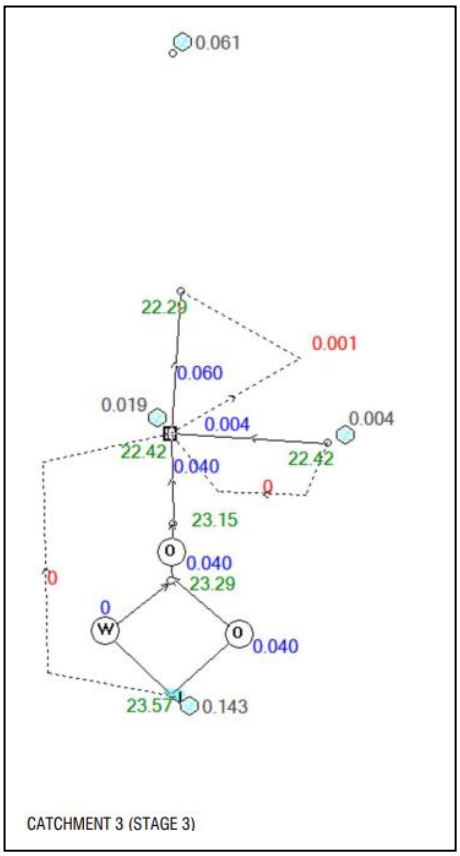
DRAINS Result (10% AEP)



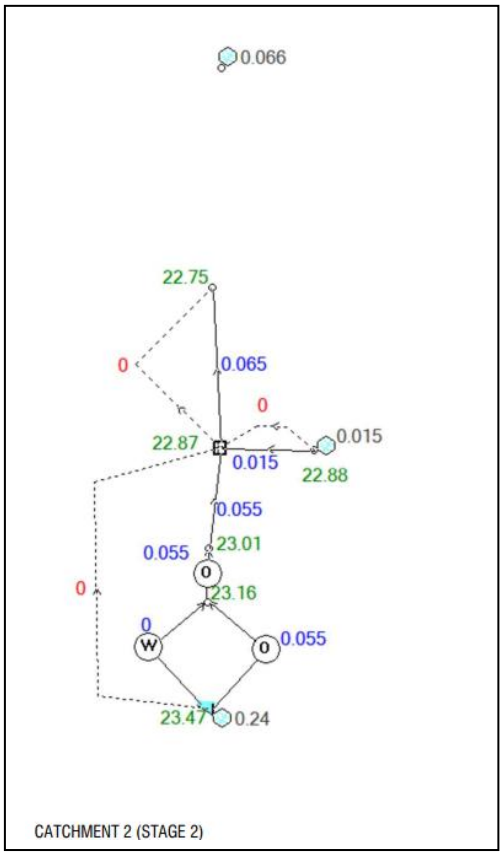




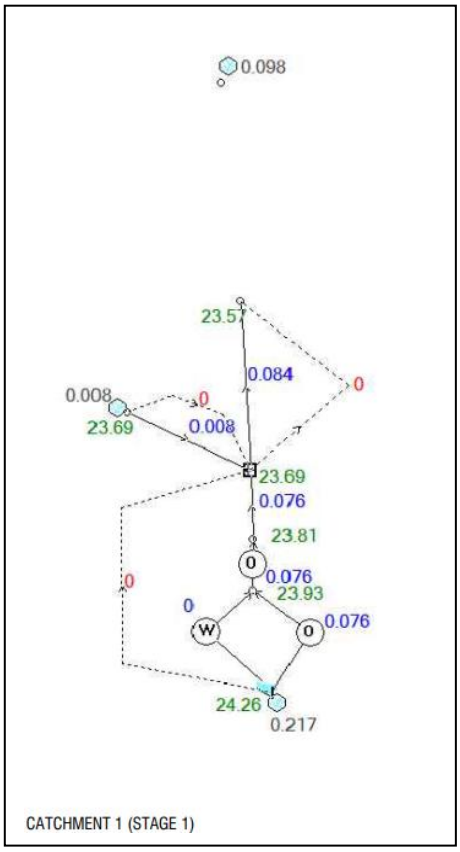
DRAINS Result (20% AEP)



CATCHMENT 3 (STAGE 3)



CATCHMENT 2 (STAGE 2)

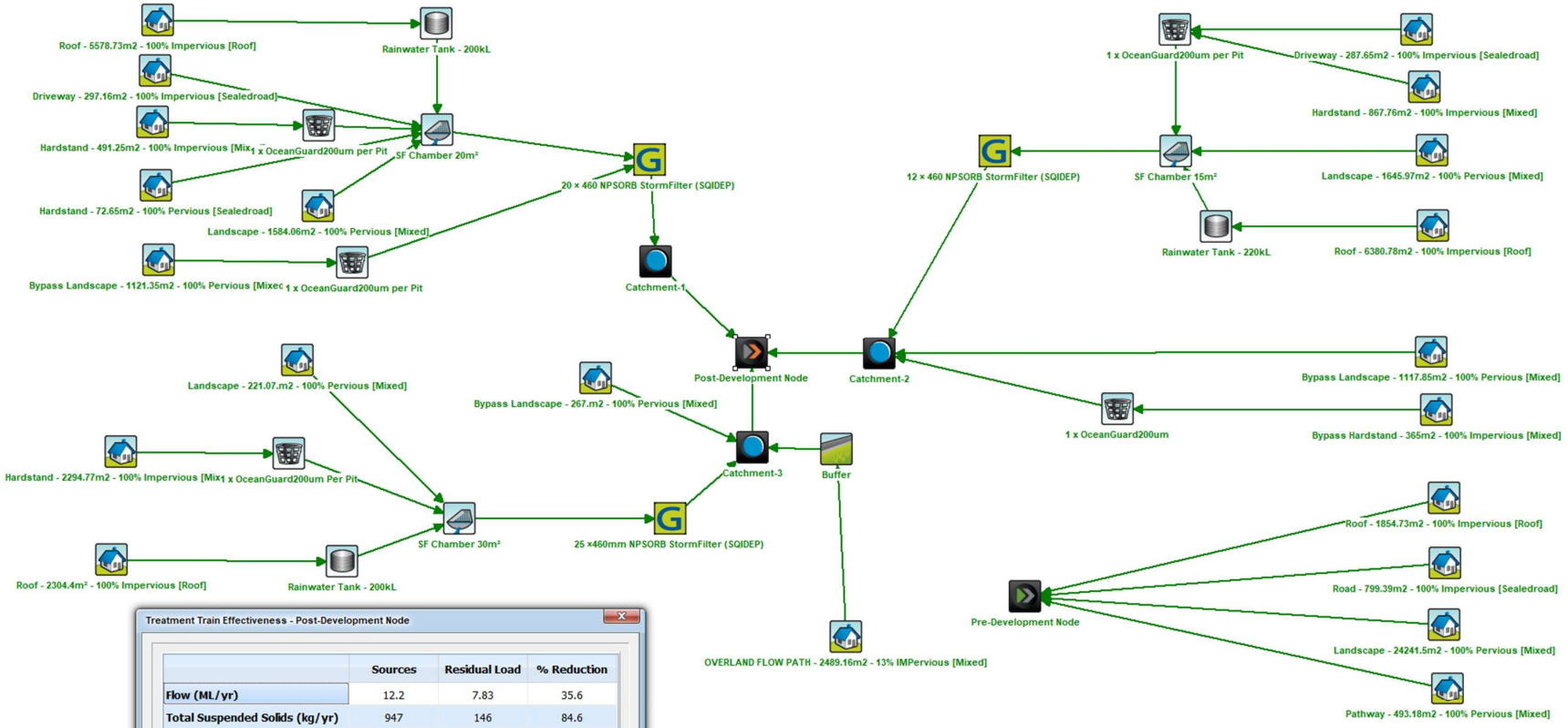


CATCHMENT 1 (STAGE 1)

APPENDIX B: MUSIC MODEL AND RESULTS

SMART STRUCTURES AUSTRALIA

MUSIC Model



Treatment Train Effectiveness - Post-Development Node

	Sources	Residual Load	% Reduction
Flow (ML/yr)	12.2	7.83	35.6
Total Suspended Solids (kg/yr)	947	146	84.6
Total Phosphorus (kg/yr)	2.47	0.687	72.2
Total Nitrogen (kg/yr)	26.8	7.69	71.3
Gross Pollutants (kg/yr)	323	9.87	96.9

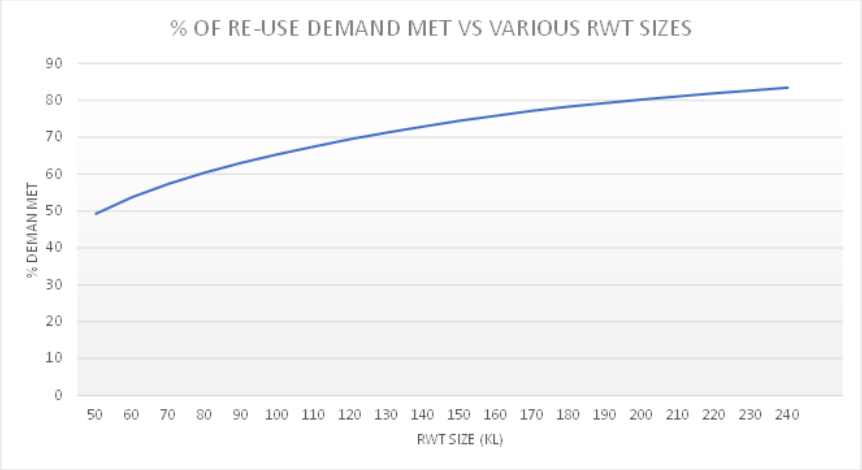
Include Pre-Development

A: Suite2.04, 35-41 Waterloo Road, Macquarie Park NSW 2113
E: info@smartstructs.com.au

APPENDIX C: EFFICIENCY TABLES FOR RAINWATER TANKS

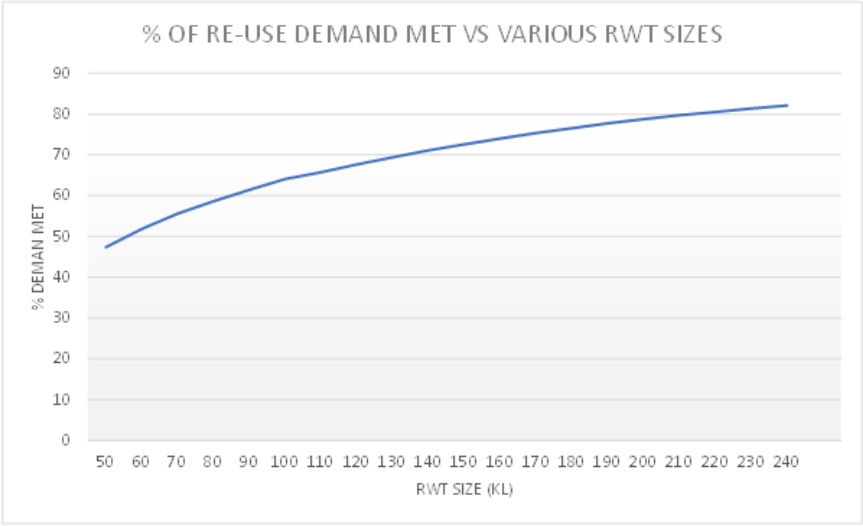
Catchment 1 Efficiency Curve & Table:

RWT Size (KL)	Percentage of demand met (%)
50	49.28
60	53.77
70	57.41
80	60.46
90	63.08
100	65.4
110	67.53
120	69.53
130	71.31
140	72.91
150	74.48
160	75.88
170	77.19
180	78.33
190	79.32
200	80.26
210	81.13
220	81.94
230	82.7
240	83.47



Catchment 2 Efficiency Curve & Table:

RWT Size (KL)	Percentage of demand met (%)
50	47.33
60	51.83
70	55.56
80	58.62
90	61.39
100	64.09
110	65.7
120	67.64
130	69.43
140	71.09
150	72.55
160	74.01
170	75.33
180	76.53
190	77.73
200	78.78
210	79.71
220	80.54
230	81.34
240	82.1



Catchment 3 Efficiency Curve & Table:

RWT Size (KL)	Percentage of demand met (%)
50	45.92
60	49.19
70	51.86
80	54.34
90	56.52
100	58.58
110	60.6
120	62.42
130	63.99
140	65.33
150	66.61
160	67.69
170	68.7
180	69.65
190	70.52
200	71.3
210	72
220	72.66
230	73.29