Appendix 5 – Stormwater Management Strategy

STORMWATER MANAGEMENT STRATEGY

RESIDENTIAL SUBDIVISION

17 & 29 Smith Street and 9 Raglan Street, Daylesford

Prepared for

Smith Development Partnership Pty Ltd

Document Reference

863SS-02

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ISO 9001 certified Equal Assurance

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Definitions

AEP	Annual Exceedance Probability
WSUD	Water Sensitive Urban Design
RORB	Runoff and stream flow routing program
MUSIC	Stormwater treatment program

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1. INTRODUCTION

This Stormwater Strategy (SS) has been prepared for a proposed staged residential subdivision on three parcels of land known as 17 & 29 Smith Street and 9 Raglan Street, Daylesford.

The broad objectives of the SS are to ensure that there are no adverse impacts on the receiving waterways along with achieving best practice pollutant reductions through Water Sensitive Urban Design (WSUD) and storage of stormwater for onsite detention requirements.

2. SITE & SURROUNDS

The topography of the catchment is undulating with varying slopes up to 1:5.

The total catchment area for the development sites is 7.54ha. Individually, 17 Smith Street is 4.88ha, 29 Smith Street is 0.66ha and 9 Raglan Street is 2ha. There is an upstream catchment area of 13.48ha, which means the total catchment area 21.01ha.

The site is located within Hepburn Shire Council and is zoned as General Residential Zone 1 (GRZ1). A locality plan is sown in Figure 1 below.

Figure 1 – Locality Plan

Overlays ESO 1 and ESO 2 exist over the site and this strategy will address with references to stormwater, mentioned within the schedules for these overlays. The schedules also mention

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requirements for sewer and the site will provide sewer reticulation that is connected to the existing sewer system.

3. PROPOSED DEVELOPMENT

A Planning Permit exists for the staged subdivision of 17 Smith Street in 53 residential lots (Council ref no. PA 2504). A plan of the proposed development is shown below in Figure 2.

Figure 2 – Proposed Development Plan

4. EXISTING STORMWATER DRAINAGE

An overland flow path exists on the eastern side of the development site, which flows in a northerly direction. The majority of the site falls to the overland flow path, with the exception of the northwest part of the site, which falls towards Smith Street.

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No formal drainage infrastructure currently exists in the overland flow path. The northwest catchment will connect to Council's existing underground drainage network in Smith Street.

5. STORMWATER DISCHARGE

The software program RORB was used to create the hydrological model. RORB is a nonlinear rainfall runoff and streamflow routing model for calculation of flow hydrographs in drainage and stream networks, which are used in the hydraulic model. The overall catchment was broken into sub-catchments and a plan showing these can be found in Appendix A. The configuration of the RORB model can be seen below in Figure .

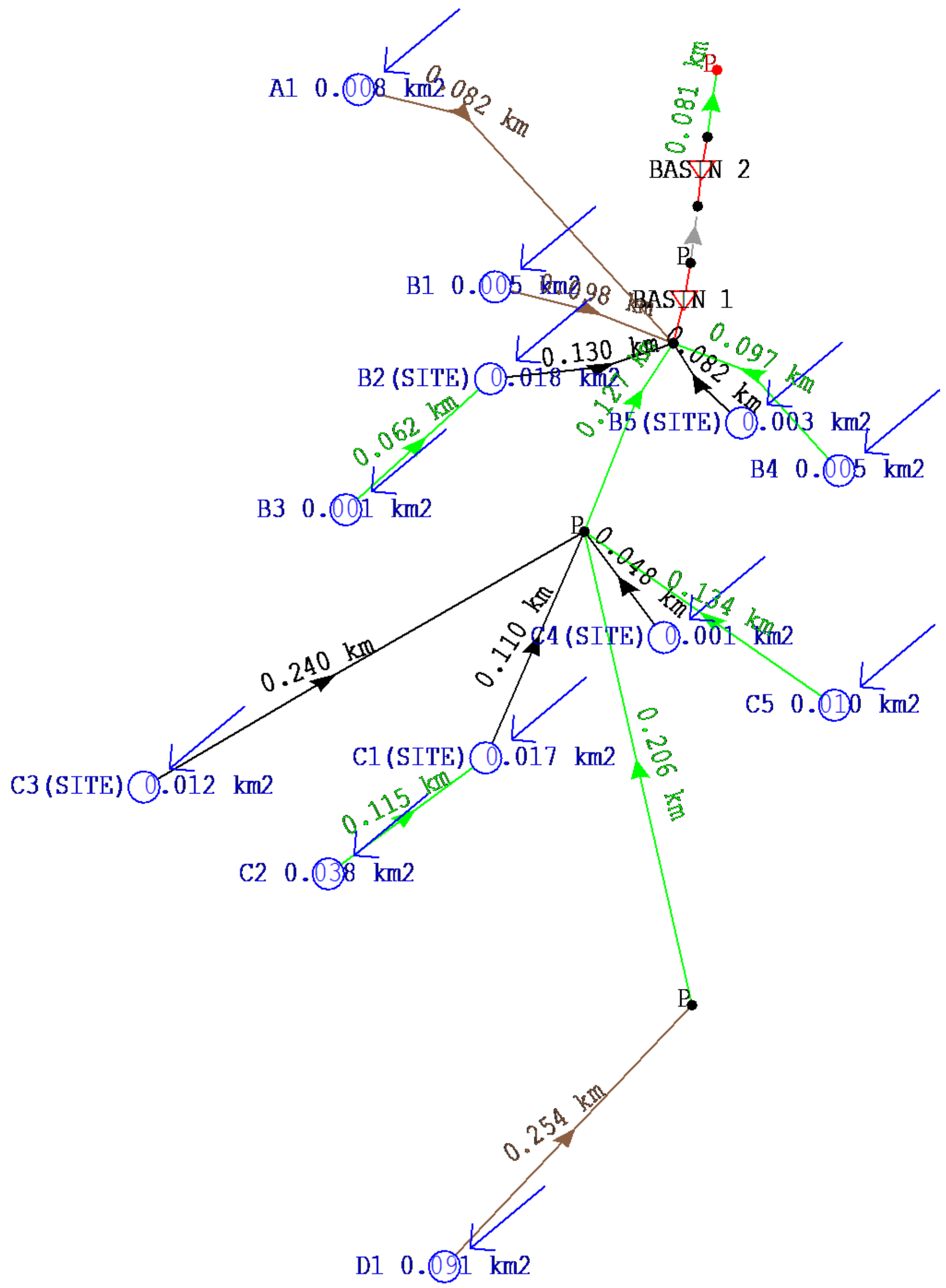

Figure 3 – RORB Model Configuration

RORB Parameters

- Runoff coefficient model
- Rainfall Intensity Frequency Duration: ARR 2016 IFD
- Filtered patterns
- Uniform Areal Pattern
- Areal Reduction Factor: ARR Data Hub File
- Kc = 0.43
- M = 0.8
- Initial Loss = 26mm
- Continuing Loss = 4.3
- Ensemble mode used to determine critical event and temporal pattern (Refer Figure 4 below)

Note: Kc was calibrated using the ARR Regional Flood Frequency Analysis and correlation was found with the Auswide Dyer Kc value. Refer to Appendix D for details.

A pre-development catchment file was created in RORB, which represents the current pre-developed scenario (natural reaches and very low fraction impervious) including the upstream catchment of the overland flow path to the east of the site. Outputs generated at the north eastern corner of the site (the outlet) for the 20% AEP event. For comparison, a post-development model was created to assess the likely increase in peak flows and storm duration. Finally, storage nodes were added to the post-development scenario in an attempt to alleviate the increase in flows between the pre and post scenarios. A summary of the RORB model outputs are shown below in Table 1.

Scenario	Peak Storm Duration	Discharge at Outlet (m^3/s)
Pre-development 20% AEP	3 hour	0.52
Post-development 20% AEP no storage	2 hour	0.71
Post-development 20% AEP with storage	2 hour*	0.49

* Selected from Ensemble Simulation:

Table 1 – RORB Flow Summary

In order to determine the most critical storm duration and accompanying temporal pattern, RORB was run in Ensemble mode. The ensemble analysis incorporates 10 different temporal patterns for each storm duration and produces an output file.

The output file determines which duration produces the peak discharge at the outlet. Then the temporal pattern that most closely represents the average of the peak flows for that duration is selected and utilized for the single storm event analysis (results are shown in Appendix C).

Two storage nodes (Basin 1 and Basin 2) were modelled in the 'Post-development 20% AEP with storage scenario' to detain the required volume that achieves a discharge flow of less than the Pre-development scenario.

Each storage node includes details relating to height, storage and outflow, also known as a HSQ table. A 1200mm x 300mm box culvert acts as an orifice in each basin. Refer to Table 2 below for details.

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Basin 1			Basin 2		
H (AHD, m)	S (m^3)	Q (m^3/s)	H (AHD, m)	S (m^3)	Q (m^3/s)
589.5	0	0	589.10	0	0
589.8	152	0.37	589.4	145	0.48
590.1	348	0.57	589.7	344	0.64
590.4	700	0.71	590.00	1000	0.77

Table 2 – RORB Storage Details

Table 3 below shows the performance of each of the storages, including inflow, outflow and storage volume for the post-development peak discharge storm duration (2 hour as shown above). It should be noted the spillways for Basins 1 and 2 are not engaged at all during the post-development 20% AEP storm event.

Storage	Inflow (m^3/s)	Outflow (m^3/s)	Storage (m^3)	Peak Elevation (AHD, m)
BASIN 1	0.70	0.53 (pipe only)	341	590.09
BASIN 2	0.53	0.50 (pipe only	165	589.43

Table 3 – RORB Storage Summary

Full results of the post-development storage scenario from RORB can be found in Appendix C.

The storage requirements in Table 2 above have been achieved by creating additional 'air space' above the treatment zones of the proposed bioretention systems (Basin 1 and Basin 2).

It should be noted the post-development with storage option produces a discharge flow rate at the outlet of 0.89m^3/s, which is slightly below the pre-development flow of 0.919m^3/s, meaning the development does not worsen the peak flow at the outlet.

As per discussions with Council, any drainage outlet connection to the existing overland flow path will incorporate methods to avoid concentrated flows entering the overland flow path, such as a wide weir or energy dissipating structure.

Figure 4 on page 6 shows a schematic of Basins 1 and 2, including proposed contours for the basins and subdivision.

In regards to the northwestern catchment that cannot physically drain to the proposed basins, a separate detention system is proposed using oversized underground pipes, generally in accordance with Figure 5 on page 7. This system will connect to existing Council infrastructure in Smith Street, via an outfall pipe through the 29 Smith Street. A drainage easement will be created for the outfall pipe.

As there is no overland flow available for the northwest catchment, the detention system will provide storage volume calculated for the 1% AEP storm event. Refer to Appendix E for the west catchment detention computations.

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Figure 4 – Basin Plan

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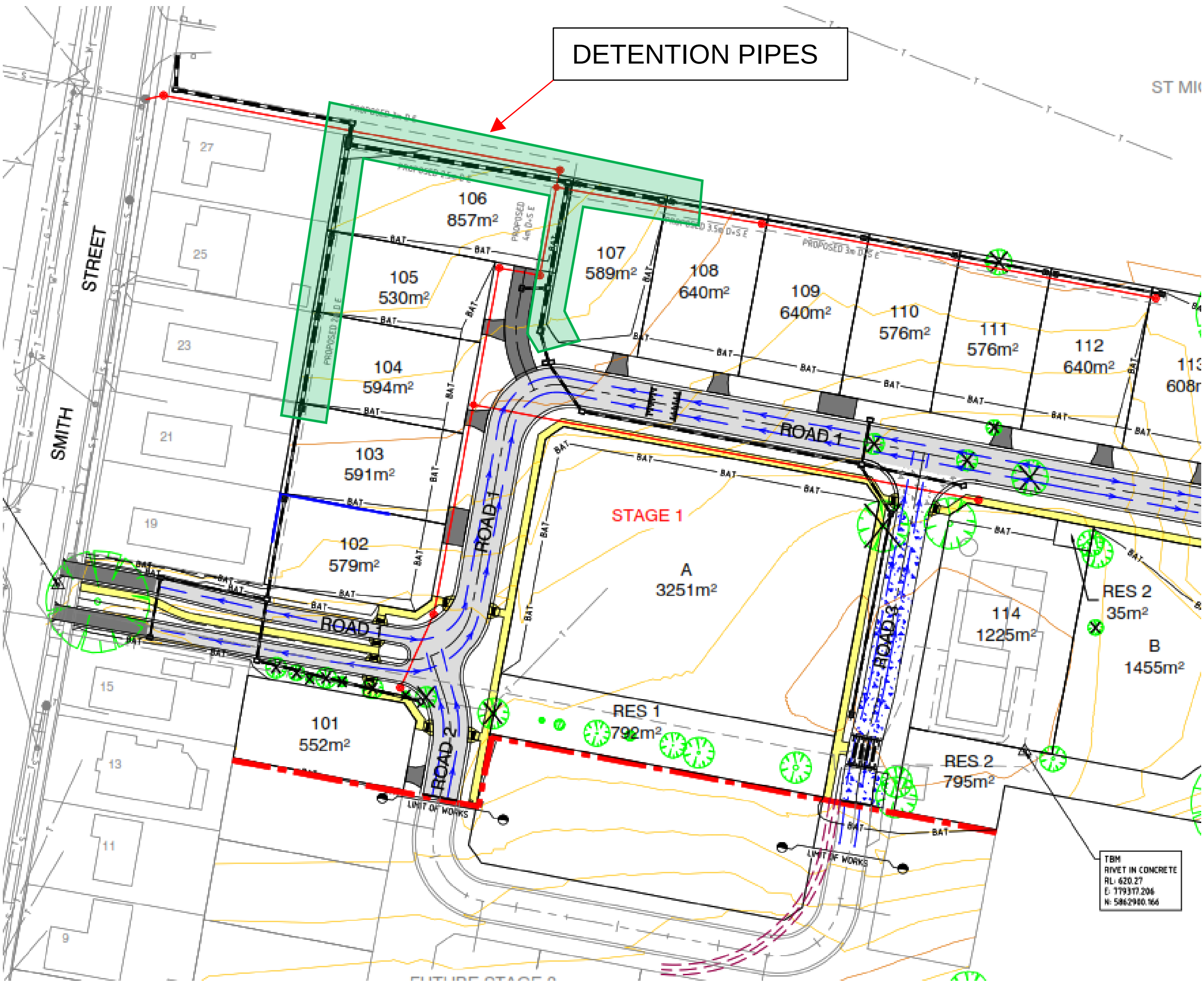

Figure 5 – Stage 1 FLP

6. OVERLAND FLOWS

There are two existing overland flow paths from the upstream catchment. One comes from the south and represents the majority of the upstream catchment. The other overland flow path comes from the west and has a much smaller catchment.

Refer to Figure 6 below for a plan showing the existing overland flow paths and how they can be managed within the development site, particularly the eastern overland flow path, which will need to be realigned as part of the 17 Smith Street development. There is also on overland flow path required in the southwest catchment to allow stormwater to flow to the basins across private land. If an agreement cannot be reached with the adjoining landowner, then the southwest catchment will need to provide a separate treatment and detention system.

It is noted that all overland flow paths will in accordance with DELWP "Guidelines for Development in Flood Affected Areas" design criteria.

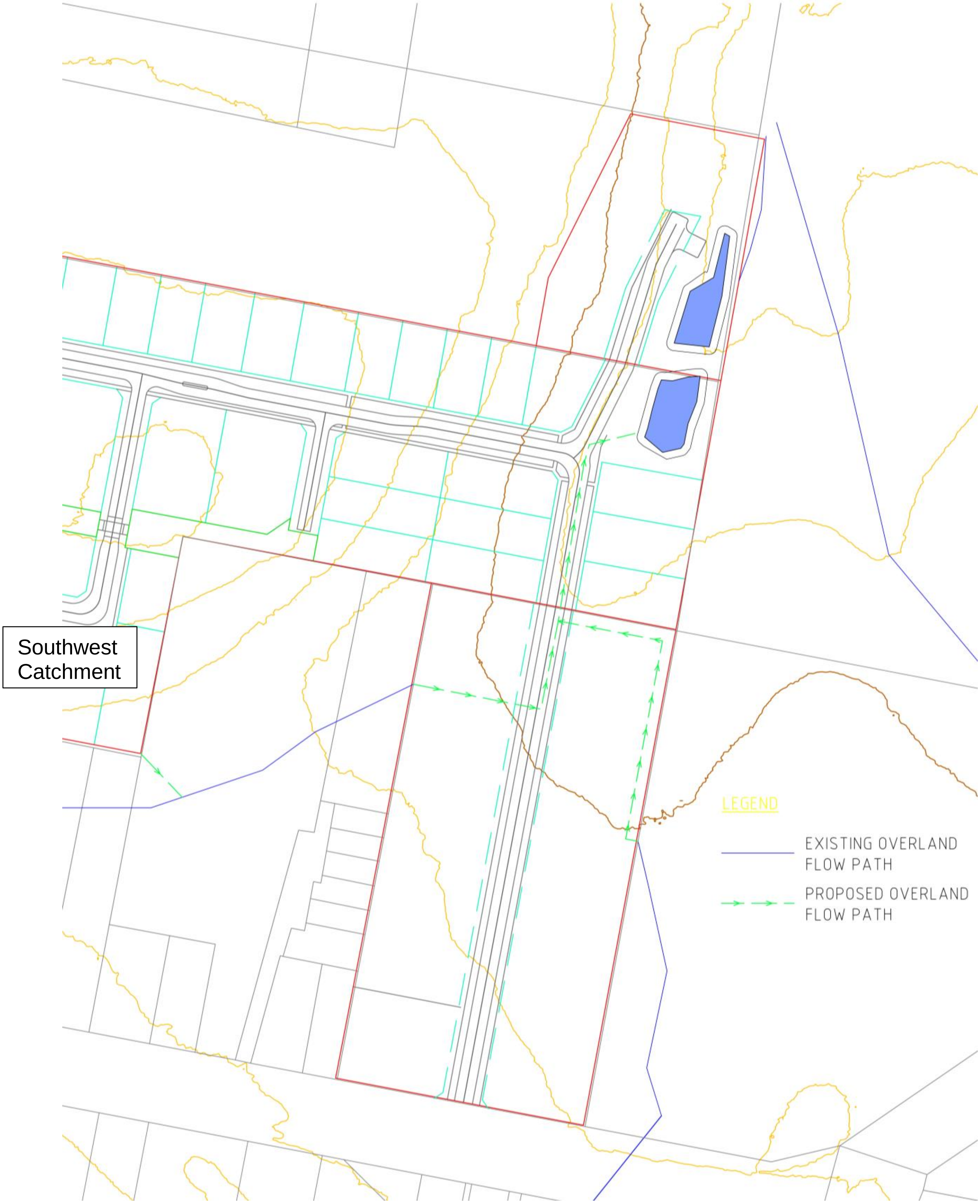

Figure 6 – Overland Flow Path Plan

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7. STORMWATER QUALITY

To address the WSUD requirements for stormwater quality treatment in the post development phase, a MUSC model has been produced. Refer to Appendix B for model layout and results for pollutant reductions.

MUSIC has the ability to simulate rainfall events for catchments and produce outputs from treatment nodes to measure the effectiveness of pollutant reductions at a given discharge point. The discharge point in the model shown in Appendix B is the existing overland flow path at the northeast corner of the development site.

As stated in *Water Sensitive Urban Design Engineering Procedures – Stormwater* published by CSIRO 2005, the requirements to meet best practice guidelines are as follows:

- 70% reduction in gross pollutants
- 80% reduction in total suspended solids
- 45% reduction in total nitrogen
- 45% reduction in total phosphorous

In order to achieve the above outcomes a series of treatment nodes are proposed, including a sedimentation pond, bioretention system and rainwater tanks.

As part of Central Highlands Water's requirements in relation to Integrated Water Management, rainwater tanks are proposed for each lot, which are to be plumbed to the dwelling for reuse in toilet flushing. An allowance for 150L/day has been made for each lot, which represents the typical daily household toilet and laundry demand.

A summary of the key elements within the wetlands and bioretention systems is shown below in Table 4.

	Rainwater Tanks	Basin 1 (Sedimentation Pond)	Basin 2 (Bioretention System)
Storage Volume (kL/lot)	3.5	N/A	N/A
Daily Reuse (kL/lot)	0.15	N/A	N/A
Surface Area (m²)	N/A	250	400
Permanent Volume (m^3)	N/A	200	N/A
Extended Detention (m)	N/A	0.01*	0.3

* The sedimentation pond will not have any extended detention depth, but MUSIC does not allow a value of 0. Therefore, a value of 0.01 has been used.

Table 4 – Treatment Node Summary

All lots will have the roof drainage connected to a 3500L rainwater tank, which will be plumbed to the dwelling for reuse in toilet flushing and laundry. This requirement will be mandated by way of a Section 173 Agreement.

The bioretention systems remove pollutants using an infiltration process incorporating various layers of sandy loam, sand and course gravel. Treated stormwater is collected in perforated pips below the filter media and transported to a discharge pit.

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8. CONCLUSION

It has been determined that the increase of stormwater runoff due to development in the described catchment area can be decreased back to pre-existing conditions via two storage basins.

All stormwater from the catchment shall be directed to existing Council drainage (western catchment) or the existing overland flow path (eastern catchment).

Stormwater quality best practice targets can be met using the described treatment nodes, which can be constructed inside each of the retarding basins.

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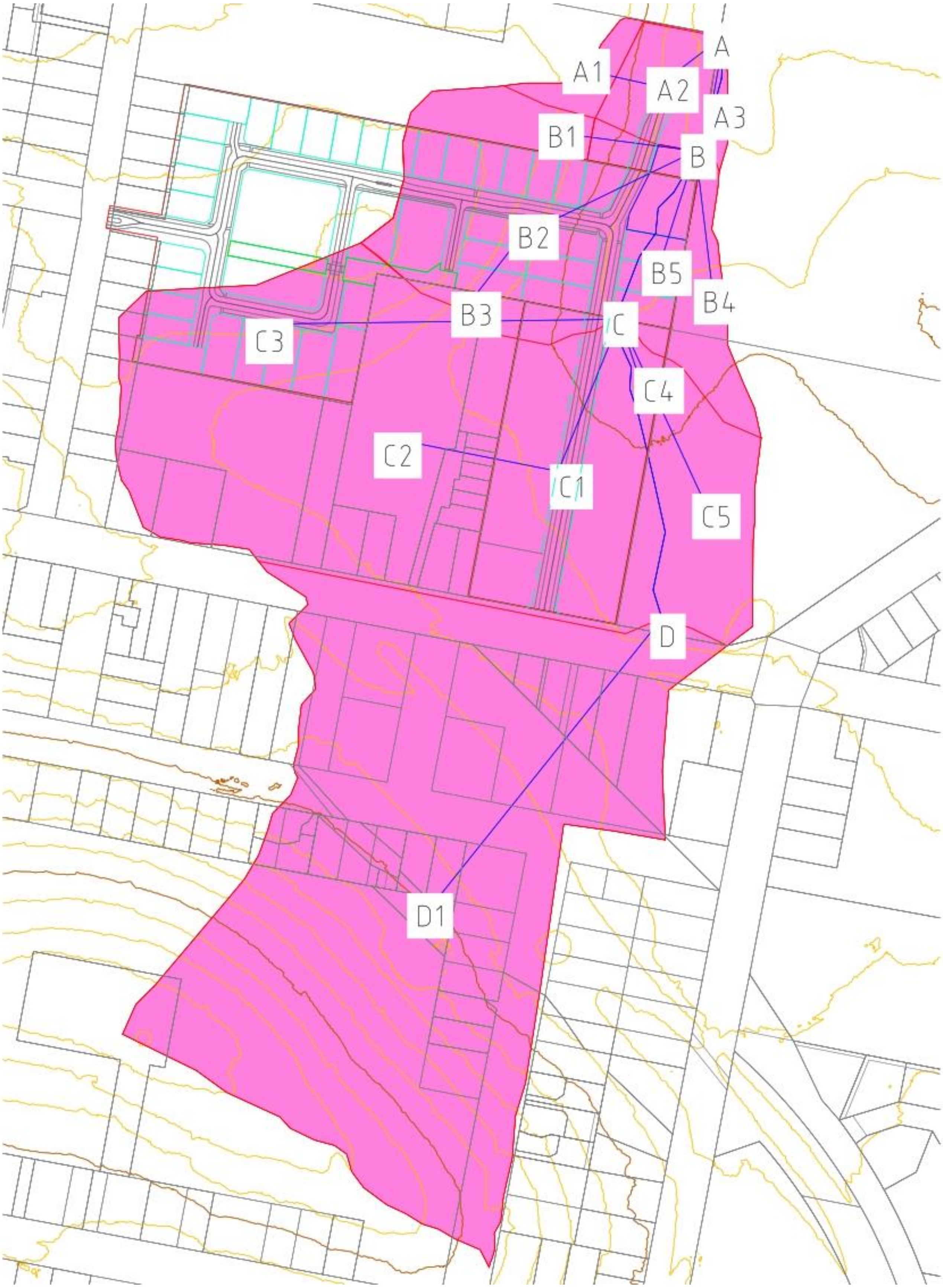
APPENDIX A



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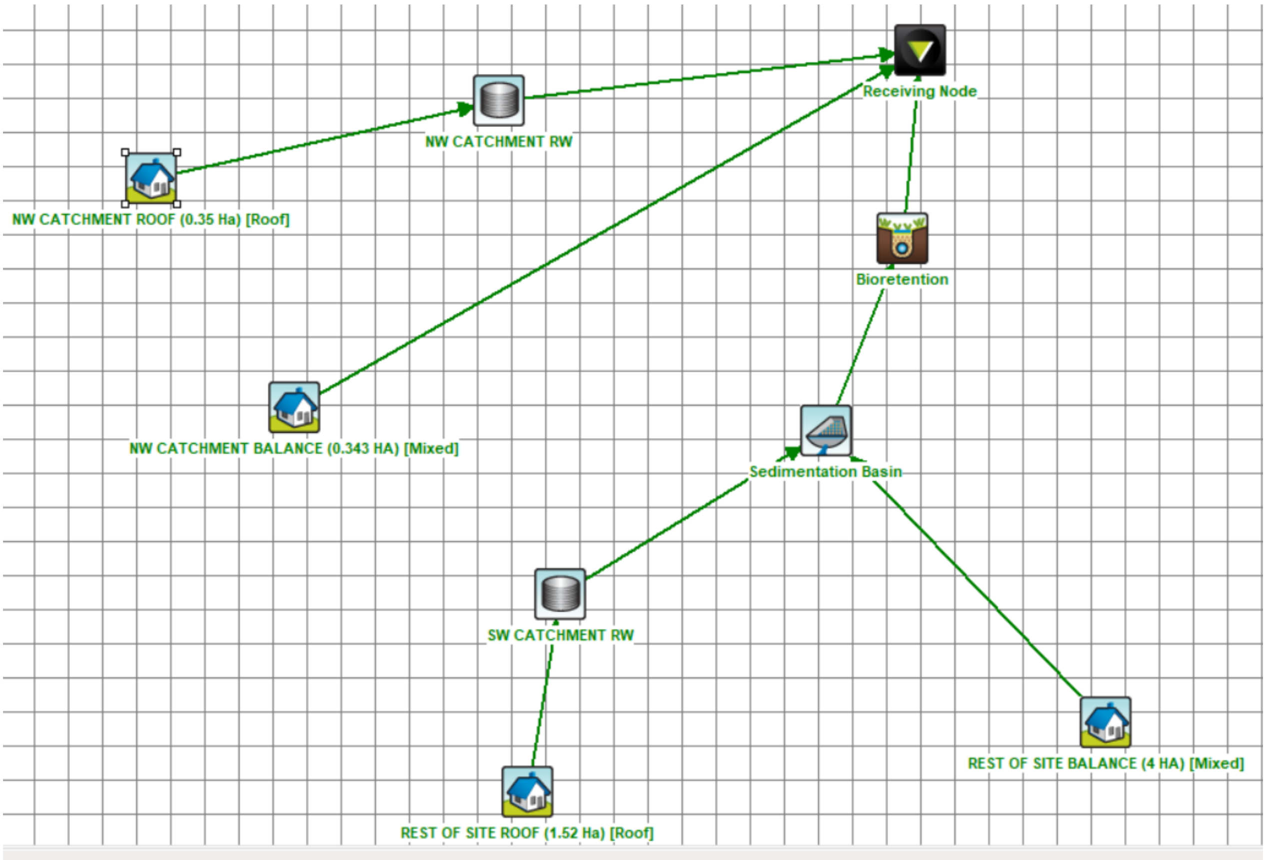
APPENDIX B



Treatment Train Effectiveness - Receiving Node

	Sources	Residual Load	% Reduction
Flow (ML/yr)	23.6	16	32
Total Suspended Solids (kg/yr)	2640	529	80
Total Phosphorus (kg/yr)	6.64	2.47	62.8
Total Nitrogen (kg/yr)	60.6	30	50.5
Gross Pollutants (kg/yr)	918	43.5	95.3

APPENDIX C

RORBWin Output File
****

Program version 6.45 (last updated 20th March 2019)
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Date run: 03 Dec 2021 10:28

Vector file : P:\Project 861 - 880\863 - 17 Smith St, Daylesford\863 - 17 Smith Street, Daylesford Stage 1\7. Road & Drainage\STORMWATER STRATEGY\December 2020\SMITH ST POST-DEV DETN 2 21Jan.catg
Storm file : P:\Project 861 - 880\863 - 17 Smith St, Daylesford\863 - 17 Smith Street, Daylesford Stage 1\7. Road & Drainage\STORMWATER STRATEGY\27 January 2021\Output Files\SMITH ST POST-DEV DETN 2 21Jan_dur2hour_aep20.stm
Output information: Flows & all input data

Data checks:
****
Next data to be read & checked:

Catchment name & reach type flag
Control vector & storage data
Code no. 5 7.0 Location read as D
Code no. 17 7.0 Location read as C
Code no. 35 16.0
Code no. 36 7.0 Location read as B
Code no. 37 16.0
Code no. 39 7.0 Location read as A
Sub-area areas
Impervious flag
Fractions impervious
Initial storm data
Rainfall burst times
Pluviograph 1
Sub-area rainfalls

Data check completed

Data:
****

SMITH STREET DAYLESFORD

Time data, in increments from initial time
SMITH STREET DAYLESFORD: 2 hour 20% Design Storm No.6 Temporal Patte
Time increment (hours)= 0.08

	Start	Finish
Rainfall times:	0	24

End of hyeto/hydrographs: 24
Duration of calculations: 70

Pluviograph data (time in incs, rainfall in mm, in
increment following time shown)

1:Temporal pattern (% of depth

Time	1
0	4.36
1	5.44
2	5.43
3	3.26
4	3.26
5	4.35
6	4.35
7	4.89
8	4.89
9	4.35
10	4.89
11	3.26
12	2.72
13	2.72
14	3.26
15	3.26

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16	3.80
17	3.80
18	3.80
19	3.80
20	4.35
21	4.89
22	4.89
23	5.98

Total 100.0

DESIGN run control vector

Step	Code	Description
1	1	Add sub-area 'A' inflow & route thru normal storage 1
2	2	Add sub-area 'B' inflow & route thru normal storage 2
3	3	Store hydrograph from step 2; reset hydrograph to zero
4	1	Add sub-area 'C' inflow & route thru normal storage 3
5	7.0	Print hydrograph, D
6	5	Route hydrograph thru normal storage 4
7	4	Add h-graph ex step 3 to h-graph ex step 6
8	3	Store hydrograph from step 7; reset hydrograph to zero
9	1	Add sub-area 'D' inflow & route thru normal storage 5
10	4	Add h-graph ex step 8 to h-graph ex step 9
11	3	Store hydrograph from step 10; reset hydrograph to zero
12	1	Add sub-area 'E' inflow & route thru normal storage 6
13	4	Add h-graph ex step 11 to h-graph ex step 12
14	3	Store hydrograph from step 13; reset hydrograph to zero
15	1	Add sub-area 'F' inflow & route thru normal storage 7
16	4	Add h-graph ex step 14 to h-graph ex step 15
17	7.0	Print hydrograph, C
18	5	Route hydrograph thru normal storage 8
19	3	Store hydrograph from step 18; reset hydrograph to zero
20	1	Add sub-area 'G' inflow & route thru normal storage 9
21	2	Add sub-area 'H' inflow & route thru normal storage 10
22	4	Add h-graph ex step 19 to h-graph ex step 21
23	3	Store hydrograph from step 22; reset hydrograph to zero
24	1	Add sub-area 'I' inflow & route thru normal storage 11
25	4	Add h-graph ex step 23 to h-graph ex step 24
26	3	Store hydrograph from step 25; reset hydrograph to zero
27	1	Add sub-area 'J' inflow & route thru normal storage 12
28	4	Add h-graph ex step 26 to h-graph ex step 27
29	3	Store hydrograph from step 28; reset hydrograph to zero
30	1	Add sub-area 'K' inflow & route thru normal storage 13
31	4	Add h-graph ex step 29 to h-graph ex step 30
32	3	Store hydrograph from step 31; reset hydrograph to zero
33	1	Add sub-area 'L' inflow & route thru normal storage 14
34	4	Add h-graph ex step 32 to h-graph ex step 33
35	16.0	Route thru existing storage, BASIN 1
36	7.0	Print hydrograph, B
37	16.0	Route thru existing storage, BASIN 2
38	5	Route hydrograph thru normal storage 15
39	7.0	Print hydrograph, A
40	0	**********End of control vector**********

Sub-area data

Sub-area	Area km²	Dist. km*	Fraction impervious
A	3.80E-02	4.33E-01	0.05
B	1.70E-02	3.18E-01	0.60
C	9.10E-02	6.68E-01	0.40
D	1.00E-03	2.56E-01	0.60
E	1.00E-02	3.42E-01	0.05
F	1.20E-02	4.48E-01	0.60
G	1.00E-03	2.73E-01	0.05
H	1.80E-02	2.11E-01	0.60
I	5.00E-03	1.79E-01	0.40
J	5.00E-03	1.78E-01	0.05
K	3.00E-03	1.63E-01	0.60
L	8.00E-03	1.63E-01	0.50

Total 2.090E-01

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For whole catchment ; Av. Dist., km* = 0.48
For interstation area 1; Av. Dist., km* = 0.48; ISA Factor = 1.000

* or other function of reach properties related to travel time

Normal storage data

Storage no.	Length km*	Rel. delay time	Type	Slope percent
1	0.1	0.242	Natural	
2	0.1	0.011	Lined	7.800
3	0.3	0.119	Unlined	10.300
4	0.2	0.433	Natural	
5	0.0	0.005	Lined	6.200
6	0.1	0.282	Natural	
7	0.2	0.032	Lined	3.000
8	0.1	0.267	Natural	
9	0.1	0.130	Natural	
10	0.1	0.014	Lined	13.400
11	0.1	0.046	Unlined	13.400
12	0.1	0.204	Natural	
13	0.1	0.027	Lined	0.500
14	0.1	0.038	Unlined	18.500
15	0.1	0.170	Natural	

* or other function of reach properties related to travel time

Special storage data

Storage: BASIN 1
Initial water level at cease to flow elevation
Storage (m³) - Discharge (m³/s) table

0.000E+00	0.0000
1.690E+02	0.3700
3.840E+02	0.5700
7.000E+02	0.7100

Elevation (m) - Storage (m³) table

589.50	0.000E+00
589.80	1.520E+02
590.10	3.480E+02
590.40	7.000E+02

Storage: BASIN 2
Initial water level at cease to flow elevation
Storage (m³) - Discharge (m³/s) table

0.000E+00	0.0000
1.450E+02	0.4800
3.440E+02	0.6400
1.000E+03	0.7700

Elevation (m) - Storage (m³) table

589.10	0.000E+00
589.40	1.450E+02
589.70	3.440E+02
590.00	1.000E+03

Input of parameters:
****

SMITH STREET DAYLESFORD
DESIGN Run
SMITH STREET DAYLESFORD: 2 hour 20% Design Storm No.6 Temporal Patte
Time increment = 0.08 hours

Constant loss model selected

Rainfall, mm, in time inc. following time shown

Time Incs	Catch ment	A	B	C	D	E	F	G	H	I	J	K	L
0	1.3	1	1	1	1	1	1	1	1	1	1	1	1
1	1.6	2	2	2	2	2	2	2	2	2	2	2	2
2	1.6	2	2	2	2	2	2	2	2	2	2	2	2

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3	1.0	1	1	1	1	1	1	1	1	1	1	1	1
4	1.0	1	1	1	1	1	1	1	1	1	1	1	1
5	1.3	1	1	1	1	1	1	1	1	1	1	1	1
6	1.3	1	1	1	1	1	1	1	1	1	1	1	1
7	1.4	1	1	1	1	1	1	1	1	1	1	1	1
8	1.4	1	1	1	1	1	1	1	1	1	1	1	1
9	1.3	1	1	1	1	1	1	1	1	1	1	1	1
10	1.4	1	1	1	1	1	1	1	1	1	1	1	1
11	1.0	1	1	1	1	1	1	1	1	1	1	1	1
12	0.8	1	1	1	1	1	1	1	1	1	1	1	1
13	0.8	1	1	1	1	1	1	1	1	1	1	1	1
14	1.0	1	1	1	1	1	1	1	1	1	1	1	1
15	1.0	1	1	1	1	1	1	1	1	1	1	1	1
16	1.1	1	1	1	1	1	1	1	1	1	1	1	1
17	1.1	1	1	1	1	1	1	1	1	1	1	1	1
18	1.1	1	1	1	1	1	1	1	1	1	1	1	1
19	1.1	1	1	1	1	1	1	1	1	1	1	1	1
20	1.3	1	1	1	1	1	1	1	1	1	1	1	1
21	1.4	1	1	1	1	1	1	1	1	1	1	1	1
22	1.4	1	1	1	1	1	1	1	1	1	1	1	1
23	1.8	2	2	2	2	2	2	2	2	2	2	2	2
Tot.	29.6	30	30	30	30	30	30	30	30	30	30	30	30
Pluvi. ref. no.		1	1	1	1	1	1	1	1	1	1	1	1

Rainfall-excess, mm, in time inc. following time shown

Time Incs	Catch ment	Sub-Area A	B	C	D	E	F	G	H	I	J	K	L
0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.0	0	0	0	0	0	0	0	0	0	0	0	0
3	0.0	0	0	0	0	0	0	0	0	0	0	0	0
4	0.0	0	0	0	0	0	0	0	0	0	0	0	0
5	0.0	0	0	0	0	0	0	0	0	0	0	0	0
6	0.0	0	0	0	0	0	0	0	0	0	0	0	0
7	0.0	0	0	0	0	0	0	0	0	0	0	0	0
8	0.3	0	1	0	1	0	1	0	1	0	0	1	0
9	0.3	0	1	0	1	0	1	0	1	0	0	1	0
10	0.4	0	1	0	1	0	1	0	1	0	0	1	1
11	0.2	0	1	0	1	0	1	0	1	0	0	1	1
12	0.5	0	1	1	1	0	1	0	1	1	0	1	1
13	0.5	0	1	1	1	0	1	0	1	1	0	1	1
14	0.6	0	1	1	1	0	1	0	1	1	0	1	1
15	0.6	0	1	1	1	0	1	0	1	1	0	1	1
16	0.7	0	1	1	1	0	1	0	1	1	0	1	1
17	0.7	0	1	1	1	0	1	0	1	1	0	1	1
18	0.7	0	1	1	1	0	1	0	1	1	0	1	1
19	0.7	0	1	1	1	0	1	0	1	1	0	1	1
20	0.8	0	1	1	1	0	1	0	1	1	0	1	1
21	1.2	1	1	1	1	1	1	1	1	1	1	1	1
22	1.2	1	1	1	1	1	1	1	1	1	1	1	1
23	1.5	1	2	2	2	1	2	1	2	2	1	2	2
Tot.	10.8	4	17	11	17	4	17	4	17	11	4	17	14

Routing results:
****

SMITH STREET DAYLESFORD
SMITH STREET DAYLESFORD: 2 hour 20% Design Storm No.6 Temporal Patte
DESIGN run no. 1

Parameters: kc = 0.43 m = 0.80

Loss parameters	Initial loss (mm)	Cont. loss (mm/h)
	26.00	4.30

*** Calculated hydrograph, D

	Hydrograph Calc.
Peak discharge, m³/s	0.4184
Time to peak, h	2.00

Volume,m^3 1.04E+03
Time to centroid,h 1.69
Lag (c.m. to c.m.),h 0.109
Lag to peak,h 0.422

*** Calculated hydrograph, C

Hydrograph
Calc.
Peak discharge,m^3/s 0.6292
Time to peak,h 2.00
Volume,m^3 1.72E+03
Time to centroid,h 1.82
Lag (c.m. to c.m.),h 0.270
Lag to peak,h 0.453

Results of routing through special storage BASIN 1
Peak elevation= 590.09 m
Peak outflow = 0.53 m^3/s
Peak storage = 3.41E+02 m^3

*** Special storage : BASIN 1

	Hydrograph Outflow	Inflow
Peak discharge,m^3/s	0.5300	0.6952
Time to peak,h	2.17	2.00
Volume,m^3	2.27E+03	2.27E+03
Time to centroid,h	2.00	1.86
Lag (c.m. to c.m.),h	0.485	0.340
Lag to peak,h	0.647	0.480

*** Calculated hydrograph, B

Hydrograph
Calc.
Peak discharge,m^3/s 0.5300
Time to peak,h 2.17
Volume,m^3 2.27E+03
Time to centroid,h 2.00
Lag (c.m. to c.m.),h 0.485
Lag to peak,h 0.647

Results of routing through special storage BASIN 2
Peak elevation= 589.43 m
Peak outflow = 0.50 m^3/s
Peak storage = 1.65E+02 m^3

*** Special storage : BASIN 2

	Hydrograph Outflow	Inflow
Peak discharge,m^3/s	0.4965	0.5300
Time to peak,h	2.25	2.17
Volume,m^3	2.27E+03	2.27E+03
Time to centroid,h	2.09	2.00
Lag (c.m. to c.m.),h	0.570	0.485
Lag to peak,h	0.730	0.647

*** Calculated hydrograph, A

Hydrograph
Calc.
Peak discharge,m^3/s 0.4937
Time to peak,h 2.33
Volume,m^3 2.27E+03
Time to centroid,h 2.18
Lag (c.m. to c.m.),h 0.665
Lag to peak,h 0.813

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Hydrograph summary
****

Site Description
01 Calculated hydrograph, D
02 Calculated hydrograph, C
03 Special storage : BASIN 1 - Outflow
04 Special storage : BASIN 1 - Inflow
05 Calculated hydrograph, B
06 Special storage : BASIN 2 - Outflow
07 Special storage : BASIN 2 - Inflow
08 Calculated hydrograph, A

Inc	Time	Hyd0001	Hyd0002	Hyd0003	Hyd0004	Hyd0005	Hyd0006	Hyd0007	Hyd0008
0	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.08	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.33	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.42	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.58	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.67	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.75	0.0000	0.0963	0.0219	0.0830	0.0219	0.0079	0.0219	0.0010
10	0.83	0.0000	0.1344	0.0676	0.1443	0.0676	0.0333	0.0676	0.0084
11	0.92	0.0000	0.1159	0.1141	0.1800	0.1141	0.0719	0.1141	0.0297
12	1.00	0.0000	0.1010	0.1494	0.1931	0.1494	0.1114	0.1494	0.0640
13	1.08	0.0559	0.0635	0.1592	0.1498	0.1592	0.1391	0.1592	0.1009
14	1.17	0.1521	0.0951	0.1573	0.1609	0.1573	0.1512	0.1573	0.1288
15	1.25	0.1947	0.1385	0.1646	0.1820	0.1646	0.1577	0.1646	0.1454
16	1.33	0.2226	0.1913	0.1838	0.2229	0.1838	0.1690	0.1838	0.1571
17	1.42	0.2478	0.2379	0.2156	0.2716	0.2156	0.1899	0.2156	0.1719
18	1.50	0.2724	0.2845	0.2572	0.3268	0.2572	0.2212	0.2572	0.1945
19	1.58	0.2756	0.3097	0.3007	0.3640	0.3007	0.2597	0.3007	0.2260
20	1.67	0.2759	0.3346	0.3410	0.4007	0.3410	0.3003	0.3410	0.2637
21	1.75	0.2978	0.3630	0.3749	0.4430	0.3749	0.3384	0.3749	0.3033
22	1.83	0.3441	0.4292	0.3996	0.5071	0.3996	0.3705	0.3996	0.3403
23	1.92	0.3710	0.5176	0.4348	0.5783	0.4348	0.4017	0.4348	0.3738
24	2.00	0.4184	0.6292	0.4846	0.6952	0.4846	0.4407	0.4846	0.4089
25	2.08	0.2544	0.5025	0.5251	0.6097	0.5251	0.4808	0.5251	0.4478
26	2.17	0.0478	0.3363	0.5300	0.4805	0.5300	0.4909	0.5300	0.4766
27	2.25	0.0157	0.2377	0.5048	0.3769	0.5048	0.4965	0.5048	0.4896
28	2.33	0.0065	0.1553	0.4616	0.2818	0.4616	0.4935	0.4616	0.4937
29	2.42	0.0031	0.1135	0.4084	0.2080	0.4084	0.4808	0.4084	0.4887
30	2.50	0.0017	0.0778	0.3317	0.1541	0.3317	0.4083	0.3317	0.4552
31	2.58	0.0010	0.0588	0.2355	0.1148	0.2355	0.3250	0.2355	0.3889
32	2.67	0.0006	0.0424	0.1698	0.0867	0.1698	0.2445	0.1698	0.3127
33	2.75	0.0004	0.0328	0.1242	0.0662	0.1242	0.1806	0.1242	0.2416
34	2.83	0.0003	0.0247	0.0922	0.0512	0.0922	0.1333	0.0922	0.1835
35	2.92	0.0002	0.0194	0.0694	0.0400	0.0694	0.0990	0.0694	0.1390
36	3.00	0.0001	0.0152	0.0530	0.0316	0.0530	0.0743	0.0530	0.1056
37	3.08	0.0001	0.0121	0.0409	0.0252	0.0409	0.0564	0.0409	0.0809
38	3.17	0.0001	0.0098	0.0320	0.0203	0.0320	0.0434	0.0320	0.0626
39	3.25	0.0001	0.0080	0.0253	0.0166	0.0253	0.0337	0.0253	0.0489
40	3.33	0.0000	0.0066	0.0203	0.0136	0.0203	0.0266	0.0203	0.0386
41	3.42	0.0000	0.0055	0.0164	0.0113	0.0164	0.0211	0.0164	0.0307
42	3.50	0.0000	0.0046	0.0134	0.0094	0.0134	0.0170	0.0134	0.0247
43	3.58	0.0000	0.0039	0.0110	0.0079	0.0110	0.0138	0.0110	0.0201
44	3.67	0.0000	0.0033	0.0092	0.0067	0.0092	0.0114	0.0092	0.0165
45	3.75	0.0000	0.0028	0.0077	0.0057	0.0077	0.0094	0.0077	0.0136
46	3.83	0.0000	0.0024	0.0065	0.0048	0.0065	0.0079	0.0065	0.0114
47	3.92	0.0000	0.0020	0.0055	0.0042	0.0055	0.0066	0.0055	0.0095
48	4.00	0.0000	0.0018	0.0047	0.0036	0.0047	0.0056	0.0047	0.0081
49	4.08	0.0000	0.0015	0.0040	0.0031	0.0040	0.0048	0.0040	0.0069
50	4.17	0.0000	0.0013	0.0035	0.0027	0.0035	0.0041	0.0035	0.0059
51	4.25	0.0000	0.0012	0.0030	0.0024	0.0030	0.0035	0.0030	0.0051
52	4.33	0.0000	0.0010	0.0026	0.0021	0.0026	0.0031	0.0026	0.0044
53	4.42	0.0000	0.0009	0.0023	0.0018	0.0023	0.0027	0.0023	0.0038
54	4.50	0.0000	0.0008	0.0020	0.0016	0.0020	0.0023	0.0020	0.0033
55	4.58	0.0000	0.0007	0.0018	0.0014	0.0018	0.0020	0.0018	0.0029
56	4.67	0.0000	0.0006	0.0016	0.0013	0.0016	0.0018	0.0016	0.0025
57	4.75	0.0000	0.0006	0.0014	0.0011	0.0014	0.0016	0.0014	0.0022
58	4.83	0.0000	0.0005	0.0012	0.0010	0.0012	0.0014	0.0012	0.0020
59	4.92	0.0000	0.0004	0.0011	0.0009	0.0011	0.0012	0.0011	0.0018
60	5.00	0.0000	0.0004	0.0010	0.0008	0.0010	0.0011	0.0010	0.0016

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61	5.08	0.0000	0.0004	0.0009	0.0007	0.0009	0.0010	0.0009	0.0014
62	5.17	0.0000	0.0003	0.0008	0.0007	0.0008	0.0009	0.0008	0.0012
63	5.25	0.0000	0.0003	0.0007	0.0006	0.0007	0.0008	0.0007	0.0011
64	5.33	0.0000	0.0003	0.0006	0.0005	0.0006	0.0007	0.0006	0.0010
65	5.42	0.0000	0.0002	0.0006	0.0005	0.0006	0.0006	0.0006	0.0009
66	5.50	0.0000	0.0002	0.0005	0.0004	0.0005	0.0006	0.0005	0.0008
67	5.58	0.0000	0.0002	0.0005	0.0004	0.0005	0.0005	0.0005	0.0007
68	5.67	0.0000	0.0002	0.0004	0.0004	0.0004	0.0005	0.0004	0.0007
69	5.75	0.0000	0.0002	0.0004	0.0003	0.0004	0.0004	0.0004	0.0006
70	5.83	0.0000	0.0001	0.0004	0.0003	0.0004	0.0004	0.0004	0.0006

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APPENDIX D

RESULTS FROM ARR RFFE 2015 MODEL

Datetime: 2021-01-28 09:11
Region name: East Coast
Region code: 1
Site name: Catchment1
Latitude at catchment outlet (degree) = -37.338
Longitude at catchment outlet (degree) = 144.155
Latitude at catchment centroid (degree) = -37.341
Longitude at catchment centroid (degree) = 144.153
Distance of the nearest gauged catchment in the database (km) = 15.04
Catchment area (sq km) = 0.2
Design rainfall intensity, 1 in 2 AEP and 6 hr duration (mm/h): 5.357612
Design rainfall intensity, 1 in 50 AEP and 6 hr duration (mm/h): 12.375106
Shape factor of the ungauged catchment: 0.84

ESTIMATED FLOOD QUANTILES:

AEP (%)	Expected quantiles (m^3/s)	5% CL m^3/s	95% CL m^3/s
50	0.180	0.0600	0.550
20	0.340	0.120	0.950
10	0.460	0.160	1.34
5	0.610	0.210	1.80
2	0.820	0.260	2.58
1	1.01	0.310	3.32

DATA FOR FITTING MULTI-NORMAL DISTRIBUTION FOR BUILDING CONFIDENCE LIMITS:

1 Mean (loge flow) = -1.718
2 St dev (loge flow) = 0.712
3 Skew (loge flow) = 0.090

Moments and correlations:

No	Most probable	Std dev	Correlation		
1	-1.718	0.676	1.000		
2	0.712	0.232	-0.330	1.000	
3	0.090	0.030	0.170	-0.280	1.000

WARNING: The catchment is outside the recommended catchment size of 0.5 to 1,000 sq km. Results have lower accuracy and may not be directly applicable in practice.

This is the end of output file.

APPENDIX E

RETENTION SYSTEM - RATIONAL METHOD

PROJECT : 17 SMITH ST
Project Number : 863
Designed : DS Date : 11-05-21 Checked : Date :
Locality DAYLESFORD

Gross Catchment Area	A	1.9216	ha (Not to exceed 8ha)
Average Recurrence Interval, Y	ARI	5	years [AEP 20 %]
Coefficient of Runoff, 10 years	C10	0.84	
Coefficient of Runoff, Y years	Cy	0.76	
Equivalent Impervious Area	Ae	1.4527	ha
Time of Concentration	tc	6.0	minutes
Rainfall Intensity at tc	Ic	82	mm / hr for ARI above
Peak Inflow Discharge	Qp	0.332	m^3 / s at tc
Allowable Outflow Discharge	Qo	0.172	m^3 / s Uniform rate after tc
Upper Limit of Storm Duration	tu	36	minutes (tc + tdi*N)
Storm Duration Interval	tdi	1	minutes
Number of (Integer) Intervals	N	30	Limit 30
Maximum Storage Volume	Vs, max	47.0	m^3

n	td	I,td From Coeff's	Qp,t	INFLOW VOLUME	OUTFLOW VOLUME	STORAGE VOLUME	
	minutes	mm / hr	m^3 / s	m ^ 3	m ^ 3	m ^ 3	
0	6.00	82	0.33	119.4	76.8	42.6	
1	7.00	78	0.31	131.4	86.2	45.2	
2	8.00	73	0.30	142.2	95.5	46.6	
3	9.00	70	0.28	151.9	104.9	47.0	MAX
4	10.00	66	0.27	160.8	114.3	46.5	
5	11.00	63	0.26	168.9	123.7	45.2	
6	12.00	61	0.24	176.4	133.1	43.3	
7	13.00	58	0.23	183.2	142.4	40.7	
8	14.00	56	0.23	189.8	151.9	37.9	
9	15.00	54	0.22	195.8	161.3	34.5	
10	16.00	52	0.21	201.4	170.7	30.7	
11	17.00	50	0.20	206.6	180.1	26.5	
12	18.00	49	0.20	211.8	189.6	22.2	
13	19.00	47	0.19	216.2	199.0	17.3	
14	20.00	46	0.18	220.8	208.4	12.4	
15	21.00	44	0.18	225.9	218.0	7.9	
16	22.00	43	0.17	230.3	227.5	2.8	
17	23.00	42	0.17	234.2	236.9		
18	24.00	41	0.16	237.6	246.4		
19	25.00	40	0.16	240.3	255.7		
20	26.00	39	0.16	244.4	265.3		
21	27.00	38	0.15	248.0	274.8		
22	28.00	37	0.15	251.2	284.3		
23	29.00	36	0.15	254.0	293.8		
24	30.00	35	0.14	256.4	303.2		
25	31.00	35	0.14	260.7	312.9		
26	32.00	34	0.14	264.7	322.6		
27	33.00	34	0.14	268.5	332.2		
28	34.00	33	0.13	271.9	341.9		
29	35.00	32	0.13	275.1	351.5		
30	36.00	32	0.13	278.1	361.1		
					Maximum Storage Volume, m^3	**47.0**	

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