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STORMWATER REPORT

PROPOSED SUBDIVISION 59 OLD SPRING BAY ROAD, SWANSEA

Project No. J171052CH

April 2017

Johnstone McGee & Gandy
incorporating **Dale P Luck & Associates**

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Issuing Office: 117 Harrington Street, Hobart 7000

Document Issue Status

Ver.	Issue Date	Description	Originator		Checked		Approved	
-	13-04-2017	ISSUED FOR CLIENT REVIEW	GLA		SHM		GLA	

1. INTRODUCTION

This report has been prepared in support of a development application, to be lodged with Glamorgan Spring Bay Council for subdivision of land at 59 Old Spring Bay Road, Swansea. The report has been prepared by Grant Atherton, a civil engineer with over 35 years post graduate experience and with Chartered Professional Engineer (CPEng) status and is a Fellow of Engineers Australia (FIEAust).

The subdivision will provide 42 residential lots ranging from approximately 661 sqm to 15,089 sqm in area with an overall density of approximately 8 lots per hectare (including area of road reserves and public open space lots). The site is zoned Zone 10 General Residential under the Glamorgan Spring Bay Interim Planning Scheme 2015.

This report provides an analysis of stormwater flow on the site and details proposed stormwater management measures that will be applied to meet Council's design standards for stormwater flow and quality. Stormwater management will include the provision of piped and overland flow paths and the implementation of WSUD (Water Sensitive Urban Design) principals which have been modelled using the MUSIC (Model for Urban Stormwater Improvement Conceptualisation) software program to demonstrate compliance with the requirements of the planning scheme.

2. SUBDIVISION PROPOSAL

The proposed development includes the subdivision of the existing title at 59 Old Spring Bay Road to create 42 resultant residential lots, five public open space lots and road reserves.

The subdivision will provide for residential development at an overall density of around 8 lots per hectare over 5.655 Ha. Public open space accounts for 0.135 Ha and road reserves account for 0.943 Ha.

The subject site has a total area of approximately 5.655 Ha as shown in Figure 1, and as noted on the title to the land.

Figure 1: Subject Site (ex TheList web site)

3. EXISTING STORMWATER SYSTEM

The site is currently vacant with grass and trees covering most the lot as shown in Figure 2 below. The site slopes from a high point at around 20m AHD down to around 8m AHD at its lowest point. Most of the site drains to the north and the east, to Cathcart Street (which is currently unmade in this area) in the north and to Old Spring Bay Road to the east. The south-western corner of the lot drains to the south-west to adjacent property which is zoned Zone 26 Rural Resource in the Glamorgan Spring Bay Interim Planning Scheme 2015. The south-eastern section of the lot drains to Old Spring Bay Road.

The upstream catchment extends approximately 1.48 km and has a defined watercourse (unnamed) which discharges into a dam to the north of Cathcart Street and west of the existing residential development along Old Spring Bay Road. The spillway from the dam runs across the Cathcart Street reservation and just passes across the north-east corner of the lot before passing under Old Spring Bay Road via a 450mm diameter culvert. The discharge from the culvert is into a well-defined open drain which runs through private property before discharging to Kennedia Beach. The existing culvert under Old Spring Bay Road is at a local low point of the road.

Figure 2 Existing aerial photo (ex the List web site)

4. ANALYSIS

JMG has determined the current peak flows for the existing and proposed situation for both 20 year ARI and 100 year ARI storm events using the Rational Method as per Australian Rainfall and Runoff. The Rational Method was chosen as an appropriate method due to the small (38 Ha), reasonably homogeneous type catchment.

To calculate an appropriate C value for the upstream rural catchment, it was conservatively assumed that the rural catchment was 100% impervious, despite the fact that there are small areas of sealed roads and isolated buildings within the catchment. A less conservative C value would result in less difference between the predevelopment and post development flows.

Intensity Frequency Duration data was obtained from the Bureau of Meteorology website for the coordinates of the development lot. The graphs and table are provided in Appendix B of this report.

The 10 year 1 hour intensity from the IFD data for the site is 24.2mm/hr. For a zero fraction impervious and this intensity, Figure 1.13 from Australian Rainfall and Runoff Book VIII yields a 10 yr ARI runoff coefficient of 0.1. For a 20 yr ARI event this is adjusted as per Table 1.6 of the same section of ARR by a factor of 1.05 to yield C=0.105 and for a 100 yr ARI event this is adjusted by a factor of 1.2 to yield C=0.12.

The critical Time of Concentration (t_c) for the peak stormwater flow in the 450mm culvert under Old Spring Bay Road was calculated for the upstream catchment. This was calculated as 43 minutes, with length of 1.48 km, area of 38.0 Ha and slope of 49 m/km by the following equation;

$$t_c = \frac{58L}{A^{0.1} S_e^{0.2}}$$

(L = length in km, A = area in km^2, S_e = slope m/km, tc = time of concentration in minutes)

For the largest catchment to be developed as part of the subdivision, the time of concentration was calculated as:
Catchment 1 – Tc = 12 minutes.
For the smaller Catchments 2 and 3, the time of concentration was assumed as 6 minutes which is an accepted value for small catchments.

To obtain the Intensity Frequency Duration (IFD) values for a given Average Recurrence Interval (ARI) event, an IFD table for Swansea was obtained from the Bureau of Meteorology Website and interpolated, refer Appendix B. The adopted values are shown in Table 2.

IFD Duration (minutes)	**ARI (years – mm/hr.)**					
	1	2	10	**20**	50	**100**
6	38.2	51.1	85.3	**103**	129	**150**
12	30	40	63	**76**	90	**108**
43	17	21	29	**36**	39	**44**

Table 2 – IFD Table

Note that figures for the 20 yr and 100 yr ARI events are bold in Table 2 as these are relevant to the minor and major stormwater systems respectively.

For the minor stormwater system (20 yr ARI), the runoff after development needs to be no more than the runoff predevelopment. For the three catchments to be developed, the predevelopment runoff coefficient is based on the catchments being completely pervious as they are currently undeveloped, and there are no large exposures of impervious material such as rock. As per above the adjusted runoff coefficient for the 20 yr ARI for the undeveloped catchments is C20 = 0.105 and C100 = 0.12.

For the developed catchments, a fraction impervious of 0.5 has been adopted which is considered reasonable for both road areas (footpath, driveways to boundaries, and road pavement are all impervious in the road reservation) and lot areas (roof areas,

driveways and paths are impervious within lot areas). From Figure 1.13 of ARR, this results in a C10 of 0.48 which further results in a C20 = 0.504 and C100 = 0.576.

Table 3 below summarises the area, time of concentration, runoff coefficients, and resultant flows from the three catchment areas to be developed.

Catchment No.	**1 pre**	**1 post**	**2 pre**	**2 post**	**3 pre**	**3 post**
Area m2	27,336	27,336	4,221	4,221	7,083	7,083
Tc min	12	12	6	6	6	6
I20 mm/hr	76	76	103	103	103	103
C20	0.105	0.504	0.105	0.504	0.105	0.504
Q20 m3/s	**0.061**	**0.291**	**0.013**	**0.061**	**0.021**	**0.102**
I100 mm/hr	108	108	150	150	150	150
C100	0.12	0.576	0.12	0.576	0.12	0.576
Q100 m3/s	0.098	0.473	0.021	0.101	0.035	0.170

Table 3 Runoff calculations with no detention provided

Note that the 20 yr ARI values are bold as these are the figures for the minor stormwater system, with the requirement for post development flows to be limited to the predevelopment flows for these events.

To determine the amount of detention storage required to be provided to limit the post development flows as required, Boyds formula is used for each catchment to calculate the difference between the inflow and outflow during storm events of various durations until a maximum storage has been found. These calculations are shown in Appendix C and are summarised in Table 4 below.

Catchment No.	1	2	3
Storage Required m3	180	23	40
Number of lots	27	6	8
Storage per lot (rounded up to nearest m3)	7	4	5

Table 4 Summary of Detention Requirements

To have a uniform requirement for all lots on the subdivision, it is recommended that each lot should have a storage detention tank which has 5,000 litres available as detention storage which would drain at the relevant pre-development flow for each catchment via the fitting of a properly sized orifice plate.

For Catchment 1 there would be a shortfall in total storage of 45 m3 which could be provided by either larger tanks, or by specifying 5,000 litre detention tanks and providing 45 m3 of storage in the public open space lot on the corner of the first cul de sac and Cathcart Street. This volume is easily accommodated on the lot.

5. STORMWATER QUALITY

The stormwater quality targets are based on the State Stormwater Strategy and are as quoted in Table E7.1 of the Glamorgan Spring Bay Interim Planning Scheme 2015, requiring the following reductions:

- Total Suspended Solids — 80% Reduction in annual load based on typical urban concentrations
- Total Phosphorous — 45% Reduction in annual load based on typical urban concentrations
- Total Nitrogen — 45% Reduction in annual load based on typical urban concentrations

Stormwater quality can be improved by a number of well proven methods, with often a combination of methods put together in a "treatment train" to provide acceptable stormwater quality. Some methods are good at removing TSS for example but do little to reduce TP or TN, hence the treatment train approach.

The developed catchments will basically have two contributing catchment types, firstly roads, footpaths and driveways, and secondly roofs of residences and any outbuildings on the lots.

The adoption of rainwater tanks which store water for reuse which can also be partly dedicated to detention requirements has a twofold benefit on stormwater quality, firstly the tanks act as a settling chamber for suspended solids to drop out of suspension, and secondly any stormwater captured and reused (eg for irrigation, toilet flushing etc.) is a reduction in the amount of annual runoff and hence is a reduction in the amount of TSS, TP and TN released.

Road stormwater inlet pits give an opportunity to help address stormwater quality at the source, with a number of inlet filters on the market which help to filter out stormwater pollutants at the source.

A detention pond also has beneficial effects on stormwater quality due to further settling out of suspended matter.

To analyse the predicted performance of these treatment trains, the software package MUSIC (Model for Urban Stormwater Improvement Conceptualisation) is used as noted in section E7.7.1 of the Glamorgan Spring Bay Interim Planning Scheme 2015.

The treatment train model is shown in Figure 3 with the following results summarised in Table 5 below: (noting that "Stormsack" is a proprietary name for an inlet pit filter). Note that MUSIC allows only 1 outflow per model, so it doesn't truly reflect the actual network, which has multiple outflows.

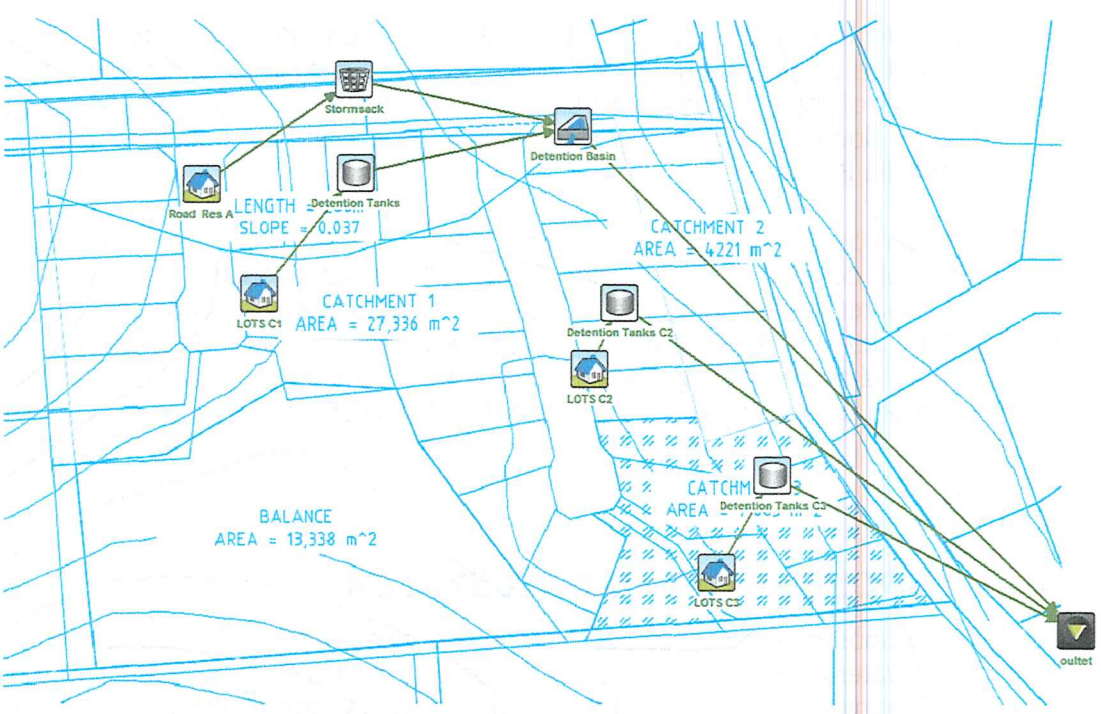


Figure 3 – Music Model Developed Site

	Source	Residual	% Reduction
Flow (ML/yr)	7.03	3.95	43.8
Suspended Solids (kg/yr)	1810	339	81.3
Total Phosphorus (kg/yr)	3	0.882	70.6
Total Nitrogen (kg/yr)	16.1	7.22	55
Total Gross Pollutants (kg/yr)	337	0.04	100

Table 5 Stormwater Quality Summary

The table clearly demonstrates compliance with the required reductions specified in the Glamorgan Spring Bay Interim Planning Scheme 2015.

6. MAJOR STORMWATER SYSTEM

The 100 yr ARI event flows were calculated for the three catchments in Section 4 above. These flows need to be catered for by a combination of piped and overland flows which do not threaten property.

As there is the potential for overland stormwater flows from both upstream and within the subdivision to impact on the site, it is necessary to provide a flow path to the inlet of the existing DN450 culvert under Old Spring Bay Road and for the excess flow to flow over Old Spring Bay Road to the existing open channel which drains to Kennedia Beach.

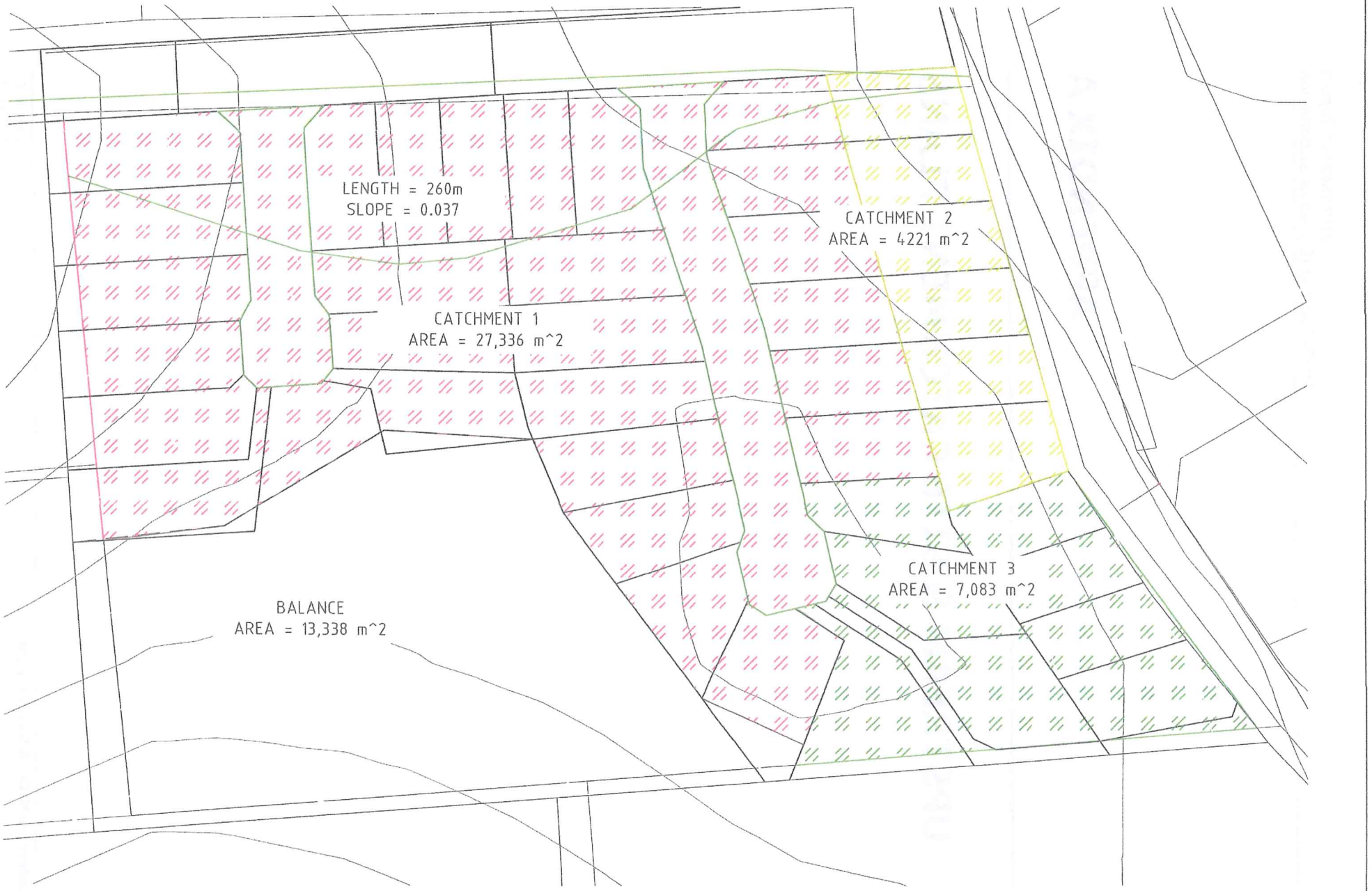
This can be achieved by the following:
The cul de sacs and Cathcart Street will act as overland flow paths for major stormwater events which are in excess of the piped system capacity. Cathcart Street will be designed to shed this excess water across the current low point in Old Spring Bay Road to the existing open channel which drains to Kennedia Beach. Catchment 3 will drain to Old Spring Bay Road and then to the south along the road reservation.

7. PROPOSED STORMWATER SYSTEM

The proposed system is as described in this report and as shown on the concept stormwater design drawing C01 attached in Appendix D. The system complies with the Stormwater Code of the Glamorgan Spring Bay Interim Planning Scheme 2015 and incorporates Water Sensitive Urban Design Principles including inlet pit filters, detention basin, and rainwater/detention tanks. These measures result in no additional flow post development in a 20 yr ARI event, and fully meet the requirements for reductions in TSS, TP & TN.

APPENDIX A

UPSTREAM & SITE CATCHMENT PLANS



REV	DATE	REMARK

Accepted GLA (Discipline Head)		Date 13.4.17
Accepted GLA (Team Leader)		Date
Approved GLA (Group Manager)		Date

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PROJECT
59 OLD SPRING BAY ROAD

TITLE
CATCHMENT PLAN

PROJECT NO. J171052CH

DWG NO. C02

REVISION

PLOT DETAILS CIVIL 3D BASE.DWG

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Accepted GLA (Team Leader)		Date "
Approved GLA (Group Manager)		Date "

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PROJECT
59 OLD SPRING BAY ROAD

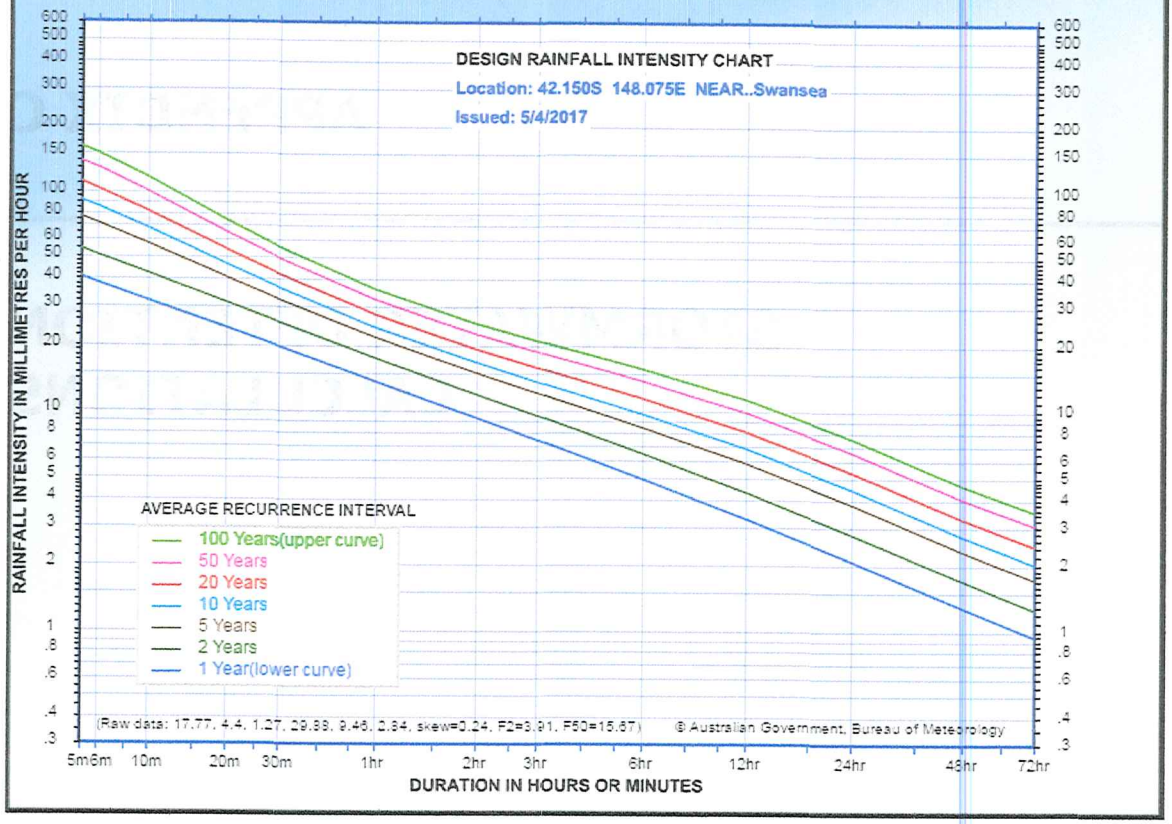
TITLE
TOTAL CATCHMENT PLAN

PROJECT NO. J171052CH
DWG NO. C03
REVISION
PLOT DETAILS CIVIL 3D BASE DWG

APPENDIX B

IFD CHART & TABLES FOR SWANSEA

Home | IFD Table | IFD Chart | Coefficients | ARI | Print IFD chart | Help IFD chart



Home | IFD Table | IFD Chart | Coefficients | ARI | Print IFD table | Help IFD table

Intensity-Frequency-Duration Table

Location: 42.150 S 148.075E NEAR.. Swansea Issued: 5/4/2017

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

Average Recurrence Interval

Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	40.7	54.5	76.4	91.1	111	138	161
6Mins	38.2	51.1	71.5	85.3	103	129	150
10Mins	31.8	42.2	57.6	67.9	81.3	100	116
20Mins	23.9	31.1	40.4	46.3	54.2	65.0	73.6
30Mins	19.7	25.4	32.2	36.4	42.1	49.8	55.8
1Hr	13.7	17.5	21.7	24.2	27.7	32.4	36.0
2Hrs	9.32	11.9	14.9	16.7	19.2	22.5	25.1
3Hrs	7.38	9.51	12.1	13.6	15.8	18.7	20.9
6Hrs	4.93	6.43	8.45	9.74	11.5	13.8	15.7
12Hrs	3.25	4.29	5.81	6.79	8.09	9.93	11.4
24Hrs	2.09	2.76	3.78	4.44	5.31	6.54	7.55
48Hrs	1.28	1.70	2.31	2.71	3.25	4.00	4.61
72Hrs	.941	1.25	1.72	2.03	2.44	3.03	3.50

(Raw data: 17.77, 4.4, 1.27, 29.88, 9.46, 2.84, skew=0.24, F2=3.91, F50=15.67)

Copy Table

APPENDIX C

STORMWATER DETENTION CALCULATIONS

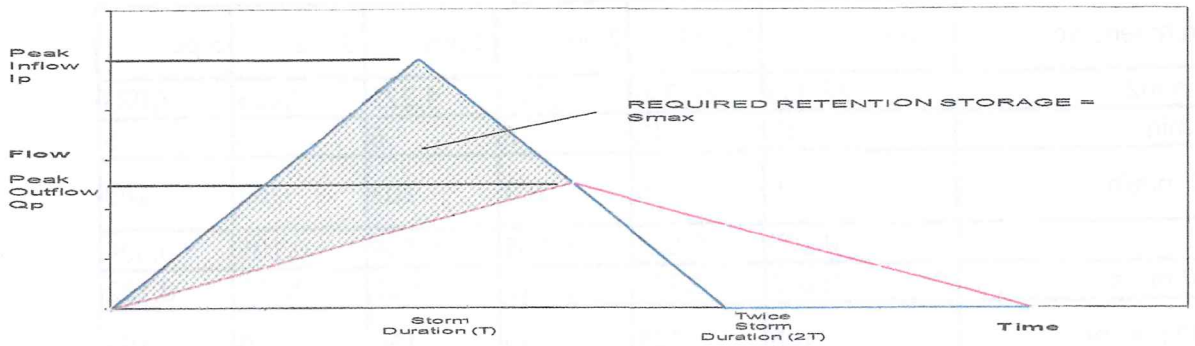
Catchment No.	1 pre	1 post	2 pre	2 post	3 pre	3 post
Area m2	27,336	27,336	4,221	4,221	7,083	7,083
Tc min	12	12	6	6	6	6
I20 mm/hr	76	76	103	103	103	103
C20	0.105	0.504	0.105	0.504	0.105	0.504
Q20 m3/s	0.061	0.291	0.013	0.061	0.021	0.102
I100 mm/hr	108	108	150	150	150	150
C100	0.12	0.576	0.12	0.576	0.12	0.576
Q100 m3/s	0.098	0.473	0.021	0.101	0.035	0.170

Q=0.278CIA

Q= m3/s
I = mm/hr
A = km2

J171052CH 59 Old Spring Bay Road

Boyds Formula Storage Calculation - 20 Year ARI



$$S_{max} = V_1 (1 - Q_p/I_p)$$

S_{max} = Maximum Volume of temporary Storage (m^3)

V_1 = Volume of inflow flood (m^3)

I_p = Peak discharge of inflow hydrograph (m^3/s)

Q_p = Peak discharge of outflow hydrograph (m^3/s)

Catchment No.	1		
Catchment Area (A) =	2.73	ha	
Runoff Coefficient (20 Year) =	0.504		
20 Year Effective Catchment Area = ∑CA =	1.38	ha	
Restricted outflow requirement =	0.061	m^3/s	20 year pre development flow

Storage requirement is highest value of S_{max} calculated in the table below

Critical storm duration is the storm duration when S_{max} occurs

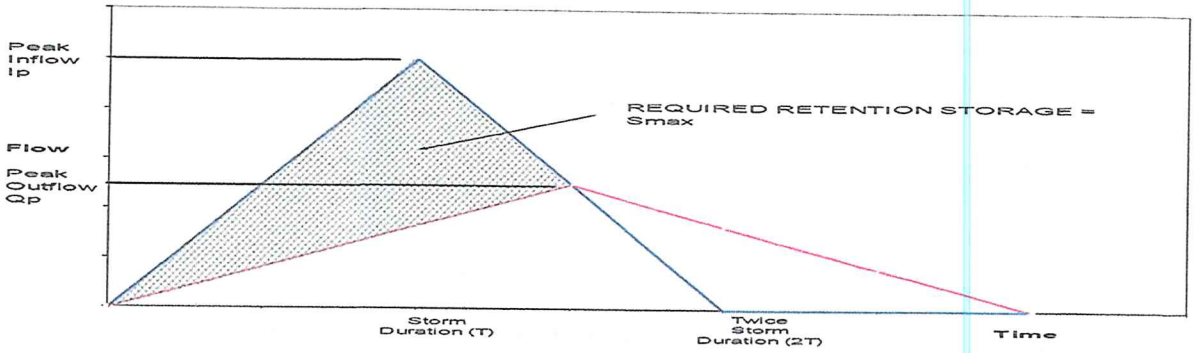
Continue table until a clear Smax is calculated

Storm Duration (min)	20 Year Intensity (mm/hr)	I_p (m^3/s)	Q_p (m^3/s)	V_1 (m^3)	S_{max} (m^3)
5	111.00	0.425	0.061	127.440	109.140
6	103.00	0.394	0.061	141.907	119.947
10	81.30	0.311	0.061	186.683	150.083
20	54.20	0.207	0.061	248.911	175.711
30	**42.10**	**0.161**	**0.061**	**290.013**	**180.213**
60	27.70	0.106	0.061	381.632	162.032
120	19.20	0.073	0.061	529.050	89.850

Number of lot	27.00	
Storage per lot	7	m3

J171052CH 59 Old Spring Bay Road

Boyds Formula Storage Calculation - 20 Year ARI



$$S_{max} = V_1 (1 - Q_p/I_p)$$

S_{max} = Maximum Volume of temporary Storage (m^3)

V_1 = Volume of inflow flood (m^3)

I_p = Peak discharge of inflow hydrograph (m^3/s)

Q_p = Peak discharge of outflow hydrograph (m^3/s)

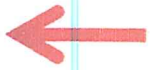
Catchment No.	2		
Catchment Area (A) =	0.42	ha	
Runoff Coefficient (20 Year) =	0.504		
20 Year Effective Catchment Area = ∑CA =	0.21	ha	
Restricted outflow requirement =	0.013	m^3/s	20 year pre development flow

Storage requirement is highest value of S_{max} calculated in the table below

Critical storm duration is the storm duration when S_{max} occurs

Continue table until a clear Smax is calculated

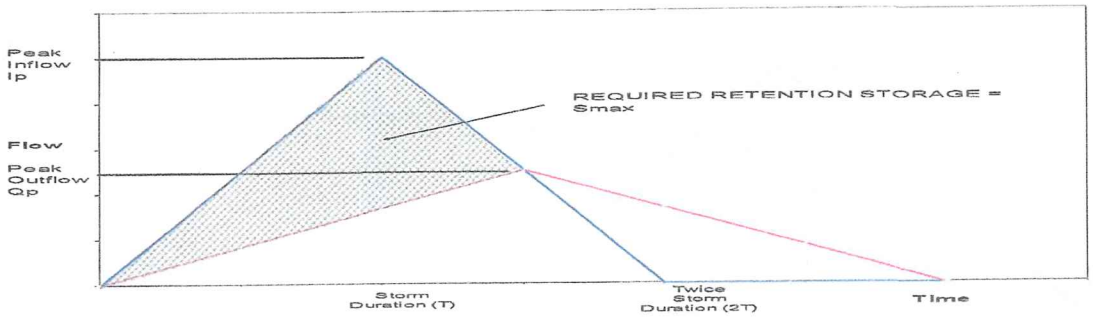
Storm Duration (min)	20 Year Intensity (mm/hr)	I_p (m^3/s)	Q_p (m^3/s)	V_1 (m^3)	S_{max} (m^3)
5	111.00	0.066	0.013	19.678	15.778
6	103.00	0.061	0.013	21.912	17.232
10	81.30	0.048	0.013	28.826	21.026
20	**54.20**	**0.032**	**0.013**	**38.435**	**22.835**
30	42.10	0.025	0.013	44.781	21.381
60	27.70	0.016	0.013	58.929	12.129
120	19.20	0.011	0.013	81.692	-11.908



Number of lot	6.00	
Storage per lot	4	m3

J171052CH 59 Old Spring Bay Road

Boyds Formula Storage Calculation - 20 Year ARI



$$S_{max} = V_1 (1 - Q_p/I_p)$$

S_{max} = Maximum Volume of temporary Storage (m^3)

V_1 = Volume of inflow flood (m^3)

I_p = Peak discharge of inflow hydrograph (m^3/s)

Q_p = Peak discharge of outflow hydrograph (m^3/s)

Catchment No.	2		
Catchment Area (A) =	0.42	ha	
Runoff Coefficient (20 Year) =	0.504		
20 Year Effective Catchment Area = ∑CA =	0.21	ha	
Restricted outflow requirement =	0.013	m^3/s	20 year pre development flow

Storage requirement is highest value of S_{max} calculated in the table below

Critical storm duration is the storm duration when S_{max} occurs

Continue table until a clear Smax is calculated

Storm Duration (min)	20 Year Intensity (mm/hr)	I_p (m^3/s)	Q_p (m^3/s)	V_1 (m^3)	S_{max} (m^3)
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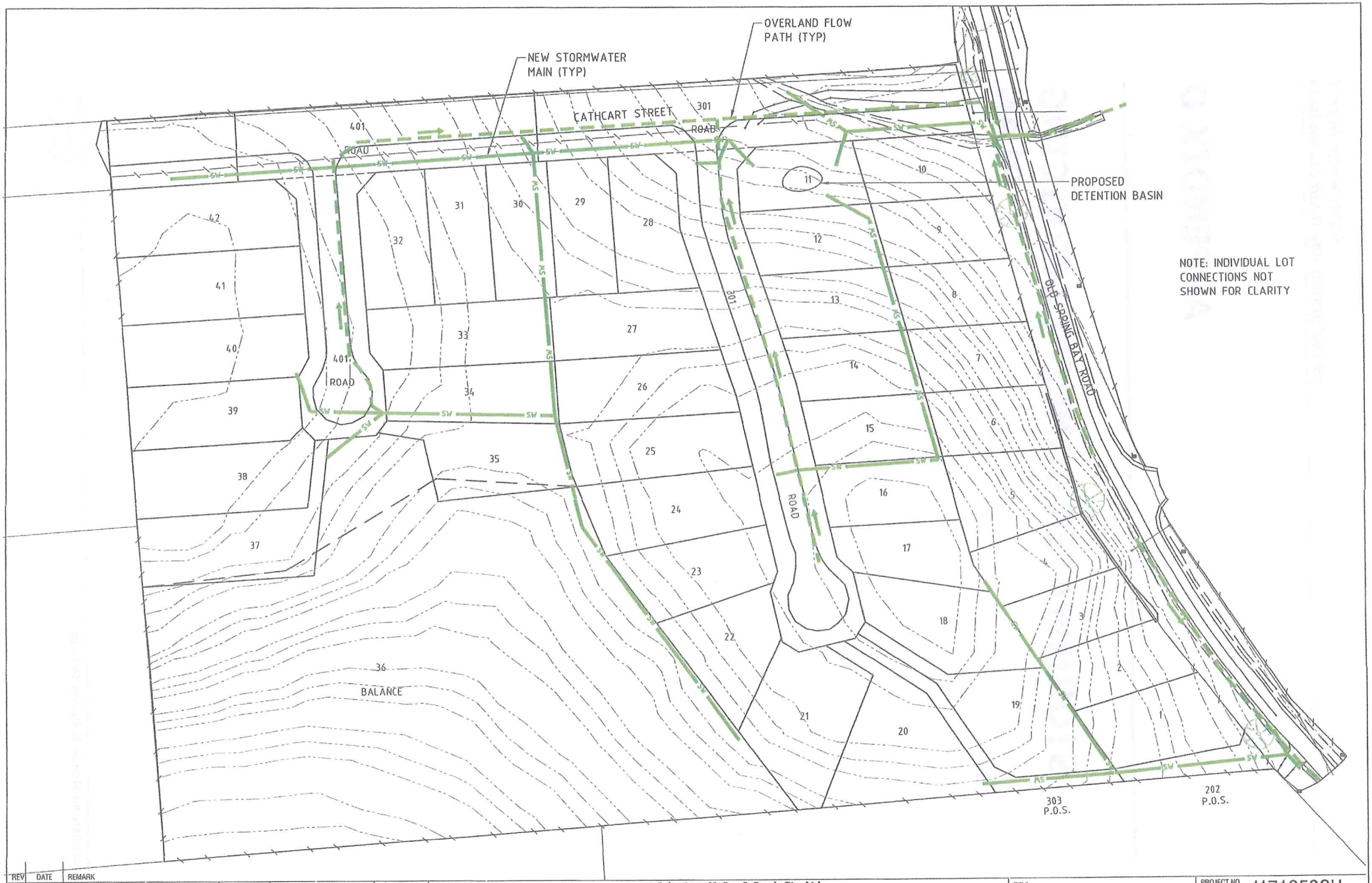
10	81.30	0.048	0.013	28.826	21.026
20	**54.20**	**0.032**	**0.013**	**38.435**	**22.835**
30	42.10	0.025	0.013	44.781	21.381
60	27.70	0.016	0.013	58.929	12.129
120	19.20	0.011	0.013	81.692	-11.908

Number of lot	6.00	
Storage per lot	4	m3

APPENDIX D

STORMWATER CONCEPT SERVICING PLAN



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PROJECT: 59 OLD SPRING BAY ROAD

TITLE: STORMWATER LAYOUT

PROJECT NO. J171052CH

DWG NO. C01

REVISION

PLOT DETAILS J171052CH SW REPORT.DWG