Stormwater Management Strategy

460 Grossmans Ocean Road, Torquay

Prepared for Mr Peter Sagar

Azurium

October 14, 2015

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APPENDICES

STORMWATER MANAGEMENT STRATEGY

460 Grossmans Road - Torquay

1. Introduction

This report represents the Stormwater Management Strategy to manage stormwater quality and quantity from the fully developed Grossman Estate in Torquay in accordance with a plan prepared by St Quentin Consulting Pty Ltd, Land Surveyors, Geelong.

The plan located in Appendix A has been prepared in relation to recent LDRZ application and comprises 68 Lots on a 29.094 hectare site generally, ranging in area from 2,500-4,000 square metres.

This drainage strategy has been developed in accordance with Council's adopted Infrastructure Design Manual objectives.

2. Document Review

The proposed development abuts the western boundary of Kithbrook Park Country Club.

As part of its development a drainage regime was developed by TGM Pty Ltd, a Geelong Consulting firm, in consultation with the Surfcoast Shire.

We have received documentation from TGM, Appendix B, which indicates that it has allowed for this area as part of its downstream drainage network, having regard to reduced outlet capacity in Ghazeepore Road dictated by the Ocean Acres Estate.

An outlet pipe and capacity have been provided and allows for the 1 in 100 year rural runoff from this property as part of the Kithbrook Park development.

3. Catchment Parameters

The development's drainage catchment is predominantly defined by Grossmans Road in the south, Kithbrook Park in the east and a ridge line that runs from its intersection with Grossmans Road in the west, to the north west corner of Kithbrook Park in the east.

A smaller triangular catchment to the north of Kithbrook Park, at the end of Dillwynia Lane, falls to its north east corner before discharging to Coombes Road.

A pre-development catchment plan indicating these areas is attached in Appendix C which indicates the majority of the of the catchment falling towards a low point approximately midway along the eastern boundary with Kithbrook Park, an area in north-east corner falling towards low point adjacent to the provided outlet through Kithbrook Park and finally the smaller triangular catchment referred to above.

The site grades generally from west to east at grades ranging from 1 in 120 - 1 in 180.

3.1 Outlet Allowances

TGM assessed the main upstream area as 25.5 ha. This was prior to the determination of the site's actual boundaries based on detailed contouring, which now sees the area as 27.5 ha; (catchments 1 & 2 Appendix D).

TGM provided a 900 mm diameter pipe outlet, located in line with Kithbrook Park's internal low point and retardation system, some 160m north of the main low point within this property. Discussions with Surfcoast Shire, saw TGM increase retardation within their property due to an underestimation by Council in assessing the upstream contributing catchment area.

That aside, an allowance of 1764 litres per second (l/s) has been provided for within the downstream system at the common boundary north of the proposed basin within this development.

4. Stormwater Strategy

4.1 Central Catchment

Appendix D indicates the post-development grading and overland drainage intention for the three catchments.

The central major catchment is proposed to have a retardation basin to retard flows back to the outlet capacity provided through Kithbrook Park once an allowance for the Northern Catchment has been made.

The intention is to convey the run-off from the majority of the site via the road network as overland flow to a retarding basin at a low point and from there via a piped outlet to the location provided for within Kithbrook Park.

Given the overall natural surface grading is reasonably flat, particularly when road cross sections are to convey the entire stormwater run-off to the retarding basin, preliminary gradings of each of the roads was undertaken.

This was for several reasons –

i) to ensure the minimum road grades could be achieved,

ii) that the sections at these grades had the required capacity,

iii) that the sections were such as to keep that one in 100 year volumes below lot levels,

iv) that the basin storage volume was able to be contained below the table drain invert and finally,

v) that the pipe outlet from the then basin invert was able to connect with the outlet pipe in Kithbrook Park.

Based on a minimum grade of 0.33% and a road cross-section as shown in Appendix E, it was determined that the capacity of the roadway was sufficient to cope with the volumes expected to be conveyed to the low point adjacent to the future retarding basin.

In order to achieve volumes and to protect lots, it was felt the roadway needed to be depressed by approximately 100-150 mm below natural surface to cater for capacity and freeboard.

This affected the basin design, as storage needed to be below the invert of the road table drain.

As a result, the invert of the basin was only 0.5 m above the outlet pipe invert in Kithbrook Park and following a preliminary pipe drain grading, it was determined that the length B20 to B21 within Kithbrook Park also shown in Appendix B was likely to require relaying in due course.

4.2 Northern Catchment

The intention will be to connect this small area directly to the system coming from retarding basin via a pipe or an open drain within the northern couple of lots, to a pit in this development before passing into Kithbrook Park.

This area is not retarded and its post-development volume will be removed from the total outlet value of 1764 l/s, with the balance being used to determine the retarding basin parameters for the Central catchment.

4.3 Dillwynia Catchment

This catchment is small, comprising only two lots.

The existing area has no formal outlet and ultimately discharges overland north to Coombes Road.

Dillwynia Lane at present is only a crushed rock "driveway" for part of its length and it is expected that it will be reformed, including table trains, to the boundary of this property in due course.

While some part of this catchment will fall to the newly created northern drain within Dillwynia Lane, the majority will be conveyed to Coombes Road via easements over land owned by the Developer.

5. Retardation Basin

5.1 Calculations

Pre-development run-off determination by the VicRoads method is not required in this instance, as downstream drainage is in place and the capacity allowance made.

Removing 260 l/s for the unretarded Northern catchment, the allowable outlet from the basin is 1504 l/s which results in a storage volume requirement of 3179 cubic metres.

This has been determined using Poertners (modified rational) Method and rainfall intensities for the area downloaded from the Bureau of Meteorology at this location.

The intensity value sheet and basin computations are seen overleaf.

Australian Government
Bureau of Meteorology

LOCATION 38.325 S 144.275 E *

LIST OF COEFFICIENTS TO EQUATIONS OF THE FORM

$$ln(I) = A + B \times (ln(T)) + C \times (ln(T))^2 + D \times (ln(T))^3 + E \times (ln(T))^4 + F \times (ln(T))^5 + G \times (ln(T))^6$$

T = TIME IN HOURS AND I = INTENSITY IN MILLIMETRES PER HOUR

RETURN PERIOD	A	B	C	D	E	F	G
1	2.591255	-0.61182E+0	-0.34981E-1	0.98510E-2	-0.30294E-5	-0.53034E-3	0.44009E-4
2	2.857208	-0.62083E+0	-0.34858E-1	0.10230E-1	0.84786E-5	-0.54725E-3	0.48877E-4
5	3.115222	-0.63999E+0	-0.35113E-1	0.86623E-2	0.52713E-3	-0.28665E-3	-0.94861E-5
10	3.255526	-0.65192E+0	-0.34779E-1	0.85238E-2	0.64828E-3	-0.22308E-3	-0.21800E-4
20	3.420681	-0.66114E+0	-0.34850E-1	0.75976E-2	0.91268E-3	-0.75106E-4	-0.53693E-4
50	3.616059	-0.67324E+0	-0.34605E-1	0.72935E-2	0.10675E-2	0.72633E-5	-0.70640E-4
100	3.752403	-0.68102E+0	-0.34829E-1	0.66340E-2	0.13068E-2	0.11514E-3	-0.95862E-4

RAINFALL INTENSITY IN mm/h FOR VARIOUS DURATIONS AND RETURN PERIODS

RETURN PERIOD (YEARS)

DURATION	1	2	5	10	20	50	100
5 mins	44.9	59.8	81.5	96.6	117.	146.	171.
6 mins	41.9	55.7	75.9	89.8	109.	136.	159.
10 mins	34.1	45.2	60.9	71.7	86.4	108.	125.
20 mins	24.8	32.6	43.2	50.4	60.1	74.1	85.7
30 mins	20.0	26.2	34.4	40.0	47.5	58.2	67.1
1 hour	13.3	17.4	22.5	25.9	30.6	37.2	42.6
2 hours	8.62	11.2	14.3	16.3	19.1	23.0	26.2
3 hours	6.61	8.55	10.8	12.3	14.3	17.2	19.5
6 hours	4.18	5.38	6.72	7.59	8.79	10.5	11.8
12 hours	2.63	3.37	4.19	4.71	5.44	6.46	7.28
24 hours	1.62	2.08	2.60	2.94	3.40	4.05	4.58
48 hours	.957	1.24	1.57	1.79	2.09	2.52	2.86
72 hours	.680	.890	1.13	1.30	1.52	1.84	2.09

BASIN DESIGN COMPUTATIONS – POERTNER METHOD

Area (sm)	260940	Coefficient of Runoff	0.52

Time of Concentration (mins)	Q (In) [l/sec]	Q (Out) [l/sec]	Intensity (mm/hr)	Poertner Method
2	8171	1486	216.78	802
4	7007	1486	185.90	1414
6	5999	1486	159.16	1803
8	5269	1486	139.81	2084
10	4723	1486	125.32	2299
12	4298	1486	114.03	2470
14	3956	1486	104.95	2610
16	3673	1486	97.46	2724
18	3435	1486	91.15	2819
20	3232	1486	85.74	2897
22	3055	1486	81.05	2962
24	2900	1486	76.93	3016
26	2762	1486	73.28	3060
28	2639	1486	70.01	3096
30	2528	1486	67.07	3124
32	2428	1486	64.41	3146
34	2336	1486	61.99	3161
36	2253	1486	59.77	3172
38	2176	1486	57.72	3177
40	2105	1486	55.84	3179
42	2039	1486	54.09	3176
44	1977	1486	52.46	3170
46	1920	1486	50.95	3160
47	1867	1486	49.53	3080
48	1817	1486	48.20	3003
49	1770	1486	46.95	2929
50	1725	1486	45.78	2858
51	1684	1486	44.67	2789

Storm Frequency (Yr)	
Torquay	100 yr
2	216.78
4	185.90
6	159.16
8	139.81
10	125.32
12	114.03
14	104.95
16	97.46
18	91.15
20	85.74
22	81.05
24	76.93
26	73.28
28	70.01
30	67.07
32	64.41
34	61.99
36	59.77
38	57.72
40	55.84
42	54.09
44	52.46
46	50.95
48	49.53
50	48.20
52	46.95
54	45.78
56	44.67

5.2 Basin Plan / Layout / Formation

As outlined earlier, the 1 in 100 year storage level is intended to be below that of the low point table drain immediately west of the basin.

Appendix E is a plan view of the components and level comparison associated with the basin.

These include –

i) batter grades,

ii) basin setbacks,

iii) basin floor grades,

iv) 1 in 100 year water level,

v) adjacent road table drain level, and

vi) floodway path, grade and alternative.

While items i) - v) are self-explanatory, item vi) relates to overflow capability for rainfall events greater than 1 in 100 years.

While Appendix E indicates the ability to take the overflow north to the Kithbrook Park outfall location via open drain, it ideally should continue on the "gully" path immediately east of the retarding basin, through Kithbrook Park to connect with their internal road network.

That said, the basin is set into the ground and if water was allowed to rise to RL 38.90, then an additional volume of 4908 cubic metres of storage would be created and at a level equal the continuing gully east through Kithbrook Park while only half filling the adjacent road table drains at the existing low point.

6. Water Sensitive Urban Design (WSUD)

Water quality performance objectives are set out in "Urban Stormwater, Best Practice Environmental Management Guidelines" and relate to the percentage removal of several nominated pollutants.

The objectives are –

80% reduction in the typical urban annual load for total suspended solids (TSS)

45% reduction in the typical urban annual load for total phosphorus (TP), and

45% reduction in the typical urban annual load for nitrogen (TN)

70% reduction gross pollutants (litter).

As this development will be drained via grassed open/table drains, the stormwater treatment method chosen to be modelled was that of Vegetated Swales.

A MUSIC (Model for Urban Stormwater Improvement Conceptualization) assessment has been carried out on a major catchment and its findings in Appendix F confirms the achievement of the targets above, except for nitrogen.

Appendix F includes a plan of the sub catchments shown contributing at the downstream nodes and excludes the value derived from the upstream drains as lots contribute at regular intervals, particularly in the run to the first node at the upstream ends.

The model also underestimates targets achieved by excluding swales on either side of roadways which contribute evenly on both sides.

As well, the only area modelled is the Central Catchment which is shown caters for the Northern and Dillwynia catchments, even though they have vegetated swales themselves.

The nett result is that the downstream outlet is receiving treated water from the total upstream catchment that has achieved the water quality treatment objectives prescribed.

7. Conclusion

The outcomes of this report can be summarized as follows –

- the majority of the site can be commanded back to a central retarding basin,
- a piped outlet and overflow arrangement from the basin can be catered for, albeit that a more direct overflow outcome to the east should be pursued, and
- downstream outlet parameters have been provided in an earlier approved development/stormwater proposal.

In essence, this strategy indicates that the development area's stormwater can be retarded and drained without compromising downstream systems and treated to best practice for quality.

eter Berry

Appendix B

From: Leigh Prossor [leighp@tgmgroup.com]
Sent: Thursday, 15 May 2014 9:14 AM
To: Peter Berry
Cc: Peter Preece
Subject: Kithbrooke Park - Upstream catchment
Attachments: 0555_001.pdf; GE-2063-01-CE A13 REV 02.pdf; GE-2063-01-CE A16 REV 02.pdf

Peter,

Further to your earlier discussion with Peter Preece, please find enclosed a copy of the catchment plans, drainage comps and the construction issue design plans for the connecting stormwater pipe at Kithbrooke Park. There a couple of inconstancies that have come flooding back since I have looked through these old files.

- The information used to calculate the upstream catchment area was very thin.
- The calculated catchment at Ghazeepore Road for the Ocean acres development was smaller than our calculation (44Ha Vs 51Ha), accordingly we slightly oversized the Kithbrooke basin to reduce the Kithbrooke outflows to suit this, however the inflows from the upstream catchment were assumed to not be mitigated. i.e. Kithbrooke Park can accommodate the TGM calculated 100yr pre-development flows from the west, but these flows will exceed the design capacity once in Ocean Acres.
- There is a very slight discrepancy between the design flow for the west in the TGM calculations (1.746m^3s) and that shown in the design plans (1.823 m^3s), from my brief look, I am not sure where this has arisen.
- I note that the Kithbrooke design assumes that a cut off drain will be constructed to the south (towards Grossmans Road) to pick up a sub catchment, to my knowledge this has not yet been constructed.

Should you have any queries, please do not hesitate to give me a call.
Regards,
Leigh Prossor | Project Manager
Mobile 0400 550 096 • **Email** Leighp@tgmgroup.com

TGM Group Pty Ltd

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From: TGM Group [mailto:irc5035@tgmgroup.com.au]
Sent: Thursday, 15 May 2014 7:47 AM
To: Leigh Prossor
Subject: Attached Image

UPSTREAM (WEST)
CATCHMENT

TGM
Engineers and Surveyors

Page No.: 1
Job No.: GE-2063-01-CE
Computed: L.P
Checked:
Date: 9/4/08

KITHBROOKE PARK - Detention Basin Sizing

Catchment Areas

Total Catchment - Surf Coast Shire - (Ocean Acres design) = ~~444~~
- Tam 51.06 Ha

Kithbrooke Park - 20.02 Ha
Upstream (North) Catchment - 4.54 Ha
Upstream (west) Catchment - 25.5 Ha

Ocean Acres design data (Ghazeepore Rd Input)

T_c = 33.38 mins
C_{10} = 0.2
$Q_5 = 0.71 m^3 s^{-1}$
$Q_{10} = 0.91 m^3 s^{-1}$
$Q_{100} = 1.98 m^3 s^{-1}$

Adopt S.C.S Flows at Ghazeepore Rd
- Kithbrooke Park = 41.16% of total catchment,

therefore restrict outflows to 41.16% of Q_{TOTAL}

$\therefore Q_{5\ ALLOWED} = 0.71 m^3 s^{-1} \times 41.16\% = 0.292 m^3 s^{-1}$
$Q_{10\ ALLOWED} = 0.91 m^3 s^{-1} \times 41.16\% = 0.375 m^3 s^{-1}$
$Q_{100\ ALLOWED} = 1.98 m^3 s^{-1} \times 41.16\% = 0.815 m^3 s^{-1}$

Drainage Catchment Plan - Stage A

DESIGN	L PROSSOR	DATE	OCTOBER 2007	TGM Group Pty. Ltd. Level 1, 27-31 Myers St. P.O. Box 1137 Geelong Victoria 3220	CASEY CONSULTING SERVICES PO BOX 819 TORQUAY, 3228	KITHBROOKE PARK - STAGE A 460 GROSSMANS RD TORQUAY, 3220	CIVIL DRAWING
SURVEY	AGS	SCALE	H 1:500, V 1:50				DRAINAGE LAYOUT PLAN
CHECKED		APPROVED			S.C.S.C.		GE-2063-01-CE 13 x 00
DATE		SHEET SIZE	A1				

WORKS SHALL NOT COMMENCE UNTIL PLANS ARE SIGNED AND APPROVED FOR CONSTRUCTION

GE-2063-01-CE 13 x 00

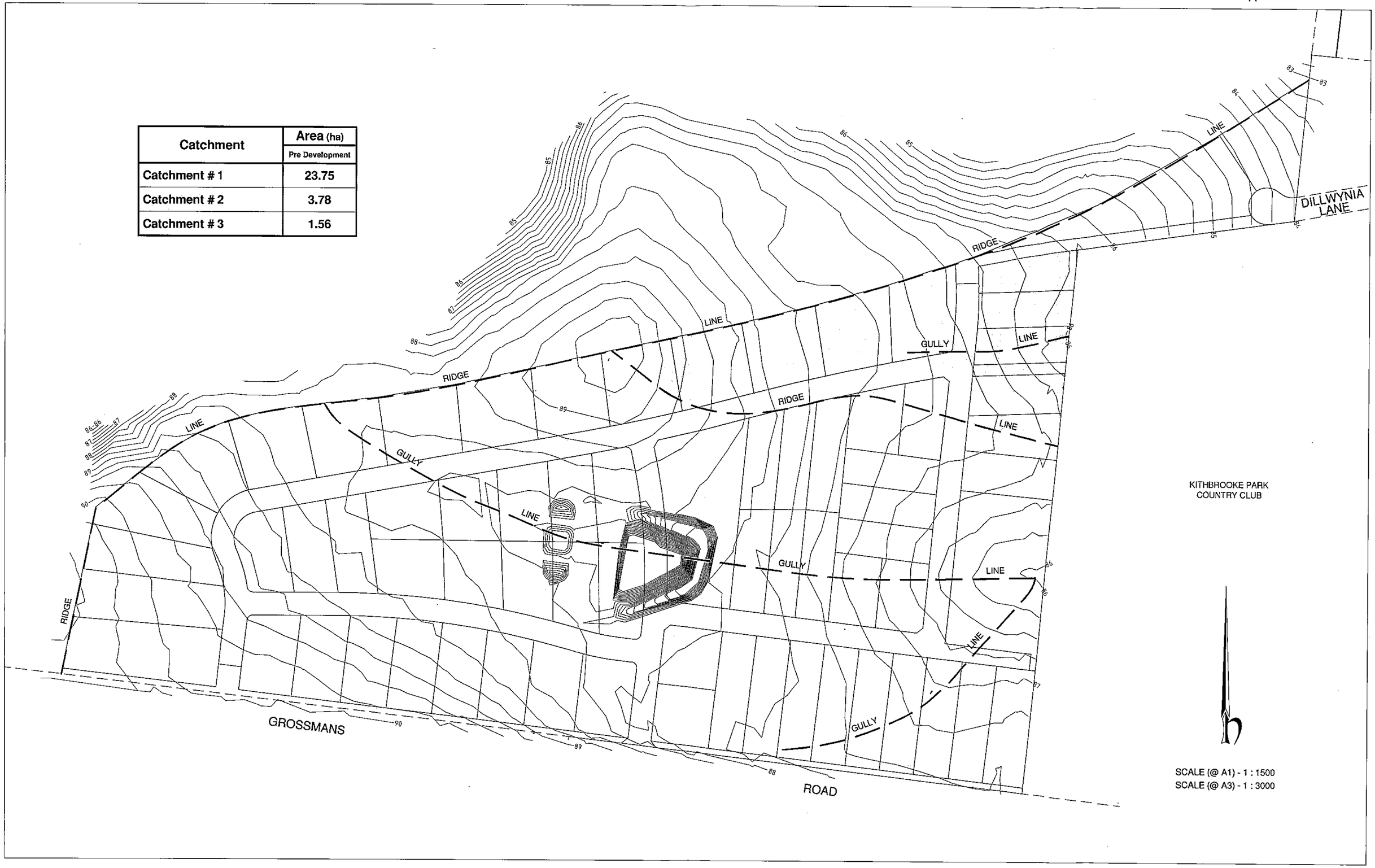
DRAINAGE COMPUTATIONS
KITHBROOKE ESTATE - SECTION A AND B 28/03/08

PIT	D/S PIT	Design ARI (yrs)	Area (ha)	CofR	Ae (ha)	Total Ae (ha)	Tc (min)	Rainfall Intensity (mm/h)	Pipe Capacity l/s	Pipe Flow l/s	Pipe Size (mm)	Pipe Grade (1 in)	Pipe Length (m)	At Grade Velocity (m/s)	Time in Pipe (min)	Velocity Head (m)	K	Head Loss (m)	HGL Slope (%)
B25	to B19	10	0.013	0 6	0 008	0.245	7 88	80	97	56	300(2)	100 21	12 126	1.37	0 15	0.032	1.8	0 057	0 34
B31	to B30	10	0 188	0 6	0.113	0.113	7	84	94	26	300(2)	106.19	27.714	1 33	0 35	0.007	5	0.035	0.07
B30	to B29	10	0.024	0.6	0.014	0.127	7 35	82	89	28	300(2)	118.14	19.375	1 26	0 26	0.008	1.4	0.011	0.09
B29	to B20	10	0.037	0.6	0.022	0.149	7 61	81	133	33	300(2)	52 88	7 033	1 88	0 06	0.011	1	0.011	0 12
B21	to B20	10	26.414	0.35	9.245	9.245	28 5	41	2675	1053	900(2)	49.98	41 03	4.07	0 17	0.13	0.5	0.065	0.31
B20	to B19	10	0 043	0.6	0.026	9 42	28 67	41	1236	1073	1050(2)	528 39	5 285	1 39	0 06	0 073	1.5	0.11	0.14
B19	to B18	10	0.022	0.6	0 013	9.678	28.73	41	1275	1103	1050(2)	496.42	7.946	1.43	0.09	0 078	1.3	0.102	0.15
B24	to B18	10	0 094	0.6	0.056	0.056	7	84	128	13	300(2)	56.85	12.166	1 81	0.11	0.002	5	0.008	0.02
B18	to B17	10	0 03	0.6	0.018	9.752	28.82	41	2277	1111	1200(2)	318.57	34.722	1 95	0.3	0.046	0.5	0.023	0 07
B23	to B22	10	0 061	0 6	0 037	0 037	7	84	60	9	300(2)	258.31	6.2	0.85	0.12	0.001	5	0.004	0.01
B22	to B17	10	0.027	0 6	0.016	0 053	7.12	83	61	13	300(2)	250 43	10.518	0.86	0.2	0.002	1 5	0.002	0.02
B17	to B16	10	0.038	0 6	0.023	9.828	29.12	40	1842	1111	1200(2)	486.97	7 791	1 58	0.08	0 046	1	0 046	0.07
100 YEAR																			
A33	to A32	100	0 192	0.7	0.134	0.134	7	147	104	55	300(2)	85 95	35 413	1 47	0 4	0.031	5	0.155	0 32
A41	to A32	100	0.127	0.7	0.089	0 089	7	147	68	36	300(2)	199.66	6.189	0.97	0.11	0.013	5	0.066	0 14
A32	to A31	100	0 098	0.7	0.068	0.291	7.4	143	111	116	300(2)	76 21	29.495	1.57	0.31	0 137	1 5	0.206	1 44
A40	to A31	100	0.062	0.7	0 043	0.043	7	147	68	18	300(2)	200.01	6 2	0 97	0.11	0.003	5	0.016	0 03
A31	to A30	100	0.162	0 7	0.113	0 447	7.71	140	245	174	375(2)	51 27	40.041	2.22	0.3	0 127	1.4	0.178	0 99
A39	to A30	100	0.07	0.7	0 049	0.049	7	147	68	20	300(2)	200.01	6 2	0 97	0.11	0.004	5	0.02	0 04
A30	to A29	100	0.033	0.7	0.023	0.519	8.01	138	321	199	450(2)	78 59	63 499	2 02	0 52	0.08	1.7	0.135	0.49
A38	to A29	100	0.058	0.7	0.041	0 041	7	147	27	17	225(2)	292.71	25 758	0.67	0 64	0.009	5	0.043	0.13
A29	to A28	100	0.104	0.7	0.072	0 632	8.53	134	0	235	525(2)		22 465	0	0 37	0 056	2.2	0.124	0 27
A16	to A15	100	0.057	0.7	0.04	0.04	7	147	68	16	300(2)	199.96	6.2	0.97	0.11	0 003	5	0.013	0 03
A15	to A14	100	0.077	0.7	0.054	0.094	7.11	146	69	38	300(2)	198.85	19.487	0.97	0.33	0 014	1.5	0.021	0 15
A27	to A14	100	0.088	0.7	0.061	0.061	7	147	68	25	300(2)	200.34	7.011	0.97	0.12	0.006	5	0.031	0 07
A14	to A13	100	0.15	0.7	0.105	0.26	7.44	143	192	103	375(2)	83.21	50.262	1.74	0.48	0.044	1 4	0 062	0 35
A26	to A13	100	0.124	0.7	0.087	0 087	7	147	137	36	300(2)	49.98	6.198	1.93	0.05	0 013	5	0.066	0 14
A13	to A12	100	0.068	0.7	0 048	0 395	7 92	139	136	153	375(2)	166.97	18 033	1 23	0,24	0.098	0 8	0 079	0.76
A12	to A11	100	0.128	0.7	0.09	0.485	8 16	137	221	185	450(2)	166 85	28 032	1 39	0.34	0.07	0.45	0.031	0.42
A25	to A11	100	0.119	0.7	0 083	0.083	7	147	108	34	300(2)	80.67	6.292	1 52	0 07	0.012	5	0 059	0.12
A11	to A10	100	0.056	0.7	0.039	0 607	8.5	134	221	227	450(2)	166 76	9 672	1.39	0.12	0.104	0.5	0 053	0 63
A10	to A9	100	0.007	0.7	0 005	0.612	8.62	133	220	227	450(2)	167.7	9.391	1.38	0 11	0.104	0.3	0.031	0.64
A24	to A9	100	0.038	0.7	0.027	0.027	7	147	68	11	300(2)	199 38	6.579	0.97	0.11	0 001	5	0.006	0.01
A9	to A8	100	0.007	0.7	0.005	0 644	8 73	132	221	237	450(2)	166 32	22.287	1.39	0 27	0.113	0 5	0.057	0.69
A8	to A7	100	0.016	0.7	0.011	0.655	9	130	293	237	450(2)	94.72	12.503	1.84	0.11	0.113	0 2	0.022	0.69
A23	to A7	100	0.027	0 7	0.019	0.019	7	147	68	8	300(2)	199.91	9.595	0.97	0.16	0 001	5	0 003	0.01
A7	to A6	100	0.011	0.7	0.008	0 682	9.11	130	202	247	450(2)	199.88	11.593	1 27	0.15	0.122	0.3	0.037	0.75
A6	to A5	100	0.208	0.7	0.146	0.828	9 26	129	316	298	525(2)	202.45	8.503	1.41	0.1	0.09	0.7	0.063	0 44
A5	to A4	100	0 05	0.7	0.035	0.863	9.36	128	318	307	525(2)	200 1	16.208	1.42	0.19	0.096	0 3	0.028	0.47
B31	to B30	100	0.188	0.7	0.131	0.131	10	124	94	45	300(2)	106.19	27.714	1 33	0.35	0.021	5	0.105	0.22
B30	to B29	100	0.024	0.7	0.017	0.148	10.35	122	89	50	300(2)	118.14	19.375	1.26	0.26	0.026	1 4	0 036	0.27
B29	to B20	100	0.037	0.7	0.026	0.174	10 61	120	133	58	300(2)	52 88	7.033	1 88	0 06	0.034	1	0.035	0 36
B21	to B20	100	26.414	0 35	9.245	9.245	28.5	68	2674	1746	900(2)	50	41.03	4 07	0.17	0.361	0.5	0.18	0.85
B20	to B19	100	0.043	0.7	0.03	9.449	28.67	68	1271	1784	1050(2)	500.16	5.285	1.42	0 06	0.204	1.5	0.306	0.39
B19	to B18	100	0.022	0.7	0.015	9.464	28.73	68	1271	1787	1050(2)	500	7.946	1 42	0.09	0.204	1.3	0.265	0 4
B24	to B18	100	0.094	0.7	0.066	0.066	10	124	128	23	300(2)	56 85	12.166	1.81	0.11	0.006	5	0.028	0 06

DRAINAGE COMPUTATIONS
KITHBROOKE ESTATE - SECTION A AND B 28/03/08

PIT	D/S PIT	Design ARI (yrs)	Area (ha)	CofR	Ae (ha)	Total Ae (ha)	Tc (min)	Rainfall Intensity (mm/h)	Pipe Capacity l/s	Pipe Flow l/s	Pipe Size (mm)	Pipe Grade (1 in)	Pipe Length (m)	At Grade Velocity (m/s)	Time in Pipe (min)	Velocity Head (m)	K	Head Loss (m)	HGL Slope (%)
B18	to B17	100	0.03	0 7	0 021	9 551	28.82	68	2281	1804	1200(2)	317.35	34.722	1 95	0 3	0.122	0.5	0.062	0.2
B23	to B22	100	0.061	0.7	0.043	0.043	10	124	61	15	300(2)	249.97	6.2	0.86	0.12	0.002	5	0 012	0.02
B22	to B17	100	0.027	0.7	0.019	0.062	10.12	123	61	22	300(2)	250.02	10.518	0.86	0.2	0 005	1 5	0.008	0.05
B17	to B16	100	0.038	0.7	0 027	9 64	29 19	67	1817	1804	1200(2)	500.09	7.791	1.56	0.08	0.122	1	0.122	0.2

Catchment	Area (ha)
	Pre Development
Catchment # 1	23.75
Catchment # 2	3.78
Catchment # 3	1.56



SCALE (@ A1) - 1 : 1500
SCALE (@ A3) - 1 : 3000

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Note:

- CONTOUR INTERVAL = 0.25 m

PRE-DEVELOPED CATCHMENT PLAN
460 GROSSMANS ROAD SUBDIVISION
TORQUAY

CATCHMENT #1 & #2

Pre-Development

From TGM Design
ΣQ_{100} = 1.746 cumecs

CATCHMENT #1

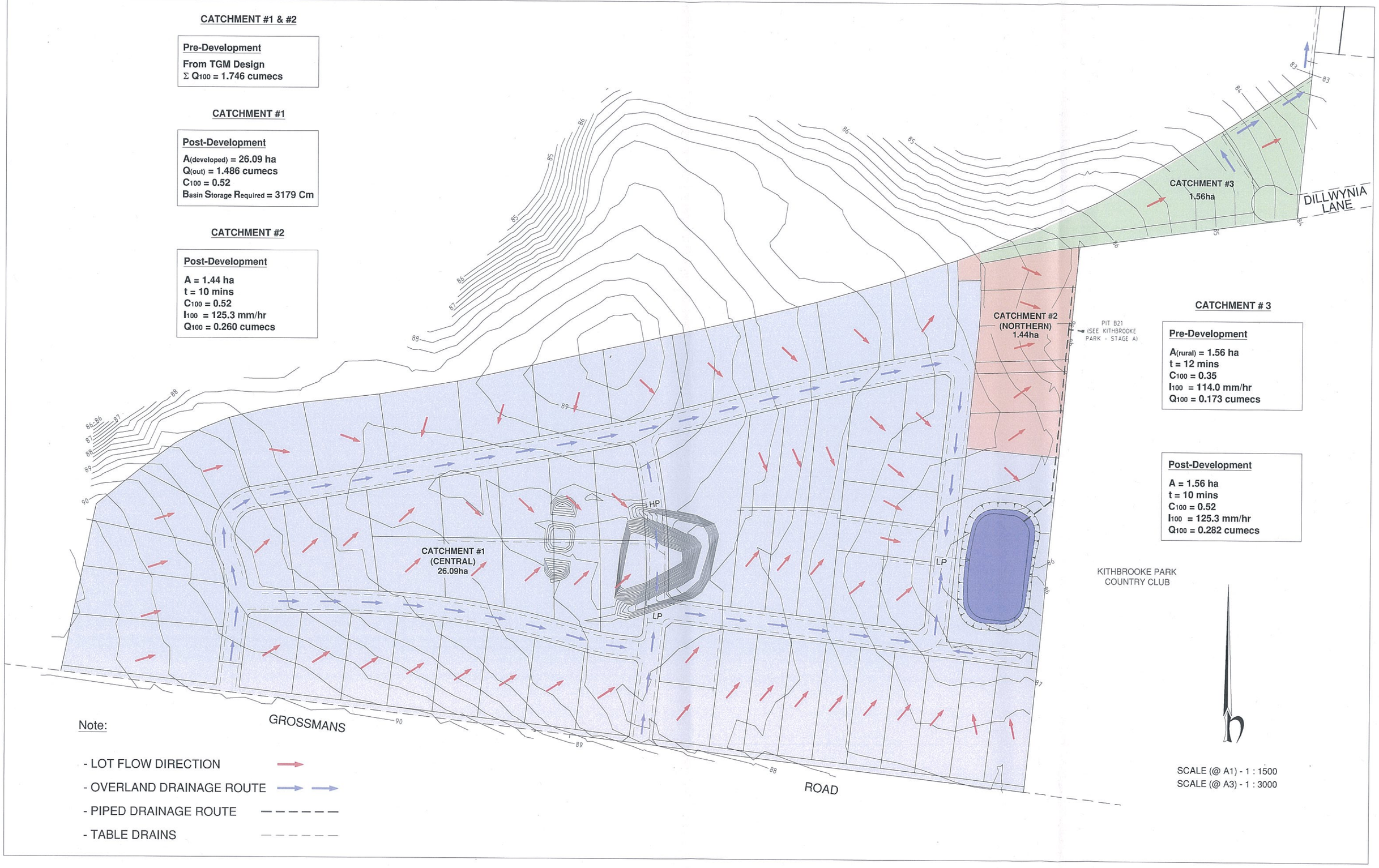
Post-Development

$A_{(developed)}$ = 26.09 ha
$Q_{(out)}$ = 1.486 cumecs
C_{100} = 0.52
Basin Storage Required = 3179 Cm

CATCHMENT #2

Post-Development

A = 1.44 ha
t = 10 mins
C_{100} = 0.52
I_{100} = 125.3 mm/hr
Q_{100} = 0.260 cumecs



CATCHMENT # 3

Pre-Development

$A_{(rural)}$ = 1.56 ha
t = 12 mins
C_{100} = 0.35
I_{100} = 114.0 mm/hr
Q_{100} = 0.173 cumecs

Post-Development

A = 1.56 ha
t = 10 mins
C_{100} = 0.52
I_{100} = 125.3 mm/hr
Q_{100} = 0.282 cumecs

Note:

- LOT FLOW DIRECTION
- OVERLAND DRAINAGE ROUTE
- PIPED DRAINAGE ROUTE
- TABLE DRAINS

SCALE (@ A1) - 1 : 1500
SCALE (@ A3) - 1 : 3000

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Note:

- CONTOUR INTERVAL = 0.25 m

POST-DEVELOPED STORMWATER MANAGEMENT PLAN
460 GROSSMANS ROAD SUBDIVISION
TORQUAY

ESTIMATED DESIGN FLOWS

$Q = CIA/360$

$A = 26.094ha$
$C_{100} = 0.52$

ASSUMED $Tc = 15$ min
$I_{100} = 101mm/hr$

$Q = 3.81m^3/s$

CROSS SECTION CAPACITY

$Q = V \times A$
$V = 1/n \times R^{2/3} \times S^{1/5}$ (MANNING'S EQUATION)

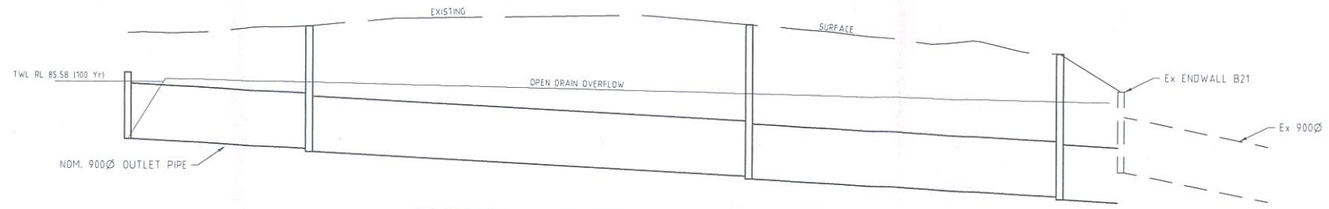
$A = 6.919m^2$
$S = 1$ IN 300 OR $0.0033m/m$
$R = A/P$
$P = 20.50m$
$n = 0.025$ (EARTH CHANNEL - GRAVELLY)

$V = 1.11m/s$

$Q = 7.68m^3/s$

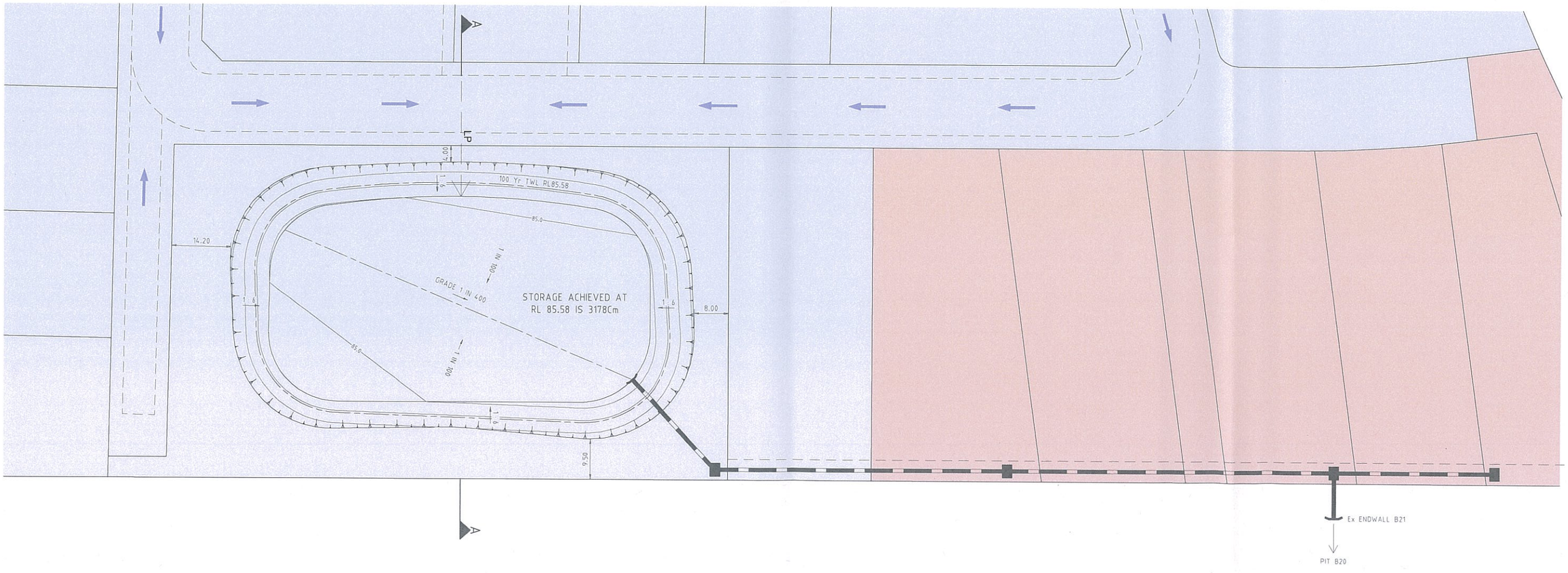
SECTION A-A
(NOT TO SCALE)

SCALE (@ A1) - 1 : 500
SCALE (@ A3) - 1 : 1000



DRAINAGE LONGITUDINAL SECTIONS

SCALES - HORIZ. 1 : 500
VERT. 1 : 50



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Note:

- CONTOUR INTERVAL = 0.50 m

BASIN DETAIL & OUTFALL DRAINAGE
460 GROSSMANS ROAD SUBDIVISION
TORQUAY

Treatment Train Effectiveness - Kithbrooke

	Sources	Residual Load	% Reduction
Flow (ML/yr)	56.7	54.8	3.3
Total Suspended Solids (kg/yr)	9890	1580	84
Total Phosphorus (kg/yr)	20.9	8.06	61.5
Total Nitrogen (kg/yr)	156	92	41
Gross Pollutants (kg/yr)	2280	123	94.6

SCALE (@ A1) - 1 : 1500
SCALE (@ A3) - 1 : 3000

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MUSIC MODEL PLAN AND RESULTS
460 GROSSMANS ROAD SUBDIVISION
TORQUAY