RESIDENTIAL SUBDIVISION

NARRAWALLEE

DRAINAGE REPORT – MAJOR FLOWS

Issue No.0
October 2010

RYGATE & WEST
(ULLADULLA) ABN 21 643 068 850
CONSULTING SURVEYORS, PLANNERS,
ROAD & DRAINAGE ENGINEERS
P.O. BOX 107, ULLADULLA N.S.W. 2539
266 GREEN STREET PH 02 44542137 FAX 02 44552916
email - rygate@shoalhaven.net.au

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1. INTRODUCTION

1.1 Background

Rygate and West were engaged to prepare a drainage report to address the downstream major overland flow path for stage one of the proposed residential subdivision SF9366 at Narrawallee.

This report provides drainage calculations to determine the necessary drainage works within private property required to adequately control major flows from the proposed residential development and existing downstream residential catchment.

1.2 Catchment Description

The catchment contributing to the road sag point, at #108 Leo Drive, consists of the proposed residential development site and the existing downstream residential area shown in ***Figure 1***.

The residential development site currently consists of moderately graded bushland that drains to the east. The development site grades in elevation from RL 31 at the south west corner to RL 8 in the eastern end of the site.

1.3 Proposed and Existing Development

The sag in Leo Drive is drained by a 750mm diameter pipe located within a 3m wide drainage easement passing through #108 Leo Drive and #4 Aries Place. Overland flows also pass through the private property generally within the existing easement.

The existing bushland upstream of the proposed development currently drains to Leo Drive.

The proposed piped drainage system for the new subdivision will be connected to the existing piped drainage system within Leo Drive. The allotment boundaries and road layout is shown on ***Figure 2***.

1.4 Development Requirements

The existing and proposed storm water systems have been assessed using the minor / major system requirements as specified in Council's Development Control Plan DCP100.

The drainage system must cope with the minor storm event to avoid nuisance flooding. The major storm event must not be allowed to cause dangerous or unsafe conditions.

2. HYDROLOGICAL ANALYSIS AND FLOODING

The peak stormwater flows were estimated using the rational method contained in book eight of AR&R. Times of concentration were calculated using the kinematic wave equation. Hydrologic analysis was carried out to determine peak flows required to design the proposed overland flow channel. The model was used to estimate design flows under both pre-developed and developed conditions for the 100 year Average Recurrence Interval (ARI) events.

2.1 Pre-Development Peak Flow

Pre-Development catchment sub-areas and percentage impervious parameters are provided in *Table 2.1*. The calculated 100 year ARI runoff coefficient C_{100}, in accordance with 1.5.5(iii) of AR&R is 0.84. A 100 year ARI peak flow of 2.52 m^3/s was determined using parameters in *Table 2.2*.

Pre-Development			
Catchment	Land Use	Area (ha)	Percentage Impervious
A	Existing Bushland	6.255	5%
B	Existing Residential	1.776	40%
	TOTAL	8.031	12.7%

Table 2.1

Pre-Development									
Land-Use	Flow Length (m)	Slope (%)	n*	Time (min)	Total Time (min)	Intensity (mm/hr)	Runnoff Coefficient	Area (ha)	100 yr ARI Peak Flow (m^3/s)
Bushland	366	6	0.30	37.6	45.2	126.8	0.85	8.03	2.40
Residential	54	6	0.21	7.6					

Table 2.2 n - surface roughness from Shoalhaven City Council DCP100.*

2.2 Post-Development Peak Flow

Post-Development catchment sub-areas and percentage impervious parameters are provided in *Table 2.3*. The calculated 100 year ARI runoff coefficient C_{100}, in accordance with 1.5.5(iii) of AR&R is 0.92. The Post-Development time of concentration was calculated by adding the proposed residential development time of concentration and the estimated overland flow time through the existing residential area.

Calculations used to determine the 100yr ARI time of concentration within the proposed residential development are contained in Appendix A. The overland flow time through the existing residential area is estimated 1.2 minutes.

The 100 year ARI peak flow of 4.1 m^3/s was determined using parameters in *Table 2.4*.

Post-Development			
Catchment	Land Use	Area (ha)	Percentage Impervious
A	Proposed Residential	6.819	40%
B	Existing Residential	1.776	40%
	TOTAL	8.595	40%

Table 2.3

Post-Development					
Land-Use	Total Time (min)	Intensity (mm/hr)	Runoff Coefficient	Area (ha)	100 yr ARI Peak Flow (m^3/s)
Residential	19	185.9	0.92	8.6	4.1

Table 2.4

3. HYDRAULIC ANALYSIS

Flows derived using the rational method, as detailed in **Section 2**, were used to estimate the hydraulic behaviour during the 100 year ARI storm event.

3.1 Existing Pipe Capacity

The capacity of the existing 750mm diameter pipe within the 3m wide drainage easement passing through #108 Leo Drive and #5 Aries Place has been calculated at 1.83 m^3/s using Colebrook White equation and parameters in *Table 3.1.*

Pipe Length	73m	
U/S invert level	4.05	
D/S invert level	2.43	
Kinematic viscosity	1.14E-06	DCP 100 – 15 deg
Roughness (mm)	0.6	Concrete Pipes
Diameter (m)	0.75	
Sf (Hydraulic Gradient) (m/m)	0.02	
Velocity (m/s)	4.148	
Discharge (m3/s)	1.832	

Table 3.1

3.2 Overland Flow Path

It is proposed to construct a formalised overland flow path, as shown in **Figure 3,** to convey major flows up to the 100 year ARI event, from Leo Drive to Aries Place within the existing 3m wide drainage easement. An open channel flow capacity of 2.27 m^3/s is required assuming the existing 750mm diameter pipe is just flowing full. A concrete lined open channel has been designed using the parameters in *Table 3.2.* Figure 3.1 shows a typical cross section of the proposed channel.

OPEN CHANNEL CALCULATIONS – MANNINGS EQUATION		
U/S invert level	6.38m	
D/S invert level	3.86m	
Length	67m	
Base Width	1.5m	
Side Slope	3:1	
Flow Depth	0.25	
Cross sectional area	0.562sq.m	
Wetted Perimeter	3.081m	
Longitudinal Slope	3.7%	
Mannings n	0.015	Concrete (trowel finish)
Hydraulic Radius	0.182	
Flowrate	2.32 m^3/s	
Velocity	4.12m/s	
Velocity x Depth Product (m^2/m)	1.03	

Table 3.2

4. REFERENCES

The Institute of Engineers, Australia, Rainfall & Runoff, 2001

Shoalhaven City Council, Development Control Plan 100 - Engineering Design Specification

FIGURES

FIGURE 1

NARRAWALLEE SUBDIVISION
CATCHMENT PLAN - PRE-DEVELOPMENT

FIGURE 2

LEGEND

PROPOSED RESIDENTIAL CATCHMENT AREA

EXISTING RESIDENTIAL CATCHMENT AREA

RYGATE & WEST
(ULLADULLA) ABN 21 643 068 850
CONSULTING SURVEYORS,PLANNERS,
ROAD & DRAINAGE ENGINEERS

50 0 50 METERS

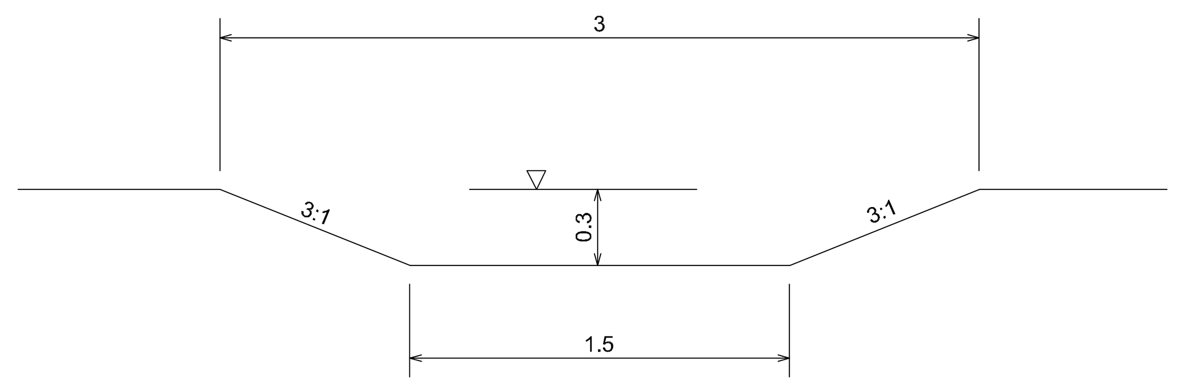
SCALE: 1 : 1500 (A3)

NARRAWALLEE SUBDIVISION

CATCHMENT PLAN - POST-DEVELOPMENT

FIGURE 3

PLAN



SECTION A - PROPOSED OPEN CHANNEL

RYGATE & WEST
(ULLADULLA) ABN 21 643 068 850
CONSULTING SURVEYORS,PLANNERS,
ROAD & DRAINAGE ENGINEERS

NARRAWALLEE SUBDIVISION
OVERLAND FLOW PATH DETAILS

HGL Report - Drainage 1 Return Period: 100yrs Location: Narrawallee

Pipe Connecting Pits\P(Downstream Upstream)	Pipe ID	Pipe Class	Pipe Diameter	Pipe Length	Pipe Design Flow	Mannings n	Pipe Velocity	Pipe Velocity Head	HGL at Downstream Pit	Pipe Friction Slope	Pipe Friction Loss	HGL at Upstream Pit	Pit Loss Coefficient	Pipe Head Loss	Adopted Upstream Water Level	Pit Surcharge Level\P(Pit Inlet/Outlet Level)	Downstream Pipe Obvert	Upstream Pipe Obvert	Downstream Pipe Invert	Upstream Pipe Invert	Pipe Slope	Pipe Design Flow	Pipe HGL Capacity	Pipe Manning Capacity
			(mm)	(m)	(l/s)		(m/s)	(m)	(m)	(%)	(m)	(m)	Ku	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(%)	(l/s)	(l/s)	(l/s)
1K 1J	1J1K	Class 2 RRJ	600	33.669	2630	0.013	9	4.132	5.404	0.09	2.947	8.352	1	4.132	12.484	8.46	5.404	7.369	4.794	6.759	5.835	2630	2141.6	1550.1
1J 1I	1I1J	Class 2 RRJ	600	28.564	2358.3	0.013	8.07	3.322	8.46	0.07	2.016	10.475	2.108	7.005	17.481	10.916	7.394	9.272	6.784	8.662	6.575	2358.3	2275	1645.4
1J 17D	17D1J	Class 2 RRJ	225	10.861	174.3	0.013	4.23	0.913	8.46	0.06	0.701	9.161	1.057	0.965	10.126	8.459	7.013	7.84	6.784	7.611	7.616	174.3	189.6	129.9
1J 15D	15D1J	Class 2 RRJ	225	5.039	208.4	0.013	5.06	1.307	8.46	0.09	0.462	8.922	1.146	1.497	10.419	8.804	7.847	8.179	7.618	7.95	6.584	208.4	176	120.8
1I 1H	1H1I	Class 2 RRJ	600	20.472	1095.1	0.013	3.75	0.716	10.916	0.02	0.32	11.236	1	0.716	11.952	11.433	9.297	10.345	8.687	9.735	5.119	1095.1	2004	1451.8
1I 2F	2F1I	Class 2 RRJ	600	9.844	1352.9	0.013	4.63	1.093	10.916	0.02	0.233	11.149	1.906	2.084	13.232	10.911	9.297	10.269	8.687	9.659	9.874	1352.9	2794.7	2016.4
17D 17C	17C17D	PVC	225	5.1	128	0.009	3.22	0.529	8.459	0.04	0.189	8.647	1.036	0.548	9.195	8.895	7.861	8.211	7.636	7.986	6.862	128	175.9	169.9
15D 15C	15C15D	PVC	225	56.5	146.8	0.009	3.69	0.695	8.804	0.05	2.725	11.529	1.307	0.909	12.438	11.946	8.2	11.044	7.975	10.819	5.033	146.8	150	145.5
1H 1G	1G1H	Class 2 RRJ	600	8.832	1063.4	0.013	3.64	0.675	11.433	0.01	0.13	11.563	2.428	1.64	13.203	11.443	10.345	10.489	9.735	9.879	1.631	1063.4	1119.1	819.4
2F 2E	2E2F	Class 2 RRJ	525	19.731	877.5	0.013	3.92	0.783	10.911	0.02	0.394	11.336	1	0.783	12.119	12.509	10.218	11.336	9.684	10.802	5.664	877.5	1491.2	1071
2F 3H	3H2F	Class 2 RRJ	375	36.554	600.5	0.013	5.44	1.508	10.911	0.06	2.124	13.036	1.259	1.899	14.935	12.802	10.059	12.129	9.684	11.754	5.662	600.5	592.5	417.2
17C 17B	17B17C	PVC	150	56.5	64.2	0.009	3.63	0.674	8.895	0.08	4.325	13.221	1.955	1.317	14.538	13.247	8.161	12.622	8.011	12.472	7.895	64.2	65.2	61.8
15C 15B	15B15C	PVC	150	72	64.2	0.009	3.64	0.674	11.946	0.08	5.516	17.463	1.956	1.319	18.781	17.297	10.994	16.672	10.844	16.522	7.887	64.2	65.2	61.8
1G 1F	1F1G	Class 2 RRJ	450	26.392	928.7	0.013	5.84	1.74	11.443	0.05	1.417	12.86	1	1.74	14.6	12.726	10.354	11.733	9.904	11.283	5.225	928.7	915.8	651.7
2E 2D	2D2E	Class 2 RRJ	525	7.926	857.4	0.013	3.83	0.748	12.119	0.02	0.151	12.27	2.48	1.855	14.125	12.509	11.361	11.874	10.827	11.34	6.477	857.4	1596.1	1145.3
3H 3G	3G3H	Class 2 RRJ	375	51.489	400.2	0.013	3.62	0.67	12.802	0.03	1.351	16.224	1.566	1.05	17.274	17.398	12.154	16.224	11.779	15.849	7.906	400.2	702.1	493
3H 4A	4A3H	Class 2 RRJ	375	9.022	187.7	0.013	1.7	0.147	12.802	0.01	0.055	12.857	9.256	1.364	14.22	12.932	12.154	12.303	11.779	11.928	1.648	187.7	315.2	225.1
17B 17A	17A17B	PVC	150	36	21.8	0.009	1.23	0.078	13.247	0.01	0.349	14.447	7.211	0.56	15.007	15.152	12.647	14.447	12.497	14.297	5.001	21.8	51.5	49.2
15B 15A	15A15B	PVC	150	35.5	21.8	0.009	1.23	0.078	17.297	0.01	0.344	19.255	7.211	0.56	19.815	19.855	16.697	19.255	16.547	19.105	7.206	21.8	62.2	59.1
1F 1E	1E1F	Class 2 RRJ	375	28.55	830.2	0.013	7.52	2.883	12.726	0.11	3.14	15.866	1	2.883	18.749	14.229	11.683	13.391	11.308	13.016	5.983	830.2	609.4	428.9
1F 16B	16B1F	PVC	150	26.608	84.8	0.009	4.8	1.174	12.726	0.13	3.498	16.224	2.045	2.401	18.625	15.788	11.458	14.636	11.308	14.486	11.944	84.8	80.7	76
2D 2C	2C2D	Class 2 RRJ	375	23.37	692.9	0.013	6.27	2.008	12.509	0.08	1.8	14.308	1.446	2.904	17.212	13.724	11.74	13.044	11.365	12.669	5.581	692.9	588.2	414.2
2D 5A	5A2D	Class 2 RRJ	375	9.588	97.2	0.013	0.88	0.039	12.509	0	0.017	12.525	18	0.711	13.236	-1E+30	11.74	11.875	11.365	11.5	1.408	97.2	290.6	208
3G 3F	3F3G	Class 2 RRJ	375	16.975	289.9	0.013	2.63	0.352	17.274	0.01	0.238	17.673	1.426	0.501	18.175	18.353	16.249	17.673	15.874	17.298	8.387	289.9	723.5	507.8
3G 6A	6A3G	Class 2 RRJ	375	8.8	118.8	0.013	1.08	0.059	17.274	0	0.022	17.296	12.372	0.73	18.027	17.398	16.249	16.777	15.874	16.402	6	118.8	610.3	429.5
1E 1D	1D1E	Class 2 RRJ	375	13.932	502.2	0.013	4.55	1.055	14.229	0.04	0.57	14.799	1	1.055	15.854	15.434	13.416	14.69	13.041	14.315	9.14	502.2	755.7	530.1
1E 14A	14A1E	Class 2 RRJ	375	8.8	118.7	0.013	1.07	0.059	14.229	0	0.022	14.252	11.212	0.661	14.912	14.229	13.416	13.595	13.041	13.22	2.032	118.7	351	249.9
1E 13A	13A1E	Class 2 RRJ	375	27.444	237.8	0.013	2.15	0.236	14.229	0.01	0.262	15.594	7.8	1.845	17.439	16.239	13.416	15.594	13.041	15.219	7.935	237.8	703.4	493.9
16B 16A	16A16B	PVC	150	58.399	22.6	0.009	1.28	0.084	15.788	0.01	0.606	19.064	6.954	0.581	19.645	19.664	14.961	19.064	14.811	18.914	7.026	22.6	61.4	58.3
2C 2B	2B2C	Class 2 RRJ	375	55.924	342.4	0.013	3.1	0.49	13.724	0.02	1.083	16.01	1	0.49	16.501	16.609	13.069	16.01	12.694	15.635	5.259	342.4	570.7	402.1
2C 11D	11D2C	PVC	225	39.599	215.9	0.009	5.43	1.504	13.724	0.1	4.051	17.774	2.2	3.309	21.083	18.107	12.919	16.937	12.694	16.712	10.146	215.9	214.9	206.6
2C 10A	10A2C	Class 2 RRJ	375	10.431	42	0.013	0.38	0.007	13.724	0	0.004	13.727	16.967	0.125	13.853	14.093	13.069	13.492	12.694	13.117	4.051	42	499.6	352.9
3F 3E	3E3F	Class 2 RRJ	375	8.092	257.4	0.013	2.33	0.277	18.175	0.01	0.09	18.265	2.538	0.703	18.968	18.337	17.698	17.739	17.323	17.364	0.5	257.4	169.9	124
1D 1C	1C1D	Class 2 RRJ	375	7.803	473.9	0.013	4.29	0.939	15.434	0.04	0.285	15.719	2.18	2.048	17.767	15.449	14.715	14.841	14.34	14.466	1.625	473.9	312.8	223.5
2B 2A	2A2B	Class 2 RRJ	375	36.884	155.4	0.013	1.41	0.101	16.501	0	0.155	17.143	10.514	1.062	18.205	17.717	16.035	17.143	15.66	16.768	3.003	155.4	428.7	303.8
2B 12A	12A2B	Class 2 RRJ	375	9.314	42	0.013	0.38	0.007	16.501	0	0.003	16.504	16.967	0.125	16.629	16.815	16.035	16.215	15.66	15.84	1.926	42	341.4	243.3
11D 11C	11C11D	PVC	225	56.885	160.3	0.009	4.03	0.829	18.107	0.06	3.255	21.362	1.583	1.312	22.674	19.845	17.062	19.238	16.837	19.013	3.826	160.3	130.2	126.9
3E 3D	3D3E	Class 2 RRJ	375	64.441	203.5	0.013	1.84	0.173	18.337	0.01	0.456	19.025	1.27	0.22	19.245	20.097	17.764	19.025	17.389	18.65	1.958	203.5	344.3	245.3
3E 7A	7A3E	Class 2 RRJ	375	13.75	29	0.013	0.26	0.004	18.337	0	0.003	18.652	17.845	0.063	18.715	19.386	17.764	18.652	17.389	18.277	6.463	29	633.8	445.7
1C 1B	1B1C	Class 2 RRJ	375	51.75	289.8	0.013	2.62	0.351	15.449	0.01	0.725	18.118	2.2	0.773	18.891	18.753	14.866	18.118	14.491	17.743	6.283	289.8	624.8	439.5
11C 11B	11B11C	PVC	225	72.461	86.6	0.009	2.18	0.242	19.845	0.02	1.261	21.323	1.687	0.408	21.731	22.508	19.247	21.323	19.022	21.098	2.866	86.6	112.1	109.8
3D 3C	3C3D	Class 2 RRJ	375	72.641	142.4	0.013	1.29	0.085	19.245	0	0.259	21.531	1.447	0.123	21.654	22.194	19.05	21.531	18.675	21.156	3.415	142.4	457.9	324
3D 8A	8A3D	Class 2 RRJ	375	7.802	50.9	0.013	0.46	0.011	19.245	0	0.004	19.493	16.28	0.176	19.67	20.092	19.05	19.493	18.675	19.118	5.677	50.9	593.3	417.8
1B 1A	1A1B	Class 2 RRJ	375	7.8	95.3	0.013	0.86	0.038	18.753	0	0.013	18.766	12.73	0.484	19.249	18.753	18.143	18.182	17.768	17.807	0.5	95.3	169.9	124
11B 11A	11A11B	PVC	150	53.5	28.3	0.009	1.6	0.131	21.731	0.02	0.847	22.578	5.736	0.749	23.327	22.141	21.273	21.541	21.123	21.391	0.5	28.3	15.3	15.6
3C 3B	3B3C	Class 2 RRJ	375	66.011	119.5	0.013	1.08	0.06	21.654	0	0.169	23.436	2.2	0.132	23.567	24.099	21.556	23.436	21.181	23.061	2.848	119.5	417.3	295.9
3C 9A	9A3C	Class 2 RRJ	375	7.8	42.8	0.013	0.39	0.008	21.654	0	0.003	21.656	16.906	0.13	21.786	22.194	21.556	21.595	21.181	21.22	0.5	42.8	169.9	124
3B 3A	3A3B	Class 2 RRJ	375	7.8	55.6	0.013	0.5	0.013	23.567	0	0.005	23.572	15.854	0.205	23.777	24.099	23.461	23.5	23.086	23.125	0.5	55.6	169.9	124

Catchment Hydrology - Drainage 1   Return Period: 100   Location: Narrawallee

Pit No.	Surface Type	Catchment Overland Flow Length	Catchment Overland Flow Slope	Catchment Overland Flow Roughness	Catchment Overland Flow Time	Gutter Length	Gutter Flow Time	Pit Tc (with Gutter)	Single Catchment Area	Catchment Pervious Area	Catchment Impervious Area	Pit C Factor	Pit Effective Area	Adopted Pit Tc	Rainfall Intensity	Total Catchment Flow	Catchment Flow Direct to Pipe	Catchment Flow to Pit Inlet	Pit Type	Specified Inflow to Pit	Bypass Received From Pit No.	Bypass Flow Received	Total Flow to Pit	Pit Inlet Inflow	Pit Bypass Flow	Bypass to Pit	Gutter Slope	Gutter Flow Width	Pit Gutter Flow Depth
		(m)	(%)		(min)	(m)	(m)	(min)	(Ha)	(Ha)	(Ha)		(Ha)	(min)	(mm/hr)	(l/s)	(l/s)	(l/s)		(l/s)		(l/s)	(l/s)	(l/s)	(l/s)		(%)	(m)	(m)
1J					5			5		0.002	0.029	1	0.031	5	290.7	25.036		25.036	2.4m + gra		1I		52.729	37.001					
																					1J	27.7			15.7	1K			
1I					5			5		0.002	0.043	1	0.045	5	290.7	36.342		36.342	2.4m + gra		3H		77.386	49.693				0	10.916
																					1G				27.7	1J			
																					1H								
																					1I	41							
17D								5.07		0.024	0.04	0.956	0.06	5.073	289.3	48.421		48.421	2.4m + gra		2F		93.84	57.92				1.576	0.064
					5			5		0.001	0.025	1	0.026								17D	45.4							
		41.5	11.9	0.17	5	6.55	0.07	5.07		0.022	0.015	0.926	0.034														9.44		
15D					5			5		0.004	0.08	1	0.084	5	290.7	67.839	69.603	-1.764	JP-600x600				-1.764	0					
1H					5			5		0.003	0.054	1	0.057	5	290.7	46.034		46.034	2.4m + gra		14A		94.393	58.197					
																					1H	48.4			36.2	1I			
2F					5			5		0.002	0.031	1	0.033	5	290.7	26.651		26.651	2.4m + gra		2D		112.838	67.419					
																					2E				45.4	17D			
																					2F	86.2							
17C					5			5		0.004	0.08	1	0.084	5	290.7	67.839	69.603	-1.764	JP-600x600				-1.764	0					
15C					5			5		0.005	0.104	1	0.109	5	290.7	88.03	90.318	-2.289	JP-600x600				-2.289	0					
1G								12.27		0.117	0.134	0.944	0.237	12.267	217.5	143.116		143.116	2.4m + gra		4A		243.116	143.116				Sag	40
					5			5		0.003	0.058	1	0.061								1F				100	1I			
		114.42	6.9	0.21	12.08	17.14	0.19	12.27		0.114	0.076	0.926	0.176								1G	100					4.58		
2E					5			5		0.002	0.032	1	0.034	5	290.7	27.459		27.459	2.4m + gra		10A		43.261	0				Sag	40
																					2E	15.8			43.3	2F			
3H								6.91		0.031	0.065	0.963	0.092	6.912	261.7	67.196		67.196	2.4m + gra		3G		104.086	63.043				1.796	0.07
					5			5		0.002	0.046	1	0.048								3H	36.9			41	1I			
		52.79	8.5	0.21	6.61	26.96	0.3	6.91		0.029	0.019	0.926	0.044														8.67		
17B					5			5		0.003	0.052	1	0.055	5	290.7	44.419	45.573	-1.155	JP-600x600				-1.155	0					
15B					5			5		0.003	0.052	1	0.055	5	290.7	44.419	45.573	-1.155	JP-600x600				-1.155	0					
1F								5.82		0.025	0.041	0.955	0.063	5.821	276.5	48.406		48.406	2.4m + gra		1E		96.29	59.145					
					5			5		0.001	0.025	1	0.026								1F	47.9			37.1	1G			
		49.23	10.7	0.21	5.82			5.82		0.024	0.016	0.926	0.037																
2D								9.53		0.077	0.07	0.936	0.138	9.527	236.4	90.311		90.311	2.4m + gra		2C		190.311	104.124					
					5			5		0.001	0.019	1	0.02								2D	100			86.2	2F			
		84.66	7.6	0.21	9.48	4.19	0.05	9.53		0.076	0.051	0.926	0.118														5.51		
3G					5			5		0.001	0.025	1	0.026	5	290.7	20.998		20.998	2.4m + gra		3F		95.781	58.891				1.639	0.066
																					3G	74.8			36.9	3H			
4A								10.83		0.164	0.154	0.937	0.298	10.83	226.7	187.673		187.673	2.4m + gra		6A		236.077	108				0	12.891
					5			5		0.002	0.047	1	0.049								4A	48.4			100	1G			
		101.57	7.6	0.21	10.77	5.69	0.06	10.83		0.161	0.108	0.926	0.249														7.39		
17A					5			5		0.001	0.026	1	0.027	5	290.7	21.805	22.372	-0.567	JP-600x600				-0.567	0					
15A					5			5		0.001	0.026	1	0.027	5	290.7	21.805	22.372	-0.567	JP-600x600				-0.567	0					
1E					5			5		0.001	0.021	1	0.022	5	290.7	17.767		17.767	2.4m + gra		1C		117.767	69.884				1.885	0.073
																					1D				47.9	1F			
																					1E	100							
16B					5			5		0.004	0.078	1	0.082	5	290.7	66.224	67.946	-1.722	JP-600x600				-1.722	0					
2C								10.2		0.125	0.122	0.938	0.232	10.199	231.2	148.844		148.844	2.4m + gra		2B		248.844	108				0	13.671
					5			5		0.002	0.04	1	0.042								2C	100			100	2D			
		83.68	6.4	0.21	10	18.33	0.2	10.2		0.123	0.082	0.926	0.19														5.25		
5A								6.56		0.046	0.088	0.981	0.131	6.559	266.1	97.155		97.155	1.2m + gra				97.155	97.155				Sag	20
		56.18	10.1	0.21	6.49	5.88	0.07	6.56		0.045	0.067	0.977	0.109														1.08		
					5			5		0.001	0.021	1	0.022																
3F					5			5		0.003	0.06	1	0.063	5	290.7	50.879		50.879	2.4m + gra		8A		74.783	0				Sag	40
																					3E				74.8	3G			
																					3F	23.9							
6A								10.58		0.082	0.115	0.95	0.187	10.575	228.5	118.807		118.807	2.4m + gra				118.807	70.404	48.4	4A		0	17.398
					5			5		0.003	0.062	1	0.065																
		67.39	3.7	0.21	10.39	16.36	0.18	10.58		0.079	0.053	0.926	0.122														7.32		
1D					5			5		0.002	0.047	1	0.049	5	290.7	39.573		39.573	2.4m + gra		1A		76.222	49.111				1.525	0.069
																					1D	36.6			27.1	1E			
14A					5			5		0.007	0.14	1	0.147	5	290.7	118.719		118.719	2.4m + gra				118.719	70.359	48.4	1H		0	14.284
13A								13.76		0.204	0.23	0.943	0.409	13.764	209.1	237.776		237.776	2.4m + gra				237.776	108	100	1C		2.393	0.088
					5			5		0.005	0.098	1	0.103																
		108.72	4.5	0.21	13.56	18.48	0.21	13.76		0.199	0.132	0.926	0.306														7.68		
16A					5			5		0.001	0.027	1	0.028	5	290.7	22.613	23.201	-0.588	JP-600x600				-0.588	0					
2B								11.21		0.155	0.13	0.933	0.266	11.212	224.1	165.594		165.594	2.4m + gra		2A		232.277	108				0	16.571
					5			5		0.001	0.028	1	0.029								2B	66.7			100	2C			
		92.59	5.6	0.21	11.21	0.15	0	11.21		0.154	0.102	0.926	0.237														3.21		
11D					5			5		0.004	0.073	1	0.077	5	290.7	62.186	63.803	-1.617	JP-600x600				-1.617	0					

Pit No.	Surface Type	Catchment Overland Flow Length	Catchment Overland Flow Slope	Catchment Overland Flow Roughness	Catchment Overland Flow Time	Gutter Length	Gutter Flow Time	Pit Tc (with Gutter)	Single Catchment Area	Catchment Pervious Area	Catchment Impervious Area	Pit C Factor	Pit Effective Area	Adopted Pit Tc	Rainfall Intensity	Total Catchment Flow	Catchment Flow Direct to Pipe	Catchment Flow to Pit Inlet	Pit Type	Specified Inflow to Pit	Bypass Received From Pit No.	Bypass Flow Received	Total Flow to Pit	Pit Inlet Inflow	Pit Bypass Flow	Bypass to Pit	Gutter Slope	Gutter Flow Width	Pit Gutter Flow Depth
10A					5			5		0.003	0.049	1	0.052	5	290.7	41.996		41.996	2.4m + gra		12A		52.894	37.092				1.403	0.065
																					10A	10.9			15.8	2E			
3E								6.56		0.233	0.144	0.188	0.071	6.561	266.1	52.478		52.478	2.4m + gra		7A		58.092	0				Sag	40
					5			5		0.004	0.067	1	0.071								3E	5.6			58.1	3F			
		58.49	4.9	0.13	6.16	35.81	0.4	6.56		0.23	0.077	0	0														2.63		
1C								13.46		0.171	0.176	0.94	0.326	13.464	210.7	190.904		190.904	2.4m + gra		13A		290.904	190.904				Sag	40
					5			5		0.003	0.064	1	0.067								1B				100	1E			
		106.62	4.7	0.21	13.16	26.99	0.3	13.46		0.168	0.112	0.926	0.259								1C	100					7.34		
2A								8.96		0.138	0.111	0.932	0.232	8.961	241	155.366		155.366	2.4m + gra				155.366	88.683	66.7	2B		0	17.721
					5			5		0.001	0.02	1	0.021																
		77.92	5.4	0.17	8.71	22.57	0.25	8.96		0.137	0.091	0.926	0.211														1.14		
12A					5			5		0.003	0.049	1	0.052	5	290.7	41.996		41.996	2.4m + gra				41.996	31.098	10.9	10A		1.368	0.064
11C					5			5		0.005	0.096	1	0.101	5	290.7	81.569	83.689	-2.121	JP-600x600				-2.121	0					
3D								17.41		0.188	0.117	0.19	0.058	17.413	192.1	30.954		30.954	2.4m + gra		3C		46.251	33.438				0	20.077
					5			5		0.003	0.055	1	0.058								3D	15.3							
		89.78	3.1	0.3	17.4	1.09	0.01	17.41		0.185	0.062	0	0														2.76		
7A								5.42		0.002	0.035	0.998	0.037	5.417	283.1	29.036		29.036	2.4m + gra				29.036	23.422	5.6	3E		1.067	0.049
					5			5		0.002	0.034	1	0.036																
					5	37.51	0.42	5.42		0.001	0	0.926	0.001														2.92		
1B								12.56		0.178	0.209	0.944	0.366	12.555	215.8	219.106		219.106	2.4m + gra				219.106	108	100	1C		0	18.522
					5			5		0.005	0.093	1	0.098																
		85.55	3.5	0.21	12.55	0.8	0.01	12.56		0.173	0.116	0.926	0.268														3.77		
11B					5			5		0.004	0.072	1	0.076	5	290.7	61.378	62.974	-1.596	JP-600x600				-1.596	0					
3C								16.93		0.191	0.112	0.172	0.052	16.932	194.1	28.042		28.042	2.4m + gra		3B		51.771	36.474				0	22.213
					5			5		0.003	0.049	1	0.052								3C	23.7			15.3	3D			
		91.19	3.4	0.3	16.92	1.47	0.02	16.93		0.188	0.063	0	0														2.86		
8A					5			5		0.003	0.06	1	0.063	5	290.7	50.879		50.879	2.4m + gra		9A		69.808	45.904				1.785	0.077
																					8A	18.9			23.9	3F			
1A					5			5		0.006	0.112	1	0.118	5	290.7	95.298		95.298	2.4m + gra				95.298	58.649	36.6	1D		1.898	0.08
11A					5			5		0.002	0.033	1	0.035	5	290.7	28.266	29.001	-0.735	JP-600x600				-0.735	0					
3B					5			5		0.073	0.024	0.887	0.086	5	290.7	69.458		69.458	2.4m + gra				69.458	45.729	23.7	3C		0	24.118
					5			5		0.059	0.003	0.836	0.052																
					5			5		0.014	0.021	0.977	0.034																
9A					5			5		0.003	0.05	1	0.053	5	290.7	42.803		42.803	2.4m + gra		3A		59.841	40.913				1.681	0.074
																					9A	17			18.9	8A			
3A								5.96		0.191	0.132	0.226	0.073	5.961	274.4	55.64		55.64	2.4m + gra				55.64	38.602	17	9A		1.629	0.072
					5			5		0.004	0.069	1	0.073																
		35.17	13	0.13	5	86.47	0.96	5.96		0.188	0.063	0	0														2.56		

Pipe Hydrology - Drainage 1 Return Period: 100yrs Location: Narrawallee

Pipe Connecting Pits\P(Downstream Upstream)	Pipe ID	Pipe Class	Pipe Diameter	Pipe Length	Pipe Mannings n	Pipe Flow Time	Pipe Design Tc	Pipe Rainfall Intensity	Upstream Pervious Areas	Upstream Impervious Areas	Upstream Single Catchment Areas	Total Upstream Areas	Total Effective Areas	Pipe Flow	Specified Inflow to Pipe	Total Pipe Flow
			(mm)	(m)		(min)	(min)	(mm/hr)	(Ha)	(Ha)	(Ha)	(Ha)	(Ha)	(l/s)	(l/s)	(l/s)
1K 1J	1J1K	Class 2 RRJ	600	33.7	0.013	0.06	19.06	185.67	2.499	3.818	0	6.348	5.099	2630		2630
1J 1I	1I1J	Class 2 RRJ	600	28.6	0.013	0.06	19	185.89	2.451	3.317	0	5.813	4.567	2358.3		2358.3
1J 17D	17D1J	Class 2 RRJ	225	10.9	0.013	0.04	5.77	277.26	0.008	0.158	0	0.229	0.226	174.3		174.3
1J 15D	15D1J	Class 2 RRJ	225	5	0.013	0.02	6.06	272.86	0.01	0.181	0	0.275	0.275	208.4		208.4
1I 1H	1H1I	Class 2 RRJ	600	20.5	0.013	0.09	14.16	207.06	0.718	1.213	0	1.988	1.904	1095.1		1095.1
1I 2F	2F1I	Class 2 RRJ	600	9.8	0.013	0.04	18.97	186.02	1.729	2.018	0	3.78	2.618	1352.9		1352.9
17D 17C	17C17D	PVC	225	5.1	0.009	0.03	5.75	277.68	0.004	0.078	0	0.166	0.166	128		128
15D 15C	15C15D	PVC	225	56.5	0.009	0.26	5.81	276.68	0.004	0.078	0	0.191	0.191	146.8		146.8
1H 1G	1G1H	Class 2 RRJ	600	8.8	0.013	0.04	14.12	207.26	0.601	1.079	0	1.931	1.847	1063.4		1063.4
2F 2E	2E2F	Class 2 RRJ	525	19.7	0.013	0.08	11.61	221.57	0.561	0.894	0	1.489	1.426	877.5		877.5
2F 3H	3H2F	Class 2 RRJ	375	36.6	0.013	0.11	18.86	186.44	1.135	1.027	0	2.258	1.16	600.5		600.5
17C 17B	17B17C	PVC	150	56.5	0.009	0.26	5.49	281.9	0.001	0.026	0	0.082	0.082	64.2		64.2
15C 15B	15B15C	PVC	150	72	0.009	0.33	5.48	282.01	0.001	0.026	0	0.082	0.082	64.2		64.2
1G 1F	1F1G	Class 2 RRJ	450	26.4	0.013	0.08	14.04	207.65	0.576	1.038	0	1.68	1.61	928.7		928.7
2E 2D	2D2E	Class 2 RRJ	525	7.9	0.013	0.03	11.57	221.79	0.484	0.824	0	1.455	1.392	857.4		857.4
3H 3G	3G3H	Class 2 RRJ	375	51.5	0.013	0.24	18.62	187.34	0.97	0.848	0	1.844	0.769	400.2		400.2
3H 4A	4A3H	Class 2 RRJ	375	9	0.013	0.09	10.83	226.72	0	0	0	0.318	0.298	187.7		187.7
17B 17A	17A17B	PVC	150	36	0.009	0.49	5	290.74	0	0	0	0.027	0.027	21.8		21.8
15B 15A	15A15B	PVC	150	35.5	0.009	0.48	5	290.74	0	0	0	0.027	0.027	21.8		21.8
1F 1E	1E1F	Class 2 RRJ	375	28.5	0.013	0.06	13.98	207.98	0.569	0.913	0	1.504	1.437	830.2		830.2
1F 16B	16B1F	PVC	150	26.6	0.009	0.09	5.76	277.44	0.001	0.027	0	0.11	0.11	84.8		84.8
2D 2C	2C2D	Class 2 RRJ	375	23.4	0.013	0.06	11.51	222.19	0.313	0.614	0	1.174	1.123	692.9		692.9
2D 5A	5A2D	Class 2 RRJ	375	9.6	0.013	0.18	6.56	266.11	0	0	0	0.134	0.131	97.2		97.2
3G 3F	3F3G	Class 2 RRJ	375	17	0.013	0.11	18.51	187.76	0.884	0.674	0	1.621	0.556	289.9		289.9
3G 6A	6A3G	Class 2 RRJ	375	8.8	0.013	0.14	10.58	228.5	0	0	0	0.197	0.187	118.8		118.8
1E 1D	1D1E	Class 2 RRJ	375	13.9	0.013	0.05	13.49	210.54	0.356	0.496	0	0.901	0.859	502.2		502.2
1E 14A	14A1E	Class 2 RRJ	375	8.8	0.013	0.14	5	290.74	0	0	0	0.147	0.147	118.7		118.7
1E 13A	13A1E	Class 2 RRJ	375	27.4	0.013	0.21	13.76	209.09	0	0	0	0.434	0.409	237.8		237.8
16B 16A	16A16B	PVC	150	58.4	0.009	0.76	5	290.74	0	0	0	0.028	0.028	22.6		22.6
2C 2B	2B2C	Class 2 RRJ	375	55.9	0.013	0.3	11.21	224.14	0.14	0.161	0	0.586	0.55	342.4		342.4
2C 11D	11D2C	PVC	225	39.6	0.009	0.12	6.35	268.9	0.011	0.201	0	0.289	0.289	215.9		215.9
2C 10A	10A2C	Class 2 RRJ	375	10.4	0.013	0.46	5	290.74	0	0	0	0.052	0.052	42		42
3F 3E	3E3F	Class 2 RRJ	375	8.1	0.013	0.06	18.45	187.98	0.651	0.53	0	1.558	0.493	257.4		257.4
1D 1C	1C1D	Class 2 RRJ	375	7.8	0.013	0.03	13.46	210.7	0.184	0.321	0	0.852	0.81	473.9		473.9
2B 2A	2A2B	Class 2 RRJ	375	36.9	0.013	0.44	8.96	241.04	0	0	0	0.249	0.232	155.4		155.4
2B 12A	12A2B	Class 2 RRJ	375	9.3	0.013	0.41	5	290.74	0	0	0	0.052	0.052	42		42
11D 11C	11C11D	PVC	225	56.9	0.009	0.24	6.11	272.18	0.006	0.105	0	0.212	0.212	160.3		160.3
3E 3D	3D3E	Class 2 RRJ	375	64.4	0.013	0.58	17.87	190.27	0.461	0.378	0	1.144	0.385	203.5		203.5

Pipe Connecting Pits\P(Downstream Upstream)	Pipe ID	Pipe Class	Pipe Diameter	Pipe Length	Pipe Mannings n	Pipe Flow Time	Pipe Design Tc	Pipe Rainfall Intensity	Upstream Pervious Areas	Upstream Impervious Areas	Upstream Single Catchment Areas	Total Upstream Areas	Total Effective Areas	Pipe Flow	Specified Inflow to Pipe	Total Pipe Flow
3E 7A	7A3E	Class 2 RRJ	375	13.8	0.013	0.87	5.42	283.08	0	0	0	0.037	0.037	29		29
1C 1B	1B1C	Class 2 RRJ	375	51.8	0.013	0.33	12.56	215.8	0.006	0.112	0	0.505	0.484	289.8		289.8
11C 11B	11B11C	PVC	225	72.5	0.009	0.55	5.56	280.71	0.002	0.033	0	0.111	0.111	86.6		86.6
3D 3C	3C3D	Class 2 RRJ	375	72.6	0.013	0.94	16.93	194.14	0.267	0.206	0	0.776	0.264	142.4		142.4
3D 8A	8A3D	Class 2 RRJ	375	7.8	0.013	0.28	5	290.74	0	0	0	0.063	0.063	50.9		50.9
1B 1A	1A1B	Class 2 RRJ	375	7.8	0.013	0.15	5	290.74	0	0	0	0.118	0.118	95.3		95.3
11B 11A	11A11B	PVC	150	53.5	0.009	0.56	5	290.74	0	0	0	0.035	0.035	28.3		28.3
3C 3B	3B3C	Class 2 RRJ	375	66	0.013	1.02	6.22	270.67	0.191	0.132	0	0.42	0.159	119.5		119.5
3C 9A	9A3C	Class 2 RRJ	375	7.8	0.013	0.34	5	290.74	0	0	0	0.053	0.053	42.8		42.8
3B 3A	3A3B	Class 2 RRJ	375	7.8	0.013	0.26	5.96	274.39	0	0	0	0.323	0.073	55.6		55.6