Appendix C

MUSIC Modelling

Appendix C MUSIC Modelling

Approach Over

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC – Version 3) has been utilised to simulate pollutant generation from stormwater runoff as well as the removal efficiencies of proposed stormwater treatment devices such as water quality basins. MUSIC allows the estimation of pollutant generation from different land uses and routes the stormwater pollutants through a user defined network of stormwater treatment measures or 'treatment train' to estimate the statistical distribution of pollutant loads and concentrations at any location within a drainage network. MUSIC determines if the proposed runoff treatment system can meet specified water quality objectives/criteria.

Note that MUSIC is not a detailed design tool as it does not contain the algorithms necessary for detailed sizing of structural stormwater quantity and/or quality facilities.

For the current exercise, the project area was assumed to comprise different types of runoff/pollutant catchment characteristics. The main type represents the motorway which is largely dominated by impervious road surfaces and the secondary type represents the adjoining pervious grassed or vegetated areas.

Flows from the motorway corridor have been analysed to estimate pollutant loads under the current motorway conditions as well as the proposed widened situation. The treatment performance of the existing water quality basins has also been analysed relative to the proposed basin modifications to establish the suitability of meeting the treatment objectives.

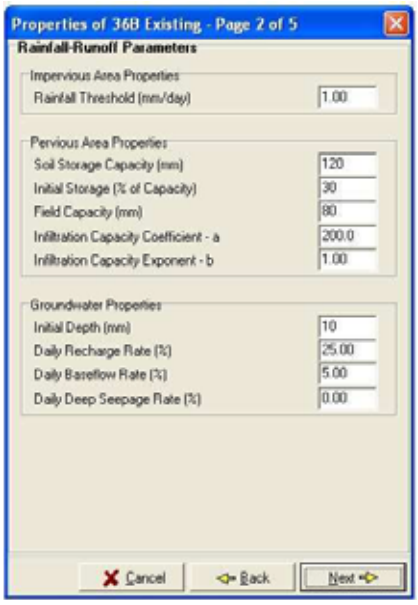
The following meteorological data have been utilised in the MUSIC modelling:

1. Rainfall Data: Sydney Observatory Pluviograph Chainage – 6 minute time step;
2. Period of Rainfall: 20 years from 1980 – 2001, and
3. Potential Evapo-Transpiration - PET: Sydney Monthly Arial PET has been selected from MUSIC template folder.

Adopted Base Parameters

Rainfall Runoff Properties - The MUSIC model for the M2 Motorway Upgrade was established using default hydrologic parameters for the rainfall -runoff due to a lack of existing data. The rainfall-runoff parameters extracted from MUSIC and shown in Figure C-1 have been applied.

Figure C-11 Rainfall Runoff Parameters



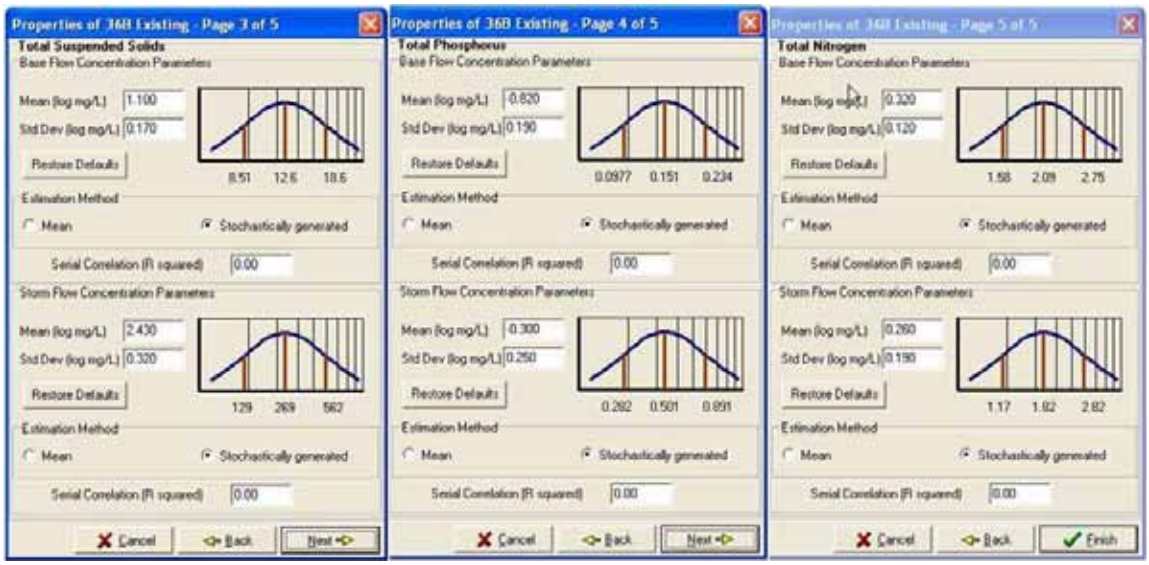
Pollutant Generation Characteristics for Selected Source Nodes - The base flow and storm flow concentration parameters applied in the MUSIC model established for the M2 Motorway are summarised in Figure C-2.

Note that for all simulations the pollutant export estimation method has been set to “stochastically generated” as per the guidelines.

Source Nodes - The Source Nodes are used to define the characteristics of the contributing catchments. (i.e. area, landuse, pollutant load generation). MUSIC Version 3 has five land uses to choose from, these being Forested, Agricultural, Rural Residential, Urban Residential, Commercial and Industrial. However, none of these relate specifically to the nature of conditions associated with roads/highways/motorways.

Therefore, landuse characteristics corresponding to the “Roads” classification in Tables 6 & 7 of Gold Coast City Council’s (GCCC) ‘MUSIC Modelling Guidelines’ (2006) were translated into the MUSIC model data sets for the purposes of establishing the Motorway Upgrade models. The adjoining pervious or vegetated catchments within the motorway corridor have been classified as a mixture of Agricultural and Forested

Figure C-12 Pollutant Concentration Parameters



Summary of MUSIC RESULTS																
		Source					Residual Load					% Reduction				
		Flow (ML/y)	TSS (kg/y)	TP (kg/y)	TN (kg/y)	GP (kg/y)	Flow (ML/y)	TSS (kg/y)	TP (kg/y)	TN (kg/y)	GP (kg/y)	Flow (ML/y)	TSS (kg/y)	TP (kg/y)	TN (kg/y)	GP (kg/y)
8B	**existing**	17.2	5610	9.67	34.7	439	16.8	816	3.01	27.8	0	2.3	85.4	68.8	20	100
	proposed	28	9600	16.2	56.1	709	27.6	1820	5.65	46.9	0	1.4	81.1	65.1	16.3	100
	designed	28	9390	16	56.4	709	27.5	1370	4.98	45.8	0	1.7	85.4	68.9	18.7	100
12B	**existing**	25.9	8840	14.9	52	656	25.6	1740	5.27	43.6	0	1.3	80.3	64.5	16.1	100
	proposed	28.7	9760	16.6	57.5	727	28.4	2030	6.08	48.6	0	1.1	79.2	63.3	15.4	100
	designed	28.7	9710	16.5	58.3	727	28.4	1860	5.82	48.7	0	1.2	80.9	64.6	16.4	100
13B	**existing**	30.3	10100	17.2	60.8	771	30.1	2910	7.56	52.2	0	0.7	71.3	56.1	14.2	100
	proposed	33.2	11000	18.5	66.7	847	33	3320	8.37	57.6	0	0.6	69.7	54.8	13.7	100
	designed	33.2	10800	18.4	67	847	33	2980	7.92	56.9	0	0.6	72.3	57	14.9	100
23B	**existing**	27.2	9490	16	54.7	677	26.9	2160	6.1	46	0	1.2	77.2	61.8	15.9	100
	proposed	28.8	10100	16.9	57.6	716	28.5	2370	6.55	48.7	0	1.1	76.5	61.2	15.4	100
	designed	28.8	9960	16.8	58	716	28.5	2230	6.37	48.6	0	1.2	77.6	62.1	16.2	100
25B	**existing**	25.8	8990	15.2	51.5	641	25.5	1660	5.18	42.7	0	1.1	81.5	65.8	17.1	100
	proposed	27.6	9690	16.3	55.3	685	27.3	1890	5.73	46	0	1.1	80.5	64.8	16.8	100
	designed	27.6	9620	16.2	55.2	685	27.3	1800	5.52	45.8	0	1.1	81.3	65.9	17	100
30B	**existing**	20.7	7190	12.1	41.8	515	20.4	1090	3.8	34.5	0	1.8	84.8	68.6	17.6	100
	proposed	28.7	9930	16.70	57.2		28.3	1870	5.80	48.4	0	1.3	81.1	65.3	15.3	100
	designed	28.7	10000	16.8	57.3	712	28.2	1520	5.25	47.3	0	1.6	84.8	68.8	17.4	100
33B	**existing**	13.6	4720	7.92	27.4	341	13.4	708	2.45	21.6	0	2.1	85	69.1	21.1	100
	proposed	16.3	5630	9.48	32.6	406	16	942	3.08	26.2	0	1.8	83.3	67.5	19.7	100
	designed	16.3	5580	9.44	32.4	406	15.9	842	2.92	25.8	0	1.9	84.9	69.1	20.6	100
35B	**existing**	9.07	3120	5.28	18.1	228	8.92	568	1.8	15	0	1.6	81.8	65.9	17.1	100
	proposed	13.4	4660	7.84	26.9		13.3	1100	3.05	22.9	0	1.1	76.5	61.1	14.7	100
	designed	13.4	4680	7.85	26.9	336	13.3	868	2.7	22.4	0	1.3	81.5	65.6	16.8	100
36B	**existing**	15	5150	8.69	30.1	377	14.5	620	2.43	22.9	0	3.3	87.9	72.1	23.8	100
	proposed	23.6	8040	13.6	47.4	594	23.1	1320	4.4	37.7	0	2	83.6	67.7	20.4	100
	designed	23.6	8040	13.6	47.4	594	23.0	985	3.85	36.4	0	2.5	87.7	71.7	23.3	100

Sensitivity Analysis Basin 8b

	Extended Depth	Avg Surface Area	Total Volume	Source					Residual Load					% Reduction				
Assumed Sensitivity Conditions	**(m)**	**(m2)**	**(m3)**	**Flow ML/y**	**TSS kg/y**	**TP kg/y**	**TN kg/y**	**GP kg/y**	**Flow ML/y**	**TSS kg/y**	**TP kg/y**	**TN kg/y**	**GP kg/y**	**Flow ML/y**	**TSS kg/y**	**TP kg/y**	**TN kg/y**	**GP kg/y**
Existing Conditions	1.8	435	978	17.2	5610	9.67	34.7	439	16.8	816	3.01	27.8	0	2.3	85.4	68.8	20	100
Proposed Catchment	1.8	435	978	28	9390	15.9	56	709	27.6	1750	5.56	47	0	1.4	81.3	65	16.1	100
Extended depth increased 0.5m	2.3	490	1338	28	9390	15.9	56	709	27.5	1520	5.2	46.3	0	1.6	83.8	67.3	17.3	100
Extended depth increased 1.0m	2.8	544	1754	28	9390	15.9	56	709	27.5	1370	4.95	45.7	0	1.7	85.5	68.9	18.4	100
Basin Area increased +25%	1.8	649	1223	28	9390	15.9	56	709	27.5	1510	5.16	45.9	0	1.7	84	67.6	18	100
Basin Area increased +50%	1.8	778	1472	28	9390	15.9	56	709	27.4	1340	4.88	45	0	2.1	85.8	69.3	19.6	100
Extended depth +0.3mm with permanent depth +0.2mm (permanent vol +35%)	2.1	499	1338	28	9390	15.9	56	709	27.5	1540	5.22	46.2	0	1.6	83.6	67.2	17.5	100

Treatment Efficiencies for Basin Modifications

Modifications required to satisfy Existing treatment effectiveness

BASIN	CATCHMENT CHARACTERISTICS										BASIN CHARACTERISTICS used in MUSIC modelling									Treatment Effectiveness - Pollutant Reduction						Proposed basin modifications to satisfy required pollutant reduction					
	Existing Conditions				Proposed Widening						Levels			Storage Depths					Volumes	Existing Catchment			Proposed Design			Depth			Volume		
	Total	Imperv.	Perv.	% Imperv.	Total	Imperv.	Perv.	% Imperv.	Increase in total area	Est. Vol recd as 2% of area	Invert	Perm. (TWL)	Max. (MWL)	Perm.	Extend.	Total	average surface area	orifice diameter	Perm.	max basin	TSS	TP	TN	TSS	TP	TN	Additional extended	new total	Increase	New Proposed max	Increase	% of catch area
	[ha]	[ha]	[ha]	[%]	[ha]	[ha]	[ha]	[%]	[%]	[m3]	mAHD	mAHD	mAHD	[m]	[m]	[m]		[mm]	[m3]	[m3]	[%]	[%]	[%]	[%]	[%]	[%]	[m]	[m]	[%]	[m3]	[%]	[%]
8B	2.06	1.44	0.62	70	3.12	2.5	0.62	80	51.5	624	66.4	67	68.8	0.6	1.8	2.4	435	55	194	978	85.4	68.8	19.8	81.1	65.1	16.3	1.00	3.40	42	1754	79	5.6
12B	2.88	2.36	0.52	82	3.18	2.57	0.61	81	10.4	636	58.4	59	60.8	0.6	1.8	2.4	371	45	118	786	80.3	64.5	16.1	79.2	63.3	15.4	0.25	2.65	10	937	19	2.9
13B	3.5	2.63	0.87	75	3.95	2.79	1.16	71	12.9	790	76.2	76.8	77.5	0.6	0.7	1.3	365	25	80	328	71.3	56.1	14.2	69.7	54.8	13.7	0.20	1.60	15	433	32	1.1
23B	2.76	2.59	0.17	94	2.92	2.74	0.18	94	5.8	584	83.1	83.9	84.9	0.8	1.0	1.8	376	30	190	566	77.3	62.1	15.9	76	60.9	15.5	0.15	1.95	8	636	12	2.2
25B	2.6	2.47	0.13	95	2.78	2.64	0.14	95	6.9	556	76.8	77.7	80	0.9	2.3	3.2	335	30	180	950	81.5	65.8	17.1	80.5	64.8	16.8	0.20	3.40	6	1056	11	3.8
30B	2.09	1.99	0.1	95	2.89	2.75	0.15	95	38.3	578	53.2	53.8	55.5	0.6	1.7	2.3	426	55	192	916	84.8	68.6	17.6	81.1	65.3	15.3	0.80	3.10	35	1508	65	5.2
33B	1.42	1.27	0.15	90	1.67	1.53	0.14	92	17.6	334	56.9	57.8	59	0.9	1.2	2.1	332	25	209	608	86	69.1	21.1	83.3	67.5	19.7	0.35	2.45	17	750	23	4.5
35C	0.97	0.84	0.14	86	1.39	1.27	0.12	91	43.3	278	39.2	40	41	0.8	1.0	1.8	176	30	76	252	81.8	66.9	17.1	76.5	61.1	14.7	0.7	2.50	39	428	70	3.1
38B	1.6	1.38	0.22	86	2.54	2.15	0.4	85	58.8	508	34.7	35.4	36.5	0.7	1.1	1.8	445	33	205	695	87.9	72.1	23.8	83.6	67.7	20.4	0.90	2.70	50	1528	120	6.0

Modifications required to satisfy ARQ pollutant reduction objectives:
TSS=80%, TP=45%, TN=45%

BASIN	CATCHMENT CHARACTERISTICS										BASIN CHARACTERISTICS used in MUSIC modelling									Treatment Effectiveness - Pollutant Reduction						Proposed basin modifications to satisfy required pollutant reduction					
	Existing Conditions				Proposed Widening						Levels			Storage Depths					Volumes	Existing Catchment			Proposed Design			Depth			Volume		
	Total	Imperv.	Perv.	% Imperv.	Total	Imperv.	Perv.	% Imperv.	Increase in total area	Est. Vol recd as 2% of area	Invert	Perm. (TWL)	Max. (MWL)	Perm.	Extend.	Total	average surface area	orifice diameter	Perm.	max basin	TSS	TP	TN	TSS	TP	TN	Additional extended	new total	Increase	New Proposed max	Increase	% of catch area
	[ha]	[ha]	[ha]	[%]	[ha]	[ha]	[ha]	[%]	[%]	[m3]	mAHD	mAHD	mAHD	[m]	[m]	[m]		[mm]	[m3]	[m3]	[%]	[%]	[%]	[%]	[%]	[%]	[m]	[m]	[%]	[m3]	[%]	[%]
8B	2.06	1.44	0.62	70	3.12	2.5	0.62	80	51.5	624	66.4	67	68.8	0.6	1.8	2.4	435	55	194	978	85.4	68.8	19.8	81.1	65.1	16.3	0	2.40	0	978	0	3.1
12B	2.88	2.36	0.52	82	3.18	2.57	0.61	81	10.4	636	58.4	59	60.8	0.6	1.8	2.4	371	45	118	786	80.3	64.5	16.1	79.9	64	15.8	0.20	2.60	8	889	13	2.8
13B	3.5	2.63	0.87	75	3.95	2.79	1.16	71	12.9	790	76.2	76.8	77.5	0.6	0.7	1.3	365	25	80	328	71.3	56.1	14.2	80	64.4	19.2	1.10	2.40	85	1057	222	2.7
23B	2.76	2.59	0.17	94	2.92	2.74	0.18	94	5.8	584	83.1	83.9	84.9	0.8	1.0	1.8	376	30	190	566	77.3	62.1	15.9	80	64.3	17.2	0.50	2.30	28	812	43	2.8
25B	2.6	2.47	0.13	95	2.78	2.64	0.14	95	6.9	556	76.8	77.7	80	0.9	2.3	3.2	335	30	180	950	81.5	65.8	17.1	80.5	64.8	16.8	0	3.20	0	960	0	3.4
30B	2.09	1.99	0.1	95	2.89	2.75	0.15	95	38.3	578	53.2	53.8	55.5	0.6	1.7	2.3	426	55	192	916	84.8	68.6	17.6	81.1	65.3	15.3	0	2.30	0	916	0	3.2
33B	1.42	1.27	0.15	90	1.67	1.53	0.14	92	17.6	334	56.9	57.8	59	0.9	1.2	2.1	332	25	209	608	86	69.1	21.1	83.3	67.5	19.7	0	2.10	0	608	0	3.6
35C	0.97	0.84	0.14	86	1.39	1.27	0.12	91	43.3	278	39.2	40	41	0.8	1.0	1.8	176	30	76	252	81.8	66.9	17.1	80.4	64.5	16.1	0.5	2.30	28	373	48	2.7
38B	1.6	1.38	0.22	86	2.54	2.15	0.4	85	58.8	508	34.7	35.4	36.5	0.7	1.1	1.8	445	33	205	695	87.9	72.1	23.8	83.6	67.7	20.4	0	1.80	0	695	0	2.7