



Appendix B Catchment Parameters

Catchment	Area (ha)	Gauge weightings				ARF
		Tutamoe	Whatoro	Mamaranui	Dargaville	
Waima	7819.6	0.49	0.51			0.926
Mangatu	3570.8	0.34	0.66			0.965
Waingarara	1953.2		1			0.97
Waipapataniwha	1704.9		1			0.98
Maropiu	2022.0		0.36	0.64		0.97
Waihue	1606.1			1		0.98
Waiatua	1343.1			1		0.99
Frith	1107.5			1		1.00
Parore	803.4			0.62	0.38	1.00
Valley	880.3				1	1.00
Ahikiwi	879.6		1			1.00
Te Kawa	1190.2		0.69	0.31		0.99
Mamaranui	212.3			1		1.00
Taita	1873.3			1		0.97
Maitahi	671.4			1		1.00
Dip	666.1			1		1.00
Pouto	240.0			1		1.00
Rotu	482.6			1		1.00
Babylon	2791.3			0.57	0.43	0.97
Scottys	452.2				1	1.00
Baylys	338.5				1	1.00
Mangatara	2519.2				1	0.97
Okahu	384.4				1	1.00

Table 9.1: Rain gauge weightings, Kaihu catchments

Catchment	Area (ha)	Percent catchment area				Curve number
		Scrub/Forest	Pasture	Water	Urban	
Waima	7819.6	28	72	0	0	71
Mangatu	3570.8	79	21	0	0	69
Ahikiwi	879.6	45	55	0	0	70.3
Babylon	2791.3	22	78	0	0	70.9
Baylys	338.5	1	99	0	1	72.1
Dip	666.1	71	29	0	0	69.2
Frith	1107.5	27	73	0	0	71.0
Maitahi	671.4	40	59	0	0	70.4
Mamaranui	212.3	50	50	0	0	70.1
Mangatara	2519.2	8	92	0	0	71.7
Maropiu	2022.0	52	48	0	0	70.0
Okahu	384.4	4	95	0	1	72.0
Parore	803.4	11	87	2	0	69.9
Pouto	240.0	60	39	0	1	69.9



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Catchment	Area (ha)	Percent catchment area				Curve number
		Scrub/Forest	Pasture	Water	Urban	
Rotu	482.6	77	23	0	0	69.1
Scottys	452.2	3	97	0	0	72.0
Taita	1873.3	56	44	0	0	69.9
Te Kawa	1190.2	52	48	0	0	70.1
Valley	880.3	4	88	3	5	70.6
Waiatua	1343.1	26	73	1	0	70.4
Waihue	1606.1	17	83	0	0	71.4
Waingarara	1953.2	86	14	0	0	68.7
Waipapataniwha	1704.9	89	11	0	0	68.6

Notes: 1. Areas of water have been ignored in calculation of curve numbers.
2. Initial loss set to 5mm for all catchments.
3. Urban areas incorporated into curve numbers and percent impervious area set to 0 for all catchments.

Table 9.2: Kaihu catchment vegetation types and SCS curve numbers

Catchment	Left plane				Right plane			
	% area	Length (m)	Slope	Roughness	% area	Length	Slope	Roughness
Waima	31	1028	0.077	0.33	69	2283	0.050	0.25
Mangatu	28	798	0.143	0.6	72	2029	0.071	0.4
Ahikiwi	100	1039	0.081	0.33				
Babylon	38	1653	0.026	0.25	62	2431	0.016	0.25
Baylys	53	925	0.017	0.17	47	614	0.014	0.17
Dip	47	757	0.035	0.42	53	912	0.037	0.42
Frith	51	994	0.025	0.27	49	1088	0.016	0.27
Maitahi	41	617	0.065	0.31	59	832	0.043	0.31
Mamaranui	71	585	0.035	0.35	29	221	0.212	0.35
Mangatara	50	1555	0.030	0.20	50	1852	0.020	0.20
Maropiu	19	660	0.207	0.36	81	2067	0.039	0.36
Okahu	40	748	0.038	0.18	60	1005	0.027	0.18
Parore	48	770	0.023	0.20	52	845	0.006	0.20
Pouto	69	457	0.073	0.38	31	227	0.132	0.38
Rotu	39	374	0.140	0.45	61	608	0.098	0.45
Scottys	36	644	0.030	0.18	64	866	0.027	0.18
Taita	60	1950	0.019	0.37	40	1341	0.027	0.37
Te Kawa	70	1394	0.080	0.36	30	960	0.064	0.36
Valley	55	994	0.010	0.18	45	642	0.012	0.18
Waiatua	22	449	0.111	0.26	78	1723	0.046	0.26
Waihue	65	1410	0.045	0.23	35	789	0.116	0.23
Waingarara	63	909	0.275	0.48	37	694	0.494	0.48
Waipapataniwha	60	4500	0.054	0.49	40	1231	0.247	0.49

Table 9.3: Kaihu catchment physical characteristics



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Catchment	Area (ha)	Length (m)	Slope	Mannings n	Width (m)	Side slope (xH:1V)	Location
Waima	7819.6	23650	0.017	0.04	10	5	Waima
Mangatu	3570.8	12640	0.040	0.04	10	5	Mangatu
Ahikiwi	879.6	8468	0.006	0.055	8	1.8	Kaihu 10.6
Babylon	2791.3	6473	0.018	0.032	5	2	Internal
Baylys	338.5	2493	0.008	0.032	5	2	Internal
Dip	666.1	4631	0.015	0.032	5	2	Internal
Frith	1107.5	6278	0.0004	0.032	10	1.3	Kaihu 23.6
Maitahi	671.4	5135	0.017	0.032	5	2	Internal
Mamaranui	212.3	2454	0.033	0.032	5	2	Internal
Mangatara	2519.2	8233	0.012	0.032	5	2	Internal
Maropiu	2022.0	5097	0.064	0.032	5	2	Internal
Okahu	384.4	2835	0.026	0.032	5	2	Internal
Parore	803.4	7628	0.0002	0.032	20	2.7	Kaihu 33.39
Pouto	240.0	3735	0.023	0.032	5	2	Internal
Rotu	482.6	5431	0.018	0.032	5	2	Internal
Scottys	452.2	2807	0.012	0.032	5	2	Internal
Taita	1873.3	6102	0.025	0.032	5	2	Internal
Te Kawa	1190.2	4529	0.027	0.032	5	2	Internal
Valley	880.3	7504	0.0002	0.032	20	2.7	Kaihu 34.2
Waiatua	1343.1	6300	0.018	0.032	5	2	Internal
Waihue	1606.1	7043	0.041	0.032	5	2	Internal
Waingarara	1953.2	11048	0.051	0.055	10	5	Internal
Waipapataniwha	1704.9	5690	0.109	0.055	10	5	Internal
Channel inverts sourced from: A. Kaihu cross sections B. LIDAR C. Estimated from 20m ground contours where A and B not available. Collector channels assumed trapezoidal, with dimensions sourced from Kaihu or estimated for streams internal to subcatchments							

Table 9.4: Kaihu catchment collector channel characteristics



Appendix C Model files

HEC-HMS hydrologic model files

Case	Basin	Meteorologic model	Control
Calibrate upper catchment			
Upper catchments, initial-constant loss model	U_Kaihu	UpTh_15m	Feb2004, Mar2006, July2007
Upper catchments, Green-Ampt loss model	U_KaihuGA	UpTh_15m	Feb2004, Mar2006, July2008
Upper catchments, SCS curve loss model	U_KaihuSCS	UpTh_15m	Feb2004, Mar2006, July2009
Fit design events			
0.5 year ARI	U_KaihuSCS	UpDesign	0.5yARI
1 year ARI	U_KaihuSCS	UpDesign	1yARI
1.5 year ARI	U_KaihuSCS	UpDesign	1.5yARI
2 year ARI	U_KaihuSCS	UpDesign	2yARI
5 year ARI	U_KaihuSCS	UpDesign	5yARI
10 year ARI	U_KaihuSCS	UpDesign	10yARI
100 year ARI	U_KaihuSCS	UpDesign	100yARI
Historic flood simulations			
Calibrated SCS loss model, June 2000 flood on lower catchment	L_Kaihu	Low1	June2000
Calibrated SCS loss model, June 2002 flood on lower catchment	L_Kaihu	Low1	June2002
Design flood simulations			
0.5 year ARI	L_Kaihu	Low1	0.5yARI
1 year ARI	L_Kaihu	Low1	1yARI
1.5 year ARI	L_Kaihu	Low1	1.5yARI
2 year ARI	L_Kaihu	Low1	2yARI
5 year ARI	L_Kaihu	Low1	5yARI
10 year ARI	L_Kaihu	Low1	10yARI
100 year ARI	L_Kaihu	Low1	100yARI



Mike11 hydraulic model files

Case	Sim11	Nwk11	Xns11	Bnd11	Dfs0	Hd11	Start condition	Res11
Historic floods								
June 2000 initialisation	Initjun00b	Kaihu10	Kaihu7	Initjun00b	init1	Kaihu4	Local H + Q	Initjun00b
June 2000 flood, final model version with refined floodgates and refined processed data on floodplains	Jun00b	Kaihu11	Kaihu7	Jun00b	Hec_Jun00, QJun00, Tide-Jun00, init1	Kaihu5	Initjun00b	Jun00b
June 2002 intialisation	Initjun02	Kaihu9	Kaihu5	Initjun02	init1	Kaihu4	Local H + Q	initjun02
June 2002 flood, steady daily rainfall	Jun02_3c	Kaihu9	Kaihu5	Jun02_3c	HecDaily_Jun02, QJun02, Tide-jun02, init1	Kaihu4	initjun02	HecDay-jun02
June 2002 flood, hourly rainfall based on scaled Dargaville pattern	Jun02_3c	Kaihu9	Kaihu5	Jun02_3c	HecHrly_Jun02, QJun02, Tide-jun02, init1	Kaihu4	initjun02	HecHr-jun02
June 2002 flood, hourly rainfall based on NRC gauged Dargaville rainfall	Jun02_3c	Kaihu9	Kaihu5	Jun02_3c	HecNRC_Jun02, QJun02, Tide-jun02, init1	Kaihu4	initjun02	HecNRC-jun02
June 2002 flood, hourly rainfall based on smoothed NRC gauged Dargaville rainfall	Jun02_3c	Kaihu9	Kaihu5	Jun02_3c	HecSmooth_Jun02, QJun02, Tide-jun02, init1	Kaihu4	initjun02	HecSmooth-jun02
June 2002 flood, hourly rainfall based on smoothed NRC gauged Dargaville rainfall, final model version with updated floodgates	Jun02	Kaihu10	Kaihu5	Jun02	HecSmooth_Jun02, QJun02, Tide-jun02, init1	Kaihu5	Initjun02	Jun02



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Case	Sim11	Nwk11	Xns11	Bnd11	Dfs0	Hd11	Start condition	Res11
June 2002 initialisation with refined processed data	Initjun02c	Kaihu10	Kaihu7	Initjun02	Init1	Kaihu4	Local H + Q	Initjun02c
June 2002 flood with refined floodplain processed data	Jun02c	Kaihu11	Kaihu7	Jun02	HecSmooth_Jun02, QJun02, Tide-jun02, init1	Kaihu5	Initjun02c	Jun02c
Simulations with flow confined to Kaihu River channel to estimate necessary stopbank heights for scheme								
6 month ARI flood scheme initialisation	6mno2init	K10no2	Kaihu6	6minit	Init1	Kaihu5	Parameter file	6mno2init
6 month ARI flood scheme	6mno2	K10no2	Kaihu6	6m	Design0_5y,mhws6m, init1	Kaihu5	6mno2init	6mno2
1 year ARI flood scheme initialisation	1yno2init	K10no2	Kaihu6	1yinit	Init1	Kaihu5	Parameter file	1yno2init
1 year ARI flood scheme	1yno2	K10no2	Kaihu6	1y	Design1y, mhws1y,init1	Kaihu5	1yno2init	1yno2
Benchmark simulations								
Benchmark initialisation	1ynb5init2	K10nb4	Kaihu7	1yinit3	Init1	Kaihu5	Local H + Q	1ynb5init2
Benchmark simulation 1 year ARI with rail embankment	1ynb5b	K10nb4	Kaihu7	1y4	Design1y, mhws1y,init1	Kaihu5	1ynb5init2	1ynb5b
Benchmark simulation 1 year ARI rail embankment removed	1ynb5bnorly	K10nb4norly	Kaihu7	1y4	Design1y, mhws1y,init1	Kaihu5	1ynb5init2	1ynb5bnorly



Appendix D Boundary conditions in benchmark model

Type of inflow	Branch	Chainage (m)	Second chainage if distributed (m)	Hydrograph and fraction
Point Source	Kaihu	2550	0	Waingarara
Point Source	Kaihu	6442	0	Waipapataniwha
Distributed Source	Kaihu	2063	7026	0.66 Ahikiwi
Distributed Source	maropiu	400	2425	0.34 Ahikiwi
Distributed Source	maropiu	2475	2800	0.74 Te Kawa
Distributed Source	Kaihu	15163	16830	0.84 Maropiu
Distributed Source	settlement	500	2455	0.06 Maropiu
Distributed Source	maitahi	0	1680	0.06 Maropiu
Distributed Source	maitahi	1730	3005	0.07 Waihue
Distributed Source	maitahi	3065	4145	0.06 Frith
Distributed Source	maropiu	2955	3785	0.04 Maropiu
Distributed Source	mamaranui	0	2040	Mamaranui
Point Source	mamaranui	185	0	0.26 Te Kawa
Distributed Source	waihue	0	2240	0.93 Waihue
Distributed Source	waiatua	0	1665	Waiatua
Distributed Source	ndl	0	615	0.08 Frith
Distributed Source	bush	0	1735	0.25 Frith
Distributed Source	cemetery	0	2565	0.16 Frith
Distributed Source	frith	0	2840	0.24 Frith
Distributed Source	taitamid	0	1905	0.2 Taita
Distributed Source	taita	0	3285	0.8 Taita
Distributed Source	taitasouth	0	975	Maitahi
Distributed Source	dip	400	1785	Dip
Distributed Source	pouto-east	0	1655	0.18 Parore
Distributed Source	brown	100	1630	0.24 Parore
Distributed Source	spillway	200	2415	0.25 Parore
Distributed Source	pouto	0	2050	0.21 Parore
Distributed Source	poutowest	0	1160	Pouto
Distributed Source	rotu	0	1930	Rotu
Distributed Source	korariwhero	1000	3675	0.2 Babylon
Distributed Source	korarinorth	500	2410	0.4 Babylon
Distributed Source	korarisouth	1000	2835	0.4 Babylon
Distributed Source	parore-rb	0	3570	0.35 Valley
Distributed Source	antibrown	0	545	0.01 Valley
Distributed Source	parorelb	0	1095	0.1 Valley
Distributed Source	valley	0	680	0.08 Valley
Distributed Source	beach	200	1375	0.25 Valley
Distributed Source	scottys	200	1035	Scottys
Distributed Source	baylys	80	1120	Baylys
Distributed Source	mangatara	0	4950	Mangatara
Point Source	mangawhare	540	0	Okahu
Distributed Source	mangawhare	60	450	0.08 Valley
Distributed Source	Kaihu	23990	24790	0.21 Frith



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Type of inflow	Branch	Chainage (m)	Second chainage if distributed (m)	Hydrograph and fraction
Open	Kaihu	0	0	Kaihu
Distributed Source	Kaihu	27663	28180	0.12 Parore
Distributed Source	Kaihu	34470	25400	0.13 Valley



Appendix E Proposed flood management scheme layout and bank longitudinal sections