APPENDIX 4

NATIONAL RAINFALL DATA

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This appendix contains selected national rainfall data. Appendix 4.1 gives rainfall data for sites throughout New Zealand, presented in terms of the annual amount of rainfall which falls during storms of a range of intensities. Appendix 4.2 comprises isohyet maps for storms with a 10% annual probability of occurrence. Appendix 4.3 interprets this data in terms of flow device configurations.

It should be noted that the data in Appendix 4.1 are representative only, and that more specific rainfall data for any particular site may be available, for example from the appropriate regional council.

A4.1 National rainfall data

The two tables below show the mean annual depths of rainfall which fall at various places throughout New Zealand during storms with intensity greater than 0.1, 9, … 20, 30 mm/hour. This information can be used in the specification of devices which are intended to treat stormwater runoff.

The general aim is to treat 92-94% of runoff. For example, in Auckland, Albert Park a runoff depth of 243 mm/hr falls more intensely than the 15 mm/hr design storm. If we assume the device treats 2/3 of the extraordinary discharges effectively so that 1/3 is not fully treated, this means that 1/3 of 243 = 81 mm/hr is not fully treated. This means that over the year 81 x 100 / 1150 = 7.04% escapes per year or 92.96% is efficiently treated. This can be compared with the ARC quoted figure of 93%.

Weather station	Mean annual depths of rainfall (mm) for specified intensities								Not fully treated	Design storm	
	Period	>0.1	>9	>12	>15	>18	>20	>30		mm/hr	% treated (min)
Kaitaia Observatory	1986 -1994	1286	421	321	252	204	179	104	84	15	93.47
Leigh 2	1986 -1994	1008	304	221	169	139	122	73	74	12	92.69
Warkworth	1986 -1994	1364	420	305	224	180	158	86	102	12	92.55
Whenuapai Aerodrome	1986 -1993	1219	379	282	221	178	156	97	94	12	92.29
Albany	1986 -1994	1151	320	226	165	124	108	48	54	12	93.45
Auckland, Albert Park	1976 -1985	1150	383	299	243	202	180	111	81	15	92.96
Coromandel	1986 -1994	1685	540	367	266	193	162	67	122	12	92.74
Te Aroha	1986 -1994	1221	329	240	188	147	125	70	80	12	93.45
Tauranga Aerodrome	1986 -1993	1090	308	234	177	141	121	72	78	12	92.84
Taupo N.Z.E.D.	1986 -1994	1051	195	141	106	85	70	39	65	9	93.81
Opotiki	1986 -1994	1137	380	289	235	188	160	82	78	15	93.11
Waimana	1986 -1993	1521	545	399	305	236	205	106	102	15	93.32
Auckland Aerodrome	1986 -1993	1058	293	217	175	140	121	68	72	12	93.16
Ruakura	1986 -1994	1092	280	218	176	145	128	77	73	12	93.35
Taumaranui	1986 -1994	1372	255	163	117	91	76	42	85	9	93.8
New Plymouth Aerodrome	1986 -1994	1343	405	296	228	184	159	86	99	12	92.65
Dannevirke	1986 -1994	973	132	90	66	50	44	24	44	9	95.48
Ruatoria	1986 -1994	1665	468	306	219	164	132	52	102	12	93.87
Gisborne Aerodrome	1986 -1993	969	197	126	96	68	56	29	66	9	93.22
Paraparaumu Aerodrome	1986 -1994	966	192	123	80	59	52	28	64	9	93.37
Ohakea Aerodrome	1986 -1994	840	173	115	83	64	53	28	58	9	93.13
Palmerston North	1986 -1994	943	186	131	97	74	62	27	62	9	93.43
Karori Reservoir	1986 -1993	1239	232	155	108	79	68	32	77	9	93.76
Wellington, Kelburn	1986 -1994	1123	212	142	110	85	73	42	71	9	93.71

Weather station	Mean annual depths of rainfall (mm) for specified intensities								Not fully treated	Design storm	
	Period	>0.1	>9	>12	>15	>18	>20	>30		mm/hr	% treated (min)
Wellington Aerodrome	1986 -1993	880	157	97	67	53	45	24	52	9	94.05
Kaitoke	1986 -1993	1913	346	231	154	109	93	39	122	9	93.97
Kaitoke Headworks	1986 -1993	2238	478	324	232	164	139	64	159	9	92.88
Wallaceville	1986 -1994	1257	195	128	89	67	55	25	65	9	94.83
Waiouru M.W.D.	1986 -1994	1044	105	69	49	39	35	21	35	9	96.65
Wanganui, Cooks Gardens	1986 -1994	896	187	132	101	79	69	33	62	9	93.04
Hokitika Aerodrome	1986 -1994	2849	868	596	432	324	275	146	199	12	93.03
Greymouth Aerodrome	1986 -1993	2147	571	387	274	207	173	84	129	12	93.99
Motueka	1986 -1994	1231	310	216	160	111	92	38	72	12	94.15
Nelson Aerodrome	1986 -1994	911	197	132	96	72	61	31	66	9	92.79
Blenheim Research	1986 -1994	570	59	34	26	17	13	8	20	9	96.55
Highbank Power Stn	1986 -1993	665	55	41	33	26	21	10	18	9	97.24
Winchmore	1986 -1994	655	48	26	16	12	10	3	16	9	97.56
Rangiora	1986 -1994	553	41	33	26	17	16	9	14	9	97.53
Christchurch Aerodrome	1986 -1994	605	42	27	20	13	11	5	14	9	97.69
Greenpark	1986 -1993	612	47	26	18	12	10	4	16	9	97.44
Gleniti Reservoir	1986 -1993	607	63	41	30	18	14	7	21	9	96.54
Makarora Station	1986 -1994	2217	180	86	52	30	25	10	60	9	97.29
Dunedin, Musselburgh	1986 -1994	766	60	34	21	13	10	5	20	9	97.39
Manapouri, West Arm 2	1986 -1993	3590	473	234	148	106	85	50	158	9	95.61
Queenstown	1986 -1994	885	59	20	10	5	3	3	20	9	97.78
Clyde	1986 -1993	390	33	21	15	12	10	7	11	9	97.18
Invercargill Aerodrome	1986 -1994	1137	120	69	48	35	32	16	40	9	96.48
Stewart Island	1986 -1994	1631	120	95	55	38	28	13	40	9	97.55

A 4.3 Flow Device Configurations

Flow conditions outlined in the guideline allow for water treatment devices to treat 90-95% of stormwater runoff on a long term basis. This is achieved by designing for a threshold rainfall intensity associated with 90-95% of the influent. A number of options exist for treatment of the remaining portion which will occur at high rainfall intensity events.

1. **With Flow Balancing**. This option involves using a storage configuration to contain stormwater in excess of the threshold storm for treatment at a time of low flow. This can involve the use of the ullage or head space in the device or by using a separate storage tank. The design needs to demonstrate that the volume of water generated from a storm event of a selected return period can be contained within the storage volume. Alternatively a high level overflow relief device can be installed to cater for storm events in excess of the available storage.
2. **Without Flow Balancing**. Stormwater in excess of the threshold storm either passes through the device at a rate greater than the design flow, or is diverted around the device and not treated at all.
    - ***Flow Through***. A flow rate greater than the design flow, will result in the water being treated less efficiently, however the influent is also likely to have a lower contaminant loading (after the first flush). Reintrainment of previously separated oil can occur if the flow rate becomes too high however and should be guarded against.
    - ***Diversion.*** Here the stormwater flow (or a portion of it) in excess of the design storm is diverted around the treatment device and is not treated. This is done to prevent the degradation of the device's efficiency. Again the contaminant loading is expected to be reduced in the high flow events.

Design solutions should be selected from, or be a combination of the above flow regimes. The choice of flow configuration should be made by the designer with due regard to local requirements.

The following are flow control structures often used in separator designs:-

Orifice Control

There is a specific relationship between the flow through an orifice, its diameter and the head of water behind it. This relationship can be used to restrict the flow to certain maximums and generate a storage of stormwater behind it. The relationship is commonly expressed as:

$$h = 2.6/2g.(Q/A_o)^2$$

h	Head generated (m)
g	Gravitational acceleration (m/s^2)
Q	Flow rate (m^3/s)
A_o	Area of orifice (m^2)

Weir Control

Weirs can used in the same manner, with the relationship between flow rate and head being expressed as:

$$h = (Q/1.7.L)^{2/3}$$

h	Head generated (m)
L	The length of the weir(m)

Q	Flow rate (m^3/s)	

By-pass

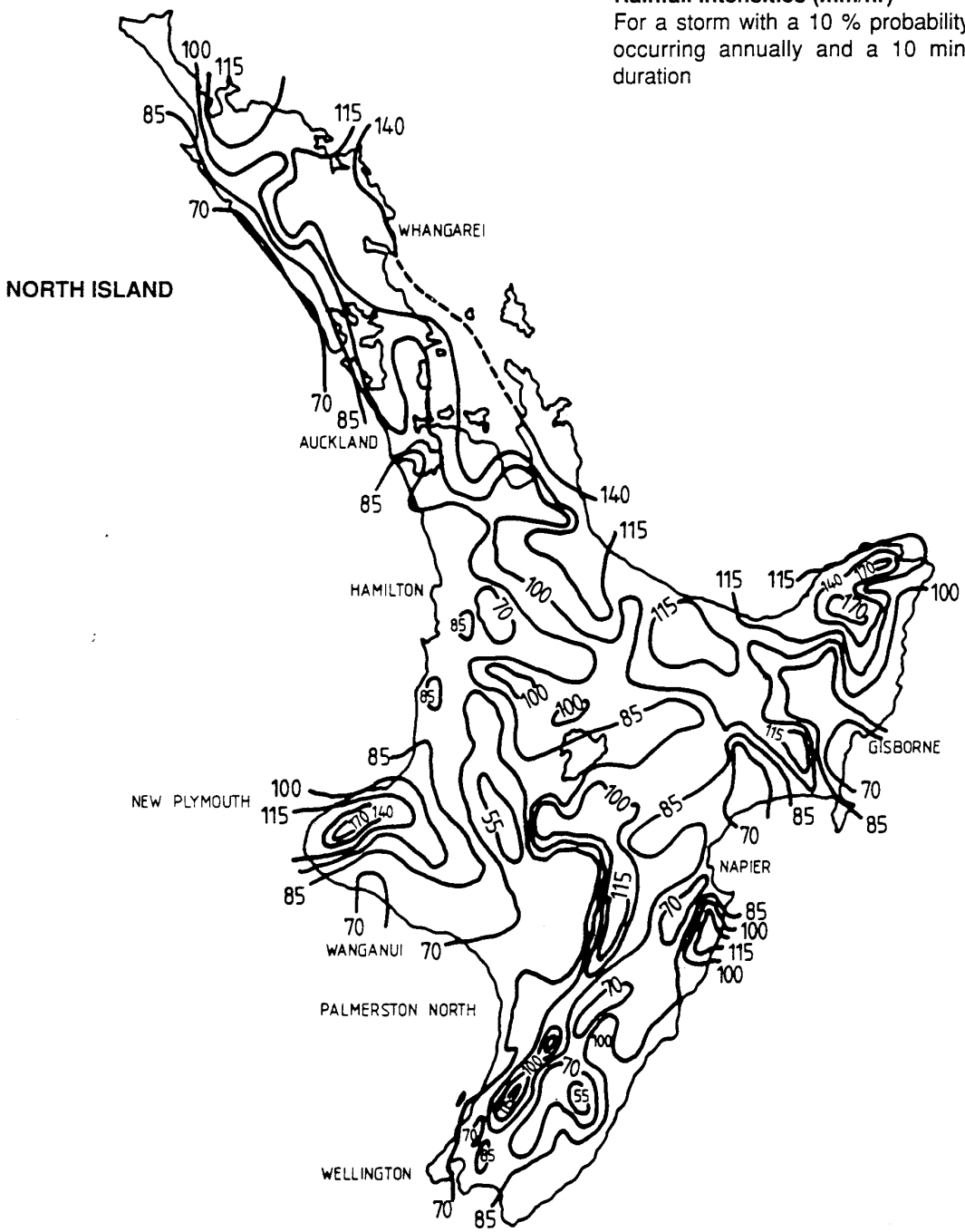
A by-pass can be fitted at the upstream end of the device to be activated when the flow rate through the device reaches a certain point. Generally the height of the by-pass is set to activate once the head of water has been generated behind either an orifice or a weir.

High Flow Relief

A high flow relief is used to relieve flooding in a flow balancing configuration. Generally it consists of a vertical pipe set at the maximum working height of the storage container, adjacent to the discharge point.

Appendix A RAINFALL INTENSITIES

Rainfall intensities (mm/hr)
For a storm with a 10 % probability of occurring annually and a 10 minute duration



Rainfall intensities (mm/hr)
For a storm with a 10 % probability of occurring annually and a 10 minute duration