ENVELOPE

RAINGARDEN SIZING

MT WELCOME, PUKERUA BAY

TO	Pukerua Property Group LP	**DATE**	04 August 2026
PROJECT NAME	Mt Welcome	**ENVELOPE REF**	1753-02
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1.0 INTRODUCTION

This memo outlines the raingarden design approach for the Mt Welcome development in support of the fast-track application. It summarises the sizing basis, applicable standards, site-specific considerations, verification methods and response to the raingarden sizing queries.

2.0 SIZING BASIS

The Mt Welcome raingardens are provided solely for water-quality treatment. The devices are lined for geotechnical reasons and located where site topography permits. They therefore provide no retention or hydrological-control function; these functions are provided separately by the downstream retention ponds.

Section 4.3.2.1 of Wellington Water's *Water Sensitive Design for Stormwater: Treatment Device Design Guideline* (2019) requires the filter-media area to be 2% of the "**contributing untreated impervious area".** The treatment-footprint criterion has therefore been applied to the untreated road catchment, rather than the total road and lot impervious area used for hydraulic routing. Roof cladding, gutters, downpipes and flashings across all lots are specified as non-contaminant-generating materials,

Although treated lot runoff mixes with road runoff before entering the centralised raingardens, the devices must still have sufficient hydraulic capacity to receive, temporarily store and filter the combined water-quality flow and water-quality volume. Each device has therefore been assessed by routing the water-quality event from its full contributing catchment through the raingarden and confirming that the design water-quality volume is accommodated and drawn down within 24 hours, using the following parameters

- WQV = 22.7mm – ⅓ × 2-yr ARI 24-hr depth, GWRC Hydrological Control Guidance Note
- WQF = 10mm/hr design intensity
- Inflow is limited to the water quality flow by an upstream orifice, with larger flows bypassing via a dedicated pipe. The devices are therefore off-line, and the filter surface is protected from high flows.
- Primary sizing: WQV/WQF routed through each device at the specified media rate of 175 mm/hr, in accordance with Taiki Wai WSUD.
- This ponded volume has been designed at 300mm, allowing the raingarden to hold more volume then the traditional 200mm.
- The contributing catchment is predominantly roof area, which does not materially add sediment or contaminants to the runoff. The road runoff carrying contaminants is therefore diluted by cleaner roof water and does not add sediment to the raingardens in a way that would shorten the maintenance life cycle with a smaller footprint.
- Table 2 attached to this memo shows a raingarden comparison at 1,000m², showing the different sizing when the function is treatment only.

3.0 VERIFICATION AGAINST DARCY'S LAW

Darcy's Law provides an independent check on the sizing, in the standard form:

- Af = WQV × df / (k × (h + df) × tf)
    - WQV = 22.7m³ per 1,000m² impervious,
    - df = 0.6 m,

- h = 0.15 m (half the 300 mm maximum ponding depth)
- tf = 1 day

- At the specified media permeability of 175mm/hr (4.2 m/day) the required filter base area is 4.3m², or 0.43% of contributing impervious area. At a permeability of 2.4 m/day the requirement is 7.6 m², or 0.76%. The design provides 1.31%, exceeding both.
- Drawdown: t = (Ap/Af) × (df/k) × ln((h + df)/df) gives 1.9 hours at 300mm ponding, against the 24-hour maximum

Therefor sizing is governed by capture of the one-hour design event, which is the more demanding factor.

4.0 RESPONSE TO RAINGARDEN SIZING QUERY

Tiaki Wai's 1.3% sizing query compares the raingarden area against the total contributing impervious catchment. However, section 4.3.2.1 of the Wellington Water guideline requires the filter-media area to be 2% of the **contributing untreated impervious area**. The untreated treatment catchment comprises the untreated road surfaces. Against this area, the proposed filter-media footprint is approximately 3.64% and exceeds the guideline.

As runoff becomes mixed upstream, the full connected impervious catchment, including roof and lot areas, has been included in the WQF and WQV routing calculations. This confirms that each raingarden can accommodate and filter the design WQV, representing approximately 90% of mean annual runoff and exceeding GWRC's minimum requirement to treat 85% MARV. Drawdown within 24 hours is also achieved.

This memo provides additional calculations and verification demonstrating that the raingardens have been appropriately sized and will provide the required treatment performance.

5.0 CONCLUSION

The calculations confirm that each raingarden can receive and treat the full water-quality volume, with drawdown achieved within 24 hours. A minimum filter-base area of 1.35% of the total contributing impervious catchment is proposed, equivalent to approximately 3.64% of the untreated impervious catchment and exceeding Wellington Water's 2% guidance. The raingardens provide water-quality treatment only, with retention and extended detention provided separately by the downstream wetlands.

The proposed design therefore achieves the required Tiaki Wai and GWRC treatment performance.

Client	Pukerua Property Group LP
Project Site	Mt Welcome
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RAINGARDEN SIZING - EVENT CAPTURE

RG ID	Impervious Road Area	Pervious Road Area	Impevious Lot Area	Total Impervious	Rain Garden Area Required	Top water level area	Top water level area (current)	Area WQ	Area WQ	WQV	WQF	WQF	Rain Garden Void Volume (40%)	Infiltration/hr	Ponding Volume (0.3m)	Total Capacity Volume (1hr)	% Utilisation (1hr WQV/Capacity)
	m^2	m^2	m^2	m^2	m^2		m^2	m^2	ha	m^3	m^3/s	m^3/hr	m^3	m^3	m^3	m^2	%
RG-01	5189	3495	7080	12269	160	200	177	12180	1.218	276	0.034	121.8	38.4	28.0	60.0	126	96%
RG-02	966	339	3540	4506	61	92	92	4332	0.433	98	0.012	43.3	14.6	10.7	27.6	53	82%
RG-03	8248	5090	23836	32084	424	500	500	31243	3.124	709	0.087	312.4	101.8	74.2	150.0	326	96%
RG-04	2148	1226	6372	8520	110	150	103	8278	0.828	188	0.023	82.8	26.4	19.3	45.0	91	91%
RG-05	5961	3339	12744	18705	250	300	185	18271	1.827	415	0.051	182.7	60.0	43.8	90.0	194	94%
RG-06	2594	1996	6844	9438	112	155	86	9266	0.927	210	0.026	92.7	26.9	19.6	46.5	93	100%
RG-07	7885	6386	11328	19213	241	311	311	19210	1.921	436	0.053	192.1	57.8	42.2	93.3	193	99%
RG-08	3050	639	4484	7534	83	127	104	7253	0.725	165	0.020	72.5	19.9	14.5	38.1	73	100%
RG-09	1263	256	1180	2443	31	58	58	2359	0.236	54	0.007	23.6	7.4	5.4	17.4	30	78%
RG-10	1815	1702	5192	7007	80	120	91	6912	0.691	157	0.019	69.1	19.2	14.0	36.0	69	100%
RG-11	1705	984	2124	3829	43	72	72	3785	0.379	86	0.011	37.9	10.3	7.5	21.6	39	96%
RG-12	14234	3245	22184	36418	450	600	319	35084	3.508	796	0.097	350.8	108.0	78.8	180.0	367	96%
RG-13	1293	492	5428	6721	80	120	79	6458	0.646	147	0.018	64.6	19.2	14.0	36.0	69	93%
RG-14	1199	255	708	1907	22	32	32	1849	0.185	42	0.005	18.5	5.3	3.9	9.6	19	99%
RG-15	5430	2809	13924	19354	240	300	184	18807	1.881	427	0.052	188.1	57.6	42.0	90.0	190	99%
RG-16	781	472	1180	1961	24	47	47	1933	0.193	44	0.005	19.3	5.8	4.2	14.1	24	80%
RG-17	1863	1026	5664	7527	90	120	95	7304	0.730	166	0.020	73.0	21.6	15.8	36.0	73	100%
RG-18	952	748	1652	2604	35	50	45	2586	0.259	59	0.007	25.9	8.4	6.1	15.0	30	88%
RG-19	760	461	1652	2412	24	46	46	2361	0.236	54	0.007	23.6	5.8	4.2	13.8	24	99%
RG-20	1902	708	4484	6386	80	115	86	6173	0.617	140	0.017	61.7	19.2	14.0	34.5	68	91%
RG-21	4472	1808	9440	13912	170	220	196	13487	1.349	306	0.037	134.9	40.8	29.8	66.0	137	99%
RG-22	9109	2140	12036	21145	260	350	288	20409	2.041	463	0.057	204.1	62.4	45.5	105.0	213	96%
RG-23	6859	1695	9440	16299	190	275	200	15738	1.574	357	0.044	157.4	45.6	33.3	82.5	161	98%
RG-24	2419	1422	4956	7375	90	120	111	7220	0.722	164	0.020	72.2	21.6	15.8	36.0	73	98%
RG-25	14369	4024	26196	40565	500	650	412	39141	3.914	888	0.109	391.4	120.0	87.5	195.0	403	97%
RG-26	472	168	1416	1888	18	40	28	1819	0.182	41	0.005	18.2	4.3	3.2	12.0	19	93%
RG-27	561	200	1888	2449	14	63	63	2356	0.236	53	0.007	23.6	3.4	2.5	18.9	25	95%
RG-28	472	168	1652	2124	20	45	28	2043	0.204	46	0.006	20.4	4.8	3.5	13.5	22	94%
RG-29	2660	1446	6136	8796	105	143	143	8573	0.857	195	0.024	85.7	25.2	18.4	42.9	86	99%

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RAINGARDEN SIZING - 2% CHECK

RG ID	Impervious Road Area	Impevious Lot Area	Total Impervious	Rain Garden Area (Base)	% of Impervious Untreated Surface	% of Impervious Surface	Notes
	m^2	m^2	m^2	m^2	m^2	m^2	
RG-01	5189	7080	12269	160	3.1%	1.3%	
RG-02	966	3540	4506	61	6.3%	1.4%	
RG-03	8248	23836	32084	424	5.1%	1.3%	
RG-04	2148	6372	8520	110	5.1%	1.3%	
RG-05	5961	12744	18705	250	4.2%	1.3%	
RG-06	2594	6844	9438	112	4.3%	1.2%	
RG-07	7885	11328	19213	241	3.1%	1.3%	
RG-08	3050	4484	7534	83	2.7%	1.1%	
RG-09	1263	1180	2443	31	2.5%	1.3%	
RG-10	1815	5192	7007	80	4.4%	1.1%	
RG-11	1705	2124	3829	43	2.5%	1.1%	
RG-12	14234	22184	36418	450	3.2%	1.2%	
RG-13	1293	5428	6721	80	6.2%	1.2%	
RG-14	1199	708	1907	24	2.0%	1.3%	*Governed by 2%*
RG-15	5430	13924	19354	240	4.4%	1.2%	
RG-16	781	1180	1961	24	3.1%	1.2%	
RG-17	1863	5664	7527	90	4.8%	1.2%	
RG-18	952	1652	2604	35	3.7%	1.3%	
RG-19	760	1652	2412	24	3.2%	1.0%	
RG-20	1902	4484	6386	80	4.2%	1.3%	
RG-21	4472	9440	13912	170	3.8%	1.2%	
RG-22	9109	12036	21145	260	2.9%	1.2%	
RG-23	6859	9440	16299	190	2.8%	1.2%	
RG-24	2419	4956	7375	90	3.7%	1.2%	
RG-25	14369	26196	40565	500	3.5%	1.2%	
RG-26	472	1416	1888	18	3.8%	1.0%	
RG-27	561	1888	2449	14	2.5%	0.6%	
RG-28	472	1652	2124	20	4.2%	0.9%	
RG-29	2660	6136	8796	105	3.9%	1.2%	

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Table 2: Raingarden comparison at 1,000m² contributing impervious area. Same WQV, media depth, void ratio and ponding depth throughout.

RAINGARDEN SIZING					
Like-for-like comparison at 1,000 m² contributing impervious area. Same WQV, media depth, void ratio and ponding depth throughout;					
Parameter	**Unit**	**WQ + ED + RET**	**WQ + RET**	**WQ only**	**Notes**
Inputs					
Contributing impervious area	m2	1,000	1,000	1,000	
Water quality volume depth	mm	22.7	22.7	22.7	*1/3 x 2-yr ARI 24-hr depth*
WQF design intensity	mm/hr	10	10	10	
Retention runoff depth	mm	15	15	0	*GWRC Hydrological Control Guidance Note*
Supplementary mitigation runoff depth	mm	5	0	0	*GWRC Hydrological Control Guidance Note*
Media permeability, k	m/day	100.0	100.0	175.0	*50-300 mm/hr where retention provided; <=1000 mm/hr treatment only*
Media permeability, k	m/day	2.4	2.4	4.2	
Filter media depth, df	m	0.60	0.60	0.60	
Media void ratio	-	0.40	0.40	0.40	
Maximum ponding depth	m	0.30	0.30	0.30	
Ponding storage per m2 of filter base	m3/m2	0.348	0.348	0.348	*mid-height volume, 300 mm ponding on 1:3 batters*
Internal water storage depth	m	0.45	0.45	0.00	*for retention*
Internal water storage void ratio	-	0.35	0.35	0.35	
Derived Quantities					
Water quality volume, WQV	m3	22.70	22.70	22.70	
Average ponding depth, h	m	0.15	0.15	0.15	
Media permeability, k	mm/hr	100	100	175	
WQF event volume (1 hour)	m3	10.00	10.00	10.00	
Retention + supplementary volume	m3	20.00	15.00	0.00	
Storage available per m2 of filter base	m3/m2	0.746	0.746	0.588	*ponding, media voids and internal water storage*
Required Filter Base Area					
Darcy treatment	m2	7.6	7.6	4.3	*Af = WQV x df / (k (h+df) tf), tf = 1 day*
as % of impervious	%	0.76%	0.76%	0.43%	
Event capture	m2	11.8	11.8	13.1	*1-hour WQF event volume divided by capacity per m2*
as % of impervious	%	1.18%	1.18%	1.31%	
Storage for retention + supplementary	m2	26.8	20.1	0.0	*volume divided by storage available per m2*
as % of impervious	%	2.68%	2.01%	0.00%	
Governing Requirement	m2	26.8	20.1	13.1	
Governing as % of impervious	%	2.68%	2.01%	1.31%	

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