**Water New Zealand Stormwater Conference**
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Te Roopu Wai Āwhātanga

# *Outcome Based Sizing of Stormwater Treatment Systems*

Kaikōrero / Presenter

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# Agenda

1. Outcome Based Design
2. Conventional Sizing Approaches
3. Research Methodology
4. Results
5. Further Considerations
6. Conclusion

Section 1

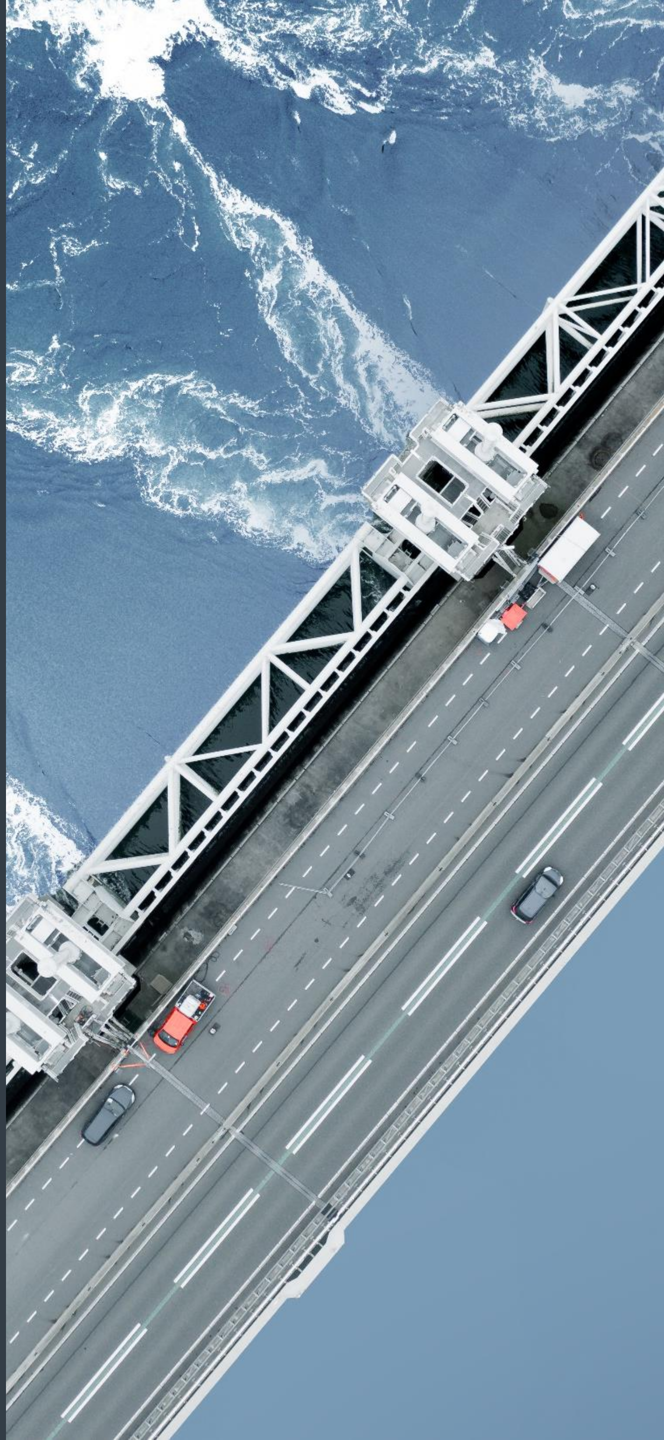
# Outcome Based Design

- Design approach intended to deliver a consistent result
- Focus on Auckland and Christchurch design methodologies and intended outcomes
    - Auckland – 90% of annual runoff treated
    - Christchurch – 80% of annual runoff treated
- This approach could easily be modified to another metric

Section 2

# Conventional Sizing Approaches

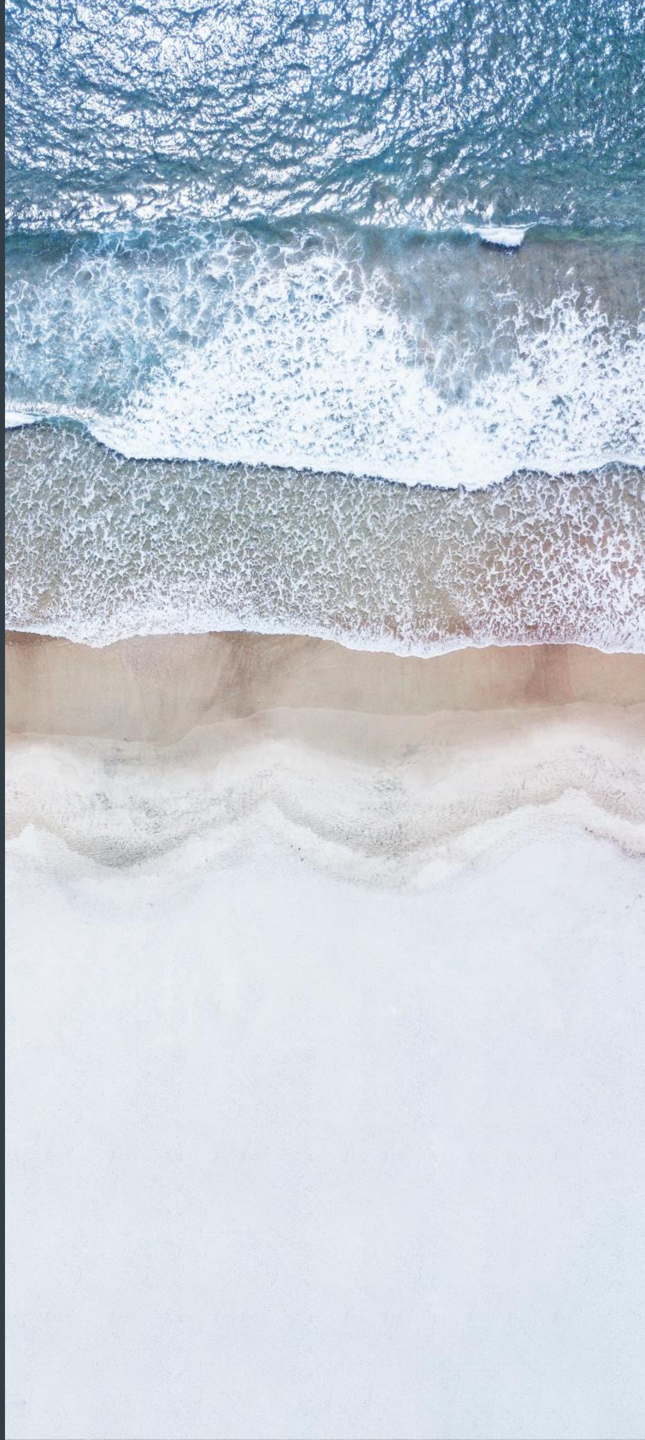
- Volume-based systems are sized based on a water quality volume
  - Calculated using a rainfall depth (mm)
- Flow-based systems are sized based on a water quality flow rate
  - Calculated using a rainfall intensity (mm/hr)
- Devices use different sizing methodologies but typically the same WQV or WQF is used, depending on whether the system is volume or flow-based
- “Input Based”



Section 3

# Research Methodology

- Two rain gauges
- Four treatment systems
  - Raingarden
  - Infiltration Basin
  - StormFilter (SW360)
  - Filterra/Bioscape (SW360)
- Conceptual hydrological (run-off and routing) and hydraulic model
- Rational Method
- Catchment of 1 hectare with a runoff coefficient of 0.65
- 5-year period series rainfall
- 1-(Volume Bypassed/Total Inflow Volume) = % runoff treated
- Each model initialised with a starting rainfall depth or intensity



# Research Methodology

Limitations

- 10-minute time-step
- Rain gauge specific
- Losses due to evapotranspiration and media storage were not included
- Climate change was not considered
- Fixed run-off was used to generate the synthetic inflow hydrographs

Section 4

# Results

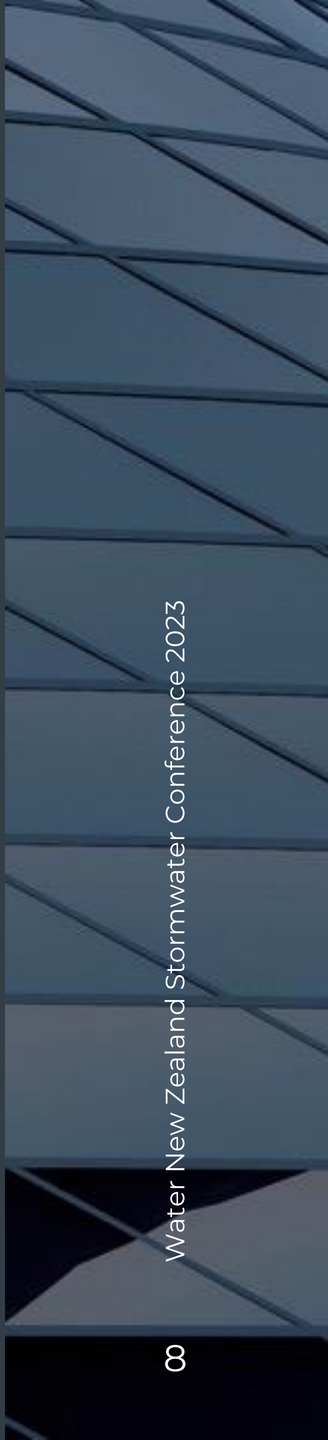
# Results

## GD01 Water Quality Only Raingarden (Auckland Sizing Methodology & Rainfall Data)

| Treatment System | Raingarden (WQ only as per GD01 guidance) | | | | | |
|---|---|---|---|---|---|---|
| Infiltration Rate, K (m/hr) | 1.0 | 0.5 | 0.2 | 0.15 | 1.0 | *1.0* |
| Infiltration Rate (mm/hr) | 1,000 | 500 | 200 | 150 | 1,000 | *1,000*[1] |
| Ponding Depth (mm) | 150 | 150 | 150 | 150 | 200 | *150*[1] |
| Footprint, A ($m^2$) | 54 | 91 | 172 | 209 | 50 | *200*[1] |
| Equivalent Rainfall Intensity (mm/hr) | 4.2 | 3.5 | 2.6 | 2.4 | 3.9 | *15.4*[1] |
| % of Total Runoff Treated | 90% | 90% | 90% | 90% | 90% | *98%*[1] |

1. *Applying the minimum area requirement of 2% of the total catchment when using an infiltration rate of 1,000 mm/hr and a ponding depth of 150 mm.*

GD01 recommends a rainfall intensity of **10 mm/hr** to treat approximately 90% of annual runoff



# Results

## Proprietary Systems (Auckland Rainfall Data)

| Treatment System | Filterra | StormFilter |
|---|---|---|
| Footprint ($m^2$) | 23.4 | 5.0 |
| Equivalent Rainfall Intensity (mm/hr) | 9.1 | 9.5 |
| % of Total Runoff Treated | 90% | 90% |

GD01 recommends a rainfall intensity of **10 mm/hr** to treat approximately 90% of annual runoff

# Results

## Raingarden (Christchurch Sizing Methodology & Rainfall Data)

| Treatment System | Raingarden | | |
|---|---|---|---|
| Infiltration Rate (mm/hr) | 30 | 30 | 200 |
| Ponding Depth (mm) | 300 | 200 | 300 |
| Base Area ($m^2$) | 146 | 134 | 7.5 |
| Top Area ($m^2$) | 175 | 226 | 60 |
| Equivalent Rainfall Depth (mm) | 20.2 | 17.4 | 6.9 |
| % of Total Runoff Treated | 80% | 80% | 80% |

CCC recommend a rainfall depth of **20 mm** to treat approximately 80% of annual runoff (for Raingardens)

# Results

## Infiltration Basin (Christchurch Sizing Methodology & Rainfall Data)

| Treatment System | Infiltration Basin | | |
|---|---|---|---|
| Infiltration Rate (mm/hr) | 20 | 20 | 12.5 |
| Ponding Depth (mm) | 1,000 | 500 | 1,000 |
| Base Area ($m^2$) | 66 | 130 | 83 |
| Top Area ($m^2$) | 131 | 176 | 155 |
| Equivalent Rainfall Depth (mm) | 10.2 | 10.0 | 12.7 |
| % of Total Runoff Treated | 80% | 80% | 80% |

CCC recommend a rainfall depth of **25 mm** to treat approximately 80% of annual runoff (for Infiltration Basins)

# Results

## Proprietary Systems (Christchurch Rainfall Data)

| Treatment System | Filterra | StormFilter |
|---|---|---|
| Footprint (m2) | 5.9 | 1.8 |
| Equivalent Rainfall Intensity (mm/hr) | 2.3 | 2.4 |
| % of Total Runoff Treated | 80% | 80% |

CCC recommend a rainfall intensity of **5 mm/hr** to treat approximately 80% of annual runoff

# Results Summary

- Systems have a large Factor of Safety in most cases
- Changes in design variables have a significant effect on the outcome
- Variation likely due to implicit Factors of Safety
- Location specific rainfall analysis is crucial

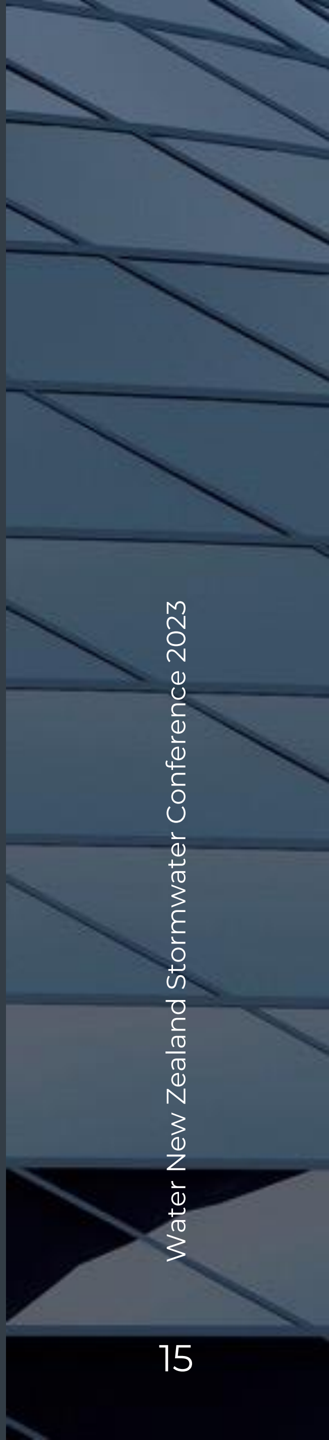
Section 4

# Further Considerations

- Factors of Safety & Catchment Level Outcomes
    - Explicit (e.g., GD01 Water Quality Raingarden)
    - Implicit (e.g., infiltration rates)
- Alternative Outcomes?

# Maintenance

- Size of the system will affect the required maintenance frequency and operational cost. Typically:
  - A smaller system = less expensive maintenance (per maintenance) but requires more frequent maintenance
  - A larger system = more expensive maintenance (per maintenance) but requires less frequent maintenance
- Maintenance frequency is predominantly dependent on system function and site-specific sediment mass loads
- When sizing treatment systems whole of life consequences on system operation and maintenance must be considered!



# End Use

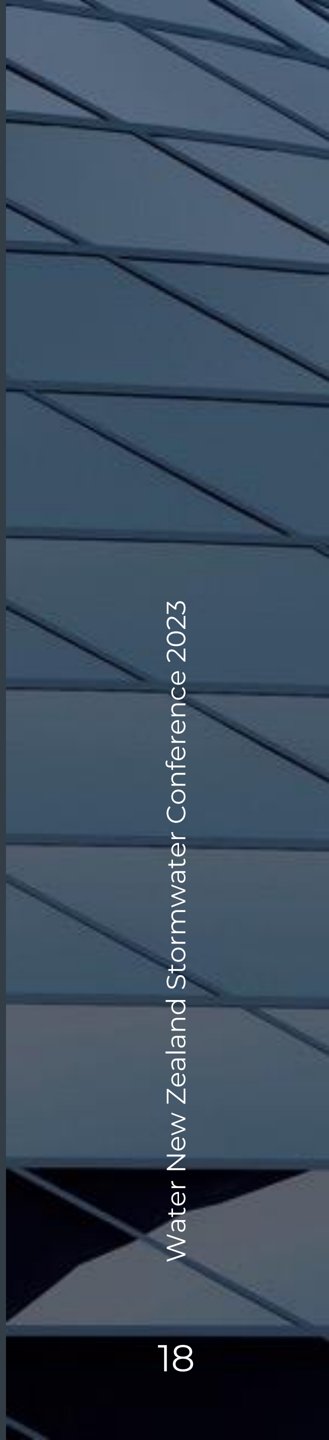
- Effort required is significant for a one-off design or small development
- Best suited for:
    - Councils looking at regionwide catchment management
    - Large scale projects, such as alliance projects
- This method should <u>not</u> be used without first engaging with the local or regional Council

Section 6

# Conclusion

# Conclusion

- Treatment systems can be sized to achieve consistent outcomes regardless of device type and location
- Device and location specific design inputs are required
- The findings highlight that some current methods are not necessarily aligned to deliver a consistent outcome
- It appears that the rainfall depth and intensities may include a FoS which is additional to other explicit or implicit FoS
- **Where FoS are transparent and explicit, informed discussion can take place between designer and regulator to agree any appropriate adjustments**
- This study suggests there is an opportunity for further optimisation of stormwater treatment system sizing



# Thank you

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