Robust decision making in an uncertain future: a Wellington water supply case study

Geoff Williams
Senior Advisor Strategy

Wellington Water

Our water, our future.

Water supply strategy workstreams

Wellington Water

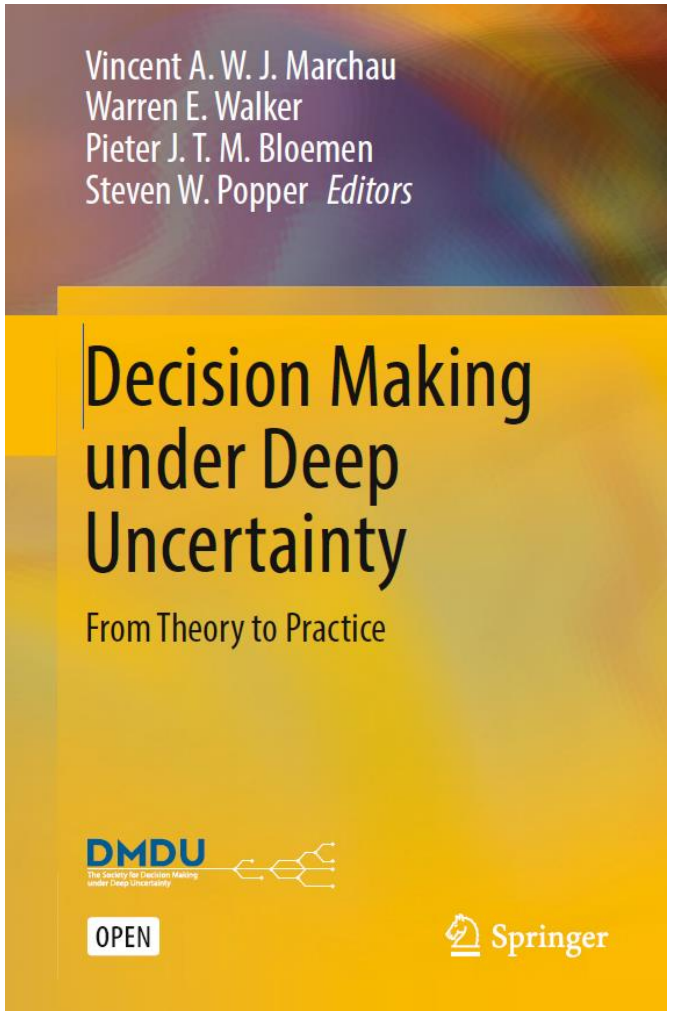
Water supply augmentation project

- Supported by Connect Water (Beca and WSP) and Dr Judy Lawrence
- Review supply upgrade options

Strategic planning tool 5-yearly update

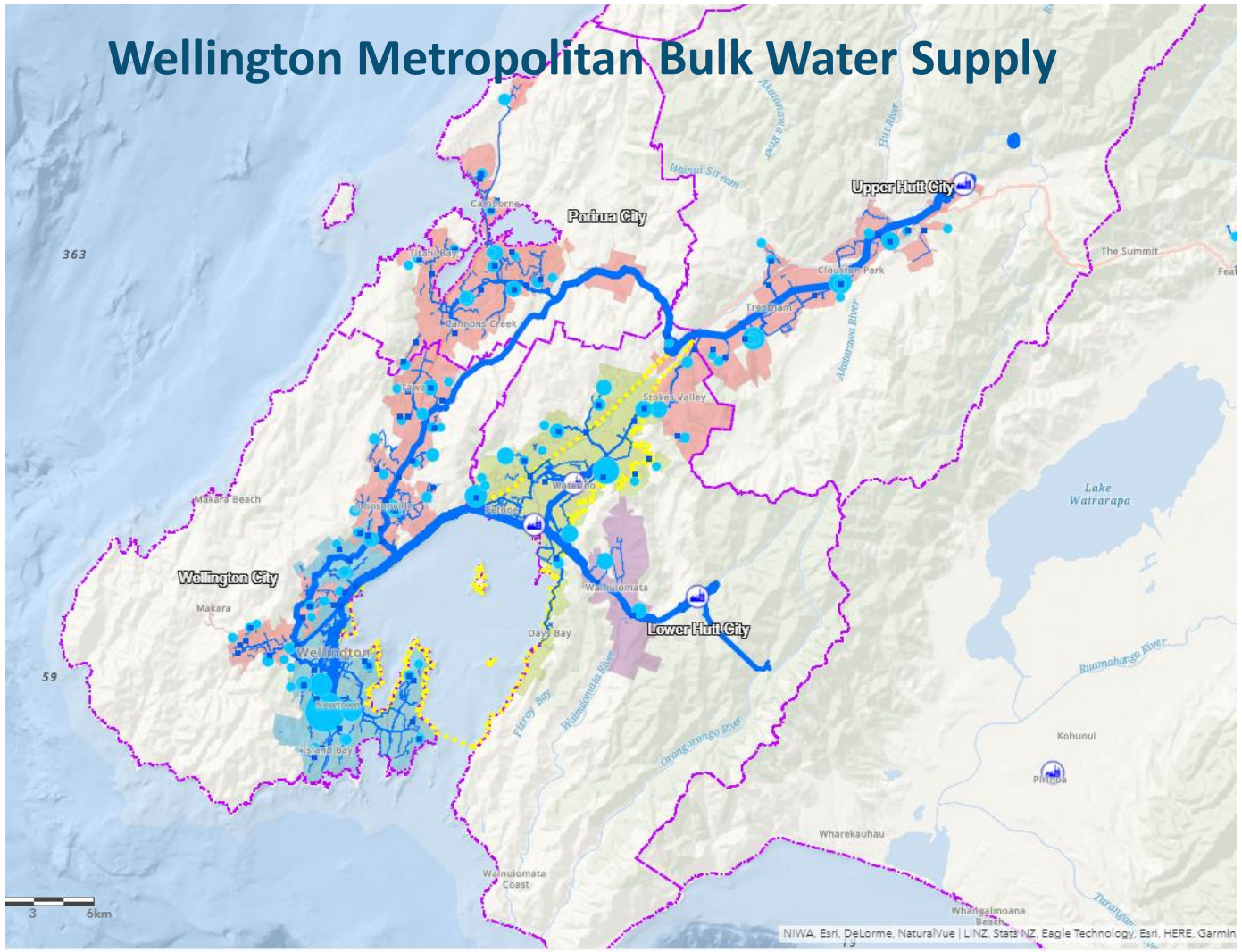
- A WATHNET model
- Ongoing partnership with NIWA
- Aim to increase visibility over uncertainty

DAPP process



1. Decision context
2. Assess vulnerabilities and opportunities
3. Identify and evaluate options
4. Design and evaluate pathways
5. Design adaptive plan
6. Implement the plan
7. Monitor the plan

Context



GWRC Long Term Plan

"Sufficient water is available to meet normal demand except in a drought with a severity of greater than or equal to 1 in 50 years"

Whaitua te Whanganui-a-Tara

"Increase the minimum flows over time to 80 per cent of MALF…"

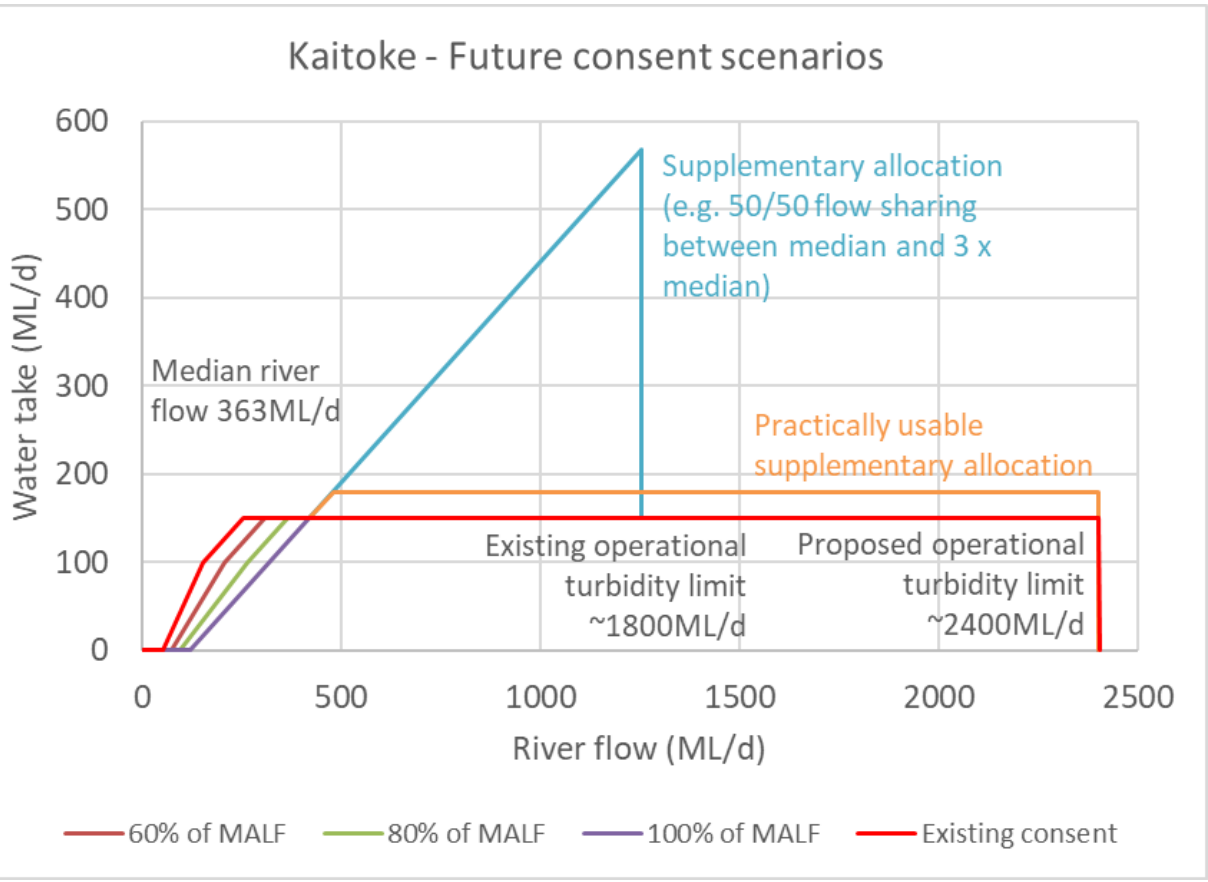
Uncertainties – Demand for water

Wellington Water

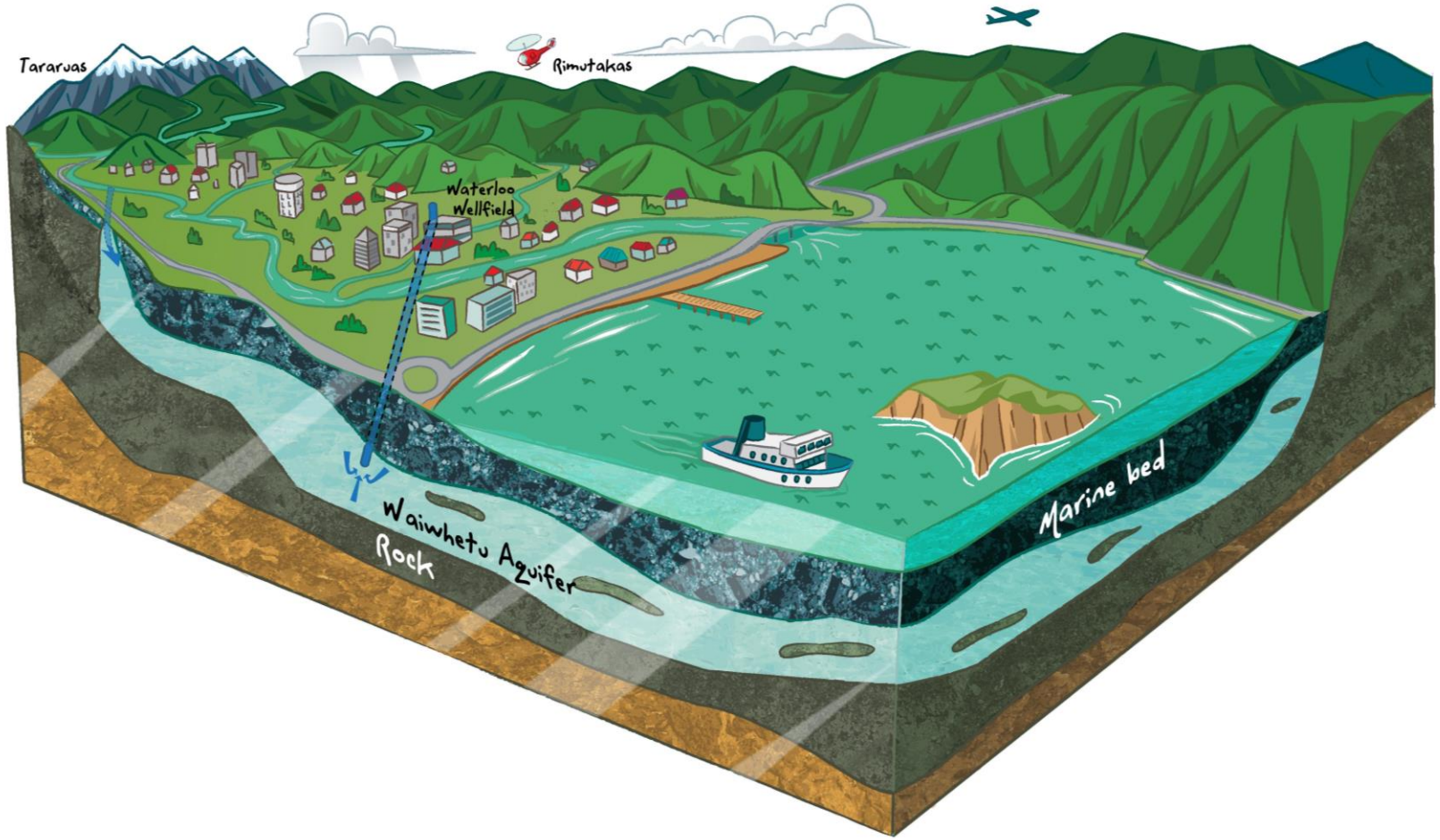
How well do we really understand demand for water?

Uncertainties – Environmental regulation

How far will changes go?



Uncertainties – Climate change and sea level rise



Summary of future scenarios

Environmental regulation

- MRF at 40%, 60%, 80% and 100%

Hydrology and demand

- 5000 replicate stochastic datasets (historic and RCP 4.5, 6.0, 8.5)

Sea level rise

- 0m, 1.5m

Residential per capita demand

- Existing, 10% reduction

Population growth

- Three projections (25th, 50th, 75th percentiles)

Level of service (community risk appetite)

- Shortfall probability 2%, 0.5% and 0.2%

192 scenario combinations for each of the three LoS

Supply/demand intervention options

WATHNET

Wellington Water

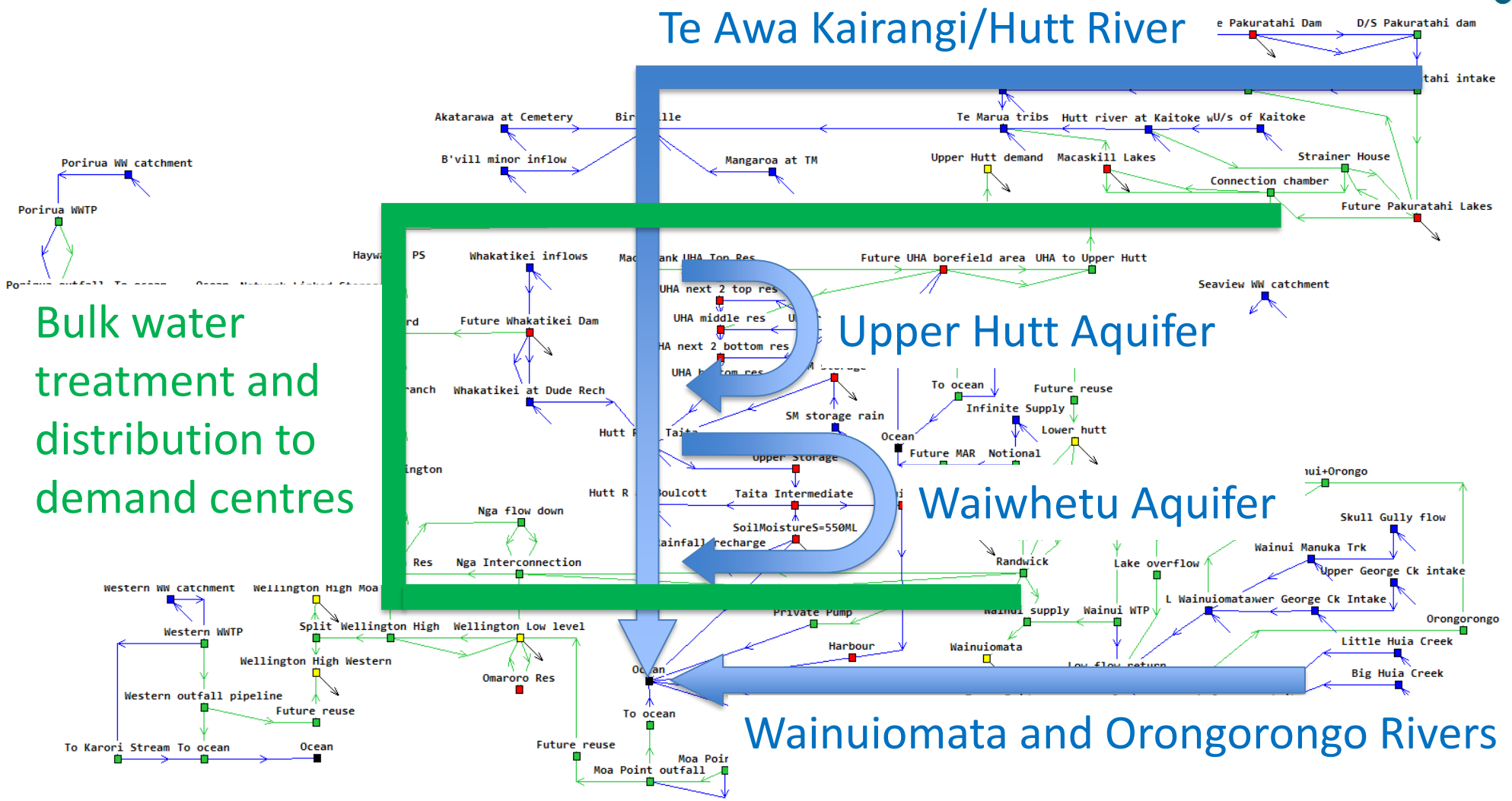
Te Awa Kairangi/Hutt River

Upper Hutt Aquifer

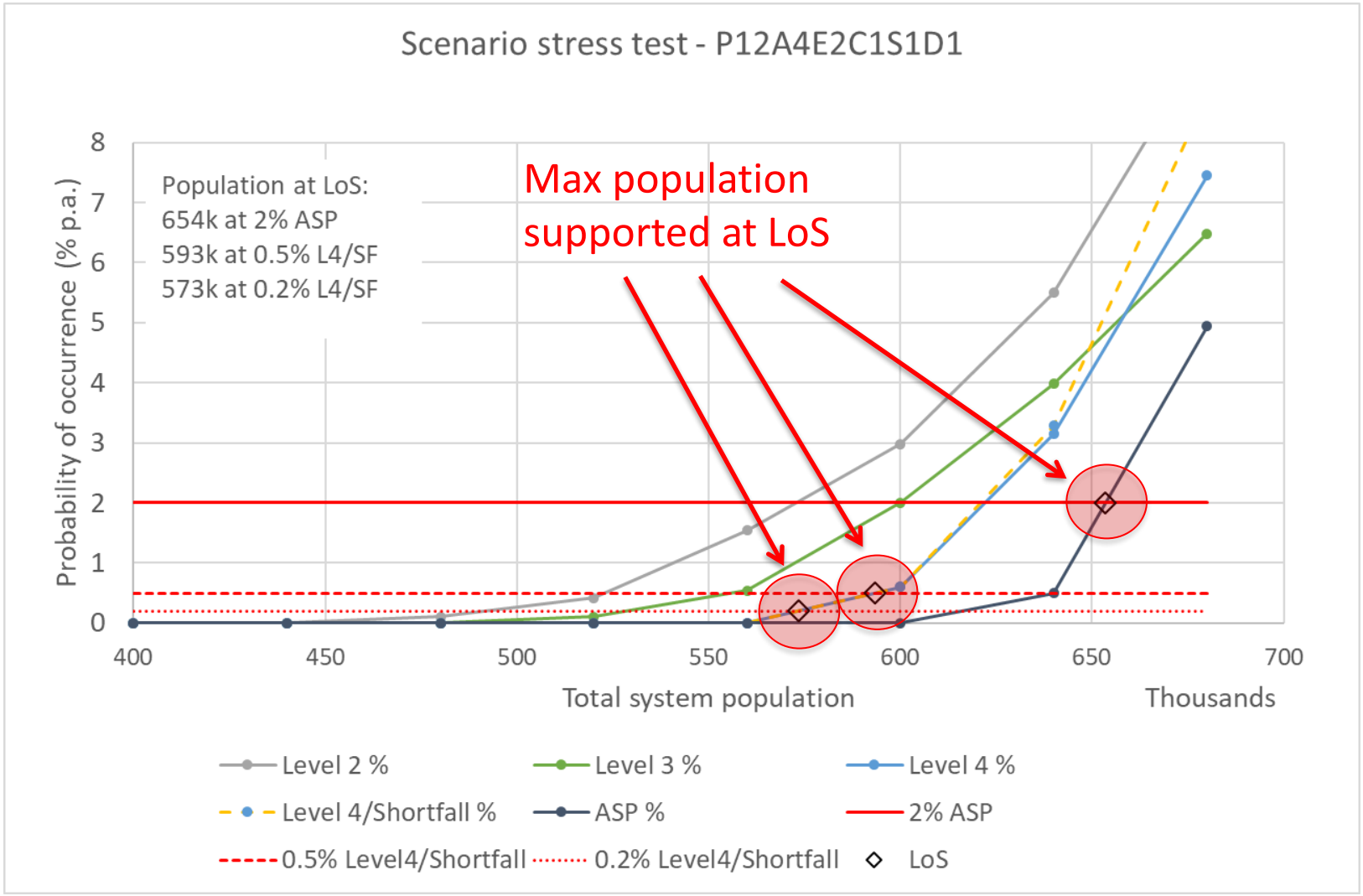
Waiwhetu Aquifer

Wainuiomata and Orongorongo Rivers

Bulk water treatment and distribution to demand centres



Network performance



Our water, our future.

Automation

Wellington Water

WATHNET network file with future options turned on/off in decision files

P1A1E1C1S1D1N10.txt

```
Wathnet decision file
22
4.000000E+05  1.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  1.010000E+00  0.000000E+00  1.000000E+00  0.000000E+00  1.300000E+00  0.000000E+00
Population    EReg option   Sea Lev rise  Demand rstn   No dist limt  Res PCD mult  Res PCD add   Com PCD mult  Com PCD add   Leakage mult  Leakage add

```

Scripts to:

- Create future scenario combinations e.g. P10A2E3C4S2D1N15
- Generate WATHNET network and decision files
- Read WATHNET result files

Excel to interpolate results to find LoS failure point

Pathway development

1. Preliminary analysis with reduced uncertainty to inform sensible action sequencing
2. Option stress test with full uncertainty
3. Refine options and pathways
4. Re-test

Pathway	Action 1	2	3	4	5	6	7	8
1	Low water loss investment	Meters + DM (20ML/d)	Pakuratahi 3GL	Managed Aquifer Recharge 10ML/d	Wainui 1.5GL	Pakuratahi 7GL	Porirua desal 25ML/d	Porirua desal 50ML/d
2	Medium water loss investment	Meters + DM (20ML/d)	Pakuratahi 3GL	Managed Aquifer Recharge 10ML/d	Wainui 1.5GL	Pakuratahi 7GL	Porirua desal 25ML/d	Porirua desal 50ML/d
3	High water loss investment (requires meters)	Meters + DM (20ML/d)	Pakuratahi 3GL	Managed Aquifer Recharge 10ML/d	Wainui 1.5GL	Pakuratahi 7GL	Porirua desal 25ML/d	Porirua desal 50ML/d

Option stress testing using NeSI HPC (supported by NIWA)

- Every Pathway/Action sequence stress tested against every future scenario
- Completed ~200B days of full system flow balance

Analysis and initial results

	Action								
Pathway	1	2	3	4	5	6	7	8	9
1	5%	9%	36%	57%	97%	99%	85%	100%	100%
2	17%	41%	84%	98%	100%	100%	100%	100%	100%
3	29%	36%	100%	100%	100%	100%	100%	100%	100%
4	5%	9%	17%	67%	77%	55%	98%	99%	
5	17%	41%	63%	98%	99%	90%	100%	100%	
6	5%	16%	33%	45%	97%				
7	17%	44%	82%	91%	100%				
8	29%	34%	100%	100%	100%				
9	5%	8%	10%	48%					
10	17%	35%	47%	92%					
11	5%	9%	36%	57%	97%	99%	99%	100%	
12	17%	41%	84%	98%	100%	100%	100%	100%	
13	29%	36%	100%	100%	100%	100%	100%	100%	

"Success score"

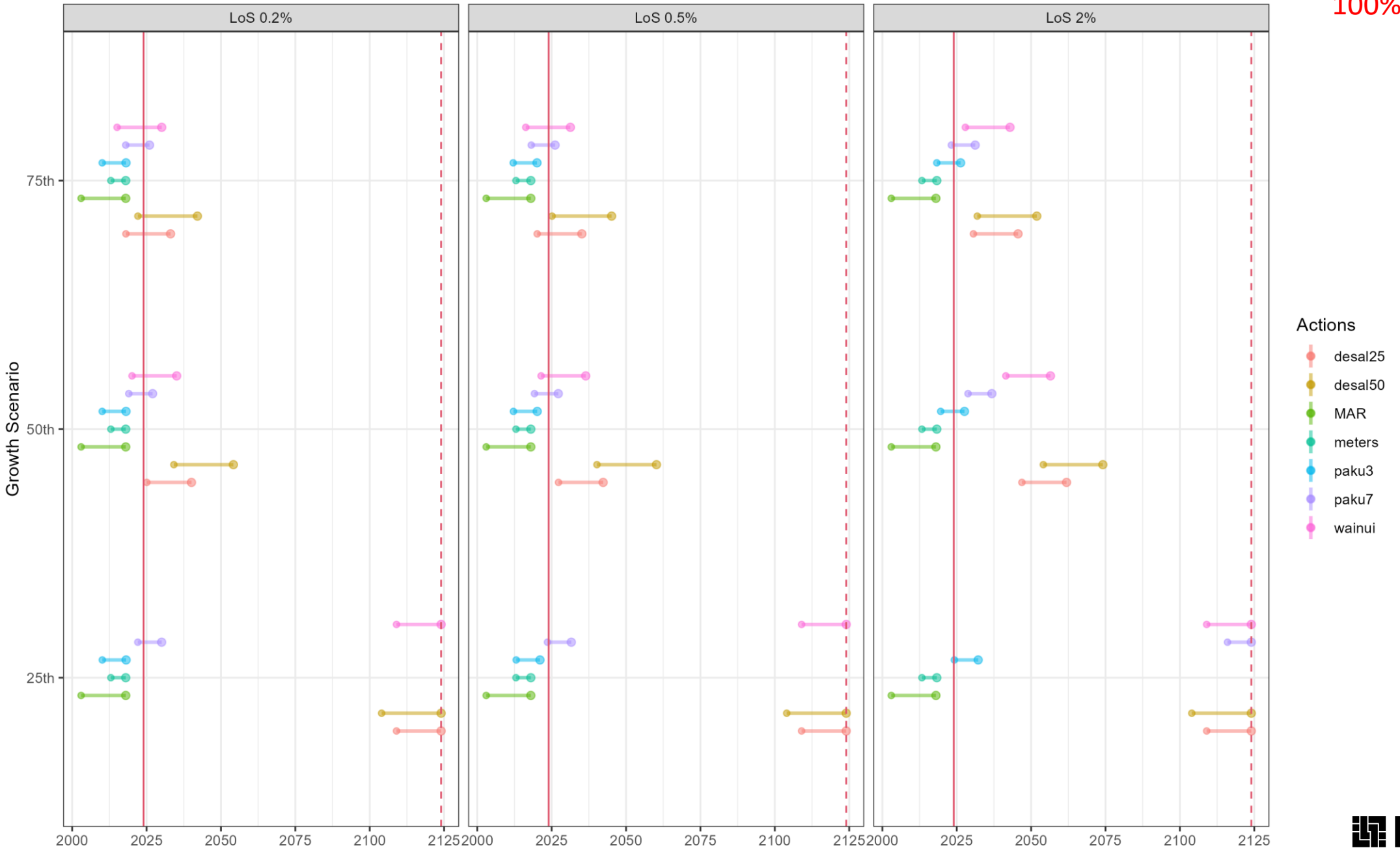
Can options be implemented before LoS failure occurs?

- All actions fail initially, BUT water loss management is a key success factor

Timing and leadtime

Pathway: P12, 100% MALF, all CC, PCD & SL scenarios (@LoS)

100% MALF

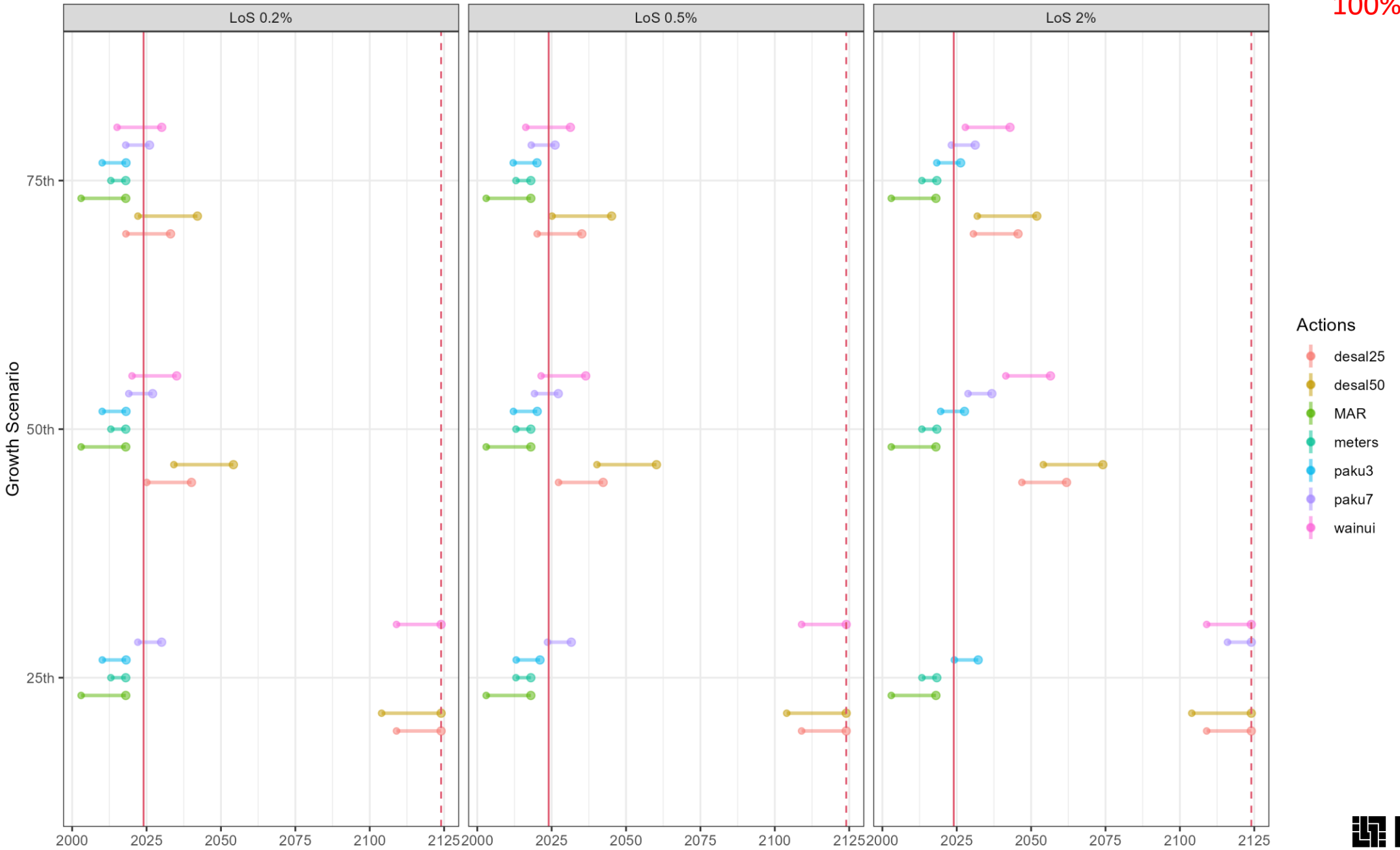


Beca

Timing and leadtime

Pathway: P12, 100% MALF, all CC, PCD & SL scenarios (@LoS)

100% MALF

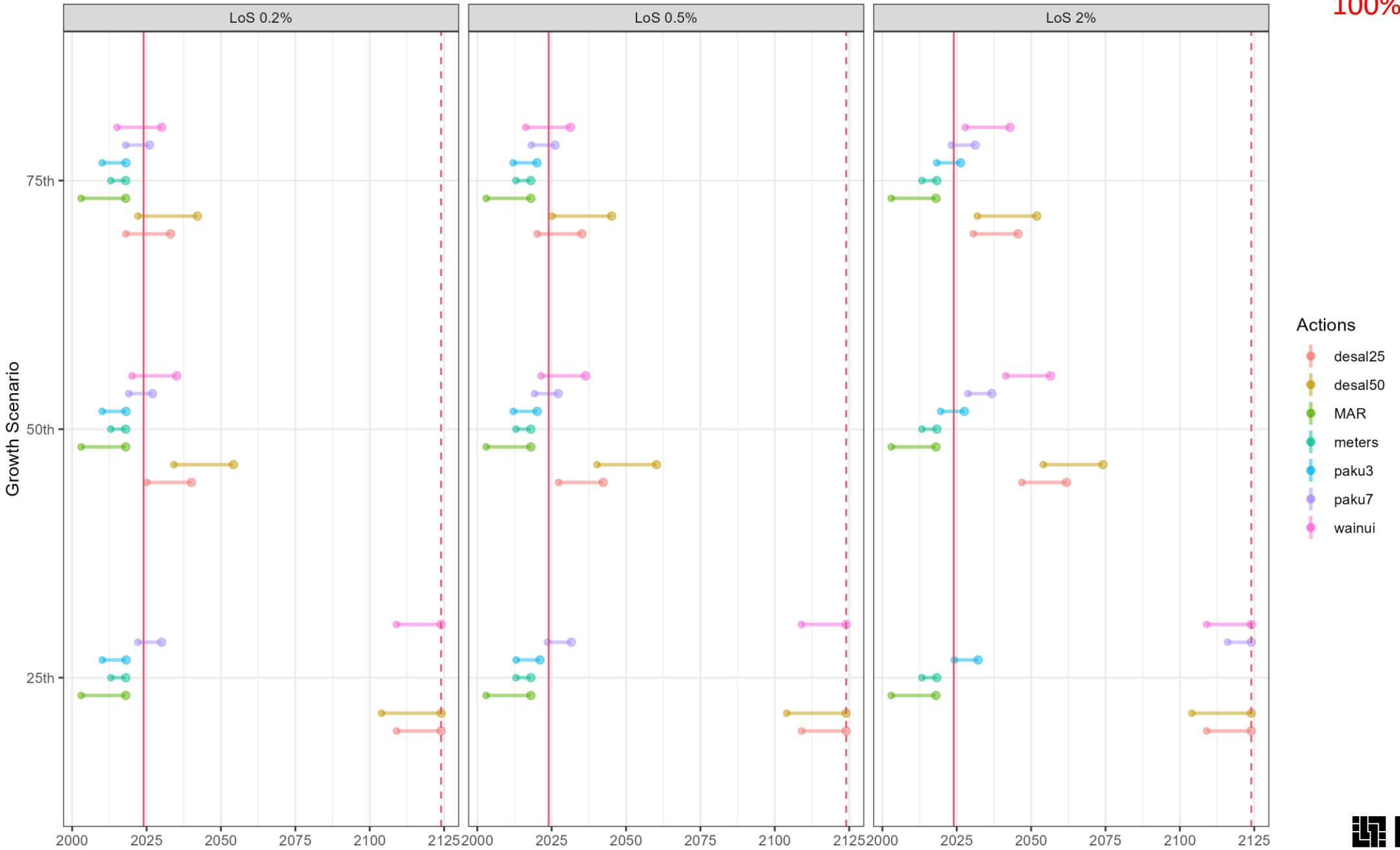


Beca

Timing and leadtime

Pathway: P12, 100% MALF, all CC, PCD & SL scenarios (@LoS)

100% MALF

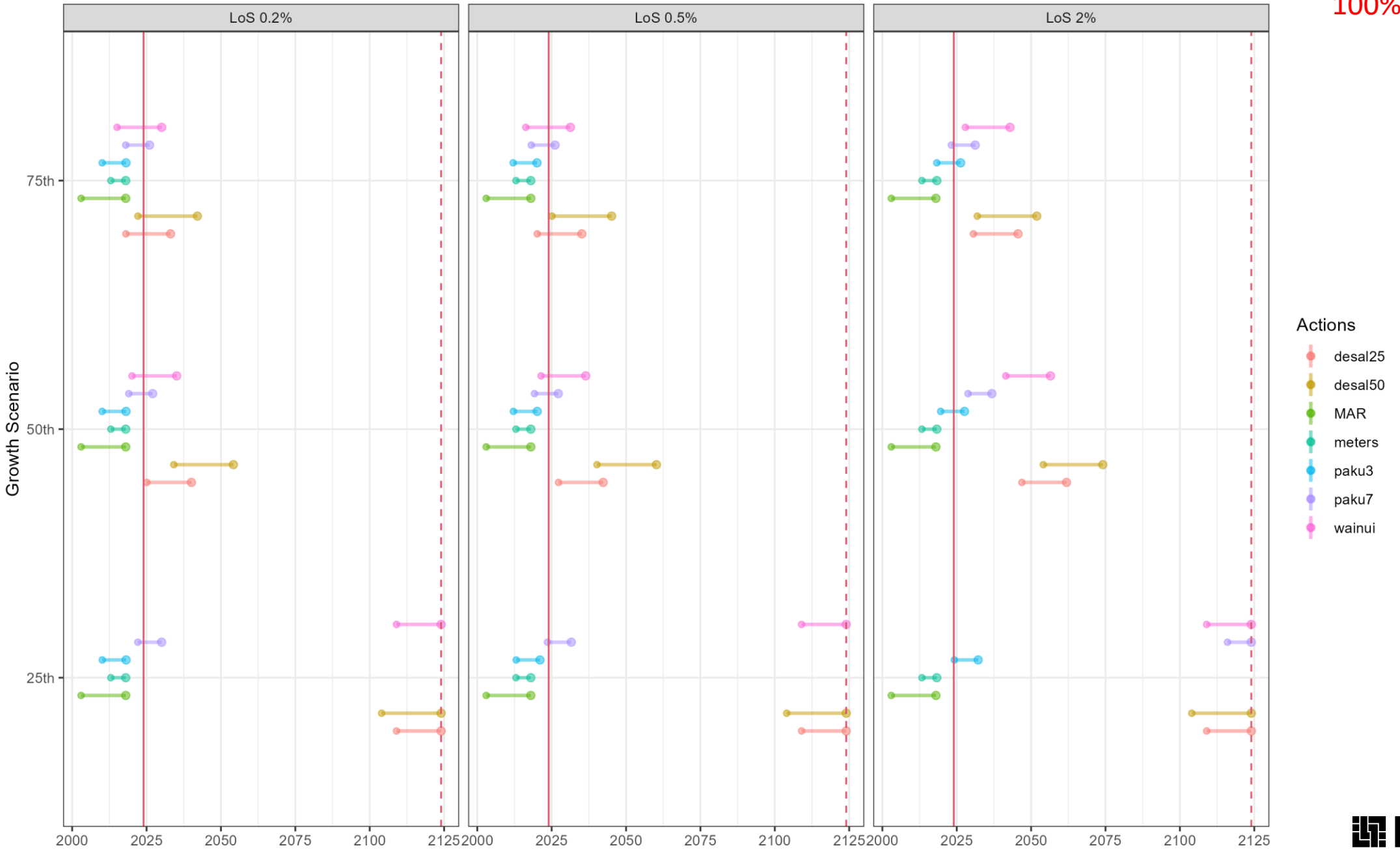


Beca

Timing and leadtime

Pathway: P12, 100% MALF, all CC, PCD & SL scenarios (@LoS)

100% MALF



Beca

Pathway performance

Current Situation

High water loss investment (requires meters)

Medium water loss investment

Low water loss investment

Managed Aquifer Recharge 10ML/d

Meters + DM (20ML/d)

Pakuratahi 3GL

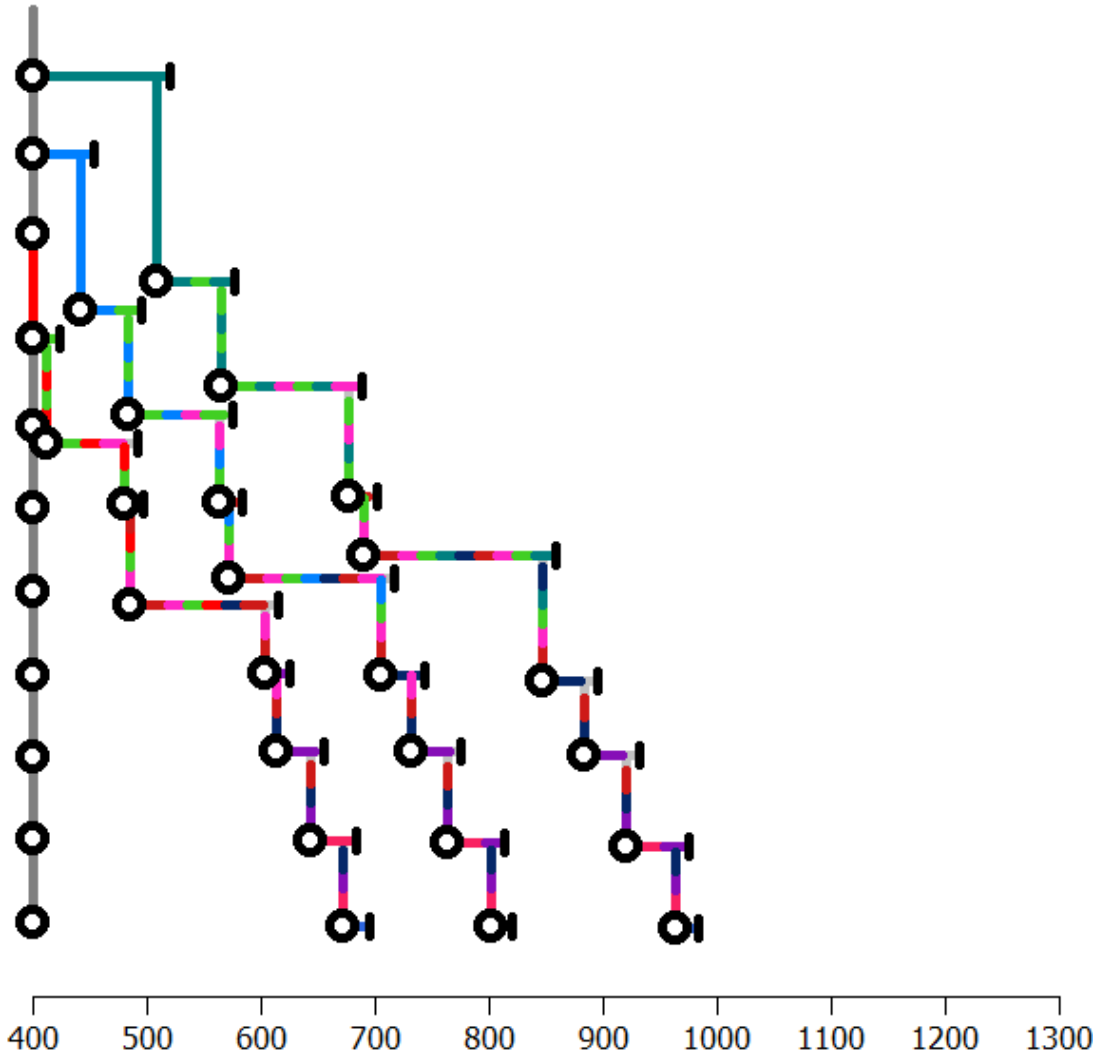
Pakuratahi 7GL

Wainui 1.5GL

Porirua PRW 25ML/d

Porirua desal 25ML/d

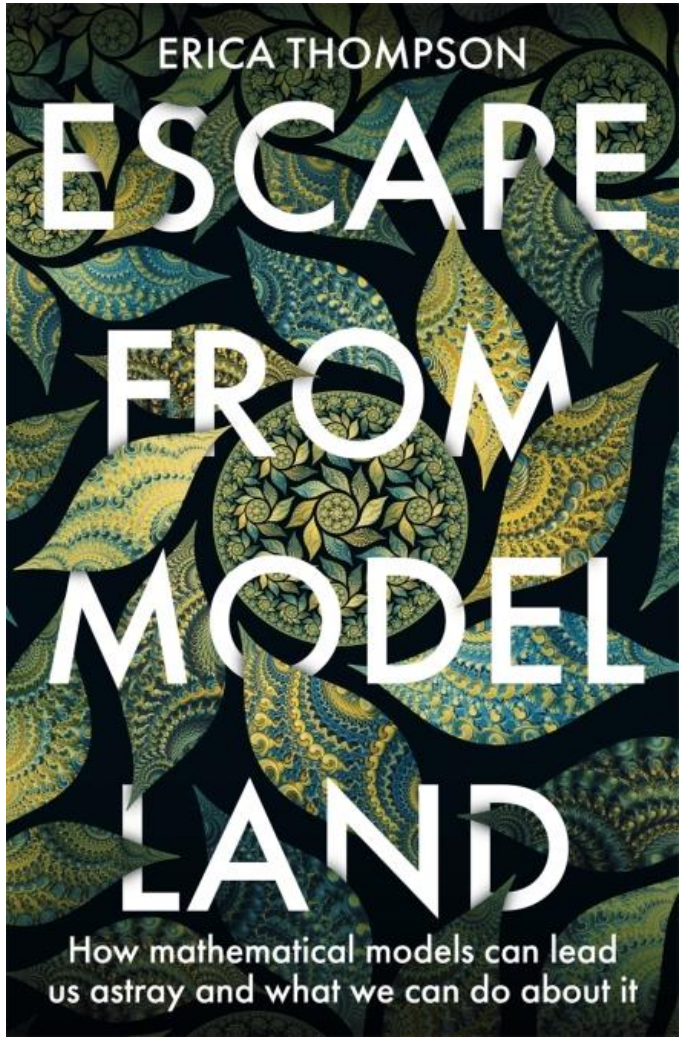
Porirua desal 50ML/d



Wellington Water

Our water, our future.

What does it mean?



- Growth, environmental regulation and community risk appetite dominate future uncertainty
- Current LoS failure will continue until supply/demand interventions are in place (realistically 10 years)
- Options are largely path independent so can be sequenced as needed to achieve objectives
- No signs of maladaptation under future scenarios
- What next? Adaptive plan, implement and monitor!