Kaituna-Pongakawa-Waitahanui Water Management Area (Plan Change 12)

Groundwater Quantity

Freshwater Futures Community Group
Workshop 11 20 November 2019

BAY OF PLENTY REGIONAL COUNCIL
TOI MOANA

- Welcome - Karakia
- Apologies/Guests
- Housekeeping

Purpose of this group

To help Council implement the National Policy Statement for Freshwater Management:

- *confirm* values, express preferred objectives
- *provide feedback* on limits for freshwater quality and quantity within this Water Management Area
- *provide input* to solutions for managing activities to meet those limits
- *advise Council* in their decision-making for Plan Change 12

We agreed that we would…..

Be….

* Respectful of others
* Respectful of cultural diversities
* Specific and frank
* Inclusive
* Focused
* Honest
* Timely
* Prepared for meetings

And….

* Work together
* Stay on topic
* Hear others
* Wait our turn
* Say what we think
* Share our experience
* Participate fully
* Keep a safe environment

Te awa honohono i te tangata mai uta ki te tai
A connector of people from the lakes to the sea

Focus today

Water quantity (surface & ground)

Water quality & ecosystem health

Lowland drain quality

Matauranga Māori

Engagement with iwi/hapū, community, stakeholders

Values and issues

Coastal receiving environment

Catchment modelling

Socio-economic information and analysis

Urban issues

Purpose of today

Group members:

- understand the groundwater system in Kaituna-Pongakawa-Waitahanui WMA
- confirm values and objectives
- explore modelling scenarios, results & implications for setting limits
- give feedback on options

Council staff clearly understand group members' issues/concerns and any preferences/feedback about policy options.

Agenda

am tea

1. National and Regional Updates
2. Hydro-geology and Groundwater
3. Modelling
4. Groundwater Values, Uses & Objectives

lunch

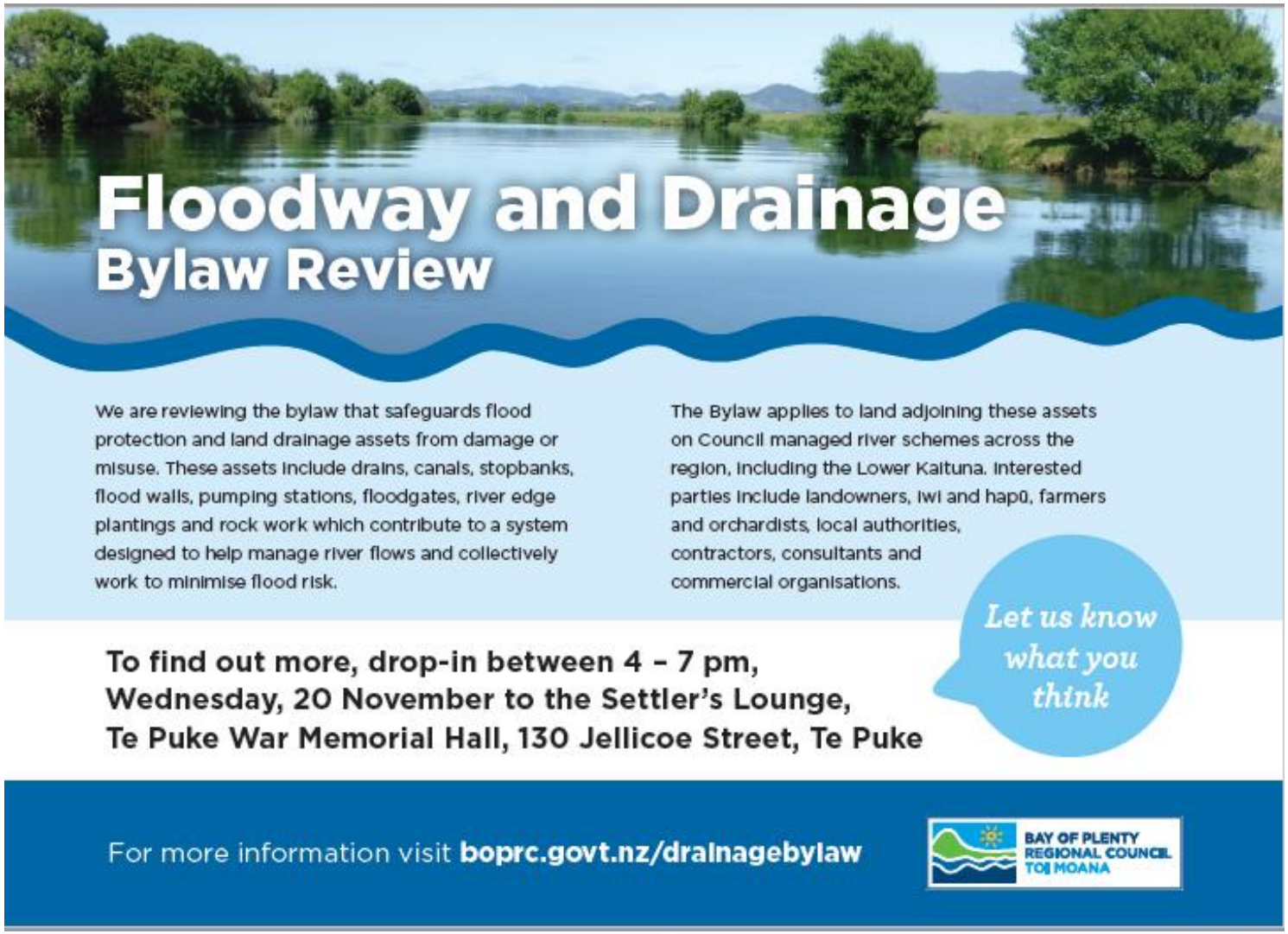
5. Scenarios and Results
6. Your Preferred Option

1.
National and Regional Updates

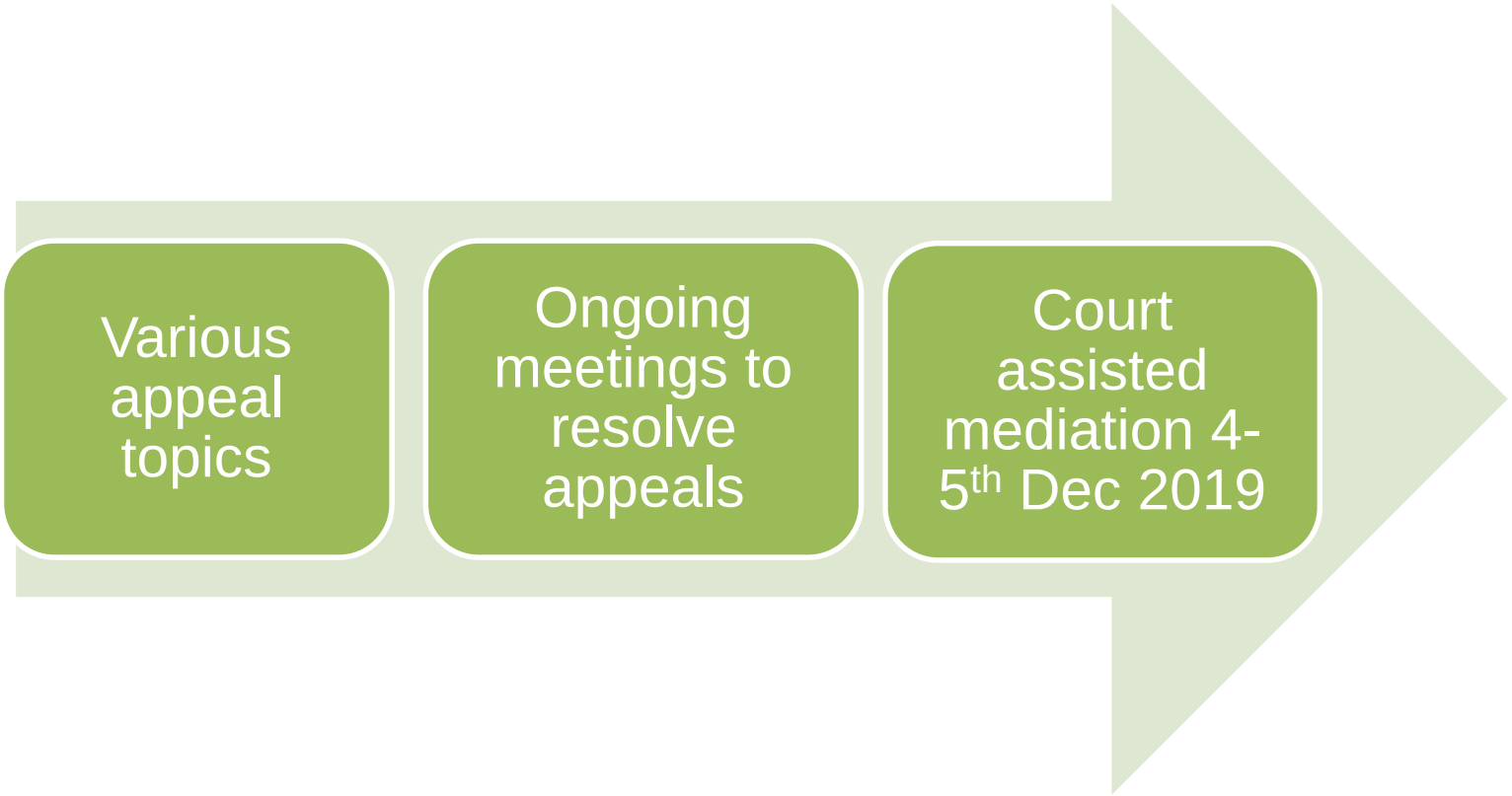
National Update - Action for Healthy Waterways

- **Summary of submissions** - end November 2019
- **Independent Advisory Panel recommendations** - mid-February 2020
- **Draft regulations** – mid May 2020
- **Final Cabinet approval** – end June 2020
- **Regulations in force** – July 2020

Regional updates

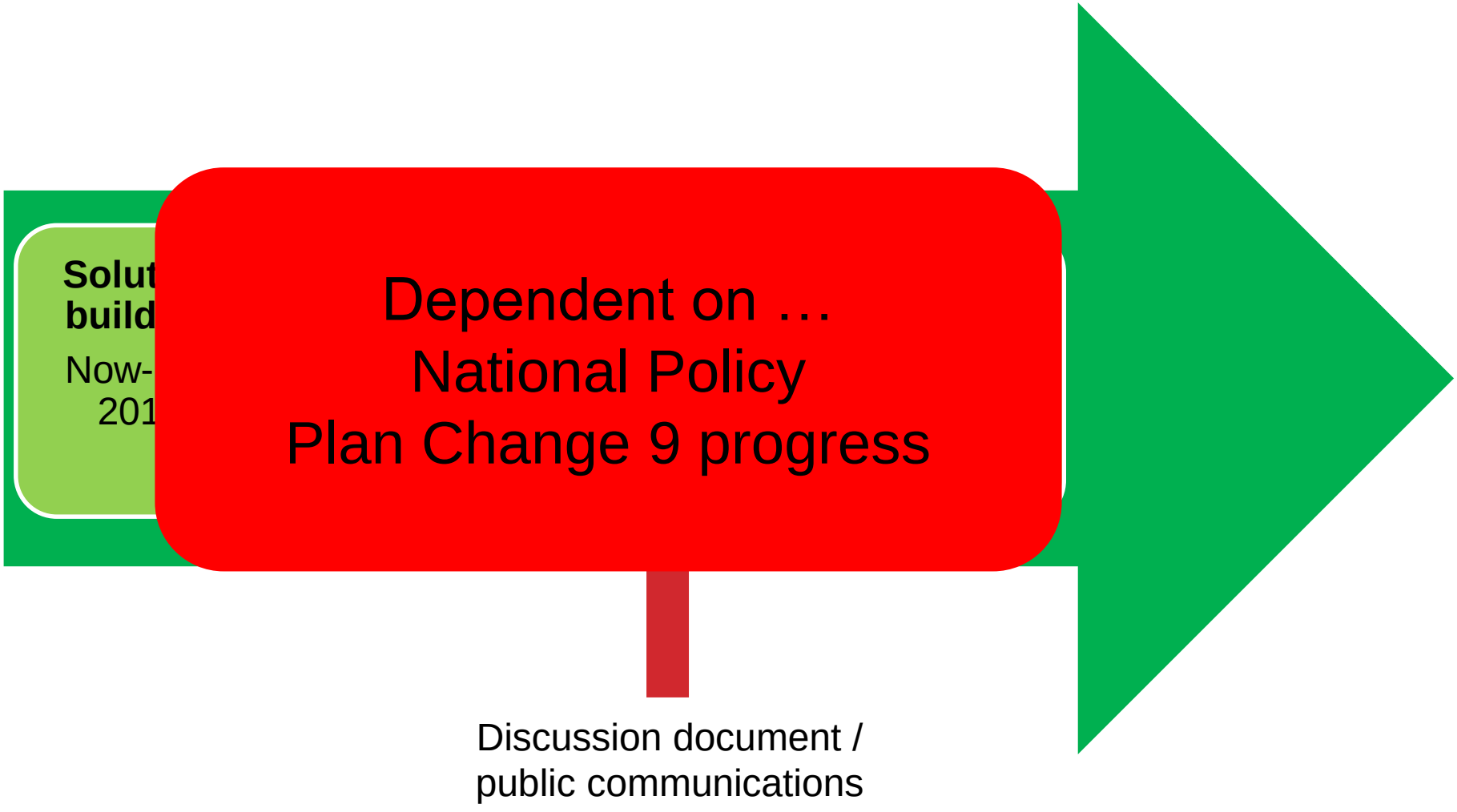


Region-wide Water Quantity – Plan Change 9



Timeline:

Kaituna-Pongakawa-Waitahanui (PC12)



Community Group Timeline

Workshop 8: Sept 2018

- Modelling results - baseline and development

Workshop 9: Mar 2019

- Water quality - Waihī and Maketū estuary load, lowland water quality and ecology, potential policy direction

Workshop 10: May

- Water quality - Good practice modelling results, policy direction cont.

Workshop 11: November

- Groundwater quantity modelling and scenarios

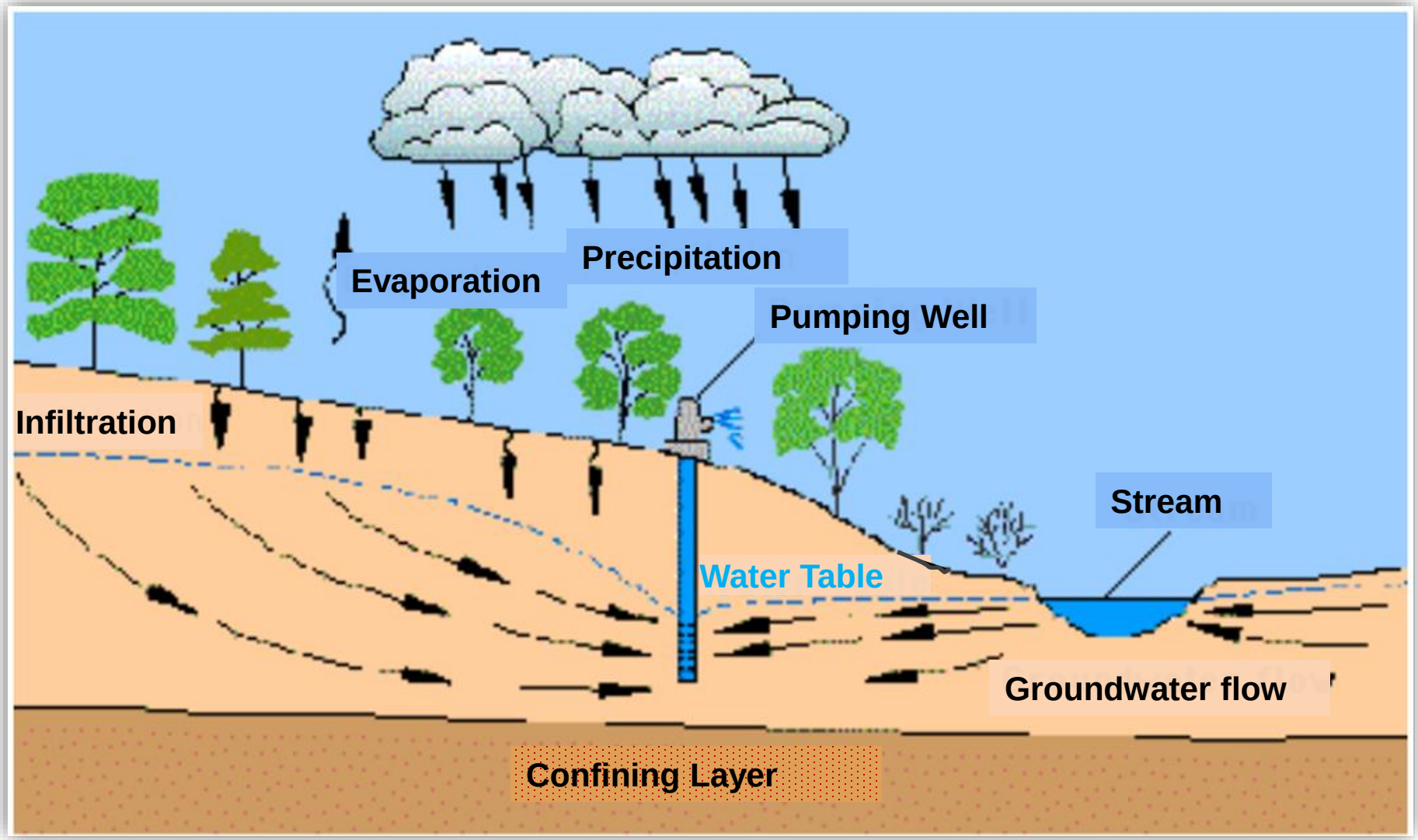
Workshop 12: 2020

- Surface water quantity

2020 - Public communications

2.
Hydro-geology and Groundwater

Groundwater basics



Aquifer Types

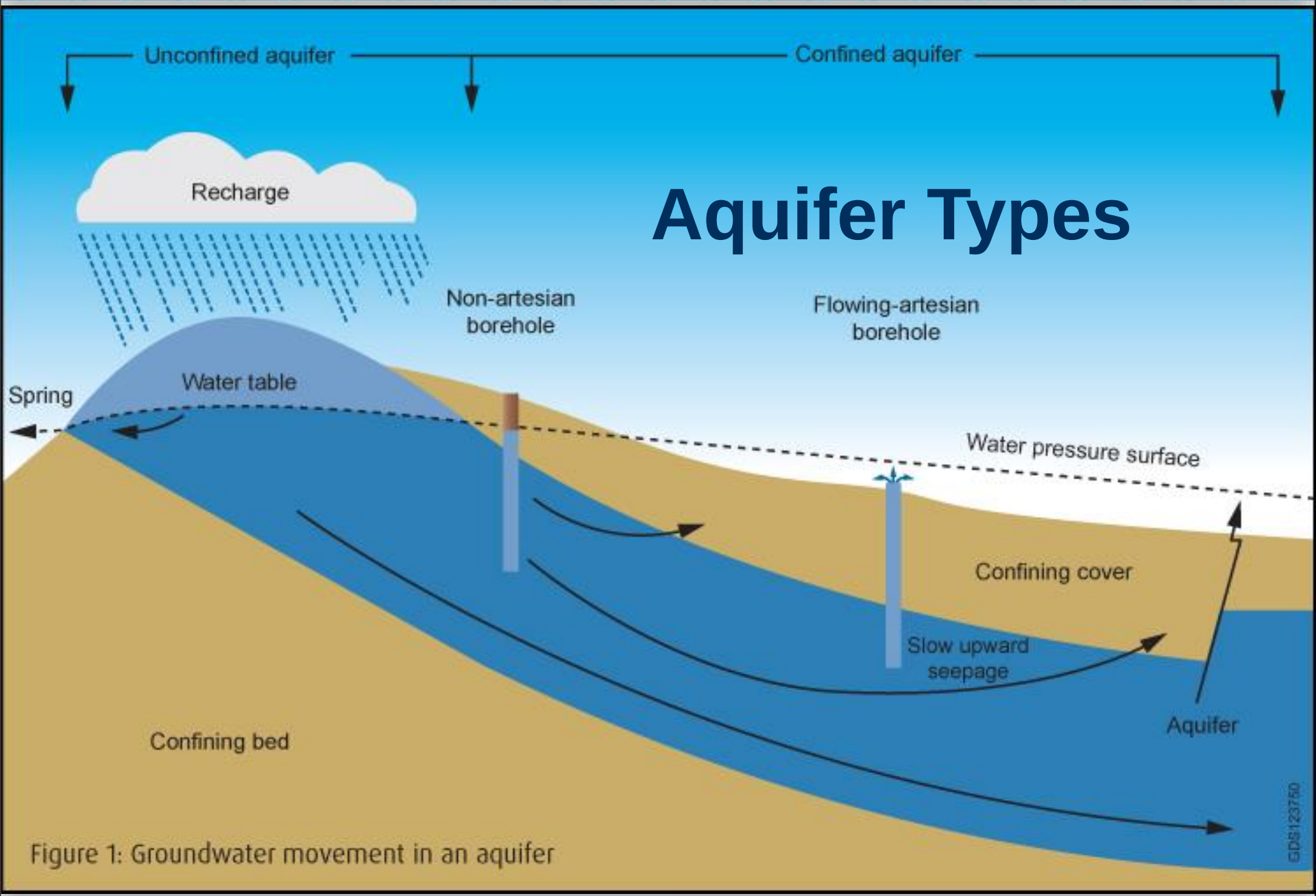


Figure 1: Groundwater movement in an aquifer

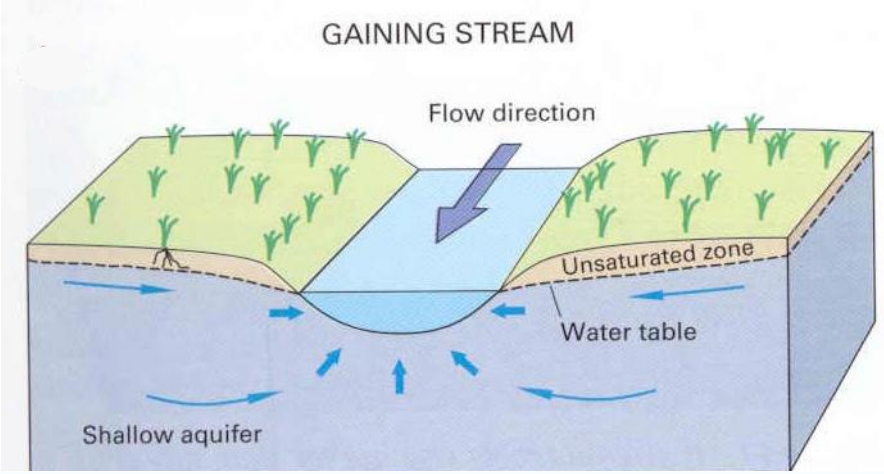
Groundwater Surface Water Interaction

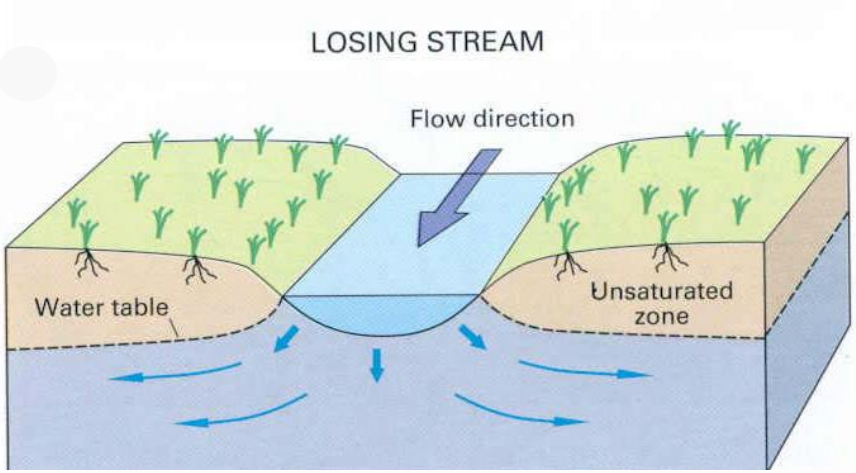
Gaining Stream

- Receive groundwater through stream bed (forms base-flow)
- Groundwater table above stream level

Losing Stream

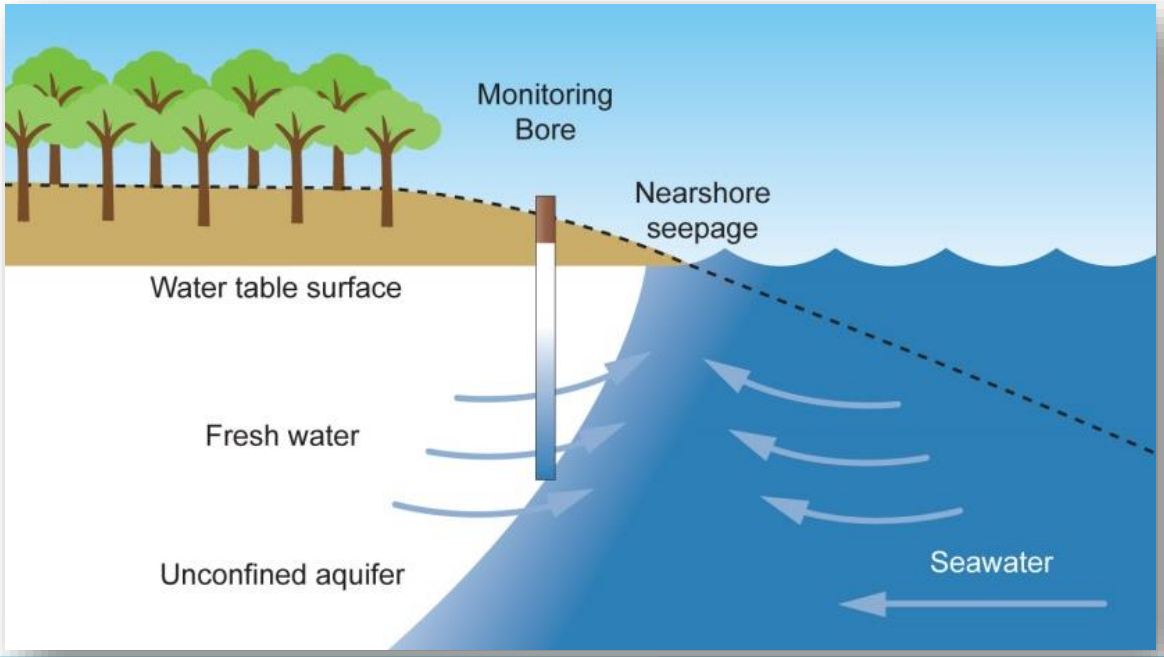
- Outflow through stream bed to groundwater
- Groundwater table below stream bed





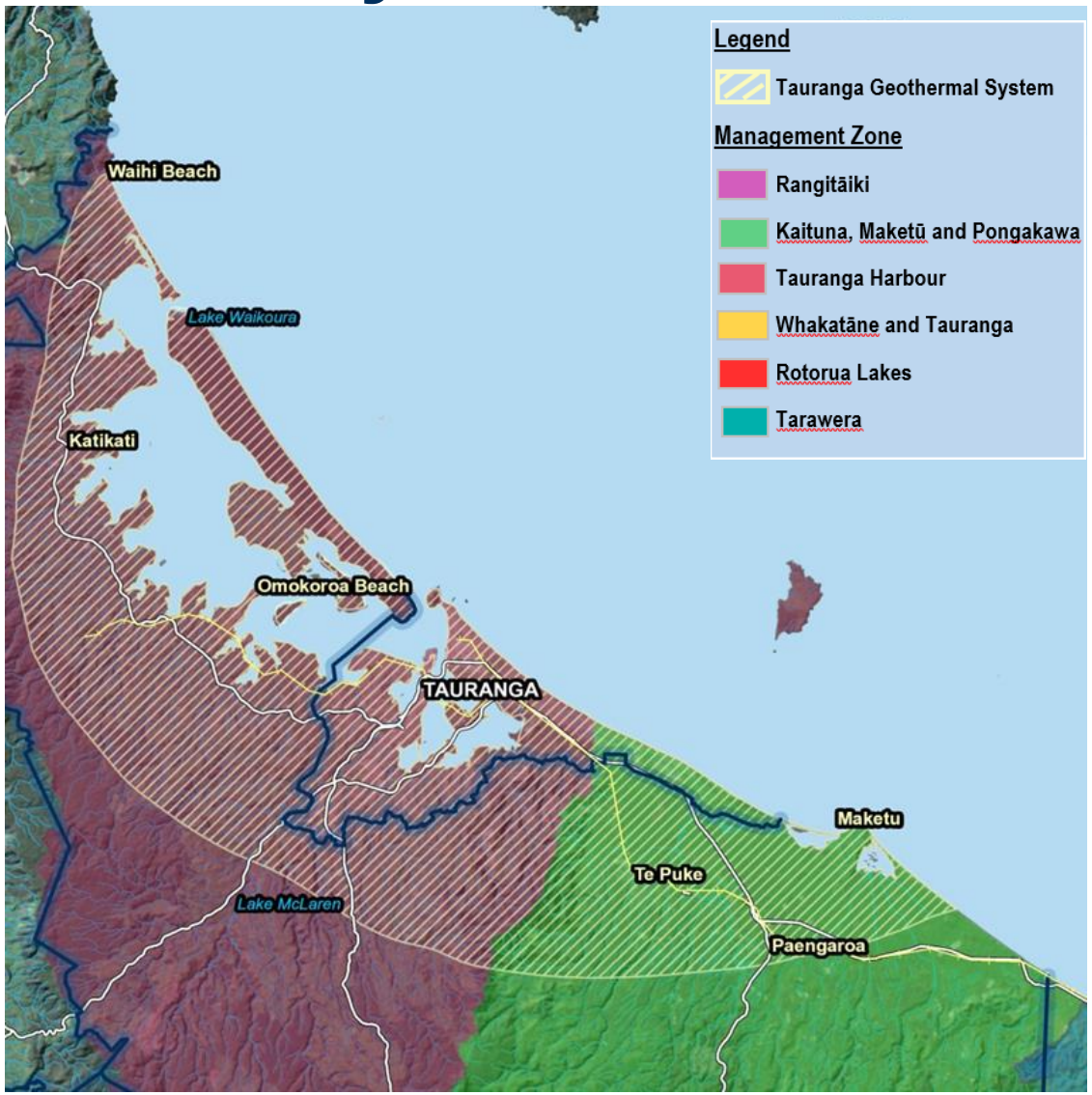
Groundwater and Saline Intrusion

- Fresh water is less dense than salt water
- Maintaining coastal outflow prevents saline intrusion / contamination of the aquifer with salt water
- If too much water is taken the saline ‘wedge’ can move inland



Tauranga Geothermal System

- Geothermal water ≥ 30°C
- Concentrated @ Tauranga
- Fresh water heated by conduction
- Few, if any surface water features
- Uses: heating, irrigation, frost protection



Potential Effects of Groundwater Use

- Reduce groundwater levels
- Reduce flows/levels in surface water bodies
- Saline intrusion
- Geothermal temperature change
- Effect may be spread over a large area and long-period (years), or localised and more immediate
- Groundwater takes have less effect on surface water bodies than a take directly from a surface water body

3.
Modelling

Introduction to modelling

What is a model?

It is a representation of a more complex system.

Why use a model (depending on the type)?

- Education
- Understand the system
- Make estimations – Allocation available
- Management options
- What-if type question

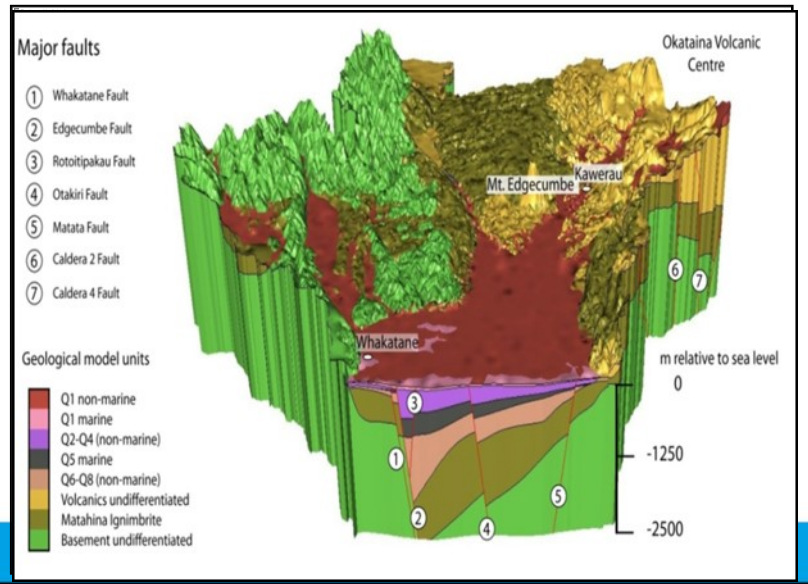
Types of models

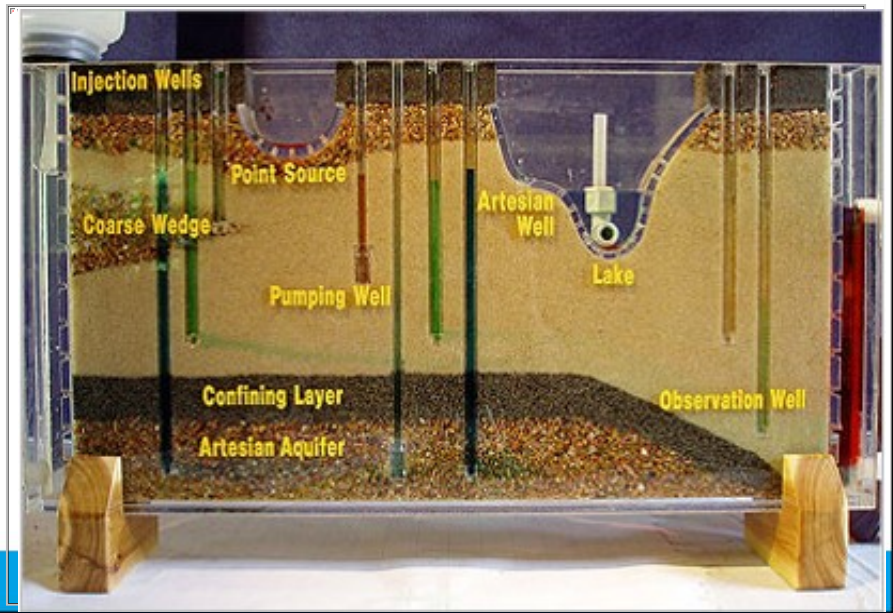
Physical

Geological Model

Mathematical

- Statistical – Q_5.
- Analytical – Mass Balance, Stream depletion calculations, regression equations.
- Numerical – MODFOW, FEFLOW.





Groundwater Resource Assessment

Water Balance

- Simple
- Based on limited data
- Qualitative assessment/estimates of hydrological effects

3-D Groundwater Modelling

- More complex / greater confidence
- Model developed & scenarios run
- Model results inform limit setting choices
- Quantitative assessment of hydrological effects

Current GNS Mass Balance Model

- Meet needs at the time (2009)
- Used for PC9 interim allocation limits
- Basis for current allocation
- Few options to explore scenarios

Groundwater Balance

Recharge: rainfall – evapotranspiration – run-off

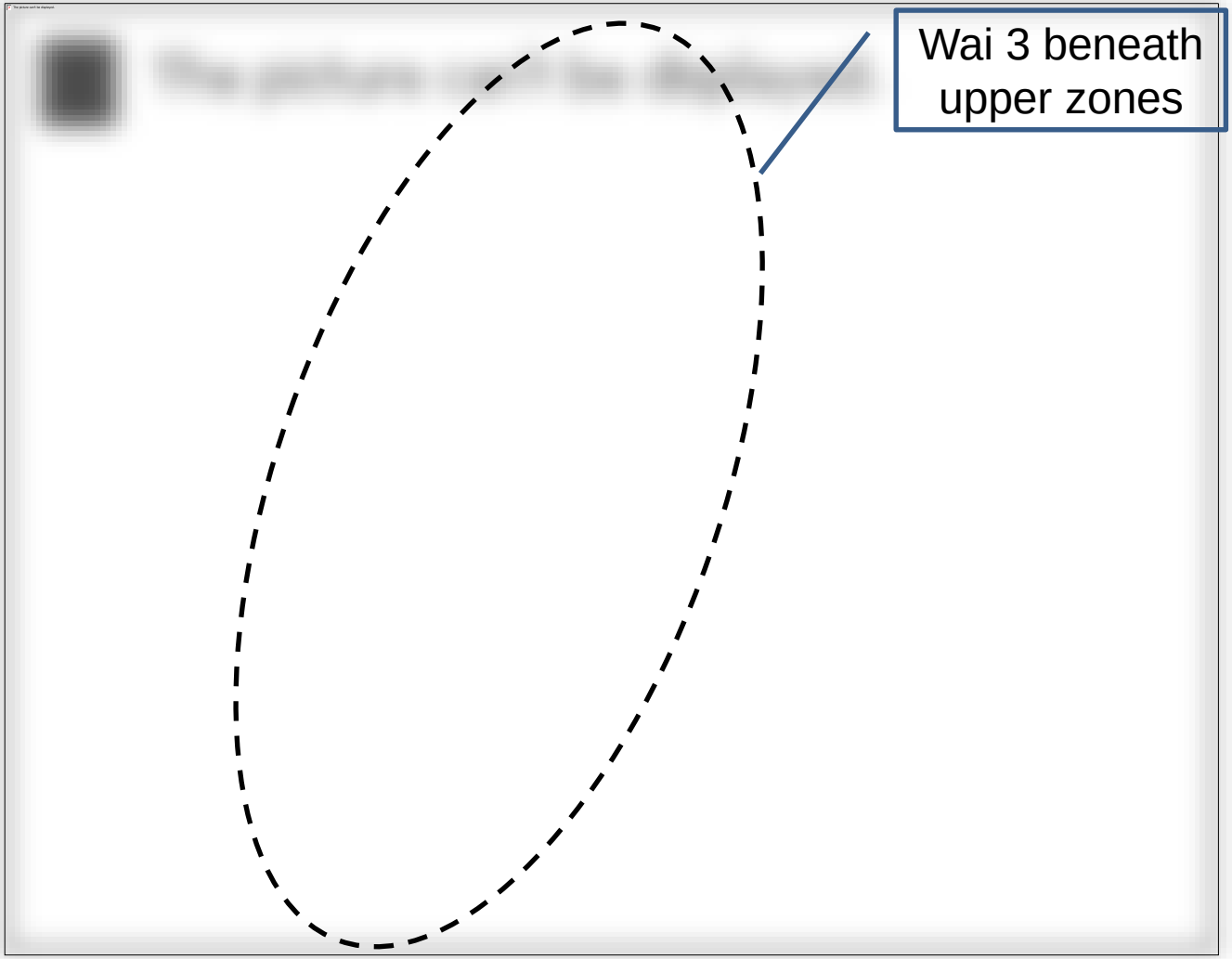
Residual recharge (GAA): recharge – base-flow to streams

Current Limit: 35% of residual recharge (GAA)

Conservative to broadly protect base flows … but this is not measured/modelled

Groundwater Management Zones

- Limits for each zone
- Assumes no groundwater movement between zones



Current Allocation KPW

Layer	Management Zone	Interim Limit m^3/y (35% GAA)	Allocated m^3/y	% Allocated
Upper	Lower Kaituna (Plains)	5,651,251	6,094,020	107.8
	Maketu	154,526	0	0
	Mangorewa	0	22,285	N/A
	Lower Kaituna (Hills)	0	972,120	N/A
Lower	WAI3 Ignimbrite	3,874,198	6,431,806	166
Other	Kaikokopu-Pokopoko-Wharere	15,938,294	13,354,014	83.8
	Pongakawa	3,267,130	1,348,108	41.3
	Otamarakau	209,714	0	0
	Waitahanui	3,123,641	1,918,964	61.4
	Pukehina Beach	110,376	0	0
	Ohinepanea	3,388,543	1,481,136	43.7
	Pukehina	838,858	585,000	69.7
	Newdicks	242,827	97,780	40.3
Total		36,799,358	32,298,401	

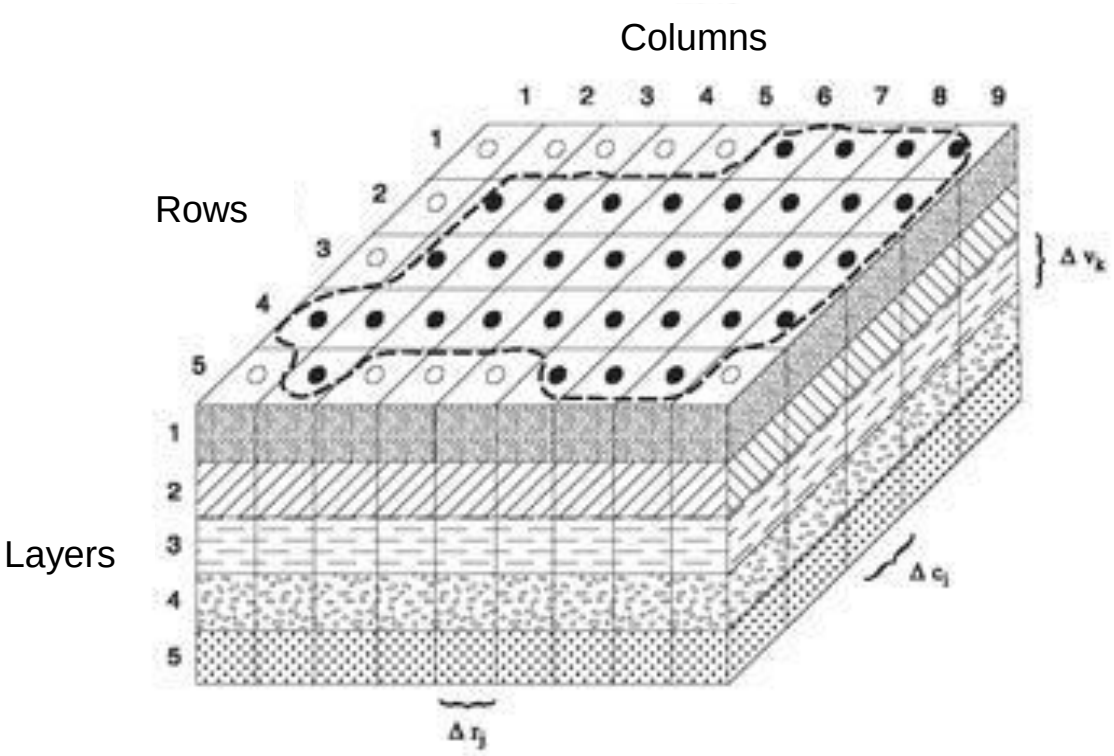
KPW MODFLOW Model

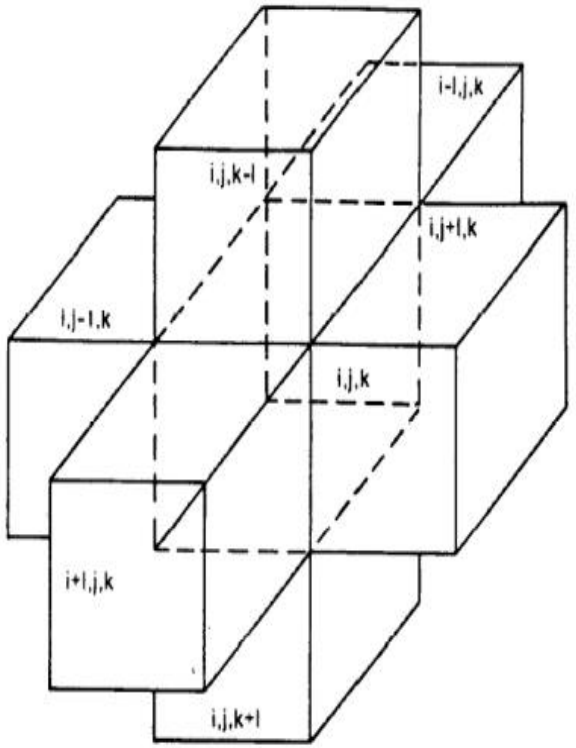
A numerical groundwater model chosen because:

- Public domain (free license)
- Open source (anyone can view the source code)
- Well documented & well proven

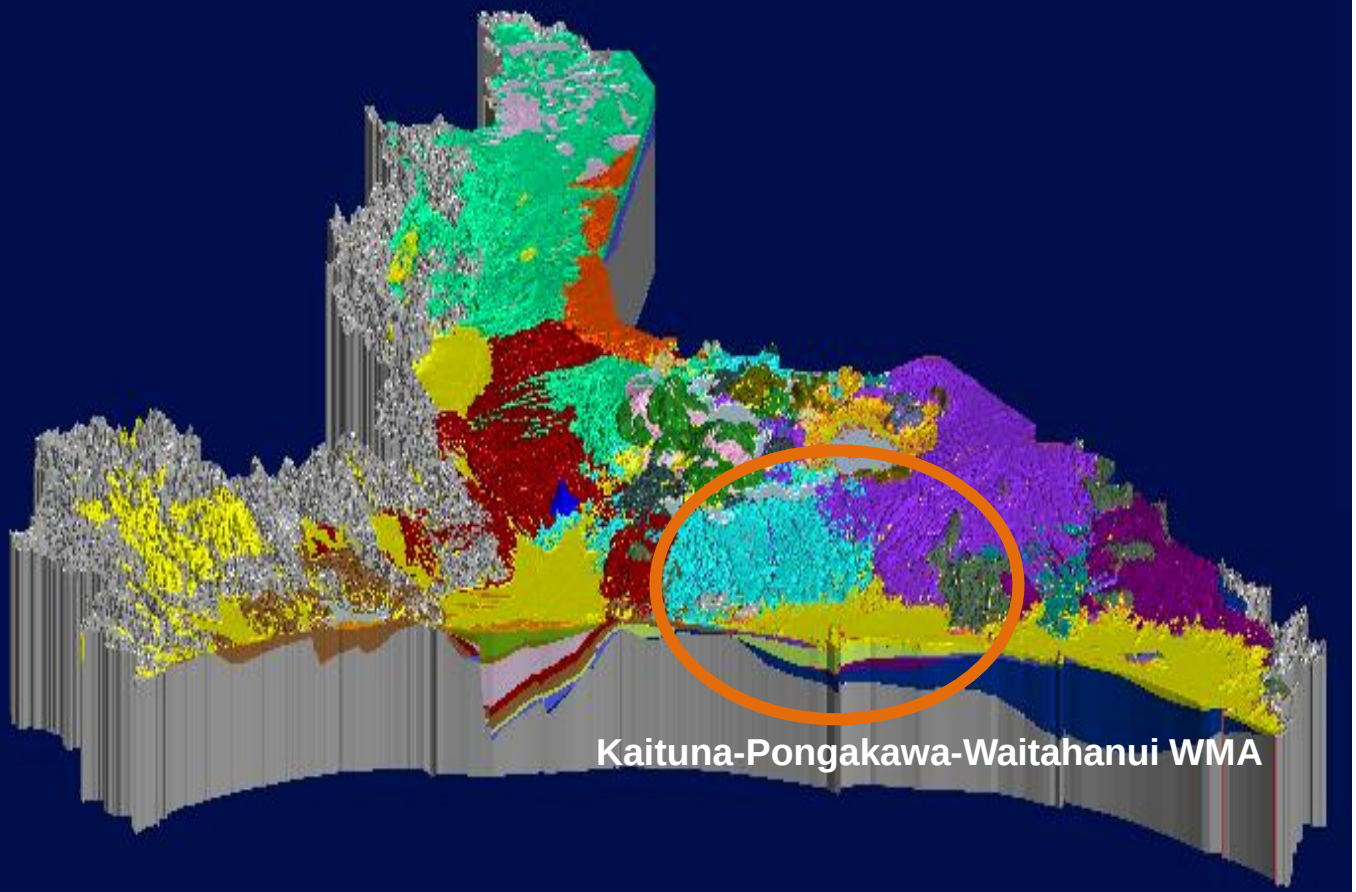
Model purpose - to inform decisions about appropriate levels of groundwater allocation

MODFLOW

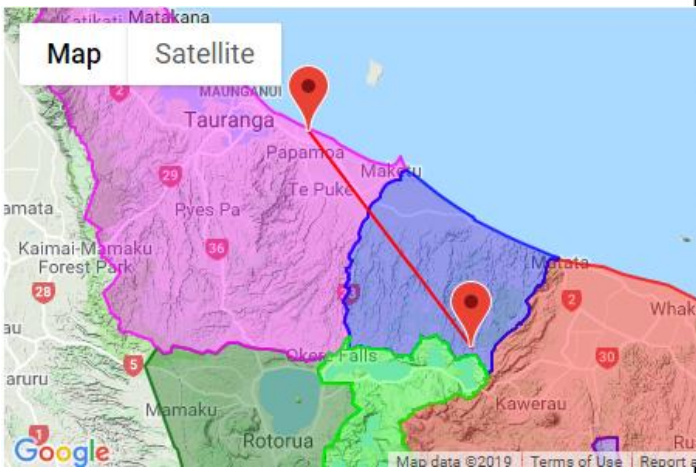

Columns
Rows
Layers
1 2 3 4 5 6 7 8 9
1 2 3 4 5
1 2 3 4 5
Δ v_k
Δ c_j
Δ r_j

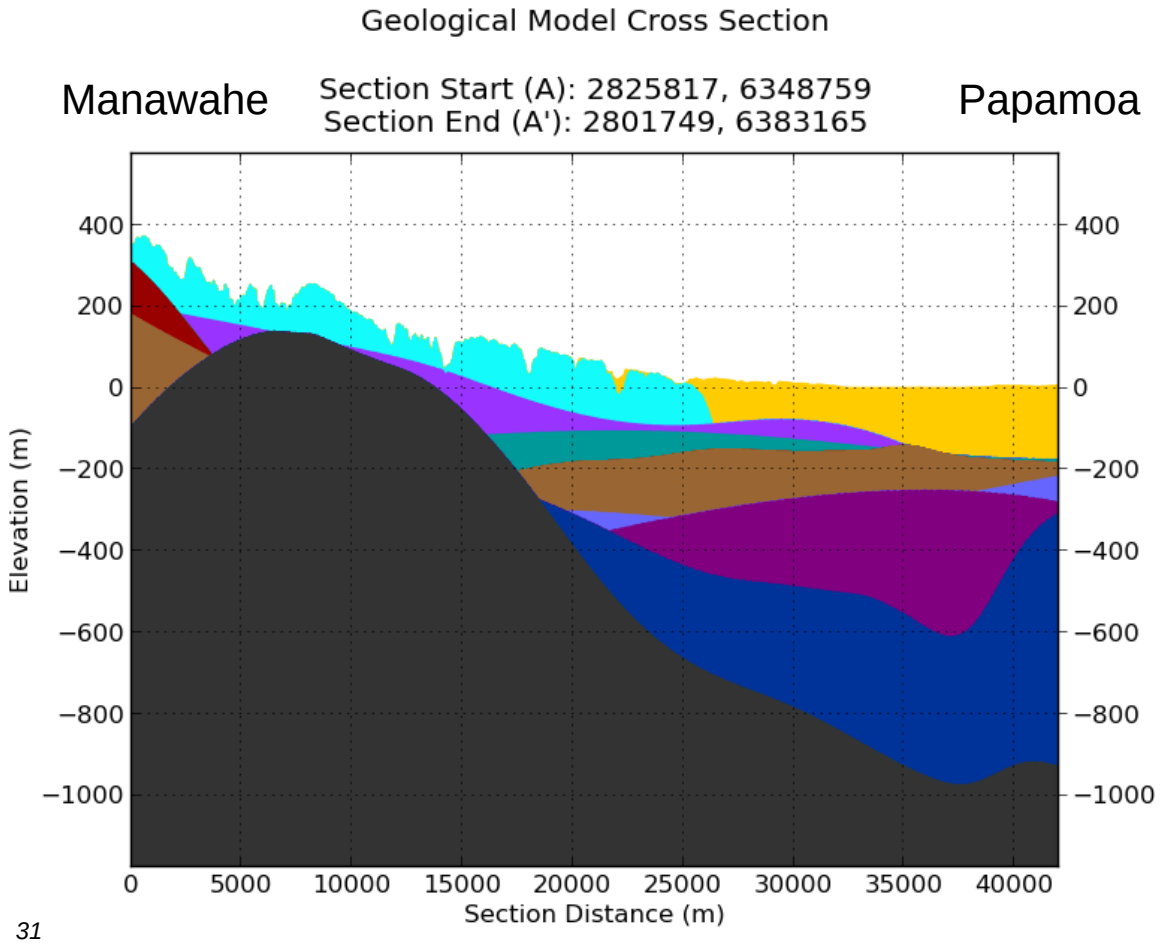

i-1,j,k
i,j,k-1
i,j+1,k
i,j-1,k
i,j,k
i+1,j,k
i,j,k+1

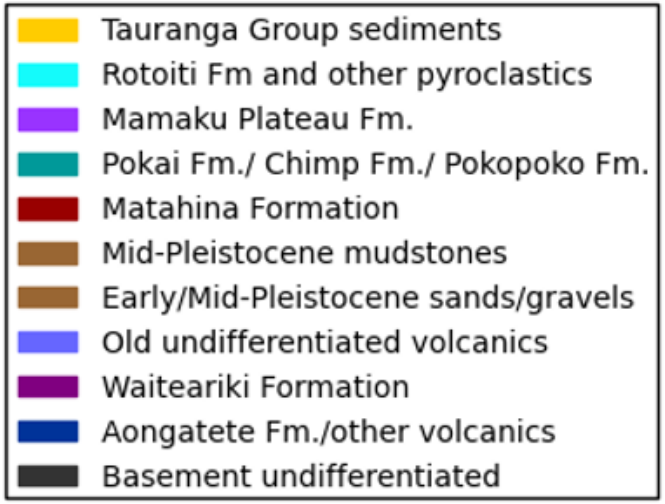
Bay of Plenty Geological Setting



Building a MODFLOW Model: Geological Layers



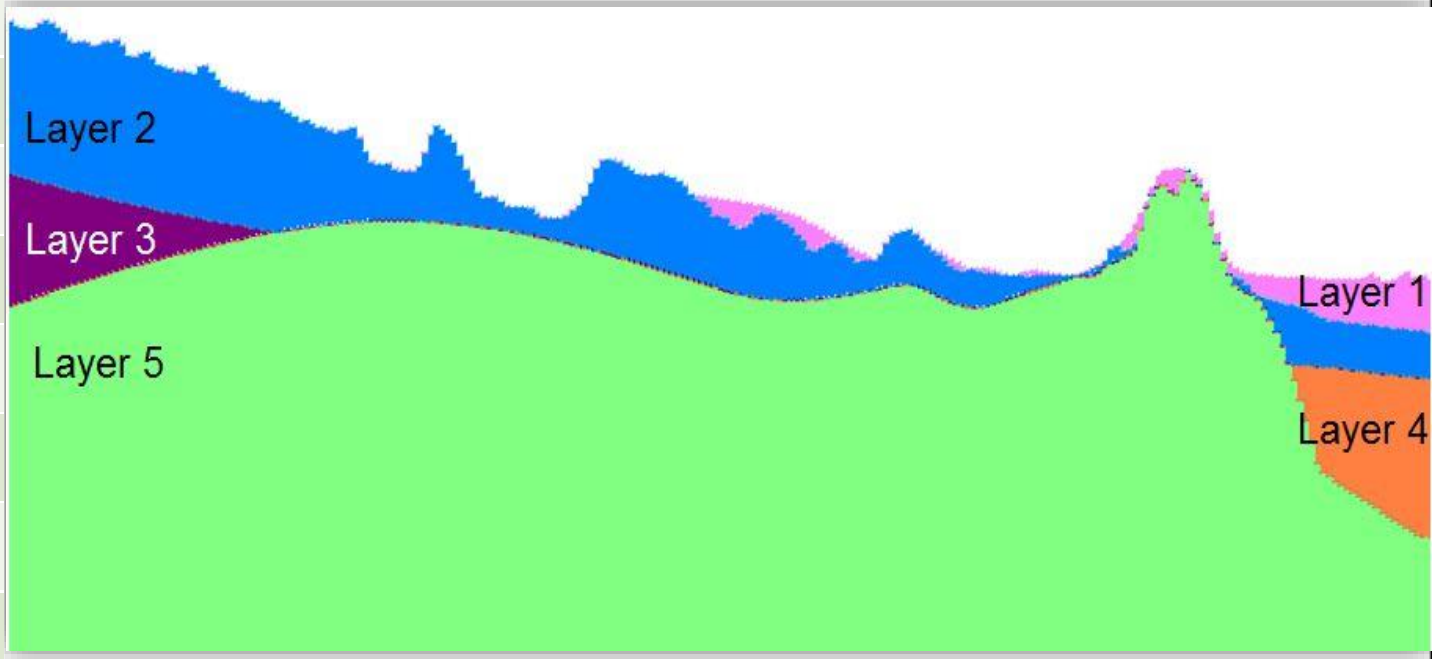




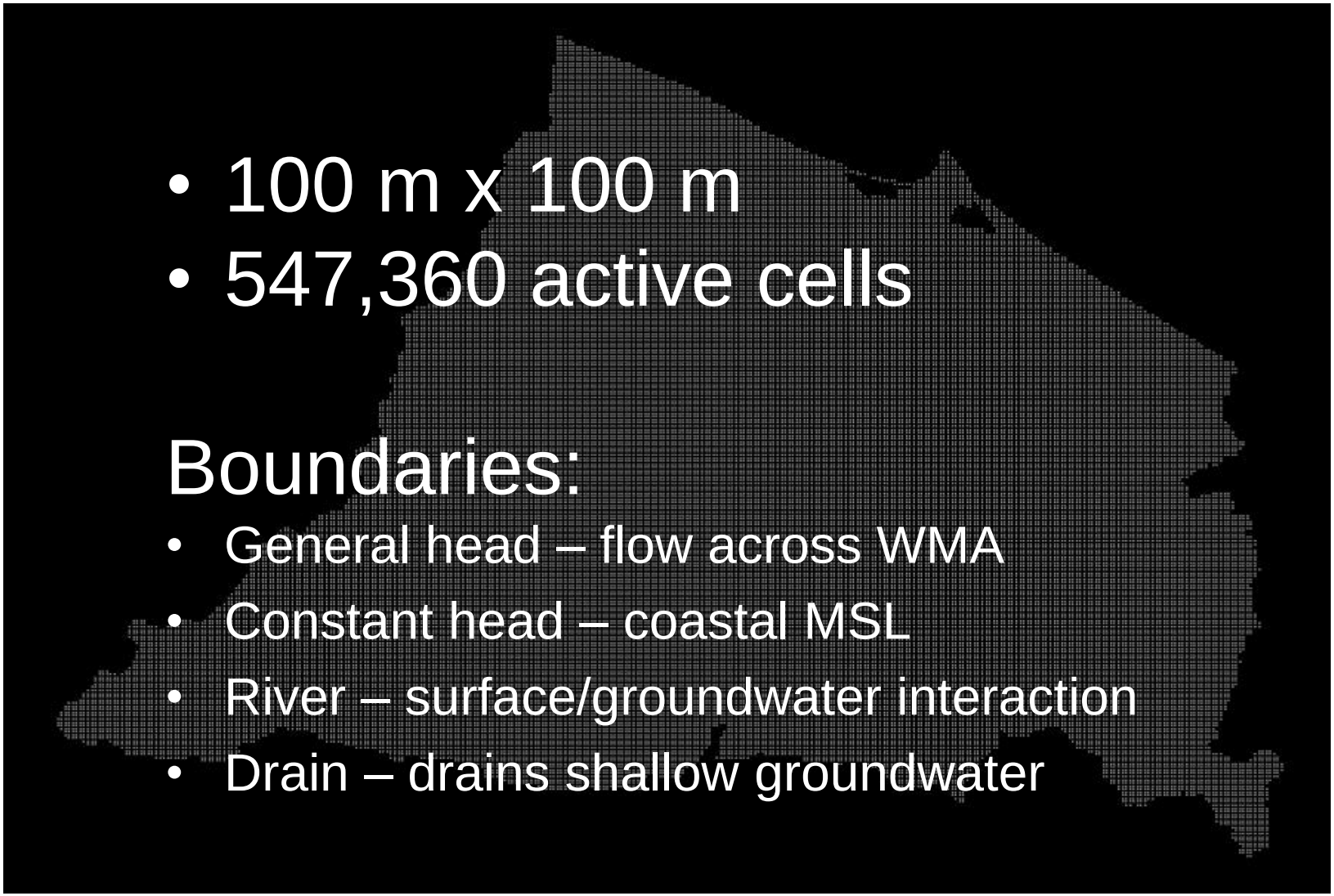
Model layer	Hydro-geological unit	Geological unit
1	Tauranga Group	Tauranga Grp (alluvium)
2	Upper volcanics	Rotoiti Formation
		Mamaku Plateau Formation
		Rotorua Rhyolites
		Pokai-Chimp Formation
		Matahina Formation
3	Mudstone	Tauranga Grp (mudstone)
4	Sand & Gravel	Tauranga Grp (sand & gravel)
5	Lower volcanics	Older volcanics
		Waitearikl Formation
		Whitianga Group
		Aongatete Formation
		Kaimai Subgroup

Building a MODFLOW Model: Conceptual Model

Section (south-north) showing model layers



Numerical model design

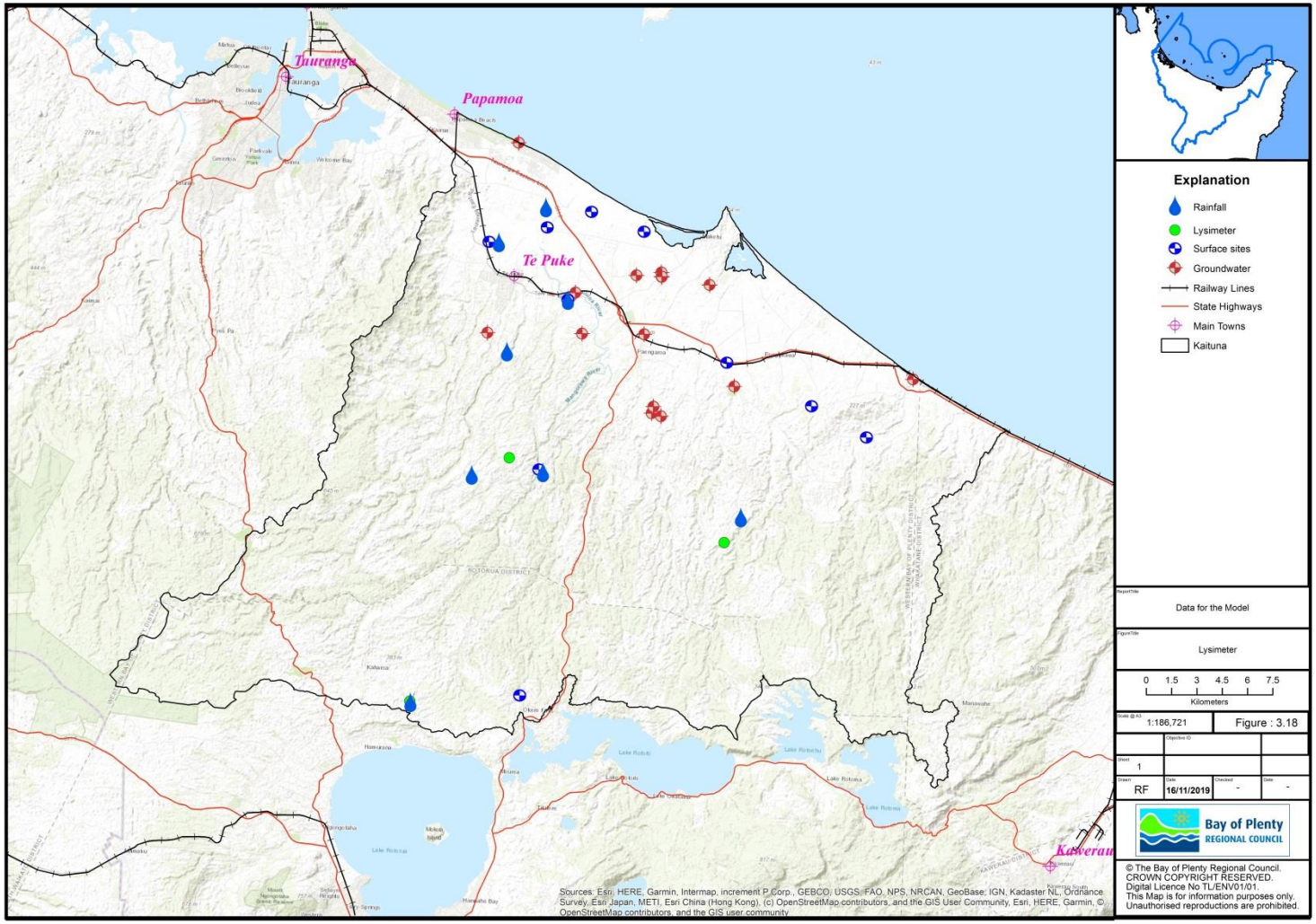


- 100 m x 100 m
- 547,360 active cells

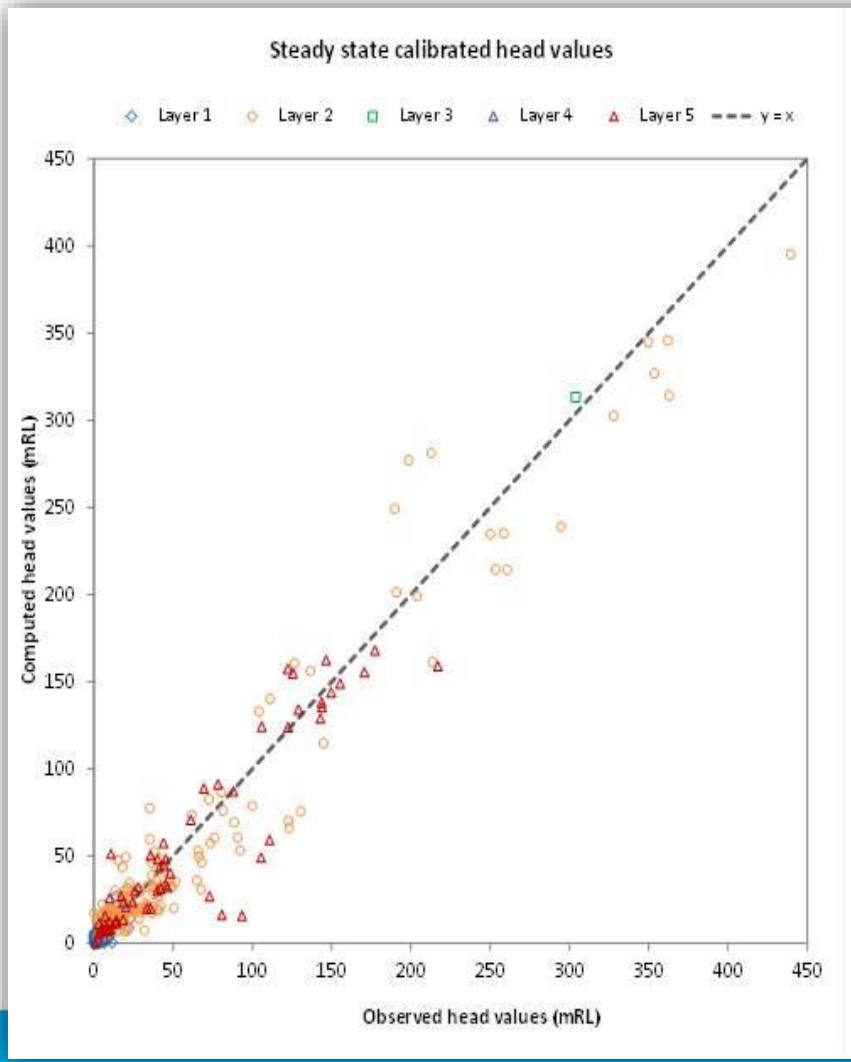
Boundaries:

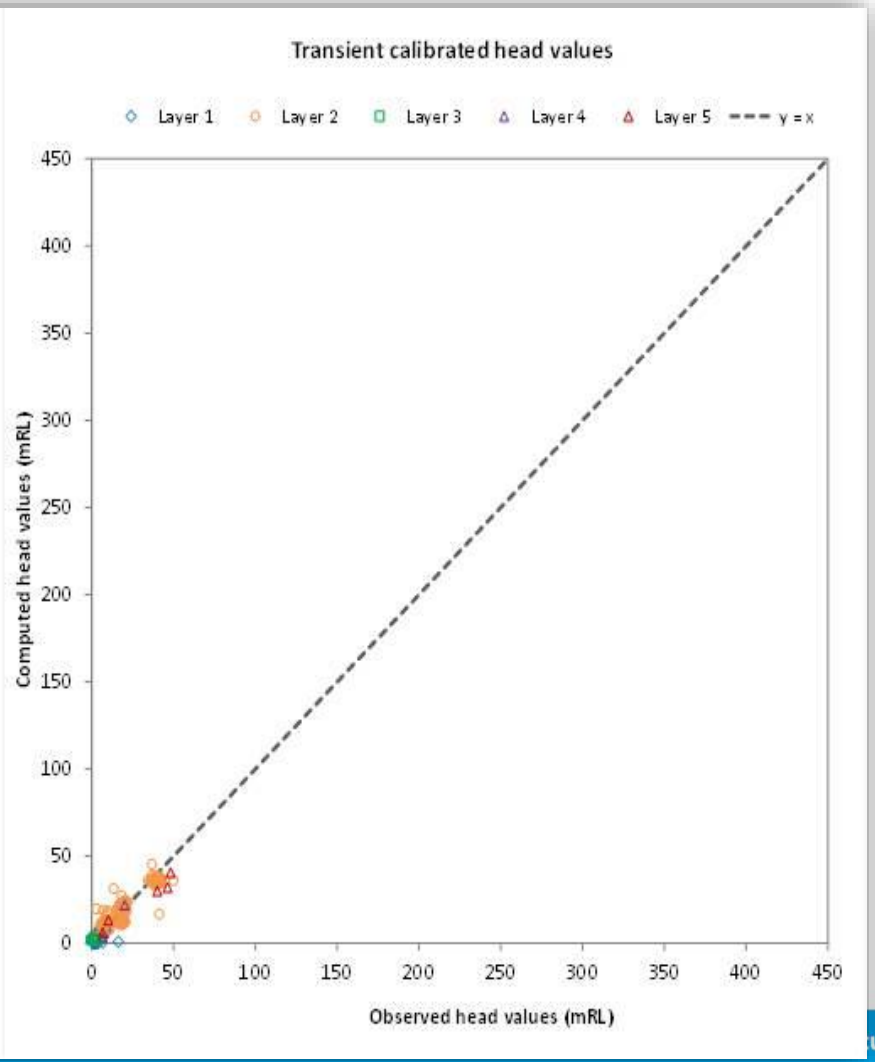
- General head – flow across WMA
- Constant head – coastal MSL
- River – surface/groundwater interaction
- Drain – drains shallow groundwater

Data Available

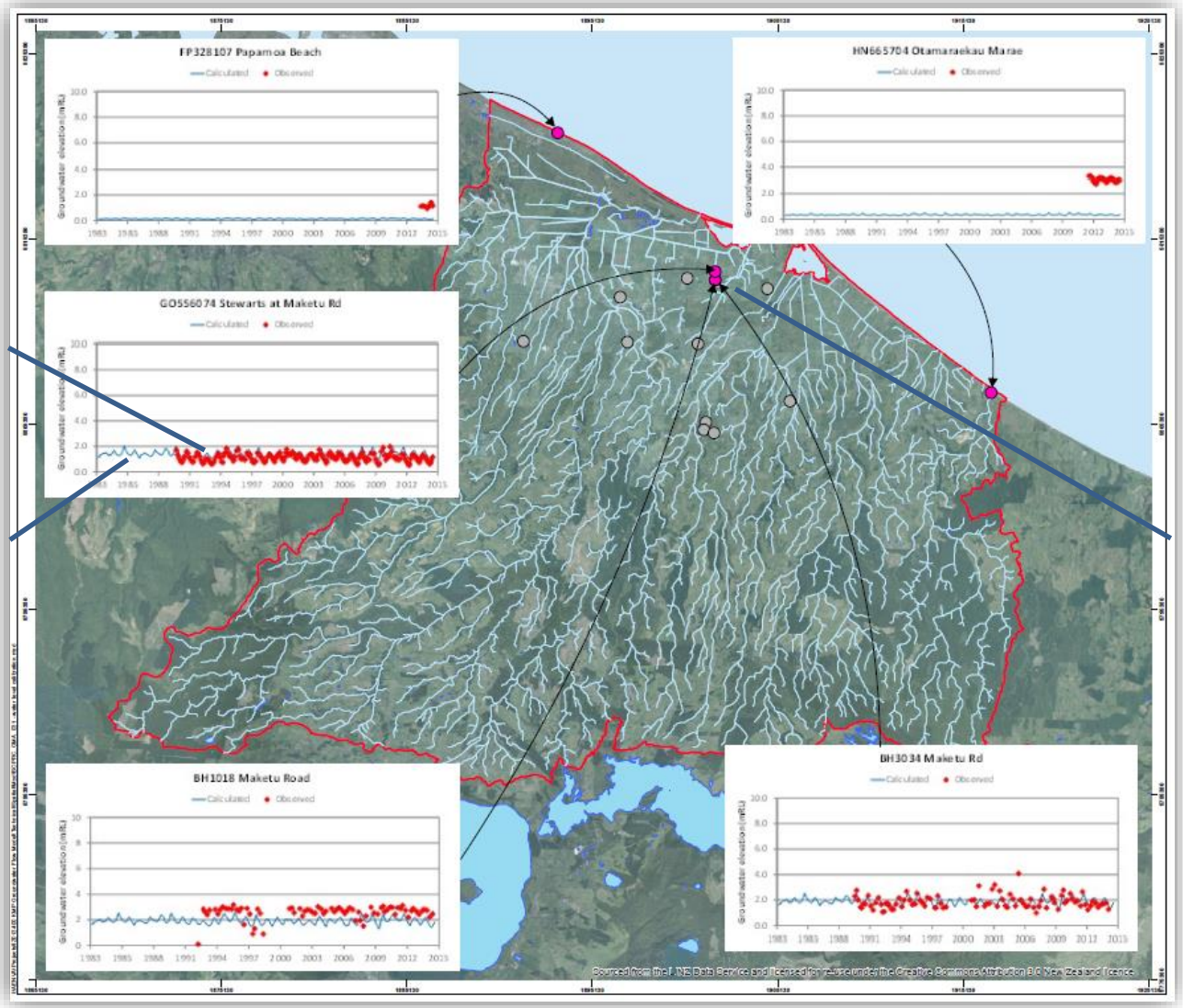


Building a MODFLOW Model: Calibration





Building a MODFLOW Model: Calibration Groundwater Levels 1983-2015



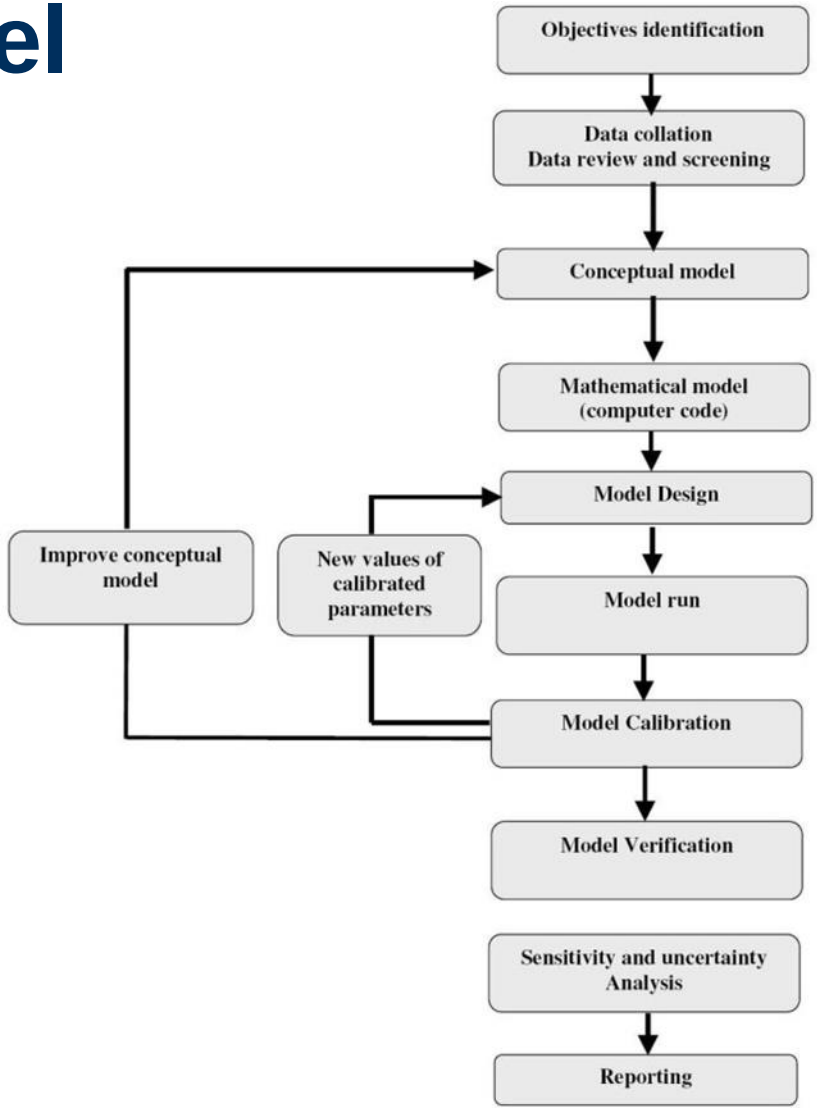
Measured

Calculated

Monitoring Bores

KPW MODFLOW Model

Not designed for	Designed for
Local effects	Volume – allocation limit
Use by individual well owner	Climate (rainfall) change scenarios
Individual scale environmental impact - applicant still needs AEE	What if scenarios **– regional scale**



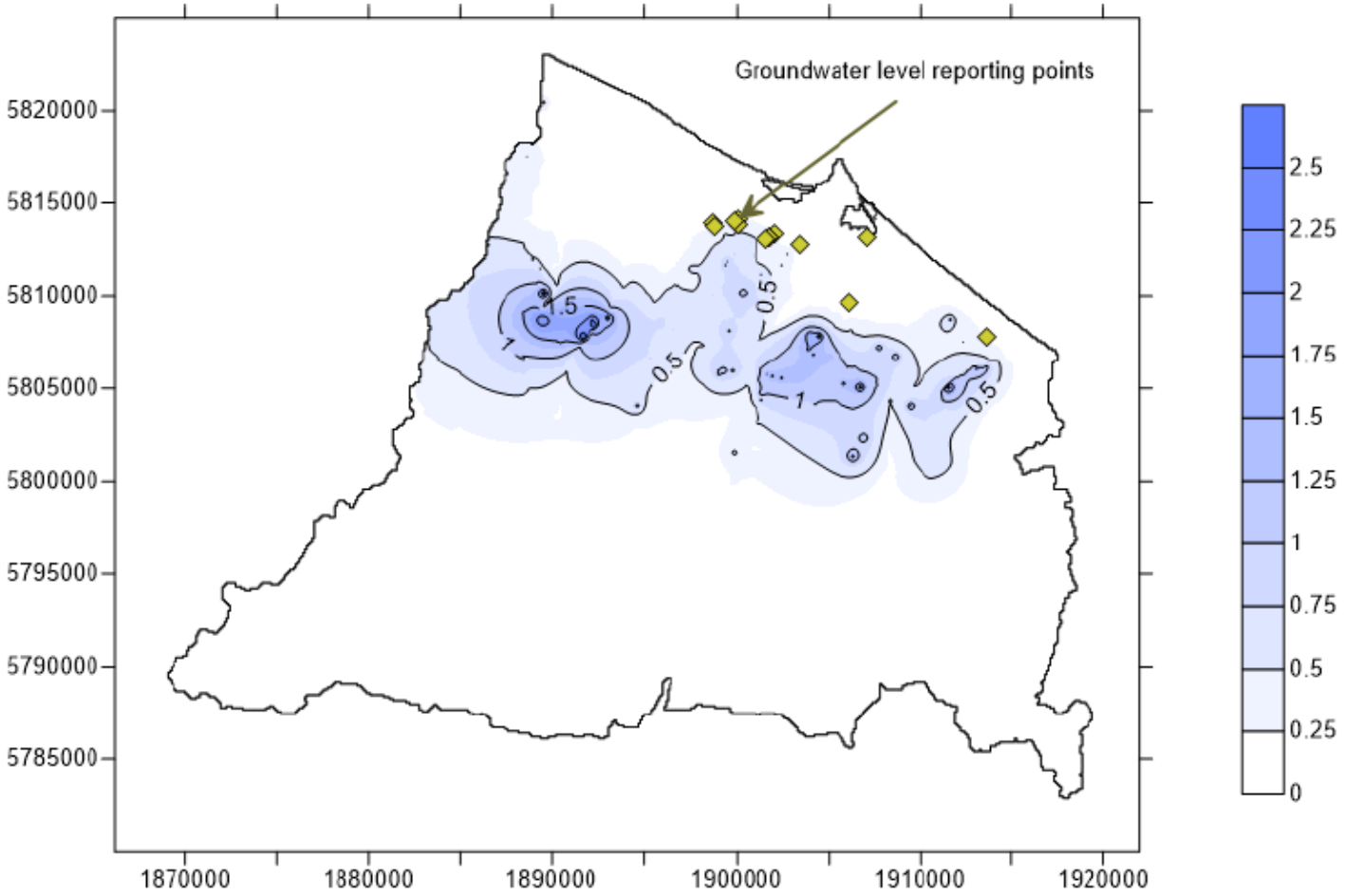
Kaituna MODFLOW Model

Built to Class 2 Confidence Level Australian Groundwater Modelling Guidelines

- Suitable for allocation limit setting

Key highlights

- Current allocation - little regional groundwater level impact
- Some localised cumulative drawdown
- Options for dynamic modelling approach


Groundwater level reporting points
5820000
5815000
5810000
5805000
5800000
5795000
5790000
5785000
1870000
1880000
1890000
1900000
1910000
1920000
1.5
1
0.5
0.5
1
0.5
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0

KPW MODFLOW Model Options

Key criteria:

- Safeguard base-flow
- Avoid saline intrusion

Options A & B consider:

- Current state
- Climate change predictions
- Land use change (infiltration)

Options C considers:

- Management zones
- Different spatial allocation

4.
Groundwater Values, Uses & Objectives

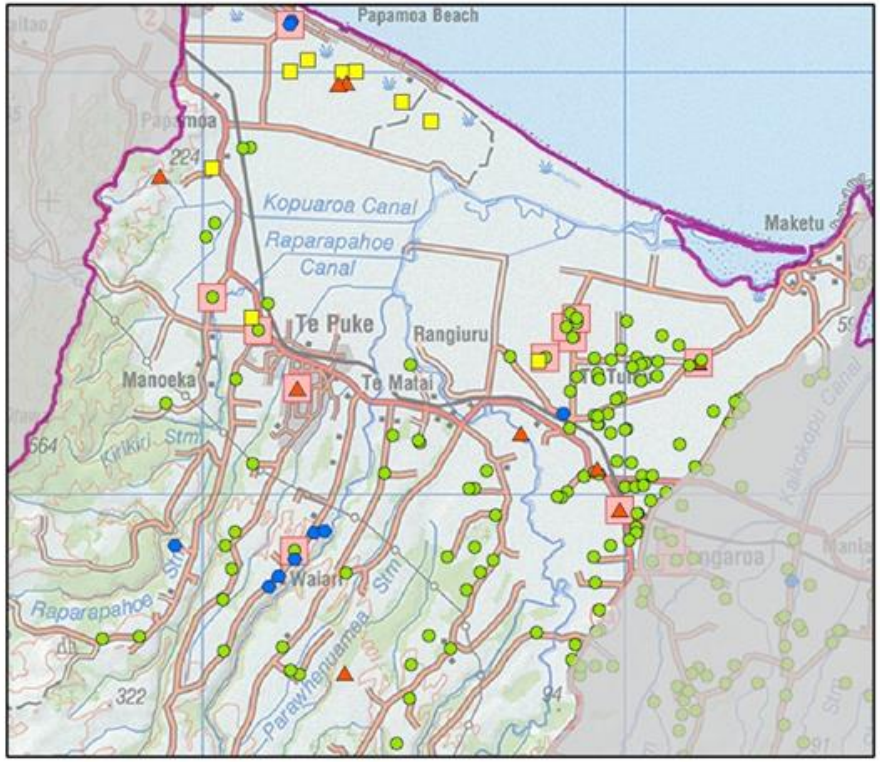
Providing for Values and Use

- Base-flow to rivers / springs
- Quality (saline intrusion)
- Geothermal temperature
- Mauri
- Use
  - Irrigation
  - Commercial and industrial uses
  - Water supply (animal drinking, domestic, municipal)
  - Heating

Provide for your values?

Are there others?

Kaituna-Maketu & Waiari: Groundwater take consents



Legend

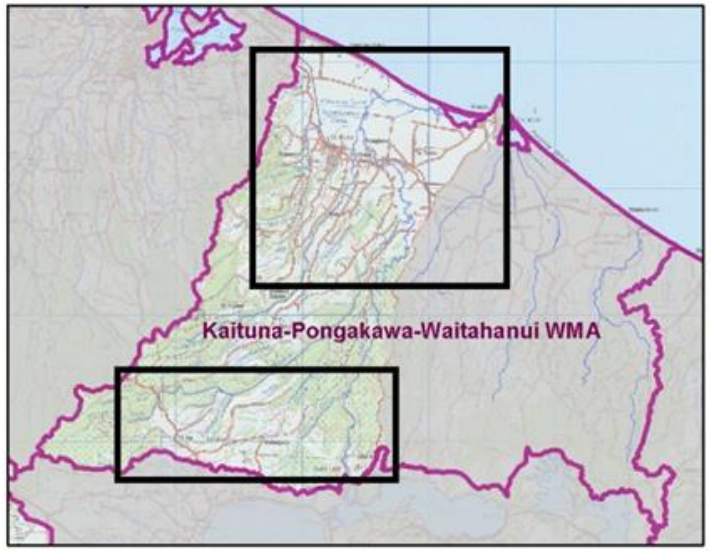
Purpose (simple)

- Commercial / Industrial
- Municipal/community/domestic
- Other
- Irrigation / frost protection

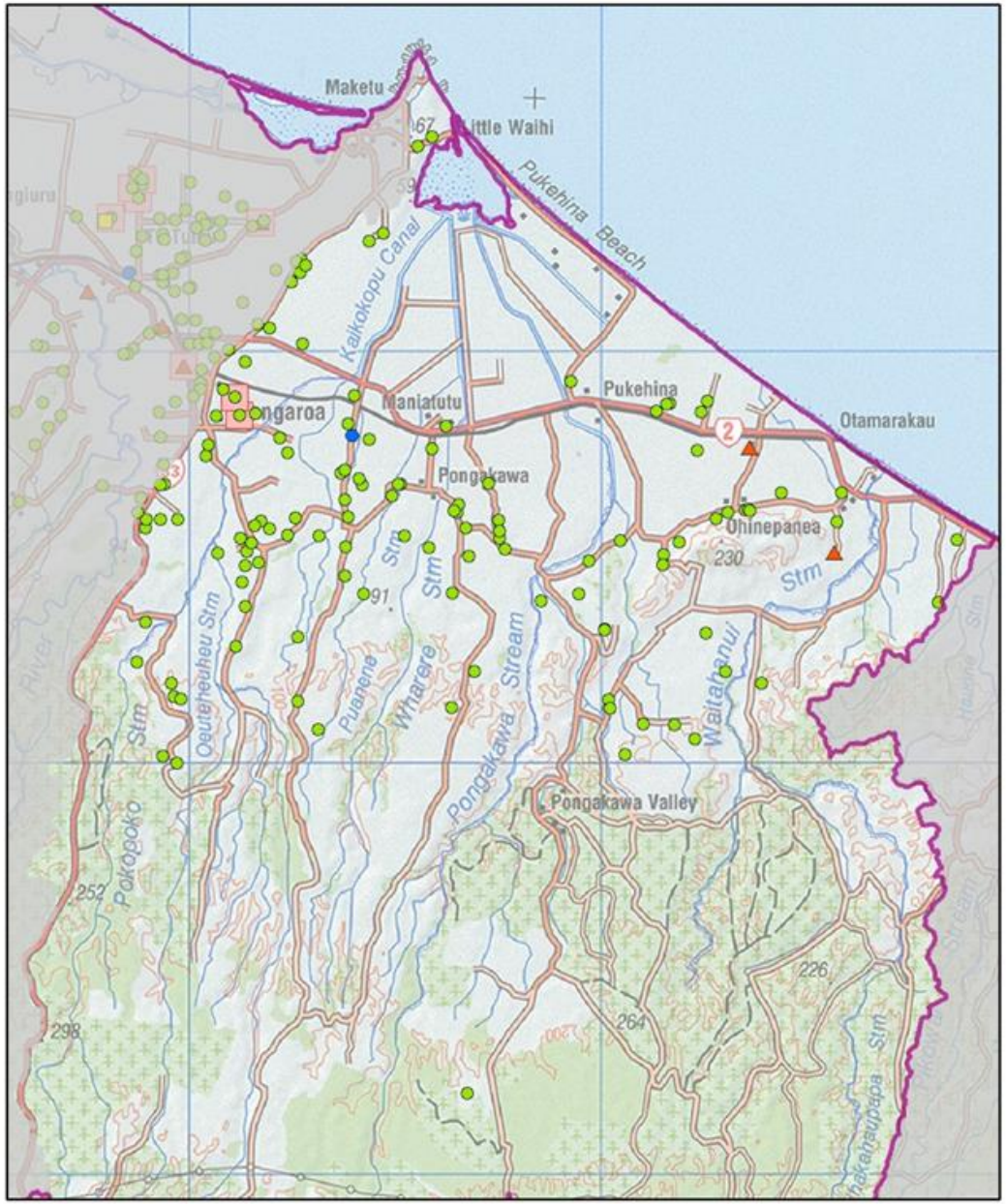
Category

- Geothermal

N



Pongakawa-Waihi & Waitahanui: Groundwater take consents



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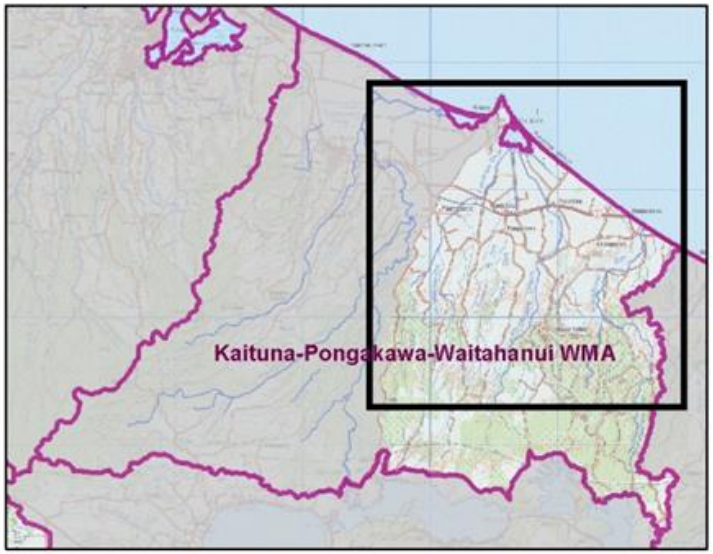
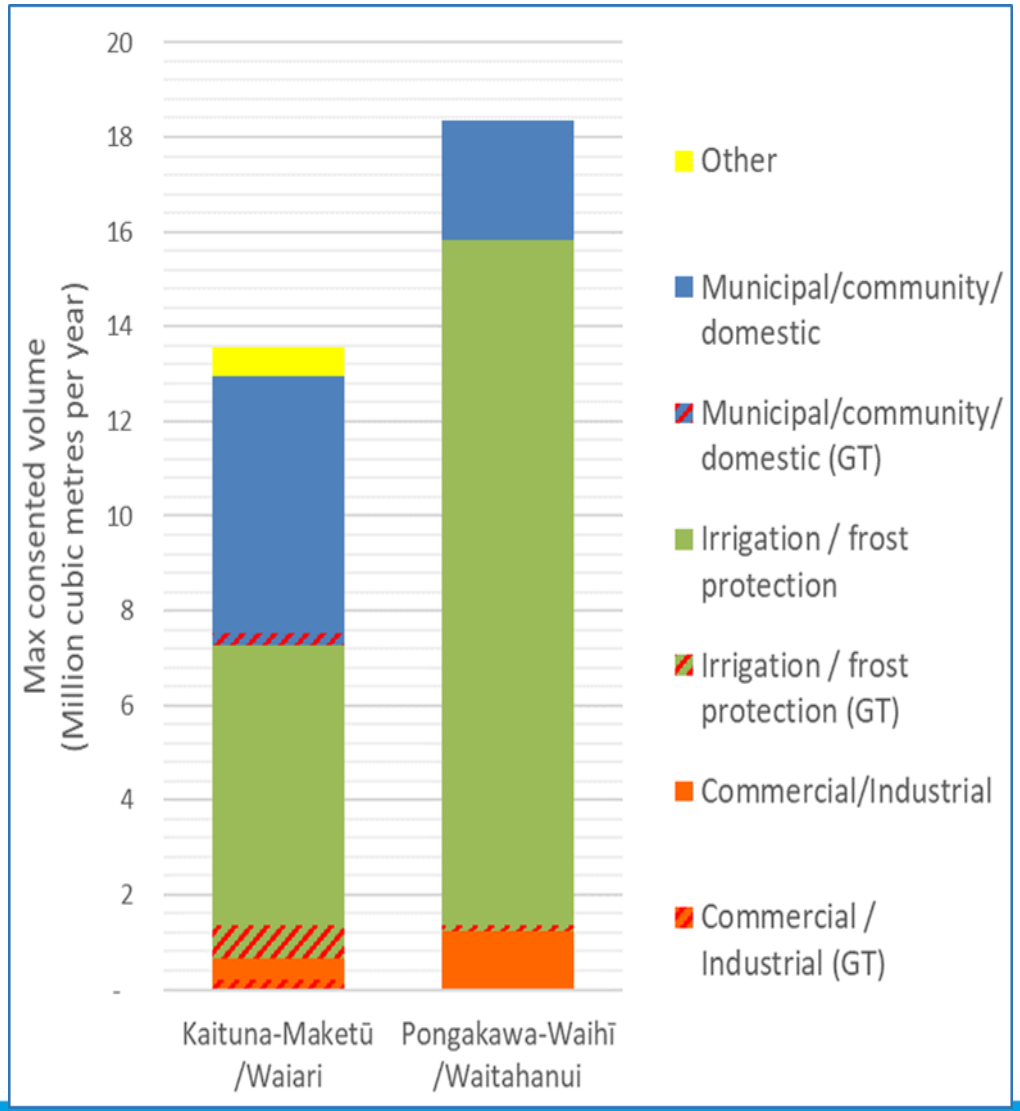
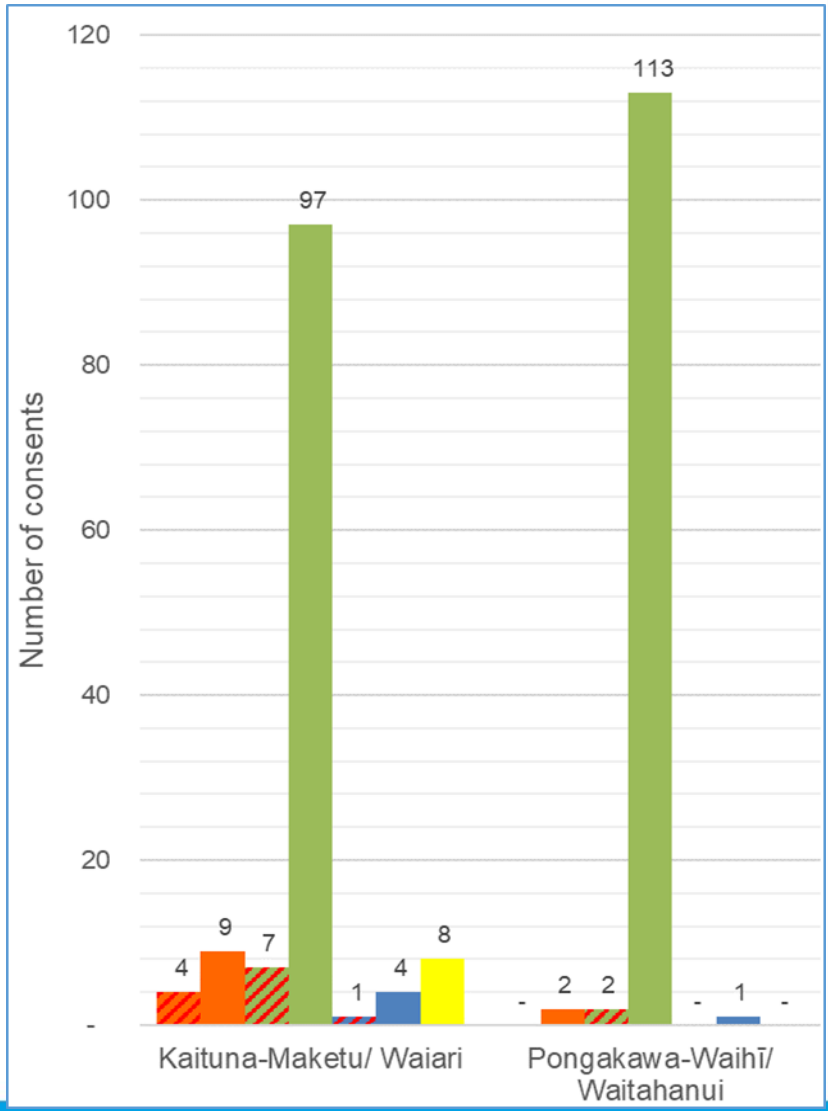


Kaituna-Pongakawa-Waitahanui WMA

Groundwater allocation and number of consents by FMU (including geothermal [GT])





Possible Future Land Use Kaituna Maketū Waiari

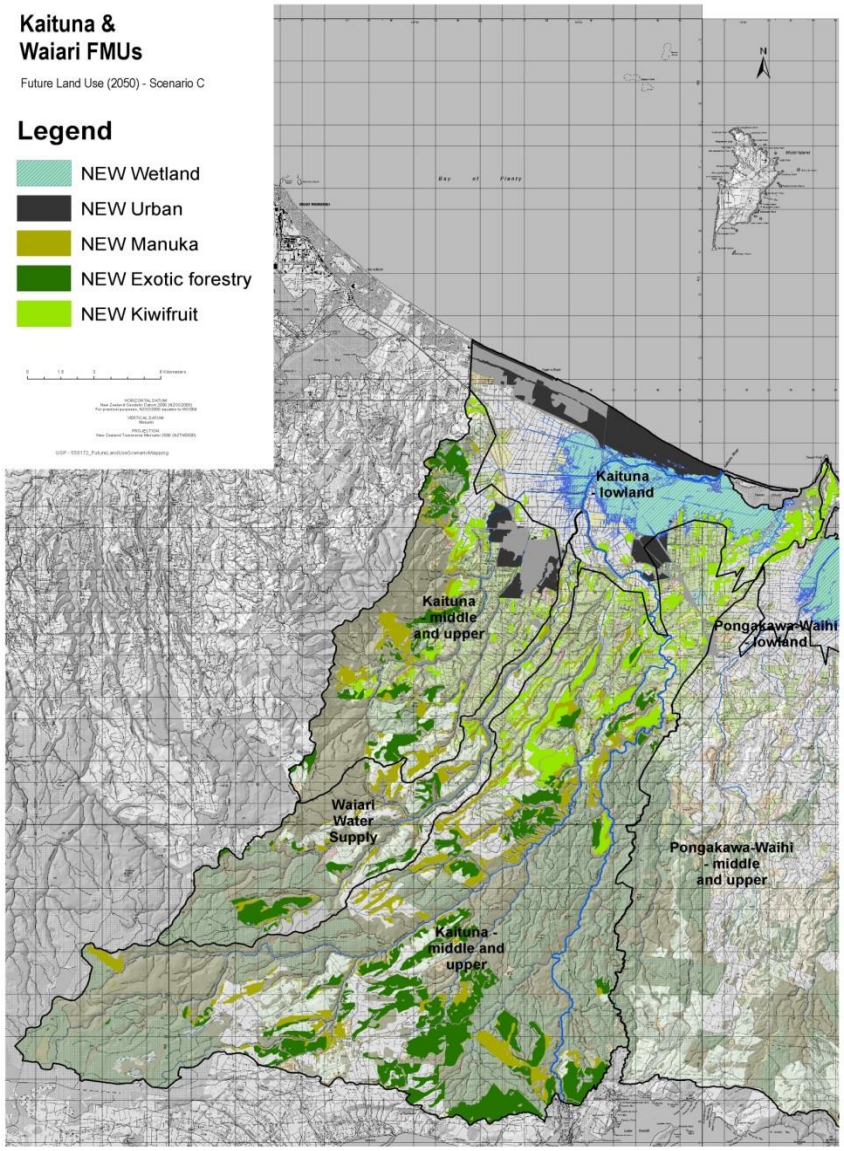
Developed with land managers, industry, & Community Group

Urban growth

Kiwifruit
+678 ha

Horticulture
+33 ha

Dairy
-36 ha



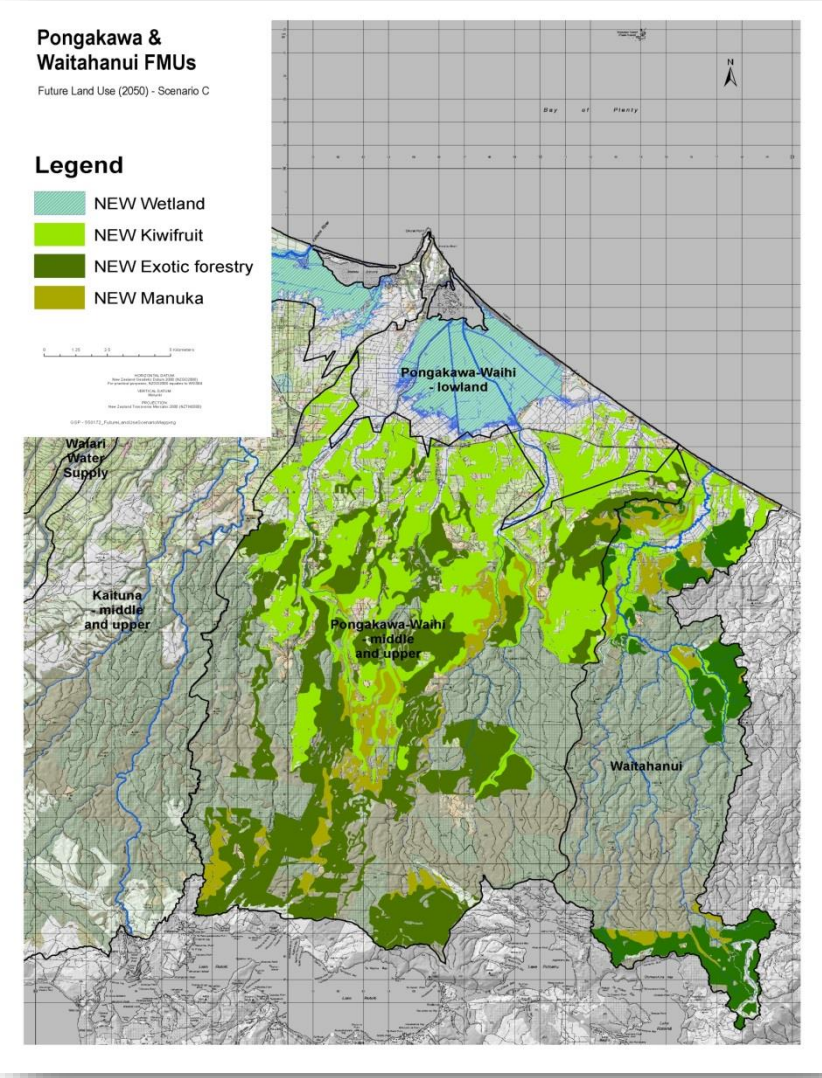
Possible Future Land Use Pongakawa Waihī Waitahanui

Developed with land managers, industry & Community Group

Kiwifruit
+5,593 ha

Horticulture
+9ha

Dairy
-1,337 ha



Groundwater Objectives

Appropriate?

- Maintain groundwater levels
- Safeguard spring flow, base-flow, connected wetlands
- Prevent saline intrusion – protect water quality
- Manage degree and rate of geothermal temperature change
- Sustain Mauri

Groundwater limits

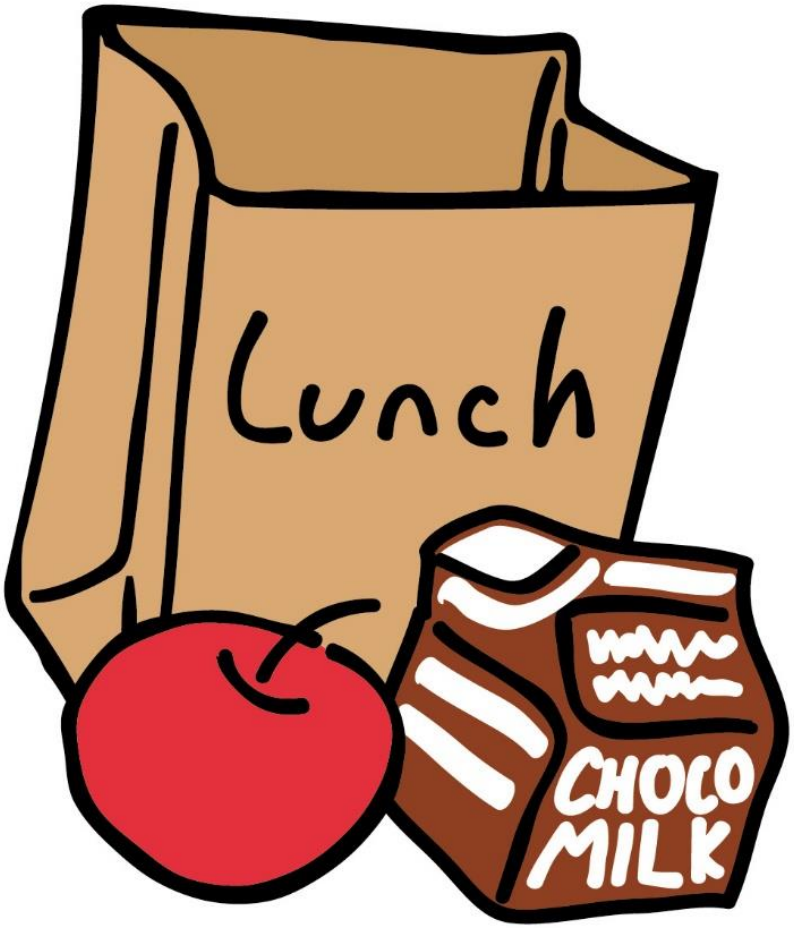
- Groundwater is available for use, *subject to the above*

Others?

Groundwater Limits

- **Different approaches to sub-regional and local effects**
- **Allocation limit:**
  - maximum amount taken from whole resource (or sub unit)
  - safeguards resource as whole
  - safeguards stream base flow/spring flow & connected wetlands
  - Manage degree/rate of temperature change
  - doesn't address local effects of individual water takes
- **Resource consent conditions:**
  - address local effects of individual water takes
  - e.g., effects on wetlands, springs, rivers, water quality, temperature

Lunch



5. Scenarios and Results

Uncertainty

Scientific uncertainty

- Science work e.g. modelling
- Information to support science work e.g. data

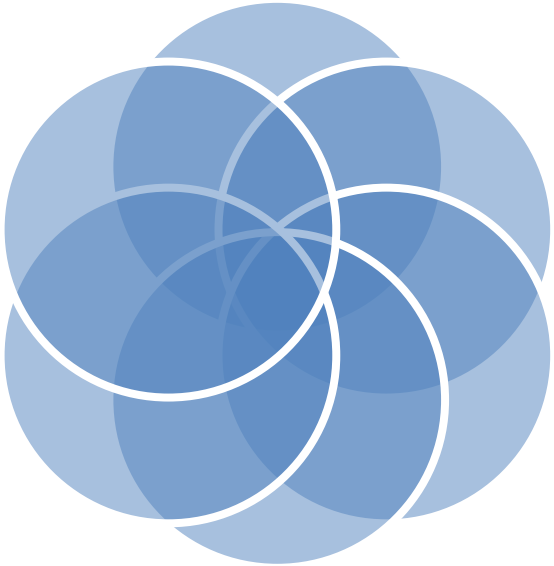
Implementation uncertainty

- Interpretation & implementation of the scientific work

Modelling and Uncertainty

Important tools / simplify reality

Different models for different purposes



All have limitations & uncertainty

Improve understanding / inform decisions

Use available information (always gaps)

Direct measurement usually impossible

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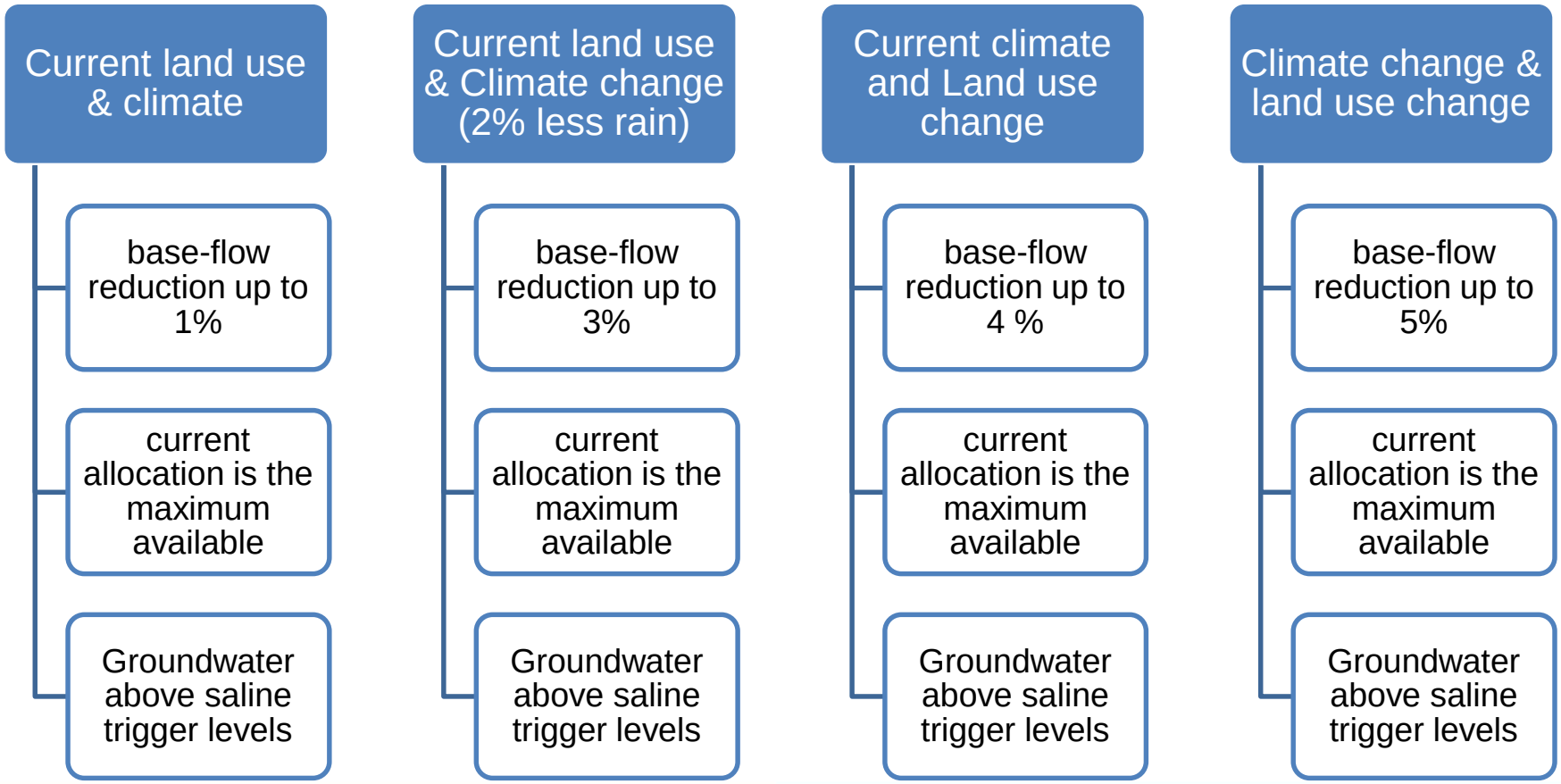
- Management zones
- Different spatial allocation

Soon, we will be asking….

- Your preferred option
- Your level of comfort with others
- Your reasonings
- Others?

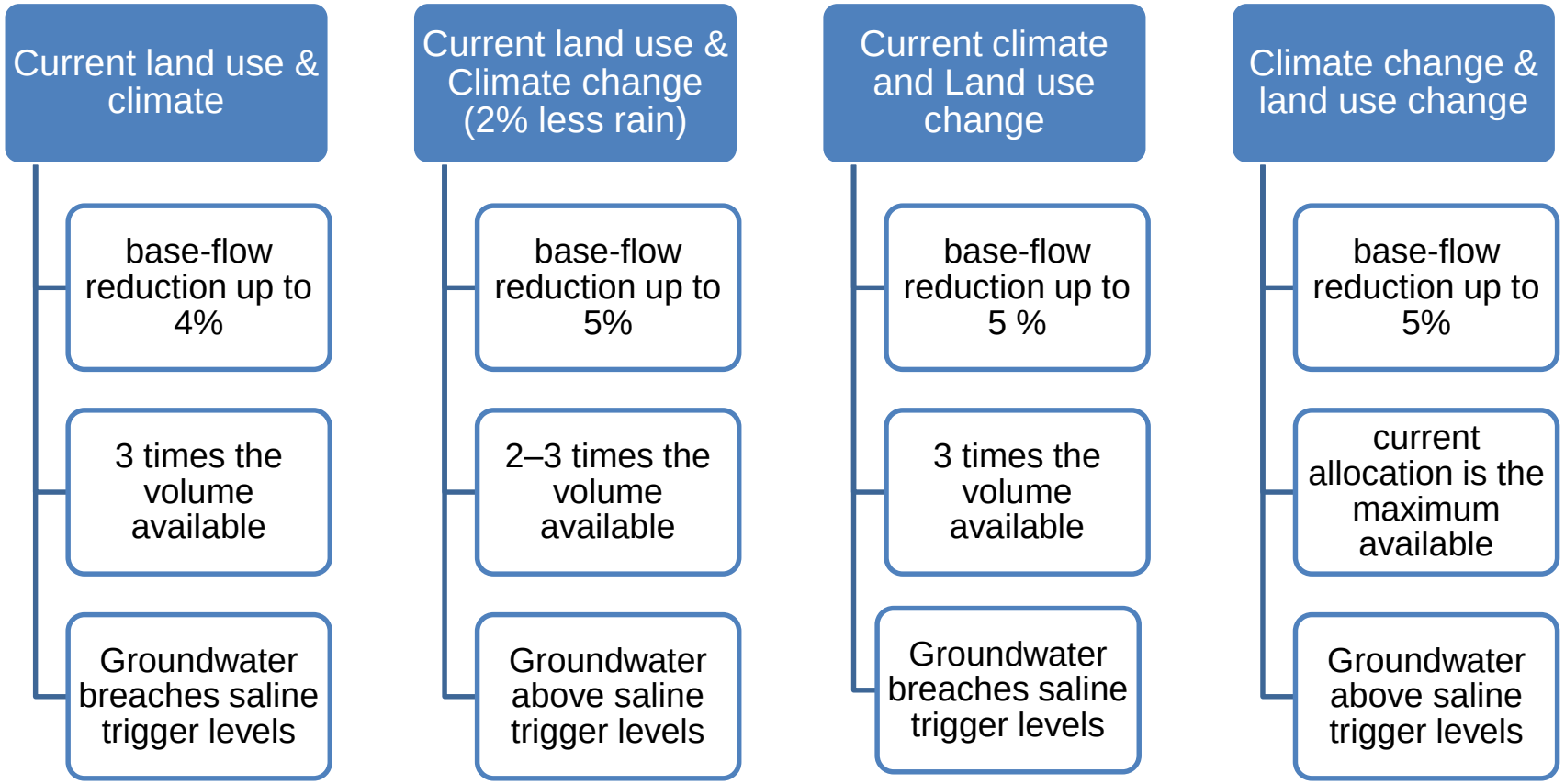
Management option A

No base-flow reduction and no saline intrusion



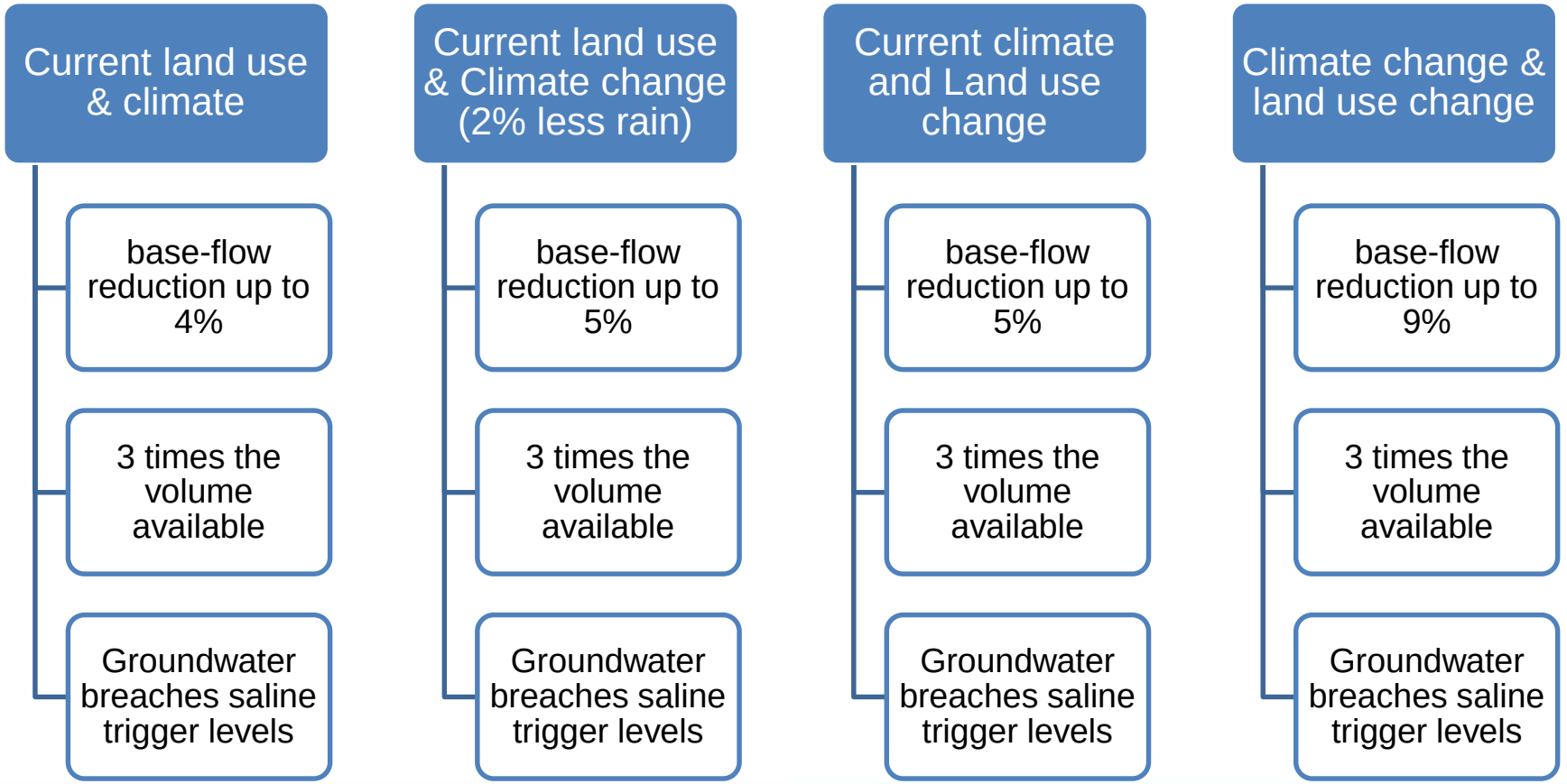
Management option B1

Maximum 5% base-flow reduction and no saline intrusion

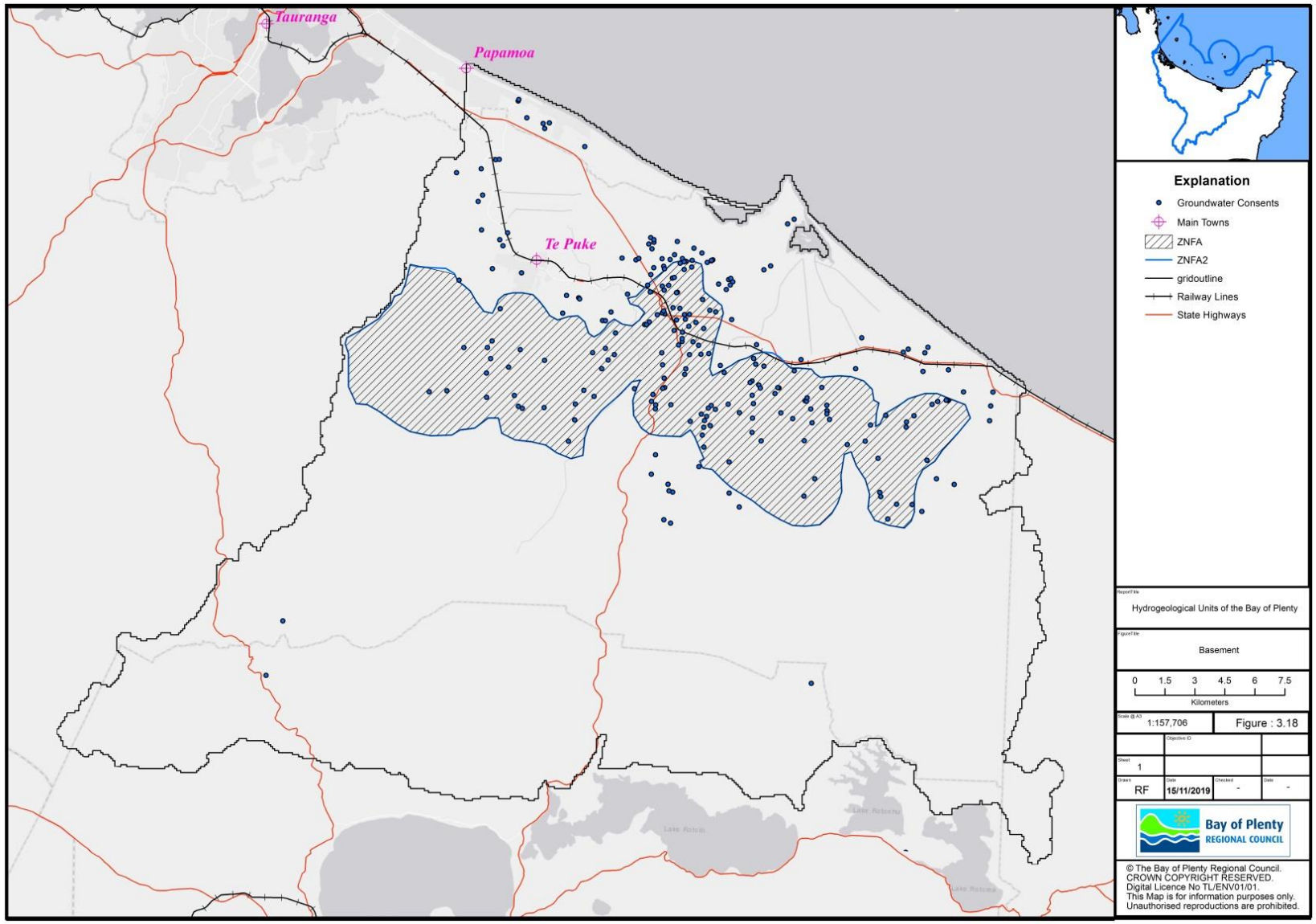


Management option B2

Maximum 10% base-flow reduction and no saline intrusion

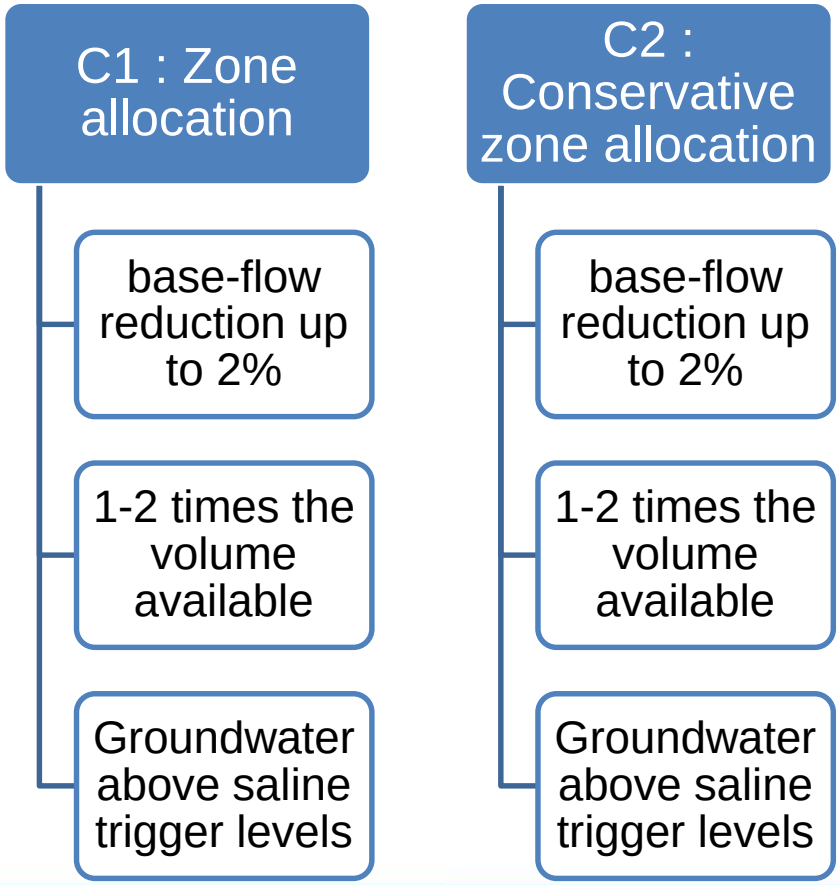


Management option C



Management option C

No further base-flow reduction and no saline intrusion. Only current use and current climate



6.
Your Preferred Option

Choosing Allocation Limits

Allocation limit depends on

- Scenario
- Base-flow & saline intrusion

PC12 (MODFLOW) - 3 options

- 2 management approaches
- 14 model runs – five sets of allocation limits
- Scenario limits won't change unless model updated
- Model reviewed before next plan change
- Limit – authorised volume = remaining allocation

Summary

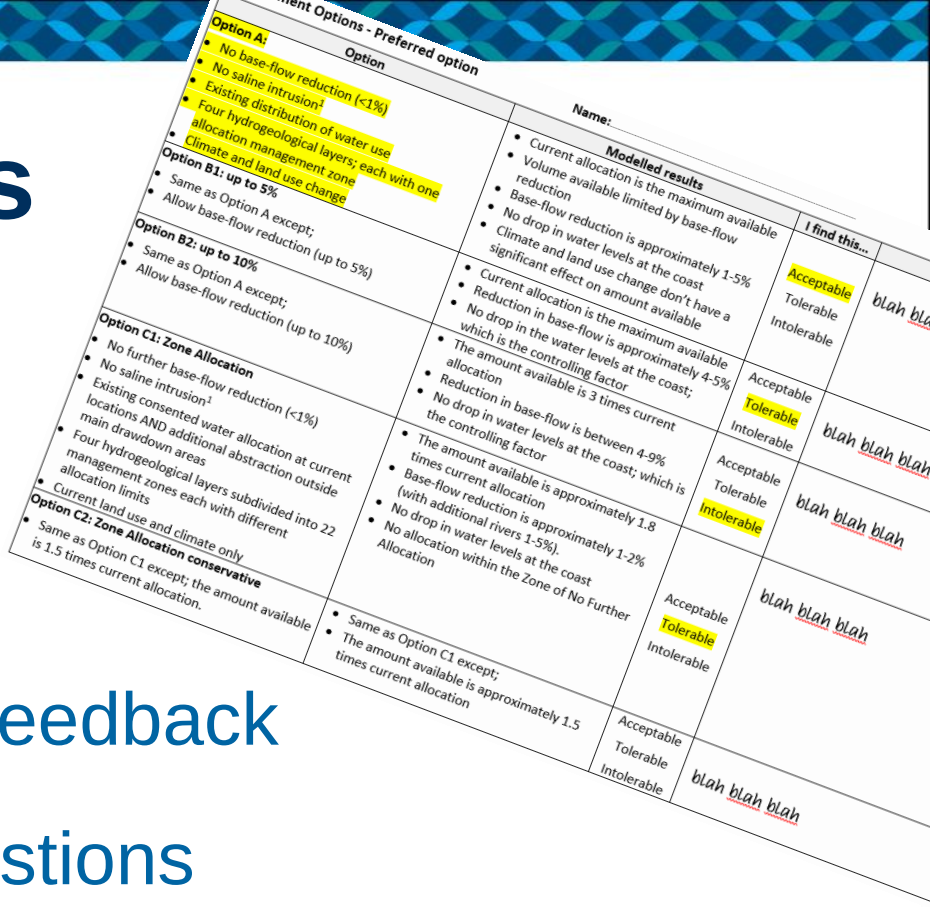
Good news

- Current allocation - little regional groundwater level impact

Decision points

- Option A: current allocation
- Option B: approx 3x current allocation
- Option C: approx 2x current allocation

Activity – Options



ment Options - Preferred option

Name:

Option	Modelled results	I find this...	
Option A: • No base-flow reduction (<1%) • No saline intrusion[1] • Existing distribution of water use • Four hydrogeological layers; each with one allocation management zone • Climate and land use change	• Current allocation is the maximum available • Volume available limited by base-flow reduction • Base-flow reduction is approximately 1-5% • No drop in water levels at the coast • Climate and land use change don't have a significant effect on amount available	Acceptable Tolerable Intolerable	blah bla
Option B1: up to 5% • Same as Option A except; • Allow base-flow reduction (up to 5%)	• Current allocation is the maximum available • Reduction in base-flow is approximately 4-5% • No drop in the water levels at the coast; which is the controlling factor	Acceptable Tolerable Intolerable	
Option B2: up to 10% • Same as Option A except; • Allow base-flow reduction (up to 10%)	• The amount available is 3 times current allocation • Reduction in base-flow is between 4-9% • No drop in water levels at the coast; which is the controlling factor	Acceptable Tolerable Intolerable	blah blah blah
Option C1: Zone Allocation • No further base-flow reduction (<1%) • No saline intrusion[1] • Existing consented water allocation at current locations AND additional abstraction outside main drawdown areas • Four hydrogeological layers subdivided into 22 management zones each with different allocation limits • Current land use and climate only	• The amount available is approximately 1.8 times current allocation • Base-flow reduction is approximately 1-2% (with additional rivers 1-5%). • No drop in water levels at the coast • No allocation within the Zone of No Further Allocation	Acceptable Tolerable Intolerable	blah blah blah
Option C2: Zone Allocation conservative • Same as Option C1 except; the amount available is 1.5 times current allocation.	• Same as Option C1 except; • The amount available is approximately 1.5 times current allocation	Acceptable Tolerable Intolerable	blah blah blah
			blah blah blah

- Break into 3 groups
- Approx 20-30 minutes
- Re-group as a whole - feedback
- General discussion/questions
- Individual feedback forms
  - **Highlight your preferred option**
  - **Note your reasonings *(use back of page if want to add more)***
  - **Rank other options by highlighting your level of comfort with that option**

What's Next?

Where we've been today

1. National and Regional Updates
2. Hydro-geology and Groundwater
3. Modelling
4. Groundwater Values, Uses & Objectives
5. Scenarios and Results
6. Your Preferred Option

Next steps

- Surface water discussion with Community Group 2020
- Engagement with the public about groundwater (and other topics) in 2020
- Plan drafting

Engagement

- Discussion document
- Continue Iwi and Hapū engagement
- Community/public engagement – in 2020
- Plan drafting

Summary

- Key areas of agreement
- Notable points of disagreement
- Actions
- Any burning questions still unanswered?

Thanks once again

- In closing…
  - Any feedback to us on this session?
- Next session
- Talk to others ……