A Cause-Effect Cascade for Managing Diffuse Pollution

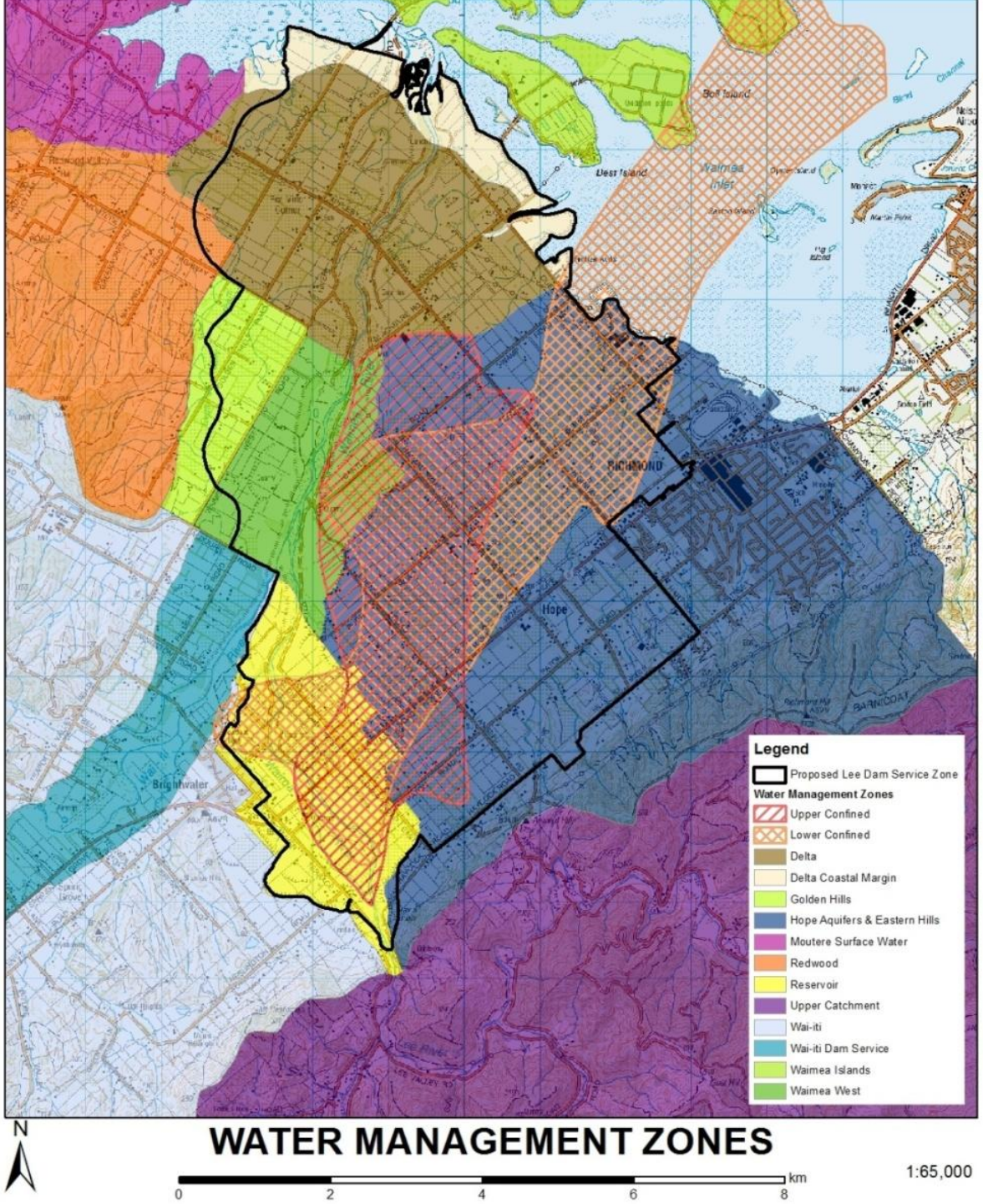
I. Leaching from below the soil profile

II. Transport and attenuation through underlying aquifers

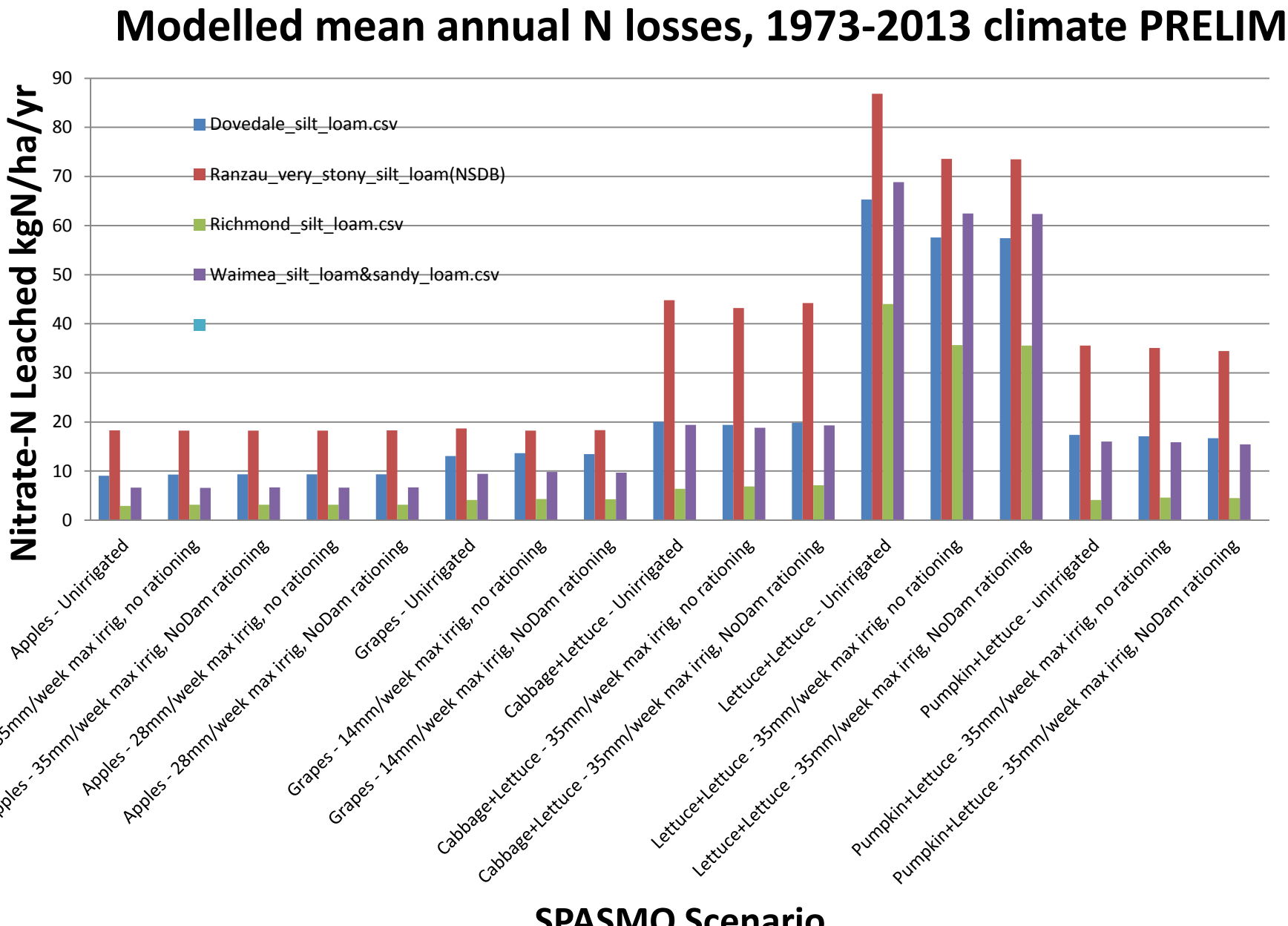
III. Recommending water quality limits for sensitive receiving waters

IV. Mitigation and management options for maintaining water quality within limits

Waimea water management zones

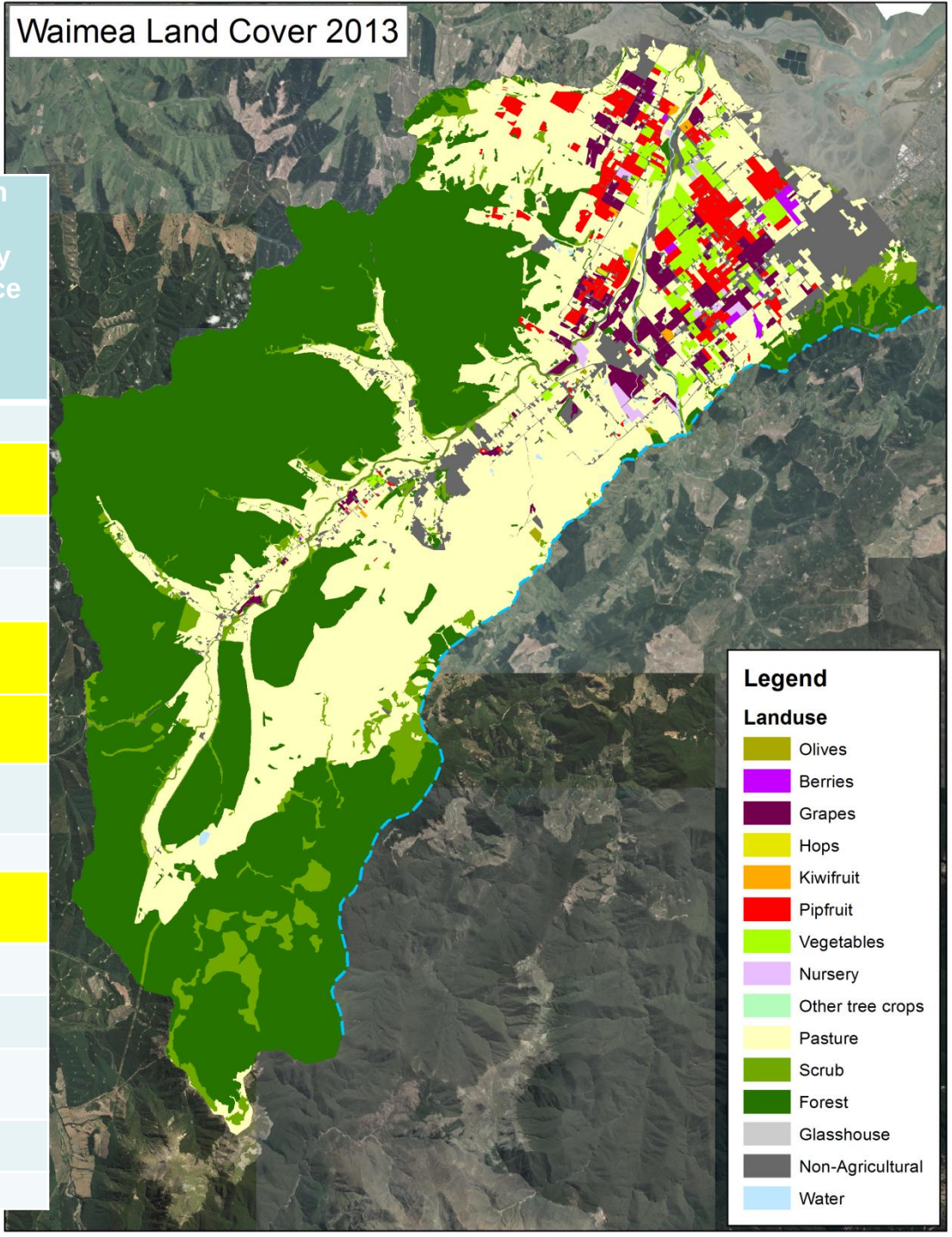


I. Leaching from below the soil profile



2013 Land Cover

Land use class	Area within Waimea Plains catchment (below Wairoa Gorge)	Area within Waimea Community Dam service zone
Berries	80	79
Grapes, Olives	957	717
Hops	15	11
Kiwifruit	37	32
Pipfruit, other tree crops	1112	807
Outdoor vegetables	680	655
Nursery	113	49
Glasshouses	29	27
Pasture	13939	3923
Scrub	2100	98
Forest	19692	22
Non-Agricultural	2192	1811
Water	86	54
TOTAL AREA	40780ha	8285ha



II. The Attenuation Question

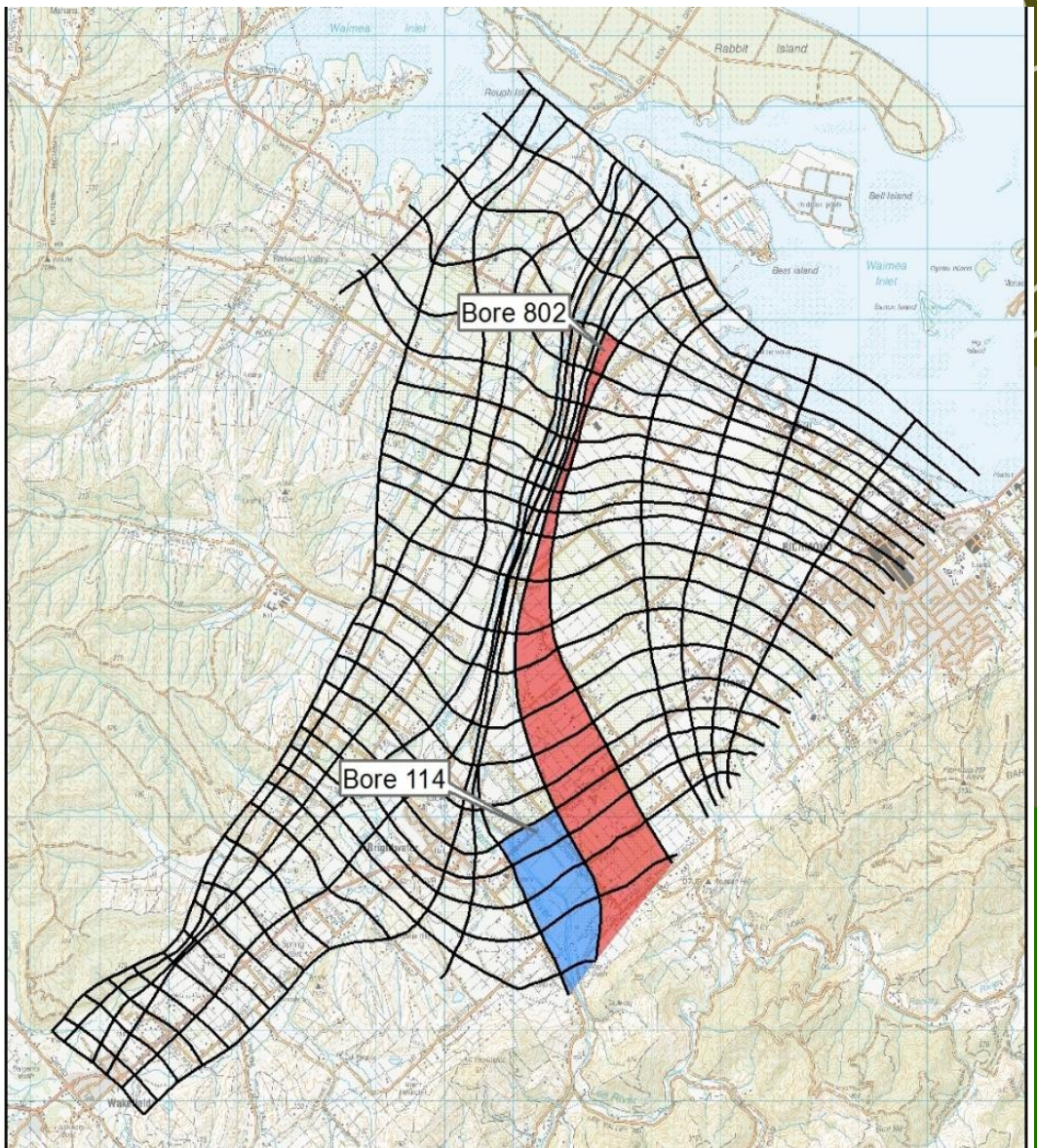
Median nitrate in 4 aquifers 1986–2005, mg/L, n=111 bores

Median	1986	1994	2000	2005	Change in Median 1986–2005	Mean annual NO_3-N leaching 2010
AGUA	6.1	3.9	3.9	3.2	–48%	8.68
HU	14.5	13.5	12.0	8.1	–44%	8.19
LCA	12.0	12.0	12.0	12.0	0%	7.31
UCA	11.5	8.7	15.0	11.5	0%	7.89
All aquifers	**10.9**	**8.9**	**9.4**	**8.1**	**–26%**	

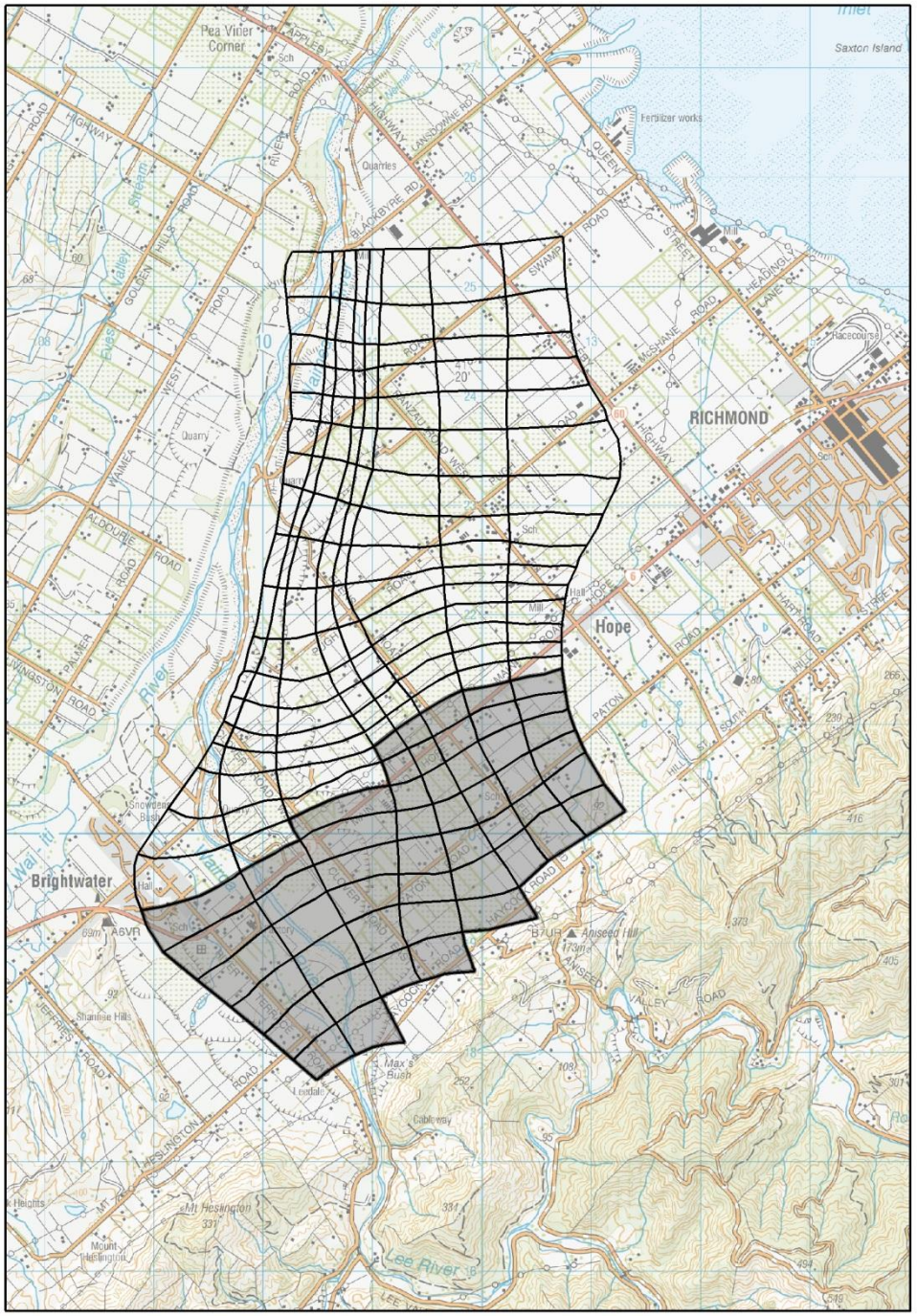
Groundwater attenuation of nitrate: 2 assessment methods

Aquifer	1 Spatial average attenuation	2 Temporal average attenuation
AGUA	63%	74 – 92%
HU	1%	-
UCA	0%	0%
LCA	39%	0%

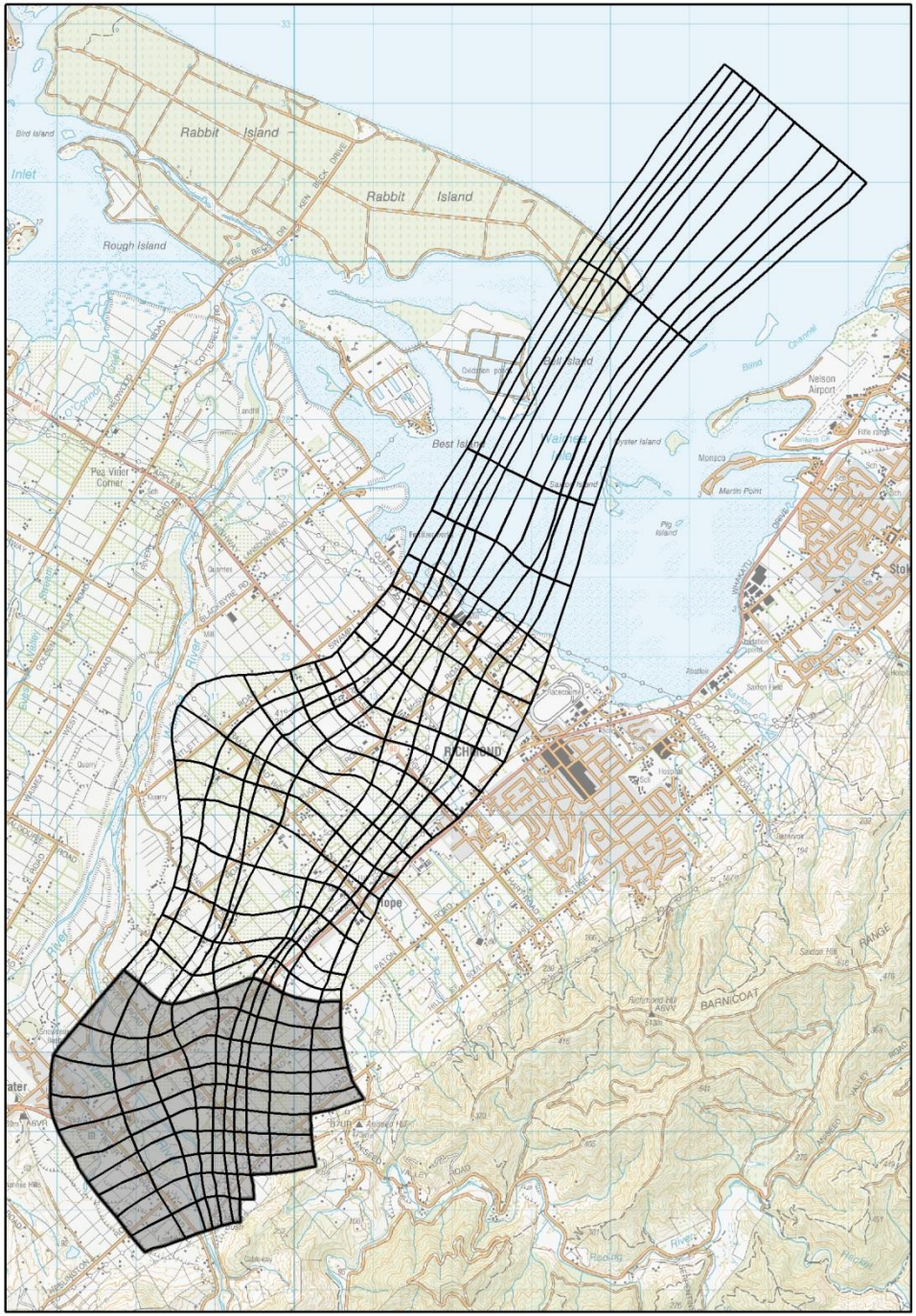
Unconfined and Hope aquifers flow net



Upper Confined Aquifer flow net



Lower Confined Aquifer flow net



III. Setting Water Quality Limits

Some Waimea water uses and values potentially most affected by water quality changes from intensified land use

- **Aquatic ecology** in the Waimea River, spring-fed streams and Waimea Inlet
- Brown **trout and native fish habitat** and abundance
- **Recreational uses** of the Waimea River and Waimea Inlet, e.g. swimming, kayaking and picnicking
- **Potable waters** from individual wells and reticulated supplies.
- **Cultural and spiritual values**, including mahinga kai (food gathering)

Surface waters as receiving waters

Potential water quality limits for Waimea catchment and Waimea Inlet

Water bodies	Objectives				
	Safe for swimming	Safe drinking water	**Limit risk of nitrate toxicity**	Control freshwater periphyton growth	Limit macroalgal blooms in the Waimea Inlet
Waimea River	95th percentile values of *E. coli* <260 /100mL	N/A	**Annual average NO_3-N <2.4 mg/L and annual 95th percentile <3.5 mg/L**	Dissolved reactive phosphorus concentrations <0.026 mg/L	Total N load to Waimea Inlet from all sources <610 tonnes/year, equivalent to <50 mg/m^2/day (or 182 kg/ha/yr over the inlet area)
Spring-fed streams	N/A	N/A	**Annual average NO_3-N <3.8 mg/L and annual 95th percentile <5.6 mg/L**	Dissolved reactive phosphorus concentrations <0.026 mg/L	
Groundwater	N/A	No *E. coli* and NO_3-N <11.3 mg/L			

IV. Can Good Management Practices deliver within recommended limits?

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Questions for FLAG

Guidance needed on which crops are most similar to modelled ones in terms of N (and other) fertilizer use

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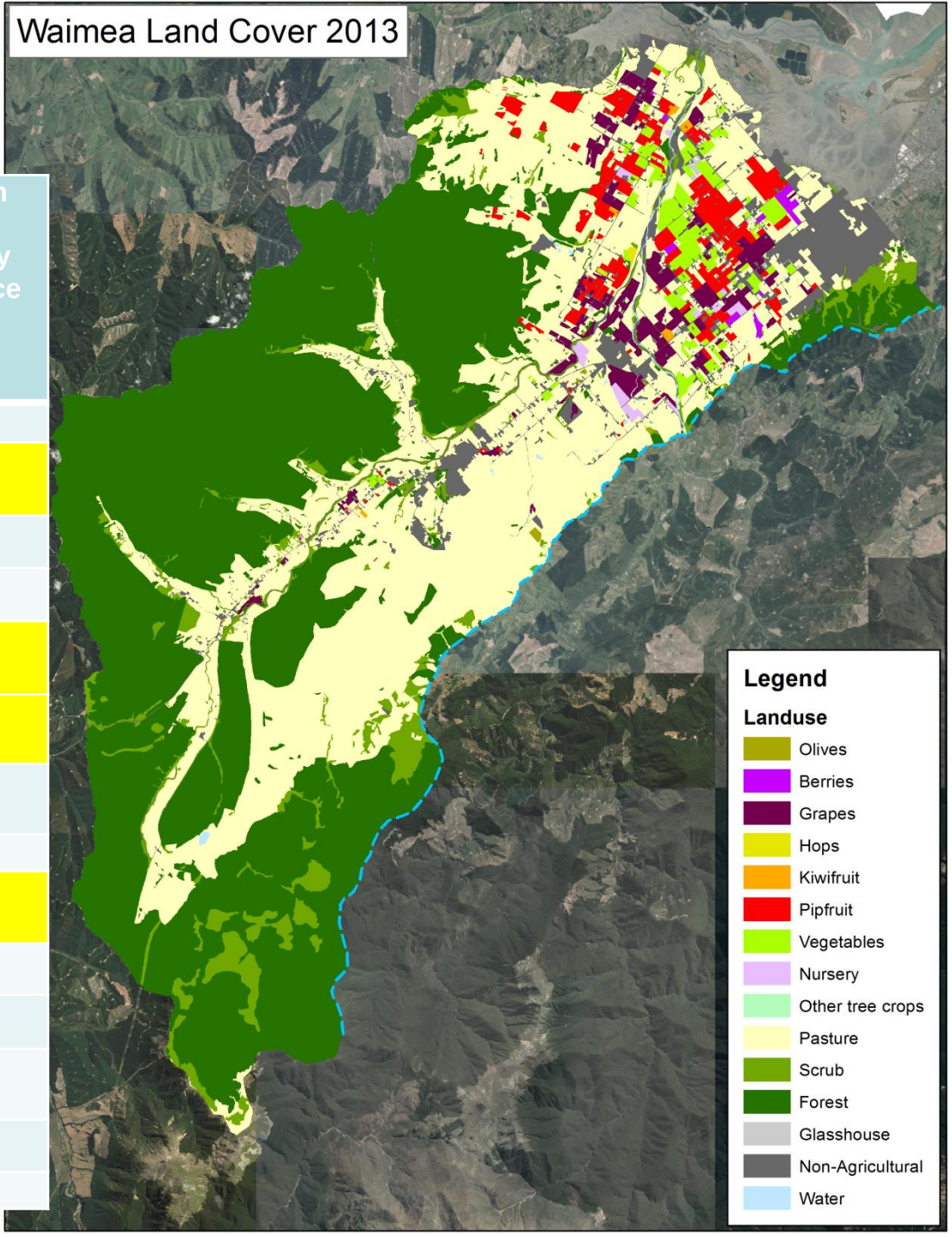

What changes to growing practices for major land uses across the catchment (pipfruit, grapes, livestock/dairy, vege growing) you think would reduce N losses the most?

- for possible scenario modelling

Any other changes you think may need consideration to achieve future N limits?

Your initial thoughts – how important is achieving each of these green types of water quality limit?

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