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MEMO

TO	Te Awarua-o-Porirua Whaitua Committee, Te Awarua-o-Porirua Project Team
COPIED TO	
FROM	Sheryl Miller/Brent King, Senior Science Coordinators, Science Integration Team
DATE	May 2018
SUBJECT	Key messages from scenario modelling results for *E. coli* and toxicity attributes

Background

This memo provides a brief overview of the five attributes (*E. coli*, ammonia, nitrate, copper and zinc) discussed at the committee meeting 19th April 2018. The purpose of the scenario modelling is to extend beyond areas that are monitored using known patterns.

Escherichia coli (E. coli)

E. coli¸ bacteria commonly found in the gut of warm blooded animals such as sheep and cattle, is used as a proxy for human health. It is a compulsory attribute under the National Policy Statement for Freshwater Management (NPS-FM) and objectives set will help provide varying levels of protection from the risk of people getting sick when they come into contact with water through various recreational means (e.g. swimming, wading, boating). For *E. coli*, the objective set must be a C band or higher.

What does the modelling tell us?

E. coli is modelled using four metrics[1] with the (overall) band shown a result of the poorest grade out of the four. In the rural WMUs, often one of the four metrics may be graded poorer than the other three giving the impression of poorer condition or little change though the result may be close to the next band level. In the urban WMUs all four metrics are often graded consistently.

The current state and business as usual (BAU) modelling shows that across most of the WMUs in the whaitua, *E. coli* falls primarily into the E band (the worst category). This suggests that wherever we set *E. coli* objectives for contact recreation, something different than BAU will be required to achieve an objective level of C band.

Rural WMUs

Under the improved scenario, fencing, stock exclusion and retirement of grazing land are big drivers of reduced *E. coli* (see attached land use table), however:

- Upper Kenepuru, Upper Duck, Judgeford and Takapu streams are unlikely to reach C band under any scenario due to extensively grazed catchments and low water flows
- Most other rural WMUs are likely to reach a C band using the improved scenario
- Taupo may need water sensitive levels of effort to reach C
- Horokiri, Pauatahanui and Stebbings may reach B band with the water sensitive scenario.

1 MfE (2017) Swimming categories for *E. coli* in the Clean water package (pg 9, Table 3)

Urban WMUs

It will be very hard to shift *E. coli* to a C band. The overall band level in the urban WMUs is due to all four metrics being very poor/poor, though there are large movements within those bands, such as:

- At Kenepuru and Porirua stream sites, a 50-75% reduction in E. coli can be achieved with the improved scenario, and
- a 70-85% reduction in E. coli under the water sensitive scenario

The biggest changes in the scenarios for reducing *E. coli* come from repairing leaking wastewater pipes and cross connections These reduce *E. coli* in those areas by around 75%, and wastewater overflows reduced from an average of 12/yr to 2-4/yr . These show up as the difference between BAU and improved.

Treatment of runoff in infill and greenfield areas is highly effective for *E. coli*, removing around 90% of *E. coli* from those areas, but those areas are relatively small so effects are probably masked in bigger catchments.

Marginal improvements in the water sensitive scenario for some urban WMUs are probably due to the additional retirement in rural areas of the catchments.

Ecological toxicity

Four toxicity attributes were discussed: ammonia, nitrate, zinc and copper. The attributes relate to the health of the stream, and are about managing the effects on fish, insects and plants that live in the water.

Effects vary and exposure can be short-term (hours to days) to long-term (weeks and months); sub-lethal (e.g. reduction in growth, decrease in reproduction) to lethal (death to all); chronic (effect on animals/plants occurs slowly) or acute (impact is quick/immediate).

Ammonia and nitrate toxicity are compulsory in the NPS-FM, with guidance about levels provided by the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZEEC 2000). Objective must maintain or improve the current state, and must be set at C band or better.

Objectives for zinc and copper are not compulsory in the NPS-FM but being common urban contaminants were identified as important in Te Awarua-o-Porirua Whaitua. Standard regulation for zinc and copper are currently being developed so ANZEEC guidelines have been used here.

The band for each attribute is calculated using two metrics related to exposure in both the short- and long-term. These are all derived in relation to protection of certain proportions of species.

Ammonia

What does the modelling tell us?

Current state was good or very good in rural catchments and good or fair in urban catchments. At places where we also had monitoring, modelling tended to over-state the band for a couple of reasons – pH adjustment and influence of wastewater overflows.

In rural areas, if we were to make a pH adjustment, many of the B bands would potentially become A.

Rural WMUs

If set objectives in A band, we might get there with little or modest effort in most places. With pH adjustment factored in, the following four rural WMUs won't reach A band under current state or BAU:

- Taupo remains B band even with water sensitive scenario
- Takapu remains B band even with water sensitive scenario
- Stebbings reaches A band with water sensitive scenario
- Belmont remains C band – due to waste water overflow influence

Urban WMUs

In urban areas, most streams are currently C band which is predominately an effect of wastewater overflows. Setting objectives above a C band will therefore require significant effort around wastewater overflows. We see a small improvement with reducing wastewater overflows from BAU => Improved => WS.

Nitrate

What does the modelling tell us?

Current state is good/very good throughout the catchment. Livestock grazing and urban parks are major drivers.

Rural WMUs

Most sites are either already an A or can achieve an A band with BAU or improved. The only rural WMUs that might not reach A under BAU or improved are:

- Takapu and Stebbings – need water sensitive efforts
- Whitireia – may not reach A with either the improved or water sensitive levels of effort

Improvements in rural areas are likely reflecting the lower nitrogen yield from shifting from grazing pasture to rural residential and retired land. Note that stock exclusion and riparian planting has no effect on nitrate.

Urban WMUs

Most urban WMUs stay in the B band, though most of those are close to moving to A band.
Drivers are primarily untreated contributions from the parks and existing urban areas.

Zinc

Potential levels to set objectives are not in the NPS-FM. They come from the best information currently available. There is uncertainty that using these band thresholds and percentiles as objectives may not address very-short term exposure to peak concentrations and potential effects of those in an urban environment.

The model results and interpretations give a good indication of streams where there are elevated risks of effects on aquatic life from either short or long term exposure to zinc.

What does the modelling tell us?
WMUs under current state are generally very good in rural areas, although Taupo Stream is perhaps affected by SH1 and the commercial and industrial area downstream of the wetland. Zinc in urban areas was poor/fair, with major sources coming from commercial and industrial areas, roads and roofs.

Rural WMUs
Most rural areas likely to maintain A band under all scenarios (exception Taupo), though Transmission Gully (TG) and the connecting roads around the interchange areas (Whitby/Waitangirua & SH58) may bring some new sources of zinc into those areas.

Urban WMUs
Modelling suggests it will be possible to achieve an A band in the urban WMUs with the water sensitive scenario. However, closer inspection suggests this might be overly optimistic around the reductions in zinc from roof painting and replacement. We expect that the overall results are more likely to be B band than A from the water sensitive efforts.

Major drivers of change in the water sensitive scenario include treatment of:

- runoff from roofs and paved surfaces in infill and greenfield development, roofs and paved surfaces in commercial and industrial areas and high traffic roads, which reduce zinc by around 70-85%,
- the replacement and/or painting of all existing roofs, which reduces zinc by around 95% from those sources.

Copper
Potential levels to set objectives are not in the NPS-FM. They come from the best information currently available and aim to provide varying levels of protection for sensitive species from the toxic effects of copper.

The low flows and some land changes, particularly retirement, the very low modelled concentrations, and the low thresholds for this attribute mean there is a lot of uncertainty about the banding and changes between these scenario model results. The model results and interpretations give a good indication of streams where there are elevated risks of effects on aquatic life from either short or long term exposure to copper.

What does the modelling tell us?
WMUs under current state are generally very good in the rural areas except for the small coastal catchments (Pukerua, Hongoeka and Whitireia), the model results may be influenced by low flows in these areas. Urban results were typically poor/fair, with major contributions from roads and paved surfaces.

Rural WMUs
Most rural areas will be likely to maintain A band under all scenarios, though Transmission Gully completion may bring some new sources into those areas, particularly in Upper Duck Creek.
BAU improvement for Taupo might be driven by changes in traffic load off SH1 onto TG.

Urban WMUs
Uncertainty about the state of conditions for copper and the scenarios show that it is difficult to make changes across the urban WMUs. It will be hard to make improvements in the urban WMUs for copper. Setting objectives higher than C band may require efforts beyond those modelled in water sensitive scenario.

Treatment of new development and high risk areas (i.e. high traffic roads and commercial and industrial paved surfaces) is effective for copper from those surfaces, but there is limited scope for treatment of other relatively high yielding and extensive sources such as residential roads and paved surfaces.

Other useful information included here:

Landuse table

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Te Awarua-o-Porirua information on fresh water current state and scenario results: Land use

		Forest and natural				Grazed livestock				Retired				Rural residential area			
WMU group	Reporting point name (from modelling)	Current state	BAU	Improved	Water sensitive	Current state	BAU	Improved	Water sensitive	Current state	BAU	Improved	Water sensitive	Current state	BAU	Improved	Water sensitive
Coastal catchments	Pukerua	48%	48%	48%	48%	32%	32%	10%	10%			22%	22%				
	Hongoeka to Pukerua	48%	48%	48%	48%	32%	32%	10%	10%			22%	22%				
	Whitireia	41%	41%	41%	41%	18%					18%	18%	18%				
Taupo Stream and Swamp	Mouth	20%	19%	19%	19%	68%	53%	43%	15%			10%	38%	1%	9%	9%	9%
	Wetland	23%	23%	23%	22%	71%	60%	48%	20%			12%	41%	1%	10%	10%	10%
Pauatahanui steep rural streams	Horokiri Battle Hill	52%	52%	52%	52%	46%	45%	26%	14%			19%	31%	1%	2%	2%	2%
	Horokiri @ Golf Club	59%	59%	59%	59%	39%	35%	19%	12%			16%	23%	2%	5%	5%	5%
	Kakaho Stream	33%	33%	33%	33%	66%	61%	37%	17%			24%	44%		4%	4%	4%
	Judgeford Stream	53%	53%	53%	53%	45%	42%	37%	25%			5%	17%	1%	5%	5%	4%
	Upper Duck Creek	11%	10%	10%	10%	89%	53%	39%	28%		35%	50%	60%				
Pauatahanui rural streams	Pauatahanui Stream	41%	41%	41%	41%	56%	45%	42%	21%			3%	24%	3%	12%	12%	11%
	Ration Creek	63%	62%	62%	62%	33%	8%	8%	4%				5%	4%	28%	28%	27%
Pauatahanui urban streams	Lower Duck Creek	21%	20%	20%	19%	49%	31%	23%	15%		18%	26%	35%	1%	1%	1%	1%
	Pauatahanui fringe streams																
Onepoto steep rural streams	Rangituhi Stream	62%	62%	62%	62%	38%					38%	38%	38%				
	Takapu Stream	36%	36%	36%	36%	60%	60%	53%	31%			7%	30%	2%	2%	2%	2%
	Upper Kenepuru	25%	25%	25%	25%	67%	37%	23%	19%		30%	43%	47%				
Onepoto rural streams	Belmont Stream	22%	20%	20%	20%	44%	16%	16%	16%					1%	1%	1%	1%
	Stebbings Stream	28%	20%	20%	19%	67%	31%	30%	7%			1%	25%				
Onepoto small urban streams	Hukarito Stream	45%	45%	45%	45%	14%	14%	14%	14%								
	Mahinawa Stream	57%	57%	57%	57%	29%	29%	29%	29%								
	Onepoto Fringe	50%	50%	50%	50%	1%	1%	1%	1%								
	Titahi																
Kenepuru Stream	Kenepuru	7%	7%	7%	7%	25%	19%	16%	9%		6%	9%	17%				
Porirua Stream	Grenada North industrial	42%	42%	42%	42%	14%	14%	14%	14%					2%	2%	2%	2%
	Mitchell Stream	39%	39%	39%	39%	23%	23%	15%	13%			8%	10%				
	Willowbank	25%	24%	24%	23%	40%	31%	28%	17%			2%	15%	1%	1%	1%	1%
	Kenepuru Drive	27%	26%	26%	26%	30%	24%	22%	14%			2%	11%	1%	1%	1%	1%

WMU group	Reporting point name (from modelling)	Urban grass/ parks				Residential				New residential				Commercial and industrial				Roads			
		Current state	BAU	Improved	Water sensitive	Current state	BAU	Improved	Water sensitive	Current state	BAU	Improved	Water sensitive	Current state	BAU	Improved	Water sensitive	Current state	BAU	Improved	Water sensitive
Coastal catchments	Pukerua	17%	17%	17%	17%	3%	3%	3%	3%									1%	1%	1%	1%
	Hongoeka to Pukerua	17%	17%	17%	17%	3%	3%	3%	3%									1%	1%	1%	1%
	Whitireia	37%	37%	37%	37%	3%	3%	3%	3%									1%	1%	1%	1%
Taupo Stream and Swamp	Mouth	4%	7%	7%	9%	4%	2%	2%	2%		4%	4%	3%	1%	1%	1%	1%	2%	3%	3%	3%
	Wetland	1%	2%	2%	3%	1%	1%	1%	1%		2%	1%	1%					2%	2%	2%	2%
Pauatahanui steep rural streams	Horokiri Battle Hill																	1%	1%	1%	1%
	Horokiri @ Golf Club																		1%	1%	1%
	Kakaho Stream				1%						1%	1%									
	Judgeford Stream																				
	Upper Duck Creek																		2%	2%	2%
Pauatahanui rural streams	Pauatahanui Stream		1%	1%	1%						1%	1%	1%					1%	1%	1%	1%
	Ration Creek																		2%	2%	2%
Pauatahanui urban streams	Lower Duck Creek	17%	16%	16%	17%	9%	8%	8%	8%	1%	2%	2%	2%					2%	4%	4%	4%
	Pauatahanui fringe streams	21%	36%	36%	39%	64%	24%	24%	24%		26%	26%	23%	3%	3%	3%	3%	12%	12%	12%	12%
Onepoto steep rural streams	Rangituhi Stream																				
	Takapu Stream													1%	1%	1%	1%				
	Upper Kenepuru	7%	7%	7%	7%	1%	1%	1%	1%										1%	1%	1%
Onepoto rural streams	Belmont Stream	17%	26%	26%	31%	12%	11%	11%	11%	1%	16%	16%	11%					3%	10%	10%	10%
	Stebbings Stream	3%	19%	19%	26%					1%	21%	20%	13%						9%	9%	9%
Onepoto small urban streams	Hukarito Stream	24%	24%	24%	24%	13%	13%	13%	13%									4%	4%	4%	4%
	Mahinawa Stream	6%	6%	6%	6%	6%	6%	6%	6%									2%	2%	2%	2%
	Onepoto Fringe	9%	9%	9%	9%	9%	9%	9%	9%					28%	28%	28%	28%	4%	4%	4%	4%
	Titahi	21%	36%	36%	39%	64%	24%	24%	24%		26%	26%	23%	3%	3%	3%	3%	12%	12%	12%	12%
Kenepuru Stream	Kenepuru	38%	35%	35%	36%	23%	20%	20%	20%		5%	5%	4%	1%	1%	1%	1%	5%	7%	7%	7%
Porirua Stream	Grenada North industrial	20%	20%	20%	20%	3%	3%	3%	3%					17%	17%	17%	17%	2%	2%	2%	2%
	Mitchell Stream	29%	25%	25%	26%	4%	3%	3%	3%		3%	3%	2%	4%	4%	4%	4%	1%	2%	2%	2%
	Willowbank	17%	20%	20%	22%	11%	11%	11%	11%		5%	5%	3%	2%	2%	2%	2%	4%	6%	6%	6%
	Kenepuru Drive	21%	23%	23%	24%	14%	14%	14%	14%		4%	4%	3%	2%	2%	2%	2%	4%	6%	6%	6%

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