Memo 2

Date	24 February 2017
To	Dan Clarke
CC	
From	Shirley Hayward

Reductions in nitrogen concentrations required to meet NPS national bottom lines

You requested an assessment of the reductions in nutrients (specifically nitrogen) needed to ensure waterways in the OTOP zone met the NPS national bottom lines. This memorandum provides a summary of this assessment.

I have focussed on two key areas in the OTOP zone where the current state analyses indicated that:

- Nitrate concentrations in streams in the coastal Orari Plains did not meet the NPS national bottom line for nitrate toxicity
- Total nitrogen concentrations in Waitarakao(Washdyke Creek) did not meet the NPS national bottom line for brackish lakes.

Orari Plains - nitrate toxicity attribute

Three streams sites in the OTOP zone were identified during the current state analysis that did not meet the NPS national bottom line for nitrate toxicity. NNN[1] concentrations at all three sites exceeded the annual median and annual 95th percentile nitrate toxicity national bottom lines at various times over the past five years (2011 -2016).(Table 1). In assessing the overall reductions needed to comply with the NPS national bottom line, this analysis has focussed on examining the median NNN concentration for each site over the entire current state period (5 years).

Table 2 details the percentage reductions in NNN concentrations needed to comply with the NPS national bottom line for nitrate toxicity. Two of the sites are on Rhodes Stream which flows into an oxbow lagoon (presumably a remnant of the Orari Lagoon) (Figure 1). The site at Rolleston Rd requires a 13% reduction in NNN concentrations, while furthermost downstream site, at Parke Road, requires a 29% reduction in median concentration. The site called Old Orari Lagoon outfall drain (SQ20544), drains out of the oxbow into the Orari Lagoon (Figure 1). This site requires a 25% reduction in median NNN concentrations to achieve the NPS national bottom line for nitrate toxicity.

[1] Surface waters are analysed for nitrate + nitrite nitrogen (NNN) concentrations. As the nitrite component is negligible in surface waters, the NNN concentrations can be used to assess against nitrate toxicity standards.

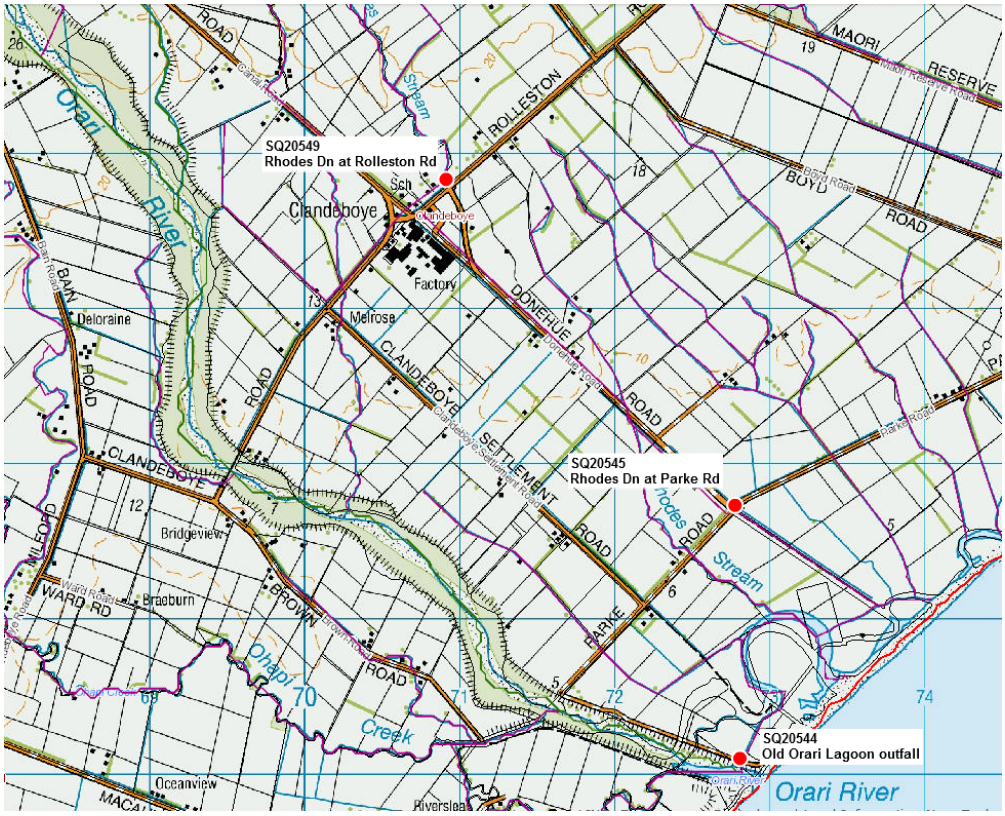

Figure 1 Location of sites that currently do not meet the NPS national bottom line for nitrate toxicity.

In the Current Pathways scenario, water quality improvements were assumed to achieve a 15% reduction in nutrients, E. coli and sedimentation at sites largely influenced by irrigated land use and a 5% reduction in contaminants in unirrigated areas. Given the extensive nature of irrigated agriculture in the Orari Plains area, I have applied a 15% reduction to the current state NNN median values, to determine potential compliance with the national bottom line for nitrate toxicity (Table 2).

The Rhodes Stream site at Rolleston Road could potentially comply with the NPS national bottom line under assumptions about implementation of GMPs. However, the downstream site at Parke Rd, and the Old Orari Lagoon outlet site both would most likely continue to not meet the national bottom line. These sites would need a 12% – 16% reduction in NNN concentrations.

For the purposes of modelling the impacts on the upgradient land uses, I recommend modelling a 16% reduction in nitrate losses for the catchment area (including groundwater sources) upstream of the Rhodes Stream site at Parke Road (SQ20545)[2].

[2] Map reference for the Rhodes Stm at Parke Rd – NZTM Easting: 1472777.9/Northing: 5101718.9

Waitarakao/Washdyke Lagoon – total nitrogen attribute

Waitarakao/Washdyke Lagoon has previously only been sampled for water quality for a 2 year period in 2009-2011. Based on that historical data, the lagoon would not meet the NPS national bottom line for total nitrogen (TN), total phosphorus (TP) and *E. coli* (Table 3). We have recently set up a new investigation of the lagoon and the data obtained to date (2 samplings) indicate that the nutrient levels remain high.

It is difficult to accurately determine the nutrient inputs (loadings to the lagoon), and their subsequent fate within the lagoon (nutrient uptake, denitrification, burial). A very conservative approach is to assume that the % reductions in nutrient concentrations within the lagoon needed to meet the NPS national bottom line are the same as the % reductions needed in nutrient inputs to the lagoon. There is considerable uncertainty about this assumption. Nevertheless, if the assumption is held, the nitrogen inputs to the lagoon would need to decrease at least 3-fold (i.e. 300%).

From the data we have available, it appears the main sources of nitrogen to the lagoon are the Seadown Drain, and groundwater that emerges into the lower Washdyke Creek (below SH1) and into the drains in the Washdyke flats area. Presumably this groundwater is being recharged upgradient in the Levels Plains area. If we assume that this is the main source of nitrogen, then N leaching across the upgradient plains area would need to decrease by 300%. This is a massive reduction in nitrogen that instinctively may be unrealistic to achieve through N leaching reductions alone. It may be possible that other interventions could be used such as increasing flushing of low nitrogen water through the lagoon, amongst other options.

Therefore, for the purposes of modelling reductions needed on upgradient land use, I recommend that two options are modelled:

1. **A 300% reduction in N leaching in the upgradient catchment (capture zone) of Washdyke Lagoon[3],**
2. **A 50% reduction in N leaching in the upgradient catchment (capture zone) of Washdyke Lagoon (and assume that other interventions would be able to address the excessive TN concentrations within the lagoon).**

[3] Map reference for the Washdyke Lagoon – NZTM Easting: 1460515.83 / Northing: 5085840.06

Table 1 – Details of the sites that currently do not meet the NPS national bottom line for nitrate toxicity. Statistics for the full 5 year current state period are shaded grey, and annual statistics are calculated where there is sufficient data.

Site name	Site ID	Easting (NZTM)	Northing (NZTM)	Sampling period	Median NNN (mg/L)	95th percentile NNN (mg/L)
NPS National bottom line					**6.9**	**9.8**
Old Orari Lagoon Outfall Drain#1	SQ20544	1472810	5100097	Aug 2011 - June 2016	9.2	13.7
Rhodes Stream Parke Rd	SQ20545	1472778	5101719	July 2011 - June 2016	9.7	13.0
				July 2011 - June 2012	9.7	11.0
				July 2012 - June 2013	11.0	12.9
				July 2013 - June 2014	11.5	14.1
				July 2014 - June 2015	8.1	10.9
				July 2015 - June 2016	8.0	9.1
Rhodes Stream Rolleston Rd	SQ20549	1470912	5103833	Aug 2011 - June 2016	7.9	11.0
				July 2011 - June 2012	8.2	9.5
				July 2012 - June 2013	9.2	12.0
				July 2013 - June 2014	9.0	Not enough data
				July 2014 - June 2015	6.3	Not enough data
				July 2015 - June 2016	6.7	7.9

#1 – this site is only sampled quarterly, and therefore, there is insufficient data to calculate annual statistics.

Table 2 Summary of percentage reductions in nitrate concentration to meet the NPS national bottom line for nitrate toxicity

		Median nitrate nitrogen						95th percentile nitrate nitrogen		
Site	Site name	Current state (5 yrs NNN) (mg/L)	National bottom line (mg/L)	Reduction needed	GMPs improvement assumption	Scenario 1 state	Reduction needed to meet NPS	Current state (5 yrs NNN) (mg/L)	National bottom line (mg/L)	Reduction needed
SQ20549	Rhodes Stream at Rolleston Rd	7.9	6.9	-13%	-15%	6.7	0%	11.0	9.8	-11%
SQ20545	Rhodes Stream at Parke Road	9.7	6.9	-29%	-15%	8.2	**-16%**	13.0	9.8	-25%
SQ20544	Old Orari Lagoon outfall	9.2	6.9	-25%	-15%	7.8	-12%	13.7	9.8	-28%

Table 3 Summary of Waitarakao/Washdyke Lagoon water quality data compared to the NPS national bottom lines

Washdyke Lagoon South End		**TN median mg/L**	**TP median mg/L**	***E. coli* median n/100 nl**	**Chlorophyll a median mg/m3**	**Chlorophyll a max. mg/m3**
NPS national bottom line (brackish lakes)		***0.75***	***0.05***	***1000***	***12***	***60***
Current state	June 2009- Jul 2011 (median)	4.3	0.10	1250	2.5	11.4
	% reduction needed to meet NPS national bottom line	-467%	-52%	-20%	0%	0%
Current Pathways scenario	GMP improvement assumptions	15%	15%	15%		
	Scenario 1 state	3.6	0.09	1063		
	Reductions needed to meet NPS	-382%	-43%	-6%		