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# FONTERRA DARFIELD GROUNDWATER NITRATE LEVELS CONSENT CONDITIONS - RECOMMENDATION

Dear Fiona

#### Introduction

Fonterra Co-operative Group Limited (Fonterra) has constructed and is operating a new milk powder plant near Darfield. Fonterra holds Canterbury Regional Council (CRC) resource consent CRC103594 to discharge contaminants onto or into land and to air at its site near Racecourse Hill.

Resource consent CRC103594 ("the consent") contains various conditions (Conditions 21 to 26) requiring monitoring of groundwater quality. The intention of the monitoring is to determine water quality related effects from irrigation of wastewater, clean process water and specific stormwater run-off (collectively forming "process water") onto Fonterra's farm properties. Furthermore, Conditions 30 to 35 detail the steps to be taken if irrigation of process water is potentially impacting on groundwater quality.

Since September 2011 Golder Associates (NZ) Limited (Golder) has prepared a number of monitoring reports and technical letters documenting the pre and post operational groundwater quality conditions at Fonterra's Darfield site. The pre-operational (pre-irrigating wastewater to land) monitoring was collected prior to the milk powder plant's construction and operation and provided good background information regarding the baseline conditions of groundwater in the proximity of the site. Following the start of the plant (August 2012), monitoring was continued by Fonterra staff including additional lysimeter monitoring as required in the consent conditions. On 1 February 2013, Fonterra, Golder and CRC staff met to review the monitoring results from the entire programme. It was decided at this meeting that the group reconvene in July 2013 to revisit the results relevant to the consent conditions.

On 10 July 2013 the follow up meeting was held with Carl Hanson (CRC – Groundwater scientist), Andy Barbati (CRC - Consents) and Fiona Mathis (Fonterra). The most recent information was presented by Fonterra including the lysimeter and groundwater quality results.

Fonterra has provided a summary of the meeting topics and actions as summarised below:

Main Topics:

 Overview of the outcome from the last meeting, whereby Fonterra would continue to monitor groundwater nitrates, in order to obtain a full season's dataset. This data was intended to provide a basis for determining the next steps regarding compliance with Conditions 30 and 31. This monitoring approach was agreed as the groundwater nitrates were elevated prior to Fonterra commencing its irrigation activities.



- 2) Review of first season's (while plant is operating) monitoring data, including mass nitrogen loading as a result of WW irrigation and the groundwater monitoring data. Agreement that there were no significant trends.
- 3) Next steps; agreed that Fonterra would submit a letter in accordance with Condition 31, as the elevated groundwater nitrates could not be directly linked with Fonterra's activities, based on the full season's data.

Actions:

- 1) Fonterra to engage a consultant to review the data and prepare a letter, in accordance with Condition 31. CRC agreed with the Fonterra recommendation that Golder would be most suitable for this task.
- 2) Fonterra to submit the letter and data to Carl Hanson as the CRC nominated scientist.
- 3) Fonterra to continue to monitor all bores monthly.

This letter provides Golder's review and recommendation regarding the concentrations of nitrate-N measured in groundwater around the Fonterra Darfield site, and whether they are a direct effect of Fonterra's irrigation activities. This is based on groundwater quality data from monitoring bores.

# **Regulatory Background**

The relevant conditions of resource consent CRC103594 state:

(30) Subject to condition 31, if:

(a) the nitrate-nitrogen concentration in groundwater from any of the individual downstream monitoring bores increases by more than two milligrams per litre, averaged over any two consecutive samples, above the overall average concentration of nitrate-nitrogen of groundwater from the two up-gradient monitoring bores (measured or estimated, if for some reason any data is missing) over the same time period; or

(b) the average mass load of nitrate-nitrogen as measured by the suction lysimeters installed in accordance with condition 27 and 28 exceeds 18 kg N/ha/yr,

Then the consent holder shall within 20 working days report to the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, on how it will modify its farming or wastewater operation to ensure that:

(c) the nitrate-nitrogen concentration in groundwater from all down-gradient bores is not greater than two milligrams per litre above the average concentration in up-gradient monitoring bores; and

(d) the mass load of nitrate-nitrogen as measured in the suction lysimeters installed in accordance with conditions 27 and 28 does not exceed an average of 18 kg N/ha/yr.

(31) If the nitrate-nitrogen concentration or mass load of nitrogen as set out in conditions 30 (a) and (b) are exceeded, and if an Environmental Scientist engaged by the consent holder and an Environmental Scientist nominated by the Canterbury Regional Council both agree that the cause of the exceedance of nitrate-nitrogen concentration or the mass load of nitrogen was not as a result of the discharge activities of the consent holder, then the consent holder shall not be required to comply with condition 30.



# **Groundwater Monitoring Programme**

In accordance with Condition 21 of the consent, five of the six proposed groundwater monitoring bores were drilled in August 2011 (Golder 2011)<sup>1</sup>. The bores (M1 to M6) are located on Figure 1. M2 was not drilled following discussions and agreement with CRC. M7 was identified as a pre-existing irrigation production bore. Details of the locations and characteristics of these monitoring bores can be found in Golder (2012)<sup>2</sup>.

Prior to commissioning of the Darfield milk powder plant, Golder carried out monthly groundwater monitoring on behalf of Fonterra from September 2011 to July 2012. The purpose of this monitoring was to provide baseline groundwater conditions prior to the operation of the Darfield milk powder plant. Throughout this monitoring period, bores M3 and M6 were periodically dry. Low groundwater levels were often encountered in M4 which caused sampling difficulties. The baseline groundwater monitoring programme and results are detailed in Golder (2012)<sup>3</sup>.

Monitoring then transferred to Fonterra's environmental staff from August 2012, and is continuing at present. Irrigation of consented process water commenced in August 2012 onto active irrigation areas 1, 4 and 6 (refer to Figure 1 attached).

### **Monitoring Results**

Due to the lack of monitoring data for bores M3 and M6, the focus of the water quality results is on bores M1, M4 and M5. M7 is representative of groundwater at a much greater depth and is therefore not presented, but has been included in the monitoring programme.

Bore M5 represents an "up-gradient" location as defined in Condition 22 of the consent, while bores M1 and M4 represent "down-gradient" locations. Designations of "up-gradient" and "down-gradient" are based on CRC's piezometric groundwater contours (Figure 1).

Golder's understanding of Condition 30 of the consent is that it requires a comparison between

- the two-monthly moving average of nitrate-N concentrations in the down-gradient bores (M1 and M4), with
- the overall average of nitrate-N concentrations in the up-gradient bore (M5).

As set out in Condition 30 (a), data is required to be estimated if any data is missing. A single data gap in M1 has been filled with the average nitrate-N concentration of the two adjacent months. However, there are significant data missing from the M4 record due to frequently low water levels in this bore. The nine gaps (Table 1) have been filled using the same approach as for M1, utilising the available data either side of the missing points. This means however that the missing gaps in August and September 2012 cannot be filled as they do not have consecutive data either side (August is the start of the irrigation). The unfilled monthly data are plotted with the two-monthly moving averages in Figure 2.

Condition 30 requires that the down-gradient bores' two-monthly moving averages show no more than a 2 mg/L increase in nitrate-N concentrations when compared to the average nitrate-N concentration in the upgradient bore. Figure 2 shows that this 2 mg/L (equivalent to 2 g/m<sup>3</sup>) limit is exceeded consistently from September 2011 to present, i.e., the two-monthly moving averages of M1 and M4 are always greater than 10 g/m<sup>3</sup>, which is 2 g/m<sup>3</sup> more than the average M5 concentration of 8.0 g/m<sup>3</sup>.

This trend is apparent across the period prior to operation of the Darfield milk powder plant (September 2011 to July 2012), as well as after irrigation of process water had commenced (August 2012 to present). Table 2 indicates that both M5 and M1 (up-gradient and down-gradient) showed an increase in average nitrate-N concentrations from prior to irrigation, to after irrigation had commenced. However, the down-gradient bore M4 showed a decrease in average nitrate-N concentrations over the same period. As a whole there has been no statistically significant change with irrigation, however there are significant differences between

<sup>&</sup>lt;sup>2</sup> Golder 2012. Fonterra Darfield Plant Final Groundwater Monitoring Report 2011-2012. Prepared by Golder Associates (NZ) Limited for Fonterra Co-operative Group Limited. Dated September 2012.



<sup>&</sup>lt;sup>1</sup> Golder 2011. Fonterra Darfield Plant Monitoring Bore Installation and Commissioning Report. Prepared by Golder Associates (NZ) Limited for Fonterra Co-operative Group Limited. Dated November 2011.

bores<sup>3</sup>. This indicates that there are other external factors influencing nitrate-N concentrations at the site prior to operations at the Darfield site. Furthermore the current consent condition is not applicable at the site because of the information collected showing non-compliance from baseline water quality results, prior to irrigation activities commencing.

Darfield site	Date	Up-gradient bore	Down-gradient bores	
status		M5	M1	M4
Prior to irrigation – groundwater baseline	13-Sep-2011	8.4	9.0	14.5
	17-Oct-2011	8.4	11.3	15.0
	22-Nov-2011	8.7	13.4	14.6
	15-Dec-2011	8.4	13.4	15.1
	18-Jan-2012	8.0	12.4	15.5
	23-Feb-2012	7.6	8.4	15.8
	21-Mar-2012	7.3	13.4	15.4*
	23-Apr-2012	7.0	13.3*	15.4*
	28-May-2012	8.2	13.1	15.4*
	29-Jun-2012	7.3	12.9	14.9
	26-Jul-2012	7.9	13.8	15.9
Post irrigation – groundwater monitoring of effects of Fonterra irrigation activities	31-Aug-2012	7.4	12.2	-
	10-Sep-2012	9.0	12.2	-
	16-Oct-2012	9.3	9.9	11.4
	21-Nov-2012	9.2	12.0	15.0
	19-Dec-2012	8.7	13.2	13.7
	8-Jan-2013	8.2	14.2	14.9
	13-Feb-2013	8.7	14.0	12.2*
	21-Mar-2013	7.8	13.0	12.2*
	18-Apr-2013	6.8	13.1	12.2*
	27-May-2013	5.7	11.5	12.2*
	27-Jun-2013	7.1	12.3	9.4

Table 1: Concentrations	of nitrate-N in bores M	1. M4 and M5 from Se	eptember 2011 to June 2013.

Notes: All units g/m<sup>3</sup>. \* italicised denotes an estimated value based the average of the adjacent months' nitrate-N concentrations.

Table 2: Unfilled monitorin	g data nitrate-N concentrations	prior to, and post irrigation
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Bore		Statistic	Prior to irrigation	Post irrigation
Up-gradient	M5	Average	7.9	8.0
		Range	7.0 – 8.7	5.7 – 9.3
		Count	11	11
Down-gradient	M1	Average	12.1	12.5
		Range	8.4 – 13.8	9.9 – 14.2
		Count	10	11
	M4	Average	15.2	12.9
		Range	14.5 – 15.9	9.4 – 15.0
		Count	8	5

Note: Statistics are based on actual measured values not filled values. All units g/m<sup>3</sup>.



<sup>&</sup>lt;sup>3</sup> Statistical analysis carried out using an ANOVA model.

# Recommendation

It is Golder's opinion that the cause of the exceedance of the 2 g/m<sup>3</sup> nitrate-N limit in Condition 30 of the consent, is not as a result of the discharge activities of the consent holder Fonterra. The 12 months of baseline groundwater monitoring prior to the exercise of the consent show that this limit was being exceeded before the consent holder commenced discharging.

In the 10 months subsequent to the exercise of the consent, there has been no consistent increase in the concentration of nitrate-N in groundwater down-gradient from the irrigation areas. Concentrations of nitrate-N have continued to show the variation observed in the groundwater prior to irrigation commencing.

The review carried out by Golder has shown that Condition 31 of the consent should be executed. With agreement from CRC, this would mean that Fonterra would not be required to comply with Condition 30 of the consent with respect to modification of its farming or wastewater operations to reduce nitrate-N concentrations in groundwater.

We also agree with the 10 July 2013 meeting actions; that Fonterra continue to monitor groundwater quality on a monthly basis at all of the existing bores at the Darfield site.

If you would like to discuss this further, please contact Bob Bower on 03 377 5696, or email rbower@golder.co.nz.

Yours sincerely,

### **GOLDER ASSOCIATES (NZ) LIMITED**

Sophie South Water Management Engineer

CC: Carl Hanson (CRC) Andy Barbati (CRC) Ian Goldschmidt (Fonterra)

Bob Bower Principal Hydrologist

Attachments: Figure 1: Fonterra Darfield monitoring well locations and active irrigation areas. Figure 2: Concentrations of nitrate-N in bores M1, M4 and M5 from September 2011 to June 2013.

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Figure 2: Concentrations of nitrate-N in bores M1, M4 and M5 from September 2011 to July 2013.

