Microbial Risk Assessment Summary

Environment Technical Group – 7 July 2020

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1 Introduction

In 2019 and 2020 Fonterra undertook four microbial risk assessments (MRAs):

- Spray Irrigation of Dairy Manufacturing Wastewater to Land for i) Edgecumbe, ii) Lichfield and iv) Hautapu. NIWA. February 2019
- Human Health Risk Assessment for Maungatūroto Dairy Factory. NIWA. May 2020

The aim of the studies was to assess potential human health risks from Fonterra dairy manufacturing sites processing wastewater, with particular focus on the impact from spray irrigation (through inhalation and skin contact) and diluted wastewater (from ingestion and skin contact). It is important to note that these processing wastewaters do not contain sanitary or sewage wastewater (i.e., human wastes). The conclusions of these studies are summarised in this memo and provide context for the proposed Hautapu wastewater treatment plant location (on Buxton Farm 270m from the property boundary and 750m from the nearest residential property).

2 Key background questions

2.1 Why assess the potential health risk?

From available data, the wastewater from dairy manufacturing generally has low pathogen concentrations because it consists primarily of nutrients (fats, proteins etc.) and spent cleaning chemicals. However, there is potential for wastewater nutrients to allow certain microbes that are in the raw processed materials to grow (i.e., multiply). Fonterra wanted to understand if there was a potential risk to human health from specific organisms in the milk processing wastewaters when the wastewater was discharged to a receiving environment (either land or water), as well as from aerosols generated during spray irrigation, or as a consequence of wave action.

2.2 Who provided the risk assessment?

Fonterra commissioned NIWA[1] to undertake microbial health risk assessments using established models which help predict risk.

2.3 How was risk assessed?

It's not ethical to do a test to see how many people get sick following exposure to different wastewaters. To assess human health risks, models were developed using existing information about pathogens, knowledge of wastewater treatment, handling and disposal practices, testing of Fonterra wastewaters for pathogens, the ways pathogens can get into the human body (exposure pathways), how much of the pathogen is needed to

[1] NIWA is New Zealand's leading risk assessment provider, with Dr Rebecca Stott assisted by Graham McBride as key authors; Rebecca is an environmental microbiologist with considerable experience in the assessment of public health risks associated with the disposal of wastewaters and Graham has decades of internationally renowned expertise in the health risk assessment space. NIWA is able to provide independent scientific advice and also has access to international expertise such as Soller Environmental LLC (USA) that NIWA has worked with in relation to human health effects associated with wastewaters.

establish an infection (infectious dose), and how the level of infection or illness in humans varies according to dose following exposure to those pathogens (dose-response relationships) . The models used the following parameters:

- **Pathogens present**: Milk processing wastewaters were tested for a range of key bacterial pathogens (the list of pathogens is provided in the 2020 MRA NIWA study, page 35). This list is determined using a combination of previous results, pathogens observed at other sites and expert opinion – it is not possible to test for all possible organisms. Some tests determine concentrations, other tests recorded presence or absence. This information is used to determine whether a risk is likely or not and if a risk appears likely and exceeds a risk threshold, how the risk model will be constructed.
- **Wastewater sources**: Wastewater from four different sites (Edgecumbe, Lichfield, Hautapu and Maungatūroto) was collected for pathogen testing. A number of samples were collected from different wastewater streams including raw wastewater, stored wastewater, aerated pond water and irrigated water.

2.3.1 Discharge method

2.3.1.1 Irrigation

There are two main irrigation systems used by Fonterra (assessed in the 2019 NIWA studies):

- fixed risers or pods, where wastewater is applied to land through a piped irrigation system.
- traveling irrigators or truck spreading where the irrigation areas are not as fixed.

The NIWA model considered the health risks at different hypothetical distances (between 10m and 300m) from the irrigation source to a human for the different irrigation systems.

2.3.1.2 Direct discharge into a marine receiving environment

In the 2020 study, NIWA assessed the human health risks after potential dilution and distribution as the wastewater enters the marine environment.

2.3.2 Exposure pathways

The exposure pathways investigated in these studies included (for land application) aerosol generation from spray irrigation and the discharge method, and potential infection due to inhalation and skin contact, whereas discharge to the marine environment considered mainly ingestion and skin contact, but also included aerosols.

3 Key findings

While the presence of selected pathogenic microbes was quantified for these studies, the health risk estimates are based on the potential to cause illness, rather than actual illnesses. The approaches used considered several conservative scenarios, so the risk estimates are conservative.

3.1 What is the risk from irrigation?

Results of the 2019 studies of irrigation spray, which focused on the potential health risks from inhalation of aerosols, found very low presence of pathogens. The model determined that there would be a risk for only 5% of the time for a person to become ill after a single irrigation event. An individual would need be standing 10m from the irrigation system and have repeated exposure to have a 5 in 10,000 chance of becoming ill.

The studies concluded that, on average, there was very little risk (<0.1%, i.e., fewer than 1 person in 1,000) of becoming ill from repeated exposure to the irrigation spray at distances ≥10m from the irrigation source.

3.2 What is the risk from discharge of untreated wastewater into a marine environment?

Results of the 2020 study of discharge at Maungatūroto, which focused on the potential health risks from ingestion and skin contact following discharge to a marine environment, also found very low presence of pathogens. The model determined that human health risk was estimated to be <0.01% for all dilution and impact assessment conservative scenarios. Less than minor adverse human health effects were predicted, and risks were likely to be localised.

3.3 What pathogens were found?

In general, pathogens were found rarely and in low concentrations in the milk processing wastewater samples. In most samples, the concentration of these pathogens was below testing detection levels. High concentrations of indicator bacteria were found, but this was attributed to persistence and/or natural regrowth in the nutrient-rich environment, and these did not indicate a likely human health risk (NIWA 2019, Table 4-1, Table 4-2) (NIWA 2020 Table 5-1).

3.4 What is the risk from waste activated sludge?

In the 2019 MRA, waste activated sludge (WAS) samples were taken from the Lichfield site. While faecal indicator bacteria concentrations were found to be elevated, pathogenic bacterial microbes were rarely found in WAS. Three samples contained the opportunistic bacteria pathogen *Staphylococcus aureus* (Table 4-2).

The risk of illness following exposure to WAS is greatest for wastewater operators on the Fonterra site who are in close contact with the WAS. Risk of exposure to those in the surrounding community is estimated to be low (less than <0.3%, Table 5-5).

3.5 What is the risk from aerated pond wastewater?

In the 2019 MRA for the Lichfield site, aerated pond samples were collected for microbial testing. Faecal indicator bacteria concentrations were elevated. Two samples were positive for Mycobacteria species and three samples contained *Staphylocuccus aureus* (Table 4-2).

The risk of illness following exposure to aerated pond wastewater is greatest for wastewater operators on the Fonterra site who are in close contact with the ponds. Risk of exposure to those in the surrounding community is estimated to be low (less than <0.3%, Table 5-5).

3.6 What is the risk from untreated wastewater?

In the 2020 NIWA MRA report, untreated factory wastewater samples were collected from the Maungatūroto site. Concentrations of faecal indicator bacteria measured in samples taken at the factory were lower than those from the discharge tank immediately prior to discharge via an outfall), suggesting persistence and/or natural regrowth in the pipe system. Untreated factory wastewater had low and intermittent presence of *Salmonella* and *Campylobacter* and very low concentrations of opportunistic microbes (Table 5-1, NIWA 2020 report).

The risk of illness following exposure to raw wastewater is greatest for wastewater operators on the Fonterra site who are in close contact with the plant. Risk of exposure to the community due to recreational activities in the area where the wastewater is discharged was predicted to be less than 0.1% after dilution and dispersion.

3.7 How do these results compare to other published data?

The 2019 NIWA MRA report for Edgecumbe identified bacterial pathogens that may potentially be present in dairy wastewater; these had previously be identified following analyses of dairy wastewater, including Hautapu (Figure 5.5 p 33); the 2020 NIWA MRA report for Maungatūroto dairy factory also summarises bacterial pathogen concentrations in dairy factory wastewaters, including those from Hautapu (DF6) (Table 5-2, page 47). The results suggest that although variable, wastewater from the Hautapu dairy factory discharge contains comparable concentrations of pathogens to other dairy factory wastewaters.