MEMORANDUM

To: [redacted]

From: [redacted]

Date: **20 August 2026**

Subject: **EFFLUENT LOADINGS PROPOSED TAHIMANA SUBDIVISION**

Summary

1. The proposed N loadings from irrigated effluent onto 4.6 ha are within farming permitted activity levels and the estimated N losses are significantly lower than farming over the total subject land.
2. The estimated P loadings on a per hectare basis may be slightly higher than under farming of the subject land (on a per hectare basis) however the total loadings over the 4.6 ha effluent area are significantly lower than farming all of the subject land.
3. Nutrient loadings and losses can be managed so the effects are considered less than minor.

Purpose

To assess the nitrogen and phosphorus loadings from the irrigated effluent for the proposed Tahimana subdivision.

N loadings from pastoral farming

The subject land is suitable for a stocking rate of 4-6 su/ha and typically the farm system on this site would be beef cattle finishing. Modelling this system in OverseerFM shows the following:

- N inputs from fertilizer of 50 kg N/ha
- N inputs from rain and legume fixation of 70 kg N/ha

The total N inputs under a pastoral regime are 120 kg N/ha/yr and over 65 hectares is 7,800 kg N.

For comparison the following inputs are at the permitted activity status for dairying:

- Up to 190 kg N/ha from fertilizer
- 150 kg N/ha from effluent
- Typically, about 150 kg N/ha from other sources.

The total N inputs under dairying for a permitted activity status are 590 kg N/ha. Extrapolating this over 65 ha is 38,350 kg N/yr.

N Loadings from the proposed subdivision

Potential nitrogen loading has been assessed by David Carison-McColl[1] as follows:

- *Maximum 83m³/day effluent production (dilution occurs in wet weather)*
- *Average 42m³/day effluent production*
- *Maximum design land application rate of 2mm/day with a 4.6 ha of primary effluent disposal field*
- *Average land application rate of 1mm/day*
- *Nitrogen concentration of 25-60mg/L in treated effluent.*

Based on the anticipated range of average to maximum flow, the nitrogen application is 92-222 kg/Ha per year. Based on the calculated average load, the anticipated nitrogen application rate is 92 kg/Ha per year. Theoretically, it would be possible to exceed the recommended maximum nitrogen application rate of 200 kg/Ha per year if a consent limit for nitrogen is not imposed. It is recommended to volunteer a nitrogen limit of 34mg/L as a condition of consent. This will ensure that even if the system operates at 50% greater than anticipated average flows, the annual average nitrogen loading rate will be less than 200kg/Ha per year. T

The total N inputs are:

- The annual average nitrogen application rate is 92 kg N/ha/yr and the estimated maximum is 222 kg N/ha/yr over 4.6 ha. If this N input is analyzed over the whole 65 ha (since the area outside the effluent irrigation field will not be receiving N but is still part of the 65 hectares) then the average N concentration ranges from 6.5 kg N/ha/yr or a maximum of 15.7 kg N/ha/yr.

The following table compares the N inputs from the proposed subdivision, a beef fattening system and a typical dairy system.

System	N Inputs/ha/yr	Total N inputs
Proposed subdivision	Average of 92 kg N/ha/yr over 4.6 ha Estimated maximum of 222 kg N/ha/yr over 4.6 ha (Average of 6.5 kg N/ha/yr or an estimated maximum of 15.7 kg N/ha/yr over 65 ha).	Average of 423.2 kg N/yr or an Estimated maximum of 1,021 kg N/yr
Beef finishing system	120 kg N/ha/yr	7,800 kg N/yr
Dairy system	590 kg N/ha/yr	38,350 kg N/yr

[1] Carison-McColl, D. (2026). Stormwater, Wastewater and Water Servicing Assessment Tahimana Limited.

In summary:

- The proposed subdivision N inputs per hectare are within the permitted activity status for farming and the total N is significantly reduced (compared to beef or dairy systems) under the proposed development.

N uptake

Pasture plants require a baseline concentration of 3-5% nitrogen per tonne of dry matter to support healthy growth. This means that for every 1,000 kg dry matter pasture must take up 30 to 50 kg N from the soil[2]. For this site the estimated dry matter potential is 6-7 T/ha/yr.

A growing manuka stand for example, has a total N uptake of 20 to 50 kg N/ha/yr which is considered low compared with pasture and significantly lower than the N inputs from effluent. Even though its active uptake is low, manuka alters soil chemistry and has a disproportionately powerful impact on nitrogen management. Mānuka roots secrete secondary compounds (such as triketones and monoterpenes) into the soil, and these chemicals actively inhibit soil bacteria responsible for nitrification (the process that converts stable ammonium into highly mobile nitrate). By locking nitrogen in the ammonium (NH_4^+) form, mānuka prevents the nitrogen from converting into nitrate (NO_3^-), which is the form most prone to leaching.

Because of this root chemistry and high water use, mānuka acts like an environmental sponge when planted in riparian zones. In trials undertaken by Plant and Food[3] where young mānuka stands were dosed with simulated urine patches equivalent to 800 to 950 kg N/ha the soil under the mānuka showed drastically less nitrate accumulation and a 21% to 80% reduction in total nitrate leaching compared to traditional grassed or pine plots.

When a high-nitrogen load like municipal effluent is applied to native bush, the ecosystem undergoes a dramatic metabolic shift. Under these artificial conditions, the total plant nitrogen uptake increases substantially to 60 to 120+ kg N/ha per year. If the application exceeds this the bush cannot absorb the entire application because it exceeds the natural capacity of native vegetation and therefore a significant portion of the remaining nitrogen is processed through soil microbes or lost to the environment.

The ecosystem handles this effluent loading through specific pathways including:

[2] DairyNZ. Farmfact 7-11: Seasonal nitrogen use. Retrieved 14 March from https://www.dairynz.co.nz/publications/farmfacts/fertiliser-and-nutrient-management/farmfact-7-11/.
[3] Halford, S., Gutiérrez-Ginés, M.J., Rees, A. *et al.* Effect of mānuka (*Leptospermum scoparium*) on nitrogen and *Escherichia coli* reductions in soils: a field experiment. *Plant Soil* **465**, 491–502 (2021). https://doi.org/10.1007/s11104-021-05035-3

1. **Plant uptake performance (60-120+ kg N/ha/yr)[4]:** While undisturbed native bush naturally takes up less than 30 kg N/ha/yr, the sudden luxury supply of nitrogen triggers "luxury consumption" and rapid biomass growth:
    - **The Ceiling:** Native trees (like Beech, Podocarps, or Broadleaves) have a much slower growth rate and a lower metabolic ceiling than commercial ryegrass pasture. They generally cap their maximum annual uptake at around **100 to 120 kg N/ha/yr**, even when oversupplied.
    - **Understorey Response:** Shrubby understorey species and nitrophilic native ferns/groundcovers account for a large portion of the increased uptake, rapidly storing the surplus N in new leaf biomass.
2. **Microbial Immobilisation & Storage (30 – 60 kg N/ha/yr)[5]:** Native bush soils have an exceptionally high Carbon-to-Nitrogen (C:N) ratio (often >20) due to thick layers of woody leaf litter. When nitrogen-rich effluent hits this carbon-dense floor, soil microbes experience a feeding frenzy and absorb and "lock up" (immobilise) an estimated 30 to 60 kg N/ha of the applied effluent into organic matter. This safely stores the nitrogen in the soil matrix, attenuating nitrogen leaching.
3. **Denitrification (20 – 50 kg N/ha/yr)[6]:** Because effluent adds both water and nitrogen, it creates localized anaerobic (oxygen-depleted) zones in the dense, damp forest soils. Soil bacteria utilize this environment to convert mobile nitrate into harmless nitrogen gas (N_2) through denitrification. In well-established native plantation settings receiving wastewater, denitrification can purge 20 to 50 kg N/ha/yr directly into the atmosphere as a gas.

In summary:

- The uptake of N from native bush is significantly less than pasture.
- Some native bush species such as manuka can alter the soil chemistry and actively inhibit soil bacteria responsible for nitrification and N leaching.
- Although the N uptake from native bush may be low, a luxury supply of N triggers luxury consumption and rapid biomass growth.
- The high C:N ratio of native bush soils accelerates microbial activity and effectively immobilises N.

N losses

Overseer modelling shows that N losses to water under a beef finishing operation for the site would be about 11 kg N/ha/yr. Over 65 ha this is about 715 kg N/yr.

Under dairying land use, typical N losses will range between 28 kg N/ha/yr through to more than 65 kg N/ha/yr.

[4] Franklin, H. (2024). The interaction of New Zealand Native Plants with Nitrogen in Canterbury's Agricultural Landscape. PhD. Lincoln University.
[5] Galloway, J.N., Aber, J.D., Erisman, J.W., Seitzinger, S.P., Howarth, R.W., Cowling, E.B., & Cosby, B.J. (2003). The Nitrogen Cascade. BioScience, 53, 341-356.
[6] Lowe Environmental Impact (2025). Assessment of Environmental Effects for Discharge of Wastewater to Land. A report for RCL Homestead Bay Limited.

The following table shows the processes (and N losses) occurring under effluent irrigated native bush for the range of N applied (92 kg N/ha to 222 kg N/ha).

	Low range end (92 kg N/ha/yr)	**High range end (222 kg N/ha/yr)**
Plant uptake (stored in biomass)	About 60 kg N/ha/yr	About 100 kg N/ha/yr
Soil microbial immobilisation (locked in leaf litter)	About 25 kg N/ha/yr	About 50 kg N/ha/yr
Denitrification (gas released to air)	About 6 kg N/ha/yr	About 40 kg N/ha/yr
Leaching risk (lost to ground water)	About 1 kg N/ha/yr	About 32 kg N/ha/yr

Of biggest interest is the N loss to ground water. Over the total effluent application area, the range is about 5 kg N to 147 kg N. In comparison, under a beef finishing system, it is about 715 kg N. The N loss from the proposed system is significantly lower than under a pastoral system.

P Loadings

Native forest is not a large user of phosphorus and typically require less than 1 to 3 kg P/ha/yr[7]. The soil microbes under native forest on the other hand actively processes and turns over 18 to 36 kg P/ha/yr[8], acting as a transient storage system that slowly feeds plant roots without letting phosphorus sit loosely in the soil. Leaching of phosphorus is virtually zero. Generally, any phosphorus lost from the system is lost attached to sediment. With adequate vegetative cover and other wastewater disposal field design parameters such as slope controls, the risk of this is considered minimal.

There is the risk of rapid P saturation considering the soil type and its low anion storage capacity. Typically, the effluent will have a N to P ratio of between 10:1 and 5:1 ratio[9] meaning that 15 to 45 kg P/ha is applied. At the low end of the range, P accumulation will not be a problem when soil microbes turn over 18 to 36 kg P/ha and plants take up 3 kg P/ha. If the P levels are at the high end of the range, there will be a build-up or spike of Olsen P levels in the soil. The excess then becomes available for transport. To minimise this transport the effluent application area should have a minimum of 20 m setback from any stream or drain, effluent will be applied in small, frequent pulses to prevent the A and B horizons from becoming saturated down to the clay horizon.

[7] Parfitt, R.L, W. T. Baisden & A. H. Elliott (2008) Phosphorus inputs and outputs for New Zealand in 2001 at national and regional scales, Journal of the Royal Society of New Zealand, 38:1, 37-50, DOI: 10.1080/03014220809510545

[8] Sparling, G.P, P.B.S Hart, J.A. August and D.M Leslie (1994): A comparison of soil and microbial carbon, nitrogen, and phosphorus contents, and macro aggregate stability of soil under native forest and after clearance for pastures and plantation forest. Bio Fetil Soils Vol 17 pgs 91-100. https://doi.org/10.1007/BF00337739.

Vegetation species selection will be critical for the success of the effluent field. There are fast growing pioneer trees and shrubs (woody vegetation) that act as opportunistic sponges when nutrients become available and take up significantly more than 3 kg P/ha.

If, under the worst scenario there is an excess of 6 kg P/ha/yr under effluent irrigation, then over the total irrigation area there could be up to 27.6 kg P lost.

Under pastoral farming, the P requirements for maintenance are about 10 kg P/ha/yr. Over 65 ha this is about 650 kg P. Typical P losses under farming would be about 2 kg P/ha/yr as calculated by Overseer or 130 kg P over the 65 ha.

In summary: P lost from pastoral farming the 65 ha is estimated at about 130 kg P whereas under the proposed effluent irrigation the worst-case scenario could be 27.6 kg P. The effects from farming are considered significantly greater than the proposed subdivision.