PATTLE DELAMORE PARTNERS LTD
PDP House, Level 5
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 523 6900 Fax +64 9 523 6901
Web www.pdp.co.nz
Auckland Hamilton Tauranga Wellington
Christchurch Invercargill

solutions for your environment

memorandum

TO	Robyn Burns	FROM	Ella Boam
	Central Hawke's Bay District Council	DATE	11 November 2021
RE	Springhill Farm Holdings – Wakarara Road/SH50 Subdivision Cumulative effects assessment for wastewater discharge		

1.0 Introduction

Springhill Farm Holdings (the Applicant) have applied to Central Hawke's Bay District Council (CHBDC) for resource consents to subdivide an area of rural land, located on the corner of Wakarara Road and SH50, into a 312-lot subdivision. It is proposed that each lot will be serviced by onsite wastewater systems and that the discharge will be via sub-surface drip irrigation lines.

Both CHBDC and Hawke's Bay Regional Council (HBRC) have concerns that this number of onsite wastewater discharges could cumulatively lead to adverse effects on the receiving environment. CHBDC has therefore engaged Pattle Delamore Partners (PDP) to undertake a review of the supplied information and consider the potential for adverse cumulative effects on groundwater and surface water quality.

The key information reviewed as part of this assessment is:

- Preliminary on-site wastewater management site evaluation report (Freeman Cook Associates Pty Ltd., 2021a); and
- Loading from on-site wastewater management and cumulative effects Springhill subdivision evaluation report (Freeman Cook Associates Pty Ltd., 2021b).

2.0 Site Description

Details of the local setting of the subdivision site can be summarised as:

- The proposed development site is located at the intersection of SH50 and Wakarara Road, Ongaonga. The land is generally flat, with a slope of less than 5% and generally less than 1%.
- The land is currently held in pasture for sheep and beef grazing. The surrounding land is rural and is utilised for a variety of agriculture and horticultural uses.
- The development site is mapped to be underlain with Quaternary aged alluvium comprising gravel, sand, silt and mud (Lee *et al*, 2011). Bore 5834 within the development site indicates that the upper 10 m of sediment consists of gravel with clay, which is consistent with stratigraphic logs in the wider area.
- The site has three mapped soil types; Bushgate, Mangatewai and Tararu (Manaaki Whenua S-Map). The Bushgate and Tararu soils are loamy to sandy and classed as well-draining, with rapid to moderate permeability over 1.0 m of soil. They have a high topsoil phosphorus retention (66%). Mangatewai soil is a poorly-drained and loamy soil and has a low topsoil phosphorus

retention (22%). The permeability is rapid to moderate in the upper 0.3 m but decreases to slow (<4 mm/hour) below 0.3 m depth. There is a rooting and permeability barrier at 0.4 m depth.

- The site is located within:
  - The Tukituki catchment and Kahahakuri sub-catchment;
  - Ruataniwha South - Tukituki Water Management Zone (WMZ); and
  - Ruataniwha Basin South - Tukituki Catchment Groundwater Allocation Zone.
- The Waipawa and Tukituki Rivers are located approximately 1.2 km north and 5 km south of the site, respectively. Both rivers flow generally northwest to southeast.
- Two tributaries to the Kahahakuri Stream pass through the southern end of the site, which are also aligned northwest to southeast. The two channels enter the site from the west, before converging into one channel. The stream leaves the site under SH50 at Chestermans Bridge. Both streams are noted by the Applicant to be ephemeral and can act as drainage for overland flow in rain events.
- The Kahahakuri Stream is primarily groundwater fed and is thought to receive water from the Waipawa River via shallow groundwater (HBRC, 2012).
- A series of paleochannels are visible across the site and wider area. Paleochannels are former stream flow paths that no longer have surface flow and may act as preferential flow paths for groundwater.
- Surface water drainage is towards the southeast, parallel to the local river and stream flow direction. Shallow groundwater is expected to predominantly follow this direction but may locally flow towards surface water bodies. The minimum depth to the shallow groundwater system is of the order of 2.5 m but could be more than 6 m over the summer months, based on the levels monitored in HBRC Bore 16249.
- The site is within the mapped confined portion of the Heretaunga – Ruataniwha Aquifer System (HBRC RRMP, 2006). Based on bores in the area, this system is thought to be more than 40 m depth locally and is separated from the ground surface and shallow unconfined groundwater system by low permeability confining material. The aquifer (Heretaunga – Ruataniwha Aquifer System) is mapped as unconfined approximately 2.8 km southeast of the development site.

3.0 Proposed Treatment and Discharge

The Applicant's consultant originally assessed three potential discharge methods for treated domestic effluent, based on the soil types present at the site. These were stated as trench, bed or subsoil drip methods (Freeman Cook Associates, 2021a). HBRC have since indicated that the disposal method for the site will be via sub-surface drip irrigation lines, in line with Freeman Cook Associates (2021b).

While various hydraulic loading calculations have been presented by the Applicant's consultant which cover off all three disposal types (Freeman Cook Associates, 2021b), the proposed discharge method has been assumed to be sub-surface drip irrigation for the purpose of this review. According to Freeman Cook Associates (2021a), this disposal method is likely to comprise:

- A design loading rate of 4 mm/day, discharged over an area of 270 m^2;
- 1080 or 3000 drippers with either 0.36 or 1 L volume per dripper; and
- Dripper spacing of either 0.3 m or 0.5 m.

The variation of the number of and spacing between drippers, as well as the volume per dripper is due to the variable soil types present at site (Freeman Cook Associates, 2021a). It is noted that this design has been undertaken assuming a daily discharge of 1080 L/day per lot. If the discharge per lot was 1200 L/day (based on 6 people and 200 L/p/day), the disposal area is likely to increase to approximately 300 m^2 to maintain the design loading rate.

Freeman Cook Associates (2021a) also recommends that, to avoid nitrogen and phosphorus accumulation, the herbage on the irrigation areas should be removed following cutting, which is a "cut-and-carry" system.

3.1 Potential Contaminants

The specific details of treatment have not been provided in the application. However, the Applicant has confirmed that the wastewater will undergo secondary treatment, as well as UV disinfection. The scope of this review is to assume nutrient levels within the published range for secondary treatment systems with UV disinfection, which are outlined below in Table 1. Depending on the treatment system used, the concentrations of key nutrients will vary but should typically be lower than those presented in Table 1.

Table 1: Expected Effluent Quality [1]

Indicator	Concentration
Total Nitrogen (g/m^3)	< 40
Total Phosphorus (g/m^3)	< 10
Faecal Coliforms (cfu/100mL)	≤ 200

Notes
[1] *Values are from GD06 (ARC, 2021) – Advanced secondary treatment with disinfection*

4.0 Nutrient Loading

The Applicant's consultant has undertaken an assessment of the likely nutrient loading at the Springhill subdivision site under both the current land use (grazing) and following the development of the subdivision (312 lots discharging wastewater to land). The nutrient loading derived from each scenario has been compared to determine the potential effects on the environment. A summary of the assessment assumptions and derived nutrient loads is provided below:

- For the current land use scenario, the nutrient loads and losses have been derived from:
  - An assumed stocking rate of 32 su/ha has been used. The HBRC RRMP considers a low intensity farming system as less than 8 su/ha, which is much lower than the assumed stocking rate;
  - An assumption of 4 stock units per cow to give 8 cows/ha, which we consider to be a very high and unrealistic stocking rate for dryland farming;
  - A median value for heifers and dry cows has been used to determine the amount of nitrogen load per cow;
  - The phosphorus load has been derived from an average daily volume of faeces per cow;
  - A published pasture production value has been used to calculate the dryland grass productivity at the site. This has then been used to calculate the plant uptake of nitrogen (2.5% of dry matter);
  - A regional value of 71 kg/ha/year for denitrification losses has been used;
  - Plant uptake for phosphate has been assumed as 0.5% of dry matter (phosphorus loss); and

   - The assessment does not incorporate any nitrogen or phosphorus input from fertilisers.
- For the proposed subdivision wastewater discharge scenario, the nutrient loads and losses have been derived from:
   - Concentrations for nitrogen (stated as ammonium) and phosphorus of 30 g/m^3 and 7 g/m^3 have been adopted, which are typical for secondary treated effluent.
   - Annual application of 394 m^3/year (1080 L/day per lot) over an area of 8.4 ha (equivalent to 312 lots with a 270 m^2 disposal bed).
   - The value used for grass production (17,000 kg DM/ha/year) is considerably higher than used for the present-day land use (13,932 kg DM/ha/year), which the Applicant notes is because there will not be a water deficit under irrigation. Using the same percentage of plant uptake of nitrogen (2.5%), this leads to much greater rate of nitrogen removal (348 kg/ha/year vs. 425 kg/ha/year)
   - A different denitrification value of 74 kg/ha/year has been used. This is higher than that used in the present-day scenario.
   - Plant uptake for phosphate is the same as the present-day scenario at 0.5% of dry matter.

The assessment concludes that the wastewater discharge would result in no net loss of nitrogen, where more uptake than discharge would occur. However, an excess phosphorus of the order of 17 kg/ha/year was calculated. The Applicant's consultant concludes that the assessment is conservative because of the assumed discharge volumes and that there will be no nutrient impact from the dripper irrigation system from nitrogen, and the calculated phosphate accumulation would still be less than the present land use.

For bacteria, the Applicant's consultant has assessed that the intensity of loading from the subdivision is double that of the current land use, as a result of concentrating the load within disposal beds. It is indicated that as a result of this, tertiary treatment (UV disinfection) has been agreed. No further assessment is provided but it is stated that the bacteriological loading will be orders of magnitude less than the present land use.

The assessment provided by the Applicant is considered to largely use non-conservative assumptions when assessing the potential nutrient leaching expected from the proposed wastewater discharge. Of key concern is the calculated plant uptake of both nitrogen and phosphorus. While the percentage of plant (grass) uptake of both of these nutrients seem reasonable, although on the high side for phosphorus (2.5% and 0.5% respectively), the calculated plant uptakes of 425 kg/ha/year and 85 kg/ha/year are high compared to some published values and local calculations:

- Work previously undertaken by PDP in the Takapau area indicates nitrogen uptake of around 250 kg/ha/yr for land irrigated with meat processing effluent (PDP, 2020);
- On-site Wastewater Systems: Design and Management Manual (TP58) identifies a nitrogen uptake of 80 to 100 kg/ha/year for grass (ARC, 2004);
- Work undertaken for other wastewater discharges in the Ruataniwha Basin, including for meat processing effluent irrigation, indicates uptake rates for phosphorus of 15 – 20 kg/ha/year; and
- Vanderholm (1984) suggests a typical value of phosphorus uptake of 30 kg/ha/year for grass.

As a result of the estimated uptake rates and an assumption by the Applicant of even uptake year round, the conclusions of the Applicant's assessment are that there will be no nutrient impact from nitrogen and that the assessed excess phosphorus concentration will be less than present-day land use. Consequently, any potential effects on groundwater and surface water have not been further considered by the Applicant. As identified above, we consider the current land use simulation has used non-conservative assumptions including a very high and unrealistic stocking rate for dry land farming. For the wastewater discharge, no consideration has been given in seasonal variability in plant uptake, for example lower growth rates in winter.

A more conservative assessment of potential effects has therefore been undertaken to assess the cumulative effects of the proposed wastewater discharge using alternative assumptions for the nutrient uptake. The parameters used and outcomes of this assessment are provided in Section 5.0 below.

It is important to note that the assessments undertaken by the Applicant and as part of our review rely on a “cut-and-carry system”, which is where the grass is mown and removed from the drip-line irrigation areas. If this does not occur, the potential nitrogen and phosphorus leaching would be much greater because the nutrients applied and used by the plants are not being removed from the drip-line irrigation areas.

5.0 Assessment of Effects

To assess the potential cumulative effects from the subdivision (312 lots), a conservative scenario has been assessed. The assumptions associated with this scenario are:

- The discharge method has been assumed to be sub-surface drip irrigation;
- The maximum discharge rate of 1,200 L/d per lot has been used and assumed to be consistent across the whole year;
- Average concentrations for each contaminant in secondary treated effluent have been assumed based on the published values in GD06 (ARC, 2021). To align with the assessment undertaken by the Applicant’ consultant, values of 30 g/m^3 for total nitrogen and 7 g/m^3 for total phosphorus have been used;
- The disposal area of each lot has been assumed as 300 m^2;
- No denitrification losses have been assumed;
- Wastewater contaminants may enter the groundwater system but there will be some attenuation and uptake of nutrients between the discharge points and the groundwater system, on the basis of the cut and carry system proposed by the applicant (removal of grass from the drip line areas):
  - The plant (grass) uptake for nitrogen has been assumed as 250 kg/ha/yr; and
  - The plant (grass) uptake for phosphorus has been assumed as 20 kg/ha/yr;
- All contaminants which enter the groundwater system will discharge into the tributary to the Kahahakuri Stream, either adjacent to the site or further downstream;
- The static groundwater level has been assumed as 2.5 m below ground level. This is based on groundwater levels from bore 16249 (within the development site); and
- The composition of the soil up to 0.3 m below ground level has been assumed to be sandy loam, underlain by 2.2 m of sand.

The use of dripline irrigation as the disposal method requires wastewater to first be filtered to reduce the potential for clogging of the emitters. The Applicant has noted that, depending on the treatment system used on each lot, the phosphate concentration within the wastewater may be lower than the 7 g/m^3 used in this assessment.

The second assumption is conservative given that the maximum flow allows for continuous 6-person occupancy in each lot (200 L/p/day). The average daily flows across the whole subdivision are likely to be smaller than that assumed.

5.1 Nutrient Loading

Based on the assumptions outlined above, this assessment has identified that the proposed wastewater discharge could result in an excess of nitrogen and phosphorus being discharged to the environment i.e. more is discharged within the wastewater than up-taken by natural processes. A nitrogen excess of 188 kg/ha/year (438 kg/ha/year input and 250 kg/ha/year assumed plant uptake) and 82 kg/ha/year (102 kg/ha/year input and 20 kg/ha/year output through plant uptake) of phosphorus has been estimated. The potential effect of these loads on the groundwater system and surface water bodies are discussed in the following sections.

Over the entire subdivision, this simple and conservative estimate of nutrient leaching would give a total potential leaching of 1,760 kg/year of nitrogen and 768 kg/year of phosphorus, although is acknowledged that drip-line irrigation to topsoil provides for significant retention for phosphorus.

It is important to note that, even if the total annual uptake exceeds the nitrogen load on the wastewater disposal fields, when considered on a seasonal basis, there is still expected to be leaching of nitrogen in cooler months when plant uptake is lower.

The actual nitrogen uptake rate will depend on grass type and frequency of mowing and grass removal (cut and carry) or grazing on the disposal fields. Maintenance measures could be specified as a requirement to help increase the plant uptake.

While the leaching beneath the drip-line irrigation areas may appear high, given the large nature of the lot sizes over the 220 ha area, average leaching over the entire site will be significantly less than when considered just over the wastewater drip-line irrigation areas. Consideration has been given to the net nutrient loading in the wastewater discharge (excluding additional nutrients from fertiliser use on gardens, lawns or pasture or animal grazing on some of the lots, which range from 4,010 m^2 to 1.5 ha). This gives an average nitrogen loading rate of 18.6 kg/ha/year and phosphorus loading rate of 4.3 kg/ha/year. The actual leaching values averaged over the subdivision would be expected to be significantly less than these loading rates, although this would depend on how the land on the properties is used.

While we consider that the Applicant's assessment of nutrient loading from grazing cattle, which is based on the current sheep and beef grazing at the site, is overestimated given the high stocking rates used, it is acknowledged that nitrogen loading (and subsequent leaching) from the current land use could potentially reduce with the change to residential land use.

Information provided by HBRC indicates that a farm environment management plan (FEMP) was completed in 2018 for part of the property that was leased by a neighbour. A summary record of the FEMP indicated use for sheep and beef across three blocks (including 200 State Highway 50, Ongaonga, title numbers HBA2/1134, HBG1/1065). The modelled nitrogen loss to water was 28 kg/ha/year, although it was not clear how the leaching was split across the three blocks and the other blocks reportedly may have had more intensive land use. If the leaching was 28 kg/ha/year on the site, this would give a total nitrogen leaching rate of 6,160 kg/year across the entire site. The modelling phosphorus loss was 0.2 kg/ha/year across all blocks, which if this were applicable to the site, would indicate a total phosphorus loss of 44 kg/year. There are significant limitations with this nutrient leaching data given it is not clear how the leaching split occurs between blocks, and that the losses were modelled using Overseer version 6.2.3 for one year only.

Based on the above, the estimate of nitrogen leaching for the current land use is higher than the leaching estimated for the proposed wastewater discharges of 1,760 kg/year across the 312 lot subdivision, although this assumes no additional sources of nitrogen and, as outlined above, the leaching from the current land use may be overestimated. The surplus of phosphorus (768 kg/year) is significantly higher for the wastewater that the current leaching estimate, but it is acknowledged that there will be significant retention in the topsoil with drip-line irrigation, although there is a higher potential for phosphorus losses, including via run-off, on the Mangatewai perch-gley soils present across part of the site.

More detailed modelling that allowed for the change in land use and allowed for seasonal changes in plant uptake would be required to obtain a more refined estimate of nutrient changes. However, if necessary, we consider it may be reasonable for the future nutrient leaching to be less than the current land use, and this could form part of a requirement for the change in land use/subdivision, supported from appropriately detailed calculations.

5.2 Effect on Groundwater

The relatively shallow depth to groundwater and the nature of the soils and underlying strata in the wider area of the site suggest that treated wastewater is likely to infiltrate relatively rapidly into the shallow groundwater system, when field capacity is exceeded in the soils beneath the disposal fields and drainage occurs. Most of this leaching is expected to occur in the cooler months, as in a dry climate, soil moisture will be below field capacity for much of the time in the warmer months, given the relatively low application rate of 4 mm/day.

The hydrological setting indicates that groundwater is likely to predominantly flow towards the southeast but may also locally flow towards the tributary to the Kahahakuri Stream at the southern end of the site. Given that the Kahahakuri Stream is primarily fed by groundwater (including from the Waipawa River) most groundwater is expected to eventually discharge into the stream, whether into a branch adjacent to the site or further downstream (HBRC, 2012). The potential effect on these surface water bodies is discussed below in Section 5.3.

There are a number of known bores, both within the proposed subdivision site and in the surrounding area. There are two existing bores within the development site (5834 and 16249), three bores near the site boundary at the western edge (2730, 10916 and 4956) and eleven bores down-gradient of the site within 1 km. There are other bores in the wider area, however they are up-gradient of the site and therefore unlikely to be affected by the proposed discharge. There are also a number of additional bores down-gradient of the subdivision area which are more than 1 km away.

Of the sixteen bores around the site (down-gradient and within 1 km distance), the majority are screened within the confined portion of the Heretaunga – Ruataniwha Aquifer System. Three of these bores are consented for water abstraction for a mixture of domestic, agricultural, and horticultural uses. Of the information available, only one bore is screened within the shallow groundwater system. This is the HBRC monitoring bore (16249) which does not have an associated consented take.

Bores screened within the upper groundwater system (above the confining layers) may be at greater risk of nutrient and microbial migration down-gradient of the subdivision. This may be of particular risk where preferential flow paths (paleochannels) connect the groundwater beneath the subdivision to down-gradient bores. While there is only one bore noted to be screened within the shallow groundwater system, there is a risk that bores further than 1 km downstream may be influenced by increased contaminant loads, should they occur. Bores screened within the lower, confined aquifer are separated from the shallow groundwater system and less likely to be affected by any increased nutrient loads by confining layers reducing vertical mixing, although this will depend on vertical gradients and flow. It is noted that further downstream of the subdivision, the aquifer becomes unconfined. Any increase in nitrogen loading will ultimately contribute to an increase in nitrogen within groundwater in the wider groundwater system, in the absence of denitrification.

Risks associated with contaminants discharging into groundwater are a key issue to be assessed. Water quality data from the shallow groundwater system has been obtained from bore 16249 (14 m deep) which is located adjacent to the subdivision site near the corner of SH50 and Wakarara Road. The data from this bore indicates that the current 5-year median concentration of nitrate-nitrogen is 8.2 mg/L, which is below the NZDWS Maximum Acceptable Value (MAV) but above the half MAV value of 5.65 mg/L, and only one instance of E. Coli detection has been identified since 2014. The 5-year median for dissolved reactive phosphorus (DRP) is currently 0.01 mg/L.

To assess the potential effect from the wastewater discharge, the possible increase in concentration of total nitrogen and phosphorus has been compared to these parameters. It is noted that we have assumed that all nitrogen will be converted to nitrate-nitrogen and conservatively assumed all phosphorus would be in the form of DRP.

The proposed wastewater discharge indicates that the concentration of nitrogen could increase by 26%, for the conservative scenario where there is no accounting for the current leaching from the existing land use. However, as described above, there will be leaching from the current agricultural land use and this could decrease with the change in land use to the subdivision, depending on other nutrient inputs from the subdivision. Therefore, no actual increase may actually occur. Restrictions could be placed on the development to ensure this is the case or an improved standard of treatment for nitrogen could be required.

The potential increase in phosphorus in groundwater would appear to be considerably higher when comparing the difference between the wastewater loading rates and plant uptake, however significant retention in soils is expected to occur. Over time however, phosphorus levels in the soil could increase to a level where leaching occurs. The Mangatewai soils have a greater potential for phosphorus run-off and leaching, due to their greater susceptibility to saturation and lower phosphorus retention. To minimise the risk of phosphorus losses, options include requiring reduced phosphorus levels in the discharge or soil testing to check Olsen P levels, which if high would indicate a need to relocate the disposal areas. We recommend a lower hydraulic loading rate is required for the Mangatewai soils. The 4 mm/day proposed appears to be in accordance with the Hawke's Bay Regional Resource Management Plan (RRMP) for loams (Table 6.2.1), however, given the issues with drainage in these gley soils, we recommend a lower maximum rate of 2 mm/day to reduce the potential for soil saturation and run-off.

The calculated increase in nitrogen has the potential to locally elevate the concentration of nitrate-nitrogen, although this is not estimated to exceed the NZDWS MAV of 11.3 mg/L as a median level, although spikes above the MAV have occurred in bore 16429 and could occur more frequently with an increase in nitrogen discharge, should that occur. However, this depends on the nitrate-nitrogen concentration within the discharge and the hydraulic nature of the shallow groundwater system (porosity, hydraulic conductivity etc.). While the DWSNZ do not specify a MAV for phosphorus or DRP, high concentrations will influence stream health where groundwater discharges to surface water.

As UV disinfection of the secondary treated effluent has been agreed, the discharge is expected to have a relatively low concentration of faecal coliforms, including E. coli (Table 1). The nature of the underlying geology in the drip-line irrigation areas and vadose zone suggests that over 90% of the remaining faecal coliforms could die-off prior to reaching the groundwater system. Significant dilution will also occur one the discharge reaches the groundwater system. The concentration of the indicator species E. Coli is therefore unlikely to have measurable effects on the groundwater system and the associated risk from microbial pathogens is considered low. However, while not considered an issue for effects on current bores based on the information provided, if each household or groups of households in the subdivision are supplied by a bore, it will be important that the distances between the drip-line irrigation areas and the bores are maximised, that the bores are of a suitable depth and that they receive appropriate treatment to minimise the risk of contamination.

Given the possible increased nitrogen loading to groundwater, there is also a risk that bores constructed within the subdivision may be at risk from water quality that does not meet the DWSNZ MAVs without treatment, depending on their location relative to the drip-line irrigation areas and whether there is an actual increase in nitrogen leaching from the subdivision. However, bores that are screened within the deeper, confined aquifer are unlikely to be affected by the discharge, so long as they are appropriately constructed and sealed to prevent cross contamination between the water-bearing units. The current 5-year median concentration of nitrate-nitrogen in the deeper aquifer is 1.3 mg/L.

5.3 Effect on Surface Water Bodies

As indicated in Section 5.2, the Kahahakuri Stream is primarily fed by groundwater and most groundwater is expected to eventually discharge into the stream, either at the subdivision site or further downstream. Based on the available information, it has been conservatively assumed for this assessment that shallow groundwater will discharge into the Kahahakuri Stream (and its tributaries). In this situation, there is the potential for a reduction in surface water quality, if there is a net increase in nutrient leaching across the site.

The subdivision site is located within the Kahahakuri catchment and is subject to specific targets to reduce nutrient levels, which have been set in the Tukituki Catchment Plan (PC6). Water quality data indicates that the stream is already in band D (as outlined in the NPS 2020) for DRP and that the median concentration of nitrate-nitrogen exceeds the NPS bottom line and within the worst 25% of sites measured across the country (LAWA, 2019). The concentration of Escherichia coli (E. coli) is currently rated in band B (NPS 2020) and the concentration of nitrogen (DIN) is significantly higher than the PC6 target. Given that the stream is already failing to meet some water quality targets, any potential addition of further contaminants needs to be carefully considered.

Assessment of the contribution of contaminants to the Kahahakuri Stream has been undertaken based on flow and water quality data from 'Kahahakuri Stream U/S Tukituki Confl'. This site is approximately 4 km down-gradient from the development and the flow is therefore expected to be higher than adjacent to the development. It is noted that sampling undertaken at the Kahahakuri Stream Tributary at SH50, Chestermans Bridge (adjacent to the subdivision site) in 2015/2016 indicated concentrations of nitrogen (DIN) and DRP significantly higher than the PC6 targets.

Under low-flow conditions, in a worse case scenario where all nutrients not taken up by plants at the site entered the Kahahakuri Stream system, the addition of wastewater discharge entering the Kahahakuri Stream system could potentially increase the concentrations of total nitrogen by approximately 2% and total phosphorus by 70%. This is an unrealistic scenario that assumes no current leaching and also provides for no phosphorus retention, however, it provides an upper limit on potential effects. The potential increase in nitrate-nitrogen would be unlikely to result in a degraded attribute band within the NPS but would still act to contribute to the degradation of ecosystem health. Given that the site is already failing to meet the PC6 targets, any increased nitrogen could worsen the existing effects. The measured concentrations for DRP are already within the lowest NPS band, therefore any increase could worsen the existing effects on species. While it is acknowledged that the phosphorus scenario is very unrealistic by allowing for no retention or adsorption, it does illustrate that the magnitude of the phosphorus discharge is high compared to the current load in the Kahahakuri Stream system. Therefore, it is important that phosphorus is managed well on the site to minimise any potential for run-off or leaching.

Given that the proposed systems now comprise secondary treatment, UV disinfection and drip-line irrigation, the wastewater discharge is not expected to have a significant concentration of faecal coliforms, including E. coli (Table 1). The nature of the underlying geology and an assumed minimum distance of 20 m between an individual discharge point (disposal bed within each lot) and the Kahahakuri Stream suggests that over 99% of faecal coliforms could die-off prior to discharging into the surface water body. At this concentration, there is unlikely to be any measurable effects on the stream. In addition, the proposed method of subsurface drip-irrigation at low rates within the soils on the site, means the potential for ponding and run-off is considered low, although we recommend a lower application rate on the Mangatewai soils given the poorly drained nature of the soils and greater potential for run-off or subsurface lateral flow over the less permeable layers.

5.4 Conclusions

The following conclusions regarding the potential environmental impacts from the proposed wastewater discharge are based on the results of this assessment:

- The nature of the geology indicates that there is potential for treated wastewater to infiltrate into an underlying shallow groundwater system, however with the low-rate drip-line irrigation disposal method proposed, exceedances of field capacity and therefore drainage will be reduced. A restriction on irrigation of the Mangatewai perch-gley soils to a maximum rate of 2 mm/day is recommended to reduce the potential for run-off or lateral flow. Groundwater is ultimately likely to discharge into the Kahahakuri Stream catchment, either at the development site or further downstream.
- An assessment of the potential contribution of nutrients to the groundwater system indicates that the nitrogen loading from the discharge could increase concentrations by 26% or more. However, this is a worse case scenario allowing for no current leaching from the site. It is unlikely that the cumulative discharge from the subdivision would result in an exceedance of the NZDWS guideline for nitrate-nitrogen based on current water quality data, provided the discharges occur as described and on the basis that there will be nitrogen leaching occurring from the current agricultural land use.
- It is considered likely that Rule 37, Condition k will be met, as the discharge is unlikely to result in, or contribute to, a breach of the "Drinking Water Quality Standards for New Zealand" (Ministry of Health, 2005 (Revised 2008) in any groundwater body after reasonable mixing, which again is provided the discharges occur as described and on the basis that there will be nitrogen leaching occurring from the current agricultural land use.
- The potential increase in phosphorus is considered low in the short term but could be high in the long term. Retention in the soils is likely to limit leaching and run-off, although over time, leaching and run-off of phosphorus could increase as soil concentrations increase, given the high loading rate (102 kg/ha/year) compared to the likely plant uptake in a cut-and-carry system (likely less than 30 kg/ha/year).
- There is one existing shallow bore within 1 km of the development site. However, this is the HBRC monitoring bore 16249, located at the southern end of the development site and is not used for drinking water. Any increase in nutrient leaching, particularly nitrogen, would contribute to cumulative increases in groundwater in the wider groundwater systems within the Ruataniwha Basin.
- There is some risk that shallow bores constructed within the subdivision may be at risk from water quality that does not meet the DWSNZ MAVs without treatment. This risk exists regardless of the proposed wastewater discharges, but we would recommend careful consideration of bore siting occurs, particularly separation distances from the discharge locations, and that the bore water is appropriately treated, in addition to the wastewater systems being well maintained.
- Bores that are screened within the deeper, confined aquifer are less likely to be affected by the discharges, so long as they are appropriate sealed to prevent ingress and we would recommend appropriate treatment occurs for any new deep bores, in addition to good wastewater treatment and maintenance.

- An assessment of the contribution of contaminants to the Kahahakuri Stream suggests that there could be potentially significant increases to key nutrients under a worse case scenario. Any increase in nitrogen and phosphorus would be particularly concerning as the stream is already failing to meet DIN targets and is rated in band D (as outlined in the NPS 2020) for DRP concentrations. For this reason, we recommend that good management of nutrients occurs on the site.
- Due to the proposed high level of treatment (secondary treatment & UV disinfection) and subsequent discharge via subsurface drip-line irrigation, the wastewater discharge is not expected to have a significant concentration of faecal coliforms. The concentration of E. Coli is therefore unlikely to have measurable effects on either the groundwater system or surface water bodies and the risk from microbial pathogens to existing bores and surface water is considered low, provided the systems are operated and maintained well.
- It is likely the Rule 37, Condition h will be met, where there shall be no increase in the concentration of pathogenic organisms in any surface water body as a result of the discharge. However, it is important that there is good maintenance of the secondary treatment systems, the UV disinfection and drip-line irrigation areas.
- These conclusions are based on a high-level desk-top assessment of potential effects. There is uncertainty in these assessments. For example, leaching rates will vary throughout the year, with the greatest potential for nutrient leaching occurring in the cooler months when soil moisture is higher and plant uptake is reduced. Overall, the assessments are conservative considering assumptions such as no current leaching from the land use for some scenarios and a high rate of occupancy in all houses (6 people per lot).

Overall, based on the information provided and acknowledging that there will be nitrogen leaching occurring from the current agricultural land use, we consider that, provided the discharges occur as described, the cumulative effects of nitrogen leaching from the wastewater discharges on the existing groundwater and surface water environment are likely to be less than minor. However, there is uncertainty in the current leaching from the site and we have some concerns on whether the systems will be maintained and operated as proposed (with regular mowing and removal of grass, which is a “cut-and-carry” system). Therefore, there is potential for the effects to be greater (minor or more than minor).

Provided the systems are installed as proposed with secondary treatment and UV treatment discharging to drip-line irrigation with regular maintenance, we consider that the cumulative effects of microbial leaching from the wastewater discharges on the existing groundwater and surface water environment would be less than minor.

In the short-term, phosphorus losses are unlikely to be a significant issue based on the wastewater systems and cut-and-carry operation proposed, although there is greater potential for run-off or lateral flow on the Mangatewai soils, which could have the potential to result in more than minor adverse effects. Over time, there is the potential for phosphorus levels to increase in the soils for all three soil types due to the relatively high loading rate compared to plant uptake, which could lead to more than minor adverse cumulative effects.

6.0 Recommendations

Given that this assessment has indicated the potential for adverse effects on the groundwater and surface water receiving environments, additional information may be helpful to assess whether the conservatism of the assessment on the groundwater system and surface water bodies could be reduced. The additional information that would be helpful would be:

- The specific treatment systems (and therefore effluent quality) intended to be used within the subdivision; and
- Further information to justify the potential loading rates of total nitrogen and total phosphorus and a more refined estimate of changes in nutrient leaching from the current land use.

However, an alternative to further information would be additional requirements regarding treatment or mitigation measures. We would recommend the following be considered, which we consider would likely result in the current and future effects on surface water and groundwater being less than minor:

- Restricting the abstraction of water from the shallow groundwater system. Any bores drilled within the subdivision for drinking water purposes should be abstracted from the confined aquifer;
- Reducing the irrigation rates on the Mangatewai soils (to a maximum of 2 mm/day);
- Minimum standards required for all on-site wastewater systems or maximum limits for nutrient concentrations as follows:
  - Total nitrogen – a limit of 20 mg/L (as a median value) to reduce the nitrogen areal loading rates to a level of 292 kg/ha/year, which is closer to likely plant uptake of 250 kg/ha/year for a cut-and-carry system. This would reduce the potential for leaching, however, leaching in the cooler months is still expected to occur when plant uptake is reduced.
  - Total phosphorus - a limit of 5 mg/L (as a median value) to reduce the phosphorus areal loading rates to a level of 73 kg/ha/year at the peak rate of 4 mm/day.
- The phosphorus loading above is still much higher than plant uptake for a cut-and-carry system (up to 30 kg/ha/year), so it is recommended that additional consideration is given for the disposal areas to be either:
  - relocated after a certain time period (the applicant could consider a time period based on soil retention calculations if this option was considered practical for this subdivision); or
  - monitored prior to discharge and at regular intervals (5 years for example) to assess phosphorus levels (including Olsen-P)
- In addition to the recommendations on removing herbage ("cut-and-carry") outlined in Cook Associates (2021a), this removal from the disposal areas via mowing should occur at regular intervals and the mown grass should be spread out outside the irrigation area or removed from the site. This will help maximise plant nutrient uptake. It is important to maximise plant uptake, but it is recognised that compliance may not occur on all lots and this would be difficult to monitor. If there is poor compliance, the potential for nitrogen and phosphorus losses to the environment would increase, which could result in minor or more than minor cumulative effects if a large number of lots did not comply, although a more refined assessment of current leaching from the site would be required to determine this. In general, if the drip-line irrigation lines are buried under lawns, they are likely to be mown, although there is less certainty on how the grass clippings would be managed.
- To allow for possible poor compliance with the recommended cut-and-carry measures, phosphorus testing or disposal field relocation, and therefore reduce the potential for adverse effects occurring, an even greater level of treatment for nutrients prior to discharge could be required. For example, a median total nitrogen of less than 15 mg/L and median total phosphorus

of less than 2 mg/L could be required, which is equivalent to an A rating in the OSET[1] trials. This would increase the likelihood of the effects being less than minor.

7.0 References

Freeman Cook Associates Pty Ltd., 2021a: Preliminary on-site wastewater management site evaluation report. Report prepared by F.J. Cook for Development Nous Limited, April 2021.

Freeman Cook Associates Pty Ltd., 2021b: Loading from on-site wastewater management and cumulative effects Springhill Subdivision evaluation report. Report prepared by F.J. Cook for Development Nous Limited, September 2021.

Lee, J.M., Bland, K.J., Townsend, D.B. and Kamp, P.J.J. (compilers), 2011: *Geology of the Hawke's Bay area.* Institute of Geological and Nuclear Sciences 1:250 000 geological map 8. 1 sheet + 93p. Lower Hutt, New Zealand.

Manaaki Whenua S-Map, 2021: S-Map online portal. Retrieved from https://smap.landcareresearch.co.nz/maps-and-tools/app/

New Zealand Government, 2020: *National policy Statement for Freshwater Management 2020.*

Saunders, W.M.H., 1965: *Phosphate retention by New Zealand soils and its relationship to free sesquioxides, organic matter, and other soil properties,* New Zealand Journal of Agricultural Research, 8:1, 30-57, DOI: 10.1080/00288233.1965.10420021

Hawkes Bay Regional Council, 2012: Hydrology of the Tukituki Catchment – Flow metrics for 17 sub-catchments. Report prepared Wilding, T. and Waldron, R., September 2012.

Auckland Regional Council, 2004: Technical Publication No. 59 (TP58) On-site Wastewater Systems: Design and Management Manual. Third Edition ARC Technical Publication 2004. Prepared by Ormiston, A.W. and Floyd, R.E., July 2004.

Auckland Council, 2021: On-site Wastewater Management in the Auckland Region – Guidance Docyment 2021/006 (GD06). Version 1, Draft. Prepared by Chen, Z. and Silyn Roberts, G.

Vanderholm. D. H. (1984) Agricultural Waste Manual. http://dspace.lincoln.ac.nz/handle/10182/1393

PDP, 2020: Irrigation nutrient balance model summary. Prepared by Pratap, N. and Lough, H. for Silver Fern Farms Limited, June 2020. Reference number A02164500.

8.0 Limitations

This memorandum has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Hawke's Bay Regional Council and Central Hawke's Bay District Council. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the memorandum. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This memorandum has been prepared by PDP on the specific instructions of Hawke's Bay Regional Council and Central Hawke's Bay District Council for the limited purposes described in the memorandum. PDP accepts no liability if the memorandum is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

[1] National Testing Programme (NTP) for treatment plant review, performance certification, and benchmarking the performance of on-site effluent treatment (OSET) systems

Prepared by

Reviewed and approved by

Ella Boam

Senior Hydrogeologist

Hilary Lough

Technical Director