Before the Southland Regional Council

APP – 20191339

Under	the Resource Management Act 1991 (**RMA**)
In the matter of	An application for replacement water and discharge permits for cooling and processing purposes at the Mataura Processing Plant
Applicant	Alliance Group Limited (**Alliance**)

Statement of evidence of Azam Khan for Alliance Group Limited

16 November 2020

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Qualifications and experience

1 My full name is Azam Khan. I am a Technical Director of the Water Infrastructure business unit and Principal Environmental Engineer in the Auckland office of Pattle Delamore Partners Ltd (PDP). I am also one of the Company Directors. I have been employed at PDP since March 1996.

2 I have a Bachelor Engineering (Natural Resources) Degree from the University of Canterbury and a Master of Engineering Degree (Waste Management) from Lincoln University. I am a Chartered Professional Engineer and registered as an International Professional Engineer. I am also a Chartered Member of Engineering New Zealand which is the internationally recognised association for professional engineers in New Zealand and have been a member since 1996. I also hold memberships of Water New Zealand, Resource Management Law Association (RMLA) and NZ Institute of Directors. I also hold RMA decision maker certificate to act as a Hearing Commissioner. I am also a party to New Zealand Patent 539117 and Australian Patent 2006201373 for inventions related to wastewater treatment.

3 I have over 26 years of experience in the consenting, design, construction and operation of civil engineering and infrastructure projects including wastewater treatment and disposal systems, land treatment systems, water and stormwater systems and landfills for municipal and industrial projects. My experience also includes providing expert witness evidence at Resource Consent Hearings and for Environment Court mediation. While I have broad experience in a range of civil and environmental engineering disciplines, my principal area of specialisation relates to treatment and disposal of high strength wastewaters.

4 In the course of my work, I have conducted investigations, undertaken environmental assessments and overseen design and construction of a number of wastewater treatment systems for the treatment of meat processing wastewater. These include work undertaken for Alliance Group Limited, Silver Fern Farms Limited, Greenlea Premier Meats, Hawkes Bay Proteins, Taranaki By-Products Ltd, Tuakau Proteins Ltd, Riverlands, Wallace Group Ltd, Te Kuiti Meat Processors Ltd and Universal Packers Ltd.

5 Outside of the meat industry, my experience involves working on three waters projects for local authorities, landfill consenting programme and development of a wastewater treatment plant for a dairy processing plant to allow discharges to surface water.

Involvement with Alliance Group Limited

6 My involvement with Alliance Group Ltd (Alliance) dates to 2002 when PDP was engaged to provide engineering and environmental assistance for the continued

discharge of treated wastewater from the Alliance Mataura plant into the Mataura River. The key outcome of this work was upgrading of the treatment facilities to substantially reduce phosphorus loads discharged into the Mataura River.

7 I have been retained to assist Alliance in providing environmental advice related to wastewater management for various sites including Mataura, Lorneville and Pukeuri.

8 I have visited the Alliance Mataura processing plant on numerous occasions and am familiar with site operations.

9 PDP was commissioned by Alliance to assist with the replacement consenting process for the Mataura Plant. I have either been directly involved and/or have overseen the following investigations and assessments:

(a) Undertaking an assessment of alternative treatment and disposal options – see the report at Appendix 7 of the AEE;

(b) Undertaking a water use and wastewater management resilience assessment – see the report at Appendix 8 of the AEE; and

(c) Re-assessment of land treatment and discharge alternatives as a result of technical review by 4Sight for Environment Southland– see Attachment 6 of the s42A Council Hearing Report package.

10 Although these proceedings are not before the Environment Court, I have read the Environment Court's Code of Conduct for Expert Witnesses and I agree to comply with it as if these proceedings were before the Court. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise except where I state that I am relying on facts or information provided by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

11 In preparing this evidence I have considered the evidence of other witnesses for Alliance including Mr Richardson, Mr Montgomerie and Dr James, and the conditions proposed by Mr Low. I have also considered the relevant parts of the section 42A recommending report, its accompanying technical reports, and the evidence of the Council reviewers.

Scope of evidence

12 The purpose of my evidence is to:

(a) summarise the results of the wastewater treatment and disposal alternatives assessment, including identification of the preferred option;

(b) summarise the results of the resilience assessment; and

(c) explain the various actions required to progressively upgrade the existing wastewater treatment system to meet the objectives of the preferred option, thereby progressively reducing the concentrations and loadings of contaminants that enter the Mataura River.

Executive summary

13 Alliance Mataura plant is seeking replacement consent for the continued discharge of treated wastewater into the Mataura River.

14 The technical investigations for determining the preferred wastewater treatment plant upgrade path involved undertaking comprehensive alternatives assessment and developing estimates of capital and operating costs.

15 Further work was undertaken to determine the water use at the Mataura plant in order to assess opportunities for water use efficiencies. An assessment of the existing wastewater infrastructure resilience was also undertaken

16 To this end, I have recommended to the site that as an initial step, further improvements in water use is investigated to reduce overall water use, examine ways to recycle “whitewater” utilised in the DAF plant and/or for future upgraded plant and address the risks associated with wastewater reticulation pipework from the beef plant to the existing wastewater treatment plant that traverses the hydro-race.

17 A comprehensive assessment of the alternatives was undertaken to determine the most appropriate pathway to address the effects of the existing discharge.

18 In determining the appropriate wastewater treatment technologies, PDP considered a range of options, however, we relied on existing technologies widely used in the meat industry that are practicable, reliable and provide resilience.

19 Based on the evidence of Mr Montgomerie and Dr James, the current discharges after physico-chemical treatment using dissolved air flotation (DAF) plant to the Mataura River show that the in-stream effects do not trigger immediate or urgent mitigation. However, I acknowledge that some of the key contaminants in the existing treated wastewater that requires further consideration continue to be *E. coli*, ammoniacal nitrogen and total nitrogen.

20 Given the uncertainty in obtaining suitable contiguous parcels of land in the vicinity of the processing plant for land treatment together with the plant experiencing near peak winter processing profile, PDP recommended that further wastewater treatment to allow continued discharges to the Mataura River will need to form the basis of long-term reliable discharge. Further analysis of land-based disposal

options and constraints has shown that land-based disposal is unlikely to be a practicable option for this discharge.

21 If the priority for the reduction of *E. coli* is agreed, then a bolt-on disinfection unit will need to be put in place to reduce bacterial contaminants. UV disinfection is generally considered the most appropriate method of disinfection so long as clarity of treated wastewater is maintained.

22 For further removal of key contaminants, establishment of biological wastewater treatment plant for the treatment of all wastewater generated from the site will be required. This will include process design for the removal of biochemical oxygen demand and nitrogen.

23 Continued use of existing chemical removal of phosphorus will need to be in place with future targeted chemical treatment in the biological treatment plant to ensure low levels of dissolved reactive phosphorus is discharged into the Mataura River.

24 It is my overall view that the proposed upgrade route for the future wastewater treatment plant with adequate proposed monitoring controls will result in the final discharge having low level of contaminants such that continued discharge to the Mataura River will be acceptable on the basis that reasonable contaminant concentrations and mass loads can be achieved.

Water use assessment

25 As part of the investigations to determine the water use efficiencies for the beef plant, pelt house and tripe processing, an audit of existing water use was undertaken. A water use investigation assessment was carried out in January 2019 by PDP to identify areas of high volume water consumption and addressing water management practices throughout the processing plant.

26 The key areas where most water use occurs comprises of stockyards, truck wash, slaughter floor and further processing washdown, tripe plant and the pelthouse. In addition to the process water use, a large part of water take also includes the makeup water known as “whitewater” for dissolved air concentrator within the dissolved air flotation (DAF) plant.

27 For the monitored period when the processing rate was 716 animals per day, a summary of estimated water use for the areas that were monitored is set out in Table 1. The assessment of water use was based on monitoring of the key water use streams rather than all water sources of water use within the processing areas, so the actual water use may vary slightly from this estimate. It must also be noted that no allowance for stormwater from hardstand areas that may enter wastewater treatment system has been allowed for.

Table 1: Summary of Estimated Water Use During Survey	
Department	**Volume**
Processing Plant (Truckwash, Stockyards, Tripe Plant, Pelt, Cattle Wash, Beef Plant)	3,315 m^3/d
DAF Plant Whitewater	2,026 m^3/d
Total Water Use during Survey	5,341 m^3/d

28 An estimate of the predicted water use based on the survey assessment and peak production capacity of 1,062 animals per day is 7,923 m^3/d. Based on this assessment, I had recommended Alliance to seek a discharge volume of 8,000 m^3/d.

29 The assessed unit rate of water is per animal slaughtered including downstream by-products processing (pelts and tripe), but excluding additional water use in the DAF Plant was 4,630 L/carcass. When adjusted for peak processing, taking account of efficient use of wash down and other fixed water use processes (sterilisers, specific area washes, cattle wash), the unit per animal water use within the beef plant could reduce to 3,330 L/carcass.

30 When comparing to a modern compact footprint beef processing plant, the per animal water use at the Mataura Plant is slightly higher than the 2,900 L/carcass that is considered normal when taking into account of high water use for tripe processing.

31 In the water use assessment, PDP has identified some water efficiency measures that could reduce water use in certain specific processes. This may include tripe processing and DAF treatment plant. Water use audits prior to any future wastewater treatment plant upgrades would be required to allow for specific process unit design.

32 In my opinion, the purpose of water use efficiencies is not necessarily about the reduction of the total volume of discharge as wastewater but continually driving at sustainable use of water. Water abstracted requires treatment for potable use with a large energy cost for heating the water for in-plant use and subsequent costs for the treatment of the discharged wastewater. This is particularly important as the existing treatment is chemical based and all water is subjected to pH adjustment requiring chemicals.

Existing wastewater infrastructure, operations and resilience

33 The existing wastewater treatment system is based on physical and chemical treatment of two main segregated waste streams using dissolved air flotation (DAF) mechanical plant. The waste streams are identified as “green waste” and “non-green waste” and the separation works for these specific waste streams was

carried out in 2004 as part of the work associated with identifying the phosphorus contributing wastes for targeted removal of phosphorus.

34 The green waste is generated from stockyards, paunch handling areas, gut cutting and tripe processing. The non-green waste stream comprises slaughter floor, further processing and hides wash overflow. Both waste streams are passed through separate milli-screening units for gross solids removal.

35 Following solids removal, the non-green waste stream is treated through acid-phase, where the pH is reduced to around 4.5 pH units using sulphuric acid to precipitate proteins. The acid treated wastewater is passed through three separate dissolved air flotation units run in parallel to remove the precipitated solids as float sludge, prior to discharge.

36 For green waste stream, the acid-phase treatment with solids removal is similar to non-green wastes. However, this waste stream following acid-phase treatment is further subjected to alkali-phase chemical treatment where the pH is elevated to above 9.5 pH units using hydrated lime to precipitate dissolved reactive phosphorus. The green wastes are treated in six DAF in series units. Further solids removal of the precipitated solids is undertaken in sequential DAF unit as float sludge.

37 The DAF treatment utilises a dedicated supply of fresh raw water from the Mataura River to make “whitewater”. Whitewater is water saturated with dissolved air that is utilised in treatment system to attach to precipitated proteins, solids and oil & grease for recovery as float sludge.

38 Both acid-phase and alkali-phase treated wastewater is discharged to Mataura River through a side entry series of two discharge pipes on the true right bank.

39 The float sludge recovered from the DAF units are dewatered in a centrifuge. The solids are disposed offsite for composting. Contingency disposal of dewatered sludge is allowed for onto land and/or transporting to Alliance’s Lorneville Plant near Invercargill.

Challenges identified in existing infrastructure and discharge

40 A site assessment of the existing wastewater treatment plant was undertaken by PDP to determine the continued use of existing infrastructure to meet the current discharge limits. This included an assessment of risks associated with wastewater treatment system performance, including failure and resulting environmental impacts.

41 Two key items for infrastructure resilience were identified. These were:

(a) Green waste stream cross contamination – the overflow of green wastes into the non-green wastes stream will result in wastewater containing higher amounts of phosphorus not being treated for the removal of phosphorus. Alliance Mataura has recognised this and further work is planned to be undertaken to minimise the risk of green waste overflows into non-green wastes.

(b) Wastewater pipes in or above the Hydro-race – there are a number of pipes that traverse either above or within the hydro-race and present an elevated risk in the event there is a pipe rupture that would result in uncontrolled discharge directly into the hydro-race. PDP has recommended re-routing of pipes away from the hydro-race.

42 The use of raw river water as whitewater is not considered an efficient use of water and assessment of recycled treated wastewater when any future upgrade of wastewater treatment plant is undertaken will become a key part of wastewater volume reduction.

43 However, in my opinion caution needs to be applied when the treatment of wastewater is undertaken by DAF system as the use of treated recycled whitewater could result in unwanted foam generation in the discharge. Until such time as further biological treatment is implemented at the site, the reuse of treated wastewater post-DAF plant as whitewater will need very careful consideration to avoid foaming at the point of discharge.

44 As assessed by Freshwater Solutions Limited in 2019[1] the current discharges to the Mataura Rive give rise to effects that do not trigger the need for immediate mitigation. However, some of the key contaminants in the existing treated wastewater that require further consideration continue to be *E. coli*, ammoniacal nitrogen and total nitrogen.

45 To address these key contaminants, PDP undertook a comprehensive alternatives assessment of the treatment and disposal options in accordance with the requirements under Schedule 4 of RMA that provided recommendations to Alliance Mataura to further examine to secure continued discharges to the receiving environment.

Assessment of alternative treatment and disposal options

46 The alternatives assessment undertaken by PDP utilised the findings of the assessment of environmental effects information. The outcome sought for

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[1] *Assessment of the Effects of Alliance Mataura's Discharges and Water Take on Mataura River and Toetoe Estuary. Freshwater Solutions Limited. May 2019.*

developing options was to establish options that focussed on the removal of *E. coli*, ammoniacal nitrogen and total nitrogen. While carbonaceous biochemical oxygen demand ($cBOD_5$) is not a contaminant of concern in the discharge, further removal of $cBOD_5$ would be inherent in any biological treatment system considered.

47 The existing DAF treatment system removes a considerable amount of phosphorus, especially from the green waste streams where targeted removal of dissolved reactive phosphorus (DRP) is undertaken. The continued reduction of DRP using chemical treatment will continue when other alternatives are bolted on for further treatment in future.

48 In determining the appropriate wastewater treatment technologies, PDP considered a range of options, however, we relied on existing technologies widely used in the meat industry and Alliance is already familiar with some of these.

49 A broad list of 4 discharge alternatives was identified by PDP. The broad alternative discharge options are:

i. Discharge to Mataura River

ii. Land treatment of total waste stream

iii. Dual discharge regime with combined land treatment and river discharge

iv. Trade wastes discharge to municipal treatment plant

50 A comprehensive list of 16 sub-options was developed based on the four discharge alternatives. These options are set out in **Attachment E1**. An initial risk and uncertainty assessment was undertaken to refine the 16 sub-options to 5 short-listed options that were examined further and costed.

51 The shortlisted options included retaining physico-chemical treatment plant using either existing or replacement DAF plant and adding other process units to further manage nitrogen and *E. coli* removal. The shortlisted options were:

(a) Option 1C - River discharge with additional biological treatment to reduce $cBOD_5$ and nitrogen. Final discharge treated with ultraviolet (UV) disinfection to reduce *E. coli*.

(b) Option 1D - River discharge with filtration and UV disinfection.

(c) Option 1F - River discharge with additional biological treatment to reduce $cBOD_5$ and nitrogen for green waste stream only. Final discharge treated with ultraviolet (UV) disinfection to reduce *E. coli*.

(d) Option 4A - Dual discharge regime with continued discharges post existing treatment to river and diversion onto land for dairy pasture during dry weather.

(e) Option 5A - Dual discharge regime with continued discharges post existing treatment to river and diversion onto land for zero grazed pasture (cut & carry) during dry weather.

52 A matrix using pros/cons assessment was developed and the capital, operating and life cycle costs analysis over 10-year period was also undertaken for the options. For the shortlisted options, the capital, operating and life cycle costs were estimated as follows:

Table 2: Summary of Costs for Shortlisted Alternatives

Option	Capital ($M)	Operating ($M)	NPV ($M)
1C	14	1.1	20.5
1D	4.1	0.23	5.6
1F	11.3	0.79	16.1
4A	11	0.53	14.2
5A	23	0.26	24.4

Notes:
Option 1 – continued discharges to Mataura River
Option 4 – Dual discharge regime with use of third-party farms
Option 5 – Dual discharge regime with land purchased for land treatment only (no stock)

53 As an alternative option to the shortlisted wastewater treatment plant options I have outlined for continued discharge to the Mataura River, PDP investigated the feasibility of disposing of all wastewater from the site to land all year round within a 5 km radius of the plant. A further revisit of these options was taken in October 2020 following technical review of the application.

54 As identified in the 2004 assessment, in the comprehensive alternatives assessment in May 2019 and a further re-examination in October 2020, the suitable land available in the vicinity of the processing plant is limited to generally terraced and rolling country eastern side of the Mataura River.

55 A key consideration for the design of land-based treatment systems is the ability of the soils encountered on available land to accept wastewater on a continued basis. Without suitable soils being available to accept wastewater, land-based disposal options are severely constrained.

56 Following the initial soils assessment and then applying further suitability tests, there are not sufficient contiguous parcels of land suitable to convert to a land treatment system.

57 Based on the average nitrogen load of 219 kg/d (equivalent to around 670,000 m^3 of wastewater excluding DAF whitewater) and assessing for 250 days of processing per year, the annual nitrogen load generated from the site after existing DAF treatment plant is estimated at 55 tonnes. Based on various different land treatment operating regimes, the minimum amount of irrigated land required is likely to be in around 160 ha. The total land area required could be as much as 240 ha taking into account setback distances for location, proximity to receptors, watercourses and roads. A summary of the land discharge re-assessment is provided in **Attachment E2**. The hydraulic loading rate onto land was assessed to be the key loading constraint even for the zero grazed option.

58 PDP has assessed that suitable farmland is not available within close proximity of the processing plant.

Preferred option and upgrade approach

59 Given the unavailability of suitable land in the vicinity of the processing plant for land treatment and the high winter processing profile, PDP recommended that further treatment to allow continued discharges to the Mataura River will need to form the basis of long-term reliable discharge.

60 To this end, the priority for the reduction of *E. coli* will need to be put in place as the summer peak discharges coincide with lower Mataura River flows. In my opinion, “bolt-on” addition of UV disinfection units to the existing plant will be a viable option subject to maintaining good clarity in the treated discharge from the existing DAF plant.

61 When further treatment to reduce key contaminants (namely biochemical oxygen demand and nitrogen) is established, then a series of steps for the upgrade path will need to be put in place. In general terms these will require:

i. Implementation of water reduction programmes and enabling use of recycle treated wastewater for the make-up of DAF whitewater.

ii. Establishment of a biological treatment plant that will treat all the wastewater generated from the processing plant to reduce biochemical oxygen demand, ammoniacal nitrogen and total nitrogen loads.

iii. Further chemical augmentation to remove residual dissolved reactive phosphorus (DRP) may be required to meet future compliance limits as some of the phosphorus may continue to transform into dissolved form in the biological treatment system.

Comments on Technical Reviews

62 The technical review by 4Sight recommends controls on the monthly and annual volume of treated wastewater to be discharged in addition the daily maximum volume. I disagree with this, as restriction on the monthly or annual volumes could severely create constraints on the efficient use of a production facility.

63 For 2019/20 season the annual discharge volume was assessed at 1.28 million cubic metres including the use of whitewater in the wastewater treatment plant compared to 0.95 million cubic metres in the 2016/17 season. I do not consider that monthly maximum limits or annual capacity limits for the volume of treated wastewater is necessary. In saying this, the daily discharge volume is controlled by the peak processing capacity of the 2-shifts in the processing plant.

64 I have assessed the production data from 2015 to 2020 and this shows the changing processing profile over the last 6 years. There has been a progressive increase in annual processing numbers of around 124,000 animals to 167,000 animals over the 6 years. This suggests to me that the utilisation rate of the plant is improving and may not have yet reached optimum processing configuration.

65 With the dis-establishment of lamb processing plant and consolidation in the region of beef processing, the Mataura plant is likely to continue to experience changes over the next few years in terms of stock supply/availability and servicing increasing market demand. The production profile for the years assessed is given in **Attachment E3**. It is apparent that substantial shifts in the processing profile has been occurring and could continue to occur over the next few years as Alliance consolidates it’s market share for the Southland region.

66 Alliance Mataura has proposed controls on the mass load of nitrogen discharged to the Mataura River on an annual basis to be less than 60 tonnes. This in effect will be the controlling factor in terms of the amount of production that could feasibly occur during the year without additional targeted nitrogen removal. Based on the 2016/17 maximum daily nitrogen loads discharged into the Mataura River of 327 kg/d, the cumulative peak processing days that could reach the annual mass limit would be 183 days. Applying the peak design volume assessed at 5,105 m^3/d (post implementation of water saving measures) will result in the annual volume of around 937,000 m^3. However, the monthly processing profile can easily shift in a given year with destocking requirements based on drought, end of life dairy cattle culling and other market or environmental risk (disease outbreak) factors. Therefore, a shift in peak processing and water use requirements could quite easily occur and compliance controls for the volume of discharge on a monthly or annual basis could quite easily become very restrictive.

67 As part of the optioneering investigations, a broad range of practical upgrade solutions have been considered. For the Mataura plant, I have restricted the

technology choices that I consider are resilient. For example, 4Sight had recommended investigation of waste to energy technologies. I have not considered waste to energy conversion technology (anaerobic digestion) as the removal of nitrogen currently occurs through protein precipitation using sulphuric acid. A bolt-on anaerobic digestion system will result in high levels of hydrogen sulphide generation that will require additional controls for biogas management. A replacement anaerobic digestion facility (replacing existing DAF treatment plant) has not been considered as the existing chemical treatment plant is very efficient in removing phosphorus, solids and oil & grease. In addition, the chemical precipitation of proteins removes a considerable amount of organic nitrogen.

Conclusion

68 Resource consents are being sought by Alliance Mataura for various activities including discharge of treated wastewater to the Mataura River.

69 A number of technical investigations were carried out by PDP either directly supervised and/or managed by me to progress comprehensive feasibility investigations for the options for the upgraded wastewater treatment facilities to meet the expected tightening of the limits for continued discharge of treated wastewater into the Mataura River.

70 A comprehensive alternatives assessment showed that continued discharge to the Mataura River after further treatment to address key contaminants is the most feasible option.

71 I consider that the alternatives assessment and the approach to implement the preferred option is well thought out, is robust and represents industry accepted good practice.

72 It is my overall view that the proposed approach for the implementation of a staged upgrade to meet the immediate constraints and development of a solution that meets future tightening of limits which I have outlined in my evidence, will result in discharges that can be well managed and comply with the proposed conditions

Azam Khan
16 November 2020

Attachment E1 - Alliance Mataura Plant Wastewater Management Options: Initial Screening Analysis – May 2019				
Disposal Option	**Treatment Option**	**Advantages**	**Disadvantages**	**Comments**
1 - Existing disposal to Mataura River	**1A - No additional treatment**	• No change in plant operation • Low cost	• Does not improve wastewater discharge quality	
	1B - Biological treatment for cBOD$_5$ Activated sludge tank + Clarifier + UV	• Smaller footprint tank based biological treatment system • Could be located next to existing site in place of old lamb plant • Reduced risk associated with pumping compared to Option 1C • Simple commonly used process	• Does not reduce nitrogen load • Increased operational complexity • Sludge management requirements • If located close to Mataura, some odour management may be required but not allowed for in costing	
	1C - Biological treatment for cBOD$_5$and Nitrogen Activated sludge lagoon + Clarifier + UV	• All target wastewater quality parameters improved • Best practice wastewater treatment	• Needs to be located on new site, potentially near pelt house • Significant pumping and piping requirement • Increased operational complexity • Sludge management requirements	
	1D - UV treatment (with filter) Sand filter + UV	• Best practice for *E. coli* reduction • Sand filter should reduce some wastewater contaminant concentrations • Could be located next to existing site	• Insufficient improvement in wastewater cBOD$_5$ or Total Nitrogen quality • UV lamps may foul quickly and may need frequent maintenance; or • Requires method to deactivate polymer to minimise fouling	
	1E - High pH disinfection Lime dosing + Tank	• Wastewater *E. coli* reduced • Simple solution to operate and implement • Could be located next to existing site • Some existing equipment on site could be used • Additional treatment on only half of wastewater stream	• Not best practice for *E. coli* reduction • Unlikely to achieve the required *E. coli* reductions, only 50% load reduction expected which will not comply with the QMRA requirements • No improvement in wastewater BOD or Ammonia quality	• Would likely only be implemented for green waste stream as non-green is at pH 4. • Potential *E. coli* reduction is limited based on trials done in 2006.
	1F – Green waste Biological treatment for cBOD$_5$and Nitrogen Activated Tanks + Clarifier + UV	• BOD and TN target treated wastewater quality parameters improved but for Green Waste Only • Could be located next to existing site in place of old lamb plant • Reduced risk associated with pumping compared to Option 1C • Simple commonly used process	• Provides partial treatment of BOD, and nitrogen only • Increased operational complexity • Sludge management requirements • If located close to Mataura, some odour management may be required but not allowed for.	Filtration and UV treatment on both streams

Attachment E1 - Alliance Mataura Plant Wastewater Management Options: Initial Screening Analysis – May 2019

Disposal Option	Treatment Option	Advantages	Disadvantages	Comments
2 - Discharge to land (year round) - Slow rate irrigation to dairy grazing land	**2A -No additional treatment**	• No additional wastewater treatment required • No wastewater discharged to the river • Land purchase not required • Dairying common land use in area	• Additional operational complexity • Significant pumping requirement • Limited potential irrigation during winter • Cannot store wastewater for extended periods due to odour risk • Reliance on third party land may cause issues in the future • Limited suitable land • Would require consultation with Dairy company regarding receipt of milk	• 160 ha Irrigation area • Land purchase not anticipated • hydraulically limited
2 - Discharge to land (year round) - Slow rate irrigation to dairy grazing land	**2B -Biological treatment for winter storage** Activated sludge lagoon + Clarifier + UV	• No wastewater discharged to the river • Summer only irrigation will be less problematic • Treatment and storage provides additional resilience • Land purchase not required • Dairying common land use in area	• Additional operational complexity • Significant construction required for winter storage • Significant pumping requirement Limited suitable land • Reliance on third party land may cause issues in the future	• 160 ha Irrigation area • Land purchase not anticipated • Hydraulically limited • Treatment prior to storage required to reduce the risk of odour generation
3 - Discharge to land (year round) - Slow Rate irrigation to company owned cut and carry operation	**3A -No additional treatment**	• No additional wastewater treatment required • No wastewater discharged to the river • Potential income from cut and carry crop to offset operating costs • No reliance on third party land for discharge	• Additional operational complexity • Significant pumping requirement • Limited potential irrigation during winter • Cannot store wastewater for extended periods due to odour risk; • Significant land purchase required	• 160 ha Irrigation area • Land purchase required • Hydraulically limited
3 - Discharge to land (year round) - Slow Rate irrigation to company owned cut and carry operation	**3B -Biological treatment for winter storage** Activated sludge lagoon + Clarifier + UV	• No wastewater discharged to the river • Summer only irrigation will be less problematic • Treatment and storage provides additional resilience • Potential income from cut and carry crop to offset operating costs • No reliance on third party land for discharge	• Additional operational complexity • Significant land purchase required • Significant construction required for winter storage • Significant pumping requirement	• 160 ha Irrigation area • Land purchase required • Hydraulically limited • Treatment prior to storage required to reduce the risk of odour generation

Attachment E1 - Alliance Mataura Plant Wastewater Management Options: Initial Screening Analysis – May 2019				
Disposal Option	**Treatment Option**	**Advantages**	**Disadvantages**	**Comments**
4 - Dual discharge to land and existing river outfall - Slow rate irrigation to dairy grazing land	**4A - No additional treatment**	• Summer only irrigation will be less problematic • Wastewater only discharged to the river in winter when flows are high • No additional wastewater treatment required • 2 disposal methods provide additional resilience • Land purchase not required	• Additional operational complexity • Untreated wastewater load still discharged to river in winter and wet periods • Requirement to establish long term agreement with third parties • Significant pumping requirement	• 103 ha Irrigation area • Land purchase not anticipated • Hydraulically limited
	4B - Biological treatment for BOD and Nitrogen Activated sludge lagoon + Clarifier + UV	• Summer only irrigation will be less problematic • Low wastewater load only discharged to the river in winter when flows are high • No additional wastewater treatment required • 2 disposal methods provide additional resilience • Land purchase not required	• Additional operational complexity • Requirement to establish long term agreement with third parties; • Significant pumping requirement • Treatment process needs to be located on new site, potentially near pelt house • Sludge management requirements	• 103 ha Irrigation area • Land purchase not anticipated • Hydraulically limited
5 - Dual discharge to land and existing river outfall - Slow Rate irrigation to cut and carry crop	**5A - No additional treatment**	• Summer only irrigation will be less problematic • Wastewater only discharged to the river in winter when flows are high • No additional wastewater treatment required • 2 disposal methods provide additional resilience • Potential income from cut and carry crop to offset operating costs • No reliance on third party land for discharge	• Additional operational complexity • Untreated wastewater load still discharged to river in winter and during wet periods • Significant land purchase required but smaller land requirement than other land treatment options • Cannot store wastewater for extended periods due to odour risk • Significant pumping and piping requirement	• 103 ha Irrigation area • Land purchase required • Hydraulically limited
	5B - Biological treatment for BOD and Nitrogen Activated sludge lagoon + Clarifier + UV	• Summer only irrigation will be less problematic • Low wastewater load only discharged to the river in winter when flows are high • No additional wastewater treatment required • 2 disposal methods provide additional resilience • Potential income from cut and carry crop to offset operating costs • No reliance on third party land for discharge	• Additional operational complexity • Significant land purchase required but smaller land requirement than other land treatment options • Significant pumping and piping requirement • Treatment process needs to be located on new site, potentially near pelt house • Sludge management requirements	• 103 ha Irrigation area • Land purchase required • Hydraulically limited

Attachment E1 - Alliance Mataura Plant Wastewater Management Options: Initial Screening Analysis – May 2019				
Disposal Option	**Treatment Option**	**Advantages**	**Disadvantages**	**Comments**
6 - Transfer to Gore municipal WWTP	**6A - Partial biological treatment (to typical municipal sewage quality)** Activated sludge lagoon + Clarifier	• No direct discharge to the river from the plant • Reduced compliance sampling requirement • Potential for combining with Mataura WW for capital cost sharing on pipeline (savings not included in cost estimate)	• Requires agreement from local authority • Additional capacity at the WWTP may need to be provided • Significant pumping and piping requirement • Additional wastewater treatment still required prior to transfer • Potentially high trade waste fees for discharging to WWTP	• Assessment of the capacity headroom of the WWTP is required • Risk of additional costs if WWTP changes to land discharge • Combining with human waste may restrict irrigation to land opportunities
7 - Transfer to Mataura municipal WWTP	**7A - Partial biological treatment (to typical municipal sewage quality)** Activated sludge lagoon + Clarifier	• No direct discharge to the river • Reduced compliance sampling requirement	• Requires agreement from local authority • Small Mataura municipal WWTP treatment plant is expected to not be able to cope with the significant increase in load therefore upgrades to provide additional capacity at the WWTP will need to be provided • Additional wastewater treatment still required prior to transfer • Significant pumping and piping requirement • Potentially high trade waste fees for discharging to WWTP	• Assessment of the capacity headroom of the WWTP is required • Risk of additional costs if WWTP changes to land discharge • Combining with human waste may restrict irrigation to land opportunities

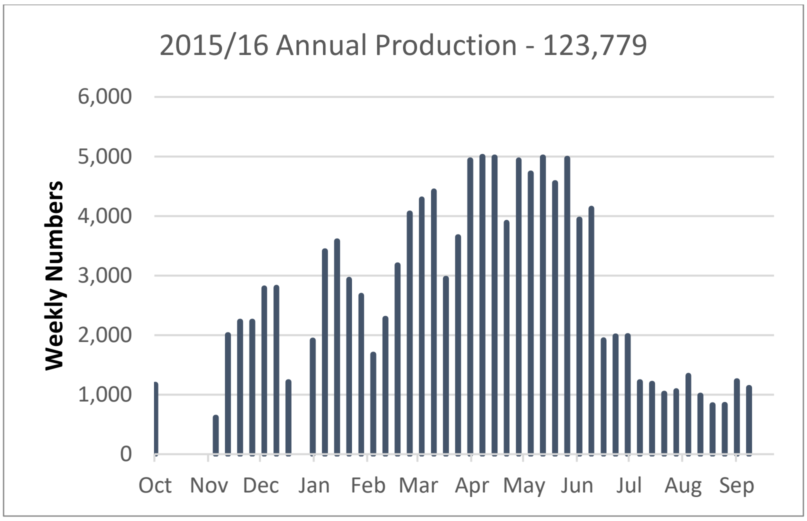
Attachment E2 - Summary of Further Assessment of Land Discharge Options – October 2020					
Option	**Description**	**Risks and Issues**	**Estimated Leaching Rate and Nitrogen Loading Rate**	**Estimated Capital Cost**	**Comments**
Seasonal Irrigation (Dual Discharge) – No Further Treatment *Equivalent to option 5A in the original assessment shortlist*	• 160 ha solid-set irrigation scheme[6]. • 240 ha total land purchase. • 6,000 m^3 wastewater storage pond (sized for 1 day of wastewater storage at peak flows). • No additional wastewater treatment. • No irrigation May – September.	• Increased capital cost when compared to other discharge options previously considered. • There is still a discharge to the river with associated environmental effects. • No reduction in the nutrient load to the river over winter. • Risk of odour generation due to the irrigation of poorly treated wastewater, either by the wastewater turning anaerobic and producing odour as it is pumped to the irrigation site or after it is irrigated. • Discharge to the river will still be required during summer wet periods as wastewater cannot be stored due to odour potential. • Likely that multiple land parcels required to be purchased to make up the required 240 ha, making a suitable land area difficult to find.	Leaching - 45 kg N/ha/yr Loading – 348 kg N/ha/yr	Total - $23M Land Purchase - $10M Reticulation/Irrigation System – $11M Indirect Project Costs - $1M	Nitrogen leaching rate unlikely to be acceptable due to adverse effects, based on comparison to generally accepted leaching rates from agricultural land. No reduction in contaminant load to the river over winter, see main report shortlist option 4A. Exceeds assumed nitrogen loading limit.[4] This could be managed by improving the level of wastewater treatment with additional treatment stages or increasing the size of the irrigation scheme.
Year-round Irrigation – Biological Nutrient Treatment (Winter Storage) – Option 3B	• 160 ha solid-set irrigation scheme[6]. • 240 ha total land purchase. • 380,000 m^3 wastewater storage pond. • Wastewater treatment to reduce odour risk from storage, similar level to option 1C. • No irrigation May – September.	• Large capital cost when compared to other discharge options previously considered. • A large dam to store all the wastewater generated during winter processing would be required. The storage dam is required to store all wastewater over the winter period so it does not have to be irrigated, the treatment provided sufficiently reduces the odour risk from this. • Prevention of fugitive contamination from wildlife (birds and ducks), and algal growth risks. • Winter irrigation still may be required to prevent storage dam overflow, leading to risk of increased leaching and runoff. • Increased irrigation rates over summer to allow the discharge of stored wastewater, may lead to higher leaching and runoff. • Multiple land parcels required to be purchased to make up the required 240 ha, making a suitable land area difficult to find.	Leaching - 25 kg N/ha/yr Loading – 159 kg N/ha/yr	Total - $52M Land Purchase - $10M Treatment Upgrade - $14M Reticulation/Storage/Irrigation System – $25M Indirect Project Costs (Design/Consenting) - $3M	Capital investment is significant and much higher than other options assessed. Requirement to still irrigate occasionally over winter will cause high risk of adverse effects due to increased runoff, leaching and soil damage. Nitrogen loading could be managed by improving the level of wastewater treatment with additional treatment stages or increasing the size of the irrigation scheme.

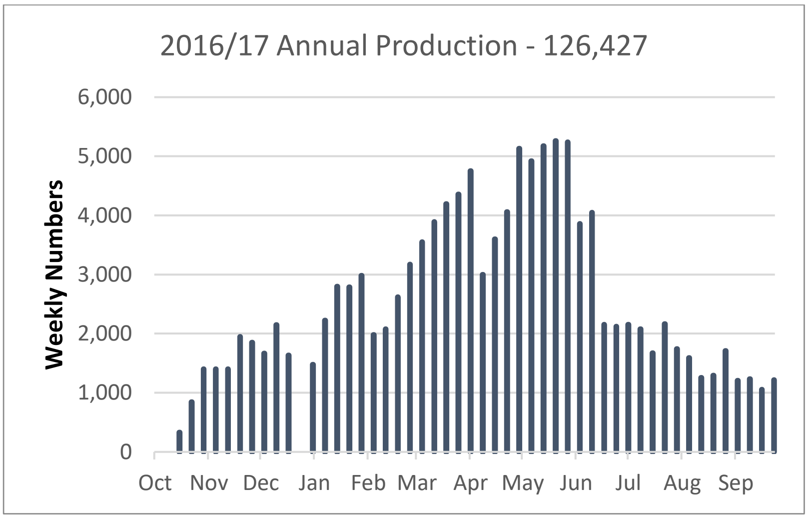
Attachment E2 - Summary of Further Assessment of Land Discharge Options – October 2020					
Option	**Description**	**Risks and Issues**	**Estimated Leaching Rate and Nitrogen Loading Rate**	**Estimated Capital Cost**	**Comments**
Seasonal Irrigation (Dual Discharge) – Biological Nutrient Treatment – Option 5B	• 160 ha solid-set irrigation scheme[6]. • 240 ha total land purchase. • 30,000 m^3 wastewater storage pond (sized for 5 days of wastewater storage at peak flows). • Biological nutrient removal wastewater treatment, similar level to option 1C. • No irrigation May – September.	• Increased capital cost when compared to other discharge options previously considered. • There is still a discharge to the river with associated environmental effects. • Discharge to the river may still be required during summer wet periods to prevent storage pond overflow. • Multiple land parcels required to be purchased to make up the 240 ha required, making a suitable land area difficult to find.	Leaching - 14 kg N/ha/yr Loading – 110 kg N/ha/yr	Total - $37M Land Purchase - $10M Treatment Upgrade - $14M Reticulation/Irrigation System – $11M Indirect Project Costs (Design/Consenting) - $2M	Capital investment is significant and much higher than other options assessed.

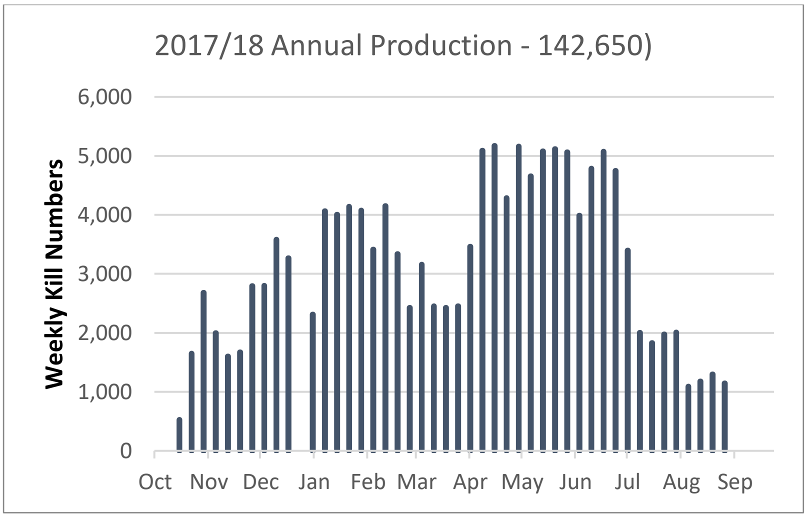
Notes:

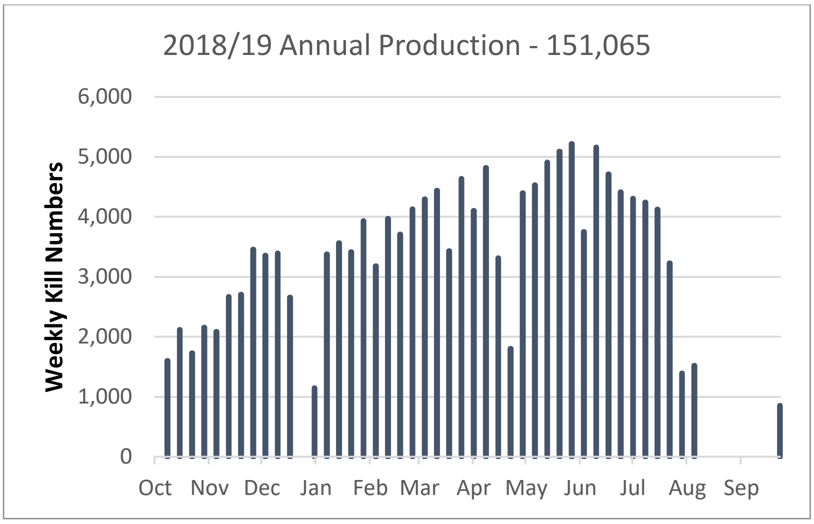
1. *Cost estimated prepares to +40%/-20% level of accuracy.*
2. *Land purchase assumed at $40,000 per hectare of pastoral farmland. An allowance of 1.5 times the actual irrigable area for total farmland has been allowed for.*
3. *Cost are in NZD and do not include GST.*
4. *Cost estimates based on same assumptions as set out in the main options assessment report.*
5. *Nitrogen Loading limit of 150 kg N/ha/yr, assumed limit is based on Rule 16C and 50 of the Environment Southland Regional Water Plan (2010) and rule 5.5.2 of the Environmental Southland Regional Effluent Land Application Plan (1998, updated May 2014).*
6. *Increase in area from shortlist assessment (135 ha) due to more detailed soil moisture balance assessment.*

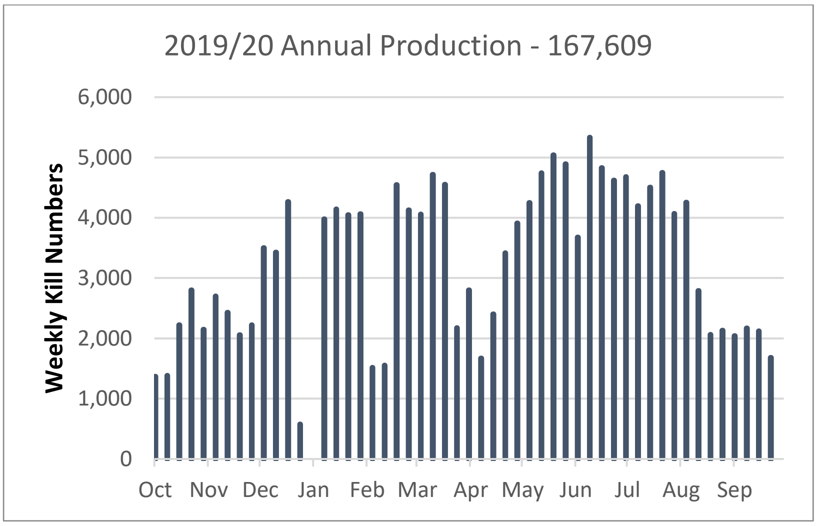
Attachment E3 - Mataura Plant Processing Profile – 2015 – 2020








2018/19 Annual Production - 151,065
Weekly Kill Numbers
6,000
5,000
4,000
3,000
2,000
1,000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


2019/20 Annual Production - 167,609
Weekly Kill Numbers
6,000
5,000
4,000
3,000
2,000
1,000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep