APPENDIX F

Land Assessment of Environmental Effects

Assessment of Environmental Effects of Discharge of Meatworks Effluent to Land

Prepared for

AFFCO NZ, Manawatu

Prepared by

LOWE Environmental Impact

September 2014

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AFFCO NZ, Manawatu

This report has been prepared for the **AFFCO NZ, Manawatu** by Lowe Environmental Impact (LEI). No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other parties.

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3	15/09/2014	HL	Final Internal Review.
2	10/08/2014	HL	Changes made from internal ANZ review
1	29/07/2014	HL	Original client draft

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1 EXECUTIVE SUMMARY

AFFCO NZ, Manawatu (ANZ) operates a beef processing plant on Campbell Road, Feilding. As part of the operation meatworks effluent (MWE) is produced which requires treatment and discharge. MWE is treated through a series of anaerobic and aerobic ponds. An existing discharge system directs a portion of the MWE produced to the Oroua River and a portion to a land application system on an adjacent farm (Byreburn Farm, third party land). Resource consent is required for the continued discharge to land. The discharge to land has been redesigned to ensure that the system is sustainable for the term of a new consent.

In addition to MWE, there are organic sludges (from the treatment pond) and solid material (separated from the wastestream and composted) that require management.

This report describes the effects to the environment of discharging MWE and solids from the effluent collection and treatment system to land in the vicinity of the treatment plant, including the existing discharge areas and additional land.

The discharge areas are located on multiple land parcels with different land uses and owners. There are four soil types across the two landforms of the proposed land application areas, being:

- Recent flood plain: Rangitikei sandy loam and Rangitikei like soils in well drained areas and Parewanui soils in poorly drained areas (Parewanui soils are minor on the areas); and
- Low terrace: Manawatu silt loam in free draining areas and Kairanga silt loam in imperfectly drained areas.

The land treatment areas have been divided into Land Management Units (LMUs) on the basis of the above mentioned differences. Key parameters for the LMUs are summarised in the following table.

	LMU 1	LMU 2	LMU 3	LMU 4
Description	Byreburn existing (rotorainer)	Byreburn existing	Byreburn new	AFFCO and St Dominics
Ownership	Byreburn Limited	Byreburn Limited	Byreburn Limited	AFFCO NZ (9.2 ha) Dalcam Company Limited (4.2 ha)
Area (ha)	56	40	33	13.4
Dominant soil	Kairanga silt loam	Rangitikei sandy loam	Kairanga silt loam	Rangitikei sandy loam
Limiting parameter	P load (60 kg P/ha/year)	Instantaneous hydraulic / P load	Instantaneous hydraulic load	N load (100 kg N/ha/year)
Average application depth (mm/year)	152	152	152	59
Average N Load (/year)	203 kg N/ha	203 kg N/ha	202 kg N/ha	76 kg N/ha
Average P Load (/year)	34 kg P/ha	34 kg P/ha	33 kg P/ha	13 kg P/ha
Max volume (m^3/year)	114,000	109,000	98,700	10,075
Max application depth (mm/year)	250	250	300	75

	LMU 1	LMU 2	LMU 3	LMU 4
Max N Load (/year)	360 kg N/ha	360 kg N/ha	400 kg N/ha	100 kg N/ha
Max P Load (/year)	60 kg P/ha	60 kg P/ha	66 kg P/ha	17 kg P/ha
# discharge events	Up to 7	Up to 20	Up to 25	Up to 7

The effects of the proposed land treatment system have been assessed based on the maximum volume able to be applied to each LMU. However it should be noted that the actual yearly discharge to land is less than the total possible. This results from the amount of storage that is available and the practicalities of the land management. It is intended that the decision regarding where the MWE is applied will be based on land management decisions and will change from year to year. In practice this means that in a discharge year some areas may receive the maximum yearly application while others receive little or no application. **Effectively there is more than 150 % of the land area needed, with the greater area providing for operational flexibility.**

On LMUs 1-3 which are farmed, if the yearly MWE application does not provide an agronomic loading of the key nutrients supplementary nutrient applications may occur in the form of organic solids from ANZ or conventional fertilisers. It should be noted that under the existing farm dairy effluent (FDE) consent held by Byreburn Farm, no area that receives FDE can also receive MWE and so for areas which receive FDE, no MWE shall be applied for that management year. A management year is considered from July to June.

MWE is apportioned between the discharge to land and discharge to the Oroua River. The average yearly volume of MWE produced by the plant may increase to 307,400 m^3, of which 179,300 m^3 would be applied to land in an average year. Currently only around 250,000 m^3 per year is produced and of that 134,000 m^3 is likely to be applied to land in a typical year. The potential increase is due to future proofing the plant's operation and providing operational flexibility, with the current operation (and likely foreseeable production) **being less than the possible future flows**.

At the present MWE quality of 133 g/m^3 of nitrogen (N) and 22 g/m^3 of phosphorus (P) a mass load of N and P across the land treatment areas would be almost 24 tonnes N and 4 tonnes P. The distribution of the wastewater amongst the LMUs will vary up to nominated maximum rates. Based on a yearly discharge increasing over the term of the consent from 134,000 m^3 to 179,300 m^3 discharged over the available area of 142 ha, **the annual average areal loading from applying MWE to the site (i.e. long term annualised average) is 126-167 kg N/ha/year**. If some areas receive a nitrogen loading greater than that expected for grazed pasture, then an Additional Nutrient Utilisation Strategy will be used to negate the effects of the localised higher applications.

Section 5 of this report describes the potential and predicted actual effects of the discharge to land based on the discharge methodology proposed. The effects have been assessed for:

- Soil and plant system;
- Groundwater;
- Surface water;
- Air quality;
- Social and cultural considerations; and
- Amenity values.

No effect has been identified which cannot be avoided or mitigated by the adoption of sound management practices and limitations to the amount and timing of MWE discharge. The effects of the proposed discharge to land are assessed as no more than minor.

2 INTRODUCTION

2.1 Background

ANZ operates a beef processing plant on the outskirts of Feilding township. As part of the operation MWE is produced. The MWE is treated and then discharged to the environment, specifically to adjacent land and to the Oroua River. The discharge of MWE must be conducted in a manner that results in no effect that is unacceptable to the receiving environment. In addition, Horizons Regional Council One Plan Policies must be met.

ANZ has engaged Lowe Environmental Impact (LEI) to assist with the redesign for consenting of the current discharge system including the land treatment system. This work replaces a resource consent application prepared and lodged with Horizons Regional Council by CPG Limited on behalf of ANZ in 2011. While the proposed system has changed since that consent application was lodged, where information provided in that consent application has not changed it is relied upon in this report.

2.2 Scope

This report provides an assessment of the environmental effects of the discharge of MWE from the ANZ plant.

The report covers:

- Section 3 outlines the receiving environment for the discharge;
- Section 4 describes the proposed activity;
- Section 5 describes the effects of the discharge;
- Section 7 outlines monitoring and mitigation suggested; and
- Section 8 gives key conclusions of the report.

The assessment of effects is based on the conceptual design of the land treatment system. Detailed design will follow resource consenting.

3 RECEIVING ENVIRONMENT

3.1 Existing Reporting

Detailed information regarding the receiving environment for the land discharge of MWE is provided in the following reports.

- LEI report: Site Investigation for Land Treatment Suitability (May 2014); and
- Previous resource consent application: Land Application of Meatworks Process Wastewater at Byreburn Farm, Feilding (CPG, 2010), particularly Appendix H.

Information provided here is summarised from those reports. For more detailed discussion the source material should be referred to.

3.2 Site Location and Description

ANZ is located off Campbell Road, Feilding. The wastewater treatment plant (WWTP) is located in the eastern portion of the property. The land that is currently, or is proposed to receive the discharge of MWE is located within or directly adjacent to the ANZ site. The legal description of the parcels that are proposed to receive MWE are given in Table 3.1. The figure "Location" (Appendix A) shows the location and layout of the land application areas.

Table 3.1: Land Areas for Investigation

Legal Description	Owner	Cadastral Area (ha)
Part Section 225 Sbdn A Manchester DIST	Byreburn Limited	14.46
Lot 191 DP 100	Byreburn Limited	13.79
Section 5 Block XIV Oroua SD	Byreburn Limited	approx. 15
Lot 2 DP 89128	Byreburn Limited	39.97
Lot 1 DP 57580	Byreburn Limited	22.71
Lot 1 DP 89045	Byreburn Limited	19.27
Lot 2 DP 89045	Byreburn Limited	11.47
Lot 30 DP 2688	Byreburn Limited	0.61
Lot 31 DP 2688	Byreburn Limited	0.61
Lot 3 DP 89045	AFFCO New Zealand Limited	16.72
Sbdn 1 Sec 12 Block XIV Oroua SD	AFFCO New Zealand Limited	0.73
Part Section 13 Clock XIV Kairanga SD	AFFCO New Zealand Limited	18.32
Lot 28 DP 2688	AFFCO New Zealand Limited	0.67
Lot 24 DP 2688	AFFCO New Zealand Limited	0.59
Lot 23 DP 2688	AFFCO New Zealand Limited	0.6
Lot 22 DP 2688	AFFCO New Zealand Limited	0.6
Lot 21 DP 2688	AFFCO New Zealand Limited	0.6
Part Aorangi 1C Block	Dalcam Company Limited	approx. 4.09
Lot 19 DP 2688	Dalcam Company Limited	0.6
Lot 18 DP 2688	Dalcam Company Limited	0.81
TOTAL AREA		**182.49**

3.3 Land Use of Site and Adjacent Areas

Areas within the ownership of Byreburn Ltd. (referred to in this report as Byreburn Farm) are managed as a dairy farm. The land is predominantly in ryegrass and clover pasture but rotations of maize are grown some years. The location of the maize varies from year to year.

Areas within the ownership of Dalcam Co. Ltd. are part of the property of St. Dominics, a health care facility. The land that is proposed to receive wastewater is presently grazed with just sufficient stock to keep the grass down.

Areas within the ownership of ANZ have a range of current land uses including pasture, stock holding yards and amenity areas. The pasture is managed as for the St Dominics land to manage grass. Stock yards are used to hold stock prior to slaughter if there is no capacity to immediately receive them in the plant. The amenity areas are around the carpark and outer buildings of ANZ and refer to land which is presently mowed to maintain a tidy appearance.

The Oroua River bounds the ANZ plant and land application areas to the west. Across the Oroua River is Feilding township with industrial zoned land, recreation zoned land and residential zoned land abutting the river in the vicinity of the land application area.

Land around the application area is predominantly rural in character.

3.4 Topography, Landform and Geology

The land application area is situated on the recent floodplain and a low terrace of the Oroua River. The area varies from around 70 to 80 m above mean sea level (mamsl). Adjacent to the site, the Oroua River runs in a south-westerly direction in a channel incised into its gravel terrace to a depth of about 5 m below the highest terrace. Some 3.2 km west of the farm is the start of the rolling downlands which lie west of Feilding, while rolling downlands to the east of Bunnythorpe lie 7 km to the east of the site. The shortest distance from the site to the coast is 30 km, to the west.

Holocene aged, greywacke-derived river gravels, sand and silt-sized alluvium deposited by the Oroua River underlie the surface in the general area of the land application site. Older Tertiary sediments lie several hundred metres below the surface, with a Mesozoic greywacke basement beneath this (Kingma, 1962).

There are two terrace surfaces of deposited alluvium over the land application area, as follows.

- The lowest and youngest is a frequently flooded floodplain (c. 73 mamsl), which is flat to undulating and mostly gravel.
- The low terrace level (c. 76 – 78 mamsl) is rarely flooded, and is flat to undulating and contains old levees, back-plains and back-basins.

The Oroua River, running alongside Byreburn Farm, carries a bed load of Mesozoic greywacke cobbles, gravels and finer graded sediments derived by recent erosion from the Ruahine ranges.

3.5 Description of Soils

The soils of the area are described in detail in the previous consent application (CPG, 2011) and the site investigation report (LEI, 2014). A summary of soil properties which are relied on for the land treatment design and assessment of effects follows.

Soils of the floodplain which have been identified on the land application area occur over much if the ANZ and St Dominic areas, and the northern most area of Byreburn Farm. Soils of the floodplain are mapped as Rangitikei sandy loam (well drained) and Parewanui silt loam (poorly drained). Parewanui soils are minor on the site and are not considered further. Within the ANZ land application areas there has been considerable soil disturbance over time. The resulting anthropic (human made) soils have properties similar to the Rangitikei soils.

Soils of the terrace are located predominantly on Byreburn Farm. They are mapped as Kairanga silt loam (imperfectly drained) which is the dominant soil type and Manawatu silt loam (moderately well drained). Key soil parameters are given in Table 3.2.

Table 3.2: Key Soil Parameters

Soil	Design irrigation rate*	Artificial drainage	Estimated hydraulic connection to River	Olsen P status
Kairanga silt loam	18 mm/d	Yes	Poor	High where irrigated, Mod high where farmed but not irrigated
Manawatu silt loam	18 mm/d	No	Moderate	High where irrigated, Mod high where farmed but not irrigated Low elsewhere
Rangitikei sandy loam	15 mm/d	No	Good	High where organic solids have been stored, Low elsewhere

* From field investigations

3.6 Hydrology

The main hydrological feature in the wider area is the Oroua River. A tributary of the Manawatu River, it flows south-westward from its catchment in the Ruahine ranges, joining the Manawatu River near Rangiotu, between Palmerston North and Shannon. The Kiwitea Stream is a major tributary that flows into the Oroua River just north of Feilding.

Water quality in the Oroua River has been detailed in the river discharge AEE (Aquanet, 2014). In consideration of the discharge of MWE to land it should be noted that the Oroua River has a limited capacity to assimilate applied contaminants under certain river flows due to point source and diffuse discharges along the mid reaches.

Key hydrological data are given in Table 3.3.

Table 3.3: Flow Statistics for the Oroua River at Kawa Wool

Flow Statistic	Value 1967-2005 (L/s)*	Value 1992-2013 (L/s)
MALF	1,240	Not determined
Half median flow	3,486	3,795
Median flow	6,971	7,591
20^{th} percentile exceedance flow	16,078	16,193
3 x median flow	20,913	22,772

* Henderson and Diettrich (2007)

Data for the entire flow record (up to 2005) have been evaluated by NIWA (Henderson and Diettrich, 2007). The data used to develop the land application regime were for the period 1992-2013 and statistics generated from that limited duration data set were used as a basis for discharge decisions. It is noted that the statistics for the shorter data set are, in general higher than for the longer data set. This potentially results fewer discharges to the river and this, more conservative, approach is favoured.

Byreburn Farm is extensively artificially drained (moles and gravel-backfilled drainage pipe) where the Kairanga soils occur. Drainage flows into an unnamed stream that meanders from its source near Byreburn Farm's ensilage pit south along Aorangi Road, through a piggery, southwest through Byreburn Farm and ANZ land to the Oroua River. This unnamed stream has a catchment area of approximately 150 ha. It's outfall into the Oroua River is the same outfall ANZ uses to discharge wastewater to the Oroua River. Maps of the drainage network are given in the Site Investigation Report (LEI, 2014).

3.7 Hydrogeology

The site is located in the Manawatu Groundwater Management Zone (Horizons, 2008). The aquifer system from which bores in the area extract groundwater is built up of at least a 400 m thick sequence of Quaternary alluvial gravels, sands, silts and clays and contains occasional peat and wood layers. The Tertiary deposits underneath the Quaternary deposits (Section 4.6) are considered to be the lower boundary of the hydrogeological system.

The groundwater flow system is bounded by geological structures that run in south-western and north-eastern direction through the region, and flow is inferred to be towards the south-west. There are no clearly distinguishable aquifers and aquitards, with the whole groundwater system being best regarded as a single, large, leaky aquifer.

Piezometers in the vicinity of the ANZ ponds, to the west of the application site, indicate a depth to shallow groundwater of about 5 m, which is consistent with the depth of incision of the Oroua River locally as noted in Section 4.2 above. Groundwater flow direction under the site is yet to be confirmed definitively from recently installed piezometers, however the initial information is that flow is effectively parallel to the Oroua River.

Horizons lists 16 bores within 1 km of the ANZ site. Where measured the bores identified have transmissivities of 67-570 m^2/d, with a median of 245 m^2/d. Depth to water ranges from 1.0 m to 10.2 m with no clear relationship between transmissivity and depth to water. The deeper bores are assumed to be from a confined or semi-confined aquifer system. Where listed the bore uses are for industrial, irrigation, farm use and domestic supply, with no known shallow bore (< 10 m) used for domestic drinking water. The nearest bore is on the ANZ site and has a transmissivity of 200 m^2/d and depth to water of 10.2 m.

3.8 Climate

3.8.1 Rainfall and Evapotranspiration

The closest meteorological station with long term records for reported rainfall was Feilding at Sandon Road (NIWA Meteorological station number 3213, about 4 km west of the site). The closest meteorological station for monthly potential evapotranspiration (PET) was Palmerston North Ews (NIWA Meteorological station number 21963, about 10 km south of the site). Rainfall and PET records from 2000-2010 are referred to in this report. Table 3.4 below presents climate data provided by National Institute of Water and Atmospheric Research (NIWA). All data was collected from the database and averaged.

It is expected that the PET and rainfall at Palmerston North Ews and Feilding respectively will be close to those at Byreburn Farm, due to their physical proximity and the lack of significant topographical features separating them. A crop coefficient of 1.0 has been adopted because the site is usually covered in high-producing, short pasture grass.

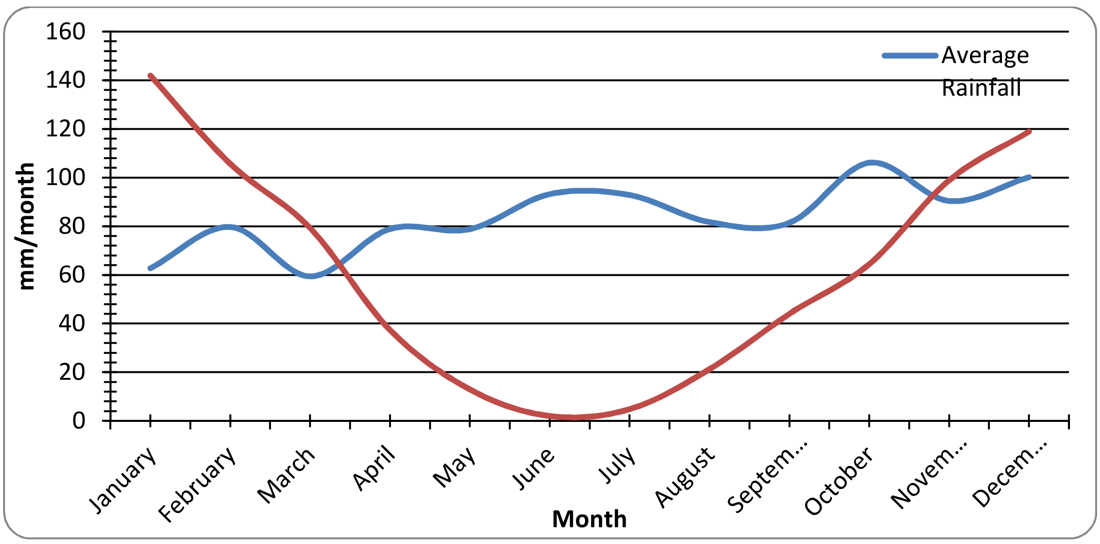
Table 3.4: Byreburn Farm – Assessed Mean Monthly Rainfall and Potential Evapotranspiration

Month	Rainfall (mm/month)	PET (mm/month)
January	63	142
February	80	106
March	59	79
April	79	37
May	79	13
June	93	2
July	93	5
August	82	21
September	81	44
October	106	64
November	90	99
December	100	119
Total	1,005	731
Site	NIWA Feilding	NIWA Palmerston North Ews
Years	2000-2010	2000 – 2010
Site No.	3213	21963

The data from Table 1 is illustrated in Figure 3.1 below.

The mean rainfall at Feilding is 1,005 mm/year. Rainfall is fairly evenly distributed throughout the year, peaking in October to December at 100 and 106 mm respectively. June and July are also wet months at 93 mm each, but at this time of year water loss due to evapotranspiration (represented by PET) is near 0. PET exceeds rainfall for the months November to March inclusive.

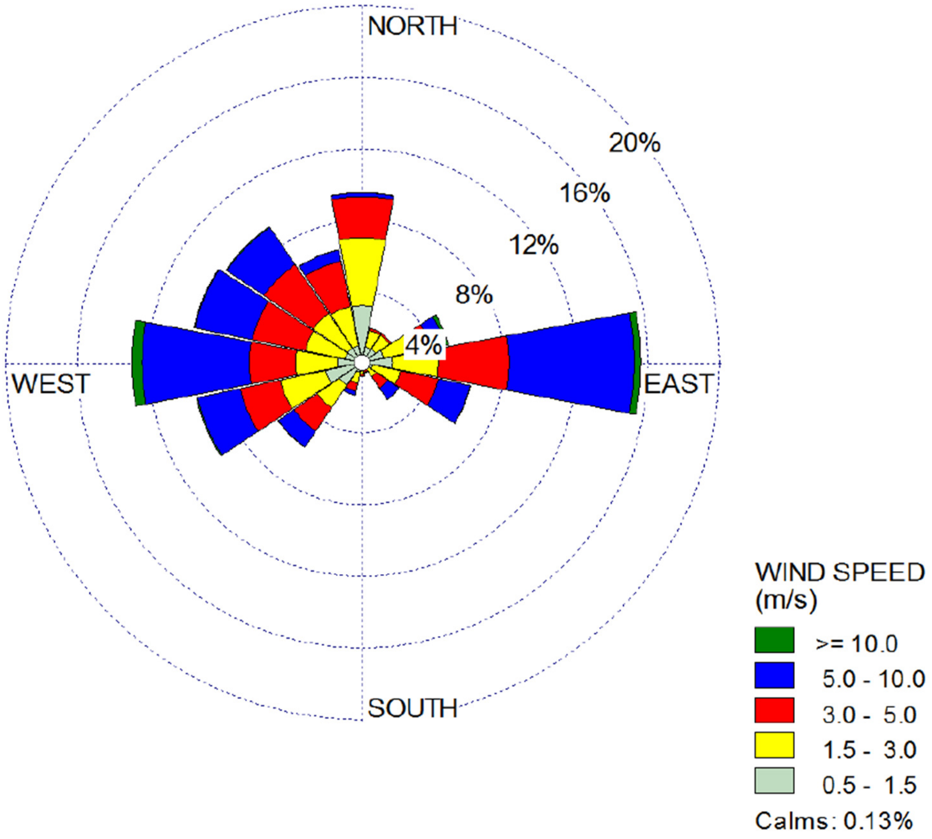
Figure 3.1: Mean Rainfall and PET, Palmerston North (2000-2010)



3.8.2 Wind

The most up-to-date and applicable information regarding wind speed and direction was considered to be that presented in the Air Quality Section 42 report for the recent Resource Consent process for the Fielding WWTP discharges. A windrose is shown in Figure 3.2 from the Taonui Road/Fielding Airfield site, which was considered to be the closest operating station to Byreburn Farm, at 2 km to the southeast.

Figure 3.2: Taonui Windrose 2011 to June 2014 (after Curtis, 2014)



The Taonui windrose is considered to be fairly representative of conditions at Byreburn Farm, with unbroken flat land between the two localities. The Taonui windrose indicates that the most frequent wind directions expected in the area of Byreburn Farm are from the east and west, and lighter winds from the north and less frequently the north-west. Winds from the south are not common.

Winds from the north are characteristically light airs, seldom rising beyond 5.0 m/s. Those from the west are more frequent, and while light airs are typical, there are also some firmer breezes in the 5.0 to 10.0 m/s range. Winds from the east are the most frequent, with a significant incidence of winds in the 5.0 to over 10.0 m/s range. Light south-easterly breezes are the least frequent across Byreburn Farm but when occurring would carry across the eastern parts of Feilding.

3.9 Sites of Significance

The Manawatu District Council Planning maps do not identify any sites of significance within the land application area. Due to the long history of pastoral farming on the site it is expected that surficial sites, being the zone impacted by the proposed activity will have been identified and excluded from the site, or would have been modified by farming practices historically.

4 DESCRIPTION OF THE ACTIVITY

4.1 General

This section outlines the activity, being a discharge of MWE to land that is proposed to occur. A detailed description of the discharge system including detailed information about the discharge to land component is given in the Conceptual Design report (LEI, 2014b) which forms part of the main consent application. To avoid duplication, this section provides a summary of the key parameters relied upon to determine the effects of the land discharge. It is strongly advised that the Conceptual Design report is reviewed to obtain a more complete understanding of the proposed CLAWD system. The existing regime and its effects has been described in some detail in the previous consent application (CPG, 2011) and is not discussed here.

4.2 MWE Collection, Treatment and Storage

MWE is derived from animal effluent, processing waste streams (unusable animal products), wash water containing detergents and processing waste from the Wallace Corp slinkskin factory. The solids are separated out and the liquid waste is piped to a large (around 6 ha) treatment pond system. The pond system provides both aerobic and anaerobic treatment prior to discharge.

The ponds provide storage to enable discharge to either land or river to be withheld when conditions are unsuitable for discharge (as described below). In all there is 64,500 m^3 of storage in excess of the systems treatment capacity i.e. 57,600 m^3 of dedicated storage and 6,900 m^3 of freeboard in the aerobic pond. This equates to around 92 days of storage under current MWE production and 76 days of storage under future MWE production.

4.3 MWE Flow and Quality

MWE from the ANZ plant has been monitored in-line with the conditions of Consents 4219 and 4220. Tables 4.1 and 4.2 summarise the MWE flow and quality.

An increase of 20 % of MWE flows has been adopted to estimate maximum MWE volumes for the term of the consent.

Table 4.1: ANZ MWE Volumes

Flow statistics	Current Flows* (2010-present) (m^3)	Future flows (m^3)
Annual average	256,132	307,358
Daily average	702	842
Daily minimum	257	308
Daily maximum	1,026	1,231
Daily median	760	912

* Current flows are based on water use at the site rather than outflows from the pond due to concern over the quality and length of the outflow dataset. The current data used here has been compared against paired river water quality to provide some assurance that the dataset is valid.

Table 4.2: MWE Quality Sampled at Pond Outlet (Albert van Oostrom, 2013)

	TSS	$cBOD_5$	NO_x-N	NH_4-N	TIN (SIN)	TN	TP	DRP	E. coli
	g/m³	g/m³	g/m³	g/m³	g/m³	g/m³	g/m³	g/m³	/100 mL
Year round									
Mean	112	34	35	81	117	133	22	20	10,933
Median	85	29	23	84	119	132	22	20	9,550
95%ile	295	74	100	140	159	176	28	26	20,750
Max	770	115	127	170	171	190	30	29	24,000
Count	183	183	183	183	183	183	183	132	6
"Summer" (land discharge)									
Mean	179	41	41	61	102	124	24	21	NA
Median	143	34	27	62	106	128	24	21	NA
95%ile	378	97	100	112	133	155	28	24	NA
Max	770	115	114	132	137	164	30	26	NA
Count	53	53	53	53	53	53	53	39	0

	Ca tot	Na tot	K tot	Mg tot	SAR	pH
	g/m³	g/m³	g/m³	g/m³		
Year round						
Mean	26	229	46	9	10	8
Median	26	198	44	9	9	8
95%ile	32	403	52	12	16	9
Max	35	442	59	12	17	9
Count	19	19	19	19	19	175
"Summer" (land discharge)						
Mean	26	216	44	9	9	8
Median	26	199	44	9	9	8
95%ile	29	291	49	11	12	9
Max	32	333	51	12	13	9
Count	12	12	12	12	12	50

4.4 Organic Amendments

There are two sources of organic solids from the plant:

- Organic solids are intercepted as described in Section 4.2 of the conceptual design. They are composted in the paunch pits; and
- Accumulated sludge in the pond system.

Information about the solids composition is given in Table 4.3.

Table 4.3: Composted Paunch Pit Solids

Sample	Units	Concentration
P	(mg/kg)	2,435
K	(mg/kg)	1,210
Na	(mg/kg)	611
Total C	(%)	15.1
Nitrate-N	(mg/L)	98
Ammonium-N	(mg/L)	1
Total N	(%)	1.355
Plant available nitrogen (PAN)	(kg N/tonne)	2.08
C/N	Ratio	11
Dry Matter	(%)	50.55

It is estimated that the volume of organic solids material is:

- 627 m^3/year of composted paunch material;
- 9,000 m^3 in total of pond sludge; and
- An additional 200 m^3 of pond sludge expected to be produced each year.

4.5 Criteria for Discharge to Land

Details of the decision making process for determining how much and where a discharge to land will occur are given in Section 3.5 and 6.2 of the Conceptual Design report.

4.6 Proposed Discharge to Land

It is proposed that an average future volume of 179,300 m^3 will be discharged to land identified in Figure "Land Management Units" (Appendix A). Buffer distances from property boundaries, dwellings and waterways have been subtracted from the available areas. The land areas for application of MWE are described in the conceptual design and land investigation reports and are summarised in Table 4.4 for each land management unit (LMU).

Table 4.4: LMU Summary

	LMU 1	LMU 2	LMU 3	LMU 4
Description	Byreburn existing (rotorainer)	Byreburn existing	Byreburn new	AFFCO and St Dominics
Ownership	Byreburn Limited	Byreburn Limited	Byreburn Limited	AFFCO NZ (9.2 ha) Dalcam Company Limited (4.2 ha)
Area (ha)	56	40	33	13.4
Dominant soil	Kairanga silt loam	Rangitikei sandy loam	Kairanga silt loam	Rangitikei sandy loam
Limiting parameter	P load (60 kg P/ha/year)	Instantaneous hydraulic / P load	Instantaneous hydraulic load	N load (100 kg N/ha/year)
Average application depth (mm/year)	152	152	152	59
Average N Load (/year)	203 kg N/ha	203 kg N/ha	202 kg N/ha	76 kg N/ha
Average P Load (/year)	34 kg P/ha	34 kg P/ha	33 kg P/ha	13 kg P/ha
Max volume (m^3/year)	114,000	109,000	98,700	10,075
Max application depth (mm/year)	250	250	300	75
Max N Load (/year)	360 kg N/ha	360 kg N/ha	400 kg N/ha	100 kg N/ha
Max P Load (/year)	60 kg P/ha	60 kg P/ha	66 kg P/ha	17 kg P/ha
# discharge events	Up to 7	Up to 20	Up to 25	Up to 7

It should be noted that while, in total there is capacity to discharge up to 331,775 m^3 of effluent to land, in reality on average only 179,300 m^3 will be discharged to land under the future wastewater flow scenario. This occurs for two reasons:

- Full discharge would interfere in the management of the land both on the farm and around ANZ; and
- The storage required to withhold the peak inflow volumes during periods of no irrigation are prohibitively large.

4.6.1 Nitrogen Management

The distribution of the wastewater amongst the LMUs will vary up to the maximum rate given in Table 4.4. Based on a yearly discharge increasing over the term of the consent from 134,000 m^3 to 179,300 m^3 discharged over the available area of 142 ha, the annual average areal loading to the site (i.e. long term annualised average) is 126-167 kg N/ha/year. Some areas will receive higher loadings and some areas will receive lower loadings.

With an application rate varying between 0 and 400 kg N/ha/year it is expected that the rate of N leaching across the site will vary but will, on average, result in total leaching losses from the total site that are similar to a farm receiving a long term average N loading of 126-167 kg N/ha/y as above. It should be noted that additional sources of N (including supplemental fertiliser and clover fixation) may be used to assist with pasture growth, as a productive pasture producing 17,000 kg DM/ha/y will require something in the order of 600 kg N/ha/y.

Additional Nitrogen Utilisation Strategy

To ensure that the average areal loading rate is maintained, and to avoid spot loading, an additional nitrogen utilisation strategy shall be implemented. Should nutrient loading rates from MWE over any LMU area reach a level deemed too great for grazed pasture (i.e. applications greater than 250 kg N/ha/y), then a partial or dedicated cut and carry component can be introduced to increase the nutrient removal capabilities of that area. This allows a higher nutrient loading rate on those areas.

Should the nominated grazed pastoral target of 250 kg N/ha/y be exceeded, the extent of nutrient removal by harvesting required would be in direct proportion to the increase in nutrient application over what would be expected from grazing alone. For example if a nutrient loading of 310 kg N/ha occurred in any year on a given paddock, then there would have to be harvesting of hay/silage to remove 60 kg N/ha (i.e. about 1,200 kg DM/ha removed).

On this basis a simple N balance indicates that, assuming a modest dry matter (DM) production (for nutrient sufficient and irrigated pasture) of 17,000 kg DM/ha/year for LMUs 1-3, the N requirement is 600 kg N/ha/y. The fate of this plant uptake can be considered as follows:

- 15 % (90 kg N/ha/y) is removed as product;
- 85 % (510 kg N/ha/y) is returned as excreta, of which:
  - 4 % is volatilised;
  - 10 % enters the FDE system and is discharged elsewhere;

This results in a deficit of 161 kg N/ha/y (i.e. removal of N off the paddock).

MWE Nitrogen

As described above it is proposed that up to 250 kg N/ha/y will be applied as MWE to grazed areas (beyond which the Additional Nitrogen Utilisation Strategy would apply). Of the applied MWE 61 % is in ammoniacal form, 26 % is in the oxidised (nitrate and nitrite) form and 13 % is organic N. The delivery of the bulk of the MWE as ammoniacal N is advantageous because it is in a form that is immediately available for plant uptake.

Due to the MWE being discharged predominantly during the high growth periods (warmer seasons) and at a low rate (43 kg N/ha/pass for LMU 1 and 15 kg N/ha/pass for LMUs 2-4) a large proportion of the applied ammoniacal N is expected to be sequestered by the growing pasture. Based on the deficit described above, 161 kg N/ha is expected to be incorporated into the above ground biomass.

Also due to the irrigation occurring during warmer, drier periods it is expected that up to 15 % (Myers *et al.*, 1999) of the N could be volatilised. Various literature puts volatilisation of applied wastewater as total N at 15-38 % (Smith *et al.,* 2001) and 12-18 % (Laurenson, J. N. S *et al.*, 2006) for high strength effluent (piggery waste) or 2-4 % (Myers *et al.*, 1999) for low strength effluent (municipal). The MWE has a strength in the mid-range between piggery effluent and municipal effluent. A volatilisation of around 10 % is considered to be appropriate for this evaluation. This equates to a loss of around 25 kg N/ha/y for an application of 250 kg N/ha/y.

The use of irrigation will result in the soil being maintained in a moist state such that a degree of denitrification is expected to occur. A typical value for denitrification is 4 % of total N resulting in a gaseous loss of 10 kg N/ha/y.

The organic N is only slowly available and tends to be mineralised as needed. Based on the applied MWE around 33 kg N/ha/y is expected to be accumulated in the soil profile. This corresponds to a change in the soil test N of 0.0033 %/year which would be undetectable.

There is 21 kg N/ha/y remaining which is unaccounted for (i.e. 250 kg – 161 kg (deficit) – 25 kg (volatilisation) – 10 kg (denitrification) – 33 kg (soil accumulation) = 21 kg). This may be incorporated into the soil N pool, it may be retained in the soil for later plant uptake or it may be leached. Assuming the entire 21 kg N/ha/y is leached, this corresponds to a low N leaching loss which would meet the 20 year limit for Class II land (predominant land class on site) if it were within a relevant management zone – which it is not (Tables 13.1 and 13.2 of the One Plan).

4.6.2 Phosphorus Management

Phosphorus has been identified as a limiting parameter for the land application regime over some of the LMU 1. To manage current elevated P levels in the soils of this area it is recommended that one quarter of the available area (14 ha) is excluded from the irrigation schedule for one year out of four. During the nil irrigation year ideally a maize crop would be grown and removed from the site i.e. not fed out on these paddocks. Under this management a four year rotation of areas would assist to "mine" P from the soil. In order to minimise mineralisation of soil nitrogen (N) stores, causing leaching, the maize and replacement pasture should be direct drilled with no, or minimal cultivation.

It should be noted that all nutrient loading and hydraulic loading values reported assume that the above mentioned 14 ha is not available i.e. the exclusion of this area doesn't change the proposed loadings.

5 ASSESSMENT OF EFFECTS

5.1 General

This section provides an assessment of the effects of the discharge of MWE as outlined in Section 4, on the receiving environment as described in Section 3.

5.2 Receiving Environment

The initial environment to receive the discharge of MWE is the soil and plant system of the application area. If the MWE is not retained or renovated in the soil it may travel to shallow groundwater, or by overland flow to local surface water. Ultimately, any MWE or MWE derived contaminants if not applied to land correctly may enter the Oroua River.

5.3 Sensitivity of the Receiving Environment

The land application areas themselves are not considered to be sensitive, but the application of MWE should not impact on farming operations.

The application areas, especially to the south, are surrounded by houses and small lifestyle blocks. If the application system is not managed adequately within the bounds of the application area there is the potential for impacts on neighbours via odours and aerosols.

The main receiving environment of concern is the Oroua River, which while there is a discharge directly to the river during higher flows, any discharge during low flow conditions should be avoided to negate nutrient enrichment conditions that may lead to eutrophication and associated effects. Discharge to the river would most likely be via groundwater resulting from over application of MWE. If MWE is to reach the river, it will be doing so with contaminants from surrounding land, including leaching from existing farming operations. While leaching should be minimised, the Oroua River is already subject to nutrient inputs and these are likely to continue irrespective of the application of MWE.

5.4 Summary of Effects

The activity that may produce actual or potential effects on the environment that need to be considered relates to:

- The discharge of treated Meat Works Effluent (MWE) to land on Byreburn Farm, AFFCO land and St Dominics land.

The MWE to be irrigated onto the land application site on Byreburn Farm will have the following properties of potential environmental concern:

- Organic material, expressed as carbonaceous biochemical oxygen demand (BOD);
- Nitrogen (N as ammoniacal nitrogen (NH4-N) and nitrite/nitrate nitrogen (NOx-N));
- Total phosphorus (P);
- Pathogens; and
- Water.

Actual or potential effects upon the environment are considered as:

- Effects of the discharge on the soil;
- Effects of the discharge on groundwater quality;

- Effects of the discharge on surface water quality;
- Effects on habitats;
- Effects on Amenity, Community, Cultural and Heritage values; and
- Effects of the discharge on air quality.

There will be no effects that are not capable of satisfactory avoidance, remediation or mitigation. The individual effects are all not more than minor. This is detailed in the following sections.

5.5 Effects of the Discharge on Soil and Plants

The MWE will be applied at a rate equivalent to a maximum application depth per application event of 34 mm/application by the existing irrigation infrastructure over LMU 1, or 12 mm/application over LMUs 2, 3 or 4. The impact of the discharge on the soil and plant system relates the potential for a reduction in soil quality, and loss of productivity leading to poor performance of crops on the site. These are discussed below.

5.5.1 Effect of Water on Soil Structure

Soil structure refers to the size and distribution of soil particles and void spaces (pores) in the soil. It is important since it controls the rate at which water can be infiltrated into and drained from the soil, and the amount of water that can be retained in the soil. In addition, the distribution of pores influences the aeration of the soil. If the soil structure is degraded, drainage and root passage becomes impeded which leads to a loss of productivity and reduction in soil quality.

Irrigation has the potential to initiate soil structural degradation if not sustainably managed. If soil is allowed to remain at a high soil moisture content or saturation for a prolonged period damage to soil structure may occur by:

- Pugging due to animal traffic on wet soils;
- Mechanical damage by cultivation or vehicle traffic on wet soils; and
- Chemical and biological damage to structure by MWE constituents or microbial action in anoxic conditions due to saturated conditions.

In order to prevent prolonged wet conditions in the soil a resting period of ideally not less than 5 days between application and grazing or harvesting will be maintained, however actual soil moisture may allow grazing or harvesting earlier. Applications will occur only during deficit conditions i.e. following the application of MWE the soil's field capacity will not be exceeded. To comply with the proposed parameters application to each area of the site will occur only 7 times in the 180 day season for the higher rate application system (LMU 1) or up to 39 times for the lower rate application system. This will ensure a long resting period between applications and sufficient time for the soil to dry out prior to grazing or harvesting. Further, by not allowing irrigation to exceed field capacity will ensure that the soils are retained in an aerated state.

The depth of MWE to be applied in any event has been designed to meet industry best practice for wastewater irrigation and is based on the actual measured hydraulic properties of the soil on the site. Application to land is to be halted during periods of wet weather to ensure that the additive effect of MWE plus rainfall does not cause prolonged soil wetness. It is considered that the effect of MWE applied water on the soil will be no more than minor.

5.5.2 Effect of Cations on Soil Structure

Soil structure can be affected by sodium (Na) in MWE which is present mostly from cleaning agents in the wastewater. The ratio of Na to calcium (Ca) and magnesium (Mg) is used to determine the risk to the soil from the MWE as measured by the sodium absorption ratio (SAR). The maximum SAR is dependent on soil type and rainfall but varies between 4 and 18 (Snow *et al.*, 1995). The soils of the proposed irrigation areas are not considered to be sensitive to SAR of wastewater due to the lack of any shrink-swell clays, and due to the soils being relatively young and poorly structured. In addition the area receives ample rainfall. Therefore a limit closer to 14 is considered appropriate for the site. Over the summer the mean SAR of the MWE is 9, while a maximum of 17 has been recorded. Based on the average SAR the effects of Na on the soil structure are considered to be minor, but require monitoring. If the MWE causes the accumulation of Na in the soil it can be remediated by application of gypsum.

5.5.3 Effect of Organic Material on Soil and Plants

Potential adverse effects of organic material, measured as BOD, on soil and plants of the site include the generation of anaerobic conditions in the soil as oxygen is consumed. This could cause production of surface slimes with the associated problems of:

- Soil pore blockage, leading to reduced soil infiltration capacity.;
- Plant die off;
- Degraded visual appearance;
- Production of odour; and
- Degradation of soil structure.

A healthy soil environment can assimilate up to 600 kg BOD/ha/day (NZLTC, 2000). The BOD of the wastewater is highest in summer at a mean of 41 g/m^3. The maximum loading of BOD to be applied by the system is 5 kg BOD/ha/application event (LMU 2, 3, 4) and 14 kg BOD/ha/application event (LMU 1). This equates to between 31 and 123 kg BOD/ha/year respectively. These rates are well within the capacity of a healthy soil, so the effects of BOD on soil and plants within the proposed application are expected to be less than minor.

5.5.4 Effect of Nitrogen on Soil and Plants

Potential adverse effects of high N loading on soil and plants may include:

- Oversupply of N in excess of plant requirements, leading to leaching to groundwater and drainage to surface water; and
- Plant damage due to high ammonia.

Much of the N will be removed by soil microbe use, plant uptake, short-term soil storage and gaseous losses (volatilisation and denitrification).

The proposed N loading from MWE to the application area varies from 100 kg N/ha/year on LMU 4 to 250 kg N/ha/year for the grazed LMUs to a maximum of 400 kg N/ha/y on LMU 3 under cut and carry management. The previous consent has a limit of 400 kg N/ha/year but in practice this level was seldom reached (see CPG, 2011 for a detailed discussion).

A per application N load of 43 kg N/ha (LMU 1) or 15 kg N/ha (LMU 2, 3, 4) will occur. This is low compared to typical Urea application rates and it will be applied during active plant growth, leading to a high potential for uptake by the pasture. The fate of the applied N from MWE is discussed in Section 4.6.1 and based on that analysis the potential leached mass is considered to be low compared to the surrounding dairy farming land use. Management of higher loading rates will be assisted by adopting the Additional Nitrogen Utilisation Strategy.

A total loading rate not exceeding the maximum N load given in Table 4.4 for each LMU is proposed for all organic sources of N including from organic solids application. At the proposed rate of application it is expected that soil fertility and plant production will benefit from the irrigation of the treated MWE. Adverse effects on soil and plants due to nitrogen from MWE application are considered be less than minor.

5.5.5 Effect of Phosphorus on Soil and Plants

The MWE contains P, which is an essential nutrient for plant growth and microbial activity. The risk from P is predominantly due to the effects if it reaches surface water, causing nuisance growth in streams and rivers.

The proposed P loading to the LMUs varies from 17 kg P/ha/y (LMU 4) to up to 60 kg P/ha/y (LMUs 1 and 2) to 66 kg P/ha/y (LMU 3). A per application P load of 8 kg P/ha(LMU 1) or 3 kg P/ha (LMU 2, 3, 4) will occur. At the proposed rate of application it is expected that soil fertility and plant production will benefit from the irrigation of the treated MWE. Soil transformation and plant uptake of the applied P is expected to match or exceed the rate of application.

Due to historic management of nutrients, specifically the practice of applying additional fertiliser to MWE irrigated areas (this is discussed in further detail in CPG, 2011, Section 5.4.4) LMU 1 has elevated soil Olsen P levels, indicating a risk of off-site movement of P in drainage water. To actively reduce the P in the soil it is proposed that one out of every four years a quarter of the area (14 ha) of LMU 1 will receive no MWE, and a maize crop will be grown until Olsen P levels are able to be maintained below 45 mg/L.

Adverse effects on soil and plants due to phosphorus from MWE application are considered be less than minor.

The impact on ground and surface water is discussed in subsequent sections.

5.5.6 Effect of Pathogens on Soil and Plants

The MWE has the potential to contain pathogens, as indicated by E. coli levels. The risk from pathogens in the soil occurs when they enter the food chain by consumption of raw crops.

On the site, the main mechanisms that operate within the soil matrix to ensure pathogen removal are filtration, adsorption and natural attrition. It is understood that 92 - 99.9 % of applied microbes are removed in the top 10 mm of the soil (Crane and Moore, 1984; Gunn, 1997).

The greatest risk is potentially not with the soil but with stock ingesting the pathogens that have been applied. This is a farm management and animal health issue. It is expected that the effect of pathogens from MWE on soil and plants will be less than minor.

5.6 Effects of the Discharge on Groundwater

Contaminants applied to the land have the potential to enter groundwater. On the land treatment sites the discharge will be applied at the surface of the soil and there is the potential for MWE or MWE derived contaminants to leach into shallow groundwater. Contaminants in groundwater may have an effect if the groundwater is abstracted for use or if groundwater enters surface water.

Effects on groundwater can be significantly mitigated by adopting an appropriate irrigation regime that avoids field capacity being exceeded following irrigation and the adoption of an instantaneous application rate that avoids preferential or bypass flow through large soil pores and cracks. Testing of the soil properties on the site has been undertaken (LEI, 2014a) to develop an application rate to minimise the potential for preferential flow and loss of applied contaminants directly to groundwater.

5.6.1 Effect of Water on Groundwater

The potential effect of irrigation applied water on groundwater is predominantly due to the contaminants that are transported in the MWE applied water. These are dealt with in the following sections. The initiation of excessive drainage has the potential to cause localised groundwater mounding where groundwater is slow moving. Water applied to the soil surface by MWE application will be to a depth of 34 or 12 mm/application with a resting period between applications to the same site. This rate has been designed to avoid excessive drainage. Most applied water will not percolate through the soil to reach the groundwater due to the deficit irrigation regime; it will pass back out to the atmosphere by way of transpiration by plants or direct evaporation.

Should wastewater contaminants pass through the soil they can be attenuated and either adsorbed to the soil material or transformed into gases which are lost to the environment. Maintaining the depth to groundwater to allow for unsaturated passage through soil media, in what is refered to as the valdose zone, assists to limit the impact of applied material on groundwater. Recent monitoring of groundwater across the site suggests that groundwater in winter conditions is at ? to ? m below the soil surface. This provides a depth for further contaminant attenuation below the plant rooting zone.

The effects of water applied as MWE on groundwater is expected to be negligible.

5.6.2 Effect of Organic Material on Groundwater

Organic material (as BOD) in groundwater becomes a problem when the water reaches the surface, either through a bore for some productive use or as it reaches surface water such as the Oroua River. High BOD causes a reduction in dissolved oxygen, leading to anaerobic conditions, mortality of river flora and fauna, and growth of undesirable flora and fauna.

BOD from MWE irrigation will be effectively intercepted in the soil as described in Section 5.5.2, so that BOD entering groundwater will be negligible, and the effect of BOD on groundwater is expected to be less than minor.

5.6.3 Effect of Nitrogen on Groundwater

Potential adverse effects of N on groundwater in this situation would become apparent when groundwater enters surface water. The agronomic N application rate, predominantly applied during summer, ensures that a substantial proportion of applied N will be taken up by plants, sequestered by soil, or volatilised/denitrified.

The low rate application to the site will ensure that the N is utilised within the soil and not flushed through. Details of the N balance for the site are given in Section 4.6.1. The nutrient balance suggests on average 21 kg N/ha/year is available for leaching. This assessment is a simplistic mass balance based on the application of MWE, and refinement of leaching taking into account farming practices may see this rate vary across the site.

While the irrigation site is not within a management zone that is subject to N leaching targets (as identified in OnePlan), those targets provide a useful benchmark. A value of 21 kg N/ha/y is equivalent to the 20 year target limit for the Class II land in a priority catchment. Noting that Class II land is dominant over the site. Should N enter groundwater, the geology in the area is such that it would soon reach surface water, being the Oroua River.

Despite the geological aspect discussed above, the mass of N entering groundwater due to the discharge is considered to be low compared to a typical dairy farm. This is achieved through a more rigorous nutrient management regime than is practiced on many dairy farms. It is expected that effects of N on groundwater will be no more than minor and equivalent to the current or a reasonably expected land use.

5.6.4 Effect of Phosphorus on Groundwater

Potential adverse effects from P occur when groundwater enters surface water, under which conditions it can contribute to eutrophication. The design of the application rate for LMUs 1 and 2 is based on P as a limiting parameter. A P loading rate of 60 kg P/ha/y has been adopted as a rate that can be managed under the current grazing regime to avoid P loss from the site in drainage water. As described in Section 5.5.4 above, land management is proposed to actively reduce soil P levels for LMU 1. LMU 3 is not limited by elevated P levels, however it is does not have a high capacity to retain P and so a rate of up to 66 kg P/ha/y under cut and carry or a mix of cut and carry and grazing is considered a sustainable application rate for the avoidance of long term release and drainage to groundwater. LMU 4 has a low requirement for nutrients, but also very low soil Olsen P levels. As a result the application of 17 kg P/ha/y is expected to all be retained in the surface soil or taken up by plants.

Over the whole land treatment area the proposed hydraulic application rate of the wastewater will be sufficiently low to avoid a high rate of leaching through the soil profile to the underlying groundwater. Therefore the risk of P entering the groundwater is expected to be no more than minor.

5.7 Effects of the Discharge on Surface Water Quality

The Oroua River is the surface water receiving environment for the applied MWE. This river receives water from ephemeral streams that drain the present land treatment area, and also from the shallow groundwater in the area. MWE derived contaminants have the potential to enter the Oroua via either surface run-off, groundwater drainage or from the artificial drainage network on parts of the site. The land application system is operated to ensure that no MWE enters surface water by direct run-off. As discussed above groundwater is not expected to be a significant source of MWE derived contaminants.

The most likely route for transport of MWE to surface water is by the drainage network on site. Design of the application regime has considered the limitation of drainage volume to ensure that the impact on surface water from the land treatment regime is minimal.

5.7.1 Effect of Organic Material on Surface Water

The potential adverse effect of organic material (as BOD) on surface waters is a reduction in the dissolved oxygen content of the water. This leads to stress on the ecosystem and mortality of river flora and fauna. Reducing conditions may occur in the sediment of the bed of a waterway, leading to release of nutrients into the water.

As discussed in Section 5.5.2, the soil of the site has ample capacity to assimilate the applied organic material. The irrigation system involves the application of MWE to the surface to travel through the soil column. Applied organic material entering surface waters from groundwater will be negligible due to filtration. The potential for run-off of organic material from the site to surface water will be mitigated by avoiding the application to saturated soils near to surface water bodies and the maintenance of 20 m exclusion zones (buffers) from surface water ways.

The organic material to be discharged will not have an effect on the quality of surface water that is more than minor.

5.7.2 Effect of Nitrogen on Surface Water

Potential adverse effects of N on surface waters may include:

- Excessive growth of nuisance aquatic plants;
- Reduction in dissolved oxygen;
- Alteration of river flow due to blockage by macrophytes;
- Change in biodiversity; and
- Reduction in recreational amenity.

The N applied to the application area is expected to be assimilated by the soil and growing plants. Nitrogen entering surface waters from the catchment via groundwater will be similar to surrounding land uses as described in Section 5.6.3 above. The application depth and lateral distance to surface water (greater than 20 m) will mitigate the risk of nitrogen entering surface water by run-off.

The N to be discharged will have an effect on the quality of surface waters that is less than minor and less than currently occurs from the site and surrounds.

5.7.3 Effect of Phosphorus on Surface Water

Potential adverse effects of P on surface waters are similar to those described for nitrogen above. At the proposed application rates plant uptake will account for most applied P with soil sorption accounting for any remainder. Run-off of P, being the main mechanism for transport to surface water, will be avoided by the inclusion a vegetated 20 m buffer from water ways. Accordingly, it is anticipated that P entering surface waters from the land application system will be negligible.

5.8 Effects of the Discharge on Surface Water Habitats

Any effect that the application of MWE to land on Byreburn Farm may have on surface water habitats will be as a result of effects on surface water quality. As noted in Section 5.7 above, effects of the activity on surface water quality are expected to be minimal, and as a result effects on habitat values are also expected to be minimal, if detectable at all.

In addition, the proposed increase in the volume of MWE discharged to land from the current situation will result in a reduction in MWE volume discharging directly to surface water. This is expected to result in a net improvement in the water quality and subsequently the surface water habitat of the Oroua River.

5.9 Effects of the Discharge on Amenity, Community, Cultural and Heritage Values

The mauri of Oroua River is of relevance and significance to Iwi. Application of MWE to land wherever possible ensures that the mauri of the river system is afforded the maximum protection that is practically possible.

As discussed above, the proposed MWE discharge to land at Byreburn Farm under the proposed management regime is unlikely to adversely affect the stream water quality or the stream habitat of the Oroua River. The effects on the instream values of the wastewater application are expected to be similar to the effects of the permitted farming land uses in the surrounding catchment. It is unlikely that the landscape of the receiving water will be affected by the discharge to the site. The application of the MWE to land will in fact enable the avoidance of the previous adverse effects of discharging the equivalent wastewater directly to the Oroua River.

Neither the contact nor the non-contact recreational users of the Oroua River are likely to be affected by the treated wastewater discharge to land, due to:

- No microbiologically contaminated water is expected to enter the river; and
- The contaminants in the wastewater are expected to be ameliorated by the soil to which they are applied, and to leach from there into the stream in only insignificant quantities.

It is considered that there will be minimal to no adverse effects on people or the community. Adherence to buffer distances and prescribed application rates will ensure that possible health effects from the discharge will be minimised.

The land treatment area is on private land. No public amenity values beyond the aesthetic value of the rural landscape currently exist on these sites. It is expected that the effects to amenity values on these sites will be no more than minor.

5.10 Effects of the Discharge on Air Quality

The use of spray irrigation has the potential to influence air quality.

5.10.1 Aerosols and Spray Drift

The land treatment system has the potential to impact on air quality through production of aerosols generated by the spray irrigators to be used. In order to minimize the production of aerosols and minimise spray drift, the system pressure and nozzle size will be selected to produce droplets greater than 200 µm in size, which do not travel far and typically do not form aerosols.

Some proportion of smaller droplets, which have the potential to become aerosolised, will still be produced and so the following methods for reducing spray drift effects are to be used:

- Minimise travel distance: Use of small moveable irrigators which have a low height of discharge to reduce the travel distance of aerosols in areas which are closer than the existing irrigation areas to neighbours;
- Buffers: maintain separation distances between irrigation and any receptors; and
- High wind speed directional buffers: Buffers can be extended in the event that average wind speeds higher than 4 m/s in the direction of Fielding are forecast (around 260-310 degrees). If wind gusts of 12 m/s are detected in a direction of 260-310 degrees (Feilding township) then a system shut-down is recommended until 30 minutes following the last measured gust.

5.10.2 Odour

The ANZ MWE has the potential to produce odorous compounds. While the MWE is in an aerobic state, as it is when it exits the pond, the potential for nuisance odour is low. The odour produced is in keeping with the ANZ plants rural surrounds and can be managed by the methods outlined for aerosols above.

Should there be an issue with odour, it is likely to be a result of MWE having gone anaerobic in the irrigation lines where there is a long period between irrigation events. Should this be the case, a flushing volume of clean water can be pumped through the irrigation lines.

5.11 Effects of the Discharge on Air Quality

The proposed loading rate of the wastewater discharge to land will enable soil remediation and plant uptake of applied contaminants including:

- Filtration and incorporation of any suspended solids;
- Assimilation of organic material;
- Plant uptake, microbe use, and soil occlusion of nitrogen and phosphorus, and gaseous loss of nitrogen;
- Cation adsorption; and
- Filtration and attrition of pathogens.

The amounts of wastewater-applied nutrients that are likely to enter surface or groundwater are low, and their effects are expected to be less than minor.

6 MONITORING AND MITIGATION

The main resource consent application document gives an outline for a comprehensive management and monitoring programme for the combined treatment, land and water discharge system.

6.1 Monitoring

Key monitoring requirements for the land treatment site which are currently used are described here.

6.1.1 Irrigation Register

An Irrigation Register is kept, recording the following:

(a) the date when irrigation occurs and the times at which irrigation starts and ends each day.

(b) the spray irrigation locations used including spray area and spray block number, and the quantity of effluent applied to each spray block.

(c) the weather conditions and wind conditions during times of irrigation.

6.1.2 MWE monitoring

During the periods of land application, the effluent is sampled on a monthly basis and tested for the following parameters:

- pH;
- Total suspended solids;
- 5 day carbonaceous biochemical oxygen demand;
- Nitrate and nitrite nitrogen;
- Ammoniacal nitrogen;
- Total nitrogen;
- Total phosphorus;
- Dissolved reactive phosphorus;
- *E.coli*;
- Total calcium, magnesium, potassium and sodium; and
- SAR.

6.1.3 Groundwater Monitoring

One control and three shallow groundwater bores in the application area are monitored, with samples collected on the same days as effluent samples are taken, and tested for the following parameters:

- pH;
- Total suspended solids;
- 5 day carbonaceous biochemical oxygen demand;
- Nitrate and nitrite nitrogen;
- Ammoniacal nitrogen;
- Total nitrogen;
- Total phosphorus;

- Dissolved reactive phosphorus;
- *E.coli*;
- Total calcium, magnesium, potassium and sodium; and
- SAR.

6.1.4 Soil Monitoring

Soil samples are taken from three sampling sites located in each representative land discharge area during November each year. Samples are taken from 10 and 20 cm depths at each site and from a similar location each year, and are analysed for:

- pH;
- Calcium;
- Phosphorus;
- Potassium;
- Sulphate sulphur;
- Magnesium;
- Sodium; and
- Nitrogen.

Soil infiltration capacities and organic matter content at the same sites are also measured.

6.2 Mitigation

Measures taken to reduce the potential adverse effects of the land application of MWE are described as follows.

6.2.1 Identification of Limiting Parameter

For the existing application scheme P accumulation on LMU 1 has been identified as the parameter of most concern. In the design of an application regime for the proposed activity, in the future P has been adopted as the limiting parameter for LMU 1. This means that if a limit is set for P then the other key parameters (available land, hydraulic load, and nitrogen load) should be calculated based on the acceptable P load. This will result in no exceedance of a recommended limit for any other parameter.

For LMU 2 the avoidance of rapid drainage is identified as the most limiting parameter and the instantaneous application rate proposed is substantially lower than under the current discharge regime.

For LMU 3 the avoidance of soil wetness is considered the most limiting parameter and a low instantaneous rate of application is proposed for the site.

For LMU 4 excess N is considered to be most limiting and correspondingly has been adopted as the most limiting parameter.

In all cases the climate and land management decisions further impact the application timing and frequency.

6.2.2 Determination of Maximum Rate of Limiting Parameter

Based on the soils capacity to assimilate the applied MWE a maximum application, both as yearly and per event limits, has been determined as described in Table 4.4.

6.2.3 Limitation of Additional Nutrient Sources

Limits are proposed for the total nutrient load to the site to avoid excessive application by sources other than MWE.

6.2.4 Avoidance of Run-off

The proposed land application system will ensure that there is no surface run-off of MWE, thus ensuring there is no direct discharge of contaminants into any waterway.

6.2.5 Land Application as Mitigation

The proposed land application system is itself the primary mitigation measure against adverse effects of the discharge of MWE directly to the Oroua River. The application of an increased proportion of AMP's total MWE production to land enables both an avoidance of discharge to the river in times of low flow, and a reduction of the total requirement for river discharge on an annual basis.

7 CONCLUSIONS

A new irrigation regime is proposed that will take more of ANZ's effluent than previously, and apply it to a larger area of land. The effects of the proposed land application regime have been assessed based on the highest potential loading of nutrients, contaminants and water. In reality the discharge is expected to be lower than that assessed and so the effects assessed are also expected to be lower. Based on the assessment of environmental effects it is concluded that:

- Based on the land use and soil types, there are 4 distinct land management units (LMU);
- By adopting LMUs the land application regime can be tailored to the specific limitations of each area;
- Where an area is to receive a N load which exceeds the requirement of the present land use an Additional Nitrogen Utilisation Strategy will be adopted which includes a change in the land use (e.g. to cut and carry) to increase N removal;
- Effectively there is more than 150 % of the land area needed, with the greater area providing for operational flexibility;
- The mass load of N and P across the land treatment areas would be almost 24 tonnes N and 4 tonnes P;
- Based on a yearly discharge increasing over the term of the consent from 134,000 m^3 to 179,300 m^3 discharged over the available area of 142 ha, the annual average areal loading from applying MWE to the site (i.e. long term annualised average) is 126-167 kg N/ha/year.

This Assessment of Environmental Effects concludes that there are no adverse environmental effects from the proposed discharge of MWE to land on Byreburn Farm, ANZ owned land and St Dominics owned land that cannot be avoided, remedied or mitigated, and whose effects are greater than minor. It is therefore concluded that the resource consent under application here may safely be granted.

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1 APPENDICES

Appendix A Figures

APPENDIX A

Figures

Location (refer to Site Investigation Report)
Land Management Units (refer to Conceptual Design Report)