Dairy Green Ltd

Practical Engineering Solutions

Consents, Effluent, Stock water, Irrigation

Design through to Installation

Irrigation NZ Accredited Designer

Woldwide Farming Group:

Woldwide One Limited and Woldwide Two Limited

27/3/2019

Application for:

- Land Use Consent for Use of Land for Dairy Farming – Replacement of **20171278-03**
- Discharge Permit – Replacement of **301663** and **20171278-01** under one discharge permit
- Water Permit – Replacement of **301664** and **20171278-02** under one water permit

Farm Location: Heddon Bush

Application prepared on behalf of applicant by:

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Key

ES	Environment Southland
HB	Horner Block
IWG	Intensive winter grazing
pSWLP	proposed Southland Water and Land Plan (2018)
PZ	Physiographic Zone
WW1	Woldwide One Limited
WW1&2	Woldwide One and Woldwide Two dairy farm
WRO	Woldwide Runoff – Merrivale and Merriburn blocks
WW2	Woldwide Two Limited

1. Overview

1.1 Background

Background

Woldwide One Limited (WW1) and Woldwide Two Limited (WW2) operate two adjoining dairy farms situated at Heddon Bush, Central Southland. Both dairy farms are under the same ownership structure.

WW1 currently operates under an effluent discharge permit (AUTH-301663) and water permit (AUTH-301664). Both consents were granted a 15-year term and expire in 2027.

WW2 currently operates under a land use consent for expanded dairy farming (AUTH-20171278-03), effluent discharge permit (AUTH-20171278-01) and water permit (AUTH-20171278-02). All were granted a ten-year term and expire in 2027.

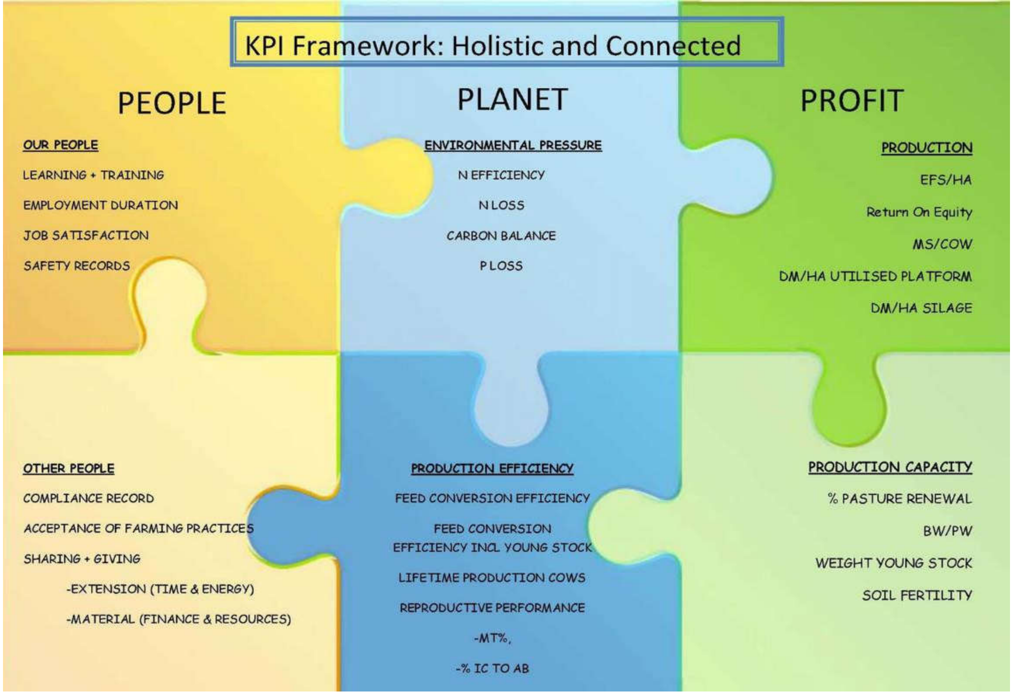
Both WW1 and WW2 utilise a nearby cut and carry block (Horner Block) to discharge pond slurry. The Horner Block is under separate ownership to the dairy platforms at WW1 and WW2 and is not part of either dairy platform. The discharge of agricultural effluent at the HB is authorised under respective effluent discharge permits for WW1 and WW2.

Both the WW1 and WW2 graze dry stock at Woldwide Runoff (WRO), which comprises the Merrivale and Merriburn blocks in the Merrivale/Western Southland area. WRO is under separate ownership to the dairy platforms at WW1 and WW2 and has significant areas under forestry.

Applicant's philosophy

In the words Abe and Anita de WW1de from the Woldwide Farming Group:

> *Sustainability (environmental, economic and social) has been at the core of all we do at Woldwide Farming group. To us these principles flow out of a desire to be good stewards, and they are all interlinked as shown in the picture.*



> *We were the first to build free stall barns in Southland to reduce outside crop wintering and we were the first (and only) ones to feed fresh grass to our cows in winter to reduce silage making losses and runoff. In 2013 we were supreme winners of the Southland Ballance Farm Environment Awards.*
>
> *Ever since we came to New Zealand we have been trying to improve the sustainability of our farms with a long decision-making horizon and an innovative mind-set. We have now come to a point in our farming career where we wish to cap our growth ambitions and truly focus on environmental sustainability. Keeping our stock off wet soils in winter is pivotal in this endeavour. We aim to have all our adult stock from all our farms indoors within five years (and work on housing all young stock after that). We believe wintering animals outside on wet soils is very damaging for the following reasons:*
>
> - *Nitrogen is lost because it is deposited on the ground (in the mud) when there are no plants actively taking it up and locking it in.*
> - *Sediment and top soil are displaced because of the following reasons:*
>   - *The ground is disturbed when it is wet*
>   - *Root structures are destroyed*
>   - *Overland flow (of Phosphate, sediment, bacteria) increases due to soil compaction*
>   - *Rain events during cropping season when soils are worked up fine and crops have not yet established can be very risky*
> - *Lots of chemicals are used in the cultivation of winter crops*
> - *It takes 85 m of wrap to produce a bale of baleage and we want to reduce our reliance on this*

We are convinced that 90 % of the environmental issues caused by farming in Southland stem from the 10 % of ground that is winter cropped. Just because something is common practice does not mean that the effects are acceptable. It is time to change this!

It needs to be kept in mind though that land- previously used for winter cropping- is vacated under our new plans and a small increase of stock numbers is needed to make up for that.

Our passionate desire is to go beyond compliance and to produce top quality food with a reduced environmental footprint. And that is the mindset behind this application.

Application history

In 2017, WW2 was granted consent for expanded dairy farming. This involved the addition of new land previously used for dairy support (i.e. SH96 and Marcel blocks) into the milking platform. In parallel with this, some land was removed from WW2's milking platform to be added to WW1's milking platform. WW2 cow numbers did not increase as part of the dairy expansion; they remained at 800. The SH96/Marcel support block, which came into WW2's milking platform as part of the expansion, had been used to graze young stock, winter graze cows/heifers on fodder crop and grow supplement (pasture silage). The discharge permit was replaced to allow for the new boundary, effluent discharge area and an increase in the size of a wintering barn. WW2's water permit was also replaced in 2017.

Agricultural effluent from WW1 and WW2 is discharged at low depth at respective dairy farms and at the Horner Block, located to the south west. The Horner Block is a cut and carry block, used to grow grass to supply various dairy farms, and receives slurry effluent from WW1, WW2 and the Woldwide Three dairy farm (which is not included in this application). The Horner Block does not graze stock.

In 2017, an application for expanded dairy farming at WW1 was submitted to Environment Southland (ES), which was publicly notified. During the notification process, the decisions version of the proposed Southland Water and Land Plan (2018) was released. Following discussions and advice from stakeholders including Environment Southland, based on many factors including how best to model pre-expansion land use, the applicants put WW1's application on hold and opted to submit a new application. The new application was submitted to ES in August 2018 and aimed to bring the WW1 and WW2 dairy farms under a single land use consent for dairy farming. The application was accepted by ES, with extensive information provided under s92 (1), at several meetings and at a site visit.

WW1&2's 2018 consent application was publicly notified by ES. An error was made during the notification process, which made the notification illegal according to legal opinion. In view of the ES error resulting in illegal public notification and following collaborative discussions on the best way forward, the applicants agreed to withdraw the consent application, address certain issues identified by ES in the s95 report and resubmit the application. This application aims to bring the WW1 and WW2 dairy platforms under a single land use consent for dairy farming and to resolve certain issues identified by ES with the 2018 application.

As is explained in section 2.1, the name of the new consent holder on the land use consent for dairy farming, the discharge and water permits will be "Woldwide One Limited and Woldwide Two Limited."

Request for public notification of application

Based on the application's history, the applicants hereby request that the consent authority publicly notify this application in accordance with s95A of the Act.

Landholding

The pSWLP defines a landholding as land held in one or more than one ownership, that is utilised as a single operating unit. The pSWLP specifies that a "single operating unit" may include, but is not limited by, effective control by any structure of ownership of the same group of people and being operated as a single business entity.

Land utilised as a "single operating unit" is defined as a landholding, and under the definition is under the effective control of the same ground of people **and** operated as a single business entity. To be part of a given landholding, both parts of the definition must be met. Where there is effective control by the same group of people, the critical test is whether land is operated as a "single business entity" or not.

HORNER BLOCK:

- The Horner Block is a nearby 160-hectare block used for cut and carry to supply various dairy farms, including but not limited to WW1 and WW2. It is used to discharge effluent from WW1, WW2 and WW3. No stock is grazed there.

- The Horner Block is owned by Woldwide Farm Limited and forms a small part of Woldwide Farm Limited's business.

- Woldwide Farm Limited trades with all Woldwide entities as well as external farms and companies.

- Woldwide Farm Limited has its own staff, accounts and management. It owns no cows or young stock, does not need WW1 or WW2 to be a successful business and is not a dairy farm.

- Woldwide Farm Limited undertakes feed trading, contracting, logistics, supply management, machine hire, office support and knowledge support.
  Some examples:
  Feed trading: silage crops, fresh grass, hay and baleage, concentrates and grain
  Contracting: ground work and pasture renewal, digger work and lane maintenance, fencing
  Winter grazing at various locations (not Horner Block): young stock and MA cows
  Logistics: carting concentrates from Bluff and Invercargill, baleage from runoff, manure from dairy farms etc.
  Supply management: trace elements, oil,
  Machine Hire: tractors, feed augers, trailers, truck, other implements
  Office support: books are kept separate
  Knowledge support

- The only service that WW1 and WW2 exports to the Horner Block is the discharge of slurry to 97 hectares of the block. Slurry is also discharged at WW1&2. Liquid effluent from the dairy sheds is only discharged at WW1&2. No grazing of cows or IWG of fodder crop is carried out at the Horner Block. The primary purpose of the Horner Block is not to support the dairy farms at WW1&2

- Although some slurry generated at WW1&2 is discharged at the Horner Block, the use of the Horner Block is not central to operations at WW1&2 dairy farm. As such, the Horner Block does not form a single business entity with WW1&2.

- Since the Horner Block is not operated as a single business entity with WW1&2, it does not form a single operating unit with WW1&2 and is therefore not part of WW1&2's landholding.

- Actual and potential effects from the discharge of slurry from WW1&2 at the Horner Block landholding are considered in the AEE for the farming activity, since they are part of the overall farming activity.

- The discharge of slurry effluent from WW1&2 at the Horner Block will be covered by a separate discharge permit. Accordingly, an application for the discharge of slurry effluent from WW1&2 at the Horner Block is included in this application.

LEGAL OPINION

Legal opinion was sought by ES in 2018 on whether the Horner Block is part of the landholding at Woldwide 1&2. Although the LO was not sought in relation to this application, the applicants believe it is relevant to this application since it addresses the same blocks of land, activities, structures and entities.

An Addendum to an original LO was provided by Wynn Williams on 8 October 2018, which clarified that the Horner Block is not considered to form a "single operating unit" with Woldwide 1&2. The LO Addendum stated (p.8) that "*It is unlikely that by only exporting one aspect of its farming operations to the Horner Block (i.e. the discharge of sludge), Woldwide 1 & 2 is utilising the Horner Block as part of a "single operating unit." This is different than if Woldwide 1 & 2 was intending to utilise the Horner Block for multiple aspects of its farming operations and if its use of the Horner Block was central to its overall farming operation. Accordingly, we consider that the Horner Block is not part of Woldwide 1 & 2's "landholding" for the purposes of their respective applications under Rule 20 of pSWLP*."

The original LO and Addendum are appended to this application. Please see for further details.

WOLDWIDE RUN-OFF (WRO)

Environment Southland hold the view that WRO forms part of the landholding at WW1&2 and while not part of this application, ES also view that WRO is part of respective landholdings at WW4 and WW5. With respect to Council's view and for this application to be accepted by Council under s88, WRO has been included in the landholding at WW1&2 and is included in the application for the use of land for farming.

It is the applicant's view that WRO is not part of the landholding for WW1&2. The applicants wish to place this issue in front of the hearing decision maker where it provides a forum and opportunity for discussion and consideration of both points of view.

Current application

The proposal seeks to add 160 cows to WW1&2, in conjunction with making several changes to the farming activity to off-set potential effects from additional cows. The applicants believe that over time there will be a cumulative reduction in contaminant loss due to the proposed land use. Holistically, they will achieve better nutrient management on farm, improved soil organic matter content/less mineralisation, improved water holding capacity and soil structure, less N accumulation at high risk times, and less pugging of soils and runoff. Consequently, they believe there will be less contaminant loss to water and less risk of adverse effects on ground and receiving surfacewaters.

A high level of investment has been required in the planning and implementing of changes, which demonstrates the applicants' commitment and determination to achieve their aim of greater environmental sustainability in the long term. Farm profitability and economic security must be maintained for this to happen; this will be achieved through milking 160 additional cows on land previously used for activities such as IWG at WW1&2.

Nutrient budget analysis shows that the proposed land use at WW1&2 has below average N loss (kg/ha/year) compared to all Fonterra dairy farms within a 20 km radius, many of whom winter some or all MA cows off farm (see section 7.3.1). The proposal includes the wintering of 1,250 cows in barns at WW1&2 and still manages to have below average N loss compared to a regional average (20 km radius); this achievement demonstrates how the applicants mitigate and minimise contaminant losses across the whole activity, which in turn mitigates and minimises effects in groundwater and receiving surfacewaters.

WRO grazes dry stock from WW1&2, among a range of other activities not related to WW1&2. Under the proposal, WRO will continue to be used to graze dry stock from WW1&2, including IWG activities. The applicants seek to continue to manage WRO sustainably, improving soils and production while minimising contaminant losses to ground and surfacewaters.

Slurry effluent from WW1&2 will continue to be discharged at very low depth to part of the Horner Block. The applicants seek to manage the Horner Block sustainably and will reduce fertiliser inputs to account for nutrients applied from slurry. They aim to maintain soils and production at the Horner Block while minimising contaminant losses to ground and surfacewaters.

Land use consent for farming

It is proposed to replace WW2's land use consent for dairy expansion (20171278-03) with a land use consent for dairy farming to include the land areas contained by both WW1 and WW2 dairy platforms and WRO. The land area of the dairy platform is not increasing. The proposed dairy platform will contain two milking sheds and two wintering barns. At an operational level, WW1 and WW2 will be run as individual dairy units. WRO will be used to run dry stock and for supplement production (among other activities not related to the farming activity at WW1&2). Only land areas at WRO linked to operations at WW1&2 will be authorised on the land use consent, e.g. forestry land will be excluded.

It is proposed to increase cow numbers milked to 1,500. Currently a total of 1,340 cows are authorised; 540 at WW1 and 800 at WW2. The proposal represents an increase of 160 milking cows or 11% overall. The increase will occur at the WW1 unit where the herd size will go from 540 to 700. Land previously used for fodder cropping/IWG at WW1&2 has been freed up by the removal of these practices and is available to graze milking cows.

It is proposed to increase the maximum number of animals (cows/heifers) wintered in barns to 1,250. The barn and effluent system have already been upgraded to cater for the additional cows and effluent.

To allow for the proposed activity, resource consent is being sought under **Rule 20 e)** of the pSWLP, for the ongoing use of the land for dairy farming including an increase in cow numbers. The expansion does not include an increase in the dairy platform's land area as all land was either within the dairy platform prior to 30 June 2016 or was authorised for dairy farming through a dairy expansion land use consent that was granted in 2017. As is described in Section 2, **this is a discretionary activity**.

The proposed activity has been considered in terms of key pSWLP policies and based on this assessment should be granted. Effects on the existing environment have been considered and assessment in accordance with Schedule 4 of the RMA. The assessment concludes that effects on receiving surfacewaters, groundwater and soils, including cumulatively, will be no more than minor due to the proposed activity.

Overseer nutrient budgets

Overseer is a useful tool to understand the nutrient interactions of a farm system based on soil properties, rainfall, drainage, feed requirements and other factors. The output from the model gives an indication of how much nutrient may be lost to the environment. Overseer nutrient budget analysis has been carried out using Overseer version 6.3.1 and using "Overseer Best Input Standards, March 2018." The increase in cow numbers will occur in parallel with significant land use changes, which act as key mitigation measures and are modelled in Overseer where possible.

NUTRIENT BUDGETS - WW1&2 DAIRY FARM Four pre-expansion nutrient budgets were prepared and one proposed post-expansion nutrient budget for 1,500 cows. The pre-expansion nutrient budgets were derived by modelling the actual lawful use of land and not by modelling consented maximums. The inputs used in pre-expansion nutrient budgets are supported with evidence, which is appended to the nutrient budget analysis report. Where the analysis report states that the land area is being increased by bringing in support land, this refers to the SH96 and Marcel Blocks, which were authorised for dairy farming as parts of WW2's land use consent granted in 2017.

~~All nutrient budgets model the same land areas, i.e. former WW1 and WW2 milking platforms, SH96 and Marcel blocks. Overseer predicts that:~~

- ~~The average N loss will decrease slightly from 41 kg/ha/year to 40 kg/ha/year, despite an additional 160 cows; and~~
- ~~The average annual P loss will remain at 0.7 kg/ha despite an additional 160 cows.~~

~~By using P loss as a proxy for sediment and microbial losses, there will be no increase in loss of sediment or microbes.~~

NUTRIENT BUDGETS - THE HORNER BLOCK Prior to obtaining legal opinion to the contrary, ES regarded the HB to be part of the landholding at WW1&2. Based on this, one pre-expansion nutrient budget (17/18) and one proposed nutrient were prepared for the Horner Block and submitted with the 2018 consent application. Since nutrient budgets were already prepared for the HB, they are included in this application as a useful source of information and are used appropriately in the AEE.

NUTRIENT BUDGET – WORLDWIDE RUNOFF

A 17/18 year-end nutrient budget has been prepared for WRO, provides guidance on activities and nutrient losses in the 17/18 year, and is used to inform the AEE.

Discharge and water permits

It is proposed to replace existing discharge permits (301663, 20171278-01) with a single discharge permit managing effluent from the WW1 and WW2 dairy units, and to replace existing water permits (301664, 20171278-02) with a single water permit for groundwater abstraction from both WW1 and WW2. The proposed discharge permit will allow for the discharge of agricultural effluent (dairy shed, wintering barn, silage pad and underpass) to land from 1,500 cows. **It is proposed to include the current irrigation methods in the discharge permit, i.e. travelling irrigator, trailing shoe slurry tanker, umbilical system; as well as to future proof the discharge activity by also including low rate irrigation.** The proposed water permit will allow for groundwater abstraction for dairy shed and stock drinking water for 1,500 cows.

Slurry

Existing discharge permits for WW1 and WW2 authorise the discharge of herd home slurry and effluent slurry respectively. Despite this, slurry is not defined in the pSWLP or RWP. An AgResearch study[1] classifies slurry as an effluent product with 5-15% DM content. FDE is classed as having less than 5% DM content and solid manures as having greater than 15% DM content. The material stored in the ponds at WW1 and WW2 is a slurry due to the large contribution of undiluted wintering barn effluent. Since the discharge of slurry is authorised on both existing discharge permits for WW1 and WW2 and the material stored in the ponds meets the description in the AgResearch paper, the term has been used to describe pond material in the replacement discharge permit application.

Horner Block

Existing discharge permits for WW1 and WW2 authorise discharge of agricultural effluent the Horner Block. The Horner Block currently receives agricultural effluent from three dairy farms; WW1, WW2 and Woldwide Three. It is proposed that Woldwide Three’s discharge area will remain mutually exclusive.

The discharge areas currently authorised to receive effluent/slurry from WW1 and WW2 will be blocked as a single slurry receiving area. **It is proposed that the discharge of slurry effluent from WW1&2 to 97 hectares at the Horner Block will be covered by a separate discharge permit**. The Horner Block will not be authorised on the proposed discharge permit for WW1&2. The Horner Block will continue to be run for cut and carry, and as a slurry receiving area.

Land use consent for feed pad/lots - wintering barns

Under Rule 35A of the pSWLP, the use of land for two wintering barns at WW1&2 is a discretionary activity as at least one of the conditions of Rule 35A (a) is not met. Applications for consent for the use of land for two feed pad/lots accompanies this application.

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[1] Houlbrooke, Longhurst, Orchiston and Muirhead (2011). Characterising dairy manures and slurries. AgResearch Report.

1.2 Property Details

Overview

WW1&2 is an existing dairy farm with required dairy infrastructure for two units and is located within both the Oreti River and Waimatuku Stream catchments at Hundred Line Road, Heddon Bush. It consists of 502 hectares of land, with an effective farm area of 479 hectares.

The slurry-receiving Horner Block is located within both the Waimatuku Stream and Aparima River catchments at Hundred Line Road, Heddon Bush and consists of 160 hectares of land, with an effective farm area of 155 hectares.

WRO is a dry stock grazing block (892 ha) for all Woldwide dairy farms, which also contains a commercial forestry operation, native bush block, commercial gravel extraction operation and land for supplement production. Activities at WRO are described in detail in the WRO section of this application.

Within the last five years, WW1&2 was managed as two dairy units (WW1 and WW2) and a support block (SH96 and Marcel Block). The SH96 and Marcel Block were authorised for dairy farming as part of WW2's land use consent for expanded dairy farming granted in October 2017. The Horner Block was used for winter grazing and heifer grazing in the past, but in recent years has been used for cut and carry, and as a discharge area.

It is proposed that two dairy units will continue to be operated at WW1&2. Cows will be milked for seasonal supply through two dairy sheds, 700 at the WW1 unit and 800 at the WW2 unit. All cows will be wintered in two existing wintering barns. The wintering barns will be used at times to house cows in the shoulders of the season and as stand-off pads during inclement weather throughout the year to reduce soil damage, pugging and runoff.

The Horner Block will continue to be used as an area to discharge slurry from two effluent storage ponds at WW1 and WW2. Pasture silage and fresh grass is harvested from the Horner Block and fed to cows at dairy farms, including but not limited to WW1 and WW2.

Table 1.1 General property details – WW1&2, Horner Block

Property details	
Dairy platform - total farm area (ha)	502
Dairy platform - effective farm area (ha)	479
Dairy platform - size of effluent disposal area (ha)	c.400
Dairy platform - stocking rate (cows/ha)	3.1
Horner Block – total area (ha)	160
Horner Block – effective area (ha)	155
Horner Block – slurry effluent area (ha) for dairy platform (WW1&2 only)	97
Legal descriptions – WW1&2 dairy platform	Part Lot 18 DP 942 Section 420 Taringatura SD Part Lot 1 DP 4092 Part Lot 18 DP 942

	Part Lot 2 DP 4092 Part Lot 1 DP 4092 Part Section 417 Taringatura SD Section 418 Taringatura SD Section 419 Taringatura SD Lot 1 DP 9925* (leased - Gavin Andrew Dykes) Lot 1 DP 14660 Lot 1 DP 14661 Lot 1 DP 451158 (leased - John Desmoulins Pine & Christina Florence Pine) Lot 1 DP 13077 (leased - John Desmoulins Pine & Christina Florence Pine) Lot 1 DP 5610 Lot 3 DP 5610 Lot 1 DP 10885
Legal descriptions – Effluent discharge area at WW1&2	Part Lot 18 DP 942 Section 420 Taringatura SD Part Lot 1 DP 4092 Part Lot 18 DP 942 Part Lot 2 DP 4092 Part Lot 1 DP 4092 Part Section 417 Taringatura SD Section 418 Taringatura SD Section 419 Taringatura SD Lot 1 DP 14660 Lot 1 DP 14661 Lot 1 DP 5610 Lot 3 DP 5610 Lot 1 DP 10885
Legal descriptions – Effluent discharge area at Horner Block	Lot 4 DP 399915

*Part of Lot 1 DP 9925 is leased by the applicants and is already within the boundary of the existing land use consent for dairy farming (see figure 1.1).

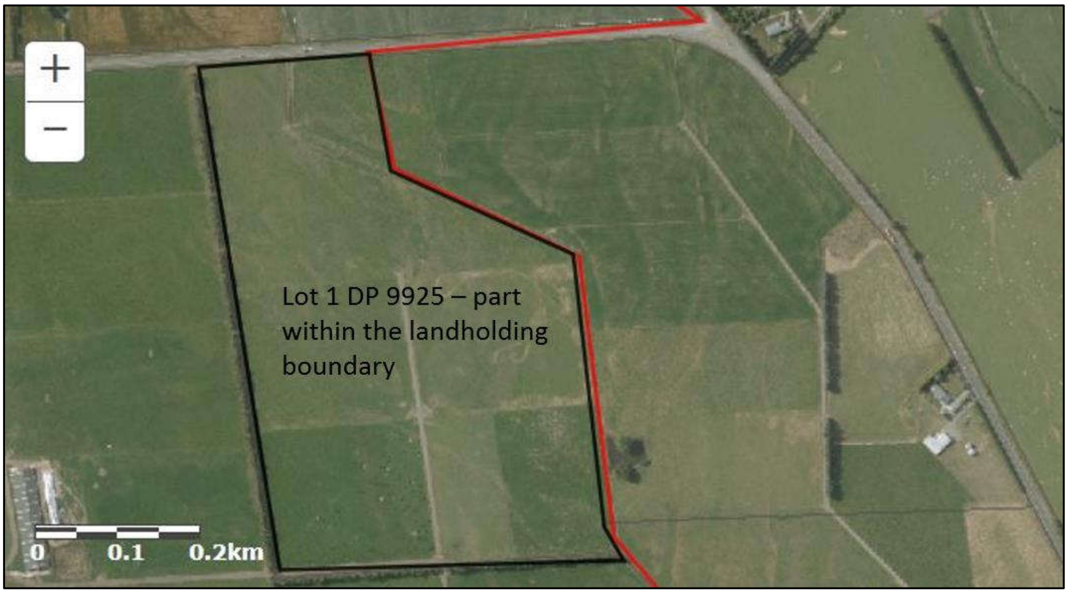

Figure 1.1 Part of Lot 1 DP 9925 within the landholding boundary at WW1&2.

Table 1.2 General property details – WRO

Property Details – WRO	
Property address	20 Gill Road – Merrivale block 1711 Otautau Tuatapere Road – Merriburn block
Property owner(s)	Woldwide Runoff Ltd
Legal Description	Merrivale Block: Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Lot 1 DP 3537 Merriburn Lease Block: Lot 1 DP 302409 Sec 26 Merrivale Settlement No. 1 Sec 27 Merrivale Settlement No. 1
Property area (ha)	507 ha total, 321 ha effective – Merrivale 385ha total, 338 ha effective – Merriburn
Location	NZTM 1201022, 4893762 – Merrivale NZTM 1200812, 4890495 – Merriburn

Effluent

Existing discharge conditions

Agricultural effluent from WW1 and WW2 dairy operations are currently managed by way of two existing discharge permits **(301663, 20171278-01)**, which expire on the 9th of November 2027 and 18th October 2027 respectively. WW1's existing discharge consent is for a 540-cow herd milked twice a day and from herd home slurry from a maximum of 400 cows. WW2's existing discharge consent is for an 800-cow herd milked twice a day and from herd home slurry from a maximum of 640 cows. WW2's existing discharge permit also provides for effluent from an underpass and a silage pad.

The authorised discharge method at WW1 includes land disposal methods limited to maximum application depths of 10 mm and 5 mm per application. The consented discharge methods at WW2 include a low depth travelling irrigator, umbilical system and slurry tanker with a trailing shoe. The travelling irrigator has a maximum application depth per application of 10 mm. The umbilical and trailing shoe slurry tanker systems have a maximum depth per application of 5 mm.

The existing operations do not involve winter milking.

Existing FDE areas

WW2's discharge area includes 194 hectares of land at WW2, and 42 hectares of land at the Horner Block. Liquid effluent is discharged at WW2 and slurry effluent from WW2's pond is discharged at the Horner Block. Council recommended buffers are implemented at WW2, except for a buffer of 100 metres from land known as Lot 3 DP237. WW1's discharge area includes most of the milking platform and another part of the Horner Block. Council recommended buffers are implemented when discharging liquid or slurry effluent at WW1.

Existing effluent storage infrastructure

WW1 and WW2 allow for deferred irrigation when soils are near or at field capacity by storing raw effluent (slurry) in two large effluent ponds, one for each operation. Both ponds receive dairy shed effluent when soil moisture conditions are unsuitable for irrigation, and wintering barn effluent from the barns. The WW2 pond also receives silage leachate from WW2's concrete silage pad. The material in the ponds is a slurry due to the major contribution of dung and urine from the free stall wintering barns. Consequently, both ponds always have a crust.

Ancillary structures at both the WW1 and WW2 units that contain, store or treat effluent are sand traps, dairy shed pump sumps and wintering barn collection sumps.

Further information on the ponds and ancillary structures is provided in sections 2, 6 and 7.

Proposed changes to effluent management and permit

It is proposed to replace existing discharge permits **(301663, 20171278-01)** with a single discharge permit covering effluent from WW1 and WW2 at WW1&2. The proposed discharge permit will allow for the discharge of agricultural effluent (dairy shed, wintering barn, silage pad and underpass) to land from 1,500 cows; 700 cows at WW1 and 800 cows at WW2. Proposed irrigation methods are all methods described in table 1.3.

It is proposed to authorise the discharge of slurry effluent from the ponds at WW1&2 at the Horner Block through a separate discharge permit. The irrigation methods at the Horner Block will be slurry tanker with the trailing shoe and umbilical system as described in table 1.2.

Table 1.3 Proposed effluent irrigation methods

Method	Usage	Conditions
Low depth travelling irrigator	Apply dairy shed effluent to land	A maximum depth per application of less than 10 mm
Low depth slurry tanker with a trailing shoe	Apply pond slurry to land	A maximum depth per application of 2.5 mm
Low depth umbilical system	Contingency measure – apply pond slurry to land	A maximum depth per application of 3.0 mm
Low rate pods	*Future proof - Apply dairy shed effluent to land	A maximum instantaneous rate of 10 mm/hour at a depth of less than 10 mm

Low rate cannon/rain gun	*Future proof - Apply dairy shed effluent to land	A maximum instantaneous rate of 10 mm/hour at a depth of less than 10 mm

*To future proof the discharge activity, it is proposed to include low rate irrigation methods as described in the above table. This will allow the applicants to upgrade their effluent system in the future without the need to vary the discharge permit.

Overall, the proposed discharge area includes most of WW1&2 and the existing area at the Horner Block that receives agricultural effluent from WW1 and WW2, less standard buffers. Significant areas of low risk soils are available. Slurry from the ponds will be applied at very low depth via the trailing shoe slurry tanker or umbilical system at both the Horner Block and at WW1&2.

No affected party approvals are required.

No change in effluent storage is proposed. According to the Massey DESC, the 90% probability volume for 1,500 cows including wintering barn effluent and silage leachate is 6,460 m^3. The existing storage capacity is 8,032 m^3, so is sufficient to meet the above requirements. The wintering barns will house a maximum of 1,250 cows despite having capacity for 1,280. Two separate DESC reports have been run, one each for the WW1 and WW2 units respectively. This ensures that each unit has enough storage for its operation.

Wintering

WW1&2

In the past, cows and heifers have been intensively winter grazed on fodder crop and heifers also have been grazed on pasture over winter. In more recent years, cows have been wintered in barns, but in-calf R2 heifers have been IGW on fodder crop and R1 heifers have been grazed on pasture over winter. These practices are fully accounted for in respective year end nutrient budgets - please refer to section 9.3 of the nutrient budget report for details.

Under the proposal, the practices of IWG and grazing stock on pasture over winter at WW1&2 will cease. No animals will be IWG on fodder crop and no heifers will be grazed on pasture over winter at WW1&2. All cows and some heifers will be wintered in two wintering barns over June and July.

1,500 is the maximum cow number, which generally will be seen at peak milking in Oct/Nov. As is standard practice on dairy farms, cows are culled as the season progresses with the main cull occurring in May/start of June. This reduces the MA cow number significantly and accordingly, reduces the number of MA cows to be wintered from the start of June. Typically, the cull rate sits at approx. 25% with minor variation from year to year. Assuming a culling rate of 25%, then approximately 375 MA cows will be culled by the end of the season leaving 1,125 MA cows to be wintered. A maximum of 1,250 animals will be housed in the barns over June/July, leaving space in barns for 125 R2 heifers.

From May 2019, cows will also be housed in wintering barns for part of May, August and September during inclement weather as required. Early calving cows will return to pasture in August, where they calve. Late calving cows will remain in the wintering barns until they are ready to calve in September. Cows are fed freshly cut grass and pasture silage in barns. The wintering barns are also used as stand-off pads during inclement weather during the milking season.

At WW2's wintering barn, a maximum of 625 cows are housed over winter. It is proposed to increase WW1's wintering barn authorised cow number from 400 to 625, to accommodate an additional 225 animals. WW1’s wintering barn has already been upgraded to meet the needs of additional animals. Effluent storage at WW1 has been increased so can accommodate effluent from additional animals in the wintering barn.

In the 17/18 winter, WW1’s barn housed 400 cows and was assessed as grade 1/fully compliant at an inspection by Environment Southland.

WRO

Wintering activities include IWG by dry stock on fodder crop. Under the proposal, the annual area under IWG will not exceed 100 hectares. All R1s will be IWG at WRO. R2s will either be housed in barns at WW1&2 (c.125) or will be IWG at WRO. Please see the WRO section of the application for a detailed description of existing and proposed wintering activities.

Young stock from WW1&2

To date, grazing of young stock has been carried out as a permitted activity. The replacement rate sits at 25% with minor variation from year to year. At a 25% replacement rate, 375 R2s join the milking herd each year. Due to culling/deaths, a further 10% replacement calves are kept ensuring 375 R2s are available to join the milking herd.

R1 heifer calves leave WW1&2 to go to WRO when they reach a minimum of 90 kg live weight (~November). All R1 heifers are IWG at WRO in June/July. R1s transition into R2s, and at about 15 months of age R2s are mated.

Heifer numbers at WRO reduce by approximately 10% due to death and culling. The heifer number reduces from 417 to 375 by the time R2 heifers return to WW1&2 for calving.

To date, R2s leave WRO to be IWG over June and July at various other blocks such as SH96/Marcel and at WW5. Under the proposal, in-calf R2s are either wintered in barns at WW1&2 (c.125) or at WRO (IWG).

Existing and proposed activities at WRO are described and assessed in detail in the WRO section of this application.

Cultivation

WW1 has been dairy farmed by the applicants since 1992, and most of WW2 has been dairy farmed by the applicants since 2003. Over this time soils have been developed sustainably, which is evident in fertiliser and agronomy reports for WW1, WW2 and the Horner Block from the fertiliser supplier (Ravensdown) – see Appendix. Summer and winter fodder crop cultivation has been carried out to provide feed for cows/heifers over summer dry periods and winter respectively. It is proposed to cease the practice of growing fodder crops at WW1&2, as a key mitigation measure to off-set additional cow numbers. The re-grassing policy will meet permitted activity rules as per Rule 25, will occur by direct grass to grass cultivation and is described in respective FEMPs.

Fodder crop (kale) is grown at WRO to provide feed for dry stock over winter. Under the proposal, the area sown in fodder crop and IWG will not exceed 100 hectares. Please see the WRO section of the application for details. Cultivation practices at WRO meet permitted activity rules as per Rule 25 of the pSWLP.

Groundwater abstraction

Groundwater is abstracted from three bores at WW1&2 for use at two dairy sheds and to supply stock drinking water to 1,500 cows. The maximum daily volume of groundwater abstracted to meet the needs of 1,500 cows is 180,000 litres.

At the WW2 unit, two bores supply groundwater. One bore (E45/0083) is located to the west of the dairy shed with a second bore (E45/0727) at the north of the block, close to Wreys Bush Highway. The maximum daily volume of groundwater supplied to WW2 is 96,000 litres.

At the WW1 unit, the bore (E45/0071) is located to the west of the dairy shed and the maximum daily volume of groundwater supplied to WW1 is 91,000 litres. This represents an increase of 31,000 litres compared to the existing water permit for WW1 (#301664), which has a maximum daily take of 60,000 litres.

WRO has a stock drinking water scheme that meets permitted activity rules and does not require consent.

Table 1.4 Physical properties and information of land and water at WW1&2 and Horner Block.

Soils	**Soil Type**	**Vulnerability Factors**		
Soil mapping on Topoclimate appears to be incorrect compared to actual soil types. Topoclimate maps Braxton soils as the dominant soil type, with Pukemutu being a minor soil type. Topoclimate maps an area of Glenelg on the east. A soil survey field investigation carried out in 2017 by Scandrett Rural Limited is described in Section 5 and a separate report. It maps two dominant soil types; Braxton soils are found on the mid-west side (c.100 ha) and Drummond soils are found at the east. Drummond soils have intergrades of more shallow Glenelg soils in places. Drummond/Glenelg account for c.400 ha of soils.		**Structural Compaction**	**Nutrient Leaching**	**Waterlogging**
	Braxton	Moderate	Slight	Severe
	Drummond	Minimal	Moderate	Slight
	Glenelg	Slight	Very severe	Nil
	Waiau	Moderate	Very severe	Nil
FDE Land Classification	A – artificial drainage or coarse soil structure E – other well drained but very stony flat land Likely to be D – well drained flat land. FDE classification is primarily based on soil type. Incorrect Topoclimate mapping of WW1&2 means large areas of Braxton/Pukemutu (Category A) are mapped where a field investigation found Drummond soils (Category E).			
Characteristics of FDE Classification	A - high risk to surface water, low risk to groundwater D, E – low risk to groundwater using low depth application, low risk to surfacewater			
Topography	Flat			
Surfacewater management zone	Waimatuku, Oreti (WW1&2) Aparima (Horner Block)			
Groundwater Zone	Waimatuku, Central Plains			
Groundwater Nitrate Levels	0.1 – > 11.3 mg/L A series of nitrate concentration bands are mapped with the lowest groundwater nitrate levels at the west side (0.1 – 0.4 mg/L) and the highest to the south east (modelled >11.3 mg/L). Most groundwater underlying WW1&2 has nitrate levels of 3.5 – 8.5 mg/L, indicative of moderate to high land use impacts.			
FMU	Oreti (WW1&2)			

	Aparima (Horner Block)	
Nearest downstream registered drinking water supply	Heddon Bush School 2.3 km to the south	
Downstream Regionally Significant Wetland/Sensitive Waterbody	Drummond Peat Swamp (>10 km to south east) Bayswater Bog (>10 km to south west)	
Physiographic Zones	**Zone**	**Contaminant pathways for Physiographic Zone**
	Central Plains	When wet soils are prone to waterlogging, resulting in the installation of extensive artificial drainage networks. When dry these soils are prone to shrinking and cracking, allowing drainage to bypass the soil to the underlying aquifer. Aquifers and streams in this zone are prone to contaminant build-up as they do not experience dilution by a major river.
	Oxidising	Soil water and groundwater are well aerated, which allows nitrogen to accumulate. Oxidised soils are good at absorbing and storing water and any nitrogen it contains. During drier months, nitrogen accumulates in soil to high levels. During winter when soils are wet, any nitrogen not used by plants leaches down into the underlying aquifer (deep drainage). Artificial drainage is used where soils have low subsoil permeability to help to reduce waterlogging. Contaminant loss through artificial drains to nearby streams can be high during wetter months.

Table 1.5. Physical properties and information of land and water at WRO

Soils	**Soil Type**	**Vulnerability Factors**		
		Structural Compaction	**Nutrient Leaching**	**Waterlogging**
	Malakoff			
	Waimatuku	Slight	Moderate	Slight
	Makarewa	Moderate	Slight	Severe
	Aparima	Moderate	Moderate	Moderate

	Orawia	Slight	Moderate	Slight
FDE Land Classification	n/a			
Characteristics of FDE Classification	n/a			
Topography	Flat, rolling to steep			
Surfacewater management zone	Waiau			
Groundwater Zone	Unmapped			
Groundwater Nitrate Levels	0.01 – > 1.0 mg/L			
FMU	Waiau			
Nearest downstream registered drinking water supply	Tuatapere (~12 km to south west)			
Downstream Regionally Significant Wetland/Sensitive Waterbody	Waiau River – Te Waewae Lagoon (~20 km to south west)			
Physiographic Zones	**Zone**			
	Bedrock/Hill country Oxidising Gleyed Lignite Marine Terraces Peat Wetlands			

2. Consents

The decisions version of the pSWLP was notified on 4 April 2018. In accordance with Section 86B(1)(a) and (3) of the Resource Management Act 1991, all provisions of the Proposed Plan have had legal effect since this date. Since the Regional Water Plan (2010) and Regional Effluent Land Application Plan are still operative, all provisions in both Plans have legal effect. The provisions of these plans therefore need to be considered alongside the provisions of the pSWLP.

Consent holder name

The existing consent holders, Woldwide One Limited, Woldwide Two Limited, have changed their name to "*Woldwide One Limited and Woldwide Two Limited*." In accordance with Section 124C of the RMA, Woldwide One Limited confirms in writing that they will not be making any future applications under as *Woldwide One Limited* on this property in accordance with Section 124C of the RMA. In accordance with Section 124C of the RMA, Woldwide Two Limited confirms in writing that they will not be making any future applications as *Woldwide Two Limited* on this property in accordance with Section 124C of the RMA. Future applications will be made on behalf of "*Woldwide One Limited and Woldwide Two Limited*."

2.1 Consents

Consents

Table 2.1 provides a summary of proposed activities and whether resource consent is required or not. Further details are provided regarding the level of each activity in the following section.

Table 2.1

Proposed activity	Consent required	Activity level
Expansion of dairy farming through an increase in cow numbers	Yes - land use consent for farming	Discretionary activity
Discharge of agricultural effluent	Yes - effluent discharge permit – one each for WW1&2 and Horner Block	Discretionary activity
Use of land for maintenance and use of existing effluent storage facilities	No pathway through the rule but applicants agree to apply for consent as directed by decision maker.	No activity level available under the rule
Use of land for wintering barns	Yes - use of land for feed pad/lot	Discretionary activity
Use of land for silage storage facilities	No	Permitted activity
Silage leachate	No	Permitted activity
Cultivation	No	Permitted activity
Groundwater abstraction	Yes - water permit	Discretionary activity

Farming

Rule 20 of the pSWLP manages farming activities, including new or expanded dairy farming of cows. The proposed activity does not meet Rule 20 (a) (ii) (2) since cow numbers are increasing beyond the maximum number specified in the dairy effluent discharge permit that existed on 3 June 2016. Rule 20 (a) (ii) (6) is met, however, as all land was either in the dairy platform prior to 3 June 2016 or was authorised for dairy farming in November 2017.

Rules 20 (b) and (c) do not apply at WW1&2 since the proposal does not include any IWG nor will occur at greater than 800 metres above mean sea level. IWG is carried out at WRO so parts (b) and (c) apply. IWG activities at WRO meet permitted activity rules regarding areas, set-backs and other GMPs as directed by parts (b) and (c).

Rule 20 (d) is met except for (d) (ii) (1), since the dairy platform’s assessment reflects the annual amount of N, P, sediment and microbial contaminants lawfully discharged on average over four years instead of over five years. A high level of evidence of land use activities during the four-year period has been supplied. Since the Merriburn Block at WRO only came under the control of the applicants though a lease agreement recently, only one nutrient budget could be provided for WRO for the 2017/18 year. Also, the scale of IWG activities of dry stock will increase at WRO, which is likely to increase contaminant losses from WRO to an extent but with minimal effects on the receiving environment. As the application does not meet all the provisions of Rule 20 (d), then Rule 20 (e) applies; **the use of land for the proposed farming activity is a discretionary activity and resource consent is required**.

Discharge activity

Agricultural effluent is defined as “effluent that is derived from livestock farming” in the pSWLP. It includes dairy shed, wintering barn, silage pad and underpass effluent since effluent generated at these sources is generated by livestock farming.

Rule 35 of the pSWLP manages the discharge of agricultural effluent to land. In this case the discharge activity at WW1&2 and the Horner Block does not meet all conditions of (a); part (i) is not met as the dairy shed services more than 20 cows; part (viii) is not met as the maximum N loading at the Horner Block will exceed 150 kg/year from effluent (maximum of 250 kg/ha). However, the maximum N loading from effluent at the dairy platform will not exceed 150 kg/year. The discharge activity does not meet part (b) (ii) since it is proposed to increase cow numbers above the maximum number specified on an existing discharge consent. **The discharge activities at both WW1&2 and the Horner Block meet all conditions described in Rule 35 (c) so are discretionary activities**.

Rule 50 of the RWP (2010) manages the discharge of agricultural effluent to land. In this case the discharge activity does not meet parts (a) or (b). It does not meet part (c) since it is proposed to increase the scale of the discharge activity through an increase in cow numbers. However, except for an increase in cow numbers, the discharge activity meets (c) part (i) in that it includes high rate irrigation to soil landscape categories A, D and E. The discharge activity meets part (d) as the scale of the activity is increasing with the increase in cow numbers and the discharge activity to soil/landscape categories A, E and D includes high rate irrigation by slurry tanker that does not exceed 5 mm depth per application. In fact, the discharge of effluent by slurry tanker does not exceed 2.5 mm depth per application. Rule 50 (d) does not specify a depth for high rate irrigation by travelling irrigator, so direction is taken from Policy 42 of the RWP. The discharge of effluent to category E land must be at less than or equal to 10 mm depth per application and at less than 50% of PAW. The travelling irrigators have been tested and apply effluent at less than 10 mm per application. The discharge of effluent must be at less than the soil water deficit for category A land and at a depth less than 50% of the soil water deficit for Category D land. The discharge of effluent to categories A, D and E land meets Policy 42 of the RWP.

Rule 5.4.6 of the Regional Effluent Land Application Plan provides for the discharge as a **discretionary activity**.

The discharge activities at WW1&2 and the Horner Block are therefore assessed as being discretionary activities.

Existing effluent storage facilities

Rule 32D of the pSWLP manages existing agricultural effluent storage facilities. Under Rule 32D (a) the use of land for the maintenance and use of existing agricultural effluent storage facilities that was authorised prior to Rule 32D taking legal effect, and any incidental discharge directly onto or into land from those storage facilities which are within the normal operating parameters of a leak detection system or the pond drop test criteria set out in Appendix P, are permitted activities provided that certain conditions are met.

WW2 STORAGE POND

WW2's pond is clayed lined and does not have a leak detection system. The material stored in WW2's storage pond is a slurry. Slurry is defined section 1 but is not defined in the pSWLP or RWP. The pond was drop tested in 2017 at the request of Council and a drop test report was submitted to Environment Southland who at the time accepted that the pond was not leaking. The drop test met all criteria set out in Appendix P, except for the unavoidable presence of a crust due to the nature of slurry stored in the pond. The 2017 drop test report was peer reviewed by a CPEng and is appended to this application.

The characteristics of slurry and liquid effluent in storage systems are quite different. Due to a much higher DM content [2], slurry has relatively low viscosity compared to liquid effluent. Slurry has self-sealing properties [3]. Whilst the process is not fully understood, self-sealing of slurry ponds/lagoons greatly reduces the risk of leakage through clay/earthen-lined ponds. Wind-driven wave action can cause bank erosion in ponds where wave energy carried by liquid damages the clay substrate. This does not arise when storing slurry since the pond surface is solid and does not move via wave action.

In the absence of operating within the normal parameters of a leak detection system or all pond drop test criteria set out in Appendix P, Rule 32D does not provide a pathway to an activity level for the use of land for the maintenance and use of an existing agricultural effluent storage pond at WW2. As such, the structure cannot align with Rule 32D. Since the pond stores slurry, which has self-sealing properties, meets all other Appendix P criteria and has minimal risk of bank erosion, the pond is very unlikely to be leaking. As such, the applicants believe the use of land for the pond at WW2 should be permitted by the Consent Authority. However, in being unable to meet all Appendix P criteria and without an avenue to an activity level within the rule, the applicants wish to place this issue in front

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[2] Houlbrooke, Longhurst, Orchiston & Muirhead (2011) Characterising dairy manures and slurries. Report prepared for Surface Water Integrated Management (SWIM), AgResearch

[3] Parker, David & Schulte, D.D. & Eisenhauer, D.E. (1999). Seepage from earthen animal waste ponds and lagoons - An overview of research results and state regulations. Transactions of the ASABE (American Society of Agricultural and Biological Engineers). 42. 485-493. 10.13031/2013.13381.

of the hearing decision maker where it can be discussed, considered and resolved. They agree to apply for consent as and when directed to by the hearing decision maker.

WW2's storage pond meets Rule 32D (a) (i) (1) in that its construction was lawfully carried out without a consent. In accordance with Rule 32D (a) (ii) (2), a visual assessment of WW2's pond was carried out by a SQP in 2018. The assessment found that the pond shows no cracks, holes or defects that would allow effluent to leak. A report certifying WW2's pond by a SQP is appended to this application.

WW1 STORAGE POND

WW1's effluent pond stores slurry and was lawfully upgraded in autumn 2018 to increase its storage capacity, install a synthetic liner and leak detection system. The pond design was certified by a CPEng as meeting Practice Note 21 standards and was approved the Council engineer in 2018. The liner is composed of 1.5 mm HDPE, overlies a leak detection drain system the specification for which was provided by a CPEng. CPEng guidance determined a suitable design to meet PN21 standards for small ponds. The leak detection system is a ring drain that terminates at a 400 mm diameter inspection well (piezo). The liner supplier confirmed that the liner was correctly installed and is not leaking. The CPEng confirms that the pond is structurally sound following the upgrade. The CPEng report was submitted to Environment Southland as required in 2018.

In meeting the aforementioned-design and construction requirements to meet Practice Note 21, we conclude that WW1's pond is operating within the normal operating parameters of a leak detection system; there is no effluent leaking from the pond. The piezo has been inspected regularly when it either has had no liquid or had liquid following heavy rainfall when the water table was high. By checking the liquid in the piezo for signs of effluent (i.e. odour and clarity), it has been confirmed that there is no effluent in the leak detection system and no effluent leaking from the pond.

In accordance with Rule 32D (a) (ii) (2), a visual assessment of WW1's pond was carried out by a SQP in 2018. The assessment found that the pond shows no cracks, holes or defects that would allow effluent to leak. A report certifying WW1's pond by a SQP is appended to this application.

We conclude that in accordance with Rule 32D of the pSWLP, the use of land for an existing effluent storage pond at WW1 is a permitted activity; resource consent is not required. However, Council's interpretation of PN21 requirements for leak detection systems differs from CPEng guidance on PN21 received during the design and construction of WW1's pond. The applicants wish to place this issue in front of the hearing decision maker where it can be discussed, considered and resolved. They agree to apply for consent as and when directed to by the hearing decision maker.

ANCILLARY EFFLUENT STRUCTURES AT WW1 AND WW2

At both WW1 and WW2, other structures that contain, treat or store effluent include a sand trap and concrete effluent sump at the dairy shed and concrete collection sump at the wintering barn. These structures have been visually assessed by a SQP and certified as having no visible cracks, holes or defects that would allow effluent to leak. A report prepared by a SQP detailing the structures is appended to this application.

An Appendix P drop test for dairy shed ancillary structures will be carried out on in the off-season. These structures cannot be diverted during the milking season. Drop testing of the wintering barn collection channel sumps will be carried out at the earliest opportunity, with drop test reports submitted to ES prior to the wintering barns being used in May 2019.

Feed pads/Lots

Rule 35A of the pSWLP manages the use of land for feed pads/lots including wintering barns. In this instance the use of land for two wintering barns at the dairy platform does not meet all conditions set out in Rule 35A (a) as each barn houses more than 120 cattle. The use of land for a feed pad/lot that does not meet one or more conditions of Rule 35A (a) is classed as a discretionary activity. Accordingly, resource consent application for the use of land for two wintering barns at WW1 and WW2 is also submitted (in a separate document) to Environment Southland.

Groundwater abstraction

Under Rule 54 (d) of the pSWLP, groundwater abstraction for 1,500 cows on the WW1&2 is a discretionary activity as a maximum of 180,000 litres per day is abstracted. This allows for 120 litres per cow per day. Under Rule 23 (c) of the Regional Water Plan, a groundwater take of 180,000 litres per day is a restricted discretionary activity provided the rate of take is less than or equal to 2 L per second; resource consent is required. **The groundwater abstraction is assessed as a discretionary activity and resource consent is required.**

Permitted activities

Silage storage - WW1 and WRO

The use of land for silage storage facilities at WW1 and WRO is a permitted activity as it meets all conditions specified in **Rule 40 (a)** of the pSWLP; resource consent is not required.

The use of land for silage storage facilities at WW1 and WRO is a permitted activity as it meets all conditions specified in **Rule 51 (a)** of the RWP (2010); resource consent is not required.

Surplus grass is harvested and generally stored as baleage at WRO, However, occasionally it may be stored as silage. Where this occurs, the applicants ensure that permitted activity rules regarding the use of land for silage storage are always met.

Both rules are met as follows:

Silage pads are situated on dry sites; the underlying substrate is well compacted and sealed (see figures 6.4 and 6.5 for the permanent pad at WW1). There is no overland flow of stormwater into silage pads and silage pads are not situated within a critical source area. Silage pads are not located on land that is made permanently or intermittently wet by the presence of springs, seepage, high groundwater, ephemeral rivers or flows of stormwater other than from any cover of the silage.

No part of any silage pad is within 50 metres of a lake, river, artificial watercourse, modified watercourse (see figure 6.6 for WW1), natural wetland or any potable water abstraction point. The nearest waterway to the WW1 pad is a fenced off open drain, which is approximately 60 metres to the east of the silage pad.

No silage pad is within 100 metres of any dwelling or place of assembly, on another landholding.
No silage pad is not within 100 metres of the microbial health protection zone of a drinking water supply site identified in Appendix J of the pSWLP, or within 250 metres of the abstraction point of a drinking water supply site identified in Appendix J.

Cattle do not graze directly from any silage pad, rather silage is carted to cows in the wintering barn or on paddocks at WW1 and to stock on paddocks at WRO. No silage pad is located on contaminated land.

Silage storage - WW2

The use of land for a silage storage facility at WW2 meets the conditions stated in Rule 40 (a) of the pSWLP (2018), so is classed as a permitted activity and resource consent is not required. The use of land for a silage storage facility meets the conditions stated in Rule 51 (a) of the RWP (2010), so is classed as a permitted activity and resource consent is not required.

Silage leachate - WW1 & WRO

The discharge of silage leachate onto or into land at WW1 and WRO is a permitted activity as it meets all conditions specified in Rule 51 (d) of the Regional Water Plan (2010); resource consent is not required.

The activity meets Rule 41 (a) (iia), (iii) and (iv) of the pSWLP and is therefore a permitted activity and resource consent is not required. There is no discharge of leachate directly to groundwater via a pipe, soak pit or other soil bypass mechanism and there is no overland flow or ponding of silage leachate outside of the silage storage facility.

Silage leachate - WW2

In accordance with Rule 41 (a) of the pSWLP, the discharge of silage leachate onto or into land in circumstances where contaminants may enter water is a permitted activity since part (i) is met and resource consent is not required; the discharge is via an agricultural effluent discharge system authorised under Rule 35.
In accordance with Rule 50 (d) of the RWP (2010), the discharge of silage leachate at WW2 is a permitted activity since all conditions set out in Rule 50 (d) are met; resource consent is not required.

Intensive winter grazing

IWG is carried out at WRO so Rule 20 parts (b) and (c) apply. IWG activities at WRO meet permitted activity rules regarding areas, set-backs and other GMPs as directed by parts (b) and (c).

Cultivation

Cultivation at WW1&2 and WRO meets permitted activity rules described in Rule 25 of the pSWLP. Cultivation is not carried out within a bed or within 5 metres of from the outer edge of the bed of any waterways. It does not occur on land with a slope of greater than 20 degrees.

In the future, if a setback of less than 5 metres is implemented when cultivating at the WW1&2 dairy platform, the activity will meet permitted activity rules described in part (b) of Rule 25. A minimum setback of 3 metres from the outer edge of any stream bed will be implemented, cultivation will not occur more than once in any 5-year period and it will be for the purpose of renewing pasture and not for any fodder crop/IWG activity.

2.2 Duration

Consent durations of 15 years are proposed for all consents, which aligns with Woldwide One's discharge and water permit terms. Special consideration is given to Policy 40 of the pSWLP and Policies 14A and 43 of the Regional Water Plan in determining the duration. The duration sought is considered consistent with these policies given the replacement nature of consents for an activity that is already well established, has benefited from a significant degree of capital investment and is operating within limits established by its existing consents and associated conditions. Considerable investment in farm infrastructure has been made to take the final steps towards future proofing the dairying operation; eliminating winter grazing of adult cattle on beet/brassica crops from high risk soils in the sensitive Heddon Bush area altogether. The level of investment demonstrates the applicant's belief in and commitment to sustainable farming and land management. The applicants believe that their presence at this location since 1992 (over 25 years) has not had a detrimental effect on the local environment, and that the proposed changes will mean a further reduction of that impact. They are likewise committed to the sustainable management of WRO with minimal adverse effects on the receiving environment. A 15-year consent term will mean that the management of the resources under the same proven stewardship will be ensured into the future.

2.3 Proposed consent conditions

The applicants propose to agree conditions once draft conditions are issued, including the conditioning of various mitigation measures where appropriate. Draft conditions will recognise the following:

Land use consent for farming

1. The land area will include WW1&2 and WRO.

   Environment Southland regard WRO to be part of the landholding at WW1&2. The applicants hold a different view as mentioned in section 1. However, in respect of Environment Southland's view and for the application to be accepted under s88 by the consent authority, WRO has been included in the landholding in this application and therefore is included in the land use consent for farming.

2. That activities at WW1&2 dairy platform are restricted using the N output from the proposed Overseer nutrient budget as a limit. The below example can be used as guidance. Using an N output figure provides Council with certainty that N losses will not increase due to future farming activities at WW1&2, while providing the applicants with flexibility to farm according to climatic and economic conditions, and to respond to unforeseen challenges as they arise (e.g. biosecurity/*M. bovis*). An output-based consent is preferable since it allows for innovation by restricting the N loss from the whole activity at the dairy platform rather than specific activities.

3. For reasons explained in the WRO section of the application, only input-based conditions are proposed for WRO.

4. To provide additional certainty over the scale of the activity, mitigations and effects that the following inputs are conditioned:

   WW1&2:
   a. Land area;
   b. Effluent discharge area;
   c. Peak cow numbers milked (1,500); and
   d. Maximum number of cows housed in wintering barns (1,250).

WRO:

- e. Land area;
- f. Maximum area in winter crop (beet or brassica) to be intensively winter grazed is 100 hectares;
- g. A maximum of 417 R1 heifers grazed all year round at WRO from WW1&2;
- h. A maximum of 417 R2 heifers grazed all year round at WRO from WW1&2, **or**
  A maximum of 417 R2 heifers grazed between August and May and during June and July in the WW1&2 wintering barns.

5. The Consent Holder shall maintain records of the following for each year between 1 June and 31 May:
    - a. Fertiliser application, including rates;
    - b. Supplements imported;
    - c. Types of crops and total area of cropping if any;
    - d. Cultivation methods;
    - e. Stock units by references to type, age and breed;
    - f. Effluent application areas (WW1&2 only);
    - g. All other inputs to the OVERSEER nutrient budgeting model.

6. Install a new monitoring bore in the same area as bore E45/0622, to monitor groundwater quality flowing south from WW1&2.

Example – WW1&2 year-end nutrient budget:

Nitrogen Loss Rate and Nutrient Budget

1. *The Consent Holder shall ensure nitrogen losses from farming activities undertaken at the WW1&2 are maintained at or below the following nitrogen loss rate of 40 kg/ha/yr, or as amended in accordance with Condition X.*

Advice Note: *The nitrogen loss rates represent the modelled discharge of nitrogen below the root zone as modelled with OVERSEER version 6.3.1 in accordance with the OVERSEER Best Practice Input Standards as of 11 May 2018.*

The determination of whether the nitrogen loss rates have been met will be made using the nitrogen loss from the most recent year, modelling using the latest version of OVERSEER®.

2. *The Consent Holder shall prepare an annual nutrient budget for the period of 1 June to 31 May for the subject land using OVERSEER in accordance with the OVERSEER Best Practice Input Standards, or an equivalent model approved by the Chief Executive of the Consent Authority.*

3. *The nutrient budget required by Condition 2 shall be accompanied by a report that includes:*
    - *a. A review of the input data to ensure that the nutrient budget reflects the farming system;*
    - *b. An explanation of any differences between the budgets of the previous year; and*
    - *c. A comparison of the nitrogen loss from the current year with the nitrogen loss rates in Condition 2.*

4. *The nutrient budget and accompanying report shall be provided to the Consent Authority by 30 September each year.*

5. *The nutrient budget shall be prepared by a Certified Nutrient Advisor or the budget may be prepared by suitably experienced person and reviewed by a Certified Nutrient Advisor.*

6. *The nitrogen loss rates described in Condition 2 shall be amended following the release of a new version of OVERSEER or the Best Practice Data Input Standards. Following the update of the nitrogen loss rates, the Consent Holder shall provide the updated OVERSEER files to the Consent Authority with the report required by Condition 5.*

Discharge permits

WW1&2

The below draft conditions are proposed for the discharge of agricultural effluent at WW1&2.

This consent shall be exercised in conjunction with Land Use Consent AUTH-X.

(a) This consent authorises the discharge of dairy shed effluent, wintering barn effluent, silage pad effluent and underpass effluent ("agricultural effluent") onto land, via a land disposal system consisting of two effluent storage ponds, two sand traps, two dairy shed pump sumps, two wintering barn concrete collection sumps, low depth travelling irrigator, low rate (pods and/or rain-gun) irrigation, slurry tanker with a trailing shoe and umbilical system, as described in the application (X) for resource consent dated X 2018 and further information dated X.

The activity shall be limited to:

- *i. The discharge to land of agricultural effluent generated from milking of up to 1,500 cows milked twice daily;*
- *ii. The discharge to land of agricultural effluent from the housing of up to 1,250 cows inside two purpose built barns;*
- *iii. The discharge of agricultural effluent to land via low depth travelling irrigator, slurry tanker with a trailing shoe, umbilical system and low rate irrigation;*
- *iv. The discharge of agricultural effluent to an area of no more than X hectares at the WW1&2 dairy platform as per the plan attached as Appendix 1;*
- *v. The discharge of effluent from a 1,200 m^2 silage pad; and*
- *vi. The discharge of effluent from a 200 m^2 underpass.*

***Advice note**: "Effluent slurry" refers only to the contents of the effluent storage ponds. "Agricultural effluent" refers to effluent from all sources (the dairy shed, yard, barns, ponds, silage pad and underpass).*

(b) This consent excludes the discharge of effluent from winter milking from June 20 to July 20 (winter milking refers to cows milked to supply a winter milking contract), or from any feed pad/calving pad/structure not listed in condition 2(a).

2. *The discharge authorised by this consent shall not exceed the following rates and/or depths at any time:*

   - (a) *For the travelling irrigator: A maximum depth of less than 10 millimetres for each individual application;*
   - (b) *For the slurry tanker with trailing shoe: A maximum depth of 2.5 millimetres for each individual application;*
   - (c) *For the umbilical system: A maximum depth of 3.0 millimetres for each individual application; and*
   - (d) *Low rate system: a maximum depth of 10 millimetres for each individual application, and a maximum rate of 10 millimetres per hour.*

3. *The maximum loading rate of nitrogen from effluent onto any land area as a result of the exercise of this consent shall not exceed:*
   - (a) *150 kilograms of nitrogen per hectare per year at the dairy platform.*

4. *The minimum return period for the discharge of effluent to land shall be no less than 28 days.*

5. *Effluent shall not be discharged within:*
   - (a) *20 metres of any surface watercourse;*
   - (b) *100 metres of any water abstraction point;*
   - (c) *200 metres of any place of assembly or dwelling not on the subject property;*
   - (d) *20 metres from any property boundaries.*

Where there is inconsistency between the plan attached as Appendix 1 and the conditions of this consent, the conditions of this consent shall prevail.

6. *The application of effluent to land shall not occur when:*
   - (a) *the moisture content of the soils is at or above field capacity,*
   - (b) *soils within the discharge area are 'cracked'; and*
   - (c) *during wind conditions that may result in odour or spray drift beyond the property boundary.*

Horner Block

The below draft conditions are proposed for the discharge of agricultural effluent at the Horner Block.

1. *The discharge of effluent slurry to an area of no more than 97 hectares at the block known as the "Horner Block" as per the plan attached as Appendix 1.*

2. *The discharge authorised by this consent shall not exceed the following depths at any time:*
   - a. *For the slurry tanker with trailing shoe: A maximum depth of 2.5 millimetres for each individual application; and*
   - b. *For the umbilical system: A maximum depth of 3.0 millimetres for each individual application.*

3. *The maximum loading rate of nitrogen from effluent onto any land area as a result of the exercise of this consent shall not exceed:*
   - a. *250 kilograms of nitrogen per hectare per year at the Horner Block (Lot 4 DP 399915).*

i. *The annual slurry volume applied at the Horner Block shall be recorded and reported to the Consent Authority upon request.*

Other conditions for land use, discharge and water consents – to be agreed with Consent Authority once draft conditions are issued.

3. Statutory Considerations

3.1 Statutory considerations:

Environment Southland must consider the following matters when they consider an application. The application is consistent with all of these relevant plans and policies because effects on water quality and quantity and the soil resource should be less than minor.

Resource Management Act 1991:

- The provisions of section 104 of the Resource Management Act 1991;
- Part 2 of the Resource Management Act;
- The applicant's assessment of effects on the environment;
- The provisions of Sections 104B, 104C, 105 and 107 of the Resource Management Act 1991.

Schedule 4 of the RMA requires that an assessment of the activity against the matters set out in Part 2 and any documents referred to in Section 104. Sections 104B and 104D of the Act set out the matters that, subject to Part 2, the Consent Authority must have regard to when considering an application for discretionary activities. Sections 105 and 107 set out additional matters the Consent Authority must have regard to when considering applications to do something that would otherwise contravene Section 15. An assessment of each of these matters follows:

Part 2 of the RMA

The activity is considered to represent an efficient use of natural resources that will give rise to significant positive benefits in terms of providing for the social and economic wellbeing of the applicants and the wider regional economy. There is, however, the potential for adverse effects on the environment to arise, including on water quality. However, it is considered that the effects of the activities have been adequately identified and assessed in the Assessment of Environmental Effects in Section 7 below and that such effects will be no more than minor.

Section 6 of the RMA lists the matters of national importance that a Consent Authority shall recognise and provide for when considering applications for resource consent. The relevant matters under Section 6 to this proposal are considered to be:

(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:
(c) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:

It is considered that the proposed activities do not impact directly on the coastal environment, wetlands, and lakes and rivers and their margins, although there is potential for adverse effects on the wider receiving environment which is inclusive of some of these features. However, as is discussed in Section 7 below, the actual and potential adverse effects of the activities are considered to be no more than minor.

Section 7 of the Act lists a number of other matters that a Consent Authority must have particular regard to when considering applications for resource consent. The matters in Section 7 that are considered relevant to this application are:

(a) kaitiakitanga:

(aa) the ethic of stewardship:

(b) the efficient use and development of natural and physical resources:

(c) the maintenance and enhancement of amenity values:

(d) intrinsic values of ecosystems:

(f) maintenance and enhancement of the quality of the environment:

(g) any finite characteristics of natural and physical resources:

(h) the protection of the habitat of trout and salmon:

For the reasons discussed in Section 7 of this report below, the proposal is considered consistent with relevant provisions of Section 7 of the RMA.

Section 8 sets out a Consent Authority's responsibilities in relation to the Treaty of Waitangi. The proposal is considered consistent with the provisions of all regional planning documents, including Te Tangi oTauira, and Sections 6(c) and 7(a) of the Act. Therefore, the proposal can also be considered consistent with Section 8 of the Act.

To avoid repetition, the following documents have been grouped together under common headings in the sections that follow.

The final part of this section of the application focuses on why the activity is consistent with key policies in the proposed Southland Water and Land Plan (2018).

Table 3.1: Ngai Tahu Values

Regulatory Document	Relevant Sections
National Policy Statement for Freshwater Management 2014	• Objectives C1, D1 • Policies C1, D1
Southland Regional Policy Statement 2017	• Objectives TW.2, TW.3, TW.4 and TW.5 • Policies TW.3, TW.4 and TW.5
Regional Water Plan 2010	• Objective 9C • Policy 1A
Regional Effluent Land Application Plan 1998	• Objectives 4.1.4, 4.1.5 • Policies 4.2.4, 4.2.7,4.2.8, 4.2.9

Proposed Southland Water and Land Plan 2018	• Objectives 3, 4, 5, 15 • Policies 1, 2, 3
Te Tangi a Tauira:	• Whole Document

Tangata Whenua values have been considered when preparing this application including reference to Te Tangi a Tauira (Iwi Management Plan). The principles of protection of the mauri of the water and mana of the land while minimising adverse effects on mahinga kai will continue to be recognised and have regard to in the exercise of the consents and the operation of the dairying activity. There are no known wahi tapu, ancestral sites, heritage sites or other taonga associated with the landholding.

Table 3.2 Water Quality

Regulatory Document	Relevant Sections
National Policy Statement for Freshwater Management 2014	• Objectives A1, A2, B1, B2, B3, B4, • Policies A3, A4, B5, B6, B7
Regional Policy Statement for Southland 2017	• Objectives WQUAL.1 and WQUAL.2 • Policies WQUAL.1, WQUAL.2, WQUAL.3, WQUAL.7, WQUAL.8, WQUAL.12
Regional Effluent Land Application Plan 1998	• Objectives 4.1.2 • Policies 4.2.3, • Rule 5.4.5
Regional Water Plan 2010	• Objectives 3,4,8 • Policies 1, 4, 6, 7, 13
Proposed Southland Water and Land Plan 2018	• Objectives 1, 2, 6, 7, 8, 9, 13, 18 • Policies 5, 10, 13, 14, 15, 16, 17, 18, 39A, 40
Te Tangi a Tauira	• Policies 1, 4, 5, 6, 11, 16, 17, 18

Dairy and dry stock farming are carried out following good management practices relevant to the physiographic zones present at the WW1&2 (Oxidising and Central Plains) and WRO (Bedrock/Hill Country, Gleyed, Oxidising, Peat Wetlands, Lignite Marine Terraces). These practices are recommended by Council and are implemented on farm to mitigate the risk of adverse effects on water quality from contaminants transported via artificial drainage, deep drainage and overland flow where relevant. Deep drainage and artificial drainage are recognised by the applicants as key contaminant pathways at WW1&2 and are managed as such. Artificial drainage and overland flow are recognised as key pathways at WRO, with deep drainage also a risk but to lesser extent. Good management practices and specific mitigation measures implemented on farm are described in this application (sections 6, 7, WRO section), and in the Appendix N Farm Environmental Plans for the WW1 and WW2 units and for WRO.

At WW1&2 there will be no increase in contaminant loss and no increase in effects on receiving water quality due to additional cows. This expansion will be achieved through the implementation of key mitigation measures to off-set additional cows, alongside the implementation of a suite of good management practices. Practices such as IWG, which generally have high rates on N loss to receiving ground and surfacewaters, are being eliminated from a sensitive area in Central Southland.

At WRO, proposed activities will result in minimal adverse effect on receiving waters.

At WW1&2 and the Horner Block, the discharge is to land rather than water and is undertaken in a manner to minimise adverse effects on water quality. Good management practices for the management of the effluent system and mitigation measures have been included in the application and respective Farm Management Plans. By only irrigating effluent to land when ground conditions are less than field capacity, and by ensuring that irrigation of effluent to land does not result in the soils reaching field capacity, the risks of leaching through the soil profile or via overland flows are mitigated. The use of very low depth irrigation, as discussed in the AEE, should reduce the risk of exceeding a soil's infiltration rate, thus preventing ponding and surface runoff of freshly applied effluent (slurry). The recommended buffer zones from waterways are adhered to when applying effluent.

Table 3.3 Water Quantity

Regulatory Document	Relevant Sections
National Policy Statement for Freshwater Management 2014	• Objectives A1, A2, B1, B2, B3, B4, • Policies A3, A4, B5, B6, B7
Southland Regional Policy Statement 2017	• Objectives WQUAN.1 and WQUAN.2 • Policies WQUAN.1, WQUAN.2, WQUAN.5, WQUAN.6, WQUAN.7 and WQUAN.8
Regional Water Plan 2010	• Objectives 5,7,8 and 9 • Policies 21, 22, 23, 28, 29, 30, 31, • Rules 16C, 23, 50
Proposed Southland Water and Land Plan 2018	• Objectives: 7, 9, 11, 12, 18 • Policies 20, 21, 22, 23, 25, 42
Te Tangi a Tauira:	• Policies 1, 4, 5, 6, 11, 16, 17, 18

The groundwater take reflects standard volumes for a dairy farm at WW1&2. The proposed volume of take is consistent with Environment Southland's guidelines of 120 litres per day per cow, which is considered reasonable for the intended end use. The maximum groundwater take is 180,000 litres per day, allowing for 120 litres per day per cow for 1,500 cows.

Groundwater is abstracted for dairy shed use and stock drinking water from three bores at the landholding. The rate of take does not exceed 2 L/sec and should not result in more than minimal stream depletion and interference effects.

Table 3.4 Soil Health and Effluent Management

Regulatory Document	Relevant Sections
Regional Policy Statement for Southland 2017	• Objectives WQUAL.1 and WQUAL.2 • Policies WQUAL.1, WQUAL.2, WQUAL.3, WQUAL.7, WQUAL.8, WQUAL.12
Regional Effluent Land Application Plan 1998	• Objectives 4.1.1 • Policies 4.2.1, 4.2.2
Regional Water Plan 2010	• Policy 41 • Rule 49
Proposed Southland Water and Land Plan 2018	• Objectives 13, 13A, 14, 15, 18 • Policies 5, 17, 33 • Rule 32D, 35, 40, 41
Te Tangi a Tauira	• Policies 4, 7, 8, 9, 11, 13, 14, 15

The applicants seek to ensure the life supporting capacity of the soil is safeguarded, along with the sustainability of the soil ecosystem by utilising land treatment of effluent without significant adverse effects. At WW1&2, soils are suitable for effluent irrigation and the discharge follows current good management practice, which is described in Section 6 and in the FEMP. These include practices of a general nature and those specific to the key contaminant transport pathways for the physiographic zones.

Two existing storage ponds allows for deferred storage of dairy shed, wintering barn and silage pad effluent until the soil moisture content is suitable for irrigation. The land disposal area meets the best practice recommendation of 8 hectares per 100 cows. The nutrient loading of soils will not exceed 150 kg N/hectare at WW1&2 dairy farm and 250 kg N/hectare at the Horner Block. The higher strength nature of slurry has been recognised and fully considered in the AEE. Slurry from the ponds will be applied at a maximum depth of 2.5 millimetres per application using the slurry tanker with the trailing shoe to avoid overloading soils with nutrients and microbes. This system is sustainable in the long term and allows the effluent to be used both as a fertiliser and a soil conditioner.

In addition to the matters in Section 104 of the Act, when considering an application for a discharge permit a Consent Authority must also have regard to Section 105. As is discussed in the assessment under Section 7, it is considered that provided the discharge is undertaken in accordance with the conditions of the consent and the best practice management techniques outlined in Section 6 of the application and in the FEMP, the adverse effects of the activity should remain no more than minor. The best method for dealing with effluent from the dairy operation is considered to be discharging to land.

There are not considered to be any matters under Section 107 of the Act that would require the Consent Authority to decline the application for discharge permit.

3.2 Proposed Southland Water and Land Plan (2018)

The application meets the relevant objectives and policies described in the pSWLP (2018). The policies are numerous; however, the following policies are particularly relevant because of their focus on good practice management in the appropriate physiographic zones; effects including cumulatively, on water quality and quantity, and the soil resource should be less than minor.

Objectives and Policies relevant to land-use and discharges at WW1&2 & Horner Block

- **Objectives 6, 7, 8, 9, 13, 18**
- **Policies 5, 10, 13, 14, 15, 16, 17, 18, 39A, 40**

Policies 5 and 10 are physiographic zone policies. Policy 5 gives direction on the land located in the Central Plains physiographic zone; Policy 10 gives direction on land located the Oxidising physiographic zone.

Under **Policy 5.1**, adverse effects on water quality from contaminant loss via artificial drainage and deep drainage in the Central Plain's physiographic zone must be avoided, remedied or mitigated by the implementation of good management practices. The Central Plain's physiographic zone is mapped as a major physiographic zone at both the WW1&2 dairy farm and Horner Block. The applicants implement a wide range of good management practices at both locations to mitigate contaminant loss via artificial drainage and deep drainage, which is demonstrated in section 6 and 7 and in the FEMPs. They have been leaders in the dairy industry in Southland, being the first to build free wintering barn stalls to reduce outside crop-based wintering, and the first to feed fresh grass to cows in winter to reduce silage making losses and run-off.

In order to meet **Policy 5.2,** this application and accompanying FEMPs have particular regard to adverse effects on water quality from contaminants transported via artificial drainage and deep drainage.

Policy 5.3 gives direction to decision makers on generally not granting resource consent for additional dairy farming of cows or additional winter grazing where contaminant losses will increase as a result of the proposed activity. *Note: Much of the following assessment also applies to Oxidising land.*

In the absence of making other changes to the farming system, an additional 160 cows would be expected to increase contaminant losses from the activity. However, other changes are being made, such as the phasing out of IWG at WW1&2 and increased capacity and use of the wintering barns. Overseer nutrient budget analysis has been carried out to determine pre-expansion nutrient N and P losses. In the absence of a suitable alternative method, P loss has been used as a proxy for sediment and microbial loss, as they generally move from land to water in a similar way (i.e. via overland flow, and via artificial drainage at times). The post-expansion nutrient budget includes an additional 160 cows. Several key mitigation measures will be implemented and are modelled in Overseer, to ensure that nutrient losses (and by proxy sediment and microbial contaminants) will not increase post expansion. Some measures are not modelled in Overseer but will also mitigate contaminant losses and associated effects. Collectively the changes will lead to increased soil organic matter content, increase soil water holding capacity, improved soil structure and less accumulation of N in high risk soils at high risk times. This should reduce the risk of contaminant loss to groundwater via deep cracks that potentially can form in Braxton soils due to swell/shrink properties, which is a risk not particularly addressed by Overseer. A field investigation by M. Killick from Environment Southland in January 2018 showed that Braxton soils at the landholding may not in fact form deep cracks due to soil, pasture type and management, which reduces the background risk of contaminant loss to groundwater in the Central Plains PZ to a degree.

The applicants will provide Environment Southland with certainty that contaminant losses will not increase through the implementation of consent conditions and by submitting a year-end Overseer nutrient budget annually. As the proposed activity will not result in an increase in contaminant losses (N, P, and by proxy sediment and microbes), the application is in line with Policy 5.3 and should be granted.

Under **Policy 10**, adverse effects on water quality from contaminant loss via deep drainage, and via artificial drainage and overland flow where relevant, in the Oxidising physiographic zone must be avoided, remedied or mitigated by the implementation of good management practices. The Oxidising physiographic zone is mapped as a major physiographic zone at WW1&2 and the Horner Block with Oxidising areas generally found on the east side of the dairy platform where free draining soils are found. Due to the nature of its topography and soils, artificial drainage or overland flow pathways are not believed to be a particular risk for Oxidising areas. Deep drainage of contaminants, particularly nitrate loss to groundwater, is a risk for Oxidising areas and must be managed under Policy 10.

The assessment provided in Policy 5 relating to the management of the risk of contaminant loss via deep drainage to groundwater also applies to the management of Oxidising soils. Rather than repeating the policy assessment, please see the above assessment provided for Policy 5.1, 5.2 and 5.3. Improved soil structure, better nutrient management and particularly less N mineralisation and N accumulation at high risk times will see less nitrate loss to groundwater via deep drainage in Oxidising areas. Oxidising soils do not have similar swell/crack properties as Central Plain's soils, so the risk of deep crack formation and subsequent by-pass drainage to the underlying aquifer is not believed to be a risk for Oxidising soils. As has been explained in Policy 5.3 above, potential contaminant losses from additional cows will be off-set through the implementation of several key mitigation measures. This will result in a small reduction in N and P loss. The applicants will provide Environment Southland with certainty that contaminant losses will not increase through the implementation of consent conditions and by submitting a year-end Overseer nutrient budget annually. Under Policy 10, the proposed activity should be granted.

Policy 13 gives direction on the management of land use activities and discharges. In line with Policy 13.1 the proposed expansion will better enable the applicants to provide for their social, economic and cultural well-being. The increase in herd size by 160 will allow changes in management practice to be made, whilst also operating a profitable and sustainable business model. The maintenance of a profitable and sustainable business model is central to the success of the business, and provides social, economic and cultural benefits to the applicants, their employees, families and whanau, and to the wider community. In the context of an agricultural-based local economy, the use and development of land and water resources at WW1&2 for primary production should be recognised. In line with Policy 13.2, land use activities and discharges (point source and non-point source) are managed to enable the achievement of Policies 15A, 15B and 15C.

In line with **Policy 14,** the discharge is to land and there is no discharge to water.

Policy 16 gives direction on farming practices that affect water quality.

Policy 16.1 (a) discourages the establishment of new dairy farming of cows in close proximity to Regionally Significant Wetlands and Sensitive Waterbodies. The nearest Regionally Significant Wetland is Dunearn Wetland, located approximately 4 km to the north west. As the direction of ground and surfacewater flow is to the south, there is no risk to water quality at Duneran Wetland from the proposed activity. Drummond Peat Swamp is located approximately 12 km to the south east of WW1&2, and Bayswater Peat Bog is located approximately 10 km to the south west of the property. Neither Drummond Peat Swamp nor Bayswater Peat Bog are *in close proximity* to the dairy farm so have little or no risk due to the proposal. Under Policy 16.1 (a) the proposed activity can be established.

Policy 16.1 (b) ensures that until the development of freshwater objectives under FMU processes, applications to establish new, or further intensify existing dairy farming of cows, or to intensify winter grazing activities will generally not be granted under certain situations. The situations relate to different effects on and measures of water quality. This application is for an increase of 160 cows (11%) on land that has been dairy farmed for between 17 and 26 years to date, or on land that has been used for dairy support and was consented for dairy farming in October 2017. As such this application is not to establish new dairy farming of cows but is to intensify through an increase in cow numbers.

In parallel with additional cows, it proposed to implement many key mitigation measures, such as the removal of all winter and summer fodder cropping, removal of IWG, expansion of size and use of wintering barn facilities and more efficient use of N fertiliser at WW1&2. The cessation of IWG is an important mitigation in a sensitive part of Central Southland since it has high N loss, especially where free draining soils are sown in fodder beet and subsequently IWG. IWG is specifically included in Policy 16 as an activity that affects water quality. The removal of this practice from WW1&2 means that cultivation practices will move to direct grass to grass methods in a sensitive area, with less disturbance of soil structure and less mineralisation processes occurring. This will lead to increased soil organic matter content and water holding capacity and reduce N loss to ground and surfacewaters over time. It is explained in the following three paragraphs why the proposed further intensification of existing dairy farming should be granted in this instance.

Policy 16.1 (b) (i) gives direction on generally not granting further intensification of existing dairy farming of cows where the adverse effects, including cumulatively, on the quality of groundwater and receiving surface waterways such as rivers, wetlands and estuaries cannot be avoided or mitigated. Section 7 of the application provides an in-depth assessment of effects (AEE) of the proposed activity on groundwater and receiving surface waters. The AEE addresses the potential for adverse effects on already elevated groundwater to the south east of WW1&2, on groundwater to the south including at Heddon Bush School, which has a registered bore for drinking water supply and on receiving surfacewaters including the Waimatuku Stream, Estuary, Lower Oreti and New River Estuary. The assessment includes contaminants N, P, sediment and microbes and their related effects in receiving waters, with P used as a proxy for sediment and microbes and supports the conclusion that adverse effects, including cumulatively, from the whole activity at WW1&2 will be mitigated.

Policy 16.1 (b) (ii) gives direction on generally not granting further intensification of existing dairy farming of cows where existing water quality is already degraded to the point of being over-allocated. There is a high degree of variation in existing groundwater quality in the area, with an area to the south east of WW1&2 showing high groundwater nitrate concentrations, above the New Zealand Drinking Water Standard of 11.3 ppm. Particularly, groundwater at an ES monitoring bore at Boyle Road to the south east has shown high nitrate-N concentrations, indicative of groundwater degradation due to land use effects in the area, such as IWG on free draining soils. This matter is assessed in depth in the AEE.

Groundwater flow for much of WW1&2 is believed to be to the south[4]. Groundwater quality measured at the southernmost bore (E45/0622) shows relatively low levels of nitrate, as does a bore located ~2.3 km due south at Heddon Bush School (1.8 – 2.0 ppm in 2017/2018). Bore E45/0622 is an indicator of groundwater quality at the base of WW1&2. It should capture the cumulative effect of land use on water quality in the groundwater stream to the north, upstream of groundwater flow including some Braxton and Drummond soils. If deep cracks form in Braxton soils, then contaminants such as nitrate can bypass the soil matrix and move to groundwater or move via subsurface drains into surfacewaters. Water quality at bore E45/0622 does not show evidence of nitrate reaching groundwater via this process, as despite occasional well-head contamination issues, nitrate levels have been consistently low at the bore. In conjunction with the low nitrate levels measured at the Heddon Bush School bore,

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[4] Hitchcock (2014). Characterising the surface and groundwater interactions in the Waimatuku Stream, Southland (Thesis, Master of Science). University of Otago. Retrieved from http://hdl.handle.net/10523/5087

data from bore E45/0622 indicate that groundwater groundwater flowing south from WW1&2 is not degraded to the point of being overallocated.

There is an increasing gradient in groundwater nitrate concentration from west to east towards Terrace Creek, which flows approximately north to south, and is located approximately 1 km beyond the eastern boundary of WW1&2. This concentration gradient is reflected by data from other bores at WW1&2 (E45/0665 and E45/0727), where the increasing gradient corresponds to a transition from heavier to lighter soils towards the east. Average groundwater nitrate concentrations at these two bores are considerably lower than concentrations seen further east and south east beyond the boundary. Due south of WW1&2, groundwater nitrate levels are predominantly low for approximately 10 km, which includes the area around Heddon Bush School.

Based on the above factors in conjunction with changing on farm practices, it is proposed that under Policy 16.1 (b) (ii), the activity should be granted. The cumulative effect of changing on farm practices over time, should see a further reduction in nitrate loss to groundwater at WW1&2. The applicants believe that farming under the current system, with a maximum of 1,340 cows but using practices such as IWG causes more cumulative loss of N to groundwater due to increased N accumulation and more mineralisation of N in soils and more soil damage. They propose to install a new bore at the south of WW1&2, which will be used to monitor groundwater quality over time. They are prepared to use data from the bore to inform future decision making. In this case, granting this application to increase cow numbers by 160 will allow the applicants to facilitate these management changes, which cumulatively should cause less N loss to groundwater and degradation of groundwater.

Policy 16.1 (c) gives direction on processes after the development of freshwater objectives under FMU processes. As freshwater objectives have not yet been developed, this policy does not apply at the present time.

Policy 16.2 gives direction on farming activities, including existing activities.

Under **part (a)**, all such activities are required to implement a farm environmental management plan (FEMP), as set out in Appendix N. The applicants implement a FEMP as set out in Appendix N, so meet part (a) of Policy 16.2.

Under **part (b)**, sediment run-off risk must be actively managed by identifying critical source areas (CSAs) and implementing practices such as setbacks from waterbodies, riparian planting, sediment traps, preventing stock from entering the beds of surface waterbodies and limiting the duration of exposed soils. WW1&2 and the Horner Block are predominantly flat with minimal CSAs. Where CSAs are found close to where tiles have outfalls to surface drains, they have been mapped and are actively managed to minimise the risk of sediment loss. See FEMPs for locations of CSAs. Practices such as fencing off waterways are implemented and have been for many years as part of the Dairy Accord. Stock do not have access to waterways at any time. Farm infrastructure such as tracks, lanes and sheds can act as critical source areas following periods of prolonged rainfall, where water can pool and move via overland flow to waterways, carrying contaminants such as sediment and microbes with it. Farm infrastructure is managed to ensure that surface drainage does not flow via overland flow directly into waterways, but is directed through pasture or riparian strips, where run-off is filtered, and sediment and microbes are trapped before reaching waterways. The applicants endeavour to limit the duration where soils are bare as much as possible and under the propoal, fallow periods will be eliminated. This will help to further reduce the risk of sediment run-off further.

Under part (c) of Policy 16.2, collected and diffuse run-off must be managed, as well as leaching of nutrients, microbial contaminants and sediment through the identification and management of CSAs *within individual properties*. The applicants manage their farm layout, infrastructure, soil types, drainage, CSAs and overall farming system to control and minimise collected and diffuse run-off, leaching of nutrients, microbial contaminants and sediment from such sources. These are explained in the FEMPs. Particularly, lanes close to waterways are appropriately managed to avoid the runoff reaching waterways.

Policy 17 gives direction on agricultural effluent management.

In line with Policy 17, significant adverse effects on water quality from the operation of, and discharges from, the effluent management system at WW1&2 and the Horner Block are avoided.

Other adverse effects are also avoided, remedied or mitigated. The effluent management system, including storage ponds, low depth and very low depth irrigation systems, follows best industry practice for effluent storage and discharge given the nature of soils and topography at WW1&2 and at the Horner Block. The systems have been designed, constructed and located in accordance with best industry practice including the relevant practice notes and guidelines, and systems are maintained and operated in accordance with best practice guidelines. By only irrigating effluent to land when ground conditions are at less than field capacity, and by ensuring that irrigation of effluent to land does not result in soils reaching field capacity, the risks of nutrient rich effluent leaching through the soil profile or moving via overland flow are mitigated.

The slurry tanker with the trailing shoe will apply slurry at depths of less than or equal to 2.5 mm per application to allow for the higher nutrient loading in slurry. It can apply slurry at depths as low as 1 mm per application, which further minimises the risk of adverse effects and increases the number of irrigation days available. It applies slurry directly on the ground, which minimises the risk of adverse odours. The recommended buffer zones from waterways are adhered to when applying effluent, effluent is not discharged over tile drains when the soil is at or near field capacity nor is effluent applied to areas where cracks in the top soil have formed.

The effluent receiving area is sufficiently large to ensure that the N loading to land from dairy shed effluent and slurry does not exceed 150 kg N/hectare at WW1&2, and that it does not exceed 250 kg N/hectare at the Horner Block. Applying a higher N loading from slurry at the Horner Block allows nutrients in slurry to be used efficiently as fertiliser with reduced risk of N loss to groundwater. This is because plants take up N efficiently from slurry applied at very low depth while N fertiliser application is reduced accordingly to ensure the input of N overall is sustainable and does not lead to leaching losses. Importantly, since there is no grazing of stock at the Horner Block there are no urine patches, which otherwise leach N at high rates from urine, slurry and fertiliser.

In line with **Policy 18**, all stock is excluded from waterways.

The range of the good management practices implemented on farm, result in improved integrated management of freshwater through good dairy farm land management practices. This is in line with **Policy 39A**.

In line with **Policy 40**, the applicants seek a term of 15 years for the activities, which aligns with Woldwide One's discharge and water permit terms. There is good certainty regarding the nature and scale of the activity going forward; there will be an increase in cow numbers as well as implementation of good management practices and specific mitigation measures to ensure that the activity is sustainable in the long term. Considerable investment in farm infrastructure has been made to take the final steps towards future proofing the dairying operation at WW1&2; eliminating IWG from a sensitive part of Central Southland altogether. The level of investment demonstrates the applicant's belief in and commitment to sustainable farming and land management. The applicants believe that their presence at this location since 1992 (over 25 years) has not had a detrimental effect on the local environment, and that the proposed changes will mean a further reduction of that impact. A 15-year consent term will mean that the management of the resources under the same proven stewardship will be ensured into the future while allowing the applicants to operate a sustainable farming and business model. As 2013 supreme winners of the Southland Ballance Farm Environment Awards, their commitment to operating a sustainable farming model has been demonstrated.

Objectives and Policies relevant to land-use at Woldwide Runoff (WRO)

- **Objectives 6, 7, 8, 9, 13, 18**
- **Policies 6, 10, 11, 13, 16, 18**

Policies 6, 10 and 11 are met ensuring adverse effects on water quality from contaminants are avoided, remedied or mitigated:

- Required GMPs are implemented to manage adverse effects on water quality from contaminants transported via artificial drainage, overland flow, deep drainage and lateral drainage.
- FEMPs and respective applications have considered the aforementioned-contaminant pathways.

Policies 10 (3) and 11(3) give direction to decision makers on **generally** not granting resource consents for additional dairy farming of cows or additional IWG where contaminant losses will increase as a result of the proposed activity in the Oxidising and Peat Wetlands PZs respectively. In assessing whether the proposal is in line with guidance provided in these policies, some considerations are relevant:

- The term **generally** is used, which is understood to mean "broadly" "in most cases" or "without regard to particulars or exceptions." By including the term **generally**, the policies clearly allow for situations where resource consent can be granted where contaminant losses from additional cows or additional IWG increase in these PZs. In accordance with the intent of the RMA, consent can reasonably be granted be granted where effects on the receiving environment are shown to be minimal.
- WRO is not a dairy farm.

- WRO is a dry stock farm supporting five dairy farms, including WW1&2. It predominantly grazes R1 and R2 heifers with a small number of carryover cows and mating bulls. It has large areas under forestry, both commercial and indigenous.
- Under the proposal, IWG at WRO is operating at a permitted activity level. The applicants are not required to apply for resource consent for IWG activities at WRO since they meet permitted activity rules set out in Rule 20.
- However, WRO is part of WW1&2's landholding and will be on WW1&2's land use consent for farming, although many activities at WRO do not relate to the farming activity at WW1&2. Some farming activities at WRO will be conditioned on WW1&2's land use consent for farming.
- The proposal will maintain a similar stocking rate to the current rate but will see an increase in IWG activities at WRO, which is expected to result in a small increase in contaminant losses, predominantly via artificial drainage and overland flow pathways. Only a portion of these losses can be attributed to IWG of dry stock from WW1&2.
- Increasing IWG at WRO will see its removal from more sensitive catchments in Central Southland, where there is greater land use intensity and elevated groundwater nitrate levels.
- The applicants propose to limit the area under IWG annually at 100 hectares, which caps it at the permitted activity level under Rule 20.
- The AEE demonstrates that the proposed activity at WRO, including an increase in IWG, will have minimal effect on the nutrient loading in receiving waters and accordingly will have minimal effect on the Waiau catchment and Te Waewae Lagoon.
- The AEE demonstrates that there is minimal risk to groundwater at WRO due to the proposal, including from additional IWG activities.

In view of the above considerations, the applicants believe the decision-maker should grant resource consent for the proposed farming activity on Oxidising and Peat Wetlands PZs.

Policy 13 gives direction on the management of land use activities and discharges. In line with Policy 13.1 the proposal will better enable the applicants to provide for their social, economic and cultural well-being. The proposed land use at WRO will allow the applicants to sustainably manage the land while operating a profitable and sustainable business model. The maintenance of a profitable and sustainable business model is central to the success the business, and provides social, economic and cultural benefits to the applicants, their employees, families and whanau, and to the wider community. In the context of an agricultural-based local economy, the use and development of the land and water resources at WRO for primary production should be recognised. In line with Policy 13.2, land use activities and discharges (non-point source) are managed to enable the achievement of Policies 15A, 15B and 15C.

Policy 16 gives direction on farming practices that affect water quality.

WRO is not in close proximity to any regionally significant wetlands or sensitive waterbodies identified in Appendix A.

The AEE demonstrates how adverse effects on receiving waters, including cumulatively, due to proposed activities at WRO will be avoided or mitigated. Existing water quality in the Waiau catchment is not degraded to the point of being overallocated.

WRO operates under a farm environmental management plan, as set out in Appendix N. Sediment runoff risk is actively managed by identifying CSAs, implementing practices including setbacks from waterbodies, limits on areas or duration of exposed soils and the prevention of stock entering the beds of surface waterbodies. The individual layout, topography, soils and drainage properties of both Merrivale and Merriburn blocks are identified and managed by the applicants.

In line with **Policy 18**, all stock is excluded from waterways at WRO.

Having assessed the matters above, it is considered that both the application for the expansion of dairy farming, the discharge and the water abstraction are generally in accordance with the relevant policies and objectives of the documents set out above, and having regard to Section 104, the proposal achieves the purpose of the RMA.

4. Notification

Section 95A of the Act requires that the Consent Authority must publicly notify an application if the applicant has requested that the application be publicly notified*. The applicant hereby requests that the application be publicly notified.*

5. Receiving Environment

WRO's receiving environment is described in the WRO section of the application.

5.1 Soils

WW1&2 - soils

WW1&2 - soils

Topoclimate soil data shows that WW1&2 primarily overlies Braxton soils, with intergrades of Pukemutu soils in places. Topoclimate maps some areas of shallow stony Glenelg soils on the east side.

Topoclimate mapping of soils types for appears to be incorrect. Mr. John Scandrett (Scandrett Rural Limited) carried out a field investigation and has mapped soils at the WW1&2. Please refer to the appended report prepared by Mr. Scandrett for methodology, results and conclusions from the soil type and boundary field investigation. Mr. Scandrett dug at total of 28 test holes during his field investigation at WW1&2.

Mr. Scandrett reports that the west of WW1&2 overlies predominantly Braxton soils, and mid to east predominantly overlies Drummond soils. This is shown in figures 5.1, 5.2-5.4. Glenlg soils are found at the north east, north of Wreys Bush Highway.

The findings from the field investigation are supported by on-farm observations by the applicants, who report there is no subsurface drainage at the mid-east of WW1&2. Soils found mid-east are free-draining, which is characteristic of Drummond and Glenelg soil types and not of Braxton soils, which have been mapped by Topoclimate for much of the area. ***Braxton soils are less extensive than mapped on Topoclimate.***

Findings from the 2017 soil field investigation with support from applicant's knowledge from over 25 years of farming the land, provides a more accurate map for WW1&2 than is provided by Topoclimate, which sought to update Soil Bureau Bulletin 27 maps and is incorrect for land at WW1&2. The soil information and map from the 2017 field investigation have been adopted in this application as they truly reflect land at WW1&2. As such, they form the basis of the nutrient budget analysis and AEE. However, for Council to adopt the evidence from the field investigation, certain conditions must be met. Mr. Scandrett has extensive knowledge of and experience in working with soils but is not a qualified pedologist. Since Mr. Scandrett is not a qualified pedologist, we do not formally request that Council adopt his evidence over what is mapped. Council should recognise that Topoclimate mapping of soils at WW1&2 is incorrect, and informally accept the Mr. Scandrett's evidence as the best soil information available for WW1&2.

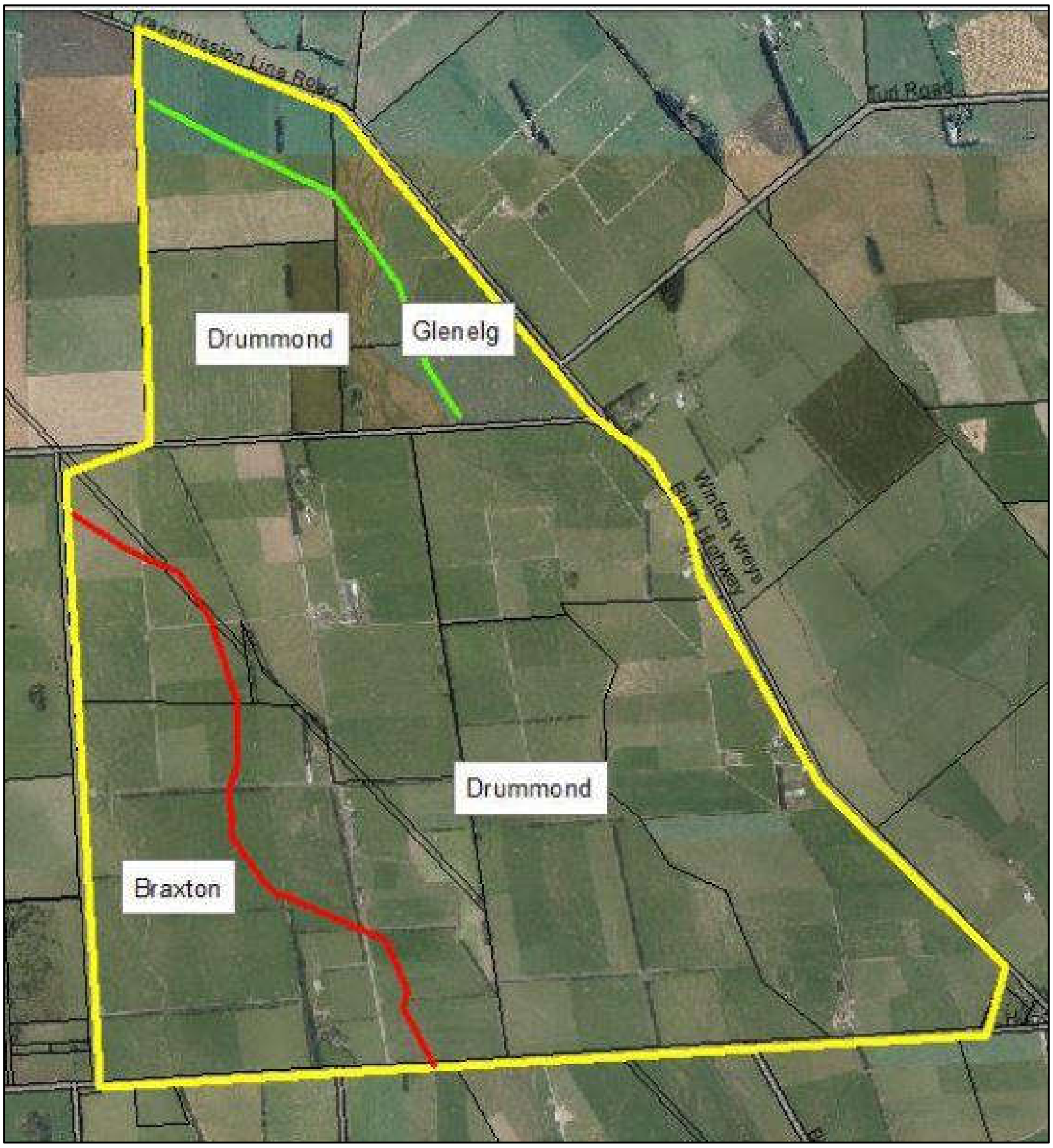


Figure 5.1 Soil types and boundaries at the WW1&2 according to field investigation by J. Scandrett, January 2017. Map sourced from Environment Southland.

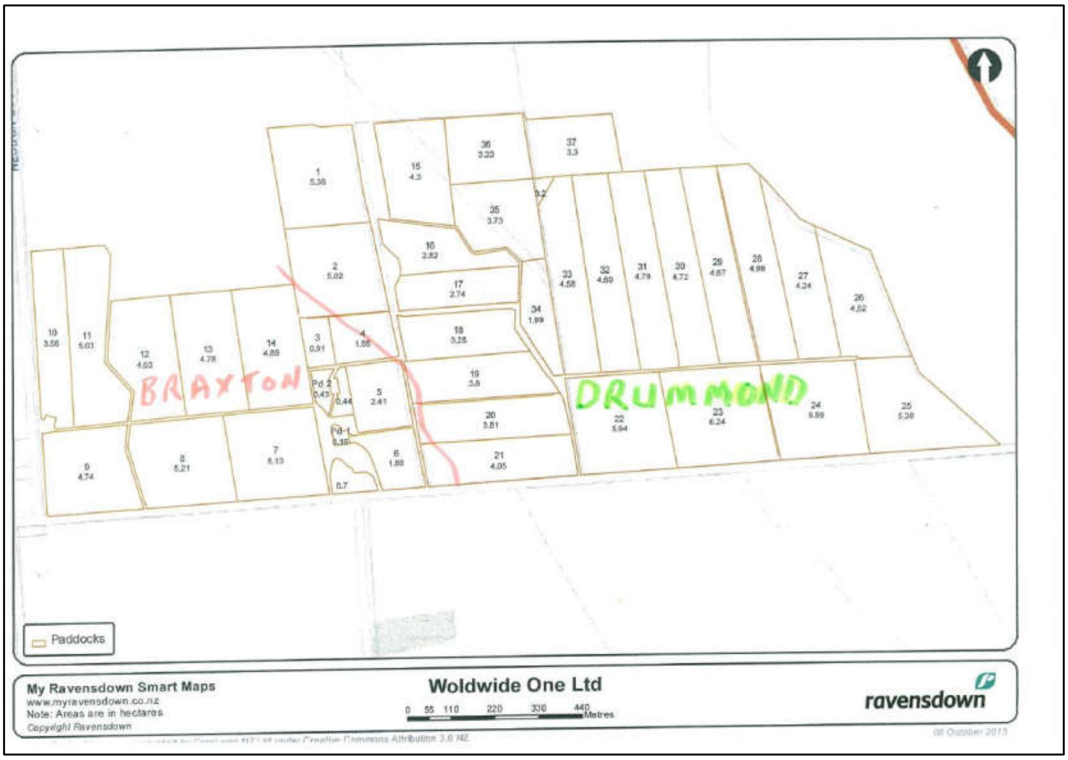


Figure 5.2 Soil mapping of WW1 area (note: this is an historic farm map).

Figure 5.3 Soil mapping of WW2 area (note: this is an historic farm map).

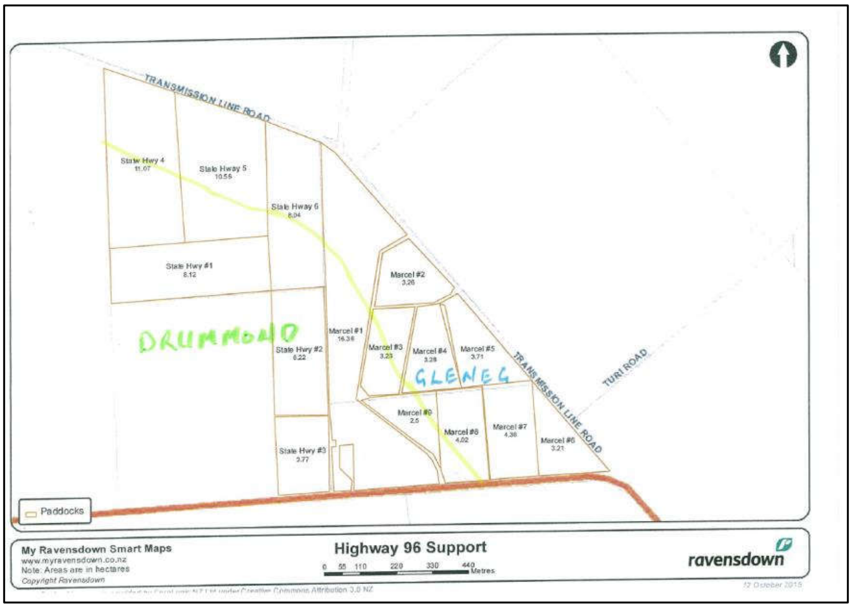


Figure 5.4 Soil mapping of former SH96 and Marcel blocks, now part of the WW1&2 (note: this is an historic map).

Soil vulnerability factors

Braxton soils have moderate risk of structural compaction, slight risk of nutrient leaching and severe risk of waterlogging. Drummond soils have minimal risk of structural compaction, moderate risk of nutrient leaching and slight risk of waterlogging. Glenlg soils have slight risk of structural compaction, very severe risk of nutrient leaching and nil risk of waterlogging.

Braxton soils types – swell/crack characteristics

Braxton soils have swell/crack properties. They can become waterlogged in wet conditions so tend to have subsurface drainage installed. They can crack during dry summer conditions. Deep cracks can provide a pathway for contaminants to reach groundwater via bypass drainage to the underlying aquifer. A site investigation of cracking soils was carried out in January 2018 by Environment Southland. The report by Michael Killick is appended to this application. Several sites were investigated, with some soils showing cracks (10 mm wide or less, with most cracks in the range of 2 – 4 mm wide) and others showing no cracks. The investigation occurred during a prolonged drought, with relatively high temperatures so if large/deep cracks were to form, they would have been expected to form in January 2018. Mr. Killick concluded:

> *It seems reasonable to conclude that the occurrence of very large cracks such as feature in some anecdotes about the soils (e.g. 'to reach your arm into') would now be rare in the soils observed for this investigation, and might not occur. Continued development or changes in management of the soils e.g. the ongoing effects of drainage, or conversion from sheep to dairy, may have influenced the historical pattern of soil behaviour. Or it may be that occurrences of Braxton soils other than those described here, crack more.*

Horner Block – soils

Topoclimate mapping of soils at the Horner Block shows that Braxton/Pukemutu soils are found on the east side, Drummond/Glenelg soils are found mid farm, and Waiau/Tuatapere soils are found on the west side towards the Aparima River. See figure 5.5 for Topoclimate mapping of soils at the Horner Block.

Braxton and Drummond soil properties are described in the previous paragraph. Pukemutu soils have very severe risk of structural compaction, slight risk of nutrient leaching and severe risk of waterlogging. Waiau soils have moderate risk of structural compaction, very severe risk of nutrient leaching and nil risk of waterlogging.

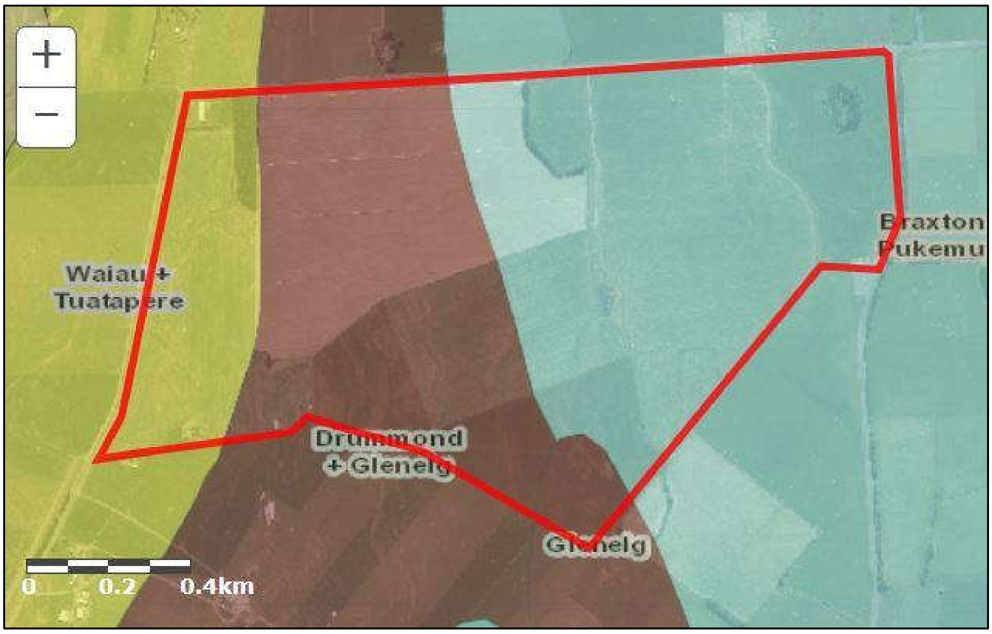


Figure 5.5 Topoclimate mapping of soils at the Horner Block (approximate boundary is outlined in red).

FDE risk

According to Beacon, the soil FDE Risk categories for WW1&2 comprise both Category A (artificial drainage/coarse soil structure) and Category E (other well drained but very stony flat land). See figure 5.6 for Beacon mapping of soils FDE risk at the dairy platform. Braxton soils are classed as Category A land and Glenelg soils are classed as Category E land.

Given the presence of Drummond soils, there are likely to be areas of Category D (well drained flat land) land, although these are not mapped on Beacon. Since Braxton soils are less extensive than mapped on Topoclimate, there is in fact less area of Category A land and more area of Category E and D land than mapped on Beacon.

The Horner Block comprises both Category A soils and Category E soils (see figure 5.6).

The soil FDE risk for both WW1&2 and the Horner Block comprise areas of both low and high risk for effluent discharge assuming low depth irrigation. These soils are suitable for dairy farming and receiving effluent provided that their vulnerabilities are recognised and that they are managed appropriately.

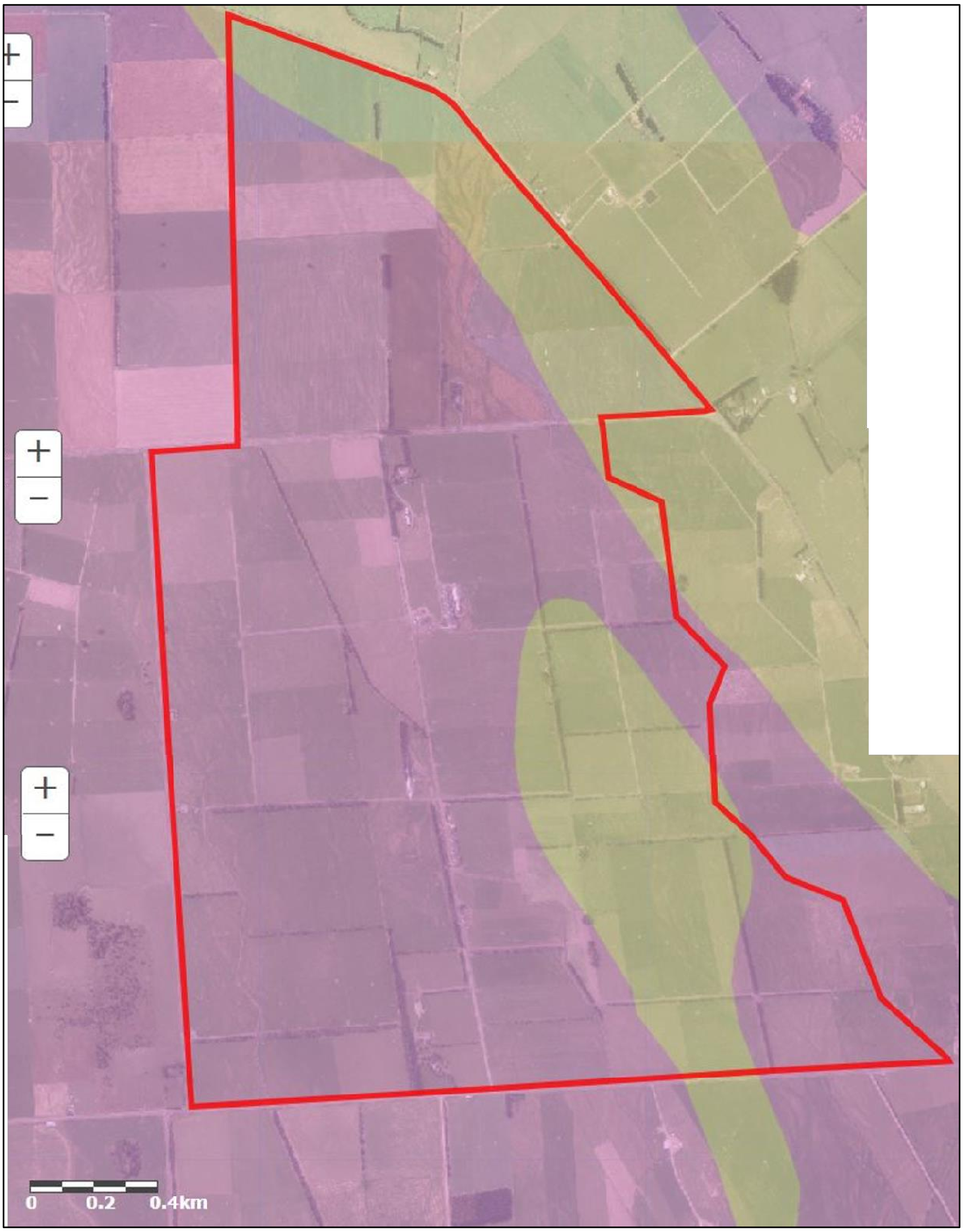


Figure 5.6 Soil FDE risk for the WW1&2 (approximate boundary is outlined in red).

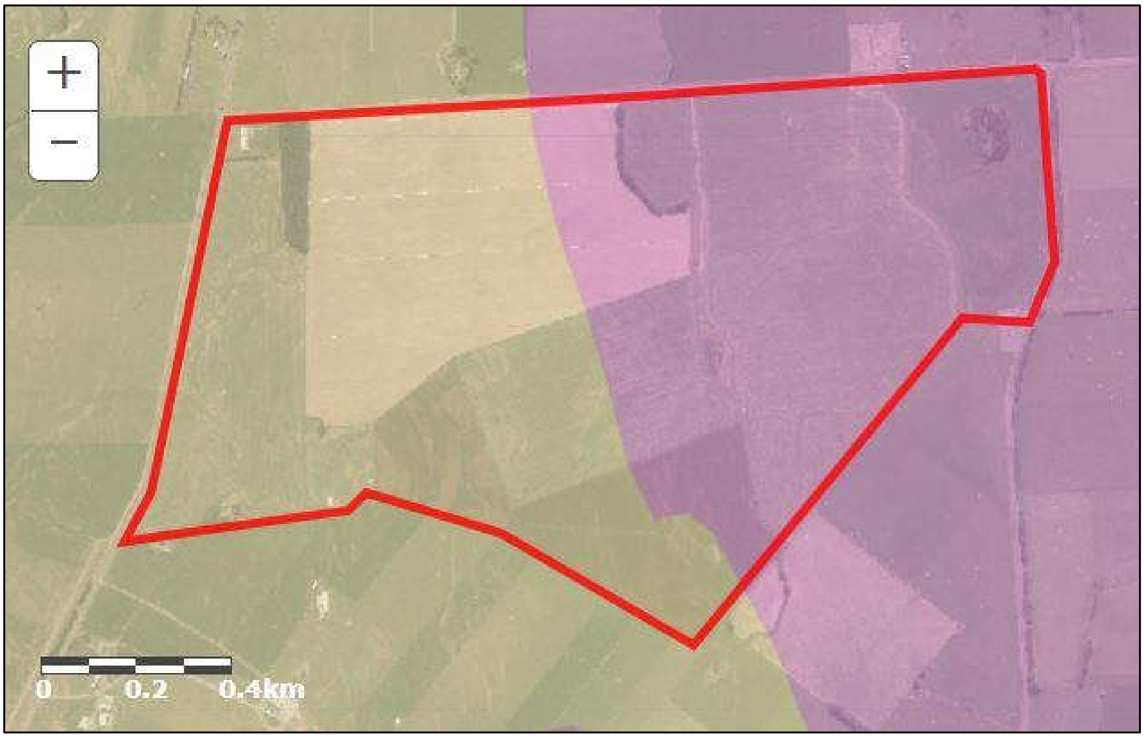


Figure 5.7 Soil FDE risk for the Horner Block (approximate boundary outlined in red).

Table 5.1. Physical properties of soils.

Soil type	Profile drainage	Plant readily available water	Potential rooting depth	Rooting restriction
Braxton	Poor	High	Deep	Limited subsoil aeration during sustained wet periods
Drummond	Well drained	High	Deep	No significant restriction
Glenelg	Well drained	Moderate-low	Shallow	Gravelly and cemented subsoil
Waiau	Well drained	Moderate	Slightly deep	Extremely gravelly subsoil

5.2 Surface water

The dairy platform lies in both the Waimatuku Stream and Oreti River catchments (see figure 5.7). The Horner Block lies predominantly in the Waimatuku Stream catchment, with its westernmost area lying in the Aparima River catchment (see figure 5.8).

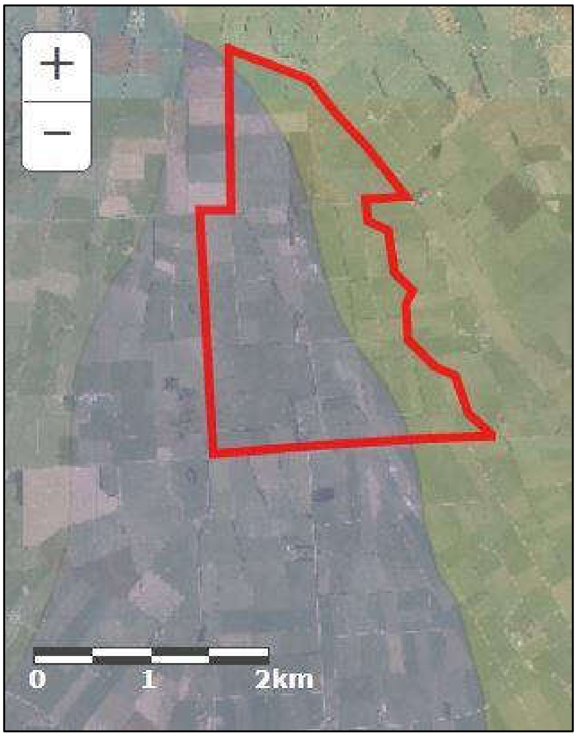


Figure 5.8 Major catchments: Waimatuku (mid-west) and Lower Oreti (east); approximate boundary is outlined in red.

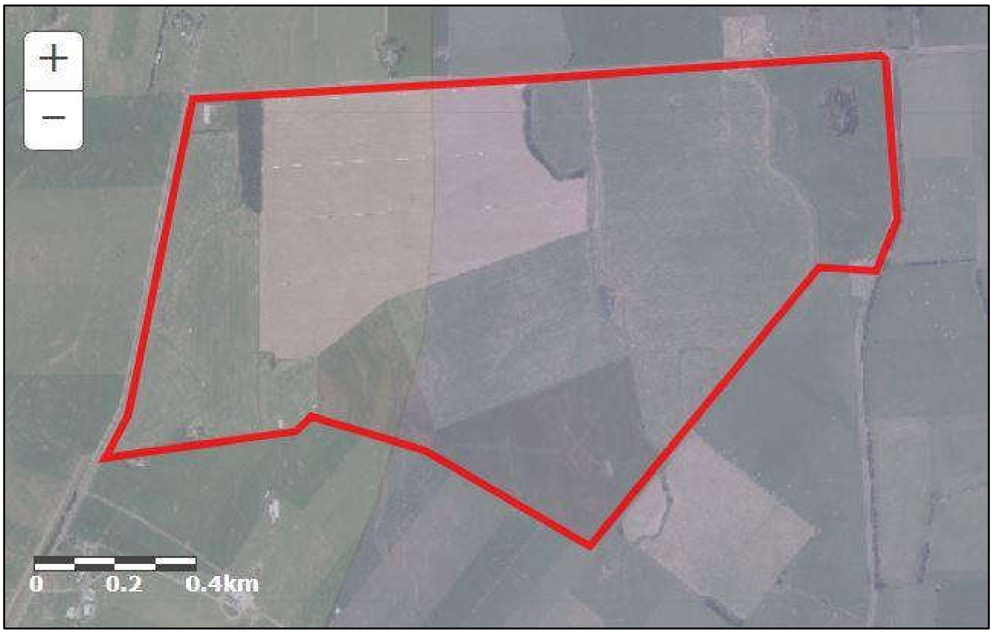


Figure 5.9 Horner Block; Waimatuku Stream (mid-east), Aparima (west); approximate boundary outlined in red.

Minor catchments

Minor catchments for WW1&2 are Terrace Creek, Oreti River and Middle Creek.

Minor catchments for the Horner Block are Middle Creek and the Waimatuku River.

Waterways are best described as surface drains. Riparian buffers are fenced off and vegetated with good grass cover.

See the accompanying FEMPs for the location of major tiles.

WW1&2 -surfacewater

Waterways generally flow in a north to south/southeast direction (see figure 5.10), are fully fenced off and culverted (see figure 5.11). One waterway flows along the eastern boundary, on to Terrace Creek to the south east and eventually to the Oreti River. Two waterways flow through the centre, on to Middle Creek and eventually the Waimatuku Stream to the south.

Subsurface drainage is installed at the west with outfall to surface drains. Subsurface drainage is only installed in heavier Braxton type soils except for one tile drain at the north east of Wreys Bush Highway. Subsurface drains (tiles) generally underlie hollows, which may act as critical source areas close to surface drains in times of prolonged heavy rainfall.

Horner Block

One waterway bisects and flows to Middle Creek to the south.

There is one swale at the Horner Block, which is found in a paddock that is not grazed by stock.

Figure 5.11 Waterway at the WW1 dairy unit.

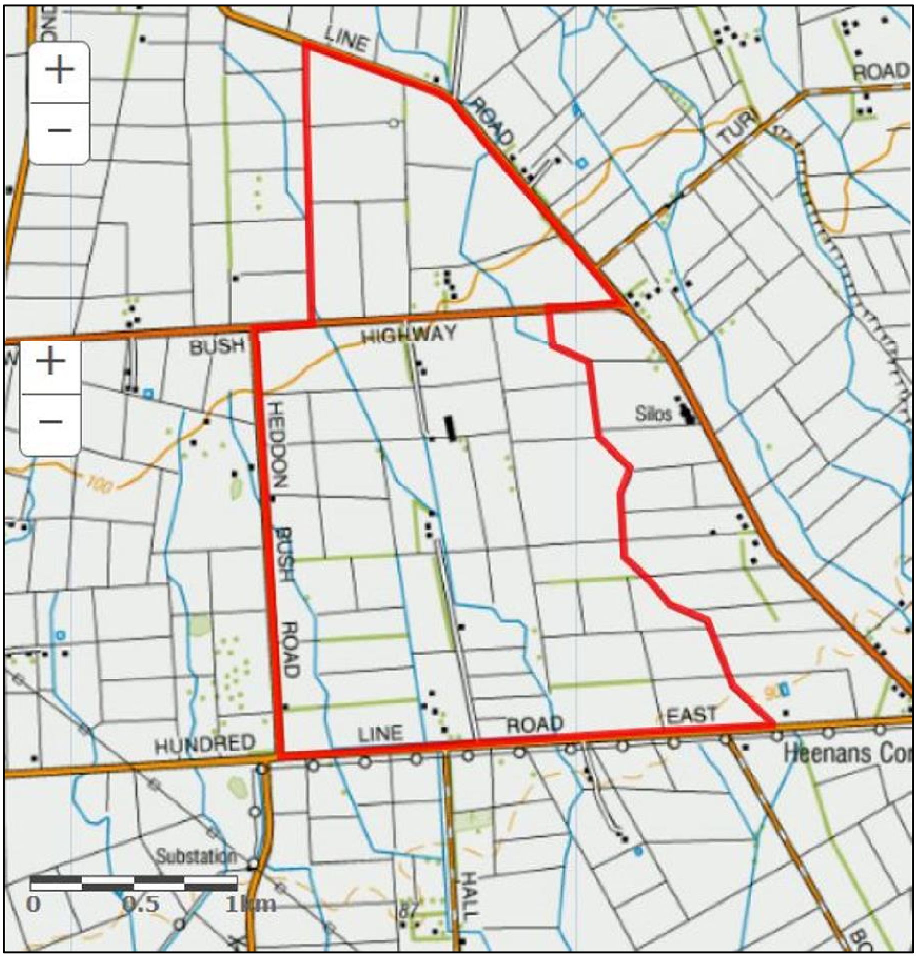


Figure 5.10 Topomap (with approximate boundary outlined in red).

Waimatuku Stream catchment

Most of WW1&2 and Horner Block are located at the northern most end of the Waimatuku Stream catchment according to Beacon. The Waimatuku Stream flows into the sea at Waimatuku Estuary in the Oreti Beach embayment. The Waimatuku Stream is located between the Oreti and Aparima catchments. Its headwaters are fed by a large swamp area (the Bayswater Peat Bog) with small springs in the Drummond district also contributing to the base flow. The catchment contains a variety of land uses including dairy farming, and dry stock farming. According to LAWA, the Waimatuku Stream was channelised in the 1920s. It typically has moderate flows, with few flood or extreme low flow events because of base flow contributions from swamp and spring areas.

~~SOE monitoring – Lower Waimatuku Stream~~

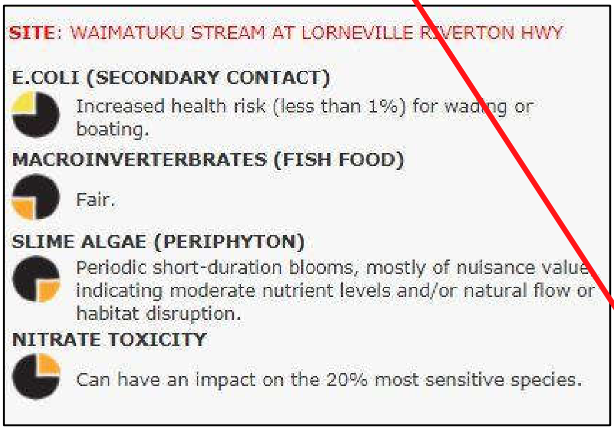
~~The closest downstream SOE water quality monitoring site for which data could be obtained in the Waimatuku catchment is the Waimatuku Stream at Lorneville Riverton Highway so it has been used as a reference. The Lorneville Riverton SOE monitoring site is classified as a lowland rural site. It is a lower-catchment site so captures the entire Waimatuku Stream catchment above Waimatuku Township.~~

~~Data obtained from The Land and Water website show evidence of cumulative effects on water quality for the Waimatuku Stream at the Lorneville Riverton site. The 5-year median black disc value is in the worst 50% of like sites. The 5-year median *E. coli* value of 450 n/100 ml is in the worst 25% of like sites~~

with a very likely improving ten-year trend. When assessed against the National Objective's Framework (NOF), the 5-year median *E coli* score is ranked in Band E. 5-year median concentrations for both Total Nitrogen and Total Oxidised Nitrogen are in the worst 25% of like sites, **however, both have a very likely improving ten-year trend.** The Total N 5-year median concentration is 3.65 g/m^3, which is above the ANZECC guideline of 0.614 g/m^3. The Total Oxidised N 5-year median concentration is 3.0 g/m^3, which is above the ANZECC Guideline value of 0.44 g/m^3 but below New Zealand Drinking Standards Maximum Acceptable Level (MAV) of 11.3 g/m^3 for nitrate nitrogen. When assessed against the NOF, the Total Oxidised Nitrogen value is classed in Band C; water quality at this site is considered "suitable for the designated use," but there may be effects on growth of up to "20% of species, mainly sensitive species such as fish." The 5-year median is below the National Bottom Line median of 6.9 g/m^3 for nitrate. The 5-year median DRP value shows meaningful degradation over ten years, with a value of 0.0425 g/m^3 is in the worst 25% of like sites. However, Total P shows a likely improving ten-year trend.

The closest downstream SOE site for which ecological data could be obtained in the Waimatuku catchment is the Waimatuku Stream at Rance Road. This SOE monitoring site is downstream of the water quality monitoring site at Lornville Riverton Highway and is close to the Waimatuku Estuary. The 5-year median MCI score was classed as fair, although there is evidence of a decreasing trend in recent years. The 5-year median Taxonomic Richness score was 20, with evidence of a slight increasing trend in more recent years. The median %EPT score was 40% over the same five-year period, with a slight drop in later years.

The nearest National Objectives Framework (NOF) site is the *Waimatuku Stream at Lorneville Riverton Highway* site. NOF water quality indicators show that generally water quality is fair to poor at the site (see figure 5.12 below). The MCI score is fair. Slime algae/periphyton is indicative of high nutrient levels or significant natural flow/habitat disruption at the site. The *E. coli* score indicates "low risk of infection (less than 1% risk) from contact with water during activities with occasional immersion (such as wading and boating)." The Total Oxidised Nitrogen score indicates that there may be an impact "on the 20% most sensitive species."



SITE: WAIMATUKU STREAM AT LORNEVILLE RIVERTON HWY

E.COLI (SECONDARY CONTACT)

Increased health risk (less than 1%) for wading or boating.

MACROINVERTERBRATES (FISH FOOD)

Fair.

SLIME ALGAE (PERIPHYTON)

Periodic short-duration blooms, mostly of nuisance value indicating moderate nutrient levels and/or natural flow or habitat disruption.

NITRATE TOXICITY

Can have an impact on the 20% most sensitive species.

Figure 5.12 NOF indicators for *Waimatuku Stream at Lorneville Riverton Highway* site.

The lower catchment SOE site for the Waimatuku Stream shows evidence of land use in the catchment with high levels nutrients and contaminants dominating. This relates to the intensity of land use in the catchment, local hydrology, attenuation of nutrients and the physiographic land types found in the catchment. Artificial drainage and deep drainage to shallow aquifers, as well as the low to moderate denitrification potential of some soils and aquifers, and the lack of a major river for diluting contaminants are factors that combine to produce this outcome. The Waimatuku catchment has shown recent improvement for nutrient N, with the 5-year median concentration for both Total N and Total Oxidised N decreasing over the last two reporting years. This is significant as it indicates that N losses and related effects in the catchment may recently have started to decrease.

Waimatuku Estuary

Coastal waters (the Waimatuku Estuary and coastal waters at the Oreti Beach Embayment) are the receiving environments for the Waimatuku Stream and catchment. The Waimatuku Estuary is a small, shallow, "tidal river mouth" estuary that drains to the sea through a sand dominated barrier beach and modified marram grass duneland. It has relatively small intertidal flats, while the estuary mouth periodically constricts, naturally reducing flushing and according to a 2012 study[5] has "very elevated nutrient inputs make the estuary highly susceptible to eutrophication as the assimilative capacity of the estuary is very quickly exceeded when the mouth is constricted. Currently, despite most catchment inputs flowing directly to the sea, nuisance macroalgal growths (e.g. *Ulva intestinalis*) are common, particularly in summer in the middle estuary, while algal blooms also occur at the mouth and along Oreti Beach." The major threat to the estuary is eutrophication due to elevated nutrient inputs, exacerbated by periodic mouth constriction to the sea and consequent restricted flushing.

A 2018 Fine Scale Monitoring and Macrophyte Mapping study[6] reported that" Despite receiving a high nutrient load from both riverine and groundwater sources......., when its mouth is open for exchange with the sea, the Waimatuku has a relatively low susceptibility to eutrophication. This is primarily because of its highly flushed nature, given that it is strongly channelised with very few poorly flushed areas, and has high freshwater inflow. However, the assimilative capacity of the estuary with regard to nutrients is very quickly exceeded when the mouth is constricted. Since monitoring began in 2008, the estuary mouth has been driven approximately 1 km to the east by long shore drift, potentially further constricting the mouth, restricting flushing, and therefore increasing the likelihood of eutrophication issues. Currently, nutrients retained in the estuary contribute to the growth of attached macrophytes and associated nuisance macroalgae, while the presence of elevated chlorophyll a levels at times may be attributable to phytoplankton blooms in saline bottom waters and from freshwater sources upstream of the estuary."

Lower Oreti catchment

The easternmost part of the property is found in the Lower Oreti Catchment. Surfacewater drainage from the eastern side of the property flows via Terrance Creek to the Lower Oreti River below the Oreti Plains.

The Oreti catchment is Southland Region's third largest. It runs from the Thomson Mountains in the north of the region to the New River Estuary. The upper catchment maintains much of its natural qualities and is internationally renowned for its trophy brown trout fishing. The mid and lower reaches of the Oreti catchment have been substantially modified for drainage, flood control and channel clearance work. Oreti River tributaries, such as the Winton and Waikiwi Streams and the Makarewa River, are each subject to point-source discharges of effluent from industry and municipal sewage treatment. Potential impacts to water quality may also arise through tile drain and non-point source discharges. In addition, stock access to waterways, drainage maintenance and gravel extraction activities can adversely affect water quality in the Oreti River.

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[5] Stevens & Robertson (2012). Waimatuku Estuary 2018. Fine Scale Monitoring and Macrophyte Mapping

[6] Robertson & Robertson (2018). Waimatuku Estuary 2018. Fine Scale Monitoring and Macrophyte Mapping

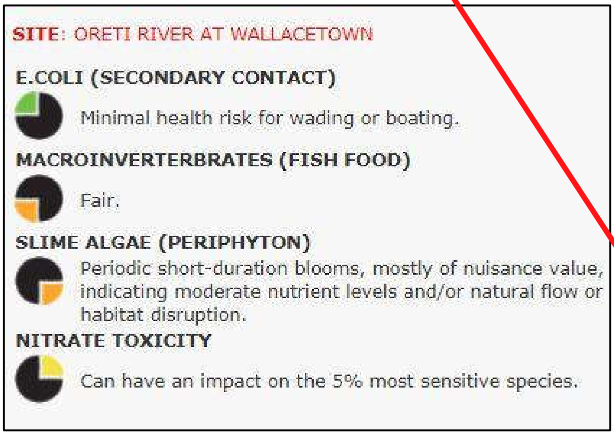
SOE monitoring – Lower Oreti River

The closest current SOE water quality monitoring site downstream of the property is at the Oreti River at Wallacetown. This SOE monitoring site is classified as a lowland rural site with a gravel bed and is the lowest SOE site in the Aparima River catchment. It is a lower-catchment site so captures the entire Oreti River catchment above Wallacetown Township.

Data obtained from LAWA's website show evidence of cumulative effects on water quality for the Oreti River at the Wallacetown site. The median black disc value (1.815 m) is in the best 50% of like sites with an indeterminate ten-year trend. The 5-year median *E. coli* value of 130 n/100 ml is in the worst 50% of like sites with a likely improving ten-year trend. When assessed against the National Objective's Framework (NOF), the 5-year median *E coli* score is ranked in Band D. Median concentrations for both Total Nitrogen and Total Oxidised Nitrogen are in the worst 25% of like sites, however, trend analysis is unavailable for both N parameters. The Total N median concentration is 1.13 g/m^3, which is above the ANZECC guideline of 0.614 g/m^3. The Total Oxidised N median concentration is 0.94 g/m^3, which is above the ANZECC Guideline value of 0.44 g/m^3 but well below New Zealand Drinking Standards Maximum Acceptable Level (MAV) of 11.3 g/m^3 for nitrate nitrogen. When assessed against the NOF, the annual median Total Oxidised Nitrogen value is classed in Band B; water quality at this site is considered "suitable for the designated use," and is regarded to have high conservation values; it is likely to have some effect on growth of up to 5% of species. The annual median DRP value of 0.006 g/m^3 is in the best 50% of like sites, however no trend analysis is available.

The closest downstream SOE site for which ecological data could be obtained in the Oreti River catchment is the *Oreti River at Wallacetown*. The 5-year median MCI score (95) was classed as fair. The 5-year median Taxonomic Richness score was 21. The 5-year median %EPT score was 40%.

The nearest National Objectives Framework (NOF) site is the *Oreti River at Wallacetown* site. NOF water quality indicators show that generally water quality is reasonable to fair at the site (see figure 5.13 below). The MCI score is fair. Slime algae/periphyton is indicative of high nutrient levels or significant natural flow/habitat disruption at the site. The *E. coli* score indicates "minimal risk of infection for wading or boating." The Total Oxidised Nitrogen score indicates that there may be an impact "on the 5% most sensitive species."



SITE: ORETI RIVER AT WALLACETOWN

E.COLI (SECONDARY CONTACT)

Minimal health risk for wading or boating.

MACROINVERTERBRATES (FISH FOOD)

Fair.

SLIME ALGAE (PERIPHYTON)

Periodic short-duration blooms, mostly of nuisance value, indicating moderate nutrient levels and/or natural flow or habitat disruption.

NITRATE TOXICITY

Can have an impact on the 5% most sensitive species.

Figure 5.13 NOF indicators for *Oreti River at Wallacetown* site.

The lower catchment Oreti River shows evidence of land use in the catchment with elevated nutrients and contaminants dominating, as well as impacts on biological indicators. This relates to some point source discharges from sewage treatment plants and industry, the intensity of land use in the catchment, local hydrology and the physiographic land types found in the catchment. Artificial drainage and deep drainage to shallow aquifers, as well as the low to moderate denitrification potential of some soils and aquifers are factors that combine to produce this outcome.

New River Estuary

The New River Estuary and coastal waters are receiving environments for the Oreti River and catchment. New River Estuary is a relatively large estuary, which receives the Oreti and Waihopai Rivers, and their tributaries. According to a 2012 Fine Scale Habitat Mapping study[7] "eutrophication and sedimentation have been identified as a major issue since at least 2007-8." The major threats to the estuary are eutrophication due to elevated nutrient inputs and elevated sediment inputs. Eutrophication triggers nuisance micro and macro algal growth. Conditions in the well flushed central basin and lower estuary are reasonable, however, gross nuisance algal conditions and sulphide rich sediments are causing problems in more sheltered, poorly flushed areas.

A 2018 Macro Algal Monitoring study[8] concluded that the "estuary is eutrophic, with conditions consistently worsening since monitoring commenced in 2001. The area of the estuary with gross eutrophic conditions has now expanded from 23ha in 2001 (1% of the estuary) to 428ha in 2018 (15% of the estuary). This has caused a significant loss of dense (>50% cover) high value seagrass from the estuary (a 94% loss in the Waihopai Arm). In short, the estuary is exhibiting significant problems associated with excessive macroalgal growth and likely represents the largest impact of this type to have occurred in a NZ SIDE estuary. Unless nutrient inputs to the estuary are reduced significantly, it is expected that there will be a continuation of these difficult to reverse adverse impacts within the estuary."

New River Estuary is the receiving environment for Invercargill City, which includes urban, industrial and storm water discharges.

Aparima River catchment

The westernmost part of the Horner Block is found in the Aparima River Catchment. The Aparima River is the smallest of Southland's four main catchments. It extends from the Takitimu Mountains west of Mossburn to the Jacobs River Estuary at Riverton and the headwaters drain alpine, native tussock and forested land. According to LAWA, the upper Aparima catchment maintains much of its natural qualities, whereas the mid and lower reaches have been substantially modified for drainage, flood control and channel clearance work. The catchment contains a variety of land uses including dairy farming, and dry stock farming. Major tributaries include the Hamilton Burn in the upper reaches and the Otautau Stream in the lower reaches, which is known to have poor water quality. According to LAWA, the main pressures on water quality in the Aparima catchment are due to dairy farm intensification as drain networks in the lower catchment can discharge degraded water to receiving streams. Overland flow and nutrient loss from wintering practices contribute significantly, particularly when soils are saturated. Flood and drainage works also potentially impact water quality in the Aparima catchment.

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[7] Robertson & Stevens (2012/1013). New River Estuary. Report prepared for Environment Southland.

[8] Stevens (2018). New River Estuary 2018 Macroalgal Monitoring. Report prepared for Environment Southland.

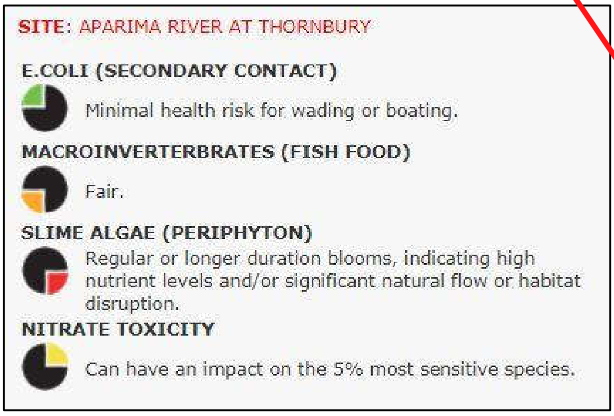
SOE monitoring – Lower Aparima River

The closest current SOE water quality monitoring site is at the Aparima River at Thornbury. This SOE monitoring site is classified as a deep, fast flowing lowland rural site with a gravel bed and is the lowest SOE site in the Oreti River catchment.

As is evident on LAWA's website, key SOE indicators for the Aparima River at Thornbury indicate that the lower catchment river is in reasonable health with trends for most indicators showing improvement. This includes trends for visual clarity, *E.coli*, nitrogen and phosphorous. The 5-year median turbidity and black disc visibility values are in the best 50% of like sites. The 5-year median *E. coli* value is 130 n/100 ml and is in the worst 50% of all lowland rural sites. *E coli* is classed in band D for the National Objectives Framework (NOF). The 5-year median Total Phosphorous concentration was 0.014 g/m^3, which is below the ANZECC Guideline value of 0.033 g/m^3. It is in the best 50% of all lowland rural sites. Dissolved Reactive Phosphorous (DRP) median concentration was 0.006 g/m^3 and is below the ANZECC Guideline value of 0.01 g/m^3. It is in the best 50% of all lowland rural sites. The median Total Nitrogen concentration was 0.91 g/m^3 putting it in the worst 50% of all lowland rural sites and slightly above the ANZECC Guideline value of 0.641 g/m^3 for this indicator. The Total Oxidised Nitrogen median concentration was 0.665 g/m^3 putting it in the worst 50% of like sites. It is slightly above the ANZECC Guideline value of 0.444 g/m^3 for nitrate nitrogen. Total Oxidised Nitrogen is classed in band B for the National Objectives Framework (NOF), and is assessed as being "suitable for designated use" but there may be growth effects on up to 5% of species. No ecological data for the Aparima River at Thornbury SOE site were available at the time of writing.

The closest downstream SOE site for which ecological data could be obtained in the Aparima River catchment is the *Aparima River at Thornbury*. The 5-year median MCI score (100) was classed as good. The 5-year median Taxonomic Richness score was 16. The 5-year median %EPT score was 43.8%.

The nearest National Objectives Framework (NOF) site is the *Aparima River at Thornbury* site. NOF water quality indicators show that generally water quality is reasonable to fair at the site (see figure 5.14 below). The MCI score is fair. Slime algae/periphyton is indicative of high nutrient levels or significant natural flow/habitat disruption at the site. The *E. coli* score indicates "minimal risk of infection for wading or boating." The Total Oxidised Nitrogen score indicates that there may be an impact "on the 5% most sensitive species."



SITE: APARIMA RIVER AT THORNBURY

E.COLI (SECONDARY CONTACT)

Minimal health risk for wading or boating.

MACROINVERTERBRATES (FISH FOOD)

Fair.

SLIME ALGAE (PERIPHYTON)

Regular or longer duration blooms, indicating high nutrient levels and/or significant natural flow or habitat disruption.

NITRATE TOXICITY

Can have an impact on the 5% most sensitive species.

Figure 5.14 NOF indicators for *Aparima River at Thornbury* site.

~~The lower catchment SOE site for the Aparima River shows evidence of land use in the catchment with slightly elevated levels of N and some contaminants present. This relates to the intensity of land use, local hydrology and the physiographic land types found in the catchment. Artificial drainage and overland flow, as well as the low to moderate denitrification potential of some soils and aquifers are factors that combine to produce this outcome. Wintering practices in the wider catchment have also been identified as a factor for the Aparima River catchment.~~

~~Jacobs River Estuary~~

~~The Aparima River is part of the Jacobs River Estuary catchment, which is considered a sensitive environment due to the accumulation of nutrients and sediment. Jacobs River Estuary is a medium-sized (720 ha) tidal lagoon estuary near Riverton. Broad scale and fine scale monitoring studies (Stevens & Robertson 2003, 2007-2011, 2013) have indicated variable levels of eutrophication and sedimentation across the estuary, with some parts being highly muddy and anoxic, eutrophic and having associated nuisance algal growth. The most recent study in 2013 revealed that “although large sections of the lower estuary remain in good condition, there has been a significant decline in estuary quality since 2003, and especially over the past five years. In particular, the poorly flushed parts of the Aparima and Pourakino arms were excessively muddy, had high nuisance macroalgal growths, and contained poorly oxygenated sediments with toxic sulphides. These gross eutrophic areas are displacing high value seagrass beds and stressing saltmarsh habitat.” Other values that were identified in the study as being adversely affected by the degrading estuary were biodiversity, aesthetic, amenity and recreational values.~~

Regionally Significant Wetlands

There is one Regionally Significant Wetland in the vicinity of the property; Dunearn Wetland is approximately 4 km to the north east of the property. Given drainage from the property is in a southerly direction, no further description of Dunearn Wetland is required.

Two Regionally Significant Wetlands lie south of the property; Bayswater Peat Bog lies approximately 10 km to the south west of the property, and Drummond Peat Swap lies approximately 12 km to the south east of the property. Both are remnant peat bogs, which once had a much greater extent in Southland.

Bayswater Peat Bog

The Bayswater Peat Bog is classified as a “lowland rushland shrubland on peat domes” peatland and is representative of peatland ecosystems, which formerly had a much greater extent in Southland[9]. Raised bogs such as the Bayswater Bog are rainfed, i.e. they derive their water and nutrients solely from rainfall. They are characterised by plants and animals adapted to the waterlogged and nutrient-poor conditions. On the Southland Plains they are dominated by peat-forming species such as *Empodisma minus* (wire rush) and Sphagnum moss species, which are characteristic of the flat, poorly drained areas.

AEE on Bayswater Peat Bog

Surfacewater drainage from both WW1&2 and the Horner Block is in a southerly direction towards Middle Creek (and Terrace Creek further east). Bayswater Peat Bog lies to the south west of the property. Middle Creek flows approximately 5 kilometres to the east of Bayswater Peat Bog (see figure

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[9] Clarkson (2003). Significance of peatlands in Southland Plains Ecological District, New Zealand. DOC Science Internal Series 116.

5.15). As surfacewater drainage does not flow in the direction of Bayswater Peat Bog, the risk of adverse effects on Bayswater Peat Bog from the proposed activities (land and discharge) is considered to be less than minor.

Furthermore, water at the 210-hectare raised bog is only derived from rainfall. As such the risk to water quality at the Bayswater Bay is further lowered. Surfacewater drainage in the vicinity of the Bog, drains through land surrounding the Bog, and on to the Waimatuku Stream; it does not drain through the Bog itself.

Groundwater flow in the Waimatuku Groundwater Zone is due south[10] and does not flow towards Bayswater Peat Bog but flows in a southerly direction to the east of the Bog. Furthermore, Hitchcock refers to a report by Robertson (1983), "*previous analysis of groundwater levels in the bog concluded that the water table domes with the bog but is a separate system is probably fed by rainfall*." Hitchcock found that that groundwater in the Waimatuku GW zone is recharged from the Bog. The risk of adverse effects related to groundwater on Bayswater Peat Bog from the proposed activities (land use and discharge) is considered to be less than minor.

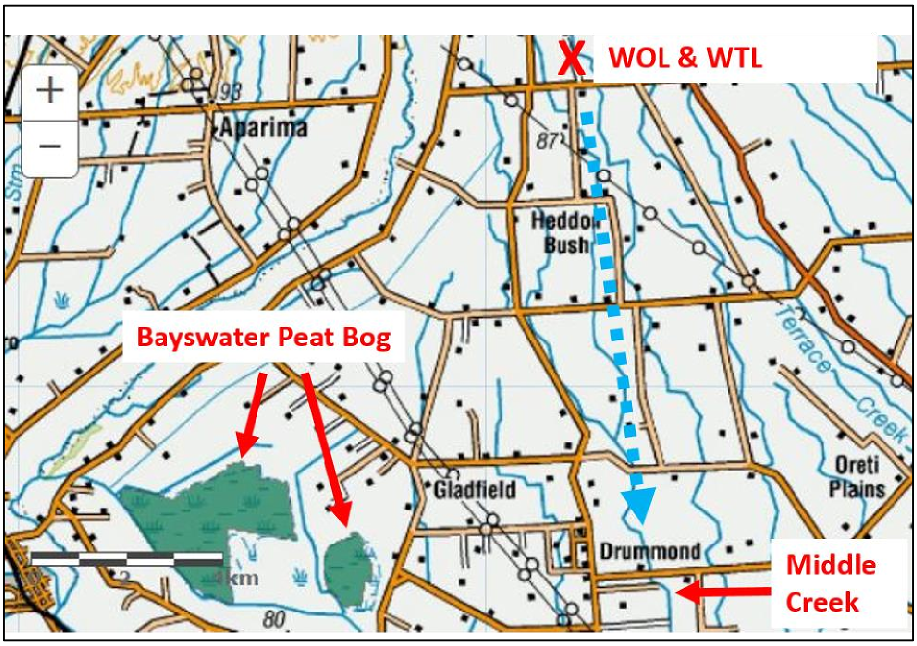

Figure 5.15 Topomap showing location of Bayswater Peat Bog, Middle Creek, property location and direction of surfacewater drainage from property (indicated by blue hatched line).

Drummond Swamp

According to Rance (2008), "Drummond Swamp is classified as a Wildlife Management Reserve and is located c.4 km south-east of Drummond. Drummond Swamp is one of the larger reserves on the Southland Plains (256.42ha). It is one of only two peatland reserves on the Southland Plains." The wetland is intact and has a modified central area due to a former gull colony. The major management challenge is weed control, with several weeds present; gorse, grey willow, silver birch, service berry, rowan and blackberry are examples of weed species present. The peatland plant community is dominated by wirerush (*Empodisma minus*), as well as tangle fern (*Gleichenia dicarpa*), sphagnum

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[10] Hitchcock (2014). Characterising the surface and groundwater interactions in the Waimatuku Stream, Southland. MSc Thesis. University of Otago.

moss (*Sphagnum cristatum*) and swamp inaka (*Dracophyllum oliveri)*. A copy of Rance's report is appended to the application.

AEE on Drummond Swamp

Surfacewater drainage is in a southerly direction towards Middle Creek (and Terrace Creek further east). Drummond Swamp lies to the south east of WW1&2 (see figure 14.16). Middle Creek flows approximately 1 kilometre to the west of Drummond Swamp. An un-named tributary of Middle Creek flows from WW1&2 to within 330 metres (west) of Drummond Swamp, where it flows along Kennedy Road (see figure 14.17). As surfacewater drainage flows close to but not through Drummond Swamp, the risk of adverse effects relating to surfacewater on Drummond Swamp from the proposed activities (land use and discharge) approximately 12 kilometres to the north west is considered to be minor.

Drummond Swamp is also a peat bog, and on that basis is expected to derive its water from rainfall. This further lowers the risk to Drummond Swamp from surfacewater drainage from surrounding land use as drainage does not flow through the Swamp itself. It is noted that Rance (2008) discusses pest plants, pest animals and fire as risks to Drummond Swamp.

There is a lack of specific information available on groundwater interactions at Drummond Swamp. Groundwater underlying is unlikely to flow to the Swamp, however, there is some uncertainly around this given the location of the Swamp and Ww1&2, and the lack of information of groundwater interactions at the Swamp. A study by Hitchcock (2014) on the Bayswater Bog referred to a study by Robertson (1983) and reported that *"previous analysis of groundwater levels in the bog concluded that the water table domes with the bog but is a separate system is probably fed by rainfall."* Since Drummond Swamp is a similar system and is partly in the same groundwater zone, it is reasonable to draw a similar conclusion. Hitchcock found that groundwater in the wider aquifer is recharged from the Bog. It is likely to also be the case for Drummond Swamp, i.e. Drummond Swamp discharges to the wider groundwater resource. The effect on Drummond Swamp due to groundwater related effects from the proposed activities (land and discharge) is minor.

Figure 5.16 Topomap showing location of Drummond Swamp, Middle Creek, property location and direction of surfacewater drainage from property (indicated by blue hatched line). Se figure 5.17 for area around Drummond Peat Swamp.

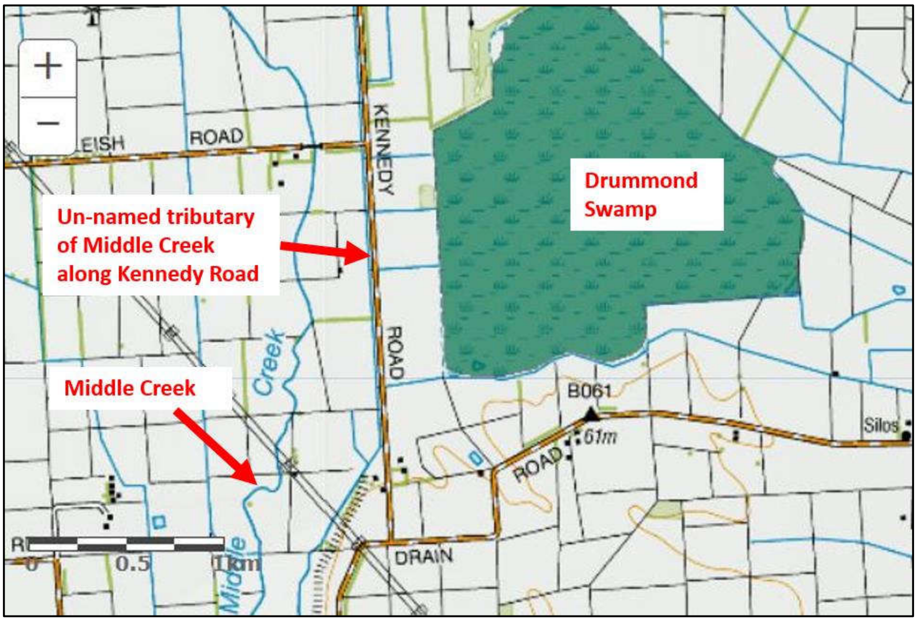

Figure 5.17 Topomap showing location of Drummond Swamp, Middle Creek and un-named tributary of Middle Creek adjacent to Kennedy Road.

5.3 Groundwater

Most of WW1&2 and Horner Block overlie the Waimatuku Groundwater Zone. Heddon Bush School 2.3 kilometres to the south also overlies the Waimatuku Groundwater Zone. The eastern WW1&2 overlies the Central Plains Groundwater Zone. The western part of the Horner Block overlies the Upper Aparima Groundwater Zone.

In this section, all three groundwater zones are firstly described. Following this, groundwater nitrate and groundwater microbial contaminants in the vicinity of WW1&2 and Horner Block are described.

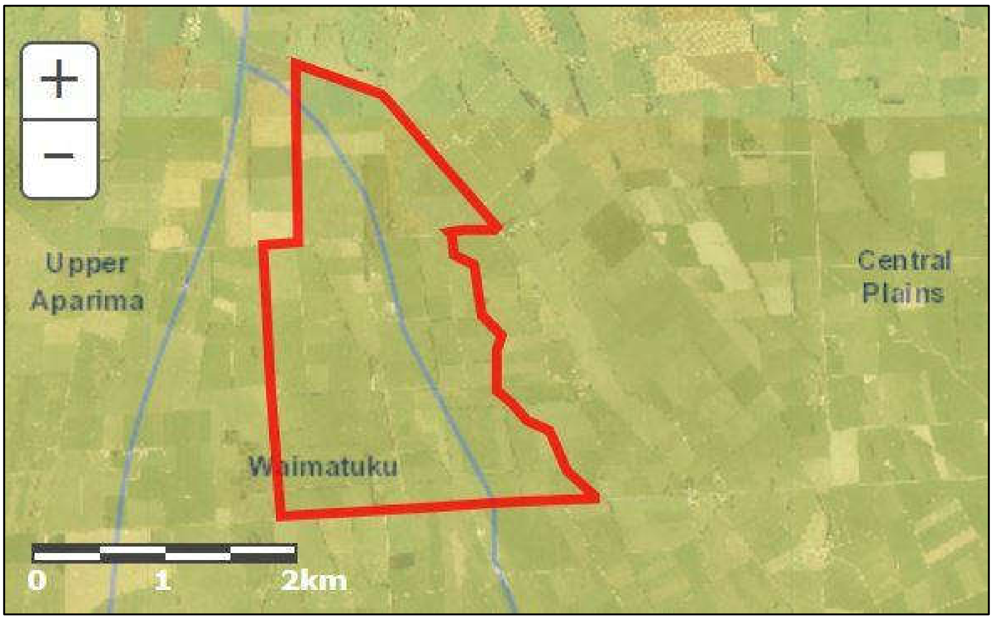

Figure 5.18 Groundwater zones in the vicinity of the WW1&2 dairy platform (approximate boundary is outlined in red).

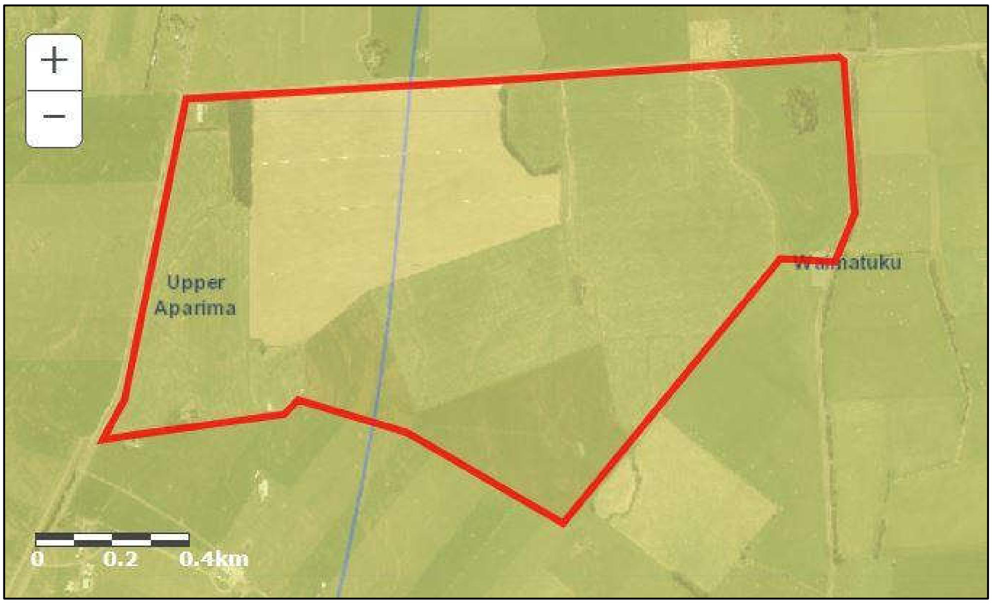

Figure 5.19 Groundwater Zones at Horner Block (approximate boundary outlined in red).

The Waimatuku Groundwater Zone

The Waimatuku Groundwater Zone is classified as a lowland aquifer type according to Environment Southland's Information Sheet and has low allocation status. The diagram below gives a schematic cross section of the Waimatuku Groundwater Zone; recharge to the Waimatuku groundwater zone is principally derived from rainfall recharge. Annual land surface recharge is estimated to be 467 mm/year. According to Environment Southland, available flow gauging and water quality information suggest that shallow groundwater makes a significant contribution to baseflow discharge in the Waimatuku catchment with recharge circulating relatively rapidly through upper levels of the unconfined aquifer and discharging via the local stream network. Groundwater circulation through deeper levels of the aquifer system is likely to be relatively slow and follow the more general southward topographic gradient.

According to Environment Southland's Information Sheet, groundwater quality in the Waimatuku Groundwater Zone is generally good, although it does vary according to source aquifer and location. Some areas of elevated nitrate concentrations are observed in shallow groundwater reflecting infiltration from surrounding land use.

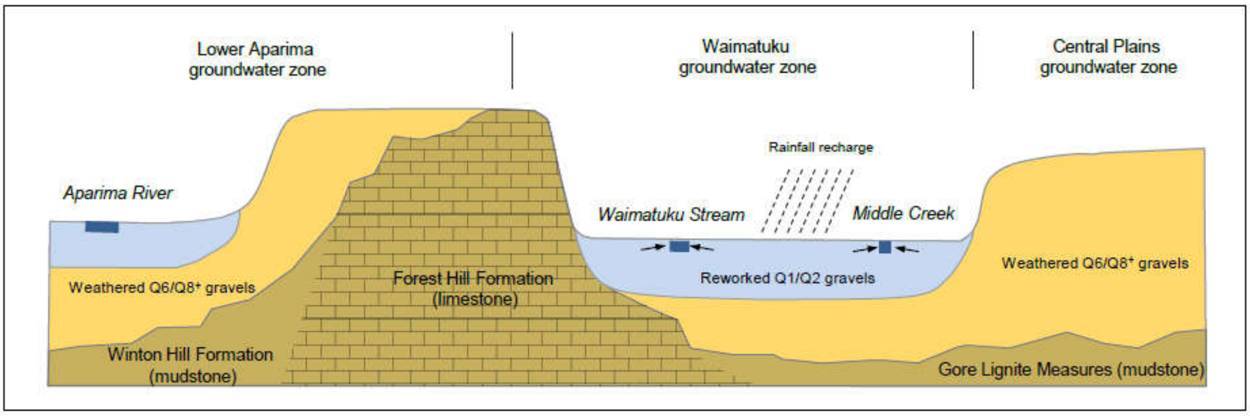

Figure 5.20 Schematic cross-section of the Waimatuku Groundwater Zone[11]

Groundwater flow

Hitchcock characterised surface and groundwater interactions in the Waimatuku Stream catchment in a master's thesis[12]. The study reported that from Wreys Bush down to Drummond "groundwater flow is from north to south down the catchment." See figure 4.7 in Hitchcock's thesis for a map depicting groundwater flow in the Waimatuku Catchment. Heddon Bush School, which has a bore for drinking water supply (HED001), is c.2.3 km due south of the WW1&2 dairy platform (see figure 5.21) and lies in the Waimatuku Groundwater Zone. Based on Hitchcock's report, groundwater underlying much of WW1&2 flows south, so flows in the direction of Heddon Bush School.

An estimate of the average linear velocity of groundwater moving south was calculated by hydrologist Mark Flintoft from Aqualinc Limited (personal communication). Using a porosity of 0.3, K of either 26 or 2,600 m/day, an average linear velocity of 0.5 to 40 m/day was estimated. Mr. Flintoft has stated that the figure provided is an approximation of linear velocity. In the absence of other references for the velocity of groundwater in the area, this estimate can be used to approximate groundwater movement.

~~Land use in wider area since 1980s – potential for effects on GW~~

~~The WW1 dairy unit was established in 1992 and the WW2 dairy unit was officially established in 2003. Land use activities in the wider area since the 1980s (if not before) include sheep farming, dairy farming, intensive winter grazing of dairy stock and cereal cropping. Dairy farming has expanded since the mid-2000s. In line with land use activity in the Central Southland area, cereal cropping was formerly a significant activity with cereal crops (barely/grain) typically being grown and harvested annually. Sheep farming and cereal cropping often went together on individual farms. Cereal cropping reduces soil organic matter content and water holding capacity so has relatively high N loss to water. IWG of fodder crops also has relatively high N loss to water. The presence of these activities in the area during the 1980s, 1990s and beyond is of note when considering N loss to groundwater, lag times and groundwater flow. Over decades, these activities can be expected to have lost N to groundwater where free draining soils are found or where there is an alternative pathway to groundwater (e.g. bypass drainage via deep cracks in Braxton soils). N signals in groundwater from these activities would be expected to have been seen for some time in the Waimatuku zone if they were present.~~

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[11] Waimatuku Gourndwater Zone Information Sheet. http://gis.es.govt.nz/apps/groundwater/zones/Waimatuku.pdf

[12] Hitchcock (2014). Characterising the surface and groundwater interactions in the Waimatuku Stream, Southland. MSc Thesis. University of Otago.

~~Using the estimate for groundwater movement of 0.5 to 40 m/day, land use effects on groundwater due to the WW1 and WW2 dairy platforms and prior activities such as intensive winter grazing and cereal cropping, if they are present will have been seen at the Heddon Bush School area for some time.~~

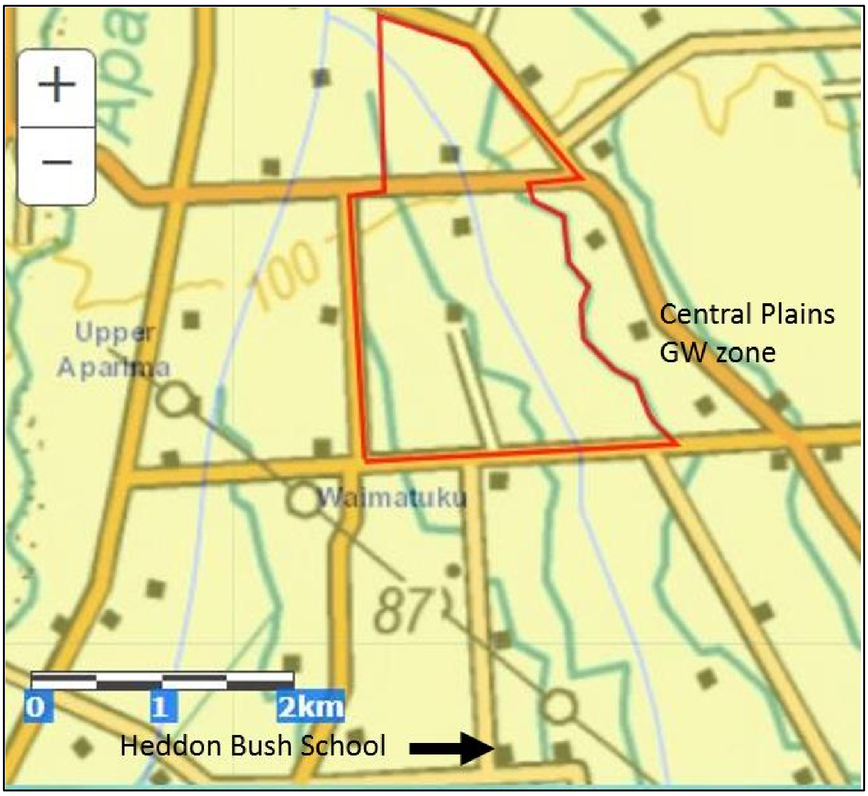

Figure 5.21 Topomap showing groundwater zones and location of Heddon Bush School (approximate WW1&2 boundary outlined in red).

Central Plains Groundwater Zone

The Central Plains Groundwater Zone is classified as a lowland aquifer type according to Environment Southland's Information Sheet and has low allocation status. The diagram below gives a schematic geologic cross section of the Groundwater Zone. Recharge to the underlying groundwater zone is primarily via rainfall infiltration with some infiltration of runoff along the lower slopes of the Tauringatura Hills. Mean annual land surface recharge in the Groundwater Zone is estimated to be 470 mm/year. According to Environment Southland's Information Sheet, groundwater quality in the Central Plains Groundwater Zone is generally good, although it does vary according to source aquifer and location. There are some "hotspot" areas where nitrate values are particularly high.

There are no Central Plains Groundwater Zone registered drinking water supplies within 10 kilometres of the property.

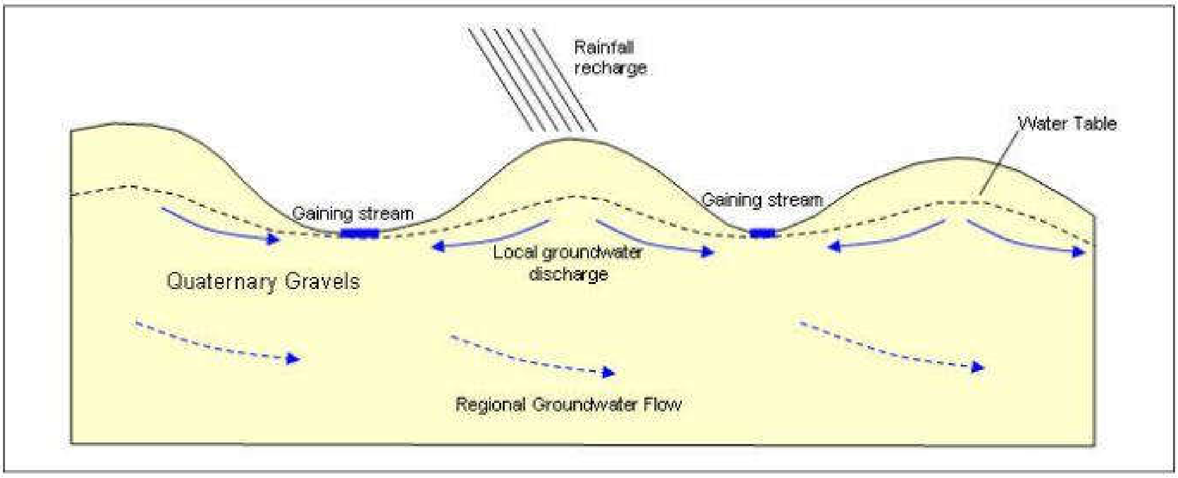

Figure 5.22 Schematic cross-section of the Central Plains Groundwater Zone[13]

Groundwater drainage occurs via the numerous small streams which cross the Central Plains groundwater zone. This drainage is aided by extensive mole, tile and artificial drainage networks which act to both intercept soil drainage and control the water table. By this mechanism a large portion of annual recharge is rapidly routed from the catchment with a much small component of deeper groundwater flow following the overall catchment drainage.

Upper Aparima Groundwater Zone

The Upper Aparima Groundwater Zone encompasses the flat-lying portion of the Upper Aparima River catchment. It is a terrace aquifer type and according to Environment Southland's Information Sheet, has low allocation status. Terrace aquifers are recharged by direct rainfall recharge and infiltration of runoff from the surrounding hills and streams, which drain the hills. There is limited riparian recharge from the Aparima River except along the riparian margins. Mean annual land surface recharge in the Aparima groundwater zone is estimated at 417 mm/year. Groundwater is discharged into the Aparima River via spring-fed streams or throughflow through the unconfined aquifer along the riparian margin of the river. The Aparima River is largely influent over much of the reach upstream of Wreys Bush, reflecting drainage of groundwater from the surrounding terrace aquifers. Groundwater quality is generally good, although it does vary according to source aquifer and location. There are minimal "hotspot" areas where nitrate values are particularly high.

There are no Upper Aparima Groundwater Zone registered drinking water supplies located within 35 kilometres of the property.

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[13] Central Plains Groundwater Zone Information Sheet. http://gis.es.govt.nz/apps/groundwater/zones/Central_Plains.pdf

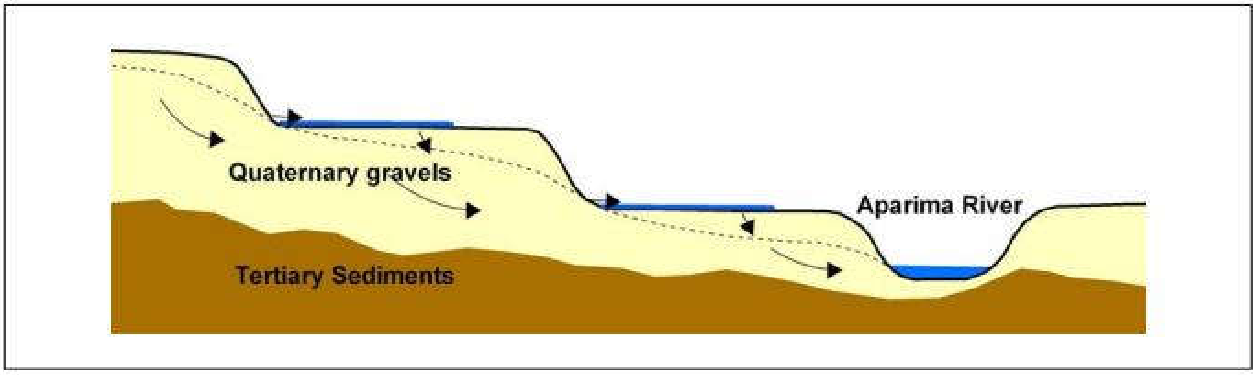

Figure 5.23 Schematic cross section of The Upper Aparima Groundwater Zone[14].

Groundwater lag times

Shallow groundwater lag times for nitrate response in Southland were estimated in a 2014 study prepared for Environment Southland[15]. 0 – 1 years was reported as an estimate of the time taken for the percolation of water through the unsaturated zone and reach the water table. The study reports that localised nitrate effects on groundwater can be expected within one year in the vicinity of WW1&2 and the Horner Block. 3 - 5 years was reported as the "total lag time" in the area (see figure 12 of report). 2.5 – 3 years was reported as an estimate for the time taken for a year of rainfall recharge to mix with the shallow aquifer.

~~Groundwater Nitrate – dairy platform~~

~~Groundwater in gravel deposits is susceptible to nitrate leaching. This reflected in the observed gradient in groundwater nitrate concentrations; groundwater nitrate concentrations are low at the west (0.4 – 3.5 g/m^3) and increase towards the east (3.5 – modelled >11.3 g/m^3) where lighter soils are found. See figure 5.24. Most of Ww1&2 is modelled as having groundwater nitrate levels in the range of 1.0 – 8.5 g/m^3, indicative of minor, moderate to high land use impacts.~~

~~Groundwater nitrate levels south of WW1&2, overlying the Waimatuku Groundwater Zone, are generally low, in the range of 0.01 – 8.5 g/m^3.~~

~~There is a nitrogen "hotspot," where groundwater nitrate levels regularly exceed New Zealand Drinking Water Standard's MAV of 11.3 ppm centred at Boyle Road/Heenans Corner immediately to the south east of WW1&2 and overlying the Central Plains Groundwater Zone (see figures 5.24, 5.26, 5.27).~~

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[14] Central Plains Groundwater Zone Information Sheet. http://gis.es.govt.nz/apps/groundwater/zones/Central_Plains.pdf

[15] Wilson, Chanut, Rissman & Ledgard (2014). Estimating time lags for nitrate response in shallow Southland groundwater. Technical report prepared for Environment Southland.

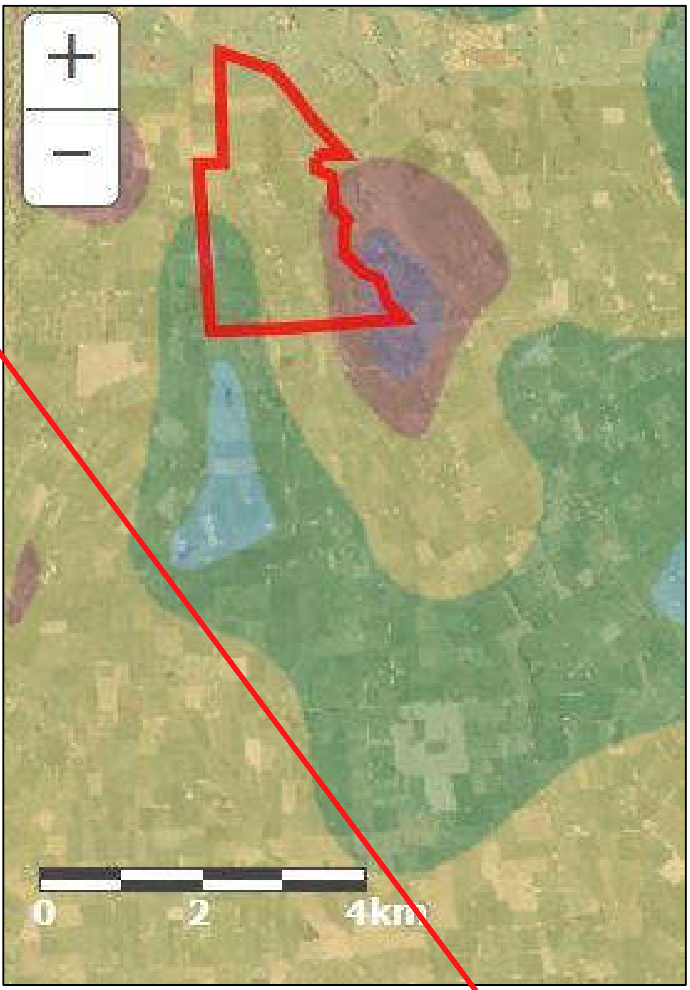

Figure 5.24 Groundwater nitrate levels in the vicinity of the WW1&2 (approximate boundary is outlined in red).

Regional Nitrate Levels 2007-2012

🟦	0.01 - 0.4 mg/L Pristine, pre-European
🟦	0.4 - 1.0 mg/L Modern day background
🟩	1.0 - 3.5 mg/L Minor to moderate land use impacts
🟨	3.5 - 8.5 mg/L Moderate to high land use impacts
🟥	8.5 - 11.3 mg/L Drinking water limits
🟪	Excess NZDWS

Figure 5.25 Key to groundwater nitrate levels

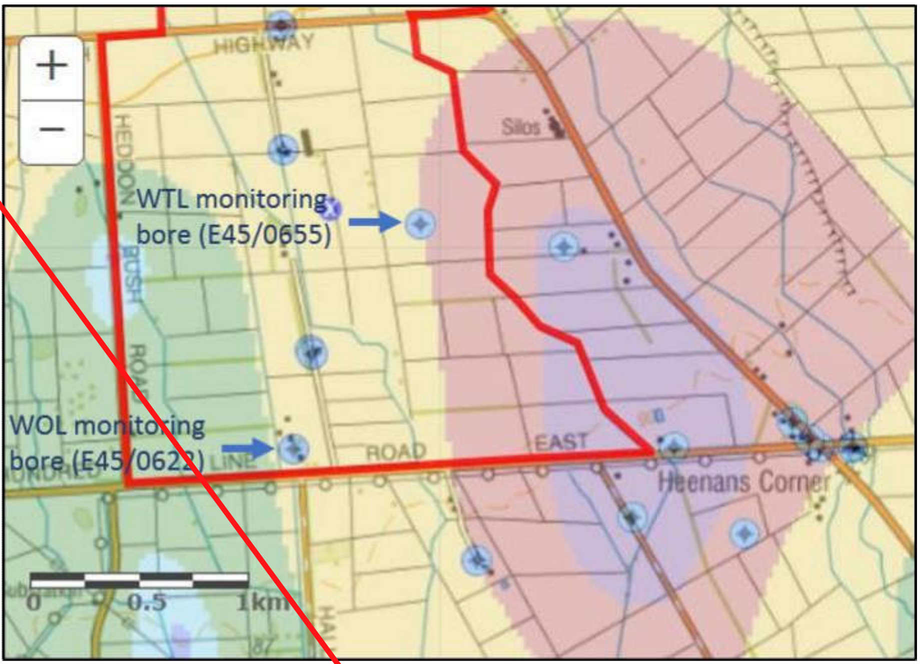

Figure 5.26 Topomap with groundwater nitrate levels showing low levels at the west and the hotspot centred at Heenans Corner to the east. The location of two bores used for monitoring are also shown.

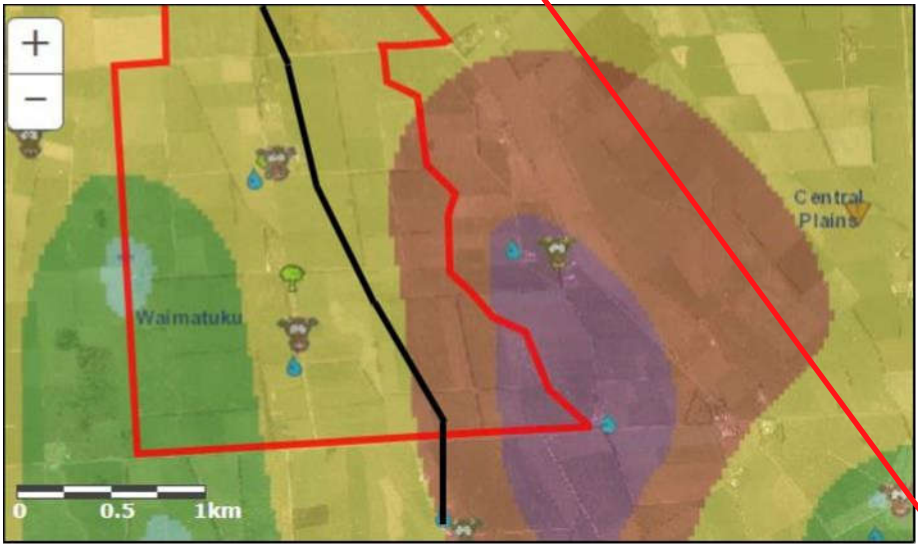

Figure 5.27 Aerial photo with groundwater nitrate levels and groundwater zones (black line indicates boundary between groundwater zones). The nitrate hotspot is in the Central Plains Groundwater Zone.

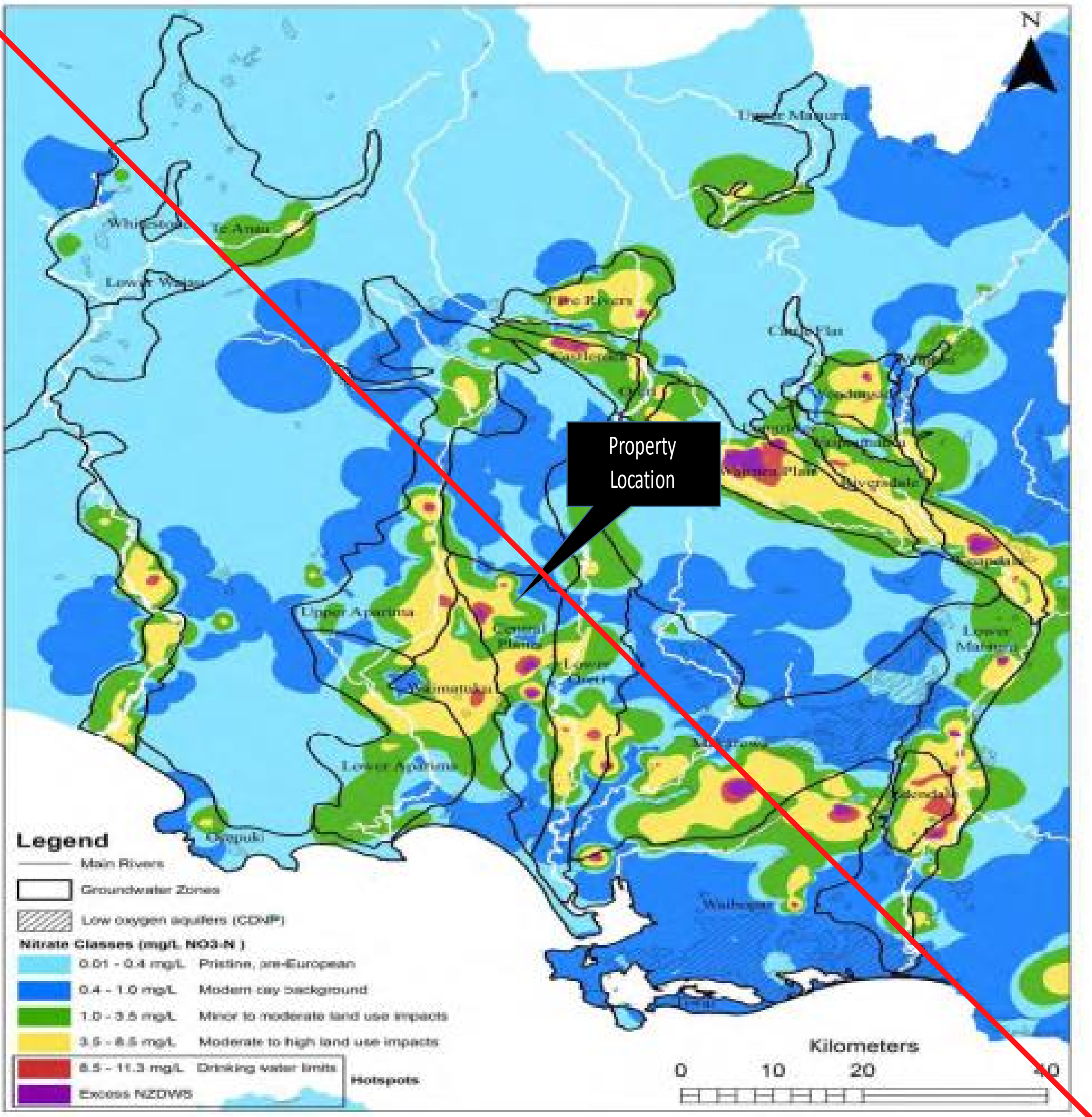

Figure 5.28 Classed NO3-N map for Southland's managed groundwater zones.[16]

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[16] Rissman (2012). The Extent of Nitrate in Southland Groundwaters. Regional 5 year median (2007-2012). Technical Report.

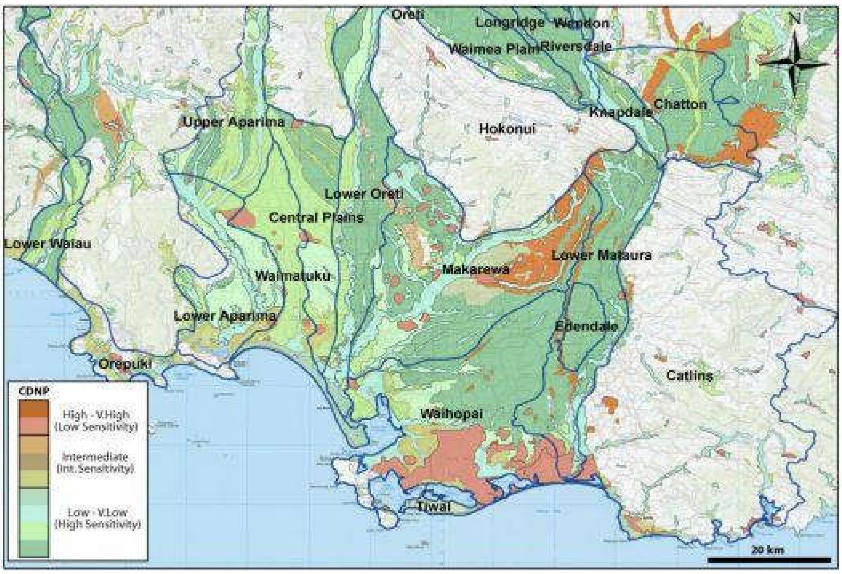

Figure 5: Spatial distribution of Combined Denitrification Potential (CDNP)(Aquifer Sensitivity) for the *Southern Southland* Region. *Where, blue lines delimit regional groundwater zones. Note the: (i) predominance of low to very low Combined Denitrification Potential aquifers across the major groundwater zones; (ii) occurrence of high to very high CDNP values associated with sections of the Makarewa, Waihopai and Chatton groundwater zones, and; (iii) thin margins of marine-terrestrial aquifers of intermediate CDNP along the Southland coast.*

Figure 5.29 Map showing modelled denitrification potential[17]

Monitoring bores

Two bores located at WW1&2 are monitored by Environment Southland for water quality; one at the south of the WW1 dairy unit (E45/0622)/Waimatuku Groundwater Zone, and one at the south east of the WW2 dairy unit (E45/0665)/Central Plains Groundwater Zone. See figure 5.26 for the location of the bores.

WW1 BORE (E45/0622)

The WW1 bore is mapped on Beacon in the Waimatuku Groundwater Zone. The bore used to monitor WW1's groundwater quality was not drilled as a monitoring bore; it is an old domestic well. It comprises a 90 cm vertical concrete pipe with a hole in the side to let the alkathene through. It is possible for birds or rodents to enter the well along the pipe, fall in and drown, which has happened in the past. Furthermore, the well's top pipe is flush with ground level, and soil in the vicinity has high organic matter content from long grass and woody shrubs in the area. Due to its design and unprotected nature, it is likely to experience frequent localised contamination especially during/following heavy rainfall, as surfacewater can flow down into the wellhead carrying organic material with it. If decaying birds (starlings) or rodents are in the well, these also will cause localised contamination. Given these factors, ***the WW1 bore is unsuitable for use as a monitoring bore,*** and data collected from the well may be unlikely to reflect wider groundwater quality. This is particularly the case for *E.coli* data, which will be more corrupted than nitrate data from localised contamination.

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[17] Rissman (2011). Regional Mapping of Groundwater Denitrification Potential and Aquifer Sensitivity. Technical Report.

Figure 5.30 WW1 bore (E45/0622) used for groundwater quality monitoring.

WW2 MONITORING BORE (E45/0622)

The WW2 bore was drilled as a monitoring bore and is mapped on Beacon in the Central Plains Groundwater Zone.

NITRATE TRENDS FOR BORES MONITORED AT DAIRY PLATFORM

The WW1 bore (E45/0622) has been sampled by Environment Southland twice per year since 2013 and the WW2 bore (E45/0665) has been sampled by Environment Southland twice per year since 2015 (see figure 5.31 below). Despite the unsuitability of the WW1 well for use as a monitoring bore, it has been included in the following analysis for nitrate. See appendix for raw data.

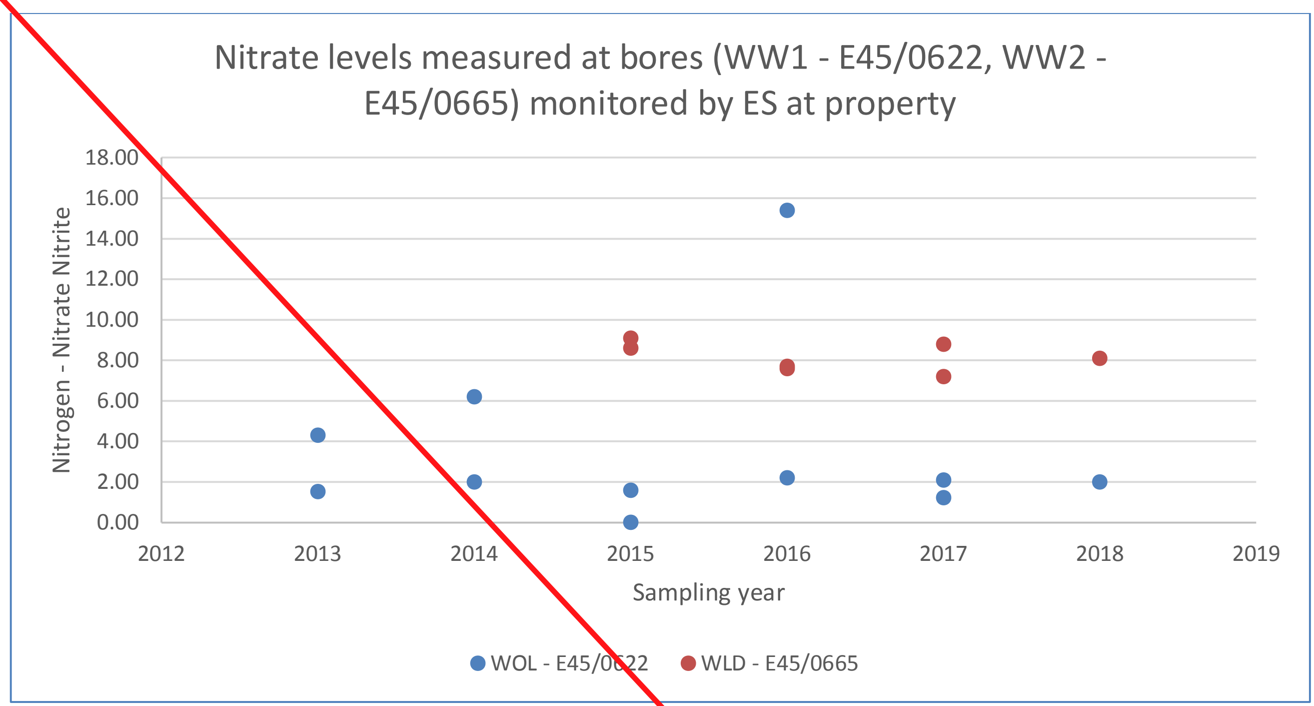

Figure 5.31 Groundwater nitrate concentrations at two bores monitored by Environment Southland WW1&2.

Except for one outlying result, groundwater nitrate levels at the WW1 bore (E45/0622) are generally low (< 3.5 g/m^3) since 2015. Given its position as an outlier in the dataset, the high 2016 result is likely to have been due to localised contamination of the bore. Bore E45/0622 is a shallow bore (3 m deep) and except for localised contamination issues, should indicate recent land use effects including cumulative effects on upstream groundwater. Groundwater nitrate levels sampled at the bore generally are low and indicate minor to moderate land use effects. Results in 2017/2018 were less than or equal to 2.1 g/m^3.

Groundwater nitrate levels measured at the WW2 monitoring bore (E45/0665) are more elevated, with a mean value of 8.16 g/m^3 over the sampling period. This reflects a general trend in the area, with higher groundwater nitrate concentrations found progressively towards the east in the Central Plains Groundwater Zone, underlying lighter soils. Longitudinal datasets for a limited number of bores located to the east and north east of WW1&2 on lighter soils show this trend. The WW2 monitoring bore has a depth of 6.5 metres and is found in the Central Plains Groundwater Zone.

ENVIRONMENT SOUTHLAND MONITORING BORE AT BOYLE ROAD

An Environment Southland monitoring bore is located on Boyle Road to the south east of WW1&2 and in the Central Plains Groundwater Zone.

Groundwater is monitored at different depths (3 m, 6 m, 9 m, 12 m, 15 m). Well ID E45/0768 measures water quality at 3 metres depth and well ID E45/0771 measures water quality at 12 metres depth. Longitudinal datasets are available for both well IDs, starting in 2005 until the present (2018).

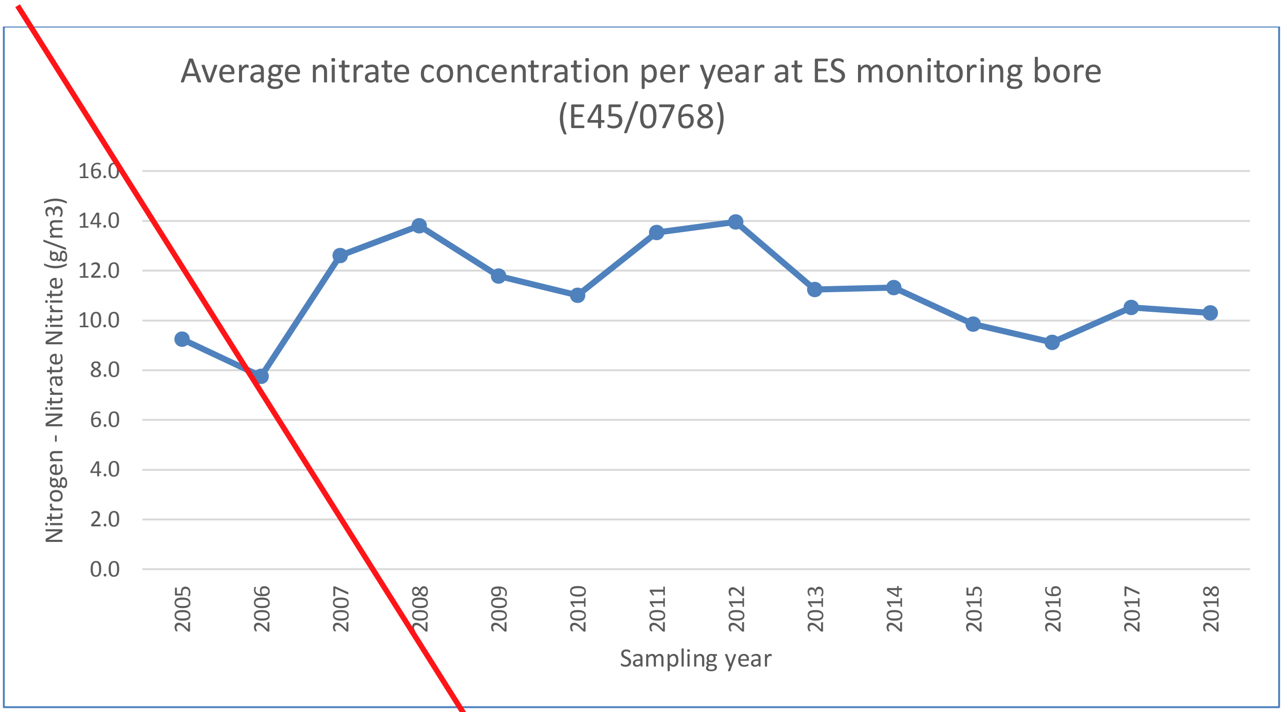

Figure 5.32 Groundwater nitrate concentrations at the ES monitoring bore (E45/0768) at Boyle Road to the south east of WW1&2 and in the Central Plains Groundwater Zone.

Groundwater nitrate levels at the Environment Southland's Boyle Road bore are generally at or above the New Zealand Drinking Waters MAV of 11.3 ppm. As this bore is also a shallow bore (3 metres depth), it is an indicator of recent land use effects and has been included here (rather than the 12-metre depth bore at the same site). Nitrate levels at the bore should be indicative of the cumulative effect of recent land use activities on upstream groundwater, which includes dairy, sheep and beef and cropping activities at numerous properties.

Comparatively groundwater nitrate levels at the two monitoring bores at Ww1&2 are lower than at the Boyle Road bore, with the WW1 data being distinctly lower and likely to reflect a different groundwater stream in the Waimatuku Groundwater Zone. The WW2 data are indicative of moderate to high land use effects in the Central Plains Groundwater Zone but are lower than the shallow bore data from the ES Boyle Road monitoring bore. The WW2 monitoring bore is likely to measure shallow groundwater quality underlying free draining soils at the east side of WW1&2, which is in the Central Plains Groundwater Zone.

Nitrate at registered drinking water supply – Heddon Bush School

Heddon Bush School overlies that Waimatuku Groundwater Zone. The bore for water supply at Heddon Bush School (E45/0718) was drilled in 2017 to a depth of 14.9 metres. It has been tested for nitrate levels since it was drilled although no recent nitrate* testing has been carried out by the school. Heddon Bush School bore testing carried out by Dairy Green Limited in December 2017, January and March 2018, returned nitrate concentrations of 1.8 – 2.0 ppm, which are indicative of minor to moderate land use effects and are well below the NZ Drinking Water Standards MAV for nitrate of 11.3 ppm. See the Appendix for laboratory results from the testing of Heddon Bush School bore by Dairy Green Limited.

*Note: The bore supply at Heddon Bush School is tested for microbial contaminants four times per year.

Groundwater Nitrate – Horner Block

Groundwater nitrate levels in the vicinity of the Horner Block are lower on the east side (1.0 – 3.5 g/m^3) and higher on the west side (3.5 – 8.5 g/m^3) towards the Aparima River (see figure 5.31). This corresponds with the heavier soil types found on the east side and lighter soils found on the west side respectively.

Figure 5.33 Groundwater nitrate levels in the vicinity of the Horner Block (approximate boundary is outlined in red).

Microbial contamination of groundwater

E.coli is widely used as an indicator of faecal contamination of water, including groundwater. *E.coli* is believed remain viable for up to three months in groundwater[18]. Groundwater sampling in the vicinity of WW1&2, including at the WW1, WW2 and ES Boyle Road bores, have generally been negative for *E.coli* (<1 MPN/100 ml). However, at times there have been positive *E.coli* results (1 or >1 MPN/100 ml).

The *E.coli* data from the WW1 bore (E45/0622) are flawed due to localised contamination relating to poor well design; this may have been the case for some other bores in the area also. In these situations, rainfall washes organic material including microbes, close to the bore site down into the well. This causes localised contamination and disappears beyond the zone of reasonable mixing. In the case of the WW1 bore, some decaying birds/rodents in the well may also be responsible for some contamination, which has been observed by the applicants in the past. Since the WW1 bore is likely to suffer frequent localised microbial contamination, *E. coli* data from samples collected at the well

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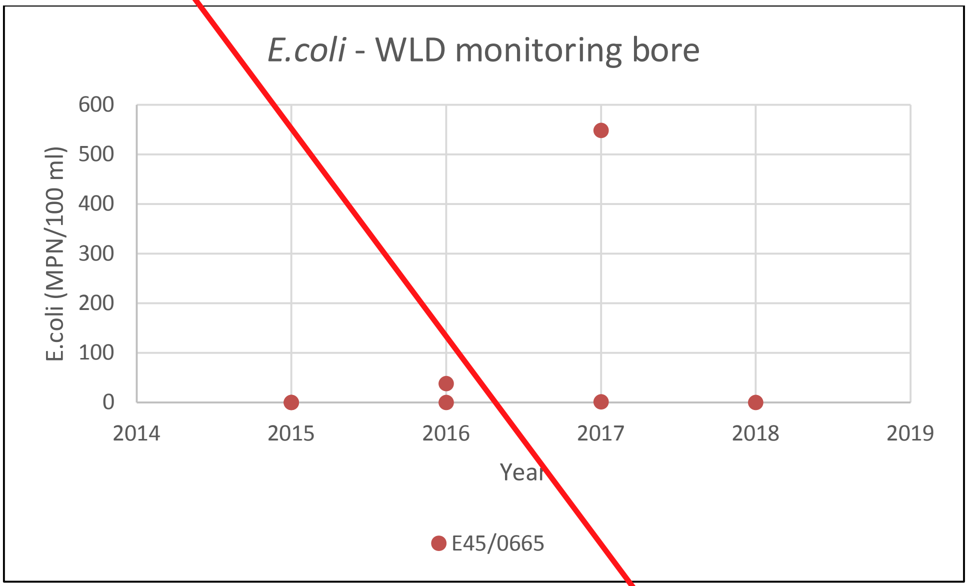
[18] Edberg, Rice, Karlin and Allen (2000). *Escherichia coli*: the best biological drinking water indicator for public health protection. Journal of Applied Microbiology 2000, 88, 106S – 116S.

~~are dubious and unlikely to reflect wider groundwater quality. For this reason, the WW1 bore has been excluded form figure 5.34.~~

~~Where positive *E.coli* results are not due to contamination/poor wellhead design, they are an indicator of the presence of faecal microbes in groundwater from drainage events, albeit to a low level and relatively short lived generally.~~

~~Figure 5.34 plots *E.coli* results from the WW2 bore from 2015 to 2018. *E.coli* results fluctuate between negative for E.coli (<1 MPN/100 ml) and 548 MPN/100 ml. It is noted that the ES Boyle Road bore was positive for *E.coli* in November 2017 (5 MPN/100 ml) but was negative on other sampling dates.~~



~~Figure 5.34 *E. coli* sampling at WW2 monitoring bore.~~

~~The ES monitoring bore at Boyle Road had some relatively high *E.coli* counts between 2006 and 2008 (e.g. 80 MPN/100 ml in April 2008) as well as many negative results (<1 MPN/100 ml). It was generally negative for *E.coli* in 2009 (< 1 MPN). There was a lack regular *E. coli* testing between 2010 and 2012. Quarterly testing by ES began in 2013, with all tests being negative for *E.coli* (<1 MPN/100 ml) with the exception of March 2014 and December 2017, which had 2 MPN/100 ml and 5 MPN/100 respectively.~~

~~No *E.coli* data are available for bores in the vicinity of the Horner Block within the last ten years.~~

~~According to school principal, Ms. E Hamilton, the bore at Heddon Bush School (E45/0718) is tested every three months since and has consistently been negative for *E.coli* (counts of <1 MPN/100 ml). Recent test results for the bore are included in the Appendix. Results show no evidence of faecal contamination of the registered drinking water supply at Heddon Bush School.~~

5.4 Physiographics

Both WW1&2 and Horner Block are identified as being located primarily within the Central Plains and Oxidising physiographic zones. Given the remapping of soil types following a site investigation, it is likely that the area of Oxidising soils is greater than is mapped by Beacon and that the Central Plains area is reduced. The main contaminant pathways for the Central Plains zoned land are artificial drainage and deep drainage. The main contaminant pathway for Oxidising zoned land is deep drainage.

Oxidising

For the Oxidising zone, nitrogen accumulation is expected, particularly during drier months, with excess nitrogen and other contaminants then leaching into underlying aquifers following periods of heavy rainfall over winter and spring. Oxidising soils (Drummond and Glenelg) at the property are free draining so do not have artificial drainage installed.

Central Plains

Central Plain's zoned land is prone to waterlogging, resulting in the installation of artificial drainage and the potential loss of contaminants (N, P, sediment and microbes) to streams and rivers. It is also believed to have risk of contaminant loss via deep drainage, which relates to swell/crack properties of Braxton type soils. Deep cracks can form in soils during dry summer periods. Subsequent rainfall can transport contaminants via bypass drainage to the underlying aquifer.

Figure 5.35 Physiographic zones (approximate WW1&2 boundary is outlined in red).

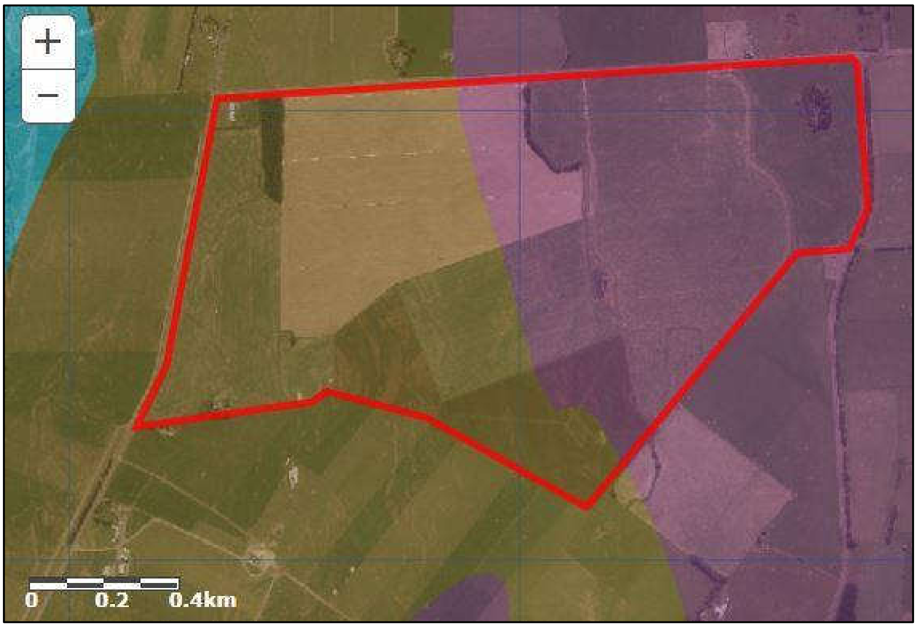


Figure 5.36 Physiographic zones in vicinity of Horner Block.

Physiographic Zones

- 🟨 Alpine - No Variant
- 🟩 Bedrock/Hill Country - Artificial Drainage
- 🟩 Bedrock/Hill Country - No Variant
- 🟩 Bedrock/Hill Country - Overland Flow
- 🟪 Central Plains - No Variant
- 🟩 Gleyed - No Variant
- 🟩 Gleyed - Overland Flow
- 🟪 Lignite - Marine Terraces - Artificial Drainage
- 🟪 Lignite - Marine Terraces - No Variant
- 🟪 Lignite - Marine Terraces - Overland Flow
- 🟧 Old Mataura - No Variant
- 🟫 Oxidising - Artificial Drainage
- 🟫 Oxidising - No Variant
- 🟫 Oxidising - Overland Flow
- 🟦 Peat Wetlands - No Variant

Figure 5.37 Key to physiographic zones

5.5 Topography

The topography found at the property is very flat. See figures 5.38 and 5.39 below. Slight hollow and low points in the flat terrain are generally underlain by subsurface drainage on the west side of WW1&2.

Figure 5.38 Photograph of flat topography found at WW1&2.

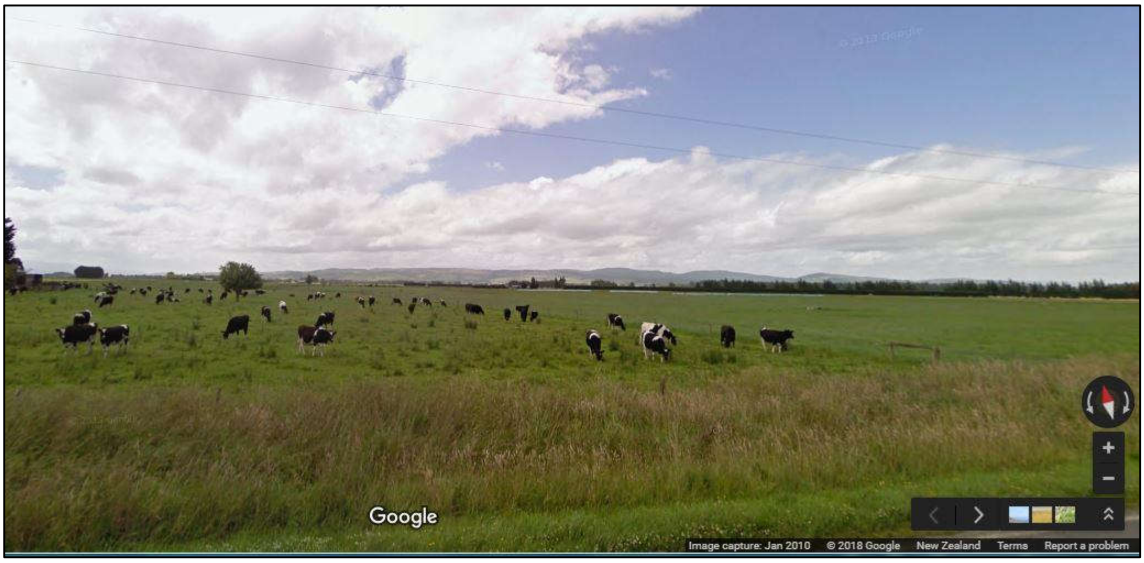


Figure 5.39 Photograph of flat topography found at WW1&2.

6. Proposal Details

6.1 Effluent Discharge

Overview of effluent discharge activity

Table 6.1

Effluent Discharge	
Replacement of consents	Replace 301663 and 20171278-01 with a single discharge permit for WW1&2
New consent	Grant consent for the discharge of agricultural effluent from WW1&2 at the Horner Block. The Horner Block is an effluent receiving area only; it has no effluent storage infrastructure or irrigation infrastructure. It is currently authorised to receive effluent on discharge consents 301663 and 20171278-01.
Duration of consent sought	15 years
Herd size	1,500 cows total: 800 cows at WW2 700 cows at WW1
Supplier number	WW2 unit = 32651 WW1 unit = 32650
Period of discharge	The cowsheds are generally operated from 1 August to 31 May each year, with a limited number of late calving cows milked until mid-June (15th). Effluent irrigation to the discharge areas will be carried out between August and May, and as ground conditions permit for June and July if deemed necessary.
Milking frequency	Twice per day
Winter milking	Not anticipated, seasonal supply only
Feed pad/wintering pad/stand-off pad	There are two wintering barns that will house a total of 1,250 cows.
Other sources of effluent collected in main effluent system	Concrete area at two vat stands Silage pad (WW2)

Feed Pad/Wintering Pad/Stand-off Pads

There are two wintering barns that will house a maximum of 1,250 cows. One barn is located on each dairy unit; each has capacity to house 640 cows but will house a maximum of 625 cows to minimise cow stress. The WW1 barn has recently been upgraded to go from 400 to 640 cow capacity as has its effluent storage infrastructure.

The wintering barns are mainly used in May, June, July, August and September but can be used as stand-off pads at other times during inclement weather. The use of wintering barns as a stand-off pads varies from year to year dependent on weather. Cows are removed from the wintering barn for calving.

The wintering barns have a sealed concrete floor. Effluent from the barns is scraped into a concrete collection channel from where it is pumped to respective storage ponds, which also store effluent from the dairy shed and silage pad (WW2 only) as required. The barns have a small uncovered area, which has been included in the Massey DESC reports.

A rainwater diversion is used on the concrete areas during the off season.

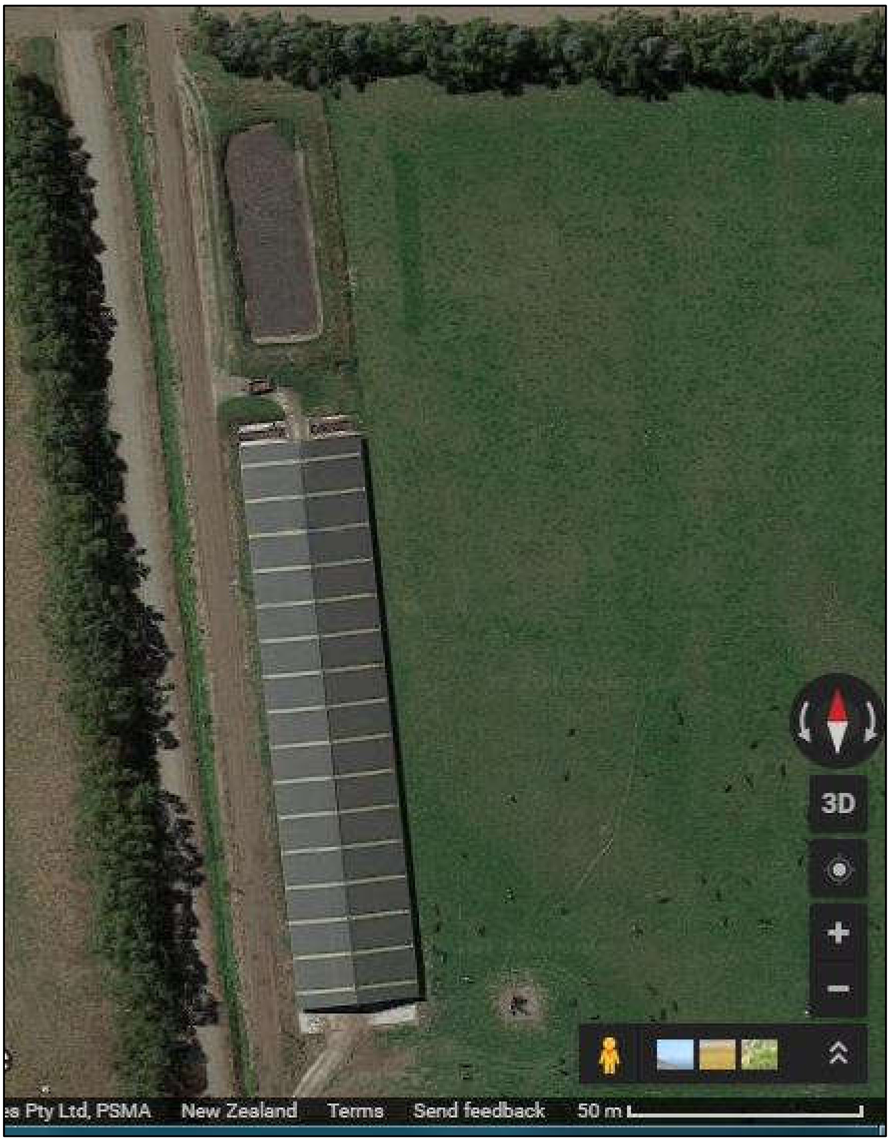


Figure 6.1 Wintering barn and effluent pond – WW1 dairy unit.

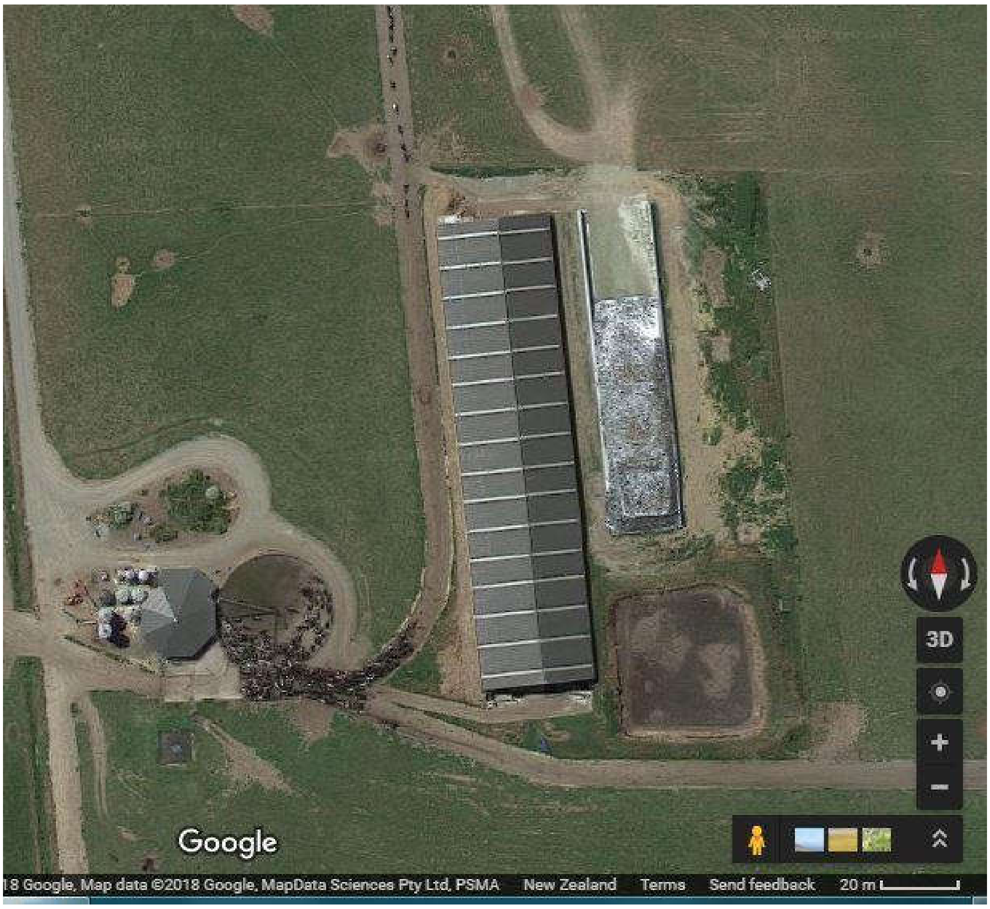


Figure 6.2 Wintering barn, silage pad, dairy shed and effluent pond – WW2 dairy unit

WW2 wintering barn – effluent volume

The total volume of effluent collected has been calculated based on approximately 50 litres per cow per 24-hour day. The volume has been calculated as follows:

May:

$$625\ cows\ x\ 12\ Hours/day\ x\ 50\ l\frac{effluent}{24}Hours\ \ x\ 31\ days = 484\ cubic\ metres$$

June and July:

$$625\ cows\ x\ \ 50\ l\frac{effluent}{day}\ x\ 61\ days = 1{,}906\ cubic\ metres$$

August:

$$370\ cows\ x\ 23\ Hours/day\ x\ 50\ l\frac{effluent}{24}Hours\ \ x\ 31\ days = 550\ cubic\ metres$$

September:

$$75\ cows\ x\ 23\ Hours/day\ x\ 45\ l\frac{effluent}{24}Hours\ \ x\ 30\ days =\ 108\ cubic\ metres$$

Total

$$484\ m3 + 1{,}906\ m3 + 550\ m3 + 108m3\ \ = 3{,}048\ cubic\ metres$$

WW1 wintering barn – effluent volume

The same calculation applies to WW1's wintering barn, which is estimated to be 3,048 m^3.

Wintering barns – total volume of effluent

The volume total of effluent collected from the wintering barns has been calculated as approximately 6,096 m^3/year.

Other sources of effluent

UNDERPASS

An underpass connects WW2 blocks north and south of Wreys Bush Highway, which has a catchment of 200 m^2. The underpass has a concrete sump, from where rainfall and effluent are pumped to a dedicated sprinkler. The underpass has not been included in the Massey DESC report.

Rainfall site used in Massey DESC: Drummond Marson Road = 1.061 m per year
200 m^2 catchment X 1.061 m rainfall = 212 m^3 volume to discharge.

Underpass effluent is very dilute as it is primarily composed of rainwater. It is irrigated using a dedicated low rate sprinkler (at an instantaneous rate of less than 10 mm/hour and less than 10 mm depth per application).

The discharge is to paddocks close to the underpass (low risk soils). Underpass effluent is not discharged to a surface waterway either directly or by overland flow. There is no discharge of underpass effluent when the soil moisture exceeds field capacity.

The discharge of underpass effluent is:

- not within 20 metres of a surface waterway;
- not within 200 metres of a neighbouring dwelling;
- not within 20 metres of a boundary with another landholding; and
- not within 100 metres of a bore.

The maximum loading of N from underpass effluent does not exceed 150 kg N/hectare/year; it is very dilute. Due to its very small volume and highly dilute nature, the nutrient loadings and losses from underpass effluent are negligible compared to that from effluent, slurry and the overall farming activity. The extremely small quantity of nutrients that fall on the underpass and are discharged are accounted for in Overseer, through cow numbers, feed inputs and system losses. Underpasses are not modelled separately in Overseer due to the negligible contribution they make.

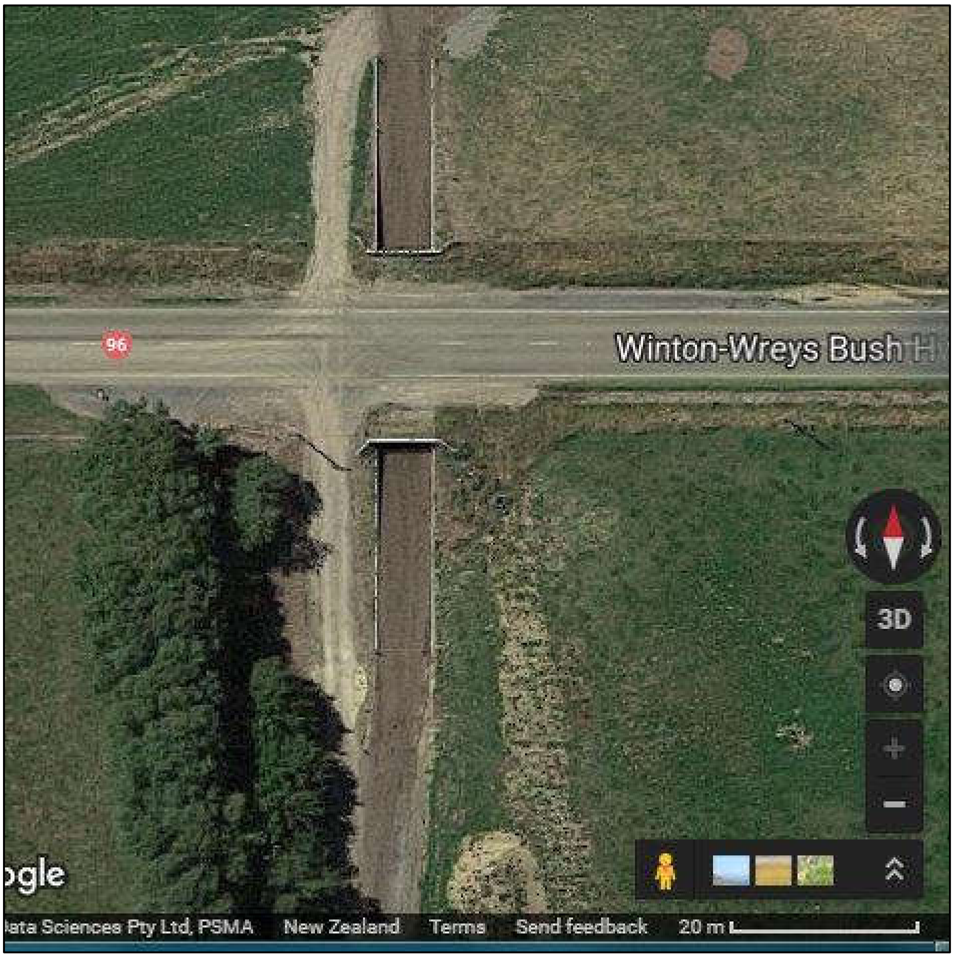


Figure 6.3 Aerial photograph of underpass.

SILAGE PAD - WW2

A concrete silage pad is located adjacent to the wintering barn at WW2. Its area is 1,200 m^2. It is constructed on a dry site. The silage pad has concrete walls and a dual drainage system; one for clean rainwater and one for silage leachate. Under the stack and immediately in front of it, the drains are opened into the leachate channel. This takes leachate to a sump from where it is pumped into the effluent storage pond and irrigated appropriately. The sumps in the rest of the pad are open to the farm drainage system so that clean rainwater can be diverted. Rain landing on the silage cover does not mix with leachate and is diverted to the farm drainage.

Only wilted silage is used to minimise the risk of creating leachate. The pad is empty for approximately 3-4 months per year. The silage pad catchment has been included in the Massey DESC report. Given the rainwater diversion in place when the pad is empty, and that rain landing on the cover does not mix with leachate so can be diverted to farm drainage, the silage pad leachate catchment is smaller than 1,200 m^2 for much of the year.

Good management practices for the concrete silage pad at WW2 are:

1. Only wilted silage is stored on the pad to minimise leachate generation;

2. The bunker is filled to the top of the walls with silage and the silage cover hangs over the walls so that rain landing on the silage cover does not mix with leachate.

3. The silage pad is flanked by 1.8 m high sealed concrete walls to prevent leachate escaping;

4. A dual drainage system is operated inside the wall on the low side; one for clean rainwater and one for silage leachate. Only leachate is collected, stored and discharged to land appropriately as follows:
    a. Drains at the front and underneath the stack are opened to the leachate channel. These drain leachate to a sump, from where it is pumped to WW2's effluent storage pond and irrigated appropriately. These areas capture no or minimal rainwater;
    b. The sumps in the rest of the pad are open to the farm drainage system so that clean rainwater can be diverted.

SILAGE PAD - WW1

The silage pad at WW1 meets permitted activity rules both for the use of land and for leachate management. See Section 2 for details. No effluent is collected and pumped to the storage system.

Figure 6.4 Silage pad at WW1

Figure 6.5 Silage pad at WW1

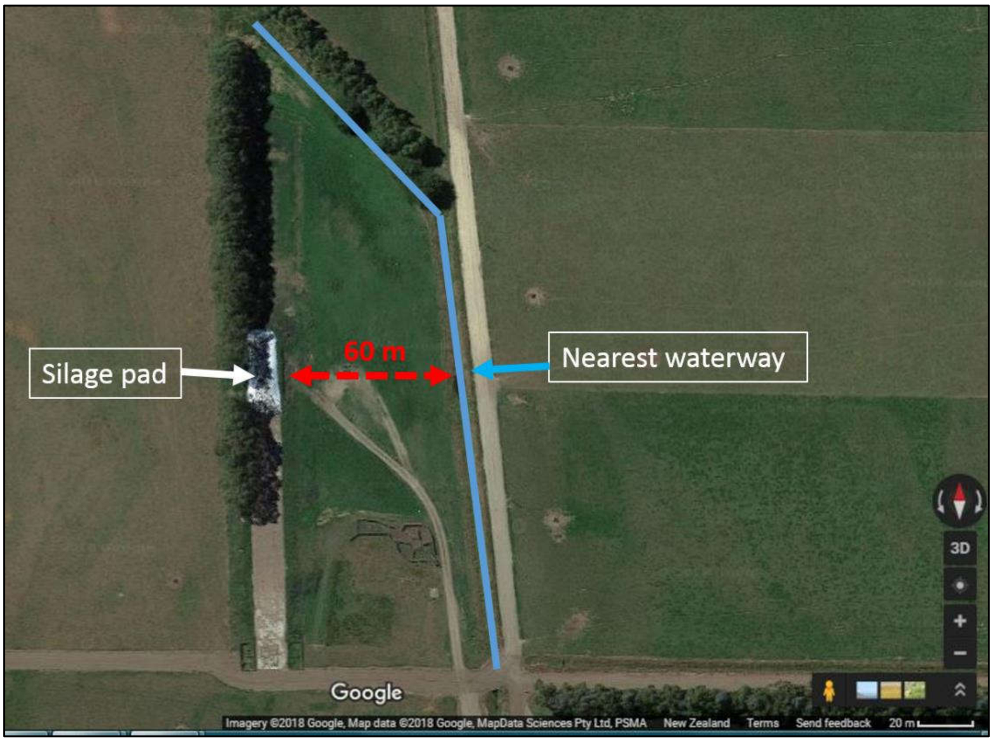


Figure 6.6 Location of the silage pad at WW1.

Effluent collection and storage system

WW1 - DAIRY SHED

The maximum daily dairy shed effluent volume comprises 35 cubic metres of effluent plus any rainfall.

I. Raw effluent from the dairy shed gravity feeds to a pump sump.
II. When soils are below field capacity and have sufficient soil moisture deficit, raw effluent is pumped to a travelling irrigator, from where it is applied to land at low depth.
III. When soils are near or at field capacity, raw effluent is pumped to the buffer storage pond and there is enough storage in the pond so that irrigation is not required.
IV. When soil moisture conditions are suitable for irrigation, raw effluent (slurry) from the pond is applied at low depth to land using a slurry tanker with a trailing shoe or using an umbilical system.
V. An off-season diversion is put in place at the dairy shed.

WW1 - WINTERING BARN

I. The effluent flows by gravity or is scraped to the concrete effluent collection sump, from where it is pumped to WW1 effluent storage pond.
II. The effluent is stored in the pond until soil moisture conditions allow for irrigation to occur.
III. The effluent is pumped from the pond to the slurry tanker with a trailing shoe or umbilical system and irrigated at very low depth to land; and
IV. A rainwater diversion is used in the off season.

WW2 - DAIRY SHED

The maximum daily dairy shed effluent volume comprises 40 cubic metres of effluent plus any rainfall.

I. Raw effluent from the dairy shed gravity feeds to a pump sump.
II. When soils are below field capacity and have sufficient soil moisture deficit, raw effluent is pumped to a travelling irrigator, from where it is applied to land at low depth.
III. When soils are near or at field capacity, raw effluent is pumped to the buffer storage pond and there is enough storage in the pond so that irrigation is not required.
IV. When soil moisture conditions are suitable for irrigation, raw effluent from the pond is applied to land at very low depth using a slurry tanker with a trailing shoe or using an umbilical system.
V. An off-season diversion is put in place at the dairy shed.

WW2 - WINTERING BARN

I. The effluent flows by gravity or is scraped to the effluent sump, from where it is pumped to WW2 effluent storage pond.
II. The effluent is stored in the pond until soil moisture conditions allow for irrigation to occur.
III. The effluent is pumped from the pond to the slurry tanker or umbilical system and irrigated at very low depth to land; and
IV. A rainwater diversion is used in the off season.

WW2 – SILAGE PAD

I. Drains at the front and underneath the stack are opened to the leachate channel. These drain leachate to a sump, from where it is pumped to WW2’s effluent storage pond and irrigated appropriately.

Storage capacity

WW1 – EFFLUENT STORAGE

The pond was upgraded in autumn 2018. As part of its upgrade the storage volume was increased and a synthetic liner (1.5 mm HDPE) was installed, overlying a leak detection system. The pond design was certified by a CPEng as meeting Practice Note 21 standards. The leak detection system terminates at a 400 mm diameter inspection well. The storage capacity of the pond is 4,281 metres cubed. The Massey Dairy Effluent Storage Calculator 90% storage probability volume for WW1 is 3,257 metres cubed, so has sufficient storage for 700 cows plus wintering barn effluent. See Appendix for the Massey DESC report.

WW1 - DESC PARAMETERS

- 700 cows milked at peak
- Milking season is 1 Aug – 15 June
- Yard is diverted from 16 June to 31 Aug
- Yard area – 553 m^2
- Milking shed roof area diverted.
- A maximum capacity of 640 cows wintered on a covered feedpad, which includes an uncovered area of 170 m^2 and is not diverted. The maximum capacity was used although 625 cows will be the maximum number housed in the barn.
- A winter/spring irrigation depth of 2 mm has been used. This reflects the predominant use of the trailing shoe slurry tanker to discharge slurry effluent from the storage pond, which can apply effluent to a depth of 1 mm if required. By applying effluent 20 m^3/hectare the slurry tanker applies slurry effluent to a depth of 2 mm. A low depth travelling irrigator is used to apply dairy shed effluent when there is sufficient soil moisture deficit.
- FDE area is split to reflect Drummond/Glenelg (low risk) and Braxton (high risk) soils at the milking platform and the Horner Block. Conservatively 50 hectares of low risk soils have been entered.

Note: if the dairy shed is upgraded/replaced in the future, additional storage is available in WW1's pond to allow for a larger yard catchment.

WW2 – EFFLUENT STORAGE

The storage capacity of the pond is 3,751 metres cubed. The Massey Dairy Effluent Storage Calculator 90% storage probability volume for WW1 is 3,203 metres cubed, so has sufficient storage for effluent from 800 cows, wintering barn effluent and silage pad leachate. See Appendix for the Massey DESC report.

WW2 - DESC PARAMETERS

- 800 cows milked at peak
- Milking season is 1 Aug – 15 June
- Yard is diverted from 16 June to 31 Aug
- Yard area – 1,126 m^2

- Milking shed roof diverted
- A maximum capacity of 640 cows wintered on a covered feedpad, which includes an uncovered area of 170 m^2 and is not diverted. The maximum capacity was used although 625 cows will be the maximum number housed in the barn.
- A silage pad catchment of 800 m^2 is entered under "Other catchments."
- A winter/spring irrigation depth of 2 mm has been used. This reflects the predominant use of the trailing shoe slurry tanker to discharge slurry effluent from the storage pond, which can apply effluent to a depth of 1 mm if required. By applying effluent 20 m^3/hectare the slurry tanker applies slurry effluent to a depth of 2 mm. A low depth travelling irrigator is used to apply dairy shed effluent when there is sufficient soil moisture deficit.
- FDE area is split to reflect Drummond/Glenelg (low risk) and Braxton (high risk) soils at the milking platform and the Horner Block. Conservatively 50 hectares of low risk soils have been entered.

WW1 and WW2 - Effluent irrigation

Primary irrigation methods – WW1&2 – low depth travelling irrigator

A low depth travelling irrigator system is used to apply dairy shed effluent to land at a depth of less than 10 mm per application. Two travelling irrigator systems are on farm, with one connected to each dairy shed. Both have been tested as per consent conditions and apply effluent at a depth of < 10 mm per application. See the Appendix for reports from testing each travelling irrigator.

The travelling irrigator systems have a safety system, which automatically switches the system off in the event of an effluent system failure, such as irrigator stoppage or breakdown.

Primary irrigation methods – WW1&2 and Horner Block – low depth slurry tanker with a trailing shoe

A low depth slurry tanker with a trailing shoe is used to apply pond slurry at a maximum depth of 2.5 mm per application. 2.5 mm is the maximum depth proposed as a consent condition.

It can apply slurry to depths as low as 1 mm depending on tractor speed. The applicants own a slurry tanker with a trailing shoe, which has a GPS system. The area and travel speed are monitored using the on-board GPS system. At a travel speed of 8-9 km/hour, the per hectare loading is 20 m^3, which gives a depth of 2 mm. By speeding up the tractor speed, the application depth of lowered further. The capacity of the slurry tanker is 24 metres cubed.

The trailing shoe part of the slurry tanker sits on the ground. It applies slurry at ground level and generates minimal aerosol and odour. It was invented in Europe to reduce adverse odours from the application of slurry/sludge to land, which is standard practice due to the housing of cows in barns over winter. It is regarded as an effective odour minimisation technology and is best practice for slurry/sludge application. Its use will help to avoid adverse odour effects on neighbouring properties.

Contingency method – WW1&2 and Horner Block – umbilical system

An umbilical system is used as a contingency irrigation method, with a maximum depth per application of pond slurry of 3.0 mm.

Future proof – WW1&2 – low rate irrigation

It is proposed to future proof the discharge activity by including low rate irrigation. The applicants may install a low rate system such as pods or a cannon/rain-gun system in the future. Both systems will apply dairy shed effluent at a maximum instantaneous rate of 10 mm/hour and a maximum depth of 10 mm per application.

By including both systems in the permit, the applicants will have flexibility when deciding which system is most suitable, while at the same time being able to assure Environment Southland via consent conditions that the new system will discharge effluent at low rate and low depth.

The system will only be plumbed to land authorised to receive liquid effluent (a.k.a. dairy shed effluent) on the discharge permit/Appendix 1 Discharge Map. If installed, the applicants intend to use a low rate system at times when the soil moisture deficit is too low to safely use the travelling irrigators. E.g. in the shoulders of the season, or in June and August if conditions are suitable and there is sufficient soil moisture deficit to irrigate at depths of 3 – 5 millimetres. The travelling irrigators would still be used over summer/early autumn when the soil moisture deficit is generally greater and irrigation of effluent at depths not exceeding 10 millimetres can be carried out without risk of drainage.

Note: The nutrient budgeting, proposal details and AEE used the high rate travelling irrigator as the primary irrigation system for dairy shed effluent. Low rate systems are regarded as best practice by Environment Southland, and as such will have similar or lesser effects as the high rate travelling irrigator system.

Other conditions – WW1&2

- A minimum return period of 28 days between applications;
- A maximum of 150 kg of N/hectare from agricultural effluent (dairy shed and pond slurry) is applied;
- No effluent is applied to soils showing evidence of cracking;
- A maximum combined depth of application of 25 mm per year for dairy shed effluent to any land area, and
- A minimum land area of 8 hectares/100 cows for the dairy shed effluent.

Other conditions – Horner Block

- A minimum return period of 28 days between applications;
- No effluent is applied to soils showing evidence of cracking; and
- A maximum of 250 kg of N/hectare from agricultural effluent (pond slurry) is applied.

WW1 and WW2 - Contingency measures

The aim is to operate the irrigation systems to always ensure there is buffer storage available. This allows a contingency for wet weather or pump failure.

The umbilical system may be used as a contingency irrigation method. The umbilical system will apply effluent at a maximum depth of application of 3 mm for each individual application.

Should the irrigation pump at either the WW1 or WW2 dairy sheds fail, a replacement pump is available within 12 hours. Alternately a petrol motor-driven or tractor driven pump could be hired. There is adequate storage to allow time for pump replacement.

Nutrient content of effluent

Dairy shed effluent

The nutrient content of dairy shed effluent has not been tested but is expected to be in line with typical dairy shed effluent[19]. An estimate for nutrient content of typical dairy shed effluent based on the above reference is as follows:

- 250 g/m^3 N
- 30 g/m^3 P
- 300 g/m^3 K
- 15 g/m^3 S

Discharging dairy shed effluent at a depth of 10 mm applies 25 kg of N/hectare, and 30 kg of K/hectare. Where the application depth is 9 mm, approximately 22.5 kg of N is applied per hectare.

Table 6.2 N loading from dairy shed effluent

	Dairy Shed
Number of cows	1,500
Nitrogen collected based on 50 L effluent per cow per day	0.013 kg N/cow/day
Daily nitrogen produced	19.5 kg N/day
Maximum days used per year	300
Annual nitrogen produced	5,850 kg N/year
Minimum annual size of discharge area (ha)	220 ha (WW1 + WW2)
Annual nitrogen loading rate	26.6 kg N/ha

Wintering barn effluent

The nutrient concentration of wintering barn effluent is higher than dairy shed effluent due to lack of dilution and the housing of cows in the barns for up 24 hours per day. Slurry effluent in the ponds is predominantly composed of wintering barn effluent, with minor dilution from rain falling on the pond, dairy shed effluent, which is diverted to the ponds when ground conditions are unsuitable for irrigation and silage leachate from WW2's pad.

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[19] Longhurst, Rajendram, Miller and Dexter (2017). Nutrient content of liquid and solid effluents on NZ dairy cow farms. Science and Policy: nutrient management challenges for the next generation. Occasional Report No. 30.

The nutrient content of pond effluent (slurry) was tested as part of a 2011 AgResearch study[20]. The nutrient content of slurry at the applicant's pond was measured at:

- 3,200 g/m^3 N
- 800 g/m^3 P
- 4,400 g/m^3 K
- 400 g/m^3 S

Applying 15.2 m^3/hectare applies slurry effluent at a depth of 1.5 mm. Discharging slurry effluent at 15.2 m^3/hectare applies:

- 49 kg of N;
- 12 kg of P;
- 69 kg of K; and
- 6 kg of S.

Slurry effluent is applied at the Horner Block and at WW1&2.

Given the use of the Horner Block for grass harvesting, slurry effluent from WW1 and WW2 is applied at very low depth as fertiliser, and grass is harvested and fed to cows at WW1&2 and at other dairy farms. Cows are not grazed at the Horner Block, so a higher slurry loading can be applied without the potential risk of adverse animal health effects due to excessive K levels and without the risk of adverse environmental effects due as described in the AEE.

Nitrogen fertiliser is reduced accordingly at both the Horner Block and WW1&2 to account for the N loading from slurry. Adverse N-related environmental effects are further avoided through the application of pond slurry at very low depths (less than or equal to 2.5 mm per application and typically at 1.5 – 2.0 mm depth per application).

E.g. Slurry effluent applied at 1.5 mm depth by applying 15.2 m^3/hectare, will apply 49 kg of N/hectare. A total of five applications at 1.5 mm depth each will apply a total of 243 kg N/hectare, which is less than the 250 kg N/hectare proposed limit for the Horner Block.

One application of slurry effluent at a similar depth and rate per hectare is also applied at WW1&2 to land that does not receive dairy shed effluent.

Slurry volume

Slurry volume is estimated based on the volume of wintering barn effluent (6,096 m^3), rainwater on the ponds' surface (606 m^3 for WW1, 912 m^3 for WW2) and an allowance for dairy shed effluent diverted to the ponds (2,400 m^3) given the presence of low risk soils and use of very low depth application using the slurry tanker/trailing shoe, which results in a large number of irrigation days available. The area available at the Horner Block (97 ha) and dairy platform (> 180 ha) is sufficiently large to receive the volume of slurry.

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[20] Houlbrooke, Longhurst, Orchiston & Muirhead (2011). Characterising dairy manures and slurries. AgReseacrh. Envirolink tools report AGRX0901.

Effluent discharge and receiving area

See table 1.1 for details of land areas within the discharge areas at WW1&2 and the Horner Block, which will be authorised on separate permits.

Effluent irrigation to the discharge areas is carried out between August and May, and if ground conditions permit in June and July as necessary. Overall, the effluent receiving area encompasses most of WW1&2 and the part of the Horner support block (c.97 hectares), less Council required buffers around waterways, bores, neighbouring dwellings, boundaries etc.:

- 20 metres from any surface watercourse;
- 100 metres from any potable water abstraction point;
- 20 metres from any property boundary (unless the adjoining landowner's consent is obtained to do otherwise);
- 200 metres from any residential dwelling other than residential dwellings on the property;
- Dairy shed effluent shall not be discharged onto any land area that has been grazed within the previous 5 – 10 days;
- Effluent shall not be discharged to leased land described as Lot 1 DP 451158, Lot 1 DP 13077 and Lot 1 DP 9925;
- Effluent shall not be discharged where the soil has cracked, and
- Effluent shall not be discharged over tiles or mole drains when the soil is at field capacity.

Allowing for the above buffers, a conservative estimate for the size of the effluent discharge area is c.350 hectares at WW1 and WW2, and c.97 hectares at the Horner Block, which gives a total FDE area of 447 hectares. Given the presence of Drummond/Glenelg soils, there are significant areas of low risk soils assuming the use of low depth irrigation.

At an operational level:

- Dairy shed effluent from WW1&2 will continue to be discharged via travelling irrigator at low depth; in the future a low rate irrigation system may be installed;
- Slurry effluent will be discharged at very low depth via slurry tanker (or umbilical system) at the WW1&2. This includes land referred to as the SH96/Marcel Block. A maximum of 150 kg N/ha/year from agricultural effluent will be applied at the dairy platform;
- Slurry effluent will be carted via slurry tanker and discharged at very low depth at the Horner Block. Approximately 97 hectares is available at the Horner Block for this purpose (see figure 6.7). A maximum of 250 kg N/ha/year from slurry will be applied at the Horner Block.
- The slurry effluent areas at the milking platform (WW1 and WW2) and at the Horner Block are sufficiently large to receive both the volume and N loading from the effluent ponds.

- Effluent will not be discharged at times where there is snow on the ground or when rainwater/irrigation water has ponded on the land surface.

- Effluent will also not be discharged when soil conditions are considered unsuitable i.e. when soil temperature is at or below 5 degrees Celsius or when the soil moisture deficit is insufficient. Environment Southland's Beacon website will be consulted as a guide to soil moisture levels.

Figure 6.7 Horner support block with slurry effluent area annotated in purple.

Horner Block – slurry receiving area

The discharge of slurry from WW1&2 at the Horner Block will be authorised on a separate discharge permit. The Horner Block has no effluent storage or permanent irrigation infrastructure. The slurry tanker with the trailing show will be used to discharge pond slurry at the Horner Block, with an umbilical system used as a contingency.

Land use

Land is used as for cut and carry, and to discharge slurry effluent from ponds at WW1&2 and from WW3. No stock is grazed at the block so there is no nutrient loss from urine patches. Cut and carry block are used to grow grass only, typically having 4 cuts per season. Relatively high N inputs are required to achieve this. In this case fertiliser and slurry provide N. Cut and carry blocks are efficient at utilising N and generally have low N loss to water despite relatively high N inputs.

The block (160 ha) will continue to be managed as it has been managed in recent years. A general description of how the block will be managed is as follows:

Cut and carry

- Pasture renewal - the pasture renewal programme is by grass to grass cultivation. Approximately 5% is re-grassed each year.
- Grass (approximately 17 t DM/ha) is harvested and is purchased by dairy farms in the Woldwide Farming Group (including WW1 and WW2 and other farms). Some grass harvested is fed fresh or is stored as silage and fed to cows at wintering barns at WW1 and WW2.

Slurry

Slurry (from WW1&2) receiving area: 97 hectares

N loading: 5 applications of slurry at 15.2 m^3 per hectare per application = 243 kg N/ha from slurry

Woldwide Three: 57.5 hectares (not part of this application)

General fertiliser use

For a detailed fertiliser programme, please see the nutrient budget inputs. N, P, K and S are applied as follows:

- N (207 kg/ha – split applications, little and often)
- P (10 kg/ha)
- K (0)

Fertiliser is applied outside high risk months (i.e. May – July). If ground conditions are suitable and there is minimal risk of drainage, fertiliser can be applied in August.

Downstream users of groundwater

- Farmland is found due south of the HB. Downstream users of groundwater are farms (sheep, dairy and cropping).
- Drummond Township is located ~ 9 km to the south east of the HB so has domestic users of groundwater including Drummond Primary School and Drummond Kindergarten. Both are located at the south of the township.

6.3 Water Take

Groundwater is abstracted from three bores for use at the dairy sheds and to supply stock drinking water. The bores are over 100 metres apart. Two bores supply groundwater to the WW2 unit, one bore supplies groundwater to the WW1 unit. **The maximum volume of groundwater abstracted for 1,500 cows will be 180 meters cubed per day.** This is abstracted as follows:

> **WW1 -**The bore (well ID E45/0071) is located to the west of the dairy shed and supplies water via a submersible pump to three tanks (3 x 30,000 litres) at the dairy shed for stock drinking water and dairy shed use. The abstraction for WW1 is currently managed under Water Permit 301664. **It is proposed to increase the groundwater take to meet the needs of 700 cows milked through the WW1 dairy shed.** The proposed groundwater take at the WW1 unit is 84,000 litres per day.
>
> **WW2** - Two bores (well ID E45/0727 and E45/0083) supply groundwater for dairy use; one is adjacent to Wreys Bush Highway north of the dairy shed, and the other is on the west side of the dairy shed. The two bores supply water via submersible pumps to three tanks (3 x 30,000 litres) at the dairy shed for stock drinking water and dairy shed use. The abstraction for WW2 is currently managed under Water Permit 20171278-02. **The proposed groundwater take at WW2 is the same as the existing take to meet the needs of 800 cows milked through the dairy shed.** The proposed groundwater take at WW2 unit is remaining at 96,000 litres per day.

Groundwater use equates to 120 litres per cow per day and is in line with the Council's standard estimate for water usage (i.e. 70 litres per cow per day for drinking water and 50 litres per cow per day for dairy shed washdown).

Water requirements

Season

During the milking season (twice per day milking), requirements are 70 l/cow/day for drinking water and 50 l/cow/day for dairy shed wash down water:

1,500 cows x 120 l/day = 180,000 litres per day

180,000 litres per day is split between the WW1 (84,000 litres per day) and WW2 (96,000 litres per day) dairy units.

An average lactation length is 280 days.

280 days x 180,000 litres per day = 50,400,000 litres

Off season

Cows remain on-farm over winter when they are housed in two wintering barns. An average lactation length for cows is 280 days, which leaves an average of 85 days when cows are dry. A drinking water allowance for dry cows is 45 l/cow/day. On average 1,280 cows require drinking water in the off season for 85 days:

1,280 cows x 45 l/day x 85 days = 4,896,000 litres for the off season.

Total volume of groundwater required

55,296,000 litres or 55,296 metres cubed

Extraction

Groundwater is abstracted from three bores over 50 metres apart from each other, which ensures that the abstraction rate will be less than 2 L/sec.

Average daily rate of take (WW1)	0.97	litres per second
Average daily rate of take (WW2)	1.11	litres per second
Maximum daily rate of take	2.0	litres per second
Maximum daily volume	180	cubic metres per day
Maximum weekly volume	1,260	cubic metres per week
Maximum monthly volume	5,400	cubic metres per month (30-day month)
Maximum annual volume	55,296	cubic meters

The bores are over 50 metres apart from each other. The bores are not within 700 metres of a neighbouring bore or groundwater take.

The dairy supply bore map references (NZTM2000) are:

- E45/0083	E1225011	N4889693
- E45/0727	E1225014	N4890268
- E45/0071	E1225145	N4888768

Water storage

Three water storage tanks (3 x 30,000 L) are utilised at WW1's dairy shed to ensure that the rate of take is less than 2 L/sec.

Three water storage tanks (3 x 30,000 L) are utilised at WW2's dairy shed to ensure that the rate of take is less than 2 L/sec.

6.4 Proposed land-use – dairy farming

WW1&2 Land use activities

Land use

The land is used as a pasture based dairy farm. Calving officially starts on 1 August and cows are typically milked from 1 August to 31 May, with late calving cows milked until 15 June. Cows (Friesan) are milked twice per day.

Stock management

- Up to 1,500 cows (i.e. mixed age cows and replacements) are calved each year. The milking herd peaks in October/November at 1,500. It drops slightly over consecutive months depending on seasonal variation in pasture production; approximately 1,410 cows are milked in March. Cows are dried off in May and June. Approximately 375 cows (25%) are culled by May/June and replaced each year.

- Median calving date is 20 August with approximately 417 heifer calves kept as replacements. R1 calves are on farm for August, September and October. Replacement calf numbers will be reduced by 10% over the following 21 months through deaths/culling, leaving 375 R2 heifers to be wintered, calve and join the milking herd at WW1&2.

  Activities at WRO are explained in detail in the WRO section of the application:
    - In November, weaned R1 calves go to WRO where they remain for approximately 19-21 months. All R1 heifers are IWG at WRO in June/July.
    - Once grown out to R2s, heifers are mated.

    - In-calf R2 heifers are either wintered in barns at WW1&2 (up to 125) or IWG at WRO.
    - The long-term goal is to house all in-calf R2 heifers from WW1&2 in winter barns although that is not part of this proposal.

- Approximately 375 in-calf R2 heifer replacements return to WW1&2, calve in August, September and October when they join the milking herd.
- Approximately 15 bulls are grazed on farm and used as part of the mating programme each year.

Wintering, cropping, grazing and supplements – WW1&2

- Wintering – all MA cows are wintered on farm where they are housed in two wintering barns over June and July. Depending on the season, R2 heifers (c.125) are also wintered in barns. Cows are housed in barns during May, August and September as required also.
- Fodder crop – no fodder crops (brassica or beet) are sown. Animals are not IWG or grazed on fodder crop at any other time.
- Pasture renewal - the pasture renewal programme is by grass to grass cultivation. Approximately 5% of the farm is re-grassed each year.
- Grazing – cows are grazed on pasture throughout the season. The wintering barns are used to stand cows off paddocks during the shoulders of the season and during high risk inclement weather events throughout the season.
- Supplements made – If there is a surplus, silage may be harvested at the dairy farm. There is no dedicated silage block, however, and in general silage is imported.
- Supplements imported – barley, molasses, PKE and grass silage (see nutrient budget inputs)

General fertiliser use

For a detailed fertiliser programme, please see the nutrient budget inputs. N, P, K and S are applied as follows:

Effluent block:

- N (139 kg/ha – split applications, little and often)
- P (25 kg/ha)
- K (0)

Slurry receiving area:

- N (179 kg/ha – split applications, little and often)
- P (22 kg/ha)
- K (0)

Non-effluent blocks:

- N (209 kg/ha – split applications, little and often)
- P (34 kg/ha)
- K (28 kg K/ha)

Fertiliser is applied outside high risk months (i.e. May – July). If ground conditions are suitable and there is minimal risk of drainage, fertiliser is applied in split applications from August to April.

Good Management Practices

Good management practices (GMPs) implemented on farm are also described in the FEMP. A general strategy of good management practice is undertaken to minimise contaminant losses across the whole activity. Details are described in table 6.3 below. Key mitigation measures (distinct from GMPS) are described in table 7.1.

Evidence of sustainable soil and nutrient management is clear in trends in soil testing over many years. See the Appendix for reports from Ravendown supporting good practice management of farm soils and farm fertility.

Table 6.3 General Good Management Practices – WW1&2

Strategy Type	Summary of Management Practices
Operational	Utilising a nutrient management plan; Soil testing is carried out each year to inform on decision making regarding fertiliser application; Trends in soil testing are evaluated and used to inform on decision making regarding soil health, fertiliser and agronomy plans; Surface waterways are fully fenced and with good grass cover, fencing is maintained and stock are excluded from the riparian areas; Wide riparian buffers are maintained; All surface waterways are culverted; Sufficient land area is available for the dairy operation; Young stock is grazed off farm from weaning; All cows are wintered in barns over June and July; Tracks and lanes predominantly sited away from streams; Lane runoff diverted to land; Good management practice of the silage pad is implemented; Restricted grazing of draining pastures in autumn/spring; Specialist machinery is used to harvest grass to minimise the risk of soil compaction; Care in irrigation of FDE, especially when the ground is near or at field capacity; A large land application area is available to ensure N & K returns are not excessive, taking into account the higher strength nature of slurry effluent; Effluent volumes are minimized at source through efficient water use; Appropriate application depths for liquid effluent (a maximum of 10 mm depth per application and less than 50% PAW on Category E soils) and slurry (a maximum of 2.5 mm depth per application across the WW1&2 and the Horner Block) are used;

	Appropriate effluent storage volume to allow for deferred irrigation; All data and maps are kept up to date and all staff are trained and informed of any changes; Programmed maintenance is done in and around FDE, and piping infrastructure around the dairy shed, silage bunkers, cow yards etc.;

Good Management Practices for Key Transport Pathways – WW1&2

See table 6.4 below for a summary of physiographic zones and key transport pathways of contaminants.

Table 6.4 Physiographic zones and key transport pathways

Physiographic Zone	Variant	Key Transport Pathways
Central Plains	n/a	Artificial drainage, deep drainage
Oxidising	n/a	Deep drainage

WW1&2 is classed in the Oxidising and Central Plains physiographic zones. The Horner support block also is classed both in the Oxidising and Central Plains physiographic zones.

Both physiographic types are susceptible to nitrate accumulation in soils and aquifers. Nitrates are transported to the underlying aquifer via deep drainage. Central Plain's type soils (Braxton) have risk of nitrate and contaminant (pathogen) loss to groundwater via deep cracks that can form in silty clay soils over extended dry summer periods. Subsequent heavy rainfall can transport nitrate or microbes down to the underlying aquifer. There is risk of contaminant loss (nutrients N and P, sediment and microbes) to surfacewaters via artificial drainage in Central Plain's type soils following heavy or prolonged rainfall.

Given the very flat topography and the tendency of soils to have good phosphorous retention, there is low risk of contaminant loss to surface waters via overland flow. Any risk of contaminant loss to surface waters from tracks and lanes via overland flow is mitigated by good management of areas where tracks and lanes are close to surface waters.

Recommendations described on Good Practice Management factsheets issues by Environment are implemented where practical. These measures will be reviewed annually with the inclusion of new measures where appropriate. Table 6.5 describes good management practices, which have been implemented on-farm through most recent annual cycle to mitigate the risk of contaminant loss to water (N, P, sediment and microbes).

Reference factsheets: Artificial drainage; Deep drainage; Overland flow

Table 6.5 Good management practices implemented on farm and further explanations.

Transport Pathway	Environmental outcome	Summary of Management Practices
Artificial drainage,	Protect soil structure	Match stock management to land use capability, e.g. avoid grazing cows on more vulnerable soils, especially when wet.

Overland flow	(especially near streams)	Fence off waterways. Stock will not graze riparian strips. Riparian strips are approximately 3 m and well are vegetated; All cows are wintered off paddocks in wintering barns; When appropriate use minimum or no-till cultivation practices such as direct drilling; Re-sow areas of bare or damaged soil as soon as is practical;
Artificial drainage, Overland flow	Reduce P use or loss	Prepare a nutrient budget; Soil test regularly; Maintain Olsen P values at agronomic optimum and no higher; Apply P fertiliser outside of high-risk months in autumn and winter; Manage CSAs close to surface drains appropriately. During and following inclement weather, CSAs close to surface drains will be temporarily fenced off to prevent stock from damaging soils and from adding nutrients to high drainage locations. No effluent will be discharged to the same areas;
Artificial drainage, Deep drainage	Reduce accumulation of surplus N in the soil, particularly during autumn and winter	Maintain sustainable stocking rate (3.1 cows/ha at WW1&2); Reduce inputs of N where possible through optimal fertilizer application on farm, use little and often approach; All MA cows are wintered off paddocks in wintering barns; Optimize timing and amounts of effluent irrigation input applications, accounting for higher strength nature of slurry effluent; Substitute autumn diets with low-N feed when practical; Time N application to meet pasture demand using split applications and when pastures are actively growing (>6 degrees Celsius); Control the duration of grazing pastures; Cut and carry feed where practical;
Artificial Drainage Deep drainage	Avoid preferential flow of effluent through drains or soil cracks	Defer irrigation to effluent storage ponds when soil conditions are unsuitable; Very low depth slurry application is implemented; Low depth dairy shed effluent application is implemented;

		Avoid applying slurry or dairy shed effluent where soils are cracked; A sufficiently large FDE area is available for effluent; Observe buffer zones and placement guidelines; Observe discharge consent conditions;
Overland flow	Manage CSAs; low areas overlying tiles close to outfalls at surface drains	Restrict grazing of pasture CSAs when soils are near saturation; Avoid working pasture CSAs and their margins; Move troughs and gateways away from water flow paths; Reduce runoff from tracks and races;
Deep drainage	Avoid loss of contaminants (nitrate and faecal microbes) to groundwater via deep cracks formed in summer dry periods in Braxton soil types.	Monitor paddocks for deep cracks in summer/autumn. If and where they form, avoid grazing the area and irrigating effluent to the area; Avoid deep crack formation by maintaining good soil structure and good pasture cover;

Specific Mitigation Measures – Expansion

The change to the 1,500-cow system brings in an additional 160 cows. This will occur in conjunction with key mitigation measures to off-set nutrient and contaminant losses potentially generated by additional cows. Overseer predicts that the average annual N loss for WW1&2 will decrease slightly per hectare and that P loss will remain stable per hectare. Some key mitigation measures not recognised by Overseer will further reduce contaminant loss, although these are not recognised by Overseer. P loss can generally be used as a proxy for sediment and microbial loss.

Key mitigation measures are described in table 7.1, along with an assessment of their effectiveness and level of effectiveness.

FURTHER INFORMATION REGARDING MITIGATION MEASURE #6 (FROM TABLE 7.1)

Two lanes lie adjacent to a stream close to the WW1 wintering barn (see figure 6.8). Only one of these lanes (i.e. the east side lane), however, is used for cow traffic to the milking shed. The west side lane is solely used to truck silage in and for truck access to the cattle yards to load and unload stock. Cows do not use the west lane, so it only collects rainwater. Since there is no cow traffic on the west side lane, there is no risk of runoff of contaminants (containing phosphorous or microbes) from dung or urine to the stream.

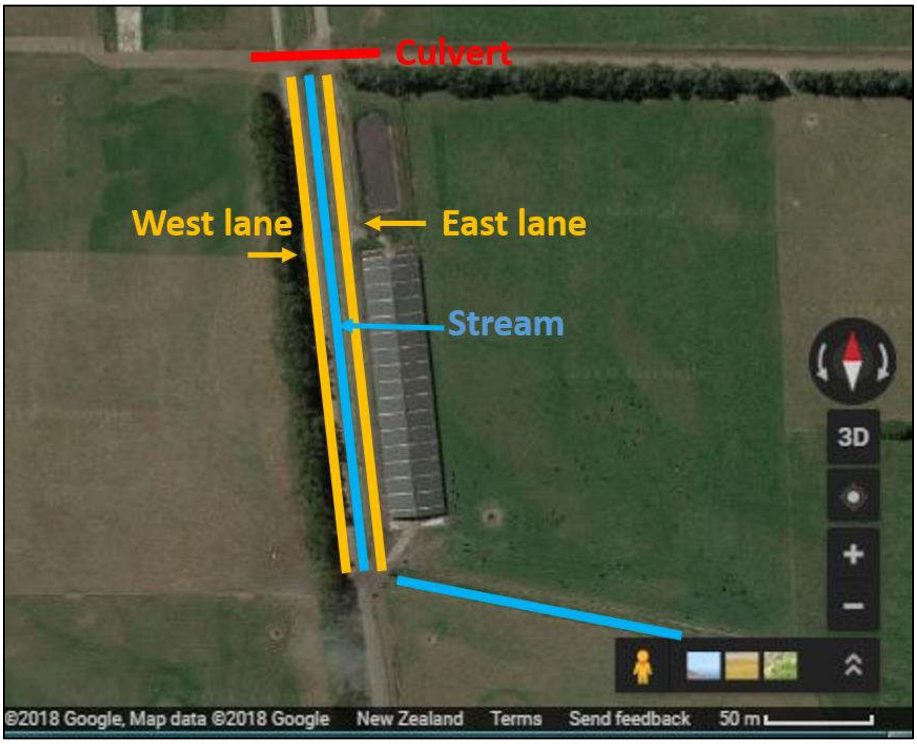

Figure 6.8 Aerial photo of stream flanked by two lanes at WW1, close to wintering barn and north of milking shed.

The east lane has cow traffic, as seen the below figures. The stream is protected by a wide buffer (>3 m) that has a slope of approximately 30 degrees and is vegetated with long grass. In view of an additional 160 cows using the lane, work has recently been carried out to contour the lane to ensure rain falling on the lane drains away from the adjacent stream. This measure will be effective at preventing runoff to the stream, which otherwise could be a greater risk with additional cows. Good grass cover will always be maintained on the stream bank to further protect the stream.

In the below photo, water flowing in the stream appears clear, which is noteworthy as the photos were taken after 40 mm of rainfall in the previous week.

Figure 6.9 Stream flanked by two lanes. Note that photo was taken from the north/facing south.

Figure 6.10 Cows crossing waterway over culvert to walk to the dairy shed on the east lane.

Overseer summary

N LOSS

The key drivers of the small decrease in N loss (kg/ha) despite an additional 160 cows are as summarised follows:

- Removal of summer and winter crop;
- Removal of cows wintered outside on crop or grass;
- Expansion of size and use of wintering barn facilities;
- More efficient use of N fertiliser.

N losses from crop blocks are driven by fertiliser and effluent application, as well as mineralization processes and accumulation of cow excreta associated. The proposed system has no fodder crops/IWG annually. The effect of this is to reduce the average N loss slightly, despite increasing cow numbers by 160.

P LOSS

The key drivers of a stable P loss (kg/ha) despite an additional 160 cows are summarised as follows:

- Decrease in winter crop area;
- Maintaining Olsen P at target level of 30;
- Expansion of size and use of wintering barn facilities.

The key measures that will mitigate P loss also will help to mitigate the loss of sediment and microbial contaminants to water, as they are generally transported to water via artificial drainage and overland flow also.

OTHER MITIGATION MEASURES FOR P LOSS

Other measures that mitigate P, sediment and microbial contaminant loss that are not modelled by Overseer prevent overland flow from critical infrastructure to surface waterways following periods of heavy rainfall. This greatly reduces the propensity of a pathway that transports P (and sediment and microbes) directly to surface waterways. P remains on lanes and/or is returned to adjacent paddocks where it is filtered, attenuated and can be taken up by plants.

These measures include:

- Only a small proportion of lanes run parallel to or close to waterways. This greatly reduces the risk of runoff from tracks and lanes into waterways. Overseer does not recognise the layout of individual farms;
- Herd movement is managed to minimise the time cows spend on lanes and other tracks, especially where there is a risk of runoff to waterways;
- Minimise the number of culvert/bridge crossings of waterways, where run-off from tracks and lanes can reach surface waterways. Any locations where run-off could potentially occur are identified as CSAs and managed to minimise the risk of runoff occurring. Track shaping and cutting is carried out to direct surface drainage at such locations to paddocks and away from waterways. If necessary, nib boarding is put in place. Runoff is filtered through pasture before draining to waterways.

Review

A review of good management practices and mitigation measures will be carried out annually. Practices undertaken in the previous 1 June to 31 May period will be reviewed and practices will be implemented over the following 1 June to 31 May as appropriate.

Nutrient budgets

Seven nutrient budgets (NBs) have been prepared:

- Four pre-expansion nutrient budgets have been prepared based on actual figures for 2013/14, 2014/15, 2015/16 and 2016/17 years. A high level of evidence has been provided to support inputs used for all year end nutrient budgets.
- One nutrient budget has been prepared to for the proposed 1,500 cow system at WW1&2.
- Two nutrient budgets for the Horner Block (one current and one proposed).
  - Environment Southland have since been advised via a legal opinion that the Horner Block is not required to be on the land use consent for farming; as such nutrient budgets are not needed. Since nutrient budgets were already prepared for the Horner Block, they will be used as a useful information source.
- One nutrient budget has been prepared for WRO based on the 2017/18 year.

Cain Duncan (CNMA) from Farm Source Sustainable Dairying carried out all Overseer work. Soil nutrient test data, the latest version of the Overseer model (ver. 6.3.1) and Overseer Best Practice Data Input Standards were used. Associated XML files have been submitted electronically.

Table 6.6 Overseer files

Number	Year	XML file name
1	2013/2014	Ovr-Woldwide 1,2 & 96 13_14 (2).xml
2	2014/2015	Ovr-Woldwide 1,2 & 96 14_15 (2).xml
3	2015/2016	Ovr-Woldwide 1,2 & 96 15_16 (2).xml
4	2016/2017	Ovr-Woldwide 1,2 & 96 16_17 (2).xml
5	Proposed WW1&2	Ovr-Woldwide 1&2 Proposed (Mitigations & Slurry) (2).xml
6	Current use - Horner Block	Ovr-Horner Block -Current (3).xml
7	Proposed use - Horner Block	Ovr-Horner Block - Proposed (3).xml
8	2017/18 – WRO	Ovr-Woldwide Runoff (Merrivale & Merriburn).xml

Mr. Duncan also prepared an in-depth nutrient budget analysis report for WW1&2 and the Horner Block, which is submitted with this application. Rather than duplicate material, please refer to the appended nutrient budget analysis report for assumptions and a summary of inputs for each nutrient budget:

- Assumptions: Sections 5, 6 and 7
- Inputs: Section 9, 12

Nutrient budgets 1 – 5 from the above table contain the same land areas: former WW1 milking platform, former WW2 milking platform, Marcel Block and SH96 block.

Where the nutrient budget report by Mr. Duncan states that the land area is being increased by bringing in support land, this refers to the SH96 and Marcel Blocks, which were consented for dairy farming as part of WW2's land use consent for farming granted in 2017. Mr. Duncan has also prepared detailed maps and a summary for each individual nutrient budget as part of the report.

The WRO nutrient budget is described in a separate report prepared by Mr. Duncan. Outputs from the WRO nutrient budget are detailed in the WRO section of the application.

Nutrient Losses as Modelled by Overseer – WW1&2

PRE-EXPANSION

Table 6.7 Modelled nutrient losses for pre-expansion year end nutrient budgets (source: Nutrient Budget Analysis Report).

	13/14	14/15	15/16	16/17	Average
Total N Loss (kg)	19055	23016	19112	20723	20477
N Loss/ha (kg)	40 (15)	46	38	41	41
N Concentration in Drainage (ppm)	7.3 - 12.9 (Pastoral) 16.4 - 27.1 (Crops) 5.9 – 12.5 (Silage/WGYS)	9.9 – 15.7 (Pastoral) 13.5 - 17.6 (Crops) 5.9 – 9.5 (Silage/WGYS)	7.3 – 14.3 (Pastoral) 13.1 - 18.8 (Crops) 4.0 – 9.8 (Silage/WGYS)	8.5 – 15.3 (Pastoral) 18.0 - 23.8 (Crops) 2.9 – 7.5 (Silage)	
Total P Loss (kg)	345	374	362	357	360
P Loss/ha (kg)	0.7 (0.2)	0.7	0.7	0.7	0.7
Pasture Grown Kg/DM/ha/yr (Dairy Platforms)	15,003	15,483	15,089	15,909	15,371

PROPOSED

Table 6.8 Modelled nutrient losses for post-expansion nutrient budget (Source: nutrient budget analysis report).

	Proposed Dairy Unit
Total N Loss (kg)	20,262
N Loss/ha (kg)	40
N Concentration in Drainage (ppm)	Pastoral – 7.8 to 17.2 ppm

Total P Loss (kg)	357
P loss/ha (kg)	0.7
Pasture Grown Kg/DM/ha/yr	15,544

Discussion – nutrient losses at WW1&2

N LOSS

The pre-expansion average annual N loss based on four years of supported data and analysis is 20,477 kg/year. The proposed 1,500 cow dairy farm is predicted by Overseer to have an average N loss of 20,262 kg/year. Overseer predicts an average reduction in N loss of 215 kg/year with the change to the proposed system. The N loss per hectare value for the proposed 1,500 cow farm (40 kg/year) is predicted to reduce slightly relative to the pre-expansion land use (41 kg/year).

This decrease is mainly driven by the removal of forage brassica and beet winter and summer crops, and their associated IWG or summer grazing, the removal of pasture grazing in winter, greater use of the wintering barns and more efficient fertiliser use. Soil aggregates are broken up and mixed when cultivated for cropping. This results in a high rate of N mineralisation through accelerated microbial decomposition of soil organic matter and subsequent rapid nitrification, which produces large quantities of nitrate. Dung and urine are deposited in relatively high volumes on winter crop ground, further driving losses of N. This is especially seen during late winter and early spring, when the ground lies fallow. Greater use of the wintering barn facilities allows the collection and storage of nutrients in dung and urine, some of which were previously deposited on winter crop and grass paddocks as they were grazed. Because of significant changes in management practices, the proposed 1,500 cow system is predicted to have slightly less average annual N loss than the pre-expansion system despite an increase of 160 cows.

Pasture production is similar for both the pre-expansion system (15,371 kg DM/ha/year) and the proposed 1,500 cow farm (15,544 kg DM/ha/year).

P LOSS

The pre-expansion average annual P loss is based on four years of supported data and analysis is 360 kg/year. The proposed 1,500 cow dairy farm is predicted to have an average P loss of 357 kg/year, which is essentially no change. The per hectare P loss value for the proposed 1,500 cow farm (0.7 kg/year) is predicted to remain as for the pre-expansion land use (0.7 kg/year). For both the pre-expansion and proposed system, the risk of P loss from effluent is classed by Overseer as low for all blocks. The risk of P loss from soil and fertiliser is classed as low for all soil type blocks.

The key drivers of the stable predicted P loss are the removal of forage brassica and beet winter and summer crops, and their associated grazing, the maintenance of Olsen P at a target of 30, and the expansion in size and use of the wintering barns.

As already explained, effective measures to mitigate P loss that are not detected by Overseer will also be implemented on farm.

Nutrient loss – Horner Block

The current nutrient budget represents a conservative approach to modelling the existing nitrogen and phosphorus losses on the HB.

~~Under both current and proposed land use, the Horner Block has very low nutrient losses. The current use is predicted to have an annual average N loss of 20 kg/hectare; the proposed has N loss of 19 kg/hectare. The current use is predicted to have an average P loss of 0.1 kg/hectare; the proposed has P loss of 0.1 kg/hectare.~~

~~Discussion – effects of losses~~

~~Please see Section 7 (AEE) for a discussion on the effects of predicted nutrient losses.~~

7. Assessment of Environmental Effects/Mitigations

An assessment of effects in accordance with Schedule 4 of the RMA is provided in this section. The assessment has been prepared in three sections covering the discharge activity, water take and land use/farming activity respectively, since each will be authorised on its own consent; discharge permits, water permit and land use consent for farming respectively.

The discharge activity will be authorised on two permits, one each for WW1&2 and the Horner Block respectively.

The discharge activity is part of the overall farming activity, so information provided in section 7.1 is also relevant to the AEE for the farming activity (section 7.3).

7.1 Effluent discharge activity

Odour

Adverse effects from odour can occur due to the discharge of agricultural effluent (liquid and slurry) where it may be encountered beyond the boundary of the site. The applicants have proposed the continued use of very low depth and low depth application technology, which coupled with the proposed effluent discharge buffers means there is little risk of adverse effects from odour and spray drift on surrounding land owners and occupiers. They irrigate according to wind direction and risk, which helps to avoid adverse odour effects.

Slurry is applied a very low depth using the slurry tanker with the trailing shoe. The trailing shoe part of the slurry tanker sits on the ground. It applies sludge at ground level and generates minimal aerosol and odour. It was invented in Europe to reduce adverse odours from the application of slurry/sludge to land, which is standard practice due to the housing of cows in barns over winter. It is regarded to be an effective odour minimisation technology and is best practice for slurry application. Its use will help to avoid adverse odour effects on neighbouring properties.

Risks to surfacewaters from effluent discharge

Adverse effects on surface water can occur from the discharge of farm dairy effluent where contaminants present in effluent such as nutrients N and P, organic matter and microbes reach receiving surface waters such as streams, rivers and estuaries. Effects such as nutrient enrichment of surface waters *are cumulative*, and can lead to algal blooms including slime, and promote nuisance aquatic plant growth. The collection of plants and animals that inhabit receiving waters are adversely affected by nuisance plant growth, as well as in-stream values such as biodiversity and ecosystem services. Values associated with surfacewater streams and coastal waters are many and relate to the landscape, biodiversity, history and people living in the catchment. These values include maintaining the health of water bodies both in-stream and coastal, protecting biodiversity and ecosystems, protecting recreational activities such as fishing, walking and boating; protecting human and animal health, maintaining sustainable farming practices and the socioeconomic well-being of people through preserving values that relate to inshore fishing, farming and tourism. Iwi/cultural values include the principles of protection or kaitiakitanga of the mauri of the water and mana of the land, while minimising adverse effects on taonga and mahinga kai.

WW1&2 receiving surface waters predominantly lie in the Waimatuku Stream catchment, Waimatuku Estuary and coastal waters, as well as New River Estuary catchment. Horner Block receiving waters also lie in the Waimatuku Stream and Waimatuku Estuary, as well as in the Aparima River, Jacobs River Estuary and coastal waters. These are considered sensitive environments due to the accumulation of nutrients, sediment and microbes. Receiving waters show evidence of land use impacts, with elevated levels of nutrients, sediment and algal blooms at times. The Waimatuku Stream catchment shows higher levels of nutrients than the Aparima River or Oreti River catchments.

Artificial drainage is a contaminant pathway, particularly subsurface drainage channels installed in silty clay Braxton soil types. Artificial drainage transports contaminants via bypass drainage to receiving surfacewaters during and following periods of heavy rainfall. Parts of the discharge area with Braxton soils types at both WW1&2 and the Horner Block are high risk for effluent discharge and require appropriate management of effluent discharge to mitigate the risk of contaminant loss to surfacewaters. Braxton soils are found in the Waimatuku catchment. Shallow groundwater in the Waimatuku catchment is understood to discharge to the local stream network and can potentially contribute cumulatively to adverse effects on surfacewaters.

Risks to Drummond Peat Swamp and Bayswater Bog are described and effects are assessed in section 5.

Risks to groundwater from effluent discharge

Adverse effects on groundwater can occur from the discharge of agricultural effluent where contaminants present in effluent such as nutrients N (nitrate) and microbes (pathogens such as campylobacter) reach receiving groundwaters via leaching/deep drainage pathways. A major risk of elevated nitrate levels in groundwater is to users (consumers) of groundwater as nitrate becomes toxic to living organisms such as humans, animals and fish at high levels. The New Zealand Drinking Water Standard maximum allowable value for nitrate is 11.3 ppm. Another risk is to consumers of groundwater is waterborne gastroenteritis through the ingestion of groundwater contaminated with pathogens such as campylobacter. This was demonstrated in Havelock North in 2016, when over 5,000 people became ill with camplyobacteriosis. Adverse effects on other users of groundwater such as other farms, small industries, schools or settlements/domestic users are possible and need to be avoided. Particularly, any risk from the discharge activity to the drinking water supply at Heddon Bush School 2.3 km south of the property needs to be avoided. *E.coli* is widely used as an indicator of faecal microbial contamination of water, including groundwater.

WW1&2 predominantly overlies the Waimatuku Groundwater Zone. The eastern part of WW1&2 overlies the Central Plains Groundwater Zone. The eastern part of the Horner Block overlies the Waimatuku Groundwater Zone and the western part overlies the Upper Aparima Groundwater Zone. Heddon Bush School also overlies the Waimatuku Groundwater Zone. Although Drummond and Glenlg soil types have risk of contaminant loss via deep drainage to underlying aquifers, they are low risk for effluent discharge due to their physical properties (and drainage properties), and due to the nature of the discharge activity (low depth and very low depth).

Braxton soil types have swell/crack characteristics that can allow contaminants in effluent to be washed down to the underlying groundwater resource via deep cracks that can form during prolonged dry summer conditions. Parts of the discharge area with Braxton soils types at both WW1&2 and the Horner Block are high risk for effluent discharge and require appropriate management of effluent discharge to mitigate the risk of contaminant loss to groundwater if and where deep cracks are formed. A site investigation by Environment Southland in January 2018 did not find evidence of deep cracks on Braxton type soils, however, leading to a conclusion Braxton soil types may not form deep cracks and are therefore less likely to provide a pathway for contaminants in effluent to reach groundwater.

Mitigation of adverse effects due to effluent discharge

Adverse effects, *including cumulative effects*, due to the discharge of agricultural effluent (liquid effluent and slurry) are either avoided, remedied or mitigated at WW1&2 and Horner Block through the implementation of good effluent management practice and mitigation measures. Contaminants present is effluent (N, P, microbes) are held in the root zone, adsorbed by plants or are filtered/adsorbed by soil particles. The below section refers to the mitigation of adverse effects due to effluent discharge at both WW1&2 and the Horner Block.

Due to its nature and scale, there will be little or no effect on receiving ground and surface waters *including cumulatively*, from the effluent discharge activity in this instance. The discharge system meets industry best practice standards for farm dairy effluent discharge by using buffer storage and low depth application. The use of best practice effluent application should avoid adverse effects on the environment. This principle is well documented in various scientific reports prepared for Environment Southland during the process of setting policies and rules around effluent discharge to land. A 2009 report[21] provides context and background to the principle that best practice effluent application should not cause adverse effects on water quality. The graph below is taken from the report to illustrate that nutrient loss from FDE application is minor if undertaken using best practice. In this example, less than 1% of nutrients applied in effluent reached drainage water on tile and mole drained soil. These soils are considered high risk relative to some of the soils available for effluent discharge at WW1&2 and Horner Block, that drain via matrix flow.

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[21] Houlbrooke & Monaghan (2009). The influence of soil drainage characteristics on contaminant leakage risk associated with the land application of farm dairy effluent. Report prepared for Environment Southland.

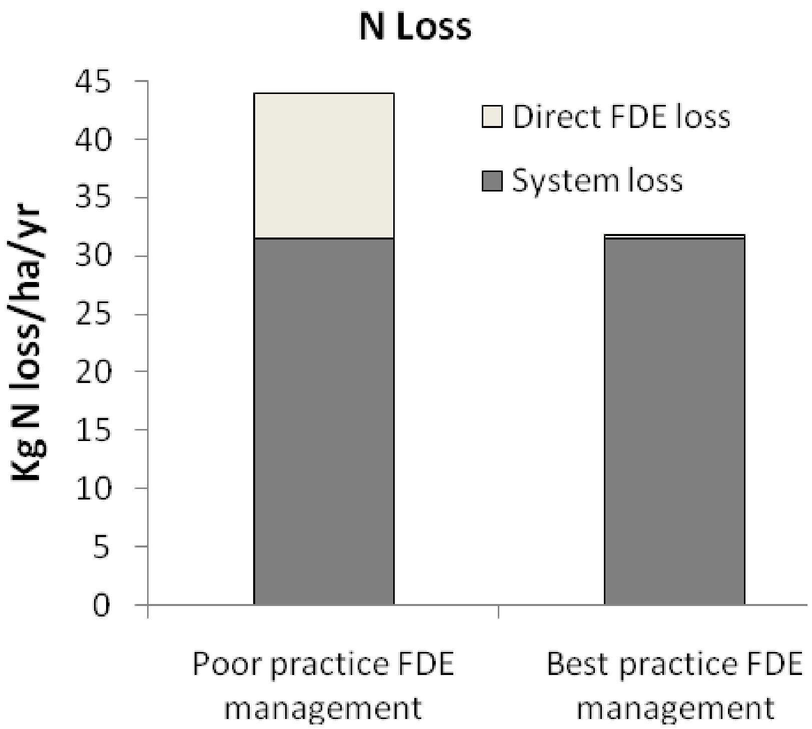

Figure 7.1. Houlbrooke and Monaghan (2009)

The applicants intend to apply effluent in accordance with best practice at all times to avoid adverse or *cumulative effects* on the receiving environment. The authors explain that if effluent is applied to soil when a soil moisture deficit exists then the effluent preferentially remains in the soil's root zone as plant available water or is adsorbed onto soil particles. The soluble nutrients in the effluent can then be taken up by the plant and used in nutrient cycling. Microbes can be filtered and held by soil particles until they are no longer viable. The applicants use the closest Environment Southland soil moisture monitoring site, which is available on the ES website, to determine whether a suitable soil moisture deficit exists for each of the irrigation systems. Effluent application, including both liquid effluent and slurry, is deferred if soil moisture levels are too high to safely and correctly apply effluent. Effluent is only applied when there is a ground moisture deficit and when effluent application will not induce drainage.

Deferred irrigation

The dairy platform currently has a total storage capacity of 8,032 m^3 in two effluent storage ponds, which provides for deferred irrigation for effluent from the dairy sheds, wintering barns and silage leachate according to the Massey Dairy Effluent Storage Calculator. 6,460 m^3 is the 90% probability volume according to the Massey DESC. The ability to defer irrigation during marginal times means that effluent will only be applied when a soil moisture deficit occurs. By deferring irrigation when ground conditions are unsuitable, losses to drainage water should be considerably less than the 1.1% of the total nutrients applied in the effluent experienced in the above-mentioned trial. When soils are near or at field capacity and there is risk of contaminant loss via artificial drainage (or overland flow when soils are saturated) to receiving surfacewaters, or risk of contaminant loss via cracks in Braxton soil types to groundwater, irrigation is deferred by storing effluent in the two storage ponds. The risk of contaminant loss from effluent discharge via artificial drainage, overland flow or deep drainage is in this way mitigated.

Low depth irrigation

Two low depth effluent irrigation methods are utilised; a travelling irrigator for dairy shed effluent (just WW1&2) and the slurry tanker with the trailing shoe for slurry (both WW1&2 and the Horner Block). Both systems will apply effluent at low depths; less or equal to 10 mm per application for the travelling irrigators and a maximum of 2.5 mm per application for the trailing shoe slurry tanker.

By discharging 15.2 m^3/hectare, the slurry tanker system applies effluent at a depth of 1.5 mm and can apply effluent at lower depths (e.g. 1 mm) by speeding up the tractor travel speed. The use of very low depth irrigation using the slurry tanker with a trailing shoe increases the frequency by which it is safe to apply effluent because a lower soil moisture deficit is required prior to irrigation. A slurry tanker with a trailing shoe is available for use as and when required.

The travelling irrigators have been tested and found to apply effluent to a depth of less than 10 millimetres each (see Appendix for reports). The travelling irrigators are only used when there is sufficient soil moisture deficit and no rain is forecasted for the following 24 hours. Where insufficient soil moisture deficit exists, dairy shed effluent irrigation is deferred by diverting to the ponds for storage.

The application of effluent (both dairy shed and slurry) in this manner should reduce the risk of exceeding a soil's infiltration rate, thus preventing ponding and surface runoff of freshly applied effluent. A low application depth also increases the likelihood of retaining the applied nutrients in the root zone. This decreases the likelihood of preferential flow and allows a greater volume of applied effluent to move through smaller soil pores via matrix flow, thus allowing for greater attenuation of effluent contaminants[22] [23]. This is of importance where subsurface drainage has been installed.

Best practice irrigation minimises the risk of contaminant loss via pathways relevant to the Central Plains and Oxidising physiographic zones; subsurface drainage (tiles) when wet in winter/spring and deep drainage when cracks are present or when soils are saturated. Effluent is not applied over low points, where tile drains have been installed, when soils are near or at field capacity. In addition to this, buffer distances from discharge area to surface waterways are maintained minimising the risk of effluent reaching surface waters directly via overland flow or spray.

Future proof – WW1&2

In order to future proof the discharge activity at WW1&2, low rate irrigation (pods or a cannon/rain-gun) is included in this application and AEE. The applicants have already demonstrated a willingness to invest, upgrade and innovate, which is evident in their recent investment in wintering barns. They will consider upgrading the dairy shed irrigation system as part of future developments once the current round of investment and expansion at WW1&2 has been completed. The proposed system is described in section 6. Low rate irrigation is considered as best practice by Environment Southland, as such it will have effects that are the same or less than the existing low depth irrigation system.

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[22] Houlbrooke DJ, Monaghan RM, Smith LC and Nicolson C (2006) Reducing contaminant losses from land applied farm dairy effluent using K-line irrigation systems. In: Currie, L.D. and Hanly, J.A. (ed.) Implementing sustainable nutrient management strategies in agriculture. Fertiliser and Lime Research Centre, Massey University, Palmerston North, pp. pp. 290-300.

[23] McLeod M, Schipper LA, Taylor MD (1998) Preferential flow in a well drained and a poorly drained soil under different overhead irrigation regimes. Soil Use and Management, 14, 96-100.

Effluent receiving areas and nutrient loading

The effluent receiving area is large and comprises a combination of low and high-risk soils at both WW1&2 and Horner Block. When the application depth is limited as already described, the presence of low risk soils reduces the risk of contaminant loss to ground and surfacewaters due to its drainage properties (matrix flow). This allows higher risk areas to be avoided when soils are at or above field capacity and there is risk of bypass drainage to ground and surfacewaters.

It has been demonstrated in section 6 and in the nutrient budget analysis report that the effluent receiving area is sufficiently large to receive both the N loading from slurry and the volume of slurry from the storage ponds. The higher strength nature of slurry effluent has been accounted for in calculating the N loading per hectare from slurry.

A maximum of 150 kg N/hectare from effluent (including both liquid and slurry) will be applied at the WW1&2. The 150 kg N/hectare limit will be adhered to, which is the standard limit placed on farm dairy effluent discharge activities on milking platforms by Environment Southland.

The scale of the discharge activity allows for the sustainable use of land to receive effluent. The consented discharge area is large and has a ratio of over 30 hectares per 100 cows, which is well above the Council recommended ratio of 8 hectares per 100 cows. As is modelled in Overseer, where effluent or slurry is applied to land, fertiliser is reduced accordingly, which mitigates the risk of overloading soils with nutrients such as N and P causing loss to water.

Horner Block – slurry receiving area

A maximum of 250 kg N/hectare will be applied from slurry at the cut and carry Horner Block (97 ha). The block is used to grow grass to feed cows at various farms and is not used to graze cows directly. Typically, there will be 4 cuts per season. Cows were IWG at the Horner Block in the past but are no longer grazed there. Urine patches are a major source of N leached to groundwater from pastoral farming. Since no stock is grazed at the Horner Block there are no recent/new urine patches, which greatly reduces N loss.

Cut and carry blocks are efficient at utilising N and generally have low N loss to water[24] despite high N inputs; this is supported by Overseer analysis for existing and proposed activities at the Horner Block. Under the proposal, Overseer modelled the application of 243 kg N from slurry and predicts low average annual N loss (i.e. 19 kg N/hectare). This supports the conclusion that the risk of nitrate loss to groundwater is very low from the use of the Horner Block as a cut and carry block. The potential issue of cracking in Braxton soils (arguably not covered by Overseer) is mitigated by always maintaining good pasture cover and plant root structure, and by monitoring and avoiding areas if and where this occurs.

As is modelled in the proposed nutrient budget, less N fertiliser will be applied to off-set the N input from slurry to ensure that N inputs at the Horner Block are not excessive. Overall (from both slurry and fertiliser), no additional N will be applied compared to what has been applied previously and pasture production will be maintained at its existing levels.

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[24] McLeod (2015). NITROGEN LEACHING FROM CUT-AND-CARRY LUCERNE. Landcare Research. https://www.massey.ac.nz/~flrc/workshops/15/Manuscripts/Paper_McLeod_2015.pdf

It is unlikely that the discharge of slurry at the Horner Block will result in elevated groundwater nitrate levels. Due to soil types (Drummond and Waiau) and their drainage properties (matrix flow), much of the HB classed as low risk for effluent discharge. So long as slurry is applied at a depth lower than the soil moisture deficit and at less than 50% of PAW, there is minimal risk of nitrate loss to groundwater from low risk soils, as supported by Houlbrooke et al. (2006).

Where high risk soils are found (Braxton), there is a potential pathway for nitrate to reach groundwater via deep cracks that can form due to swell/crack properties of these soils. The east of the HB where Braxton soils are found, is monitored for evidence of cracking at high risk times (summer/autumn); slurry will not be discharged to areas where cracks form. Good soil management practices, as shown in the soil test trends appended to the application, mean that deep cracks are unlikely to form. Good pasture cover (and plant root structure) is always maintained, again minimising the risk of cracks to groundwater forming in the soil profile.

Downstream users of groundwater are dairy, sheep and cropping farms. These will not be adversely affected by the N loading of soils from slurry at the HB, as little or no N applied in slurry will be lost to groundwater; it will be taken up by plants and harvested as part of the cut and carry operation. Similarly, Drummond Township, Primary School and Kindergarten will not be affected by the N loading of soils from slurry at the HB. Groundwater nitrate levels in the vicinity and south of the HB are in the range of 1.0 – 8.5 g/m^3, so are below the NZ Drinking Water MAV of 11.3 g/m^3. The cumulative effect on groundwater nitrate levels from the N loading from slurry at the HB will extremely low due to the above reasons. The effects of the N loading from slurry effluent on groundwater will be minor, and much lower than when the HB was used in the past to IWG cows on fodder crop.

Summary of mitigations for Horner Block

- Slurry is applied at very low depth using slurry tanker with trailing shoe (less than or equal to 2.5 millimetres per application), when there is sufficient soil moisture deficit and nil risk of drainage;
- Soils are monitored for evidence of cracking; if and where this occurs slurry and fertiliser are not discharged;
- N loading (from slurry and fertiliser) is to a cut and carry block, so uses relatively high N inputs to grow grass. N is utilised efficiently to grow grass resulting in low N loss below the root zone;
- A maximum of 250 kg N/hectare will be applied from slurry annually with N fertiliser reduced to allow for the loading from slurry;
- Recommended buffers will be adhered to when discharging slurry.

Summary of surfacewater mitigations for effluent discharge at WW1&2 and Horner Block

Due to the implementation of good management practices and mitigation measures, there will be minimal risk to receiving surfacewaters in the Waimatuku, Oreti and Aparima catchments, the Waimatuku, Jacobs River and New River Estuaries, coastal waters and their values from the discharge activity. Effects on receiving surfacewaters due to the proposed discharge activities at WW1&2 and the Horner Block will be no more than minor.

The discharge of agricultural effluent at both WW1&2 and the Horner Block will be operated so that:

- Irrigation of effluent is deferred when there is insufficient soil moisture deficit to safely apply effluent or when there is risk of drainage following irrigation of effluent. Effluent is stored in two large effluent ponds at WW1&2, which have sufficient storage for proposed activity according to the Massey DESC. This is effective at avoiding the risk of contaminant loss to surfacewaters from effluent when soils are at or above field capacity.

- Low depth irrigation methods are used to apply effluent to land. A slurry tanker with a trailing shoe is always available for use at WW1&2 and the Horner Block, and can apply slurry effluent to depths as low as 1 mm per application. Slurry is always applied at no more than 2.5 mm per application, which increases the number of irrigation days when effluent can safely be applied to land without risk of drainage. The travelling irrigators are only used at WW1&2 to apply effluent to depths of less than 10 mm per application. Irrigation using the travelling irrigators is deferred by diverting effluent to the storage ponds unless there is sufficient soil moisture deficit. There is minimal risk to receiving surfacewaters when irrigating using these methods where there is sufficient soil moisture deficit. A low rate system may be installed at WW1&2 in the future, which will similar or less effect on surfacewaters.

- Recommended buffers to waterways are implemented, mitigating the risk of contaminants present in effluent (i.e. N, P, microbes) reaching surfacewaters via overland flow. Effluent is not applied over tile drains when there is risk of preferential flow via drains to surfacewaters, mitigating the risk of the same contaminants present in effluent reaching surfacewaters via artificial drainage.

- The discharge area is sufficiently large both in terms of the area (ha) per 100 cows, and the N loading from effluent to effectively mitigate the risk of contaminant loss from effluent to surfacewaters. WW1&2's application rate will not exceed 150 kg/hectare, and the Horner Block will not exceed 250 kg N/hectare. The high strength nature of slurry effluent has been allowed for in calculating the N loading from slurry. The on-site slurry tanker allows for very low application depths, which effectively controls the N loading per hectare from slurry and minimises the risk of contaminants present in effluent being lost to receiving surfacewaters.

Groundwater – mitigation of effects

Many good management practices and mitigation measures for effluent discharge at both WW1&2 and the Horner Block described above also apply to avoiding, remedying and mitigating adverse effects on groundwater. These practices and measures are not repeated here; please refer to above. Whilst the effects of the discharge and dairy farming activities on groundwater are assessed separately in Section 7.1 and 7.3 respectively, it is difficult to separate these effects in practice.

Nitrate in groundwater due to the discharge activity:

Given the nature of effluent management at the WW1&2 and Horner Block, in addition to the scale of the discharge activity including the N loading of soils from effluent (dairy shed/liquid and slurry), it is very unlikely that the discharge of effluent at WW1&2 and the Horner Block will adversely affect water quality through an increase in groundwater nitrate concentrations from effluent.

Despite its tendency to suffer from localised contamination, the bore at the south end of WW1&2 (E45/0622) has demonstrated relatively low groundwater nitrate concentrations over the last five years (1.0 – 3.5 g/m^3), albeit with evidence of wellhead contamination due to its design, and therefore elevated nitrate levels at times. These localised events should not adversely affect groundwater quality beyond the zone of reasonable mixing. A monitoring bore located mid-farm/east on lighter soils and in a different groundwater zone (E45/0665) shows higher levels of groundwater nitrate over the last three years, indicative of moderate to high land use impacts (3.5 – 8.5 g/m^3), but lower than at an ES monitoring bore located at Boyle Road to the south east, where groundwater nitrate levels are at or above the NZ Drinking Water Standards MAV of 11.3 g/m^3. Bores located to the south east show evidence of higher groundwater nitrate levels than at WW1&2.

~~Given that groundwater nitrate levels are lower at WW1&2 it is unlikely that the discharge of effluent is adversely affecting water quality through an increase in groundwater nitrate concentrations from effluent discharge. Groundwater nitrate levels have been reasonably stable since bore testing began. The “farming” effect on free draining soils is likely to have a greater effect on groundwater nitrate levels than effluent discharge at very low and low depths on low risk soils. For instance, farming practices such as growing fodder beet/IWG on free draining soils are expected to have a greater cumulative effect on groundwater quality. Moving away from this practice should see an improvement for groundwater quality, although it may be difficult to detect this due to effects from other properties and activities in the area.~~

~~There is minimal risk to the registered bore for drinking water supply at Heddon Bush School from the discharge of effluent (dairy shed/liquid and slurry) at WW1&2 and the Horner Block. The bore for school water supply (E45/0718) was recently tested (2017/2018) and returned nitrate concentrations in the range of 1.8 – 2.0 g/m^3. Given the following factors, adverse effects from the discharge activity such as an increase in groundwater nitrate levels would have been seen for some time in the vicinity of the school if they were present:~~

- ~~the proximity of the school approximately 2.3 km south of the landholding;~~
- ~~the direction of groundwater flow from much of the landholding (south towards the school);~~
- ~~land use at and around the landholding, and north of the school since the 1980s. This includes cereal cropping, sheep farming, dairy farming and intensive winter grazing. Cereal cropping and IWG are activities that lose high levels of N through increased mineralisation processes;~~
- ~~the length of time the land has been used for dairy farming (Woldwide 1 since 1992, Woldwide 2 since early 2000s);~~
- ~~the estimated lag times for nitrate to percolate through the vadose zone, reach the water table and the underlying groundwater stream are short, and~~
- ~~the estimated velocity of groundwater flow.~~

~~The evidence so far does not indicate that the discharge activity at WW1&2 and the Horner Block is having an adverse effect on the Heddon Bush School water supply through an increase in groundwater nitrate levels. The depth of the school bore further helps to protect it from land-use effects. The proposed activity is the same in nature and is of slightly increased scale compared to the existing discharge activity and will pose minimal risk of groundwater nitrate related adverse effects at Heddon Bush School.~~

~~The bore located at the south of WW1&2 has been described above and is believed to be in the same “stream” of groundwater flow as the Heddon Bush groundwater supply. Its nitrate levels are generally low, with the already described localised contamination events due to poor well design. The applicants are proposing to install a new monitoring bore using industry best practice methods, which should not have issues with wellhead contamination. The new bore will be located at the south of WW1&2, in the groundwater “stream” believed to flow towards Heddon Bush School. Water quality results from~~

the bore will be monitored by the applicants and used to inform decision making relating to the management of the discharge activity.

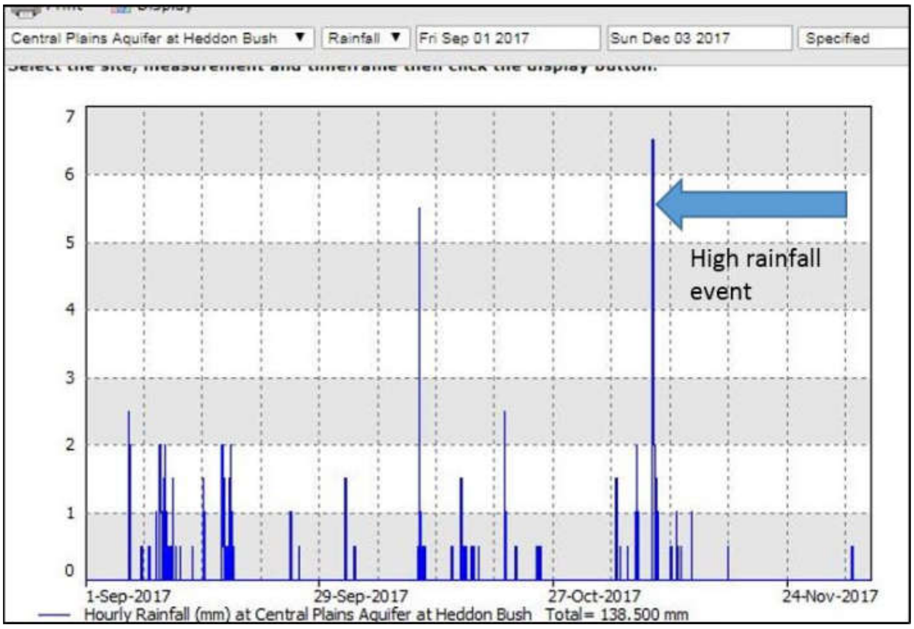
Shallow groundwater in the Waimatuku Catchment is understood to discharge to the local stream network. An effect of groundwater nitrate could be an increase in nitrate levels in downstream receiving waters such as shallow streams (connected to groundwaters), the Waimatuku Stream and eventually coastal waters. The risk of nitrates in effluent reaching groundwater is mitigated through using deferred storage and low depth irrigation. There is minimal risk to receiving surfacewaters through the discharge of groundwater from the discharge activity.

Faecal contamination of groundwater due to the discharge activity

If faecal microbes from the discharge activity are/have been reaching groundwater, the testing of groundwater, especially from bores located in the south, could reveal this to be the case.

Groundwater testing of bores at and at WW1&2 are generally negative for *E.coli*, but at times have returned positive results with general low counts. As has already been explained, the south bore (E45/0622) experiences localised contamination due to its design, which makes it unsuitable for use a monitoring bore and makes interpretation of *E.coli* data from the bore questionable; *E.coli* data from the WW1 bore are corrupted by localised contamination. Following the zone of reasonable mixing, there is likely to be minimal adverse effect on the wider groundwater resource from this localised source. However, it is proposed to repair the existing bore and to install a new monitoring bore. These steps should eliminate the issue of localised contamination and provide a valid source of reliable groundwater *E.coli* data.

The mid-farm/east monitoring bore (E45/0665) has generally been negative for *E.coli* since it was installed in 2015. It has however returned three positive *E.coli* results in that time. The relatively high result in November 2017 is an outlier in the dataset and was likely to have been due to recent prolonged heavy rainfall, which occurred between November 3rd and 12th, and resulted in a high level and rate of drainage and the observed *E.coli* result (see figure 7.2). The subsequent test in April 2018 was negative for *E.coli* (<1 MPN/100 ml). The ES monitoring bore at Boyle Road, which is southeast of the WW2 bore and in the same groundwater zone, is tested every three months. It has consistently been negative for *E.coli* in recent years with the exception of December 2017 (5 MPN/100 ml). It too was subsequently negative for *E.coli* in March 2018 (<1 MPN/100 ml). This indicates that if groundwater contamination occurs due to very high and intense rainfall and subsequent rapid drainage, it is relatively short lived, which is in line with the length of time that *E.coli* and similar microbes are believed to remain viable in groundwater (three months or less).



Central Plains Aquifer at Heddon Bush ▼ Rainfall ▼ Fri Sep 01 2017 Sun Dec 03 2017 Specified

Figure 7.2. Rainfall at Central Plains Aquifer at Heddon Bush.

Slurry effluent is high strength in nature, including its microbial content. Applying slurry effluent at very low depth when there is sufficient soil moisture deficit (e.g. 2 mm depth per application), ensures that the microbial loading of soils is low enough to allow soils to filter microbes. This will allow them to be retained in the topsoil sufficiently long so that they die off and become unviable. U.V. radiation plays a role in this process. The N loading limits of 150 kg/hectare and 250 kg/hectare at WW1&2 and Horner Block respectively, will allow for control on the soil loading of microbes from effluent by proxy. So long as effluent irrigation is always deferred when the water table is high and there is risk of bypass drainage, microbes present in effuent will be filtered and attenuated onto soil particles without passing through the soil and will die off[25][26].

A risk of bypass drainage from the potential cracking process of Braxton soils also applies to microbes. On-site investigation found that the risk of Braxton soils at WW1&2 and Horner Block cracking is lower than previously thought. So long as soils are managed to minimise the risk of cracking, best practice effluent management is followed, soils are monitored for cracking and cracked areas are avoided, then there is minimal risk of microbes being transported to groundwater via deep cracks.

In summary the effect from the discharge of effluent (dairy shed and slurry) at WW1&2 and Horner Block in terms of microbial contamination of groundwater will be no more than minor.

~~There is minimal risk of microbial contamination of the registered bore for drinking water supply at Heddon Bush School from the discharge of effluent (dairy shed and slurry) at WW1&2 and the Horner Block. The bore has been tested quarterly since it was drilled and has consistently returned negative *E.coli* results (<1 MPN/100 ml). Given the factors listed on page 130, as well as the lifetime of *E.coli* in the environment (up to 3 months according to Edberg et al. 2000), adverse effects from the discharge~~

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[25] McLeod et al. (2008). Regionalising Potential for Microbial Bypass Flow through New Zealand Soils. J. Environ. Qual. 37:1959-1967

[26] Liping Pang et al. (2008). Modeling Transport of Microbes in Ten Undisturbed Soils under Effluent Irrigation. Vadose Zone J. 7:97–111

~~activity such as microbial contamination would have been seen for some time in the vicinity of the school *if they were present*. The evidence so far does not indicate that the discharge activity is having an adverse effect on the Heddon Bush School water supply through faecal contamination of groundwater. The proposed discharge activity is the same in nature and is of slightly increased scale compared to the existing discharge activity; there will be little or no increase in faecal microbes due to the proposed activity. It is noted that the depth of the school bore further helps to protect it from land-use effects, as does the presence of an ozone purification treatment system.~~

~~The bore located at the south of the property (E45/0622) has been described above and is believed to be in the same "stream" of groundwater flow as the Heddon Bush groundwater supply. It is unsuitable for use as a monitoring bore as it suffers from localised contamination due to its design. The applicants are proposing to repair it to avoid localised contamination of groundwater. The will also install a new monitoring bore using industry best practice methods, which should not have issues with localised contamination. The new bore will be located at the south of WW1&2, in the groundwater "stream" believed to flow towards Heddon Bush School. *E. coli* results from the bore will be monitored by the applicants and used to inform decision making.~~

~~In conclusion there is minimal risk that consumers of groundwater, including at Heddon Bush School, will develop gastroenteritis due to faecal contamination of groundwater from the discharge activity.~~

Summary of mitigations for groundwater – WW1&2 and Horner Block

Due to the implementation of good management practices and mitigation measures, there will be minimal risk to underlying groundwater resources, including the Waimatuku, Central Plains and Upper Aparima Groundwater Zones, and consumers of groundwater including Heddon Bush School due to the discharge of effluent at WW1&2 and Horner Block. Effects on groundwater due to the proposed discharge activities will be no more than minor.

The discharge of agricultural effluent at both WW1&2 and the Horner Block will be operated so that:

- Irrigation of effluent is deferred when there is insufficient soil moisture deficit to safely apply effluent or when there is risk of drainage following irrigation of effluent. Effluent is stored in two large effluent ponds at WW1&2, which have sufficient storage for effluent from the proposed activity according to the Massey DESC.

- Low depth irrigation methods are used to apply effluent to land. A slurry tanker with a trailing shoe is always available for use at WW1&2 and the Horner Block, and can apply slurry effluent to depths as low as 1 mm per application. It typically applies slurry effluent to depths of 1.5 mm per application, which increases the number of irrigation days when effluent without risk of drainage. The travelling irrigators at WW1&2 apply effluent to depths of less than 10 mm per application. There is minimal risk to receiving groundwater when irrigating using these methods where there is sufficient soil moisture deficit. A low rate irrigation system may be installed at WW1&2 in the future.

- Soils are managed to minimise the risk of crack formation. They are monitored for cracks and effluent is not applied on Braxton type soils, if and where cracks form following extended summer dry periods. This mitigates the risk of contaminants loss via preferential flow down deep cracks to shallow groundwater.

- The discharge area is sufficiently large both in terms of the area (ha) per 100 cows, and the N loading from effluent. The high strength nature of slurry effluent has been allowed for in calculating the N loading from slurry effluent. The on-site slurry tanker allows for very low application depths, which effectively controls the N loading per hectare from slurry and minimises the risk of contaminants present in effluent being lost to groundwater during drainage events. The slurry tanker application depth allows for effective control of N loading and microbial loading of soils, which allows microbes to be retained in the topsoil, filtered and attenuated until they become unviable.

- Installation of a new monitoring bore is proposed at the south of WW1&2 to eliminate monitoring issues relating to localised contamination of the shallow E45/0622 bore. The bore will be used to monitor groundwater quality flowing south, in the predominant direction of groundwater flow at WW1&2 and in the direction of Heddon Bush School. Data collected from monitoring groundwater quality will be used to inform on decision making, including effluent management. The existing house bore will be upgraded to prevent localised contamination of the groundwater resource.

Soil health

There is little or no risk to the life supporting capacity of soils at WW1&2 or the Horner Block due to the effluent discharge activity. The utilisation of land treatment for effluent allows for the sustainability of the soil ecosystem. The soils are suitable for effluent irrigation and the discharge follows current good management practice. These include practices of a general nature and those specific to the contaminant transport pathway for the physiographic zones (artificial drainage, deep drainage).

The existing storage ponds allows for deferred storage until the soil moisture content is suitable for irrigation for 1,500 cows on the farm. The land disposal area is larger than the best practice recommendation of 8 hectare per 100 cows. The land disposal areas at the Horner Block and WW1&2 is sufficiently large to receive slurry effluent from the ponds, without exceeding the 250 kg N/hectare limit for the Horner Block, and 150 kg N/hectare for WW1&2. The WW1&2 N loading is below the recommended restriction of 150 kg N typically placed on discharge permits by Environment Southland. The N loading to the Horner Block is appropriate due to the nature of activities carried out there. This system is sustainable in the long term as it allows the effluent to be used both as a fertiliser and a soil conditioner, which improve the soil's health.

An ongoing soil monitoring programme is carried by the applicants and their fertiliser supplier (Ravensdown) at WW1&2 and Horner Block. Trends in soil tests are evaluated and used to inform on decision making, including effluent management. See the appended reports from Ravensdown for the WW1 and WW2 dairy units and the Horner Block. Good nutrient management is evident in soil fertility trends and is indicative of healthy soils. Effects on the soil resource due to the proposed effluent discharge activity will be no more than minor.

Effluent storage and infrastructure

The effluent system meets the needs of the proposed activity according to the Massey DESC.

WW2's pond stores slurry, is clayed lined and does not have a leak detection system. It has been drop-tested but could not meet all Appendix P criteria due to the high solid content of slurry. Based on the CPEng peer reviewed drop test report, in 2017 Environment Southland accepted that pond was not leaking. The applicants believe that by storing slurry, the risk of the pond leaking is reduced. This is because the characteristics of slurry versus liquid effluent in ponds/lagoons are quite different. Due to a much higher DM content [27], slurry has relatively low viscosity compared to liquid effluent and has self-sealing properties [28]. Whilst the process is not fully understood, self-sealing of slurry ponds reduces the risk of leakage through clay/earthen-lined ponds. Wind-driven wave action can cause bank erosion in ponds where energy carried in waves damages the clay substrate. This does not arise when storing slurry since the pond surface is solid and does not move via wave action. WW2's pond was designed and built in c.2009 to meet the required standards at the time. It was visually inspected by a SQP in 2018. The inspection confirmed that there were no visible cracks, holes of defects that would allow effluent to leak. Based on these factors, the applicants believe that WW2's pond is fit for purpose and that there is minimal risk to ground, surfacewaters and soils through using it to store effluent (slurry) from the wintering barn, dairy shed and silage pad at the WW2 unit.

WW1's pond was upgraded in autumn 2018, when its storage capacity was increased and a synthetic liner (1.5 mm HDPE) was installed. The liner overlies a leak detection drain system, the specification for which was provided by a CPEng and approved by the Council engineer in 2018 as meeting Practice Note 21 requirements for small ponds. CPEng sign off for the pond was submitted to Council as required. The leak detection system has a ring drain, which terminates at a 400 mm diameter inspection well (piezo). The leak detection inspection well has been inspected regularly and either had no liquid or had liquid when the water table was high. The liquid had was clear and had no odour, indicating that it did not contain effluent. There is therefore no evidence of leakage from the pond. Based on operating with the normal operating parameters of a leak detection system, the specifications of which were provided by a CPEeng and approved by the Council engineer, the applicants believe that WW1's pond is fit for purpose and there is minimal risk to ground, surfacewaters and soils through using it to store effluent (slurry) from the wintering barn and dairy shed at the WW1 unit.

WW1 and WW2 units both have ancillary structures that store effluent including a sand trap, dairy shed pump sump and wintering barn collection sump. All have been visually inspected by a SQP and show no visible cracks, holes or defects that would allow effluent to leak. Structures connected to the dairy shed cannot be diverted during the milking season. Drop tests can be carried out on the dairy shed ancillary structures in the off-season if required. An Appendix P drop test on wintering barn collection sumps will be carried out as soon as possible and prior to the wintering barns being used in May. Results will be submitted to Council accordingly. The applicants believe that ancillary structures that contain, store or treat effluent at WW1&2 are fit for purpose and that there is minimal risk to ground, surfacewaters and soils from using them.

Two low depth travelling irrigation systems used at the dairy platform have been tested as per consent conditions and found to meet the required depth of less than 10 mm/application (see Appendix). The slurry tanker with the trailing shoe has been tested in the past and shown to achieve very low application depths; it can be retested if necessary. A low rate system such as pods or a cannon/rain-

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[27] Houlbrooke, Longhurst, Orchiston & Muirhead (2011) Characterising dairy manures and slurries. Report prepared for Surface Water Integrated Management (SWIM), AgResearch

[28] Parker, David & Schulte, D.D. & Eisenhauer, D.E. (1999). Seepage from earthen animal waste ponds and lagoons - An overview of research results and state regulations. Transactions of the ASABE (American Society of Agricultural and Biological Engineers). 42. 485-493. 10.13031/2013.13381.

gun system may be installed in the future, once the current round of investment and expansion has been completed.

Summary

It is reasonable to conclude that there will be little or no risk to groundwater or surface waters including cumulatively, or to the soil resource by granting replacement of the existing discharge permit to allow for the discharge of effluent from 1,500 cows at the WW1&2, and by granting consent to discharge agricultural effluent (slurry) from WW1&2 to 97 hectares of land at the Horner Block. Actual and potential effects from the activity have been considered and are no more than minor.

Alternatives to effluent discharge methods

The irrigation systems in place are designed to meet best practice guidelines – specifically the use of very low depth, low depth irrigation and deferred storage of effluent. The applicants believe their system is both cost-effective and easy to manage.

An umbilical system has been included in the discharge permit because it provides a method of discharging large volumes of effluent at very low depths to different parts of the effluent discharge area. The umbilical system will be used as a potential back up to the very low depth slurry tanker.

The umbilical system is a high rate/low depth application method. The depth of application is closely controlled by tractor speed. The depth of application will not exceed 3 mm for the umbilical system and it can apply slurry at lower depths (e.g. 2 mm) by increasing the tractor travel speed. At this depth it poses no more potential for adverse effects on the receiving environment as the low depth system.

Low rate irrigation has been included in the discharge permit because it is a best practice management irrigation method. A low rate pod or cannon/rain-gun irrigation system may be installed and used to complement the low depth travelling irrigator irrigation system and low depth slurry tanker.

The pods and cannon travelling irrigator systems are low rate/low depth application methods. They pose no more potential for adverse effects on the receiving environment as the low depth irrigation systems.

7.2 Water Take

The water take is from the Waimatuku Groundwater Zone.

The abstraction should have a less than minor effect on aquifer sustainability and water availability. The Waimatuku Groundwater Zone has low allocation status and the proposed take is moderate, although it is increasing relative to applicant’s existing take. The applicants seek a maximum abstraction of 180,000 litres of groundwater per day. This is consistent with a total of 120 L/cow/day by allocating 70 L for stock drinking water and 50 L for shed wash down water for 1,500 cows. This equates to an annual take of 55,296 m^3 based on seasonal milk supply and a winter take for drinking water for stock housed in barns. The take is considered reasonable in terms of Policy 21 of the Regional Water Plan. Based on the estimated recharge rate to the Waimatuku Groundwater Zone (Lincoln Environmental, 2003), annual recharge of the aquifer underlying the property is approximately 2,344,340 m^3. The annual water take is 2.4% of this volume.

Groundwater is abstracted from three bores at WW1&2 for dairy shed supply and stock drinking water, and bores are over 50 metres apart. The rate of take from individual bores does not exceed 2 L/sec and should not cause stream depletion effects on adjacent water bodies. Three water storage tanks are utilised at each dairy shed to ensure that the rate of take does not exceed 2 L/sec. The nearest neighbouring bore is over 700 m from the abstraction point and should not experience drawdown effects due to the take. There will be little or no effect on other water uses due to the water take.

Water efficiency will be a key focus on farm. Simple tasks such as keeping water reticulation systems and dairy shed plumbing in a good state of repair will prevent water leaks and reduce water wastage. Water metering devices have been installed to ensure the water use is monitored via a standard cumulative water meter and will allow the data to be supplied to Council as per the consent conditions.

Overall the abstraction should have a less than minor effect on water availability, other water users or the Waimatuku Groundwater Zone.

Assessment of Alternatives for Water Supply

There have not been any improvements in technology, which would achieve a better environmental result than the current groundwater supply to the farm. Effects on bore yields on neighbouring bores are expected to be no more than minor; the proposed groundwater take is greater than the existing take but is still low relative to recharge rates in the groundwater zone. There is no surface water take. There will be no effect due to this activity on in-stream life, wetlands, recreational activities or marginal strips.

7.3 Assessment of effects from the farming activity

This section provides an assessment of effects from the farming activity at WW1&2 in its entirety, in accordance with Schedule 4 of the RMA. Based on advice from Environment Southland, it has been structured to answer three broad questions:

1. What are the effects from the whole activity on the receiving environment?
2. What are the effects from the additional cows over and above what is already in place?
3. What are the broad scale cumulative effects from farming on the receiving environment?

The discharge activities at WW1&2 and the Horner Block form part of the overall farming activity. Effects considered and assessed in section 7.1 also fall within the AEE for the overall farming activity.

An assessment of effects for activities at the Horner Block is provided on pages 124 and 125. Rather than duplicating the material, please see for details.

Activities at WRO form part of the overall farming activity at WW1&2. Due to the complexity of assessing effects at different farms (dairy platform versus effluent receiving versus dry stock) that lie in fundamentally different catchments, activities at WRO are considered and assessed in a separate AEE, in accordance with Schedule 4 of the RMA.

Effects from whole activity on the receiving environment

Introduction

When considering expansion applications, Environment Southland understand Policy 39 of the pSWLP to direct that the farming activity is not the permitted baseline and as such, actual or potential effects from the “whole activity” as proposed, on the receiving environment must be assessed. This section aims to provide such an assessment in accordance with Schedule 4 of the RMA.

The “whole activity” is understood to mean the sum of all proposed activities at Woldwide 1&2 dairy farm, which includes a 1,500-cow dairy platform, two wintering barns and the range of activities such as fertiliser application, pasture management and supplement. The discharge of agricultural effluent at WW1&2 and the Horner Block is also part of the “whole activity,” as are activities at WRO. Activities also include site-specific GMPs and mitigation measures that will be implemented across the operation. Within the assessment of the whole activity, individual activities and mitigation measures are highlighted and discussed where appropriate.

For WW1&2, the receiving environment includes the Waimatuku catchment (including Waimatuku Estuary), Waimatuku groundwater zone, Oreti catchment (including New River Estuary) and Central Plains groundwater zone. For the Horner Block, the receiving environment includes the Waimatuku catchment (including Waimatuku Estuary), Waimatuku groundwater zone, Aparima catchment, Jacobs River Estuary and Upper Aparima groundwater zone. Where P is assessed, it can generally be used as a proxy for sediment and microbial contaminants.

In the context of assessing actual and potential effects from the whole activity, it is recognised that all dairy farms lose contaminants (nutrients, sediment and microbes) to some degree. So long as losses are minimised through the implementation of effective GMPs and mitigation measures, and effects on receiving ground and surfacewaters are no more than minor, then land at Woldwide 1&2 dairy farm can be used and developed by the applicants to provide for their social, economic and cultural wellbeing in accordance with policy 13 of the pSWLP. The applicants will provide certainty to the consent authority regarding activities and effects through operating under a land use consent for farming at WW1&2.

In operating an economically viable dairy farm at WW1&2, the applicants seek to minimise contaminant losses across the whole activity. Their success in achieving this has support from a desk top comparison, which places their N loss (40 kg/ha/year as per Overseer) below the average N loss (46 kg/ha/year) from all Fonterra dairy farms (n=350) within a 20 km radius of WW1&2. At first glance this may not appear to be significant. However, the farming activity at WW1&2 includes the wintering of 1,250 cows whereas many farms within a 20 km radius winter some or all cows off farm. In the dataset:

- 74 farms (21%) winter no cows in June;
- 122 farms (35%) winter between 1% and 40% of the peak herd number at home.

Many N loss figures in Fonterra N reports only reflect the milking platform and include no/limited wintering of cows. By including and accounting for the wintering of all cows on-site at WW1&2, the efficiency of the operation in achieving below average N loss at WW1&2 is clear. Please see the Appendix for data sourced from Fonterra (average annual N loss per hectare for the last 3 years for farms within a 20 km radius; monthly cow numbers for farms within a 20 km radius).

At the farm scale it is difficult to quantify contaminants being lost to receiving surfacewaters and groundwater, and their contribution to effects on receiving waters; there will be much seasonal and spatial variation in this. Furthermore, measuring the volume of drainage water leaving a sub-catchment and the concentration of nutrients in drainage water would require expensive equipment as well as long term monitoring to allow for temporal and spatial variation; this is not practical given available scientific methods. For these reasons, Overseer is used as a tool to help understand the nutrient interactions of farm systems based on soil properties, rainfall, drainage, feed requirements and other inputs such as fertiliser. The output from Overseer provides an indication of how much nutrient (N and P) may be lost below the root zone but it does not describe how much nutrient ends up in the receiving environment and what the effect of losses is likely to be. Assessing the effect of modelled nutrient losses from individual properties is complex because nutrients travel via different pathways through the receiving environment undergoing attenuation in the vadose zone, processing, mixing, dilution and dispersion processes, which can significantly change the quantity and nature of these nutrients in the receiving water bodies. The assessment here uses knowledge of soil properties, drainage characteristics and rainfall infiltration, hydrology, the receiving environment and Overseer predictions to estimate:

1. The quantity of nutrients (N and P) from the whole activity lost to the receiving waters using Overseer predictions as a starting point, and
2. What the actual or potential effects from the whole activity on receiving ground and surfacewaters are likely to be.

Notes:

1. *Land referred to as Marcel/SH96 is part of Woldwide 1&2 dairy farm and is assessed here as part of the "whole activity." It is not assessed/considered separately as it is authorised for dairy farming under a land use consent (#20171278-03) and is part of the existing environment. The entire application and nutrient budgets have been structured to reflect this.*

2. *The Horner Block is a separate landholding and is not part of the landholding at WW1&2. However, some slurry generated at WW1&2 is discharged at very low depth at the Horner*

Block. Effects at the Horner Block are considered as part of the "farming activity" as Environment Southland regard it to make up part of that activity.

~~Quantity of N lost below the root zone to receiving surfacewaters~~

~~Drummond and Glenelg soils are free draining and generally do not pose a direct risk to surfacewaters via artificial drainage channels/overland flow. The mid-west part of WW1&2 (approximately 100.5 hectares or 21%) has Braxton type soils; these have subsurface drainage installed and drain to the Waimatuku catchment and estuary.~~

~~QUANTITY OF N LOST BELOW THE ROOT ZONE TO THE WAIMATUKU CATCHMENT~~

~~Braxton soils are predicted by Overseer to lose 2,674 kg N/year below the root zone. A portion of this will be transported in drainage waters to shallow streams in the Waimatuku catchment. Some will be lost to the atmosphere via denitrification processes in the vadose zone and a small amount will be transported to groundwater.~~

~~A conservative estimate for the concentration of N in drainage waters to the Waimatuku catchment is calculated below using the average annual N loss figure from Braxton soils from Overseer. The mean annual land surface recharge rate was used to calculate an estimate of drainage volume to surfacewaters.~~

~~100 ha = 1,000,000 m^2~~

~~Recharge rate estimate (Lincoln Environmental, 2003) = 0.467 m~~

~~(1) *Area (m^2) X drainage (m) = drainage volume (m^3)*~~

~~Approximate drainage volume annually = 1,000,000 m^2 x 0.467 m = 467,000 m^3~~

~~If <u>all</u> 2,671 kg of N lost to water annually from the Braxton block is transported via subsurface/artificial drainage channels and overland flow to the Waimatuku catchment, then the average annual N concentration of drainage water to the Waimatuku catchment is predicted to be:~~

~~2,671 kg/467,000 m^3 = 5.7 g/m^3 = 5.7 ppm~~

~~As already mentioned, some N will be lost to the atmosphere via denitrification/attenuation processes in the vadose zone, and a small quantity of N will be lost to groundwater. Based on these factors, the concentration of N in water draining to surfacewaters will on average be less than 5.7 ppm. As such 5.7 ppm N is an estimate for the average concentration of N in drainage waters from the whole activity reaching streams in the Waimatuku catchment, without taking attenuation processes into account.~~

~~FATE OF N IN RECEIVING STREAMS – WAIMATUKU CATCHMENT~~

~~Drainage water reaching receiving streams in the Waimatuku catchment undergoes mixing and nutrients are diluted. The dilution process is likely amplified by significant rates of groundwater discharge to surfacewaters in the upper Waimatuku catchment and should off-set adverse N effects from the whole activity in the Waimatuku catchment to an extent. Due to mixing, dilution and dispersion processes occurring on a catchment scale, this cumulatively gives a median N concentration of 3.65 ppm for the lower Waimatuku catchment (5-year median Total Nitrogen for SOE site at Waimatuku Stream at Lornville Riverton Highway).~~

~~CONCENTRATION OF N IN DRAINAGE WATERS TO LOWER ORETI CATCHMENT~~

~~Direct losses to the Lower Oreti receiving suracewaters are expected to be low due to the free draining nature of soils (draining to the aquifer) that lie in the Lower Oreti catchment, and cumulatively will~~

give a median concentration of 1.06 ppm for the Lower Oreti catchment (5-year Median Total Nitrogen at SOE site at Oreti River at Wallace Town).

Quantity of P lost to receiving surfacewaters

The major pathway for P loss (and by proxy sediment and microbes) is from Braxton soils via artificial drainage and overland flow following major drainage events. Drummond and Glenelg soils have good P retention and primarily drain via matrix flow, reducing their risk of P loss.

CONCENTRATION OF P IN DRAINAGE WATERS TO WAIMATUKU CATCHMENT

Overseer predicts relatively low average P losses of 0.7 kg/ha/year or 357 kg/year due to the whole activity, with an average P loss of 0.4 kg/ha/year for Braxton soils. Since there are 100 hectares of Braxton soils, an annual average of 44 kg of P is predicted to be lost to the Waimatuku catchment. By pro-rataing "other sources" P loss across the farm, Overseer predicts a further 54 kg of P will be lost from tracks and lanes to surfacewater drainage in the Braxton area. Using the annual drainage volume from Braxton soils as calculated in the previous section, the average concentration of P in drainage waters reaching the Waimatuku catchment is estimated at $2.0*10^{-4}$ ppm.

P loss is split between "Other Sources," which is loss from tracks, lanes and infrastructure to waterways via overland flow, and "Blocks," which is P loss from paddocks due to dairy farming. "Other sources" P loss is estimated by Overseer to be 256 kg/year, with "Block" loss estimated to be 100 kg/year. "Other sources" P loss is calculated by a sub-model, which assumes that 30% of P that lands on tracks, lanes, yards and other infrastructure, ends up in waterways[29]. Overseer does not account for individual farm layout, however, and in this case tracks and lanes for the most part do not run close to or parallel to waterways. This is expected to reduce the quantity of P reaching waterways from tracks and lanes via runoff and will reduce the concentration of P in drainage waters below the figure calculated above. Additionally, by appropriately managing locations where overland flow from tracks and lanes etc. can potentially reach waterways (such as adjacent to the wintering barn at Woldwide 1), loss of "Other sources" P can be further reduced although once again, Overseer does not recognise this. Given available tools, it is very difficult to accurately quantify this reduction at the farm scale.

FATE OF P IN RECEIVING STREAMS – WAIMATUKU CATCHMENT

Due to physical interactions, P tends to be adsorbed by soil particles in surfacewaters and is taken out of solution to a large extent. A small portion of P, however, will remain soluble and available for uptake by aquatic plants in receiving water bodies. Some adsorbed P will subsequently be released from sediments as soluble P to be taken up by plants in the future. Mixing of drainage and receiving waters should result in dilution of soluble P, which should off-set potential adverse effects in receiving waters to an extent. A combination of adsorption, mixing and dilution processes occurring on a catchment scale, cumulatively gives a median P concentration of 0.06 ppm for the lower Waimatuku catchment (5-year median Total Phosphorous for SOE site at Waimatuku Stream at Lornville Riverton Highway).

CONCENTRATION OF P IN DRAINAGE WATERS TO LOWER ORETI CATCHMENT

Losses to the Lower Oreti receiving suracewaters from the whole activity are expected to be low due to the nature of soils and topography that lie in the Lower Oreti catchment, and cumulatively will give

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[29] Gray, Wheeler and McDowell (2016). Review of Phosphorous submodel in Overseer. Report prepared for AgResearch.

~~a median concentration of 0.012 ppm for the Lower Oreti catchment (Median Total Phosphorous at SOE site at Oreti River at Wallace Town).~~

~~Actual or potential effects from the whole activity on receiving surfacewaters~~

~~Since surfacewater drainage is primarily to the Waimatuku catchment, actual and potential effects due to contaminants N, P, sediment and microbes from the whole activity may be seen for the Waimatuku catchment and estuary. Since drainage is primarily to the aquifer in the Lower Oreti catchment, the underlying risk to the Lower Oreti catchment is reduced somewhat, with potential effects (Oreti River and New River Estuary) due to groundwater discharge of N to surfacewaters being the main risk.~~

~~Table 7.1 describes key measures, which will be implemented over and above GMPs, to mitigate effects from the whole activity on the on the Waimatuku and Oreti surfacewater catchments, including the Waimatuku and New River estuaries, and on the groundwater resource (Waimatuku and Central Plains aquifers). The effectiveness and level of effectiveness is also assessed.~~

~~Table 7.2 describes actual or potential effects from the whole activity on the Waimatuku and Oreti surfacewater catchments, including the Waimatuku and New River estuaries. Further comment is subsequently provided on actual or potential effects from the whole activity in each catchment.~~

Table 7.1 Specific mitigation measures proposed for the dairy farming activity, their effectiveness and assessed level of effectiveness.

No.	Specific mitigation measures proposed for N, P, sediment and microbial contaminant loss.	Effectiveness of mitigation measure	Level of effectiveness
1	Continued development of soils and pastures through removal of fodder crop rotation, implementation of grass to grass cultivation methods and a focus on sustainable agronomy;	Over time this leads to less mineralisation of N, increased soil organic matter content, water holding capacity, improved soil structure and consequently less N, P, sediment and microbial contaminant loss in artificial drainage, runoff and less N loss to groundwater via deep drainage.	High – this measure mitigates N, P, sediment and microbial contaminant loss and is implemented across the entire dairy farm. It will be particularly effective at reducing N loss to groundwater on leakier soils at the north east of WW1&2.
2	No land cultivated into fodder crop and intensively winter/summer grazed: Fodder crop/IWG by R2 heifers and summer grazing on turnips by cows have been carried out annually at WW1&2 landholding. These practices will no longer occur at WW1&2;	Nutrient (N and P) loss from fodder crop blocks is high due to mineralisation processes in soils, inputs of nutrients from animal dung and urine and fallow periods post grazing. Eliminating these practices is effective at reducing nutrient losses via deep drainage, artificial drainage and to less of an extent, overland flow pathways. Sediment and microbial contaminant loss from fodder crop blocks is high due to soil compaction, pugging and breakdown of the soil structure, and inputs of faecal microbes from animal dung and urine. Fallow periods following the grazing of crop blocks generates runoff across bare land, carrying contaminants to waterways. Elimination of these practices will be effective at reducing contaminant losses via artificial drainage and overland flow pathways.	High Where IWG is carried out on free draining soils, N loss to groundwater is high. P, sediment and microbial contaminant loss is high where soils are pugged following IWG and land lies fallow.
3	Expansion of the size and use of the wintering barn facilities	An additional 225 animals (cows and R2 heifers) will be wintered in the WW1 wintering barn. Both barns will be used more in the shoulders of the season (May, August and September) than they have	High – reduces loss of N and P, sediment and microbial contaminants to ground and

		been in the past. This is effective as effluent that would otherwise be deposited as dung and urine on paddocks at high risk times is captured and stored; less pugging of soils and accumulation of N in soils at high risk times occurs. The barns will be also used to stand cows off during inclement weather events during the season, which will also reduce soil damage, compaction and runoff risk associated with severe weather events.	surfacewaters, which otherwise is likely to occur at high risk times (May, August, September and during severe weather events during the season).
4	More efficient use of N fertiliser, e.g. effluent block will have less N fertiliser applied than non-effluent block;	This is effective at reducing N loss to water in drainage events following fertiliser application.	Moderate – the reduction in N loss will be seen across the effluent receiving area, reducing N lost in drainage to ground and surfacwaters in that area.
5	Conditioning very low depth application of slurry with the trailing shoe slurry tanker;	In recognition of the high strength nature of slurry and avoiding the overloading soils with N and microbes from slurry, this is effective at providing Environment Southland with certainty that slurry will be applied at less than or equal to 2.5 millimetres depth per application. In practice, an application depth of 1.5-2.0 millimetres per application will be used when applying slurry with the trailing shoes slurry tanker. This activity is assessed separately in section 7.1 (AEE for discharge activity).	Moderate – soils and pastures are not overloaded with nutrients from slurry, which reduces both N and P loss, and microbial contaminant loss from slurry receiving areas. This protects both ground and surfacwaters.
6	Lane adjacent to WW1 wintering barn will be contoured to drain away from the adjacent stream *see section 6 for further details	The cow lane in between WW1's wintering barn and a stream will be contoured away from the adjacent stream to avoid the risk of runoff flowing into the waterway. This measure has been actioned in March 2019. This will be effective at preventing runoff to the stream, which otherwise could be a greater risk with additional cow traffic on the lane. Good grass cover will always be maintained on the stream bank to further protect the stream.	Moderate – prevents a potential point source discharge of nutrients N and P to surfacewaters in the Waimatuku catchment

~~7~~	~~Eliminate direct contamination of house bore (45/0622), which is also used by ES at a monitoring bore;~~	~~Measures to eliminate contamination of the bore will be carried out: the casing will be extended far enough above ground level to ensure stormwater cannot enter the well. A sloping concrete pad will be placed around the casing. Any holes in the well liner will be sealed, the piping and fittings will be serviced, and any leaks will be repaired.~~	~~Minor – this will prevent localised contamination of groundwater in the Waimatuku GW zone with N, P and microbes;~~
~~8~~	~~Olsen P levels are slightly below optimum level. Once target Olsen P levels are achieved, P fertiliser will be applied to maintain Olsen P levels within optimum range. Target Olsen P levels are 30.~~	~~This will avoid the loss of excess P to water in artificial drainage and runoff following prolonged wet periods.~~	~~Moderately effective for mitigating P loss to surfacewaters across farm. Overall due to flat topography and soil types, the risk of P loss is relatively low.~~
~~9~~	~~Tracks/lanes management and layout to reduces runoff to streams;~~	~~Overseer assumes that 30% of P that lands on all tracks/lanes ends up in waterways. Given the farm layout (tracks and lanes do not run close/adjacent to waterways for the most part) and management of track/lanes, culvert crossings and associated buffers, P loss as assumed by Overseer is reduced.~~ ~~The entire landholding has been operated as a dairy farm for many years and already has a well-developed lane network. No new land is coming into the dairy farm. Some flexibility to improve the existing network of farm lanes is needed as part of operating and managing the dairy farm. Any future lane development will be very minor in scale with the purpose of eliminating soil compaction/pugging issues as they arise over time.~~ ~~Lane contours will be maintained to drain away from any adjacent waterways and prevent runoff.~~	~~Highly effective at mitigating P, sediment and microbial contaminant loss to surfacwaters across the landholding.~~

Table 7.2 Actual and potential effects from the whole activity (N, P, sediment and microbes) in surfacewaters. This table links to table 6.5 (mitigation measures).

Contaminant	Potential effect in receiving surfacewaters	Related effects	Specific mitigations proposed for whole activity	Likelihood of effect due to whole activity	Risk of effect due to whole activity
N, P	Increased algal growth in the water column, especially when flows are low and/or temperatures are elevated in shallow streams and the Waimatuku Stream: • Degrades water quality and blocks light (increases turbidity and reduces clarity)	Ecological: exclusion of macrophytes, reduced visibility for fish and other aquatic organisms, loss of habitat, decreased suitability for recreational activity	As per table 7.1 Measures mitigating N loss are #1, 2, 3, 4, 5, 6, 7 and 9; Measures for mitigating P loss are #1, 2, 3, 5, 6, 7, 8 and 9 Particularly, the removal of fodder beet/IWG from high risk soils and greater capacity and use of the wintering barns at high risk times are effective at mitigating N and P loss from the whole activity. Capturing and storing of dung/urine at high risk times, in conjunction with the application of nutrients at very low depth (slurry) at low risk times (when pastures are actively growing, and soil moisture conditions are suitable) are also major mitigation measures.	Low likelihood of effect and related effects occurring due to the nature and scale of activity and implementation of migration measures: N and P losses are minimised across the whole activity while still operating an economically sustainable dairy farm; however, some nutrients are inevitably lost as predicted by Overseer, but N losses are low relative to other dairy farms (see section 7.3.1). This shows that losses are minimised as much as practical across the whole activity. N and P lost in drainage undergo attenuation (denitrification and adsorption respectively), mixing and dilution in the vadose zone and receiving waters; the concentration of available nutrients in receiving waters for phytoplankton from to the whole activity is low and the likelihood of associated algal blooms and related effects is low. Summary: N and P losses are minimised across the whole activity, are low for dairy farming in the wider area, and due to physical processes are unlikely to lead to algal blooms and related effects in the	No more than minor

				Waimatuku Stream, Estuary, Oreti River and New River Estuary.	
N, P	Increased algal growth in the water column: - Potentially increasing BOD	Ecological: reduced DO causing stress on aquatic organisms, loss of species and habitat	As per above	Very low likelihood since point source discharges affect BOD rather than diffuse sources. Although the discharge of FDE is a point source discharge, it is to land rather than water is managed appropriately.	Less than minor – point source discharges affect BOD rather than diffuse sources
N, P	Increased periphyton growth on stream beds, especially in smaller streams (Waimatuku) when temperatures are elevated, or flows are low: - Smother streambed Increased aquatic weed growth on stream beds when temperatures are elevated, or flows are low: - Choke waterways	Ecological: loss of habitat, effects on invertebrates and organisms in associated food webs, reduced biodiversity	As per above	Low likelihood of effects and related effects occurring due to the nature and scale of activity and implementation of migration measures: As per row 1 above. Summary: N and P losses are minimised across the whole activity, are low for dairy farming in the wider area, and due to physical processes are unlikely to lead to increased periphyton growth, increased aquatic weed growth and related effects in the Waimatuku Stream, Estuary, Oreti River and New River Estuary	No more than minor
N, P	Increased periphyton growth, especially in streams and rivers when temperatures are elevated, or flows are low: - Promote the growth of toxic matts of cyanobacteria (blue green algae)	Toxic effects on biota including domestic animals. Also, people using waterways for recreational activities are at risk of adverse health effects	As per above	Low likelihood due to the natures and scale of activity and implementation of migration measures: As per row 1 above except that there is likelihood of toxic cyanobacteria growth and related effects occurring in the Waimatuku Stream, Estuary, Oreti River and New River Estuary due to the whole activity.	No more than minor

N	N toxicity effects if N concentration is high enough, particularly in the Waimatuku Stream	Ecological: loss of habitat, fish kills Animal health due to nitrate toxicity	As per above for N loss mitigation	Low likelihood since N concentration in receiving waters is lower than toxicity level and encouragingly N levels have decreased over the last two consecutive years in the Waimatuku Stream: The scale of the activity and implementation of proposed migration measures further reduce the likelihood of the effect occurring.	No more than minor
P	Increased nuisance plant growth on estuaries (Waimatuku and/or New River): P sorbed to soil particles following runoff is deposited in sediment and then released from bed into the water column	Weed-driven habitat modification and loss; effects on invertebrates and organisms in associated food webs leading to reduced biodiversity	As per above for P loss mitigation	Low likelihood due to nature and scale of activity and implementation of proposed migration measures: The layout of the farm, optimal management of infrastructure CSAs and implementation of mitigation #6 reduce sediment loss in runoff to the Waimatuku and Oreti catchments. By reducing sediment loss (and sorbed P) as much as practical while still operating an economically viable dairy farm, P loss is reduced below modelled levels as per Overseer. Mitigating sediment loss from the whole activity and its associated deposition in the Waimatuku and New River Estuaries means that less P will be released back into the water column from sediment in the future. The concentration of soluble P (released from sediment) in receiving estuaries from to the whole activity is low and the likelihood of algal blooms and related effects is low.	No more than minor

~~Sediment~~	~~Following runoff, increased turbidity and reduced water clarity in Waimatuku Streams, Oreti River and respective estuaries.~~	~~Ecological: exclusion of macrophytes, reduced visibility for fish and other aquatic organisms, loss of habitat, decreased suitability for recreational activity~~	~~As per table 1.~~ ~~Measures 1, 2, 3, 5, 6, 7, 9 are the main mitigation measures for sediment loss.~~	~~Low likelihood due to nature and scale of activity and implementation of proposed migration measures:~~ ~~Runoff occurs following high drainage events. The layout of the farm, optimal management of paddock and infrastructure CSAs and implementation of mitigation #6 reduce sediment loss in runoff to the Waimatuku and Oreti catchments. Sediment loss is reduced as much as practical while still operating an economically viable dairy farm. Maintaining sediment loss at a minimal level helps to improve water clarity and reduce turbidity in receiving waters including, streams, rivers and estuaries.~~	~~No more than minor~~
~~Sediment~~	~~Following runoff, increased deposition of sediment in Waimatuku Stream & Estuary, Oreti River and New River Estuary.~~ • ~~Smother streambed~~	~~Ecological: loss of habitat and increased anoxic conditions (estuaries), effects on invertebrates and organisms in associated food webs, reduced biodiversity~~	~~As per above~~	~~Low likelihood due to nature and scale of activity and implementation of proposed migration measures:~~ ~~Runoff occurs following high drainage events. The layout of the farm, optimal management of paddock and infrastructure CSAs and implementation of mitigation #6 reduce sediment loss in runoff to the Waimatuku and Oreti catchments. Sediment loss is reduced as much as practical while still operating an economically viable dairy farm. Maintaining sediment loss at a minimal level reduces deposition of sediment on the bed of receiving waterways including, streams, rivers and estuaries.~~	~~No more than minor~~

~~Microbial contaminants~~	~~Following run-off, elevated levels of microbial contaminants in streams, Waimatuku Stream, Oreti River and respective estuaries:~~ • ~~Exposure to pathogens~~	~~People using waterways for recreational activities and food gathering are at risk of adverse health effects (gastroenteritis)~~	~~As per above~~	~~Low likelihood due to nature and scale of activity and implementation of proposed migration measures:~~ ~~Runoff occurs following high drainage events. The layout of the farm, optimal management of paddock and infrastructure CSAs and implementation of mitigation #6 reduce microbial contaminant loss in runoff to the Waimatuku and Oreti catchments. Microbial contaminant loss is reduced as much as practical while still operating an economically viable dairy farm. Maintaining microbial contaminant loss at a minimal level reduces the risk of exposure to pathogens and related effects.~~	~~No more than minor~~

Further comment on actual and potential effects on the Waimatuku Estuary and New River Estuaries

Due to the nature of drainage from the whole activity, actual and potential effects described in table 7.2 may apply to the Waimatuku Estuary. Waimatuku Estuary is a sensitive environment that is adversely affected by nutrients, sediment and microbial contaminants from land use in the catchment, such as dairy farming. Contaminant losses to the Waimatuku Estuary from the whole activity are minimised due to the implementation of site-specific GMPs and key mitigations that reduce N accumulation, N mineralisation processes, protect soil structure and reduce runoff. These are described in tables 7.1 and 7.2. These measures are complemented by the general strategy of good nutrient and soil management as demonstrated in soil fertility trend reports from Ravensdown. Since contaminant losses from the whole activity to the Waimatuku Estuary are low, and undergo attenuation, mixing and dilution in receiving waters, effects from the whole activity on the Waimatuku Estuary are expected to be low. Broad scale cumulative effects on the Waimatuku Estuary are discussed in section 7.3.3.

Due to the predominant nature of drainage (to the aquifer) from the whole activity to the Oreti catchment, there is lower risk of actual and potential effects described in table 7.2 occurring in the New River Estuary. The major pathway for contaminants reaching the New River Estuary from the whole activity is via runoff following severely adverse weather events and via groundwater discharging N to streams and waterways draining the Oreti catchment to New River Estuary. New River Estuary is a sensitive environment that is adversely affected by nutrients, sediment and microbial contaminants from land use in the catchment, such as dairy farming. So long as site-specific GMPS and mitigations are implemented as described, reduced N accumulation and N mineralisation processes, the protection of soil structure and minimal runoff should be achieved and effects on New River Estuary are expected to be low. Broad scale cumulative effects on the New River Estuary are discussed on in section 7.3.3.

~~Actual or potential effects from the whole activity on groundwater~~

~~INTRODUCTION~~

~~Adverse effects on groundwater can occur from the expanded dairy farm activity where contaminants present in dung, urine, effluent, fertiliser and silage pad leachate, such as nutrients N (nitrate) and microbes (pathogens such as campylobacter) reach groundwater via leaching/deep drainage pathways. A major risk of elevated nitrate levels in groundwater is to users (consumers) of groundwater as nitrate becomes toxic to living organisms such as humans, animals and fish at high levels. The New Zealand Drinking Water Standard maximum allowable value for nitrate is 11.3 ppm. Another risk is to consumers of groundwater is waterborne gastroenteritis through the ingestion of groundwater contaminated with pathogens such as campylobacter. This was demonstrated in Havelock North in 2016, when over 5,000 people became ill with campylobacteriosis. Adverse effects on other users of groundwater such as Heddon Bush School, other farms, small industries or settlements/domestic users can occur and need to be avoided or mitigated.~~

~~There is risk to groundwater from the whole activity at the landholding from two soil processes:~~

1. ~~Drummond/Glenelg soils are free draining and therefore have risk of contaminant loss via deep drainage to underlying aquifers due to their physical properties. Approximately 378 hectares (or 79%) has Drummond and Glenelg soil types.~~

2. ~~Braxton soil types have swell/crack characteristics that can allow contaminants present in dung and urine to be washed down to the underlying groundwater resource via deep cracks that can form during prolonged dry summer conditions. Parts of WW1&2 with Braxton soils types (approximately 100.5 hectares or 21%) require appropriate management to mitigate the risk of contaminant loss to groundwater if and where deep cracks form.~~

~~Water percolating through the vadose zone to the underlying aquifer undergoes mixing and nutrients are diluted. As is explained in section 5, land use nitrate effects on groundwater in the area start to be seen within a year, and certainly are evident within three years. Since much of the wider area has been used for dairy farming, cereal cropping, IWG and sheep farming for many decades, effects on groundwater have been present for decades. The hotspot at Heenen's Corner to the southeast in the Central Plains groundwater zone is likely to reflect this. In terms of the whole activity, there will be extensive mixing within a large aquifer and some dilution thereafter, which will change background N concentrations by a small degree, and cumulatively will give a concentration within a range of 1.0 – 8.5 ppm for most of the landholding.~~

~~Table 7.3 describes actual or potential effects from the whole activity on the Waimatuku and Central Plains groundwater zones, including potential effects on the registered drinking water bore supply at Heddon Bush School. Further assessment is also provided on actual or potential effects from the whole activity on each groundwater zone.~~

Table 7.3 Risk of adverse effects from the proposed dairy farming activity due to contaminants N and microbes in groundwater. This table links to table 7.1 (mitigation measures).

Potential effect of N in groundwater	Related effects	Specific mitigations proposed for whole activity	Likelihood of effect due to whole activity	Risk of effect due to whole activity
Human health effects (i.e. methemoglobinemia) from groundwater consumption at Heddon Bush School (Waimatuku GW zone) if groundwater nitrate concentrations are excessive (NZ Drinking Water Standard MAV is 11.3 ppm)	n/a	See table 7.1 for explanations of effectiveness of mitigation measures. Measures #1, 2, 3, 4, 5, 6, 7 and 9	Low likelihood due to the: • nature and scale of activity; • evidence of low groundwater nitrate levels at the south of the property and at Heddon Bush School in 17/18; and • implementation of mitigation measures. N losses are minimised across the whole activity while still operating an economically sustainable dairy farm; however, some N is inevitably lost as predicted by Overseer, but N losses are low relative to other dairy farms (see section 7.3.1). N lost below the root zone undergoes some denitrification in Braxton soils, then mixing and dilution in the aquifer (Waimatuku). The risk of N reaching the Waimatuku aquifer through deep cracks the can form in Braxton soils is mitigated through appropriate pasture and soil management to avoid crack formation, and the avoidance of grazing/discharging effluent to areas where cracks have formed. The evidence from water quality sampling of a bore at the south of WW1&2 and a bore at Heddon Bush School indicates that nitrate levels are low (less than 2.1 ppm at the school in 2018) despite the presence of the dairy farm north of the school for decades.	No more than minor

			This indicates that nitrate losses from the whole activity to the Waimatuku GW zone are low; Evidence supports low nitrate loss to the Waimatuku GW zone from the whole activity. The concentration of nitrate in groundwater at Heddon Bush School is low; therefore, the likelihood of associated adverse health effects (methemoglobinemia) on consumers of groundwater at Heddon Bush School due to the whole activity is low.	
Human health effects (methemoglobinemia) on groundwater consumers in the Central Plains groundwater zone to the south east where groundwater nitrate concentrations are excessive (NZ Drinking Water Standard MAV is 11.3 ppm)	n/a	See table 7.1 for explanations of effectiveness of mitigation measures. Measures #1, 2, 3, 4, 5, 6, 7 and 9 Particularly, the removal of fodder beet/brassica cropping/IWG practices from the north east of Ww1&2 where lighter/more leaky soils are found is a key mitigation.	Low likelihood due to the: • nature and scale of activity; • evidence of groundwater nitrate levels on the east side of the landholding generally being between 3.5-8.5 ppm; and • implementation of migration measures N losses are minimised across the whole activity while still operating an economically sustainable dairy farm; however, some N is inevitably lost as predicted by Overseer, but N losses are low relative to other dairy farms (see section 7.3.1), which shows that N losses are minimised across the whole activity. Ceasing the practice of fodder beet/IWG on lighter, free draining soils removes a practice that loses high levels of N to GW in the Central Plains zone. Less N mineralisation and less N accumulation at high risk times will occur. The removal of IWG is facilitated by greater capacity and use of the wintering barns. N lost below the root zone undergoes minimal denitrification in Oxidising soils that overlie the Central	No more than minor

			Plains GW zone, so N accumulates in soils and in the aquifer. This is reflected in high GW nitrate levels seen to the east and south east, with a hotspot at Heenan's Corner. GW sampling at a monitoring bore on the east side of WW1&2 has a mean nitrate concentration of 8.16 ppm, which is lower than levels seen to the south east. This indicates that despite the presence of leaky soils overlying the Central Plains aquifer, nitrate losses to GW are being kept to a minimum while still operating a viable dairy farm. By removing IWG on fodder beet from leaky soils, the concentration of N in GW flowing towards Heenan's Corner from the whole activity should be reduced over time; however, N losses from neighbouring farms and activities are not allowed for here. Nitrate related effects on consumers of GW in the Central Plains GW zone (farms, rural/domestic) from the whole activity are expected to be low.	
Ecological effects due to discharge of groundwater with elevated nitrate to shallow streams in Waitmatuku and Oreti catchments	Fish kills due to nitrate toxicity; Eutrophication of receiving surfacewaters (Waimatuku, Oreti); Recreational effects; fishing in Waimatuku is reduced;	See table 7.1 for explanations of effectiveness of mitigation measures. Measures #1, 2, 3, 4, 5, 6, 7 and 9	Low likelihood since N concentration in receiving waters is lower than toxicity level, and the nature and scale of the activity and implementation of proposed migration measures further reduce the likelihood of the effect occurring. Evidence indicates that relatively low levels of N are being lost to the Waimatuku GW zone from the whole activity so GW discharging to the Waimatuku catchment is expected to have low N from the whole activity. Ecological effects and related effects are expected to be low. Evidence indicates that higher levels of N are being lost to the Central Plains GW zone but this is being kept to a	No more than minor

			minimum while still operating a viable dairy farm. A major mitigation measure (removing fodder beet/IWG) from leaky soils should reduce N loss to the aquifer. The Oreti River is a major river that has a diluting effect on N. Ecological effects and related effects on the Oreti River due to the discharge of GW to the Oreti catchment are low.	
Human health effects due to faecal contamination of groundwater at Heddon Bush School (Waimatuku GW zone) and rural consumers of GW (Central Plains GW zone)	Gastroenteritis (e.g. camplyobacteriosis) by consuming contaminated groundwater	As per table 7.1 Measures #1, 2, 3, 5, 6, 7 and 9	Low likelihood due to implementation of mitigation measures: Very low depth slurry application (max 2.5 mm per application) to limit microbial loading of soils from slurry. Sunlight and soil processes act on microbes reducing their viability and likelihood of causing waterborne infection; Protecting soils and maintaining good pasture cover to avoid crack formation in Braxton soils. Monitoring for soil cracks and avoidance of cracks when grazing stock or discharging effluent or slurry; limited viability of microbes in groundwater; and use of an ozone purification system at Heddon Bush School.	No more than minor
Human health effects due to long term consumption of nitrate in GW (bowel cancer)	n/a		Please see commentary provided on page 158.	

ACTUAL AND POTENTIAL EFFECTS FROM GROUNDWATER NITRATE ON HEDDON BUSH SCHOOL DUE TO WHOLE ACTIVITY – FURTHER COMMENT

As is described in section 5, groundwater nitrate levels at the south flowing toward Heddon Bush School are consistently low (despite an issue with localised well contamination). Given the following factors, elevated groundwater nitrate levels and related effects, would have been seen for some time in the vicinity of the school, if they were present:

- the proximity of the school approximately 2.3 km south of WW1&2;
- the direction of groundwater flow from much of WW1&2 (south towards the school);
- land use at and around WW1&2, and north of the school since the 1980s. This includes cereal cropping, sheep farming, dairy farming and intensive winter grazing. Cereal cropping and IWG are activities that lose high levels of N through increased mineralisation processes;
- the length of time the land has been used for dairy farming (WW1 since 1992, WW2 since early 2000s);
- the estimated lag times for nitrate to percolate through the vadose zone, reach the water table and the underlying groundwater stream are short, and
- the estimated velocity of groundwater flow.

Sampling of the school bore over three dates in late 2017 and early 2018 returned a mean nitrate concentration of 1.9 ppm. This indicates that groundwater nitrate levels at the school are low and pose minimal risk to health. It also indicates that there are minimal effects on groundwater quality at the school from the dairying activity 2.3 km north of the school; effects from activities (at WW1&2 and other farms) over the past decades would have been seen for some time at the school, if they were present. Simply put, the land did not operate in a “vaccum” prior to the official establishment of dairy platforms at WW1 and WW2. Finally, the school bore is drilled to a depth of over 14 metres, which further reduces any potential risk to consumers of groundwater at the school.

ACTUAL AND POTENTIAL EFFECTS FROM GROUNDWATER MICROBIAL CONTAMINATION ON HEDDON BUSH SCHOOL DUE TO WHOLE ACTIVITY – FURTHER COMMENT

The south bore at WW1&2 (E45/0622) suffers from localised contamination due to its design. This is reflected in the positive *E. coli* results for that bore, which corrupt the dataset making the bore unsuitable for monitoring purposes. Following the zone of reasonable mixing, there is likely to be minimal adverse effect on the wider groundwater resource from this localised source. *It is proposed to install a new monitoring bore at the south of the farm, which will eliminate the issue of localised contamination, making E.coli results valid, reliable and an important information source that can be used in decision-making. It is also proposed to carry out remedial work on the existing bore, to prevent localised contamination in the future.*

According to the principal at Heddon Bush School, the school bore has been tested quarterly since it was drilled and has consistently returned negative *E.coli* results (<1 MPN/100 ml). Given the bullets points summarised in the previous section as well as the lifetime of *E.coli* in the environment (up to 3 months[30]), adverse microbial effects on the school bore should have been detected in quarterly testing if they were present. The evidence so far does not indicate that whole activity WW1&2 is having (or will have) an adverse effect on the Heddon Bush School water supply through faecal contamination of groundwater. Furthermore, the depth of the school bore further helps to protect it from land-use effects, as does the presence of an ozone water purification treatment system.

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[30] Edberg, Rice, Karlin and Allen (2000). *Escherichia coli*: the best biological drinking water indicator for public health protection. Journal of Applied Microbiology 2000, 88, 106S – 116S.

ACTUAL AND POTENTIAL EFFECTS FROM GROUNDWATER MICROBIAL CONTAMINANTS IN THE CENTRAL PLAINS GW ZONE DUE TO WHOLE ACTIVITY – FURTHER COMMENT

Groundwater testing of the monitoring bore at the east overlying the Central Plains zone has generally been negative for *E.coli* since it was installed in 2015. It has returned three positive results in that time, with one result likely to be an outlier in the dataset. The relatively high result in November 2017 was likely to have been due to recent heavy rainfall that occurred between November 3rd and 12th and resulted in a very high level of drainage and the observed positive *E. coli* result. The subsequent test in April 2018 was negative for *E.coli* (<1 MPN/100 ml). The ES monitoring bore at Boyle Road to the south east and in the same groundwater zone, has consistently been negative for *E.coli* in recent years with the exception of December 2017. It too was subsequently negative for *E.coli* in March 2018 (<1 MPN/100 ml). This indicates that if groundwater contamination occurs due to an extreme rainfall event and subsequent high level and rate of drainage, it is relatively short lived, which is in line with the length of time that *E.coli* and similar microbes are believed to remain viable in groundwater (three months or less). Land immediately south of WW1&2 is agricultural (dairying, dry stock and cropping) with an associated very low human population density. Based on these factors, the likelihood of effects on human health such as gastroenteritis occurring is low.

ACTUAL AND POTENTIAL EFFECTS FROM GROUNDWATER NITRATE – CHRONIC HUMAN HEALTH EFFECTS (BOWEL CANCER)

Bowel cancer is a complex, chronic human disease that has relatively high prevalence in Western, developed nations. Diet is understood to be one factor in the development developing bowel cancer, which is multifactorial disease[31]. A potential link between the long-term consumption of drinking water with elevated nitrate and bowel cancer has been investigated in recent years[32] [33]. Nitrate can become a carcinogen when it is ingested and converted to nitrite by gut bacteria in humans. However, certain other dietary amino compounds are also required for nitrite become carcinogenic.

A large scale, longitudinal study carried out in Denmark and published in 2018[34] found that people who were exposed to the highest concentration of nitrate in drinking water had a 15 per cent greater risk of getting colorectal cancer compared to those who had least exposure. The study identified an association at the population level, between consumption of nitrate in drinking water and risk of developing bowel cancer. According to Professor Ian Shaw at the University of Canterbury and reported by Tom McDougall in Agriview NZ[35], "In my opinion nitrate is associated with colon cancer because it can be converted to nitrite by gut bacteria and form nitrosamines with dietary amino compounds. Nitrosamines are profound carcinogens. Links with water nitrate would, therefore, not be definitive because other components of the diet would be necessary to facilitate carcinogenesis. If exposure to an appropriate dietary mixture, plus the right bacterial species in the microbiome do not coincide carcinogenesis will not occur. This is a complex scenario that cannot be attributed to a single exposure to a single chemical." Whilst the Danish study picked up a "signal" at the population level, due to the complex and

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[31] Ryan-Harshman& ALdoori. Diet and colorectal cancer: Review of the evidence. *Can Fam Physician*. 2007 Nov; 53(11): 1913–1920. PMID: 18000268

[32] Jörg Schullehner, Birgitte Hansen, Malene Thygesen, Carsten B. Pedersen, Torben Sigsgaard. **Nitrate in drinking water and colorectal cancer risk: A nationwide population-based cohort study**. *International Journal of Cancer*, 2018; DOI: 10.1002/ijc.31306

[33] Espejo-Herrera et al. Colorectal cancer risk and nitrate exposure through drinking water and diet. *Cancer Epidemiology*, 2016. DOI: **https://doi.org/10.1002/ijc.30083**

[34] Jörg Schullehner, Birgitte Hansen, Malene Thygesen, Carsten B. Pedersen, Torben Sigsgaard. **Nitrate in drinking water and colorectal cancer risk: A nationwide population-based cohort study**. *International Journal of Cancer*, 2018; DOI: 10.1002/ijc.31306

[35] https://www.agriview.nz/forum?author=5acff4fa2b6a28b7ea99c4f1

~~multifactorial nature of bowel cancer pathology, causation cannot be directly attributed to consumption of nitrate in groundwater.~~

~~A case-control study carried out in Spain[36] over several years also investigated whether colorectal cancer risk is linked to nitrate exposure through drinking water and diet. Increased risk was associated with gender and in subjects with high red meat intake. A positive association between CRC risk and waterborne ingested nitrate was suggested among subgroups with other risk factors. This again highlights the multifactorial nature of bowel cancer, which cannot be attributed to exposure to a single chemical.~~

~~Land immediately south of WW1&2 in the direction of GW flow is agricultural (dairying, dry stock and cropping) with an associated very low human population density. Heddon Bush School represents a small population centre but has been demonstrated to have low levels of groundwater nitrate. Given the nature of the link identified in the above studies, it is very unlikely that there is a risk of human consumers of groundwater south of WW1&2 developing bowel cancer due to the proposed activity.~~

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[36] Espejo-Herrera et al. Colorectal cancer risk and nitrate exposure through drinking water and diet. *Cancer Epidemiology*, 2016. DOI: **https://doi.org/10.1002/ijc.30083**

Effects from additional cows over and above what is already in place

Introduction

An additional 160 cows at the WW1&2 will add nutrients to the farming system and can potentially cause treading damage to soils (compaction) and CSAs. In the absence of any other changes/off-sets to the system, additional cows would be expected to increase contaminant losses to the receiving environment with a likely increase in effects on the receiving environment also occurring. To meet requirements set out in council policy, actual and potential effects on the receiving environment from an additional 160 cows must be off-set through changes to the farm system, allowing water quality to be maintained or improved despite additional cows. The additional of 160 cows is one input to the farming system; so long as contaminant losses from the system in its entirety do not increase and adverse effects on receiving waters are avoided or mitigated, there should be no greater effect from additional cows over and above what is already in place.

Overseer nutrient budgeting has been used to model nutrient losses below the root zone from the proposed system, which includes an additional 160 cows and a range of changes to the system that will also occur. The existing system has also been modelled in Overseer and reflects average annual nutrient losses below the root zone over four years of farming at the landholding (and is based on four separate nutrient budgets). While Overseer is useful at modelling long-term average nutrient losses of farming systems, it has limitations. As already mentioned, it does not predict transformations, attenuation or dilution of nutrients between the root zone and the receiving water body. Also, Environment Southland have raised a concern that Braxton soils may not be modelled well in Overseer. Overseer is one tool, albeit a useful one, used in determining nutrient losses from additional cows over and above what is already in place. By quantifying nutrient losses below the root zone Overseer is a starting point, with knowledge of soil processes, drainage, hydrology, receiving waters and various farming practices also used to assess effects from additional cows over and above what is in place.

By using the same tool (Overseer) to quantify nutrient losses below the root zone for the proposed and pre-expansion systems, consistency is maintained across the analysis and associated assessment of effects. Any limitations of Overseer, such as potentially underestimating N loss from Braxton soils, will occur in all nutrient budgets. This should ensure that comparisons made between respective systems are valid and relative differences are real.

Contaminant losses and effects - over and above what is in place

The average annual N loss for the proposed system with additional cows is predicted by Overseer to be 40 kg/ha; the prior average annual N loss is predicted at 41 kg/ha. Overall N loss for the proposed system with additional cows is 215 kg/year lower than losses for the pre-expansion system. The average annual P loss for the proposed system with additional cows is predicted by Overseer to be 0.7 kg/ha; the prior average annual P loss is predicted at 0.7 kg/ha. In conclusion, losses of N and P below the root zone are predicted by Overseer remain stable or decrease slightly despite additional cows.

Changes to the farming system are off-setting additional nutrients from additional cows and act as mitigation measures that form part of the proposed farming system. Key off-sets that are recognised by Overseer are the removal of fodder crop/IWG and increased capacity and use of wintering barns. Collectively, less N will accumulate in soils at high risk times, less N mineralisation will occur, and greater soil organic matter will be retained than before. The outcome will be less N lost below the root zone and ultimately to groundwater and/or receiving surfacewaters. The removal of cows and heifers (including additional cows) from paddocks over high risk months and the avoidance of fallow periods following IWG of fodder crops will reduce pugging of soils and runoff of N, P, sediment and microbes to receiving waters. Paddocks formerly used for winter feed will instead be grazed outside winter time, when plants are actively growing and taking up nutrients. Nutrients from additional cows will be collected and stored in ponds at high risk times to be applied to land at very low depth when pastures are actively growing/taking up nutrients and the risk of drainage is minimal.

Evidence from trial data measured in two field studies carried out in Southland and summarised in a review[37] show that fodder crop blocks under IWG lose high levels of N in drainage. Particularly, results from the Woodlands trial showed that per hectare N losses from fodder crop (kale) were 4 to 5 times greater than losses measured under dairy pasture on equivalent soil types and land use. Relatively high concentrations of nitrate-N were measured in drainage over three years from IWG forage crops on shallow soil types at the Five Rivers site. Much lower nitrate-N concentrations were subsequently measured in drainage when cropped areas were returned to pasture, then grazed by deer followed by sheep. Comparison of measured trial data (57 kg N/ha/year +/-43) versus Overseer data (48 kg N/ha/year) for fodder cropping/IWG at the Fiver Rivers site showed that Overseer underestimated the quantity of N lost below the root zone somewhat.[38] Overseer has undergone several version changes since the report was published, which has seen predicted N losses increase from fodder crop/IWG blocks in particular. Evidence from trial data in Southland broadly supports a reduction in N loss below the root zone with the removal of fodder cropping/IWG in conjunction with a change to full dairy pasture at WW1&2. This is especially the case on free draining Drummond and Glenelg soils.

Some changes to the farming system from additional cows are not recognised by Overseer. For example, contouring a cow lane adjacent to WW1 wintering barn to ensure that any overland flow from the lane flows away from the adjacent stream, thus avoiding potential runoff down into the waterway. The stream bank will always be vegetated with good grass cover to further protect of the waterway by facilitating filtration and attenuation processes. The potential risk to the stream will be avoided, which otherwise could be a greater risk with additional cows. This will reduce the risk of P, sediment and microbial loss to surfacewaters draining to the Waimatuku catchment and estuary and their associated effects.

Given the range of GMPs and key mitigation measures that will be implemented in conjunction with the addition of 160 cows to the milking herd, no increase in N or P loss is predicted relative to the prior system. The proposed system is expected to have less accumulation of N at high risk times, generate less mineral N in soils and greater soil organic matter content, less pugging of soils and reduced runoff. Potential effects from additional cows such as increased treading damage causing compaction and runoff will be avoided by good stock management, always providing stock with enough feed and water to minimise stress and by standing cows off in the barns during severe weather events. Based on these factors with support from Overseer predictions, effects on groundwater and receiving surfacewaters due to an adapted system with additional cows would be expected to be similar or less than under the prior farming system and certainly be no greater than what is already in place.

Specific effects from the whole activity, which includes additional cows, are described and considered in the context of soil processes, drainage, attenuation, hydrology and receiving waters in section 7.3.1. To avoid repetition, please see section 7.3.1 for details.

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[37] Monaghan (2012). The impacts of animal wintering on water and soil quality. Report prepared for Environment Southland.

[38] Smith & Monaghan (2013). Comparing Overseer estimates of N leaching from winter grazed forage crops with results from Southland trial sites. Report prepared for Environment Southland.

Cumulative effects from farming on the receiving environment

Introduction

S 3 of the RMA defines cumulative effects as effects that arise over time or in combination with other effects. This assessment aims to identify and consider effects on the receiving environment that arise over time, accounting for other land use activities in the catchment and other influences such as hydrology, drainage properties and nutrient attenuation. Since the landholding lies in two catchments, each has been considered separately.

Oreti catchment and New River Estuary catchment

The easternmost part of WW1&2 lies in the Lower Oreti catchment. Sitting at the base of the Oreti catchment, New River Estuary has been impacted over time by land use activities in the wider catchment. New River Estuary drains a catchment area of 4,314 km^2 comprising 55% intensive pasture, 14% low producing pasture, 20% native forest, and 9% exotic forest[39]. Urban land use also contributes to effects on New River Estuary, with urban and industrial wastes from Invercargill city being other sources of contaminants. Approximately 194 hectares of WW1&2 is mapped to the Lower Oreti catchment, which is part of the wider New River Estuary catchment (431,400 ha). The land area at WW1&2 draining to the Oreti and ultimately New River Estuary catchment amounts to 0.04% of the total catchment area.

Agricultural land use in the New River Estuary catchment is made up of sheep & beef, dairy farming and forestry. In 2014, there were 271 dairy farms, 821 sheep & beef farms and 33 forestry blocks[40]. Sheep & beef farming remains the dominant land use although there is crossover since some sheep & beef enterprises carry out dairy support activities such as IWG. The study concluded that “sheep & beef remains the dominant land use by area in the Southland region, but losses from dairy farms are greater per hectare. Overall, the contributions from both land uses are significant. However, given the higher per hectare losses, it follows that mitigation on dairy farms provides a greater per hectare benefit for water quality.” Using information reported by Environment Southland webpage, the area under dairy farming or dairy support in the Oreti and Invercargill catchments totals 106,514 hectares[41]

The wider New River Estuary catchment is characterised by the major Oreti river and other significant tributaries, which provide for potential dilution of contaminants. There are several groundwater zones, reflecting different aquifer profiles. The Central Plains GW zone underlies the westernmost side of the catchment. Groundwater discharge occurs via the numerous small streams which cross the Central Plains GW zone. This drainage is aided by extensive mole, tile and artificial drainage networks, which act to both intercept soil drainage and control the water table. By this mechanism, a large portion of annual recharge is rapidly routed from the catchment with a much small component of deeper groundwater flow following the overall catchment drainage. Groundwater nitrate levels at the top of the catchment/CP zone are high, with some hotspots; levels at the south of the catchment are much lower. The denitrification potential rating for the

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[39] Stevens, L.M. 2018. New River Estuary: 2018 Macroalgal Monitoring. Report prepared by Wriggle Coastal Management for Environment Southland. 29p.

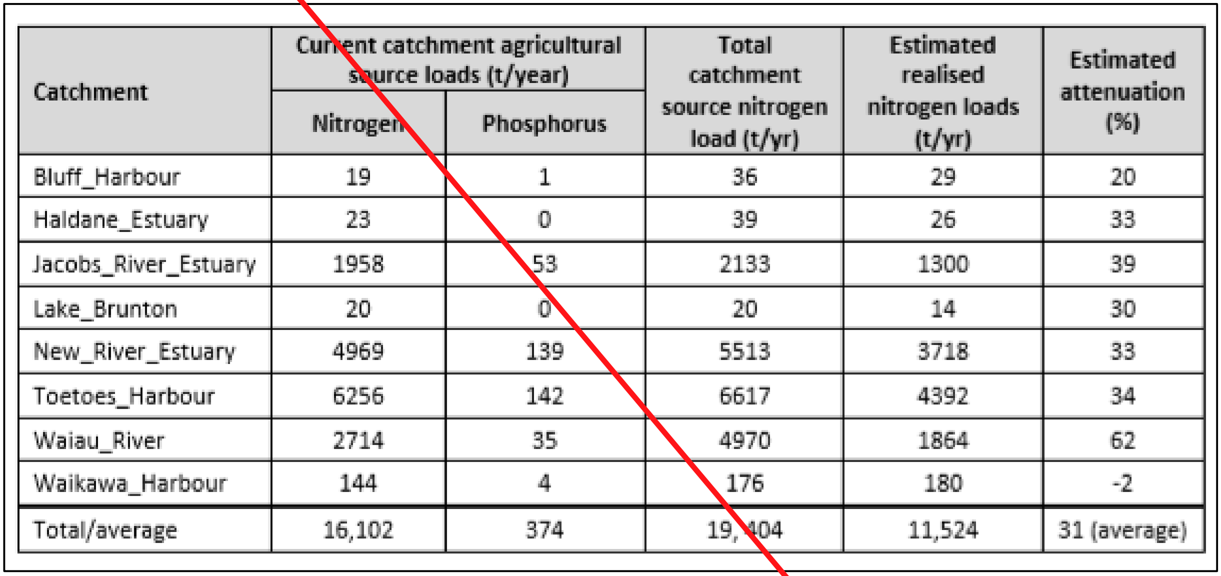
[40] Assessment of Farm Mitigation Options and Land Use Change on Catchment Nutrient Contaminant Loads in the Southland Region. Aqualinc Report C13055/04, 2014 Prepared for Environment Southland.

[41] Environment Southland (n.d.) https://www.es.govt.nz/environment/estuaries/Pages/Estuaries-in-the-Oreti.aspx

Central Plains GW zone ranges from very low at the top of the zone, low mid zone and intermediate/high at the base of the zone[42].

N LOAD - ORETI RIVER

A report prepared for Environment Southland assessed farm mitigation options and land use change on catchment nutrient contaminant loads in Southland[43]. Nutrient loss estimates were based on the Overseer farm nutrient budgeting model, which was also used to estimate how loss rates would change under three levels of on-farm mitigation measures. Information from the report has been used to estimate the contribution to the total N and P loads of the New River catchment from the farming activity at WW1&2. The report estimates that dairy farming contributes 52% of the agricultural source load of N in New River catchment, with sheep and beef contributing the balance (48%). Dairy farming contributes 67% of the agricultural source load of P in New River catchment, with sheep and beef contributing 32%. Significantly, wintering-off dairy cows within the catchment is a component of the sheep & beef activity.



Catchment	Current catchment agricultural source loads (t/year)		Total catchment source nitrogen load (t/yr)	Estimated realised nitrogen loads (t/yr)	Estimated attenuation (%)
	Nitrogen	Phosphorus			
Bluff_Harbour	19	1	36	29	20
Haldane_Estuary	23	0	39	26	33
Jacobs_River_Estuary	1958	53	2133	1300	39
Lake_Brunton	20	0	20	14	30
New_River_Estuary	4969	139	5513	3718	33
Toetoes_Harbour	6256	142	6617	4392	34
Waiau_River	2714	35	4970	1864	62
Waikawa_Harbour	144	4	176	180	-2
Total/average	16,102	374	19,404	11,524	31 (average)

Figure 7.3 Estimated loads of N and P in the eight study catchments[44]

Approximately 8,959 kg N/year may be lost from 194 hectares of land at WW1&2 mapped in the Lower Oreti catchment according to Overseer nutrient budget analysis (see proposed Block Nitrogen report). Assuming an attenuation rate of 33% from the above table, approximately 5,967 kg N/year could over time end up in receiving waters. This amounts to 0.16% of the estimated realised N load for New River Estuary catchment.

A similar calculation can be carried out to estimate the P load from WW1&2 to New River Estuary catchment without using an attenuation rate. 126 kg of P (100 kg of which is “Other Sources”) may be lost annually from 194 hectares of WW1&2 that lie in the Oreti/New River Estuary catchment (see proposed Block Phosphorous report from Overseer). This amounts to 0.09% of the current catchment agricultural source P load in New River Estuary catchment.

Both estimates show that the farming activity at WW1&2 contributes a very small proportion of the nutrient (N and P) loading to New River Estuary catchment and represents a very small proportion of total nutrient

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[42] Rissman (2011). Regional Mapping of Groundwater Denitrification Potential and Aquifer Sensitivity. Technical Report.

[43] Aqualinc, Assessment of farm mitigation options and land use change on catchment nutrient contamination loads in the Southland region, 2014

[44] Aqualinc, Assessment of farm mitigation options and land use change on catchment nutrient contamination loads in the Southland region, 2014

load in that catchment. It follows that cumulative effects from the activity will be minimal. Relative to other dairy farms, the applicants are operating at the lower end of the scale for nutrient losses despite wintering 1,250 cows at WW1&2 (in barns), and nutrient losses will not increase with additional cows. This assurance is provided to the Consent Authority through the capping of N loss per hectare through a consent condition. The investment in wintering barns is allowing for the removal of fodder cropping/IWG, which on a catchment scale is an activity that has a significant contribution to cumulative adverse effects in the Lower Oreti River and New River Estuary catchment. Arguably, the applicants are operating at an M3 mitigation level for dairy farming according to the Aqualinc study, given the range of site-specific GMPs and mitigation measures that will be implemented under the proposal. While the limit-setting process will primarily address the challenge of improving water quality in the coming years, this proposal is expected to allow water quality in New River Estuary catchment to be maintained if not improved in the meantime. Accounting for effects from all other land uses in the catchment, cumulative effects on New River Estuary from the proposed activity at WW1&2 are minimal.

Waimatuku catchment and Estuary

As is described in section 5, the mid-western part of WW1&2 lies at the top of the Waimatuku catchment. Very limited data could be sourced about the wider Waimatuku catchment. It is a relatively small catchment with an estimated size of 25,500 hectares as approximately measured on Beacon Mapping Services. Approximately 306 hectares of WW1&2 lies within the catchment, which is equivalent to an estimated 1.2% of the total catchment land area. Waimatuku Estuary is a small estuary (20 ha) at the bottom of the catchment and has been impacted over time by land use activities in the catchment. Land use in the wider catchment is dominated by sheep & beef, dairy farming and dairy support although specific information on land use in the catchment could not be found. LAWA report that 90% of the land area is the Waimatuku catchment is exotic grassland, with the balance split between herbaceous vegetation and horticulture[45]. A desktop count on Beacon Mapping Service of current discharge permits in the Waimatuku catchment indicate that there are approximately 55 dairy platforms in the Waimatuku catchment.

The Waimatuku catchment is characterised by the lack of a major river, which reduces the potential for dilution of contaminants. Headwaters of the Waimatuku Stream are fed by Bayswater Bog, with small springs in the Drummond area also contributing to baseflow. Shallow groundwater makes a significant contribution to baseflow discharge in the catchment with recharge circulating relatively rapidly through upper levels of the unconfined aquifer and discharging via the local stream network. According to Topoclimate, a range of soil types such as heavy Braxton and Pukemutu types, and lighter Glenelg systems dominate the upper and mid catchment. Heavier soils have moderate to good denitrification potential with lighter Oxidising soil types having little or no denitrification potential. Groundwater nitrate levels are low at the top of the catchment and underlying Bayswater Bog, elevated mid catchment and are low towards the catchment base. Denitrification potential predominantly for the Waimatuku GW zone is rated as low[46].

NUTRIENT LOADS – WAIMATUKU CATCHMENT

Specific data detailing the total nutrient load (from all land use or farming) in the Waimatuku catchment could not be found in the literature. Attempting to calculate the total nutrient load for N and P using empirical calculations has a high degree of uncertainty so has not been attempted here. Approximately 10,420 kg N/year may be lost from 306 hectares of land at WW1&2 mapped in the Waimatuku catchment according to Overseer nutrient budget analysis (see proposed Block Nitrogen report). Assuming an N attenuation rate of between

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[45] https://www.lawa.org.nz/explore-data/land-cover/

[46] Rissman (2011). Regional Mapping of Groundwater Denitrification Potential and Aquifer Sensitivity. Technical Report.

~~33% (New River catchment) and 39% (Aparima catchment)[47], somewhere in the region of 6,775 kg of N/year may end up in the Waimatuku, either directly from drainage to surfacewaters or via groundwater discharge. What contribution this makes to the total N load in the Waimatuku catchment is unknown (since the total N load has not been calculated) but it may be similar or somewhat greater than 1.2%, which is an estimate of WW1&2's proportion of the total catchment land area.~~

~~A similar difficulty arises with P. 230 kg of P (156 kg of which is "Other Sources") may be lost annually from 306 hectares of WW1&2 that lie in the Waimatuku catchment (see proposed Block Phosphorous report from Overseer). Due to adsorption and attenuation of P, much of this will be taken out of solution. What contribution this makes to the total P load in the Waimatuku catchment is unknown (since the total P load has not been calculated) but it may be similar or slightly less (due to attenuation) than 1.2%, which is an estimate of WW1&2's proportion of the total catchment land area.~~

~~It is likely that the farming activity at WW1&2 contributes a small proportion of the nutrient (N and P) loading to the Waimatuku catchment and represents a small proportion of total nutrient load in that catchment. It follows that cumulative effects from the activity will be minimal. Relative to other dairy farms, the applicants are operating at the lower end of the scale for nutrient losses despite wintering 1,250 cows at WW1&2 (in barns), and nutrient losses will not increase with additional cows. This assurance is provided to the Consent Authority through the capping of N loss per hectare through a consent condition. The investment in wintering barns is allowing for the removal of fodder cropping/IWG, which on a catchment scale is an activity that has a significant contribution to cumulative adverse effects in the Waimatuku catchment. Arguably, the applicants are operating at an M3 mitigation level for dairy farming according to the Aqualinc study[48], given the range of site-specific GMPs and mitigation measures that will be implemented under the proposal. While the limit-setting process will primarily address the challenge of improving water quality in the coming years, this proposal is expected to allow water quality in Waimatuku catchment to be maintained if not improved in the meantime. This is supported by an improving trend over the last two consecutive years for N in the lower lower Waimatuku catchment. Accounting for effects from all other land uses in the catchment, cumulative effects on the Waimatuku catchment from the proposed activity at WW1&2 are minimal.~~

Intensive Winter Grazing

No intensive winter grazing of cows or heifers will occur at the WW1&2. A s such, no AEE for winter grazing is required as this activity.

IWG will be carried out at WRO. An AEE is provided for this activity in the WRO section of the application.

Consideration of alternatives for land use

The land at WW1&2 has been developed and used for dairy farming for many decades. Through their investment and experience farming, the applicants have developed a dairy farming model to suit the land. Given the level of investment, time and commitment to sustainability in the long term, the proposed dairying activity represents the best use of land at WW1&2. If this application is unsuccessful, the applicants will consider other uses for land at WW1&2 not under an existing land use consent for farming. Activities such as

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[47] Aqualinc, Assessment of farm mitigation options and land use change on catchment nutrient contamination loads in the Southland region, 2014

[48] Aqualinc, Assessment of farm mitigation options and land use change on catchment nutrient contamination loads in the Southland region, 2014

beef bull grazing (and associated IWG) or cereal cropping are realistic options. Neither of these activities will achieve a better outcome for the land environmentally as the dairying proposal.

8. Consultation

The applicants have requested that the application be publicly notified in accordance with s95A of the Act. During the hearing process, the public including potentially affected parties, will have the opportunity to submit their views and be consulted in due process.

9. Conclusion

The applicants seek replacement consents for their current land use consent for expanded dairy farming, effluent discharge to land and groundwater take for a 1,500-cow dairy operation. The expansion is due to an increase of 160 cows to a maximum of 1,500 cows. The expansion will occur in conjunction with key changes to the existing farm system; these changes are expected to result in a farming system with effects on receiving ground, surfacewaters and soils that are minimal, and that are less than existing effects.

The application includes a policy assessment, an assessment of environmental effects and Farm Environmental Management Plan that demonstrate that the expected, actual or potential adverse effects generated by the continuation of the proposed activities on the environment can be avoided, remedied or mitigated to the extent that they are considered to be no more than minor.

The key concern with the expansion and effluent discharge is the potential for the activities to have adverse effects on groundwater and surface water quality, and on soils. Provided any consent conditions imposed by the Council are adhered to, and management practices are implemented in line with the attached Farm Environmental Management Plans, the activities should have minimal adverse effect on the environment.

The water take is should have little adverse effect on neighbours' bores, and a less than minor effect on aquifer sustainability, current allocation and stream depletion.

Overall the proposal is considered consistent with the purpose of the Resource Management Act 1991 and does not conflict with the purpose of the Act, or with Council policy. The adverse effects of the dairying activity, the water take and the discharge of dairy shed effluent onto land should be no more than minor.