WOLDWIDE RUNOFF – PROPOSAL AND AEE

1. Executive summary

Woldwide Runoff (WRO) is a dry stock support block which currently supports all of the five Woldwide dairy farms by providing grazing for dry stock associated with the farms.

This document supports the concurrent resource consent applications for Woldwide 1&2(WW1&2) and Woldwide 4 (WW4) and Woldwide 5 (WW5) which seek various resource consents under the PSWLP for farming activities. This document details the activities currently occurring at WRO and how these activities are proposed to change if the proposals for the abovementioned four dairy farms are approved and enacted. An assessment of effects is provided in this document to enable the Council to be able to fully understand all effects associated with the proposal on WRO.

2. Existing use of WRO

WRO is a dry stock grazing block which also contains a commercial forestry operation, native bush block, commercial gravel extraction operation and land for supplement production. WRO is considered by Environment Southland to form both an individual landholding as well as being part of the landholdings for WW1&2, WW4 and WW5.

In summary, the existing use of the WRO landholding includes:

- The use of land (732ha) for dry stock farming
- The use of land (160ha) for commercial pine plantation and native bush
- The grazing of R1 and R2 heifers plus mating bulls and carry over cows from WW1&2, WW3, WW4 and WW5
- The use of land for intensive winter grazing of dry stock (52 hectares in 2018)

Status of activities at WRO

The land use consent applications for the farming activities for WW1&2, WW4 and WW5 seek consent for all activities located on the landholding which are directly associated with the operation of the respective dairy farms for 365 days of the year.

The proposed farming activity for WW1&2, WW4 and WW5 includes the grazing of dry stock all year round at WRO. Dry stock includes R1 and R2 grazing, mating bull grazing and carry over cow grazing. In this respect, WRO is considered to be part of the landholding for WW1&2, WW4 and WW5 and the grazing of dry stock at WRO has been included in the respective land use consent applications.

When considering WRO as an individual landholding, the use of land at WRO for the current and proposed activities in their entirety would otherwise be a **permitted activity** under Rule 20(a) of the PSWLP:

- There is no dairy platform on the landholding
- There is no associated discharge permit which specifies a maximum number of cows

- A FEMP in accordance with Appendix N of the PSWLP has been prepared for the landholding and implemented (see attached).
- The landholding contains no more than 100ha of intensive winter grazing
- The good management practices for intensive winter grazing specified in Rule 20(a)(iii)(3) have been implemented and detailed in the FEMP.
- A vegetated strip including stock inclusion will be in place adjacent to any water bodies in accordance with the setbacks in Rule 20(a)(iii)(4-6)

The applicant accepts that the activities at WRO which form part of the farming activity on WW1&2, WW4 and WW5 require land use consent as detailed above. However, it is important to note that when viewing WRO as an individual landholding then the current and proposed activities would otherwise be a permitted activity under the PSWLP and would remain so at any point in the future so long as they comply with any requirements, conditions and permissions specified in the RMA, detailed in Rule 20(a) and any applicable regional plans.

The applicant has included WRO in the respective land use consent applications as part of the farming activity and landholding at the request of Environment Southland staff, however the matter of whether it should technically be included in the respective farming activity and the landholdings for WW1&2, WW4 and WW5 lies in the interpretation of the term "landholding" in the PSWLP and in the conclusions from an Environment Southland legal opinion. This is a matter that will be raised and discussed in the upcoming hearing process.

3. Property description

Woldwide Runoff is located 20km to the west of Otautau, on the western side of the Longwood Ranges. WRO is comprised of two separate blocks. The Merrivale Block is owned by Woldwide Runoff Limited and the Merriburn block is leased. The Merriburn lease block is under a 5-year lease agreement, with Woldwide Runoff Limited having first right of renewal.

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
Proposed land use	Both blocks are run as a single operating unit. Grazing of R1 and R2 heifers, grazing of carry over cows and grazing of mating bulls all year round (includes intensive winter grazing)

	Production of baleage 100ha of commercial pine plantation 60ha beech forest under sustainable management
Dry stock in 2017/2018 season	1265 R1 1265 R2 37 carry over cows 70 mating bulls

Figure 1: Current/Proposed farm boundary for WRO. [1]

[1] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

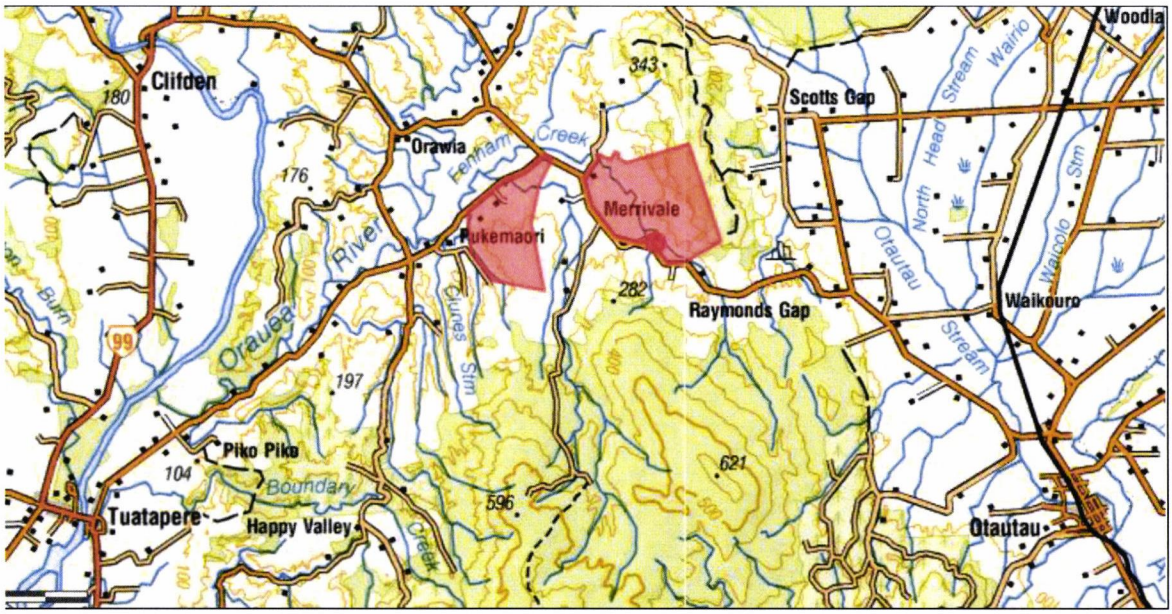


Figure 2: General location of WRO[2]

Figures 3 and 4 show the mapped farm boundaries and features of interest on the original part of the runoff block and the leased part of the runoff block respectively.

[2] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

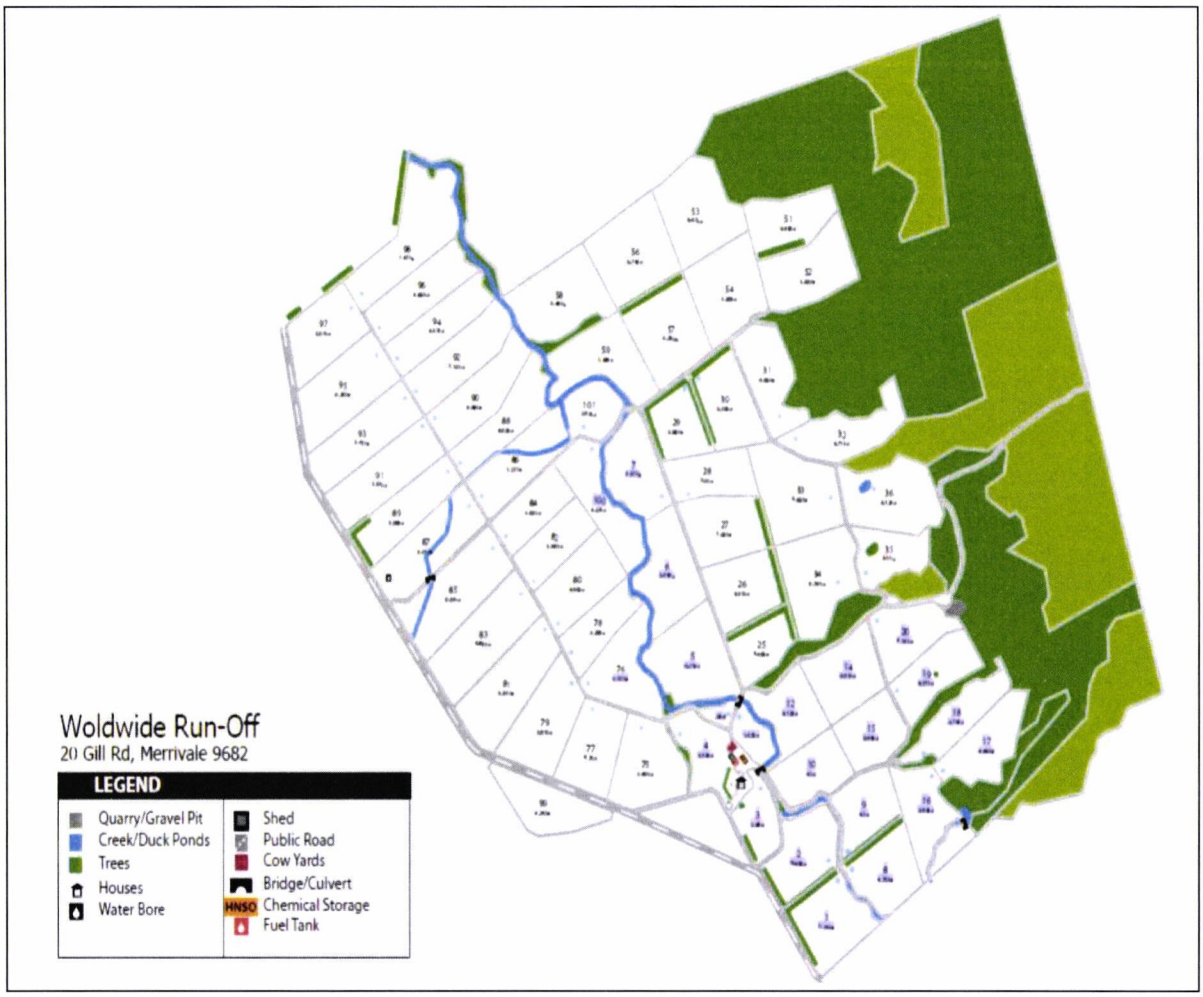


Figure 3: Farm map for Merrivale block

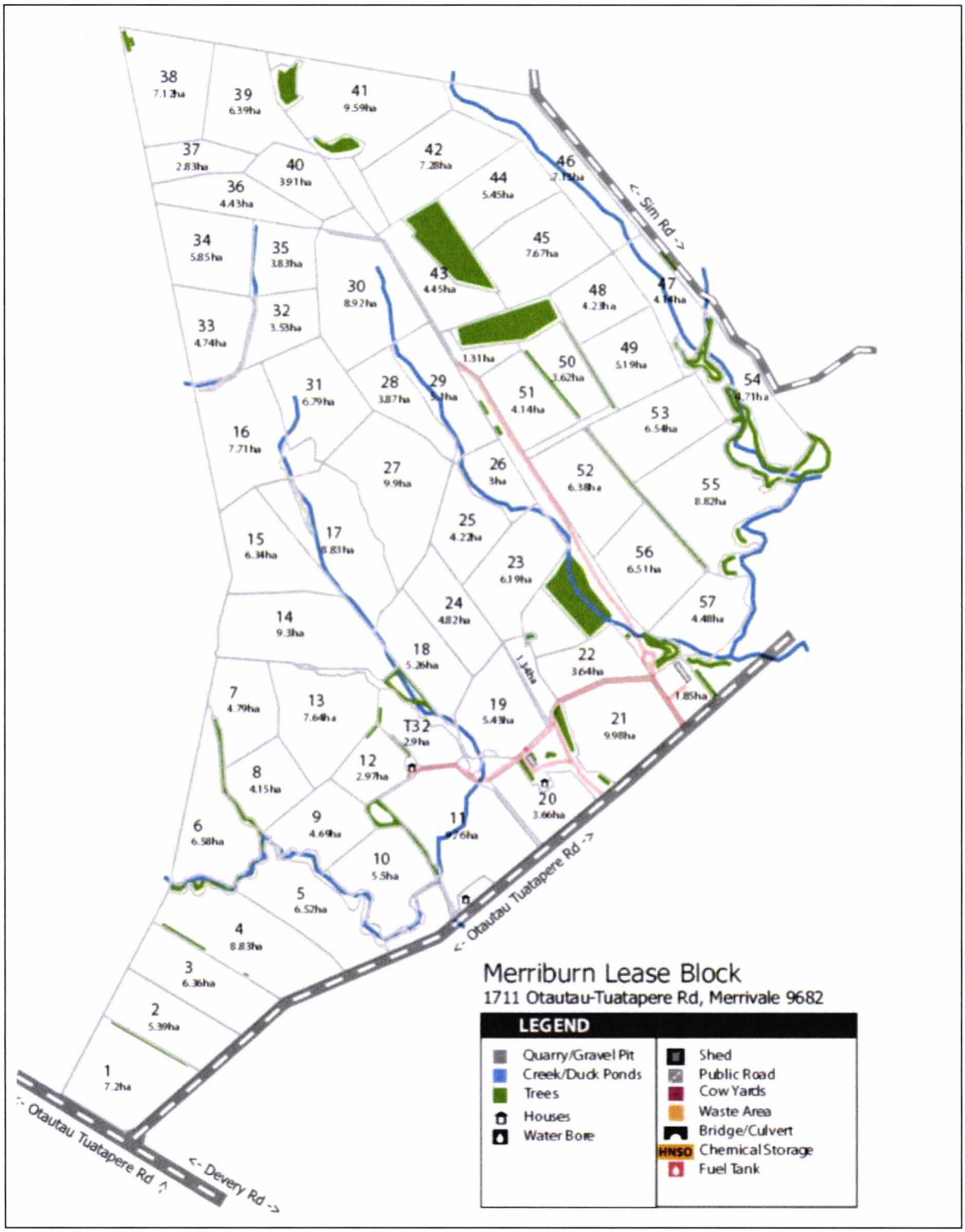


Figure 4: Farm map for Merriburn block (leased)

4. Soils and Physiographic Zones

The Merrivale block contains Malakoff, Waimatuku and Makarewa soils and the Merriburn lease block contains Aparima, Orawia and Makarewa soils. These soils are a mixture of heavier wetter soils and free draining soils.

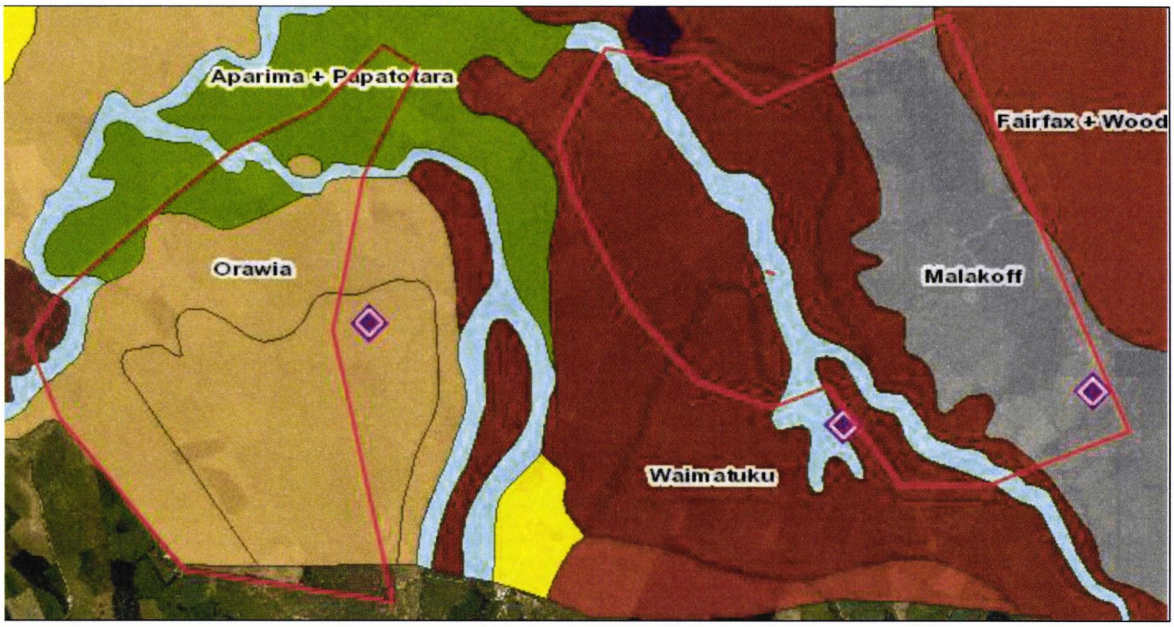


Figure 5: Soil map[3]

The Merrivale block is classified as Hill Country, Oxidizing and Gleyed physiographic zones. The Merriburn lease block is classified as Hill Country, Oxidizing, Gleyed, Marine terraces and Peat physiographic zones.

[3] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

Figure 6: Physiographic zones[4]

5. Surface water receiving environment

WRO is located within both the Fenham and Merry Creek catchments. Both creeks are tributaries of the Orauea River which flows south-westerly towards Tuatapere township and joins the Waiau River. There is a SOE monitoring site on the Orauea River at Orawia Pukemaori Road which is used to measure water quality information data. The Land and Water website (www.lawa.org.nz) collates this water quality data and provides the most recent water quality data and trends available. **Table 1** below gives a summary of the state and trend measured at this site for key river water quality indicators.

Table 1: Summary of Measurement and State of Orauea River at Orawia[5]

	State	Quality	NOF Band Annual Median	Trend
E. coli	In the worst 25% of all lowland rural sites	315 n/100ml (median 5 year)	E	Likely improving
Clarity	In the worst 25% of all lowland rural sites	1.13 metres (median 5 year)	N/A	Indeterminate
Total Oxidised N	In the worst 25% of all lowland rural sites	0.415 g/m^3 (median)	A - median	Meaningful improvement
Total N	In the worst 50% of all lowland rural sites	0.73 g/m^3 (median)	N/A	Indeterminate
Ammoniacal N	In the best 25% of all lowland rural sites	0.0005 g/m^3 (median)	A – 99% species protection level.	N/A
Dissolved Reactive P	In the worst 50% of all lowland rural sites	0.011 g/m^3 (median)	N/A	Indeterminate

[4] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

[5] https://www.lawa.org.nz/explore-data/southland-region/river-quality/waiau-river/orauea-river-at-orawia-pukemaori-road/

The water quality medians indicate that the Orauea catchment is degraded in regards *E. coli*, however there is a definite trend of improvement. High *E. Coli* levels are a concern for overall water quality within a waterway due to human health risks. Typically, *E. coli* contamination of waterways is caused by stock contact with surface water, point source discharges from septic tanks, wastewater treatment at upstream towns and effluent discharges to land reaching surface water. A high proportion of land within the Orauea catchment is both intensive and extensive sheep farms which is likely to contribute to the high *E. coli* levels because stock on sheep farms are not excluded from waterways in the same manner in which it is compulsory on dairy farms. The other activities listed above may also be contributing factors. *E. coli* is rated as E band in the National Objectives Framework (NOF) of the National Policy Statement for Freshwater Management. An E band rating equates to an average infection risk of greater than 7%.

Conversely, total oxidised nitrogen concentration has improved and is rated as A band under the NOF which means that water quality is considered suitable for the designated use and associated with a high conservation values ecosystem where there is unlikely to be effects even on sensitive species. The national bottom line value is 6.9 mg/L which far exceeds the 0.415 mg/L median at this site.

The median dissolved reactive phosphorus (DRP) is below ANZECC guideline levels and is not showing an evident trend. The raw data shows that DRP is low on the majority of the sampling dates, with spikes most likely occurring during rainfall events where phosphorus can be transported to surface water bodies via runoff and erosion.

The overall impact of the trends in nutrient concentrations is not clear at this stage, however the receiving water is considered low in relation to nitrogen and phosphorus concentrations overall. There is very limited published information on periphyton extent or macroinvetebrate community status in the Orauea River, so it is difficult to assess the current status or trend in biological quality of the stream. However, it is accepted that any increase in nutrient concentrations is likely to create the potential for an increase in periphyton and/or other plant biomass in the stream.

Ecological indicators are measured at the lower catchment *Waiau River at Tuatapere* SOE site with 5-year medians for MCI score, taxonomic richness score and %EPT available. The median MCI score is good at 103 with an indeterminate trend. The median Taxonomic Richness score is 15 and the median %EPT is 47%. One NOF water quality indicator for the *Waiau River at Tuatapere* site shows evidence of land use impacts (periphyton) and three indicators show minimal evidence of land use impacts (*E.coli*, macroinvertebrates and nitrate toxicity). The periphyton parameter indicates moderate nutrient levels and/or natural flow or habitat disruption. In this case the nuisance periphyton levels are likely to be primarily due to natural flow disruption due to the diversion of c.95% of the flow of the Waiau River to Doubtful Sound for hydroelectricity generation.

Over the summer period in 18/19, Environment Southland monitoring of the Waiau River at Tuatapere has confirmed the presence of toxic algae benthic cyanobacteria in the lower Waiau. Given the relatively low level of nutrients N and P in the lower Waiau, it likely that natural flow disruption is a major factor contributing to the growth of algae, including toxic algae in the lower Waiau.

The lower Waiau River also has a significant issue with the invasive stalked diatom *Didymosphenia geminate*, commonly known as didymo or "rock snot." Didymo blooms smother river beds with nuisance mats of algae and typically occur in rivers with low nutrient concentrations, i.e. low levels of N and P. Didymo blooms can lead to changes in communities of invertebrates and other algae on the river bed.

The available physical/chemical data show the Waiau River catchment to be in relatively good health. Nitrate, DRP and *E.coli* levels are relatively low and water clarity is moderately good. Some biological indicators such as the MCI index indicate good water quality with minimal land use effects whereas others such as periphyton levels are elevated at times. The toxic benthic algal bloom seen in the 18/19 summer period is indicative of land use effects, such as natural flow disruption and possibly nutrient losses to an extent although this complex issue is poorly understood.

Surface water is the primary receiving environment for contaminants lost from WRO due to the nature of the soils, topography and drainage channels.

Figure 7: Topomap showing both WRO blocks (marked with X) and SOE site *Orauea River at Orawia Pukemaori.*[6]

6. Groundwater receiving environment

WRO is located in an area of unclassified groundwater management zone. Groundwater nitrate levels in the vicinity of WRO are in the range 0.01 – 1.0 g/m^3, regarded as pristine to modern day background levels. Due to a combination of the topography, depth of groundwater and drainage channels there is a low risk of nitrate accumulation in groundwater in this area. This is supported by the very low mapped nitrate levels.

[6] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

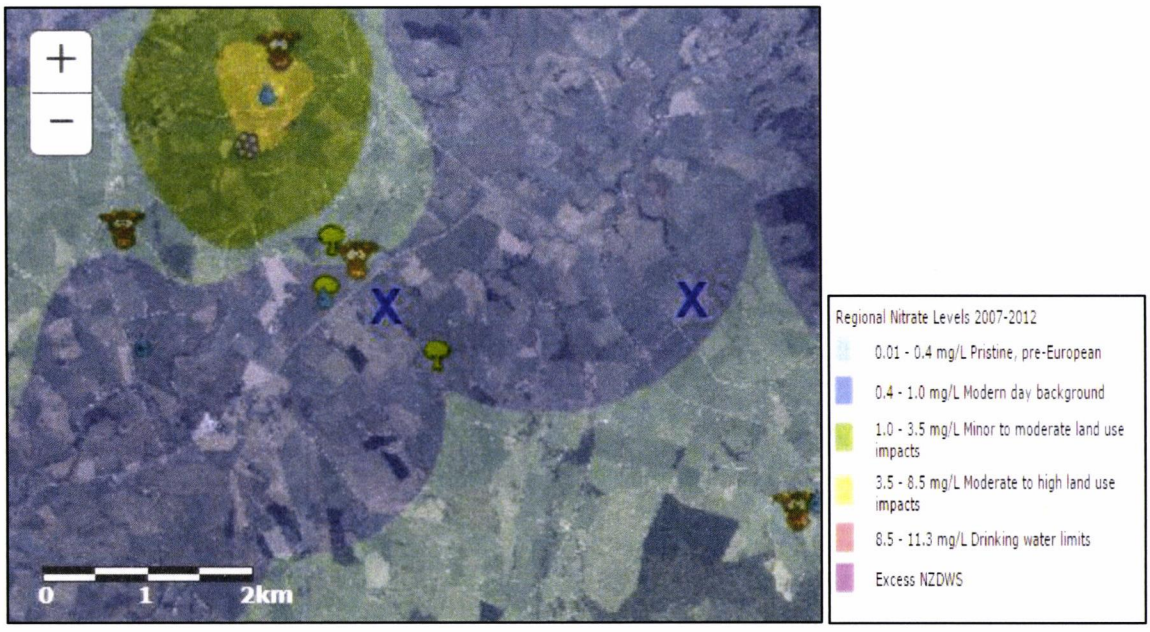


Figure 8: Groundwater nitrate in the vicinity of WRO (approximate location of WRO blocks marked with X)[7]

7. Contaminant Pathways

The production of grass for stock grazing and supplements requires the input of nutrients into the farming system. On a stock grazing block, excess nutrients are primarily lost to the environment from the deposition of dung and urine spots on pasture. For this property the main contaminant pathways are identified as overland flow, deep drainage and artificial drainage due to the variety of different soil types and physiographic zones on the farm. Woldwide Runoff predominantly grazes young dry stock (R1 and R2 heifers), which cause less soil damage and related effects due to their smaller size and lighter weight than mature cows, in addition the lease arrangement for Merriburn Block prohibits the wintering of adult cows.

Contaminant Pathways – Overland Flow and Artificial drainage

Loss of nutrients via overland flow and artificial drainage presents the highest risk to the environment on the wetter, poorly drained soils on this property primarily in the Gleyed physiographic zone. These areas have high vulnerability to waterlogging, and in some areas require subsurface artificial drainage, which can become a mechanism for the rapid transfer of contaminants to the water bodies they drain to. The applicant will avoid and mitigate the risk of contaminant loss via overland flow and artificial drainage by:

- Ensuring critical source areas are left as buffer zones for cropping and fenced off to exclude stock;
- Re-sowing bare soils as soon as possible;
- Avoid grazing very wet soils by opening the breaks up to reduce tramping damage;
- Using good management practice for intensive winter grazing on either grass or forage crop – back fencing, CSA management, last bite grazing, portable troughs etc.; (See FEMP)
- Ensure water ways are fenced off to exclude stock and existing riparian vegetation is maintained;

[7] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

- Time fertilizer application to meet pasture demand and apply in a little and often manner;
- Protecting steeper, erosion prone land with trees.

Contaminant Pathways – Deep drainage

Loss of nutrients via deep drainage presents the highest risk to the environment on the free draining soils mainly within the Oxidizing physiographic zone. These areas have high vulnerability for nutrients, particularly N, leaching through the soil profile which has the potential to reach groundwater and surface water receiving environments. The applicant will avoid and mitigate the risk of contaminant loss via deep drainage using the same measures as above, with the primary goal to avoid the accumulation of excess N in the soil profile prior to high drainage periods.

- Maintaining stocking rates at sustainable levels;
- Avoiding the over-application of fertilizer by matching application to pasture demand and undertaking in a little and often manner;
- Utilizing pasture species which result in less N loss;
- Utilizing soil testing to guide fertilizer usage;
- Time fertilizer application to meet pasture demand and apply in a little and often manner.

8. Good Management Practices (GMPs)

GMP adopted on WRO are detailed in the attached FEMP.

9. Description of activities

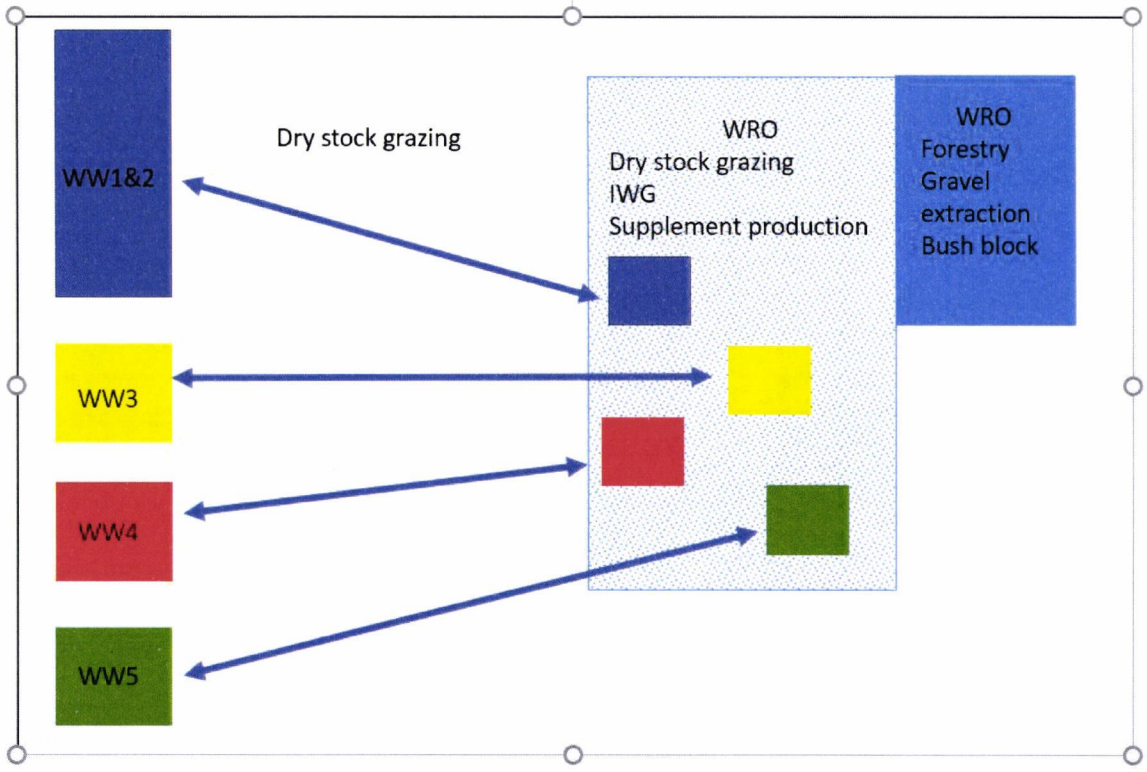
A year end nutrient budget has been completed by Cain Duncan CNMA for the 2017/2018 season to give an indication of the nature and scale of the activities which occurred at WRO during this one reporting year. The nutrient budget and accompanying report are appended to this application and should be referred to for a full description of the farm system at WRO during the 2017/18 year.

The applicant has now had WRO in its entirety (with the combination of the two separate blocks) for two and a half seasons. When the Merriburn block was initially leased it was heavily pugged and pasture productivity and fertility was low. Over the last two and a half seasons, the applicants have focussed on pasture renewal and increasing fertility. The 2018/19 season has seen the benefit of pasture and soil development with a big lift in pasture production. The applicants have found that they may need to alter the activities on this block in light of the increased productivity in order to farm it sustainably and economically making use of the quantities of feed available.

10. Proposed Activities

The diagram below presents a schematic impression of the relationship between the applicants five dairy farms and WRO. The diagram shows the individual dairy platforms sending dry stock grazing to the grazing block part of WRO (hatched box). The dry stock grazing, IWG and supplement production for the five dairy farms rotates through this grazing block of WRO every year. The legal descriptions of the land within the hatched box area is included in the separate land use consents for WW1&2, WW4 and WW5. The number of dry stock sent from each dairy farm is represented by the corresponding coloured boxes within the blue hatched area. A proposed condition of consent would specify the maximum number and class of stock grazed on WRO from each farm.

The solid blue WRO box contains activities which are not part of the respective farming activities (forestry, gravel extraction and bush block) and the legal descriptions of the land within this area will not be included on the respective land use consents.



The activities on WRO which will be covered under the land use consent applications for the farming activities on WW1&2, WW4 and WW5 include the grazing of dry stock (R1, R2, mating bulls and carry over cows) all year round:

- All R1 heifers currently grazed all year round at WRO continues unchanged.
- R2 heifers currently grazed from the time of transitioning from R1s and May of the following season on WRO continues unchanged.
- For future seasons during June and July, R2s from WW1&2 will be intensively winter grazed on WRO or housed in existing wintering barns at WW1&2 dairy platform (approximately 125 R2s).
- R2 heifers from WW4 and WW5 may spend the winter period in the wintering barns on WW4 and WW5 dairy platforms in some seasons.
- R2 heifers from WW4 and WW5 may be intensively winter grazed at WRO in some seasons.
- Mating bulls required for all five dairy farms will be on WRO all year round. Mating bull numbers may fluctuate marginally in future seasons.
- Carry over cows from all five dairy farms will be on WRO all year round. Carry over cow numbers may fluctuate marginally in future seasons.

The applicant has not provided an Overseer nutrient budget which models the proposed farm system due to concerns with providing a model which is representative of a long-term scenario farm system at WRO. The reasons behind this include:

- The increasing fertility levels on WRO combined with the large size of the block make it very difficult for the applicant to predict exactly what the block is capable of in terms of stocking rate, crop growth and pasture production much further into the future than the upcoming season.
- The siting of non-farming activities on the block which will not be covered under the land use consent applications.
- The large impact climatic conditions have on the management of a large support block which is more dramatic, variable and pronounced than a dairy farm system.
- The need and desire for flexibility (within reason) in the management of the farm system based on the above factors.

The applicant recognises that the Consent Authority needs certainty around the scale and nature of the activities proposed at WRO and the likely effects of these activities which have been detailed in the AEE. The applicant proposes the following input restrictions as consent conditions for the proposed land use consents applicable to activities at WRO. These input consent conditions are requested in place of any consent conditions referring to a nutrient output restriction based on an Overseer nutrient budget model:

For WW1&2

- A maximum of 417 R1 heifers grazed all year round at WRO from WW1&2
- 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 at WRO and during June and July in the WW1&2 wintering barns

For WW4

- A maximum of 286 R1 heifers grazed all year round at WRO from WW4
- A maximum of 286 R2 heifers grazed all year round at WRO from WW4 or
  A maximum of 286 R2 heifers grazed between August and May at WRO and during June and July in the WW4 and WW5 wintering barns

For WW5

- A maximum of 270 R1 heifers grazed all year round at WRO from WW5
- A maximum of 270 R2 heifers grazed all year round at WRO from WW5 or
  A maximum of 270 R2 heifers grazed between August and May at WRO and during June and July in the WW4 and WW5 wintering barns

On all land use consents

- A maximum of 100 hectares of winter fodder crop for intensive winter grazing at WRO

This recommendation to impose these input restrictions as consent conditions as opposed to an Overseer nutrient output restriction consent condition has been carefully considered by the applicant and recognises the inherent complications in including WRO on the resulting individual land use consents for WW1&2, WW4 and WW5. The primary complication that arises is that compliance and the enactment of individual consents must be able to stand alone and must not be reliant on third parties or third party actions. For example, if the land use consent granted for WW4 farming activities on WRO

are restricted with a consent condition requiring an overall WRO Overseer nutrient output limit be complied with, then compliance with the land use consent relies on the actions of several third parties: WW1&2 Ltd, WW3 Ltd and WW5 Ltd. This would inadvertently link all of the dairy farm systems together and create a scenario of reliance on compliance by third parties which may deem the land use consents unenforceable. This notion has been widely considered in case law. Common law derived from the House of Lords decision in *Newbury DC v Secretary of State for the Environment* determined that any resource consent condition needs to satisfy a range of criteria in order to be valid. This created what is known as the *Newbury* validity tests, of which (b) is particularly relevant to this application:

> (a) The condition must be imposed for a [resource management] purpose and not an ulterior purpose;
>
> (b) The condition must fairly and reasonably relate to the activities authorised by the consent to which the condition is attached; (emphasis added) and
>
> (c) The condition must not be so unreasonable that a reasonable planning authority, duly appreciating its statutory duties, could not have approved such a condition.

The individual applications for WW1&2 and WW4 and WW5 do not seek the authorisation of activities on any of the other landholdings. Since *Newbury*, the validity tests above have been modified by New Zealand courts and a review of case law strongly indicates that consent conditions relying on the actions or compliance by third parties are not valid.

The imposition of the 100-hectare winter fodder crop restriction is linked back to the permitted activity threshold in Rule 20 (a) of the PSWLP, which WRO would otherwise be able to operate under as an individual landholding in its own right.

11. Assessment of Environmental Effects

The table below describes the proposed activities occurring on WRO under the proposal.

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
Capital fertilizer applications to lift Olsen P levels	The 2017/18 year end Overseer model included capital phosporus fertilizer applications to lift Olsen P levels. In future, capital fertilizer applications may be undertaken for K and S also. Capital fertilizer applications will apply larger quantities of N, P, K and S to land in order to increase fertility. These applications of larger quantities of nutrients have the potential to result in losses to the environment if applied at rates which exceed the plants ability to utilize these applied nutrients. Excess applied N likely to be lost to water bodies via nutrient leaching and artificial drainage channels. Excess applied P	Capital fertilizer application timings avoid high drainage periods such as late autumn and winter and periods when soil temperature is less than 7 degrees to mitigate against excess N leaching through the soil profile. All other fertilizer applications will use a little and often approach to avoid the application of excess nutrients which cannot be utilized. Regular soil testing to guide capital fertilizer requirements to avoid the application of excess N and P which cannot be used for plant uptake to mitigate against losses via artificial drainage.	Capital fertilizer applications will only be done as required by the latest soil test results and will be undertaken where P, K or S levels are below agronomical optimum levels. P = 20-30 K = 6-10 S= 10-12 The target Olsen P level on this block is 25. Capital P fertilizer applications will be applied at a maximum of 100kg P/ha which may require P fertilizer applications to be split.	Capital fertilizer applications are only undertaken where there is a nutrient deficit and are done at a rate which meets this deficit and avoids the application of excess nutrients. There is a low risks of adverse effects eventuating as application will meet pasture demand. The fertilizer regime described in the nutrient budget will be the default fertilizer regime and capital fertilizer applications will only be done according to soil test results and completed using GMP principles which should adequately mitigate adverse effects on water quality.

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
	likely to be lost to water bodies via overland flow, particularly on the sloping land. Excess N and P in water bodies may lead to water quality degradation resulting in ecological stresses on aquatic life and human health consequences such as blue baby syndrome.			
Cultivation of new pastures	Short term increase in potential sediment, microbial and phosphorus losses to the environment which can cause ecological stresses on plants and animals due to sedimentation, algae blooms and water temperature increases in waterways and estuaries	Re-sow bare paddocks as soon as possible Use buffer zones around critical source areas and use direct drilling if possible. Cultivation will be undertaken to meet permitted activity criteria in Rule 25(a) of the PSWLP maintaining a 5 meter buffer zone	Further mitigations not required as the imposition of buffer zones reduces the risk of overland flow of sediment and phosphorus when cultivating land. Riparian buffer zones will be installed with stock fencing and vegetated filter areas.	Adverse effects should be adequately avoided as this is a low risk activity in this location. GMPs provide adequate mitigation of effects.
Intensive winter grazing	Potential for significant amounts of contaminants	Buffer zones maintained between crop cultivation and	The intensive winter grazing of R1 calves will occur on a similar scale as the 2017/18 year. Mitigation	Adverse effects potentially still exist from this activity due to the

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
Potential future increase in the scale of the activity	(N, P, sediment and microbials) to be lost to both surface and groundwater bodies as a result of the complete de-vegetation of pasture/crop, treading damage on soil structure and runoff following rainfall events. Nutrient losses from this activity occur via deep drainage through the soil profile into the underlying aquifer or via overland flow into adjacent waterways or artificial drainage channels. Excessive nutrient losses can cause nutrient accumulation in groundwater and excessive nutrient load in waterways causing water quality degradation and	critical source areas to provide an area where runoff can be filtered and captured limiting risks of entering water. Grazing direction will be away from buffer zones/critical source areas leaving last bite to provide a buffer zone for nutrient capture through until the end of the fodder grazing period. Back fencing and portable water troughs to limit treading damage over already de-vegetated ground. Cultivation of paddocks timed to avoid paddocks sitting bare for long periods of time which reduces risks of contaminant losses through leaching and overland flow. All other GMPs listed in rule 20 will be implemented by May 2019.	measures include choosing suitable fodder crop paddocks which are predominantly flat with no waterways, away from critical source areas and on paddocks which may require additional fertility. Paddock selection is important to avoid and mitigate the risk of the direct runoff of nutrients to water bodies (particularly P, sediment and microbials). The intensive winter grazing of R2 heifers will be a new activity on this block in the future and would require the cultivation of an additional approximately 48ha of fodder crop. Currently this activity is located on the WW5 dairy platform and Gladfield block. It has been located on the WW1&2 platform (Marcel/SH96) in recent years. The current location of this intensive winter grazing activity within the highly sensitive Heddon Bush/Central Plains area results in significantly higher contaminant losses due to the nutrient leaching risks of the soils in this location. Suitable fodder crop paddocks will be chosen which are predominantly flat with no waterways or artificial drainage channels, away from critical source areas and on paddocks which may require additional fertility and concurrently, fertilizer usage	high level of contaminant losses which occur from intensive winter grazing despite the implementation of GMPs and mitigations. The GMPs and the mitigations proposed will mitigate adverse effects to a certain extent, with the long-term goal of the applicant to abolish intensive winter grazing from the dairy platforms/Central Plains area and overall to reduce the frequency and scale of intensive winter grazing at WRO by utilizing the wintering sheds in preference to fodder crop over winter.

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
	the resulting ecological stress on plants and animals when the life-supporting capacity of the water is compromised by excess nutrients.	Bare soils are cultivated using full cultivation and timed to avoid paddocks siting bare for long periods of time which reduces risks of losses of excess nutrients remaining from the grazing activity to the environment via overland flow and leaching.	may be able to be reduced given the soil nutrient levels following cropping. The siting of this activity on WRO in the future on heavier soils presents a lower risk of nitrate accumulation in groundwater and therefore a lower risk of water quality effects. The area surrounding WRO is currently low in groundwater nitrate levels and is low risk of nutrient leaching and is considered a more appropriate choice to site intensive winter grazing than the Central Plains area. Approximately 125 R2 heifers will be wintered in existing barns at the WW1&2 dairy platform. In some years, R2 heifers will be wintered in respective wintering sheds on the dairy platforms at WW4 and WW5. The final decision on whether stock will be in the sheds or at WRO rests in the feed available and overall pasture management of WRO in the preceding season – often heavily dictated by climatic conditions.	

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
Fertilizer application regime across entire block	The application of nutrients in fertilizer has the potential to result in direct nutrient losses to the environment if fertilizer is applied either in excess to plant requirements or at a time when it cannot be utilized for pasture/crop production. Nitrogen losses from fertilizer application most likely to occur via deep drainage. Phosphorus losses from fertilizer most likely to occur via soil loss and/or direct loss through runoff or erosion. Adverse effects of inappropriate fertilizer application or excess application include a loss	Time N, P, K and S fertilizer application to meet crop and pasture demand using split applications and avoid high risk times of the year i.e when soil temperature is less than 7 degrees, during drought periods and during periods when soils are at field capacity. Reduce use of P fertilizer where Olsen P values are above agronomic optimum. Maintain Olsen P levels at around 20-30. Use nutrient budgeting and annual soil testing to manage nutrient inputs from fertilizer and outputs to guide farm management decisions which can maintain overall nutrient losses at desired level.	Fertilizer applications occur in August, September, November, December and January on different blocks avoiding high drainage and high-risk periods that occur in late summer, late autumn, mid spring and during the winter. Fertilizer on crop blocks is applied in December which is considered a low risk month due to lower rainfall and higher soil temperatures. The fertilizer regime will remain flexible and will be undertaken to match pasture and crop requirements.	Adverse effects both avoided and mitigated with use of GMPs for fertilizer usage

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
	of excess nutrients to water causing water quality degradation in both groundwater and surface water bodies. Water quality degradation can adversely impact aquatic plant and animal ecosystems and impact on human health.			
Potential increase in contaminant losses in the future	The future use of WRO is highly likely to involve an increase in the scale of intensive winter grazing which is likely to increase contaminant losses. Higher contaminant loss activities increase the risk of the leaching of nutrients (N, P and microbials) through the soil profile from urine and dung spots or transported via subsurface drainage.	Use of selective grazing to avoid grazing very wet paddocks during adverse weather conditions to reduce risks of pugging and treading damage to soil structure which can accelerate contaminant losses. Increase the size of feed breaks during adverse conditions to give animals more of the paddock to graze than the volume of feed required to reduce stocking rate on wet and vulnerable pasture to avoid pugging and treading damage of feed.	Overall stocking rate of cows grazing from August to May is kept to a level similar with an extensive operation and with its current level. Areas of native forest and commercial forest are maintained to balance out areas of dairy support land and non-grazed areas. Intensive winter grazing is sited on this block to shift it away from the higher risk Central Plains/Heddon Bush area which is classified as higher risk for water quality degradation.	Adverse effects both avoided and mitigated with use of GMPs and mitigation measures which site activities in the appropriate location where receiving environments are less susceptible to water quality degradation.

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
	Increased nutrient losses as total figures to groundwater and surface water bodies may potentially cause water quality degradation which can cause ecological stresses on aquatic plants and animals from algal growth, temperature increases and eutrophication. Human health concerns can also arise from microbial contamination of waterways upon contact and risks of blue baby syndrome from nitrate accumulation in groundwater	Use nutrient budgeting to manage nutrient inputs and outputs to guide farm management decisions which can maintain overall nutrient losses at desired level.		

12. Broad scale/cumulative effects assessment

The AEE above concludes that the implementation of targeted mitigation measures on-farm will ensure that adverse effects on water quality from activities within the proposal are either avoided or mitigated to levels that are consistent with the relevant regional plan water quality objectives whilst still maintaining a viable, efficient and profitable farm system. The amount of nutrients lost from the farm system which may end up in the receiving water bodies depends on a wide range of different factors often collectively referred to as attenuation rates. Similarly, the catchment hydrology and characteristics are critical in affecting the resultant concentration and/or mass loadings of nutrients and other contaminants in water bodies.[8]

This broad scale/cumulative effects assessment includes a catchment scale assessment in relation to attenuation and hydrology processes, characteristics of the catchment and consideration of the state of the receiving environment. This assessment also assesses the proposed activity in its entirety against the actual existing environment, i.e. not using a permitted or consented baseline approach. The term "practicable minimum" is used frequently and is used to portray the fact that any farming activity results in nutrient losses to the environment of some scale and that the applicant has reduced nutrient losses as far as they are practically able to do so given available mitigations, innovations and technology whilst still maintaining an efficient and profitable farm system that meets their social and economic needs. The term "practicable minimum" does not refer to an effect on the environment. The summary to this AEE concludes that water quality will be maintained in the receiving environments given the proposed mitigations, the characteristics of the catchment and the predicted changes to water quality as a result of the proposed activity.

Attenuation

A 2011 report by Clint Rissmann undertook regional groundwater denitrification potential and aquifer sensitivity analysis throughout the Southland region. Unfortunately, the area surrounding WRO and the Orauea catchment was not analysed in this report and therefore the denitrification potential in this area remains largely unknown.

However, we can surmise that the risks of nitrogen losses from below the root zone ending up in groundwater and eventually surface water bodies is low in the vicinity of WRO due to the low mapped groundwater nitrate levels, the presence of heavy soils, the depth of groundwater and the general topography of the site. The applicant has recognised that this catchment is low risk for groundwater contamination and decided it is more environmentally beneficial to site higher contaminant loss activities (particularly high N loss activities such as intensive winter grazing) on WRO in the future in preference to the siting of these activities within the higher risk Central Plains area which is where these activities are currently occurring. The proposed activities located on WRO would otherwise be a permitted activity which strongly suggests that the proposed scale and nature of the activities is likely to result in less than minor adverse effects on the environment.

Groundwater nitrate concentrations are of particular concern to human health. The risk of bottlefed infants getting 'blue baby syndrome' from consuming high nitrate nitrogen water is widely accepted and is the primary driver for the current NZ Drinking water standard for nitrate nitrogen. Other studies

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[8] Enfocus, *Using Overseer in Water Management Planning*, October 2018.

indicate that other contaminants, or dietary nitrate sources, may also play a role in the syndrome.[9] A recent Danish study suggested a link between groundwater nitrates and bowel cancer. The study found that those people exposed to nitrate levels in excess of 9.3 mg/L (NZ drinking water standard is 11.3 mg/L) had a 15% increased carcinogenic risk. In December 2018, Agriview NZ published an article attempting to correlate the Danish study within the New Zealand agricultural context. The article noted that "most of the international research conducted throughout the past four decades on this topic has found either a negligible or only slight correlation between nitrates in drinking water and colon/bowel cancer rates" and also that "the idea that colon cancer is heavily influenced by diet surfaces in many of the studies evaluating its link to the intake of nitrate through drinking water." The article further noted "Ian Shaw, professor of toxicology at the University of Canterbury, says it is this very factor that makes the associations between water nitrate and colon cancer unconvincing:

"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."

In other words, attributing high colon cancer rates to nitrates in drinking water would be oversimplifying things to a considerable level. One must consider the variations of diet and lifestyle also considered potential factors for increasing colon cancer risk, and this is something the Danish study failed to do."[10]

Given the level of current science, effects on human health should be protected under the proposal which is likely to result in less than minor adverse effects on groundwater quality due to the imposition of mitigation measures to address nitrate accumulation and the siting of intensive winter grazing within a catchment which is low risk for nitrate accumulation, has deep groundwater and heavy soils.

Phosphorus, Sediment and Microbial losses

The loss of P, sediment and microbials via erosion, overland flow and artificial drainage presents the highest risk on this property. Loss of contaminants via erosion and will be partly mitigated by the presence of established vegetation along the riparian margins, fencing to exclude stock and the low stocking rate.

These contaminants may also enter artificial drainage channels if applied to land inappropriately via fertilizer application, intensive winter grazing activities or by the inappropriate grazing of animals during high drainage periods (such as late autumn and mid-spring). The low stocking rate will partly mitigate potential losses via artificial drainage channels as less urine and dung deposition per hectare will occur.

Another factor to consider is the risk of P, sediment and microbial losses directly to surface water bodies within this catchment via overland flow – primarily occurring from runoff from laneways and via critical source areas. Overall losses of these contaminants directly to waterways is considered low risk on this property due to the low stocking rate. Overseer gives an estimate of what P may be lost directly to the

[9] https://en.wikipedia.org/wiki/Blue_baby_syndrome accessed 8 February 2019

[10] https://www.agriview.nz/forum/2018/12/11/investigating-the-nitrate-colon-cancer-link accessed 8 February 2019

environment from laneways, waterway crossings and critical source areas in the 'other sources' output within the model. The model does not consider sediment and microbial losses, however as all three contaminants typically enter surface water bodies via the same transport pathways then P loss modelled by Overseer can be used as a proxy for estimating sediment and microbial losses to the environment also.

The problem with the 'other sources' output estimated by Overseer is that it is not spatially explicit and does not account for site-specific mitigation measures which may be in place on a farm to mitigate losses directly to waterways from these laneways and critical source areas. The GMPs implemented on WRO specifically address and seek to minimise contaminant losses from these areas.

GMPs and mitigation measures to reduce P, sediment and microbial losses

The applicant will be implementing specific critical source area GMPs that will seek to minimise potential P loss via overland flow from these new lanes and/or culvert crossings such as the fencing of waterways, establishing vegetated riparian margins, contouring lanes to direct runoff to pasture, installing bargeboards on culvert crossings and locating laneways away from waterways.

P losses have therefore been reduced to the practicable minimum. The implementation of targeted GMPs and mitigation measures should result in effects on the environment which are less than minor.

Hydrology of the catchment

The property is located in an area of unclassified groundwater management zone. This means that little information is available on groundwater and surface water connectivity, recharge and groundwater levels. Local anecdotal evidence strongly suggests that groundwater is very deep on the western side of the Longwoods ranges in the location of WRO as neighbours have had extreme difficulty drilling for groundwater. Despite the lack of knowledge and deep groundwater, there is expected to be some level of steady discharge of groundwater to surface water bodies. The discharge of groundwater to surface water bodies provides for mixing and dilution of nutrients from either source (groundwater or surface water). The dilution of nutrients can reduce the concentration of these nutrients in these water bodies which can lead to less prevalence of the adverse effects of water quality degradation.

Catchment Characteristics

The WRO farm sits within the wider Orauea catchment. The Orauea River is a cobble/gravel bedded river which drains pastoral land from near the town of Nightcaps to its confluence with the Waiau River near Tuatapere. According to a 2014 Aqualinc Report, the wider Waiau River catchment is large at 827,299 ha and is comprised of 33 dairy farms, 3 forestry blocks and 311 sheep and beef farms. Approximately 23% of the catchment is pastoral farmland. [11]

Nutrient Load

We have used some of the workings in this Aqualinc report to illustrate how nutrient load from a particular farm impacts on the resulting concentration of nutrient within the end receiving environment.

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[11] Aqualinc, *Assessment of farm mitigation options and land use change on catchment nutrient contamination loads in the Southland region*, 2014

Total nutrient load within the Waiau River catchment have been estimated in the Aqualinc report.

The table estimates the total source load within the catchment at 4970 T N/year undergoing attenuation to result in an estimated 1864 T N/year as a nutrient load within the receiving waters at the Te Waewae Lagoon at the base of the catchment. Attenuation is estimated to be 62% which is the highest rate of attenuation seen across the subject catchments.

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 9: Estimated loads of nitrogen and phosphorus in the eight study catchments[12]

The report then estimated how much these loads may reduce if mitigation scenarios are imposed on all farms within the catchment. For the Waiau River catchment, N could be reduced by 29% and P reduced by 39% and an overall improvement to water quality of 16% under the full suite of mitigations (M3).

The full suite of mitigations assessed by Aqualinc includes:

Mitigation level	Name	Sheep & Beef	Dairy
Mitigation level 1	M1	• Optimised nutrient inputs • Low solubility P • Wetlands	• Stock exclusion from streams • Improved nutrient management • Improved farm dairy effluent (FDE) management
Mitigation level 2	M2	• Stock exclusion from streams • Reduced stocking rates, improved productivity	• Wetlands • Improved FDE management • Reduced stocking rates, improved per animal productivity.
Mitigation level 3	M3	• Grass buffer strips • Feed pad for beef cattle	• Restricted grazing strategies • Grass buffer strips • Improved FDE management

Figure 10: Description of mitigations assumed to apply under each mitigation level[13]

The referenced Aqualinc report classified off-site grazing blocks which support dairy farms as sheep and beef farms. We have used the same classification and consider that WRO is currently operating at what could be considered M3 level for sheep and beef farms. WRO contains forested areas in swales and

[12] Aqualinc, *Assessment of farm mitigation options and land use change on catchment nutrient contamination loads in the Southland region*, 2014

[13] Aqualinc, *Assessment of farm mitigation options and land use change on catchment nutrient contamination loads in the Southland region*, 2014

duckponds which are act in a similar manner to wetlands. WRO does not contain a feed pad due to its low stocking rate and nature of the major stock class it grazes; i.e. young dairy stock.

The Overseer model predicts that 19,868 kg N was lost below the root zone from the entire farm at WRO in 2017/18. Based on the N load data from figure 10, WRO contributes in the vicinity of 0.4% of the nitrogen load to the Waiau River catchment. This equates to 22 kg N/hectare across WRO annually. Overseer predicts that 4,721 kg N was lost to below the root zone from the 52ha fodder crop block. If the area of the fodder crop block is increased to the maximum of 100ha then an additional 3,552 kg N would be lost to below the root zone (using a subsequent reduction in pastoral block losses for the lowest per hectare N loss pastoral block). Combining both figures, then a change to the farm system to increase to 100ha of fodder cropping may result in total farm losses below the root zone predicted by Overseer to be 23,420 kg N. Assuming the Waiau catchment's attenuation rate of 62%, this represents 0.47% of the estimated realised catchment N load detailed in the Aqualinc report for the Waiau catchment.

The Overseer model predicts that 23 kg P is lost below the root zone from the 52ha fodder crop block. If the area of the fodder crop block is increased to the maximum of 100ha then Overseer predicts that no additional P would be lost to below the root zone due to the fact that pastoral blocks are modelled to lose more P than the fodder crop block. The overall farm system P losses at 529 kg P represents 1.5% of the catchment P load detailed in the Aqualinc report for the Waiau catchment.

The figures above show that the nutrient load from the applicant's operation represents a small proportion of the total Waiau River catchment nutrient load.

Nutrient Concentration

As described above, the proposal may see an increase in the contribution to N source contaminant load of 0.07% if intensive winter grazing is increased on WRO to 100ha. The proposal would see a decrease in the contribution to P contaminant load if intensive winter grazing is increased. Sediment and microbial contaminant losses are likely to decrease at a similar scale given they are lost to the environment under the same contaminant pathway processes as phosphorus.

A concurrent increase in the concentration of nitrogen in these waterways is possible. The median concentration of nutrients in the Orauea River between 2009 and 2017 are described above. These concentrations would include the implementation of M3 level mitigations on WRO but will not show the expected increase in nutrient load under the proposal. For example, WRO contributes in the vicinity of 0.4% of the nitrogen load to the Waiau River catchment and the proposal is likely to result in an increase of 0.07% to nitrogen load. Nitrogen concentrations are then likely to follow suit and result in a 0.028% increase to median nitrogen concentrations in the catchment. This increase represents such a miniscule amount that it is unlikely to show an increase in water quality degradation effects within this catchment. The water quality parameters measuring nitrogen in the receiving environments in this catchment are rated A band under the NOF standards and therefore the proposal is unlikely to result in adverse effects on water quality.

If we use phosphorus as a proxy for *E.coli* then the proposal is likely to result in a decrease in E. coli load to the receiving water bodies and therefore result in no adverse effects on water quality.

Both receiving waters are showing some signs of water quality degradation, but not at a level witnessed in many of the other lowland water bodies in other areas of Southland. The Orauea River has high *E.coli* levels but these are showing a meaningful improvement trend. Total oxidised nitrogen is also showing improvement and total phosphorus is not showing any trends. The Waiau River on the whole has good water quality. *E.coli* levels are improving, total oxidised nitrogen is rated A band with no evident trends and total phosphorus levels are low and not showing any trend. The applicant recognises that their proposal introduces more intensive winter grazing (of young dairy stock) into this catchment. However, as can be seen from the calculations above and the existing water quality medians, this catchment has the capacity for a negligible increase in N contaminants.

Summary

The proposal results in an expected negligible increase in total N lost to the environment and a predicted reduction in total P, sediment and microbial losses to the environment. Water quality will be maintained in the receiving environment.