Farm Environmental Management Plan

Pukaki Flats North

Prepared for Simons Pass Station Ltd

Ryder Consulting

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by

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Cover photo: Pukaki Flats on Simons Pass Station (Photo by Melissa Robson).

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1.0 Introduction

The Water Quality Study ('WQS') funded by Mackenzie Water Research Limited ('MWRL'), found that the additional irrigation proposed in the catchment could take place without significant adverse effects on the environment providing that nutrient reduction occurred on the farms.

The process that was advocated for ensuring this on-farm nutrient reduction was through Farm Environmental Management Planning. A clear process for building a Farm Environmental Management Plan (FEMP) was laid out in the WQS and has been followed here. An overview schematic of the process of building a FEMP is shown in Figure 1.

The responsibility of the implementation, monitoring and auditing of the plan lies with the farmer.

1.1 Purpose of a Farm Environmental Management Plan

This Farm Environmental Management Plan (FEMP) has been written to serve two purposes, to ensure the proposed farm system can meet the nutrient mitigation requirements set out by the Water Quality Study, and to identify and mitigate other farm specific environmental risks that arise from the inherent characteristics of the farm or from the proposed farm system and its management. These farm specific risks include uncontrolled discharges that are not identified in farm nutrient budget modelling but that may still have an environmental effect.

1.2 Why use a Farm Environmental Management Plan?

Farm management planning and the use of best management practices and mitigation methods are commonly used to reduce diffuse pollution from farms.

Diffuse pollution, as the name suggests, does not come from a single traceable source. In many cases the impacts are both temporally and spatially distanced from the source. This makes measurement from and traceability to an individual property difficult. For this reason, instead of measuring the losses, the emphasis is placed on the implementation of techniques that are known to reduce the contaminant.

1.3 Scope of a Farm Environmental Management Plan

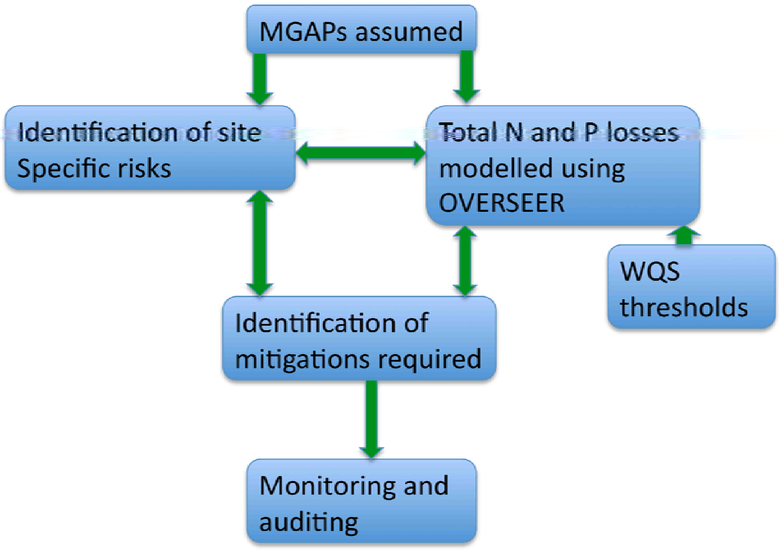
The development of a FEMP is divided into four sections:

- The first section describes Mandatory Good Agricultural Practices (MGAPs) that need to be implemented across the farm, and include the base assumptions of the OVERSEER model[1]. This helps to validate the use of the model on the property;

[1] In the future, should an alternative model be used, the assumptions for that model would need to be specified in this good agricultural practice section.

- The second section involves the construction of a representative farm model in OVERSEER and demonstrating the fulfilment of the nutrient mitigation required by the Water Quality Study; and
- The third section involves the identification and mitigation of site-specific environmental risks.
- The fourth section describes the proposed monitoring and auditing strategy.

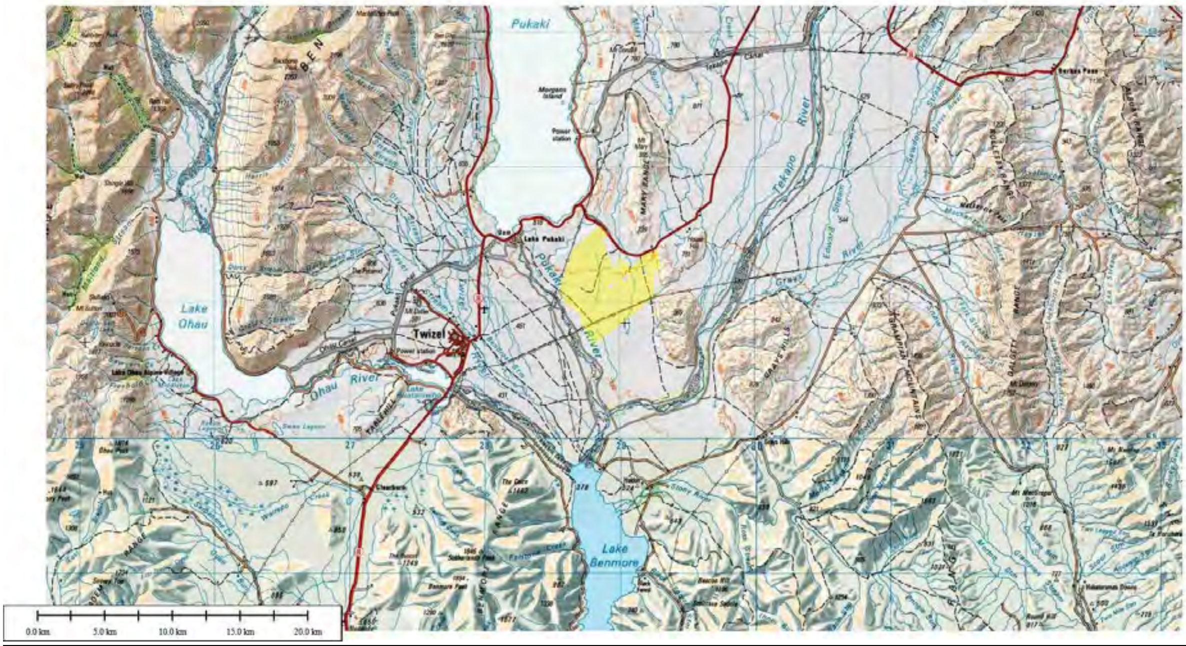
1.4 Figure 1: An overview schematic of the process of building a Farm Environmental Management Plan



2.0 Farm Description

Pukaki Flats North is currently part of Simons Pass Station. Pukaki Flats North is located to the south of Lake Pukaki and west of House Hill (Figure 2). The station consists of 5355 ha of some flat and some rolling country. Pest species such as rabbit and wilding pine are controlled, however there is a heavy infestation of *Hieracium*.

Figure 2 Location map for Pukaki Flats North (provided by Water Dynamics)



2.1 Soils

There are three main and two subsidiary soil series on Pukaki Flats North; Mackenzie soils, an association of Pukaki/Holbrook soil series, and an association of Tekapo/MaryBurn soil series. In addition there are more minor incursions of an association of Bendrose/Larbreck soil series and of an association of Grampian/Simons/Glenrock. For modelling purposes, the irrigation command area has been split along the Mackenzie and Pukaki/Holbrook boundary demarcating deeper soils to the north and shallower Mackenzie soils to the south.

The Mackenzie soils cover the main outwash plain and the southern part of the farm and area proposed to be irrigated. Mackenzie series are predominantly shallow and stony and excessively to somewhat excessively well drained, and are characterized by sandy loam to very stony loamy sand top soils and B horizons over very stony sand C horizons below 30 cm (Webb, 1992). Most variations in soil properties are related to depth and stoniness (Webb, 1992).

A detailed soil survey was conducted by Webb (1992) on Pukaki Flats North and found 4 variations of Mackenzie soils in a 200 by 250 m plot. The variations were associated with topsoil depth, % sand and stoniness.

Pukaki/Holbrook soil series association occurs on old terraces associated with moraines. Pukaki soils formed from deep fine sandy loess deposits and predominantly stony Holbrook soils found in wind deflation hollows (Webb, 1992). These soils are found in the centre of the property and irrigation command area.

Soils of the Holbrook series are excessively to somewhat excessively well drained stony soils formed from sandy outwash gravels and occur in deflation hollows. These soils are characterised by sandy loam to very stony loamy sand topsoils very stony sandy loam to very stony loamy sand subsoils and structureless stony sands below 25-30 cm (Webb, 1992).

Soils of the Pukaki series are well drained shallow to moderately deep loessial soils. These soils are characterised by weak to moderately structured fine sandy loam to loamy fine sand topsoils and B horizons with weakly structured C horizon below 50 cm (Webb, 1992).

Tekapo/Mary soil series associations occur mainly on rolling moraines. Deep phases of Tekapo soils occur on toe slopes and soil depth thins to the crest. Mary soils occur on sites exposed to the north-westerly wind and are generally wind deflated (Webb, 1992). In the north of the proposed irrigation command area, this association may contain significant incursions of the imperfectly drained Cox soil in concave sites (Webb, 1992), although this was not verified during site visit. These soils are found in the northern part of the property and the top of the irrigation command area.

Soils of the Tekapo series are well drained shallow to deep soils formed from loess or loess over till and are characterised by fine sandy loam topsoil and B horizon, weak to moderately developed structure grading to a structureless C horizon below 50 cm. Although the upper horizons are friable the underlying till is usually very firm (Webb, 1992).

Soils of the Mary series are excessively to somewhat excessively drained, stony and bouldery soils derived from till occurring on moraines exposed to north westerly winds (Webb, 1992). They are characterised by loosely structured fine sandy loam to very stony loamy sand top soil and a very stony loamy sand B horizon overlying very firm till at 30-50 cm.

Grampian/Simons/Glenrock soil series association occurs on easy rolling to rolling piedmont fans which grade into more gently sloping fans and terraces. Where fans coalesce, Grampians soils occur on more gently sloping land. Simons soils will occupy planar old fans with moderately deep silty loess mantle and will also occupy nearly level glacial outwash terraces, with pockets of Glenrock soils occupying associated wind deflation hollows (Webb, 1992). These soils are found on the eastern edge of the property and irrigation command area at the foot of the hills.

Soils of the Simons series are well drained soils formed from deep to moderately deep loess deposits and are characterised by 15-25 cm silt loam to fine sandy loam top soils and B horizons with a friable structureless C horizon beginning at around 60 cm. The depth of gravels varies between 45 and 150 cm. These soils have an increased bulk density in the subsoil and in deeper profiles a fragipan can be found below 50 cm (Webb, 1992).

Soils of the Grampians series are similar to Simons series although with better developed nut structure in the upper horizons and a more pronounced fragipan that can lead to perching of water within 60 cm of the soil surface (Webb, 1992).

Soils of the Glenrock series are somewhat excessively to well drained soils, mainly shallow and stony, formed on fan detritus on younger fans and are characterised by 8-20 cm of silt loam to fine sandy loan weakly structured top soils with a silt loam to very stony loam B horizon and a structureless C horizon at about 40-50 cm (Webb, 1992). Wide variations of stoniness and texture can occur over short distances (Webb, 1992).

Bendrose/Larbreck association soils occur as a distinct unit adjacent to major rivers (Webb, 1992), on this property they occur along the western perimeter along the course of the Pukaki River. The Larbreck soils occupy the young terraces with distinctive terrace scarps separating them from the Mackenzie soils on the terrace above and the Bendrose are found on the flood plain below. Small wet depressions adjoining streams contain poorly drained Dobson soils (Webb, 1992).

Soils of the Bendrose series are excessively to well drained shallow and stony or bouldery recent alluvial soils and are characterised by 5-18 cm fine sandy loam to very stony loamy sand weak to moderately structured top soil merging to a stony structureless C horizon. (Webb, 1992)

Soils of the Larbreck series are excessively to somewhat excessively drained shallow and stony soils formed from alluvium on younger terraces and are characterised by 5-12 cm of sandy loam to very stony loamy sand weakly structured top soils, weakly structured very stony loamy sand B horizon grading to a very stony sand C horizon at 30-40 cm (Webb, 1992).

2.2 Climate

The climate in the Mackenzie Basin is characterized by dry summers and cold winters. Average annual rainfall on this station is 589 mm (GHD, 2009), and there is moderate variability in the monthly rainfall. Mean annual temperature is 10.3 degrees C, with a minimum winter temperature of < -2 degrees C (Snow and King, 2008).

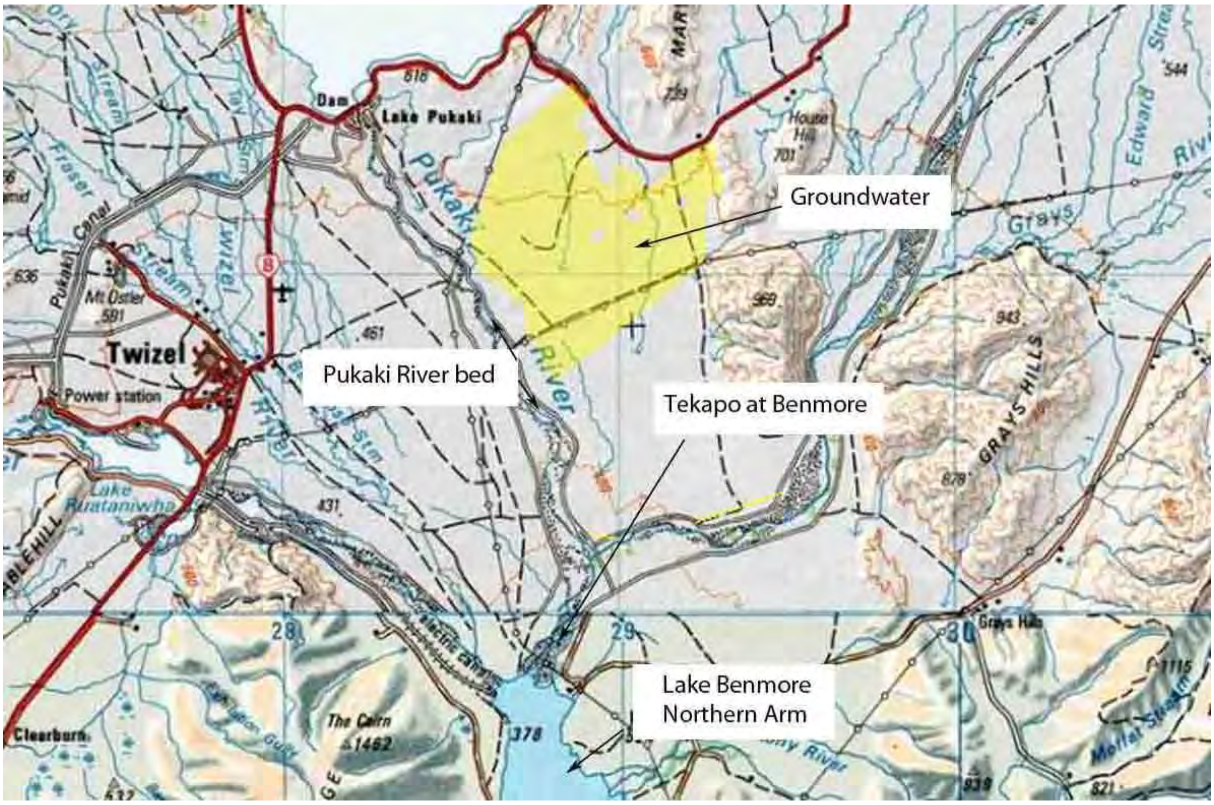
2.3 Topography

The majority of the property is flat country and runs over two distinct terraces. In the north of the station, the country become easy rolling. The lower terraces border the station on the western boundary along the line of the Pukaki river channels. These lower terraces will not be irrigated and have been removed from the irrigation command area.

3.0 Environmental Context

The environmental context of the farm is a reference to both the local and wider receiving environments. Figure 3 shows the receiving environments of Pukaki Flats North.

Figure 3 Map showing receiving environments of Pukaki Flats North



3.1 Water Quality Study mitigation requirement

The irrigated area of Pukaki Flats North, according to the WQS, lies in the Tekapo at Benmore surface water sub-catchment and in the Pukaki groundwater sub-catchment (refer to Annexure 1).

Table 1a and Table 1b show the calculated nutrient mitigation requirement for the receiving environments as determined in the WQS and the resulting thresholds for Pukaki Flats North.

For this farm, the Pukaki Groundwater thresholds are the most restrictive N and there are no required reductions for P. These mitigation requirements cap Pukaki Flats North's nutrient discharges at 94,490 kg N and 7,162 kg P per annum.

3.2 Local receiving environments

There are no on farm local receiving environments for Pukaki Flats North that are not considered in the WQS.

Pukaki River

The Pukaki River is a mainly dry river bed and flows only occasionally when water is released over the dam. During spilling, the flows released can be very high.

Table 1a Water Quality Study mitigation requirements for Pukaki Flats North. Yellow highlights indicate receiving environment most restrictive mitigation (GHD, 2009)

Farm	Surface water sub-catchment	Secondary surface water sub-catchment	Ground water sub catchment	Lake Sub-catchment	Proposed whole farm N loss from WQS	Proposed whole farm P loss/ha from WQS	Stream mitigation required for periphyton kg/ha irrigated land		Secondary stream mitigation required for periphyton kg/ha irrigated land		Stream mitigation required for ANZECC kg/ha irrigated land		Secondary stream mitigation required for ANZECC kg/ha irrigated land		Groundwater mitigation required kg/ha irrigated land		Lake mitigation required kg/ha irrigated land	
							N	P	N	P	N	P	N	P	N	P	N	P
Pukaki Flats North	Tekapo/Pukaki	na	Pukaki	Northern	101580	7162	0.5	0.3							-3.1	0		

Table 1b Water Quality Study mitigation requirements for Pukaki Flats North continued

Stream mitigation required for periphyton kg/farm		Secondary stream mitigation required for periphyton kg/farm		Stream mitigation required for ANZECC kg/farm		Secondary stream mitigation required ANZECC kg/farm		GWR mitigation required kg/farm		Lake mitigation required kg/farm		Stream mitigation threshold for periphyton kg/year		Secondary stream mitigation threshold for periphyton kg/year		Stream mitigation threshold for ANZECC kg/year		Secondary stream mitigation threshold for ANZECC kg/year		Groundwater mitigation required threshold kg/year		Lake mitigation required threshold kg/year		Overall Farm thresholds for WQS mitigation kg/year	
N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P
1143.5	686.1	0.0	0.0	0	0	0	0	-7090	0	0	0	102724	7848	101580	7162	101580	7162	101580	7162	94490	7162	101580	7162	94490	7162

4.0 FEMP Development

4.1 Mandatory good agricultural practice (MGAPs)

Table 2 below shows the mandatory good agricultural practices that will be adopted. These include the base assumptions of OVERSEER and therefore help validate the use of the model on the farm.

Table 2 Mandatory good agricultural practices

Mandatory good agricultural practices	**What these practices mean on farm**
Fertilisers applied according to code of practice for fertiliser use (NZFMRA, 2002).	The fertiliser users' code of practice aims to ensure that where fertilisers are used that they are used safely, responsibly and effectively and in a way that avoids, remedies or mitigates any adverse environmental effects. The code of practice includes guidance on fertiliser use, application, storage, transport, handling and disposal.
Use a fertiliser recommendation system and account for all sources of nutrients including applied effluents and soil reservoirs accounted for	Planning fertiliser applications to all crops, determining crop requirement and accounting for soil nutrients and organic nutrient supplies, all reduce the risks of applying excessive fertiliser above the crop requirement. This maximises the economic return from the use of fertilisers and reduces the risk of causing nutrient pollution of the environment Accounting for all sources of nutrients including imported sources and soil reservoirs is an important management measure in all farming systems and become especially important on farms where manure is produced and applied to the land. The re-application of organic manures to land is often thought of as a disposal of a waste product, and the available nutrients within the organic manures are not accounted for. The use of an integrated nutrient budgeting tool such as OVERSEER automatically accounts for nutrients supplied in organic manures.
Fertiliser application applied evenly	The even application of fertiliser is an assumption of the OVERSEER model as included in the fertiliser code of practice. Fertiliser spreaders should be tested and calibrated in-house at least annually and every 5 years by an independent auditor.
Irrigation applied evenly	The even application of water is an assumption of the OVERSEER model. Irrigators should be tested and calibrated in-house at least annually and every 5 years by an independent auditor.
Crop, cultivation, nutrient inputs and yield records kept per farm management unit	Maintaining good crop input records is important for: ◗ The calculation of cumulative annual organic fertiliser applications and also their contribution to long term nutrient supply; ◗ The prediction of realistic crop yields that are used to

Mandatory good agricultural practices	What these practices mean on farm
	determine crop requirements; ◗ Providing accurate inputs to the OVERSEER nutrient budgeting model that is being used here as a proxy for measuring diffuse nutrient losses.
Good design of irrigation systems	Design will match soil properties and low application amounts on shallower soil to prevent summer drainage.
Robust irrigation scheduling	Good irrigation scheduling to prevent summer drainage.
Supplement and feeding out management	Proper storage of supplements and responsible methods of feeding out that do not result in accumulations of excreta on small proportions of the farm. Where large amounts of supplements are fed out, a feed pad should used.
Winter grazing management	Winter management of stock to prevent pugging and high densities of stock in one area for long times.

4.2 OVERSEER and meeting WQS mitigation requirements

The WQS thresholds set for Pukaki Flats North, using the most stringent nutrient mitigation requirement, are 94,490 kg N and 7,162 kg P per annum. However, due to a reallocation to the Rosehip properties, this threshold has been reduced to 82,401kg N and 7,026 kg P.

Table 3 shows the output from OVERSEER for the modelled proposed farming system at Pukaki Flats North[2]. The results illustrate that the farm system mitigations proposed meet the N and P thresholds set out in the WQS at both a Developed and a Highly Developed setting.

The Highly Developed setting allows for no immobilisation of N, and as the modelled losses are below the WQS threshold at this setting, no further mitigation would be required should the soils become highly developed.

A list of OVERSEER model inputs and outputs have been supplied separately.

[2] OVERSEER modelling was conducted by AgResearch

Table 3 Total N and P losses modelled by OVERSEER for the proposed farming system on Pukaki Flat South and WQS thresholds

	Proposed losses from WQS	WQS threshold[3] kg/year	OVERSEER modelling outputs kg/year	
			Dairy off	S & B
Total N leaching/ runoff	101,580	82,401	50,660	35,958
Total N leaching/ runoff using Highly Developed	101,580	82,401	56,541	43,799
Total P leaching/ runoff	7,162	7,026	1,492	675

[3] Threshold including reallocation to High Country Rosehip and Rosehip Orchard Station

4.3 *Identification and mitigation of site specific environmental risks – Scenario 1 - Dairy wintered off*

The farm environmental risk assessment (FERA) has highlighted current or potential stock, effluent/infrastructure, soil, fertiliser and chemical site-specific risks. These risks are described below and are colour coded to indicate the severity of the risk or sensitivity of the environment to that risk[4]. All risks identified will need to be addressed in the FEMP.

Soil risks

The current soil risks arise from there being soils at risk of wind erosion, the presence of bare soils (common with *Hieracium* infestations) and the presence of some surface capping and consolidation of soil. There is no consequent risk associated with the capped and consolidated soils as there are no receiving environments. Irrigation will lead to improved ground cover and will reduce the risks associated with bare ground and wind erosion. The areas outside the proposed irrigation area, on the northern part of the property will continue to be subject to wind erosion.

In general the soil risks associated with the proposed system are the risk of compacted and capped soils from overwintering stock and trafficking soil when wet. However, these activities distanced from any receiving environments, and the flat topography and permeable nature of the soils makes the risk of runoff very low.

More specifically, the soils are prone to soil capping and subsoil consolidation under the pivot overlying the Grampians/Simons/Glenrock association with a fragipan commonly occurring around 50 cm, and this can lead to perching of water.

In the Pukaki/Holbrook association, the main soils have very different profile and drainage characteristics, moderately deep loessial soils with stony and relatively shallow soils in wind deflated hollows. With a single application depth this could lead to over/under irrigation and fertilisation.

Similar risks are associated with Tekapo/Mary association soils, however these have an additional risk of already firm underlying till being within 50 cm of the soil surface in some areas (Mary soils), this makes the soils more vulnerable to compaction from machinery and especially in poor conditions.

Additional soil risks associated with the proposed farm system are the use of conventional tillage to re-establish pasture.

Effluent/Infrastructure risks

The effluent risks associated with the proposed system are that clean and dirty water are not separated on the yard, silage liquor may not be collected and spread, no provision has been specified for the safe collection and containment of effluent (liquid and solid fraction) and direct discharges may occur from the silage pits, and from the yard.

[4] **High risk**, **medium risk**, **low risk**

Fertiliser risks

The fertiliser risks associated with the proposed farming system are that more than 50 kg fertiliser N may be applied in a single application, Olsen P levels may exceed 30 and no suitable storage and filling area has been identified.

Stock nutrient loss risks

The stock nutrient losses associated with the proposed farming system are that stock may be fed on lower terraces over autumn and later winter, stock may have access to open irrigation races and there are no provisions for dealing with fallen stock.

Water, runoff and tracks risks

There are very few water, runoff and tracks risks associated with the proposed farming system due to the very permeable nature of the soils and the absence of watercourses on the property.

Chemical risks

The chemical risks associated with the proposed farming system are that no provision for the safe storage, handling, using and disposing of chemicals has been made and no back siphoning prevention measures have been made for when water used from an un-isolated supply is used to fill sprayers.

4.3 Identification and mitigation of site specific environmental risks – Scenario 2 – Intensive sheep and beef with dairy grazing

The farm environmental risk assessment (FERA) has highlighted current or potential stock, effluent/infrastructure, soil, fertiliser and chemical site-specific risks. These risks are described below and are colour coded to indicate the severity of the risk or sensitivity of the environment to that risk[5]. All risks identified will need to be addressed in the FEMP.

Soil risks

The current soil risks arise from there being soils at risk of wind erosion, the presence of bare soils (common with *Hieracium* infestations) and the presence of some surface capping and consolidation of soil. There is no consequent risk associated with the capped and consolidated soils as there are no receiving environments. Irrigation will lead to improved ground cover and will reduce the risks associated with bare ground and wind erosion. The areas outside the proposed irrigation area, on the northern part of the property will continue to be subject to wind erosion.

In general the soil risks associated with the proposed system are the risk of compacted and capped soils from overwintering stock and trafficking soil when wet. However, these activities distanced from any receiving environments, and the flat topography and permeable nature of the soils makes the risk of runoff very low.

More specifically, the soils are prone to soil capping and subsoil consolidation under the pivot overlying the Grampians/Simons/Glenrock association with a fragipan commonly occuring around 50 cm, and this can lead to perching of water.

In the Pukaki/Holbrook association, the main soils have very different profile and drainage characteristics, moderately deep loessial soils with stony and relatively shallow soils in wind deflated hollows. With a single application rate this could lead to over/under irrigation and fertilisation.

Similar risks are associated with Tekapo/Mary association soils, however these have an additional risk of already firm underlying till being within 50 cm of the soil surface in some areas (Mary soils), this makes the soils more vulnerable to compaction from machinery and especially in poor conditions.

Additional soil risks associated with the proposed farm system are the use of conventional tillage to establish fodder crops and some soils will be left bare over winter after a fodder crop has been grazed in situ.

Effluent/Infrastructure risks

The effluent risks associated with the proposed system are that silage liquor may not be collected and spread, direct discharges may occur from the silage pits, and from the yard.

Fertiliser risks

The fertiliser risks associated with the proposed farming system are that Olsen P levels may exceed 30 and no suitable storage and filling area has been identified.

[5] **High risk**, **medium risk**, **low risk**

Stock nutrient loss risks

The stock nutrient losses associated with the proposed farming system are that stock are overwintered outside on the property, however, stock numbers are reduced over the winter period. Additional risks are that stock may be fed on lower terraces over autumn and winter, stock may have access to open irrigation races and there are no provisions for dealing with fallen stock.

Water, runoff and tracks risks

There are very few water, runoff and tracks risks associated with the proposed farming system due to the very permeable nature of the soils and the absence of watercourses on the property. The wetland and river beyond are fenced and no irrigation is planned for this bottom terrace, and runoff is extremely unlikely.

Chemical risks

The chemical risks associated with the proposed farming system are that no provision for the safe storage, handling, using and disposing of chemicals has been made and no back siphoning prevention measures have been made for when water used from an un-isolated supply is used to fill sprayers.

5.0 Proposed farm system with mitigation – Scenario 1

This proposed farming system on Pukaki Flats North is an irrigated dairy farm with little winter grazing. It is designed to fit the pasture growth pattern by wintering all cows off as soon after drying off as possible. Replacements are also grazed off the property. Returning stock's feed requirements are met through silage. Excess pasture will be cut and ensiled between mid November and end of January (Ogle, 2009). All effluent will be tinkered away on a daily basis.

5.1 Soils

The FERA highlighted current soils risks are associated with soils vulnerable to wind erosion on the property and the presence of some bare soils (associated with *Hieracium* infestations). These risks will be greatly reduced with the onset of irrigation and good associated ground cover. Potential additional soil risks arise from the use of conventional tillage to re-establish pastures (risk of wind erosion). The proposed management or mitigation measures are:

Use direct drilling as principal method for establishing pastures. If this is not possible, methods such as light irrigation may be employed post cultivation to reduce the likelihood of wind blow.

The FERA highlighted area specific soil risks for irrigated areas on Grampians/ Simons/ Glenrock association. This soil is vulnerable to capping and may exhibit perching of water in the top 50 cm above a fragipan.

These soils should not be trafficked when wet.

These soils should not be left bare over winter.

The FERA highlighted area specific soil risks for irrigated areas on Tekapo/Mary association. This soil association have firm till in some areas within 50 cm of the surface and are therefore vulnerable to subsurface compaction.

These soils should not be trafficked when wet.

5.2 Stock

The proposed stock on the station are approximately 6,207 dairy cows with approximately 1,350 R2 heifers and 1,350 R1 heifers and heifer calves (Ogle 2009).

The FERA highlighted potential stock risks associated with stock being fed on the lower terraces in autumn and late winter, stock access to open irrigation races, and there being no provisions for fallen stock. The proposed management or mitigation measures are:

No stock will be fed out on the lower terraces of the property;

No stock access to any open irrigation channel; and,

All fallen stock will be removed from the property.

In addition, the existing fence along the property boundary preventing stock access onto the banks of the Pukaki River bed will be retained.

5.3 *Production*

The irrigated area will be under a pasture mix including ryegrass and clover. Pasture production is expected to be approximately 13.5 t dry matter/ha on irrigated and fertilised land. An 85 % pasture utilisation rate has been assumed on irrigated land. A bi-cropped turnip and annual ryegrass crop is grown, fed out in situ and re-grassed in spring (Ogle, 2009). Cows are expected to produce between 409 and 417 kg MS/cow (Ogle, 2009).

5.4 *Manure, effluent and silage storage*

Manure production and handling

Effluent will be captured during milking. The stocked areas will be regularly scraped into a temporary effluent storage facility ready to be collected and removed.

The FERA highlighted potential effluent risks arising from there being no provision for clean and dirty water separation on the yard, and the potential for direct discharges. The proposed management measure is:

Clean water will be separated and collected and used, or diverted and discharged to ground; and,

No direct discharges of contaminated water to occur from the yard.

Manure storage

The FERA highlighted potential effluent risks arising from no provision specified for the safe storage of effluent. The proposed management measures are:

The effluent stored in a suitable lined temporary storage facility; and

The storage capacity of the facility should be sufficient for at least 3 days of effluent

Silage storage

The FERA highlighted potential effluent risks arising from silage liquor[6] not being collected and spread to land and that direct discharges may be occur from the silage pits. The proposed management measures are:

Silage is made and stored on a concrete pad and drains to an effluent collection facility;

The silage liquor will be recycled to land or tankered from the site.

5.5 *Anticipated fertiliser use*

Specific fertiliser recommendations will be produced on an annual basis using a recommended system. Plant nutrient supply will be estimated from inorganic fertilisers as well as N fixation and animal return using a nutrient budgeting system. An annual application of 138 kg N is applied across the irrigated areas except the cropping areas and the irrigated areas are maintained at an Olsen P of 30.

[6] All facilities containing silage and silage liquor must be of the appropriate specification as the liquor is highly corrosive.

The FERA highlighted potential fertiliser risks arising from larger than 50 kg/ha applications of N fertiliser, soil Olsen P increasing above 30 and from no suitable storage and filling area being identified. The proposed mitigation measures are:

Soil Olsen P levels to be maintained at or below 30;

Split applications of N fertiliser to <50 kg N/ha;

Fertiliser to be stored in a covered area;

The identified filling areas will be at least 50 m from a watercourse, spring or bore and will have no drains that discharge to clean water or that can discharge direct to ground; and,

If liquid fertilisers are used, fertiliser should be stored in a bunded tank and protected from vehicle movements.

In addition, the soils will be regularly tested.

The FERA highlighted area specific fertiliser risks for irrigated areas on Tekapo/Mary association. This soil association has diverse drainage and profile characteristics with some deep soils interspersed with shallow stony soils in NW wind exposed areas, making these areas vulnerable to under or over fertilisation.

Differential fertiliser application is recommended, through GPS application to avoid over application of fertiliser on Mary soils in particular.

The FERA highlighted area specific fertiliser risks for irrigated areas on Pukaki/Holbrook association. This soil association has diverse drainage and profile characteristics with moderately deep soils interspersed with shallow stony soils in deflation hollows, making these areas vulnerable to under or over fertilisation.

Differential fertiliser application is recommended, through GPS application to avoid over application of fertiliser on Holbrook soils in particular.

5.6 Water

The FERA highlighted area specific irrigation risks for irrigated areas on Pukaki/Holbrook association. This soil association has diverse drainage and profile characteristics with moderately deep soils interspersed with shallow stony soils in deflation hollows, making these areas vulnerable to under or over irrigation.

Differential irrigation is recommended for example through solenoid valve technology to avoid over irrigation on Holbrook soils in particular.

The FERA highlighted area specific soil risks for irrigated areas on Tekapo/Mary association. This soil association has diverse drainage and profile characteristics with some deep soils interspersed with shallow stony soils in NW wind exposed areas, making these areas vulnerable to under or over irrigation.

Differential irrigation is recommended for example through solenoid valve technology application to avoid over irrigation on Mary soils in particular.

5.7 Chemical storage and management

The FERA highlighted that no chemical management strategy was in place. To satisfy the issues raised in the FERA the proposed management measures are:

A contractor or approved handler to be used to supply, handle, and apply chemicals on the farm;

The services of a professional crop adviser or other suitably qualified person to be used to advise on pesticide options, doses and tank mixes; and,

Back siphoning prevention measures will be implemented on the farm when filling sprayers from an un-isolated water supply.

5.0 Proposed farm system with mitigation – Scenario 2

This proposed farming system on Pukaki Flats North is an irrigated intensive beef and sheep farm with dairy grazing. This system makes use of surrounding high country runs, dairy farms and downland farms to source stock that are either grazed under contract or traded for finishing (Ogle, 2009). Stock are wintered outside and winter feed requirements are buffered through feeding silage and fodder crops. Two cuts for silage will be made between early October and mid December to be fed out in winter (Ogle, 2009).

5.1 Soils

The FERA highlighted current soils risks are associated with soils vulnerable to wind erosion on the property and the presence of some bare soils (associated with *Hieracium* infestations). These are risks will be greatly reduced with the onset of irrigation and good associated ground cover. Potential additional soils risks arising the use of conventional tillage to establish fodder crops (risk of wind erosion), fodder crops grazed in situ over winter. The proposed management or mitigation measures are:

Use direct drilling as principal method for establishing fodder crops and pastures. If this is not possible, methods such as light irrigation may be employed post cultivation to reduce the likelihood of wind blow; and,

Regrass at the earliest opportunity after winter grazed Kale crop.

In addition, growing the fodder crops as a part of the pasture renewal process thus not mining soil organic matter levels in a few paddocks, should be practiced.

The FERA highlighted area specific soil risks for irrigated areas on Grampians/ Simons/ Glenrock association. This soil is vulnerable to capping and may exhibit perching of water in the top 50 cm above a fragipan.

These soils should not be trafficked when wet.

These soils should not be left bare over winter.

The FERA highlighted area specific soil risks for irrigated areas on Tekapo/Mary association. This soil association have firm till in some areas within 50 cm of the surface and are therefore vulnerable to subsurface compaction.

These soils should not be trafficked when wet.

5.2 Stock

The proposed stock on the station are between 4593 and 9186 cows (beef and dairy heifer) and between 7955 and 38250 sheep (lambs and hoggets) (Ogle 2009).

The FERA highlighted potential stock nutrient loss risks associated with stock being wintered outside on the property, and stock being fed on the lower terraces, stock access to open irrigation races and there being no provisions for fallen stock. The proposed management or mitigation measures are:

Stock units will be reduced over autumn and winter;

No stock access to any open irrigation races;

No stock will be fed out on the lower terraces of the property; and

All fallen stock will be removed from the property.

In addition, the existing fence along the property boundary preventing stock access onto the banks of the Pukaki River bed will be retained.

5.3 Production

The irrigated area will be under a pasture mix including ryegrass and clover. Pasture production is expected to be approximately 13.7 t dry matter/ha on irrigated and fertilised land. A 70 % pasture utilisation rate has been assumed on irrigated land. Two separate crop rotations are grown, a bi-cropped turnip (7.3 t DM/ha) and annual ryegrass crop followed by kale (12.3 tDM/ha), fed out in situ and re-grassed in spring, and secondly swede (12.2 tDM/ha), drilled in December, grazed over winter and re-grassed in spring. (Ogle, 2009).

5.4 Effluent and Silage

The FERA highlighted potential effluent risks arising from silage liquor[7] not being collected and spread to land and that direct discharges may be occur from the silage pits and the yard. The proposed management measures are:

No direct discharge of contaminated water from the yard;

Silage is made and stored on a concrete pad and drains to an effluent collection facility; and,

The silage liquor will be recycled to land.

5.5 Anticipated fertiliser use

Specific fertiliser recommendations will be produced on an annual basis using a recommended system. Plant nutrient supply will be estimated from inorganic fertilisers as well as N fixation and animal return using a nutrient budgeting system. An annual application of approximately 50 kg N is applied across the irrigated areas except the cropping areas. The irrigated areas are maintained at an Olsen P of 25.

The FERA highlighted potential fertiliser risks arising from soil Olsen P increasing above 30 and from no suitable storage and filling area being identified. The proposed mitigation measures are:

Soil Olsen P levels to be maintained at or below 30;

Fertiliser to be stored in a covered area;

The identified filling areas will be at least 50 m from a watercourse, spring or bore and will have no drains that discharge to clean water or that can discharge direct to ground; and,

If liquid fertilisers are used, fertiliser should be stored in a bunded tank and protected from vehicle movements.

[7] All facilities containing silage and silage liquor must be of the appropriate specification as the liquor is highly corrosive.

In addition, the soils will be regularly tested.

5.6 Water

The FERA highlighted area specific irrigation risks for irrigated areas on Pukaki/Holbrook association. This soil association has diverse drainage and profile characteristics with moderately deep soils interspersed with shallow stony soils in deflation hollows, making these areas vulnerable to under or over irrigation.

Differential irrigation is recommended for example through solenoid valve technology to avoid over irrigation on Holbrook soils in particular.

The FERA highlighted area specific soil risks for irrigated areas on Tekapo/Mary association. This soil association has diverse drainage and profile characteristics with some deep soils interspersed with shallow stony soils in NW wind exposed areas, making these areas vulnerable to under or over irrigation.

Differential irrigation is recommended for example through solenoid valve technology application to avoid over irrigation on Mary soils in particular.

5.7 Chemical storage and management

The FERA highlighted that no chemical management strategy was in place. To satisfy the issues raised in the FERA the proposed management measures are:

A contractor or approved handler to be used to supply, handle, and apply chemicals on the farm;

The services of a professional crop adviser or other suitably qualified person to be used to advise on pesticide options, doses and tank mixes; and,

Back siphoning prevention measures will be implemented on the farm when filling sprayers from an un-isolated water supply.

6.0 Farm Environmental Management Plan for Pukaki Flats North – Scenario 1

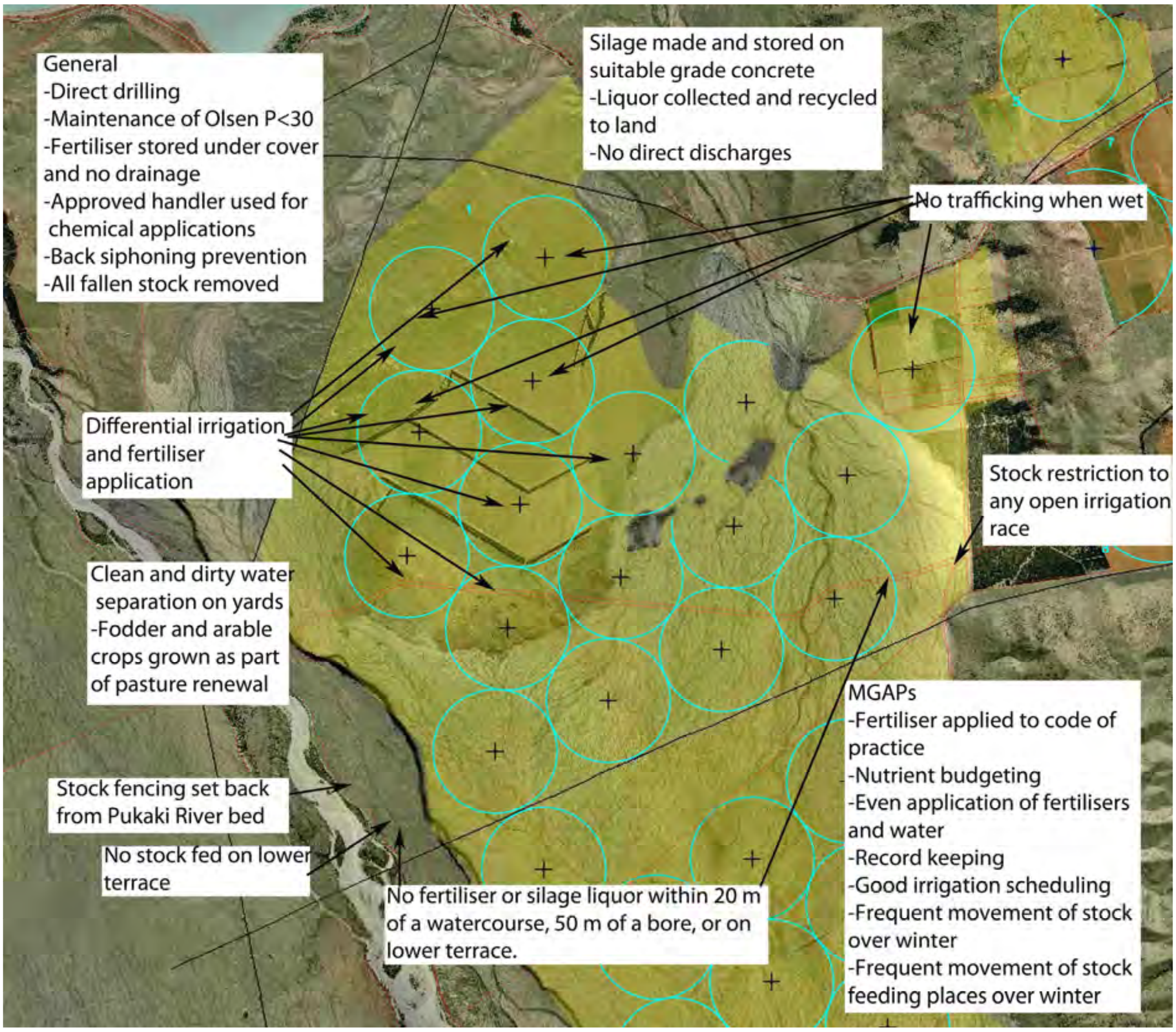
Table 4 shows the all the mitigation and management tools that are proposed to be undertaken on Pukaki Flats North. Measures indicated as FEMP stage 1 are those identified as Mandatory Good Agricultural Practice, measures identified as FEMP stage 2 are those changes that have been modelled in OVERSEER to meet the WQS mitigation requirement, and those indicated as FEMP stage 3 are mitigation measures chosen to ameliorate site specific environmental risks on the farm. The table indicates in brief how the measures are to be monitored and audited, and a map showing the locations of the proposed mitigation measures is shown in Figure 4.

Table 4 Table of mitigation options for Pukaki Flats North - Scenario 1

FEMP stage	Measure	Monitoring	Auditing
1	Fertilisers applied according to code of practice for fertiliser use		Self certification
1	Accounting for all sources of nutrients including animal returns and soil reservoirs	Soil testing and use of a nutrient budgeting	Reconciliation of fertiliser and soil records with nutrient budget for example blocks. Submission of example soil tests
1	Even fertiliser application	Calibrate and optimise fertiliser spreaders annually and every 5 years by an external auditor	Submission of testing and calibration
1	Even irrigation application	Calibrate and optimise irrigators annually in house and every 5 years by an external auditor	Submission of testing and calibration
1	Record crop, cultivation, stock days, nutrient inputs and yields per farm management unit	Upkeep of records	Submission of example block records
1	Good design of irrigation systems	Design of irrigation system by a certified professional	Irrigation system audited after installation and then by a certified auditor every 5 years
1	Robust irrigation scheduling	Use of example pivots for aquaflex soil moisture monitoring	Submission of soil moisture monitoring data
1	Good silage storage and good feeding out management		Annual audit of feedpad and silage pits
1	Frequent movement of stock over winter to prevent pugging and reduce winter stock losses when stock are present. Plus verification of stock removal over 2 winter months.	Upkeep of stock movement records	Submission of example stock movement records
2	Reduce risk of wind blow following cultivation through use of direct drilling or other methods such as light irrigation on cultivated area.	Upkeep of records	
2	Olsen P of below 30 maintained	Regular soil testing (every 3 years)	Submission of soil tests
2	No fertiliser will be applied within 20 m of a watercourse or 50 m of a bore or on lower terraces		Self certification
2	Stock restricted from any open irrigation races and Pukaki River		Annual audit
2	Effluent stored in a suitably lined and sized temporary storage facility	Trench containing perforated pipe buried below effluent pit that drains to an inspection pit where drainage water can be sampled to check for leakages	Annual audit of effluent and inspection facility and submission of design parameters (once only)
2	Fertiliser N application should be split to < 50 kg N/ha per application	Upkeep of records	Annual audit
2	No direct discharges should occur from effluent facility, parlour or yards		Annual audit
3	Undersow or bi-crop the second fodder crop	Upkeep of records	OVERSEER nutrient budget
3	No stock will be fed out in the lower terraces of the property	Upkeep of stock movement records	Annual audit

3	All fallen stock will be removed from the property		Submission of details of removers
3	Back siphoning prevention measures when filling chemical sprayers from un-isolated water supplies		Back siphoning prevention measures reported
3	Fertiliser to be stored under cover		Photograph of store
3	Fertiliser filling area to be where there are no drains and where a direct discharge to ground in not possible		Photograph of filling area
3	A contractor or approved handler to supply, handle and apply chemicals		Submission of contractor details
3	Professional crop adviser for chemical use, doses and tank mixes.		Submission of consultant details
3	Clean water separated on yards and either collected and used or diverted and discharged		Annual audit
3	Silage should be made and stored on suitable concrete that drains to an effluent collection facility		Annual audit and submission of design parameters (once only)
3	Silage liquor to be recycled to land		Annual audit
3	No trafficking when wet on Grampian/Simons/Glenrock association or Tekapo/Mary soils		Annual audit
3	Precision fertiliser application on Pukaki/Holbrook association and Tekapo/Mary association soils is recommended		Block fertiliser map (GPS)
3	Differential irrigation application on Pukaki/Holbrook association and Tekapo/Mary association soils is recommended		Block irrigation map (GPS)

Figure 4 Annotated map with key mitigation options an locations on Pukaki Flats North – Scenario 1



6.1 Monitoring and Auditing

Monitoring and auditing of the FEMP are as important as the plan itself.

Table 4 shows the monitoring suggested for the mitigation and management options chosen for Pukaki Flats North. Additional monitoring will be carried out in conjunction with other farmers in the sub-catchments by the Mackenzie Irrigation Company, on the Tekapo River and Northern Arm of Lake Benmore, and in the Pukaki groundwater sub-catchment.

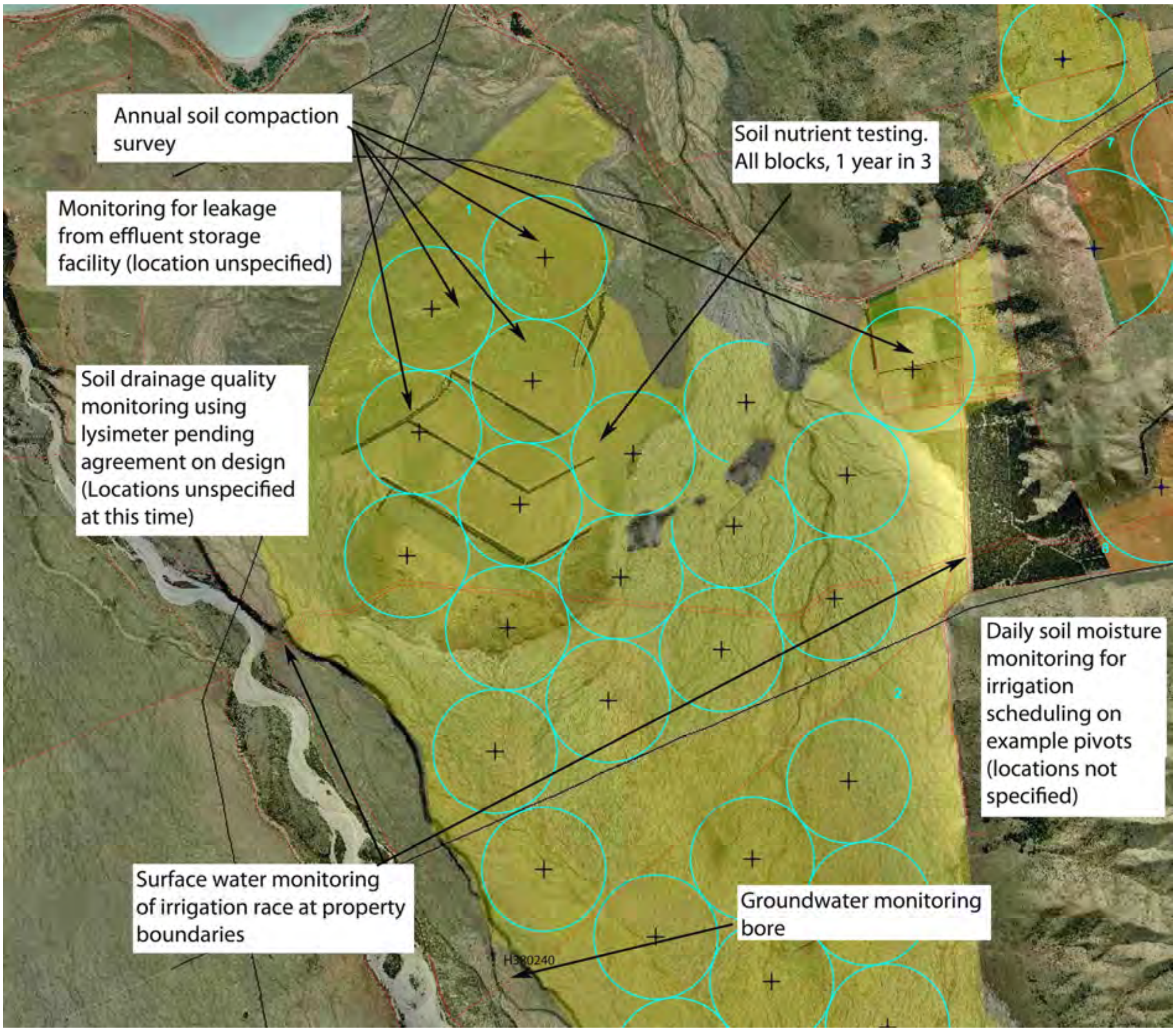
Table 5 shows the frequency and parameters for the environmental monitoring, Figure 5 shows these monitoring points on a map of the property.

Additional monitoring will be carried out in conjunction with other farmers in the sub-catchments by the Mackenzie Irrigation Company, on the Tekapo River and Northern Arm of Lake Benmore, and in the Pukaki groundwater sub-catchment.

Table 5 Location, frequency and parameters for environmental monitoring on Pukaki Flats North – Scenario 1

	Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
Soil nutrient testing	All pivots in rotation	1 in 3 years	Standard suite of soil nutrients.	Olsen P of 30	Reduce or stop addition of P to area and monitor
Soil drainage quality - Lysimeters	TBC	Monthly	Nitrogen species	No trigger - for model verification purposes only	
Groundwater quality	Recently drilled bores around perimeter of property	Annually at mid depth of aquifer	Total Nitrogen, nitrate, ammonia, total phosphorus, dissolved reactive phosphorus.	1 mg/l	Continued exceedences should be investigated and compared with the baseline data from the previous 36 months data of the existing bore. A trend tending towards the 1mg/l trigger is satisfactory. A negative trend would require mitigation such as reducing winter stock numbers.
Surface water	Any open irrigation races on property boundaries	Every 3 months	Total Nitrogen, nitrate, ammonia, total phosphorus, dissolved reactive phosphorus.	Significant increase in monitored parameters	Exceedences should be investigated with specific attention to elevated parameters, as these may indicate the type of contamination.
Irrigation application		Annually in house and 1 in 5 years by an independent	Application uniformity	<80 %	Optimisation of the irrigator performance will take place at the time of testing
Soil moisture	Example pivots	Daily during irrigation system	Soil moisture and deficit	67 %-85% PAW for irrigation scheduling purposes	NA
Fertiliser application		Annually in house and 1 in 5 years by an independent	Application uniformity		Optimisation of the irrigator performance will take place at the time of testing
Leakage from effluent facility	Effluent facility	Weekly for 2 month after installation and the weekly for 2 months after first use	Ammonia (using ammonia test kit)	Elevated ammonia concentrations indicating a leak	If a leak is suspected after installation, the contractors and manufacturers should be contacted and the effluent pond emptied.
Soil compaction	Pivots on Gm/Sm/Gk association and Tk/My association soils	Annually	Soil compaction	Compaction (plus surface capping for Gm/Sm/Gk association soil)	Remove compaction with appropriate tool for depth.

Figure 5 Annotated map showing location of monitoring points on Pukaki Flats North - Scenario 1



Where triggers are exceeded, the immediate contingency plans in Table 5 should be implemented while a 'root cause' analysis is carried out. Any further mitigation measures to be adopted as a result of monitoring should be added to Tables 4, 5 and 6.

1) Is the current mitigation option implemented correctly?

No – Implement and monitor

Yes – to 2)

2) Has anything changed in the farm system?

Yes – remodel and monitor

No – to 3)

3) Have there been abnormal conditions[8] at the time of trigger breach?

[8] Abnormal conditions include extreme weather conditions and catastrophic failure of irrigation/effluent infrastructure

Yes – continue monitoring to see if trigger breach continues

No – Seek advice of suitably qualified person to further investigate root cause and suggest appropriate further mitigation.

If emergency conditions occur that risk a pollution event, such as severe flooding event that puts the effluent storage system at risk or a catastrophic failure of the effluent system, seek immediate guidance from the Canterbury Regional Council **0800 76 55 88**.

Auditing

The auditing process allows both the farm operator to illustrate, and other interested parties to have confidence that the management practices and mitigations planned for the farm are being implemented. In addition, the audit shows that there is a mechanism for the adaptive management of the property should the chosen mitigation or management not perform to expectations.

An annual audit is proposed, and requires both external and in-house input. The annual audit should be completed and submitted to Environment Canterbury by end of July each year. Table 6 shows the proposed contents of an annual audit report for Pukaki Flats North.

Table 6 Table showing proposed contents of an annual audit report for Pukaki Flats North – Scenario 1

Audit measures	Action in the case of non-compliance if applicable
Additional auditing that must be done externally	
Check the clean and dirty water separation methods in and around the parlour and yards, plus photographs	If any contamination of clean water is found all water should be directed to effluent store until problem is found and effective separation is verified
Check for evidence of direct discharges from the parlour and yard area	Any direct discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check the storage of silage for visible signs of discharge and destination of silage liquor	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check fertiliser storage and filling area.	There should be no possibility of loss of fertiliser to drains or direct discharge to ground. Any drains should be covered, or the filling area moved to where no discharges will occur.
Check integrity of irrigation race fencing and perimeter fencing	Any gaps in fencing should be blocked temporarily when stock are present until a permanent repair can be made
Reconcile total effluent removed with effluent generated	Where reconciliation is not possible, this should be rectified in the following year. Following that - non compliance
Review of stock movement records to show late winter feeding and stock movement, and no feeding out on lower terraces.	Where verification is not possible this should be rectified in the following year. Following that - non compliance
Annual audit of OVERSEER nutrient budget and report based on previous 3 years. Submission of compliance with thresholds.	Should the OVERSEER report show losses exceeding the threshold, further mitigations should be adopted to effect a reduction in nutrient loss to below thresholds.
Reconciliation of fertiliser and soil records with nutrient budget and fertiliser recommendations	Where reconciliation is not possible and an over application has occurred, this should be rectified in the following year. Following that - non compliance
Review of fertiliser records to verify split applications	Where verification is not possible this should be rectified in the following year. Following that - non compliance
Review of cumulative effluent applications to verify no winter application and application depth	Where verification is not possible this should be rectified in the following year. Following that - non compliance
Review measures recommended by irrigation audit have been implemented	Recommendations not already implemented should be done so prior to next audit.
Review of back siphoning prevention measures	Immediate stop of use of unprotected water supply for filling chemical sprayers while permanent measures are put in place. If measures are not in place for following audit - non compliance.
Review of fallen stock policy - use of a contractor to removed	Concerns or absence of policy should be rectified for next

fallen stock	audit. Following that - non compliance
Review of chemical management policy - use of contractor or approved handler, use of a crop adviser	Concerns or absence of policy should be rectified for next audit. Following that - non compliance
Review of no spread zones for fertiliser and silage effluent	Map should be displayed for next audit. Following that - non compliance
Review methods employed to reduce wind blow on cultivated land	Concerns or absence of methods should be rectified for next audit. Following that - non compliance
Review of crop records to verify rotation of fodder crops	Concerns or absence of over rotation should be rectified for next audit. Following that - non compliance
Review measures recommended to remove compaction across Gr/Sm/Gk association and Tk/My association soil	Recommendations not already implemented should be done so prior to next audit. Following that - non compliance
Independent fertiliser spreader and irrigation testing and calibration 1 in 5 years	Spreaders and irrigators not performing should be recalibrated
Additional auditing that can be done either externally or internally	
Submission of silage clamp and effluent storage design plans	Once approved, the plans need only to be submitted once
Submission and brief interpretation of soil, water quality, and machinery calibration tests	Where triggers have been exceeded, immediate contingency plans should have been effected and a root cause analysis conducted. The results of which should be presented here. Continual breach - non compliance
Submission of example irrigation schedules and reconciliation with soil moisture monitoring	The restriction of irrigation water to 600 mm/ha is an important driver to efficiency. Other sanctions are unlikely to be necessary to promote water use efficiency.
Submission of GPS fertiliser application map for pivots on Pk/Hk association and Tk/My association soils	Map should be produced for next audit. Following that - non compliance
Submission of precision irrigation application map for pivots on Pk/Hk association and Tk/My association soils	Map should be produced for next audit. Following that - non compliance
Annual fertiliser spreader and irrigation testing and calibration	Spreaders and irrigators not performing should be recalibrated
Auditing that must be done internally	
Self certification for application of fertiliser according to code of practice	Any failures in observing the code of practice for applying fertiliser should be rectified and followed up in the next audit

6.0 Farm Environmental Management Plan for Pukaki Flats North – Scenario 2

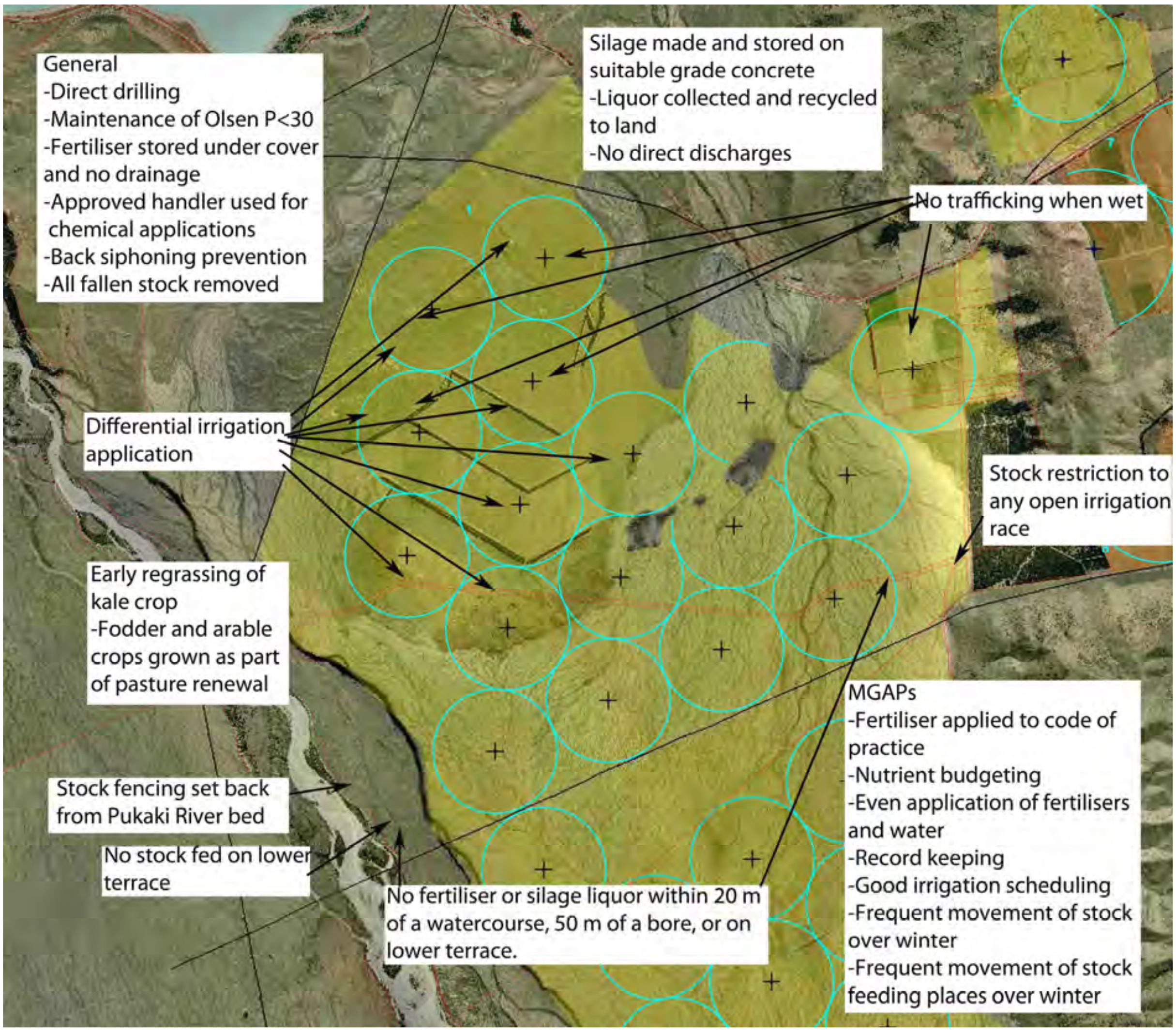
Table 7 shows the all the mitigation and management tools that are proposed to be undertaken on Pukaki Flats North. Measures indicated as FEMP stage 1 are those identified as Mandatory Good Agricultural Practice, measures identified as FEMP stage 2 are those changes that have been modelled in OVERSEER to meet the WQS mitigation requirement, and those indicated as FEMP stage 3 are mitigation measures chosen to ameliorate site specific environmental risks on the farm. The table indicates in brief how the measures are to be monitored and audited, and a map showing the locations of the proposed mitigation measures is shown in Figure 6.

Table 7 Table of mitigation options for Pukaki Flats North - Scenario 2

FEMP stage	Measure	Monitoring	Auditing
1	Fertilisers applied according to code of practice for fertiliser use		Self certification
1	Accounting for all sources of nutrients including animal returns and soil reservoirs	Soil testing and use of a nutrient budgeting	Reconciliation of fertiliser and soil records with nutrient budget for example blocks. Submission of example soil tests
1	Even fertiliser application	Calibrate and optimise fertiliser spreaders annually and every 5 years by an external auditor	Submission of testing and calibration
1	Even irrigation application	Calibrate and optimise irrigators annually in house and every 5 years by an external auditor	Submission of testing and calibration
1	Record crop, cultivation, stock days, nutrient inputs and yields per farm management unit	Upkeep of records	Submission of example block records
1	Good design of irrigation systems	Design of irrigation system by a certified professional	Irrigation system audited after installation and then by a certified auditor every 5 years
1	Robust irrigation scheduling	Use of example pivots for aquaflex soil moisture monitoring	Submission of soil moisture monitoring data
1	Good silage storage and good feeding out management		Annual audit of silage pits
1	Frequent movement of stock over winter to prevent pugging and reduce winter stock losses	Upkeep of stock movement records	Submission of example stock movement records
2	Reduce risk of wind blow following cultivation through use of direct drilling or other methods such as light irrigation on cultivated area.	Upkeep of records	
2	Early regrassing after winter grazed kale	Upkeep of records	OVERSEER nutrient budget
2	Stock restricted from all open irrigation races and Pukaki River		Annual audit
2	Olsen P of below 30 maintained	Regular soil testing (every 3 years)	Submission of soil tests
2	No fertiliser or silage effluent will be applied within 20 m of a watercourse or 50 m of a bore or on lower terraces		Self certification
3	No stock will be fed out in the lower terraces of the property	Upkeep of stock movement records	Annual audit
3	All fallen stock will be removed from the property		Submission of details of removers
3	Back siphoning prevention measures when filling chemical sprayers from un-isolated water supplies		Back siphoning prevention measures reported
3	Fodder and arable crops will be grown as part of the pasture renewal process and will therefore rotate around appropriate parts of the station	Upkeep of records	Annual audit

3	Fertiliser to be stored under cover		Photograph of store
3	Fertiliser filling area to be where there are no drains and where a direct discharge to ground in not possible		Photograph of filling area
3	A contractor or approved handler used to supply, handle and apply chemicals		Submission of contractor details
3	Professional crop adviser for chemical use, doses and tank mixes.		Submission of consultant details
3	Silage should be made and stored on suitable concrete that drains to an effluent collection facility		Annual audit and submission of design parameters (once only)
3	Silage liquor to be recycled to land		Annual audit
3	No trafficking when wet on Grampian/Simons/Glenrock association or Tekapo/Mary soils		Annual audit
3	Differential irrigation application on Pukaki/Holbrook association and Tekapo/Mary association soils recommended		Block irrigation map (GPS)

Figure 6 Annotated map with key mitigation options an locations on Pukaki Flats North – Scenario 2



6.1 *Monitoring and Auditing*

Monitoring and auditing of the FEMP are as important as the plan itself.

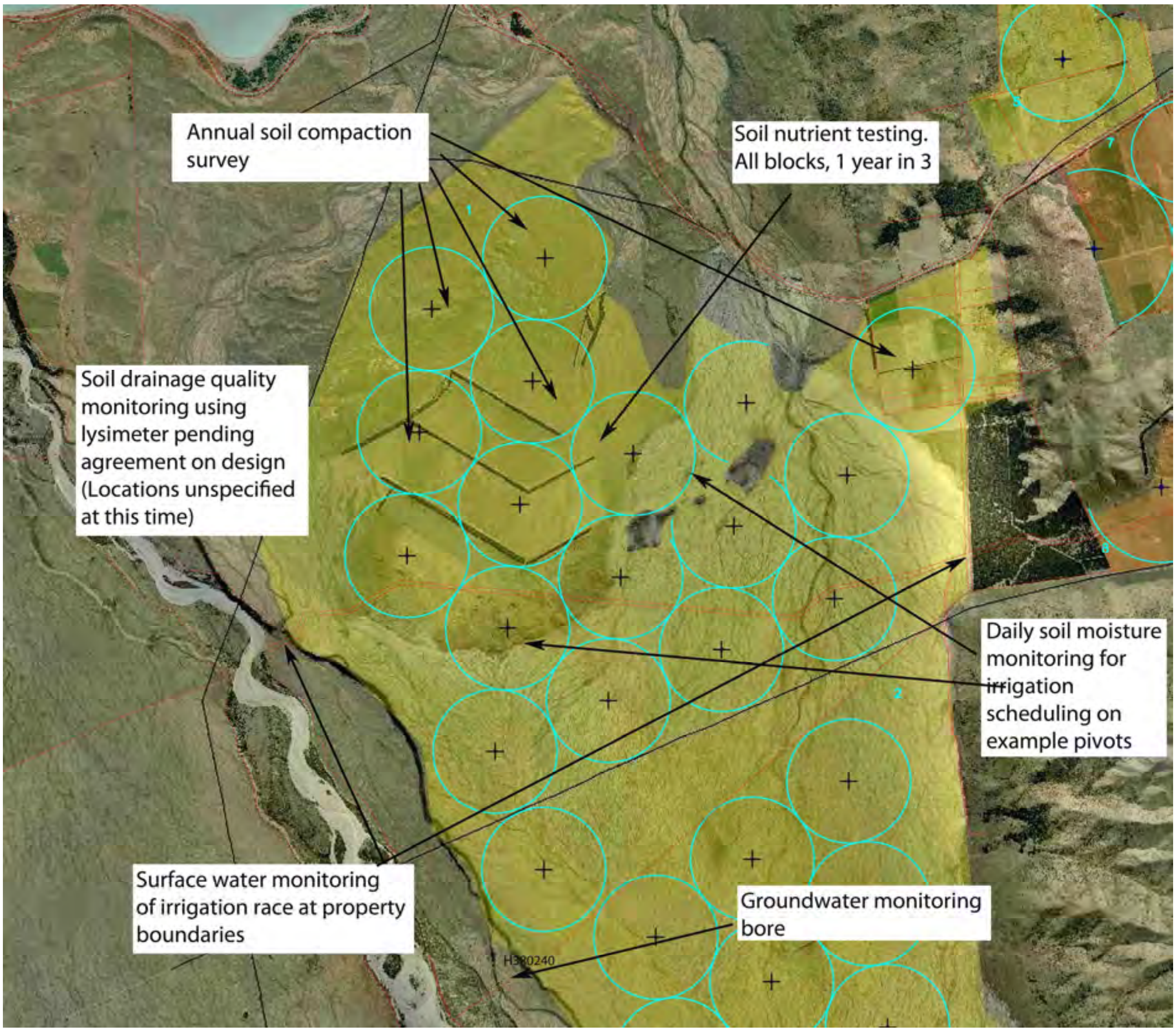
Table 7 shows the monitoring suggested for the mitigation and management options chosen for Pukaki Flats North. Table 8 shows the frequency and parameters for the environmental monitoring. Figure 7 shows these monitoring points on a map of the property.

Additional monitoring will be carried out in conjunction with other farmers in the sub-catchments by the Mackenzie Irrigation Company, on the Tekapo River and Northern Arm of Lake Benmore, and in the Pukaki groundwater sub-catchment.

Table 8 Location, frequency and parameters for environmental monitoring on Pukaki Flats North – Scenario 2

	Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
Soil nutrient testing	All pivots in rotation	1 in 3 years	Standard suite of soil nutrients.	Olsen P of 30	Reduce or stop addition of P to area and monitor
Soil drainage quality - Lysimeters	TBC	Monthly	Nitrogen species	No trigger - for model verification purposes only	
Groundwater quality	Recently drilled bores around perimeter of property	Annually at mid depth of aquifer	Total Nitrogen, nitrate, ammonia, total phosphorus, dissolved reactive phosphorus.	1 mg/l	Continued exceedences should be investigated and compared with the baseline data from the previous 36 months data of the existing bore. A trend tending towards the 1mg/l trigger is satisfactory. A negative trend would require mitigation such as reducing winter stock numbers.
Surface water	Open irrigation races on property boundaries	Every 3 months	Total Nitrogen, nitrate, ammonia, total phosphorus, dissolved reactive phosphorus.	Significant increase in monitored parameters	Exceedences should be investigated with specific attention to elevated parameters, as these may indicate the type of contamination.
Irrigation application		Annually in house and 1 in 5 years by an independent	Application uniformity	<80 %	Optimisation of the irrigator performance will take place at the time of testing
Soil moisture	Example pivots	Daily during irrigation system	Soil moisture and deficit	67 %-85% PAW for irrigation scheduling purposes	NA
Fertiliser application		Annually in house and 1 in 5 years by an independent	Application uniformity		Optimisation of the irrigator performance will take place at the time of testing
Soil compaction	Pivots on Gm/Sm/Gk association and Tk/My association soils	Annually	Soil compaction	Compaction (plus surface capping for Gm/Sm/Gk association soil)	Remove compaction with appropriate tool for depth.

Figure 7 Annotated map showing location of monitoring points on Pukaki Flats North - Scenario 2



Where triggers are exceeded, the immediate contingency plans in Table 8 should be implemented while a 'root cause' analysis is carried out. Any further mitigation measures to be adopted as a result of monitoring should be added to Tables 7, 8 and 9.

1) Is the current mitigation option implemented correctly?

No – Implement and monitor

Yes – to 2)

2) Has anything changed in the farm system?

Yes – remodel and monitor

No – to 3)

3) Have there been abnormal conditions[9] at the time of trigger breach?

Yes – continue monitoring to see if trigger breach continues

[9] Abnormal conditions include extreme weather conditions and catastrophic failure of irrigation/effluent infrastructure

No – Seek advice of suitably qualified person to further investigate root cause and suggest appropriate further mitigation.

If emergency conditions occur that risk a pollution event, such as severe flooding event that puts the effluent storage system at risk or a catastrophic failure of the effluent system, seek immediate guidance from the Canterbury Regional Council **0800 76 55 88**.

Auditing

The auditing process allows both the farm operator to illustrate, and other interested parties to have confidence that the management practices and mitigations planned for the farm are being implemented. In addition, the audit shows that there is a mechanism for the adaptive management of the property should the chosen mitigation or management not perform to expectations.

An annual audit is proposed, and requires both external and in-house input. The annual audit should be completed and submitted to the Canterbury Regional Council by the end of July each year.

Table 9 shows the proposed contents of an annual audit report for Pukaki Flats North.

Table 9 Table showing proposed contents of an annual audit report for Pukaki Flats North- Scenario 2

Audit measures	Action in the case of non-compliance if applicable
Additional auditing that must be done externally	
Check the storage of silage for visible signs of discharge and destination of silage liquor	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check for evidence of direct discharges from the yard	Any direct discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check fertiliser storage and filling area.	There should be no possibility of loss of fertiliser to drains or direct discharge to ground. Any drains should be covered, or the filling area moved to where no discharges will occur.
Check integrity of irrigation race fencing and perimeter fencing	Any gaps in fencing should be blocked temporarily when stock are present until a permanent repair can be made
Review of stock movement records to show winter feeding and stock movement, and no feeding out on lower terraces.	
Annual audit of OVERSEER nutrient budget and report based on previous 3 years. Submission of compliance with thresholds.	Should the OVERSEER report show losses exceeding the threshold, further mitigations should be adopted to effect a reduction in nutrient loss to below thresholds.
Reconciliation of fertiliser and soil records with nutrient budget and fertiliser recommendations	Where reconciliation is not possible and an over application has occurred, this should be rectified in the following year. Following that - non compliance
Review measures recommended by irrigation audit have been implemented	Recommendations not already implemented should be done so prior to next audit.
Review of back siphoning prevention measures	Immediate stop of use of unprotected water supply for filling chemical sprayers while permanent measures are put in place. If measures are not in place for following audit - non compliance.
Review of fallen stock policy - use of a contractor to removed fallen stock	Concerns or absence of policy should be rectified for next audit. Following that - non compliance
Review of chemical management policy - use of contractor or approved handler, use of a crop adviser	Concerns or absence of policy should be rectified for next audit. Following that - non compliance
Review of no spread zones for fertiliser and silage effluent	Map should be displayed for next audit. Following that - non compliance
Review methods employed to reduce wind blow on cultivated land	Concerns or absence of methods should be rectified for next audit. Following that - non compliance
Review of crop records to verify rotation of fodder crops and early regrassing after kale crop	Concerns or absence over rotation should be rectified for next audit. Following that - non compliance
Review measures recommended to remove compaction across Gr/Sm/Gk association and Tk/My association soil	Recommendations not already implemented should be done so prior to next audit. Following that - non compliance
Independent fertiliser spreader and irrigation testing and calibration 1 in 5 years	Spreaders and irrigators not performing should be recalibrated

Additional auditing that can be done either externally or internally	
Submission of silage clamp and silage effluent storage design plans	Once approved, the plans need only to be submitted once
Submission and brief interpretation of soil, water quality, and machinery calibration tests	Where triggers have been exceeded, immediate contingency plans should have been effected and a root cause analysis conducted. The results of which should be presented here. Continual breach - non compliance
Submission of example irrigation schedules and reconciliation with soil moisture monitoring	The restriction of irrigation water to 600 mm/ha is an important driver to efficiency. Other sanctions are unlikely to be necessary to promote water use efficiency.
Submission of precision irrigation application map for pivots on Pk/Hk association and Tk/My association soils	Map should be produced for next audit. Following that - non compliance
Annual fertiliser spreader and irrigation testing and calibration	Spreaders and irrigators not performing should be recalibrated
Auditing that must be done internally	
Self certification for application of fertiliser according to code of practice	Any failures in observing the code of practice for applying fertiliser should be rectified and followed up in the next audit

7.0 Summary

This FEMP has been written to serve two purposes, to illustrate that the proposed farm system can meet the nutrient mitigation requirements set out by the Water Quality Study, and to identify and mitigate other farm specific environmental risks that arise from the inherent characteristics of the farm or from the proposed farm system and its management. These farm specific risks include uncontrolled discharges that are not identified in farm nutrient budget modelling but that may still have an environmental effect.

The mitigation and management measures detailed in Tables 4 and 7 lay out the techniques that have been adopted to fulfil these two objectives. The WQS thresholds and modelling outputs from OVERSEER detailed in Table 3 illustrate that the proposed farming system meets the WQS thresholds and the risk assessment and mitigation measures proposed in Section 5 illustrate how site specific environmental issues, including uncontrolled discharges, have been identified and are mitigated.

The monitoring and auditing of this plan, addressed in Section 6 allow the performance of the measures chosen to be monitored and where they are performing sub-optimally, these can be addressed through the root cause analysis process.

8.0 References

GHD (2009). Cumulative Water Quality Effects of Nutrients from Agricultural Intensification in the Upper Waitaki Basin – Summary Report.

GHD (2009a). Cumulative Water Quality Effects of Nutrients from Agricultural Intensification in the Upper Waitaki Basin – Rivers and Lakes Report.

NZFMRA (2002). Code of Practice for Fertiliser Use. Providing practical and specific guidance for safe, responsible and effective nutrient management.

Olge, G. (2009). Farm system models for land to be irrigated in the Mackenzie basin by Simons Pass Station Limited and Simons Hill Station Limted. Report prepared by Ogle Consulting.

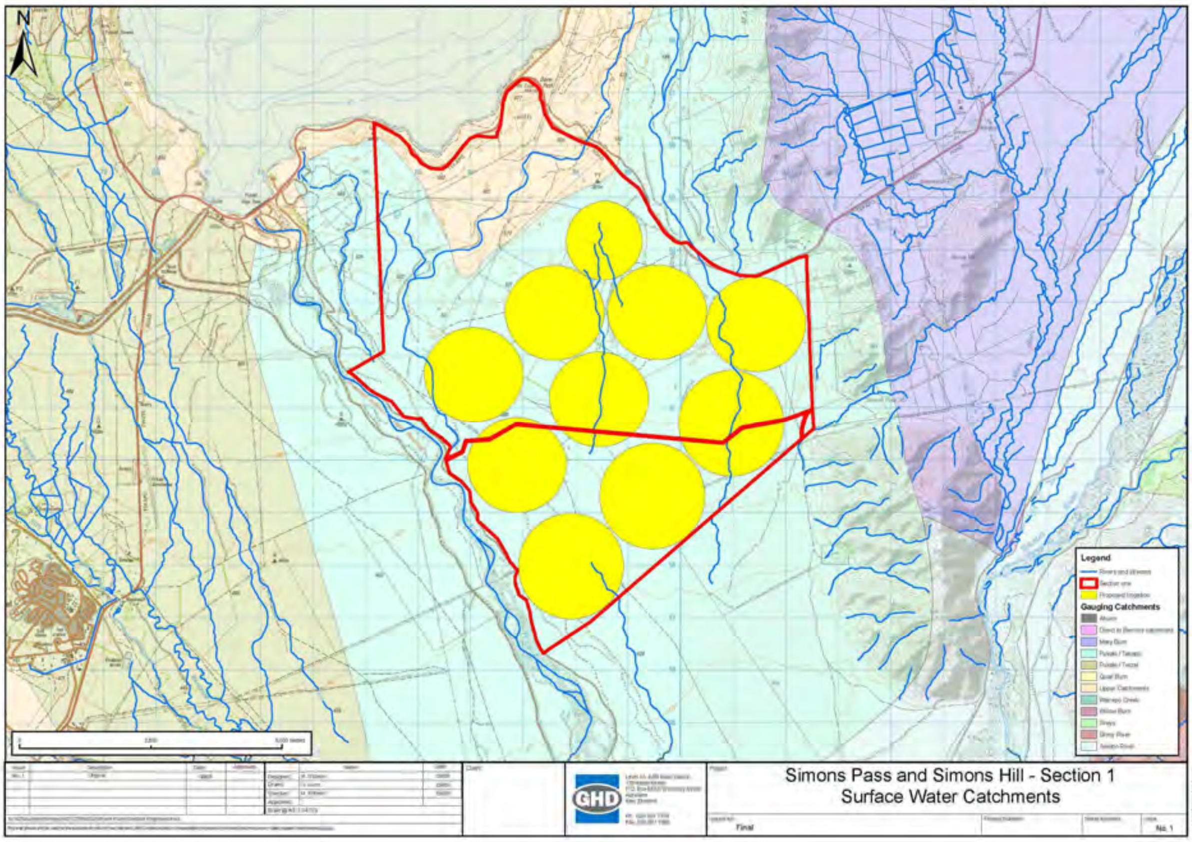
OVESEER v.5.3.4 . AgResearch.

Snow, V., King, W. (2008). Upper Waitaki Farm Systems and Nutrient Assessment. Stage 2: Pasture and Ryecorn Growth Modelling. Report prepared for GHD by AgResearch.

Webb, T. H. (1992). Soils of the Upper Waitaki Basin, South Island, New Zealand, DSIR.

ANNEXURE 1

WQS ground and surface water sub-catchments from Pukaki Flats North
Maps provided by GHD Lts to illustrate sub-catchment boundaries only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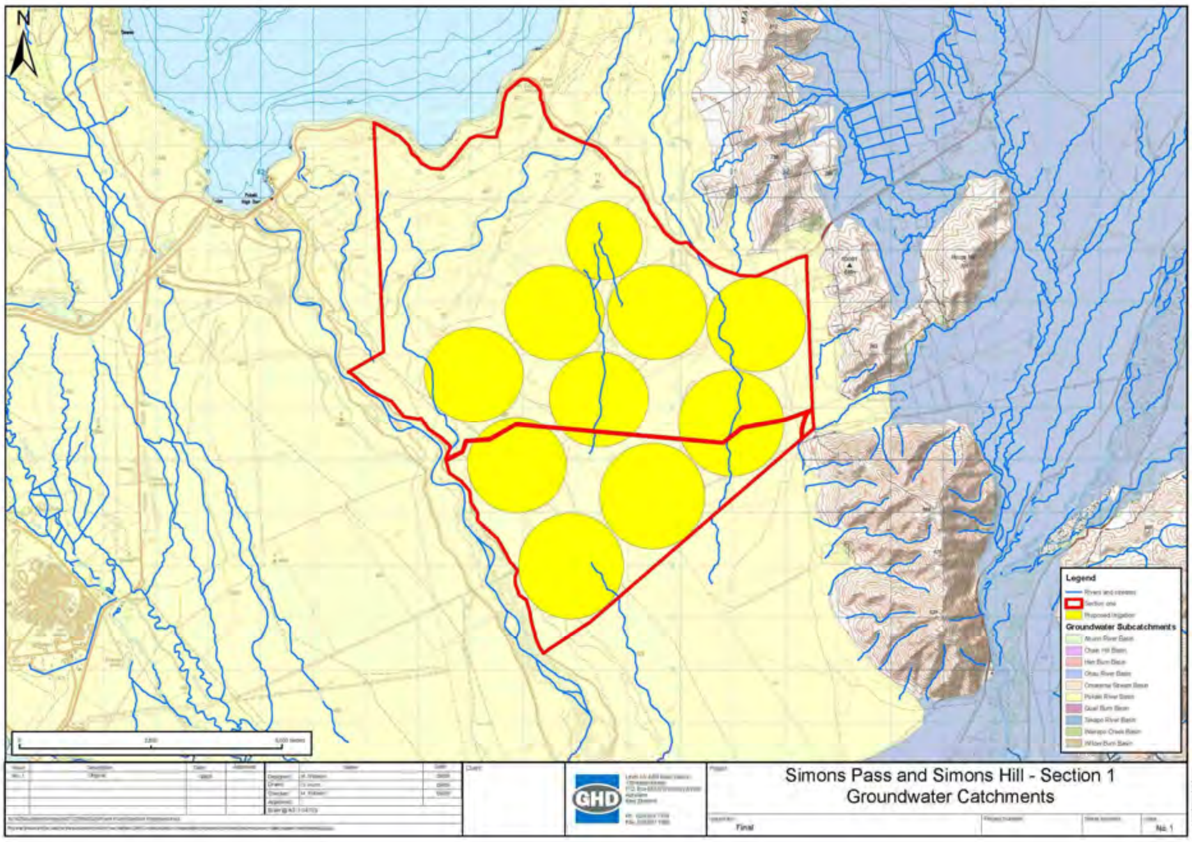
Legend
Gauging Catchments
Simons Pass and Simons Hill - Section 1
Surface Water Catchments
GHD
Final
No. 1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Legend
Groundwater Subcatchments
Simons Pass and Simons Hill - Section 1
Groundwater Catchments
GHD
Final
No. 1

ANNEXURE 2

Farm Environmental Risk Assessment

Simons Pass - Pukaki Flats

Some guideline questions for track management and runoff	**Current**		Dairy wintered off	Intensive sheep and beef with dairy grazing
Are there tracks in hydrologically connected areas?	No		No	No
Do any tracks run through streams?	No		No	No
Do any tracks directly runoff to a water course	No		No	No
Are devices in place for removing and/or treating contaminated water from tracks?	NA		NA	NA
Are tracks for stock specifically maintained?	No		Not determined, however there are no surface water receiving environments on the property, only bounding the southern part of the property and it has very flat topography and permeable soils, and therefore little risk of overland flow.	Not determined, however there are no surface water receiving environments on the property, only bounding the southern part of the property and it has very flat topography and permeable soils, and therefore little risk of overland flow.
Do stock regularly pass through water courses?	No		No, if required bridges over open irrigation race channels	No, if required bridges over open irrigation race channels
Are there any sloping fields adjacent or hydrologically connected to a water course?	No, lower terraces next to Pukaki and Tekapo Rivers are flat.		No, lower terraces next to Pukaki and Tekapo Rivers are flat.	No, lower terraces next to Pukaki and Tekapo Rivers are flat.
Any previous runoff or soil wash?	Evidence of wind erosion in areas			
If arable or fodder crops are grown, are measures taken to conserve or build soil organic matter on arable land?	No		No	Proposed scenario will have two fodder crop rotations at any one time. Rotation 1 is a 2 year pasture break of fodder crops before returning to pasture, and Rotation 2 is a 1 year break. Organic matter levels will be maintained through pasture phase of rotation. However, conventional cultivation to establish both the turnips and kale and the swedes has been modelled. These impacts are reduced by having the turnip crop bicropped with annual ryegrass.
Are remedial measures to prevent runoff in place after winter grazed crops?	No		Na	Winter grazing is reduced lower winter stocking numbers. Fodder crops are reinstated into pasture in spring. Flat topography andpermeble soils preclude runoff even from compacted winter grazed fodder crops.
Is there a possibility of run off from winter grazed areas reaching a water course?	No		No natural surface water receiving environments on the irrigated part of the property and it has very flat topography and permeable soils, and therefore little risk of overland flow. Although open irrigation races may pass over the property. The southern and western borders of the property bound the Tekapo and Pukaki Rivers. These will be fenced and the bottom terraces will not be irrigated.	No natural surface water receiving environments on the irrigated part of the property and it has very flat topography and permeable soils, and therefore little risk of overland flow. Although open irrigation races may pass over the property. The southern and western borders of the property bound the Tekapo and Pukaki Rivers. These will be fenced and the bottom terraces will not be irrigated.
Some guideline questions for stock nutrient loss				

	If stock over wintered outside on the farm, are strategies in place to reduce winter nutrient losses?	NA		Stock are wintered off the farm	Cross bred lambs and merino hoggets are finished and sold before winter thereby reducing stocking over the winter period.
	Are measures taken to control dietary intakes of N and P? (Intensive beef and dairy)	NA		No supplements imported. Extra dry matter conserved on farm and fed out in winter. DM deficit is avaoided by wintering off.	No supplements imported. Extra dry matter conserved on farm and fed out in winter, and fodder crops grown. DM deficit is avoided by reducing numbers over winter.
	Are stock restricted from entering watercourses?	NA		Yes	Yes
	Are feed areas moved during winter in hydrologically connected fields?	NA		Stock should not be fed out on lower terrace in autumn or winter	Stock should not be fed out on lower terrace in autumn or winter
	Other stock nutrient issues or incidences? Please describe	NA			
Some guideline questions for biodiversity					
	Are there any special areas or species of interest or conservation on the farm?			Ecology Report	Ecology Report
	Are there any water or wetland features on the farm?	No		Tekapo River bounds the southern end of the property. There is also a wetland area at this southern boundary. The western boundary of the property runs set back from the river bed of the Pukaki River (dry river bed but subject to rapid flooding should spilling be required from Lake Pukaki)	Tekapo River bounds the southern end of the property. There is also a wetland area at this southern boundary. The western boundary of the property runs set back from the river bed of the Pukaki River (dry river bed but subject to rapid flooding should spilling be required from Lake Pukaki)
	Are these features actively protected?	NA		The Tekapo River is fenced as is the wetland area. The lower terrace at the southern end of the property will not be irrigated. There should be no feeding out or fert/effluent spread on these lower terraces. The open irrigation channels should be restricted from stock access. The Pukaki River will also be fenced off	The Tekapo River is fenced as is the wetland area. The lower terrace at the southern end of the property will not be irrigated. There should be no feeding out or fert/ silage effluent spread on these lower terraces. The open irrigation channels should be restricted from stock access. The Pukaki River will also be fenced off
	Are surface water features protected from stock access?	NA		Yes for Tekapo and the Pukaki and open channels should be fenced	Yes for Tekapo and the Pukaki and open channels should be fenced
	Is there evidence of bankside erosion	No		No	No
	Other biodiversity issues? Please describe	NA		NA	NA
Some guideline questions for chemical usage					
	Are those handling chemicals of 'approved handler status'?	Currently use a contractor		ND	ND
Some guideline questions for water					
	Do you use irrigation scheduling?	NA		Yes	Yes

	How do you estimate soil moisture deficit?	NA		Yes - aquaflex is proposed in selected pivots to assist scheduling	Yes - aquaflex is proposed in selected pivots to assist scheduling
	Do you use surface irrigation (border dyke, wild flood)	NA		NA	NA
	Do you collect wipeoff losses?	NA		NA	NA
	Are these wipeoff losses discharged to a watercourse	NA		NA	NA
	Are your borders laser levelled?	NA		NA	NA
	If you have spray irrigation, do you practice fertigation?	NA		Fertigation has not been modelled.	Fertigation has not been modelled.
	Is clean water yards collected separately and discharged or used?	NA		Clean water will be collected and used or discharged. No direct discharges of contaminated water will occur off the yard.	Clean water will be collected and used or discharged. No direct discharges of contaminated water will occur off the yard.
	Are back siphoning prevention measures in place?	NA		Back siphoning prevention measures will be used	Back siphoning prevention measures will be used
	Other water issues or incidences? Please describe	NA		Pk/Hk and Tk/My soils are both associations where main soils have significant differences in profile characteristics. Risk here is with mode deep and shallow stony soils in close proximity, risk of over/under irrigating	Pk/Hk and Tk/My soils are both associations where main soils have significant differences in profile characteristics. Risk here is with mode deep and shallow stony soils in close proximity, risk of over/under irrigating
Some guideline questions for fertiliser					
	Do you apply more than 50 kg N per application?	No		Not specified in modelling so yes	No
	Do you apply N fertiliser during later autumn and winter?	No		No	No
	Do you apply P fertiliser within 3 weeks of surface irrigation?	NA		NA	NA
	Do you regularly soil test?	No		Soils will be regularly tested	Soils will be regularly tested
	Do you have Olsen P levels over 30 ?	No		Soils may reach Olsen P of 30, altough the soils have low P retention and therefore large additions of P fertiliser is likely to result in elevated losses.	Soils may reach Olsen P of 30, although the soils have low P retention and therefore large additions of P fertiliser is likely to result in elevated losses.
	Are fertilisers ever applied within 20 m of a watercourse or 50m of a borehole?	NA		No - a layback will be put in place around bores and watercourses	No - a layback will be put in place around bores and watercourses
	Are fertiliser spreaders calibrated regularly?	NA		MGAP - annual calibration	MGAP - annual calibration
	Are there 'no-fertiliser' areas on farm?	No		Yes - riparian layback and lower terraces	Yes - riparian layback and lower terraces
	Other fertiliser issues or incidences? Please describe	NA		Pk/Hk and Tk/My soils are both associations where main soils have significant differences in profile characteristics. Risk here is with mode deep and shallow stony soils in close proximity, risk of over/under fertilising. No suitable storage or filling area	Pk/Hk and Tk/My soils are both associations where main soils have significant differences in profile characteristics. Risk here is with mode deep and shallow stony soils in close proximity, risk of over/under fertilising - although low fert rates reduce the risk. No suitable storage or filling area
Some example questions on effluent					
	Do you produce effluent?	No		Yes	No
	Do you have less than 4 weeks storage of effluent?			ND	ND

	Is your effluent storage facility fully sealed?	NA		ND	ND
	Do you separate clean and dirty water in the yard?	NA		Clean and dirty water should be separated on the yard.	Clean and dirty water should be separated on the yard.
	Do any direct discharges occur off the yard?	NA		Direct discharges should be prevented from occurring from the yard	Direct discharges should be prevented from occurring from the yard
	Do you spread effluent by a travelling irrigator? If not, how	NA		ND	ND
	What rate do you apply effluent at?	NA		< 12 mm/day	
	What depth of effluent do you typically apply?	NA		SMD will be used to determine application depth	
	Do you use soil moisture deficits to decide on application depth?	NA		SMD will be used to determine application depth	
	How do you determine application depth?	NA		SMD will be used to determine application depth	
	Do you apply more than 150 kg N/ha/yr of effluent N?	NA		No	No
	If silage is made on farm, is effluent collected and spread to land?	NA		Silage effluent should be collected and spread to land	Silage effluent should be collected and spread to land
	Are there any direct discharges from silage pit?	NA		No direct discharges should occur from the silage pits. The clamps should be on concrete of an appropriate quality and drain to a collection tank.	No direct discharges should occur from the silage pits. The clamps should be on concrete of an appropriate quality and drain to a collection tank.
	Other effluent issues or incidences? Please describe			Effluent application may build up K indices - Staggers. Effluent should not be spread on lower terraces	Effluent should not be spread on lower terraces
Some example questions on cropping					
	Is inversion tillage used? Describe	No		Conventional tillage will be used to prepare paddocks forpasture re-establisment. Risk here due to wind erosion	Conventional tillage will be used to prepare paddocks for 2 rotations of fodder crops. Risk here due to wind erosion
	Are soils left bare over winter?	There are existing bare areas on the flats. This is a common phenomenon with heiracium infestations		No	Mainly no as paddocks are usually under pasture. However, rotation 1 - first fodder crop will have a winter cover from the bi-cropped ryegrass, the second crop will be grazed out in situ in April May and then left fallow until reseeded in spring, so 1 winter in rotation 1. Rotation 2 Swedes fed out over winter and sown back into grass in spring, so 1 winter in rotation 2.
	Are remedial measures in place after winter grazed crops to reduce nutrient loss?	NA		NA	The turnip fodder crop is bi-cropped with annual ryegrass to provide feed after the turnips are eaten, however this will also provide a degree of nutrient capture.
	Is there a possibility of run off from winter grazed areas reaching a water course?	NA		No. No surface runoff likely on these soils to irrigation channel	No. No surface runoff likely on these soils to irrigation channel
	Other cropping issues or incidences? Please describe	No		No	No
Some example questions on soil health					

	Previous incidence of soil erosion or wash? (wind or water)	Yes, evidence of wind erosion		The irrigation and consequent ground cover will reduce wind erosion losses	The irrigation and consequent ground cover will reduce wind erosion losses
	Are there compacted, consolidated or capped soils?	Where bare, there is some running together of the surface soils. Digging pits showed a weakly structured top soil and structureless subsoil. In areas of severe wind erosion, most of the top soil had been removed		Soil may become compacted, however there are no surface water receiving environments in the irrigated area and the flat topography will prevent the risk of surface runoff. Gn/Sm/Gk are prone to capping and subsoil consilidation (fragipan) that can lead to perching of water. Tk/My soils have subsoil compaction risks. They already have firm till within 50 cm of the surface - risks of compaction by machinery.	Soil may become compacted, however there are no surface water receiving environments in the irrigated area and the flat topography will prevent the risk of surface runoff. Gn/Sm/Gk are prone to capping and subsoil consilidation (fragipan) that can lead to perching of water. Tk/My soils have subsoil compaction risks. They already have firm till within 50 cm of the surface - risks of compaction by machinery.
	Is the soil trafficked when wet?	No		Soil may be trafficked when wet, however there are no surface water receiving environments in the irrigated area and the flat topography will prevent the risk of surface runoff	Soil may be trafficked when wet, however there are no surface water receiving environments in the irrigated area and the flat topography will prevent the risk of surface runoff
	Are remedial measures for soil health in place after winter grazing	No		Winter grazing is reduced by stock wintering off, thereby reducing soil physical damage	Winter grazing is reduced by stock being sold off, thereby reducing soil physical damage
	Are stock over wintered outside?	No		Partially. 8 weeks are spent wintered off.	Partially. Although stock numbers are reduced over the winter period.
	Other soil issues or incidences? Please describe			Pk/Hk and Tk/My soils are both associations where main soils have significant differences in profile characteristics. Risk here is with mode deep and shallow stony soils in close proximity, risk of over/under irrigating /fertilising	Pk/Hk and Tk/My soils are both associations where main soils have significant differences in profile characteristics. Risk here is with mode deep and shallow stony soils in close proximity, risk of over/under irrigating /fertilising. Although low fert rates decrease the fert risk