Farm Environmental Management Plan

Report for Five Rivers Limited

Ohau Downs Station

August 2009

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1. 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 below.

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

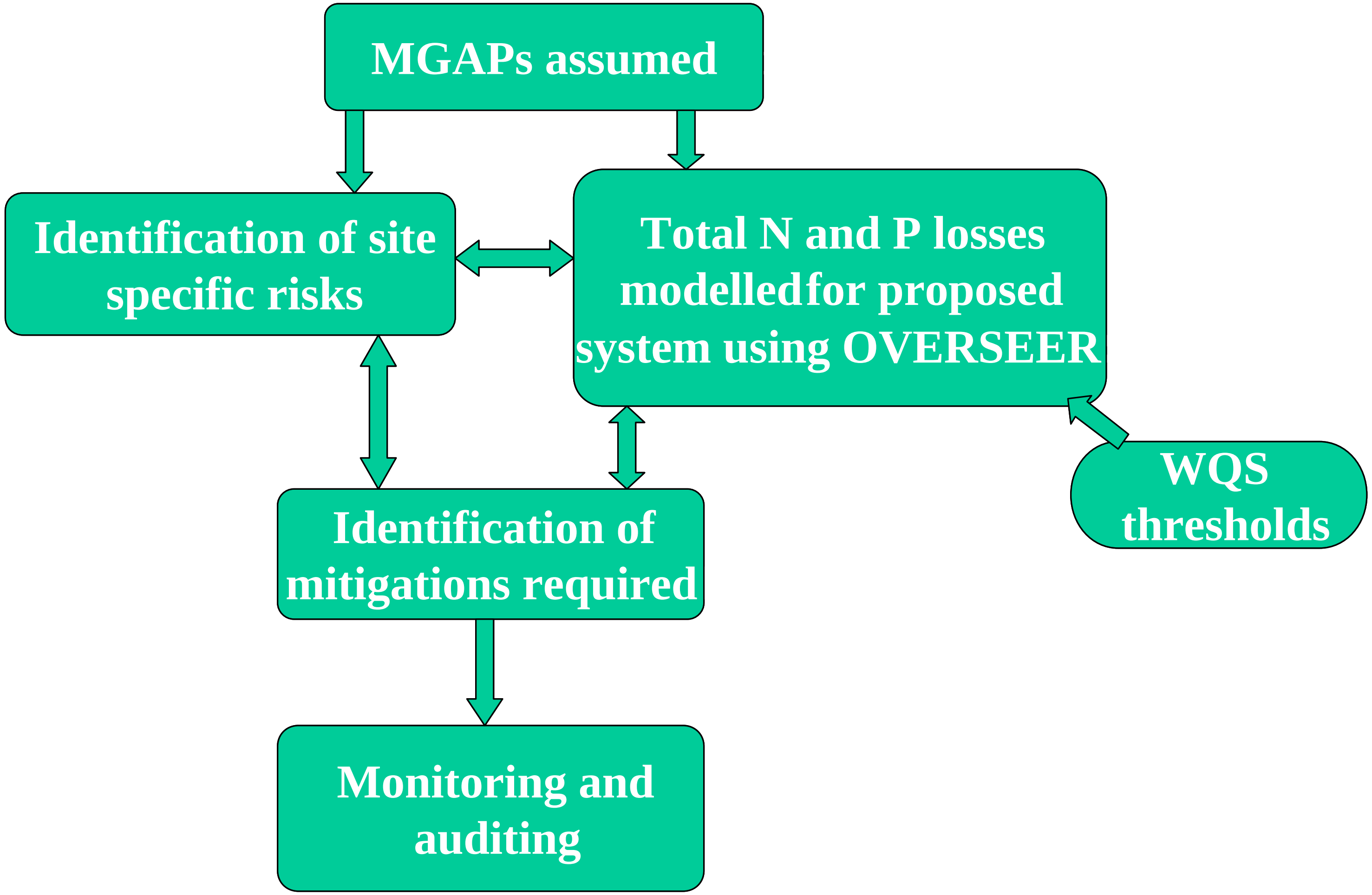
The development of a FEMP is divided into four sections:

- 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;
- 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] 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.

This Farm Environmental Management Plan was prepared by GHD, however has been subsequently added to by Ryder Consulting at the request of Fiver Rivers Limited. *Additions made by Ryder Consulting after the release of the report by GHD have been italicised*. The rest of the report unless stated was done by GHD Ltd.

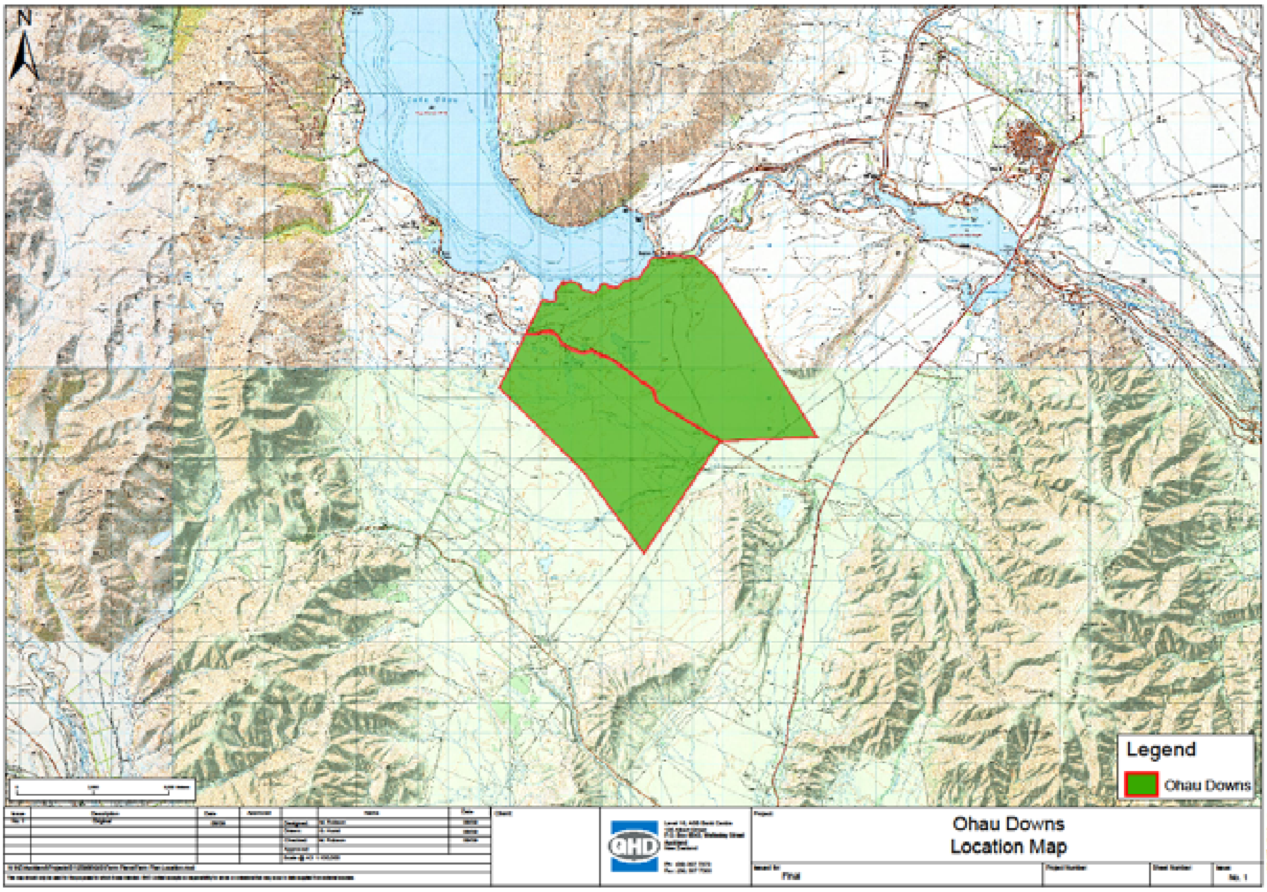
Figure 1 An overview schematic of the process of building a Farm Environmental Management Plan



2. Farm Description

Ohau Downs Station is located to the south of Lake Ohau approximately 20 km north of Omarama township, (Figure 2), and has been farmed by the current owner since 2005. The station consists of both rolling and flat country with the flats in several terraces. The farm is 5100 ha and contains undeveloped ‘native’ pasture, QEII reserve land, arable crops and improved dryland pasture for the sheep and cattle enterprise.

Figure 2 Location map for Ohau Downs



2.1 Soils

There are four main soil series on Ohau Downs Station, Ohau, Fork, Mackenzie and Pukaki/Houlbrook, with incursions of Cass/Cragieburn/Cox soils in the west of the property and Buscot/Sawdon/ Dobson soils running through the property along the course of the Wairepo Creek and the lower reaches of the Six Mile Creek.

Soils of the Ohau series are well drained shallow to deep soils derived from loess or loess over till, and are characterised by well structured silt loam tops soils over well structured silt loam to stony fine sandy loam B horizon grading to stony fine sandy loam to loamy sand C horizon at 45-55 cm (Webb, 1992).

Soils of the 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. Most variations in soil properties are related to depth and stoniness (Webb, 1992).

Soils of the Fork series are predominantly shallow and stony and excessively to somewhat excessively well drained from sandy fluvio-glacial gravels overlain by varying thicknesses of sandy alluvium. These soils are characterised by sandy loam to very stony loamy sand topsoils and upper B horizons, to loamy sand to very stony sand lower B horizons and structureless stony sands below 30-50 cm. Most variations in soil properties are related to depth and stoniness (Webb, 1992).

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).

Five 60-100 m transects were sampled from 0-10 cm and below 10 cm. 10 cores were drilled at 10 m spacing along the transect and a representative bulked sample was taken. Figure 3 shows the location of the transects.

Figure 3 Location of soil transects on Ohau Downs

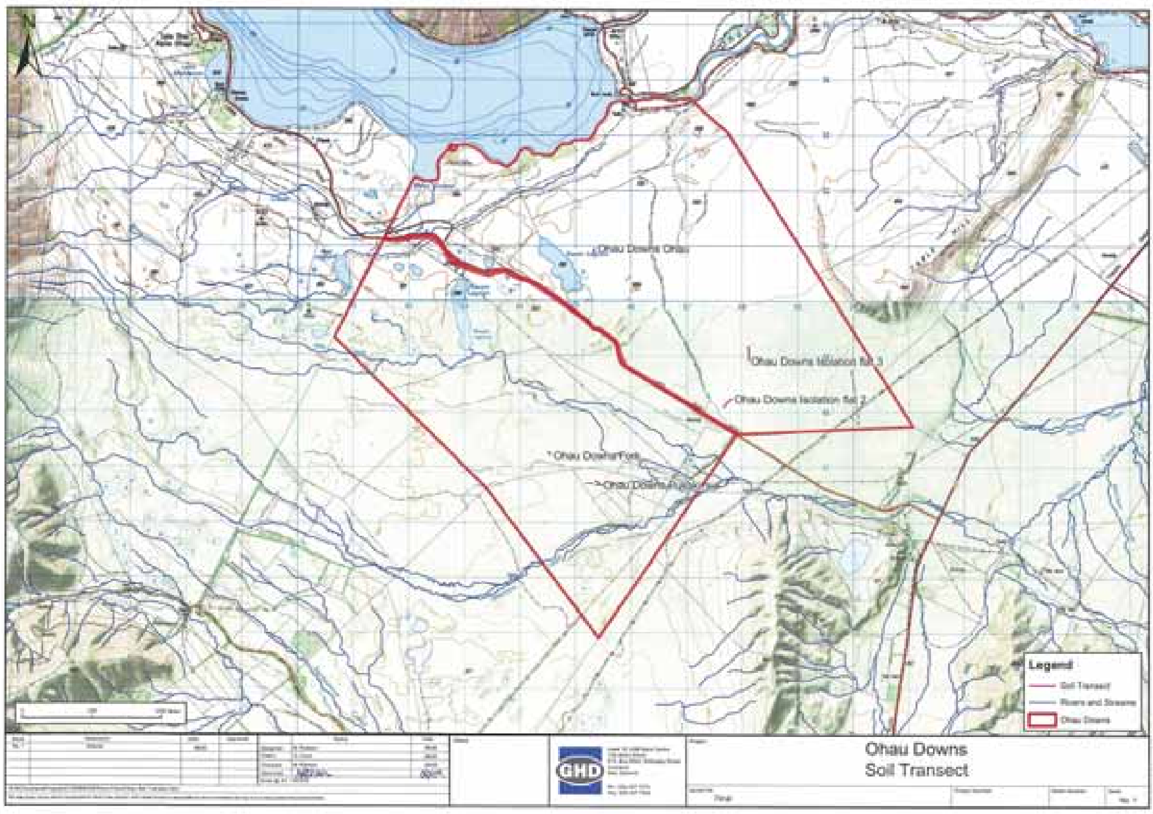


Figure 4 to Figure 8 below show the range of depths to C horizon in 10 m reaches along 5 transects across the property. In each reach, the depth to the stones or C horizon was ascertained by probing the soil 20-30 times. A minimum and a maximum depth were recorded.

During the site visit, little compaction was evident on any of the soils, except for one paddock that was being grazed by beef stock and showed some consolidation in the top 5 cm. There was clear evidence of wind erosion on the Mackenzie soils. Soil samples taken during the site visit showed that more acidic soils were located on the Mackenzie soils on the Isolation flats area and where tested for exchangeable-Al, returned concentrations in the high toxicity range.

Figure 4 Soil depth to C horizon or stones over a 100 m transect on Mackenzie soils

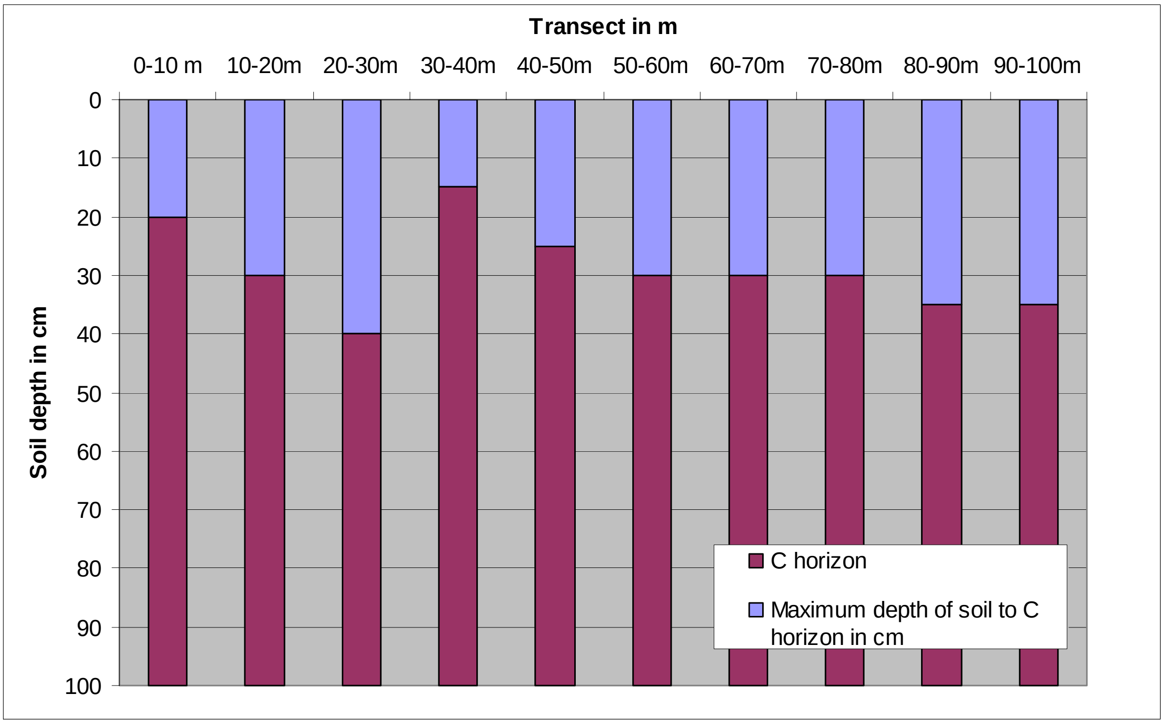


Figure 5 Soil depth to C horizon or stones over a 100 m transect on Mackenzie soils

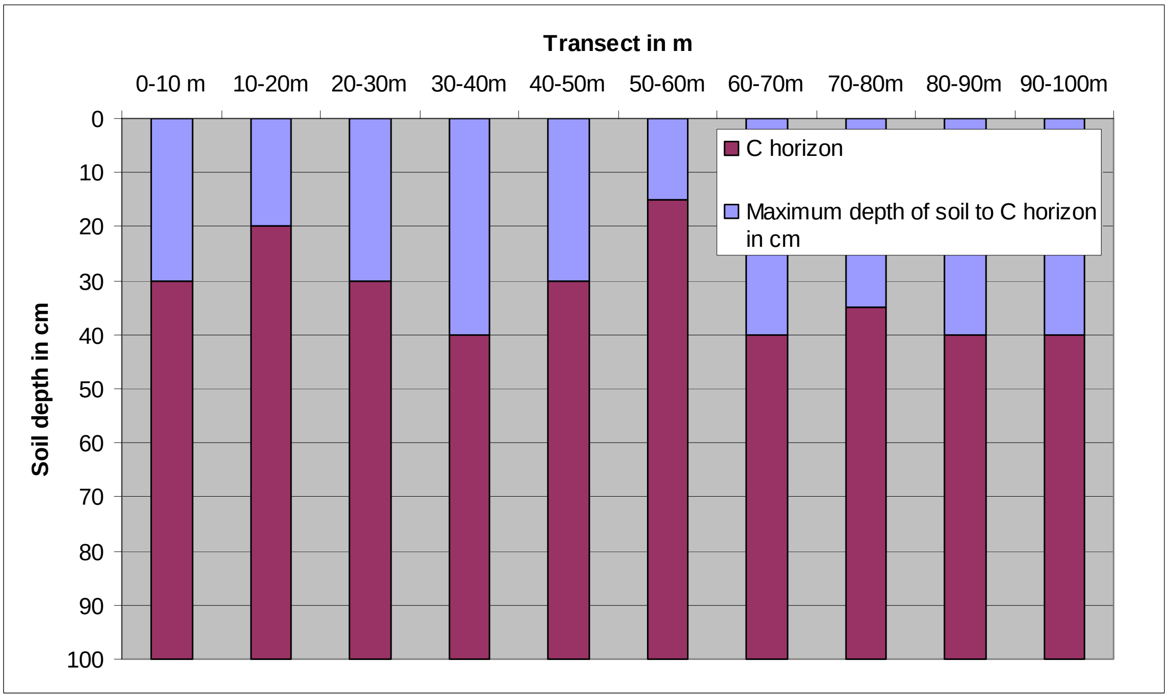


Figure 6 Soil depth to C horizon or stones over a 60 m transect on Ohau soils

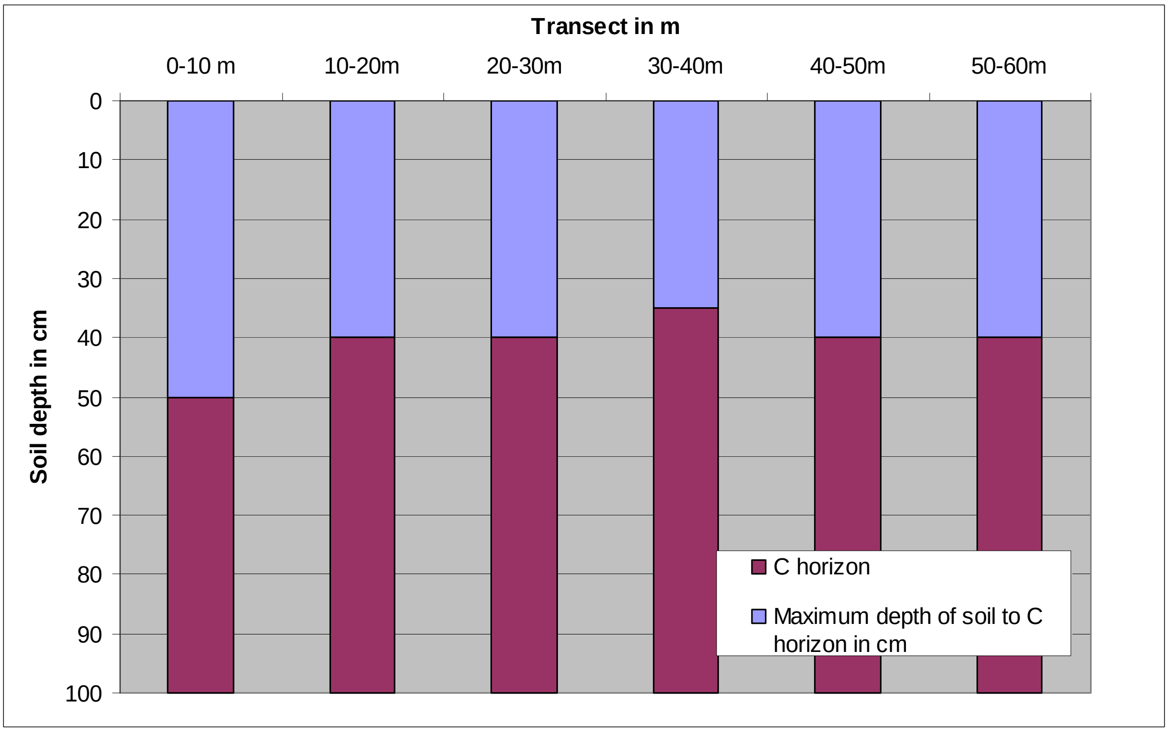


Figure 7 Soil depth to C horizon or stones over a 60 m transect on Fork soils

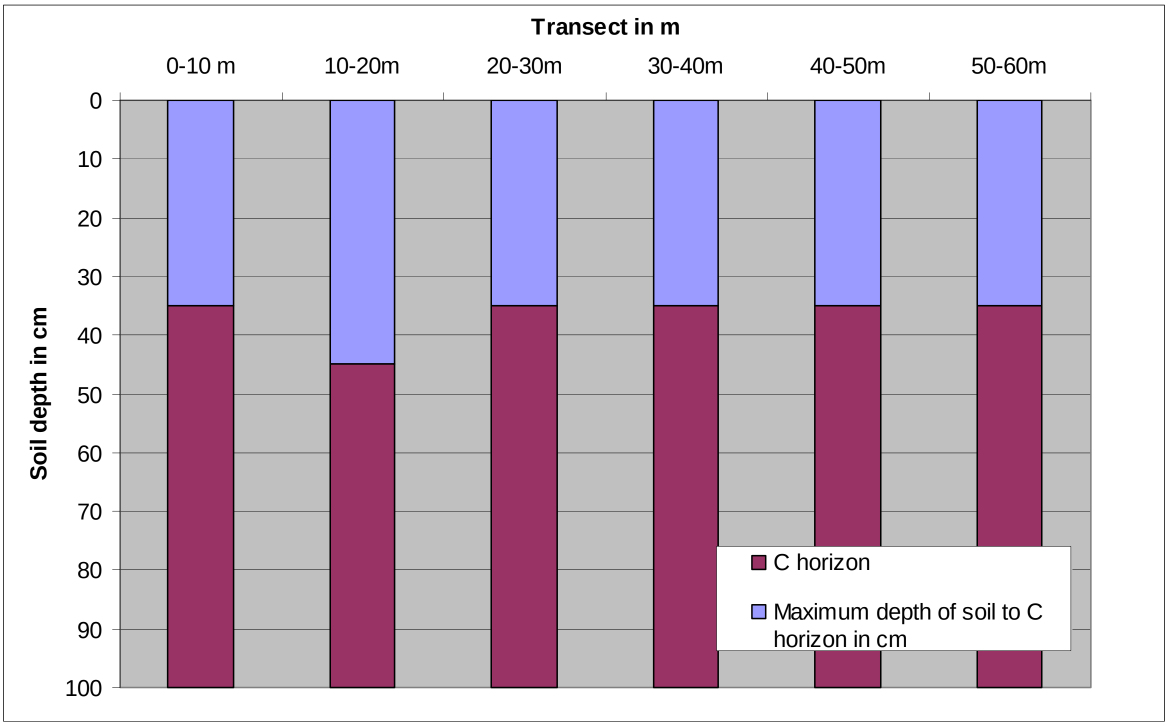
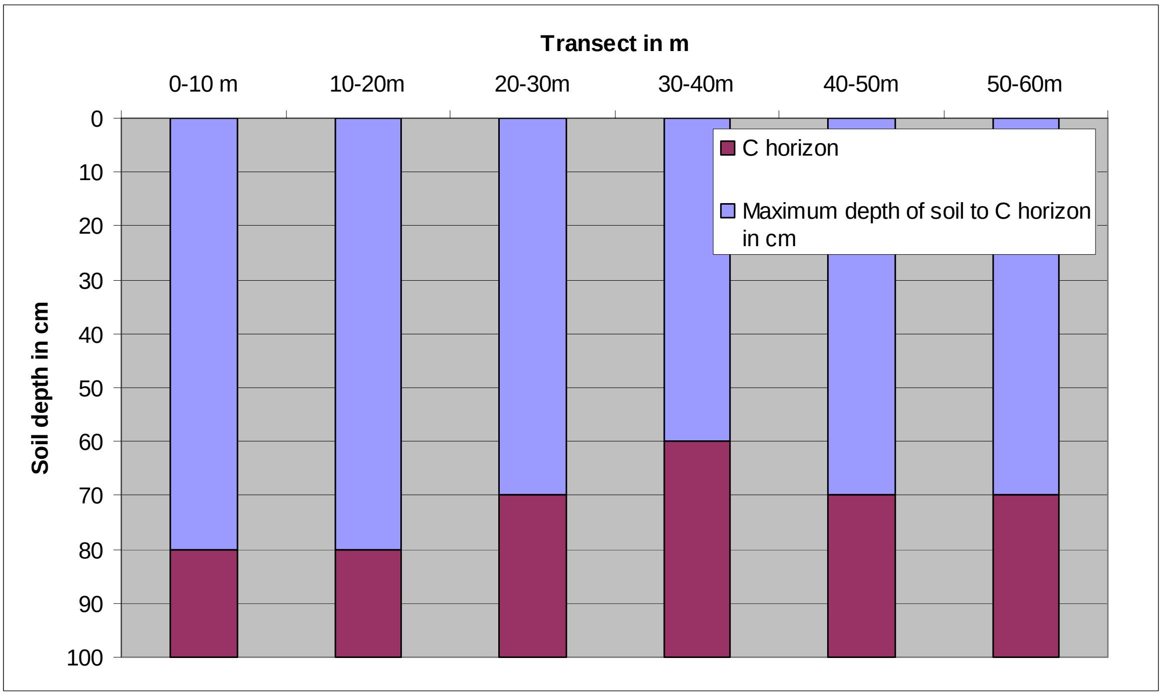


Figure 8 Soil depth to C horizon or stones over a 60 m transect on Pukaki/Holbrook soils



2.2 Climate

The climate in the Mackenzie Basin is characterized by dry summers and cold winters. Average annual rainfall on this station is 706 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).

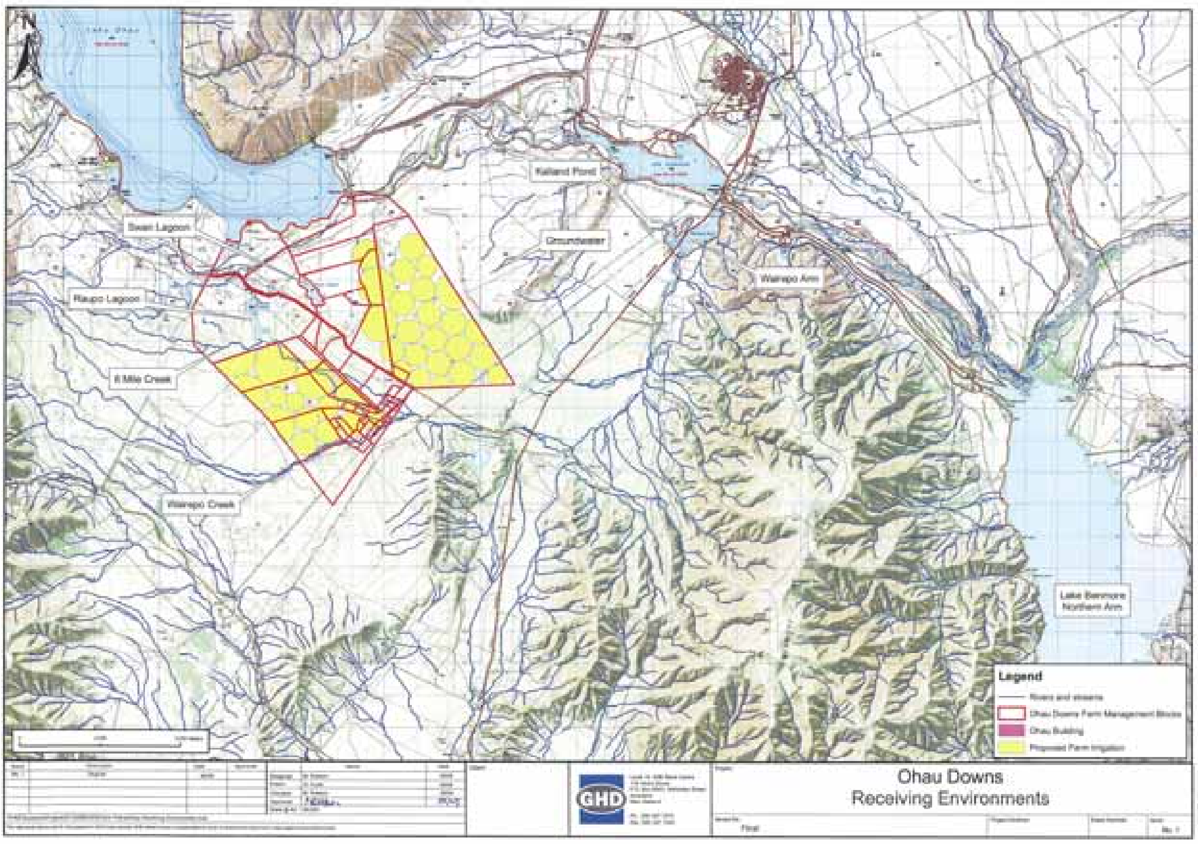
2.3 Topography

The slope of the land varies throughout the irrigated area. The flattest land occurs north of Lake Ohau Road. Here the land gradient tends in a south easterly direction ranging between 0.007 m/m and 0.01 m/m. South of Lake Ohau Road the land slopes in a more easterly direction with a gradient of approximately 0.011 m/m. Along the northern boundary of the property the land gradient steepens reaching around 0.076 m/m towards Lake Ohau (Mitchell Partnerships, 2009a).

3. Environmental context

The environmental context of the farm is a reference both to local and wider receiving environments. Figure 9 shows the receiving environments of Ohau Downs.

Figure 9 Map showing the receiving environments for Ohau Downs (available as an A3 in Appendix F)



3.1 Water Quality Study mitigation requirement

The proposed irrigation area on Ohau Downs Station, according to the WQS, lies across the Ohau River and Wairepo Creek groundwater sub-catchments, and the Wairepo Creek surface water sub-catchment (Appendix A). More detailed investigations have confirmed the direction of groundwater movement (Appendix B).

Table 1a and Table 1b show the calculated nutrient mitigation requirement of the receiving environments determined in the WQS and the resulting thresholds for N and P for Ohau Downs.

For this farm, the N mitigation requirements are the most stringent for groundwater in the Ohau River groundwater sub-catchment and the P mitigations are most stringent for the Ahuriri Arm. These mitigation requirements cap Ohau Down’s nutrient discharges at 55,954 kg N per annum and 3,793 kg P per annum.

3.2 Local receiving environments

The potential local receiving environment not captured in the WQS is the Six Mile Creek.

Six Mile Creek crosses the property from west to east on the southern side of Lake Ohau road. The creek's riparian margins and surrounds support a limited number of indigenous species mixed with exotic pasture grasses and herbaceous species. In an environment like this, where almost all of the indigenous vegetation has been lost, this wetland and riparian margin can be considered to be of moderate value, providing connectivity between the wetland areas in the upper tributaries of the stream (the Raupo and Red Lagoon areas) and the environment further downstream which joins the Wairepo Creek.

The proposed irrigation area will not impact on the QEII covenanted land, of the lagoons and ephemeral tarns as the movement of groundwater direction is in the opposite direction. The margins of Lake Ohau are likely to be impacted during the construction of the intake, however measures have been advised in Ryder Consulting (2009) and Mitchell Partnerships (2009) to minimise the damage and reinstate to the former condition.

The direction of groundwater flow as predicted by the detailed groundwater modelling indicates that the general groundwater is moving from west to east. In the northern part of the property, the groundwater is modelled to move in a south-easterly direction around Table Hill. Therefore any impacts seen in the Six Mile Creek in the irrigation command area are likely to be as a result of activities in that area and from the Northern blocks of Glen Eyrie Downs.

Table 1a Water Quality Study mitigation requirements for Ohau Downs

Farm	Surface water sub-catchment	Secondary surface water sub-catchment	Groundwater 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
Ohau Downs	Wairepo Creek	NA	Wairepo Creek	Northern Arm/Ahuriri Arm	90754	5893	0	0	0	0	-1.9	-1	0	0	-16.4	-0.7	-10.7	-1.1
Ohau Downs	Wairepo Creek	NA	Ohau River	Northern Arm	90754	5893	0	0	0	0	-1.9	-1	0	0	-17.4	0	0.0	0.0

Table 1b Water Quality Study mitigation requirements for Ohau Downs 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
0	0	0	0	-3800	-2000	0	0	-32800	-1400	-21300	-2100	90754	5893	90754	5893	86954	3893	90754	5893	57954	4493	69454	3793	57954	3793
0	0	0	0	-3800	-2000	0	0	-34800	0	0	0	90754	5893	90754	5893	86954	3893	90754	5893	55954	5893	90754	5893	55954	3893

4. FEMP development

4.1 Stage 1 – Mandatory good agricultural practices

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 and effluent applied evenly	The even application of water and or effluent 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 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 Stage 2 – OVERSEER and meeting WQS mitigation requirements

The WQS thresholds set for Ohau Downs, using the most stringent nutrient mitigation requirement, are 55,954 kg N per annum and 3,793 kg P per annum. Table 3 below shows the output from OVERSEER for the modelled proposed farming system at Ohau Downs. The results illustrate that the farm system mitigations proposed meet the N and P thresholds set out in the WQS.

A list of OVERSEER model inputs and outputs are given in Appendices D and E.

Table 3 Total N and P losses modelled by OVERSEER for the proposed farming system on Ohau Downs and WQS thresholds

	OVERSEER modelling outputs kg/year	**WQS threshold kg/year**
Total N leaching/runoff	44,762 (*alternative system 49,804)*	55,954
Total P leaching/runoff	1,361 *(alternative system 1,565)*	3,793

At a highly developed setting, the modelled N losses increase to 56,030 kg N with a higher amount of N fertiliser used (150 kg N) and 47,643 kg N using the same as the under developed (100 kg N). An increase of the restricted grazing from two months to six months reduces the N losses to 52,363 kg N and within the threshold at the higher fertilisation rate. Under the alternative system at a highly developed status, losses of 57,003 kg N were modelled. In order to maintain this system under the threshold, an increase of the % beef stock on the feed pad in the winter was modelled (to 100%). This gave a new loss of 52,714 kg N/ha, thus complying with the threshold.

4.3 Stage 3 – Identification and mitigation of site specific environmental risks

The Farm Environmental Risk Assessment (FERA) has been conducted on the proposed farming system (pre-mitigation), and has highlighted that there are potentially soil, effluent, stock, track, biodiversity and fertiliser environmental risks on the proposed farm and that there may be chemical risks as well. These risks are described below and are colour coded to indicate severity of risk or sensitivity of environment to risk, **high risk**, **medium risk** and **low risk**. All risks will need to be addressed in the Farm Environmental Management Plan (FEMP). The full FERA is attached as Appendix C.

4.3.1 Soil risks

The current soil risks identified are associated with wind erosion on the undeveloped 'Isolation Flats', some surface running together of soils where groundcover is poor, some consolidation of the surface soil in Wether Run where cattle were being grazed, and low pH soils susceptible to Al toxicity. The soil risks associated with the proposed farming system are; trafficking when wet, stock grazing over winter, and inversion tillage to establish pastures. *For the alternative proposed system, additional soil risks would arise from inversion tillage to establish crops, no measures to conserve or build organic matter under arable cropping, and subsoil and surface compaction arising from arable cropping*.

4.3.2 Effluent risks

The effluent risks associated with the proposed farming system are, that large quantities of effluent will be produced, clean and dirty water is not separated on the yard, close to 200 kg N organic manure N will be applied, silage liquor is not collected and spread to land and that direct discharges may occur from the silage pits. *For the alternative system, there will be less effluent collected and the 200 kg/ha threshold will not be approached.*

4.3.3 Fertiliser risks

The fertiliser risks associated with the proposed farming system are that more than 50 kg fertiliser N is to be applied in a single application, and applications are not excluded in winter and autumn, Olsen P levels may exceed 30, fertiliser spreaders are not calibrated, and a suitable storage and filling area has not been identified. *There will be similar risks in the alternative system*.

4.3.4 Stock risks

The stock risks associated with the proposed farming system are that stock are not excluded from the watercourses, stock will spend some time grazing over winter, there are no provisions for dealing with fallen stock, and there are no provisions for further reducing winter stock nutrient losses. *There will be similar risks in the alternative system*.

4.3.5 Runoff risks

The runoff risks associated with the proposed farming system are the possibility of runoff from grazed areas reaching a watercourse, the grazing, albeit restricted, of stock over winter, *There will be similar risks in the alternative system*.

4.3.6 Biodiversity risks

Much of the vegetation on the property, on the terraces and slopes surrounding the plains remains in a relatively natural condition and the vegetation is a mix of exotic and native species similar to that on the adjacent QEII land (Mitchell Partnerships, 2009). The area proposed for development is also the area that has been cultivated or already used for cropping, and consequently retains extremely little ecological value however, the riparian margins of the Six Mile and Wairepo Creeks and their surrounds support a limited number of indigenous species (Mitchell Partnerships, 2009). The biodiversity risks associated with current practices are principally from the grazing of stock on riparian margins, access of stock to the watercourse and poor riparian habitat management. *There will be similar risks in the alternative system*.

4.3.7 Chemical risks

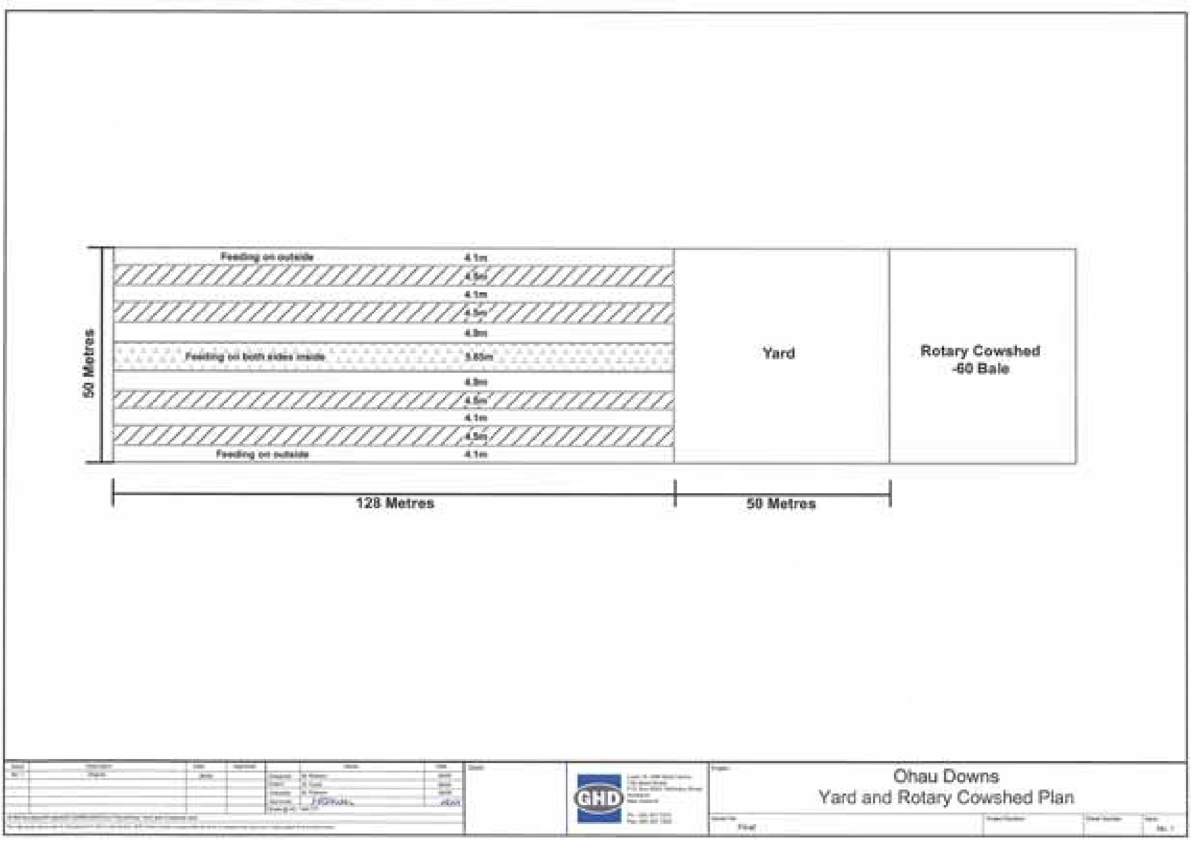
The chemical risks associated with the proposed farming system are that no provision for the safe storage, handling, using and disposing of chemicals has been made. *There will be similar risks in the alternative system*.

5. Proposed farm system with mitigations

The proposed farming system is an irrigated dairy farm with stock wintered on the farm using a cubicle stable system. The stock are planned to be housed full time for 6 months of the year and housed partially (12 hrs/day) for between 2 and 6 months of the year[2]. However, this system allows housing up to 365 days per year. The farm will primarily operate a cut and carry system to bring pasture to the herd in the barns. Pasture will be cut, conserved and fed to the herd throughout the year along with imported supplement (Englebrecht, 2009).

The layout of the cubicle stable is shown below in Figure 10. The plan view shows the milking sheds and yard on the right and the layout of the cubicles in the centre interspersed with alternative effluent lanes and feeding lanes. Effluent is scraped along the effluent lanes and into an effluent bunker to be separated and then stored (not shown), also draining to the effluent bunker are the silage clamps, also not shown. The whole unit is covered by a roof.

Figure 10 Proposed layout of the cubicle stables including silage clamp and effluent collection facility



An alternative system has been modelled based on an intensive beef and sheep until with dairy support and some arable cropping. This system was proposed by Bob Englebrecht as a potential alternative to

[2] Modelling has been based on six months nil grazing and 2 months restricted grazing.

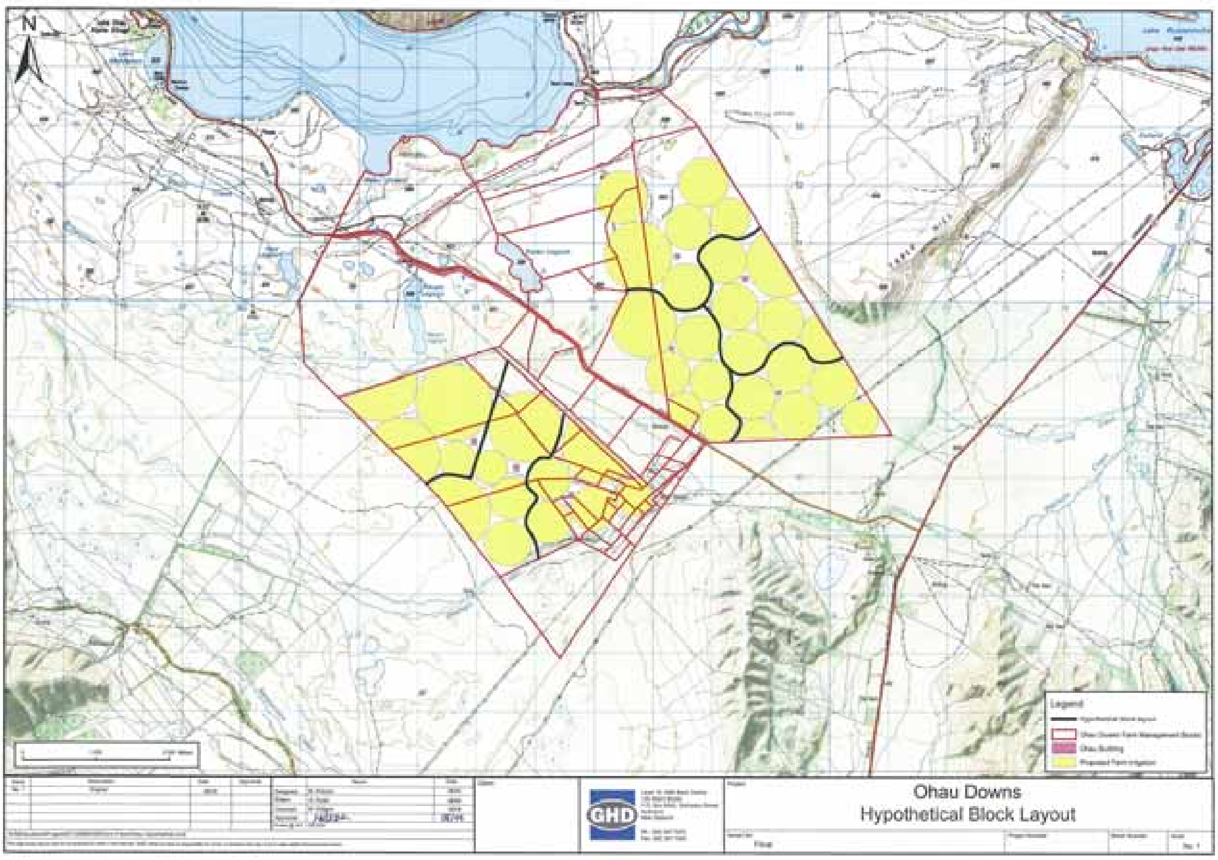
'Cubicle Stables', albeit with some concerns about the economics. The proposed system is approximately 7500 cows, and 5000 Merino sheep. The finishing beef will not over winter on the farm, but the dairy replacements will. These overwintered stock are modelled to spend part of the winter period on a feed pad to comply with the Mandatory Good Agricultural Practices for winter grazing management and supplement feeding.

5.1 Blocks

Seven independent management units are proposed on the property, each comprising approximately 285 ha and carrying approximately 1,000 milking cows.

In the alternative system, the farm would be run as a single enterprise.

Figure 11 Map showing proposed irrigation layout and farm management blocks on Ohau Downs (available as an A3 in Appendix F)



5.2 Soils

The FERA highlighted existing or potential soil issues arising from the vulnerable nature of the soils to erosion, the grazing of stock over winter and the possibility of trafficking soils when wet. The proposed management options or mitigations are:

Proposed irrigation and consequent full ground cover to protect the soil from erosion;

The housing of stock over the winter period to remove potential for soil damage from grazing stock in adverse conditions; and,

No trafficking of soils when wet, and as this is not always possible, the annual monitoring and identification of soil compaction in hydrologically connected areas and documented remedial actions taken.

In the alternative farm system, additional potential soil issues arise from the use of inversion tillage to establish crops, no provision to maintain or builds soil organic matter in arable soils and compaction arising from arable cropping. The proposed management options or mitigations are:

Use of direct drilling for establishment of crop (unless compaction necessitates more intervention)

Annual monitoring and identification of soil compaction in arable areas and documented remedial actions taken.

5.3 Stock

The dairy herds will consist of both Holstein crosses and Holstein cows, making in total a herd size of 7000 cows and at a stocking rate of 3.5 SU/ha. Young stock will be grazed off farm from weaning as will dry stock. Only milking cows will be present on the farm and milking cow numbers will be maintained throughout the year, and the farm will milk all year (B. Englebrecht, *Pers Comm*, 2009). The sheep flock will consist of 5000 SU and will mainly graze the dryland areas of the farm. The sheep flock (5000 SU) are expected to produce 22000 kg wool/year.

The FERA highlighted potential stock issues arising from the non-exclusion of stock from watercourses, , the partial grazing of stock over winter with no further provision for reducing these losses, and no provision for dealing with fallen stock. The proposed mitigation measures are:

The exclusion of stock from watercourses by planting and fencing dual function riparian margins. The outermost area of the margin will be densely planted to aid attenuate flow and promote infiltration and sedimentation. The periodically waterlogged inner area of the margin will be protected and maintained in t his waterlogged state to promote conditions favourable to denitrification. A minimum distance of 5 m from the outside bank of the watercourse has been agreed, although due to the meandering nature of the streams, the margins are usually greater than 5 m;

The closer management of the herd due to housing allows the feeding of animals according to their requirements (phase feeding);

All fallen stock to be collected; and,

The housing of stock over the winter period will mitigate winter stock nutrient losses.

In the alternative farm system, there will be approximately 7500 cows, comprising of dairy replacements (weaned calves through to 2 year old heifers) and a beef finishing enterprise where yearlings are brought onto the property over the later spring, summer and autumn and are sold off before winter. The sheep enterprise is predominantly on the dryland areas of the farm and comprises 3400 breeding ewes, with 750 replacement hoggets and the remaining lambs sold off the farm in May. Similar mitigation measures are recommended, however there is only partial mitigation of winter stock losses through stock being sold off the farm and remaining stock spending some hours every day over winter on a feed pad.

5.4 Production

The irrigated area will be under ryegrass /white clover, however clover levels may be depressed by the even and substantial return of organic manures unless cutting pressure is used to maintain levels (a medium level of clover is assumed). Pasture production is expected to be approximately 14 t dry matter/ha on irrigated and fertilised land. An 85 % pasture utilisation rate has been assumed on the irrigated land as the mechanical harvesting and feeding of silage in the cubicle stables will result in greater utilisation rates, and the lack of pasture damage from stock will enhance pasture production (Engelbrecht, 2009). Milk Solids production is expected to be approximately 400 kg MS/cow. The close management possible with housed herds will permit all year round calving and milking, taking advantage of the winter milk premium (Engelbrecht, 2009). *On dryland areas, a 60 % pasture utilisation has been assumed.*

In the alternative system, a lower pasture utilisation rate has been assumed, of 70 % on the irrigated areas and 60 % on the dryland areas, this is to reflect the losses due to damage from stock grazing and inefficiencies associated with grazing.

5.5 Manure, effluent and silage storage

5.5.1 Manure production

The stock are expected to be housed full time for 6 months and for 12 hours per day for at least 2 months. 7000 cows housed for this period will produce approximately 207,700 m^3 of effluent that will be stored in seven individual facilities of 30,000 m^3 and includes some dilution from parlour washings. However, no uncovered yards drain to the collection area.

In the alternative system approximately a third of the dairy replacements are modelled to spend 12 hrs a day on a feed pad between June and September. These yards are uncovered.

5.5.2 Manure handling

In the cubicle stables, alleys and other stocked areas will be regularly scraped down to deliver effluent to a sump at one end of the stables. From the sump, the effluent will be pumped to the effluent collection facility.

The FERA highlighted potential effluent issues arising from no clean and dirty water separation on the yards. The proposed management measure is:

<u>Clean</u> water will be separated in any uncovered yards and roof water either diverted and discharged to ground or collected and used.

In the alternative system the feed pad will be scraped and the solid fraction stored and spread back to the farm and the liquid effluent will be collected and sprayed onto the irrigated pastures during the growing season. All water from the feed pad is expected to be contaminated and should be treated as dirty water.

5.5.3 Manure storage

There will be seven months storage, 30,000 m^3 in lined facilities for the effluent. A freeboard of at least 750 mm will be maintained at all times.

In the alternative system, 5 months storage of liquid and solid fractions will need to be in place, and the freeboard requirement remains the same.

5.5.4 Manure application

Effluent will be applied through the centre pivots and the solid fraction left as pond sludge will be spread using a calibrated muck spreader. Effluent will be injected to irrigation water prior to being irrigated. Effluent will be applied at the most appropriate times for crop uptake, during active pasture growth in the spring and summer. Effluent application depth will be determined by soil moisture deficit and a minimum of 5.9 mm of soil moisture deficit will be maintained.

No effluent will be applied within 20 m of the watercourse. All applications will be recorded and accounted for when determining fertiliser requirements.

All applications will be recorded and accounted for when determining fertiliser requirements.

The FERA highlighted potential effluent issues arising from close to 200 kg /ha /year of organic N being applied. However, improved storage and prolonged housing may increase the effluent to be recycled to land. A total effluent loading rate of less than 200 kg/N/year permits this activity to maintain a consented activity status under ECan’s dairy effluent rules. This threshold is in compliance with the consent for effluent application lodged for this property.

The proposed management measures are:

To test effluent nutrient concentrations during spreading season, and record cumulative applications;

If applications indicate that more than 200 kg N of organic manure will be added should all the remaining effluent and solid manure be applied, the solid fraction will be exported; and,

A farm map showing no spread areas should be clearly displayed in the farm office and if effluent is spread by tractor, these should be carried in tractor cabs.

In the alternative system, the collected effluent will be applied back onto the irrigated pastures during the growing season at a low application rate and the solid fraction with a calibrated muck spreader. The same mitigation measures apply in the alternative system, however the loading from organic N will not approach 200 kg N/ha.

5.5.5 Silage

The FERA highlighted potential effluent issues arising from silage liquor not being collected and spread to land and that direct discharges are made from the silage pits. The proposed management option is that silage is stored on a concrete pad and drains to the effluent collection facility. The silage liquor will be recycled to land along with effluent[3]. Due to the unknown nutrient concentrations in the liquor, the effluent will be regularly tested during spreading and cumulative applications recorded.

5.6 Anticipated fertiliser use

Specific fertiliser recommendations will be produced on an annual basis using a recommended system. Plant nutrient supply will be estimated from both organic and inorganic fertilisers as well as N fixation

[3] The concrete will need to be an appropriate specification for containing silage as the liquor is highly corrosive.

using a nutrient budgeting system. The effluent and solid manure collected from the sheds will provide an important part of the nutrient requirement.

Nitrogen losses may occur during collection, storage and application and also when solid manure is applied, not all of the nutrients, especially the N will be immediately available. However these quantities would be sufficient to meet over half of the P and K requirements of a silage field with four cuts taken (MAFF, 2000).

Although a significant amount of N will be recycled, inorganic fertiliser will also be required. The P fertilisation strategy will be to build soil P concentrations to between 20 and 30 Olsen P (the agronomic optimum range), and to maintain them in this range. Full account will be taken of the organic fertiliser inputs of phosphorus through the use of a nutrient budget. The FERA highlighted potential fertiliser issues arising from more than 50 kg fertiliser N being applied in a single application, N applications occurring in autumn and winter, fertiliser spreaders not being calibrated and no suitable storage and filling area having been identified. The proposed mitigation measures are:

No N fertiliser to be applied in autumn and winter;

N fertiliser applications to be split to less than 50 kg N/ application;

Soil Olsen P levels to be maintained within agronomic target range at or below 30;

Fertiliser spreaders to be on-farm calibrated annually and optimised;

Fertiliser will be stored in a covered area;

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

If liquid fertiliser used, fertiliser will be stored in a bunded tank and also protected from vehicle movements.

The same mitigations and measures apply in the alternative system.

5.7 Chemical storage and management

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

Where chemicals are used on farm, these will be stored in a secure shed. Containers and foil caps will be disposed of as hazardous waste, or triple rinsed and disposed of as non-hazardous;

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

Sprayers will either be filled on a concrete yard draining to a sealed tank or a biobed or in the field. When filling, a portable bund will be placed beneath the induction hopper;

Back siphoning prevention measures will be used when filling sprayers, through the use of bowsers;

Tank washings will be resprayed to same fields ensuring no exceedance of dose;

Sprayer washdown area will drain to sealed tank or biobed and sprayers should be stored under cover; and,

'No spray' areas will be clearly marked on a map and displayed in the farm office and in the sprayer cabs. An emergency 'in case of a spillage' procedure should be clearly displayed in office, chemical store and sprayer filling area. A bucket of sand will be available in the sprayer filling area to be used on any spills.

The same mitigations and measures apply in the alternative system.

5.8 Cultivations and trafficking

After initial cultivation for the establishment of permanent pasture, little cultivation is expected. Re-establishment of pastures is not expected to involve inversion tillage.

The FERA highlighted potential soil risks arising from trafficking soil when wet.

The proposed mitigation measure is:

Compaction on hydrologically connected land caused by machinery movement will need to be identified on an annual basis between late autumn and mid spring, excluding times when land is frozen. Compaction is identified both through visual inspection (of the soil surface and plant stress indicators) and through testing for compaction using a soil penetrometer and digging verification pits. Identified compaction should be removed at the earliest opportunity with an appropriate technique for the depth of compaction.

*In the alternative system, an additional risk was identified from the use of inversion tillage to establish crops. The proposed mitigation is**:***

The use of direct drilling to establish crops (unless soil compaction requires more intervention).

5.9 Water and runoff

2,000 ha of the farm is planned to be irrigated at a rate of 600 mm/year, the proposed farm irrigation layout is shown in Figure 11. The source of the irrigation water is from Lake Ohau. In total, 38 centre pivots are proposed (26 full circle and 12 half to three-quarter circle). Final pivot design has avoided crossing watercourses were possible. Where this is not possible bridges will be in place for pivots and no effluent will be applied within 20 m of the watercourse. Full details of the irrigation water take, transport and application can be found in the Aqualinc (2009) (3 August, 2009).

The FERA highlighted potential runoff risks from the possibility of runoff from grazed areas reaching a watercourse, runoff from pivot tracks reaching a watercourse, stock access to watercourses and the grazing of stock over winter.

The proposed mitigation measures are:

Riparian fencing will prevent stock encroachment of waterways;

Dual function riparian zones will be planted up as detailed in Section 5.3, to attenuate and remove nutrients entering the waterways.

The restriction of stock access to waterways will require stock water facilities to be provided. However, due to the very restricted grazing system proposed, soils are not expected to be seriously damaged around troughs. Where damage does occur, this will be assessed during the annual soil compaction assessment, and remedial action taken if necessary.

The same mitigations and measures apply in the alternative system.

5.10 Biodiversity

Mitigation measures to protect ecology are discussed in full in Ryder Consulting (2009) and Mitchell Partnerships (2009). In brief, riparian planting and fencing is proposed to prevent stock access, enhance remaining ecological value through planting and protection of indigenous species shade waterways, provide cover and habitat for fish and invertebrates and stabilise banks. Measures to protect avifauna include controlling pest species and predators.

Riparian fencing will prevent stock encroachment of waterways and dual function riparian zones will be planted up as detailed in Section 5.3.

The same mitigations and measures apply in the alternative system.

6. Farm Environmental Management Plan for Ohau Downs

Table 4 below shows the all the mitigation and management tools that are proposed to be undertaken on Ohau Downs. 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 and that are not modelled within OVERSEER. 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 12.

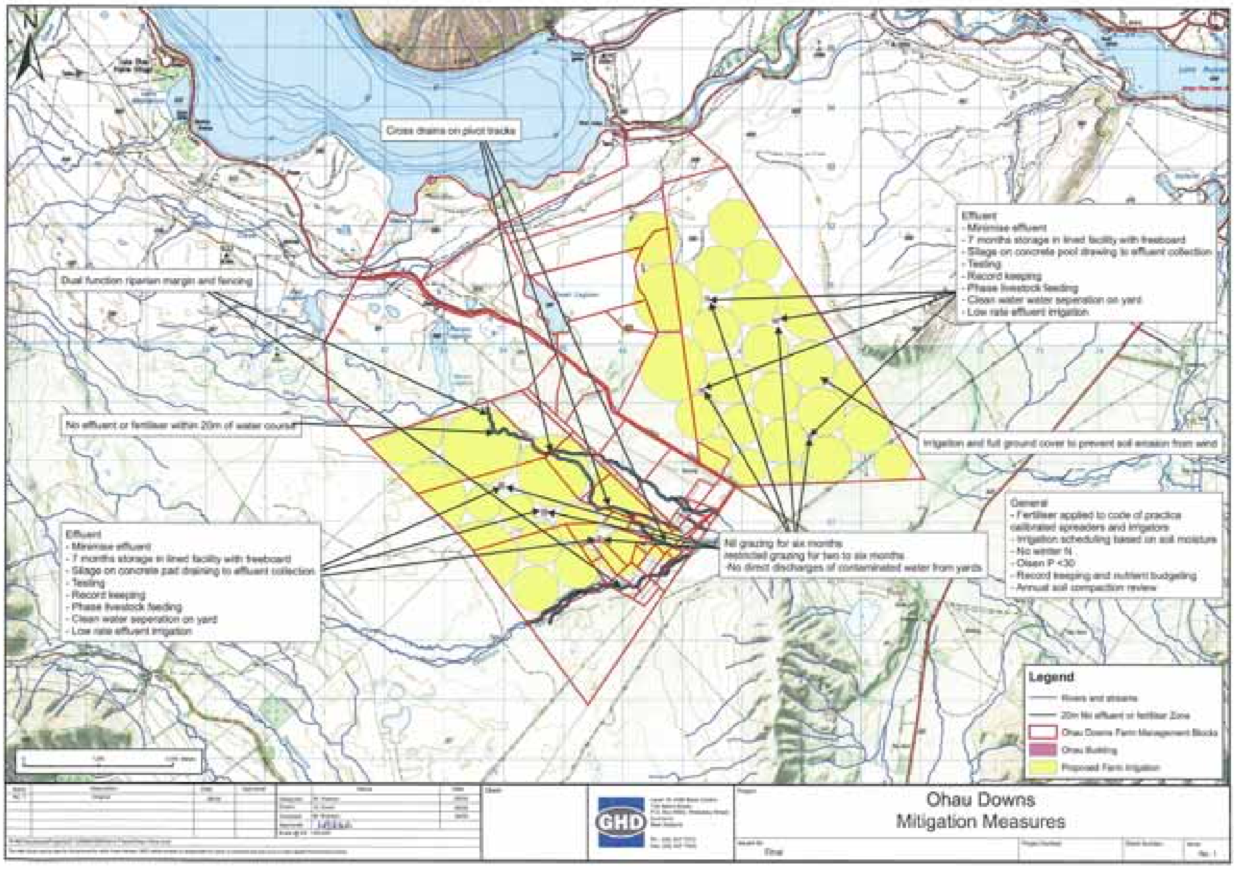
Table 4 Table of mitigation options, monitoring and auditing for Ohau Downs

FEMP stage	Measure	Monitoring	Auditing
1	Fertilisers applied according to code of practice for fertiliser use *(also for alternative system)*		Self certification
1	Accounting for all sources of nutrients including applied effluents and soil reservoirs *(also for alternative system)*	Soil and effluent testing and cumulative effluent inputs per management unit	Reconciliation of fertiliser, effluent and soil records with nutrient budget for example blocks. Submission of examples soil and effluent tests
1	Even fertiliser application *(also for alternative system)*	Calibrate and optimise fertiliser spreaders annually and every 5 years by an external auditor	Submission of testing and calibration
1	Even irrigation and effluent application *(also for alternative system)*	Calibrate and optimise irrigators annually in house and every 5 years by an external auditor	Submission of testing and calibration
1	Record crop, cultivation, nutrient inputs and yields per farm management unit *(also for alternative system)*	Upkeep of records	Submission of example block records
1	Good design of irrigation systems *(also for alternative system)*	Design of irrigation system by a certified professional	Irrigation system audited by a certified auditor every 5 years
1	Robust irrigation scheduling *(also for alternative system)*	Calculation of annual % effective water	Submission of annual % effective water use

FEMP stage	Measure	Monitoring	Auditing
		use	
1	Supplement and feeding out management *(also for alternative system)*	Not applicable as stock are wintered indoors. *(A feed pad is used in the alternative system).*	
1	Winter grazing management *(also for alternative system)*	Not applicable as stock are wintered indoors. (*Some stock are sold off farm before winter and a feed pad is used for some remaining stock I the alternative system).*	
2	Nil grazing for 6 months (*Not applicable in alternative system)*	Field records showing when restricted grazing starts and ends	Signed field records
2	Restricted grazing for at least 2 months (*restricted grazing through the use of a feed pad is used in the alternative system)*	Field records showing when restricted grazing starts and ends	Signed field records
2	Minimisation of effluent produced through separating and discharging clean water (*Not applicable in alternative system)*		Annual auditing visit. Photographic evidence of extent of roofing, diversion on any open yards and robotic milkers.
2	Fencing stock out of waterways through riparian fencing and planting *(also for alternative system)*	Surface water testing of race as it enters and exits the property	Annual auditing visit to check integrity of fence.
	Dual function riparian margins with a minimum width of 5 m *(also for alternative system)*	Annual wet weather survey to assess whether there is runoff through margins	Annual wet weather
2	No winter application of fertiliser *(also for alternative system)*	Field records	Signed field records
2	N fertiliser applications split to under 50 kg N/application *(also for alternative system)*	Field records	Signed field records
3	Effluent Storage *(also for alternative system)*		Storage volume calculation and plans submitted. Annual audit visit.
3	Low rate irrigation of dilute effluent *(also for alternative system)*	Irrigation scheduling and cumulative application records	Submission of example irrigation schedules and cumulative application records

FEMP stage	Measure	Monitoring	Auditing
3	Improved ground cover to protect from wind erosion on Isolation Flats *(also for alternative system)*	Annual quadrat testing for % cover in all blocks and photographs	Submission of testing results and photographs
3	Identify and remove soil compaction and consolidation in hydrologically connected areas*(also for alternative system)*	Annual soil compaction assessment of hyrologically connected areas. (*Annual soil compaction survey should include arable areas I the alternative system).*	Submission of assessment and remedials
3	Phase feeding of livestock (*Not applicable in alternative system)*	Feed ration monitoring	Submission of example of feed rations.
3	Clean water separated from roofs and any uncovered yards, collected and used or diverted discharged to ground.		Annual wet weather survey.
3	Silage stored on a concrete pad and draining to effluent collection facility. *(also for alternative system).*		Submission of silage clamp plans. Annual audit visit.
3	Silage liquor and effluent regularly tested for nutrient content in spreading season *(also for alternative system)*	Implicit within mitigation – accounting for all nutrient sources	Implicit within mitigation – accounting for all nutrient sources
3	Olsen P of below 30 maintained *(also for alternative system)*	Regular soil testing (every 3 years)	Submission of soil tests
3	Fertiliser stored in covered area *(also for alternative system)*		Photograph of storage area. Annual audit visit.
3	Identified fertiliser filling area will be at least 50 m from a waterway and will have no drains of direct discharges to ground *(also for alternative system)*		Photograph of filling area, and map showing drains and watercourses. Annual audit visit.
3	If liquid fertiliser is used, fertiliser will be stored in a bunded tank *(also for alternative system)*		Photograph of storage area. Annual audit visit.
3	Chemical storage and management *(also for alternative system)*		Submission of proof of 'approved handler' status
3	Prevention of runoff from pivot tracks entering waterway through series of cross drains approaching the waterway *(also for alternative system)*	Annual wet weather survey to assess whether there is runoff.	Photographic evidence of cross drains. Submission of wet weather survey results and remedials

Figure 12 Annotated map with key mitigation options and locations on Ohau Downs (available as an A3 in Appendix F)



6.1 Monitoring and Auditing

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

Table 4 above shows the monitoring suggested for the mitigation and management options chosen for Ohau Downs. Table 5 below shows the frequency and parameters for the monitoring, and Figure 13 shows these monitoring points on a map of the property.

Additional monitoring will be carried out in conjunction with other farmers in the sub-catchment by Mackenzie Irrigation Company, on a sub-catchment basis on the Wairepo Creek, the Ahuriri River, in the Ahuriri Arm and Northern Arm of Lake Benmore, and in the Wairepo Creek and Ohau River groundwater sub-catchments.

Detailed groundwater modelling has been conducted for the farm and the modelled nitrate contribution from Ohau Downs to groundwater concentrations have been modelled for 5, 20 and 30 years. These outputs are shown in Appendix B. The maximum modelled contribution from Ohau Downs to groundwater nitrate concentrations after 5, 20 and 30 years, is 0.7 mg/l nitrate-N. The concentrations have been modelled without the dilution of seepage from Lake Ohau.

Table 5 Location, frequency and parameters for monitoring on Ohau Downs

		Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
Soil	Soil nutrient testing	All blocks in rotation	1 in 3 years	Standard suite of soil nutrients, C, N and organic matter	Olsen P of 30	Reduce or stop addition of P fertiliser to area and monitor.
Soil	Soil compaction survey	All hydrologically connected blocks (and arable blocks under the alternative system)	Annually	Surface and subsoil compaction	Compaction, surface capping	Remove compaction with appropriate tool.
Soil	Wet weather survey	All blocks	Annually	Runoff from centre pivot tracks	Runoff occurring	Immediately review current runoff mitigation options for pivot tracks. Introduce further runoff removal infrastructure.
Effluent	Irrigated effluent nutrient testing	All blocks receiving effluent	Regularly throughout spreading season	Total N, nitrate, ammonia, dissolved reactive phosphorus, BOD	NA	
Effluent	Cumulative effluent application	All blocks receiving effluent	Record each time effluent is applied	Application depth	200 kg effluent N including solid fraction	Store until exportation can be arranged. Export enough to maintain application at less than 200 kg.
Water	Groundwater quality	Any farm bores	Annually at mid depth of aquifer	Total Nitrogen, nitrate, ammonia, total kjeldahl nitrogen, total phosphorus, dissolved reactive phosphorus.	> 2 mg/l nitrate-N from current modelled baseline conditions	If groundwater analysis indicates an excedence of 2 mg/l above current modelled baseline, the N application to land should be reduced or stock withheld for longer until a root cause analysis can be conducted.

		Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
Water	Surface water quality	Entry and exit of Six Mile Creek and Wairepo Creek on property boundaries.	Monthly for first couple of years to establish patterns	Total Nitrogen, nitrate, ammonia, total kjeldahl nitrogen, total phosphorus, dissolved reactive phosphorus, suspended solids.	No significant decrease in water quality	If comparative surface water analysis indicates a decrease in surface water quality, the degraded determinands should be identified, as these may indicate the likely cause of the contamination, while a full root cause analysis is undertaken. If the determinands suggest effluent, then effluent irrigation should cease on the implicated pivots. If the analyses indicate stock encroachment, the stock should be withheld from the connected paddocks.
Water	Irrigation application		Annually in house and 1 in 5 years by an independent	Application uniformity	>80 %	Optimisation of the irrigator performance will be performed at the time of testing.
Fertiliser	Fertiliser application		Annually in house and 1 in 5 years by an independent	Application uniformity		Optimisation of the spreader performance will be performed at the time of testing.
Pasture	Ground cover	Isolation Irrigated block	2 x per year until full cover	% Ground cover	>80%	Soil nutrient and compaction testing should be performed to identify possible causes if unexplained by management.

Figure 13 Map showing location of monitoring points on Ohau Downs (available as an A3 in Appendix F)

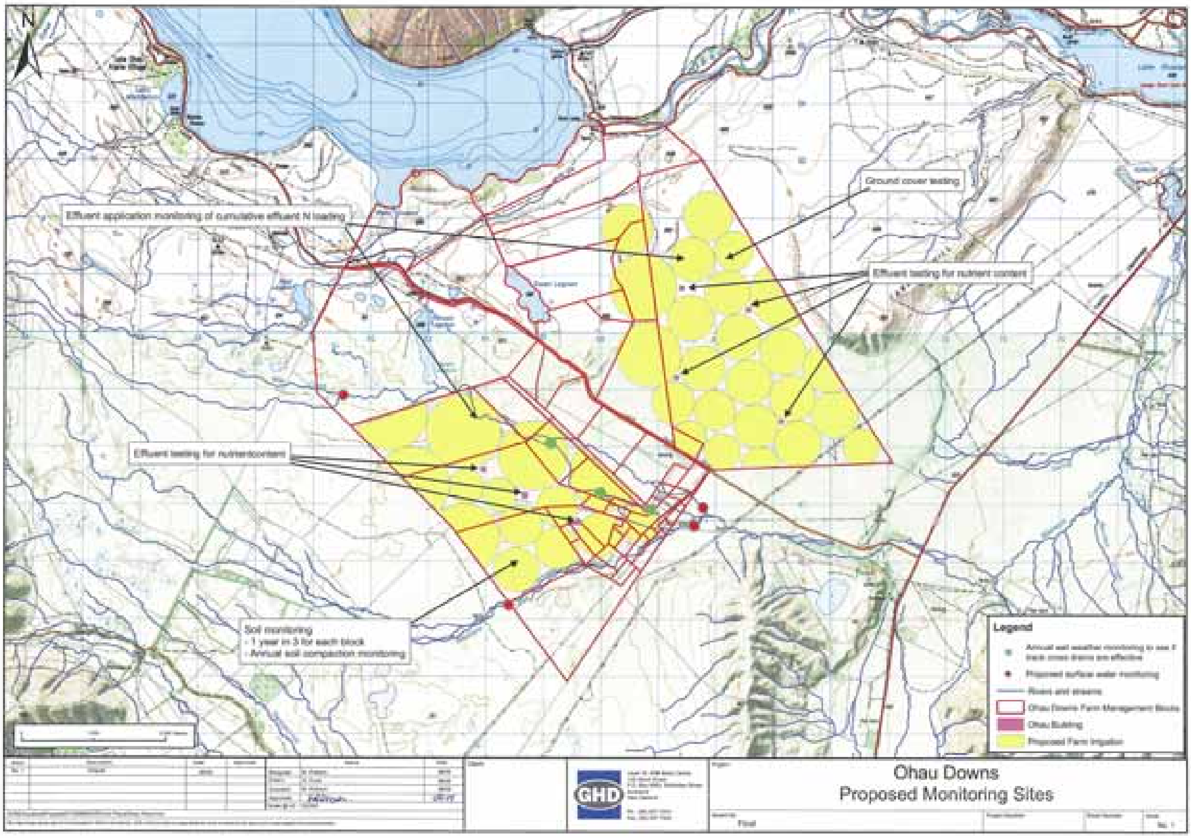
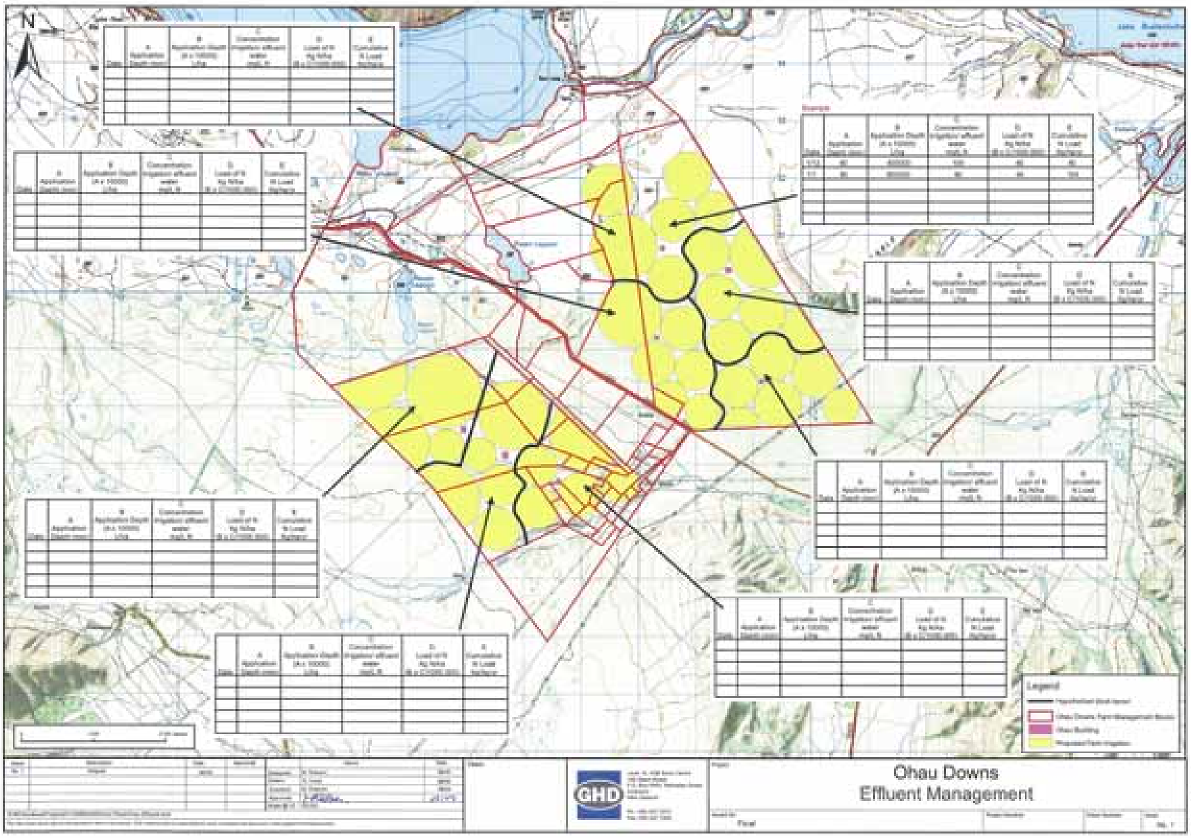


Figure 14 Map showing block effluent applications and cumulative loading on Ohau Downs



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 5, 6 and 7.

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 at the time of trigger breach?

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 you regional council:

Environment Canterbury 0800 76 55 88

6.1.1 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 below shows the proposed contents of an annual audit report for Ohau Downs.

Table 6 Table showing proposed contents of an annual audit report for Ohau Downs

Audit measures	Action in the case of non-compliance
Additional auditing that must be done externally	
Check the clean and dirty water separation methods in and around the cubicle stables, parlour and yards, plus photographs *(not applicable in alternative system)*	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 cubicle stables, parlour and yard area (*discharges from feed pad in the alternative system)*	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 riparian planting and fencing is present where it should be and that it is intact, plus photographs *(also for alternative system)*	Any failure in the integrity of the fencing should be repaired immediately or a barrier placed around gap to prevent stock access until repair is made
Check the storage of liquid fraction for visible signs of discharge and maintenance of freeboard. When empty, the integrity of the lining should be checked and repairs made if necessary. *(also for alternative system)*	Any uncontrolled discharge of effluent must be stopped immediately. If a failure of the lining is suspected, the store must be pumped out and the lining inspected and repaired if necessary The freeboard should be maintained at all times.
Check the storage of silage for visible signs of discharge and destination of silage liquor *(also for alternative system)*	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 *(also for alternative system)*	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.
Annual audit of OVERSEER nutrient budget and report based on previous 3 years. Submission of compliance with thresholds *(also for alternative system)*	Should the OVERSEER report show losses exceeding the threshold, further mitigations should be adopted to effect a reduction in nutrient loss to below thresholds.
Fertiliser spreader, muck spreader and irrigation testing and calibration 1 in 5 years by independent auditor *(also for alternative system)*	Spreaders and irrigators not performing should be recalibrated

Audit measures	Action in the case of non-compliance
Additional auditing that can be done either externally or internally	
Reconciliation of fertiliser, effluent and soil records with nutrient budget and fertiliser recommendations *(also for alternative system)*	Where reconciliation is not possible and an over application has occurred, this should be rectified in the following year
Submission and brief interpretation of soil, effluent, water quality, supplement and machinery calibration tests *(also for alternative system)*	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.
Submission of field records demonstrating fertiliser and effluent practice and nil and restricted grazing periods *(not apllicable for alternative system)*	Where field records show variation from proposed nil and restricted grazing, changes must be justified and the farm shown to remain within threshold limits, or the practice must revert to the proposed system
Submission of silage clamp and effluent storage design plans *(also for alternative system)*	Once approved, the plans need only to be submitted once
Submission of example irrigation schedules and calculated water use efficiency *(also for alternative system)*	Where calculated water use efficiency is such that the trigger is exceeded, remedial action of how the system is to be optimised should be submitted, and followed up in the next audit
Annual quadrat testing for % ground cover, submission broad findings *(also for alternative system)*	Where poor groundcover is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual soil compaction survey, submission broad findings and remedials *(also for alternative system and including arable areas)*	Where poor soil structure is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual wet weather survey, submission broad findings and remedials *(also for alternative system)*	Where runoff is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual fertiliser spreader and irrigation testing and calibration in house *(also for alternative system)*	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 *(also for alternative system)*	Any failures in observing the code of practice for applying fertiliser should be rectified and followed up in the next audit
Submission of proof of 'approved handler' status *(also for alternative system)*	Inappropriate handling of chemicals should cease until an approved handler is in place

7. 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 Table 4 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 Sections 4 and 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 Sections 5 and 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. References

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Appendix A

WQS ground and surface water sub-catchments for Ohau Downs

Appendix B

Detailed groundwater modelling for Ohau Downs

Appendix C

Farm Environmental Risk Assessment

Appendix D

OVERSEER Input Parameters

Appendix E

OVERSEER Output Data

Appendix F

A3 Maps

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Document Status

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