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# Financial impact of the Waikato Regional Plan nitrogen cap on Taupo farmers

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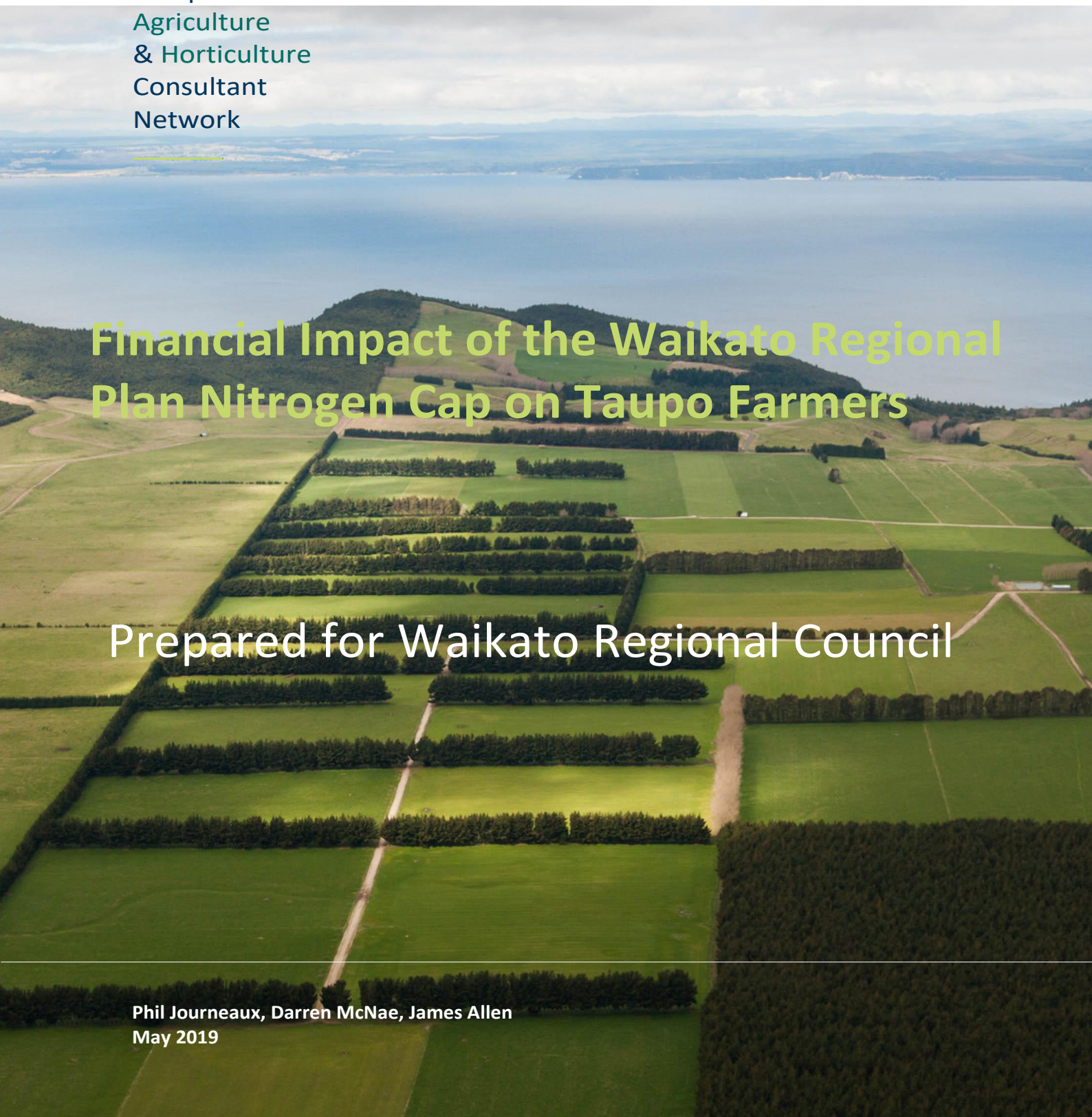

# Financial Impact of the Waikato Regional Plan Nitrogen Cap on Taupo Farmers

## Prepared for Waikato Regional Council

**Phil Journeaux, Darren McNae, James Allen**
**May 2019**

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# 1.0 Executive Summary

The objective of this study was to undertake an analysis as to the impacts of the nitrogen cap on farmers within the Taupo catchment, and modelling of future long-term impacts. The questions required to be addressed are:

1. What has been the financial impact to date of the nitrogen cap imposed by the Waikato Regional Plan Taupo land use rules on farmers in the Taupo catchment?
2. Has the ability to trade nitrogen discharge rights reduced the financial impact on Taupo farmers?
3. If some farmers have been more impacted than others by the nitrogen cap, what factors may explain this?
4. What financial impacts may the nitrogen cap have on farmers in the Taupo catchment, both current and future, over the coming 20 years?
5. Given the findings with respect to the above questions, what conclusions can be drawn about the potential future impact of nitrogen restrictions on farmers across the Waikato region?
6. Does the research suggest any further research or policy analysis that could usefully inform discussions about regulatory responses to nitrogen leaching from farming?

The methodology involved:

- A literature review;
- Workshops with the Taupo catchment farmers;
- Information on land values, and changes over time, both within and outside of the catchment was collated and analysed; and
- A workshop with WRC staff to discuss the results.

## 1.1 Financial impact

The financial impact of the nitrogen cap was analysed across various aspects:

(i) Impact on farm working expenses. As a generalisation, the rate of increase in farm working expenses across farms in New Zealand over time is greater than the rate of increase in farm income. This is the classic 'cost/price' squeeze which has affected New Zealand farming for many decades.

Within the catchment, there was insufficient information available to readily determine if the nitrogen cap was having any additive impact on this issue.

(ii) Compliance costs. There has been an increase in compliance costs for the catchment farmers, with respect to:

- Cost of consenting.
- Time cost to farmers and/or staff in monitoring and annual audits.
- Annual monitoring cost to Waikato Regional Council.
- Cost of employing professions (consultants, accountants) to assist in the annual monitoring/audit process.

This compliance cost is often exacerbated for the Māori farming entities, given their governance and multiple-ownership structures.

The total cost of this, as a Present Value discounted at 6% over 20 years, is $4.7 million.

(iii) Impact on land value. Analysis of the farm sale data from within and outside of the catchment indicates that the farms within the catchment are selling at 7-14% less (depending on size and type) than similar farms outside of the catchment. The total cost of this differential is $151.4 million.

Interestingly, regression analysis found no relationship between NDA level and farm value; obviously there are a range of other factors influencing land value apart from the NDA level. A key aspect of this could well be the *perception* that the nitrogen regulations will affect farm profitability.

(iv) Opportunity costs. This was essentially split into four aspects:

(a) The opportunity cost of not being able to convert the land into a different, more intensive farm system, e.g. into dairying. Within this there are two aspects:

- Pasture conversion. An estimated 10,000 hectares of current pasture land could be converted into dairying. The opportunity cost of not being able to do this, as a Present Value, is $69.4 million.
- Forestry conversion. This is more problematic, as the cost of converting out of forestry is now very expensive, exacerbated by the carbon tax under the Emissions Trading Scheme. Any conversion into a pastoral system mostly results in a negative figure, hence no opportunity cost.

This may not necessarily be so for conversion into housing or possibly some horticultural options, but these need to be assessed on their individual merits.

(b) The opportunity cost of not being able to intensify the existing farming operation, and the loss of some flexibility in the farming system, especially not necessarily being able to take advantage of short-term opportunities. This was the most significant issue raised by the farmers, and the estimated Present Value of this opportunity cost is $144 million.

(c) Many farms are operating slightly below their NDA level; many did so as a natural hedge in the sense they did not want to breach their NDA, the annual accounting of which is done retrospectively, and in some instances as a means of retaining some flexibility to take account of opportunities if/when they arose.

In the 2016/17 year, the aggregate under-utilisation of NDA amounted to 80.5 tonne, or 8.4% of the total allocation. This is a direct opportunity cost to the farmers, with an estimate value of $33.8 million.

(d) Variation 5 also included an allowance of 11 tonne of nitrogen for the development of undeveloped Māori land. In the event this allowance expired largely unused, and the issue is currently under discussion between WRC and Ngati Tuwharetoa.
If the 11 tonne is not used, it represents an opportunity cost estimated at $0.59 million (being the value of the nitrogen less the development costs of converting the land to pastoral farming).

If the 11 tonne is eventually used, then no opportunity cost arises.

(v) Part of Variation 5 involved the removal of the 20% of manageable nitrogen (accounting for approximately 7% of total nitrogen inflow into the lake). Achieving this was the primary responsibility of the Lake Taupo Protection Trust, whose total cost was $81.5 million.

While this was not a financial cost to the farmers, it is an additional cost of achieving the nitrogen cap.

A summary of the various costs calculated are:

| | **$ million** |
|---|---|
| Land value differential | 151.4 |
| Opportunity cost of: | |
| ➢ not intensifying existing farming system | 144 |
| ➢ no land use change | 69.4 |
| ➢ not fully utilising NDA nitrogen | 33.8 |
| Increased compliance costs | 4.7 |

It is important to note that all these costs are **not** necessarily cumulative. Economic theory would indicate that the opportunity cost of not being able to intensify production, or change land use, is a component of the land price. In essence, theory indicates that a potential purchaser would take into account the lack of opportunity to intensify and/or change land use and adjust their purchase price accordingly.

The overall estimated net cost of the nitrogen cap to farmers within the Taupo catchment therefore is:

| | **$ million** |
|---|---|
| Land value differential | 151.4 |
| Opportunity cost of not fully utilising NDA nitrogen | 33.8 |
| Increased compliance costs | 4.7 |
| **Total** | **189.9** |

## 1.2 Ability to trade nitrogen

The nitrogen trading regime is seen as a very useful tool, with analyses done by various authors indicating that it has been quite successful, a lesson that could be applied elsewhere.

Has it reduced the financial cost to farmers in the catchment? Basically, the answer is yes, in the sense that it has, for some farmers, increased the flexibility of their farming systems and/or allowed more intensive farming systems.
The trading system also appears to be moving towards more of a short-term leasing approach, which again is assisting in increasing the flexibility of farming systems, particularly allowing for some short term unders and overs. In some ways this is a de facto 'rolling average' approach, in the absence of an actual rolling average annual NDA.

For some farmers though, the sale of nitrogen has adversely impacted on their farming systems, largely due to them not understanding, or investigating, the implications prior to sale. The result has been a relatively low NDA, which has limited the farming operation.

## 1.3 Have some farms been impacted more?

On the basis that the cost/price squeeze continues - a reasonable assumption given the last 50 years in New Zealand, it is the smaller and/or lower NDA farms which are likely to feel the financial pinch earliest.

This is difficult to readily quantify in the absence of case study information. But largely reflects the restriction on land development/farm intensification as a result of the nitrogen cap. In some ways this is an ongoing issue across all of New Zealand farming, where smaller farms have amalgamated up to endeavour to achieve an economy of scale.

How soon the nitrogen cap impacts on these smaller/low NDA farms would depend on the characteristics of the farm, and especially their financial structure; any that were heavily indebted, for example, are likely to be impacted earliest.

The most likely outcome over time could be:

(i) The farm continues, subsidised by off-farm income

(ii) Is sold to/amalgamated into a larger unit

(iii) Land use change - possibly to horticulture

(iv) Subdivision

## 1.4 Ongoing viability

What are the financial impacts of the nitrogen cap over the coming 20 years? Again the answer to this is difficult to quantify, as there are many factors which will influence this.

A key aspect to this is commodity prices received by the farmers; while these have improved in recent years, it remains to be seen how long this will be maintained. The long-term trend has been for a steady fall in the real price of commodities, which accentuates the cost/price squeeze. The Taupo catchment farmers are additionally caught in the sense that they cannot simply intensify their farming systems or bring more land into production, in order to counter falling prices.

One approach to counter this has been Taupo Beef, seeking a higher premium for their product, as an offset to the cost of not intensifying. How well this approach will work on a larger scale remains to be seen.
Another factor is the dynamic nature of farming, meaning farm systems and technologies are forever changing and adapting. The nitrogen cap was imposed in 2005; any farmer who is still using 2005 technologies and management systems is likely to feel the pinch much sooner than farmers who have changed their approach.

From the farmer discussions it would appear that some farmers are handling the new environment well, while others are struggling, largely dependent on their knowledge and understanding of the impacts of the nitrogen cap at the time, which is perhaps a reflection of any cross section of the community.

Given the situation that the Taupo catchment farmers face, the options going forward, other than a yet to be discovered new technology, would include a mix of the following:

(i) Conversion of land to a higher profitability/lower nitrogen leaching activity. While some options are indicated in this report, none offer an immediate panacea, and are yet to be commercially proven in the Taupo environment;

(ii) Increased returns for the product, to offset the increased costs. Which is essentially the route being taken by the Taupo Beef and Lamb farms; and/or

(iii) Improve the productivity of the farm business within the nitrogen cap. The ability to achieve this is very much a farmer aspect and takes time to achieve.

### 1.4.1 Land values

The impact on land values within the catchment has already occurred, and the probability of any further reductions relative to land outside of the catchment is unlikely unless a further reduction in nitrogen leaching is required. If anything, land values outside of the catchment are likely to adjust downwards as the impact of other Council plans unfolds.

In noting this, there are a number of key drivers of land values, and land values both within and without the catchment are likely to vary depending on these factors.

## 1.5 Extrapolation across the rest of the Waikato

The potential future impacts of nitrogen leaching restrictions across the wider Waikato region are likely to be much the same as those faced by the Taupo catchment farmers:

(i) Land values are likely to reduce.

(ii) Farmers will face opportunity costs with respect to not being able to intensify their farming operations and have reduced flexibility to adjust to short-term opportunities.

(iii) Compliance costs will increase.

(iv) Farmers are also likely to operate below their NDAs as a natural hedge against exceeding the NDA level, and as a means of maintaining some flexibility.

(v) Smaller farms and those with low NDAs are likely to feel the financial pinch the earliest.

(vi) There is likely to be an increase in the area of production forestry.

As discussed in the report, the impact in Taupo was effectively 10 years ahead of the rest of the region.

It is difficult again to be too definitive, as the wider Waikato region does offer a much larger scope for land use change into horticultural options; the Waikato region has the second largest absolute and proportional area of high-quality soils (i.e. LUCs 1,2,3) in New Zealand and a range of climatic areas. All of which does offer a wider range of horticultural possibilities relative to the Taupo catchment.

The end result is likely to be a more mixed land use across the landscape, although the individual farms/orchards will still be monocultures, as this is dictated by economic necessity.

## 1.6 Further research and policy analysis

(i) The key factor within this analysis is the financial cost to the farmers within the catchment. Would this have been useful at the start of the process? Probably, but it would have been difficult to quantify, as the impacts take time to manifest themselves, and are heavily influenced by farmer behaviour, which in itself takes time to adjust. Would knowing the results in advance change the decision to cap nitrogen leaching? No. As discussed in this report, much of the land use carried out in New Zealand up until recent decades, did not readily take into account environmental impacts. This is now changing, and environmental externalities are being costed into our land use decisions. Although, having an idea of the cost does assist the debate around trade-offs.

If land uses are to be 'nutrient discharge limited' (and quite probably 'carbon discharge limited') then one of the main requirements is for the land owners affected to know what options are available, and the implications of these, to achieve the new limits.

Which is perhaps one of the main areas for research and analysis; what are the options that land owners can pursue in order to reduce their environmental impact? This is probably more of an industry/central government requirement rather than Regional Councils, but the latter have a role in pushing for the research to be done.

(ii) For the Council, understanding the drivers behind the financial cost would be useful in considering policy and regulations. While there is probably little that could be done directly to mitigate the restriction on intensification, apart from options and system research as noted above, there could be things that could be done to assist in the flexibility of the farming system within the nitrogen cap. Examples of this, using the Taupo catchment as an example:

(a) Overseer version. While there were good reasons for deciding on a set version of the model, its limitations are now well known, particularly the limit on the model accepting mitigation strategies. The policy issue here, apart from the specific issues with the version of Overseer, is that if a model is to be used, what are the likely implications as a result of farm system change and new technology, as well as changes in model version? For this later aspect, a discussion with Bay of Plenty Regional Council as to their 'relativity' process for handling Overseer version changes for their Plan Change 10 would be worthwhile.

(b) Flexibility around NDA levels between years. Currently the annual NDA accounting system does result in some reduction in flexibility and is one of the drivers in the 'NDA undershoot'. As discussed in the report, a five-year rolling average, as mooted for PC1, would directly assist in helping flexibility between years, and is taking advantage of short-term opportunities, notwithstanding it would also impose a discipline of its own - an over would have to be followed at some stage within the five years with an under.

Some policy analysis would help in developing a system which could directly assist in implementing such a rolling year average system.

(c) Directly associated with (b) would be the concept of 'sharing' stock between two farms for a defined period. As discussed in the report, if Farm A in the catchment has surplus feed and Farm B is short of feed, then there needs to be a mechanism whereby stock from Farm B can be grazed on Farm A, and the increase in nitrogen leaching on Farm A can be offset against the decrease on Farm B.

This same mechanism could also be used for stock grazing fire breaks/electricity pylon corridors within a forestry block, assuming the stock originated from a farm within the catchment.

(d) Part of the issue around flexibility is that the annual NDA audit is retrospective. Another factor which would assist would be to monitor the NDA in real time, which would involve modelling the impact on the NDA of any management changes at the time they are thought of, so that the farmer understands the nitrogen leaching implications of what is proposed and can therefore better farm to their NDA. In many respects this is a farmer responsibility, but the council does have a role via education, as noted below.

In short, council needs to undertake some analysis as to how it can improve farm system flexibility, while the farms involved, or the wider catchment, still operate within the overall cap. A significant opportunity cost to the farmers was via operating below their NDA, driven by a

variety of reasons, of which concerns around flexibility was a major aspect. The issues outlined above would all help to alleviate this cost.

(iii) Another area is farmer education. It is apparent that some farmers have adapted much more readily to the new regulatory regime than others. In noting this, councils should not underestimate the level of support and knowledge transfer that is required for probably 25% of farmers in any region - the top 25% will understand the science and rules and make the most of opportunities, the middle 50% will carry on doing what they have always done and the bottom 25% will not understand the rules and long-term impacts and are at significant risk of making poor decisions.

This is not necessarily a council-only role; industry and central government have a distinct role to play in this as well, but again council is in a position to help force the issue.

(iv) Trading in diffuse discharges of nitrogen within the Taupo catchment is a world-first and has been quite successful. Another area for council analysis would be to look at how this can be transferred to other catchments and areas.

In the same vein, short-term leasing is becoming more prevalent, especially as a means to help farmers manage nitrogen more flexibly. Some research would be useful in looking at how the council can support this, particularly in making the leasing easier and less costly from a compliance view-point.

Also as discussed, the advent of trading means that nitrogen in the form of an NDA is now a capital asset, and farmers need to understand this. This is important in that farmers within a constrained catchment need to understand the difference in value of investing in more nitrogen compared to investing in more land or other investments. Again this is part of the farmer education aspect.

# 2.0 Objectives

The Waikato Regional Plan provisions for the protection of Lake Taupo (Chapter 3.10) are currently being reviewed. The Draft Issues and Options paper for this review noted that: "Grandparenting allowed farmers to continue farming as they had before the nitrogen cap. However, because the cap acts as a constraint on production, and due to a lack of profitable low nitrogen leaching alternative land uses, as costs rise over time it will become more difficult for current activities to remain profitable."

The objective of this study is to undertake an analysis as to the impacts of the nitrogen cap on farmers within the Taupo catchment since the cap was established, and modelling of future long-term impacts. The questions required to be addressed are:

1. What has been the financial impact to date of the nitrogen cap imposed by the Waikato Regional Plan Taupo land use rules on farmers in the Taupo catchment? Note that in seeking to answer this question, it is expected that some account will be given of the trends in farm income, expenses and land value in the Taupo catchment, and comparison with trends outside the catchment where there is no nitrogen cap.
2. Has the ability to trade nitrogen discharge rights reduced the financial impact on Taupo farmers?
3. If some farmers have been more impacted than others by the nitrogen cap, what factors may explain this?
4. What financial impacts may the nitrogen cap have on farmers in the Taupo catchment, both current and future, over the coming 20 years? This should include consideration of how changes in profitability might affect land values, and the consequent implications for the ongoing financial sustainability of pastoral farming in the Taupo catchment.
5. Given the findings with respect to the above questions, what conclusions can be drawn about the potential future impact of nitrogen restrictions on farmers across the Waikato region?
6. Does the research suggest any further research or policy analysis that could usefully inform discussions about regulatory responses to nitrogen leaching from farming?

**Note:** The purpose of the study is to highlight the financial impact on the farming community. This does not involve any calculation of any environmental benefits.

# 3.0 Methodology

The methodology for the analysis was:

(i) Review of relevant literature.

(ii) Workshops with Taupo farmers, split as follows:

(a) Farm owners

(b) Māori owned entities, both managers and governance.

While this division was somewhat arbitrary, it was based around:

- The need to have relatively small groups at the workshop to enhance discussion.
- While there are many similarities, there are some differences in outlook between European and Māori land owners, particularly around the issue of land value.

(iii) Financial information on expenses and income was sought from the farmers.

(iv) In addition, a range of questions/topics were proposed (Refer Appendix 1) and included in the invitation letter to the farmers to consider prior to the workshops.

(v) Following the workshops, the information provided was analysed and compared with wider industry information.

(vi) Information on land values, and change over time, both within and outside of the catchment was collated via Telfer Young, Valuers, Rotorua.

(vii) Following provision of a draft report, a workshop was held with WRC staff to discuss the results.

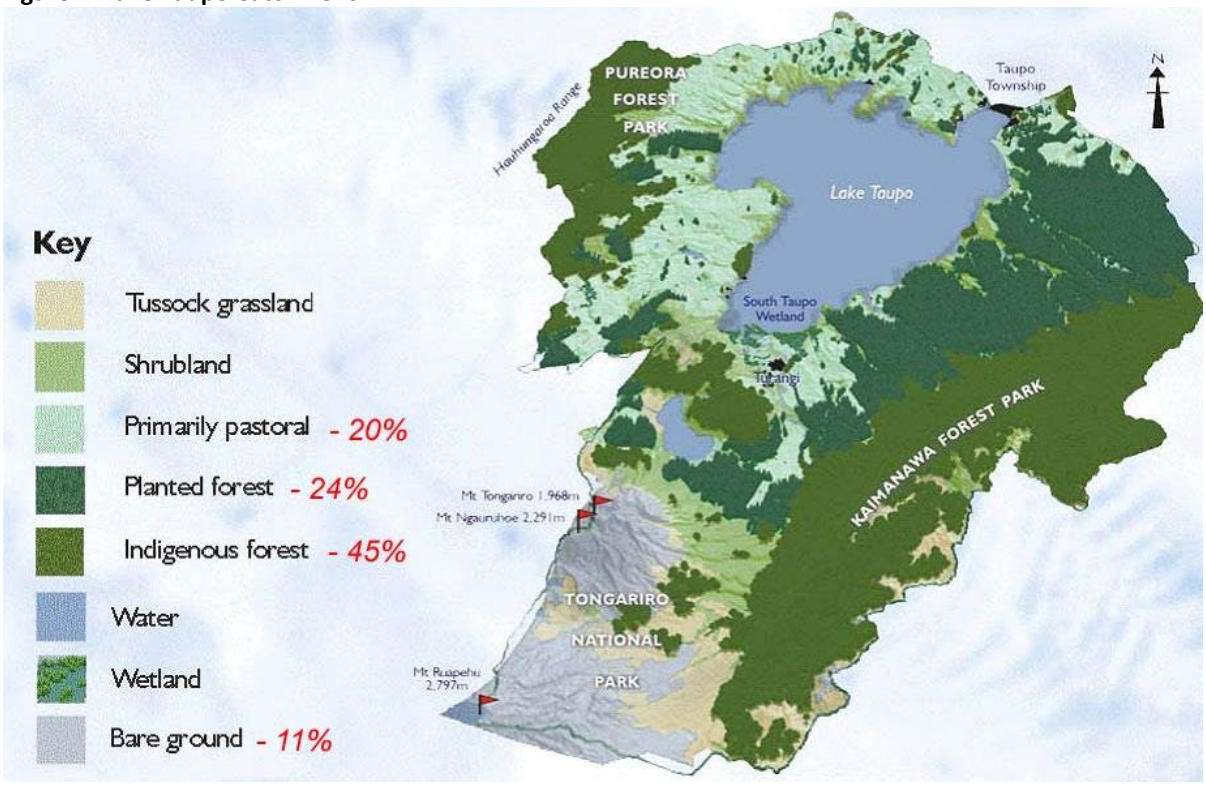
(viii) Following which the final report was produced.

# 4.0 Background

Taupo District is situated in the central area of the North Island and covers an area of 6,970 square kilometres. Dominant features of the landscape are the volcanic cones to the south of the district, and Lake Taupo which covers an area of 616 square kilometres. The topography of the district is generally hilly to rolling land, with the soils being volcanic ash overlaying pumice. These soils are infertile in their natural state, free draining, and prone to erosion.

Within this is the Lake Taupo catchment, covering 3,487 square kilometres, including the lake. Approximately half the catchment remains in native vegetation, with much of this managed by the Department of Conservation.

**Figure 1: Lake Taupo Catchment**




Source: Waikato Regional Council

The main period of land development into pasture occurred from the 1970's onwards, particularly under the aegis of central government agencies - Department of Lands and Survey, and Department of Māori Affairs. By 2002 there were 525 square kilometres in pasture (Yerex, 2009).

The New Zealand Government was the largest landowner within the catchment, holding 45% of the land (refer Table 1 below), with Ngati Tuwharetoa (the acknowledged Tangata Whenua for the catchment and kaitiaki for the Lake) having the second largest holding at 40%. Subsequently the Government has sold its sheep and beef farms[1] to private buyers.

**Table 1: Land use in Lake Taupo Catchment by ownership, at 2005**

[1] Previously held by Landcorp

| Land-use | Tuwharetoa Land (ha) | Crown Ownership (ha) | Private Ownership (ha) | Total |
|---|---|---|---|---|
| Undeveloped | 50,840 | 103,660 | 0 | 154,500 |
| Planted forests | 35,500 | 4,300 | 24,700 | 64,500 |
| Sheep and beef | 23,800 | 14,800 | 12,100 | 50,700 |
| Dairy | 778 | 0 | 1,022 | 1,800 |
| Urban | 0 | 0 | 3,500 | 3,500 |
| **Total** | **110,918** | **122,760** | **41,322** | **275,000** |

From Yerex 2009, Spicer 2017

Water quality within the lake was/is of a very high standard and monitoring of the lake water quality, which began in 1994 (in Edgar, 1999) started to show a deterioration in water quality, which was largely linked to the pastoral farming development within the catchment.

In 1998 the (then) Parliamentary Commissioner for the Environment published a report outlining the impact agriculture was having on the environment, which was followed in 1999 with results from the water quality monitoring showing a definite deterioration in quality, coupled with a major threat of increased dairy expansion within the catchment. At the time, approximately 37% of the nitrogen inflow into the lake was from pastoral farming.

As a result, in 2000 Waikato Regional Council (then Environment Waikato) initiated a process that cumulated in 2005 with the notification of Variation 5, which for landowners in the catchment included the following key elements:

(i) 20% of the '*manageable*' nitrogen from pasture land was to be bought out via a public fund;

(ii) Nitrogen leaching was capped for each individual property at the highest over the period 2001-2005, as measured by Overseer[2];

(iii) Forestry was effectively grandparented at its existing nitrogen discharge level;

(iv) A trading system for nitrogen discharge allowances was set up.

For landowners, the implication was that while they could continue farming in their present mode, if they wished to intensify the operation and/or change land use which resulted in a higher nitrogen discharge, then they could only do this by buying in nitrogen.

The concern raised by the farmers is that as the cost/price squeeze continues, in the absence of the opportunity to intensify, their farms will eventually become uneconomic. The main thesis behind this study is to explore that concern.

Prior to the implementation of the nitrogen cap, the Taupo farmers, under the aegis of Taupo Lake Care (a group the farmers had formed to represent themselves) commissioned Nimmo-Bell (2002) to provide an estimate of the cost of Variation 5 to farming within the catchment.

Nimmo-Bell considered three scenarios:

(i) Nitrogen cap;

(ii) A 10% reduction (by the farmers); and

(iii) A 20% reduction (by the farmers).

[2] Nutrient budget software model: https://www.overseer.org.nz/

The results they indicated were:

**Figure 2: Nimmo-Bell estimates of nitrogen restriction impacts (NPVs)**

| | Land use change without restrictions | |
|---|---|---|
| **Restriction** | **Moderate** | **Substantial** |
| Cap N output | $96m | $159m |
| 10% reduction | $104m | $167m |
| 20% reduction | $112m | $175m |

Note: “moderate” and “Substantial” relate to the degree of land use change assumed. For example, converting 9,000ha of sheep & beef land to dairying is “moderate”, while converting 15,000ha is “substantial”.

Of these, the one most relevant to this study is the 'Cap N output', as that was the eventual regulation. Nimmo-Bell noted that:

*The results demonstrate that the majority of the loss is associated with the inability to pursue alternative land uses and the loss in potential to achieve productivity gains where restrictions are imposed. This is evidenced by the relatively large loss associated with a cap restriction when compared to the -10% and -20% scenarios*.

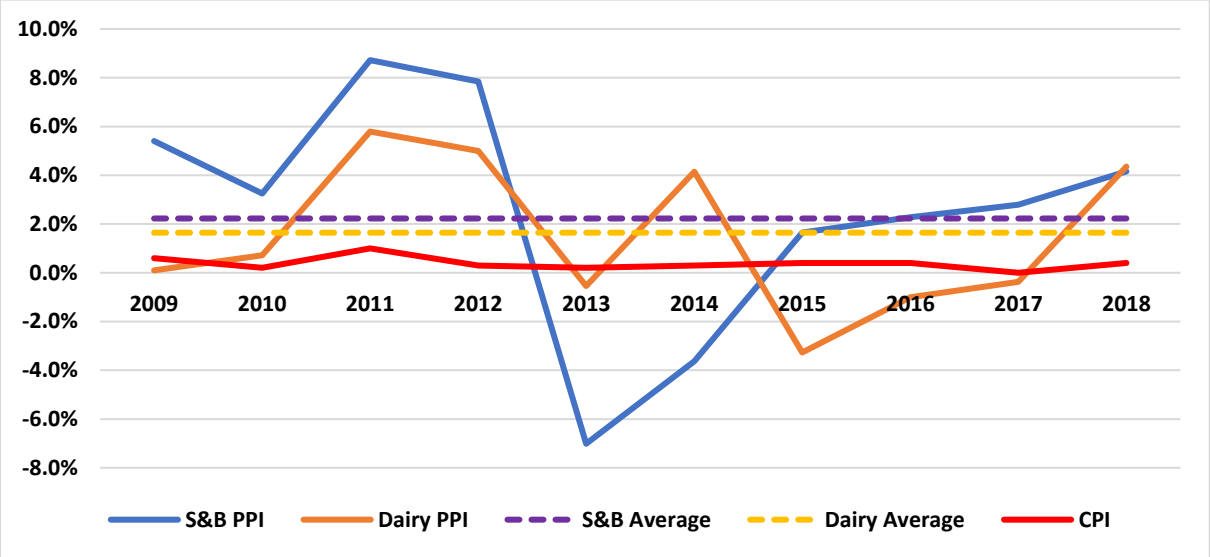
# 5.0 Impact on Farm Working Expenses

## 5.1 On-farm cost inflation and productivity growth

A key issue facing the Taupo catchment farmers is the ongoing 'cost/price' squeeze which has impacted on farms in New Zealand for many years. This is the issue that on-farm costs often rise faster than the general rate of inflation (i.e. Consumer Price Index, CPI) and faster than commodity prices improve.

This can be illustrated:

**Figure 3: Movements in on-farm inflation relative to the CPI**




Note: Based on the Sheep and Cattle farming, and Dairy Cattle farming PPI's[3], Year ending June
Source: Statistics NZ

This shows that over the last 10 years, sheep and beef on-farm cost inflation in New Zealand has averaged 2.2% p.a., and dairy farming on-farm cost inflation has averaged 1.6% p.a., while the CPI has risen, on average, by 0.4% p.a. Which shows that farm costs have inflated much faster than the general rate of inflation.

The reason behind the difference in on-farm inflation versus the CPI is outside of the scope of this analysis, but largely driven by the uncompetitive nature of the New Zealand domestic economy. The concern behind this is that farms continually need to improve their productivity to counter this.

The other concern as part of this issue is how the rate in increase in farm working expenses (FWE) compares to the rate of increase in farm income - the issue being that if FWE is increasing faster than income, then, in the absence of productivity gains, at some stage the farm becomes financially unviable.

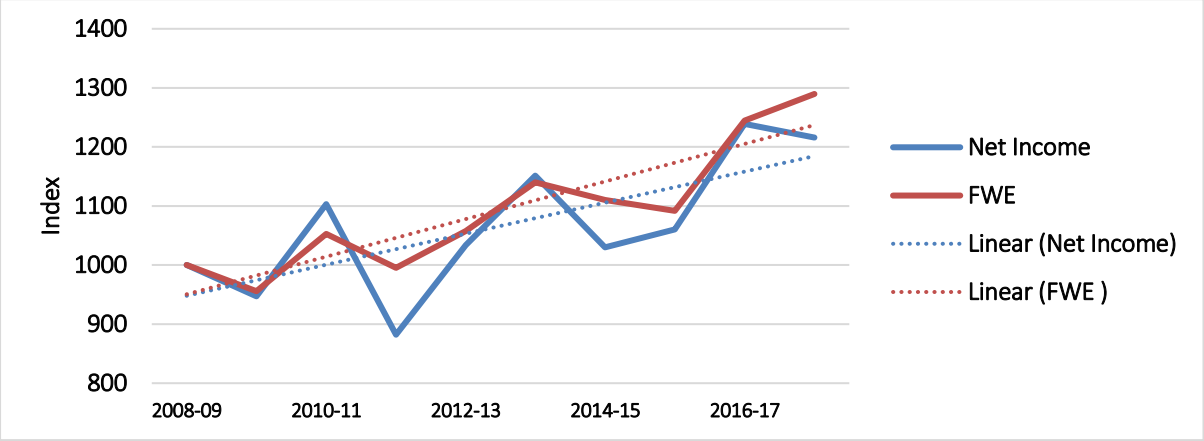
For the dairy industry, Dairy NZ (2017) shows that Total Factor Productivity (TFP)[4] has averaged -0.7% per year over the period 2006/07 - 2016/17. Over the same period, dairy on-farm inflation averaged 1.6% per year, meaning that dairy farmers were effectively going backwards at 2.3% per year on average.

[3] PPI = Primary Producers Index – an index of on-farm cost inflation
[4] TFP measures the efficiency of producing all outputs against the usage of all inputs, including assets, in the production process

For the sheep and beef industry TFP has lifted by 1.5% over the period 2009/10 to 2017/18[5], or by 0.2% per year on average. With on-farm inflation averaging 2.2%/year, this gain in TFP effectively reduces on-farm cost inflation to 2% per year.

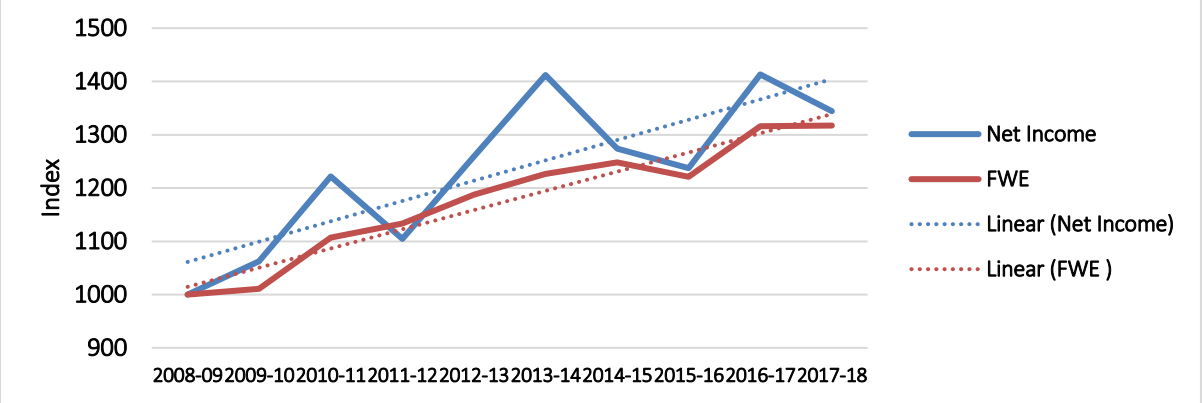
Analysis at an industry level, for the Beef + Lamb NZ North Island Class 4 Hill Country, which corresponds to many of the farms within the catchment, and the North Island Class 5 Intensive Finishing farm[6] shows the following.

**Figure 4: Class 4 farms: Income versus Farm Working Expenses**




Source: Beef + Lamb NZ Economic Service

**Figure 5: Class 5 farms: Income versus Farm Working Expenses**



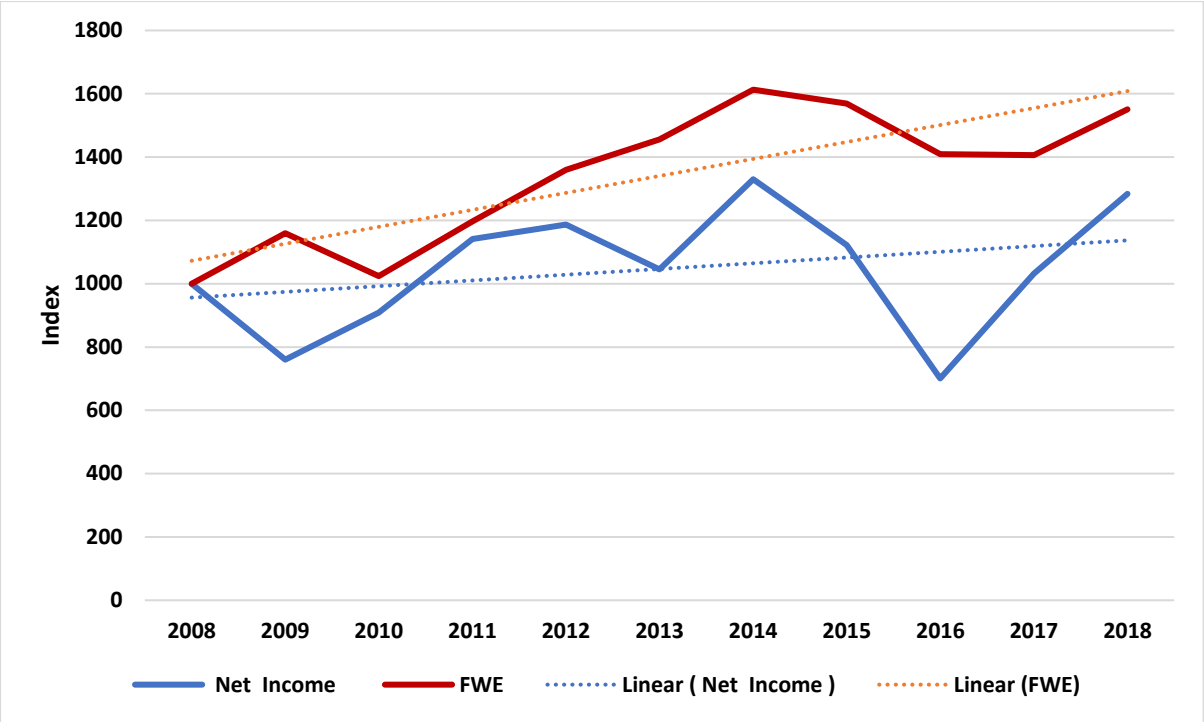

Source: Beef + Lamb NZ Economic Service

**Figure 6: Waikato/BoP dairy farm: Income versus Farm Working Expenses**

[5] Beef + Lamb NZ Economic Service

[6] Class 4: Easier hill country or higher fertility soils than Class 3. Mostly carrying between 7-13 stock units per hectare. A high proportion of sale stock sold is in forward store or prime condition.

Class 5: Easy contour farmland with the potential for high production. Mostly carrying between 8-15 stock units per hectare. A high proportion of stock is sent to slaughter and replacements are often bought in.




Source: AgFirst

The indices in Figures 2 - 4 are:

- Net Income = gross farm income less stock purchases.
- Farm working expenses covers all operating costs, but excludes interest/rent, personal drawings and depreciation.
- For both figures, income and expenses have been indexed such that 2008/09 = 1000[7].
- The dotted lines show the average rate of increase over the 10-year period.

Key points to note are:

(i) Both income and expenses have increased over the period, although income has been much more volatile (representing some of the risk inherent in farming).

(ii) The rate of increase in Farm Working Expenses for the sheep and beef Class 4 farms has averaged 2.6% (compounding) versus 2.0% for Net Farm Income; the rate of increase in expenses is higher than the rate of increase in income.

(iii) Whereas for the sheep and beef Class 5 farm, the rate of increase in Farm Working Expenses averaged 2.8% compounding, as against 3.0% for the average rate of increase in net income. For this type of farm therefore, the rate of increase in income has kept ahead of expenses over the period.

(iv) For the dairy farm, the rate of increase in Farm Working Expenses averaged 4.1% compounding, as against 2.3% for the average rate of increase in net income; again the rate of increase in expenses is higher than the rate of increase in income.

(v) These relativities can change depending on the time period measured.

[7] While the actual income and expenses figures are much different – income is usually much higher than expenses, indexing them to the same point allows an easier calculation of the **rate of increase** from the initial start point.

The implications of this can be illustrated, using the sheep and beef Class 4 farm as an example. The proportion of farm working expenses to gross income is outlined below:

**Figure 7: Class 4 proportion of expenditure and net profit to gross income; average 2008/09 - 2017/18**

| | |
|---|---|
| Farm Working Expenses as a % of Gross Revenue | 55% |
| Other* % GR | 22% |
| Net Profit before tax** % GR | 23% |

*'Other' costs include interest, rent, depreciation, imputed managerial wages
**Net profit before tax covers: personal drawings, tax, farm development, principal debt repayments

If farm working expenses and gross income are inflated at the rates mentioned above (2.0% p.a. for income, 2.6% p.a. for expenses) and **everything else remains the same**, it then takes 60 years before farm working expenses average 78% of gross income; i.e. net profit before tax is zero.

The farm as a business would have failed financially well before the 60 years, however, obviously the items that are covered by these net profit funds still need to be met, but it is difficult to be definitive as each farm would be different. For example, off-farm income could substitute for personal drawings. As the net profit shrunk, the financial resilience of the farm would also decrease, reducing the ability to survive unforeseen events such as an adverse climatic event.

For the farms in the catchment, four farms supplied their income and expenditure data. This showed:

(i) One of the farms showed the same trend as the Class 4 farm above, i.e. farm working expenses rose faster than income, while the other three showed the same trend as the Class 5 farm; income rose faster than farm working expenses. This latter situation was exacerbated slightly given the improvement in commodity prices in recent years; while farm working expenses rose on the back of increased income, overall income rose faster.

(ii) As in the industry examples above, income was more volatile than farm working expenses.

From this small sample it is not really possible to discern if farm working expenses have been adversely affected by the nitrogen cap. In many respects this could be expected given the relatively short time period (10 years) since the cap was imposed. As discussed in Section 9, farmers feel that the cap has had a more direct impact on income.

## 5.2 Compliance Costs

For the catchment farmers, there is also an increase in costs associated with compliance with Variation 5 regulations; ongoing monitoring and consent fees, annual audit fees, professional fees if needed; plus the cost of personal time involved in managing and monitoring the consent.

This was one of the issues discussed with the catchment farmers, and as this is a direct financial cost to the farmers of the scheme, it therefore needs to be counted.

The estimate of the time involved for this varied from around one day/three months, through to one day per month. The variation was due to a number of factors, particularly the accessibility of records, as well as relating to the amount of nutrient budgeting done to consider management options through the year.

In addition to this was the fees charged by the Council, which varied from $300 up to $2,000, as well as the professional fees - consultants and accountants used to develop and providing the information.

It is difficult to give an accurate average figure based on this, but the assumptions for the analysis are:

- Average initial consent cost was $1,050/farm
- Average annual time input by the farmer or farm staff is 0.5 day/month, or 6 days equivalent per year, costed at $50/hour
- An average annual Council fee of $500
- An average annual professionals fee of $1,000

This gives an annual cost of $3,900 per farm.

The Present Value of this, assuming a 20-year time horizon and a 6% discount rate[8], and extrapolated across all farms in the catchment, is $4.7 million.

For the Māori owned entities, there are additional costs as well, due to the governance structure in place and the multiple-ownership nature of the entities. These entities typically rely heavily on professional advice to manage and guide their business. In addition, there is the time spent at a governance level discussing matters pertaining to the N cap, training and upskilling of new Trustees plus the cost of communicating with owners regarding the impacts of the N cap and the impact on the whenua. This cost varies between the entities and is difficult to quantify in the absence of any case studies.

[8] Current government discount rate

# 6.0 Land Values

The value of land is an important component of any farming business. Often it is the largest balance sheet item, a key determinant of farm ownership, and a key factor in the level of debt a farming business incurs.

There are three fundamental drivers of land value:

(i) Productive value - the value relative to the rent, or profits, obtainable from the land;

(ii) Consumptive value - this includes amenity factors such as recreational opportunities, scenery, and closeness to urban facilities, plus intangibles such as the countryside is a nice place to live, a great place to bring up children, you are your own boss, and farming is a great lifestyle; and

(iii) Speculative value - the ability of an asset to retain its value/the return on the asset as an investment. Within this is also an 'option value', which is the ability to either intensify or change the land use.

In addition, there is a lesser fourth component; transactional factors, which may affect the price on the day, such as forced sales and family transactions.

Research (Journeaux, 2015) indicates that over the last two decades, productive value has only been a moderate (dairy) to minor (sheep and beef) influence on farm values, whereas speculative value has been a major driver. Up until 2008 (Global Financial Crisis) capital gains on farm land was significant, and the research indicated that a major driver of sheep and beef farmland prices was the profitability of dairying (i.e. option value).

Research in the USA (cited in Journeaux, 2015) indicates that consumptive value can have a significant effect on land values, but it is difficult to quantify this due to the variability and individuality of the impact.

Within the Taupo catchment, it could be expected that:

(i) Any productive value influences would largely be influenced by national-level factors, such as the sheep meat and beef schedules, log prices, and the dairy payout;

(ii) There would be little change in the consumptive value component; and

(iii) Most of the impact of the nitrogen cap would fall within the speculative value component, especially around the '*option value*' aspect given the perceived limitations on intensification and/or land use change, possibly ameliorated to some degree by the ability to trade nitrogen.

## 6.1 Land value analysis

Work by Telfer Young (2015) in the Lake Rotorua Catchment, following the introduction of Rule 11 in 2007 (directly analogous to the nitrogen capping in the Lake Taupo catchment) showed that:

(i) There was no real change in the volume of farm sales within the catchment.

(ii) For dairy farms, there was a nominal 10% reduction in value reflective of the imposition of land use restrictions, with a further 5-10% reduction relating to the actual nutrient allocation - the lower the allocation, the greater the reduction in value. Overall therefore the estimated impact was for a 15-20% decline.

(iii) For sheep and beef farms (>40ha), the estimate was for a 15-25% decline in value.

An econometric analysis carried out by NZIER (2016)[9] on farm sales within and outside the Taupo catchment indicated that:

(i) The scheme began to influence land prices from 2004 onwards as landowners began to anticipate how the scheme would develop.

(ii) On average, the scheme reduced the sale price of land parcels within the catchment, relative to similar land outside the catchment, by 7%.

(iii) On average that equates to a decrease in price of $672/hectare.

NZIER note that there is some uncertainty with the above results, due to the relatively small dataset.

Analysis of farm sales within and outside of the Taupo catchment[10] over the last decade show the following results:

**Figure 8: Sheep and Beef farm sales greater than 100 ha**

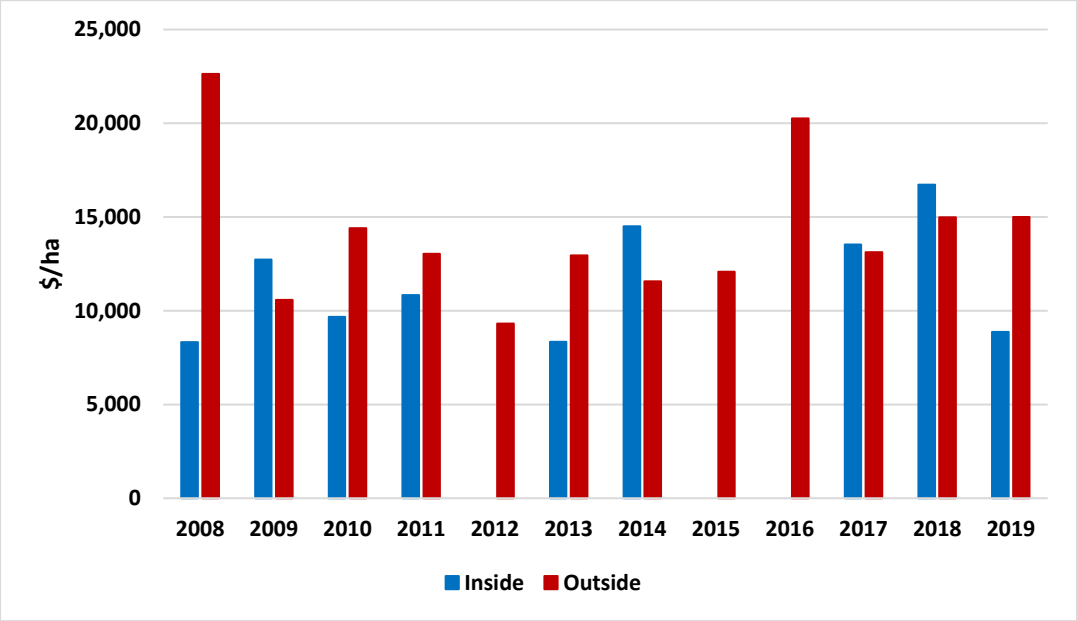



**Figure 9: Sheep and Beef farm sales less than 100 ha**

[9] This was based on farm sales from 2000 to 2015 for land within the Lake catchment (146 sales) and outside the catchment within a 50-kilometre radius (3,108 sales). The analysis was across all farm types and size of farms.

[10] Data provided by Telfer Young Rotorua. Farms outside of the Lake Taupo catchment predominantly are from Taupo and South Waikato Districts, and the southern part of Rotorua District. The values shown are land values excluding improvements.

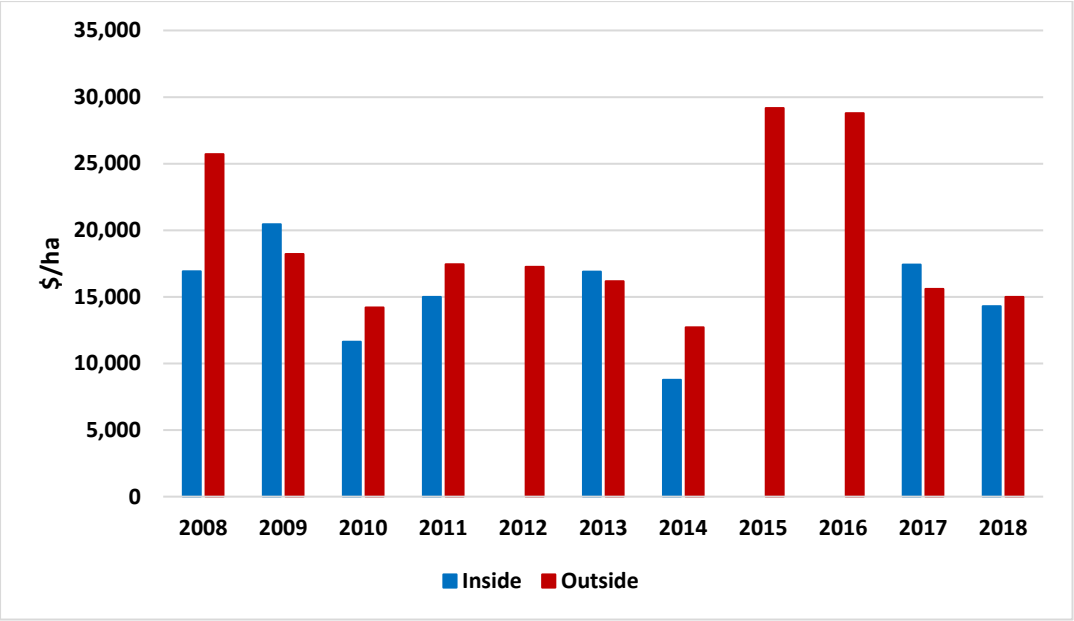
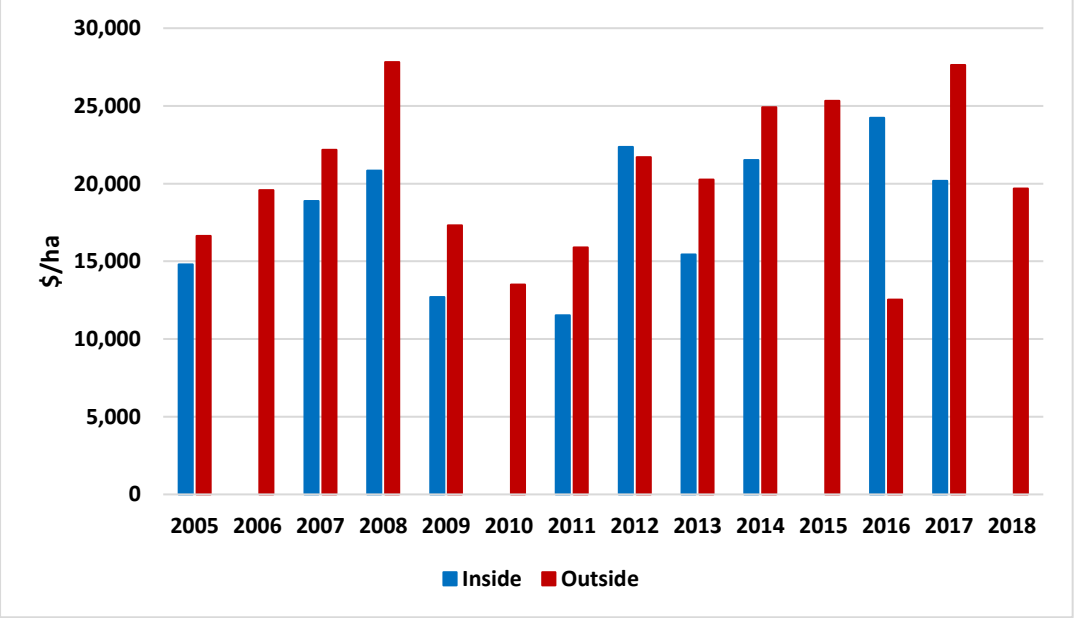



**Figure 10: Dairy farm sales**




**What these figures show is that for the period indicated:**

- For sheep and beef farms greater than 100 hectares, the difference between 'inside' versus 'outside' is an average difference of 14%; i.e. the 'inside' farms sold for an average of 14% less, or $2,749/ha.
- For sheep and beef farms less than 100 hectares, the difference between 'inside' versus 'outside' is an average difference of 8%, i.e. the 'inside' farms sold for an average of 8% less, or $1,518/ha.
- For dairy farms, the between 'inside' versus 'outside' is an average difference of 7%, i.e. the 'inside' farms sold for an average of 7% less, or $2,446/ha. Note the data series for dairy is slightly longer (2005 - 2018); if the same time period as per the sheep and beef data series is used, the average decline is 6%, or $2, 415/ha.

*Note*

1. The data series available on land sales within the catchment is very limited, and in some years the 'average' sale price is based on only one sale.
2. This is especially so for the dairy farm sales; given there are only seven dairy farms within the Taupo catchment, many of the 'inside' sales relate to dairy farms within the Lake Rotorua catchment. This is regarded as much the same as the Taupo catchment inasmuch as both are highly constrained regarding nitrogen leaching.
3. In some years there were no sales within the catchment.
4. Given the above, some caution is required in extrapolating the results.

A regression analysis of the sheep and beef (>100 ha) farm sales within the catchment which also had the Nitrogen Discharge Allowance (NDA) recorded (a total of 18 sales), showed the following relationship between the NDA and the sales price.

**Table 2: Regression analysis values: NDA versus land value**

| | Total sale $/ha | Land value $/ha |
|---|---|---|
| $R^2$ | 0.03858 | 0.00643 |
| Correlation | 0.196 | 0.082 |

This shows there is no relationship between land values and NDAs (a perfect relationship would have an $R^2$ and correlation = 1.0). This is somewhat surprising but means that for many of the sales there were other drivers apart from the NDA determining the purchase price.

A key component of this is likely to be the *perception* that the nitrogen discharge restrictions would adversely impact on farm profitability; NZIER (2016) noted that land values had started to decline in 2004 prior to the introduction of Variation 5, as *landowners began to anticipate how the scheme might develop*.

The NZIER report (2016) put the reducted land values down to three components:

(i) Increasing cost of intensification
(ii) Regulatory uncertainty, and
(iii) Changing mix of land parcels offered for sale (e.g. large farms may take a “wait & see” approach, thereby distorting the size of properties for sale)

Later in this report there is analysis and discussion to show that there is a significant cost to the farmers in the lack of flexibility/ability to intensify their properties as a result of the nitrogen cap. These factors are directly reflected in land values.

## 6.2 Land value impact at the catchment level

**Analysis of the Waikato Regional Council database for the catchment shows:**

**Table 3: Number of farms and effective area by farm type**

| | No. farms | Total Effective Area (ha) |
|---|---|---|
| Sheep and Beef >100 ha | 74 | 51,764 |
| Sheep and Beef <100 ha | 36 | 1,293 |
| Dairy | 7 | 2,943 |

**Note: The term 'sheep and beef' covers a range of farming systems including sheep, beef, deer, dairy grazing, horse grazing.**

**Based on the land value differential identified in the previous Section, the total reduction in value is:**

**Table 4: Total land value differential**

| | Land value differential ($m) |
|---|---|
| Sheep & Beef >100ha | $142.3 |
| Sheep & Beef <100ha | $2.0 |
| Dairy | $7.1 |
| Total | $151.4 |

Overall therefore, the total difference in land value due to the nitrogen cap is $151.4 million.
This is based on the comparison with 'non nitrogen restricted' farms outside of the catchment. While that is the current situation, this is rapidly changing; Waikato Regional Council has notified Plan Change 1 (PC1) which affects the rest of the Waikato River catchment, and is currently proposing:

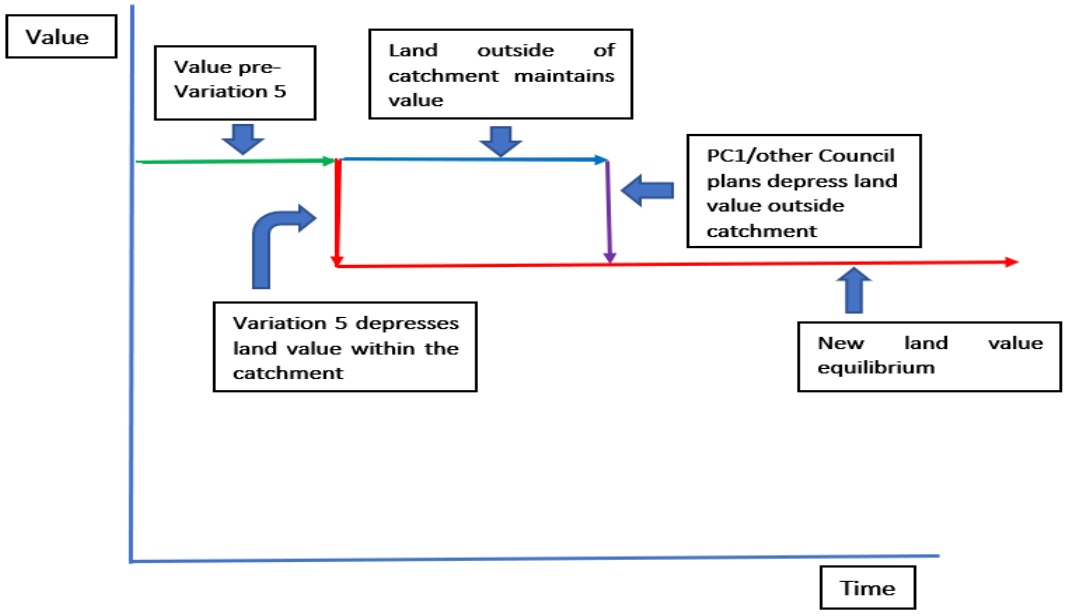
- A cap on nitrogen leaching for pastoral farms;
- A reduction in nitrogen leaching for those pastoral farms above the dairy 75$^{th}$ nitrogen leaching percentile down to the 75$^{th}$ percentile level; and
- Significant restrictions on land use change.

Similarly Bay of Plenty Regional Council will be introducing a water quality plan which covers the rest of the Bay of Plenty region; all Councils are required to do this by 2025.

Where these plans end up remains to be seen, but the probability of some restrictions on nutrient discharges is reasonably high. The implication of this is that, *ceteris paribus*, land values outside of the Lake Taupo catchment will soften, and the differential caused by the nitrogen cap between the 'inside catchment' and 'outside' values is likely to reduce. In many respects therefore the reduction in land values with the Lake Taupo catchment was a precursor; if Variation 5 had not happened, then the farms would now be covered by Plan Change 1, to largely the same effect.

This can be shown schematically:

**Figure 11: Land Value Schematic**



Farmers within the catchment note that, paradoxically, the NDA consent provides a degree of certainty, which is currently of some value given the uncertainty created by PC1, and that this certainty is important, and has a value, given the long-term nature of farming.

### 6.2.1 Rating System

Within the catchment, the rateable value of the land is based on the NDA status of the property, based on the following approach:

(i) The first step is to value an 'average efficient farm' with an average NDA.

(ii) This is done taking into account the topography of the farm, using a gradient system across flat, medium hill and steep hill country, which is reflected by the NDA.

(iii) The actual NDA of the property is then take into account; if the actual NDA is higher, then the value is increased by the difference in NDA's, times the average sale price of nitrogen in the catchment, and similarly if the actual NDA is below the average, reduce the value by the difference in NDA's, times the average sale price of nitrogen in the catchment plus a 10% risk premium based on the cost required to bring the farm's 'potential' up to average for the district.

As a hypothetical example:

(i) Assume average NDA = 17 kgN/ha
(ii) Farm with an actual NDA of 20 would have its value increased by 3 x $420[11] = $1,260/ha
(iii) Farm with an actual NDA of 10 would have its value decreased by 7 x $462[12] = $3,324/ha

[11] Assumed current average nitrogen purchase price
[12] The $462 = $420 + 10%. The additional 10% cost is a risk premium based on the cost required to bring the farm's 'potential' up to average for the district

# 7.0 Opportunity Cost

An opportunity cost is a benefit, profit, or value of something that must be given up to acquire or achieve something else[13]. Since every resource (land, money, time, etc.) can be put to alternative uses, every action, choice, or decision has an associated opportunity cost. In many respects it is the cost of the next best alternative forgone.

This section contains a discussion on the opportunity cost, and its relevance, on four aspects relating to the nitrogen leaching cap in the Lake Taupo catchment:

(i) Conversion to dairying

(ii) Conversion of forestry to pasture

(iii) Intensification of existing farming operations

(iv) Land use change to horticulture

## 7.1 Conversion to dairying

A number of references (e.g. Spicer, 2017, Vant & Huser 2000) refer to a potential area convertible to dairying of 250 $km^2$ within the catchment, based on the MAF (1997) study (Note 1 $km^2$ = 100 hectares, so 250 $km^2$ = 25,000 hectares). There are two important aspects to this:

(i) The MAF report never mentions 250 $km^2$ as convertible; extrapolation of several of the scenarios discussed gives areas varying from 20,000 - 27,000 ha; and

(ii) More importantly, these areas relate to the whole of the Taupo District, not the Lake catchment.

Davidson (1999) estimated an area of 100 $km^2$ (10,000 ha) within the catchment. Based on this, the opportunity cost of not converting this area to dairy was calculated:

(i) Conversion cost, from sheep and beef to dairying was $3,151/hectare (MAF 1997).

(ii) The difference in livestock cost; dairy livestock purchase less sheep and beef sales added a further $577/hectare to the initial cost.

(iii) The difference in Net Trading Profit between sheep and beef and dairy farming from 1997 to 2018 was ascertained based on the Waikato/BoP dairying and Central North Island Hill Country farm monitoring data from the MAF and AgFirst Farm Monitoring from 1997 to 2018.

(iv) This was then discounted back to a single figure, using a 6% discount rate, giving a net present value of $6,937/hectare.

Extrapolating that to the 10,000 hectares, gives an overall opportunity cost of $69.4 million at the catchment level.

This assumes that all the suitable land was converted in 1997, which is very unlikely - a more likely scenario would be that the land was converted over a period of years. In addition, from 1997 onwards any farmers converting need to pay upfront for shares (initially at $2/share) for supplying the NZ Dairy Group, and the imposition of this capital contribution greatly diminished conversions.
Discussion with the catchment farmers indicated that few were interested in converting to dairying, while a few also potentially could consider selling their farm to someone else who could convert. Overall therefore, the $69.4 million opportunity cost calculated would be considered a maximum figure.

[13] www.businessdictionary.com

## 7.2 Conversion of forestry to pasture

The potential conversion of forestry to another land use within the catchment is another example of an opportunity cost, especially as it was noted by Tuwharetoa during the development of Variation 5 that they had ambitions to develop some of their forestry land into other land uses (Yerex 2009).

At the time of the Variation, much of the Tuwharetoa forestry land in the catchment was under a Crown Forest lease, with the land to be returned following harvesting of the existing forest. In noting this, Tuwharetoa by 2002 had 9,000 hectares of forestry under direct control, with 1,200 hectares being returned per year following harvest following lease revisions with Crown Forestry.

While this meant they had some opportunity to convert if required, this was not considered in an immediate sense. Given their long-term view of land use, they had the expectation, prior to Variation 5, that at some stage in the future the land might be converted to some other use.

Through the 2000's there was a significant amount of forestry conversion in the South Waikato and Taupo Districts, although in the case of Taupo this was outside of the Lake catchment. The main drivers for this were:

(i) The price of forestry land was relatively low.

(ii) The cost of conversion was also relatively low, at circa $10,000 - $15,000/ha.

(iii) The Emissions Trading Scheme (ETS) was not in place, and when it was introduced in 2008, land owners converting land could buy very cheap carbon credits internationally to offset their liabilities.

(iv) The financial returns from dairying were (relatively) high, as was the value of dairying land (often the conversion resulted in a direct capital gain).

Many of these factors are now no longer applicable. Current conversion costs from forestry to dairy farming is:

**Table 5: Indicative Land Conversion Costs - Forestry to Dairying ($/ha)**

| | |
|---|---|
| Land clearance, fertiliser/lime, sowing into pasture | $7,000 |
| Tracks/races, fencing, water | $3,400 |
| Electricity, milking shed, effluent system, houses | $15,000 |
| Vehicles, plant and equipment | $1,200 |
| Livestock | $6,000 |
| **Total** | **$32,600** |

Based on a 150 ha conversion

These costs can vary, depending on the circumstances and land involved. Land converted from forestry also takes between 8-10 years before it is fully functioning as a 'status quo' farm. Over this period significant additional costs are also often necessary, particularly extra fertiliser, and 1 or 2 resowings of pasture.

In addition to these conversion costs, the carbon tax via the ETS is now significant; a mature (28 year) forest in the Taupo district has the equivalent of 755 tonnes $CO_2e$/hectare[14], which at the current cost of $25/tonne $CO_2e$, means an additional cost of $18,875/hectare.

[14] MPI Look-up tables

Current land values are circa $20,000/hectare (refer Figure 3), so there is no immediate capital gain above the conversion cost.

**Excluding any nitrogen purchase cost, the cost of conversion from forestry to pasture is now very high, to the point where any opportunity cost is either minimal or likely negative. The main point is that there are now other factors outside of the nitrogen cap; economic (cost of conversion) and regulatory (ETS), which severely hinder the potential conversion of forestry to other land uses.**

Similarly, while conversion to housing or to another land use, e.g. horticulture, may or may not be possible in the future, it is difficult to quantify an opportunity cost to this in a generic sense; essentially it requires a case study of the proposition in question to determine any opportunity cost.

## 7.3 Intensification of existing farming operations

A key concern raised by the farmers at the time of the implementation of Variation 5, and again at the farmer meetings, was the loss of the potential to intensify farms, such as increasing stock numbers via land development, coupled with the loss of flexibility to change farming practices to meet market changes, grass surpluses or shortages or to change stock types to reduce workload or achieve higher returns (Richardson 2012, Barry *et al*, 2010).

Determining the value of the loss of flexibility around managing pasture surpluses or shortages is again problematic, as it depends on the individual farm, and the nature of the event, which tends to be sporadic.

### 7.3.1 Opportunity cost of not intensifying, methodology #1

All of which means there is an opportunity cost of not being able to do this. The difficulty is in quantifying this, as each farm would be different. One case study in the catchment (Ledgard *et al*, 2016) showed an 85.8kg/ha carcase weight (of beef) increase between the nitrogen-constrained system, and an unconstrained system. The difference in profit was $237/hectare.

If this is extrapolated over all the hectares in sheep and beef farming within the catchment, it gives an opportunity cost figure of $12.6 million per year. The Present Value of this, assuming a 20-year time horizon and a 6% discount rate, is $144.5 million.

The Ledgard *et al* (2016) paper also noted that, assuming the nitrogen cap was in place, the beef schedule would need to increase by an extra 25c/kg to equate with the income from the unconstrained scenario.

### 7.3.2 Opportunity cost of not intensifying, methodology #2

Another approach to calculating the opportunity cost of not being able to intensify is to consider the level of de-intensification that has occurred as a result of the nitrogen cap, and the removal of the 20% of manageable nitrogen, relative to the maximum potential number of stock units.

Analysis of the Council database shows that the total benchmarked stock units in the catchment was 729,606 SU, as against the current potential stock units of 499,618[15], i.e. a difference of 229,988 SU.

The annual average operating profit for Class 4 farms[16] over the last 10 years (2008/09 - 2017/18) is $48.84/SU, and for the Class 5 farm is $60.12/SU. It is not readily possible to classify all the farms

[15] This is the potential stock units that can be carried post the 170 tonne reduction in nitrogen leaching from pastoral land.

[16] "Operating Profit" is defined as Gross Revenue less Farm Working Expenses, excluding standing charges and admin. Data is from the Beef + Lamb NZ Economic Service Survey. Class 4 and Class 5 farms are defined earlier in the report.

within the catchment as to how they line up with either the Class 4 or Class 5 farm, so the assumption was to give them an equal weighting, giving an overall average of $54.48/SU.

If this $54.48/SU figure is applied across the difference in stock units within the catchment and calculated as a present value over 20 years at a 6% discount rate, the opportunity cost calculated is $143.7 million - very similar to the figure calculated in Section 7.3.1 above.

## 7.4 Alternative Farm Systems

Another aspect of this issue is the ability to improve the productivity of the farm, or change land use, within the NDA constraint. A number of studies have looked at this issue, with the aim of identifying more profitable systems within the NDA cap.

Dooley et al (2005) identified 14 possible systems for a farm with an NDA cap of 12 kgN/ha/year, some of which improved profitability, while others didn't.

**Table 6: Alternative farm systems for an example sheep and beef farm in the Taupo catchment**

| Farm System Description | GM ($/ha) | kgN/ha/yr | Difference in GM from base |
|---|---|---|---|
| Base*, no N, 117% lambing | $464 | 11 | |
| Base, average N (17 kg N/ha/yr), 117% lambing | $482 | 12 | $18 |
| Base, N, 136% lambing | $532 | 12 | $68 |
| Base, N, 136% lambing, buy & finish 3 crops store lambs | $519 | 12 | $55 |
| Base, N, 117% lambing, no cows, buy weaners April, sell R2 steers | $449 | 11 | -$15 |
| Base, N, 117% lambing, no cows, buy weaners August, sell R2 steers | $453 | 11 | -$11 |
| Base, average N, 117% lambing, sheep only | $549 | 11 | $85 |
| Base, N, finishing cattle only | $386 | 8 | -$78 |
| Base, N, 117% lambing, DCD (5% productivity response assumed) | $380 | 10 | -$84 |
| Base, average N, 117% lambing, cattle stand-off (winter) | $460 | 11 | -$4 |
| Grass silage harvesting and sale (no N in winter) | $280 | 4 | -$184 |
| Pine trees, contractors used, no annuity paid | $470 | 3 | $6 |
| Pine trees, contractors used, annuity paid | $400 | 3 | -$64 |
| Base, average N, 150% lambing, fewer cows, 10% in pine trees | $621 | 12 | $157 |

*Base = 480 ha, 9800 kgDM/ha/yr pasture production, no hogget mating, yearling heifer mating, buy heifer replacements.
Note: "No N/N" relates to nitrogen fertiliser usage
Source: Dooley *et al* 2005, Table 1.

Ledgard *et al* (2006) considered options for both a traditional sheep and beef farm, and an intensive beef farm. For the sheep and beef farm, options considered were:

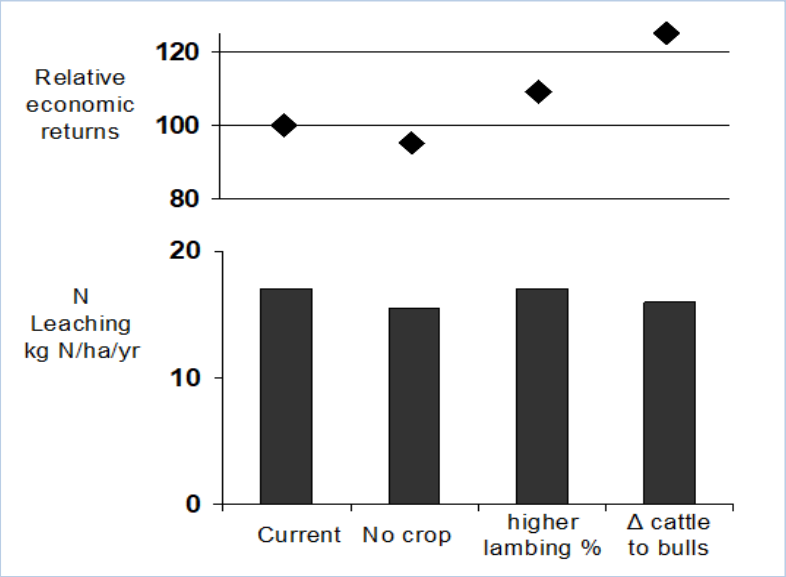
(i) Cease cropping; a 10 ha block was regularly cropped for grazing over winter.

(ii) Increase lambing percentage from 95 to 123.

(iii) Change cattle policy to finishing Friesian bulls.

The results showed:

**Figure 12: Impact of alternative farm systems on N leaching and profitability; sheep and beef farm**




Source: Ledgard *et al* 2006 Figure 1

For the intensive beef property, the options considered were:

(i) Reduce stocking rate.

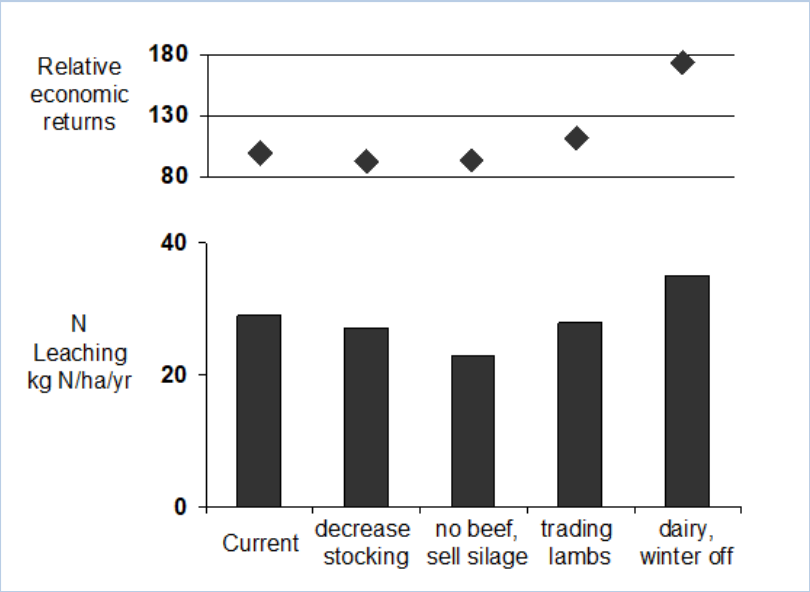
(ii) Only graze dairy cows, no beef, sell silage.

(iii) Finish lambs over the summer.

(iv) Convert to dairying.

The results showed:

**Figure 13: Impact of alternative farm systems on N leaching and profitability; intensive beef farm**




Source: Ledgard et al 2006 Figure 2

Similarly, Thorrold and Betteridge (2006) looked at a range of options, with their overall conclusions being:

(i) The efficiency of forestry and cut forage systems in terms of yield and profit per kg N leached suggests that they require further analysis to overcome issues around yield and feasibility; and

(ii) Improving stock performance emerges as the most profitable route for farmers in the short-term as they seek to improve profitability without increasing N leaching.

The main point of this research is that it shows there are some alternative systems that can maintain or improve profitability within the prescribed nitrogen leaching level. Part of the issue is that for much of last century agricultural research was very production orientated, with little regard to environmental externalities. In the latter part of the century research into productivity issues gained ground, but it is only in the last two to three decades that much research has been done combining all three - production, productivity, and environmental impact.

As per the discussion in Section 5 around farm working expenses and productivity, the only two measures farmers can employ, in order to maintain profitability, other than a yet-to-happen technological breakthrough, is to either increase the productivity of their farms and/or receive a higher return for their environmentally sustainable produce. On this latter matter, which is outside of the scope of this analysis, the point could be made that for the last 50+ years, consumer expectation is for high quality food at an ever-decreasing real price. So it will take some time and effort to lift consumer expectation to pay more for environmentally sustainable food.

### 7.4.1 Alternative farming systems within the catchment

With respect to the comments in Section 7.4 above, mention needs to be made of alternative farming approaches occurring in the catchment.

(i) The first of these is Taupo Beef[17], which is an exercise by a number of farms within the catchment to promote the beef and lamb raised on their properties as being farmed sustainably and assisting in protecting Lake Taupo. The aim is to elicit a premium from the market to cover the additional costs associated in doing this, for example: the opportunity cost of not intensifying production, and the cost of producing beef on a year-round basis (estimated in total at 55 c/kg carcase weight).

Currently Taupo Beef and Lamb is being sold in a number of top-end restaurants and supermarkets around New Zealand at a premium. A container load of Taupo Beef and Lamb is exported to Japan each month for retailing at a small chain of high-end supermarkets. Recent moves to extend the premium to the lower value cuts have resulted in a year-round, committed payment schedule to supplying farmers.

(ii) The second is Maui Milk[18], a sheep-milking venture established near Kuratau, currently milking 5,000 ewes on two farms within the Taupo catchment. While the operation is profitable, albeit still in a development phase, milking sheep have a similar nitrogen leaching level to many sheep and beef operations, at around 15 kgN/ha/year. One of the properties purchased for the sheep milking operation had a relatively low NDA (10 kgN/ha/year), meaning the rest of the farm (in the absence of purchasing in nitrogen), has to be farmed very conservatively.

## 7.5 Development of undeveloped Māori land

A component of Variation 5 was the provision of allowing consent applications for up to an additional 11 tonne of Nitrogen for undeveloped and forested Ngati Tuwharetoa land, which expired in June 2017 with very little taken up.

[17] https://www.taupobeef.co.nz/
[18] https://mauimilk.co.nz/

The discussion at the farmer workshop with Ngati Tuwharetoa indicated that the reason this nitrogen allowance was not taken up was that much of the undeveloped land was subject to a Treaty claim, and as the claim was settled post the expiry of the nitrogen allowance, obviously the allowance could not be taken up.

The discussion indicated that Ngati Tuwharetoa intend to approach the Council to release the 11 tonne to now allow the development of the land.

The opportunity cost of not taking up the 11 tonne can be calculated as the value of the nitrogen (as per its current purchase value, representing the value of future cashflows) less the capital cost of developing the land.

Exactly how the land development would take place would vary, but for the purposes of this analysis, the following is used as **indicative.**

*Assumptions:*

- That the resultant developed land would leach 15 kgN/ha. Which means the 11 tonne would equate to 733 hectares developed.
- The current price of nitrogen ($420/kg) represents the present value of its worth (i.e. the value of future cash flows from using the nitrogen).
- The cost of conversion of undeveloped land is $5,500/ha (covering spray/crush scrub, capital fertiliser and lime, seed, fencing, water reticulation, livestock, and some infrastructure).

At 15 kgN/ha leached, the value of the nitrogen is $6,300 ha, offset against the cost of development of $5,500/ha, giving a present value benefit of $800 ha. Over the 733 hectares, this gives a total NPV of $587,000.

Whether this is an opportunity cost or not depends on whether the 11 tonne of nitrogen are utilised or not. If it is not utilised, then there is an opportunity cost. If it is utilised, then the opportunity cost does not exist.

## 7.6 Land use change to horticulture

**Most of the soils in the catchment are free-draining, and in that respect would be suitable for some permanent horticultural crops. The main disadvantage for horticulture in the area is the very cold winters and out of season frosts, which preclude many permanent horticultural crops.**

Recent work by AgFirst and Fruition Horticulture at Rerewhakaaitu and Taumarunui has indicated that a number of tree crops would be suitable for these areas, which are very similar to the Taupo catchment. An example of a possible crop is chestnuts[19], which grow well in free draining soils, and tolerates cold winters.

The economics of chestnuts are:

**Table 7: Chestnut costs and returns**

| Description | Assumption/Output | Notes |
|---|---|---|
| Area planted | 10 hectares | Scale required for investment in capital equipment. |
| Development Costs | $21,560/ha | $9,560/ha for planting in Year 1 then buildings and storage facilities required by Year 3. |
| Mature Yield | 7,500 kg/ha | Allows for 50 kg/tree with a 25% reject rate |
| Sales price | $2.50/kg | Assumes minimal processing, i.e. nuts sold fresh or frozen. |

[19] This is not a recommendation for chestnuts per se, but they are used as an indicative crop to illustrate the point.

| | | |
|---|---|---|
| Mature Gross Margin | $9,825/ha | |

Source: Fruition Horticulture 2018

From a nitrogen leaching viewpoint, most tree crops leach around 10 kgN/ha/year, which for many sheep and beef farms is within their consented NDA. For forestry land to be converted, additional nitrogen would still need to be purchased, and the cost of the ETS would still affect this option.

This is not to say that tree crops are a silver bullet; there are still issues to be considered, such as:

- Capital costs and access to finance
- Access to information as well as processing and servicing industries
- Marketing and market development
- Topography restrictions - most such crops would be restricted to the easier contour land.

**The farmer discussions also mentioned other relatively low N-leaching horticultural crops, such as blueberries, grapes, and Manuka that are being grown in the catchment. While again there are issues with all of these, they do indicate some possibility of alternative land uses that could operate within the nitrogen limitations of the catchment. While not necessarily an opportunity cost per se, they could offer an alternative to pastoral farming.**

# 8.0 Other Costs

## 8.1 Removal of the 20% of manageable nitrogen

A key aspect of the management plan for Lake Taupo was the reduction by 20% of the 'manageable' nitrogen flowing into the lake, with 'manageable' defined as what could be directly managed, which essentially was the nitrogen leaching from pastoral farming, and wastewater discharges.

To achieve this 20% reduction, which equated to around 7% of total nitrogen inflow into the lake, $81.5 million of public money was provided; 45% by central government, 33% by Waikato Regional Council, and 22% by Taupo District Council. This was administered by the Lake Taupo Protection Trust whose role was to *use the funds to encourage and assist land use change, to purchase land/nitrogen in the Lake Taupo catchment and to fund any other initiatives that assist land owners to reduce the nitrogen impact of their activities on Lake Taupo*[20].

The Trust was set up in 2007, made its first trade in 2009, and had achieved its nitrogen purchase goal by 2015.

The main point with respect to this analysis is that while the $81.5 million was a cost of the nitrogen cap, it was borne by the public in general, not by the individual farmers within the catchment (not withstanding they are ratepayers to both Waikato Regional Council and Taupo District Councils, as well as taxpayers).

If the reduction had to be made by the farmers, then on average their situation would be more tightly constrained compared to the current situation.

[20] http://www.laketaupoprotectiontrust.org.nz/page/lake_5.php

# 9.0 Farmer Workshops

Two farmer workshops were held - one in Taupo attended mostly by (10) farm owners in the north-north-western part of the catchment, and another in Turangi, attended by (11) Tuwharetoa managers and governance.

## 9.1 Constraints on Farming

This was clearly identified by all the farmers, with the main comments being:

- The inability to intensify the farming operation; some farmers mentioned the inability to increase stocking rates, while others mentioned change in stock type - some want to increase their breeding cow numbers, whereas others had decreased cow numbers and were finishing trading stock instead. Others mentioned they would like to run Friesian bulls, but were restricted because of the NDA

- The loss of flexibility to take advantage of an opportunity that may arise, e.g. buy in more stock to finish over a short period either if the price is right and/or the farm has surplus feed available.

- An inability to crop larger areas to finish stock, or as part of this, to use an expanded cropping regime to introduce improved pasture species. This issue was also raised as a restriction on further farm development; often cropping was seen as a means of bringing in under-developed land into production, which is no longer possible.

- There was some discussion on the inflexibility of the rules whereby farms could not 'share' stock depending on circumstances. For example, Farm A may have a surplus of feed, whereas Farm B is short of feed. In the past, they would have come to an arrangement whereby stock from Farm B would graze on Farm A for a period. From a nitrogen leaching viewpoint, leaching would increase on Farm A, and decrease on Farm B, but in aggregate remain the same.

  Under the current rules this is not possible, as each individual farm has to balance its own NDA on an annual basis.

  This issue was particularly raised by the Ngati Tuwharetoa land owners, as in the past there had been a high degree of co-operation between the different farms along these lines, which is rapidly diminishing as a result of the current NDA rules.

  It was also raised as an issue with grazing fire-breaks within a forest; previously stock from an adjacent farm would be used to graze the fire breaks, or electricity pylon corridors, in the spring/early summer, resulting in a much lower vegetative cover. In the absence of being able to do this, the end result is an exacerbation of the fire risk.

- Concern was also raised about the fixed nature of the NDA, in the sense that it must be accounted for on an annual basis. There was much support for the idea of a three or five-year rolling average, as is proposed for Plan Change 1 affecting the rest of the Waikato and Waipa River catchments, which would provide some degree of flexibility between years.

  In noting this, it was also recognised that a rolling average approach would also impose its own discipline; assuming nitrogen leaching was above the NDA for one or two years, this then means that it would need to be reduced below the NDA for a period such that the average equated with the NDA.

- While some of the farmers noted that they were farming close to their NDA level, most admitted that they were farming somewhat conservatively relative to the NDA, given a (widespread) concern that they did not wish to breach the level. Especially given that the annual accounting is largely retrospective. Many are also farming conservatively because they want to have some flexibility, i.e. if they have a good autumn and want to take cattle to a higher weight for one or two months they can. It should be noted that farmers operating close to their NDA are also subject to more intensive auditing by WRC, and therefore face a higher monitoring cost.

  This meant, for the 2016/17 year, the aggregate underutilisation was 80.5 tonne[21] (or 8.4% of the total farm NDA allocation). Given the inherent practical difficulties of managing just at or immediately below the NDA level, this underutilisation of nitrogen is probably an ongoing feature of the nitrogen cap regime.

  But it does represent an opportunity cost to the farmers. In the absence of reliable data on the average return per kilogramme of nitrogen, the current price of nitrogen in the catchment (at $420/kg) is used as a proxy. In which case the 2016/17 under utilisation represents an opportunity cost of $33.8 million. Inasmuch as the current value of nitrogen, similar to land price, represents the present value of future cash flows, the $33.8 million figure is in itself a present value.

## 9.2 Land Values

While the farmers were well aware of the impact on land values, at this stage for many it is more of a psychological factor in the sense that, as they noted, the impact will not affect them until they come to sell the farm.

For the Ngati Tuwharetoa land owners, the issue is also somewhat academic. Given that they will never sell the land, they are much more concerned with the impact of the nitrogen cap on farm profitability rather than land value. In noting this, for Māori entities, Variation 5 did give the ability to sell off nitrogen and release some capital. This was, however, in effect selling off productive future value which for a long term land owner needed to be treated with caution. In effect, selling 20% of the nitrogen was like selling 20% of the farm.

Another factor raised by the farmers was that land values had appeared to firm slightly relative to outside the catchment, on the basis that within the catchment there was a greater degree of certainty, i.e. the rules are known, compared with the current uncertainty created outside the catchment by the Waikato Regional Council's proposed Plan Change 1.

Concern was expressed as to how well banks understood the system, and the flow on effects of reductions in land values. While the banks understand and take into account the value of nitrogen and the NDA's, and often hold security against this, nitrogen only has a value within the catchment and may not be readily saleable.

## 9.3 Big versus small farms

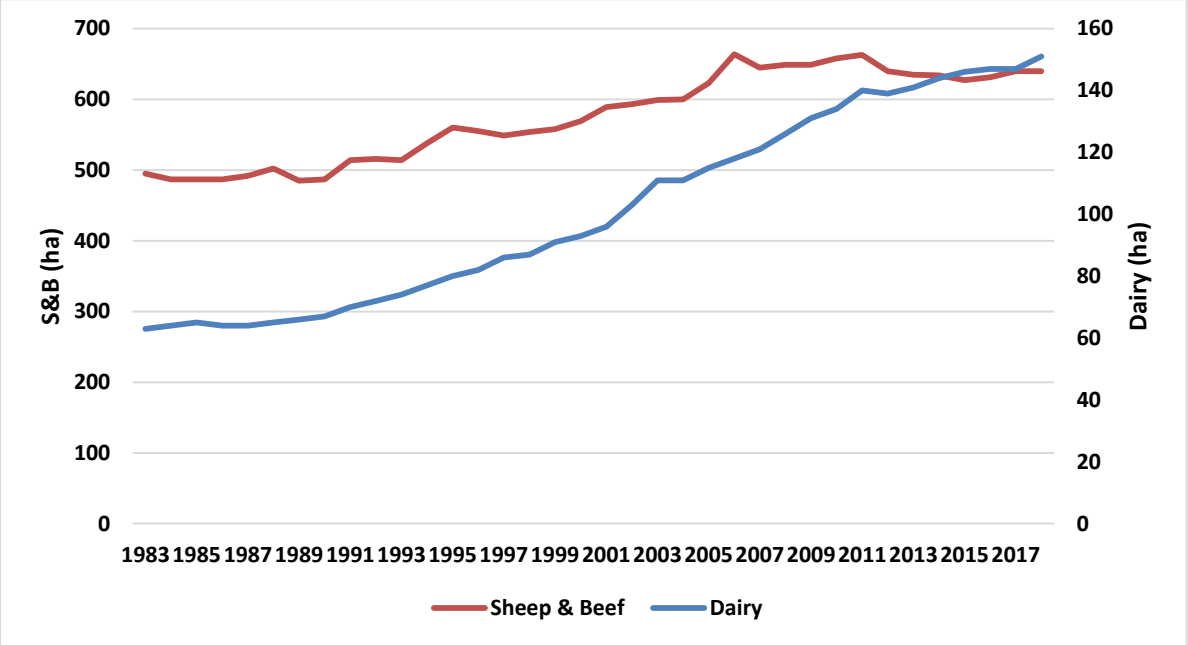
Discussion was also held on the impact of the nitrogen cap on smaller (i.e. less than 200 ha) properties compared to larger properties.

While there is no quantifiable data available, the feeling was that the smaller farms would struggle more, as the impact of the loss of flexibility would be greater, particularly as they are more affected by the general cost/price squeeze on farms. This is a phenomenon that has affected farming in New Zealand for decades; as the cost/price squeeze has continued, there has been a general move to amalgamate farms into bigger units, in an endeavour to create economies of scale.

[21] Based on a compilation of WRC monitoring records

This is illustrated in Figure 14:

**Figure 14: New Zealand average farm size 1983 – 2018**




In the absence of any technological breakthrough, it is very likely that this trend will continue, and within the catchment the most likely result is amalgamation of the smaller farms into bigger units, land use change to a yet-to-be-identified higher profitability/low nitrogen leaching activity, or possibly subdivided.

The comment was also made that the smaller blocks with low NDA's would effectively be doubly caught.

# 10.0 Nitrogen Trading

The imposition of a cap or allowance on nutrient discharge at a farm level obviously imposes a degree of restraint on the land use, or potential land use change. One means of improving the flexibility of land use within the constraint, is to allow trading in the nutrients (i.e. nitrogen*);* for individuals *trading provides flexibility and, in theory, reduces the cost of regulatory compliance* (Kerr *et al*, 2015), for society, trading reduces the overall cost of the policy.

Nitrogen trading was an integral part of the Variation 5 regulations, particularly as it enabled the Lake Taupo Protection Trust to buy out the required 20% of manageable nitrogen; trading started in 2009 and became fully operational in 2011 when Variation 5 became operative. Essentially the nitrogen market permits the transfer of NDAs around the Lake Taupo catchment by allowing any increases in nitrogen leaching on one farm to be offset by corresponding and equivalent reductions in nitrogen leaching on another farm, within the catchment. The Lake Taupo nitrogen trading system is currently the only diffuse-discharge trading system in the world.

Some people see 'cap and trade' as a constraint all in one, and it is important to note that it is the **cap** which imposed the constraint, and thereby achieves the environmental objective, whereas **trading** offers a degree of flexibility and a means of improving the efficiency of use of the restricted nutrient - in this case nitrogen.

Kerr *et al* (2015) report that by June 2014, the following number of trades had occurred:

**Figure 15: NDA trades in Lake Taupo catchment, to June 2014**

| Year | Number of trades to LTPT | Amount traded to LTPT (kgN) | Number of trades to farmers | Amount traded to farmers (kgN) | Total trades | Total amount of N traded (kgN) |
|---|---|---|---|---|---|---|
| 2009 | 3 | 17,242 | 3 | 12,184 | 6 | 29,426 |
| 2010 | 5 | 56,100 | 2 | 3,500 | 7 | 59,600 |
| 2011 | 4 | 43,614 | 2 | 1,311 | 6 | 44,925 |
| 2012 | 9 | 24,311 | 3 | 362 | 12 | 24,673 |
| 2013 | 2 | 9,799 | 1 | 113 | 3 | 9,912 |
| 2014 | | 0 | 1 | 164 | 1 | 164 |
| **Total** | **23** | **151,066** | **12** | **17,634** | **35** | **168,700** |

Source: Kerr *et al* 2015

The Trust achieved its goal of buying out 20% of the manageable nitrogen (170.3 tonne) by 29 June 2015, several years ahead of target (LTPT, 2015). Since that time further private sales have occurred (M Peck, LTPT Manager, personal communication).

Overall therefore, Kerr *et al* (2015) note that:

*The trading component of the policy package is achieving what it was theoretically meant to do - it is providing the flexibility for land to move to its highest and best use and still meet the overall nitrogen load targets to the lake. The regulatory cap was necessary to achieve, with certainty, the community goal of maintaining a healthy lake into the future. Trading has allowed this cap to be imposed in a more efficient and flexible manner. Assuming the cap was going to be achieved through regulation, the creation of the market probably provided a net benefit to the farmers in the catchment*.

The issue of nitrogen trading was also raised at the farmer workshops. Overall the vast majority were in favour of the concept, acknowledging that it allowed for a greater degree of flexibility within the constraints of the cap.

Several of the farmers had traded nitrogen, either buying or selling (or both), whereas several had not traded, and indicated that they probably never would. Some indicated that at the start of the Variation some farms had perhaps not fully understood the implications of selling, and now had some regrets, as the result has been a relatively low NDA, which now restricts their farming options.

In addition, the need to complete a new resource consent and the costs associated with this have put a number of farmers off trading.

An increasing feature is the leasing of nitrogen over a relatively short period, i.e. one to three years. Again this was seen as a means to improve the flexibility of the farming system, particularly allowing for a degree of opportunistic trading/finishing of stock. It is likely that the degree of leasing will increase on this basis, although as one farmer noted, the economics of such leasing depends very much on the lease price.

The advent of nitrogen trading means that nitrogen in the form of an NDA is a capital asset, and on a wider note is the issue around using capital to buy nitrogen to intensify a farming operation as opposed to using capital to buy more land. While the latter is often preferred it is the former that may in fact offer a greater return on capital, particularly if there is a direct value associated to a farm with a higher NDA (although the analysis is currently not highly supportive of this). Moving forward, both in and out of Taupo, farmers need to get their head around nitrogen being a long term investment, just as another 100 hectares is - and in fact another 1,000 kgN in a farm operation rather than another 100 hectares with a 10 kg NDA may in fact be a lower risk investment with greater future opportunities.

# 11.0 Discussion

This section references back to the questions raised in the objectives.

## 11.1 Financial impact on farmers

The imposition of a nitrogen leaching cap in the Taupo catchment has directly financially affected farmers in a variety of ways.

Farming in New Zealand has been affected by a cost/price squeeze for many decades, in the sense that costs have often risen at a faster rate than income, which has been a direct driver of farmers specialising in a production system (i.e. all dairy, all sheep and beef), intensifying the farming system, and in amalgamating farms into bigger units in order to achieve economies of scale.

Data on the farms within the catchment, albeit very limited, does not suggest that this impact is any different to the wider farming situation. In recent years, the improvement in product prices received by farmers has helped ameliorate this situation, notwithstanding that as farm incomes rise, farm working expenses also tend to rise.

As could be expected, land prices in the catchment have reduced relative to land outside of the catchment which is not subject to the same restrictions. Currently this reduction is in the order of 7-14%, which when extrapolated across the catchment, equates to $151 million. It is likely that this differential will shrink over time, as land outside of the Taupo catchment also becomes subject to much stricter nutrient discharge rules, and land values consequently reduce.

For the farmers, the most obvious impact has been the restriction on intensifying the farming operation, and/or reducing the flexibility of how they farm, which imposes an opportunity cost against the business. The estimate of the cost of this restriction, expressed as a Present Value at a 6% discount rate, is circa $144 million.

In addition to this is the opportunity cost of not being able to change land use to a more profitable but higher nitrogen leaching activity as a result of the leaching restriction. The obvious example here is conversion of existing pastoral farms to dairying in parts of the catchment that would be suitable, and the estimate of the cost of this restriction, expressed as a Present Value at a 6% discount rate, is $69.4 million.

There is also possibly an opportunity cost to forestry land owners in not being able to convert, but this is more difficult to estimate. Currently the financial cost of converting forestry to pastoral farming is very expensive, exacerbated by the high cost of the ETS carbon tax, which means that currently there is no opportunity cost for this activity. Ngati Tuwharetoa have indicated that one option they have considered is conversion of some forestry areas to housing. The opportunity cost of this is difficult to calculate, as it would depend on the specifics of the development, and whether any nitrogen would be required to be purchased in order to achieve the development (recognising that the purchase of the nitrogen would in itself be an opportunity cost).

One thing that needs to be recognised is that there is always an opportunity cost of any activity, but it depends on how realistic this opportunity cost is. In this respect, the answer to the question; is there an opportunity cost of having a restriction on nitrogen leaching from a farming business relative to not having such a restriction, is yes. But - the rules have now changed and the nitrogen leaching restriction is now the new reality.

Many of the farmers are farming (just) below their NDA level, as a conservative hedge against breaching the limit. The overall result of this is an underutilisation by 80.5 tonne of nitrogen in 2016/17

(8.4% of the total), which represents an opportunity cost of $33.8 million. In many respects this is a natural expression of not wanting to break the rules, in part exacerbated by the fact that the annual audit on the NDA level is retrospective. But it is a real cost to the farmers.

Part of the solution to this underutilisation is to look at evaluating the NDA on a three or five-year rolling average, which gives some flexibility to allow for unders or overs on an annual basis.

There are also additional compliance costs for the farmers, particularly relating to the annual monitoring and audit of their NDA. In addition to the time input by the farmers, there are direct cash costs from the Regional Council, as well as input provided by professional advisers (e.g. consultants, accountants). The estimated present value of this, at a 6% discount rate, is $4.7 million.

A summary of these costs is:

**Table 8: Summary of estimated cost impacts:**

| | **$ million** |
|---|---|
| Land value differential | 151.4 |
| Opportunity cost of: | |
| ➢ not intensifying existing farming system | 144 |
| ➢ no land use change | 69.4 |
| ➢ not fully utilising NDA nitrogen | 33.8 |
| Increased compliance costs | 4.7 |

It is important to note that all these costs are **not** necessarily cumulative. Economic theory would indicate that the opportunity cost of not being able to intensify production, or change land use, is a component of the land price. In essence, theory indicates that a potential purchaser would take into account the lack of opportunity to intensify and/or change land use and adjust their purchase price accordingly.

The overall estimated net cost of the nitrogen cap to farmers within the Taupo catchment therefore is:

**Table 9: Financial cost of the nitrogen cap to Taupo catchment farmers**

| | **$ million** |
|---|---|
| Land value differential | 151.4 |
| Opportunity cost of not fully utilising NDA nitrogen | 33.8 |
| Increased compliance costs | 4.7 |
| **Total** | **189.9** |

A possible addition to this is the opportunity cost to Ngati Tuwharetoa of the 11 tonne of nitrogen originally allocated for the development of undeveloped land. While the 11 tonne is valuable in itself, there is a potentially significant capital cost involved, meaning the estimated net present value of the opportunity cost is $587,000. This has not been included in the above summary because it is still possible that the 11 tonne may be made available, in which case there is no opportunity cost.

The $81.5 million expended by the Lake Taupo Protection Trust in achieving the 20% manageable nitrogen reduction (and other aspects of the Trust's activity) is a cost of achieving the nitrogen cap but is not a direct financial cost to the farmers.

## 11.2 Ability to trade nitrogen

The nitrogen trading regime is seen as a very useful tool, with analyses done by various authors indicating that it has been quite successful, a lesson that could be applied elsewhere.

Has it reduced the financial cost to farmers in the catchment? Basically, the answer is yes, in the sense that it has, for some farmers, increased the flexibility of their farming systems and/or allowed more intensive farming systems. The trading system also appears to be moving towards more of a short-term leasing approach, which again is assisting in increasing the flexibility of farming systems, particularly allowing for some short term unders and overs. In some ways this is a de facto 'rolling average' approach, in the absence of an actual rolling average annual NDA.

For some farmers though, the sale of nitrogen has adversely impacted on their farming systems, largely due to them not understanding, or investigating, the implications prior to sale. The result has been a relatively low NDA, which has limited the farming operation.

## 11.3 Have some farms been impacted more?

On the basis that the cost/price squeeze continues - a reasonable assumption given the last 50 years in New Zealand, it is the smaller and/or lower NDA farms which are likely to feel the financial pinch earliest.

This is difficult to readily quantify in the absence of case study information, but largely reflects the restriction on land development/farm intensification as a result of the nitrogen cap. In some ways this is an ongoing issue across all of New Zealand farming, where smaller farms have amalgamated up to endeavour to achieve an economy of scale.

How soon the nitrogen cap impacts on these smaller/low NDA farms would depend on the characteristics of the farm, and especially their financial structure; any that were heavily indebted, for example, are likely to be impacted earliest.

The most likely outcome over time could be:

(i) The farm continues, subsidised by off-farm income.

(ii) Is sold to/amalgamated into a larger unit.

(iii) Land use change - possibly to horticulture.

(iv) Subdivision.

(v)

## 11.4 Ongoing viability

What are the financial impacts of the nitrogen cap over the coming 20 years? Again the answer to this is difficult to quantify, as there are many factors which will influence this.

A key aspect to this is commodity prices received by the farmers; while these have improved in recent years, it remains to be seen how long this will be maintained. The long-term trend has been for a steady fall in the real price of commodities, which accentuates the cost/price squeeze. The Taupo catchment farmers are additionally caught in the sense that they cannot simply intensify their farming systems or bring more land into production, in order to counter falling prices.

One approach to counter this has been Taupo Beef, seeking a higher premium for their product, as an offset to the cost of not intensifying. How well this approach will work on a larger scale remains to be seen.

Another factor is the dynamic nature of farming, meaning farm systems and technologies are forever changing and adapting. The nitrogen cap was imposed in 2005; any farmer who is still using 2005 technologies and management systems is likely to feel the pinch much sooner than farmers who have changed their approach.

From the farmer discussions it would appear that some farmers are handling the new environment well, while others are struggling, largely dependent on their knowledge and understanding of the impacts of the nitrogen cap at the time. Which is perhaps a reflection of any cross section of the community.

Given the situation that the Taupo catchment farmers face, the options going forward, other than a yet to be discovered new technology, would include a mix of the following:

(i) Conversion of land to a higher profitability/lower nitrogen leaching activity. While some options are indicated in this report, none offer an immediate panacea, and are yet to be commercially proven in the Taupo environment;

(ii) Increased returns for the product, to offset the increased costs, which is essentially the route being taken by the Taupo Beef and Lamb farms; and/or

(iii) Improve the productivity of the farm business within the nitrogen cap. The ability to achieve this is very much a farmer aspect and takes time to achieve.

### 11.4.1 Land values

The impact on land values within the catchment has already occurred, and the probability of any further reductions relative to land outside of the catchment is unlikely unless a further reduction in nitrogen leaching is required. If anything, land values outside of the catchment are likely to adjust downwards as the impact of other Council plans unfolds.

In noting this, there are a number of key drivers of land values, and land values both within and without the catchment are likely to vary depending on these factors.

## 11.5 Extrapolation across the rest of the Waikato

The potential future impacts of nitrogen leaching restrictions across the wider Waikato region are likely to be much the same as those faced by the Taupo catchment farmers:

(i) Land values are likely to reduce.

(ii) Farmers will face opportunity costs with respect to not being able to intensify their farming operations and have reduced flexibility to adjust to short-term opportunities.

(iii) Compliance costs will increase.

(iv) Farmers are also likely to operate below their NDAs as a natural hedge against exceeding the NDA level, and as a means of maintaining some flexibility.

(v) Smaller farms and those with low NDAs are likely to feel the financial pinch the earliest.

(vi) There is likely to be an increase in the area of production forestry.

As discussed in the report, the impact in Taupo was effectively 10 years ahead of the rest of the region.

It is difficult again to be too definitive, as the wider Waikato region does offer a much larger scope for land use change into horticultural options; the Waikato region has the second largest absolute and proportional area of high-quality soils (i.e. LUCs 1,2,3) in New Zealand (Journeaux et al, 2017) and a range of climatic areas. All of which does offer a wider range of horticultural possibilities relative to the Taupo catchment.

The end result is likely to be a more mixed land use across the landscape, although the individual farms/orchards will still be monocultures, as this is dictated by economic necessity.

## 11.6 Further research and policy analysis

(i) The key factor within this analysis is the financial cost to the farmers within the catchment. Would this have been useful at the start of the process? Probably, but it would have been difficult to quantify, as the impacts take time to manifest themselves, and are heavily influenced by farmer behaviour, which in itself takes time to adjust. Would knowing the results in advance change the decision to cap nitrogen leaching? No. As discussed in this report, much of the land use carried out in New Zealand up until recent decades, did not readily take into account environmental impacts. This is now changing, and environmental externalities are being costed into our land use decisions. Although, having an idea of the cost does assist the debate around trade-offs.

If land uses are to be 'nutrient discharge limited' (and quite probably 'carbon discharge limited') then one of the main requirements is for the land owners affected to know what options are available, and the implications of these, to achieve the new limits.

Which is perhaps one of the main areas for research and analysis; what are the options that land owners can pursue in order to reduce their environmental impact. This is probably more of an industry/central government requirement rather than Regional Councils, but the latter have a role in pushing for the research to be done.

(ii) For the Council, understanding the drivers behind the financial cost would be useful in considering policy and regulations. While there is probably little that could be done directly to mitigate the restriction on intensification, apart from options and system research as noted above, there could be things that could be done to assist in the flexibility of the farming system within the nitrogen cap. Examples of this, using the Taupo catchment as an example:

(a) Overseer version. While there were good reasons for deciding on a set version of the model, its limitations are now well known, particularly the limit on the model accepting mitigation strategies. The policy issue here, apart from the specific issues with the version of Overseer, is that if a model is to be used, what are the likely implications as a result of farm system change and new technology, as well as changes in model version? For this later aspect, a discussion with Bay of Plenty Regional Council as to their 'relativity' process for handling Overseer version changes for their Plan Change 10 would be worthwhile.

(b) Flexibility around NDA levels between years. Currently the annual NDA accounting system does result in some reduction in flexibility and is one of the drivers in the 'NDA undershoot'. As discussed in the report, a five-year rolling average, as mooted for PC1, would directly assist in helping flexibility between years, and it taking advantage of short-term opportunities, notwithstanding it would also impose a discipline of its own - an over would have to be followed at some stage within the five years with an under.

Some policy analysis would help in developing a system which could directly assist in implementing such a rolling year average system.

(c) Directly associated with (b) would be the concept of 'sharing' stock between two farms for a defined period. As discussed in the report, if Farm A in the catchment has surplus feed and Farm B is short of feed, then there needs to be a mechanism whereby stock from Farm B can be grazed on Farm A, and the increase in nitrogen leaching on Farm A can be offset against the decrease on Farm B.

This same mechanism could also be used for stock grazing fire breaks/electricity pylon corridors within a forestry block, assuming the stock originated from a farm within the catchment.

(d) Part of the issue around flexibility is that the annual NDA audit is retrospective. Another factor which would assist would be to monitor the NDA in real time, which would involve modelling the impact on the NDA of any management changes at the time they are thought of, so that the farmer understands the nitrogen leaching implications of what is proposed and can therefore better farm to their NDA. In many respects this is a farmer responsibility, but the council does have a role via education, as noted below.

In short, council needs to undertake some analysis as to how it can improve farm system flexibility, while the farms involved, or the wider catchment, still operate within the overall cap. A significant opportunity cost to the farmers was via operating below their NDA, driven by a variety of reasons, of which concerns around flexibility was a major aspect. The issues outlined above would all help to alleviate this cost.

(iii) Another area is farmer education. It is apparent that some farmers have adapted much more readily to the new regulatory regime than others. In noting this, councils should not underestimate the level of support and knowledge transfer that is required for probably 25% of farmers in any region - the top 25% will understand the science and rules and make the most of opportunities, the middle 50% will carry on doing what they have always done and the bottom 25% will not understand the rules and long-term impacts and are at significant risk of making poor decisions.

This is not necessarily a council-only role; industry and central government have a distinct role to play in this as well, but again council is in a position to help force the issue.

(iv) Trading in diffuse discharges of nitrogen within the Taupo catchment is a world-first and has been quite successful. Another area for council analysis would be to look at how this can be transferred to other catchments and areas.

In the same vein, short-term leasing is becoming more prevalent, especially as a means to help farmers manage nitrogen more flexibly. Some research would be useful in looking at how the council can support this, particularly in making the leasing easier and less costly from a compliance view-point.

Also as discussed, the advent of trading means that nitrogen in the form of an NDA is now a capital asset, and farmers need to understand this. This is important in that farmers within a constrained catchment need to understand the difference in value of investing in more nitrogen compared to investing in more land or other investments. Again this is part of the farmer education aspect.

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# 13.0 Appendix 1: Taupo N Cap Workshop – Questions/Topics

1. What are the constraints you have identified as a result of the nitrogen cap?
   e.g. can't increase stocking rate, had to change stock type, can't develop more area into pasture.

2. What of these have had a real impact on your business?

3. How has that impacted on your profitability?

4. Have you reduced your stocking rate, or stock type? How/why?

5. What increased compliance costs can you identify?

6. If the cap did not exist, what would be different as to how the farm has progressed since the cap was imposed?

7. Is your farm suitable for dairying and/or further intensification - had you considered converting? If it was suitable and you didn't convert (before the cap) - why not?

8. Have you altered the value of your farm on your balance sheet? If not, why not; if yes, by how much?

9. Does this value reflect the change in rateable value?

10. What is your expectation of the impact of the cap on relative profitability between small (say less than 200 ha) properties, and those larger than 200 ha?

11. Similarly, what is your expectation of the impact of the cap on relative profitability between farms with a lowish NDA (say less than 12 kgN/ha), versus those with a larger NDA (say greater than 20 kgN/ha)?

12. What is your experience/expectation of improving your farm productivity/profitability under the cap? [Learnings from the monitor farm programme, other research]

13. What do you understand as opportunity cost - what would you say is the opportunity cost to you/your business, of the nitrogen cap?

14. What would you say is the impact of this opportunity cost on your overall business, versus the impact on day to day operation decisions?

15. What are your thoughts on the trading scheme - is trading useful?

16. What social impacts have you noticed - accessibility to contractors, impact on school role, etc?

17. How much time would you spend on NDA related matters - monitoring, audits, assessing stock management impacts, etc?

18. Any other comments?

# 14.0 Appendix 2: Social Impacts

While social impacts were not part of the project brief, they did come up in discussions with the farmers.

In addition to any financial costs, farmers also identified a range of social impacts that were/are of concern. This is apart from the stress of dealing with the whole process and need to acquire a resource consent to farm (Botha, 2012, Duhon *et al* 2015). Issues include:

- Impacts on the farming community as some farmers sell up and move out, farms are amalgamated, and/or new people move into the community. All of which affects the overall population within the catchment which in turn affects the social capital and resilience of the community.
- Concern at the sale and conversion of pastoral properties into forestry - a combination of the visual effect, a feeling of isolation (i.e. cut off from neighbours), the impact on the community as noted above, and the impact on land value and the saleability of land.
- The impact on community infrastructure and services - a concern at potential reduction in local school numbers, commercial viability of local services, e.g. contractors, vets, shearers, fencers.

All of these are inter-connected and represent a real 'cost' of the nitrogen cap and new regulatory regime. It is not readily possible to value these in a generic sense, as they vary depending on the individual, but still need to be recognised as a cost.

Another factor, noted by Richardson (2012) was the loss of the unrecognised benefits of pastoral farming, which he defined as:

*The tourism attraction which farming gives, the open vistas, the diversification of seeing livestock and people interacting in the environment. Well grassed pastoral land prevents erosion of our light pumice soils, well managed farms prevent the invasion of unwanted weeds which could potentially lead to higher N leaching, such as gorse and broom. Without the aid of farming money the pest control which has improved the health of our forests would be nowhere near as effective.*

Farmers thoughts on the current situation, as voiced at the workshops were:

- The impact around the top part of the catchment is not as bad as feared, as subdivisions and dairy conversions have resulted in more people within the community, and the local school role has increased. Part of this effect is due to a tight rental market in Taupo pushing people out into the rural areas.

- The situation around the southern and southwestern part of the catchment is different, as subdivision has not been readily allowed, and combined with the increase in forestry areas has seen a fall in the local school roll.

- There was some comment that the community now 'feels different', with more transient people moving through the community.

- Access to contractors varies, with farmers noting that with the reduction in the farmed area shearers and fencers are scarcer, although this is also a national trend. Several mentioned that access to docking crews was now much harder.

- A number of the Ngati Tuwharetoa farms noted that in the past they had a number of houses on the farm which were occupied, whereas now many are not, due to the reduction in work available.

- With the increase in forestry, and subdivision into small lifestyle blocks, there was some feeling of missing farming neighbours, particularly around the ability to share machinery.

- There was some comment from the larger farms that attracting managers, particularly given the level of compliance required and restriction on farm development/farm flexibility, is likely to be more difficult.

Two other aspects raised by the farmers as part of these discussions were:

- Several raised concerns that lifestyle blocks were not regulated as per the farms, pointing out that many ran relatively high stocking rates, and hence would have high nitrogen leaching levels, on top of septic tank discharges. But were free to do so.

- Concern over the use of Overseer as the tool to measure nitrogen leaching. This was with respect to two aspects:

  - That the current version used (5.4) did not accommodate any mitigation strategies, and therefore hindered the adoption of these mitigation practices; and
  - The farmers were nervous about the implications of moving to the latest version of Overseer, which is very likely to show higher nitrogen leaching levels relative to the current version used, and uncertainty as to how the Council will handle this.

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