Economic impacts of minimum flow regimes on the Lindis River

A report to Otago Regional Council

March 2015

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Background

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Reference No: 5548

March 2015

Executive Summary

Current Regional Plan changes are considering the setting of minimum flows – where all water permits (existing and new ones) will be made subject to the minimum flow. Where existing consents are reviewed: a new condition - making the consent holder subject to the minimum flow – will be added or existing conditions on the consent will be altered. Deemed permits/mining privileges are exempt from the minimum flow, but replacement consents that are issued under the RMA will be made subject to the minimum flow.

It is argued that restricting water allocations will result in significant environmental benefits without necessarily having negative impact on economic activity. This report examines what the economic impacts would be if proposed minimum flow levels of 450 L/s, 750 L/s, and 900 L/s were introduced.

This report has focussed on those land areas exclusively dependent on the Lindis catchment for their irrigation needs. The command areas which are able to draw from the Clutha River or aquifer if and when access to Lindis water is restricted were excluded, as production in these areas would presumably be able to continue regardless of any minimum flows in the Lindis catchment.

The lower Lindis catchment is one of the driest areas in New Zealand, with low rainfall combined with high temperatures throughout summer. This has a substantial impact on irrigation in the catchment area as it means that the naturalised flows of the Lindis catchment diminish or dry up to the extent that water takes are already subject to substantial fluctuations and natural restrictions. This is before a minimum flow has even been introduced.

For instance, under the current primary allocation limit of 4,134 l/s, in a 240 day irrigation season, water takes would be restricted for an average of 49 days. Put simply, given the climate and natural environment in the Lindis catchment, water takes from the Lindis catchment will almost certainly be subject to take restrictions even without a minimum flow in place.

This assessment has taken the approach of analysing the number of available irrigation days per irrigation season and adjusting changes in land use accordingly. The two scenarios of there being no irrigation at all, and current levels of irrigation (i.e. the naturalised flows), were treated as being at the two extremes of a continuum. The hydrological analysis conducted by Opus then allowed us to approximate where on this continuum the three different minimum flows would sit.

The various levels of proposed minimum flows would lead to some change in land use; namely from intensive sheep farming, to more-extensive sheep and beef and breeding and finishing. From this, we determined the change in gross margins. The greater the minimum flow imposed, the fewer irrigation days per season available. This would lead to a greater shift away from intensive finishing farming and towards farm types requiring less irrigation but also lower gross margins. However, the magnitudes of the decreases in gross margins with minimum flows imposed are not particularly large as seen in the following table.

Lindis irrigation zone	Current flow	Restricted Lindis flows		
	NoMin	450 l/s	750 l/s	900 l/s
Total irrigation days per season	191	171	159	154
Total Gross Margin ($'000)	$1,755.9	$1,693.2	$1,656.8	$1,640.7
Gross margin reduced by (%)		3.6%	5.6%	6.6%

Overall, the analysis revealed that the imposition of minimum flows *would* have some negative bearing on economic activity in the catchment, District and Region, but that the magnitude of the impact would be relatively small in an average year.

There are opportunities for producers in the Lindis-dependent irrigation area to mitigate the current constraints on land use resulting from the variations in the naturalised flow in the Lindis Catchment, by increasing the irrigation efficiency of their use of Lindis water. These measures would also to some extent mitigate any constraints due to a minimum flow regime.

The overall production from the Lindis-dependent irrigation area could be increased by investments to improve the Lindis water supply reliability. Opus cost estimates based on their current experience with other schemes indicate that the capital coasts of off-farm, and on-farm infrastructure to achieve reliable supply on the 2,500 hectares would cost between $51 million, and $107million, or about $20,000 to $40,000 per hectare. The operation and maintenance cost would be between $840 and $1,670 per hectare per year. Actual costings of increasing reliability would require detailed design of options, investigation of possible land use changes and development of an investment business case for the selected option for the Lindis-dependent area.

We have given some consideration to the potential tourism impacts of increased minimum flows at Ardgour Bridge. We understand that this could result in greater trout angling opportunities. However an angler survey some years ago indicated that the Manuherikia catchment has more attraction to anglers than the Lindis River. In any event there are other similar attractions with the Clutha River, Manuherikia River and Lake Dunstan all in the same area.

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1 Scope of this report

1.1 Aim of the analysis and report

The aim of the analysis undertaken and reported on is to provide an approach and method to assess the potential production and economic impacts of imposing minimum flow levels on the Lindis River.

The intention is that the general approach could then be applied to assessing the potential production and economic impacts of imposing minimum flow levels on other rivers in Otago.

1.2 Limitations of the analysis

Our report is based on summary data on land use etc. as provided. This information is investigated to determine what the likely changes in production and economic activity would be of imposing minimum flow levels on the Lindis River. Official and published, defensible information is used where relevant to obtain an order-of-magnitude of the expected production and economic impacts.

The analysis is NOT based on detailed surveys of actual land use, production levels, and economic impacts of actual present production in the relevant areas of the catchment. If this matter proceeds to the Environment Court, a fully detailed survey of the current land use and its economics will be necessary.

1.3 Layout of this report

This report is comprised of two main parts, with Part One covering the land use, production and economic impacts of present production, and the production expected if three different levels of minimum flow were imposed on the Lindis River. The first part has been substantively completed by BERL economics in consultation with Opus International Consultants Limited, Wellington.

Part Two covers the hydrological analysis of the Lindis catchment, and its current water takes. It shows historical analyses of the impacts on water available for irrigation currently due to climatic factors, what the impact would have been if all irrigation water had been used efficiently; and if three different levels of minimum flows were imposed. The second part has been completed by Opus International Consultants Limited, Wellington.

1.4 Intentions on water flows, and current demand

The Central Otago area is a region of New Zealand in which water is in many places essential for pastoral, arable and horticultural production. Parts of Central Otago have the lowest rainfall in New Zealand, with areas of low elevation experiencing approximately 350mm per annum, and there is a large area of semi-arid land. Areas in the ranges, however can receive in excess of 1400mm of rainfall per annum.

1.4.1 Minimum flow proposal

Changes being considered for the Regional Plan to apply minimum flows in rivers, such that all water permits (existing and new ones) will be made subject to the minimum flow. Where existing consents are reviewed: a new condition - making the consent holder subject to the minimum flow – will be added or existing conditions on the consent will be altered. Deemed permits/mining privileges are exempt from the minimum flow, but replacement consents that are issued under the RMA will be made subject to the minimum flow.

It is argued that restricting water takes allocations will result in significant environmental benefits without necessarily having a significant negative impact on economic activity. Such a management regime is likely to be even more effective following the expiration of a large number of "mining privileges" in 2021.

The proposal is that there will be a "The primary allocation limit is set *to provide certainty regarding the availability of water resources for taking, while ensuring the effects of takes on the life-supporting capacity for aquatic ecosystems and natural character of rivers are no more than minor."*

Abstraction from the primary allocation will be linked to a minimum surface flow i.e., *"When river levels drop below the minimum flow any permits to abstract water takes under primary allocation consents, except deemed permits/mining privileges will have to cease."*

The minimum flows and primary allocation limits for catchments will be determined through a community consultation process and consideration of their potential environmental, socio-economic and cultural impacts.

This current work is to assess the scale of likely economic impact of imposing such minimum flows.

1.4.2 Current water demand and zones

Currently, the sum of consented maximum instantaneous water takes has been estimated to be 4,141L/s for the Lindis River. The catchment is considered over-allocated.

Water from the Lindis water is abstracted for use in three irrigation 'zones' as follows:

- Areas irrigated by water sourced solely from the Lindis River and adjacent groundwater. This could be called the 'Lindis irrigation zone';
- Command area 13.362, which is irrigated by either water from the Lindis catchment or from the Clutha River; and
- Command area 13.451, which is irrigated by either water from the Lindis catchment or from the Clutha River.

It should be noted that some areas in the 'Lindis irrigation zone' also appear to be serviced by the two different command areas (i.e. 13.362 & 13.451). Consequently there may be some 'double accounting' in the hydrological analysis resulting in a conservative assessment of water availability i.e. slightly greater apparent water demand.

It has been argued that the setting of allocation limits and minimum flows will result in increased efficiency, as well as increased environmental benefits and services. For example, in 2011 approximately 2,300L/s of water was allocated to irrigate up to 2,000ha, according to feedback from the local community provided to the Otago Regional Council in 2011. Analysis has shown that the actual agricultural need for water is only 1,000L/s. Questions, however, still remain over the relationships between actual water use, water need, water demand, and allocation, and Part Two of this report explores those relationships.

1.5 Impacts of Lindis water availability on irrigation zones

Of the three irrigation zones described above, only one will have its production levels directly affected by the level of availability of Lindis water. That zone is the one described as the Lindis irrigation zone. The only current source of water available for irrigation in this zone is that from the Lindis

River and groundwater. The production levels in this zone are therefore now, and will in future be directly affected by the water availability from the Lindis River and groundwater.

The other two irrigation zones, Command area 13.362, and 13.451 can be irrigated by either water from the Lindis catchment, or from the Clutha River. Consequently if water for irrigation is not available from the Lindis Catchment, the irrigated production in these zones can be maintained by continuing irrigation using water from the Clutha River. Obtaining water from the Clutha River may come at some additional commercial cost, e.g. for pumping from the Clutha River, however the level of economic production can be maintained.

1.6 Direct impacts of Lindis water for irrigation

Given that irrigation can continue in the two Command areas, whether or not there is water available to them from the Lindis Catchment, the economic impact work now analyses the change in production and consequent economic activity derived from the Lindis irrigation zone alone.

The approach is to analyse the level of production at the two extreme ends of the spectrum, namely in the Lindis irrigation zone with current irrigation, given current water availability, and then the Lindis irrigation zone with no irrigation.

We then estimate the level of water availability with each of the three levels of minimum water flows in the Lindis River, and estimate the extent to which the production level will be reduced from current levels, towards the production level with no irrigation.

2 Lindis zone current land use and economy

The current section describes the land in the Lindis irrigation zone, namely that identified as obtaining irrigation water from only the Lindis River and groundwater. It derives an estimate of land use and production from available maps and farm production data under the current irrigation regime.

The next section will estimate the impacts of minimum flow regimes on that production.

Water from the Lindis water is abstracted for use in three irrigation 'zones' as follows:

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- Command area 13.451, which is irrigated by either water from the Lindis catchment or from the Clutha River.

Full maps of the Lindis irrigation zone and the two Command areas are given in Part Two, the hydrological analysis by Opus. The maps in this land use and economic impact section of the report are the maps of the Lindis irrigation zone. This zone includes some overlap with the two Command areas. These overlaps have the opportunity to obtain water from the Clutha if there is insufficient from the Lindis catchment. For that reason the overlap zone is omitted from this land use and economic impact analysis.

We have received two descriptions of the land use on this land:

- the Agribase dataset which describes land use in terms of the broad farm type on the land, such as Sheep farming, mixed sheep and beef farming, lifestyle block etc.; and
- the LCDB2 dataset which classifies the land in terms of the surface cover of the land, such as High-producing exotic grassland, depleted tussock grassland, surface water, etc.

By considering the maps of these two land use classifications, and the nature of the relief of the specific area of land it is possible to interpret and deduce the pattern of farming system on the different areas of land. For example relatively flat land in sheep farming, with mostly high-producing exotic grassland, and some short rotation cropland can be expected to be intensively farmed.

2.1 Land use data 2014 and interpretation

We have initially taken the area in this land irrigated from the Lindis River, and by comparison of the maps, have derived estimates of the land use in 2014. As a second step we show the land overlapping both the Lindis irrigation zone, and the two Command areas.

2.1.1 Land use in Lindis irrigation zone including overlap areas

The maps of the Lindis irrigation zone area with the Agribase farm type and the LCDB2 land cover types are shown below.

We have included only those areas irrigated by water sourced from within the Lindis catchment, either surface or groundwater. ·These areas are those mapped by ORC and presented in one of the PowerPoints they provided us.

Figure 1: Agribase farm types on land irrigated from the Lindis River

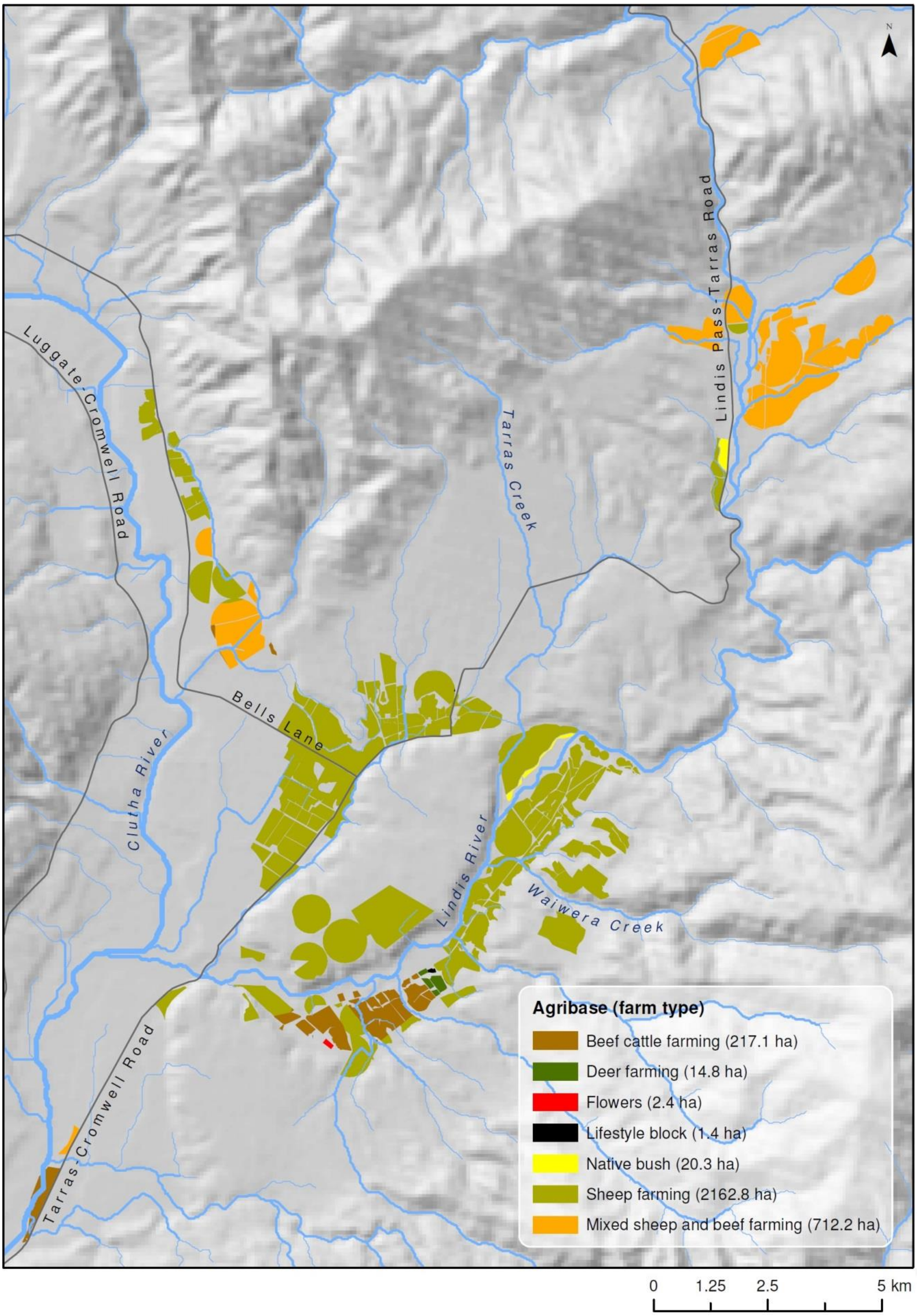
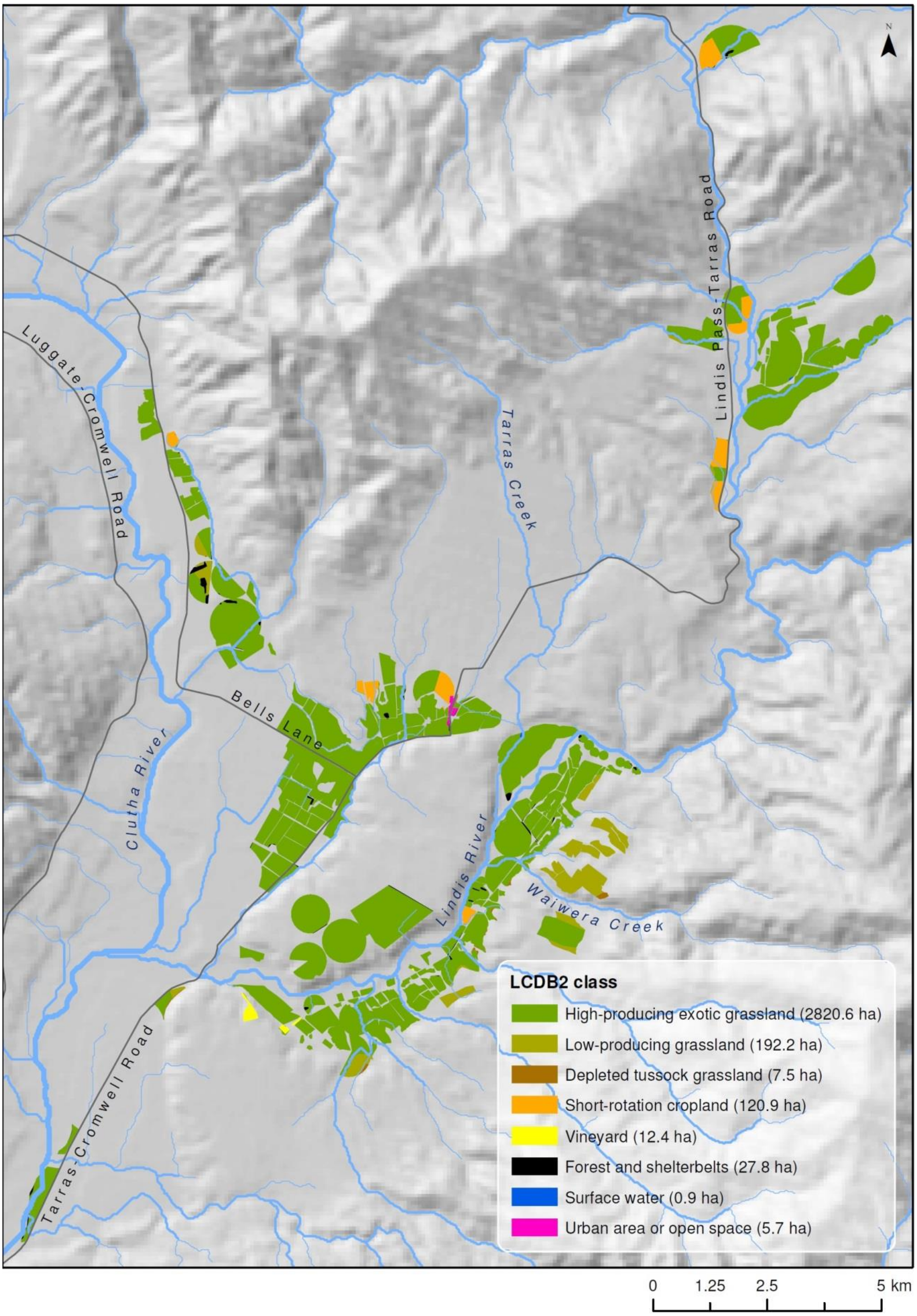


Figure 2:LCDB2 classes of ground cover on land irrigated from the Lindis River



We have mapped the 'Farm Type' – as shown on the Agribase data. We have done no quality assurance of these data but have assumed they are accurate.

We note that there are several areas which would appear to be under 'centre-pivot' irrigation and are mapped as either 'sheep farming' or 'mixed sheep and beef farming'. We understand that these areas are mainly in dairy support land use. The surface cover is either high-producing exotic grassland or the associated short-rotation cropland. The economics of the land use as dairy support on this type of farming system is very similar to that of sheep intensive finishing land use as discussed below. These centre-pivot areas are therefore analysed as a part of the sheep intensive finishing land use.

We have also mapped the 'Land cover' from the national Land Cover Data Base V2. While this does not directly correlate with farming activity or practices there is a reasonably strong correlation, and the relationship between farm type and land cover enables us to interpret the likely intensity of land use, especially in pastoral farming.

The land areas in each classification are shown in summary in the following tables.

Table 1: Agribase land use areas

Farm type	Area (Ha)
Beef cattle farming	217.1
Deer farming	14.8
Flow ers	2.4
Lifestyle block	1.4
Native bush	20.3
Sheep farming	2,162.8
Mixed sheep and beef farming	712.2
Total	**3,131.1**

Source: Agribase

Table 2: LCDB2 land cover areas

LCDB2 class (generalised)	Area (Ha)
Depleted Tussock Grassland	7.5
Forest	27.8
High Producing Exotic Grassland	2,820.6
Low Producing Grassland	192.2
Short-rotation Cropland	120.9
Surface w ater	0.9
Urban area or open space	5.7
Vineyard	12.4
Total	**3,188.1**

Source: LCDB2

By comparing the Agribase farm types in different areas on that map, with the LCDB2 land cover on the other map we have been able to determine where a certain farm type has land all with the same cover, as for example beef cattle farming has all land covered in high-producing exotic grassland. Other land uses have a range of different land cover, as with the two sheep farming types. These also share some land cover e.g. short-rotation cropland, and so these land cover areas must be allocated to the respective farm types.

This allocation is shown in the table below.

Table 3: Estimated land cover areas in each farm class

Farm type	Pasture type	Approximate area (Ha)	Total Area (Ha)
Sheep farming			2,162.8
	Low-producing grassland	186.0	
	Depleted tussockgrasland	7.5	
	Shelterbelts	7.5	
	Short rotation cropland	70.0	
	High producing exotic grassland	1891.8	
Sheep farming intensive productive area		*1961.8*	
Mixed sheep and beef farming			712.2
	Low-producing grassland	6.2	
	Short rotation cropland	50.9	
	High producing exotic grassland	655.2	
Mixed sheep and beef farming intensive productive area		*706.1*	
Beef cattle farming			217.1
	High producing exotic grassland	217.1	
Deer farming			14.8
	High producing exotic grassland	14.8	
Flowers			2.4
Vineyard			12.4
Lifestyle block			1.4
Native bush			20.3
Urban area or open space			5.7
Total irrigated land (excludes Urban area or open space)			**3,143.5**

Source: Agribase, LCDB2 and BERL, 2014

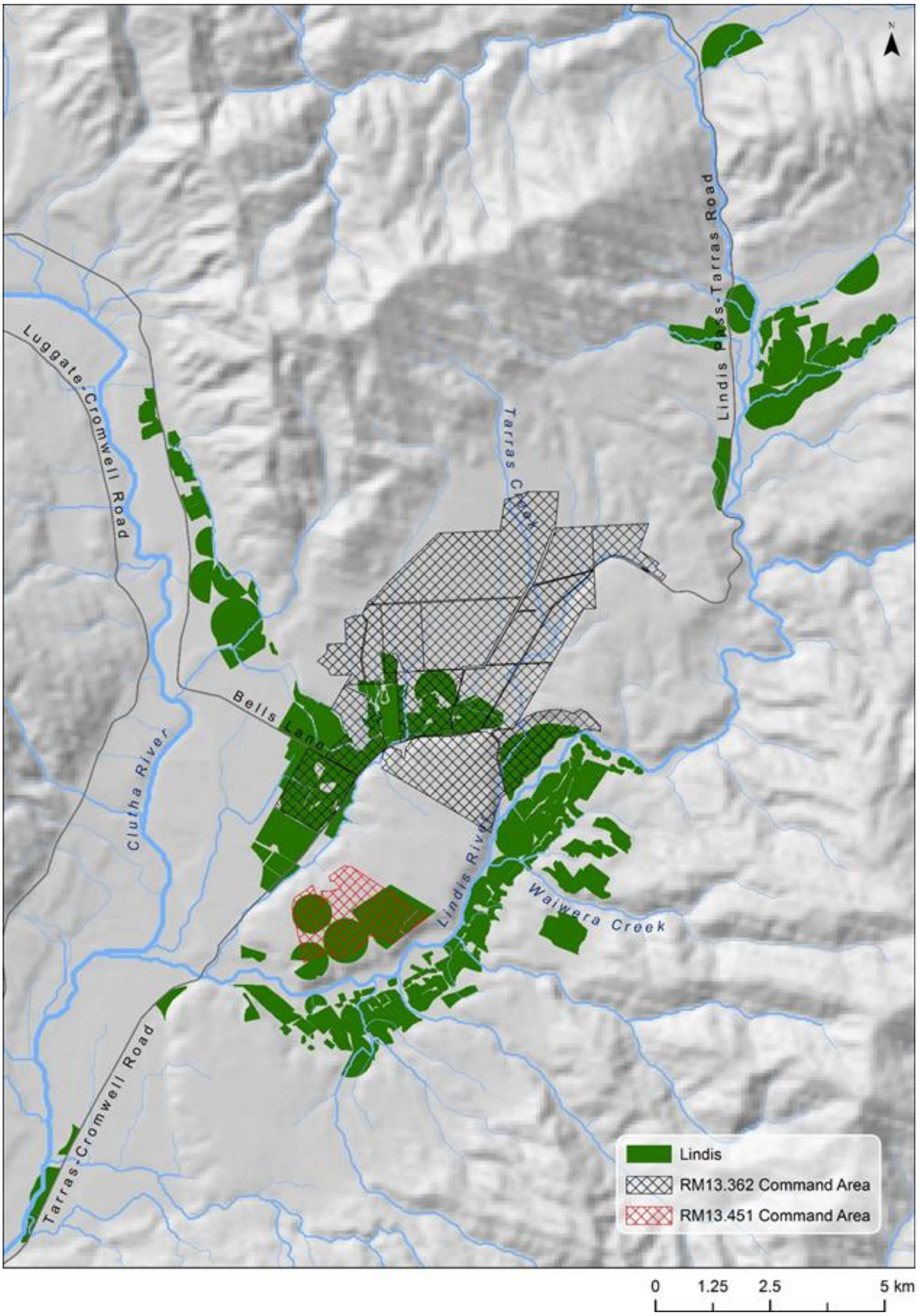
The main substantive findings for estimating agricultural production are the figures of the productive areas in high-producing exotic grassland and short-rotation cropland in sheep farming (1,961.8 hectares) and mixed sheep and beef farming (706.1 hectares), as other pastoral land uses had all their land cover in high-producing exotic grassland.

2.1.2 Reduction of Lindis irrigation zone by the overlap

The areas covered by the Lindis irrigation zone, and the two Command areas have been mapped by Opus in such a way that they are able to estimate the area of the Lindis irrigated zone excluding the Command area overlap. This area is 2,420 hectares which is 711 hectares less than the 3.131 hectares shown on the Agribase land use map above.

Comparison of the three maps shows that the overlap area is all in that area found in the work above to be sheep intensive finishing. Its land cover is mainly high-producing exotic grassland, together with some short-rotation cropland, used in the finishing. Therefore the land area used in sheep intensive finishing is the 1,961 hectares in the table above, less 711 hectares which leaves 1,250 hectares.

Figure 3: Three irrigation zones showing the overlapping areas



2.2 Current pastoral production estimates with irrigation

The Agribase farm types indicate that the pastoral farm type was dominantly sheep farming, with a lesser area of mixed sheep and beef farming, and smaller areas in beef cattle farming, and deer farming. We would be very surprised if the area designated sheep farming, with quality pasture and feed crops under irrigation, is only farming sheep, without some beef production also.

In New Zealand pastoral systems there is in most cases farming of sheep together with more or less cattle according to local conditions. In some areas deer are included and in others deer are run on separate farming operations. What this implies is that pastoral farming described as sheep farming is likely to include some cattle as well. Similarly pastoral farming described as cattle farming is likely to include some sheep as well.

The level and extent of quality pasture will determine whether the farming is intensive finishing, or the more extensive breeding and finishing.

We have not completed a survey of detailed land use in the Lindis catchment, and so have assessed the likely farming pattern from the combination of grassland and cropland types recorded in the LCDB2 mapping.

In order to use defensible coefficients of pastoral production, we have related each pastoral land use of sheep and cattle farming to a farm class in the Beef and Lamb NZ class distinctions as outlined below. To assist in this we investigated the regional scope and the ratio of sheep and cattle revenue in Classes which we believe are likely to quite closely reflect the farm types described in the Agribase dataset respectively as, Sheep farming, Mixed sheep and beef farming, and Beef cattle farming.

Bearing in mind that the sheep farming land was mostly covered in high-producing exotic grassland, had associated feed crops, and had irrigation available, we assess that the land is capable of intensive stock finishing, predominantly sheep typical of the South Island Class 7, Sheep farming – intensive sheep. The Mixed sheep and beef farming had some low-producing grassland, and was on land with more relief than the sheep farming land and so we assess the production as likely to be the slightly less-intensive South Island Class 6, Sheep and beef farming, finishing and breeding.

The beef cattle farming farms present somewhat more of a problem, because there is no specific B&L NZ class for predominantly beef cattle farming in the South Island. We therefore investigated the B&L NZ Class 5, North Island Beef farming – intensive finishing. The coefficients for this class are likely to be similar to beef farming in Central Otago, on mostly high producing exotic grassland on river flats, with irrigation available. The characteristics are as follows.

Table 4: Production characteristics of pastoral farm types

Farm type	BLNZ Class	Production characteristics			
		Average effective area	Carrying capacity	Livestock revenue shares	
		Hectares	*Stock units per hectare*	*Sheep percent*	*Cattle percent*
Sheep intensive finishing	Class 7	220	11.6	82.6%	7.6%
Sheep and beef breeding and finishing	Class 6	480	8.0	65.3%	22.6%
Beef intensive finishing	Class 5 NI Finishing	290	9.2	40.3%	54.5%
Deer intensive	n.a.				

Note that the carrying capacity is the number of stock units able to be carried year-round. In the case of the sheep intensive finishing and the beef intensive finishing is it most probable that on these Classes of farms, in any year the land will finish more than one batch of store animals through to finishing. This will mean that the total number of stock units handled will exceed the average carrying capacity.

Each farm class is now described in more detail.

2.2.1 Sheep farming – intensive finishing

The sheep farming farm type in the Agribase database, on exotic pasture, with supplementary feed crop and irrigation is postulated to have production characteristics that correspond to the Beef and Lamb NZ Class 7.

- BLNZ classification – Class 7 (South Island Intensive Finishing); estimated 1,306 farms in this class.
- General description of what it is - High producing grassland farms carrying about 10 to 14 stock units per hectare, with some cash crop. These farms are located mainly in Southland, South and West Otago.
- Pastoral land within this Class is a mixture of Short rotation cropland and High producing exotic grassland, with the latter being the predominant source constituting approximately 96 percent of intensive finishing pastoral land area in the catchment.
- Total acreage – 1,250 hectares of irrigated Class 7 land in the Lindis catchment area.
- Significance to local area is that as a proportion of total irrigated land area, this is approximately 67 percent of total irrigated land within the Lindis catchment, making sheep farming intensive finishing the largest type of pastoral production area. With a total of 2,162.8 hectares dedicated to sheep farming in general in the catchment area, 1961.8 ha or 90.7 percent of this is intensive finishing sheep farming.

2.2.2 Sheep and beef farming – finishing and breeding

- BLNZ classification – Class 6 (South Island Finishing Breeding)
- General description of what it is – an estimated 2,690 farms in the South Island. A more extensive type of finishing farm, also encompassing some irrigation units and some cash cropping. Carrying capacity ranges from six to eleven stock units per hectare on dryland farms and over twelve stock units per hectare on irrigated units. Located mainly in Canterbury and Otago, this is the dominant farm class in the South Island.
- Land type i.e. depleted tussock vs high producing exotic grassland – mixture of low producing grassland, short rotation cropland, and high producing exotic grassland. In terms of intensive production area for mixed sheep and beef farming, this is constituted of short rotation cropland and high producing exotic grassland, of which the latter made up the majority of at 92.8 percent.
- Total acreage – 706.1 hectares of irrigated Class 6 land in the Lindis catchment area.

  Significance to local area as a proportion of total irrigated land area – this is approximately 24.2 percent of total irrigated land within the Lindis catchment, and is the second largest type of pastoral production area in the catchment.

2.2.3 Beef farming – intensive finishing

- BLNZ classification – there is no Class which pertains specifically to South Island intensive finishing beef farming; the closest equivalent in Class 5 from the North Island, which we have used to approximate the characteristics of intensive finishing beef farming in Central Otago.
- General description of what it is – this type of farm consists of easy contour farmland with the potential for high production, mostly carrying between eight and 15 stock units per hectare. A high proportion of stock is sent to slaughter and replacements are often bought in.
- Land type i.e. depleted tussock vs high producing exotic grassland –consists of high-producing exotic grassland.
- Total acreage – 217.1 hectares of irrigated Class 5 (North Island used as an approximation) in the Lindis catchment area.
- Significance to local area as a proportion of total irrigated land area – this is approximately 7.4 percent of total irrigated land within the Lindis catchment, and is the third largest type of pastoral production area in the catchment.

2.2.4 Deer farming – intensive

- Deer farming predominantly consists of high-producing exotic grassland.
- Total acreage – 14.8 hectares of irrigated land used for deer farming in the Lindis catchment.
- Significance to local area as a proportion of total irrigated land area – this is approximately 0.5 percent of total irrigated land within the Lindis catchment.

The actual system of deer farming can determine the production economics, and this will require further information from a later survey if the work is taken further.

2.3 Current horticultural production estimates with irrigation

2.3.1 Vineyard

- Vineyards make up 12.4 hectares or 0.43 percent of total production area in the Lindis catchment.
- Mapping out the land use in the catchment indicates that these 12.4 hectares are on land that is similar to that used for intensive finishing farming which will likely consist of high-producing exotic grassland.

While the actual production, grape yield and value will depend upon the grape variety, etc., we have generated average yield, revenue and cost data working from an earlier MAF Policy report[1] on irrigation, and from recent New Zealand wine production data[2].

2.3.2 Flowers

- At only 2.4 hectares of irrigated land used for flowers in the Lindis catchment, it is the second smallest type of production area in the catchment. Mapping details of the land area used for flower production indicates that the area in question is all concentrated on one farm or land

[1] *Waters of national importance for irrigation, water programme of action*, MAF Policy. August 2004.33pp.
[2] *Annual report 2014*, New Zealand Winegrowers. 32pp

parcel. Given its relative diminutive size, flower 'farming' does not constitute a significant proportion in terms of irrigated land area.

The actual economics of this very small area of flower production is likely to be very dependent on the specific operation. Rather than postulate a general level of production and value, this requires specific information on the enterprise itself, obtained from a survey if the work is taken further.

2.4 Summary of estimated current economic production

Working from the economic parameters at the per hectare level for each of the three B&L NZ farm classes for 2013-24 we have estimated the total revenue and total gross margin from the area irrigated from Lindis water sources. We have included our estimate for the vineyard productivity, but deer production and flower production require more-specific information on their actual production types to give meaningful estimates. Also they comprise a very small component of production.

2.4.1 Total revenue and gross margin

The summary is that our current estimate of revenue (or gross output) from the main pastoral farming types using irrigation from Lindis water sources is approximately $3.7 million per year.

The total gross margin from this activity is approximately $1.76 million per year.

Table 5: Estimated revenue and gross margin from farm types with irrigation

	Total area	Revenue	Farm working expenses	Gross margin	Total revenue	Total gross margin
Farm type	*Hectares*	*$ per hectare*	*$ per hectare*	*$ per hectare*	*$'000*	*$'000*
Sheep intensive finishing	1,250.8	1,850.00	980.00	870.00	2,314.1	1,088.2
Sheep and beef breeding and finishing	706.1	1,319.00	664.00	655.00	931.3	462.5
Beef intensive finishing	217.1	1,510.00	773.38	736.62	327.8	159.9
Deer intensive	14.8	n.a	n.a	n.a	n.a	n.a
Vineyard	12.4	9,000.00	5,350.00	3,650.00	111.6	45.3
Flow ers	2.4	n.a	n.a	n.a	n.a	n.a
Total	**2,203.6**				**3,684.8**	**1,755.9**

2.4.2 Employment impact of current irrigated production

The direct employment impacts of irrigated production are limited.

Labour units per 100 hectares were sourced from the three B&L NZ farm classes for the key pastoral farm types while labour units for vineyards were sourced from 2006 Statistics NZ Census figures.

Using Statistics NZ Census figures, we approximated productivity per labour unit of a vineyard worker (i.e. grape grower/picker) to be 4 hectares per labour unit. This then would equate to an equivalent of 25 labour units per 100 hectares, making vineyards the most labour intensive of the various farm types in the Lindis catchment area, significantly more so than any of the other farm types. However given that there are only an approximate 12.4 hectares of vineyard in the catchment, the total number of labour units is relatively small at 3.11.

Table 6 Estimated employment with irrigation

	Land use with irrigation (Ha)	Labour units per 100 Ha	Total labour units
Sheep intensive finishing	1,250.8	0.60	7.51
Sheep and beef breeding and finishing	706.1	0.35	2.47
Beef intensive finishing	217.1	0.50	1.09
Vineyard (with irrigation)	12.4	25.00	3.11
Total	**2,186.4**		**14.2**

Meanwhile labour use among the pastoral production farm types (i.e. sheep and beef) is much lower, with less than one labour unit per 100 hectares. Overall, total labour units across these four farm types is 14.2 labour units.

3 Lindis zone restricted water land use and economy

The aim of this section is to build scenarios of the impact on current land use and economy in the Lindis irrigation zone if water takes for irrigation were restricted in order to maintain three different levels of minimum flow. The three minimum flows at the Ardgour Road modelled here are 450 Litres/second, 750L/s and 900L/s.

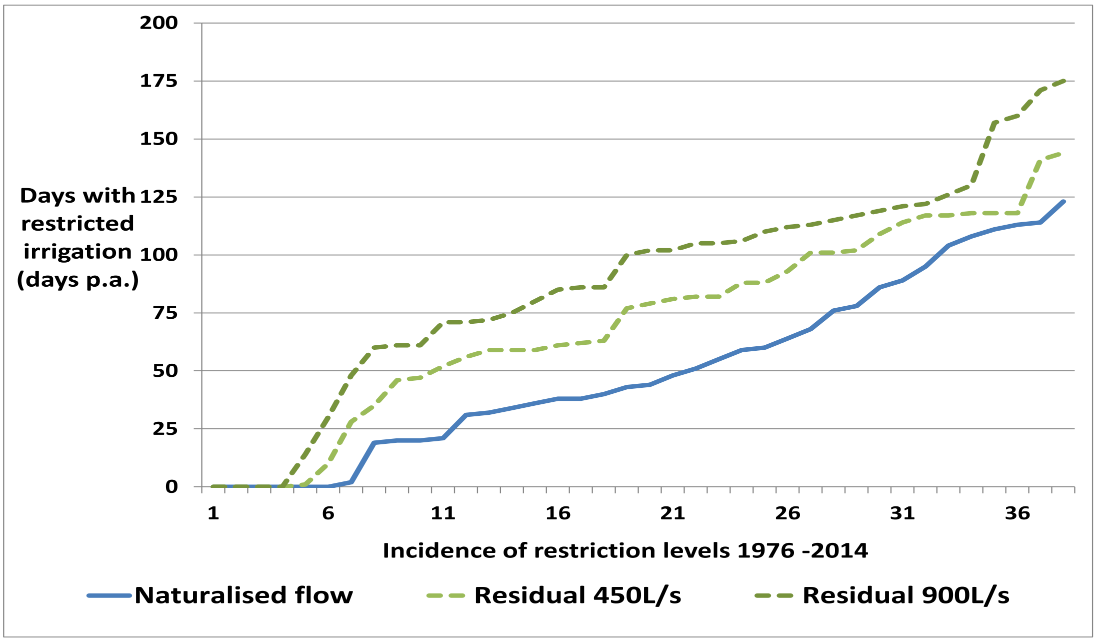
3.1 Natural and imposed restrictions on Lindis irrigation

Current production is achieved with a highly variable naturalised flow in the Lindis River and catchment. As we have noted above, the Central Otago area is a region of New Zealand in which water is in many places essential for pastoral, arable and horticultural production. Parts of Central Otago have the lowest rainfall in New Zealand, with areas of low elevation experiencing approximately 350mm per annum, and there is a large area of semi-arid land. Areas in the ranges, however can receive in excess of 1400mm of rainfall per annum. The incidence of this rainfall is variable, and so the naturalised flows in rivers and catchments like the Lindis place restrictions on the water available for irrigation.

The current production is achieved in this environment of variable irrigation availability.

The hydrological analyses completed by Opus provide us with a useful picture of this variability in the naturalised flow and with minimum flow restrictions.

Figure 4: Annual days with restricted irrigation 1976 – 2014



The profile of the number of years with restricted irrigation days due to inadequate naturalised flow, show that in the period between 1976 and 2014, there were only seven years in which there were no days with restrictions in the Lindis irrigation zone. There were 20 years, or about half of the 38 year period, in which there were between 20 and 75 restricted days. There were 10 years in which there were between 75 and 125 restricted days.

Against that profile of the current situation with the naturalised flow, the imposition of a minimum flow of 900 litres per second on the Lindis would result in increased numbers of days with restricted irrigation. In fact in the period between 1976 and 2014, there would still be four years in which there were no days with restrictions in the Lindis irrigation zone. There would be 20 years, or about half of the 38 year period, in which there were between 60 and 115 restricted days. There would be 10 years in which there were between 115 and 175 restricted days.

These profiles are reflected in the average number of days per year with restricted irrigation in the Lindis irrigation zone as follows:

- With naturalised flows: average 49 days per year;
- With minimum flow 450L/s average 69 days per year;
- With minimum flow 750L/s average 81 days per year;
- With minimum flow 900L/s average 86 days per year.

3.2 Changes in land use with restricted irrigation

The main production changes which we anticipate if this farming area was operating with restrictions on irrigation water available are that some of the sheep farms with intensive fattening with an average carrying capacity of about 12 stock units per hectare would have reduced carrying capacity. They would therefore have to reduce intensity and carry out sheep and beef breeding and finishing. In this activity their carrying capacity needed is reduced to 8 stock units per hectare. It is interesting to note that the earlier MAF irrigation report assesses that carrying capacity in such dryland operation would be about two-thirds of that with irrigation available, and this is also implied in this change.

Similarly, without access to irrigation, we assess that some of the beef cattle farming would become less intensive and similarly carry out sheep and beef breeding and finishing.

In the extreme situation, if restrictions resulted in no water being available for irrigation in the Lindis irrigation zone, we suggest that all three sheep and beef farm classes would undertake sheep and beef breeding and finishing.

For the vineyard, we assumed that the production level without irrigation would be reduced by the same factor as in the MAF report.

3.3 Scenario approach to model restricted production

The hydrological analysis has provided us with estimates of the total number of days that have occurred with restricted access to irrigation, in the last 38 years. The total irrigation period is taken to be from 1 September to 30 April, i.e. a 240 day season. The Opus modelling shows that over the last 38 years, in the Lindis irrigation zone, the water takes would be restricted on average for 49 days per season. This implies there would be unrestricted irrigation for 191 days per season.

They have also modelled the total number of days with restricted access to irrigation in those years with each of the three required minimum flows. The respective average number of days per season with restricted flows are: 450L/s flow: 69 days; 750L/s flow: 81 days; and 900L/s flow: 86 days. Subtracting the restricted days from the 204 day season means the unrestricted irrigation days per season would average as follows: 450L/s: 171 days; 750L/s: 159 days, and 900L/s: 154 days.

When access to water for irrigation is restricted there is an almost infinite number of effects that could take place, depending upon which takes were affected, whether there was mitigating action taken by irrigators and so on.

For the purpose of this analysis we have taken a relatively simple approach of taking the land use with current irrigation as from Section 2 above, and reducing that production towards the production that would be achieved with no irrigation. The amount by which the production is reduced is the proportion of the current average 191 unrestricted irrigation days that are lost.

For example the 450L/s minimum flow would cause irrigation restriction to increase on an average of 20 days per season. The land use change assumed in our modelling is that which would reduce production by the 20 days over the current 191 days average irrigation per season. This is a reduction by about 10% of the difference in production between that currently produced, and what would be produced with no irrigation.

On the 49 days which currently have restricted access, there will be variety of patterns to the irrigation possible. We have no way of determining how the water is currently allocated on those days, nor how it will be allocated on the additional days with restrictions due to minimum flow requirements. The implication of taking the production as proportional to the number of unrestricted irrigation days is that the pattern of allocation on the current 49 restricted days will be reflected in the pattern of allocation in the increased number of restricted days under the minimum flow requirements.

In order to estimate the impact of the minimum flows, we therefore need to model the land use and production in the Lindis irrigation zone with no irrigation.

3.4 Land use and production no irrigation

We use the above assumptions of the change in farming types on the land without access to irrigation. We then estimate economic production parameters using Beef&Lamb NZ estimates of revenues and farm working expenses for these land uses without irrigation.

Table 7: Estimated revenue and gross margin from farm types with no irrigation

	Total area	Revenue	Farm working expenses	Gross margin	Total revenue	Total gross margin
Farm type	*Hectares*	*$ per hectare*	*$ per hectare*	*$ per hectare*	*$'000*	*$'000*
Sheep intensive finishing	0.0	1,461.82	755.85	705.97	0.0	0.0
Sheep and beef breeding and finishing	2,174.0	1,017.00	490.00	527.00	2,211.0	1,145.7
Beef intensive finishing	0.0	1,161.94	594.91	567.03	0.0	0.0
Deer intensive	14.8	n.a	n.a	n.a	n.a	n.a
Vineyard	12.4	6,700.00	5,200.00	1,500.00	83.1	18.6
Flowers	2.4	n.a	n.a	n.a	n.a	n.a
Total (interim)	**2,203.6**				**2,294.0**	**1,164.3**

The summary is that our current estimate of revenue (or gross output) from the main pastoral farming types if they were unable to use irrigation is approximately $2.3 million per year.

The total gross margin from this activity is approximately $1.16 million per year.

Table 8: Estimated employment without irrigation

	Land use without irrigation (Ha)	Labour units per 100 Ha	Total labour units
Sheep intensive finishing	0.0	0.60	0.00
Sheep and beef breeding and finishing	2,174.0	0.35	7.61
Beef intensive finishing	0.0	0.50	0.00
Vineyard (w ithout irrigation)	12.4	20.00	2.48
Total	**2,186.4**		**10.1**

Employment impacts without irrigation while nominally small would see overall labour units fall from approximately 14.2 with irrigation, to 10.1 without irrigation.

Meanwhile the amount of labour required in vineyards would decrease, from one labour unit for approximately 4 hectares when there is irrigation, to one labour unit for approximately 5 hectares without irrigation as grape production per hectare falls with the loss of irrigation.

3.5 Economic production with restricted water flows

The direct contribution to the economy, the total gross margin from the Lindis irrigation zone currently is estimated to average $1.756 million per annum. If there was no irrigation in the Lindis irrigation zone, the estimated total gross margin is estimated to average $1.164 million per annum.

3.5.1 Reduced number of days with restricted flows

We now use our scenario approach and allow a pro rata reduction in the current gross margin according to the share of current irrigation days that would be restricted. Carrying out that analysis, we arrive at estimates of the average gross margins per annum with restricted flows as follows.

Table 9: Reduced gross margins with restricted Lindis flows

Lindis irrigation zone	Current flow	Restricted Lindis flows		
	NoMin	450 l/s	750 l/s	900 l/s
Total irrigation days per season	191	171	159	154
Total Gross Margin ($'000)	$1,755.9	$1,693.2	$1,656.8	$1,640.7
Gross margin reduced by (%)		3.6%	5.6%	6.6%

These estimates show that with restricted Lindis minimum flows, the number of days of unrestricted irrigation per season is reduced from an average of 191 days per year currently, to a lowest level of 154 days per year if the residual minimum flow is maintained at 900L/s. Reducing the current gross margin towards the gross margin with zero irrigation on a pro rata basis, implies that the total gross margin per annum would reduce from the current average of $1.76 million, to a level of $1.64 million. This is a reduction by 6.6%.

On the surface this does not seem to be a large reduction, but the fact is that current production on irrigated land is already suppressed below its potential by the naturalised flow reducing the production towards the zero irrigation level. The restricted flow purely drives production back down some more.

3.5.2 Restricted number of days and longer 'droughts'

There are already droughts with consecutive days with restricted irrigation. In the last 38 years, there was an average of 25 consecutive days each year on which the naturalised flow caused restrictions on irrigation.

This number of consecutive days will be increased with imposition of minimum flow restrictions. In fact a number of consecutive days without irrigation is expected to have a greater effect than simply an increase in the total days. Other secondary effects are likely to be caused, such as a greater delay in pasture recovery once irrigation is able to resume.

Table 10: Average restricted total days and consecutive days

Lindis irrigation zone	Current flow	Restricted Lindis flows		
	NoMin	450 l/s	750 l/s	900 l/s
Total days with restricted irrigation	49	69	81	86
Of these:				
Consecutive days with restricted irrigation	25	37	42	44

The modelling indicates that on average about one half of the days with restricted irrigation in any year have been consecutive. This situation would continue with restricted minimum flows on the Lindis.

Again, while this is quite a marked reduction in irrigation availability, it is purely an increase in the effect already experienced due to the fluctuations, and consecutive low flow days with the naturalised flow.

4 Wider current economic impacts, and mitigation

The value added from production, and the employment generated on farm and in vineyard can now be related to the indirect and induced value added and employment generated. The indirect employment is the employment generated by suppliers to the farm and vineyard producers. The induced employment is the downstream employment generated by these direct and indirect employees spending their incomes.

4.1 Wider economic impacts in District and Region

The wider economic impacts are estimated using multipliers derived from input-output tables of the inter-industry relationships in the specific economy. The level of multipliers reflects the breadth of services and other inputs generated within each economy.

In this instance we have estimated the wider impacts in the Central Otago District economy, and those in the Otago Region's economy. Needless to say the Otago Region's economy has a broader range of suppliers and services to provide to the farm and vineyard producers, and so the wider impacts in the Region are greater than those in the District.

Table 11: Wider economic impacts of Lindis production with reduced irrigation

		Total area	Direct value added	Total value added		Direct employment	Total employment	
			Lindis irrigation area	Central Otago District	Otago Region	Lindis irrigation area	Central Otago District	Otago Region
Farm type		*Hectares*	*$'000*	*$'000*	*$'000*	*FTEs*	*FTEs*	*FTEs*
Sheep intensive finishing		1,250.8	1,088.2	2,045.88	2,698.81	7.5	14.0	17.5
Sheep and beef breeding and finishing		706.1	462.5	869.48	1,146.98	2.5	4.6	5.8
Beef intensive finishing		217.1	159.9	239.84	324.58	1.1	1.6	2.1
Vineyard		12.4	45.3	71.51	94.59	3.1	4.4	5.3
Total with current irrigation		**2,186.4**	**1,755.9**	**3,226.7**	**4,265.0**	**14.2**	**24.6**	**30.7**
With Minumum flow 450L/s	**Less 3.6%**		**1,693.2**	**3,111.6**	**4,112.8**	**13.7**	**23.7**	**29.6**
With Minumum flow 750L/s	**Less 5.6%**		**1,656.8**	**3,044.6**	**4,024.3**	**13.4**	**23.2**	**29.0**
With Minumum flow 450L/s	**Less 6.6%**		**1,640.7**	**3,015.1**	**3,985.3**	**13.2**	**23.0**	**28.7**

Allowing for indirect and induced effects, the value added impacts increase from $1.76 million at farm gate, to $3.2 million in Central Otago District, and $4.3 million in Otago Region. Employment increases from 14 FTEs 'on-farm', to 25 FTEs in Central Otago District, and over 30 FTEs in Otago Region.

With reduced irrigation due to minimum flow restrictions there would be lower value added generated at farm gate, and a lower levels of employment 'on-farm'. These lower figures are reflected in the wider economic impacts.

Overall, the direct impacts at farm gate, and the wider impacts on the Central Otago economy and the Otago Region's economy with reduced irrigation due to minimum flows on the Lindis river are of a small overall order of magnitude. It should be remembered here that the assessments of the changes in land use and farm types if less irrigation was available, assumed that there would be little or no mitigation of these effects by the farms and vineyards.

This estimate is probably the worst case scenario from a minimum flow regime for two reasons:

- The minimum flow regime is most unlikely to completely eliminate the possibility of using irrigation on the restricted days on all of this land; and
- There are a number of moves the farms and vineyards can make to retain most of their existing irrigation, either by increasing the efficiency of current water use, and/or by accessing other water sources, such as the Clutha aquifer.

4.2 Measures to increase irrigation efficiency from Lindis water

Having a minimum flow regime in place would likely see efforts made by farms and vineyards to increase the efficiency of their existing irrigation from the Lindis River.

As a part of the hydrological assessment, Opus has accessed work completed for Otago Regional Council by Aqualinc on irrigation efficiencies in the area. In section 3.2 of their hydrological analysis they state that: “It would appear that to irrigate the total irrigable area ‘efficiently’, as defined by Aqualinc (2006), would require a maximum rate of abstraction of approximately 3,100L/s. This compares with the current primary allocation of 4,134L/s”.

This implies that if more of the current irrigable area was to be irrigated by more efficient means, the impact of reduced availability of irrigation water could be substantially mitigated.

4.3 Costs to improve Lindis water supply reliability

We have carried out estimates of the costs of supplying the daily irrigation need for the Lindis-dependent area. Opus has completed these estimates of an Upper estimate and a Lower estimate of the costs based on their current experience with schemes for Tarras Water, Ashburton Lyndhurst, Central Plains Water, Lower Waitaki, and Wairarapa Water.

The actual costs will require detailed design of options, investigation of possible land use changes and development of an investment business case for the selected option for the Lindis-dependent area. However the examples of other schemes, especially the Tarras, provide a basis for the upper and lower estimates of the level of investment and annual operating costs.

The general specifications are to supply water to the full 2,500 hectares dependent upon the Lindis catchment, at a need of 5 mm per day, and to supply for 100 to 150 net operational days per season. Storage would be required for 60 days’ demand.

Table 12: Capital and operating costs of increasing Lindis water supply reliability

Lindis-dependent area	Lower estimate	Upper estimate
Area Irrigated: hectares	2,500	2,500
Capital Costs: $ million	$51.3	$107.5
Capital costs: $ per hectare	$20,500	$43,000
Operation & maintenance cost per year: $ million	$2.1	$4.2
Operation & maintenance cost: $ per hectare per year	$842	$1,670

The estimates are that the capital costs including the off-farm infrastructure, the on-farm infrastructure for more efficient irrigation, and the storage would cost between $51 million and $107 million. This is approximately between $20,000 and $40,000 per hectare capital cost. The annual operating costs including power and maintenance would be between $842 per hectare per year and $1,670 per hectare per year.

We have made the point strongly throughout this assessment that the present land use and estimated production levels and economic activity are achieved with constraints on the water supply due to the level of naturalised flow in the Lindis catchment. There is an estimated average of 50 days in each season with restrictions on irrigation takes. In other words the average days for unrestricted irrigation each season are about 190 days of the 240 days in the season.

Consequently an investment in at least some of these improvements to water supply reliability so that irrigation is made possible in all 240 days of the irrigation season each year can be expected to increase current production significantly with or without water supply restrictions due to minimum flow requirements. For example it can be expected that land use changes will include a shift of some of the 706 hectares currently used for sheep and beef breeding and finishing, to increase the intensity as sheep intensive finishing and/or beef intensive finishing. Either one of these could possibly include expansion of grazing for dairy support. There could be other land use changes to more intensity if the irrigation water supply was reliable.

4.4 Tourism impacts

The wider Lindis River area provides for a range of recreational activities including mountain biking, tramping, fishing, swimming, picnicking and other informal recreation activities. Anecdotally, fishing, swimming, picnicking and other river side activities occur at the Ardgour Bridge site, although swimming and fishing (more specifically trout angling) can be limited by the absence of water in summer months. With Ardgour Bridge being located on State Highway 8, given the presence of some limited visitor accommodation and associated nearby recreation activities would suggest that the area does currently have some tourism value.

With increased flows, that are compatible with trout habitat, it would appear that tourist activity could increase in the area. The accessibility and attractiveness of the Ardgour Bridge area (being relatively flat and accessible from State Highway 8) means that in drier months with improved flow, tourists may be more enticed to pull into the area and undertake the recreation activities mentioned previously. In turn they may be more inclined to experience some of the other attractions that are available in the area, although the Clutha River and the Manuherikia River and Lake Dunstan already offer opportunities for recreational activities in this area.

Anecdotally, fishing, swimming, picnicking and other river side activities occur at the Ardgour Bridge site (Robert Bond Pers. Comm. March 2015), although swimming and fishing (more specifically trout angling) can be limited by the absence of water in summer months. Of note trout angling and swimming are considered to be the most important recreational uses of the Lindis River, with the River providing important spawning habitat for both brown and rainbow trout.

Although anecdotal evidence has suggested that the Lindis River provides a locally significant brown trout fishery, an angler survey undertaken in 2001/02 (Unwin & Image 2003) has shown that there were only approximately 150 angler days on the Lindis River during this period. This figure is relatively low compared to the 5,630 angler days spent on the adjacent Manuherikia Catchment during the same period. The implication would seem to be that the Manuherikia catchment has much more attraction to the anglers than the Lindis River.

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