

## **Crown Pastoral Land Tenure Review**

**Lease name : LOWBURN VALLEY**

**Lease number : PO 256**

### **Conservation Resources Report – Part 1**

As part of the process of Tenure Review, advice on significant inherent values within the pastoral lease is provided by Department of Conservation officials in the form of a Conservation Resources Report. This report is the result of outdoor survey and inspection. It is a key piece of information for the development of a preliminary consultation document.

The report attached is released under the Official Information Act 1982.

**DOC CONSERVATION RESOURCES REPORT  
ON TENURE REVIEW OF**

**LOWBURN VALLEY PASTORAL LEASE**

**PAL 14-04-256**

**UNDER PART 2 OF THE CROWN PASTORAL  
LAND ACT 1998**



# TABLE OF CONTENTS

## PART 1

<b>INTRODUCTION .....</b>	<b>3</b>
1.1 Background .....	3

## PART 2

<b>INHERENT VALUES: DESCRIPTION OF CONSERVATION RESOURCES AND ASSESSMENT OF SIGNIFICANCE.....</b>	<b>4</b>
2.1 Landscape.....	4
2.2 Landforms Geology and Soils .....	5
2.3 Land Environments of New Zealand (LENZ) .....	6
2.4 Climate .....	8
2.5 Vegetation .....	8
2.5.2 Problem Plants.....	14
2.6 Fauna .....	14
2.6.1 Invertebrate Fauna.....	14
2.6.3 Herpetofauna .....	15
2.6.5 Avifauna .....	15
2.6.7 Aquatic Fauna.....	17
2.6.9 Problem Animals.....	17
2.7 Ecological Sustainability and Ecosystem Services.....	18
2.8 Historic .....	22
2.9 Public Recreation .....	33

## PART 3

<b>OTHER RELEVANT MATTERS &amp; PLANS .....</b>	<b>38</b>
3.1 Consultation .....	38
3.2 Regional Policy Statements & Plans .....	40
3.3 District Plan.....	41
3.4 Conservation Management Strategy & Plans .....	41
3.5 New Zealand Biodiversity Strategy.....	42
3.6 Protecting Our Places .....	43

## PART 4

### ATTACHMENTS

4.1 Additional Information	
4.1.1 References	
4.2 Maps	
4.2.1 (a) Topographic and Cadastral	
4.2.1 (b) Topographic and Cadastral - Strategic Context	
4.2.2 Landscape Units and Significant Landscape Units	
4.2.3 Values – Ecological, Recreation and Historic	
4.2.4 LENZ Units and Threat Status	
4.3 Photographs	
4.4 NGO Comments	
4.5 Appendices	

## PART 1

### INTRODUCTION

#### 1.1 Background

Lowburn Pastoral Lease (PL) was originally inspected in January 1996. A further inspection was carried out in January 2002. The length of time that has elapsed since those surveys has necessitated a further reappraisal of botanical and historic values. This latest inspection was undertaken in March 2012.

This report incorporates findings from the 2012 inspection and additional conservation information including a description of Land Environments of New Zealand (LENZ). The significance of values has been updated using the latest criteria. Entomological, freshwater fish and landscape values were not updated although in some cases their significance has been reassessed.

Early tenure review surveys were generally not as comprehensive as those that are undertaken today and the use of additional tools (e.g. LENZ and structured SIV Guidelines) are now available to assist with assessment of ecological patterns and values present.

Lowburn Valley is a medium sized (5814 ha) PL on the southern end of the Pisa Range. The homestead is situated on Swann Road, 7 km north of Cromwell. The PL is made up of relatively steep faces on the east side of the Pisa Range which have been historically AOSTD up to 1000 metres (m) above sea level, similarly steep faces on the eastern side of Roaring Meg Stream and the Kawarau Gorge and the rolling dissected country of the summit plateau.

Altitude ranges between 340 m near the homestead in the Lowburn Valley to 1480 m north of the Mitre Rocks on the summit plateau.

The PL is in the south-east part of Pisa Ecological District (ED). The Pisa ED comprises 84,750 ha, bounded in the north and east by the Clutha River, in the west by Lake Wanaka and the Cardrona River and in the south by the Kawarau River.

The Pisa Range was surveyed as part of the Protected Natural Areas Programme in the summer of 1984/85. Two areas on the PL were identified as Recommended Areas for Protection (RAPS). The first, Pisa RAP A6 Skeleton Stream, encompasses 330 ha of predominantly shrubland with associated narrow leaved *Chionochloa rigida* (snowtussock) grassland and the second, Pisa A8 Lower Meg, comprises 20 ha selected for the c.30 remnant *Nothofagus menziesii* (silver beech) trees and a small area of manuka.

The adjoining Pisa Conservation Area which has been created through nine pastoral lease tenure reviews and one review of a pastoral occupation licence now comprises some 17,000 ha of contiguous public conservation land and several smaller disjointed conservation areas and reserves. Lowburn Valley and Robrosa are the only pastoral leases on the Pisa Range which have not completed tenure review.

## PART 2

### INHERENT VALUES: DESCRIPTION OF CONSERVATION RESOURCES AND ASSESSMENT OF SIGNIFICANCE

#### 2.1 Landscape

The PL has been divided into the following landscape units (LU) described below:

- a) Lowburn Faces (LU1);
- b) Summit Plateau (LU2); and
- c) The Roaring Meg and Kawarau Faces (LU3).

##### **Lowburn Face (LU1)**

The Lowburn Face runs from the crest of the summit plateau (between the 1000m and 1200m contour) to the valley floor and encompass the Low Burn, Tongue Spur Creek, Packspur Gully and the Cardrona- Cromwell pack track.

The base of the slope from the Lowburn Valley floor is characterised by a series of low rounded hills and small gullies peppered with rock outcrops. Above this the main ridge and gully system extends up to the summit crest. Between the Lowburn Valley floor and the summit crest the landform is undulating slump topography with extensive rocky outcrops.

Large rock outcrops and bluffs occur along the ridge crest. These outcrops and bluffs represent a significant landscape feature. The Lowburn Faces, being part of the Pisa Range eastern face, form part of the distinctive Central Otago block range backdrop view from the Cromwell-Lake Dunstan area.

##### **Summit Plateau (LU2)**

The summit plateau crest (from between the 1000m and 1200m contour) runs from a series of tors in the vicinity of Mitre Rocks to Mt Michael and from Mt Michael onto the true right of Mitre Creek and marks the contrast between the steep Lowburn, Kawarau and Roaring Meg Faces and the smooth rounded profiles of the summit plateau. Although Mitre Rocks are marked on NZ Topo50 CB12 as being on the PL, this appears to be an error as the most impressive tors actually lie over the boundary in the Pisa Conservation Area.

The summit plateau consists of broad, gently undulating ridges with rock tors protruding above the rounded and weather-worn surface. The rock tors are a dominant and very impressive feature. Tributaries of the Roaring Meg form alluvial valleys entrenched into the plateau surface. The valleys become more deeply entrenched towards the south-west end of the summit. Old water races follow around the contour at the head of Skeleton Creek and fit neatly into the landscape with stone revetments supporting the race in some sections. Water races, the occasional fence and access tracks are the only obvious cultural intrusions.

Towards Mt. Michael the plateau slopes to the south, with short alpine tussockland, *Aciphylla* (spear grass), rock and bare ground dominating. There are also small remnants of *Chionochloa rigida* and some large rock tors. This end of the summit plateau has sustained a higher level of modification from grazing and burning than the remainder of the plateau.

Other characteristics of the summit plateau include its broad, expansive nature, the obvious harshness of the environment, its remoteness, and views out to surrounding ranges and valleys. It has high visual resource values derived from its sheer scale, impressive landform and the diversity and relative intactness of the vegetation. In landscape terms, the whole of the summit represents a single entity.

### **Roaring Meg and Kawarau Faces (LU3)**

These faces are bounded to the east by the section of the summit crest between Mt Michael and Mitre Creek, to the north by the PL's northern boundary on true right of Mitre Creek, to the west by the Kawarau River/Roaring Meg and to the south by the southern boundary. The Kawarau and Roaring Meg Faces are typical block range slopes of slump and landslide topography. Adjoining the true left side of Skeleton Creek is a distinctive area of extensive rock outcrops, boulders and lumpy topography within the short tussock zone.

The faces form part of Kawarau Gorge's visual and scenic corridor and as such are an entrance to the Queenstown Lakes District.

#### **2.1.1 Significance of Landscape**

The section of the Lowburn Faces above 1000m with its distinctive large rock outcrops and bluffs make it a significant landscape feature.

The entire summit plateau is a single landscape entity. Although the southern end of the plateau has been somewhat modified, the presence of rock tors, the persistence of a diverse native vegetation cover and its visibility qualify this entire landscape unit as highly significant. Given time and the appropriate management degraded parts of this landscape will slowly recover.

The section above 1000m of both the Kawarau and Meg Faces contain distinctive large rock outcrops and bluffs and forms part of the Kawarau Gorge visual and scenic corridor. On the true left of Skeleton Stream, between 800 and 1000m there is a distinctive area of extensive rock outcrops, boulders and lumpy topography.

## **2.2 Landforms Geology and Soils**

The PL forms part of the Pisa Range massif, the highest of Central Otago's characteristic fault-block ranges. Along with other South Island mountain ranges, the Pisa Range was uplifted as part of the Kaikoura Orogeny during the Pliocene 5-2 million years ago. Tectonic movement during the Kaikoura Orogeny formed the characteristic basin and range topography of Central Otago as some blocks of the country were pushed up faster than others. The underlying bedrock comprises Haast schist.

Periglacial phenomena are widespread. In particular soil hummocks (stripes/mounds of closely packed soil) are extensive on the smooth upland surfaces except on the most exposed sites where lag gravels have developed.

Above the Kawarau Gorge and Roaring Meg is a large land slide mass. Parts of the slide contain large floating block rock outcrops or extensive boulder fields with active slumping and blockslides. The moderate (25 degree) southwest dip of the Haast schist is responsible for the instability. This feature is identified as Geopreservation Inventory site LAN 183, which is described below.

Landform:	Rock block slide
District:	Clutha
Importance:	B (National Importance)
Locality:	Alongside Kawarau River extending 4 km between Roaring Meg and Scrubby Stream
Significance:	An extremely good example of a large-scale movement
Vulnerability:	3 (unlikely)
Hazards:	No known realistic hazards
Morphogenic:	Map reference F41012713.

The main soil types are Carrick Hill soils (upland yellow brown earths) on the plateau, Dunstan steep-land yellow brown earth on the higher altitude faces and Arrow steep-land yellow grey earths on the lower faces. These soils are not particularly prone to erosion under normal circumstances. If denuded, wind erosion can be severe at all altitudes while water erosion is a problem at higher altitude if the soil is disturbed by tracks, fencelines and races etc.

Two sites assessed as being of special soil significance are located with the PL (Arand et al. 1991). One site corresponds with RAP Pisa A8 (Lower Meg) and is described as “a good example of a moderate range woodland vegetation on yellow-grey earths”.

The other site corresponding with RAP A6 (Skeleton Stream) is described as containing “a moderate range of soil-vegetation associations, including remnants of previously widespread soils under narrow-leaved snow tussockland and diverse shrubland associations.”

## **2.2 Significance of Landform Geology and Soils**

The Geopreservation Inventory site (LAN 183) is of national importance but is deemed not to be under any significant threat. The PNAP survey did not assess the landforms of the two RAP's as being significant.

Arand et al. (1991) rank the Lower Meg significant soil site as being of national significance and vulnerable to damage whilst the Skeleton Stream site has been assessed as being of Regional Importance and also vulnerable to damage/degradation.

## **2.3 Land Environments of New Zealand (LENZ)**

There are two databases that have been used to assess biodiversity protection (Walker et al 2003).

1. Environmental distinctiveness has been assessed through the Land Environments of New Zealand (LENZ). This is a classification of New Zealand landscapes using a comprehensive set of climate, landform and soil variables chosen for their roles in driving geographic variation in biological patterns (Leathwick et al 2002 & 2003). It is presented at four levels of detail containing 20, 100, 200 or 500 environments nationally. The most detailed is called LENZ Level IV.
2. The area of unprotected indigenous cover in threatened land environments has been identified in the national land cover database (LCDB).

From the above databases, spatial data depicting indigenous cover and legal protection were overlaid on LENZ Level IV environments to identify biodiversity that is most vulnerable (most likely to be lost). This provides a measure for:

- a. percentages legally protected and;
- b. percentages of remaining indigenous cover

Based on these two criteria, five categories of threatened environments have been used to identify environments containing indigenous biodiversity at most risk of loss. They are classified as follows:

1. **Acutely threatened:** <10% indigenous cover remaining
2. **Chronically threatened:** 10-20% indigenous cover remaining
3. **At risk:** 20-30% indigenous cover remaining
4. **Critically underprotected:** >30% indigenous cover remaining and <10% protected
5. **Underprotected:** >30% indigenous cover remaining and 10-20% protected
6. **No Threat:** >30% indigenous cover remaining and >20% protected

**Table 1: Land Environments of New Zealand (LENZ) Units on PL**

Threat Category	Level 4 LENZ Unit	% Indigenous vegetation cover remaining	% Protected nationally for conservation purposes	Indigenous Vegetation Cover Change 1997-2002	Approximate Area on PL(ha)
Chronically Threatened	N4.1d	19	3	No Change	749
At Risk	N4.1e	24	3	No Change	66
Acutely Threatened	N5.1c	3	2	No Change	3
Acutely Threatened	N8.1b	5	2	Decrease	23
No Threat Category	Q1.1a	98	25	No Change	353
Critically Underprotected	Q1.1b	77	8	Decrease	930
Underprotected	Q1.1c	91	18	No Change	1133
Critically Underprotected	Q2.2a	40	4	Decrease	1695
No Threat Category	Q3.3a	97	26	No Change	853
Critically Underprotected	Q3.3b	81	1	Decrease	1
Underprotected	Q3.3c	90	17	Decrease	8
<b>Total</b>					5814

### 2.3.1 Significance of LENZ

Attributing significance to LENZ units, while a useful exercise must be treated with caution. Work is currently underway to improve the accuracy of underlying spatial data. For example, soils data is being upgraded, as median patch size for polygons sourced from the Land Resource Inventory is currently between 10,000 and 100,000 hectares, while at Level IV resolution, LENZ units cover areas as small as 10 hectares. Also underway, albeit as lesser priority, is ongoing work relating to continuous improvements of the underlying classification process which generates LENZ units.



The PL has the following land environments that are significant because the indigenous vegetation has largely been removed, and/or little of the environment is represented in lands protected primarily for conservation purposes.

- <1 % of the PL has Level IV LENZ units that have less than 10% of their land area still in indigenous vegetation cover (whether protected or unprotected). These include two 'Acutely Threatened' Units (N5.1c and N8.1b).
- <13% of the PL has Level IV LENZ Units that have 10-20% of indigenous vegetation cover (whether protected or unprotected). These comprises the 'Chronically Threatened' Unit (N4.1d).
- <1 % of the PL has Level IV LENZ Units that have 20-30% of its land area still in indigenous cover. This comprises the 'At Risk' Unit (N4.1e).
- ~ 29 % of the PL has Level IV LENZ Units that have 30% of their land area still in indigenous cover and <10% is protected. These include three 'Critically Underprotected' Units (Q1.1b, Q2.2a & Q3.3b).
- The balance of the PL has Level IV LENZ Units that have >30% of its land area still in indigenous cover and >20% protected.

Where indigenous cover remains within under protected or threatened LENZ units, the area attains added significance for tenure review.

The location LENZ units and their respective threat status is depicted on Map 4.2.3.

## 2.4 Climate

The climate of the Pisa Range is generally typical of Central Otago with warm dry summers and cool winters. Rainfall varies from 400 mm at the homestead to over 1000 mm on the higher country, which is under snow for 3-5 months in most years.

## 2.5 Vegetation

### Vegetation Description

For the purposes of describing the vegetation the PL has been divided into three land units; Roaring Meg and Kawarau faces, Summit Plateau, and Lowburn Faces.

### Roaring Meg and Kawarau faces

This unit includes all the steep faces from the Roaring Meg eastwards up to where the steep hill slopes transition to the easier terrain of the summit plateau and rolling ridge crests. It includes much of the Skeleton Creek and Mitre Creek catchments and numerous small tributaries of both the Roaring Meg and the Kawarau River.

A number of mature silver beech (*Nothofagus menziesii*) and saplings are present in small clumps along about 300 m of the northeastern bank of the Roaring Meg. Associated with them are a small range of native shrubs including *Olearia aviceniifolia*, koromiko (*Hebe salicifolia*), matagouri (*Discaria toumatou*), mountain lacebark (*Hoheria lyallii*) and mingimingi (*Coprosma*

*propinqua*). This entire community has however been heavily impacted by the spread of Douglas fir (*Pseudotsuga menziesii*) from a nearby plantation.

Much of the low to mid-altitude gullies and slopes are covered in a low diversity shrubland dominated by matagouri, mingimingi, sweet briar (*Rosa rubiginosa*), and cottonwood (*Ozothamnus vauviliersii*). Less common are *Olearia odorata*, porcupine shrub (*Melicytus alpinus*), *Coprosma tayloriae*, mingimingi and *Pimelea aridula*. Briar is common up to c. 800 m and occasional up to c. 1000 m. Wilding trees, particularly Douglas fir, are common in shrubland on the true left Roaring Meg between Skeleton Creek and the confluence of the Meg and Kawarau. This area shows evidence of shrub die-back following the application of herbicides directed at the wilding Douglas fir. At least one shrub of *Olearia hectorii* is present near the Kawarau Road. This shrubland has developed following disturbance brought about by fire, grazing and land slumping.

Riparian shrublands, particularly those associated with Roaring Meg Creek and Skeleton Creek, have a little more diversity having been protected from some of the burning and grazing impacts. While still dominated by matagouri and mingimingi, other species include *Olearia odorata*, *O. bullata*, *O. cymbifolia*, *Hebe subalpina*, desert broom (*Carmichaelia petriei*), mountain lacebark, koromiko, mountain wineberry (*Aristotelia fruticosa*), and in upper Skeleton Creek, *Hebe propinqua*.

A fescue tussockland (*Festuca novaezelandiae*) community is extensive throughout this block above the zone of montane shrublands or where these shrublands are sparse or absent, extending up to c. 1100 m. The influence of oversowing is particularly evident at lower altitude and in the southern end of the unit. Associated native species include golden speargrass (*Aciphylla aurea*), Maori onion (*Bulbinella angustifolia*), patotara (*Leucopogon fraseri*), *Raoulia subsericea*, *Celmisia gracilentia*, harebell (*Wahlenbergia albomarginata*), blue tussock (*Poa colensoi*), *Gentinnella bellidifolia* and *Brachyglottis bellidioides*. The most prominent exotic species are mouse-ear hawkweed (*Pilosella officinarum*), tussock hawkweed (*Hieracium lepidulum*), catsear (*Hypochaeris radicata*), sheep's sorrel (*Rumex acetosella*), sweet vernal (*Anthoxanthum odoratum*), and browntop (*Agrostis capillaris*).

On the southern edge of Skeleton Creek, amongst rock outcrops at c. 1100 m, are relict shrublands containing regional rarities such as mountain totara (*Podocarpus cunninghamii*), bog pine (*Halocarpus bidwillii*), and celery pine (*Phyllocladus alpinus*), along with the more widespread *Gaultheria crassa*, fools beech (*G. antipoda*), *Coprosma tayloriae*, and *Olearia cymbifolia*. Rock outcropping on the southern slopes of Skeleton Creek is particularly extensive and provides habitat for many rupestral species.

Extensive areas of narrow-leaved snow tussock (*Chionochloa rigida*) are limited in this unit to the shady faces of Mitre and Skeleton Creeks where it extends to the valley floors. Elsewhere snow tussock is patchy and highly variable. Dense tussocklands have heavy leaf litter that allows for few other species but more open tussocklands often include alpine fescue tussock, blue tussock, *Pimelea oreophila*, golden speargrass, *Raoulia subsericea*, *Scleranthus uniflorus*, *Coprosma petriei* and *Anisotome aromatica*.

## **Summit Plateau**

This unit includes the broad gently undulating ridges and plateau with rock tors that protrude above the rounded and weather-worn surfaces above Roaring Meg and Kawarau faces, and the Lowburn Faces, extending south to Mt Michael. Tributaries of both the Roaring Meg and Low Burn form alluvial valleys entrenched into the plateau surface.

Alpine fescue tussockland (*Festuca mathewsii* subsp. *pisamontis*) is the major community across much of the gently rolling summit plateau and has been induced from a formerly more extensive snow tussockland as a consequence of burning and grazing. The community is often co-dominated by blue tussock and alpine fescue with a range of intertussock herbs that include golden speargrass, false speargrass (*Celmisia lyallii*), *Lycopodium fastigiatum*, *Pentachondra pumila*, *Scleranthus uniflorus*, snowberry (*Gaultheria depressa*), *Raoulia subsericea*, *Pimelea oreophila*, *Leptinella pectinata* and sweet vernal.

Narrow-leaved snow tussock and slim snow tussock (*Chionochloa macra*) are both present in fragmented patches within the matrix of alpine fescue tussockland. Snow tussocklands are strongest on shady aspects or in shallow depressions and valley heads. They share many of the same intertussock species as described for alpine fescue tussockland. Locally some tall snow tussocks are heavily browsed by stock.

Low shrubland dominated by *Dracophyllum pronum* occurs on many south-facing gravelly slopes and exposed ridge crests. Associated species include alpine fescue tussock, cottonwood (*Ozothamnus vauvilliersii*), patotara, *Kelleria dieffenbachii*, *Anisotome flexuosa*, *Craspedia incana*, *Luzula pumila*, *Brachyglottis bellidioides* and *Euphrasia zelandica*.

The many and varied alpine rock tors and outcrops support a range of plants that are uncommon elsewhere on the PL. These include necklace fern (*Asplenium flabellifolium*), bladder fern (*Cystopteris tasmanica*), Jersey fern (*Anogramma leptophylla*), *Blechnum vulcanicum*, *Pachycladon cheesemanii*, *Koeleria novozelandica*, *Anisotome cauticola*, *Senecio dunedinensis* and *Gingidia decipiens*.

Although not a major feature of the PL, several alpine fen wetlands occur in the head of streams and creeks within the unit. These small areas have high species diversity including several species that are nationally uncommon. Most are dominated by sedges; either comb sedge (*Oreobolus pectinata*) or *Carex gaudichaudiana* but with a large range of prostrate herbs including *Caltha obtusa*, *Gaultheria parvula*, *Plantago triandra*, *Euchiton lateralis*, *Coprosma perpusilla*, *Leptinella* "seep", *Schizeilema cockaynei* and *Ranunculus gracilipes*. Nationally uncommon herbs in these wetlands include *Ranunculus maculatus*, *Plantago obconica*, and *Euchiton polylepis*. Fens at the head of creeks that drain into the lower Roaring Meg show signs of heavy use and browsing by sheep with discarded comb sedge tufts littering the surface of the fens.

Other wetland types are also present. An unusual periodically wet gravelfield near Mt Michael has a population of the threatened herb *Crassula multicaulis*. (see Photo 5, Section 4.3). There are also occasional small cushion bogs on the gentle ridge crest north of Mt Michael. While sharing many of the same species as fens they also have species tolerant of low nutrient status associated with such areas including *Abrotanella caespitosa* and *Ranunculus maculatus*.

### **Lowburn Faces**

This unit runs from the Low Burn valley floor and homestead westwards up steep slopes until these transition to the easier terrain of the Summit Plateau (c. 1200 m). It includes the lower and middle reaches of the Lowburn and its named tributaries; Tongue Spur Creek, Pennycocks Creek, and Rose Creek.

The lowermost toeslopes are mostly in developed pasture although very small pockets of native shrubs still occur on steep slopes or around rock outcrops. Low hill slopes on the true left of the Low Burn at c. 350 m support a predominantly native shrubland of surprising diversity, despite

recovering from being sprayed by previous lessees. The shrub canopy includes *Coprosma virescens*, porcupine shrub, *Olearia odorata*, mountain wineberry, koromiko, sweet briar, elder (*Sambucus nigra*), matagouri and cottonwood. Lianes are common and include native jasmine (*Parsonsia heterophylla*) and *Clematis marata*, along with the exotic bittersweet (*Solanum dulcamara*). Rock outcrops support the uncommon *Einadia allanii* and *Pimelea aridula*.

A site at c. 460 m in Rose Creek has about 30 shrubs and small trees of the threatened tree daisy *Olearia hectorii* on damp slumpy hillslope. Most plants are 2-5 m tall with largest 7 m tall. They are associated with elder, mingmingi, *Olearia odorata*, *O. lineata*, matagouri, sweet briar, prickly shield fern (*Polystichum vestitum*), *Carex* sp., sweet vernal and *Clematis foetida*.

A small swamp on Tongue Spur at c. 600 m has a sedge and rush cover comprising native *Carex secta* and sharp-spike sedge (*Eleocharis acuta*), and the exotic *Juncus tenuis*. Low-growing wetland herbs include a range of natives (*Hypericum rubicundulum*, *Ranunculus cheesemanii*, *R. amphitricus*, *Galium propinquum*, *Potentilla anserinoides* and *Viola cunninghamii*) and exotics (*Myosotis laxa*, *Mimulus moschatus*, *Linum cartharticum* and *Parentucellia viscosa*).

Much of the low to mid-altitude gullies and slopes are covered in a low diversity shrubland comprising matagouri, mingimingi and sweet briar, with cottonwood common near its upper margins. Briar is common up to c. 800 m but has generally disappeared by 1000 m. This shrubland has developed following disturbance brought about by fire, grazing and land slip. Near its upper limits other native shrubs are more common and these include *Olearia odorata*, porcupine shrub, and *Coprosma tayloriae*.

Rock outcrops near the upper limit of briar also support a more diverse native shrub and herb community. Relict mountain totara are occasionally present but more common are *Coprosma tayloriae*, *Helichrysum intermedium* and weeping matipo (*Myrsine divaricata*). Associated ferns and herbs include everlasting daisy, *Brachyglottis haastii*, thousand-leaved fern (*Hypolepis millefolium*), alpine hard fern (*Blechnum penna-marina* subsp. *alpina*, *Anisotome brevistylis*, *A. aromatica*, *Scleranthus uniflorus* and *Helichrysum filicaule*.

Rock talus at c. 930 m between Tongue Spur Creek and Low Burn supports an unusually large population of weeping matipo of at least 100 shrubs and small trees. Other associated shrub species include mingimingi, *Coprosma dumosa*, *C. tayloriae*, *Olearia odorata*, desert broom, mountain wineberry, porcupine shrub, *Helichrysum intermedium* and fools beech. This rock jumble is likely to have provided some degree of protection from fire and domestic stock.

A sparse shrubland of desert broom, *Olearia* and *Coprosma* spp. interspersed with hard and silver tussock (*Poa cita*) also occurs on the hummocky landslide surface at the head of the Low Burn.

Above the level of montane shrubland an alpine short tussockland prevails and continues up into the Summit Plateau unit. This is dominated by fescue and alpine fescue with intertussock species that commonly include blue tussock, golden speargrass, *Raoulia subsericea*, snowberry, *Pimelea oreophila*, sweet vernal, patotara, tussock hawkweed and mouse-ear hawkweed. Golden speargrass and narrow-leaved tussock become much more common with increasing altitude.

### **2.5.1 Significance of Vegetation**

The PL contains representation of the plants and plant communities in the montane, sub-alpine, and low alpine bioclimatic zones of the Pisa ED and Meg, Lowburn and Canine Land Systems. Two RAPs lie in part within the PL.

At least 207 native vascular plant species (Attachment 4.5) are present, representing approximately 61 % of the indigenous vascular plant diversity recorded during the PNA survey of the much larger (84750 ha) and ecologically diverse Pisa ED.

#### **Threatened and At Risk species**

Of the native vascular plant species present, five are listed as ‘Threatened’ and 14 as ‘At Risk’ in the most recent threat classification system listing (de Lange et al. 2009). A list of these species with their threat of extinction status and distribution within the PL is provided below in Table 2.

The New Zealand Threat Classification System provides a tool for assigning a threat status to candidate taxa. Species listed in the super category ‘Threatened’ are grouped into three categories: ‘Nationally Critical’, ‘Nationally Endangered’, and ‘Nationally Vulnerable’. Taxa in these three categories are facing a very high risk of extinction in the wild.

The latest revision (Townsend et al. 2008) of the 2002 system includes the addition of the new categories ‘Declining’, ‘Naturally Uncommon’, ‘Recovering’ and ‘Relict’ within a super category ‘At Risk’. Declining taxa do not qualify as ‘Threatened’ because they are buffered by a large total population size and/or slower decline rate. However, if the declining trends continue, these taxa may be listed as ‘Threatened’ in the future. The category ‘Naturally Uncommon’ is adopted to distinguish between biologically scarce and threatened taxa. ‘Recovering’ allows for threatened taxa whose status is improving through management action and ‘Relict’ is used to encompass taxa that have experienced very large historic range reductions and now exist as remnant populations that are not considered unduly threatened.

**Table 2: Threatened plant species found on Lowburn Pastoral Lease**

Super Category	Threat Category	Species	Location on PL
Threatened	Nationally Critical	<i>Crassula multicaulis</i>	Mt Michael ephemeral wetland
	Nationally Endangered	<i>Olearia hectorii</i>	Rose Creek & Lower Meg Face shrublands
	Nationally Vulnerable	<i>Anogramma leptophylla</i>	Rose Creek headwater rock outcrop
		<i>Kirkianella novaezelandiae</i>	Upper Lowburn short tussock grassland
		<i>Pachycladon cheesemanii</i>	Skeleton Stream and Mitre Creek rock outcrops
At Risk	Declining	<i>Carmichaelia vexillata</i>	Upper Rose Creek snow tussocklands
		<i>Lobelia ionantha</i>	Meg tributary wetland
		<i>Olearia lineata</i>	Wide distribution in montane shrubland
		<i>Pimelea aridula</i>	Meg faces & lower Lowburn Creek montane shrublands
	Naturally Uncommon	<i>Acaena tesca</i>	Alpine zone base of rock outcrops
		<i>Anisotome cauticola</i>	Skeleton Stream rock outcrops
		<i>Deyeuxia youngii</i>	Mitre Creek gorge
		<i>Einadia allanii</i>	Lower Lowburn Creek shrublands
		<i>Euchiton polylepis</i>	Upper Skeleton Stream seeps
		<i>Festuca mathewsii</i> subsp. <i>pisamontis</i>	Widespread in alpine zone
		<i>Hypericum rubicundulum</i>	Tongue Spur swamp
		<i>Leptinella serrulata</i>	Rose Creek montane shrublands
		<i>Plantago obconica</i>	Mt Michael ridge cushion bog
		<i>Ranunculus maculatus</i>	Mt Michael ridge cushion bog
		<i>Senecio dunedinensis</i>	Upper Skeleton Stream rock outcrops

In addition, two species that are uncommon in Otago (Regionally Significant) and four species uncommon in this area but reasonably common in the rest of Otago (Locally Notable) were found. A list of these species is provided below in Table 3.

**Table 3: Regionally significant and locally notable plants found on Lowburn Pastoral Lease**

Status	Species	Location on PL
Regionally Significant	<i>Coprosma virescens</i>	Lowburn Creek
	<i>Halocarpus bidwillii</i>	Skeleton Stream bluffs
Locally Notable	<i>Nothofagus menziesii</i>	Roaring Meg
	<i>Phyllocladus alpinus</i>	Skeleton Stream bluffs
	<i>Sophora microphylla</i>	Slopes above Rose creek
	<i>Podocarpus cunninghamii</i>	Skeleton Stream bluffs & upper Meg faces

## Rare Ecosystems

Terrestrial ecosystems that were rare before human colonisation of New Zealand often have highly specialised and diverse flora and fauna characterised by endemic and nationally rare species. Rare ecosystems are defined as those having a total extent less than 0.5% (i.e. < 134 000 ha) of New Zealand's total area (268 680 km<sup>2</sup>). A framework has been developed (Williams et al. 2007) based on descriptors of physical environments that distinguish rare ecosystems from each other and from more common ecosystems. Using this framework 72 rare ecosystems have been defined using pertinent environmental descriptors selected from soil age, parent material, soil chemistry and particle size, landform, drainage regime, disturbance, and climate

Three rare ecosystems were identified on the PL, all in the wetland category (cushion bogs, seepages and flushes, and ephemeral wetland).

### 2.5.2 Problem Plants

At least 35 exotic species of plants are present on the PL but relatively few are of conservation concern. Many are plants of agricultural importance or are common pastoral weeds. Most are present only at lower elevations. At least two hawkweed species are present but are seldom common except in localised dry sites where all taller vegetation has been removed. Of most serious concern are the Douglas fir infestations that occupy the Roaring Meg gorge and lower Meg faces. Their further spread presents a risk to lower stature vegetation throughout the PL. Other wilding *Pinus* sp. will also require ongoing vigilance to prevent their establishment in priority areas. At the time of the 2012 inspection work was underway to remove the wilding tree infestation in the vicinity of the Roaring Meg.

Broom, elder, bittersweet, and Old Man's Beard also present a threat to the ecological integrity of montane shrubland communities. Although currently at low density, control of these species is desirable in shrubland areas identified as containing SIVs.

## 2.6 Fauna

### 2.6.1 Invertebrate Fauna

No invertebrate survey of the PL has been undertaken; however as with many of the Central Otago mountains, the subalpine and alpine zones of the Pisa Range support a rich fauna by New Zealand standards, usually associated with less modified vegetation. While the Pisa Range is part of the alpine core of Central Otago, with a characteristic Central Otago fauna, it has extra diversity because of distributional overlaps with species characteristic of the wetter mountains of north-west Otago (Ward et al. 1994). It forms the eastern limit for a number of species including the yellow tortricid moth *Ascerodes prochlora*.

The Pisa Range has its own endemic black butterfly, *Percnodaimon* sp. which is locally distributed across the tops (B. Patrick *pers. comm.*). Although there are no known endemic moths, there are many moth species that have distributions shared between the Pisa Range and one or two of the adjacent ranges (B. Patrick *pers. comm.*)

The Pisa Range is the Type locality for two species of stoneflies: *Zelandobius inversus* and *Z. mariae*, and was the only known site for these two species at the time of description (McLellan 1993).

### **2.6.2 Significance of Invertebrate Fauna**

Although no invertebrate survey has been conducted on the PL work elsewhere on the Pisa Range (most recently for the Roborosa tenure review conservation resources report) has identified a range of significant habitats for invertebrate fauna.

The upper plateau, of the Pisa Range has outstanding invertebrate conservation value on the basis of the distinctiveness and high diversity of high altitude habitats. These habitats are generally in good condition. Their invertebrate communities strongly reflect a Western-Central Otago influence with wider links both north and south. The tenure review inspection of Robrosa yielded endemic Central Otago moths, butterflies, weevils, a chafer beetle and the threatened grass hopper *Sigauss obelisci*.

Invertebrate diversity is high in grey shrublands in Central Otago. 22 species of moth known to be supported on the threatened tree daisy *Olearia hectorii* (Department of Conservation 2007). Derraik et al (2003) note that modified native habitats with a prominent exotic plant component may still harbour a significant indigenous invertebrate fauna. On the Rock and Pillar Range they recorded 115 invertebrate taxa from *Olearia bullata* alone and a further 93 from the ubiquitous dryland shrub *Coprosma propinqua*. It can be safely assumed that native shrublands on the Lowburn and Meg faces will be similarly rich in native invertebrate fauna.

### **2.6.3 Herpetofauna**

The PL was not surveyed for herpetofauna for tenure review purposes.

On nearby Robrosa PL two species of lizard were recorded. McCann's skink (*Oligosoma maccanni*) was seen in abundance in open vegetation and rock habitat areas below 1500 m whilst Cromwell gecko (*Woodworthia* "Cromwell") were seen at a few selected loose rock habitat sites between 1200 m and 1600 m (Department of Conservation 2006). McCann's skinks were commonly sited during the 2012 inspection.

On the Larches PL some 14km to the north on the adjoining Criffell Range, McCann's skink and common skinks (*O. nigriplantare polychroma*) were recorded through a tenure review inspection (Department of Conservation 2002).

The DOC Bioweb Database contains records for McCann's skinks and Cromwell geckos found at Pack Spur Gully in 1986.

Jewell & McFarlane (1997) and Hitchmough et al. (1998) note that geckos on the Pisa Range differ morphometrically from populations to the north and south (being similar in some respects to Otago/ Southland large geckos). Allozyme analysis has shown it to be a distinctive form of the Cromwell gecko.

### **2.6.4 Significance of Herpetofauna**

The three lizard species recorded nearby have no threat status.

### **2.6.5 Avifauna**

Birds seen or heard during the 2012 tenure review inspection are listed in Table 4 over page.



**Table 4: Birds Recorded During Survey of the PL**

Common Name-* denotes native species	Scientific Name	Threat Status (Miskelly et al 2008)	Comments
New Zealand Falcon *	<i>Falco novaeseelandiae</i>	Nationally Vulnerable	Open range on the Pisa Range is prime habitat.
New Zealand pipit *	<i>Anthus novaeseelandiae</i>	Declining	Large numbers of pipits seen on the tops – up to 60 birds in a flock
South Island Pied Oystercatcher*	<i>Haematopus finschi</i>	Declining	Breed on open tops of Pisa Range.
Black Shag *	<i>Phalacrocorax carbo novaehollandiae</i>	Naturally uncommon	Rookery in the Low Burn
Southern black-backed gull *	<i>Larus dominicanus</i>	Not Threatened	These birds breed up on the open tops of Pisa Range in late Spring and Summer.
Australasian *harrier	<i>Circus approximans</i>	Not Threatened	Two harriers seen in Luggate Creek area and lower slopes of PL.
Silvereye*	<i>Zosterops lateralis lateralis</i>	Not Threatened	Widespread in shrublands
Paradise Shelduck*	<i>Tadorna variegata</i>	Not Threatened	
Fantail*	<i>Rhipidura fuliginosa</i>	Not Threatened	Widespread in shrublands
Bellbird*	<i>Anthornis melanura</i>	Not Threatened	
Tomtit *	<i>Petroica macrocephala</i>	Not Threatened	
Greywarbler*	<i>Gerygone igata</i>	Not Threatened	Widespread in shrublands
Welcome Swallow*	<i>Hirundo tahitica neoxena</i>	Not Threatened	
Yellow Hammer	<i>Emberiza citrinella</i>	Introduced	
Skylark	<i>Alauda arvensis</i>	Introduced	
Greenfinch	<i>Carduelis chloris</i>	Introduced	
Californian quail	<i>Callipepla californica</i>	Introduced	
Blackbird	<i>Turdus merula</i>	Introduced	

### **2.6.6 Significance of Avifauna**

The New Zealand falcon is the only threatened bird species recorded on the PL with a threat ranking of 'Nationally Vulnerable'. The PL provides large areas of good habitat for this species.

The siting of large numbers of pipits is of significance given this species recent elevation to "At Risk – Declining" status.

The paucity of native forest severely limits the population of forest birds to the common although the bellbird record is of note.

### **2.6.7 Aquatic Fauna**

No indigenous fish were recorded during electric fishing surveys on the PL.

Fish surveys concentrated on the Roaring Meg and Low Burn catchments. Many of the streams on the Lowburn and Roaring Meg Faces were considered too steep and small to retain fish populations. This was confirmed when Tongue Spur Creek was fished at an altitude of 750 m and no fish were found. The Low Burn contains brown trout (*Salmo trutta*) in its lower reaches near the homestead. These fish do not occur in steeper gradient streams and can hence be expected to occupy the Low Burn only up to an altitude of 600 m.

In the Roaring Meg brown trout exist downstream of the Plank Creek confluence and brook char (*Salvelinus fontinalis*) from the said confluence upstream. Skeleton Stream neither contains fish in the lower, steep cascade section nor in the higher altitude lower gradient sections. The upper reaches of Mitre Creek are also fishless, although the upstream extent of brook char is undetermined. Both Mitre Creek and Skeleton Stream contain abundant freshwater invertebrates and water quality is high. This, together with the relatively undisturbed nature of these upper reaches means both creeks have good conservation values.

### **2.6.8 Significance of Aquatic Fauna**

Although indigenous fish were not found during the inspection, Mitre Creek and Skeleton Stream have significant value in that they are catchments that currently contain no fish and may have never had any. Such areas are therefore valuable because they contain aquatic invertebrate communities that have evolved in the absence of fish predation, or at least with little fish predation.

### **2.6.9 Problem Animals**

Chamois, goats, pigs, possums and rabbits are present. Numbers are currently low. The department monitors the numbers of these species and conducts the necessary control work in liaison with landowners across the Pisa Range.

A high percentage of pigs on the Pisa Range have been found to be infected with bovine TB. The Animal Health Board however focuses on the control of possums in this area to prevent the spread of this disease, as it is believed that possums are the main vector for bovine TB.

## 2.7 Ecological Sustainability and Ecosystem Services

### Land Use Capability

The Land Use Capability (LUC) system is a nationally consistent land classification system based on physical sustainability that has been used in New Zealand to help achieve sustainable land development and management since 1952. The LUC system has two key components. Firstly, Land Resource Inventory (LRI) is compiled as an assessment of physical factors considered to be critical for long-term land use and management. Secondly, the inventory is used for LUC classification, whereby land is categorised into eight classes according to its long-term capability to sustain one or more productive uses (Lynn et al. 2009).

Analysis of LUC for the PL reveals that the land falls predominantly into two classes. Land at highest altitude (above c. 900 m but also extending down the Roaring Meg) is classified as class 7 and that below as class 6. Class 7 land has severe physical limitations and consequently it is high risk land requiring active management to achieve sustainable production (Lynn et al. 2009). This class has a subclass 'e' which indicates that susceptibility to erosion is the main kind of physical limitation or hazard to use that has been identified. Class 6 land indicates low suitability for pastoral grazing or production forestry but with less severe limitations than class 7. This class also has a subclass 'e' indicating erosion limitations. The small area of easy terrain around the homestead and valley floor is class 3 indicating land of arable cropping suitability.

### Ecosystem Services

Ecosystem services can be defined as “*flows of materials, energy, and information from natural capital stocks, which combine with manufactured and human capital services to produce human welfare.*” Constanza et al. (1997).

The PL makes a significant contribution to providing ecosystem services (especially water harvesting) for the wider Otago region. Many people rely on these services as a basis for hydro electricity generation, irrigation, domestic consumption and for water-based outdoor recreational activities.

There is a wealth of published hydrological information attained from studies on the Lammerlaw Range which quantify ecosystem services provided by tussocklands and wetlands. Research has been funded and conducted by several organisations including the Forest Research Institute (FRI), Landcare Research (as the successor to FRI), University of Otago and the Otago Regional Council (ORC). Much of this information was obtained to assess the impacts of different land uses on water yield from uplands. Studies include: research on fog deposition in tall tussock grassland; hydrological effects of burning tall tussock; water yields from paired catchments under different land uses; snow hydrology; seasonal flow regimes; and water yield variability.

Constanza et al. (1997) define ecosystem services as “flows of materials, energy, and information from natural capital stocks which combine with manufactured and human capital services to produce human welfare”; they identify 17 “services”. The PL contributes to eight of these services, excluding those of a recreation and cultural nature which are described elsewhere. These are outlined below.

#### 1. Gas Regulation:

Much of the existing tussockland and shrubland has potential for further carbon sequestration. The full potential of subalpine and low alpine tussocklands to increase in density and stature and for

lower altitude tussocklands to succeed to indigenous woody cover, is currently limited by stock grazing. The succession of montane shrublands to forest is also limited by stock grazing, shrubland clearance and very limited seed sources.

Table 5 below summarises estimated carbon storage capacity for various vegetation types present on the PLs. (Carswell *et al.* 2008).

**Table 5 – Carbon Storage by Vegetation Type**

Vegetation Class	Carbon Storage (t ha <sup>-1</sup> )	Soil Carbon (t ha <sup>-1</sup> )
Improved Pasture	3	148
Unimproved Pasture	2	151
Snow Tussock Grassland	27	134
Grassland & mixed indigenous scrub	42	164
Tussock grassland & subalpine scrub	22	138
Mixed Indigenous scrub	99	166

Note that one hectare of mixed indigenous scrub stores about 265 tonnes of carbon (above and below ground) versus approximately 151 for unimproved grassland.

## 2. Climate Regulation:

Carbon storage in expanding shrublands, tussock grasslands and wetlands contributes to ameliorating the current anthropogenic induced rise in atmospheric carbon dioxide levels.

## 3. Disturbance Regulation

The upper slopes and wetlands on the Pisa Range play an important role in the provision and regulation of water for a variety of downstream uses.

The headwaters of many streams both in the Roaring Meg and Lowburn faces catchment comprise peat bogs. Fahey and Jackson (1991a) note that bogs are important water-holding areas for the headwaters of many streams. They help reduce flood peaks and sustain flows. Also important are the shallow unconfined aquifers holding ground water on colluvium mantled slopes; thereby damping environmental fluctuation from floods and droughts.

## 4. Water Regulation

High altitude tussock grassland areas “are known to yield unusually high proportions of precipitation as runoff” ORC (1999, p15). They therefore play a significant role in determining flows in the catchments which they feed

Waugh (2005) notes that:

- Snow-tussock catchments have less variable flows than degraded (burnt) tussock, oversown tussock or improved pasture.
- Flows are steadier on a monthly basis and are less variable in the summer-autumn period.

- To maximise water yield it is necessary to maintain tall, unmodified tussock vegetation over the headwater catchments. This is best achieved by completely destocking these areas, preventing fires of any kind and controlling wilding pine tree growth.

Mark and Rowley (1969) demonstrated that undisturbed snow tussocks produced a greater water yield than either a sward of blue tussock or snow tussocks which have been recently defoliated by clipping or burning.

Duncan and Thomas (2004) in their study of the hydrological effects of burning tall tussock grasslands on the Lammerlaw Range showed that for the summer period, modification of tall tussock grassland did reduce water yield. Measured decreases in catchment runoff were greatest in the first two years following burning, as tussock tillers rapidly grow from surviving tussock stumps and deplete soil moisture. Duncan and Thomas concluded that “burning tall tussock grassland reduces water yield in the short term (2-3 years). It can be implied from this and other studies that if burning and grazing persist, then so will reductions in water yield.

## **5. Water Supply and Retention**

Fitzharris (1979) notes that the accumulation of snow into drifts is largely controlled by micro-relief in the landscape. He also makes the observation that the presence of snow tussocks assists in the accumulation of drifts or a more widespread snow pack. The annual snowmelt helps to recharge the shallow regolith storage and sustains base flow over the summer. With less cover or bare ground, freshly fallen snow tends to be blown away, by the strong winds which sweep across the uplands, leaving only the frozen bare soil or ice coated rocks (Waugh 2005).

Fahey and Jackson, 1991(a) note that bogs are important water-holding areas for the headwaters of many streams helping reduce flood peaks and sustain flows. They also state that “Evaporation from tussock grasslands has important implications for water-resource management. The strong physiological control of transpiration by tall tussock produces low rates of water use in summer and contributes to the well sustained stream flow”.

Duncan and Thomas (2004) found depleted tussock catchments yield lower water flows and Fahey and Jackson (1991b) attribute this in part to the higher transpiration rates from exotic pasture species.

## **6. Erosion control and sediment retention**

Snow tussock catchments monitored for sediment yield elsewhere in Otago have been shown to have very low sediment yields by New Zealand standards (Waugh 2005).

## **7. Nutrient cycling**

Monitoring elsewhere in Otago has shown that tussock covered catchments yield very good water quality (ORC 1999).

ORC records taken in 1999 at Stonehenge on the Lammerlaw Range reveal high water quality characterised by:

- Cool water temperatures
- High levels of dissolved oxygen
- Approximately neutral pH values
- Low conductivities

- Low total nitrogen levels
- Low NH<sub>4</sub> + NH<sub>3</sub> levels
- Low total phosphorous levels
- Low turbidity
- Low faecal coliform levels

## **8. Food and Raw materials**

Water yielded from sub catchments on the upper Lowburn faces of the Pisa Range feeds into the Low Burn which is used to irrigate farms, vineyards and orchards on the Lowburn flats and surrounds.

Preservation and enhancement of the current vegetation cover has a critical role to play in regulating water flows in numerous catchments which are sourced in whole or part from the PL. 11 Otago Regional Council permits or deemed permits are in place for water extraction from the Low Burn and one from Duohys or Rose Creek. Some of these permits are for a considerable volume of water with one securing an allocation of 288 million litres per month

There are two power stations on the Roaring Meg River. The Upper Roaring Meg Station generates 1200 KW and the Lower Roaring Meg generates 3000KW (Pioneer Generation Ltd Website).

2800 hectares or 19% of the 15,000 hectare Roaring Meg catchment lies within the PL. An intact montane and alpine vegetation cover reduces the frequency and magnitude of floods and reduces fluctuations in river flow; both desirable attributes for hydro power generators. Results of hydrological studies referenced above indicate that protection of the upper Roaring Meg catchment would over time increase the efficiency of power generation.

Similarly protecting catchments from which water is used for irrigation will likely lead to a more constant water yield and increase the time period over which water can be extracted from the Low Burn.

A recent study conducted using hydrological data from the Shag and Manuherkia catchments (Heller 2011) predicts an increase in the frequency of minimum flow events if snow tussock cover is converted to pasture, planted in trees or succumbs to wilding tree invasion. Under these land use changes modelling predicts water users will face an increased number of days when abstraction is restricted or prohibited. These findings can be extrapolated to the Pisa Range and its catchments. Maintaining stable summer river flows will become increasingly important; especially when mining privileges (deemed water rights) expire in 2021.

### **2.7.1 Significance of Ecosystem Services**

The upper catchments and Pisa Range play a critical role in yielding a reliable and high quality water supply. This water in turn supports a range of in stream fauna and supplies numerous irrigators in the Lowburn area. Water from the Meg catchment is used by Pioneer Generation Ltd to operate two hydro electric power stations.

## 2.8 Historic

### Background

Previous historic surveys have been undertaken on the PL. Ritchie (1983) undertook survey work in the late 1970's along the Kawarau River for the Clutha Valley Development hydro project. Jill Hamel undertook survey work in 1991 and 1996 for the Protected Natural Area programme with concise reports on historic features present on the PL. Other sites have been recorded by the Otago University Expedition in 1976.

There are 20 archaeological sites listed with ArchSite (NZAA) that are located within the bounds of the PL (Table 6). A further 13 recorded sites are located just outside the PL boundaries.

A previous Conservation Resources Report (DOC 2002) outlines some of the significant historic resources on the PL. An historic desktop assessment was undertaken June 2011. A further inspection was undertaken between 19-23 March 2012. The significance of the key historic sites on the PL is described below.

### Pre-contact Maori Sites

There are no recorded Maori sites on the PL although trails were used to access mahika kai particularly the Cardrona Roaring Meg trail (Waikoroiko). Anderson (1986: cited in Ngai Tahu 2002: 3) described the use of this trail by a Ngati Tama war party under Te Puoho during 1836 - 1837.

The cultural resources report notes the lower reaches of the Low Burn were used by Maori as a source of fish, eels, and birds and that higher altitude areas yield abundant Taramea (golden Spaniard) (Ngai Tahu 2002: 2-3). Ritchie (1983: 17) inferred that it is likely Maori used the Kawarau Gorge as an inland route with small camps sited along the river banks similar to those recorded along the Cromwell Gorge.

### Pastoral Farming

The PL corresponds to two earlier pastoral runs, Queensberry Hill Run 340, straddling the Roaring Meg, and Mt Pisa Run 245, from Cromwell north to Luggate (Sinclair 2003). The Mt Pisa run was granted to Herbert Myers ca. 1858 following the break up of Lake Wanaka Station held by William Thompson and Robert Wilkin. William Thompson and Robert Wilkin took up the Mt Pisa run in 1859 being the western portion of the Clutha Valley from Wanaka to the Kawarau (Beattie 1979: 325 cited in Hamel 1990: 2, Parcell 1976: 153 - 4).

The Mt Pisa lease, Run 245, was sold to Russell Howell, Robert Loughnan and Thomas Loughnan in 1866. The run was managed by Robert Loughnan and a cousin Ignatius Loughnan to be followed by David Howell. Thomas Somers Cocks, a prominent Canterbury settler, joined the Russell Howell and Thomas Loughnan partnership in mid - 1868. David Howell took over as manager of the run in 1885 covering 82,044 acres (George 2011: 8, Parcell 1976: 279).

William Grant Stronach took over management of the Mt Pisa run in 1886 (Pinney 1981: 98). Stronach was manager until 1896 when he was injured in his coal mine at Cromwell and later died. Edmund William Parker bought the lease in October 1895 of 148,413 acres and 750 acres freehold running 42,000 sheep. The run was transferred to Willis Scaife in 1896 (George 2011: 9 - 10).

The Mt Pisa run was sold to Colonel Joseph Cowie Nichols in 1907. Nichols was a Colonel commanding the Otago Mounted Rifle Brigade. Nichols widow, Helen Nichols, was the last

runholder of Mt Pisa before it was subdivided into 12 runs in February 1924. Sheep numbers were reduced to 9,000 dropping to ca. 3,000 in 1942 (George 2011: 9 – 10, Parcell 1976: 295).

James William Donnelly Brown, goldminer from Kyeburn Diggings, was granted the Mt Pisa lease, Run 634, in March 1925 being 14,412 acres. Stock yards were located south of the lease at the Natural Bridge site, Kawarau Gorge (OT336/49: Landonline).

A half share was granted to Vincent John Brown in 1965. James Browns' interest was transferred to Mary Melville Brown, Vincent John Brown, and William Russell Brown in 1967. The run was transferred to Vincent Brown, William Brown, and Brian James Challis in 1990 (OTA2/1222: Landonline).

The PL is currently held by Anne Brix Nielsen and Dave McLean with their family.

Two pastoral stone huts noted in Hamel's (1996: 5) report at Lowburn belonged to the original Mt Pisa run. Only one is located within the PL, the Mt Pisa boundary riders hut (NZAA F41/337) at the junction of Low Burn and Pennycooks Creek. The hut is an interesting example of early stonework with a notable chimney built within the wall (DOC 2002: 10). Higham (Higham *et. al.* (1976) noted the hut had been partially destroyed by vandals.

### **Bridle/pack tracks**

Three 19<sup>th</sup> century bridle/pack tracks cross the PL providing linkages between the Kawarau Gorge, Lowburn and the Cardrona Valley. These are the Cardrona - Roaring Meg track (see photo 12, Section 4.3) , Lowburn - Cardrona track and the Cromwell - Cardrona track. Sections of the tracks have been modified to provide 4WD access but large sections of the original tracks remain, especially on the top of the range (Hamel 1996: 6).

### **Gold mining**

Various gold mining claims and major water races are located on the PL. SO 351 (dated 1884) shows some of the major water races and hut site locations. Hamel (1990, 1991, 1996) has searched water race licenses held by the Otago Regional Council to try to unravel the history of the water supply networks. Hamel's reports on the PL and the surrounding area provide detailed descriptions of the water supply systems and the gold mining areas they fed.

Gold mining began up the Roaring Meg in the 1860's. Most of the alluvial mining in the Meg and along the Gorge was over by the 1880's although Reverend Don recorded 26 Chinese miners in the summer of 1890 and 28 in 1891 (Don's maps 1888 - 1891: NZ Presbyterian (cited in Hamel 1991: 69 - 70). The Roaring Meg diggings are one of the last two notable discoveries of gold diggings in Otago undertaken by Chinese. They were established between 1892 and 1900 and are described in the annual goldfields report in the AJHR (Ng 1993: 221).



**Table 6. Description of Historic Resources and NZAA Site Record Numbers.**

<b>NZAA site record</b>	<b>Description</b>	<b>Comments</b>	<b>Recorded by</b>
F41/254	Water race	Diverts from tributary of Culvert Creek to Ripponvale, traverses western face of Mt Michael facing the Kawarau River. May be Lord Byron race.	Ritchie and Harrison 1979, Jill Hamel 2008
F41/258	Rock pile	poss low stone wall - on southern boundary Kawarau Gorge Road	J. Bell 1979
F41/337	Boundary riders hut	Mt Pisa Station hut	Otago University Expedition 1976
F41/634	Lowburn water race	Live race in use diverts from low in the Lowburn to Kawarau Gorge	Hamel 2008
F41/635	Ripponvale Settlers water race	Diverts from the Lowburn above the Lowburn race	Hamel 2008
F41/636	Towans Race complex	original Moonlight race from Mitre Creek, later irrigation by John Towan	Hamel 2008
F41/637	Reservoir	Mystery site at high altitude	Hamel 2008
F41/640	Hendersons water race	true left Mitre Creek probably to Roaring Meg	Hamel 2008
F41/643	Towans Camp	Sod hut and tent site	Hamel 2008
F41/644	Hepburns gold workings	Head of Skeleton Creek, reservoir, water races, stone hut ruin, dam, tailings, header race	Hamel 2008
F41/645	Southern Winters Creek	Gold workings and water race	Hamel 2008
F41/646	Boundary gold workings	Water race and reservoir	Hamel 2008
F41/670	Hairpin Bend gold workings	Stone hut, water race, siphon - Roaring Meg	Hamel 2008
F41/671	Gold workings	Small workings above Hairpin Bend	Hamel 2008
F41/672	Gold workings and hut site	Roaring Meg below Meg huts	Hamel 2008
F41/673	Roaring Meg Cardrona pack track		Hamel 2008
F41/663	Gold mining Meg hut workings	Massive tailings and races extend down Roaring Meg from the huts	Hamel 2008
F41/666	Tailings and races	Evan Roberts Creek confluence true right Roaring Meg	Hamel 2008
F41/667	Gold workings Plank Creek	Sluice pits, poss elevator pond, two stone huts and a diversion wall in the Roaring Meg. Ballingal and Paton in 1914	Hamel 2008
F41/669	Long sluice pit Roaring Meg	Tailings, water races either side of Roaring Meg pack track	Hamel 2008

### **Survey Method**

To assess significance of historic heritage within the PL more data on the archaeological evidence remaining in the landscape was required. Historic records provided some information on the identification of areas of interest.

Key sites were inspected and GPS coordinates taken (see Table 7).

### **Historic Heritage Description**

#### **Pre-contact Maori Sites**

No sites of Maori origin were noted during the survey although sub – surface evidence is likely to be present.

#### **Pastoral Farming**

Historic sites on the PL include Lowburn Valley station buildings, sheep dip, boundary riders hut (Mt Pisa run), musterers hut (McMillan's hut), and 19 – 20<sup>th</sup> century fence lines. The Lowburn Valley homestead, woolshed, implement shed and sheep dip were probably built following the break up of the Mt Pisa run in 1924.

#### Lowburn Valley Station (NZAA F41/714)

The current homestead (GPS 125) was built in 1929 at a cost of £1,100 by Cliff Betts (George 2011: 92 – 93, Plate 1). The original Lowburn Valley homestead came from Ophir in 1906 on a bullock wagon (Anne Nielsen pers comm.). The small original cottage has been renovated by the addition of new windows, re-cladded and re-piled. The original floor and wall sarking have been retained.

The woolshed (NZAA F41/714 - GPS 128) displays three makers marks on the corrugated iron cladding, two internally (Dolphin and Windmill brands) and a Bristol Crown mark displayed on the outside of the woolshed. Morewood and Rogers sold the Dolphin brand of corrugated iron into New Zealand until 1860 (Thomson 2005: 91). Dances were held in the woolshed that were well attended by local families (George 2011: 93).

A concrete plunge sheep dip and associated concrete drying pad (NZAA F41/713) is located ca. 800 m north of the homestead (GPS 132). See Photo 10, Section 4.3. A small water race leads to the dip (GPS 145) but the alignment is not clear where it fed water into the trough. Wire fenced yards lead to the dip with timber fencing around the control gate. An early photo of the sheep dip is shown in David George's book (2011: 88).

#### Mt Pisa boundary riders hut (F41/337)

Comparison of photographs in Higham et. al. (1976: 51, 94, Plate 45) and Jill Hamel's reports (1996: Fig. 3 pages 5 – 6) to that of today indicates partial restoration of the side walls visible by incorporation of new packing between the stones. There is no sign of the internal chimney due to heavy vegetation growth but a photo is supplied in Hamel (1996: Fig. 3a). See Photo 11 Section 4.3.

McMillan's hut and yards (NZAA F41/715)

McMillan's hut and yards are located at the head of Skeleton Stream (GPS 035) south – east of Deep Creek hut. The hut is wood framed with corrugated iron cladding. Date of construction has not been clarified.

Hamel (1996: 27) noted a shepherds hut one and a half miles above John Hepburn's tail race (TR No. 3178Cr dated 13/2/1891) in Deep Creek (Skeleton Creek). This hut was not relocated during the survey of the PL.

Fence lines (NZAA F41/729)

Fabric of 19<sup>th</sup> – 20<sup>th</sup> century fence lines were recorded on the PL. The northern boundary fence line consists of 6 wire, flat metal standards and wood posts recorded at the head of Mitre Creek (GPS 072).

An internal fence line consisting of five wire, wood posts and flat metal standards runs south – west from Mc Millan's hut (GPS 036).

SO 351 (dated 1884) shows two wire fence lines heading from Mt Michael (Trig G), on the southern boundary running west and south to the Kawarau River and the second an internal fence running north-west to the Roaring Meg south of Skeleton Creek. The southern boundary fence line, consisting of metal standards and No.8 wire recorded at Mt Michael could have been built any time over the past 100 years (Hamel 1996: 6).

**Transportation/pack tracks**

The Roaring Meg – Cardrona pack track (NZAA F41/673) retains its original profile north of Skeleton Stream to Plank Creek but has been widened for vehicles from SH6 up to Skeleton Stream. Stacked stone revetment supports the lower wall of the track in steeper areas. The pack track up the Roaring Meg into Cardrona was cut in 1874 (George 2011: 11), presumably along the line of the earlier Maori trail. Reverend Don regularly walked the Roaring Meg - Cardrona pack track in his Chinese mission work from 1888 - 1892 (Hamel 1991: 70).

A more direct route was the Lowburn - Cardrona track from the Low Burn through the Lowburn Valley lease via Packspur Gully. This route was used by farmers to drive sheep to the railhead at Cromwell from Cardrona using yards located at Lowburn Station.

The Cromwell (Ripponvale) - Cardrona track has been destroyed by farm roading from SH6 over Double Rock and Mt Michael and around the head of Skeleton Stream and Mitre Creek but is intact where it runs into and out of the Roaring Meg (Hamel 1990: 7, 1991: 137). SO 352 (not dated) and SO 351 (dated 1884) show the Cromwell - Cardrona bridle track running from the Kawarau River to Mt Michael alongside sections of the Moonlight water race.

A flat bench parallel with the upper northern boundary fence along side Mitre Creek (GPS 143) could have functioned as either a section of the Cardrona - Cromwell pack track, a water pipeline bench, or a former boundary fence line. Low stacked stone ca. 18 m long functions as a viaduct across the head of a tributary of Mitre Creek.

### **Irrigation**

Some of the major water races that cross the PL provide water for irrigation to Lowburn and Ripponvale. The races were initially constructed for gold mining. Hamel (1996) provides detailed descriptions of the major water races crossing the PL. Only brief notes are included in this report.

#### Towan's Race Complex (NZAA F41/636) License No. 1922Cr

The upper part of Towan's race at 1300 m is one of the three highest live races in Central Otago (Hamel 1996: 21). Two parallel water races are clearly visible skirting the slopes around McMillan's hut (GPS 034) coming off the Pisa Range (Castle Rock) are assumed to be John Towan's water races. A license issued to James Ritchie and Elizabeth Towan in 1906 in exchange for No.6360Cr dated 1891 (Hamel 1996: 12, 26).

The Towan's race complex has utilised the Moonlight water race from Mitre Creek (originally constructed 1865 by Captain Moonlight for mining in the Kawarau) and is still in use for irrigation today. The first dairy farm at Lowburn was built by John Towan in 1864 at Grove farm considered one of the oldest small farms in the upper Clutha. The Towan's were one of the first in the district to use irrigation for lucerne (ca. 1890) to provide winter hay leading to improved capacity (Hamel 1990: 3 - 4, Hamel 1996: 7 - 12, 21, Hamel 2001: 110, Parcell 1976: 289, 294).

Towan's racemans camp is located below one branch of the water race in Duohys or Rose Creek on the 920 m contour. Two stacked chimneys (GPS 030 and 032) and wood framing present denote tent sites (Hamel 1996: 11 and Fig 6). A flume takes water across Duohys Gully at GPS 028. See Photo 14, Section 4.3). Artefacts are scattered around the site.

#### Ripponvale Settlers Water Race (NZAA F41/635) License No.1394Cr

The Ripponvale Settlers water race which runs along the 700 m contour of the eastern faces was recorded where it crosses the Packspur pack track (GPS 020). The race is still in use supplying water to orchards at Ripponvale. The Settlers race was probably cut in 1863 and converted to irrigation at an early stage (date not known).

#### Lowburn water race (NZAA F41/634) License No. 1378Cr

The Lowburn water race diverts from the Low Burn (GPS 003) running 24 km to the Kawarau Gorge. The race was cut in 1863 around the 340 m contour (GPS 011). In the 1890's its use changed to irrigation for which it is still used. A short diversion from Pennycooks Creek into the race is very old with no trace of the original trench remaining (Hamel 1996: 8 - 9, 24, Fig 4).

A flat bench (GPS 012) runs alongside and above this race. It appears to be a pack track but is shown as a parallel water race on SO 352 (not dated).

A stacked chimney (NZAA F41/712) located at the juncture of Packspur Gully and Low Burn may be a Raceman's tent site (GPS 010) for the Lowburn water races. Flat laid stones extending out from the chimney indicate a platform ca. 4.3 m long.

### Low Burn

A small water race (GPS 007) crosses the Low Burn where its alignment has been modified by rerouting the creek. This work may have been carried out by the Low Burn Curling Club when a recreation permit was issued to access and use the dam sited on the PL (dated March 1981). The race crosses the PL (GPS 131) east from the Low Burn.

Matheson's water race is shown diverting from Duohys or Rose Creek (noted as Charcoal Creek) above the Ripponvale Settlers water race on a map outlining water race intakes for the Cromwell Development's Co.'s irrigation scheme (dated March 1941: Archives Dunedin).

### **Old Road Bridge** (NZAA F41/708)

Remnant stacked stone support walls for an old road bridge cross a gully east of the Roaring Meg in the Kawarau Gorge (GPS 123) are hidden by heavy vegetation. The road through the gorge from Cromwell to the Roaring Meg was constructed in the mid 1860's (Hamel 1991: 69).

### **Gold mining**

Gold workings were recorded in the upper reaches of Skeleton Creek, Mitre Creek, Roaring Meg, and Lowburn Valley. Historic gold mining sites inspected include 18 hut sites, possible tent sites, water races, hard rock tailings, stacked sludge channels, pack tracks, dams and reservoirs.

### Skeleton Stream

Three stacked schist hut sites (NZAA F41/709 – F41/711) and patches of hard rock tailings were recorded in lower Skeleton Stream (GPS 168, 169 and 171).

John Hepburn's workings (NZAA F41/644) include a water race diverting from the creek south of John Hepburn's hut (GPS 188) that runs north - west to a small C shaped reservoir (GPS 049). A small race exits the reservoir (GPS 052) to feed workings in the next gully north where hard rock tailings extend down gully to GPS 057. The workings are located on the 1200 m contour. A large stacked stone dam wall (GPS 055) has enabled the ground below the dam to be worked. A second outlet race feeds water back to the gully below Hepburn's hut. These workings correspond to licenses issued to John Hepburn in 1891 and 1900 (Hamel 1996: 16, 27).

A stacked feature (NZAA F41/717, GPS 186) may represent a chimney for a tent site appears to have been damaged by grading of the track.

A miners pick with a separate wood handle was found lying in a small rock shelter opposite a small stacked stone hut/tent site (NZAA F41/724) ca. 130 m southwest of John Hepburn's hut.

### Mitre Creek

Eight stacked schist huts were recorded in Mitre Creek with a possible two further tent sites noted. Hard rock tailings extend up the lower northern branch from its juncture with the Roaring Meg to a stacked stone cairn at GPS 071 named the Boundary workings (NZAA

F41/646) (Hamel 1996: 17). No water races were noted in the upper part of the creek and the reservoir was not relocated. A water race (GPS 081) runs along the true right bank in the mid section where the majority of the hard rock tailings are present.

One hut (NZAA F41/722) utilises a large overhang with stacked internal walls separating the shelter into two main rooms. Each main room contains two levels. Items and clothing lie scattered in the shelter.

Three of the hut sites are located in lower Mitre Creek. A hut (NZAA F41/720) built into the slope at GPS 093 has no apparent chimney or doorway although it appears that someone has moved the stone about confusing the hut plan. A water race skirts below a hut site (NZAA F41/719) in the lower reaches of Mitre Creek (GPS 092).

A heavily mud packed stacked stone hut (NZAA F41/721, GPS 096) built up against a rock outcrop was located by the presence of a gin bottle fragment and porcelain fragment lying on a steep eroding slope below the hut.

One of the huts (NZAA F41/723) lies in the main branch of Mitre Creek (GPS 166) with a stacked sludge channel (GPS 187) and hard rock tailings noted (GPS 177).

#### Henderson's Reef

Park's 1908 geological map shows Henderson's Reef between Mitre Creek and the Cardrona Cromwell pack track. This site was not inspected but may be located in the upper northern branch of Mitre Creek.

#### Henderson's water race (NZAA F41/640) License No. 374Cr

William and David Henderson were issued a water race licence in 1900 to divert water from a tributary of Moonlight Creek about a mile below Towan's and Ritchie's race, ending at the junction of Moonlight and Deep Creeks (Mitre Creek and Skeleton Stream: Hamel 1996: 27). The race trailed around the top of Winters Creek to nip over the saddle to Mitre Creek ca. 1300m but it is not clear where on the Roaring Meg the workings are located.

J Partridge registered a quartz claim of 19 acres in Moonlight (Mitre) Creek (AJHR 1903, C3: 49: cited in Hamel 1991: 70 and 1996: 17). It is not confirmed if this claim was worked or where it was located.

#### Roaring Meg

The Roaring Meg Sluicing Company Limited bottomed a paddock and erected a water wheel for hydraulic elevating the upper portion of the flat at the confluence of Plank Creek where the Cardrona pack track crosses the Roaring Meg (Cromwell Argus 1890: 29<sup>th</sup> May page 14). Hamel (NZAA F41/667) noted sluice pits, a possible elevator pond, two stone huts, and a large river diversion at the juncture of Plank Creek that may be the work of Charles Ballingall and Patrick Patton in 1914. Three water races were brought in but it is not noted which side of the Meg the races divert from. Fluming pipes were sourced from Arrowtown (September 1916) with two men clearing out the races under the manager, Mr Sanson. The company wound up December 1917 (Archives Dunedin: Roaring Meg Sluicing Company Limited).

#### Hairpin Bend workings (NZAA F41/670 - 2)

Gold workings have previously been recorded from below the Roaring Meg hut to Hairpin Bend (Hamel 1991 and 1996). The Conservation Resources Report (2002: 10) notes the Hairpin Bend workings as an important site. An aerial photograph shows the workings (F41/672) below the Meg hut. SO 1169 (dated Nov 1920) shows the old workings at Hairpin Bend.

A newly recorded ground sluicing field (NZAA F41/716) is located in a tributary of Roaring Meg just below Mitre Creek (GPS 100). Three small water races feed to the workings from the unnamed tributary of the Meg. Old gold workings shown on Parks 1908 Geological map correspond to these alluvial workings although quartz reef workings were not recorded.

Ng (1993: 315) reports that Chinese made discoveries of good auriferous finds at the Roaring Meg in 1890. A prospector wrote an article for the Cromwell Argus (1890: 29<sup>th</sup> May page 14) noting rich patches of gold in the Roaring Meg found by Chinese miners working the area. The bed of the upper Roaring Meg (below the Meg huts) has been worked over three or four times with gold left in one or two very rough places which will yet be worked. The river bed had been blasted out to get at the cracks in the reef. Another rich patch was four miles further down which may correspond to the workings at Hairpin Bend.

Below the Plank Creek slip the Roaring Meg was worked by Chinese miners in a most systematic manner with good results (NZAA F41/667). The claim at the foot of Deep Creek (Skeleton Creek) proved very remunerative with four Chinese miners obtaining £400 of gold for a months work (Cromwell Argus 1890: 29<sup>th</sup> May page 14).

Four hut/tent sites were recorded on the true left of the Roaring Meg (NZAA F41/725 – F41/728, GPS 176, 120 - 122) that may have been occupied by gold miners or racemen although some may relate to a pastoral use.

Hamel (1996: 16) noted that apart from water races it seems unlikely that there are any workings in the tributaries of the lower Meg. Hamel (1991: 135) noted reservoirs and at least three small water races running between Goat Camp Creek and the Roaring Meg. The races may have fed water to gold sluicings around Cleghorn's hut across the Kawarau River. Details of the races are noted in Hamel (1996: 13 – 14, 25 – 26).

#### Lowburn Valley

Lowburn was the scene of a gold mining rush in 1866 named Three Mile Rush with a settlement initially located along the north side of Lowburn Creek (George 2011: 24 - 25). A second mild rush set in May 1899 when most of Lowburn Creek was pegged out (Otago Daily Times). Disturbed ground that appears worked for gold and two rectangular pits that may be possible tent sites (GPS 134, 136 – 138) are noted east of the sheep dip in Lowburn Valley.

A large water race (372Cr) diverts ca. 300 yards above the Roaring Meg road bridge for a dredging claim (No.744) that may be located on the Cromwell Flats. This race was issued to John Nevis Robertson in 1900 (Hamel 1996: 14, 27).

**Roaring Meg power scheme**

The Roaring Meg power scheme was established in March 1936 as a joint venture between the Otago Electric Power Board and two dredging companies, the Molyneux Gold Dredging and Clutha Gold dredging Companies. It took two years to construct the 2.5 kms of pipeline from the weir in the upper Meg to the power house beside the road on the Kawarau River. A dam was built above the weir and a small power house in the upper Meg between 1945 and 1948 (Chandler & Hall 1986: 96, 113 - 115, Ellis 1972: 19 - 20 cited in Ritchie 1983: 28, Hamel 1991: 70 – 71, Parcell 1976: 308). The upper Meg power house and associated structures appear to lie outside of the PL although access roads and transmission facilities are within the PL.

**Other**

Peat cutting was an activity probably undertaken on higher ground on the PL. Hamel (1990: 8) noted peat available as fuel in the stream flats at the head of Skeleton Stream.

**Trig Stations**

Two 19<sup>th</sup> century Trig stations reside on the PL were not inspected during the survey, Trig ‘G’ on Mt Michael (code A364: LINZ Geodetic database), and Sub-Trig ‘C’ beside the Cardrona Roaring Meg bridle track. Trig ‘G’ is a bayonet spike set into modern concrete (upgraded 2005 and 2007) within a stacked rock cairn originally set up by F. Howden in 1866. A 2 m high beacon was erected over the cairn in April 2007.

Sub-Trig ‘C’ is shown on SO 3808 dated 1876 north of the Kirtleburn Hotel site on the true left of the Roaring Meg.

**Table 7. List of key features recorded on Lowburn Valley PL.**

GPS ID	Description	GPS ID	Description
001	fence line	103	row of wood posts
002	Mt Pisa boundary riders hut	104	row of power poles
003	water race intake	105	benched track
005	water race	109	stacked revetment Roaring Meg track
007	small water race	111	stacked revetment Roaring Meg track
008	rock shelter	113	stacked revetment Roaring Meg track
010	chimney tent site	114	stacked revetment Roaring Meg track
011	water race	115	Plank Creek workings
012	pack track or parallel water race	117	stacked revetment creek edge
020	Settlers water race & fluming	118	billy tin
021	Towan's water race	119	raised rim pit by hut site
028	Towan's water race flume and fence post	120	hut site



029	fence post	121	hut site
030	Towan's camp chimney tent site	122	revetment and hut below, Roaring Meg
032	Towan's camp collapsed chimney tent site	123	old bridge stacked supports Kawarau Gorge
035	McMillans hut	124	original Lowburn Valley homestead
037	internal flat std fence line	125	current Lowburn Valley homestead
040	taranaki gate	126	garage
044	fence post	127	fence line and post
047	John Hepburn's, rock shelter, stacked wall	128	woolshed
049	John Hepburn's reservoir	129	implement shed
053	John Hepburn's workings	130	small water race
055	John Hepburn's dam wall	131	fence line
058	view to Hendersons water race	132	sheep dip
059	rock shelter	134	2 x poss tent sites
062	mining Mitre Creek	135	corner fence line
063	tailings Mitre Creek	136	pit
066	stacked rock poss tent site	137	pits and sluicings
069	poss stacked hut in tailings	138	large pit
070	stacked hut	139	large pit
071	stacked cairn	140	small water race
072	boundary fence line	143	pack track or boundary fence line
073	hut/tent site	145	dip race
074	pick & handle & small shelter	148	dip yards
076	tailings Mitre Creek	163	header race 1
078	stacked hut/tent site	164	header race 2
079	stacked wall poss water race	166	hut site
081	water race	167	hut site
083	stacked sludge channel	168	hut site
088	tailings	171	hut site
089	small shelter and shoes	176	tent site
090	tailings	177	mining tailings
091	stacked tailing	181	water race
092	stacked hut site and water race	186	collapsed chimney tent site

093	stacked hut site	187	stacked trench
096	well mud packed stacked hut	188	John Hepburn's hut site
098	extent of lower sluicing gulch	189	stacked wall
101	stacked revetment Roaring Meg track	190	water race 1
102	stacked revetment Roaring Meg track	191	water race 2
		192	trench

### 2.8.1 Significance of Historic

Significant historic resources recorded during the Lowburn Valley survey include gold fields and sites related to transportation and pastoral/agricultural use. Gold mining features consist of hard rock gold tailings, gold miners hut/tent sites, water races and reservoirs/dams. Pastoral and agricultural sites consist of a boundary riders hut, sheep dip and yards, homestead station buildings including a woolshed, a racemans camp and water races, and 19 – 20<sup>th</sup> century fence lines. Transportation features include three major pack tracks and remaining fabric of an early bridge alongside the Kawarau.

The history of many of the sites is well documented. Use and occupation of sites can be linked with numerous high profile and influential people.

## 2.9 Public Recreation

### 2.9.1 Physical Characteristics

The PL is close to Cromwell and is easily accessible from Wanaka, Alexandra and Queenstown. The PL bounds the Pisa Conservation Area along its entire northern boundary.

Visitor numbers to the Pisa Range are increasing due to easy vehicle access via the Snow Farm access road, the presence of the Meg and Lowburn Pack Tracks (legal roads) and improved access opportunities elsewhere along the range which have arisen from various tenure review outcomes.

There are important opportunities for public recreation on the PL. This is due to the:

- The location of the PL into the heart of the Pisa Conservation Area. The land is well suited to the range of recreational activities which occur on adjoining public conservation lands. The PL is therefore strategically important.
- In most winters snow conditions allow for backcountry ski touring and cross-country skiing.

- The presence of the recently upgraded Deep Creek Hut and the Meg Hut on neighbouring conservation land in close proximity to the PL.
- A network of high altitude tracks on the PL which provide opportunities for mountain biking, walking, horse riding and four wheel driving in a natural setting. Some of these tracks link with tracks on adjoining public conservation land.
- The Pisa Range Crest and most of the Roaring Meg catchment are a spectacular natural setting, provided by the natural vegetation cover and interesting landforms present, including rocky tors, rocky gorges and rolling tops.
- Magnificent scenery, with outstanding 360° views towards Mount Aspiring National Park, the Cromwell Basin, the Roaring Meg and Kawarau River catchments.
- The abundance of historic mining remains, particularly in the vicinity of Mitre Creek.
- The presence of both the Lowburn and Meg Pack tracks within the PL boundaries which lie on or close to legal road lines. These tracks form part of an increasing recreational network on the Pisa Range.
- The dry Central Otago climate and high frequency of fine weather amenable to both summer and winter activities.

The PL is currently enjoyed by a range of recreational users including backcountry skiers, mountain bikers, horse trekkers, mountain runners, hunters, walkers, natural history enthusiasts, four wheel drivers and trail bikers (commercial tours). The majority of these activities occur on the Pisa Range tops and along the Cardrona–Roaring Meg and Lowburn pack tracks.

In 1992 DOC compiled a Recreation Opportunity Spectrum for the entire conservancy whereby all areas, regardless of land tenure, were classified and mapped according to setting, activity and recreational experience characteristics.

The recreational opportunities identified within and around the PL were Back Country Walk In and Back Country Four Wheel drive in. Back Country opportunities are defined in the Otago CMS as being *characterised by a feeling of relative remoteness from populated areas, yet has good recreational facilities. The highly natural setting is a valued part of the experience and may be associated with motivations of “escape from town”, education, exercise, and/or a sense of being close to nature.*

The Otago Conservation Management Strategy (1998) identifies the Pisa summit ridge as having *remote* recreational setting, especially in winter, when the area is inaccessible to vehicles.

### **2.9.2 Legal Access**

There are three un-surveyed legal roads through the PL (see Maps 4.2.1(a) and (b)) and a marginal strip along the Roaring Meg. Two of the legal roads, being near the Roaring Meg and over Mt Michael lie very close to old pack tracks. The third, in the vicinity of Packspur Gully (Cardrona Cromwell Pack track) lies somewhat to the north of the historic formation which has been upgraded to 4WD standard. These three legal road lines are all likely to be aligned with nearby formations at survey.

The operators of the Roaring Meg generating plant, Pioneer Electric, maintain (via a locked gate) the portion of legal road between the Kawarau Gorge road and the power plant. Pioneer Electric believes that while the road formation is partly on the legal road, as they maintain the road at their cost, extra vehicle traffic would add to this cost. They also advised that as the road is only one vehicle width in many places it would be dangerous if there was public vehicle use of the road. Resolution of access issues associated with this road lies with Queenstown Lakes District Council.

Similarly the locked legal road leading to Mount Michael appears to lie close to formed tracks where it traverses freehold land from Ripponvale near Cromwell to the Lowburn PL boundary. Once inside the PL the legal road line remains close to a formed track.

The Roaring Meg and Cardrona Cromwell Pack Tracks are sign posted and marked for public foot and bicycle use.

### **2.9.3 Activities**

The PL is strategically important for recreation on the Pisa Range, as it effectively cuts the adjoining Pisa Conservation Area in two along its eastern side. Recreational use of the Pisa Conservation Area has seen a steady increase in use in recent years.

The Cardrona-Cromwell and Roaring Meg Pack Tracks and the Mt Michael pack track provide legal public access through the PL (subject to confirmation of road alignments). The two pack tracks receive a regular and increasing level of use, primarily by walkers, mountain bikers and horse riders. The Cardrona-Cromwell pack track is the most popular vehicle access on to the southern Pisa Range.

Both the Cardrona - Cromwell and Roaring Meg Pack Tracks are signposted and marked along their lengths with stiles over the fences. This development has been in co-operation with the lessees. Both tracks can be treated as either a one day or a two day trip camping overnight or staying at the Meg or Deep Creek Huts.

Multi-day tramping trips, taking in the crest of the Pisa Range from as far south as the Crown Saddle via Mt Allen, to as far north as Queensberry Ridges are likely to include a traverse of the PL away from the existing marked pack tracks.

The old pack tracks and surrounding plateau are also popular with local horse riders. The Otago Goldfields Cavalcade has previously used the tracks.

Backcountry skiers periodically use the Cardrona – Cromwell Pack Track to access the Pisa Plateau. Both the newly renovated public Deep Creek Hut and the Meg Hut which lie near the PL boundary can be used as a base for ski touring and summer excursions.

The Pisa Range has provided a venue for adventure racing and Rogaine events on a semi regular basis.

Heli biking is undertaken on adjoining pastoral leases.

Gold workings and associated mining relics set in a superb backcountry setting, particularly in the vicinity of Mitre Creek provide for a high quality historical appreciation experience

Rabbit numbers can be high. Some rabbit shooting takes place. There are limited hunting opportunities for goat, deer and chamois.

With landholder permission four wheel drivers use the various access farm tracks to access the Pisa Range. Inappropriate use of four wheel drive vehicles (i.e. not keeping to the track) can lead to damage to sensitive areas, including wetlands and historic sites.

#### **2.9.4 Significance of Recreation**

The PL forms a ‘wedge’ into the Pisa Conservation Area and is therefore highly significant in providing a recreational linkage along the spine of the Pisa Range.

There are excellent opportunities to advance CMS objectives on the PL. The Otago CMS objective for recognising mountain biking as an increasingly popular activity is *“to make improved provision for mountain biking in rural and backcountry settings in Otago including on land administered by the department provided adverse effects on natural, historic and cultural resources and other recreational resources are avoided or minimized”*. The network of tracks on the Pisa Range (including the PL) and its natural setting, provides excellent opportunities for mountain biking.

The PL also provides important opportunities for horse trekking. The Otago CMS objective for horses is *“To provide opportunities for access into land administered by the Department by horses and pack animals where natural, historic and recreation values are unlikely to be adversely affected”*. Cardrona Valley is a known destination for horse trekking, with commercial outfitters operating elsewhere in the valley. With the growth in Cromwell and Wanaka, there is a likely increase in demand for interesting day trips on horseback, within easy travelling distance of these towns.

The Objective for the Pisa Special Place, of which the PL is a part, reads: *“To protect representative low altitude lands and high altitude lands in the area for their landscape, nature conservation and historical values; the latter lands on an **extensive basis providing enhanced***

*public recreational opportunities complementary to those already being provided commercially.”*

Implementation includes:-

- *“Seek opportunities arising out of pastoral lease tenure review negotiations to protect extensive high altitude areas of high landscape, nature conservation, recreational and water and soil conservation significance.*
- *Ensure appropriate public access, both vehicular and by horse where appropriate and on foot, to lands administered by the Department.*
- *As tenure reviews are concluded, keep under consideration the unifying concept of a high altitude Pisa Conservation Park. If the park proposal proceeds, a management plan for the park will be developed.*

The PL contributes to the outstanding setting for the diverse range of outdoor recreational activities available on the Pisa Range. The Pisa Range is a very important area for backcountry skiing. Summer activities include mountain biking, mountain running, walking, tramping, horse trekking, historic and natural heritage appreciation and four wheel driving. Visitor numbers to this area are increasing due to the rapid growth in the Lakes & Central Otago region, and the increased awareness of the Pisa Conservation Area as a destination for public recreation. The intention to create a Pisa Conservation Park is likely to lead to increased visitor use.

The PL provides the opportunity for strategic public access to areas of significant inherent natural and historic value identified elsewhere in this report.

## PART 3

### OTHER RELEVANT MATTERS & PLANS

#### 3.1 Consultation

NGO input has been provided at various meetings and subsequent written comments in 1996, 2001, 2002 and 2012. A summary of NGO input and recommendations is provided below.

1. Land to be retained by the Crown and administered by the department.
  - Federated Mountain Clubs (FMC) and Forest and Bird (F&B) recommended that all the land above 1000m- 1100m should be retained in full Crown ownership.
  - Professor Allan Mark suggested the land above 1200m should be retained in full Crown ownership.
  - F&B advised that totara located on the eastern faces at 1200m amongst some tors should be protected.

All three parties recommended that both RAP's should be retained by the Crown and FMC stated that Pisa RAP A8 should be classified as a conservation area or scenic reserve.

2. Access through the PL
  - FMC recommend unrestricted public foot, mountain bike and horse trekking access along the Cardrona - Cromwell and Roaring Meg pack tracks. They advise that legal roads should be realigned so that they are consistent with the said pack tracks. FMC also recommended an easement for vehicle access to the foot of the Cardrona-Cromwell track and vehicle access to above the dam at the confluence of Skeleton Stream and Roaring Meg and that space for car parking be created at both the head of the easement and road.
  - Both the Cromwell Riding Club and the Otago Goldfields Heritage Trust requested that horse access through the PL be maintained. The riding club requested that provision be made to allow the passage of horses over all fences which cross the pack tracks.
  - F&B requested that 4WD access on the eastern side of the Pisa Range be secured via the Cardrona-Cromwell track.
3. All parties stated that conservation/freehold boundary should be consistent with those secured through tenure reviews of adjacent runs.

Written input was received from FMC, CORUF, Professor Alan Mark and Forest and Bird Dunedin Branch. Points raised in these reports are summarized in Table 8.

**Table 8.**

<b>NGO</b> <b>Recommendation</b>	<b>CORUF</b>	<b>Alan Mark (2001)</b>	<b>Forest &amp; Bird Central Otago</b>	<b>Forest &amp; Bird Dunedin</b>	<b>FMC</b>
Restore Land above 1000-1100m to public ownership	✓		✓	✓	✓
Secure right of public foot, bicycle and horse access over the pack tracks if not already legal	✓		✓		✓
Seek public 4WD access up Lowburn Pack Track to 1000m -	✓		✓	✓	
Public access easement down the zig-zag to the Kawarau Gorge exiting near the Roaring Meg Mouth	✓				
Seek protection of mining remains, water races & the Pennycook stone hut.	✓			✓	
Seek protection of an altitudinal vegetation sequence on the eastern faces	✓		✓		
Seek protection of Roaring Meg Headwaters including Rap A6 as a conservation area		✓			
Seek protection of RAPs as conservation areas	✓		✓	✓	✓
Subject to confirmation of values seek protection of over Pack Spur Gully shrublands			✓	✓	✓
Public vehicle access should be secured up Roaring Meg Road as far as Skeleton Ck			✓	✓	✓
Protect Tongue Spur and Rose Creek shrublands			✓		

\* PCL – Public conservation land.

The most recent submissions from FMC, F&B, the Cromwell Riding Club, the Otago Goldfields Heritage Trust and Prof. Allan Mark are appended as Appendix 4.4.



## 3.2 Regional Policy Statements & Plans

### Regional Policy Statement

The Regional Policy Statement for Otago provides a policy framework for all of Otago's significant regional resource management issues. It does not contain rules. District Plans shall not be inconsistent with the Regional Policy Statement. In respect of natural values the Regional Policy Statement includes the following policy and method statement:

**Policy:** To maintain and where practicable enhance the diversity of Otago's significant vegetation and significant habitats of indigenous fauna, trout and salmon.

**Method:** Identify and protect Otago's significant indigenous vegetation and significant indigenous habitat of indigenous fauna, trout and salmon, in consultation with relevant agencies and with Otago's communities.

In respect of landscape and natural features it includes the following policy and method statement.

**Policy:** To recognise and provide for the protection of Otago's outstanding natural features and landscapes.

**Method:** Prepare in conjunction with relevant agencies and in consultation with the community and affected landowners, an inventory of outstanding features and landscapes that are regionally significant.

Within the Otago Regional Council Regional Plan: Water for Otago, there are no significant wetlands identified on the PL; however consent is required to modify any wetlands above 800m asl.

### District Plan

The PL is within the Central Otago District and is identified in the fully operative Central Otago District Plan (the Plan) as being within the Rural General Zone. The entire PL is zoned as Outstanding Natural Landscape (ONL).

Subdivisions which create lots which on average are less than 8ha or any lot that individually is less than 2ha requires a resource consent as does the construction of buildings within 20m of any waterbody; while a consent is required for any earthworks, deposition of sediment, earthworks greater than 20m<sup>3</sup> and the removal of vegetation within 10m of any waterbody. Earthworks exceeding 2000m<sup>2</sup> and/or 3000m<sup>3</sup> from any one site also require a consent.

The clearance of indigenous vegetation of specified areas and/or types and the establishment of exotic woodlots requires a consent, but note these provisions do not apply to land that is freeholded under the Crown Pastoral Land Act (1998).

Consent is required for earthworks that breach specified thresholds, activities including but not limited to cutting new roads etc, subdivision (except for the creation of legally protected areas)

and the planting of exotic plantation species. Again note these provisions do not apply to land that is freeholded via tenure review.

### 3.3 District Plan

The PL is within the Central Otago District and is identified in the fully operative Central Otago District Plan (the Plan) as being within the Rural General Zone. The entire PL is zoned as Outstanding Natural Landscape (ONL).

Subdivisions which create lots which on average are less than 8ha or any lot that individually is less than 2ha requires a resource consent as does the construction of buildings within 20m of any waterbody; while a consent is required for any earthworks, deposition of sediment, earthworks greater than 20m<sup>3</sup> and the removal of vegetation within 10m of any waterbody. Earthworks exceeding 2000m<sup>2</sup> and/or 3000m<sup>3</sup> from any one site also require a consent.

The clearance of indigenous vegetation of specified areas and/or types and the establishment of exotic woodlots requires a consent, but note these provisions do not apply to land that is freeholded via tenure review.

Consent is required for earthworks that breach specified thresholds, activities including but not limited to cutting new roads etc, subdivision (except for the creation of legally protected areas) and the planting of exotic plantation species. Again note these provisions do not apply to land that is freeholded via tenure review.

Within the Otago Regional Council Regional Plan: Water for Otago, there are no significant wetlands identified on the PL, but note that consent is required to modify any wetlands above 800m asl.

### 3.4 Conservation Management Strategy & Plans

The Otago Conservancy of DOC has prepared a Conservation Management Strategy (CMS) which was approved by the New Zealand Conservation Authority in August 1998. The CMS identifies 41 special places of conservation interest in Otago Conservancy.

The CMS objective for the Pisa Special Place is:

*“To protect representative low altitude lands and high altitude lands on a more extensive basis in the area for their landscape, nature conservation and historical values; the former lands on an extensive basis providing enhanced public recreational opportunities complementary to those already being provided commercially”.*

Priorities for Special Place are:

Completion and continuation of protection negotiations at both high and low altitudes, including tenure reviews, will be a priority in this Special Place.

The key implementation methods relevant to Lowburn Valley PL are:

*(a) Seek opportunities arising out of further pastoral lease tenure review negotiations to protect extensive high altitude areas of high landscape, nature conservation, historical, recreational and water and soil conservation significance.*

*(b) As tenure reviews are concluded, keep under consideration the unifying concept of a high altitude Pisa Range Conservation Park. If the park proposal proceeds, a management plan for the park will be developed.*

*(c) Ensure appropriate public access, both vehicular where appropriate and on foot, to lands administered by the Department.*

*(d) Continue to gather ecological and historical information that aid management and pastoral lease tenure review negotiations, including surveys for indigenous fish.*

*(e) Recreation and tourist concessionaire use of the range may be allowed where detrimental effect on the natural, historic and recreational resources and opportunities can be avoided, remedied or mitigated.*

*(f) Continuing education of summertime recreationists about the fragility of upland wetlands to vehicle traffic, and fire hazards.*

*(h) Aiming to protect at least one complete mining system.*

*(j) Foot access to and along the Roaring Meg-Cardrona and Lowburn-Cardrona Pack Tracks will be negotiated/identified, and their natural, cultural and historic resources protected, in relation to demand. Cultural aspects will be interpreted in consultation with Kai Tahu.*

### **3.5 New Zealand Biodiversity Strategy**

The New Zealand Government is a signatory to the Convention on Biological Diversity. In February 2000, Government released the New Zealand Biodiversity Strategy which is a blueprint for managing the country's diversity of species and habits and sets a number of goals to achieve this aim. Of particular relevance to tenure review, is goal three which states:

Maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state, enhance critically scarce habitats, and sustain the more modified ecosystems in production and urban environments, and do what is necessary to:-

*Maintain and restore viable populations of all indigenous species across their natural range and maintain their genetic diversity.*

The strategy outlines action plans to achieve this goal covering terrestrial and freshwater habitat and ecosystem protection, sympathetic management, pest management, terrestrial and freshwater habitat restoration, threatened terrestrial and freshwater species management, etc.

### **3.6 Protecting Our Places**

In April 2007 the Ministry for the Environment produced a new policy document titled 'Protecting Our Places' which was jointly launched by the Minister of Conservation and the Minister for the Environment. This publication introduces four national priorities for protecting rare and threatened native biodiversity on private land. The national priorities identify the types of ecosystems and habitats most in need of protection.

The policy statement supports the government's pledge to maintain and preserve New Zealand's natural heritage. This began in 1992 when New Zealand signed the United Nations Convention on Biodiversity; followed in 2000 with the release of the New Zealand Biodiversity Strategy.

The four national priorities for biodiversity protection are listed below. They are based on the most up to date scientific research available.

#### **National Priority 1:**

To protect indigenous vegetation associated with land environments, (defined by Land Environments of New Zealand at Level IV), that have 20 percent or less remaining in indigenous cover.

#### **National Priority 2:**

To protect indigenous vegetation associated with sand dunes and wetlands; ecosystem types that have become uncommon due to human activity.

#### **National Priority 3:**

To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2.

#### **National Priority 4:**

To protect habitats of acutely and chronically threatened indigenous species.

These national priorities have relevance beyond conservation initiatives on private land. For example they are used to help assess applications for grants under the government funded Community Conservation Fund which funds conservation projects on public land by community groups.

The national priorities also provide a useful measure for assessing tenure review recommendations and outcomes.

**PART 4**

**ATTACHMENTS**

**4.1 Additional Information**

**4.1.1 References**

**Angus, J.H. (19810).** *Aspiring Settlers: European Settlement in the Hawea and Wanaka Region to 1914.* Dunedin: John McIndoe Ltd.

**ArchSite.** NZAA database. <http://www.archsite.org.nz/>

**Archives New Zealand.** V J Brown, Lowburn Valley Station (R2488168). CAYN D467 19/e P/256. Dunedin Regional Office.

**Archives New Zealand.** The Roaring Meg Sluicing Company Limited 1914 - 1918. DAAB D93 9055 Box 81. Dunedin Regional Office.

**Archives New Zealand.** Lowburn, Cromwell Flats and Roaring Meg Irrigation 1929 – 1954. DAGC D249 9012 Box 1. Dunedin Regional Office.

**Arand, J., Basher, L., McIntosh, P.D., Heads, M. (1991).** *Inventory of New Zealand Soil Sites of International, National and Regional Importance. Part 1 – South Island and southern offshore islands.* 1st Edition. *N.Z. Society of Soil Science occasional publication 1.*

**Barkla, J.W. (2012).** Alpine occurrences of *Anogramma leptophylla* in Otago. Botanical Society of Otago Newsletter 66: pg 9

**Beattie, H. (1948).** *Otago Place Names: As Bestowed by the Pakeha and Jotted down by Herries Beattie.* Dunedin: Otago Daily Times and Witness Newspapers Co. Ltd.

**Bliss, L.C.; Mark, A.F. (1970).** The High-Alpine Vegetation of Central Otago, New Zealand. *N.Z.J. Bot.* 8: 381-451.

**Briden, S. (2011).** Desktop assessment of Historic Resources on Lowburn Valley Pastoral Lease. Unpublished Report to the Department of Conservation, Otago Conservancy.

**Carswell, F.E; Mason, NWH, Davis, M.R, Briggs, C.M, Clinton, P.W, green, W, Standish,R.B, Allen,L.E & Burrows, L.E. (2008).** *Synthesis of Carbons stock Information Regarding Conservation Land.* Landcare Research Contract Report LCO708/701. Prepared for Department of Conservation Policy Group Wellington, New Zealand.

**Chandler, P.M & Hall R.C (1986).** Let There be Light: A history of Bullendale and the generation of electric power in Central Otago. Alexandra: Otago Central Electric Power Board.

**Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, M. van den Belt. (1997).** The Value of the World's Ecosystem and Natural Capital. *Nature*, 387 (6230): 255.

**Department of Conservation. (2002)** Conservation Resources Report On Tenure Review of Lowburn Pastoral Lease. Unpublished Report -Otago Conservancy Dunedin..

**Department of Conservation (2007):** Hectors Tree Daisy Information Sheet. Southland Conservancy Invercargill.

**de Lange, P.J., Norton, D.A., Courtney, S.P., Heenan, P.B., Barkla, J.W., Cameron, E.K., Hitchmough, R., Townsend, A.J. (2009).** Threatened and Uncommon Plants of New Zealand (2008 revision). *New Zealand Journal of Botany* 47: 61-96.

**Derraik JGB, Barratt BIP, Sirvid P, MacFarlane RP, Patrick BH, Early J, Dickinson KJM, Closs GP. 2001:** Invertebrate Survey of a Modified Native Shrubland, Brookdale Covenant, Rock and Pillar Range, Otago, New Zealand. *New Zealand Journal of Zoology* 28: 273–290.

**Druce, A.P., Simpson, N., Rance, B. (1993).** Indigenous Psilopsids, Lycopods, Quillworts, Ferns, Gymnosperms, and Flowering Plants of the Mountains of Inland Otago and North Southland. Unpublished Landcare Research checklist 292 held at Landcare Research, Lincoln

**Duncan, M.J.; Thomas, M.B. (2004).** Hydro-logical effects of burning tall tussock grassland on the Lammermoor Range, East Otago, *New Zealand Journal of Hydrology (NZ)* 43: 125-139.

**Fahey, B.D; Jackson, R.J, (1991a).** Hydrologic Study of Deep Creek and Deep Stream Catchments. Unpub. Forest research Institute Report . FEW 91/5.

**Fahey, B.D; Jackson, R.J, (1991b).** Water Yields and Land-use in Deep Creek and Deep Stream Catchments. Unpub. Forest research Institute Report . FEW 91/51

**Fitzharris, B.B. (1979).** Snow Hydrology. In *Physical Hydrology. New Zealand Experience.* (ed. D.L. Murray and P.Ackroyd: 23-43. N.Z. Hydrological Society, Wellington.

**Hamel, J. (1990).** Historic and archaeological sites on Mount Pisa and Queensberry runs. An unpublished Report to the Department of Conservation, Otago Conservancy,

**Hamel, J. (1991).** Gold mining at Criffel and Roaring Meg, Pisa Range. An unpublished Report to the Department of Conservation, Otago Conservancy, and the New Zealand Historic Places Trust.

**Hamel, J. (1996).** Lowburn Valley Station. Its water races and other historic sites. A Report to the Department of Conservation, Otago Conservancy.

**Hamel, J. (2001).** The Archaeology of Otago. Department of Conservation, Wellington.

**Heller, T. (2011).** Land Cover Conversion and Catchment Flow Analysis. Unpublished report commissioned by the Department of Conservation prepared by Environmental and Associates Limited. Dunedin.

**Higham, C. Mason, G. and Moore, S. (1976).** Report on a survey of prehistoric sites in the Cromwell Area, Central Otago. University of Otago, Department of Anthropology (Otago University studies in prehistoric anthropology Vol. 8).

**Hitchmough, R.A., Tutt, K., Daugherty, C.H. (1998).** Significance of Gecko Populations on Islands in Lakes Wanaka and Hawea. Conservation advisory science notes No. 193. 7 p.

**Jewell, T., McFarlane, L. (1997).** Research on grey geckos (genus *Hoplodactylus* Fitzinger, 1843) in the Hawea–Wanaka district, 5–9 May 1997. Unpublished report, Otago Conservancy, Department of Conservation, Dunedin. 73 p.

**Leathwick, J., Wilson, G; Rutledge, D., Wardle, P., Morgan, F., Johnston, K., McLeod, M., Kirkpatrick, R (2003).** Land Environments of New Zealand. Ministry for the Environment

**Lewis, M. (2009).** Corrugated Iron Gazetteer. Appendix A: Corrugated iron.  
<http://mileslewis.net/australian-building/pdf/appendix-a.pdf>

**Lynn IH., Manderson AK., Page MJ., Harmsworth GR., Eyles GO., Douglas GB., Mackay AD., Newsome PJF (2009).** Land Use Capability Survey Handbook – a New Zealand handbook for the classification of land 3<sup>rd</sup> ed. Hamilton, AgResearch; Lincoln, Landcare Research; Lower Hutt, GNS Science. 163 p.

**Mark, A.F. (1992).** Indigenous Grasslands of New Zealand. In Coupland, R.T. and Goodall, D.W. (Eds.) Grasslands: Ecosystems of the World. Vol. 8B Elsevier, Amsterdam. pp. 372-410.

**Mark, A.F. & Rowley, J. 1969:** Hydrological effects in the first two years following modification of snow tussock grassland. The Proceedings of a Symposium on Watershed Management, 8, 188-202.

**McIntyre, R. (2007).** Historic heritage of high-country pastoralism: South Island up to 1948. Wellington: Science & Technical Publishing, Department of Conservation.

**Ministry for the Environment. (2007).** Protecting Our Places, introducing the National Priorities for Protecting Rare and Threatened Native Biodiversity on Private Land. Ministry for the Environment, Wellington.

**Miskelly, C.M., Dowding J.E., Elliott G.P, Hitchmough R.A, Sagar P.M, Scofield P.R and Taylor A.G (2008):** Conservation Status of New Zealand Birds. *Notornis*, 2008, Vol. 55: 117-135 0029-4470 © The Ornithological Society of New Zealand, Inc.

**Morton K D 2007.** The saga of Smallburn, Lowburn, Cromwell, Central Otago. Dunedin: Uniprint.

**Mount Pisa Schedule of Pastoral Runs for License February 1924.** Map held by current lessee, Anne Nielsen.

**Ng, J. (1993).** Windows on a Chinese Past. How the Cantonese gold seekers and their heirs settled in New Zealand. Volume 1. Dunedin, Otago Heritage Books.

**Ngai Tahu Cultural Values Assessment. (2002).** Tenure review Property Report: Lowburn Pastoral Lease.

**Otago Regional Council (1999).** Tairei River Catchment Monitoring Report. Report N0 99-316, 94pp.

**Otago Daily Times. (1899).** Mining. Issue 11432, 25 May Page 6. <http://paperspast.natlib.govt.nz>

**Otago Witness. (1890).** The Roaring Meg Diggings. Issue 1895, 29 May, Page 14. <http://paperspast.natlib.govt.nz>

**Parcell, J.C. (1976).** Heart of the Desert: A History of the Cromwell and Bannockburn Districts of Central Otago. Christchurch: Whitcoulls Limited.

**Park, J. (1908).** The Geology of the Cromwell Subdivision, Western Otago Division. Bulletin No. 5, NZ Geological Survey, Department of Mines. Wellington: John McKay, Government Printer.

**Petrie, D. (1886[1885]).** Description of New Species of Native Plants. *Transactions and Proceedings of the New Zealand Institute* 18: 295-298.

**Pinney, R. (1981).** Early Northern Otago Runs. Auckland: William Collins Publishers Ltd.

**QuickMap.** Survey Office Plans. Land Information New Zealand.



**Ritchie, N. (1983).** Kawarau River Valley Archaeological Survey. A Report to the NZ Historic Places Trust.

**Sinclair, J. (2003).** The Early Pastoral Runs of Otago and Southland: A Listing to Provide Quick Reference to the Runs by Number and Name and by Name and Number: with Maps Indicating the Boundaries, for the most part drawn from the 1871 provincial map. Dunedin, New Zealand.

**Thomson, S. (2005).** Wrinkly Tin: The Story of Corrugated Iron in New Zealand. Wellington: Steele Roberts.

**Townsend, A.J., de Lange., PJ; Duffy., CAJ; Miskelly., CM; Molloy., J;Norton, DA. (2008).** New Zealand Threat Classification System manual. Science & Technical Publishing, Department of Conservation, Wellington.

**Ward, C.M., Bruce, D.L., Rance, B.D., Roozen, D.A., Grove, P. (1994).** Lindis, Pisa and Dunstan Ecological Districts. A Survey Report for the Protected Natural Areas Programme. Department of Conservation, Dunedin.  
Waugh (2005)

**Williams, P. A. (1981).** Aspects of the Ecology of Broom (*Cytisus scoparius*) in Canterbury, New Zealand. *New Zealand Journal of Botany*, Vol 19: 31-43.

**Williams, PA., Wiser S., Clarkson B., Stanley M.C. (2007).** New Zealand's Historically Rare Terrestrial Ecosystems Set in a Physical and Physiognomic Framework. *New Zealand Journal of Ecology* 31(2): 119-128.

## **4.2 Maps**

**4.2.1 (a) Topographic and Cadastral**

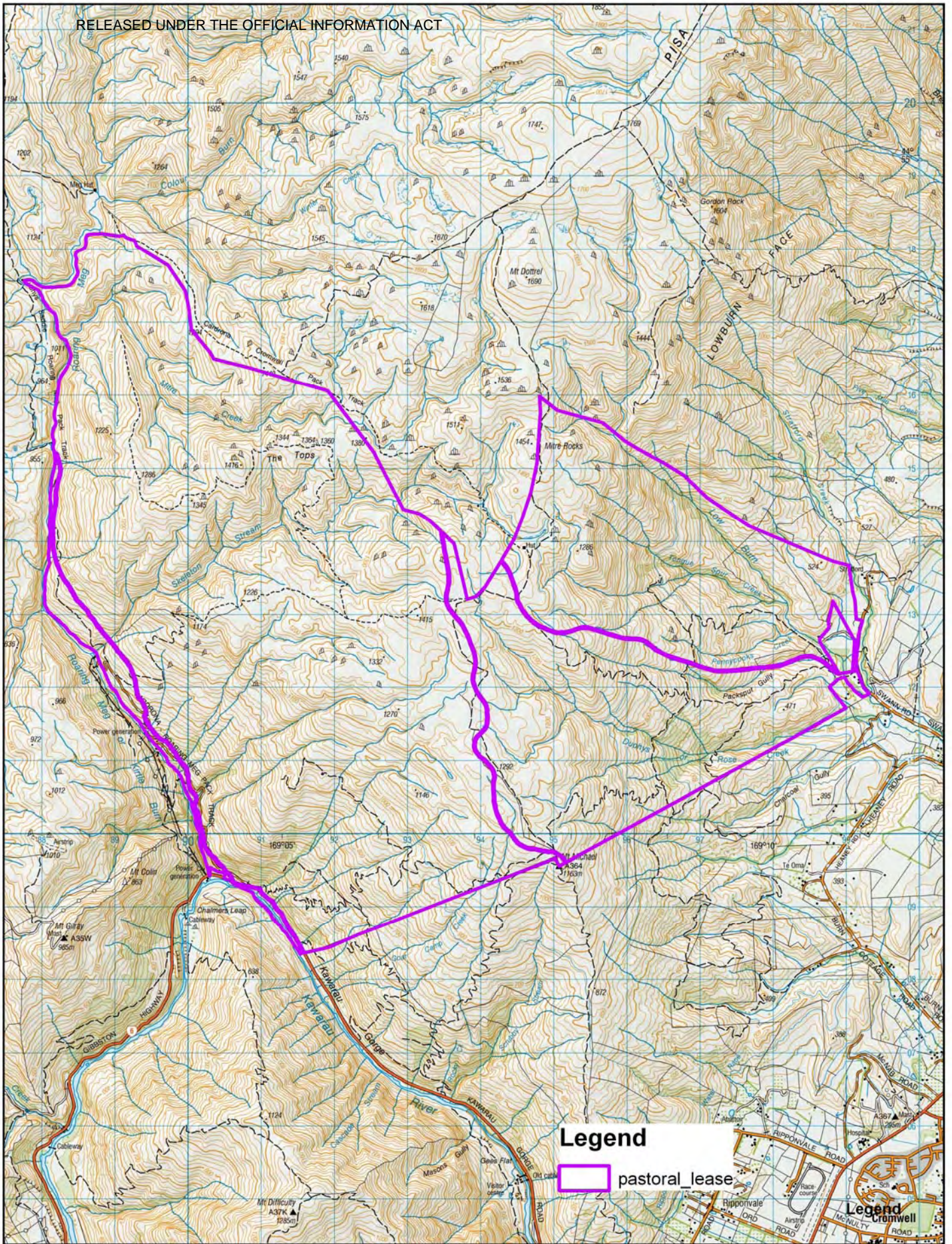
**4.2.1 (b) Topographic and Cadastral - Strategic Context**

**4.2.2 Landscape Units and Significant Landscape Units**

**4.2.3 Values – Ecological, Recreation and Historic**

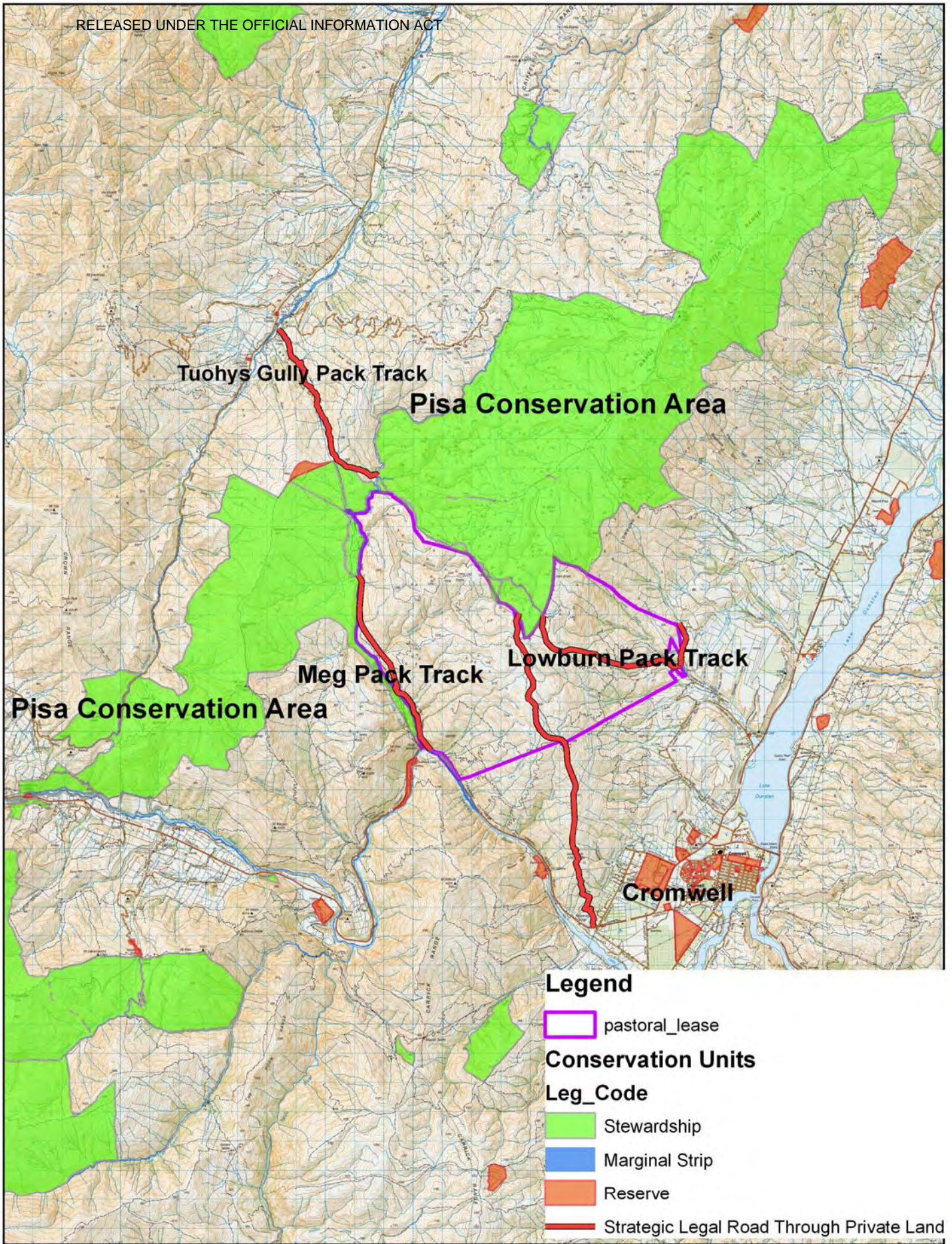
**4.2.4 LENZ Units and Threat Status**





**Map 4.2.1(a)**  
 Topo Cadastral - Lowburn Valley Pastoral Lease

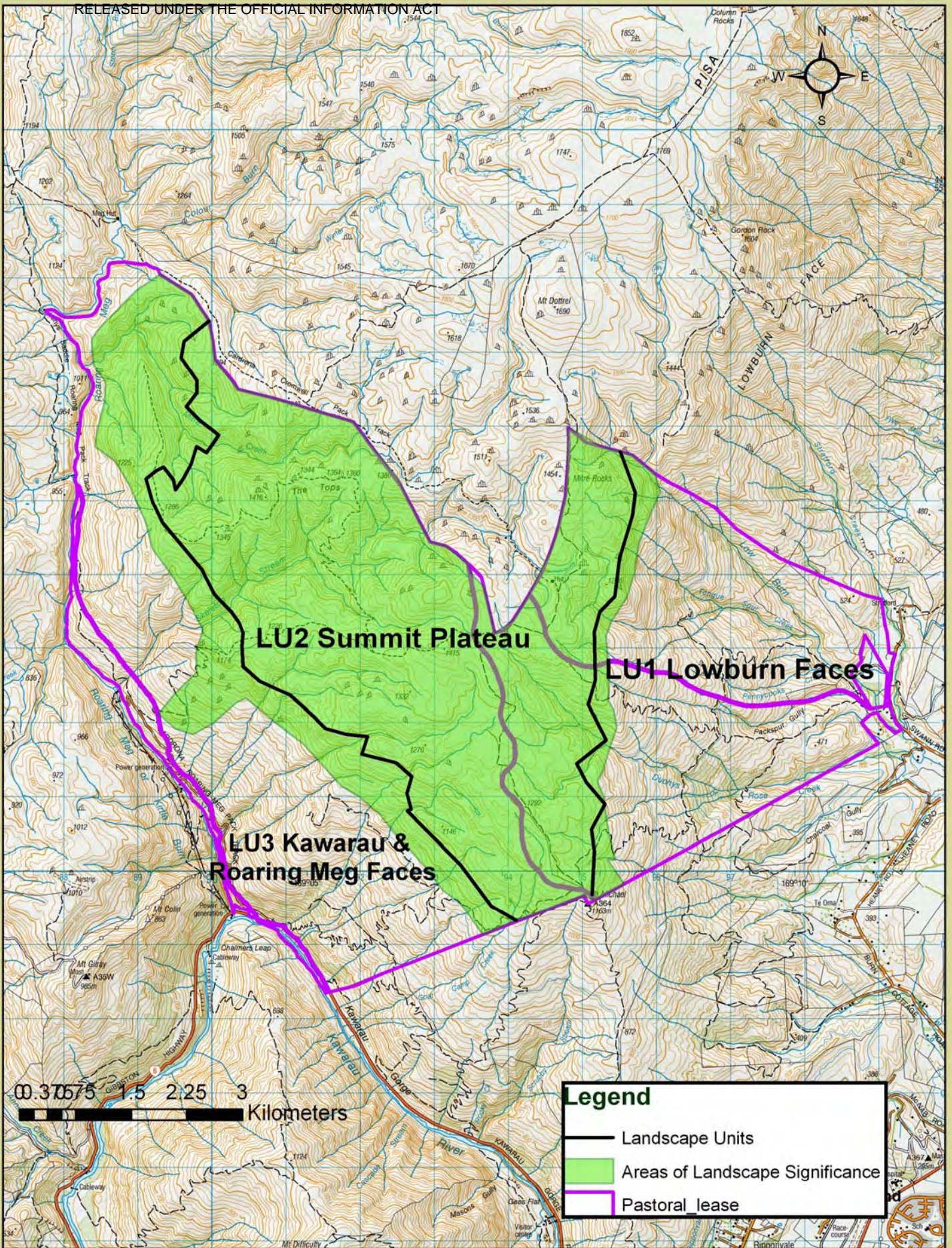




### Map 4.2.1(b)

Topo Cadastral - Lowburn Valley Pastoral Lease Strategic Context



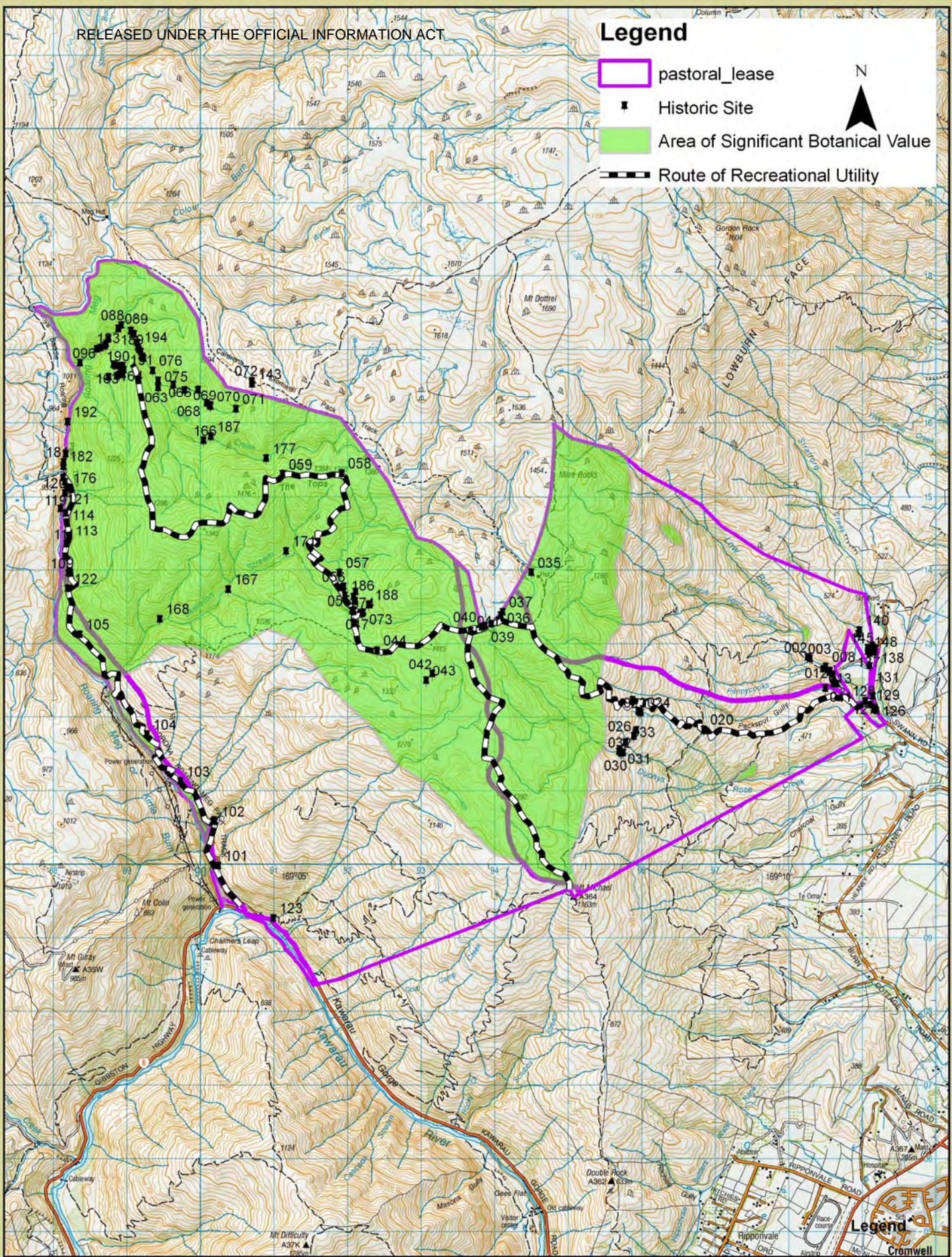


**Map 4.2.2**  
Landscape Units and Landscapes of Significance



### Legend

-  pastoral\_lease
-  Historic Site
-  Area of Significant Botanical Value
-  Route of Recreational Utility



**Map 4.2.3**  
Values - Ecological Recreational Historic

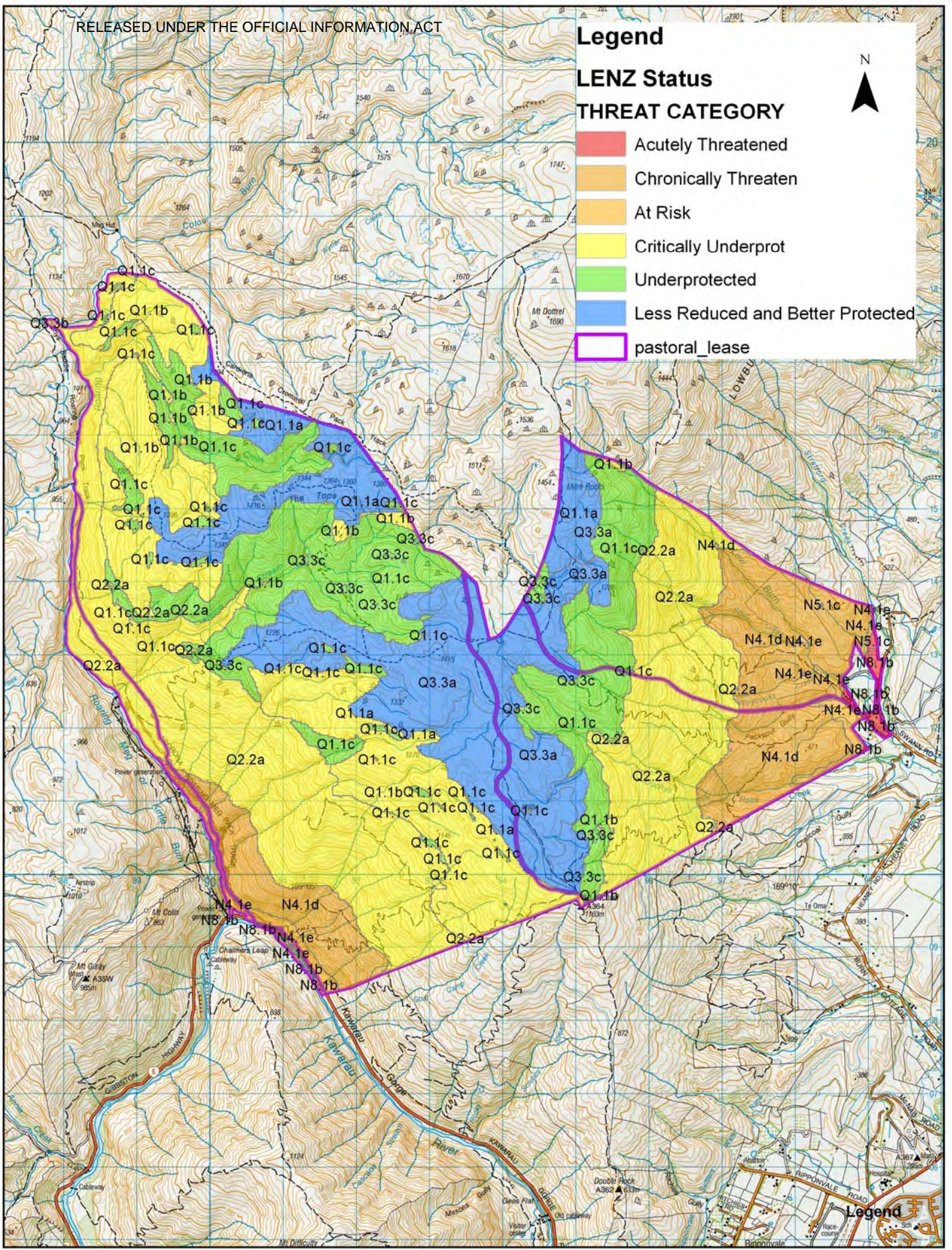


### Legend

#### LENZ Status

#### THREAT CATEGORY

- Acutely Threatened
- Chronically Threaten
- At Risk
- Critically Underprot
- Underprotected
- Less Reduced and Better Protected
- pastoral\_lease



## Map 4.2.4

Lowburn Valley LENZ Threat Status