

Crown Pastoral Land Tenure Review

Lease name : HUKARERE

Lease number : PO 009

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**

HUKARERE PASTORAL LEASE

PAL 14-14-09

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



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PART 1

INTRODUCTION

1.1 Background

The lessees of Hukarere Pastoral Lease (PL) have applied to the Commissioner of Crown Lands for a review of tenure. The PL was originally inspected by DOC specialists for tenure review purposes in March 1997. Further inspections, primarily of a botanical nature, occurred in November 2002 and March 2010. Additional bird and invertebrate records were also made during the 2010 inspection. Findings from these inspections have been incorporated into this report.

Hukarere is a moderately large PL of 7177 ha with supporting freehold. It is located on eastern flanks of the southern Umbrella Mountains. Most of the PL lies west of the Pomahaka River. The homestead is 24 km west of Heriot and 64 km north of Gore. Hukarere is the southernmost of four PL's on the east faces of the Umbrella Range. It adjoins Argyle PL to the west, Crown Rock to north and Leithen Bush Scenic Reserve to the south west. The balance of the PL adjoins freehold land.

The PL lies at relatively low altitude, extending from c. 250 to 1156 m.a.s.l on the summit of the Umbrella Range. The eastern part of the PL comprises some of the lowest altitude pastoral lease country in New Zealand.

Hukarere lies in the central portion of the Umbrella Ecological District (ED). This ED is one of two that constitute Waikaia Ecological Region. The Umbrella ED extends from the Waikaia River in the west, through to the Clutha River in the north. The higher plateau country to the north-west of the PL lies within the Old Man ED. The Umbrella ED has been described by McEwan (1987) as consisting of low to moderate altitude hill and mountain lands, centred upon the Umbrella Mountains.

The Umbrella ED was surveyed as part of the Protected Natural Areas Programme (PNAP) over the 1985/86 summers (Dickinson et al. 1988). The PNAP survey identified two recommended areas for protection (RAPs) on the PL; RAP Umbrella 4, Leithen Burn Headwaters (700 ha), and RAP Umbrella 11: Devils Gorge (20 ha). A description of these RAPs is attached as Appendix 1.

Both past and current lessees have shown a willingness to sympathetically consider protection of conservation values on the PL. In 1978 the previous lessee gifted to the Crown a large area of beech forest in the Leithen Burn, which subsequently formed part of the Leithen Bush Scenic Reserve. The current lessees agreed to a conservation covenant to protect their portion (6.29 ha) of the Devils Gorge RAP in 1990.

PART 2

INHERENT VALUES: DESCRIPTION OF CONSERVATION RESOURCES AND ASSESSMENT OF SIGNIFICANCE

2.1 Landscape

This PL is located in the band of high hill country of West Otago, rising from the Pomahaka River in the east, up to the crest of the Black Umbrella Range in the west.

The most significant landform on Hukarere is Parasol Hill, which is a dome-shaped hill located in the centre of the property. This prominent landscape feature has a number of valleys radiating out from its summit that flow directly or via the Parasol Creek into the Pomahaka River.

A large proportion of Hukarere has been subdivided into grazing blocks, with most being over sown and top dressed. This has resulted in much of the natural cover being modified for production purposes. The western high country, darker gullies, and the deeply incised Parasol Creek retain a good representation of snow tussock, shrublands and beech forest remnants.

Those parts of the PL retaining significant natural landscape values have been divided into the following units (see Map 4.2.2):

Landscape Unit 1

This unit incorporates the rangelands from the existing Leithen Bush Scenic Reserve to the northern boundary of the station (Trig, D 1115 m). This unit contains all the natural features that are typical of the west Otago high country, including tussock covered ridgelines and shrubby gullies. It conveys an open character with no sense of boundaries. Being contiguous with the scenic reserve, there is an uninterrupted sequence of natural features and landscape types, from the lower beech forest to the more depleted rangelands on Sandy Hill. In the lower warmer country, browntop is quite conspicuous, however the overall impression is of a contiguous tussock cover.

Landscape Unit 2

This unit encompasses the middle section of the Parasol Creek which follows a sinuous and rough course through a deeply incised valley. Both sides of the creek are clad in a ribbon of both beech forest and shrublands. There are numerous rocky outcrops and bluffs that give the creek its wild and scenic quality.

Parasol Creek and one of its larger tributaries that extends to Trig J have all the characteristics that are common in the west Otago high country.

Landscape Unit 3

In a broader context, the long slopes that comprise this unit form a natural backdrop to the wild and scenic Parasol Creek. It also contains a range of vegetation types that provide a natural linkage between the Parasol and Leithen Bush.

In landscape terms, this linkage helps to form a large coherent natural landscape.

Landscape Unit 4

Little Parasol Creek flows into the Pomahaka River at Devils Gorge. At this point the Pomahaka River is contained within a rugged gorge, characterised by a series of deep pools connected by long riffles.

Devils Gorge forms both a physical and visual backdrop to the Pomahaka River and, being still clad in native shrublands, contrasts markedly with the more modified grasslands on the surrounding hills. Although Devils Gorge is separated from the more cohesive natural areas further west on Hukarere, the landscape still conveys its original character.

The balance of the PL has little value as a natural landscape.

2.1.1 Significance of Landscape

Landscape Units 1-4 collectively typify the landscape character, major landforms and natural vegetation patterns of the Umbrella Ecological District. Landscape Units 1-3 represent an intact and coherent example of the regionally important west Otago high country. Landscape Unit 4 is visually important as it includes the least modified part of the Pomahaka River setting and conveys its original character.

2.2 Landforms, Geology & Soils

Basement rock of the PL is Palaeozoic Haast Schist Group metamorphosed to textural zone III, displaying strong schistosity with either weak or no foliation.

Landform is typically block-faulted and dictated to by the north-south trending Black Umbrella Range which is geologically the southern extent of the Old Man Range. Extensive upland plateaux are the eroded remnants of a mid Tertiary erosion surface. Differential uplift and subsidence and local tilting and warping have formed the lower hill country.

The present drainage pattern is largely superimposed and random. Streams present prior to uplift are now deeply incised and often occupy gorges e.g. Pomahaka and Leithen Burn.

Colluvial slopes flank these watercourses with rock bluff outcrops, some of which are distinctive landform features.

There are no landform features present on the PL which are listed in the Geopreservation Inventory.

Soils

Soils are mainly hill and steepland soils derived from schist with a variable cover of loess. Soils are more leached in higher rainfall areas. There are areas of poorly drained, peaty soils on broad ridge crests.

Soils are grouped as follows:

- Lowland yellow brown earths – Tuapeka Hill soils on moderately steep rolling ridges and short steep slopes, with low to medium natural nutrient status.
- Upland and High Country yellow brown earths – Waipori Hill soils with low to very low natural nutrient status.
- Waikaia steepland soils, formed under beech forest with low to very low natural nutrient status.
- Upland and High Country podzolised yellow brown earths and podzols – Maungatua soils with very low natural nutrient status.
- Organic soils – Kaherekoau soils, sub alpine with very low natural nutrient status.

A summary of the landform features of the two RAPs present within the PL follows:

RAP UMB 04 Leithen Burn Headwaters

This area comprises a deeply incised valley in semi schist, which contains the headwaters of the Leithen Burn. Steep colluvial slopes rise from the creek to both east and west. The valley head rises steeply to the main Black Umbrella Range which forms a narrow but prominent ridge. A few rock bluffs outcrop, mainly on the leading ridge which forms the eastern catchment boundary. Some bluffs are up to 20 m high, and are typical of the ridge-top landform of the southern Umbrella Mountains.

High country yellow-brown earths with related steepland soils (Waikaia/Leithen) plus high country podzolised yellow-brown earths and podzols (Maungatua) occur within the area. Textures vary from silt loams and stony silt loams to peaty loams being derived from greywacke, schist, semi-schist and/or schist loess.

RAP UMB 11 Devils Gorge

Devils Gorge is deeply incised through schist, cut by the Pomahaka River and consists of rock bluffs and steep debris slopes. The bluffs flanking the river are a distinctive landform feature.

Lowland yellow-brown earths derived from schist and schist loess of silt loam and stony loam texture (Tuapeka soils) cover the RAP.

2.2.2 Significance of Landforms, Geology and Soils

Both RAPSs include landforms which are typical and representative of the Umbrella ED, namely deeply incised steep-sided waterways with associated rock bluff formations. Overall, the landform is dominated by the block faulted north-south trending mountain range.

2.3 Land Environments of New Zealand (LENZ)

Description

The environmental distinctiveness of this area 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. 2003). It is presented at four levels of detail containing 20, 100, 200 or 500 environments nationally. The data in this report is presented at Level IV which more adequately reflects the distribution of biodiversity, past clearance and current vulnerability across the landscape than higher levels of LENZ (e.g. Level II). Threat classification at Level IV results in substantially more effective and efficient identification of threatened remaining indigenous cover.

When the Level IV LENZ information is combined with information describing the area of unprotected indigenous cover in threatened land environments, as identified in the national land cover database (LCDB), the biodiversity most likely to be lost can be identified. Five categories identify those threatened environments containing indigenous biodiversity at most risk of loss. These categories which are derived from a combination of measures for the percentage of biodiversity legally protected and percentage of remaining indigenous vegetation cover, are described as follows:

Table 1: Land Environments of New Zealand Threat Classification Categories

Threat Classification	Description
Acutely threatened	<10% indigenous vegetation cover remaining
Chronically threatened	10-20% indigenous vegetation remaining
At risk	20-30% indigenous vegetation cover remaining
Critically underprotected	> 30% indigenous vegetation cover remaining and <10% protected
Underprotected	>30% indigenous vegetation cover remaining and 10-20% protected
No threat	>30% indigenous vegetation cover remaining and >20% protected

Map 4.2.4 depicts the location of land environments by threat classification. Areas of LENZ environments present on the PL and their threat status are presented in Table 2.

Table 2: LENZ environments present on Hukarere Pastoral Lease

Threat Category	LENZ Level IV units	Area of LENZ unit on PL (ha) (Approx. only)	Area of LENZ unit as a % of Hukarere PL
Acutely Threatened	L1.1a	17	0.25
	N2.2b	1	0.01
At Risk	N4.3a	3062	44.41
Critically Underprotected	Q2.1a	376	5.45
Underprotected	Q1.1c	161	2.34
	Q3.2a	15	0.22
	Q3.3c	927	13.44
	Q4.1c	29	0.42
No threat category	Q1.1a	6	0.09
	Q1.1d	2171	31.49
	Q1.2a	21	0.30
	Q2.1b	4	0.06
	Q3.1a	45	0.65
	Q3.3a	48	0.70
	Q4.2a	11	0.16
Total		6895	c. 100

2.3.1 Significance of LENZ

Attributing significance to LENZ units, 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 is continuous improvement of the underlying classification process which generates LENZ units.

National priority 1 in "Protecting our Places" (MfE 2007) is to protect indigenous vegetation associated with land environments (defined by Land Environments of New Zealand at Level IV) that have 20% or less remaining in indigenous cover. Of the Level IV land environments on the PL, L1.1a and N2.2b have less than 20% indigenous vegetation remaining nationally. The main areas where these environments with indigenous vegetation remain are along the lower portion of the Pomahaka River.

2.4 Climate

The PL experiences a cool temperate, humid-subhumid climate. Precipitation rises to c.1145mm per annum in the uplands. In winter, a large proportion falls as snow, which can lie for up to four months of the year.

On the lower PL rainfall averages 765 mm per annum. Rainfall is evenly spread throughout the year and is predominantly from the south-west quarter. Frosts may occur during all seasons. There are frequent fogs. Prevailing winds are from the north-west and south-west.

Summers are mild and winters are cold with frosts common. Droughts are uncommon.

2.5 Vegetation

Ecological Setting

The original vegetation of the Umbrella ED has been summarised in the Southland Protection Strategy (Harding 1999). Harding recognised eight main ecosystems (see Table 3).

Vegetation was dominated by silver and mountain beech forests which occupied ~ 75% of the ED. Narrow-leaved (*Chionochloa rigida var rigida*) snow tussocklands dominated above the treeline at 1000-1100m. Other minor ecosystems were shrublands on colluvium; montane rock outcropping, including bluffs, tors and associated rubblefields; red tussockland occurring on poorly drained broad summit ridges; wetlands and alpine ecosystems including rock tors, fellfields and snow banks. Hukarere PL contains some examples of all eight original ecosystems recognised by Harding.

Table 3 Analysis of original ecosystems of the Umbrella ED (from Harding 1999)

Ecosystem type	Original extent (% of ED)	Proportion of original extent remaining (%)	Proportion of original extent protected (%)	Proportion of remaining area Protected (%)
Montane toutouwai-mixed beech forest	40	30	19	65
Montane titipounamu-silver beech forest	35	5	5	40
Montane mixed shrubland on colluvium	2	5	<1	5
Montane gecko-lichenfield on tors and bluffs	1	90	36	40
Subalpine red tussockland-mossfield-rushland	2	90	0	0
Alpine karearea-snow tussockland	10	100	0	0
Alpine mossfield-sedgeland	5	100	0	0
Alpine herbfield-cushionfield-rockland	5	100	0	0

Since human arrival tussocklands have persisted on the upper slopes of the Umbrella Mountains. However as a consequence of Polynesian fires forests have been heavily fragmented and much reduced in extent. The original forest cover was progressively replaced by tussocklands at higher altitudes, with narrow-leaved snow tussock moving

down slope and red tussock (*Chionochloa rubra*) moving upslope. Shrublands have expanded at lower altitudes. European settlement and pastoralism, with associated grazing, burning, over-sowing, topdressing and cultivation, led to a further wave of modification to the vegetation.

The Protected Natural Areas Programme (PNAP) survey (Dickinson 1988) was the first comprehensive survey of general ecological features of the Umbrella ED. Subsequently there have been several conservation resources reports (CRR) prepared for pastoral leases that have entered the High Country Tenure Review process.

Survey Method

This report relates to surveys undertaken 10-11 March 1997, 18 May 1998, 18-19 November 2002 and 8-10 March 2010. The initial survey work (1997-2002) has been repeated and updated in order to assess vegetation change and confirm vegetation values on the PL. Approximately 50 man hours were spent undertaking survey on the PL. The composition of major plant communities has been described. Threatened plants were searched for in potentially suitable habitats. Digital photographs were taken of particular species, communities and landscapes to aid in interpretation. Specimens were collected of noteworthy or uncertain taxa for herbarium accession and determination.

Vegetation Description

Twenty one distinct vegetation communities have been recognised on the Hukarere Pastoral Lease (see Table 4). Of these 18 are predominantly native in composition and three are dominated by exotic species. A detailed description of each community is presented in Appendix 2.

The PL has been divided into 15 units (see Map 4.2.5). Vegetation is described for each unit using the 21 communities referred to above.

Table 4 – Vegetation communities found on Hukarere Pastoral Lease (See Appendix 2 for descriptions)

Community name	Bioclimatic zone (L = lowland; M = montane; U = upland)	Extent (E = Extensive; M = moderate, L = Limited/ localised)
Silver beech forest	L, M	M
Mixed beech forest	M	L
Hall's totara forest	M	L
Mixed hardwood forest	L, M	L
Exotic plantation	L	L
Olearia shrubland/low forest	L	L
Grey shrubland on sunny faces	L, M	L
Grey shrubland of shady faces	L, M	M
Mixed riparian shrubland	L, M	M
Manuka shrubland	M	E
Upland shrubland	U	L
Narrow-leaved snow tussockland	U	E
Red tussockland	M	L
Modified tussockland	M, U	E
Pasture	L, M	E
Lowland/montane rock faces/gorge/ rock cropping	L, M	L
Upland rock faces/gorge/ rock cropping	U	L
Valley floor wetland	L, M	L
Seepages and flushes	M, U	L
Cushionbog	U	L
Fellfield	U	L

Vegetation features on the PL

- Mid altitude snow tussocklands – a widespread and highly representative feature of the Umbrella ED.
- Silver and mixed beech forest remnants – a widespread and highly representative feature of the Umbrella ED.
- Regenerating forest areas – a successional community associated with many forest stands within the ED.
- Shrublands – The diversity of shrubland types is a distinctive feature of the PL. The health and vigorous regeneration of shrublands and their association with each other and the forest remnants is an important feature. Shrublands include grey shrubland on both sunny and shady faces, diverse riparian shrubland, manuka shrubland and upland shrubland. These shrublands are considered of significance within the Pomahaka Valley, the Umbrella ED and the wider northern Southland area.
- The relatively low altitude of the forest and shrublands enhances their significance.
- Stands of *Olearia fimbriata* – these are an important and characteristic feature of the Pomahaka Valley. The stands found on the PL are the most significant populations on any pastoral lease in New Zealand, in terms of numbers and

health of plants, regeneration potential, association with other vegetation and the diversity of landforms on which they are found.

Description of vegetation units within the PL

The PL has been broken into 15 units. Each unit has been described and mapped (see Map 4.2.5).

1. Leithen Burn Headwaters: This unit includes the headwaters of the Leithen Burn and adjoins the Leithen Burn Scenic Reserve. The unit was identified as RAP4, Umbrella ED. The survey report provides a detailed description of this area. The unit extends from 520 up to 1096 m.a.s.l.

The unit is dominated by narrow-leaved snow tussockland. South facing slopes and upper slopes are in particularly good condition with a strong snow tussock cover, limited sign of stock use, and very little browntop or other exotic species. South facing slopes are generally damp with seepage areas characterised by the presence of much *Schoenus pauciflorus*. There is a component of mountain flax (*Phormium cookianum*), *Hebe odora* and other shrubs on the lower slopes.

The opposing sunny faces were only examined from a distance. They appear to have a greater level of modification. Below 700-750 m.a.s.l there appears to be a light tussock cover. These areas lie below the original regional treeline. Lower to mid altitude slopes have a light shrub cover with patches of denser manuka shrubland. In the absence of burning or heavy grazing woody vegetation will expand to occupy most of the low to mid altitude slopes, as has happened within the adjacent Leithen Bush Scenic Reserve.

In the south of the unit, an area of forest, shrubland and regenerating forest has been fenced into the reserve. The ridge crest is more exposed and has some rock outcrops.

2. Upper Parasol Tributary: This unit contains the upper part of a catchment that flows into Parasol Creek and is fenced into the head of the Leithen Burn as a single block. It is adjacent to the mid-portion of Parasol Creek (unit 7). The unit extends from 560 to 1011 m.a.s.l.

The unit is dominated by narrow-leaved snow tussockland. The tussock is generally in good condition, though there is greater stock use along the broad summit ridge. Much of the upper part of this catchment is very wet with many seepage areas. The lower portion of the unit contains some silver beech (*Nothofagus menziesii*) forest and associated shrublands.

3. Headwaters of Parasol Creek: This is a large basin which extends from 500 to 1149 m.a.s.l. The basin is dominated by narrow-leaved snow tussock. The upper tussocklands are highly natural with few exotic species present. Many of the values are similar to those described in Unit 1 (and RAP UMB4).

Fellfields are present on high exposed ridges. The largest area of fellfield recorded (~60m by 40 m) lies at 1149 m.a.s.l on the summit of Sandy Hill (the highest point on the PL). Here vegetation cover is dominated by edelweiss (*Leucogenes grandiceps*) which is notable for its abundance. Other common native species include herbs *Celmisia densiflora*, *Wahlenbergia albomarginata* and *Anisotome flexuosa*, native grasses *Rytidosperma pumila*, blue tussock (*Poa colensoi*), *Agrostis muelleriana*, *Koeleria* spp. and *Deyeuxia* spp., the rush *Luzula rufa*, mat plants *Raoulia subsericea* and *Kelleria villosa*, and the sedge *Oreobolus strictus*. A scattering of exotic grasses and herbs are present amongst the fellfield comprising of browntop (*Agrostis capillaris*), tussock and mouse-ear hawkweed (*Hieracium lepidulum* and *pilosella*).

The lower sunny face (above a fence line that forms the grazing block boundary with unit 6), is dominated by browntop, with strong manuka (*Leptospermum scoparium*) regeneration underway. There is a moderate tussock cover above c. 700 m and generally strong tussock cover above 800 m. Much of this unit lies below the original tree line.

The lower altitude shady face, in the upper Parasol catchment (near Parasol Hut) contains diverse woody vegetation. This unit contains a disjointed area of silver beech forest, which is some of the highest altitude beech forest on the PL. Associated with this beech forest are areas of regenerating forest and a range of shrub communities. Generally the hill slopes around this forest have an abundance of woody species indicating strong regeneration processes. The most prominent components of the shrublands are *Coprosma dumosa*, *Coprosma tayloriae*, cottonwood (*Ozothamnus vauvilliersii*), *Hebe odora* and manuka. Inaka (*Dracophyllum longifolium*) is locally common. Also found in this area are mountain ribbonwood (*Hoheria glabrata*) and *Hebe rakaiensis*, which are locally uncommon. Some areas are dominated by browntop, however shrublands will continue to rapidly regenerate on these cool, moist slopes. Strong narrow-leaved snow tussockland is found above c. 850 m.a.s.l.

4. Headwaters of Sandy Creek: This is the smallest and northern-most of the three valleys on the PL which drain the Black Umbrella Range. This unit extends from 450 to 1156 m.a.s.l.

The upper part of the catchment contains intact snow tussocklands with few exotic species present. The composition of the tussockland is similar to that within units 1, 2 and 3. The summit ridge has some prominent rocks, with associated rubble and fellfield areas. The upper slopes also have some localised seepages and bare eroded areas. There is a stand of beech forest with associated regenerating shrublands along the valley floor.

Lower sunny faces exhibit a greater level of stock impact with an associated prominence of browntop; however above approximately 700 m.a.s.l a moderately intact tussock cover persists. Much of this lower unit lies below the original treeline. Woody vegetation would expand rapidly if destocked.

5. Parasol Hill: This is a small unit that extends from Parasol Hill down to Parasol Creek (500-940 m.a.s.l.). The unit contains a cap of intact snow

tussock around Parasol Hill. Along the ridge from Parasol Hill south east towards Trig J is a series of rock outcrops and debris fields. These outcrops contain a range of species which are absent or uncommon in the tussocklands, including *Parahebe lyallii* and *Brachyglottis southlandica*. The gully to the south west of Parasol Hill contains much shrubland. Common shrub species include inaka, *Coprosma dumosa* and manuka. Riparian shrublands fringe Parasol Creek. Mid and lower altitude slopes are dominated by browntop; however below 650 m.a.s.l there is a prominent woody component, including much young and rapidly regenerating manuka.

6. Mid Parasol Creek catchment: This area comprises the true left of Parasol Creek and extends from c. 390 – 922 m.a.s.l. The area shows some sign of having been oversown and top-dressed in the past but is now dominated by browntop. This unit has not been burnt for several years and consequently contains an abundance of regenerating shrub species, especially manuka.

The southern-most part of this unit contains some of the most extensive and advanced regenerating forest on the PL. There are excellent examples of successional vegetation including grey shrublands (mainly on shady faces), tall manuka shrublands, regenerating forest and some mixed beech forest. These communities extend onto both sides of the Parasol Creek track. Regenerating forest includes much broadleaf (*Griselinia littoralis*) and marbleleaf (*Carpodetus serratus*), some silver beech and lancewood (*Pseudopanax crassifolius*). This unit also adjoins areas of more extensive mixed and silver beech forest in the mid Parasol Creek area.

7. Forested area in the mid Parasol Creek catchment (easterly aspect): This unit forms an extension to Leithen Bush and adjoins Unit 2. The unit contains the most extensive forest in Parasol Creek. Silver, mountain and red beech are present. There is also regenerating forest which exhibits wide ranging composition dependent upon its age. Younger stages are dominated by *Coprosma* spp., inaka and manuka, while older stages are dominated by broadleaf, marbleleaf and manuka. Forest is continuous along Parasol Creek, however above the forest remnants tree cover yields to mixed shrublands and browntop. The uppermost slopes contain a modified narrow-leaved snow tussockland. The unit extends from 390 m.a.s.l along Parasol Creek up to 800 m.a.s.l. It is within this unit that *Melicytus flexuosus* (status – Declining) is present. This is the only record for this species for the Umbrella ED.
8. Rough Creek (large northern tributary of Parasol Creek): This large tributary of Parasol Creek extends from c. 300 – 880 m.a.s.l. There is a cap of snow tussock below Trig J down to approximately 750 m.a.s.l. This upper tussocklands are interspersed with rock outcrops, seepages and shrublands. Along the valley floor, and extending up side branches, is a stand of silver beech forest often fringed by regenerating shrublands.

Most areas above the forest are dominated by browntop, with areas of shrubland and many small seepages. The eastern side of the unit has abundant rock outcrops. Most of this unit would originally have been clothed in beech

forest. The moist, mild climate is conducive to vigorous growth and expansion of woody vegetation, constrained only by the impacts of stock and fire.

9. South side of Parasol Creek: This unit extends from Parasol Creek up to Leithen Bush Scenic Reserve and the ridge forming the southern boundary of the PL (290 – 800 m.a.s.l). The unit is north facing and has several small tributary streams. Near-continuous beech forest is present along Parasol Creek and two large stands occur in headwater tributaries. Above the upper forest margins a band is dominated by browntop with scattered native shrubs. On mid altitude slopes there is widespread and strong manuka regeneration within modified snow tussockland. A cap of intact narrow-leaved snow tussockland descends to c. 700 m.a.s.l. A few scattered large rock outcrops are present. The upper streams are incised and rocky and retain a range of shrub species.

10. Lower Parasol Creek: This unit occupies the shady faces (north side) of lower Parasol Creek. The unit is at low altitude (240 – 620 m.a.s.l) and has consequently been oversown and topdressed. Stocking levels are high in comparison to upper parts of the catchment. The diversity of woody vegetation is a special feature including stands of beech forest, regenerating forest and a rich diversity of shrublands. The unit contains diverse riparian shrublands, grey shrublands on steep rocky faces, dense regenerating grey shrubland on shady faces, grey shrubland containing stands of *Olearia fimbriata* and *O. lineata* and manuka shrublands. Woody regeneration vegetation is expected to continue at a rapid rate further enhancing the significance of these low altitude remnants.

The unit also contains moist river terraces, with wetland areas which have been much modified by stock grazing.

11. Doakes Stream: This unit mainly comprises the Doakes Stream catchment. Altitude ranges from the Pomahaka River at 250 up to 820 m.a.s.l. To a greater extent than similar areas in Little Parasol and Parasol Creeks vegetation is generally modified by agricultural development; however the beech forest remnant is one of the largest silver beech stands on the PL. Adjoining the forest stand is a pocket of Hall's totara, notable as this vegetation type is not found elsewhere on the PL and is uncommon within the ED. Associated with the forest are areas of regenerating forest, shrubland and rock outcrops that add interest and diversity.

The lower valley below the silver beech stand supports areas of regenerating forest, shrublands, rock outcrops, a population of the rare tree daisies *Olearia fimbriata* and *O. lineata* and the only record on the PL for the threatened hook grass *Uncinia strictissima* (status - Nationally Endangered). This is only the second record from the ED.

12. Little Parasol Creek: This is a relatively large unit that extends from the Pomahaka River at 250 m up to Parasol Hill (981 m.a.s.l). The upper-most parts of the catchment, especially between Parasol Hill and Trig J, retain relatively intact tall snow tussock, with some associated seepage areas. Much of the unit contains a mixture of modified tussockland and rough pasture. The

major ecological value is the diversity and condition of woody vegetation associated with Little Parasol Creek. The valley floor contains a small stand of silver beech forest. The sunny faces contain a relatively intact and diverse grey shrubland community. A special feature of this sunny aspect shrubland is the presence of kowhai (*Sophora microphylla*) (both a grove and scattered trees), *Olearia fimbriata* and *O. lineata*. Extensive, diverse and intact shrublands occur on the shady face. The stream margins support a diverse riparian shrubland. Rock outcrops occur on both the sunny and shady aspects.

Above the Pomahaka River near the mouth of Doakes Stream is a steep rocky face vegetated with grey shrubland. This area is largely fenced.

13. Devils Gorge: This unit includes the Devils Gorge covenant and extends up the true right of the Pomahaka River to beyond the mouth of Little Parasol Creek. Much of this unit is very steep and rocky. The values in the covenant area include mixed beech forest, regenerating forest, and a bluff system (these values form the basis for RAP UMB11). Other values include silver beech forest patches, extensive shrublands and abundant rock outcrops. In the lower portion of the unit, vigorously regenerating shrublands containing emergent broadleaf and black mapou (*Pittosporum tenuifolium*) cling to steep rocky faces. North of Little Parasol Creek is a mixed shrubland dominated by *Coprosma propinqua*, with much *Carmichaelia petriei*. Other common species include *Coprosma tayloriae*, matagouri (*Discaria toumatu*), *Corokia cotoneaster* and broadleaf. A gully below the road in the vicinity of the mouth of Little Parasol Creek is notable for prominent kowhai and *Olearia fimbriata*.
14. Pomahaka River: This small unit extends upstream from area 13. The most significant feature is a large stand of grey shrubland containing abundant young *Olearia fimbriata*. Also present are small groves of large mature *O. fimbriata* trees. This area contains the largest single population of *O. fimbriata* on the PL. The mixed aged nature of the *O. fimbriata* stands including abundant regeneration is an important attribute for the long term viability of the population.

A ribbon of silver beech and mixed beech forest extends along the bank of the Pomahaka River. Along with unit 13, this area provides potential for regeneration of riparian beech forest, extending from the existing beech pockets down to Devils Gorge.

15. North-eastern faces: This unit mostly comprises sunny faces above Sandy Creek and the Pomahaka River in the north-east of the PL. Vegetation largely comprises rough pasture although small stands of *Olearia fimbriata*, wetlands, small creeks and rock outcrops are present.

Flora

260 native vascular plant species have been recorded from the PL (see Table 5 and Appendix 3). 73 woody species have been recorded which represents c. 28% of the flora. The flora characteristic of forest and shrubland habitats includes 93 species representing c. 38% of the recorded flora.

Table 5 – Indigenous Flora of Hukarere Pastoral Lease

Life form	No. of Taxa
Ferns and fern allies	27
Podocarps	1
Dicot trees & shrubs	63
Dicot climbers & vines	9
Composite herbaceous plants	29
Non-composite herbaceous plants	68
Grasses	21
Sedges	25
Rushes	2
Orchids	7
Other monocot plants	8
Total	260

2.5.1 Significance of Vegetation

One c. 700 ha recommended area for protection (RAP UMB 04) is located wholly on the PL.

Flora

There are at least 260 native vascular plant species (see Appendix 3 and Table 6). This flora is considered very rich representing approximately 49% of the indigenous vascular plant diversity recorded for the much larger (157 000 ha) and ecologically diverse Umbrella ED.

Table 6 – Flora of Hukarere Pastoral Lease

Life form	Native Taxa	Exotic taxa	Total taxa
Ferns and fern allies	27	0	27
Gymnosperms	1	2	3
Dicot trees & shrubs	63	8	71
Dicot climbers & vines	9	1	10
Composite herbaceous plants	29	9	38
Non-composite Herbaceous plants	68	27	95
Grasses	21	10	31
Sedges	25	1	26
Rushes	2	4	6
Orchids	7	0	7
Other monocot plants	8	0	8
Total	260	62	322

Threatened and At Risk plants

Of the native vascular plant species present, two are listed as 'Threatened' and 9 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 7.

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.

Table 7: Threatened and At Risk plant species found on Hukarere Pastoral Lease

Threat Division	Threat Category	Species	Comments
Threatened	Nationally Endangered	<i>Uncinia strictissima</i>	Recorded from a single site in the lower Doakes Stream
Threatened	Nationally Vulnerable	<i>Olearia fimbriata</i>	Recorded from various parts of the PL, largest populations in blocks 14, 10 and 12.
At Risk	Declining	<i>Epilobium insulare</i>	Recorded from wetlands in the lower Doakes Stream.
At Risk	Declining	<i>Melicytus flexuosus</i>	A single plant recorded from the mid Parasol Creek.
At Risk	Declining	<i>Olearia lineata</i>	Recorded from various parts of the PL, largest populations in blocks 10, 12 and 11.
At Risk	Declining	<i>Teucrium parvifolium</i>	Recorded from Devil's Gorge during Umbrella ED PNAP survey.
At Risk	Naturally Uncommon	<i>Aciphylla lecomtei</i>	Recorded from rocky areas at higher altitude.
At Risk	Naturally Uncommon	<i>Anisotome caudicola</i>	Recorded from a single rock outcrop site in the head of Rough gully.
At Risk	Naturally Uncommon	<i>Lagenifera barkeri</i>	Recorded from seep in head of Little Parasol Creek
At Risk	Naturally Uncommon	<i>Pimelea poppelwellii</i>	Recorded from a single rock outcrop site in the head of Rough gully.
At Risk	Naturally Uncommon	<i>Ranunculus maculatus</i>	Recorded from a wetland in the head of Little Parasol Creek catchment.

There are 4 additional threatened plant species that may be present (see Table 8).

Table 8: Threatened plant species that may be present on Hukarere PL

Threat Division	Threat Category	Species	Comments
Threatened	Nationally Endangered	<i>Epilobium pictum</i>	Recorded from Crown Rock Station
At Risk	Naturally Uncommon	<i>Anemone tenuicaulis</i>	Recorded from Crown Rock Station
At Risk	Naturally Uncommon	<i>Juncus pusillus</i>	Recorded from Crown Rock Station
At Risk	Naturally Uncommon	<i>Uncinia purpurata</i>	Recorded from Crown Rock Station

There are 5 'Regionally Significant' and 21 'Locally Notable' species present (see Table 9).

Table 9: Regionally significant and locally notable species found on Hukarere PL

Significance	Species
Regionally significant	<i>Asplenium hookerianum</i>
Regionally significant	<i>Carex forsteri</i>
Regionally significant	<i>Echinopogon ovatus</i>
Regionally significant	<i>Lagenifera pinnatifida</i>
Regionally significant	<i>Ranunculus ensyii</i>
Locally notable	<i>Coprosma crassifolia</i>
Locally notable	<i>Clematis foetida</i>
Locally notable	<i>Clematis marata</i>
Locally notable	<i>Cyathea smithii</i>
Locally notable	<i>Gingidia montana</i>
Locally notable	<i>Gleichenia dicarpa</i>
Locally notable	<i>Gonocarpus montanus</i>
Locally notable	<i>Hoheria glabrata</i>
Locally notable	<i>Microtis oligantha</i>
Locally notable	<i>Olearia avicenniaefolia</i>
Locally notable	<i>Olearia bullata</i>
Locally notable	<i>Parahebe decora</i>
Locally notable	<i>Pellaea rotundifolia</i>
Locally notable	<i>Polystichum neozelandicum</i> subsp. <i>zerophyllum</i>
Locally notable	<i>Podocarpus hallii</i>
Locally notable	<i>Raoulia apicinigra</i>
Locally notable	<i>Rubus schmidelioides</i> var. <i>subpauperatus</i>
Locally notable	<i>Senecio quadridentatus</i>
Locally notable	<i>Sophora microphylla</i>
Locally notable	<i>Wahlenbergia rupestris</i>

Naturally Rare Ecosystems

Terrestrial ecosystems that were rare before human colonisation of New Zealand often have a 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 km²). 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.

On the PL two naturally rare ecosystems were identified, both in the wetland category. These are cushionbogs and seepages/flushes.

Scientific Values

The large and healthy populations of *Olearia fimbriata* found on the PL are of national importance. This PL has the largest population of any pastoral lease and the Pomahaka catchment is the stronghold for this species. Therefore sites on this PL represent ideal research opportunities on the ecology of this threatened species.

2.5.2 Problem Plants

A flora of 68 exotic species was recorded. These are listed in Table 6 and Appendix 3 (Note: This flora is not complete). Fortunately only a few of these are considered problem plants. The PL is relatively weed free. Most of the problem plants are localised, with many confined to near the old homestead from where they are thought to have originated.

Pinus radiata (Monterey pine) – These are mainly present in plantations and other plantings near the old homestead. There are also a few trees near the hut in the upper Parasol Creek. Only a few wildings were observed.

Pseudotsuga menziesii (Douglas fir) - These are mainly present in plantations along the Pomahaka River near the old homestead. Wilding plants are starting to spread from these plantations. This species which can spread into both native forest and open land has potential to be a significant problem plant in the future.

Cotoneaster simonsii (a cotoneaster) - Only a few plants were observed in the lower Parasol Creek.

Cytisus scoparius (broom) – This weed is largely confined to the riverbed. Previous control operations have limited its abundance.

Leycesteria formosa (Himalayan honeysuckle) – This plant is uncommon, but has potential to spread rapidly through bird dispersal of its seed.

Rosa rubiginosa (briar) – only a few plants were recorded.

Salix fragilis (crack willow) – This tree is largely confined to the Pomahaka River.

Sambucus nigra (elderberry) – This tree is currently uncommon, but has potential to spread rapidly through bird dispersal of its seed.

Sorbus aucuparia (rowan) – These are mainly confined to near the old homestead, which is probably where the wildings first originated from. A single plant was observed in the lower Parasol Creek.

Ulex europaeus (gorse) – There are a few small infestations.

2.6 Fauna

2.6.1 Invertebrate Fauna

The Waikaia Ecological Region is well surveyed for representative insects. A range of invertebrate habitats on the PL were surveyed during the original 1997 tenure review inspection. During the 2010 inspection, botanists made some further records of invertebrate species (see Appendix 4 and Dickinson et. al. 1998).

The wide range of habitats present within the ED support a diverse and interesting fauna which is distinctive. Many species reach their eastern or western distribution limits within the district. Faunal affinities appear greatest to the Garvie Mountains and Old Man Range as well as having shared characteristics with the Lammermoor Range and Blue Mountains.

During the PNAP survey, invertebrates recorded from the Black Umbrella Range and from Parasol Hill at a similar altitude include the moths: *Heterocrossa cryodana* (Meyrick), *Capua semifera* (Walker), *Gelophaula* sp., *Lycaena salustius* (Fabricius), *Stenoptilia orites* (Meyrick), *Orocrambus aethonellus* (Meyrick), *Eudonia chalarata* (Meyrick), *E. feredayi* (Knaggs), *E. sabulosella* (Walker), *Chloroclystis nereis* (Meyrick), *Dasyuris transaureus* (Howes), *Notoreas paradelpha* (Meyrick), and "*Aponotoreas*" *orphnaea* (Meyrick).

The following values were noted from the 1997 tenure review survey:

- a. **Large Mountain Weta:** *Hemideina maori* is distributed along the ridge from at least as far north as Stronach Hill to Sandy Hill on both sides of the fence on the ridge. Harems of up to five animals were seen. The weta are up to 5 cm long and "chunky" in shape. This is the southern-most occurrence of the species in New Zealand (previously Lammermoor Range).
- b. **Large Beetles:** Two large native beetles, a shiny green and black carabid *Megadromus bullatus* and a weevil *Anagotus lewisi* were found quite commonly along the ridge. Both are widespread but local in occurrence in southern New Zealand.
- c. **Fellfield, Tor and Rocky Sites:** These are extensive and support a range of invertebrates that complement the invertebrate values in the summit grasslands. Native flies, bugs, moths and beetle species are conspicuous in this fellfield zone.
- d. **Seepages, Wetlands and Headwaters of Creeks:** These are numerous and contain an assemblage of aquatic insects, including short-winged stoners, scorpion-flies and caddis species. One species of stoner may be localised in distribution to the ranges between the Hector and Umbrella Mountains, while other species found are a mixture of high altitude Central Otago species and northern Southland alpine species. The quality of the habitat and the mix of native species which is different to other known areas make these areas of high scientific and conservation interest. Species of note are:

- stoners: *Zelandobius* n. sp., *Z. macburneyi*, *Z. foxi*
- scorpionfly: *Nannochorista philpotti*
- Caddis: *Psilochorema cheirodes*

- e. **Snow Tussock:** Good quality snow tussock, often mixed with shrubland of *Ozothamnus* or *Hebe odora* (*Hebe anomola* type) covers large areas of the summit ridge. The typical native moth species of this habitat were seen including the large black diurnal *Aponotoreas orphnaea*, several grass moths including *Orocrambus machaeristes* and one species of very limited distribution, the colourful *Asaphodes cinnabari*. The last named is local across alpine northern Southland and eastern Takatimu Mountains. Also rarely seen is the small black and white moth *Scoparia tuicana*. Its occurrence here is only its fourth known location, underlining the importance of the Umbrella Mountains biogeographically and the quality of the habitat. The Umbrella Mountains stand at the crossroads to the drier Central Otago mountains and the wetter northern Southland mountains, each supporting a distinct fauna mixed with a more widespread fauna.
- f. **Olearia Shrublands:** Small leaved *Olearia* shrubland species have a rich, distinctive and well documented insect fauna associated with them (Patrick 2000). Over 23 moth species alone feed on them in characteristic ways (foliage feeders, leaf-miners, flowers, etc). An array of beetle, fly and bug species are also implicated. The moth species include *Pasiphila continea*, *Pyrgotis* new species, and *Stigmella ilsea*. These insects are totally reliant on hosts such as *Olearia odorata* and *O. frimbriata* for their survival, making these communities of *Olearia* dominated woodland of national significance for conservation.
- g. **Forest:** Invertebrate fauna of forest habitats were not described in the original conservation resources report. In the Waikaia Ecological Region, which includes the Umbrella Mountains, a few local endemic forest species are known including a weevil beetle, spider and velvet worm/peripatus. The PL forest remains poorly surveyed for such invertebrates which may be discovered there in future. However, a large black predatory ground beetle *Mecodema laeviceps* was recorded in forest at Parasol Creek in 2010. This beetle is classified as "Nationally Critical" having gone extinct in Central Otago and with only two relict populations known elsewhere. One population remains in northern Waikaia Forest. Part of this site lies on public conservation land. The second population is in a site in North Otago Kakanui Mountains. In common with the new Parasol Creek record it was found on a pastoral lease.

2.6.2 Significance of Invertebrate Fauna

The Black Umbrella Range contain a variety of high quality habitats supporting a distinctive, diverse and rich invertebrate fauna, some of which reach their limits of distribution, e.g, *Hemideina maori*. A new species of stoner was collected. Some moth species which are rarely collected were present, underlining the biogeographic importance of the Umbrella Mountains.

The *Olearia* woodlands support a rich distinctive insect fauna including new species, many of which are host specific. In conjunction with their botanical values these plant communities are of national significance for conservation.

The population of the large black beetle *Mecodema laeviceps* in forest shrubland and tussock in mid Parasol Creek is a significant find. This species is ranked as “Nationally Critical” in DOC’s 2007 Threatened Species Categorisation. The new finding extends the southern range limit for this species.

The presence of the mountain stone weta (*Hemideina maori*) at the southern limit of its range among the schist exposures of the Black Umbrella Range is also of significance. It is otherwise known in ranges east of the South Island Main Divide in Canterbury and Otago.

2.6.3 Herpetofauna

Lizard species recorded during the survey include the following: *Hoplodactylus* sp. “Eastern Otago” (Eastern Otago gecko), distribution Central and Eastern Otago, status widespread; *Oligosoma maccanni* (McCann’s skink), distribution inland Southland to Banks Peninsula, status common.

Both lizard species were encountered wherever there were rock outcrops (including the covenant area) but were most abundant in unmodified tussockland and shrublands.

2.6.4 Significance of Herpetofauna

Hukarere Station contains no individual species of conservation concern, however, it does support large populations of two widespread species. The Eastern Otago gecko in particular shows great geographic variation over its range and the Hukarere population is typical of this variation.

2.6.5 Avifauna

Birds: Records were made during the 1997 and 2010 tenure review surveys. There are also earlier records available from the Fauna Survey Unit of the Wildlife Service of their 1980 survey and the PNAP survey of 1986. Grouped by habitat, the species listed in Tables 10 and 11 have been recorded from the PL.

Table 10. Bird Species Recorded on Hukarere PL: Pomahaka Gorge/Open Country

Threat Division	Threat Category	Common Name	Native (N) – Exotic (E)
Not Threatened		Blackbird	E
Not Threatened		Black-backed gull	N
Not Threatened		Bellbird	N
Not Threatened		Australian harrier	N
Not Threatened		Black shag	N
Not Threatened		Grey Duck	N
Not Threatened		Grey warbler	N
Not Threatened		Gold finch	E
Not Threatened		Mallard duck	E
Threatened	Nationally Vulnerable	NZ falcon	N
Not Threatened		Paradise shelduck	N
Not Threatened		Magpie	E
Not Threatened		Pied fantail	N
At Risk	Declining	Pipit	N
Not Threatened		Redpoll	E
Not Threatened		Skylark	E
Not Threatened		Silvereye	N
Not Threatened		Thrush	E
Not Threatened		Yellowhammer	E
Not Threatened		Yellow-breasted tit	N
Not Threatened		Welcome Swallow	N
Not Threatened		White-backed magpie	E
Not Threatened		White-faced heron	N

Table 11. Bird Species Recorded on Hukarere PL: Beech Forest Remnants

Threat Division	Threat Category	Common Name	Native (N) – Exotic (E)
Not Threatened		Bellbird	N
Not Threatened		Blackbird	E
Not Threatened		Brown creeper	N
Not Threatened		Chaffinch	E
Not Threatened		Goldfinch	E
Not Threatened		Grey warbler	N
Not Threatened		Greenfinch	E
Not Threatened		New Zealand pigeon	N
Not Threatened	Declining	SI Rifleman	N
Not Threatened		Yellow-breasted tit	N
Not Threatened		Yellowhammer	N
Not Threatened		Silvereye	N
Not Threatened		South Island fantail	N

2.6.6 Significance of Avifauna

The forest remnants are ranked as being of moderate habitat value, supporting a good variety of species. The higher than usual number of species present is possibly due to an overflow of progeny from the nearby Leithen Bush Scenic Reserve, a 1500 ha⁺ forest remnant.

The Pomahaka River Gorge (Devils Gorge) is ranked as a habitat of moderate value with good species diversity.

The presence of New Zealand falcon (Nationally Vulnerable), New Zealand Pipit (Declining) and South Island Rifleman (Declining) is significant. (Miskelly 2008).

2.6.7 Aquatic Fauna

A survey of major streams and tributaries accessible from vehicle tracks on the PL was undertaken as part of the original 1997 tenure review inspection. This survey entailed 14 sites being electric fished. Results are summarised in this report. Further electric fishing was undertaken in Parasol Creek in 2007 (Dungy 2007).

Results

A total of three fish species and the freshwater crayfish or koura (*Paranephrops zelandicus*) were collected from the 14 sites fished (See Table 12). The fishes included; 1) Brown trout (*Salmo trutta*) – a very widespread fish in New Zealand introduced from Europe in the late 1800's. 2) Long finned eel (*Anguilla dieffenbachia*) a fish endemic to the New Zealand region. These eels carry out extraordinary migrations from the sea and colonise streams far inland. 3) Clutha flathead galaxias (*Galaxias* species 'D'). This fish which is confined to the Clutha catchment, primarily inhabits the headwaters of streams where trout are absent.

Records of Clutha flathead galaxias have been made where trout are present, including the Pomahaka River, but their ongoing presence at these sites is thought to rely on constant replenishment from trout free waters further upstream.

- a. **Parasol Creek:** Above a series of waterfalls in the upper reaches (Table 12, sites 9 and 10) no fish were recorded. However, a rich and diverse invertebrate fauna appears to be present. Two kilometres upstream from the vehicle crossing at ~600 m.a.s.l Clutha flathead galaxias were found where no brown trout were present. Below the falls, where the vehicle track crosses Parasol Creek, an abundant population of Clutha flathead galaxias was present principally in riffles and runs. A smaller number of trout, (~150 mm long) were present in pool/backwater areas where deeper water was present and cover provided by boulders and cobbles. No small trout were present. This pattern was repeated down river to and including site 14 (Table 12.), with the occasional long-finned eel also being recorded with trout in pools.

A significant waterfall exists at site 14 (Table 12). However, trout are still rare below this and although flathead galaxiids were not as common below the fall, they were still the most abundant fish present.
- b. **Doakes Creek:** Sites 7 and 8 (Table 12.) were either side of the vehicle track. Below the culvert small numbers of Clutha flathead galaxias and a single brown trout were collected. Above the culvert no fish were present. The hung culvert may prevent upstream migration of fish, as good habitat appeared to be present above the road.
- c. **Little Parasol Creek:** About 500 m of this stream was fished intermittently above the road. Brown trout was the only fish species present. They were abundant and a range of size classes was present (range about 60-150mm length). The stream was a typical forested stream, with pool riffle sequences and intact riparian scrub community. This shows some signs of grazing. No native fish were recorded even though it looked like ideal habitat.
- d. **Sandy Creek:** The mainstem of Sandy Creek was fished in one locality in the head waters (site 1 – Table 12). Young brown trout (60-70 mm) were abundant, hence only a small section was fished. Bottom substrate was loose river gravels with a conspicuous filamentous algae cover. Density of trout suggest Sandy Creek may be an important trout nursery stream.
- e. **Tributaries Sandy Creek:** Numerous tributaries are marked on the map, although few seem to contain permanent water. A small permanent stream is present on site 2 (Table 12). Where it crosses the vehicle track the bank has collapsed directly downstream so that the water exits the culvert in a small waterfall. The stream flows down a steep bank. In this section of stream, Clutha flathead galaxias is abundant, whereas above the culvert the population is smaller. No other fish were recorded. The culvert may inhibit fish passage, and could be improved. The absence of trout suggests there may be another impediment to passage downstream and this should be maintained.

At site 3 (Table 12) a small pond is present above the vehicle track with what appears to be an intermittent stream flowing into it. A single long-finned eel was recorded in the lower section of this stream.

- f. **Pomahaka River:** This was only fished at one location, site 5 Table 12). Brown trout were abundant in a range of size classes (60-150+ mm), whereas Clutha flathead galaxias was common. Long-finned eels are also likely to be present.
- g. **Unnamed Stream:** (Site 4 - Table 12, tributary of Pomahaka R.): Abundant population of Clutha flathead galaxias above the road. No other fish appear to be present.

Table 12. SAMPLING SITES AND RELATIVE ABUNDANCE OF ALL FISH RECORDED: 10-11 MARCH 1997

Site*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Species														
<i>Galaxias sp.D</i>	-	A	-	A	C	-	O	-	-	-	A	A	A	A
<i>Anguilla dieffenbachii</i>	-	-	R	-	-	-	-	-	-	-	-	R	-	-
<i>Salmo trutta</i>	A	-	-	-	A	A	R	-	-	-	O	R	R	R
<i>Paranephrops zelandicus</i>	-	-	-	C	-	-	-	-	-	-	R**	-	-	-

Site 1 – Sandy Creek, Sites 2-3 Sandy Creek Tributary, Site 4 – Unnamed tributary Pomahaka, Site 5 Pomahaka River, Site 6 Little Parasol Creek, Sites 7-8 Doakes Stream, Sites 9-14 Parasol Creek.

R = rare (one fish caught) **Koura observed to be abundant in Upper Parasol Creek in March 2010.

O = occasional (2-4 fish) C = common (5-10 fish) A = abundant (> 10 fish)
 P = likely to be present

2.6.8 Significance of Aquatic Fauna

At Risk fishes and freshwater crayfish/koura

Three aquatic animals –two fish species and one crayfish are assessed as nationally in decline or vulnerable (Table 13). The assessment was compiled by freshwater experts in 2010 (Allibone et. al in press).

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 trend continues, these taxa may be listed as ‘Threatened’ in the future. Nationally vulnerable species face a risk of extinction in the wild.

Table 13. At risk aquatic species found on Hukarere Pastoral Lease

Threat Division	Threat Category	Species	Comments
At Risk	Gradual Decline	<i>Anguilla dieffenbachii</i> long-finned eel	Individuals with long stream territories encountered
Threatened	Nationally vulnerable	<i>Galaxias sp. 'D'</i> Clutha flathead Galaxias	Within the region found in some streams below 650 m.a.s.l. Vulnerable to trout but persist where stream refugia are also present
At Risk	Gradual Decline	<i>Paranephrops zelandicus</i> Koura	Found in a few streams. Locally abundant in Parasol Creek
	Not threatened	<i>Salmo trutta</i> Brown Trout	Widespread in streams

While long-finned eels are classified as in gradual decline, they inhabit waters throughout New Zealand. Clutha flathead galaxias however, belong to a species group of small stream inhabiting fishes that do not migrate to lakes or the sea to spawn. Instead, these fish spawn and young develop in small streams at modest altitude. This galaxiid fish is endemic to streams of the Clutha River catchment. They are not normally found in rivers but can sometimes persist where trout are uncommon. Clutha flathead galaxias are also found in association with trout when individuals drift down from refuges upstream and regularly replenish the population. This would appear to be the case on the PL in the mid reaches of Parasol Creek. The data from the fish sampling in 1997 and then in 2007 (see appendix 6) show that the upper reaches of Parasol Creek go through a transition from reaches with brown trout, Clutha flat head galaxias & eels then upstream to reaches with only Clutha galaxias recorded and then upstream where no fish are recorded.

Refugia for Clutha flathead galaxias where no trout are present are of conservation significance. Table 12 above does not identify precise localities but show Clutha galaxias refugia on the PL for: tributary of Sandy Creek, un-named tributary Pomahaka R., Doakes Creek and Parasol Creek.

Summary significance of freshwater fauna

1. Localities with the nationally vulnerable fish Clutha flathead galaxias are significant.
2. Reaches of Parasol Creek with the faunal assemblage of (nationally declining) longfinned eel, freshwater crayfish/koura and Clutha flathead galaxias are significant.
3. Sites in Parasol Creek where Clutha flathead galaxias are present and trout are absent are significant, particularly so where catchment hydrology and water quality are not degraded.

4. Stream sites that have physical barriers preventing trout colonisation upstream are significant.
5. Stream sites where no fish (native or exotic) are present are typical of the Umbrella and Garvie Mountain region and are of significance for their naturally fish free ecology.
6. Parasol Creek stands out for its integration of different in-stream faunal values. This includes an assemblage of two 'At Risk' and one 'Threatened' species. From sites 14 to 11 (Table 12) and up to somewhere below 600 m.a.s.l the creek contains a dense population of Clutha flathead galaxias. Data from 1997 combined with data from 2007 (Appendix 5) show that the upstream limit of trout is probably within two kilometres upstream of the Parasol Ck. road ford (between ~500 -600 m.a.s.l).

2.6.9 Problem Animals

A moderate to high population of red deer occurs on the PL, essentially utilising forest remnants for shelter. Extensive damage to some forest shrubland areas is evident. Hares occur in tussocklands. Possums are widespread but do not appear at population levels where forest damage would result.

The usual array of predators, e.g., stoats, ferrets and cats are present.

2.7 Historic

Historic and Archaeological Features

Information has been extracted from the unpublished DOC report "*Survey of the Historic and Cultural Values on Pastoral Leases in the Umbrella Ecological District and the Southern Tops of the Old Man Range*" prepared by Jill Hamel in 1989 (see Appendix 5).

Pastoral History

The run, commanded by the house and woolshed at the Hukarere farmstead must always have been relatively small. The original 1896 house was a simple barn-shaped structure of two large rooms and five smaller ones. It is earth walled with corrugated iron cladding on the outside, and tongue and groove boarding on the inside. The walls are thin for an earth constructing, being only 12 cm thick and made of mud and tussock with some diagonal lathes (N Hazlett, pers. Comm.), possibly a lathe and daub construction. The earth walls are absent in the north-west corner, replaced by wood which is in relatively poor condition. The design is unusual in that there is no leanto at the back of the house, which has been extended linearly into an L-shape. The front had a Georgian symmetry of a central front door and pairs of double hung, small paned windows on each side of the door, with a veranda right across the front. The windows have been replaced with aluminium framed single panes. The

woolshed, which is thought to be the same age as the house, is a typical single gable with lean to additions, all in corrugated iron.

Goldmining

The Pomahaka River has been worked extensively by miners last century. Most of the mining activity occurred in the upper reaches of the valley, particularly near the Bain Conservation Area on the southern Old Man Range, downstream to Hamiltons Flat. Only a few scattered sites occur along the Hukarere section of the river. Most sites are located within the river channel or its margins, except for sites 45 and 51, which are on the Hukarere side of the river.

The section of the river from Sandy Creek to the Hukarere homestead is virtually free of sluicing, and contains longer and more elaborate wing dams, three house sites and almost no water races (sites 44-51). The wing dams are often visible from the road, and are probably easier located from this more vertical viewpoint. The long wing dam at site 44 is estimated to be about 100 m long and is made up of larger stones than usual with not so many side-stacked slabs. Further downstream at site 49, the wing dam may have originally been 200m long but now consists of two sections about 70 m and 30 m long respectively, separated by a 100 m gap. The dam at site 47 is built of double rows of rounded boulders, and is an unusual dog-leg shape, allowing the river to be diverted through the middle of it.

The most complex site on this stretch of river is the last one, not far below the dog-leg dam and above Devils Gorge (sites 50 and 51). The wing dam is about 40 m long with three short side arms. For some inexplicable reason, the river bank has been strongly revetted with side stacked slabs from well upstream to well downstream of the wing dam to a height of 0.8-1.0 m, but there is no sign of workings on the terrace above. It is difficult to imagine why these miners wished to maintain this section bank so carefully. Similar revetting of the river bank occurs upstream at Bains Huts.

About 100 m down river on a pleasant terrace, surrounded by beech trees, there is a single substantial stone chimney on a base 2 x 1 m and still standing 2.2 m high. Slabs of local schist and other rocks have been reasonably well trimmed and mortared with mud. The fireplace cavity is large (1 m each way) and has stone side ledges, but there is no surface trace of walls which presumably extended out from this chimney.

Goldmining sites in the Pomahaka Valley diminish steadily in frequency and size below Hamiltons Flat and the runholders did not know of any sites downstream of Hukarere Station. The placing of the southern boundary of the Nokomai Goldfield where Parasol Creek meets the Pomhaka, suggests there is little 19th Century evidence to be found south of Hukarere.

2.7.1 Significance of Historic

The Hukarere Station farmstead is of conservation significance due to its lathe and daub construction. It is one of the very few known examples of this construction technique in New Zealand.

The goldmining sites are protected by the Historic Places Act if they pre-date 1900. Most actually lie outside of the pastoral lease within the Pomahaka Crown land riverbed or marginal strip. Those sites within the PL are not particularly significant.

2.8 Public Recreation

2.8.1 Physical Characteristics

The Pomahaka River is a trophy brown trout fishery and as such attracts considerable attention from anglers. A lack of legal road access limits angling pressure to some degree. Hukarere extends westwards to the summit of the Black Umbrella Range and adjoins Leithen Bush Scenic Reserve, a popular deer stalking area. There is a good internal network of farm access tracks, which traverse or provide access to the main mountain range and to beech forest remnants on the PL.

2.8.2 Legal Access

Marginal Strips

The only marginal strip in existence on the PL adjoins the Pomahaka River.

A qualifying waterways report has been completed. Qualifying water ways are the Leithen Burn, Parasol creek and Sandy Creek (see Map 4.2.1).

Legal Roads

The PL has formed legal road access which terminates at the eastern side of the Pomahaka River. A private bridge spans the river. Within the PL are unformed legal roads leading to Trig J, Parasol Hill, and on to Sandy Hill on the summit of the Black Umbrella Range.

There are also sections of unformed legal road which extend along parts of the western frontage with the Pomahaka River. These sections of road do not correspond with the main farm access road extending upstream from the farmstead to the boundary with Crown Rock Station. This farm access road is private.

2.8.3 Activities

There are no authorised commercial recreation activities on the PL. The main private recreational activity relates to access for angling on the Pomahaka River. Deerstalking occurs by arrangement with the lessees, mostly associated with hunting of forest remnants and occasionally to gain access to Leithen Bush Scenic Reserve. The PL is used infrequently for horse trekking.

Potential exists for activities such as mountain biking and tramping, the latter possibly linking with the Leithen Bush Scenic Reserve and the Black Umbrella Range and Umbrella Mountains generally.

The Pomahaka river is infrequently used for kayaking. For those wishing to paddle the Devils Gorge section only, access is required up the main Hukarere-Castle Rock farm road.

The Blue Mountains Branch of the New Zealand Deerstarkers Association own a hut on the northern boundary of the reserve adjacent to Hukarere Station. This hut is available for public use, by arrangement with the Association.

2.8.4 Significance of Recreation

The location of this PL is strategically important in terms of securing access to and enjoyment of the Pomahaka River, the adjoining Leithen Bush Scenic Reserve and the wider Umbrella Mountains for hunting, tramping, angling, mountain biking.

Through completion of the pastoral lease tenure review on the Umbrella, Old Man and Carrick Ranges it is envisaged that there will be a continuous public access corridor from Hukarere on the southern end of the Umbrella Mountains to the Kawarau River.

The Huakarere - Crown Rock Road is particularly importance as it provides access to the Pomahaka River.

PART 3

OTHER RELEVANT MATTERS & PLANS

3.1 Consultation

The PL was commented on by NGOs at an early warning meeting on 30 April 1997. Key points raised were:

- The NGOs queried the status of the riparian strip along the Pomahaka River. Some considered it to be legal road not marginal strip.
- Riparian management is required along the Pomhaka River to exclude cattle.
- Major interest in securing public access along the Hukarere/Crown Rock farm access road along the Pomahaka River and across from it to the river for angling.
- Public access to Black Umbrella Range for foot, mountain bike and horse trekking use.

3.2 Regional Policy Statements & Plans

3.2.1 Regional Plan- Water for Otago

Hukarere Station bounds and straddles the Pomahaka River Catchment. The Pomahaka River is recognised in the Regional Plan - Water for Otago under Schedule 1A (Natural Values, Pg. 296) as having:

- *A regionally significant presence of trout;*
- *Both trout and salmon spawning in this river;*
- *A significant eel population;*
- *A significant range of indigenous fish species;*
- *Rare fish species;*
- *Indigenous invertebrate diversity.*

With regard to Kai Tahu values, the plan (Schedule 1D Pg 311) recognises that the Pomahaka River has the following values:

- *Kai Tahu Kaitiakitanga;*
- *The Mauri life force;*
- *The presence of Wāhi Tapu and/or Waiwhakaheke (sacred places, site, areas and values); and*
- *Wāhi Taoka (treasured resources) of the Pomahaka River.*

This plan's rule's (Rules 13.5.1.7 & 13.5.3.1) requires resource consent for suction dredge mining in this river. All dams other than for stock water supply purposes are

prohibited on the Pomahaka River and its tributaries. There are no rules which control the use of land such as controlling tussock grassland clearance for the purpose of maintenance and enhancement of the quality of water and the quantity of water in water bodies such as the Pomahaka River.

3.3 District Plan

The property is located within the Rural Resource Area of Clutha District Plan. In general, the operative Clutha District Plan does not currently act as a trigger for the protection of any tussock grasslands and smaller wetlands and forest areas. The plan requires resource consent for clearance of areas 5 ha or more of indigenous forest vegetation or 2ha or more of wetlands, and development within 10 m of any watercourse. In addition, ground exceeding 30° slope that has been made bare by removal of vegetation must be re-vegetated.

The District Plan does not identify any Potentially Outstanding Landscapes, Outstanding Natural Features, registered archaeological sites, significant wetlands, or areas of significant habitat of indigenous fauna for this location. Protection is therefore limited to the controls set under the general rules section of the District Plan.

However, it is noted that a draft Clutha District Council Landscape assessment has identified the area as having the characteristic Otago peneplain landform. It has also identified the Black Umbrella Range and the Pomahaka River as a significant landform feature. That assessment also notes that the higher parts of the area with largely natural looking tussock cover have high naturalness values. The grassland cover provides for high landform coherence and a most distinctive "Otago" landscape.

3.4 Conservation Management Strategy & Plans

The Southland Conservancy CMS has identified the Umbrella Mountains as a significant landscape unit and has described the conservation features within the unit (see section 6.16).

Statements made that are relevant to the PL are the recommended protection of ecosystems at Crown Rock/, identification of sites where the giant land snail *Powelliphanta spedeni spedeni* occur, and determining what opportunities exist for preserving indigenous fisheries habitats.

The Leithen Bush Scenic Reserve is acknowledged as being "*the only area with any significant recreation on lands managed by the Department*" in the vicinity of the Umbrella Mountains. This Scenic Reserve is, in part, adjacent to Hukarere Station. "*Open spaces at the southern end of the reserve are used by various groups for camping and picnicking. Recreation hunting is the most extensive use within the reserve. The reserve is very popular deerstalking area for both local hunters and those residing in urban areas such as Gore and Dunedin. Hunting for red deer is balloted during the roar period.*"

3.5 New Zealand Biodiversity Strategy

The New Zealand Government is a signatory to the Convention on Biological Diversity (1993). In February 2000, Government released the New Zealand Biodiversity Strategy which is a blueprint for managing the country's diversity of species and habitats 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.

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.

3.6 Ngai Tahu Claims Settlement Act 1998

The Pomahaka River bisects Hukarere Station. The Pomahaka River has a statutory acknowledgement for its kanakana (lamprey) fishery as outlined below. Adult kanakana migrate many kilometres upstream and spawn in small tributaries.

Schedule 52 of the Ngai Tahu Claims Settlement Act 1998 (Statutory Acknowledgement for Pomahaka River) details this as a Statutory Area in part.

The statutory area to which this statutory acknowledgement applies is the River known as Pomahaka, the location of which is shown on Allocation Plan MD 12 (SO 24726).

The Preamble of this schedule states that "*Under section 206, the Crown acknowledges Te Runanga o Ngai Tahu's statement of Ngai Tahu's cultural, spiritual, historic, and traditional association to the Pomahaka River, as set out below.*

Ngai Tahu Association with the Pomahaka River The Pomahaka was an important mahinga kai for Ngati Mamoe and Ngai Tahu kainga (settlements) in the Catlins and Tautuku areas. The river was particularly noted for its kanakana fishery. Other mahinga kai associated with the river included weka and other manu (birds).

The tupuna had considerable knowledge of whakapapa, traditional trails and tauranga waka, places for gathering kai and other taonga, ways in which to use the resources of the Pomahaka, the relationship of people with the river and their dependence on it, and tikanga for the proper and sustainable utilisation of resources. All of these values remain important to Ngai Tahu today.

The mauri of the Pomahaka represents the essence that binds the physical and spiritual elements of all things together, generating and upholding all life. All elements of the natural environment possess a life force, and all forms of life are related. Mauri is a critical element of the spiritual relationship of Ngai Tahu Whanui with the river."

3.7 Ecological Sustainability and Carbon Storage

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 small part of the property which lies above c. 1100m is classified as class 8. Most of the western upper portion of the PL including the upper catchments of the Leithen Burn, Parasol Creek and Sandy Creek are predominantly classes 6 and 7 land. Class 8 land has severe to extreme physical limitations or hazards which make it unsuitable for arable, pastoral, or commercial forestry use. Erosion control, water management and conservation of flora and fauna are the main uses of this land (Lynn et al. 2009). Class 7 land has severe physical limitations and consequently it is high risk land requiring active management to achieve sustainable production. These classes have a subclass 'e' or 'c' which indicates that erodibility and climate are the main kinds of physical limitation or hazard to use that have been identified.

Ecosystem Services

The PL contributes to a number of "ecosystem services." 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". This PL clearly contributes to seven of these services excluding those of a recreation and cultural nature which are described elsewhere.

1. Gas Regulation:

One hectare of mixed grassland/shrubland stores about 42 tonnes of carbon versus approximately 2 tonnes for unimproved grassland. Mixed indigenous scrub stores approximately 99 tonnes per hectare whilst mature beech-broad leaved forest stores 289 tonnes per hectare (Carswell et al 2008).

2. Climate Regulation:

Carbon storage in shrublands, forest and tall tussock grasslands makes a modest contribution to ameliorating the current anthropogenic induced rise in atmospheric carbon dioxide levels. Much of the existing extensive tussockland and shrubland has potential for further carbon sequestration. The full potential of lower altitude tussocklands to increase in density and stature and ultimately to succeed to indigenous woody cover, is currently retarded by stock grazing. The succession of montane shrublands to forest is occurring rapidly though is limited by stock grazing in some sites (esp. on sunny faces and at lower altitude). The ability for shrublands to succeed is enhanced by the relative abundance of seed sources, a favourable climate with relatively high rainfall and the relatively low altitude of much of the PL.

3. Disturbance Regulation:

Wetland and upland bogs comprise a small proportion of the upland catchment areas. These areas play a disproportionate role in controlling flood runoff. These same wetland areas also store water which helps to maintain summer flows, as does storage of water in the shallow unconfined ground water on the colluvium mantled slopes. These values contribute to "disturbance regulation" by damping out environmental fluctuation such as floods and droughts.

4. Water Regulation/Regulation of hydrological flows:

The PL forms part of the Pomahaka River catchment. In the Pomahaka catchment there are currently 20 permits for surface water take to a maximum of 0.471m³/s (ORC Website). Tussocklands, wetlands, forest and shrublands on the Umbrella Mountains serve a vital role in regulating water flow utilised under these permits.

5. Water Supply Storage and Retention of Water:

Studies in the upper Taieri River found that low flows occurring below the median flows are particularly well sustained. Waterways in the Pomahaka catchment display similar characteristics. This is an important attribute in relation to public water supply for irrigation and other uses. Snow tussock catchments have less variable flows than degraded (burnt) tussock, oversown tussock or improved pasture (Fahey and Jackson 1991).

6. Erosion Control and Sediment Retention:

Snow tussock catchments monitored for sediment yield on the nearby Lammermoor and Lammerlaw Ranges were shown to have very low sediment yields by New Zealand standards (O'Loughlin et al. 1984).

7. Nutrient cycling Storage, Internal Cycling, Processing and Acquisition of Nutrients (nitrogen fixation, N, P and other elemental or nutrient cycles):

Monitoring in the nearby Upper Taieri has shown that similar tussock covered catchments yield very good water quality. (O'Loughlin et al (1984). This corresponds with recent Otago Regional Council monitoring results from the Pomahaka River.

The Otago Regional Council (Kitto 2010) established a 12 month water quality sampling programme in 2008, with the aim of getting a better understanding of the effects of land use on water quality in the Pomahaka catchment. Water quality in the lower Pomahaka catchment has been decreasing for a number of years as land use has rapidly intensified

Table 14 sourced from the ORC study shows the clear relationship between intensity of landuse and almost all water quality parameters. The neighbouring Leithen Burn ranks highest of sites monitored in the Pomahaka catchment for a range of water quality parameters.

Table 14. Summary of categories for Chemical, Physical Habitat, MCI and Trout condition related density for each stream.

Site	% catchment dairy farm	Chemical and Bacteria	Physical Habitat	MCI	Trout density/condition
Leithen Burn	0	Excellent	Excellent	Excellent	Excellent
Pomahaka @ Glenken (Upper)	0	Good	Excellent	Excellent	n/a*
Black Gully (Upper)	0	Good	Excellent	Excellent	Good
Spylaw Burn	1	Fair	Good	Fair	Excellent
Pomahaka @ Burkes Ford (Lower)	7	Fair	Good	Good	n/a*
Flodden @ SH90	26	Good	Good	Good	Good
Crookston Burn @ Walker	44	Poor	Good	Good	Good
Heriot Burn (Upper)	12	Fair	Poor	Good	Good
Waikoikoi	20	Fair	Good	Fair	Fair
Waipahi @ Waipahi (Lower)	1	Fair	Good	Fair	n/a*
Heriot Burn (Lower)	15	Fair	Good	Fair	Fair
Waipahi @ Cairns Peak (Upper)	0	Poor	Poor	Good	Fair
Black Gully (Lower)	36	Poor	Poor	Good	Fair
Washpool @ Kilhastie	79	Poor	Poor	Fair	Poor
Wairuna @ Clydevale Rd	51	Poor	Poor	Poor	Poor

*n/a means density data could not be collected as the river was too wide to effectively net.

PART 4

ATTACHMENTS

4.1 Additional Information

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