

Crown Pastoral Land Tenure Review

Lease name : BEAUMONT STATION

Lease number : PO 362

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.

Note: Plans which form part of the Conservation Resources Report are published separately.

These documents are all released under the Official information Act 1982.

December

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**DOC CONSERVATION RESOURCES REPORT ON TENURE REVIEW OF
BEAUMONT PASTORAL LEASE
(PO362)
UNDER PART 2 OF THE CROWN PASTORAL LAND ACT 1998**



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PART 1: INTRODUCTION

1.1 Background

The lessees of Beaumont Pastoral Lease (referred to in this report as “the Lease”) have applied to the Commissioner of Crown Lands for a review of the property’s pastoral lease tenure. The property is leased by Beaumont Station Ltd.

The Lease is located near Millers Flat in the Clutha River valley, 53 km south of Alexandra, Central Otago. It occupies approximately 21137 ha on the Lammerlaw Range. The property runs some 47 km from the Clutha River at Island Block on State Highway 8, north-eastwards back to Lake Onslow. The Taieri River forms the eastern boundary of the Lease. Access to the southwest of the property is provided by Beaumont Station Road.

The Lease is run in conjunction with 6848 ha of adjoining freehold land near the Clutha River.

Altitude ranges from 60 m at the Clutha River to 1210 m asl at Lammerlaw Top, located on the main Lammerlaw Range.

The Lease lies within the Waipori Ecological District (ED) of the Lammerlaw Ecological Region (McEwen 1987). This district is characterized as an upland schist plateau reaching 1211 m asl. It experiences a cool and moist climate and contains tussocklands, numerous peat bogs, a few forest remnants and some shrublands (McEwen 1987).

Three sites of significance (Recommended Areas for Protection; hereafter RAPs) were identified under the Protected Natural Area Programme (PNAP) (Carter 1994; see Appendix 1 and Map 4.2.1). RAP 1: Fortification Creek contains red tussocklands on the alluvial valley floor of the upland plateau basins; RAP 2: Teviot Swamp and McKays Stream is notable for its alpine grasslands, wetland and snowbank vegetation; and RAP 8: Taieri Rapids has tall tussocklands, shrublands, waterfalls and rapids on steep rocky slopes above the Taieri River (Carter 1994).

Carter (1994) did not survey the Clutha faces, stating that the environmental characteristics of this locality were more akin to those exhibited in the adjacent Tapanui ED. No PNA survey has been conducted for Tapanui ED.

Vegetation cover includes extensive tall tussocklands, red tussock wetlands, short tussocklands, bogs, rocklands, beech forest, native shrublands and exotic pasture.

No conservation lands or unoccupied Crown Land is present within the Lease. However, the 21,000 ha Te Papanui Conservation Park adjoins the Lease to the east. This protected area covers almost all of the Lammermoor and Lammerlaw Ranges and is dominated by tussock grasslands. In addition, the Canadian Flats Wildlife Management Reserve and Taieri Rapids Scenic Reserve are separated from the Lease by the marginal strip of the Taieri River at the property’s north-eastern boundary.

Legal access to the south-west end of the property is from Beaumont Station and Millers Flat-Beaumont Roads. The eastern boundary has legal vehicle access from SH 85 and SH 87 via Te Papanui Conservation Park. This access is subject to seasonal closure due to track conditions. There is no legal vehicle access to the north end of the property. There is legal foot access via marginal strip around Lake Onslow.

In addition, there is a large network of legal roads that traverse both the front and backcountry of the Lease. Those that either follow, or are very close to, the legal alignment include the main access track from Beaumont Station Road to Lammerlaw Range top to Teviot Swamp, and northern boundary; Teviot Swamp to Lake Onslow; Lammerlaw Range ridge from Te Papanui Conservation Park boundary to the main access track, and Davidsons Top to the formed airstrip down to the Taieri River.

PART 2 INHERENT VALUES: DESCRIPTION OF CONSERVATION RESOURCES AND ASSESSMENT OF SIGNIFICANCE

2.1 Landscape

Location and Landscape Context

The Lease occupies a huge land area and stretches from the Teviot Valley to the Upper Taieri Basin. It covers the majority of the Lammerlaw Range and drains into two major river catchments, the Clutha and Taieri. Beaumont PL is one of the largest leases in Otago.

The front part of the Lease extends from the Clutha River to the Lammerlaw Range, and includes downlands gradually rising to rolling tussocklands up to the property’s high point of 1210 m at Lammerlaw Top.

The back part of the Lease is highly distinctive and is part of the rolling uplands and vast tussock hinterland that separates coastal Otago from the basins and block mountain ranges of Central Otago.

To the north, the Lammerlaw Range merges with the Lammermoor Range, which has similar topography and vegetation patterns, and further north still, the Rock and Pillar Range.

The Lammerlaw Range and connected uplands separate coastal Otago from surrounding inland valleys and plains of Central Otago including the Maniototo Plain, the Upper Taieri Basin (Styx Basin) the Strath Taieri, the Teviot Valley and far away as the Alexandra Basin.

The rolling uplands drain west to the Clutha River via the Teviot River. The north-west boundary of the Lease is bounded by Lake Onslow, a relatively large water mass. The lake occupies a natural depression, and was created by damming the Teviot River, and drowning swampland. The remainder of the upland plateau drains to the Taieri River via an intricate and highly distinctive drainage network.

The Taieri River headwaters act as the eastern boundary of the Lease, forming a gorge incised into the upland plateau.

Beaumont Lease adjoins the 22,000 ha Te Papanui Conservation Park.

Methods

The Lease has been divided into defined landscape units (LUs), reflecting areas of similar landscape character. Landscape character is the quality that makes an area different from another and can be defined as follows:

‘Landscape character results from a particular combination of characteristics formed by the interaction of natural processes and cultural (human) activities.’
 NZ Institute of Landscape Architects

For each unit a landscape character description is provided, along with a description of the key visual and scenic attributes present. An evaluation summary is presented, using a range of criteria to assess each unit and assist with determining each unit's significant inherent values. The criteria include:

Naturalness: Refers to the condition of the natural vegetation, patterns and processes and the degree of modification present.

Legibility: Refers to its expressiveness - how obviously the landscape demonstrates the formative processes leading to it.

Aesthetic Factors: Include criteria such as *distinctiveness* - the quality that makes a particular landscape visually striking. Frequently this occurs when contrasting natural elements combine to form a distinctive and memorable visual pattern. A further criterion assessed under aesthetic factors is *coherence*. This is based on characteristics including intactness, unity, continuity, and compatibility. Intrusions, alterations, disruptions tend to detract from coherence.

Historic Values: Refers to historically valued attributes in the context of a high country landscape.

Visibility: Refers to the visibility from public places such as highways, waterways or local vantage points.

Landscape Description

For this assessment, the Lease is divided into four landscape units (refer Map 4.2.2 and Appendix 2 for photos). These include:

- Clutha River Faces (LU1)
- Beaumont Downs (LU2)
- Beaumont Upper Faces (LU3)
- Lammerlaw Tops and Rolling Uplands (LU4)

2.3.1 Clutha River Faces (LU1)

Character Description

The Clutha River Faces include the eastern hill faces of the Clutha River, and occupy a small part of the Lease. The highest point is only 224 m asl. Very small pockets of river flats are included. The Beaumont Station Road runs parallel with the river. A small sliver of Lease crosses the road onto Craig Hill, an isolated pyramidal-shaped landform next to the river.

The hill faces are generally smooth and gentle, with occasional exposed rocky outcrops and large rounded boulders. Gentle valleys and tributary creeks are down-cut into the faces. Named tributary creeks include the Little Minzion Burn, Craig Creek and the largest, the Talla Burn. The Talla Burn acts as the Lease boundary on the southwest.

Vegetation is highly modified and consists of pockets of sparse manuka, elderberry, gorse and broom inter-mixed with pasture. *Juncus* rushlands occur on the valley floor. Gorse and broom areas have been recently sprayed, and are mostly dead but with new shoot sprouting at the base. Some mixed shrubland and broom occurs within the riparian margin of the Talla Burn at the entrance to the gorge.

Visual and Scenic Values

The unit is significant as the corridor to the Clutha River and to the Millennium Clutha Gold Trail. However the degree of vegetation modification gives it generally a scruffy, indistinct appearance which diminishes visual and scenic values.

Landscape Vulnerability

The river faces are already highly modified and therefore not obviously threatened. Insensitive earthworks are the most likely threat. Allowing native revegetation of riparian strips along watercourses would allow for a much improved visual landscape as well as improvement to the land’s ecological health.

Table 1: Summary of Landscape Evaluation of LU1

Criteria	Value	Comment
Naturalness	Low	Vegetation patterns highly modified
Legibility	Medium	Formative processes not obviously expressed
Aesthetic Factors	Low	Spraying and burning have imparted a scruffy appearance
Historic Factors	Medium	Significant cultural (Maori and European mining and pastoral history)
Visibility	Med./High	Adjacent to public road and future Clutha Gold Trail

Beaumont Downlands (LU2)

Character Description

This large area encompasses the southwest faces of the Lammerlaw Range, rising up to a ridge at approximately 650 m, bisecting the Talla Burn and following the ridge that separates the Talla Burn from the Fruid Burn. It equates roughly with the elevation where there is a change from developed hill farmland to tussock grassland as the dominant cover.

The character of this unit is derived in part from the repetitive dissected hills with rolling and sloping ridges and down-cut gullies.

Rolling farmland occurs below the Beaumont Station Road down to the Clutha face. Vegetation cover is predominantly pasture, sprayed gorse and broom with a few scrubby shrub remnants associated with rocky areas. One or two kowhai trees persist. Some water races and infrastructure associated with mining activity remain around Craig Flat.

Little Minzion Burn and Craig Creek drain south-east from below Beaumont Station Road and the Fruid Burn drains the area between the road and the ridge on the true right of the Talla Burn. The Fruid Burn Flats are the most significant area of flats on the Beaumont downlands. A rectangular shaped block of freehold is located on the Fruid Burn and extends onto adjacent hills. The general appearance of the land is of developed farmland. The Fruid Burn flats are mainly pasture, sprayed gorse and broom and scattered willow. The stream follows a meandering course across the flats.

The north-west faces up to the west ridge of the Talla Burn are most notable for the large-scale destruction of manuka, leaving large areas of standing deadwood. Further north towards Gibson Hill is short manuka regrowth, which presumably has been sprayed or burned at an earlier time and since regrown.

The lower Talla Burn is similar, with large areas of dead manuka and primarily developed pasture. Small slivers of shrubland and beech forest have survived along the riparian margins.

Visual and Scenic Values

Beaumont downlands has been, or is in the process of being, converted to a pasture monoculture with little or no indigenous component. The wholesale destruction of manuka shrubland and resultant deadwood has a significant and negative impact on visual and scenic values.

Views from within the downlands to the top of the Lammerlaw Range and to surrounding farmland and distant ranges are notable.

Landscape Vulnerability

The Beaumont downlands are highly modified. A serious attempt has been made to remove all indigenous vegetation. An opportunity has been lost to integrate shrubland within gully systems with open pasture on the ridges. This has occurred on adjoining land and has resulted in an integrated landscape where farming and indigenous biodiversity co-exist.

Table 2: Summary of Landscape Evaluation of LU2

Criteria	Value	Comment
Naturalness	Low	Natural landform patterns remain but vegetation is highly modified
Legibility	Medium	The action of water is very legible
Aesthetic Factors	Low	Dead manuka and mass destruction of indigenous vegetation is visually discordant
Historic Factors	Medium	Some infrastructure left from mining activity e.g. water races and abutment walls
Visibility	Low	Not highly visible from public places

Beaumont Uplands (LU3)

Character Description

Beaumont Uplands is an extension of the Beaumont Faces of the Lammerlaw Range, and extends from the upper boundary of the Downlands (LU2) to the Lammerlaw Tops. It includes all of the Upper Talla Burn and upper Moffats Stream.

The landform patterns are repeated across the whole of the upper faces and consist of rounded rolling slopes and with incised, concave gullies. The gullies contain wetlands and bogs. Relatively small areas of flat peat bogs are also characteristic. The upper slopes are easy to moderately steep.

The dominant cover is tall tussock grassland of highly variable condition.

A dominant feature of the lower zone particularly in Moffats Stream is gorse infestation reputedly started from a gorse fence that was planted in early pastoral times. This has spread over a wide area.

(a) Moffats Stream

Tussock is chewed out and depleted, and gorse has a firm hold over large areas. Short manuka and patchy grey shrubland species also occur.

(b) Eastern sector and upper slopes

The eastern sector, next to Te Papanui Conservation Park and above Moffats Stream, falls away into Beaumont Stream and is predominantly tussock grassland. However, the tussockland is diminished in stature and depleted in places, especially in areas of stock concentration such as at the corner of grazing blocks and close to gates. The upper faces from Carsons Rock to Lammerlaw Rock support intact tussock grassland in reasonable to good condition, but with signs of grazing pressure.

(c) Upper Talla Burn

The Upper Talla Burn is also fairly natural with predominately tall tussock. Tussock cover is fragmented in some areas, either due to sheep camps or uneven grazing, and there are pockets of gorse present.

Riparian shrubland is a feature especially in the middle sections of the Talla Burn, extending up side-gullies and often associated with rocky walls and outcrops.

Peat bogs occur on the broad ridge and depression west of the Talla Burn. These bog communities include bog pine, and are in association with red tussockland. These areas all appear natural, although grazing is impacting on them. A band of depleted tussock and gorse is present above the bogs, which appears to be related to a holding paddock and has been more heavily grazed. The gorse is a continuation of the fence previously discussed.

Visual and Scenic Values

The majority of the unit forms part of the upper Lammerlaw faces and, for the most part, appear as an intact tussock grassland. Visual values here are high. The Talla Burn peat bogs and riparian shrublands are visually interesting and distinctive. The landscape at Moffats Stream and the adjacent modified areas, where gorse and much depleted tussock dominate, is disrupted and the visual and scenic values are considerably reduced.

Landscape Vulnerability

Unsustainable grazing and burning, and the ongoing spread of weeds are the most significant and real threats to intact tussock grasslands of the upper Beaumont faces.

Table 3: Summary of Landscape Evaluation of LU3

Criteria	Value	Comment
Naturalness	Medium to High	Depleted in lower faces and fragmented by gorse
Legibility	Medium	Dendritic landforms are highly expressive of the processes that lead to them
Aesthetic Factors	Medium to High	Variable. Low in Moffats Stream and highly modified areas
Historic Factors	Medium	Not significant
Visibility	Low	Not highly visible from public places

Lammerlaw Uplands (LU4)

Landscape Character

The Lammerlaw Uplands unit includes the whole of the Lammerlaw Range and upland plateau. Sub-units are assigned for the purposes of description. The primary attributes that apply to the whole unit include:

- Expansive; open large scale; simple.
- Repetitive, rolling, smooth gently rolling spurs dissected by an intricate drainage network.
- Scattered schist rock outcrops, especially associated with streamsides and sides of spurs; continuum of tall tussock, interrupted intermittently by swamps and bogs. Some wetlands are very large; others are small finger bogs.
- Sense of remoteness.
- Ephemeral effects associated with sky, light, season and weather patterns are significant i.e. mist shrouded, blanketed in snow, gale westerlies and southerlies, evening and morning light, approaching weather patterns etc.
- Human impacts few - related to pastoral farming, access tracks, firebreaks and sheep camps. There are few internal fences.

The sub-units are described below:

(a) Lammerlaw Tops

The Lammerlaw Range Tops form the south-east dividing ridge across the Lease, and extends onto the adjoining Te Papanui Conservation Park. It also includes the north and east slopes away from the dividing ridge (upper basin of MacKays Creek), and the basin that encloses the Teviot Swamp. The Lammerlaw Tops overlap with the Beaumont Uplands unit (LU3). The western and highest end of the Lammerlaw Range, including Lammerlaw Top (1210 m), is present. Lammerlaw Rock is the only significant rock outcrop on the ridgeline.

The ridges and spurs of the Lammerlaw Tops have a repetitive pattern. Snowbanks on short, steep, east or leeward facing slopes are a feature on the north and east slopes of the ridge. A further feature is a system of sphagnum wetlands with stepped pools. Lower down, wetlands occupy stream sides or places of poor drainage.

Short herbfield and high altitude tussockland occupy the ridges, with tall tussock on side slopes and spurs away from the ridge.

Teviot Swamp is contained in a basin and surrounded by the signature tussock-covered rounded spurs and incised gullies typical of the whole of the uplands. The swamp includes large patches of sphagnum, bog pools and string bogs, meandering streams, and red tussock. The wetlands are in various shades of green, yellows and browns, which provide a striking contrast with the red tussock. Teviot Swamp appears fairly natural but there are grazing signs, especially from cattle.

(b) Teviot

Teviot sub-unit covers the western side of the Unit, from the ridge separating the Teviot catchment from the Taieri. Davidsons Top (1127 m) is the highest point. The large water mass of Lake Onslow, created by damming the Teviot River, dominates the landscape of the upland plateau and borders the Lease on the lake's eastern side. Vegetation cover towards the Styx Basin reflects a decrease in rainfall.

Other attributes and features include tussock-covered gently rolling spurs and gullies, with intermittent wetlands in the gullies. The largest and most impressive wetlands include Red Swamp, and wetlands associated with Fortification Creek and the Teviot River South Branch. There are also many other smaller wetlands and finger bogs.

Scattered schist outcrops occur within the tussock slopes, and are usually associated with side slopes of gullies and stream sides.

The dominant tussock cover is generally uniform, but reduced in size through the effects of grazing and burning. Hawkweed becomes more pronounced on the lower north-west slopes above Lake Onslow. However, viewed as a whole, the tussock landscape appears continuous and predominantly natural.

The northern sector toward the Styx Basin appears as tussock covered slopes in reasonably good condition, with drainage falling away to the Styx Basin. High voltage power lines pass through the northern end.

Other signs of human activity on the Teviot side are access tracks, and one or two water races and dams remaining from early mining.

(c) Taieri

This sector includes the eastern half of the LU, forming the headwaters of the Taieri River on the true left of the river (the Lease boundary). The river is deeply incised within a gorge which becomes increasingly entrenched within steep walls and rocky side-slopes downstream. Rapids and whitewater are a feature south of Spillers Hill. Tussock appears depleted on the sides of the gorge.

Elsewhere, the same pattern of gently rolling spurs with intermittent swamps and peatlands occurs, consistent with the rest of the upland plateau.

Signs of human activity are limited to a musterers hut, an airstrip, an internal fence, and the impact of grazing on the vegetation.

(d) Styx Valley

The northern sector of the Upland Plateau includes part of Riddles Creek, Canadian Creek and their associated flats. These are mostly north-facing tussock slopes that drain to the Taieri River as it emerges from the gorge and enters the Styx Basin. Rock stacks and outcrops are a feature here.

Canadian Creek and flats adjacent to the river are modified, with little or no tussock. There are some signs of mining activity (e.g. water-races), but these are not obvious. High voltage lines and access tracks are other human-induced changes.

Visual and Scenic Values

The Lammerlaw uplands have very high visual and scenic values. The simplicity of the landscape, the repetition of smooth flowing tussock spurs and gullies, in association with incised drainage lines, and the intricate network of wetlands and peatbogs, makes for an outstanding natural landscape. It is a landscape that is highly characteristic of this part of Otago, and is representative of an original New Zealand landscape.

The scale of this landscape (within the Lease) and seen in the context of adjoining upland areas of similar landscape type, is vast and magnificent. Lighting effects that highlight the repetitive rolling spurs combined with the colour and textural effects of tussock are highly memorable and distinctive.

An important visual value of the Lease is that parts of the it form the western and southern backdrop to Lake Onslow, and are visible from the Onslow backcountry road linking Teviot to Paerau. In addition, the northern flanks form part of the tussock backdrop to the Styx Basin.

Landscape Vulnerability

The Lammerlaw Uplands landscape is highly vulnerable to any human-induced impacts that threaten the key attributes of openness, the smooth flowing tussock-covered landforms and wetlands, and the general naturalness of the landscape. On first appearance, the existing pastoral management has retained values, however the condition of tussocklands and wetlands is significantly compromised by grazing. The sustainability of grazing on this upland plateau is a major issue. Already tussock height is reduced and the tussock is fragmented by sheep camps and uneven grazing in places. The spread of hawkweed is also a serious threat and wetlands are being damaged by pugging by animals and grazing.

Further threats include:

- New structures and land-uses (e.g. sheds/buildings, wind farm structures, power pylons)
- Wilding tree and weed spread

Table 4: Summary of Landscape Evaluation of LU4

Criteria	Value	Comment
Naturalness	Medium to High	All natural patterns and processes intact. Appears natural but signs of grazing and burning apparent
Legibility	High	Smooth, rolling landforms and drainage network highly expressive of formative processes
Aesthetic Factors	High	Very coherent, visually impressive landscape. Distinctive Otago landscape
Historic Factors	Medium	Some localised signs of mining activity e.g. water-races, dams. Pastoral history is important
Visibility	Medium	Teviot side visible from Onslow Road and Lake Onslow. Lammerlaw Ridge visible over wide area including parts of the Teviot Valley and Roxburgh area. Northern slopes of Upland Plateau visible from southern end of the Styx Valley

2.1.1 Significance of Landscape

Map 4.2.2 show the areas with significant landscape values.

The Lease has significant landscape values that include the entire Lammerlaw Range and Upland Plateau, and the Upper Beaumont slopes including the Upper Talla Burn and slopes below Carsons Rock, downslope to where tussock is beyond recovery and/or above the worst of the weed zone. These areas support unimproved tussockland that retain all the attributes of the indigenous character, and are fully representative of an original New Zealand landscape.

The upper Beaumont faces (including the Talla Burn), together with the Lammerlaw Range and the upland plateau, is part of a homogenous large scale, intact upland landscape. Beaumont occupies a large part of this landscape, but it also extends onto adjoining land including the Te Papanui Conservation Park.

The values of this landscape lie in its vastness, simplicity, degree of naturalness and sense of remoteness. Integral to the character of this landscape is the repetitive rolling landforms and homogenous golden coloured tussock stretching into the horizon along with the intricate drainage pattern. Impressive wetlands and peatlands throughout are a special feature which provide contrast and punctuate the rolling tussocklands. The effects of weather and light in dramatising and highlighting the natural landforms and vegetation are also important.

The Lammerlaw Upland landscape is unquestionably an iconic and outstanding natural landscape.

The Beaumont upper tussock faces up to the Lammerlaw ridge are modified and fragmented in places by grazing and weeds (gorse). However, it remains an intact natural landscape. Modified and compromised areas are capable of restoration with appropriate management.

2.2 Landforms, Geology & Soils

Landforms

Information provided in this section is derived from detailed geomorphologic descriptions given in the Protected Natural Areas Survey Report (Carter 1994). The geomorphology of the property has characteristics of both Central Otago and the eastern Otago uplands. The eastern part of the property is part of the extensive eastern Otago uplands, comprised of undulating, smooth topped, rolling and finely dissected hills from about 500 m to over 1000 m asl along the Lammerlaw Range. This range is one of the sources of the major catchment systems, including the Taieri River. The catchments are controlled by the parallel schist geology, and many of the rivers are entrenched (Otago Catchment Board 1983). The western part of the Lease drains into the Clutha River.

The upland plateau between Teviot Swamp and Lammerlaw Top has a repetitive pattern of ridges and spur, created in part by the angle of dip in the schist bed rock and by the action of cold climate processes leading to snowbank formation. There are no significant areas of rock outcrops on ridgelines, except for Lammerlaw Rock.

The upland plateau is generally above 750 m asl. There are wide basins such as Lake Onslow, with broad ridges separating the catchments. Smaller basins include Red Swamp, Teviot and MacKays Creek. The streams draining into Lake Onslow have significant meandering sections with oxbow lakes, which are a distinctive feature of the Waipori ED. The ox-bow lakes are characterised by island-like centres where they have been cut off from the river. Patterned ground occupies a large area between the two rivers, characterised by raised ribbon-like ridges of vegetation and/or evenly spaced pedestals. Rock outcrops are common along ridgelines in this locality. Uneven slopes on the true left of Fortification Stream valley indicate ancient slumping.

Vegetation hummocks of “thurfur” ground formations are located in the upper basin of MacKays Creek. They are up to 30 cm high and aligned perpendicular to the contours. These are formed as a cold climate process which may or may not be associated with periglacial conditions.

Bog pools are a feature on the *Sphagnum* sheets of the main Red Swamp, Teviot Swamp and upper MacKays Creek. They do not appear to be associated with controlling geological structures.

While streams above 1000 m asl are usually short, with a shallow gradient and are slow moving, lower down, the streams become more incised. The Taieri River flows northwards along the Lease's eastern boundary. Where the river leaves the headwaters of the upland plateau, it cuts down to the plains below forming a steep, dramatic gorge, with rock cliffs and boulderfields. The strata dip in a steep easterly direction and outcrop in long spurs from the top to the bottom of the slope.

Geology

The Central Otago ranges were formed by folding and uplift during the later Miocene to Pliocene periods. Asymmetric basins and ranges, bounded by major fault systems, formed in response to tectonic events on the Australian-Pacific Plate boundary to the west, and compression east of the Alpine Fault (Turnbull 2000). The relatively flat summits of these ranges are derived from the Otago peneplain, part of the Waipounamu Erosion Surface WES (LeMasurier and Landis 1996).

The Lammerlaw Range is one of several schist ranges in Central Otago. The range is bound by northeast trending faults and the peneplain surface is well preserved on the top of the ridge (Forsyth 2001).

The basement rock of the Lammerlaw Range is Otago schist of the Caples terrane. The Caples terrane rocks comprise schists of the biotite-garnet-albite zone, greenschist facies (Mortimer 1993). There is no mappable stratigraphy, as the rocks have been overprinted by at least two phases of deformation, with most original features destroyed (Turnbull 2001). The Caples-Rakaia terrane boundary trends northwest-southeast across the Lammerlaw Range (Turnbull 2001).

Foliation dips gently north or northeast, and lineations plunge gently north or south. The depositional settings of the protolith Caples terrane sediments are inferred to have ranged from trench slope to trench-slope basins, and possibly trench floor (Carter et al. 1978; Turnbull 1979; Roser et al. 1993).

Quaternary sediments include fluvial deposits of weathered quartz-schist gravel, sand and boulders in former channels of the Taieri River. These represent the Manuherikia Group and older sediments recycled by an ancient river. Elsewhere, these gravels have been extensively sluiced for gold e.g. in the upper Taieri – Lammermoor area (Turnbull 2001).

There is a small outlier of basaltic rock near Fortification Stream, which is part of the Taratu Formation.

Soils

The soils of this area were originally mapped and described by the New Zealand Soil Bureau (1968). The range crest soils are mapped as Maungatua and Teviot Hill soils.

Maungatua soils are upland and high country podzolised yellow-brown earths/podzols that occur on rolling lands and hills of the highest part of the Lease. While these soils have similar properties to their lowland counterparts, the higher altitude and lower temperatures of the Lammerlaw tops have resulted in weaker weathering and lower production and turn-over of organic matter. The gley podzol has a thin iron pan.

Teviot Hill soils are extensive, present from the range top, down to about 1000 m asl. These are shallow high country yellow-brown earths with friable and erodable topsoils. The remainder of the property down to the Clutha Valley is dominated by Tuapeka Hill soils, which are a lowland yellow-brown earth. These occur on steep slopes, and have a stony silt loam texture.

The NZ Soil Bureau (1968) also identified the presence of localised deposits of Taieri Soils, a gley soil located within the Fruid Burn. Taieri Soils occur on sites (mostly low-lying swampy land) where soils receive moisture from the groundwater as well as from precipitation, and have the characteristic grey gley horizon.

More recently, a detailed soil survey of the Otago uplands (McIntosh and Backholm 1981) identified five soil units on the Lammerlaw Range that correspond to the Maungatua, Lammerlaw, Waipori, Tawhiti and Teviot soils of the Soil Bureau surveys. It found that most properties of top soil associated with these soils correlated with short-term rainfall rather than altitude; this is called a pluvosequence.

McIntosh and Backholm (1981) found that the Lammerlaw soils unit occurs between 855-1200 m asl, with annual rainfall ranging between 650 and 1090 mm. The top soil is very acid, with severe phosphorus deficiencies.

The Tawhiti soil unit occurs at lower altitude (670-975 m asl) and has a low pH and low Olsen phosphorus (P) levels. McIntosh and Backholm (1981) concluded that the low Olsen P and medium P retention values in top soils has resulted in severe P deficiency, too low for the growth of legumes commonly used for pasture development. They also noted that the top soil sulphate values in all these soil sets were regarded as being below the minimum required for healthy legume growth.

2.2.2 Significance of Landforms, Geology and Soils

No sites of international geological importance have been identified on the Lease (Kenny and Hayward 1993). No structural features are considered to be of regional, national or international significance by Nowell and Sporli (1991), although schist tors are a notable local landform.

The meandering streams and oxbow lakes are important landforms, typical of the open flat basins of the upland plateau where streams flow into Lake Onslow. Similar systems in the downland area of the property have been modified to some extent by fencing and drains (Carter 1994), and have almost been lost from other areas.

2.3 Land Environments of New Zealand (LENZ)

Two databases have been used to assess biodiversity protection (Walker et al. 2005):

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 II).

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. This provides a measure for:

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

Based on these two criteria, five categories of threatened environments have been allocated 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 5 summarises the land environments resented on the Lease. Detailed information for each land environment is provided in Appendix 3.

Table 5: Land Environments of New Zealand (LENZ) Units on Beaumont Pastoral Lease

Threat Category	Level 4 LENZ Unit	% Indigenous vegetation cover remaining nationally	% Protected nationally for conservation purposes	Indigenous Vegetation Cover Change 1997-2002	Approximate Area on Lease (ha)
Acutely Threatened	L1.1a	2	4	No change	0.37
	L1.3b	3	1	No change	56.2
	L4.1a	3	1	Decrease	31.4
	L4.1b	1	0	No change	61.2
	N2.2b	1	0	No change	0.9
Chronically Threatened	N3.1e	13	2	Decrease	210
	Q4.3b	17.14	3.8	Decrease	267
At Risk	K3.2a	25	6	No Change	4
	Q4.3a	23.41	7.74	Decrease	1855
Critically Underprotected	K5.1b	61	9	No change	49.1
	Q2.1a	38	9.27	Decrease	2
	Q2.2a	39.92	3.91	Decrease	77
	Q3.3b	81	1	Decrease	174
Underprotected	Q1.1c	91.23	17.86	No Change	85.8
	Q3.2a	49	17	Decrease	723.6
	Q3.3c	90.03	17.21	Decrease	15358.3

	L3.1b	67	24	Decrease	585
No Threat Category	Q1.2a	99	37	No change	0.06
	Q3.1a	67	36	No change	7.1
	Q3.3a	96.91	25.62	No Change	636
	Q4.2a	34	25	Decrease	749

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.

The Lease comprises the following land environments that are significant. Within each LENZ environment nationally, indigenous vegetation has largely been removed, and/or little of the environment is represented in lands protected primarily for conservation purposes.

- ~0.7% of the property has a Level IV LENZ unit that has less than 10% of their land area still in indigenous vegetation cover (whether protected or unprotected). This includes four ‘Acutely Threatened’ Units (L1.1a, L1.3b, L4.1a and N2.2b). These units support some indigenous woody vegetation on the Clutha faces and Craig Hill.
- ~0.2% of the property has Level IV LENZ units that have 10-20% of indigenous vegetation cover (whether protected or unprotected). These include two ‘Chronically Threatened’ Units (N3.1e and Q4.3b). These units are on the Clutha river faces, and support a mix of indigenous shrubland and exotic species. N3.1e near Canadian Flats, supports degraded snow tussocklands, with a large population of Nationally Vulnerable native dandelion *Kirkianella novae-zealandiae* present.

Where indigenous cover remains within threatened LENZ units, the significance of inherent values is enhanced. The distribution of threatened land environments is shown in Appendix 4.

2.4 Climate

The Lammerlaw Range is closer to the coast and subject to a greater maritime influence than other Central Otago ranges. Cold climate regimes descend to a lower elevation in Otago than most other regions in New Zealand. The Waipori ED is influenced by this regime to a greater extent than might be expected, evident by the alpine vegetation growing at relatively low altitudes i.e. 800-1200 m asl (Garnier 1948).

The Lammerlaw Range is often shrouded by cloud and fog which contributes to the total precipitation. There has been considerable research undertaken to determine how much the low cloud and potential evapotranspiration balance contribute to the water budget of the general area (Mark, Rowley & Holdsworth 1980; Mark & Rowley 1976; Holdsworth & Mark 1990).

Rainfall on the Clutha flats is in the vicinity of 600 mm/ year. Areas above 900 m receive in excess of 1000 mm/ year (Otago Regional Council 1999), well above the local evapotranspiration rate of 700-800 mm/ year. May and June are the wettest months. Air temperatures are frequently low, especially at higher altitudes.

High wind speeds can occur on the upland plateau because of its rolling terrain and exposure from all directions.

On the upper reaches of the Lammerlaws, snow accumulation is highly variable from year to year, with regular winter snowfalls, redistribution by wind, and the effects of intermittent periods of melt. In years with substantial snowfall, up to 2 m of snow may accumulate, which represents approximately 33-42% of annual precipitation on the uplands (Waugh 2005).

2.5 Vegetation

Ecological Context

The Lease encompasses the majority of the Lammerlaw Range and adjoins Te Papanui Conservation Park. Most of the Lease lies within the Lammerlaw Ecological Region and comprises approximately 25% of Waipori ED. This ED is characterised by tall tussocklands and wetlands. Johnson and Lee (1988) identified Fortification Creek, Red Swamp and Teviot Swamp as a sequence of wetlands at different elevations with complex vegetation patterns of high conservation value.

The Protected Natural Areas Programme (PNAP) of the Waipori ED (Carter 1994) identified three RAPs on the Lease. RAP 1: Fortification Creek comprises a red tussock grassland and sedge wetland on poorly drained valley floor near Lake Onslow. RAP 2: Teviot Swamp and MacKays Creek comprises side slopes clothed in narrow leaved snow tussocks and peaty wetlands dominated by sphagnum moss and shrubby areas supporting bog pine and celery pine. RAP 3: Taieri Rapids located in the upper Taieri River has a bluff community (see Appendix 1 for details).

There is little forest in the Waipori ED, and the cover of shrublands has been much reduced.

Vegetation Descriptions

The vegetation has to some degree been altered by a long history of grazing and fire. The condition of the vegetation generally improves with both increasing altitude and decreasing distance to streams. Near-natural examples exist at higher elevations (above c. 700 m) with natural remnants below this centred on gullies and rocky sites.

The Lease has a diverse native flora with 386 species recorded during this survey (see Appendix 5). Eighty (17.2% of the total recorded flora) exotic species were recorded during the survey, mainly in patches of exotic grassland at lower elevations. This is a relatively low proportion indicating that considerable naturalness remains, particularly at higher altitudes. It was estimated that about 20% of the area surveyed is of a predominantly exotic nature.

Seven broad vegetation communities were apparent:

- Lowland grey shrublands/broadleaf-dominated forest on gullies and rocky sites in lower catchment areas
- Widespread tall tussockland on the Lammerlaw Tops and backcountry ridgetop areas
- Short tussockland-herbfield on the lower altitude and backcountry spurs
- Extensive seepage wetlands in gully heads forming upland cushion fens in impounded valleys and gully-head patterned mires
- Lowland pools and mixed rushland & sedgeland on Canadian Flats and Fortification Creek
- Silver beech forest
- Exotic grassland on the flats and lower front faces.

These communities to some extent intergrade. There is no easily visible boundary between degraded exotic-dominated lowland country and upland areas with more natural vegetation.

To aid description, the property has been divided into five zones:

- Front Faces & Fruid Burn
- Moffats Stream catchment
- Teviot Wetlands and feeder streams
- Upper Talla Burn basin and backcountry tussockland
- Canadian Flats

Front faces and Fruid Burn

This area encompasses the true right of the lower Talla Burn and the catchments of Craig Creek and the Fruid and Little Minzion Burns. This area has a matrix of different habitats. Extensive areas of lower diversity and density shrubland (as a result of recent burning and spraying) intergrade with large areas of induced exotic grassland. Above about 500 m asl in the upper Fruid Burn, there is a gradual transition to a mixed short/tall tussockland with extensive shrubland that is of lower diversity and density. Much of this shrubland has been reduced in density and diversity following weed spraying. However, there are a reasonable number of native shrub species present including weeping matipo *Myrsine divaricata*, kowhai, *Olearia lineata*, *Coprosma propinqua*, *Melicytus alpinus*, *Corokia cotoneaster*, *Coprosma crassifolia* and rare cabbage tree. These shrublands become more intact along the lowest part of the Talla Burn where broadleaf and scattered silver beech trees are present. Extensive areas of gorse occupy the shrub to exotic grassland transition zone. The flats are dominated by cultivated exotic pasture and tall exotic rushland with rare patches of *Eleocharis acuta*.

Moffats Stream catchment

This area encompasses the middle reaches of the Talla Burn and the Moffats Stream catchment. This area has a matrix of tall tussock grassland dominated by short-stature lower-density narrow-leaved snow-tussock *Chionochloa rigida* tussockland with intermixed spaniard *Aciphylla aurea*, native herbs and large areas of exotic grasses dominated by sweet vernal (*Anthoxanthum odoratum*) and browntop (*Agrostis capillaris*), and hawkweed (*Hieracium pilosella*). At lower elevations, an incipient manuka (*Leptospermum scoparium*) shrubland is developing (but retarded by burning), and hard tussock grassland increases in

extent with decreasing narrow-leaved tussock density. An area of silver beech (*Nothofagus menziesii*) forest surrounded by mixed hardwood and tall kanuka (*Kunzea ericoides*) shrubland is present along the Talla Burn. The middle reaches of the Talla Burn above this shrubland is a mix of fire-induced gorse, manuka, kanuka, *Olearia bullata*, mountain flax, tutu, koromiko (*Hebe odora* and *Hebe salicifolia*), *Coprosma propinqua* and inaka (*Dracophyllum longifolium*). The wetland in Moffats Stream is dominated by hybrid snow tussocks (*Chionochloa rigida* x *Chionochloa rubra* subsp. *cuprea*) with mossfield interstices with a high loading of exotic species. A considerable gorse infestation is expanding from a gorse fence.

Teviot River wetlands and feeder streams

This area encompasses the Teviot Swamp, Red Swamp and Fortification Creek wetlands and their feeder tributaries as well as the low alpine and snowbank vegetation around the Lammerlaw Top. The Teviot Swamp, Red Swamp and Fortification Creek wetlands have been described by Johnson (1986), Carter (1994) and Rapson et al. (2006), and their current condition and composition is as described therein. In some parts of the Lammerlaw Tops areas of gully head ribbon fens (string bog) have developed. The low alpine vegetation here consists of patches of *Hebe hectorii* shrubland and extensive blue tussock grassland and herbfield containing *Celmisia densiflora*, *Aciphylla hectorii*, *Hebe imbricata*, *Abrotanella patea-roa*, *Carex hectorii*, *Kelleria croizatii*, *Craspedia incana*, *Uncinia divaricata*, and *Astelia linearis* var. *novaezelandiae*. Snowbank vegetation consists of *Raoulia grandiflora*, *Argyrotegium mackayi*, *Plantago lanigera*, *Agrostis muscosa*, *Rytidosperma australe*, *Gaultheria nubicola* with *Psychrophila obtusa*, *Carex pyrenaica* and *Raoulia subulata* in damp areas. Interfluvial tussockland vegetation is as described for the 'Upper Talla Burn basin Backcountry tussockland' area.

Upper Talla Burn basin and Backcountry tussockland

This area encompasses the tall tussock grasslands and fluvial seepage wetlands of the true right of the Taieri River and MacKays Creek, Red Swamp Creek, Bullocky Creek and Riddles Creek catchment areas and the upper Talla Burn catchment area above c. 550 m up to the Lammerlaw Tops. Obvious vegetation features of this area are extensive narrow-leaved tussocklands and the variety of wetland formations. The interfluvial vegetation of this area is varied and consists of extensive shorter-stature sparse to closely spaced narrow-leaved snow-tussock becoming denser and taller in gullies. Inter-tussock exotic species such as browntop, hawkweed and sheep's sorrel are common, particularly in fence corners and stream crossings (as a result of grazing pressure). The tall tussocklands in the Riddles Creek area in particular have been modified. Native inter-tussock species include speargrass and occasional mountain daisy *Celmisia semicordata*.

A distinctive vegetation community is present around rocks (as it is in other higher altitude parts of this property) with a variety of native herbs and small grasses and *Coprosma dumosa* in areas of rockfall. Riparian shrublands are poorly preserved, but some areas of *Olearia bullata* and *Hebe anomala* are present.

In the lower elevation areas along the Taieri River, hawkweed and hard tussock become more dominant. Riverine flats along the Taieri River have distinctive ephemeral wetland communities with *Brachyscome humilis*, *Microseris scapigera*, *Galium* "lacustrine", and *Cardamine* "tarn". These ephemeral wetlands extend into the Canadian Flat area. Seepage

wetlands are dominated by *Schoenus pauciflorus*, *Carex gaudichaudiana*, mosses and herbs such as *Euchiton polylepis* and *Utricularia dichotoma*. Extensive areas of cushion bog with scattered shrub copses are found in the upper gullies and these merge into a flow bog vegetation with increasing gradient. Vegetation of these wetlands includes bog pine, *Dracophyllum pronum*, *Pseudopanax colensoi*, *Hebe hectorii*, *Androstoma empetrifolia*, *Dracophyllum rosmarinifolium*, *Aporostylis bifolia*, mountain flax and *Astelia nervosa* in the shrubland copses and sundew (*Drosera arcturi*), *Carpha alpina*, *Oreobolus pectinatus*, *Phyllachne colensoi*, *Donatia novae-zelandiae* and *Gentianella* species in the bog communities.

Some areas of copper tussock wet grassland are also present, most notably in the headwaters of the Talla Burn. In the Taieri Rapids area, a taller herbaceous community is interspersed amongst remnant shrublands and tussockland. The forget-me-not *Myosotis* “Lammerlaw” is particularly common on bluffs here.

Canadian Flats

This area encompasses the Canadian Flat wetlands and associated feeder streams plus the broad spur top above Riddles Creek. The extensive wetlands (open pools, sedgeland and rushland mires) in this area are comprised of a mix of predominantly native rushes and sedges with intermixed herbs as well as exotic species such as *Carex ovalis*, *Juncus articulatus*, kneed foxtail and *Ranunculus flammula* which are dominant in some areas. Notable native species include several buttercups (*Ranunculus glabrifolius*, *R. ternatifolius*, *R. maculatus* and *R. macropus*), sedges (*Carex virgata*, *C. echinata*, *C. tenuiculmis*, *C. coriacea*, and *C. sinclairii*), willowherbs (*Epilobium macropus* and *E. chionanthum*), native dock *Rumex flexuosus* and milfoil *Myriophyllum triphyllum*. The dominance of exotic species in areas of the wetland is likely to be due in part to grazing by stock. These wetlands are also home to a range of rare and threatened species including *Carex tenuiculmis*, *Euchiton paludosus*, *Ranunculus ternatifolius* and *R. macropus*.

The bluffs in this area (and along the remainder of the Taieri River bank) have a vegetation community distinctive from that at higher elevations with the presence of *Carex allanii*, *Simplicia laxa*, *Poa kirkii*, *Acrothamnus colensoi*, *Schizeilema trifoliatum* and *Ranunculus foliosus* and this vegetation community is also present in the Taieri Rapids area. A dry hard tussock grassland occupies the spur crest and slopes. Associated with it are large areas of hawkweed-dominated herbfield and scattered matagouri, porcupine shrub, desert broom and *Acrothamnus colensoi*. Some arid spur-tops have a depauperate herbfield with *Hymenochilus tanypodus* and *Leptinella serrulata*.

Lobelia perpusilla, *Lobelia ionantha*, threatened mousetail (*Myosurus minimus* ssp. *novaezealandiae*) and *Montia sessiliflorum* are present in ephemeral wetlands, as well as colonising the floor of historic mine low-head earth dams.

2.5.1 Significance of Vegetation

Areas with significant botanical values are shown on Map 4.2.3.

Rare and threatened plant species

Thirty three ‘Nationally Threatened’ or ‘At Risk’ species and five ‘Data Deficient’ species were found during this survey. These are (threat rankings from de Lange et al. 2009):

Table 6: Threatened, At Risk and Data Deficient plant species found on the Lease

Threat Division	Threat Category	Species	Location on Lease
Threatened	Nationally Critical	<i>Cardamine</i> “tarn”	Ephemeral wetlands. The populations on this Lease. are the largest known in Otago.
		<i>Myosurus minimus</i> ssp. <i>novaezelandiae</i>	Stock camp. This record is one of the southernmost records for this species.
		<i>Pseudognaphalium ephemerum</i>	Fortification Creek wetlands. This is the largest known population for this species in Otago and is one of the largest populations nationally.
		<i>Simplicia laxa</i>	Taieri River. This is the southernmost population.
	Nationally Endangered	<i>Isolepis basilaris</i>	Fortification Creek. A large and healthy population.
	Nationally Vulnerable	<i>Kirkianella novae-zelandiae</i>	Short tussockland round Canadian Flats. One of the largest populations nationally.
		<i>Pachycladon cheesemanii</i>	Taieri Rapids. One of the southernmost records for this species.
At Risk	Declining	<i>Carex tenuiculmis</i>	Canadian Flats. A healthy population.
		<i>Deschampsia cespitosa</i>	Fortification Creek. Possibly the largest population in Otago.
		<i>Juncus pauciflorus</i>	Wetlands. Status on Lease uncertain.
		<i>Lobelia ionantha</i>	Damp sites. Large populations.
		<i>Olearia lineata</i>	Clutha faces and Talla Burn shrubland. Much reduced in numbers following recent spraying on the Lease, but scattered plants still remain.
	Naturally Uncommon	<i>Abrotanella patearoa</i>	Tops. An outlying, southernmost, population.
		<i>Acaena tesca</i>	Ridgetop rock outcrops. Southernmost population?
		<i>Anemone tenuicaulis</i>	Gully rock outcrops. Scattered plants probably present in most damp gullies within tussockland area.
		<i>Cardamine</i> (c) “Reporoa Bog”	Taieri River. Rare on Lease.
		<i>Carex allanii</i>	Gully rock outcrops. Rare.

		<i>Carex berggrenii</i>	Damp sites. Unusually rare.
		<i>Carex lachenalii</i> ssp. <i>parkeri</i>	Lammerlaw Tops. A small but healthy population.
		<i>Deyeuxia youngii</i>	Gully rock outcrops. Scattered plants.
		<i>Einadia allanii</i>	Clutha faces. Reasonably common.
		<i>Euchiton paludosus</i>	Canadian Flat. Rare.
		<i>Euchiton polylepis</i>	Taieri River. The largest populations currently known in Otago.
		<i>Hypericum rubicundulum</i>	Teviot wetland and Canadian Flats. A healthy population.
		<i>Juncus pusillus</i>	Wetlands. Very large populations.
		<i>Leptinella pusilla</i>	Rock bluffs. Localised but not infrequent.
		<i>Leptinella serrulata</i>	Canadian Flats tussockland. Rare.
		<i>Montia angustifolia</i>	Fortification Creek wetlands. Very large and healthy populations.
		<i>Myosotis</i> (hh) "Garvie"	Teviot wetland. One small population seen.
		<i>Myosotis</i> (ii) "small white"	Rock outcrops. Scattered plants.
		<i>Ranunculus maculatus</i>	Lammerlaw Tops. Scattered in wetlands.
		<i>Ranunculus ternatifolius</i>	Canadian Flats and Fortification Creek. Very large populations.
		<i>Uncinia purpurata</i>	Rock outcrops. Status on Lease uncertain.
Data Deficient		<i>Brachyscome humilis</i>	Ephemeral wetlands, Taieri R. banks. Small scattered populations.
		<i>Gingidia baxterae</i>	Snowbanks. Small localised populations.
		<i>Leptinella maniototo</i>	Ephemerally wet areas. Large healthy populations.
		<i>Myosotis</i> (s) "Lammerlaw"	Ridgetop rock outcrops. Scattered plants. A very large population in Taieri Rapids.
		<i>Ranunculus macropus</i>	Canadian Flats. This is the only recent confirmed South Island locality for this species.

In addition, eleven species that are uncommon in Otago (Regionally Significant) or uncommon in this area but reasonably common in the rest of Otago (Locally Notable species) were found:

Table 7: Regionally Significant and Locally Notable species found on the Lease

Significance Status	Species	Location
Regionally Significant	<i>Coprosma virescens</i>	This small-leaved shrub was found in shrublands along the Clutha faces.
	<i>Elatine gratioloides</i>	This wetland herb was found in a wetland pool on Canadian Flats.
	Bogpine <i>Halocarpus bidwillii</i>	This dwarf conifer was present in several upland fens.
	<i>Myosotis pygmaea</i> var. <i>drucei</i>	This small forget-me-not was present around the base of several rock outcrops.
	<i>Myosotis</i> cf <i>forsteri</i>	This apparent local-endemic is known from small populations in overhangs on the southern Lammerlaws to Macraes.
	<i>Pelargonium inodorum</i>	This geranium was found in recently burned land adjacent to the Beech forest in the Talla Burn. This is one of few localities known for this species in Otago.
	<i>Uncinia</i> cf <i>rubra</i>	This hook sedge has a similar range to <i>M. cf forsteri</i> . On Beaumont it was recorded from several rock overhangs.
Locally Notable	<i>Centrolepis pallida</i>	This small herb is present in several of the cushion bogs.
	<i>Fuchsia perscandens</i>	This sprawling shrub is present in the lower Talla Burn.
	Celery pine <i>Phyllocladus alpinus</i>	This remnant species was recorded by Carter (1984) in the headwaters of MacKays Creek.
	Kowhai <i>Sophora microphylla</i>	Rare in the Ecological District and is present in the lower Talla Burn.

In addition some plants were found that appear to be of unknown taxonomic status. These are provisionally tag-named *Brachyscome* “Lammerlaw” and *Cardamine corymbosa* “hairy siliqua”. The distribution of these forms outside of the Lease is unknown, but neither has been seen elsewhere by the two botanists. An unusual *Ranunculus* was also recorded from the Fortification Creek wetlands.

Rare plant communities

Several rare plant communities are present on the Lease.

The shrubland/broadleaf forest community on the front face of the Lease is a rare community in a regional context, and also contained several species rare in shrublands in the Central Otago region.

Ephemeral wetland vegetation communities are nationally significant (Johnson and Rogers 2003). Ephemeral wetlands on this Lease occur at a number of sites bordering the Taieri River, in the Fortification Creek area and on the spur above Canadian Flat. The condition of these wetlands ranges from highly weed-invaded, to near natural.

The upland cushion fens and gully-head ribbon fens on the property are extensive, near-pristine, and of national significance (Johnson 1986, Carter 1994, Rapson et al. 2006). Each fen varies slightly in species composition probably as a result of slight hydrological and nutrient differences.

The lowland red tussockland with mixed rushland/sedgeland wetlands in the Fortification Creek and Canadian Flats area are some of the largest remaining in Central Otago. They also provide habitat for a range of species, one of which are currently not known elsewhere in the South Island.

Wetland seepages of the nature recorded on this Lease are restricted to higher altitude, shallowly sloping gully heads. The vegetation type varies with water content and movement, and on this property is dominated by either sedgeland or mossfield.

The wetlands of the Teviot River (Teviot Swamp, Red Swamp, Fortification Creek, and MacKays Creek headwaters) are nationally significant because of their size, intactness, range of hydrology and diversity of plant communities. They also provide habitat for a range of rare and threatened plants, and populations of some of these are the largest known in Otago. The ecological integrity of these wetlands is very dependant on the hydrology of the feeder waterways and maintaining intact vegetation on these is important. These wetlands are slowly being degraded in places due to stock trampling, grazing and importation of weeds. The significance of these wetlands has previously been recognised by Johnson (1986), Carter (1994) who designated two Recommended Areas for Protection in this area (RAP 1: Fortification Creek, RAP 2: Teviot Swamp and MacKays Stream), Mark et al. (1995), Johnson and Rogers (2003), Johnson and Gerbeaux (2004) and Rapson et al. (2006) and they have been designated a rare ecosystem by Landcare Research. They have considerable scientific importance due to the history of research at this site.

The wetland associated with Canadian Flat is also significant as a result of its size and the diversity of species present, some of which are rare or threatened.

The extensive narrow-leaved snow tussocklands are significant because of their size, water regulation ability, and carbon sequestration opportunity. Other species (particularly shrubs) which normally would be expected to occur within this community are rare as a result of past burning and the ongoing grazing.

The bluff communities, particularly those at Taieri Rapids have high botanical values as a result of their harbouring species that have been eliminated or made rare elsewhere on the property by burning and grazing animals.

The ephemeral wetlands created in flood channels of the Taieri River are of varied nature and have high value due to their number, diversity of species, relative intactness, and as habitat for threatened plants. Ephemeral wetlands are also a rare and threatened ecosystem type (Johnson and Rogers 1993; Landcare Research).

The lower altitude hard tussock short grassland bordering the Taieri River has value as it provides habitat for a range of dryland plant species, including the native dandelion *Kirkianella novaezelandiae*. This grassland type is underprotected (Mark and McLennan 2005; Mark et al. 2009).

The silver beech forest in the Talla Burn is significant as this forest is rare in the Waipori ED. Likewise, shrublands are also much reduced, and this gives significance to the surviving examples on the Pastoral Lease. The best remaining examples now exist above the beech forest remnant and in the lower Talla Burn.

Within the Fruid Burn catchment, pockets of natural vegetation exist but these are usually depauperate and weed infested. In the Moffats Stream area, there is a greater extent of natural vegetation, but the significance of this is lowered due to the spread of gorse from the planted gorse fence, and degradation as a result of burning and grazing. Likewise large areas of the middle reaches of the Talla Burn are heavily weed infested which lowers their botanical value.

Threats to Significant Inherent Values

Cattle are having a negative impact on the wetlands directly through pugging and hoofprint damage and indirectly through importation of the seed of weed species. Regular burning of the tussockland and shrublands has reduced their density and species diversity. Recent (and past?) spraying of shrublands has also reduced their extent, density, and species richness. Sheep grazing has depleted sunny and dry aspects, and inhibited recovery from burning. Burning and grazing keeps the tussock canopy open, making the tussocklands more vulnerable to hawkweed ingress.

2.5.2 Problem Plants

The gorse fence that traverses the property at about 700 m asl, being particularly prevalent in Moffats Stream catchment, is a major seed source for gorse. Above the gorse fence, problem plants are rare and consist of occasional wilding pines. A large plantation of recently established Douglas fir on the western boundary of the property will need monitoring. The other exotic species present are of lesser concern. Below the gorse fence, exotic woody (e.g. broom, gorse and elderberry) and herbaceous weed species become more prevalent.

2.6 Fauna

2.6.1 Invertebrate Fauna

Ecological Context

Prior to the Protected Natural Areas Survey being conducted, the moths *Gymnobathra* sp. and *Scoparia sideraspis* were found in RAP 3 at the Te Papanui Conservation Park boundary (Patrick et al. 1993). Several rare moth species have been found on the Lease in the wetlands of Teviot and Fortification Creek RAP's. An example is the Sphagnum porina (*Heloxycanus patricki* Dugdale, 1994), which is associated with sphagnum mires and blanket bogs on sloping ground. Host plants of *H. patricki* are mosses, especially *Sphagnum* in and at the margins of bogs and seepages (Patrick & Dugdale 2000).

The invertebrate fauna on the Lammerlaw Range (and environs) is characterised by many species endemic to Otago that are normally found at higher altitudes. The phenomenon is the combined effect of latitude, altitude and climate, resulting in a distinct biota that has been described as nationally important (Patrick et al. 1993).

Other insects of note found in the Lammerlaw/ Lammermoor area include scarab beetles (*Prodontria capito*), moths (*Notoreas* and *Dasyuris* spp.), flightless moth taxa (*Aoraia* spp.) and the large grasshopper *Sigauss campestris*. All of these taxa are associated with native vegetation (predominantly snow tussock) that requires a low disturbance regime of infrequent fires and low (or no) grazing. The recently established and neighbouring Te Papanui Conservation Park is dominated by tall tussocklands, and no doubt has a significant ecological role in maintaining populations of endemic moths and butterflies across the tussock zones of the Lease.

Methods

Invertebrates were collected from spot sites, within the least (visually) modified habitats by hand searching, aspirator and sweep net. Temperatures were rarely above 12°C – a critical temperature for moth and butterfly activity.

Collecting effort was targeted toward endemic taxa of the following groups; Arachnids (spiders, harvestmen and Pseudoscorpions), Coleoptera (beetles), Orthopteroids (grasshoppers, weta and cockroaches) and Myriapoda (millipedes and centipedes). These groups represent many flightless invertebrates that often display local endemism and are more familiar to the author.

Invertebrate species of conservation interest were identified to recognisable taxonomic units (RTU's) and checked against the Hitchmough Threat rankings (Hitchmough and Bull 2007; McGuinness (2001).

Descriptions of Habitats and Invertebrate Fauna

A full list of species found on the Lease is provided (Appendix 6).

Front Country

This area encompasses the extensively modified (mainly pasture) south-western lobe of the Lease, extending north to the lower Talla Burn and Moffats Stream.

Several common native invertebrate species were recorded on slopes above the true left bank of the Clutha River. Extensive kanuka shrublands on slopes above the Clutha River support several common native spiders (including the nursery web spider *Dolomedes minor*, a species of orb web *Coloranea* and the common sheet web spider *Cambridgea antipodiana*).

Despite habitat modification, the majority of invertebrate taxa were native and include a complete range of litter types including the small cockroach *Parellipsidion inaculeatum*, centipedes (*Zelanophilus* sp.), ground beetles (*Megadromus* and *Oregus aereus*), manuka beetles (*Pyronota* sp.) and a tussock moth (*Orocrambus philpotti*). Orthoptera were represented by the ubiquitous grasshopper *Phaulacridium marginale* and a single specimen of cave weta (*Pleiolepton* sp.) - collected from within a building at Beaumont station.

Central Property

This area encompasses the central part of the property, north of the 'Front Country', extending north to the ridge above Teviot Swamp and MacKays Creek.

Lammerlaw Top, the highest point on the Lease (1210 m), is the central feature, and divides the river catchments into roughly north, south and west. To the northwest is Teviot Swamp and the South Branch of the Teviot River (Teviot Swamp is an RAP and was in high natural condition at time of inspection). Sphagnum wetlands of this calibre are old and stable with deep, peaty soils beneath. The signature of the past biota may be present in these anaerobic peaty soils as pollen, invertebrates and vegetation.

To the south the Talla Burn drains into the Clutha, while the western slopes drain into MacKays Creek and Taieri River. The landscape is dominated by an extensive cover of healthy *Chionochloa* tussock which is characteristic of the ecological region. Despite cool conditions, numerous native moths and butterflies were collected from these tussock habitats. Notable lepidoptera included; ringlets (*Argyrophenga antipopdum*), the snow grass owlet (*Ichneutica ceraunias*), the large speargrass moth *Graphania nullifera* and the common owlet (*Graphania nullifera*). Common grass moths (*Orocrambus*), native bees and beetles were active throughout the warmest hours.

Several invertebrates of interest were collected from this area. The large Otago endemic ground beetle *Megadromus bullatus* was found under rocks at Lammerlaw Rock, a schist tor set amongst homogeneous tussock. Large congregations of darkling beetles (*Zeadelium intermedium* and *Mimopeus opaculus*) were found under exfoliating schist slabs at every rock tor visited. Darkling beetles are detritivores, consuming lichen, moss, fungus and general organic plant matter and they are probably part of the diet for gecko (M. Lettinck *pers comm.* Feb 2010).

To the south west, a specimen of the uncommon grasshopper *Sigaus campestris* was collected from the rolling tussock tops above gullies draining into MacKays Creek. Speargrass (*Aciphylla scott-thomsonii*) plants were common on shady slopes above MacKays Creek and were rich with invertebrates including; weevils, big-jawed spiders (Tetragnathidae), an endemic lax beetle (*Selenopalpus aciphyllae*) and cockroaches (*Parellipsidion inaculeatum*). A specimen of the data deficient spider *Neoramia otagoa* (Agelenidae) was also collected from rocks above MacKays Creek. As the name implies, *N. otagoa* is an Otago endemic. Other notable spiders found on the Lease include an endemic 'scuttling' spider (*Cycloctenus* sp.), a group which are generally found at higher altitude within the Otago mountains. The Gnaphosid ('stealthy' spider) *Anzacia gemma*, was relatively abundant under rocks and is indicative of intact tussock habitat (it does not appear to exist in modified pasture for instance).

Northern Block

This is the largest of the collection areas, and produced the highest diversity of endemic invertebrate species. Notable endemics include *Holcaspis placida* (a ground beetle), a wolf spider (*Anoteropsis urquharti*), a millipede (*Icosidesmus worthingtoni*) and the grasshopper *Sigaus campestris*. The tussock habitat was remarkably consistent throughout this sampling area and showed only minor disturbance or modification at select locations. Pig damage of speargrass plants was evident on the true left bank of the Taieri River, a two fold issue for invertebrates because pigs eat beetle larvae associated with the tap root and secondly, pig rooting kills the plant – a host for many indigenous invertebrates throughout the year. This is particularly significant for male speargrass plants as many female weevils feed on the flower spike consuming pollen for egg maturation.

Several large wetlands are present, each with red tussock, cushion plants and sphagnum mosses. Sweep netting in these habitats produced high numbers of flies, grasshoppers, damselflies, native spiders and bugs (Homoptera). In terms of invertebrate diversity, these areas are of high value within the tussock monoculture as they are probably important source/sink environments for population distribution and refugia during dry spells.

2.6.2 Significance of Invertebrate Fauna

Areas with significant invertebrate values are shown on Map 4.2.3.

Significant Invertebrate Species

Seven invertebrate species found on the Lease are of conservation interest. Table 8 outlines the species listed on the Hitchmough Threat database (Hitchmough and Bull 2009; McGuinness 2001). Species that are either naturally uncommon or endemic to Otago include spider *Cycloctenus* sp., ground beetles *Holcaspis placida* and *Megadromus bullatus*, grasshopper *Sigaus campestris* and millipede *Icosidesmus worthingtoni*.

Table 8: ‘At Risk’ and ‘Data Deficient’ Invertebrate species present on Beaumont Pastoral Lease.

Threat Category	Species	Location on Lease
Range Restricted	Wolf spider <i>Anoteropsis urquharti</i>	Tussocklands in northern block of Lease
Data deficient	Spider <i>Neoramia otagoa</i>	Rocks above MacKays Creek

Significant Communities for Invertebrates

The northern two thirds of the Lease are ecologically intact with little modification to its natural ecosystems. To the north of the Talla Burn, the ecological values include extensive *Chionochloa* tussocklands that support native moths and butterflies throughout. This area includes numerous ecologically intact wetlands, which host a suite of invertebrates specific to that habitat.

The scattered rock tors and outcrops that exist on ridges and in gullies represent ecological ‘islands’ set amongst homogeneous tussock. These rock habitats support their own invertebrate micro-ecosystems of detritivores/scavengers (darkling beetles and cockroaches) and predators (spiders, ground beetles and lizards). The significance of these rock outcrops is their role as biological refugia for, and source stocks of, flightless invertebrates - a valuable ecological feature for colonisation after fires. For these reasons, the collective distribution of tors in the landscape is also a significant inherent value of the Lease.

2.6.3 Herpetofauna

Ecological Context

The Lammerlaw ER supports a diverse assemblage of lizards, including six threatened species: Otago skink *Oligosoma otagense* (Nationally Critical), grand skink *Oligosoma grande* (Nationally Critical), green skink *Oligosoma chloronoton* (Gradual Decline), cryptic skink *Oligosoma inconspicuum* (Gradual Decline), large Otago gecko *Hoplodactylus* “large Otago” (Gradual Decline) and jewelled gecko *Naultinus gemmeus* (Gradual Decline) (Herpetofauna Database; Whitaker et al. 2002). There is also a unique population of cryptic skink known from the Lammermoor Range (Geoff Patterson, pers. comm.). The “cryptic skink” appears to be a species complex, and work is underway to describe the various members of this complex (Rod Hitchmough, DOC Wellington, pers. comm.).

Non-threatened lizard species known from the Lammerlaw ER are McCann’s skink, common skink *Oligosoma polychroma*, Central Otago gecko *Hoplodactylus* “Central Otago” and Cromwell gecko *Hoplodactylus* aff. *maculatus* ‘Cromwell’. The latter two species are part of the “common gecko” species complex (Daugherty et al. 1994; Hitchmough 1997). The members of this complex have yet to be formally described, but are recognized as being distinct species for conservation purposes (Hitchmough et al. 2007). Some gecko species belonging to this complex are extremely difficult, if not impossible, to tell apart in the field (Jewell 2006; pers. obs.).

There is limited information on lizard abundance and species richness for adjacent properties. For example, “brown geckos” and “brown skinks” were recorded from Rocklands Pastoral Lease (PL). “No known special populations” and “no known significant herpetofauna values” were recorded respectively during the tenure review inspections of Halwyn and Castle Dent PLs. The possible presence of jewelled gecko was noted for these properties. This species has been recorded from Beaumont and several sites near Lake Mahinerangi (Herpetofauna Database). Results from a recent survey for jewelled gecko suggest that it may be approaching local extinction at inland Otago sites (Jewell & McQueen 2007).

No mention of lizards was made for the three RAPs identified on the Lease, but the presence of “common brown geckos” and “common skinks” was noted for other sites (Carter 1994).

Survey Methods

Suitable and accessible faunal habitats were surveyed. Land Environments of New Zealand (LENZ) threat categories (Leathwick et al. 2003; Walker et al. 2005) were also considered. The Lease was reasonably well-serviced by vehicle tracks, allowing for fairly good coverage. Weather conditions were generally poor for lizard activity.

Lizards were located visually by close approach and/or the use of binoculars, as well as by checking natural retreats (e.g., in crevices and under rocks) and artificial debris (e.g. under corrugated iron sheets). Areas of outcropping rock were deliberately targeted because such areas are favoured by lizards (particularly geckos) for their thermal properties and refuge from predators. Lizard information was supplemented with records from DOC’s Herpetofauna Database, relevant DOC reports and observations from other members of the tenure review team.

Habitats

The herpetofauna values are described below for each of the areas as shown in Appendix 7.

North-western catchments

This area contains the eastern half of the Teviot River South Branch catchment, Fortification Creek, Red Swamp and the upper Riddles Creek catchment. The area is bounded to the north and west by the Lease boundary, and to the south and east by the main vehicle track that services the northern half of the Lease. The prominent ridge at the northern tip of the Lease define this area to the far north. Dominant landforms are rolling hills covered in tall tussock. Swamps, wetlands and areas of outcropping rock are also present.

Lizard species found in this area were large Otago gecko (Gradual Decline), McCann's skink, common skink, green skink (Gradual Decline), and an unidentified skink species (most likely to be McCann's skink). Geckos were only found in large rock outcrops. Skinks were encountered in tussocklands, rock outcrops and stream gullies containing outcropping rock and some shrublands. The Teviot River South Branch is notable for being the only site on the Lease from which three species of skink were recorded.

North-eastern catchments

This area contains Teviot Swamp and various sub-catchments that drain into the Taieri River, including Canadian Creek, Bullocky Creek, Red Swamp Creek and MacKays Creek. The area is bounded to the east by the Taieri River, to the west by the main vehicle track that services the northern half of the Lease, and to the south by the prominent ridge extending from either side of Lammerlaw Top. Dominant landforms are rolling hills covered in tall tussock, river flats and wetlands. Substantial areas of outcropping rock are present along the Taieri River (particularly in the gorge below the Taieri Rapids) and in some stream gullies.

Lizard species recorded from this area were large Otago gecko (Gradual Decline), McCann's skink, common skink, an unidentified skink species (most likely to be McCann's skink). Large Otago gecko appears to be restricted to substantial areas of outcropping rock. This species is likely to be relatively abundant in the gorged section of the Taieri River near the Rapids. Skinks were found in tussocklands, rocky areas and under miscellaneous debris.

Southern catchments

This area is the most modified part of the property. It contains the Talla, Fruid and Little Minzion Burns, Craig Creek, the upper catchment of Moffats Stream and part of Craig Hill. This area is bounded to the north by the Lammerlaw Top ridge, and to the east, south and west by the Lease. At lower altitudes, exotic pasture is dominant and gullies containing shrublands have been repeatedly sprayed and/or burnt. The upper catchment of the Talla Burn contains tall tussocklands, shrublands and wetlands. Areas of outcropping rock, woody weeds and mixed shrublands are present along the Clutha River.

This area had the lowest lizard abundance and species richness: McCann's skink was recorded from four sites in this area. Rock outcrops near the Clutha River were unsuccessfully searched for geckos.

Lizard Fauna Recorded

Table 9 summarises the lizard species recorded, the distribution of which are shown in Appendix 7.

Table 9: Lizard species recorded on Beaumont Pastoral Lease

Common Name	Scientific Name	Threat Status (Hitchmough 2007)	Distribution on property
Green skink	<i>Oligosoma chloronoton</i>	Gradual Decline	Stream bed of the Teviot River South Branch
large Otago gecko	<i>Hoplodactylus</i> "large Otago"	Gradual Decline	Substantial areas of outcropping rock throughout
McCann's skink	<i>Oligosoma maccanni</i>	Not Threatened	Tussocklands, shrublands and rocklands throughout
Common skink	<i>Oligosoma nigriplantare polychroma</i>	Not Threatened	Tussocklands and rocky areas throughout

Geckos were restricted to substantial areas of outcropping rock. Skinks were found in a greater variety of habitats (tussocklands, shrublands and rocklands).

2.6.4 Significance of Herpetofauna

Areas with significant herpetofauna values are shown on Map 4.2.3.

The Lease provides habitats for two threatened lizard species (green skink and large Otago gecko; both in Gradual Decline) and two non-threatened lizard species (common skink and McCann's skink). Tall tussocklands, shrublands and rocky areas provide extensive habitat for the three skink species. Large Otago gecko is restricted to larger areas of outcropping rock that provide suitable micro-habitats for thermoregulation and refuge from introduced mammalian predators (i.e. cats, hedgehogs, mustelids and rodents).

Lizard species that were not recorded during the survey, but may be present include cryptic skink (Gradual Decline) and Central Otago gecko (Not Threatened). These species are known from Burgan Stream on the Lammermoor Range and from rock outcrops near the Beaumont bridge, respectively (Herpetofauna Database). Because cryptic skinks from Burgan Stream closely resemble McCann's skinks, some skinks may have been incorrectly identified. Jewelled gecko is highly unlikely to be present due to the Lease's history of extensive spraying and burning of indigenous woody vegetation. Schist rock outcrops on the property appeared insufficient in size and number to support grand and Otago skink populations (both Nationally Critical).

2.6.5 Avifauna

Birds recorded on the Lease during the tenure review inspection are listed below.

Table 10: Birds noted on the Lease during the inspection. Exotic species are denoted by an asterisk.

Common Name	Species	Comments/Distribution
Australasian Harrier	<i>Circus approximans</i>	
Banded dotterel	<i>Charadrius bicinctus bicinctus</i>	Around wetlands including Teviot Swamp
Bellbird	<i>Anthornis melanura</i>	
Black fronted tern	<i>Chlidonias albostratus</i>	Nest near Craig Flat
Black shag	<i>Phalacrocorax carbo</i>	
Black swan	<i>Cygnus atratus</i>	
California Quail*	<i>Lophortyx californicus</i>	
Canadian goose*	<i>Branta canadensis</i>	
“Eastern” falcon	<i>Falco novaeseelandiae</i> “eastern”	Near Taieri Rapids
Feral pigeon*	<i>Columba livia</i>	
Goldfinch*	<i>Carduelis carduelis</i>	
Grey Warbler	<i>Gerygone igata</i>	Clutha front faces
Mallard duck*	<i>Anas platyrhynchos</i>	Flying over Taieri River
New Zealand pied oyster catcher	<i>Haematopus finschi</i>	Around wetlands including Teviot Swamp. Breeding pairs
New Zealand pipit	<i>Anthus novaeseelandiae</i>	Scattered across property
Pheasant*	<i>Phasianus colchicus</i>	
Redpoll*	<i>Acanthis flammea</i>	
South Island Rifleman	<i>Acanthisitta chloris chloris</i>	Kanuka shrubland near Craig Flat
Spurwinged plover	<i>Vanellus miles novaehollandiae</i>	
Starling*	<i>Sturnus vulgaris</i>	
Tomtit	<i>Petroica macrocephala</i>	In beech forest

2.6.6 Significance of Avifauna

The property provides habitat for three ‘Nationally Threatened’ and four ‘At Risk’ species (Table 11).

Table 11: ‘Threatened’ and ‘At Risk’ Bird species on Beaumont Pastoral Lease

Threat Division	Threat Category (Miskelly et al. 2008)	Common Name	Species
Threatened	Nationally Endangered	Black fronted tern	<i>Chilidonias albostratus</i>
	Nationally Vulnerable	Banded dotterel	<i>Charadrius bicinctus</i>
		“Eastern” Falcon	<i>Falco novaeseelandiae</i> “eastern”
At Risk	Declining	New Zealand pied oyster catcher	<i>Haematopus finschi</i>
		New Zealand pipit	<i>Anthus novaeseelandiae</i>
		South Island Rifleman	<i>Acanthisitta chloris</i>
	Naturally Uncommon	Black shag	<i>Phalacrocorax carbo</i>

2.6.7 Aquatic Fauna

Introduction

The Lease includes the true left bank headwater tributaries of the Taieri River catchment; headwater tributaries of the Teviot River and headwaters of the Talla Burn sub-catchments of the Clutha catchment; the true right bank tributaries of Beaumont River (also a sub-catchment of the Clutha catchment), which forms the Lease’s eastern boundary; and two small tributaries of the Clutha River itself.

Major Taieri catchment tributaries within the property include Riddles Creek, Canadian Creek, Bullocky Creek, Red Swamp Creek, an unnamed creek; and MacKays Creek.

Major Teviot River sub-catchment tributaries are Fortification Creek and Teviot River South Branch.

Talla Burn sub-catchment tributaries include Moffats Stream; Talla Burn headwaters; and Fruid Burn.

Clutha Catchment tributaries include Little Minzion Burn and Craig Creek.

The headwaters of the Taieri catchment, Teviot catchment tributaries, Talla Burn and Moffats Stream are sourced in snow tussock grasslands that show past effects of burning and grazing, but are otherwise relatively unmodified. The headwaters of Little Beaumont Stream drain snow tussock grasslands that have had a greater degree of pastoral development and stock grazing. The lower reach margins of the Talla Burn (above Beaumont Station homestead) are clothed in remnant beech forest, while the Fruid Burn and Craig Creek are surrounded by

developed farmland and marginal scrub weeds such as gorse and broom along with scattered patches of manuka shrubland.

Previous freshwater fish surveys of Beaumont Station and adjacent areas (though relatively few), recorded on the New Zealand Freshwater Fish Database (maintained by the National Institute of Water and Atmospheric Research NIWA), have documented the presence of brown trout (*Salmo trutta*), Teviot galaxias (*Galaxias* sp. 'Teviot'), dusky galaxias (*G. pullus*), flathead galaxias (*G. depressiceps*), longfin eel (*Anguilla dieffenbachii*), as well some sites where no species were recorded (Appendix 8). Brown trout were recorded in the Teviot River South Branch, Fruid Burn, Talla Burn; Dusky galaxias from Red Swamp Creek and two Beaumont River tributaries; Teviot galaxias also from Red Swamp Creek and the outflow of Teviot Swamp; and longfin eel from the Talla Burn and Craig Creek.

Methods

A total of 18 sites were surveyed (Appendix 9). Survey site locations were recorded using a Global Positioning System (GPS). At least one site was sampled within each tributary, but where possible, two sample sites were attempted to ascertain any disparity in fish species assemblages due to altitude or natural migration barriers.

Each site was surveyed pursuant to the guidelines specified in “*Non-migratory galaxiid survey methods*” (Department of Conservation 2003). A Kainga 300 electric fishing machine was employed at all survey sites. Survey sites were selected from the topographical map (NZTopo50 CD14 and CE14), and chosen specifically for accessibility and survey ability. All captured fish species were identified, measured to the nearest millimetre (mm), and where possible, samples taken for later genetic analysis and the remainder released. The dominant aquatic insect fauna observed were also identified to a genus level and recorded.

In-stream freshwater fauna habitat descriptions (width/depth/substrate composition) and site characteristics (riparian/catchment vegetation and water flow velocity types) were recorded on the NZFFD form format.

Despite inclement weather at the start of the survey, stream-flow conditions and in-stream flows appeared normal to low, no doubt influenced by the overall dry conditions experienced over the previous month.

Aquatic Species Recorded

Endemic non-migratory galaxiids were recorded in five Taieri catchment tributaries; one Teviot sub-catchment tributary; the main-stem headwaters of the Talla Burn sub-catchment and Moffats Stream; a Beaumont River sub-catchment tributary (Little Beaumont Stream) and the upper Fruid Burn (see Table 12). Koaro, the second-most common whitebait species, had been previously recorded from the lower Talla Burn.

There were no other native or endemic fish species found on the Lease, although there was movement under the bank, which could have been an eel, in the lower Fruid Burn. The upper Fruid Burn and the Little Minzion Burn tributary contained the endemic freshwater crayfish or koura (*Paranephrops zealandicus*).

Table 12: Freshwater species recorded on the Lease from the current and previous surveys.

Species Name	Distribution
Dusky galaxias (<i>G. pullus</i>)	Bullocky Creek Unnamed Taieri tributary Teviot Swamp out-flow Talla Burn headwaters Moffats Stream upper Fruid Burn Little Beaumont Stream
Flathead galaxias (<i>G. depressiceps</i>).	Riddles Creek Bonds Creek Red Swamp Creek Taieri main-stem (above Taieri Rapids)
Teviot galaxias (<i>G. sp</i> "Teviot")	Teviot Swamp outflow Red Swamp Creek
Unidentified galaxias (probably Teviot galaxias (<i>G. sp</i> "Teviot")	Fortification Creek tributary (above Grey Mares Tail falls) Talla Burn
Koaro (<i>G. brevipinnis</i>)	lower Talla Burn
Koura / freshwater crayfish (<i>Paranephrops zealandicus</i>)	upper Fruid Burn Little Minzion Burn tributary
Brown trout (<i>Salmo trutta</i>)	Canadian Creek (Taieri tributary) Fortification Creek Teviot River South Branch Talla Burn
Nil recorded	Little Minzion Burn Lower Fruid Burn

Introduced brown trout (*Salmo trutta*) were found to be present in Fortification Creek, the lower Talla Burn, and Canadian Creek. Trout had previously been recorded in the Teviot River South Branch and are known to be present in the Taieri River below Taieri Rapids. Previous survey work (in 1995 – NZFF Database) found no trout above Taieri Rapids, the river being dominated by flathead galaxiids (*G. depressiceps*) and this appears to be still the case. The Teviot River South Branch is an important spawning tributary for the Lake Onslow sport fishery. Fortification Creek is also likely to contribute to this fishery.

Aquatic invertebrates

Koura / freshwater crayfish (*Paranephrops zealandicus*) were found at two sites (Table 12). The size-range of other invertebrates (e.g. *Deleateadium* and *Nesametus* mayflies; *Zelandoperla* stoneflies) observed in streams in the relatively undeveloped tussock-clad part of the property, indicate high MCI values in the 120's and thus excellent water quality with no evidence of pollution (Stark 1993).

Evidence of cattle damage, and low levels of pollution as a result, were noted at the site fished at Moffats Stream. Moderate levels of pollution, and a highly degraded silt-covered

streambed were noted at sites fished in the lower Fruid Burn and Little Minzion Burn tributary. However, the upper Fruid Burn site, while adjacent to developed farmland has better riparian protection (margins of manuka shrub-land and gorse) and does not suffer the same siltation problems.

2.6.8 Significance of Aquatic Fauna

Three of the four endemic non-migratory galaxiids recorded and koura are listed as threatened species by Hitchmough et al. (2007) (Table 13). However, a more recent assessment of threat classification for indigenous freshwater fish (Allibone submitted), has updated the threat rankings. Although yet to be published, it is recommended that these more recent rankings be used. This sees threat rankings for dusky galaxias and Teviot galaxias increased, removes flathead galaxias from the threatened species list, and now identifies the previously “not threatened” koaro as being “at risk” (Table 13).

Koura / freshwater crayfish (*Paranephrops zealandicus*) were the only threatened aquatic invertebrate species recorded.

The presence of Teviot, dusky and flathead galaxias in the lower reaches of Red Swamp Creek is a significant find as there are very few streams where three species of non-migratory galaxiids are found.

The New Zealand non-migratory galaxiid fishes recovery plan (DOC 2004), has an objective of identifying, protecting and managing a minimum of 30 habitats with key non-migratory populations, for each species (Objective 9.1). There are, at present, no protected populations of Teviot galaxias, four protected populations of dusky galaxias and seven protected, or partially protected, populations of flathead galaxias.

Table 13: Threatened freshwater species found on Beaumont Pastoral Lease (includes historic records)

Species Name	Threat status (Hitchmough et al 2007)	Proposed Threat Status (Allibone submitted)	Comments
Teviot galaxias (<i>Galaxias</i> sp “Teviot”)	Nationally vulnerable	Nationally critical	Only 6 known populations nationally; all found in the Teviot River sub-catchment, except for one population in Red Swamp Creek.
Unidentified galaxias (probably Teviot galaxias (<i>G. sp</i> “Teviot”))	? Nationally vulnerable	Nationally critical	The galaxiids found in the Fortification Creek tributary are also likely to be Teviot galaxias, as no other non-migratory galaxiid species has been found in this sub-catchment.
Dusky galaxias (<i>G. pullus</i>)	Gradual Decline	Nationally endangered	Most common galaxiid found on Lease. The threat ranking is proposed to increase to due to several vulnerable populations having been lost as a result of forestry harvesting operations since the last ranking was done in 2005.
Flathead galaxias (<i>G. depressiceps</i>).	Gradual Decline	Not threatened	Presence in the lower reaches of Red Swamp Creek indicates that there is a barrier somewhere between the collection site and the point where Teviot galaxias and dusky galaxias have been collected in the past. This is a significant find as there are very few streams where three species of non-migratory galaxiids are found. Taieri catchment remains the stronghold for this Otago endemic. The largest known population is found in the main-stem Taieri River above Taieri Rapids (Department of Conservation 2004), located along the property’s northeastern boundary. Other populations are found in the Waikouaiti, Shag and Tokomairiro catchments and in Akatore Creek (Department of Conservation 2004).
Long fin eel (<i>Anguilla dieffenbachii</i>)	Gradual Decline		Lower Talla Burn and Craig Creek
Koaro (<i>G. brevipinnis</i>)	Not threatened	At risk	Recorded in lower Talla Burn only.
Koura / freshwater crayfish (<i>Paranephrops zealandicus</i>)	Gradual decline		

2.6.9 Problem Animals

Goats, pigs, rabbits, hares, possums, feral cats, weasels, ferrets, stoats, hedgehogs, rats and mice are present throughout the Lammerlaw Range. All these species will undoubtedly be present on the Lease and reduce populations of palatable native plants, birds, reptiles and invertebrates. Browsing animals threaten habitat of lizards by removing and damaging vegetation.

2.7 Historic

Previous Surveys and Historical Records

Individual sites of interest have previously been surveyed on the Lease and its neighbouring areas. Bagley (1973) undertook a two week survey along the Clutha/Matau-au River between Ettrick and Beaumont in January 1973. Croad (1978) briefly surveyed the Teviot River prior to power development.

Maori

The Clutha/Matau-au was a major pathway and food gathering area for southern Maori. Mahika kai (e.g. eels, moa, weka and other resources) were collected from the Clutha/Matau-au River, the Lammerlaws and the Upper Taieri Plains. Previous archaeological surveys or chance finds on or surrounding the Lease have found ovens, pits, umu, boxes, porcellanite flakes and moa bones.

The New Zealand Archaeological Association (NZAA) database holds two site records for the Lease: a feather box (G44/8) found in a rock cleft at the southern end of Craig Flat by the Beaumont station shepherd George Rae in 1933 when sheltering from bad weather; and a pit (H43/2) of probable Maori origin, in a peat bog on the Lammerlaw Range near the juncture of Red Swamp Creek and the Taieri River. The pit was described to H.D. Skinner by W.R. Routhledge who discovered a thick layer of bogwood and sticks covering a rectangular cavity filled with water in February 1933. Flaked stone in the bottom of the pit suggested Maori use.

A Statutory Acknowledgement Area (SO 24727) applies to the Clutha/Matau-au River (Schedule 40, Kai Tahu ki Otago 2005:192-193).

Pastoral and Gold Mining

The Lease has a rich history of pastoral farming and gold mining.

A valuable source of information on the history of the area comes from the diary of Charles Ayton who lived in a hut between Riddles Creek and the Taieri River. Ayton's unique day to day account of living and working in the Upper Taieri covers more than 25 years. Ayton came to the Serpentine area in 1881 and may have worked with William Storey, an early gold miner at German Jacks, before working small claims by himself either cradling or small scale sluicing. He was employed on six of the major sheep runs, Puketoi, Linnburn, Rocklands, Beaumont, Galloway and Teviot. On these stations, his work included rabbiting, peat-cutting, race-cutting, filling in mining prospecting holes and shafts, repairing tracks and river

crossings, fence maintenance, and various repair jobs for his neighbours. Ayton acted as Deputy Returning Officer for the election in 1902 and supervised the 1905 elections for the County Council and the House of Representatives (Maniototo Early Settlers' Association 1982).

Pastoral

Records date ownership of what is now the Lease, back to 1856. People involved in the running the Lease include: Henry Rutherford, Alexander Innes Grant, James Rattray, Walter Miller, John Roy and Robert John Gairdner.

Prior to inspection, only one NZAA site record existed for the Lease: a water race (G44/59) from the Little Minzion Stream to downstream of Lonely Graves.

Tracks were important for farm access and property management. The run was accessed using a track from Waipori, the early Clutha route to the Dunstan from Dunedin (SO 1745 dated to 1863). This section of track, named Gardiner's Track (H44/1074) was the major route prior to 1863 (Hanger 1975). From the Tuapeka River the Devil's Backbone Track (G44/126) (SO 137 dated to July 1876), runs along a ridge line in the headwaters of the Lowburn and cuts west to Beaumont Station. The track continues past the homestead to access the pre-emptive right No.1 above Craig Flat (SO 3093 dated to May 1868). The track also allows access to the north of the Lease to the Lammerlaw and Lammermoor Ranges including access to the Serpentine gold field (Hanger 1975, Mayhew 1949).

A track is noted on SO 150 dated May 1921 (QuickMap Landonline) running from the Millers Flat Beaumont Road to the Beaumont Station Road west of Grants pre-emptive right No.2. The track is named the 'steep track to Island Block'.

An old farm track (Larry Patterson of Millers Flat *pers. comm.* to Brian Allingham) was used to bring wool down to the Millers Flat Beaumont Road at the southern end of Craig Flat. Around 1863, an ex-sailor named Patillo (known as Jack the boatman) was employed as a ferryman to take the season's wool clip across the river (Webster 1977:15).

Gold mining

The gold bearing nature of the Clutha River/Matau-au was discovered in 1862 by Hartley and Riley (AJHR 1890: C-3 page 71). Initially, gold was extracted from alluvial deposits by cradling and small scale sluicing, followed by hydraulic sluicing and extensive dredge operations. Early alluvial mining took place in the upper part of the Lease (the Teviot and Upper Taieri catchments), with hydraulic lifting operations in the Upper Taieri River.

Survey Methods

The Lease covers a large area, so only those places of potential historic interest were field checked. Historic documents, NZAA records and other sources¹ helped identify areas of

¹ Landonline Office Survey Plans (QuickMap database) and Geodetic database, NZ Archaeological Association site record database (NZAA Archsite), Department of Conservation (DOC) records, Archives New Zealand (Dunedin), and books on early pastoral leases such as

interest. The survey on 14th-18th December 2010 was undertaken by archaeologists from the department, Historic Places Trust and Ngai Tahu. An additional helicopter survey was conducted on 4th May 2010 over the northern extent of the Lease.

Field work identified new features and checked the condition of some known sites. GPS coordinates of all sites and the location of any photographs were recorded (coordinates are held in the Otago Conservancy historic database). Site records for newly recorded archaeological sites or features have been lodged with the NZAA (Appendix 10). The distribution of archaeological and historic sites is shown on Map 4.2.4.

Newly Recorded Archaeological/Historic Sites

Twenty seven new archaeological/historic sites were found during the field survey: four potential Maori sites and 23 others of probable European/Chinese origin related to pastoral farming and gold mining activities.

Maori

Two possible umu and two dry rock shelters were found. No rock art or cultural material was visible, but it is assumed that any dry shelter in this area would have been used by Maori.

One umu is on a knoll overlooking the Talla Burn ca.1.6 km north of the Beaumont homestead, while the second is beside a rock tor on the true right of the South Branch of Teviot River overlooking Lake Onslow. The two rock shelters are at the very extent of the internal access track high above the second umu and tor overlooking Lake Onslow.

Pastoral

Thirteen hut sites, three fenced enclosures (possibly horse pens or stock yards), four 19th century fence lines, a farm track, and a possible peat cutting bog were newly recorded historic features.

There are two Taieri huts: the current Taieri hut, built in the 1920s and still used as musterer's quarters, is located in the upper reaches of Red Swamp Creek to the south east of the airstrip. The earlier 19th century Taieri hut is located ca.300 m south west of the current Taieri hut. Old stock yards are located to the north of the airstrip have been incorporated into modern stock yards.

Early fence lines, with *in situ* old wooden posts, flat standards, and wire, still exist on the Lease. Wood posts were seen alongside the access track and modern fence line running north through the property. Some of these fences were probably constructed in the 19th century and continually maintained through the early 20th century. Gorse and fence boundary lines are shown on early survey plans. Two wooden posts positioned along a ridge line on the true left of the Fruid Burn denote the alignment of early telephone and/or power to the homestead.

Charles Ayton's diary, A. Webster's 'Teviot Tapestry', J. Crawford's 'Tales from the Woolshed', and J. Hamel's 'High mining on the Lammermoors', a report to DOC on the Rocklands pastoral lease.

Peat cutting on the Lease is described in Ayton's diary; the peat being used as a source of fuel in musterer's huts. Straight-cut edged areas seen at low lying flats along the Taieri River may be associated with this activity. Alternatively, they could be remnant hydraulic sluiced ponds (although they do appear shallow) or possibly prospecting pits cut to determine the quality of the peat whereas the longitudinal trenches at Riddles Creek appear to be from gold mining. Their history is uncertain.

Gold mining

Early alluvial mining using cradling and small scale sluicing took place in the upper part of the Lease within the Teviot and Upper Taieri catchments (encompassing sites in Riddles Creek, Canadian Flat, upper and lower Red Swamp Creek and Fortification Creek including Welshmans Gully – refer Map 4.2.4). Later more extensive hydraulic lifting operations occurred in the Upper Taieri River. The Riddles Creek gold workings and evidence of an early northern boundary fence extend beyond the current northern edge of the Lease (Map 4.2.4).

Prospecting pits and shafts were also used to hunt for gold. One possible shaft (a cinnabar mine) was located, along with numerous pits and trenches. Evidence of gold mining activities has largely been lost with time, due to changes in the landscape and vegetation, and the filling of prospecting holes and shafts by farmers to reduce stock losses (e.g., Charles Ayton was employed to do this on Beaumont Station). Tailings are generally well covered by vegetation.

The Island Block Gold-mining Company (Ltd) situated in the Fruid Burn-Clutha area at the south west end of the Lease (Map 4.2.4, and extending onto the true right of the Clutha River) was once described at the time to have “one of the best hydraulic lifting plants ever used in this country” (AJHR 1890: C-3 page 72), and archaeological remnants of this remain on the Lease. Of particular note are the features and pipelines associated with the water supply systems leading from the Fruid Burn dam to Craig Flat. In 1899 the company took its water supply from the Talla Burn and Fruid Burn, with storage reservoirs located on each creek. Water races, six and a half miles long, conveyed the water to a penstock 700ft above the workings. A two and a quarter mile long pipeline took a direct route to the claim. Lead joints in the main line were not successful, so flanged joints were substituted (AJHR 1899:-3 page 129, 1902:-3 page 67). Two pipelines ran from the Fruid Burn dam to the workings at Island Block. The company employed up to 100 employees, accommodated in tents and huts, to lay in the water supply networks (AJHR 1889: C-2 page 125); potential hut or tent sites were noted at some locations, but no thorough investigation was undertaken. A telephone line from the dam on the Fruid Burn to the works at Island Block allowed regulation of the water supply (Tuapeka Times 14th August 1889:3).

Significant gold mining was undertaken along much of the Clutha River, and this includes workings near the south-western boundary of the Lease by notable mining characters such as J. Eddie and J. Kirkpatrick. These may have been contiguous with the Fruid Burn workings and water race systems. Dredging within the Clutha River adjacent to the Lease was done by the Golden Gate Dredging Company (Limited) and the Golden Link Dredging Company.

Other features

Transport Routes

The Millers Flat Beaumont Road was the main interior trunk route from Beaumont to Roxburgh and the Manuherikia River from the early 1860s. The highway on the west bank of the Clutha replaced the east bank route from 1868 (Hangar 1975:8).

A railway line was constructed through to Lawrence in 1876, but did not reach Beaumont until the 1910's (Webster 1977: 99-100). A rail line formation through to Millers Flat was completed by 1925 (Webster 1977: 72). Sections of both the early road formation and the railway formation appear to lie within the Lease around Craig Flat.

Peat cutting

Charles Ayton referred to peat cutting on the Lease in his diary; this is possibly the first reference to peat cutting in Otago. However, little evidence of this seems to have been left on the ground. Square cut areas on river flats and rectangular trenches cut into creek banks at Canadian Flat may be from peat cutting or other prospecting, although this is conjecture. Similar trenches found on the Emerald Hills PL and the Rock & Pillar Range may also have been from peat cutting (Briden 2008).

Bottle Rock sites

Two sites were found at Bottle Rock (refer Map 4.2.4): a small hut of stacked schist against a large rock which may have been used by rabbiters, and a larger site (about 3 times the size of a normal miner's hut) where schist wall remnants had been demolished and pushed into a heap. The purpose of this latter site is unknown, but there is local talk about an old hotel in the northern part of the property.

Trig stations

Nineteenth century surveyors' markers are an important part of Otago's history enabling the orderly settlement of land by the first runholders and marking gold mining claims. These 19th century trigs are no longer maintained.

Nine trig stations and 2 sub-trigs (often circles of rocks or small cairns) are shown on Office Survey Plans to occur on the Lease. Of those, three trigs and one sub-trig were examined in the field (Map 4.2.4; Trig 'C' situated between the Fruid Burn and Talla Burn, Trig 'D' at Bottle Rock, Trig 'Q' at Davidsons Top, and a sub-trig north of Craig Flat). The remaining trig stations were checked on the Geodetic database (LINZ), although a second sub-trig situated on the top of Craig Hill is not recorded in the database.

2.7.1 Significance of Historic Values

Areas of significant historic value are shown on Map 2.4.4. The Clutha River area adjacent to the Lease, where gold dredging took place, is included on the map as it provides an important historic context for the gold mining sites located on the Lease.

The Lease is a large property with a rich, multilayered Maori, pastoral and gold mining history that resided within the wider historic landscape of Central Otago. Today's archaeological remnants visible on the surface reflect just a small proportion of these activities. Details of all sites are provided in the specialist historic report (Briden 2010) on which this CRR report is based.

Significant historic values are shown on Map 4.2.4. These include possible umu and rockshelters (Teviot River South Branch and southern edge of the Lease), earthen walled reservoirs, water race and pipe systems, gold sluiced gullies, musterer's hut sites, trig stations, fence lines, pack tracks and roads, the railway line, and associated site artefacts. All originally predate 1900, but various fences, huts, stockyards, trigs and some mining elements at Fortification Creek and Fruid Burn continued to be used into the 20th century. Boundary fences at the west and north of the property are probably early 20th century in construction, but should be assessed further if they are to be removed.

The remaining pastoral fabric of the early Taieri hut and associated musterer's huts, stock yards and enclosures at upper Red Swamp Creek are of significance and reflect the early pastoral life of the Lease.

Significant gold mining sites exist in the upper half, and lower south-western tip of the property, most notably at Riddles Creek, Canadian Flat, upper and lower Red Swamp Creek, Fortification Creek-Welshmans Gully, and Fruid Burn (Map 4.2.4).

The water supply systems located at Fruid Burn and adjacent to the Clutha River are associated with the Island Block Gold Mining Company Limited (C. Rawlins, Charles Nicholson, and Rennie Prouse) and are of significance for their intactness and extent.

Water supply networks in the upper Taieri catchment (Riddles Creek, Canadian Flat, Red Swamp Creek and Welshmans Gully to the east of Fortification Creek, and Fortification Creek itself) are extensive and significant for their intactness and dramatic location. These sites were associated with personalities such as Charles Ayton, and mining entrepreneurs such as the Kitto brothers (Francis, Harry, John, and William), and the founder of the Fortification Hydraulic Sluicing Company John T. Johnson. They reflect the determination, courage and hard graft that drove these men in search of their fortunes in these remote and harsh locations. The race systems and occupation sites should be viewed in a wider context with other gold fields on the margins of the Clutha and Taieri catchments (e.g. a different Canadian Flat east of the Taieri and the Serpentine goldfield to the north).

The 19th century surveyor Trig stations are important features related to land parcel subdivisions for early pastoral runs and delineation gold mining claims.

The road and railway formations along the east bank of the Clutha (Matau-au) River are important late 19th and early 20th century features. These improved access for the run holders, settlers, and gold miners active on this side of the river.

2.8 Public Recreation

Physical Characteristics

The Lammerlaw Range is one of the lesser-known and used mountain ranges in Otago, but provides a variety of opportunities for public recreation. The higher altitude section of the Lease is a very scenic mix of expansive rolling tussock-covered upland plateaux and large multicoloured wetlands. The southern boundary provides a backdrop to the Clutha River, while the northern parts of the property form rolling hills that descend to the Taieri River to the east and Lake Onslow to the west. The Lease is within easy travelling distance to Dunedin, as well as to residents of the Central Otago and Clutha districts. Recreation opportunities on the Lease provide for the extension and enhancement of existing recreation opportunities within the Te Papanui Conservation Park (CP) and the Canadian Flats Wildlife Management Reserve (WMR).

The Lease lies within the '*Backcountry*' recreation opportunity setting in the Department's Otago Conservation Management Strategy (Department of Conservation 1998). The CMS defines the backcountry recreation experience 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" (CMS: 602).

The recreation opportunities of the Lammerlaw Range are further described in the Otago Conservancy Recreation Opportunity Spectrum (ROS) (Harper 1992) as '*Backcountry Experience*' which changes to '*Remoteness Experience*' during the winter months. The area provides both 'Backcountry Drive-in' and 'Backcountry 4x4 Drive-in' during the summer and also includes '*Backcountry walk-in*' opportunities during the winter. Harper's ROS describes the entire Conservancy, and all areas regardless of land tenure were classified and mapped according to setting, activity and recreational experience characteristics.

The Recreation Strategy: Otago Conservancy (Springer 1993) referred to the need for "extended walking, mountain biking, cross country skiing, off road vehicle and horse riding opportunities" in this part of Otago, while noting poor public access to pastoral leases as an issue. Although these works are under revision, their commentary on this area holds true.

In 1988, Federated Mountain Clubs compiled an outdoor recreation plan for Central Otago's block mountains (Mason 1988). The document identifies limited use of the area for cross country skiing, botanising, 'wilderness' tramping/cycling and four wheel driving and records three recreational experience zones within the Lease. The area from the top of the Lammerlaw Range and extending north until approximately the 950 m contour is considered to provide a 'Remote Experience.' This area is bound on the east by Te Papanui CP and extends west to the partially unformed legal road which runs from Lammerlaw Top to Davidsons Top. When considered with Te Papanui CP, the area "provides untracked valley heads [which] provide opportunities for recreation on a scale that is increasingly rare in inland Otago. This is one of the last areas of unroaded tussock grassland in Central Otago." While still a large area, it is not at the scale required to be classified "Wilderness". It is therefore classified 'Remote'.

The southern face of the Lammerlaw Range above approximately 950 m lies within the 'Natural Experience' zone, but has 'Remote Experience' characteristics during winter. Mason

notes that within this zone “existing patterns of use ... indicate that the natural qualities of this zone should be conserved for aesthetic appreciation and as a setting for compatible recreation”. Maintenance of natural settings and the avoidance of detrimental land uses and activities such as new vehicle track formation and off road vehicle were identified as management priorities.

The remainder of the property is zoned ‘Open Space’. Management needs identified include the consideration of locations for tracks/road with regard visibility from both within and outside the zone and the provision of access through this zone to the natural experience zone beyond.

There are two hut sites on the Lease, both of which are located on the track adjacent to Red Swamp Creek. One hut is derelict while the other is currently used for mustering accommodation. This second hut is composed of three structures – a building, a 40 ft shipping container used for accommodation, and a pit toilet.

Opportunities for public recreation in the area encompassed by the Lease arise from the following:

- The large and remote nature of the property with superb panoramic views of the Maniototo Plains, Ida Range, inland block mountains and Clutha Valley.
- Existing legal road access to the south east corner of the Lease.
- Provision of alternative four wheel drive access to Te Papanui Conservation Park.
- In conjunction with a short section of private track on Stonehenge freehold, there is provision of an alternative through-route from the Clutha River to the Old Dunstan Road.
- Provision for access from Lake Onslow Road to an extended Canadian Flats Wildlife Management Reserve.
- Access to important wetlands and uninterrupted rolling tussock land.
- Access to historic areas and sites.
- Access to points of interest and provision of scenic amenity adjacent to the Miller Flat Beaumont Rd and the proposed New Zealand Cycle Trail between Millers Flat and Beaumont.

Legal Access

Legal vehicle access to the Beaumont Pastoral Lease is from Beaumont Station Road and Millers Flat-Beaumont Road. The eastern boundary has legal vehicle access from SHs 85 and 87 via Te Papanui Conservation Park. This access is subject to seasonal closure due to track conditions. There is no legal vehicle access to the northern end of the property. The western boundary between Teviot Swamp and Wattys Knob has legal vehicle access from Beaumont Station Road, along Bennet Road, which is a farm track, to within 500 m of the Lease boundary. The farm track deviates from the legal road alignment for that last section (see Map 4.2.4). This legal road connects with the network of legal roads within the Lease. There is legal foot access via marginal strip around Lake Onslow.

Other legal roads cross the property, some of which do not form practical access. Formed tracks that either follow the legal alignment or are very close to the alignment include:

- Main access track -Beaumont Station Rd to the Lammerlaw Range top to Teviot Swamp, Davidsons Top, Bottle Rock and the northern boundary.
- Teviot Swamp to Lake Onslow (above Fortification Creek)
- Lammerlaw Range ridge from Te Papanui CP boundary to the main access track.
- Davidsons Top to the Airstrip (formed) to Taieri River (unformed).

Activities

The CMS identifies the activities most often associated with the 'Backcountry Zone' as including hunting, tramping, fishing, camping, mountain biking, outdoor education and nature appreciation. Day and overnight trips are common. The Lammerlaw Range provides opportunities for recreation in 'remote' tussock grassland setting relatively close to Dunedin, Central Otago and Balclutha. The Lammerlaw Range poses a navigation challenge even in the summer, due to the rolling nature of the terrain. While patterns of current recreational use are not completely understood, there is clear potential for a greater amount of extensive recreational use on the range should access become formalised. A feature of the recreation on the Lease is that the activities are not focused around particular points, such as a hut or track network, but rather tend to be activities involving roving through the landscape.

Hunting & fishing

The majority of hunting opportunities lie between the ridge of the Lammerlaw Range, north to the pylon track where there are low numbers of wild pigs, red and fallow deer. Game bird (quail, chukar) and waterfowl hunting occurs around the Canadian Flats Wildlife Management Reserve (WMR) and Lake Onslow. The dredge ponds on the Canadian Flats are the primary site for waterfowl hunting. Some of the ponds are located in the WMR while others lie within the Lease. Fishing occurs on both Lake Onslow and the Taieri River. While neither of these sites is on the Lease, access to and movement between these sites occurs within the Lease. The Lease provides a high level of amenity value associated with this recreational activity.

Tramping, horse trekking, mountain biking, cross-country skiing

The Lammerlaw Range has a history of limited use for tramping, horse riding, cross-country skiing, mountain biking and multisport purposes. The limited use is caused in part by limited access and in part by the low profile and homogenous terrain which is subject to rapid and extreme changes in weather. Horse trekking and mountain biking opportunities fall within the middle of the difficulty spectrum. The 'featureless' terrain and the steep climb required to reach the range crest make the area more suitable to those with a high level of backcountry skills and fitness. However once recreationists reach the range tops, they are exposed to panoramic views and gentle rolling slopes.

Cycling

The south western boundary of Lease lies adjacent to the Millers Flat - Beaumont Rd and provides the backdrop to the Beaumont Millennium/Clutha Gold Trail. A feasibility study by the Clutha Gold Trust identifies a cycling/walking opportunity from Roxburgh to Lawrence which would run largely along the disused railway embankment that runs directly adjacent to the Lease. The Roxburgh Lawrence track has been nominated to become part of the New Zealand Cycle Trail. An important feature of a cycling/walking opportunity is having

pleasant surroundings. Recent spraying of shrublands adjacent to the Cycle Trail has reduced the amenity value considerably, although under appropriate management, this could be reversed.

Four wheel driving & motorcycles

A growing level of motorized vehicle use is occurring within the adjacent Te Papanui CP, which would also occur within the Lease if access were formalised. Recreation groups identified access to the Lammerlaws as being important in the draft Central Otago Outdoor Recreation Strategy (2010). Most of the tracks that follow legal roads are well formed and are located largely on easily maintainable substrates. The track surface contains a high clay level so a winter closure of the tracks in line with the adjacent Conservation Park would be logical.

Botanising and naturalising

The many multicoloured wetlands located within the Lease are of interest to both specialists and lay people alike. Similarly the tussock/shrubland mosaic in the upper parts of the property provides points of interest for those interested in flora and fauna.

Cultural history

The remnants of a significant historical gold mining period in Central Otago provide opportunities for those interested in exploring the history of the region. Also of interest is the historic gorse hedge associated with pastoral subdivision.

Kayaking

Although possible, currently there is very little kayaking in the Taieri River above the Taieri Rapids. As kayak technology results in ever-decreasing boat size/weight and more manoeuvrable craft, and rivers previously considered unpaddleable are now regularly run, it is conceivable that the upper Taieri could become a regular run in above average flows.

2.8.1 Significance of Recreation

Routes and areas of recreational significance are shown on Map 4.2.5.

The Lease is *strategically important* in terms of existing recreational use due to its location beside Te Papanui CP on the Lammerlaw Range, and its proximity to Dunedin, the Clutha River and the proposed New Zealand Cycle Trail and existing Millenium Track.

There are excellent opportunities to advance CMS objectives on the Lease:

The property provides a range of recreation opportunity settings. The Otago Conservation Management Strategy (CMS) identifies the Lammerlaw Range as providing remote experience, especially in winter when vehicle access is limited or non-existent. Potential activities include cross country skiing in good snow years, and hunting. The Lammerlaw Range meets the CMS requirement to provide for a predominantly remote recreation experience with little recreation development.

The CMS identifies the majority of the Lease as having backcountry drive-in characteristics and provides for activities such as day and overnight trips, mountain biking, fishing, four wheel driving and nature appreciation.

The Clutha faces are recognised in the CMS as having rural natural remnant characteristics that provide a suitable setting for walking, cycling, picnicking and nature appreciation. The Clutha Gold Trail from Roxburgh to Lawrence that bounds this part of the property, has been preliminarily approved as part the New Zealand Cycle Trail (NZCT), which is a government nationwide priority.

The Objective for the Lammermoor-Upper Taieri Special Place, of which the Lease is part, is: *“To protect the high conservation, landscape, hydrological and historic values of the uplands while allowing and providing for appropriate recreational use.”*

Implementation includes:-

- *Endeavour to negotiate with landowners through a variety of mechanisms including pastoral lease tenure review to provide protection for important landscape, nature conservation, recreational and water supply areas.*
- *Develop and promote a Te Papanui Conservation Park concept for the tussock grasslands and associated wetlands to be administered by the department on the range crests, as a predominantly remote experience area with little recreational development.*
- *Improve recreational facilities and access points.* Improvement of facilities can include securing the natural setting and natural quiet in which a recreational activity takes place and this is particularly important at the Canadian Flats WMR.
- *The use of ORVs on land administered by the department will be confined to firm, formed vehicle tracks selected in accordance with the criteria in Section 28.3.13.* The presence of well-formed tracks on the Lease is significant in that they provide linkages to the western boundary of Te Papanui CP from both Beaumont Station Road and Lake Onslow Road. Motorised access would also compliment the existing summer 4WD access within the Te Papanui CP.
- The Lease provides opportunities to meet the CMS requirement to encourage recreational use through the provision of motorised access to public conservation land.
- The Lease provides for mountain biking, horse riding, outdoor education, nature appreciation opportunities.

PART 3 OTHER RELEVANT MATTERS & PLANS

3.1 Consultation

The following comments were made at the meetings with NGO's in Alexandra on 10 September 2009:

- The gorse fenceline running for many km may be an original gorse fence.
- Would be good to secure access over road. May be off line or alignment may not be defined by survey. Suggested that a local purpose reserve may be an option for road.
- Important to have linkages of ecosystems.
- Suggested that 2/3 property should be conservation land or at least the 3 RAPs plus all land in between.
- May be some large kahikatea as in the Beaumont Reserve.
- Lots of potential for public access routes e.g. from Lake Onslow, Gold Trail, Talla Burn, Millennium Walkway.
- Property may have important native fish.
- River corridor has important landscape values and from opposite Taieri Gorge. Uplands have high landscape values.
- Sought clarification on legal status of Beaumont Road. Noted that Millennium track is legal as it is on an old railway. Will be replaced with something similar by Contact Energy if flooded by hydro development
- Swampy area on topo map in Moffats Stream.
- Many names come from Scotland.
- Issues with wilding trees in future from nearby forestry plantings.
- Minimum expectation for land to become public conservation land is RAP 2 through to Te Papanui boundary.

The full written submissions by Federated Mountain Clubs, Forest and Bird Protection Society (Dunedin and Central Otago-Lakes Branches), Dr. Alan Mark, New Zealand Deerstalkers' Association, and the Clutha Gold Trail Charitable Trust are included in Appendices 11-16.

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.

Regional Plans

Within the Otago Regional Council Regional Plan: Water for Otago (Water Plan), the headwaters of the Taieri River and MacKays Creek are identified as being waterways that are sensitive to suction dredging; a resource consent is required to undertake this activity. The following wetlands located on the Lease have been identified in the Water Plan as areas where specified activities will/may require resource consent:

- Part of the Upper Taieri Wetlands Complex and the Fortification Creek Wetland Management Area are identified in the Water Plan as being significant wetlands and so specified activities (excluding vegetation clearance) require a resource consent.
- The Black Stream Tributary Swamps and the Moffats Stream Swamp are identified as being ‘additional wetlands’: specified activities may require a resource consent.

Protection is therefore limited to the controls set out above.

3.3 District Plan

The majority of the Lease is located in the Rural Resource Area (RU) of the fully operative Central Otago District Council District Plan (Plan). Approximately 1/6 of the Lease is identified as being located within Upper Manorburn/Lake Onslow Landscape Management Area (LMA) in the said plan. Parts of Significant Natural Areas (SNA) 10: Upper Taieri Wetlands and 40: Fortification Creek Wetland are located within the Lease, while an additional wetland W18: Moffats Stream Swamp is located entirely within the Lease.

Under the fully operative provisions, subdivision of less than 8 ha in the RU requires a resource consent, as does erection of buildings within 20 m of any waterbody. A resource consent is required for any earthworks, deposition of sediment, or the removal of vegetation within 10 m of any waterbody. Earthworks not exceeding an area of greater than 2000 m² or quantity of 3000 m³ from any one site also require a resource consent.

The clearance of indigenous vegetation requires a resource consent within any SNA, or if the area or type (i.e. schedule of threatened species) triggers specified thresholds (in any part of the district, irrespective of zone). Note however that these provisions do not apply to land that is freeholded via tenure review.

Planting of greater than 2 ha of specified exotic species requires a resource consent. The planting of species with a high wilding potential have higher restrictions placed on their planting than those with less such potential.

Within the areas identified as being LMA and/or are over 900 m asl., resource consent is required for activities including but not limited to the cutting of new roads, subdivision (except for the creation of legally protected land), and the planting of exotic forest/woodlots/shelterbelts; and earthworks which breach specified thresholds. These provisions do not apply to land that is freeholded via tenure review.

Esplanade reserve provisions apply to the section of the true right bank of the Beaumont River which is within the Lease.

Under proposed plan changes 5A-5W (publicly notified on 10 October 2008), the sections of Lake Onslow and the Upper Taieri Wetlands within the Lease were identified as being Significant Landscape Features, whilst the remainder of the property was identified as being a mixture of landscapes of significant and limited sensitivity.

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. Eastern parts of Beaumont Pastoral Lease are incorporated in the Lammermoor-Upper Taieri Special Place.

The CMS objectives for the Lammermoor-Upper Taieri Special Place relevant to Beaumont Pastoral Lease include:

To protect the high conservation, landscape, hydrological and historic values of the uplands while allowing and providing for appropriate recreational use. To protect and restore (where necessary) the wetland and wildlife values of the upper Taieri scroll plain wetlands and continue to provide for recreational use.

The key implementation methods relevant to the Lease are:

- Endeavour to negotiate with landholders through a variety of mechanisms including tenure review to provide protection for important landscape, nature conservation, recreational and water supply areas.
- Develop and promote a “Te Papanui Conservation Park” concept for the tussock grasslands and associated wetlands to be administered by the department on range crests, as a predominantly remote experience area with little recreational development.
- Removal of wild animals and pest plants as appropriate.
- Survey and protection of historic sites with the area, including consultation with Kai Tahu regarding possible waahi tapu/waahi taoka.
- Continue advocacy involvement with the RC in an effort to ensure that its regional policy statement and regional plans for water and land contain policies and goals designed to protect and enhance wetlands, riparian zones, water quality and quantity, and improve landuse practices in the catchment.

Priorities for the Lammermoor-Upper Taieri Special Place are:

Protection, negotiation and advocacy in relation to the range crest tussock grasslands and scroll plain wetland will be priorities for this Special Place.

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.

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

3.7 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 Lease makes a major contribution to providing ecosystem services (especially water harvesting) for the wider Otago region. Many people rely on these services as a basis for their livelihood, a source of drinking water and for water-based and outdoor recreational activities.

The following section attempts to quantify the value of the Lease as a water catchment area, over and above its strictly intrinsic values.

There is a wealth of published hydrological information for adjoining lands on the Lammerlaw Range that indicate that the Lammerlaw tops provide exceptional ecosystem services. 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 attained to assess the impacts of different land uses on water yield from the Lammerlaw 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.

Other data available includes economic studies relating to irrigation in the Taieri and Teviot districts (Sanderson and Slack, BERL Economics 2008) and an analysis of the economic benefits of water from neighbouring Te Papanui Conservation Park (Butcher Partners Ltd 2006).

Hydrological Services

i) Limiting Flood Runoff

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 the colluvium mantled slopes; thereby damping environmental fluctuation from floods and droughts.

This role in limiting flood runoff is particularly important in the Taieri and, to a lesser degree, the Teviot catchments. The Taieri River quite frequently floods in its lower reaches, inundating farmland. Enhancing summer flow during dry periods plays a critical role for summer irrigation and year round hydro-electricity production in the Taieri and Teviot Rivers.

ii) Water Yield

High altitude tussock grassland areas of the Lammerlaws “are known to yield unusually high proportions of precipitation as runoff, therefore play an significant role in determining flows in the Taieri River and its tributaries” ORC (1999, p15). Waugh (2005) notes that the upper Taieri River is known for the consistent steady flows from year to year; 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; and 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.

Studies have found that modification of snow tussocks by clipping or burning will reduce water yield (Mark & Rowley 1976), with the greatest decreases in catchment summer runoff being measured in the first two years following burning (Duncan and Thomas 2004). This latter study was conducted close to the Lease. It can be implied from this and other studies that if burning and grazing persist, then so will reductions in water yield.

Fahey and Jackson (1991b) estimate that in Deep Creek and Deep Stream, which form part of the Dunedin water supply, restoration of tussock cover to nil depletion could lead to water yield increases in the order of 42%-52% at the water intakes for the three summer months in dry years. These catchments now lie within Te Papanui Conservation Park and continue to provide water to Dunedin City. The Dunedin City Council assisted with funding the retirement of some 12,000 ha of Rocklands Station under pastoral lease tenure review, and directly purchased other land as an investment in maintaining the city’s water supply.

Change in land use can reduce water yield from snow tussock catchments. Fahey and Watson (1991) assessed the impact of afforestation of tussocklands in the nearby Glendhu catchments on water yield and stream flow. They found that establishing pine forest reduced annual runoff by 20% in comparison to an adjacent lightly grazed tussock catchment. A longer running study in the same area found that as plantations mature, interception of rainfall increased to 31% and were expected to increase further (Fahey 2004). Interception rates are particularly high where rain falls as many small events, as is the case on the Lammerlaws (Waugh 2005). Fahey (2004) found that in the 13 years from canopy closure in 1991 to 2003, the annual reduction in runoff has averaged 252 mm or 31% less than the tussock catchment. Reduction in water yield reduces hydro capacity year round and in summer, impacts on the demand for water for irrigation and recreation.

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

Waugh (2005) advised that to maximise water yield from neighbouring lands which now form Te Papanui Conservation Park, vegetation cover should be retained, or restored to tall unmodified snow tussock, and not be subject to burning or grazing.

iii) Sustaining low river flows in Summer

Studies in the upper Taieri River found that low flows are particularly well sustained. This is an important attribute in relation to public water supply for irrigation and urban uses. Snow tussock catchments have less variable flows than degraded (burnt) tussock, oversown tussock or improved pasture.

Fitzharris (1979) notes that the accumulation of snow into drifts is largely controlled by micro relief in the landscape. He also notes 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 thereby ensures sustained 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). Major snow drifts may still be releasing melt-water in December. Late lying snow drifts were observed during the tenure review inspection in the headwaters of the Taieri and Talla Burn catchments.

Low river flows are also affected by afforestation. After 13 years of afforestation of a snow tussock catchment close to the Lease, low flows are 22% lower on average than those from the tussock catchment (Fahey 2004).

Fahey and Jackson (1991a) note “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”.

Erosion Control and Sediment Retention

Snow tussock catchments monitored for sediment yield in the nearby Glendhu were shown to have very low sediment yields by New Zealand standards (Waugh 2005). Measurement of sediment yields from the nearby Glendhu catchment (O’Loughlin et al. 1984) reveal rates between 13 and 4.0 m³/km²/yr which indicates the landforms of the Lammerlaws are stable and have low erosion rates.

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

Monitoring at Stonehenge, some 40 km downstream from the Lease boundary in the Upper Taieri, has shown that tussock covered catchments yield very good water quality (ORC 1999) characterised by:

- Cool water temperatures
- High levels of dissolved oxygen
- Approximately neutral pH values
- Low conductivities
- Low total nitrogen levels
- Low NH₄ + NH₃ levels
- Low total phosphorous levels

- Low turbidity
- Low faecal coliform levels

MCI (Macro-invertebrate Community Index) values also recorded by ORC indicate water quality and good habitat condition. Measurements by Ryder (2001) in nearby Deep Stream at the Trust Power intake indicate very good to excellent conditions. Observations in the upper reaches of all catchments examined during inspection of the Lease (see Aquatic Fauna Values section) indicated good water quality and invertebrate communities, although some evidence of stock impacts were apparent.

Carbon Storage and Climate Regulation

While storage and regulation of water flow are much more significant ecosystem services on the Lease, carbon storage in regenerating shrublands, forest and tall tussocklands makes a modest contribution to ameliorating the current anthropogenic induced rise in atmospheric carbon dioxide levels.

Carbon storage varies depending on the vegetation cover present (Table 13).

Table 13: Carbon stock estimates for broad vegetation cover classes in the Vegetation Cover Map (VCM) found on the Lease, derived from Tate et al. (1997) with estimates for forest classes used in this study, as derived from Hall et al. (2001). (Source: Carswell et al. 2008)

Vegetation class	Carbon (t ha ⁻¹)
Unimproved pasture	2.1
Snow-tussock grassland	27.2
Mixed indigenous scrub	99.4
Manuka/kanuka scrub or fern	50.5
Beech forest & scrub	179.8
Wetland communities	31.5

Over half (13,800 ha) of the property is predominantly clothed in tall tussocklands. The shrubland component to these grasslands is currently largely kept at bay through the use of fire. In the absence of burning and grazing the undeveloped part of the property could in time be expected to store some 580,000 tonnes of carbon as a mixed grassland/shrubland system.

Those parts of the property that support manuka shrubland store about 51 t/ha of carbon, while beech forest/scrub stores about 180 t/ha of carbon (Carswell et al. 2008).

Food and Raw Materials

The high water yield from the Upper Taieri catchments is the most import source of water for irrigation in the Maniototo Basin. The Maniototo Irrigation and Hydro Electric Power Scheme (MIHPS) supplies irrigation water to around 9,300 ha on over 50 farms, and has permits to take up to 6400 l/s for combined power generation and irrigation use. Private irrigators also take substantial flows from the Taieri mainstream, tributaries and from the

ground water of the Maniototo Basin. Lake Onslow provides water storage for two hydro-electric power schemes on the Teviot River (Pioneer Generation).

Dunedin City Council uses the Taieri bores at Outram to supply a substantial percentage of the Dunedin water supply. These bores have capacity to pump 33,000 m³ per day (DCC website). The Taieri bores are directly charged from the Taieri River (Gerard McCombie DCC *pers comm.*).

Dunedin City Council staff have noticed a decrease in water turbidity since the headwaters of Deep Creek and Deep Stream were destocked (Gerard McCombie DCC *pers comm.*).

The classic example illustrating the importance of natural vegetation for water supply comes from New York City, where it was determined that protecting and restoring the Catskill Mountain forests (at a cost of more than a billion US dollars) would purify the city’s drinking water for a fraction of the price of a water filtration plant (Chichilnisky & Heal 1998).

3.7.1 Economic Benefits of Water from Beaumont Lease

In 2006, the Department of Conservation commissioned Butcher Partners Limited to report on the economic benefits of Te Papanui Conservation Park (CP). The Lease adjoins the Conservation Park and the upland portion of the property comprising the Lammerlaw Range is very similar in terms of vegetation, topography, soils and hydrological properties. Many of the figures contained in the Butcher report can be adapted to the Beaumont situation using the following assumptions (Table 14):

Table 14: Assumptions used to derive estimates of economic benefits of water from Beaumont Lease

Catchment	Area of Catchment within :	
	Te Papanui CP (Butcher & Partners 2006)	Beaumont Lease
Upper Taieri	23%	46% (~73 km ² of the 158 km ² catchment)
Teviot	-	20% (~59 km ² of the 299 km ² catchment)

i) Irrigation

Taieri

Butcher and Partners (2006) calculated that the value of irrigation derived from land contained within Te Papanui CP has a Net Present Value (NPV) of \$12m, using a 7.5% discount rate. This was calculated on the basis that 8 % of the irrigation on the Taieri River is dependent on water from Te Papanui CP.

Applying Butcher and Partners 2006 assumptions, the NPV of water from the Lease for irrigation in the Taieri catchment is in the order of \$24m, assuming that the land is in comparable condition and provides similar water yield per hectare.

These figures correlate with ORC advice (*pers comm.*) that approximately 20,000 ha is irrigated from the Taieri and that 15,000 ha of this is from river flow above Canadian Flat. Adopting the same assumptions as used by Ford (2004) that irrigation adds \$6000 ha⁻¹ to the value of land (exclusive of the cost of on farm infrastructure required for irrigation) and an estimate that 46% of the Taieri catchment above Canadian Flat lies within Beaumont Pastoral Lease, approximately 6900 ha is irrigated by water from the Lease. The NPV of water from the Lease could therefore be as high as \$88m. However taking into account (as did Butcher and Partners) factors including location, and that the land would likely be irrigated (albeit less frequently) without the Beaumont water, the real figure is probably in the order of \$19-28m.

In other words enough water is harvested from every hectare of land on the Lease to irrigate almost half a hectare of offsite dryland, and each hectare has a NPV \$3212 for irrigation water harvest. As much of the Lease's uplands are not in pristine condition, this figure may be lower, but could be expected to steadily rise under a nil grazing and burning regime. The value of unimproved pastoral land is in the order of \$100 ha⁻¹.

Teviot

Water sourced from the Teviot River irrigates 1460 ha of land under the Teviot Valley Scheme. As the Lease forms ~ 20 % of the Teviot River catchment, 292 ha are effectively irrigated by water from the Lease.

Sanderson and Slack (2008) estimate that irrigation in the Teviot Valley contributes to a gross output per hectare of \$30,000 for fruit production and \$1433 for pastoral use. On these low altitude versatile lands it is probable that irrigation adds \$6000 ha⁻¹ to the value of land and that the NPV of irrigation water from the Teviot catchment is in the order of \$8.8m. \$1.7m can be attributed to the Lease area, or \$298 NPV/ha towards the Teviot Irrigation Scheme.

ii) Hydro Electricity

Hydro electric power is generated from water derived from three catchments located on the Lease. The power production and NPV of water attributed to that part of the catchment that lies within the Lease is shown in Table 15.

Taieri

The power production of the Paerau and Patearoa hydro power stations is 55.3GWh per annum. The NPV of water attributed to that part of the catchment which lies in the Te Papanui CP has been assessed by Butcher and Partners (2006) (Table 15). The NPV of 1GWh of power produced from the Upper Taieri equates to \$353,000. Since twice as much land within the catchment lies within the Lease, the value of water utilised by these power schemes from within the Lease will be in the vicinity of \$7m or 956ha⁻¹.

Table 15: Hydro electric Power schemes dependent on water sourced from Lease and Te Papanui CP- production and Net Present Value (NPV) of water

Catchment	Total annual Power production	Production attributed to water sourced from		NPV of water sourced from:	
		Te Papanui CP (Butcher & Partners 2006)	Beaumont PL	Te Papanui CP	Beaumont PL ²
Taieri (Paerau Patearoa schemes)	53.3 GWh/annum	4.2 GWh/annum (8% of catchment)	8.4 GWh/annum (16% of catchment)	\$3.5m	\$7m or \$956 ha-1
Teviot (Horseshoe Bend, Michelle, Gorge, Teviot Bridge & Ellis stations)	87.7 GWh/annum ³		18 GWh/annum assuming Lease comprises 20% of catchment, but likely to be more	-	\$6.4m or \$1078 ha-1
Talla Burn	Under construction; estimated 2.6 MWh/annum	n/a		n/a	

Teviot

There are five power stations on the Teviot River that together produce 87.7 GWh (Pioneer Generation Ltd website).

A conservative estimate of the amount of electricity generated from that part of the Lease lying within the Teviot catchment equates to 18GWh. At a NPV of \$353,000 per GWh, electricity generated from the Lease is worth \$6.4m or \$1078 ha⁻¹.

Talla Burn

Talla Burn Generation Ltd is constructing a run-of-river hydro-electric scheme on the Talla Burn at Beaumont Station, 20 km from Millers Flat and 10 km from Beaumont. All of this catchment lies within the Lease.

It has the capacity to generate 2.6 MW of electricity using a maximum water take of 1.5 cumecs as permitted by natural flow.

Summary

While the figures presented above make for a compelling account of the estimated value/contribution of ecosystem services derived from the Lease, it is difficult to quantify the impact of current pastoral practices on these values. However it is known that low summer flows could quite quickly increase if stocking and burning were to cease (Waugh 2005). Improvements over and above this initial response would likely be slow. Similarly, declines

² Based on assumption that costs of owning and operating Teviot power scheme is similar to upper Taieri scheme, and that the NPV of 1GWh produced from these stations is also in the vicinity of \$353,000

³ From Pioneer Generation Ltd website

in water yield or an alteration to the temporal nature of water yield will likely be gradual under the current management regime.

There may be some additional concerns and costs relating to fire management arising from fuel management.

PART 4: ATTACHMENTS

4.1 Additional Information

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4.2 Appendices

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APPENDIX 1: Extract from *Carter, J. 1994: Waipori Ecological District. Survey Report for the Protected Natural Areas Programme. Department of Conservation, Dunedin*, pp 5:2-5:9; 5:30-5:33.

5.1 RAP 1: FORTIFICATION CREEK.

Land System : Upland plateau.

TWINSpan Group, Ecological units, (Plots)

- 3 *Chionochloa rubra* and *Agrostis capillaris* wetland and grassland on fluvial valley floor. (29.1, 29.2, 29.4, 29.6, 29.7)
- 14 *Chionochloa rubra* and sedge wetland on poorly drained valley floor. (29.3)

Location and Landform

The lower reaches of Fortification Stream and the south branch of the Teviot River drain into Lake Onslow. This area is significant for its meandering streams. The streams flow within steep sided and highly sinuous channels less than a metre deep (Fig. 5.1). The channels are about two m wide and the water flows briskly at a depth of around 30 to 40 cm. The stream channel widens, deepens and the stream velocity slows down in the lower reaches before the water enters Lake Onslow. There are numerous oxbow lakes and small ponds created by periodic changes in the stream courses. The oxbow lakes have cut off island-like centres which create vegetation refugia from fire and possibly from grazing animals. The terraces have shallow risers that only slightly elevate the valley floor above the active stream zone.

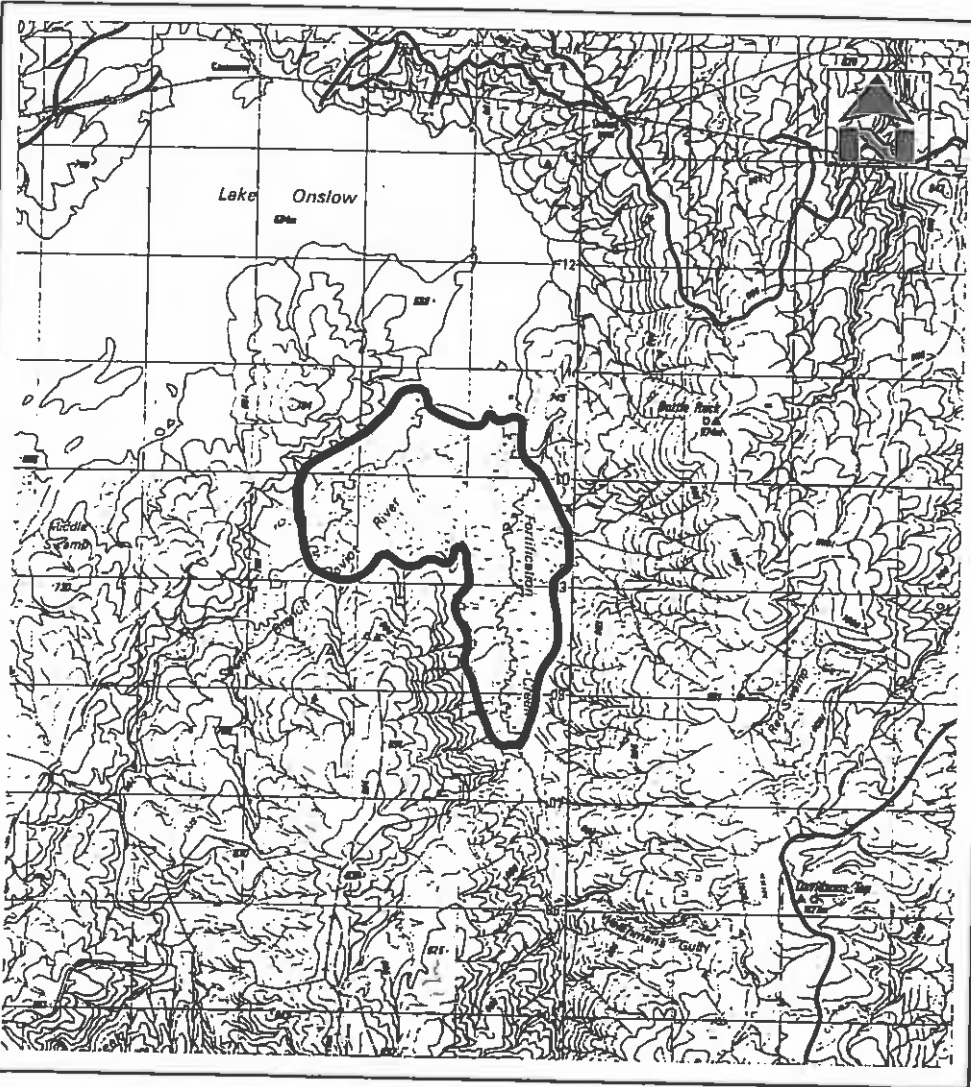
There is a relatively large area of patterned ground between the two rivers. This area has raised ribbon-like ridges of vegetation which sometimes break up to form evenly spaced pedestals. The ground between the pedestals or ridges is sometimes waterlogged and the area is generally poorly drained.

In the stream's lower reaches, the valley floor has indistinct aspect but generally faces north. The surrounding hill slopes are steep and poorly vegetated. Rock outcrops break the profile line of many of the ridges surrounding the RAP. Uneven slopes on the true left of the valley indicate ancient slumping.

Vegetation

Chionochloa rubra is the dominant canopy species on the valley floor, and gives this landscape its distinctive character. The vegetation had an intact appearance from a distance but at closer inspection a high component of the inter-tussock species is adventive grasses, particularly *Agrostis capillaris* and *Anthoxanthum odoratum*. *Festuca novae-zelandiae* is mixed in with the *Chionochloa rubra* tussocks on the open plain between Teviot river and Fortification Creek.

Nearly all the *Chionochloa rubra* plots fell into TWINSpan Group 3 (Fig. 2.2) and in the DCCA ordination covered the middle range of the group (Fig. 4.4). One ecological unit (plot 29.3), which did not fit this pattern, was placed on its own in the TWINSpan classification between wetland and snowbank communities. However, its position in the DCCA ordination (Fig. 4.5) shows it to be very different from the other wetland samples and perhaps more closely associated with the ecological units of this RAP, on alluvial substrate. It may have been separated because it contained only a few species, all native, and it also had the only recording of *Sphagnum falcatulum*.



GRID REFERENCE CENTRE : G43 / 490 095
 AREA : 400 ha
 ALTITUDE RANGE : 695 - 700 metres
 TENURE : Pastoral Lease
 SAMPLE SITES : 29.1-29.4, 29.6, 29.7
 AERIAL PHOTOS : SN 8768 / G3
 DOCDM-640009 - Beaumont CRR

1 2 3 kilometres

Discussion

The meandering streams and oxbow lakes are important landforms. These landforms are typical of the open flat basins of the upland plateau where the streams flow into Lake Onslow and the Loganburn Reservoir. Similar systems in the downland area have been modified to some extent by fences and drains.

The *Chionochloa rubra* canopy is a major vegetation type that is easily modified by farming activities, particularly burning and cultivation. This is one of the last relatively uniform areas of *C. rubra* combined with meandering streams remaining in the Walpori Ecological District. It was more widespread in the past (Hilgendorf 1935, Zotov 1939). The *C. rubra* was tall and was in good condition around the meandering stream courses. *Hebe propinqua* was found on one oxbow lake island at the lowest and most north-west position recorded in the District.

This area is a very valuable habitat for water fowl, the running and standing water provide an excellent range of habitat for Canada geese, black swans and paradise ducks.

Summary : RAP 1 - Fortification Creek**Representativeness :**

Chionochloa rubra on alluvial valley floor of the upland plateau basins.

Diversity and pattern :

Limited to one canopy species with subtle changes in the inter-tussock species depending on drainage qualities.

Rarity and special feature :

Relatively restricted vegetation communities. *Hebe propinqua* at low elevation. Meandering streams are a special landform feature.

Naturalness :

Vegetation modified by burning and grazing.

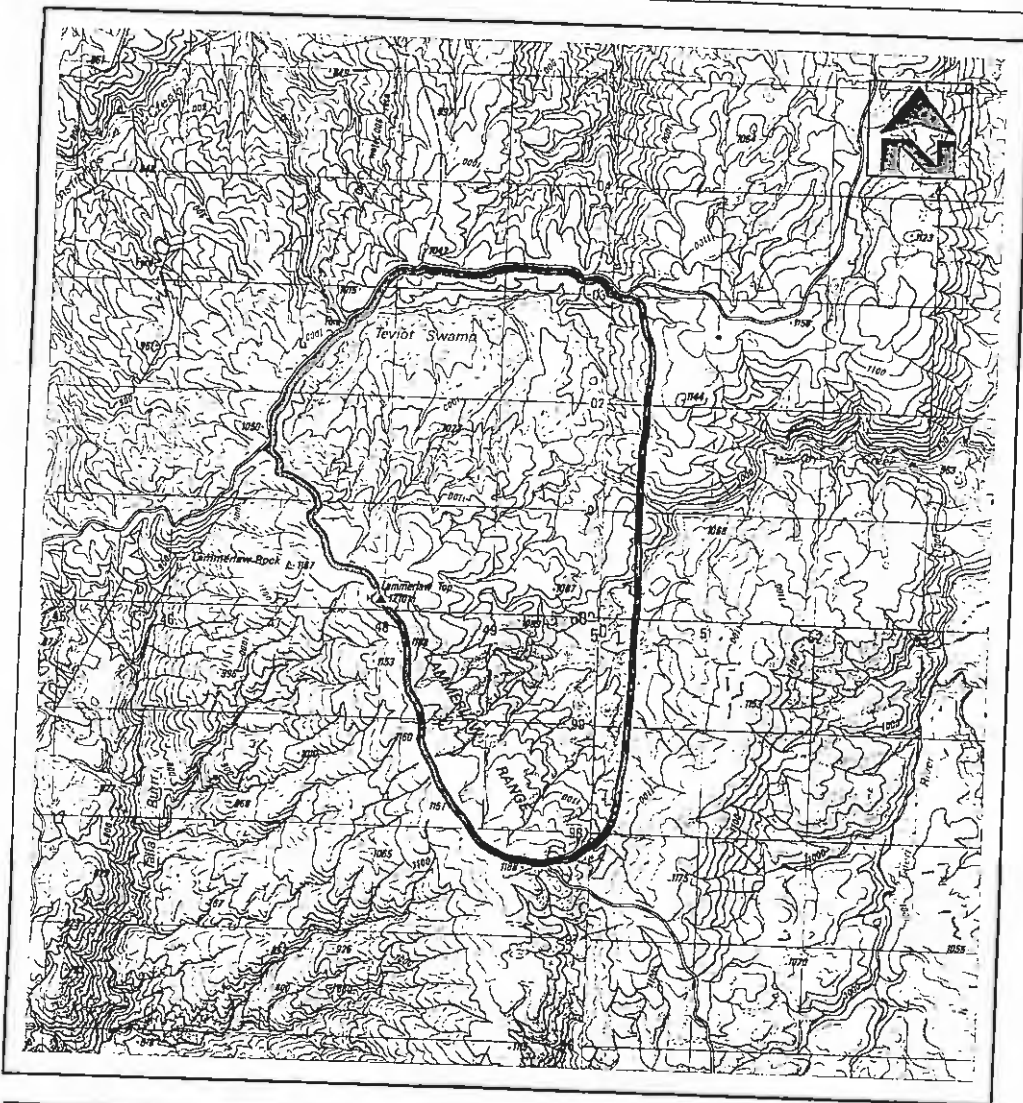
Long-term viability: Dependent on land management. Very vulnerable to processes of land degradation evident in the adjacent ecological district and on side slopes of catchments like this one.

Size and Shape :

Large enough to avoid boundary problems related to edge effects.

Buffering and surrounding landscape :

Vulnerable to the consequences of land use of the surrounding area, especially from upstream areas with little buffering in place or available at present.



GRID REFERENCE CENTRE : G43 / 490 010

AREA : 1080 ha

ALTITUDE RANGE : 970 - 1090 metres

TENURE : Pastoral Lease

SAMPLE SITES : 28.1-28.9, 33.1-33.5

AERIAL PHOTOS : SN 8286 / H3

DOC DM-640009 - Beaumont CRR
Map Licence No 1991/42

1

2

3 kilometres

5.2 RAP 2 : TEVIOT SWAMP AND MACKAYS STREAM

Land system : Upland plateau

TWINS PAN group, Ecological Units, (Plots)

- 9 *Chionochloa rigida* grassland and *Poa colensoi* herbfield on sideslopes. (28.1, 28.2, 28.6, 33.1, 33.3)
- 10 *Chionochloa rigida* and *Hebe odora* tussockland on sideslope (28.4)
- 11 *Halocarpus bidwillii* and *Phyllocladus alpinus* on mountain side wetland. (33.5)
- 12 *Halocarpus bidwillii* and *Chionochloa rigida* grass-wetland on poor draining footslope. (28.7)
- 13 *Chionochloa rigida* and sedge wetland on *Sphagnum* sheet and hill side flush. (28.8, 28.9, 28.5a)
- 14 Lichen, moss and sedge wetland in shallow sloped basin. (28.5b, 28.3)
- 15 *Dracophyllum* and herbfield and snowbank. (33.2, 33.4)

Location and Landform

Teviot Swamp and the headwaters of Mackays Stream have similar landforms. These two catchments drain the north and east slopes of Lammerlaw Top at the western and highest end of the Lammerlaw Range. The Lammerlaw Top is the highest point in the Waipori District at 1211 m.

The ridges and spurs of the Lammerlaw Top have a repetitive pattern of slope angle and dimensions (Fig. 5.2). This pattern is created in part by the angle of dip in the schist bedrock and by the action of cold climate processes leading to snowbank formation. On some of these banks, small patches of earth and vegetation has been peeled away by the plucking and sliding of snow patches indicating that snowbank formation is still active.

There are no significant areas of rock outcrops on the skyline or ridge-lines except for the rock outcrop (Lammerlaw Rock) on the south-west side of Lammerlaw Top, outside the RAP. The streams at the head of the Teviot and Mackays catchments have a step-like (variable gradient) longitudinal profile. In places the streams fall and tumble steeply and sometimes become miniature waterfalls and cut down through rocky areas. In other places the streams drain shallow sloped basins in-filled with *Sphagnum*, that have domed ombrotrophic centres in the most homogeneous areas (Rapson et al. in prep.). In these poorly drained areas the streams cut permanent sinuous courses through the *Sphagnum*-formed peat. The streams transport pebble-sized schist alluvium and create minerotrophic conditions along their banks (Rapson et al. in prep.).

An area in the centre of the Mackay's upper basin has vegetated hummock or "thurfur" ground formations. The thurfurs are up to 30 cm high and aligned perpendicular to the contours. This phenomena is described in Selby (1985) as a cold climate process which may or may not be associated with periglacial conditions. It is not known if these thurfurs are actively forming at present or are relics from a colder period.

Bog pools are common on the *Sphagnum* sheets of the main Teviot Swamp and Mackays Stream and along the stream banks in smaller deposits of peat. The pools are variable in dimension, they occur in steep steps with high downstream banks and in networks with string-like barriers between each pool. The pools do not appear to be associated with controlling geological structures and their random scatter is difficult to explain. Their origin in this area has been investigated (Rapson et al. in prep.). It is possible that the effects of snow and ice on micro-topographic development have some influence on the location of the pools.

Vegetation

The vegetation has two main components. The side slopes and better drained areas are dominated by *Chionochloa rigida* while *Sphagnum cristatum* dominates the peat accumulating element of the wetlands. The main cushion plants such as *Oreobolus pectinatus* and *Dracophyllum prostratum* are also dominant species that give the wetlands a distinct colour. The most poorly drained wetland communities grade towards the drier lichen-dominated patches which are in the zone that grades towards tussockland. These wetland ecological units fell into TWINSPAN Groups 13 and 14. They cover the full range of the wetland community in the DCCA ordination (Fig. 4.5).

Shrub species were not common on the main Teviot Swamp basin but were more so in Mackays stream. There was a small patch of *Halocarpus bidwillii* in the area between Teviot Swamp and MacKays Stream. Another small patch of *Phyllocladus alpinus* stood out by its texture and colour and was associated with a stand of *Halocarpus bidwillii*. These ecological units are classified into the TWINSPAN Groups 12 and 11 respectively. The *Phyllocladus alpinus* stand was at the extreme end of the wetland group overlapping the higher-altitude grassland group in the DCCA ordination (Figs. 4.5 and 4.7). Areas of *Hebe odora* occurred within the tussockland; it was more common in the Mackays Stream catchment than in Teviot Swamp. The *Hebe odora* and *Chionochloa rigida* combination was classified as part of TWINSPAN Group 10.

The *Poa colensoi* and herbfield communities were different from the other ecological units of TWINSPAN vegetation Group 9 in this area. Species such as *Anisotome imbricata*, *Abrotanella caespitosa* and *Kelleria villosa* plus the lichen species contribute to the character of this group. *Poa colensoi* was dominant on the thurfurs. The herbfield species such as *Hebe poppelwellii*, *Scleranthus uniflora*, *Ranunculus enysii* and *Celmisia prorepens* also occur on the thurfurs. The main *Chionochloa rigida* associations of this group had *Hebe odora*, *Celmisia semi-cordata* and *Celmisia prorepens* present.

The snowbank communities of this area were a major part of the ecological character of this RAP. Snowbank species occur on the short steep east or leeward-facing slopes which accumulate snow. This type of plant group also occurs on the wide open slopes towards the top of the Lammerlaw Range where snow presumably persists for considerable lengths of time each year. This association was placed in TWINSPAN Group 15 and in the DCCA ordination was most strongly associated with altitude (Figs. 4.2 and 4.8).

Discussion

The upper catchments of the north side of the Lammerlaw Top are considered of high botanical and geomorphic value (Johnson 1986b, Johnson and Lee 1988, and Rapson et al. in prep.). Some of the landform features noted are the asymmetrical valleys, peat in-filled streams and basins, bog pools and ground modified by cold-climate processes. This RAP represents some of the best alpine wetland vegetation in the highest westerly section of the Waipori Ecological District.

"Entomological diversity is high in Teviot Swamp, the surrounding grasslands and the snowbank herbfields around the highest parts of the Lammerlaw Range. Diurnal insects are a feature of these sites with flightless beetles, black cicadas and colourful alpine grasshoppers among the groups active by day. The snowbanks are especially interesting because of the insect diversity present at such a modest altitude (B. Patrick pers. comm.)."

Banded dotterels and South Island Oyster Catchers were seen on the s.

Summary : RAP-2 - Teviot Swamp and McKays Stream

Representativeness :

Alpine grasslands, wetland and snowbank vegetation.

Diversity and pattern :

Good diversity of vegetation types on different types of landform.

Rarity and special feature :

Bog pools and thurfurs. Banded dotterels on wetland.

Naturalness :

Excellent, except for spurs in MacKays stream modified by fire.

Long-term viability :

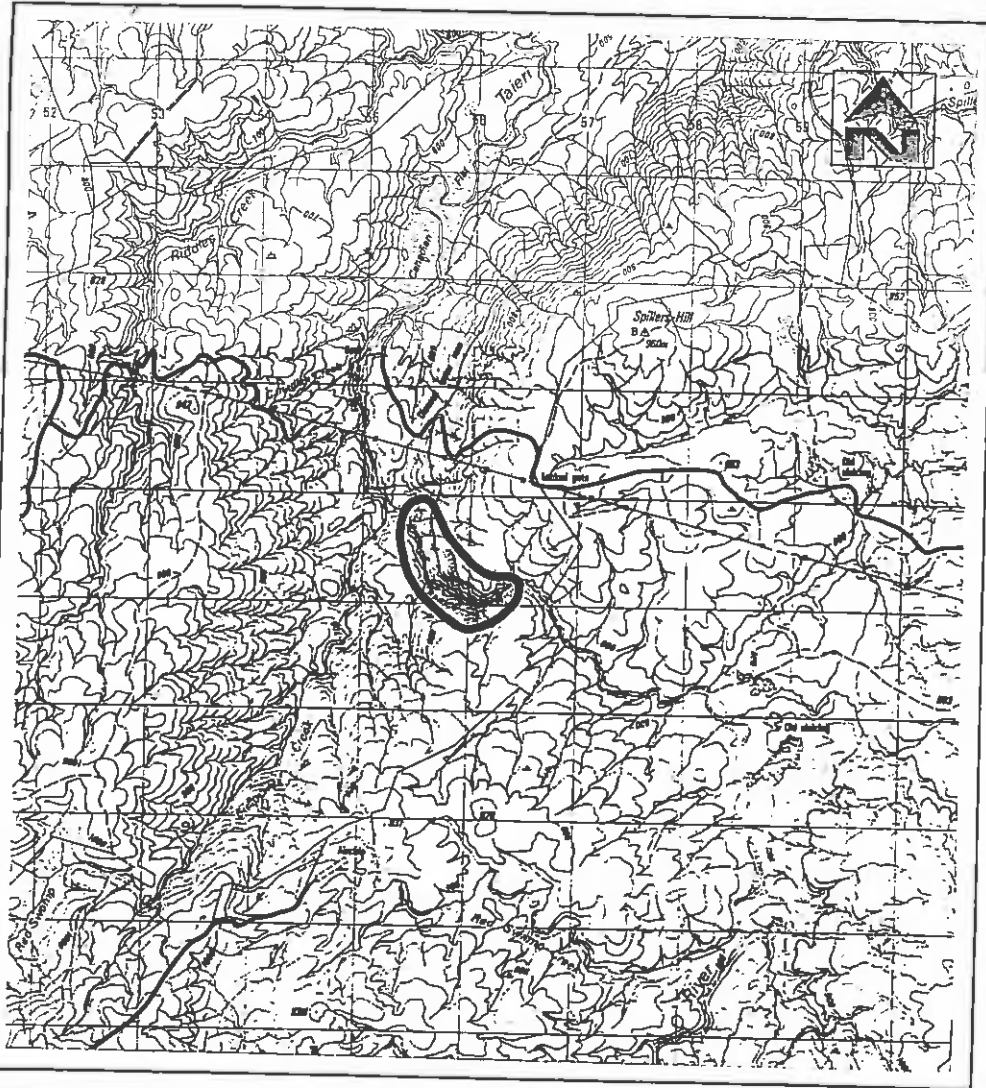
Good, depending on land management, restricting cattle and fire.

Size and shape :

Large, roughly circular area.

Buffering and surrounding landscape :

Surrounding landscape in similar condition, some areas nearby have been heavily grazed and burnt and are vulnerable to weed invasion. Buffered in places by fence and track.



GRID REFERENCE CENTRE : H43 / 560 114
 AREA : 100 ha
 ALTITUDE RANGE : 680 - 820 metres
 TENURE : Pastoral Lease
 SAMPLE SITES : 14.1-14.3
 AERIAL PHOTOS : SN 8286 / G5

Map License No. 199142 DCCDM-640009 - Beaumont CRR 1 2 3 kilometres

5.8 RAP 8 : TAIERI RAPIDS

Landsystem : Upland rise

TWINSPAN group, Ecological units, (Plots)

- 2 *Coprosma*, *Cassinia* and tussock shrubland on gorge side slopes. (14.3)
- 4 *Hebe* spp. and *Chionochloa rigida* shrubland in rocky gorge. (14.1)
- 9 Modified *Poa colensoi*, *Chionochloa rigida* and *Aciphylla aurea* grassland on upper side slope of gorge. (14.2)
 Narrow-leaved snow tussockland on spurs and in gullies of gorge side slope.
Hieracium pilosella modified grasslands on side slope.
 Modified streamside flushes

Location and Landform

The Taieri rapids gorge is formed where the River leaves the headwaters of the upland plateau and cuts down to the plains below to create a dramatic landform. It is steep sided and deeply incised. The river cascades and tumbles down a steep gradient. In places there are waterfalls which are visually and audibly impressive (Fig. 5.8). The river is bound by areas of rock cliffs with boulderfields under the cliffs. The strata dip in a steep easterly direction and outcrop in long spurs running from the top to the bottom of the slope. The chutes between the rock outcrops are more like block fields than scree and run in long tongues from the top of the side slopes to the edge of the river. In plan view this area does not cover a very large area but the deep and long slopes have a range of landform types and provide potentially diverse flora and fauna habitat.

Vegetation

The vegetation in the gorge falls into three TWINSPAN groups, two shrubland and one modified grassland group. There are many small variations seen in the gorge vegetation but the predominant character is of shrubland; some depleted *Chionochloa rigida* grasslands occur in the open areas exposed to grazing pressure.

One of the typical shrubland communities consists of small-leaved divaricating shrubs. Species such as *Coprosma* sp.(T), *Corokia cotoneaster* and *Melicytus alpinus*, and other shrubs like *Carmichaelia* species were noted. This type of shrubland was placed in the TWINSPAN Group 2 and in a similar position to other gorge shrublands on the DCCA ordination (Fig. 4.3). This group was found mainly on the rubblefields beside or under the rock outcrops in very dry, well drained areas. These rubblefields were probably too dry to have ever carried forest.

The ecological unit (14.1) in TWINSPAN Group 4 overlaps the grassland ecological units in the ordination graph (Fig. 4.6 and 4.7), indicating a transitional environment tending towards woody species if the habitat remains undisturbed for a significant period. *Chionochloa rigida* and *Hebe rakaiensis* form the canopy. *Festuca novae-zelandiae* was also recorded within this community. A mixture of native herbs and ferns contribute to the ground tier composition. This combination points to a moister habitat with deeper soils compared to the shrubland in TWINSPAN Group 2.

The modified grassland community in TWINSPAN Group 9 is the most common on the side slopes surrounding the gorge, especially around the rock outcrops along the brow of the

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sideslopes and in the areas that open enough within the gorge to be subjected to grazing and fire. *Chionochloa rigida* is still dominant but *Poa colensoi* and *Aciphylla aurea* are very common. There are many inter-tussock species, some of the notable herbs were *Kirkinellia novae-zelandiae*, *Brachycome radicata* and *Stackhousia minima*. The modified grasslands are similar to those found in Central Otago. This RAP is on the boundary of the worst *Hieracium pilosella* infestation in Otago (Hunter 1991).

The small streamside flushes that flow into the gorge were very modified and pugged by stock. These flushes are composed of mosses and liverworts including *Sphagnum cristatum* and *Marchantia* sp. respectively, and a mixture of introduced and native herbs as well as introduced grasses.

Discussion

This gorge has the most dramatic rocky cliffs and large rock and boulder-fields in the District. It is worthy of protection because of its landform attributes alone. It has remnant shrubland communities on both sides of the gorge. In general the vegetation on surrounding areas is degrading so the gorge is a valuable retreat that still supports a range of species and vegetation types that may have once been common beyond the gorge.

The rock faces and shrublands in this gorge have high entomological values with many moth species of restricted distribution present. Among this array, the lichen-feeding moth larva in the genera *Tingena*, *Izatha*, *Reductoderces* and *Dichromodes* are significant (Patrick et al. 1993).

Among some of the birds seen in the area were pipit, skylark and New Zealand falcon. Feral mammals seen were rabbits and goats.

Summary : RAP 8 - Taleri Rapids

Representativeness :

Shrubland and tall tussockland communities on steep rock slopes.

Diversity and pattern :

Small remnant pockets of different types of shrubland protected by surrounding rock outcrops.

Rarity and special feature :

Waterfalls and rapids. New Zealand falcon habitat. Historic pipeline in gorge.

Naturalness :

Moderate

Long-term viability :

Affected by grazing animals, fire and invasion of *Hieracium pilosella*.

Size and shape :

Long narrow area.

Buffering and surrounding landscape:

Vegetation buffered by rock and steep slopes and is in better condition than the surrounding landscape.

APPENDIX 2: Landscape Unit Photos

Clutha River Faces (LU1)



Typical vegetation cover



Beaumont Road

Beaumont Downlands (LU2)



From Beaumont Station Road



South of Beaumont Station Road



Dead manuka and pasture



View towards homestead and station buildings

Beaumont Uplands (LU3)



Peat bogs

Carsons Rock area

(a) Moffats Stream



Moffat Stream. Chewed tussocks & gorse



Manuka regrowth

(b) East sector and upper slopes



Below Carsons Rock



Towards Carsons Rock



Chewed tussock SW of Carsons Rock



(c) Upper Talla Burn



Bog pine peat bog and red tussock within Poorly drained sites west of the Talla Burn



Peat bogs on true right of Talla Burn

Lammerlaw Uplands (LU4)

(a) Lammerlaw Tops



View SW. Lammerlaw Ridge Snowbank

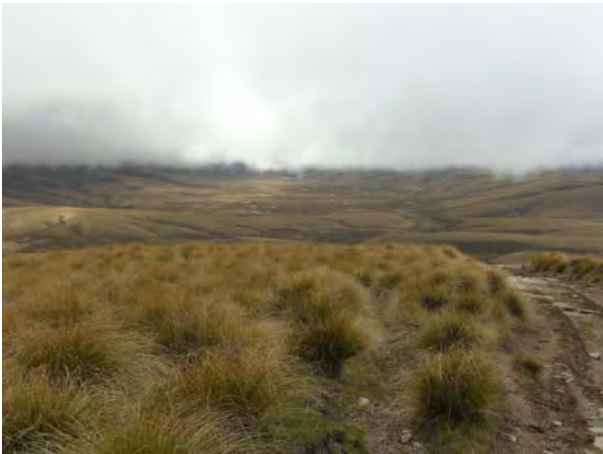


Snowbank



Teviot swamp with Lake Onslow in background

(b) Teviot



(c) Taieri



Taieri River Gorge

(d) Styx Valley



Riddles Creek at Canadian Flat



Taieri River upstream of Canadian Flat

APPENDIX 3: Summary of Land Environments of New Zealand Units present on Beaumont Pastoral Lease

From Leathwick, J., F. Morgan, G. Wilson, D. Rutledge, M. McLeod and K. Johnston. 2002: Land Environments of New Zealand. Technical Guide. Ministry for the Environment.

Level IV Environment	Description
K3.2a	Central Upland Recent Soils of Central Otago. Recent imperfectly drained soils of moderate fertility from fine schist alluvium, on undulating floodplains. Cool temperatures, moderate solar radiation, low annual water deficits. 765m asl.
K5.1b	Central Upland Recent Soils of Central Otago. Recent, poorly drained soils of moderate fertility from a fine schist alluvium with loess on gently undulating floodplains. Cool climate with moderate solar radiation, moderate vapour pressure deficits and slight annual water deficits. 625 m asl.
L1.1a	Southern Lowlands- floodplains. Recent, well-drained soils of high fertility from fine greywacke alluvium, alluvium from tuffaceous greywacke and dune sand; Cool temperatures, low solar radiation, moderate vapour pressure, low monthly water balance ratios, low annual water deficits. 150 m asl.
L1.3b	Southern Lowlands- floodplains. Recent, well-drained soils of high fertility from fine greywacke alluvium, alluvium from tuffaceous greywacke and dune sand; Moderately cool temperatures, low solar radiation, moderate vapour pressure, very low monthly water balance ratios, moderate annual water deficits. 270 m asl.
L3.1b	Southern Lowlands; includes high elevation wetlands in Central Otago. Recent, imperfectly drained soils of moderate fertility from alluvium from Fiordland complex with extensive peat. Much cooler temperatures, low solar radiation, moderate vapour pressure deficits, low monthly water balance ratios, slight annual water deficits. 125 m asl.
L4.1a	Southern Lowlands on gently sloping undulating plans of Southland Plains, around Dunedin and on Otago Peninsula. Older imperfectly drained soils of moderate fertility from greywacke loess and schist and loess from tuffaceous greywacke. Cool temperatures, low solar radiation, moderate vapour pressure deficits, very low monthly water balance ratios, low annual water deficits. 140 m asl.
L4.1b	Same as for L4.1a except found on flat plains. 140 m asl.
N2.2b	Eastern South Island Plains south of Timaru. Imperfectly drained soils of high fertility from greywacke gravels with some loess; mild temperatures, low solar radiation, moderate vapour pressure deficits, moderately low annual water deficits. 110 m asl.
N3.1e	Eastern South Island Plains of Timaru, Oamaru and Otago. Imperfectly drained soils of moderate fertility from greywacke alluvium with some loess on undulating plains. Much cooler temperatures than N3.1; moderate solar radiation, moderate vapour pressure deficits, moderate annual water deficits. 300 m asl.
N4.1d	Eastern South Island Plain; of steep hills in Central Otago. Well drained soils of moderate fertility from schist and greywacke; cool temperatures (though warmer winter temperatures than N4.1), moderate solar radiation, moderate vapour pressure deficits, very low monthly water balance ratios, moderate annual water deficits. 495 m asl.
Q1.1c	South-eastern Hill Country and Mountains – very steep mountainous terrain of inland Otago. Well drained soils of moderate fertility from greywacke, schist.

	Cold temperatures, moderate solar radiation, low vapour pressure deficits, low monthly water balance ratios, and slight annual water deficits. 1095 m asl.
Q1.2a	South-eastern Hill Country and Mountains including Harris Mountains; of very steep mountains. Well drained soils of moderate fertility from greywacke rock, colluvium and basalt. 1305m asl.
Q2.1a	South-eastern Hill Country and Mountains, of steep mountain ranges in inland Otago. Well-drained soils of moderate fertility from greywacke. Cool climate with moderate solar radiation, moderate vapour pressure deficits, very low monthly water balance ratios, low annual water deficits. 640m asl.
Q2.2a	South-eastern Hill Country and Mountains, of steep mountains. Similar to Q2.1a, but with low monthly water balance ratios (instead of very low). Imperfectly drained soils of moderate fertility from schist. 730m asl.
Q3.1a	South-eastern Hill Country and Mountains, of steep mountains. Imperfectly drained soils of moderately natural fertility from greywacke. Cool-cold temperatures, moderate solar radiation, moderate vapour pressure deficits, low monthly water balance ratios, slight annual water deficits; 690 m asl.
Q3.2a	South-eastern Hill Country and Mountains- Lammerlaw and Lammermoor ranges. Imperfectly drained soils of moderate natural fertility from schist on undulating mountains. Cold temperatures, moderate solar radiation, moderate vapour pressure deficits, low monthly water balance ratios, low annual water deficits. 990 m asl.
Q3.3a	South-eastern Hill Country and Mountains; of undulating mountains, with imperfectly drained soils of moderate natural fertility from schist. Cold temperatures, moderately low vapour pressure deficits; moderate solar radiation, very low annual water deficits, moderately low monthly water balance ratios. 990m asl.
Q3.3b	South-eastern Hill Country and Mountains; of undulating mountains, with imperfectly drained soils of moderate natural fertility from schist. Differs from Q3.3a by having: warmer annual temperatures, cooler winter temperatures, higher vapour pressure deficits, lower monthly water balance ratios, much higher annual water deficits. 990m asl.
Q3.3c	South-eastern Hill Country and Mountains; of undulating mountains, with imperfectly drained soils of moderate natural fertility from schist. Cold temperatures, moderate solar radiation, very low annual water deficits, low monthly water balance ratios. 990m asl.
Q4.2a	South-eastern Hill Country and Mountains; of well-drained soils of high fertility from loess and alluvium from tuffaceous greywacke on gently undulating hills around Invercargill & valleys in Catlins. Cooler temperatures, low solar radiation, moderate vapour deficits, low monthly water balance ratios, slight annual water deficits. 215 m asl.
Q4.3a	South-eastern Hill Country and Mountains. Imperfectly-drained soils of moderate fertility from schist and quartz gravels on rolling hills in Eastern Otago. Cool temperatures, low solar radiation, moderate vapour deficits, very low monthly water balance ratios, very low annual water deficits. 330 m asl.
Q4.3b	Same as Q4.3a but has much higher annual water deficits and is associated with strongly rolling hills.

APPENDIX 4: Map of Land Environments of New Zealand Units on Beaumont Pastoral Lease

