Vegetation and Flora Baseline Survey
L & M Coal Ltd Escarpment Mine Project
Denniston Plateau

Prepared for:

Resource and Environmental Management Ltd

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Richard Nichol
138 Peel St
Westport 7825
New Zealand
P 03 789 4132
F 03 789 8646
M 0274 592828
E: byhokirichard@hotmail.com

Fred Overmars
Sustainability Solutions
189 Kennedys Bush Rd
Christchurch 8025
New Zealand
P 03 322 8267
F 03 322 8261
M 027 699 7389
E fred.overmars@ihug.co.nz

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COVER PHOTO: View across upper western end of survey area, with manuka/wire rush rushland in foreground and forest and scrub in Trent Stream gully across photo centre (partly obscured). The boundary between the scrub and rushland on the plateau with forested slopes at right may be a relic of a former fire. The forest at right is not included in the survey area. Photo: R. Nichol 9 July 2008.

EXECUTIVE SUMMARY

Introduction

1. L&M Coal Ltd intends to apply for an access arrangement from the Department of Conservation to undertake opencast coal mining in the area of the former Whareatea and Escarpment underground coal mines on the Denniston Plateau in Buller. The proposal is known as the Escarpment Mine Project. It covers an area of approximately 148 ha and it is expected that most of this would be opencast mined.

2. This report describes a baseline vegetation and flora survey of the area of the proposed opencast coalmine and immediately adjoining areas ('survey area') and an assessment of potential adverse effects on the vegetation and flora caused by mining development and activities.

3. The survey objectives were to:
   - To describe the principal vegetation associations within the survey area and their environmental parameters;
   - To assess the degree of modification of the vegetation, especially from previous mining and burning;
   - To compile a list of vascular plant species encountered within the survey area and particularly to search for threatened species and species with a limited distribution or other special floristic character.

Physical Environment, Vegetation and Flora

4. The survey area is exposed to winds from all directions and its climate is characteristically cold, wet and bleak. Rainfall is approximately 6000 mm per year and often intense.

5. The survey area consists largely of northerly aspect hillslopes, sandstone plateau and dissected gully systems. The altitudinal range is 600–820 m asl. The site is located entirely on Brunner coal measures, which comprises fluvially deposited quartzose sandstone, grit, carbonaceous mudstone and basal conglomerate with coal seams. The topography around Escarpment Mine and Brazils Dam has been profoundly affected by historic mining activity. Vee Forty series (rocky or orthic raw soils) are the dominant soils; minor soils are Trent series (gley soils) and Denniston series (humus iron podzols) which occur in a very complex, localised pattern on the pavement and hill slopes with the Vee Forty series. The soils tend to be at or near saturation throughout the year and have very low fertility.

6. Intact indigenous vegetation covers most of the survey area. Beech forest and pink pine/yellow silver pine forest are the main vegetation along the southern margin. Northwards, manuka-wire rush rushland is extensive over gentler terrain areas, interspersed by gullies where taller manuka and yellow silver pine and/or pink pine predominate. Around Escarpment Mine, the natural forest cover includes taller beech forest. Red and silver beech forest, which is prevalent in the V37 catchment, remains in places but close to the old mine workings has made way for a mixture of indigenous seral species as well as gorse and other invasive exotic species. Other cover includes bare rock, minor areas of gorse and modified indigenous vegetation (i.e. flax and seral species), water (Brazils Dam) and recently disturbed sites such as roads and tracks. Brazils Dam generally has rocky margins and wetland vegetation has not developed around it.

7. The eight principal vegetation associations and their estimated percentage composition in the survey area are:
   - red beech forest (4%)
   - mixed beech southern rata forest (8%)
   - mountain beech forest (7%)
   - pink pine-mountain beech/yellow silver pine forest (10%)
   - [mountain beech]/manuka scrub (10%)
   - manuka/wire rush rush-shrubland (17%)
   - manuka /wire rush rushland (27%)
   - *Baumea teretifolia*/manuka-wire rush rushland (2%)
   - other cover (bare rock, minor associations, water, disturbed sites) (15%).

8. The vegetation has been modified by historic fires, by cracking and subsidence associated with the former underground coal mining, by roads, tracks and other earth disturbance and by establishment of species not indigenous to the site (especially gorse and heath rush) on disturbed sites. Overall, approximately 20% of the survey area (principally the forest) is considered to have highly natural vegetation, about 60% has had a fire history but has not been burnt in recent decades and is in relatively natural condition and about 20% has been highly modified by a combination of fire, roads and other mining activities and weeds.

9. A total of 131 vascular plant species was recorded in the survey area, 122 (93%) of them native and 9 (7%) naturalised.

10. One threatened plant species, a single red mistletoe (gradual decline), was found on an unthrifty mountain beech tree in the west of the survey area. Although no further specimens were found during a short search of the site locality, further searching especially at flowering time (December-January) may result in finding more plants in the survey area.

11. Two populations of the fern *Sticherus flabellatus* found in the centre of the survey area represent the southern limit of this fern species in New Zealand. These populations lie 10.5 km southwest of the previously known southern limit for this species and this represents a significant range extension for this fern of mostly warmer climates.

12. The following species are not threatened or at distribution limits but their presence in and near the survey area is notable:
   - *Chionochloa juncea* (coal measure tussock, endemic to Ngakawau Ecological District; 'ED');
   - *Pseudowintera traversii* (small shrub, found only in Northwest Nelson and North Westland with southern limit nearby at Mt Rochfort);
   - *Metrosideros parkinsonii* (small tree with disjunct distribution, northern North Island and northwest South Island);
   - *Actinotus novae-zelandiae* (small sub-alpine herb with localised national distribution);
   - *Euphrasia wettsteiniana* (endemic to west Nelson and North Westland);
   - Mountain cedar (uncommon within Ngakawau ED but forms a minor but physiognomically significant component of three forest types in survey area).

Ecological Significance of Survey Area

13. The survey area is evaluated on four criteria for assessing ecological significance:
    - Although the Land Cover Database 2 (LCDB2) vegetation cover classes within the survey area remain relatively common, have a high level of legal protection and are better represented elsewhere in the Ngakawau ED (e.g. Mt Rochfort RAP), all indicating low representativeness value, their distinctive ecological character and limited national distribution warrant a *medium representativeness value*;
    - The survey area is considered to have a *high rarity/distinctiveness value*. Most of these features lie on the western and southern margins of the survey area but the *Sticherus flabellatus* populations lie in the centre east of the area;
    - The survey area is considered to have a *medium ecological context value* for flora and vegetation;
    - The survey area is considered to have a *high sustainability value* for vegetation and flora.

Assessment of Environmental Effects

14. The two principal LCDB2 vegetation cover classes of the survey area are low producing grassland and broadleaved indigenous hardwoods. These two vegetation cover classes in the survey area comprise 12.5% and 22.3% of the total area of such vegetation on the Denniston plateau (and smaller but unknown percentages of the total area on the Stockton and Denniston plateaux). The potential loss of the areas of these cover classes to coal mining, while not small (124 ha), would not reduce them to levels that trigger high representativeness values.

15. Most specific rarity and distinctiveness features found lie on the margins or immediately outside the survey area. Effects on the single red mistletoe plant, *Pseudowintera traversii* population and main mountain cedar occurrences may be avoided by excluding these areas from mining and providing adequate buffering, and/or possibly by investigating the feasibility of transplanting the currently known single red mistletoe and its mountain beech host.

16. The southern limit of *Sticherus flabellatus* lies in the centre of the proposed mining area and effects on it from opencast coal mining will probably be difficult to avoid. The loss of a distribution limit is not as significant for biodiversity conservation as the loss of a threatened species population; rather it may (or may not) represent a particular genotype that is adapted to live at the limits of the species' range. A follow-up survey to see if there are other nearby populations, both within and adjoining the survey area, would increase certainty of the scale of the possible loss of the *Sticherus* populations and reduce the significance of the loss if other populations were found.

17. The proposed mine would cause the loss of indigenous forest, scrub and open coal measures vegetation and create ecological edge effects on the adjoining vegetation, for the duration of mining and until post-mining rehabilitated vegetation has been completed. This loss would be of a lengthy but finite period of time (some decades). This loss could be mitigated in two ways:
    - A high standard rehabilitation programme building on the indicative rehabilitation plan, although these re-created communities are unlikely to ever truly represent the original vegetative condition;
    - by a commitment to an off-site environmental offset programme, such as seeking legal protection and/or conservation management for non-protected under-represented ecosystems in Buller.

Possible Mitigation Measures

Possible mitigation measures for the effects of the proposed coal mine on vegetation and flora values include:

Pre-Mining and Mine Design

- Design to minimise the disturbed area consistent with mining objectives;
- Minimising and mitigating the release of carbon dioxide to the atmosphere from the proposed vegetation loss, for example through minimising the vegetation storage quantity by direct transfer of this material as far as possible to rehabilitated sites;
- Exclusion from mining of floristic features on the margin of the survey area, including red mistletoe, *Pseudowintera traversii* and most cedar occurrences, and/or possibly by investigating the feasibility of transplanting the currently known single red mistletoe and its mountain beech host;
- Undertaking a follow-up survey during the mistletoe flowering period (mid-December to mid-January) to find whether further red mistletoes occur inside or adjoining the survey area, and protecting any that are found and/or establishing and protecting a new off-site population (which may include collaring of host trees and predator control to enhance bird pollination and dispersal success);
- Undertake a follow-up survey to determine if *Sticherus flabellatus* occurs more widely both within and adjoining the survey area, focussing on likely habitats (i.e. rock overhangs), and investigate the feasibility of off-site translocation and even re-translocation back to the original site in the post-mining landscape;
- Preparation of a comprehensive rehabilitation plan, including weed and pest management, to restore the mined areas to a cover of indigenous species that would necessarily be different at least in part to the current vegetation composition because of the altered substrates but that would be compatible with the surrounding ecosystems. This would build on the indicative rehabilitation plan;
- Preparation of a fire contingency plan before commencing operations, including listing safety codes, providing secure storage for fuels and ensuring adequate precautionary measures are in place (e.g. fire extinguishers and access to water, no-smoking within 10 m of stored fuels);
- Off-site legal protection and/or conservation management for non-protected under-represented ecosystems in Buller (e.g. coastal and alluvial ecosystems), or for threatened species (e.g. search for red mistletoe in nearby areas and protect these and also the other known occurrence in Ngakawau ED at Cedar Creek);
- Off-site compensatory weed and pest control to restore the ecological integrity of other sites of similar ecological character, possibly including contributing to or taking on responsibility for the current DOC gorse control programme on the Denniston plateau;
- A risk assessment that the roading use of gravels from lowland rivers infested with didymo poses to waterways on the Denniston plateau.

Mining

- Prevention or control of the establishment and spread of weeds on and off-site;
- Adequate fire control measures;
- Minimising pinhole borer attack risk by:
    a) minimising the creation of at-risk hosts during vegetation clearance by using directional felling to avoid or minimise damage to adjacent trees and by minimising beech vegetation storage;
    b) cutting trunks and branches greater than 20 cm mid diameter into 1–2 m lengths to accelerate drying or breakdown;

c) promoting the rapid breakdown of in-situ tree stumps by application of urea (and then covering with moss and humus);
d) scheduling tree felling for autumn and early winter when risk of attack is reduced.

- Implementation of the rehabilitation plan in conjunction with mining.

Post-mining

- Completion of the rehabilitation plan, including monitoring of its success and taking remedial action if necessary.

1 INTRODUCTION

L&M Coal Ltd (L&M) intends to apply for an access arrangement from the Department of Conservation (DOC) to undertake opencast coal mining in the area of the former Whareatea and Escarpment underground coal mines on the Denniston Plateau in Buller (Figure 1). The proposal is known as the Escarpment Mine Project. It covers an area of approximately 148 ha, although at this stage the actual mine location and area involved is indicative. It is expected that most of this would be opencast mined.

The area is conservation land owned by the Crown and administered by DOC as stewardship land. Access to the mine area is via the existing metalled road from Denniston to Mt Rochfort (the Whareatea Mine Road) and a short stretch of the now disused road to the former Escarpment Mine.

This report was requested by L&M through Resource and Environmental Management Nelson Ltd (REM). It describes a baseline vegetation and flora survey of the proposed opencast coalmine and immediately adjoining areas ('survey area'[1]) and an assessment of potential adverse effects on the vegetation and flora caused by mining development and activities. This is one of several current environmental investigations whose purpose is to identify values potentially affected by the proposed opencast coal mine and to propose ways

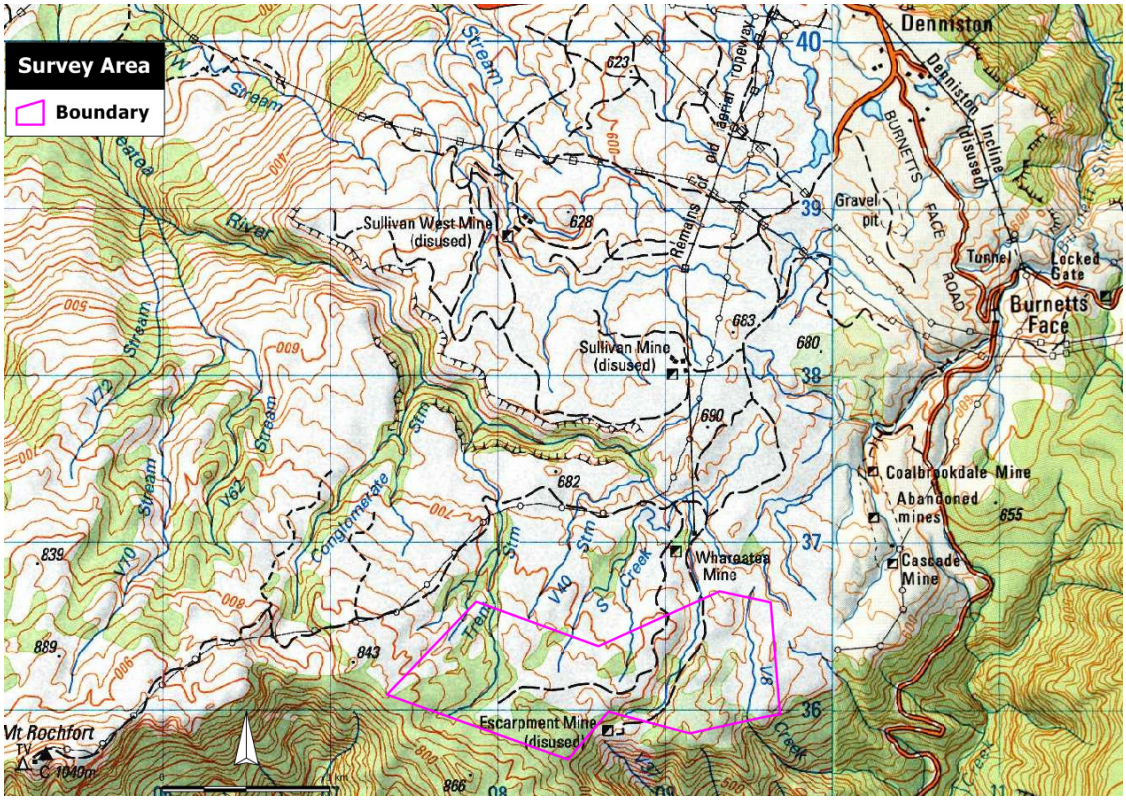

Figure 1. Location map of surveyed area for proposed Escarpment Mine on Denniston Plateau, Buller.

[1] The size of the proposed mining application area is approximately 148 ha. However, in the absence of a defined application area, the GIS boundary of the 'survey area' (being an approximation of the application area) as used in this report has an area of 141 ha.

to avoid, remedy or mitigate effects on values that could be adversely affected. These investigations will assist with preparing an AEE and obtaining a DOC access arrangement and resource consents for the proposed mine.

The survey objectives were to:

- To describe the principal vegetation associations within the survey area and their environmental parameters;
- To assess the degree of modification of the vegetation, especially from previous mining and burning;
- To compile a list of vascular plant species encountered within the survey area and particularly to search for threatened species and species with a limited distribution or other special floristic character.

The survey was undertaken in three parts:

- site inspection and description, largely undertaken during the baseline fauna survey (Buckingham 2008) undertaken as part of the environmental assessment for the proposed mine (19–21 June 2008, by RN)
- a general baseline vegetation and flora survey (8–10 July 2008, by RN)
- a survey of particular sites and a brief field assessment of Land Cover Database 2 (LCDB2; Terralink International Limited) mapping in areas of the Denniston Plateau adjoining the survey area (30–31 August 2008, by RN and FBO).

This report has five parts:

- introduction and survey objectives (Section 1)
- survey methods (Section 2)
- description of physical environment, vegetation and flora (Section 3)
- assessment of the vegetation and flora significance (Section 4)
- identification of potential adverse effects and mitigation opportunities for the proposed opencast coalmine (Section 5).

2 SURVEY METHODS

The survey programme comprised:

- Compilation of existing vegetation and flora and related environmental information;

- Site inspection and description, including 'ground truthing' of vegetation distribution as mapped on LCDB2 and shown on aerial photos;

- 15 'Recce' vegetation plots (Allen 1992) of variable size appropriate to vegetation association (forest, shrubland, tussock grassland etc) were randomly placed within the survey area (Figure 2). The number of plots per vegetation association was approximately proportional to their mapped area within the survey area. Plot sizes were 5 x 5 m^2 in open grassland, 10 x 10 m^2 in shrubland and 20 x 20 m^2 in forest. Vegetation cover classes were assessed in each tier. All species within each plot were recorded and checked off against or added to the species list for the overall survey area. A vegetative mapping unit name (Atkinson 1985) was derived for each site;

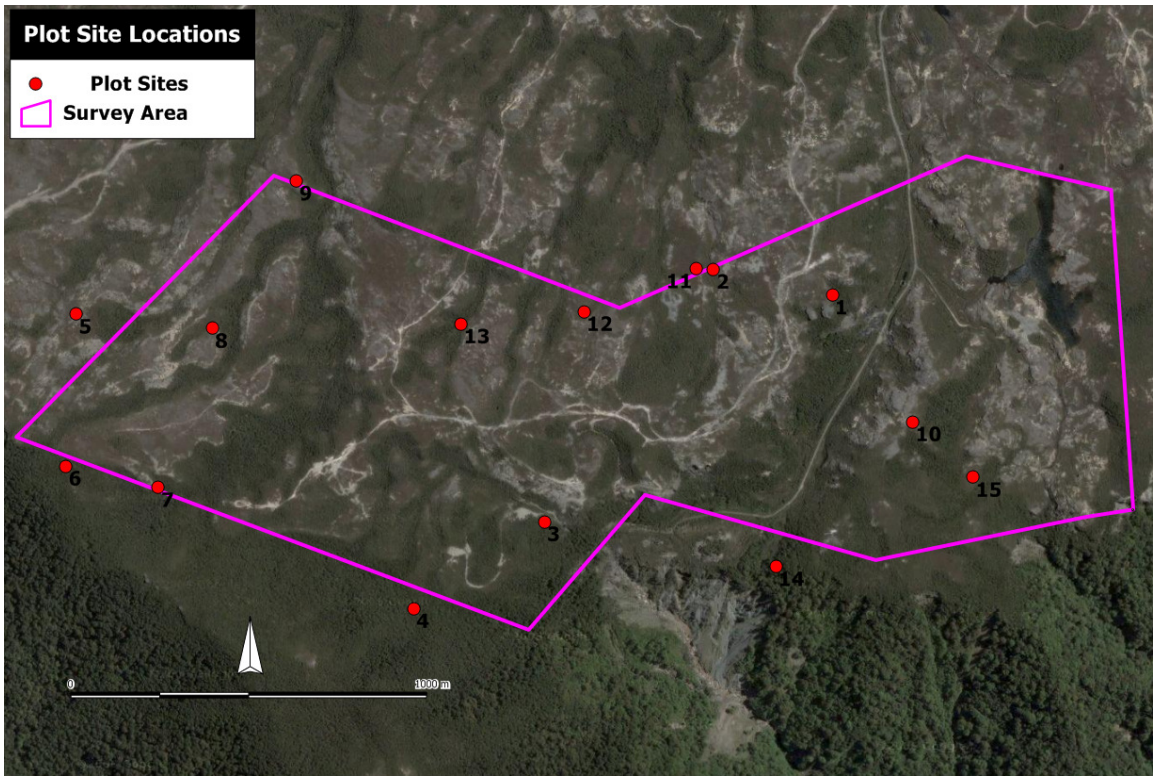

Figure 2. Location of vegetation association plot sites in and adjoining the survey area.

- Compilation of a list of all vascular plant species encountered within the survey area, with particular attention to threatened species and species with a limited distribution or other special floristic character;

- Assessment of the degree of modification of the vegetation, especially from previous mining and burning.

Field work was undertaken largely during winter conditions. Conditions were generally fine and cold. Some snow lay on the ground on shady aspect slopes during the July field work. While winter conditions did not hinder the survey or reliability of data in most respects, they posed potential difficulty in the identification of some plant species. At this time, the above ground portion of some diminutive species has either died back or are inconspicuous because of the absence of flowers. Identification of some of these species as well as monocotyledonous sedges and grasses is difficult if not impossible without the reproductive parts being evident. Likewise, the fleshy above ground parts of many orchids die back in winter and Mt Rochfort is the type locality for at least one orchid species. For this reason, further detailed investigation of some species during more favourable growing conditions may need to be considered.

No attempt was made to assess the bryophyte and lichen flora.

3 PHYSICAL ENVIRONMENT, VEGETATION AND FLORA

3.1 Biogeographic Context

The proposed mine is located in Ngakawau Ecological District ('ED'; McEwen 1987). Ngakawau ED is the only ecological district in New Zealand defined by the presence of extensive elevated coal measure rocks and associated landforms, vegetation and flora including endemic species (McEwen 1987, Overmars et al. 1998).

3.2 Physical Environment

3.2.1 Climate

The survey area is exposed to winds from all directions and its climate is characteristically cold, wet and bleak. Rainfall is approximately 6100 mm per year (NZ Meteorological Service isohyet maps) and often intense (24 hour two year return period average rainfall is 237 mm, Resource and Environmental Management 2008). Mean annual temperature is approximately 8.0^{o}C (assuming a lapse rate of 6^{o}C on the Westport mean of 12.1^{o}C). Snowfalls in winter and spring are frequent. Cloud and fog are often present and humidity is high.

3.2.2 Topography, Geology and Soils

The southern boundary of the survey area cuts across the low northwest to southeast trending ridge at the southern end of the Denniston plateau and the survey area consists largely of northerly aspect hillslopes, sandstone plateau and dissected gully systems. The altitudinal range is 600–820 m asl.

The survey area is located entirely on Brunner coal measures. This comprises fluvially deposited quartzose sandstone, grit, carbonaceous mudstone and basal conglomerate with coal seams. Greenland Group greywacke and argillite occurs on the southwest margin and Berlins porphyry granodiorite occurs on the southeast margin in the catchment of Cascade Creek (Nathan et al. 2002).

The topography around Escarpment Mine and Brazils Dam has been profoundly affected by historic mining activity. Underground mining and subsequent collapse have caused ground subsidence in many places. Narrow, steep sided ravines have formed around Escarpment Mine and mine shafts dot the terrain south of Brazils Dam. Steep rock bluffs are probably a natural feature around the former mine, though in places the removal of material during mining has also left these same features. A rocky ridge leads up to a small coal measure tableland between Escarpment Mine and Brazils Dam and this slopes away to V8 Stream in the east.

Vee Forty series (Rocky or Orthic Raw Soils) are the dominant soils (estimated 65% of the soil cover). Minor soils (estimated 30%) are Trent series (Gley Soils) and Denniston series (estimated 5%; Humus Iron Podzols) which occur in a very complex, localised pattern on the pavement and hill slopes with the Vee Forty series. Vee Forty soils were the only soils found on the rocky escarpment faces and steep-sided stream gullies. The soils tend to be at or near saturation throughout the year and have very low fertility, plant nutrients being probably largely supplied from the organic regime rather than weathering of the mineral soil. This accounts for the very slow growth rates of native plants on the coal measures soils (Ross 2008).

3.2.3 Drainage

Most of the headwater gully systems in the survey area flow northward before merging outside of the survey area. Together with Conglomerate Stream, they constitute the upper reaches of the Whareatea River. The drainage flows southwards in the eastern part of the survey area. V8 Stream, the main stream which drains from the southern end of Brazils Dam, and V37, which descends steeply from the old Escarpment Mine, enter Cascade Creek more than a kilometre outside of the survey area.

Brazils Dam is an artificial water body that was used for water storage for the previous underground hydro-mining. It has an area of approximately two hectares and has an outlet southwards over a small dam (about 1.5 m high) into V8 Creek. Also, there is a possible contribution to Whareatea catchment when this dam is full.

3.3 Vegetation and Flora

Field reconnaissance and survey confirmed the general pattern of vegetation distribution as suggested by the LCDB2 satellite imagery-based mapping. However, field work on the ground has allowed a better description of vegetation associations, in some cases leading to a quite different understanding of the overall vegetation composition of the survey area.

Intact indigenous vegetation covers most of the survey area. Beech forest and pink pine/yellow silver pine forest are the main vegetation along the southern margin. Northwards, manuka-wire rush rushland is extensive over gentler terrain areas, interspersed by gullies where taller manuka and yellow silver pine and/or pink pine predominate. Around Escarpment Mine, the natural forest cover includes taller beech forest. Red and silver beech forest, which is prevalent in the V37 catchment, remains in places but close to the old mine workings has made way for a mixture of indigenous seral species as well as gorse and other invasive exotic species. Other cover includes bare rock, minor areas of gorse and modified indigenous vegetation (i.e. flax and seral species), water (Brazils Dam) and recently disturbed sites such as roads and tracks. Brazils Dam generally has rocky margins and wetland vegetation has not developed around it.

3.3.1 Vegetation Associations

The eight principal vegetation associations and their estimated percentage composition of the survey area are summarised at Table 1 and described below. These vegetation association descriptions follow Overmars et al. (1998).

Table 1. Vegetation associations of survey area, their estimated percentage occurrence and plot site numbers (as shown on Figure 2).

Vegetation association	Estimated % of survey area	Plot site numbers
i. Red beech forest	4	14
ii. Mixed beech southern rata forest	8	6
iii. Mountain beech forest	7	4
iv. Pink pine-mountain beech/yellow silver pine forest	10	7, 13
v. [Mountain beech]/manuka scrub	10	2, 3
vi. Manuka/wire rush rush-shrubland	17	1, 9, 15
vii. Manuka /wire rush rushland	27	5, 8, 10, 12
viii. Baumea teretifolia/manuka-wire rush rushland	2	11
Other cover (bare rock, minor associations, water, disturbed sites)	15	

i) Red Beech Forest
Red beech forms a canopy at least 20 m in height. Silver beech is often an important component within the subcanopy and may share the canopy in places where it attains greater stature. Other subcanopy species include southern rata, kamahi and quintinia. The understorey includes mountain neinei, peppertree, *Pseudopanax colensoi, Raukaua simplex* and broadleaf. Shrubs include *Coprosma lucida* and *C. foetidissima*. The forest floor is often covered with *Blechnum discolor, B. procerum* and bush rice grass.

The red beech forest association tends to be associated with the low elevation sites around Escarpment Mine. Red beech is extensive in the catchment of V37 Creek and the red beech forest within the survey area is at the upper extent of this tract of forest. Occasional outliers are observed however, including a 3 m red beech sapling emerging from a patch of manuka scrub on the plateau proper.

ii) Mixed Beech-Southern Rata Forest
A variable association depending on which beech species predominate. Silver and mountain beech dominate and southern rata features to a lesser extent. Mountain cedar and southern rata are sometimes emergent over the low (10–12 m) canopy. Mountain neinei, celery pine, pink pine and broadleaf occupy the subcanopy. Shrubby understorey species include *Archeria traversii*, *Coprosma tayloriae*, *C. pseudocuneata*, *Pseudopanax linearis, P. colensoi* and *Raukaua simplex*. The forest floor often has a significant moss cover due to poor drainage. Also typically within the forest floor tier are *Astelia linearis*, *Gahnia procera, Luzuriaga parviflora, Blechnum procerum* and seedlings of regenerating shrubs and tree species. *Pseudowintera traversii* was found within this association.

This association occurs patchily throughout the forested portions of the survey area, both within the intact forest tract along the southern ridge as well as within isolated pockets within gully systems. Silver beech tends to dominate in wetter situations such as low gradient sites or valley floors. Mountain beech tends to favour drier and more difficult sites. Southern rata is more prevalent within this association in places where this association has been modified in the past e.g. the western slopes above Brazils Dam.

iii) Mountain Beech Forest
Mountain beech dominates an otherwise floristically diverse forest structure. The low canopy, typically 8–10 m in height, may include also mountain cedar, southern rata, kamahi, pokaka and pink pine. Subcanopy species include broadleaf and mountain neinei while the shrubby understorey includes *Archeria traversii*, stinkwood and *Coprosma tayloriae*. Forest floor litter constitutes a lot of the ground cover, since the drainage is often better than that within the previous association, but moss is still common along with species such as *Blechnum procerum, Libertia micrantha* and *Herpolirion novae-zelandiae*.

Mountain beech forest occurs patchily amongst the hillslope vegetation along the central southern portion of the survey area and in Trent Stream, as well as isolated pockets on the plateau itself, where it is fringed by manuka shrubland of 1–2 m in height.

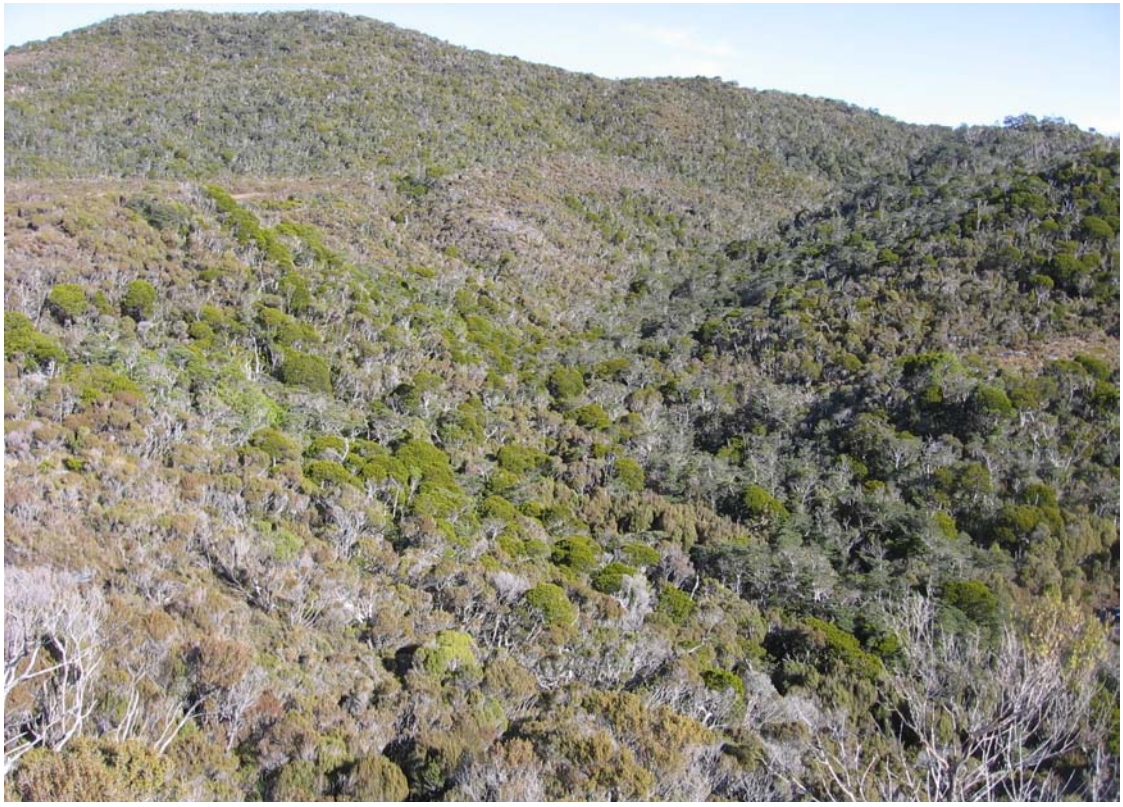

Photo 1: Yellow silver pine and mountain beech forest and tall manuka scrub in Trent Stream. Low forested skyline ridge is not in survey area. Photo: R. Nichol 10/07/2008.

Photo 2: Manuka/wire rush rush-shrubland east of Escarpment Mine road. Rock pavement at left upper photo, Brazils Dam in distance. Photo: R. Nichol 10/07/2008.

iv) Pink Pine-Mountain Beech/Yellow Silver Pine Forest
A short forest type, with a canopy typically 6–8 m in height. Mountain beech and pink pine dominate the canopy while yellow silver pine often forms the subcanopy. Southern rata and mountain cedar are sometimes emergent above this low canopy. Yellow silver pine is prominent within the dense lower tiers along with *Dracophyllum uniflorum* and celery pine while *Archeria traversii*, southern rata, *Myrsine divaricata*, mingimingi and *Coprosma pseudocuneata* feature to a lesser extent. *Gahnia procera* and moss species are common in the ground tier along with regenerating seedlings of the above species.

This forest association predominates in places on the southern ridge slopes as well as being one of the main vegetation types within the fluvial gully systems. In the latter situation it tends to occupy the eastern aspect slopes. This community is often fringed by tall manuka shrubland. This association also occurs along the steep bluffy slopes on the western side of the Escarpment Mine road.

v) [Mountain Beech]/Manuka Scrub
Mountain beech is occasionally emergent over a low manuka canopy (2–4 m height) that also contains celery pine, southern rata, soft mingimingi, mountain beech. There is a mixture of other species such as mountain flax, *Dracophyllum uniflorum*, pink pine, *Myrsine divaricata* and yellow silver pine. The undergrowth is dominated by *Gahnia procera*, *Blechnum procerum* and regenerating manuka, while moss and litter are conspicuous ground cover.

This association is often transitional between forest and low manuka shrubland, though it may form an unbroken cover throughout large areas of shallow gully systems. Manuka shrubland is found along the eastern shore of Brazils Dam, on the fringes of the taller forested areas in the central and southeast corner of the survey area and in many of the shallow fluvial gullies.

vi) Manuka/Wire Rush Rush-Shrubland
A low community, usually between 100 and 500 mm high, with variable shrub cover dominated by prostrate manuka and wire rush. Other cover species include *Dracophyllum politum*, *Carpha alpina*, *Celmisia dubia* and *Drosera spatulata*. The tussocks *Chionochloa juncea, C. australis* and *C. rubra* occur in varying degrees of importance. *Oreobolus strictus, Donatia novae-zelandiae* and *Lycopodiella lateralis* are characteristic of some areas.

This association occurs over many of the gentle gradient areas underlain by flat coal measure pavement or on gently undulating slopes. Better drainage tends to favour this association (c.f. those sites on which rushland develops).

vii) Manuka /Wire Rush Rushland
Prostrate manuka provides open shrub cover over *Chionochloa juncea*, wire rush, *Carpha alpina, Celmisia dubia*, *Lycopodiella lateralis* and *Oreobolus strictus*.

This community differs from the previous group by having generally denser cover, greater dominance of *Chionochloa juncea* and *C. australis* and less cover of *Dracophyllum politum*. There are also a number of other species which are not generally found in the previous group. These include *Dracophyllum palustre*, the hybrid yellow silver pine x pigmy pine and a range of species commonly associated with montane and alpine bogs and seepage areas (e.g. *Utricularia dichotoma, Drosera spatulata, Donatia novae-zelandiae* and *Androstoma empetrifolia*).

This association tends to develop on sites underlain by flat or gentle pavement and often on sites where the surface proximity of the coal measures has retarded soil development. For this reason it is often seen interspersed with quartzose coal measure exposures e.g. near bluff edges or other exposed sites.

This vegetation association and the previous association have a varying component of bare sandstone pavement, estimated on average to occupy about 20% cover.

viii) *Baumea teretifolia*/Manuka-Wire Rush Rushland

Baumea teretifolia, manuka and wire rush dominate this dense association. Other species present include *Chionochloa juncea, Dracophyllum uniflorum* and mosses, while *Pentachondra pumila,* pygmy pine*, Celmisia dubia, Lycopodiella lateralis, Androstoma empetrifolia* and *Donatia novae-zelandiae* form a minor component. This community occupies a small area (approximately one hectare) on a poorly drained ridge crest in the central survey area.

3.3.2 LCDB2 Vegetation Mapping

Vegetation mapping at the level of the vegetation associations in Table 1 was not feasible within the resources of this survey. However LCDB2 vegetation cover classes provide a broad scale vegetation map and it is possible to compare these mapped classes with field observations. The vegetation cover classes for the survey area are shown at Table 2 and Figure 3.

Table 2. Land Cover Database 2 vegetation classes and percentage composition of survey area.

LCDB2 Classes	Area (ha)	%
13 Alpine gravel and rock	0	0
41 Low producing grassland	81.5	57.7
52 Manuka and/or kanuka	6.4	4.5
54 Broadleaved indigenous hardwoods	44.1	31.2
69 Indigenous forest	9.3	6.6
Total	141.3	100

Some of the LCDB2 vegetation cover class mapping did not match with observations during this survey. There are two main areas in which LCDB2 information showed inconsistencies:

- Broadleaf indigenous hardwoods were overestimated at the expense of indigenous forest and manuka shrubland;
- Coal measure tussock grassland might be more accurately defined as shrubland or rushland in which there is a tussock component.

None of the forest vegetation associations observed could be best described as broadleaved hardwoods (cf. Thompson et al. 2003). Their dominant canopy cover species were three beech species and the podocarps pink pine and yellow silver pine. It is estimated that together this forest cover contributes about 25–30% of the survey area. This is largely along the southern portion of the survey area but isolated pockets of low stature forest are found throughout, especially in the fluvial gully systems as well as a tract of forest along the steep slopes on the western side of the Escarpment Mine road.

Figure 3. Map of LCDB2 cover classes within survey area. Cover class names are shown at Table 2.

Manuka shrubland is more extensive than was anticipated by the LCDB2 mapping. In some places even-aged stands of manuka form a continuous canopy over the larger part of a valley system. However, it is difficult to estimate the cover of manuka shrubland since it is variable in stature and often grades into adjacent association types.

The LCDB2 indicates that approximately 58% of the survey area consists of coal measure tussock grassland. In reality, while tussock species (i.e. *Chionochloa juncea*, *C. australis* and *C. rubra*) are present throughout most of the prostrate shrubland and wire rush communities, the proportion of the vegetative cover which is contributed by tussock coverage is usually minimal (less than 20%). In most cases prostrate manuka and wire rush are the dominant species within all low stature associations and this is reflected in the descriptive type name derived for the vegetation plots and the main associations identified here.

Brazils Dam, although twice the size of the LCDB2 minimum mapping unit (i.e. 1 ha), is not separately mapped. It lies within the low producing grassland vegetation cover class.

3.3.3 Vegetation Modification

There is a history of burning of the open coal measures vegetation on the Denniston and Stockton plateaux (Townson 1906, Mason & Moar 1955, Kelly 1992). In the survey area, it is likely that the open coal measures vegetation has been burnt, perhaps repeatedly, although it retains the characteristic pool of species of this infertile superhumid environment (Given & Park 1975). However, the forest vegetation, comprising about 25–30% of survey area, is unlikely to have been burnt.

The open coal measure vegetation is not likely to have replaced more wooded pre-European vegetation. Burnett (1862) wrote, a decade before substantial coal mining activities, that "the

country is spread out before you open, bare, and barren, a desolate wilderness of flat rocks" (p.75). It is also unlikely that the coal measure vegetation has replaced wooded vegetation in the pre-European period, because the area's high rainfall and humidity, low evapotranspiration and temperature and infertile soils are not favourable for the establishment of natural or Polynesian fires (e.g. McGlone 1989).

A subtle form of modification is resulting from cracking and subsidence associated with the former underground coal mining. Approximately 50 ha of the survey area has been pillared (Figure 4). Cracking is largely confined to the area of the Escarpment Mine, the rocky bluff to the west, on the sandstone ridge east of the Escarpment Mine road and around Brazils Dam. In limited sandstone pavement areas, this is allowing the establishment of forest tree species in cracks where material is accumulating, thereby speeding a succession to a future forest cover.

Roading throughout the survey area is quite extensive, with 4WD tracks extending off the Mt Rochfort access road as well as the Escarpment Mine road. West of Trent Stream physical disturbance is limited to an access track and prospecting drill sites (Craig Ross pers. comm. 18/09/2008). Soil disturbance as a result of road formation almost invariably results in colonisation of the road-verge with invasive species.

The number of naturalised plant species is very low (9 out of 131 species; Section 3.4). In the survey area the two main problem species are gorse and heath rush (also commonly known by its scientific name *Juncus squarrosus*). Gorse is very well established around the old Escarpment and Whareatea mine sites, alongside the tracks leading to these, and at Brazils Dam and alongside V8 Stream which has its outlet at the southern end of the dam (Photo 3).

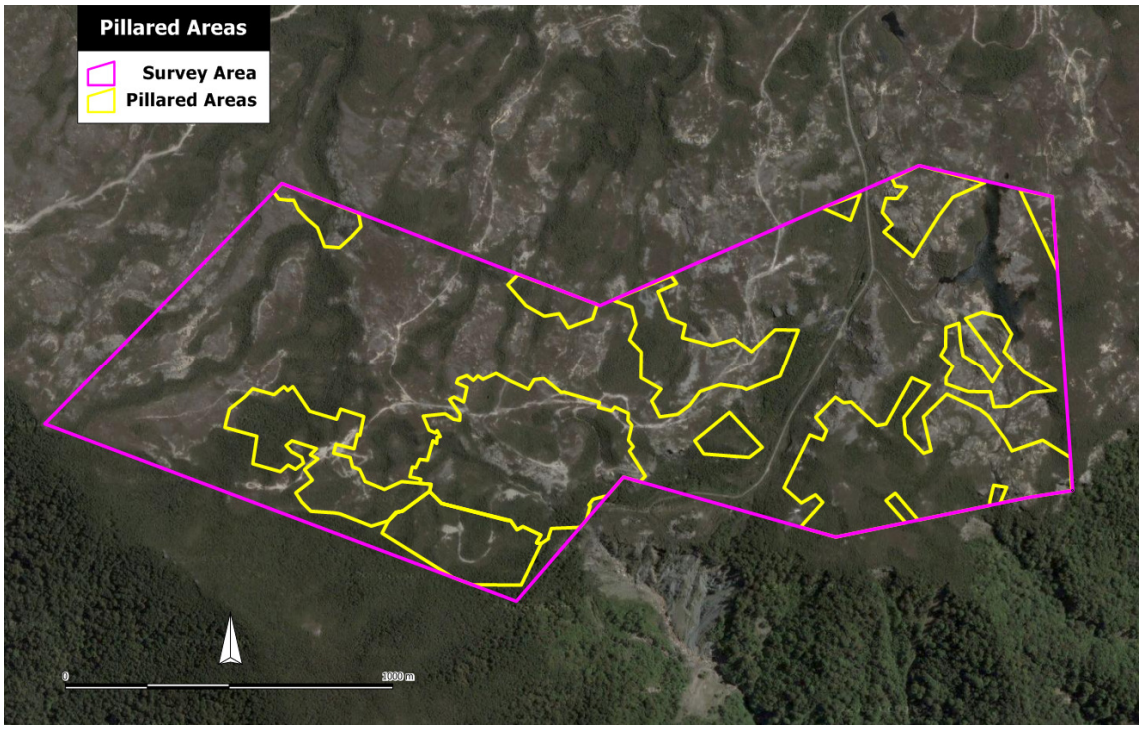

Figure 4. Pillared areas within the survey area, where surface cracking and/or subsidence is occurring or may occur in future and alter existing vegetation patterns. Data courtesy of David Manhire (L&M).

Photo 3. Scrub dominated by gorse and indigenous species on disturbed substrates alongside Escarpment Mine road. Photo: R. Nichol 10/07/2008.

Gorse is probably confined to disturbed areas. Heath rush is found mainly amongst the disturbed sediment of the extensive track network throughout the survey area, though it tends to become less prevalent in a westward direction.

In addition, a number of exotic grasses, as well as the native koromiko, have colonised road-side earth disturbance sites. Establishment of koromiko appears to have been hastened by the formation of the road to Escarpment Mine; this shrub is common along this stretch but seems to be starting to colonise areas away from obvious disturbance.

Browsing by introduced animals was generally not very conspicuous in the survey area. The habitat appears to be less than optimal for possums and most obvious sign was on *Pseudopanax colensoi* on the road to Escarpment Mine. Most plant species are of low palatability. Goats were seen along the ridgeline on the southern boundary of the survey area, frequenting dry overhangs. Some deer sign was seen in a few places.

Overall, approximately 20% of the survey area (mainly the forest) is considered to have highly natural vegetation and about 60% has probably had a fire history but has not been burnt in recent decades and is in relatively natural condition. About 20% of the survey area has been highly modified by a combination of fire, roads and other mining activities and weeds.

3.3.4 Flora

A total of 131 vascular plant species was recorded in the survey area, 122 (93%) of them native and 9 (7%) naturalised (Appendix 1).

One threatened plant species, a single red mistletoe (*Peraxilla tetrapetala;* gradual decline, Hitchmough et al. 2007) was found in the west of the survey area (GPS E2407473 N 5936131; Figure 5). The plant was located near the base of a 2 m high mountain beech tree. The tree was stunted and had dead upper limbs, indicating an unhealthy condition. Although no further specimens were found during a short search of the site locality, further searching especially at flowering time (mid-December to mid-January) may result in finding more plants in the survey area. This species was once abundant in the 'Westport district' (Townson 1906), but now occurs in very small populations or as single plants in Buller, North Westland and Northwest Nelson (Overmars 1997, Courtney 1997, DOC Bioweb). Five were found at Cedar Creek in Ngakawau ED in the early 1990s (Overmars et al. 1998) but whether these remain is uncertain. It remains abundant in some parts of New Zealand (de Lange & Norton 1997).

Two populations of the fern *Sticherus flabellatus* (Photo 4) found in the centre of the survey area represent the southern limit of this fern species in New Zealand (GPS E2409181 N5936188, E2409206 N5936222; Figure 5). A larger population occurred in a rocky cliff overhang and the smaller one (five fronds only) occurred in a nearby small rock crevice. The overhang is on a north-facing quartz sandstone escarpment. The main overhang is about 10 m wide, 3 m high and about 5 m above the surrounding landform and vegetation. To the west the bluff extends a further 10 m and has small localized overhang areas. Water seeps into cracks and crevices in the overhang and the floor of the overhang is also damp. While the upper parts of the overhang are mostly bare of vegetation, the lower parts support diverse vegetation that includes small plants of woody species to about 1 m tall (e.g. manuka, mountain flax, quintinia) and also herbaceous species and ferns. A total of 32 species was recorded (Appendix 2). The plateau sandstone surface is only about 3 m above and has prostrate coal measure vegetation and bare rock surface.

These populations lie 10.5 km southwest of the previously known southern limit for this species on the Kiwi Fault line (Norton & Overmars 1990). This represents a significant range extension for this fern of mostly warmer climates (Takaka, northern North Island and eastern Victoria to New Guinea; Given 1982).

Pseudowintera traversii was found within the survey area and here is near its southern distribution limit at Mt Rochfort (Overmars & Norton, unpubl data).

The following species are not threatened or at distribution limits but their presence in and near the survey area is notable:

- *Chionochloa juncea* is common but endemic to Ngakawau ED;
- *Pseudowintera traversii* was found in the western segment on the margin of the survey area. This shrub is found only in Northwest Nelson and North Westland (Eagle 2006) and has its southern limit near the survey area at Mt Rochfort. It was noted at a number of upland sites in Ngakawau ED (Overmars et al. 1998) but its distribution there has been reduced by recent mining on Mts Frederick and Augustus;
- *Metrosideros parkinsonii* is a small tree that occurs in bluffy parts of the coal measure forests; it has a disjunct distribution, northern North Island and northwest South Island;

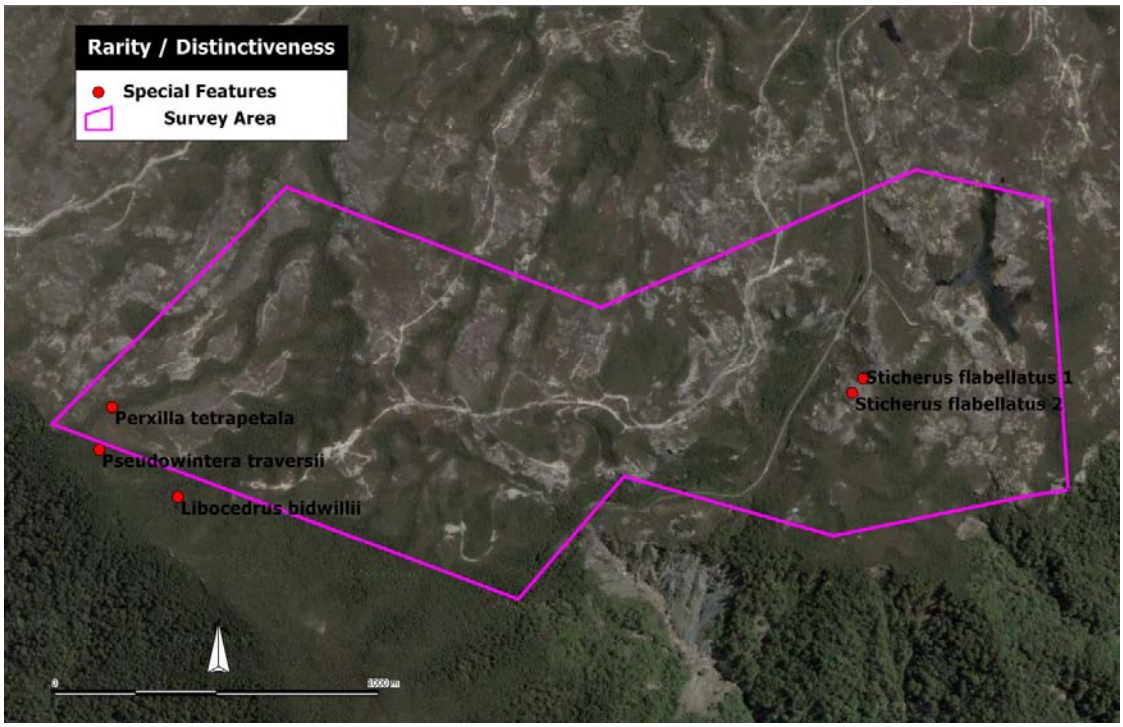

Figure 5. Location of rare and distinctive flora in and near the proposed coal mine area. *Peraxilla tetrapetala*, red mistletoe; *Libocedrus bidwillii*, mountain cedar.

Photo 4: *Sticherus flabellatus* in a rock overhang on a sandstone pavement ridge east of the Escarpment Mine road. This is a fern for this fern of mostly warmer climates and reaches its known southern limit in the survey area. Photo: F. Overmars 30/08/2008.

- *Actinotus novae-zelandiae* is a small sub-alpine herb with a localised national distribution. *Actinotus* prefers cushion bogs and flushed areas in forest and scrub (Mark & Adams 1986) and was seen in a number of situations within the survey area;
- The minute herb *Euphrasia wettsteiniana* is largely confined to boggy ground and very easily overlooked except when flowering. It was not seen during the current survey. Its preferred habitat is well represented within the poorly drained rushland sites and detection of its presence would be facilitated by follow-up survey work during summer. It is no longer listed as rare or threatened, but it is endemic to west Nelson and North Westland (Williams & Courtney 1999);
- Mountain cedar is regarded as uncommon within Ngakawau ED (although it is common elsewhere). It forms a minor but physiognomically significant component of three of the four forest types identified during this survey. Regeneration of this species is occurring outside of the core forest areas – a small sapling (about 2 m tall) was seen growing in a modified landscape next to V8 Creek. The dead remains of tall specimens were noted around Escarpment Mine and it appears that these died as a result of natural causes rather than as a result of fire or other human influence. Overmars et al. (1998) identified mountain beech-cedar forest as an uncommon and distinct vegetation type within Ngakawau ED, although it also occurs elsewhere. It occurs on the toe-slopes of the Mt William Range, flanking the Waimangaroa River, and as part of a complex forest-scrub mosaic east of the Blackburn pakihi. The presence of cedar, within a number of cohorts, in different parts of the survey area, is one of its special features. These trees are located mainly on the southern periphery of the survey area.

Several other species of interest were seen near Escarpment Mine. Some of these have colonised sites where the natural vegetative cover had been stripped or modified. Pigeonwood, mountain cabbage tree and *Cordyline banksii*, soft tree fern and wheki were seen in the roadside vegetation approaching Escarpment Mine. Mountain cabbage tree is uncommon in the district (Overmars et al. 1998) though both *Cordyline* species appear to be colonisers of roadside vegetation. Likewise, lemonwood, which has a limited distribution in Ngakawau ED, was noted at the road fork to Escarpment Mine and Brazils Dam in roadside vegetation.

Several plants that appear to be hybrids of *Pseudowintera traversii* and *P. colorata* (Sampson 1980) were found in a chasm on the margin of the survey area (GPS 2407383 5936081).

3.4 Survey Limitations

There have been no previous vegetation and flora surveys within the proposed coalmine area and this survey has been baseline account only. Inevitably its coverage is not comprehensive and it has been constrained by the winter timing of the survey.

Were potentially significant populations of threatened species missed because of the timing of the survey? The orchid *Calochilus paludosus* ('sparse', Hitchmough et al. 2007) has been recorded from the Stockton area and may be present on the Denniston plateau and would have been subterranean at the time of survey. The risk that a significant population of this species was missed is considered to be very low because of its relatively low conservation status (sparse) and because the plant is probably more abundant than its records suggest because of its inconspicuousness. Follow-up survey work, while desirable, is not considered necessary for species whose identification was made difficult or impossible by the timing of this survey.

However, follow-up surveys are recommended to determine if red mistletoe and *Sticherus flabellatus* occur more widely both within and outside the survey area. This information is necessary to ensure that these features have been fully documented for the purposes of the environmental assessment and to indicate whether there are mitigation opportunities off-site for these two features.

4 ECOLOGICAL SIGNIFICANCE OF SURVEY AREA

4.1 Criteria to Assess Ecological Significance

Evaluation criteria are used to assess the ecological significance of a site. They provide an objective means to assess its ecological values. Variation in assessments may arise because ecosystems are complex and an element of judgement is often required, but the intention of using evaluation criteria is to determine significance in a consistent and transparent way.

Two broad approaches for evaluation criteria have been used in New Zealand. The first is sourced from the protected natural areas programme (PNAP); this was adapted, for example, for use in the Buller District Plan (Buller District Council 2004). The second was developed to meet the need of councils and communities to identify significant natural areas for the purpose of Section 6(c) of the Resource Management Act (RMA) 1991. This approach uses four criteria (Norton & Roper-Lindsay 2004): rarity and distinctiveness, representativeness, ecological context and sustainability. The latter four criteria enable a comprehensive, objective evaluation of a site and they incorporate the range of criteria that have been used in previous evaluation schemes.

These four criteria are briefly defined as (after Norton & Roper-Lindsay 2004):

- representativeness – a measure of the current extent of a vegetation type or ecosystem compared to that which existed at some time in the past;
- rarity/distinctiveness – a measure of the presence of rare species (using appropriate threatened species classifications) or of a distinctive species feature (e.g. a species at a distributional level or that is uncommon within an area);
- ecological context – a measure of the ecological role played by an area in the health of the wider ecosystems in its landscape (buffering to another site/reducing edge effects, the potential to enhance connectivity between sites and the provision of critical resources for a species);
- sustainability – a measure of the ability of the identified areas to remain viable or their potential to become viable in the long term.

Use of these criteria is informed by benchmarks established in the recent Government "Statement of national priorities for protecting rare and threatened biodiversity on private land" (Ministry for the Environment & Department of Conservation 2007). Although these priorities were developed for use on privately owned land, they are equally be applicable to conservation land. These priorities are:

- to protect indigenous vegetation associated with land environments (defined by Land Environments of New Zealand at Level IV, 'LENZ'; Leathwick et al. 2003) that have 20% or less remaining in indigenous cover;
- to protect indigenous vegetation associated with sand dunes and wetlands, ecosystem types that have become uncommon due to human activity;

- to protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2;
- to protect habitats of acutely and chronically threatened indigenous species (i.e. endangered and vulnerable).

These priorities express the first two criteria in the Norton & Roper-Lindsay (2004) conceptual framework. The priorities include specific measures for representativeness (20%) and threatened species (endangered and vulnerable status) and specific rarity/distinctiveness features (sand dunes and wetlands, 'originally rare' ecosystem types).

For the purpose of this assessment, the set of evaluation criteria promoted by Norton & Roper-Lindsay (2004) is adopted because they are simply expressed, scientifically grounded and widely used. There has been some debate over the use of the sustainability criterion (Denyer et al. 2005, Roper-Lindsay & Norton 2005) but this debate is more germane to urban remnants than the Denniston plateau area.

4.2 Representativeness

Methods

Although LENZ has been the preferred ecosystem classification system for assessing representativeness on the West Coast (e.g. Smith & Norton 2001) and is used in setting national priorities for protecting biodiversity on private land (Ministry for the Environment & Department of Conservation 2007), there are significant problems with its application for representativeness analysis at Level IV. Rather, in this analysis, land-vegetation systems in Ngakawau ED are classified using the 1: 250 000 geological QMAP series (Nathan et al. 2002[2]) in conjunction with the known close relationship between West Coast landforms, soils and vegetation types (e.g. Norton 1991, Overmars et al. 1998). In effect, the geological-vegetation units are a surrogate measure of the historical extent of the vegetation types that occur on them.

Indigenous vegetation on Brunner coal measures in Ngakawau ED comprises an altitudinal sequence from stunted or dwarf podocarp beech forests near the Mokihinui Valley (200 m asl) through the shrub and tussockland communities of the coal plateaux to alpine vegetation on Mts Rochfort, William, Augustus and Frederick, all over 1000 m (Overmars et al. 1998). The altitudinal range (600–820 m asl) of the vegetation in the proposed coalmine area lies in the upper middle of this sequence. To assess its representativeness, this vegetation has been compared with vegetation elsewhere on the Denniston plateau on Brunner coal measures, using the LCDB2 vegetation cover classes[3]. The analysis was confined to the Denniston plateau because LCDB2 does not adequately differentiate the natural vegetation on sandstone pavement on the Stockton plateau from current and former mine areas associated with the Stockton mine and because vegetation on sandstone pavement is different between the two plateaux (Overmars et al. 1998).

This representativeness analysis does not consider faunal and aquatic values, as these are reported separately (Buckingham 2008, Resource and Environmental Management 2008).

[2] Digital data supplied by GNS Science. This comprises interim datasets that have not yet passed full attribution or verification tests.

[3] Despite the inaccuracies described in found Section 3.3.2, LCDB2 vegetation cover class mapping is preferred to LENZ as the latter does not at all distinguish vegetation classes on elevated coal measure substrates in the Ngakawau ED.

Results

Ngakawau ED[4] has an area of approximately 45144 ha, of which 36281 ha (80.4%) is public conservation land (Table 3). The proposed coal mine occurs almost entirely on QMAP unit Brunner Coal Measures and the total area of this map unit (including landslide material of coal measure origin) in Ngakawau ED is 12327 ha (27.3% of the ED). A high percentage of this is protected as public conservation land (8043 ha, 65.2%)

Table 3. Representativeness features of Brunner coal measures vegetation in Ngakawau ED/Denniston plateau and its representation in public conservation land (PCL). Brunner coal measures includes landslide material of coal measure origin. BCM = Brunner coal measures.

	Area (ha)	% of Ngakawau ED	% of BCM	% of BCM on Denniston Plateau
Ngakawau ED	45144			
PCL in Ngakawau ED	36281	80.4%		
Brunner coal measures in Ngakawau ED	12327	27.3%		
Brunner coal measures in Ngakawau ED in PCL	8043	17.8%	65.2%	
Brunner coal measures on Denniston plateau	2844	6.3%	23.1%	100%
Brunner coal measures on Denniston plateau in PCL	2644	5.9%	21.5%	93.0%

The current indigenous vegetation as defined by LCDB2 on Brunner coal measures on the Denniston Plateau and within the survey area is shown at Table 4. Loss of natural cover on the Denniston plateau is approximately measured by LCDB2 classes 1 (built-up area) and 20 (lake and pond) plus a proportion of 13 (alpine gravel and rock) associated with roads and tracks. If natural vegetation is defined as LCDB2 classes 41, 52, 54 and 69 only, then 2753.4 ha (90.5%) remains. A very high proportion of the Denniston plateau is protected in public conservation lands (93%).

Table 4. Land Cover Database 2 vegetation classes of survey area in relation to the extent of Brunner Coal Measures on Denniston Plateau.

% of BCM on Denniston Plateau	% of BCM on Denniston Plateau	% of BCM on Denniston Plateau	% of BCM on Denniston Plateau
0.0	0.0	0.0	0.0
12.5	12.5	12.5	12.5
0.7	0.7	0.7	0.7
22.3	22.3	22.3	22.3
1.3	1.3	1.3	1.3
0	0	0	0
5.0	5.0	5.0	5.0

These levels of ecosystem loss do NOT trigger the benchmark that necessarily establishes high representativeness value (<20%), as formalised in the recent statement of national priorities for protecting biodiversity on private land (Ministry for the Environment & Department of Conservation 2007). Nor are they are in any under-protected category (Walker et al. 2005).

[4] As defined by DOC West Coast (pers. comm.).

These broad measures that indicate generally low representativeness value for the vegetation in the survey area are supported by the choice of the Mt Rochfort area as the recommended area for protection (RAP) to represent the Denniston plateau in the DOC Protected Natural Areas Programme report (Overmars et al. 1998).

However, at a national level, Ngakawau ED is the only ecological district in New Zealand defined by the presence of extensive elevated coal measure rocks and associated landforms, vegetation and flora including endemic species (McEwen 1987, Overmars et al. 1998). The two vegetation associations in the survey area that contain *Chionochloa juncea* as a significant cover species (numbers vi & vii, Section 3.3.1) are found only in Ngakawau ED, although such vegetation is widespread elsewhere in the ecological district. This biogeographic context warrants assigning a higher representativeness value than the LCDB2 analysis indicates, and the vegetation of the survey area is overall considered to have a medium representativeness value.

Although the LCDB2 vegetation cover classes within the survey area remain relatively common, have a high level of legal protection and are better represented elsewhere in the Ngakawau ED (e.g. Mt Rochfort RAP), all indicating low representativeness value, their distinctive ecological character and limited national distribution warrant a medium representativeness value.

4.3 Rarity/Distinctiveness

One threatened plant species, a single red mistletoe (gradual decline), was found on an unthrifty mountain beech tree in the west of the survey area. Additional individuals of this species may be found with follow-up survey effort. Two populations of *Sticherus flabellatus* found in the centre of the survey area represent the southern limit of this fern species in New Zealand. This represents a significant range extension for this fern of mostly warmer climates. *Pseudowintera traversii* found on the southwest margin of the survey area is near its southern limit at Mt Rochfort.

The presence of mountain cedar in three of the four forest vegetation associations in the survey area is noteworthy, as this species is uncommon within Ngakawau ED (Overmars et al. 1998). It is not a nationally threatened species however.

The number of indigenous vascular plant species found in the survey area (122) is high for a reconnaissance level survey in a fairly small area.

The sandstone erosion pavements of the survey area fall within the scope of national priority 3 (to protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2) of the recent Government "Statement of national priorities for protecting rare and threatened biodiversity on private land" (Ministry for the Environment & Department of Conservation 2007). As previously noted, these priorities can be equally applied to protection of biodiversity on conservation land. Naturally rare plant community types have been identified as important because they hold about half of New Zealand's nationally threatened plant species, which is vastly disproportionate to their total area. Williams et al. (2007) also list cliffs, scarps and tors of quartzose rocks as a naturally rare ecosystem; this also occurs in the survey area. While no nationally threatened plant species were found in these two naturally rare ecosystem types, the main *Sticherus flabellatus* population was found in an overhang on a rocky bluff in the Brunner coal measures.

The survey area is considered to have a high rarity/distinctiveness value. Most of these features lie on the western and southern margins of the survey area but the Sticherus flabellatus *populations lie in the centre east of the area.*

4.4 Ecological Context

The survey area contains a diverse vegetation mosaic which includes at least eight distinct communities. It lies within an extensive matrix of mainly natural and protected habitats in Ngakawau ED, including the Denniston plateau, the Mt Rochfort RAP and the densely forested low-altitude catchments of Cascade Creek and the Orikaka River. It has a range of vegetation associations that reflect variation in parent material and soil, slope and drainage, vegetation disturbance and shelter. It lies in a transition zone between the low and rather sparse sandstone pavement vegetation on the plateau and the tall lowland red beech forests in the Cascade Creek catchment. The survey area is relatively small against the scale of these surrounding ecosystems.

The seasonal habitat component of ecological context relates to fauna and is not further considered here.

The survey area is considered to have a medium ecological context value for flora and vegetation.

4.5 Sustainability

The survey area is large and is surrounded by natural habitats. Mostly, its vegetation and flora values are sustainable without significant management inputs. Minor changes will or may occur from the following sources: further vegetation change consequent upon cracking and subsidence, disturbance by vehicles to the margins of some roads and tracks, and further spread of invasive species to disturbed sites and even undisturbed sites in the case of heath rush.

The survey area is considered to have a high sustainability value for vegetation and flora.

4.6 Summary of Survey Area Significance

The significance values of the survey area for flora and vegetation are summarised at Table 5.

Table 5. Ranking of survey area on site significance criteria. For explanation, see text.

Criterion	***Ranking***
Representativeness	Medium
Rarity and distinctiveness	High
Ecological context	Medium
Sustainability	High

5 ASSESSMENT OF ENVIRONMENTAL EFFECTS

5.1 Description of the Proposal

It is understood that the entire survey area will be subject to opencast coalmining. It is anticipated the existing vegetation and flora will be replaced by an indigenous vegetation cover that will reflect post-mining surface conditions. An indicative rehabilitation plan has been prepared (Ross 2008) but detailed prescriptions of post-mining surfaces and possible re-vegetation were not available at the time of report writing.

5.2 Possible Alternative Locations or Methods

These are beyond the scope of this baseline vegetation and flora assessment.

5.3 Actual or Potential Effects

5.3.1 Effects on Representativeness Values

The two principal LCDB2 vegetation cover classes of the survey area are low producing grassland and broadleaved indigenous hardwoods (Table 2). These two classes in the survey area comprise 12.5% and 22.3% of the total area of such vegetation on the Denniston plateau (and smaller but unknown percentages of the total area on the Stockton and Denniston plateaux). The potential loss of the areas of these areas to coal mining, while not small (124 ha), would not reduce these vegetation classes to levels that trigger high representativeness values (Section 4.2). The potential losses of the other LCDB2 vegetation classes in the survey area would be very minor (Table 4).

5.3.2 Effects on Rare and Distinctive Features

Most specific rarity and distinctiveness features found lie on the margins or immediately outside the survey area (Figure 5). The *Pseudowintera traversii* population is about 30 m outside the approximate application area boundary as shown on Figure 5 and one of the main cedar occurrences cuts across this boundary and extends about 20 m inside it. Effects on these populations may be avoided by excluding these areas from mining and providing some buffering (e.g. 50 m).

The potential loss of the single red mistletoe plant would be significant as it is one of just a few extant occurrences in an area where this species was once very common (Section 3.3.4). Follow-up survey effort to determine the extent of the local population in and outside the application area may result in other plants being found, making for a more complete assessment of the scale of the effect of mining on red mistletoe. A conservative approach now would be to protect this single plant, which because of its haustorial connection necessarily requires protection of the host mountain beech tree. The mistletoe and its host lie approximately 100 m inside the approximate application area boundary, at its southwestern corner. Retention *in situ* would probably require would probably require the retention of the forested gully and associated drainage, which comprise an area of 1–2 ha. An alternative option is to transplant the mountain beech host but this is not likely to be successful given the apparent ill-thrift of the host. However, beech trees up to 5 m tall have been successfully transplanted during mining restoration (Ross et al. 2000) and this option could be further investigated if required.

The southern limit of *Sticherus flabellatus* lies in the centre of the proposed mining area and effects on it from opencast coal mining will probably be difficult to avoid. The loss of a distribution limit is not as significant for biodiversity conservation as the loss of a threatened species population; rather it may (or may not) represent a particular genotype that is adapted to live at the limits of the species' range. Distribution limits are also significant in scientific understanding of a species' adaptation to environmental conditions. The significance of the loss of the population in the proposed mining area might be reduced if other populations could be found in nearby parts of the Denniston plateau. A follow-up survey to see if there are other nearby populations, both within and outside the survey area, would increase certainty of the scale of the possible loss of the *Sticherus* populations and reduce the significance of the loss if other populations were found. Transplantation or re-establishment to nearby suitable sites, if they could be found, is likely to be very difficult in the harsh environmental conditions and the apparent need for a very specific habitat (rock overhang) and would detract from the scientific value of the southern limit record. Follow-up survey to find the local extent of *Sticherus flabellatus* is recommended, as is an investigation of the feasibility of off-site translocation and even re-translocation back to the original site in the post-mining landscape.

5.3.3 Effects on Ecological Functioning and Life Supporting Capacity

The proposed mine and accessory operations would cause the loss of indigenous forest, scrub and open coal measures vegetation and create ecological edge effects on the adjoining vegetation, for the duration of mining and until post-mining rehabilitated vegetation has been completed. This loss would be of a lengthy but finite period of time (some decades).

This loss could be mitigated in two ways:

- A high standard rehabilitation programme building on the indicative rehabilitation plan (Ross 2008). However, modern rehabilitation techniques still allow only the picking out of some elements for reestablishment - rehabilitation is only successful for certain species and practical for fewer species again. Further, the plateau environment presents a very harsh physical environment for plant life and establishment and growth of plants within rehabilitated areas will be greatly retarded by the extreme climate, soil conditions etc. Sandstone pavement vegetation is likely to be the most difficult to re-create. Rehabilitation at Stockton has shown that although ecosourced plants can be propagated and established on-site after mining has ceased, these re-created communities are unlikely to ever truly represent the original vegetation condition;
- by a commitment to an off-site environmental offset programme, such as seeking legal protection and/or conservation management for non-protected under-represented ecosystems in Buller (e.g. coastal and alluvial ecosystems).

It will be important to prevent or control the establishment and spread of weeds both within the rehabilitation process and off-site, including preventing the introduction of new species with machinery, road metal etc. Use of gravels from the beds of rivers that carry didymo (*Didymosphenia geminata*) may pose a risk of spreading this invasive non-indigenous freshwater diatom into waterways on the plateau.

In New Zealand beech forests three species of pinhole borer (*Platypus* spp.), in association with fungal pathogens of the genus *Sporothrix*, are a risk to the forests when there are large amounts of recently dead, persistently moist wood (Wardle 1984). Increased populations arising from an increase of suitable habitat (e.g. through vegetation clearance) could stimulate mass attacks that overwhelm defences of adjoining trees. Suitable host material

includes healthy and weakened trees, stumps and freshly felled logs and larger branches. Outbreaks are more likely to occur when trees are stressed and will become apparent only when broods have been successfully raised (2–4 years). Beech logs stored in vegetation stockpiles or on rehabilitated sites, if left as they are, are likely to provide suitable conditions for *Platypus* beetles – a large supply of recently dead, permanently moist wood. Effective mitigation is warranted, notwithstanding there is some uncertainty about the reliability of current mitigation methods (McCracken et al. 1994, Brockerhoff & Baker 2003).

The proposed vegetation loss may cause the release of carbon dioxide to the atmosphere. The scale of this effect has yet to be determined but appropriative means to minimise and mitigate it exist or are being established (e.g. post-mining revegetation and off-site animal pest control). Vegetation is also at risk from fire.

5.3.4 Effects on Surrounding Ecological Landscape

The proposed mine (148 ha) represents a small but not insignificant proportion of an extensive matrix of mainly natural and protected habitats in Ngakawau and Buller EDs. The post-mining flora and vegetation patterns are likely to be different to the present and could introduce fragmentation, weeds and pests into the surrounding ecosystems. The potential effect of this alteration on the flora and vegetation of the surrounding area is difficult to assess in the absence of more detailed knowledge of likely post-mining vegetation patterns. Restoration as far as possible to existing patterns is desirable.

5.4 Possible Mitigation Measures

Possible mitigation measures for the effects of the proposed coal mine on vegetation and flora values include:

Pre-Mining and Mine Design

- Design to minimise the disturbed area consistent with mining objectives;
- Minimising and mitigating the release of carbon dioxide to the atmosphere from the proposed vegetation loss, for example through minimising the vegetation storage quantity by direct transfer of this material as far as possible to rehabilitated sites;
- Exclusion from mining of floristic features on the margin of the survey area, including red mistletoe, *Pseudowintera traversii* and most cedar occurrences, and/or possibly by investigating the feasibility of transplanting the currently known single red mistletoe and its mountain beech host;
- Undertaking a follow-up survey during the mistletoe flowering period (mid-December to mid-January) to find whether further red mistletoes occur inside or adjoining the survey area, and protecting any that are found and/or establishing and protecting a new off-site population (which may include collaring of host trees and predator control to enhance bird pollination and dispersal success);
- Undertake a follow-up survey to determine if *Sticherus flabellatus* occurs more widely both within and adjoining the survey area, focussing on likely habitats (i.e. rock overhangs), and investigate the feasibility of off-site translocation and even re-translocation back to the original site in the post-mining landscape;
- Preparation of a comprehensive rehabilitation plan, including weed and pest management, to restore the mined areas to a cover of indigenous species that would necessarily be different at least in part to the current vegetation composition because of the altered substrates but that would be compatible with the surrounding ecosystems. This would build on the indicative rehabilitation plan;

- Preparation of a fire contingency plan before commencing operations, including listing safety codes, providing secure storage for fuels and ensuring adequate precautionary measures are in place (e.g. fire extinguishers and access to water, no-smoking within 10 m of stored fuels);
- Off-site legal protection and/or conservation management for non-protected under-represented ecosystems in Buller (e.g. coastal and alluvial ecosystems), or for threatened species (e.g. search for red mistletoe in nearby areas and protect these and also the other known occurrence in Ngakawau ED at Cedar Creek);
- Off-site compensatory weed and pest control to restore the ecological integrity of other sites of similar ecological character, possibly including contributing to or taking on responsibility for the current DOC gorse control programme on the Denniston plateau;
- A risk assessment that the roading use of gravels from lowland rivers infested with didymo poses to waterways on the Denniston plateau.

Mining

- Prevention or control of the establishment and spread of weeds on and off-site;
- Adequate fire control measures;
- Minimising pinhole borer attack risk by:
    a) minimising the creation of at-risk hosts during vegetation clearance by using directional felling to avoid or minimise damage to adjacent trees and by minimising beech vegetation storage;
    b) cutting trunks and branches greater than 20 cm mid diameter into 1–2 m lengths to accelerate drying or breakdown;
    c) promoting the rapid breakdown of in-situ tree stumps by application of urea (and then covering with moss and humus);
    d) scheduling tree felling for autumn and early winter when risk of attack is reduced.
- Implementation of the rehabilitation plan in conjunction with mining.

Post-mining

- Completion of the rehabilitation plan, including monitoring of its success and taking remedial action if necessary.

6 MONITORING

A full monitoring programme will need to be developed once decisions on mine development have been made and the effects of flora and vegetation are better defined. Monitoring of vegetation and flora recovery would be an important part of the rehabilitation plan.

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APPENDIX 1. Vascular plant species recorded in survey area.

Botanical Name	Common Name
Trees and Shrubs	
Archeria traversii	
Androstoma empetrifolia	bog mingimingi
Coprosma colensoi	
Coprosma foetidissima	stinkwood
Coprosma lucida	shining karamu
Coprosma pseudocuneata	
Coprosma tayloriae	
Cordyline banksii	tī ngahere
Cordyline indivisa	broad-leaved cabbage tree
Dracophyllum filifolium	
Dracophyllum palustre	swamp neinei
Dracophyllum politum	
Dracophyllum traversii	mountain neinei
Dracophyllum uniflorum	turpentine scrub
Elaeocarpus hookerianus	pokaka
Epacris alpina	nehenehe
Epacris pauciflora	tamingi
Gaultheria antipoda	bush snowberry
Gaultheria depressa var. novae-zelandiae	
Gaultheria rupestris	
Griselinia littoralis	broadleaf
Halocarpus biformis	pink pine
Hebe salicifolia	koromiko
Hedycarya arborea	pigeonwood
Lepidothamnus intermedius	yellow silver pine
Lepidothamnus laxifolius	pigmy pine
Leptecophylla juniperina	mingimingi
Leptospermum scoparium	mānuka
Leucopogon fasciculatus	tall mingimingi
Libocedrus bidwillii	kaikawaka
Metrosideros parkinsonii	Parkinson's rata
Metrosideros umbellata	southern rata
Myrsine divaricata	weeping matipo
Myrsine salicina *x* Myrsine divaricata	
Neomyrtus pedunculata	rōhutu
Nothofagus fusca	red beech, hututawai
Nothofagus menziesii	silver beech, tawhai
Nothofagus solandri var. cliffortioides	mountain beech, tawhai rauriki
Ozothamnus leptophyllus	tauhinu, cottonwood
Pentachondra pumila	
Phyllocladus alpinus	mountain toatoa, celery pine
Pinus radiata *	radiata pine
Pittosporum crassicaule	
Pittosporum eugenioides	lemonwood

Podocarpus hallii	Halls totara
Pseudopanax colensoi var. ternatus	
Pseudopanax linearis	
Pseudowintera colorata	mountain horopito
Pseudowintera traversii	
Quintinia acutifolia	Westland quintinia
Raukaua simplex	haumakāroa
Ulex europaeus *	gorse
Weinmannia racemosa	kamahi
Lianes	
Metrosideros diffusa	white rata
Metrosideros perforata	small white rata, aka
Muehlenbeckia australis	pōhuehue
Rubus cissoides	bush lawyer
Dicotyledonous herbs	
Abrotanella linearis	
Actinotus novae-zelandiae	
Anisotome aromatica	aromatic aniseed
Brachyglottis bellidioides	
Celmisia alpina	
Celmisia dallii	
Celmisia dubia	
Celmisia gracilenta	common mountain daisy
Celmisia similis	
Donatia novae-zelandiae	
Drosera spatulata	sundew
Forstera mackayi	
Gentianella montana subsp. montana var. stolonifera	bog gentian
Hypochaeris radicata *	catsear
Mitrasacme montana var. helmsii	
Nertera depressa	
Nertera villosa	
Monocotyledons	
Agrostis capillaris *	browntop
Anthoxanthum odoratum *	sweet vernal
Astelia linearis	
Astelia linearis	
Astelia sp. (unnamed; aff. A. nervosa)	
Baumea teretifolia	pakihi rush
Carpha alpina	
Centrolepis ciliata	
Chionochloa australis	carpet grass
Chionochloa juncea	
Chionochloa rubra ssp. occulta	red tussock
Cortaderia richardii	toetoe
Crocosmia × crocosmiiflora *	montbretia

Earina autumnalis	Easter orchid
Empodisma minus	wire rush
Gahnia procera	giant sedge
Herpolirion novae-zelandiae	grass lily
Holcus lanatus *	Yorkshire fog
Juncus effusus *	soft rush
Juncus squarrosus *	
Lepidosperma australe	square-stemmed sedge
Libertia micrantha	
Microlaena avenacea	bush rice grass
Oreobolus pectinatus	combsedge
Oreobolus strictus	
Phormium cookianum	mountain flax
Phormium tenax	NZ flax
Schoenus pauciflorus	sedge tussock
Thelymitra pulchella	
Uncinia gracilenta	
Winika cunninghamii	

Ferns and Fern Allies

Asplenium flaccidum	hanging spleenwort
Blechnum discolor	crown fern
Blechnum fluviatile	ray water fern
Blechnum novae-zelandiae	kiokio
Blechnum procerum	small kiokio
Blechnum vulcanicum	mountain hard fern
Cyathea colensoi	mountain tree fern
Cyathea smithii	soft tree fern
Dicksonia squarrosa	harsh tree fern, wheki
Gleichenia dicarpa	swamp umbrella fern
Grammitis billardierei	
Histiopteris incisa	water fern
Hymenophyllum multifidum	much-divided filmy fern
Hymenophyllum rarum	
Leptopteris superba	Prince of Wales' feathers
Lindsaea trichomanoides	
Lycopodiella lateralis	
Lycopodium scariosum	creeping clubmoss
Microsorum pustulatum	hound's tongue fern
Paesia scaberula	lace fern
Polystichum vestitum	prickly shield fern
Rumohra adiantiformis	leather fern
Schizaea australis	southern comb fern
Sticherus cunninghamii	umbrella fern
Sticherus flabellatus	
Tmesipteris tannensis	
Trichomanes strictum	erect bristle fern

APPENDIX 2. Indigenous vascular plant species recorded at *Sticherus flabellatus* bluff site.

Botanical Name	Common Name
Trees and Shrubs	
Archeria traversii	
Coprosma colensoi	
Coprosma foetidissima	stinkwood
Dracophyllum politum	
Epacris alpina	nehenehe
Leptospermum scoparium	mānuka
Leucopogon fasciculatus	tall mingimingi
Libocedrus bidwillii	kaikawaka
Metrosideros parkinsonii	Parkinson's rata
Metrosideros umbellata	southern rata
Nothofagus menziesii	silver beech, tawhai
Phyllocladus alpinus	mountain toatoa, celery pine
Quintinia acutifolia	Westland quintinia
Weinmannia racemosa	kamahi
Dicotyledonous herbs	
Brachyglottis bellidioides	
Celmisia alpina	
Celmisia dubia	
Celmisia similis	
Drosera spatulata	sundew
Forstera mackayi	
Astelia sp. (unnamed; aff. A. nervosa)	
Monocotyledons	
Carpha alpina	
Chionochloa australis	carpet grass
Oreobolus strictus	
Phormium cookianum	mountain flax
Blechnum procerum	small kiokio
Ferns and Fern Allies	
Dicksonia squarrosa	harsh tree fern, wheki
Gleichenia dicarpa	swamp umbrella fern
Lindsaea trichomanoides	
Schizaea australis	southern comb fern
Sticherus flabellatus	
Trichomanes strictum	erect bristle fern