

PORTERS SKI AREA

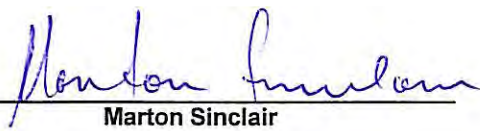
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prepared for Porters Ski Area Ltd

Preliminary Engineering Report For Proposed Porters Ski Area Expansion.



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1 Porters Ski Area Expansion Project

1.1 Introduction

Eliot Sinclair and Partners has been engaged to complete the preliminary design of the ski field trails, the village and access roading and the summer access road / ski out trails for the proposed Porters Ski Area Expansion in preparation for plan change and resource consent applications.

This report describes the design features and environment relevant to the access road /ski out trails, ski field trail design and the village roading. It also describes the design considerations, preliminary design concepts and identifies the engineering related effects which are relevant to the resource consent considerations.

1.2 Project Description

The proposal involves the expansion of the Ski Area terrain into the adjoining Crystal Basin, the construction of a ski village with the provision of accommodation and vehicle parking at an elevation of about 960metres amsl in the Porter River Valley. The ski village will be located on elevated river terraces adjacent to the north bank of the Porter River between the Porter Stream and the Crystal Valley Stream.

Extensive road upgrades and new roading will be required to service the Ski Area including the upgrading of the main access road from the State Highway and new village roading to a standard suitable to accommodate the projected visitor numbers.

Large numbers of buses and private vehicles are expected to visit the site on a daily basis.

It is expected that when fully developed Porters Ski Area will receive up to 6700 visitors per day during the ski season and up to 600,000 visitors per year.

Crystal Basin to the north east of the present Porters ski field will be opened to skiers and boarders by the construction of trails and installation of lifts and a Day Lodge.

Access to the Crystal Basin will be exclusively by a gondola direct from the village to the Day Lodge at 1510 metres amsl. Eventually access to the

existing Porters Basin will be provided by a gondola direct from the village. At this time public vehicle access to the Porters Basin will be discontinued.

A ski out trail from Crystal Basin to Porters Basin will also serve as summer maintenance access. A steeper ski out trail will also run from the Porters Basin to the Village Base Area with a branch trail to the Crystal Chalets.

Extensive snow making facilities will be installed to extend the ski season and provide snow on the ski out trails and the snow play area planned for the village.

2 Description of Existing Environment

2.1 General

Boffa Miskell, CPG and URS have extensively described the existing environment and geology in their associated reports and much of this is relevant to the ski field trails and roading. It has not been repeated here but is referred to in the list of references attached.

2.2 Present Access and Ski Area

The present Porters Ski Area access road follows the valley floor from State Highway 73 past the lime quarry and runs alongside and above the Porter River to a stream crossing below the proposed Village Base Area. From there the access road winds up the valley to the present ski field base facilities. The road gradients are classed as easy as far as the stream crossing but they steepen markedly for the climb to the present ski field.

The road carriageway is generally 6-7 metres wide and provides the only access for the public to the Ski Area. It is presently unsealed from State Highway 73. Gradients are not steep and normally chains do not need to be fitted to most vehicles except immediately after heavy snow.

The existing access road crosses the Porter River just up river of the confluence of the Porter River and Crystal Stream, and then steepens as it climbs to the present Ski Area.

There are a number of tight hairpin turns on the steeper section of road leading up to the ski field. The road was formed by excavation and side casting of the excavated material and crosses scree slopes and rocky bluffs.

Two buildings are present in the general locality of the proposed Village Base Area at an elevation of about 950metres amsl. These are the on-field staff accommodation unit and the Porter Heights Ski Club lodge. The Ski Club lodge will be incorporated into the village design but the on-field accommodation building will be removed.

Extensive base facilities are present adjacent to the existing Ski Area car parks well up the mountain at an elevation of 1300metres amsl. Ski tows run from the ski field car park area to the ridge at the top of the Porters Basin at an elevation of 1950 metres amsl.

The initial 2 kilometres of road from the State Highway also gives access to a lime quarry operated by Springfield Lime and adjacent farmland.

2.3 Crystal Basin

Crystal Basin, the site of the proposed Ski Area expansion is a large open valley facing southwest and subdivided by a small ridgeline into north and south basins. This area is to be developed for a new Ski Area which will be complimentary to the existing Porters Basin with a Day Lodge, mountain administration and ski field operations facilities.

A large rocky bluff immediately below the proposed Day Lodge and on the extension of the dividing ridgeline provides a suitable location for this building although earthworks are required to create the necessary level areas around the Lodge.

During winter the access to the Ski Area from the village will be by gondola only although the ski out trail will function as an access road for maintenance purposes during summer. The public will not use the access road for vehicular access, only as a winter ski out trail.

The ecology and geology of the basin have been described by Boffa Miskell and URS in their reports.

The basin walls consist of extensive scree slopes giving way to tussock and other sparse vegetation on the basin floor. The soils consist of rock screes, glacial moraines and rock avalanche debris with sand and gravel deposits.

Rock outcrops around the ridgelines and at isolated locations are also present. The soils are extremely permeable and surface water does not appear to flow on the basin floor area except where springs outcrop immediately above the basement rock below the proposed Day Lodge.

The gradients of the terrain range from flat to steep with typical basin floor gradients of 15° to 25° steepening to 37° on the scree slopes. The soil deposits of the basin floor are generally poorly graded and consist mainly of coarse gravels and angular cobbles to boulders. Boulders may range in size up to 1 metre in diameter but most are less than 300mm in diameter.

2.4 Ski Out Trails

The Crystal Basin ski out trail will fall from the proposed Day Lodge to the existing Porters Ski Area at a constant grade of 7% and width of 6 to 7 metres. The trail will cross the southern face of the Crystal Basin and then the lower slopes of Bluff Face to join the existing Ski Area just above the upper Pomma terminal on the intermediate slopes.

The terrain is steep and consists of tussock-covered slopes giving way to rock bluffs and scree slopes. The typical slope gradients are 30° to 37° but up to 60° on the rock bluffs.

A further ski out trail will be constructed to fall from the existing Porters Ski Area down a valley immediately north east of the main Porters Stream to the Village Base Area with a branch trail to the Crystal Chalets. This will have a typical gradient of 25% and a width of 6 to 12 metres.

The valley down which the trail will run is largely concealed and is not visible from the present Porters access road. The vegetation along this route is predominantly tussock and low shrubs.

3 Site Investigations

Site investigations have been undertaken by both CPG and URS and reported on in their associated reports. The key points from those reports are summarised as follows:

- No active faults have been identified in the immediate vicinity of the Village or proposed Ski Area but faulting is present along the Porter River Valley.

- The soils on the elevated terraces within the Village Base Area consist of either glacially deposited till/moraine or fluvio-glacial material that has been deposited by river processes. These materials comprise silty/sandy gravels with cobbles overlain by a layer of yellow loess silt about 0.5 metres thick.
- Rock is not expected to be encountered in the shallower foundations for the village buildings.
- The URS assessment confirms that the Village Base Area is essentially stable on a large scale and is not likely to be subject to rock or snow avalanche.
- The CPG assessment confirms that the soils of the village area are free draining with high permeabilities.

Extensive walkover surveys of the valley floor alongside the Porter River and the Porter Basin and in the Crystal Basin were undertaken to assess the topography and soils and to determine the constraints on earthworks required to form the new access roads, village, ski area access and ski terrain in the Crystal Basin.

The investigations and inspections confirm that the ski out trail route from Crystal Basin crosses the scree slopes and rock bluffs on the southern side of the Basin and will be subject to scree debris deposition and minor rockfall. The route may also be subject to avalanche and will need avalanche control in a similar manner to the ski field.

The access road along the Porter River has been subject to avalanche in past years but these have been controlled in conjunction with the normal ski field operations.

The access road is elevated above the river and will not be subject to flooding from the Porter River. The section of access road at the chain-fitting bay has the least elevation above the river. Flood level predictions by URS for the Porter River indicate that the road in this area will have a freeboard of 1.8m in a 1 in 100 year AEP event.

These surveys and the investigations by URS and CPG confirm that there are no major constraints on the earthworks required to form the access and village roading.

The construction of the ski trails and the service areas about the Crystal Basin Day Lodge will involve extensive earthworks, some of which will involve rock excavation.

The coarse poorly graded nature of the materials and the steep gradients indicate that it will not generally be feasible to transport material upslope to fill areas. The earthworks operations will be planned such that most excavated material will be transported down slope to fill locations in the immediate vicinity.

The stormwater design and the erosion sediment control design will be undertaken by CPG and is not included in this report.

4 Road Construction Standards

4.1 General

There are no New Zealand standards that relate specifically to rural roads that lie within snow prone areas and no standards are set in the Selwyn District Plan for such roads.

The Austroads standard " Guide to Road Design Part 3: Geometric Design" is generally used for rural road design and is considered applicable to the geometric design for the Ski Area access road from the State Highway. This standard covers the horizontal and vertical alignment as well as lane widths, drainage and associated matters.

The Porters Ski Area access road will be classified as a low speed rural road given the steep terrain and frequent snow and ice conditions during winter. The operating speed for such a road is in the range of 50 to 70 km/hr.

The extreme alpine climate will require special measures to combat snow and ice covered roads. Well-established techniques such as snow clearance and gritting of the roads are available to minimise these effects.

Frost heave of road carriageways and other surfaces can result in pavement damage and increased maintenance costs. Minimising this effect requires good road surface drainage, impermeable pavements and effective water table drains that minimise water entry into the road metal courses.

4.2 Geometric Standards

4.2.1 Road Gradients

The recommended maximum gradient specified by Austroads for low speed rural roads is 1: 10 or 10% although it is accepted that steeper gradients may be warranted in special circumstances.

In order to provide a comparison, the gradients of the State Highway climbing from the Christchurch side of Porters Pass were assessed and found to be in the range of 14.5% to 9.5%. The initial section of the climb up to Porters Pass on the Christchurch side is at the flatter gradient and experience indicates that most vehicles including two-wheel drive vehicles can negotiate this section of the road most of the time without fitting chains. However the steeper section of the last 1 km east of the Pass can be difficult for many vehicles even with chains fitted.

The policy adopted for the Porters Ski Area access road is that the road gradients should not exceed the flatter gradient on the State Highway climbing to the Porters Pass and where possible should not exceed 9.5%. This means that if vehicles can negotiate the Pass without chains they will also be able to climb to the village without chains. Conversely if they have to fit chains they will need them on the village access road as well. The motorists' experience will therefore be similar on both roads.

4.2.2 Carriageway Widths

The Austroads standards recommend a lane width of 3.5m making a total sealed carriageway width of 7.0 m. Additional allowance then needs to be made for shoulder construction. This will be a combination of sealed shoulder and metal shoulder taking the sealed carriageway width to 7.5m.

A typical carriageway cross-section is attached as Appendix 1.

4.2.3 Horizontal and Vertical Alignment

The Austroad standard sets requirements for sight distances and horizontal and vertical alignments. These standards will be complied with for the design of the access road from the chain-fitting bay to the Village and within the Village.

5 Proposed Roding

5.1 Porters Ski Area Access Road (SH73 to Village)

The access road along the line of the legal road is not part of this application but may be upgraded to a sealed carriageway of 7.5m width to the normal rural road standards in consultation with the Selwyn District Council. It is intended that from the present chain fitting bay opposite the confluence of the Porters River and the Crystal Stream to the Village that the access road will follow the existing alignment but be re-graded and lifted to reduce the present gradient to a maximum gradient of 10%. Due to non-compliance with NZTA standards for sight-lines the intersection with the State Highway may have to be relocated. If so this will result in a change in road alignment for a certain length back from the State Highway. This will be subject to negotiations with the landowner.

5.2 Village Roding

Within the Village Base Area and extending to the Crystal Chalets new roding will be constructed with gradients generally not exceeding 10%.

Care has been taken in the design for the village roding to avoid falling gradients on the leg to a tee intersection, as under ice or snow conditions a braking vehicle may be unable to stop for right of way traffic.

The carriageway width will generally be 7.5m with an allowance for a parking lane in some areas subject to detailed design. In other locations defined parking areas will be provided and a parking lane will not be necessary.

Within the Village Centre the carriageway will be confined by kerbs, both in order to provide for carriageway drainage and to confine vehicles in wet and snow conditions.

In other respects the village roding will comply with the requirements of NZS 4404:2004 'Land Development and Subdivision Engineering'.

5.3 *Crystal Chalets Access Road*

The Crystal Chalets access road climbs at a gradient of 10% to a turning head at the upper end. Access to the individual chalets will be directly off the road or via driveways serving groups of units.

The carriageway width will generally be 7.5m with off carriageway parking provided at suitable locations. The carriageway will be sealed but with metal shoulders falling to a water table on the uphill side. This will be provided with a coarse stone aggregate lining to prevent scour as described in the CPG stormwater report.

5.4 *Ski Field Access Road (Village to Porters Ski Field)*

The section of the existing road immediately above the Village Base Area passes through an area set aside for a series of streamside apartments (visitor accommodation) chalets. This will become a cul-de-sac with a turning head at its end.

It is intended to construct a new access road to give access to the Porters Chalets and to connect with the existing ski field access road. This will pass south of the slope below the Porters Chalets and climb to meet the second hairpin bend on the present access road. The access to the Porters Chalets will branch off this to the south of the ridge. The road gradients on this section of road will be between 10% and 11.2%.

The carriageway will be sealed to a width of generally 7.5m but with widening on the bends and metal shoulders falling to a water table on the uphill side. This will be provided with a coarse stone aggregate lining to prevent scour as described in the CPG stormwater report.

This road will predominantly be used by the ski field staff and summer maintenance vehicles accessing both the Porters and Crystal Ski Areas. Private vehicles will not be allowed beyond the Village boundary (at the end of the Porters Chalets access road) once the gondola to the Porters Ski Area is operational.

6 Earthworks

6.1 Porters Ski Area Access Road (SH73 to Village)

The present main access road from the chain-fitting bay does not meet the gradient requirements as it climbs from the Porter River to the village. In order to achieve the design gradients the road will be re-graded using the excavated material from the Village Base Area. The re-grading will result in a substantial culvert and embankment at the Porter River crossing with filling and reshaping of the side slopes on the climb to the Village. The road will however generally follow the existing alignment.

The embankment will be 10 metres above the valley floor at the stream crossing to provide the required road gradients. As some side slope filling will extend onto the lower river terraces riprap protection will be provided where there is a risk of river flood levels reaching the toe of the embankments. Except at the river crossing the road embankments will not extend into the flood channel of the Porter River.

The filling of the access road to create the design gradients will account for much of the excavated material that is created by the excavations for the village core.

6.2 Village Centre

A significant volume (133,000m³) of excavation to a depth of 10 metres will be required to form the underground car parking under and adjacent to the Village Centre and the Snow Play Area. This material will be available to assist with the re-grading of the access road from the chain fitting area to the village.

Within the village the road levels will be dictated by the access requirements to the car parking areas, plaza level and the route to the hotel and Crystal Chalets. The Village Centre has been designed to match the topography as far as is practical, but shaping of cut and fill batters will be required. Cuts and fills typically 1-2m in height will be created in order to form the road. However occasional and limited areas may have cut slopes of up to 4m in height.

It is anticipated that cut banks will be retained by a combination of walls and planting, batter slopes etc where there is a risk of fretting and frost heave causing bank instability.

6.3 Crystal Chalets

The access road to the Crystal Chalets will be formed with cuts and fills of up to 1 to 2m although there may be occasional cuts of up to 4 metres in limited areas. Fill on the lower side of the road will be constructed to high standards such that chalets can be built within the fill areas.

It is anticipated that cut banks will be retained by a combination of walls and planting, batter slopes etc. where there is a risk of fretting and frost heave causing bank instability.

The volume of excavated material resulting from the formation of the Crystal Chalets roading is approximately 9,000m³.

6.4 Ski Field Access Road (Village to Porters Basin)

The ski field access road will be deviated to the south of the Porters Chalets and will climb the side slope to the second hairpin bend in the present ski field access road. It will cross an area of shallow landsliding before returning to the northeast to meet the existing ski field access road. The earthworks associated with the construction of this section of road will involve cut to fill over most of the length. As far as possible the volumes of cut and fill will be balanced to minimise the heights of cut batters.

Within the landslide area retaining structures may be required on either the lower or upper sides of the road depending on the detailed geotechnical design. It may also be possible to reinstate some of the landslide area with stable fill batters as an alternative to retaining structures.

It is anticipated that surface and subsurface drainage will be installed to reduce hydraulic pressures and protect the road area from surface water flows when undertaking earthworks in the landslide area.

The existing ski field road above the second hairpin bend will not be upgraded or sealed as part of the development as the traffic will be restricted to service vehicles once the access chair lift is installed.

A slight surplus of material after cutting and filling to form the ski field access road will be used to fill the main access road in the vicinity of the Porter River crossing. The volume to be excavated will be approximately 24,000m³.

6.5 Ski Out Trails

6.5.1 Porters Basin to Crystal Basin

A 6 to 7 metre wide access trail is to be constructed from Porters Basin to the Crystal Basin Day Lodge. . At no time will this trail be accessible for public vehicles.

In addition to providing summer access and a winter ski out route the trail will provide a route for power and communications cables along with water and sewage pipelines that serve the Crystal Basin Ski Area.

The route, which is some 1600 metres long from Porters Basin to the Crystal Basin Day Lodge traverses a number of extensive scree slopes and rock bluffs.

In order to minimise the extent of side cast material on the lower side of the trail the cross section will be formed mostly in cut material. The excavated material will consist almost entirely of angular rock and gravel. Some of this material will be screened to provide aggregates for the road surfacing and other construction materials. The remainder will be placed in a permanent stockpile on the lower car park at the present Porters Ski Area. The stockpile will be levelled to maintain the car park areas and to provide for materials storage during construction of the Crystal Basin Ski Area.

At between 1100 metres and 1450 metres from the Porters Basin several very steep scree slopes within deeply incised rock gullies will necessitate extensive gabion basket walling to support the lower side of the trail. The scree slopes are active and during the spring thaw and during summer rainfall scree will be deposited on the trail requiring periodic clearance. In these areas the trail cross-section will be mostly in fill to minimise excavation into the scree slope.

Where rock bluffs are encountered the rock will be excavated to form steep (approximately 60°) slopes on the uphill side of the trail.

The finished surface of the trail will be a well-graded sandy gravel aggregate suitable for construction and maintenance traffic.

The excavated material from the ski out trail will be approximately 24,000m³.

6.5.2 Porters Ski Area to Village Base Area

A ski out trail will be constructed from the Porters Ski Area to the Village down the northeastern gully. This trail will be steeper, at 25%, than the Crystal Basin

ski out trail and will involve excavation and filling to form a 6 to 12 metre wide trail.

The soils in this area are mostly gravels overlain by a loess capping and will present no difficulties in construction. However as the gravels will contain higher levels of silts the establishment of suitable tussock and other grass species will be required to stabilise the finished track surface.

This trail will not be used for access under summer conditions and does not need a gravel surface.

This trail will provide a route for the underground services from the Porters Basin and Crystal Basin to the village and a water supply reservoir located on the ridgeline above the village.

The volume of excavated material required to form the trail will be approximately 28,000m³. The trail alignment has been adjusted to balance the cut and fill requirements as far as possible.

6.6 Crystal Basin -Trail and Base Formation

A large level area is required on which to site the Day Lodge and beginner and novice facilities. Much of the excavation of this area will be in rock and may be up to 16 metres deep. The excavated material will be used to form the lower ski trails especially in the Basin to the east of the Day Lodge and in the vicinity of the lower terminal for the chair lift. Volume calculations indicate that there is a reasonable balance of cut to fill in this area.

The design of the trails is governed by the need to achieve gradients suited to beginner, novice and intermediate level skiers as these skiers dominate the skier population. The terrain areas must be in proportion to the skier population to avoid a mismatch between areas and skier numbers. In addition trails nominated as suitable for a skier level must not contain a section of greater difficulty. These criteria have been integrated into the trail design and have dictated the extent of the terrain modifications.

Upslope in the central Basin area some material must be cut from steeper areas to fill lower land and achieve the design gradients. In general this material can be moved short distances down slope rather than upslope.

In the upper Basin area extensive excavation and filling will be required to form the snowmaking reservoir. In addition extensive earthworks will be

required to form the trails leading from the upper chair terminal. These trails must be formed in the scree slopes by side casting material which is excavated from the scree slope above the trail.

Excavation and filling will also be required in the south basin above the Day Lodge to form the novice and low intermediate trails. Again the formation of these trails will involve the excavation and side casting of material from the scree slopes.

The rock and gravels obtained from the cut areas will be coarse and poorly graded and will require heavy construction plant to excavate, place and compact them.

The ski trail earthworks will be subject to detailed design but it is clear that with the use of appropriate plant the materials can be placed to the required standards.

The volume to be cut and placed in the upper half of the Basin is approximately 300,000m³ and in the lower half of the Basin is 400,000m³.

7 Geotechnical Constraints

The URS report describes the geotechnical, seismic and flooding issues associated with the site extending from the Porter River Valley up to the Crystal Basin and is not repeated here.

7.1 Porters Ski Area Access Road (SH73 to Village)

The access road requires re-grading to achieve the design gradients. The depth of fill to be placed on the line of the existing road for this purpose is up to 10 metres at the river crossing. This will involve the placing of fill on the valley floor in locations that could be subject to inundation by extreme flood events in excess of the 100-year event.

Protection of the toe of the fill by the use of large selected stone rip rap will be effective in protecting the toe of the fill slopes in such circumstances.

The culvert at the Porter River crossing will be designed for the 1 in 100 year event of 39 cumecs with backing up to 4 metres above the bed of the river.

7.2 Village Area

There are no significant geotechnical constraints in the proposed Village Area although the ground steepens markedly as it falls to the Porter River below the car parking building which will require specific foundation design for buildings and earthworks.

The toe of the spur to the north of the Village will be over-steepened during the excavations and will be retained where stable batter slopes cannot be formed.

The snow play area above the Village in the Porter Valley will be excavated below existing ground level to form suitable gradients. Stable batter slopes will be created using suitable retaining systems where necessary.

The Porter Valley stream passes through this area and the western end of the Village. The flow path will be provided with sufficient capacity to convey the 100 year AEP event.

7.3 Crystal Chalets Access Road

The Crystal Chalets Access Road climbs up the river terrace to the south of the Crystal Stream to terminate in a cul-de-sac. Cut banks formed during the road construction will be retained or battered to stable slopes. Where the road encroaches on the edge of the river terrace specific design of retaining structures will be required.

7.4 Ski Field Access Road (Village to Porters Ski Area)

The new ski field access road climbing the spur to the south of the ridge line will cross an extensive landslide area that is now largely evacuated to the underlying slide surface at an estimated 2 to 3 metres depth. Further geotechnical investigation of this slide area is required for design purposes but it will be possible with appropriate surface and subsoil drainage, retaining structures and fill batters to form the road across the slide area.

The road will be formed partly in fill and partly in cut across the side slopes of the spur. Experience with the existing cut banks on the Porters access road has shown that the cut banks will stand at steep angles (approximately 60°) without retaining although there will be some fretting of the cut surfaces due to frost heave. Material accumulating at the toe of such banks can be removed during road maintenance works.

8 Ski Out Trails

8.1 Porters Basin Ski Trails

8.1.1 Porters Basin to Crystal Basin

The route of the access trail from Porters Basin to the Crystal Basin is severely constrained by geotechnical issues. Initially it must cross several large shingle screes before reaching the ridgeline and entering the Crystal Basin Ski Area where again it must cross a number of shingle screes and rocky bluffs including two deeply incised gullies before reaching the flatter terrain of the Crystal Basin Day Lodge area.

The shingle screes are active and significant volumes of material will need to be moved in order to create stable slopes within the shingle slopes above and below the access trail.

The rocky bluffs consist of highly fractured and jointed greywacke blocks which can be excavated with heavy construction plant. It is likely that 6-8m high rock batters will be created on the upper side of the access trail and that some of this material will be prone to fretting and release of small rocks especially under freeze/thaw conditions.

The deeply incised gully crossings will largely be constructed by forming stone filled gabion basket walls on the lower side of the roadway and a minimal cutting on the uphill side of the roadway. This will enable the shingle scree within these gullies to pass over the roadway and continue down slope, although periodic grading of the access track surface will be required to move the scree deposits from the upper side to the lower side of the track. These gullies do not appear to carry surface waters flows although it is likely that the permeable rock within the gullies will carry subsurface water under rainfall and spring thaw conditions.

The route of the trail has been carefully chosen to provide a summer access trail and ski out trail between the Ski Areas but also to cut across as high as possible on the scree slopes and to cross the gullies and other scree slopes at suitable locations which minimises the construction difficulties.

The scree slopes below the access trail fall to the Crystal Stream and are generally at their angle of repose which is close to 37°. Fill material placed on these slopes could overload the slopes and result in increased rates of downslope movement of the scree. Unless further investigation is undertaken to establish the effect of placing rock and gravel on the scree slopes this should be avoided.

8.1.2 Porters Basin to Village

The ski out trail will follow the south face of the ridge extending from Bluff Face to the Village and will be partially formed in cut and partially in fill. The material is primarily glacial moraine with a capping of loess. Removal and re-establishment of vegetation will be required on the trail and where necessary on the batter slopes.

There are no other geotechnical constraints that will affect the design of the trail.

8.2 Crystal Basin Ski Trails

Crystal Basin is composed of scree slopes, rock outcrops, debris flows and glacial moraines with a capping of loess and finer soils on the lower basin floor. These materials do not present any geotechnical difficulties although large construction plant will be required to excavate, transport and place them.

Excavation of the bedrock will be required in the vicinity of the Day Lodge to form the platform for the ski facilities. It is anticipated that specialised plant will be required to undertake this work.

The upper terminal to the 6-seater chair serving the Crystal Basin will be located below a rock bluff projecting from the scree slopes at the head of the Basin. The bluff will give a good foundation and will provide avalanche and rock fall protection to the upper terminal. However the bluff is highly fractured and jointed. Scaling and bolting and the installation of steel mesh will be required to protect the terminal structure from rock fall originating on the bluff.

8.3 Conclusion

The design of the roading and ski trails for the Porters expansion project has been advanced to the preliminary design stage. A number of issues, especially of a geotechnical nature have been identified but these can be overcome with appropriate design and construction techniques.

Both the access roading and village roading can be designed to meet the appropriate standards and requirements.

Of particular note are the extreme climate conditions which require consideration of the design measures necessary to combat frost heave and ice and snow. The measures proposed in response to these conditions have been set out in the relevant sections above.

9 References

Boffa Miskell Limited: Porters Proposed Ski Area Expansion: Assessment of Ecological Effects

CPG New Zealand Ltd: Porters Ski Area: Wastewater, Stormwater and Water Supply Infrastructural Options Assessment Report *June 2010*

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10 Drawings Index

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