

THE HILLS RESORT LIMITED

THE HILLS RESORT ZONE, ARROWTOWN

**ADDENDUM NATURAL HAZARDS ASSESSMENT
HOUSE SITES HS6 TO HS15, SPORTS GARDEN
& ACTIVITY AREA A1**

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Report prepared by: Geotago Ltd
36 Glencoe Road
Arrowtown Junction
9371

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Task	Geotago Personnel	Title	Date Signed
Author of Report	Peter Forrest BSc PhD FGS CEngNZ (PEngGeol)	Director Principal Engineering Geologist	17 Oct 2024
Reviewer of Report	Tom Goosey BSc (Geol) MEngSc (EngGeol & Geotech)	Principal Engineering Geologist	17 Oct 2024



Signature of author of report



Signature of reviewer

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1 Introduction

1.1 Commission & Limitations

Geotago Limited has been engaged by The Hills Resort Limited, in conjunction with Brown & Company, to undertake additional geotechnical and natural hazard assessment to support the proposed plan variation to the current Hills Resort Zone.

Geotago Ltd has undertaken this assessment in accordance with the brief as provided, based on the site and locations as shown on Drawing 001. This report has been provided for the benefit of our client, and for the authoritative council to rely on for the purpose of processing the plan variation for the specific project described herein. No liability is accepted by this firm or any of its directors, servants or agents, in respect of its use by any other person, and any other person who relies upon information contained herein does so entirely at their own risk.

1.2 Proposed Development

The Hills Golf Course is pursuing a plan variation to their existing The Hills Resort Zone (HRZ) zoning under QLDC's Proposed District Plan. At the time the HRZ was promulgated through the District Plan review, an investigation into site conditions (and specifically the natural hazards mapped for the area) was undertaken for the wider site being rezoned, which included ten house sites, identified as HS1 to HS10. The current variation is now seeking additional house sites, to be located in the southern part of the zone.

The current proposal identifies a total of 15 house sites, of which house sites HS6 to HS15 are effectively new locations or in similar positions to previous sites. House sites HS1 to HS5 are existing or 'active' under the current HRZ Structure Plan.

In addition to the house sites, two activity areas have also been investigated as part of this reporting. These sites are depicted on the Proposed Structure Plan as:

- SG: Sports Garden – intended as a recreational area with hard courts and pavilion.
- Activity Area A1 and A1.b being visitor accommodation.

The Proposed Hills Structure Plan and the existing plan with an overlay of the proposed changes, both showing the house sites are presented in Appendix A. The position of the house sites with reference to the current site configuration and land use is presented as Drawing 001.

1.3 Site Description

The area of interest is effectively the southern section of the wider Hills property, located to the west of McDonnell Road and north of Hogans Gully Road. The ten new house sites are all south and west of the current fairways of Holes 17 and 18 of The Hills Golf Course respectively, with house sites HS9 to HS15 all being within the current par three course known as The Farm.

The sports garden area is the flat open space immediately to the south of the golf course main entrance and driveway, adjacent to McDonnell Road. The A1 accommodation area is situated to the immediate north west of the clubhouse and current 18th green, being situated on the current No. 1 fairway.

Prior to the development of the property for the golf courses, associated structures and several residential dwellings, the site comprised farmland. The existing vegetation cover comprises a combination of farm pasture, developed golf course areas, isolated woodland and landscaped areas.

(General site descriptions of the house sites, sports garden and accommodation area are presented in Table 3, Section 6 of this report. Site photographs are presented in Appendix E).

1.4 Project Scope

To support the plan variation, a review and update of the general ground conditions and natural hazards affecting the new house sites is required. In addition, the area identified for the sports garden has been physically investigated and the accommodation area (A1 & A1b) subject to desk top study.

In order to provide an appropriate assessment, the following work has been undertaken:

- Review of the previous site investigation and natural hazards assessments for the property;
- A site walkover and mapping exercise of the ten new house site locations (HS6 to HS15 inclusive) to confirm general ground conditions, surface features, drainage and potential natural hazards;
- Updated natural hazards assessment using the current information available for Otago Regional Council and Queenstown Lakes District Council GIS database portals for natural hazards;
- Summary of the status of each of the current house sites in terms of risks identified from natural hazards and general commentary on geotechnical considerations for development;
- Test pitting in the area of the sports garden to prove ground conditions and potential natural hazards; and
- Desk top assessment of the ground conditions and natural hazard vulnerability of the accommodation area.

2 Previous Reporting

2.1 General

The area of interest has been subject to two former geotechnical investigations and assessments carried out by Tonkin & Taylor in 2008 and Hadley Consultants Limited in 2015. Both reports were associated with proposed residential development, comprising discrete semi-rural building platforms and house sites distributed across the wider Hills property.

2.2 Tonkin & Taylor 2008

Prepared for The Hills Limited, the geotechnical report (reference 891184, dated August 2008) was prepared to determine the general ground conditions, natural hazards and geotechnical considerations for the development of 19 new residential building platforms. The area of investigation extending beyond the current zone, to include land referred to as the South West Block north of Hogans Gully Road and east of Lake Hayes-Arrowtown Road.

Intrusive investigations comprising deep excavated test pits and Scala penetrometer testing was completed across the general area to determine the underlying ground conditions and geotechnical characteristics likely to impact any new development.

The report presents a competent baseline level of information which remains valid for the current proposed plan variation. The following summary is considered to be the most pertinent information:

- The ground conditions comprise glacial deposits (outwash and glacial sediments) overlying dense glacial till, the latter mantling schist bedrock. Schist is also noted to crop out at several locations across the site, some of which comprise cliff and escarpment features.

- Regional groundwater is deep but localised perched groundwater can be expected in areas of surface water and wetland areas. No aquifer resource is anticipated to be affected by any proposed residential development or activity.
- No natural hazards were identified for any of the proposed building platform areas.
- No geotechnical conditions were identified that would pose any significant issue to future development, providing the usual attention to New Zealand design standards, procedures and design criteria were adhered to.

The factual data presented in the report can continue to be relied on for preliminary master planning and concept design purposes, being cognisant of several updated iterations of the Standards referenced by T&T at the time of writing.

A copy of the report is presented as Appendix B for ease of reference.

2.3 Hadley Consultants Ltd 2015

Hadleys were commissioned by Trojan Helmet Ltd to complete a natural hazards assessment for essentially the same area of interest detailed by the previous T&T report. The assessment aimed to address natural hazards affecting specific development areas in support of the Proposed District Plan Submission. The report built on the information previously provided by T&T.

The report was developed to provide a reference document to ‘assess whether any natural hazard constraints exist in a global context which will adversely impact proposed development areas on the Trojan Helmet Ltd land holdings’. In particular, the report addressed natural hazards that would impact on ten identified house sites, with specific recourse to alluvial fan activity, liquefaction and flooding.

Hadley’s investigation included site mapping and reliance on the limited intrusive investigations across the area of interest from the previous T&T information. In addition, it included a review of the QLDC Hazard Maps of the time and evaluation of that information in the context of the topography and geomorphology of the wider site.

The report focused on three defined areas of the wider property, namely the Proposed Rural Lifestyle Areas A and B and the golf course area with the designated sites referenced as

- ‘HS’ (homesites) and
- ‘A’ (visitor accommodation/residential).

It is noted that Areas A and B are outside the scope or area described by this current Geotago Report. In addition, the Hadley report did not assess the former sites referenced then as HS6 and HS7 as they were already developed with residential structures.

In order to provide context to the assessment completed by Hadley’s in terms of the house sites subject to this current assessment, the following table summarises the two sets of sites and their respective references:

Table 1: Homesite Referencing

Hadleys homesites	Current house sites under proposed structure plan	Commentary
HS1	~ HS5	HS5 is ‘Active’ and is not subject to assessment by Geotago
HS2	~ HS9	Approximately the same position
HS3	~ HS10	Approximately the same position
HS4	HS15	Effectively same position

HS5	HS11	Effectively same position
HS6	Existing house site	Occupied with a residential dwelling (now referenced HS4)
HS7	Current Lodge site	Occupied with a residential dwelling (now referenced HS1)
HS8	~ HS7	Also close to current sites HS6 and HS8
HS9	~ HS12	Approximately the same position
HS10	~ HS13 and HS14	HS10 was located in the position halfway between the two new sites.

Based on their assessment of the ground conditions, geomorphology and natural hazards affecting the ten homesites, the following conclusions were drawn:

- Homesites HS1, HS5, and HS8 were identified as free of any natural hazard and as such required no further assessment or mitigation. Standard approach to residential development cognisant of normal building controls and verification would be required.
- Sites HS2, HS3 and HS4 were noted as being within the influence of ephemeral surface drainage features and were wet at the surface at the time of their assessment. In addition, they were considered at risk from failure of the water race situated topographically higher than the sites causing some flooding issues. However, construction at these locations was deemed possible with appropriate drainage and ground improvement.

(It is noted that these sites have subsequently been subject to earthworks and drainage management systems associated with The Farm golf course).
- Site HS9 was located in a slight depression that may attract surface drainage issues, but with appropriate mitigation at construction stage would not negate the site from being developed.
- Site HS10 was identified as being affected by water race leakage that would have to be attended to before development commenced.

A copy of the report is presented in Appendix C for ease of reference.

3 Current Site Investigation

3.1 Test Pitting in the Sports Garden (SG)

Two test pits were excavated in the area of sports garden as shown on Drawing 002. The shallow test pits were completed to prove the shallow soil profile of the area and identify if there were any natural hazard or geotechnical constraints at the site that may influence future development.

The test pit logs are presented below in Table 2 with photographs presented in Appendix E.

Table 2: Ground Conditions in Area SG

Test Pit	Depth (m)	Description
TP SG01	0 -0.3m	Topsoil. Brown sandy SILT with roots and rootlets
	0.3 – 0.6m	Loess. Sandy SILT, light greenish brown, tightly packed, dry. Sand fine grained.
	0.6 – 1.3m	Glacial Outwash. Sandy GRAVEL with some silt, light orange brown, loosely to tightly packed, dry. Sand fine to coarse grained. Gravels fine to medium coarse subangular to subrounded.
	1.3 to 1.5m	Glacial Outwash. Sand with some gravel, grey, loosely to tightly packed, dry. Sand fine to medium coarse. Gravels fine to medium coarse subangular to subrounded.

Test Pit	Depth (m)	Description
TP SG02	0 -0.2m	Topsoil. Brown sandy SILT with roots and rootlets
	0.2 – 0.7m	Loess. Sandy SILT, light greenish brown, tightly packed, dry. Sand fine grained.
	0.7 – 1.4m	Glacial Outwash. Sandy GRAVEL with some silt, light orange brown, loosely to tightly packed, dry. Sand fine to coarse grained. Gravels fine to medium coarse subangular to subrounded.
	1.4 to 1.6m	Glacial Outwash. Sand with some gravel, grey, loosely to tightly packed, dry. Sand fine to medium coarse. Gravels fine to medium coarse subangular to subrounded.

Based on the ground conditions encountered, there are no natural hazard or geotechnical constraints associated with this soil profile. The loess soils would typically provide an ultimate bearing capacity of 200-300kPa, which will increase to 300kPa for the sandy gravels of the glacial outwash at depth.

3.2 Desk Study of Area A1 & A1.b

Due to the position of areas A1 and A1.b being within the current No.1 fairway of the golf course, no intrusive investigation was undertaken. However, based on the previous investigations and the recent investigations completed for the adjacent Golf Training Centre (report by Geotago referenced GL24-140 QT 003 GIR Rev 0), the soil profile will more than likely comprise loess soils over glacial till or outwash deposits.

Because it is part of the fairway and landscaped area, some reworking of the upper natural soils could be expected, but not to the extent that it would pose a geotechnical constraint.

The area of A1 and A1.b does not fall within any identified or mapped natural hazard zone.

4 Current Natural Hazards Assessment

4.1 General

Subsequent to the 2015 report by Hadleys, the databases for natural hazards in the district have been developed with new information from GNS and MfE, particularly around seismic hazard. With the main purpose of this addendum to provide an update on the hazard assessment for the proposed new structure plan, the following subsections review the main hazards affecting the wider area.

The QLDC and ORC Natural Hazards Portals have been reviewed for the purposes of reassessing potential natural hazards that may impact the site(s). The information from the database is used together with our observations from the recent site walkover to inform the discussion below.

Appendix D presents excerpts from the ORC and QLDC hazard mapping.

4.2 Groundwater

With reference to the ORC bore and well database, there are a number of registered wells within The Hills property. The details of these wells indicate that where recorded, the local groundwater regime suggests the water table is between 15 and 20m below current ground level.

4.3 Alluvial Fan

The sites are not underlain by any form of active alluvial fan or alluvial landform. This is concordant with the observations of the previous test pits, whereby colluvial soils and glacial deposits overlay dense glacial till and schist bedrock.

4.4 Flooding

The sites are not prone to flooding. There are no natural surface water courses that are prone to inundation.

4.5 Liquefaction

With reference to the 2019 GNS dataset developed for the ORC the sites are all underlain by ground conditions classified as Domain A. This classification suggests that the ground is predominantly underlain by rock or firm sediments, with a low to zero liquefaction potential. This is aligned with the site investigation data and the fact that the sites are close to the crop out positions of the schist bedrock. In addition, there is no groundwater identified within 15m of ground level, further reducing the risk of liquefaction to extremely low to nil.

The QLDC mapping of the area, which was completed in 2012 at a greater level of detail compared to the ORC database, indicates that the majority of the golf course area is classified as LIC1(P) which underlies wholly house site HS7 and partially underlies house sites HS6, HS8, HS11, HS13 and HS14 and accommodation area A1 & A1b. The remainder of the house sites and the sports garden are located on ground that falls out with the mapping area.

LIC1(P) is described as a liquefaction susceptibility of 'Probably Low Risk' but that it should be subject to site specific investigations for a definitive assessment of liquefaction. Based on the intrusive investigations and assessment carried out by T&T and Hadley Consultants, and the site observations from this current assessment, we are satisfied that the LIC1(P) classification is inaccurate and can be classed as LIC1 with nil to low possibility of liquefaction occurring.

4.6 Slope Stability

Although house sites HS6 and HS7 are situated on or near moderate to steep soil slopes and schist outcrops, there was no evidence of any topographical expression of instability or rock fall. Further investigation of these sites will be necessary at the time of conceptual design to ensure that any potential slope or rock instability is assessed and mitigated.

All other house sites are on undulating to moderately steep slopes that have no evidence of any underlying stability issues and are unlikely to develop any during development.

4.7 Seismic

The soil classification for the sites according to the regional mapping vary from Class B, relating to rock within 3m of the ground surface, and D, relating to deep or soft soils. Based on the investigations undertaken and with reference to the mapping available for the area, these are considered an appropriate classification.

House sites HS6, HS7, HS8, HS10, HS11, HS12 and HS13 are all on ground where rock is at close proximity to the surface and should be considered Class B.

House site HS14 is mapped as on the boundary of Class B and Class D. HS9 and HS15 are on soil classified as Class D.

The sports garden is indicated as Class B, with the accommodation area as Class D.

Soil Classes cannot be confirmed until intrusive site investigation is carried out on the sites at the time of construction.

No active faults were mapped in the field, however, the active NW Cardrona Fault is shown on the published Qm 18 approximately 10km east from the site and the Moonlight Fault some 19km to the west. There is a significant seismic risk to the Wakatipu region when the rupture of the Alpine Fault system occurs; recent probability predictions estimate a magnitude 7.5 or greater is highly likely within the next 45 years. Significant ground shaking is expected from this type of event.

4.8 Conclusions

The current assessment of the natural hazards has not identified any issues that would negate the development of any of the house sites. It is accepted that surface drainage may be a minor constraint to construction and long term stormwater management must be accounted for, but these would be easily mitigated through appropriate design and application of the usual construction methodologies and building codes.

5 Geotechnical Considerations

5.1 General

The geotechnical investigation report provided by T&T for the wider property remains valid as a baseline investigation from which preliminary design parameters can be used. It is anticipated that at the time of design, site specific investigation will be undertaken commensurate with the nature and size of the dwelling being proposed.

5.2 Bearing Capacity for Foundations

On the grounds that all house sites are effectively underlain by glacial till and or schist bedrock, it is reasonable to assume that each and every platform will be effectively 'Good Ground' in accordance to the criteria set out in NZS3604. As such, subject to site inspection and removal of any unsuitable material at the time of construction, an ultimate bearing capacity of at least 300kPa can be used for design purposes.

The soils below the sports garden can be considered NZS3604 'Good Ground' but the accommodation area A1 will need site investigation at the time of construction to prove appropriate bearing capacity.

5.3 Site Drainage

Seepages are common in excavations completed in hillside areas and drainage measures may be required if excessive groundwater seepages are encountered during excavation. This may well be the case in the deeper excavations where perched groundwater may be encountered. The final design and location of all sub-soil drainage works should be confirmed during construction by a suitably qualified and experienced geotechnical engineer or engineering geologist.

Surface overland flow paths and or ephemeral flow will need to be assessed on a site by site basis with mitigation design being influenced by on the design of the dwelling being proposed. House sites HS10, HS11, HS14 and HS15 are the sites most likely to require drainage measures to ensure the building platform and foundations are suitably protected.

Some cognisance of potential overland flow for house sites HS6 and HS7 will be required at design stage. House site HS15 occupies level ground at the toe of two shallow gully systems emanating from the north that would be considered overland flow paths.

The sports garden area is effectively level, so surface water would be sheet flow and soakage to ground. The accommodation area would likely be surface flow to the north, depending on final form of any future landscaping.

Generalised overland flow path directions for the house sites are shown on Drawing 001.

5.4 Slope Stability

The proposed house sites (excluding HS6 and HS7) and the accommodation area are generally located on gentle to moderate sloping topography which are underlain by competent ground conditions and are remote from steeper slopes and/or slopes prone to the development of slope instability features. The sports garden is on level ground.

The modest overall slope angles and underlying competent ground conditions in the vicinity of the proposed house sites and the accommodation area should provide safe and stable ground with respect to slope stability conditions.

A safe and stable building platform is defined as having a low to negligible risk of failure over the lifetime of the dwelling and is assessed as a factor of safety where a quantitative slope stability assessment is undertaken. Given the modest slope angles in the vicinity of the sites, we consider that a qualitative assessment of slope stability (as provided above) is acceptable for defining risk for these sites and that a more rigorous quantitative analysis is not required.

House sites HS6 and HS7 are situated on or close to soil and rock slopes. These sites will require specific site investigation and potentially slope stability assessments to determine mitigation measures for the development of these sites. HS7 is considered the most vulnerable due to the exposed nature of the schist bedrock and the moderately steep to steep north facing slope of the site.

Site earthworks will be required to provide suitable level building platforms within the house sites. It is envisaged that at the time of development, both QLDC's Code of Practice for Land Development and Subdivision and NZS4431:2022 Engineered Fill Construction for Lightweight Structures will be adhered to ensure appropriate design and process are followed.

6 Summary & Conclusions

6.1 General

Table 3 below presents a summary of the house sites HS6 to HS15, the sports garden and the accommodation area in terms of the natural hazards and geotechnical considerations discussed in this report.

In conclusion, there are no significant natural hazards or geotechnical constraints that would prohibit the development of the house sites for residential dwellings, subject to the normal application of building code and development standards.

Table 3: Summary of Natural Hazards and Geotechnical Considerations by House Site.

Sites	Description	Alluvial Fan	Flooding	Surface Drainage	Liquefaction	Soil Class	Slope Stability	Bearing Capacity
HS6	Open site on gently sloping ground with north east aspect. Break of slope with steeper slopes to the north east of the site.	No	No	Sheet flow reporting to the gully to the north east.	Low to Nil risk: Domain A / LIC 1	B	Potential instability to the north east at the break of slope. Can be mitigated at design stage. Not significant risk.	UBC 300kPa
HS7	Located on steep north east facing slopes with exposed schist bedrock forming rock ledges and escarpment.	No	No	Surface drainage to the north	Low to Nil risk: Domain A / LIC 1	B	Rock fall and rock face instability will be an issue for the site during construction and for permanent engineered slopes. Can be mitigated at design stage.	UBC >300kPa
HS8	Open site on the western flank of a shallow gully feature with slopes of 10-18°.	No	No	Surface drainage to the north east.	Low to Nil risk: Domain A / LIC 1	B	No issues.	UBC 300kPa
HS9	Open site of undulating ground with a westerly aspect. Situated within the landscaped Farm golf course	No	No. Race to be considered at design stage.	No definitive surface flow direction, but with a tendency to the west.	Low to Nil risk: Domain A / LIC 1	D	No issues.	UBC 300kPa
HS10	Relatively flat site with slope rising up at 15° to the east and north east. The area to the north east appears to have a small overland flow path and supports long grasses. Drainage noted. Race situated above the site.	No	No. Race to be considered at design stage.	Surface drainage noted to the immediate east of the site. Sheet flow across the site to the south west.	Low to Nil risk: Domain A / LIC 1	B	No issues.	UBC 300kPa
HS11	Open ground situated within a slight depression and undulating ground. No obvious flow paths.	No	No	Seepage to ground.	Low to Nil risk: Domain A / LIC 1	B	No issues.	UBC 300kPa
HS12	Essentially level site within a larger bowl feature. The race is situated to the north east.	No	No. Race to be considered at design stage.	Surface flow to the south west and seepage to ground.	Low to Nil risk: Domain A / LIC 1	B	No issues.	UBC 300kPa
HS13	Currently occupied by a double green of The Farm golf course. Undulating ground with reasonably steep slopes to the south beyond the race.	No	No. Race to be considered at design stage.	Seepage to ground.	Low to Nil risk: Domain A / LIC 1	B	No issues.	UBC 300kPa

Sites	Description	Alluvial Fan	Flooding	Surface Drainage	Liquefaction	Soil Class	Slope Stability	Bearing Capacity
HS14	Adjacent to a surface water feature/small lake. North facing aspect. Surface water course to the 50m west of site.	No	No but close to surface water	Surface flow reporting to the lake and water course to the north and west respectively.	Low to Nil risk: Domain A / LIC 1	B/D	No issues.	UBC 300kPa
HS15	Site currently occupied by existing farm shed and yards. The ground to the north and north east of the site slope down towards the site area, with two overland flow paths within the gully systems.	No	No.	Sheet flow to the south, reporting to Hogans Gully Road.	Low to Nil risk: Domain A / LIC 1	D	No issues.	UBC 300kPa
SG	The site occupies level ground adjacent to McDonnell Road.	No	No	Seepage to ground	Low to Nil risk: Domain A / LIC 1	B	No Issues	UBC 300kPa
A1 & A1b	Modified ground with a general slope to the north (current golf course area).	No	No	Surface flow to the north	Low to Nil risk: Domain A / LIC 1	D	No Issues	UBC 200kPa to 300kPa

Drawings





Appendix A – Proposed Structure Plan & Overlay Plan

KEY

- G Golf course, open space and farming
- C Clubhouse
- A Visitor Accommodation / Residential
- HS Homesite (3000m² max.)
- S Resort Service & Staff Accommodation
- DR Driving Range
- GF Golf Training Facility
- SG Sports Garden
- H Helicopter Landing Area

Note: all activity areas include G: Golf course, open space and farming

-  Activity Areas
-  Road Access
-  Access Point
-  Walking / Bike Trail (Location Indicative)

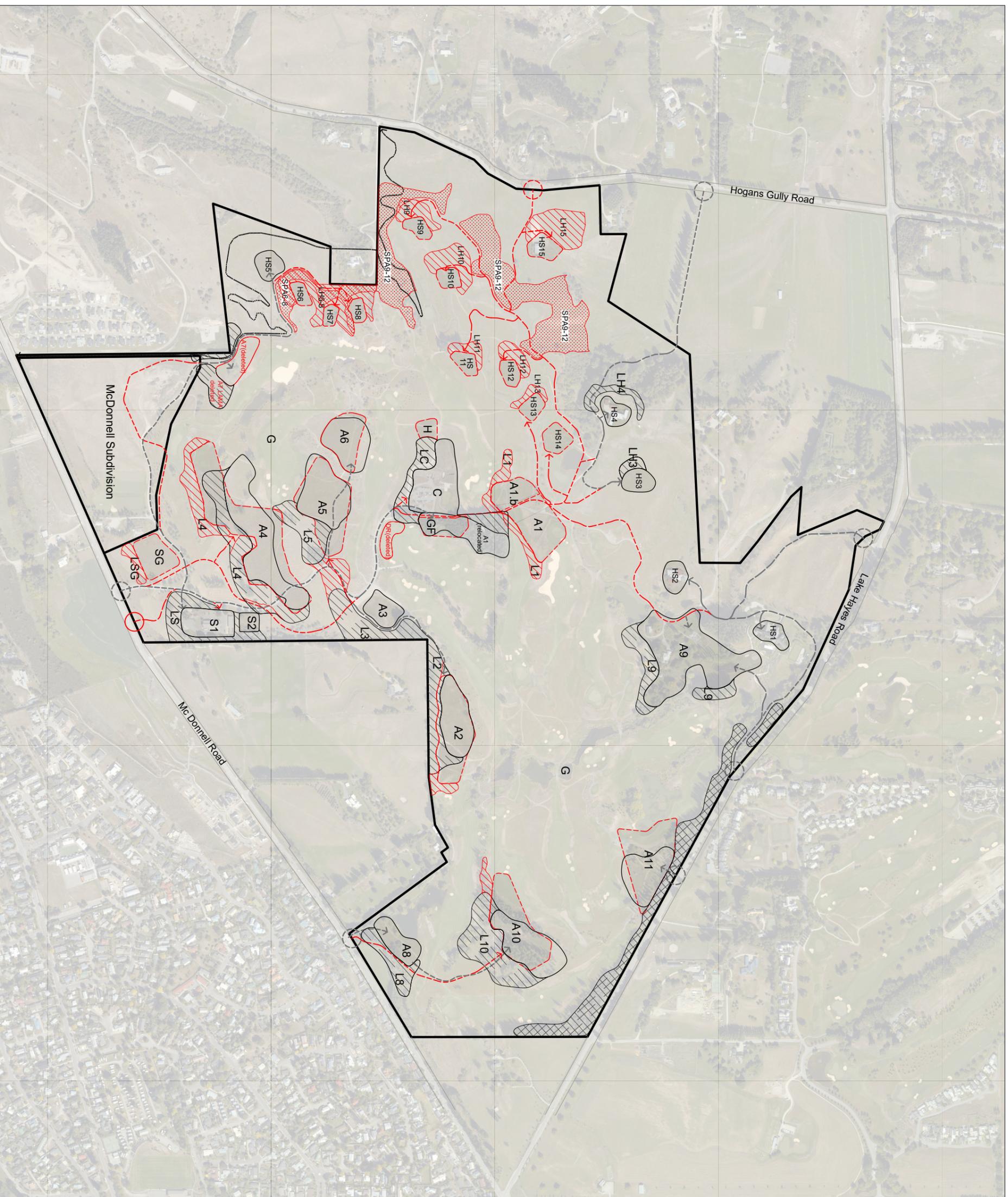
OVERLAYS

-  Landscape Amenity Management Area (LAMA)
-  Existing Vegetation to be retained for Landscape Amenity Management
-  Structural Planting Area (SPA)



SCALE 1:12500 @ A4 9th October 2024





- KEY**
- G Golf course, open space and farming
 - C Clubhouse
 - A Visitor Accommodation / Residential
 - HS Homestead (3000m² max.)
 - S Resort Service & Staff Accommodation
 - DR Driving Range
 - GF Golf Training Facility
 - SG Sports Garden
 - H Helicopter Landing Area

Note: all activity areas include G: Golf course, open space and farming

- Current Activity Areas
- Proposed Activity Areas
- Current Road Access
- Proposed Road Access
- Current Access Points
- Proposed Access Points
- Walking / Bike Trail (Location Indicative)

OVERLAYS

- Current Landscape Amenity Management Area (LAMA)
- Current Existing Vegetation to be retained for Landscape Amenity Management
- Proposed Landscape Amenity Management Area (LAMA)
- Revegetation Framework

REV	DATE	DESCRIPTION
A	09.10.24	INFORMATION
	15.10.24	INFORMATION



SCALE : 1:4000@A1

DATE : 09.10.2024

DRAWN : Aplestley

VERIFIER : B.Thomson

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HILLS-L-SP-010

NOT FOR CONSTRUCTION

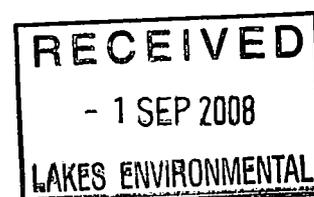
ISSUE

Appendix B – Tonkin & Taylor Geotechnical Report

REPORT

**BROWN AND PEMBERTON
PLANNING GROUP**

**GEOTECHNICAL REPORT
THE HILLS LIMITED**



Report prepared for:

BROWN AND PEMBERTON PLANNING GROUP

Report prepared by:

TONKIN & TAYLOR LTD

Distribution:

BROWN AND PEMBERTON PLANNING GROUP

2 copies

TONKIN & TAYLOR LTD (FILE)

1 copy

August 2008

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Appendix A: Site Location and Test Location Plan

Appendix B: Field Logs and Scala Penetrometer Results

1 Introduction

This report presents the results of a geotechnical investigation that has been completed by Tonkin & Taylor Ltd (T&T) for The Hills Limited Development at Arrowtown.

This geotechnical investigation was commissioned by the Brown and Pemberton Planning Group (BPPG) and has been completed in accordance with the brief supplied to us by BPPG and T&T's proposal dated 13 April 2006.

2 Site Description

2.1 General

The Hills Limited development is located on McDonnell Road approximately 1km south of Arrowtown.

The development which is covered by this report comprises the construction of 19 residential units within and adjacent to the Hills golf course. Details of the proposed dwellings, other than the approximate building platform locations, were not available at the time of writing this document.

The residential units are to be located in the southern part of the Hills golf course and a block of land immediately to the south west. Details of the Hills golf course, the south western block of land, and the proposed building platform locations are shown on Figure 1, Appendix A.

The Hills Limited development is accessed from McDonnell Road which runs along the eastern boundary of the site and the south western Block is accessed from Hogans Gulley Road which runs along the southern site boundary (see Figure 1).

Prior to development of the golf course the Hills site comprised farmland. The existing vegetative cover comprises a combination of long pasture, golf course green, landscaped areas and wooded areas. Vegetative cover on the south western Block currently comprises farmland.

There are no existing structures present within the proposed building platform areas, however, a few isolated farming related structures such as sheds and water troughs are scattered across the site.

2.2 Topography and Surface Drainage

Topographic contours of the site are shown on Figure 1, Appendix A.

From Figure 1 it can be seen that the site is undulating and ground levels typically vary between RL360m and RL440m. Slopes on the site are predominantly gentle (5 to 15°); however, localised steep slopes up to sub vertical are also present on site. Rock exposures were observed in several locations across the site, most notably on the golf course where rock outcrops up to 10 metres high are present. Landscaping of the site has been undertaken within the golf course area.

The steepest soil slopes are located within the south western block, in particular adjacent to an existing track that joins with Hogans Gulley Road on the southern boundary of the site. T&T understands the Sainsbury block southern access track is to be upgraded and widened to provide access to several of the proposed residential unit sites.

A 200 metre long section of the south western block southern access track passes up a wooded slope and the western side of this section has been cut to form a steep bank. This 1 to 5 metre high cut bank is frequently steeper than 60° and is sub-vertical in several locations.

Beyond the eastern side of the southern access track the ground surface falls steeply at an average angle of 50° over a height of 10 metres. Marshy ground is present at the toe of this slope.

Several natural and man made drainage features are present across the site. The largest drainage feature comprises a stream which runs along the southern boundary roughly parallel with Hogans Gulley Road. Elsewhere across the site several ponds and ditches are present, some of which appeared to be associated with farmland irrigation or landscaping for the golf course.

An area of wetland was noted on the boundary between the south western block and the Hills golf course site immediately adjacent to development Site 15. A natural depression is present in this area.

3 Geotechnical Investigations

The following geotechnical site investigation works have been completed by T&T for the purposes of this report:

- A site walkover and inspection of each building platform site by an Engineering Geologist,
- 12 backhoe test pits excavated to depths of between 1.8 and 4.8m, and,
- Scala Penetrometer Tests.

The Test Pit and Scala Penetrometer locations are shown on Figure 1 Appendix A. Test Pit logs and Scala Penetrometer results are presented in Appendix B.

4 Subsurface Conditions

4.1 Geological Setting

The site is located in the Wakatipu Basin, a feature formed predominantly by glacial advances.

Published information indicates the most recent glacial event occurred in the region between 10,000 and 20,000 years ago. These glaciations have left till, outwash and lake sediments over ice-scoured bedrock. Sub-glacial deformation in the upper few metres of the schist bedrock is a common feature, with extensive shearing and silt injection into fractures.

Post-glacial times have been dominated by erosion of the bedrock and glacial sediments and deposition of alluvial gravels by local watercourses. Layers lacustrine sediments have also be deposited in some areas during periods of high lake levels.

No active fault traces were observed on or in the immediate vicinity of the site. However, more significant seismic risk exists in this region from potentially strong ground shaking, likely to be associated with a rupture of the Alpine Fault located along the West Coast of the South Island.

There is a high probability that an earthquake with an expected magnitude of over 7.5 will occur along the Alpine Fault within the next 50 years.

4.2 Stratigraphy

The sub-surface materials encountered during the site investigation works were found to typically comprise:

- 0.2 to 0.4 m of Topsoil overlying,
- 0 to 1.2 m of Glacial Outwash overlying,
- 0 to 4.2 m of Glacial Sediments overlying,
- 0 to >3.3m of Glacial Till overlying,
- Schist Bedrock

The Glacial Outwash deposits were found to generally comprise medium dense silty, gravelly (fine to coarse) SAND.

The Glacial Sediments that were encountered in the test pit excavations generally comprised medium dense silty SAND with rare gravel, rare cobbles and rare boulders. The glacial deposits were considerably thicker on the western side of the site where they extended to the base of the test pit excavations without intercepting the underlying Till.

The Till deposits typically comprise dense sandy fine to coarse GRAVEL. The Till was encountered in the eastern half of the site where the thickness of the overlying Glacial deposits was less than elsewhere across the site.

Schist bedrock was encountered in test pit number TP3 at a depth of 1.8m. Schist bedrock is also exposed at the existing ground surface in several locations across the site.

The schist exposures were typically slightly to moderately weathered with moderately to widely spaced defects. Aperture up to 100mm wide and clay and breccia infilling was observed on defects several metres in length. The foliation showed some variation across various outcrops with dip angle varying between 42 and 64° and dip direction ranging between bearing 250 and 300°.

4.3 Groundwater

The depth to the water table is expected to show local variation across the site and reflect the topography and proximity to drainage features.

The regional groundwater table was not encountered in any of the test pits and is expected to lie several meters below the existing ground surface at the location of the proposed building platforms.

Perched groundwater was intercepted in TP1 within the Glacial Till at a depth of 4.0 metres. The groundwater level remained at a depth of 4.0 metres following completion of the test pit.

In TP10 perched groundwater was present within the glacial outwash gravels at a depth of between 0.3 and 1.0 metres. The groundwater was perched upon glacial sediments comprising silty sand. The seepage rate was sufficient to destabilise the excavation and was estimated at approximately 5 litres per minute. It should be noted that TP10 was located down slope of an irrigation ditch and up slope of a wetland area. The irrigation ditch was observed to be dry at the time of the site investigations.

5 Engineering Considerations

5.1 General

The recommendations and opinions contained in this report are based upon ground investigation data at discrete locations and historical information held on the T&T database.

Inferences about the nature and continuity of the subsoil between investigation test locations is inferred but cannot be guaranteed. The actual sub-surface conditions may vary from those described.

All design recommendations that are contained in this report are subject to confirmation by inspection during construction.

5.2 Geotechnical Design Parameters

Table 5.1 provides a typical ground profile together with the recommended geotechnical design parameters.

Table 5.1 Recommended Geotechnical Design Parameters

Unit	Observed Thickness (m)	Bulk Density γ (kN/m ³)	Effective Cohesion c' (kPa)	Effective Friction ϕ' (deg)	Elastic Modulus E (kPa)	Poisson's Ratio ν
Topsoil and roots	0.2 to 0.4	16	---	---	---	---
Glacial Outwash (medium dense silty gravelly Sand)	0.0 to 1.2	18	0	33	30,000 to 50,000	0.35
Glacial Sediment (medium dense silty Sand)	0.0 to 4.2	18	0	33	40,000 to 60,000	0.35
Glacial Till (dense sandy Gravel)	0.0 to 3.3	20	0	38	50,000 to 80,000	0.30
Slightly weathered to unweathered Schist	Base of Schist not intercepted	26	0 to 100+	25	>100,000	0.20
Defect within slightly weathered to unweathered Schist	---	---	0	20 to 25	5,000	0.35

5.3 Site Preparation

Upon commencement of the proposed earthworks operations, all topsoil, organic matter and unsuitable materials should be removed from beneath the fill areas in accordance with NZS 4431:1989.

Owing to the erodible nature of the glacial soils present across the site, we recommend that robust, shallow graded sediment control measures be installed prior to the commencement of construction. Should slope gradients in the exposed soils exceed 4%, then lining of drainage channels is recommended, e.g. with geotextile and suitably graded rock, or similarly effective armouring.

All soils should have exposure to the elements limited with bulk excavations left proud of the finished subgrade level by 200 to 300mm, and the final cut to grade performed immediately prior to foundation construction. Alternatively, these areas can be undercut and rebuilt to formation level with hardfill should the subgrade deteriorate due to exposure.

Covering exposed soils with polythene sheeting will reduce degradation due to rain and surface water run-off.

All water should be removed from excavations by using appropriate surface drains and / or pumping where necessary. Under no circumstances should water be allowed to pool and sit on exposed areas or be allowed to pond or collect near or under a foundation slab. Positive grading of the subgrade should be constructed to prevent water ingress or ponding.

All fill that is to be utilised as bearing for foundations should be placed and compacted in accordance with NZS 4431:1989 with certification to that affect.

5.4 Excavations

5.4.1 General

Recommendations for slope batter angles are described in the following sections. Slopes that are required to be steeper than those described below should be structurally retained or subject to specific design by a Chartered Professional Engineer.

All slopes should be periodically monitored during construction for instability and excessive erosion, and corrective measures should be implemented, where necessary, to the approval of a suitably qualified Chartered Professional Engineer or Engineering Geologist.

Widening of the Sainsbury Block southern access track is expected to require considerable modification of the existing slopes. Due to the potential height of the modified slopes, it is recommended that detailed geotechnical analysis and design be undertaken as part of the engineering design for this road.

5.4.2 Cut slopes

All cut slopes which are greater than 5.0 metres high must have specific stability analysis and engineering design carried out by a suitably qualified Geotechnical Engineer or Engineering Geologist who is familiar with the materials and the contents of this report.

Table 5.2 details the recommended batter angle for cut slopes associated with formation of the proposed building platforms.

Table 5.2 Recommended Batter Angles for Cut Slopes

Material Type	Maximum Slope Batter in Dry Ground (Horizontal to Vertical)	Maximum Slope Batter in Wet Ground (Horizontal to Vertical)
Glacial Outwash	1.5 : 1.0	2.0 : 1.0
Glacial Sediment	1.5 : 1.0	2.0 : 1.0
Glacial Till	0.5 : 1.0	1.0 : 1.0
Unweathered Schist	1.0 : 6.0 (See Note 1)	1.0 : 6.0 (See Note 1)

Note 1: Rock bolts and/or shotcrete may be required to stabilise defect controlled blocks and/or wedges in the Schist rock.

It is recommended that:

- i) A suitably qualified Geotechnical Engineer or Engineering Geologist review the building platform and access road earthworks drawings to assess and confirm the materials that are likely to be exposed in the proposed cut slopes,
- ii) Appropriate contingency be made in the construction budget and construction programme if cut slopes are likely to be formed in schist rock, and,
- iii) A suitably qualified Geotechnical Engineer or Engineering Geologist periodically inspect the earthworks and cut slope excavations to review the need for additional slope stabilisation works.

Drainage measures must be installed to the approval of a suitably qualified Geotechnical Engineer or Engineering Geologist if wet soils are encountered during construction of the cut slopes.

The glacial soils are prone to erosion, both by wind and water, and should be protected by hardfill capping or retopsoiled/mulched and re-vegetated as soon as the finished batter or subgrade levels are achieved.

5.4.3 Fill slopes

All fill slopes which are greater than 3.0 metres high must have specific stability analysis and engineering design carried out by a suitably qualified Geotechnical Engineer or Engineering Geologist who is familiar with the materials and the contents of this report.

All fill should be placed and compacted in accordance with NZS4431:1989 and certified in accordance with QLDC standards.

Unreinforced fill batter slopes should not be constructed steeper than 2.5 : 1.0 (H:V).

5.5 Retaining Walls

Retaining walls are recommended in all areas where slopes steeper than those indicated in Section 5.4 are required.

All retaining walls should be designed by a Chartered Professional Engineer who is familiar with the contents of this report.

5.6 Groundwater Issues

The regional groundwater table is expected to be located several metres below the existing ground surface and is not expected to be encountered during construction of the proposed building platforms. However, a perched groundwater level was observed at the location of development site 10 (see Figure 1).

The effect of perched groundwater should be considered during the design and construction of all foundations and excavations associated with the proposed building platforms.

Subsoil drainage measures must be installed to the approval of a suitably qualified and experienced geotechnical engineer if groundwater is encountered in any of the proposed excavations during construction.

The batter angle of all cut slopes in wet soils must be reduced in accordance with the recommendations of Table 5.2.

No aquifer resource is expected to be adversely affected by the proposed residential unit developments.

5.7 Slope Stability

No evidence of existing slope instability was observed in the vicinity of any of the proposed building platforms.

However, evidence of existing slope instability was observed on the eastern side of the southern access track which passes through the south western block area from Hogan's Gulley Road.

Slope angles of up to 50° were measured immediately adjacent to the southern access track and the slope was observed to be undulating with terracing and leaning and fallen trees. In two locations drainage pipes exit at the slope crest and discharge down the slope. Discharge from one drain has eroded a channel on the slope face to a depth of 0.8m. Sections of the slope within the erosion channel were recorded as sub-vertical. Marshy areas were also observed at the toe of the slope.

Widening of the south western block southern access track is expected to require considerable modification of the existing slopes. Due to the potential height of the modified slopes, it is recommended that detailed geotechnical analysis and design be undertaken as part of the detailed design associated with widening of this road.

The southern access track, and the adjacent verge, was less than 4 metres wide at several locations. Widening of the southern access track will require increasing the height of cut slope on the western side of the track and/or the construction of an engineered fill platform on the eastern side of the track.

Increasing the height of cut on the western side is the preferred option for widening the south western block southern access track due to the presence of slope instability on the eastern side.

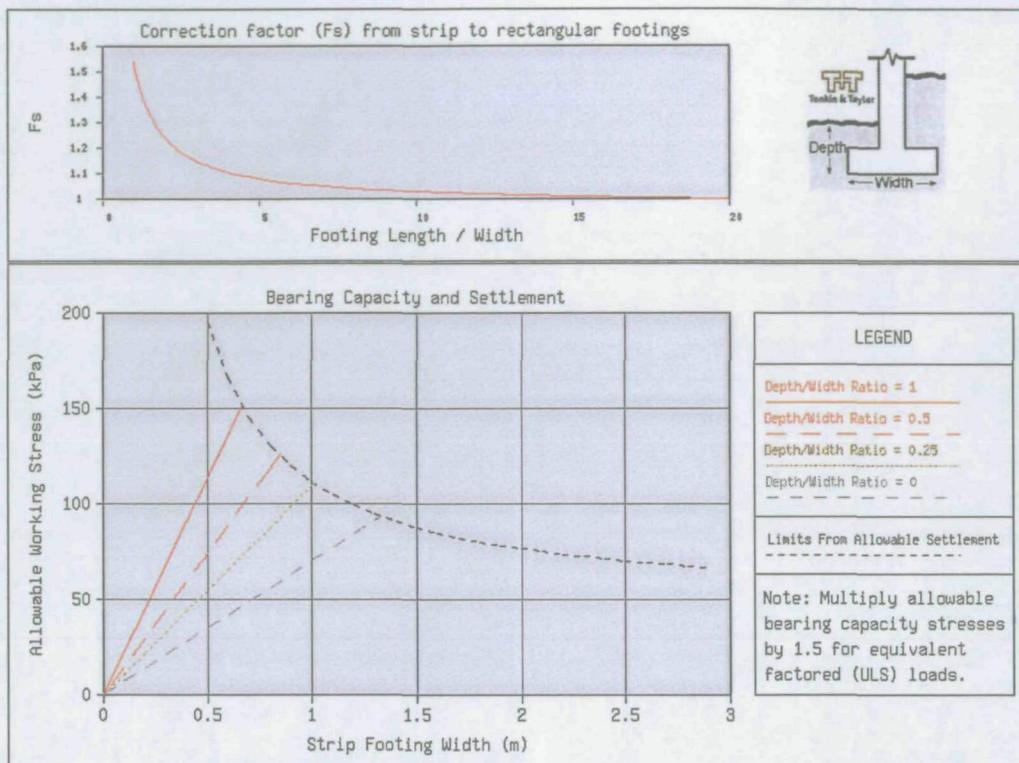
5.8 Settlement and Foundations

The subgrade materials at all of the proposed building platforms are expected to comprise medium dense to dense glacial outwash deposits and/or glacial sediments. These materials are expected to provide good bearing for shallow foundations.

Settlement of the subgrade materials under seismic loading is expected to be minimal providing all unsuitable material; in particular those softened by storm water or groundwater, are undercut and replaced with engineered fill that meets the requirements of NZS4431:1989.

Figure 5.1 summarises T&T's recommendations for shallow foundation working stresses governed by bearing capacity (for narrow footings) or settlement (for wide footings) on the glacial outwash and glacial sediment deposits.

Figure 5.1. Allowable Working Stress for Footings Founded on Medium Dense Glacial Outwash & Glacial Sediments.



From Figure 5.1 it can be seen that a working load bearing stress of 75 kPa is recommended for a 300mm wide by 300mm deep strip footing. This corresponds to a factored (ULS) bearing capacity of approximately 110 kPa and an ultimate bearing capacity of 225 kPa.

All foundation subgrade should be inspected and tested by a suitably qualified and experienced Geotechnical Engineer or Engineering Geologist to confirm subgrade conditions are in accordance with the assumptions and recommendations of this report.

5.9 Subsoil Class for Seismic Design

For detailed design purposes it is recommended that the magnitude of seismic acceleration be estimated in accordance with the recommendations of NZS 1170.5:2004 assuming Class C subsoil conditions exist under all building sites.

5.10 Pavements

The construction of new access roads and/or the improvement of existing access tracks are expected to be a requirement of the proposed development.

Topsoil and roots were found to be present across the site to a depth of up to 400mm below existing ground level. All topsoil material should be removed from beneath the road footprints prior to the commencement of pavement construction.

The glacial sediments that underlie the topsoil layer were found to comprise silty and gravelly sands extending to a depth of between 1.5 and 4.5m below existing ground level.

The Scala Penetrometer test results in the glacial materials were typically greater than 3 blows for 100mm advancement. These test results indicate an in-situ design (10 percentile) CBR value of 5% is appropriate for the road subgrade.

5.11 Existing Structures and Neighbouring Properties

No existing buildings or neighbouring properties are expected to be adversely affected by the proposed residential unit developments.

5.12 Natural Hazards

The proposed building platforms are not located in an area of potential natural hazards nor are they likely to exacerbate an existing hazard potential.

5.13 Aquifers

No aquifer resource is expected to be adversely affected by the proposed residential unit developments.

5.14 Environmental Issues During Construction

5.14.1 Erosion and sediment control

Effective systems for erosion control are runoff diversion drains and contour drains, while for sediment control, options are earth bunds, silt fences, hay bales, vegetation buffer strips and sediment ponds.

Only the least amount of subsoil should be exposed at any stage and vegetation re-established as soon as practicable, or mulch applied.

Details for implementation of erosion and sediment control measures are given in Appendix B within the following internet links:

<http://www.aucklandcity.govt.nz/council/documents/district/Ann14.pdf>

with further detail related to construction sites in

http://www.itd.idaho.gov/manuals/Online_Manuals/BMP/

5.14.2 Noise

It is expected that conventional earthmoving equipment such as bulldozers, excavators and trucks, will be used to form the proposed building platforms.

Construction noise is not expected to be an issue to neighbouring properties due to the large distance between the proposed building platforms and the site boundaries.

5.14.3 Dust

The sub-surface soils on site may present a potential to generate dust. Regular dampening with sprinklers should be effective to control this potential hazard during construction.

6 Conclusions and Recommendations

- The stratigraphy at the proposed building platform sites typically comprise:
 - 0.2 – 0.4 metres of Topsoil, overlying,
 - 0.0 – 1.2 metres of Glacial Outwash, overlying,
 - 0.0 – 4.2 metres of Glacial Sediments, overlying,
 - 0.0 – 3.3 metres of Glacial Till, overlying,
 - Schist Bedrock.

Table 5.1 summarises the recommended geotechnical design parameters for the above materials.

- No evidence of existing slope instability was observed in the vicinity of any of the proposed building platforms.

Instability of existing slopes was identified on the eastern side of the southern access track which passes through the south western block area.

- The following table summarises the recommendations for cut and fill slope batters. All batter slopes steeper than those recommended below should be structurally retained or subject to specific slope stability analysis and design by a suitably qualified and experienced Geotechnical Engineer or Engineering Geologist.

Material Type	Maximum Slope Batter in Dry Ground (Horizontal to Vertical)	Maximum Slope Batter in Wet Ground (Horizontal to Vertical)
Glacial Outwash	1.5 : 1.0	2.0 : 1.0
Glacial Sediment	1.5 : 1.0	2.0 : 1.0
Glacial Till	0.5 : 1.0	1.0 : 1.0
Unweathered Schist	1.0 : 6.0 (See Note 1)	1.0 : 6.0 (See Note 1)
Engineered Fill	2.5 : 1.0	---

Note 1: Rock bolts and/or shotcrete may be required to stabilise defect controlled blocks and/or wedges in the Schist rock.

- A suitably qualified Geotechnical Engineer or Engineering Geologist should review the building platform and access road drawings to assess the proposed earthworks and cut slopes.
- Appropriate contingency should be made in the construction budget and construction programme if cut slopes are likely to be formed in schist rock.
- All cut batter slopes greater than 5.0 metres high, and all fill batter slopes greater than 3.0 metres high, should have specific slope stability analysis and design carried out by a suitably qualified and experienced Geotechnical Engineer or Engineering Geologist.

- Drainage measures should be installed to the approval of a suitably experienced Geotechnical Engineer or Engineering Geologist if wet soils are encountered during construction of the earthworks excavations.
- All slopes should be periodically monitored during construction for instability and excessive erosion, and corrective measures should be implemented, where necessary, to the approval of a suitably qualified Chartered Professional Engineer or Engineering Geologist.
- All retaining walls should be designed by a Chartered Professional Engineer who is familiar with the contents of this report.
- The proposed building foundations are expected to be founded on glacial outwash and glacial sediments which should provide good bearing for shallow foundations constructed in accordance with NZS3604:1999.
Figure 5.1 summarises T&T's recommendations for shallow foundation working bearing stresses. A working load bearing stress of 75 kPa is recommended for a 300mm wide by 300mm deep strip footing. This corresponds to a factored (ULS) bearing capacity of approximately 110 kPa and an ultimate bearing capacity of 225 kPa.
- All foundation excavations should be inspected during construction by a suitably qualified and experienced Geotechnical Engineer or Engineering Geologist who is familiar with the contents of this report.
- The depth to groundwater is expected to vary across the site and will reflect variations in topography.
The regional groundwater table was not encountered at any proposed building platform site and is expected to lie at a depth several below existing ground surface.
Perched groundwater tables were encountered during excavation of some of the investigation test pits. The effect of perched groundwater should be considered during the design and construction of all foundations and excavations associated with the proposed building platforms and access roads.
- All earthworks operations should be conducted in accordance with NZS 4431:1989 and the relevant QLDC standards.
- The construction of new access roads and/or the improvement of existing access tracks are expected to be a requirement of the proposed development.
Increasing the height of cut on the western side is the preferred option for widening the south western block southern access track.
It is recommended that detailed geotechnical analysis and design be undertaken as part of the design associated with widening of the southern access track.
- An in-situ design (10 percentile) CBR value of 5% is recommended for the road subgrade during detailed design of the road pavement.
All topsoil material should be removed from beneath the road footprints prior to the commencement of pavement construction.

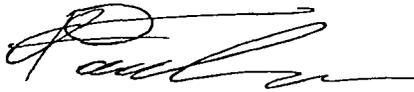
7 Applicability

This report has been prepared for the benefit of the Brown and Pemberton Planning Group with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

TONKIN & TAYLOR LIMITED
Environmental and Engineering Consultants

Report Prepared By:

Report Review and Authorisation for
TONKIN & TAYLOR by:



.....

.....

Paul Faulkner
Engineering Geologist

Anthony Fairclough
Senior Geotechnical Engineer

Appendix A: Site Location and Test Location Plan

Appendix B: Field Logs and Scala Penetrometer Results



TONKIN & TAYLOR LTD EXCAVATION LOG

EXCAVATION NUMBER:
TP 1

PROJECT: The Hills Limited		Job Number: 891184	
LOCATION: Development Point 7		Incination: N/A	Direction: N/A
EASTING: N/A mE	EQUIPMENT: 12T Wheeled Digger	OPERATOR: Trevor Jones	
NORTHING: N/A mN	INFOMAP NO.	COMPANY: Jones Contracting	
ELEVATION: topo survey m	DIMENSIONS:	HOLE STARTED: 1-May-06	
METHOD: N/A	EXCAV. DATUM: Ground Level	HOLE FINISHED: 1-May-06	

ENGINEERING DESCRIPTION				GEOLOGICAL		
PENETRATION (SPT)	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.4	X X	Orange brown, clayey SILT with occasional gravel and rootlets. Gravel is fine, schist is angular. Low plasticity, soft.	moist	TOPSOIL
		0.8		Light greyish yellow, silty gravelly SAND with rare cobbles. Sand is fine to medium, gravel is fine to coarse, gravel is angular to rounded of quartz and schist, cobbles are angular of quartz. Medium dense. Homogenous.	dry	GLACIAL OUTWASH DEPOSIT
		1.2				
		1.6	X X			
		2.0	X X	Light greyish brown, silty SAND with rare gravel, rare cobbles and boulders. Sand is fine to medium, gravel is fine to coarse, sub-angular to rounded of quartz and schist, cobbles and boulders are sub-angular to rounded schist. Medium dense to dense. Thickly bedded.	moist below 2m	GLACIAL SEDIMENT
		2.4	X X			
		2.8	X X			
		3.2	X X			
		3.6		Dark grey, sandy GRAVEL. Gravel is fine to medium, sand is fine to coarse, gravel is sub-angular to rounded of quartz and schist. Dense. Homogenous.	moist	GLACIAL TILL
		4.0				
		4.4				
		4.8		Total Depth = 4.2 m		
		5.2				
		5.6				
		6.0				
		6.4				

COMMENT: Maximum boulders to 250mm, Seepage at 4m	Logged By: PGF
	Checked Date:
PHOTO REF.: N/A	Sheet: 1 of 1



TONKIN & TAYLOR LTD EXCAVATION LOG

EXCAVATION NUMBER:
TP 2

PROJECT: The Hills Limited		Job Number: 891184	
LOCATION: Development Point 8		Inclination: N/A	Direction: N/A
EASTING: N/A mE	EQUIPMENT: 12T Wheeled Digger	OPERATOR: Trevor Jones	
NORTHING: N/A mN	INFOMAP NO.	COMPANY: Jones Contracting	
ELEVATION: topo survey m	DIMENSIONS:	HOLE STARTED: 1-May-06	
METHOD: N/A	EXCAV. DATUM: Ground Level	HOLE FINISHED: 1-May-06	

ENGINEERING DESCRIPTION				GEOLOGICAL			
PENETRATION (SPT)	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION	
		0.4	X X X	Orange brown, clayey SILT with occasional gravel and rootlets. Gravel is fine, angular and schist is angular. Low plasticity, soft.	moist	TOPSOIL	
		0.8	•••••	Light greyish yellow, silty gravelly SAND with rare cobbles. Sand is fine to medium, gravel is fine to coarse, angular to rounded of quartz and schist, cobbles are angular of quartz. Medium dense. Homogenous.	dry	GLACIAL OUTWASH DEPOSIT	
		1.2					
		1.6	X X X	Light greyish brown, silty SAND with rare gravel, rare cobbles and rare boulders. Sand is fine to medium, gravel is fine to coarse, sub-angular to rounded of quartz and schist, cobbles and boulders are sub-angular to rounded schist. Very low plasticity, medium dense to dense. Thickly bedded.	moist below 2m	GLACIAL SEDIMENT	
		2.0	X X X				
		2.4	X X X				
		2.8	•••••	Dark grey, sandy GRAVEL. Gravel is fine to medium, sand is fine to coarse, gravel is sub-angular to rounded of quartz and schist. Dense. Homogenous.		GLACIAL TILL	
		3.2					
		3.6			wet		
		4.0					
		4.4					
		4.8					
		Total Depth = 4.6 m					
		5.2					
		5.6					
		6.0					
		6.4					

COMMENT:	Logged By: PGF
	Checked Date:
PHOTO REF.: N/A	Sheet: 1 of 1

Appendix C – Hadley Consultants Natural Hazard Report

Trojan Helmet Ltd

**Hills Golf Course (including
McDonnell Road Land) and
Hogans Gully Road Land**

Proposed District Plan Submission

Natural Hazard Assessment

Contact Details:

Hadley Consultants Ltd
44 Robins Road
PO Box 1356
Queenstown 9348

Ph: 03 450 2140
Fax: 03 441 3513
Web: www.hadleys.co.nz



Responsible Engineer:
James Hadley
Director

Document Status

Revision	Author:		Reviewer:		
	Name	Signature	Name	Signature	Date
A (Initial Issue)	J. Hadley		J. McCartney		20 October 2015
B (For Submission)	J. Hadley		J. McCartney		21 October 2015
C (Final)	J. Hadley		J. McCartney		22 October 2015

Limitations

This report has been written for the particular brief to HCL from their client and no responsibility is accepted for the use of the report for any other purpose, or in any other context or by any third party without prior review and agreement.

In addition, this report contains information and recommendations based on information obtained by inspection, sampling or testing at specific times and locations with limited site coverage as outlined in this report. This report does not purport to completely describe all site characteristics and properties and it must be appreciated that the actual conditions encountered throughout the site may vary, particularly where ground conditions and continuity have been inferred between test locations. If conditions at the site are subsequently found to differ significantly from those described and/or anticipated in this report, HCL must be notified to advise and provide further interpretation.

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Appendix A

Darby Partners and HCL Topographic Drawings

Appendix B

QLDC Hazard Maps

Appendix C

Figure 2

Appendix D

Figure 10

1. Introduction

Trojan Helmet Ltd (THL) has engaged Hadley Consultants Limited (HCL) to conduct a natural hazards assessment of their land which comprises both the Hills Golf Course and an adjacent land holding which fronts Hogans Gully Road.

This report considers the relevant site conditions and natural hazard issues affecting the potential building development within possible development areas identified by others. Specifically, the natural hazard elements investigated and assessed are:

- Liquefaction hazard,
- Alluvial fan hazard, and
- Inundation and flood risk.

The purpose of this report is to provide a reference document to assess whether any natural hazard constraints exist in a global context which will adversely impact proposed development areas on the THL land holdings.

This report is intended to inform submissions made by THL on the Queenstown Lakes District Council's (QLDC) Proposed District Plan.

2. Nature of Proposed Development

The development proposed across the THL land comprises new zoned Rural Lifestyle Areas combined with a new Resort Zoning (the Hills Resort Zone) in which specific pockets of building development are identified for activities which include discrete Homesites, Visitor Accommodation, Farm and Resort Services and Staff Accommodation.

There are two primary Proposed Rural Lifestyle zones as follows;

- Proposed Rural Lifestyle Area A comprising a 19.7Ha block bounded by Hogans Gully Road to the south and Arrowtown – Lake Hayes Road to the west; and
- Proposed Rural Lifestyle Area B comprising an 8.4Ha block with frontage to McDonnell Road.

The remainder of the proposed development areas are located wholly within the existing Golf Course area (which will form the new Hills Resort Zone) and represent discrete pockets of development across the site.

The overall development sites and areas are indicated on the Darby Partners and HCL topographic drawings contained in Appendix A.

Some of the proposed development areas within the Golf Course site include building platforms previously consented under RM081223. Where relevant, previous work on these platforms has been considered in this more global evaluation of natural hazards impacting the land holding.

3. Scope of Assessment

The purpose of this report is to provide a global overview of the natural hazard issues which might affect development capability across the THL land holdings. In making this assessment, HCL have undertaken the following activities;

- Stereo pair photo analysis of geological features to identify potential areas of instability.
- Review of previous site investigation and assessment work by others for previous developments at the THL site. These investigations have been used to verify the HCL developed geological and geotechnical models adopted when assessing hazard.
- Detailed site walkover and geological mapping of all proposed development areas.
- Logging and mapping of open excavations and test pits across the site to confirm site lithologies.
- Review and consideration of QLDC Hazard Maps and their impact and relevance to the THL site following specific evaluation and verification of the geomorphology which exists.

It is intended that this document form a master Natural Hazards document for the THL land holdings which may be referred to when considering discrete planning submissions for the separate Rural Lifestyle A and B areas, and the other Activity Areas within the proposed Hills Resort Zone.

4. Site Description

The proposed development takes in the Hills Golf Course Land, located at 164 McDonnell Road approximately 1km south of Arrowtown and an area of land comprising 19.7Ha to the south of the Golf Course. This land, referred to as the Hogans Gully Land, is bounded by Hogans Gully Road to the south and Arrowtown – Lake Hayes Road to the west. The drawings included in Appendix A illustrate the site location and development areas.

The Golf Course is accessed from McDonnell Road which runs along the eastern boundary of the site and the Hogans Gully Land is accessed from Hogans Gully Road which runs along the southern site boundary.

Prior to the development of the golf course the THL land comprised farmland. The existing vegetative cover comprises a combination of long pasture, golf course green, landscaped areas and wooded areas. Vegetative cover on the Hogans Gully Land currently comprises farmland, paddocks and pasture.

The site includes several existing structures and these existing building sites have not been assessed as it is assumed they have been considered in detail as part of previous assessment work which allowed their construction.

Topographic contours of the site are shown on HCL Drawings 152859-S01 and S02 in Appendix A.

The site is undulating and ground levels typically vary between RL350m to RL430m. Slopes on the site are predominately gentle (5 to 15°); however, localised steep slopes are also present in some areas across the site.

Rock exposures also exist across the site, most notably on the Golf Course Land but also on the south facing flanks above the Hogans Gully Land.

There are a number of springs, gullies and manmade drainage features present across the site which will give rise to ephemeral flows during wet periods. The most significant drainage features include a stream which runs along the southern boundary of the THL land roughly parallel with Hogans Gully Road and an internal water race system which traverses the higher elevation Golf Course Land roughly west to east.

The site is primarily accessed from McDonnell Road, although additional farm track access is possible from Hogans Gully Road and from Arrowtown – Lake Hayes Road for existing private residences.

The site also includes a relatively complex system of internal roads, footpaths, cart paths and farm tracks that will impact local catchment boundaries and run off characteristics.

The land receives approximately 850mm of rainfall per annum and may be subject to drought conditions during the summer months.

5. QLDC Hazard Register and Previous Work

QLDC Hazard Maps (refer Appendix B) note that the site may be affected by;

- Liquefaction Hazard, assessed as provisionally LIC1.
- Alluvial Fan Hazard.

The liquefaction risk classification is shown to affect the majority of the Golf Course Land, whilst the Alluvial Fan Hazard is limited in its extent, taking in parts of the south facing slopes above the Hogans Gully Land.

In August 2006, Tonkin and Taylor Ltd (T&T) conducted a detailed investigation of the Golf Course area as part of a previous development proposal. This work by T&T included;

- Site evaluation,
- The excavation and logging of 12 test pits ranging in depth from 1.8m to 4.8m,
- Scala Penetrometer testing.

As part of their reporting T&T also provided soil parameters for foundation design and slope stability analysis.

T&T recorded that there was no evidence of slope instability recorded in the vicinity of the proposed building platforms, although some instability was observed in the oversteepened slopes above the Hogans Gully Land.

With regard to liquefaction, T&T noted that;

- i) Subgrade materials were expected to provide good bearing for shallow foundations.
- ii) Settlement of the subgrade materials under seismic loading is expected to be minimal.
- iii) For detailed design in accordance with NZS 1170.5:2004, subsoil Class C conditions could be assumed.
- iv) The regional groundwater table was not encountered and is expected to lie at a depth several metres below existing ground surface across the site.

Overall the T&T work did not identify any natural hazard issues (such as liquefaction) affecting any of the proposed Golf Course sites and concluded that building foundations were expected to be founded on glacial outwash and glacial sediment which should provide good bearing.

6. Geological Setting

6.1 Physiography

The site is located within the Wakatipu Basin, a feature formed by a series of glacial advances.

The most recent glacial advance occurred in the area between 10,000 and 20,000 years ago. This glacial activity has deposited glacial till, outwash and lake sediments over scoured bedrock.

Post glacial times were then dominated by erosion and deposition of alluvial gravels by local watercourses and river systems and during periods of high lake levels. This is relevant in the context of the Hogans Gully Land, where Shotover River derived alluvium is identified.

6.2 Site Lithologies

The predominant site lithologies across the site may be summarised as follows;

- i) **Schist.** Schist outcrops irregularly, and is particularly evident beneath the higher terrain towards the south above the Hogans Gully Land. No particular distress was observed (eg glacial shearing/plucking), nor was there any evidence of mass movement.
- ii) **Glacial Till.** Glacial Till dominates across the Golf Course Land, and is particularly notable by the presence of the hummocky terrain. Where visible in outcrop and suboutcrop, it is a lodgement till, comprising compact silt/sand, with subordinate gravel clasts, and generally rare cobbles with rare boulders.

There appear to be three different ages of tills, the oldest being a capping on schist in the vicinity of Sites HS1 and HS8, intermediate age tills form the hummocky terrain within the Golf Course proper, while the youngest till has intruded into the Hogans Gully Land. The latter is finer than the older type, but there isn't a marked difference in grading. Additional observations include;

- No mass movement noted in the till,
- Possible historic fill mounds sometimes hard to differentiate from insitu till.

- iii) **River Alluvium.** The presence of river alluvium is defined in different areas of the site as follows;

- **Within Proposed Rural Lifestyle Area A:** This area is assessed as Shotover derived alluvium sourced from the west. Of particular note are the finger-like beach deposits which accumulated at the surface of the river alluvium by long shore drift when the lake was high.
 - **Within Proposed Rural Lifestyle Area B:** Observations in a test pit near the western margin of this zone disclosed a well-bedded, river alluvium comprising well-graded sandy gravel to cobbly sandy gravel. Clasts appear to be Shotover sourced, hence it is likely that the sediments were deposited by a former Hayes Creek draining the basin south of Coronet Peak. Degradation has produced a stepped morphology, grading gently down towards McDonnell Road.
- iv) **Fans.** Small fans do grade out into the Proposed Rural Lifestyle Area A, but they do not appear to be active. A small, intra-course fan is present near Site A6 and there may be other fan elements around the site and away from proposed development areas. Due to their lack of activity these fan areas require consideration in any detailed design, but are not considered a high risk hazard.

7. Specific Development Area Assessment

7.1 General

Consideration of the Development Area as a whole has been separated as follows;

- i) Proposed Rural Lifestyle Area A,
- ii) Proposed Rural Lifestyle Area B,
- iii) Development Sites designated "HS" and "A" across the Golf Course area.

We note that due to the presence of existing structures the following sites were excluded from evaluation by HCL;

- Site S – the Resort Services Area,
- Site C – the Clubhouse,
- HS6 – An existing house site,
- HS7 – Existing loge.

We confirm that all other development areas indicated on the Darby Partners drawings contained in Appendix A have been assessed. To avoid repetition in reporting, we have grouped sites with common features.

7.2 Liquefaction Risk and Flood Hazard

We collectively address the Liquefaction Risk noted by QLDC as affecting Proposed Rural Lifestyle Area B and all of the HS and A development areas within the Golf Course Land.

HCL's assessment of the site lithologies is that the Golf Course Land is mantled by glacial till comprising compact sands and gravels with a regional groundwater level located at depth. Schist bedrock outcrops in several locations and neither the compact till or the bedrock are susceptible to liquefaction. Further, Proposed Rural Lifestyle Area B includes alluvial deposits, again with a significant depth of groundwater.

HCL's assessment is also verified by the previous reporting and site investigation work of T&T.

The confirmed presence of compact glacial tills and the absence of shallow groundwater allow us to confirm that liquefaction hazard is not a relevant risk for any of the proposed development areas.

A flood hazard is not recorded by QLDC and we confirm that subject to normal cut off drainage and catchment management, no large scale flood or inundation risk exists.

7.3 Proposed Rural Lifestyle Area A

Observations relevant to this area include;

- Greater than 50% of the proposed site is located on flat to gently sloping terrain comprising Shotover-derived alluvium.
- Some inactive fan elements encroach into the development area from the north and northeast mantling both glacial till and alluvial deposits in these areas. This is depicted in Figure 2 contained in Appendix C.
- Streams associated with the fan elements are small and assessed as ephemeral with minor source catchments.
- Former high level Lake Wakatipu storm benches are identifiable features in the central reaches of the site and are well drained.
- Based on field inspection and the small size of the streams and source catchments, we do not believe the QLDC classification of the fan elements as active and debris dominated to be correct.

In summary, we believe that the alluvial fan hazard risks associated with this development area are very low subject to;

- a) Provision of normal cut off drainage measures to control upslope runoff from ephemeral watercourses.
- b) Further test pitting as part of any resource consent application to confirm the age and activity of the fan deposition.

7.4 Proposed Rural Lifestyle Area B

The following observations were made with respect to Proposed Rural Lifestyle Area B;

- The area contains alluvial deposits and consists of low relief with terraces degrading to the east.
- The exposed cut in the western edge of the development area shows Shotover-derived alluvium circa 23,000 years old comprising sandy gravels.
- The lithology is consistent across the site with the depth to groundwater likely to exceed 10m.

In summary, and noting our earlier comment under Section 7.2 with regard to liquefaction and flood risk, we again believe that the natural hazard risks associated with this development area are very low.

7.5 Sites Requiring Little or No Mitigation

The following sites have been assessed and grouped as relatively benign with minimal mitigation required for building development. These sites are;

- A1,
- A2,
- A3,
- A4,
- A5,
- A9,
- HS1,
- HS5, and
- HS8.

Other than the southern extent of A4 where a small depression exists, all of these sites are well drained with competent subgrade conditions. The sites are considered very low risk with regard to natural hazard where normal building controls around verification of bearing capacities for foundation design along with the provision of positive surface drainage control will allow development of these sites.

7.6 Site A8

Site A8 at the northern end of the Golf Course Land occupies a low relief mound on the north east side of the low relief pond.

Concern exists that the building or development area could include uncertified fill as part of pond construction. The relative heights of the pond water level (controlled by its outlet) and likely subgrade levels for foundations increases the risk of saturated subgrade conditions.

The site is not subject to natural hazard, but should be the subject of a specific geotechnical investigation to confirm the presence or otherwise of uncertified fill prior to the construction of any building.

7.7 Site A6

This site occupies a low relief localised fan which grades out from the hummocky till zone to the west. The site is located slightly above the creek level, suggesting a perched water table may be present in this area.

Some surface water control from the catchment to the west is required.

Again, the site is not subject to any natural hazard issues, but prior to construction of buildings the site should be subject to a specific geotechnical investigation to confirm the nature and extent of any fan materials and presence or otherwise of a perched water table which may require draining.

7.8 Site A10

This site takes in a substantial area of saturated ground in a through-drainage depression heading south. There are also overland flow issues to be resolved from the steep terrain catchment to the east.

The site could be developed subject to specifically designed drainage and ground improvement works involving cut to waste, installation of piped stormwater reticulation including resolution of secondary overflow issues and import to fill to achieve positive drainage to the area and to provide suitable foundation conditions.

7.9 Site A7

This site is currently constrained by existing services due to the presence of a pump shed, transformer and inspection panels.

There is also localised uncertainty regarding lithologies with the possible presence of fill due to the services modifications.

There are no natural hazard issues affecting the site, however we recommend a detailed geotechnical investigation to define fill areas prior to any building construction occurring.

7.10 Site HS10

This site is affected by water race leakage concentrating in the slope comprising the house site area.

Prior to building development at this site it will be necessary to;

- Complete subsurface investigations to confirm the impact of the race leakage on overall slope stability.
- Pipe the water race for long term security of the site and provide for some form of diversion away from buildings in the event of a catastrophic pipe rupture.

7.11 Site HS9

This site is located in a localised depression and it will be necessary to resolve drainage to the south to avoid a ponding risk.

Similar to HS10, it will be necessary to;

- Complete subsurface investigations to confirm the depth to competent bearing materials (till) in the base of the depression due to likely thick colluvium/soil layer accumulation in the natural basin.
- Pipe the water race for long term security of the site and provide for some form of diversion away from buildings in the event of a catastrophic pipe rupture in the race.

7.12 Sites HS2, HS3 and HS4

These three sites are all located in the valley lines of ephemeral drainage systems. Consequently they are presently wet and saturated. Figure 10 included in Appendix D illustrates the location of the sites and how the channel and ephemeral gully systems affect each area.

It will be possible to develop Sites HS2, HS3 and HS4 if drainage, diversion and ground improvement work is completed, but we recommend that at the time detailed house designs are proposed, consideration is given to locating construction to higher relief ground within the respective Housesite areas. This will minimize the diversion and drainage works required.

All of HS2, HS3 and HS4 are subject to risk from a failure in the water race. Again, piping of the race and consideration of diversions in the event of a breach are recommended to mitigate this risk.

8. Conclusions and Recommendations

Based on our site evaluation and assessment work we have made the following conclusions with regard to Natural Hazards and how they impact the THL Golf Course Land (encompassing the proposed Hills Resort Zone and proposed Rural Lifestyle Area B Zone) and Hogans Gully Land (encompassing the proposed Rural Lifestyle Area A Zone);

Natural Hazard Risks

- i) The Golf Course Land, including Proposed Rural Lifestyle Area B where alluvial deposits are identified, comprises competent and compact glacial till underlain by near surface schist bedrock. These materials are not susceptible to liquefaction and the risk of liquefaction is further reduced by low regional groundwater levels.
- ii) Based on our assessment and investigation of the Golf Course Land, the provisional classification of the site as an LIC1 liquefaction risk by QLDC is not valid. The risk of liquefaction impacting the site is assessed as very low and liquefaction does not constrain the site as a natural hazard.
- iii) The Proposed Rural Lifestyle Area A (Hogans Gully) Land comprises predominately alluvial material where the northern section of the Proposed Rural Lifestyle Area A may potentially be impacted by an alluvial fan hazard. Based on our assessment we don't believe the fan area is active and in the event it was active, its extent would be significantly reduced from that indicated by QLDC Hazard Maps. We have assessed any risk from alluvial fan hazard as low, recognising that if further investigation confirms activity, the risk can be mitigated through bunding protection and regrading at the time of resource consent.
- iv) None of the land areas or development areas are subject to regional flood or inundation hazard.

Specific Development Site Controls

- v) Prior to any building construction occurring we recommend that sites A6, A7 and A8 require specific geotechnical investigation and design of foundations by a Chartered Professional Engineer. This investigation shall include rationalisation of cut off drainage to improve subgrade conditions and to address overland flow paths.
- vi) Sites HS9 and HS10 are impacted by the existing water race and potential leakage from this race. Prior to any building construction occurring we recommend that a specific geotechnical investigation be completed by a Chartered Professional Engineer to confirm the extent of potential soil accumulation in the depression on HS9 and slope stability impacts of the water race on HS10. Both sites will require piping of the water race and diversion design in the event of a catastrophic pipe breach.

vii) Development sites A10, HS2, HS3 and HS4 are more complex sites as a result of being sited across some natural drainage paths. The sites are not subject to large scale natural hazard risk, but to develop them will require specific design of works to cut off and divert existing flow paths to prevent site inundation, and to address hazards associated with the water race to the north. To ensure that these site development issues are properly addressed, we recommend that prior to any building construction occurring, specific engineering design of drainage and ground improvement works be completed by a Chartered Professional Engineer. We recommend consideration be given to refining the location of these development sites so that they take in higher ground within their respective activity areas, removed from natural drainage paths.

Appendix A
Darby Partners and HCL
Topographic Drawings

KEY:

-  Structure Plan Boundary
-  Activity Area



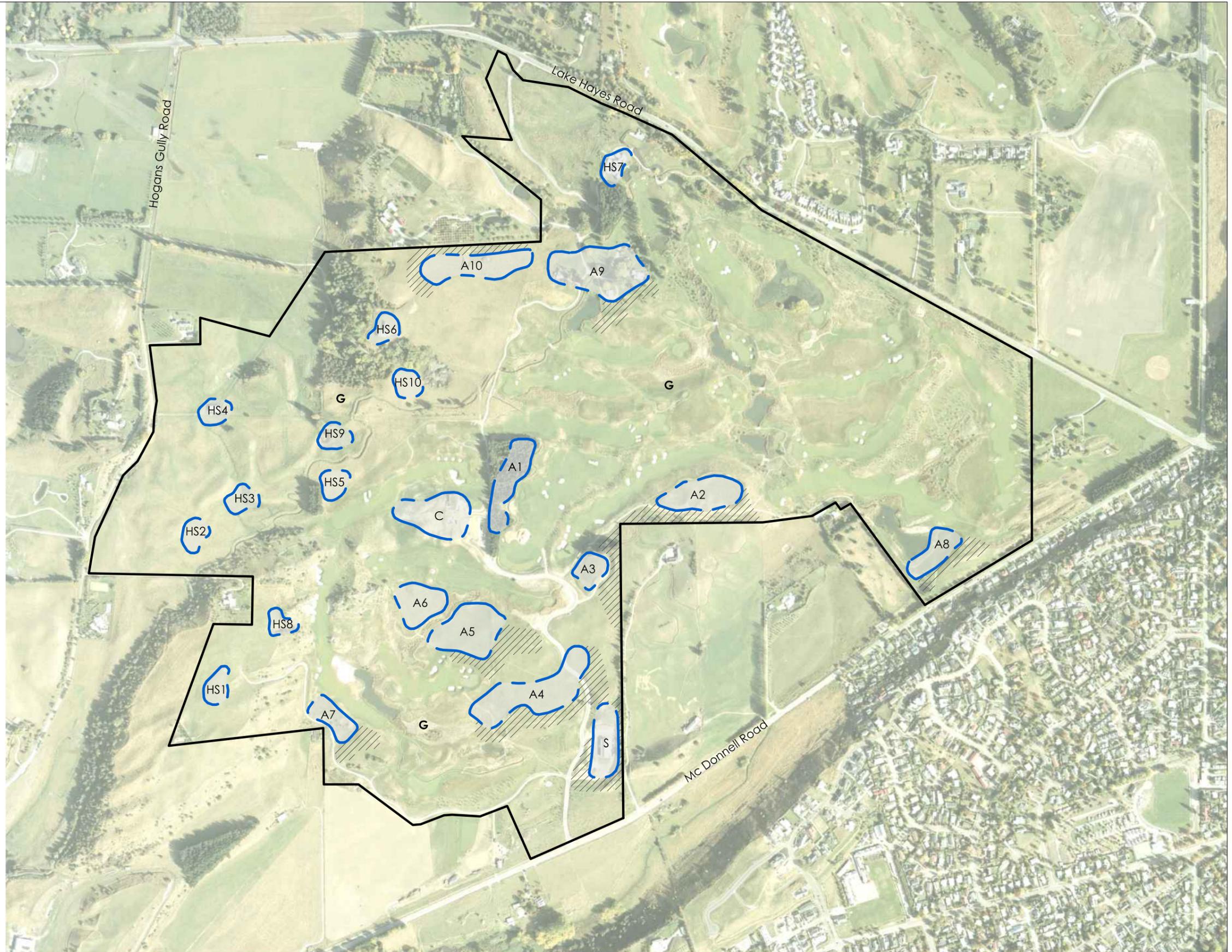
Activity Areas:

- G: Golf course, open space and farming
- C: Clubhouse
- A: Visitor Accommodation / Residential
- HS: Homesite (3,000m²)
- S: Resort Services & Staff Accommodation

Note: all activity areas include G: Golf course, open space and farming

Overlays:

-  Landscape Amenity Management Area



V:\MH_The Hills\10_Master\1_Preliminary\MH_10_1_MLP_010F (Structure Plan).dgn



DARBY PARTNERS

Level 1, Steamer Wharf, Lower Beach Street
 PO Box 1164, Queenstown 9348
 Tel +64 3 450 2200 Fax +64 3 441 1451
 info@darbypartners.co.nz
 www.darbypartners.co.nz

SCALE: 1:4,000 (A1); 1:8,000 (A3)



PLAN STATUS:

DP REVIEW

THE HILLS STRUCTURE PLAN

DRAWN / REVIEWED: RT / JC
 APPROVED: DT
 DATE: 14.10.15

DRAWING NO:

MH_10_1_MLP_010F

KEY:

-  Structure Plan Boundary
-  Activity Area

Activity Areas:

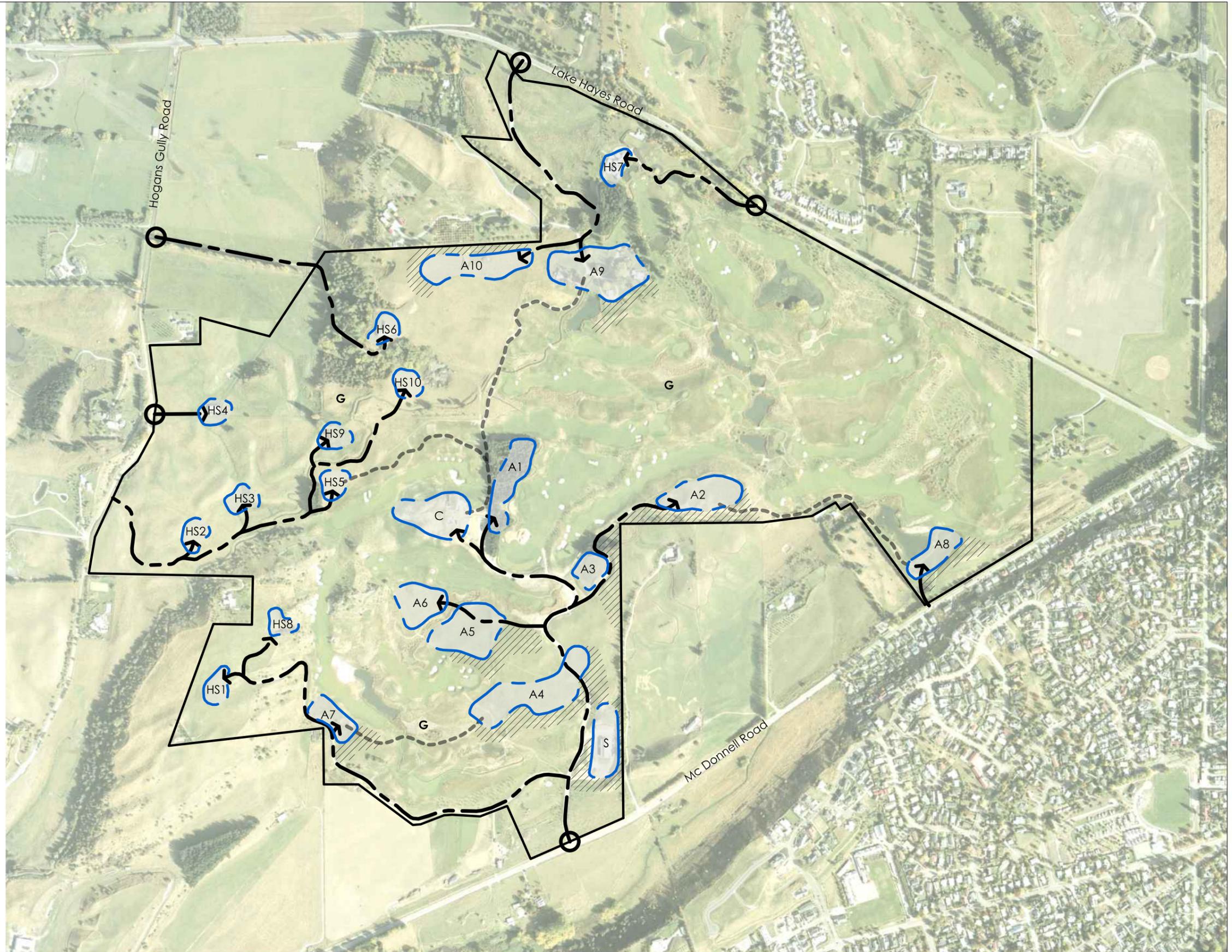
- G: Golf course, open space and farming
- C: Clubhouse
- A: Visitor Accommodation / Residential
- HS: Homesite (3,000m²)
- S: Resort Services & Staff Accommodation

Note: all activity areas include G: Golf course, open space and farming

Overlays:

-  Landscape Amenity Management Area

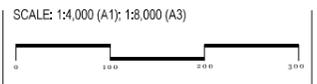
-  Existing access point
-  Road access
-  Buggy / cart access



V:\MH_The Hills\10_Master\1_Plan\10_1_MLP_011B (Structure Plan - Access).dgn



Level 1, Steamer Wharf, Lower Beach Street
 PO Box 1164, Queenstown 9348
 Tel +64 3 450 2200 Fax +64 3 441 1451
 info@darbypartners.co.nz
 www.darbypartners.co.nz



PLAN STATUS:
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**THE HILLS
 STRUCTURE PLAN - ACCESS**

DRAWN / REVIEWED: RT / DT
 APPROVED: DT
 DATE: 14.10.15

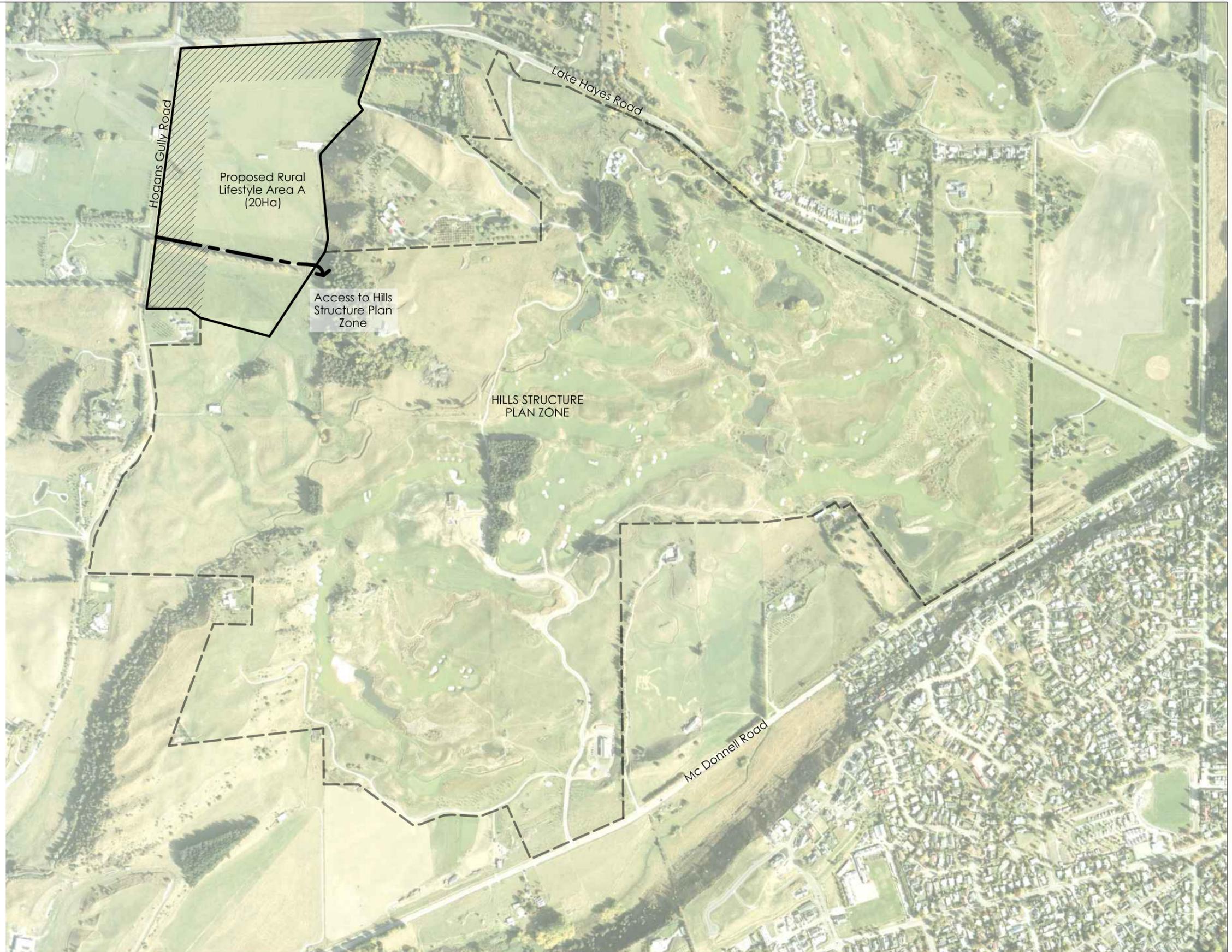
DRAWING NO:
MH_10_1_MLP_011B

KEY:

- Hills Structure Plan Boundary
- Proposed zoning Areas

Overlays:

- /// Landscape Amenity Management Area:
Includes tree planting, sited to preserve views of surrounding landscape and partially screen proposed dwellings



V:\MH_The Hills\10_Master1_Preliminary\MH_10_1_MLP_012B (Rural Lifestyle Area A).dgn



Level 1, Steamer Wharf, Lower Beach Street
 PO Box 1164, Queenstown 9348
 Tel +64 3 450 2200 Fax +64 3 441 1451
 info@darbypartners.co.nz
 www.darbypartners.co.nz

SCALE: 1:4,000 (A1); 1:8,000 (A3)



PLAN STATUS:
DP REVIEW

THE HILLS PROPOSED RURAL LIFESTYLE AREA A

DRAWN / REVIEWED: RT / JC
 APPROVED: DT
 DATE: 14.10.15

DRAWING NO:
 MH_10_1_MLP_012B

KEY:

- Hills Structure Plan Boundary
- Proposed zoning Areas



Overlays:

- /// Landscape Amenity Management Area:
Includes tree planting, sited to preserve views of surrounding landscape and partially screen proposed dwellings



V:\MH_The Hills\10_Master1_Preliminary\MH_10_1_MLP_013A (Rural Lifestyle Area B).dgn



DARBY PARTNERS

Level 1, Steamer Wharf, Lower Beach Street
 PO Box 1164, Queenstown 9348
 Tel +64 3 450 2200 Fax +64 3 441 1451
 info@darbypartners.co.nz
 www.darbypartners.co.nz

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PLAN STATUS:

DP REVIEW

THE HILLS PROPOSED RURAL LIFESTYLE AREA B

DRAWN / REVIEWED: RT / JC
 APPROVED: DT
 DATE: 14.10.15

DRAWING NO:

MH_10_1_MLP_013A

ORIGINAL SIZE A3 DO NOT SCALE. REFER ALL DISCREPANCIES TO THE ENGINEER



Issue	Description	By	Date
A	Preliminary Issue	JWPH	20.10.15

Project: **NATURAL HAZARD ASSESSMENT**

Title: **TOPOGRAPHIC SITE PLAN 1**

Client: **TROJAN HELMET LTD**

hadley consultants LTD
CONSULTING CIVIL & STRUCTURAL ENGINEERS

44 Robins Road, PO Box 1396, Queenstown, New Zealand, P. +64 3 450 2140, F. +64 3 441 3513, W. www.hadleys.co.nz

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Drawn: M.D.	Checked: JWPH	Scale: 1:5000 @ A3	Drawing Number: 152859	Sheet: S01	Issue: A
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ORIGINAL SIZE A3 DO NOT SCALE. REFER ALL DISCREPANCIES TO THE ENGINEER



Issue	Description	By	Date
A	Preliminary Issue	JWPH	20.10.15

Project: NATURAL HAZARD ASSESSMENT
 Title: TOPOGRAPHIC SITE PLAN 2

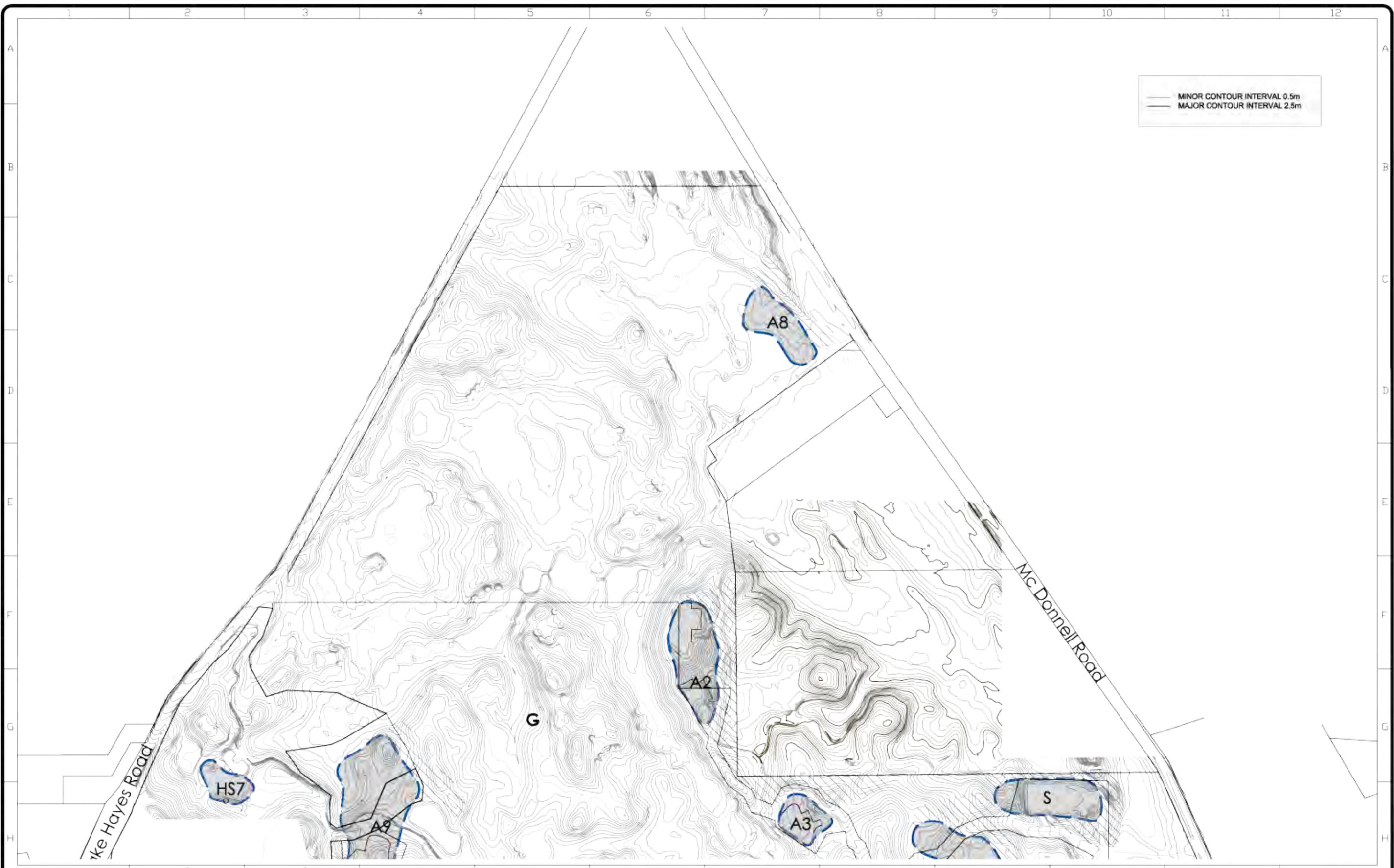
Client: TROJAN HELMET LTD

hadley consultants LTD
 CONSULTING CIVIL & STRUCTURAL ENGINEERS
 44 Robins Road, PO Box 1556, Queenstown, New Zealand, P. +64 3 450 2141, F. +64 3 441 3513, W. www.hadleys.co.nz

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Issue	Description	By	Date
A	Preliminary Issue	JWPH	20.10.15

Project: **NATURAL HAZARD ASSESSMENT**

Title: **ACTIVITY AREA PLAN 1**

Client: **TROJAN HELMET LTD**

hadley consultants LTD
CONSULTING CIVIL & STRUCTURAL ENGINEERS

44 Roims Road, PO Box 1596, Queenstown, New Zealand, P. +64 3 450 2140, F. +64 3 441 3513, W. www.hadleys.co.nz

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Notes:	Issue	Description	By	Date
	A	Preliminary Issue	JWP/H	20.10.15

Project: **NATURAL HAZARD ASSESSMENT**

Title: **ACTIVITY AREA PLAN 2**

Client: **TROJAN HELMET LTD**

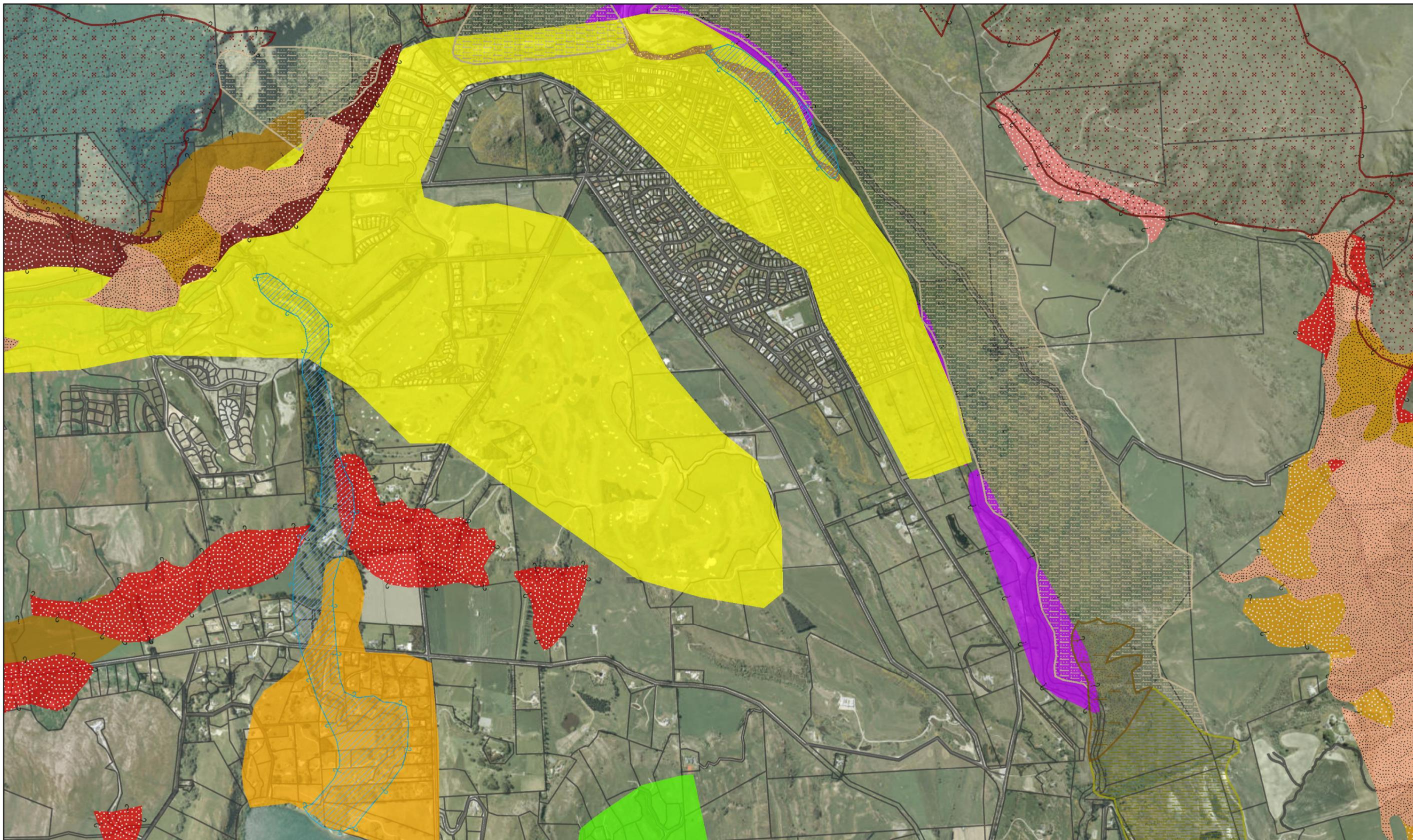
hadley consultants LTD
CONSULTING CIVIL & STRUCTURAL ENGINEERS

44 Roling Road, PO Box 1356, Queenstown, New Zealand, P: +64 3 450 2143, F: +64 3 441 3513, W: www.hadley.co.nz

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Appendix B
QLDC Hazard Maps



The map is an approximate representation only and must not be used to determine the location or size of items shown, or to identify legal boundaries. To the extent permitted by law, the Queenstown Lakes District Council, their employees, agents and contractors will not be liable for any costs, damages or loss suffered as a result of the data or plan, and no warranty of any kind is given as to the accuracy or completeness of the information represented by the GIS data. While reasonable use is permitted and encouraged, all data is copyright reserved by Queenstown Lakes District Council. Cadastral information derived from Land Information New Zealand. CROWN COPYRIGHT RESERVED



The Hills

Legend

Property Land

 Parcel Boundaries

Property Address

 Roads

Hazards

 Active Fault - Location approximate

 Inactive Fault - Location approximate

 Flooding due to Rainfall

 Flooding due to Damburst

 Landslide: Active Pre-existing Schist Debris Landslides

 Landslide: Pre-existing Schist Debris Landslides (Activity Unknown)

 Landslide: Dormant Pre-existing Schist Debris Landslides

 Landslide: Shallow Slips and Debris Flows in Colluvium

 Landslide: Debris Flow Hazards

 Landslide: Slope Failure Hazard in Superficial Deposits

 Landslide: Rockfall

 Landslide: Pre-existing or Potential Failure in Lake Sediments or Tertiary Sediments

 Landslide: Piping potential in the Artesian Zone of the Wanaka Aquifer

 Landslide: Potential Hazard - Debris Flood/Debris Flow

 Landslide Areas - non verified

 Erosion Areas

 Alluvial Fan - Incision Line

 Alluvial Fan - Channels

 Alluvial Fan - Source Area

 Alluvial Fan - Catchment Areas

 Alluvial Fan - Hazard Area

 Alluvial Fan - ORC: fan active bed

 Alluvial Fan - ORC: fan recently active

 Alluvial Fan - ORC: fan less recently active

 Alluvial Fan (Regional scale) Active, Composite

 Alluvial Fan (Regional scale) Active, Debris-dominated

 Alluvial Fan (Regional scale) Active, Floodwater-dominated

 Alluvial Fan (Regional scale) Inactive, Composite

 Alluvial Fan (Regional scale) Inactive, Debris-dominated

 Alluvial Fan (Regional scale) Inactive, Floodwater-dominated

 Avalanche Areas

 Liquefaction Risk: Nil to Low (T&T 2012)

 Liquefaction Risk: Probably Low (T&T 2012)

 Liquefaction Risk: Possibly Moderate (T&T 2012)

 Liquefaction Risk: Possibly High (T&T 2012)

 Liquefaction Risk: Possibly Susceptible (Opus 2002)

 Liquefaction Risk: Susceptible (Opus 2002)

Appendix C

Figure 2

KEY:

- Structure Plan Boundary
- Activity Area

Activity Areas:

- G: Golf course, open space and farming
- C: Clubhouse
- A: Visitor Accommodation / Residential
- HS: Homesite (3,000m²)
- F: Farm
- S: Resort Services & Staff Accommodation

Note: all activity areas include G: Golf course, open space and farming

Overlays:

- /// Landscape Protection Area

The Hills Structure Plan - Yield Schedule
Sep-10

Activity Area	Size	Density (unit/Ha)		Lots	
		Low	High	Low	High
A1	0.9 Ha	1	8	1	7
A2	0.9 Ha	1	8	1	7
A3	0.4 Ha	1	8	1	3
A4	1.7 Ha	1	8	1	13
A5	1.2 Ha	1	8	1	10
A6	0.7 Ha	1	8	1	6
A7	0.5 Ha	1	8	1	4
A8	0.6 Ha	1	4	1	2
A9	1.7 Ha	1	8	1	13
A10	1.1 Ha	1	8	1	8
Subtotal				10	74
H1	0.3 Ha			1	1
H2	0.3 Ha			1	1
H3	0.3 Ha			1	1
H4	0.3 Ha			1	1
H5	0.3 Ha			1	1
H6	0.3 Ha			1	1
H7	0.3 Ha			1	1
H8	0.2 Ha			1	1
H9	0.3 Ha			1	1
H10	0.3 Ha			1	1
Subtotal				10	10
Total				20	84

Total Structure Plan Area	162.7 Ha		
Ave. Lot size (per total land area)		8.1 Ha	1.9 Ha

FOR DISCUSSION



Fig.2

QLDC hazard zonations. Depiction of liquefaction and alluvial fan hazards at site.



Liquefaction risk, probably low



Alluvial fan, Active, Debris dominated.

DARBY PARTNERS
Level 1, Streamer Wharf, Lower Beach Street
PO Box 1164, Queenstown 9348
Tel +64 3 457 2200 Fax +64 3 441 1451
info@darbypartners.co.nz
www.darbypartners.co.nz

SCALE: 1:4,000 (A1) 1:8,000 (A3)
PLAN STATUS
DRAFT

THE HILLS STRUCTURE PLAN

DRAWN / REVIEWED: RT / JC
APPROVED: DT
DATE: 14.09.15

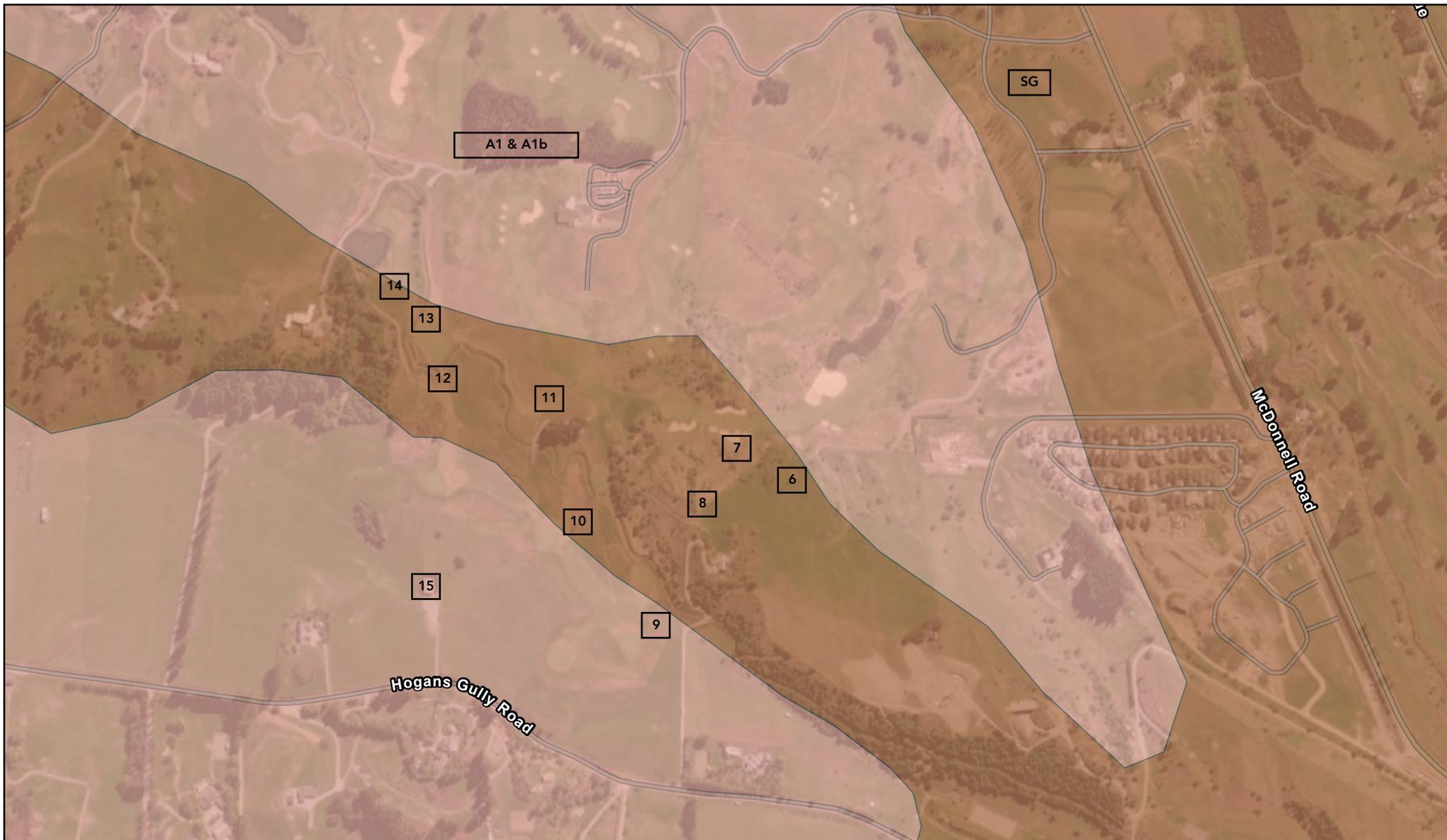
DRAWING NO:
MH_10_1_MLP_010E

Appendix D

Figure 10

Appendix D – Natural Hazards Mapping

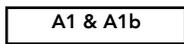
Seismic Soil Classification

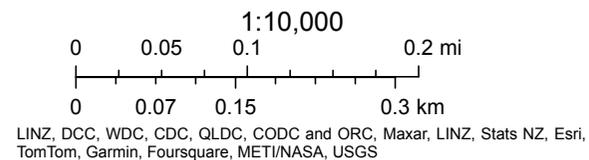


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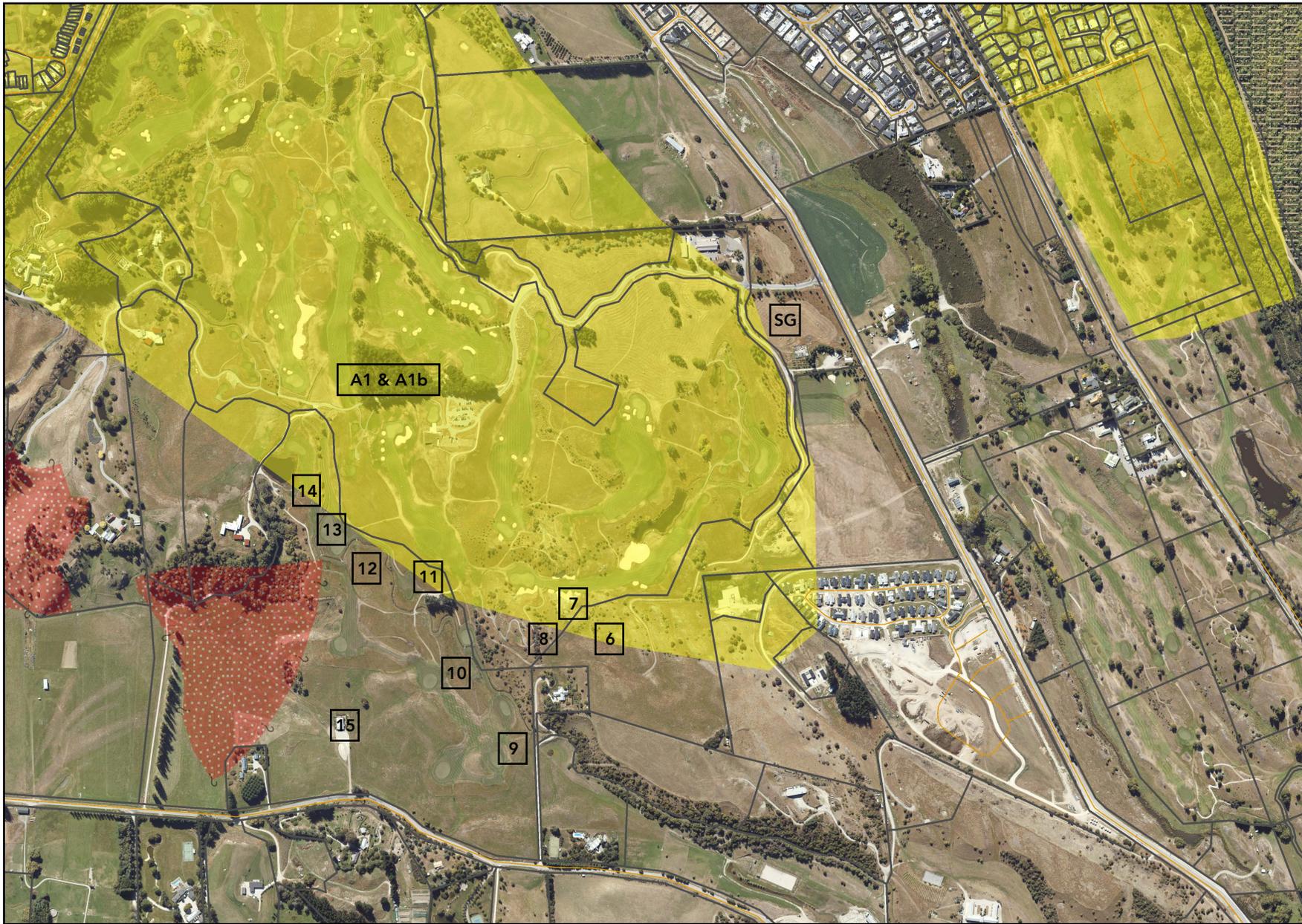
Ground Classification

-  B - Rock
-  D - Deep or Soft Soil

-  SG Sports Garden
-  A1 & A1b Accommodation Area
-  11 House Sites

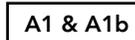


The Hills - Hazards

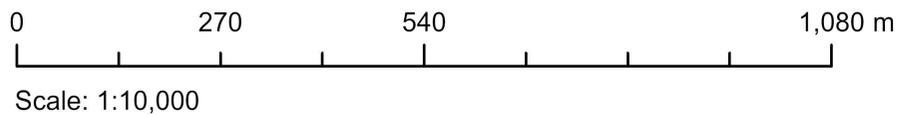


- Legend**
-  Road
 -  Parcels and
 - 2012 Tonkin & Taylor Local Analysis - Aggregation
 - Classification
 -  LIC 1 (P) - Probably
 - 2007 GNS Regional Analysis - Otago Alluvial Fans Project
 -  Active, Debris-dominated - Location
 - Landslide Areas - ORC Regional Analysis
 -  Pre-existing Schist Debris Landslides (Activity)

Approximate Positions for Reference

-  Sports Garden
-  Accommodation Area
-  House Sites

The information provided on this map is intended to be general information only. While considerable effort has been made to ensure that the information provided on this map is accurate, current and otherwise adequate in all respects, Queenstown Lakes District Council does not accept any responsibility for content and shall not be responsible for, and excludes all liability, with relation to any claims whatsoever arising from the use of this map and data held within.



Appendix E – Site Photographs

HS6 Looking north



HS7 Looking north west



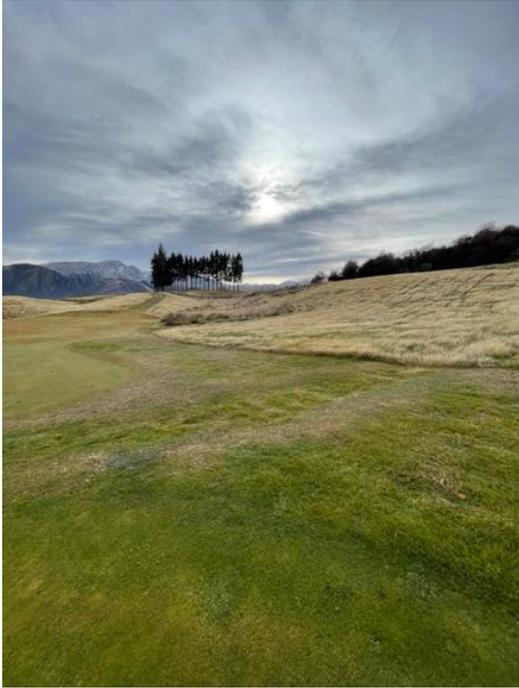
HS8 Looking north



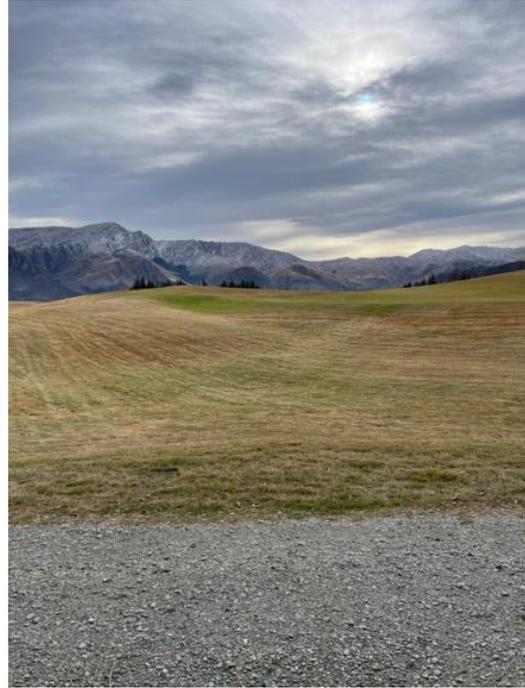
HS9 Looking south west



HS10 Looking north



HS11 Looking north



HS12 Looking north



HS13 Looking south east



HS14 Looking north east



HS15 Looking south



TPSG01



TPSG01 Soil



TPSG02



TPSG02 Soil

