

**Before the Panel of Hearing Commissioners  
For the Queenstown Lakes Proposed District Plan**

In the Matter of                      the Resource Management Act 1991

And

In the Matter of                      the Queenstown Lakes Proposed District Plan  
**(Stage 2 – Hearing Stream 14)**

**Statement of Evidence of James William  
Peter Hadley for Boxer Hill Trust  
(Submitter 2385 and 2386)**

Dated: 13 June 2018

---

**Table of Contents**

<b>INTRODUCTION .....</b>	<b>3</b>
<b>CODE OF CONDUCT .....</b>	<b>3</b>
<b>SCOPE OF EVIDENCE.....</b>	<b>3</b>
<b>DOCUMENTS REVIEWED .....</b>	<b>5</b>
<b>NZS4404:2010 LAND DEVELOPMENT AND SUBDIVISION</b>	
<b>INFRASTRUCTURE - PREVIOUS REPORTING.....</b>	<b>5</b>
<b>THE KEY CHANGES IN THE STAGE 2 PROPOSAL .....</b>	<b>6</b>
<b>INCREASED WATER DEMAND.....</b>	<b>6</b>
<b>INCREASED WASTEWATER FLOW GENERATION .....</b>	<b>7</b>
<b>NATURAL HAZARDS.....</b>	<b>8</b>
<b>STORMWATER .....</b>	<b>8</b>
<b>ADJACENT DEVELOPMENT AND DEVELOPMENT PROPOSALS .....</b>	<b>9</b>
<b>SUMMARY .....</b>	<b>9</b>
<b>ANNEXURES .....</b>	<b>10</b>

## INTRODUCTION

1. My name is James William Peter Hadley. I am a consulting civil and structural engineer and Principal of the consulting engineering company Hadley Consultants Ltd (**HCL**)
2. I hold the qualifications of Bachelor of Engineering (Civil) with Honours. I am a Chartered Member of Engineering New Zealand (CMEng), a Chartered Professional Engineer (CPEng) and a member of the International Professional Engineers Register (IntPE). I have over 25 years' experience in the design and construction of civil and building structures with particular expertise in the design and construction of development infrastructure for roading, water supply, wastewater and stormwater disposal systems. I have extensive experience in design and implementation of infrastructure works for both private companies and for Local Authorities throughout the lower South Island.

## CODE OF CONDUCT

3. While this is not an Environment Court hearing, I confirm that I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Practice Note dated 1 December 2014. I agree to comply with this Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

## SCOPE OF EVIDENCE

4. HCL has been engaged by Boxer Hill Trust (**BHT**) to assess the natural hazard risks and servicing and infrastructure requirements in respect of BHT's two separate land holdings, one adjacent to Hogans Gully Road and the other adjacent to McDonnell Road which are both proposed to be zoned Wakatipu Basin Lifestyle Precinct (**WBLP**).
5. In 2015 my firm prepared the Infrastructure Feasibility and the Natural Hazards Assessments (**Stage 1 Reports** or **Stage 1 Assessments**) that accompanied BHT's submissions on Stage 1 of the Proposed District Plan (**PDP**). BHT's Stage 1 submissions sought a Rural Lifestyle zoning for each landholding, under which up to 10 dwellings could be established on the

Hogans Gully landholding, and up to 4 dwellings on the McDonnell landholding.

6. In the Stage 1 Reports, the two land parcels were referred to as “Proposed Rural Lifestyle Area A” (being the Hogans Gully Road landholding) and “Proposed Rural Lifestyle Area B” (being the McDonnell Road landholding). Under BHT’s Stage 2 submissions, (to which this evidence relates), a WBLP zoning is sought for each landholding. In this evidence, I refer to the landholdings as the “Hogans Gully Site” and the “McDonnell Road Site” (together, the **Sites**). I understand that BHT’s submission on Stage 2 differs from its Stage 1 submission as a result of the now proposed Wakatipu Basin Lifestyle Precinct (**WBLP**) zoning of the Sites.
7. I understand that under a WBLP zoning, up to 20 residential units could be established on the Hogans Gully Site and up to 8 residential units on the McDonnell Road Site.
8. My evidence will address the following:
  - (a) Confirmation of the basis and conclusion of HCL’s earlier Stage 1 reporting on the Hogans Gully and McDonnell Road Sites.
  - (b) The changes now made to the zoning proposals for the Sites since the Stage 1 Reports were prepared and in particular the change in water demand volumes and wastewater flow generation that will occur after increasing the maximum yield of Residential Units.
  - (c) Commentary on the impacts, if any, of changes to the wider Arrowtown fringe area which might affect previous Stage 1 assessments of the 3 Waters Infrastructure feasibility and/or natural hazard matters for the two Sites.
  - (d) Assessment of whether the changes made to the zoning proposals for the Sites since the Stage 1 Reports were prepared alter the Stage 1 Assessments of Natural Hazards and whether any constraints exist for development of the Sites under the Stage 2 WBLP proposals.
  - (e) Assessment of the feasibility of 3 Waters Infrastructure servicing under the new Stage 2 demand scenario at each Site.



## DOCUMENTS REVIEWED

9. In preparing this evidence I have reviewed the following documents and reports:
  - (a) HCL's Stage 1 Reports;
  - (b) THL's Stage 2 submission, including the relevant accompanying expert reports;
  - (c) The evidence of XX for the Queenstown Lakes District Council (QLDC), dated 28 May 2018; and

## NZS4404:2010 LAND DEVELOPMENT AND SUBDIVISION INFRASTRUCTURE - PREVIOUS REPORTING

10. HCL's Stage 1 Reports (in 2015) related to the feasibility of infrastructure services and the impact of Natural Hazards under a Rural Lifestyle zoning for each of the two Sites. In addition, when preparing the Stage 1 Reports, at the request of THL, my firm engaged Davis Consulting Limited (DCL) to undertake a soil contamination assessment for each of the Sites. I understand that HCL's Stage 1 Reports and DCL's assessment were lodged along with THL's Stage 1 submissions (Submissions 443 and 452), but not the Stage 2 submissions (Submissions 2385 and 2386), although the conclusions reached remain relevant presently and I refer to the Stage 1 Reports through this evidence, so for ease of reference both they and DCL's assessment are appended to my evidence as **Annexure A**.
11. The Stage 1 Reports assessed a maximum equivalent yield of 10 residential units for the Hogans Gully Site and four residential units for the McDonnell Road Site. The Stage 1 Assessment for each Site concluded that:
  - (a) It was feasible to service the residential development enabled by the proposed Rural Lifestyle zoning with both potable water and wastewater disposal solutions which would satisfy QLDC standards.
  - (b) Stormwater runoff could be adequately managed at each Site in accordance with QLDC Standards, including use of Low Impact Design (LID) principles.

- (c) Natural hazard issues, particularly liquefaction, did not inhibit the development proposals at each Site.

### **THE KEY CHANGES IN THE STAGE 2 PROPOSAL**

12. Since the Stage 1 Reports were prepared, key changes that have been made to the zoning proposals pursued for each Site (being a WBLP zoning via Stage 2 of the PDP) are as follows:
  - (a) The areas to which the Stage 2 zoning proposals relate are largely the same as addressed in the Stage 1 Reports. There are some minor changes in the defined areas of the Hogans Gully Site, however these minor changes do not materially affect HCL's Stage 1 Assessments of natural hazard impacts for the Site.
  - (b) The proposed density in terms of future residential development potential has changed, in that for each Site it has doubled. This does impact HCL's previous Stage 1 Assessment in that potential water demand and wastewater flows have increased.

### **INCREASED WATER DEMAND**

13. The doubling of the number of dwellings at each Site (from 10 to 20 for the Hogans Gully Site and from 4 to 8 for the McDonnell Road Site) increases both water demand and wastewater flow generation.
14. The Stage 1 Assessments in respect of the then proposed Rural Lifestyle zonings confirmed that there were two options available for both Sites to service the Sites with water supply;
  - (a) Connection to the QLDC Arrowtown and Lake Hayes Water Supply Schemes where QLDC supply pipes already border or are adjacent to the site along both Arrowtown – Lake Hayes Road and McDonnell Road.
  - (b) Use of existing water bores or development of new bores as required to meet demand. These bore sources would be developed to become a private water scheme separate from any public QLDC scheme.
15. Under the WBLP Stage 2 zoning of each Site, there is a 100% increase in daily water demand from what was assessed in the Stage 1 Reports, being

an increase from 21m<sup>3</sup>/day to 42m<sup>3</sup>/day for the Hogans Gully Site and from 8.4m<sup>3</sup>/day to 16.8m<sup>3</sup>/day for the McDonnell Road Site. This increase does not alter the feasibility of the solution reported in HCL's Stage 1 Assessments however and it remains feasible to service these Sites with water as described in the Stage 1 Reports.

16. I note that our Stage 1 Assessments assumed an average daily water demand of 2,100 litres/day/Residential Unit equivalent prescribed by QLDC. I am aware that for some recent development proposals such as Housing Infrastructure Fund projects, QLDC has accepted that scheme designs and scheme assessments which include all new infrastructure may be advanced on the lower demand figures, as described in NZS 4404:2010 Land Development and Subdivision Infrastructure. Adoption of the NZS 4404:2010 parameters would result in a lowering of the per capita Residential Unit demand to 1,400 litres/day. This would result in a total daily demand of 28m<sup>3</sup>/day for Hogans Gully and 11.2m<sup>3</sup>/day for the McDonnell Road Site.
17. The feasibility of supply to the proposed 20 Residential Units at Hogans Gully and 8 Residential Units at McDonnell Road is not contingent on the lower per capita demand figures noted above however. The Stage 2 proposals can still be serviced using the higher, more conservative demand figure of 2,100 litres/day. The potential adoption of the lower 1,400 litres per day is mentioned only to assist and alert QLDC should it wish to minimise cost when assessing capacity of its scheme and scheme upgrade options, if indeed upgrades and developer contributions are found to be necessary.

#### **INCREASED WASTEWATER FLOW GENERATION**

18. The Stage 1 assessment work confirmed it was feasible to service each of the Sites with wastewater by one of two options;
  - (a) Connection to the QLDC wastewater scheme which runs through and adjacent to each Site.
  - (b) Development of a private communal on-site wastewater disposal scheme within each Site.
19. The doubling of the potential residential unit yield under the Stage 2 proposals for the Sites results in an 100% increase in daily wastewater generation from 10.5m<sup>3</sup>/day to 21m<sup>3</sup>/day for the Hogans Gully Site and from

4.2m<sup>3</sup>/day to 8.4m<sup>3</sup>/day for the McDonnell Road Site. Once again, this increase does not alter the feasibility of the solutions reported in HCL's Stage 1 Assessments and it remains feasible to service each Site with wastewater reticulation and disposal solutions if zoned WBLP by adopting the solutions as outlined in the Stage 1 Reports.

20. There is significant land area available at both Sites which makes accommodation of the increase in wastewater flows within a private scheme (should it be the option advanced) very feasible, with few, if any, limitations. Notwithstanding this, I expect it is more likely that connection to the QLDC Wastewater scheme will ultimately be the preferred solution by QLDC.

## **NATURAL HAZARDS**

21. The Stage 1 Assessments of Natural Hazards were specific to each Site. There were minor recommendations to mitigate flows from dormant alluvial features at the Hogans Gully Site, however I consider these matters could be addressed at the time of subdivision or dwelling consent.
22. The relatively minor amendments to the proposed zoned area for the Hogans Gully Site does not alter or impact the findings of the 2015 Stage 1 Report, and I confirm that there are no natural hazard issues which constrain future development under a WBLP zoning for either the Hogans Gully or the McDonnell Road Site.

## **STORMWATER**

23. Whilst there is potentially an increase in impermeable surfaces, and therefore increased runoff associated with the higher number of dwellings now proposed, the land areas available remain significant in terms of the ability to attenuate post development flows such that they do not exceed pre development flows. Therefore, the now proposed WBLP zoning of the Hogans Gully and McDonnell Road Sites does not alter HCL's Stage 1 Assessments of the feasibility of control of Stormwater. I therefore confirm that the collection and subsequent disposal of Stormwater from each Site under a WBLP zoning is entirely feasible via collecting and controlling the Stormwater runoff and disposing by draining to the local water courses passing or within each Site.

## **ADJACENT DEVELOPMENT AND DEVELOPMENT PROPOSALS**

24. Since 2015 when the Stage 1 Reports were prepared, there have been new developments constructed in the area (Arrowtown Lifestyle Retirement Village) along with numerous other rezoning and development proposals put forward for by owners of land neighbouring and nearby the BHT sites. Some of these proposals will result in significant increases in demand on both the QLDC Water and Wastewater networks.
25. Whilst the solutions outlined for the BHT proposals in the Stage 1 Reports are feasible, it is suggested that a potentially more efficient approach would be for QLDC to lead an Area Wide expansion of its water and wastewater networks in the wider Arrowtown area to provide capacity for all zoned areas and approved developments. This would avoid a first come first served approach to existing system capacity, would maximise development contributions to QLDC to fund infrastructure expansion and would avoid the proliferation of discrete private schemes in the area.

## **SUMMARY**

26. To summarise, the zonings sought by BHT in its Stage 2 submissions for the Hogans Gully and McDonnell Road Sites materially impact the previous 2015 Stage 1 Assessments only in terms of the increase in the potential number of dwellings. I have examined the effect of this increase in demand and confirm that under a WBLP zoning it is still feasible to service both the Hogans Gully and the McDonnell Road Site with 3 Waters infrastructure as per the solutions outlined in HCL's 2015 Stage 1 Reports.
27. Further, the 2015 Stage 1 Reports conclusions, with regard to Natural Hazards are unchanged and there are no Natural Hazard issues which adversely impact the proposed WBLP zonings for either the Hogans Gully or McDonnell Road Sites.

**J W P Hadley**

June 2018

## ANNEXURES

**HCL Stage 1 Reports**

Trojan Helmet Ltd

**Proposed Rural Lifestyle Area A**

**Proposed District Plan Submission**

**Infrastructure Feasibility Report**



**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:  
John McCartney  
Civil Director

**Document Status**

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

**Limitations**

This report has been written for the particular brief to HCL 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.

# Contents

<b>1. Introduction</b>	<b>1</b>
<b>2. Nature of Proposed Development</b>	<b>2</b>
<b>3. Site Description</b>	<b>3</b>
<b>4. Water Supply</b>	<b>5</b>
4.1 General	5
4.2 Water Demand Assessment	5
4.3 Fire Fighting Demand	5
4.4 Water Supply - Option 1	6
4.5 Water Supply - Option 2	7
4.6 Conclusions and Recommendations	8
<b>5. Wastewater Disposal</b>	<b>9</b>
5.1 General	9
5.2 Demand Assessment	9
5.3 Wastewater Drainage – Option 1 – Council Reticulated Scheme	9
5.4 Wastewater Drainage – Option 2 – Communal System	11
5.5 Conclusions and Recommendations	12
<b>6. Stormwater Disposal</b>	<b>13</b>
6.1 General	13
6.2 Planning Rules and Regulations	13
6.3 Stormwater Quantities	14
6.4 Conclusions and Recommendations	15
<b>7. Natural Hazards</b>	<b>16</b>
<b>8. Conclusions and Recommendations</b>	<b>17</b>

## Appendix 1

Site Plan

## Appendix 2

HCL Natural Hazards Assessment Report

# 1. Introduction

This report has been prepared to inform a Submission on Queenstown Lakes District Council's (QLDC) Proposed District Plan to re-zone approximately 19.7 hectares of land near Arrowtown from Rural General to Rural Lifestyle zone ("the site"). The Submission is to be made by Trojan Helmet Limited (THL).

The site is located adjacent to Hogans Gully Road and Arrowtown – Lake Hayes Road. The site is contained in two parcels held by differing entities and is currently zoned Rural General under the Operative Queenstown Lakes District Plan.

THL seeks the re-zoning of the site to Rural Lifestyle, thereby enabling development of up to 10 new dwellings.

THL has engaged Hadley Consultants Limited (HCL) to investigate and report on the feasibility of providing utility services and the necessary development infrastructure for the development of the site.

This report considers the nature of the proposed development, the site conditions affecting the implementation of the necessary utility services and development infrastructure and describes the proposed implementation of the following elements:

- Water supply reticulation,
- Wastewater reticulation,
- Stormwater control, and
- Natural Hazards.

## 2. Nature of Proposed Development

THL proposes to rezone the existing site near Arrowtown. The site, located to the south of Arrowtown and covering 19.7 hectares will cover land legally described as:

- Lot 6 Deposited Plan 392663, comprising 15.0399 ha, owned by Richard Michael Hill, Ann Christine Hill and Veritas Hill Limited.
- Part of Lot 4 Deposited Plan 392663, comprising 53.2908 ha, owned by Trojan Helmet Limited.

No subdivision plan for the proposed zone has been developed as yet. However, a preliminary structure plan indicating a Landscape Amenity Management Area has been prepared and has been used to carry out the feasibility reporting and is included in Appendix 1.

We note that the assessment of the necessary development infrastructure provided below is limited to consideration of the scale of the development as it is currently proposed and excludes consideration of specific stages and the specific locations of future dwellings and infrastructure within the site.

### 3. Site Description

The site is located on 19.7 ha of land north east of the corner of Hogans Gully Road and Arrowtown – Lake Hayes Road. There is currently access to the site from Hogans Gully Road. There is existing QLDC infrastructure for water supply and wastewater located along Arrowtown – Lake Hayes Road and Hogans Gully Road adjacent to the site.

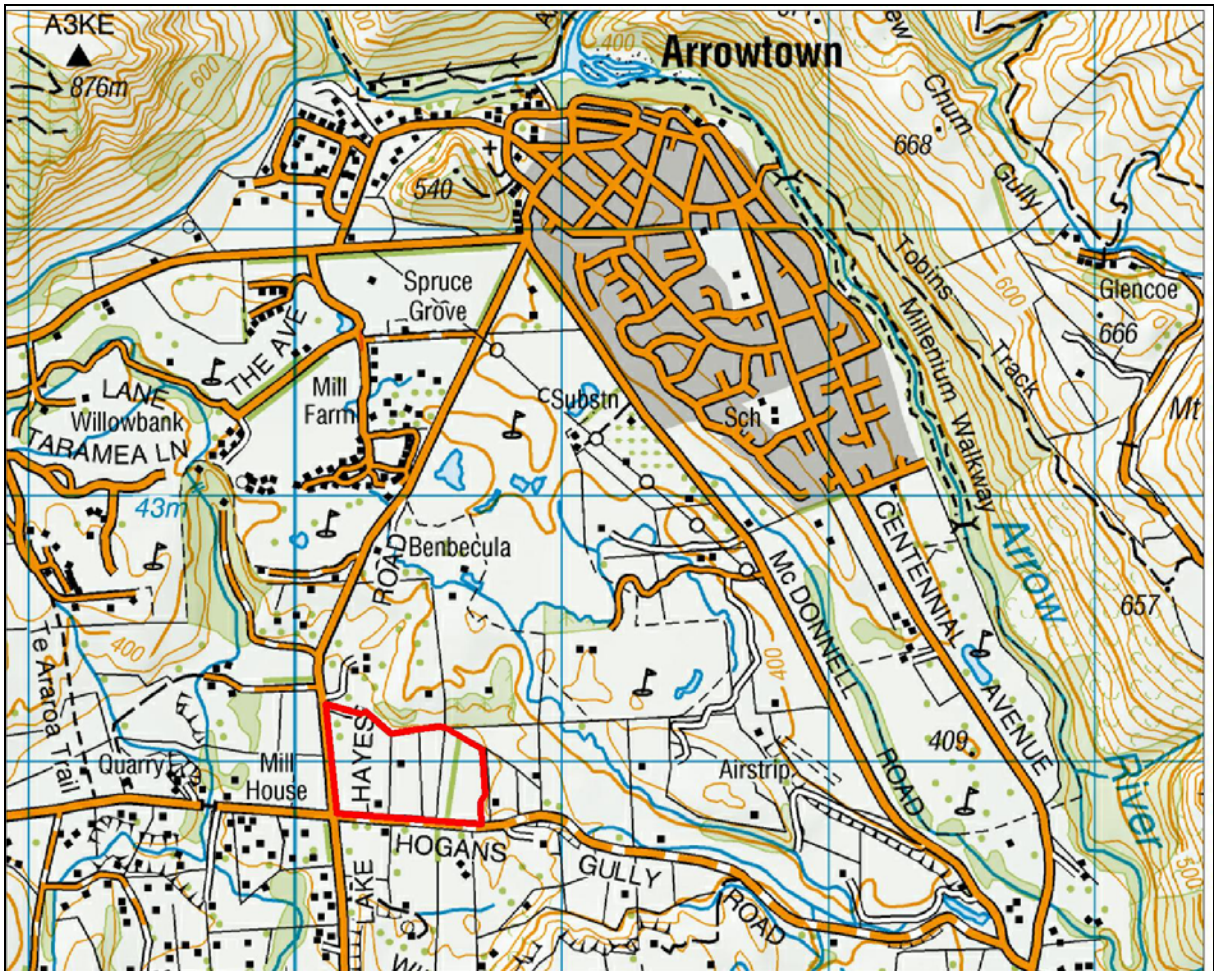


Figure 1 - Topographical Map Excerpt Showing Subject Site

The site comprises generally flat land. The overall topography of the site is gently falling to the south.

Based upon the published geological information (Institute of Geological and Nuclear Sciences (IGNS), 1:250,000 Geological Map 18, Geology of the Wakatipu) and geological examination carried out by others the underlying geological materials within the site are comprised of outwash gravels and till and morainic deposits. These soils overlie schist bedrock that is expected to exist at depth. There are alluvial deposits over the till.

The existing land use at the site is for pastoral grazing. Vegetation covering the area is grass.

Standing water in the form of a pond and drainage channel was observed on site. It is expected that ephemeral watercourses may be formed in some of the topographic depressions on site during periods of high precipitation although these are expected to be short lived and poorly defined.

The proposed development site and surrounding Arrowtown area experience generally cold winters with severe frosts at times and hot dry summers. Strong north-westerly winds are also a climatic characteristic of the area. The land receives approximately 850mm of rainfall per annum and may be subject to drought conditions during the summer months.



## 4. Water Supply

### 4.1 General

The site is located close to the QLDC water supply scheme for Lake Hayes with infrastructure for the water scheme being in the Arrowtown – Lake Hayes Road and Hogans Gully Road adjacent to the site. In addition, the existing buildings and dwellings on the neighbouring sites are currently serviced by existing on site water bore supplies. The Arrow Irrigation Company irrigation water race runs nearby the site and may be able to be reticulated to the site to provide future landscaping irrigation water demand.

### 4.2 Water Demand Assessment

Peak water demand would be expected during the summer months when seasonal populations are at their peak and irrigation usage will be at its highest. The following design figures have been adopted.

Demand Item	Potable Demand (litres/day)	No.	Total (litres/day)
Dwelling (average day)	2,100	10	21,000

The additional average daily water supply demand of 21 m<sup>3</sup> per day equates to 0.24 litres per second average flow over twenty four hours.

From the QLDC Land Development and Subdivision Code of Practice the peaking factors for either the Arrowtown or Lake Hayes water supply schemes are as follows:

Item	Peaking Factor
Average daily flow to peak daily flow	3.3
Average daily flow to peak hourly flow	6.6

Using the QLDC peaking factor, the peak hour flow is estimated at 1.6 litres per second.

### 4.3 Fire Fighting Demand

In accordance with *SNZ PAS 4509:2008 New Zealand Fire Service Firefighting Water Supplies Code of Practice*, the usage for the developed site is expected to fall into the "Housing: includes single family dwellings, multi-unit dwellings but excludes multi storey apartment

*blocks*” category. This will result in a fire fighting water supply classification of FW2. An FW2 classification requires 12.5 l/s of water flow available within a distance of 135 metres and an additional 12.5 l/s of water flow available within a distance of 270 metres.

Alternatively, in the absence of suitable flows and pressures to enable construction of fire hydrants, the future dwellings may be provided with a static firefighting reserve of 20,000 litres (fitted with appropriate fire service couplings) within 90 metres of any future dwelling.

#### **4.4 Water Supply - Option 1**

The first option to provide a water supply to the proposed zone, is to connect to an existing QLDC water supply scheme. Given the relative elevations and proximity to site, it would be most appropriate to connect to the Lake Hayes water supply scheme. Part of the site lies within the Lake Hayes Water Supply Scheme boundary.

No network modelling has been undertaken due to time constraints. However, it would appear that the relatively modest levels of flow required would be able to be accommodated. This would be by way of either a direct connection to the existing infrastructure or via some on site buffering to reduce the peak demands on the existing water supply scheme. If buffering was required, it is expected that booster pumping will be required to then reticulate water to the development areas around the site.

In order to connect to the QLDC Water Supply Scheme, approval of Council would be required to extend the water supply scheme boundary to include the proposed zone. In addition, Development Contributions would need to be paid for each dwelling connected. Council may include other conditions for extending the water supply scheme to include the proposed zone which may result in additional upgrade costs being borne by the developer. Early liaison with Council will be required in order to determine exact Council requirements and potential cost liabilities.



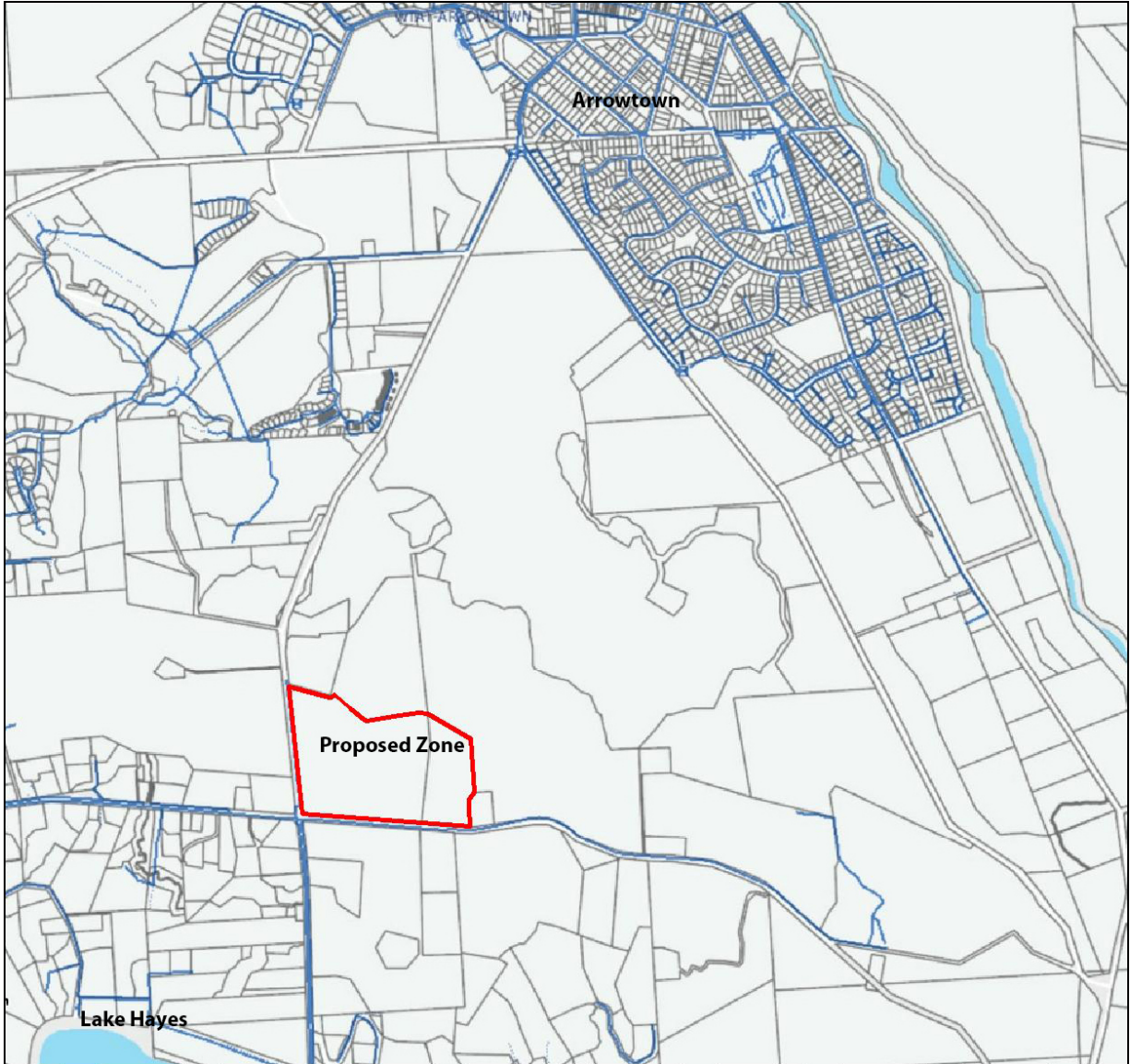


Figure 2 - Map Showing Existing QLDC Water Supply Infrastructure.

## 4.5 Water Supply - Option 2

The second option for providing a water supply for the development would be to use either a new water bore or an existing bore (or a combination of the two) to supply the proposed zone with potable water. This would mean that the zone would have a standalone water supply that was separate from any Council reticulation.

The basic components of such a system would include the water bore intakes and pumps, rising main and storage reservoir as well as a water treatment system sufficient to bring the supply in line with Drinking Standards for New Zealand 2005 (Revised 2008) (DWSNZ).

The water supply storage reservoir for the proposed zone would be relatively small as it would be a buffer only and would likely be accommodated within a 20,000 litre tank or similar. From this buffer storage, water would be supplied to the zone by a water pressure boosting pump station to provide domestic pressures. Each future allotment would provide their own firefighting reserve and associated couplings.

As well as the physical construction issues involved with this option a number of consenting and maintenance matters would also need to be addressed. A resource consent will be required to construct any new bore and a further consent may be required for the water take itself if either the calculated total daily demand or the peak hourly flow exceed the permitted water take rates set out in the Otago Regional Council's Regional Plan for Water. Land use and building consents may also be required for the reservoir and water treatment facilities.

There are existing productive bores on neighbouring sites. Two bores are currently used for servicing the associated golf course site with both potable and irrigation water. It is likely that these two bores would provide sufficient water for the potable demand for the proposed zone. However, this may reduce the amount of water available for irrigation of the associated golf course and landscaping and this would need to be assessed at the time development proceeded to ensure there was sufficient water for all purposes across the site.

The main issue to be considered with regards to this option would be the on-going maintenance and management of the water supply and treatment system. For a system of the expected size to service this site, the water supply could be owned by a lot owners association (or similar) responsible for the on-going management and maintenance of the infrastructure. A similar system to this has been used for various small private schemes around Queenstown.

## **4.6 Conclusions and Recommendations**

Both of the two options outlined above to supply water to the subject site are feasible. Further investigation, consultation with Council and cost analysis will be necessary to establish the final methodology used.

## 5. Wastewater Disposal

### 5.1 General

A Council reticulated sewerage scheme exists adjacent to the site in Arrowtown – Lake Hayes Road. In addition, there is the possibility of constructing a standalone communal treatment and disposal system to cater for the wastewater drainage from the development of the proposed zone.

Both of these options are considered further below.

### 5.2 Demand Assessment

Peak wastewater generation is expected to coincide with peak water demand. The following design figures have been adopted:

Wastewater Generation Item	Wastewater Generation (litres/day)	No.	Total (litres/day)
Dwelling (average day)	1,050	10	10,500

The additional average daily wastewater generation of 10.5 m<sup>3</sup> per day equates to 0.12 litres per second average flow over twenty four hours.

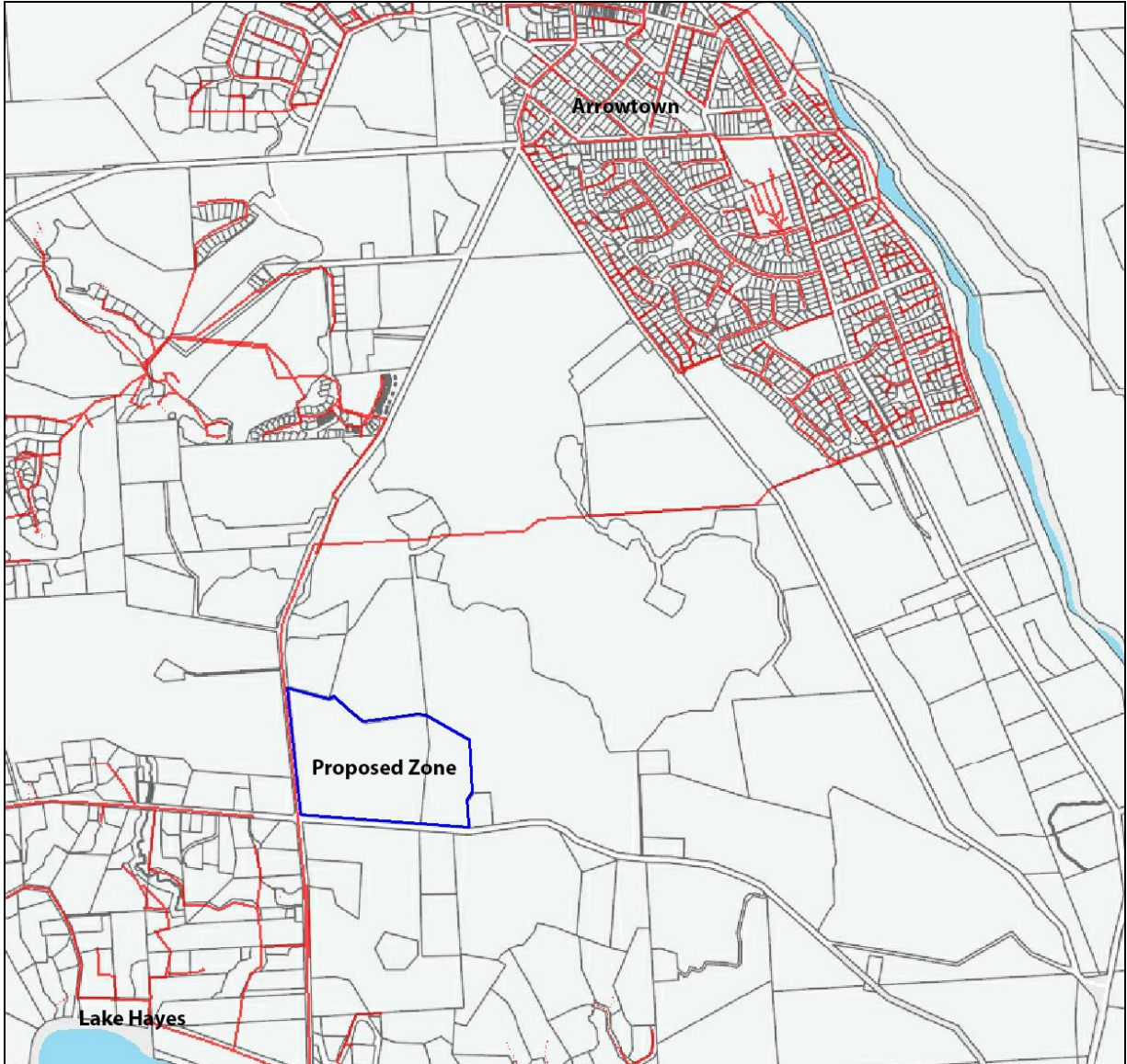
From the QLDC amendments to NZS4404:2004 Land Development and Subdivision Engineering, the peaking factors for the wastewater network are as follows:

Item	Peaking Factor
Dry weather diurnal peak flow	2.5
Wet weather dilution/infiltration factor	2

Using the QLDC peaking factors, during the wet weather peak flow is estimated at 0.61 litres per second.

### 5.3 Wastewater Drainage – Option 1 – Council Reticulated Scheme

This option involves connecting to the existing Council reticulation in Arrowtown – Lake Hayes Road adjacent to the site.



**Figure 3 - Map Showing Existing QLDC Wastewater Drainage Infrastructure.**

As previously stated, the site is generally flat. It is anticipated that much of the site will be able to be drained using standard trunk and lateral gravity pipelines. These will drain to a central pump station that will then pump to a suitable discharge point in the Council network.

The primary pump station would be able to be designed and constructed in such a fashion to enable buffering to reduce flows into the existing Council infrastructure at peak times.

In order to connect to the QLDC Wastewater Drainage Scheme, approval of Council would be required to extend the wastewater scheme boundary to include the proposed zone. In addition, Development Contributions would need to be paid for each dwelling connected.. Council may include other conditions for extending the wastewater scheme to include the



proposed zone that may result in additional upgrade costs being borne by the developer. Early liaison with Council will be required in order to determine exact Council requirements and potential cost liabilities.

#### **5.4 Wastewater Drainage – Option 2 – Communal System**

This option involves constructing a new communal wastewater treatment and disposal system at a suitable location on site and treating all wastewater flows from the proposed development prior to discharge to land.

It is envisaged that a package plant system similar to that used at Jacks Point could be accommodated to service the site. The system would involve the primary treatment of wastewater at each individual dwelling by way of a septic tank to remove solids. Primary treated effluent from each septic tank is then pumped or drained to the communal package treatment facility where it undergoes secondary and possibly tertiary treatment prior to disposal to land.

This type of system has a number of positive attributes including:

- The ability to stage expansion of the treatment plant to cater for staged development of the zone.
- No pond based treatment.
- Possible reuse of water for irrigation purposes.

The system would be made up of the following components:

1. Each dwelling would drain wastewater flows to a septic tank located close by. This septic tank would be installed at the time the dwelling was constructed. Depending on the location and topography, the tank would be fitted with a pump and rising main to reticulate flows to gravity reticulation or would simply connect via gravity to nearby reticulation. The septic tanks will require routine inspections and maintenance. This will mostly involve pumping out the solid wastes from time to time. The inspections and maintenance would be managed by a lot owners association or similar.
2. It is likely that a mix of gravity and pumped mains will reticulate flows to a suitably located treatment facility. In the case of pumped mains, individual tanks would connect to this via a non-return valve kit.
3. At this stage, a package treatment plant is anticipated to be located near the existing service area. This will receive all wastewater flows into a buffer tank and then treat it using a proprietary treatment system. This system would be a package treatment plant

from a proprietary manufacturer/supplier. The actual process adopted will be the subject of detailed design and procurement evaluation. For some guidance, the system used at Jacks Point involves the use of textile packed bed reactors. If deemed necessary at the time of detailed design, tertiary treatment such as UV disinfection could be included to further treat the effluent.

4. The final treated effluent would be reticulated to a suitable disposal location. If suitable tertiary treatment is included, it is likely that this treated effluent could be used for shallow subsurface irrigation around the site. This would need to be carefully considered at the time of detailed design to ensure freezing pipes and public access were appropriately managed.

As well as the physical construction issues involved with this option a number of consenting and maintenance matters would also need to be addressed. A resource consent will be required to dispose effluent to ground as the flows are likely to exceed the permitted effluent disposal rates set out in the Otago Regional Council's Regional Plan for Water. Land use and building consents may also be required for the wastewater treatment facilities.

Similar to the water supply system, one of the main issues to be considered with regards to this option would be the on-going maintenance and management of the wastewater treatment and disposal system. One option would see the system vested with Council. Alternatively, the wastewater drainage and treatment system could be owned by a lot owners association (or similar) responsible for the on-going management and maintenance of the infrastructure. A similar approach to this has been adopted at Jacks Point near Queenstown and accepted by QLDC.

## 5.5 Conclusions and Recommendations

It is recommended that the wastewater generated from the proposed development be disposed of by way of connection to either the QLDC reticulated scheme or a new purpose built communal treatment and disposal facility on site. The feasibility of the chosen wastewater option will need further detailed analysis, consultation and consenting prior to implementation.

## 6. Stormwater Disposal

### 6.1 General

Generally, it is proposed to maintain the runoff characteristics of the existing catchment. However the proposed development on the site will alter the existing stormwater run off patterns and will serve to increase the peak flow runoff. We recommend to collect and control the stormwater runoff and dispose via connection to local water courses or to dispose of on site using stormwater infiltration and soakage features.

### 6.2 Planning Rules and Regulations

Rule 12.5.1.1 of the Regional Plan: Water for Otago states that the discharge of drainage water to water (or onto land where it might enter water) from any drain is a permitted activity so long as certain conditions are met. The conditions of particular relevance to the discharge of stormwater from the proposed new roads and domestic allotments are as follows:

*12.5.1.1 (b) The discharge, after reasonable mixing, does not give rise to all or any of the following effects in the receiving water:*

- (i) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or*
- (ii) Any conspicuous change in the colour or visual clarity; or*
- ...*
- (v) Any significant adverse effects on aquatic life.*

It is further stated that:

*The discharge of drainage water under Rule 12.5.1.1 will have no more than minor adverse effects on the natural and human use values supported by water bodies, or on any other person. This rule is adopted to enable drainage water to be discharged while providing protection for those values and the interests of those people. Any other activity involving the discharge of drainage water is a restricted discretionary activity in order that any adverse effects can be assessed.*

Contaminants associated with vehicular traffic can include oils, rubber, heavy metals and sediments. In large amounts these contaminants can greatly decrease the natural and human use values of bodies of water. As the stormwater from the site will likely be discharging either directly into local water courses or to ground, appropriate protections will need to be installed in the on-site drainage system in order to remove such contaminants

from the stormwater. The aim of stormwater quality treatment used at the site would be to ensure that the runoff from the new development is in a similar condition to that being achieved before the development. Of particular concern are the "first flush" flows that carry the highest pollutant loadings.

Appropriate technologies to separate contaminants from the stormwater flows might include the use of mud-tanks located in the on-site drainage sumps and a vortex separator mechanism such as a Hynds Downstream Defender which provide high removal efficiencies of suspended solids and floatables over a wide range of flow rates.

Careful design of the stormwater reticulation for the site will ensure that the requirements set out in the Regional Plan: Water for Otago are met.

### **6.3 Stormwater Quantities**

At this early stage in the development of the proposed zone, it is difficult to determine the increase in storm water runoff from the site. Initial calculations have been undertaken and these indicate that for a 10 minute rain event with an average reoccurrence interval (ARI) of 10 years the development is expected to increase the storm water flow rate by approximately 500 litres per second. This will vary depending upon the density of the development and the permeability of the site.

This level of increase in runoff would result in very large infrastructure if the traditional approach of reticulating all the flows from the site was adopted. If a single point of discharge was developed, the required outlet pipe would be approximately 525 mm in diameter. This level of infrastructure would be expensive and can be mitigated using a Low Impact Design (LID) approach.

From NZS4404:2010 Land Development and Infrastructure:

*Low impact design aims to use natural processes such as vegetation and soil media to provide stormwater management solutions as well as adding value to urban environments. The main principles of low impact design are reducing stormwater generation by reducing impervious areas, minimising site disturbance, and avoiding discharge of contaminants. Stormwater should be managed as close to the point of origin as possible to minimise collection and conveyance. Benefits include limiting discharges of silt, suspended solids, and other pollutants into receiving waters, and protecting and enhancing natural waterways.*

And:

*Low impact design is a type of storm water system that aims to minimise environmental impacts by:*



- (a) Reducing peak flow discharges by attenuation;*
- (b) Eliminating or reducing discharges by infiltration or soakage;*
- (c) Improving water quality by filtration;*
- (d) Installing detention devices for beneficial reuse.*

The types of low impact devices and practices that could be included in the zone include the following:

- Detention Ponds;
- Vegetated swales;
- Rain gardens;
- Rainwater tanks;
- Soakage pits and soak holes;
- Filter strips; and
- Infiltration trenches/basins.

Subdivision urban design principles may also assist in mitigating runoff from the site. These include clustering development to increase open area around developed areas and decreasing road setbacks in order to decrease the likely impervious areas.

In addition to reducing the peak discharge from the site, LID approaches may also improve the quality of the runoff from the site.

## **6.4 Conclusions and Recommendations**

We consider that the collection and subsequent disposal of stormwater from the proposed development is entirely feasible via collecting and controlling the stormwater runoff and disposing by draining to the local water courses passing the site.

Dependent upon the overall design approach for the subdivision, the storm water runoff leaving the site could be greatly reduced by the introduction of low impact design approaches including the use of attenuation and filtration devices.

## 7. Natural Hazards

Natural Hazards have been separately assessed by HCL as part of a global Natural Hazards Assessment for THL land holdings.

The HCL Natural Hazards Assessment report is included as Appendix 2 and confirms there are no natural hazard constraints applying to the Rural Lifestyle Area A Land.

## 8. Conclusions and Recommendations

The subject site and the proposed development have been assessed to determine the suitability for development in relation to infrastructure services. No significant constraints have been identified and the Rural Lifestyle A land is suitable for the proposed development from an infrastructure servicing viewpoint.

The key findings are summarised as follows;

- i. There are two options for supplying water to the site. The first option would be to utilise the QLDC reticulated water supply. The second option would be to install a new, private water bore intake and treatment along with a new reservoir and a water supply boosting pump station. The final decision on which methodology to use will be decided at a later point following further investigation, consultation and cost analysis.
- ii. Wastewater drainage reticulation from the site will be able to be catered for with either connection to the existing QLDC reticulation or construction of a proposed wastewater reticulation and treatment and disposal system. The majority of the site will be able to be reticulated by the construction of gravity sewer pipes. However, it is anticipated that parts of the development site will require pump stations in order to convey flows to either the existing QLDC infrastructure or the new treatment plant.
- iii. Stormwater runoff from the site can be satisfactorily disposed of by the construction of necessary reticulation with disposal to local water courses. It is recommended that in order to reduce the peak runoff and to improve runoff quality, low impact design approaches are adopted.
- iv. Based on the global Natural Hazard Assessment prepared by HCL, no natural hazard issues exist which constrain development on the Rural Lifestyle A land.

Overall, we confirm that there are no significant impediments to development of the site with respect to Infrastructure Services or Natural Hazard.

We recommend that the timing and scale of the proposed infrastructure upgrades be further assessed once the layout of the proposed zone has been further progressed and staging of development has been confirmed.

Appendix 1  
Site Plan

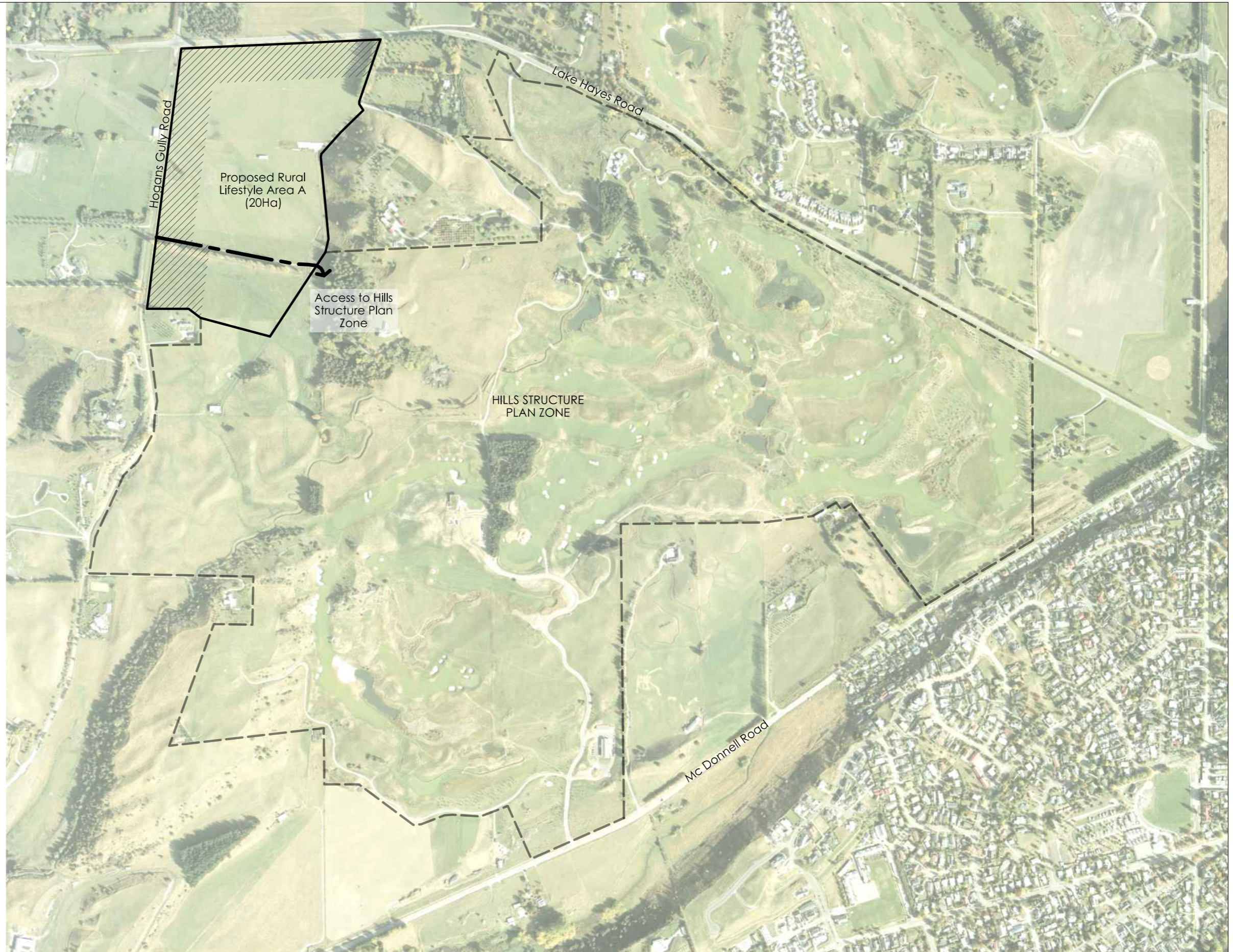


**KEY:**

- 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\_Master\1\_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



Appendix 2  
HCL Natural Hazards  
Assessment 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.



## Contents

<b>1. Introduction</b>	<b>2</b>
<b>2. Nature of Proposed Development</b>	<b>3</b>
<b>3. Scope of Assessment</b>	<b>4</b>
<b>4. Site Description</b>	<b>5</b>
<b>5. QLDC Hazard Register and Previous Work</b>	<b>7</b>
<b>6. Geological Setting</b>	<b>8</b>
6.1 Physiography	8
6.2 Site Lithologies	8
<b>7. Specific Development Area Assessment</b>	<b>10</b>
7.1 General	10
7.2 Liquefaction Risk and Flood Hazard	10
7.3 Proposed Rural Lifestyle Area A	11
7.4 Proposed Rural Lifestyle Area B	11
7.5 Sites Requiring Little or No Mitigation	12
7.6 Site A8	12
7.7 Site A6	13
7.8 Site A10	13
7.9 Site A7	13
7.10 Site HS10	13
7.11 Site HS9	14
7.12 Sites HS2, HS3 and HS4	14
<b>8. Conclusions and Recommendations</b>	<b>15</b>

### **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




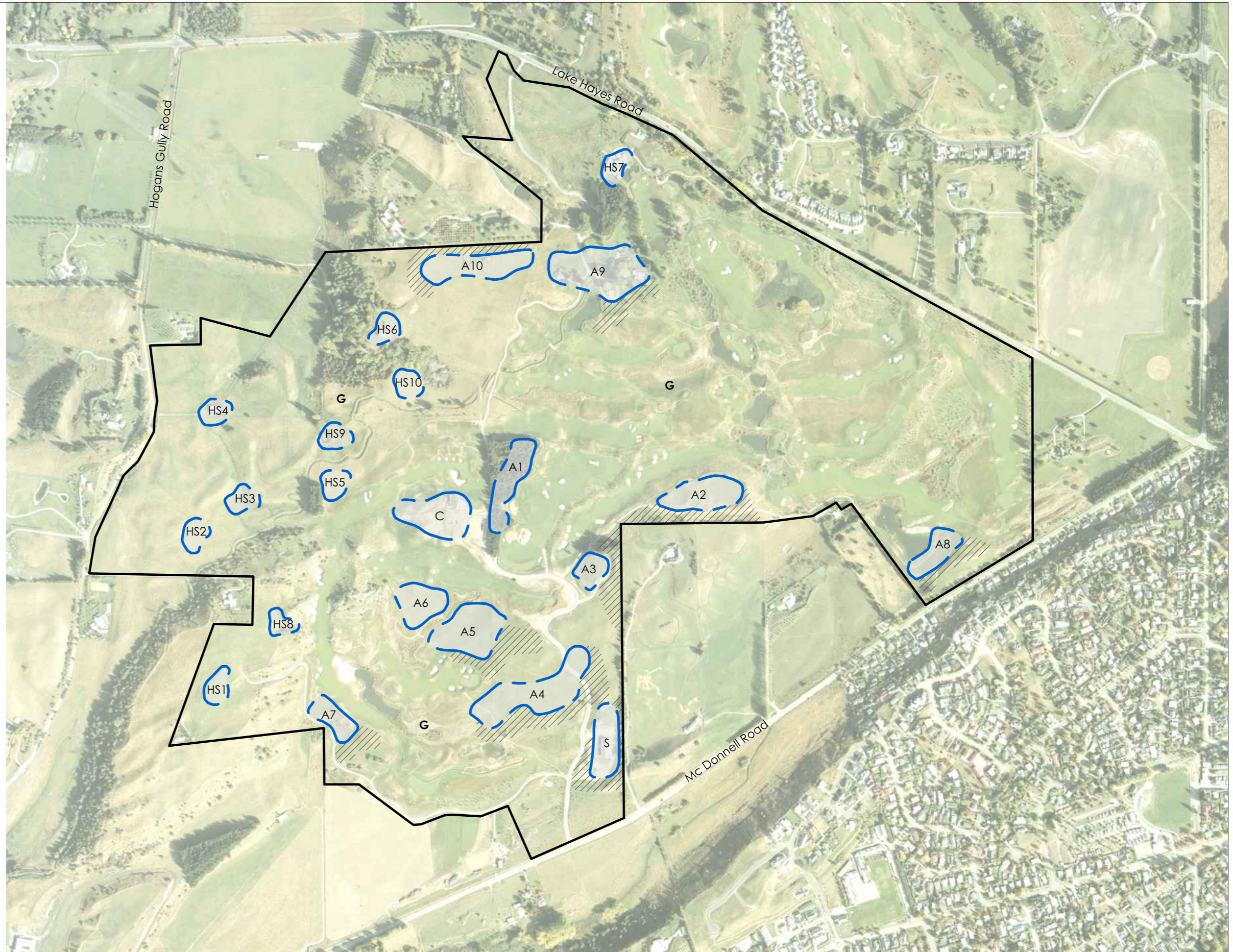
**Activity Areas:**

- G: Golf course, open space and farming
- C: Clubhouse
- A: Visitor Accommodation / Residential
- HS: Homesite (3,000m<sup>2</sup>)
- 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



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 (3,000m<sup>2</sup>)
- S: Resort Services & Staff Accommodation

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

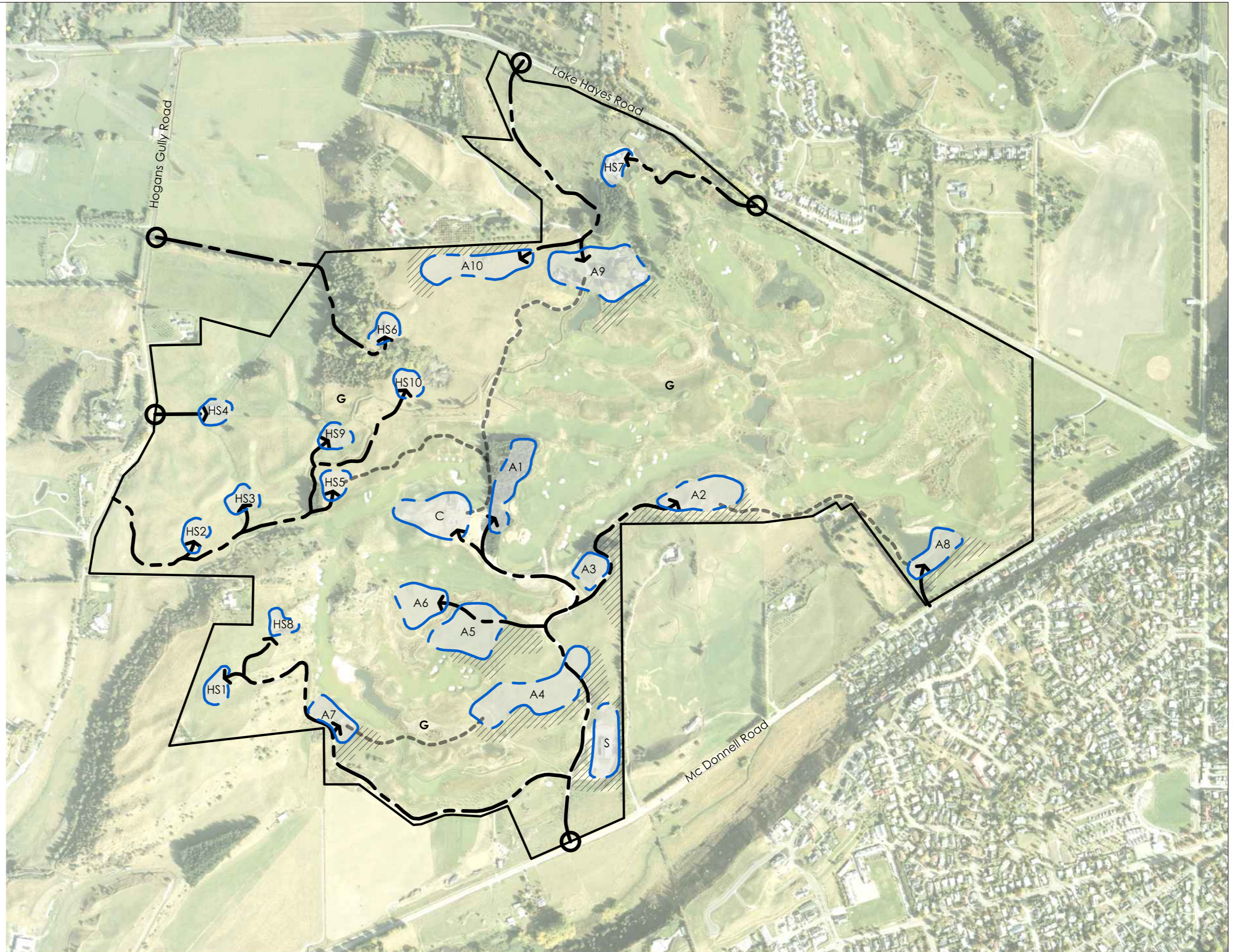
**Overlays:**

/// 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

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



PLAN STATUS:

**DP REVIEW**

**THE HILLS  
 STRUCTURE PLAN - ACCESS**

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

DRAWING NO:

MH\_10\_1\_MLP\_011B



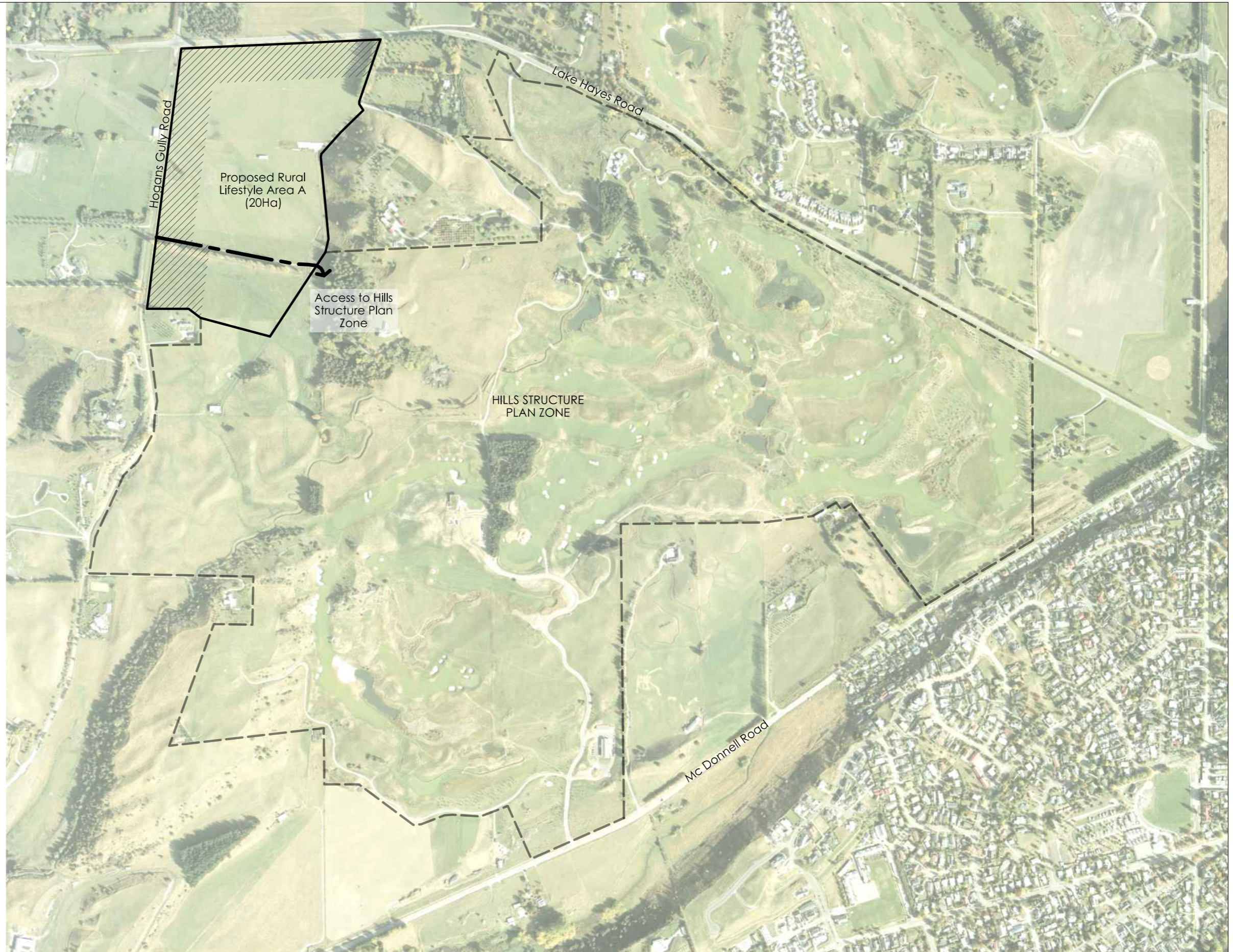
**KEY:**

- 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*

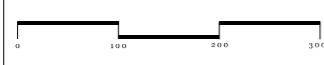


V:\MH\_The Hills\10\_Master1\_Preliminary\MH\_10\_1\_MLP\_012B (Rural Lifestyle Area A).dgn



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

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



PLAN STATUS:

**DP REVIEW**

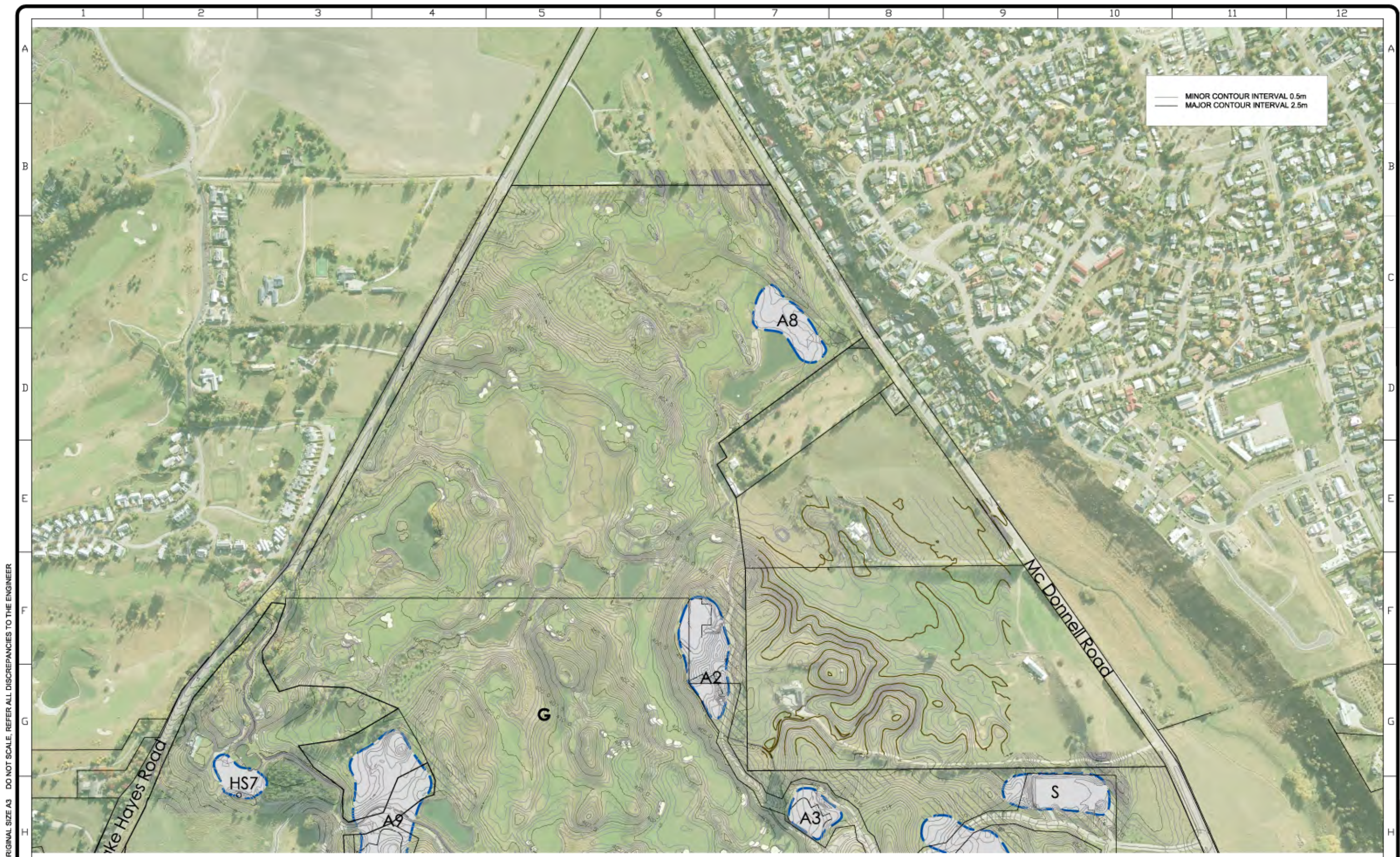
# THE HILLS PROPOSED RURAL LIFESTYLE AREA B

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

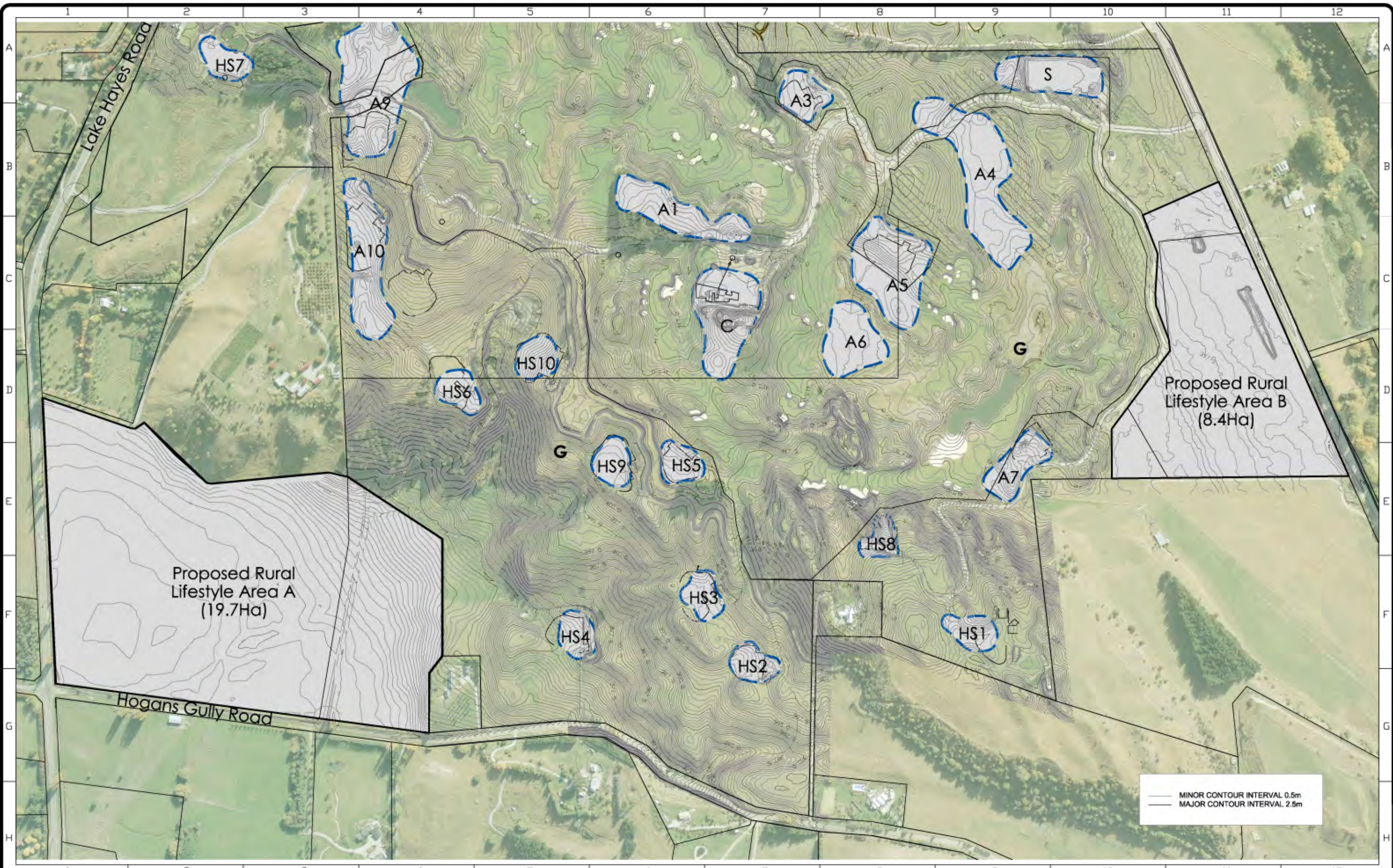
44 Robins Road, PO Box 1396, Queenstown, New Zealand, P. +64 3 450 2140, F. +64 3 441 3513, W. www.hadleys.co.nz

Drawn: MU	Checked: JWPH	Scale: 1:5000 @ A3	Drawing Number: 152859	Sheet: S01	Issue: A
-----------	---------------	--------------------	------------------------	------------	----------

This drawing is supplied on the understanding that the information contained hereon will not be passed to any other party without written permission first being obtained from Hadley Consultants Ltd.



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**

CONSULTING CIVIL & STRUCTURAL ENGINEERS

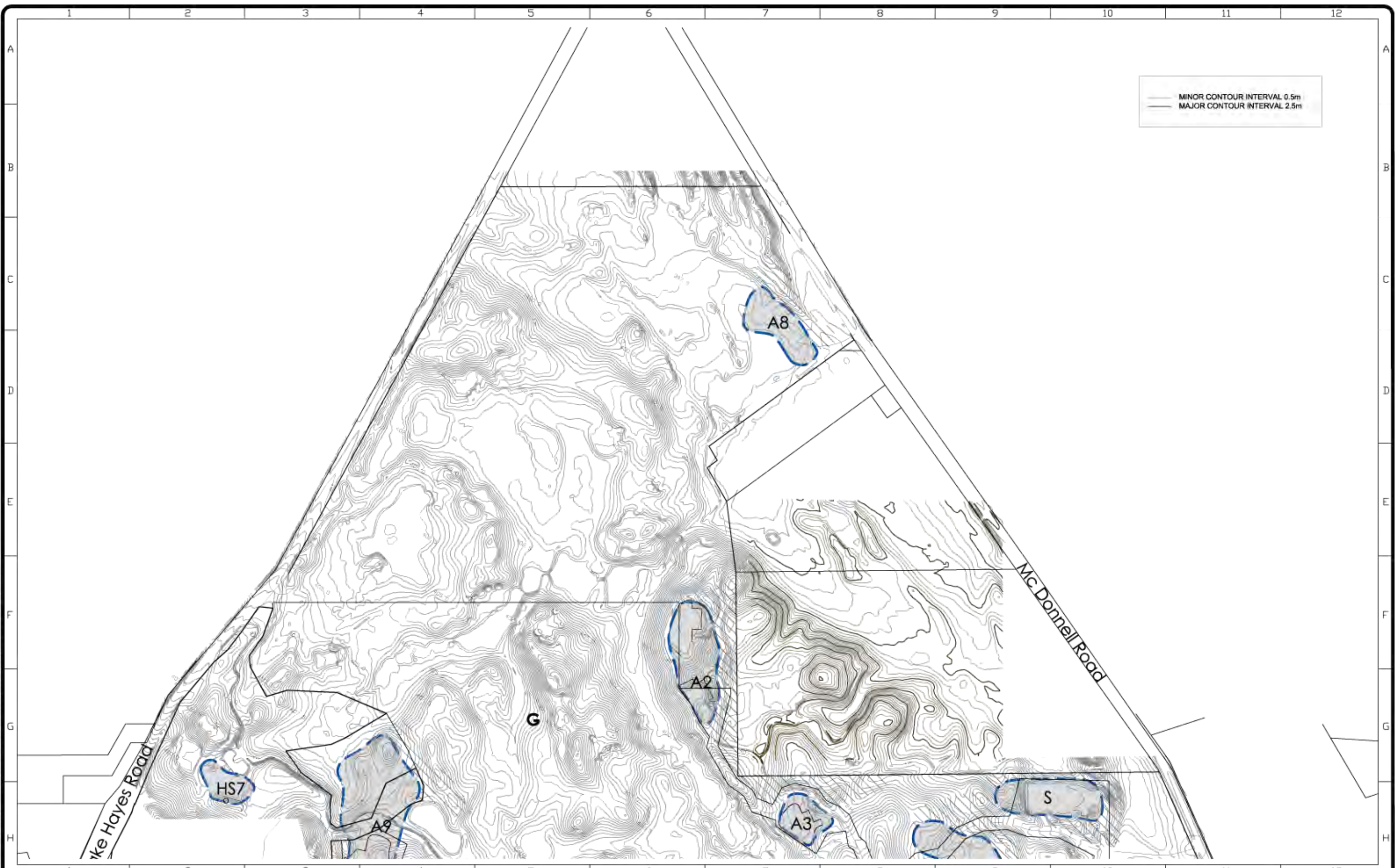
44 Robins Road, PO Box 1556, Queenstown, New Zealand, P. +64 3 450 2140, F. +64 3 441 3513, W. www.hadleys.co.nz


This drawing is supplied on the understanding that the information contained herein will not be passed to any other party without written permission first being obtained from Hadley Consultants Ltd.

Drawn: MU	Checked: JWPH	Scale: 1:5000 @ A3	Drawing Number: Project: 152859	Sheet: S02	Issue: A
-----------	---------------	--------------------	---------------------------------	------------	----------



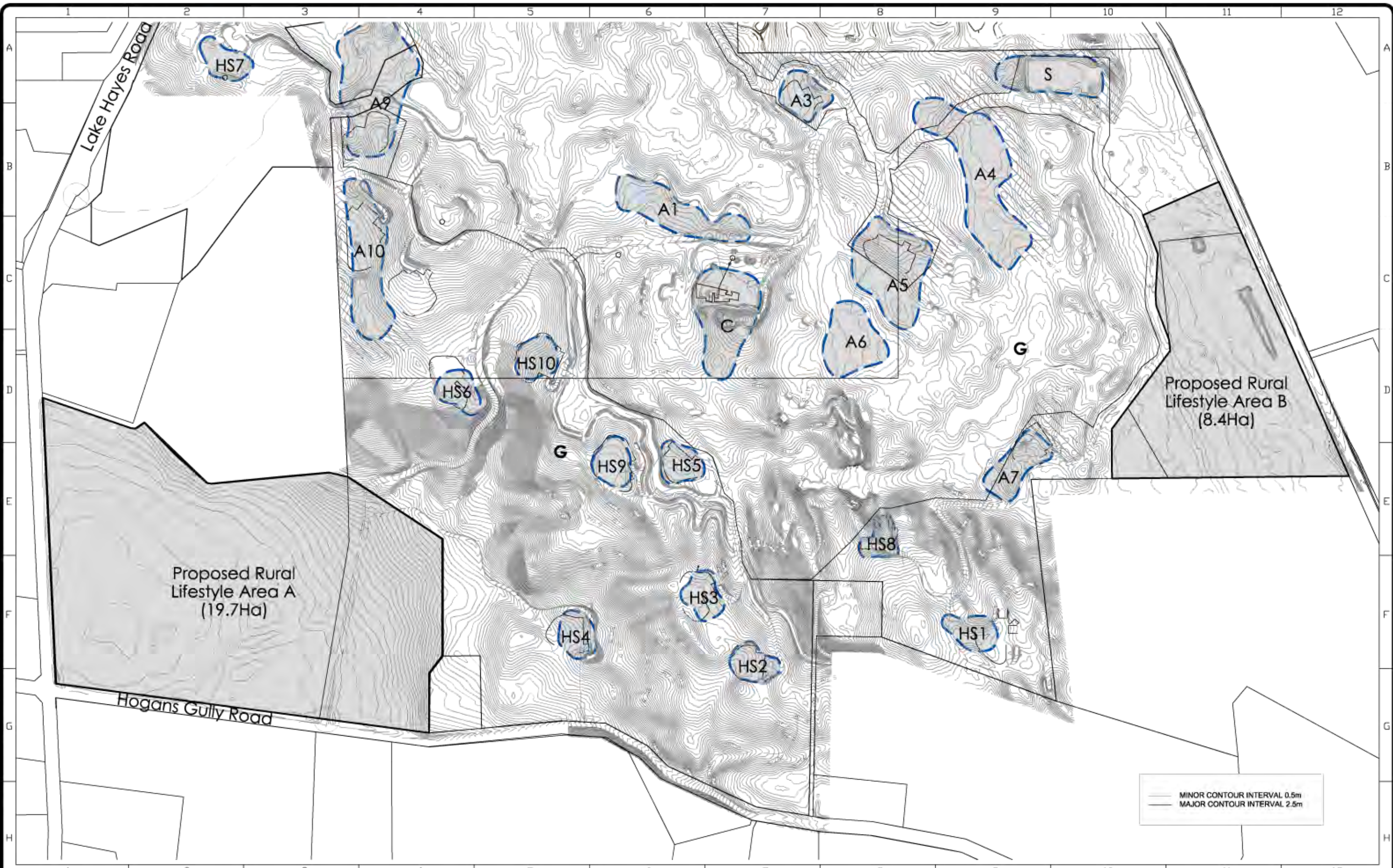
ORIGINAL SIZE A3 DO NOT SCALE, REFER ALL DISCREPANCIES TO THE ENGINEER



Notes:	Issue	Description	By	Date	Project:	Client:	 CONSULTING CIVIL & STRUCTURAL ENGINEERS <small>44 Roime Road, PO Box 1596, Queenstown, New Zealand, P. +64 3 450 2140, F. +64 3 441 3513, W. www.hadleys.co.nz</small>	<small>This drawing is supplied on the understanding that the information contained hereon will not be passed to any other party without written permission first being obtained from Hadley Consultants Ltd.</small>				
	A	Preliminary Issue	JWPH	20.10.15	<p><b>NATURAL HAZARD ASSESSMENT</b></p> <p><b>ACTIVITY AREA PLAN 1</b></p>				<p><b>TROJAN HELMET LTD</b></p>			
					Title:	Drawn:	Checked:	Scale:	Drawing Number:	Project:	Sheet:	Issue:
						MU	JWPH	1:5000 @ A3	152859	152859	S03	A



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



Notes:	Issue	Description	By	Date
	A	Preliminary Issue	JWPH	20.10.15

Project:	NATURAL HAZARD ASSESSMENT
Title:	ACTIVITY AREA PLAN 2

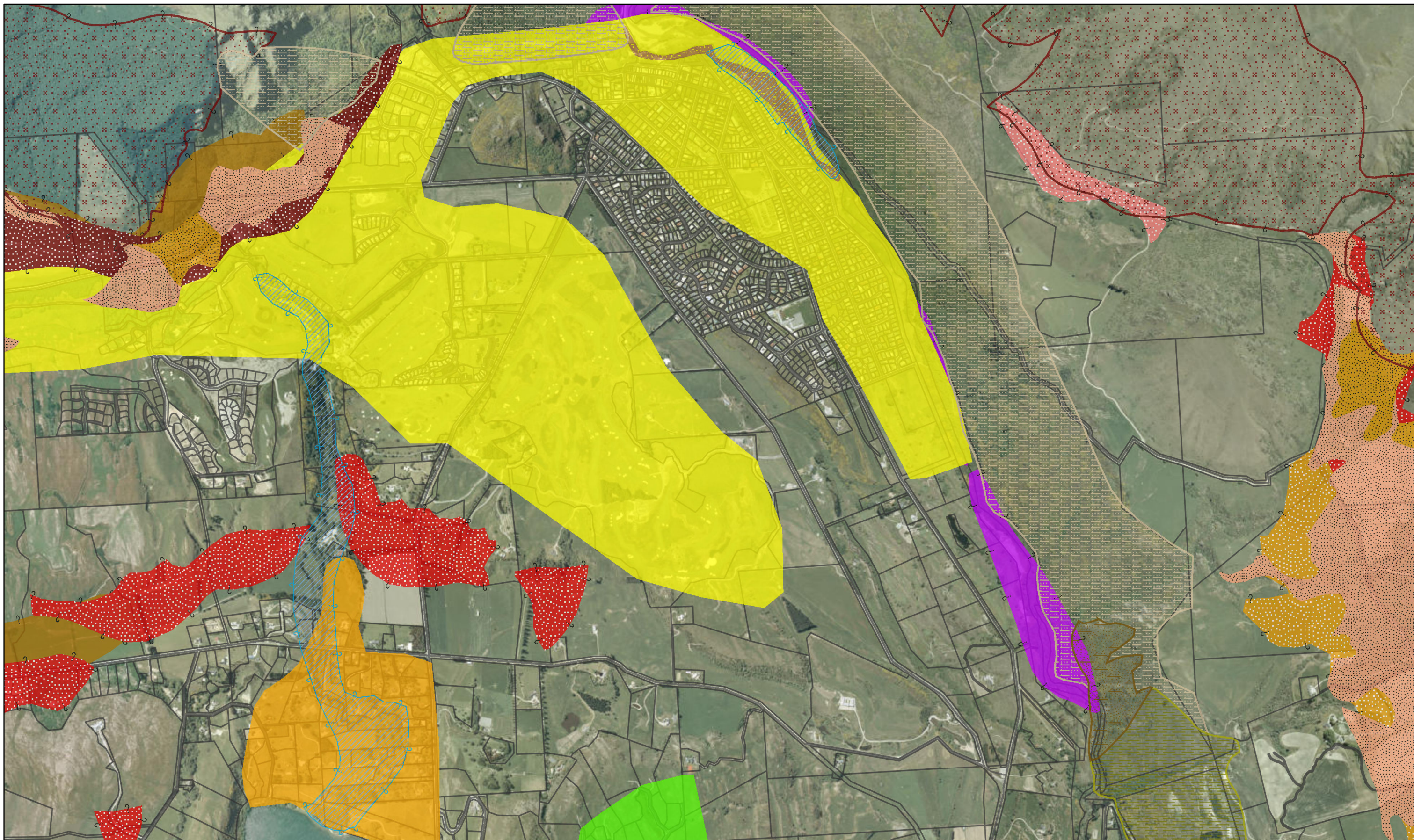
Client:	TROJAN HELMET LTD
---------	-------------------

		<small>This drawing is supplied on the understanding that the information contained herein will not be passed to any other party without written permission first being obtained from Hadley Consultants Ltd.</small>	
Drawn:	Checked:	Scale:	Drawing Number:
MU	JWPH	1:5000 @ A3	Project: 152859 Sheet: S04 Issue: A



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 (3,000m<sup>2</sup>)
- 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
<b>Subtotal</b>				<b>10</b>	<b>74</b>
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
<b>Subtotal</b>				<b>10</b>	<b>10</b>
<b>Total</b>				<b>20</b>	<b>84</b>

<b>Total Structure Plan Area</b>	162.7 Ha		
<b>Ave. Lot size (per total land area)</b>		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 3 450 2200 Fax +64 3 441 1451  
info@darbypartners.co.nz  
www.darbypartners.co.nz

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



PLAN STATUS  
**DRAFT**

THE HILLS  
STRUCTURE PLAN

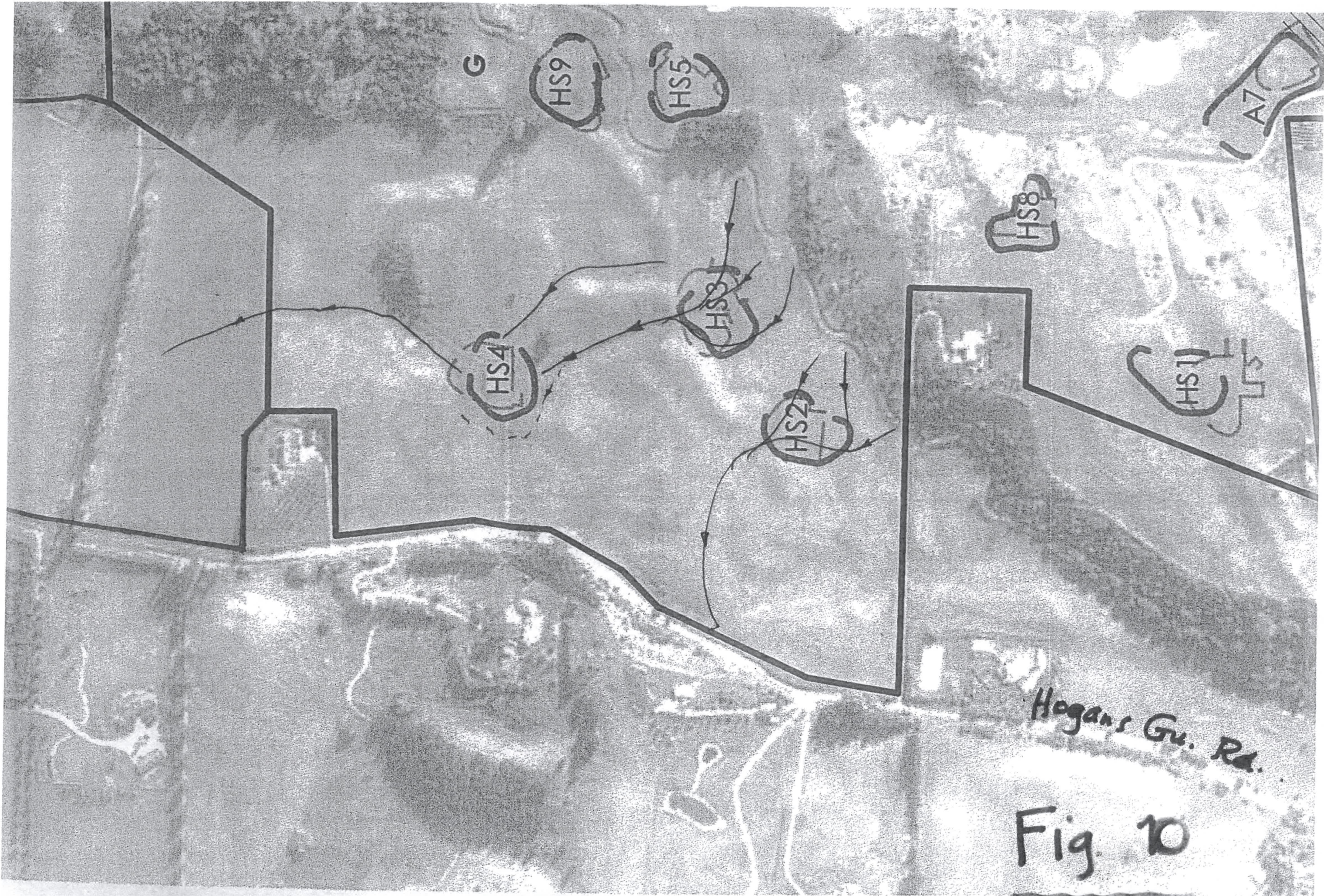
DRAWN / REVIEWED: RT / JC  
APPROVED: DT  
DATE: 14.09.15

DRAWING NO:  
MH\_10\_1\_MLP\_010E



Appendix D  
Figure 10





Hogan's Gu. Rd.

Fig. 10





Trojan Helmet Ltd

**Proposed Rural Lifestyle Area B**

**Proposed District Plan Submission**

**Infrastructure Feasibility Report**

**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:  
John McCartney  
Civil Director

**Document Status**

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

**Limitations**

This report has been written for the particular brief to HCL 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.

# Contents

<b>1. Introduction</b>	<b>1</b>
<b>2. Nature of Proposed Development</b>	<b>2</b>
<b>3. Site Description</b>	<b>3</b>
<b>4. Water Supply</b>	<b>5</b>
4.1 General	5
4.2 Water Demand Assessment	5
4.3 Fire Fighting Demand	5
4.4 Water Supply - Option 1	6
4.5 Water Supply - Option 2	7
4.6 Conclusions and Recommendations	8
<b>5. Wastewater Disposal</b>	<b>9</b>
5.1 General	9
5.2 Demand Assessment	9
5.3 Wastewater Drainage – Option 1 – Council Reticulated Scheme	9
5.4 Wastewater Drainage – Option 2 – Communal System	11
5.5 Conclusions and Recommendations	12
<b>6. Stormwater Disposal</b>	<b>13</b>
6.1 General	13
6.2 Planning Rules and Regulations	13
6.3 Stormwater Quantities	14
6.4 Conclusions and Recommendations	15
<b>7. Natural Hazards</b>	<b>16</b>
<b>8. Conclusions and Recommendations</b>	<b>17</b>

## Appendix 1

Site Plan

## Appendix 2

HCL Natural Hazards Assessment Report

# 1. Introduction

This report has been prepared to inform a Submission to Queenstown Lakes District Council's (QLDC) Proposed District Plan Review to re-zone approximately 8.4 hectares of land near Arrowtown from Rural General to Rural Lifestyle zone ("the site"). The Submission is to be made by Trojan Helmet Limited (THL).

The site is located adjacent to McDonnell Road near Arrowtown. The site is contained in three parcels held by differing entities and is currently zoned Rural General under the Operative Queenstown Lakes District Plan.

THL seeks the re-zoning of the site to Rural Lifestyle, thereby enabling development of up to 4 new dwellings.

THL has engaged Hadley Consultants Limited (HCL) to investigate and report on the feasibility of providing utility services and the necessary development infrastructure for the development of the site.

This report considers the nature of the proposed development, the site conditions affecting the implementation of the necessary utility services and development infrastructure and describes the proposed implementation of the following elements:

- Water supply reticulation,
- Wastewater reticulation,
- Stormwater control, and
- Natural Hazards.

## 2. Nature of Proposed Development

THL proposes to develop the existing site near Arrowtown. The site, located to the south of Arrowtown and covering 8.4 hectares will cover land legally described as:

- Lot 2 Deposited Plan 392663, comprising 7 ha, owned by Richard Michael Hill, Ann Christine Hill and Veritas Hill Limited.
- Part of Lot 4 Deposited Plan 392663, comprising 53.2908 ha, owned by Trojan Helmet Limited.
- Part of Lot 7 Deposited Plan 392663, comprising 101.5914 ha, owned by Trojan Helmet Limited.

No subdivision plan for the proposed zone has been developed as yet. However, a structure plan indicating a Landscape Amenity Management Area has been prepared and has been used to carry out the feasibility reporting and is included in Appendix 1.

We note that the assessment of the necessary development infrastructure provided below is limited to consideration of the scale of the development as it is currently proposed and excludes consideration of specific stages and the specific locations of future dwellings and infrastructure within the site.

### 3. Site Description

The site is located on 8.4 ha of land to the west of McDonnell Road. There is currently access to the site from McDonnell Road via the main Hills Golf Course entrance. There is existing QLDC infrastructure for water supply and wastewater located along McDonnell Road north of the site.

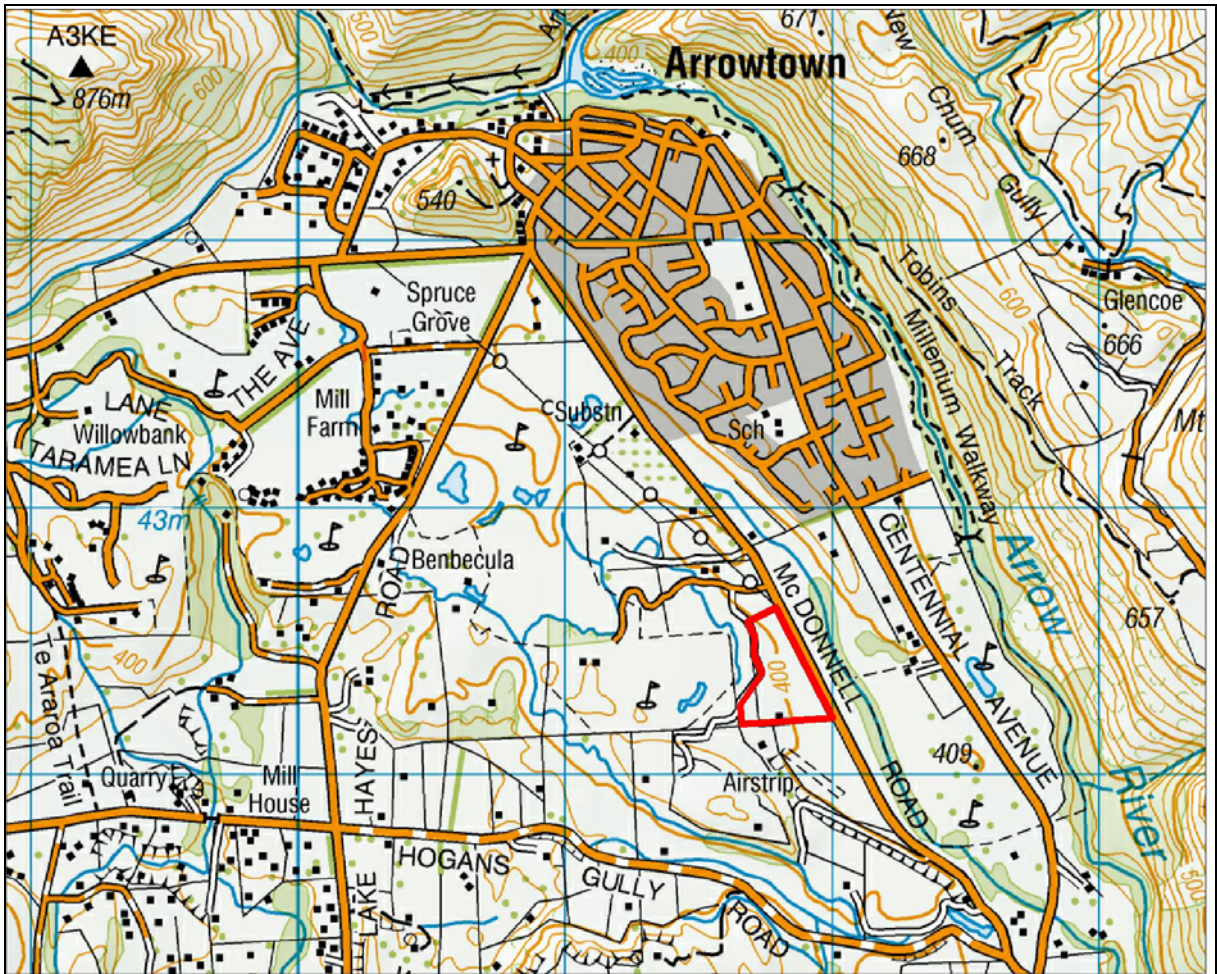


Figure 1 - Topographical Map Excerpt Showing Subject Site

The site comprises generally flat land elevated by a metre or two above McDonnell Road. The overall topography of the site is gently falling to the east.

Based upon the published geological information (Institute of Geological and Nuclear Sciences (IGNS), 1:250,000 Geological Map 18, Geology of the Wakatipu) and geological examination carried out by others the underlying geological materials within the site are comprised of outwash gravels and till and morainic deposits. These soils overlie schist bedrock that can be seen as outcropping in various locations on neighbouring sites.



The existing land use at the site comprises mainly a landscaped golf course driving range. Vegetation covering the area is mainly grass. There is an existing row of conifers along the road side boundary.

No standing water such as streams, ponds and landscape features were observed on site. It is expected that ephemeral watercourses may be formed in some of the topographic depressions on site during periods of high precipitation although these are expected to be short lived and are poorly defined.

The proposed development site and surrounding Arrowtown area experience generally cold winters with severe frosts at times and hot dry summers. Strong north-westerly winds are also a climatic characteristic of the area. The land receives approximately 850mm of rainfall per annum and may be subject to drought conditions during the summer months.



## 4. Water Supply

### 4.1 General

The site is located south of the QLDC water supply scheme for Arrowtown with infrastructure for the water scheme being in McDonnell Road some 750 metres to the north of the site. In addition, the existing buildings and dwellings on the neighbouring sites are currently serviced by existing on site water bore supplies. The Arrow Irrigation Company irrigation water race runs nearby the site and may be able to be reticulated to the site to provide future landscaping irrigation water demand.

### 4.2 Water Demand Assessment

Peak water demand would be expected during the summer months when seasonal populations are at their peak and irrigation usage will be at its highest. The following design figures have been adopted.

Demand Item	Potable Demand (litres/day)	No.	Total (litres/day)
Dwelling (average day)	2,100	4	8,400

The additional average daily water supply demand of 8.4 m<sup>3</sup> per day equates to 0.097 litres per second average flow over twenty four hours.

From the QLDC Land Development and Subdivision Code of Practice the peaking factors for the Arrowtown water supply scheme are as follows:

Item	Peaking Factor
Average daily flow to peak daily flow	3.3
Average daily flow to peak hourly flow	6.6

Using the QLDC peaking factor, the peak hour flow is estimated at 0.64 litres per second.

### 4.3 Fire Fighting Demand

In accordance with *SNZ PAS 4509:2008 New Zealand Fire Service Firefighting Water Supplies Code of Practice*, the usage for the developed site is expected to fall into the "Housing: includes single family dwellings, multi-unit dwellings but excludes multi storey apartment

*blocks*” category. This will result in a fire fighting water supply classification of FW2. An FW2 classification requires 12.5 l/s of water flow available within a distance of 135 metres and an additional 12.5 l/s of water flow available within a distance of 270 metres.

Alternatively, in the absence of suitable flows and pressures to enable construction of fire hydrants, the future dwellings may be provided with a static firefighting reserve of 20,000 litres (fitted with appropriate fire service couplings) within 90 metres of any future dwelling.

#### **4.4 Water Supply - Option 1**

The first option to provide a water supply to the proposed zone, is to connect to an existing QLDC water supply scheme. Given the relative elevations and proximity to site, it would be most appropriate to connect to the Arrowtown water supply scheme.

No network modelling has been undertaken due to time constraints. However, it would appear that the relatively modest levels of flow required would be able to be accommodated. This would be by way of either a direct connection to the existing infrastructure or via some on site buffering to reduce the peak demands on the existing water supply scheme. If buffering was required, it is expected that booster pumping will be required to then reticulate water to the development areas around the site.

In order to connect to the QLDC Water Supply Scheme, approval of Council would be required to extend the water supply scheme boundary to include the proposed zone. In addition, Development Contributions would need to be paid for each dwelling connected. Council may include other conditions for extending the water supply scheme to include the proposed zone which may result in additional upgrade costs being borne by the developer. Early liaison with Council will be required in order to determine exact Council requirements and potential cost liabilities.

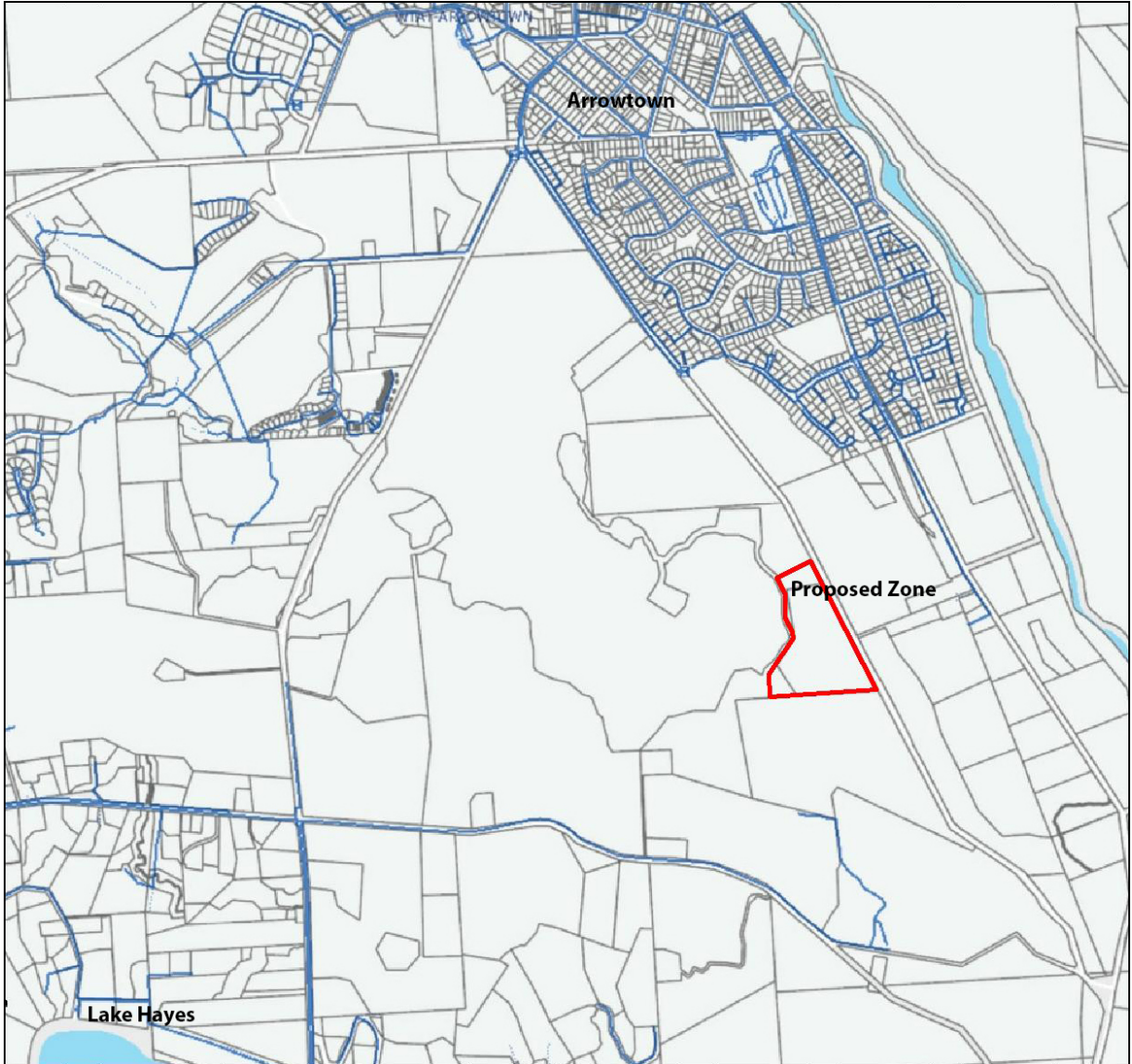


Figure 2 - Map Showing Existing QLDC Water Supply Infrastructure.

#### 4.5 Water Supply - Option 2

The second option for providing a water supply for the development would be to use either a new water bore or an existing bore (or a combination of the two) to supply the proposed zone with potable water. This would mean that the zone would have a standalone water supply that was separate from any Council reticulation.

The basic components of such a system would include the water bore intakes and pumps, rising main and storage reservoir as well as a water treatment system sufficient to bring the supply in line with Drinking Standards for New Zealand 2005 (Revised 2008) (DWSNZ).

The water supply storage reservoir for the proposed zone would be relatively small as it would be a buffer only and would likely be accommodated within a 20,000 litre tank or similar. From this buffer storage, water would be supplied to the zone by a water pressure boosting pump station to provide domestic pressures. Each future allotment would provide their own firefighting reserve and associated couplings.

As well as the physical construction issues involved with this option a number of consenting and maintenance matters would also need to be addressed. A resource consent will be required to construct any new bore and it is likely that a further consent may be required for the water take itself if either the calculated total daily demand or the peak hourly flow exceed the permitted water take rates set out in the Otago Regional Council's Regional Plan for Water. Land use and building consents may also be required for the reservoir and water treatment facilities.

There are existing productive bores on neighbouring sites. Two bores are currently used for servicing the associated golf course site with both potable and irrigation water. It is likely that these two bores would provide sufficient water for the potable demand for the proposed zone. However, this may reduce the amount of water available for irrigation of the associated golf course and landscaping and this would need to be assessed at the time development proceeded to ensure there was sufficient water for all purposes across the site.

The main issue to be considered with regards to this option would be the on-going maintenance and management of the water supply and treatment system. For a system of the expected size to service this site, the water supply could be owned by a lot owners association (or similar) responsible for the on-going management and maintenance of the infrastructure. A similar system to this has been used for various small private schemes around Queenstown.

## **4.6 Conclusions and Recommendations**

Both of the two options outlined above to supply water to the subject site are feasible. Further investigation, consultation with Council and cost analysis will be necessary to establish the final methodology used.

## 5. Wastewater Disposal

### 5.1 General

A Council reticulated sewerage scheme exists in McDonnell Road to the north of the site some 750 metres away. In addition, there is the possibility of constructing a standalone communal treatment and disposal system to cater for the wastewater drainage from the development of the proposed zone.

Both of these options are considered further below.

### 5.2 Demand Assessment

Peak wastewater generation is expected to coincide with peak water demand. The following design figures have been adopted:

Wastewater Generation Item	Wastewater Generation (litres/day)	No.	Total (litres/day)
Dwelling (average day)	1,050	4	4,200

The additional average daily wastewater generation of 4.2 m<sup>3</sup> per day equates to 0.049 litres per second average flow over twenty four hours.

From the QLDC amendments to NZS4404:2004 Land Development and Subdivision Engineering, the peaking factors for the wastewater network are as follows:

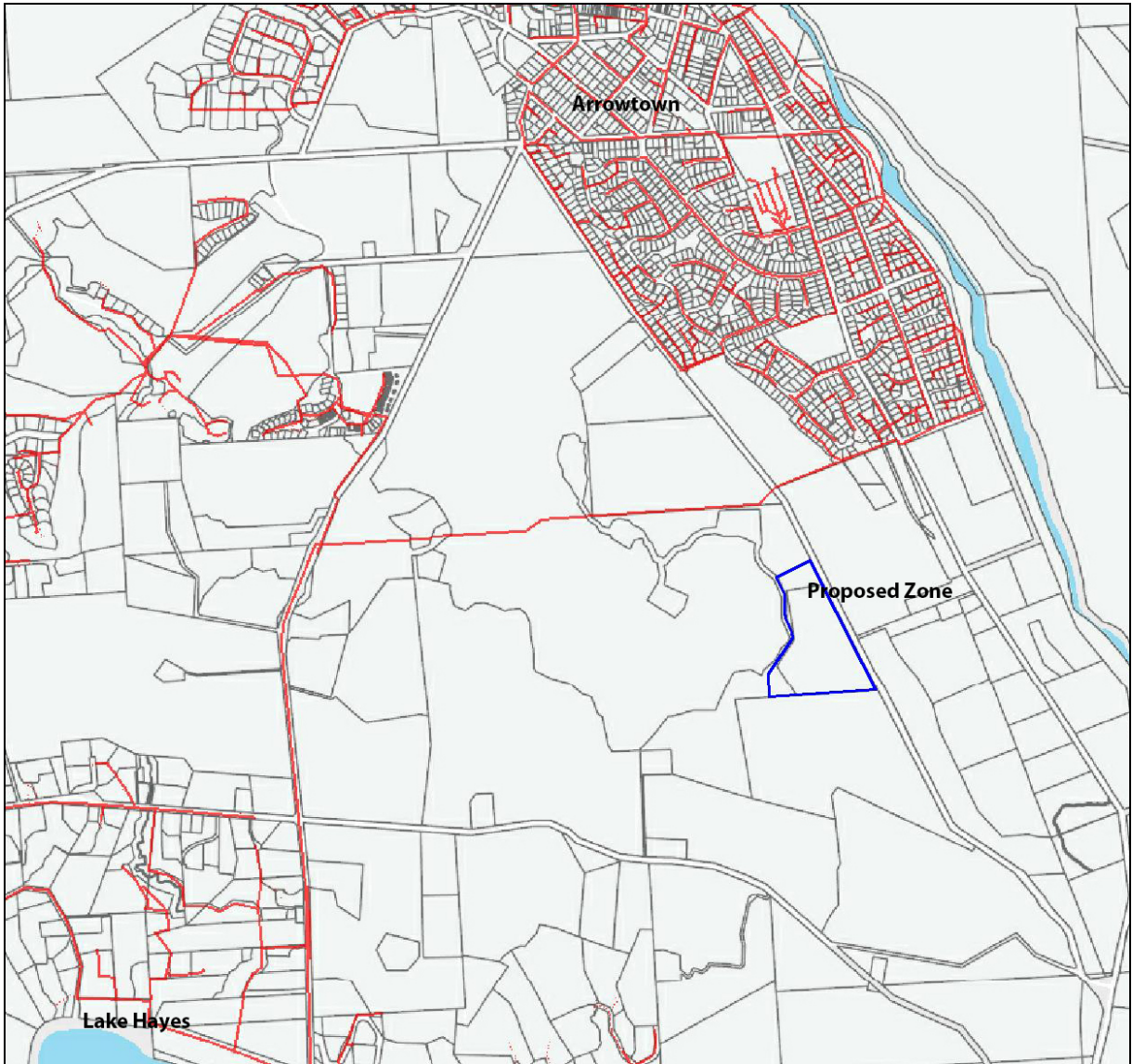
Item	Peaking Factor
Dry weather diurnal peak flow	2.5
Wet weather dilution/infiltration factor	2

Using the QLDC peaking factors, during the wet weather peak flow is estimated at 0.24 litres per second.

### 5.3 Wastewater Drainage – Option 1 – Council Reticulated Scheme

This option involves connecting to the existing Council reticulation in McDonnell Road to the north of the site.





**Figure 3 - Map Showing Existing QLDC Wastewater Drainage Infrastructure.**

As previously stated, the site is flat. It is anticipated that much of the site will be able to be drained using standard trunk and lateral gravity pipelines. These will drain to a central pump station that will then pump to a suitable discharge point in the Council network.

The primary pump station would be able to be designed and constructed in such a fashion to enable buffering to reduce flows into the existing Council infrastructure at peak times.

In order to connect to the QLDC Wastewater Drainage Scheme, approval of Council would be required to extend the wastewater scheme boundary to include the proposed zone. In addition, Development Contributions would need to be paid for each dwelling connected. Council may include other conditions for extending the wastewater scheme to include the proposed zone that may result in additional upgrade costs being borne by the developer. Early

liaison with Council will be required in order to determine exact Council requirements and potential cost liabilities.

## 5.4 Wastewater Drainage – Option 2 – Communal System

This option involves constructing a new communal wastewater treatment and disposal system at a suitable location on site and treating all wastewater flows from the proposed development prior to discharge to land.

It is envisaged that a package plant system similar to that used at Jacks Point could be accommodated to service the site. The system would involve the primary treatment of wastewater at each individual dwelling by way of a septic tank to remove solids. Primary treated effluent from each septic tank is then pumped or drained to the communal package treatment facility where it undergoes secondary and possibly tertiary treatment prior to disposal to land.

This type of system has a number of positive attributes including:

- The ability to stage expansion of the treatment plant to cater for staged development of the zone.
- No pond based treatment.
- Possible reuse of water for irrigation purposes.

The system would be made up of the following components:

1. Each dwelling would drain wastewater flows to a septic tank located close by. This septic tank would be installed at the time the dwelling was constructed. Depending on the location and topography, the tank would be fitted with a pump and rising main to reticulate flows to gravity reticulation or would simply connect via gravity to nearby reticulation. The septic tanks will require routine inspections and maintenance. This will mostly involve pumping out the solid wastes from time to time. The inspections and maintenance would be managed by a lot owners association or similar.
2. It is likely that a mix of gravity and pumped mains will reticulate flows to a suitably located treatment facility. In the case of pumped mains, individual tanks would connect to this via a non-return valve kit.
3. At this stage, a package treatment plant is anticipated to be located near the existing service area. This will receive all wastewater flows into a buffer tank and then treat it using a proprietary treatment system. This system would be a package treatment plant from a proprietary manufacturer/supplier. The actual process adopted will be the

subject of detailed design and procurement evaluation. For some guidance, the system used at Jacks Point involves the use of textile packed bed reactors. If deemed necessary at the time of detailed design, tertiary treatment such as UV disinfection could be included to further treat the effluent.

4. The final treated effluent would be reticulated to a suitable disposal location. If suitable tertiary treatment is included, it is likely that this treated effluent could be used for shallow subsurface irrigation around the site. This would need to be carefully considered at the time of detailed design to ensure freezing pipes and public access were appropriately managed.

Similar to the water supply system, one of the main issues to be considered with regards to this option would be the on-going maintenance and management of the wastewater treatment and disposal system. For a system of the expected size to service this site, the wastewater drainage and treatment system could be owned by a lot owners association (or similar) responsible for the on-going management and maintenance of the infrastructure. A similar approach to this has been adopted at Jacks Point near Queenstown and accepted by QLDC.

## 5.5 Conclusions and Recommendations

It is recommended that the wastewater generated from the proposed development be disposed of by way of connection to either the QLDC reticulated scheme or a new purpose built communal treatment and disposal facility on site. The feasibility of the chosen wastewater option will need further detailed analysis, consultation and consenting prior to implementation.



## 6. Stormwater Disposal

### 6.1 General

Generally, it is proposed to maintain the runoff characteristics of the existing catchment. However the proposed development on the site will alter the existing stormwater run off patterns and will serve to increase the peak flow runoff. We recommend to collect and control the stormwater runoff and dispose via connection to local water courses or to dispose of on site using stormwater infiltration and soakage features.

### 6.2 Planning Rules and Regulations

Rule 12.5.1.1 of the Regional Plan: Water for Otago states that the discharge of drainage water to water (or onto land where it might enter water) from any drain is a permitted activity so long as certain conditions are met. The conditions of particular relevance to the discharge of stormwater from the proposed new roads and domestic allotments are as follows:

*12.5.1.1 (b) The discharge, after reasonable mixing, does not give rise to all or any of the following effects in the receiving water:*

- (i) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or*
- (ii) Any conspicuous change in the colour or visual clarity; or*
- ...*
- (v) Any significant adverse effects on aquatic life.*

It is further stated that:

*The discharge of drainage water under Rule 12.5.1.1 will have no more than minor adverse effects on the natural and human use values supported by water bodies, or on any other person. This rule is adopted to enable drainage water to be discharged while providing protection for those values and the interests of those people. Any other activity involving the discharge of drainage water is a restricted discretionary activity in order that any adverse effects can be assessed.*

Contaminants associated with vehicular traffic can include oils, rubber, heavy metals and sediments. In large amounts these contaminants can greatly decrease the natural and human use values of bodies of water. As the stormwater from the site will likely be discharging either directly into local water courses or to ground, appropriate protections will need to be installed in the on-site drainage system in order to remove such contaminants

from the stormwater. The aim of stormwater quality treatment used at the site would be to ensure that the runoff from the new development is in a similar condition to that being achieved before the development. Of particular concern are the "first flush" flows that carry the highest pollutant loadings.

Appropriate technologies to separate contaminants from the stormwater flows might include the use of mud-tanks located in the on-site drainage sumps and a vortex separator mechanism such as a Hynds Downstream Defender which provide high removal efficiencies of suspended solids and floatables over a wide range of flow rates.

Careful design of the stormwater reticulation for the site will ensure that the requirements set out in the Regional Plan: Water for Otago are met.

### **6.3 Stormwater Quantities**

At this early stage in the development of the proposed zone, it is difficult to determine the increase in storm water runoff from the site. Initial calculations have been undertaken and these indicate that for a 10 minute rain event with an average reoccurrence interval (ARI) of 10 years the development is expected to increase the storm water flow rate by approximately 150 litres per second. This will vary depending upon the density of the development and the permeability of the site.

This level of increase in runoff would result in very large infrastructure if the traditional approach of reticulating all the flows from the site was adopted. If a single point of discharge was developed, the required outlet pipe would be approximately 300 mm in diameter. This level of infrastructure would be expensive and can be mitigated using a Low Impact Design (LID) approach.

From NZS4404:2010 Land Development and Infrastructure:

*Low impact design aims to use natural processes such as vegetation and soil media to provide stormwater management solutions as well as adding value to urban environments. The main principles of low impact design are reducing stormwater generation by reducing impervious areas, minimising site disturbance, and avoiding discharge of contaminants. Stormwater should be managed as close to the point of origin as possible to minimise collection and conveyance. Benefits include limiting discharges of silt, suspended solids, and other pollutants into receiving waters, and protecting and enhancing natural waterways.*

And:

*Low impact design is a type of storm water system that aims to minimise environmental impacts by:*

- (a) Reducing peak flow discharges by attenuation;*
- (b) Eliminating or reducing discharges by infiltration or soakage;*
- (c) Improving water quality by filtration;*
- (d) Installing detention devices for beneficial reuse.*

The types of low impact devices and practices that could be included in the zone include the following:

- Detention Ponds;
- Vegetated swales;
- Rain gardens;
- Rainwater tanks;
- Soakage pits and soak holes;
- Filter strips; and
- Infiltration trenches/basins.

Subdivision urban design principles may also assist in mitigating runoff from the site. These include clustering development to increase open area around developed areas and decreasing road setbacks in order to decrease the likely impervious areas.

In addition to reducing the peak discharge from the site, LID approaches may also improve the quality of the runoff from the site.

## **6.4 Conclusions and Recommendations**

We consider that the collection and subsequent disposal of stormwater from the proposed development is entirely feasible via collecting and controlling the stormwater runoff and disposing by draining to the local water courses passing the site.

Dependent upon the overall design approach for the subdivision, the storm water runoff leaving the site could be greatly reduced by the introduction of low impact design approaches including the use of attenuation and filtration devices.

## 7. Natural Hazards

Natural Hazards have been separately assessed by HCL as part of a global Natural Hazards Assessment for THL land holdings.

The HCL Natural Hazards Assessment report is included as Appendix 2 and confirms there are no natural hazard constraints applying to the Rural Lifestyle B Land.

## 8. Conclusions and Recommendations

The subject site and the proposed development have been assessed to determine the suitability for development in relation to infrastructure services. No significant constraints have been identified and the Rural Lifestyle B land is suitable for the proposed development from an infrastructure servicing viewpoint.

The key findings are summarised as follows;

- i. There are two options for supplying water to the site. The first option would be to utilise the QLDC reticulated water supply. The second option would be to install a new, private water bore intake and treatment along with a new reservoir and a water supply boosting pump station. The final decision on which methodology to use will be decided at a later point following further investigation, consultation and cost analysis.
- ii. Wastewater drainage reticulation from the site will be able to be catered for with either connection to the existing QLDC reticulation or construction of a proposed wastewater reticulation and treatment and disposal system. The majority of the site will be able to be reticulated by the construction of gravity sewer pipes. However, it is anticipated that parts of the development site will require pump stations in order to convey flows to either the existing QLDC infrastructure or the new treatment plant.
- iii. Stormwater runoff from the site can be satisfactorily disposed of by the construction of necessary reticulation with disposal to local water courses. It is recommended that in order to reduce the peak runoff and to improve runoff quality, low impact design approaches are adopted.
- iv. Based on the global Natural Hazard Assessment prepared by HCL, no natural hazard issues exist which constrain development on the Rural Lifestyle B land.

Overall, we confirm that there are no significant impediments to development of the site with respect to Infrastructure Services or Natural Hazard.

We recommend that the timing and scale of the proposed infrastructure upgrades be further assessed once the layout of the proposed zone has been further progressed and staging of development has been confirmed.