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_Pre Planning\MH_10_1_MLP_013A (Rural Lifestyle Area B).dgn

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PLAN STATUS:

DP REVIEW

THE HILLS
PROPOSED RURAL LIFESTYLE AREA B

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

DRAWING NO:
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Appendix 2

HCL Natural Hazards Assessment Report

hadley consultants LTD
CONSULTING ENGINEERS STRUCTURAL / CIVIL / PROJECT MANAGEMENT / GEOTECHNICAL

Trojan Helmet Ltd

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

Proposed District Plan Submission

Natural Hazard Assessment

hadley consultants LTD
CONSULTING ENGINEERS STRUCTURAL / CIVIL / PROJECT MANAGEMENT / GEOTECHNICAL

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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

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 15º); 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 emphemeral 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 Are A Zone);

Natural Hazard Risks

i) The Golf Course Land, including Proposed Rural Lifestyle Area B where alluvial deposits are identified, comprises competent and compact glacial till underlain by near surface schist bedrock. These materials are not susceptible to liquefaction and the risk of liquefaction is further reduced by low regional groundwater levels.

ii) Based on our assessment and investigation of the Golf Course Land, the provisional classification of the site as an LIC1 liquefaction risk by QLDC is not valid. The risk of liquefaction impacting the site is assessed as very low and liquefaction does not constrain the site as a natural hazard.

iii) The Proposed Rural Lifestyle Area A (Hogans Gully) Land comprises predominately alluvial material where the northern section of the Proposed Rural Lifestyle Area A may potentially be impacted by an alluvial fan hazard. Based on our assessment we don't believe the fan area is active and in the event it was active, its extent would be significantly reduced from that indicated by QLDC Hazard Maps. We have assessed any risk from alluvial fan hazard as low, recognising that if further investigation confirms activity, the risk can be mitigated through bunding protection and regrading at the time of resource consent.

iv) None of the land areas or development areas are subject to regional flood or inundation hazard.

Specific Development Site Controls

v) Prior to any building construction occurring we recommend that sites A6, A7 and A8 require specific geotechnical investigation and design of foundations by a Chartered Professional Engineer. This investigation shall include rationalisation of cut off drainage to improve subgrade conditions and to address overland flow paths.

vi) Sites HS9 and HS10 are impacted by the existing water race and potential leakage from this race. Prior to any building construction occurring we recommend that a specific geotechnical investigation be completed by a Chartered Professional Engineer to confirm the extent of potential soil accumulation in the depression on HS9 and slope stability impacts of the water race on HS10. Both sites will require piping of the water race and diversion design in the event of a catastrophic pipe breach.

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

Appendix A

Darby Partners and HCL

Topographic Drawings

KEY:

Structure Plan Boundary

Activity Area

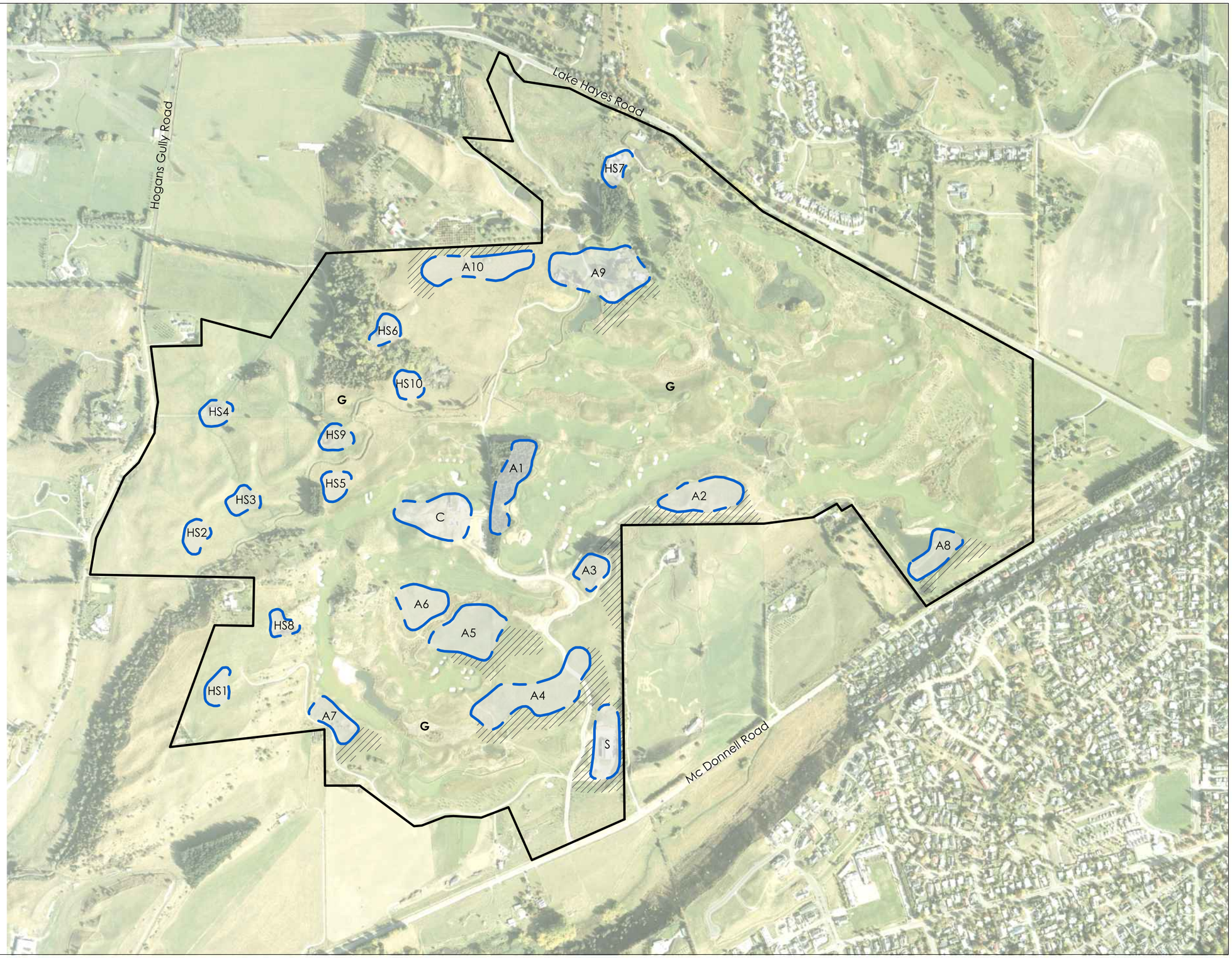
Activity Areas:

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

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

Overlays:

Landscape Amenity Management Area



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THE HILLS
STRUCTURE PLAN

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KEY:

Structure Plan Boundary

Activity Area

Activity Areas:

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A: Visitor Accommodation / Residential
HS: Homesite (3,000m2)
S: Resort Services & Staff Accommodation

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

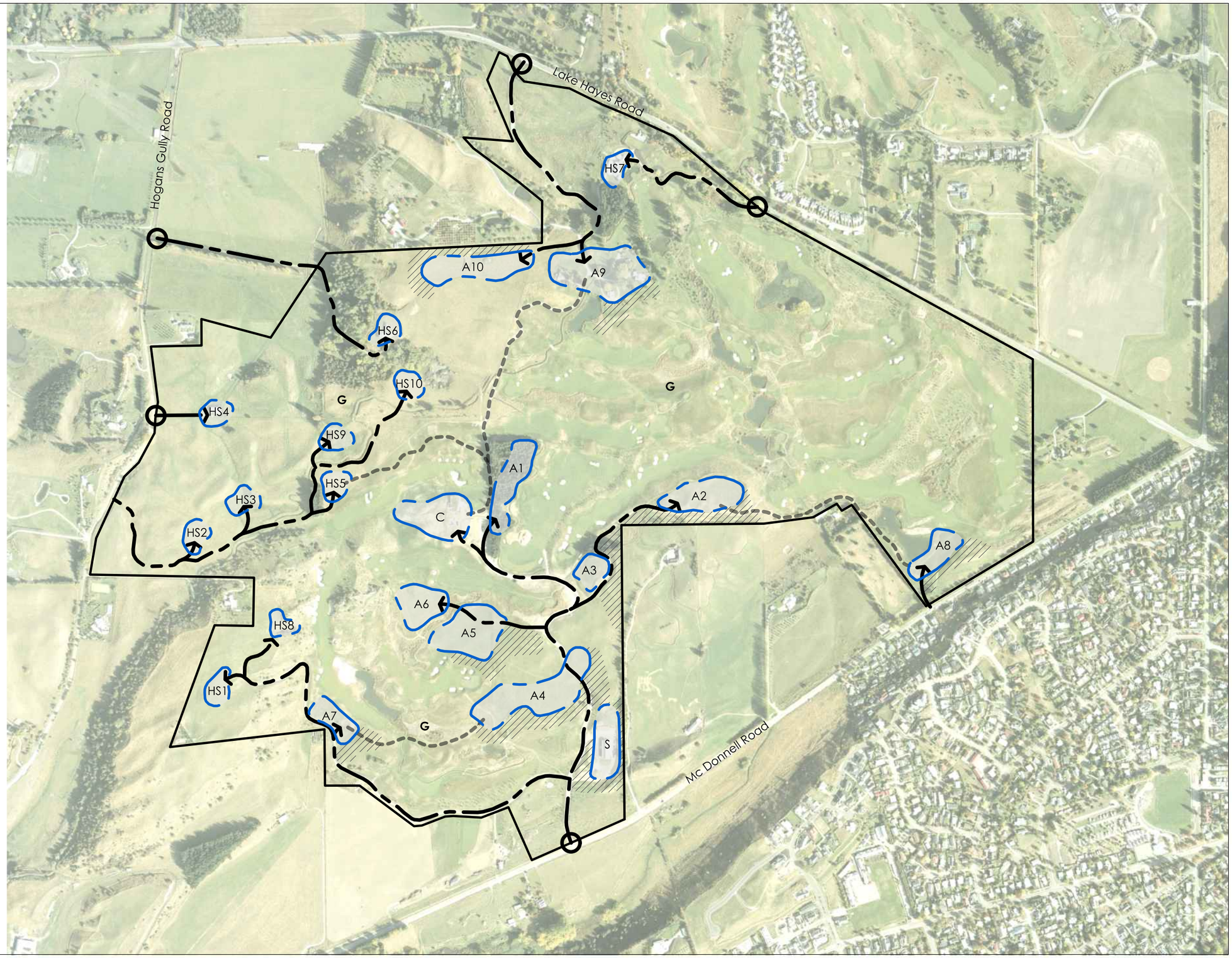
Overlays:

Landscape Amenity Management Area

Existing access point

Road access

Buggy / cart access



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DP REVIEW

THE HILLS
STRUCTURE PLAN - ACCESS

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MH_10_1_MLP_011B

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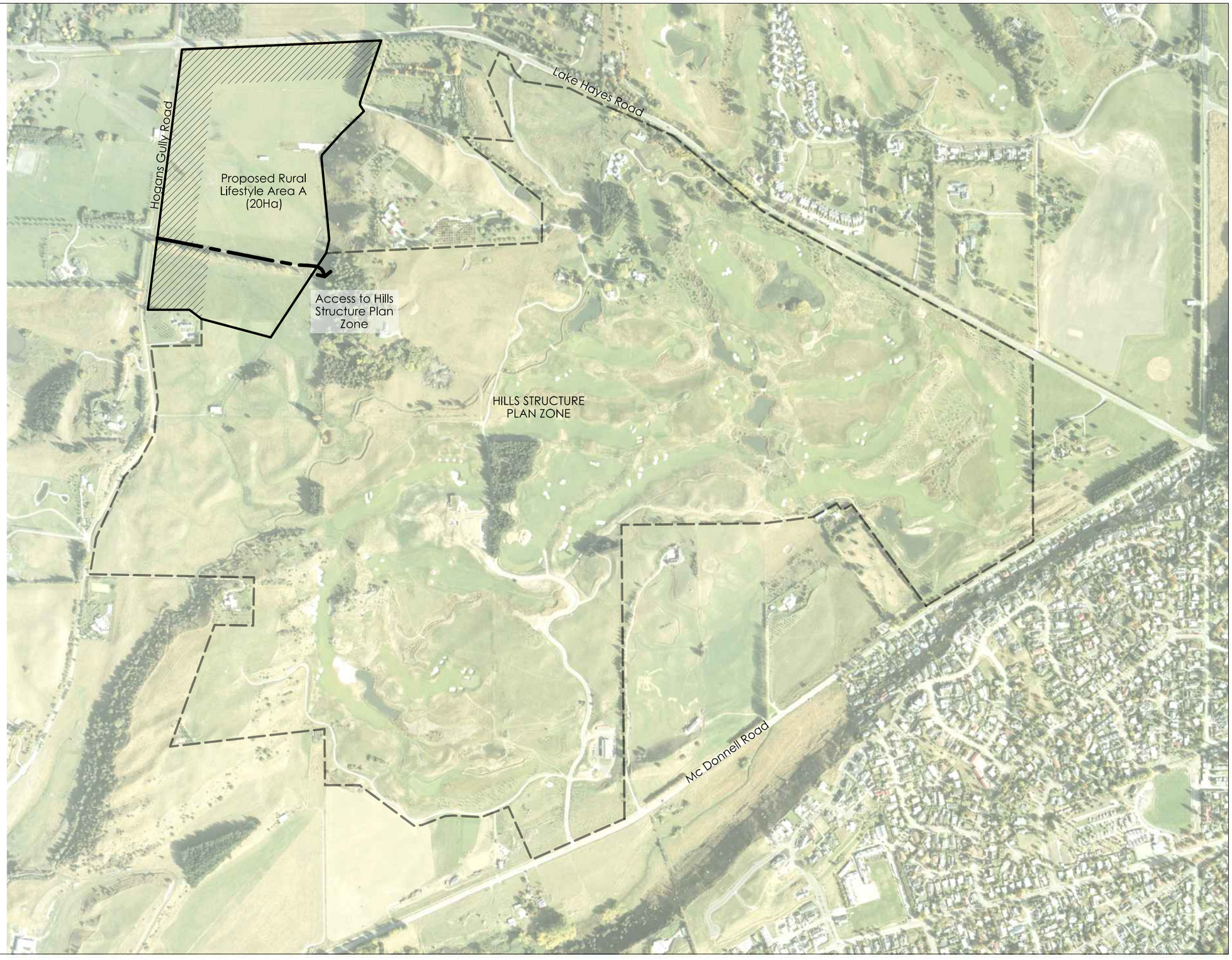
KEY:

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



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PLAN STATUS:

DP REVIEW

THE HILLS
PROPOSED RURAL LIFESTYLE AREA A

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Hills Structure Plan Boundary

Proposed zoning Areas

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THE HILLS
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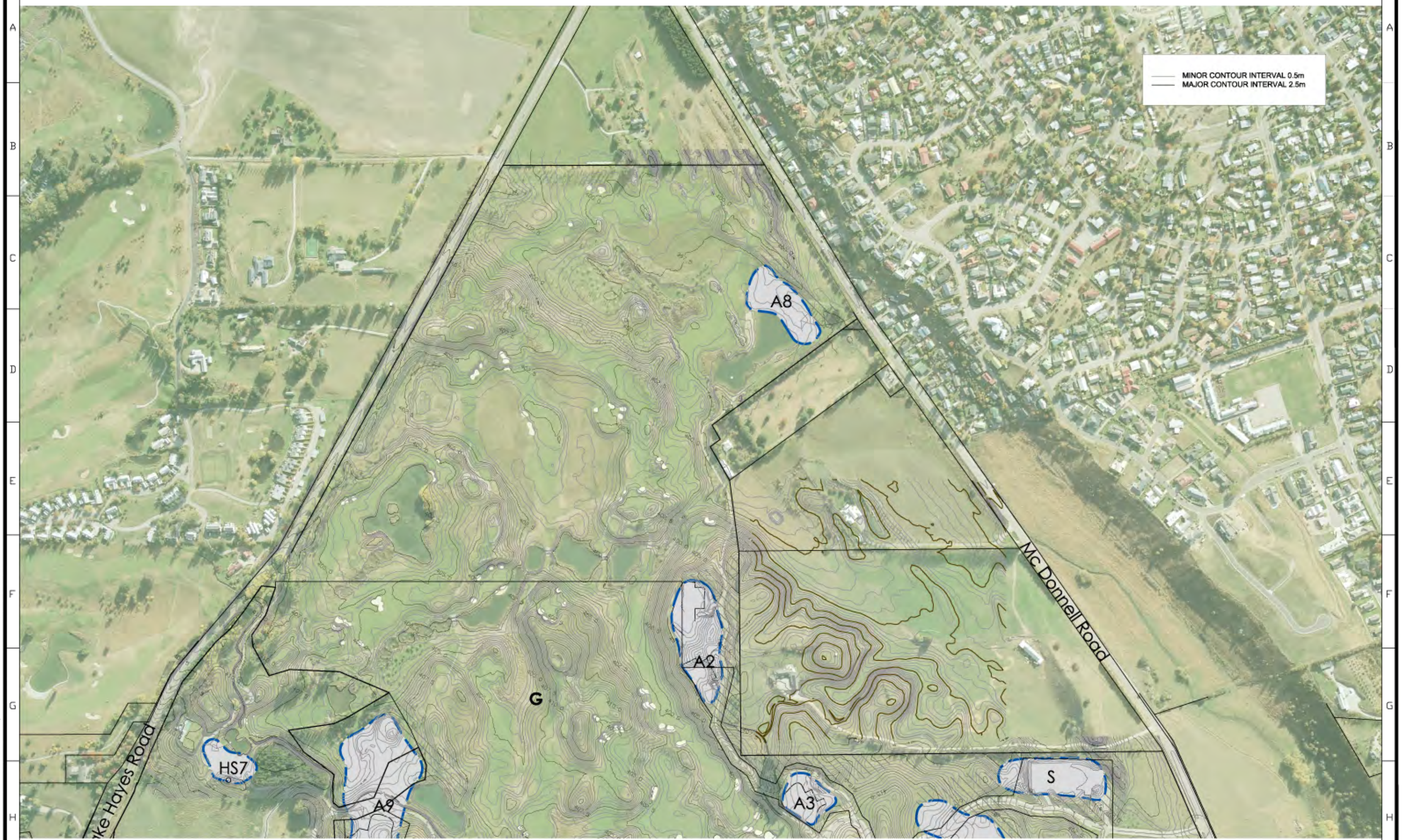

ORIGINAL SIZE A3 DO NOT SCALE, REFER ALL DISCREPANCIES TO THE ENGINEER

Notes:

Issue	Description	By	Date
A	Preliminary Issue	JWPH	20.10.15

Project:
NATURAL HAZARD ASSESSMENT

Title:
TOPOGRAPHIC SITE PLAN 1

Client:
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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: TOPOGRAPHIC SITE PLAN 2

Client: TROJAN HELMET LTD

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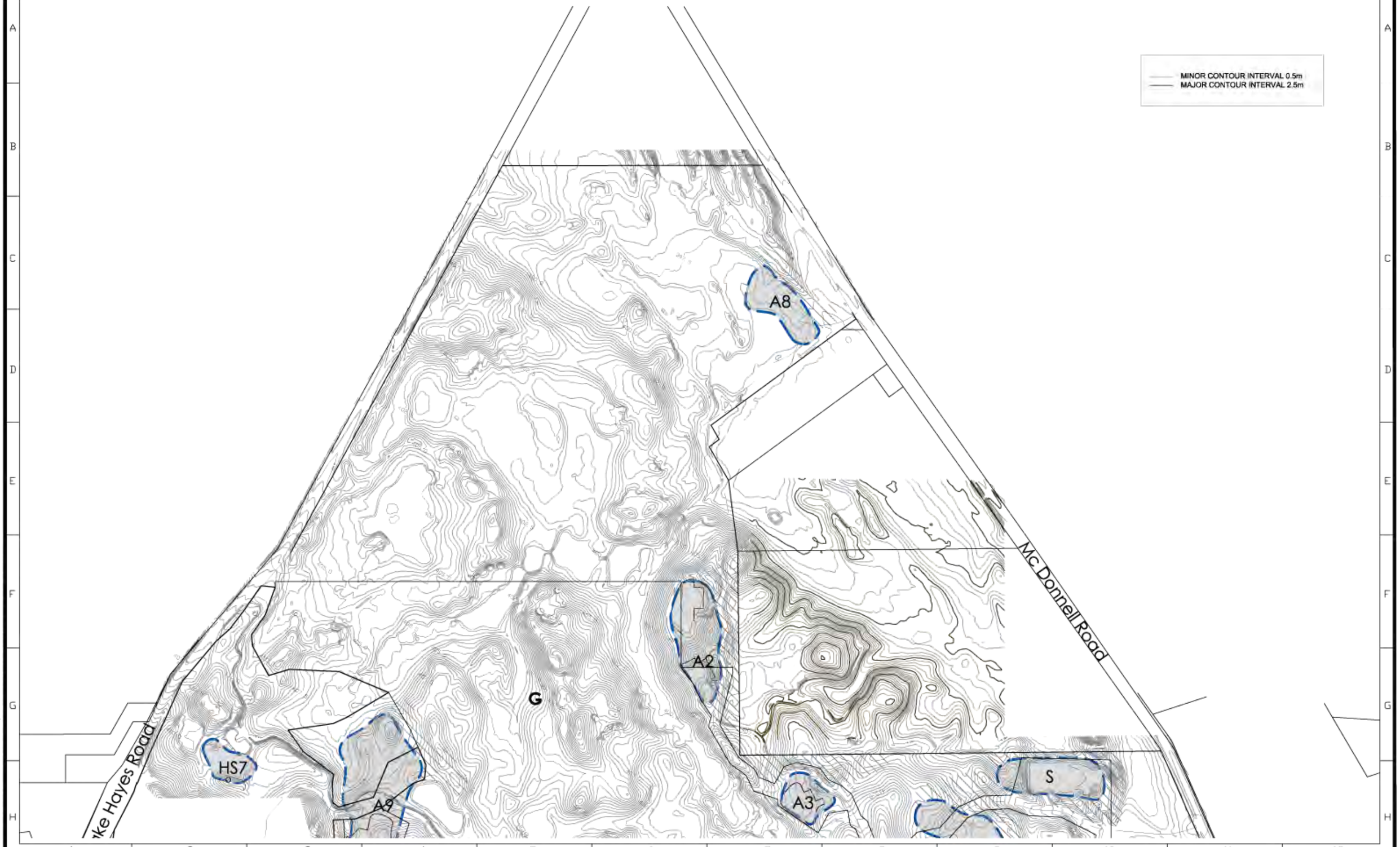

ORIGINAL SIZE A3 DO NOT SCALE, REFER ALL DISCREPANCIES TO THE ENGINEER

Notes:

Issue	Description	By	Date
A	Preliminary Issue	JWPH	20.10.15

Project: NATURAL HAZARD ASSESSMENT

Title: ACTIVITY AREA PLAN 1

Client: TROJAN HELMET LTD

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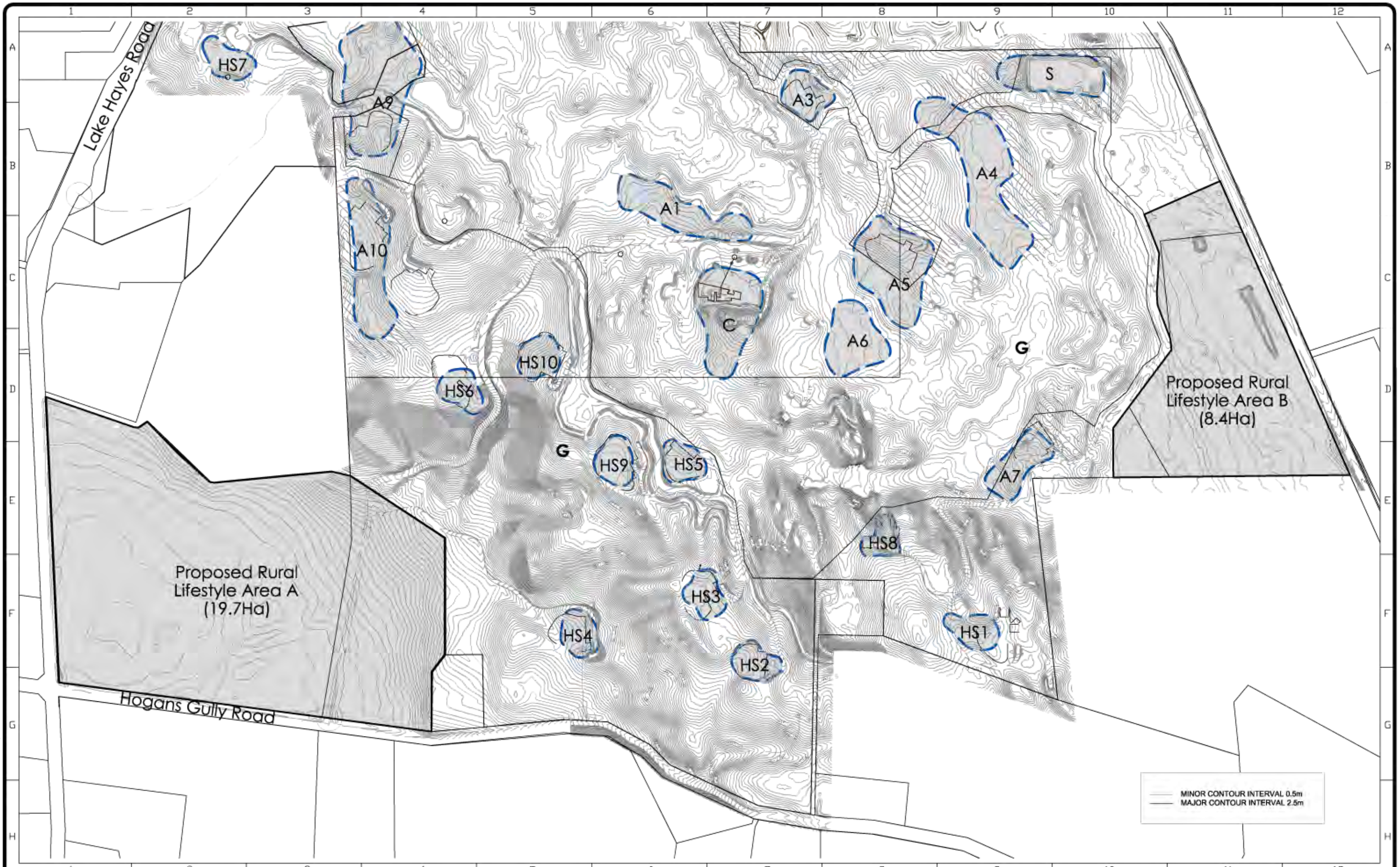
MU	JWPH	1:5000 @ A3	Project: 152859	Sheet: S03	Issue: A



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

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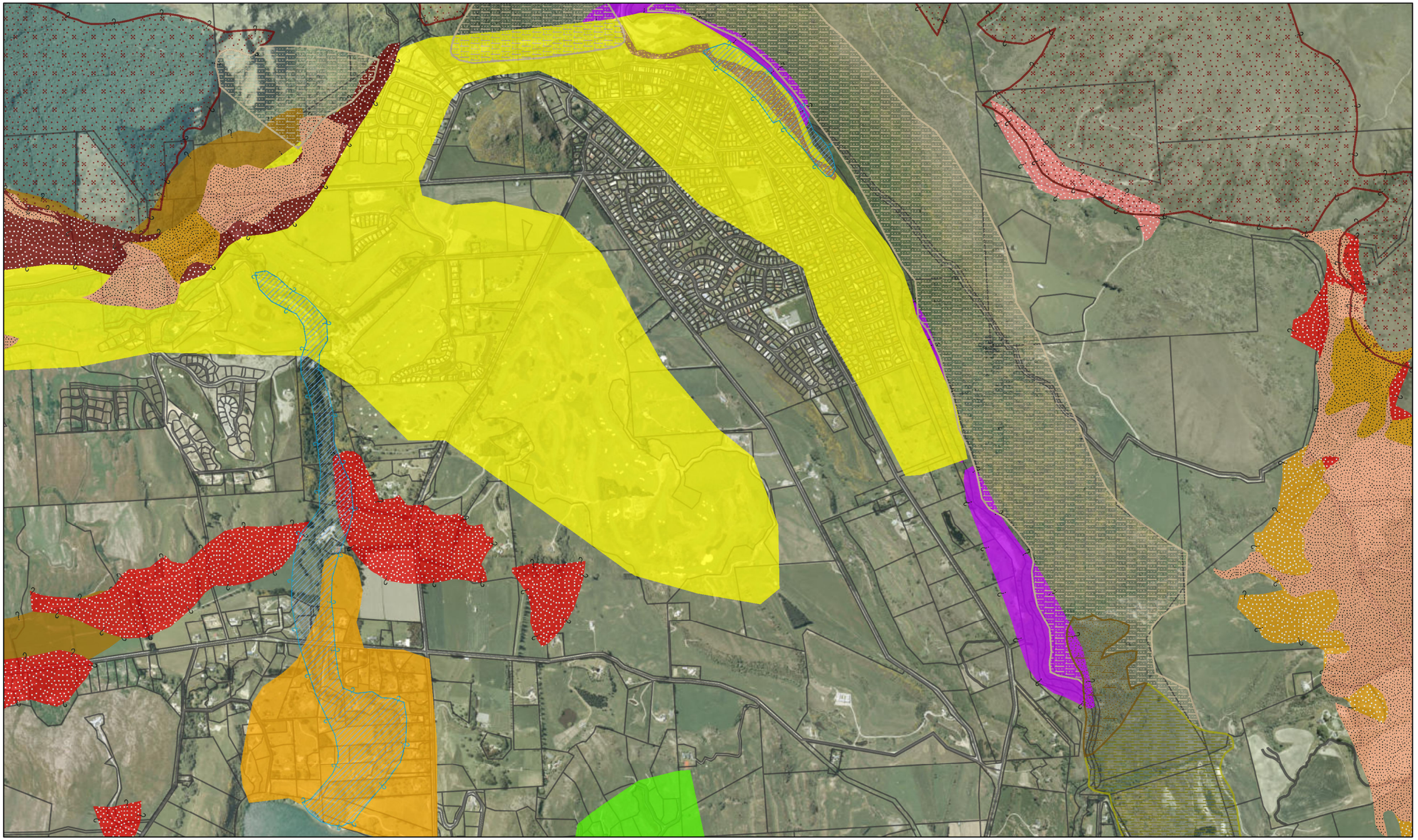
MU	JWPH	1:5000 @ A3	Project: 152859	Sheet: S04	Issue: A

Appendix B

QLDC Hazard Maps



Queenstown Lakes District Council

Webmaps your view of your information

The Hills

19 October 2015

0 0.15 0.3 0.45 0.6 Kilometres

N

The Hills

Legend

Property Land

Parcel Boundaries

Property Address

Roads

Hazards

Active Fault - Location approximate

Inactive Fault - Location approximate

Flooding due to Rainfall

Flooding due to Damburst

Landslide: Active Pre-existing Schist Debris Landslides

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

Landslide: Dormant Pre-existing Schist Debris Landslides

Landslide: Shallow Slips and Debris Flows in Colluvium

Landslide: Debris Flow Hazards

Landslide: Slope Failure Hazard in Superficial Deposits

Landslide: Rockfall

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

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

Landslide: Potential Hazard - Debris Flood/Debris Flow

Landslide Areas - non verified

Erosion Areas

Alluvial Fan - Incision Line

Alluvial Fan - Channels

Alluvial Fan - Source Area

Alluvial Fan - Catchment Areas

Alluvial Fan - Hazard Area

Alluvial Fan - ORC: fan active bed

Alluvial Fan - ORC: fan recently active

Alluvial Fan - ORC: fan less recently active

Alluvial Fan (Regional scale) Active, Composite

Alluvial Fan (Regional scale) Active, Debris-dominated

Alluvial Fan (Regional scale) Active, Floodwater-dominated

Alluvial Fan (Regional scale) Inactive, Composite

Alluvial Fan (Regional scale) Inactive, Debris-dominated

Alluvial Fan (Regional scale) Inactive, Floodwater-dominated

Avalanche Areas

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

Liquefaction Risk: Probably Low (T&T 2012)

Liquefaction Risk: Possibly Moderate (T&T 2012)

Liquefaction Risk: Possibly High (T&T 2012)

Liquefaction Risk: Possibly Susceptible (Opus 2002)

Liquefaction Risk: Susceptible (Opus 2002)

Appendix C

Figure 2

KEY:

Structure Plan Boundary

Activity Area

Activity Areas:

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

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

Overlays:

Landscape Protection Area

The Hills Structure Plan - Yield Schedule
Sep-10

Activity Area	Size	Density (unit/Ha)		Lots	
		Low	High	Low	High
A1	0.9 Ha	1	8	1	7
A2	0.9 Ha	1	8	1	7
A3	0.4 Ha	1	8	1	3
A4	1.7 Ha	1	8	1	13
A5	1.2 Ha	1	8	1	10
A6	0.7 Ha	1	8	1	5
A7	0.5 Ha	1	8	1	4
A8	0.6 Ha	1	4	1	2
A9	1.7 Ha	1	8	1	13
A10	1.1 Ha	1	8	1	8
		Subtotal		10	74
H1	0.3 Ha			1	1
H2	0.3 Ha			1	1
H3	0.3 Ha			1	1
H4	0.3 Ha			1	1
H5	0.3 Ha			1	1
H6	0.3 Ha			1	1
H7	0.3 Ha			1	1
H8	0.2 Ha			1	1
H9	0.3 Ha			1	1
H10	0.3 Ha			1	1
		Subtotal		10	10
		Total		20	84
Total Structure Plan Area	162.7 Ha				
Ave. Lot size (per total land area)				8.1 Ha	1.9 Ha

FOR DISCUSSION

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

PLAN STATUS:
DRAFT

Fig. 2

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

Liquefaction risk. Probably low

Alluvial fan. Active. Debris dominated.

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

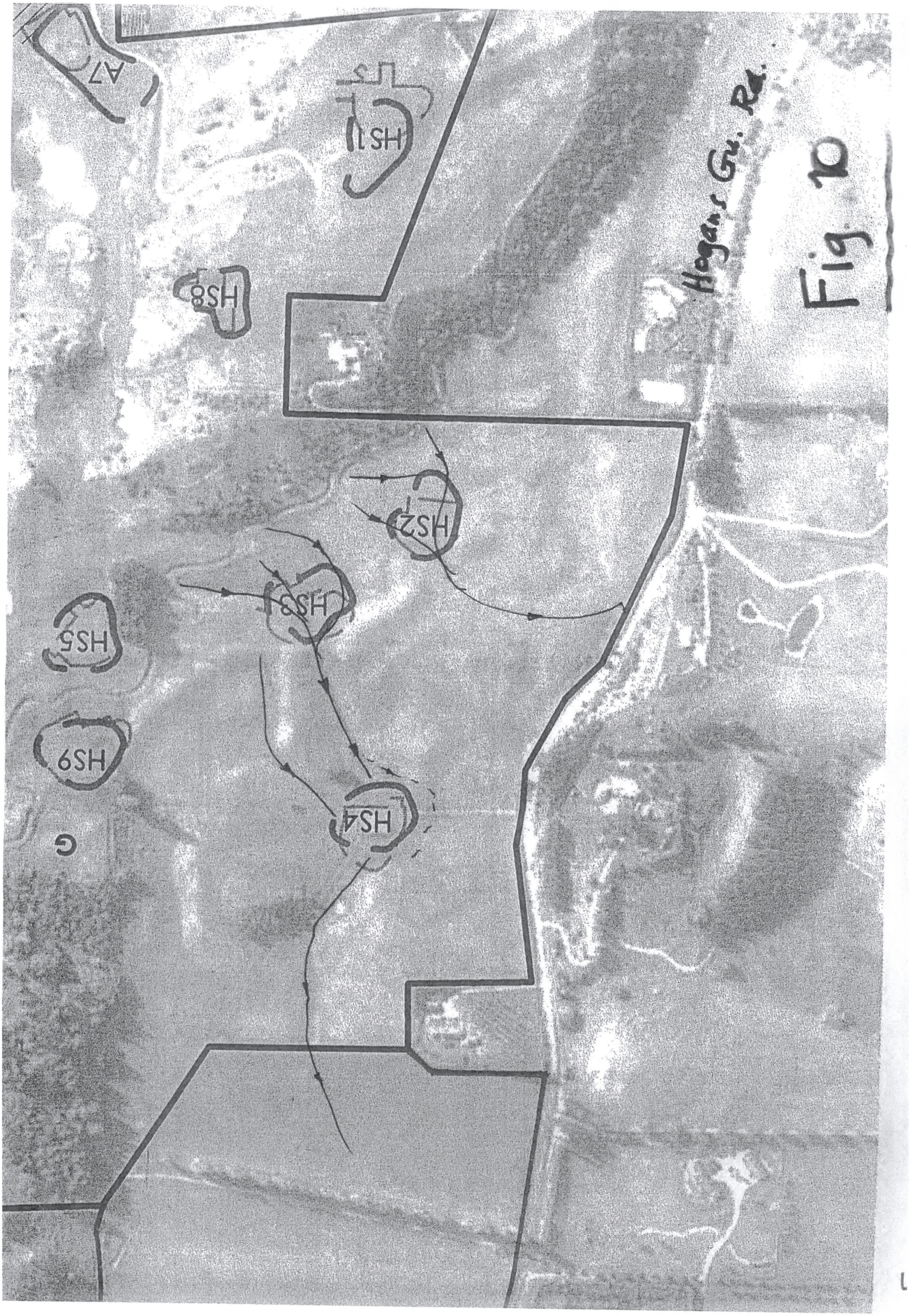

Fig. 10

hadley consultants LTD
CONSULTING ENGINEERS STRUCTURAL / CIVIL / PROJECT MANAGEMENT / GEOTECHNICAL

Trojan Helmet Ltd

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

Proposed District Plan Submission

Natural Hazard Assessment

hadley consultants LTD
CONSULTING ENGINEERS STRUCTURAL / CIVIL / PROJECT MANAGEMENT / GEOTECHNICAL

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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

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 15º); 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 emphemeral 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 Are A Zone);

Natural Hazard Risks

i) The Golf Course Land, including Proposed Rural Lifestyle Area B where alluvial deposits are identified, comprises competent and compact glacial till underlain by near surface schist bedrock. These materials are not susceptible to liquefaction and the risk of liquefaction is further reduced by low regional groundwater levels.

ii) Based on our assessment and investigation of the Golf Course Land, the provisional classification of the site as an LIC1 liquefaction risk by QLDC is not valid. The risk of liquefaction impacting the site is assessed as very low and liquefaction does not constrain the site as a natural hazard.

iii) The Proposed Rural Lifestyle Area A (Hogans Gully) Land comprises predominately alluvial material where the northern section of the Proposed Rural Lifestyle Area A may potentially be impacted by an alluvial fan hazard. Based on our assessment we don't believe the fan area is active and in the event it was active, its extent would be significantly reduced from that indicated by QLDC Hazard Maps. We have assessed any risk from alluvial fan hazard as low, recognising that if further investigation confirms activity, the risk can be mitigated through bunding protection and regrading at the time of resource consent.

iv) None of the land areas or development areas are subject to regional flood or inundation hazard.

Specific Development Site Controls

v) Prior to any building construction occurring we recommend that sites A6, A7 and A8 require specific geotechnical investigation and design of foundations by a Chartered Professional Engineer. This investigation shall include rationalisation of cut off drainage to improve subgrade conditions and to address overland flow paths.

vi) Sites HS9 and HS10 are impacted by the existing water race and potential leakage from this race. Prior to any building construction occurring we recommend that a specific geotechnical investigation be completed by a Chartered Professional Engineer to confirm the extent of potential soil accumulation in the depression on HS9 and slope stability impacts of the water race on HS10. Both sites will require piping of the water race and diversion design in the event of a catastrophic pipe breach.

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

Appendix A

Darby Partners and HCL

Topographic Drawings

KEY:

Structure Plan Boundary

Activity Area

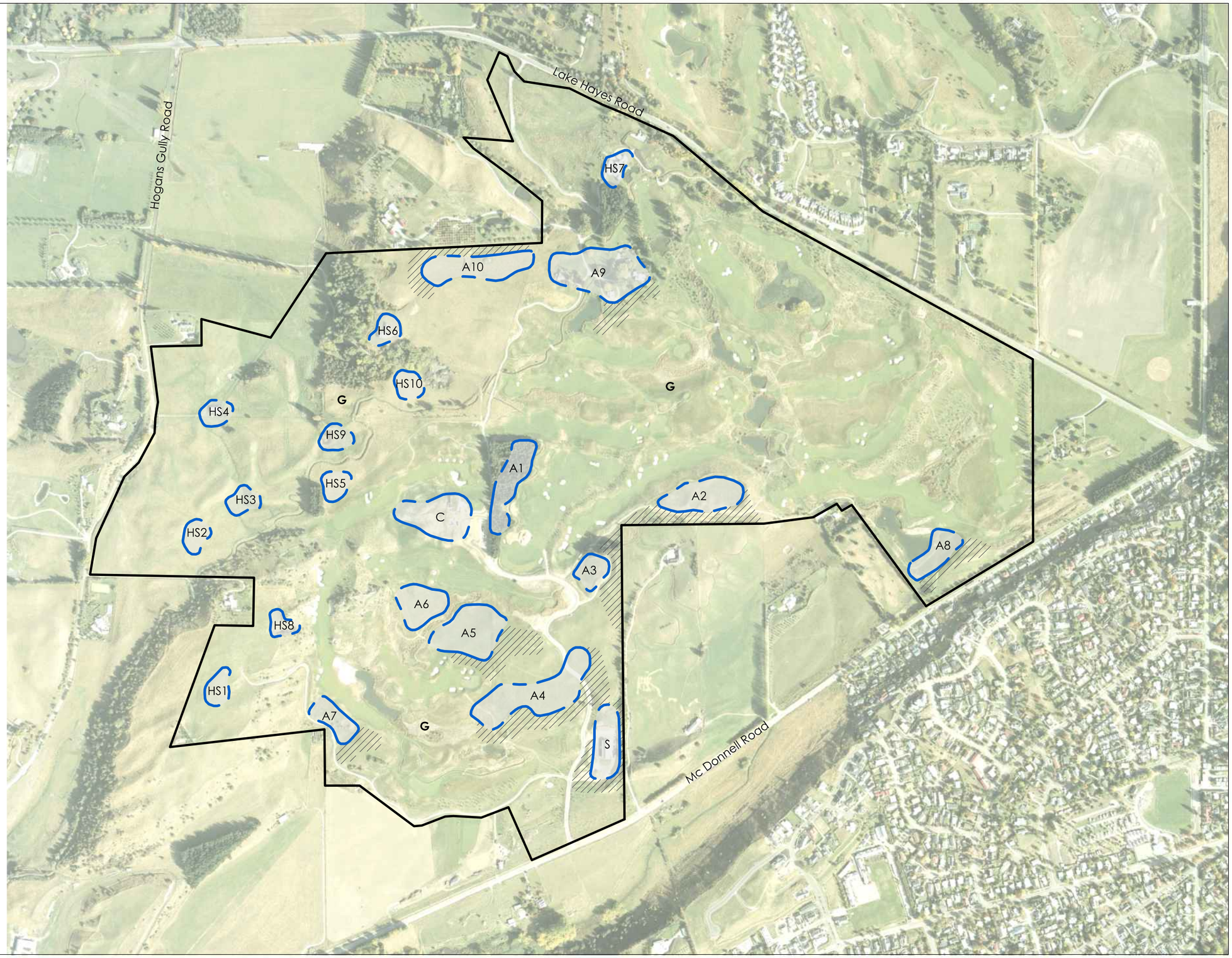
Activity Areas:

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

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

Overlays:

Landscape Amenity Management Area



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

0 100 200 300

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

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

KEY:

Structure Plan Boundary

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Activity Areas:

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

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

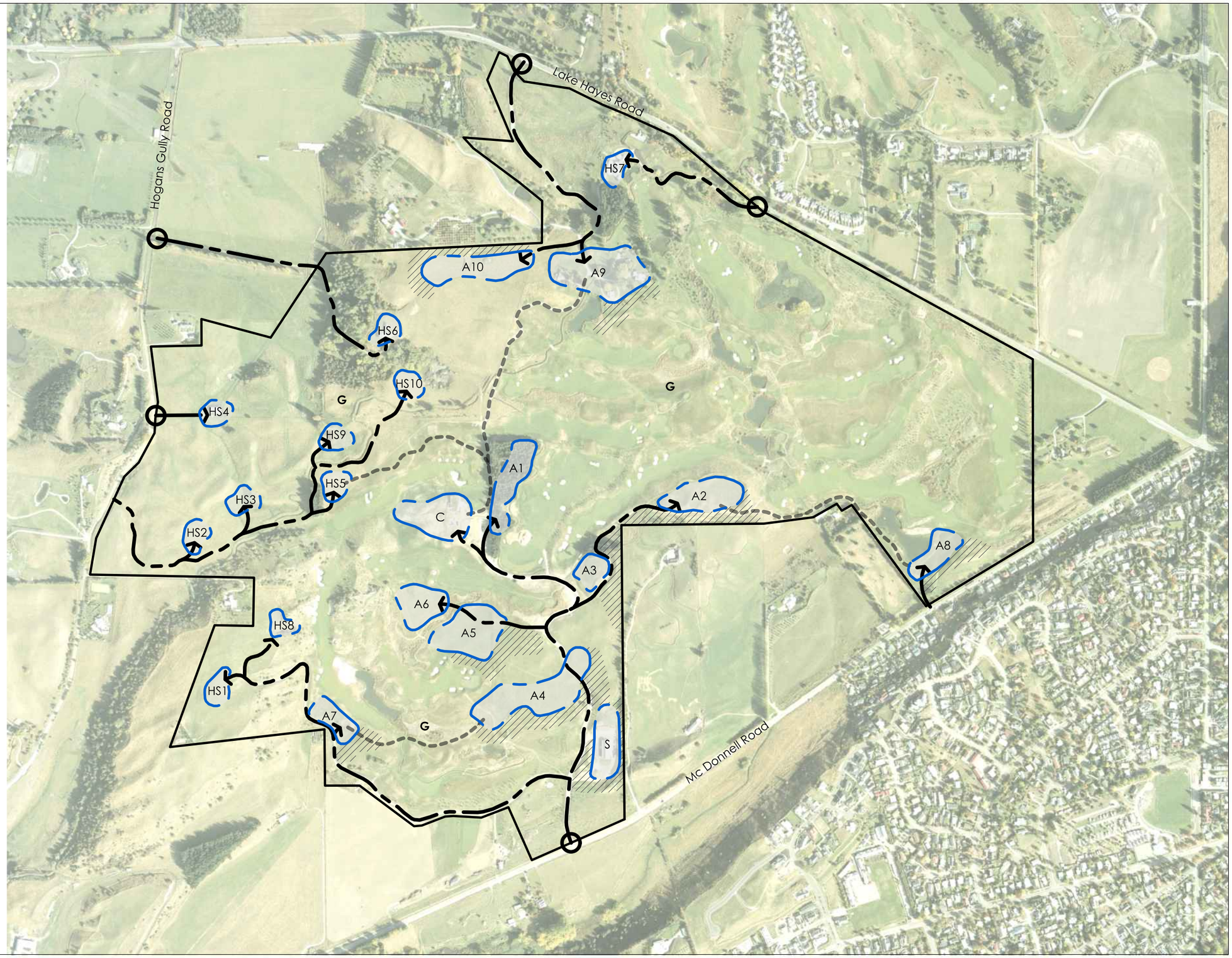
Overlays:

Landscape Amenity Management Area

Existing access point

Road access

Buggy / cart access



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

0 100 200 300

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

V:\MH_The Hills\10_Master\1_Pre Planning\MH_10_1_MLP_011B (Structure Plan - Access).dgn

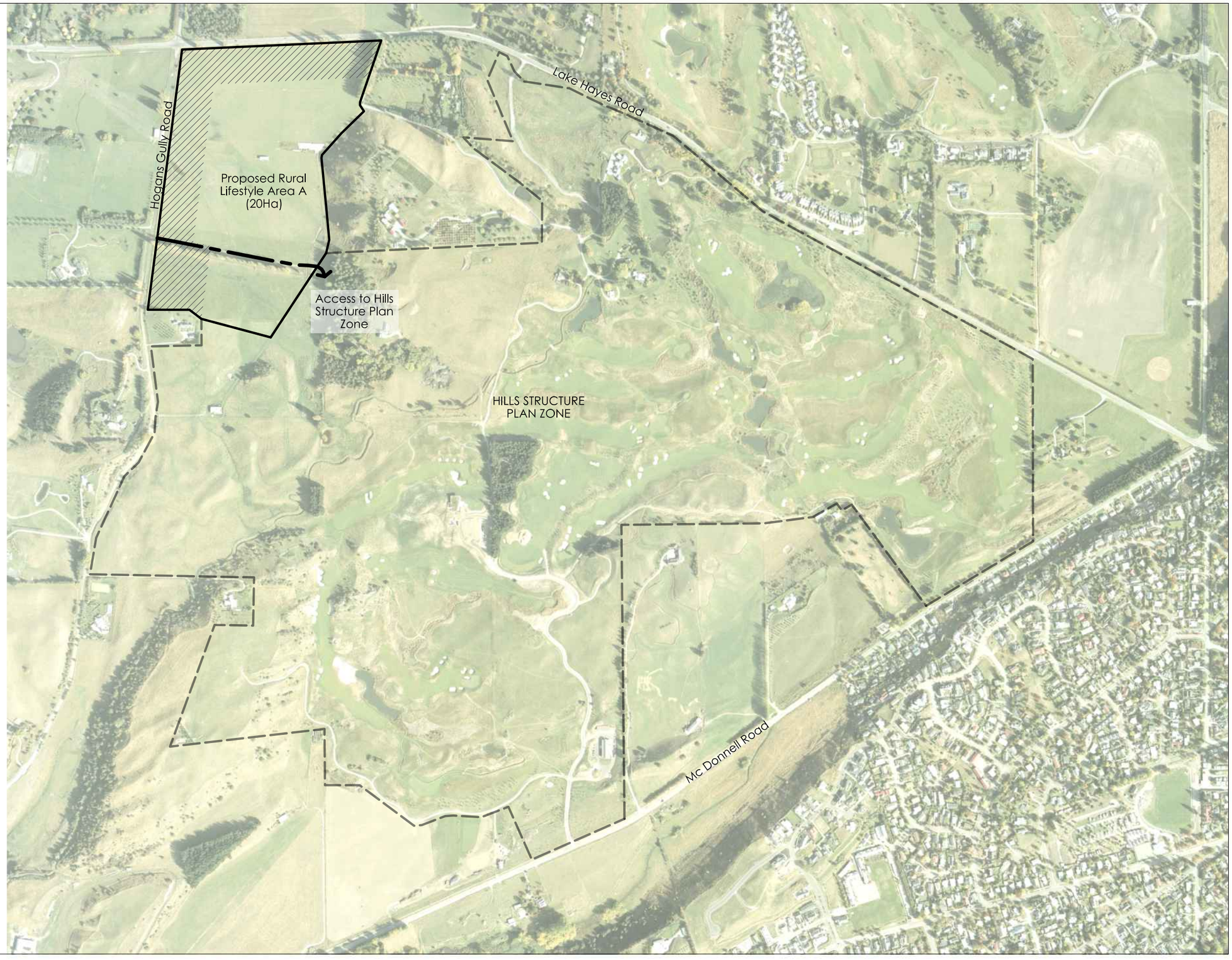
KEY:

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



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

0 100 200 300

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_Master\1_Pre Planning\MH_10_1_MLP_013A (Rural Lifestyle Area B).dgn

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

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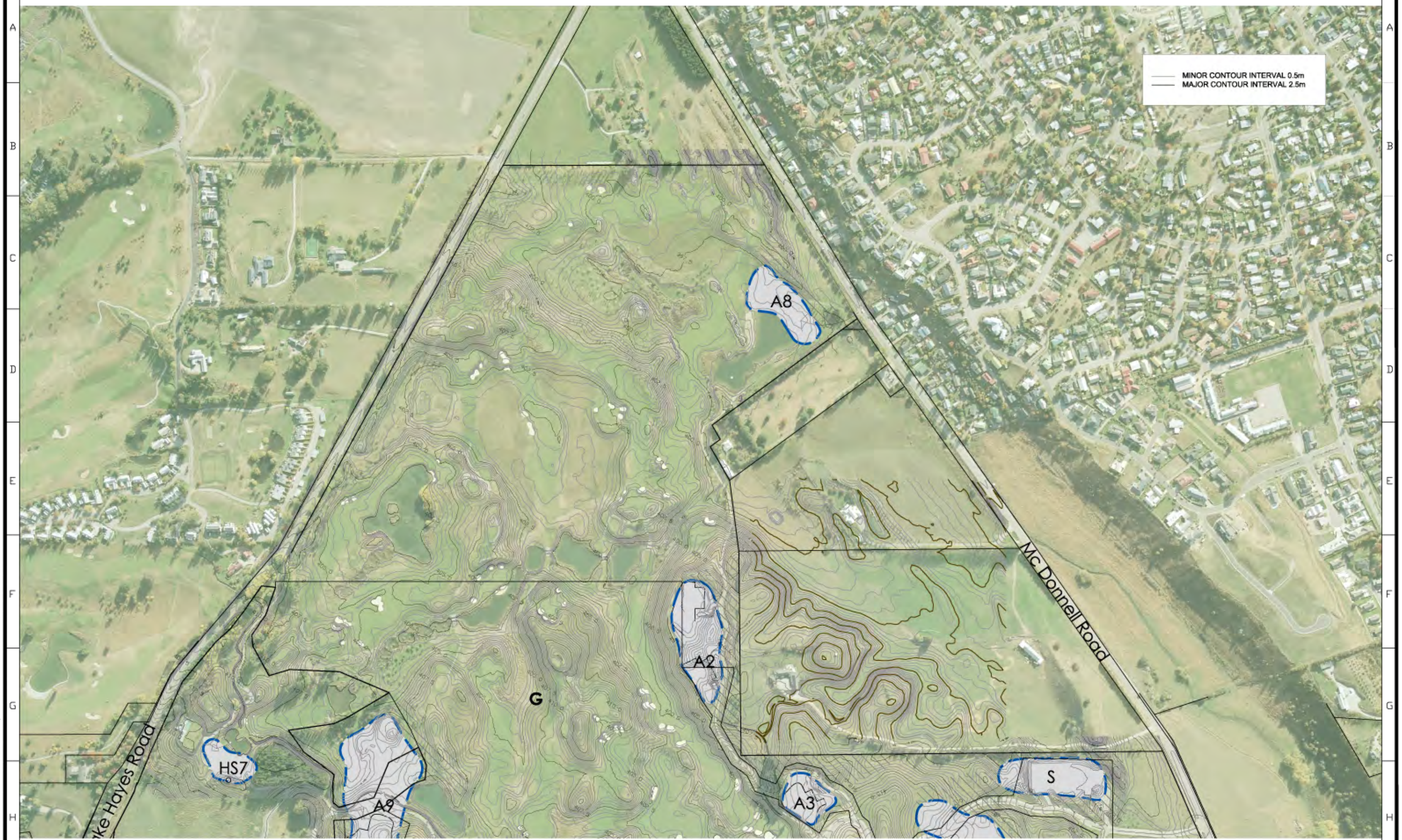
PLAN STATUS:

DP REVIEW

THE HILLS
PROPOSED RURAL LIFESTYLE AREA B

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

DRAWING NO:
MH_10_1_MLP_013A



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Notes:

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:	Checked:	Scale:	Drawing Number:			
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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: TOPOGRAPHIC SITE PLAN 2

Client: TROJAN HELMET LTD

hadley consultants LTD
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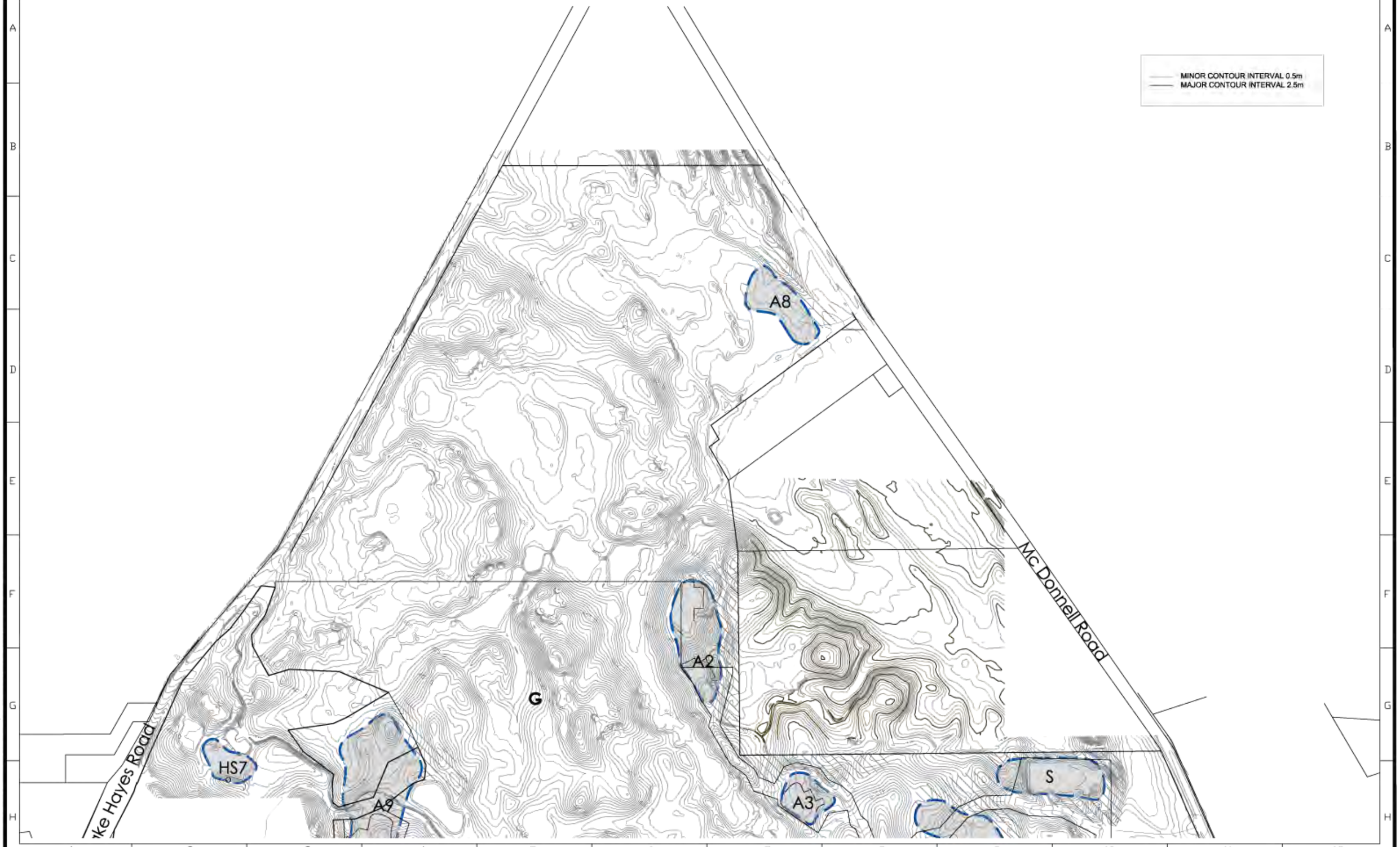

ORIGINAL SIZE A3 DO NOT SCALE, REFER ALL DISCREPANCIES TO THE ENGINEER

Notes:

Issue	Description	By	Date
A	Preliminary Issue	JWPH	20.10.15

Project: NATURAL HAZARD ASSESSMENT

Title: ACTIVITY AREA PLAN 1

Client: TROJAN HELMET LTD

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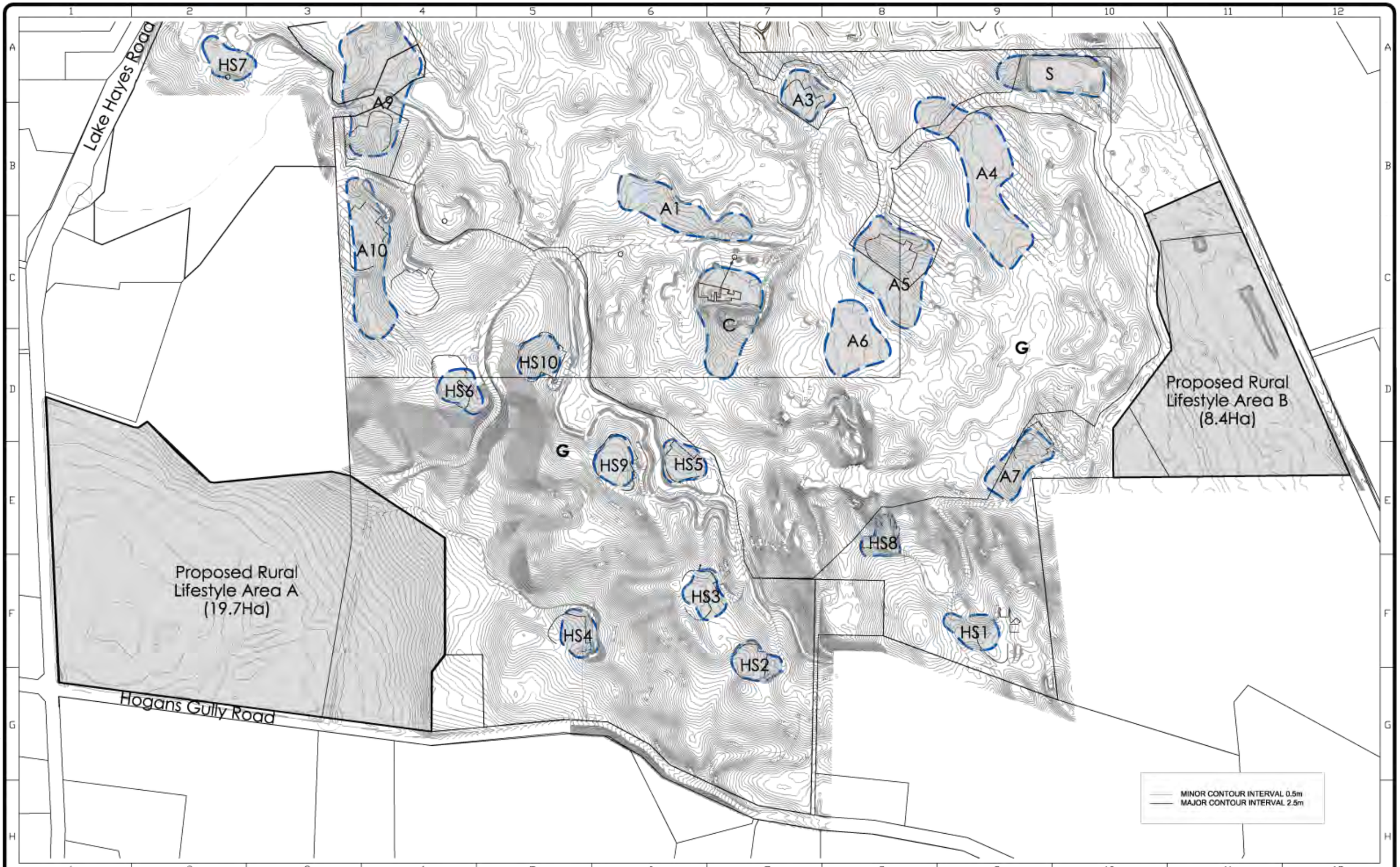

ORIGINAL SIZE: A3 DO NOT SCALE, REFER ALL DISCREPANCIES TO THE ENGINEER

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

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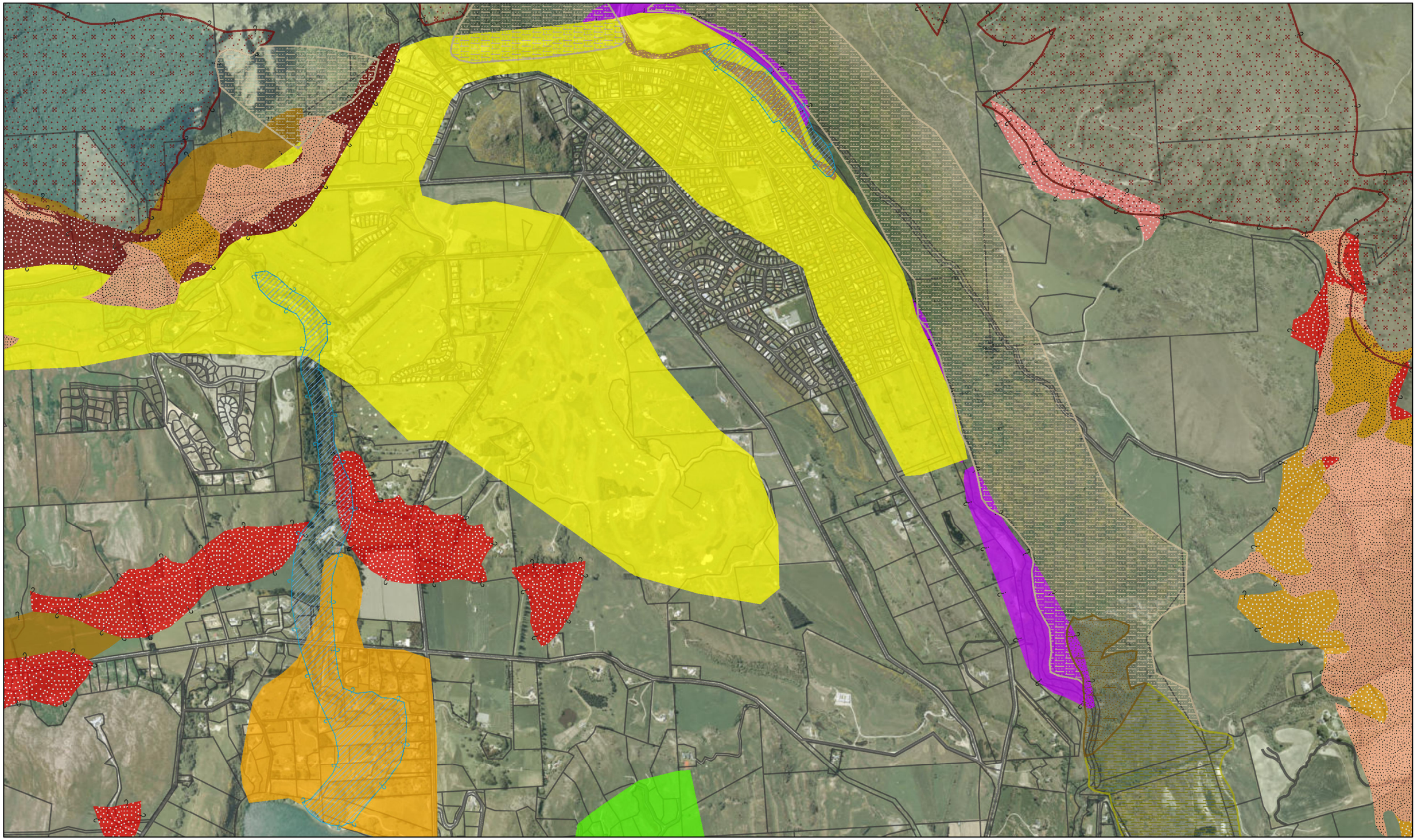
Appendix B

QLDC Hazard Maps



Queenstown Lakes District Council

Webmaps your view of your information

The Hills

19 October 2015

0 0.15 0.3 0.45 0.6 Kilometres

N

The Hills

Legend

Property Land

Parcel Boundaries

Property Address

Roads

Hazards

Active Fault - Location approximate

Inactive Fault - Location approximate

Flooding due to Rainfall

Flooding due to Damburst

Landslide: Active Pre-existing Schist Debris Landslides

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

Landslide: Dormant Pre-existing Schist Debris Landslides

Landslide: Shallow Slips and Debris Flows in Colluvium

Landslide: Debris Flow Hazards

Landslide: Slope Failure Hazard in Superficial Deposits

Landslide: Rockfall

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

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

Landslide: Potential Hazard - Debris Flood/Debris Flow

Landslide Areas - non verified

Erosion Areas

Alluvial Fan - Incision Line

Alluvial Fan - Channels

Alluvial Fan - Source Area

Alluvial Fan - Catchment Areas

Alluvial Fan - Hazard Area

Alluvial Fan - ORC: fan active bed

Alluvial Fan - ORC: fan recently active

Alluvial Fan - ORC: fan less recently active

Alluvial Fan (Regional scale) Active, Composite

Alluvial Fan (Regional scale) Active, Debris-dominated

Alluvial Fan (Regional scale) Active, Floodwater-dominated

Alluvial Fan (Regional scale) Inactive, Composite

Alluvial Fan (Regional scale) Inactive, Debris-dominated

Alluvial Fan (Regional scale) Inactive, Floodwater-dominated

Avalanche Areas

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

Liquefaction Risk: Probably Low (T&T 2012)

Liquefaction Risk: Possibly Moderate (T&T 2012)

Liquefaction Risk: Possibly High (T&T 2012)

Liquefaction Risk: Possibly Susceptible (Opus 2002)

Liquefaction Risk: Susceptible (Opus 2002)

Appendix C

Figure 2

KEY:

Structure Plan Boundary

Activity Area

Activity Areas:

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

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

Overlays:

Landscape Protection Area

The Hills Structure Plan - Yield Schedule
Sep-10

Activity Area	Size	Density (unit/Ha)		Lots	
		Low	High	Low	High
A1	0.9 Ha	1	8	1	7
A2	0.9 Ha	1	8	1	7
A3	0.4 Ha	1	8	1	3
A4	1.7 Ha	1	8	1	13
A5	1.2 Ha	1	8	1	10
A6	0.7 Ha	1	8	1	5
A7	0.5 Ha	1	8	1	4
A8	0.6 Ha	1	4	1	2
A9	1.7 Ha	1	8	1	13
A10	1.1 Ha	1	8	1	8
		Subtotal		10	74
H1	0.3 Ha			1	1
H2	0.3 Ha			1	1
H3	0.3 Ha			1	1
H4	0.3 Ha			1	1
H5	0.3 Ha			1	1
H6	0.3 Ha			1	1
H7	0.3 Ha			1	1
H8	0.2 Ha			1	1
H9	0.3 Ha			1	1
H10	0.3 Ha			1	1
		Subtotal		10	10
		Total		20	84
Total Structure Plan Area	162.7 Ha				
Ave. Lot size (per total land area)				8.1 Ha	1.9 Ha

FOR DISCUSSION

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

PLAN STATUS:
DRAFT

Fig. 2

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

Liquefaction risk. Probably low

Alluvial fan. Active. Debris dominated.

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

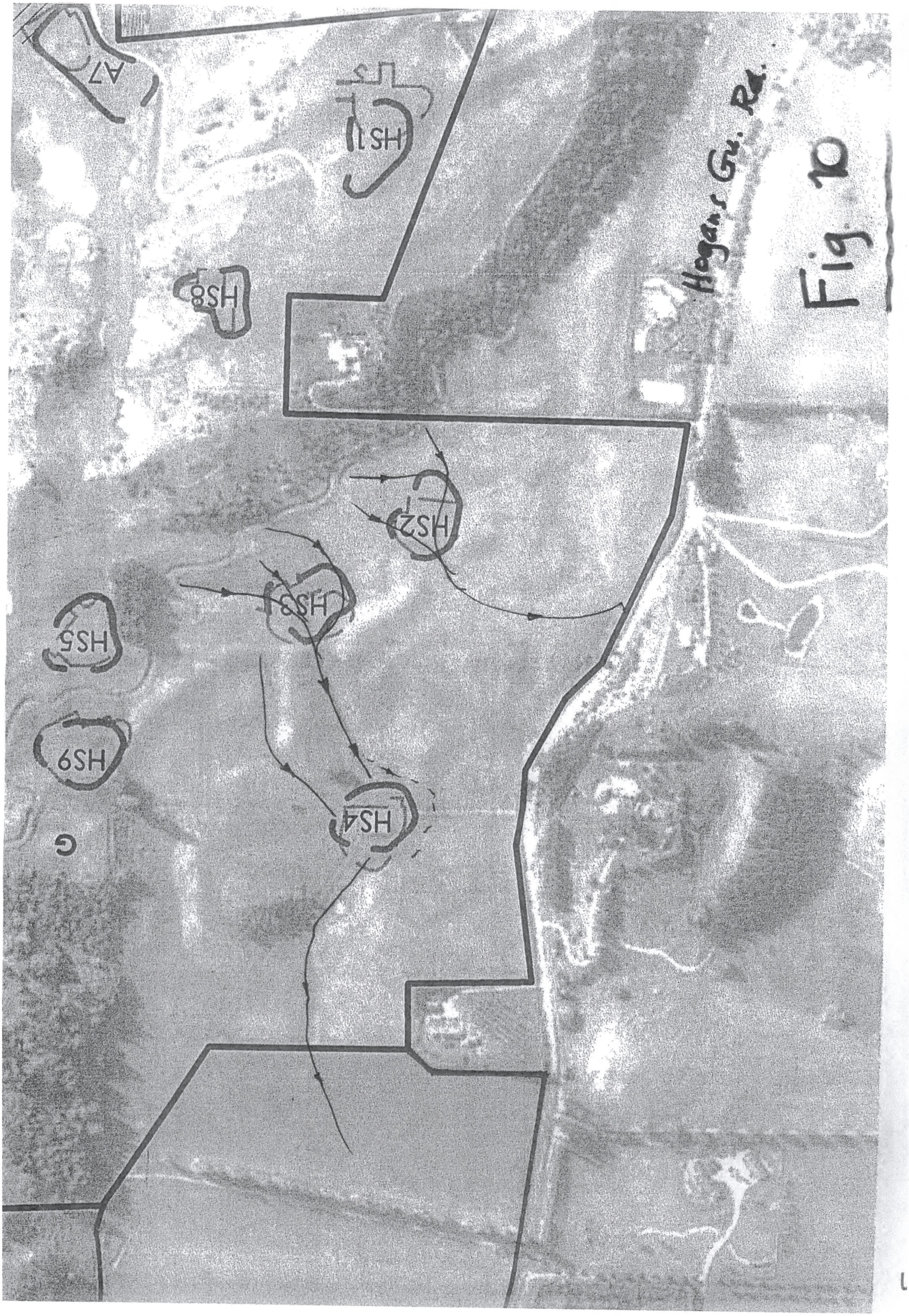

Fig. 10

DCL Soil Contamination Assessments

DCL Assessment – Hogans Gully Land

Rezoning Submission to the District Plan, Preliminary and Detailed Site Investigation

For

Trojan Helmet Ltd

October 2015

Davis Consulting Group Limited
Arrow Lane,
Arrowtown 9302
03 409 8664
Document ID: 15063B

Rezoning Submission to the District Plan,

Preliminary and Detailed Site Investigation

Document Status

Version	Purpose of Document	Prepared By	Reviewer	Review Date
A	Draft for Internal Review	FR	GD	19 Oct 2015
B	FINAL for Client Review	FR	GD	20 Oct 2015
O	Final Report	FR	GD	22 Oct 2015

TABLE OF CONTENTS

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EXECUTIVE SUMMARY

Trojan Helmet Limited (THL) has prepared a submission to the district plan that seeks to rezone a parcel of land on Lake Hayes Arrowtown Road from the current rural general zone to rural lifestyle. The proposed site has had a long history of pastoral activity that may have received applications of pesticides and fertilisers. The proposal would result in subdivision, landuse change and earthwork activities that trigger the National Environment Standard for Assessing and Managing Contaminants in Soil (NES).

In order to support the submission, THL commissioned Davis Consulting Group to consider the potential effect of historical activities on the soil quality of the site and undertake a review of risks to human health to meet the provisions of the NES.

The scope of work completed during the Preliminary and Detailed Site Investigation (PSI and DSI) included the following:

- Review of the site history including a review of the property file, certificate of title and historic aerial photographs;
- Completion of a site inspection to examine the condition of the property;
- Collection of soil samples across the site and analysis for heavy metals and organochlorine pesticides; and
- Consideration of the risk to human health based on the detected soil contaminant concentrations and proposed landuse of the site.

Based on the findings of the PSI and DSI, the following conclusions are made:

- The THL submission seeks to rezone the site from rural general to a rural lifestyle zoning;
- A review of the historical and current landuse of the site identified a range of potentially hazardous activities that could have impacted soil quality including the broad acre application of pesticides and fertilisers and storage of waste oil. A range of farming materials such as timber, wire and railway sleepers are also stored on the site however we concluded these activities have been for a short duration and unlikely to impact soil quality;
- DCG concluded the risk to soil quality on the site is associated with the possible historical application of the pesticides and fertilisers;
- Soil sampling was undertaken across the site to support the assessment with a total of 15 soil samples collected;

- The soil samples were analysed for organochlorine pesticides and heavy metals that are associated with the broad acre application of pesticides and fertilisers;
- The analytical results show that the DDT was historically utilised on the site but was detected at concentrations well below the risk based NES soil contaminant standard; and
- Most of the heavy metal results returned concentrations that are considered to represent background levels however arsenic was detected on one of the composite soil samples that exceeds the NES soil contaminant standards.

In summary, most of the site is suitable for activities that may be undertaken under the proposed rural lifestyle zoning however some additional investigation is required to assess the extent of the soils that contain arsenic exceeding the adopted guideline. DCG considers the impacted area will be relatively small and localised and readily remediated if necessary.

1.0 INTRODUCTION

1.1 Purpose

Trojan Helmet Limited (THL) has prepared a submission to the district plan that seeks to rezone a parcel of land on Lake Hayes Arrowtown Road from the current rural general zone to rural lifestyle. The proposed site has had a long history of pastoral activity that may have received applications of pesticides and fertilisers. The proposal would result in subdivision, landuse change and earthworks activities that may trigger the National Environment Standard for Assessing and Managing Contaminants in Soil (NES).

In order to support the submission, THL commissioned Davis Consulting Group to consider the potential effect of historical activities on the soil quality of the site and undertake a review of risks to human health to meet the provisions of the NES.

DCG's experience in the provision of contaminated land services is provided in Appendix A.

1.2 Scope of Work

The scope of work completed during the Preliminary and Detailed Site Investigation (PSI and DSI) included the following:

- Review of the site history including a review of the property file, certificate of title and historic aerial photographs;
- Completion of a site inspection to examine the condition of the property;
- Collection of soil samples across the site and analysis for heavy metals and organochlorine pesticides;
- Consideration of the risk to human health based on the detected soil contaminant concentrations and proposed landuse of the site; and
- Preparation of a soil investigation report in accordance with the requirements of the Contaminated Land Management Guidelines (CLMG) No. 1.

1.3 Limitations

The findings of this report are based on the Scope of Work outlined above. DCG performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental science profession. No warranties, express or implied, are made. Subject to the Scope of Work, DCG's assessment is limited strictly to identifying the risk to human health based on the historical activities on the site. The confidence in the findings is limited by the Scope of Work.

The results of this assessment are based upon site inspections conducted by DCG personnel, information from interviews with people who have knowledge of site conditions. All conclusions and recommendations regarding the properties are the professional opinions of DCG personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, DCG assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside DCG, or developments resulting from situations outside the scope of this project.

2.0 SITE LOCATION AND DESCRIPTION

2.1 Site Location and Description of the Activity

The site is located on the corner of Arrowtown Lake Hayes Road and Hogans Gully Road and has the following legal description Lot 6 DP 392663 Lot 4 DP 392663 (see Figure 1). THL are seeking to change the land use of Lot 6 DP 392663 and 4.7 ha of Lot 4 DP 392663. The total area of the site is approximately 19.7 ha and is situated southwest of Arrowtown. Figure 2 presents the layout of the proposed activity contained within the THL submission.

According to the Queenstown Lakes District Council (QLDC) District Plan, the property lies within the Rural General Zone.

Coordinates for the property are E 2180439, N 5574691.

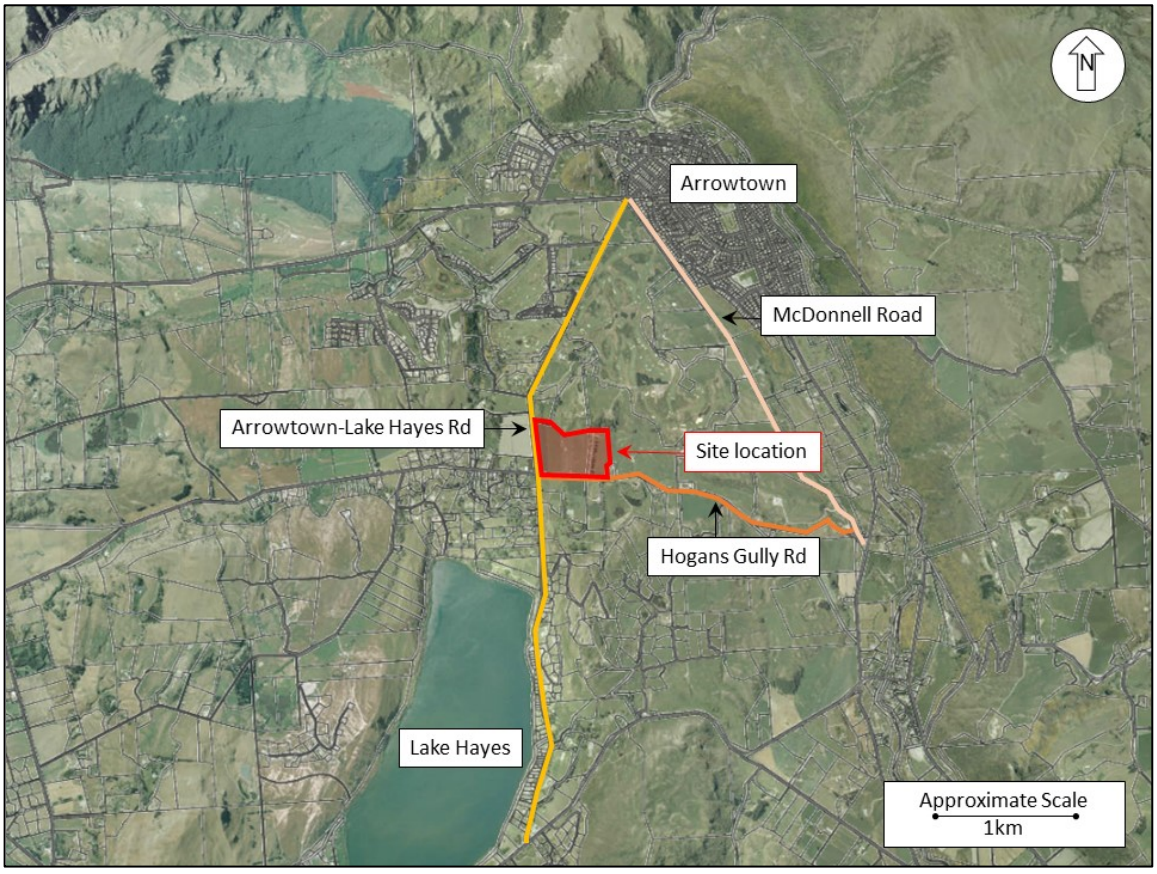

Figure 1: Site Location Plan

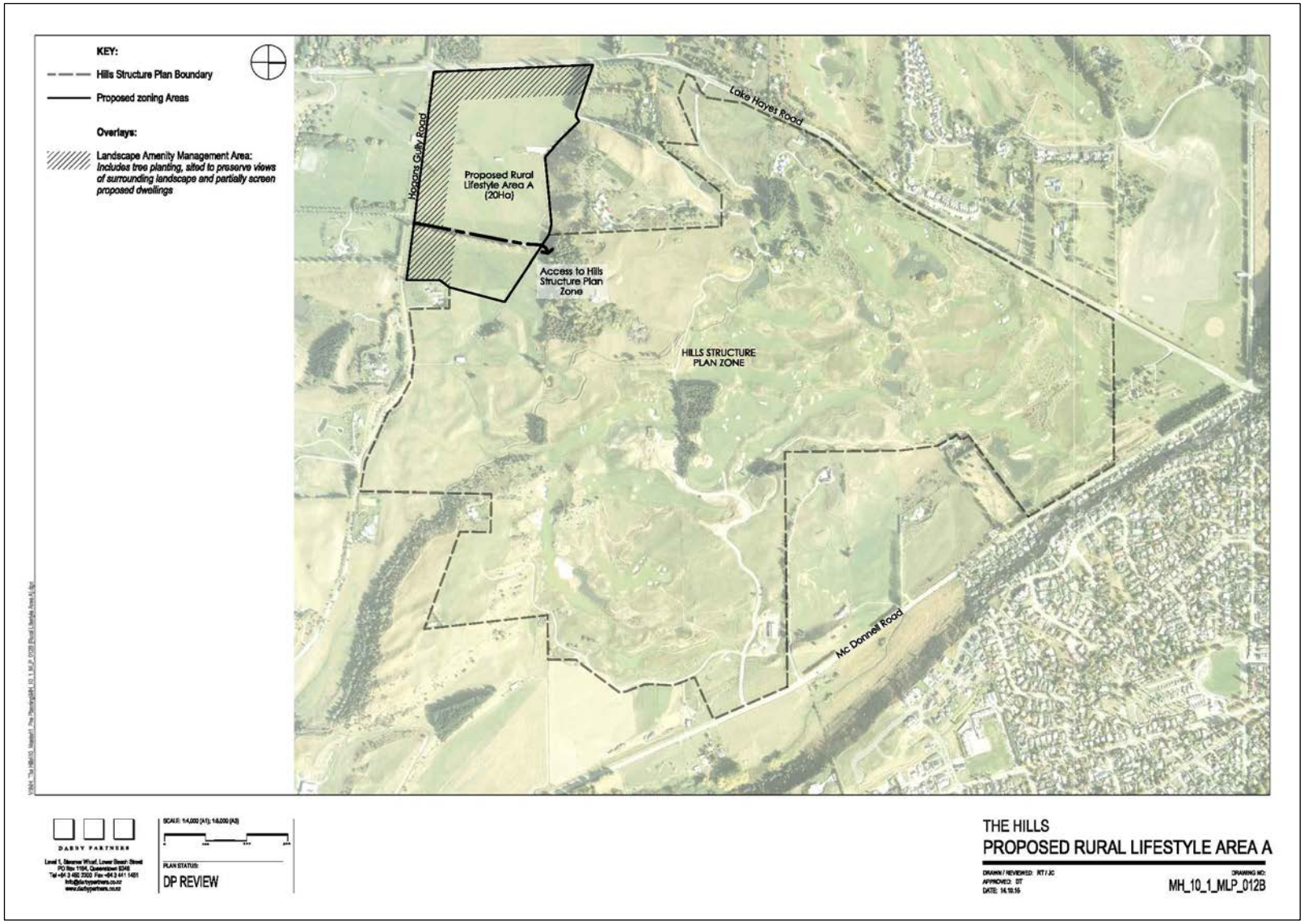

Figure 2: Proposed Rural Lifestyle Area A – Prepared by Darby Partners

2.2 Site History

Historic photographs obtained from the Lakes District Museum (accessed 15/10/2015) indicate the property was used for pastoral activity from circa 1910 (see Plate 1). A second historical photograph taken in 1954 (see Plate 2) indicates the area continued to be under pastoral management at this time.

DCG understands the site was part of the Bob Jenkins Farm in the 1930s. The property was subsequently purchased in the 1940s by brothers Jack and Lawson Summer who then sold it on to Jim Monk (McDonald, 2010). The current owners, Trojan Helmet Limited, purchased the property in circa 1992 and the site has been used for grazing since this time. Historic title for the site is located in Appendix B.

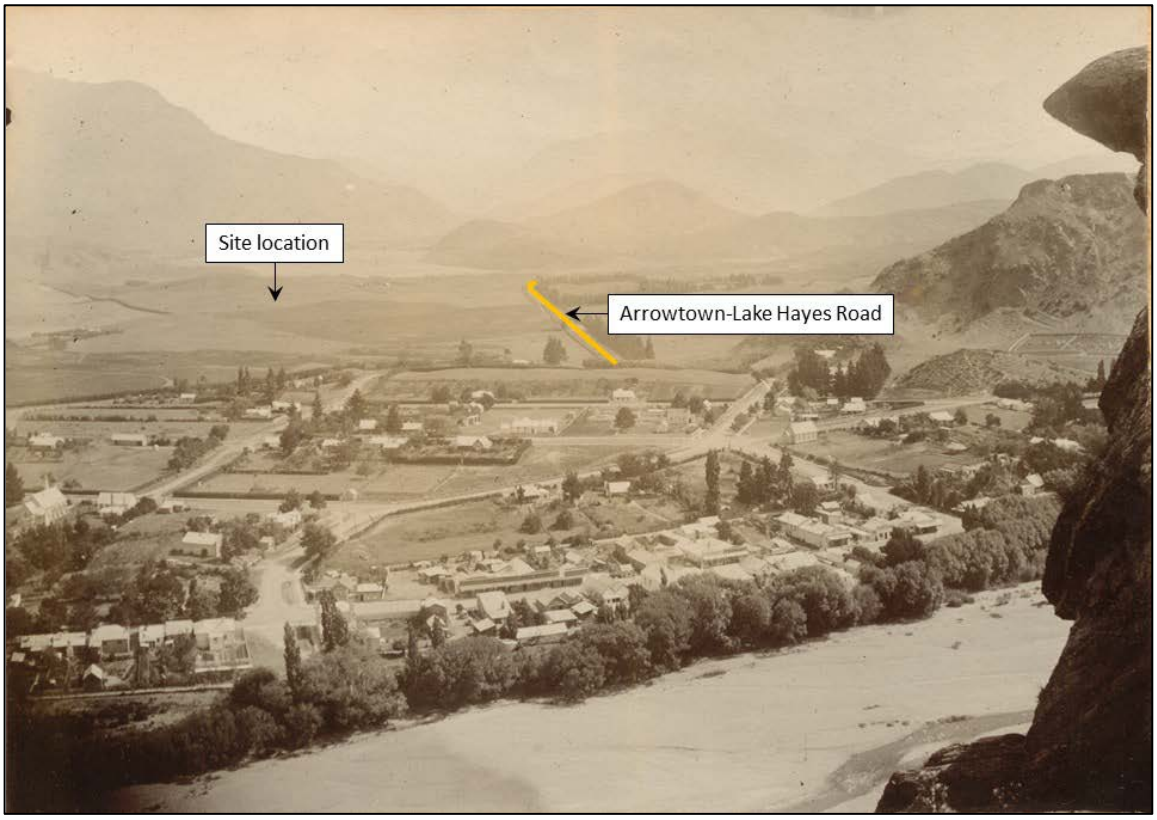

Plate 1: Looking southwest over Arrowtown towards Lake Hayes 1910

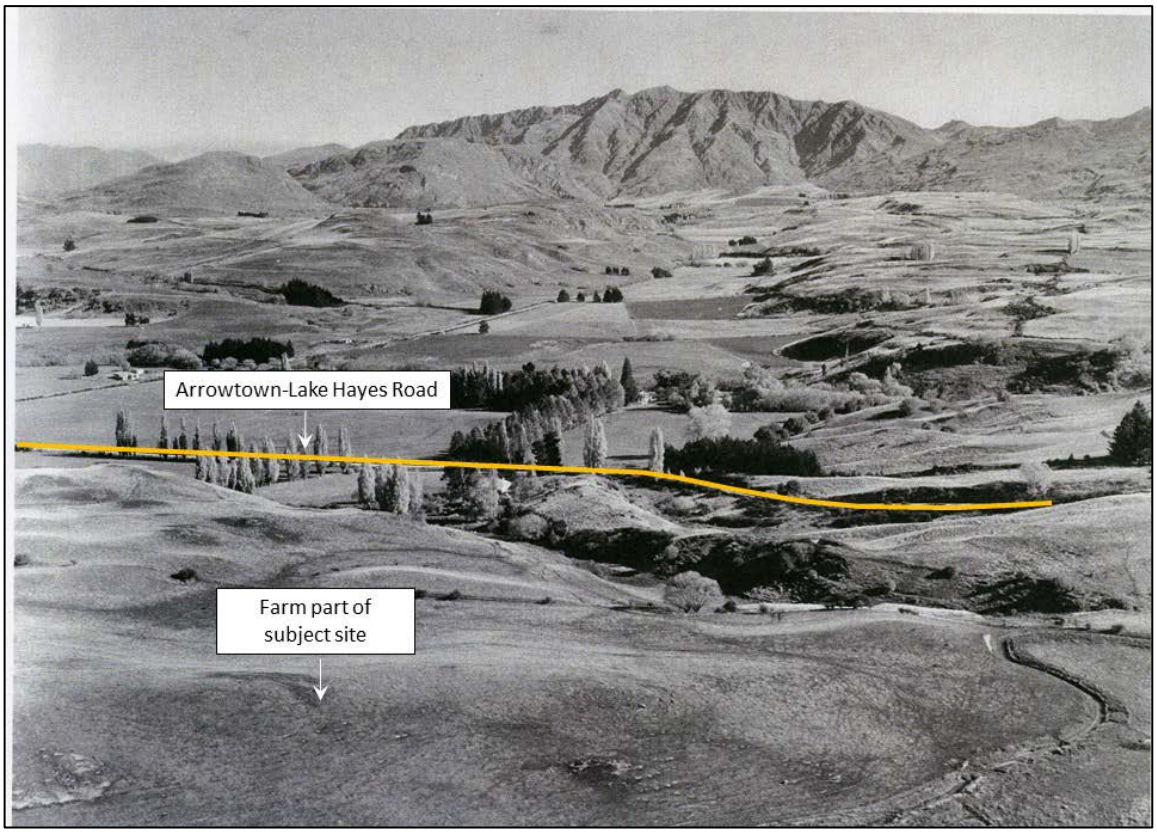

Plate 2: Looking West from above The Hills site 1954

2.3 Site Condition and Surrounding Environment

Figure 3 presents a site plan showing the current layout of the site.

The site contains a storage area where the following items are stored: Railway sleepers, plastic hosing, some light machinery, waste oil drums, deer fence netting, corrugated iron, timber, pellets, baleage and logs. The surface soil within this area did not look stained or impacted from storing the above items.

The hay shed currently stores some hay and shelters one empty waste oil can and a caravan. The remainder of the site includes a gravel track, a drain and pasture. Plates 3-6 provide representative photographs for the layout and current condition of the site.

According to the QLDC Webmaps (http://maps.qldc.govt.nz/qldcviewer/) the property is currently zoned rural general along with properties to the north and east. Neighbouring to the west is rural general and rural residential and to the south is rural lifestyle. The site borders an active alluvial fan to the east and northwest (QLDC Webmaps).

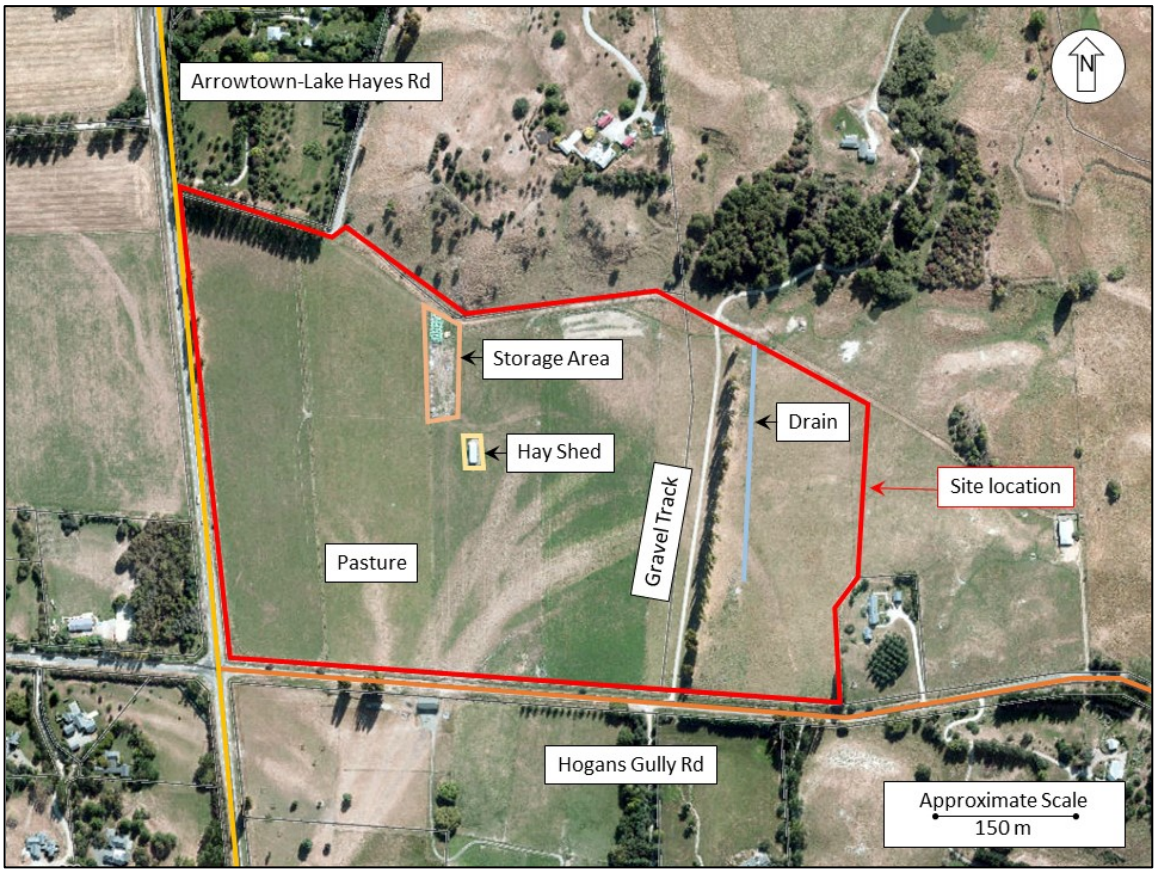

Figure 3: Site Layout Plan

Plate 3: Timber, logs and railway sleepers at the storage area

Plate 4: Fencing wire, corrugated iron, timber and baleage at the storage area

Plate 5: Waste oil drums at the storage area

Plate 6: Looking south from centre of site across pasture

2.4 Geology and Hydrogeology

The site is situated on a glacial till (Turnbull, 2000). According to the QLDC Webmap, the site borders an active alluvial fan. The surface soils were described during the collection of soil samples; see Appendix C for the soil profile logs.

2.4.1 Hydrogeology

The site investigation did not include a groundwater assessment. The site is located within the Wakatipu Basin aquifer system however it is not situated above any identified aquifers. The Mid Mill Creek Aquifer is situated east the subject site and north of Lake Hayes (ORC, 2014). The depth to groundwater on the site is unknown.

The location of groundwater bores within a 1 kilometre radius of the site (held by the ORC) is provided in Appendix D. A total of 12 consented bores have been installed within 1 km of the site. The wells have been installed for a variety of purposes and are summarised as follows:

- 7 wells are used for domestic purposes;
- 2 well is disused;
- 2 well is unknown; and
- 1 wells are used for geological investigation.

2.4.2 Hydrology

On site there is one drain which during the site visit contained water. The closest surface water is Mill Creek located 50 m west of the site.

2.5 Additional Site Information

The CLMG No 1 requires information associated with fuel storage facilities, spill loss history, recorded discharges and onsite and offsite disposal locations. DCG requested a search of the Otago Regional Council (ORC) records, and examined the Queenstown Lakes District Council (QLDC) records, for Landuse and Site Contamination Status, Resource Consents, and Resource Management Act (RMA) incidents for the site. The ORC stated the following.

There are no records held on the Otago Regional Council's "Database of Selected Landuses" for the above site. The database identifies sites where activities have occurred that are known to have the potential to contaminate land. The record of a property in the database does not necessarily imply contamination. Similarly, the absence of available information does not necessarily mean that the property is uncontaminated; rather no information exists on the database.

Reference should be made to the Ministry for the Environment's Hazardous Activities and Industries List. If any of these activities have occurred on the above site, then it may be considered potentially contaminated.

Property files were obtained from the QLDC eDocs webpage (https://edocs.qldc.govt.nz/) for Lots 6 and 4 DP 392663. The property file held information regarding applications for a billboard on the corner of Lake Hayes and Hogans Gully Roads and a consent to undertake a subdivision and identification of building platform, a boundary adjustment to create a 4ha lot around an existing dwelling and landuse consent to construct a new dwelling. Both applications are dated 2015.

The following provides a summary of information that the CLMG No. 1 (MfE, 2003a) indicates should be included in a DSI report:

- Presence of Drums – Two waste oil drums were located in the storage area of the site (see Plate 5). The drums were full of oil. The drums appeared to be in good condition and were not leaking.
- Wastes – waste oil is stored on the site as described above.
- Fill Materials – No fill material was present on site.
- Odours – No odours were noted.

- Flood Risk – According to QLDC Hazard map the site is not at risk of flooding;
- Surface Water Quality – There was a small drain with water flowing from the northern neighbouring lot to the south.
- Site boundary condition – The west, north and southern boundaries are deer fenced. The eastern boundary is not fenced or marked.
- Visible Signs of Contamination – No obvious stains or signs of contamination were present during the site visit.
- Local Sensitive Environments –The closest sensitive environment is Mill Creek located 50 m west of the property boundary.

2.6 Contaminants Commonly Associated with the Landuse

Based on the Contaminated Land Management Guidelines Schedule B, the hazardous substances that may be associated with the farming activity include a range of organochlorine pesticides and heavy metals. In addition waste oil is stored on a pellet and there is a risk of some loss of waste oil to ground however there was no evidence of staining of soils. We therefore concluded it was highly unlikely there has been losses of waste oil to ground.

It is our view that the contaminants of concern across the site are predominantly those associated with historic farming and agriculture landuse. Specifically, the broad acre application of persistent pesticides and fertilisers has the potential for organochlorine pesticides and heavy metals to accumulate in soils to a level that may present a risk to human health.

3.0 SAMPLING AND ANALYSIS PLAN

3.1 Data Quality Objectives

The data quality objectives (DQOs) of the DSI were to:

- Characterise the nature of any contamination associated with the historical landuse of the site; and
- Determine the risk of any soil contamination encountered onsite to human health, based on the proposed rural lifestyle landuse of the site.

3.2 Sampling and Analysis Plan

The sampling and analysis plan was designed to address the specific objectives, namely gain an understanding of contaminants associated with historic farming and pesticide use. The sampling approach was systematic using a 70 m by 70 m grid. Note that the 'Landscape Protection Area' was not sampled. Samples were also not collected within the storage area as it is highly unlikely the materials stored on the site would have impacted the soil quality.

The sampling plan is presented in Figure 4. The sample IDs and coordinates are provided on the soil descriptions (Appendix C).

Soil samples were composited into groups of three for the analysis of heavy metals. From each set of three samples one sample was analysed for organochlorine pesticides. A total of 15 surface soil samples were collected on site from 0 – 10 cm depth, with a further sample also taken for duplicate purposes. The sampling depth was considered appropriate due to the nature of the potential contaminants present such as pesticides and heavy metals, which generally bind strongly to soils. Furthermore, the risk of exposure to people working and living on the site is associated with surface soils.

The soil sample and analysis summary table is located below in Table 1.

Table 1: Soil Sample Summary Table

Sample ID	Sample Depth	Heavy Metals Composite
AA#1	0-0.1	1
AA#2	0-0.1	
AA#3	0-0.1	
AA#4	0-0.1	2
AA#5	0-0.1	
AA#6	0-0.1	
AA#7	0-0.1	3
AA#8	0-0.1	
AA#9	0-0.1	
AA#10	0-0.1	4
AA#11	0-0.1	
AA#12	0-0.1	
AA#13	0-0.1	5
AA#14	0-0.1	
AA#15	0-0.1	
Sample ID	Sample Depth	Individual Analysis
AA#2	0-0.1	Organochlorine Pesticides
AA#5	0-0.1	Organochlorine Pesticides
AA#8	0-0.1	Organochlorine Pesticides
AA#11	0-0.1	Organochlorine Pesticides
AA#14	0-0.1	Organochlorine Pesticides
A Dup #1	0-0.1	Heavy Metals
AA#4	0-0.1	Heavy Metals

Figure 4: Sample Location Plan

3.3 Soil Sampling Methodology

Soil sampling was undertaken with the use of a spade. The following procedures were applied during the soil sampling process to gain representative samples:

- Field personnel wore a fresh pair of nitrile gloves between sampling events.
- Soil samples were transferred to 250 mL glass jars with teflon lids as supplied by Hill Laboratories.
- All soil samples were unambiguously marked in a clear and durable manner to permit clear identification of all samples in the laboratory.

3.4 Analytical Parameters

The laboratory analytical suite determined for the site investigation is in recognition of our understanding of the current and historical use of the subject site. DCG understands the site has had a history of agricultural activity. Based on these activities the following substances were included in the analytical suite:

- Organochlorine pesticides (including 4,4-DDE, 2,4-DDT and Dieldrin);
- Heavy metals.

The laboratory methods utilised for the analysis are provided in the laboratory report (see Appendix E).

3.5 Soil Sample Field and Laboratory QA/QC

The field QA/QC procedures performed during the soil sampling are listed as follows:

- Use of standardised field sampling forms and methods;
- Samples were transferred under chain of custody procedures;
- All samples were labelled to show point of collection, project number, and date;
- Headspace in sample jars was avoided;
- The threads on the sampling jars were cleaned to avoid Volatile Organic Compound (VOC) loss;

All soil samples were couriered on ice to Hill Laboratories. Hill Laboratories is IANZ accredited for the analysis of heavy metals and pesticides. Hill conduct internal QA/QC in accordance with IANZ requirements.

3.6 Soil Guideline Values

Soil guideline values (SGVs) selected for application on this project are provided in Table 2. The selection of these guidelines is consistent with the principles of the Contaminated Land Management Guidelines No. 2: Hierarchy and Application in New Zealand of Environmental Guideline Values (MfE, 2003b).

The heavy metal and organochlorine pesticide SGVs adopted for the site assessment were based on either the NES Soil Contaminant Standards (MfE, 2012) or the National Environmental Protection Measure (NEPM, 2013). Guidelines for the rural residential and residential landuse scenarios as set out in the NES were adopted for the house sites and residential activity areas respectively.

Table 2: Soil Guidelines

Analyses	Guideline
Heavy Metals and Organochlorine and Multi-residue pesticides	1. Soil Contaminant Standards *in* New Zealand 'Users' Guide: NES for Assessing & Managing Contaminants in Soil to Protect Human Health 2012 (MfE, 2012). 2. Guideline on the Investigation Levels for Soil and Groundwater *in* National Environment Protection (Assessment of Site Contamination) Measure 1999 - Volume # 2 (NEPC, 2013).

3.7 Soil Analytical Result Review

Following the receipt of laboratory data, a detailed review of the data was performed to determine its accuracy and validity. All laboratory data was checked for analytical and typographical errors.

Once the data quality was established the soil data was checked against the Sampling Program DQOs.

4.0 INVESTIGATION RESULTS

4.1 Analytical Results

The soil sample locations are provided in Figure 4 and summarised in Appendix E.

4.1.1 Organochlorine Pesticides Results

The organochlorine pesticides (OCP) detected above the laboratory detection limit are provided in Table 3. The remaining results are presented in the laboratory reports provided in Appendix E. In summary the OCP analytical results show the following:

- DDT was detected in four of the five soil samples analysed ranging from 0.096 mg/kg to 0.257 mg/kg;
- All DDT concentrations detected are well below the NES soil contaminant standard for the rural residential landuse scenario of 45 mg/kg; and
- All other OCP results returned concentrations below the laboratory reporting limit.

The results indicate that DDT has been utilised across the property, most likely to control pests such as grass grub. Notwithstanding this finding, the concentrations are well below levels that present a risk to people working or living on the site.

Table 3: Organochlorine Pesticide Results (mg/kg)

Sample ID	AA#2 (0.1)	AA#5 (0.1)	AA#8 (0.1)	AA#11 (0.1)	AA#14 (0.1)	Guideline
2,4'-DDD	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	-
4,4'-DDD	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	-
2,4'-DDE	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	-
4,4'-DDE	0.138	0.15	0.073	0.043	< 0.010	-
2,4'-DDT	< 0.010	0.011	< 0.010	< 0.010	< 0.010	-
4,4'-DDT	0.06	0.066	0.018	0.013	< 0.010	-
Total DDT	0.238	0.257	0.131	0.096	<0.06	45[1]

< denotes concentration below laboratory detection limits
- Denotes no guideline value
[1] Appendix B Soil Contaminant Standards in New Zealand 'Users' Guide: NES for Assessing & Managing Contaminants in Soil to Protect Human Health 2012 (MfE, 2012).

4.1.2 Heavy Metal Results

The heavy metal results are presented in Table 4 and summarised as follows:

- Arsenic concentrations detected in the composite soil samples ranged from 8 mg/kg to 22 mg/kg;
- Arsenic concentrations were detected below the adopted NES soil contaminant standard in four of the five soil samples analysed;
- An arsenic concentration of 22 mg/kg was detected in Composite Sample #2 that exceeds the adopted NES soil contaminant standard; and
- Cadmium, chromium, copper, lead, nickel and zinc concentrations were all detected below the adopted rural residential soil guidelines.

The consistency of the results indicates that most of the heavy metal concentrations are representative of background concentrations. However, Composite Sample #2 contained arsenic levels that are elevated above background and also the soil contaminant standard. DCG expects the concentration detected to be representative of a relatively localised hotspot that may be the result of the storage of treated timber posts. Further investigation to delineate the extent of the impacted soil will be required prior to lodgement of a landuse consent to ensure the risk to human health is characterised appropriately.

Table 4: Heavy Metal Composite Results (mg/kg)

Composite #	1	2	3	4	5	Guideline
Arsenic	12	**22**	12	10	8	17[1]
Cadmium	0.17	0.22	0.14	0.13	0.2	0.8[1]
Chromium	13	13	10	11	11	>10,000[1]
Copper	18	18	11	11	15	>10,000[1]
Lead	18.2	21	14.8	12.7	12.5	160[1]
Nickel	14	14	10	10	11	400[2]
Zinc	71	74	51	55	58	7,400[2]

< denotes concentration below laboratory detection limits
[1] Appendix B Soil Contaminant Standards in New Zealand 'Users' Guide: NES for Assessing & Managing Contaminants in Soil to Protect Human Health 2012 (MfE, 2012).
[2] Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater in National Environment Protection (Assessment o Site Contamination) Measure 2013 Volume 2 (NEPC, 2013).

4.2 QA/QC Results

4.2.1 Field Duplicates

One field duplicate soil sample was collected during the site investigation and analysed to review the reproducibility of the laboratory analysis. The duplicate and the corresponding sample results are presented in Table 5 below.

Table 5: Duplicate Percentage Differences

Sample ID	AA#4 (0.1)	A Dup #1	% Difference
Arsenic	9	10	10.50%
Cadmium	0.17	0.15	1%
Chromium	9	9	0%
Copper	13	13	0%
Lead	16.2	16.6	2.40%
Nickel	8	8	0%
Zinc	53	55	3.80%

An acceptable percentage difference between duplication samples is less than 30 to 50 % (MfE, 2011). The highest relative percentage difference between the six samples was 10.5 % (for arsenic), which is considered acceptable for soil analysis. The QA/QC analysis indicates the sampling and analysis undertaken was reproducible.

4.2.2 Laboratory Procedures

Hills Laboratories did not complete specific in-house QA/QC analysis such as spike recoveries or laboratory duplicates during the processing of the soil samples.

The Chain of Custody form and the Hills Laboratory results are provided in Appendix E.

5.0 SUMMARY AND RECOMMENDATIONS

Based on the findings of the PSI and DSI, the following conclusions are made:

- The THL submission seeks to rezone the site from rural general to a rural lifestyle zoning;
- A review of the historical and current landuse of the site identified a range of potentially hazardous activities that could have impacted soil quality including the broad acre application of pesticides and fertilisers and storage of waste oil. A range of farming materials such as timber, wire and railway sleepers are also stored on the site however we concluded these activities have been for a short duration and unlikely to impact soil quality;
- DCG concluded the risk to soil quality on the site is associated with the possible historical application of the pesticides and fertilisers;
- Soil sampling was undertaken across the site to support the assessment with a total of 15 soil samples collected;
- The soil samples were analysed for organochlorine pesticides and heavy metals that are associated with the broad acre application of pesticides and fertilisers;
- The analytical results show that the DDT was historically utilised on the site but was detected at concentrations well below the risk based NES soil contaminant standard; and
- Most of the heavy metal results returned concentrations that are considered to represent background levels however arsenic was detected on one of the composite soil samples that exceeds the NES soil contaminant standards.

In summary, most of the site is suitable for activities that may be undertaken under the proposed rural lifestyle zoning however some additional investigation is required to assess the extent of the soils that contain arsenic exceeding the adopted guideline. DCG considers the impacted area will be relatively small and localised and readily remediated if necessary.

6.0 REFERENCES

Ministry for the Environment (2003a) *Contaminated Land Management Guidelines No. 1: Reporting on Contaminated Sites in New Zealand.*

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