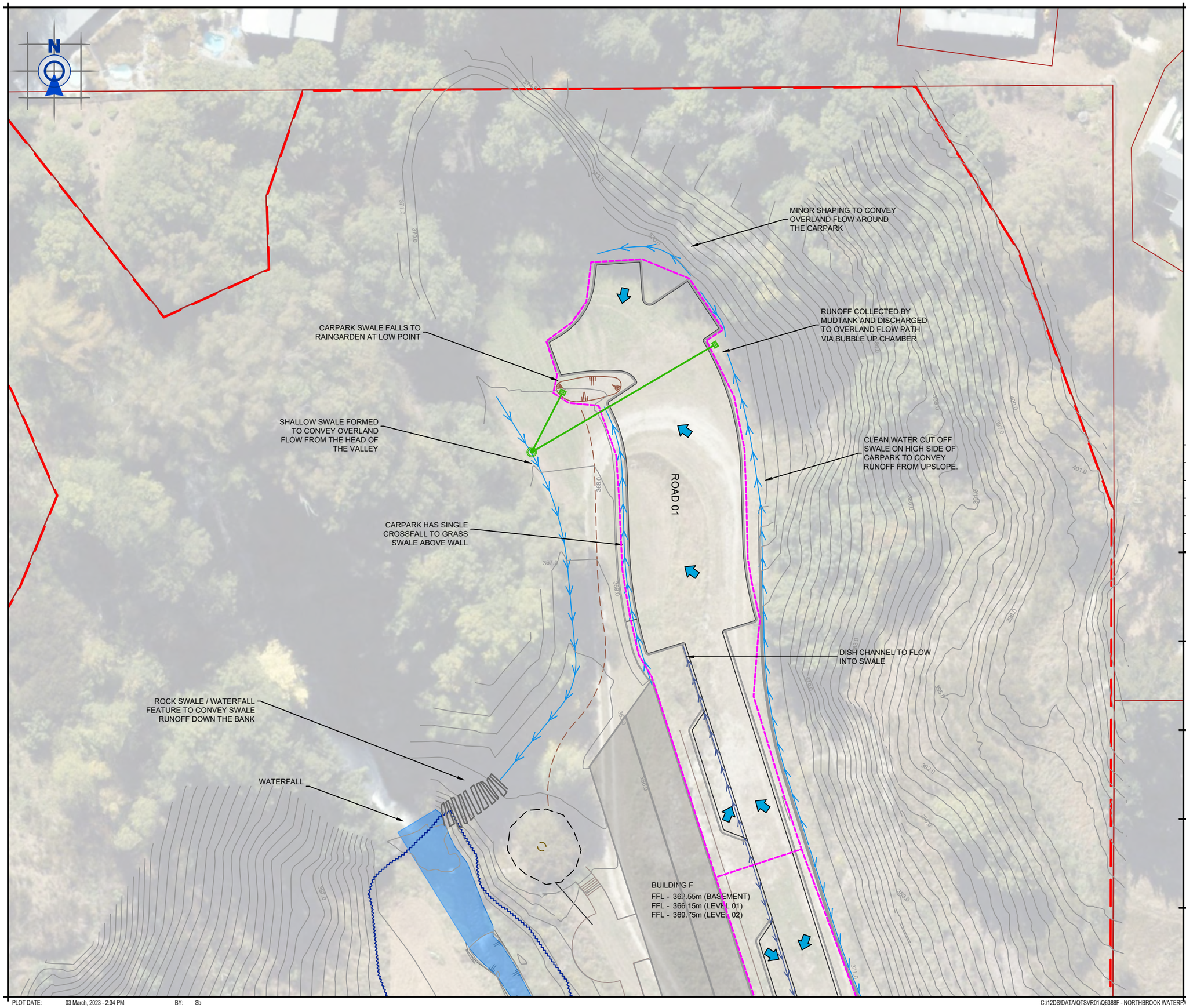

LEGEND

- LEGAL BOUNDARY (SUBJECT PROPERTY)
- LEGAL BOUNDARY (ABUTTALS)
- MILL CREEK
- SITE EXTENT
- CATCHMENT EXTENT (PRIMARY NETWORK)
- RAIN GARDEN
- OPEN SWALE
- KERB / CONCRETE CHANNEL
- SHEET FLOW DIRECTION
- STORMWATER PIPE / CULVERT
- MUDTANK / MANHOLE
- FLOOD EXTENT 100y ARI
- PROPOSED BUILDING
- 357.0 PROPOSED CONTOUR (1m INTERVAL)
- RL: 369.85 FLOOD EXTENT/FREEBOARD RL

NOTES

1. REFER TO CKL REPORT FOR DETAILS OF SW TREATMENT
2. ROOF RUNOFF WILL BE PIPED DIRECTLY TO OPEN SWALES AND BE CONVEYED TO MILL CREEK,
3. ALL CATCHMENT EXTENTS SHOWN ARE INDICATIVE ONLY, AREA MAY CHANGE DURING DETAILED DESIGN.

FOR RESOURCE CONSENT

REV.	REVISION DETAILS	DATE
A	ORIGINAL ISSUE	30/03/22
B	FOR RESOURCE CONSENT	12/06/22
C	RFI RESPONSE	28/02/23

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E queenstown@ppgroup.co.nz

Client/Location:

WATERFALL PARK DEVELOPMENTS LTD
LOT 1 DP 540788

Purpose/Drawing Title:

NORTHBROOK - ARROWTOWN STORMWATER LAYOUT

Surveyed by:		Original Size:	Scale:	
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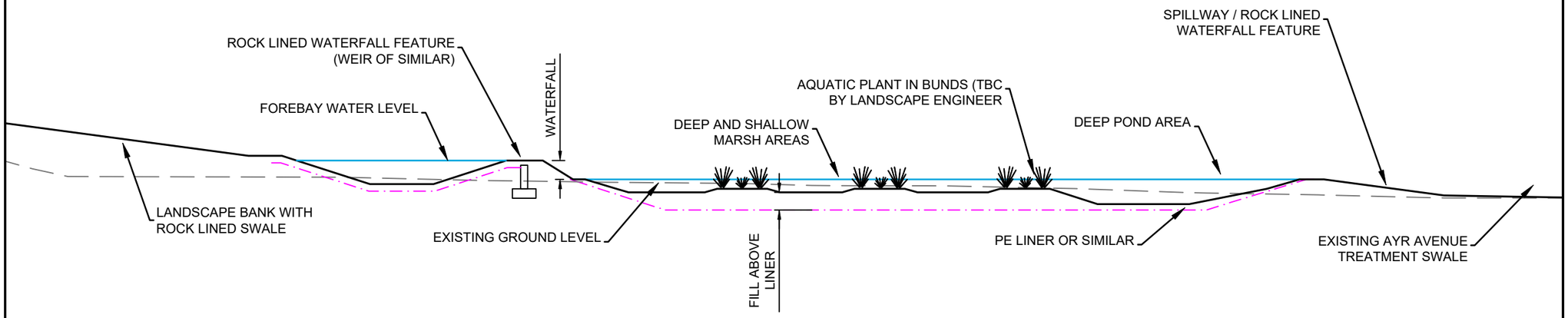
Drawn by:	SB			
Checked by:	SP		DO NOT SCALE	
Approved by:				
Job Ref: Q6388 - 82 - 01		Sheet No: 406	Revision No: C	Date Issued: 28/02/2023



SECTION A - PROPOSED WETLAND LONG SECTION

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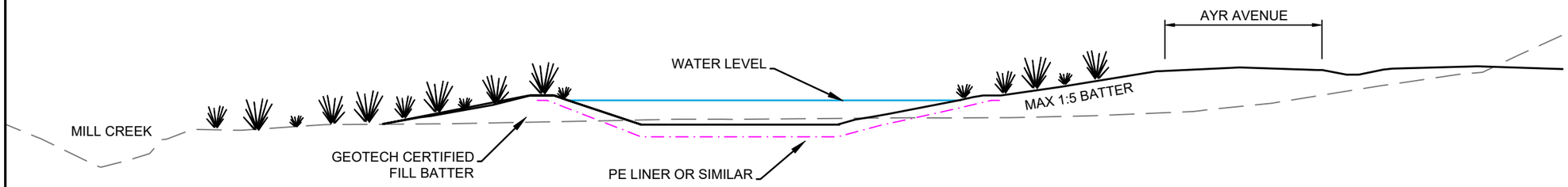

SECTION B - PROPOSED WETLAND CROSS SECTION

SCALE: 1:200

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DEVELOPMENTS LTD
LOT 1 DP 540788

Purpose/Drawing Title:

NORTHBROOK - ARROWTOWN
WETLAND SECTIONS

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Approved by:			
Job Ref: Q6388 - 82 - 01		Sheet No: 410	Revision No: C / Date Issued: 28/02/2023

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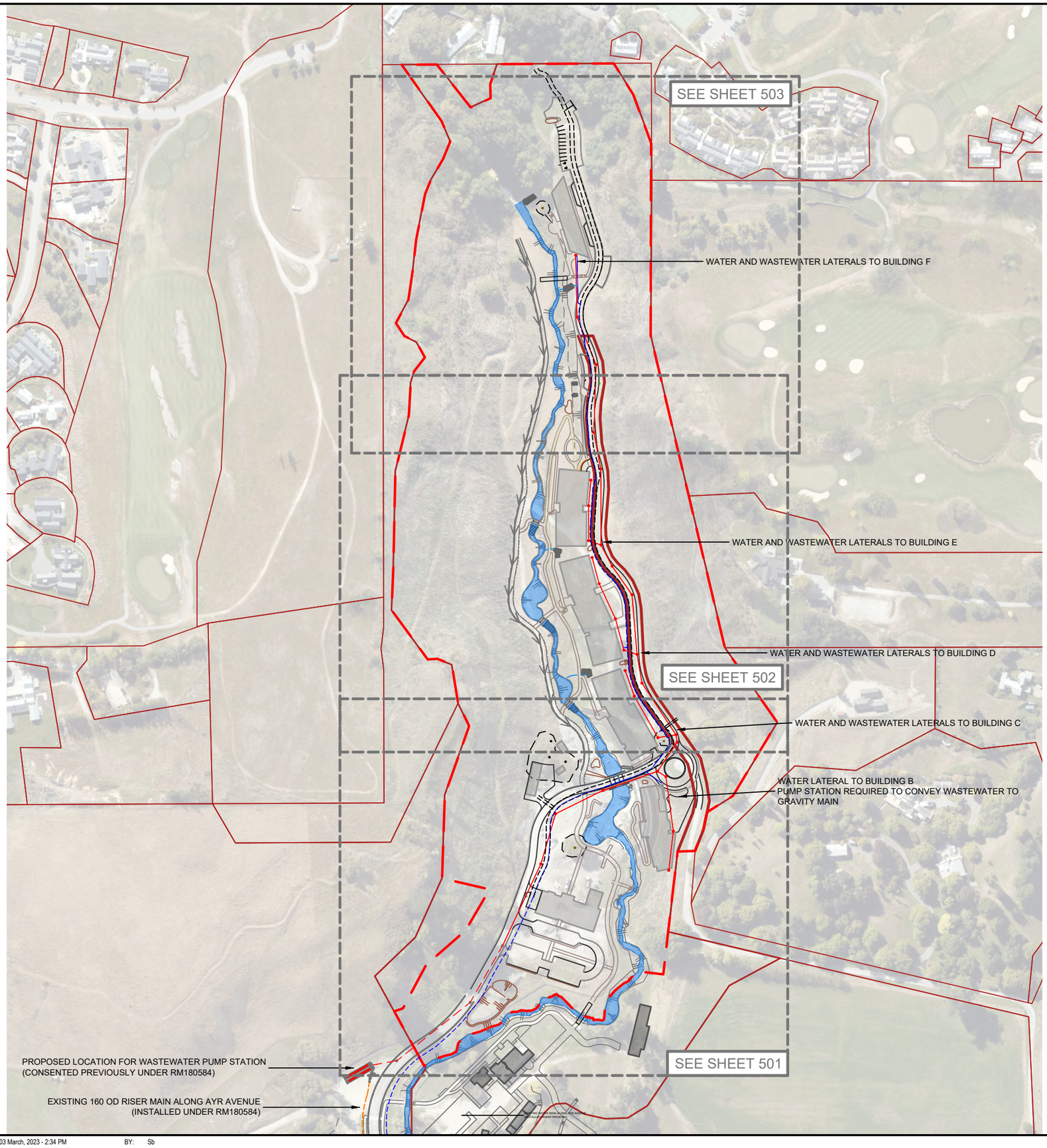

LEGEND

- LEGAL BOUNDARY (SUBJECT PROPERTY)
- LEGAL BOUNDARY (ABUTTALS)
- MILL CREEK
- SITE EXTENT
- EXISTING WATERMAIN
- PROPOSED WATERMAIN
- EXISTING WASTEWATER (GRAVITY)
- PROPOSED WASTEWATER (GRAVITY)
- SHEET FLOW DIRECTION
- PROPOSED WASTEWATER (PRESSURE)
- WASTEWATER PUMP STATION
- WASTEWATER MANHOLE
- COMMON SERVICE TRENCH

NOTES

1. REFER TO CKL INFRASTRUCTURE REPORT FOR DETAILS OF WATER SUPPLY AND WASTEWATER DEMANDS

FOR RESOURCE CONSENT

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LOT 1 DP 540788

Purpose/Drawing Title:

NORTHBROOK - ARROWTOWN WASTEWATER/WATER LAYOUT

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Drawn by:	SB		
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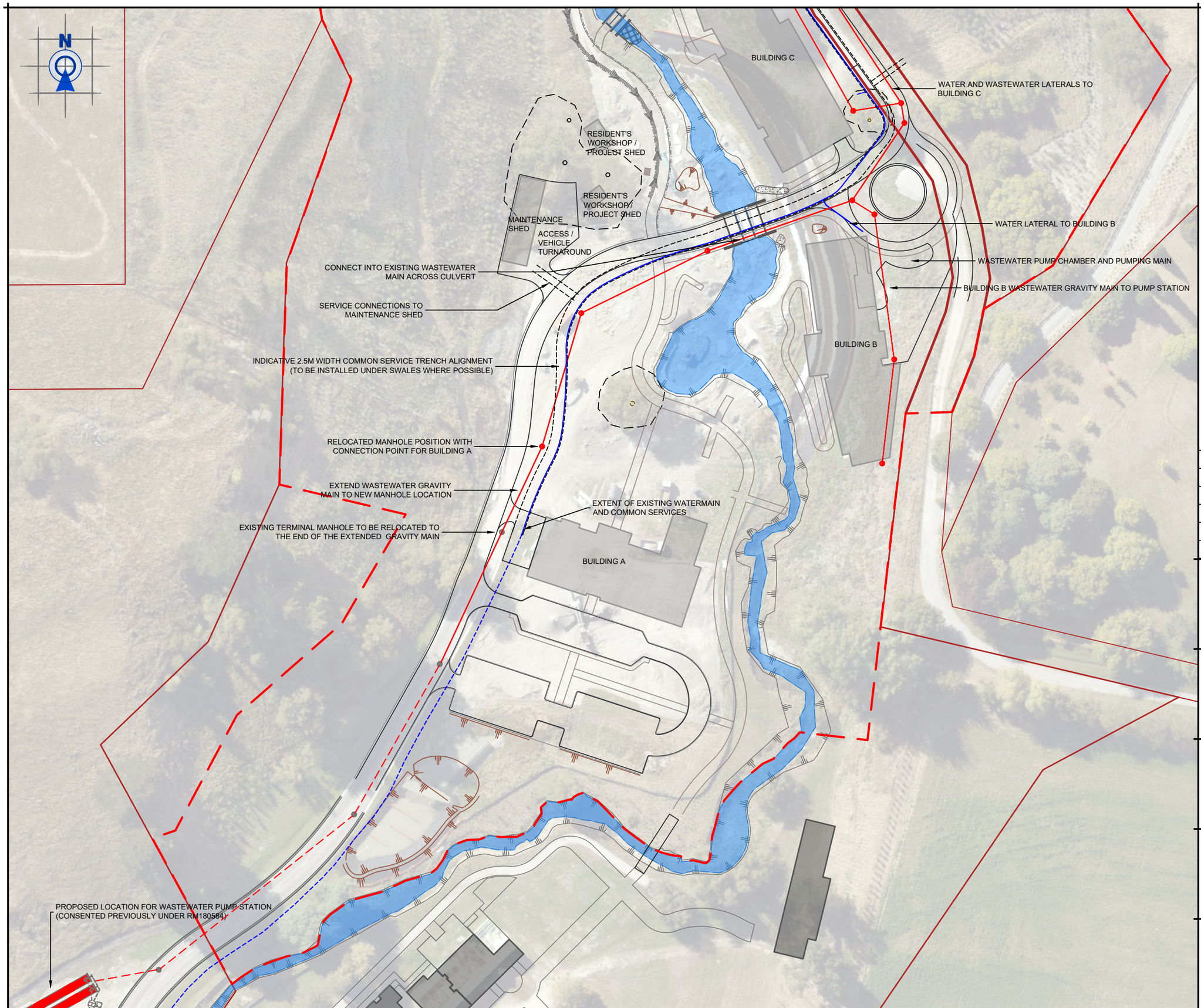
Approved by:			
Job Ref: Q6388 - 82 - 01		Sheet No: 500	Revision No: C
			Date Issued: 28/02/2023



LEGEND

- LEGAL BOUNDARY (SUBJECT PROPERTY)
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Purpose/Drawing Title:

NORTHBROOK - ARROWTOWN WASTEWATER/WATER DETAIL

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Drawn by:	SB		DO NOT SCALE
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Approved by:			
Job Ref: Q6388 - 82 - 01		Sheet No: 501	Revision No: C / Date Issued: 28/02/2023

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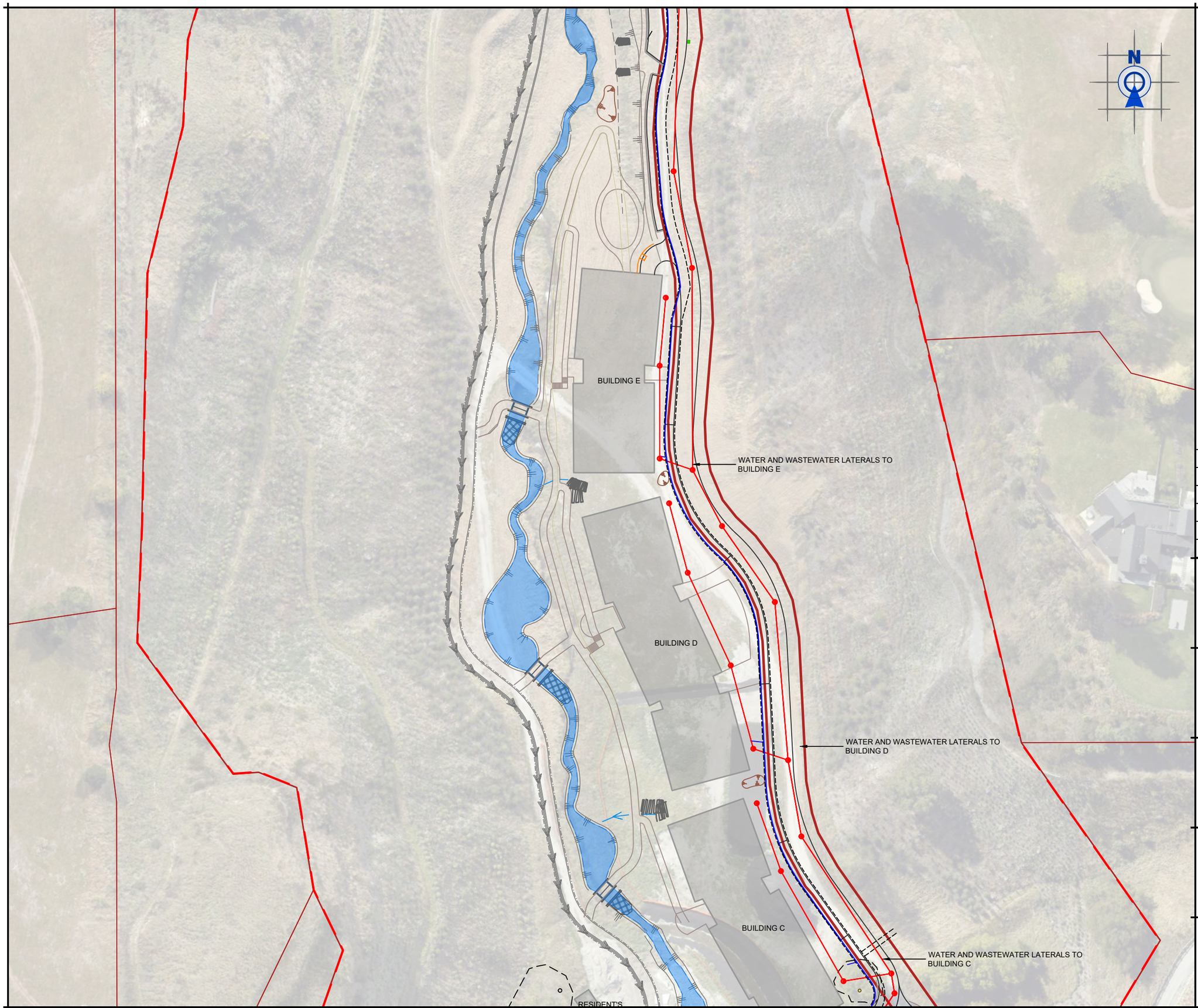

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LOT 1 DP 540788

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NORTHBROOK - ARROWTOWN WASTEWATER/WATER DETAIL

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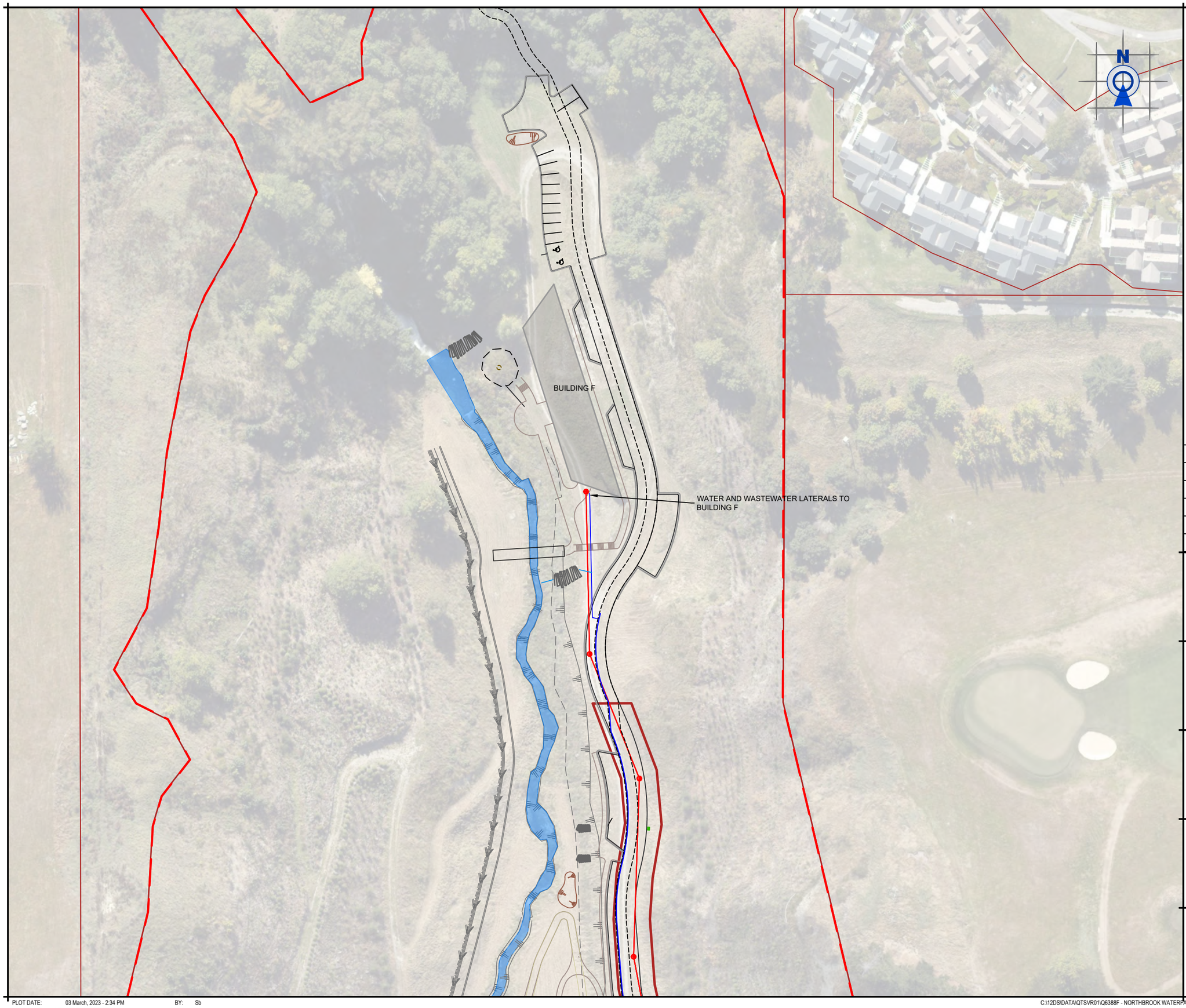

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CKL

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Stormwater Management Plan

Northbrook Arrowtown

Document Information

Client	Waterfall Park Developments Ltd
Site Location	Ayr Avenue, Arrowtown
Legal Description	Lots 1 DP540788
CKL Reference	A20254
Office of Origin	Auckland

Author	Frances Deamer-Phillips		
Signed		**Date**	10/10/2022

Reviewed & Authorised By	Bronwyn Rhynd		
Signed		**Date**	10/10/2022

Revision	Status	Date	Author	Reviewed By	Authorised By
A	Approved	1 March 23			

Contents

Figures

Tables

Appendices

1 Introduction

CKL has been engaged by Waterfall Park Developments Ltd (WPDL) to develop a Stormwater Management Plan (SMP) for the proposed later living development at Waterfall Park (Northbrook Arrowtown). The site is located at Ayr Avenue, of Arrowtown Lake Hayes Road. The site is approximately 2km south of Arrowtown.

The purpose of this report is to outline the stormwater management objectives and best practicable stormwater management plan for the proposed development of the site in accordance with QLDC Land Development and Subdivision Code of Practice, and guide development in such a way as to avoid, remedy or mitigate adverse effects on the receiving environment.

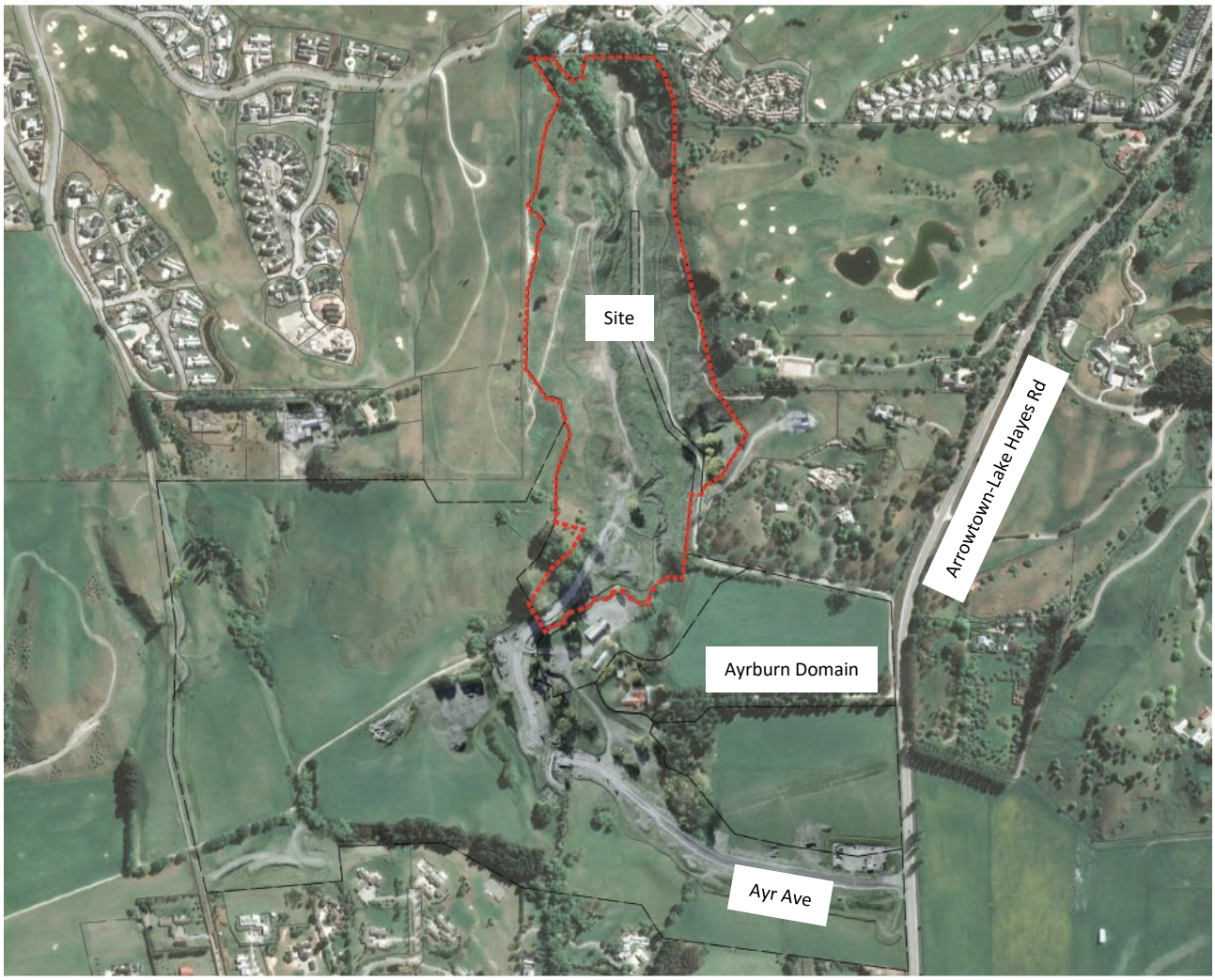

Figure 1: Site Location (WPDL Provided, November 2021)

1.1 Reference Documents

The development of this stormwater management plan is guided by the following key documents, which are referenced throughout this report;

- QLDC Land Development and Subdivision Code of Practice (QLDC COP)
- Northbrook Arrowtown Resource Consent Drawings by Paterson Pitts Group dated February 2023

- Northbrook Arrowtown Landscape Strategy by Winton dated February 2023
- Northbrook Arrowtown – Floor Assessment – Resource Consent by Fluent Solutions dated March 2023

2 Existing Site Conditions

The site is located between Lakes Hayes and Arrowtown, approximately 2km south of Arrowtown and is accessed via Ayr Avenue, coming off Arrowtown-Lake Hayes Road.

The site is zoned Waterfall Park Zone (**WPZ**) and contains what has become known as Waterfall Park – a unique valley within the Wakatipu Basin where Mill Creek spills over the head of the valley as a significant waterfall, running through the valley to the south towards Lake Hayes. The valley has been cleared of exotic forest and the steep valley slopes are currently being replanted with native vegetation.

To the immediate south of the site the valley opens up into what is known is Ayrburn Farm, flat paddocks fronting Arrowtown-Lake Hayes Road and at the base of Christine's Hill. The historic Ayrburn stone farm buildings are located immediately to the south of site, located in northern extent of Ayrburn Farm in the area known as Ayrburn Domain.

Adjoining the site immediately to the north, east and west is Millbrook Resort, which provides for residential activities and visitor accommodation set amongst a golf course. To the immediate east of the site, at the top of the valley slopes, are approximately five rural residential properties, ranging in size from 4000m^2 to 4ha.

Currently, stormwater sheet flows from the edge of site into Mill Creek which flows from the north to the south of site. Existing site area is shown above in Figure 1.

A flood model has previously been conducted by Fluent for the 100yr flood plain surrounding Mill Creek to establish the flow patterns during various rainfall events. This information has been reviewed as part of developing this SMP.

3 Proposed Development

The proposal for Northbrook Arrowtown includes three residential apartment buildings, a care and serviced apartments building, a arrivals and amenities building, and a boutique hotel and spa, and associated roads, parking and walkways. Figure 2 below shows the proposed site plan.

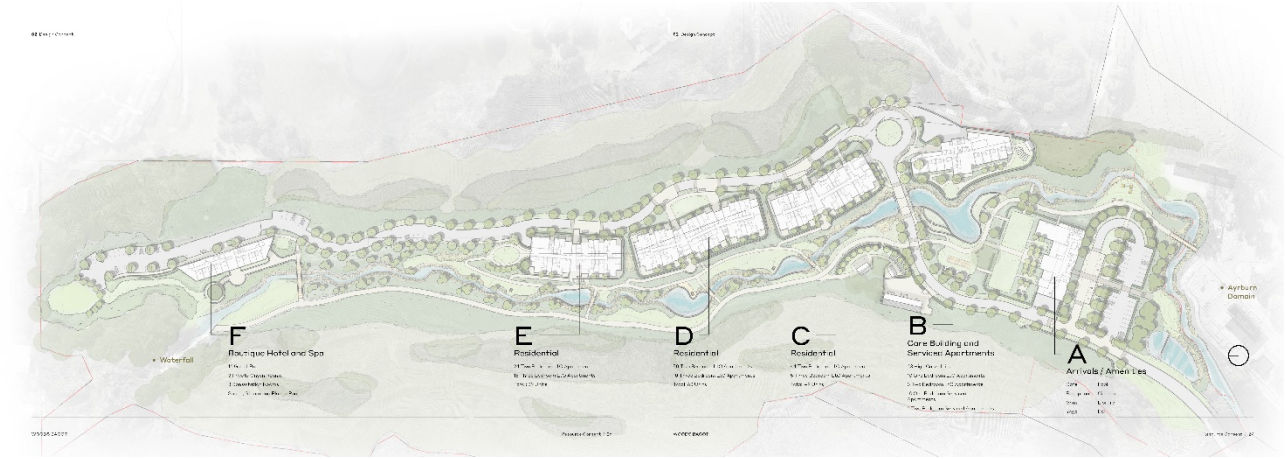

Figure 2: Proposed Site Plan

Table 1 below provides a summary of coverage areas for both pre- and post-development for the site area being developed, the steep bush areas are not considered as they are unchanged. The difference between pre- and post-development areas is used to estimate the net change in impervious area for the site.

Figure 2 above demonstrates post- development site coverage areas. The proposed building roof areas will potentially be collected for re-use. They will be made of inert materials and are therefore not considered for stormwater treatment (these roof areas not considered in area change below for stormwater treatment). It is currently proposed that Building A and maintenance shed roof areas will discharge to treatment swales, so are considered in the calculations of swale sizing and the land use change development areas below.

Table 1: Net Change Between Pre- and Post-Development Areas

Surface Coverage	Pre-development Existing Areas		Post-development Proposed Areas		Net Change	
	(m^2)	%	**(m^2)**	%	**(m^2)**	**%**
Pervious Area	13,402	83%	7,107	44%	-6,295	-39%
Roof Area for Building A and Maintenance Shed	0	0%	1,102	7%	+1,102	+7%
Impervious Area (Carpark and Roads)	2,652	17%	7,845	49%	+5,193	+32%
Total	**16,054**	**100%**	**16,054**	**100%**	**16,054**	**0%**

4 Stormwater Management Strategy and Objectives

For the site, it is proposed to adopt the stormwater management objectives outlined in the current QLDC COP to guide stormwater management within the development area.

Given the receiving environment for the site is Lake Hayes and lake environments are susceptible to nutrient loading, the focus on managing water quality from the site is on Phosphorus and Nitrogen loading and removing Total Suspended Solids (TSS) as Phosphorus and Nitrogen sometimes cling to TSS. Heavy metals are also considered given they are often found in carpark stormwater runoff.

4.1 Proposed Stormwater Management Objective

High level objectives for Stormwater Management within the development area have been prepared, and can be summarised as follows:

Water Quality

Treat stormwater runoff from road and carpark areas with particular attention to Phosphorus, Nitrogen and TSS

Hydrological Mitigation

No attenuation or detention is required for this site (refer to Fluent Solutions Report)

Conveyance

Primary Conveyance of the 20yr ARI peak flow (including the effects of climate change)
Secondary Conveyance of the 100yr ARI peak flow (including the effects of climate change)

5 Stormwater Management Plan

This section illustrates the existing stormwater management system on site and option assessment for the proposed condition.

5.1 Existing Stormwater Management System

Stormwater runoff from the site discharges as surface runoff to Mill Creek which runs through the middle of site from the North to South. The edges of the valley are steep planted hills that are not proposed to be developed.

Fluent Solutions conducted a flood model (given a portion of the site sits within the $100yr_{cc}$ floodplain associated with Mill Creek) for pre-development and post-development scenario. The post-development scenario in the model was run for $100yr_{cc}$, 9hr storm event (considered the critical storm duration), shows significant flooding around Mill Creek. The proposed development has been designed so the finished floor levels of the buildings are above proposed 100yr ARI rainfall event and the foundations will not be affected during a 500yr ARI rainfall event. The outcomes of the model can be found in Fluent Solution's Flood Risk Assessment.

6 Best Practicable Stormwater Management Option

Given the ultimate receiving environment is Lake Hayes, which is susceptible to nutrient loading, it was determined that treatment train approach to treat contaminants from site is the preferred option to ensure robust treatment and reduce risk of contaminants entering Lake Hayes. Given the site's constraints, the best practicable option for stormwater treatment for each sub catchment is a swale followed by a bioretention device or wetland (where practical) to treat all roads and carpark areas. All roof areas will be clad with non-contaminant generating materials, as such the focus of this assessment is for the remaining impervious areas, (roads, carparks etc).

Figure 3 below demonstrates the overall best practicable option for stormwater management for the entire area. Table 2 below indicated the proposed treatment devices per sub catchment.

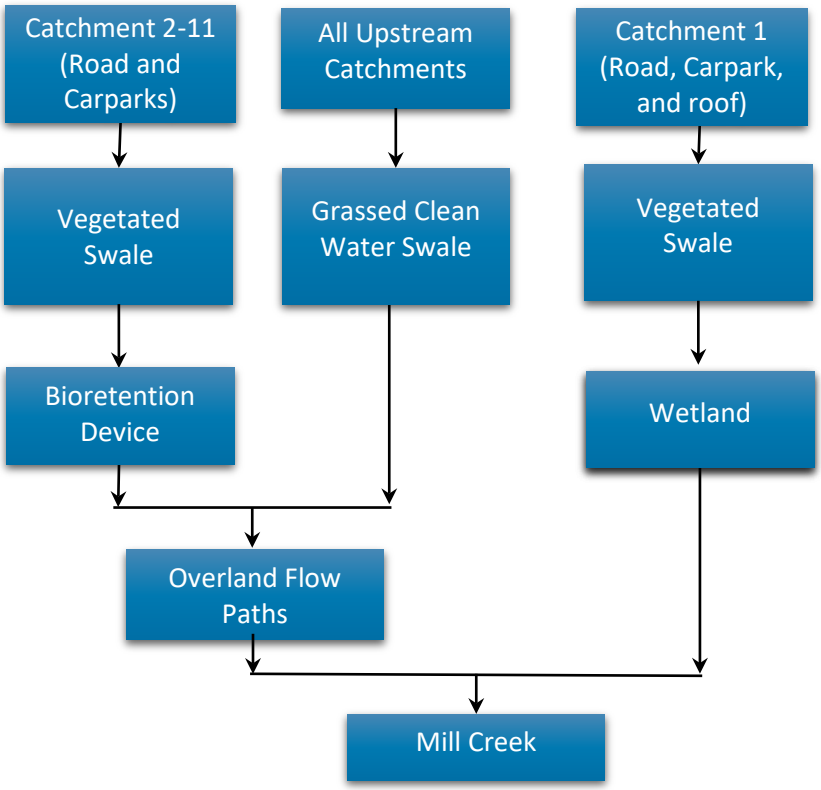

Figure 3: Example diagram of the proposed stormwater management system

Paterson Pitts Group's 400 series drawings illustrate the stormwater management approach proposed. Section 6 below describes each component of the stormwater management. As previously mentioned, the buildings roofs are proposed to be of low (or non) contaminant generating materials and runoff may be collected in tanks for water reuse (except Building A and maintenance shed).

Table 2: Proposed Treatment Devices Per Sub Catchment

Treatment Devices Per Catchment	
Catchment 1	Swale -> Wetland
Catchment 2	Swale -> Bioretention
Catchment 3	Swale
Catchment 4	Bioretention
Catchment 5	Bioretention
Catchment 6	Swale -> Swale
Catchment 7	Swale -> Bioretention
Catchment 8	Swale -> Bioretention
Catchment 9	Swale -> Bioretention -> Swale
Catchment 10	Bioretention -> Swale
Catchment 11	Swale -> Bioretention

The following sections describe the best practicable options for each sub catchment.

Catchment 1 (Building A and Associated Road and Carpark)

Road 1 and Building A carpark within Catchment 1 will all drain towards a series of treatment swales that discharge to a proposed wetland for secondary treatment. Roof runoff from Building A will enter a treatment swale and then discharge to the wetland.

The upstream catchment, to the west of Road 1, runoff will be collected in a grass cut off swale and directed to Mill Creek via existing overland flow paths. This will ensure clean runoff does not mix with the untreated runoff ensuring adequate treatment of roads and carparks.

Catchment 2 (Maintenance Shed Carpark and Road over Mill Creek)

Catchment 2 consists of maintenance sheds, associated carpark area and Road 1, between the maintenance shed and Buildings B and C.

For the sub catchment area to the west of Mill Creek the surface runoff enters roadside swales for treatment.

For the sub catchment area to the east of Mill Creek, due to limited area, the runoff will be conveyed in kerb and channel.

At the low point of both sub catchments, runoff will enter dual mudtanks which discharge to a bioretention device.

Catchment 3 (Building B Service Area)

Catchment 3 include the service area for ambulance and trucks to access Building B (the care building). Runoff from the service area will be collected in a channel and conveyed to a treatment swale south of Building B prior to discharging to Mill Creek.

This catchment will have one level of treatment, which is appropriate as this area is expected to be low use with no car parking or access (only services vehicles). As such a treatment swale is considered adequate for this catchment.

Catchment 4-5 (Entry Loop A to Building B)

Catchments 4 and 5 includes the loop road north of Building B. These catchments will drain towards bioretention areas either in the middle of the loop (Catchment 5) or to a small device to the west of the loop (Catchment 4).

The treated runoff will discharge to ground, through the base of the devices. In events larger than the design event, devices will overflow to scruffy domes and discharge to a grass swale north of Building B and ultimately to Mill Creek.

These catchments have one device for treatment given the tight site constraints and is considered adequate for this catchment.

Catchment 6 -8 (Building C, D and E Road)

These catchments include Road 1, between Buildings C-E and the bottom of the eastern hill. A proposed vegetated swale, adjacent to the downstream side of the single cross fall road, will convey and treat stormwater from the road for these sub catchments. Swales within Catchment 7 and 8 (Buildings D and E) will then discharge to bioretention devices between the buildings. These devices will be designed with scruffy domes for flow in excess of the design events, discharging to stormwater culverts running below the bioretention devices. Treated water will be collected in underdrains below bioretention media and discharge to the scruffy dome and ultimately to Mill Creek.

Catchment 6 will apply a secondary swale with check dams after the first roadside swale.

Along the eastern side of the road in each catchment, at the base of the hill, the clean stormwater runoff will enter a roadside grassed swale that will eventually discharge to Mill Creek.

Catchment 9-10 (Link Road to Building F)

Catchments 9 and 10 include Road 1 between Building E and F. Similar to Catchments 6-8, there will be a clean water cut-off swale along the eastern side of the Road and culverts to discharge clean water to Mill Creek.

Catchment 9 has a treatment swale that runs between the road and footpath north of Building E.

Catchment 10 has limited area for additional treatment due to tight spatial constraints in the valley.

Both catchments will discharge to a single bioretention device that will discharge to an additional treatment swale prior to discharging to Mill Creek. Thus, double treatment in a swale and bioretention device is provided.

Catchment 11 (Building F Carpark)

Building F carpark is supported with a bioretention device in the north-eastern corner of the carpark. Most of the road and carpark will fall towards a roadside treatment swale prior to discharging to the bioretention device. A small portion (northern part) of the carpark will fall direct to the bioretention devices. A scruffy dome and underdrain in the bioretention device will collect clean water and runoff in excess of the water quality event and discharge to a grass conveyance swale that will provide polishing. This swale will discharge to Mill Creek over a rock feature near the waterfall in Mill Creek at the north of the site, blending into the native rock.

The upstream catchment to the east will be collected in a swale and culvert and will discharge to the grass conveyance swale and rock feature.

7 Proposed Stormwater Management Components

As described above, the best practicable option for stormwater management for runoff from the roads and carparks are treatment swales followed by several bioretention devices or wetland, where practical. The following sections describe the treatment devices that are the stormwater management components proposed for the site.

7.1 Swale

There are numerous swales proposed throughout the side to treat and convey water from roads and carparks. They are all designed to treat the Water Quality Flow (WQF) rate and convey the $20yr_{cc}$ ARI storm event. Appendix B shows the sizing for each swale.

The swales include 300mm of topsoil, at the base and sides, and planted with meadow grasses, sedges, and rushes. The vegetation settles out contaminants within the flow and the topsoil will act as a filter. Vegetation also absorbs some nutrients in uptake. The swales convey runoff during all rainfall events up to an including 100yr event. Therefore, a grassed swale is fit for purpose as opposed to any other vegetated swale which has larger plant types which could hinder flow dynamics during these large events.

7.2 Bioretention

Eight bioretention devices are proposed within the site to provide secondary treatment and recharge groundwater where possible. Soakage testing was undertaken nearby which resulted in a relatively high soakage rate of 250mm/hr. Assuming 50% reduction factor, the design rate is 125mm/hr. Soakage calculations are supplied in Appendix 2.

The bioretention devices are sized to discharge the entire treated WQF from each catchment hardstand areas to ground and no underdrains are necessary as there is sufficient soakage capacity within the subsoils.

Bioretention devices in Catchments 7 and 8 lie between buildings and above the stormwater culvert, therefore these will be lined. There is an underdrain to prevent discharge to ground (soakage) which is detrimental to buildings and infrastructure.

Appendix B demonstrates the sizing for all bioretention devices.

7.3 Wetland

Building A and associated road and carpark in Catchment 1 will sheet flow to several swales that will drain to a wetland and pond. Flow will firstly discharge to the wetland forebay to reduce velocity and settle out larger sediment. The flow will continue through the wetland. A series of shallow and deep marsh sections are designed to treat stormwater. The wetland is designed to treat the WQF from Catchment A and provide secondary treatment after the swales.

This (treatment) wetland will be at the head of a pond with deeper water to create an aesthetically planted pond for the entry to Northbrook Arrowtown and Ayrburn Domain adjacent to, and on the opposite side of the creek. The pond will be at least 1m deep and planted around the edge to provide shade ensuring temperature of the water does not rise significantly.

8 Summary

A stormwater management assessment was completed for Northbrook Arrowtown and associated road and carparks. The best practicable stormwater management plan for this site has been developed to mitigate the effects of Northbrook Arrowtown on the receiving Mill Creek and the downstream Lake Hayes environment.

This stormwater management includes discharging stormwater runoff from the hardstand areas to a treatment swale followed by a bioretention device or wetland. This treatment train approach will ensure higher removal rates of Nitrogen, Phosphorus, and TSS the main nutrients of concern for the receiving environment, Lake Hayes.

The upstream catchment runoff is diverted away from the contaminant generating areas by discharging to grass cut off swales along the eastern and western edge of the site. This will ensure no mixing of upstream runoff with the untreated water from the road and the treatment devices function as designed.

The discharge point for the bioretention devices will be several overland flow paths to Mill Creek. The discharge from the wetland will be a swale that runs south and ultimately to Mill Creek.

9 Limitations

This report has been prepared solely for the benefit of WPDL with respect to the particular brief and it may not be relied upon in other contexts for any other purpose without the express approval by CKL. Neither CKL nor any employee or sub-consultant accepts any responsibility with respect to its use, either in full or in part, by any other person or entity. This disclaimer shall apply notwithstanding that the memo/report may be made available to other persons including Council for an application for consent, approval or to fulfil a legal requirement.

Appendix 1 Calculation Summary

- Site Coverage
- Peak Flows
- Swale Calcs
- Bioretention Calcs
- Wetland Calcs

Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Area Summary Carpark
Date	10/10/2022		
By	FDP	Checked	KW

Site Coverage Breakdown Post- Development Conditions

	Pre-Development		
Total	**16054**	100%	
Roof Area	**0**	0%	
Impervious pavement	**2652**	17%	*waterfall park Rd
Landscaping	**13402**	83%	

	Post development														
	Catchment 1	**Catchment 2**	**Catchment 3**	**Catchment 4**	**Catchment 5**	**Catchment 6**	**Catchment 7**	**Catchment 8**	**Catchment 9**	**Catchment 10**	**Catchment 11**	**Total Area**		Net Change	
Total	7278	1152	1186	495	507	474	762	705	585	1476	1434	**16054**		0	-100%
oof Area (going to treatmen	934	168	0	0	0	0	0	0	0	0	0	**1102**	7%	1102	7%
Impervious Area	2263	802	412	336	276	309	459	367	515	1040	1066	**7845**	49%	5193	32%
Landscaping/Footpaths	4081	182	774	159	231	165	303	338	70	436	368	**7107**	44%	7107	44%

Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Peak Flow
Date	10/10/2022		
By	FDP	Checked	KW

2yr ARI Pre and post Development Peak Flow

Assumptions:

Runoff Coefficient (c):

c=0.95 for roof
c=0.9 for paved surafces
c=0.5 for permeable pavements
c=0.3 for permeable surafces

Rainfall intensity to be obtained from NIWA HIRDS V4 with climate change adjustment for post development

Existing WQF (10mm)

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CiA	
1.60540	0.30	10.0	13.4	Total Development Area

Existing - 20yr

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CiA	
1.60540	0.90	39.7	159.5	Total Development Area

Existing - 100yr

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CiA	
1.60540	0.90	60.7	243.8	Total Development Area

Proposed WQF (10mm)

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CiA	Area
0.06640	0.90	10.0	1.7	Catchment 1- Road 1
0.15990	0.90	10.0	4.0	Catchment 1 - Parking sections
0.09340	0.95	10.0	2.5	Catchment 1 - Roof
0.04830	0.90	10.0	1.2	Catchment 2- Over Culvert
0.03190	0.90	10.0	0.8	Catchment 2- Maintenance Shed Parking
0.01680	0.95	10.0	0.4	Catchment 2- Maintenance Shed Roof
0.04120	0.90	10.0	1.0	Catchment 3
0.03360	0.90	10.0	0.8	Catchment 4
0.02760	0.90	10.0	0.7	Catchment 5
0.03090	0.90	10.0	0.8	Catchment 6
0.04590	0.90	10.0	1.1	Catchment 7
0.03670	0.90	10.0	0.9	Catchment 8
0.05150	0.90	10.0	1.3	Catchment 9
0.10400	0.90	10.0	2.6	Catchment 10
0.10660	0.90	10.0	2.7	Catchment 11
0.71070	0.30	10.0	5.9	All Pervious
1.60540		**Max.Flow (L/s)**	**28.5**	**Sum Proposed**

Proposed - 20yr

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CiA	
0.06640	0.90	43.4	7.2	Catchment 1- Road 1
0.15990	0.90	43.4	17.4	Catchment 1 - Parking sections
0.09340	0.95	43.4	10.7	Catchment 1 - Roof
0.04830	0.90	43.4	5.2	Catchment 2- Over Culvert
0.03190	0.90	43.4	3.5	Catchment 2- Maintenance Shed Parking
0.01680	0.95	43.4	1.9	Catchment 2- Maintenance Shed Roof
0.04120	0.90	43.4	4.5	Catchment 3
0.03360	0.90	43.4	3.6	Catchment 4
0.02760	0.90	43.4	3.0	Catchment 5
0.03090	0.90	43.4	3.4	Catchment 6
0.04590	0.90	43.4	5.0	Catchment 7
0.03670	0.90	43.4	4.0	Catchment 8
0.05150	0.90	43.4	5.6	Catchment 9
0.10400	0.90	43.4	11.3	Catchment 10
0.10660	0.90	43.4	11.6	Catchment 11
0.71070	0.30	43.4	25.7	All Pervious
1.60540		**Max.Flow (L/s)**	**123.5**	**Sum Proposed**

Proposed - 100yr

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CiA	
0.06640	0.90	66.5	11.0	Catchment 1- Road 1
0.15990	0.90	66.5	26.6	Catchment 1 - Parking sections
0.09340	0.95	66.5	16.4	Catchment 1 - Roof
0.04830	0.90	66.5	8.0	Catchment 2- Over Culvert
0.03190	0.90	66.5	5.3	Catchment 2- Maintenance Shed Parking
0.01680	0.95	66.5	3.0	Catchment 2- Maintenance Shed Roof
0.04120	0.90	66.5	6.9	Catchment 3
0.03360	0.90	66.5	5.6	Catchment 4
0.02760	0.90	66.5	4.6	Catchment 5
0.03090	0.90	66.5	5.1	Catchment 6
0.04590	0.90	66.5	7.6	Catchment 7
0.03670	0.90	66.5	6.1	Catchment 8
0.05150	0.90	66.5	8.6	Catchment 9
0.10400	0.90	66.5	17.3	Catchment 10
0.10660	0.90	66.5	17.7	Catchment 11
0.71070	0.30	66.5	39.4	All Pervious
1.60540		**Max.Flow (L/s)**	**189.3**	**Sum Proposed**

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Bioretention Sizing
Date	10/10/2022		
By	FDP	Checked	KW

Bioretention Sizing Per Catchment

	Catchment 2	Catchment 4	Catchment 5	Catchment 7	Catchment 8	Catchment 9+10	Catchment 11
Bioretention Area (m^2)	20.00	8.00	7.00	11.00	9.00	37.00	26.00
WQF (m^3/hr)	7.22	3.03	2.49	4.13	3.31	14.01	9.60
K (native soil) m/hr	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Soakage volume (m^3)	2.5	1.0	0.9	1.4	1.1	4.6	3.3
Required Storage volume	4.72	2.03	1.61	2.76	2.18	9.38	6.35
Drainage Layer Depth (m)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Drainage Layer Void Ratio	35%	35%	35%	35%	35%	35%	35%
Drainage Layer Volume (m^3)	2.10	0.84	0.74	1.16	0.95	3.89	2.73
Media Layer Depth (m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Media Layer Void Ratio	30%	30%	30%	30%	30%	30%	30%
Media Layer Volume (m^3)	3.00	1.20	1.05	1.65	1.35	5.55	3.90
Raingarden Big enough?	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treat
Job No.	A20254	Sheet Name	Clean Swale Size
Date	10/10/2022		
By	FDP	Checked	

Catchment 3-6 Clean Water Swale

Area (ha)	C No.	$100yr_{cc}$ (mm/hr)	Q = 2.78CiA
1.49000	0.90	66.5	247.9

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.2
Top width (m)	1.7
Slope (m/m)	0.020
n - grass swale	0.03

Depth	n	A	R	V	Q (L/s)
0	0.03	0.00	0.00	0.000	0.0
0.1	0.03	0.08	0.07	0.798	63.9
0.2	0.03	0.22	0.12	1.168	257.0
0.35	0.03	0.54	0.20	1.603	869.7
0.4	0.03	0.68	0.22	1.732	1178.0
0.5	0.03	1.00	0.27	1.976	1975.5
0.6	0.03	1.38	0.32	2.203	3040.4

Planning | Surveying | Engineering | Environmental

Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treat
Job No.	A20254	Sheet Name	Clean Swale Size
Date	10/10/2022		
By	FDP	Checked	

Catchment 9 Clean Water Swale

Area (ha)	C No.	$100yr_{cc}$ (mm/hr)	Q = 2.78CiA
1.38590	0.90	66.5	230.6

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.2
Top width (m)	1.7
Slope (m/m)	0.020
n - grass swale	0.03

Depth	n	A	R	V	Q (L/s)
0	0.03	0.00	0.00	0.000	0.0
0.1	0.03	0.08	0.07	0.798	63.9
0.2	0.03	0.22	0.12	1.168	257.0
0.35	0.03	0.54	0.20	1.603	869.7
0.4	0.03	0.68	0.22	1.732	1178.0
0.5	0.03	1.00	0.27	1.976	1975.5
0.6	0.03	1.38	0.32	2.203	3040.4

Planning | Surveying | Engineering | Environmental

Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treat
Job No.	A20254	Sheet Name	Clean Swale Size
Date	10/10/2022		
By	FDP	Checked	

Catchment 7 Clean Water Swale

Area (ha)	C No.	100yr$_{cc}$ (mm/hr)	Q = 2.78CiA
0.82400	0.90	66.5	137.1

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (to	0.2
Top width (m)	1.7
Slope (m/m)	0.020
n - grass swale	0.03

Depth	n	A	R	V	Q (L/s)
0	0.03	0.00	0.00	0.000	0.0
0.15	0.03	0.14	0.10	0.997	142.0
0.2	0.03	0.22	0.12	1.168	257.0
0.35	0.03	0.54	0.20	1.603	869.7
0.4	0.03	0.68	0.22	1.732	1178.0
0.5	0.03	1.00	0.27	1.976	1975.5
0.6	0.03	1.38	0.32	2.203	3040.4

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treat
Job No.	A20254	Sheet Name	Clean Swale Size
Date	10/10/2022		
By	FDP	Checked	

Catchment 10 Clean Water Swale

Area (ha)	C No.	100yr$_{cc}$ (mm/hr)	Q = 2.78CiA
2.43580	0.90	66.5	405.3

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (to	0.25
Top width (m)	2
Slope (m/m)	0.020
n - grass swale	0.03

Depth	n	A	R	V	Q (L/s)
0	0.03	0.00	0.00	0.000	0.0
0.11	0.03	0.09	0.08	0.841	76.8
0.25	0.03	0.31	0.15	1.323	413.6
0.35	0.03	0.54	0.20	1.603	869.7
0.4	0.03	0.68	0.22	1.732	1178.0
0.5	0.03	1.00	0.27	1.976	1975.5
0.6	0.03	1.38	0.32	2.203	3040.4

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook T
Job No.	A20254	Sheet Name	Clean Swale Size
Date	10/10/2022		
By	FDP	Checked	

Catchment 8 Clean Water Swale

Area (ha)	C No.	100yr$_{cc}$ (mm/hr)	Q = 2.78CiA
0.79750	0.90	66.5	132.7

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (to	0.2
Top width (m)	1.7
Slope (m/m)	0.020
n - grass swale	0.03

Depth	n	A	R	V	Q (L/s)
0	0.03	0.00	0.00	0.000	0.0
0.15	0.03	0.14	0.10	0.997	142.0
0.2	0.03	0.22	0.12	1.168	257.0
0.35	0.03	0.54	0.20	1.603	869.7
0.4	0.03	0.68	0.22	1.732	1178.0
0.5	0.03	1.00	0.27	1.976	1975.5
0.6	0.03	1.38	0.32	2.203	3040.4

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook T
Job No.	A20254	Sheet Name	Clean Swale Size
Date	10/10/2022		
By	FDP	Checked	

Catchment 11 Clean Water Swale

Area (ha)	C No.	100yr$_{cc}$ (mm/hr)	Q = 2.78CiA
0.74200	0.90	66.5	123.5

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (to	0.2
Top width (m)	1.7
Slope (m/m)	0.020
n - grass swale	0.03

Depth	n	A	R	V	Q (L/s)
0	0.03	0.00	0.00	0.000	0.0
0.15	0.03	0.14	0.10	0.997	142.0
0.23	0.03	0.27	0.14	1.263	345.6
0.35	0.03	0.54	0.20	1.603	869.7
0.4	0.03	0.68	0.22	1.732	1178.0
0.5	0.03	1.00	0.27	1.976	1975.5
0.6	0.03	1.38	0.32	2.203	3040.4

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Culvert Sizing
Date	10/10/2022		
By	FDP	Checked	

Catchment Breakdowns and Peak Flow Calculation for Existing Pipe Network

Assumptions:

Runoff Coefficient (c): c=0.95 for roof
c=0.9 for driveway
c=0.3 for permeable surafces

Roughness factor (k): k = 0.6 (conservative value for existing concrete & plastic pipes)
See NZS4404 Table 4.2 for more details

Colebrook-White Equation for Pipe Velocity

$$V = -2\sqrt{2g \cdot D \cdot S_f} \cdot log\left(\frac{k_s}{3{,}70 \cdot D} + \frac{2{,}51 \cdot \upsilon}{D\sqrt{2g \cdot D \cdot S_f}}\right)$$

with $S_f = \frac{h_f}{L}$

V =	mean velocity	[m/s]
D =	Hydraulic Diameter	[m]
k_s =	surface roughness	[m]
υ =	Kinematic viscosity water, 20°C= $1{,}00 \cdot 10^{-6}$	[kg/ms]
S_f =	slope of hydraulic gradient	[-]
h_f =	frictional head loss	[m]
L =	Length between the Head Loss	[m]
g =	earths gravity	[m/s²]

Pipe Capacity

Pipe	Roughness Factor	Pipe size(mm)	Pipe Slope (%)	Velocity (m/sec)	Capacity (Q = VA)	Peak Flow from Catchment (L/s)	Does pipe have sufficient capacity?
Catchment 3-6 Clean (roundabout)	0.6	375	2.00	**2.57**	**283.3**	**247.91**	**YES**
Culvert C-Under carpark enterence	0.6	225	2.00	**1.85**	**73.6**	**5.14**	**YES**
Clean Culvert 7	0.6	300	2.00	**2.23**	**157.4**	**137.10**	**YES**
Clean Culvert 8	0.6	300	2.00	**2.23**	**157.4**	**132.69**	**YES**
Clean Culvert 9	0.6	375	2.00	**2.57**	**283.3**	**230.59**	**YES**
Clean Culvert 10	0.6	450	2.00	**2.88**	**457.8**	**405.28**	**YES**
Clean Catchment 11	0.6	300	2.00	**2.23**	**157.4**	**123.46**	**YES**
Caulvert Building F Treatment	0.6	225	2.00	**1.85**	**73.6**	**11.58**	**YES**

Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment
Job No.	A20254	Sheet Name	Catchment A Wetland
Date	10/10/2022		
By	FDP	Checked	KW

Volumes:

Water Quality Volume	32	m3

Side Slopes:

Internal (below PWL)	4	H:1V
Internal (above PWL)	3	H:1V

Forebay:

Forebay volume	5	m3 (15% of unfactored PWV)
Forebay nominal depth	1.0	m
Forebay nominal area	5	m2

Wetland Zone:

PWV required	32	m3

Wetland minimum water surface area at PWL

Depth Ratio =	0.43	assumed
Permanent water surface area =	75	m2
Treatment Area =	70	
Shallow Marsh (0.35m depth) =	35	m2 (50% of treatment area)
Deep Marsh (0.50m depth) =	35	m2 (50% of treatment area)

Shallow Marsh (0.35m depth) =	0	m2 (50% of treatment area)
Deep Marsh (0.50m depth) =	0	m2 (50% of treatment area)

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 1 Swales
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 1- Road 1

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	**1.66**
20yr 10min +CC Flow	**7.21**
100yr 10min +CC Flow	**11.05**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.2
Top width (m)	1.7
Slope (m/m)	0.060
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	100

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	100.0	0.0	
0.031	0.25	0.02	0.03	0.086	1.6	100.0	19.4	*WQF
0.075	0.25	0.05	0.06	0.142	7.7	100.0	11.8	*20yr Flow
0.09	0.25	0.07	0.06	0.157	10.9	100.0	10.6	*100yr Flow
0.2	0.25	0.22	0.12	0.243	53.4	100.0	6.9	
0.3	0.25	0.42	0.18	0.305	128.1	100.0	5.5	
0.4	0.25	0.68	0.22	0.360	244.8	100.0	4.6	

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 1 Swales
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 1- Parking

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	**1.00**
20yr 10min +CC Flow	**4.34**
100yr 10min +CC Flow	**6.65**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.2
Top width (m)	1.7
Slope (m/m)	0.015
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	24

Depth	n	A	R	V	Q (L/s)	Length	Residence time
0	0.25	0.00	0.00	0.000	0.0	24.0	0.0
0.035	0.25	0.02	0.03	0.046	1.0	24.0	8.7
0.08	0.25	0.06	0.06	0.073	4.3	24.0	5.4
0.1	0.25	0.08	0.07	0.083	6.6	24.0	4.8
0.2	0.25	0.22	0.12	0.121	26.7	24.0	3.3
0.3	0.25	0.42	0.18	0.152	64.0	24.0	2.6
0.4	0.25	0.68	0.22	0.180	122.4	24.0	2.2

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 2 Swale
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 2- Maintenance Shed Swale

	Peak Flow (L/s)
Water Quality (10mm)	**0.80**
20yr 10min +CC Flow	**3.46**
100yr 10min +CC Flow	**5.31**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.4
Top width (m)	2.9
Slope (m/m)	0.020
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	25

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	25.0	0.0	
0.029	0.25	0.02	0.02	0.048	0.8	25.0	8.7	*WQF
0.065	0.25	0.05	0.05	0.076	3.4	25.0	5.5	*20yr Flow
0.085	0.25	0.06	0.06	0.088	5.6	25.0	4.8	*100yr Flow
0.2	0.25	0.22	0.12	0.140	30.8	25.0	3.0	
0.3	0.25	0.42	0.18	0.176	74.0	25.0	2.4	
0.4	0.25	0.68	0.22	0.208	141.4	25.0	2.0	

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 2 Swale
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 2- Bridge

	Peak Flow (L/s)
Water Quality Flow (10mm)	**1.21**
20yr 10min +CC Flow	**5.24**
100yr 10min +CC Flow	**8.04**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.4
Top width (m)	2.9
Slope (m/m)	0.010
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	15

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	15.0	0.0	
0.045	0.25	0.03	0.04	0.043	1.2	15.0	5.8	*WQF
0.1	0.25	0.08	0.07	0.068	5.4	15.0	3.7	*20yr Flow
0.125	0.25	0.11	0.08	0.077	8.4	15.0	3.3	*100yr Flow
0.2	0.25	0.22	0.12	0.099	21.8	15.0	2.5	
0.3	0.25	0.42	0.18	0.125	52.3	15.0	2.0	
0.4	0.25	0.68	0.22	0.147	100.0	15.0	1.7	

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 3 Swale
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 3- Swale

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	**1.03**
20yr 10min +CC Flow	**4.47**
100yr 10min +CC Flow	**6.85**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.2
Top width (m)	1.7
Slope (m/m)	0.020
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	33

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	33.0	0.0	
0.035	0.25	0.02	0.03	0.053	1.1	33.0	10.3	*WQF
0.075	0.25	0.05	0.06	0.082	4.4	33.0	6.7	*20yr Flow
0.095	0.25	0.07	0.07	0.093	6.9	33.0	5.9	*100yr Flow
0.2	0.25	0.22	0.12	0.140	30.8	33.0	3.9	
0.3	0.25	0.42	0.18	0.176	74.0	33.0	3.1	
0.4	0.25	0.68	0.22	0.208	141.4	33.0	2.6	

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 6 Swale
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 6 Swale

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	**0.77**
20yr 10min +CC Flow	**3.36**
100yr 10min +CC Flow	**5.14**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.2
Top width (m)	1.7
Slope (m/m)	0.020
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	24

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	24.0	0.0	
0.028	0.25	0.02	0.02	0.047	0.8	24.0	8.6	*WQF
0.064	0.25	0.04	0.05	0.075	3.3	24.0	5.3	*20yr Flow
0.08	0.25	0.06	0.06	0.085	5.0	24.0	4.7	*100yr Flow
0.2	0.25	0.22	0.12	0.140	30.8	24.0	2.9	
0.3	0.25	0.42	0.18	0.176	74.0	24.0	2.3	
0.4	0.25	0.68	0.22	0.208	141.4	24.0	1.9	

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 7 Swale
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 7 Swale

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	**1.15**
20yr 10min +CC Flow	**4.98**
100yr 10min +CC Flow	**7.64**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.2
Top width (m)	1.7
Slope (m/m)	0.030
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	39

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	39.0	0.0	
0.032	0.25	0.02	0.03	0.062	1.2	39.0	10.5	*WQF
0.07	0.25	0.05	0.05	0.096	4.8	39.0	6.7	*20yr Flow
0.09	0.25	0.07	0.06	0.111	7.7	39.0	5.9	*100yr Flow
0.2	0.25	0.22	0.12	0.172	37.8	39.0	3.8	
0.3	0.25	0.42	0.18	0.216	90.6	39.0	3.0	
0.4	0.25	0.68	0.22	0.255	173.1	39.0	2.6	

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 8 Swale
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 8 Swale

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	**0.92**
20yr 10min +CC Flow	**3.99**
100yr 10min +CC Flow	**6.11**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.4
Top width (m)	2.9
Slope (m/m)	0.010
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	36

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	36.0	0.0	
0.04	0.25	0.02	0.03	0.041	1.0	36.0	14.8	*WQF
0.085	0.25	0.06	0.06	0.062	4.0	36.0	9.7	*20yr Flow
0.11	0.25	0.09	0.08	0.071	6.5	36.0	8.4	*100yr Flow
0.18	0.25	0.19	0.11	0.094	17.5	36.0	6.4	
0.3	0.25	0.42	0.18	0.125	52.3	36.0	4.8	
0.4	0.25	0.68	0.22	0.147	100.0	36.0	4.1	

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 9 Swale
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 9 Swale

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	**1.29**
20yr 10min +CC Flow	**5.59**
100yr 10min +CC Flow	**8.57**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.4
Top width (m)	2.9
Slope (m/m)	0.010
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	17

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	17.0	0.0	
0.045	0.25	0.03	0.04	0.043	1.2	17.0	6.5	*WQF
0.1	0.25	0.08	0.07	0.068	5.4	17.0	4.2	*20yr Flow
0.13	0.25	0.12	0.09	0.078	9.0	17.0	3.6	*100yr Flow
0.18	0.25	0.19	0.11	0.094	17.5	17.0	3.0	
0.3	0.25	0.42	0.18	0.125	52.3	17.0	2.3	
0.4	0.25	0.68	0.22	0.147	100.0	17.0	1.9	

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 10 Swale
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 10 Swale- after bioretention

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	**2.60**
20yr 10min +CC Flow	**11.29**
100yr 10min +CC Flow	**17.30**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.4
Top width (m)	2.9
Slope (m/m)	0.010
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	22

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	22.0	0.0	
0.068	0.25	0.05	0.05	0.055	2.6	22.0	6.7	*WQF
0.15	0.25	0.14	0.10	0.085	12.1	22.0	4.3	*20yr Flow
0.18	0.25	0.19	0.11	0.094	17.5	22.0	3.9	*100yr Flow
0.2	0.25	0.22	0.12	0.099	21.8	22.0	3.7	
0.3	0.25	0.42	0.18	0.125	52.3	22.0	2.9	
0.4	0.25	0.68	0.22	0.147	100.0	22.0	2.5	

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Job Name	Waterfall Park	File Name	A20254-EV- -Northbrook Treatment.xlsx
Job No.	A20254	Sheet Name	Catchment 11 Swale
Date	10/10/2022		
By	FDP	Checked	KW

Catchment 11 Swale

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	**2.67**
20yr 10min +CC Flow	**11.58**
100yr 10min +CC Flow	**17.74**

Swale sizing

Z-horiz slope	3
Base width (m)	0.5
Swale depth (m) (total)	0.4
Top width (m)	2.9
Slope (m/m)	0.010
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	40

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	40.0	0.0	
0.07	0.25	0.05	0.05	0.056	2.8	40.0	12.0	*WQF
0.1	0.25	0.08	0.07	0.068	5.4	40.0	9.8	
0.15	0.25	0.14	0.10	0.085	12.1	40.0	7.9	*20yr Flow
0.18	0.25	0.19	0.11	0.094	17.5	40.0	7.1	*100yr Flow
0.3	0.25	0.42	0.18	0.125	52.3	40.0	5.4	
0.4	0.25	0.68	0.22	0.147	100.0	40.0	4.5	

Appendix 2 Soakage Testing

Address: Waterfall Park, Lake Hayes			
Inspected by:	☒ GeoSolve ☐ Client ☒ Contractor (Wilson Contractors) ☐ Other:		
Project:	Waterfall Park Pavement Construction	**GeoSolve Job No:**	150098.04
Contractor:	Wilson Contractors	**Inspection Date:**	17/09/2021
Key Staff:	Josh Moir, Stu Minty		
Report By:	Josh Moir		

INTRODUCTION AND PURPOSE:

To inspect the test pits excavated in the borrow area to assess the soils suitability to be used as engineered fill.
Carry out soakage testing in the southern flood plain.

PERSONNAL ON-SITE:

- Josh Moir from GeoSolve was the only staff member present during the site inspection.
- Isaac and Darren from Wilson Contractors were also present during the site inspection.

OBSERVATIONS & RESULTS:

Please see attached site location plan and associated test pit logs.
Summary of observations and results below.

Borrow Area

- Test pits 1 and 2 revealed well-graded, sandy GRAVEL at depths between 0.2 and 2.2 m. These soils will be suitable to be used as engineered fill.

Soakage Testing

- Permeability testing for Soak Pits 1 and 2 were completed at 2.3 and 1.0 m depth respectively.
- The calculated infiltration rates were:
- Soak Pit 1 = 7 mm/hour; Soak Pit 2 = 90 mm/hour.

Please note that Soak Pit 2 was carried out 20 m away from Mill Creek. Groundwater inflow was recorded at a depth of 2.4 m within Soak Pit 2.

SITE PHOTOGRAPHS – Waterfall Park, Lake Hayes

Photograph 1: *Test Pit 1.*

Photograph 2: *Test Pit 2.*

Photograph 3: *Soak Pit 1.*

Photograph 4: *Soak Pit 2.*

Waterfall Park
GeoSolve Test Location Plan

Legend:

Test pit locations

Soak pit locations

GEOSOLVE
ENGINEERING CONSULTANTS

TEST PIT LOG

EXCAVATION NUMBER:
TP 1

PROJECT:	Waterfall Park			JOB NUMBER:	150098.04
LOCATION:	See Site Plan	INCLINATION:	Vertical		

EASTING:		EQUIPMENT:	5T Excavator	OPERATOR:	Niles
NORTHING:		COORD. SYSTEM:		COMPANY:	Wilson Contractors
ELEVATION:		EXCAV. DATUM:		HOLE STARTED:	17/09/2021
METHOD:	Aerial Photography	ACCURACY:		HOLE FINISHED:	17/09/2021

Soil / Rock Type	Description	Graphic Log	Depth (m)	Groundwater / Seepage	Scala Penetrometer
TOPSOIL	Organic SILT; dark brown. Soft; dry to moist. 0m – 0.2m		0.0 – 0.2		
ALLUVIAL SAND	Silty fine to medium SAND; grey, Bedded. Moist. 0.6m		0.2 – 0.6		
ALLUVIAL GRAVEL	Sandy fine to coarse GRAVEL; grey, Bedded. Medium dense; moist; well-graded; Sand is fine to coarse. 2m		0.6 – 2.0		
ALLUVIAL SILT	Sandy SILT; grey, Massive. Firm; moist; micaceous; Sand is fine. 2.4m		2.1 – 2.4	NO SEEPAGE	

Total Excavation Depth = 2.4 m

COMMENT:	Test pit dry.	LOGGED BY:	JM
		CHECKED DATE:	21/09/2021
		SHEET:	1 of 1

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TEST PIT LOG

EXCAVATION NUMBER:
TP 2

PROJECT:	Waterfall Park			JOB NUMBER:	150098.04
LOCATION:	See Site Plan	INCLINATION:	Vertical		

EASTING:		EQUIPMENT:	5T Excavator	OPERATOR:	Niles
NORTHING:		COORD. SYSTEM:		COMPANY:	Wilson Contractors
ELEVATION:		EXCAV. DATUM:		HOLE STARTED:	17/09/2021
METHOD:	Aerial Photography	ACCURACY:		HOLE FINISHED:	17/09/2021

Soil / Rock Type	Description	Graphic Log	Depth (m)	Groundwater / Seepage	Scala Penetrometer
TOPSOIL	Organic SILT; dark brown. Soft; dry to moist. 0m – 0.2m		0.0 – 0.2		
ALLUVIAL GRAVEL	Sandy fine to coarse GRAVEL; grey, Bedded. Medium dense; moist; well-graded; Sand is fine to coarse. 0.2m – 2.2m		0.2 – 2.2		
ALLUVIAL SILT	Sandy SILT; grey, Massive. Firm; moist; Sand is fine. 2.2m – 2.6m		2.2 – 2.6	NO SEEPAGE	

Total Excavation Depth = 2.6 m

COMMENT:	Test pit dry.	LOGGED BY:	JM
		CHECKED DATE:	21/09/2021
		SHEET:	1 of 1

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TEST PIT LOG

EXCAVATION NUMBER: **SP 1**

PROJECT:	Waterfall Park			JOB NUMBER:	150098.04
LOCATION:	See Site Plan	INCLINATION:	Vertical		

EASTING:		EQUIPMENT:	5T Excavator	OPERATOR:	Niles
NORTHING:		COORD. SYSTEM:		COMPANY:	Wilson Contractors
ELEVATION:		EXCAV. DATUM:		HOLE STARTED:	17/09/2021
METHOD:	Aerial Photography	ACCURACY:		HOLE FINISHED:	17/09/2021

Soil / Rock Type	Description	Graphic Log	Depth (m)	Groundwater / Seepage	Scala Penetrometer
TOPSOIL	Organic SILT; dark brown. Soft; dry to moist. 0m – 0.2m		0.0 – 0.2		
LOESS	SILT; yellow brown, Massive. Firm; moist; non-plastic. 0.5m		0.2 – 0.5		
ALLUVIAL GRAVEL	Sandy fine to coarse GRAVEL; grey, Bedded. Medium dense; moist; Sand is fine to coarse. 0.8m		0.5 – 0.8		
ALLUVIAL SILT	SILT with minor sand; grey, Massive. Firm; moist; Sand is fine. 2m		0.8 – 2.0		
ALLUVIAL SAND	Fine to coarse SAND with minor gravel; grey, Bedded. Moist; Gravel is fine. 2.9m		2.0 – 2.9	NO SEEPAGE	

Total Excavation Depth = 2.9 m

COMMENT:	Test pit dry.	LOGGED BY:	JM
		CHECKED DATE:	21/09/2021
		SHEET:	1 of 1

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TEST PIT LOG

EXCAVATION NUMBER: **SP 2**

PROJECT:	Waterfall Park			JOB NUMBER:	150098.04
LOCATION:	See Site Plan	INCLINATION:	Vertical		

EASTING:		EQUIPMENT:	5T Excavator	OPERATOR:	Niles
NORTHING:		COORD. SYSTEM:		COMPANY:	Wilson Contractors
ELEVATION:		EXCAV. DATUM:		HOLE STARTED:	17/09/2021
METHOD:	Aerial Photography	ACCURACY:		HOLE FINISHED:	17/09/2021

Soil / Rock Type	Description	Graphic Log	Depth (m)	Groundwater / Seepage	Scala Penetrometer
TOPSOIL	Organic SILT; dark brown. Soft; dry to moist. 0m – 0.2m		0.0 – 0.2		
ALLUVIAL GRAVEL	Sandy fine to coarse GRAVEL; grey, Bedded. Medium dense; moist; Sand is fine to coarse. 0.2m – 1.3m		0.2 – 1.3		
ALLUVIAL GRAVEL	Sandy fine to medium GRAVEL; grey, Bedded. Medium dense; moist; Sand is fine to coarse. 1.3m – 2.8m		1.3 – 2.8	GW inflow @ 2.4 m	

Total Excavation Depth = 2.8 m

COMMENT:	Test pit dry.	LOGGED BY:	JM
		CHECKED DATE:	21/09/2021
		SHEET:	1 of 1

1 March 2023

Waterfall Park Developments Ltd
c/o Nicola Tristram
Development Manager
WINTON
Unit 1, 26 Glenda Drive
Frankton
Queenstown 9300

Dear Nicola

Proposed Northbrook Arrowtown
Contaminated Site Considerations

A later living development is proposed to be constructed at Waterfall Park (Northbrook Arrowtown). Waterfall Park is accessed via Ayr Avenue, off Arrowtown-Lake Hayes Road.

The land was originally part of Ayrburn Farm which operated from the 1860's. To the south of the site the farm contained a sheep dip, woolshed and yards, and underground and above-ground fuel storage tanks. A farm landfill was located on the southern portion of the site. These are activities on the Hazardous Activities and Industries List (HAIL), and the provisions of the *Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011* (NES) apply to these areas.

This letter addresses the potential for soil contamination within Northbrook Arrowtown and the broader application boundary, as shown in Figures 1 and 2, by reviewing and summarising the Otago Regional Council (ORC) HAIL database, Preliminary Site Investigation (PSI)[1], Detailed Site Investigation (DSI)[2] and subsequent remediation earthworks[3]. The proposed activity constitutes a change of use of the land, with the new land use being most consistent with residential activity. However, the proposed use of Buildings A (Arrivals and Amenities) and F (Boutique Hotel and Spa) is more consistent with commercial land use.

The PSI covered the entire property identified as Ayrburn Farm and Waterfall Park and included extensive surface soil sampling for contaminants identified as being associated with past HAIL activities (heavy metals and pesticides). The sampling across the property identified the only areas of contamination were associated with the farm homestead, the farmyard precinct and adjacent landfill area. The site history is well understood and nothing in the site history indicates that significant contamination would be expected beyond these areas identified.

[1] EC Otago Ltd, 2016. *Preliminary Site Investigation for Soil Contamination - Ayrburn Farm and Waterfall Park Residential Development, Wakatipu*. Job Reference: 16-16 Waterfall.
[2] EC Otago Ltd, 2018. *Detailed Site Investigation - 341-345 Arrowtown-Lake Hayes Road, Wakatipu.* Job Reference: 54-17 Ayrburn.
3 EC Otago Ltd, 2020. *Site Remedial Action Plan v7 - 341 – 345 Arrowtown–Lake Hayes Road, Wakatipu*. Job Reference: 112-18 Ayrburn Remediation.

Figure 1: Site plan for the proposed Northbrook Arrowtown with the application boundary shown in red.

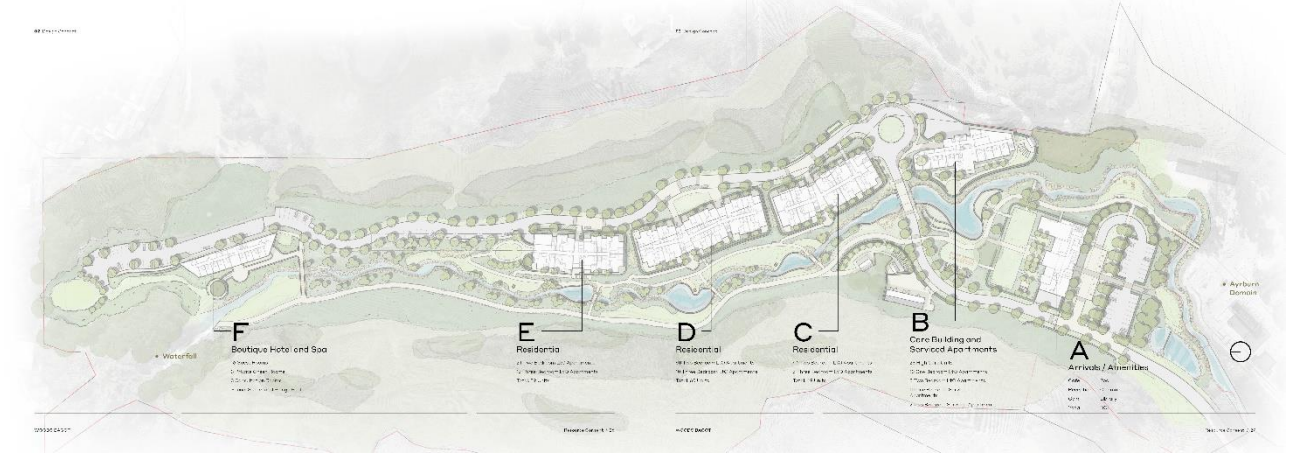


Figure 2: Concept design.

The PSI found exceedances of the applicable soil contamination standard (SCS) for arsenic and lead in the soils around the existing homestead, farmyard buildings and the adjacent landfill. The soil sampling across the greater part of the property found contaminants were present at concentrations that are likely to be the natural background levels. A DSI was undertaken to better

define the HAIL sites within the property by ascertaining the extent of contamination in the three sites (A, B and C) and to inform remediation options. Remedial earthworks were subsequently undertaken under consents RM181597 and RM18.426.01-03, with contaminated soils removed from the sites being placed into a purpose designed Encapsulation Cell to isolate contaminants and prevent remobilisation. The location and extent of the sites and the Encapsulation Cell is shown in Figure 3 in turquoise. Site B is located within the application boundary.

Figure 3: Site layout showing the locations of the contaminated sites (A, B and C) and the Encapsulation Cell in turquoise. The site boundary is shown in red.

Following the remedial works, Sites B and C are fully remediated and Site A is capped and contained. Site A and the Encapsulation Cell have long-term management plans in place. The contaminated soil is contained and not anticipated to affect Northbrook Arrowtown which is primarily located to the north of these areas. In the unlikely event containment is breached, the contamination is unlikely to affect the proposed buildings, which are located at a higher elevation.

Site B has been fully remediated with all contaminated material removed from the area and placed within the Encapsulation Cell. Validation sampling confirmed that the arsenic concentration in remaining soils was below the *Commercial / industrial outdoor worker (unpaved)* Soil Contaminant Standards (SCS) of 70 mg/kg, and within the range determined likely to be the natural background during the PSI. In the Site Validation Report[4], the results were assessed against the *Commercial / industrial* SCS due to proposed commercial land use, however the arsenic concentration which ranges from <2 – 16 mg/kg are also below the *Residential* SCS of 20 mg/kg. Therefore there are no restrictions on the use of Site B or soil disturbance works.

Figure 4 shows the proposed site layout in relation to Site B. Building A is designed as the Arrivals and Amenity building, containing the main reception in addition to a pool, gym, cinema, library and cafe. A hard-surface car parking area and associated landscaping will be constructed over Site B. These activities are more consistent with commercial land use which is highly unlikely to present a risk to human health or the environment.

Figure 4: Concept Plan of the Building A in relation to Site B (October 2022).

[4] EC Otago Ltd, 2020. *Site Validation Report: Sites A, B and the Encapsulation Cell - 341 – 345 Arrowtown–Lake Hayes Road, Wakatipu*. Job Reference: 112-18 Ayrburn Remediation.

The Otago Regional Council (ORC) HAIL database also notes several other potential HAIL sites within the application boundary as shown in Figure 5 and detailed in Table 1.

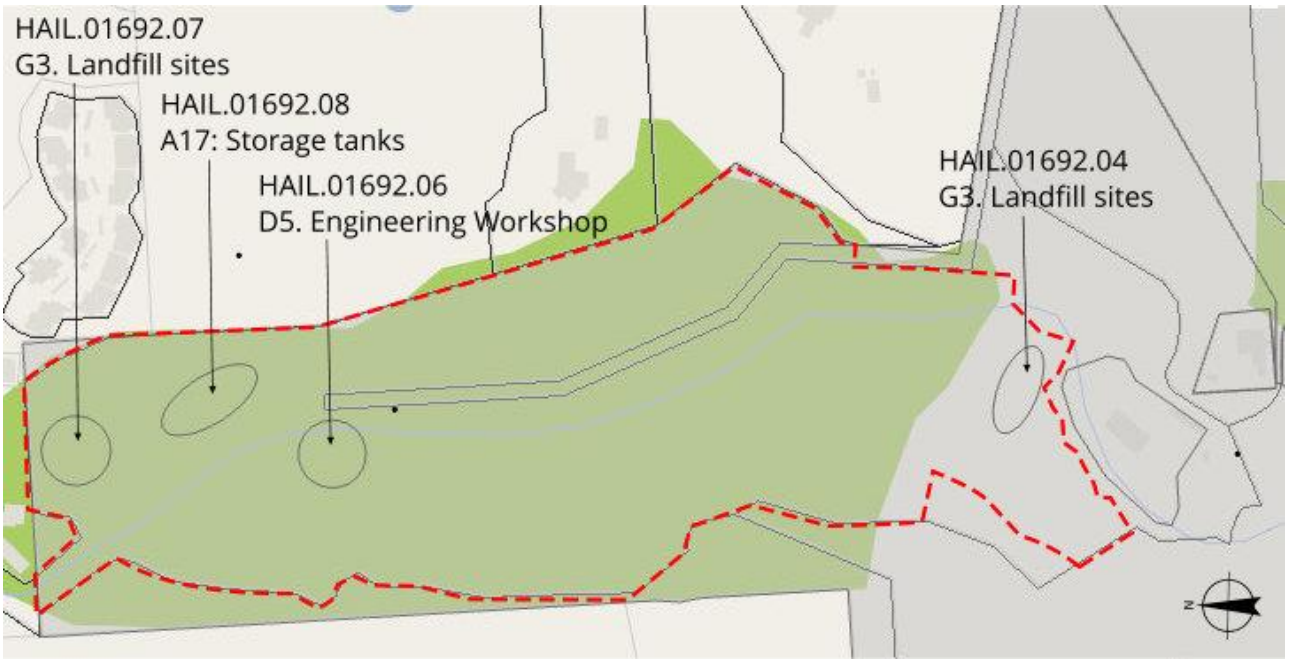


Figure 5: HAIL sites as recorded on the ORC HAIL database.

Table 1: ORC HAIL Database Sites

Site Number	HAIL Category	Comments
HAIL.01692.07	G3. Landfill sites (Verified HAIL)	Not investigated - Test pits in this area encountered rubbish, wire rope, and timber
HAIL.01692.08	A17: Storage tanks or drums for fuel, chemicals or liquid waste (Unverified HAIL)	Partially investigated - Diesel boiler present within building but diesel tank not found. No evidence of hydrocarbon contamination.
HAIL.01692.06	D5. Engineering Workshops with metal fabrication (Verified HAIL)	Partially investigated - Lathe discovered after tree clearance. Two samples returned low results
HAIL.01692.04	G3. Landfill sites (Verified HAIL)	Completed remediation – suitable for unpaved commercial land use (Site B)

The PSI found that across the greater part of the property contaminants were present at concentrations that are likely to be the natural background levels, including the surface soils near the lathe and A Frame building associated with HAIL.01692.08 or HAIL.01692.06. No contamination was detected near HAIL.01692.07 (northern landfill), however only surface soils were sampled. Contamination was only present in the deeper soils at HAIL.01692.04 (Site B). No development is proposed near HAIL.01692.07 and HAIL.01692.06, while Building F will be constructed over HAIL.01692.08. Building F is proposed to be a Boutique Hotel and Spa, again this is more consistent with commercial land use, however based on the sampling undertaken even residential land use in this area is highly unlikely to result in a risk to human or environmental health. A building with the same footprint as Building F was previously consented under RM180584.

The sampling locations from the PSI within the application boundary are shown in Figure 6 and the results are summarised in Table 2. Surface soil samples were collected in groups of 4, analysed as one individual and a composite of three subsamples to increase the sampling density while

controlling analysis costs. Across the site the individual results were consistent with the composites.

Figure 6: Sampling locations from the PSI undertaken in 2016, with the application boundary shown in red.

Table 2: Summary of results from PSI samples collected within the application boundary

Sample [A]	Arsenic	Cadmium	Mercury	Lead	Organochlorine Pesticides
Composite samples					
A1, A2 & A3	10	< 0.10	< 0.10	16.8	< 0.06
D1, D2 & D3	7	< 0.10	< 0.10	15.2	< 0.06
E1, E2 & E3	15	< 0.10	< 0.10	21	< 0.06
WF1A, WF1B & WF1	11	< 0.10	-	23	-
WF2A, WF2B & WF2	6	< 0.10	-	12.6	-
WF3A, WF3B & WF3C	8	< 0.10	-	14.0	-
WF4A, WF4B & WF4C	6	< 0.10	-	13.8	-
Average	*9*	*< 0.10*	*< 0.10*	*17*	*< 0.06*
RSD	*36%*	-	-	*24%*	-
UCL	*11*	-	-	*20*	-
Individual samples					
A	13	0.11	< 0.10	24	< 0.06
D	7	< 0.10	< 0.10	22	< 0.06
E	11	0.10	< 0.10	18.5	< 0.06
WF1	3	< 0.10	-	5.1	< 0.06
WF2	11	< 0.10	-	19.8	-
WF3	8	< 0.10	-	12.7	-
WF4	11	< 0.10	-	14.2	< 0.06
Average	*9*	*< 0.11*	*< 0.10*	*17*	*< 0.06*
RSD	*37%*	-	-	*39%*	-
UCL	*12*	-	-	*21*	-
Soil Acceptance Criteria					
NES[B] SCS	20	3	310	210	-
Predicted Background [C]					
Median	2.88	0.066	-	12.2	-
95th Quantile	12.06	0.34	-	44.34	-

[A] Results for total concentration analysis, average, soil acceptance criteria and predicted background in mg/kg dry weight, RSD in %.

[B] Ministry for the Environment, 2012. *Users' Guide, National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health.* Residential land use criteria applied.

[C] Landcare Research, 2015. *Background soil concentrations of selected trace elements and organic contaminants in New Zealand*. Chemical4 Factor: gravel predicted median and 95th Quantile reported. Also refer: (https://lris.scinfo.org.nz/layer/48470-pbc-predicted-background-soil-concentrations-new-zealand).

The E composite sample and A individual sample show slightly elevated arsenic relative to the predicted background, however concentrations are well below the *Residential* SCS and within the range determined likely to be the natural background during the PSI, which was an average of 9 mg/kg for individual samples and a 95% Upper Confidence Limit of 15 mg/kg. Elevated arsenic concentrations in the region are not uncommon as a result of local gold bearing schist[5].

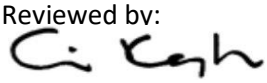
In summary, it is highly unlikely that use of the land for the proposed development will present a risk to human health as a result of soil contamination. However, caution is advised for any earthworks that occur within close proximity to HAIL.01692.07 (northern landfill) given no deeper soils have been sampled in this area. The geotechnical investigation in 2017 identified fill in the upper 1-4 m in this area at head of the creek that had been levelled, with trace to minor rubbish in two test pits (TP2c and TP3c) consisting of wire rope, sawn wood, wood fragments and plastic pipe. While these locations are outside of the development area, if any earthworks encounter buried waste materials, additional soil sampling and analysis should be undertaken.

We trust that this provides sufficient information to address the potential for soil contamination in relation to the proposed development. Please feel free to contact us if additional information is required.

Yours faithfully,

Bernice Chapman, PhD, MEIANZ
Senior Contaminated Land Consultant
Environmental Consultants Otago Ltd

Reviewed by:



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Principal and Senior Environmental Planner
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[5] https://www.otago.ac.nz/geology/research/environmental-geology/metals-in-the-nz-environment/arsenic.html

RMM

ROUGH MILNE MITCHELL
LANDSCAPE ARCHITECTS

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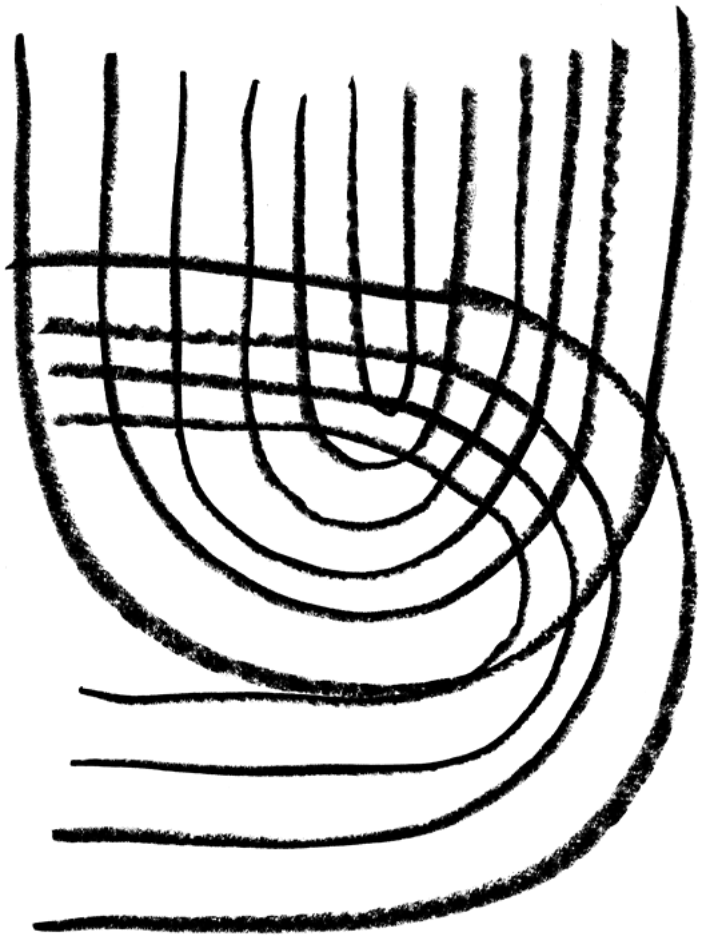
Landscape Assessment Report

Northbrook Arrowtown
Job number: 21304

2 March 2023



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Contents

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Level Two
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1.0 Introduction

1.1 Purpose and Scope

Rough Milne Mitchell Landscape Architects (**RMM**) have been engaged by Waterfall Park Development Limited (the **Applicant**) to assess the landscape and visual effects of the proposed Northbrook Arrowtown later living development (Northbrook Arrowtown) Ayr Avenue, Arrowtown. The application site (the **site**) is a 15.25 ha property legally described as Lot 1 DP 540788. Northbrook Arrowtown is a comprehensive later living development including an arrivals and amenities building, approximately 161 apartments, approximately 12 Serviced Apartments, approximately 23 High Care Apartments, 16 Hotel Rooms and spa, community workshops, a maintenance shed, and supporting infrastructure.

A comprehensive consent was granted in March 2019 (RM180584) for the development of a hotel and associated facilities. This consent also included a conference centre, wellness centre, wedding chapel, outdoor pavilion and the restoration and repurposing of the heritage farm building at Ayrburn into a hospitality precinct (Ayrburn Domain).

1.2 Methodology

The methodology and terminology used in this report has been informed by the Draft Aotearoa New Zealand Landscape Assessment Guidelines[1].

This report is further tailored to suit the nature of the project and its context.

The preparation of this assessment of landscape and visual effects has included:

- Preliminary discussions and workshops with the Applicant, Planner, Architect, Landscape Architect and Engineer.
- A review of the underlying zoning and associated documents including the Queenstown Lakes District Council's (**QLDC**) Operative District Plan (**ODP**) and Proposed District Plan (**PDP**).
- Background research regarding the history of the site and surrounds and previous resource consent applications.
- In addition to general familiarity with the site and vicinity due to previous work on the site and in the area, site visits were carried out on 27 January 2022, 28 March 2022 and 16 June 2022. Site and assessment viewpoint photographs were taken during the site visit on 16 June 2022.
- A review of the proposed masterplan and landscape concept prepared by Winton Partners.
- A review of the architectural 'Resource Consent Scheme' prepared by Woods Bagot.

[1] 'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022.

- Preparation of a written description of the proposal.
- Preparation of a written description of the site and receiving environment, with consideration given to the Landscape Character Units specified in the PDP
- Identification of existing landscape and visual amenity values including physical, perceptual, and associative values. These are based on the site observations and a review of existing information.
- An assessment of landscape effects was undertaken utilising the descriptions and landscape values identified previously. This assessment utilised the industry standard[2] seven-point scale, rating effects from very low to very high or as 'no effect' and determining the nature of effect as adverse, neutral or positive.
- An assessment of visual effects was undertaken based on the visual assessment viewpoint photographs taken on 16 June 2022. Visual effects were assessed based on the descriptions and landscape values identified previously. For each viewpoint both the degree of change and the actual and potential visual effects was assessed for each viewpoint. This assessment was undertaken utilising the industry standard seven-point scale as described above.
- The findings of the report were then summarised and stated in a conclusion.
- The report was then internally peer reviewed and provided to the planner for review to ensure all landscape and visual matters relevant to the AEE have been addressed.

This report is accompanied by a Graphic Attachment (**GA**), that contains maps and aerial images of the site location, the relevant PDP planning maps, photographs of the site from within the site, and viewpoint photographs of the site taken from the surrounding public places and the relevant boundaries of private properties.

[2] 'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022.

2.0 The Proposal

2.1 Description of the Proposal

Northbrook Arrowtown has been described in full in the Woods Bagot Resource Consent[3]. In summary the proposal will consist of the following:

- amenity and reception building (Building A) at the entrance to the site with a ground floor area of 935 m^2
- approximately 23 High Care Apartments in Building B on the eastern side of the valley floor with a ground floor area of 1,106 m^2
- approximately 173 residential apartments across three buildings (Building C-E) on the eastern side of the valley floor with a total ground floor area of 4,396 m^2.
- Approximately 16 hotel rooms at the head of the valley in Building F with a ground floor area of 648 m^2. Building F shall be constructed as per the Waterfall Park Hotel consent (RM180584 approved 13/03/2019)
- public access through the site along Mill Creek ending at the waterfall and public open space adjacent to the waterfall; and
- infrastructure associated with the development described above, including roads, bridges, parking, and pathways.
- The proposed development is documented in the following design reports:
    - Northbrook Arrowtown Resource Consent prepared by Woods Bagot, dated: 28 February 2023
    - Northbrook Arrowtown Landscape Strategy - For Resource Consent prepared by Winton Partners Ltd, dated: 28 February 2023
    - Northbrook Arrowtown Resource Consent Drawings prepared by Paterson Pitts Group Ltd, dated: 23 February 2023

Refer to Sheets 14 and 15 of Northbrook Arrowtown Landscape Strategy for the overall masterplan.

[3] Northbrook Arrowtown Resource Consent prepared by Woods Bagot, Revision C 28 February 2023.

3.0 Relevant Statutory Provisions

3.1 Relevant Statutory Documents

The following planning documents have been considered in the preparation of this assessment and are relevant to the assessment of landscape and visual amenity effects:

- Queenstown Lakes District – Operative District Plan (**ODP**)
- Queenstown Lakes District – Proposed District Plan (**PDP**)

The Queenstown Lakes District Plan gives effect to the RMA and other statutory documents within the context of the Queenstown Lakes District.

The ODP is superseded by the PDP. It is understood that all the relevant rules of the PDP are beyond challenge, and the earlier rules of the ODP no longer apply. Accordingly, this report focuses on the PDP.

Note: As at the date of this report a small part of the proposed development (southern carpark and southern half of Building A) is located in the Wakatipu Basin Rural Amenity Zone. However, it is understood that a decision due shortly (arising from an appeal to the PDP) will amend the Waterfall Park Zone boundary to include that area. Accordingly, this report assumes that all of the development site is within the WPZ.

3.2 Proposed District Plan

The landscape related matters particularly relevant to the proposed development are addressed in;

- Chapter 3: Strategic Direction,
- Chapter 6: Landscapes and Rural Character,
- Chapter 42: Waterfall Park

Chapter 3: Strategic Direction

Chapter 3 sets out the over-arching strategic direction for the management of growth, land use and development in a sustainable manner, in the context of the District's special qualities. Regarding landscape matters, the key issues identified include: the protection of outstanding natural features and landscapes, identification of landscape values, character and visual amenity, protection of rural character landscapes, determination of landscape capacity.

In regard to landscape matters, the following Objectives and Policies are relevant:

- 3.2.1.8 Diversification of land use in rural areas beyond traditional activities, provided that the visual amenity values are maintained or enhanced.
- 3.2.2.1 Management of urban growth
- 3.2.3.2 Built form integrates well with its surrounding urban environment

- 3.2.4.2 Protection of the natural environments and ecosystems of the district, including maintaining or enhancing public access to the natural environment.
- 3.2.5 Retention of the District's distinctive landscapes (Rural Character Landscapes) so that visual amenity values are maintained or enhanced.
- 3.3.20 Manage subdivision and / or development that may have adverse effects on the natural character and nature conservation values of the district and natural character is maintained or enhanced as far as practicable.

Chapter 6: Landscapes and Rural Character

The purpose of this Chapter is to provide greater detail as to how the landscape, particularly outside urban settlements, will be managed to implement the Strategic Objectives and Policies in Chapter 3. Landscapes have been categorised to provide greater certainty of their importance to the district, and to respond to regional policy and national legislation. This Chapter provides guidance on the various visual amenity and landscape values of each Rural Character Landscape (**RCL).**

The policies of the RCL do not apply to the site as it falls within the Waterfall Park Zone[4].

Chapter 42: Waterfall Park (zone)

Chapter 42 sets out the rule and objectives of the Waterfall Park Zone. Regarding landscape matters, the key issues identified include: the natural and scenic values of the setting, protection of ecology of Mill Creek, consideration of district wide provisions.

In regard to landscape matters, the following Objectives and Policies are relevant:

- 42.2.1.1, 42.2.1.2, 42.2.1.3 Visitor, residential and recreation facilities and activities shall be developed in an integrated manner with regard for the natural and scenic values of the setting.
- 42.2.2.2 Development avoids adverse effects on Mill Creek and ecological values.

[4] Queenstown Lakes Proposed District Plan, Chapter 6, policy 6.3.1.3

4.0 Landscape Description

4.1 Background

The following descriptions have been informed by site visits undertaken by the author, desktop research, and RMM's previous involvement with this site. Supporting documents have also been provided to inform the ecology commentary in this report.

4.2 Receiving Environment Description

Site Location & Extent of the Receiving Environment

The majority of the Waterfall Park Zone boundary is shared with Millbrook Country Club to the north and west. There are three properties that border the site to the east. These appear to be residential dwellings. *(Refer to Sheet 09 Graphic Attachment).* All properties described can overlook the valley from limited locations near the boundary of their respective properties.

The landscape context of the site is a modified rural landscape. A variety of activities, including living, farming, golf courses, visitor accommodation and hospitality are located and take place within the wider setting of the site. The site is located across two Landscape Character Units (**LCU**).[5] The Millbrook LCU 23 encompasses most of the site and the Speargrass Flat LCU 8 covers a small portion in the south on part of the site.

The Millbrook LCU 23 has predominantly elevated moraine landforms with plateaus, hummocky hills, and remnant kettle lakes. The area is relatively intensively developed with clusters of semi-detached two storey dwellings, large single storey residential homes, commercial areas, and a parkland golf course landscape. The landscape has a manicured appearance due to the prevalence of lawns and parkland landscapes. The unit is considered to have a low level of naturalness due to the existing and anticipated development and the majority of the unit is considered to have a moderate capability to absorb additional development.

The Speargrass Flat LCU 8 contains the relatively flat, and gently terraced landscape to the north of Lake Hayes. A predominantly pastoral landscape, dwellings are concentrated along roads, shelter belts and other plantings assist in screening dwellings and built form from views. The unit has a reasonable level of naturalness due to the relatively limited level of built development evident across the unit.

For the purposes of this assessment, the receiving environment is considered as the area that is potentially adversely affected by the proposal. Due to the discrete location of the valley, topography, existing and proposed vegetation, the receiving environment is quite limited in extent.

[5] Schedule 24.8 Landscape Character Units, Queenstown Lakes District Council, Proposed District Plan Decisions Version (Oct 2021).

Historical & Cultural Context

The regional history of the Wakatipu Basin has been shaped by three waves of Māori migration since the year 1200. The first people came from Hawaiki followed by two later migrations from Te Ika A Maui (the North Island). The first Pākeha settlers arrived in the 1850's with people migrating from Dunedin for farming. Gold was first discovered in 1862 bringing a wave of European goldminers followed by Chinese goldminers in 1864. It is understood that there are no reported Māori artefacts or interest within the site, nor has there been any recording of gold found.

The site is adjacent to the historic Ayrburn Farm, initially established as a vegetable, cereal and cropping farm to provide for the local mining population and flour mills. The farm was first settled by William Paterson in 1862, named after Ayrburn, West Kilbride, Scotland where he was born. The buildings, originally forming the farm centre, have previously been identified and recorded as a category 2 historic heritage feature within the PDP[6].

A Giant Redwood - *Sequoiadendron giganteum*, in front of Ayrburn Farm homestead is individually listed as a protected tree within the PDP[7]. On the same site there is a protected avenue of larches and spruces[8] that line the driveway to the historic homestead. A collection of farm buildings still stands within Ayrburn Farm today. These include a cart and implement shed, a dairy, and stables. These buildings are currently being restored and repurposed (under RM180584).

The first Lakes District Agricultural and Pastoral Show was held at Ayrburn Farm in 1904. The Giant Redwood, situated in front of the existing homestead, was originally sited in the centre of a carriage turning circle and is a focal point for the tree avenue drive.

Landform & Geology

The geological processes that have led to the formation of the Waterfall Park valley are a combination of ancient glacial and more recent fluvial processes.

The wider Wakatipu Basin has been formed by several growing and retreating glaciers that carved the wide U-shaped valley out of the schist bedrock, and left behind a varied landscape of moraine deposits, glacial till and outwash, roche moutonnees, depressions (lakes) and terrace formations. Following the most recent glacial retreat, flowing water and wind replaced the role of ice in eroding and shaping the landscape of the Wakatipu Basin. Rivers and streams carved terraces and valleys and moved around glacial deposits, while wind picked up and deposited fine sediment ground up by the glaciers. Key views are formed by these geological processes, notable views from the site and receiving environment are of Brow Peak, The Remarkable and Lake Hayes.

Mill Creek, which is fed by the Coronet Peak catchment, carved its path from the mountains, through the landscape toward Lake Hayes. This path involved descending the

[6]Queenstown Lakes District Council, Proposed District Plan, Decisions versions (April 2021), Chapter 26, Historic Heritage, Reference 110
[7] Queenstown Lakes District Council, Proposed District Plan, Decisions versions (April 2021), Chapter 26, Historic Heritage, Reference 196
[8] Queenstown Lakes District Council, Proposed District Plan, Decisions versions (April 2021), Chapter 26, Historic Heritage, Reference 275

terrace that separates Speargrass Flat (below) and Malaghans Ridge (above). Over time, the flowing waters of Mill Creek have gradually eroded the terrace face of glacial till and pond sediments, creating the steep sided, V-shaped valley that exists today.

Landcover

Historically, the vegetation within the broad Wakatipu Basin would have been scrub, shrubland and tussock-grassland. Forests in the area would have been dominated by Beech or Podocarp (native conifers). Kowhai were also likely to have been a dominant species. The shore of Lake Hayes would have likely been a wetland with a diverse array of plant species including native sedges, flax and toi toi, providing habitat and food sources for native birds, lizards, insects and bats[9].

Historical and present-day agricultural activity within the region has resulted in very low levels of indigenous planting and habitat today. Vegetation within the basin is fragmented and is dominated by exotic pasture and introduced trees. Research[10] indicates that fires within the period 1280 – 1600AD destroyed a significant amount of the native forest cover within the Wakatipu Basin. Fire was also used by Europeans in the mid-19th century as they transformed native scrub to grassland.

Land Use & Built Form

The area of land to the south of the site, broadly considered as Speargrass Flat, has been used for agricultural activities, primarily grazing and crops since arrival of the first European settlers to the area in the mid 1800's. At present built form and domestication radiates out from Speargrass Flat Road and spreads towards Lake Hayes. An area of open rural space remains between the domestication of Speargrass Flat Road and the southern boundary of the site.

Millbrook Country Club borders the site to the north, east and west, this landscape is highly domesticated. The primary land uses across the resort are the residential dwellings, golf course, and amenities connected to the resort. Millbrook Country Club is located between the site and historic Arrowtown.

4.3 Site Description

Site Location & Access

The site is located at atWaterfall Park. It is located in the countryside between Arrowtown and Lake Hayes. The site is accessed from Arrowtown - Lake Hayes Road via the recently constructed Ayr Avenue.

The site is positioned on the north-eastern edge of Speargrass Flat and includes a valley in the south facing flanks of Ayrburn Ridge, below Millbrook Country Club. The long, irregularly shaped site incorporates a significant section of Mill Creek, which enters the site as a spectacular waterfall at the northern end of the valley, before meandering in a southerly direction through a steep sided valley toward Lake Hayes.

[9] Statement of Evidence of Glenn Alister of QLDC: Ecology – Wakatipu Basin Variation Area, 28 May 2018
[10] 'Rapid landscape transformation in South Island, New Zealand, following initial Polynesian Settlement'. December 2010. McWethy, Whitlock, Whilmshurst and Cook. PNAS Vol 107.

The site boundary generally follows the top of the valley walls to the west, north and east, and is defined to the south by Mill Creek. Within the site boundary and to the south of Mill Creek is a cluster of heritage farm buildings currently under restoration on the historic landholding known as Ayrburn Farm.

Planning Context

The site sits within the Waterfall Park Zone in the PDP. There are no Outstanding Natural Landscape, Outstanding Natural features, or Rural Character Landscape overlays that need to be taken into consideration for this site. The majority of the site sits within LCU 23, with a small area in the south within LCU 8, Schedule 24.8, Chapter 24 – Wakatipu Basin of the PDP.

Historical Context

Waterfall Park was not part of the original Ayrburn Farm landholding. Within the valley, a wooden waterwheel and water-race remnants are located near the Mill Creek waterfall. It is thought that water directed through this waterwheel may have generated power for the farm and possibly also for the homestead. Remnants of a water race constructed some time in 1910 exist along the upper western valley edge. It is thought the water diverted through this race from Mill Creek, was transported via an elevated timber aqueduct to the Lake Hayes Flour Mill downstream.

Landform & Landcover

While the site sits in the context of the Speargrass Flat and Millbrook LCU's the site forms a landscape character of its own. The unbuilt Waterfall Park site is obscured from view by the natural topography and existing vegetation patterns[11]. The site is made up of a valley and flood plains containing a permanent creek. It is best described in three distinct character zones: Valley Entrance, Mid-Valley, and Valley Head. Modifications to the landscape of the site are occurring under a RM180584, and therefore it is considered the current landscape character is undergoing change.

The valley entrance, at the southernmost end of the valley, is where the transition happens between Speargrass Flat and Waterfall Park. It is a relatively confined area, enclosed by the valley walls to the west and east, and by mature willow trees that line Mill Creek to the south. Mill Creek dominates the view, with a recently constructed slow-moving pond and a scattering of mature walnut trees. A vehicle bridge has recently been constructed under RM180584, rock work and weirs have been installed to the edges of and within the creek. The valley walls have been planted with a mixture of native trees, shrubs, and flaxes. The area opens to the north, where a portion of the greater valley is visible.

The mid-valley is defined by two spurs in the western valley wall that restrict visibility along the length of the valley from the western side of the creek. It is in this mid-valley area, where the valley walls tower to the east and west, that there is a sense of being completely within the valley and removed from Speargrass Flat. The folded nature of the valley walls often hides the waterfall from view in this zone. The valley walls have a new cover of native planting that was undertaken in 2019 and is being successfully established. Mill

[11] Schedule 24.8 Landscape Character Units, Queenstown Lakes District Council, Proposed District Plan Decisions Version (Oct 2021).

Creek is the main feature of the valley floor, which has otherwise been cleared of woody vegetation. Mill Creek in this zone is currently undergoing stabilisation works, with most of the valley floor as bare earth and other construction elements.

The head of the valley is where Mill Creek enters as a dramatic waterfall. In this location, the valley is at its steepest, narrowest, and most enclosed. The waterfall, some 40m high and framed by ferns and sycamores, cascades over rocks to a pool below and is the eye-catching main feature of the area. Tucked away beside the waterfall is a steep sided amphitheatre. Fern and moss-clad rock faces enclose the tall dell walls, while a thick forest of mainly naturalised sycamores occupy the space between them. The natural amphitheatre is fully enclosed to the east, north and west, and opens to the south, framing views down the valley to The Remarkables.

Planting on the valley walls is composed of a mixture of exotic and native trees. At the base of the walls are groups of Italian Alders and Silver birch. Native Beech are planted in large groups across the mid slope with a mixture of native shrubs and flaxes planted in the mid – upper slopes. Since 2016 most of the invasive exotic vegetation – willows, sycamores and pines have been cleared from the valley.

Existing Built Form & Modifications

Considerable earthworks have occurred on the site under RM180584. These earthworks largely relate to Mill Creek, with substantial creek stabilisation occurring across the site. At the time of writing this report these works were still under construction. *(Refer to Sheet 13 Graphic Attachment).* Further consented works that have been undertaken include restoration of the Ayrburn farm buildings, construction of Ayr Ave, earthworks around Building A and the construction of a vehicle bridge that crosses Mill Creek.

Notable existing trees in this area include two native red beech near the entrance to the dell and a specimen great white cherry tree next to the waterfall.

Tracks, terraces and building platforms formed under previous ownership and earthworks, are all features of the valley and in places these are partially covered by the recent planting that has been undertaken on the valley walls. There are large retaining walls in the valley, near the dell, that are also evidence of past occupation and several buildings which have been cleared. *(Refer to Sheet 14 Graphic Attachment).*

Consented Baseline

The hotel consent (RM180584) allowed for the construction of the following;

- A reception building with two restaurants, a convention centre, a bar and back of house services. The building varied in height but was 10.76m at its apex and had a ground floor area (**GFA**) of 1,713m^2.
- Two small auxiliary buildings at the toe of the western slope,
- Four hotel buildings along the true left of Mill Creek. Each building was consented at 4-storeys and a height of 12.8m. Each building had a carpark to the rear (east) of each building. The hotel buildings had a total GFA of 3,962m^2.
- Wellness centre with a day spa, retreat facilities, fitness centre, yoga studios and swimming pool across 3 levels, circa 10.5m high and GFA of 433m^2.

- A small Chapel on the western side of Mill Creek, 7.2m high and GFA of 25m².
- Dell pavilion with stone walls, raised deck and pergola structure within the natural amphitheatre at the head of the valley
- Supporting infrastructure including roads, pathways, carparks, and bridges.

The hotel consent has created a baseline that building outside the Waterfall Park Zone Structure Plan development areas is deemed acceptable due to the geotechnical and hydrological constraints of the site. Further to this it has also been deemed acceptable that buildings exceed the 8m building height limit set out in Chapter 42 of the PDP[12]. A comparison of the consented baseline to the proposal can be found on sheet 12 of the Graphic Attachment.

[12] Rule 42.5.3 Building height, Chapter 42 of the Queenstown Lakes Proposed District Plan, December 2021

5.0 Identification of Landscape Values

5.1 Landscape Classification

The site is made up of a valley and flood plains containing a permanent creek as described in "Landform and Landcover" in Section 4.3 of this assessment.

There are no Outstanding Natural Landscape, Outstanding Natural features, or Rural Character Landscape overlays that need to be taken into consideration for this application.

5.2 Physical Values

*"**Physical** [13] means both the natural and human-derived features, and the interaction of natural and human processes over time."* [14] Typical physical factors include geological, ecological, and biological elements within the landscape.

The physical values of the site and receiving environment include:

- Geological processes that have led to the formation of the Waterfall Park as described in Sections 4.2 and 4.3 of this report.
- Mill Creek and the waterfall at the head of the valley
- The topographic features of the site including steep valley walls, valley floor, amphitheatre and waterfall.
- Mill Creek is the main ecological feature of the site and is an important part of the wider Mill Creek ecological corridor. The creek provides habitat for brown trout and a species of native galaxiid (koaro). The creek environment is also home to a handful of native birds including pukeko and native scaup.
- A dense stand of naturalized sycamore trees remains at the top of the valley on the slopes surrounding the waterfall and ravine. A scattering of willow and walnut trees remain on the valley floor, as well as a single specimen cherry tree and several rowan trees.
- At the southern end of the site beyond the valley (and site), mature willows have been retained along the creek edge and there is a concentration of exotic specimen trees including elms and birches surrounding the Ayrburn farm buildings.
- Recently, WPDL has carried out extensive weed management and has begun revegetating the valley walls with a forest of native mountain beech (*Fuscospora cliffortioides*), Himalayan birch (*Betula utilis* var. *jacquemontii)* and Italian alder (*Alnus cordata*) trees.

[13] 'Physical' means both natural and human-derived features, whereas 'biophysical' is potentially problematic if it is taken to mean only the natural aspects of the landscape. 'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 35.

[14] 'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 35.

5.3 Perceptual Values

*"**Perceptual** means both sensory experience and interpretation. Sensory appreciation typically occurs simultaneously with interpretation, knowledge, and memory."* [15] Typical perceptual factors relate to experiential and aesthetic qualities such as naturalness, visual coherence, legibility as well as transient aspects.

The perceptual values of the site and receiving environment include:

- Recent earthworks around the creek and within the valley floor has left the landscape with relatively low aesthetic appeal. There are, however, highly aesthetic features remaining within the site. The highest level of aesthetic exists at the head of the valley where the impressive waterfall is the centre of attention. The dell beside the waterfall is also a highly aesthetic feature. Mill Creek itself has moderate aesthetic appeal throughout the site.
- The site is highly memorable, as the valley is unlike anywhere else in the Wakatipu Basin. Many people would not even know the Mill Creek waterfall exists, let alone the hidden dell and valley. This uniqueness and discreteness make the site highly memorable to those who can access it.
- A high level of naturalness exists in the underlying topography (and geomorphology) as well as specific features such as the Mill Creek waterfall, Mill Creek and the circular dell at the head of the valley. Naturalness is also derived from the remaining exotic trees on the site, recent planting, the open space, and the absence of buildings within the valley.
- While earthworks and construction of the Mill Creek upgrades are underway the site's natural character (and visual amenity) has been temporarily affected.
- A moderate level of naturalness exists with the (relatively) recent planting of the valley walls. As this planting grows, matures, and establishes the perceived naturalness (and amenity) will increase. In time, the valley walls will exhibit a high level of perceived naturalness, improving and supporting the broader ecological environment.

5.4 Associative Values

*"**Associative** means the intangible things that influence how places are perceived – such as history, identity, customs, laws, narratives, creation stories, and activities specifically associated with a landscape."* [16] Typical Associative factors includes cultural (tangata whenua) and historic values as well as shared and recognised attributes such as recreational opportunities.

The associative values of the site and receiving environment include:

- Within the valley, a wooden waterwheel and steel piping water-race remnants are located near the Mill Creek waterfall. It is thought that water directed through this waterwheel may have generated power for the farm and possibly also for the homestead.

[15] 'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 35

[16] Ibid

- Remnants of a water race constructed some time in 1910 exist along the upper western valley edge. It is thought the water, diverted through this race from Mill Creek, was transported via an elevated timber aqueduct to the Lake Hayes Flour Mill downstream.

5.5 Summary of Landscape Values

In summary, from a landscape perspective it is considered the site has **high** physical value, **moderate-high** perceptual values, and **moderate** associative values.

6.0 Landscape and Visual Amenity Assessment

6.1 Identifying Potential Issues

The potential landscape and visual effects arising from the proposal include the following:

- Effects on the character and values of Waterfall Park.
- Effects on visual amenity as experienced from the receiving environment.

6.2 Assessment of Landscape Effects

"A landscape effect is a consequence of changes in a landscape's physical attributes on that landscape's values. Change is not an effect: landscapes change constantly. It is the implications of change on landscape values that is relevant." [17]

Any natural or physical activity has the potential to alter the character or values of a landscape. Change need not necessarily be adverse. Whether effects are adverse or not depends to a large extent on public expectation of what can be reasonably anticipated to occur in the landscape. Allied to this is the receiving environment in terms of its existing degree of naturalness/modification, patterns, scale, visibility, levels of public appreciation and to what degree these will change with the proposed development.

Effects on the Character & Values of Waterfall Park

The character and values have been described in Section 5 of this report. Chapter 42 of the QLDC PDP describes the scenic and environmental values of the site including the natural features of the site; Mill Creek and the waterfall, as well as the scenic environment that surrounds the site. Given these scenic and environmental qualities, any development should conserve and enhance natural and scenic values contained within the property and its setting[18]. This chapter also relates to the capacity of the site for development in accordance with the Zone Structure Plan. The site's character is anticipated to change significantly from a modified natural landscape to a landscape containing built form.

Given the discrete nature of the valley. proposed development has very limited potential to be viewed from the wider landscape. As a result, change that occurs within the valley is not likely to influence the landscape character and values of the surrounding environment. From Millbrook Country Club (which adjoins much of the top of the valley walls), the valley is viewed from and in the context of an adjacent resort zone. Consequently, people would not be surprised to find a development located within the valley, provided this held a similar or higher level of visual amenity value.

There are currently works being undertaken on Mill Creek as part of RM180584. These works include realigning and stabilising the creek in some areas. In addition to this the

[17] 'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 61.
[18] Queenstown Lakes PDP, Chapter 42, 42.1 Zone Purpose

valley walls have undergone revegetation planting. These changes will be incorporated into the proposed landscape design of the development.

As the site is currently devoid of buildings, the greatest degree of apparent change will result from the presence of the proposed buildings. Other changes will arise from the presence of roads and paths, carparks, bridges, and small pockets of manicured lawn amongst extensive planted areas. Further earthworks will inevitably be required to develop the proposed buildings and site circulation, but this will have only temporary effects during construction. Overall, although the earthworks may be substantial in quantity (in places) they will not adversely affect the character of the landform to any more than a **low** degree.

Ultimately, proposed landscape treatment will involve revegetation along the riparian margin and additional amenity planting around the proposed buildings and infrastructure, the result of which will be a significantly more vegetated environment. Landscapes adjacent to buildings will appear more manicured with defined garden beds, areas of lawn and terraces. The riparian zone and valley walls will take on a more natural planting character. Mill Creek and its margins will be revegetated with extensive riparian planting, with lawn terraces to improve the visual and physical connection to the creek. This will enhance the natural character of the creek at a closer scale, but at a broader scale, the valley context will be modified with buildings and bridges, therefore reducing its natural character. On balance, the proposal will not adversely affect natural character to any more than a **low** degree.

Amenity will be derived through extensive planting and high-quality building and landscape design that in turn will be maintained at a very high level (or be encouraged to maintain itself as natural ecosystem). The attributes that contribute existing rural amenity will diminish - namely extensive open space and absence of built form. Although lessened by the presence of significant buildings, naturalness in the form of extensive re-vegetation will be improved compared to the current situation. This will also constitute a **positive** landscape effect.

The site is in a state of flux, with new planting, the Mill Creek stabilisation and works being undertaken around the Ayrburn buildings. There is an expectation of change across the Waterfall Park site largely due to the recent consents and work. Prior to this work beginning RMM assessed this site as a degraded rural landscape, it was considered that on balance the changes to the landscape would provide improvement to the valley's amenity.

The proposed development of the site includes protecting and enhancing the natural features of the site, with regard to Mill Creek and the waterfall at the northern end of the site[19]. Further to this public access will be provided along the western side of Mill Creek up

[19] 42.2.1.3 "Protect and enhance the natural features of the site", Chapter 42, Waterfall Park, QLDC PDP

to the 40m waterfall, in accordance with outcomes sought with the PDP[20]. This portion of Mill Creek and the Waterfall itself were previously inaccessible to the public.

Landscape Effects Summary

In summary, landscape effects arising from the proposed development will be substantial, but when considered in the context of the existing site, previous uses of the site and the purpose of the zone these will be in no more than **low - moderate**. Amenity will be improved on the site, albeit sourced from a modified and revegetated setting. The effects on landscape values as experienced in views are determined and discussed in the following section.

6.3 Assessment of Visibility and Effects on Visual Amenity

"Visual effects are a subset of landscape effects. They are consequences of change on landscape values as experienced in views. They are one technique to understand landscape effects." [21]

The criteria applied to the assessment of visibility and effects on visual amenity includes the viewing distance, the viewing elevation and/or the elevation of the works or proposal, the area of change, whether the proposal is in character with the view context, the level of activity visible and the degree of change in the view.

In undertaking an assessment of the proposal on visual amenity, viewpoints representative of the views most likely to be important are identified and form the basis of this assessment. As previously mentioned, due to location and topography there is very limited opportunity to view the Waterfall Park site from public places. Locations on Speargrass Flat Road and Arrowtown-Lake Hayes Road are the two public viewpoints that have been used to represent the landscape and visual effects from public places.

Sharing the site boundary at the top of part of the western valley walls are privately owned properties *(Refer to Sheet 09 Graphic Attachment).* There are limited locations (close to the site boundary) from within the neighbouring properties that the Waterfall Park valley is clearly visible. There is also variation in the ability to view the valley throughout the year due to the seasonal screening effect of existing deciduous trees. It is important to consider the visual effect of both the permitted activity allowed to occur within the Zone Structure Plan, and the consented activity when assessing the landscape and visual effects from these locations, as significant modification is anticipated within the zone.

For each of the viewpoints, the following are outlined:

- Existing landscape character and amenity values within the current scene
- Extent of visibility of the site and proposed development
- Extent of visibility of development anticipated by the existing Structure Plan and permitted as part of the consented baseline

[20] 3.2.4.2 "enhancing public access to the natural environment", Chapter 3, QLDC PDP
[21] 'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 61.

- Assessment of effects of proposed development on landscape character and amenity values

The nature and degree of effects on visual amenity is described for each representative viewpoint, using a seven-point scale **Very Low** – **Low** – **Low-Moderate** – **Moderate** – **Moderate-High** – **High** – **Very High** according to the common dictionary meaning of these terms.

Viewers will typically be residents and seasonal visitors throughout the year. Public views of the site are limited due to the site's topography and location. Motorists may get oblique and filtered views when travelling down Lake Hayes-Arrowtown Road and Speargrass Flat Road. In addition to this, viewers will be passing the site at around 80km, with the open pastoral landscapes (typical of Speargrass Flat LCU 8) will dominate the foreground views.

Private viewpoints have also been identified for this report. There are limited locations (close to the site boundary) from within the neighbouring properties that the Waterfall Park valley is clearly visible. Viewers from these neighbouring properties would be a mixture of residents and visitors. There is also variation in the ability to view the valley throughout the year due to the seasonal screening effect of existing deciduous trees.

Viewpoint 1

Viewpoint 1 is taken from Lake Hayes-Arrowtown Road, looking in a north-westerly direction approximately 300m from the site. *(Refer to Sheet 16 Graphic Attachment).*

The audience at the viewpoint will primarily be persons travelling towards Arrowtown from the Lake Hayes area. This view is most likely to be a transient one experienced from a vehicle. It is also considered representative of a section of gradually rising road approximately 100m long, where there is potential to view the site when looking in a northwest direction.

The existing character of the scene is characterised by pastoral open space surrounded by rows and groupings of mature, exotic trees. The landscape is very aesthetic and typical of the Wakatipu Basin rural character, resulting in a high level of visual amenity value. Waterfall Park Road wraps around the foreground (eastern) and northern sides of the flat pasture. The south facing flanks of the valley walls are visible in the background to the north are densely planted in exotic specimen trees. The ONL of Coronet Peak and Brow Peak Mountain range is visible beyond the ridge.

The southern end of the western valley wall within the site is visible from this location. It is also possible to catch glimpses through the trees of the existing buildings on Ayrburn Farm, including parts of the farm buildings on the lower terrace. It is possible to catch very small glimpses of the Ayrburn Homestead and farm buildings from the road. These are mostly hidden on a lower terrace, behind mature trees. The landscape is otherwise devoid of visible buildings.

It is unlikely that any buildings within the build zones marked on the current Structure Plan and constructed to meet the site standards in relation to height, would be visible from this viewpoint.

The proposed building A is significantly smaller than a building in the same location in RM180584. Building A of the proposed development may be marginally visible from this location in the viewshaft looking northwest. A small corner of the building could potentially protrude above the existing terrace which otherwise screens the bulk of the building. In this location, views of the building would be easily mitigated with a continuation of planting along the terrace edge that could completely screen any potential glimpses of the building.

Visual Effects Summary

Mitigation planting will ensure no proposed built form will be visible from this location therefore the visual effect from this location would be **negligible**.

Viewpoint 2

Viewpoint 2 is taken from Speargrass Flat Road (near Mill Creek), looking north towards the valley, approximately 600m from the site. *(Refer to Sheet 17 Graphic Attachment).*

The presence of existing buildings and vegetation along Speargrass Flat Road make it almost impossible to view the site at all from this location. It is possible to catch occasional glimpses through the roadside trees (often down driveways) and over the dense plantings within adjacent properties to the more distant landscapes to the north. Only upon close examination is it possible to identify the upper valley walls of the site in the distance of several narrow viewshafts at driveway entrances. Viewpoint 2 is representative of the viewshafts.

Viewpoint 2 has been selected as a representative viewpoint as planting on neighbouring properties cannot be relied upon for visual mitigation. In this instance bulk and location modelling is particularly useful to test the hypothetical situation where none of the foreground objects that currently hide the site existed at all.

The section of Speargrass Flat Road that is potentially affected by the proposed development is characterised by a consistent wall of trees that line the road boundaries of adjacent rural living properties creating a tunnel effect. A higher concentration of driveways, buildings and domestic amenity plantings are all characteristic of the surrounding rural residential zone.

Although evidently modified and more densely populated with buildings than surrounding rural landscapes, the character of Speargrass Flat Road is still considered to be countryside, reflected in the wide, grassy berms, presence of vegetation lining the roadside and consequently limited visibility to buildings. The landscape as appreciated from the road has a moderately high level of visual amenity value and this would increase to a high level in autumn when the trees display their seasonal colour. When the deciduous trees lose their leaves in winter it is likely to be possible to see further into the more distant landscape.

There are buildings, trees and other vegetation that currently screen any possible views of the site from Speargrass Flat Road. If nothing existed in the landscape between Speargrass Flat Road and the site boundary, it is anticipated that development as set out by the existing Waterfall Park Structure Plan *(refer to Sheet 17 Graphic Attachment)* may

be marginally visible behind the Ayrburn heritage farm buildings. It is very likely that this would be screened by existing trees on Ayrburn Farm and proposed amenity tree planting associated with the development.

The foreground of rural residential development screens potential views of Waterfall Park from Speargrass Flat Road. If the properties and planting adjacent to the road did not exist, it would be possible to make out the Waterfall Park valley and proposed development may be visible at the base of the valley walls. It may be marginally more visible than buildings constructed under RM180584, due to the taller buildings proposed. Existing trees on Ayrburn Farm (owned by WPDL) as well as extensive tree planting as part of the Masterplan would provide visual softening and possibly complete screening of the buildings in the distant landscape.

Visual Effects Summary

Due to the very limited ability to view the site from this location, there will be **no** adverse effects of proposed development on current landscape character and visual amenity values from Speargrass Flat Road.

Even if all existing vegetation and buildings were removed, the site would exist in such a distant view behind the existing heritage buildings and softened by a foreground of woodland plantings that adverse effects on the current visual amenity would be **negligible.**

Viewpoint 3

Viewpoint 3 is taken from 557 Speargrass Flat Road, looking north towards the valley, approximately 470m from the site. *(Refer to Sheet 18 Graphic Attachment).* This viewpoint represents the northward views from the properties that share the Waterfall Park, Ayrburn Farm boundary along Speargrass Flat Road.

The panorama photo was taken standing near the northern boundary of 557 Speargrass Flat Road, which is the dwelling that has the greatest potential to view proposed development.

The existing scene comprises a foreground of flat, open pastoral land, surrounded by a terrace to the east and Mill Creek to the west. The viewshaft is truncated in the mid-ground by the south facing flanks of the valley walls. Mature trees are scattered throughout the landscape and enclose the pastoral terrace to some extent on all sides. The small, historic Ayrburn dairy is visible in the mid ground, nestled into the trees on the valley floor below the ridge slopes. Brow Peak and the adjacent mountain ranges form a highly natural backdrop to the scene. The remainder of the Ayrburn Farm buildings and Waterfall Park valley remains hidden in this view by mature deciduous and conifer trees.

The scene has high levels of both rural character and natural character and is picturesque in a pastoral sense. As a result, a high level of visual amenity value exists.

Given the Waterfall Park valley is completely hidden from view by existing trees, it is anticipated that development as per the Structure Plan would be barely discernible from this viewpoint.

Proposed development within the valley will not be visible behind existing foreground trees. It may be possible to catch glimpses of the buildings in the valley in winter when the deciduous trees drop their leaves, although the number and density of trees present would likely screen buildings to the extent that they would be barely discernible. Also, some development within the valley is anticipated by the Waterfall Park Structure Plan. In the case that the trees should be removed from the foreground, it is anticipated that there would be sufficient screening by existing and proposed trees, within the site, to still render the buildings difficult to see.

Visual Effects Summary

Proposed buildings will be barely discernible behind existing trees (if at all). Therefore, there will be **very low** adverse effects on visual amenity from this viewpoint.

Viewpoint 4

Viewpoint 4 is taken from 397 Arrowtown-Lake Hayes Road, looking southwest down the valley, from the boundary of the site. *(Refer to Sheet 19 Graphic Attachment).*

The viewpoint assessed is representative of the view when standing on the property boundary rather than from within the dwelling. A 1.8 -2m high fence constructed along this boundary directs the views from the dwelling to the south. The dwelling's southern viewshaft looks across Speargrass Flat East toward Lake Hayes and The Remarkables. The viewshaft from the dwelling is therefore anticipated to be different to that shown in the panorama photo as it would be more elevated and a slightly different aspect to what has been demonstrated in the viewpoint.

A moderate level of rural character is derived from the presence of open space with clusters of domestication. Buildings are dotted throughout the basin floor, with concentrations of dwellings on the hillsides overlooking Lake Hayes and on Speargrass Flat. Houses on Bendemeer and Millbrook are also visible at a similar elevation to the property. The historic farm buildings on Ayrburn are also identifiable from this location. The construction work being undertaken on the site is visible in the foreground periphery of the wider scene.

The current scene has a moderate-high level of visual amenity value due to its high level of natural character and moderate level of rural character.

Built form within the zones identified on the Structure Plan would be highly visible from this viewpoint location. It is anticipated that from the dwelling, development within the valley would not be visible to the same extent as shown in this viewpoint.

Building A will be visible at the opening to the valley. The entry road and service areas may be visible on the north side of Building A and the cluster of workshop and maintenance buildings may also be visible behind retained walnut trees. Buildings B and C may be visible when looking down into the valley (rather than out to the view). Planting on the valley floor and walls will assist in softening the visible built form. In time it is likely that this planting will screen much of the development.

The landscape masterplan proposes to regenerate the valley with native and exotic planting which will improve the natural and ecological integrity of the site. Natural character will be enhanced, and high-quality amenity landscaping associated with buildings will be aesthetically pleasing. As a result, it is expected that the visual amenity of the site will be drastically improved. Due to the elevation of the viewpoint and restricted height of the buildings within the valley, the wider view to Lake Hayes, The Remarkables and the wider Wakatipu Basin will remain uninterrupted by the proposed development.

From within the dwelling, it is expected that, once mature, vegetation on the valley walls will mitigate almost all the proposed development from view and will form a soft, green border to the wider views of the surrounding landscape.

Visual Effects Summary

In time, it is considered that adverse effects on visual amenity (as viewed from the dwelling) will be **very low** to **low**. Adverse effects on visual amenity as experienced from the boundary will be **moderate**, although this level of effect in this location is anticipated by the Waterfall Park Zone Structure Plan.

Viewpoint 5

Viewpoint 5 is taken from Millbrook Country Club Villas, looking south down the valley. *(Refer to Sheet 20 Graphic Attachment).*

The photograph used to represent this viewpoint was taken standing on the ground in front of the villas, rather than inside the villas and on the elevated first floor. It is anticipated that the views from within the villas are likely to encompass even more of the wider Wakatipu Basin landscape, as well as more of the Waterfall Park valley.

The current landscape character and amenity values enjoyed by the south facing villas at Millbrook are like those described for Viewpoint 4 above. They also include a golf course within the foreground. The villas enjoy panoramic views of the wider Wakatipu Basin, encompassing Lake Hayes, a section of the densely treed Speargrass Flat rural residential area, Morven Hill, Ferry Hill and Millbrook golf courses. Views south are backdropped by the northern flanks of The Remarkables. Waterfall Park, particularly the western valley wall and the southern end of the valley floor visible in the mid-lower portion of the viewshaft.

A high level of visual amenity is derived from the moderate-high level of natural and rural landscape character in the wider scene, as well as the rolling, manicured open space of golf course landscape in the eastern foreground. Recent planting of the Waterfall Park valley walls provides visual amenity to the viewshaft's western foreground.

If development were to proceed as per the existing Structure Plan, buildings within the valley would be moderately visible within this viewshaft on the valley floor at the south end of the valley. Buildings would also be visible between existing trees, on the western side of Mill Creek in the viewshaft looking west.

Buildings are proposed to be located on the wider, flatter valley floor on the eastern side of the creek. In this position, Buildings E and D and parts of Building C are likely to be visible

on the valley floor and will encroach further up the valley than the current Structure Plan allows. The buildings proposed are a maximum of 6.8 to 7.14m taller than the consented buildings in the same location. The additional height will be noticeable from this aspect. Trees planted on the lower valley walls will grow to soften views of the buildings and may eventually screen some of the built form. It is possible that the road will be visible from the villas.

As previously established, the existing landscape character of the valley will inevitably change through modification, but the visual amenity value of the valley landscape will arguably improve.

Modification in the form of buildings will exist in the lower peripheral view of the wider landscape, where buildings had otherwise not been present. There will be built form located in the general area permitted by the existing structure plan toward the southern end of the valley floor, built form is anticipated in this valley by the PDP. The bulk and form of the buildings can be absorbed in the landscape due the proposed surrounding forested setting and the aspect at which buildings are viewed (looking down from above).

Visual Effects Summary

Adverse effects on visual amenity as experienced from this viewpoint will be **moderate**, although this level of effect in this location is anticipated by the Waterfall Park Zone Structure Plan.

Viewpoints 6, 7, 8

Viewpoints 6, 7 and 8 are taken from Millbrook Country Club Kobe restaurant, the path to the Day Spa and the Day Spa Fitness Studio respectively, looking south down the valley. *(Refer to Sheets 21-23 Graphic Attachment).*

Three of the northern-most viewpoints from Millbrook are grouped together for the purpose of this assessment as they share similar descriptions. Views adjacent to the Kobe Restaurant, the path to the day spa and adjacent to the fitness studio have all been considered. The restaurant and day spa are buildings that are visible from within the valley as they appear to almost perch on the edge of the northern valley wall, right on the boundary shared with Waterfall Park.

From these viewpoints varying amounts of the valley is visible throughout the year due to the sycamore trees on the site. In the winter, the valley is more visible than when the sycamore trees are in leaf.

From each of the viewpoint locations the site is visible, largely due to the substantial earthworks that are being undertaken across the site. The valley floor currently has bare earth and construction activities that contrast with the adjacent planting on the valley walls as well as the open pastoral landscape beyond. In the distance the snow covered Remarkables are visible. Views from each of the viewpoints are filtered through the existing cover of sycamore trees.

Viewpoint 6 has been taken at ground level on the southern corner of Kobe restaurant. It is assumed that the Wakatipu Basin (with the site in the foreground periphery) will be more visible from within the (elevated) building. Glimpses of the site are visible through the thick cover of trees; it is assumed that the site will not be visible when the trees are in leaf from this viewpoint. From the elevated position of the restaurant, it is likely that the southern end of the valley floor would be visible in the foreground periphery of the pastoral landscape of Speargrass Flat with The Remarkables in the background. The visual amenity value of the landscape is low-moderate, derived from the presence of vegetation (albeit invasive). It is assumed that the elevated views from the restaurant would have a moderate-high visual amenity.

Only glimpses of Buildings C and D may be visible from viewpoint 6, however, it is likely that from the elevated view within the restaurant a greater portion of Buildings C and D would be visible. It is anticipated that the proposed landscaping will soften their appearance.

From Viewpoint 7 the site is visible through the sycamore trees. Visual amenity value of the landscape that is experienced on the path is considered low as it passes by the back of house servicing areas of Millbrook and looks down onto the site which is currently undergoing substantial earthworks.

It is unlikely that any buildings would be visible from Viewpoint 7 while the sycamores are in leaf. In the wintertime, or if trees were ever to be removed, views of development within the entire valley would be revealed. Buildings C-E would sit in the mid-ground of the view toward Lake Hayes and the roof top of the Building F would be visible in the lower foreground. Much of the re-vegetated valley floor and walls would be visible from this aspect and this would contribute to settling the buildings in to the valley floor, decreasing their bulk and softening their form.

Viewpoint 8 has been taken from the north of the Fitness Studio. The site is visible through the thick cover of trees; it is assumed that viewers will only get glimpses of the site the trees are in leaf. From this location (in winter) the site and eastern valley walls are visible, with Millbrook Country Club and The Remarkables in the background. As the fitness studio protrudes out into the valley it is assumed that the views from the building would be more open, and therefore both the site and the wider Wakatipu Basin are likely to be more visible. The visual amenity value from the viewpoint is considered low, but it is likely the visual amenity from the Fitness Studio building would be moderate.

Glimpses of Buildings C, D and F may be visible from this location. Visibility would change throughout the year, and it is anticipated that the buildings would be more visible from the fitness studio.

If development were to proceed as per the existing Structure Plan, buildings within the valley would be visible during winter from all three viewpoints. For the rest of the year the sycamores will be in leaf and the glimpses of the structure plan buildings would be seen from both viewpoints 6, 7 and 8.

The bulk and location images give an indication of the extent of proposed development that would be visible if there were no trees present in the landscape. Trees and planting proposed for within the valley would soften the form of buildings and lessen their bulk. Due

to the aspect of the valley Millbrook Country Club user will look down on the roof tops of buildings. The buildings will likely be visible to some extent in perpetuity unless mitigation planting was grown in the foreground to restrict views into the valley altogether.

The proposed development will significantly modify the existing landscape character; however, this change is anticipated by the Waterfall Park Zone. The visual amenity of the site will drastically improve from the current construction site to a high amenity development. The valley will contain architecturally designed buildings within a natural, vegetated setting.

From these viewpoints the proposed development has a similar effect to what is anticipated by the Structure Plan. The proposed buildings are taller than what is permitted by the zone standards, although they would remain much lower than the surrounding valley walls. The development would not appear out of context in the environment, particularly as it is viewed from within a neighbouring resort development.

Visual Effects Summary

Adverse effects on visual amenity as experienced from these viewpoints will be **moderate**, in winter, and **low** while the trees are in leaf. Adverse effects on visual amenity as experienced from the Kobe Restaurant and Fitness Studio are anticipated to be **moderate-high.** This level of effect in this location was anticipated by the Waterfall Park Zone.

Viewpoint 9

Viewpoint 9 is taken from Millbrook Country Club Golf Course, looking southeast down the valley. *(Refer to Sheet 24 Graphic Attachment).*

The viewpoint from Millbrook golf course at the top of the western valley wall is a wide reaching and panoramic view that overlooks the Waterfall Park to the east. The southern end of the valley floor and eastern valley wall makes up the foreground view.

Undulations in the valley wall restrict views into the valley so that it is not possible to see the valley floor in its entirety. The location from which the photograph was taken is a high point in the landscape where there is enough elevation to see parts of the valley floor. It is from this point that proposed development on the valley floor is likely to be most visible.

The landscape character of the existing scene is both rural and natural with a high level of visual amenity value derived from the highly textured Wakatipu Basin floor and surrounding mountainous landscape. The eastern valley wall of the site is covered in native and exotic vegetation, contributing to the amenity values of this view. The valley floor itself is characterised by the construction works underway, carrying out the Mill Creek improvement works of RM180584.

Buildings built as per the existing structure plan would be clearly visible at the southern end of the valley floor. The development would form a relatively small part of the wider scene, isolated to the foreground periphery.

The proposed development it is likely to be visible in the south-eastern view from this location. Building A will be visible on the southern valley floor and Buildings B, C and potentially D will extend into the lower foreground peripheral view. Planting on the lower valley walls will soften the buildings into the valley landscape and may screen the bulk of the buildings in time.

Visual Effects Summary

Adverse effects on visual amenity as experienced from these viewpoints will be **low-moderate**. This level of effect in this location was anticipated by the Waterfall Park Zone.

Visual Effects of Lighting at Night

The proposed development will be adequately lit to provide a safe environment for residents and guests at night. While the lighting may be noticeable when looking into the valley from the various viewpoints overlooking the valley, the lighting will use low light luminaries and be positioned downward to ensure any glare or light spill beyond the valley is avoided. All lighting will meet the QLDC Southern Light standards. To a certain degree, bearing in mind the additional height of the proposed buildings, a similar extent of lighting is anticipated by the Waterfall Park Zone.

6.4 Summary of Landscape and Visual Assessment

In summary, adverse effects of the proposed development on landscape and visual amenity from public places will be **negligible** and any potential effects on existing landscape character are able to be easily mitigated with planting of trees.

Changes to the landscape character of the existing site will in some cases be highly visible from neighbouring properties, particularly those that overlook the valley. Effects on existing visual amenity vary from **negligible** to **moderate-high**, but in most cases, proposed visual amenity value will remain high, albeit sourced from a high quality, modified environment rather than rural open space. Proposed public access to the Waterfall is considered a positive effect. Overall, the landscape and visual effects of proposed development are in line with what is anticipated within the Waterfall Park Zone.

6.5 Schedule 24.8 of Chapter 24 for Landscape Character Unit (LCU) 23 Millbrook

It is understood the focus of the LCU's is on the identification of the landscape characteristics and visual amenity values to be maintained and enhanced, while identifying development absorption capacity and associated landscape and visual change.

Following a review of the key landscape characteristics and visual amenity values identified, along with an understanding of the potential issues, constraints and opportunities identified for LCU 23 it is considered adverse effects of the proposed development on these values will be reasonable and well managed.

Overall, the Site has the capacity to absorb the proposed development whilst maintaining the environmental characteristics and visual amenity values to be maintained and enhanced – an attractive urban parkland setting and landscape coherence (*the relatively*

consistent planting treatment and architectural forms lend a reasonably strong degree of coherence to the Millbrook development)[22] for LCU 23.

Furthermore, Schedule 24.8 identifies the capability of LCU 23 to absorb additional development as moderate to high. It is considered the proposed development satisfactorily maintains and enhances landscape character and visual amenity values, therefore avoiding inappropriate cumulative adverse effects on landscape values identified for LCU 23.

[22] Queenstown Lakes District Council - Proposed District Plan Decisions Version (Oct 2021) - Schedule 24.8 Landscape Character Unit (LCU) 23 Millbrook

7.0 Conclusion

7.1 Conclusion

While the proposal will change the character of Waterfall Park, this change is in keeping with what is anticipated based on the Waterfall Park Zone Structure Plan and it will maintain the values identified in the PDP.

Within the receiving environment and identified visual catchment, the proposed development will result in a low degree of adverse effects on existing visual amenity. Overall, it is considered that the proposal will be generally consistent with the provisions and expected outcomes sought by the PDP.

8.0 Appendix

8.1 Relevant Policies, Proposed District Plan

Chapter 3: Strategic Direction

Chapter 3 sets out the over-arching strategic direction for the management of growth, land use and development in a sustainable manner, in the context of the District's special qualities. Regarding landscape matters, the key issues identified include: the protection of outstanding natural features and landscapes, identification of landscape values, character and visual amenity, protection of rural character landscapes, determination of landscape capacity.

In regard to landscape matters, the following Objectives and Policies are relevant:

- 3.2.1.8 Diversification of land use in rural areas beyond traditional activities, including farming provided that: (b) The landscape character of Rural Character Landscape is maintained and their visual amenity values are maintained or enhanced.
- Management of urban growth (Objective 3.2.2.1) Urban development occurs in a logical manner so as to: (a) promote a compact, well designed and integrated urban form; (g) contain a high-quality network of open spaces and community facilities; (h) be integrated with existing, and proposed infrastructure and appropriately manage effects on that infrastructure.
- Character of communities (Objective 3.2.3.2) Built form integrate well with its surrounding urban environment
- Natural environments and ecosystems of the District (Objective 3.2.4) 3.2.4.2 The spread of wilding exotic vegetation is avoided. 3.2.4.5 Public access to the natural environment is maintained or enhanced.
- 3.2.5 Retention of the District's distinctive landscapes (rural Character Landscapes) 3.2.5.5 Within Rural Character Landscape, adverse effects on landscape character and visual amenity values from subdivision, use or development are anticipated and effectively managed through policies and rules, so that: a. landscape character is maintained; and b. visual amenity values are maintained or enhanced.
- Natural Environment (Policy 3.3.20) Manage subdivision and / or development that may have adverse effects on the natural character and nature conservation values of the District's lakes, rivers, wetlands and their beds and margins so that their life-supporting capacity is safeguarded; and natural character is maintained or enhanced as far as practicable.

Chapter 6: Landscapes and Rural Character

The purpose of this Chapter is to provide greater detail as to how the landscape, particularly outside urban settlements, will be managed in order to implement the Strategic Objectives and Policies in Chapter 3. This chapter needs to be read with particular reference to the Chapter 3 Strategic Objectives and Policies, which identify the outcomes

the policies in this Chapter are seeking to achieve. The relevant Chapter 3 Strategic Objectives and Policies are identified in brackets following each policy. Landscapes have been categorised to provide greater certainty of their importance to the District, and to respond to regional policy and national legislation. Categorisations of landscapes will provide decision makers with a basis to consider the appropriateness of activities that have adverse effects on those landscapes.

6.3.1.3 Provide a separate regulatory regime for the Gibbston Valley (identified as the Gibbston Character Zone), Rural Residential Zone, Rural Lifestyle Zone and the Special Zones within which the Outstanding Natural Feature, Outstanding Natural Landscape and Rural Character Landscape categories and the policies of this Chapter related to those categories do not apply unless otherwise stated. (SO 3.1B.5 and 3.1B.6).

Chapter 42: Waterfall Park (special zone)

The site forms the Waterfall Park Zone. Regarding landscape matters, the key issues identified include: the natural and scenic values of the setting, protection of ecology of Mill Creek, consideration of district wise provisions.

In regard to landscape matters, the following Objectives and Policies are relevant:

- Visitor, residential and recreation facilities and activities developed in an integrated manner with particular regard for the natural and scenic values of the setting. (Policies 42.2.1.1, 42.2.1.2, 42.2.1.3)
- Development avoids adverse effects on Mill Creek and ecological values. (Policy 42.2.2.2)

RMM

ROUGH MILNE MITCHELL
LANDSCAPE ARCHITECTS

Northbrook Arrowtown
Graphic Attachment to Landscape Assessment Report

7 October 2022

Document Information

Project
Northbrook, Arrowtown
Address
Waterfall Park, Lakes Hayes-Arrowtown Road
Client
Winton Partners
Document
Graphic Attachment to Landscape Assessment Report
Status
For Resource Consent
Revision
0
Prepared By
Rough Milne Mitchell Landscape Architects Ltd
Project Number: 21304
Author: Emily-Rose Dunn
Peer Reviewed: Tony Milne

Disclaimer
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Contents

Context - Wakatipu Basin

Legend

Application Site

Site Context

Legend

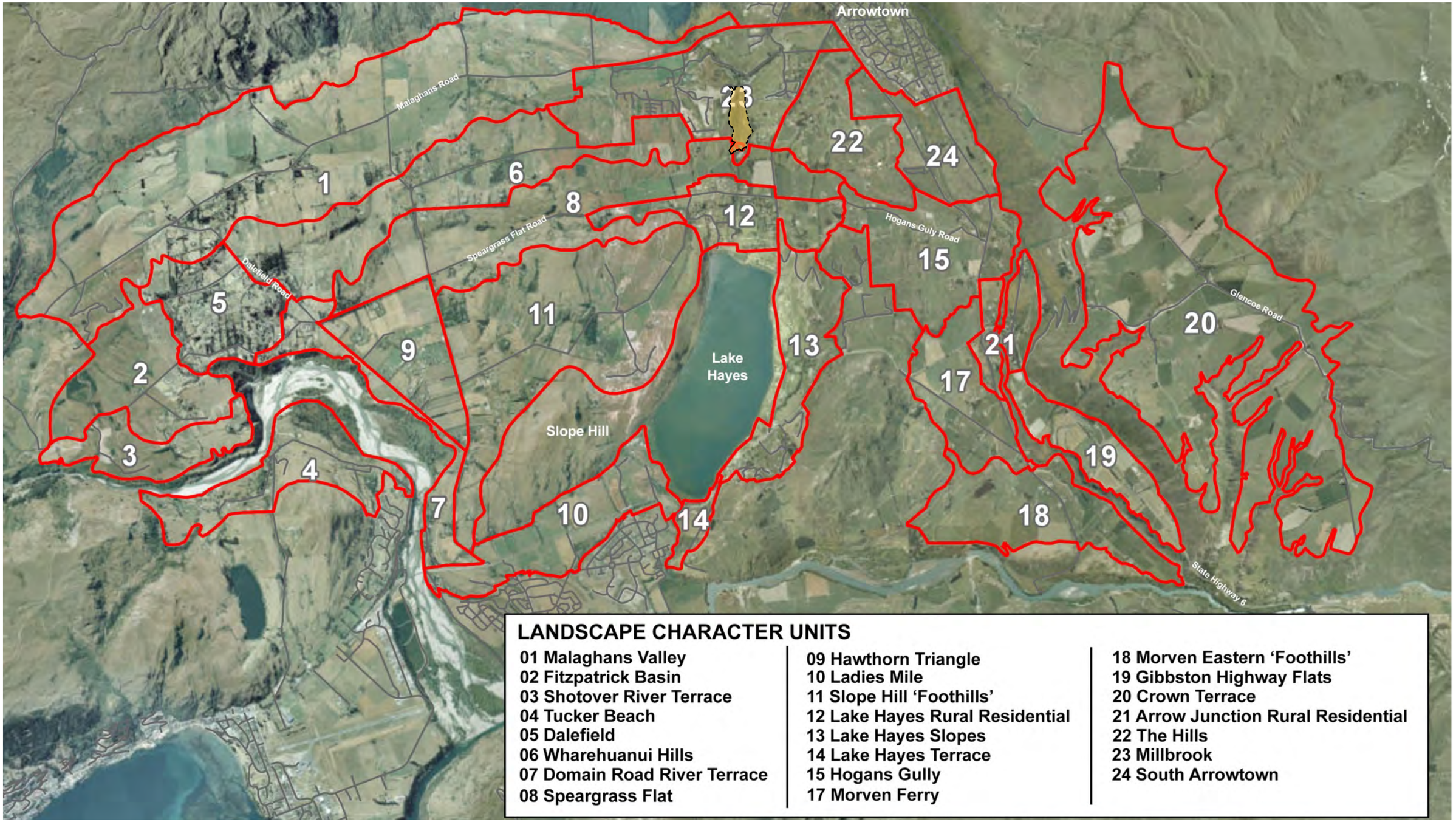
Application Site

Planning Context - Landscape Character Units

Legend

Approximate Extent of Application Site

Source: QLDC Proposed District Plan

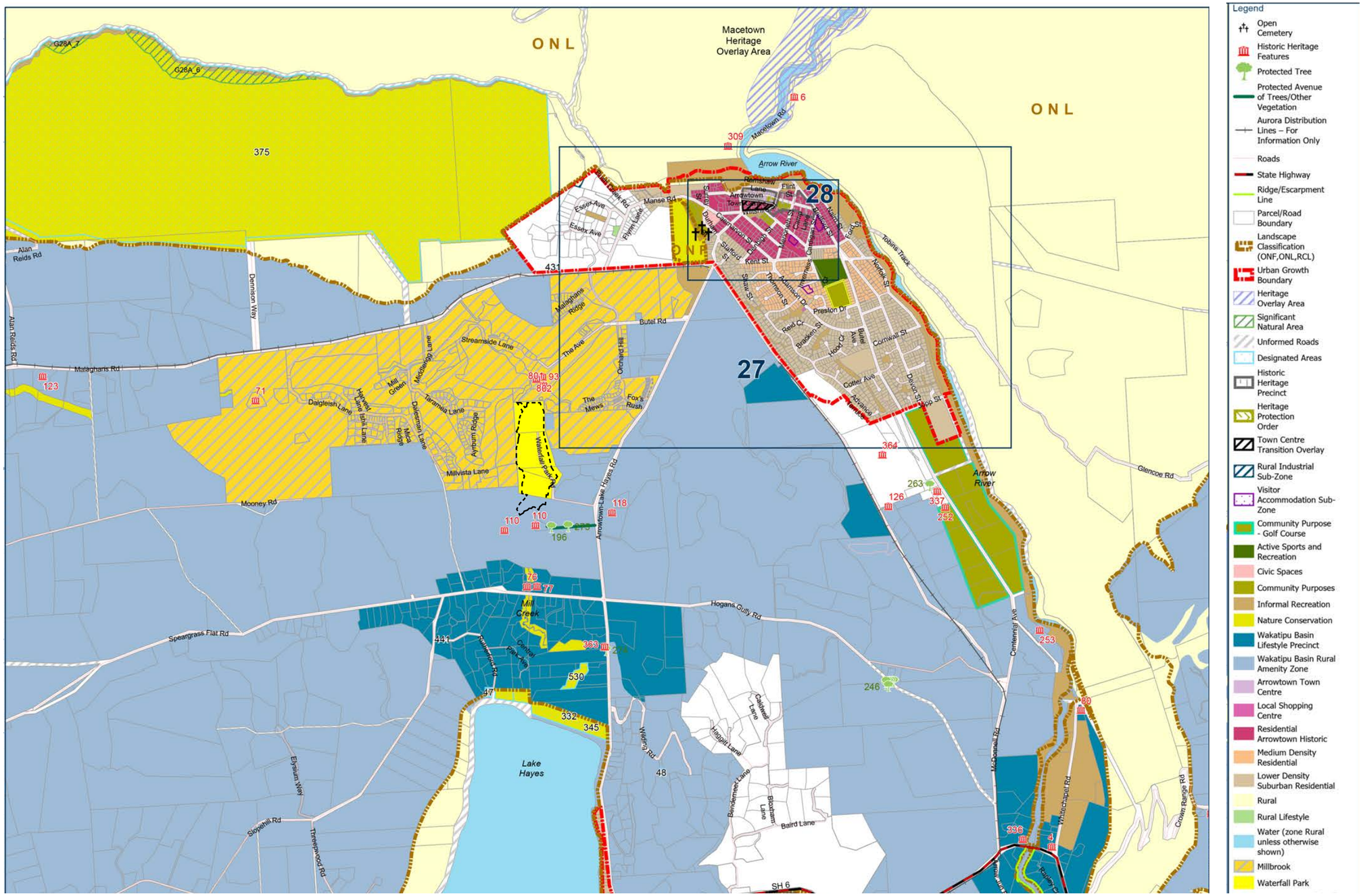


Planning Context - Proposed District Plan (PDP)

Legend

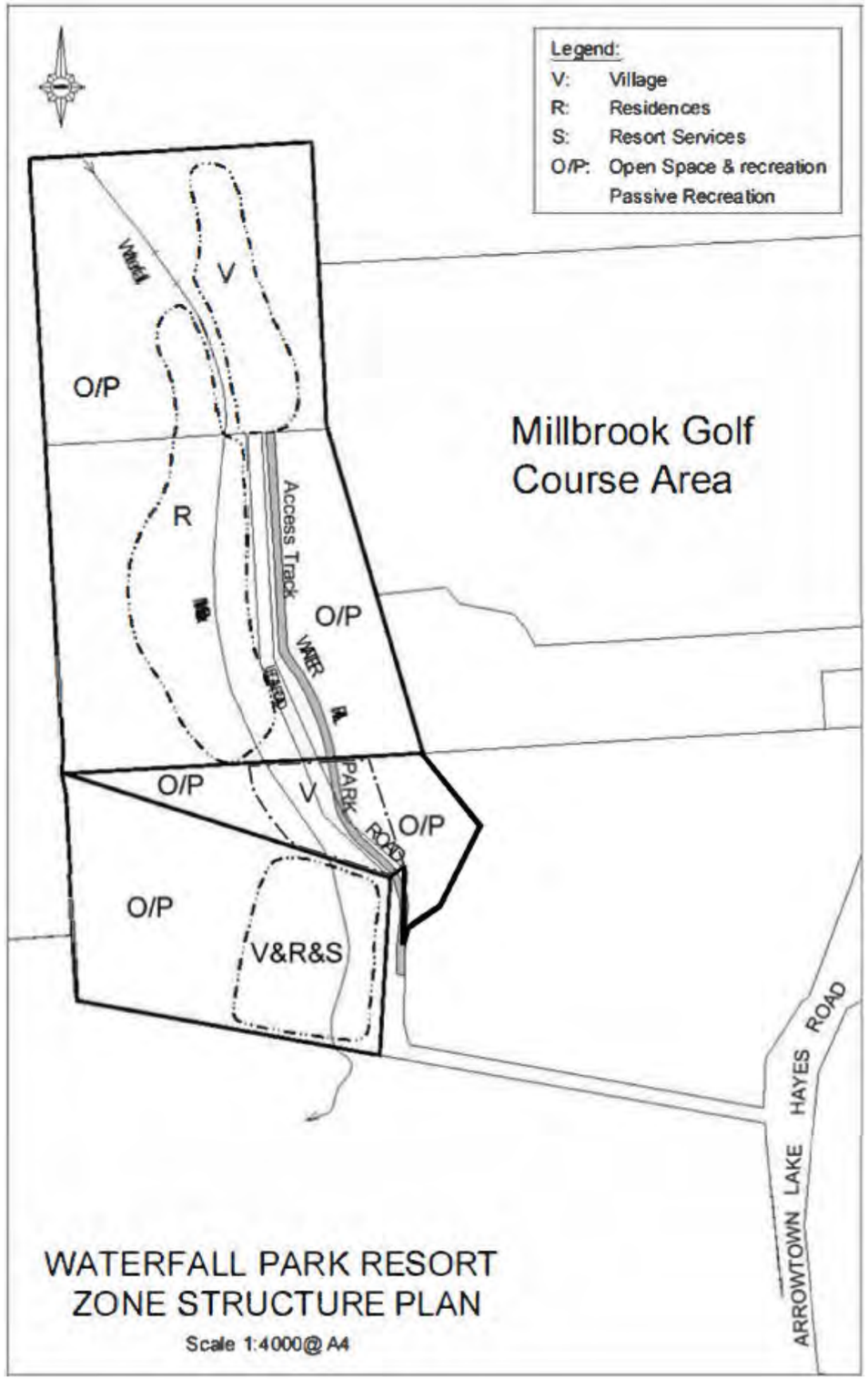
Approximate Extent of Application Site

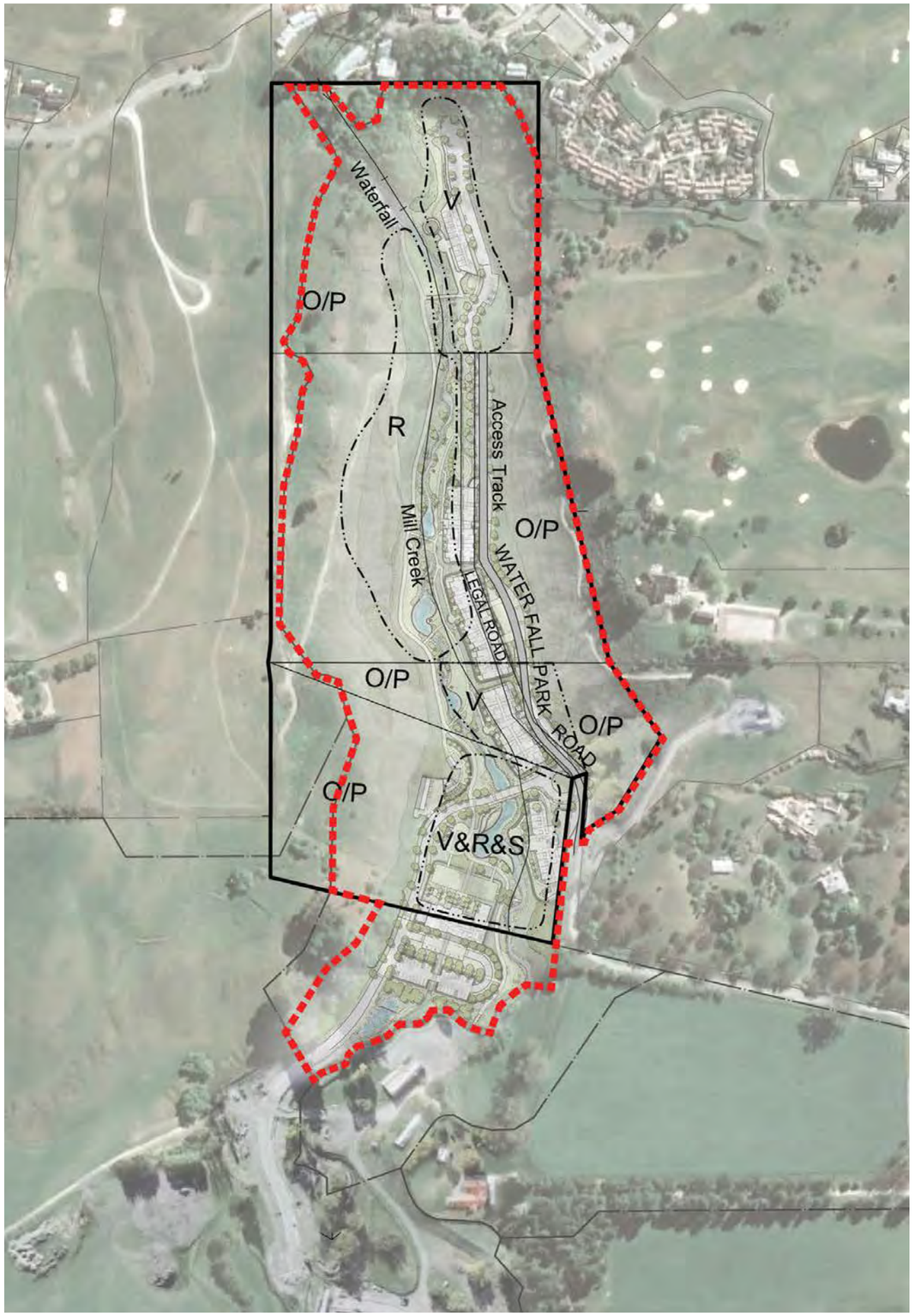
Source: QLDC Proposed District Plan



Zone Structure Plan

Source: QLDC PDP Chapter 42





Application Site

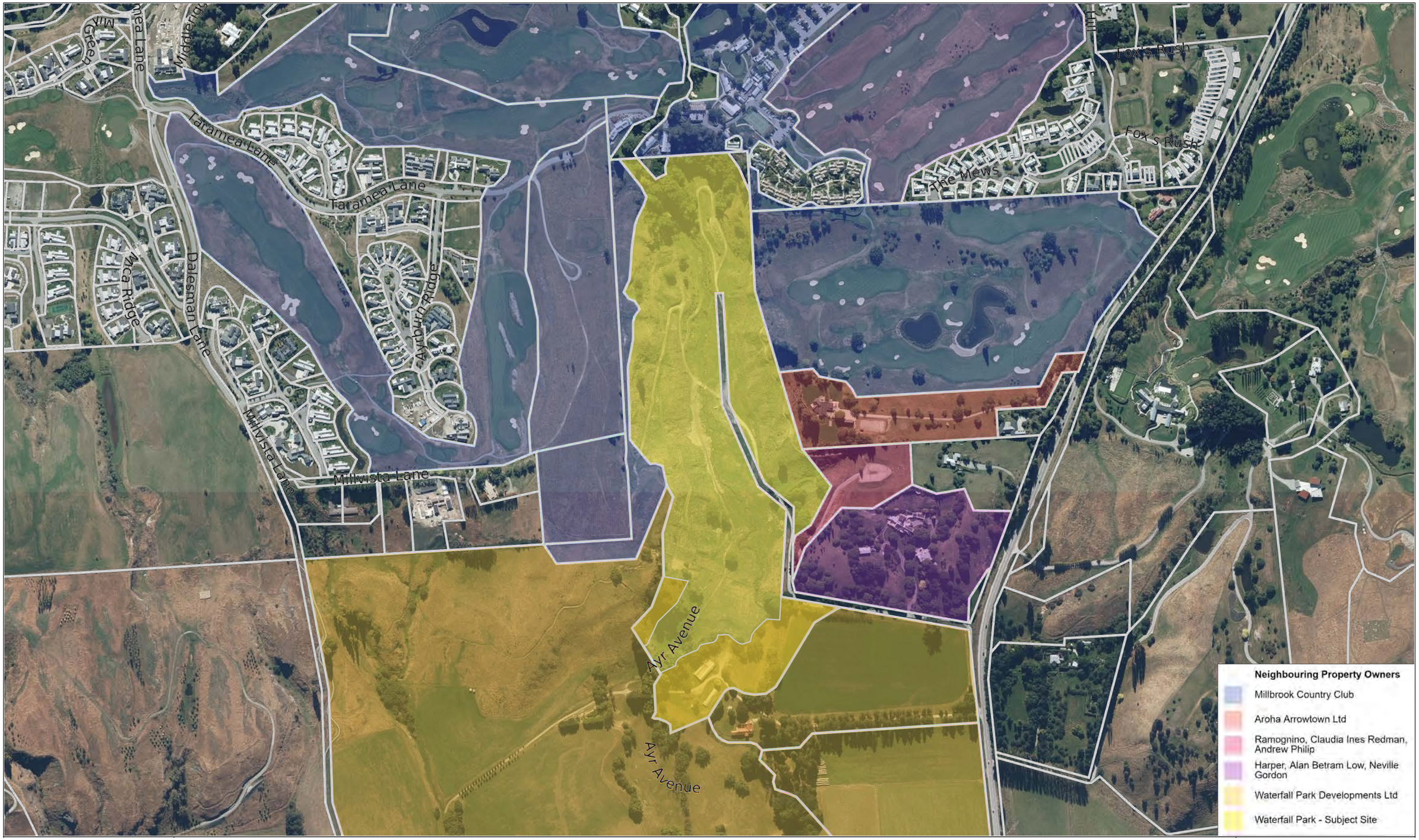
Source: Waterfall Park Development Limited

Legend

	Extent of Application Site
	Lot Boundary

Receiving Environment - Neighbouring Properties

Source: Grip Maps



Landscape Masterplan

Source: Winton Partners

NOT TO SCALE

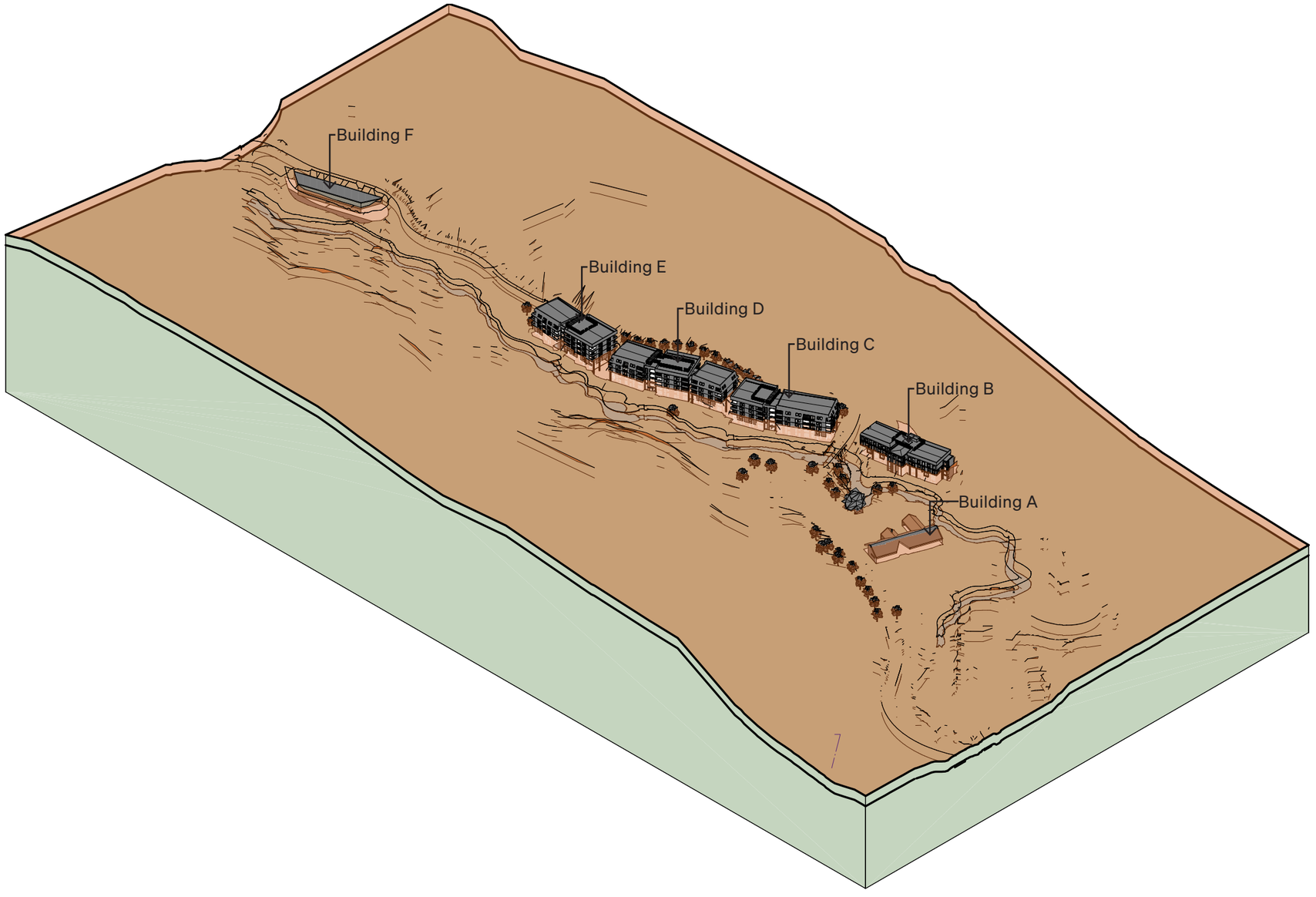
Waterfall Park Zone Height Restriction

Source: Woods Bagot

Axonometric

Legend

	Proposed Buildings
	8m Height Plane



Consented vs Proposed Buildings

Source: Woods Bagot

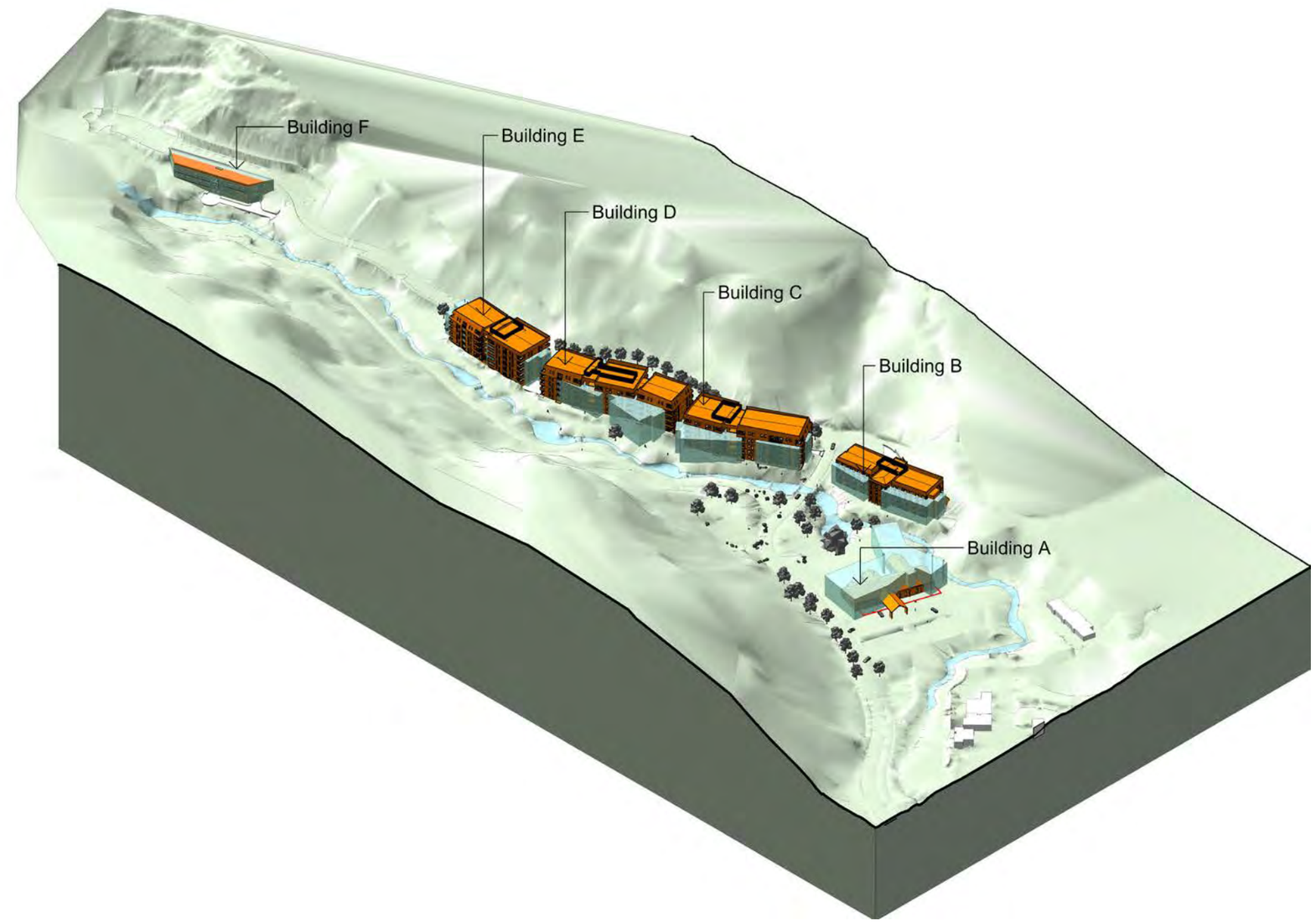
Legend

	Proposed Buildings
	Consented Baseline

Height Comparison Table

Building	Proposed Height (max)	Consented Height (max)
Building A	360.711	362.800
Building B	370.629	366.375
Building C	375.825	368.205
Building D	377.925	370.075
Building E	379.725	371.985
Building F	375.350	374.120

Axonometric



Existing Site Photos

A View towards the site from Ayr Avenue
B View down into site from the top of the western valley wall.
C View down into site from the top of the eastern valley wall.

A

B

C

Source: RMM photographs
Date: 16 June 2022

Existing Site Photos

A Notable features including historic waterwheel, waterfall, and cherry tree
B Existing construction works on valley floor and mature walnut tree
C View down into the site from the eastern valley wall
D View from the dell looking up towards the Millbrook Country Club Fitness Studio with the temporary services track in the foreground
E Existing retaining walls
F Creek works on the valley floor looking south

A

B

C

D

E

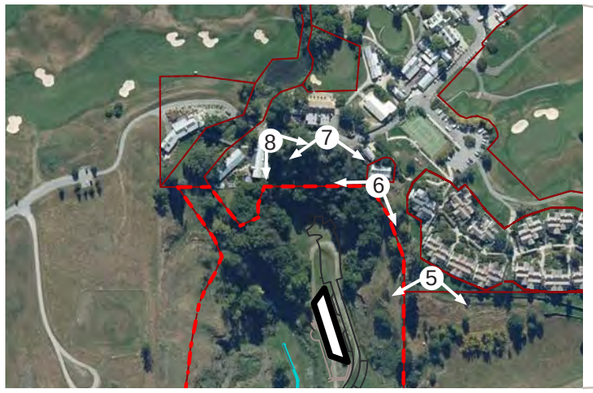
F

Source: RMM photographs
Date: 16 June 2022

Viewpoint Photo Locations

Legend

▬	Application Site
▬	Parcel Lines
	Photo Location

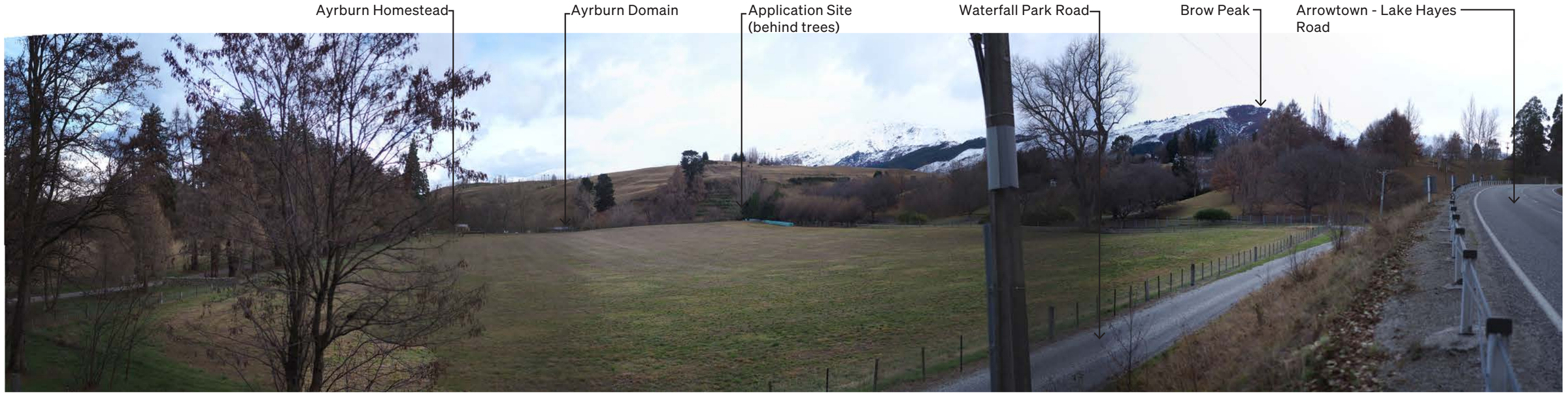


Scale 1:5,000 @ A3

Scale 1:10,000 @ A3

Source: LINZ Data Source

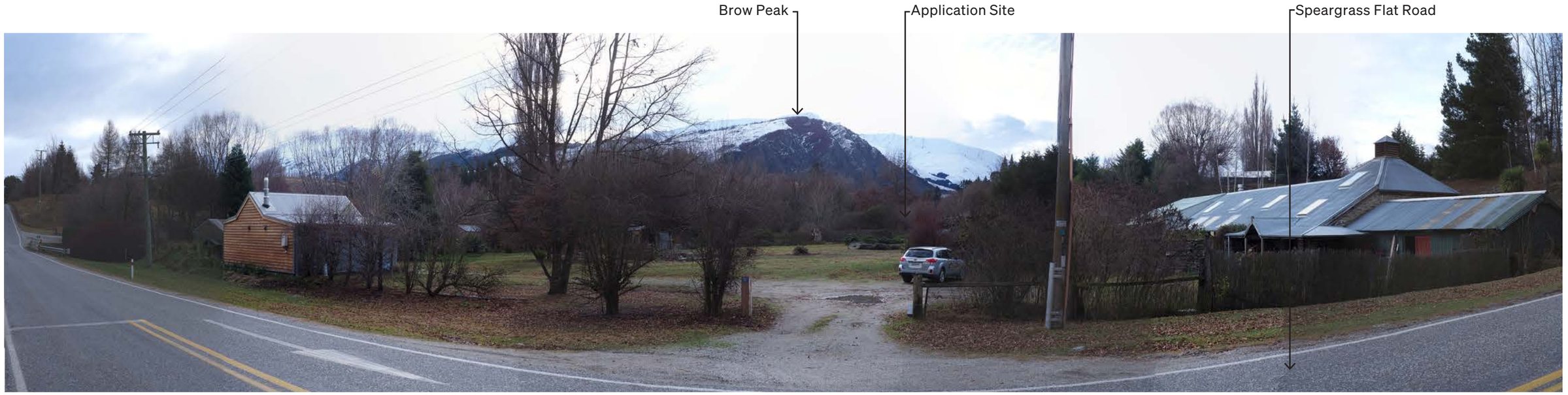
Viewpoint 1



Viewpoint Photograph 1: From Arrowtown - Lake Hayes Road (looking north-west) approximately 300m from the site

Photograph Information:
Date of Photography: 16 June 2022
Camera: Olympus OM-D E-M10 Mark II
Print Size: A3

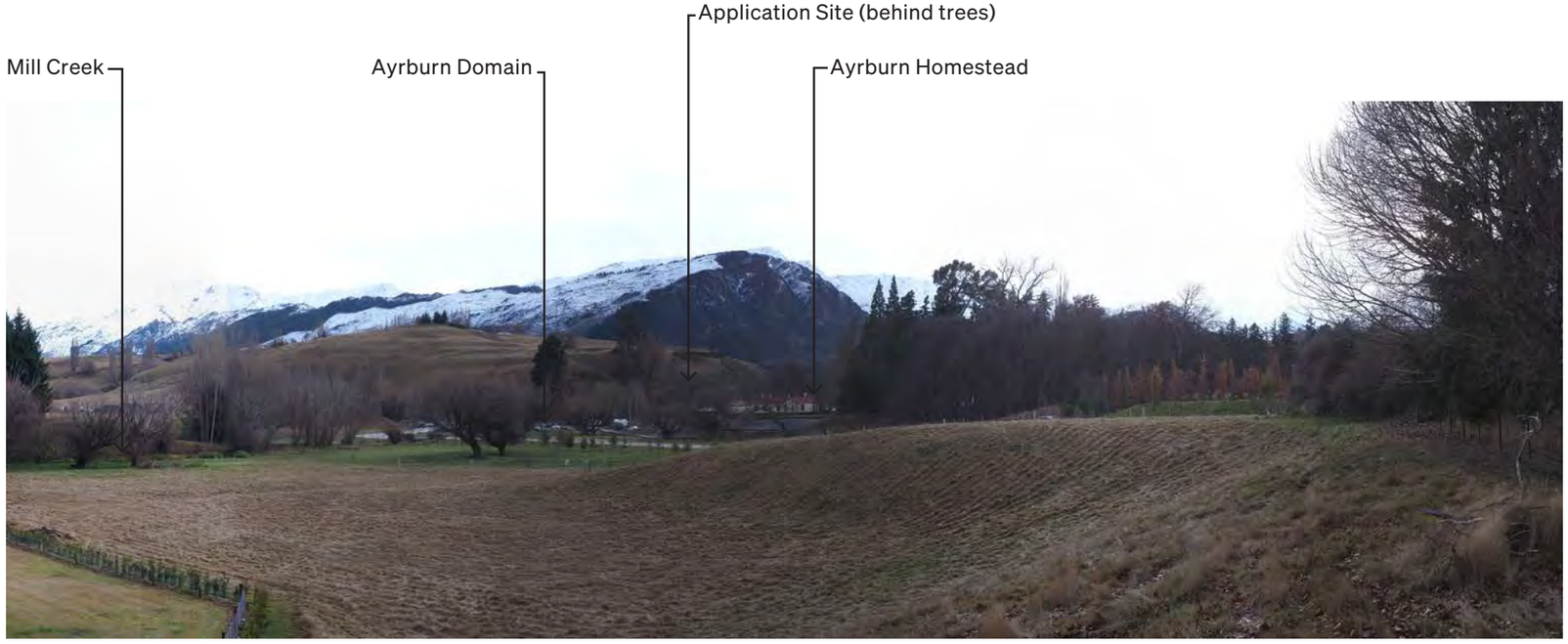
Viewpoint 2



Viewpoint Photograph 2: From 557 Speargrass Flat Road (looking north), approximately 600m from the site

Photograph Information:
Date of Photography: 16 June 2022
Camera: Olympus OM-D E-M10 Mark II
Print Size: A3

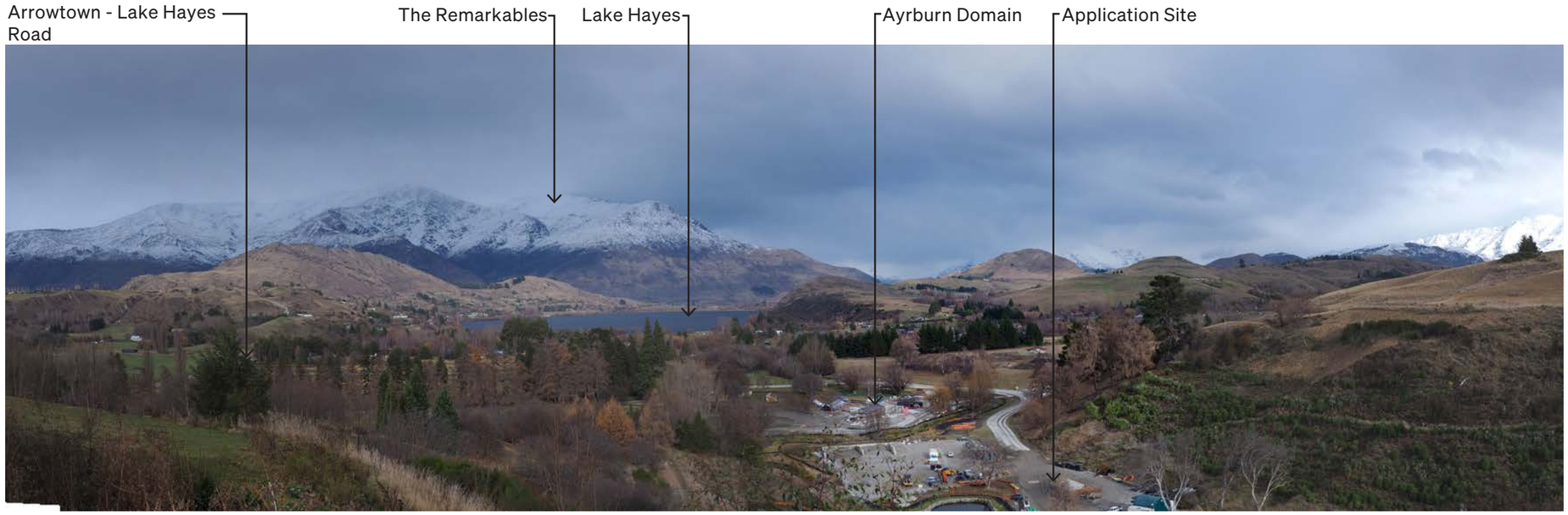
Viewpoint 3



Viewpoint Photograph 3: From the Waterfall Park boundary with 557 Speargrass Flat Road (looking north) approximately 470m from the site

Photograph Information:
Date of Photography: 16 June 2022
Camera: Olympus OM-D E-M10 Mark II
Print Size: A3

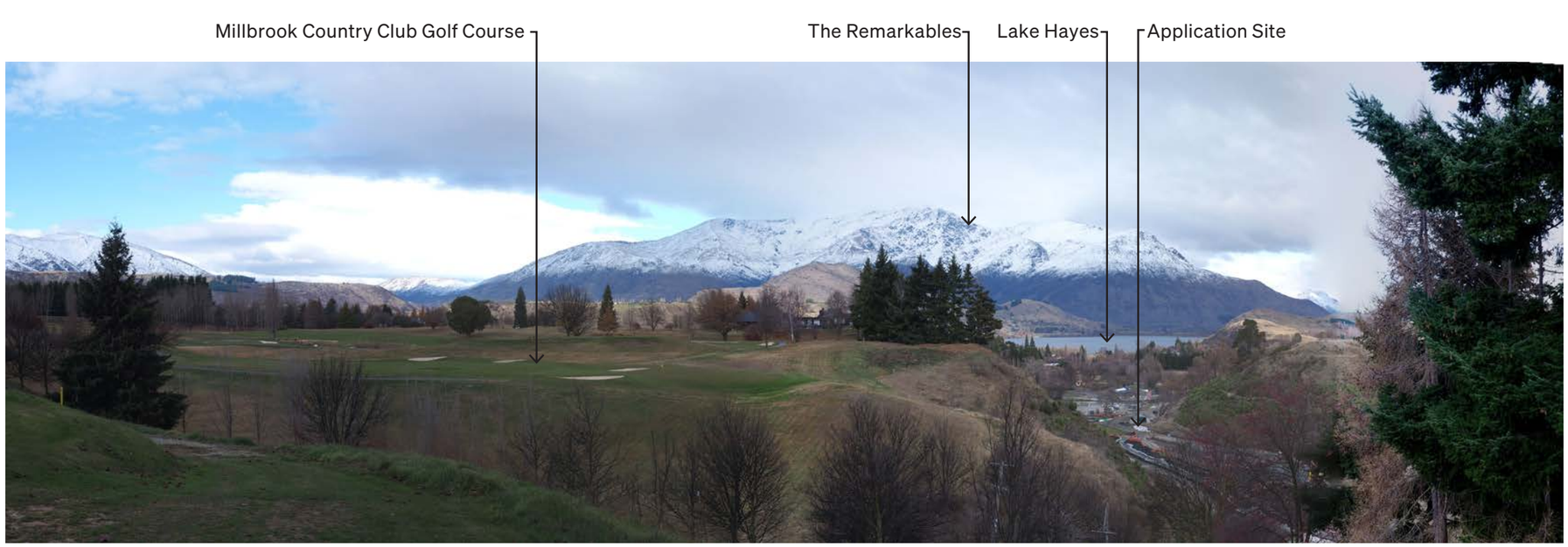
Viewpoint 4



Viewpoint Photograph 4: From the Waterfall Park boundary with 397 Arrowtown-Lake Hayes Road (looking southwest)

Photograph Information:
Date of Photography: 16 June 2022
Camera: Olympus OM-D E-M10 Mark II
Print Size: A3

Viewpoint 5



Viewpoint Photograph 5: From Millbrook Country Club Villas (looking south)

Photograph Information:
Date of Photography: 16 June 2022
Camera: Olympus OM-D E-M10 Mark II
Print Size: A3

Viewpoint 6

Viewpoint Photograph 6: From Millbrook Country Club Kobe restaurant (looking south)

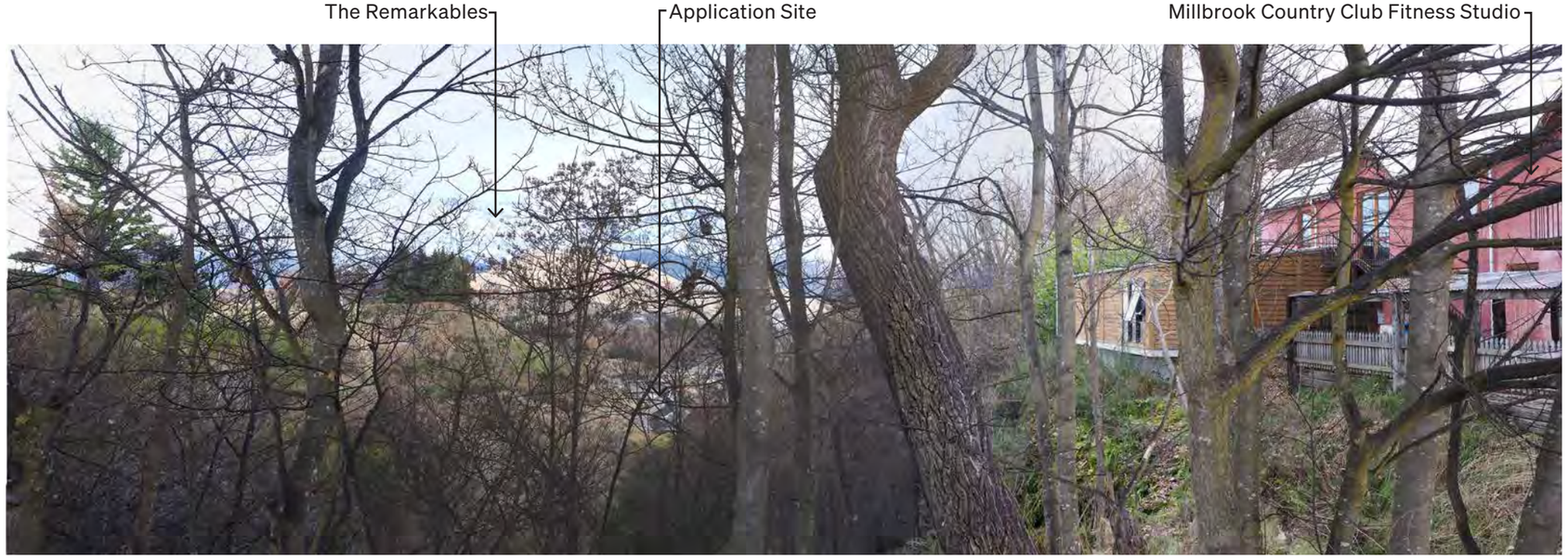
Photograph Information:
Date of Photography: 16 June 2022
Camera: Olympus OM-D E-M10 Mark II
Print Size: A3

Viewpoint 7

Viewpoint Photograph 7: From Millbrook Country Club path to the day spa (looking south)

Photograph Information:
Date of Photography: 16 June 2022
Camera: Olympus OM-D E-M10 Mark II
Print Size: A3

Viewpoint 8



Viewpoint Photograph 8: From Millbrook Country Club Fitness Studio (looking south)

Photograph Information:
Date of Photography: 16 June 2022
Camera: Olympus OM-D E-M10 Mark II
Print Size: A3

Viewpoint 9

Viewpoint Photograph 9: From Millbrook Country Club Golf Course (looking south east)

Photograph Information:
Date of Photography: 16 June 2022
Camera: Olympus OM-D E-M10 Mark II
Print Size: A3

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RMM

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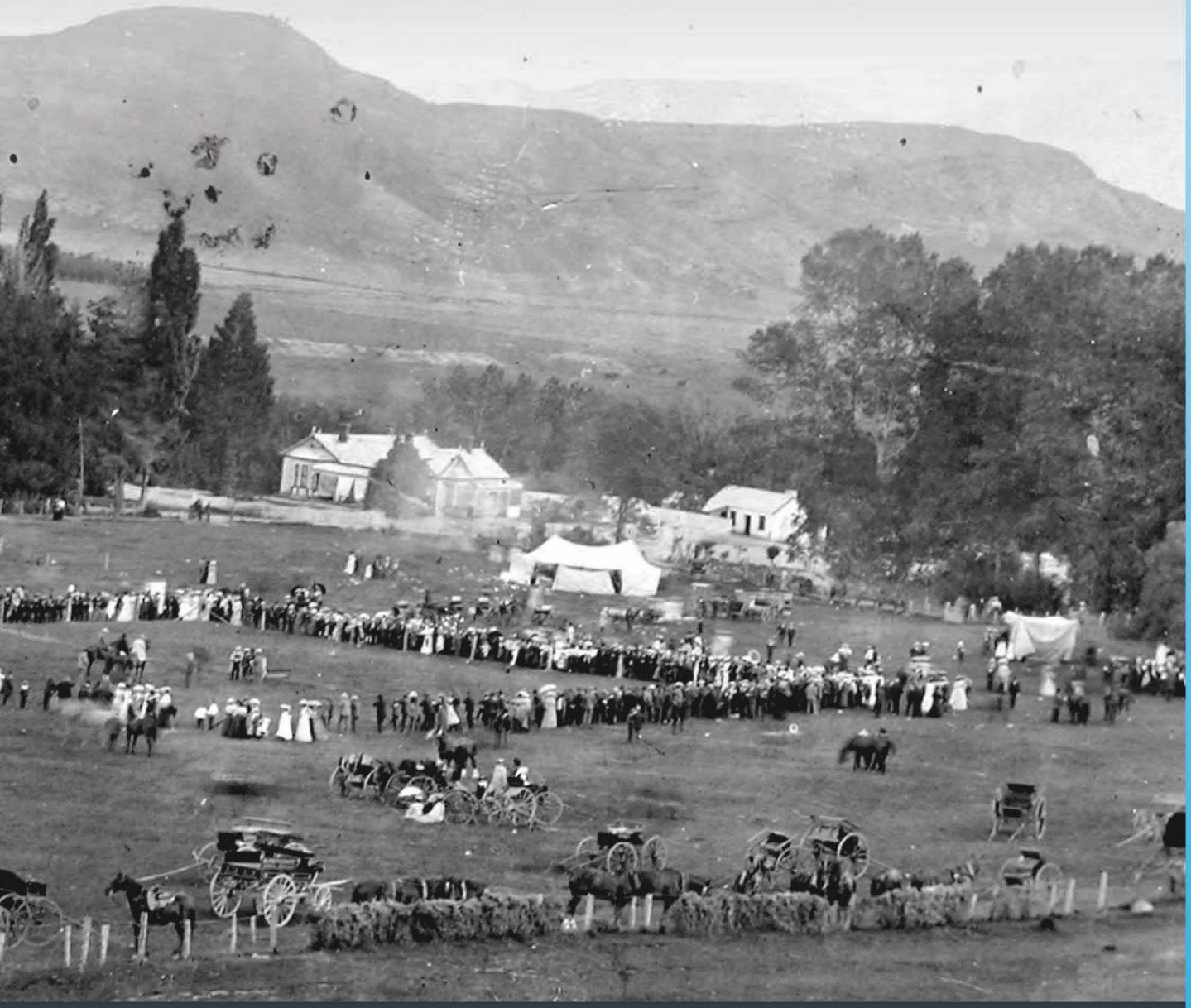
NORTHBROOK ARROWTOWN

Heritage Impact Assessment
March 2023



Origin
CONSULTANTS

1 March 2023

Heritage Impact Assessment: Northbrook Arrowtown (Lot 1 DP 540788)

Origin Consultants Ltd (Origin) has been instructed by Waterfall Park Developments Ltd (WPDL) to prepare a heritage impact assessment (HIA) for resource consent for the construction of the Northbrook Arrowtown later living development (Northbrook Arrowtown) within the Waterfall Park valley. The historic Ayrburn stone farm buildings are located immediately south of the site, located in the northern extent of Ayrburn Farm in the area known as Ayrburn Domain.

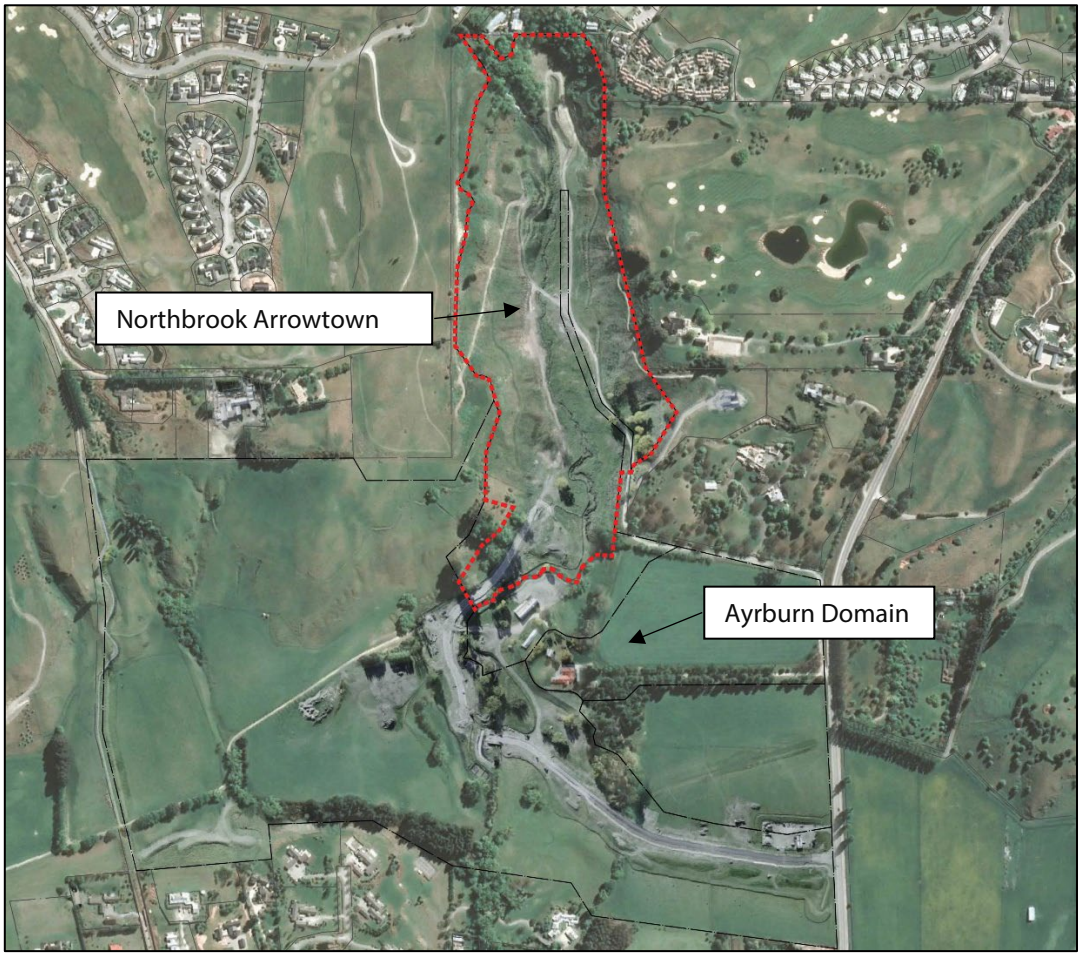


Figure 1. Northbrook Arrowtown site (outlined in red) and Ayrburn Domain.

Ayrburn Farm was established by 1867, with multiple stone buildings constructed around this date and a substantial timber homestead constructed near the turn of the century for William Paterson, an early settler in the Wakatipu Basin. The Paterson family prospered and during the 1870s extended their farming and pastoral interests to include the Ayrburn and Soho Runs on the Crown Range. Likewise, the farm site itself changed and developed over the years, in part due to Paterson's own development of his farming interests and in part due to external events such as fires that occurred in a number of the farm buildings.

The stone farm buildings that remain at Ayrburn Farm are a direct reflection of the economic and commercial needs of the time and of Paterson's success; they are large and substantially constructed. They included stone walls, timber floor and roof structures, and timber shingle and iron roof coverings.

Ayrburn Domain is currently under construction and includes the consented adaptive reuse of the stone farm buildings (the Stables, Cart Shed, and Dairy) into a hospitality precinct.

The proposed development includes the construction of Northbrook Arrowtown north of the stone farm buildings on the other side of Mill Creek.

Disclaimer

This assessment has been prepared in relation to the particular brief outlined above. The advice and/or information contained in this assessment may not be used or relied on in any other context for any other purpose. No responsibility is accepted for the use of any advice or information contained in it in any other context or for any other purpose.

The professional advice and opinions contained in this report are those of Origin Consultants, and do not represent the opinions and policies of any third party. The professional advice and opinions contained in this report do not constitute legal advice.

Methodology

Information in this assessment has been based on:

- Woods Bagot, Northbrook Arrowtown Resource Consent Scheme, dated February 2023;
- Winton, Northbrook Arrowtown Landscape Strategy, dated February 2023.

It is also based upon research provided from a variety of archival sources, reports, and information held by Origin. The principal research sources have been:

- Origin, Ayrburn Homestead and Farm Buildings Conservation Plan, October 2017 (Ayrburn Conservation Plan); and
- Queenstown Lakes District Council Heritage Inventory Register, Ayrburn Station, June 2016.

In general terms, this report follows an accepted best-practice approach as described in Sustainable Management of Historic Heritage Guidance Information Sheet 9 by Heritage New Zealand Pouhere Taonga in that it states: what heritage place is affected or involved; what work or changes are proposed; the principles that guide the assessment/heritage impact advice; and how the proposal measures up to the Regional and District Plan assessment standards (or other best practice standards).

Site Details

Address	Ayr Avenue, Arrowtown 9302
Legal Description	Lot 1 DP 540788
District Plan Zone	Waterfall Park Zone; Wakatipu Basin Rural Amenity Zone

Heritage Listing

The buildings at Ayrburn Domain are scheduled in the Queenstown Lakes District Council Proposed District Plan (PDP) as:

Ref. No.	Description	Legal Description (Valuation Reference)	Category
110	Ayrburn Homestead and Stone Farm Buildings	Lot 2 DP 540788 (house) and Lot 1 DP 540788 (Dennisons Farm) (2907113108, 2907113107)	2

Ayrburn Farm is registered on the New Zealand Archaeological Association's archaeological site recording scheme (ArchSite) as F41/578.

Location & Orientation

The Ayrburn stone farm buildings are located to the west of the Arrowtown-Lake Hayes Road on the edge of Mill Creek. Three stone farm buildings are located on Lot 1 DP 540788 – the Stables, Cart Shed, and Dairy. The Homestead and stone Cookhouse are located on Lot 2 DP 540788, an adjacent title (refer Figure 2).

Figure 2. Ayrburn Domain Masterplan.

Site Description

The core of the Ayrburn Farm site was concentrated around the original stone homestead, now described as the Cookhouse, and ancillary farm buildings adjacent to the Mill Creek. The buildings are situated at what would have probably been a natural focus for the siting and development of an early farm. The topography of the site, protected by a steep bank to the south and contained on the north and west by Mill Creek, would have seemed like an ideal place for Paterson to locate and construct his farm buildings.

Site History

A brief site history has been attached as Appendix A.

Stables

The Stables is the largest building on the site and, before being converted to a working woolshed, had stalls for nine horses, a tack room, a chaff room, and a large hayloft overhead. This was modified probably sometime

in the late nineteenth century with the construction of a large, timber framed woolshed on the north side that was later extended to the southwest. A stables building was constructed as part of the original farm phase in the 1860s, but later fires may have had some impact on the original building.

At present, the Stables extends a full 30 meters from east to west with a continuous gable roof and high stone walls. The building comprises three parts; a one and a half storeyed Stables and hay barn; a double height space at the western end; and a timber framed, lean-to shearing shed structure on the northern side.

Cart Shed

The Cart Shed is also large with four wide bays for carts and other farming machinery, possibly a milking shed at the north end and an enclosed stone room at the south. The Cart Shed is an extremely rare building type in the Wakatipu Basin. It is a long low gable-roofed structure built into the bank behind it with stone walls to the south, east, north and part west elevations. The west elevation is broken up into six bays, four of which are open to the farmyard, while one is a fully enclosed stone room and the last is partially enclosed with stone walls. The function of the building is presumed to be for the storage of farm equipment and in particular carts and wagons, since these could be simply backed into the building from the yard in front. It is less clear what function the enclosed stone room served, but presumably it was linked to the vehicles in some way.

Although all early farms must have had a space for storing wagons etc., the scale of this Cart Shed and the fact that it still remains makes it extremely special. The building suffered from a lack of maintenance for some time, with a small area towards the western end collapsing.

Dairy

The Dairy is a common feature of many early farms and was an essential element of such farms for the storage of milk and the preparation of butter. The Dairy is a small rectangular stone building set at the western end of the farmyard. Unlike the Cart Shed, this is a building type which is still relatively commonly found in old farms in the area. As a dairy, it needed to be capable of being kept cool, clean and hygienic. The Ayrburn Dairy follows these principles with thick stone walls, small windows and internal plastered walls.

Consenting Background

The following consents and authorities are considered to be relevant to this application:

Ref.	Description
RM180584	Application to construct a hotel and associated activities: a) Develop a 4+ star hotel, including two restaurants, a bar and conference centre/large event facilities within the reception building, four accommodation blocks providing for 380 guest rooms; b) Restore and repurpose the existing heritage farm buildings at Ayrburn to include a restaurant and bar, an outdoor equipment hire and retail shop and storage; c) Construct two new storage buildings for hotel furniture/equipment and grounds keeping/maintenance; d) Establish a wellness center, housing facilities such as a day spa, yoga studio, group therapy, and swimming pool; e) Construct a wedding chapel; f) Construct an outdoor pavilion within the dell to be used for events and weddings; g) Extensive re-vegetation and ecological enhancement of the valley landscape including the clearing of weed species and replanting of the valley walls and riparian margins of Mill Creek; h) Construct bridges, culverts and crossings for vehicles and pedestrians over Mill Creek;

	i) Construct weirs and undertake aesthetic creek widening for landscaping and the enjoyment of Mill Creek by visitors to the site. This consent has been partly implemented.
2018/123	Archaeological authority granted in September 2017 for earthworks at Waterfall Park and Ayrburn Domain for residential and commercial development affecting archaeological site F41/578. At that time, WPDL's plans were for a staged development including the creation of residential buildings lots on the western portion of the site, the creation of a homestead block around the Ayrburn Homestead, and a proposal for a hotel in the northern portion of the site.
2019/363	Archaeological authority granted by Heritage New Zealand Pouhere Taonga in December 2018 based on updated plans for the development of Waterfall Park and Ayrburn Domain.
RM190278	Application to vary RM180584 with updated landscape plans.
RM210591	Application to vary RM180584 and enable the commercial use of all the stone farm buildings within the Ayrburn Domain. This application was granted subject to conditions.
RM211193	Application to construct and establish a range of commercial activities: a) Restore and repurpose the existing heritage-listed Ayrburn Homestead and Cookhouse; b) Construct the Bakehouse (café, bakery, and office) to replace the maintenance shed within Ayrburn Domain consented under RM180584; c) 12 temporary activities per year within the Dell; and d) Associated car parking.

Identification of Significance

The following significance assessment has been adapted from the Ayrburn Conservation Plan to the evaluation criteria at 26.6 of the QLDC Proposed District Plan.

Historic and Social Value

Collectively, the Stables, Cart Shed, and Dairy have high historical significance due to their construction during an early and formative period in the settlement of the Wakatipu Basin. Ayrburn was also one of the earliest and most successful farms in the District and the intact nature of the surviving group of buildings is increasingly rare, so raising their historical significance.

The association of the buildings with the early, successful and well-documented settler, William Paterson, and his family's long occupation and development of the farm, make important contributions to the high historical significance of these buildings. Through this association, Ayrburn quickly became one of the focal farms of the district, further enhanced by its hosting of the annual A&P show from 1904 onwards, which was held for both important farming and social reasons in the District.

The Cart Shed is a rare regional survivor of a historic and specialised agricultural form – a cart shed (or implement shed) that was an essential component of most developed farm complexes.

Assessment – High

Cultural and Spiritual Value

The three stone farm buildings are significant for their representational value of farming, as a long-standing cultural practice in the District. Likewise, Ayrburn is both symbolic of, and evidence for, the establishment of farms as practices of European immigration and settlement in New Zealand and other colonised countries. The farm buildings can be said to identify with specifically Scottish immigration and therefore contribute to

the development of Otago farming culture and practices; for example, dominantly stone buildings grouped around a central yard with an adjacent small homestead. This form follows an English/Scottish farm model rather than an Australian one, where farm buildings tended to be much more spread out.

The buildings are considered to have no spiritual value.

Assessment – High (Cultural)

Architectural Value

The architectural significance of the buildings derives from the traditional materials and construction in the local vernacular style, featuring limewashed stacked stone walls and a principal gabled roof clad with corrugated iron sheeting.

Significance is also found in the large scale, proportions and strong form of the Stables, derived from its original agricultural purpose. The gabled, low-slung and elongated form of the Cart Shed creates a distinctive character, which is enhanced by, and grounded on its agricultural origin. The Dairy particularly derives significance from the 'form follows function' principle of needing an enclosed, cool space to store and prepare dairy products.

Assessment – High (Stables); Moderate (Cart Shed & Dairy)

Townscape and Contextual Value

The group significance of the buildings is high due to the unity of scale, materials, and function of the buildings. Together, the buildings provide a pleasing experience of old and weathered stone buildings. The Cart Shed and Stables are particularly dramatic and aesthetically powerful building forms.

The surviving farm buildings form a cohesive agricultural group that relates closely to its topographical setting. The central, open farmyard surrounded by the extant buildings, which was arranged on a typical British or English farmyard plan, would have been even further defined by the presence of earlier farm structures no longer present, but identified in the historic record (for example, the chaff house and working men's quarters). The current curtilage of the three farm buildings continues to reflect their early location in a natural bend of Mill Creek and their footprints appear to closely reflect those of their earlier forms, particularly in the case of the Cart Shed and Dairy.

Assessment – High

Rarity and Representative Value

Whilst the use of stone for agricultural buildings of this nature is not uncommon, the substantial size of the building and the use of stone for its walls does signifies the confidence with which Paterson built this part of the farm. There are few other examples of similar collections of buildings in the Wakatipu Basin.

Assessment – High

Technological Value

The Stables demonstrates a medium level of technological significance derived from its specialised agricultural form and function as a stables block that has been adapted and expanded to accommodate a woolshed and shearing stand.

For the most part, the Cart Shed demonstrates a relatively low level of technological significance derived from its form and materials. The timber shingle roof cladding that remains under the corrugated iron is a reasonably rare survivor from the days when roofs were finished with locally-sourced materials before galvanised iron became readily available.

The Dairy demonstrates a low level of technological significance derived from its specialised agricultural form and function as a dairy. Its technological construction demonstrates traditional, vernacular methods of building.

Assessment – Moderate (Stables & Cart Shed); Low (Dairy)

Archaeological Value

The various interventions and modifications to the Stables and its curtilage since its construction in the mid-19th century have resulted in a wealth of built archaeological features that provide rich evidence of the continued development, adaptation to new farm uses, and reinvention of the building's form. The uncertainty surrounding the origination and development of the woolshed addition creates the possibility that the current woolshed footprint overlies a 1940s yard and a circa 1900 woolshed structure adjoining the stables. Graffiti found in the woolshed dates to 1902.

The rare surviving early form and materials of the Cart Shed contribute to its high archaeological significance as a specialised farm building, which has the potential to provide further archaeological evidence for its original use and construction.

Although a relatively common form of structure within a mid-19th century farming context, the highly original nature, form and possibly undisturbed curtilage of the Dairy, may provide further archaeological evidence for its original use and construction.

Assessment – High

Summary of Proposed Works

The following provides a summary of the proposed works (as relevant to this current assessment):

- **Building A** – A main arrivals and amenities building with a pool, gym, reception, cinema, library, and café. Building A is a single storey building facing the Ayrburn Domain, with timber shingle roof and cladding, stacked stone cladding, and timber louvres.
- **Building B** – A care building including 23 care suites and 12 serviced apartments. Building B is a four-storey modular building. It has a modernised hipped roof form, with standing seam metal roofing, timber cladding, GRC panels, and windows with timber surrounds.
- **Buildings C-E** – Three five-storey residential buildings containing 148 residential apartments. These buildings also have a modular design, with some slight variations, and the exterior materials are the same as Building B.
- **Building F** – A standalone boutique hotel and spa.
- Some small ancillary buildings and maintenance sheds.

A one-way circulation road and carparking area (with 44 carparks) will be located to the south of Building A. Planting is proposed on the southern side of this carparking area, with a visual link retained between Building A and Ayrburn Domain. After crossing Mill Creek, vehicle circulation throughout the site is located to the east of Buildings B-E.

Assessment of Effects on Heritage

The following section assesses the nature and magnitude of the effects of the proposal on the site's heritage significance. This assessment has been carried out in accordance with the relevant provisions of the QLDC PDP and heritage best practice. For ease of reference, relevant provisions and clauses have been reproduced in italics below.

Receiving Environment

As outlined above, resource consent has been granted to develop the site of Ayrburn Farm with the construction of a 380-room hotel and associated carparking/circulation for visitors. Consent was also granted for the adaptive reuse of the stone farm buildings as Ayrburn Domain. The Ayrburn Domain component and development of Mill Creek of RM180584 are currently being implemented. The Ayrburn Homestead and stone

Cookhouse (on an adjacent title) are also proposed for adaptive reuse as a restaurant and outdoor bar/folly (consented under RM211193).

Origin's HIA for RM180584 recognised that agriculture in the Wakatipu Basin had declined, leaving Ayrburn Farm disused and redundant. Instead, the economic drivers for the area are tourism and residential development. The proposed use of the Ayrburn Farm site is designed to give the buildings a viable, economic future in which they are repaired, their heritage values retained, they are accessible to the public and, and they have a valuable purpose. Adaptation of the site from agricultural use to commercial is a major change; however, the alternative was to leave the heritage features which would ultimately result in their demise. For the stone farm buildings, good heritage practice involved the successful management of change, mitigating adverse impacts, finding opportunities for beneficial ones, and making the buildings available for the public to enjoy.

The current proposal is similar to the consented hotel development in terms of building scale and location. The proposed carparking and circulation routes are also proposed in the same locations, with small changes to layout proposed. Comparison of the current proposal with the previous hotel development proposal indicates two major changes:

- A smaller arrival building (Building A), with changes in form and materials – Under the current proposal, Building A is smaller with a shorter southern elevation facing Ayrburn Domain. The proposed materials include timber shingles and stacked stone, materials present in the historic buildings of Ayrburn Domain.
- Changes in building form and materials of Buildings C-E – Buildings C-E appear to be in the same location; however, the current proposal includes five-storey buildings, rather than four-storeys. The current proposal also adopts a modernised, hipped roof form of buildings clad in timber and GRC.

Heritage Charters & Guidance

ICOMOS New Zealand Charter 2010[1]

All conservation work should be carried out in accordance with the ICOMOS New Zealand Charter 2010. The following clause is considered relevant to the current proposal:

> *Clause 8. Use*
>
> *The conservation of a place of cultural heritage value is usually facilitated by the place serving a useful purpose.*
>
> *Where the use of a place is integral to its cultural heritage value, that use should be retained. Where a change of use is proposed, the new use should be compatible with the cultural heritage value of the place, and should have little or no adverse effect on the cultural heritage value.*
>
> *Clause 9. Setting*
>
> *Where the setting of a place is integral to its cultural heritage value, that setting should be conserved with the place itself. If the setting no longer contributes to the cultural heritage value of the place, and if reconstruction of the setting can be justified, any reconstruction of the setting should be based on an understanding of all aspects of the cultural heritage value of the place.*

'Setting' is defined as: *the area around and/or adjacent to a place of cultural heritage value that is integral to its function, meaning, and relationships. Setting includes the structures, outbuildings, features, gardens, curtilage, airspace, and accessways forming the spatial context of the place or used in association with the place. Setting also includes cultural landscapes, townscapes, and streetscapes; perspectives, views, and viewshafts to and from a place; and relationships with other places which contribute to the cultural heritage value of the place. Setting may*

[1] Accessed at: https://icomos.org.nz/wp-content/uploads/2020/12/NZ_Charter.pdf.

extend beyond the area defined by legal title, and may include a buffer zone necessary for the long term protection of the cultural heritage value of the place.

Historic England, GPA4: Enabling Development and Heritage Assets 2020[2]

This planning note provides guidance on enabling development that may not comply with local or national planning policies but would secure the future conservation of a heritage asset or feature. It recognises that conflict with planning policies may be justified if the development proposed would secure the future conservation of the asset(s) and the wider benefits outweigh the disbenefits of not adhering to those policies.

District Plan Matters

Rule 26.5.9 provides that development within the setting or extent of place is a restricted discretionary activity.

> *For the purpose of this rule, development means new buildings and structures, earthworks requiring consent under Chapter 25, car park areas exceeding 15m2 within the view from a public road, and car park areas exceeding 40m2 located elsewhere.*
>
> *For Category 2 and 3 heritage features, discretion is restricted to:*
>
> *a. Development within the setting, or within the extent of place where this is defined in the Inventory under Rule 26.8;*
> *b. The extent of the development and the cumulative effects on the heritage feature, and its setting or extent of place;*
> *c. The effects on the heritage values and heritage significance of the feature in accordance with the evaluation criteria in Section 26.6;*
> *d. The operational reasons associated with the use of the heritage feature for the development to be located within the setting or extent of place.*
>
> *Note: This rule does not apply to any use of buildings, structures and land other than the activities specified above.*

'Setting' is defined as: *the area around and/or adjacent to a heritage feature listed under the Inventory of Listed Heritage Features in Section 26.8 and defined under 26.8.1, which is integral to its function, meaning, and relationships, and which is contained in the same legal title as the heritage feature listed on the Inventory of Listed Heritage Features.*

Assessment

The following provides an assessment against the matters of discretion reserved in the District Plan, taking into account the relevant heritage charters and guidance:

a. Development within the setting, or within the extent of place where this is defined in the Inventory under Rule 26.8;

As described above, four new buildings and associated carparking areas are proposed within the same legal title as the stone farm buildings (Stables, Cart Shed, and Dairy). Earthworks are also required for the development.

As agricultural buildings, the appearance of a rural setting is integral to the meaning of the stone farm buildings. The surrounding, undulating and fertile landscape of the Wakatipu Basin, together with Mill Creek, provided some key necessities for Ayrburn Farm to thrive, amply demonstrated by the construction of a second, much larger and grander homestead to the east of the farmstead in the 1890s.

[2] Accessed at: https://historicengland.org.uk/images-books/publications/gpa4-enabling-development-heritage-assets/heag294-gpa4-enabling-development-and-heritage-assets/.

The stone farm buildings form a cohesive group clustered around a central yard and, as such, the buildings have a strong relationship with each other. Together, they present an intact group of agricultural buildings demonstrating their early functions and purpose on Ayrburn Farm. The buildings' relationship with Mill Creek also has some importance, as the early successes of the farm relied on access to water and, in the early 1900s, Mill Creek was also utilised as a source of power.

RM180584 recognised that the stone farm buildings were redundant for their original agricultural use and an adaptive reuse was needed if the buildings were to be valued for the future. The consenting of the new hotel buildings to the north also recognised that the future of this land no longer lies in agriculture, but in development for the new 'industries' of the Wakatipu Basin – tourism and residential/commercial development.

b. *The extent of the development and the cumulative effects on the heritage feature, and its setting or extent of place;*

As outlined above, the appearance of a rural setting is integral to the interpretation of the buildings. As such, any development within the setting of the stone farm buildings will have an impact on the heritage features. However, consents have been granted to modify the rural nature of the area and for the adaptive reuse of the stone farm buildings.

Largely, the proposed development is located to the north of the stone farm buildings, with Building A in closest proximity to the stone farm buildings and the southern elevation most visible from the Ayrburn Domain. Comparison with the previously consented hotel development identifies that this entrance building is much smaller in scale: It is one-storey (versus two) and the southern elevation is approx. 40m in length, whereas the consented hotel building was approx. 61m. There are also changes in design and materials with Building A adopting a gabled form and clad in stacked stone. While reflecting the traditional materials and form of the stone farm buildings, Building A is clearly delineated as a modern building.

Due to their location, the proposed buildings do not interfere with the grouping of the stone farm buildings and their relationship with Mill Creek. While they will have an impact on the overall appearance of the rural setting, this impact will be similar to the consented hotel development. The current proposal also includes a modern form, inspired by a hipped roof, with natural materials.

Hard surfaced carparking and parking bays are also proposed throughout the site. These will largely be obscured behind the proposed buildings, with a visible parking area positioned to the south of Building A. The introduction of carparking will be mitigated by the proposed landscaping design. The intent of the landscaping design is to retain the historic farmyard character of the setting, while encouraging visual and physical access to Mill Creek.

Any required earthworks are considered to have a temporary effect only.

c. *The effects on the heritage values and heritage significance of the feature in accordance with the evaluation criteria in Section 26.6;*

The historic, social, and cultural values and significance of the stone farm buildings are tied to their association with William Paterson and the early successes of the Ayrburn Farm. The use of the site may improve knowledge of the history of the site, with a positive impact on historic and social values.

The buildings' architectural significance is derived from their scale and use of traditional materials. In particular, the Stables and Cart Shed are large scale buildings constructed in a gabled form. The introduction of additional large-scale buildings near the stone farm buildings will have some impact on their architectural significance

Together, the buildings have high significance as a unified group of agricultural buildings centred around an open farmyard. Due to the location of the proposed development, the relationship between the

buildings is unaffected. The introduction of modern buildings and carparking is expected to have an impact on the buildings' contextual significance by affecting the appearance of a rural setting; however, these effects are no more than what has already been consented as part of RM180584. This impact is mitigated by the proposed development being located to the north of the stone farm buildings with the land to the east, bordering Arrowtown-Lake Hayes Road, retaining a rural appearance.

As no physical changes are proposed to the buildings in this application, the expected impact on the buildings' technological and archaeological values will be limited.

d. *The operational reasons associated with the use of the heritage feature for the development to be located within the setting or extent of place.*

Ayrburn Domain and the Ayrburn Domain Extension, comprising the adaptive reuse of the stone farm buildings and the Homestead into a hospitality precinct, has recently been consented. In RM180584, the proposed hotel development close to the stone farm buildings was seen as a positive driver and enabler for their adaptive reuse. It provided the economy and greater public appreciation, which would support the stone buildings in the future.

The success of the adaptive reuse of the stone farm buildings continues to rely on a nearby development to supply patronage to the hospitality venues. It is considered that there will be no adverse change to these stimuli by the replacement of the hotels with Northbrook Arrowtown; the captive audience for their use and enjoyment will remain.

Easily accessible carparking is crucial for the success of the use of the site as Northbrook Arrowtown and a hospitality precinct.

<u>District Plan Objectives & Policies</u>

The following District Plan objectives and policies are considered to be relevant to the current proposal:

26.3.1 Objective – The District's historic heritage is recognised, protected, maintained, and enhanced.

26.3.1.3 Protect historic heritage values while managing the adverse effects of land use, subdivision and development, including cumulative effects, taking into account the significance of the heritage feature, area or precinct.

26.3.1.4 Where activities are proposed within the setting or extent of place of a listed heritage feature, to protect the heritage significance of that feature by ensuring that:

- *a) the form, scale and proportion of the development, and the proposed materials, do not detract from the listed heritage feature located within the setting or extent of place;*
- *b) the location of development does not detract from the relationship that exists between the listed heritage feature and the setting or extent of place, in terms of the values identified for that feature;*
- *c) existing views of the listed heritage feature from adjoining public places, or publicly accessible places within the setting or extent of place, are maintained as far as is practicable;*
- *d) hazard mitigation activities and network utilities are located, designed, or screened to be as unobtrusive as possible.*

26.3.1.7 Protect archaeological and historic heritage values of listed archaeological sites while managing the adverse effects of land use and development, including cumulative effects.

The significance of the buildings on Ayrburn Farm are tied to their location within a rural setting and orientation around a central farmyard; however, an agricultural land use is no longer viable. This was recognised in approved consents which has enabled the adaptive reuse of the historic stone farm buildings and Homestead and construction of a hotel complex.

The form, scale and proportion of the current proposal is similar to the existing consent. While large, these buildings are located to the north of the Ayrburn Domain, which retains a relationship with the rural setting

adjacent to the Arrowtown-Lake Hayes Road. The stone farm buildings also retain their relationship with each other and Mill Creek. The construction of a Northbrook Arrowtown will also provide a permanent patronage to the Ayrburn Domain. This provides the site with a new, viable purpose, which will provide ongoing maintenance and use of the heritage features.

Conclusion

Resource consent has been granted for the development of the site and adaptive reuse of the historic buildings as part of a hospitality and commercial precinct. Consent has also been granted for the construction of a hotel in the Waterfall Park valley. The current proposal is similar to the consented hotel development in terms of building scale and location, with a reduction in the size of the arrivals building (Building A) which is located closest to the stone farm buildings. Building A also adopts a gabled form with stacked stone cladding, reflecting the form of the historic buildings but clearly delineated as a modern addition to the site. The wider Northbrook Arrowtown development is located to the north of Building A and is not considered to interfere with the key relationships between the stone farm buildings. In RM180584, the proposed development near the historic buildings was seen as a positive driver, providing ongoing patrons to support the adaptive reuse of the buildings.

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Appendix A – Brief Site History

The following history has been adapted from the Ayrburn Conservation Plan.

The early European exploration and settlement of the Wakatipu Basin was by pastoralists and in 1859 William Gilbert Rees established a homestead on the lake shore in the location of present-day Queenstown. This initial settlement was quickly followed by the Otago goldrushes of the early 1860s, which brought large numbers of miners to the area. Gold was discovered in the Arrow River and a small township was established. By the end of 1862, there were 1,500 men camped at the Arrow amongst a sea of canvas tents.

The township grew rapidly on the back of the gold rush, but this prosperity was relatively short-lived and it was wheat and other cereals that sustained the local economy. By 1870, Bendix Hallenstein and JW Robertson had established the successful Brunswick Mill at the mouth of the Kawarau River and, near Arrowtown, Robert and William Gilmore constructed the Wakatipu Flour Mill at Hayes Creek. Another large flour mill and farm, Mill Farm, was established in 1865 by the French brothers, John and Peter Butel just to the north of the present Ayrburn Farm. These farms initially focused on a mix of cereal and vegetable crops, with grain very quickly becoming the main crop grown in the basin.

Ayrburn Farm was established by William Paterson in the 1860s, and named after the town Paterson was born in West Kilbride, Scotland. Paterson settled at Ayrburn and then sent for his wife and young family to join him. They arrived in Bluff about November 1863 with a few horses, goats, cows, and farming implements. The family lived in a small stone dwelling, which was reportedly the first house in the Lake County to have glass windows.

Ayrburn was a significant farm in the Wakatipu Basin. The homestead comprised several outbuildings constructed near the stone dwelling, which included a men's quarters. The main cluster of stone farmstead buildings was recorded on a survey plan from 1865. Paterson also took up a lease on the Crown Range, naming it the Ayrburn Run. This was retained by the family until about 1913 when it was sold and renamed Glencoe. Paterson also opened the first butcher shop in Arrowtown.

Several buildings were affected by fires in the 1880s and 1890s. In 1882, a fire was discovered in the woolshed, stables, and chaff-house building just in time to save the destruction of the building. The newspaper article noted that a fire had destroyed the woolshed, stables, and chaff-house building seven years earlier. In 1895, another fire was discovered in the stables and the building was gutted; the woolshed adjoining the building was considered to be in great danger.

Near the turn of the century, the original stone dwelling was replaced with the larger timber building currently identified as the Homestead building. The date of the Homestead's construction is not mentioned in historic accounts of the time, but a photograph of the site in 1904 clearly shows the Homestead building in addition to the other outbuildings. The valuation records from 1904 lists a house worth £500, two stables worth £200, a woolshed worth £150, a barn worth £100, and two huts worth £100. The buildings' ages were listed at 33 years old, placing their construction date around 1871.

In 1906, the Ayrburn Farm was described in detail in the *Lake County Press*. At that time, it contained 247 acres of freehold land, and 61,000 acres of leasehold, incorporating Runs 25 and 334c. They ran around 12,250 merino and half-bred sheep, as well as cattle and eight horses and it was described as one of the best pastoral properties in the Lake Wakatipu district.

William Paterson died of influenza in 1910 and the property passed to his son, Robert. During this period, it appears that the family capitalised on the waterpower provided by the nearby Mill Creek. In 1911, the Homestead was recorded as having electrical lighting, powered by a dynamo driven by waterpower. This dynamo also provided power to the chaff cutter, shearing machines, grindstone, and a Smith's suction pump for emptying the sheep dip.

In 1941, the Ayrburn Estate, as it was now referred to, was sold to Mrs J. W. Smith of Hollywood Terrace, Invercargill. This was the first time the Ayrburn property had left the Paterson family since it was first acquired.

CCL Ref: 14562-030323-tristram

3 March 2023

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Dear Nicola

Northbrook Arrowtown: Assessment of Transportation Effects

As instructed, we have reviewed the proposal for a 'later living' development (**Northbrook Arrowtown**) located mostly within the Waterfall Park Zone (WPZ). The layout and built form of Northbrook Arrowtown is consistent with that approved under RM180584 (**the Hotel Consent**) and due to the buildings of both developments occupying the same physical location, progressing one development means that the other is precluded. There is therefore no scenario which results in cumulative effects arising from both developments occurring simultaneously.

Our review is of the drawings received on 2 March 2023, and has been carried out against the transportation provisions of the proposed Queenstown Lakes District Plan ("*District Plan*").

Overview of Proposed Later Living Development

The proposed layout of Northbrook Arrowtown is shown below.

Figure 1: Retirement Village Layout (Extract from Woods Bagot Drawing)

From the information provided, we understand that the proposal will have 161 units for independent living (Buildings C, D and E), plus 12 serviced apartments where residents may require some level of assistance (Building B). There will also be 23 specialist care beds (Building B).

The Arrivals and Amenity Building (Building A) will provide a range of amenities for residents, including a lounge and cafe, yoga room, gym, cinema, library, and swimming pool and spa. There

will also be a reception area, toilets, plant room, kitchens, and back-of-house areas. These facilities will only be open to residents rather than being available to members of the public.

Building F at the north of the site was consented under the Hotel Consent as a wellness centre. The footprint and height of this building has not changed but as part of the proposed consent it is intended to be a 16-room boutique hotel and spa. From a transportation perspective, the site is located on either side of a spine road (previously consented under RM180584 and known as Ayr Avenue) and this provides the sole means of access to the development. Car parking is provided in four locations.

One location is to the immediate south of Building A, where 36 parking spaces are proposed plus 4 spaces for pick-up and drop-off and 4 mobility spaces. This will be used by staff and visitors.

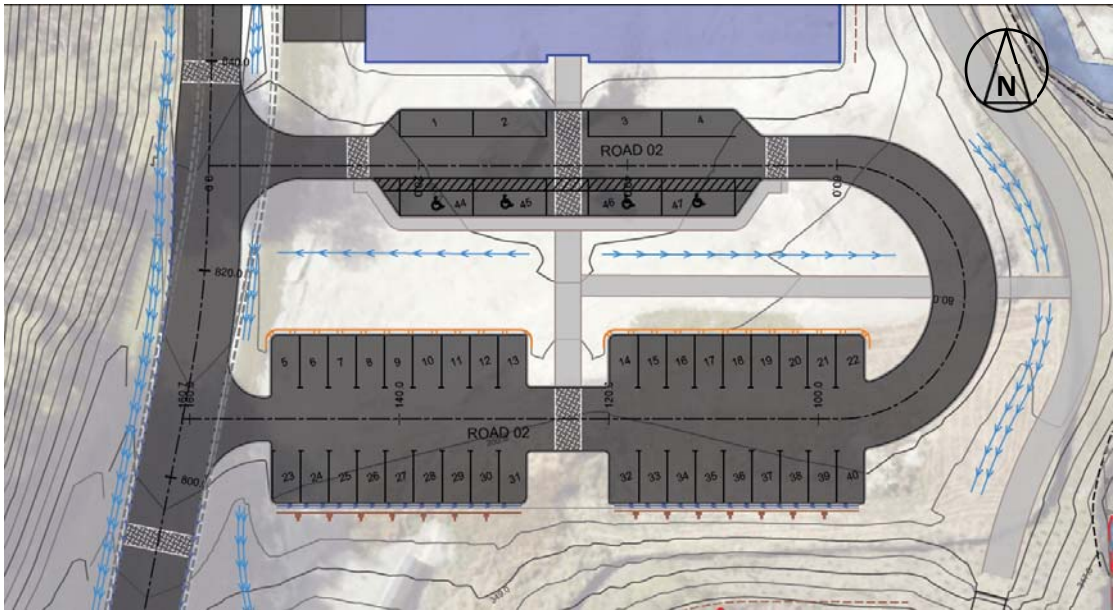

Figure 2: Car Park at Building A (Extract from Paterson Pitts Drawing)

There is a basement car park which runs the full length of Buildings C, D and E. It is served from an entry on the southern side of Building C with an exit at the northern side of Building E. This has a total of 94 car parking spaces (including 5 spaces that provide additional width such that they can be used by people with mobility impairments) arranged on either side of a central aisle. This car park will be reserved solely for use by residents.

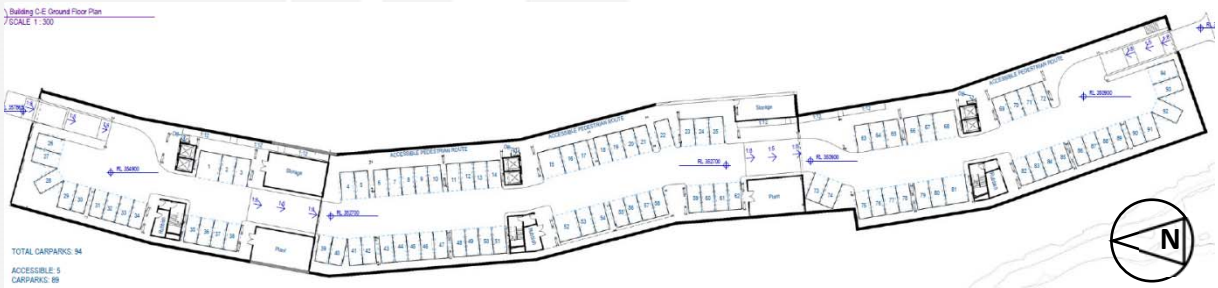

Figure 3: Basement Car Park (Extract from Woods Bagot Drawing)

There are 15 parking spaces provided on the western side of Ayr Avenue to the north of Building E. Seven of these are provided in parallel format and eight are provided at an angle of 60 degrees.

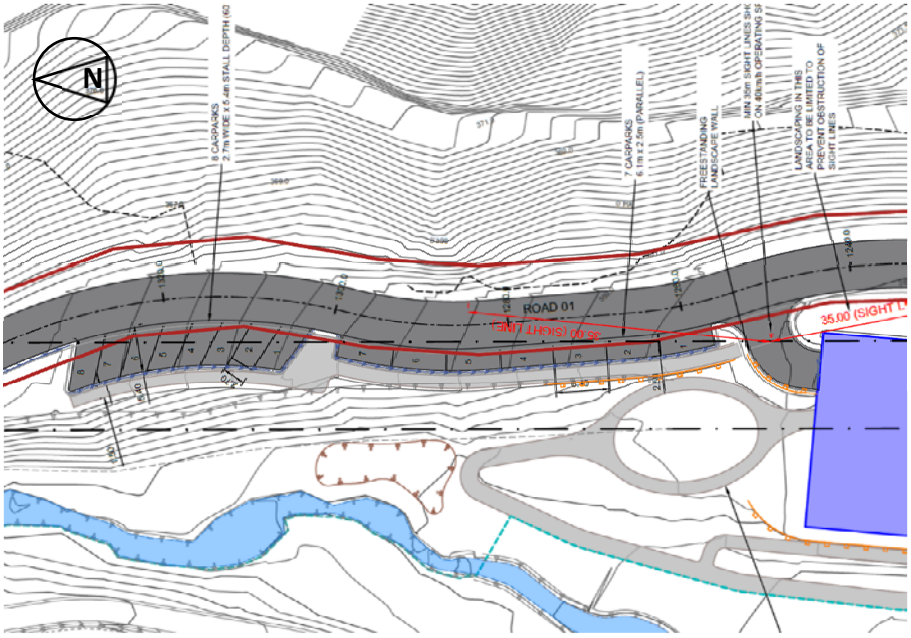

Figure 4: Kerbside Parking North of Building E (Extract from Paterson Pitts Drawing)

There is a total of 39 car parks proposed around Building F. Of these, 8 are provided to the south the building on the eastern side of Ayr Avenue in 90-degree format, with four parallel spaces on the western side of the road. It is understood that these four parallel parks are for pick-up and drop-off and very short-stay parking. Just north of Building F is a car park with 28 spaces of which two are marked for mobility impaired people and two are noted as being large car parks.

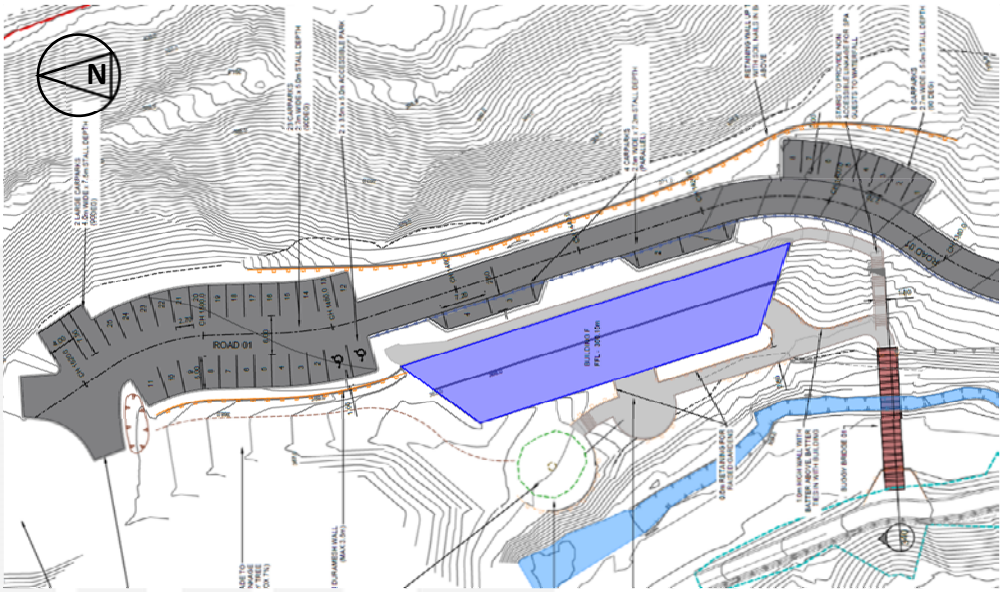

Figure 5: Parking Near Building F (Extract from Paterson Pitts Drawing)

There is a small maintenance shed towards the north of Building A and this also has a small associated car park. However no spaces are marked and the size of this area means that formal car parking spaces cannot be provided.

Finally, there are four pick-up/drop-off spaces located on the circulating carriageway just north of Building B.

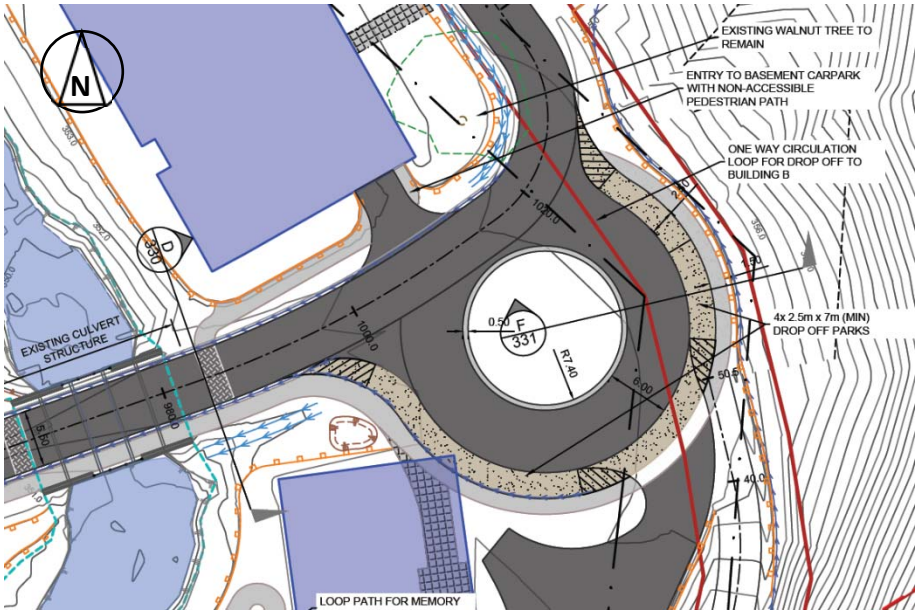

Figure 6: Pick-Up / Drop-off Area North of Building B (Extract from Paterson Pitts Drawing)

Traffic Generation and Assessment

We previously provided a detailed Integrated Transportation Assessment for the Hotel Consent. Taking into account the visitor accommodation, conference facilities and other development within this consent, it was expected to generate:

- Morning peak hour: 148 vehicles entering / 244 vehicles exiting;
- Evening peak hour: 233 vehicles entering / 239 vehicles exiting;
- Daily: 1,463 vehicles entering / 1,463 vehicles exiting.

With this level of traffic generation, we modelled the Arrowtown-Lake Hayes Road / Ayr Avenue and Arrowtown-Lake Hayes Road / Speargrass Flat Road intersection and concluded that the performance of both intersections would remain excellent, with low queues and delays. Overall, we concluded that "*the traffic generated by the development can be accommodated on the adjacent roading network without capacity or efficiency issues arising*".

Retirement villages have the following traffic generation:

- Units for independent living
  - 0.4 vehicle movements per unit in the peak hour
  - 2.6 vehicle movements per unit per day
- Care beds / serviced apartments
  - Trip rate of 0.3 vehicle movements per unit in the peak hour
  - 2.4 vehicle movements per unit per day

Given the number of units proposed in this case, the traffic generation will be:

- 161 units for independent living
  - 65 vehicle movements in the peak hour
  - 419 vehicle movements per day
- 23 care beds + 12 serviced apartments
  - 11 vehicle movements in the peak hour
  - 84 vehicle movements per day

- Total
    - 76 vehicle movements in the peak hour
    - 503 vehicle movements per day

In addition, Building F (the boutique hotel and spa) will generate traffic. Adopting the same rates used in the Hotel Consent, the traffic generation rate for a hotel is a peak hour volume of 0.8 vehicles per room in the peak hours and an average of 5 vehicle movements per room per day. The hotel will not be fully occupied on all days however, and recent applications for visitor accommodation in the district have recognised this, and allowed for 85% occupancy. The same has been applied in this instance. Thus the 16 rooms will generate 11 vehicle movements in the peak hours and 68 vehicle movements per day.

There is no typical traffic generation rate for a spa, and in this location, the activity may generate patrons who are not staying within the hotel. The plans provided show that 9 different rooms will be provided (four onsen/spa, three consulting rooms, two steam rooms), meaning that there may be 18 different groups present (nine using the rooms and nine waiting to use the rooms) in additional to staff. Staff will arrive and depart after customers however, meaning that the greatest traffic generation will be 9 arriving vehicles and 9 departing vehicles in the hour. It is not plausible that the spa will operate at full capacity throughout the day, but allowing for each room to have a one hour session and for there to be a 30-minute period in-between to allow for cleaning the room, this suggests there would be 6 sessions per day per room. Hence the absolute maximum visitor traffic generation would be 108 vehicle movements (9 rooms, 6 sessions per room, hence 54 vehicles entering and 54 vehicles departing).

Taking into account the later living complex, plus hotel and spa, the development would generate 105 vehicle movements in the peak hour and 679 vehicle movements per day. When compared with the Hotel Consent (at least 392 vehicle movements in the peak hour and 2,926 vehicle movements per day, it can be seen that the traffic generation of Northbrook Arrowtown is around 25% of the traffic volume of the Hotel Consent. We therefore confirm that the traffic generation of the proposed development will be considerably lower than that of the consented development. As such, any efficiency or road safety-related effects of the proposed development will also be less than those arising from the consented development.

District Plan Chapter 29: Activities

Rule 29.4.11 High Traffic Generating Activities

This Rule is triggered where more than 50 car parking spaces are proposed, which is the case here, and therefore a Transportation Assessment is required.

However, as set out above, the Hotel Consent was subject to a detailed Transportation Assessment, and the consent was granted. Consequently, the associated transportation effects were therefore deemed acceptable.

The current proposal generates considerably less traffic than the consented development.

On this basis, even if a Transportation Assessment was produced, it would simply confirm the outcomes of the work supporting the Hotel Consent, that the transportation-related effects of the proposal can be accommodated on the adjacent roading network without capacity or efficiency issues arising. Accordingly, we do not consider that a Transportation Assessment is required in this instance.

District Plan Chapter 29: Parking and Loading

Parking Requirements

The District Plan has recently been updated to remove all parking ratios, as required under the National Policy Statement on Urban Development. Prior to this however, the transportation provisions of the District Plan had been through a rigorous review as part of the process of updating the District Plan. The parking ratios that were set out in the Decisions version of the District Plan were therefore those that the Council considered to be appropriate to accommodate parking demand generated by various activities. These showed the following parking ratios:

- Elderly persons unit: 1 per residential unit
- Care homes: 1 per 5 beds for residents/visitors plus 1 per 5 beds for staff/guests

By way of comparison, the values for the retirement activities are more onerous than other sources of parking information (such as Waka Kotahi Research Report 453, and the RTA Guide to Trip Generating Activities).

One matter that is not addressed within parking surveys (nor the District Plan parking ratios) is the extent of parking required for visitors to the residents of the independent living units. We are not aware of any surveys that indicate such a parking ratio (nor in fact for visitors to standard residences). In many instances where on-street parking occurs it is difficult to tell the purpose of the parked vehicle from an observational parking survey. The RTA Guide however suggests that for standard residential units, 1 visitor parking space per 5 to 7 units is appropriate, with a rate of 1 visitor parking space per 5 to 10 units for retirement villages. Overall then, we consider that 1 space per 7 units would be appropriate.

A further matter relates to staff parking provision. Although the previous District Plan parking ratios indicated 1 staff parking space per 5 beds, we understand that the Applicant has already progressed detailed staffing requirements at the site, as follows:

- Morning shift: 25 staff;
- Afternoon shift: 19 staff; and
- Night-time shift: 6 staff.

The greatest parking demand for staff will arise at the time when the morning shift hands over to the afternoon shift, and for a brief period of time, both shifts will be present on the site. Allowing for a typical staff parking ratio of 1 space per 2 members of staff, this then means that for a short time in the afternoon, parking demand will be for 22 spaces, but otherwise the peak demand will be for 13 spaces.

Accordingly, the practical parking requirement for the later living development is:

- 161 units for independent living
    - 161 parking spaces for residents
    - 23 spaces for visitors
- 23 care beds + 12 serviced apartments
    - 7 spaces for residents/visitors
- 13 spaces for staff, with a short period of demand for 22 spaces early afternoon

This indicates a total demand for 204 spaces whereas the drawings show a total substantially less than this, including 94 spaces provided for residents but a calculated demand for more than 160 spaces.

In order to mitigate this shortfall in car parking, which would otherwise lead to extensive informal parking within the site, the proposed development has adopted an approach of providing an on-site car-share system. This operates in a manner where there are a certain minimum number of car-share vehicles available on the site, which can be booked by residents as and when they require the use of a vehicle. This arrangement has been adopted because:

- Residents do not have to purchase and maintain their own vehicle when (as set out above) it is demonstrably used only infrequently[1].
- Residents will still have the advantages of using a personal motor vehicle when they need.
- The advent of commercial car-sharing services means that the need for a privately-owned motor vehicle is reducing. Uber already operates throughout the Whakatipu Basin with Ola currently operating to/from the airport.
- Providing fewer parking spaces means that the land resource within the site is used more efficiently

There are presently few such schemes operating at scale in New Zealand, but overseas studies suggest that one car-share vehicle replaces between 7 and 13 private vehicles[2]. In Australia, studies show one car-share vehicle replaces 7 to 10 private vehicles[3]. One New Zealand scheme which has been implemented and studied is the Mevo car-share scheme in Wellington, with the Council noting that studies show one car-share vehicle replaced 11 private vehicles[4].

Adopting a figure towards the conservative end of the range of one car-share vehicle replacing 9 private cars, this means that having 9 car-share vehicles within the basement would mean that residents parking needs would be met:

- There would usually be expected to be demand for 162 spaces
- However 9 car-share vehicles reduce demand for 81 private cars and thus parking spaces (but themselves require 9 spaces)
- As the basement provides 94 spaces, this means that 9 spaces are used for car-share vehicles and 85 spaces are available for residents' private vehicles.

With regard to the parking for the hotel, given that this location is both small and some distance from the public road network, it is unlikely to be well-served by shuttle buses and on-street parking is not available, Accordingly, allowing for an 85% occupancy, we consider that 14 spaces are required for guests plus a further 3 spaces for staff.

As set out above, the spa could accommodate 16 groups (9 groups using the rooms and 9 groups waiting, but if a 30-minute period is required for cleaning the rooms between groups, it is unlikely that all groups will still be present when the next group arrives. Accordingly, in practice, 13 parking spaces is likely to be the maximum demand, and we have also allowed for 1 member of staff at the spa plus 3 professional staff in the consulting rooms.

Accordingly then, the following allocation represents a viable parking solution:

[1] Even a typical motor car is only used for 5% of the time and so for a retirement village, this figure will be even lower https://www.reinventingparking.org/2013/02/cars-are-parked-95-of-time-lets-check.html
[2] https://www.epa.gov/sites/default/files/2017-06/documents/05312017-shaheen.pdf
[3] https://www.knowledgehub.transport.govt.nz/assets/TKH-Uploads/TKC-2018/Car-sharing-in-New-Zealand-benefits-and-barriers.pdf
[4] https://wellington.govt.nz/news-and-events/news-and-information/our-wellington/2020/09/car-share-schemes

Car Park User	Spaces Provided						Parking Demand
	Basement (94 spaces)	Building A (36 spaces	Ayr Avenue (north of Building E) (15 spaces)	Ayr Avenue (south of Building F) (8 spaces)	Building F (28 spaces)	Total	
Independent living: residents	85 private spaces + 9 car share	-	-	-	-	94 spaces	85 spaces + 9 car share
Independent living: visitors	-	23 spaces	-			23 spaces	23 spaces
Care beds / serviced apartments	-	7 spaces	-			7 spaces	7 spaces
Later Living Staff	-	6 spaces	15 spaces	1 space		22 spaces	13 spaces (change-over: 22 spaces)
Visitor Accommodation Guests	-	-	-	-	14 spaces	14 spaces	14 spaces
Visitor Accommodation Staff	-	-	-	3 spaces	-	3 spaces	3 spaces
Spa guests	-	-	-	-	13 spaces	13 spaces	13 spaces
Spa staff	-	-		4 spaces	-	4 spaces	4 spaces
Total	*94 spaces*	*36 spaces*	*15 spaces*	*8 spaces*	*27 spaces*	*180 spaces*	*171-180 spaces*

Table 1: Proposed Allocation of Car Parking

It can be seen that the expected parking demand for Northbrook Arrowtown is accommodated through the proposed parking provision.

Accordingly, we therefore consider that the on-site parking provision will meet likely parking demand.

The analysis above is based on all patrons of the boutique hotel and spa travelling by car, but it is possible that groups may travel by minibus instead, and this will reduce demand for car parking. There are two parking spaces at the northern end of the car park which are wider and longer than usual, with these dimensions provided in order to accommodate a minibus.

Pick-up/drop-off spaces are over and above the car parking figures set out in Table 1. There are a total of 20 such spaces:

- 4 are within the Building A car park,
- 4 are located to the northern side of Building B
- 2 are adjacent to Building C
- 4 are adjacent to Building D
- 2 are adjacent to Building E
- 4 are located adjacent to Building F.

While there is no survey data to indicate the appropriate amount of pick-up/drop-off spaces, 20 spaces represents equates to more than 10% of the parking space numbers, which we consider to

be a good level of provision. To prevent parking occurring in these areas, we recommend that they are marked as P5 or similar.

Rule 29.5.1: Location and Availability of Parking Spaces

The layout indicates that each space will be unobstructed and can be accessed independently, and none are located within an access or other area used for other purposes.

Rule 29.5.2: Size of Parking Spaces and Layout

The parking spaces are not numbered uniquely, and we have therefore considered each group of parking separately

Building A Car Park

The plans show the 90-degree spaces are each 5m wide, and are 2.7m wide with an aisle of 6.0m. This meets the minimum dimensions expected for Class 2 users.

The mobility spaces are shown as 3.6m wide and in a parallel formation. These meet the dimensions expected in the District Plan.

No spaces are adjacent to structural elements and thus no additional widening is required.

Basement Car Park

The plans show the spaces are each 5m long, and have following dimensions:

- Space 1: 4.1m wide, aisle of 7.1m
- Spaces 2 and 3: 2.7m wide, aisle of 7.1m
- Spaces 4 to 14, 41 to 51, 59 to 61, 75 to 78: 2.5m wide, aisle of 7.2m
- Space 15, 52: 4.1m wide, aisle of 7.0m
- Spaces 16, 17, 53, 54: 2.7m wide, aisle of 7.0m
- Spaces 18 to 21, 55 to 58, 62, 69 to 72, 82 to 85: 2.5m wide, aisle of 7.0m
- Space 22: 2.7m wide, aisle of 6.8m
- Space 23: 2.7m wide, aisle of 6.7m
- Spaces 24, 25, 63 to 67, 79, 80: 2.7m wide, aisle of 7.2m
- Spaces 26, 27, 92, 93: 2.7m wide, aisle of more than 8m
- Spaces 28, 31 to 34, 87, 88: 2.5m wide, aisle of more than 8m
- Spaces 29, 30, 35 to 38: 2.5m wide, aisle of 7.1m
- Spaces 39 and 40: 2.6m wide, aisle of 6.2m
- Spaces 68 and 81: 4.1m wide, aisle of 7.2m
- Space 73: 2.7m wide, aisle of 6.0m
- Space 74: 2.7m wide, aisle of 5.8m
- Space 86: 2.5m wide, aisle of 6.6m
- Space 89: 2.5m wide, aisle of 8.0m
- Space 90 and 91: 2.6m wide, aisle of 7.8m
- Space 94: 3.2m wide, aisle of more than 8m

These spaces are intended for residents (Class 1 users), and the vast majority of spaces easily exceed the minimum dimensions for such spaces (in fact, they exceed the minimum dimensions for Class 2 users). Space widths of 2.7m are not contemplated for Class 1 users in the District Plan, but for Class 2 users, an aisle of 6.0m is required for this width of space, and the layout easily achieves this.

Space 74 is 2.7m wide but has an aisle of 5.8m, which is 0.2m less than expected. However the space is angled, which means that it is easier to enter and exit than a true 90-degree space. A swept path for this space is shown subsequently

An additional 0.3m width is required to be provided if a space abuts an obstruction such as a wall or column. The layout shows that most spaces have a clearance of at least 0.3m to any structural elements, or the structure is located in a position where widening is not required (under Standard AS/NZS2890.1:2004). We understand that the structural layout is indicative at this stage, but note that there are multiple areas where additional structure can be located without creating any difficulties for the expected car park dimensions.

Ayr Avenue Car Parking

The car parks have duplicate numbering and so are grouped separately below.

- Spaces 1 to 7 of the row of parallel spaces just north of Building E
  - 6.1m long, 2.5m wide, aisle (provided by access road) or 5.5m
- Spaces 1 to 8 of the row of angled spaces further north of Building E
  - 2.7m wide at narrowest point, 5.4m stall depth, aisle of 5.5m
- Spaces 1 to 7 of the row of 90 spaces just south of Building F
  - 2.7m wide at narrowest point, 5m stall depth, aisle of 6.5m

This area will only be used by Class 1 users (staff), meaning all dimensions are appropriate.

Building F Car Parking

The parking spaces in this area are each 2.7m wide at the narrowest point, 5.0m long and have an aisle of 6.0m. These meet the dimensions of the District Plan for Class 2 users.

There are two mobility spaces in this car park, which are 3.5m wide, 5.0m long and with an aisle of 6.0. The width of 3.5m does not meet the District Plan requirements for 3.6m but meets Standard NZS4121:2001 ('Design for Access and Mobility: Buildings and Associated Facilities'). There is also a shortfall in the aisle width, as the District Plan requires a minimum of 8m and only 6m is provided. However Standard AS/NZS2890.1:2004 ('Parking Facilities Part 1: Off-Street Car Parking') sets out that mobility spaces can be the same width as adjacent standard spaces, and this is achieved.

Pick-Up/Drop-off Spaces

The pick-up and drop-off spaces are not included within any total for car parking spaces, and therefore the dimensions are not discussed in detail (since in theory, they could be removed from the layout without affecting car parking space supply). However we note that the dimensions of these spaces comply with the District Plan provisions.

Rule 29.5.3: Gradient of Car Parks

In the car park next to Building A and within the basement, the parking spaces have a gradient of at most 1 in 28. This meets the District Plan requirement.

We are advised that the parking spaces on Ayr Avenue have the same gradient as the adjacent roadway. The long sections provided for ch1250 to ch1330 show a gradient is 1 in 12.5, and for the 8 parking spaces at ch1370 to 1410, the gradient is 1 in 9.6. This is considerably steeper than the maximum permitted gradient of 1 in 20. However these spaces will be used solely by staff, who will

be regular users of the parking spaces, and therefore familiar with the steeper gradient. We recommend that these spaces are specifically marked as being for staff only.

The parking spaces in the northern car park lie between ch1470 to ch1520, and the long sections show a maximum gradient of 1 in 23. This meets the District Plan requirement.

Rule 29.5.4: Mobility Parking Spaces

Four mobility spaces are shown within the Building A car park which are 7.0m long, 3.6m wide with an adjacent aisle of 5.5m.

Mobility spaces can be used by either mobility impaired drivers or mobility impaired passengers. The one-way nature of the access means that a driver can pull close to the footpath on the southern side of the spaces to enter and exit their vehicle, and a marked pathway is also shown to enable a mobility impaired passenger to exit the vehicle and then move onto a footpath.

Within the basement car park, the spaces are reserved solely for residents. With 94 spaces provided, 2 spaces are required for the mobility impaired. In practice, the needs of residents will vary, and thus there are 5 of the 94 spaces that are at least 3.6m wide and could therefore be used by those with mobility impairments. Each of the basement car parking spaces will be allocated to specific residents, and thus the wider spaces can be allocated to those requiring full vehicle door opening. However if there are no such residents (or fewer than 5) then the spaces can simply be used as standard parking spaces. For this reason, the spaces will not be formally marked with a mobility symbol.

We highlight that although the aisle width for these spaces is less than the District Plan anticipated (around 7m rather than 8m), this is permissible under Standard AS/NZS2890.1:2004. Moreover, these spaces have extra width over and above the required 3.6m, which further assists vehicle manoeuvring.

The car park near Building F will be open to the public and with 27 spaces provided (plus a further 22 spaces provided on Ayr Avenue), 2 mobility spaces are required. Two spaces are shown.

Rule 29.5.5: Drop Off / Pick Up

The site does not provide day care facilities, educational activities, or healthcare facilities and therefore this Rule is not applicable.

Rule 29.5.6: Reverse Manoeuvring

In view of the number of parking spaces provided, under this Rule reversing onto the frontage roads is not permissible. Further, each parking space should be accessible with at most one reversing movement. From previous commissions we are aware that the Council applies this as being one reverse movement to enter a space, or one reverse movement to exit a space, but not both.

Since the dimensions of the bulk of the parking spaces meet the District Plan requirements, and the car parking areas are set out in a standard configuration that will be familiar to drivers, we consider that these requirements will be met.

As noted above however, there is one parking spaces within the basement where the proposed dimensions appear to fall below the anticipated values. Tracking curves for vehicles entering and exiting this space is shown below. In these Figures, the cyan line is the vehicle bodywork and the thin red line is a clearance of 0.3m around the bodywork.

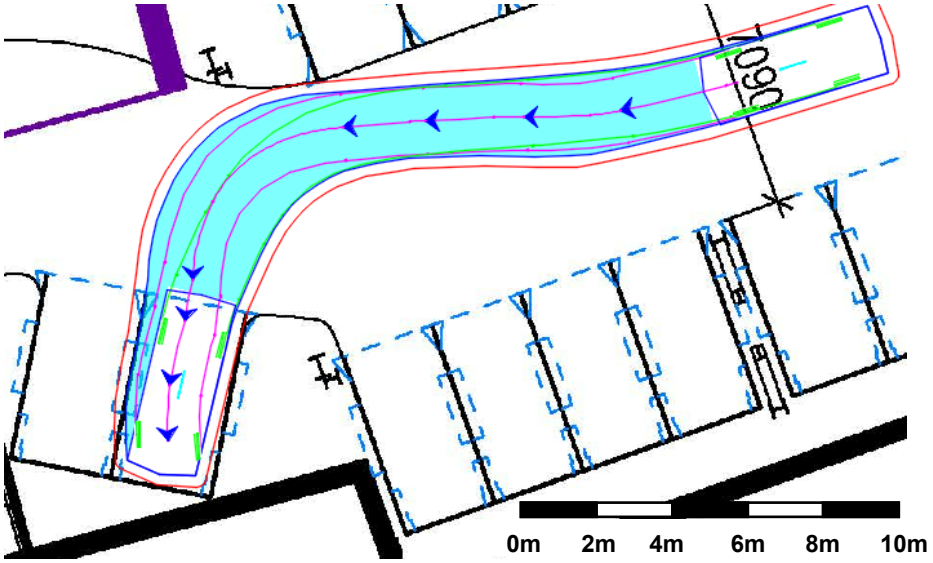

Figure 7: B85 Car Entering Space 74

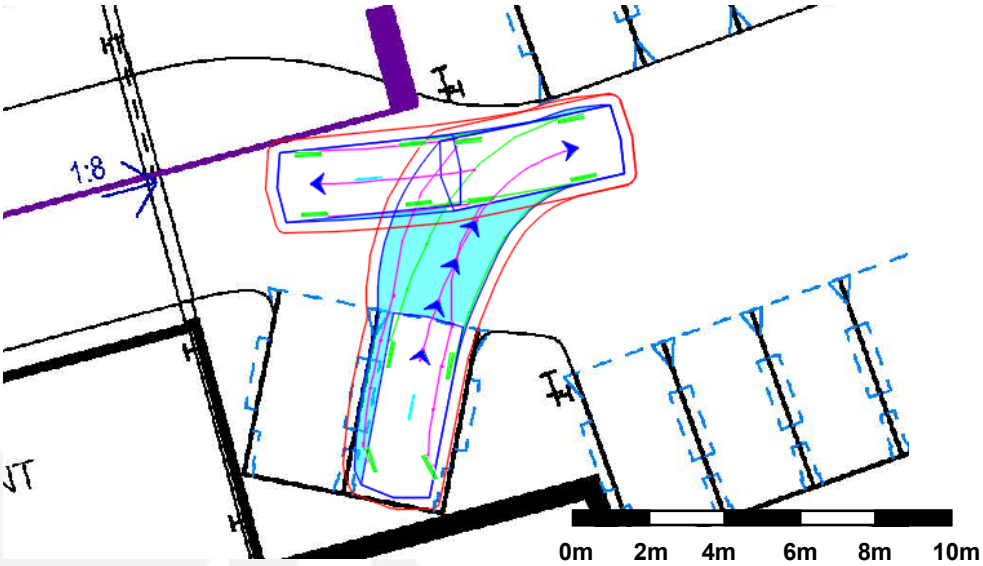

Figure 8: B85 Car Exiting Space 74

It can be seen that the space is accessible with just one reverse movement as required.

There is a service yard at Building A which is some 7.8m in length, but the length of a standard medium-sized truck is 8m. Accordingly, this area is largely inaccessible to service vehicles, other than directly adjacent to the vehicle crossing, where a truck could reverse into the site using Ayr Avenue as the manoeuvring area.. We also highlight that with a width of 7.8m in the service yard, this area would need to be kept clear if even a small vehicle was to be able to turn.

This requirement to reverse from or to a road[5] is not permitted under the District Plan. However we note that this section of Ayr Avenue will be lightly-trafficked and vehicles entering the service area

[5] A 'road' is defined as "*a road as defined in section 315 of the Local Government Act 1974*". This stipulates that a road includes "*every place intended for use of the public generally*". Since Building F is to be open to the public, we consider that this means that the spine road is classified as a road.

will also be infrequent, meaning that the potential for a vehicle to meet a service vehicle that is entering the service yard is very low.

There is also a service yard provided at the Maintenance Shed, also served from Ayr Avenue. Provided that the yard is kept clear, there is sufficient width available for a vehicle to undertake a three-point turn within the service area, such that the vehicle exits back onto the roadway in a forward direction.

Rule 29.5.7: Residential Parking Space Design

Although residential units are proposed, parking spaces are all provided within a communal area rather than individual garages.

Rule 29.5.8: Queuing

The wording of this Rule requires that queuing space is provided between the road boundary and the point at which conflict with another vehicle in the car park might arise.

The Building A car park has 44 spaces (including the pick-up/drop-off and mobility spaces) and therefore requires 12m of queuing space. This is provided at the entry to the pick-up/drop-off area, but is not required the southern access point as a one-way system is proposed through this car park.

The basement car park has 94 spaces are therefore requires 18m of queuing space. This is provided.

The parking area near Building F requires 12m of queuing space. Because Ayr Avenue transitions to become the aisle of the car park, in effect this queuing space is provided.

Rule 29.5.9: Loading Spaces

For the zoning of the land, this Rule does not require any loading areas to be provided. As noted above, one service yard is provided adjacent to Building A.

Rule 29.5.10: Surface of Parking Spaces, Parking Areas and Loading Spaces

There are no reasons why the parking and loading areas could not be surfaced as required.

Rule 29.5.11: Lighting of Parking Areas

There are no reasons why the parking and loading areas could not be lit as required.

Rule 29.5.12: Bicycle Parking and the Provision of Lockers and Showers

Residential development (which includes retirement units) does not require any cycle parking. Equally, no cycle parking is required at visitor accommodation.

The District Plan does not specifically discuss spa activities, but we note that no cycle parking is required for ‘places of entertainment’ that are less than 500sqm in floor area. This is the case for the spa (which is around 330sqm) and we therefore do not consider that cycle parking is required.

District Plan Chapter 29: Access

General

Based on previous correspondence, we understand that the main spine road through the site (Ayr Avenue) remains as per the Hotel Consent. This was designed to allow for the passage of a tour coach in each direction. Given that tour coaches are much less likely to be present, and rather the bulk of traffic will now comprise of small vehicles, Ayr Avenue will therefore remain fit for purpose.

Accordingly, the following sections only address those parts of the proposal which have not previously been consented.

Rule 29.5.13: Access and Road Design

The access roadway serving the parking area adjacent to Building A is intended to operate with one-way traffic flow, and is presently shown as being 4.0m wide on entry and exit. This width is appropriate for one-way operation.

The curved connecting roadway between the pick-up/drop-off area and the main car park is 6m wide which therefore creates a risk that drivers will attempt to travel in the wrong direction, as it is sufficiently wide to operate as a two-lane roadway. We recommend that signage (such as 'no entry' signs) are provided at the southern end of the connecting roadway, facing into the car park, to ensure that drivers do not attempt to undertake a movement against the intended direction of travel.

The entry and exit to/from the basement car park are shown as 4.0m wide, which supports one-way operation.

The District Plan does not contemplate one-way roads and rather, the only roads that are considered within the Council's Land Development and Subdivision Code of Practice are assumed to carry two-way traffic. The widths noted above therefore do not comply with the Code of Practice, but are appropriate for one-way operation.

Rule 29.5.14: Width and Design of Vehicle Crossings – Urban Zones

The widths of the vehicle crossings are between 4m and 6m wide, meeting the dimensions of this Rule for residential development.

The accesses cross the road boundary at an angle of between 45 degrees and 90 degrees and intersect with the carriageway at an angle of 90 degrees plus or minus 15 degrees, as required. They can be constructed to meet Diagram 7 of the District Plan.

Rule 29.5.15: Width and Design of Vehicle Crossings – Rural Zones

The site is not within a rural zone.

Rule 29.5.16: Maximum Gradient for Vehicle Access

The accessways into the car park at Building A have a gradient of no more than 1 in 12, which is considerably less than the maximum permitted.

At the Basement car park, the access ramp has 1:8 transition grades at the bottom and top, with the main ramp being 1:5. The latter is steeper than permitted under the District Plan, but aligns with Standard AS/NZS2890.1:2004 for private/residential driveways.

Ayr Avenue forms the accessway into the car park at Building F, and the gradient of this is at most 1 in 23, considerably flatter than the maximum permitted.

Rule 29.5.17: Minimum Sight Distances from Vehicle Access on all Roads other than State Highways

Ayr Avenue is subject to a 50km/h speed limit and consequently, 45m sight distances are required for residential activity, and 80m for non-residential activity. That said, due to the winding nature of Ayr Avenue and the extent of side friction, we expect that operating speeds will be in the order of 40km/h or lower.

At the exit from the Building A car park, the plans provide show that a 45m sightline is available to both the north and south, with at least 45m also available at the access to the service yard to Building A and also at the Maintenance Shed.

The plans show that the exit from the basement car park has sightlines of 35m in each direction, which is suitable for an operating speed of 40km/h (and in view of the on-street spaces and curve in this part of Ayr Avenue we consider that this speed is likely).

At the exit from the circulatory roadway near Building B, the sight distance available towards the northeast is in the order of 34m, which is appropriate for an operating speed of 28m for non-residential vehicles. Vehicles approaching from this direction will have slowed in order to negotiate a curve, and taking into account the curve radius, the operating speed will be in the order of 25km/h. The sight distance is therefore appropriate. More than 80m appears available towards the southwest.

We highlight that in many cases there is landscaping proposed within the sightlines. While this is not an issue per se, the landscaping should be of a type and nature that it does not block drivers views of oncoming traffic.

Rule 29.5.18: Minimum Sight Distances from Vehicle Access onto State Highways

The site does not have frontage onto a state highway.

Rule 29.5.19: Maximum Number of Vehicle Crossings

We understand that no subdivision will occur as part of the application and thus ascertaining the specific frontage of each ‘lot’ is not possible. However, given that Ayr Avenue functions as a Local Road, we consider that the provision of two vehicle crossings to serve the Building A car park (which has an approximate frontage of 45m), two crossings serving the basement car park and one vehicle crossing servicing the Building F car park, is reasonable.

Rule 29.5.20: Minimum Distance Between Vehicle Crossings onto State Highways

The site does not have frontage onto a state highway.

Rule 29.5.21: Minimum Distances of Vehicle Crossings from Intersections

There are no intersections on Ayr Avenue for some considerable distance, meaning that the required 25m separation between any vehicle crossing and intersection is easily achieved.

Rule 29.5.22: Minimum Distances of Vehicle Crossings from Intersections onto State Highways

The site does not have frontage onto a state highway.

Rule 29.5.23: Service Stations

The proposed activity is not a service station.

Summary of District Plan Compliance

On the basis of our assessment we consider that there are non-compliances with the following Rules of the District Plan:

- Rule 29.5.2: Size of Parking Spaces and Layout
  - One space in the basement has dimensions that are less than anticipated, but the space is accessible in the manner expected.
  - In a number of instances, spaces in the basement have not been widened by 0.3m where they abut obstructions. However, in such cases, the obstruction is located in a position where widening is not required (under Standard AS/NZS2890.1:2004), and it is understood that the structure of the basement at this stage is indicative.
  - Several of the mobility spaces do not comply with the stall width or aisle width of the District Plan, but meet the overarching Standards
- Rule 29.5.3: Gradient of Car Parks
  - The parking spaces on Ayr Avenue have a gradient of up to 1 in 9.6, greater than the 1 in 20 permitted under the District Plan. However these spaces will be used solely by staff, who will be regular users of the parking spaces, and therefore familiar with the steeper gradient.
- Rule 29.5.4: Mobility Parking Spaces
  - The basement layout includes for five, wide spaces, that can be used by the mobility impaired. However these are not marked, to reflect the particular way in which the basement car park will be managed.
- Rule 29.5.6: Reverse Manoeuvring
  - Trucks can only access the loading bay on the western side of Building A by reversing to or from Ayr Avenue, which is not permitted. However the number of vehicles using Ayr Avenue and using the service yards is low, meaning that the potential for two vehicles to meet is very low.
- Rule 29.5.13: Access and Road Design
  - The one-way roadways will not comply with the Council's Land Development and Subdivision Code of Practice, since this does not contemplate one-way roads, but the width proposed will be appropriate.
- Rule 29.5.16: Maximum Gradient for Vehicle Access
  - At the Basement car park, the access ramp has 1:8 transition grades at the bottom and top, with the main ramp being 1:5. The latter is steeper than permitted under the District Plan, but aligns with Standard AS/NZS2890.1:2004 for private/residential driveways.
- Rule 29.5.18: Minimum Sight Distances from Vehicle Access on all Roads other than State Highways
  - In some instances, the sightlines fall below the distance required for the maximum permitted speed on Ayr Avenue, but will be appropriate for the prevailing operating speeds.

We confirm that the traffic generation of the proposal will be considerably lower than the traffic generation of the Hotel Consent. Consequently, although the proposal triggers Rule 29.4.11 (High Traffic Generating Activities), the effects on road efficiency and safety are smaller, and so we do not consider that a Transportation Assessment is required in this instance.

While the District Plan no longer includes parking ratios, an assessment from first principles shows that sufficient car parking spaces are provided. We note that although there is a shortfall in the number of residential parking spaces, the proposal will include an on-site car-share facility, which will reduce demand for private (individual) spaces and therefore mitigate this.

We have not discussed the pick-up/drop-off spaces in detail, since these do not form part of the parking supply on the site and are over and above the number of spaces needed to meet demand at the site.

We also consider that:

- The parking spaces accessed directly from Ayr Avenue should be clearly marked as being for staff only to mitigate the non-compliance regarding their gradient.
- Signage (such as 'no entry' signs) should be provided at the southern end of the curved connecting roadway at the car park near Building A, facing into the car park, to ensure that drivers do not attempt to undertake a movement against the intended direction of travel.
- In many cases there is landscaping proposed within the sightlines. While this is not an issue per se, the landscaping should be of a type and nature that it does not block drivers views of oncoming traffic.

Overall, and subject to the comments above, we are able to support the proposal from a transportation perspective.

Please do not hesitate to contact me if you require anything further or clarification of any issues.

Kind regards
Carriageway Consulting Limited

Andy Carr
Traffic Engineer | Director

Mobile 027 561 1967
Email andy.carr@carriageway.co.nz

MARSHALL DAY Acoustics

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6 October 2022

Waterfall Park Developments Ltd
PO Box 2962
Wakatipu 9349

Attention: Nicola Tristram

Dear Nicola

NORTHBROOK WATERFALL PARK - NOISE ASSESSMENT

Marshall Day Acoustics (MDA) has been commissioned to consider potential noise from the proposed later living development at Waterfall Park (Northbrook Waterfall Park).

MDA has previously been involved with application (RM180584) at this site for a consented hotel development that included conference rooms, outdoor restaurant area and lounge bar facilities (the Hotel Consent).

In addition to the Hotel Consent, RM171280 was granted to build a road (Ayr Avenue) and bridge to access the Waterfall Park Zone.

The purpose of this letter is to consider the potential change in noise emissions from Northbrook Waterfall Park to the hotel previously consented.

What are the proposed site uses?

The layout and built form of Northbrook Waterfall Park is consistent with that approved under the Hotel Consent. The Arrivals and Amenities Building (Building A) will include wellness and lifestyle facilities including a café, library, cinema and indoor swimming pool and fitness areas. Buildings B-E will remain for residential apartments, care and serviced apartments.

The proposed chapel/wedding venue has been removed and the previously consented Wellness Building (Building F) adjacent to the waterfall will now be a boutique hotel and spa.

Importantly, the proposed activity will remove the previously consented conference facilities, outdoor restaurant dining and lounge bar facilities. Removing these facilities means the noise from the site will be lower. It is proposed that residents will use the adjacent Ayrburn Domain facilities for dining and entertainment.

Northbrook Waterfall Park will comply with the Plan noise limits

Noise from all the activities under the Hotel Consent was shown to be able to comply with the Queenstown Lakes District Council Proposed District Plan (QLDC PDP) noise limits. This consent included the consideration of conference facility noise with an occupancy of 600 people, outdoor restaurant dining and lounge bar facilities.

Given the nature and reduced scale of the proposed facilities within Northbrook Waterfall Park and particularly Building A, it is our opinion the noise levels from this proposal will be less than the Hotel Consent and will therefore also comply with the QLDC PDP noise limits. This conclusion is reached on the basis that the proposed use is considered to generate less noise than the consented activity.

Do the conditions of consent need to be updated?

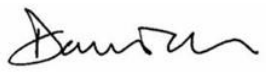
The Hotel Consent noise specific conditions are included in Attachment A.

All conditions with the exception of 57, 58, and 59 are considered relevant to this application.

Conditions 57 and 58 are not considered relevant as no restaurants, bar or conference facility are proposed as part of this application. In the Hotel Consent, Building A included a conference/function centre to cater for up to 600 people.

Given the significantly reduced scale and nature of the proposed facilities in the Northbrook Waterfall Park Building A, there is no reason to impose a condition requiring unnecessary restrictions on the ability to have windows and doors open on these smaller scale activities, particularly given the ability to monitor noise levels in accordance with Condition 53.

Condition 59 is not considered relevant as restaurants are no longer proposed within Building A and Ayrburn Domain is not included within this application.



Yours faithfully

MARSHALL DAY ACOUSTICS LTD

Damian Ellerton

Associate

Appendix A

RM180584 – Noise Conditions

NOISE

53. Noise from the site shall comply with the following noise limits:

    a) Sound from non-residential activities measured in accordance with NZS6801:2008 and assessed in accordance with NZS6802:2008 shall not exceed the following noise limits at any of the points marked R1-R12 in Figure 1 below:

       (i) daytime (0800 to 2000 hrs) 50dB LAeq (15 min)
       (ii) night-time (2000 to 0800 hrs) 40dB LAeq (15 min)
       (iii) night-time (2000 to 0800 hrs) 70dB LAFmax

    b) The noise limits in (a) shall not apply to construction sound which shall be assessed in accordance with NZS6803:1999.

Figure 1: Noise measurement and assessment positions

54. Prior to commencement of operations, the consent holder shall provide to the Manager Resource Consents a letter from a suitably qualified acoustic consultant that noise from all building services plant on site has been designed to adopt the best practicable options to mitigate and control noise beyond the application site to an appropriate level in addition to meeting the noise limits in Condition 53 above.

55. Prior to commencement of operations, the consent holder shall provide to the Manager Resource Consents a letter from a suitably qualified acoustic consultant that all building envelope constructions have been designed to adopt the best practicable options to mitigate and control noise beyond the application site to an appropriate level in addition to meeting the noise limits in 53 above. The letter shall state the maximum sound level assumed in each space.

56. The use of amplified music in any outside area shall cease at 8pm. Should outdoor speakers be used during the day, they shall not exceed a noise level of 85dB LAeq at 1m in addition to meeting the noise limits in Condition 53 above.

57. The Building A restaurants and lounge bar shall have all windows and doors closed between the hours of 8pm and 8am.

58. Building A shall have all windows and doors closed at all times when it is used for a function where amplified music is being used.

59. Amplified music in Building A and the Ayrburn Domain restaurant shall only be played through the installed in-house systems. The system shall have an automatic sound limiting device installed that has been commissioned by a suitably qualified and experienced acoustic consultant or specialist. Prior to commencement of operations, the consent holder shall provide to the Planning Manager a letter from a suitably qualified acoustic consultant that and automatic sound limiting device has been installed and the sound level at which the system has been set.

    For clarity, the sound limiting device will need to be set at a level that ensures compliance with Condition 53.

PROPOSED NOISE CONDITIONS

1. Noise from the site shall comply with the following noise limits:

   (a) Sound from non-residential activities measured in accordance with NZS6801:2008 and assessed in accordance with NZS6802:2008 shall not exceed the following noise limits at any of the points marked R1-R12 in Figure 1 below:

      (i) daytime (0800 to 2000 hrs) 50dB LAeq (15 min)
      (ii) night-time (2000 to 0800 hrs) 40dB LAeq (15 min)
      (iii) night-time (2000 to 0800 hrs) 70dB LAFmax

   (b) The noise limits in (a) shall not apply to construction sound which shall be assessed in accordance with NZS6803:1999.

Figure 1: *Noise measurement and assessment positions*

2. Prior to commencement of operations, the consent holder shall provide to the Manager Resource Consents a letter from a suitably qualified acoustic consultant that noise from all building services plant on site has been designed to adopt the best practicable options to mitigate and control noise beyond the application site to an appropriate level in addition to meeting the noise limits in Condition (1) above.

3. Prior to commencement of operations, the consent holder shall provide to the Manager Resource Consents a letter from a suitably qualified acoustic consultant that all building envelope constructions have been designed to adopt the best practicable options to mitigate and control noise beyond the application site to an appropriate level in addition to meeting the noise limits in (1) above. The letter shall state the maximum sound level assumed in each space.

Geotechnical Report for Resource Consent

Northbrook Arrowtown

Arrowtown – Lake Hayes Road

Report prepared for:

Winton Partners Pty Limited

Report prepared by:

GeoSolve Limited

Distribution:

Winton Partners Pty Limited

GeoSolve Limited (File)

March 2023

GeoSolve Ref: 150098.04

GEOTECHNICAL WATER RESOURCES PAVEMENTS

Table of Contents

1 Introduction

1.1 General

This report presents the results of a geotechnical investigation and assessment undertaken by GeoSolve to determine the subsoil conditions and provide geotechnical inputs for a proposed Northbrook Arrowtown later living development (Northbrook Arrowtown) at Arrowtown-Lake Hayes Road, referred to herein as “the Site”.

Photo 1 – Showing the Site area looking north

This assessment has been completed for Waterfall Park Developments Limited (WPDL) in accordance with the terms and conditions outlined in the 2019 Agreement between WPDL and Geosolve.

1.2 Development

We understand the proposed development comprises the construction of a later living development. Multiple accommodation buildings up to five storeys, some with basements, and associated facilities are proposed. The general layout of the development is shown on the Figure 2.1 below and Figures 1a to 1f, Appendix A.

Earthworks will be required to establish level building platforms and access roads. Cuts of up to approximately 6 m in depth will be required mainly around Building B and F. Retaining walls and slope remediation such as soil nails will be required in these areas. Local excavation and fill placement is expected to be required to provide level areas for courtyards, parking and general access.

Further discussion on the proposed layout is provided in Section 5.1

1.3 Scope of Work

The purpose of this report is to assess the feasibility of the proposed Northbrook Arrowtown development in the chosen location from a geotechnical perspective and provide recommendations, as appropriate, with respect to resource consent. Geotechnical issues or hazards pertaining to the Site; specifically liquefaction, slope stability and alluvial fan hazard have been addressed.

Further investigation and assessment will be required at the detailed design stage once development proposals, e.g. building design requirements, are better established to address the geotechnical issues identified, and to carry out detailed foundation design

2 Site Description

2.1 General

The subject property is located approximately 2km south of Arrowtown and 1km north of Lake Hayes. It is accessed via Ayr Avenue off the Arrowtown - Lake Hayes Road the Site, see Figure 2.1 below.

Figure 2.1 – Site Location Plan

The property is bounded to the south by farmland, and to north by the Millbrook Resort Development. Undeveloped farmland, golf amenity areas and residential developments adjoin the remaining boundaries of the Site. An existing woolshed and associated buildings (Ayrburn Farm) and amenities are present in the southern area. Aerial views of the approximate site area are provided in Appendix A, Figure 1a -1f.

2.2 Topography and Surface Drainage

2.2.1 General

The majority of Northbrook Arrowtown is located in a north south trending valley. At the southern end the valley gives way to undulating farmland around the eastern end of the Speargrass Flat Road area. To the north, east and west of the development the valley sides rise to a level approximately 60 m above the valley floor. The valley floor itself falls gently to the south and is locally undulating with some level areas.

Mill Creek, which drains the Malaghans Road and Millbrook areas to the north, enters the valley from the north west where it flows over a steep rock face forming a waterfall. Mill Creek flows southwards through the centre of the valley towards Lake Hayes.

3 Geotechnical Investigations

The opinions and conclusions presented in this report are based on the following sources of information:

- A walkover inspection and surface mapping of the Site by a geotechnical practitioner;
- A review of the Queenstown Lakes District Council and Otago Regional Council Hazard Register Maps;
- A review of the published geological map, 'Institute of Geological & Nuclear Sciences Ltd, Geology of the Wakatipu, 1:25,0000 Geological Map 18'; and
- Geotechnical investigations carried out in multiple stages comprising:
    - 115 test pits;
    - 108 cone penetrometer tests (CPT);
    - Four seismic cone penetration tests (sCPT);
    - 16 drill holes;
    - Laboratory testing on samples collected in the boreholes including fines content and plasticity index testing;
    - Two heavy duty dynamic penetration tests (HDCP); and
    - Installation of six single standpipe piezometers and four double standpipe piezometers in boreholes (total of 14 standpipe piezometers).

The investigation locations are show on Figures 1a-1f, Appendix A, and the investigation logs are provided in GeoSolve factual geotechnical report which can be provided on request.

4 Subsurface Conditions

4.1 Geological Setting

The Site is located within the Wakatipu Basin, a feature formed predominately by glacial advances. Published references indicate the last glacial event occurred in the region between 10,000 and 20,000 years ago. The glaciations have left glacial till, glacial outwash and lake sediments over ice-scoured bedrock. Post glacial times have been dominated by erosion of the bedrock and glacial sediments, deposition of alluvial gravels by local watercourses, deposition of lacustrine sediments during periods of high lake levels and the deposition of wind-blown loess.

The Site is located in an area where the soil materials comprise windblown, lake sediments, alluvial and glacial deposits overlying schist bedrock.

No active fault traces were observed in the immediate vicinity of the Site. However, a significant seismic risk exists in the region from potentially strong ground shaking associated with rupture of the Alpine Fault located along the west coast of the South Island.

There is a high probability an earthquake with a magnitude greater than 7.5 will occur on the Alpine Fault within the next 50 years.

4.2 Stratigraphy

4.2.1 General

The stratigraphy is variable across the Site. For the purpose of this report the Site stratigraphy has been divided into several sections; see Figure 1a-1f, Appendix A. The stratigraphy for these areas is summarised in the following sub sections.

Full details of the observed subsurface stratigraphy can be found within the test pit and borehole logs contained in the GeoSolve factual report.

4.2.2 Valley Floor

The subsurface soils observed during site investigations adjacent to Mill Creek typically comprised surficial layers of topsoil, fill and floodplain deposits overlying variably interbedded layers of alluvial deposits which are underlain by lake sediments.

The main geological units present adjacent to Mill Creek are as follows:

Topsoil comprises black/dark brown, soft to firm, organic SILT with rootlets.

Buried topsoil layers were observed to underlie fill and floodplain deposits in places comprising soft to firm, organic SILT.

Isolated layers of **uncontrolled fill** were observed at the surface in places and comprising grey/brown, medium dense, silty, sandy GRAVEL, silty SAND with minor to some gravel and gravelly, silty SAND.

Floodplain deposits were observed to underlie the topsoil in places and comprises grey, loose to medium dense SAND, silty SAND and soft to firm, grey SILT.

Alluvial deposits comprise variable interbedded SANDS, SILTS and GRAVELS. These deposits are generally loose to medium dense/soft to firm. Swamp/alluvial SILT and SAND

deposits with a high proportion of organic material were observed in places at a depth of between 0.4 - 1.5 m bgl.

Lake sediment comprises grey, medium dense SANDS and silty SANDS to firm, sandy SILTS and SILTS which extend to a proven depth of 25.5 m bgl. The base of the lake sediment unit was not observed in the test pit excavations or within some boreholes.

4.2.3 Western Terrace Slope

A combination of test pits and boreholes were completed on the western terrace slope which was observed to comprise variable surficial deposits including topsoil, colluvium and loess overlying lake sediments and glacial deposits. Schist is expected to underlie the terrace slopes at depth and is exposed towards the head of the valley. The in-situ schist foliation was measured to dip at 37° to 234° (southwest).

4.2.4 Valley Head

Mapping of the slopes at the head of the valley, around the margins of Area C, has been completed. On the western side a schist bluff is present with localised thin colluvium soils. On the eastern and northern sides schist bedrock is present in lower areas. Glacial till and colluvium soils are present in central and upper areas. Ground instability was noted in this area and is discussed in Section 4.5.2 below.

4.3 Groundwater

Groundwater depth is variable across the Site. Measured groundwater in test pits and piezometers are shown in Figures 2a to 2i, Appendix A.

5 Natural Hazards

5.1 General

On the Queenstown Lakes District Council (QLDC) mapping data base the following potential natural hazards are identified within the development area:

- Alluvial Fan hazard, Regional Scale;
- Flooding associated with Mill Creek.

The extent of these mapped hazards in relation to the development is shown on Figure 3, Appendix A.

Areas of slope instability have been identified at the Site and are discussed in Section 5.7. Liquefaction and lateral spreading are not shown on the QLDC hazard maps however are considered to be a risk at the Site and are discussed in Sections 5.8 and 5.9.

The risk of natural hazards has been identified at the Site. The final development proposal was reached following the review of several layouts and the impact of the identified hazards on construction feasibility. The proposed buildings are located where the geotechnical risks can be more easily assessed and accommodated in the building/foundation design. Areas with higher and/or more uncertain risk, such as the steep valley slopes, areas of identified rock fall and slope movement, or where significant building retaining makes development impractical, have been considered and where possible avoided in the proposed layout.

5.2 Alluvial Fan Hazard

QLDC hazard mapping identifies parts of the development site as potentially subject to active debris-dominated alluvial fan activity, see Figure 3, Appendix A. The affected area is the southeast corner of the site, noted in Red on Figure 3.

The relevant fan assessment and mapping is to regional scale (1:50,000) and as such is of relatively coarse resolution, indicating that site-specific assessment is desirable.

Subsequent higher resolution (1:25,000) assessment by ORC of specific alluvial fan areas did not identify any of the Site as lying with active fan areas, but noted "…the absence of information on alluvial fan hazard for a certain property or area does not necessarily mean that alluvial fan activity will not affect that property or area", again indicating that site-specific assessment may be desirable.

The hillslopes above the Site in central and southern areas show no signs of historic instability with gradients generally less than 20° in upper areas increasing to 30-40° in lower terrace slopes, with the exception of several small steep bluffs. Slopes adjacent to the northern end of the creek channel show minor indications of localised soil creep on some of the steeper slopes but predominately show no signs of historic instability. No active deep seated land sliding is visible or likely in areas adjacent the creek; thus there is negligible sediment supply for debris mobilisation. Site sub soils are generally alluvial but not indicative of debris flow or debris flood activity. The risk factors for alluvial fan hazard are not present to any significant extent and there is no evidence of previous such activity. Therefore, it is considered that the risk from alluvial fan hazards are very low for the Site.

5.3 Flooding

Geosolve understand the flooding risk associated with Mill Creek has been assessed separately by Fluent Solutions Ltd.

5.4 Slope Stability

Mapping of the slopes at the head of the valley, around the margins of the northern part of the Site, has been completed. A summary of the observations on the north eastern side of the Site is provided as Figure 4, Appendix A. In this area observations indicate shallow instability of both soil and rock materials has occurred. Variable schist foliation measurements and failure of surface soils were observed. Failure of the rock face has occurred locally from the low bluffs at the toe and debris is present in some locations. Some ongoing creep movement of the central and upper sloping areas is occurring.

On the north- western side of the Site a sub-vertical schist bluff is present. Preliminary mapping indicates no evidence for deep seated instability is present, however the potential for localised block fall and fretting of the rock face has been identified. Elsewhere some localised shallow soil instability, soil creep and surface scouring has been identified on the valley slopes in several locations.

5.5 Liquefaction

A detailed liquefaction assessment has been undertaken for the Site. This has involved using the CPT based method of Boulanger & Idriss (2014)[1] to calculate potential liquefiable layers with Zhang et al (2002) to calculate reconciliation settlement.

Two design earthquakes scenarios have been assessed in accordance with NZS1170 – Structural Design Actions[2] for an Importance Level 2 structure with a 50-year design life. Peak horizontal ground accelerations and effective magnitudes taken from the Bradley Seismic Limited report[3].

We have used laboratory testing to specifically calculate a fines content correction (CFC) of

0.3 and a soil classification index (Ic) cut off of 2.8. A thin layer correction has been applied to the CPT based liquefaction assessment. This is based on the comparison of both shear wave velocity Kayen et al (2013) method and above CPT assessment results.

Conservatively we have adopted at 1 m groundwater level across the entire site. The detailed liquefaction analysis results show:

- No liquefaction is calculated in the SLS earthquake event;
- Minor to moderate liquefaction is calculated in the ULS earthquake event. This involves indexed settlement up to 85 mm and LSN up to 28; and
- No consistent liquefiable layer on the stream side of the building has been calculated. Therefore, lateral spreading will likely not govern the foundation design once the upper softer soil has been removed. Once the building foundations and earthworks has been finalised the lateral spreading risk should be reviewed.

[1] Boulanger, R.W. & Idriss, I.M. (2014). CPT & SPT based Liquefaction Triggering Procedures.
[2] NZS1170-5 (2004) Structural Design Actions, Part 5: Earthquake Actions – New Zealand.
[3] Bradley Seismic (2018) Probabilistic Seismic hazard analysis for Waterfall Park, Arrowtown. Revised 26 September 2018.

Standard and widely used engineering and foundation solutions are available for the level of liquefaction induced settlement identified in the assessment, see Section 5.6 of this report for foundation considerations. Further geotechnical input will be required in the structure design process.

6 Preliminary Engineering Considerations

6.1 General

The recommendations and opinions contained in this report are based upon ground investigation data obtained at discrete locations and historical information held on the GeoSolve database. The nature and continuity of subsoil conditions away from the investigation locations is inferred and cannot be guaranteed.

6.2 Site Preparation

During the earthworks operations all topsoil, organic matter, fill, colluvium and other unsuitable materials should be removed from the construction areas in accordance with the recommendations of NZS 4431:2022.

Owing to the erodible nature of some of the soils present across the Site, sediment control measures should be instigated during earthworks construction.

Water should not be allowed to pond or collect near or under a foundation slab. Positive grading of the subgrade should be undertaken to prevent water ingress or ponding.

All fill that is utilised as bearing for foundations should be placed and compacted in accordance with the recommendations of NZS 4431:2022 and certification provided to that effect. We recommend topsoil stripping and subsequent earthworks be undertaken only when a suitable interval of fair weather is expected, or during the earthworks construction season.

It is recommended the foundation excavations be inspected by a suitably qualified and experienced geotechnical specialist to confirm the conditions are in accordance with the assumptions and recommendations provided in this report.

6.3 Excavations & Retention

6.3.1 General

We recommend that any excavations should be inspected by a geotechnical practitioner during earthworks construction.

Recommendations for temporary batters are as follows:

Table 6.1 Recommended Batter for Temporary Cuts up to 3 m in Height

Material Type	Recommended Maximum Batter for Temporary Cuts Less than 3 m High (horizontal to vertical)	
	Dry Ground	Wet Ground
Loess, Fill, Topsoil, Silty Alluvial Deposits	2 : 1	3 : 1.
Sandy/Granular Alluvial Deposits	1.5 : 1	3 : 1

Temporary batters which are required to be higher or steeper than those described above should be subject to specific design.

Localised re-grading of the existing valley slopes is proposed in some locations. A permanent batter angle of 25° for re-graded areas is recommended in the first instance. Due to local variations in geology and slope characteristics this angle should be reviewed on a case-by-case basis to ensure it is appropriate.

Steeper slopes should be subject to specific assessment at the detailed design stage. Structural retaining may be appropriate in some cases to ensure long term stability is acceptable. Alternatively, methods to increase stability such installing soil nails will be required.

Groundwater has the potential to develop during and upon completion of excavations. Accordingly, the retention design (temporary or permanent) should ensure groundwater seeps are properly controlled behind the retaining walls. This should be considered as part of the detailed retention design.

6.3.2 Retaining Walls

Retaining walls will be required to support slopes above Building B and to support the slope above and below Building F.

All retaining walls should be designed using the geotechnical advice provided by GeoSolve. Due allowance should be made during the detailed design of all retaining walls for any additional loads upslope of the wall (i.e. surcharge due to backslope).

All temporary slopes for retaining wall construction should be battered at slopes provided above.

Groundwater was not identified in the test pits but has the potential to develop following completion of the earthworks, in particular as a result of heavy or prolonged rainfall. To ensure potential groundwater seeps and flows are properly controlled behind the retaining walls, the following recommendations are provided:

- A minimum 0.3 m width of durable free draining granular material should be placed behind all retaining structures;
- A heavy duty non-woven geotextile cloth, such as Bidim A14, should be installed between the natural ground surface and the free draining granular material to prevent siltation and blockage of the drainage media; and
- A heavy-duty (TNZ F/2 Class 500) perforated pipe should be installed within the drainage material at the base of all retaining structures to minimise the risk of excessive groundwater pressures developing. This drainage pipe should be connected to the permanent piped storm water system.

The safety implications of working under temporary cuts will need to be adequately addressed.

6.4 Engineered Fill Slopes

All engineered fill slopes which are required to support building foundations should be subject to specific design.

6.5 Groundwater Issues

Perched groundwater seepages were noted within the upper soil strata throughout the Site.

A detailed groundwater model should be produced following further investigation to enable an assessment of groundwater impacts on design and construction. This should be carried out at the detailed design stage on a building specific basis.

6.6 Settlement and Foundations

6.6.1 General

Based on provided plans we understand that the following buildings are currently proposed.

- Building A – Single storey structure;
- Building B to E – Four to five storey structures with connected basement carparking area;
- Building F – Three storey structure tiered into the slope.

We understand that the Site is required to be built up for non-geotechnical reasons. Therefore, the main geotechnical risks for the structures are the presence of uncontrolled fill and potentially softer soils at the near surface and the liquefaction risk calculated in the lake sediments.

All unsuitable materials identified in foundation excavations, particularly those softened by exposure to water, should be undercut and replaced with engineered fill during construction. Any fill that is utilised as bearing for foundations should be placed and compacted in accordance with NZS 4431:2022 and certification provided to that effect.

6.6.2 Foundation Considerations

A preliminary foundation study has been completed for the buildings and is presented in table 6.1 below.

Owing to the complexity of the geological and settlement model across the building platforms an iterative approach between the structural and geotechnical models will be required to finalise the design prior to construction.

Table 6.1 – Concept Foundation Summary

Building Type	Foundations Options	Considerations for Design
Building A Up to 2 Storey	• Liquefaction induced settlements are within the MBIE TC2 criteria provided. No liquefaction is calculated in the SLS earthquake. Therefore, specifically designed, robust shallow foundation systems could be used. • Deep piles are the alternative approach. Due to proposed earthworks we understand that shallow foundations would be the preferred approach.	• Relatively thick layer of engineered fill is proposed under the structure. Therefore, settlement implications will need to be considered as part of the building design. As part of this additional soil may need to be removed and replaced to minimise this settlement risk.
Building B to E 4 & 5 Storey with a basement	• Liquefaction risk shown to be moderate (i.e. MBIE TC2). Due to the size of the structure specific analysis will be required to determine if underlying soils are appropriate for supporting the structure. • Previous assessments when the buildings did not contain a basement, showed that well detailed shallow foundation could be used with specific gravel undercuts. Therefore, it is likely that a similar solution would be able to be adopted. • Deep piles are the alternative approach. Due to proposed earthworks and basements, we understand that shallow foundations would be the preferred approach.	• Earthworks plans will need to be adopted to include temporary stability (especially around building B) and potential dewatering effects. • Additional undercuts past the basement level may be required to install a gravel undercut to increase bearing capacity and reduce settlement to the structures foundations. • Relatively thick layer of engineered fill is proposed under the structure. Therefore, settlement implications will need to be considered as part of the building design. As part of this additional soil may need to be removed and replaced to minimise this settlement risk.
Building F 3 Storey Building	• Liquefaction risk shown to be moderate (i.e. MBIE TC2). Due to the size of the structure specific analysis will be required to determine if underlying soils are appropriate for supporting the structure. • Previous assessments, showed that well detailed shallow foundation could be used with specific gravel undercuts. Therefore, it is likely that a similar solution would be able to be adopted. However, a retaining wall was required on the creek side of the structure • Deep piles are the alternative approach. Due to proposed earthworks and internal retaining wall, we understand that shallow foundations would be the preferred approach.	• Earthworks plans will need to be adopted to include temporary stability and potential dewatering effects. • Relatively thick layer of engineered fill is proposed under the structure. Therefore, settlement implications will need to be considered as part of the building design. As part of this additional soil may need to be removed and replaced to minimise this settlement risk.

For any of the foundation options presented above, detailed geotechnical assessment will be required at the detailed design phase to determine the geotechnical conditions specific to the building location and inform specific design.

6.6.3 Foundation Selection

Ultimately the foundation decision must be made in conjunction with the client to ensure that the residual site risks meet the building code, are understood and are accepted by all parties.

Selection of the building foundation system should be made in collaboration by the structural engineer, the geotechnical engineer, and the client, based on an appraisal of the client's seismic performance expectations, financial constraints, and constructability issues.

6.7 Slope Stability/lateral Spreading Considerations

6.7.1 General

A detailed seismic stability assessment of the proposed building platforms should be undertaken as part of the detailed design phase once detailed earthworks plans are available. The following techniques could be implemented to address slope stability/lateral spread issues where required:

- Crest setbacks;
- Site ground improvement;
- Embedded palisade walls;
- Excavation and replacement using reinforced earth;
- Specific design of structural foundations that can cope with the identified movements; and
- Earthworks to re grade the terrace slope to a reduced batter, removing the need for a setback.

Slope stability and potential impacts under static and seismic loading should be considered for general infrastructure aspects e.g. access roads, bridges, services etc at the detailed design phase.

Typical target factors of safety (FoS) for structures constructed close to sloping ground are presented in Table 6.2 below.

Table 6.2 – Typical Target Factors of Safety for Slope Stability

Load Case	Typical Target Design FoS
Static Load Conditions	FoS > 1.5
Serviceability Limit State (SLS) Seismic Load Conditions Seismic Load Conditions	FoS > 1.2
Ultimate Limit State (ULS) Seismic Load Conditions Seismic Load Conditions	No Target FoS, estimate likely displacements

A detailed stability assessment of the proposed building platforms which are within 3 m of any slope crest or toe should be undertaken as part of the detailed design phase.

6.7.2 Slope Stability Valley Head

The head of the valley is present approximately 100 m north of Building F. As outlined in Section 5.4 above instability has been identified in this area. Building F is set-back sufficiently from the head of the valley to avoid the identified risk areas.

Development north of Building F will require detailed assessment to determine the most appropriate remedial works to address this instability. Combinations of scaling, rock bolting, anchors and rock fall mesh are expected to be appropriate for the western slope.

For the eastern slope several feasible solutions are available to address the risk from shallow slumping and include, avoidance of the area, re-grading the slope, buttressing with fill, retaining, or a combination of these options.

6.8 Alluvial Fan Hazard

The alluvial fan hazard is discussed in Section 4.5 above. No specific engineering recommendations are considered necessary with respect to alluvial fan activity.

6.9 Flooding Risk

Flooding risks associated with Mill Creek are indicated on the QLDC hazard mapping. We understand this hazard has been assessed separately by others and is not addressed in this report. Suitable erosion/scour protection will be required along Mill Creek.

In topographically lower areas of the Site total liquefaction re-consolidation settlements following a large earthquake event may be in the order of 100 mm – 200mm. Such movements are typically within the freeboard requirements of building levels, however, consideration when finalising site and building levels is recommended.

6.10 Site Subsoil Category

Drill holes were carried out to determine the subsoil class at the Site.

The southern extent of the valley including is a Class D (deep soils) site as determined by NZS 1170.5:2004. This includes buildings A-E.

The northern end of the valley (valley head) Class C (shallow soils) site as determined by NZS 1170.5:2004. This includes building F.

There is a transition zone around the location of BH 3c (building E) and for preliminary design purposes building D should be assumed to be a Class D (deep soil site). Further investigations and a specific assessment is recommended to determine the subsoil class where applicable (particularly around building E). This should be carried out as part of the detailed design.

6.11 Pavements

Soil materials will vary across the proposed pavement areas and will comprise loess, lake sediments, alluvial silts, sands and gravels. Variations in CBR values for pavement design purposes should therefore be expected.

Assessments completed for nearby areas on similar materials indicate CBR values of 3.5% are likely to be appropriate for areas that are well drained. Locally, soft spots with CBR values of <2% should be expected. These values are expected to be appropriate for preliminary design purposes and could be refined further with site specific investigation

e.g. Scala penetrometer testing, in specific areas.

6.12 Earthworks Design Review

In accordance NZS4404, the geo-professional shall undertake a review of earthworks drawings and specifications and issue a report to QLDC detailing the foundation and stability

aspects of the project. We recommend this review should be undertaken as part of the detailed design and prior to tendering the contract.

The appointed geo-professional will need to have early and ongoing involvement with the earthworks designer as the geo-professional will ultimately be responsible for site stability following construction (geotechnical sign off for schedule 2a).

We have not been provided final earthworks plans for the proposed scheme. Due to the compressible nature of the underlying soils, extensive fills will trigger long term settlement which should be assessed and catered for as part of the detailed design of the scheme.

7 Neighbouring Structures

Distances to adjoining structures: No adverse effects are expected to impact the existing structures on or neighbouring the Site, however any potential implications should be assessed at the detailed design stage.

Aquifers: The Wakatipu Basin aquifer underlies the Site area. The development is not expected to adversely affect the aquifer, however, if the development requires deep drilling e.g. for foundations, ground source heating systems or other purpose, then the appropriate consents will be required prior to completing this work.

Erosion and Sediment Control: The Site presents potential to generate silt runoff. Effective systems for erosion control are runoff diversion drains and contour drains, while for sediment control, options are earth bunds, silt fences, hay bales, vegetation buffer strips and sediment ponds. Refer to PPG draft earthworks management plan for further information.

Noise: Conventional earthmoving equipment such as excavators will be required to complete earthworks at the Site however rock-breaking and/or blasting is unlikely to be required.

Dust: Unlikely to be an issue, but regular dampening of soil materials with sprinklers should be effective if required.

Vibration: Minor vibration induced settlement may occur in these soil types. Due to the distance to existing neighbouring structures no adverse impact is expected on the surrounding properties.

8 Further Investigation & Assessment

During the detailed design phase of the project the following geotechnical inputs are recommended:

- The recommended assessments described within this report should be undertaken. Additional assessments may be required as part of the detailed design.
- Significant geotechnical investigations have been carried out across the Site as part of the assessment to date. However, during this process the geotechnical engineer should assess if further geotechnical investigations are required to better define the geotechnical risks.
- Close collaboration between the structural and the geotechnical engineer will be required to ensure investigations are appropriately targeted.

9 Conclusions and Recommendations

- Northbrook Arrowtown at the Site is considered feasible from a geotechnical perspective provided the recommendations of this report are followed;
- The proposed building layout takes into account the identified geotechnical issues and hazards at the Site. The location of building structures away from areas of more uncertain and higher geotechnical risk, and areas of higher development costs, has been achieved with the proposed layout;
- The geological model shows some variation across the Site and is outlined in Section 4.0;
- The potential for liquefaction has been identified and will need to be considered during the detailed design phase of the project;
- An area of existing slope instability and rock fall risk has been identified at the northern area of the development. These hazards can be suitably managed and/or remediated to enable the development in close proximity;
- Flooding risks associated with Mill Creek are indicated on the QLDC hazard mapping. We understand this hazard has been assessed separately by others and is not addressed in this report;
- Further assessment is required to confirm all building foundation design. This should include a specific assessment of slope stability/lateral spreading, liquefaction and any other requirements depending on the building platform location. Concept foundation solutions are discussed in Section 5.6;
- Localised perched groundwater seepages were noted within the upper soil strata. A detailed groundwater model should be produced following further investigation to enable an assessment of groundwater impacts on design and construction. This should be carried out at the detailed design stage;
- The southern extent of the valley including the majority of development is a Class D (deep soils) site as determined by NZS 1170.5:2004. The northern extend of the valley is a Class C (shallow soils) site as determined by NZS 1170.5:2004;
- Selection of the building foundation system should be made in collaboration by the
- structural engineer, the geotechnical engineer, and the client, based on an appraisal of the client's seismic performance expectations, financial constraints, and constructability issues, and;
- The recommended assessments described within this report should be undertaken as part of the detailed design phase of the project.

10 Applicability

This report has been prepared for the benefit of WPDL with respect to the particular brief given to Geosolve and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.
It is important that we be contacted if there is any variation in subsoil conditions from those described in this report.

Report prepared for GeoSolve Ltd by:

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.....
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Authorised for GeoSolve by:

.....
Colin Macdiarmid
Geotechnical Group Manager (CPEng)

Appendices: Appendix A – Site Plans & Cross-sections

Appendix A: Site Plan & Cross-Sections

Legend:

- Proposed Contours (Source: Patterson Pitts Feb.23)
- Test Pit Locations
- Borehole Locations
- CPT Locations

SCALE 1:500

0 5 10 15 20 25 (m)

GEOSOLVE
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CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:1250		
PROJECT No: 150098.04	FIG No: Figure 1a	REV. 3

Waterfall Park Developments Ltd

Arrowtown-Lake Hayes Road

Geotechnical Assessment

Site Investigation Plan A

Legend:

- Proposed Contours (Source: Patterson Pitts Feb.23)
- Test Pit Locations
- Borehole Locations
- CPT Locations

SCALE 1:500

0 5 10 15 20 25 (m)

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SCALES (AT A3 SIZE): 1:1250		
PROJECT No: 150098.04	FIG No: Figure 1b	REV. 3

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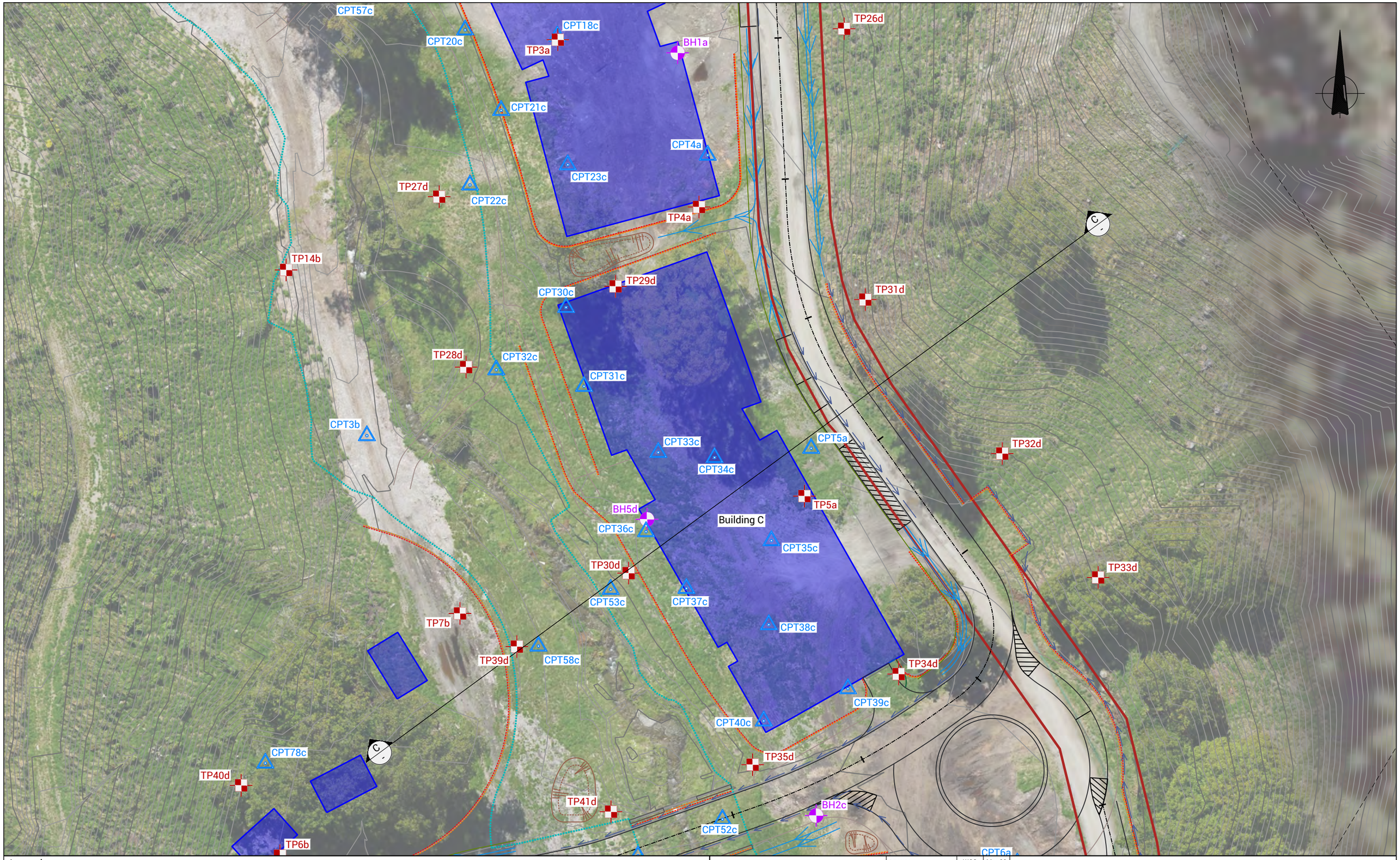
Geotechnical Assessment

Site Investigation Plan B



Legend:

- Proposed Contours (Source: Patterson Pitts Feb.23)
- Test Pit Locations
- Borehole Locations
- CPT Locations

SCALE 1:500

0 5 10 15 20 25 (m)

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SCALES (AT A3 SIZE): 1:1250		
PROJECT No: 150098.04	FIG No: Figure 1c	REV. 3

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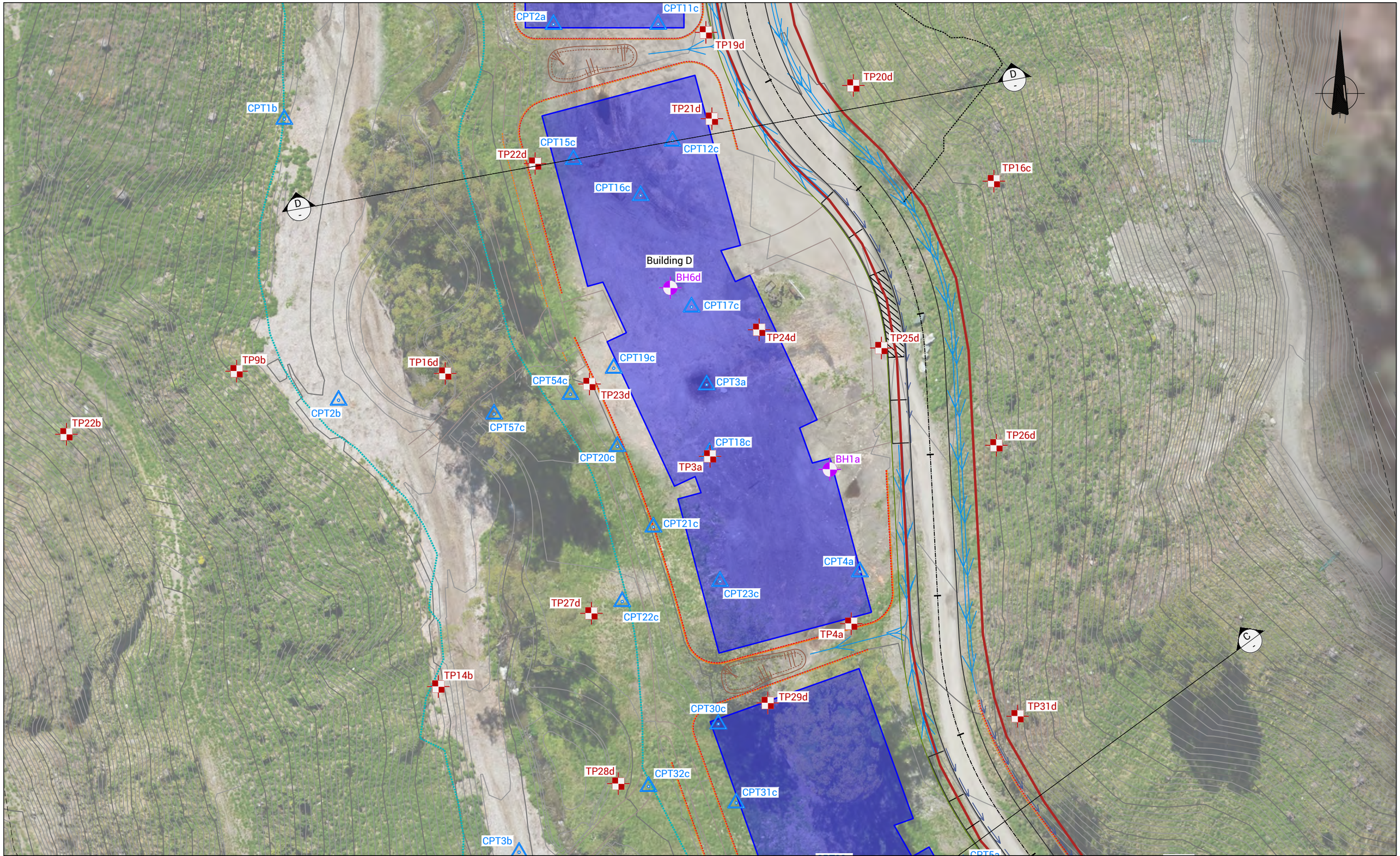
Geotechnical Assessment

Site Investigation Plan C



Legend:

- Proposed Contours (Source: Patterson Pitts Feb.23)
- Test Pit Locations
- Borehole Locations
- CPT Locations

SCALE 1:500

0 5 10 15 20 25 (m)

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CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:1250		
PROJECT No: 150098.04	FIG No: Figure 1d	REV. 3

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Arrowtown-Lake Hayes Road

Geotechnical Assessment

Site Investigation Plan D

Legend:

- Proposed Contours (Source: Patterson Pitts Feb.23)
- Test Pit Locations
- Borehole Locations
- CPT Locations

SCALE 1:500

0 5 10 15 20 25 (m)

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CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:1250		
PROJECT No: 150098.04	FIG No: Figure 1e	REV. 3

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Arrowtown-Lake Hayes Road

Geotechnical Assessment

Site Investigation Plan E

Legend:

- Proposed Contours (Source: Patterson Pitts Feb.23)
- Test Pit Locations
- Borehole Locations
- CPT Locations

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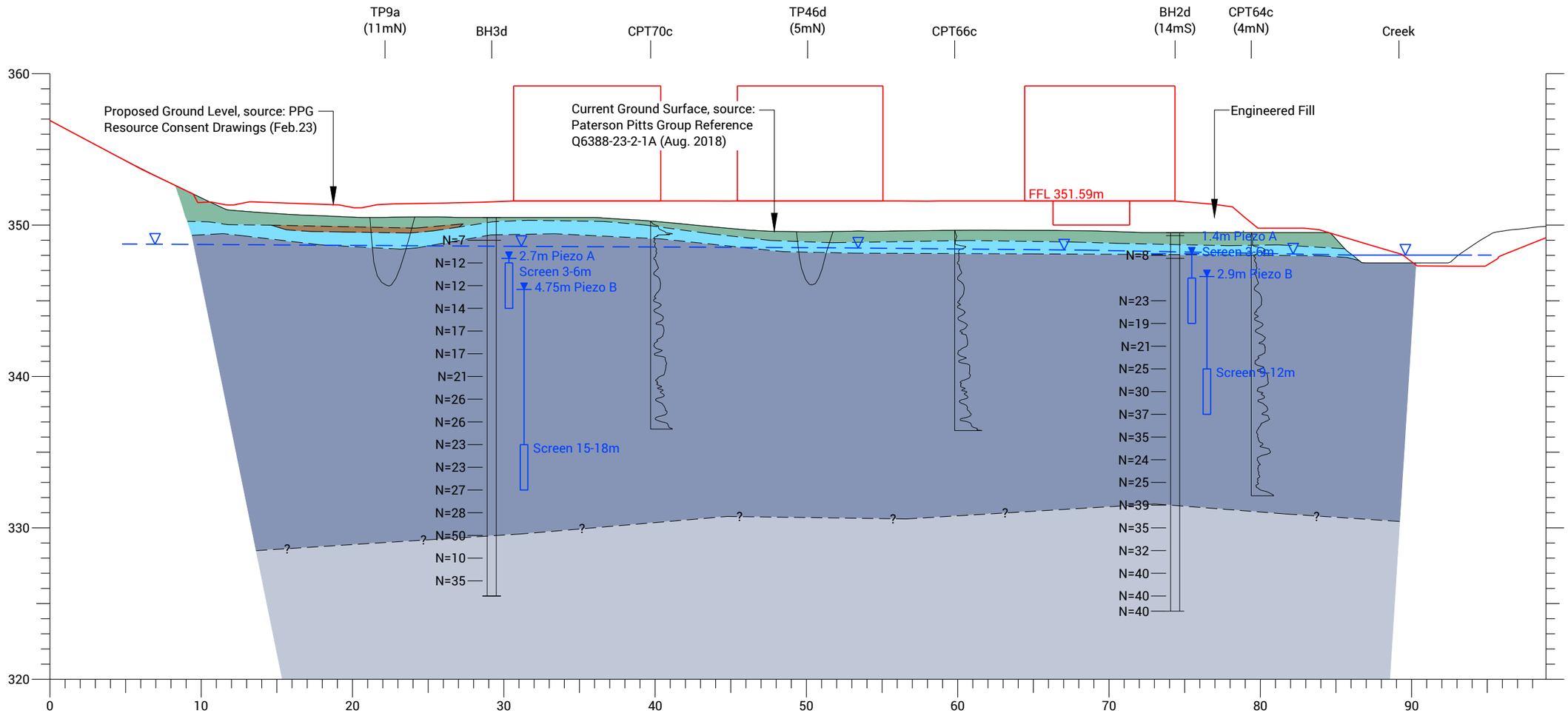
CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:1250		
PROJECT No: 150098.04	FIG No: Figure 1f	REV. 3

Waterfall Park Developments Ltd

Arrowtown-Lake Hayes Road

Geotechnical Assessment

Site Investigation Plan F



Legend:

- Topsoil, Overbank Deposits and Loess
- Buried Topsoil
- Alluvial Gravel
- Lake Sediments (Interbedded Silt & Sand)
- Dense Lake Sediments

N=23 — SPT N-Value

Surface Seepages from Test Pits (Perched)

Piezometer Water Levels at Depth

*Building height inferred

SCALE 1:300

0 3 6 9 12 15 (m)

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CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:300		
PROJECT No: 150098.04	FIG No: Figure 2a	REV. 3

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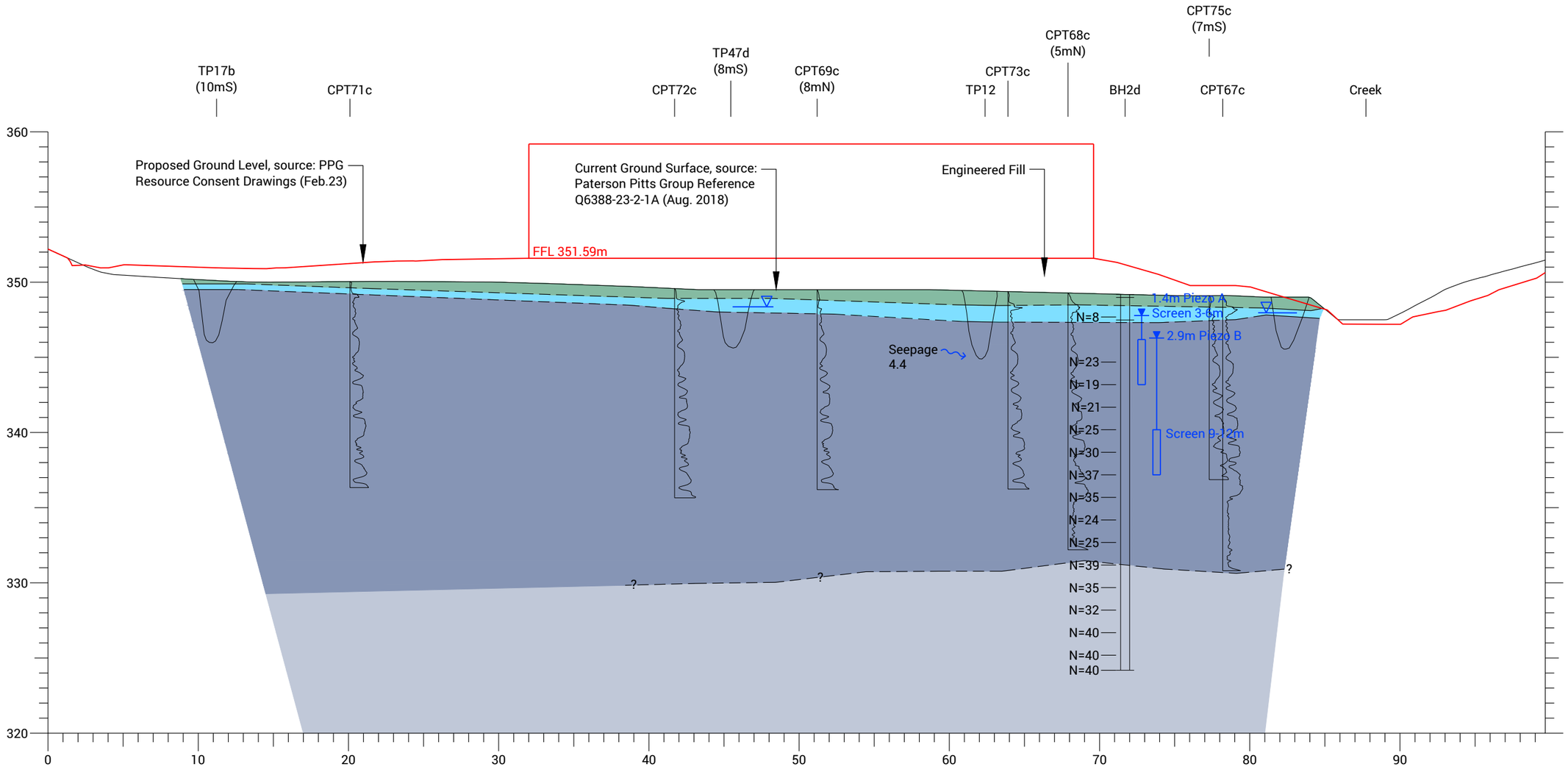
Arrowtown-Lake Hayes Road

Geotechnical Assessment

Cross Section A1



Legend:

- Topsoil, Overbank Deposits and Loess
- Alluvial Gravel
- Lake Sediments (Interbedded Silt & Sand)
- Dense Lake Sediments
- N=23 — SPT N-Value
- Surface Seepages from Test Pits (Perched)
- Piezometer Water Levels at Depth
- *Building height inferred

SCALE 1:300

0 3 6 9 12 15 (m)

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CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:300		
PROJECT No: 150098.04		

Waterfall Park Developments Ltd

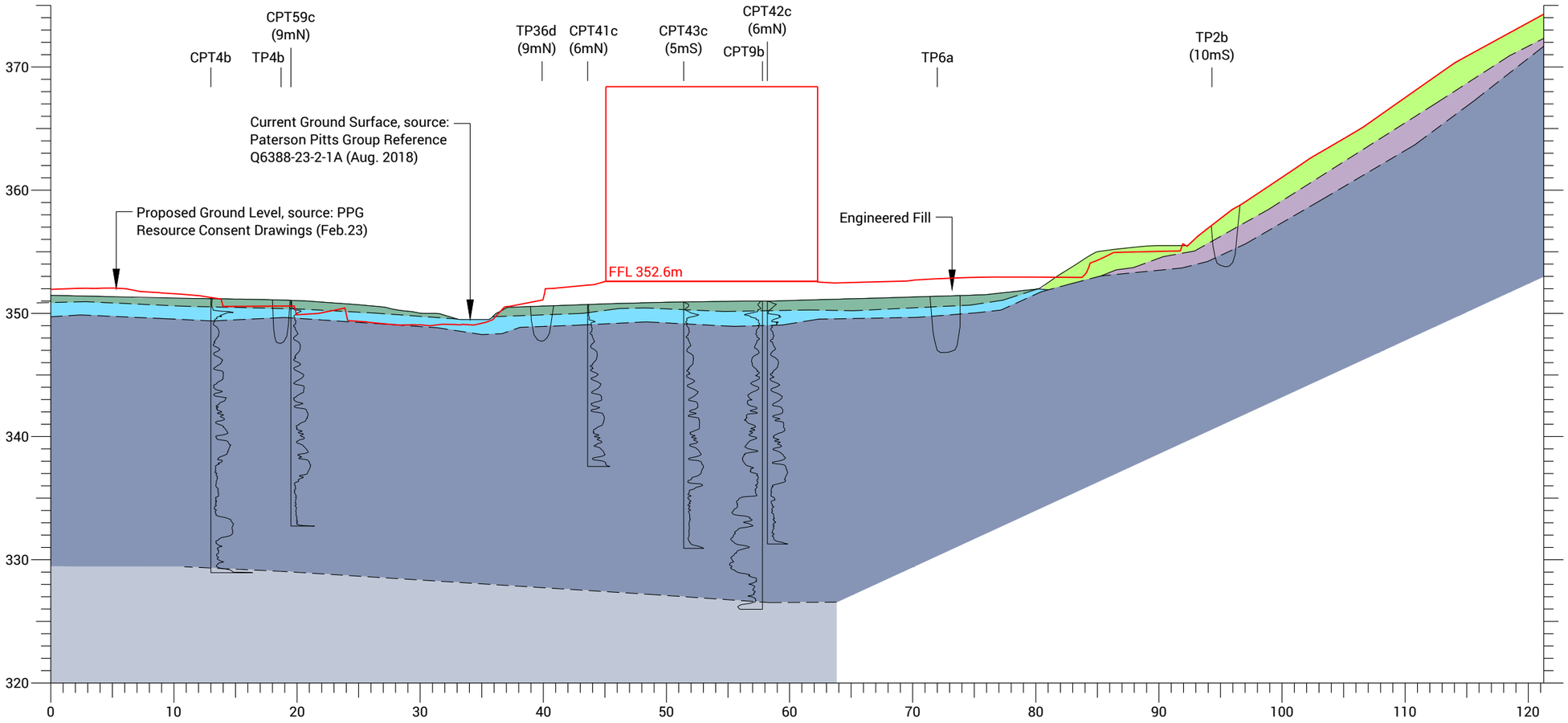
Arrowtown-Lake Hayes Road

Geotechnical Assessment

Cross Section A2

FIG No: Figure 2b

REV. 3



Legend:

- Topsoil, Overbank Deposits and Loess
- Alluvial Gravel
- Lake Sediments (Interbedded Silt & Sand)
- Dense Lake Sediments
- Colluvium
- Landslide Debris
- Surface Seepages from Test Pits (Perched)
- Piezometer Water Levels at Depth
- N=23 — SPT N-Value
- *Building height inferred

SCALE 1:400

0 4 8 12 16 20 (m)

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APPROVED		
CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:400		
PROJECT No: 150098.04		

Waterfall Park Developments Ltd

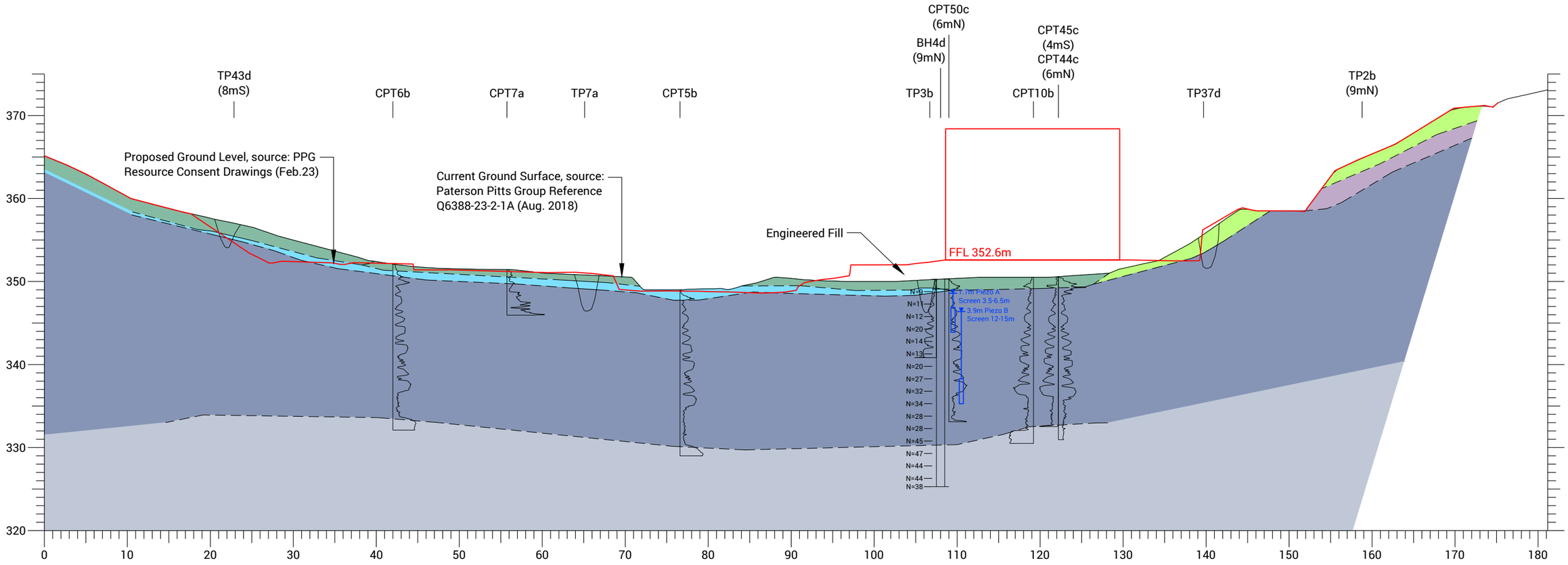
Arrowtown-Lake Hayes Road

Geotechnical Assessment

Cross Section B1

FIG No: Figure 2c

REV. 3



Legend:

- Topsoil
- Alluvial Gravel
- Lake Sediments
- Dense Lake Sediments
- Colluvium
- Landslide Debris
- Surface Seepages from Test Pits (Perched)
- Piezometer Water Levels at Depth
- N=23 SPT N-Value
- *Building height inferred

SCALE 1:500

0 5 10 15 20 25 (m)

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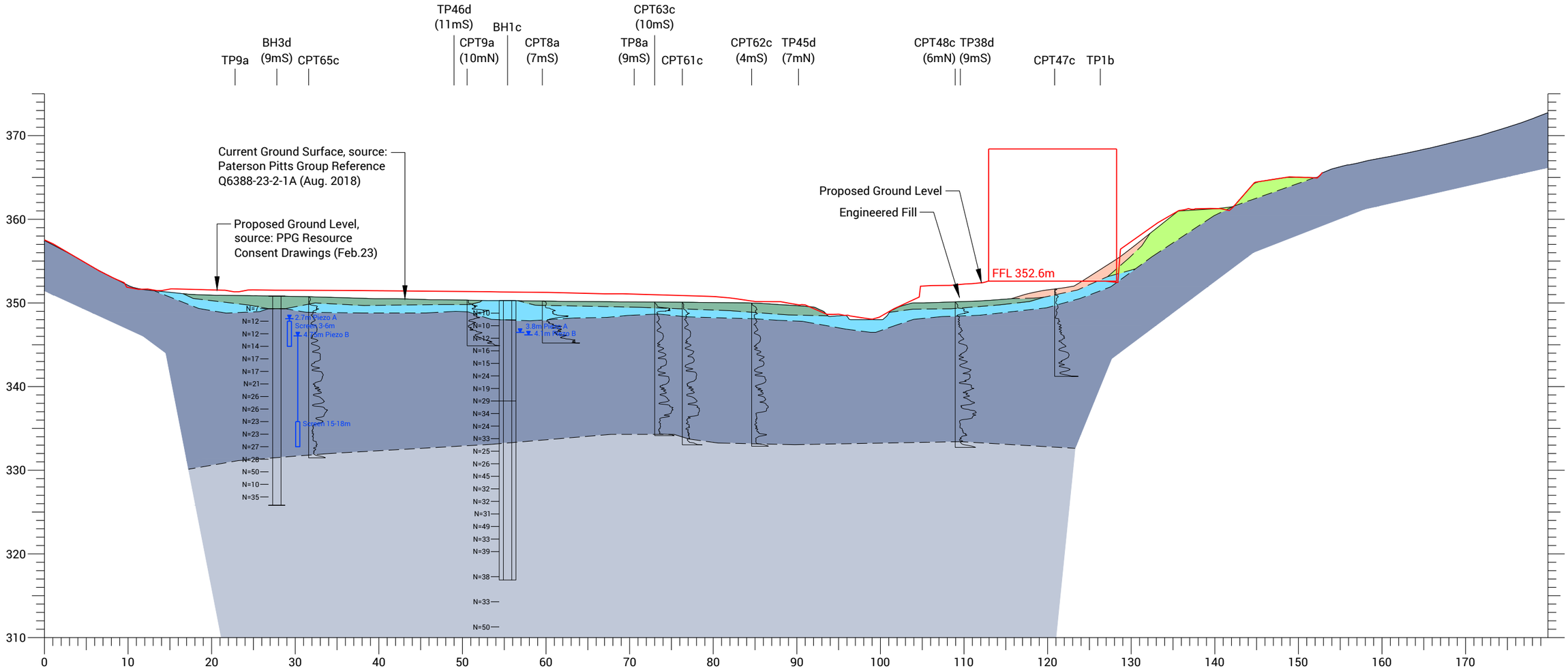
APPROVED		
CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:500		
PROJECT No: 150098.04	FIG No: Figure 2d	REV. 3

Waterfall Park Developments Ltd

Arrowtown-Lake Hayes Road

Geotechnical Assessment

Cross Section B2



Legend:

- Topsoil
- Alluvial Gravel
- Lake Sediments
- Dense Lake Sediments
- Colluvium
- Uncontrolled Fill
- Surface Seepages from Test Pits (Perched)
- Piezometer Water Levels at Depth
- N=23 SPT N-Value
- *Building height inferred

SCALE 1:500

0 5 10 15 20 25 (m)

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CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:500		
PROJECT No: 150098.04	FIG No: Figure 2e	REV. 3

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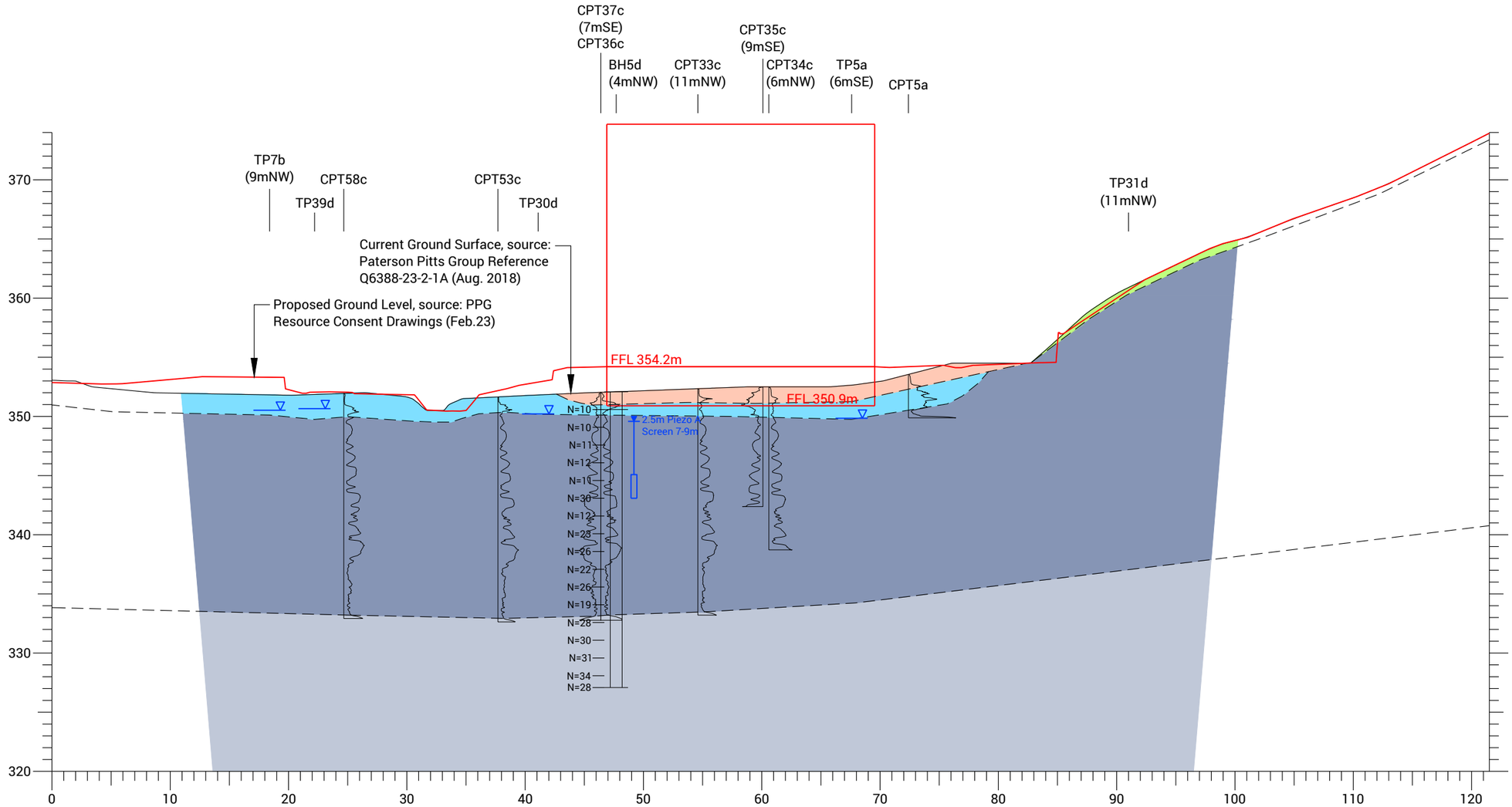
Arrowtown-Lake Hayes Road

Geotechnical Assessment

Cross Section B3



Legend:

- Uncontrolled Fill
- Alluvial Gravel
- Lake Sediments
- Dense Lake Sediments
- Colluvium

Surface Seepages from Test Pits (Perched)

Piezometer Water Levels at Depth

N=23 SPT N-Value

*Building height inferred

SCALE 1:400

0 4 8 12 16 20 (m)

GEOSOLVE
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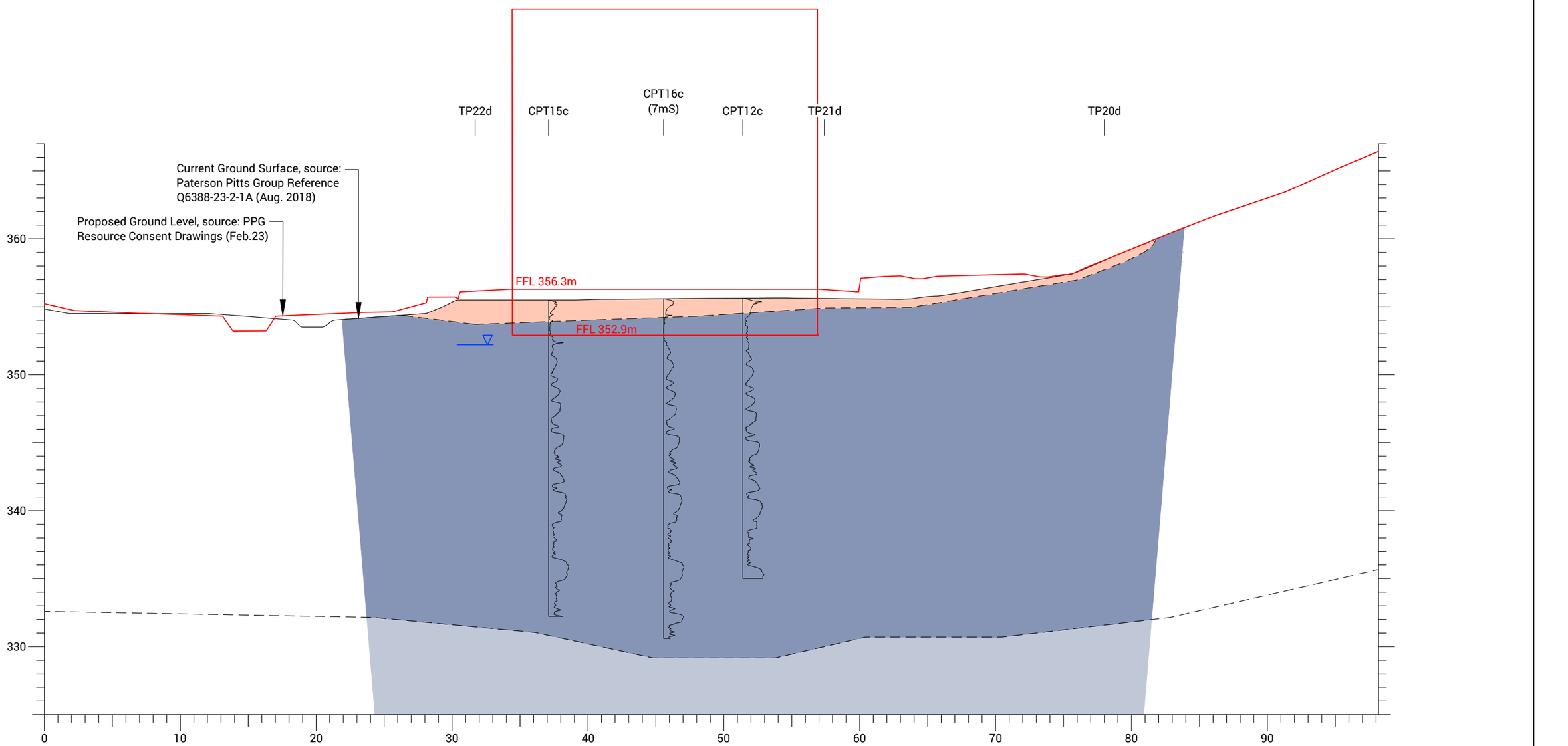
APPROVED		
CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:400		
PROJECT No: 150098.04	FIG No: Figure 2f	REV. 3

Waterfall Park Developments Ltd

Arrowtown-Lake Hayes Road

Geotechnical Assessment

Cross Section C



Legend:

- Uncontrolled Fill
- Lake Sediments
- Dense Lake Sediments
- Surface Seepages from Test Pits (Perched)
- Piezometer Water Levels at Depth
- N=23 SPT N-Value

*Building height inferred

SCALE 1:300

0 3 6 9 12 15 (m)

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DRAFTING CHECKED		
APPROVED		
CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:300		
PROJECT No: 150098.04		

Waterfall Park Developments Ltd

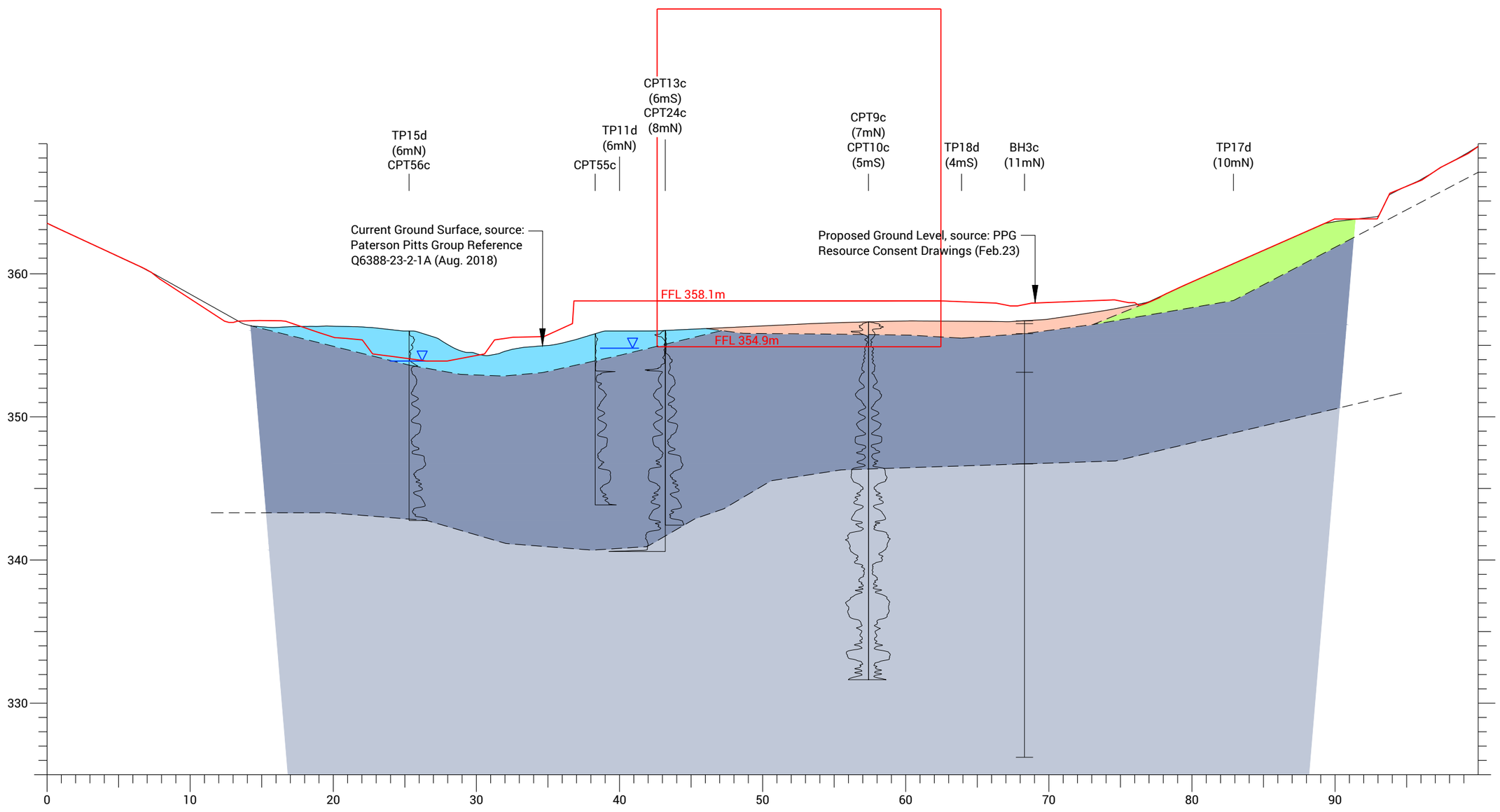
Arrowtown-Lake Hayes Road

Geotechnical Assessment

Cross Section D

FIG No: Figure 2g

REV. 3



Legend:

- Alluvial Gravel
- Lake Sediments
- Dense Lake Sediments
- Colluvium
- Uncontrolled Fill
- Surface Seepages from Test Pits (Perched)
- Piezometer Water Levels at Depth
- N=23 SPT N-Value
- *Building height inferred

SCALE 1:300

0 3 6 9 12 15 (m)

GEOSOLVE
Level 1, 70 MacAndrew Road, South Dunedin
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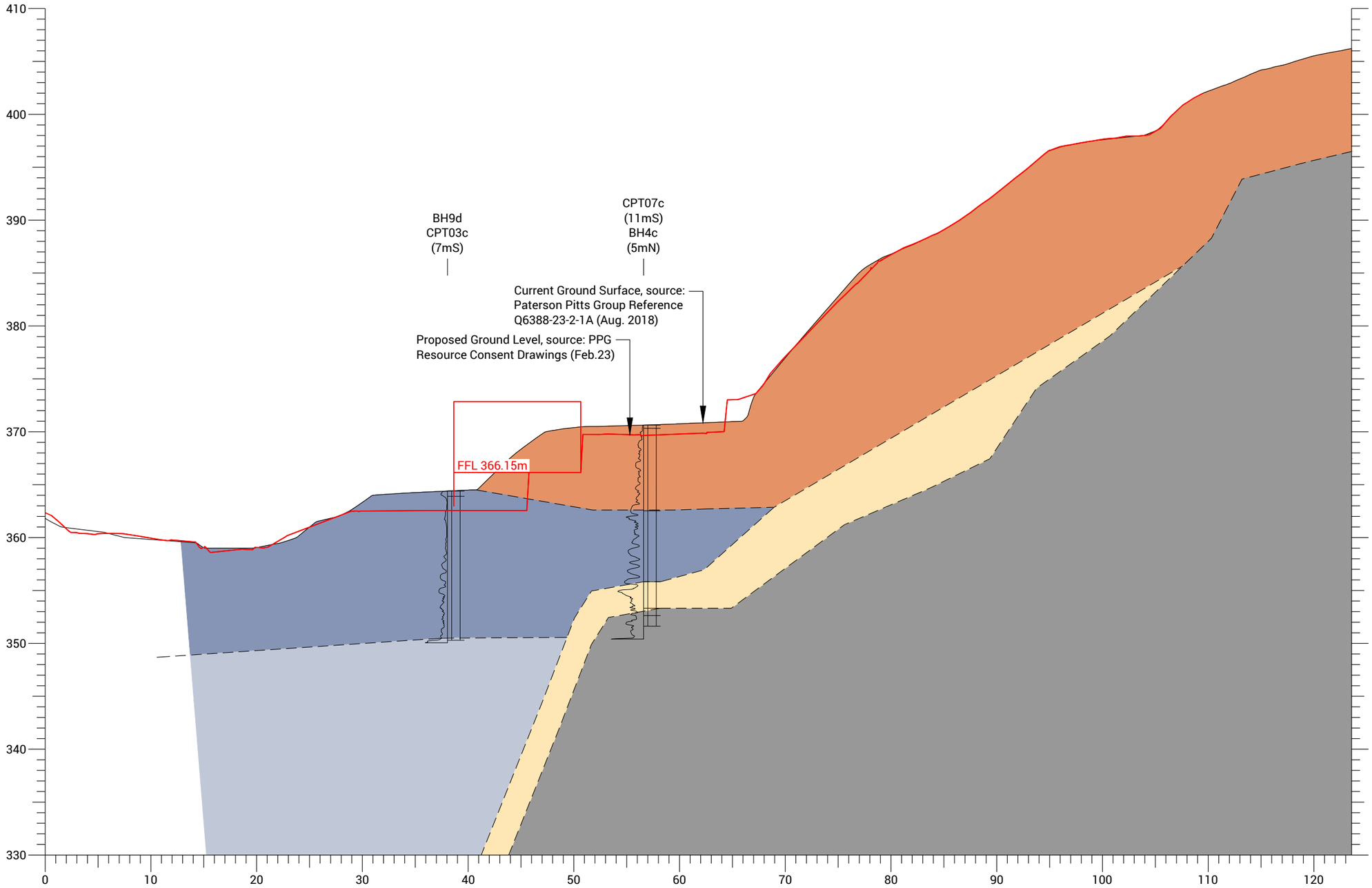
DRAWN	WCG	Mar.23
DRAFTING CHECKED		
APPROVED		
CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:300		
PROJECT No: 150098.04	FIG No: Figure 2h	REV. 3

Waterfall Park Developments Ltd

Arrowtown-Lake Hayes Road

Geotechnical Assessment

Cross Section E



Legend:

- Glacial Outwash
- Glacial Till
- Lake Sediments
- Dense Lake Sediments
- Schist Rock

- Surface Seepages from Test Pits (Perched)
- Piezometer Water Levels at Depth
- N=23 SPT N-Value

*Building height inferred

SCALE 1:400

0 4 8 12 16 20 (m)

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DRAFTING CHECKED		
APPROVED		
CADFILE: 150098.04-SP.dwg		
SCALES (AT A3 SIZE): 1:400		
PROJECT No: 150098.04		

Waterfall Park Developments Ltd

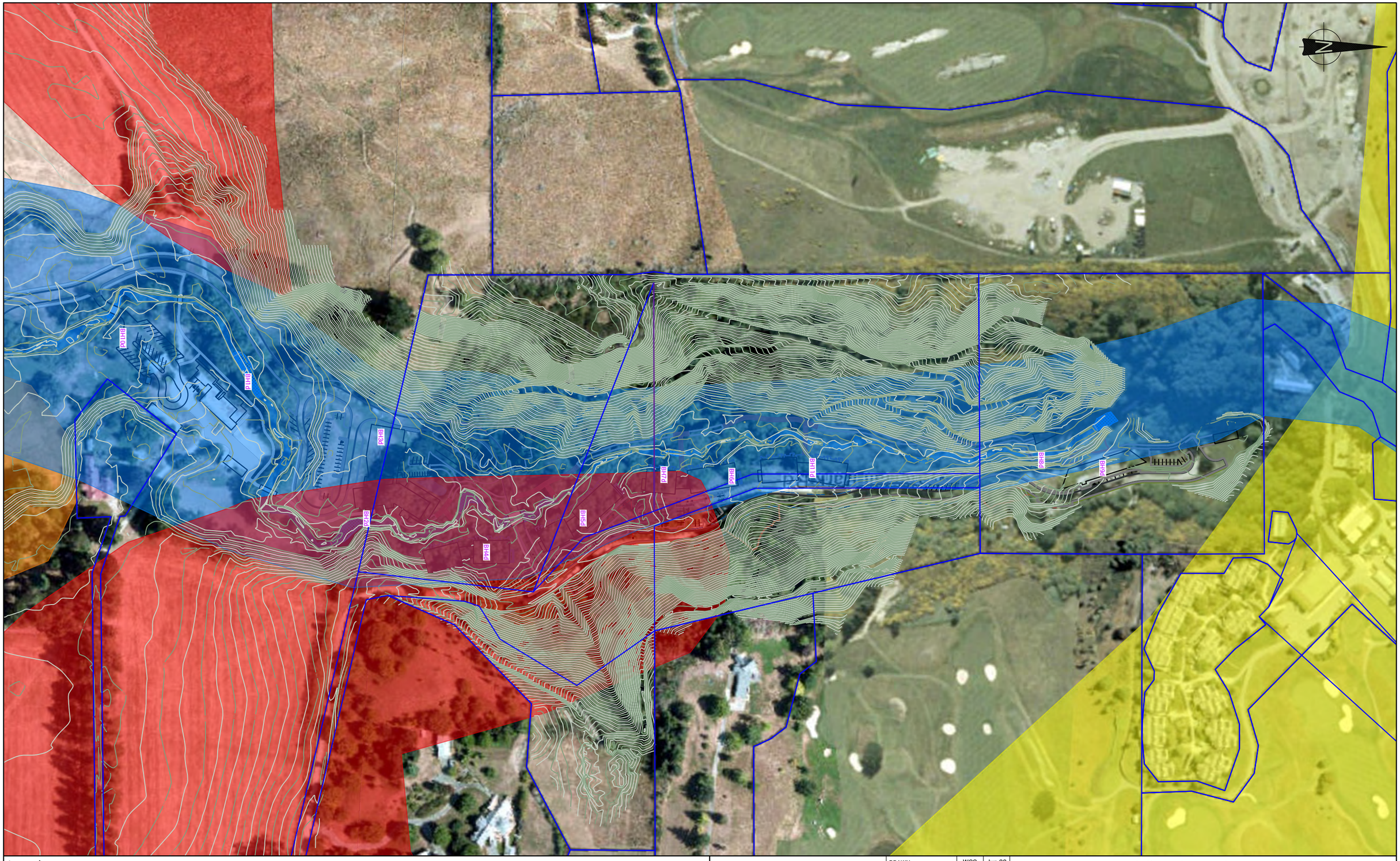
Arrowtown-Lake Hayes Road

Geotechnical Assessment

Cross Section F

FIG No: Figure 2i

REV. 3



Legend

- Regional scale alluvial fan activity
- LIC1 liquefaction risk area
- Flooding Area

SCALE 1:2500

0 25 50 75 100 125 (m)

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APPROVED		
CADFILE: 150098.04-Figs.dwg		
SCALES (AT A3 SIZE): 1:2500		
PROJECT No: 150098.04		

Waterfall Park Developments Ltd

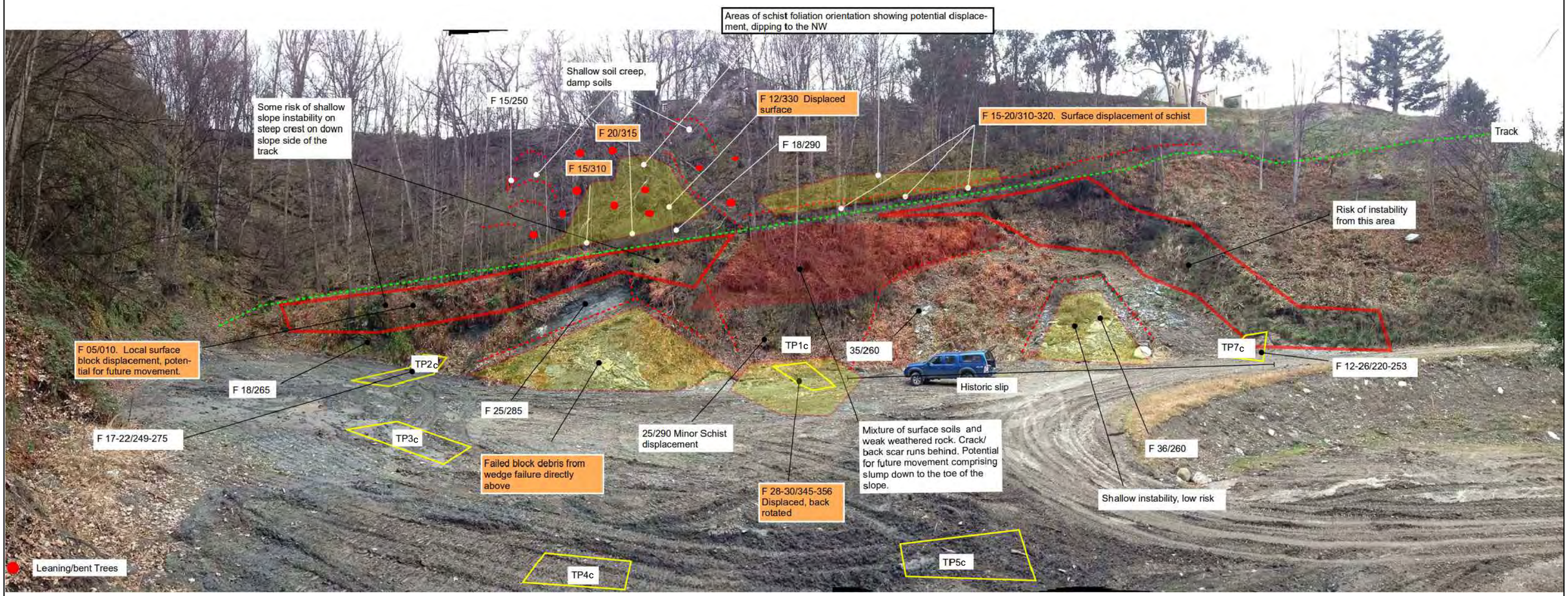
Arrowtown-Lake Hayes Road

Geotechnical Assessment

Hazard Plan

FIG No: Figure 3

REV. 1



Legend

F 20/315 Insitu Schist Foliation Measurement

F 18/290 Displaced Schist Foliation Measurement

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CADFILE: 150098.04-Figs.dwg		
SCALES (AT A3 SIZE): NTS		
PROJECT No: 150098.04		

Waterfall Park Developments Ltd

Arrowtown-Lake Hayes Road

Geotechnical Assessment

Geotechnical Summary Northeast Slope

FIG No: Figure 4

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Waterfall Park Developments Limited

Northbrook Arrowtown Flood Assessment – Resource Consent

March 2023

Fluent SOLUTIONS

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Waterfall Park Developments Limited
Northbrook Arrowtown – Flood Assessment
Resource Consent

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Job No.: Q000491
Date: 12 October 2022
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Version: 1, Version Date: 07/03/2023

Waterfall Park Developments Limited
Northbrook Arrowtown – Flood Assessment
Resource Consent

1.0 Introduction

Fluent Infrastructure Solutions Ltd (Fluent Solutions) has been engaged by Waterfall Park Developments Ltd (WPDL) to prepare a report detailing the flood flows in Mill Creek and how any potential adverse effects in relation to the Mill Creek flood flows would be managed and/ or mitigated for the Northbrook Arrowtown later living development (Northbrook Arrowtown).

The proposed flood mitigation measures relate to any effects due to the proximity of Northbrook Arrowtown to Mill Creek, the accessways across Mill Creek, pedestrian path and bridges/crossings, erosion protection measures, and landform improvements along Mill Creek as part of the landscape design.

This report has been prepared to inform an application for resource consent for the flood mitigation works associated with Northbrook Arrowtown.

Note: This report is limited to flood flow assessment, as stormwater design has been undertaken by others. In addition, no creek works are proposed as part of this application and therefore this report does not address the ecology of Mill Creek.

2.0 Background

2.1 Northbrook Arrowtown Locality

The Northbrook Arrowtown site (the Site) is located to the north of Lake Hayes and approximately 2km southwest of Arrowtown. Mill Creek drains a moderately large catchment that discharges to Lake Hayes that in turn discharges via Hayes Creek to the Kawarau River. Northbrook Arrowtown is accessed by the Ayr Avenue access road, off of Arrowtown-Lake Hayes Road. The Ayr Avenue access road has been partially constructed as part of previously consented works.

The southern end of the Site lies in relatively rolling land. However, a large portion of the Northbrook Arrowtown development lies in a relatively incised valley at the northern extent of the Site. At the head of the valley, the floor of the valley rises steeply by approximately 40 metres (m), to form the well-known natural waterfall feature that the Waterfall Park Zone takes its name from. Refer to Figure 2.1 below for the locality.

The stream running from the waterfall through the Site is referred to as “Mill Creek” because that is what the stream between the waterfall and Lake Hayes is referred to by the Otago Regional Council (ORC). It should be noted that the stream is not named on the 1:50,000 scale topographical map series typically used for locality references.

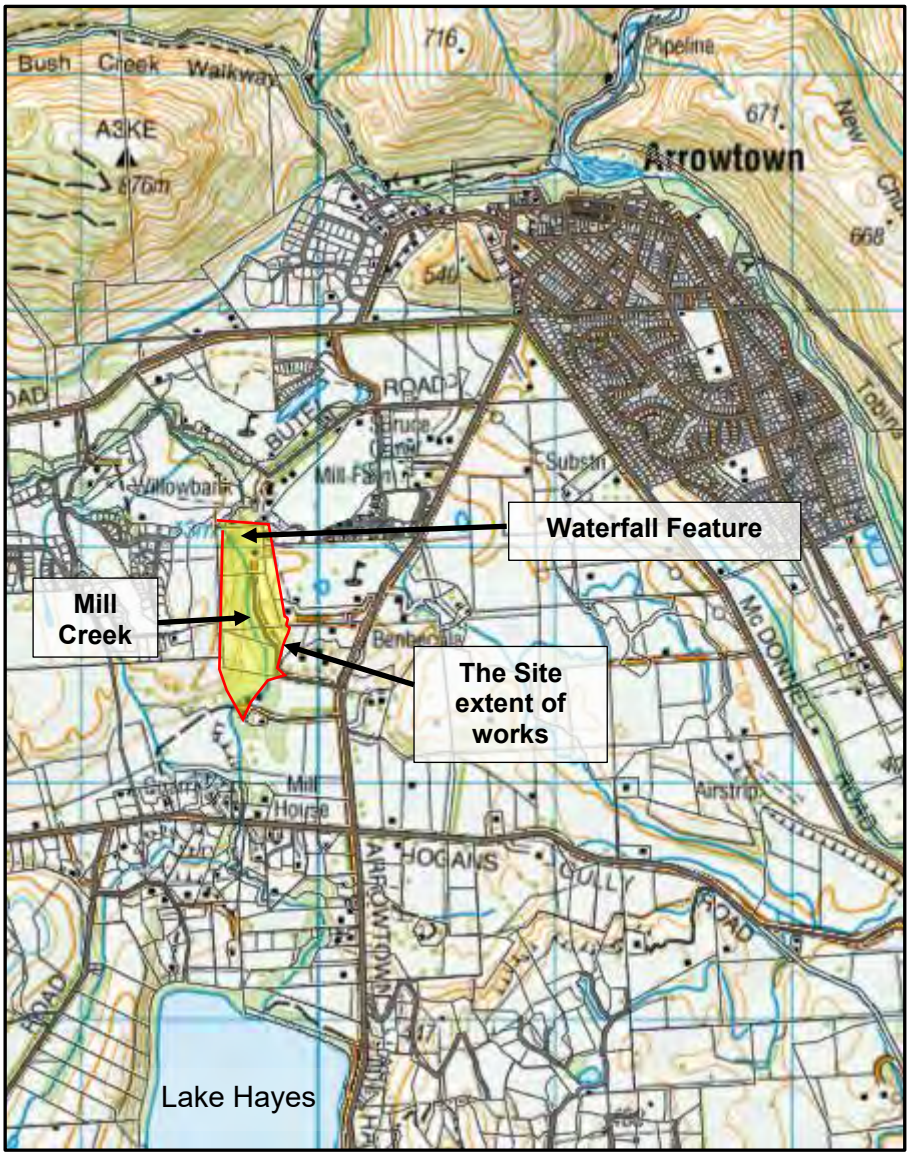


Figure 2.1: Locality Plan

2.2 Mill Creek Characteristics

2.2.1 Typical Flow Regime

The Mill Creek catchment above the Site extends northwest to Coronet Peak and westwards almost to Arthurs Point, refer to Figure 2.2. Upstream of the waterfall at the upstream and northern extent of the Site, the Mill Creek valley floor rises very gradually from 400m to 440m over a distance of 10km, which is representative of a relatively flat valley floor that is typically 1km wide. Despite the significant catchment area and the steep valley sides, the wide valley floor has the ability to absorb and disperse large flows in what is essentially a dry lake bed topographic feature.

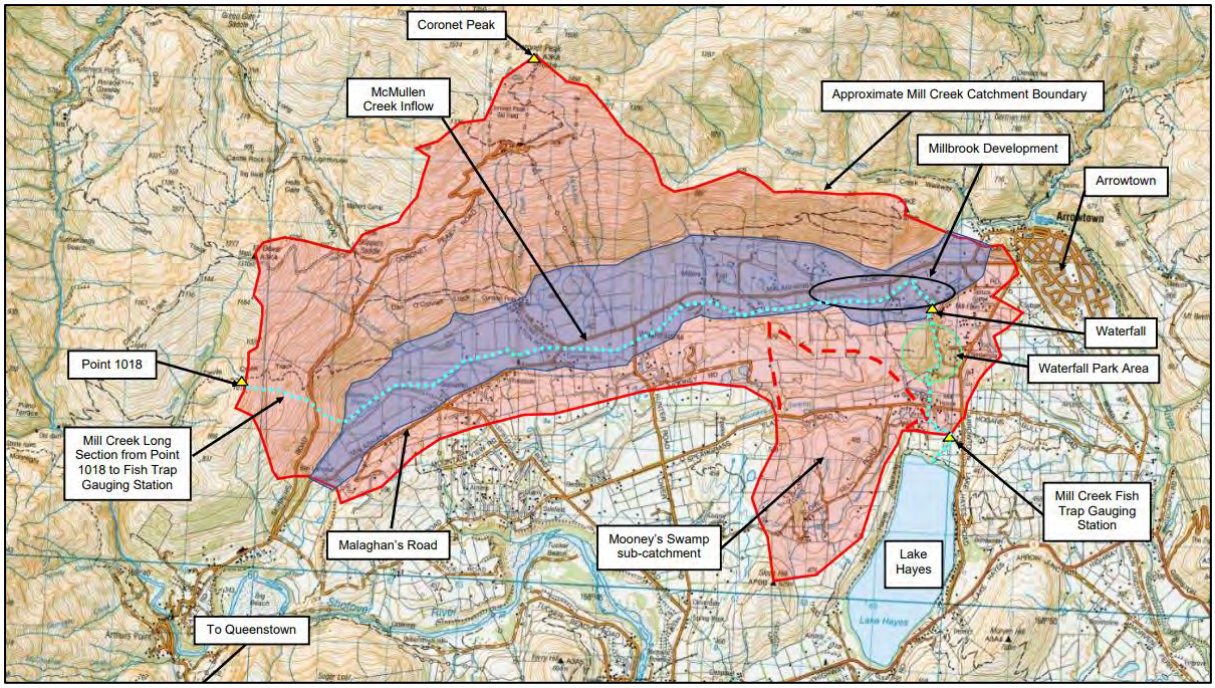


Figure 2.2: Mill Creek Catchment

Through the Site, and elsewhere between Waterfall Park and Lake Hayes, the main channel of Mill Creek is confined and is relatively stable. The channel stability is indicative of a relatively stable flow regime typical of a stream downstream of a lake or wetland as shown in the purple area of Figure 2.2. The median dry weather flow is of the order of 350 litres per second (l/s). The stability of the flow regime creates an attractive habitat for fish and therefore Mill Creek is a valuable fish spawning area. Figure 2.3 shows the stream appearance and is typical of what can be seen throughout the Site.

Figure 2.3: Mill Creek Environment (Prior to Development)

2.2.2 Upper Reach Stream Environment – Incised Valley

The upper reach of Mill Creek is characterised by an incised valley where the margins of the stream channel have been cleared of a dense willow thicket and pine plantation. See Figure 2.4 for the "Upper Reach" location. Note that the majority of the Site boundary falls within this area.

The main channel of the stream is typically 3 to 5 metres (m) wide in the bottom and 10 to 15m wide at the top of the bank and is typically 1m to 2m deep. Where the channel is less than 1.5m deep there is a risk that flood flows would leave the main channel locally to the flood plain and return to the channel downstream.

At the southern end of the incised valley, Mill Creek then flows through a shallow terraced landform at the northern end of the east bank floodplain adjacent to the main channel.

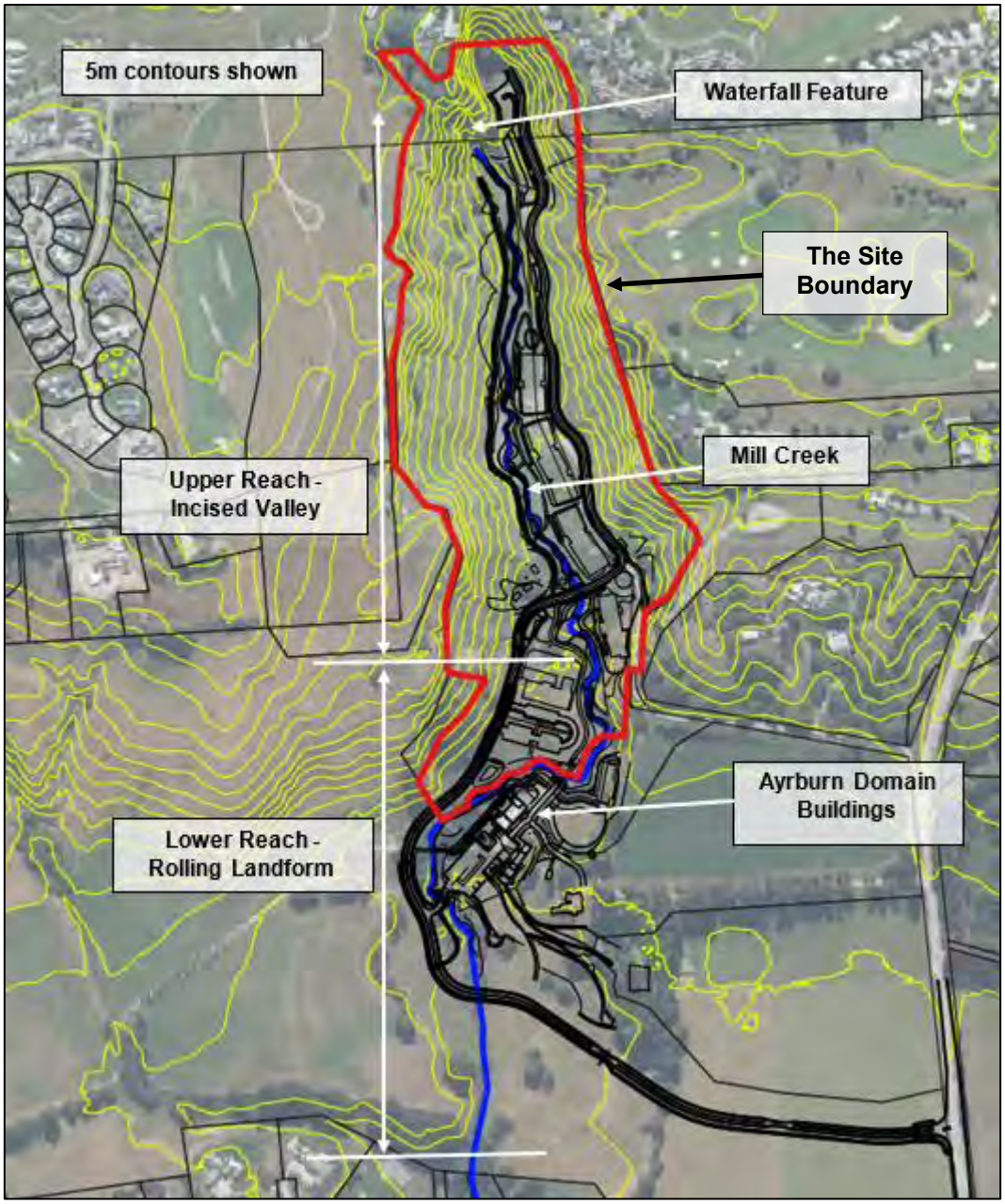


Figure 2.4: Existing Mill Creek Locality

2.2.3 Lower Reach Stream Environment – Rolling Land Form

The lower reaches of Mill Creek within the Site are characterised by a rolling landform. The "Lower Reach" is downstream of the incised valley and is similar to that upstream in the incised valley except that bank heights are frequently less than 1.5m and therefore there are areas where during major flood events flood flows can leave the main stream channel. Flows leave the creek downstream of Ayrburn Domain (see Figure 3.1 for location) and flow over the floodplain. The flow on the floodplain is significant for moderate and extreme events.

2.3 Hazard Information

2.3.1 Alluvial Fan Hazard

Figure 2.5 below shows an alluvial fan hazard area in relation to the Site (taken from the Otago Regional Council Hazard Map). The upstream hazard is characterised as Active Composite and the hazard partially within the Site is characterised as active debris dominated, as noted in the ORC Hazard Register Data.

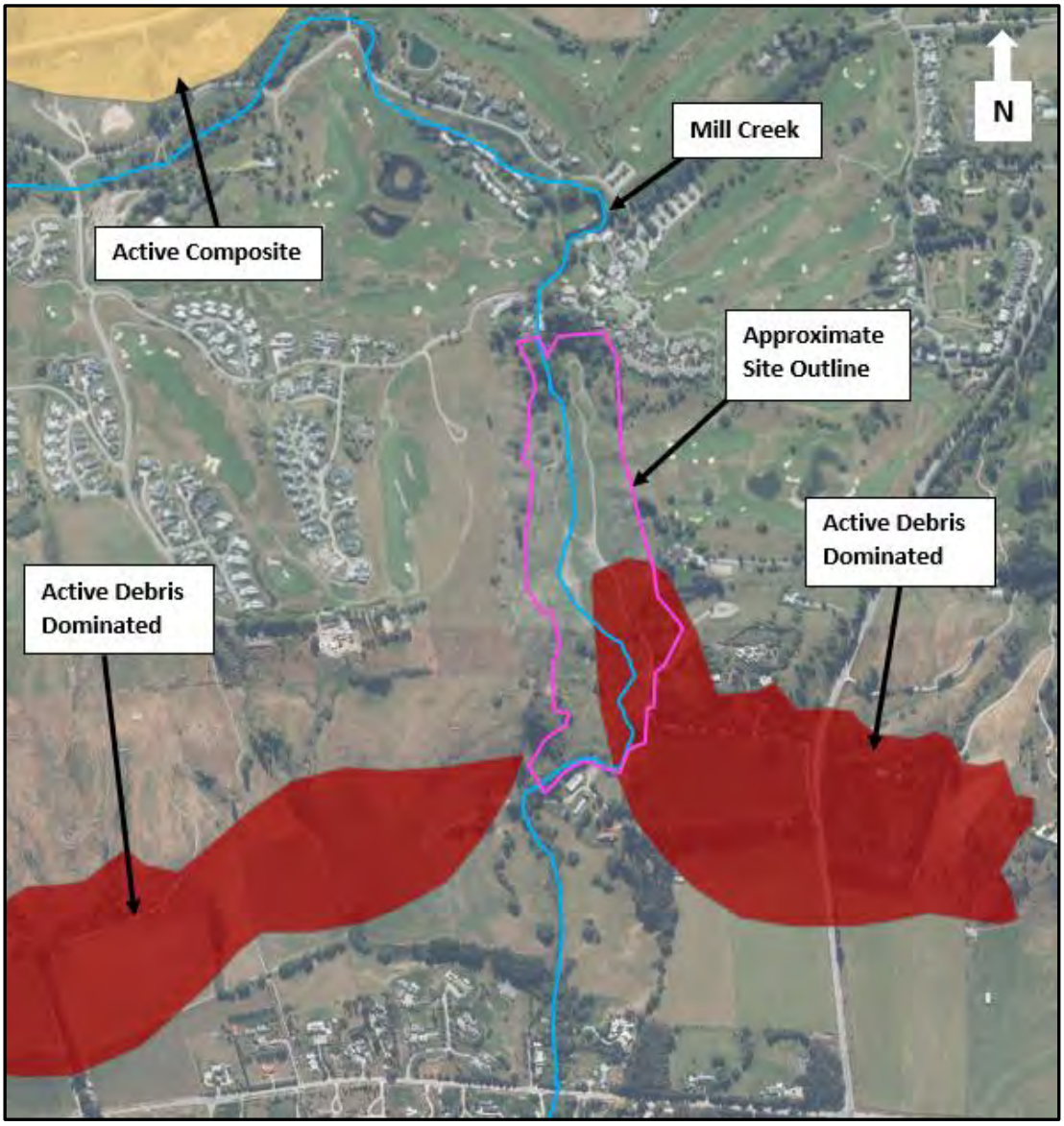


Figure 2.5: Hazard Information – Alluvial Fan – Otago Regional Council Hazard Register Data

Note that a detailed debris flow assessment relating to alluvial fan hazard is not included in this investigation.

2.3.2 Flood Hazard

Figure 2.6 below shows an indicative flooding hazard associated with Mill Creek through the Site (taken from the Queenstown Lakes District Council hazard maps – based on ORC flooding data from 2012). The updated Otago Regional Council hazard maps do not show a flood hazard in this area.

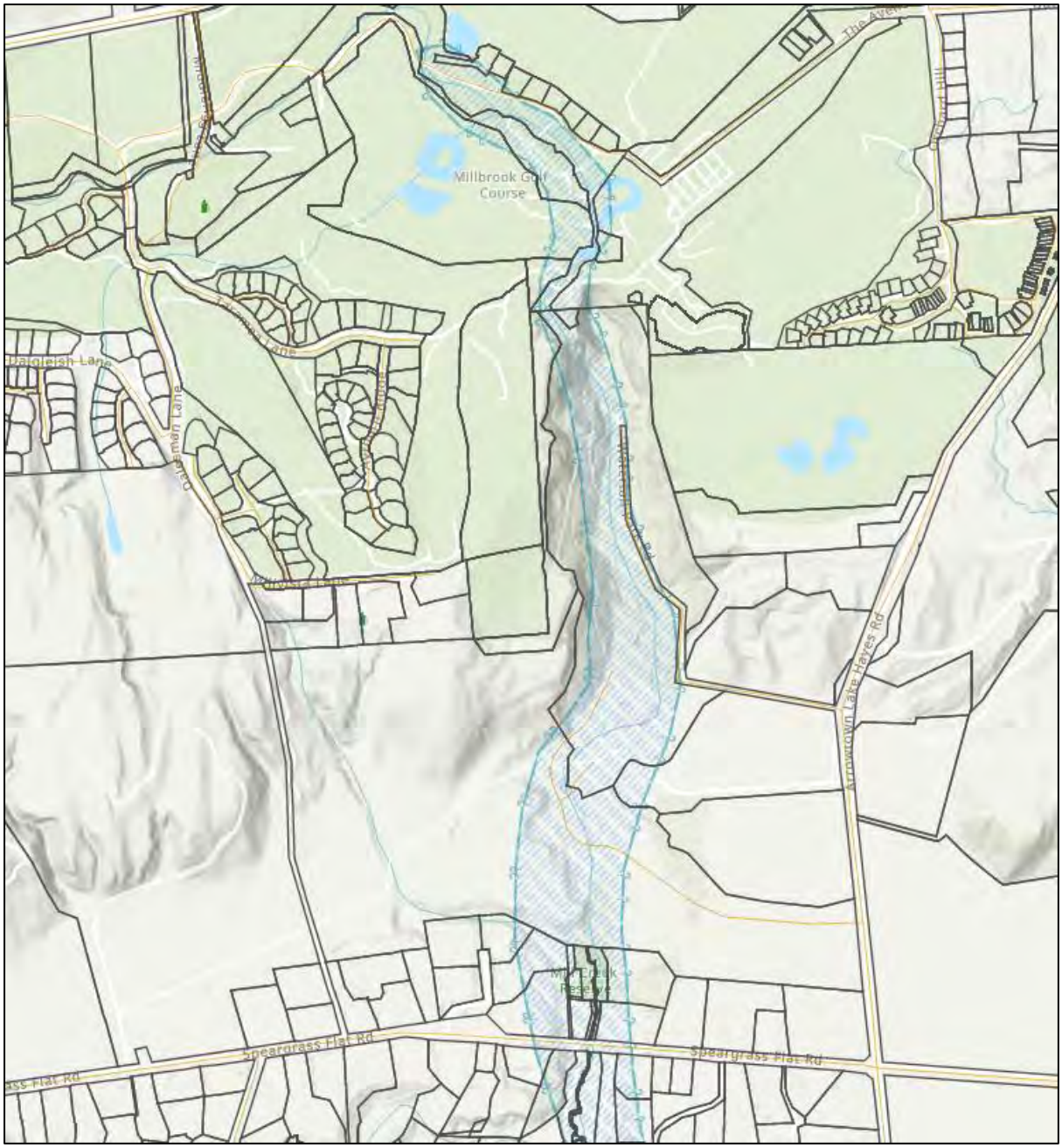


Figure 2.6: QLDC Hazard Map – Flooding

3.0 Proposed Development Layout

Figure 3.1 shows the general layout of the proposed Northbrook Arrowtown. The proposed development is accessed by vehicle via Arrowtown-Lake Hayes Road to the east and driving on the partially constructed Ayr Avenue access road and proposed Ayr Avenue extension from Ayrburn Domain to the waterfall at the head of the valley.

The main features of Northbrook Arrowtown are listed below. Developed areas associated with this application are labelled in yellow in Figure 3.1.

Northbrook Arrowtown Development – this Application:

- Building A – Arrival/Amenities Building
- Building B – Care Building and Serviced Apartments
- Buildings C, D, and E - Residential Buildings
- Building F – Boutique Hotel and Spa
- New Sealed Carpark to service Building A
- Landscaping and ground improvements regarding the new buildings – refer to PPG Northbrook Arrowtown Resource Consent Drawings, October 2022 for further detail
- Pedestrian path along Mill Creek from Ayrbrun Domain to the head of the valley
- Waterfall Buggy Bridge across Mill Creek
- Earthen Bund (adjacent to Culvert 01)
- Ayr Avenue access road extension being constructed from Ayrburn Domain to the head of the valley near the Waterfall
- Erosion Protection designs throughout the Site.

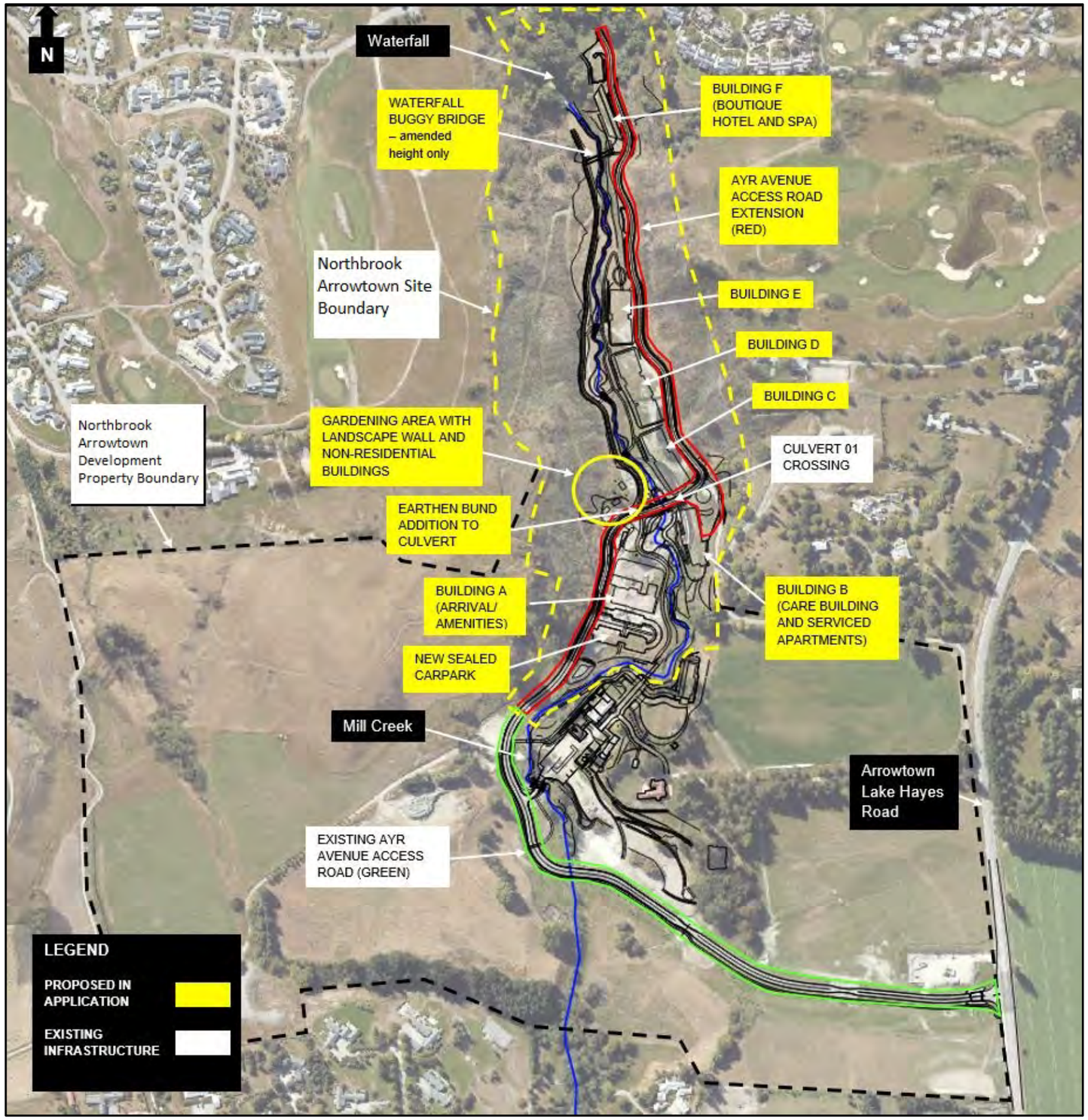


Figure 3.1: Proposed Development Layout

4.0 Mill Creek Flood Management Concept

The proposed Mill Creek flood management concept for Northbrook Arrowtown is designed to provide mitigation of peak flood flows in Mill Creek to pre-development flows for the 2-year through 100-year ARI events, as well as protect site features during these flood events. This flood management concept includes the Culvert 01 crossing for Ayr Avenue over Mill Creek which provides the greatest effect on managing flows for the proposed development. The Culvert 01 crossing, along with the Ayr Avenue road elevations and the earthen bund, restrict flood flows as well as provide additional flood storage upstream of the crossing, as such mitigating peak flows downstream. The flood management components of the proposed design are described in detail in section 4.1 below.

Please refer to Figure 3.1 above which shows the locations of these flood management concept components.

It is important to note, due to the land characteristics of the upper Waterfall Park valley (steep and incised channel), the majority of the Northbrook Arrowtown development has been situated outside of the existing floodplain, as demonstrated in the pre-development flood maps (Appendix A).

These features, footprints of development outside of flood plain, have minimised the impacts the development has on Mill Creek in regard to post vs. pre development flood flows for the more frequent storm events. In addition, the Culvert 01 design in combination with the Ayr Avenue road extension provides peak flow mitigation for the larger 100-year ARI storm event.

4.1 Flood Management Components

4.1.1 Ayr Avenue Access Road Extension

Ayr Avenue will be extended from the previous road end at Ayrburn Domain to the top of the Waterfall Park valley, as outlined in red in Figure 3.1. The road is elevated above the Mill Creek channel and due to this location provides flood water detention on the upstream side of the road.

4.1.2 Culvert 01 Crossing with Earthen Bund and Ayr Avenue Extension

The Culvert 01 crossing for Ayr Avenue access road extension over Mill Creek restricts flows and together with the ground contour, provides additional flood storage upstream of the road and culvert. The T-shaped concrete culverts restrict the flows for the 100-year ARI storm and rainfall events above this return period. The earthen bund proposed on the west side of the crossing and the Ayr Avenue access road extension elevations result in the provision of additional flood storage upstream of the crossing. These design components have the greatest impact on mitigating peak flows downstream of Culvert 01.

4.1.3 Landscaping Improvements

Landscaping and ground improvements throughout the development mitigate flood flow impacts to developed areas. Refer to the PPG Northbrook Arrowtown Resource Consent Drawings, October 2022 for further information regarding landscaping and ground improvements.

4.1.4 Building Levels

The Finished Floor Levels (FFL) for the proposed buildings A to F are set at or above minimum freeboard requirements from the Queenstown Lakes District Council (QLDC) Land Development and Subdivision Code of Practice (COP). Detailed analysis of the required finished floor levels for each building are outlined in the sections below.

4.1.5 Waterfall Buggy Bridge

A proposed buggy bridge near Building F spans Mill Creek (as also included in RM180584). This bridge has been designed to meet minimum freeboard requirements and to withstand any debris loads from flood waters. Detailed analysis of the required freeboards is presented in the sections below.

4.1.6 Erosion Protection

Erosion protection throughout the Site is proposed to mitigate any potential erosion. The details of the erosion protection design are to be developed as part of the detailed design for the floodway (noting that works within and in the immediate vicinity of the creek bed are already underway under RM180584).

5.0 Flood Flow Assessment

In order to evaluate the effects of the development and the feasibility/effectiveness of the proposed flood management works discussed in Section 4.0, the hydraulic and hydrological modelling software Infoworks ICM 2021.9 (ICM) was used to derive the flood flows of the catchment in the area around the Site.

5.1 Methodology and Parameters

The development of the ICM flood model is described in detail in the summary provided in Appendix C of this document.

5.2 Pre- and Post-Development Flood Flow Results Summary

The results of the flood assessments are included in Appendices A and B. Mapping from the assessments presented show the pre and post development flood depth and velocity maps for the 20-year and 100-year ARI flood events. Please see Figure 5.1 for the location of the flow line where the pre- and post-development flows were taken.

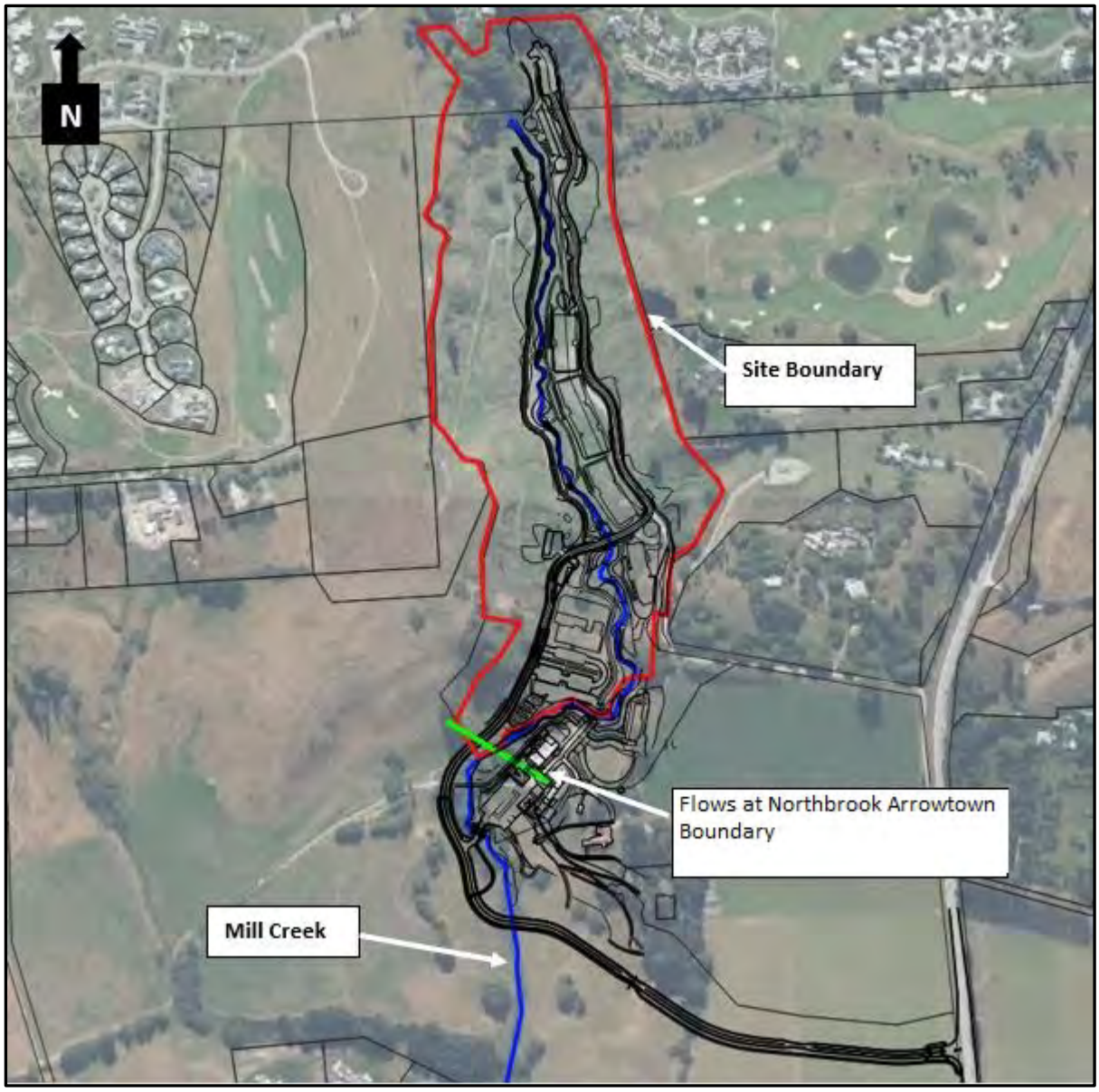


Figure 5.1: Northbrook Arrowtown Flow Line Location

Table 5.1 below provides a summary of the peak ARI pre- and post-development Mill Creek flood flows at the Northbrook Arrowtown boundary.

As a further sensitivity analysis, a long period (12hr) sustained peak flow hydrograph was developed for each ARI storm event and run in the model to assess the effects of a sustained peak flow, which applies a larger volume to the model. These results are also presented in Table 5.1. The long period sustained peak flow hydrograph methodology is described in more detail in Appendix C.

Table 5.1: Summary Peak Flow Estimates

Peak ARI Flows at Northbrook Arrowtown Boundary		
Storm Event	**Pre-Development Mill Creek Peak Flow Estimates at Northbrook Arrowtown Boundary Flow Line (m^3/s)**	**Post-Development Mill Creek Peak Flow Estimates at Northbrook Arrowtown Boundary Flow Line (m^3/s)**
2 Year ARI	4.7	4.5
10 Year ARI	8.0	7.9
20 Year ARI	8.9	8.8
50 Year ARI	10.1	10.0
100 Year ARI	33.8	33.7
Peak ARI Flat Top Hydrograph Flows at Northbrook Arrowtown Boundary		
Storm Event	**Pre-Development Mill Creek Peak Flow Estimates at Northbrook Arrowtown Boundary Flow Line (m^3/s)**	**Post-Development Mill Creek Peak Flow Estimates at Northbrook Arrowtown Boundary (m^3/s)**
2 Year ARI	4.8	4.6
10 Year ARI	8.1	8.0
20 Year ARI	9.0	8.9
50 Year ARI	10.1	10.0
100 Year ARI	34.0	33.8

At the Northbrook Arrowtown boundary, the peak post-development flow in the 2-year, 10-year, 20-year, 50-year, and 100-year ARI storm events for both scenarios are equal to or less than the estimated peak pre-development flows. These results are due to the flood management design components discussed in Section 4.0 above. The proposed design components near Culvert 01 contribute the greatest peak flow mitigation due to restricted flows through the culvert and increased storage being provided upstream of the road.

5.3 Pre and Post Development Flow Velocities and Erosion Potential

The 20-year and 100-year ARI pre and post development flood flow velocity maps in Appendix B show the maximum estimated velocities based on the peak flow for the different storm events.

As shown in Appendix B, velocities in Mill Creek at certain locations are expected to be in the order of 3-4m/s for the 100-year ARI event. Due to areas of high flow velocities present in the 100-year ARI event and the proximity of development infrastructure in the vicinity of the creek, the potential for scour was analysed for the 500-year ARI flow event throughout the Site. The details for the scour analysis performed within Mill Creek are presented in Appendix D. The following bullet points outline the general analysis conclusions:

- General channel scour depth estimations for the 500-year ARI flow event were generated using HEC-RAS at cross-section locations along Mill Creek within the Site.
- The scour depth estimates assisted in design decision making pertaining to the implementation of erosion/scour protection (channel and bank armouring), as well as structural and geotechnical design plans.

Throughout the Site, erosion/scour protection measures have been incorporated into the design of the development (including existing works being undertaken under RM180584). Appendix D discuss the above conclusions in more detail.

5.4 Estimated Flood Levels Near Critical Infrastructure

This section provides an overview of the estimated flood levels near critical infrastructure and proposed freeboard allowances in Northbrook Arrowtown. Section 9.3 expands on the freeboard requirements as per the COP and required freeboards within Northbrook Arrowtown. The sections below give an overview of the COP and estimated flood depths.

5.4.1 Buildings

The COP requires a minimum freeboard height above the maximum 100-year ARI estimated water level to buildings (Cl 4.3.5.2).

The minimum modelled freeboards are shown below.

Buildings B, C, D, and E are considered residential buildings and require the highest freeboard allowances of 0.5m. Buildings A and F are considered commercial and therefore have a lesser freeboard requirement of 0.3m. For this application however, all buildings have been assumed to require a minimum freeboard height of 0.5m above the 100-year ARI water level to “the building platform level or underside of the floor joists or underside of the floor slab, whichever is applicable” due to the proximity of the buildings to the creek.

Table 5.2 displays the freeboards for proposed buildings within Northbrook Arrowtown. All proposed building finished floor levels meet or exceed the minimum FFL requirements set out by the COP.

Table 5.2: Northbrook Arrowtown Building Freeboards

Building Name	Max 100-year ARI WL (m)	Finished Floor Level (m RL)	Freeboard Measured To Underside of Floor Slab (100mm thick)	Freeboard (m)
Building A – Arrival/Amenities	350.9	351.6	351.5	0.6
Building B – Care & Serviced Apartments	351.9	352.6	352.5	0.6
Building C – Southern Residential	353.3	354.2	354.1	0.8
Building D – Middle Residential	355.7	356.3	356.2	0.5
Building E – Northern Residential	357.0	358.1	358.0	1.0
Building F – Boutique Hotel and Spa	361.0	362.6	362.5	1.5
Underside of floor slab assumed to be 100mm thick based on discussions with the design team – TBC at detailed design				

5.4.2 Maintenance Sheds and Project Workshop

A community gardening area is being proposed to the west of Ayr Avenue Culvert 01, with three maintenance shed buildings to house and store gardening equipment. These buildings are considered non-residential buildings.

The NZ Building code, Section E1.3.2, states “Surface water resulting from an event having a 2% probably of occuring annually, shall not enter buildings.”

The lowest maintenance shed building floor level has approximaetly 1.0m of freeboard from the 50-year ARI storm event (2% AEP) flood water surface elevation. Modelling of the 50-year ARI storm event shows flood water will not enter the buildings.

5.4.3 Waterfall Buggy Bridge

For bridges, the COP requires a minimum freeboard of 0.6m above the 50-year ARI maximum water level to the underside of the bridge deck. Table 5.3 below shows a summary of the bridge levels and freeboards for the buggy bridge by the waterfall, which is the only bridge included in this resource consent application. Note that Table 5.3 below also includes the 100-year ARI water levels and corresponding freeboard.

Table 5.3: Waterfall Buggy Bridge Freeboard

Bridge	Underside of deck level (m)	50-year ARI Max WL (m)	Freeboard from 50-year WL to underside of deck (m)	100year ARI Max WL (m)	Freeboard from 100-year WL to underside of deck (m)
Waterfall Buggy Bridge	361.7	359.8	1.9	360.6	1.1

The Waterfall Buggy Bridge deck levels meet or exceed the minimum FFL requirements set out by the COP.

5.4.4 Ayr Avenue Culvert 01 Crossing

The earthen bund was added to the Culvert 01 Crossing. Therefore, it was necessary to consider freeboard implications at this location even though the culvert was previously constructed under previous consents and approvals.

The COP provides a minimum of 0.5m freeboard above the maximum 50-year ARI event water level to the road level for culverts. Table 5.4 below shows the freeboard allowance at Ayr Avenue Culvert Crossing.

Table 5.4: Ayr Avenue Culvert 01 Crossing Freeboard

Culvert	Road Level (m)	50-year ARI Max WL (m)	Freeboard from 50-year WL to Road Level (m)	100-year ARI Max WL (m)	Freeboard from 100-year WL to Road Level (m)
Ayr Avenue Culvert 01 Crossing	352.0	351.18	0.82	352.55	Overtopping Road by 0.55

The Ayr Avenue Culvert exceeds the minimum freeboard requirements set out by the COP.

In the 100-year ARI flow event, the road culvert is overtopped and flood water flows across the road, back into the stream channel. The following sections will discuss the detailed plans and procedures in regards to flooding over the road at the Ayr Avenue Culvert 01.

5.5 Secondary Overland Flow Path and Blockage Assessment

The below sections highlight the secondary overland flow path commentary and blockage assessments undertaken for the Site.

5.5.1 Existing Ayr Avenue Culvert 01 Crossing with Earthen Bund

There are three culvert openings at the existing Ayr Avenue Culvert 01 Crossing: No. 1 x 3.0m by 1.5m high central culvert and two auxiliary culverts on each side measuring 3.0m by 0.75m high. The soffits of each culvert are at the same elevation with the two auxiliary culverts having inverts 0.75m higher than the centre culvert. The culvert has entry and exit wingwalls.

Under normal flow conditions the culvert conveys the 20-year and 50-year ARI flow events with sufficient freeboard. During the 100-year event, flood flows overtop the road and flow

around the sides of the road crossing. The flows return to the stream channel and continue to flow downstream. The road is shaped with a sag point to the west of the road culvert crossing to ensure overland flows are directed downstream, away from developed areas. The road is constructed on engineered fill with vegetated banks on either side of the road.

If a full blockage were to occur at this culvert, flood flows from any predicted ARI event would overtop Ayr Avenue at the sag point near the culvert, flow over the road and continue to flow back into the stream channel and continue downstream. An Operations and Maintenance plan specifying monitoring of the floodway during a flood event is to be developed at detailed design. Road closures and any other measures that can be quickly implemented in the event of a blockage at the culvert will be addressed in the proposed plan.

5.5.2 Waterfall Buggy Bridge

At the upstream extent of the Site is the Waterfall Buggy Bridge. This proposed pedestrian bridge is designed to have an approximate 20m span across Mill Creek and a bridge deck beam 3.5m above the stream invert elevation. The bridge deck is 0.675m thick and equipped with pedestrian barriers spanning the length of the bridge. Design details are to be confirmed in detailed design.

The 500-year ARI event does not over top the bridge deck. It does not clear the underside of the bridge.

In the unlikely event of the opening being fully blocked, flow will overtop the bridge deck and over the pedestrian pathway, returning to the stream channel downstream. The Boutique Hotel and Spa is proposed to be built sufficiently above the bridge elevation and the pedestrian path and bridge will be closed to pedestrians during a major flood event.

6.0 Floodway Maintenance Plan

The Otago Regional Council (ORC) has issued Consent RM18.088.01 for work in the upper sections of Mill Creek in which Condition 13 outlines the requirements for the Floodway Maintenance Plan (FMP). The purpose of the FMP is “to monitor the condition of the Mill Creek waterway and provide a mechanism for identifying channel conditions that could adversely affect flood levels and channel stability.”

Due to the requirements from the previous consent, a Mill Creek Floodway Maintenance Plan is already in place to monitor the condition of the Mill Creek flood flow path and provide a mechanism for addressing channel conditions that could adversely affect flood levels and channel stability. It is proposed to continue the use of the FMP and to continue updating it as work continues within Mill Creek. The use of an FMP is a suggested condition of consent.

Routine maintenance works include inspections of the Mill Creek channel and bridge and culvert structures after major storm events and annual inspections in March to monitor stream condition. Where trigger conditions occur, such as the potential for debris deposition upstream of the bridges and culverts, maintenance requirements would be reported in the course of the inspections and corrective action planned and implemented as a result.

7.0 Safety and Operations

The sections below outline the safety and operational considerations for the Site. Considerations are presented in more detail below, but include:

- Development of an Operations Plan for the Site
- Temporary flood barriers to protect buildings for large flood events
- Flood protection for underground carparks
- Pedestrian access throughout the Site
- Ayr Avenue access road serviceability for vehicle access
- Road closures and emergency access routes
- Additional safety and operational considerations

7.1 Operations Plan

In order to assist with controls, an Operations Plan for the Site should be developed. It is proposed that the manual contain the following as a minimum:

- System for recognising forecasted rainfall events which could result in potentially high flow events in Mill Creek.
- Monitoring of flows within the floodway through the Site during events.
- Setting out actions that are to be taken should flood flows be likely to occur in Mill Creek. These actions could include installation of temporary flood barriers for the protection of buildings where applicable and closures of roads and carparks where floodwaters overflow from the Mill Creek floodway in large events.
- Setting out how the system will be managed and by whom and relevant emergency contact details.

It is proposed that the development of an operations plan be completed as part of the continued design process for the Site and be included as a condition of consent.

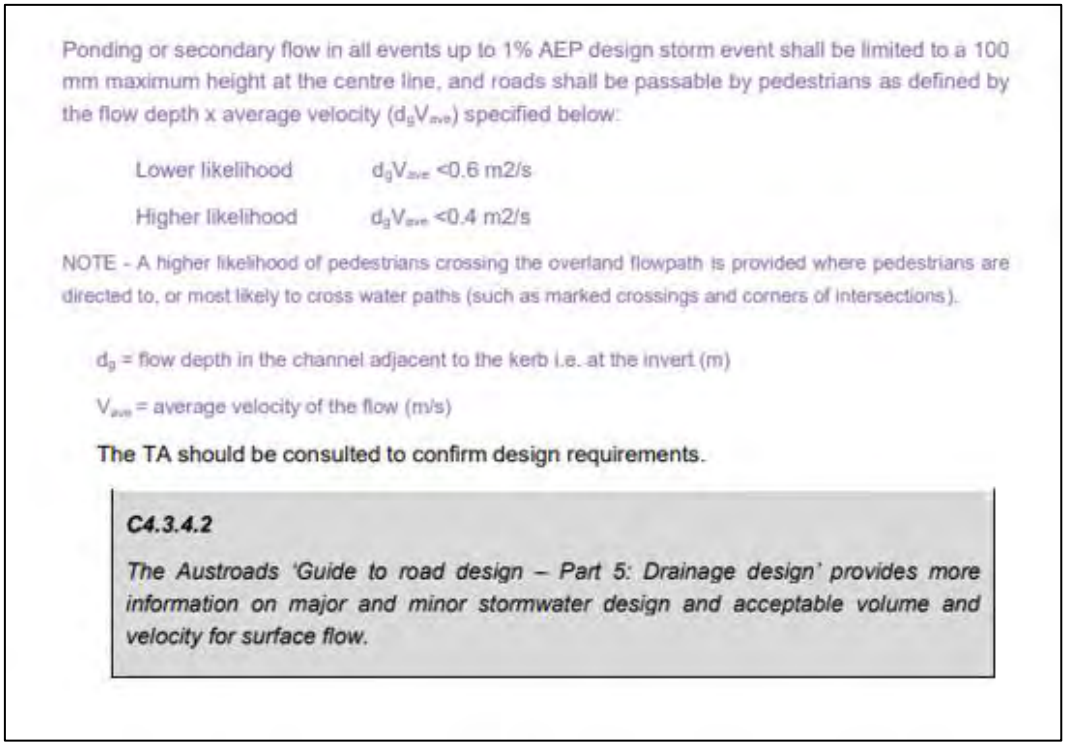
7.2 Basement Carpark Flood Protection

The carpark entrance elevations are to be set above the 100-year ARI flood levels to prevent flood waters from entering the basement car park.

7.3 Ayr Avenue Road Extension Pedestrian Access

During the 100-year ARI storm event, the modeling predicts flooding on the Ayr Avenue extension road at two localised locations within Northbrook Arrowtown, as show in Appendix A. In the event of an emergency during a flood event, pedestrian accessibility within the Ayr Avenue extension was assessed based on requirements in the COP as discussed in the sections below.

Figure 7.1 is a copy of Section 4.3.4.2 of the COP, which sets out the requirements for secondary flow over road surfaces and notes that roads shall be passable by pedestrians in the 100-year ARI event. This is calculated using a product of depth x average velocity to determine the likelihood of pedestrians gaining access across the road without injury, in the case of an emergency.



Ponding or secondary flow in all events up to 1% AEP design storm event shall be limited to a 100 mm maximum height at the centre line, and roads shall be passable by pedestrians as defined by the flow depth x average velocity ($d_g V_{ave}$) specified below:

Lower likelihood	$d_g V_{ave}$ <0.6 m2/s
Higher likelihood	$d_g V_{ave}$ <0.4 m2/s

NOTE - A higher likelihood of pedestrians crossing the overland flowpath is provided where pedestrians are directed to, or most likely to cross water paths (such as marked crossings and corners of intersections).

d_g = flow depth in the channel adjacent to the kerb i.e. at the invert (m)

V_{ave} = average velocity of the flow (m/s)

The TA should be consulted to confirm design requirements.

C4.3.4.2

The Austroads 'Guide to road design – Part 5: Drainage design' provides more information on major and minor stormwater design and acceptable volume and velocity for surface flow.

Figure 7.1: QLDC Secondary Flow Path Requirements from Section 4.3.4.2 of the COP

Figure 7.2 below shows the potential pedestrian pass ability based on maximum depth x maximum velocity (not average) for the 100-year ARI Mill Creek flow event as a conservative approach.

Note the only areas identified as a potential pedestrian crossing hazard as part of the works proposed for this application (i.e. where there is water over the extension of the access road) is over Culvert 01 and a section of road further downstream (purple circles in Figure 7.2 below). Here, it is noted that the area has a high likelihood of being passable during the 100-year ARI event (even noting use of the maximum velocity instead of average as a conservative measure).

The results show minimal hazard to pedestrians in the 100-year ARI event within Northbrook Arrowtown.

Note that pathways running along the creek edge have been excluded as part of this assessment as these would be closed during flooding.

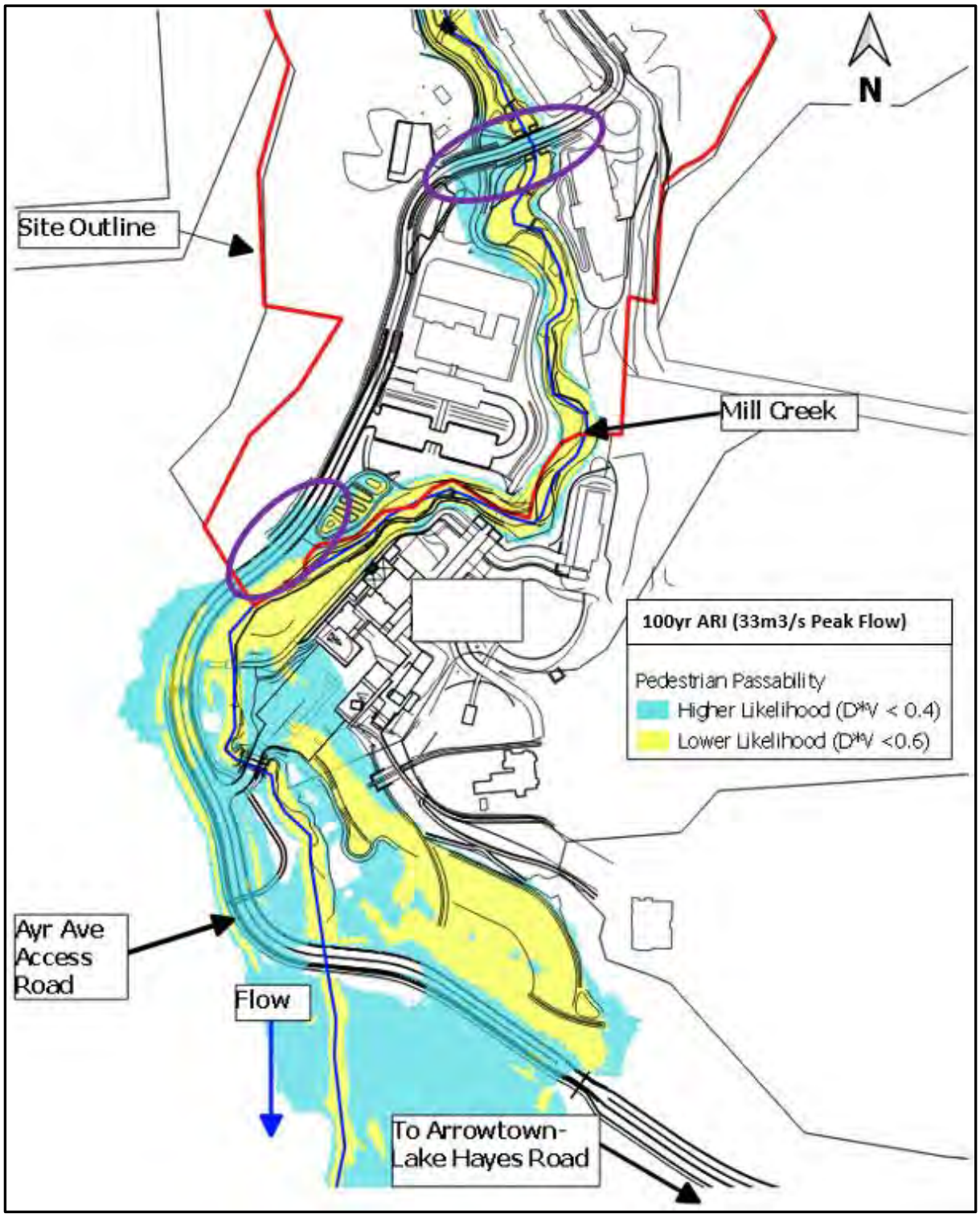


Figure 7.2: Ayr Avenue Access Road Pedestrian Access Map for the 100-year ARI Event

7.4 Ayr Avenue Road Vehicle Hazard

Section 4.3.4.2 of the COP (refer to Figure 7.1 above) specifies flooding in secondary flow paths, such as roads, should be limited to 100mm at the centreline for the 100-year ARI event.

For the 100-year ARI flow event and greater, areas along Ayr Avenue are inundated with flood water greater than 100mm depth for a period estimated between 2-4 hours. Flood water depths at the centreline of the road are above 100mm for approximately 2 hours at the Ayr Avenue Culvert 01 Crossing (this application) and approximately 3-4hours downstream of the Site during the 100-year event (previously constructed).

The QLDC COP references use of AustRoads guidance to provide further information on design criteria for road hazards.

The Ayr Avenue access road vehicle serviceability was analysed using the criteria from AustRoads Research Report AP-R481-15 Safety Provisions for Floodways Over Roads, Section 3.2. The following parameters from the table (Figure 7.3) below were used when analysing the Ayr Avenue access road serviceability during the 100-year ARI event.

Class of vehicle	Length (m)	Kerb weight (kg)	Ground clearance (m)	Limiting still water depth with zero velocity	Limiting high velocity flow depth (3 m/sec)	limiting velocity (m/sec) at low depth	Equation of stability
Small passenger	< 4.3	< 1250	< 0.12	0.3	0.1	3.0	DxV < 0.3
Large passenger	> 4.3	> 1250	> 0.12	0.4	0.15	3	DxV < 0.45
Large 4WD	> 4.5	> 2000	> 0.22	0.5	0.2	3	DxV < 0.6

Source: Shand et al. (2011).

Figure 7.3: Austroads Flood Hazard Vehicle Serviceability Safety Criteria

For conservativism, the work published by GSN in 2010 which outlines the findings of a project undertaken for the New South Wales (NSW) State Emergency Service (SES) on people's behaviour in and around floodwater ("Pedestrian and Motorist Flood Scoping Study") was also consulted. An excerpt from the report is presented below.

The stability of a vehicle is influenced by the velocity and depth of floodwater at any given location (see Figure 1; Jonkman et al., 2002; Keller & Mitsch, 1992, 1993; NSW Government, 2005; USBR, 1988). For instance, when crossing a rapidly-flowing causeway small, light, low motor vehicles can become unstable when the depth of water is greater than 0.3 metres (CSIRO, 2000; EMA, 1999). Similarly, it is usually only feasible and safe for larger, higher sedans to proceed when water depths are less than 0.4 metres (CSIRO, 2000; EMA, 1999). Research has considered the influence vehicle mass and dimensions (height, length and width), buoyancy and drag forces have on the velocity of water needed to make a vehicle unstable at low depths, and also the depth at which a "water-tight vehicle" would float (Keller & Mitsch, 1992, 1993; Mens et al., 2008; Walsh et al., 1998). This research shows that as the depth increases the velocity required to make a vehicle unstable decreases (see Figure 1; Keller & Mitsch, 1993; Mens et al., 2008). This is because "the downward force of

the vehicle is countered by increased buoyancy" (Mens et al., 2008, p. 46). It also illustrates that the stability of a vehicle is influenced by the vehicle mass and dimensions (height, length and width), buoyancy and drag forces.

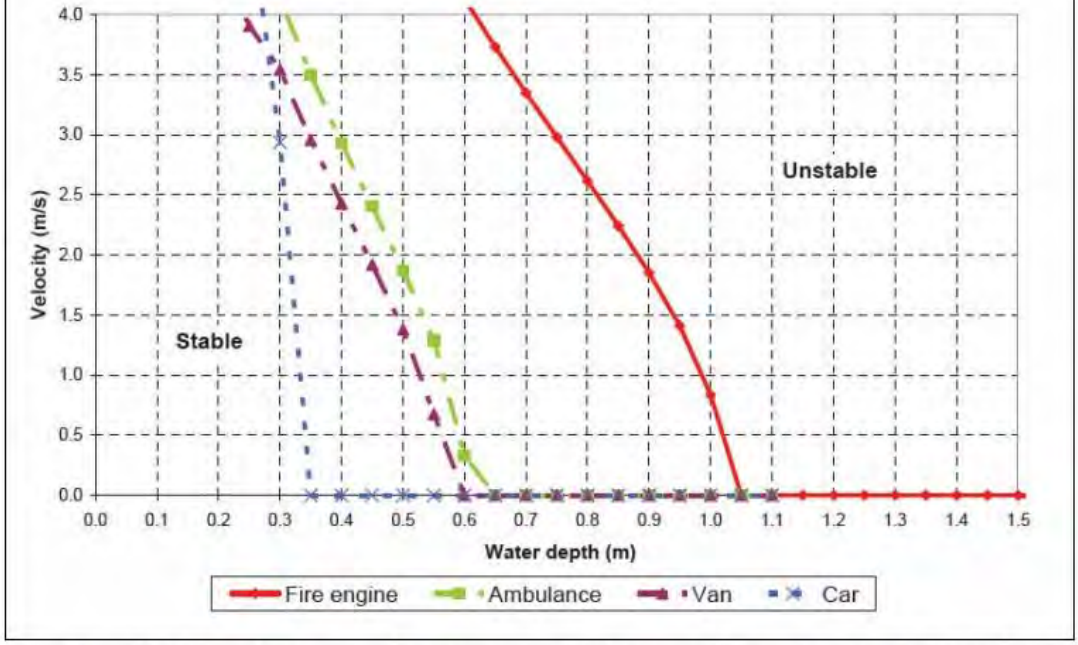


Figure 1 Vehicle stability curves for a car, van, ambulance and fire engine as a function of water depth and velocity. Source: Mens et al. (2008)

Figure 7.4: Vehicle Stability Curves – GSN Report

The values presented in Figure 7.4 above generally are less conservative than those presented in Figure 7.3. Therefore, the assessment undertaken takes into account the values using a lesser flood depth and velocity threshold as an added level of conservativism in the assessment.

It is potentially unsafe to drive through flood waters and the operations and maintenance plan proposed for the Site would allow for road closures. The vehicle hazard information discussed as part of this report is provided only for emergency situations.

7.4.1 Road Serviceability – Access Road Extension

Figure 7.5 shows the road vehicle hazard based on the 100-year ARI peak Mill Creek flood flow event for the proposed Ayr Avenue access road extension within the Site. Note that white areas indicate that there is minimal to no road flooding.

During the peak of the 100-year ARI flow event, it is estimated that a small car would be able to drive over the Culvert 01 crossing and the road at the southern end of the Site. This area is passable by using large cars and/or 4WD vehicles as discussed in the following section.

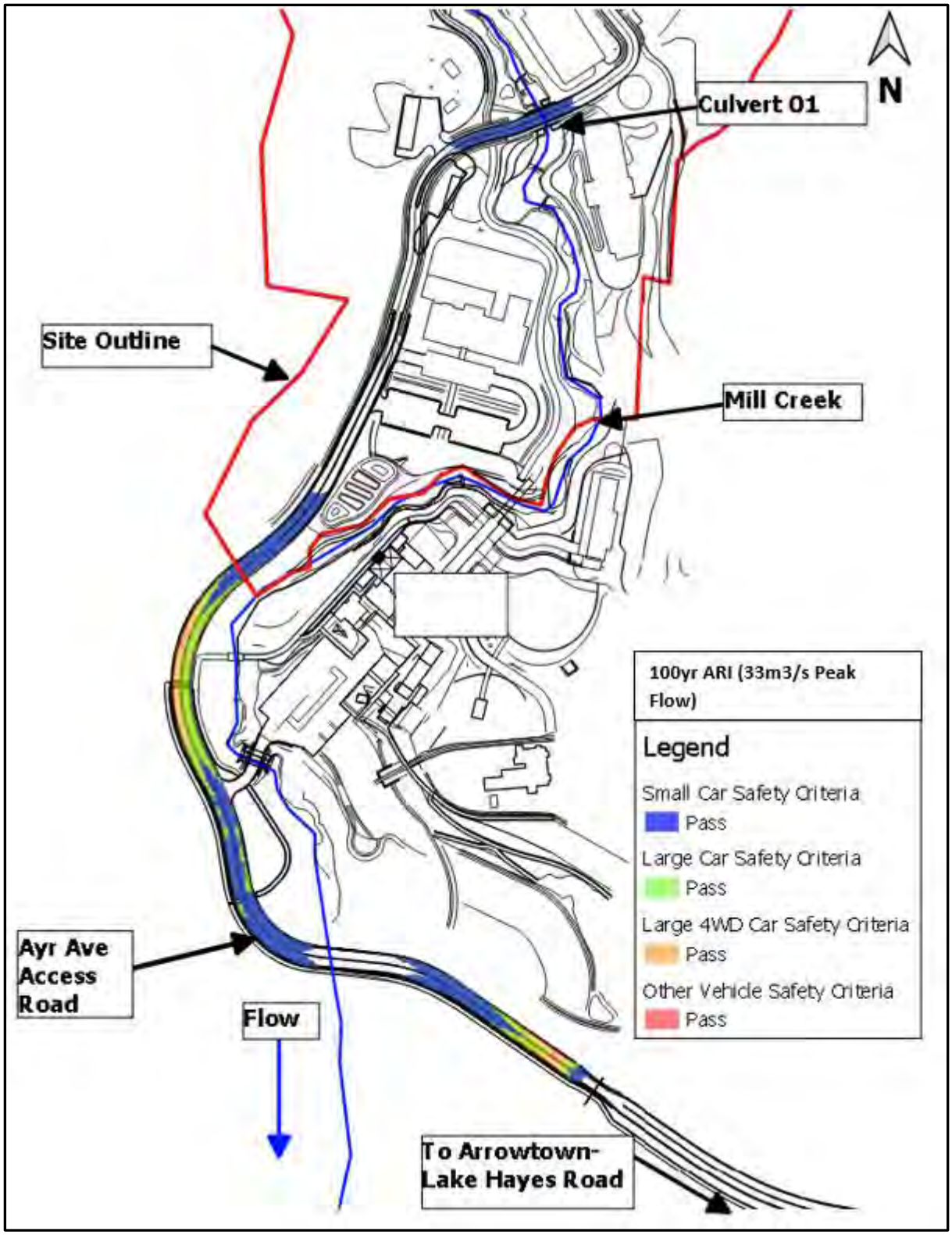


Figure 7.5: Ayr Avenue Access Road Extension 100-year ARI Hazard Vehicle Serviceability Safety Criteria Map

7.4.2 Northbrook Arrowtown – Road Serviceability

Access to Northbrook Arrowtown is via Ayr Avenue, an existing road from Arrowtown-Lake Hayes Road. The vehicle serviceability along the access road was analysed using the same criteria detailed in Figure 7.3 above. Refer to Figure 7.5 above which displays the Ayr

Avenue access road to Northbrook Arrowtown vehicle serviceability maps for the 100-year ARI event.

According to the AustRoads criteria shown in Figure 7.3, large 4WD vehicles are still able to access Northbrook Arrowtown during the 100-year ARI storm event. However, this should only be considered in emergency situations and is more applicable to emergency service vehicles as the roads would be closed during a flooding event.

7.5 Additional Safety and Operations Considerations

Please refer to Table 7.1 below which outlines a summary of additional identified items to consider from a safety and operations perspective for detailed design and for the use of property owners in relation to managing high flood flow conditions.

Table 7.1: Identified Safety and Operations Considerations

Identified Risk/Hazard	Controls
High Flood Flow Events	▪ Building finish floor levels and landscape design/ground modifications have been incorporated into design to provide the required freeboard necessary for the 100-year events. ▪ Road closures and auxiliary emergency access route procedures are in place and detailed in the Operations and Maintenance plan. ▪ Temporary flood barriers can be integrated into the design to protect buildings and carparks from flooding.
Blockages	▪ The existing Ayr Avenue Culvert Crossing is the most likely place for blockages to occur. In the case of a full blockage, flows would overtop the culvert and flow over the road at the designed sag point, flowing back into the stream channel downstream. ▪ Road closures for flood events are already incorporated into the Operations and Maintenance Manual.
High Flow Velocities	▪ Velocities in Mill Creek exceed 2m/s during the 100-year ARI event which have potential to cause erosion/scour to the channel/bank. Scour protection measures and rock rip-rap have been incorporated into the design to mitigate erosion/scour damage. ▪ Erosion/scour has been taken into consideration regarding infrastructure (bridges/buildings) near Mill Creek. Sheet piling and Geofabrics Reno Mattress have been implemented into the design to mitigate the effects of scour on critical infrastructure.
Proximity to River	▪ Access to Mill Creek is available throughout the development. During flood events, pedestrian pathways and access routes to the Creek are closed off to pedestrians.
Steep Slopes/Falls	▪ Landscaping used to deter pedestrians from steep sections of Mill Creek. Pedestrian pathways direct people to accessible areas of lower hazard next to the Creek. ▪ Pedestrian guardrails over bridges and crossings with high elevations are incorporated into the design.

8.0 Assessment of Effects

Please refer to the following documents in the Appendices for the 20-year and 100-year ARI events:

- Appendix A – Maximum Flood Depth Extents
- Appendix B – Maximum Velocities

8.1 Maximum Flood Depth Extents

The pre- versus post-development flood depth maps for these storm events are displayed in Appendix A for the 20-year and 100-year ARI storms.

Downstream of Ayr Avenue, there is no significant change in the flood depths or maximum flood extents between the pre- and post-development scenarios.

8.2 Maximum Flow Velocities

Velocities within the proposed development generally increase in the post-development case due to the channel modifications and development of structures near the stream channel.

External to Northbrook Arrowtown, velocities are very similar in the pre- and post-development cases. Some key areas for consideration are as follows:

- Downstream of Northbrook Arrowtown, velocities are similar in magnitude but redirected with the development of Ayr Avenue and culverts across Mill Creek.
- Downstream of Ayr Avenue, velocities are virtually unchanged between the pre-development and post development scenarios.

Bank armouring and rip rap design considerations in relation to high velocities within the Site are commented on in Section 5.3 above. These design considerations assist in mitigating effects from high flow velocities. The bank armouring and rip rap design considerations will be further developed in detailed design.

8.3 Flood Mitigation

The flood mitigation strategy for the works associated with Northbrook Arrowtown focus on ensuring the downstream flows of Mill Creek are not increased by the buildings and structures within the development as well as protecting critical infrastructure from adverse effects of large flood events.

The proposed mitigation work achieves the following:

a. The design of Culvert 01, with the earthen bund and the Ayr Avenue road extension, mitigates peak flows of the post-development storm events as described in Section 4 above. Section 5 presents the modelling results showing the post development peak flows do not exceed pre-development peak flows at the Site boundary.

b. The buildings on site are protected from flooding by locating them outside the flood flow paths and setting appropriate freeboard levels in regard to the FFL's.

c. Modest earthworks and landscaping ensure the flooding is managed within the Site.

d. The Mill Creek Floodway Maintenance Plan is important in ensuring that the flood carrying capacity of the Mill Creek flow path is maintained for the protection of property within and downstream of the Site.

e. Erosion is managed onsite through erosion protection design options and monitoring and maintenance of the floodway. Identifying and remediating areas of erosion and deposition is critical in maintaining the designed flood scheme for Mill Creek.

9.0 QLDC COP Requirements

9.1 Flow Path Conveyance

The COP requires that a primary stormwater system be designed to convey, as a minimum a 20-year ARI storm event runoff flow taking into account climate change. Where a secondary flow path is available, the secondary flow path is required to convey the balance of a 100-year ARI flow without damage to the property and with freeboard to any buildings. If a secondary flow path is not available, the primary system is required to convey a 100-year ARI flow with freeboard (Cl 4.3.5.2).

In relation to this application, Mill Creek and the associated floodplain is the primary flood flow path.

9.2 Pre- and Post-development Downstream Flows

The COP outlines the mitigation requirements for management of peak discharge rates as well as overall considerations for the downstream effects of the discharge point. The relevant clauses are noted below.

Clause 4.2.4:
The implications of future development on adjoining land should be on the basis of replicating the pre-development hydrological regime whereby the maximum rate of discharge and peak flood levels post-construction are no greater than pre-development.

Clause 4.2.7:
Downstream impacts could include (but are not limited to) changes in flow peaks and patterns, flood water levels, contamination levels and erosion or silting effects, and effects on the existing stormwater system. Where such impacts are more than minor, mitigation measures such as peak flow attenuation, velocity control, and treatment devices will be required.

As stated in the sections above, this application would have minimal, if any, effect on the flood flow patterns in Mill Creek and have been addressed as part of previous applications.

Flood mitigation for Northbrook Arrowtown includes using road crossings/culverts and flood storage areas to attenuate flood flows and reduce the timings of the peak flows within the Mill Creek system. As shown is Section 5.2 above, the post-development flows for the 2-year through 100-year ARI events are less than the pre-development flows at the downstream property boundary, mitigating the downstream flood effects from the proposed development.

These mitigation processes will be described in more detail as part of the detailed design.

9.3 Minimum Building Freeboard Levels

The COP requires a minimum freeboard height above the maximum 100-year ARI estimated water level to buildings (Cl 4.3.5.2). The minimum freeboard allowances are shown below. Note that the COP indicates that "the minimum freeboard shall be measured from the top water level to the building platform level or underside of the floor joists or underside of the floor slab, whichever is applicable." For this application, the freeboards have been measured from the underside of the floor slab (estimated to be 100mm from FFL).

Freeboard	Minimum height
Habitable dwellings (including attached garages)	0.5 m
Commercial and industrial buildings	0.3 m
Non-habitable residential buildings and detached garages	0.2 m

For this application, all the proposed buildings are being classified as residential albeit that some of them are commercial, which requires at least 0.5m of freeboard above the 100-year ARI flood level. Please refer to Section 5.4 above.

All the proposed buildings meet or exceed the minimum freeboard requirements set out by the COP.

9.4 Ayr Avenue Extension Road 100-year ARI Event Flooding

As stated in Section 7.3 above, there are two localised areas of the Ayr Avenue extension which experience flooding during the 100-year ARI flow event within the Northbrook Arrowtown development.

With regard to flood depths in these areas, the QLDC COP states "ponding or secondary flow in all events up to 1% AEP design storm event shall be limited to a 100mm maximum height at the centre line."

When referring to the flood depth maps in Appendix A, it is noted that flood depths in the two localised areas of road flooding do not meet the COP requirements. Road flooding does exceed 100mm above the centreline (approximately 215mm) for a limited time period of approximately 2 hours. As described in Sections 7.1, during major flooding events, Ayr Avenue will be closed to prevent non-emergency personal and vehicle access. In case of emergency situations, Sections 7.3 and 7.4 detail pedestrian and vehicle access to Northbrook Arrowtown via Ayr Avenue. These sections detail COP requirements and assess the level of risk based on the modeled results.

10.0 Conclusions

Northbrook Arrowtown is an alternative development to the previously consented hotel (RM180584). The proposed development components as part of this resource consent are outlined below:

- 5 new buildings (Buildings A-E) with landscaping and ground improvements
- Retaining Building F with updated car parking and landscaping
- Pedestrian accessway continuing along Mill Creek from Ayrburn Domain
- Flood mitigation improvements (earthen bund) to existing Culvert 01 and roadway extension
- Erosion/Scour protection measures
- Waterfall Buggy Bridge
- Ayr Avenue access road extension to the head of the valley
- Landscape wall and non-residential buildings for the gardening area west of Culvert 01.

Incorporated within the proposed development are designed flood mitigation measures to ensure post development flood flows exiting the Site are equal to or lower than pre-development flows. As Section 5.0 demonstrates, post-development flows, measured at the downstream boundary of the Northbrook Arrowtown Site, are less than the pre-development flows for the 2-year through the 100-year ARI events.

Within Northbrook Arrowtown, road flooding occurs on Ayr Avenue road extension at two localised areas along the road. Sections 7 and 9 outline the road flooding analysis and mitigation processes in detail. Flood mitigation measures are incorporated into the design of Culvert 01 and the Ayr Avenue road extension to reduce flood hazards to both pedestrians and vehicles if access is required during an emergency while the road is flooded.

Buildings (A-F) have been designed to meet the minimum FFL freeboards as set out by the COP. Section 5 and 9 discuss the modeled flood levels and freeboard requirements in detail.

With higher velocities present in larger flow events, the 500-year ARI was analysed to provide an estimate scour depth occurring at cross-sections in Mill Creek throughout Northbrook Arrowtown. Erosion/scour protection methods (Reno Mattress/Rock Rip-Rap/ Sheet Piles) have been incorporated into the overall design of the development to attempt to mitigate impacts from scour and protect critical infrastructure from damage. Section 5 and Appendix D discuss this analysis in detail.

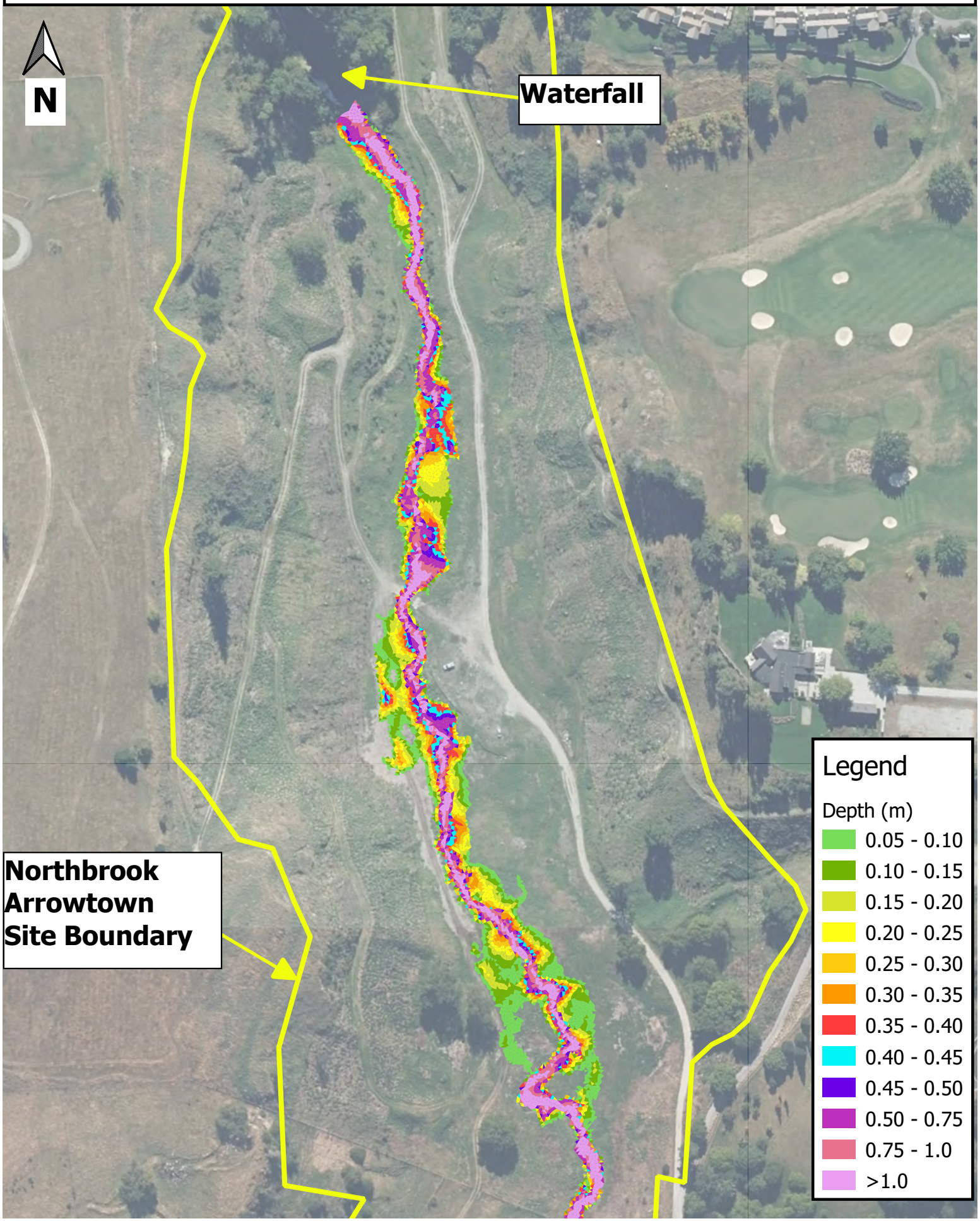
It is considered that the proposed development, with the proposed mitigation measures, is consistent with, and has appropriate regard to the objectives and policies of the ORC Regional Plan: Water for Otago and addresses the COP requirements with regard to flood management.

Additional design details will be completed as part of the detailed design, but the overall flood management scheme presented in this application provides feasible solutions for comprehensive flood management of the Site.

APPENDIX A

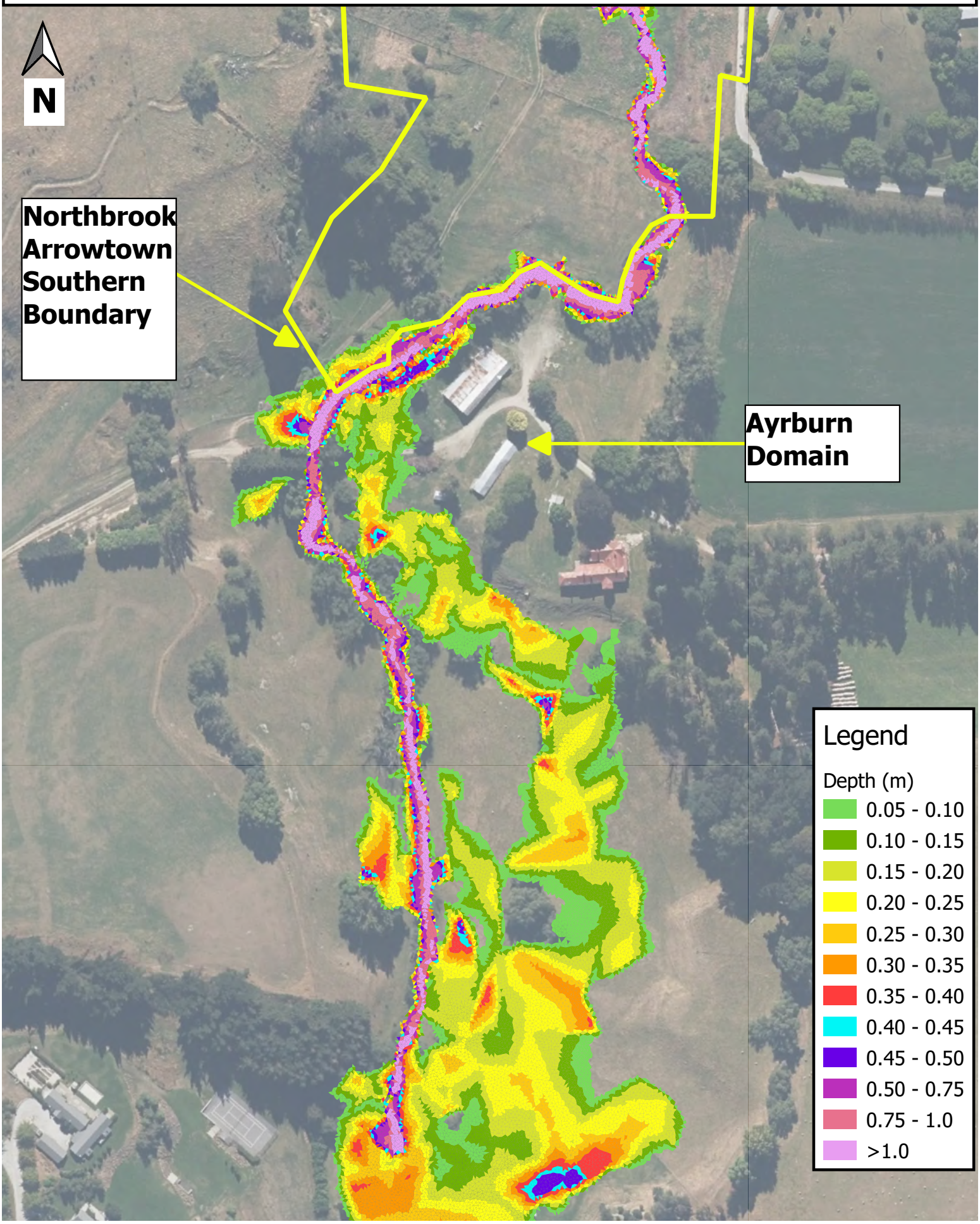
Maximum Flood Depth Maps – 20-year and 100-year ARI Events

Pre-Development 20yr ARI (8.5 m3/s) Mill Creek Peak Flow
Flood Depths - Upper
29/09/2022



RUN 220905 PRE Upper S6_72-10mm 20yr

Pre-Development 20yr ARI (8.5 m3/s) Mill Creek Peak Flow
Flood Depths - Lower
29/09/2022



RUN 220905 PRE Upper S6_T2-10mm 20yr