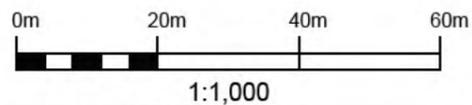




PROPOSED CONTOURS



DEPTH CONTOURS

LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- 351.8
- PROPOSED CUT CONTOUR (0.25m INTERVAL)
- PROPOSED FILL CONTOUR (0.25m INTERVAL)
- PROPOSED HAYBARN VENUE BUILDING
- PROPOSED BUS DROP OFF BAY, CARPARK EXIT AND GRAVEL ACCESS TO HAYBARN VENUE BUILDING
- PROPOSED PEDESTRIAN GRAVEL PATHWAY
- SITE EXTENTS

EARTHWORKS

1. TOPSOIL	
1.1 STRIP	4,100 m ³
1.2 RESPREAD	1,600 m ³
1.3 EXCESS	2,500 m ³
2. EARTHWORKS	
2.1 CUT	6,500 m ³
2.2 FILL	4,400 m ³
2.3 EXCESS (WASTE OFF SITE)	2,100 m ³
2.4 IMPORTED TO FILL	2,000 m ³
3. MAX CUT/FILL DEPTH	-5.00m / 2.00m
4. AREA OF EARTHWORKS	1.3 Ha

- NOTES**
5. ALL SEDIMENT AND EROSION CONTROLS TO BE ESTABLISHED IN ACCORDANCE WITH AUCKLAND CITY COUNCIL GD05. REFER SHEETS 250-252 FOR FURTHER DETAIL.
 6. CONTRACTOR TO ESTABLISH SEDIMENT AND EROSION CONTROLS PRIOR TO COMMENCING EARTHWORKS.
 7. CONTRACTOR TO LOCATE ALL EXISTING UTILITIES PRIOR TO COMMENCING EXCAVATION.
 8. ALL FILL TO BE PLACE IN ACCORDANCE WITH APPLICABLE GEOTECHNICAL OR ROAD PAVEMENT SPECIFICATION.

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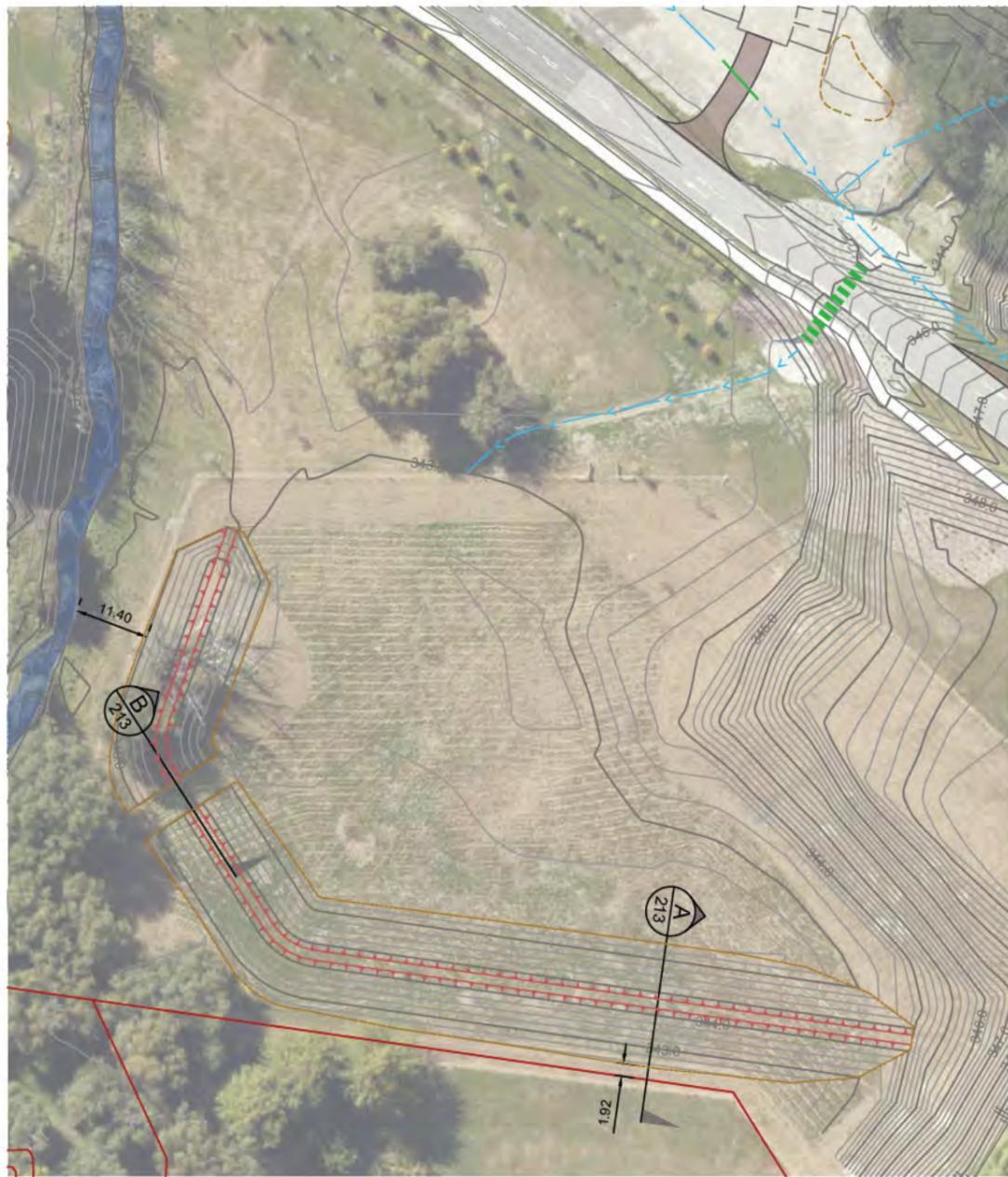
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Purpose & Drawing Title:
HAYBARN VENUE
 PROPOSED AND DEPTH CONTOURS

FOR CONSENT

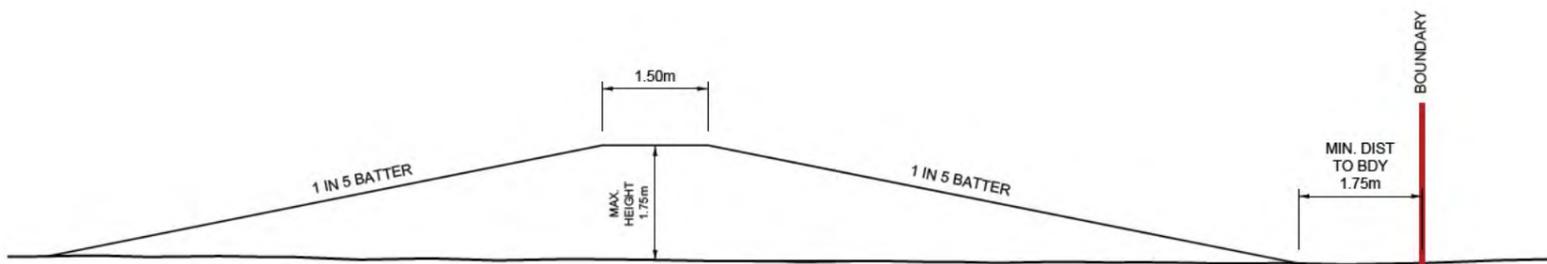
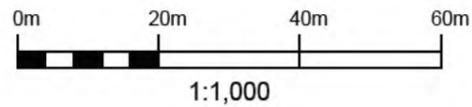
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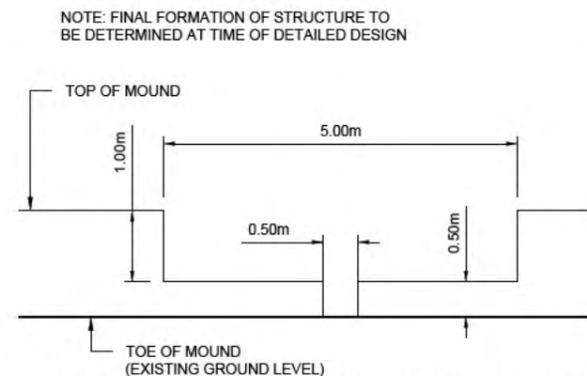
PROPOSED CONTOURS
SCALE 1:1000



DEPTH CONTOURS
SCALE 1:1000



SECTION A - FLOOD BUND CROSS SECTION
SCALE 1:100



SECTION B - FLOOD BUND OUTLET CONTROL STRUCTURE
SCALE 1:100

LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- PROPOSED CONTOURS (0.25m INTERVAL)
- -0.50 PROPOSED CUT CONTOUR (0.25m INTERVAL)
- 0.50 PROPOSED FILL CONTOUR (0.25m INTERVAL)
- PROPOSED HAYBARN VENUE BUILDING
- PROPOSED BUS DROP OFF BAY, CARPARK EXIT AND GRAVEL ACCESS TO HAYBARN VENUE BUILDING
- PROPOSED PEDESTRIAN GRAVEL PATHWAY
- SITE EXTENTS

EARTHWORKS

1. TOPSOIL	
1.1 STRIP	4,100 m ³
1.2 RESPREAD	1,600 m ³
1.3 EXCESS	2,500 m ³
2. EARTHWORKS	
2.1 CUT	6,500 m ³
2.2 FILL	4,400 m ³
2.3 EXCESS (WASTE OFF SITE)	2,100 m ³
2.4 IMPORTED TO FILL	2,000 m ³
3. MAX CUT/FILL DEPTH	-5.00m / 2.00m
4. AREA OF EARTHWORKS	1.3 Ha

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 - ALL FILL TO BE PLACE IN ACCORDANCE WITH APPLICABLE GEOTECHNICAL OR ROAD PAVEMENT SPECIFICATION.

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PROPOSED AND DEPTH CONTOURS

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FORM AND LINE SWALE ABOVE EARTHWORKS WITH PINNED OVERLAPPED GEOTEXTILE AND EXTEND THE CHANNEL TO THE EXISTING CULVERT UNDER AYR AVENUE.

CONSTRUCT 1% MAXIMUM GRADE CONTOUR DRAINS / DIVERSION CHANNELS IN THE CUT / FILL SURFACES TO DIRECT DIRTY WATER TO THE DECANTING EARTH BUND (DEB) AS THE EARTHWORK'S PROGRAMME PROCEEDS

STABILISED SITE ENTRANCE WITH CULVERT UNDER

SEDIMENT RETENTION POND (SRP) AT THE HEAD OF THE EXISTING SWALE TO TREAT EARTHWORK'S RUNOFF. 150m³ REQUIRED STORAGE VOLUME. FLOATING BOOM DECANT AS PER EMP

ROCK LINED DRAIN ALONG EDGE OF EXISTING FARM TRACK

CLEAN WATER DIVERSION CHANNEL TO CONVEY DOWN THE SLOPE INTO THE EXISTING GRASS SWALE

EARTH BUND AROUND STOCKPILE AREA WITH DECENTATING EARTH BUND (DEB) AT LOW POINT, 0.5Ha CATCHMENT AREA. OUTLET TO LINED CLEAN WATER CHANNEL.

EXISTING WATERFALL PARK STOCKPILE AREA

EXISTING GRASS SWALE, RUNOFF FLOWS TO MILL CREEK VIA EXISTING SRP. SRP TO PROVIDE SECONDARY TREATMENT OF RUNOFF BEFORE DISCHARGE.

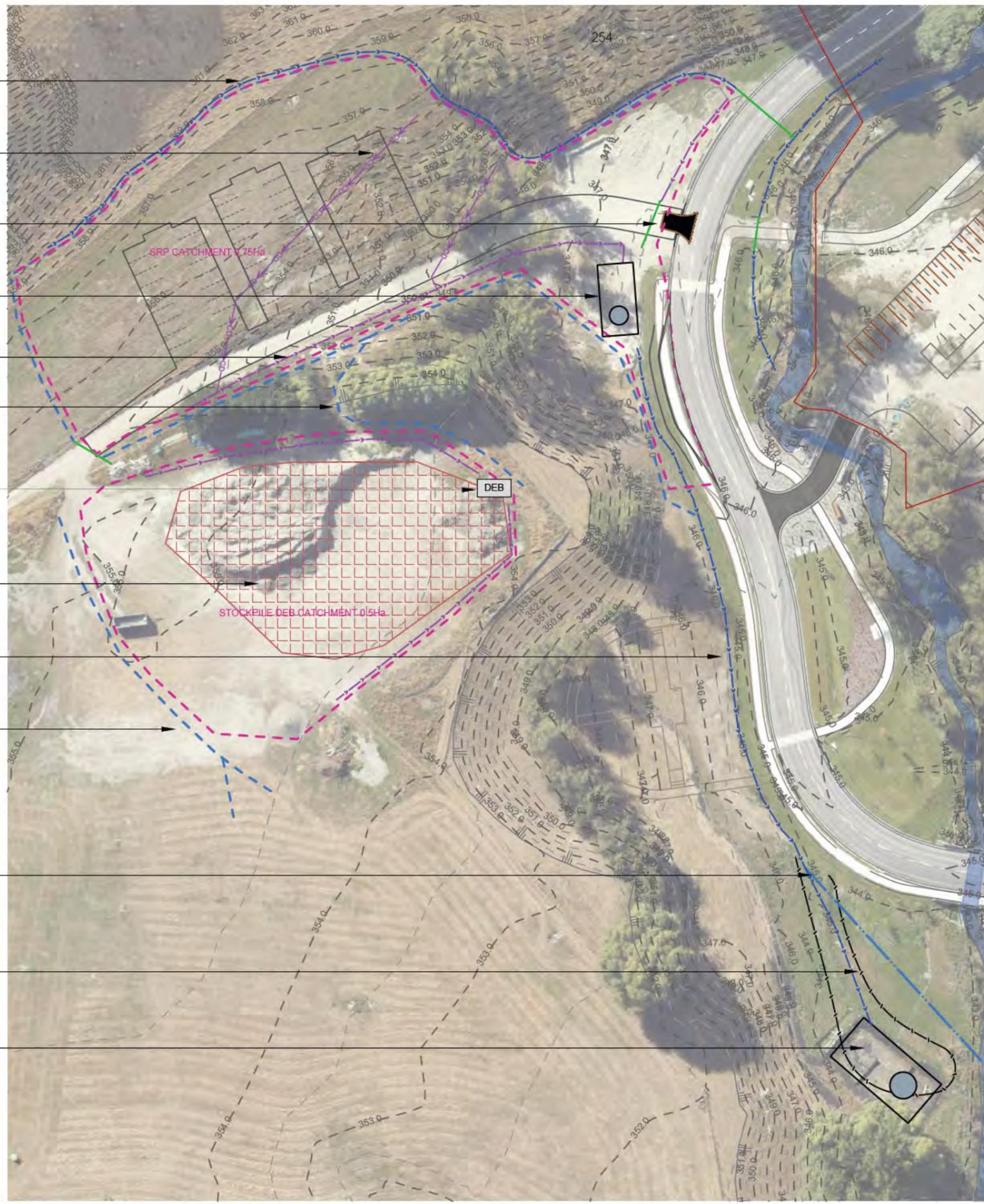
STABILISED CLEAN WATER DIVERSION CHANNEL UPSLOPE OF STOCKPILE AREA. DISCHARGE TO SHEET FLOW ACROSS VEGETATED PADDOCK

EROSION AND SEDIMENT CONTROL FOR RAINGARDEN AT THE CONCLUSION OF THE OVERFLOW CARPARK WORKS AND REMOVAL OF THE DECANTING EARTH BUND AND REINSTATEMENT OF THE SWALE

TEMPORARY PIPE TO DISCHARGE CLEAN WATER TO MILL CREEK FROM REINSTATED EXISTING SWALE AFTER BLOCKING THE ENTRANCE TO THE SEDIMENT RETENTION POND (SRP) AND REMOVAL OF OVERFLOW CARPARK EARTHWORK'S DECANTING EARTH BUND (DEB)

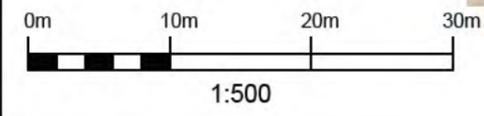
CLEAN WATER DIVERSION BUND CONSTRUCTED AROUND THE FOOTPRINT OF THE PROPOSED RAINGARDEN FOOTPRINT

EXISTING SEDIMENT RETENTION POND (SRP) SIZED FOR 1Ha CATCHMENT



- LEGEND**
- LEGAL BOUNDARY
 - MILL CREEK
 - TOP OF BANK
 - EXISTING CONTOURS (0.5m INTERVAL)
 - OVERLAND FLOW PATH
 - DIRTY WATER DIVERSION CHANNEL
 - CONTOUR DRAIN
 - SILT FENCE
 - CULVERT CROSSING
 - STABILISED SITE ENTRANCE
 - CONTAINMENT BUND / CATCHMENT AREA
 - CLEAN WATER DIVERSION BUND
 - DEB DECANTING EARTH BUND
 - SRP SEDIMENT RETENTION POND
 - TEMPORARY PIPE

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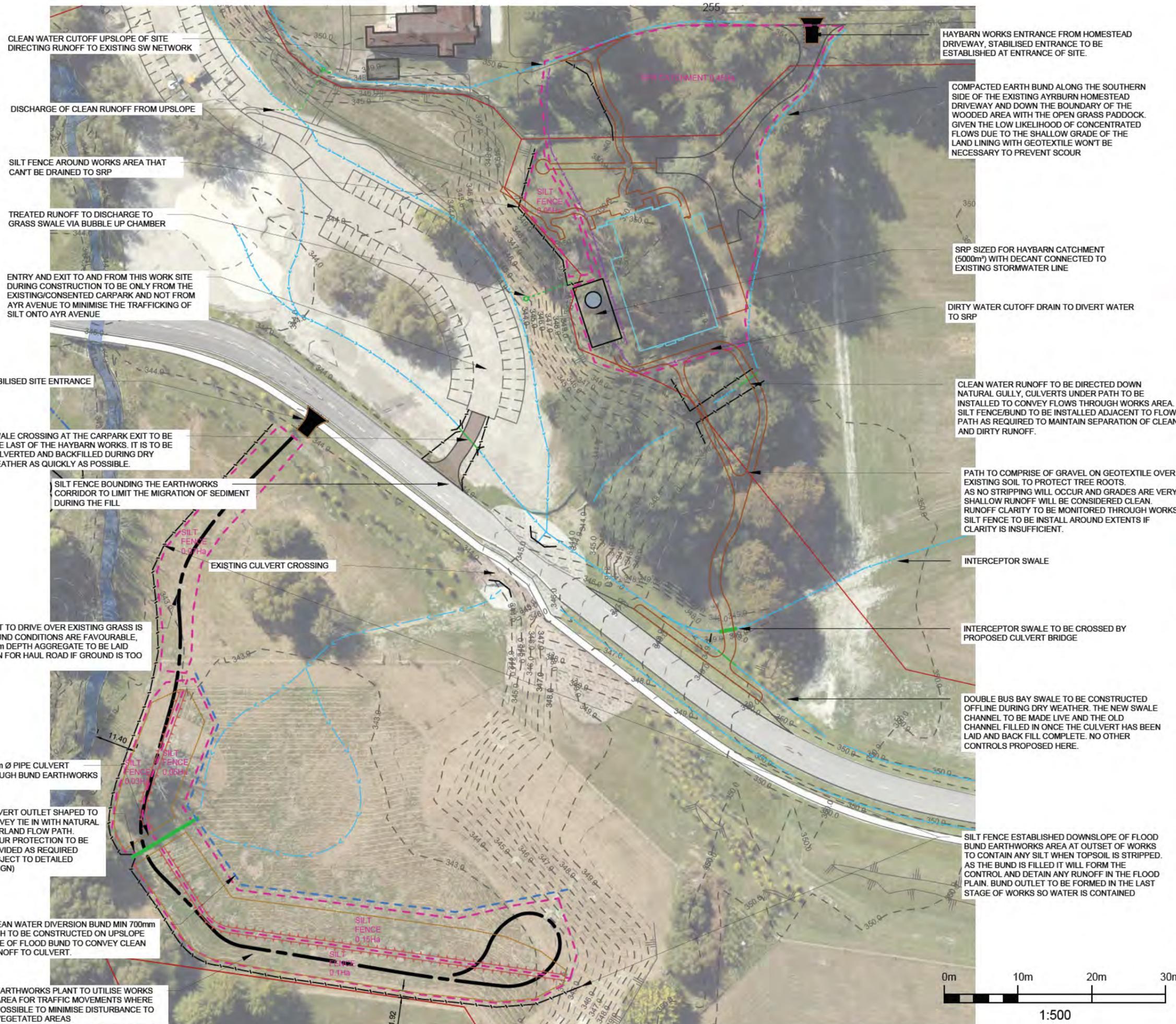
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Purpose & Drawing Title:
HAYBARN VENUE
 PROPOSED OVERFLOW CARPARK AND
 RAINGARDEN ESCP

FOR CONSENT

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CLEAN WATER CUTOFF UPSLOPE OF SITE DIRECTING RUNOFF TO EXISTING SW NETWORK

DISCHARGE OF CLEAN RUNOFF FROM UPSLOPE

SILT FENCE AROUND WORKS AREA THAT CANT BE DRAINED TO SRP

TREATED RUNOFF TO DISCHARGE TO GRASS SWALE VIA BUBBLE UP CHAMBER

ENTRY AND EXIT TO AND FROM THIS WORK SITE DURING CONSTRUCTION TO BE ONLY FROM THE EXISTING/CONSENTED CARPARK AND NOT FROM AYR AVENUE TO MINIMISE THE TRAFFICKING OF SILT ONTO AYR AVENUE

STABILISED SITE ENTRANCE

SWALE CROSSING AT THE CARPARK EXIT TO BE THE LAST OF THE HAYBARN WORKS. IT IS TO BE CULVERTED AND BACKFILLED DURING DRY WEATHER AS QUICKLY AS POSSIBLE.

SILT FENCE BOUNDING THE EARTHWORKS CORRIDOR TO LIMIT THE MIGRATION OF SEDIMENT DURING THE FILL

EXISTING CULVERT CROSSING

PLANT TO DRIVE OVER EXISTING GRASS IS GROUND CONDITIONS ARE FAVOURABLE, 300mm DEPTH AGGREGATE TO BE LAID DOWN FOR HAUL ROAD IF GROUND IS TOO WET.

600mm Ø PIPE CULVERT THROUGH BUND EARTHWORKS AREA

CULVERT OUTLET SHAPED TO CONVEY TIE IN WITH NATURAL OVERLAND FLOW PATH. SCOUR PROTECTION TO BE PROVIDED AS REQUIRED (SUBJECT TO DETAILED DESIGN)

CLEAN WATER DIVERSION BUND MIN 700mm HIGH TO BE CONSTRUCTED ON UPSLOPE SIDE OF FLOOD BUND TO CONVEY CLEAN RUNOFF TO CULVERT.

EARTHWORKS PLANT TO UTILISE WORKS AREA FOR TRAFFIC MOVEMENTS WHERE POSSIBLE TO MINIMISE DISTURBANCE TO VEGETATED AREAS

HAYBARN WORKS ENTRANCE FROM HOMESTEAD DRIVEWAY, STABILISED ENTRANCE TO BE ESTABLISHED AT ENTRANCE OF SITE.

COMPACTED EARTH BUND ALONG THE SOUTHERN SIDE OF THE EXISTING AYRBURN HOMESTEAD DRIVEWAY AND DOWN THE BOUNDARY OF THE WOODED AREA WITH THE OPEN GRASS Paddock. GIVEN THE LOW LIKELIHOOD OF CONCENTRATED FLOWS DUE TO THE SHALLOW GRADE OF THE LAND LINING WITH GEOTEXTILE WON'T BE NECESSARY TO PREVENT SCOUR

SRP SIZED FOR HAYBARN CATCHMENT (5000m²) WITH DECANT CONNECTED TO EXISTING STORMWATER LINE

DIRTY WATER CUTOFF DRAIN TO DIVERT WATER TO SRP

CLEAN WATER RUNOFF TO BE DIRECTED DOWN NATURAL GULLY, CULVERTS UNDER PATH TO BE INSTALLED TO CONVEY FLOWS THROUGH WORKS AREA. SILT FENCE/BUND TO BE INSTALLED ADJACENT TO FLOW PATH AS REQUIRED TO MAINTAIN SEPARATION OF CLEAN AND DIRTY RUNOFF.

PATH TO COMPRISE OF GRAVEL ON GEOTEXTILE OVER EXISTING SOIL TO PROTECT TREE ROOTS. AS NO STRIPPING WILL OCCUR AND GRADES ARE VERY SHALLOW RUNOFF WILL BE CONSIDERED CLEAN. RUNOFF CLARITY TO BE MONITORED THROUGH WORKS. SILT FENCE TO BE INSTALL AROUND EXTENTS IF CLARITY IS INSUFFICIENT.

INTERCEPTOR SWALE

INTERCEPTOR SWALE TO BE CROSSED BY PROPOSED CULVERT BRIDGE

DOUBLE BUS BAY SWALE TO BE CONSTRUCTED OFFLINE DURING DRY WEATHER. THE NEW SWALE CHANNEL TO BE MADE LIVE AND THE OLD CHANNEL FILLED IN ONCE THE CULVERT HAS BEEN LAID AND BACK FILL COMPLETE. NO OTHER CONTROLS PROPOSED HERE.

SILT FENCE ESTABLISHED DOWNSLOPE OF FLOOD BUND EARTHWORKS AREA AT OUTSET OF WORKS TO CONTAIN ANY SILT WHEN TOPSOIL IS STRIPPED. AS THE BUND IS FILLED IT WILL FORM THE CONTROL AND DETAIN ANY RUNOFF IN THE FLOOD PLAIN. BUND OUTLET TO BE FORMED IN THE LAST STAGE OF WORKS SO WATER IS CONTAINED

LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- TOP OF BANK
- EXISTING CONTOURS (0.5m INTERVAL)
- CLEAN WATER DIVERSION CHANNEL/BUND
- DIRTY WATER DIVERSION CHANNEL
- SILT FENCE
- EXISTING CULVERT
- STABILISED SITE ENTRANCE
- TREATMENT DEVICE CATCHMENT
- HAUL ROUTE
- DEB DECANTING EARTH BUND
- SEDIMENT RETENTION POND
- SITE EXTENTS



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THE CREATION OF THE FOOTPATH DOWN THE DOUBLE BUS BAY, THE DOUBLE BUS BAY AND THE EXIT FROM THE AYRBURN CARPARK TO AYR AVENUE ALL CROSS ESTABLISHED STORMWATER SWALES AND WILL BE CONSTRUCTED IN DRY WEATHER. AS THE TERRAIN IS FLAT AND THE SWALE GRADES ARE SHALLOW, NO FURTHER CONTROLS ARE PROPOSED FOR THESE WORKS.

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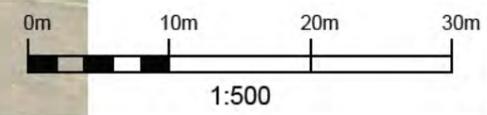
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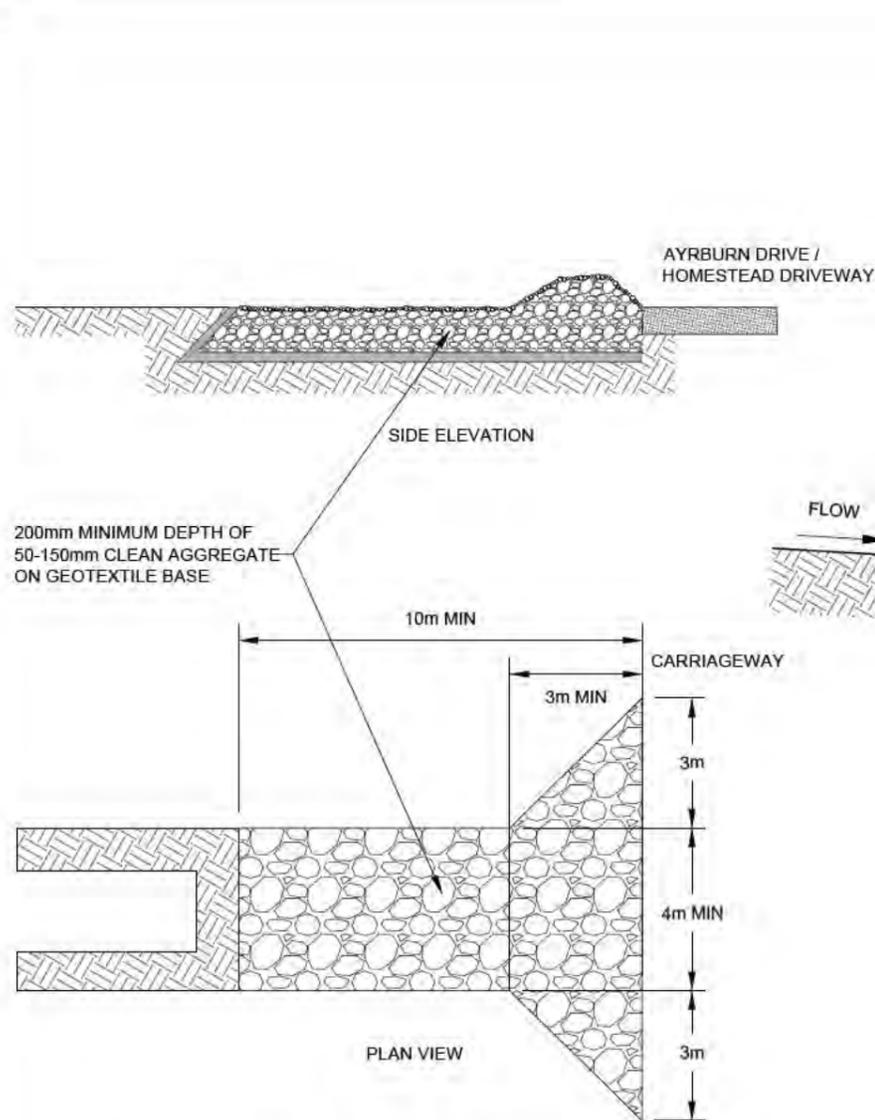
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Purpose & Drawing Title:
HAYBARN VENUE
 PROPOSED HAYBARN, BUS BAY, EARTH BUND AND CARPARK EXIT ESCP

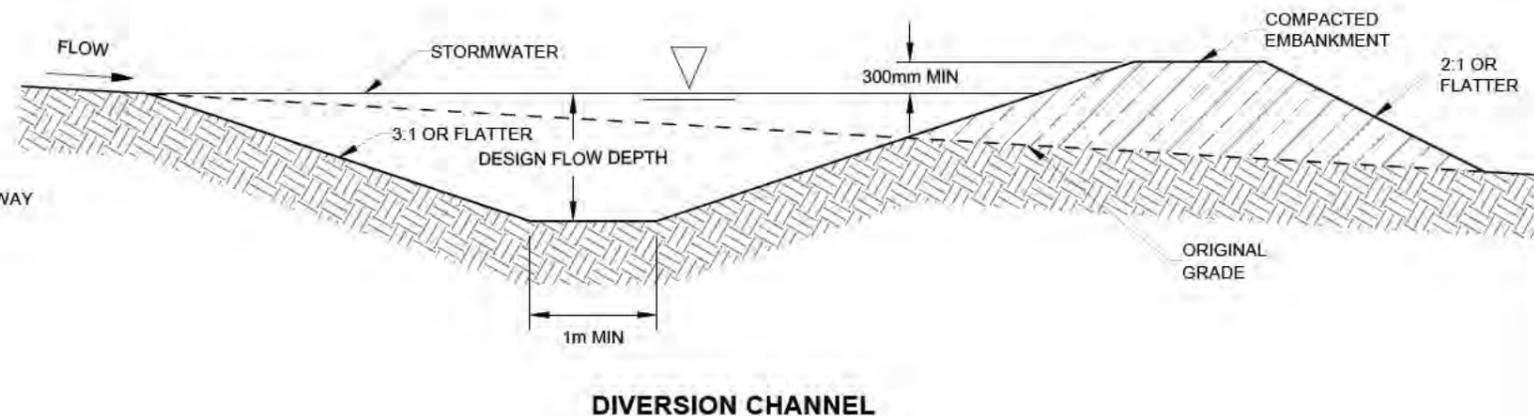
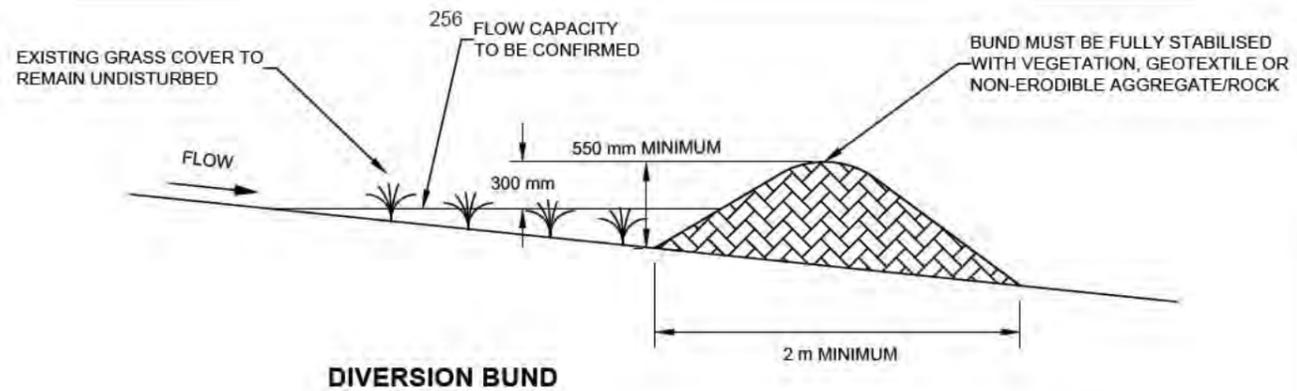
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Approved by:		Job No:	Drawing No:
		Q6388	32 - 10
		Sheet No:	Revision No:
		251	C
		Date:	28/11/2023





STABILISED SITE ENTRANCE



- NB. 1. SOIL TO FORM BUND TO BE TAKEN FROM DISTURBED AREA
2. VEGETATION IN UNDISTURBED AREA TO REMAIN INTACT

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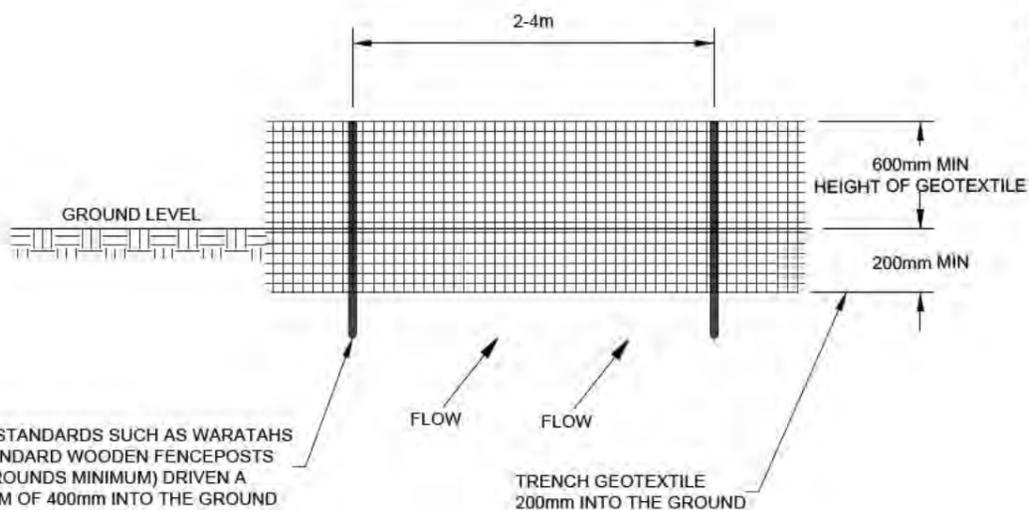
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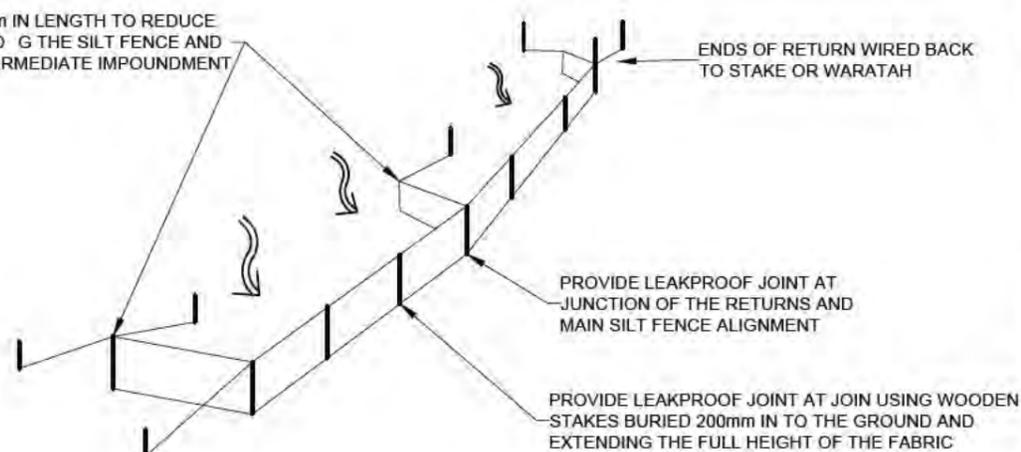
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Purpose & Drawing Title:
HAYBARN VENUE
DEVICE CONCEPTS

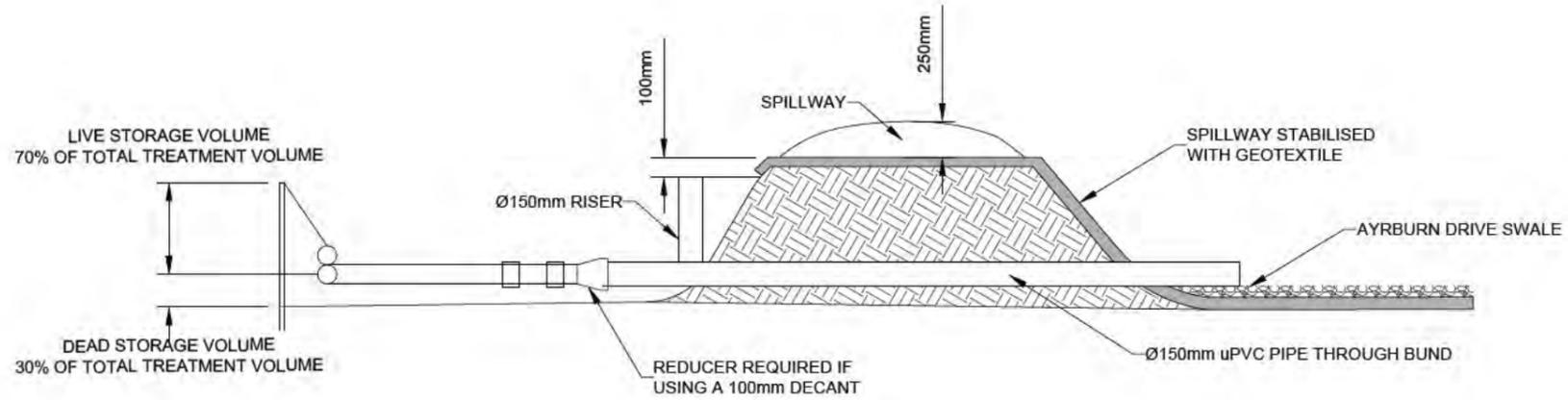
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RETURNS 1-3m IN LENGTH TO REDUCE
VELOCITY ALONG THE SILT FENCE AND
PROVIDE INTERMEDIATE IMPOUNDMENT



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DEB - CROSS SECTION

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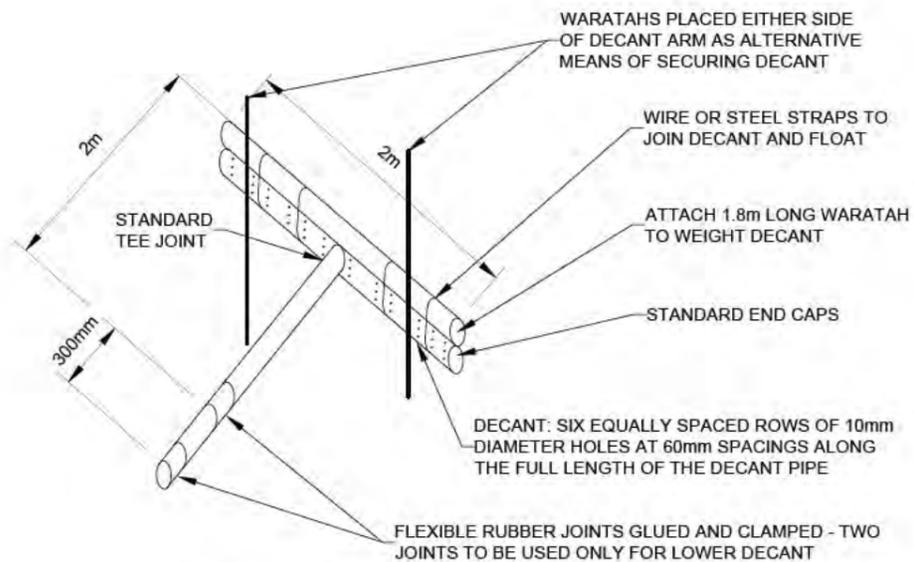
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Purpose & Drawing Title:
 HAYBARN VENUE
 DECANTING EARTH BUND

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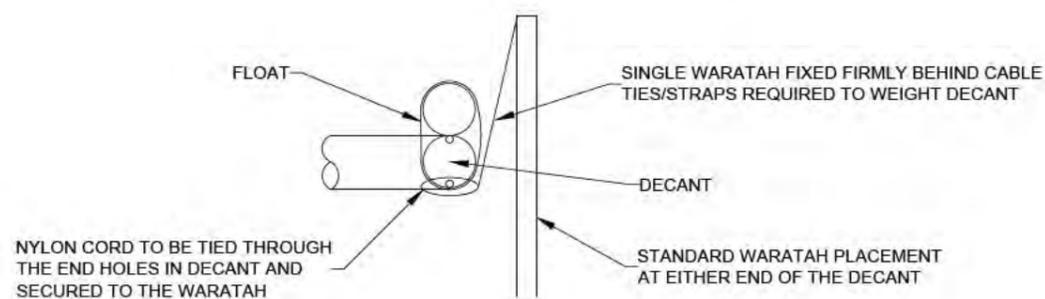
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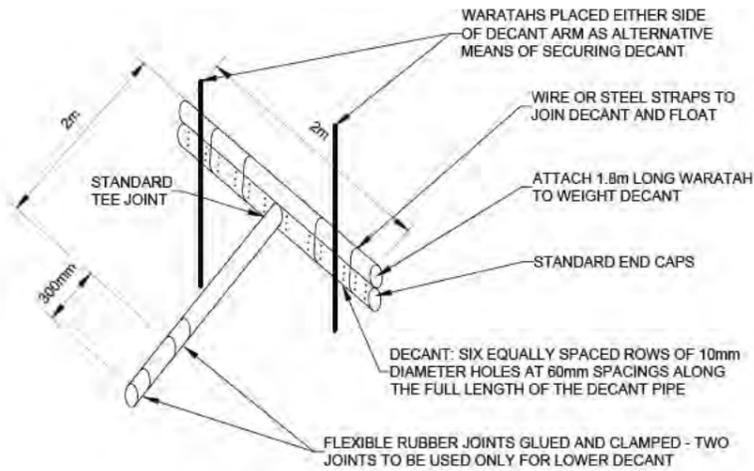
BOOM DECANT: T-BAR DESIGN



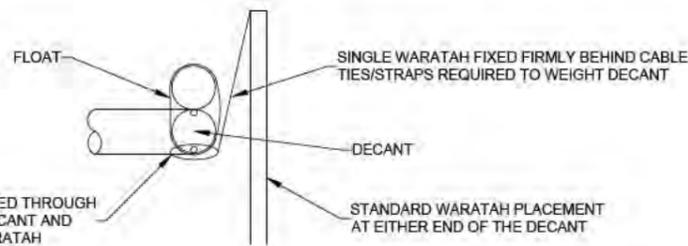
PHOTO OF DECANTING EARTH BUND



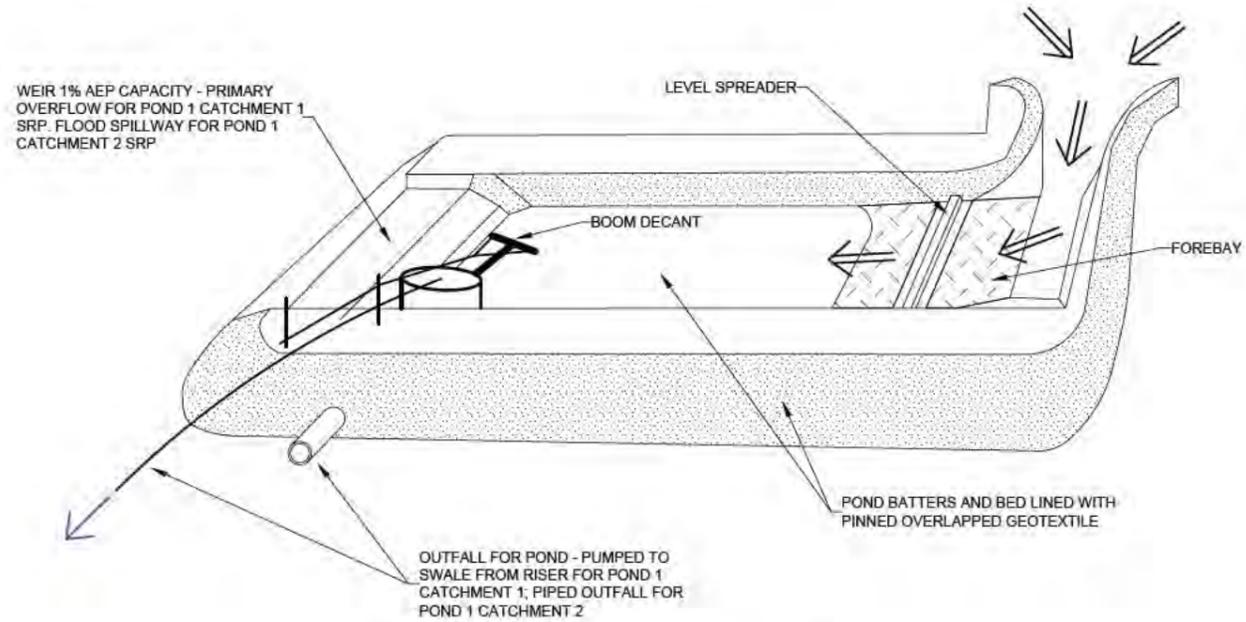
BOOM DECANT: T-BAR CROSS SECTION



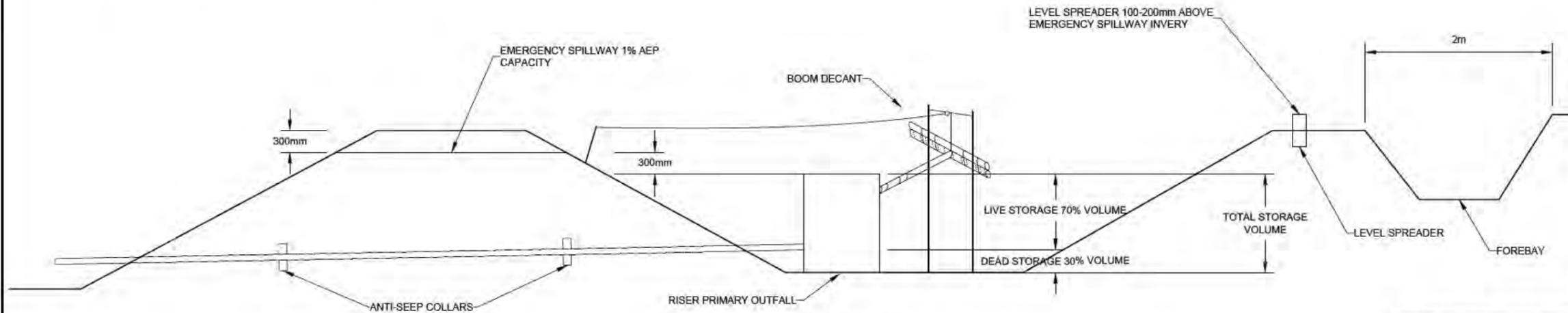
BOOM DECANT: T-BAR DESIGN



BOOM DECANT: T-BAR CROSS SECTION



SRP - PLAN VIEW



SRP - CROSS SECTION

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Purpose & Drawing Title:
HAYBARN VENUE
 SEDIMENT RETENTION POND

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APPENDIX B – SITE ENVIRONMENTAL MANAGEMENT FORMS

FLOOD BUND CULVERT CALCULATION

CHEMICAL TREATMENT MANAGEMENT PLAN

INDUCTION FORM & REGISTER

WEEKLY SITE INSPECTION CHECKLIST

ENVIRONMENTAL INCIDENT

FAILURE ASSESSMENT FORM

COMPLAINTS FORM

Catchment				
Network Node (Type)	C	I (mm/hr)	A (Ha)	Q (m³/s)
Upslope Catchment	0.4	3.54	18	0.0704

Culvert Mannings Calc

Pipe Size	mm	600
Pipe Section Area	m ²	0.283
Wetted Perimeter	m	1.885
Hydraulic Radius	m	0.15
Slope	%	1.00%
Manning's n		0.011
Velocity Design Flow	m/s	2.566
Design Capacity	m ³ /s	0.7257

Site Details	Historical Data	RCP2.0 Scenario	RCP4.5 Scenario	RCP6.0 Scenario	RCP8.5 Scenario				
Rainfall Intensities (mm/hr) :: Historical Data									
ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h
1.58	0.833	16.4	12.7	10.9	8.38	6.31	3.85	2.72	1.85
2	0.500	18.4	14.3	12.2	9.32	7.00	4.24	2.98	2.02
5	0.200	26.1	19.9	17.0	12.8	9.47	5.82	3.90	2.62
10	0.100	32.5	24.6	20.9	15.6	11.4	6.70	4.61	3.07
20	0.050	39.8	29.9	25.2	19.6	13.6	7.88	5.37	3.54
30	0.033	44.5	33.3	28.0	20.8	15.0	8.59	5.84	3.83
40	0.025	48.1	35.8	30.1	22.1	16.0	9.12	6.15	4.04
50	0.020	51.0	37.9	31.6	23.3	16.6	9.55	6.45	4.21
60	0.017	53.5	39.7	33.2	24.3	17.5	9.91	6.68	4.35
80	0.013	57.5	42.8	35.5	25.9	18.8	10.5	7.05	4.58
100	0.010	60.9	44.9	37.4	27.2	19.5	11.0	7.34	4.75
250	0.004	75.9	55.4	48.0	33.1	23.4	13.0	8.80	5.51

- Notes:
- Culvert capacity is greater than catchment runoff calculation.
 - Rainfall intensity values have been adopted from HIRDS 24hr 20yr ARI
 - No allowance for climate change given duration of works
 - Catchments largely pastoral have allowed for the highlighted values to determine C factor
 - Calculation is considered conservative, raingarden and hollows in paddocks contain additional detention storage that has not been factored into the calculation.

Table 1: Run-off Coefficients
Paragraphs 2.0.1, 2.1.1, 2.1.3

Description of surface	C
Natural surface types	
Bare impermeable clay with no interception channels or run-off control	0.70
Bare uncultivated soil of medium soakage	0.60
Heavy clay soil types	
- pasture and grass cover	0.40
- bush and scrub cover	0.35
- cultivated	0.30
Medium soakage soil types	
- pasture and grass cover	0.30
- bush and scrub cover	0.25
- cultivated	0.20
High soakage gravel, sandy and volcanic soil types:	
- pasture and grass cover	0.20
- bush and scrub cover	0.15
- cultivated	0.10
Parks, playgrounds and reserves:	
- mainly grassed	0.30
- predominantly bush	0.25
Gardens, lawns, etc.	0.25
Developed surface types	
Fully rooted and/or sealed developments	0.90
Steel and non-absorbent roof surfaces	0.90
Asphalt and concrete paved surfaces	0.90
Near flat and slightly absorbent roof surfaces	0.80
Stone, brick and precast concrete paving panels	
- with sealed joints	0.80
- with open joints	0.60
Unsealed roads	0.50
Railway and unsealed yards and similar surfaces	0.35



CHEMICAL TREATMENT MANAGEMENT PLAN

CLIENT:

AYRBURN PRECINCT LTD

PROJECT LOCATION:

AYR AVENUE WATERFALL PARK

DATE:

13/6/2023

REPORT ID:

0800 CIRTEX (247 839) | WWW.CIRTEX.CO.NZ



Introduction

Cirtex Industries has prepared this Chemical Treatment Management Plan on behalf of Wilson Contractors, for site earthworks at the Waterfall Park Developments, Ayr Avenue, Diversion Channel 4, Arrowtown, site. An electronic chemical dosing system is going to be used for treatment.

The project scope includes the construction of a temporary diversion channel to convey the flows of Mill Creek so that works can be carried out in the original creek bed and the development of environmental controls to manage water discharge on-site.

When working in the original stream bed a volume of ground water infiltration is expected and to prevent saturation of the works area, ground water will be pumped to an SRP for treatment before being discharged back into Mill Creek. The rate of ground water infiltration is unknown and expected to vary along the creek alignment. The diversion channel will remain in place for the duration of the works.

This report includes the following:

- » Bench test result from testing completed in the Geocert Laboratory.
- » The primary treatment application methodology for the site.
- » Other responsibilities in relation to system set up, management, maintenance, and spill contingency.



Electronic Dosing System (provided by Prime Pump Ltd.)

A representative soil sample was provided to the laboratory for bench testing. The tests were conducted in the Geocert Laboratory using the industry standard bench testing methodology, Appendix F1.0 of the Auckland Council GD05, Erosion and Sediment Control guidelines.

The chemical Polyaluminium Chloride was tested for use. The findings are published in the laboratory report SP-571 which is attached to this document as Appendix 2.

The treatment chemical selected for use in this plan was Cirtex Polyaluminium Chloride, because:

- It has been used extensively with Electronic Dosing Systems in the past with great success in multiple regions around New Zealand.
- It does not change the baseline pH more than one unit when applied as per the specified methods and dose rates listed in this report.
- Limited manual handling when used with an electronic dosing system, making site use safer and simpler.
- Cost effective treatment option. (Contact Cirtex to get the quoted rates for this project.)

Cirtex holds an ISO 9001:2015 certification for its quality management system

Certificate No: NZ001834-2



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2. Laboratory floc dosing trials
3. Test results and recommendation

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4. Dosing systems and compliance
5. Dosing system setup and installation
6. Batch dosing of retention ponds, bunds, or tanks

MONITORING AND MAINTENANCE

7. Monitoring and maintenance requirements
8. Replenishing the chemical reservoir
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- 1.0 Forms
 - » Dosing system setup confirmation form
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1. SUMMARY OF FINDINGS

Laboratory bench test results:

Testing on the sample received shows that the chemical Polyaluminium Chloride gives the required visual clarity of 100mm at a **dose rate of 62 mL/m³ (4 ppm Al)**.

The laboratory testing showed the natural pH of the sample to be 6.6 and it is expected that after chemical treatment the pH will not be outside the 5.5 to 8.5 pH limit (as set in GD05, refer to GD05 section F2.1.6). Vigilance with monitoring is advised and if there are any issues, please refer to section 12 of this report for contingency management.

A few important points to note:

- Good mixing after the dose point is important.
- If you come across a situation where the desired clarity is not being achieved, stop dosing and seek advice.

The test report SP-571, will give details on water clarity in mm (visual) and NTU for your reference.

2. LABORATORY FLOC DOSING TRIALS

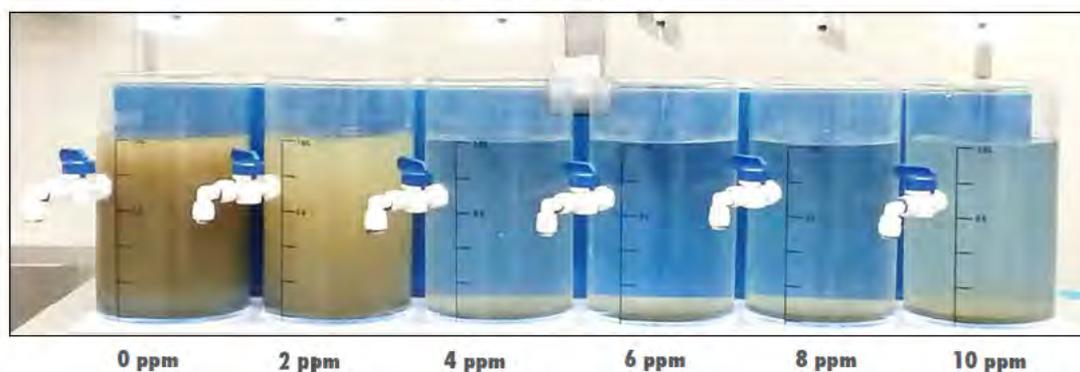
The laboratory test, known as a Jar Test, attempts to emulate the best representation of sediment laden runoff that is generated during a rainfall event.

For the purpose of this test, 20L of turbid water was created from a soil sample provided by the client. 6 identical jars were filled with 1L of the turbid water. CIR-PAC was added as per the following dosing schedule:

Chemical	Jar 1	Jar 2	Jar 3	Jar 4	Jar 5	Jar 6
CIR-PAC	0 ppm Control	2 ppm (Al)	4 ppm (Al)	6 ppm (Al)	8 ppm (Al)	10 ppm (Al)

The jar stirrer is then run at 120rpm for 5 minutes across all six jars and the clarity is subsequently recorded at relevant time intervals. The industry standard requirement for compliant discharge from site is 100mm of clarity at 60 minutes. For reference, the jars used for testing purposes are 100mm in diameter. A 30mm Secchi disk was used to measure the clarity of the samples at specified intervals and once the test has reached the final time point, NTU (Nephelometric Turbidity Units) readings are taken using a laboratory turbidimeter along with pH and temperature.

Sample 1 – SP-571



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3. TEST RESULTS AND RECOMMENDATION

SP-571:

The following 4 photos are of the SP-571 bench test in action at 0, 5, 30 and 60-minute intervals.



0 MINUTES – CIR-PAC ADDED



5 MINUTES AFTER ADDING CIR-PAC



30 MINUTES AFTER ADDING CIR-PAC



60 MINUTES AFTER ADDING CIR-PAC

ALUMINIUM DOSE (ppm)	CLARITY (mm) 0 minutes	CLARITY (mm) 5 minutes	CLARITY (mm) 30 minutes	CLARITY (mm) 60 minutes	pH / Temperature (°C)
0	0	0	10	20	6.6 / 20
2	10	10	20	30	6.5 / 20
4	20	90	100	>100	6.5 / 20
6	30	100	100	>100	6.5 / 20
8	40	100	100	>100	6.4 / 20
10	30	90	90	90	6.3 / 20

Clarity >100mm = Green
pH change > one unit of pH from baseline = Yellow

4. DOSING SYSTEMS & COMPLIANCE

The traditional GD05/ TP90 rainfall activated dosing system was designed in conjunction with Auckland Council specifically for earthworks and construction sites. Precipitation collected on the rainfall tray is collected and diverted to a header tank which in turn stores the first 12mm of rainfall and then activates the displacement system. This falls into a displacement tank which floats inside the chemical tank. Displaced chemical is transferred via a dosing hose to the channel leading to the forebay of the sediment pond.

The electronic dosing system is flow controlled. This means that it doses chemical proportionate to the volume of water coming past an inline flow sensor in a dewatering setup. The system draws chemical from a reservoir and pumps it to an inline dose point. This is where the chemical is mixed with the sediment laden water. This dose point is normally located before a section of the dewatering system where sufficient agitation or mixing can occur prior to the water reaching the settlement phase. We normally see electronic dosing systems where sediment laden water has been pumped to either a lamella clarifier or a settling pond or tank. These systems can come in many forms but are usually solar powered and enclosed in a watertight housing. They will normally incorporate a manual override switch for setup and maintenance purposes.

The industry standard Auckland council GD05 guidelines do not specifically give guidance on electronic dosing systems for sediment control, but it does mention that specific details of alternative dosing procedures proposed should be listed in the Chemical Treatment Management Plan. We can confirm that all calculations and recommendations that have been provided in this CTMP, are to ensure that the discharge from the system complies with the local body guidelines regarding the clarity and pH of discharge to the receiving environment.

5. DOSING SYSTEM SETUP & INSTALLATION

The setup parameters for the chemical dosing systems on this site are listed in the summary of findings (section 1 of this report).

The dosing system used in this application is an electronic, flow-controlled dosing system that has been tested for use with Cirtex water treatment chemicals. The prescribed dose rate established in laboratory bench testing should be programmed into the system upon installation. Please refer to the manufacturers operating procedures for this.

The treatment system will be supplied by Prime Pump. The proposed solution is a flow activated, electronic chemical dosing system. The model of unit shall be decided by the equipment supplier and shall have sufficient capacity to enable the sedimentation process to fully complete before water is discharged.

This will be indicated by the clarity of discharge matching results achieved in laboratory testing.

28th April 2022
3039-2

If the scope of sediment generating activities increase or decrease by more than the design capacity of the treatment system, the treatment system will need to be adjusted accordingly. In these situations, it might be necessary to modify the setup of the system to control either:

- The flow rate into the system
- The retention time within the system
- The sludge levels
- The chemical dose rate or concentration

The system should be installed in accordance with the recommendations in this CTMP. The supplier of the dewatering systems will be able to provide technical assistance with the location and commissioning of the treatment system.

Consideration should be given to further activity that may take place on site when positioning the dosing system. Once the system is set up in-situ, the chemical storage tank should be filled and the system primed, to ensure that there is no delay in activation when in use.



Example of an Electronic Dosing system in operation in a dewatering application.

This report has been prepared for guidance on areas relating to chemical treatment only. Any information provided in this report regarding the equipment/ systems to be used is a guide only, and where conflicting information is identified, the manufacturers operating guide shall be used.

If you have any questions or require assistance with the equipment or systems discussed in this section, please contact the equipment supplier as follows:

Supplier: Prime Pump | Phone: 0800 482 747 | Email: Info@primepump.co.nz

P +64 7 868 9909 **F** +64 7 868 3435
INFO@CIRTEX.CO.NZ | 0800 CIRTEX (247 839) | WWW.CIRTEX.CO.NZ



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6. BATCH DOSING OF PONDS, BUNDS OR TANKS

Batch dosing is not recommended without training and guidance on how to best apply it in this application. Contact Cirtex for further guidance if you have a situation where batch dosing might be required.

Batch dosing may be required if the desired clarity or pH has not been achieved via the primary dosing system and the water has been transferred to a pond, bund, or tank for further treatment.

Batch dosing calculations can be provided for this project, but we would also recommend on-site or laboratory jar testing prior to batch dosing to accurately calculate actual batch dosing requirements.

7. MONITORING AND MAINTENANCE REQUIREMENTS

It is a compliance requirement that regular monitoring and maintenance is carried out. For this project it is recommended that this is completed daily during periods where there is a high load on the treatment system and weekly during periods of standard operation.

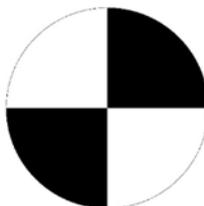
Monitoring results and maintenance activity should be recorded on the attached schedule. The monitoring and maintenance records should be stored with the treatment system or at the site/management office and be made available to the council monitoring officer upon request.

A copy of the monitoring records shall be available on file and updated as required. The integrity of the treatment system will be checked weekly. All plumbing components should be regularly checked for blockages or leaks.

It is recommended that the advice of suitably qualified professionals is followed if there are any complications or difficulties experienced when treatment is applied as per the stated parameters and procedures outlined in this CTMP.

Methods and tips for measuring water clarity

To measure clarity, a Secchi Disk or similar measuring device should be used. This can be attached to a pole or rope/string. It is lowered vertically into the water body until it disappears and then raised again until it reappears. At this point the distance between the disc and the surface of the water should be measured. This distance is recorded as clarity.



Methods and tips for pH measurement

There are a few methods that can be used to determine the pH of a liquid:

- Using pH strips/ paper
- Using a pH Indicator solution and chemical titration (normally only done in a lab)
- Using a Digital pH probe (options for field use and laboratory applications)

The recommended method for pH measurement for treatment monitoring is using a digital pH meter made by a reputable manufacturer. These meters are simple to use and leave little room for error. They can be easily calibrated using solutions with a known pH value and are normally quite compact and simple to store.

To take a pH measurement you will need a sample from the discharge point of your sediment retention pond. If there is no discharge, this can also be taken from the pond near the decants or outlet using a sampling cup (clean cup or half-bottle that is attached to the end of a length of wood or broom handle). Take a reading from the pH probe as per the operating instructions of the device you use. You may need to wait a few moments for the device to give you a stable reading. Three readings should be taken from the sample, and the average should be taken as the pH value.

It is recommended that you store the pH probe a storage solution to ensure the longevity of the pH probe. Depending on the frequency of use it is recommended that you test the reading of the device using a calibration solution (solutions with a known pH value, also known as pH buffer solutions). pH meters from most reputable suppliers should provide readings of sufficient accuracy to be used in decision making regarding chemical treatment as outlined in this plan. If you want laboratory testing for the pH of water or soil from your site, we do have the capability to do this. This would normally not be necessary unless there are problems with treatment performance. Please contact us for more information if you require this service.



8. REPLENISHING THE CHEMICAL RESERVOIR

The reservoir tank should be refilled when the reservoir is half full, or sooner if high use is predicted. If the system is treating flows influenced by rainfall, the level of chemical in the system needs to be sufficient to treat a 100-year rainfall event should one occur. Refilling procedures will be outlined in the manufacturers operating procedures.

With an electronic dosing system, it is important to always prime the system after refilling. This will ensure that dosing begins immediately when the system is activated.

9. OBSERVATION OF WATER QUALITY

The quality of water discharged will be checked at least weekly, and the clarity determined using a Secchi disc or similar (as detailed above) and recorded on the monitoring sheet. pH shall be recorded to ensure it meets council guidelines.

10. STORAGE OF CHEMICAL ON SITE

Water treatment chemical supplied by Cirtex in 20L or 200L polyethylene containers or drums, 1,000L IBCs or 25kg powder bags, shall be kept in secure storage when on site. Chemical drums will be stored on end with the screw caps uppermost. Bags of chemical in powder form need to be kept away from water until they are used.

Replenishing the chemical reservoirs will be completed weekly as part of the regular inspection regime. We encourage the recycling of drums and containers on site wherever possible but there are organisations who will repurpose them if this is not an option. Care should be taken with the washing of drums and the rinsing of residual chemical.

11. PROCEDURE FOR TRANSPORTATION OF FLOCCULATION CHEMICALS

The transport of water treatment chemicals to and from the project will be undertaken by commercial carriers or the Cirtex delivery service in accordance with current Hazardous Goods, Traffic & Transport regulation. CIR-PAC weighs about 250kg in 200L drums and is most easily moved within the site in a loader bucket. Drum lifting chains can be supplied by Cirtex if required. The use of PAC or any other chemical must be done in accordance with the site Health & Safety Plan. The CIR-PAC MSDS is available on the Cirtex website www.cirtexcivil.co.nz or by contacting 0800 CIRTEX (247 839).

[CIR-PAC MSDS LINK NUMBER: MSDS C 001 004](#)

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12. CHEMICAL SPILL CONTINGENCY PLAN

If there is a spill of water treatment chemical onto the ground it will be immediately contained using earth bunds to prevent it from entering water. The spilt chemical should be recovered if possible, using a spill kit. If the spilt chemical cannot be recovered, it should be mixed with a volume of soil equal to at least ten times the volume of spilt chemical and buried in dry soil. If there is a spill of flocculation chemicals into pond water or banded area, discharge from the impounded water body into natural water should be prevented. Contact the Council or its representative for advice on appropriate action.

If there is a spill of chemical into flowing water i.e. a stream, river, or stormwater drain:

1. The regional council should be advised immediately.
2. If possible, the water and the spilt chemical should be pumped into a bund or pond until all the spilt chemical has been removed from the watercourse.
3. If the chemical cannot be removed from the watercourse any downstream users.

13. CONTINGENCY MANAGEMENT

A plan must be put in place to manage contingencies in accordance with site environmental management plans. Contingencies could include poor performance of the treatment system, vandalism, stormwater damage or effects of other influences on stormwater quality. The equipment supplier can provide guidance or training with regard to the use of the dewatering systems.

If the treated water is consistently very clear to depths >100 mm, it could indicate overdosing and the possibility of a lowered pH. This can present a risk to the receiving environment. If the treated water is consistently clear, the pH should be retested. Contingencies such as poor treatment performance or consistently very clear treated water should be dealt with by consultation with the appropriate organisation or its representative.

If pH falls outside the permissible range of 5.5 – 8.5, you will need to take one of the following actions after stopping all discharge from the catchment system:

1. Use the impounded water for dust control (this won't require treating it.)
2. Subject to the weather conditions at the time, and the level by which the range has been exceeded, it is possible to use pH balancing chemicals. These must be applied in accordance with the batch dosing guidelines provided in section 6 of this report.

The pH scale is logarithmic which means that the more pH balancing chemical added, the faster the pH will change. Because of this, it is important to increase the pH dosing in small increments to ensure that you don't increase or decrease past the pH value you are aiming

for. If the pH levels require significant adjustment, it is advisable that the advice of suitably qualified professionals is requested and oversight is provided on-site.

The following chemicals have been used successfully in the past to balance pH:

- » To **Increase** the pH it is recommended that Sodium Carbonate is used.
- » To **Decrease** the pH it is recommended that Sodium Bisulphate is used.

3. Engage a laboratory to take samples and perform chemical titrations to determine appropriate chemicals and dose rates to correct pH. Implement these findings as per the recommendations in section 14 of this report.

14. TRAINING OF PERSON RESPONSIBLE FOR MONITORING AND MAINTENANCE OF CHEMICAL TREATMENT SYSTEMS

It is very important to regularly monitor and maintain the treatment system. Changing site conditions can have significant impacts on the success of the chemical treatment. Cirtex can undertake training of site personnel to carry out the required tasks and assist with understanding the basic principles of chemical treatment. Please let us know if you require this service.

15. RESPONSIBILITY

While all care has been taken in preparing this CTMP, it is based on the information provided by the client and equipment suppliers, and results may vary during the course of project works. It is the responsibility of the contractor to ensure compliance with all aspects of the appropriate regulations pertaining to these works. Cirtex would recommend that this report is refreshed at least every 6 months or more depending on the nature of the application. This will ensure dosing and flocculation designs provide the best results, as site conditions can change throughout the lifecycle of any project. All recommendations and calculations were completed in conformance with industry guidelines and best practice. This information is not to be used for any other purpose, without prior consultation and the written consent from Cirtex. No liability is accepted for misuse of this information.

APPENDIX 1.0 - FORMS AND ATTACHMENTS

DOSING SYSTEM SETUP CONFIRMATION FORM (as built)

CONTRACTOR			
SITE			
INSTALLED BY			
CHEMICAL			
DOSE RATE			
SYSTEM	Flow (m ³ /hr)	RECOMMENDATION	CHECK
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

I _____ hereby state that the above methodology has been followed and prepared in accordance with the chemical treatment management plan.

SIGNATURE:

NAME:

DATE:

APPENDIX 2.0 – GEOCERT BENCH TEST REPORT

Test Date: 09/11/21

Operator: Joel Sorensen | Laboratory Manager

Approved By: Nicola Levy | Laboratory Technician

Report ID: SP-571



TEST REPORT: WATER CLARITY

Waterfall Park, Arrowtown - GD05 Jar Test

CIR-PAC Dose Rate	Clarity (mm) 0 Minutes	Clarity (mm) 5 Minutes	Clarity (mm) 30 Minutes	Clarity (mm) 60 Minutes	NTU	pH	Temperature (°C)
Control Sample (No Treatment)	0	0	10	20	>800	6.6	20
2 ppm (Al) or 31 mL/m ³	10	10	20	30	>800	6.5	20
4 ppm (Al) or 62 mL/m ³	20	90	100	100	79	6.5	20
6 ppm (Al) or 94 mL/m ³	30	100	100	100	61	6.5	20
8 ppm (Al) or 125 mL/m ³	40	100	100	100	47	6.4	20
10 ppm (Al) or 156 mL/m ³	30	90	90	90	177	6.3	20
SAMPLE INFORMATION	5kg dark gray clay, contains topsoil						

TEST INFORMATION

Date Testing Commenced:

9/11/2021

Date Testing Completed:

9/11/2021

Client:

Cirtex Industries,
16 Queen Street Kopu
Thames, New Zealand - 3500

Identification Number:

361-3039-571

Laboratory Address:

2/366 Ngati Maru Highway
Thames, Waikato,
New Zealand - 3578
PO Box 470, Thames, 3540

Laboratory Ref:

SP-571

This document is only valid if it is signed by the Quality Manager. Test results only relate to the samples received. This report was performed in compliance with all the relevant Test methods listed above. Any deviations/ additions to the standards are listed in the attached test method report. The aim of the test is to try and achieve a minimum clarity of 100mm during the test period. It is noted that with some soil types this might not be achievable. KEY: "°C" = Degrees Celsius. "ppm" = parts per million. "mm" = millimetres.

THIS DOCUMENT MAY ONLY BE REPRODUCED IN FULL.



Any Questions? Please let us know;

P: 0800 247 839 | E: info@geocert.co.nz | W: www.geocert.co.nz

x

Nicola Levy

Laboratory Technician

x

Joel Sorensen

Laboratory Manager

Site Environmental Induction – Haybarn

1. Roles and Responsibilities for Environmental Management

Role	Name	Phone	Email
Principal (overseer of project)	TBA		
Contract Engineer (onsite manager – First response for site environmental management)	TBA		
Environmental Manager (Lead responsibility for Environmental management of project/complaints/incidents)	TBA		
Environmental Consultant (Author of report/ expert advice)	Andrew Nichols	██████████	████████████████████
QLDC Monitoring (follows up re water/dust discharges when notified)	Sam Marsh	██████████	████████████████████
ORC Pollution Hotline (Visits site when notified of Pollution of air water and land)		0800800033	compliance@orc.govt.nz
Heritage New Zealand – Pouhere Taonga (Visits site when there is discovery of Cultural Finds/Koiwi Tangata)	Dr Matthew Schmidt	██████████	████████████████████

These are the principal contacts, but the law says that all workers involved with this project including subcontractors have responsibility for environmental management of this site. Read the EM plan and be familiar with its contents as it relates to your role

2. Erosion and Sedimentation Control Measures and their Maintenance

1. Enter and leave the site via the designated entrance and ensure your vehicle/equipment does not track sediment onto the public road
2. Sediment fence and bunds comprise the boundary of earthworks.
3. As areas are completed, provide stabilisation before beginning a new area
4. If dust is being generated call for water to be applied . Do not leave it to others
5. Report

- all damage to/clogging of perimeter controls
 - finished surfaces
 - clogging of the stabilised entrance pads when they get clogged and unable to function adequately
 - contamination of the public road and stormwater entrances.
- no matter who does it so that it can be remedied.

6. Procedures for Imminent Rain and/or Wind event

Prior to a rain event, ensure all site perimeter stockpile and public drain defences are visibly in good order with no gaps. Report any defects you see that they may be fixed immediately.

When wind speed is higher than 14 metres per second, and the soil is dry and prone to becoming airborne avoid operating dust generating vehicle /equipment movement, soil disturbance or soil shifting, unloading, or loading, unless a dust is suppressed. It is your responsibility to call for the water truck/hose. Do not saturate the soil as this will create the risk of causing sediment to be adhered to tyres/dirty runoff.

If the site is shut down longer-term stabilisation methods applicable to stockpiling as covered in Section 5 of the EM Plan document should be applied including covers for stockpiles and soil binders.

7. Parking and Material Storage areas including Refuelling and Spill management

Park private vehicles on the Ayr Avenue and do not drive on the site unless it is required for the earthworks programme.

Stockpile in the designated area and keep materials especially topsoils and subsoils separate.

Refuel off site as much as possible. If you do refuel/service vehicle or equipment on site, you are responsible for the clean-up of any spills. Clean-up materials and any contaminated soil must be disposed of offsite at an approved facility.

8. Archaeological/Cultural/Contamination Discovery Protocols

If kōiwi tangata, archaeology and artefacts of Māori origin or other archaeological items are discovered, stop work immediately with draw equipment from the area and notify the site engineer who will in turn notify Heritage New Zealand – Pouhere Taonga. The contact is listed in 4 of the EM Plan.

The same procedure must be followed for discovery of potentially contaminated material. Report to the site Engineer who will notify the ORC Pollution Hotline to discuss the safe correct identification and appropriate management of the material. The contact is listed in Section 4 of the EM Plan.

9. Procedures for Notifying of Potential Environmental Incidents and Complaints

If there is an environmental incident that could indicate the EMP has failed, leading to any adverse environmental effects offsite, immediately contact the Contract Engineer who will inform the Environmental Manager. QLDC / ORC will then be informed within 12 hrs.

If a complaint is made be polite and immediately refer the matter to the Site Engineer who is authorised to engage with the public. They will in turn notify the Environmental Manager in the formulation of a response.

Incidents and complaints will be recorded and kept for examination by ORC/QLDC upon request as per Section 9 of the EM Plan.

Weekly Site Inspection

LOCATION

INSPECTION OFFICER DATE

SIGNATURE

Legend: OK Not OK N/A Not applicable

1. Ayrburn Avenue clear of visibly significant sediment.
2. Stabilised Entry/exit pads from Ayrburn Avenue and the northern driveway clear of excessive sediment deposition.
3. The construction site is clear of litter and unconfined rubbish.
4. Adequate stockpiles of emergency ESC materials exist on site.
5. Site dust is being adequately controlled.
6. Appropriate drainage and sediment controls have been
7. installed prior to new areas being cleared or disturbed.
8. Up-slope "clean" water is being appropriately diverted around/through the site.
9. Diversion bunds are free of soil scour and sediment deposition.
10. Soil stockpiles are protected from wind, rain and
11. stormwater flow with appropriate drainage and erosion controls.
12. Sediment fences are free from damage.
13. Sediment-laden stormwater is not simply flowing "around" the sediment fences or other sediment traps.
14. Both decanting earth bunds are free of excessive sediment deposition.
15. The settled sediment layer within these is clearly visible through the supernatant prior to the discharge of such water.
16. All reasonable and practicable measures are being taken to control sediment runoff from the site. . . .
.....
17. Stabilised surfaces have a minimum 80% soil coverage.
18. The site is adequately prepared for imminent storms.
19. All ESC measures are in proper working order.

ENVIRONMENTAL INCIDENT REPORT FORM

Project Address:	QLDC Consent Number (if applicable): RM123456 BC123456
Brief Project Description:	

Instructions

Complete this form for all environmental incident that cause contaminants (including sediment) or environmental nuisance to leave the site. Please be succinct, stick to known facts and do not make assumptions.

Once completed submit to the Regulatory team at Queenstown Lakes District Council at RCMonitoring@qldc.govt.nz Call the Regulatory team immediately on [03 441 0499](tel:034410499) for any serious or ongoing incidents that cannot be brought under control.

Incident details

Date and Time	Date: <input type="text"/> /xx/xx Time: <input type="text"/> :xx am <input type="checkbox"/> pm <input type="checkbox"/>
Description Provide a brief and factual description of what happened during the incident, include relevant details such as: <ul style="list-style-type: none"> > The estimated distance to the nearest waterway (include storm water and dry courses) > The estimated distance to the nearest sensitive receiver > The activity being undertaken when the incident occurred Sketches/diagrams/photos may be reference and appended to this report to aid in the description of the incident.	
EXACT location of the incident Include address, landmarks, features, nearest cross street, etc. Maps and plans can be attached to the incident report if appropriate	
Quantity or volume of material escaped or causing incident (provide and estimate if quantity unknown)	
Who identified the incident?	<input type="checkbox"/> Contractor <input type="checkbox"/> Council <input type="checkbox"/> Community <input type="checkbox"/> Other

What immediate actions/control measures were taken to rectify or contain the incident?

What initial corrective action will be taken to prevent similar incidents recurring in the near future?

Has the Otago Regional Council been notified? Yes No

Approvals:

Environmental Representative/Person making report

Name..... Signature.....

Organisation..... Date.....

Mobile phone number.....

Site Supervisor

Name..... Signature.....

Organisation..... Date.....

Mobile phone number.....

ESC Failure Assessment Form

Date	
------	--

Recorded by	
-------------	--

Failure (what failed)

What management measures were in place to prevent the incident from occurring and what are the likely causes of the failure?

Outcome (what was affected)

Action (how does the Contractor propose to mitigate the issue and prevent re-occurrence)

Signed	
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Reviewed by	
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Memorandum

Date:	14/02/2024
To:	Courtney Briggs (Queenstown Lakes District Council)
From:	Jason Smith
Project Number:	4217
Reviewed and Released by:	Mark Lowe

Subject: RM230425: Environmental Management Plan Review

Background

Morphum Environmental Limited (Morphum) has been engaged by Queenstown Lakes District Council (QLDC) to provide a review of a resource consent application referred to as RM230425. Aryburn Precinct Limited (**The Applicant**) seek consents for earthworks to form carpark facilities, accessways, a flood mitigation bund and associated civil infrastructure.

The scope of this review as requested by QLDC is to review the Environmental Management Plan (**EMP**) for the site.

The following application material has been reviewed:

- *Environmental Management Plan (Consent Draft)*, report prepared by Paterson Pitts, revision 4, dated 29/11/2023 (**EMP**).
- The plan set: *Aryburn Precinct LTD Haybarn Venue – Resource Consent Drawings*, plans prepared by Paterson Pitts Group, revision C, dated 08/12/2023.

This review is framed in respect to the document *QLDC Guidelines for Environmental Management Plans (QLDC guideline)*.

The EMP correctly identifies the site's environmental risk-rating as "High Risk". The QLDC guideline requires a High Risk site EMP to contain all Administrative and Operational requirements for all of the environmental elements.

Administrative Requirements

The EMP submitted with the application material contains all of the necessary administrative requirements. Specifically, it includes provision for:

- A site environmental induction, and includes a template as to what would be covered in such an induction (see section 7 and appendix B).
- Management of sub-contractors, these are required to attend in the site induction (see sections 4, 7 and appendix B).
- Notification and management of environmental incidents (see section 8 and appendix B).

- Environmental roles and responsibilities of personnel (see section 4 and appendix B). That not all roles are named is usual practice during the application phase and it would be expected that these are filled once a contractor is appointed.
- Environmental representative. The position and responsibilities are allowed for (see section 4 and appendix B).
- Records and registers. Appropriately detailed templates are provided as appendices to the EMP.
- Weekly, as well as, pre and post event site inspections. See section 5.12 and appendix B.
- Monthly reporting by a Suitably Qualified and Experience Professional (**SQEP**) is allowed for (see section 9). The site's SQEP is given as Andrew Nicholls, I have been provided with a copy of Andrew's CV from QLDC previously and can advise that he meets the definition of a SQEP as per the QLDC Guideline.

Operational Requirements

The EMP submitted with the application material contains all of the operational requirements; however there are technical details regarding the erosion and sediment controls that must be addressed prior to implementation.

Erosion and Sedimentation

- For the preparation of Erosion and Sediment Control Plans (**ESCPs**), the QLDC guidance refers to numerous technical guidelines. The most widely applied, and applied in the EMP, is Auckland Council's 2016/005: Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region (**GD05**).

The EMP submitted with the application material contains all of the necessary requirements. However, there is a minor technical point to note regarding the Decanting Earth Bund (**DEB**) proposed to control the earthworks for the overflow carpark.

The DEB proposed to control the earthworks for the overflow carpark is shown as having a contributing catchment of 0.5 ha. GD05 recommends the maximum catchment for a DEB is limited to 0.3 ha. A rationale for this departure is provided in section 5.5.1 of the EMP.

I concur with the applicant's assessment that the DEB represents a practicable option for providing sediment control to this earthworks catchment. The DEB has otherwise been designed appropriately and as such would provide for a greater degree of sediment removal efficiency than a super silt fence and involve less land disturbance than a sediment retention pond's construction (if a sediment retention could be constructed in this location).

The EMP also retains a reference to soakage devices (section 5.12), that have been removed from the ESCP.

- Water Quality – water quality monitoring is appropriately provided for in terms of frequency analytes, thresholds values and response measures (see section 5.13).
- Dust – sensitive receivers are appropriately identified, the activities that could potentially generate dust, appropriate management methods that could be employed and monitoring is appropriately provided for (see section 5.11).
- Cultural Heritage – provisional methods to be implemented in case of the accidental discovery of cultural heritage items are provided for in section 6.7, and these methods are provided for in the reporting templates in appendix B.

- Noise and vibration – given the context of this application noise and vibration are appropriately incorporated into the EMP (see section 6.1).
- Contaminated sites – provisional methods to be implemented in case of the accidental discovery of cultural heritage items are provided for in section 6.6.
- Vegetation Management - given the context of this application, with previously consented bulk earthworks in progress across the site, vegetation management is appropriately incorporated into the EMP.
- Chemical and Fuels Management – the management of chemicals and fuels are provided for in section 6.2 and 6.3. The management proposed is in accordance with the QLDC guideline.
- Waste Management - the management of chemicals and fuels are provided for in section 6.5. The management proposed is in accordance with the QLDC guideline.

Summary / Conclusion

It is considered that the EMP submitted with the s92 Response contains sufficient provision to ensure that the earthworks can be undertaken in accordance with best practice methodologies. Provided that the minor technical points noted are addressed in the final EMP, and certified by Council as being as such, then it is considered that the potential effects appropriately addressed. It is recommended that a suitably worded condition of consent is imposed in this regard.



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Senior Environmental Scientist
Morphum Environmental Ltd
Phone: 09 377 9779
Email: jason.smith@morphum.com



ENGINEERING REPORT

TO: Courtney Briggs

FROM: Catriona Lamont

DATE: 16/01/2023

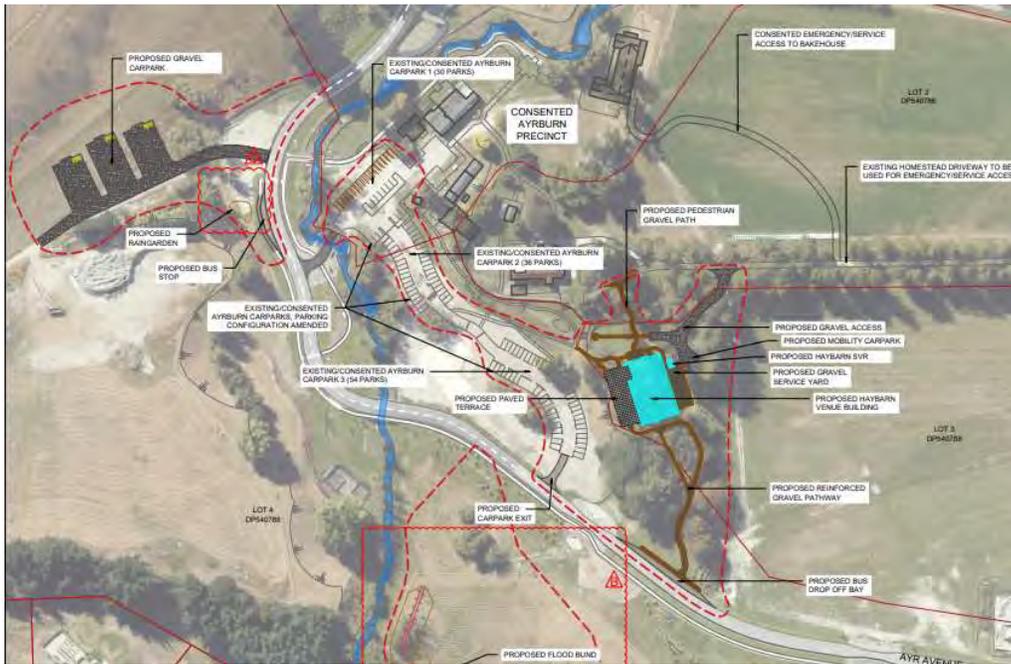
APPLICATION DETAILS	
REFERENCE	RM230425
APPLICANT	Ayrburn Precinct Limited
APPLICATION TYPE & DESCRIPTION	Construct an events venue within an approved building platform, with associated carparks and bus stops
ADDRESS	339 Arrowtown-Lake Hayes Road
LEGAL DESCRIPTION	Lots 1, 2, 3, 4 DP540788
ZONING	Wakatipu Basin Rural Amenity Zone (PDP) Waterfall Park Zone (WPZ) Rural General (ODP)
SITE AREA	42.23 Ha
ACTIVITY STATUS	Non-complying Public Notification is required as it is requested by the applicant
VALUATION NUMBER	-

Application	Reference Documents	As per documents provided with consent application
	Previous Relevant Consents	RM171280 – Construction of private road (Ayr Avenue) RM180584 – establish Ayrburn Domain and hotel complex RM190278 – Variation to RM180584 for landscaping RM191096 – Boundary adjustment RM200791 – Residential building platform and residential building on Lot 3 DP540788 RM200897 – Right of way for legal access to Lot 3 over Lot 4 DP540788 RM210591 – Variation to RM180584 for extension of car park RM210609 – Variation to RM171280 for stormwater detention pond RM211193 – Extension of Ayrburn Domain including undertaking 12 temporary events per year and associated earthworks and transport RM220481 – For the planting, cultivation and management of grapevines RM220829 – Establishment of a new building known as the Barrel Room RM220874 – changes to activities consented under RM211193 RM230163 – earthworks to construct ponds for frost-fighting
	Date of site visit	13 July 2023

Location Diagram:



Lot 3 DP 540788 – Location of Hayburn Venue



Overflow car park and Hayburn venue with associated pedestrian access

Proposal

Resource consent is sought to establish an events venue with a ground floor area of 748m² that will accommodate up to 180 guests. The events venue is to be located in a new building, called the Haybarn Venue, which is primarily within the approved building platform approved under RM200791.

Comments	
Existing Use	Site partially developed / partially under construction
Neighbours	Millbrook Resort Zone, Waterfall Park Resort Zone and Wakatipu Basin Rural Amenity Zone (WBRA) land borders to the north. Arrowtown - Lake Hayes Road, road reserve land borders to the east while Wakatipu Basin Lifestyle Precinct zone borders to the south and WBRA zone borders to west.
Topography/Aspect	Subject site gently slopes southwest towards Mill Creek.
Water Bodies	Mill Creek is located within about 50m of the proposed development and the site is located within the Lake Hayes catchment.

		COMMENTS	Condition
TRANSPORT	Referenced Reports	<p>The applicant has provided the following reports related to transport:</p> <ol style="list-style-type: none"> Title: <i>'The Proposed Haybarn Venue: Parking and Access Assessment'</i>, Reference: 14372-120623, Dated: 12/06/2023 by Carriageway Consulting Title: <i>'The Proposed Haybarn Venue (RM230425): Response to s92 Request'</i>, Reference: 14372-261023, Dated: 26/10/2023 by Carriageway Consulting Engineering Drawings Package by Paterson Pitts Group, Titled: <i>'Ayrburn Precinct Ltd: Hayburn Venue – Resource Consent Drawings'</i>, Reference: Q6388, Dated: 8/12/2023 	
	Parking	<p><u>Existing Carparks 1, 2, and 3</u></p> <p>As part of previous consents and development on the subject site the car parking areas 1, 2 and 3 have already been approved, locations shown below. Between the 3 carparking areas a total of 120 car parks and 4 mobility parks were provided. This number of car parks relies on the car parks being delineated, which was not permanently required under the previous consents.</p> <p>As part of this consent it is proposed to formalise these car parks and I therefore recommend a condition regarding the permanent marking of car parks.</p> 	X

TRANSPORT	Parking (cont.)	<p>The car parks will not be formally delineated and as per the transport assessment, a wider stall width of 3m is proposed to account for this. The depth of the car parking spaces is 5.5m with an aisle width of 6.0m, I am satisfied that this is in accordance with Table 29.11 for Class 2 (unfamiliar) users.</p> <p>The surface of the Overflow Car Park is shown as gravel, and I am satisfied that this is suitable. However, I recommend a condition that the first 6m of the access to the car park is sealed in accordance with Council Standards.</p> <p>The car park is at a higher elevation than Ayr Avenue and earthworks are required to form the access, although the grade of the access has not been provided, based on the contour plans I am satisfied that it can be formed to Council standards. The car park area is shown to be at a gradient of 5% and I am satisfied that this is in accordance with Council standards.</p> <p>I recommend a condition that the detailed design of all parking and manoeuvring areas proposed be provided to Council for Engineering Acceptance prior to the commencement of works. I recommend a condition that they be installed in accordance with the Accepted plans prior to the commencement of the commercial activity.</p> <p>The access/egress to the car park is from Ayr Avenue and the sight distance is shown on the Engineering Design Drawings to be 80m in both directions. I am satisfied that this is in accordance with Rule 29.5.17 for this commercial activity.</p> <p>A cut off drain is required for the slope behind the overflow car park, this is discussed in more detail in the stormwater section below.</p>	<p>X</p> <p>XX</p>
TRANSPORT	Means of Access	<p>There are two existing accesses to the proposed venue, the first from Ayr Avenue and the other from the existing driveway to the Homestead.</p> <p>Ayr Avenue Access</p> <p>The main access will be from Ayr Avenue, which will provide access to the site for private buses and for cars to Car Park 3. From the bus stop and car park pedestrian access is provided via footpaths/buggy tracks.</p> <p>The '<i>Parking and Access Assessment</i>' undertaken by Carriageway Consulting considered the increase in traffic demand on Ayr Avenue and the Lakes Hayes / Ayr Av intersection. In the assessment it concludes that Ayr Av road and the intersection can accommodate the additional traffic. I accept this expert advise and make no recommendations in this regard.</p> <p>Within the report it also discusses the breach of Rule 29.5.15 (width and design of Vehicle crossings for Rural Zones), although Ayrburn is within the rural zone, the speed limit along Ayr Ave is 50km/hr and therefore the assessment considers the crossings to be Urban oppose to Rural. It is compliant with Rule 29.15.14 (width and design of Vehicle crossings for Urban Zones) but results in it being non-compliant against the rural considerations. I am satisfied that this breach is technical in nature only and make no recommendations in this regards.</p> <p>Buses</p> <p>It is anticipated that due to the nature of the activities to be held at the Haybarn Venue guests are likely to travel by bus opposed to private vehicles.</p> <p>The proposed development shows a double bus bay and is located adjacent to the pedestrian footpath on the southbound route and a single bus stop on the northbound lane, adjacent to the entry to the overflow car park, past the entrance to Car Park 1, 2, and 3.</p> <p>Dimensions of the double bus bay is 3m wide and 43m in length (excluding tapers). Within the transport RFI response tracking curves for entering and existing the double bay are provided, this shows that buses can manoeuvre in and out of both bays independently. Auckland Transport Code of Practice provides dimensions for bus stops, for a 'Standard' 13.5m long tag axle bus requires an overall length of 70m for a double bus bay and a straight length of 39m. From scaled measurements the overall length is 65m with a straight length of 39m. Within the transport assessment it discusses that the sizes of buses are likely to be 11m in length and the tracking curves</p>	

TRANSPORT	Means of Access (cont.)	<p>Legal:</p> <p>While all four lots are under the same ownership should they change ownership independently in the future there is nothing in place to enable legal access. Therefore the following Right of Ways are required in favour of Lot 3 DP 540788, where the Hayburn Venue is located.</p> <ul style="list-style-type: none"> - RoW over Lot 2 for the use of the Homestead Driveway and access to the mobility parks - RoW/Right to Park over Lot 4 for access to Car Park 3 and the bus stops and the use of Car Park 3. (This has been created in part under RM200897 but does not extend to the car park or the bus bays) - RoW over Lot 1 for access for bus manoeuvring for buses that use the northbound bus stop (Note, RoW over Lot 1 in favour of Lot 4 may also be required but it is not applicable for this consent). <p>A "right to park/ROW" easement will need to be created to enable legal access to the Hayburn Venue. I therefore recommend a condition that these easements are shown on a computed easement plan and submitted to Council for engineering review and acceptance prior to commencement of works onsite and a condition that all necessary easements are created prior to the commencement of the commercial activity.</p>	XX

ENGINEERING		COMMENTS	Condition	
EARTHWORKS	Extent	Description	Earthworks are required to create a level building area and a level car parking and manoeuvring area as well as create bunds for stormwater.	
		Cut /Fill Volume (m ³)	Topsoil: Cut 4,100, Fill: 1,600 Subsoil: Cut 6,500, Fill: 4,400 Imported: Fill: 2,000	
		Total Volume (m ³)	Cut: 10,600, Fill: 8,000	
		Area Exposed (m ²)	1.3 Ha	
		Max Height Cut/Fill (m)	Cut: 5.0m, Fill: 1.0m	
	Prox. to Boundary	Earthworks are shown on Lot 4 DP 540788 for the formation of the car park area and stormwater bund and Lot 3 DP 540788 to create a level building area. Minor earthworks are shown on Lot 2 DP 540788 for the formation of the pedestrian and service access way. I am satisfied that the earthworks can be undertaken wholly within the applicants' Lots, and I make no recommendations in this regard.		
	Prox. to Water	Mill Creek bisects the site. The site is within the Lake Hayes Catchment.		
	Stability	Geosolve Limited Titled: <i>Geotechnical Memo for Resource Consent: The Hayburn venue and Carparking</i> , Ref 150098.10-rev1, Dated: 6 June 2023 Which advises that this memo shall be read in conjunction with the previous Geosolve report: Titled: <i>Geotechnical Report for Resource Consent</i> , Ref: 150098.07, Dated: June 2020)		

	Report comment	The report presents specific recommendations for the Hayburn event venue (including building location and foundations) and the car parking area (undertaking earthworks, batter slopes and stormwater runoff). I accept the report as evidence that the proposal is geotechnically feasible. I recommend a condition that the earthworks be supervised by a suitably qualified geotechnical professional, in accordance with the report's recommendations.	X
	Rock breaking	Not anticipated.	
	Rock blasting	Not anticipated.	
	Preconstruction survey	Not required.	
	Retaining	Not proposed.	
	Recommendations on cut/batter slopes	As per the recommendation in the Geotechnical Report, including specific recommendations regarding the armouring of the cut off drain.	X
	Fill certification/specific foundation design required	Based on the Geotechnical report shallow foundations are expected and the ground conditions do not provide 'good ground' bearing as per the recommendations of NZS 3640:2011. The plans submitted with the application do not indicate that there will be an area of fill placed within the building footprint. The applicant will need to ensure that the foundations of the building are designed appropriately according to soil conditions. An appropriate condition is recommended.	X
	Engineers supervision	Engineering supervision is required in accordance with the Geosolve report. An appropriate condition is recommended.	X
Site Management	Report reference		
	Specific sedimentation management	I am satisfied that the planner will address these through the Environmental Management Plan (EMP) review. I make no recommendations in this regard.	X
	Specific stormwater management		
	Neighbours	I am satisfied that the earthworks are feasible and that if the recommendations contained within the geotechnical report are followed no adverse effects will result on neighbouring sites.	
	Traffic management	Traffic management will be required.	X
	Revegetation	A condition is recommended requiring earth worked areas to be revegetated prior to occupation of the residential unit.	X

SERVICES	Existing Services	<p>The servicing to the site has been considered as part of previous consents on this site. The site has access to Council's reticulated wastewater and water supply as well as power and telecommunications. The applicant proposes to utilise on-site stormwater disposal.</p> <p>The use of the commercial activity relies on infrastructure on neighbouring lots and RM200791 conditions legal instruments to be registered on the title. I recommend a similar condition in this regards.</p> <p>As part to the water supply, firefighting and wastewater servicing assessment the Applicant has provided the following report and drawings:</p> <ul style="list-style-type: none"> - CKL Limited: <i>Haybarn Venue: Water and wastewater Assessment, Ayrburn Precinct</i>, Reference: A20254, Dated: 09/06/2023 - Engineering Drawings Package by Paterson Pitts Group, Titled: '<i>Ayrburn Precinct Ltd: Hayburn Venue – Resource Consent Drawings</i>', Reference: Q6388, Dated: 8/12/2023 	
	Potable	<p>A 315 OD PE100 PN 12.5 water main has been installed along Ayr Avenue to service the development. This watermain is connected to the existing DN 225 mPVC watermain in the Arrowtown-Lake Hayes Road. A 180 OD PE100 PN12.5 watermain branches off from the existing 315 OD watermain to service Ayrburn Domain. The plans provided show the reticulation extending from the DN180 pipe to the Haybarn venue.</p> <p>The demand (including irrigation) has been determined based of a first principles approach due to the nature of the activity. Within the CKL report referenced previously, the applicant has provided a running total for all activities within the Ayrburn Development. This total, including this development, is less than what was used to confirm the capacity of the QLDC water network in the modelling undertaken by QLDCs modelling consultants (Mott MacDonald). CKLs own modelling also confirms sufficient supply is available. I am therefore satisfied that there is suitable and reliable water supply available to service this activity.</p> <p>I recommend a condition that the detailed design of the extension of the reticulation proposed be provided to Council for Engineering Acceptance prior to the commencement of works. I recommend a condition that the reticulation be installed in accordance with the Accepted plans prior to 224c certification.</p>	XX
	Water	<p>Within the CLK report it confirms that the Hayburn venue is proposed to be sprinklered (sprinkler system: 1500 l/min @ 400 kPa) and that FW2 is achievable within the reticulation.</p> <p>The plans provided with the application show that the location of three hydrants in close proximity of the existing homestead and the new venue, within a suitable handstand area in close proximity to each of them. The plans provided show that two hydrants are within 135m of each building.</p> <p>The hydrants closest to the Homestead are already consented, with an additional hydrant on the extended DN180 pipe.</p>	
Fire-fighting			

	<p style="text-align: center;">Stormwater</p>	<p>The applicant has provided a Stormwater Management Plan undertaken by CKL. (Titled: <i>Stormwater Management Plan: The Haybarn Venue</i>, Reference: A20254, Dated: 08/06/2023) and further information provided in a Memo (Titled: <i>Haybarn Section 92 Responses - Stormwater Matters</i>, Reference: A20254, Dated: 10/11/2023).</p> <p>Under previous consents stormwater management has already been implemented in other areas across the four land parcels. Within in this consent the following areas have been considered:</p> <ul style="list-style-type: none"> - Haybarn Venue - Overflow Car Parking Area <p>As part of this consenting process, a peer review of the stormwater management plan (SMP) was undertaken by Morphum Environmental and the applicant has had direct discussions with the Friends of Lake Hayes, which has resulted in several volunteered conditions regarding stormwater quality.</p> <p><i>Quantity</i></p> <p>The applicant has provided the resultant flow rates for the different storm events, which show the post development flow rate to be less that the pre-development flow rate.</p> <p><i>Soakage Tests</i></p> <p>Several soakage tests have been undertaken around car park 2 and 3 area with varying results between 52mm/hr to 375mm/hr. Due to these variations it is recommended that additional soakage tests proposed to at the location of the bioretention devices and swales during the detailed design phase. An appropriate condition is recommended in this regard.</p> <p><i>Haybarn Venue</i></p> <p>With the exception of the existing haybarn, the areas of the Haybarn venue are currently grassed. The surface flows discharge to the proposed network via the Car Park 3 swales and the Car Park 3 bioretention device, where the flows combine with other flows in the catchment and are conveyed through the culvert under Ayr Avenue, and continue via existing overland flow paths.</p> <p>The runoff from the bus bay will discharge down the northern batter and combine with the existing swale and combine with other flows in the catchment along the norther side of Ayrburn Avenue Road with the final section of the swale including a bioretention media.</p> <p>As described in the "Stormwater Section 92 Response – Stormwater Matters Memo" on the south of Ayr Avenue the area includes a low bund which will provide attenuation during rainfall events from the runoff from the Venue and the bus bay. Along the bund includes a cut out weir which is proposed to regulate flows for different duration events, after which in certain events flows discharge to Mill Creek and ultimately Lake Hayes.</p> <p><i>Overflow Car Parking Area / Western Carpark</i></p> <p>The overflow parking area is on the opposite side of Mill Creek from the Haybarn Venue and the area is mostly grassed. It is proposed that the surface flows from this area will discharge to a proposed treatment swale along the southern edge of Ayr Ave and to a bioretention device (vegetated swales or rain gardens) prior to discharge to Mill Creek. Both the swale and the bioretention device have been designed to for soakage of the Water Quality Flow (WQF) only, with the excess flows being carried on to Mill Creek. This bioretention device is located outside of the flood plain.</p>	<p>X</p>
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Stormwater	<p>b) The grassed treatment swale and planted detention pond shall be monitored yearly to ensure that sediment levels are <125mm and the device shall be reinstated to the surveyed as-built levels. A record shall be kept by the consent holder and sent to Friends of Lake Hayes Society Incorporated and the Consent Authority on request. If there is a positive height variance of >125mm the device shall be reinstated to the surveyed as-built levels. After the first 3 years of yearly monitoring, if the devices are <<100mm above design levels, the period may be extended to 3 yearly monitoring.</p> <p>2. Monitoring of soakage in detention pond</p> <p>a) The design performance of the planted treatment detention ponds is based on a soakage rate to ground of >125mm/hour. Within two months of installation of the detention ponds being completed, an as-built soakage test shall be undertaken to ensure that the design soakage rate of >125mm/hour is achieved. Should adequate soakage not be achieved the devices shall be reconstructed to achieve the designed soakage rate.</p> <p>b) The detention ponds shall be monitored yearly to ensure they maintain a soakage rate of >125mm/hour. A record shall be kept by the consent holder and sent to Friends of Lake Hayes Society Incorporated and the Consent Authority on request. If the monitored soakage rate is <125mm/hour the devices shall be remediated to achieve a soakage rate of >125mm/hour. After the first 3 years of annual monitoring, if the devices achieve soakage rates of <>150mm/hour of soakage every year, the period may be extended to 3 yearly monitoring.</p> <p>3. Monitoring and maintenance of planting within planted detention pond</p> <p>a) To ensure that any stormwater-related plantings survive and carry out their treatment function, the consent holder must replace any plant that has died or become diseased >5%. Replacement planting shall be carried out in the planting season following their loss. The replacement plants shall be of the same species, grade and size as per the approved landscape drawings.</p> <p>4. Fertiliser</p> <p>a) The use of fertiliser containing nitrogen or phosphorous shall be prohibited within the Site apart from the initial establishment of hydroseed grass areas and the initial establishment of plants. Organic fertiliser such as compost, manure or seaweed shall be permitted. For plant establishment, fertiliser shall be limited to 1 x 10g slow-release tablet placed below the base of the rootball.</p>	
Power & Telecoms	<p>Condition 25(g) of RM200791 requires the lot owner to be responsible for the ongoing provision and maintenance of a cellular, satellite or wifi connection for telecommunication services until such time that underground services have been provided by a telecommunications network supplier. <i>Note: This condition only applies if Condition 24.h)i. has not been complied with.</i> Where 24.h)i) is in underground telecommunication services have been provided.</p> <p>Within the application, written confirmation of the telecommunication provider has not been provide, I recommend a supporting condition in this regard.</p>	X

<p>NATURAL HAZARDS</p>	<p>Hazards on or near the site</p>	<p>I am satisfied that the hazards for the Haybarn Venue were adequately assessed as part of RM200791. This assessment relied on a hazards assessment undertaken by Geosolve and it concluded:</p> <p><i>“I accept the report [by Geosolve] that the site is free of natural hazards but is not suitable for foundation bearing without improvement or engineer designed foundations.”</i></p> <p>In addition to this, regarding this consent specifically, Geosolve notes the following (in the report referenced in the Earthworks section above):</p> <ul style="list-style-type: none"> - for the Haybarn: that the building position set back by no less than 8m ensures results in no special provisions are required regarding slope stability. - for the car park: the slope situated at the immediate north of the car park has schist bedrock exposures, but these are not considered capable of providing a rock fall risk. <p>These are discussed in the Earthworks Section above and I make no further recommendations in this regards. The Haybarn Venue and the Western Carpark are on the elevated terrace and are therefore elevated significantly above the flood plain.</p> <p>As part of this development a flood model report was completed by Fluent Solutions titled ‘Waterfall Park Hotel Development – Flood Assessment, Management Proposal, and Effects Assessment’ Job No. Q000391 dated April 2018. This has been reviewed as part of previous consents, including RM180584 where in the Engineering Assessment:</p> <p><i>“Overall I am accept the findings of the Fluent Solutions ‘Flood Assessment, Management Proposal, and Effects Assessment’ and I am satisfied that based on the proposed comprehensive flood management strategy the majority of the development will be above the 100yr flood level with appropriate freeboard. Where commonly utilised outdoor and parking areas in the vicinity of Ayrburn Domain fall below the required level of protection this is accepted on the basis of a specific management plan to monitor creek levels and if required close off areas to the public.”</i></p> <p>As the above refers to areas already consented and the Haybarn Venue and Western CarPark are not within the 100 year flood plain, I am satisfied that the specific management plan to monitor creek levels is not a requirement of this consent.</p> <p>As part of this consent includes the construction of a low bund, and therefore altering the flood plain the applicant provided in the RFI response by CKL (Titled: <i>Haybarn Section 92 Responses -Stormwater Matters</i>, Reference: A20254, Dated: 110/11/2023) Appendix A: CKL Hydraulic Flood Model Summary, with the 100 year shown below and as can be seen the subject site is outside of this:</p>	<p>X</p>
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PROJECT INFORMATION	Developers Engineering Representative	Required.	X
	Notice of commencement	Not required.	
	Traffic Management Plan	Required.	X
	Design Certificates	Required.	X
	Completion Certificates	Required.	X
	As builds	Required.	X
TITLE	Covenants/consent notices	<p>The decision from RM200791 for the building platform has several engineering related conditions on it in regards to the following:</p> <ul style="list-style-type: none"> - Buildings located within the Building platform - Easements and required RoW - Specific Engineering design foundations - Private ownership of the wastewater pump stations - Future connection to the Waterfall Park wastewater pump station - Stormwater disposal - Firefighting - Telecommunication <p>These have been discussed in the relevant sections above and conditioned accordingly. I make no further recommendations in this regards.</p> <p>Consent Notice 11494440.1 has conditions in regards to hazards, services (wastewater, stormwater, water supply, legal access, power and telecommunications). I am satisfied that the requirements have been addressed in this application and related recommended conditions.</p> <p>Covenant 11737981.1: Council is a party to the covenant which is in regards to water connection to Council's reticulation. I am satisfied that this has been addressed in this report and I make no recommendations in this regards.</p> <p>Covenant 11940062.5: Council is a party to the covenant which is in regards to contaminant soils and areas of uncertified fill. These areas are not related to the location of the Hayburn Venue nor the car park. I make no recommendations in this regards.</p>	

1.0 **RECOMMENDED CONDITIONS**

It is recommended that the following conditions are included in the consent decision:

General

1. All engineering works, shall be carried out in accordance with the Queenstown Lakes District Council's policies and standards, being QLDC's Land Development and Subdivision Code of Practice adopted on 8th October 2020 and subsequent amendments to that document up to the date of issue of any resource consent.

Note: The current standards are available on Council's website via the following link:
<https://www.qldc.govt.nz/>

To be completed prior to the commencement of any works on-site

2. The consent holder shall implement the following traffic management measures when undertaking any works within or adjacent to the road network:
 - Suitable site warning signage shall be in place on the road in both directions from the site entrance.
 - Safe sight distances and passing provisions shall be maintained at all times.
 - The provision for safe passage shall be provided for pedestrians and cyclists at all times.
3. At least 7 days prior to commencing excavations, the consent holder shall provide the Manager of Resource Management Engineering at Council with the name of a suitably qualified geo-professional as defined in Section 1.7 of QLDC's Land Development and Subdivision Code of Practice who is familiar with the Geosolve Reports: *Geotechnical Memo for Resource Consent: The Hayburn venue and Carparking*, Ref 150098.10-rev1, Dated: 6 June 2023 and *Geotechnical Report for Resource Consent*, Ref: 150098.07, Dated: June 2020) and who shall supervise the excavation/earthworks/fill procedures and ensure compliance with the recommendations of this report. This engineer shall continually assess the condition of the excavation and shall be responsible for ensuring that temporary retaining is installed wherever necessary to avoid any potential erosion or instability.
4. The owner of the land being developed shall provide a letter to the Manager of Resource Management Engineering at Council advising who their representative is for the design and execution of the engineering works and construction works required in association with this development and shall confirm that these representatives will be responsible for all aspects of the works covered under Sections 1.7 & 1.8 of QLDC's Land Development and Subdivision Code of Practice, in relation to this development.
5. Prior to commencing works on the site, with the exception of earthworks with controls approved through the Environmental Management Plan (EMP) process within this consent, the consent holder shall obtain 'Engineering Review and Acceptance' from the Queenstown Lakes District Council for development works to be undertaken and information requirements specified below. The application shall include all development items listed below unless a 'partial' review approach has been approved in writing by the Manager of Resource Management Engineering at Council. The 'Engineering Review and Acceptance' application(s) shall be submitted to the Manager of Resource Management Engineering at Council for review, prior to acceptance being issued. At Council's discretion, specific designs may be subject to a Peer Review, organised by the Council at the applicant's cost. The 'Engineering Review and Acceptance' application(s) shall include copies of all specifications, calculations, design plans and Schedule 1A design certificates as is considered by Council to be both necessary and adequate, in accordance with Condition (1), to detail the following requirements:
 - a) The provision of a water supply to the 'Hayburn Venue' in terms of Council's standards and connection policy, and in general accordance with the report by CKL Limited: Hayburn Venue: Water and wastewater Assessment, Ayrburn Precinct, Reference: A20254, Dated: 09/06/2023 and the Engineering Drawings Package by Paterson Pitts Group, Titled: 'Ayrburn Precinct Ltd: Hayburn Venue – Resource Consent Drawings', Reference: Q6388, Dated: 8/12/2023. This shall include a Council approved isolation valve and an approved

water meter as detailed in QLDC Water Meter Policy (Appendix J), dated 2017. The costs of the connection shall be borne by the consent holder.

- b) The provision of a foul sewer connection to from the 'Haybarn Venue' in terms of Council's standards and connection policy, and in general accordance with the report by CKL Limited: Haybarn Venue: Water and wastewater Assessment, Ayrburn Precinct, Reference: A20254, Dated: 09/06/2023 and the Engineering Drawings Package by Paterson Pitts Group, Titled: 'Ayrburn Precinct Ltd: Hayburn Venue – Resource Consent Drawings', Reference: Q6388, Dated:8/12/2023.The costs of the connection shall be borne by the consent holder.
- c) Preliminary details of the private onsite Haybarn wastewater pump station with 9hrs emergency storage that will service the development site and pump into the internal development reticulation and into Council reticulation. Additional details shall be provided that demonstrate the wastewater reticulation can be reconfigured to allow the Haybarn pump station to pump to Waterfall Park pump station in the future. The details shall include evidence that sucker trucks can easily and readily access and service the pump station if required.
- d) The provision of a stormwater collection and disposal system which shall provide both primary and secondary protection for future development within the development, in accordance with Council's standards and the reports produced by CKL Limited (Titled: *Stormwater Management Plan: The Haybarn Venue*, Reference: A20254, Dated: 08/06/2023 and Titled: *Haybarn Section 92 Responses - Stormwater Matters*, Reference: A20254, Dated: 10/11/2023). The proposed stormwater system shall be designed by a suitably qualified professional as defined in Section 1.7 of QLDC's Land Development and Subdivision Code of Practice and be subject to the review of Council prior to implementation. This shall include:
 - (i) A reticulated primary system to collect and dispose of stormwater from all potential impervious areas proposed as part of this consent to the stormwater management and treatment system consisting of swales and bioretention devices, into approved outfalls discharging to Mill Creek. ;
 - I. Percolation testing shall be undertaken at the individual bioretention device and swales locations to confirm soakage. A copy of the test results shall be provided and shall be in general accordance with the "Acceptable Solutions and Verification Methods for New Zealand Building Code Clause: E1 Surface Water".
 - II. The final design and sizing of each bioretention device and swales shall be based on the individual percolation test results prior to installation of the individual soak pit infrastructure
 - (ii) A secondary protection system consisting of secondary flow paths to cater for the 1% AEP storm event and/or setting of appropriate building floor levels to ensure that there is no inundation of any buildable areas within the lots, and no increase in run-off onto land beyond the site from the pre-development situation.
 - (iii) A copy of the full stormwater model and report outlining the parameters used shall be provided.
- e) Provision of a suitable firefighting water supply and hydrants with adequate pressure and flow to service the development and accompanying report from a suitably qualified professional demonstrating compliance with the NZ Fire Service Code of Practice for Firefighting Water Supplies 2008 (SNZ PAS 4509:2008). Any buildings on the lots shall either be fitted with a sprinkler system and/or be designed with an appropriate fire cell size to meet the requirements of SNZ PAS 4509 for the relevant water supply classification prior to the occupation of any buildings.

This shall include hydrant testing carried out during the peak period of an average day to confirm that there are sufficient hydrants with adequate pressure and flow to service the development with a Class FW2 fire risk in accordance with Appendix G of SNZ PAS 4509:2008 NZ Fire Service Code of Practice for Firefighting Water Supplies. Any lesser risk must be approved in writing by Fire & Emergency NZ, Queenstown Office. The testing shall be carried out by a suitably qualified and experienced person (SQEP) as defined in section

1.8 of QLDC's Land Development and Subdivision Code of Practice and evidence of the SQEP suitability to undertake or oversee such testing shall be submitted with the hydrant testing results. The results shall be submitted to Council and all related costs shall be borne by the consent holder.

- f) The provision of Design Certificates for all engineering works associated with this development submitted by a suitably qualified design professional (for clarification this shall include, but not limited to, all Roads, Water, Wastewater and Stormwater Infrastructure). The certificates shall be in the format of the QLDC's Land Development and Subdivision Code of Practice Schedule 1A Certificate.
- g) The provision of a Design Certificate submitted by a suitably qualified design professional for the wastewater pump station and wastewater reticulation. The certificates shall be in the format of Engineering NZ Producer Statement PS1 or the QLDC's Land Development and Subdivision Code of Practice Schedule 1A Certificate.
- h) The provision of car parking, manoeuvring areas and access in accordance with Council Standards and the plans provided by Paterson Pitts Group, Titled: '*Ayrburn Precinct Ltd: Hayburn Venue – Resource Consent Drawings*', Reference: Q6388, Dated:8/12/2023. This shall include:
 - (i) The provision of an access way from Ayr Avenue to the Overflow Carpark, with the first 6m being sealed as a minimum.
 - (ii) The provision of all vehicle manoeuvring and car parking areas for the '*Overflow Carpark*' to Council's standards. Provision shall be made for stormwater disposal.
 - (iii) The provision of a sealed, one-way exit to the existing Car Park 3.
 - (iv) Parking spaces of Car Park 1, 2 and 3 shall be clearly and permanently marked out.
 - (v) The provision of an access way from the existing Homestead access to new commercial building.
 - (vi) The provision of all vehicle manoeuvring and car parking areas accessed from the Homestead driveway. This shall include a sealed mobility car park and suitable surface for the accessway from the parking space to the commercial building.
 - (vii) The provision of the pedestrian accesses.
 - (viii) The provision of bus stops.
- i) The provision of a Computed Easement Plan and Easement Instrument showing all necessary easements over adjacent lands required to legally service the Lot 3 DP 540788 for where the access and services to the site is reliant on neighbouring lots (this includes, but not limited to roads, water, wastewater and stormwater).

To be monitored throughout earthworks

- 6. The earthworks and batter slopes shall be undertaken in accordance with the recommendations of the reports by Geosolve (including the provision of necessary cut off drains):
 - a. Titled: *Geotechnical Memo for Resource Consent: The Hayburn venue and Carparking*, Ref 150098.10-rev1, Dated: 6 June 2023
 - b. Titled: *Geotechnical Report for Resource Consent*, Ref: 150098.07, Dated: June 2020).
- 7. The consent holder shall implement suitable measures to prevent deposition of any debris on surrounding roads by vehicles moving to and from the site. In the event that any material is deposited on any roads, the consent holder shall take immediate action, at his/her expense, to clean the roads. The loading and stockpiling of earth and other materials shall be confined to the subject site.

8. No earthworks, temporary or permanent, are to breach the boundaries of the site (excluding internal boundaries between Lots 1, 2, 3, 4 DP 540788).

On completion of earthworks and prior to commencement of the commercial activity

9. On completion of earthworks within the building footprint and prior to the construction of the commercial building, the consent holder shall ensure that either:
- a) Specific Engineering Design (SED) of all building foundations are designed and constructed for the "Haybarn Venue" in accordance with the recommendations for the geotechnical memo by Geosolve (Titled "Geotechnical Memo for Resource Consent: The Hayburn venue and Carparking, Ref 150098.10-rev1, Dated: 6 June 2023.
Or
 - b) Ground improvements endorsed by a suitably qualified geo-professional can otherwise confirm the presence of 'good ground'. In the event that 'good ground' can be established then standard NZS3604 building foundation solutions may be utilised instead of SED
10. All necessary easements shall be created prior to the commencement of the commercial activity. The following requirements shall be satisfied in conjunction with this condition:
- a) Where the development is reliant on access to the site via neighbouring properties, the consent holder shall demonstrate that all necessary Right of Way easements have been created to legally provide for this. This shall include any pedestrian or vehicle access, parking and manoeuvring areas associated with this development that are utilised by staff or visitors to the site (including coaches or service vehicles).
 - b) A Licensed professional shall prepare all necessary documentation to enable the easements to be lodged and registered with Land Information New Zealand.
 - c) The final wording of the easement instruments shall be reviewed and approved by Council's solicitors prior to registration. At Council's election either:
 - (i) An additional encumbrance / other legal instrument deemed to be appropriate by Council shall be registered to ensure that the easement cannot be varied or cancelled without Council's approval; or
 - (ii) The easement instrument shall include the following acknowledgement:

The Grantor and Grantee acknowledge and agree that this instrument may not be surrendered or varied without consent from Queenstown Lakes District Council (or any replacement local authority). The Grantor and Grantee must obtain written consent from Queenstown Lakes District Council (or any replacement local authority) before surrendering or varying this instrument. This clause is for the benefit of, and is enforceable by, Queenstown Lakes District Council (or any replacement local authority) pursuant to section 12 of the Contract and Commercial Law Act 2017
11. On completion of the earthworks, and prior to commencement of the commercial activity, the consent holder shall complete the following:
- a) The submission of 'as-built' plans and information required to detail all engineering works completed in relation to or in association with this subdivision/development at the consent holder's cost. This information shall be formatted in accordance with Council's 'as-built' standards and shall include all Roads (including rights of way and access lots), Water, Wastewater and Stormwater reticulation (including private laterals and toby positions). This shall include:
 - b) Within two months of installation being completed, the grassed treatment swale and planted detention pond shall be surveyed, using a licenced surveyor, and an as-built plan created, and a record kept by the consent holder and lodged with the consent authority. This plan shall show as-built levels at the invert or base of all devices. A survey reading shall be taken every 2 linear meters for swales and every 1m² for the pond.
 - c) Within two months of installation of the detention ponds being completed, an as-built soakage test shall be undertaken to ensure that the design soakage rate of >125mm/hour is achieved.

Should adequate soakage not be achieved the devices shall be reconstructed to achieve the designed soakage rate. The design performance of the planted treatment detention ponds is based on a soakage rate to ground of >125mm/hour.

- d) The completion and implementation of all reviewed and accepted works detailed in Condition (5) above. All infrastructure and parking spaces installed under this consent and RM180584 (as varied by RM190278 and RM210591 and RM211193) which the proposed buildings are reliant upon, shall be completed and signed off by a QLDC Subdivision Inspector.
- e) An Elster PSM V100 or Sensus 620 water meter shall be installed on to the Acuflo manifold for the commercial building as per condition (5a) above, and evidence of supply shall be provided to Council's Subdivision Inspector.
- f) The consent holder shall obtain a Code of Compliance Certificate under a Building Consent for any retaining walls constructed as part of this consent which exceed 1.5m in height or are subject to additional surcharge loads as set out in Schedule 1 of the Building Act.
- g) Any power supply connections to the commercial building shall be underground from existing reticulation and in accordance with any requirements/standards of the network provider's requirements.
- h) Any telecommunications connections to the commercial building shall:
 - (i) be underground from existing reticulation and in accordance with any requirements/standards of the network provider's requirements.
 - Or
 - (ii) The consent holder shall demonstrate that telecommunication services can be provided by way of a cellular, satellite or wifi connection and maintained at the sole responsibility of the consent holder until such time as underground services have been provided in accordance with (i) above.
- i) The applicant's solicitor shall provide, for Council's approval, a land covenant in gross document or alternative effective legal instrument acceptable to Council to be registered on the Computer Freehold Registers for Lot 3 DP 540788 being provided with a pressure foul sewer connection. This legal document shall include provisions to ensure:
 - (i) Individual lot-owners are aware of installation requirements for on-lot pressure sewer system components to be retained in private ownership i.e. pipes, pumping unit and chamber, control/alarm panel, and associated electrical components;
 - (ii) Individual lot-owners are aware of ownership responsibilities, operational performance characteristics and maintenance requirements associated with the private pressure foul sewer system components, including compliance with all relevant legislation and Council Bylaws, Policies & Standards applicable at the time a dwelling is constructed on the lot;

The applicant shall liaise with the Subdivision Planner and Manager for Resource Management Engineering at Council in respect of the above. All costs, including costs that relate to the checking of the document by Council's solicitors and registration of the covenant or alternative legal document, shall be borne by the applicant.
- j) The submission of Completion Certificates from both the Contractor and Accepted Engineer for all infrastructure engineering works completed in relation to or in association with this development (for clarification this shall include all Roads, Water, Wastewater and Stormwater Infrastructure). The certificates shall be in the format of the QLDC's Land Development and Subdivision Code of Practice Schedule 1B and 1C Certificate.
- k) The submission of Completion Certificates from both the Approved Contractor and Approved Certifier for the Haybarn wastewater pump station. The certificates shall be in the format of Engineering NZ Producer Statements, or the QLDC's Land Development and Subdivision Code of Practice Schedule 1B and 1C Certificate.
- l) All earthworked areas shall be top-soiled and revegetated or otherwise permanently stabilised.

- m) The consent holder shall remedy any damage to all existing road surfaces and berms that result from work carried out for this consent.

Ongoing Conditions/Covenants

12. In the event that the Engineering Acceptance issued under Condition (5) contains ongoing conditions or requirements associated with the installation, ownership, monitoring and/or maintenance of any infrastructure subject to Engineering Acceptance, then at Council's discretion, a Covenant in Gross (or other alternative legal instrument acceptable to Council) shall be registered on the relevant Records of Title detailing these requirements for the lot owner(s). The final form and wording of the document shall be checked and approved by Council's solicitors at the consent holder's expense prior to registration to ensure that all of the Council's interests and liabilities are adequately protected. The applicant shall liaise with the Subdivision Officer and/or Manager of Resource Management Engineering at Council in respect of the above. All costs, including costs that relate to the checking of the legal instrument by Council's solicitors and registration of the document, shall be borne by the applicant.

[Note: This condition is intended to provide for the imposition of a legal instrument for the performance of any ongoing requirements associated with the ownership, monitoring and maintenance of any infrastructure within this development that have arisen through the detailed engineering design and acceptance process, to avoid the need for a consent variation pursuant to s.127 of the Resource Management Act].

13. On completion of earthworks, a covenant pursuant to Section 108(2)(d) of the Resource Management Act 1991 shall be registered on the Record of Title of the subject site providing for the performance of any ongoing requirements for protection of secondary flow paths or minimum floor levels for buildings, where deemed necessary by Council to satisfy Condition 5(c)(ii) above. The final wording of the instrument shall be checked and approved by the Council's solicitors at the consent holder's expense prior to registration to ensure that all of the Council's interests and liabilities are adequately protected.
14. A covenant shall be registered on the Lots 1, 2, 3, 4 DP 540788 alerting that the Right of Way, Right to Park and services easements in favour of Lot 3 DP 540788 cannot be varied or cancelled without Council approval.
15. At such a time that Waterfall Park Pump Station is operational and vested to Council, within a period of no more than three months from the vesting of the pump station, the consent holder shall make a permanent connection to the reticulated network within Ayr Avenue through the use of the Waterfall Park Pump Station.
16. The lot owner is responsible for the ongoing provision and maintenance of a cellular, satellite or wifi connection for telecommunication services until such time that underground services have been provided by a telecommunications network supplier. Note: This condition only applies if Condition 10(i)(i) has not been complied with
17. A covenant pursuant to Section 108(2)(d) of the Resource Management Act 1991 shall be registered on the Computer Freehold Register for Lots 1, 2, 3, 4 DP 540788 providing for the performance of the stormwater treatment of the following condition on an ongoing basis:
- a) The grassed treatment swale and planted detention pond shall be monitored yearly to ensure that sediment levels are <125mm the device shall be reinstated to the surveyed as-built levels. A record shall be kept by the consent holder and sent to Friends of Lake Hayes Society Incorporated and the Consent Authority on request. If there is a positive height variance of >125mm the device shall be reinstated to the surveyed as-built levels. After the first 3 years of yearly monitoring, if the devices are if the devices are <100mm m above design levels, the period may be extended to 3 yearly monitoring.
 - b) The detention ponds shall be monitored yearly to ensure they maintain a soakage rate of >125mm/hour. A record shall be kept by the consent holder and sent to Friends of Lake Hayes Society Incorporated and the Consent Authority on request. If the monitored soakage rate is <125mm/hour the devices shall be remediated to achieve a soakage rate of >125mm/hour. After the first 3 years of annual monitoring, if the devices achieve soakage rates of >150mm/hour of soakage every year, the period may be extended to 3 yearly monitoring.

- c) To ensure that any stormwater-related plantings survive and carry out their treatment function, the consent holder must replace any plant that has died or become diseased >5%. Replacement planting shall be carried out in the planting season following their loss. The replacement plants shall be of the same species, grade and size as per the approved landscape drawings.
18. A covenant pursuant to Section 108(2)(d) of the Resource Management Act 1991 shall be registered on the Computer Freehold Register for Lots 1, 2, 3, 4 DP 540788 providing for the use of fertilisers within the development of the following condition on an ongoing basis:
- a) The use of fertiliser containing nitrogen or phosphorous shall be prohibited within the Site apart from the initial establishment of hydroseed grass areas and the initial establishment of plants. Organic fertiliser such as compost, manure or seaweed shall be permitted. For plant establishment, fertiliser shall be limited to 1 x 10g slow-release tablet placed below the base of the rootball.

Advice Notes

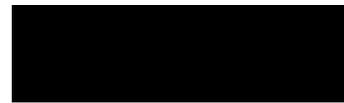
1. The consent holder is advised that any retaining walls, including stacked stone and gabion walls, proposed in this development which exceeds 1.5m in height or walls of any height bearing additional surcharge loads will require Building Consent, as they are not exempt under Schedule 1 of the Building Act 2004.
2. This consent triggers a requirement for Development Contributions, please see the attached information sheet for more details on when a development contribution is triggered and when it is payable. For further information, please contact the DCN Officer at QLDC.
3. An advice note is recommended to inform the consent holder that Council cannot guarantee a firefighting classification above FW3 and therefore fire cell sizes for the proposed buildings will need to be considered during the design stage.

Prepared by:



Catriona Lamont
SNR LAND DEVELOPMENT ENGINEER

Reviewed by:



Steve Hewland
SNR LAND DEVELOPMENT ENGINEER



Planning | Surveying | Engineering | Environmental

Stormwater Management Plan

The Haybarn Venue

339 Arrowtown-Lake Hayes Road, Arrowtown

Document Information

Client	Ayrburn Precinct Ltd
Site Location	339 Arrowtown-Lake Hayes Road, Arrowtown
Legal Description	Lots 2, 3 and 4 DP540788
CKL Reference	A20254
Office of Origin	Auckland

Author	Frances Deamer-Phillips		
Signed		Date	25/05/2023

Reviewed & Authorised By	Bronwyn Rhynd		
Signed		Date	29/05/2023

Revision	Status	Date	Author	Reviewed By	Authorised By
0	DRAFT for project team issue	29/05/2023	FDP	BR	BR
1	For RC	08/06/23	FDP	BR	BR

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1 Introduction

CKL has been engaged by Ayrburn Precinct Ltd to undertake a stormwater management assessment and prepare the Stormwater Management Plan (SMP) for the Haybarn venue and associated accessways and additional parking. The site is located within the existing woodland at 339 Arrowtown-Lake Hayes Road. Pedestrian access is via Ayr Avenue and service access via the existing Homestead driveway.

The purpose of this report is to outline the stormwater management objectives 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: Location and Extent of Works Plan

1.1 Reference Documents

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

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 (COP)
- Queenstown Lakes District Council Proposed District Plan
- Paterson Pitts Group (PPG) Haybarn Venue - Resource Consent Drawings, June 2023
- Landscape Drawings by Winton, June 2023

2 Existing Site Conditions

The wider site currently consists of rural land with a Homestead and other associated historical farm buildings, and recently constructed access ways and carparking. There are existing consents in place that are currently being implemented within Ayrburn Domain and wider Site area, these include the remediation of the existing heritage stone farm buildings and associated landscaping, stormwater management, and carparking.

The proposed works in this SMP is the addition of the Haybarn venue located south of the Homestead and additional parking, located on the opposite side of Ayr Ave, which will be utilised for temporary events at the Dell (consented under RM211193).

Other than the existing haybarn (235m²) which is to be removed, the area of the Haybarn venue is currently grassed and gently slopes to the east with surface flows sheeting east and south over grassed areas prior to discharging to the south. These surface flows discharge downstream through the culvert under Ayr Avenue and continue via existing overland flow paths where (in certain sized events) flows discharge to Mill Creek and ultimately to Lake Hayes.

The proposed additional parking area is located across Mill Creek (opposite side to the Haybarn venue) farther along Ayr Ave at the base of the surrounding hills. This area is mostly grassed with surface flows entering the Ayr Ave swale system which discharges east to Mill Creek.

3 Proposed Development

The proposal for the Haybarn venue includes the addition of;

- 1 new building (887m²) and associated footpaths (578m²), outdoor terraces, and ceremony area
- Service access track and pedestrian access off the existing Homestead driveway (450m²)
- Bus drop off within Ayr Ave (179m²)
- New gravel parking area for temporary events at the Dell (consented under RM211193) along western side of Ayr Ave (3,171m²)
- Additional exit from Ayrburn Domain Carpark 3 (89m²)
- 2 culverts associated with footpath to the Haybarn venue and exit of Ayrburn Domain Carpark 3.
- Bus stop on Ayr Avenue opposite Ayrburn Domain

This application includes an exit, including a culvert or ford to cross the swales, from Carpark 3 to Ayr Ave which will provide better traffic flow within the carpark (the carpark was consented under RM211193 and RM22084). As such this application builds on these existing consented carparks and stormwater systems. A summary of the new impervious areas is provided in Table 1 below.

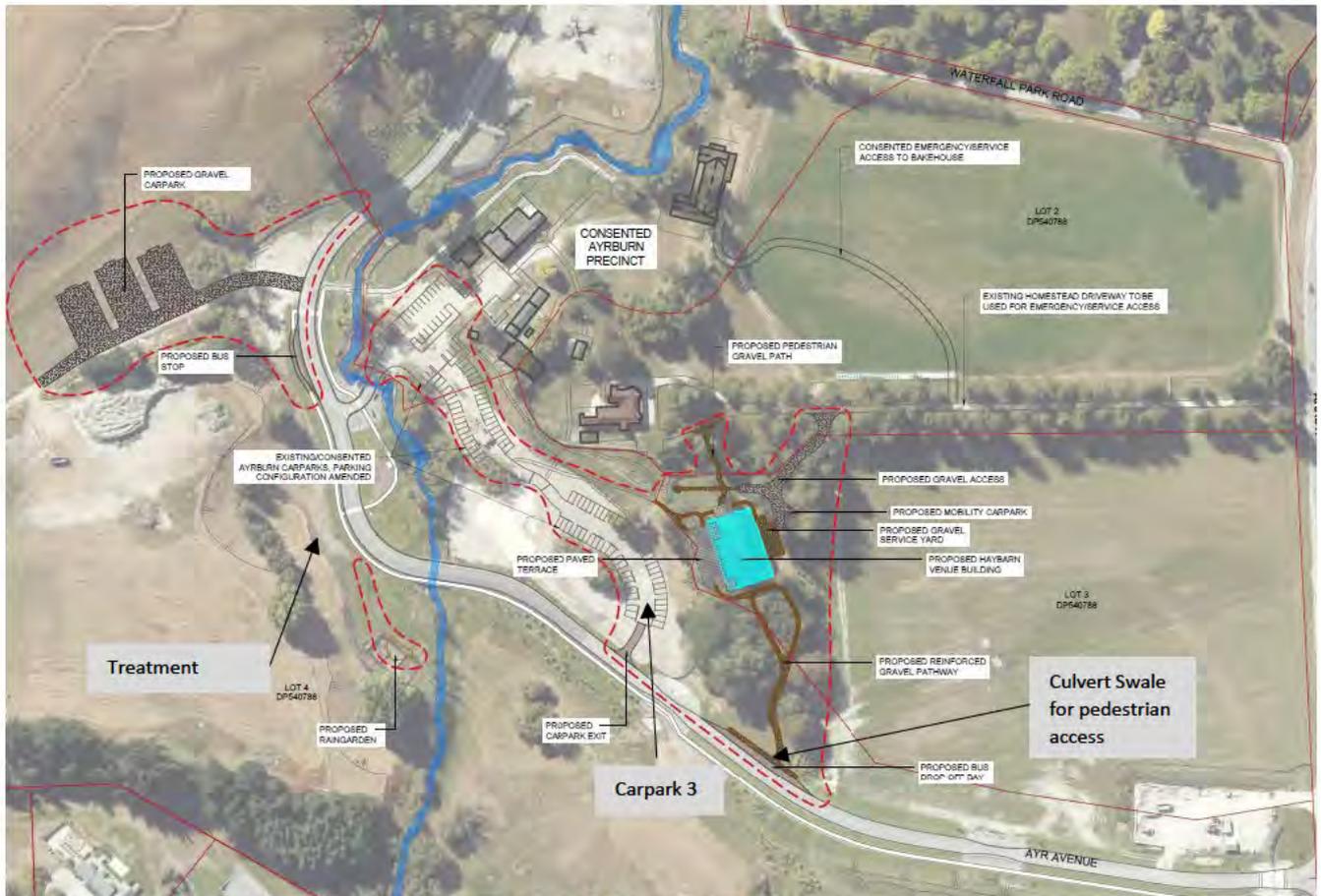


Figure 2: Proposed Site Plan

Figure 2 above demonstrates the areas being converted to venue space and carpark for the purpose of this assessment. The proposed Haybarn roof areas and other impervious areas associated with the building drain to west towards the down the batter to the swale along Ayburn Domain Carpark 3 and ultimately to bioretention device. The footpath from the proposed bus drop off bay to Haybarn will cross the swale from outlet of the proposed frost ponds and a culvert is proposed to convey flows under the footpath.

The proposed western carpark will discharge to a proposed treatment swale along the southern edge of Ayr Ave and to a bioretention device prior to discharge to Mill Creek. Grasslands within the site are considered sheep and beef farming for the purpose of contaminant loading (described below in Section 8).

Table 1 below provides a summary of coverage areas for both pre- and post-development, for just the additional works proposed in this SMP. There is one additional proposed gravel carpark and bus stop to the west of Ayr Ave. There is additional impervious area associated with Haybarn including the roof of venue, footpaths, service access track and bus bay. The difference between pre and post re-development areas is used to estimate the net change in impervious area for this application only.

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	4,765	100%	0	83%	-5,000	-100%
Roof Area	235	5%	887	15%	+887	+10%
Other Impervious Area	0	0%	4,199	85%	+4,199	+85%
Haybarn Footpath	0	0%	578	12%	+578	+12%
Haybarn Service Access	0	0%	450	9%	+450	+9%
Bus Drop off	0	0%	179	1%	+179	+1%
Western Carpark	0	0%	3,171	63%	+3,171	+63%
Total	5,179	100%	5,179	100%	5,000	100%

4 Stormwater Management Strategy and Objectives

For the site, it is proposed to adopt the stormwater management objectives outlined in the current COP to guide stormwater management within the development area. In addition, there is a District Plan Policy 24.2.4.2 that states:

“Restrict the subdivision development and use of land in the Lake Hayes catchment, unless it can contribute to water quality improvement in the catchment commensurate with the nature, scale and location of the proposal”.

Given the receiving environment for the site is Lake Hayes and lake environments are susceptible to nutrient loading, the focus on improving water quality from the site is on Phosphorus and Nitrogen loading and removing Total Suspended Solids (TSS) as Phosphorus and Nitrogen attach to TSS. Heavy metals are also considered given they are often present 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 carpark areas with particular attention to Phosphorus, Nitrogen and TSS

Hydrological Mitigation

No change in attenuation or detention is required for this site

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 Haybarn venue site discharges downstream as surface runoff to the existing culvert under Ayr Avenue. Runoff follows an overland flow path and ultimately (in large events) discharges to Mill Creek. The western carpark area surface runoff sheet flows to the east to Mill Creek via overland flow paths.

5.2 Proposed stormwater management options assessment

Based on previous projects in Ayrburn Domain the stormwater options have been reviewed and includes the following.

- Swales
- Filter strips
- Raingardens

Each of these options have pros and cons however the best practicable option is to utilise the existing systems as much as possible and ensure that the treatment train approach is adopted to provide the highest level of surface runoff quality prior to discharge.

6 Best Practicable Stormwater Management Option

It has been established through previous projects within Ayrburn Domain that it is critical to have a treatment train approach for gravel/hardstand carparks for the removal of nutrients in order to improve the water quality leaving site and entering Lake Hayes. Given the site's constraints, the best practicable option for stormwater treatment for the western carpark is a swale followed by a bioretention device. The proposed bus stop just south of the western carpark entrance will also get treatment through the existing swale along the eastern side of Ayr Ave as it discharges through a cesspit to the east.

The service access track to the proposed Haybarn venue is not considered to be high contaminate generating due to infrequent use, however, it will be treated by the swale and bioretention device adjacent to Carpark 3. The bus bay will be treated by a bioretention swale prior to culvert under Ayr Ave as it is a small area and site constraints limit the ability of a treatment train approach.

Figure 3 below demonstrates the best practical option for stormwater management.

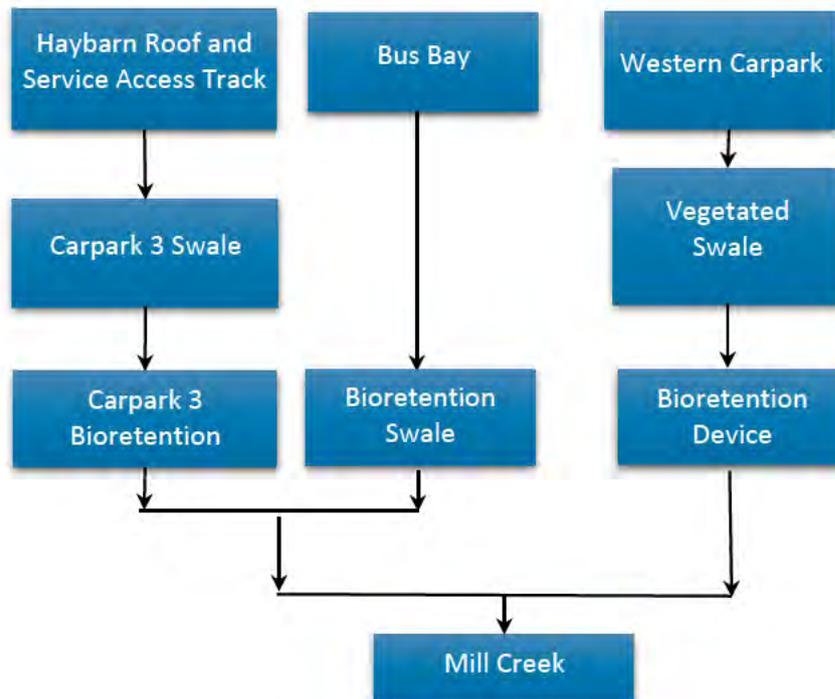


Figure 3: Example diagram of the proposed stormwater management system

PPG's Resource Consent Drawings - 400 series drawings illustrate the stormwater management approach proposed. Section 7 below describes each component of the stormwater management.

From a contaminant management and treatment perspective the roof of the proposed Haybarn venue is powder coated corrugate that limits contaminants generated. The roof will discharge to the proposed network which goes down the batter slope the east and discharges to the swale next to Ayrburn Domain Carpark 3 and ultimately to the bioretention device downstream. The service access track will sheet flow to a sump that will also connect into the proposed network and get treated through swale and bioretention device adjacent to Carpark 3. The swale includes 300mm of topsoil, at the base and sides, and planted. The plants settle out contaminants within the flow and the topsoil will act as a filter. The bioretention device will further clean the runoff from service track through filtration and plant uptake.

Runoff from the bus bay will discharge down the northern batter and into the swale from outlet of ponds. The final section of the swale will include 500mm of bioretention media, planted a small bund at the end to create ponding and a bioretention swale to treat the bus bay. While this does not provide a treatment train approach, the flow from the bus bay is minor and water quality flow will discharge through the media and to ground, larger events will discharge through the culvert and sheet flow across grass which will provide polishing of any runoff that overflows the bioretention device.

The western carpark on Ayr Avenue will discharge to a new vegetated swale followed by a bioretention device that will overtop in larger rainfall events and carry on in a grassed swale to Mill Creek. A vegetated swale is similar to a grassed swale but planted with bigger more robust plants to increase treatment function and aesthetic look. The upstream catchment of the carpark will discharge to a dish drain along the top edge of the carpark so that it does not mix with untreated water from the carparks and ensures the bioretention devices function as designed. This dish drain will discharge to culvert under Ayr Ave to Mill Creek.

The bus stop near the western carpark will discharge to a cesspit to get treated through existing swale on the eastern side of Ayr Ave.

7 Proposed Stormwater Management Components

The following section describes the parameters of each stormwater device proposed.

7.1 Western Gravel Carpark Swale

The western carpark swale will be designed to treat the Water Quality Flow (WQF) rate and convey the 20yr_{cc} ARI storm event for the carpark.

Table 2 below demonstrates the swale sizing and design.

Table 2: Upper Carparks Swale Components

WQF Carpark (L/s)	7.93
20yr Carpark (L/s)	34.43
TWL WQF (m)	0.10
TWL 20yr (m)	0.20
Z-horiz slope	4
Base width (m)	0.6
Swale depth (m) (total)	0.3-0.7
Top width (m)	3.8
Slope (m/m)	0.015
Res time (mins)- WDF	33.3
n - vegetated swale	0.25
Swale Length (m)	165

7.2 Western Bioretention Device

The bioretention device at the end of the swale is proposed to be located south of Ayr Ave around 40m from Mill Creek. Soakage testing was undertaken nearby upstream of the Ayr Ave culvert. Geotech logs¹ indicate similar soil composition in both locations. A relatively high soakage rate of 250mm/hr was found. Assuming 50% reduction factor, the design rate is 125mm/hr. Soakage calculations are supplied in Appendix 2. Therefore, the bioretention devices are sized to discharge the entire treated WQF from all carpark to ground and no underdrains are necessary as there is sufficient soakage capacity within the subsoils. Table 3 demonstrates the sizing for the two bioretention devices.

Table 3: Western Carpark Bioretention Device Sizing

	Existing carpark and Upper Gravel Carpark
Bioretention Base Area	76
WQF (m ³ /hr)	28.56
K (native soil) m/hr	0.125
Soakage volume (m ³)	9.5
Required Storage volume	19.06
Drainage Layer Depth (m)	0.3
Drainage Layer Void Ratio	35%
Drainage Layer Storage Volume (m ³)	7.98
Media Layer Depth (m)	0.5

¹ GeoSolve Excavation Logs Ayrburn Farm, April 15th 2022

Media Layer Void Ratio	30%
Media Layer Storage Volume (m ³)	11.40

The location of the bioretention device is inside the 100yr floodplain as modelled by Fluent Solutions in the flooding report done for Northbrook Waterfall Park Retirement Village² upstream of site along Mill Creek. The bioretention device is located near the red circle. A small bund along the north-eastern side of the bioretention device can be proposed to restrict Mill Creek flood water from entering the device and therefore prolonging the life of the device. The top of the device can include river stones or other non-floating material to ensure it does not wash out in the event Mill Creek flood waters rise over the bund and inundate the bioretention device. Velocities are expected to be low in this area given it at the end of the floodplain.

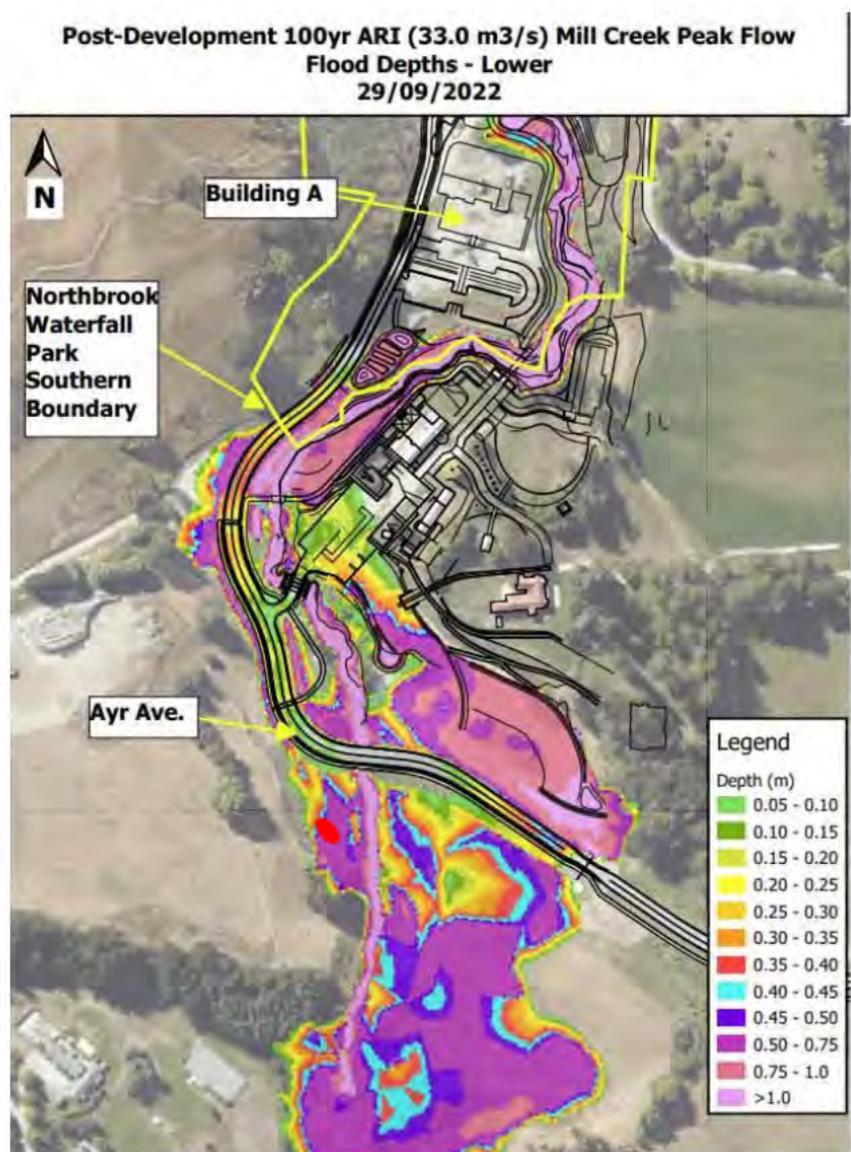


Figure 4: Fluent Solution 100yr Flooding Northbrook Retirement Village

² Northbrook Waterfall Park – Flood Assessment – Resource Consent, Fluent Solutions, October 2022

7.3 Haybarn Venue Bus Bay Bioretention Swale

The swale that discharges runoff from the ponds when the spillway is engaged, will run north of the bus drop off bay (through the footpath culvert), and ultimately discharge to the culvert under Ayr Ave. The bus bay runoff is proposed to discharge to this swale and prior to discharging through the Ayr Ave culvert, will be created with bioretention media and planted to provide additional treatment of the bus bay runoff. This bioretention swale will be designed to treat the Water Quality Flow (WQF) rate and soak to ground.

Table 4 below demonstrates the swale sizing and design.

Table 4: Bus Bay Bioretention Swale Components

Z-horiz slope	3
Base width (m)	3
Swale depth (m) (total)	0.4
Top width (m)	3.4
Bioretention Swale Length (m)	8
Bioretention Media Depth (mm)	500

7.4 Ayrburn Domain Carpark 3 Swale and Bioretention Device

The service access track and roof runoff will discharge to the proposed stormwater network that bubbles up into the swale designed adjacent to the lower Ayrburn Domain carpark (Carpark 3). The swale will provide primary treatment prior to discharging to the Ayrburn Domain bioretention device south of Carpark 3. This bioretention device was designed to be larger than required for Carpark 3 treatment for future development such as this. The required size to treat Carpark 3 is 40m² and it is designed to be 85m². Leaving 42m² capacity for the service access track and roof area. The required size for the service access track would be only 11m². The roof is made of inert materials and therefore does not require treatment, however the raingarden will be large enough to provide some treatment of the roof area.

It should be noted that the contaminant loadings assumptions for the service access track are based on an urban environment loading for nitrogen and phosphorus and roads with 1k vehicle per day for heavy metals and TSS. Given this is only used by service vehicles during events at the Haybarn, the contaminant loading assumed in the assessment is very conservative and is expected to be much lower in reality.

7.5 Culverts

Two culverts will be required to convey overland flow path under the proposed footpath from the bus bay to the Haybarn venue and for the new exit from Ayrburn Domain Carpark 3. The footpath culvert is only engaged when the ponds are full and during a rainfall event, however the catchment area for the ponds is significant and so the culvert is sized for 100yr event for the entire catchment. There is a small catchment that collects clean runoff from Ayrburn Domain which the overland flow path (OLFP) crosses where the exit of Ayrburn will be, therefore a small culvert and ramp for the exit or creating a ford for runoff to cross the exit to convey this OLFP to the culvert under Ayr Ave. The details on both culverts are provided below in Table 5.

Table 5: Culvert Parameters

Parameter	Footpath Culvert	Carpark Exit Culvert
100yrcc Peak Flow	956 L/s	116 L/s
Culvert Size	4m X 1m Box Culvert (embedded 0.2 with riprap	0.6m circular culvert embedded 0.3m to create arch

Both provide sufficient capacity for the 100yrcc peak flow rate. The footpath culvert is significantly larger than required to provide a bridge between the elevated bus bay and toward the Haybarn venue. It is proposed to be embedded and laid with riprap to aesthetically sit in with the swale, if a culvert is used here.

8 Contaminant Loading Assessment

CKL assessed contaminant loading for the proposed western carpark given it is expected to have higher contaminant loading. The assessment looks at existing (prior to 2017 and Ayr Avenue construction) and proposed conditions in order to determine the level of treatment required to improve the water quality of stormwater discharging from site. The existing scenarios was considered to be sheep and beef farming. Given nutrient loading is an issue in Lake Hayes, the focus was on Phosphorus and Nitrogen and TSS, however heavy metals are also considered.

8.1 Total Phosphorus and Total Nitrogen Yields

The Ministry for Environment conducted contaminant loading for different land uses in New Zealand for Total Nitrogen (TN) and Total Phosphorus (TS). Table 6 below demonstrates the contaminant yield for each type of land use.

Table 6: Land use specific yields for Total Nitrogen and Total Phosphorus

Landuse	LCDB4 category	TN specific yield (kg/ha/year)	TP specific yield (kg/ha/year)	Reference-land use type
Urban	Built-up Area (settlement)	8.0	0.8	MfE (2002) -Urban
Exotic	Exotic Forest	2.8	0.35	MfE (2002) -Exotic
Dairy	High Producing Exotic Grassland	25.0	1.00	MfE (2002) -Dairy
Sheep and beef	High Producing Exotic Grassland	9.0	1.98	MfE (2002) -Hill
Lifestyle	High Producing Exotic Grassland	5.2	0.46	MfE (2002) -low intensity pasture
Crop and Orchard	Orchard, Vineyard or Other Perennial Crop	15	No Data	Plant & Food

The existing grass area within the site are considered to be farmed by sheep in light of its current zoning and potential use.

The proposed land use is considered urban given the use of the carpark includes cars, human activity and peripheral landscape areas associated with the Haybarn venue which will release TP and TN. This is considered a conservative assumption given the daily use of the proposed carparks will be significantly lower than an urban road and nutrients in an urban environment will come from other sources besides roads. However, for this assessment the Urban land use is used as a benchmark to achieve a conservative assessment of removal rates of TN and TP.

8.2 Total Suspended Solids and Heavy Metal Yields

Total Suspended Solids (TSS) and heavy metals loading was assessed based on the contaminant yields applied within the Auckland Council's contaminant load model. TPH below stands for Total Petroleum hydrocarbons, not considered here given the low vehicle traffic. The Table 7 below demonstrates TSS and heavy metal yields for different and uses.

Table 7: Auckland Council's Land Use Specific Contaminant Yields

	AREA	Contaminant yield g m-2 year-1			
		TSS	Total zinc	Total copper	TPH
Roofs	galvanised steel unpainted	5	2.24	0.0003	0
	galvanised steel poor paint	5	1.34	0.0003	0
	galvanised steel well painted	5	0.20	0.0003	0
	galvanised steel coated	12	0.28	0.0017	0
	zinc/aluminium surfaced steel	5	0.20	0.0009	0
	zinc/aluminium surfaced steel coated long run and tiles	5	0.02	0.0016	0
	concrete	16	0.02	0.0033	0
Roads	copper	5	0.00	2.1200	0
	other materials	10	0.02	0.0020	0
	<1k vpd	21	0.004	0.0015	0.033
Paved	1k-5k vpd	28	0.026	0.0089	0.201
	5k-20k vpd	53	0.110	0.0369	0.838
	20K-50K	96	0.257	0.0858	1.947
	50k-100k vpd	158	0.471	0.1570	3.564
	>100K vpd	234	0.729	0.2431	5.519
Pervious	Residential paved	32	0.195	0.0360	0
	Industrial paved	22	0.590	0.1070	0
	Commercial paved	32	0.000	0.0294	0
Rural	Urban grasslands and trees	45	0.001	0.0003	0
		92	0.003	0.0006	0
		185	0.006	0.0013	0
	Urban stream channels (length x	6,000	0.210	0.0420	0
	Construction sites	2,500	0.088	0.0180	0
	Slope	5,600	0.196	0.0390	0
		106,0	0.371	0.0740	0
Rural	Exotic production forest	35	0.001	0.0002	0
	Slope	104	0.003	0.0007	0
		208	0.007	0.0015	0
	Stable forest	14	0.000	0.0001	0
	Slope	42	0.001	0.0003	0
		83	0.002	0.0006	0
	Farmed pasture	152	0.005	0.0011	0
	Slope	456	0.016	0.0032	0
		923	0.032	0.0065	0
	Retired pasture	21	0.000	0.0001	0
Slope	63	0.002	0.0004	0	
	125	0.004	0.0009	0	

Based on the above contaminant yields, the existing grassed area TSS yield was assumed to be 152 g/m²/yr, Zinc has 0.005 g/m²/yr and Copper has 0.0011 g/m²/yr, given it would be considered farmed pasture on flatter land.

The carparks were assumed to have a yield of 21 g/m²/yr for TSS, 0.004 g/m²/yr for Zinc, and 0.0015 g/m²/yr for Copper given it is assumed to have less than 1,000 cars per day on average.

8.3 Pre- and Post-Contaminant Yields

8.3.1 Western Gravel Carpark

Using the above assessment for contaminant yields Table 8 and Table 9 below identifies the contaminant loading for the pre- and post-development scenario for the western carpark, which is the area where highest contaminants may be generated in relation to this application.

Table 8: Pre-Development Contaminant Loading Lower Carparks (Farmed)

	Area (m ²)	TP Loading (g/m ² /yr)	Runoff TP (kg/yr)	TN Loading (g/m ² /yr)	Runoff TN (kg/yr)	TSS Loading (g/m ² /yr)	Runoff TSS (kg/yr)	Zinc Loading (g/m ² /yr)	Runoff Zinc (kg/yr)	Copper Loading (g/m ² /yr)	Runoff Copper (kg/yr)
Farmed Grassed Area	3171	0.198	0.19	0.90	0.86	152	144.60	0.005	0.0048	0.0011	0.0010
Sum	3171		0.19		0.86		144.60		0.0048		0.0010

Table 9: Post-Development Contaminant Loading Lower Carparks (untreated)

	Area (m ²)	TP Loading (g/m ² /yr)	Runoff TP (kg/yr)	TN Loading (g/m ² /yr)	Runoff TN (kg/yr)	TSS Loading (g/m ² /yr)	Runoff TSS (kg/yr)	Zinc Loading (g/m ² /yr)	Runoff Zinc (kg/yr)	Copper Loading (g/m ² /yr)	Runoff Copper (kg/yr)
Gravel Carpark Area	3171	0.08	0.23	0.8	2.28	21	59.9	0.004	0.0114	0.0015	0.0043
Sum	3171		0.23		2.28		59.9		0.0114		0.0043

8.4 Contaminant Removal Rates from Treatment Devices

Estimated removal rates of each contaminant for different stormwater management practices are assumed using NZTA's rates³. NZTA removal rates are considered best practice for wider NZ. The removal rates are in line with the range of removal rates used by Christchurch City Council. Figure 5 below shows NZTA's removal rates for various stormwater practices.

³ Stormwater Treatment Standard for State Highway Infrastructure, NZTA, May 2010

Practice	Removal rates (%)				
	TSS	Nitrogen	Phosphorus	Zinc	Copper
Swales	70	20	30	75	60
Filter Strips	80	20	20	75	60
Sand Filters	80	35	45	90	90
Rain Gardens (normal)	90	40	60	90	90
Rain Gardens (w/anaerobic zone)	90	50	80		
Infiltration Practices	80	30	60	80	70
Wet Ponds	75	25	40	50	40
Wetlands	90	40	50	80	80
Oil Water Separators	15	0	5	5	5

Figure 5: NZTA Removal Rates for Various Stormwater Devices

The removal rates are relatively low for Phosphorus and Nitrogen in some stormwater treatment devices and given these nutrients are of particular interest in the catchment, a treatment train approach is suggested as the best practical option to treat runoff from the site.

Phosphorus and Nitrogen are removed from stormwater within swales/filter strips and bioretention devices as stormwater filters into/through the media and clings to the sediments and soil's structure. The nutrients are then absorbed by the roots of the plants within the devices and removed from the stormwater. Treated water then drains from the bottom of the device.

Heavy metals cling to TSS which, when stormwater is slowed down through swales/filter strips and bioretention devices, settles out and is filtered through topsoil and bioretention media. The TSS will fill the void space in the topsoil and bioretention media overtime and devices usually need to be dug up and fresh soil replaced given the build-up of TSS and heavy metals in the soil. This typically happens every 25 years.

The upstream catchment of the gravel carparks discharges to a dish drain along the top edge of the carpark so that it does not mix with untreated water from the carparks and ensures the bioretention devices function as designed.

8.5 Treatment Train Approach

A treatment train approach is suggested to treat the proposed gravel carpark and service in order to achieve high removal rates of TP, TN, TSS and heavy metals. The bus bay for the proposed Haybarn venue is proposed to be treated in a bioretention swale as it is small area and treatment train approach is difficult to achieve with site constraints.

Several treatment devices were considered, a swale leading to a bioretention device was the best practical option for the carpark, bus stop and service access track.

NZTA uses a simplified equation for the total removal of a given contaminant for two or more stormwater treatment devices in a series. The equation is as follows:

$$R = A + B - [(A \times B) / 100]$$

Where:

R = total removal rate

A = Removal rate of the first or upstream practice

B = Removal rate of the second or downstream practice

This equation was used to determine the total removal rate of contaminants for a swale followed by a bioretention device for the western carpark. Table 10 below indicated the total removal rates for each contaminant in question.

Table 10: Total Removal Rates of Contaminants for Treatment Train Approach

Options	% P removal	% N removal	% TSS removal	% Zinc removal	% Copper removal
Swale	30%	20%	70%	75%	60%
Bioretention	60%	40%	90%	90%	90%
Total Swale + Bioretention	72%	52%	97%	98%	96%

As seen above, it is difficult to achieve (relatively) high rates of TN removal rates in comparison to TP, TSS and heavy metals which have relatively high rates of removal based on this treatment train approach. Additionally, nitrogen and phosphorus often bind to TSS, so the high levels of TSS removal will ensure elevated levels of TN and TP removal are achievable.

8.6 Treated Stormwater Contaminant Yields

Based on the above assessment for removal rates provided in a treatment train approach for the western carpark and bus stop, the overall reduction factor in Table 10 was used against the generated contaminant loading in Table 9 to determine the contaminant yield discharging from site after treatment. Table 11 below demonstrates the pre-development runoff contaminant yields and post-development runoff contaminant yields after treatment as comparison.

Table 11: Pre-Development (**Farmed**) and Post-Development Contaminant Yield After Treatment for Lower Gravel Carparks

	Runoff TP (kg/yr)	Runoff TN (kg/yr)	Runoff TSS (kg/yr)	Runoff Zinc (kg/yr)	Runoff Copper (kg/yr)
Pre-Development (Farmed Grass)	0.19	0.86	114.60	0.0048	0.0010
Post-Development (Treated)	0.06	1.10	1.8	0.0003	0.0002
Reduced Yield	-0.12	+0.240	-142.80	0.0045	-0.0009
% Reduced	-66%	+28%	-99%	-94%	-84%

As seen above, all contaminants of interest are reduced in the runoff from the proposed site compared to the existing situation (farmed) except for Nitrogen. Total nitrogen is difficult to remove even though a treatment train approach given the dissolved nitrogen is not removed unless nitrification and denitrification occurs, where an anoxic environment is created. The estimated nitrogen levels in this assessment come from an urban environment study as it is the most relevant assessment found to date in New Zealand. However, the nitrogen levels in an urban environment will come from multiple places including but not limited to; fertilizers of lawns, pet waste, and atmospheric deposition. Atmospheric deposition is uncontrollable, however, this carpark is not expected to have any pet waste and the development can limit

the fertilizers used in surrounding vegetation to reduce nitrogen loading. Therefore, it is expected that the nitrogen loading in the post-development scenario will be significantly lower than suggested here.

9 Policy

August 2021, an Environment Court Consent Order in relation to the Queenstown Lakes District Council District Plan resulted in the following Policy 24.2.4.2 being inserted into the PDP Chapter 24 Wakatipu Basin:

“Restrict the subdivision development and use of land in the Lake Hayes catchment, unless it can contribute to water quality improvement in the catchment commensurate with the nature, scale and location of the proposal”.

The policy is clear that water quality leaving the site in post-development scenario should be proven to be better than what exists currently. As seen in Table 9 above, all contaminants in stormwater runoff in the proposed condition are reduced in comparison to the existing farmed situation except for Nitrogen, however, the nitrogen loading is expected to be much lower than what is assessed as urban in Contaminate Load Model. All other impervious areas are treated through existing swale and bioretention that have been oversized or a new bioretention swale for the bus drop off bay. Overall, it is considered that the proposed development will improve water quality (of the stormwater runoff from this site) through the function of low impact design treatment which will achieve the requirements of this policy.

10 Summary

A stormwater management assessment was completed for Ayrburn Precinct Ltd for the addition of the Haybarn venue, associated service and pedestrian tracks, and a carpark/bus stop west of Ayr Ave by CKL. The best practicable stormwater management option for this site is to discharge stormwater runoff from the gravel carpark (highest contaminant generating area of site) to a swale followed by a bioretention device. This treatment train approach will ensure high removal rates of contaminants. The service access track will get treated through the swale and bioretention device adjacent to Ayrburn Domain Carpark 3. The proposed bus bay will get treatment from proposed bioretention swale.

The service access track is not expected to get much use so the risk level of contaminants from cars is relatively low. The proposed treatment train approach is considered sufficient for this area. Therefore, the Contaminant Load Model (CLM) only considers the proposed western carpark as it is expected to have higher contaminant loading. The CLM indicates that all generated contaminates assessed will be reduced to less than pre-development scenario, except for nitrogen. However, the land use type of Urban was used to estimate nitrogen loading as it is the best assumption found to date in New Zealand, however nitrogen loading in a carpark is expected to be much less than an urban environment. To conclude, the proposed treatment regime will achieve the policy regarding improving water quality treatment in the Lake Hayes Catchment.

11 Limitations

This report has been prepared solely for the benefit of our client 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
- Contaminant Load Model



Job Name	Waterfall Park	File Name	A20254-EV- -Haybarn.xlsx
Job No.	A20254	Sheet Name	QpCC_Culverts
Date	26/05/2023		
By	FDP	Checked	KW

Pre and post Development Peak Flow

Assumptions:

Runoff Coefficient (c):

- c=0.95 for roof
- c=0.9 for paved surfaces
- c=0.5 for permeable pavements
- c=0.3 for permeable surfaces

Culvert at Carpark Exit- 100yr + CC

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CiA	
0.06360	0.95	66.4	11.2	Building Coverage
0.28980	0.90	66.4	48.1	Impermeable Paving
1.01840	0.30	66.4	56.4	Landscaping
1.37180		Max.Flow (L/s)	115.7	Sum Existing

Culvert at Ped Crossing- 100yr + CC

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CiA	
0.77000	0.95	66.4	135.0	Building Coverage
0.22550	0.90	66.4	37.5	Impermeable Paving
1.12900	0.95	66.4	198.0	Pond
10.57550	0.30	66.4	585.6	Landscaping
12.70000		Max.Flow (L/s)	956.1	Sum Proposed



Job Name	Waterfall Park	File Name	A20254-EV- -Haybarn.xlsx
Job No.	A20254	Sheet Name	QpCC_Treatment
Date	26/05/2023		
By	FDP	Checked	KW

Pre and post Development Peak Flow

Assumptions:

Runoff Coefficient (c):

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

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

Western Carpark - WQF (10mm)

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CIA	
0.31710	0.90	10	7.9	Impermeable Paving Western Carpark
0.31710		Max.Flow (L/s)	7.9	Sum Existing

Haybarn Access Track - WQF (10mm)

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CIA	
0.04495	0.90	10.0	1.1	Impermeable Paving
0.04495		Max.Flow (L/s)	1.1	Sum Proposed

Existing total site area - 20yr ARI 10 minute

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CIA	
0.31710	0.90	43.4	34.4	Impermeable Paving
0.31710		Max.Flow (L/s)	34.4	Sum Existing

Haybarn Access Track - 20yr ARI 10 minute +CC

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CIA	
0.04495	0.90	43.4	4.9	Lower carpark
0.04495		Max.Flow (L/s)	4.9	Sum Proposed

Existing total site area - 100yr ARI 10 minute

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CIA	
0.31710	0.90	66.5	52.8	Impermeable Paving
0.31710		Max.Flow (L/s)	52.8	Sum Existing

Haybarn Access Track - 100yr ARI 10 minute +CC

Area (ha)	C No.	Int (mm/hr)	Q = 2.78CIA	
0.04495	0.90	66.5	7.5	Lower carpark
0.04495		Max.Flow (L/s)	7.5	Sum Proposed

Job Name	Waterfall Park	File Name	A20254-EV- -Haybarn.xlsx
Job No.	A20254	Sheet Name	Western Carpark Swale
Date	26/05/2023	Checked	KW
By	FDP		

Upper Gravel Carparks Vegetated Swale Sizing

	Peak Flow (L/s)
Water Quality Flow Northern Catchment (10mm)	7.93
20yr 10min +CC Flow	34.43
100yr 10min +CC Flow	52.76

Swale sizing

Z-horiz slope	4
Base width (m)	0.6
Swale depth (m) (total)	0.4
Top width (m)	3.8
Slope (m/m)	0.015
Minimum Res time (min)	9
n - vegetated swale	0.25
Swale Length (m)	165

Depth	n	A	R	V	Q (L/s)	Length	Residence time	
0	0.25	0.00	0.00	0.000	0.0	165.0	0.0	
0.1	0.25	0.10	0.07	0.083	8.3	165.0	33.3	*WQF
0.2	0.25	0.28	0.12	0.121	34.0	165.0	22.7	
0.2	0.25	0.28	0.12	0.121	34.0	165.0	22.7	*20yr Flow
0.26	0.25	0.43	0.16	0.141	60.0	165.0	19.5	*100 yr flow
0.3	0.25	0.54	0.18	0.153	82.5	165.0	18.0	
0.4	0.25	0.88	0.23	0.181	159.0	165.0	15.2	



CKL NZ Limited
 PO Box 171, Hamilton, 3240
 58 Church Road
 Ph: 07 849 9921

Job Name	Waterfall Park	File Name	A20254-EV- -Haybarn.xls
Job No.	A20254	Sheet Name	Bioretention Sizing
Date	26/05/2023	Checked	KW
By	FDP		

Bioretention Sizing

	Western Carpark + Ayr Ave	Haybarn Service Access Track
Bioretention Base Area	76.00	11.00
WQF (m ³ /hr)	28.56	4.05
K (native soil) m/hr	0.125	0.125
Soakage volume (m ³)	9.5	1.4
Required Storage volume	19.06	2.67
Drainage Layer Depth (m)	0.3	0.3
Drainage Layer Void Ratio	35%	35%
Drainage Layer Volume (m ³)	7.98	1.16
Media Layer Depth (m)	0.5	0.5
Media Layer Void Ratio	30%	30%
Media Layer Volume (m ³)	11.40	1.65
Raingarden Big enough?	Yes	Yes



Job Name	Ayrburn Precinct	File Name	A2025-EV- - SMP
Job No.	A20254	Sheet Name	CLM Carpark
Date	26/05/2023		
By	FDP	Checked	KW

Contaminate Load Model- Farm to Urban

	Phosphorus	Nitrogen	TSS	Zinc	Copper	Units
Roof	0.080	0.8	5	1.34	0.0003	g/m ² /yr
Carpark/Driveways	0.080	0.8	21	0.004	0.0015	g/m ² /yr
Paving	0.080	0.8	32	0	0.0294	g/m ² /yr
Farmed (sheep and beef)	0.198	0.9	152	0.005	0.0011	g/m ² /yr

Existing Contaminants

	Area (m ²)	Runoff Coefficient (C)	Runoff TP (kg/yr)	Runoff TN (kg/yr)	Runoff TSS (kg/yr)	Runoff Zinc (kg/yr)	Runoff Copper (kg/yr)
Farmed (Grassed Area)	3171	0.3	0.19	0.86	144.60	0.0048	0.0010
Driveway	0	0.9	0.00	0.00	0.00	0.0000	0.0000
Sum	3171		0.19	0.86	144.60	0.0048	0.0010

Proposed Contaminants

	Area (m ²)	Runoff Coefficient (C)	Runoff TP (kg/yr)	Runoff Treated TP (kg/yr)	Runoff TN (kg/yr)	Runoff Treated TN (kg/yr)	Runoff TSS (kg/yr)	Runoff Treated TSS (kg/yr)	Runoff Zinc (kg/yr)	Runoff Treated Zinc (kg/yr)	Runoff Copper (kg/yr)	Runoff Treated Copper (kg/yr)
Driveway	3171	0.9	0.23	0.06	2.28	1.10	59.9	1.80	0.0114	0.0003	0.0043	0.0002
Sum	3171		0.23	0.06	2.28	1.10	59.9	1.8	0.0114	0.0003	0.0043	0.0002
			Total TP Reduced	-0.12	Total TN Reduced	0.240	Total TSS Reduced	-142.80	Total TSS Reduced	-0.0045	Total TSS Reduced	-0.0009
			% TP Reduced	66%	% TN Reduced	-28%	% TSS Reduced	99%	% TSS Reduced	94%	% TSS Reduced	84%

Options	% P removal	% N removal	% TSS removal	% Zinc removal	% Copper removal
Swale	30%	20%	70%	75%	60%
Filter Strip	20%	20%	80%	75%	60%
Pond	40%	25%	75%	50%	40%
Bioretention	60%	40%	90%	90%	90%
Total Swale + Bioretention	72%	52%	97%	98%	96%
Total Filter Strip + Pond	52%	40%	95%	88%	76%

Appendix 2 Soakage Testing

Site Inspection Record

Page 1 of 3

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.



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	0.0	NO SEEPAGE	
		0.2m	0.1		
ALLUVIAL SAND	Silty fine to medium SAND; grey, Bedded. Moist.		0.2		
			0.3		
			0.4		
			0.5		
			0.6		
ALLUVIAL GRAVEL	Sandy fine to coarse GRAVEL; grey, Bedded. Medium dense; moist; well-graded; Sand is fine to coarse.		0.6		
			0.7		
			0.8		
			0.9		
			1.0		
			1.1		
			1.2		
			1.3		
			1.4		
			1.5		
			1.6		
			1.7		
			1.8		
			1.9		
			2.0		
ALLUVIAL SILT	Sandy SILT; grey, Massive. Firm; moist; micaceous; Sand is fine.	2m	2.0		
			2.1		
			2.2		
			2.3		
			2.4		

Total Excavation Depth = 2.4 m

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

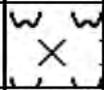
PROJECT:	Waterfall Park			JOB NUMBER:	150098.04
LOCATION:	See Site Plan	INCLINATION:	Vertical		
EASTING:		EQUIPMENT:	5T Excavator	OPERATOR:	Niles
NORTHING:		COORD. SYSTEM:		COMPANY:	Wilson Contractors
ELEVATION:		EXCAV. DATUM:		HOLE STARTED:	17/09/2021
METHOD:	Aerial Photography	ACCURACY:		HOLE FINISHED:	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 X	0.0 0.1		
ALLUVIAL GRAVEL	Sandy fine to coarse GRAVEL; grey, Bedded. Medium dense; moist; well-graded; Sand is fine to coarse.	0.2m 	0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2		
ALLUVIAL SILT	Sandy SILT; grey, Massive. Firm; moist; Sand is fine.	2.2m X X X X X	2.2 2.3 2.4 2.5 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

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.		0.0 0.1 0.2		
ALLUVIAL GRAVEL	Sandy fine to coarse GRAVEL; grey, Bedded. Medium dense; moist; Sand is fine to coarse.		0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3		
ALLUVIAL GRAVEL	Sandy fine to medium GRAVEL; grey, Bedded. Medium dense; moist; Sand is fine to coarse.		1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8	Seepage @ 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



Memorandum

Date:	19/12/2023
To:	Catrina Lamont (Queenstown Lakes District Council)
From:	Amanda Ling
Project Number:	4239
Reviewed by:	Theo Dombroski
Released by:	Jason Smith

Subject: RM230425 s92 Response Engineering Review

Background

Morphum Environmental Limited (Morphum) has been engaged by Queenstown Lakes District Council (QLDC) to provide engineering review of a resource consent application referred to as RM230425. Ayrburn Precinct Ltd (**The Applicant**) seeks consents to enable the construction and operation of the Haybarn Venue.

The scope of this review as requested by QLDC is to review the water quality aspects of the Stormwater Management Plan (SMP) prepared by CKL.

Having reviewed the lodged application material, Morphum provided the memorandum *RM230425 Engineering Review* (dated 28/07/2023) which included requests for further information. A s92 response *Haybarn Section 92 Responses - Stormwater Matters*, memorandum prepared by CKL, dated 10 November 2023 was provided by the applicant to address the queries. Morphum reviewed the s92 response and provided the memorandum *RM230425 s92 Response Engineering Review* (dated 01/12/2023) with an additional request for further information.

The applicant has provided a s92 response to the request for further information:

- *Haybarn Venue Engineering Drawings - 8 November 2023*, prepared by Paterson Pitts Group.

This memorandum provides our comments to the s92 response.

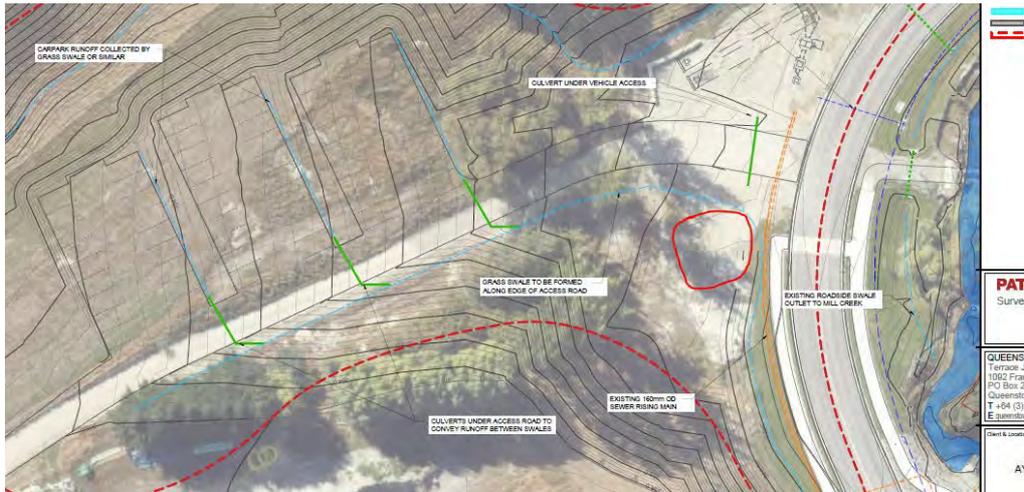
S92 Further Request No. 1 (01/12/2023)

The Ayrburn Domain Bioretention Device sizing has been recalculated based on the Carpark 3 soakage testing results.

The location of soakage testing for Carpark 2 is close to the proposed Western Bioretention Device location. The soakage rate for Carpark 2 is higher than the design rate used for the raingarden sizing. It is proposed a specific soakage test will be undertaken for the proposed raingarden location at detailed design stage. A condition is recommended for the soakage testing to be undertaken and results provided at building consent application/engineering acceptance stage.

Investigate the feasibility of relocating the Western Bioretention Device adjacent to the Western carpark proposed. The distance from the location of Carpark 2 soakage testing appears to be similar proximity

to the current proposed location. The raingarden would then provide direct treatment for the carpark catchment and ideally be outside the 100-year ARI flood plain.



Applicant Response

The location of the Western Bioretention Device was originally chosen to be at the end of the treatment swale to optimise the existing landscape features. However, more consideration has been given to overall layout of the civil engineering design aspects of this area with CKL and PPG agreeing that the new proposed location is the best practical and most efficient option. This new location is further away from the 100-year ARI flood plain and now designed to treat just the carpark as it won't be susceptible to 'clean' runoff entering it and diluting the water from the carpark.

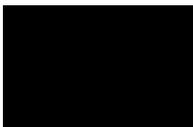
Morphum Response

The Western Bioretention Device has been relocated adjacent to the proposed Western carpark. The device will now be outside of the 100-year ARI flood plain and provide direct treatment of carpark runoff. The response is accepted and satisfies the s92 query.

Summary

Guideline Document 2017/001 Stormwater Management Devices in the Auckland Region (GD01) is considered a best practice guideline for design of stormwater management devices and is referenced in the QLDC Land Development and Subdivision Code of Practice. GD01 devices (bioretention swale and raingardens) are proposed for the stormwater quality management of the new impervious areas serving trafficable movements. The treatment train approach proposed aids with achieving higher removal rates of contaminants.

All further information requests have now been addressed and satisfied. One specific condition of consent is recommended for the soakage testing to be undertaken for the proposed Western Bioretention Device and the results and calculations to be provided at building consent application/engineering acceptance stage (refer s92 Request No. 1). With this condition in place to inform the detailed design stage, the proposed stormwater quality management system is considered a feasible and appropriate solution.



Amanda Ling
Civil & Environmental Engineer
Morphum Environmental Ltd

MEMORANDUM

TO:	Ayrburn Precinct Ltd	Job No.:	Q000492
ATTENTION:	Nicola Tristram	Date:	2 June 2023
FROM:	Fluent Solutions	Page 1 of 3	
SUBJECT:	Haybarn Venue Flood Hazard Assessment	Reference:	MEMO-23-06-01 Q000492_Haybarn Venue.Docx

1.0 Introduction

1.1 General

Fluent Infrastructure Solutions Ltd (Fluent Solutions) has been engaged by Ayrburn Precinct Ltd to perform a flood hazard assessment for the proposed Haybarn venue located at 339 Arrowtown-Lake Hayes Road, Arrowtown.

This memo addresses the Mill Creek peak 100-year ARI (including RCP 8.5 Climate Change Factor) flood hazard assessment of the Haybarn venue.

2.0 Flood Hazard Assessment

2.1 Background

A comprehensive flood model has been developed for approved consents within Ayrburn Domain and Northbrook, Arrowtown. Results from the existing flood model (which has been extensively peer reviewed) were used to determine the Mill Creek peak 100-year ARI flood water elevations for the flood hazard assessment of the Haybarn venue. The flood modeling details can be found in the Northbrook Arrowtown Resource Consent Application (RM220926).

2.2 Mill Creek Peak 100-Year ARI Flood Extents and Elevations

Figure 2.1 shows the estimated Mill Creek peak 100-year ARI flood extents and depth/elevations in relation to the Haybarn venue outline, as well as the Finished Floor Level (FFL) of the Haybarn venue.

MEMORANDUM

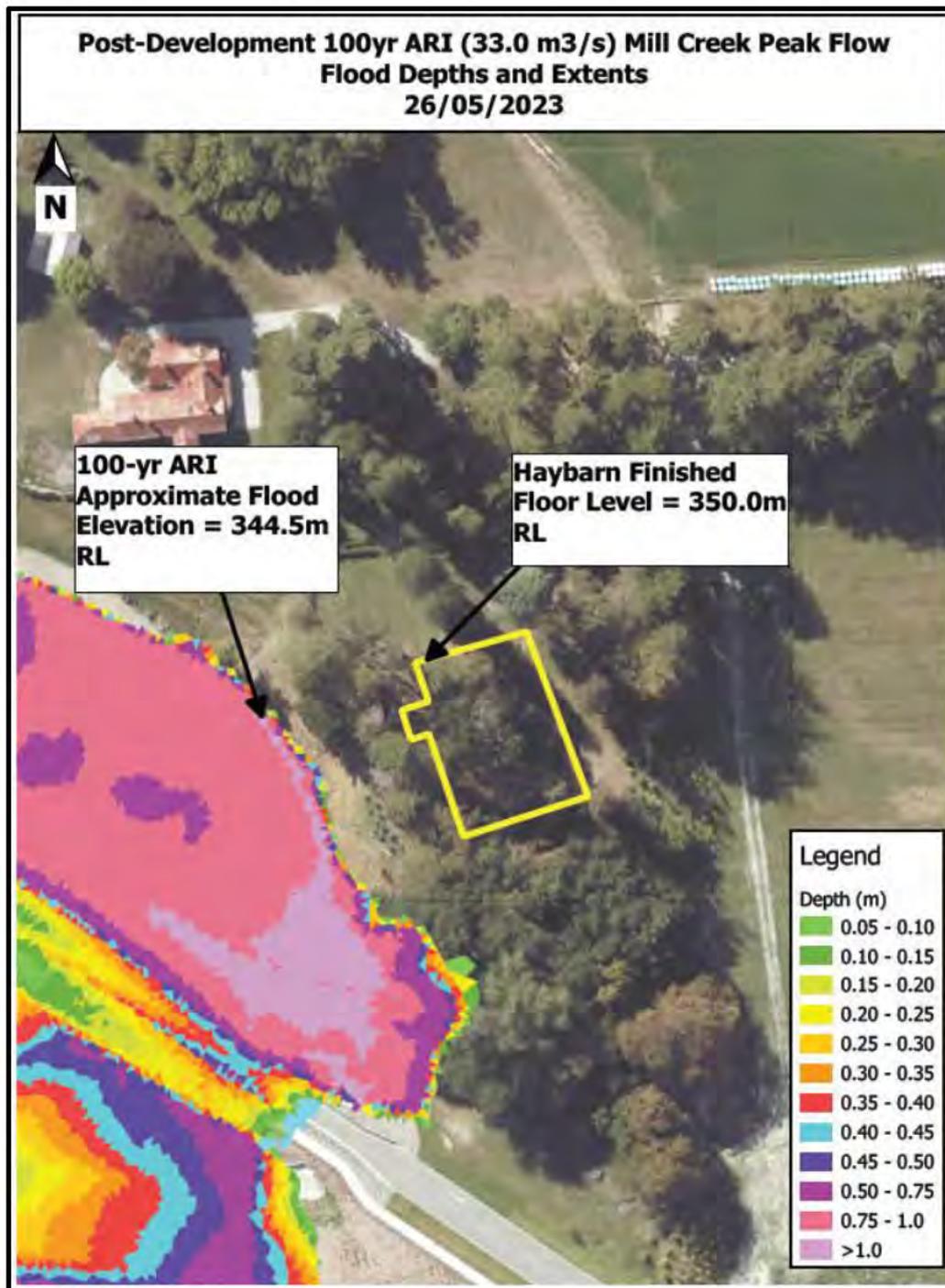


Figure 2.1: The Mill Creek Peak 100-Year ARI Flow Flood Extents and Elevations near the Haybarn venue

As shown in Figure 2.1, the Mill Creek peak 100-year ARI flood extents do not contact the Haybarn venue and is well below the FFL of the proposed building. Queenstown Lakes District Councils' "Land Development and Subdivision Code of Practice" (COP) set out FFL flood freeboard requirements based on the 100-year ARI which is discussed in further detail in Section 2.4.

MEMORANDUM

Haybarn Venue Flood Hazard Assessment

Page 3 of 3

2.3 Flow Path Conveyance

The COP requires that a primary stormwater system be designed to convey, as a minimum, a 20-year Average Recurrence Interval (ARI) runoff flow taking into account climate change. The design of the primary stormwater system has been undertaken by Paterson Pitts Group as shown in reports and drawings included in this application.

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.

In relation to this memo the secondary overland flows run towards Mill Creek and the associated floodplain.

2.4 Minimum Building Freeboard Levels

The COP requires a minimum freeboard height above the maximum 100-year ARI estimated water level to buildings (CI 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.”

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

The Haybarn venue is a commercial building, which requires at least 0.3m of freeboard above the Mill Creek peak 100-year ARI flood level. As shown in Figure 2.1, the estimated 100-year ARI flood elevation at the upstream end of the Haybarn entrance is approximately 344.5m. The proposed Haybarn venue will have an FFL of 350.0m. Assuming the building slab is 200mm thick, the underside of the slab will have a level of 349.8m. The Haybarn venue slab level therefore meets COP minimum freeboard requirements (5.3m estimated freeboard compared to 0.3m allowable freeboard).

3.0 Conclusion

The flood hazard assessment of the Haybarn venue analysed the impacts of the Mill Creek peak 100-year ARI (Including Climate Change Factor) flow flood extents in relation to the building and the flood elevation freeboard requirements based on the FFL of the building.

As demonstrated in the sections above, the Mill Creek peak 100-year ARI flow flood extents do not impact the Haybarn venue and the building’s FFL meets freeboard requirements as set out by the COP.

MEMORANDUM



GeoSolve Ref: 150098.10-rev1
6 June 2023

Ayrburn Precinct Ltd
1 William Paterson Close
Arrowtown 9302

Geotechnical Memo for Resource Consent The Haybarn venue and Carparking

Attention: Nicola Tristram

Introduction

GeoSolve Ltd has been engaged by Ayrburn Precinct Ltd to undertake a geotechnical assessment for the proposed Haybarn venue at 339 Arrowtown-Lake Hayes Road, Arrowtown. The location is shown on the GeoSolve investigation site plan in Appendix A & on Figure 1.1 below.

The site is legally described as Lots 2-4 DP 540788.



Figure 1.1: Locality and Extent of Works Plan

The extent of the earthworks proposed is detailed in the Paterson Pitts Group (PPG) drawings C2976 Haybarn (provided in Appendix B).

DUNEDIN
CROMWELL
QUEENSTOWN
WANAKA
INVERCARGILL

GeoSolve Limited - Queenstown Office:
829 Frankton Road, Frankton Marina
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queenstown@geosolve.co.nz

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Page 1 of 6



Assessment

We have reviewed the architectural and engineering plans supplied and consider the previous GeoSolve report for the site (*ref: 150098.07 – Geotechnical Report for Resource Consent, dated June 2020*) for Lots 2, 3 and 4 DP 540788, to be suitable for the purpose of resource consent for the Haybarn venue building. This report is provided in Appendix C.

This memo should be read in conjunction with the above referenced GeoSolve Geotechnical Report for the Haybarn venue location which presents; geotechnical investigations, the geological model, discussion of natural hazards and engineering considerations. The 2020 Geosolve report does not cover the car parking area and specific engineering considerations are provide below for this area.

The following section presents additional engineering considerations specific to the Haybarn venue and proposed carpark area.

Haybarn Venue Engineering Considerations

- Based on review of surrounding test pit investigation data the site is expected to be underlain by surficial topsoil and loess which overlies alluvial sand.
- Based on a setback of no less than 8 m from the crest of the slope the building position will satisfy the foundation requirements as outlined in Section 3 of NZ3604:2011 and no special provisions are required regarding slope stability.
- The subject site is located on an elevated terrace above Mill Creek. The inferred depth to the regional groundwater level and the relatively dense granular soils underlying the site confirm the liquefaction risk is nil to low. No further investigation or assessment is considered necessary with respect to liquefaction.
- Standard shallow foundations are expected to be utilised. The loess and alluvial sand will not provide 'good ground' bearing as per the recommendations of NZS3604:2011. A detailed bearing capacity assessment will be carried out once foundation loadings have been determined at the detailed design phase.
- For detailed structural design purposes, it is recommended the site is classified as "Class D – deep soils site" in accordance with NZS 1170.5:2004 seismic provisions.
- The proposed development is considered to be feasible from a geotechnical perspective provided the recommendations within this memo, and the Geosolve 2020 Geotechnical report, are followed.

Carpark Engineering Considerations

- Based on review of existing geotechnical investigation data the carpark area is expected to be underlain by surficial topsoil and loess which overlies alluvial sand and gravel comprising gravelly SAND and sandy GRAVEL. Schist was observed to outcrop directly upslope of the proposed carpark extents.
- A 50-60 m high slope is situated to the immediate north of the carpark. The slope generally dips south-east towards the carpark at 30-40 degrees and becomes gently sloping at 10-15 degrees at the slope base. The slope is undulating and irregular in some areas, due to the presence of schist bedrock exposures. Schist foliation dips at 20-30 degrees to the west, indicating the schist bedrock is in-situ. The rock outcrops are less than 1 m in height and are not considered capable of providing a rock fall risk.
- Several small gullies are present across the slope draining from north to south towards the carpark. It is expected that perched groundwater seepage may develop near the soil-rock contact during periods of heavy rainfall. Subsoil drains may be required to address perched seepage and the requirement for drainage should be confirmed during earthworks.
- The PPG Plans show a cut-off drain is proposed upslope of the proposed earthworks batter. This is recommended to prevent any surface flow running down the cut face. The cut-off drain should be lined or armoured to prevent scouring along the cut-off drain surface.
- Earthworks are required to form the proposed carpark area and excavations up to approximately 5 - 6 m in depth with batters of 2H:1V are indicated on the PPG drawings.

- Test pit data indicates the ground conditions in the carpark area generally comprise alluvial sand and gravel, logs attached.
- The proposed 2H:1V batter is generally considered suitable in the expected materials, however, further test pits are recommended at the detailed design stage along the north-eastern extent of the carpark. The pits should extend to the base of the proposed cut to confirm ground conditions are consistent with the existing data. The presence of bedrock and perched groundwater should also be assessed.
- Retaining or extension of the batter slope at a lower angle can be considered if the proposed batter slopes are not suitable for the observed soil conditions following completion of test pits.
- All batter slopes should be topsoiled or vegetated upon completion to provide surficial erosion protection.
- All batter slopes should be inspected during construction by a suitably qualified engineering geologist or geotechnical engineer.
- No adverse effects on neighbouring slopes/properties are expected provided the recommendations of this report are followed and detailed review of the ground conditions is undertaken at the detailed design and construction stages.

Further Investigation and Assessment

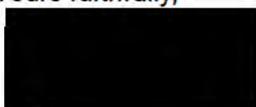
During the detailed design phase of the project the following geotechnical inputs are recommended:

- Geotechnical review of foundation loads to provide bearing capacity recommendations for the proposed building.
- Additional test pits extending to the base of the proposed carpark excavation to confirm the geological model will be required for the carpark area during the detailed design phase.
- The recommended assessments described within this report should be undertaken. Additional assessments may be required as part of the detailed design.

Applicability

This report has been prepared for the sole use of our client, Ayrburn Precinct Ltd, with respect to the particular brief and on the terms and conditions agreed with our client. It may not be used or relied on (in whole or part) by anyone else, or for any other purpose or in any other contexts, without our prior review and written agreement.

Yours faithfully,



Mike Plunket

Geotechnical Engineer

Reviewed for GeoSolve Ltd by: Paul Faulkner, Senior Engineering Geologist



Attachments:

- **Appendix A – GeoSolve Site Investigation Plan and Investigation Logs**
- **Appendix B – Paterson Pitts Group Drawings - For Resource Consent**
- **Appendix C – GeoSolve Resource Consent Report – Arrowtown-Lake Hayes Road/Ayr Avenue**

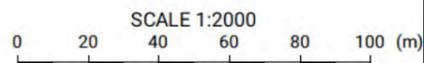
Appendix A: Site Plan, Cross-section & Investigation Data



Notes:
 1. These drawings have been prepared for the benefit of Ayrburn Precinct Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Legend:

-  Test Pit Locations
-  Extent of Works

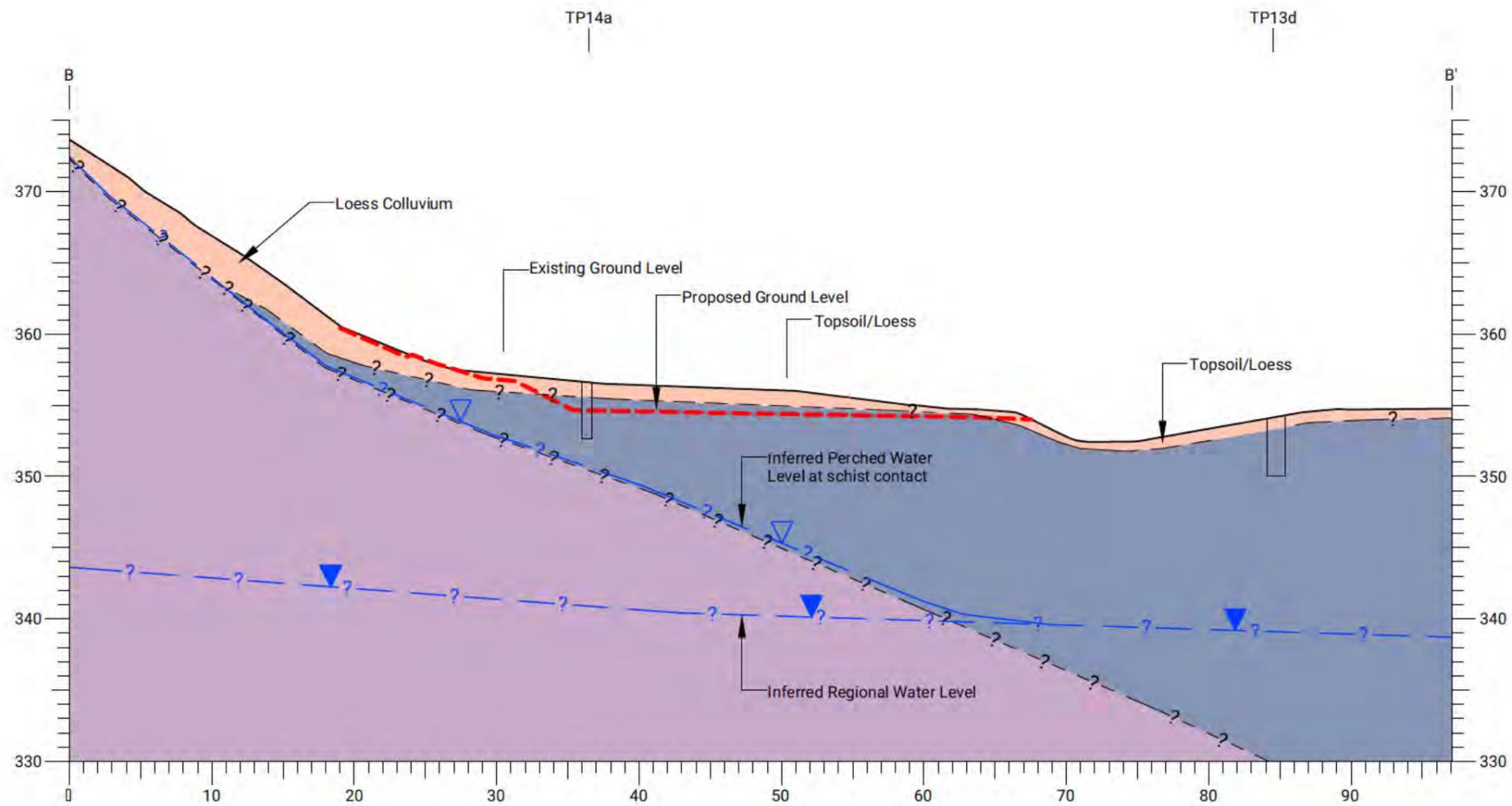


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 Level 1, 70 MacAndrew Road, South Dunedin
 www.geosolve.co.nz

DRAWN	MDP	Jun.23
DRAFTING CHECKED	PGF	Jun.23
APPROVED	PGF	Jun.23
CADFILE: 150098.04.dwg		
SCALES (AT A3 SIZE): 1:2000		
PROJECT No: 150098.10		

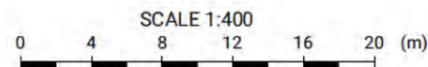
Ayrburn Precinct Ltd
 Ayrburn Haybarn and Carparking
 Geotechnical Investigation
 Investigation Site Plan

FIG No: Appendix A, Figure 1	REV. 1
---------------------------------	-----------



Notes:
 1. These drawings have been prepared for the benefit of Ayrburn Precinct Limited with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

- Legend:
- Loess
 - Schist Bedrock
 - Alluvial Sand & Gravel
 - ▼ Inferred Regional Water Level
 - ▽ Inferred Perched Water Level at schist contact



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DRAWN	MDP	May.23
DRAFTING CHECKED	PGF	May.23
APPROVED	PGF	May.23
CADFILE: 150098.06.dwg		
SCALES (AT A3 SIZE): 1:400		
PROJECT No: 150098.10		

Ayrburn Precinct Limited
 Haybarn and Carpark
 Geotechnical Assessment
 Cross Section A

FIG No:
Figure 2a

REV.
1

EXCAVATION LOG

EXCAVATION NUMBER:

TP 1H

PROJECT:	Lot 3 Building Platform, Waterfall Park			JOB NUMBER:	150098.07	
EASTING:		mE	EQUIPMENT:	5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.		COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:		HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:		HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER Blows per 100mm 0 5 10 15
0.2	TOPSOIL		Dark brown, organic SILT. Soft. Dry to moist.		NO SEEPAGE	
0.7	LOESS		Light brownish grey, SILT. Non-plastic. Stiff. Massive. Dry.			
1.3	ALLUVIAL SAND		Light grey, SAND with trace to minor silt. Sand is fine. Micaceous. Medium dense. Bedded. Dry to moist.			
3.0	ALLUVIAL SAND		Light grey, silty SAND with occasional laminated SILT layers up to 30 mm thick. Sand is fine. Micaceous. Loose to medium dense. Bedded. Dry to moist.			

Total Depth = 3 m

COMMENT: Test pit dry and side walls stable.

Logged By: JM

Checked Date:

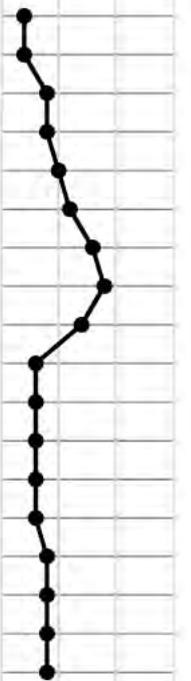
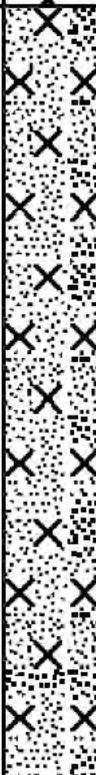
Sheet: 1 of 1

EXCAVATION LOG

EXCAVATION NUMBER:

TP 2H

PROJECT:	Lot 3 Building Platform, Waterfall Park			JOB NUMBER:	150098.07	
EASTING:		mE	EQUIPMENT:	5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.		COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:		HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:		HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER Blows per 100mm 0 5 10 15
0.2	TOPSOIL		Dark brown, organic SILT. Firm. Moist.		NO SEEPAGE	
1.0	LOESS		Light brownish grey, SILT with trace sand. Sand is fine. Non-plastic. Stiff. Massive. Dry.			
3.0	ALLUVIAL SAND		Light grey, silty SAND with trace to minor silt and trace gravel. Occasional laminated SILT layers up to 30 mm thick. Sand is fine. Gravel is fine to medium; angular. Micaceous. Loose to medium dense. Bedded. Dry to moist.			

Total Depth = 3 m

COMMENT: Test pit dry and side walls stable.

Logged By: JM

Checked Date:

Sheet: 1 of 1



EXCAVATION LOG

EXCAVATION NUMBER:
TP 3H

PROJECT: Lot 3 Building Platform, Waterfall Park				JOB NUMBER: 150098.07	
EASTING:		mE	EQUIPMENT: 5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.	COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:	HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:	HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER Blows per 100mm 0 5 10 15
0.15	TOPSOIL		Dark brown, organic SILT. Firm. Moist.		NO SEEPAGE	
0.9	LOESS		Light brownish grey, SILT. Non-plastic. Firm to stiff. Massive. Dry to moist.			
3.0	ALLUVIAL SAND		Light grey, silty SAND with occasional laminated SILT layers up to 30 mm thick. Sand is fine. Gravel is fine to medium; angular. Micaceous. Loose to medium dense. Bedded. Dry to moist.			

Total Depth = 3 m

COMMENT: Test pit dry and side walls stable.	Logged By: JM
	Checked Date:
	Sheet: 1 of 1



EXCAVATION LOG

EXCAVATION NUMBER:
TP 4H

PROJECT: Lot 3 Building Platform, Waterfall Park				JOB NUMBER: 150098.07	
EASTING:		mE	EQUIPMENT: 5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.	COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:	HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:	HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER Blows per 100mm 0 5 10 15
0.05	TOPSOIL		Dark brown, organic SILT. Firm. Moist.		NO SEEPAGE	
0.25	UNCONTROLLED FILL		Greyish brown, sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse; subangular. Loose to medium dense. Moist.			
0.3	BURIED TOPSOIL		Dark brown, organic SILT. Soft. Moist.			
1.1	LOESS		Light brownish grey, SILT with trace to minor sand. 30 mm thick silty GRAVEL lense @ 0.7 m. Sand is fine. Non-plastic. Firm to stiff. Massive. Moist.			
3.0	ALLUVIAL SAND		Light grey, SAND with some silt. Occasional laminated SILT layers up to 20 mm thick. Sand is fine. Gravel is fine to medium; angular. Micaceous. Medium dense. Bedded. Moist.			

Total Depth = 3 m

COMMENT: Test pit dry and side walls stable.	Logged By: JM
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:
TP 1C

PROJECT: Ayrburn Farm		Job Number: 150098	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING: mE	EQUIPMENT: 13 Tonne Excavator	OPERATOR: Tony Brookes	
NORTHING: mN	INFOMAP NO.	COMPANY: Earthworks and Drainage	
ELEVATION: m	DIMENSIONS:	HOLE STARTED: 22-Apr-15	
METHOD:	EXCAV. DATUM:	HOLE FINISHED: 22-Apr-15	

				GEOLOGICAL	
SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	
				WATER CONTENT	SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Moist	TOPSOIL
		0.8		Moist	LOESS
		2.4		Moist	ALLUVIAL SAND
	NO SEEPAGE	4.0		Moist	ALLUVIAL GRAVEL

Total Depth = 4 m

COMMENT: Test pit was dry and sides were stable.	Logged By: PGF
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:
TP 2C

PROJECT: Ayrburn Farm		Job Number: 150098	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING: mE	EQUIPMENT: 13 Tonne Excavator	OPERATOR: Tony Brookes	
NORTHING: mN	INFOMAP NO.	COMPANY: Earthworks and Drainage	
ELEVATION: m	DIMENSIONS:	HOLE STARTED: 22-Apr-15	
METHOD:	EXCAV. DATUM:	HOLE FINISHED: 22-Apr-15	

				GEOLOGICAL		
SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	SOIL / ROCK TYPE, ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE, FORMATION
		0.3		Dark brown, sandy organic SILT with rootlets and traces of clay. Soft.	Moist	TOPSOIL
		0.7		Yellow grey, SILT with some fine sand. Firm to stiff.	Moist	LOESS
		1.0		Grey brown, sandy GRAVEL with minor silt and cobbles. Gravel is fine with sub-rounded to rounded clasts. Medium dense. Sub-horizontal bedding.	Moist	ALLUVIAL GRAVEL
		2.3		Grey brown, gravelly SAND with minor silt and gravel lenses. Gravel is fine with sub-rounded to rounded clasts. Medium dense. Sub-horizontal bedding.	Moist	ALLUVIAL SAND
	NO SEEPAGE	4.1		Grey brown, sandy GRAVEL with minor silt and cobbles. Gravel is fine with sub-rounded to rounded clasts. Medium dense. Sub-horizontal bedding.	Moist	ALLUVIAL GRAVEL

Total Depth = 4.1 m

COMMENT: Test pit was dry and sides were stable.	Logged By: PGF
	Checked Date:
	Sheet: 1 of 1



GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:
TP 6C

PROJECT: Ayrburn Farm		Job Number: 150098	
LOCATION: See Site Plan		Inclination: VERTICAL	Direction:
EASTING: mE	EQUIPMENT: 13 Tonne Excavator	OPERATOR: Tony Brookes	
NORTHING: mN	INFOMAP NO.	COMPANY: Earthworks and Drainage	
ELEVATION: m	DIMENSIONS:	HOLE STARTED: 22-Apr-15	
METHOD:	EXCAV. DATUM:	HOLE FINISHED: 22-Apr-15	

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
		0.3		Dark brown, sandy organic SILT with rootlets and traces of clay. Soft.	Moist	TOPSOIL
		0.7		Grey brown, sandy SILT. Soft.	Moist	FILL
		1.0		Yellow grey, SILT with some fine sand. Firm to stiff.	Moist	LOESS
		2.5		Grey brown, sandy GRAVEL with minor silt and cobbles. Gravel is fine with sub-rounded to rounded clasts. Medium dense. Sub-horizontal bedding.	Moist	ALLUVIAL GRAVEL
	NO SEEPAGE	4.8		Yellow grey, silty SAND. Loose to medium dense. Massive.	Moist	ALLUVIAL SAND

Total Depth = 4.8 m

COMMENT: Test pit was dry and sides were stable.	Logged By: PGF
	Checked Date:
	Sheet: 1 of 1



366

GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:
TP 14C

PROJECT: Waterfall Park Subdivision, Lake Hayes		Job Number: 150098.01	
LOCATION: See Site Plan		Inclination: Vertical	Direction:
EASTING: mE	EQUIPMENT: 8T excavator	OPERATOR: Tony	
NORTHING: mN	INFOMAP NO.	COMPANY: Earthworks and Drainage	
ELEVATION: m	DIMENSIONS:	HOLE STARTED: 5-Aug-16	
METHOD:	EXCAV. DATUM:	HOLE FINISHED: 5-Aug-16	

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
	NO SEEPAGE	0.3		Black, organic SILT with roots. Soft.	Moist	TOPSOIL
		0.65		Light brown, silty SAND with a trace of gravel and rootlets. Sand is fine. Gravel is fine. Uniformly graded. Loose to medium dense. Massive.	Moist	LOESS
		0.95		Light brown, gravelly SAND. Sand is fine to coarse. Gravel is fine to medium. Poorly graded. Medium dense. Massive.	Moist	COLLUVIUM
		2.1		Grey, SAND with some gravel. Sand is fine to medium. Gravel is fine to medium, angular. Poorly graded. Medium dense. Massive.	Moist	ALLUVIAL SAND
		2.6		Grey, sandy GRAVEL. Sand is fine to coarse. Gravel is fine to medium. Poorly graded. Medium dense. Bedded.	Moist	ALLUVIAL GRAVEL
		4.0		Grey, gravelly SAND and SAND with some gravel. Sand is fine to coarse. Gravel is fine to medium. Poorly graded. Medium dense. Massive.	Moist	ALLUVIAL SAND

Total Depth = 4 m

COMMENT: Minor slumping of test pit walls.	Logged By: JAS
	Checked Date:
	Sheet: 1 of 1



367

GeoSolve Ltd EXCAVATION LOG

EXCAVATION NUMBER:
TP 15C

PROJECT: Waterfall Park Subdivision, Lake Hayes		Job Number: 150098.01	
LOCATION: See Site Plan		Inclination: Vertical	Direction:
EASTING: mE	EQUIPMENT: 8T excavator	OPERATOR: Tony	
NORTHING: mN	INFOMAP NO.	COMPANY: Earthworks and Drainage	
ELEVATION: m	DIMENSIONS:	HOLE STARTED: 5-Aug-16	
METHOD:	EXCAV. DATUM:	HOLE FINISHED: 5-Aug-16	

SCALA PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
		0.25		Black, organic SILT with roots. Soft.	Moist	TOPSOIL
		0.35		Light brown, silty SAND. Sand is fine. Uniformly graded. Loose to medium dense. Massive.	Moist	LOESS
		1.1		Brown grey, sandy GRAVEL. Sand is fine to coarse. Gravel is fine to medium schist clasts. Poorly graded. Medium dense. Bedded.	Moist	ALLUVIAL GRAVEL
	NO SEEPAGE	3.7		Light grey, gravelly SAND and sandy GRAVEL. Sand is fine to coarse. Gravel is fine to medium. Poorly graded. Medium dense. Bedded.	Moist	ALLUVIAL SAND/GRAVEL

Total Depth = 3.7 m

COMMENT: Significant slumping of test pit walls.	Logged By: JAS
	Checked Date:
	Sheet: 1 of 1



GeoSolve EXCAVATION LOG

EXCAVATION NUMBER:

TP 10C

PROJECT: WaterfallParkRetirement		Job Number: 150098.06	
LOCATION: Waterfall Park		Inclination: Vertical	Direction:
EASTING: 168.816796	EQUIPMENT: 21T	OPERATOR: Aaron	
NORTHING: -44.949362	INFOMAP NO.	COMPANY: Wilson Contractors	
ELEVATION: 0.00	DIMENSIONS:	HOLE STARTED: 23-Sep-2019	
METHOD:	EXCAV. DATUM: Ground level	HOLE FINISHED: 23-Sep-2019	

SCALE PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
		0.20	~	Dark brown, organic SILT. Soft.	Moist	TOPSOIL
		0.80	X X X	Light brown, SILT with minor gravel and trace roots. Massive. Firm. Non-plastic.	Moist	COLLUVIUM
		1.70	•••••	Light grey, SAND with trace gravel and trace cobbles. Sand is fine to medium. Bedded. Loose to medium dense. Bedding is gently inclined.	Moist	ALLUVIAL SAND
	NO SEEPAGE	4.00	/ / / / /	Completely weathered, grey, foliated, SCHIST. Extremely weak to weak.		SCHIST BEDROCK

Total Depth = 4.00 m

COMMENT:	Logged by: Josh
	Checked Date:
	Sheet: 1 of 1

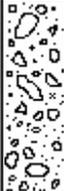
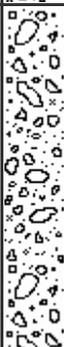


GeoSolve EXCAVATION LOG

EXCAVATION NUMBER:

TP 13C

PROJECT: WaterfallParkRetirement		Job Number: 150098.06
LOCATION: Waterfall Park	Inclination: Vertical	Direction:
EASTING: 168.810212	EQUIPMENT: 21T	OPERATOR: Aaron
NORTHING: -44.958330	INFOMAP NO.	COMPANY: Wilson Contractors
ELEVATION: 0.00	DIMENSIONS:	HOLE STARTED: 23-Sep-2019
METHOD:	EXCAV. DATUM: Ground level	HOLE FINISHED: 23-Sep-2019

SCALE PENETRATION	GROUNDWATER / SEEPAGE	DEPTH (m)	GRAPHIC LOG	SOIL / ROCK CLASSIFICATION, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, WEATHERING, SECONDARY AND MINOR COMPONENTS	WATER CONTENT	GEOLOGICAL
		0.20	~	Dark brown, organic SILT. Soft.	Moist	TOPSOIL
		0.90	XXXX	Light greyish brown, SILT with trace roots. Massive. Firm to stiff. Non-plastic.	Moist	LOESS
		2.00		Light grey, sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse and sub-rounded to rounded. Bedded. Medium dense. Iron and manganese staining.	Moist	ALLUVIAL GRAVEL
	NO SEEPAGE	4.00		Light grey, sandy GRAVEL. Sand is fine to coarse. Gravel is fine to medium and sub-angular to sub-rounded. Bedded. Loose to medium dense.	Moist	ALLUVIAL GRAVEL

Total Depth = 4.00 m

COMMENT:	Logged by: Josh
	Checked Date:
	Sheet: 1 of 1

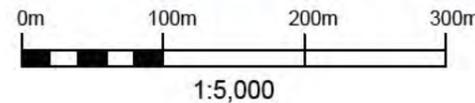
Appendix B: Paterson Pitts Group Engineering Drawings

AYRBURN PRECINCT LTD

HAYBARN VENUE - RESOURCE CONSENT DRAWINGS

PLAN INDEX

SHEET	CONTENTS	REV	DATE
INDEX			
001	SHEET INDEX	A	06/06/2023
GENERAL			
100	SITE PLAN	A	06/06/2023
EARTHWORKS			
200	EXISTING CONTOUR PLAN	A	06/06/2023
210	PROPOSED CONTOURS	A	06/06/2023
211	PROPOSED AND DEPTH CONTOURS	A	06/06/2023
212	PROPOSED AND DEPTH CONTOURS	A	06/06/2023
250	PROPOSED OVERFLOW CARPARK AND RAINGARDEN ESCP	A	06/06/2023
251	PROPOSED HAYBARN, BUS BAY AND CARPARK EXIT ESCP	A	06/06/2023
252	EROSION AND SEDIMENT CONTROL - DEB	A	06/06/2023
253	EROSION AND SEDIMENT CONTROL - ESC DEVICES	A	06/06/2023
ROADING			
301	ROADING - CARPARK LAYOUT	A	06/06/2023
302	ROADING - HAYBARN LAYOUT	A	06/06/2023
310	VEHICLE TRACKING - TOUR COACH	A	06/06/2023
311	VEHICLE TRACKING - HAYBARN	A	06/06/2023
320	AYRBURN CARPARK ALLOCATION	A	06/06/2023
340	ROADING - CROSS SECTIONS	A	06/06/2023
350	ROADING - SIGHT LINE SECTIONS	A	06/06/2023
3 WATERS			
400	PROPOSED 3 WATERS - OVERVIEW	A	06/06/2023
410	PROPOSED 3 WATERS	A	06/06/2023
411	PROPOSED 3 WATERS	A	06/06/2023
610	HYDRANT LAYOUT PLAN	A	06/06/2023



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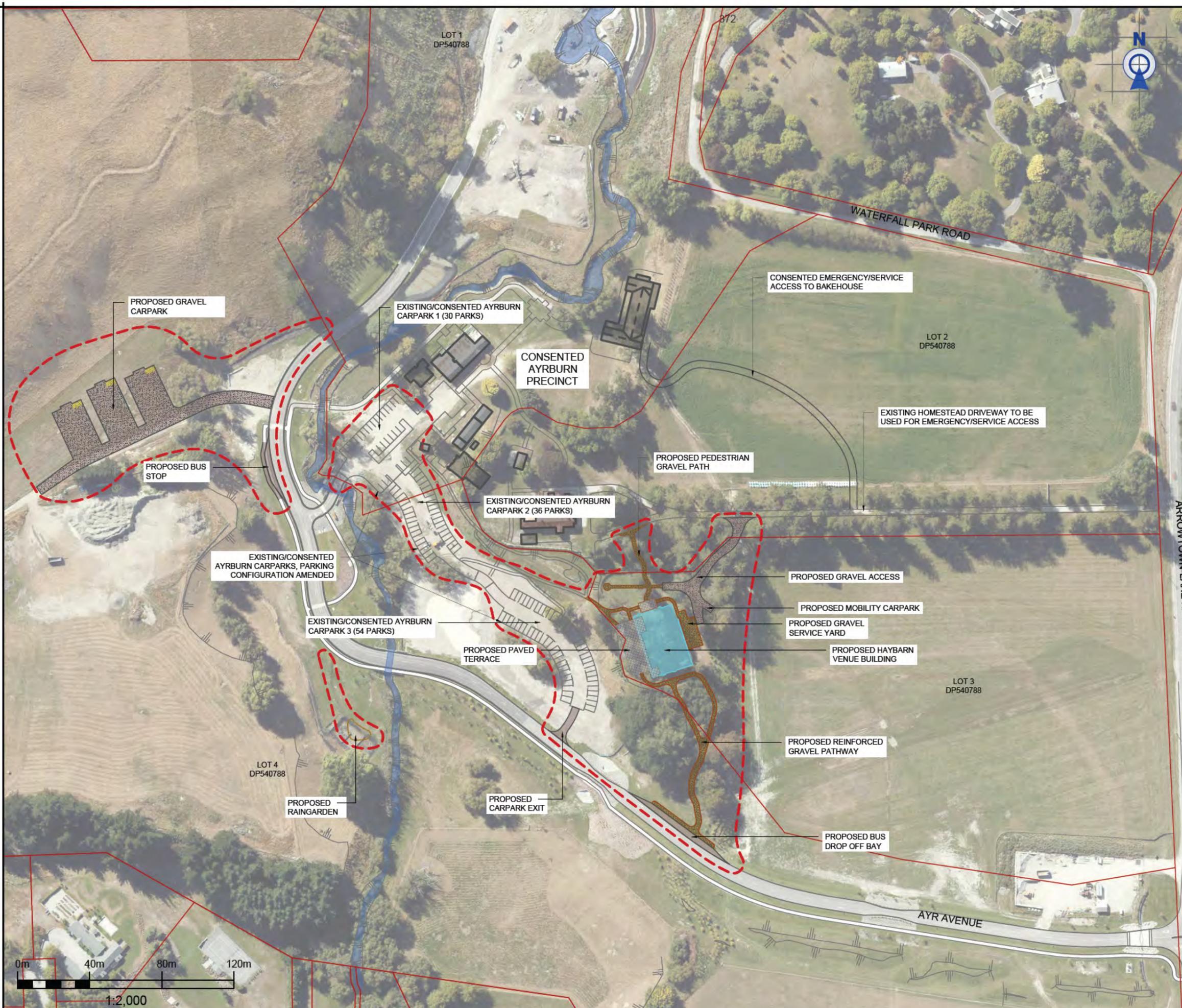
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Client & Location:
AYRBURN PRECINCT LTD
 AYR AVENUE - LOTS 1, 2, 3 & 4
 DP540788

Purpose & Drawing Title:
HAYBARN VENUE
 SHEET INDEX

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		Sheet No:	001
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		Date:	06/06/2023



LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- PROPOSED HAYBARN VENUE BUILDING
- PROPOSED PEDESTRIAN GRAVEL PATHWAY
- PROPOSED BUS DROP OFF BAY & CARPARK EXIT
- PROPOSED GRAVEL CARPARK & ACCESS
- PROPOSED PAVED TERRACE
- EXISTING / CONSENTED BUILDINGS
- SITE EXTENTS

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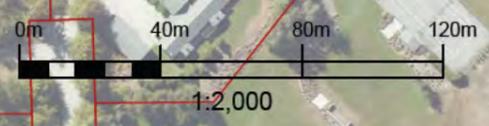
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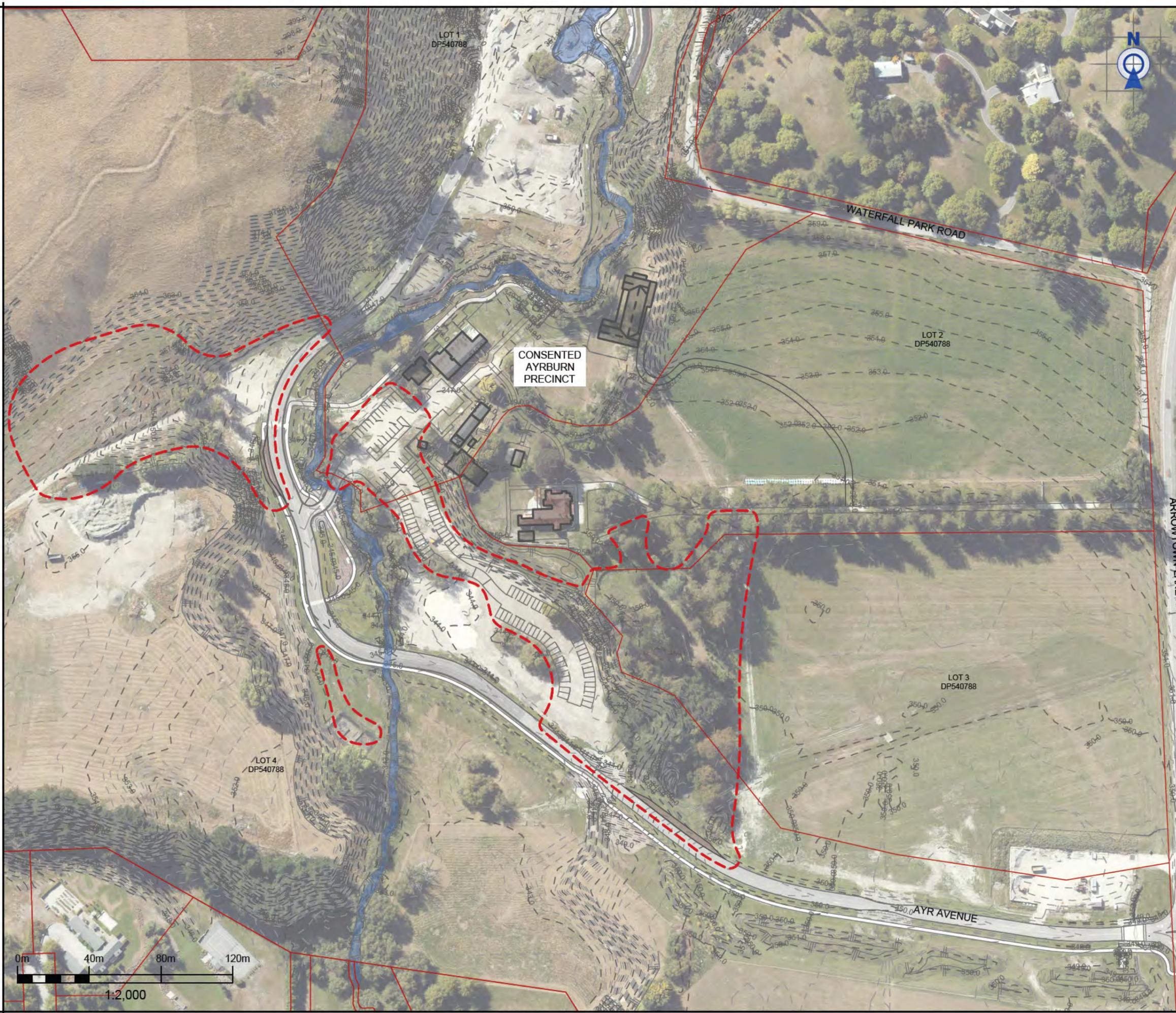
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Purpose & Drawing Title:
 HAYBARN VENUE
 SITE PLAN

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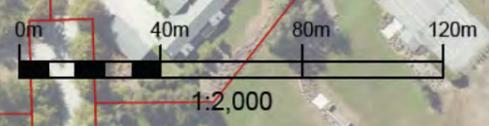
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LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- EXISTING CONTOURS (0.25m INTERVAL)
- EXISTING / CONSENTED BUILDINGS
- SITE EXTENTS



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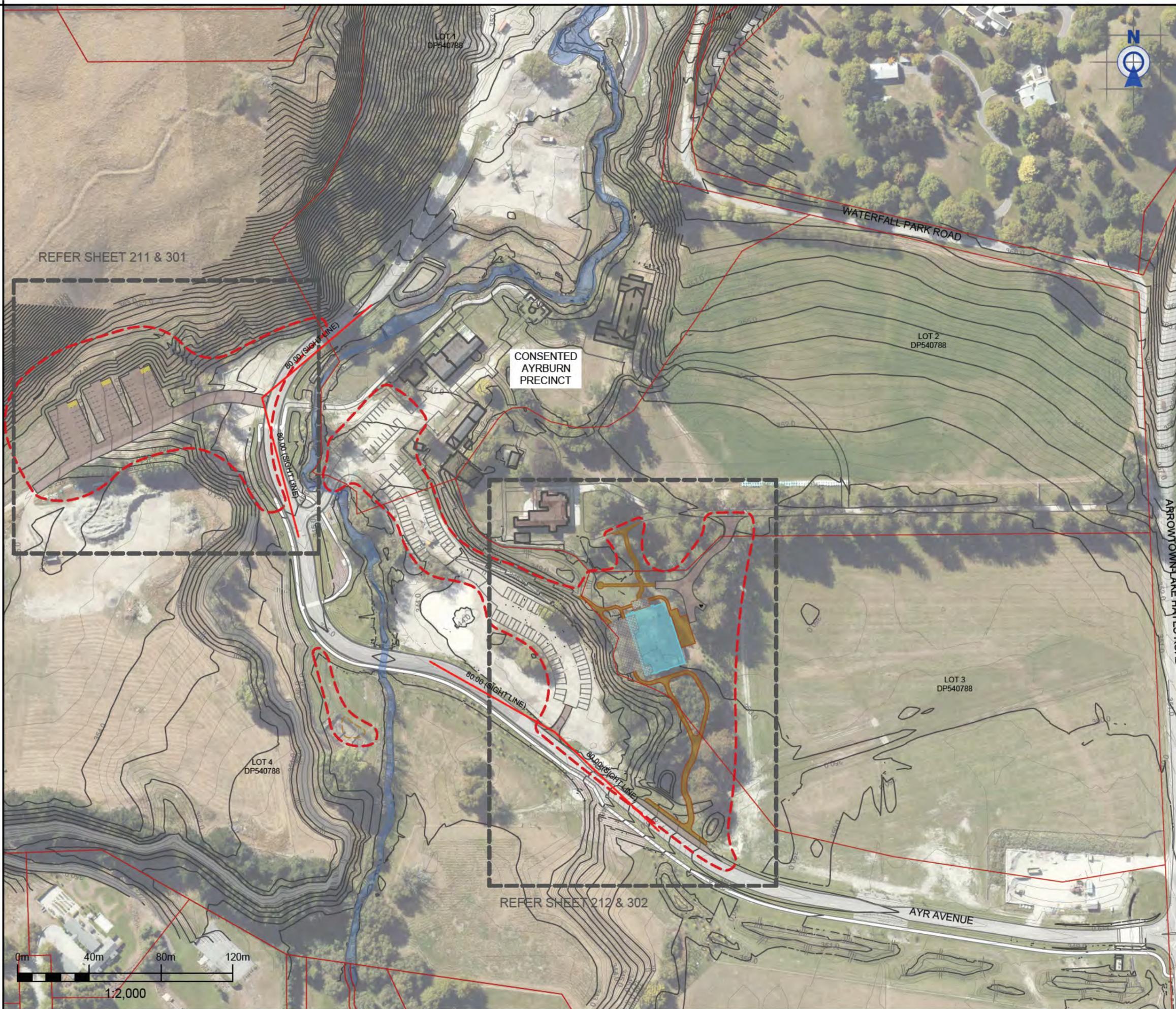
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 EXISTING CONTOURS

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LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- PROPOSED CONTOURS (0.25m INTERVAL)
- PROPOSED HAYBARN VENUE BUILDING
- PROPOSED PEDESTRIAN GRAVEL PATHWAY
- PROPOSED BUS DROP OFF BAY & CARPARK EXIT
- PROPOSED GRAVEL CARPARK & ACCESS
- PROPOSED PAVED TERRACE
- EXISTING / CONSENTED BUILDINGS
- - - SITE EXTENTS

REFER SHEET 211 & 301

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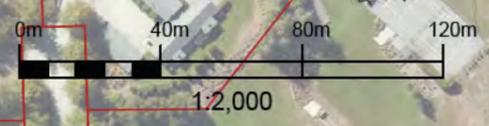
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Purpose & Drawing Title:
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 PROPOSED CONTOURS - OVERVIEW

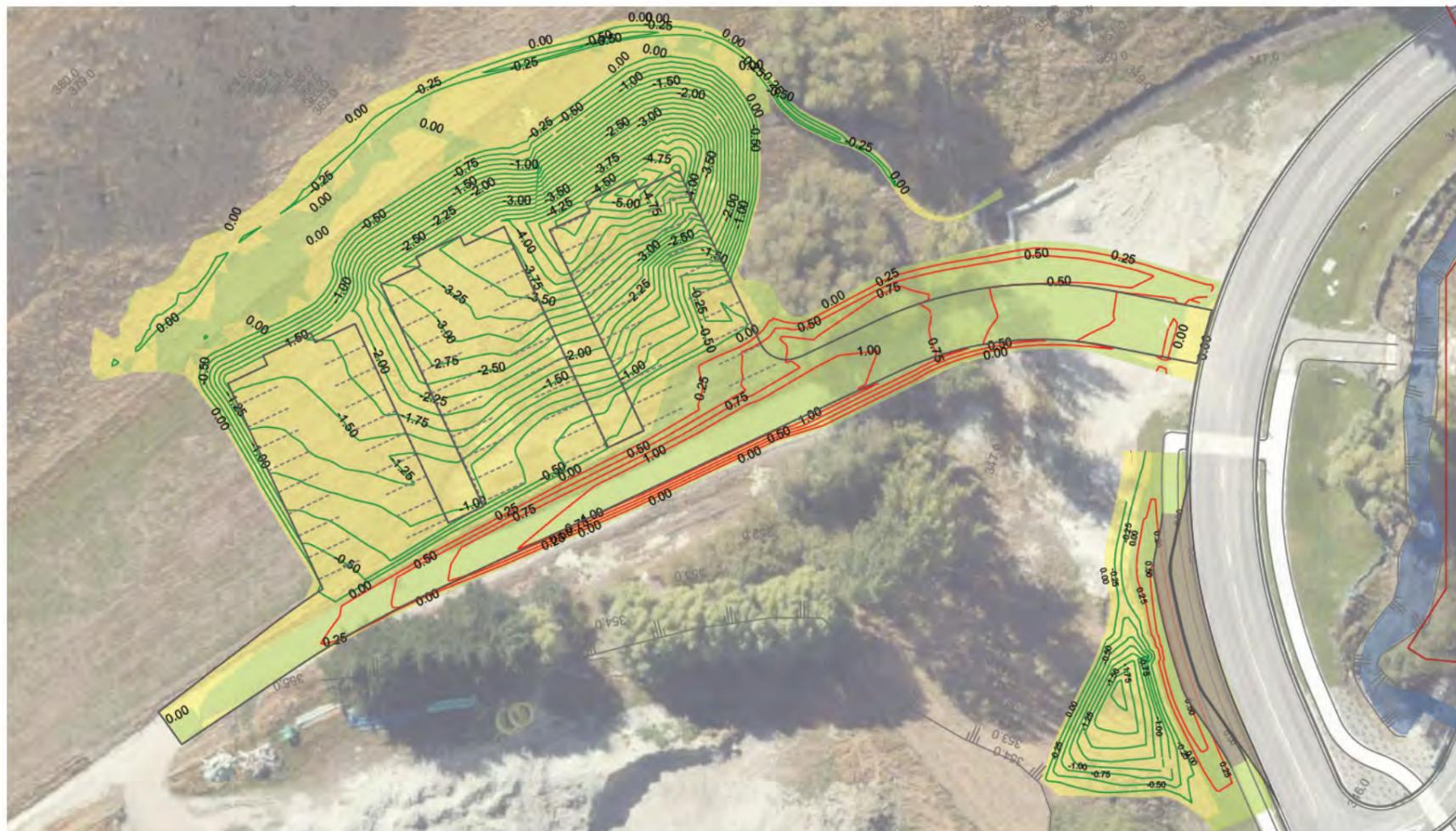
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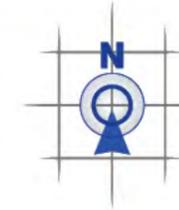




PROPOSED CONTOURS



DEPTH CONTOURS

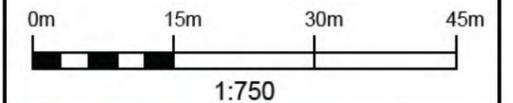


- LEGEND**
- LEGAL BOUNDARY
 - MILL CREEK
 - 354.0 PROPOSED CONTOURS (0.25m INTERVAL)
 - 0.50 PROPOSED CUT CONTOUR (0.25m INTERVAL)
 - 0.50 PROPOSED FILL CONTOUR (0.25m INTERVAL)
 - PROPOSED GRAVEL CARPARK
 - SITE EXTENTS

EARTHWORKS

1. TOPSOIL	
1.1 STRIP	3,000 m ³
1.2 RESPREAD	1,100 m ³
1.3 EXCESS	1,900 m ³
2. EARTHWORKS	
2.1 CUT	6,500 m ³
2.2 FILL	1,500 m ³
2.3 EXCESS (WASTE OFF SITE)	5,000 m ³
2.4 IMPORTED TO FILL	2,000 m ³
3. MAX CUT/FILL DEPTH	m / m
4. AREA OF EARTHWORKS	1.0 Ha

- NOTES**
5. ALL SEDIMENT AND EROSION CONTROLS TO BE ESTABLISHED IN ACCORDANCE WITH AUCKLAND CITY COUNCIL GD05. REFER SHEETS 250-252 FOR FURTHER DETAIL.
 6. CONTRACTOR TO ESTABLISH SEDIMENT AND EROSION CONTROLS PRIOR TO COMMENCING EARTHWORKS.
 7. CONTRACTOR TO LOCATE ALL EXISTING UTILITIES PRIOR TO COMMENCING EXCAVATION.
 8. ALL FILL TO BE PLACE IN ACCORDANCE WITH APPLICABLE GEOTECHNICAL OR ROAD PAVEMENT SPECIFICATION.



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Purpose & Drawing Title:
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 PROPOSED AND DEPTH CONTOURS

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PROPOSED CONTOURS



DEPTH CONTOURS

LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- PROPOSED CONTOURS (0.25m INTERVAL)
- 0.50 PROPOSED CUT CONTOUR (0.25m INTERVAL)
- 0.50 PROPOSED FILL CONTOUR (0.25m INTERVAL)
- PROPOSED HAYBARN VENUE BUILDING
- PROPOSED BUS DROP OFF BAY, CARPARK EXIT AND GRAVEL ACCESS TO HAYBARN VENUE BUILDING
- PROPOSED PEDESTRIAN GRAVEL PATHWAY
- SITE EXTENTS

EARTHWORKS

1. TOPSOIL	
1.1 STRIP	3,000 m ³
1.2 RESPREAD	1,100 m ³
1.3 EXCESS	1,900 m ³
2. EARTHWORKS	
2.1 CUT	6,500 m ³
2.2 FILL	1,500 m ³
2.3 EXCESS (WASTE OFF SITE)	5,000 m ³
2.4 IMPORTED TO FILL	2,000 m ³
3. MAX CUT/FILL DEPTH	m / m
4. AREA OF EARTHWORKS	1.0 Ha

NOTES

5. ALL SEDIMENT AND EROSION CONTROLS TO BE ESTABLISHED IN ACCORDANCE WITH AUCKLAND CITY COUNCIL GD05. REFER SHEETS 250-252 FOR FURTHER DETAIL.
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Purpose & Drawing Title:

HAYBARN VENUE
PROPOSED AND DEPTH CONTOURS

FOR CONSENT

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LINE EXISTING SWALE ABOVE EARTHWORKS WITH PINNED OVERLAPPED GEOTEXTILE AND EXTEND THE CHANNEL TO THE EXISTING CULVERT UNDER AYR AVENUE.

CONSTRUCT 1% MAXIMUM GRADE CONTOUR DRAINS / DIVERSION CHANNELS IN THE CUT / FILL SURFACES TO DIRECT DIRTY WATER TO THE DECANTING EARTH BUND (DEB) AS THE EARTHWORKS PROGRAMME PROCEEDS

STABILISED SITE ENTRANCE

DECANTING EARTH BUND (DEB) AT THE HEAD OF THE EXISTING SWALE TO TREAT EARTHWORK'S RUNOFF. 102m³ REQUIRED STORAGE VOLUME. FLOATING BOOM DECANT AS PER EMP

EARTH BUND ALONG THE BOUNDARY OF THE WATERFALL PARK STOCKPILE AREA TO DIRECT RUNOFF AWAY FROM THE SOUTHERN BOUNDARY OF THE OVERFLOW CARPARK FILL AREA AND DOWN THE SLOPE SOUTHEAST TO THE EXISTING SEDIMENT RETENTION POND (SRP).

EXISTING WATERFALL PARK STOCKPILE AREA

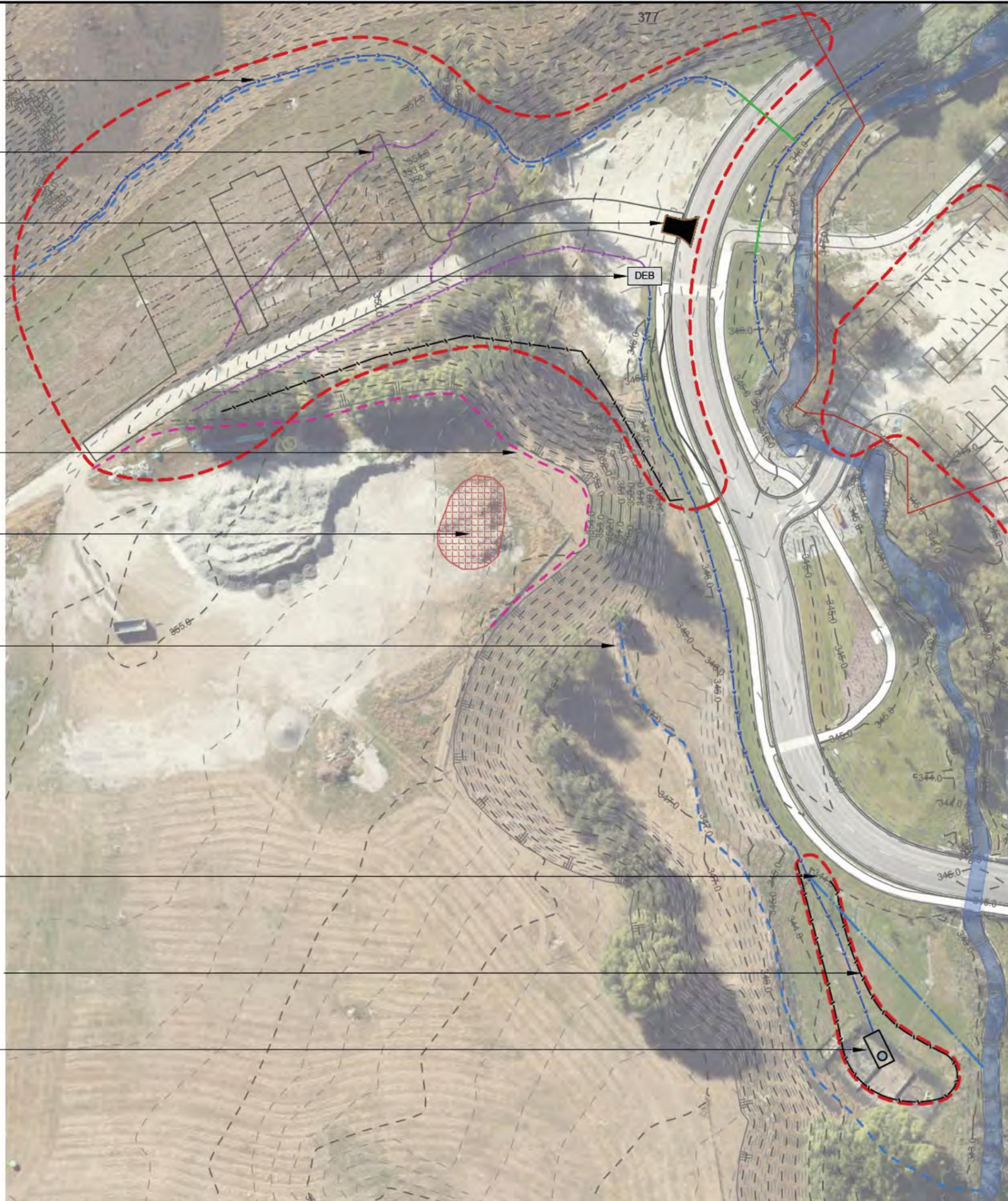
STOCKPILE CATCH DRAIN ALONG BASE OF SLOPE DISCHARGES TO MILL CREEK

EROSION AND SEDIMENT CONTROL FOR RAINGARDEN AT THE CONCLUSION OF THE OVERFLOW CARPARK WORKS AND REMOVAL OF THE DECANTING EARTH BUND AND REINSTATEMENT OF THE SWALE

TEMPORARY PIPE TO DISCHARGE CLEAN WATER TO MILL CREEK FROM REINSTATEMENT EXISTING SWALE AFTER BLOCKING THE ENTRANCE TO THE SEDIMENT RETENTION POND (SRP) AND REMOVAL OF OVERFLOW CARPARK EARTHWORK'S DECANTING EARTH BUND (DEB)

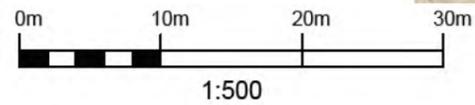
CLEAN WATER DIVERSION BUND CONSTRUCTED AROUND THE FOOTPRINT OF THE PROPOSED RAINGARDEN FOOTPRINT

EXISTING SEDIMENT RETENTION POND (SRP)



- LEGEND**
- LEGAL BOUNDARY
 - MILL CREEK
 - TOP OF BANK
 - 353.0 EXISTING CONTOURS (0.5m INTERVAL)
 - OVERLAND FLOW PATH
 - DIRTY WATER CHANNEL
 - SILT FENCE
 - CULVERT CROSSING
 - STABILISED SITE ENTRANCE
 - CONTAINMENT BUND
 - CLEAN WATER DIVERSION BUND
 - DEB DECANTING EARTH BUND
 - SRP SEDIMENT RETENTION POND
 - TEMPORARY PIPE
 - SITE EXTENTS

NOTE: CONCEPTUAL DESIGN ONLY AND NOT TO BE USED FOR CONSTRUCTION. THE LOCATION OF ANY OR ALL OF THE FEATURES MAY ALTER FROM WHAT IS DEPICTED ON THIS PLAN



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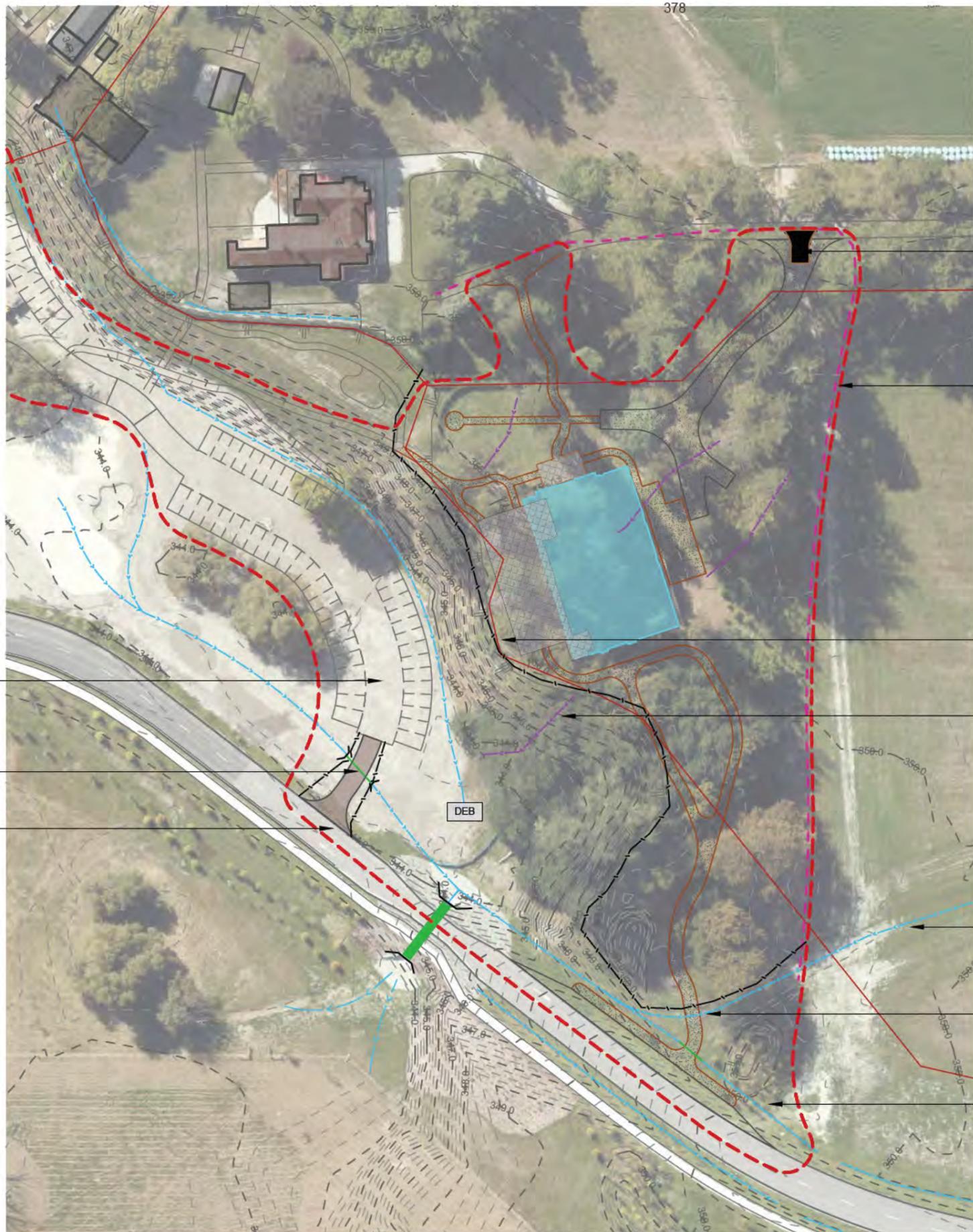
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Client & Location:
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 AYR AVENUE - LOTS 1, 2, 3 & 4
 DP540788

Purpose & Drawing Title:
 HAYBARN VENUE
 PROPOSED OVERFLOW CARPARK AND
 RAINGARDEN ESCP

FOR CONSENT

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			Date:
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- LEGEND**
- LEGAL BOUNDARY
 - MILL CREEK
 - TOP OF BANK
 - - - EXISTING CONTOURS (0.5m INTERVAL)
 - OVERLAND FLOW PATH
 - DIRTY WATER OVERLAND FLOW
 - SILT FENCE
 - CULVERT CROSSING
 - STABILISED SITE ENTRANCE
 - CONTAINMENT BUND
 - CLEAN WATER DIVERSION BUND
 - DEB DECANTING EARTH BUND
 - SEDIMENT RETENTION POND
 - SITE EXTENTS

HAYBARN WORKS AT THE ENTRANCE FROM AYRBURN HOMESTEAD ON THE SERVICE ACCESSWAY TO BE USED AS THE MAIN HAUL ROAD ACCESS TO WORKS ON THE TOP OF THE TERRACE

COMPACTED EARTH BUND ALONG THE SOUTHERN SIDE OF THE EXISTING AYRBURN HOMESTEAD DRIVEWAY AND DOWN THE BOUNDARY OF THE WOODED AREA WITH THE OPEN GRASS Paddock. GIVEN THE LOW LIKELIHOOD OF CONCENTRATED FLOWS DUE TO THE SHALLOW GRADE OF THE LAND LINING WITH GEOTEXTILE WON'T BE NECESSARY TO PREVENT SCOUR

SILT FENCE ESTABLISHED DOWNSLOPE OF ALL THE HAYBARN CATCHMENT WORKS AT THE OUTSET OF WORKS INCLUDING THE TREE AND ROOT CLEARANCE

RUNOFF THAT HAD PASSED DOWN THROUGH THE SILT FENCES BELOW THE WORK SITES AND WIDER SURFACE RUNOFF WITHIN THE BUND CONTAINED CATCHMENT WILL BE DIRECTED DOWN THE ESCARPMENT VIA ESTABLISHED CULVERTS TO THE CARPARK AREA AND TREATMENT VIA THE EXISTING DECANTING EARTH BUND

INTERCEPTOR SWALE

INTERCEPTOR SWALE TO BE CROSSED BY PROPOSED CULVERT BRIDGE

DOUBLE BUS BAY SWALE TO BE CONSTRUCTED OFFLINE DURING DRY WEATHER. THE NEW SWALE CHANNEL TO BE MADE LIVE AND THE OLD CHANNEL FILLED IN ONCE THE CULVERT HAS BEEN LAID AND BACK FILL COMPLETE. NO OTHER CONTROLS PROPOSED HERE.

ENTRY AND EXIT TO AND FROM THIS WORK SITE DURING CONSTRUCTION TO BE ONLY FROM THE EXISTING/CONSENTED CARPARK AND NOT FROM AYR AVENUE TO MINIMISE THE TRAFFICKING OF SILT ONTO AYR AVENUE

SWALE CROSSING AT THE CARPARK EXIT TO BE THE LAST OF THE HAYBARN WORKS. IT IS TO BE CULVERTED AND BACKFILLED DURING DRY WEATHER AS QUICKLY AS POSSIBLE.

SILT FENCE BOUNDING THE EARTHWORKS CORRIDOR TO LIMIT THE MIGRATION OF SEDIMENT DURING THE FILL / DECOMISIONING PROCESS OF THE EXISTING DECANTING EARTH BUND (DEB)

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THE CREATION OF THE FOOTPATH DOWN THE DOUBLE BUS BAY, THE DOUBLE BUS BAY AND THE EXIT FROM THE AYRBURN CARPARK TO AYR AVENUE ALL CROSS ESTABLISHED STORMWATER SWALES AND WILL BE CONSTRUCTED IN DRY WEATHER. AS THE TERRAIN IS FLAT AND THE SWALE GRADES ARE SHALLOW, NO FURTHER CONTROLS ARE PROPOSED FOR THESE WORKS.

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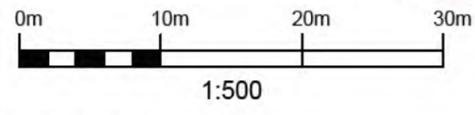
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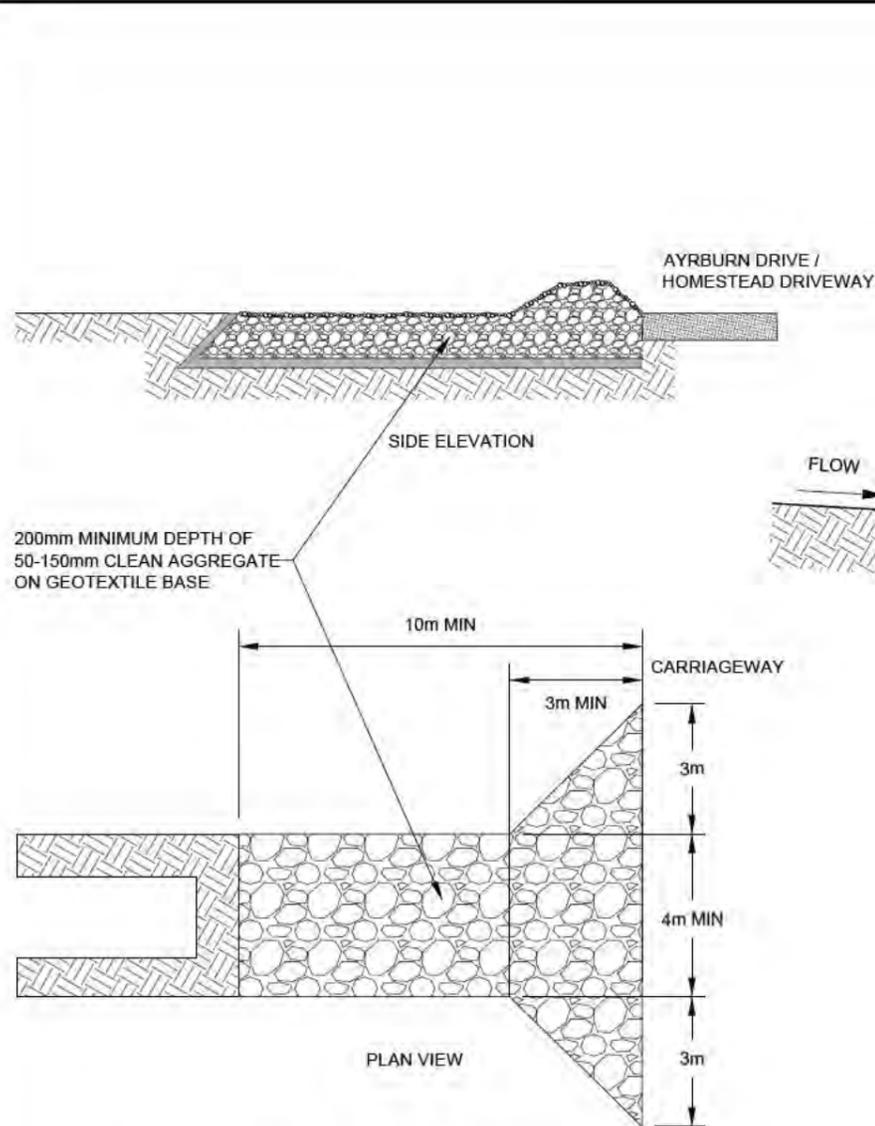
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Purpose & Drawing Title:
 HAYBARN VENUE
 PROPOSED HAYBARN, BUS BAY AND CARPARK EXIT ESCP

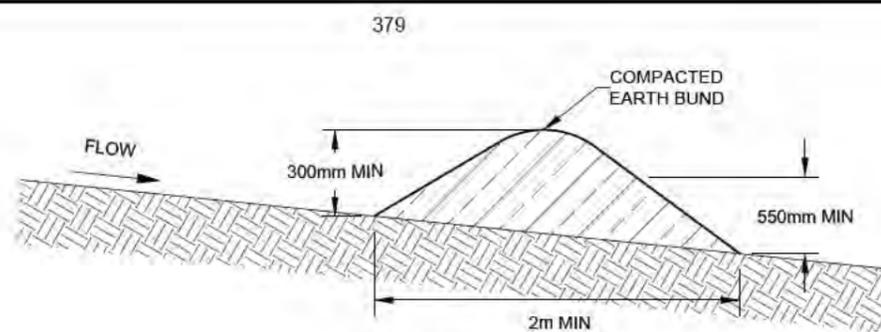
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Checked by:	SW		
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		Sheet No:	251
		Revision No:	A
		Date:	06/06/2023

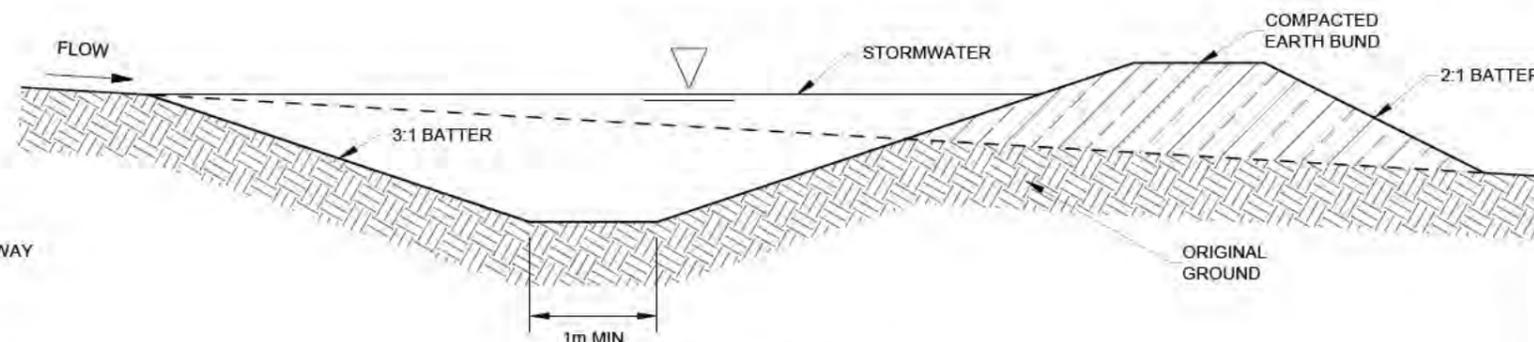




STABILISED SITE ENTRANCE



DIVERSION BUND



DIVERSION CHANNEL

NB. 1. SOIL TO FORM BUND TO BE TAKEN FROM DISTURBED AREA
2. VEGETATION IN UNDISTURBED AREA TO REMAIN INTACT

NOTE: CONCEPTUAL DESIGN ONLY. RL OF KEY DESIGN
FEATURES TO BE DETERMINED BY LOCAL SURVEY AND
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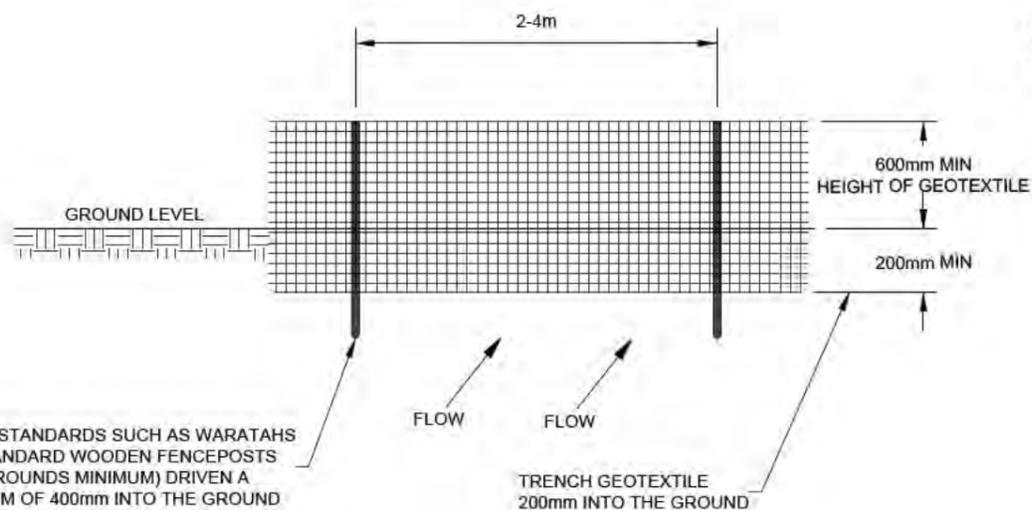
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AYR AVENUE - LOTS 1, 2, 3 & 4
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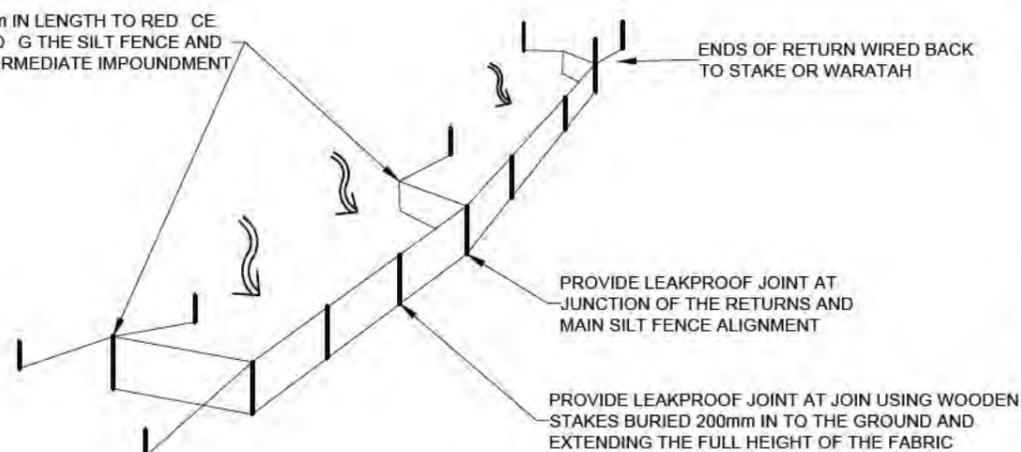
Purpose & Drawing Title:
HAYBARN VENUE
PLAN 4 APPENDIX A - DECANTING
EARTH BUND

FOR CONSENT



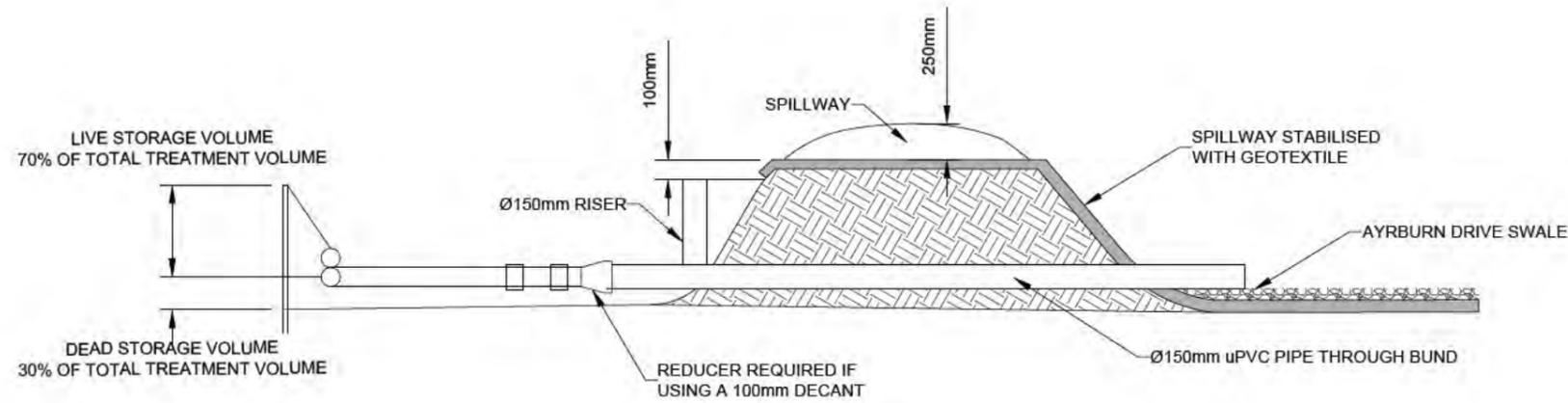
SILT FENCE - ELEVATION

RETURNS 1-3m IN LENGTH TO REDUCE
VELOCITY ALONG THE SILT FENCE AND
PROVIDE INTERMEDIATE IMPOUNDMENT



SILT FENCE PLAN VIEW SHOWING RETURNS

Surveyed by:	PPG	Original Size:	Scale:
Designed by:	MG	A3	NTS
Drawn by:	SB, EA		
Checked by:	SW		
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Job No:	Drawing No:	Sheet No:	Revision No: Date:
Q6388	32 - 10	252	A 06/06/2023



DEB - CROSS SECTION

NOTE: CONCEPTUAL DESIGN ONLY. RL OF KEY DESIGN FEATURES TO BE DETERMINED BY LOCAL SURVEY AND INCLUDED IN CONSTRUCTION INSTRUCTIONS

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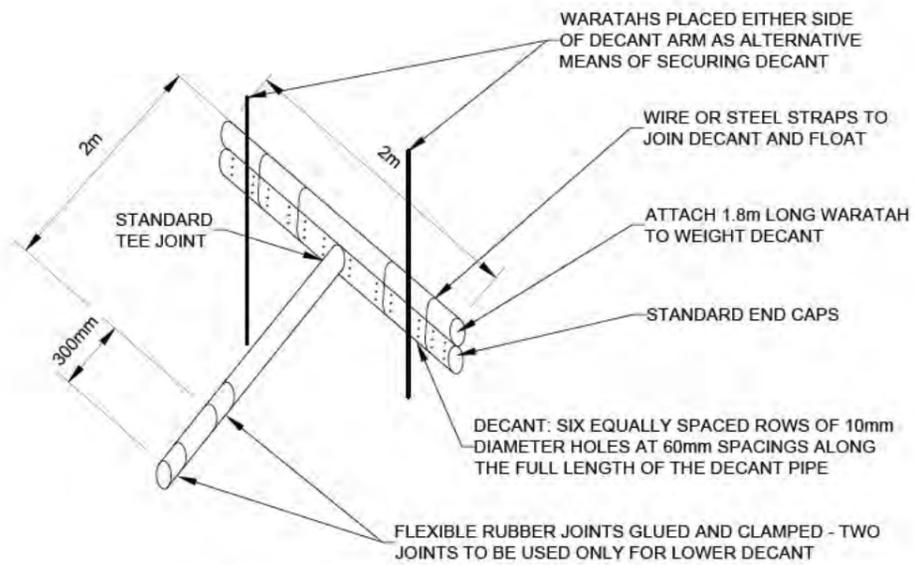
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 AYR AVENUE - LOTS 1, 2, 3 & 4
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Purpose & Drawing Title:
HAYBARN VENUE
 PLAN 3 APPENDIX A - ESC DEVICES

FOR CONSENT

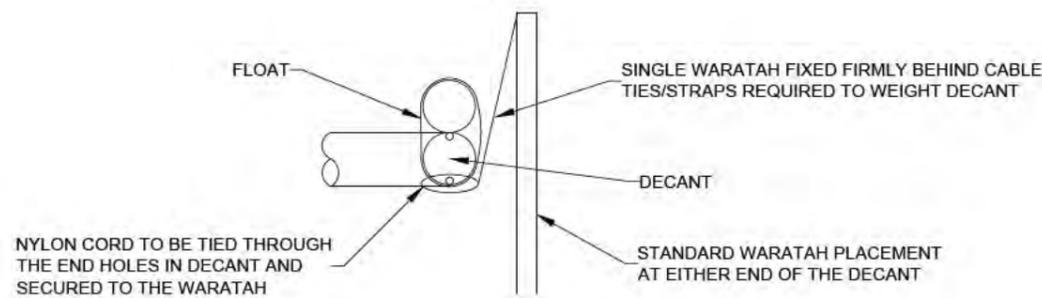
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Job No:	Q6388	Drawing No:	32 - 10
		Sheet No:	253
		Revision No:	A
		Date:	06/06/2023



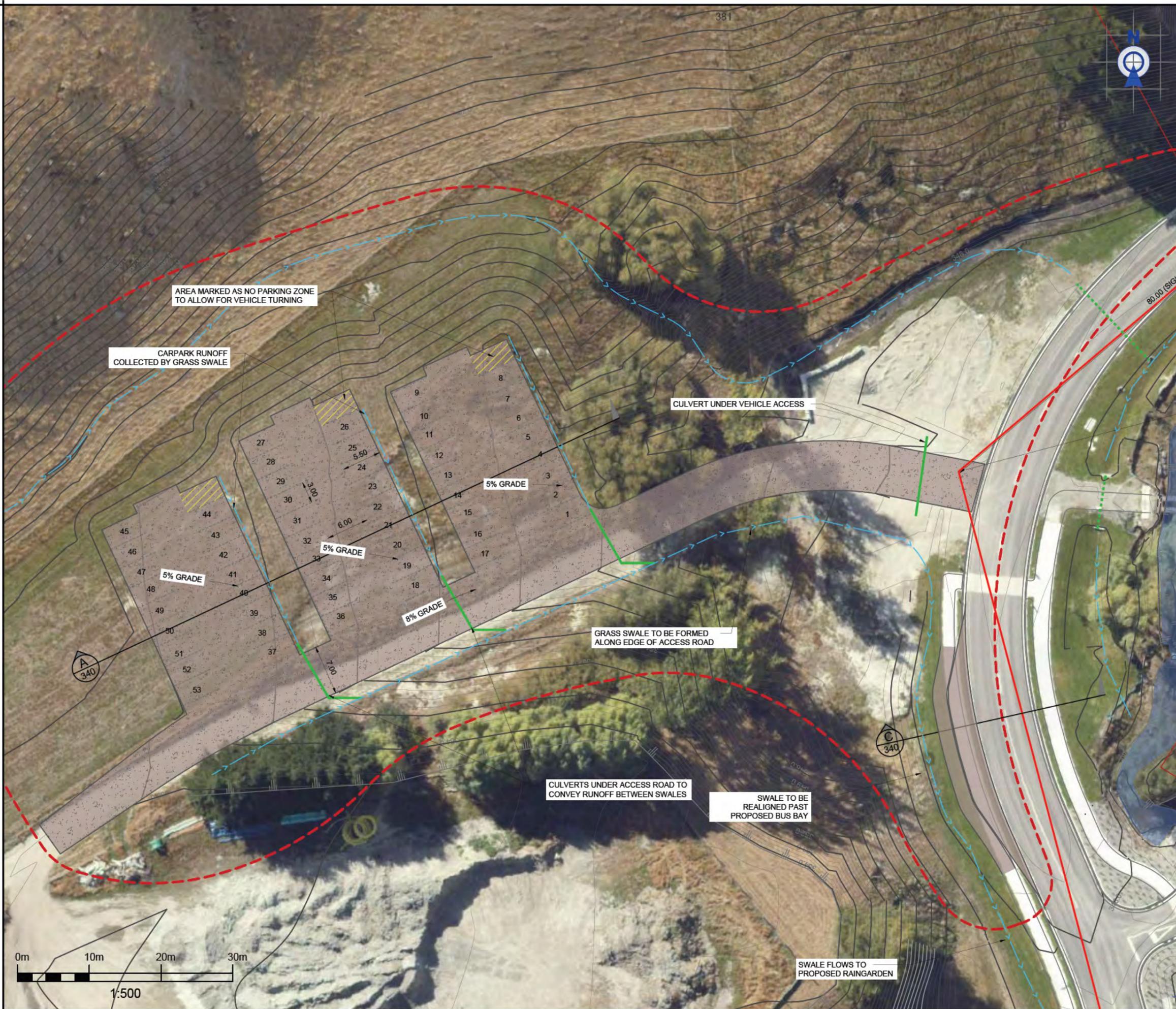
BOOM DECANT: T-BAR DESIGN



PHOTO OF DECANTING EARTH BUND



BOOM DECANT: T-BAR CROSS SECTION



LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- PROPOSED CONTOURS (0.25m INTERVAL)
- PROPOSED GRAVEL CARPARK
- PROPOSED STORMWATER MAIN
- EXISTING STORMWATER MAIN
- STORMWATER OVERLAND FLOW PATH
- SITE EXTENTS

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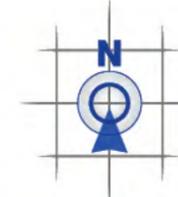
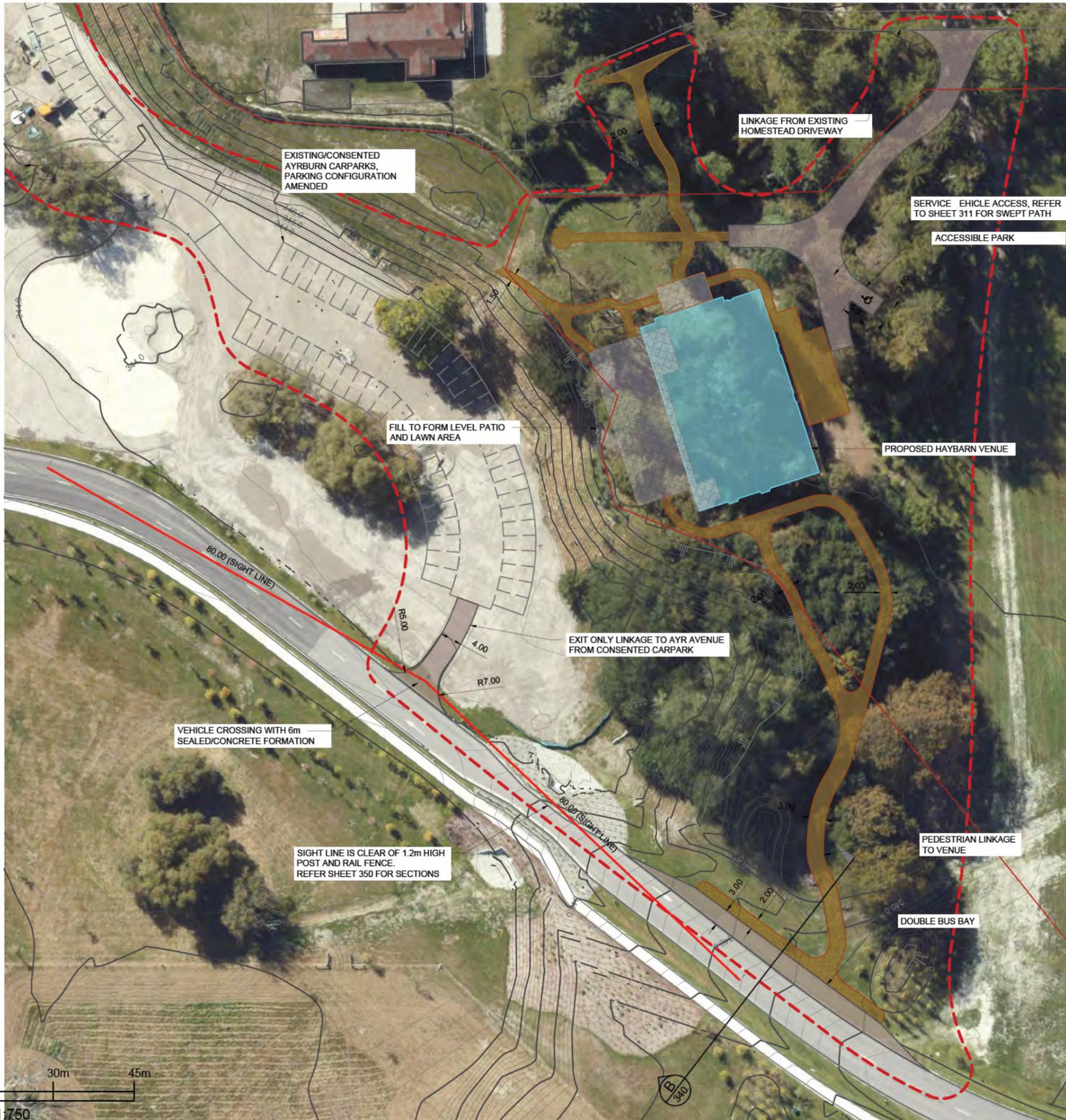
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Purpose & Drawing Title:
HAYBARN VENUE
 ROADING - CARPARK LAYOUT

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		Sheet No:	301
		Revision No:	A
		Date:	06/06/2023



LEGEND	
	LEGAL BOUNDARY
	MILL CREEK
	PROPOSED CONTOURS (0.25m INTERVAL)
	PROPOSED HAYBARN VENUE BUILDING
	PROPOSED PEDESTRIAN GRAVEL PATHWAY
	PROPOSED BUS DROP OFF BAY & CARPARK EXIT
	PROPOSED GRAVEL CARPARK & ACCESS
	PROPOSED PAVED TERRACE
	EXISTING / CONSENTED BUILDINGS
	SITE EXTENTS

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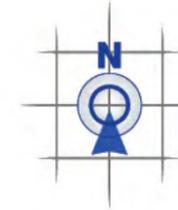
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Purpose & Drawing Title:
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 ROADING - HAYBARN LAYOUT

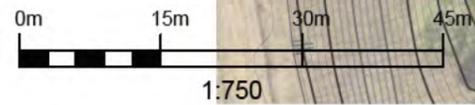
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Checked by:	SW		
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		Sheet No:	302
		Revision No:	A
		Date:	06/06/2023



- LEGEND**
- LEGAL BOUNDARY
 - MILL CREEK
 - PROPOSED CONTOURS (0.25m INTERVAL)
 - PROPOSED HAYBARN VENUE BUILDING
 - PROPOSED PEDESTRIAN GRAVEL PATHWAY
 - PROPOSED BUS DROP OFF BAY & CARPARK EXIT
 - PROPOSED GRAVEL CARPARK & ACCESS
 - PROPOSED PAVED TERRACE
 - EXISTING / CONSENTED BUILDINGS
 - - - SITE EXTENTS

- NOTE**
1. 12.5m TOUR COACH USED AS DESIGN VEHICLE. TOUR BUS CAN ENTER CARPARK IN CLOCK WISE DIRECTION.
 2. TRACKING SHOWN INCLUDED 0.5m BUFFER AROUND EXTENTS OF SWEEP PATH.



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Purpose & Drawing Title:
HAYBARN VENUE
 VEHICLE TRACKING - TOUR COACH

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8m TRUCK VEHICLE TRACKING (SERVICE ACCESS)



99th PERCENTILE CAR (ACCESSIBLE PARK)



LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- PROPOSED CONTOURS (0.25m INTERVAL)
- PROPOSED HAYBARN VENUE BUILDING
- PROPOSED PEDESTRIAN GRAVEL PATHWAY
- PROPOSED BUS DROP OFF BAY & CARPARK EXIT
- PROPOSED GRAVEL CARPARK & ACCESS
- PROPOSED PAVED TERRACE
- EXISTING / CONSENTED BUILDINGS
- - - SITE EXTENTS

NOTE

1. 8m MEDIUM RIGID TRUCK USED AS DESIGN VEHICLE FOR SERVICING
2. 99th PERCENTILE CAR HAS BEEN USED TO TEST SWEEPED PATHS INTO THE ACCESSIBLE CARPARK

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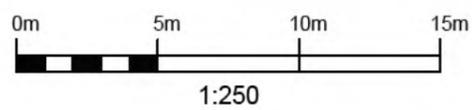
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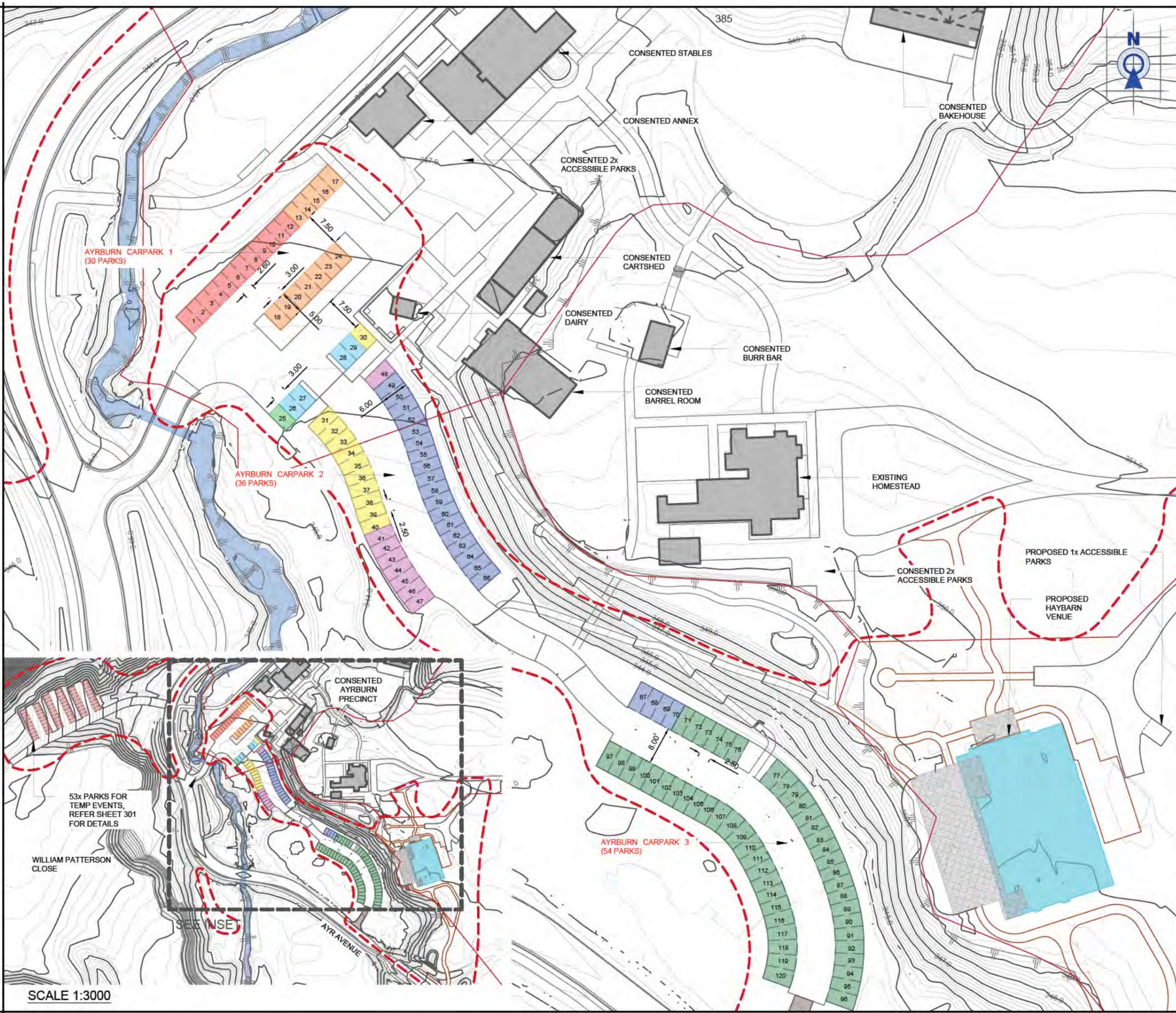
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Purpose & Drawing Title:
 HAYBARN VENUE
 VEHICLE TRACKING - HAYBARN

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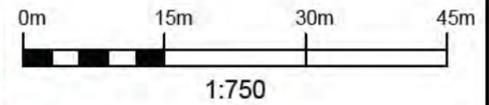
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Approved by:			
Job No:	Q6388	Drawing No:	32 - 10
		Sheet No:	311
		Revision No:	A
		Date:	06/06/2023





LEGEND

[Red Box]	STABLES
[Orange Box]	CARTSHED
[Green Box]	DAIRY
[Blue Box]	BURR BAR
[Yellow Box]	HOMESTEAD
[Purple Box]	BARREL ROOM
[Dark Blue Box]	BAKEHOUSE
[Light Green Box]	HAYBARN
[Pink Box]	TEMPORARY EVENT PARKING



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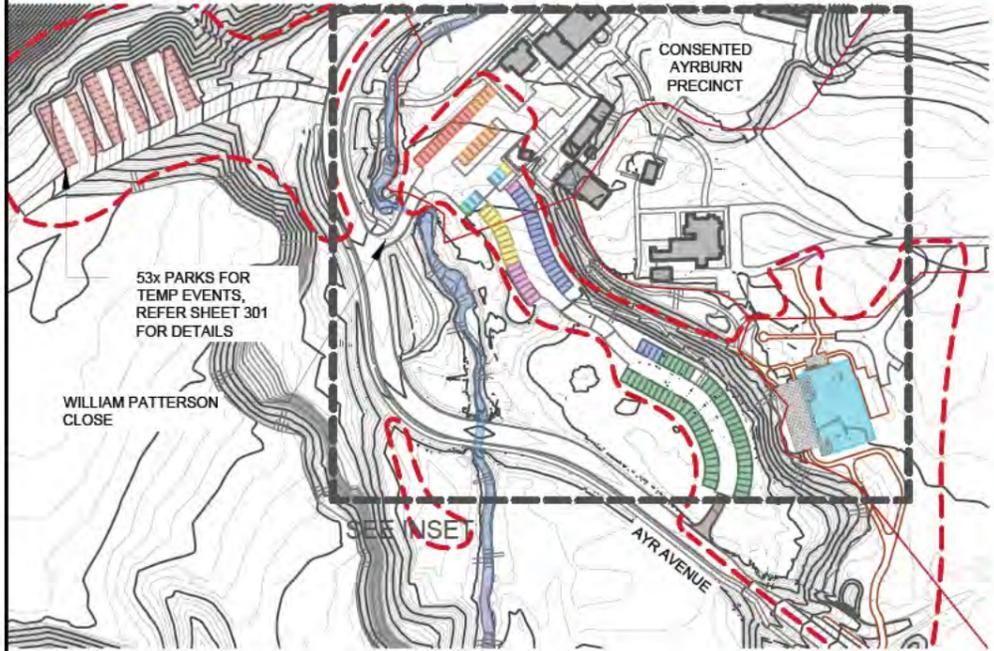
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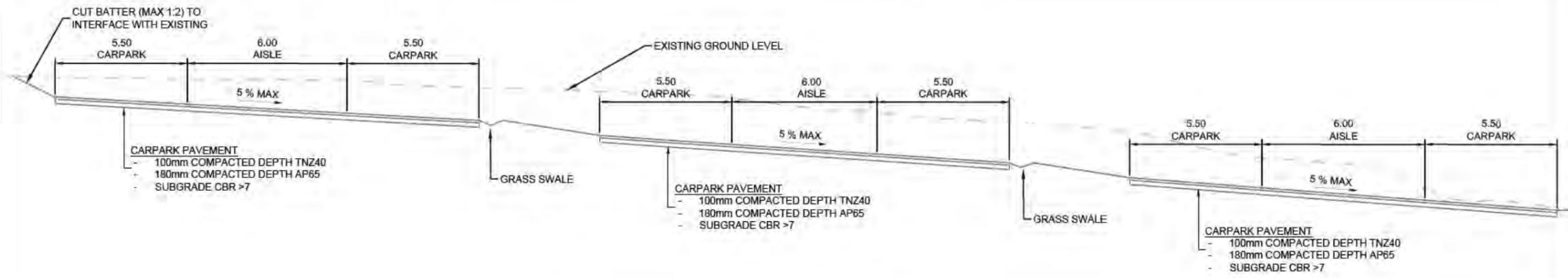
Purpose & Drawing Title:
 HAYBARN VENUE
 AYRBURN CARPARK ALLOCATION

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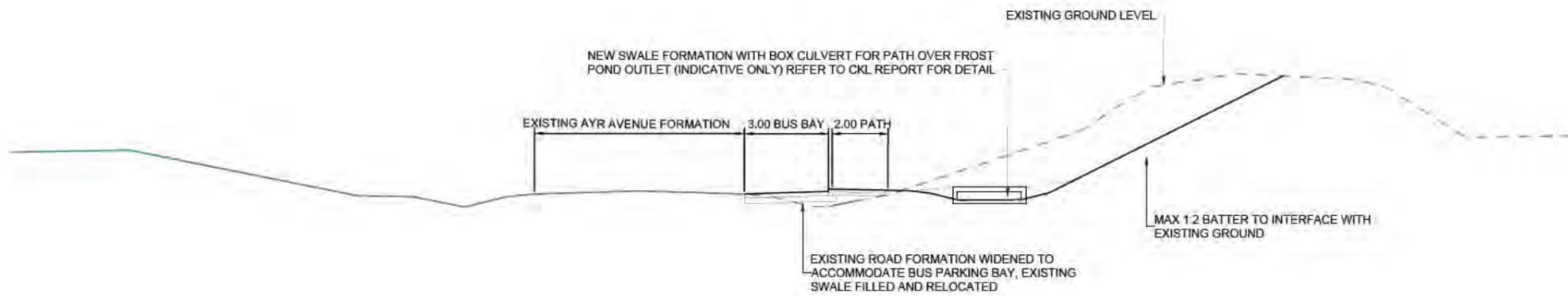


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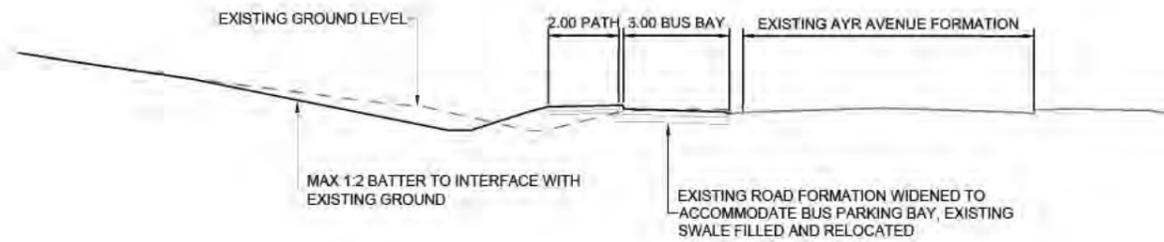
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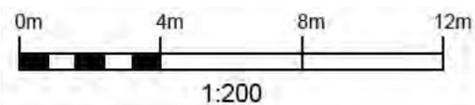
SECTION B - BUS BAY SECTION

SCALE 1:200



SECTION C - BUS BAY SECTION

SCALE 1:200



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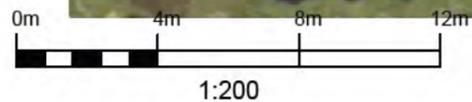
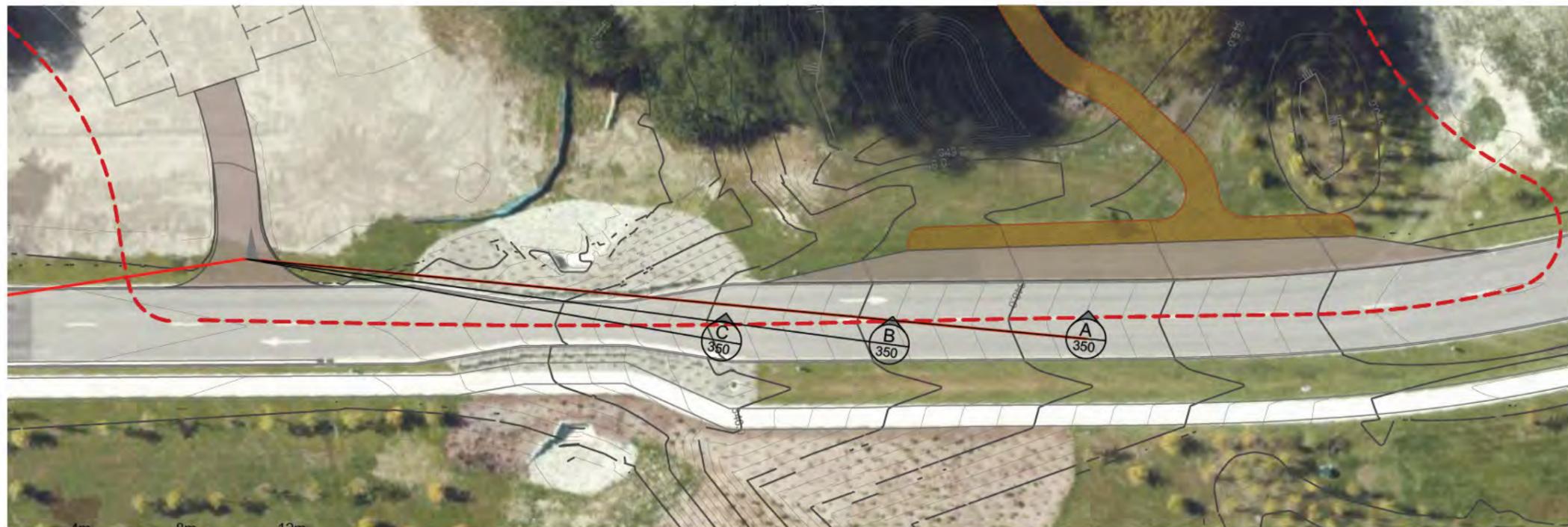
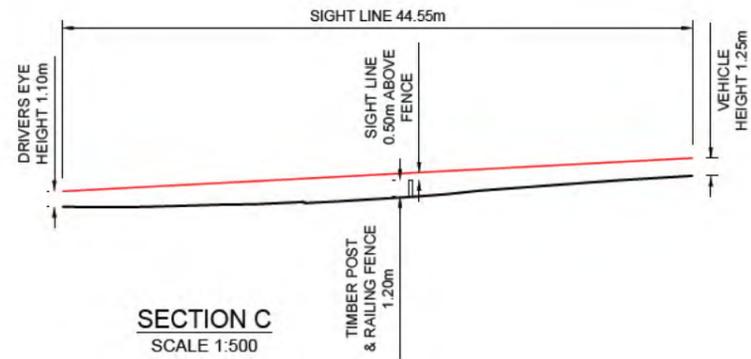
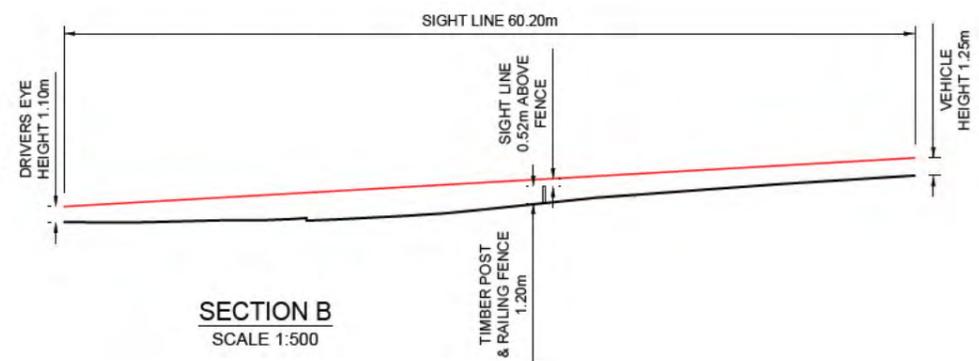
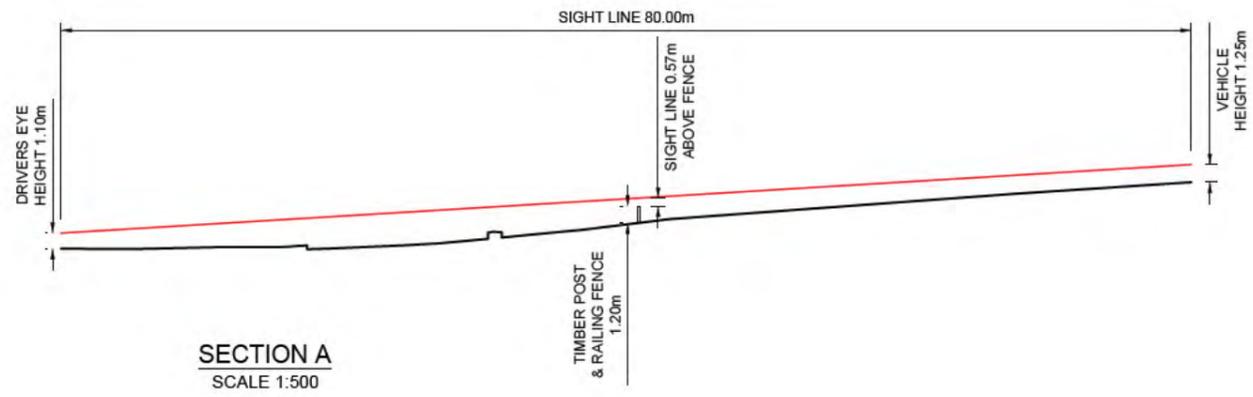
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Purpose & Drawing Title:
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 ROADING - CROSS SECTIONS

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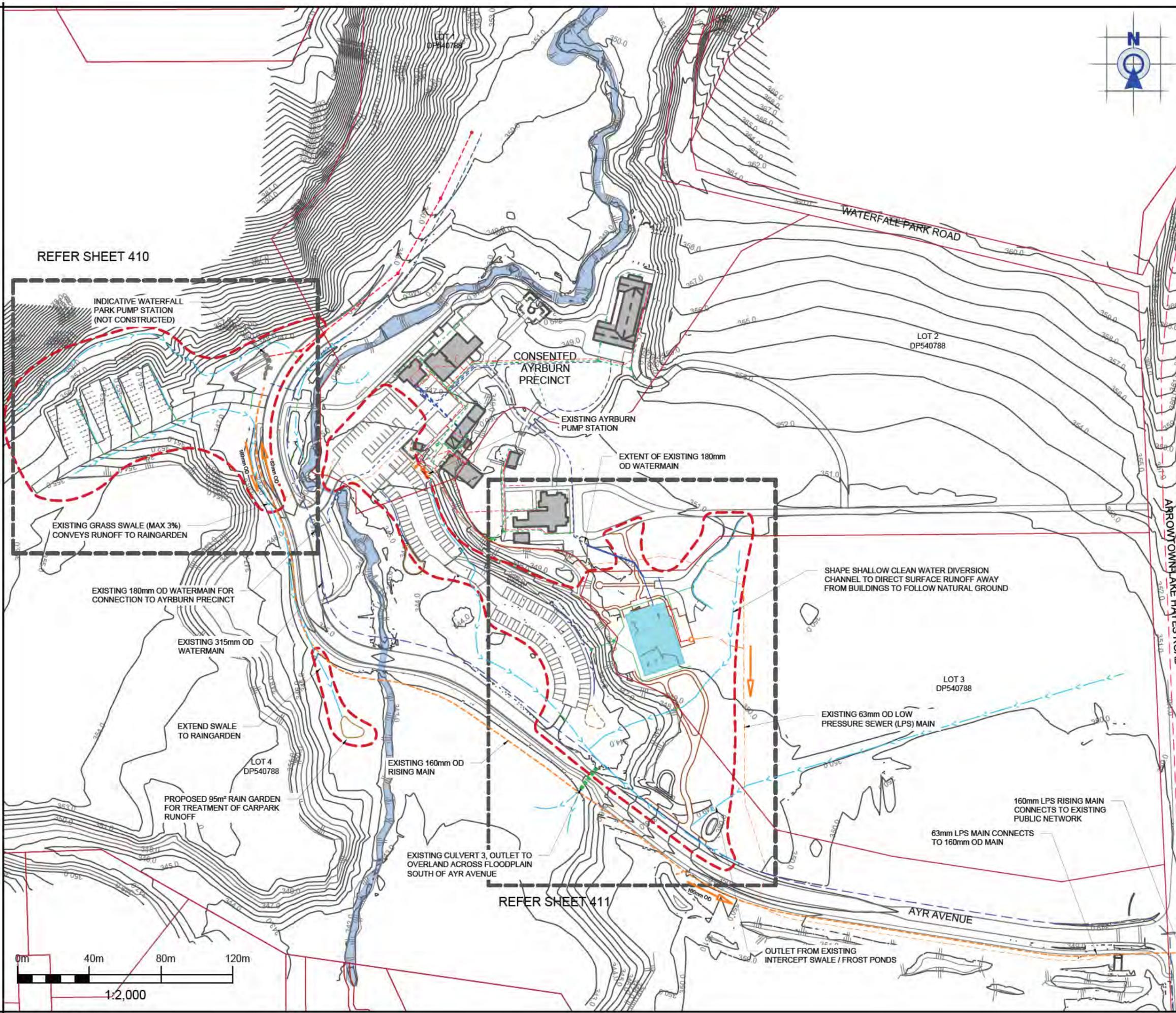
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Purpose & Drawing Title:
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 ROADING - SIGHT LINE SECTIONS

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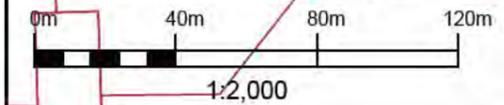
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- LEGEND**
- LEGAL BOUNDARY
 - MILL CREEK
 - PROPOSED CONTOURS (1.00m INTERVAL)
 - PROPOSED LOW PRESSURE SEWER MAIN
 - EXISTING LOW PRESSURE SEWER MAIN
 - PROPOSED GRAVITY SEWER MAIN
 - EXISTING GRAVITY SEWER MAIN
 - PROPOSED STORMWATER MAIN
 - EXISTING STORMWATER MAIN
 - STORMWATER OVERLAND FLOW PATH
 - STORMWATER TREATMENT SWALE
 - RAIN GARDEN
 - PROPOSED WATERMAIN
 - EXISTING WATERMAIN
 - PROPOSED HAYBARN VENUE BUILDING
 - EXISTING / CONSENTED BUILDINGS
 - SITE EXTENTS

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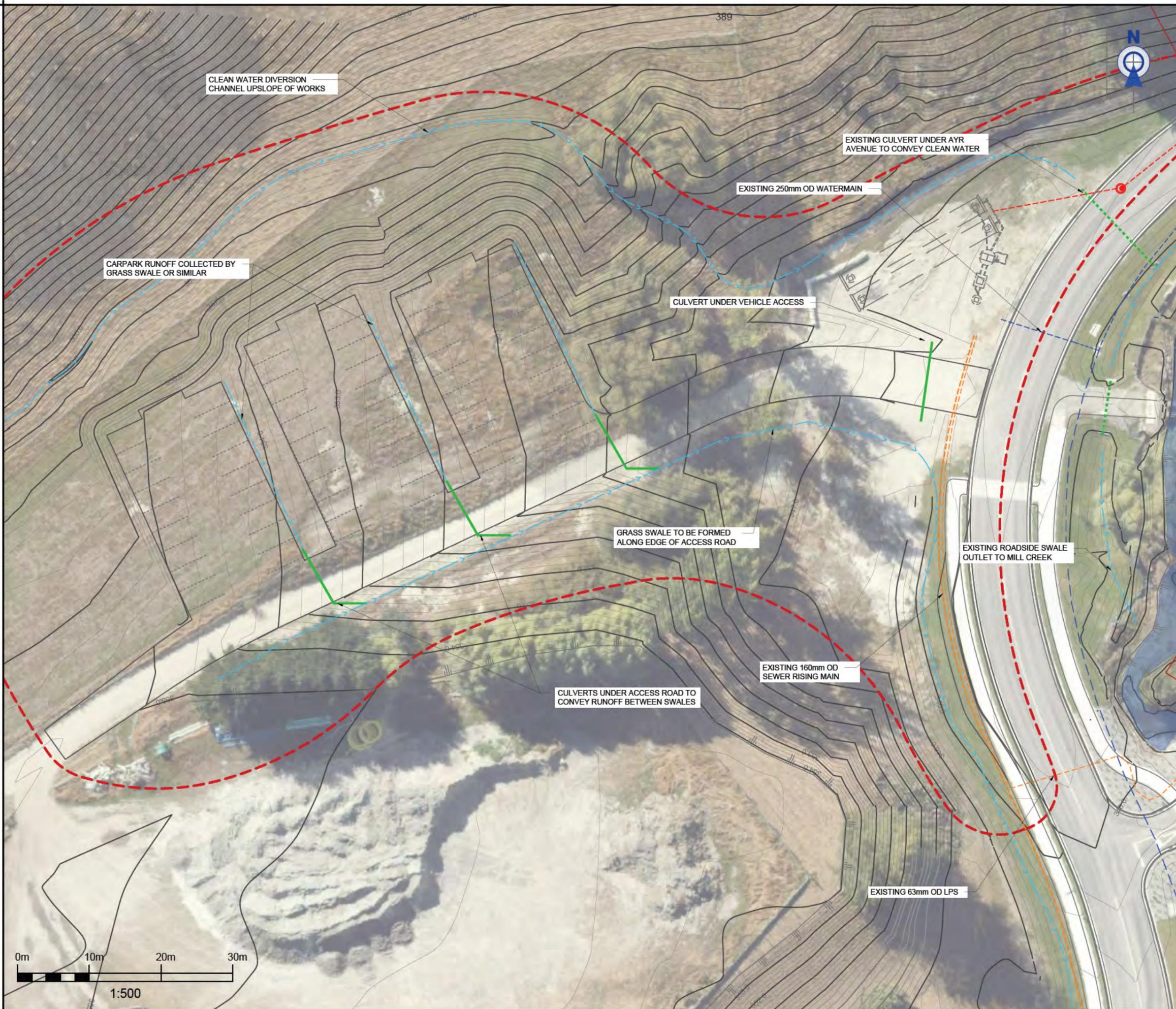
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Purpose & Drawing Title:
 HAYBARN VENUE
 PROPOSED 3 WATERS - OVERVIEW

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LEGEND

- LEGAL BOUNDARY
- MILL CREEK
- PROPOSED CONTOURS (0.25m INTERVAL)
- PROPOSED LOW PRESSURE SEWER MAIN
- - - EXISTING LOW PRESSURE SEWER MAIN
- PROPOSED GRAVITY SEWER MAIN
- - - EXISTING GRAVITY SEWER MAIN
- PROPOSED STORMWATER MAIN
- - - EXISTING STORMWATER MAIN
- STORMWATER OVERLAND FLOW PATH
- STORMWATER TREATMENT SWALE
- RAIN GARDEN
- PROPOSED WATERMAIN
- - - EXISTING WATERMAIN
- PROPOSED HAYBARN VENUE BUILDING
- EXISTING / CONSENTED BUILDINGS
- - - SITE EXTENTS

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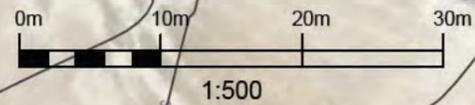
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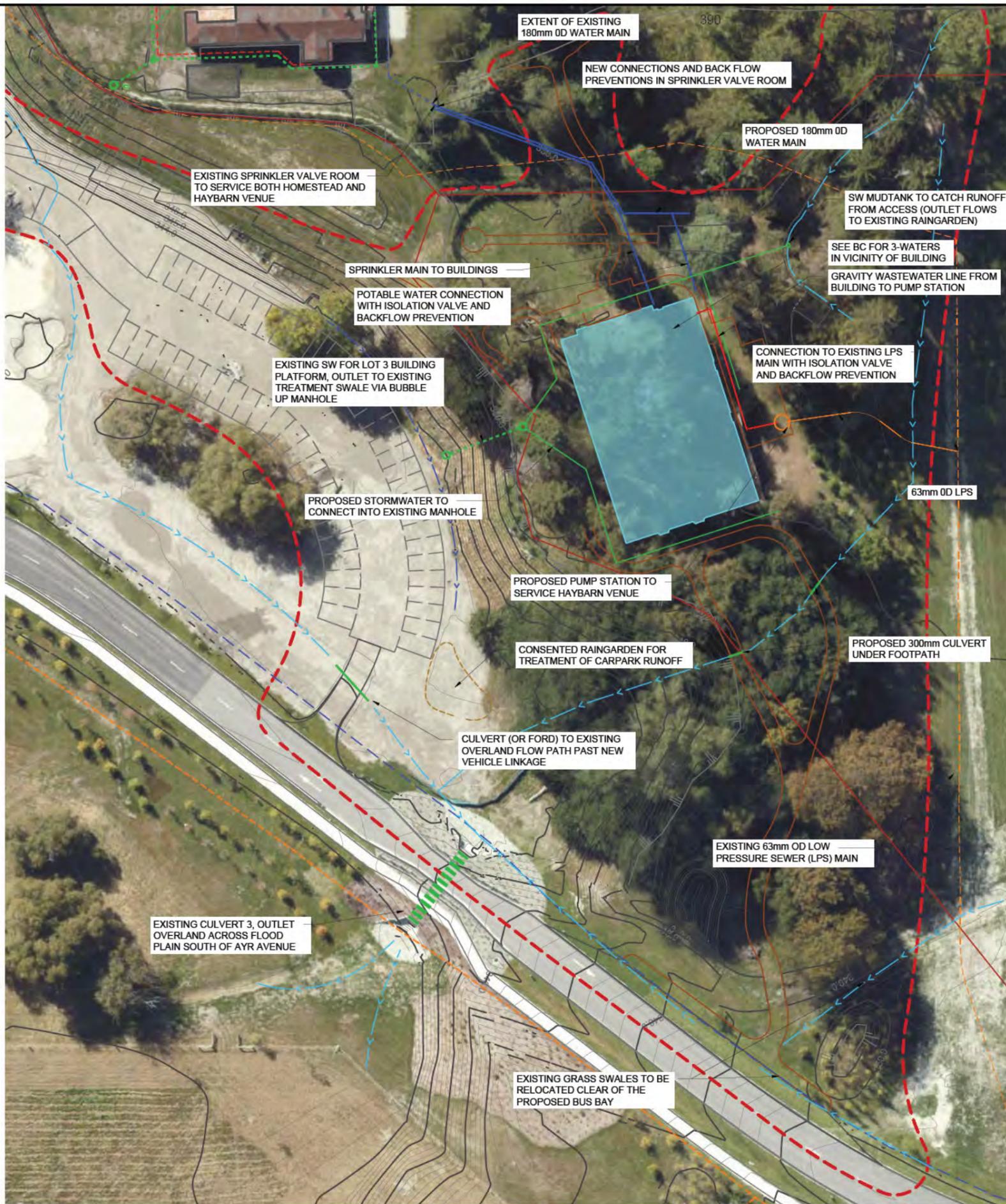
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Purpose & Drawing Title:
 HAYBARN VENUE
 PROPOSED 3 WATERS

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Q6388	32 - 10	410	A 06/06/2023





- LEGEND**
- LEGAL BOUNDARY
 - ~ MILL CREEK
 - PROPOSED CONTOURS (0.25m INTERVAL)
 - PROPOSED LOW PRESSURE SEWER MAIN
 - EXISTING LOW PRESSURE SEWER MAIN
 - PROPOSED GRAVITY SEWER MAIN
 - EXISTING GRAVITY SEWER MAIN
 - PROPOSED STORMWATER MAIN
 - EXISTING STORMWATER MAIN
 - STORMWATER OVERLAND FLOW PATH
 - STORMWATER TREATMENT SWALE
 - RAIN GARDEN
 - PROPOSED WATERMAIN
 - EXISTING WATERMAIN
 - PROPOSED HAYBARN VENUE BUILDING
 - EXISTING / CONSENTED BUILDINGS
 - SITE EXTENTS

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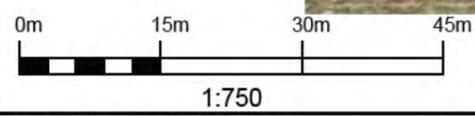
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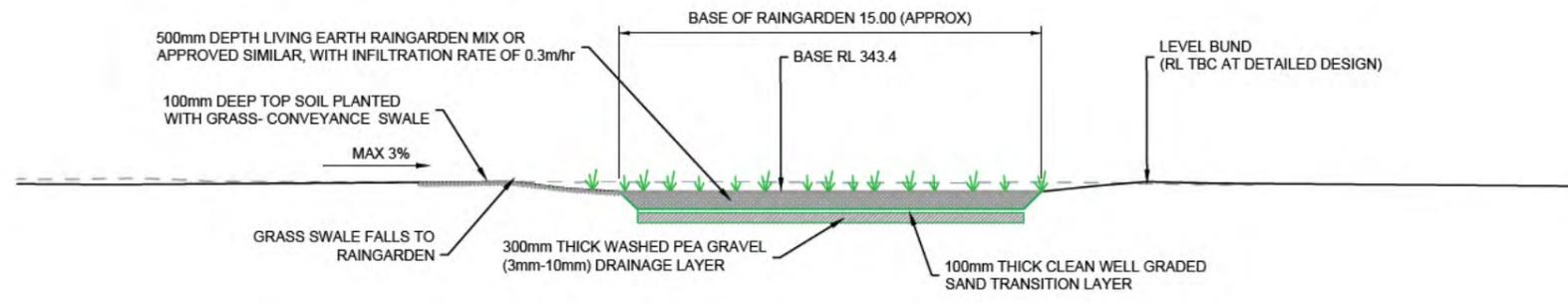
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AYRBURN PRECINCT LTD
 AYR AVENUE - LOTS 1, 2, 3 & 4
 DP540788

Purpose & Drawing Title:
HAYBARN VENUE
PROPOSED 3 WATERS

FOR CONSENT

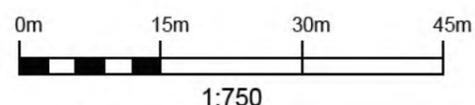
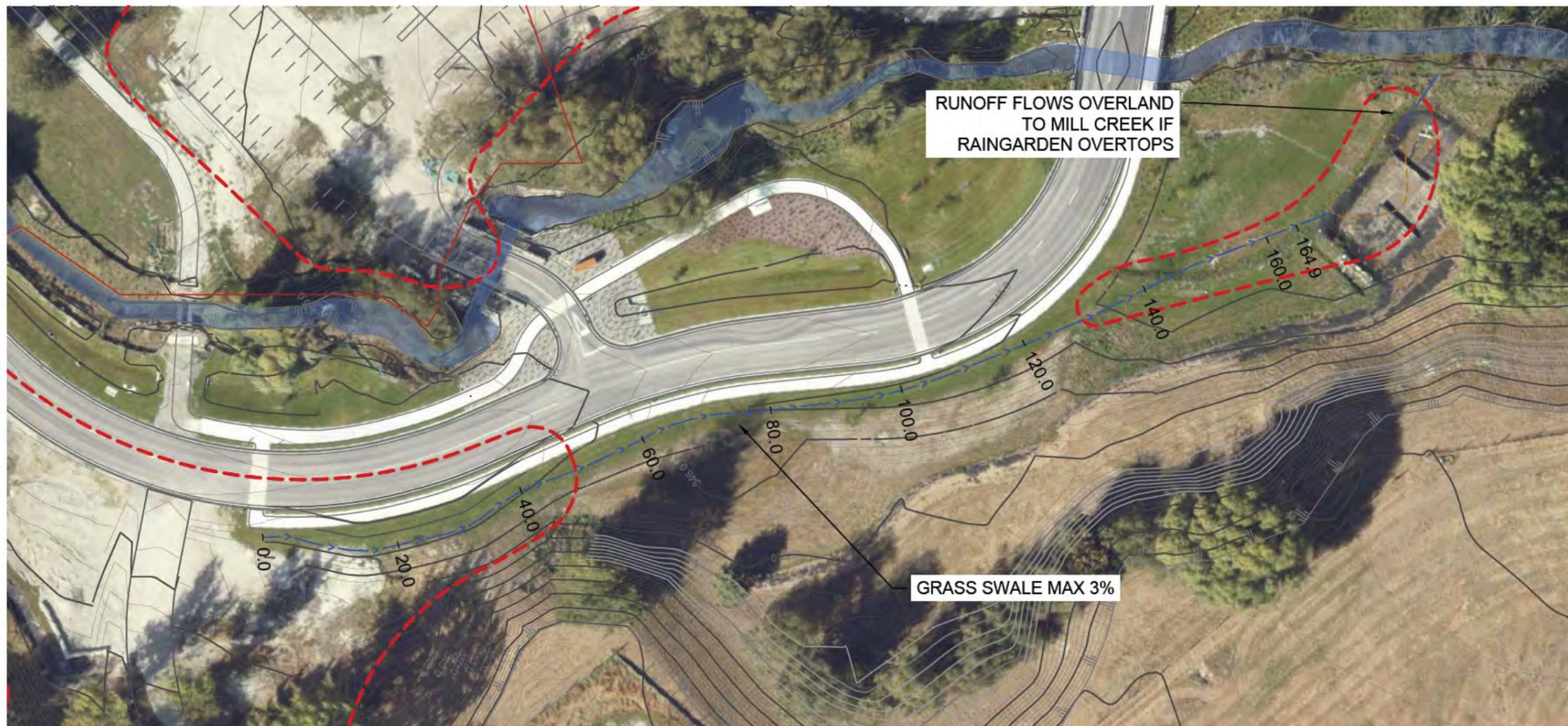
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Checked by:	SW		
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		Sheet No:	411
		Revision No:	A
		Date:	06/06/2023





RAIN GARDEN DETAIL (INDICATIVE ONLY, SUBJECT TO DETAILED DESIGN)

- LEGEND**
- LEGAL BOUNDARY
 - MILL CREEK
 - PROPOSED CONTOURS (0.25m INTERVAL)
 - PROPOSED LOW PRESSURE SEWER MAIN
 - EXISTING LOW PRESSURE SEWER MAIN
 - PROPOSED GRAVITY SEWER MAIN
 - - - EXISTING GRAVITY SEWER MAIN
 - PROPOSED STORMWATER MAIN
 - - - EXISTING STORMWATER MAIN
 - STORMWATER OVERLAND FLOW PATH
 - STORMWATER TREATMENT SWALE
 - RAIN GARDEN
 - PROPOSED WATERMAIN
 - - - EXISTING WATERMAIN
 - PROPOSED HAYBARN VENUE BUILDING
 - EXISTING / CONSENTED BUILDINGS
 - - - SITE EXTENTS



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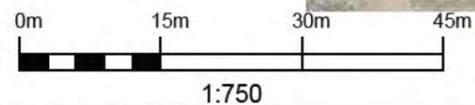
Purpose & Drawing Title:
HAYBARN VENUE
 PROPOSED 3 WATERS

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		Sheet No:	430
		Revision No:	A
		Date:	06/06/2023



- LEGEND**
- LEGAL BOUNDARY
 - MILL CREEK
 - PROPOSED WATERMAIN
 - - - EXISTING WATERMAIN
 - 4m x 11m HARDSTAND
 - FIRE HYDRANT
 - - - HYDRANT PIPE RUN DISTANCE



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Purpose & Drawing Title:
HAYBARN VENUE
HYDRANT LAYOUT PLAN

FOR CONSENT

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Appendix C: Previous GeoSolve Reporting



Geotechnical Report for Resource Consent

Arrowtown–Lake Hayes Road/Ayr Avenue
Queenstown

Report prepared for:
Waterfall Park Developments Ltd

Report prepared by:
GeoSolve Limited

Distribution:
Waterfall Park Developments Ltd
GeoSolve Limited (File)

June 2020
GeoSolve Ref: JN 150098.07

Revision	Issue Date	Purpose	Author	Reviewed
1	18/06/2020	Client Issue	SR	PGF
2	23/06/2020	Consent Issue	SR	PGF



GEOTECHNICAL



**WATER
RESOURCES**



PAVEMENTS



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1

1 Introduction

1.1 General

This report presents the results of geotechnical investigations carried out by GeoSolve Ltd in order to determine subsoil conditions and provide geotechnical inputs for a proposed building platform/house land use consent at Lot 3 DP540788. This lot is located adjacent Arrowtown-Lake Hayes Road with access proposed off Ayr Avenue, Queenstown.



Photo 1 –Site location Lot 3 Homestead Building Platform.

The investigations were carried out for Waterfall Park Developments Ltd in accordance with GeoSolve Ltd email agreement dated 21 May 2020, which outlines the scope of work and is a variation to GeoSolve's agreement dated 18 January 2019 which outlines the conditions of engagement.

1.2 Development

We understand it is proposed to establish a building platform for a future residential building. No plans have been provided detailing the future development. An existing barn is located within the proposed building platform which will be demolished as part of works to form the proposed building platform.



2

2 Site Description

2.1 General

The site is located to the west of Arrowtown-Lake Hayes Road, legally described as Lot 3, DP 540788. See Figure 1 below.



Figure 1 – Site location (red) (QLDC GIS Map Viewer - Extracted 15.06.2020. Crown Copyright Reserved).

The site is bounded by 341 Arrowtown-Lake Hayes Road to the north, 1 Ayr Avenue to the south and west and Arrowtown-Lake Hayes Road to the east. The current ground cover comprises grass and mature trees.

2.2 Topography and Surface Drainage

The site topography is sub-horizontal to gently sloping at the building platform location. The crest of a moderately sloping river terrace is located adjacent to the western boundary of the subject site, at a horizontal distance of between 8 m and 16 m from the edge of the proposed building platform. The terrace slope is approximately 6 m in vertical height and slopes at angles of between 18 °and 26°. Site topography is shown in Figure 1, Appendix A.

The site is naturally free draining and no seepages were evident within the site boundary. Mill Creek is located approximately 130 m west from the western site boundary and topographically lower.



3

3 Geotechnical Investigations

An engineering geological site inspection has been undertaken with confirmatory subsurface investigations. GeoSolve Ltd visited the subject property on 3 June 2020, undertaking a geotechnical investigation comprising 4 test pits which were advanced to a maximum depth of 3.0 m and 8 Scala penetrometer tests which were conducted within the test pits. Soakage testing was also undertaken in soakage pits 1 and 2.

Test pit, soakage pit and Scala penetrometer locations and logs are contained in Appendices A and B respectively.



4 Subsurface Conditions

4.1 Geological Setting

The site is located in the Wakatipu basin, a feature formed predominantly by glacial advances. Published references indicate the last glacial event occurred in the region between 10,000 and 20,000 years ago. Glaciations have left deposits of glacial till, glacial outwash and lake sediment over ice-scoured bedrock. Post glacial times have been dominated by the erosion of the bedrock and glacial sediment, with deposition of alluvial gravel by local watercourses and lacustrine sediment during periods of high lake levels.

No active fault traces are known by Geosolve to exist 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 which is located along the west coast of the South Island. There is a high probability that an earthquake with a magnitude greater than 7.5 will occur on the Alpine fault within the next 50 years.

4.2 Stratigraphy

The stratigraphy of the site is inferred from the test pit logs and comprised:

- 0.05 to 0.25 m of topsoil, overlying;
- 0.00 to 0.20 m of uncontrolled fill, overlying;
- 0.00 to 0.05 m of buried topsoil, overlying;
- 0.25 to 0.8 m of loess, overlying;
- 0.3 to 2.3 m of alluvial sand, overlying;
- Alluvial gravel (extent unknown).

An engineering geological model for the site is shown in Figure 2a & 2b, Appendix A.

Topsoil, up to 0.25 m thick was observed in all the test pits and comprises soft to firm organic SILT.

Uncontrolled Fill overlying buried topsoil were encountered in test pit 4 to a depth of 0.30 m bgl.

Loess was observed to underlie the surficial topsoil, uncontrolled fill and buried topsoil in all the test pits. The loess comprises light brownish grey, SILT, non-plastic which is firm to stiff.

Alluvial sand was observed to underlie the loess at depths of between 0.4 and 1.1 m. The alluvial sand comprises medium dense, light grey SAND with trace to minor silt and loose to medium dense silty SAND with occasional laminated SILT layers. The base of the alluvial sand was not intercepted during site investigations.

Alluvial Gravel is expected to underlie the site at moderate depths. Alluvial gravel was observed to be interbedded between two alluvial sand units in Soak Pit 2 and generally comprised light grey, medium dense, silty GRAVEL.



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Full details of the observed subsurface stratigraphy can be found within the test pit logs contained in Appendix B.

4.3 Groundwater

No groundwater seepage was observed in any of the test pits during investigations. The soils observed were predominantly moist in condition. Nearby well data indicates the regional groundwater table is at a depth of approximately 14 m below current ground level.

4.4 Natural Hazards

4.4.1 Seismic

A severe seismic risk is present in the region as discussed in Section 4.1 and appropriate allowance should be made for seismic loading during detailed design of any proposed building, foundations or retaining walls.

4.4.2 Slope Stability

The crest of a moderately sloping river terrace is located adjacent to the western boundary of the subject site, at a horizontal distance of between 8 m and 16 m from the proposed building platform.

No deep seated, recent or active slope instability was observed during the site walkover, and no known mapped slope stability risks are present on the Queenstown Lakes District Council (QLDC) GIS system.

4.4.3 Alluvial Fan

QLDC hazard mapping identifies the eastern part of site as potentially subject to active debris dominated alluvial fan activity. The relevant fan assessment and mapping is to regional scale (1:50,000) and as such is of relatively coarse resolution, indicating simply that site-specific assessment is desirable.

The site was generally lacking any features that would suggest recent alluvial fan activity. In general, topsoil was surficial underlain by loess and alluvial sand, indicating a substantial passage of time since alluvial activity. No alluvial fan deposits were identified, and the mapped regional scale alluvial fan risk does not encroach into the location of the proposed building platform.

Based on the above, the risk of alluvial fan activity affecting the site is considered to be very low and unlikely to affect a future development and no mitigation measures or further assessment is required for the proposed development with respect to this hazard.

4.4.4 Flooding

Flooding risks associated with Mill Creek are confined to the Mill Creek flood plain as indicated on the QLDC hazard mapping. The proposed platform is elevated 6 m above this area and so no adverse impact is expected on future development. No localised channels are present in the platform area and minimum finished floor levels as per standard



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construction and regulatory requirements will be sufficient for any future proposed development.

4.4.5 Liquefaction

On the QLDC hazard mapping the property adjacent to the southern site boundary is classified as LIC 2 (P). This LIC 2 (P) area is confined to the Mill Creek floodplain, located to the southwest and topographically lower than the proposed building platform.

The subject site is located on an elevated terrace, separated by a terrace slope. The inferred depth to regional groundwater and the relatively dense granular soils underlying the site confirm the liquefaction risk is nil to low. No further investigation or assessment is considered necessary with respect to liquefaction.



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5 Engineering Considerations

5.1 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.

5.2 Geotechnical Parameters

Table 1 provides a summary of the recommended geotechnical design parameters for the soil materials expected to be encountered during construction of any proposed development.

Table 1 – Recommended geotechnical design parameters

Unit	Thickness (m)	Bulk Density γ (kN/m ³)	Effective Cohesion c' (kPa)	Effective Friction ϕ' (deg)	Elastic Modulus E (kPa)	Poissons Ratio ν
Topsoil/uncontrolled fill and buried topsoil	0.15 – 0.3	16-17	To be removed from building platforms, or piles to extend through these layers			
Loess (firm to stiff sandy SILT with some gravel)	0.25 – 0.8	18	0	30	5,000	0.3
Alluvial Sand (light grey, medium dense SAND with trace/minor silt and loose to medium dense silty SAND with occasional laminated SILT layers)	0.3 – 2.3	18	0	31	5,000-7,500	0.3
Alluvial Gravel (light grey, medium dense silty GRAVEL)	Extent unknown	18	0	33	15,000	0.3

5.3 Site Preparation

During the earthworks operations all topsoil, uncontrolled fill, organic matter, water-softened soils and other unsuitable materials should be removed from the construction areas in accordance with the recommendations of NZS 4431:1989. Alternatively, piles can extend to bear below these layers.

Robust, shallow graded sediment control measures should be instigated during construction where rainwater and drainage run-off over exposed soils is anticipated. If slope gradients in excess of 4% are proposed in soils then lining of drainage channels is



recommended, e.g. with geotextile and suitable graded rock, or similarly effective armouring.

Exposure to the elements should be limited for all soils during construction and covering the soils with polythene sheeting or site concrete (for example) will reduce degradation due to wind, rain and surface run-off.

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

If engineered fill is utilised as bearing it should be placed and compacted in accordance with the recommendations of NZS 4431:1989 and certification provided to that effect.

5.4 Excavations

Recommendations for temporary and permanent slope batters are described in the following sections. Slopes that are required to be steeper than those described below should be structurally retained or subject to specific geotechnical design. Low soil cuts (less than 1.0 m) can stand well for short construction periods and practical site management measures such as staged excavation and construction of the permanent walls, protecting the exposed soil faces with polythene sheeting, and visual inspections should be employed to ensure no issues arise.

All slopes should be periodically monitored during construction for signs of instability and excessive erosion, and, where necessary, corrective measures should be implemented to the satisfaction of a Geotechnical Engineer or Engineering Geologist.

No seepage was encountered during test pitting and hence groundwater is unlikely to be encountered during excavations. However, a geotechnical practitioner should inspect any seepage, spring flow or under-runners that may be encountered during construction.

Recommendations for temporary and permanent slope batters are provided below in Table 2 as follows.

Table 2 – Recommended Maximum Batter Angles for Cut Slopes in Soil Materials 3.0 m in Height or less.

Material Type	Recommended Maximum Batter Angles for <u>Temporary</u> Cut Slopes Formed in Soil (horizontal to vertical)		Recommended Maximum Batter Angles for <u>Permanent</u> Cut Slopes Formed in dry Soil (horizontal to vertical)
	Dry Ground	Wet Ground	
Topsoil & Loess	2.0H : 1.0V	3.0H : 1.0V	3.0H : 1.0V
Alluvial Sand & Alluvial Gravels	1.5H : 1.0V	2.5H : 1.0V	2.5H : 1.0V

Permanent batter slopes in wet soils are provisional, if wet slopes are encountered they should be inspected on a case by case basis by a geotechnical engineer/engineering geologist to confirm this recommendation is appropriate.



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5.5 Foundation Considerations

5.5.1 General

All unsuitable soils 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 4431:1989 with certification provided to that effect.

To minimise the effects of freeze-thaw cycles in footings founded on soil, all shallow foundations should be founded a minimum of 0.4 m below the adjacent finished ground surface.

Loess and Alluvial Sand material will provide a reduced bearing capacity and do not meet 'good ground' requirements as outlined in NZS3604. The loess soils can also weaken substantially if subject to rainfall, frost and trafficking.

Figure 2 summarises the recommended working stresses for shallow footings, which bear upon undisturbed, dry loess and alluvial sand material. It should be noted the foundation working stresses presented in Figure 2 are governed by bearing capacity in the case of narrow footings and settlement in the case of wide footings.

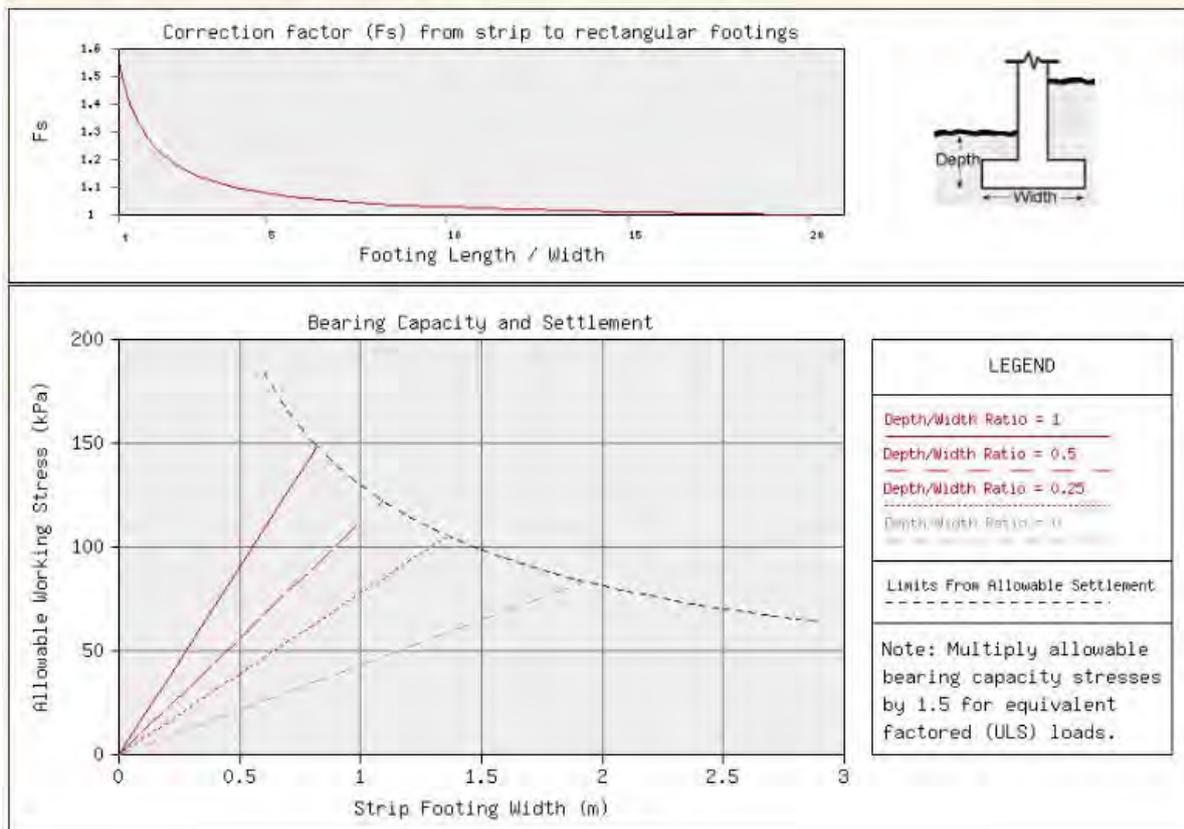


Figure 2. Recommended Bearing for Shallow Footings on Loess and Alluvial Sand.



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From Figure 2 it can be seen an allowable working stress of approximately 65 kPa is recommended for a 400 mm wide by 400 mm deep strip footing founded on natural loess and alluvial sand material. This corresponds to a factored (ULS) bearing capacity of approximately 95 kPa and an ultimate geotechnical bearing capacity of 195 kPa.

5.5.2 Ground Improvement

Ground improvement could be conducted to improve the bearing capacity of the underlying soil materials. A 0.4 m undercut of the loess material (encountered to a depth of between 0.25m and 0.8 m below the existing ground surface) and alluvial sand material, and replacement with imported granular engineered fill, below any proposed foundation system, will be sufficient to provide 300 kPa ultimate geotechnical bearing capacity. The imported fill should be placed and compacted in accordance with NZS4431 and certification provided to that effect. Note, as the loess is subject to significant weakening if disturbed (trafficked, saturation) then undercutting and replacement with engineered fill also provides protection to the loess and is recommended.

A filter fabric separation layer is recommended to underlie the engineered fill.

The engineered fill should extend at least 1.0 m beyond the edge of any proposed building footprint.

5.5.3 Shallow Foundations adjacent to the slope crest

The proposed building platform is approximately 8 m from the crest of the terrace slope to the west of the platform.

The proposed 8 m set-back of the building platform from the slope crest will satisfy the foundation requirements outlined in Section 3 of NZS3604, and the proposed building platform is suitable for the construction of shallow bearing foundations with no special slope provisions.

5.6 Settlement

Settlement and differential settlement of shallow foundations are expected to be within structurally acceptable limits provided the recommendations of Section 5.5 are followed and all unsuitable materials, particularly those softened by water, are undercut and replaced with engineered fill during construction.

5.7 Site Subsoil Category

For detailed design purposes it is recommended the magnitude of seismic acceleration be estimated in accordance with the recommendations provided in NZS 1170.5:2004.

The site is Class D (Deep soil site) in accordance with NZS 1170.5:2004 seismic provisions.

5.8 Stormwater and Wastewater Disposal

We understand that on-site wastewater and stormwater disposal systems may be required for a future development.



On-site soakage pit testing was undertaken at two locations at the site, as shown in Figure 1, Appendix A.

The test procedure comprised filling an open pit with water up to the maximum level achievable and recording the drop in level over time, i.e. a falling head test. The tests were undertaken at depths of between 0.5 and 1.3 m, within alluvial sand & alluvial gravel.

The base of the soak pit was then excavated through and the stratigraphy logged by an engineering geologist. Logs are presented in Appendix B.

The static groundwater was not encountered during testing and based on ORC well logs nearby, is inferred to lie more than 14 m below the site. Calculations indicate that this is sufficiently deep to avoid influencing the soakage test.

The test results are presented in Table 3 below.

Table 3. Assessed soakage rates (note all values presented are factored)

Test	Depth (m)	Soil type at base of pit	Soil Category AS/NZS 1547:2012	Factored infiltration rate*	Factored soakage rate*
Soak 1	1.3	Silty SAND	4	6 mm/hr	0.10 Litres/m ² /min
Soak 2	0.5	Sandy GRAVEL	3	39 mm/hr	0.65 Litres/m ² /min
*Includes a reduction factor of 0.5 to account for loss of soakage performance over time and does not include soakage through the side walls					

It is recommended that no soakage is undertaken to the west of the proposed building platform, adjacent to the crest of the existing terrace slope.



6 Neighbouring Structures/Hazards

Natural Hazards: A risk of seismic activity has been identified for the region as a whole and appropriate allowance should be made for seismic loading during detailed design of the proposed building, foundations and associated earthworks.

Alluvial fan, flooding and liquefaction risk is discussed in Section 4.4.3, 4.4.4 and 4.4.5 above.

Distances to adjoining structures: No adverse geotechnical implications apply for neighbouring properties during construction of the proposed development provided the above excavation considerations are noted.

Aquifers: No aquifer resource will be adversely affected by future residential development. It is noted that the Wakatipu basin aquifer underlies the site. Deep drilling, e.g. for ground source heating, are expected to require consent from the regional council.

Erosion and Sediment Control: The site presents minor potential to generate silt runoff during heavy rainfall events and this would naturally drain downslope. Effective systems for erosion control are runoff diversion drains and contour drains, while for sediment control, options are earth bunds, silt fences, vegetation buffer strips and sediment ponds. Only the least amount of subsoil should be exposed at any stage and surfacing established as soon as practical. QLDC environment management plan requirements should be consulted for site management.

Noise: Standard excavation and compaction plant will be required. As the surrounding area includes residential properties, the construction contractor should take appropriate measures to control the construction noise and ensure QLDC requirements are met in regard to this issue.

Dust: The soil materials at the site have potential to generate dust. Regular dampening of soil materials with sprinklers should be effective if required.

Vibration: No vibration induced settlement is expected in these soil types; however, any works that create vibrations should be subject to geotechnical advice.



7 Conclusions and Recommendations

- The stratigraphy at the site typically comprises topsoil/uncontrolled fill overlying loess, alluvial sand and alluvial gravel;
- No groundwater was observed during site investigations. The regional groundwater table is expected to lie approximately 14 m beneath the site;
- No deep seated, recent or active slope instability was observed by Geosolve Ltd during the site walkover in the vicinity of the proposed building platform;
- All topsoil, uncontrolled fill and any other unsuitable soils identified in foundation excavations, particularly those softened by exposure to water, should be undercut and replaced with engineered fill during construction.
- Loess and alluvial sand material will provide a reduced bearing capacity and does not meet 'good ground' requirements as outlined in NZS3604. The loess soils can also weaken if subject to rainfall, frost and trafficking.
- Ground improvement could be conducted to improve the bearing capacity of the underlying soil materials as discussed in Section 5.5.2.
- The proposed 8 m set-back of the building platform from the slope crest will satisfy the foundation requirements outlined in Section 3 of NZS3604 and the proposed building platform is suitable for the construction of shallow bearing foundations with respect to stability of the terrace slope.
- Geotechnical parameters are presented in Table 1 of this report.
- Any fill that is utilised as bearing for foundations should be placed and compacted in accordance with NZS 4431:1989 and certification provided to that effect.
- For detailed structural design purposes, it is recommended that the site is classified as "Class D – deep soils site" in accordance with NZS 1170.5:2004 seismic provisions.
- Soakage rates for wastewater and stormwater design are provided in Section 5.8.
- It is recommended that no soakage is undertaken to the west of the proposed building platform, adjacent to the crest of the existing terrace slope.
- A geotechnical practitioner should inspect and test all footing and foundation slab excavations during the construction phase of any proposed future development.



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8 Applicability

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

It is important that we be contacted if there is any variation in subsoil conditions from those described in this report.

Report prepared by:



.....
Simon Reeves
Engineering Geologist

Reviewed for GeoSolve Ltd by:



.....
Paul Faulkner
Senior Engineering Geologist



Appendix A: Site Investigation Plan & Ground Model



Legend:

-  Test pit locations
-  Soakage pit locations
-  Cross-section location and facing



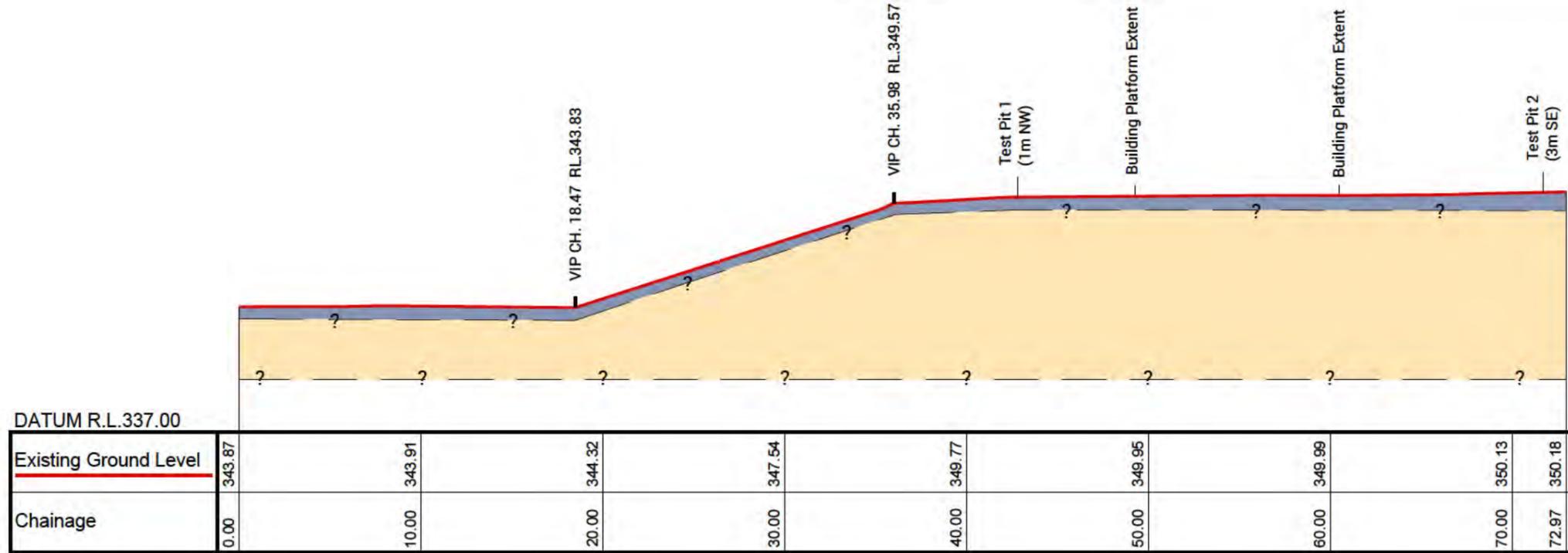

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APPROVED	PGF	June.20
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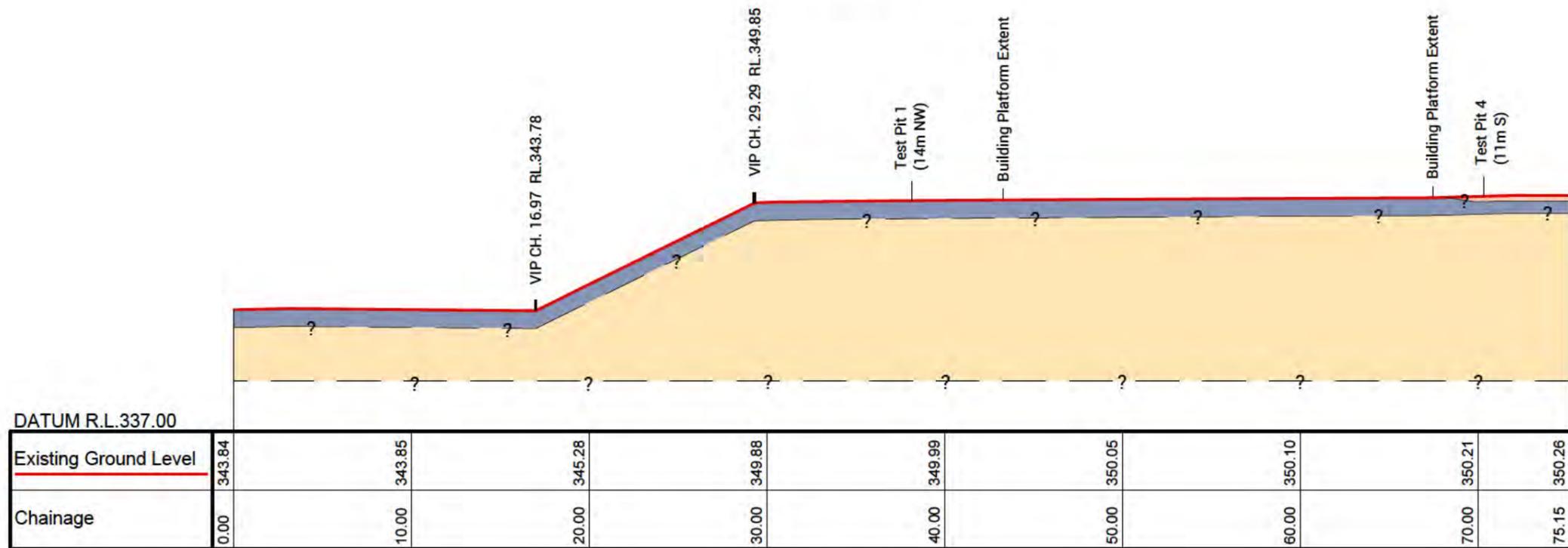
Waterfall Park Developments Ltd
 Lot 3 Homestead Building Platform
 Waterfall Park, Queenstown
 Site Investigation Plan

FIG No:
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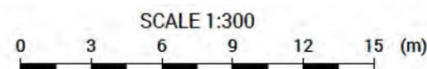
Section 01



Section 02

Legend:

- Uncontrolled fill & buried topsoil
- Loess
- Alluvial Sand & Gravel

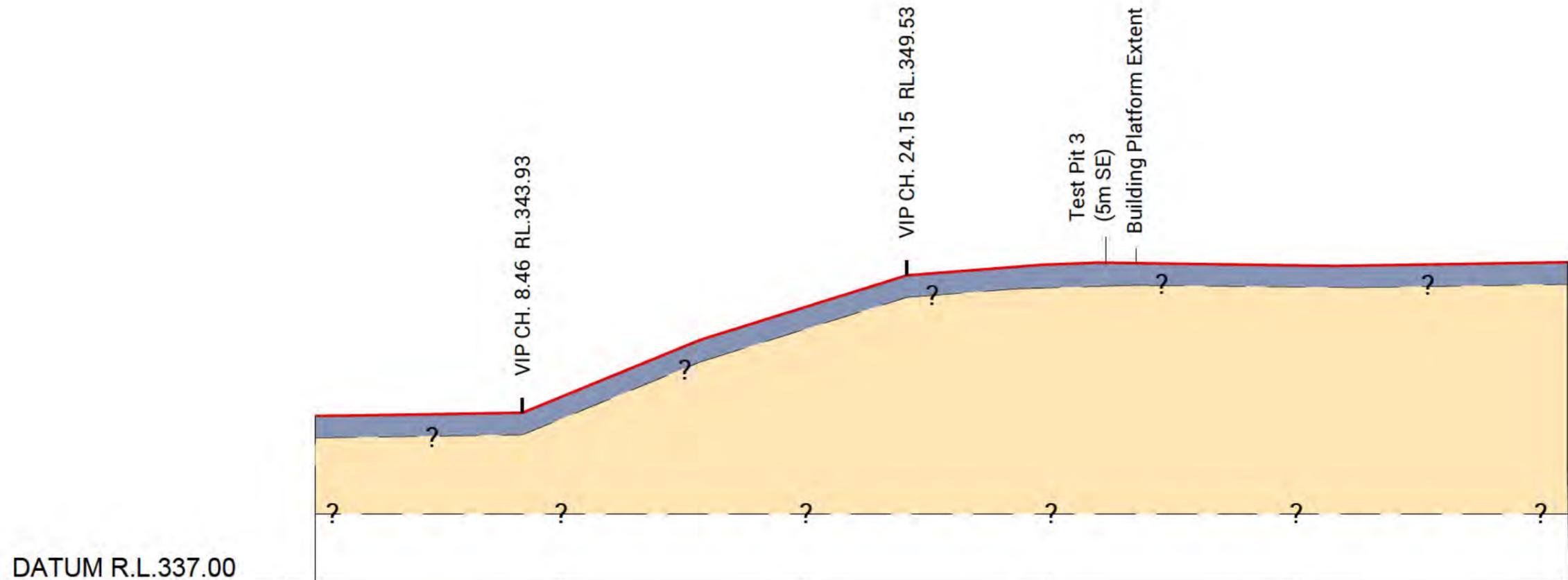


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DRAFTING CHECKED	SAR	Jun.20
APPROVED	PGF	June.20
CADFILE: 150098.07_SP.dwg		
SCALES (AT A3 SIZE): 1:300		
PROJECT No: 150098.07		FIG No: Figure 2a, Appendix A

Waterfall Park Developments Ltd

Lot 3 Homestead Building Platform
Waterfall Park, Queenstown
Site Investigation Plan

REV.
0



DATUM R.L.337.00

Existing Ground Level	343.80	344.56	348.24	349.97	349.94	350.04	350.06
Chainage	0.00	10.00	20.00	30.00	40.00	50.00	51.14

Section 03

Legend:

- Loess
- Alluvial Sand and Gravel



DRAWN	JM	Jun.20
DRAFTING CHECKED	SAR	Jun.20
APPROVED	PGF	June.20
CADFILE: 150098.07_SP.dwg		
SCALES (AT A3 SIZE): 1:200		
PROJECT No: 150098.07		FIG No: Figure 2b, Appendix A

Waterfall Park Developments Ltd

Lot 3 Homestead Building Platform
Waterfall Park, Queenstown
Site Investigation Plan

REV.
0



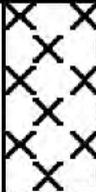
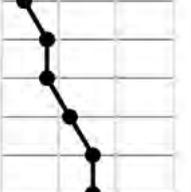
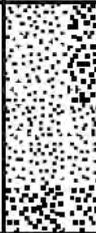
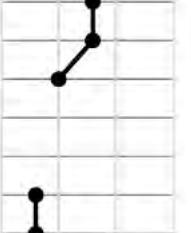
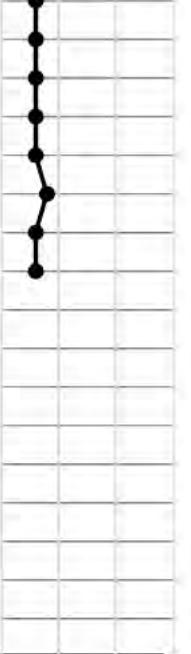
Appendix B: Investigation Data

EXCAVATION LOG

EXCAVATION NUMBER:

TP 1

PROJECT:	Lot 3 Building Platform, Waterfall Park			JOB NUMBER:	150098.07	
EASTING:		mE	EQUIPMENT:	5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.		COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:		HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:		HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER Blows per 100mm 0 5 10 15
0.2	TOPSOIL		Dark brown, organic SILT. Soft. Dry to moist.		NO SEEPAGE	
0.7	LOESS		Light brownish grey, SILT. Non-plastic. Stiff. Massive. Dry.			
1.3	ALLUVIAL SAND		Light grey, SAND with trace to minor silt. Sand is fine. Micaceous. Medium dense. Bedded. Dry to moist.			
3.0	ALLUVIAL SAND		Light grey, silty SAND with occasional laminated SILT layers up to 30 mm thick. Sand is fine. Micaceous. Loose to medium dense. Bedded. Dry to moist.			

Total Depth = 3 m

COMMENT: Test pit dry and side walls stable.

Logged By: JM

Checked Date:

Sheet: 1 of 1



EXCAVATION LOG

EXCAVATION NUMBER:
TP 2

PROJECT: Lot 3 Building Platform, Waterfall Park				JOB NUMBER: 150098.07	
EASTING:		mE	EQUIPMENT: 5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.	COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:	HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:	HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER Blows per 100mm 0 5 10 15
0.2	TOPSOIL		Dark brown, organic SILT. Firm. Moist.		NO SEEPAGE	
1.0	LOESS		Light brownish grey, SILT with trace sand. Sand is fine. Non-plastic. Stiff. Massive. Dry.			
3.0	ALLUVIAL SAND		Light grey, silty SAND with trace to minor silt and trace gravel. Occasional laminated SILT layers up to 30 mm thick. Sand is fine. Gravel is fine to medium; angular. Micaceous. Loose to medium dense. Bedded. Dry to moist.			

Total Depth = 3 m

COMMENT: Test pit dry and side walls stable.	Logged By: JM
	Checked Date:
	Sheet: 1 of 1



EXCAVATION LOG

EXCAVATION NUMBER:
TP 3

PROJECT: Lot 3 Building Platform, Waterfall Park				JOB NUMBER: 150098.07	
EASTING:		mE	EQUIPMENT: 5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.	COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:	HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:	HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER Blows per 100mm 0 5 10 15
0.15	TOPSOIL		Dark brown, organic SILT. Firm. Moist.		NO SEEPAGE	
0.9	LOESS		Light brownish grey, SILT. Non-plastic. Firm to stiff. Massive. Dry to moist.			
3.0	ALLUVIAL SAND		Light grey, silty SAND with occasional laminated SILT layers up to 30 mm thick. Sand is fine. Gravel is fine to medium; angular. Micaceous. Loose to medium dense. Bedded. Dry to moist.			

Total Depth = 3 m

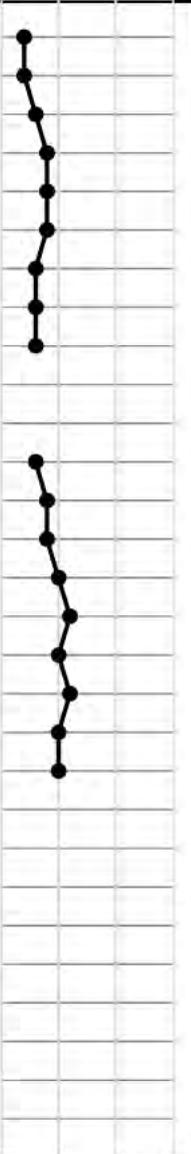
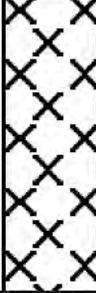
COMMENT: Test pit dry and side walls stable.	Logged By: JM
	Checked Date:
	Sheet: 1 of 1

EXCAVATION LOG

EXCAVATION NUMBER:

TP 4

PROJECT:	Lot 3 Building Platform, Waterfall Park			JOB NUMBER:	150098.07	
EASTING:		mE	EQUIPMENT:	5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.:		COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:		HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:		HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER Blows per 100mm 0 5 10 15
0.05	TOPSOIL		Dark brown, organic SILT. Firm. Moist.		NO SEEPAGE	
0.25	UNCONTROLLED FILL		Greyish brown, sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse; subangular. Loose to medium dense. Moist.			
0.3	BURIED TOPSOIL		Dark brown, organic SILT. Soft. Moist.			
1.1	LOESS		Light brownish grey, SILT with trace to minor sand. 30 mm thick silty GRAVEL lense @ 0.7 m. Sand is fine. Non-plastic. Firm to stiff. Massive. Moist.			
3.0	ALLUVIAL SAND		Light grey, SAND with some silt. Occasional laminated SILT layers up to 20 mm thick. Sand is fine. Gravel is fine to medium; angular. Micaceous. Medium dense. Bedded. Moist.			

Total Depth = 3 m

COMMENT: Test pit dry and side walls stable.

Logged By: JM

Checked Date:

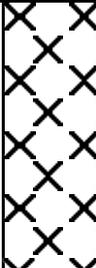
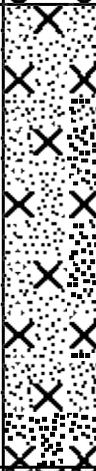
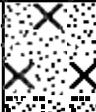
Sheet: 1 of 1

EXCAVATION LOG

EXCAVATION NUMBER:

SP 1

PROJECT:	Lot 3 Building Platform, Waterfall Park			JOB NUMBER:	150098.07	
EASTING:		mE	EQUIPMENT:	5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.		COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:		HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:		HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER
0.2	TOPSOIL		Dark brown, organic SILT. Firm. Moist.		NO SEEPAGE	
0.9	LOESS		Light grey, SILT. Non-plastic. Stiff. Massive. Dry to moist.			
2.1	ALLUVIAL SAND		Light grey, silty SAND with occasional laminated SILT layers up to 30 mm thick. Sand is fine. Micaceous. Loose to medium dense. Bedded. Moist.			
2.4	ALLUVIAL GRAVEL		Light grey, silty GRAVEL with minor sand. Sand is fine to coarse. Gravel is fine to coarse; subangular to subrounded. Iron stained. Medium dense. Bedded. Moist.			
2.7	ALLUVIAL SAND		Light grey, silty SAND. Sand is fine. Micaceous. Loose to medium dense. Bedded. Moist.			

Total Depth = 2.7 m

COMMENT: Test pit dry and side walls stable. Pit dug from 1.3 to 2.7 m at end of soakage testing.

Logged By: JM

Checked Date:

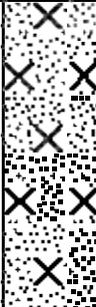
Sheet: 1 of 1

EXCAVATION LOG

EXCAVATION NUMBER:

SP 2

PROJECT:	Lot 3 Building Platform, Waterfall Park			JOB NUMBER:	150098.07	
EASTING:		mE	EQUIPMENT:	5.5T Excavator	OPERATOR:	Luke
NORTHING:		mN	INFOMAP NO.		COMPANY:	Wilson Contractors
ELEVATION:		m	DIMENSIONS:		HOLE STARTED:	3-Jun-20
METHOD:			EXCAV. DATUM:		HOLE FINISHED:	3-Jun-20

DEPTH (m)	SOIL / ROCK TYPE	GRAPHIC LOG	DESCRIPTION	USCS GROUP	GROUNDWATER / SEEPAGE	SCALA PENETROMETER
0.25	TOPSOIL		Dark brown, organic SILT. Firm. Moist.		NO SEEPAGE	
0.4	LOESS		Light brownish grey, SILT with trace sand. Sand is fine. Firm. Moist.			
0.9	ALLUVIAL GRAVEL		Grey, sandy GRAVEL. Sand is fine to coarse. Gravel is fine to medium; angular. Iron stained. Medium dense. Bedded. Moist.			
1.7	ALLUVIAL SAND		Grey, silty SAND. Sand is fine. Medium dense. Bedded. Moist.			

Total Depth = 1.7 m

COMMENT: Test pit dry and side walls stable. Pit dug from 0.5 to 1.7 m at end of soakage testing.

Logged By: JM

Checked Date:

Sheet: 1 of 1



Appendix C: QLDC Wastewater Disposal Site and Soils Assessment Form

Onsite Wastewater Disposal Site & Soils Assessment



Use for Subdivision or Land Use Resource Consent

The design standard for waste water treatment and effluent disposal systems is AS/NZS 1547:2012. All references in this form relate to this standard.

Applications should provide sufficient information to demonstrate that all lots will be capable of accommodating an on-site system.

Site Description

Property Owner: WATERFALL PARK DEVELOPEMENTS LTD

Location Address: 339 ARROWTOWN-LAKE HAYES RD

Legal Description (eg Lot3 DP1234) : LOT3 DP 540788

List any existing consents related to waste disposal on the site: N/A

General description of development / source of waste water: _____

FUTURE RESIDENTIAL DEVELOPMENT

The number and size of the lots being created: N/A

Site Assessment (refer to Tables R1 & R2 for setback distances to site features)

Land use RURAL AMENITY ZONE

Topography GENTLY SLOPING

Slope angle 0-5°

Aspect SUB-HORIZONTAL

Vegetation cover GRASS

Areas of potential ponding NIL

Ephemeral streams NIL

Drainage patterns and overland paths NIL

Flood potential (show with return period on site plan) NIL

Distance to nearest water body 130m

Water bores with 50m (reference ORC Maps) NO

Other Site Features _____

Slope stability assessment details – summarise any areas unsuitable for waste water irrigation.
(Attach report if applicable): _____

REPORT ATTACHED - SOAKAGE TO BE UNDERTAKEN TO THE EAST OF THE PROPOSED BUILDING PLATFORM

(Highest potential) Depth to ground water:

Summer ~ 10m

Winter ~ 10m

Information Source BOREHOLE (F41/0062) 160 m NW,

What is the potential for waste water to short circuit through permeable soils to surface and / or ground water?

NO EVIDENCE - SOAKAGE TESTING DID NOT SHORT CIRCUIT

Soil Investigation (Appendix C)

Field investigation date: 3/6/2020

Number of test pit bores (C3.5.4): 6

Soil investigation addendum to be attached that includes a plan showing test pit or bore location, log results and photos of the site profile.

If fill material was encountered during the soil investigation state how this will impact on the waste water system:

SURFICIAL - IN TP4 - TARGET SOAKAGE BELOW FILL

Average depth of topsoil: 0.20m

Indicative permeability (Appendix G) : 0.93 m/day

Percolation test method (refer to B6 for applicability) : OPEN SOAK PIT TEST
(attach report if applicable)

Soil Category (Table 5.1)	Soil Texture (Appendix E)	Drainage	Tick One
1	Gravel and sands	Rapid	
2	Sandy loams	Free	
3	Loams	Good	✓
4	Clay loams	Moderate	
5	Light clays	Moderate to slow	
6	Medium to heavy clays	Slow	

Reasons for placing in stated category:

SOIL & GRAIN SIZE AND PERMEABILITY OBSERVED IN TESTING

10mm/day (Primary - Conservative)
15mm/day (Primary - Maximum)

Loading rate, DLR (Table L1): 30mm/day (Secondary)

Explanation for proposed loading rate: In-ground soakage testing and field observations revealed Soil Category 3 - Loam, weakly structured or massive is present at 0.5m depth in the proposed wastewater effluent field location.

Recommendations from site and soils assessment

Specify any design constraints

Specify any areas unsuitable for location of the disposal field

Specify any unsuitable treatment and/or disposal systems

Propose suitable mitigation to enable successful effluent treatment

- Suitable disposal systems to be used are primary and secondary trenches and beds.
- Disposal system to be located in the vicinity of Soakage Pit 2 as shown on Figure 1, Appendix A of GeoSolves geotechnical report, Ref: 150098.07 dated June 2020.

Attachments Checklist

- Copy of existing consents
- Soil investigation addendum
- To scale site plan, the following must be included on the plan:
 - Buildings
 - Boundaries
 - Retaining Walls
 - Embankments
 - Water bodies
 - Flood potential
 - Other septic tanks / treatment systems
 - Water bores
 - Existing and proposed trees and shrubs
 - Direction of ground water flow
 - North arrow

Note that an Otago Regional Council (ORC) consent may also be required to discharge domestic waste water to land if any of the following apply:

- Daily discharge volume exceeds 2,000 litres per day
- Discharge will occur in a groundwater protection zone
- Discharge will occur within 50 metres of a surface water body (natural or manmade)
- Discharge will occur within 50 metres of an existing bore/well
- Discharge will result in a direct discharge into a drain/water ace/ground water
- Discharge may runoff onto another persons' property

If any of these apply then we recommend that you correspond with the ORC;

*Otago Regional Council
"The Station" (upstairs)
Cnr. Camp and Shotover Streets
P O Box 958
Queenstown 9300*

Tel: 03 442 5681

I believe to the best of my knowledge that the information provided in this assessment is true and complete. I have the necessary experience and qualifications as defined in Section 3.3 AS/NZS 1547:2012 to undertake this assessment in accordance with the requirements of AS/NZS 1547:2012:

Company: GEOSOLVE LTD
 Email: SREEVES@GEOSOLVE.CO.NZ
 Phone number: 0272457470
 Name: SIMON REEVES
 Signature: 
 Date: 17/06/2020

Queenstown Lakes District Council
Private Bag 50072
10 Gorge Road
QUEENSTOWN 9348

Phone: 03 441 0499
Fax: 03 442 4778
Email: services@qldc.govt.nz
Website: www.qldc.govt.nz

Ayrburn Precinct Ltd
c/o Nicola Tristram
Development Manager
WINTON
Ayr Avenue
Arrowtown
Dear Nicola

**Proposed Haybarn Venue
339 Arrowtown-Lake Hayes Road, Arrowtown
Contaminated Site Considerations**

Consent is being sought for the proposed Haybarn venue within the existing woodland at 339 Arrowtown-Lake Hayes Road, Arrowtown (Lot 3 DP540788). As part of the development, an overflow car parking area with capacity for 53 vehicles will be constructed within the adjacent property at 1 Ayr Avenue (Lot 4 DP 540788), to the west of Ayr Avenue.

Both properties were originally part of Ayrburn Farm which operated from the 1860's and contained a sheep dip, woolshed and yards, a farm landfill, and underground and above-ground fuel storage tanks. These are activities on the Hazardous Activities and Industries List (HAIL), due to their potential to result in soil contamination. An existing timber post and corrugated iron haybarn is located within the proposed Haybarn venue platform and will be demolished as part of the works.

This letter addresses the potential for soil contamination within the proposed development areas by reviewing and summarising the Preliminary Site Investigation (PSI)¹, Detailed Site Investigation (DSI)² and subsequent investigations and remediation earthworks³. The site extent of works for this application is shown in Figure 1, which includes an amended configuration to the parking areas associated with the Ayrburn Domain that is presently being developed at 1 William Paterson Close.

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: The proposed development area with the extent of works outlined in red.

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. A possible landfill area was identified and is recorded on the HAIL database (HAIL.01692.05), but no evidence of landfilling was seen during the PSI site inspection and no soil contamination was found. The site history is well understood and nothing in the site history indicates that localised contamination would be expected to have occurred beyond these areas identified.

The PSI found exceedances of the applicable soil contamination standards (SCS) for arsenic and lead in the soils around the existing homestead, farmyard buildings and the adjacent landfill. Subsequently a DSI was undertaken to better define the HAIL sites within the property by ascertaining the extent of contamination which was confirmed in three sites (A, B and C) and to inform remediation options. No additional sampling was undertaken during the DSI at the possible landfill.

Remedial earthworks have subsequently been 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 three sites and the Encapsulation Cell is shown in Figure 2 in turquoise, the possible landfill area where no contamination was found is shown in yellow. The possible landfill is located

within the proposed overflow parking area, no other HAIL sites are present within the site. The Encapsulation Cell is located approximately 25 m from the proposed Haybarn venue building area, and Site C is approximately 50 m.

The possible landfill was identified by the former Ayrburn Farm Manager as a result of occasionally observing metal scraps when grading the farm road adjacent to this area where the road runs through a cutting in the terrace face. He considered that this may indicate an old farm landfill, however there was no evidence of landfilling at this location during the site inspection. A comparison of aerial photographs from 1959, 1981 and the 2000's shows that in 1981 there appeared to be a small disturbed or excavated area adjoining the farm track which has subsequently been covered over. Soil samples collected during the PSI (the H group and Bridgefill 1 and 2 samples) showed no signs of elevated contaminants. In May 2020 an additional investigation was undertaken of the possible landfill area with three trenches transecting the area excavated to a depth of 0.75 – 1.5 m. No indications of buried materials, rubble or rubbish were uncovered. The area contains silts and gravels consistent with the soils across the rest of the property, with a 30 cm layer that appears to be natural soils placed across the surface. Sampling of the surface and deeper soils found results were consistent with the concentrations found to be natural background levels in the PSI and the Bridgefill samples. Based on these results, there is no evidence that this area was used as a landfill but rather earthworks have occurred in this area. As a result, the entry for HAIL.01692.05 on the ORC HAIL database has been updated to “Verified Non-HAIL” for the possible landfill site.

Based on the findings of the PSI and DSI, the May 2020 investigation and the remedial works undertaken, only the areas shown in turquoise in Figure 2 should be considered HAIL sites. 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 the proposed Haybarn venue building area which is sited at a higher elevation. The building will be located at an elevation of approximately 350 m, similar to Site C. Site A is slightly lower at 348 m, and the base of the Encapsulation cell is at 345 m. The top of the Encapsulation cell is located at 349 – 350 m, however this includes a cap of 0.7 - 1 m of clean soil.

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. The sampling locations that are located within the extent of works are shown in Figure 3 and the results are summarised in Table 1. For the PSI samples were collected in groups of 4, with one sample analysed as an individual and three analysed as a composite to increase the sampling density while controlling analysis costs. The individual results are consistent with the composites. For the May 2020 investigation of the possible landfill, surface samples were collected as individual samples (one per trench) and the deeper samples were analysed as a composite set (2 or 3 per trench).



Figure 2: Site layout showing the locations of the original contaminated sites (A, B and C) and the Encapsulation Cell in turquoise, and the possible landfill in yellow. The proposed building location is shown in pink and the extent of works is outlined in red.



Figure 3: Sampling locations from the PSI undertaken in 2016 and possible landfill investigation in 2020, with the extent of works outlined in red.

**Proposed Haybarn Venue
Contaminated Site Considerations**

Table 1: Summary of results from PSI samples collected within and adjacent to the extent of works

Sample ^A	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Organochlorine Pesticides
Composite samples									
G1, G2 & G3	9	< 0.10	-	-	14.7	< 0.10	-	-	ND
H1, H2 & H3	9	< 0.10	-	-	16.5	< 0.10	-	-	ND
I1, I2 & I3	9	< 0.10	-	-	17	< 0.10	-	-	ND
P1, P2 & P3	10	< 0.10	-	-	28	< 0.10	-	-	ND
Q1, Q2 & Q3	8	< 0.10	-	-	18.1	< 0.10	-	-	ND
R1, R2 & R3	9	< 0.10	-	-	16.2	< 0.10	-	-	ND
S1, S2 & S3	7	0.10	-	-	13.6	< 0.10	-	-	ND
A1, A2 & A3 (Trench)	5	< 0.10	4	8	10.1	-	5	18	-
B1, B2 & B3 (Trench)	7	< 0.10	4	9	9.8	-	6	20	-
C1 & C2 (Trench)	9	< 0.10	5	15	12.2	-	9	26	-
Average	8.2	< 0.10	4	11	15.6	< 0.10	7	21	-
RSD	18%	-	13%	35%	33%	-	31%	20%	-
UCL	9.1	-	-	-	18.6	-	-	-	-
Individual samples									
G	6	0.15	-	-	14.1	< 0.10	-	-	ND
H	10	< 0.10	-	-	14.9	< 0.10	-	-	ND
I	9	0.10	-	-	14.2	< 0.10	-	-	ND
P	9	< 0.10	-	-	31	< 0.10	-	-	ND
Q	10	< 0.10	-	-	17.8	< 0.10	-	-	ND
R	9	0.11	-	-	14.8	< 0.10	-	-	ND
S	7	0.12	-	-	12.4	< 0.10	-	-	ND
BRIDGEFILL 1 (0-20)	7	< 0.10	-	-	9.9	-	-	-	-
BRIDGEFILL 2 (20-40)	7	< 0.10	-	-	9.5	-	-	-	-
A4 (Trench)	8	< 0.10	7	8	13.0	-	6	29	ND
B4 (Trench)	9	< 0.10	5	12	18.9	-	5	39	ND
C3 (Trench)	9	< 0.10	6	17	13.1	-	11	30	ND
Average	8.3	< 0.11	6	12	15.3	< 0.10	7	33	-
RSD	16%	14%	17%	37%	37%	-	44%	17%	-
UCL	9.0	-	-	-	18.8	-	-	-	-
Soil Acceptance Criteria									
NES ^B SCS	17	0.8	290	>10,000	160	200	-	-	-
NEPM ^C SGV	-	-	-	-	-	-	400	7,400	-
Predicted Background ^D									
Median	2.88	0.066	16.56	10	12.2	-	7.98	44.06	-
95 th Quantile	12.06	0.34	80.15	42.85	44.34	-	44.96	182.8	-

^A Results for total concentration analysis, average, 95% upper confidence limit (UCL), soil acceptance criteria and predicted background in mg/kg dry weight, RSD in %. ND is not detected. - indicates not applicable or not analysed.

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

^C National Environment Protection Council (Australia), 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999*. The values applied represent a Health Investigation Level (HIL) for Low Density Residential land use (HIL A).

^D 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://iris.scinfo.org.nz/layer/48470-pbc-predicted-background-soil-concentrations-new-zealand>).

The results from within the extent of works are consistent with the predicted background concentration based on the underlying geological unit (gravel)⁴, in addition to the natural background levels determined for the farm in the PSI.

The P group of samples shows slightly elevated lead however concentrations are well below the *Rural Residential SCS*, which has been applied on a conservative basis. Given the proposed use of the site, the much higher *Recreational* criteria could be applied. While the concentrations are within the range of the predicted background concentration for lead, the proximity to the homestead and farm buildings indicates an anthropogenic source is possible. The low level of contamination indicates the area is highly unlikely to present a risk to human health.

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.

In addition, it is highly likely that only clean soils will be disturbed by the proposed development earthworks, including the cut associated with construction of the overflow parking area.

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, CEnvP, PhD, MEIANZ
Senior Contaminated Land Consultant

Reviewed by:



Ciaran Keogh, MBA, MRRP
Principal and Senior Environmental Planner

⁴ Landcare Research, 2015. *Background soil concentrations of selected trace elements and organic contaminants in New Zealand*. And <https://iris.scinfo.org.nz/layer/48470-pbc-predicted-background-soil-concentrations-new-zealand>.

CCL Ref: 14372-120623-tristram

12 June 2023

Nicola Tristram
Ayrburn Precinct Limited



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Dear Nicola

The Proposed Hayburn Venue: Parking and Access Assessment

Following our recent discussions, we understand that an events venue is proposed at 339 Arrowtown-Lake Hayes Road, to be known as the Hayburn, that will accommodate up to 180 guests.

This letter addresses the relevant parking and access matters, with particular reference to issues identified in the District Plan.

Site Location and Proposed Development

The Hayburn is proposed to be an events venue, able to accommodate up to 180 guests within a Public Floor Area (PFA) of 426sqm and a Ground Floor Area (GFA) of 748sqm.

The venue includes ancillary activities typically associated with venues, including a bar, toilets, kitchen, stores and offices. In the event of a wedding, there is also a bride and groom suite upstairs.



Figure 1: Site Location (Extract from Paterson Pitts Drawing)



The number of car parking spaces across Ayrburn has been determined via previous consents. As part of the latest consent (RM220874) the following car parking plans were approved.

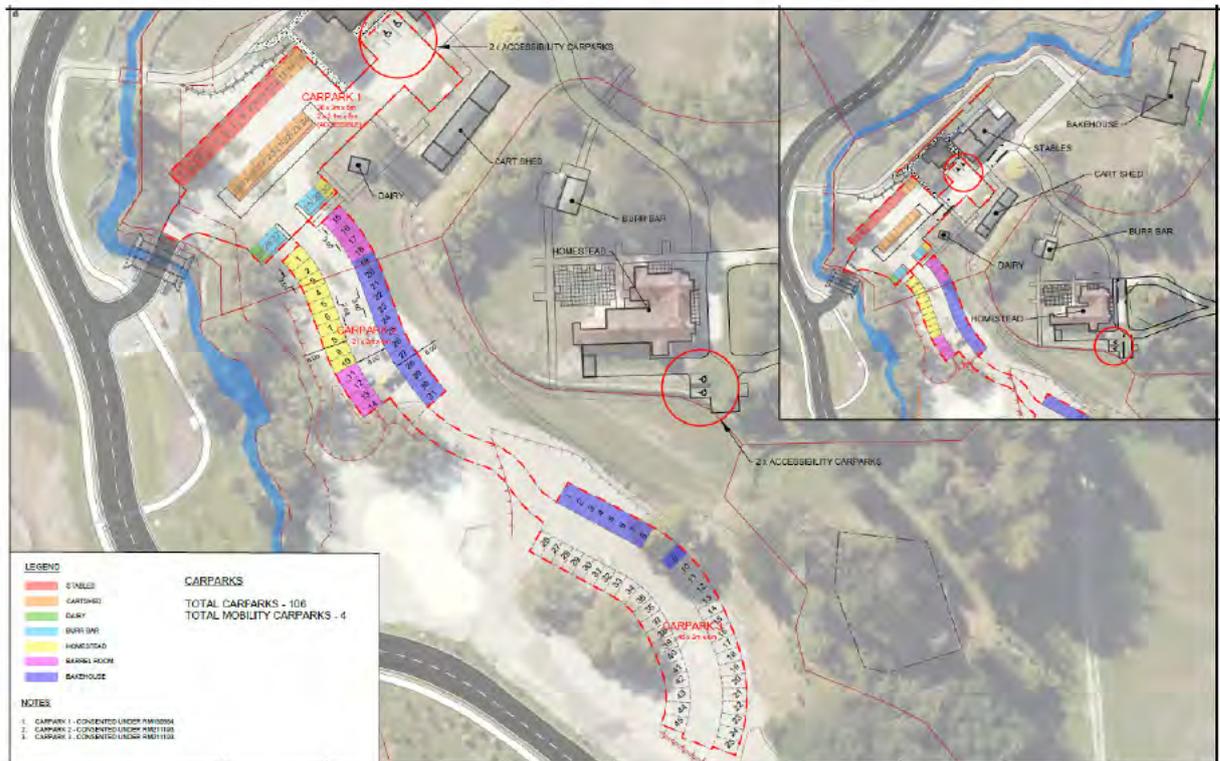


Figure 2: Car Parking Numbers and Layout under Normal Operation

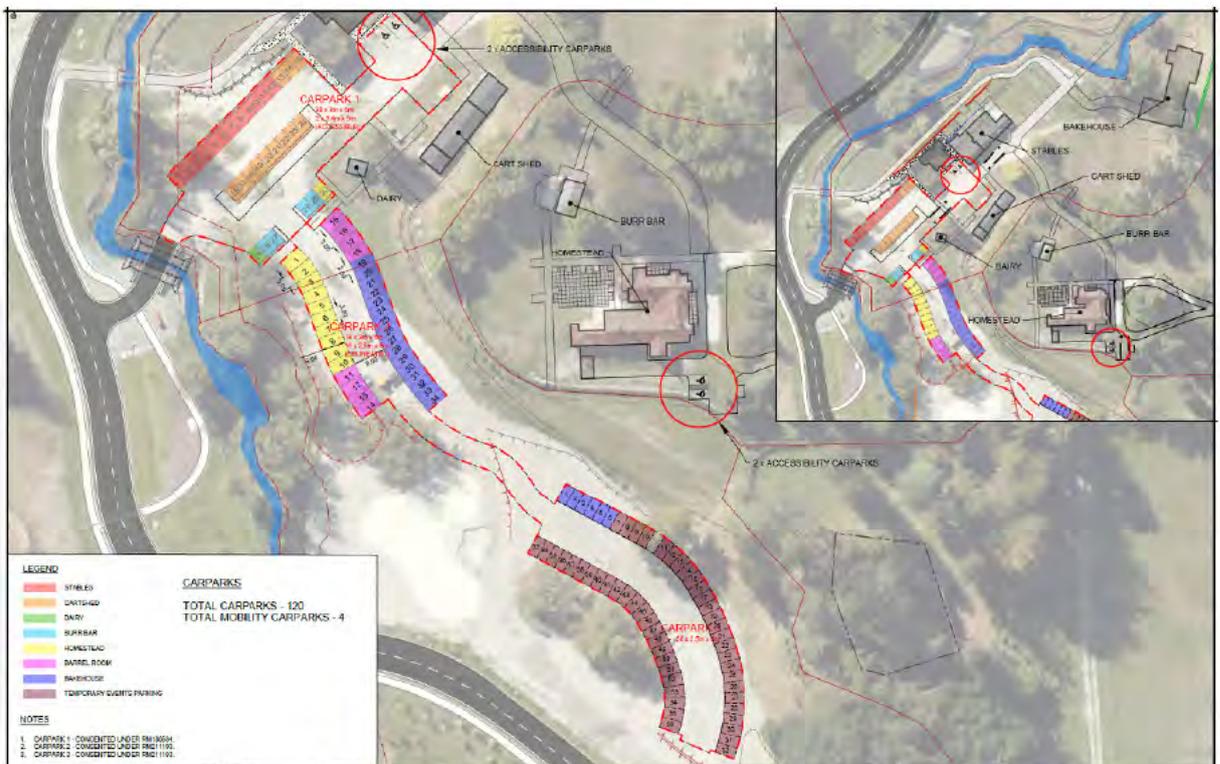


Figure 3: Car Parking Numbers and Layout During Temporary Events



During normal operation of the wider site 106 car parks are consented and available. However when temporary events are held, the spaces within a number of parking areas are temporarily delineated and 120 parking spaces are then provided. The number of temporary events is limited to 12 (under RM211193) and can be attended by up to 500 people.

As part of this application, it is proposed to formalise and repurpose the existing consented car parking and allow for parking associated with the proposed Haybarn venue within Car Park 3. This will then provide 120 car parking spaces at all times, with the spaces in Car Park 1 being 2.6m wide and the spaces in Car Parks 2 and 3 being 2.5m wide. A new exit from Car Park 3 will be formed onto Ayr Avenue.

A new overflow car park will be formed on the western side of Ayr Avenue approximately 140m to the west of Car Park 1, and this will be served via a new access onto Ayr Avenue. The new overflow car park will allow for 53 car parking spaces. These will not be formally delineated, and as per previous parking assessments for Ayrburn, a notional width of 3.0m has been allowed for these spaces, to recognise that drivers usually leave a greater gap between their vehicle and the next when spaces are not formally marked.



Figure 4: Proposed New Car Parking Area (Extract from Paterson Pitts Drawing)

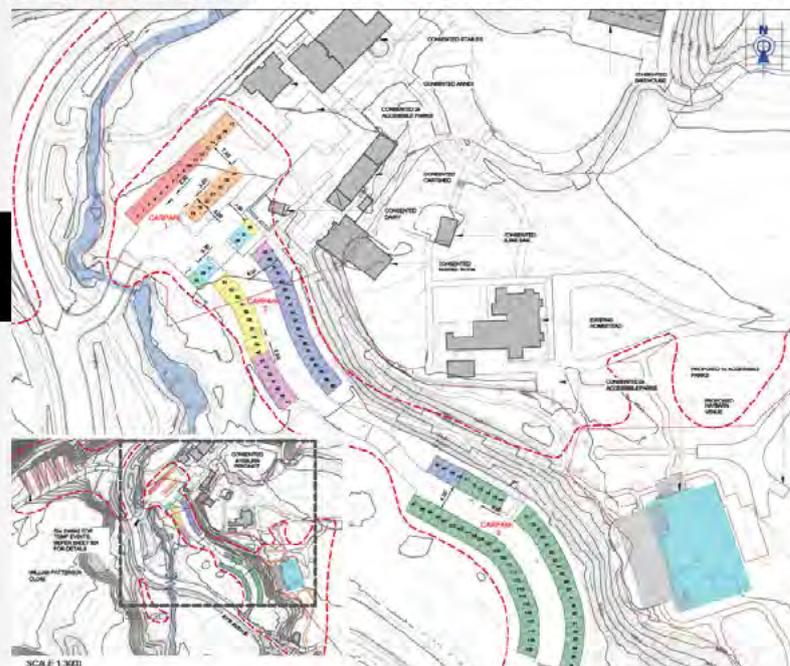


Figure 5: Proposed Car Parking Layout (Extract from Paterson Pitts Drawing)



The existing driveway leading from Arrowtown-Lake Hayes Road to the Homestead will be used for emergency vehicle access to the proposed Haybarn venue, as well as serving mobility spaces, service vehicles, and for drop-off of VIPs (such as a wedding party).

The proposal recognises that at many events, guests will wish to drink alcohol, and in order to accommodate non-car travel, the formed width of Ayr Avenue has been increased to allow for a bus layby. The bus layby is 3.0m and is a total of 42m in length plus entry and exit tapers. This length ensures that two coaches can be accommodated and both coaches can independently enter and exit the layout without the need for the other to move. There is a sealed area on the immediate north of the layby to accommodate passengers alighting or boarding coaches, and this is connected to the Haybarn via a dedicated off-road walking route. Over the lower 50m the walking route is 3.0m wide, but then this splits for 40m to form two potential routes to the Haybarn venue, each of 1.5m width. This route may be used by golf carts to transfer guests between the coaches and the proposed Haybarn venue.

To avoid coaches having to undertake complex reversing movements to enter the layby, a route has been provided through Car Parks 1, 2 and 3, such that an incoming (northbound) coach initially drives past the layby, turns right and proceeds south through the car parks, and then exits from Car Park 3 back onto Ayr Avenue (southbound).

Finally, a bus layby is proposed for Ayrburn Domain. This is located on the western side of Ayr Avenue, opposite the pedestrian connection into Ayrburn Domain and just south of the access for the overflow car park. There is no scheduled public transport service that operates along Ayr Avenue and therefore this stop will be used only by private services operated by the consent-holder. Again, in order to avoid complex turning movements taking place, in the long term and once the consented Hotel (or Northbrook Arrowtown) have been constructed, the bus will travel around 200m northwards on Ayr Avenue and turn around in Car Park A. In the short term, prior to the formation of this car park, a temporary turning head will be provided within the same area. For completeness, the consented layout of Car Park A has already been designed to accommodate buses.



Figure 6: Location of Car Park A and Turning Facility



Transportation Effects

Traffic Generation

The traffic generation of an events venue depends on a range of factors, and in this regard we note that:

- Not every function will anticipate the maximum number of 180 guests;
- Even when a guest expects to attend, late-minutes changes in their circumstances means that they might not;
- Some functions will have a specific start and end time, and others will have more flexibility, meaning that traffic generation may be 'peaky' or may be more diffused;
- Vehicle occupancy may vary; and
- Use of non-car modes will vary. For instance, if minibuses are used then the total number of cars will reduce – conversely, while taxis may have greater vehicle occupancy (which suggests fewer vehicle movements), they will not stay within the site for long and thus will give rise to 2 vehicle movements in short succession. Conversely, a private vehicle will have a greater time period between arriving and departing.

Surveys have shown that a typical event gives rise to an average car occupancy of 2.5 guests per vehicle. However within this there is considerable variation. For instance, an event where guests expect to drink alcohol will typically have higher car occupancy as people seek to make use of a sober driver or share a taxi. In this regard, a series of seven surveys of functions at a venue in Christchurch observed an average occupancy of 3.3 people per vehicle.

Notwithstanding the maximum capacity of 180 guests, it is highly unlikely that each and every function will be attended by this number of people. Equally though, it is implausible that very small functions will be regularly held in this location because there are more suitable venues which have a lesser capacity. As a general principle of traffic engineering, peak generation rates are based on 85th percentile values and for the purposes of this analysis, this has been taken to be a function with 155 people.

Finally, we have assumed that all guests will arrive within a single hour prior to the event commencing, and will depart in a single hour after the event ends.

Thus an event with 155 people, allowing for 2.5 people per vehicle, would generate a peak hour traffic generation of 62 vehicle movements.

By way of sensitivity tests:

- [REDACTED] 3.3 people per vehicle would result in 47 vehicle movements;
- [REDACTED] used taxis but vehicle occupancy remained the same, then the calculated 62 vehicle movements would increase by 10% to 68 vehicle movements (and similarly, there would be a 10% increase in the other traffic generation results set out above; and
- Conversely, use of coaches, buses or minibuses would result in lower traffic generation. Just using one, 16-seater minibus would reduce the 62 vehicle movements to 56 vehicle movements, and this reduction would be greater for more minibuses or larger coaches.

We highlight that because events will invariably be several hours in length, the period when vehicles will arrive will be different to the period when they depart. Even under the hypothetical worst case of two events being held on the same day, the time taken for the breakdown of the



first event ('pack-out') and the setting up of the second event ('pack-in') means that the two events must be separated from one another by several hours.

Effects on Ayr Avenue

In our recent assessment of the Barrel Room (RM220829), we set out that “*under previous analyses, traffic flows on Ayr Avenue were calculated as 331 vehicles entering from Arrowtown – Lake Hayes Road in the evening peak hour, and 335 vehicles exiting.*” The Barrel Room would add a further 40 vehicle movements per hour to this but we also noted that “*the assessments of the Arrowtown – Lake Hayes Road / Ayr Avenue and Arrowtown – Lake Hayes Road / Speargrass Flat Road intersections (as set out in the accompanying documentation to RM211193) showed ample capacity to accommodate the then-expected traffic volumes, with queues of at most 2 vehicles in any location, and Level of Service A or B for each turning movement. The slight increase in traffic due to the Barrel Room can therefore easily be accommodated without materially affecting the performance of the intersections.*”

The times at which the Haybarn would add traffic onto Ayr Avenue will vary depending on the event being held. However, as noted above, because an event will be several hours long, it will not be possible for the peak hour inbound traffic generation of the Haybarn to occur at the same time as the peak hour outbound traffic generation. In other words, if an event was to commence in the evening peak hour, it would generate inbound traffic but little outbound traffic (and vice versa for an event that ends in the evening peak hour).

The increase in traffic on Ayr Avenue is therefore limited to around 60-70 vehicle movements in the peak hour, which can easily be accommodated by the configuration of the road.

Effects on Arrowtown – Lake Hayes Road / Ayr Avenue Intersection

With any priority intersection, the greatest delays occur for vehicles turning right out of the minor approach. Accordingly, the greatest effects arising from the Haybarn will be if an event ends at the same time as the evening peak hour arises. In order to evaluate the effects of this, we have adopted a highly 'worst case' scenario:

- We have used the same transportation model that was used to assess the performance of the Arrowtown – Lake Hayes Road / Ayr Avenue intersection for the current hotel consent;
- We have used the evening peak hour, as this is the period with the highest traffic flows on Arrowtown – Lake Hayes Road;
- We have then added the 40 vehicles associated with the Barrel Room plus 70 vehicles notionally associated with the Haybarn, assuming a 'worst case' of both generating peak traffic at the same time (which is highly unlikely); and
- We have then assumed a scenario where all of these 110 vehicles turn right out of Ayr Avenue, as this is the movement that experiences the greatest delay (which is also highly unlikely).

We summarise the results below:



From a practical perspective, the parking generated by an event would depend on the number of guests, mode of transport, and vehicle occupancy, and as set out above these will vary on a case-by-case basis. Furthermore, parking demand also depends on how long people stay, because if a guest leaves an event, their parking space then becomes available for another guest to use.

This yields the following potential parking demands, for different scenarios (assuming no use of buses or coaches) for the 85th percentile occupancy of 155 people:

Percentage Non-Car Travel ¹	Number of Spaces Required		
	2.5 Car Occupancy	3.0 Car Occupancy	3.3 Car Occupancy
5%	59	49	45
10%	56	47	42
15%	53	44	40

Table 2: Parking Demand under Different Scenarios

It can be seen that the provision of 50 spaces plus 7 spaces in the coach parking bay will accommodate parking demand for all scenarios other than a larger event with a low proportion of taxis and ride-share. However even under his scenario, the shortfall is just 1 parking space which we consider can be easily accommodated within the site (such as the overflow area).

If a coach/bus was to be present, then there would be fewer car parking spaces available within the layby, but we highlight that car parking demand would also be lower (as guests would be travelling by bus/coach instead of by car) and hence the net vehicle occupancy would increase.

Overall, we consider that the parking provided will accommodate practical peak demand.

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.

Matter a. an Integrated Transport Assessment has been provided with the application and is sufficiently detailed to provide a full understanding of the projected trip generation by all modes of transport, the accessibility of a proposal by all modes of transport, the transport effects of the proposal, and the proposed methods of avoiding or mitigating the transport effects

[REDACTED] not been produced for the proposal, matters pertaining to traffic on the roading network are addressed above. It is considered that the traffic generated by the proposal can be accommodated on the roading network without adverse efficiency or road safety issues arising.

Matter b. the trip generation and transport effects of the proposed landuse or subdivision will be the same or similar in character, intensity and scale to those assessed in an approved Integrated Transport Assessment for any existing resource consent approved for the site

The proposal is additional to consented development at the site.

¹ In this case, this is likely to be taxis, ride-share and people dropping off whanau



Matter c. the proposed landuse or subdivision is in accordance with district plan provisions that were informed by a detailed Integrated Transport Assessment and will result in associated trip generation and transport effects that are the same or similar in character, intensity and scale to those identified in the previous assessment

It is understood that the underlying zoning of the site was informed by the council's modelling, but this did not necessarily include a function venue. The proposal has been assessed as a new activity.

Matter d. any improvements to the transport network either within the site or in the vicinity of the site are proposed, including additions or improvements to the active and public transport network and infrastructure and the road

As noted above, the transport-related effects of the proposed development are not expected to give rise to adverse impacts on safety or efficiency. No significant improvements to the network are therefore proposed. However provisions are made for non-car travel to the venue, through new coach laybys.

Matter e. the site and/ or its frontage have been designed to accommodate any planned public transport infrastructure proposed by Council

There is no public transport service that uses Ayr Avenue.

Matter f. public and active transport infrastructure is proposed to be provided or upgraded or, where planning for such infrastructure is not sufficiently advanced, space is provided for such infrastructure to be installed in the future

The proposal includes the provision of coach laybys which are well-connected to the Haybarn venue through a dedicated walking route.

Matter g. public transport stops are provided in locations and at spacings that provide safe and efficient access to users

There is no public transport service that uses Ayr Avenue. Consequently the activity does not make provision for new public transport stops, although a stop is provided for the consent-holder bus service.

Matter h. a Travel Plan is proposed to be provided containing travel demand management techniques

[REDACTED] d.

[REDACTED] accessory parking proposed will contribute toward travel demand management

The extent of parking provided is appropriate to meet demand, while not providing an excess of spaces.

Matter j. a Development Agreement has been agreed to, as provided for by the Local Government Act

No agreement has been entered into.



Matter k. electric vehicle charging points/ parking spaces are proposed to be provided

We understand that four electric vehicle charging points will be provided within Ayrburn Domain. The layout of the car park means that additional charging points can easily be retrofitted at a later stage if required.

District Plan Chapter 29: Parking and Loading

Rule 29.5.1: Location and Availability of Parking Spaces

The layout of Car Parks 1, 2 and 3, and the proposed overflow car park means 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 dimensions of the parking spaces provided are:

- Car Park 1:
 - 5.0m long, at least 2.6m wide and with an aisle of 7.0m;
- Car Park 2:
 - 5.0m long, 2.5m wide and with an aisle of 8.0m; and
- Car Park 3:
 - 5.0m long, 2.5m wide and with an aisle of 8.0m.

This means that the spaces are suitable for both Class 1 and Class 2 users.

The parking spaces provided in the overflow car park are 3.0m wide, 5.0m and have an aisle of 7m. We understand that these spaces will not be formally marked, and therefore that an additional width has been allowed for the parking spaces to take into account that drivers tend to leave a greater gap to the adjacent vehicle when roadway markings are not present. Accordingly, we confirm that these spaces will be suitable for both Class 1 and Class 2 users.

With regard to mobility spaces, there is one space provided which is 5.0m long, 3.6m wide and has an 8m aisle, as anticipated under the District Plan.

Rule 29.5.3: Gradient of Car Parks

The proposed overflow car parking spaces have a gradient of no more than 1 in 20, as required.

██████████ marks 1, 2 and 3 have already been consented.

██████████ ng Spaces

The District Plan sets out that for a 'meeting place and entertainment facility' of 101-500sqm Public Floor Area or 101 to 500 seats (as is the case here), one mobility space is required. This is provided.

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

No reverse manoeuvring to the frontage roads is expected under the proposed layout. Car Parks 1, 2 and 3 are accessed from the north, and the proposal is for a new exit-only to be provided directly onto Ayr Avenue, creating a through-route for traffic without the need to reverse.

The overflow parking area is divided into three separation sections. However each of these has a turning head at the end, meaning that reversing onto the accessway will not be required. Similarly, there will be no requirement to reverse onto Ayr Avenue.

Rule 29.5.7: Residential Parking Space Design

Residential units are not proposed in this case.

Rule 29.5.8: Queuing

No revisions are required to the already-consented queuing space at Car Park 1, 2 and 3, as the proposal simply formalises these spaces.

The proposed overflow area provides 53 spaces and therefore queuing space of 18m is required, and a distance in excess of 50m is provided.

Rule 29.5.9: Loading Spaces

In view of the zoning of the site, no loading space is required.

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

The overall provision requirements for cycle parking for a venue with 748sqm GFA is for 3 cycle parking spaces for visitors located directly outside the main entrance plus 1 cycle parking space for staff. The plans show five cycle parking spaces adjacent to the main entrance.



Access

Road Design

There are two new accessways proposed, one from Car Park 3 (which will provide exit only), and at the overflow car park.

The exit from Car Park 3 is 4m wide, which we consider is appropriate for a single traffic lane. However this width is not contemplated in the Council's Code of Practice where only two-way roads are discussed. The access to the proposed overflow car park is proposed to be 7m wide, which is ample for two-way traffic flow.



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

Although the site is within a rural zone, the speed limit on Ayr Avenue is 50km/h and therefore it is classified as an urban road. Therefore we consider that the most appropriate vehicle crossing designs and provisions are those relating to urban roads and not to rural roads. We therefore consider that the provisions of this Rule are relevant.

An access to a non-residential property must be between 4m and 9m in length (width), and this is achieved at each location.

All vehicle crossings cross the property boundary at 90 degrees (plus or minus 15 degrees) and intersect the carriageway at 45 degrees to 90 degrees.

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

As noted above, notwithstanding that the site is within a rural zone, we have assessed the accesses as being urban due to the 50km/h speed limit of Ayr Avenue. One outcome of this is that the vehicle crossings do not comply with the provisions for rural crossings as layouts to Diagrams 8, 9 or 10 of the District Plan. However in view of the speed limit, we do not consider that these layouts are appropriate in this instance.

Rule 29.5.16: Maximum Gradient for Vehicle Access

No details have been provided in respect of the access gradients, but we expect that compliance with the rule can be achieved.

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

Ayr Avenue has a posted 50km/h speed limit and therefore sight distances of 80m are required. From the information provided, this distance is achieved at both the exit from Car Parks 1, 2 and 3 and the proposed overflow car park.

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

Only one access is proposed at each of the parking areas.

Rule 29.5.20: Minimum Distances 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

Given that Ayr Avenue is not specifically classified in the District Plan, it is assessed as a Local Road and therefore a 25m separation is required between accesses and intersections. This is 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.

Conclusions

Taking the above matters into consideration, we consider that the traffic generated by the proposed Haybarn venue can be accommodated on Ayr Avenue and at the Arrowtown – Lake Hayes Road / Ayr Avenue intersection without adverse effects arising on roading capacity or road safety. The Arrowtown – Lake Hayes Road / Ayr Avenue intersection continues to have ample spare capacity even under a ‘worst case’ scenario. Similarly, the low traffic flows on the Homestead driveway mean that adverse capacity or road safety effects are highly unlikely.

The site provides for sufficient car parking, taking into account the size of events, vehicle occupancies and ways in which guests might travel.

When considered against the District Plan provisions, we consider that there are two non-compliances with respect to the transportation-related Rules:

- Rule 29.5.13 (Access and Road Design):
 - This only contemplates two-way access of 5.5m or more, whereas the exit from Car Park 3 is 4m wide and provides for one-way traffic. We consider that the width of this access is appropriate for its expected use.
- Rule 29.5.15 (Width and Design of Vehicle Crossings – Rural Zones)
 - Although the site is within a rural zone, we have assessed the accesses as being urban because Ayr Avenue has a 50km/h speed limit. One outcome of this is that the vehicle crossings do not comply with the provisions for rural crossings as layouts to Diagrams 8, 9 or 10 of the District Plan. However in view of the speed limit, we do not consider that these layouts are appropriate in this instance.

Overall, we are able to support the proposed Haybarn venue and overflow car park 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



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Planning | Surveying | Engineering | Environmental

HAYBARN VENUE
WATER & WASTEWATER ASSESSMENT

Ayrburn Precinct Ltd
339 Arrowtown-Lake Hayes Road
Arrowtown

Document Information

Client	Ayrburn Precinct Ltd
Site Location	339 Arrowtown-Lake Hayes Road, Arrowtown
CKL Reference	A20254
Office of Origin	Hamilton

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Signed		Date	9/06/2023

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1. Introduction

The proposal outlines the development of the proposed Haybarn, a venue situated within the existing woodland at 339 Arrowtown-Lake Hayes Road (refer to **Figure 1** below). CKL has been appointed to evaluate the water and wastewater demands of this proposed facility and analyse its potential impact on the existing and planned infrastructure in order to support a resource consent application. This memorandum highlights the key findings and recommendations stemming from our assessment. In order to illustrate the water and wastewater demands for the venue we have based our assessment on the venue being used for a wedding function which generates indicative peak water and wastewater demands. The venue, however, may be used for a range of other events but these would likely have less demand on services.



Figure 1 – Locality and Extent of Works Plan

2. Scope (CKL)

2.1 Review of available information

The following information has been reviewed to determine likely water demands and wastewater flows:

- Haybarn Venue for Resource Consent Drawings prepared by SA Studio dated 6 June 2023.
- Haybarn Venue Resource Consent Drawings prepared by Paterson Pitts Group dated 6 June 2023
- Ayrburn Domain Extension Water Supply and Wastewater Infrastructure Assessment prepared by Fluent Solutions dated December 2021
- Water Network Analysis for Waterfall Park and Ayrburn Domain prepared by CKL dated 27 April 2023
- AS/NZS 1547:2012 On Site Domestic Wastewater Management
- QLDC's Land Development and Subdivision Code of Practice 2020

339 Arrowtown-Lake Hayes Road - Proposed Haybarn venue

- NZS4404:2010 Land Development and Subdivision Infrastructure
- Example reports from similar developments

3. Description of Facilities

3.1 Facilities to be assessed.

The Haybarn venue will consist of a two-storey building with a function hall, lounge, office, storeroom, kitchen, bar and toilet facilities on the first floor. In the event of a wedding, the second floor will consist of “bride and groom” dressing rooms, and bathroom facilities. The maximum loading scenario for demand calculations has been assumed to comprise 180 visitors and 21 service staff. Figure 2 below indicates a layout of the proposed building.

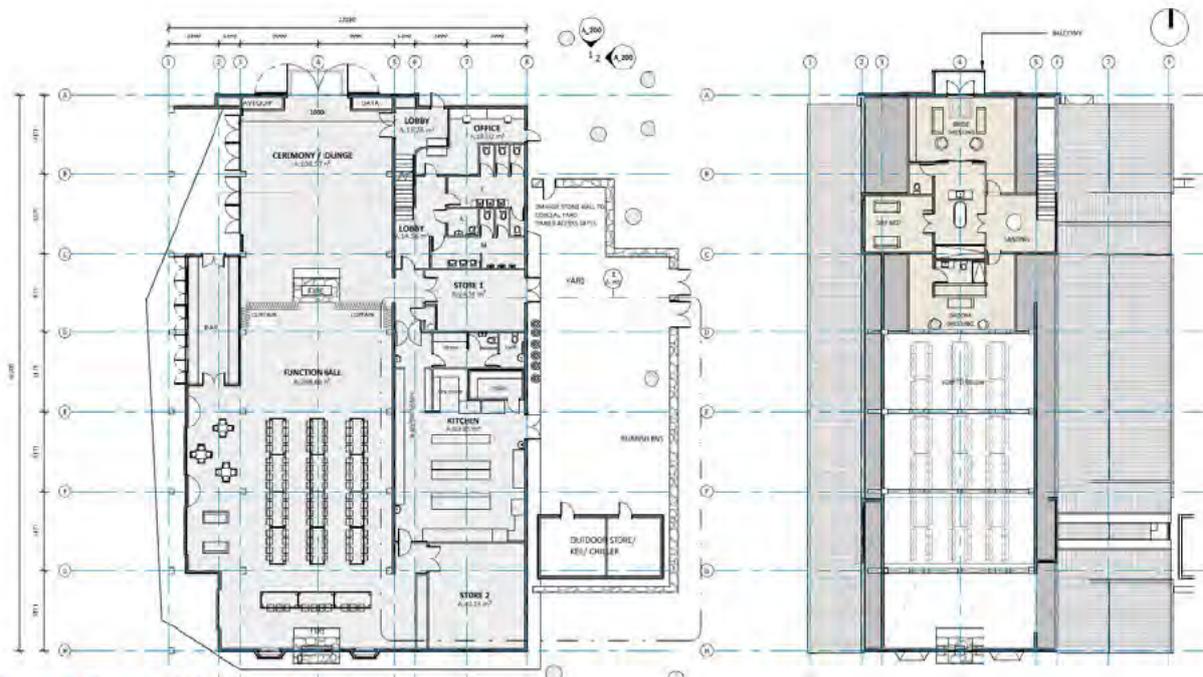


Figure 2: Proposed Haybarn Venue Layout

3.2 Staff Numbers

Assumed staff numbers have been derived in Table 1 below as follows:

Table 1: Assumed Staff Numbers

Role	Minimum Staff Members	Maximum Staff Members	Description
Event Manager/Coordinator	1 person	1 person	Overseeing events, coordinating logistics, and ensuring everything runs smoothly
Kitchen Staff	5 people	10 people	Including chefs, cooks, and kitchen assistants
Service Staff	1 staff per 10 guests	1 staff per 15 guests	Handling tasks such as serving food, attending to guest needs, and bussing tables
Bartenders	1 bartender per 75 guests	1 bartender per 50 guests	Ensuring prompt service for a venue with 180 guests, requiring 2-4 bartenders
Setup and Breakdown Crew	2 people	5 people	Responsible for setting up and breaking down the event space, including tables, chairs, and decor
Security	1 person	1 person	At least one security personnel on-site to ensure guest safety, especially when alcohol is served
Totals	10-12 people	19-21 people	Total staff numbers for the Haybarn venue

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Based on these guidelines, a venue like the Haybarn, typically hosting a maximum of 180 guests could require approximately 10-21 staff members for optimal event management. We have assumed a worst-case scenario of 21 staff members.

Table 2 below indicates what services are being included for demand calculations.

Table 2: Service Demand – summary of facilities services

Facility	Water Demand	Wastewater Demand
Function Hall	No	No
Lounge	No	No
Office	No	No
Storeroom	No	No
Kitchen	Yes	Yes
Bar	Yes	Yes
First-floor Toilets	Yes	Yes
Bride Dressing Room	No	No
Groom Dressing Room	No	No
Landing	No	No
Second-floor Bathrooms	Yes	Yes

4. Water Demand Estimates

4.1 General Approach

The estimation of water demand (average and peak) for the Haybarn venue requires an understanding of the provided facilities, the resident population including staff and guests, and the impact on the existing QLDC water network, particularly under peak instantaneous flow conditions. The following assessment is based on:

- Proposed occupancy, including guests, staff, and visitors
- Potable water demand, including peak factors
- Irrigation requirements
- Firefighting requirements for hydrants and sprinklers (as advised by Cosgroves Ltd)
- Available capacity of the existing QLDC water network, supported by previous modelling exercises undertaken by Mott Macdonald, Fluent, and CKL

To determine the specific flow demands for the site, the following maximum scenario occupancy rates were applied:

- 180 guests for the Haybarn venue at 30 L/p/day
- 21 kitchen and service staff at 30 L/p/day

4.2 Estimated Consumptions.

The following table, Table 3, presents the estimated water demands for the proposed Haybarn venue, based on various facilities, the maximum number of guests, and staff members. The table takes into account daily water demand per person and peak hour demands, using a peak factor of 6.6 to account for periods of high-water usage. The calculations are made according to AS/NZS 1547:2012 standards and the provided assumptions.

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Table 3: Water Demand Estimates for Proposed Haybarn Venue

Facility	No. of People	Daily Water Demand (L/p/day)	Daily Water Demand (m ³ /day)	Daily Water Demand (L/s)	Peak Factor	Peak Hour Demand (L/s)	Comments
Kitchen	180	30	5.4	0.0625	6.6	0.4125	AS/NZS 1547:2012, Table H4: Accommodate for Restaurant (Accommodate full 180 guests)
Bar	140	30	4.2	0.0486	6.6	0.3208	AS/NZS 1547:2012, Table H4: Accommodate for Bar trade. Assume maximum of 140 guests per day.
First-floor toilets	160	30	4.8	0.0555	6.6	0.3663	
Second-floor toilets	20	30	0.6	0.0069	6.6	0.0455	
Staff	21	30	0.63	0.0073	6.6	0.0481	AS/NZS 1547:2012, Table H4: Accommodate for non-resident staff
Total			15.63			1.1932	

The following is a summary of the assumptions made while calculating the water demands for the Haybarn venue:

- The maximum number of guests at the venue is 180.
- There will be 21 staff members.
- The second-floor bathroom has limited use, relatively to the ground floor facilities.
- Water demand calculations are based on the AS/NZS 1547:2012 standards.
- The daily water demand per person (L/p/day) for each facility is 30 litres.
- A peak factor of 6.6 is applied to the water demand to estimate the peak hour demand.

The following table, Table 4, gives an overview of the current water demands for Ayrburn, taking into account the addition of the proposed Haybarn venue. This table has been adapted from CKL's previous water modelling report from 27 April 2023, and updated to reflect the addition of the Haybarn venue demand as well as the remaining future capacity.

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Table 4: Ayrburn Updated Water Demand

Unit Type	No. of Facilities	Max No. of People Facility / Day	Daily Water Demand (L/p/d)	Daily Water Demand (m ³ /d)	Daily Water Demand (L/s)	Domestic Peak Hour (daytime only), no irrigation	
						Peak Hour Peaking Factor	Peak Hour Demand (L/s)
Ayrburn							
Dairy (Ice cream parlour)	1	48	15	0.72	0.01	6.6	0.06
Sub-Total		48		0.72	0.01		0.06
Bakehouse							
Restaurant	1	240	20	4.8	0.06	6.6	0.37
Office space	1	24	35	0.84	0.01	6.6	0.06
Sub-Total		264		5.64	0.07		0.43
Annex Building/Stable							
Restaurant	1	572	30	17.16	0.20	6.6	1.31
Bar & Lounge	1	52	20	1.04	0.01	6.6	0.08
Non-residential Staff	1	19	30	0.57	0.01	6.6	0.04
Sub-Total		643		18.77	0.22		1.43
Cart Shed (Deli)							
Sub-Total	1	96	20	1.92	0.02	6.6	0.15
Sub-Total		96		1.92	0.02		0.15
Burr Barr							
Sub-Total	1	52	20	1.04	0.01	6.6	0.08
Sub-Total		52		1.04	0.01		0.08
Homestead Building							
Sub-Total	1	504	30	15.12	0.18	6.6	1.16
Sub-Total		504		15.12	0.18		1.16
Barrel Room							
Piano Room	1	60	30	1.8	0.02	6.6	0.14
Barrel Room	1	40	20	0.8	0.01	6.6	0.06
Non-residential staff	1	10	30	0.3	0.00	6.6	0.02
Sub-Total		110		2.9	0.03		0.22
Display Suite							
Sub-Total	1	10	30	0.3	0.003	6.6	0.023
Sub-Total		10		0.30	0.00		0.02
Haybarn							
Kitchen	1	180	30	5.40	0.06	6.6	0.41
Bar	1	140	30	4.20	0.05	6.6	0.32
First-floor toilets	1	160	30	4.80	0.06	6.6	0.37
Second-floor toilets	1	20	30	0.60	0.01	6.6	0.05
Staff	1	21	30	0.63	0.01	6.6	0.05
Sub-Total		521		15.63	0.18		1.19
Ayrburn Total							
		2248		62.04	0.72		4.74
Future Capacity							
Sub-Total		0		61.01	0.706	6.6	4.66
		0		61.01	0.71		4.66
Sub Total (Domestic)				123.1	1.4		9.4
Add Irrigation Demand							1.6
Total (Domestic + Irrigation)							11

The subtotal in Table 4 of 11 l/s is made up of previously consented water demands namely RM180584 (1.4l/s) and RM211193 (9.4l/s). The future capacity indicated in Table 4 of 4.66 l/s has been calculated using the consented total for Ayrburn Domain less the sum of the current Ayrburn Domain water demand i.e 11 l/s – 4.74 l/s = 4.66 l/s.

As indicated in Table 5 below, the consented totals for the Peak Daily Volume have not changed (these have been previously accepted by QLDC). The demands for Ayrburn and additional facilities are also indicated below. Table 5 shows an available Future Capacity of 23.53 l/s.

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Table 5: Consented Flows & Future Capacity

Development Area	Modelled (Mott MacDonald - 2018) Peak Hour (l/s)	Consented and Proposed Development
Waterfall Park Hotel	18.9	-
Northbrook Arrowtown	-	9.10
Ayrburn Domain (Consented as part of RM 180584)	1.4	1.40
Ayrburn Domain Change of use buildings		0.15
Ayrburn Farm - No longer proposed Residential Development	24.7	-
Ayrburn Domain Extension (RM211193)	-	9.40
Barrel Room (RM220829)		0.22
Bakehouse (RM220874) ***		
Display Suite (RM221133)**		
Haybarn venue		1.19
Sub-total (Current Proposal)		21.47
Future Capacity (subject to future RC applications)	-	23.53
Total	45	45

***The Display Suite building is planned to be decommissioned prior to the Northbrook Arrowtown or the Hotel being fully commissioned. This means that any water and wastewater demand generated will be of a temporary nature and will not impact on the previously consented demands.*

****The Bakehouse water demand forms part of the "Ayrburn Domain Extension Variation"*

4.3 Irrigation Requirements for Haybarn

The irrigation demand for the proposed Haybarn venue plays a small role in the overall water requirements for the site. With a landscaping area of 300 m² and a daily irrigation rate of 3 mm/m²/day, the calculated average daily irrigation demand is 21 m³/day. To accommodate the irrigation requirements, an 8-hour overnight irrigation period has been proposed. During this period, the peak hour demand for irrigation is estimated to ensure that the water supply system can adequately meet the maximum demand during these peak periods. The peak hour demand for irrigation during the 8-hour overnight irrigation period is calculated to be approximately 0.03 L/s.

Table 6 summarises the irrigation demand and peak hour demand:

Table 6: Irrigation Demand for Haybarn

Description	Value	Unit
Area of Landscaping	300	m ²
Daily Irrigation Rate	3	mm/m ² /day
Irrigation Demand	21	m ³ /day
Irrigation Period	8	hours
Peak Hour Demand for Irrigation	0.03	L/s

4.4 Fire Flow Requirements

The following requirements need to be met by the proposed development in terms of pressure and fire demand:

1. A minimum residual peak hour pressure of 300 kPa and maximum of 900 kPa is required as per the QLDC COP 2020.

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2. A total of 25 l/s is required from within 270 m of each non-sprinklered, residential dwelling for Class FW2 fire fighting as per SNZ PAS 4509:2013.
3. A minimum of 12.5 l/sec is required from each hydrant as per SNZ PAS 4509:2008.

Further Notes on Fire Flow requirements:

- FW2 classification for firefighting water supplies: 1500 L/min with residual towns mains pressure of 100 kPa. This is on the assumption that the Haybarn venue will be sprinkler protected.
- The Haybarn venue is proposed to be sprinklered. Sprinkler system: 1000 L/min @ 400 kPa (Confirmed by Cosgroves, see Appendix B)
- In order to estimate the highest firewater demand the highest sprinkler demand plus the FW2 demand plus 60% of peak domestic demand need to be combined - the maximum concurrent fire demand therefore is summarised in Table 7 as follows:

Table 7: Total Peak Fire Flow in Ayrburn Domain

Parameter	Value
PDD (Peak Daily Demand for Ayrburn Domain inclusive of future capacity)	11 l/s
60% of PDD (Based on SNZ PAS 4509:2008)	6.60 l/s
Irrigation Rate	1.6 l/s
Two Fire Hydrants discharging @ 12.5 l/s (FW2)	25 l/s
Sprinkler flow (Assumed)	16.67 l/s
Total Peak Fire Water Demand (Incl. Irrigation)	49.87 l/s

In conclusion, CKL has modelled the Ayrburn Domain at a maximum flow rate of 56.6 l/s and residual pressures were found to be higher than the minimum requirement. The flow rate of 49.87 l/s in table 7 above will therefore produce higher residual pressures and is therefore considered acceptable.

4.5 Existing Infrastructure

A 315 OD PE100 PN 12.5 water main has been installed along Ayr Avenue to service the development. This watermain is connected to the existing DN 225 mPVC watermain in the Arrowtown-Lake Hayes Road. A 180 OD PE100 PN12.5 watermain branches off from the existing 315 OD watermain to service Ayrburn Domain.

It is proposed that the Haybarn venue will be serviced with a connection from the above mentioned 180 OD Ayrburn Domain water main. See Figure 3 below.

4.6.1 Key Findings and Observations

The results of the pressure and flow testing confirmed that the water distribution system design effectively maintains the required minimum residual pressures during normal operation and fire flow scenarios. This ensures an adequate water supply and pressure for all users. Additionally, velocities within the network are maintained within acceptable ranges, mitigating risks such as water hammer or excessive wear on the pipeline infrastructure. The unit head loss values have been optimized to enhance the system's overall efficiency and minimize energy consumption.

4.6.2 Recommendations for Future Actions

The report recommended that regular monitoring and maintenance should be established to ensure the long-term efficiency and reliability of the water supply infrastructure. As the development grows, the design of the water supply infrastructure should be periodically revisited to assess its capacity to accommodate additional demand. The report also suggested implementing water conservation initiatives, such as promoting water-efficient appliances, rainwater harvesting, and greywater recycling, to reduce overall demand on the water supply infrastructure and contribute to the development's sustainability and resilience.

4.6.3 Haybarn Venue Demands and Effect on Existing Network

The water modelling analysis was performed considering future capacity needs, and as such, the water demand of the Haybarn venue was incorporated into the overall water requirements of the development.

4.6.4 Conclusion of Water Modelling Report

The report concluded that the water supply infrastructure meets the required standards for both domestic consumption, irrigation and firefighting purposes. The EPANET model simulations have shown that the water distribution system design effectively addresses essential parameters, including residual pressures, velocities, and unit head loss. Moreover, additional pressure and flow testing will be carried out by Oceana Fire Protection Services and Holmes before commissioning their respective sprinkler systems, further ensuring the reliability and safety of the system.

5. Wastewater Flow Assessment

5.1 General Approach

The conceptualisation of the proposed wastewater (WW) solution for the Haybarn venue includes gaining an understanding of the facilities to be provided, the staff population to be served and the capacity of the existing QLDC wastewater network, particularly under peak wet weather flow scenarios.

The following aspects have been investigated:

- Proposed figures including for customers and staff numbers
- Wastewater flows including peak wet weather and peak dry weather flows
- Proposed Haybarn WWPS and interim pumping arrangement while main Waterfall Park WWPS is being constructed
- Available capacity of the main Waterfall Park WWPS
- Available capacity of the existing QLDC wastewater network supported by previous modelling exercises undertaken by BECA and HAL.

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5.2 Estimated WW Flows

The design flows for the proposed Haybarn are summarised in Table 8 below.

Table 8: Peak Wastewater Flows for Haybarn Venue

Unit Type	No. of Units	Max No. of People / Unit / Day	Average Per Capita Daily Wastewater Demand (l/p/d)	Average Daily Wastewater Demand (m ³ /d)	Dry Weather Diurnal Peaking Factor	Peak Dry Weather Flow (L/s)	Wet Weather Peaking Factor	Peak Wet Weather Wastewater Flow (L/s)	Comments
Haybarn venue									
Kitchen	1	180	30	5.40	2.50	0.16	2.00	0.31	AS/NZS 1547:2012, Table H4: Accommodate for Restaurant
Bar	1	140	20	2.80	2.50	0.08	2.00	0.16	AS/NZS 1547:2012, Table H4: Accommodate for Bar trade. Assume maximum of 100 customers per day.
First-floor toilets	1	160	30	4.80	2.50	0.14	2.00	0.28	Assume 6L per flush @ 3 flushes per person + 3L for hand wash per person (Round up)
Second-floor toilets	1	20	30	0.60	2.50	0.02	2.00	0.03	Assume 6L per flush @ 3 flushes per person + 3L for hand wash per person (Round up)
Staff	1	21	30	0.63	2.50	0.02	2.00	0.04	AS/NZS 1547:2012, Table H4: Accommodate for non-resident staff
Sub Total (Domestic)				14.23		0.41		0.82	

The proposed Haybarn venue is not a residential subdivision, and it doesn't directly adhere to the guidelines specified in the QLDC COP 2020. The design metrics in Table 8 were therefore drawn from various sources, among them AS/NZS 1547:2012.

It was assumed that the building would have an average daily flow ranging from 20 to 30 l/p/d, with a diurnal peaking factor of 2.5 and a wet weather peaking factor of 2 to account for potential infiltration.

5.3 Existing Infrastructure

According to the conducted modelling and studies so far, the existing 300mm uPVC trunk main along Arrowtown-Lake Hayes Road possesses sufficient capacity to accommodate wastewater flow from Ayrburn Domain, the proposed extension of Ayrburn Domain, and other Waterfall Park developments.

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The 160 OD PE 100 PN12.5 rising main that's already in place can also accommodate flows from the Waterfall Park WWPS to the 300DN uPVC trunk main situated along Arrowtown-Lake Hayes Road. Within Ayrburn Domain site, the proposed Haybarn venue will maintain its own WWPS, which will pump through an existing rising main that will tie into the existing 160 OD PE 100 PN 12.5 rising main.

Ayrburn Domain will feature its own pump station capable of managing flow from all present, currently proposed, and future developments within the Domain, as outlined in **Table 8**.

Before the establishment of the main WP WWPS, both the Ayrburn Domain WWPS and the Haybarn Pump Station will utilize the temporary rising main, which connects directly into the 160 OD PE100 PN12.5 main on Ayr Avenue, just ahead of the existing connection to the Arrowtown-Lake Hayes Road trunk main.

Upon completion of the main WP WWPS, flow from the Haybarn venue will continue to be pumped towards the 160 OD pipeline and flow from Ayrburn Domain will be redirected across to the main WP WWPS through the existing 63 OD rising main. A considerable section of this 63 OD main has already been installed over the Mill Creek bridge and along Ayr Avenue.

5.4 Network Modelling & Available Capacity

Previous modelling undertaken by BECA and summarised in section 4.4 of Fluent's report dated December 2021, indicates that the existing 300mm uPVC trunk main and the existing 160 OD rising main both have adequate capacity to service the flows from Waterfall Park Hotel and Ayrburn Domain.

The total consented flow for all these developments is 23.4 l/s* (PWWF).

Table 9, detailed below, reveals that the approved quantities for the Peak Daily Volume and the PWWF remain unaltered (previously sanctioned by QLDC). The flow rates for the Ayrburn Domain, the repurposed buildings, and other facilities are collated in **Table 9**.

According to **Table 9**, there's a Future Capacity of 13.4 l/s that can be utilized. The estimated peak demand from the Haybarn venue is 0.82 l/s which sits within the spare capacity of the existing network. It is therefore concluded that the wastewater demands from the Haybarn venue can be met by the existing infrastructure.

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Table 9: Consented Flows & Future Capacity

Development Area	Modelled (HAL 2019)		Proposed Development	
	Peak Daily Volume (m ³)	PWWF (l/s)	Peak Daily Volume (m ³)	PWWF (l/s)
Waterfall Park Hotel	247.4	14.3		
Waterfall Park			99.3	5.7
Ayrburn Domain (Consented as part of RM180584)			18.8	1.1
Ayrburn Domain Change of use buildings			2.6	0.2
Ayrburn Farm - no longer proposed Residential Development	150.0	9.0		
Ayrburn Domain Extension			32.5	1.9
Barrel Room (RM220829)			3.3	0.2
Bakehouse (RM220874)**				
Display Suite *				
Haybarn			14.23	0.82
Sub-total (Current Proposal)			170.8	10.0
Future Capacity (subject to future RC applications)			245.5	13.4
Total	416.2	23.4	416.2	23.4

*The Display Suite buildings are planned to be decommissioned prior to the Northbrook Waterfall Park being fully commissioned. This means that any water and wastewater demand generated will be of a temporary nature and will not impact on the previously consented demands. **The Bakehouse water demand forms part of the "Ayrburn Domain Extension Variation"

6. Conclusion

The expected water and wastewater demands of the proposed Haybarn venue have been carefully evaluated in relation to the existing and future infrastructure in Ayrburn Domain and the broader development.

Water demand analysis has confirmed the adequacy of supply for the proposed occupancy, potable water needs, irrigation requirements, and firefighting requirements. It concludes that the water supply infrastructure meets the required standards for both domestic consumption and firefighting purposes. It also verifies the efficiency and reliability of the current water distribution system design to maintain the required minimum residual pressures and velocities within acceptable ranges.

The wastewater flow assessment for the Haybarn venue has been formulated based on the projected guest and staff numbers, proposed Haybarn wastewater pumping station, and the available capacity of the existing QLDC wastewater network. The findings from the flow testing and modelling exercises confirm that the existing 300mm uPVC trunk main and the existing 160 OD rising main have sufficient capacity to manage the projected wastewater flows from Ayrburn Domain, the proposed extension of Ayrburn Domain, other Waterfall Park developments, and the proposed Haybarn venue.

Overall, the study supports the proposal of the Haybarn venue and its integration with the current and planned water and wastewater infrastructure in Ayrburn.

7. Recommendations

In light of the study's findings and to ensure the continuous performance and sustainability of the water and wastewater systems, the following recommendations are made:

- Regular monitoring and maintenance of the water supply infrastructure should be established to ensure its long-term efficiency and reliability.
- As the development progresses, the design of the water supply infrastructure should be periodically revisited to evaluate its capacity to accommodate additional demand.

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- Water conservation initiatives, such as promoting water-efficient appliances, rainwater harvesting, and greywater recycling, should be implemented. This will help to reduce overall demand on the water supply infrastructure and contribute to the development's sustainability and resilience.
- Additional pressure and flow testing will be carried out by Oceana Fire Protection Services and Holmes before commissioning their respective sprinkler systems. This is to further ensure the reliability and safety of the system.
- Upon completion of the main WP WWPS, flow from the Ayrburn Domain WWPS will be redirected to the main WP WWPS and flow from the Haybarn will continue to be pumped via the existing 63mm OD rising main to the existing 160 OD rising main.

These recommendations aim to support the efficient functioning of the proposed Haybarn Venue in harmony with the Ayrburn Domain's water and wastewater infrastructure, while promoting sustainable practices and preparedness for future growth.

8. Distribution

This report is intended for the sole purpose of informing the stakeholders involved in the planning, development, and maintenance of the Haybarn Venue and the associated water and wastewater infrastructure. This includes Waterfall Park Developments Ltd, Winton Ltd and any approved stakeholder involved in the project. It should be disseminated among these stakeholders to facilitate informed decision-making processes. Additionally, the findings and recommendations of this report may also serve as a reference for future infrastructure planning and development projects in the Ayrburn Domain and other similar settings.

9. Limitation

The analysis and conclusions drawn in this report are based on the current design plans and demand projections of the Haybarn Venue and the available data of the existing water and wastewater infrastructure. As such, they are subject to the accuracy of these inputs. Moreover, while every effort has been made to apply the most relevant and up-to-date standards and guidelines, the field of water and wastewater management is dynamic and evolving, which may warrant reassessment as new standards and technologies become available. The report does not account for unforeseen factors that might arise during construction, including geological surprises, extreme weather events, or changes in legal and environmental regulations. Therefore, while this report provides a comprehensive assessment given the information available at the time of writing, its conclusions and recommendations should be reviewed periodically and revised as necessary in light of new data or changes in the project scope or context.

10. Appendix A

10.1 CKL Water Modelling Report



Planning | Surveying | Engineering | Environmental

WATER NETWORK ANALYSES

Winton Ltd

Queenstown - Waterfall Park

Document Information

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1. Introduction:

CKL Ltd has been engaged by Winton Ltd to develop a water network model as part of a resource consent application for the proposed Waterfall Park and Ayrburn Domain. The aim of this report is to present an analysis of the water network model specific to Waterfall Park. This report covers the pressure and flow testing conducted, an overview of the EPANET model, background information on the system being modelled, a description of the EPANET model and its outputs, a comparison with the earlier Mott MacDonald modelling, and a discussion on the available pressure and flow for the proposed development. We are pleased to present our findings from the water network modelling for both the Waterfall Park and Ayrburn Domain.

2. Background Information:

2.1 Mott MacDonald Modelling:

Mott MacDonald conducted water supply modelling in 2018 for proposed facilities, including the Ayrburn Domain and a hotel. The updated water distribution network models for current, future 2028, and 2058 peak days incorporate the demand from the Waterfall Park resort development. The model predicts that the levels of service for minimum pressure and head losses will be met, although slightly higher pressures are expected in areas below 350m. Additionally, the fire flow requirements can be met for both current and future scenarios, and head losses along Arrowtown Lake Hayes Road will be within an acceptable LOS.

Previous Mott MacDonald modelling found a residual pressure of 47m at RL 368m (at the Waterfall Park Hotel Location) during modelling of firefighting flows, which is above the minimum residual pressure of 10m required by the standards.

A copy of Mott MacDonalds report can be found in Annexure D.

Following Mott MacDonald's modelling exercise in 2018, the proposed hotel facility was replaced with a proposed retirement village, and there have been changes to various other facilities within the development. This report aims to update the water demand information for the development and to determine whether it still meets the minimum LOS requirements outlined in the Queenstown Lakes District Council COP and NZS PAS 4509.

Referenced documents used in this report are as follows:

- Fluent Solutions Memorandum dated 6 July 2021 – Ayrburn Domain
- Mott Mac Donald Report dated July 2018

2.2 Fluent Modelling

In Fluent's July 2021 report, the residual pressure in the Ayrburn Domain during firefighting flows was assessed and found to be approximately 60m, which is above the minimum residual pressure of 100kPa required by the standards including the minimum 400kPa to 500kPa required for the sprinkler systems. A copy of Fluent's report can be found in Annexure E.

Additionally, the results of the water network modelling presented in this report will be compared to the findings of Fluent's July 2021 report, ensuring that the proposed development continues to meet the minimum residual pressure requirements during firefighting flows and other relevant standards. By comparing our modelling results to Fluent's, we aim to verify the accuracy and consistency of our analysis while taking into account any changes in the proposed development.

3. Description of the system being modelled:

The water distribution network was modelled based on the preliminary water reticulation designs prepared by PPG. The initial pipe sizes and lengths shown on these plans were used as the starting input for the model, and their suitability was assessed according to hydraulic principles. The plans can be found in Annexure A.

The internal water network primarily consists of pipe sizes ranging from 180mm to 315mm in diameter, utilizing the following pipe materials:

- 225 OD PN 12.5 PE100 HDPE (720m)
- 315 OD PN 12.5 PE100 HDPE (940m)
- 180 OD PN 12.5 PE100 HDPE (343m)

Additionally, a Pressure Reducing Valve (PRV) is located at the entrance to the Ayrburn Domain. Static head pressures exceed the required maximum QLDC 90m in the vicinity of the Ayrburn Domain, which necessitates pressure control below the maximum. The PRV has been integrated into the model, and the network performance has been tested accordingly.

The proposed development connects to the existing DN 225 PVC QLDC water main at the intersection of Speargrass Flat Road and Arrowtown-Lake Hayes Road, as illustrated in Figure B. Modelling has been conducted up to specific points within the development, excluding off-takes from the bulk potable supply, such as sprinkler reticulation. The proposed network has been tested against FW2 and FW3 requirements as stipulated in the SNZ PAS 4509:2008 Firefighting Water Supplies Code of Practice. The existing and proposed network layouts can be seen in Figure 1 and Figure 2, respectively.

Queenstown Waterfall Park

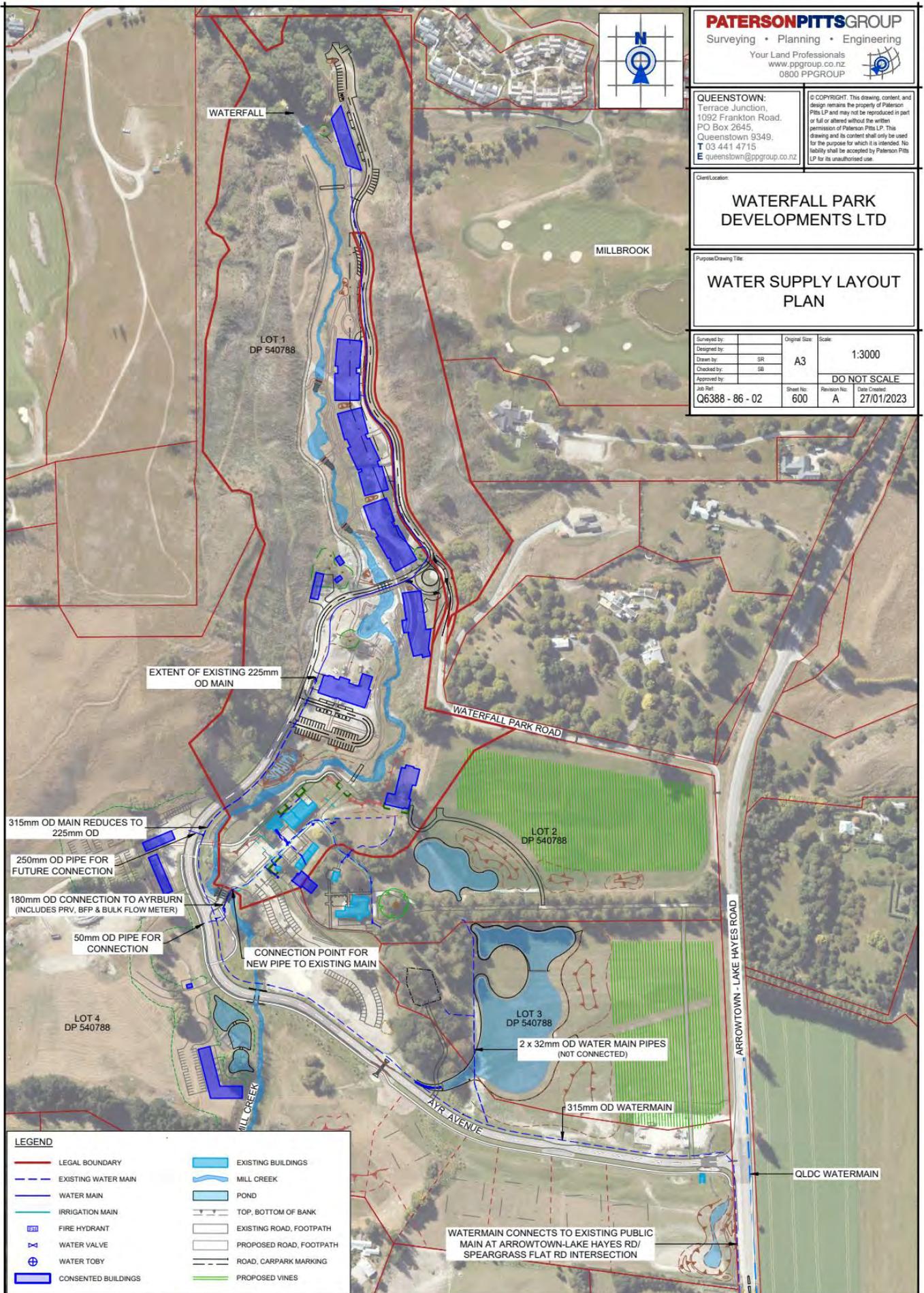
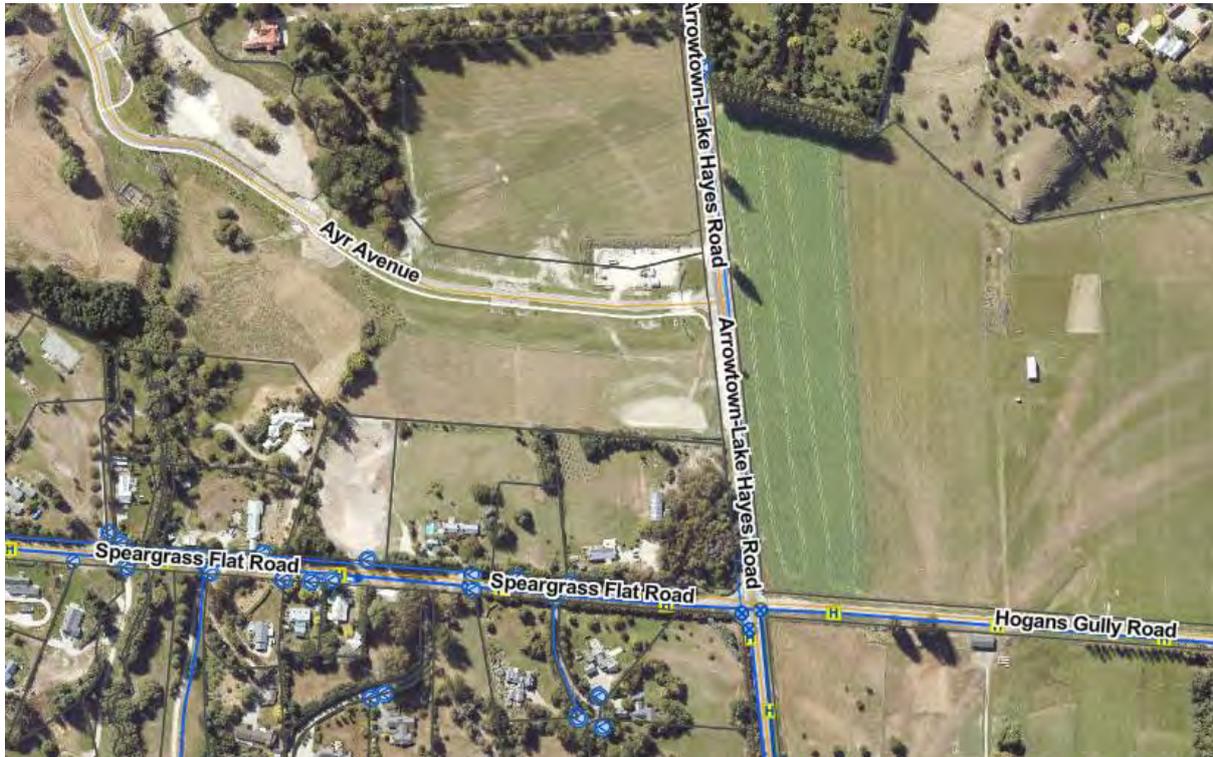


Figure 1: Proposed Water Reticulation Network

Queenstown Waterfall Park

Figure 2: Existing QLDC Water Network

4. Modelling Methodology

As outlined in section 2.1 of this report, the purpose of this modelling is to provide an updated view of the expected development demands and assess the proposed network based on the following criteria:

1. Ensuring that the available firefighting flows meet the firefighting requirements in accordance with SNZ PAS 4509:2008 "New Zealand Fire Fighting Service Fire Fighting Water Supplies Code of Practice".
2. Verifying that the minimum residual pressures at each connection are $\geq 300\text{kPa}$ during peak hour demand, as stipulated in the Queenstown Lakes District Council "Land Development and Subdivision Code of Practice" 2015

5. Water Demands – Ayrburn Domain

CKL were tasked with determining the water demands for various facilities within the development. The various water demands are discussed in the sections below.

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5.1 Ayrburn Domain

The design flows for Ayrburn Domain buildings were initially presented in the Fluent Solutions Water, Wastewater, and Stormwater Infrastructure Assessment for Waterfall Park Hotel, dated 28 May 2018. The water demand assessment has taken into account the capacity for a few small retail buildings and the homestead building, in anticipation of future development. CKL have since provided assessments to various buildings within the domain.

Design flows were calculated based on maximum occupancy rates (verified by Winton), and per capita daily water demand sourced from AS/NZS 1547:2012, Table H4.

Cosgroves Fire Engineers provided the firefighting flow requirements. Irrigation is planned to operate over a 24-hour timeframe. The water demand estimate is outlined in Table 1 below.

Table 1: Water Demand Summary

Unit Type	No. of Facilities	Max No. of People Facility / Day	Daily Water Demand (L/p/d)	Daily Water Demand (m ³ /d)	Daily Water Demand (L/s)	Domestic Peak Hour (daytime only), no irrigation	
						Peak Hour Peaking Factor	Peak Hour Demand (L/s)
Ayrburn Domain							
Dairy (Ice cream parlour)	1	48	15	0.72	0.01	6.6	0.06
Sub-Total		48		0.72	0.01		0.06
Bakehouse							
Restaurant	1	240	20	4.8	0.06	6.6	0.37
Office space	1	24	35	0.84	0.01	6.6	0.06
Sub-Total		264		5.64	0.07		0.43
Annex Building/Stable							
Restaurant	1	572	30	17.16	0.20	6.6	1.31
Bar & Lounge	1	52	20	1.04	0.01	6.6	0.08
Non-residential Staff	1	19	30	0.57	0.01	6.6	0.04
Sub-Total		643		18.77	0.22		1.43
Cart Shed (Deli)	1	96	20	1.92	0.02	6.6	0.15
Sub-Total		96		1.92	0.02		0.15
Burr Barr	1	52	20	1.04	0.01	6.6	0.08
Sub-Total		52		1.04	0.01		0.08
Homestead Building	1	504	30	15.12	0.18	6.6	1.16
Sub-Total		504		15.12	0.18		1.16
Barrel Room							
Piano Room	1	60	30	1.8	0.02	6.6	0.14
Barrel Room	1	40	20	0.8	0.01	6.6	0.06
Non -residential staff	1	10	30	0.3	0.00	6.6	0.02
Sub-Total		110		2.9	0.03		0.22
Display Suite	1	10	30	0.3	0.003	6.6	0.02
Sub-Total		10		0.30	0.003		0.02
Future Capacity				75.99	0.880	6.6	5.80
Sub-Total		0		75.99	0.88		5.80
Sub Total (Domestic)							9.4
Add Irrigation Demand							1.6
Total (Domestic + Irrigation)							11.0

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5.2 Fire Flows

In compliance with SNZ PAS 5409:2008 New Zealand Fire Service Firefighting Water Supplies Code of Practice, fire flows must be maintained with a minimum residual pressure of 10m coincidental with 60% of peak day demand. It is also required to account for the additional water demand generated by the sprinkler systems during a fire event.

The sprinkler flow rates are contingent on the specific design of the sprinkler system and the protection requirements for the type of building involved. To integrate sprinkler flow into the model, the necessary sprinkler flow rate is added to the peak hour demand at appropriate points within the network. This method ensures that the water network is capable of supplying both domestic water demands and the heightened demand resulting from the activation of sprinkler systems during a fire event.

When assessing the network's performance under these circumstances, it is critical to verify that the minimum residual pressure requirements (10m as per SNZ PAS 5409:2008) remain satisfied, when also accounting for the added sprinkler flow demand. By doing so, it can be confirmed that the water network is able to provide adequate pressure and flow for both domestic use and fire protection, adhering to the relevant standards and codes. Table 2 below indicates the various FW ratings (Fire flows) and sprinkler flows for each building within the Ayrburn Domain.

Table 2: Fire Demand Ayrburn Domain

Structure	FW	Flow Rate per Hydrant (l/s)	Number of simultaneous Hydrants Discharging	Sprinkler Discharge (l/s)	Total Fire Flow (l/s)
Dairy (Ice cream parlour)	FW3	25	2	N/A	50
Bakehouse	FW2	12.5	2	13.3	38.3
Annex Building/Stable	FW2	12.5	2	20	45
Cart Shed (Deli)	FW2	12.5	2	25	50
Burr Barr	FW3	25	2	N/A	50
Barrel Room	FW3	25	2	N/A	50
Display Suite	FW3	25	2	N/A	50
Homestead Building	FW2	12.5	2	13.3	38.3
Future Capacity	FW3	25	2	N/A	50

6. Water Demands - Waterfall Park

6.1 Waterfall Park

CKL Ltd have undertaken a water and wastewater demand assessment Waterfall Park Developments Ltd (WPD) for the proposed Waterfall Park later living development (Northbrook Arrowtown). The assessment analysed the potential change in peak water demand due to the proposed shift from the

Queenstown Waterfall Park

Hotel Consent (peak water consumption of 18.9l/s) to the retirement village. The assessment considered factors such as proposed occupancy, potable water demand, irrigation requirements, minimum pressure requirements, firefighting requirements, and available capacity of the existing QLDC water network. The analysis did not include internal water reticulation, as it was to be covered under detailed design.

The retirement village's water demand differs from typical residential subdivisions, requiring a more conservative per capita usage rate. The QLDC COP 2020 suggests a 700 l/p/d usage rate for residential subdivisions, but a more realistic rate of 250 l/p/d was adopted for Waterfall Park. A peak factor of 6.6 (QLDC COP) was assumed for most facilities, with a higher peak factor of 10 deemed appropriate for specific facilities, including the wellness centre, pool, gym, yoga, laundry, and boutique hotel spa. Building occupancy rates and staff numbers were derived from Woods Bagot's data and averages from similar retirement villages.

The water demand estimate is outlined in Table 3 below.

Table 3: Domestic Demand Waterfall Park

Unit Type	No. of Facilities	Max No. of People Facility / Day	Daily Water Demand (L/p/d)	Daily Water Demand (m ³ /d)	Daily Water Demand (L/s)	Case 1: Domestic Peak Hour (daytime only), no irrigation	
						Peak Hour Peaking Factor	Peak Hour Demand (L/s)
Northbrook Waterfall Park Retirement Village							
Building A - Arrivals & Amenities							
Café / Lounge	1	250	20	5	0.06	6.6	0.38
Wellness Centre - Pool, gym, yoga	1	200	40	8	0.09	10	0.93
Visitors	1	50	125	6.25	0.07	6.6	0.48
Cinema	1	50	40	2	0.02	6.6	0.15
Library	1	50	40	2	0.02	6.6	0.15
Non-residential staff	1	25	30	0.75	0.01	6.6	0.06
						Sub-total	2.15
Building B - Care & Services Apartments							
Care Units 1 Bed	23	1	250	5.75	0.07	6.6	0.44
One Bedroom LtO Apartments	10	1.3	250	3.25	0.04	6.6	0.25
Two Bedroom LtO Apartments	3	1.3	250	0.975	0.01	6.6	0.07
Serviced Apartments 1 Bed	10	1.3	250	3.25	0.04	6.6	0.25
Serviced Apartments 2 Bed	2	1.3	250	0.65	0.01	6.6	0.05
Kitchen	1	7	30	0.21	0.00	6.6	0.02
Laundry	1	4	50	0.2	0.00	10	0.02
Residential Staff	1	25	50	1.25	0.01	6.6	0.10
						Sub-total	1.19

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Building C - Residential							
Two Bedroom LtO Apartments	44	1.3	250	14.3	0.17	6.6	1.09
Three Bedroom LtO Apartments	5	1.3	250	1.625	0.02	6.6	0.12
						Sub-total	1.22
Building D - Residential							
Two Bedroom LtO Apartments	50	1.3	250	16.25	0.19	6.6	1.24
Three Bedroom LtO Apartments	10	1.3	250	3.25	0.04	6.6	0.25
						Sub-total	1.49
Building E - Residential							
Two Bedroom LtO Apartments	24	1.3	250	7.8	0.09	6.6	0.60
Three Bedroom LtO Apartments	15	1.3	250	4.875	0.06	6.6	0.37
						Sub-total	0.97
Building F - Boutique Hotel & Spa							
Hotel Room	16	2	250	8	0.09	6.6	0.61
Spa	1	64	40	2.56	0.03	10	0.30
Non-residential Staff	1	10	30	0.3	0.00	6.6	0.02
						Sub-total	0.93
Miscellaneous							
Maintenance Shed	1	5	20	0.1	0.00	6.6	0.01
Workshop	1	15	20	0.3	0.00	6.6	0.02
Projects shed	1	15	20	0.3	0.00	6.6	0.02
						Sub-total	0.05
Future Capacity				325.96	3.77	6.6	24.90
Sub Total (Domestic)				425.2	4.9		32.9
Add Irrigation Demand							1.1
Total (Domestic + Irrigation)							34.0

6.2 Fire Flows

The proposed development must adhere to specific firefighting and pressure demands, which include a minimum residual peak hour pressure of 300 kPa and a maximum of 900 kPa as per QLDC COP 2020, a 25 l/s flow within 270 m of each non-sprinklered residential dwelling for Class FW2 firefighting, and a minimum of 12.5 l/sec flow from each hydrant according to SNZ PAS 4509:2008.

Cosgrove's preliminary assessment for Waterfall Park proposes an FW2 classification of 1500 L/min with a residual towns mains pressure of 100 kPa, provided that all buildings are equipped with sprinkler systems. The sprinkler system's demand is 1200 L/min at 400 kPa and 500 L/min at 550 kPa, slightly exceeding the consented hotel's requirements due to the inclusion of additional parking facilities in Building A. The maximum combined fire demand is 2700 L/min with residual towns' mains pressures of 100 kPa for hydrants and between 400 kPa and 550 kPa for sprinklers.

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Mott MacDonald verified that the proposed development's operating pressures will fall within the normal range (30m to 90m of residual head) established by QLDC COP 2020 until 2058 and that the residential fire flow plus sprinkler fire flow can be supported with a residual pressure of 47m at RL 368m. The highest elevation that can be serviced for the residential development is 395m. Cosgrove's confirmed the site's ability to be serviced with the required 2700 l/min flow rate at a residual pressure of 47m. If flow or pressure is inadequate, supplementary storage tanks and/or booster pumps might be necessary, but as discussed in section 10 of this report, it is expected that pressure and flow will satisfy the required Level of Service (LOS).

Mott MacDonald's initial water network modelling considered fire demands and domestic peak allowance, as mandated by SNZ PAS 4509:2008, making further modelling unnecessary. However, the development's internal water network has since been modelled to design the reticulation and confirm residual pressures for fire demands, offering increased certainty regarding the availability of pressure and flow for the proposed development. The outcomes of this modelling have been discussed in section 10 of this report.

7. Combined Domestic & Fire Water Demand

Table 4 presented below combines the domestic and firefighting water demand for the Ayrburn Domain (section 5) and Waterfall Park (section 6) developments into a single summary table. This table offers a detailed overview of the water demand requirements for each part of the development, considering their unique features and the specific demands associated with domestic consumption and firefighting needs. The data gathered was employed to effectively model the water network, to confirm sufficiency of water supply for both sections of the development. The results of this water network modelling are further explored in section 10 of this report.

Table 4: Combined Domestic + Fire Flows

Structure	Domestic Peak Hr Flow (l/s)	FW	Fire Hydrant Flow (l/s)	Sprinkler Discharge (l/s)	Total Domestic Flow + Fire Flow + Sprinkler Flow (l/s)
Ayrburn Domain					
Dairy (Ice cream parlour)	0.06	FW3	50	N/A	50
Bakehouse	0.43	FW2	25	13.3	38.3
Annex Building/Stable	1.43	FW2	25	20	45
Cart Shed (Deli)	0.15	FW2	25	25	50
Burr Barr	0.08	FW3	50	N/A	50
Barrel Room	0.22	FW3	50	N/A	50
Display Suite	0.02	FW3	50	N/A	50
Homestead Building	1.16	FW2	25	13.3	38.3
Future Capacity (Ayrburn Domain)	5.80	FW3	50	N/A	50
Irrigation	1.6			NA	
Sub-Total	11			NA	
Waterfall Park					
Building A - Arrivals & Amenities	2.15	FW2	25	20	45
Building B - Care & Services Apartments	1.19	FW2	25	20	45
Building C - Residential	1.22	FW2	25	20	45
Building D - Residential	1.49	FW2	25	20	45
Building E - Residential	0.97	FW2	25	20	45
Building F - Boutique Hotel & Spa	0.93	FW2	25	20	45

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Miscellaneous	0.05	FW2	25	20	45
Future Capacity (Waterfall Park)	24.9	FW2	25	20	45
Irrigation	1.1	NA			
Sub-Total	34	NA			
TOTAL	45				

Table 4 presents the figures that were utilized as a base to model the water network in EPANET for both the Ayrburn Domain and Waterfall Park developments. For the Ayrburn Domain, a maximum flow rate of 61 l/s was calculated, which comprises 50 l/s for fire hydrant demand and 11 l/s for peak hour domestic demand. Similarly, for the Waterfall Park, a maximum flow rate of 79 l/s was determined, consisting of 45 l/s for fire hydrant and sprinkler demand and 34 l/s for peak hour domestic demand. These figures include the water demand for future capacity and irrigation purposes.

It is however noted that only 60% of the Peak Water Demand was used to model the network in EPANET in line with the requirements of NZS PAS 4509:2008. This is further clarified in section 9 of this report.

The EPANET model incorporated these flow rates to simulate FW2 and FW3 scenarios, which are further explored in section 10 of this report. It is important to note that the total ultimate domestic flow will not exceed the consented 45 l/s during normal operations; however, it will surpass this threshold during firefighting scenarios. The EPANET model's results help in understanding the water network's capacity to meet the water demand under various conditions and ensure the adequate provision of water supply for both developments.

8. Pressure and Flow Testing of Existing Water Network

8.1 Scope of Work

In this section of the report, the scope of work for pressure and flow testing for the proposed development is discussed. An email was sent to Detection Services South Island Ltd, outlining the requirements and methodology for the testing process, based on the guidelines in Appendix G of SNZ PAS 4509:2008.

Appendix G of SNZ PAS 4509:2008 specifies the following requirements for pressure and flow testing:

1. Testing must be conducted during peak demand periods to simulate real-world conditions and obtain accurate results. Testing was conducted on the 3 April 2023 between 10:51am and 11:46 am.
2. Measurements should be taken at both flowing and non-flowing hydrants to determine static and residual pressures. Results are summarised in section 8.2 of this report.
3. The test should involve at least two hydrants to simulate simultaneous fire demand. Two hydrants within the Ayrburn Domain were discharged and residual pressures throughout the development were recorded.

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4. The distance between the flowing hydrants and the pressure hydrant should be recorded. This has been documented in section 8.2.
5. Water main diameter and the approximate vertical height difference between the flowing and pressure hydrants must be noted. This has been documented in section 8.2.
6. The flow rate and pressure readings should be recorded at specified intervals, such as every 500 L/min, to obtain a comprehensive understanding of the system performance. This has been documented in section 8.2.
7. Results should be analyzed and compared against relevant standards and guidelines to determine if the water supply system meets the required performance criteria. This has been documented in section 8.2 and further analyses given in section 10 of this report.

Following these guidelines, the development was tested against both FW3 and FW2 requirements.

The pressure and flow testing ensured that the proposed development's water supply infrastructure met the necessary standards and requirements for both domestic consumption and firefighting purposes. The results of this testing provided valuable input for the water network modelling and design, as discussed further in section 10 of this report.

8.2 Results

Figure 1 below shows the layout and location of the tested hydrants.

The 2 hydrants within the Ayrburn Domain, "Fire Flow Test Site 1" and "Fire Flow Test Site 2" were discharged simultaneously over various flow rates and the residual pressures at FH (CH805) and FH (CH460) were recorded over the testing duration. A graphical representation of this data can be found in Figures 3 and 4 below.

A third hydrant was meant to have been tested for its corresponding residual pressure however, this hydrant has not yet been installed and therefore could not be tested. For this reason, we have relied on the EPANET model to determine the residual pressure within the Ayrburn Domain. This is further discussed under section 10.1.1.1 of this report.

CKL have analysed data provided by Detection Services South Island Ltd and our analysis is discussed further below. Raw Data can be found in Annexure C.

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Figure 3: Hydrant Locations



Figure 2 presents an expanded view of the associated decrease in residual pressure at hydrant FH (CH460) during the simultaneous discharge of the two hydrants within the Ayrburn Domain. Throughout the testing, the residual pressure at FH (CH805) did not fall below 826 kPa or 82.6m of residual head, while FH (CH460) maintained a minimum residual pressure of 791 kPa or 79.1m of residual head. The observed flow rates ranged from a minimum of 500 L/min to a maximum of 2,235 L/min per hydrant. The raw data is available in Annexure C. Notably, at 11:24:35 am, the flow rates of the two discharging hydrants converged at approximately 1500 L/min per hydrant, with corresponding residual pressures at FH (CH805) and FH (CH460) measuring 892 kPa and 815 kPa, respectively.

The results indicate residual pressures are well above the required 100 kPa for hydrants and between 400 kPa and 550 kPa for sprinklers mentioned in section 6.3 of this report with flow rates in excess of 3000 lpm (FW3 – 2 hydrants discharging at max 1500 l/m each).

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Figure 4: Residual Pressure at FH (CH460) – Macro Scale

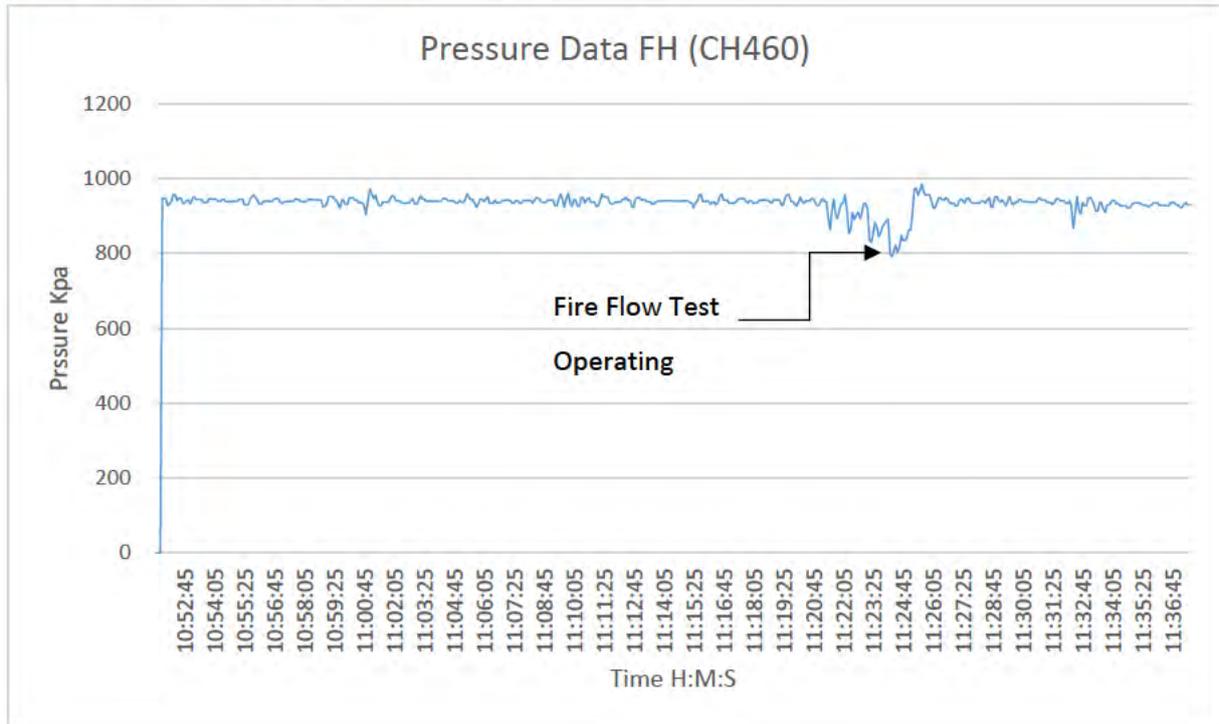
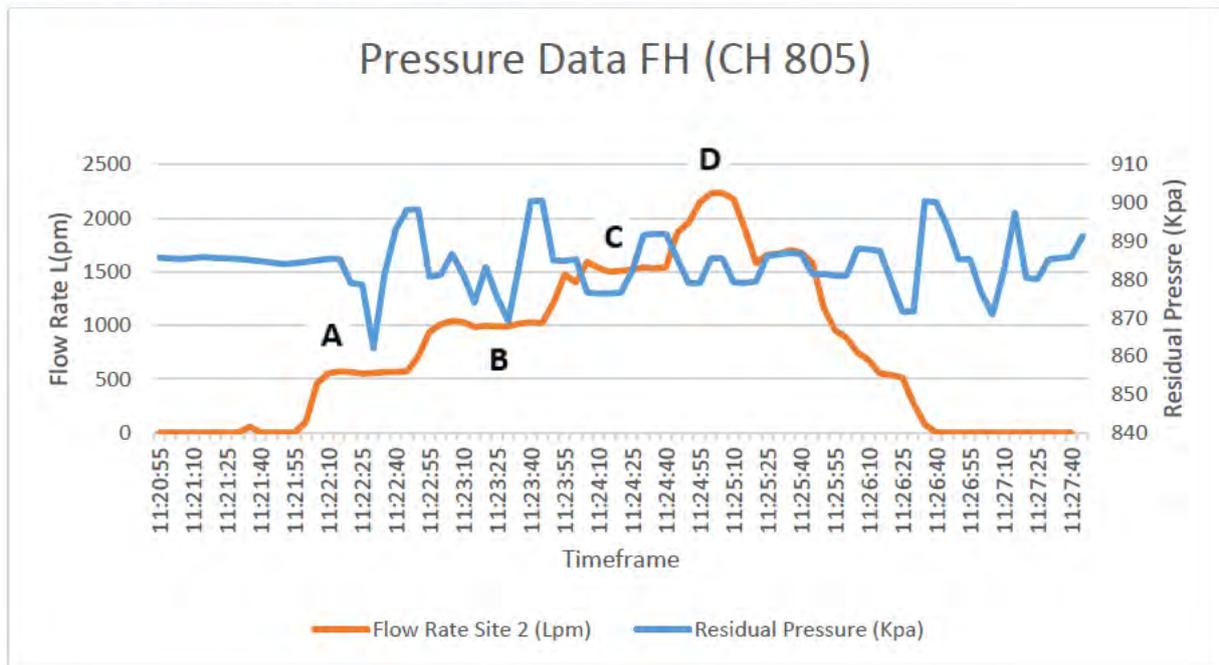
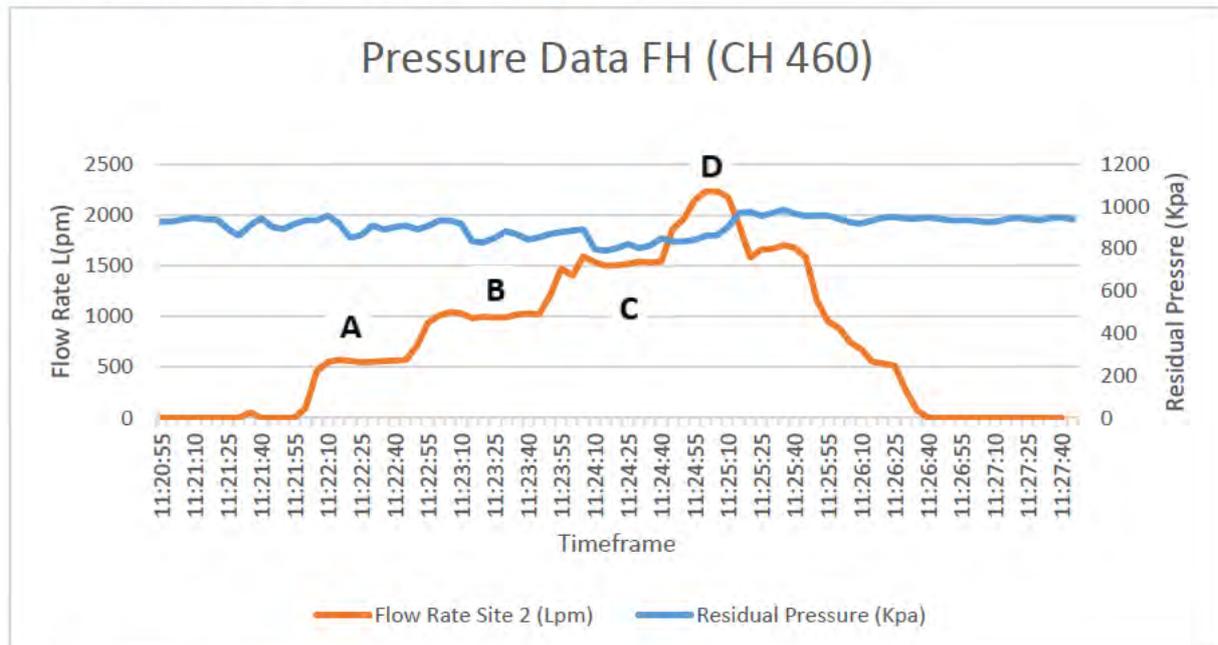


Figure 5: Flow Data Site 2 & Residual Pressure Data FH (CH 805)



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Figure 6: Flow Data Site 2 & Residual Pressure Data FH (CH 460)



A = Flow at 500 lpm

B = Flow at 1000 lpm

C = Flow at 1500 lpm

D = Flow at Max

Static pressures (minimum) were also recorded before and after the test as follows:

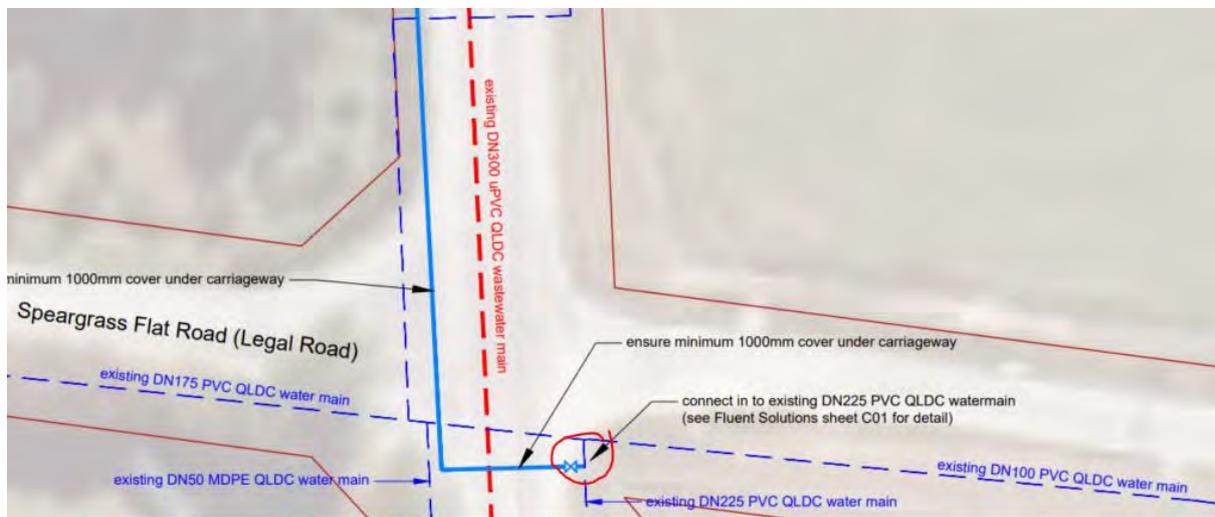
- FH (CH805)= 725 Kpa or 72.5m
- FH(CH460)= 867 Kpa or 86.7 m
- FH (112,928) = 925 Kpa or 92.5m
- FH (113,183) = 925 Kpa or 92.5m
- FH (112,968) = 900 Kpa or 90m (Adopted Static Pressure for Modeling – See Figure 6)

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Figure 7: Arrowtown-Lake Hayes Rd and Speargrass Flat Rd Intersection



Figure 8: Proposed Development Connection Point



9. Explanation of the EPANET model

The EPANET model is designed to simulate water distribution networks and provides output data that includes flow rates, velocities, frictional losses and pressures. The model also calculates the minimum and maximum pressures at each node in the network.

Two scenarios were each modelled for the Ayrburn Domain and the Waterfall Park namely for an FW2 and FW 3 scenario. In compliance with SNZ PAS 5409:2008 New Zealand Fire Service Firefighting Water Supplies Code of Practice, fire flows must be maintained with a minimum residual pressure of 100Kpa

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at 60% of peak day demand. Two hydrants within the Waterfall Park area and two hydrants within the Ayrburn Domain were selected to discharge at the required flow rates. Sprinkler flows for FW2 were then assigned to nodes in close proximity.

9.1 Scenario A: Peak Daily Flow -Domestic Flow Only

(No hydrants or sprinklers discharging)

100% of Peak Domestic Flow = 45l/s

9.2 Scenario B: Ayrburn Domain - FW 2

(2 Hydrants discharging in the Ayrburn Domain @ 12.5 l/s each + Sprinkler Flow)

- Ayrburn Domain: 60% of PDF (11 l/s) + FW2 (25 l/s) + Sprinkler Flow @ 25 l/s = 56.6 l/s
- Waterfall Park: 60% of PDF (34 l/s) = 20.4 l/s
- Total = 77 l/s

9.3 Scenario C: Ayrburn Domain - FW 3

(2 Hydrants discharging in the Ayrburn Domain @ 25 l/s each)

- Ayrburn Domain: 60% of PDF (11 l/s) + FW3 (50l/s) = 56.6 l/s
- Waterfall Park: 60% of PDF (34 l/s) = 20.4 l/s
- Total = 77l/s

9.4 Scenario D: Waterfall Park - FW 2

(2 Hydrants discharging in the Waterfall Park @ 12.5 l/s each + Sprinkler Flow)

- Ayrburn Domain: 60% of PDF (11 l/s) = 6.6 l/s
- Waterfall Park: 60% of PDF (34 l/s) + FW2 (25l/s) + Sprinkler Flow (20l/s) = 65.4 l/s
- Total = 72 l/s

9.5 Scenario E: Waterfall Park - FW 3

(2 Hydrants discharging in the Waterfall Park @ 25 l/s each)

- Ayrburn Domain: 60% of PDF (11 l/s) = 6.6 l/s
- Waterfall Park: 60% of PDF (34 l/s) + FW3 (50l/s) = 70.4 l/s
- Total = 77 l/s

10.Model Output

In the context of water distribution systems, it is essential to consider several key parameters to ensure the proper functioning of the system. These parameters include velocities, unit headloss, and residual pressures during both normal operation and fire flow scenarios.

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Velocities within the distribution system should be maintained within an acceptable range (less than 2m/s) to prevent issues such as water hammer or excessive wear on the pipeline infrastructure. Unit headloss is another critical factor, as it affects the overall efficiency of the system and the energy required to transport water through the network. Minimizing head losses ensures that the system operates effectively and with reduced energy consumption (between 3m/km and 5m/km).

Residual pressures play a crucial role in determining the overall performance of the water distribution system. During normal operation, a minimum residual pressure of 300 kPa is typically required to guarantee adequate water supply and pressure for the end-users in terms of the QLDC guidelines. In fire flow scenarios, the system must maintain a minimum residual pressure of 100 kPa to ensure that firefighting efforts are not hindered due to inadequate water pressure in terms of NZS PAS 4509.

The following scenarios all assume the PRV at the entrance to the Ayrburn domain is set to a maximum limit of 750Kpa. This has been confirmed by Fluent who undertook the initial design.

10.1 Scenario A: Peak Daily Flow - Domestic Flow Only

In compliance with the Queenstown Lakes District Council guidelines, we confirm that all key parameters relating to residual pressures, velocities, and unit headloss for domestic flows have been met in the design of the water distribution system for the development. Our engineering analysis and simulations have demonstrated that the system consistently maintains the required minimum residual pressures of 100 kPa during fire flows and 300 kPa during normal operation, ensuring adequate water supply and pressure for all end-users. Additionally, the velocities within the distribution network have been maintained within acceptable ranges, not exceeding 2.0 meters per second, mitigating the risk of water hammer or excessive wear on the pipeline infrastructure. The unit headloss values have been optimized to stay below 10 m/km, enhancing the system's overall efficiency and minimizing energy consumption. By adhering to these critical requirements set forth by the Queenstown Lakes District Council, we have ensured the reliability, safety, and effectiveness of the water distribution system for the entire development.

10.2 Scenario B: Ayrburn Domain - FW 2

In compliance with the Queenstown Lakes District Council guidelines and NZS PAS 4509, we can confirm that all key parameters concerning residual pressures, velocities, and unit headloss for domestic and firefighting flows under an FW2 scenario within the Ayrburn Domain have been successfully met in the design of the water distribution system for the development. The test results indicate a minimum residual pressure of 637 kPa and a maximum of 928 kPa in the development, ensuring sufficient water supply and pressure for all users during both normal operations and emergency situations. The residual pressure at the sprinkler room is approximately 669 Kpa which is consistent with Fluent's residual pressure of approximately 600 Kpa in their 2021 report (Annexure E).

Additionally, the maximum velocity achieved in the Ayrburn Domain's 180mm diameter supply line was 3.2 m/s, and the maximum unit headloss was 46.32 m/km. In accordance with NZS PAS 4509, the flow rate requirements for firefighting have also been met. Although these parameters exceed the requirements set forth by the Queenstown Lakes District Council guidelines, discussions with Fluent have led to an agreement that the overall system efficiency and water hammer concerns will not be

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adversely affected, as these conditions only occur under firefighting scenarios. Velocities and unit headloss elsewhere in the development are within an acceptable level of service.

10.3 Scenario C: Ayrburn Domain - FW 3

In line with Section 10.2, we can confirm that the design of the water distribution system for the development effectively meets the requirements set forth by the Queenstown Lakes District Council guidelines and NZS PAS 4509. This includes fulfilling all essential parameters related to residual pressures, velocities, and unit headloss for domestic and firefighting flows under an FW3 scenario within the Ayrburn Domain. The residual pressure at the sprinkler room is approximately 659 Kpa.

10.4 Scenario D: Waterfall Park - FW 2

In accordance with the Queenstown Lakes District Council guidelines and NZS PAS 4509, we can verify that the design of the water distribution system for the development successfully addresses all essential parameters related to residual pressures, velocities, and unit headloss for domestic and firefighting flows under an FW2 scenario within Waterfall Park. The test results demonstrate a minimum residual pressure of 607 kPa and a maximum of 932 kPa, ensuring an adequate water supply and pressure for all users during both regular operations and emergency situations. Even when accounting for a sprinkler discharging at 20 l/s and two hydrants at 12.5 l/s each, the 550 kPa requirement discussed in section 6.2 has been satisfied.

10.5 Scenario E: Waterfall Park - FW 3

In line with Section 10.4, we can confirm that the design of the water distribution system for the development effectively meets the requirements set forth by the Queenstown Lakes District Council guidelines and NZS PAS 4509. This includes fulfilling all essential parameters related to residual pressures, velocities, and unit head loss for domestic and firefighting flows under an FW3 scenario within the Waterfall Park. Refer to Table 5 for a summary of EPANET results.

Table 5: Summary of EPANET Results

Fire Flow Scenarios	Residual Head (m)		Velocity (m/s)		Unit Headloss (m/km)	
	Min	Max	Min	Max	Min	Max
Scenario A: Peak Daily Flow -Domestic Flow Only	67.16	95.23	0.01	0.8	0.01	17.25
Scenario B: Ayrburn Domain - FW 2	63.77	92.77	0.01	3.2	0.01	46.32
Scenario C: Ayrburn Domain - FW 3	63.56	92.77	0.01	3.2	0.01	46.32
Scenario D: Waterfall Park - FW 2	60.74	93.23	0.01	1.76	0.01	38.37
Scenario E: Waterfall Park - FW 3	59.06	92.77	0.01	1.93	0.01	46.35

11. Visualization of the results:

11.1 Scenario A: Peak Daily Flow - Domestic Flow Only

Figure 10: Residual Pressure



Figure 9: Velocity



Figure 11: Unit Headloss



Figure 12: Diameters



11.2 Scenario B: Ayrburn Domain - FW 2

Figure 15: Velocity

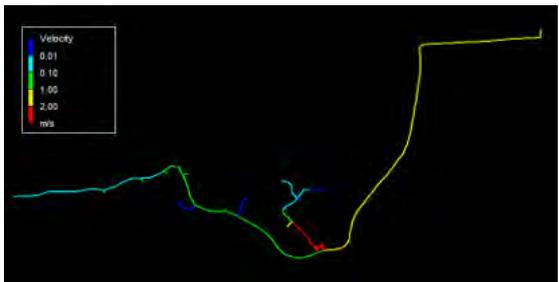


Figure 14: Residual Pressure



Figure 16: Diameters

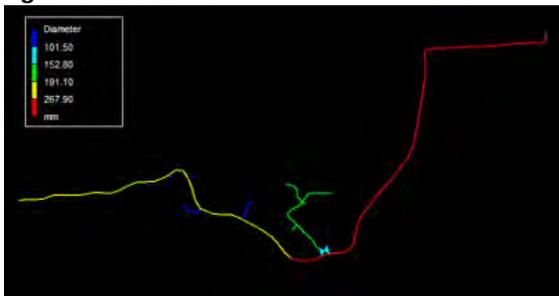
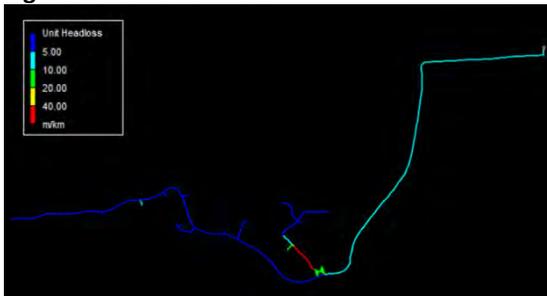


Figure 13: Unit Headloss



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11.3 Scenario C: Ayrburn Domain - FW 3

Figure 19: Residual Pressure



Figure 18: Velocities

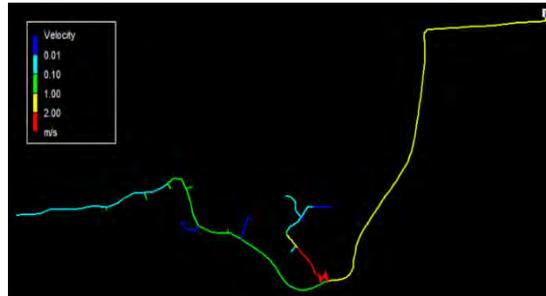


Figure 20: Unit Headloss

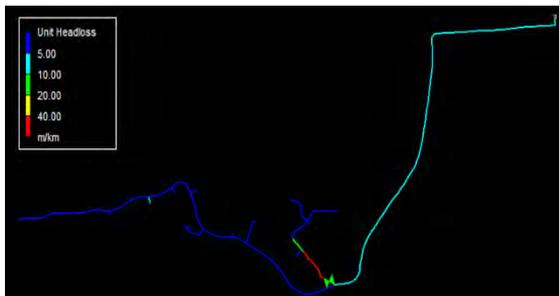
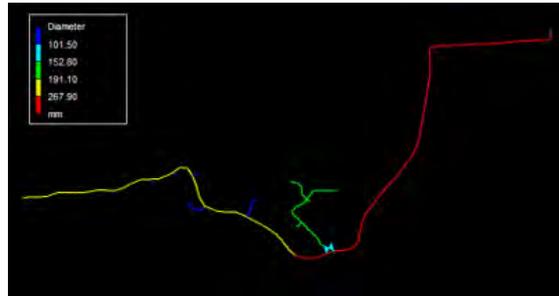


Figure 21: Diameters



11.4 Scenario D: Waterfall Park - FW 2

Figure 23: Residual Pressure

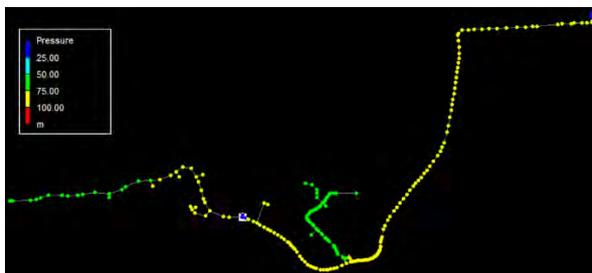


Figure 22: Velocities

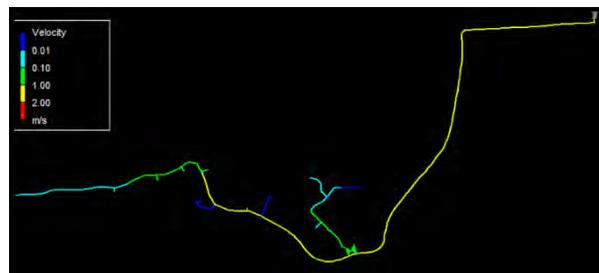
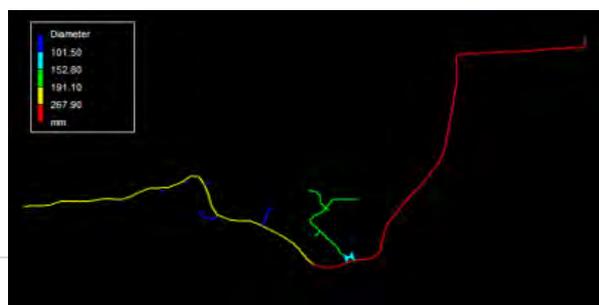


Figure 24: Unit Headloss



Figure 25: Diameters



11.5 Scenario E: Waterfall Park - FW 3

Figure 26: Residual Pressure



Figure 29: Velocities

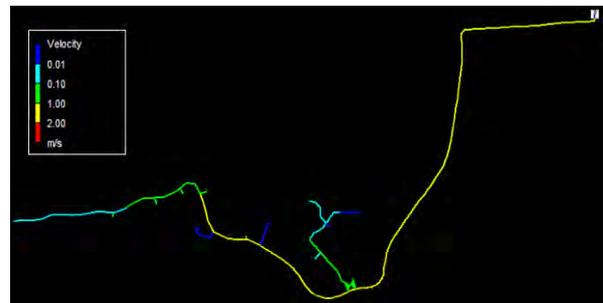


Figure 28: Unit Headloss

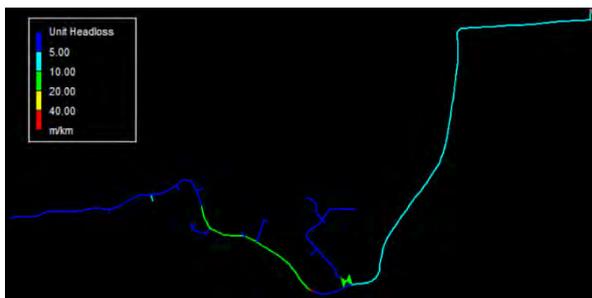
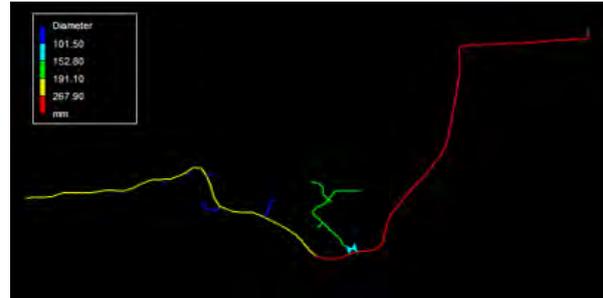


Figure 27: Diameters



12. Key findings and observations:

This report presents the results of pressure and flow testing for the proposed development, carried out in accordance with Appendix G of SNZ PAS 4509:2008 guidelines. The testing process was conducted on April 3, 2023, between 10:51 am and 11:46 am, ensuring accurate real-world conditions. The analysis shows that the water distribution system's design successfully meets the essential parameters related to residual pressures, velocities, and unit headloss for domestic and firefighting flows under both FW2 and FW3 scenarios within the Ayrburn Domain and Waterfall Park.

The water distribution system's design effectively maintains required minimum residual pressures during normal operation (300 kPa) and fire flow scenarios (100 kPa), providing an adequate water supply and pressure for all users. Velocities within the distribution network are maintained within acceptable ranges, minimising the risk of water hammer or excessive wear on the pipeline infrastructure. Furthermore, the unit headloss values have been optimized, enhancing the system's overall efficiency and minimizing energy consumption.

The results of the pressure and flow testing provide valuable input for the water network modelling and design, ensuring the reliability, safety, and effectiveness of the water distribution system for the entire development.

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It should also be noted that Oceana Protection Services will carry out additional pressure and flow testing before commissioning the sprinkler systems within the Ayrburn Domain. Holmes will be responsible for designing the sprinkler system for Waterfall Park and will conduct similar testing before commissioning.

13. Conclusion:

In conclusion, this report has provided a comprehensive analysis of the pressure and flow testing for the proposed development, adhering to the guidelines set forth in Appendix G of SNZ PAS 4509:2008. The results demonstrate that the water supply infrastructure meets the required standards and criteria for both domestic consumption and firefighting purposes. The EPANET model simulations for various scenarios have shown that the water distribution system's design effectively addresses essential parameters such as residual pressures, velocities, and unit headloss, ensuring the reliability, safety, and effectiveness of the system for the entire development. Furthermore, it is noted that Oceana Protection Services and Holmes will conduct additional pressure and flow testing for the Ayrburn Domain and Waterfall Park, respectively, before commissioning their respective sprinkler systems. This thorough approach will ensure that the water supply infrastructure is well-prepared to meet the needs of the development and its residents in both normal operations and emergency situations.

14. Recommendations for future actions:

Regular Monitoring and Maintenance to ensure the long-term efficiency and reliability of the water supply infrastructure, it is essential to establish a regular monitoring and maintenance schedule. This will help identify and address any potential issues or inefficiencies in the system proactively.

Expansion and upgrades as the development grows and evolves, it is crucial to revisit the water supply infrastructure design periodically to assess its capacity to accommodate additional demand. This may involve expansion or upgrading of the existing infrastructure to ensure it continues to meet the needs of the community.

Implementing water conservation initiatives, such as promoting water-efficient appliances, rainwater harvesting, and greywater recycling, can help to reduce overall demand on the water supply infrastructure. This will contribute to the sustainability and resilience of the development in the long run. The PRV setting should be set to ensure fire and sprinkler pressure requirements are met but also not excessive in order to minimise water losses within the development.

15. Appendices:

16. Annexure A

EPANET Junction Output

Network Name - Node	Scenario A: Peak Daily Flow - Domestic Flow Only			Scenario B: Ayrton Domain - PV 1			Scenario C: Ayrton Domain - PV 3			Scenario D: Waterfall Park - PV 2			Scenario E: Waterfall Park - PV 3		
	Elevation m	Base Demand LPS	Pressure m	Base Demand LPS	Pressure m	Base Demand LPS	Pressure m	Base Demand LPS	Pressure m	Base Demand LPS	Pressure m	Base Demand LPS	Pressure m		
June n2	349.4634596	0	96.44	0	93.81	0	93.81	0	93.81	0	91.73	0	90.72		
June n3	349.4633539	0	96.42	0	93.78	0	93.78	0	93.78	0	91.72	0	90.71		
June n4	349.4424744	0	96.47	0	93.83	0	93.83	0	93.83	0	91.53	0	90.53		
June n5	349.4387212	0	96.48	0	93.84	0	93.84	0	93.84	0	91.99	0	91.02		
June n6	349.4651837	0	96.76	0	94.11	0	94.11	0	94.11	0	92.45	0	91.51		
June n8	348.8339644	0	97.09	0	94.40	0	94.40	0	94.40	0	92.9	0	91.99		
June n9	348.4049988	0	97.53	0	94.88	0	94.88	0	94.88	0	93.44	0	92.56		
June n10	347.9079317	0	98.09	0	95.38	0	95.38	0	95.38	0	94.02	0	93.15		
June n11	347.2578821	0	98.64	0	95.99	0	95.99	0	95.99	0	94.73	0	93.87		
June n12	346.5248401	0	99.39	0	96.73	0	96.73	0	96.73	0	95.58	0	94.75		
June n13	346.2035828	0	99.79	0	97.09	0	97.09	0	97.09	0	96.03	0	95.22		
June n14	345.7581177	0	99.2	0	97.53	0	97.53	0	97.53	0	96.58	0	95.79		
June n15	345.6704529	0	99.09	0	97.42	0	97.42	0	97.42	0	96.59	0	95.78		
June n16	345.7293899	0	99.2	0	97.54	0	97.54	0	97.54	0	96.73	0	95.96		
June n17	345.7662964	0	99.2	0	97.53	0	97.53	0	97.53	0	96.74	0	95.98		
June n18	345.378648	0	99.59	0	97.92	0	97.92	0	97.92	0	97.2	0	96.46		
June n19	345.2644959	0	99.7	0	98.03	0	98.03	0	98.03	0	97.38	0	96.65		
June n20	345.3903983	0	99.97	0	98.3	0	98.3	0	98.3	0	97.81	0	96.99		
June n21	345.2234739	0	99.7	0	98.07	0	98.07	0	98.07	0	97.51	0	96.81		
June n22	345.269104	0	99.71	0	98.03	0	98.03	0	98.03	0	97.66	0	96.98		
June n23	345.3000488	0	99.68	0	98	0	98	0	98	0	97.72	0	96.98		
June n24	345.2005615	0	99.79	0	98.1	0	98.1	0	98.1	0	97.91	0	97.27		
June n25	345.0832825	0	99.91	0	98.22	0	98.22	0	98.22	0	98.13	0	97.5		
June n26	345.0977079	0	99.09	0	98.04	0	98.04	0	98.04	0	98.23	0	98.25		
June n46	344.9266431	0	91.07	0	98.39	0	98.39	0	98.39	0	98.61	0	98.06		
June n47	344.9047954	0	91.12	0	98.41	0	98.41	0	98.41	0	98.7	0	98.15		
June n48	344.5330738	0	91.5	0	98.79	0	98.79	0	98.79	0	98.09	0	98.53		
June n49	344.5094109	0	91.53	0	98.81	0	98.81	0	98.81	0	98.14	0	98.6		
June n50	344.7290486	0	91.29	0	98.57	0	98.57	0	98.57	0	98.91	0	98.37		
June n51	344.7461486	0	91.3	0	98.58	0	98.58	0	98.58	0	98.93	0	98.4		
June n52	344.6956549	0	91.36	0	98.63	0	98.63	0	98.63	0	99.01	0	98.48		
June n53	344.5296729	0	91.5	0	98.77	0	98.77	0	98.77	0	99.18	0	98.69		
June n54	343.9910484	0	92.08	0	99.39	0	99.39	0	99.39	0	99.79	0	99.26		
June n55	343.5426251	0	92.14	0	99.4	0	99.4	0	99.4	0	99.87	0	99.35		
June n56	343.5073295	0	92.22	0	99.48	0	99.48	0	99.48	0	99.98	0	99.46		
June n57	343.6642064	0	92.23	0	99.48	0	99.48	0	99.48	0	99.99	0	99.47		
June n59	343.8122272	0	92.29	0	99.53	0	99.53	0	99.53	0	99.06	0	99.53		
June n60	343.8109016	0	92.3	0	99.56	0	99.56	0	99.56	0	99.07	0	99.56		
June n61	343.8183015	0	92.3	0	99.57	0	99.57	0	99.57	0	99.08	0	99.57		
June n62	343.8196949	0	92.3	0	99.58	0	99.58	0	99.58	0	99.09	0	99.58		
June n63	343.7966203	0	92.33	0	99.63	0	99.63	0	99.63	0	99.13	0	99.63		
June n64	343.8091764	0	92.33	0	99.64	0	99.64	0	99.64	0	99.14	0	99.64		
June n65	343.8167842	0	92.32	0	99.64	0	99.64	0	99.64	0	99.14	0	99.64		
June n66	343.7702245	0	92.38	0	99.71	0	99.71	0	99.71	0	99.2	0	99.71		
June n67	343.7292078	0	92.39	0	99.72	0	99.72	0	99.72	0	99.22	0	99.72		
June n68	343.7400097	0	92.42	0	99.76	0	99.76	0	99.76	0	99.25	0	99.75		
June n69	343.7101652	0	92.40	0	99.81	0	99.81	0	99.81	0	99.3	0	99.81		
June n70	343.7064754	0	92.46	0	99.83	0	99.83	0	99.83	0	99.32	0	99.83		
June n71	343.6992219	0	92.47	0	99.84	0	99.84	0	99.84	0	99.33	0	99.84		
June n72	343.6421118	0	92.53	0	99.91	0	99.91	0	99.91	0	99.4	0	99.91		
June n73	343.5944162	0	92.6	0	99.98	0	99.98	0	99.98	0	99.47	0	99.98		
June n74	343.5109093	0	92.66	0	99.96	0	99.96	0	99.96	0	99.06	0	99.96		
June n75	343.4461817	0	92.79	0	99.19	0	99.19	0	99.19	0	99.63	0	99.13		
June n76	343.336385	0	92.81	0	99.22	0	99.22	0	99.22	0	99.7	0	99.22		
June n77	343.3421893	0	92.86	0	99.27	0	99.27	0	99.27	0	99.79	0	99.27		
June n78	343.3196456	0	92.88	0	99.31	0	99.31	0	99.31	0	99.79	0	99.31		
June n79	343.2500023	0	92.99	0	99.38	0	99.38	0	99.38	0	99.89	0	99.38		
June n80	343.0053611	0	93.1	0	99.48	0	99.48	0	99.48	0	99.04	0	99.48		
June n81	342.8514169	0	93.36	0	99.81	0	99.81	0	99.81	0	99.28	0	99.81		
June n82	342.889308	0	93.68	0	99.08	0	99.08	0	99.08	0	99.59	0	99.08		
June n83	342.3800574	0	93.84	0	99.3	0	99.3	0	99.3	0	99.77	0	99.3		
June n84	342.0187171	0	94.21	0	99.67	0	99.67	0	99.67	0	99.14	0	99.67		
June n85	341.4415909	0	94.8	0	99.8	0	99.8	0	99.8	0	99.25	0	99.8		
June n86	341.4360138	0	94.8	0	99.89	0	99.89	0	99.89	0	99.29	0	99.89		
June n87	341.3916507	0	94.85	0	99.84	0	99.84	0	99.84	0	99.3	0	99.84		
June n88	341.0472093	0	95.21	0	99.72	0	99.72	0	99.72	0	99.18	0	99.72		
June n89	341.0296788	0	95.23	0	99.77	0	99.77	0	99.77	0	99.23	0	99.77		
June n90	341.2263448	0	95.09	0	99.59	0	99.59	0	99.59	0	99.09	0	99.59		
June n91	341.9994001	0	94.91	0	99.51	0	99.51	0	99.51	0	99.51	0	99.51		
June n92	342.8782348	0	93.49	0	99.07	0	99.07	0	99.07	0	99.52	0	99.07		
June n93	342.1875305	0	94.16	0	99.83	0	99.83	0	99.83	0	99.28	0	99.83		
June n94	342.291687	0	94.07	0	99.77	0	99.77	0	99.77	0	99.2	0	99.77		
June n95	342.3296693	0	94.04	0	99.79	0	99.79	0	99.79	0	99.2	0	99.79		
June n96	342.5421827	0	94.9	0	99.67	0	99.67	0	99.67	0	99.67	0	99.67		
June n97	342.5807447	0	95.05	0	99.69	0	99.69	0	99.69	0	99.06	0	99.69		
June n98	342.5872231	0	95.87	0	99.71	0	99.71	0	99.71	0	99.11	0	99.71		
June n99	342.7431033	0	95.73	0	99.62	0	99.62	0	99.62	0	99.01	0	99.62		
June n100	342.7613957	0	95.73	0	99.69	0	99.69	0	99.69	0	99.04	0	99.69		
June n101	342.5288199	0	95.99	0	99.54	0	99.54	0	99.54	0	99.92	0	99.54		
June n102	342.0072947	0	96.07	0	99.47	0	99.47	0	99.47	0	99.82	0	99.47		
June n103	342.9247404	0	92.62	0	99.62	0	99.62	0	99.62	0	99.1	0	99.62		
June n104	344.834569	0	91.73	0	99.76	0	99.76	0	99.76	0	99.13	0	99.76		
June n105	345.510065	0	90.67	0	98.74	0	98.74	0	98.74	0	99.1	0	98.74		
June n106	346.39293	0	90.21	0	98.3	0	98.3	0	98.3	0	98.69	0	98.3		
June n107	347.1218196	0	90.45	0	97.69	0	97.69	0	97.69	0	97.69	0	97.69		
June n108	348.146994	0	88.3	0	96.66	0	96.66	0	96.66	0	97.01	0	96.66		
June n109	348.9293719	0	87.74	0	95.95	0	95.95	0	95.95	0	96.29	0	95.95		
June n110	349.0938877	0	87.64	0	95.89	0	95.89	0	95.89	0	96.21	0	95.89		
June n111	349.0021364	0	87.73	0	96.04	0	96.04	0	96.04	0	96.35	0	96.04		
June n112	348.9179957	0	87.85	0	96.24	0	96.24	0	96.24	0	96.54	0	96.24		
June n113	348.8934706	0	87.83	0	96.27	0	96.27	0	96.27	0	96.5	0	96.27		
June n114	348.7982607	0	88.09	0	96.52	0	96.52	0	96.52	0	96.8	0	96.52		
June n115	348.7007731	0	88.16	0	96.69	0	96.69	0	96.69	0	96.97	0	96.69		
June n116	348.6298825	0	88.25	0	96.83	0	96.83	0	96.83	0	97.09	0	96.83		
June n117	348.6789867	0	88.32	0	96.99	0	96.99	0	96.99	0	97.19	0	96.99		
June n118	348.5078482	0													

Network Name - Node	Elevation m	Scenario A: Peak Daily Flow - Domestic Flow Only		Scenario B: Ayrton Domain - PW 1		Scenario C: Ayrton Domain - PW 3		Scenario D: Waterfall PW - PW 2		Scenario E: Waterfall PW - PW 3	
		Base Demand LPS	Pressure m	Base Demand LPS	Pressure m	Base Demand LPS	Pressure m	Base Demand LPS	Pressure m	Base Demand LPS	Pressure m
Junc n154	347.5617205	0	89.74	0	89.72	0	89.72	0	89.72	0	89.72
Junc n155	344.7344	0.06	73.84	0.04	69.93	0.04	69.93	0.04	73.95	0.04	73.95
Junc n163	345.1093	0	73.65	0	72.13	0	72.13	0	73.69	0	73.69
Junc n164	344.6087399	0	74.12	0	72.09	0	72.09	0	74.18	0	74.18
Junc n165	344.5292999	0	74.47	0	72.11	0	72.11	0	74.23	0	74.23
Junc n166	344.3920162	0	74.39	0	72.12	0	72.12	0	74.39	0	74.39
Junc n167	344.192697	0	74.52	0	72.21	0	72.21	0	74.59	0	74.59
Junc n168	344.1969927	0	74.52	0	72.01	0	72.01	0	74.59	0	74.59
Junc n169	344.2607741	0	74.44	0	71.83	0	71.83	0	74.51	0	74.51
Junc n170	344.2478114	0	74.45	0	71.79	0	71.79	0	74.53	0	74.53
Junc n171	344.2496374	0	74.44	0	71.85	0	71.85	0	74.52	0	74.52
Junc n172	344.2503962	0	74.43	0	71.99	0	71.99	0	74.51	0	74.51
Junc n173	344.2570992	0	74.43	0	71.91	0	71.91	0	74.51	0	74.51
Junc n174	344.4294814	0	74.2	0	70.76	0	70.76	0	74.3	0	74.3
Junc n175	344.4282707	0	74.2	0	70.68	0	70.68	0	74.3	0	74.3
Junc n176	344.6187084	0	74.09	0	70.3	0	70.3	0	74.14	0	74.14
Junc n177	344.7340927	0	73.9	0	69.97	0	69.97	0	74.01	0	74.01
Junc n178	345.0394720	0	73.97	0	69.19	0	69.19	0	73.7	0	73.7
Junc n179	345.0397346	0	73.25	12.5	68.39	25	68.39	0	73.36	0	73.36
Junc n180	345.3207936	0	73.23	0	68.31	0	68.31	0	73.33	0	73.33
Junc n181	345.4432594	0	73.14	0	68.18	0	68.21	0	73.28	0	73.28
Junc n182	345.4577352	0	73.09	0	68.13	0	68.15	0	73.24	0	73.24
Junc n183	345.5566708	0	72.71	0	67.72	0	67.67	0	72.96	0	72.96
Junc n184	345.6172675	0	72.54	0	67.54	0	67.54	0	72.9	0	72.9
Junc n185	346.4713296	0	72.07	0	67.02	0	66.94	0	72.24	0	72.24
Junc FH1	346.5444485	0	71.99	12.5	66.93	25	66.72	0	72.16	0	72.16
Junc n187	346.5238356	0	72.01	0	66.95	0	66.74	0	72.18	0	72.18
Junc n188	346.5822979	0	71.99	0	66.89	0	66.68	0	72.13	0	72.13
Junc n189	346.634609	0	71.85	0	66.79	0	66.58	0	72.02	0	72.02
Junc Domain FutureHinge	346.9322529	7.4	71.69	4.44	66.64	4.44	66.43	4.44	71.87	4.44	71.87
Junc n191	346.9285261	0	71.6	0	66.54	0	66.33	0	71.78	0	71.78
Junc n192	347.233904	0	71.29	0	66.23	0	66.02	0	71.47	0	71.47
Junc n193	347.3990486	0	71.13	0	66.07	0	65.86	0	71.31	0	71.31
Junc n194	347.5194673	0	71.01	0	65.99	0	65.74	0	71.18	0	71.18
Junc n197	347.5191993	0	70.91	0	65.73	0	65.49	0	70.95	0	70.95
Junc n196	347.9007134	0	70.62	0	65.37	0	65.13	0	70.8	0	70.8
Junc n197	348.0869531	0	70.44	0	65.38	0	65.17	0	70.62	0	70.62
Junc n198	348.170609	0	70.35	0	65.3	0	65.09	0	70.53	0	70.53
Junc n199	348.1743826	0	70.35	0	65.3	0	65.08	0	70.53	0	70.53
Junc n200	348.2868997	0	70.24	0	65.18	0	64.97	0	70.42	0	70.42
Junc n201	348.4385124	0	70.08	0	65.09	0	64.88	0	70.32	0	70.32
Junc n202	348.5419144	0	69.98	0	64.93	0	64.72	0	70.16	0	70.16
Junc n203	348.6719091	0	69.89	0	64.8	0	64.59	0	70.03	0	70.03
Junc n204	348.734205	0	69.79	0	64.74	0	64.52	0	69.97	0	69.97
Junc n205	348.9149495	0	69.6	0	64.59	0	64.34	0	69.78	0	69.78
Junc n206	348.0952585	0	69.47	0	64.44	0	64.19	0	69.63	0	69.63
Junc n207	349.3161231	0	69.21	0	64.13	0	63.94	0	69.39	0	69.39
Junc n208	349.3482186	0	69.18	0	64.13	0	63.91	0	69.36	0	69.36
Junc n209	349.6286801	0	68.86	0	63.81	0	63.6	0	69.04	0	69.04
Junc n210	349.6994502	0	68.82	0	63.77	0	63.56	0	69	0	69
Junc n211	349.4851109	0	69.04	0	63.95	0	63.77	0	69.22	0	69.22
Junc n19	349.4367826	0	69.09	0	63.93	0	63.75	0	69.27	0	69.27
Junc n213	349.5713326	0	68.99	0	63.8	0	63.63	0	69.13	0	69.13
Junc Homestead	349.6676422	1.16	68.89	0.7	63.8	0.7	63.59	0.7	69.09	0.7	69.09
Junc n215	349.427	0	68.48	0	63.84	0	63.64	0	68.79	0	68.79
Junc n216	350.9107	0	84.98	0	82.36	0	82.36	0	78.99	0	78.99
Junc n17	351.3258	0	84.74	0	82.11	0	82.11	0	78.58	0	78.47
Junc n218	351.1919	0	84.68	0	82.07	0	82.07	0	78.57	0	78.57
Junc n219	351.1413	0	84.73	0	82.12	0	82.12	0	78.92	0	77.68
Junc FH A New	351.036	0	84.83	0	82.22	0	82.22	12.5	78.81	25	77.59
Junc n221	351.1979	0	84.66	0	82.09	0	82.09	0	78.51	0	77.28
Junc n222	351.4619	0	84.39	0	81.79	0	81.79	20	78.17	0	76.96
Junc n223	352.0199	0	84.18	0	81.5	0	81.5	0	77.92	0	77.5
Junc n224	352.6379	0	83.21	0	80.61	0	80.61	0	76.94	0	75.63
Junc n225	353.4253	0	82.42	0	79.82	0	79.82	0	76.11	0	74.71
Junc n226	354.1218	0	81.71	0	79.12	0	79.12	0	75.38	0	73.92
Junc n227	355.1738	0	80.66	0	78.07	0	78.07	0	74.27	0	72.69
Junc n228	356.2998	0	79.73	0	77.14	0	77.14	0	73.31	0	71.66
Junc n229	356.3199	0	79.51	0	76.91	0	76.91	12.5	73	25	71.8
Junc n231	357.1933	0	78.68	0	76.09	0	76.09	0	72.21	0	70.52
Junc n232	357.4671	0	78.36	0	75.77	0	75.77	0	71.93	0	70.25
Junc FH C New	357.7891	0	78.06	0	75.47	0	75.47	0	71.63	0	69.95
Junc n234	359.1136	0	76.71	0	74.12	0	74.12	0	70.28	0	68.6
Junc n235	360.1586	0	75.09	0	72.06	0	72.06	0	69.24	0	67.56
Junc n236	362.2356	0	73.59	0	71	0	71	0	67.46	0	65.48
Junc n237	363.0163	0	72.81	0	70.22	0	70.22	0	66.38	0	64.7
Junc n238	363.4402	0	72.38	0	69.8	0	69.8	0	65.96	0	64.28
Junc Irrigation WPARC	364.0054	1.1	71.82	0.66	69.23	0.66	69.23	0.66	65.39	0.66	63.71
Junc n240	367.4508	0	68.96	0	65.98	0	65.98	0	62.14	0	60.49
Junc Haydam	368.02	0	67.64	0	65.66	0	65.54	0	62.86	0	61.56
Junc Building A	368.427	1.25	68.42	1.29	63.82	1.29	63.82	1.29	61.79	1.29	60.72
Junc n249	351.4604	0	84.42	0	81.8	0	81.8	0	77.92	0	77.79
Junc n250	351.4604	0	84.42	0	81.8	0	81.8	0	77.92	0	77.79
Junc n251	351.4604	0	84.42	0	81.8	0	81.8	0	77.92	0	77.79
Junc n252	351.4604	0	84.42	0	81.8	0	81.8	0	77.92	0	77.79
Junc n253	351.4604	0	84.42	0	81.8	0	81.8	0	77.92	0	77.79
Junc n254	351.4604	0	84.42	0	81.8	0	81.8	0	77.92	0	77.79
Junc Building B	351.9319	1.19	84.2	0.71	81.67	0.71	81.67	0.71	78.09	0.71	76.89
Junc n257	353.0579	0	82.78	0	80.19	0	80.19	0	76.5	0	75.13
Junc Building C	353.0579	1.12	82.66	0.73	80.14	0.73	80.14	0.73	76.49	0.73	75.09
Junc n259	354.6181	0	81.23	0	78.63	0	78.63	0	74.96	0	73.59
Junc Building D	353.0579	1.49	82.62	0.89	80.12	0.89	80.12	0.89	76.36	0.89	74.84
Junc n261	356.3209	0	78.98	0	76.39	0	76.39	0	72.53	0	70.87
Junc Building E	356.3209	0.97	78.92	0.98	76.37	0.98	76.37	0.98	72.53	0.98	70.89
Junc Building F	368.628	0.93	67.16	0.96	64.59	0.96	64.58	0.96	60.74	0.96	58.06
Junc Annex Building Cart5	347.723	1.58	70.8	25.99	65.67	0.99	65.69	0.99	70.94	0.99	70.84
Junc n265	344.9287	0	73.62	0	71	0	68.72	0	73.77	0	73.77
Junc n274	349.3057	0	68.61	0	63.97	0	63.97	0	62.22	0	61.28
Junc DisplaySuite	349.3057	0.02	68.61	0.01	63.97	0.01	63.97	0.01	62.22	0.01	61.28
Junc n277	349.3207	0	62.26	0	58.16	0	58.16	0	60.09	0	59.52
Junc n278	349.3207	0	62.26	0	58	0	58	0	60.09	0	59.52
Junc n279	349.3207	0	62.26	0	58	0	58	0	60.09	0	59.52
Junc n280	344.5618	0	74.09	0	70.43	0	70.43	0	74.19	0	74.19
Junc BARREL ROOM	345.0972	0.12	73.56	0.13	69.16	0.13	69.16	0.13	73.68	0.13	73.68
Junc 3	345.1764	0	73.98	0	68.31	0	68.12	0	73.53	0	73.53
Junc 4	345.1764	0	73.97	0	68.39	0	68.21	0	73.54	0	73.54
Junc 5	345.2307	0	73.28	0	69.53	0	69.53	0	73.04	0	73.04
Junc 6	349.3207	0	68.61	0	63.97	0	63.97	0	62.22	0	61.28
Junc Burr Bar	349.107	0.05	69.42	0.05	64.36	0.05	64.15	0.05			

17. Annexure B

EPANET Pipe Output

Network Table - Links	Scenario A: Peak Daily Flow - Domestic Flow Only			Scenario B: Ayrburn Domain - FW 2		Scenario C: Ayrburn Domain - FW 3		Scenario D: Waterfall Park - FW 2		Scenario E: Waterfall Park - FW 3	
Link ID	Diameter mm	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km
Pipe p2	250	0.18	0.15	0.11	0.06	0.11	0.06	1.03	3.33	1.13	3.95
Pipe p3	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p4	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p7	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p8	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p9	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p10	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.39	1.93	14.76
Pipe p11	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p12	191.1	0.32	0.55	0.19	0.21	0.19	0.21	1.76	12.38	1.93	14.76
Pipe p13	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.77
Pipe p14	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.39	1.93	14.76
Pipe p15	191.1	0.32	0.55	0.19	0.22	0.19	0.22	1.76	12.39	1.93	14.77
Pipe p16	191.1	0.32	0.54	0.19	0.21	0.19	0.21	1.76	12.37	1.93	14.76
Pipe p17	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.39	1.93	14.76
Pipe p18	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p19	191.1	0.32	0.54	0.19	0.21	0.19	0.21	1.76	12.39	1.93	14.77
Pipe p20	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p21	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p22	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.76
Pipe p23	191.1	0.32	0.55	0.19	0.22	0.19	0.22	1.76	12.38	1.93	14.77
Pipe p24	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.39	1.93	14.76
Pipe p25	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.39	1.93	14.76
Pipe p44	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.84	1.25	4.39
Pipe p45	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.83	1.25	4.39
Pipe p46	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.83	1.25	4.4
Pipe p47	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.84	1.25	4.39
Pipe p48	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.84	1.25	4.4
Pipe p49	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.84	1.25	4.39
Pipe p50	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.83	1.25	4.39
Pipe p51	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.83	1.25	4.39
Pipe p52	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.83	1.25	4.39
Pipe p53	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.83	1.25	4.39
Pipe p54	267.9	0.6	1.17	0.36	0.46	0.36	0.46	1.16	3.83	1.25	4.39
Pipe p57	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p58	267.9	0.8	1.92	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p59	267.9	0.8	1.94	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p60	267.9	0.8	1.92	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.19
Pipe p61	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.17
Pipe p62	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p63	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p64	267.9	0.8	1.94	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p65	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p66	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p67	267.9	0.8	1.93	1.37	5.17	1.37	5.17	1.28	4.58	1.37	5.17
Pipe p68	267.9	0.8	1.91	1.37	5.17	1.37	5.17	1.28	4.57	1.37	5.17
Pipe p69	267.9	0.8	1.93	1.37	5.19	1.37	5.19	1.28	4.57	1.37	5.19
Pipe p70	267.9	0.8	1.92	1.37	5.17	1.37	5.17	1.28	4.57	1.37	5.19
Pipe p71	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.17
Pipe p72	267.9	0.8	1.93	1.37	5.19	1.37	5.19	1.28	4.57	1.37	5.19
Pipe p73	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p74	267.9	0.8	1.93	1.37	5.17	1.37	5.17	1.28	4.58	1.37	5.17
Pipe p75	267.9	0.8	1.92	1.37	5.18	1.37	5.18	1.28	4.56	1.37	5.18
Pipe p76	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p77	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p78	267.9	0.8	1.92	1.37	5.19	1.37	5.19	1.28	4.58	1.37	5.19
Pipe p79	267.9	0.8	1.93	1.37	5.17	1.37	5.17	1.28	4.56	1.37	5.18
Pipe p80	267.9	0.8	1.94	1.37	5.2	1.37	5.2	1.28	4.58	1.37	5.17
Pipe p81	267.9	0.8	1.92	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p82	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p83	267.9	0.8	1.98	1.37	5.2	1.37	5.2	1.28	4.59	1.37	5.2
Pipe p84	267.9	0.8	1.91	1.37	5.17	1.37	5.17	1.28	4.57	1.37	5.17
Pipe p85	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p86	267.9	0.8	1.92	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p87	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p88	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p89	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p90	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p91	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p92	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p93	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p94	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p95	267.9	0.8	1.92	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p96	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p97	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p98	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p99	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p100	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p101	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p102	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p103	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p104	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p105	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p106	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p107	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p109	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p110	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18

Network Table - Links	Scenario A: Peak Daily Flow - Domestic Flow Only			Scenario B: Ayrburn Domain - FW 2		Scenario C: Ayrburn Domain - FW 3		Scenario D: Waterfall Park - FW 2		Scenario E: Waterfall Park - FW 3	
Link ID	Diameter mm	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km
Pipe p111	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p112	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p113	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p114	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p115	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p116	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p117	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p118	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p119	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p120	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p121	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p122	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p123	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p125	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p126	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p127	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p128	267.9	0.8	1.94	1.37	5.19	1.37	5.19	1.28	4.58	1.37	5.17
Pipe p129	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p130	267.9	0.8	1.92	1.37	5.22	1.37	5.22	1.28	4.56	1.37	5.16
Pipe p131	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p132	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p133	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p134	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p135	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p136	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p137	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p138	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p139	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p140	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p141	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p142	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p143	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p144	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p145	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p146	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p147	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.57	1.37	5.18
Pipe p148	267.9	0.8	1.9	1.37	5.18	1.37	5.18	1.28	4.62	1.37	5.18
Pipe p149	267.9	0.8	1.93	1.37	5.15	1.37	5.15	1.28	4.57	1.37	5.15
Pipe p150	267.9	0.8	1.96	1.37	5.22	1.37	5.22	1.28	4.56	1.37	5.22
Pipe p151	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe p152	267.9	0.8	1.94	1.37	5.19	1.37	5.19	1.28	4.56	1.37	5.19
Pipe p164	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.89	0.36	0.89
Pipe p165	152.8	0.6	2.21	3.08	46.32	3.08	46.32	0.36	0.9	0.36	0.9
Pipe p166	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.9	0.36	0.9
Pipe p167	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.88	0.36	0.88
Pipe p168	152.8	0.6	2.23	3.08	46.28	3.08	46.28	0.36	0.9	0.36	0.9
Pipe p169	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.89	0.36	0.89
Pipe p170	152.8	0.6	2.23	3.08	46.28	3.08	46.28	0.36	0.89	0.36	0.89
Pipe p171	152.8	0.6	2.24	3.08	46.27	3.08	46.27	0.36	0.89	0.36	0.89
Pipe p172	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.9	0.36	0.9
Pipe p173	152.8	0.6	2.23	3.08	46.29	3.08	46.29	0.36	0.89	0.36	0.89
Pipe p174	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.89	0.36	0.89
Pipe p175	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.9	0.36	0.9
Pipe p177	152.8	0.6	2.24	3.08	46.27	3.08	46.27	0.36	0.89	0.36	0.89
Pipe p179	152.8	0.58	2.13	3.08	46.01	3.08	46.01	0.35	0.85	0.35	0.85
Pipe p180	152.8	0.58	2.13	2.39	28.77	1.71	15.41	0.35	0.86	0.35	0.86
Pipe p182	152.8	0.49	1.58	0.98	5.51	1.66	14.57	0.3	0.65	0.3	0.65
Pipe p183	152.8	0.49	1.59	0.98	5.51	1.66	14.57	0.3	0.64	0.3	0.64
Pipe p184	152.8	0.49	1.6	0.98	5.5	1.66	14.56	0.3	0.64	0.3	0.64
Pipe p187	152.8	0.49	1.6	0.3	0.64	0.3	0.64	0.3	0.64	0.3	0.64
Pipe p188	152.8	0.49	1.61	0.3	0.64	0.3	0.64	0.3	0.64	0.3	0.64
Pipe p189	152.8	0.49	1.59	0.3	0.64	0.3	0.64	0.3	0.63	0.3	0.63
Pipe p190	152.8	0.49	1.59	0.3	0.63	0.3	0.63	0.3	0.65	0.3	0.65
Pipe p191	152.8	0.09	0.1	0.06	0.03	0.06	0.03	0.06	0.03	0.06	0.03
Pipe p192	152.8	0.09	0.08	0.06	0.04	0.06	0.04	0.06	0.03	0.06	0.03
Pipe p193	152.8	0.09	0.08	0.06	0.03	0.06	0.03	0.06	0.03	0.06	0.03
Pipe p194	152.8	0.09	0.08	0.06	0.03	0.06	0.03	0.06	0.03	0.06	0.03
Pipe p195	152.8	0.09	0.07	0.06	0.03	0.06	0.03	0.06	0.04	0.06	0.04
Pipe p196	152.8	0.09	0.08	0.06	0.03	0.06	0.04	0.06	0.03	0.06	0.03
Pipe p197	152.8	0.09	0.08	0.06	0.04	0.06	0.03	0.06	0.03	0.06	0.03
Pipe p198	152.8	0.09	0.08	0.06	0.02	0.06	0.04	0.06	0.04	0.06	0.04
Pipe p199	152.8	0.09	0.19	0.06	0.19	0.06	0	0.06	0	0.06	0
Pipe p200	152.8	0.09	0.08	0.06	0.03	0.06	0.03	0.06	0.04	0.06	0.04
Pipe p201	152.8	0.09	0.07	0.06	0.03	0.06	0.03	0.06	0.03	0.06	0.03
Pipe p202	152.8	0.09	0.09	0.06	0.03	0.06	0.04	0.06	0.03	0.06	0.03
Pipe p203	152.8	0.09	0.07	0.06	0.03	0.06	0.03	0.06	0.03	0.06	0.03
Pipe p204	152.8	0.09	0.08	0.06	0.04	0.06	0.04	0.06	0.04	0.06	0.04
Pipe p205	152.8	0.09	0.08	0.06	0.03	0.06	0.03	0.06	0.03	0.06	0.03
Pipe p206	152.8	0.06	0.05	0.04	0.02	0.04	0	0.04	0.02	0.04	0.02
Pipe p207	152.8	0.06	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p208	152.8	0.06	0	0.04	0.08	0.04	0	0.04	0	0.04	0
Pipe p209	152.8	0.06	0.04	0.04	0.01	0.04	0.01	0.04	0.02	0.04	0.02
Pipe p210	152.8	0.06	0.05	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p211	152.8	0.06	0.04	0.04	0.02	0.04	0.02	0.04	0.01	0.04	0.01
Pipe p212	152.8	0.06	0.05	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p213	152.8	0.06	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02

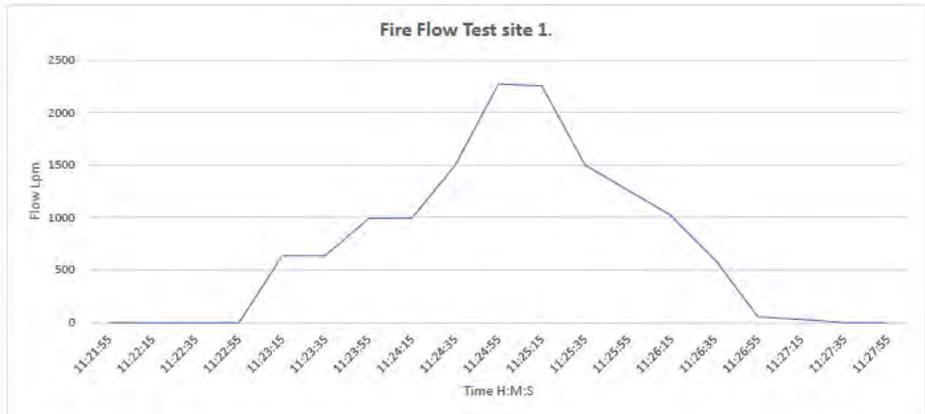
Network Table - Links	Scenario A: Peak Daily Flow - Domestic Flow Only			Scenario B: Ayrburn Domain - FW 2		Scenario C: Ayrburn Domain - FW 3		Scenario D: Waterfall Park - FW 2		Scenario E: Waterfall Park - FW 3	
Link ID	Diameter mm	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km	Velocity m/s	Unit Headloss m/km
Pipe p214	152.8	0.06	0.04	0.04	0.02	0.04	0.01	0.04	0.01	0.04	0.01
Pipe p215	191.1	0.24	0.33	0.14	0.13	0.14	0.13	1.71	11.8	1.89	14.13
Pipe p216	191.1	0.24	0.33	0.14	0.13	0.14	0.13	1.71	11.8	1.89	14.13
Pipe p218	191.1	0.24	0.33	0.14	0.14	0.14	0.14	1.71	11.8	1.89	14.13
Pipe p219	191.1	0.24	0.33	0.14	0.13	0.14	0.13	1.71	11.8	1.89	14.13
Pipe p220	191.1	0.24	0.33	0.14	0.13	0.14	0.13	1.28	6.85	1.02	4.5
Pipe p221	191.1	0.24	0.33	0.14	0.13	0.14	0.13	1.28	6.85	1.02	4.5
Pipe p222	191.1	0.2	0.24	0.12	0.1	0.12	0.1	0.56	1.5	0.99	4.3
Pipe p223	191.1	0.2	0.24	0.12	0.1	0.12	0.1	0.56	1.49	0.99	4.3
Pipe p225	191.1	0.16	0.15	0.09	0.06	0.09	0.06	0.53	1.37	0.97	4.1
Pipe p227	191.1	0.1	0.08	0.06	0.03	0.06	0.03	0.5	1.23	0.93	3.86
Pipe p228	191.1	0.1	0.08	0.06	0.03	0.06	0.03	0.5	1.23	0.93	3.86
Pipe p231	191.1	0.07	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p232	191.1	0.07	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p233	191.1	0.07	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p234	191.1	0.07	0.04	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.02
Pipe p235	191.1	0.07	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p236	191.1	0.07	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p237	191.1	0.07	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p238	191.1	0.07	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe p239	191.1	0.03	0.01	0.02	0	0.02	0	0.02	0	0.02	0
Pipe p245	63	0.69	8.62	0.41	3.45	0.41	3.45	0.41	3.46	0.41	3.46
Pipe p251	50	0.62	9.52	0.37	3.82	0.37	3.82	0.37	3.82	0.37	3.82
Pipe p252	50	0.76	13.63	0.45	5.43	0.45	5.43	0.45	5.43	0.45	5.43
Pipe p253	50	0.49	6.32	0.3	2.55	0.3	2.55	0.3	2.55	0.3	2.55
Pipe FH_D_New	191.1	0.03	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
Pipe p255	152.8	0.09	0.07	1.42	10.84	0.05	0.03	0.05	0.03	0.05	0.03
Pipe p261	50	0.01	0.01	0.01	0	0.01	0	0.01	0.01	0.01	0
Pipe p263	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.9	0.36	0.89
Pipe 18	191.1	0.07	0.04	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Pipe 19	191.1	0.1	0.08	0.06	0.03	0.06	0.03	0.06	0.03	0.06	0.03
Pipe 21	191.1	0.1	0.08	0.06	0.03	0.06	0.03	0.5	1.23	0.93	3.86
Pipe 22	191.1	0.16	0.15	0.09	0.06	0.09	0.06	0.53	1.37	0.97	4.1
Pipe 23	191.1	0.16	0.15	0.09	0.06	0.09	0.06	0.53	1.37	0.97	4.1
Pipe 24	191.1	0.2	0.24	0.12	0.1	0.12	0.1	0.56	1.49	0.99	4.3
Pipe 25	50	0.61	9.11	0.36	3.64	0.36	3.64	0.36	3.64	0.36	3.64
Pipe 47	191.1	0.24	0.33	0.14	0.13	0.14	0.13	1.71	11.8	1.89	14.12
Pipe 48	191.1	0.24	0.33	0.14	0.13	0.14	0.13	1.71	11.8	1.89	14.13
Pipe 49	191.1	0.32	0.54	0.19	0.21	0.19	0.21	1.76	12.38	1.93	14.76
Pipe 50	191.1	0.32	0.54	0.19	0.22	0.19	0.22	1.76	12.39	1.93	14.76
Pipe 52	152.8	0.49	1.59	0.98	5.51	1.66	14.56	0.3	0.65	0.3	0.65
Pipe 53	152.8	0.49	1.61	0.98	5.5	1.66	14.59	0.3	0.63	0.3	0.63
Pipe 54	152.8	0.49	1.59	0.98	5.51	1.66	14.57	0.3	0.64	0.3	0.64
Pipe 55	152.8	0.49	1.59	0.98	5.51	1.66	14.56	0.3	0.64	0.3	0.64
Pipe 58	152.8	0.59	2.21	3.08	46.21	3.08	46.21	0.36	0.88	0.36	0.88
Pipe 59	152.8	0.6	2.2	3.08	46.31	3.08	46.31	0.36	0.88	0.36	0.88
Pipe 60	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.9	0.36	0.9
Pipe 61	152.8	0.6	2.23	3.08	46.28	3.08	46.28	0.36	0.89	0.36	0.89
Pipe 62	152.8	0.58	2.11	3.08	46.04	3.08	46.04	0.35	0.89	0.35	0.89
Pipe 63	152.8	0.58	2.1	2.39	28.75	1.71	15.45	0.35	0.86	0.35	0.86
Pipe 64	152.8	0.49	1.6	0.98	5.51	1.66	14.55	0.3	0.62	0.3	0.62
Pipe 65	267.9	0.6	1.16	0.36	0.47	0.36	0.47	1.16	3.83	1.25	4.4
Pipe 66	267.9	0.8	1.93	1.37	5.16	1.37	5.16	1.28	4.57	1.37	5.16
Pipe 67	152.8	0.6	2.23	3.08	46.28	3.08	46.28	0.36	0.89	0.36	0.89
Pipe 68	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe 69	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe 87	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.88	0.36	0.88
Pipe 89	152.8	0.6	2.21	3.08	46.27	3.08	46.27	0.36	0.92	0.36	0.92
Pipe 90	152.8	0.6	2.24	3.08	46.27	3.08	46.27	0.36	0.9	0.36	0.9
Pipe 91	152.8	0.6	2.23	3.08	46.27	3.08	46.27	0.36	0.88	0.36	0.88
Pipe 92	225	0.23	0.25	0.14	0.09	0.14	0.09	1.27	5.55	1.39	6.63
Pipe 3	267.9	0.8	1.93	1.37	5.18	1.37	5.18	1.28	4.58	1.37	5.18
Pipe 4	267.9	0.6	1.16	0.36	0.46	0.36	0.46	1.16	3.84	1.25	4.39
Pipe 5	267.9	0.16	1.25	0.1	0.45	0.1	0.45	0.89	38.37	0.98	46.35
alve Ayrburn_PRV	150	0.62	17.25	3.2	14	3.2	14	0.37	15.03	0.37	14.52

18. Annexure C

Pressure & Flow Raw Data

File Name: Fire Flow Test Development Area 1, 3 April 2023
 Title: FFT site 1, 03/04/2023

Flow Measurement Information	Liters per minute
Time	Flow (L/min)
11:21:55	0
11:22:15	0
11:22:35	0
11:22:55	0
11:23:15	636
11:23:35	636
11:23:55	996
11:24:15	996
11:24:35	1500
11:24:55	2274
11:25:15	2256
11:25:35	1500
11:25:55	1260
11:26:15	1020
11:26:35	600
11:26:55	54
11:27:15	30
11:27:35	0
11:27:55	0



NB: Data provided from FFT site 1 was recorded using a flow unit that only records water flow.

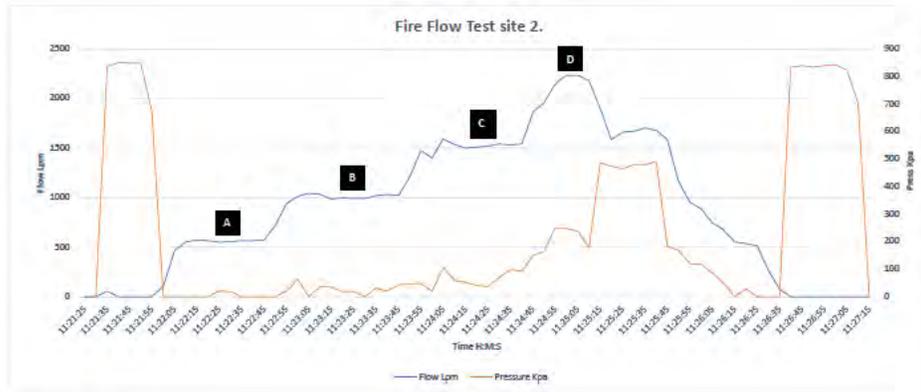
File Name Fire Flow Test Development Area 1, 3 April 2023
 Title FFT site 2, 03/04/2023

Information

Flow Measurement Liters per minute

Pressure Measurement Kilopascals

Time (s)	Flow (L/min)	Pressure (Kpa)
11:21:25	0	0
11:21:30	0	0
11:21:35	55	836
11:21:40	0	851
11:21:45	0	848
11:21:50	0	848
11:21:55	0	674
11:22:00	100	0
11:22:05	461	0
11:22:10	552	0
11:22:15	571	0
11:22:20	563	0
11:22:25	550	21
11:22:30	554	18
11:22:35	563	0
11:22:40	564	0
11:22:45	571	0
11:22:50	711	0
11:22:55	938	21
11:23:00	1010	64
11:23:05	1042	0
11:23:10	1032	37
11:23:15	985	34
11:23:20	995	18
11:23:25	991	18
11:23:30	990	0
11:23:35	1017	31
11:23:40	1029	21
11:23:45	1020	43
11:23:50	1207	46
11:23:55	1472	49
11:24:00	1401	18
11:24:05	1592	107
11:24:10	1534	58
11:24:15	1499	52
11:24:20	1507	40
11:24:25	1516	37
11:24:30	1540	70
11:24:35	1532	98
11:24:40	1542	92
11:24:45	1863	149
11:24:50	1958	165
11:24:55	2146	250
11:25:00	2233	247
11:25:05	2235	238
11:25:10	2176	177
11:25:15	1900	485
11:25:20	1581	473
11:25:25	1659	464
11:25:30	1667	479
11:25:35	1702	479
11:25:40	1679	491
11:25:45	1583	183
11:25:50	1162	168
11:25:55	953	119
11:26:00	887	119
11:26:05	745	85
11:26:10	677	49
11:26:15	551	0
11:26:20	536	27
11:26:25	514	0
11:26:30	269	0
11:26:35	76	0
11:26:40	0	833
11:26:45	0	839
11:26:50	0	833
11:26:55	0	838
11:27:00	0	842
11:27:05	0	824
11:27:10	0	705
11:27:15	0	0



A = Flow at 500 lpm
 B = Flow at 1000 lpm
 C = Flow at 1500 lpm
 D = Flow at Max

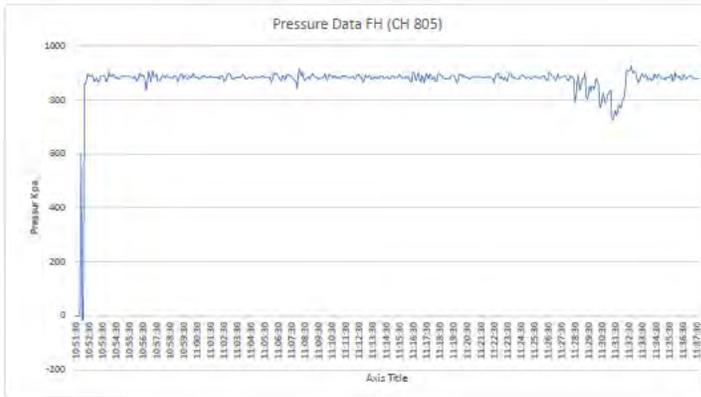
Pressure logger data FH (CH 805)

10:51:30	0
10:51:35	0
10:51:40	0
10:51:45	0
10:51:50	0
10:51:55	600.14
10:52:00	-15.6
10:52:05	-16.08
10:52:10	858.68
10:52:15	858.08
10:52:20	869
10:52:25	894.69
10:52:30	894.57
10:52:35	887.49
10:52:40	887.01
10:52:45	892.65
10:52:50	880.17
10:52:55	867.2
10:53:00	875.73
10:53:05	881.61
10:53:10	866.6
10:53:15	866.48
10:53:20	883.41
10:53:25	889.77
10:53:30	889.53
10:53:35	889.53
10:53:40	889.89
10:53:45	867.2
10:53:50	867.32
10:53:55	883.53
10:54:00	901.37
10:54:05	888.45
10:54:10	888.21
10:54:15	893.01
10:54:20	892.77
10:54:25	879.57
10:54:30	879.93
10:54:35	886.53
10:54:40	881.13
10:54:45	875.73
10:54:50	881.73
10:54:55	888.33
10:55:00	888.09
10:55:05	887.73
10:55:10	887.37
10:55:15	887.13
10:55:20	886.89
10:55:25	886.53
10:55:30	886.17
10:55:35	886.05
10:55:40	885.69
10:55:45	879.81
10:55:50	880.05
10:55:55	887.49
10:56:00	870.32
10:56:05	870.56
10:56:10	881.01
10:56:15	900.81
10:56:20	892.89
10:56:25	887.49
10:56:30	892.89
10:56:35	885.69
10:56:40	870.68
10:56:45	835.76
10:56:50	859.16
10:56:55	907.17
10:57:00	894.09
10:57:05	866.24
10:57:10	899.97
10:57:15	907.41
10:57:20	885.57
10:57:25	885.81
10:57:30	895.89
10:57:35	870.32
10:57:40	870.2
10:57:45	870.32
10:57:50	879.57
10:57:55	885.09
10:58:00	892.41
10:58:05	884.01
10:58:10	884.13
10:58:15	891.21
10:58:20	891.45
10:58:25	882.57
10:58:30	882.21
10:58:35	881.97
10:58:40	881.73
10:58:45	881.49
10:58:50	889.89
10:58:55	890.13
10:59:00	884.13
10:59:05	865.28
10:59:10	877.29
10:59:15	889.77
10:59:20	896.37
10:59:25	896.01
10:59:30	878.37
10:59:35	889.53
10:59:40	889.65
10:59:45	875.97
10:59:50	875.85
10:59:55	888.81
11:00:00	883.17
11:00:05	883.65

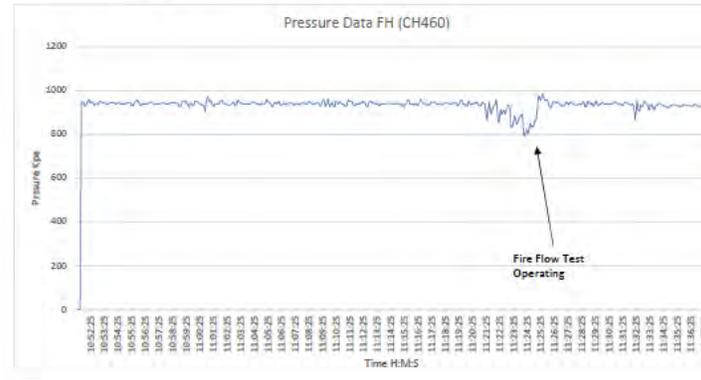
Pressure logger data FH (CH 460)

10:51:30	0
10:51:35	0
10:51:40	0
10:51:45	946.9
10:51:50	946.9
10:51:55	946.66
10:52:00	927.72
10:52:05	933.03
10:52:10	940.51
10:52:15	957.15
10:52:20	956.55
10:52:25	941.84
10:52:30	947.63
10:52:35	947.99
10:52:40	933.87
10:52:45	933.51
10:52:50	941.71
10:52:55	942.08
10:53:00	931.82
10:53:05	945.09
10:53:10	952.81
10:53:15	944.49
10:53:20	944.13
10:53:25	944.13
10:53:30	943.77
10:53:35	936.53
10:53:40	936.17
10:53:45	936.29
10:53:50	945.45
10:53:55	945.57
10:54:00	945.21
10:54:05	944.85
10:54:10	944.61
10:54:15	938.46
10:54:20	938.58
10:54:25	944.37
10:54:30	944.25
10:54:35	938.22
10:54:40	938.34
10:54:45	938.7
10:54:50	939.06
10:54:55	939.3
10:55:00	939.18
10:55:05	938.82
10:55:10	944.37
10:55:15	944.73
10:55:20	944.73
10:55:25	930.5
10:55:30	930.62
10:55:35	930.62
10:55:40	945.57
10:55:45	951.36
10:55:50	956.55
10:55:55	948.83
10:56:00	941.59
10:56:05	932.19
10:56:10	932.31
10:56:15	939.06
10:56:20	939.42
10:56:25	939.42
10:56:30	939.18
10:56:35	939.18
10:56:40	939.54
10:56:45	946.06
10:56:50	946.42
10:56:55	946.66
10:57:00	938.1
10:57:05	932.67
10:57:10	938.1
10:57:15	938.22
10:57:20	938.58
10:57:25	938.94
10:57:30	938.94
10:57:35	938.82
10:57:40	944.61
10:57:45	944.49
10:57:50	944.13
10:57:55	938.34
10:58:00	938.34
10:58:05	938.34
10:58:10	938.58
10:58:15	944.25
10:58:20	944.13
10:58:25	943.77
10:58:30	943.4
10:58:35	943.28
10:58:40	943.04
10:58:45	942.68
10:58:50	942.32
10:58:55	925.55
10:59:00	925.67
10:59:05	932.91
10:59:10	952.81
10:59:15	952.57
10:59:20	952.45
10:59:25	946.18
10:59:30	940.51
10:59:35	933.27
10:59:40	921.57
10:59:45	942.08
10:59:50	942.32
10:59:55	931.46
11:00:00	931.46
11:00:05	948.95

Pressure data FH (CH 805)



Pressure data FH (CH 460)



11:00:10	889.29	11:00:10	949.19
11:00:15	896.61	11:00:15	948.95
11:00:20	883.41	11:00:20	942.56
11:00:25	883.53	11:00:25	942.8
11:00:30	883.77	11:00:30	935.56
11:00:35	883.77	11:00:35	935.2
11:00:40	877.17	11:00:40	934.96
11:00:45	877.05	11:00:45	926.64
11:00:50	883.53	11:00:50	903.72
11:00:55	889.89	11:00:55	944.37
11:01:00	889.89	11:01:00	971.75
11:01:05	889.53	11:01:05	958.24
11:01:10	883.17	11:01:10	946.9
11:01:15	883.41	11:01:15	956.19
11:01:20	883.17	11:01:20	938.82
11:01:25	883.17	11:01:25	928.08
11:01:30	888.45	11:01:30	927.96
11:01:35	883.05	11:01:35	937.13
11:01:40	882.69	11:01:40	937.37
11:01:45	882.57	11:01:45	937.01
11:01:50	882.93	11:01:50	936.89
11:01:55	883.29	11:01:55	948.35
11:02:00	883.41	11:02:00	954.02
11:02:05	883.05	11:02:05	953.78
11:02:10	877.41	11:02:10	940.87
11:02:15	889.05	11:02:15	940.51
11:02:20	889.41	11:02:20	940.15
11:02:25	889.29	11:02:25	934.48
11:02:30	866.12	11:02:30	934.24
11:02:35	877.53	11:02:35	934.6
11:02:40	876.45	11:02:40	934.96
11:02:45	891.09	11:02:45	935.32
11:02:50	898.05	11:02:50	941.35
11:02:55	898.29	11:02:55	947.38
11:03:00	891.09	11:03:00	931.82
11:03:05	878.01	11:03:05	931.82
11:03:10	877.65	11:03:10	941.47
11:03:15	877.53	11:03:15	954.38
11:03:20	883.89	11:03:20	945.7
11:03:25	883.89	11:03:25	945.45
11:03:30	883.65	11:03:30	939.3
11:03:35	883.29	11:03:35	939.42
11:03:40	883.17	11:03:40	939.66
11:03:45	883.41	11:03:45	939.42
11:03:50	889.41	11:03:50	939.06
11:03:55	894.93	11:03:55	939.42
11:04:00	889.29	11:04:00	939.42
11:04:05	878.97	11:04:05	939.06
11:04:10	878.61	11:04:10	939.3
11:04:15	878.61	11:04:15	946.54
11:04:20	884.49	11:04:20	946.3
11:04:25	884.73	11:04:25	945.94
11:04:30	884.73	11:04:30	940.75
11:04:35	879.33	11:04:35	940.51
11:04:40	879.69	11:04:40	940.15
11:04:45	885.45	11:04:45	940.03
11:04:50	885.57	11:04:50	934.36
11:04:55	885.21	11:04:55	934.6
11:05:00	884.85	11:05:00	942.32
11:05:05	884.49	11:05:05	936.17
11:05:10	884.13	11:05:10	936.05
11:05:15	884.13	11:05:15	943.77
11:05:20	889.41	11:05:20	958.96
11:05:25	889.05	11:05:25	950.28
11:05:30	883.53	11:05:30	943.89
11:05:35	883.53	11:05:35	943.64
11:05:40	883.89	11:05:40	934.6
11:05:45	884.13	11:05:45	923.14
11:05:50	884.01	11:05:50	932.79
11:05:55	883.89	11:05:55	944.85
11:06:00	864.32	11:06:00	944.97
11:06:05	873.57	11:06:05	937.61
11:06:10	885.93	11:06:10	945.57
11:06:15	901.53	11:06:15	951.12
11:06:20	896.37	11:06:20	933.99
11:06:25	896.25	11:06:25	934.24
11:06:30	889.05	11:06:30	934.6
11:06:35	882.69	11:06:35	941.35
11:06:40	876.09	11:06:40	935.44
11:06:45	869.96	11:06:45	935.8
11:06:50	888.69	11:06:50	936.17
11:06:55	888.57	11:06:55	941.35
11:07:00	872.85	11:07:00	941.71
11:07:05	880.89	11:07:05	942.08
11:07:10	895.41	11:07:10	941.96
11:07:15	895.17	11:07:15	941.59
11:07:20	889.65	11:07:20	934.48
11:07:25	889.41	11:07:25	934.84
11:07:30	889.17	11:07:30	940.87
11:07:35	877.89	11:07:35	940.99
11:07:40	876.09	11:07:40	934.72
11:07:45	876.21	11:07:45	934.72
11:07:50	866.12	11:07:50	941.11
11:07:55	841.4	11:07:55	941.47
11:08:00	889.05	11:08:00	941.71
11:08:05	915.94	11:08:05	941.47
11:08:10	900.09	11:08:10	941.11
11:08:15	888.57	11:08:15	934.72
11:08:20	903.09	11:08:20	941.84
11:08:25	878.97	11:08:25	949.07
11:08:30	871.29	11:08:30	949.19
11:08:35	876.57	11:08:35	942.08
11:08:40	882.57	11:08:40	936.41
11:08:45	882.57	11:08:45	936.41
11:08:50	874.53	11:08:50	936.17
11:08:55	883.65	11:08:55	942.2
11:09:00	892.89	11:09:00	942.56

11:09:05	898.53	11:09:05	942.44
11:09:10	891.33	11:09:10	942.08
11:09:15	883.77	11:09:15	927.36
11:09:20	883.41	11:09:20	927.48
11:09:25	883.05	11:09:25	948.59
11:09:30	876.21	11:09:30	958.96
11:09:35	876.09	11:09:35	944.85
11:09:40	881.97	11:09:40	924.22
11:09:45	882.09	11:09:45	945.82
11:09:50	882.09	11:09:50	960.77
11:09:55	889.77	11:09:55	933.87
11:10:00	895.41	11:10:00	924.83
11:10:05	876.33	11:10:05	943.04
11:10:10	870.68	11:10:10	942.92
11:10:15	889.89	11:10:15	926.52
11:10:20	895.41	11:10:20	926.52
11:10:25	887.97	11:10:25	949.68
11:10:30	887.85	11:10:30	949.8
11:10:35	881.61	11:10:35	935.68
11:10:40	887.61	11:10:40	943.4
11:10:45	887.25	11:10:45	949.07
11:10:50	880.65	11:10:50	937.49
11:10:55	880.77	11:10:55	937.25
11:11:00	886.77	11:11:00	937.61
11:11:05	881.25	11:11:05	927.12
11:11:10	881.25	11:11:10	927.12
11:11:15	888.57	11:11:15	940.39
11:11:20	888.93	11:11:20	958.48
11:11:25	888.69	11:11:25	951.24
11:11:30	888.33	11:11:30	951
11:11:35	887.97	11:11:35	950.64
11:11:40	882.09	11:11:40	937.85
11:11:45	881.85	11:11:45	931.7
11:11:50	881.97	11:11:50	931.82
11:11:55	881.73	11:11:55	937.25
11:12:00	881.49	11:12:00	937.13
11:12:05	887.85	11:12:05	936.77
11:12:10	876.93	11:12:10	936.77
11:12:15	877.05	11:12:15	943.89
11:12:20	887.01	11:12:20	944.25
11:12:25	893.61	11:12:25	950.04
11:12:30	893.61	11:12:30	942.56
11:12:35	885.69	11:12:35	942.2
11:12:40	885.81	11:12:40	923.86
11:12:45	876.09	11:12:45	924.22
11:12:50	862.76	11:12:50	945.45
11:12:55	878.49	11:12:55	949.68
11:13:00	891.93	11:13:00	949.31
11:13:05	884.37	11:13:05	942.92
11:13:10	884.13	11:13:10	943.04
11:13:15	891.33	11:13:15	943.04
11:13:20	891.69	11:13:20	937.61
11:13:25	875.25	11:13:25	937.61
11:13:30	881.01	11:13:30	937.85
11:13:35	881.01	11:13:35	932.31
11:13:40	886.29	11:13:40	932.43
11:13:45	880.89	11:13:45	939.18
11:13:50	881.25	11:13:50	939.54
11:13:55	881.61	11:13:55	939.66
11:14:00	881.97	11:14:00	939.78
11:14:05	887.37	11:14:05	940.15
11:14:10	887.61	11:14:10	940.51
11:14:15	887.37	11:14:15	940.51
11:14:20	880.89	11:14:20	940.51
11:14:25	880.65	11:14:25	940.51
11:14:30	880.89	11:14:30	940.39
11:14:35	886.89	11:14:35	940.03
11:14:40	886.65	11:14:40	939.66
11:14:45	877.89	11:14:45	939.3
11:14:50	877.89	11:14:50	939.54
11:14:55	883.53	11:14:55	939.91
11:15:00	889.29	11:15:00	940.27
11:15:05	889.05	11:15:05	940.63
11:15:10	882.33	11:15:10	940.87
11:15:15	881.97	11:15:15	935.2
11:15:20	881.61	11:15:20	934.84
11:15:25	886.89	11:15:25	922.05
11:15:30	894.93	11:15:30	934.48
11:15:35	889.05	11:15:35	940.03
11:15:40	881.85	11:15:40	956.79
11:15:45	881.73	11:15:45	956.67
11:15:50	881.37	11:15:50	938.7
11:15:55	881.13	11:15:55	938.94
11:16:00	887.25	11:16:00	939.3
11:16:05	887.61	11:16:05	939.06
11:16:10	881.13	11:16:10	931.58
11:16:15	881.25	11:16:15	937.01
11:16:20	866.84	11:16:20	937.13
11:16:25	867.8	11:16:25	930.62
11:16:30	903.45	11:16:30	936.53
11:16:35	901.05	11:16:35	952.93
11:16:40	881.01	11:16:40	958.72
11:16:45	872.01	11:16:45	942.68
11:16:50	895.17	11:16:50	942.32
11:16:55	902.61	11:16:55	942.44
11:17:00	874.29	11:17:00	934.84
11:17:05	865.88	11:17:05	934.48
11:17:10	890.25	11:17:10	934.24
11:17:15	883.53	11:17:15	934.24
11:17:20	863.12	11:17:20	939.54
11:17:25	878.13	11:17:25	945.82
11:17:30	897.21	11:17:30	946.18
11:17:35	889.41	11:17:35	946.3
11:17:40	876.93	11:17:40	946.3
11:17:45	893.13	11:17:45	940.03
11:17:50	893.01	11:17:50	934.48
11:17:55	877.05	11:17:55	940.27

11:18:00	877.29	11:18:00	940.51
11:18:05	886.89	11:18:05	934.84
11:18:10	867.56	11:18:10	934.6
11:18:15	867.92	11:18:15	934.96
11:18:20	893.37	11:18:20	941.71
11:18:25	901.05	11:18:25	942.08
11:18:30	894.81	11:18:30	942.44
11:18:35	889.41	11:18:35	942.56
11:18:40	889.77	11:18:40	942.2
11:18:45	879.21	11:18:45	941.84
11:18:50	878.85	11:18:50	936.05
11:18:55	878.61	11:18:55	936.17
11:19:00	878.85	11:19:00	942.8
11:19:05	878.85	11:19:05	942.92
11:19:10	878.61	11:19:10	942.68
11:19:15	878.85	11:19:15	942.44
11:19:20	890.73	11:19:20	929.41
11:19:25	890.97	11:19:25	929.41
11:19:30	891.33	11:19:30	949.31
11:19:35	885.93	11:19:35	956.79
11:19:40	878.49	11:19:40	956.43
11:19:45	864.2	11:19:45	938.58
11:19:50	870.56	11:19:50	938.94
11:19:55	895.05	11:19:55	932.79
11:20:00	893.97	11:20:00	926.88
11:20:05	893.61	11:20:05	935.92
11:20:10	885.45	11:20:10	950.88
11:20:15	891.57	11:20:15	939.42
11:20:20	885.09	11:20:20	933.39
11:20:25	884.73	11:20:25	940.03
11:20:30	884.37	11:20:30	940.39
11:20:35	884.25	11:20:35	940.75
11:20:40	876.81	11:20:40	946.54
11:20:45	876.81	11:20:45	946.18
11:20:50	885.33	11:20:50	937.49
11:20:55	885.69	11:20:55	928.81
11:21:00	885.45	11:21:00	928.45
11:21:05	885.33	11:21:05	940.39
11:21:10	885.57	11:21:10	946.42
11:21:15	885.81	11:21:15	938.94
11:21:20	885.57	11:21:20	938.94
11:21:25	885.45	11:21:25	894.19
11:21:30	885.33	11:21:30	862.71
11:21:35	885.09	11:21:35	912.4
11:21:40	884.73	11:21:40	944.85
11:21:45	884.37	11:21:45	902.03
11:21:50	884.01	11:21:50	893.47
11:21:55	884.25	11:21:55	918.43
11:22:00	884.61	11:22:00	933.75
11:22:05	884.97	11:22:05	933.87
11:22:10	885.33	11:22:10	956.55
11:22:15	885.33	11:22:15	917.83
11:22:20	878.97	11:22:20	853.54
11:22:25	878.61	11:22:25	865
11:22:30	862.04	11:22:30	909.99
11:22:35	881.25	11:22:35	890.93
11:22:40	893.01	11:22:40	902.15
11:22:45	898.17	11:22:45	909.99
11:22:50	898.29	11:22:50	892.5
11:22:55	880.77	11:22:55	906.97
11:23:00	881.13	11:23:00	933.75
11:23:05	886.65	11:23:05	933.75
11:23:10	881.25	11:23:10	918.55
11:23:15	873.93	11:23:15	834.96
11:23:20	883.29	11:23:20	829.65
11:23:25	875.37	11:23:25	851.25
11:23:30	869.12	11:23:30	883.57
11:23:35	884.13	11:23:35	869.34
11:23:40	900.45	11:23:40	844.37
11:23:45	900.57	11:23:45	854.62
11:23:50	884.97	11:23:50	871.03
11:23:55	884.85	11:23:55	878.99
11:24:00	885.21	11:24:00	886.35
11:24:05	876.57	11:24:05	891.9
11:24:10	876.33	11:24:10	799.26
11:24:15	876.33	11:24:15	791.3
11:24:20	876.57	11:24:20	802.76
11:24:25	882.21	11:24:25	823.14
11:24:30	891.57	11:24:30	803.12
11:24:35	891.93	11:24:35	815.18
11:24:40	891.93	11:24:40	849.32
11:24:45	885.33	11:24:45	834.72
11:24:50	879.09	11:24:50	834.48
11:24:55	878.97	11:24:55	841.6
11:25:00	885.57	11:25:00	862.71
11:25:05	885.45	11:25:05	863.07
11:25:10	879.21	11:25:10	902.03
11:25:15	879.09	11:25:15	969.7
11:25:20	879.45	11:25:20	975.01
11:25:25	886.17	11:25:25	955.35
11:25:30	886.53	11:25:30	969.22
11:25:35	886.89	11:25:35	985.38
11:25:40	886.65	11:25:40	965.6
11:25:45	881.37	11:25:45	956.19
11:25:50	881.37	11:25:50	956.43
11:25:55	881.01	11:25:55	956.79
11:26:00	880.89	11:26:00	941.96
11:26:05	888.09	11:26:05	925.07
11:26:10	887.85	11:26:10	919.76
11:26:15	887.49	11:26:15	934.12
11:26:20	879.57	11:26:20	948.59
11:26:25	871.53	11:26:25	948.95
11:26:30	871.65	11:26:30	943.16
11:26:35	900.45	11:26:35	943.04
11:26:40	900.21	11:26:40	948.83
11:26:45	893.73	11:26:45	942.32
11:26:50	885.21	11:26:50	934.24

11:26:55	885.33	11:26:55	934.12
11:27:00	876.57	11:27:00	934.48
11:27:05	870.8	11:27:05	927.36
11:27:10	882.09	11:27:10	927
11:27:15	897.33	11:27:15	940.27
11:27:20	880.41	11:27:20	945.94
11:27:25	880.05	11:27:25	940.15
11:27:30	885.21	11:27:30	934.84
11:27:35	885.57	11:27:35	947.02
11:27:40	885.93	11:27:40	947.38
11:27:45	891.21	11:27:45	939.91
11:27:50	885.81	11:27:50	934.12
11:27:55	876.81	11:27:55	934.48
11:28:00	870.2	11:28:00	934.72
11:28:05	877.29	11:28:05	934.36
11:28:10	887.49	11:28:10	934.24
11:28:15	887.73	11:28:15	940.03
11:28:20	881.49	11:28:20	939.91
11:28:25	881.61	11:28:25	934.36
11:28:30	790.99	11:28:30	943.04
11:28:35	808.51	11:28:35	949.19
11:28:40	865.4	11:28:40	923.86
11:28:45	889.89	11:28:45	924.22
11:28:50	836.84	11:28:50	951
11:28:55	840.08	11:28:55	951.36
11:29:00	864.56	11:29:00	942.44
11:29:05	879.81	11:29:05	937.25
11:29:10	879.69	11:29:10	943.52
11:29:15	903.57	11:29:15	935.08
11:29:20	813.43	11:29:20	927.24
11:29:25	803.95	11:29:25	940.75
11:29:30	816.55	11:29:30	952.69
11:29:35	849.68	11:29:35	935.56
11:29:40	829.16	11:29:40	930.13
11:29:45	849.8	11:29:45	936.65
11:29:50	849.8	11:29:50	937.01
11:29:55	839.12	11:29:55	944.25
11:30:00	853.16	11:30:00	944.61
11:30:05	880.05	11:30:05	938.1
11:30:10	867.2	11:30:10	937.73
11:30:15	861.68	11:30:15	937.73
11:30:20	772.86	11:30:20	937.85
11:30:25	769.74	11:30:25	937.49
11:30:30	800.59	11:30:30	937.13
11:30:35	824.59	11:30:35	936.77
11:30:40	807.19	11:30:40	936.77
11:30:45	786.07	11:30:45	944.13
11:30:50	791.71	11:30:50	949.43
11:30:55	818.35	11:30:55	942.92
11:31:00	818.71	11:31:00	942.56
11:31:05	833.12	11:31:05	942.2
11:31:10	833	11:31:10	936.05
11:31:15	732.05	11:31:15	936.05
11:31:20	724.49	11:31:20	935.92
11:31:25	744.42	11:31:25	930.5
11:31:30	762.18	11:31:30	937.49
11:31:35	744.18	11:31:35	945.57
11:31:40	752.7	11:31:40	945.82
11:31:45	782.58	11:31:45	940.39
11:31:50	775.02	11:31:50	940.51
11:31:55	769.02	11:31:55	940.51
11:32:00	791.23	11:32:00	933.51
11:32:05	805.51	11:32:05	933.51
11:32:10	810.79	11:32:10	939.91
11:32:15	855.68	11:32:15	926.88
11:32:20	911.25	11:32:20	866.81
11:32:25	905.49	11:32:25	906.25
11:32:30	906.33	11:32:30	952.57
11:32:35	906.45	11:32:35	912.52
11:32:40	925.78	11:32:40	905.65
11:32:45	907.17	11:32:45	935.32
11:32:50	897.93	11:32:50	926.52
11:32:55	908.01	11:32:55	927.36
11:33:00	902.61	11:33:00	949.07
11:33:05	881.73	11:33:05	948.71
11:33:10	865.28	11:33:10	942.2
11:33:15	865.16	11:33:15	931.34
11:33:20	880.41	11:33:20	913.85
11:33:25	890.01	11:33:25	913.49
11:33:30	895.53	11:33:30	935.92
11:33:35	884.73	11:33:35	935.92
11:33:40	884.97	11:33:40	919.64
11:33:45	895.29	11:33:45	910.71
11:33:50	886.53	11:33:50	929.89
11:33:55	873.57	11:33:55	929.77
11:34:00	879.93	11:34:00	935.2
11:34:05	880.05	11:34:05	941.11
11:34:10	871.17	11:34:10	941.23
11:34:15	871.65	11:34:15	932.91
11:34:20	886.89	11:34:20	932.55
11:34:25	894.21	11:34:25	927.24
11:34:30	881.85	11:34:30	927.48
11:34:35	881.61	11:34:35	927.84
11:34:40	893.13	11:34:40	927.72
11:34:45	893.37	11:34:45	921.33
11:34:50	880.89	11:34:50	921.57
11:34:55	880.53	11:34:55	927.48
11:35:00	880.89	11:35:00	934.6
11:35:05	880.77	11:35:05	934.96
11:35:10	874.05	11:35:10	935.2
11:35:15	882.33	11:35:15	934.84
11:35:20	882.69	11:35:20	934.48
11:35:25	882.69	11:35:25	929.17
11:35:30	882.45	11:35:30	929.05
11:35:35	888.69	11:35:35	928.69
11:35:40	894.09	11:35:40	923.38
11:35:45	869.6	11:35:45	929.17

11:35:50	869.6	11:35:50	929.53
11:35:55	901.77	11:35:55	935.68
11:36:00	891.45	11:36:00	935.32
11:36:05	884.13	11:36:05	934.96
11:36:10	884.13	11:36:10	928.81
11:36:15	889.41	11:36:15	928.45
11:36:20	875.37	11:36:20	928.2
11:36:25	874.53	11:36:25	928.33
11:36:30	890.97	11:36:30	927.96
11:36:35	892.53	11:36:35	927.72
11:36:40	876.93	11:36:40	935.56
11:36:45	876.69	11:36:45	935.92
11:36:50	884.49	11:36:50	935.68
11:36:55	884.49	11:36:55	929.29
11:37:00	890.13	11:37:00	929.29
11:37:05	890.25	11:37:05	922.66
11:37:10	884.61	11:37:10	922.29
11:37:15	879.21	11:37:15	930.26
11:37:20	879.57	11:37:20	936.17
11:37:25	879.81	11:37:25	930.74
11:37:30	879.57	11:37:30	930.38
11:37:35	879.45	11:37:35	930.74
11:37:40	879.09		
11:37:45	879.33		
11:37:50	891.21		
11:37:55	891.45		
11:38:00	885.81		
11:38:05	885.57		
11:38:10	880.53		
11:38:15	880.53		
11:38:20	880.53		
11:38:25	880.29		
11:38:30	874.17		
11:38:35	883.65		
11:38:40	891.09		
11:38:45	891.21		
11:38:50	885.57		
11:38:55	885.57		
11:39:00	885.33		
11:39:05	875.73		
11:39:10	875.97		
11:39:15	882.09		
11:39:20	738.17		
11:39:25	828.43		
11:39:30	858.2		
11:39:35	892.77		
11:39:40	847.16		
11:39:45	853.76		
11:39:50	880.05		
11:39:55	870.68		
11:40:00	868.64		
11:40:05	895.41		
11:40:10	890.01		
11:40:15	884.49		
11:40:20	870.08		
11:40:25	851.72		
11:40:30	851.6		
11:40:35	881.25		
11:40:40	875.37		
11:40:45	857.72		
11:40:50	849.56		
11:40:55	869.6		
11:41:00	869.6		
11:41:05	878.49		
11:41:10	878.85		
11:41:15	878.73		
11:41:20	871.41		
11:41:25	871.29		
11:41:30	870.92		
11:41:35	870.8		
11:41:40	870.8		
11:41:45	865.16		
11:41:50	864.8		
11:41:55	864.8		
11:42:00	873.21		
11:42:05	873.57		
11:42:10	879.93		
11:42:15	879.69		
11:42:20	874.05		
11:42:25	873.69		
11:42:30	873.33		
11:42:35	872.97		
11:42:40	865.88		
11:42:45	865.52		
11:42:50	870.8		
11:42:55	876.21		
11:43:00	876.09		
11:43:05	875.85		
11:43:10	875.49		
11:43:15	868.88		
11:43:20	868.64		
11:43:25	868.64		
11:43:30	868.76		
11:43:35	868.4		
11:43:40	868.28		
11:43:45	874.89		
11:43:50	881.25		
11:43:55	875.01		
11:44:00	869.36		
11:44:05	869.48		
11:44:10	862.64		
11:44:15	862.4		
11:44:20	873.33		
11:44:25	873.69		
11:44:30	868.04		
11:44:35	868.16		
11:44:40	875.73		

11:44:45	867.44
11:44:50	867.2
11:44:55	874.89
11:45:00	875.25
11:45:05	869.24
11:45:10	869.12
11:45:15	869.48
11:45:20	869.72
11:45:25	869.48
11:45:30	869.24
11:45:35	869.24
11:45:40	869.36
11:45:45	867.2
11:45:50	866.84
11:45:55	885.21
11:46:00	878.37
11:46:05	878.25
11:46:10	871.17
11:46:15	876.45
11:46:20	864.8
11:46:25	857.72
11:46:30	863.24
11:46:35	878.25
11:46:40	872.85

Residual pressure recordings taken at Development test area 2, following fire flow test.



Location of Pressure loggers and fire flow test sites



19. Annexure D

Mott MacDonald Modelling

2 Assumptions

2.1 Demand Calculations

A demand assessment was provided by the client as summarised in Table 1 below. The detailed calculation is attached in appendix.

Table 1 - Demand Calculation

Hotel Facility (Elevation: RL 368m)	
No. Hotel rooms	380
Maximum people per room	2
Peak daily consumption (l/day/room)	440
Peak water demand (m ³ /day) - room	167.2
Additional demand (conference centre, restaurant, irrigation, etc) (m ³ /day)	205.2
Instantaneous Peak Flow (l/s)	18.9
Residential Development (Elevation: RL 367m)	
No. Primary Dwelling (3 people)	125
No. Secondary Dwelling (2 people)	125
Peak consumption Primary Dwelling (l/day/property)	2,100
Peak consumption Secondary Dwelling (l/day/property)	700
Peak water demand (m ³ /day)	350
Instantaneous Peak Flow (l/s)	26.7

The calculated demand seems conservative when compared to the observed consumption in Queenstown (2000l/property/day) and Lake Hayes (see table below).

Table 2 - Lake Hayes Demands

DMA Zone	Total demand (m ³ /day)	Number of connections	Average demand per connection (l/prop/day)
Shotover Country	374	495	756
Lake Hayes Estate	822	596	1379
Lake Hayes	928	421	2204
Bendeemer	17	13	1308
Terraces	25	9	2778
DMAs Combined	2,166	1,534	1,412

As shown in the table above, the proposed development peak day demand is equivalent to a third of the current peak day demand in the entire service area.

2.2 Proposed Connection Point

The minimum and maximum elevations within the proposed development areas of the lots are shown in the table below:

Table 3 - Proposed Development Elevations

	Min elevation in proposed development area	Max elevation in proposed development area
Hotel Development	347.5m (with 4 story hotel building ~12.8m height)	368m (with single story building only)
Residential Development		342m
		367m

Overall, the maximum elevation within the lot proposed for the residential development is 423m.

As suggested by the developer, it was assumed that the proposed development would be connected to the 235 mm ID main at the Arrowtown-Lake Hayes Rd and Speargrass Flat Rd junction. Figure 2 below shows the development location, and the proposed network and connection point considered in this study.



Figure 2 – Proposed Development Location, Network and Connection Point

3 Scenario Investigated

Three scenarios were investigated, including the above demand and the current network operations:

- Existing peak day scenario.
- 2028 peak day scenario.
- 2058 peak day scenario.

Planned upgrades along Frankton Ladies Mile Highway were included in the future 2028 and 2058 scenarios.

To ensure head losses in the proposed network remain between 1 and 3 m/km (recommended head losses for pipeline design), it was assumed that the proposed development would be serviced through a 260mm (ID) pipe connected to the supply point. The proposed network layout was provided by the client and is attached in appendix.

Two elevation points were included, one for the hotel (max. elevation:368m) and one for the residential development (max. elevation:367m). Respective demands were assigned to each point.

Fire flow capacity was assessed based on FW2 requirement plus sprinklers flow of 16.6l/s, as defined by the client.

4 Model Results

4.1 System Performance Analysis in the Proposed Development

This section describes the results of the system performance analysis undertaken for the above scenarios after including the proposed development demands. Results have been analysed to verify whether levels of service can be met in the proposed development without any network modification. The table below summarises the results in terms of minimum and maximum pressure, maximum head losses in the proposed network (260mm pipe) and fire flow capacity.

Table 4 - Minimum Pressure and Maximum Head Losses in Proposed Development

Scenario	Minimum Pressure (m)	Maximum Pressure (m)	Maximum Head Losses (m/km)	Fire Flow
Existing	60.9	97.1	3.0	Can meet residential fire flow (FW2 –25 l/s + 16.6l/s sprinklers flow)
2028	59.9	97.1		
2058	58.0	97.0		

The normal operating pressure set by QLDC addendum to NZS4404:2004 (Development and Subdivision Engineering Standards) is 30 to 90m. As shown in the table above, minimum pressure in the proposed development is predicted to meet the recommended LOS for all scenarios. However, pressures higher than the recommended LOS are predicted in areas below 349m.

FW2 fire flow was tested at the end of the proposed 260mm (ID) line. The model predicts that residential fireflow (FW2 – 25l/s) plus the sprinkler flow required can be provided with a residual pressure of 47m at RL 368m.

The highest elevation that would be serviceable for the residential development is 395m. Recommended LOS in terms of pressure and fire flow are predicted to be met up to this point.

4.2 System Performance Analysis in the Remaining of the Network

The section below describes the results of the system performance in the remaining of the Lake Hayes network. Results have been analysed to assess the effect of the proposed development for each scenario.

Figure 3 to **Figure 8** below show the system performance for current operational conditions, including current, 2028 and 2058 peak demand.

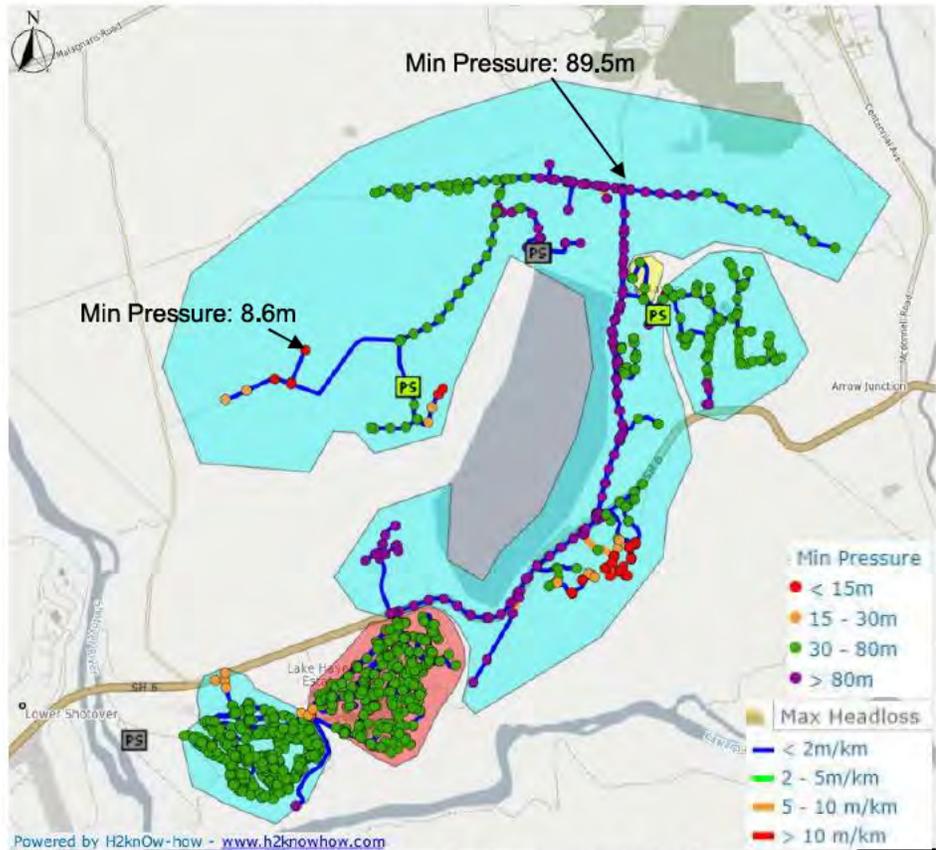


Figure 3 – Current Peak Day System Performance – Prior Development

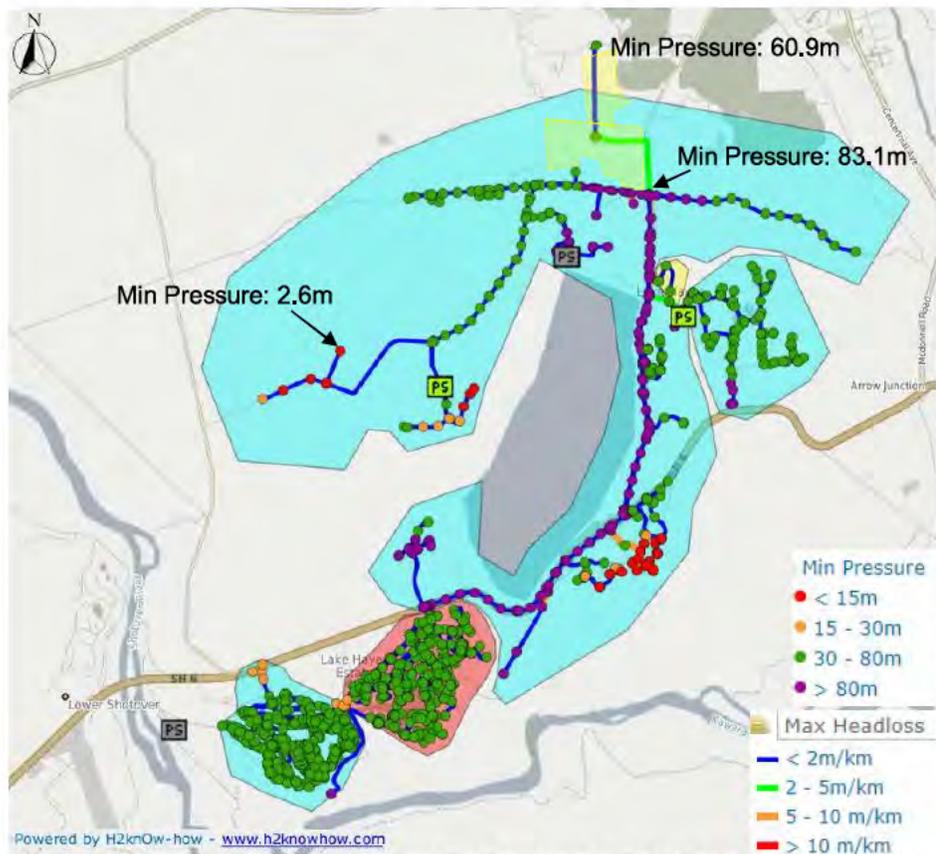


Figure 4 – Current Peak Day System Performance - Post Development

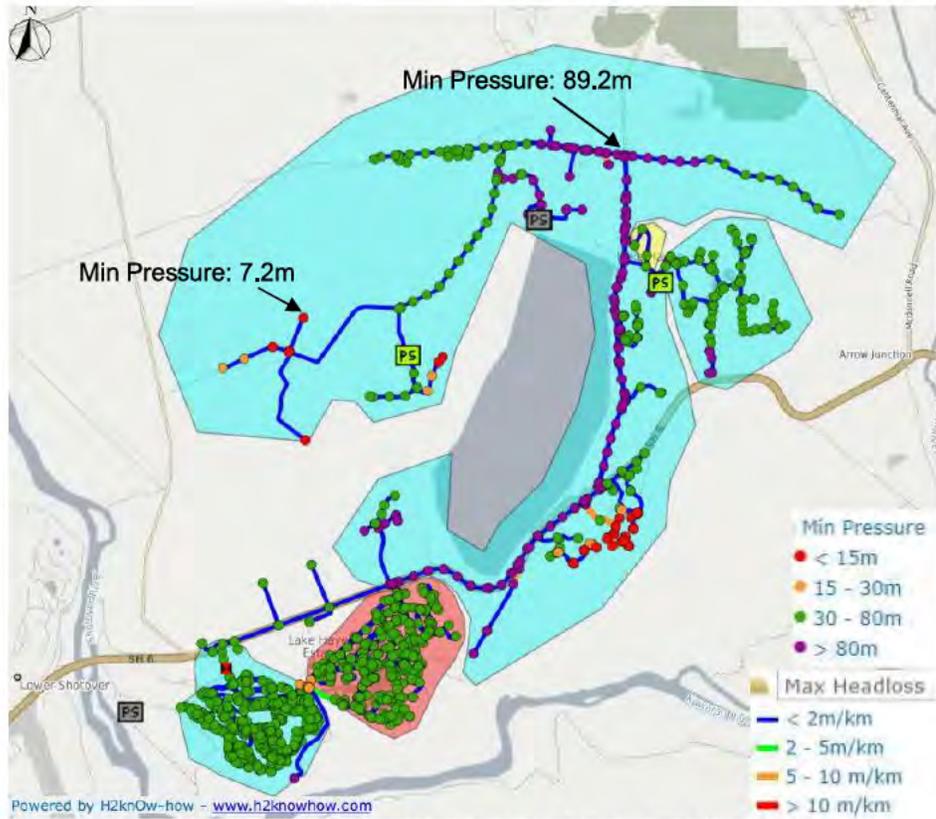


Figure 5 - 2028 Peak Day System Performance - Prior Development

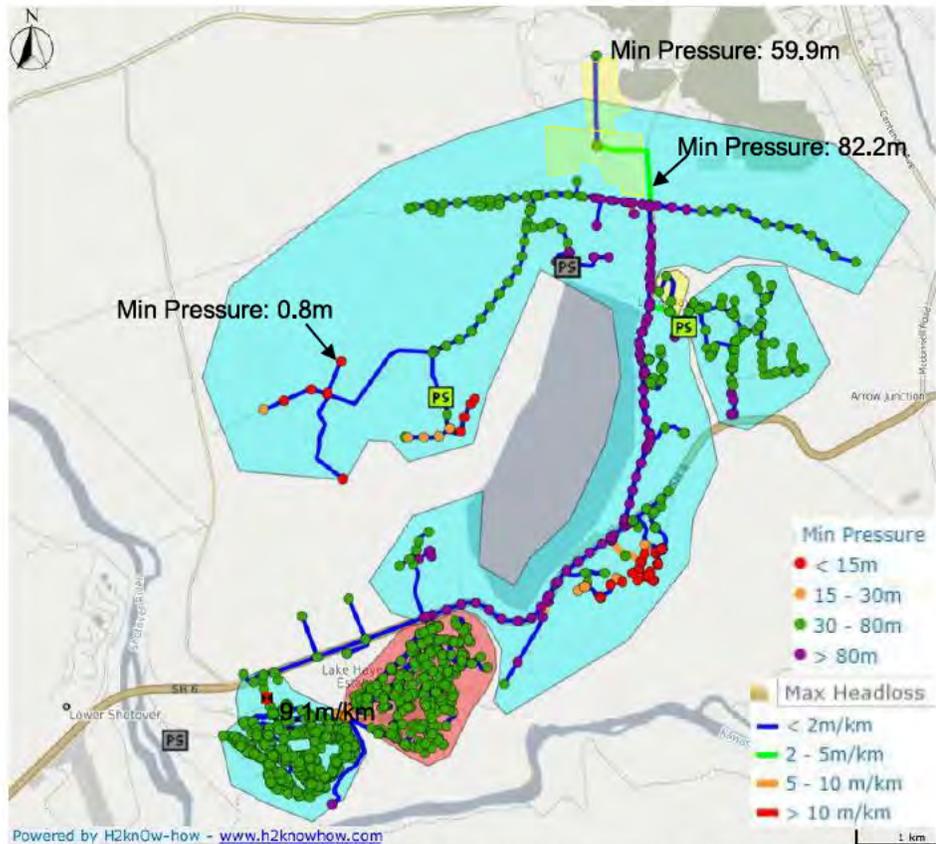


Figure 6 - 2028 Peak Day System Performance - Post Development

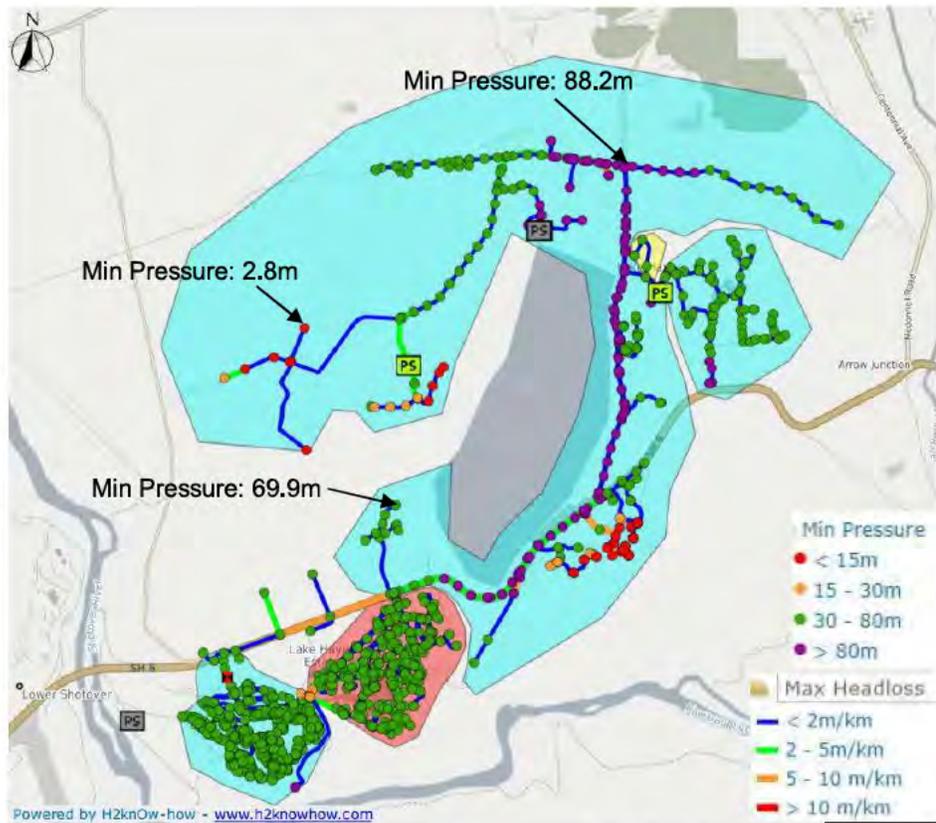


Figure 7 - 2058 Peak Day System Performance - Prior Development

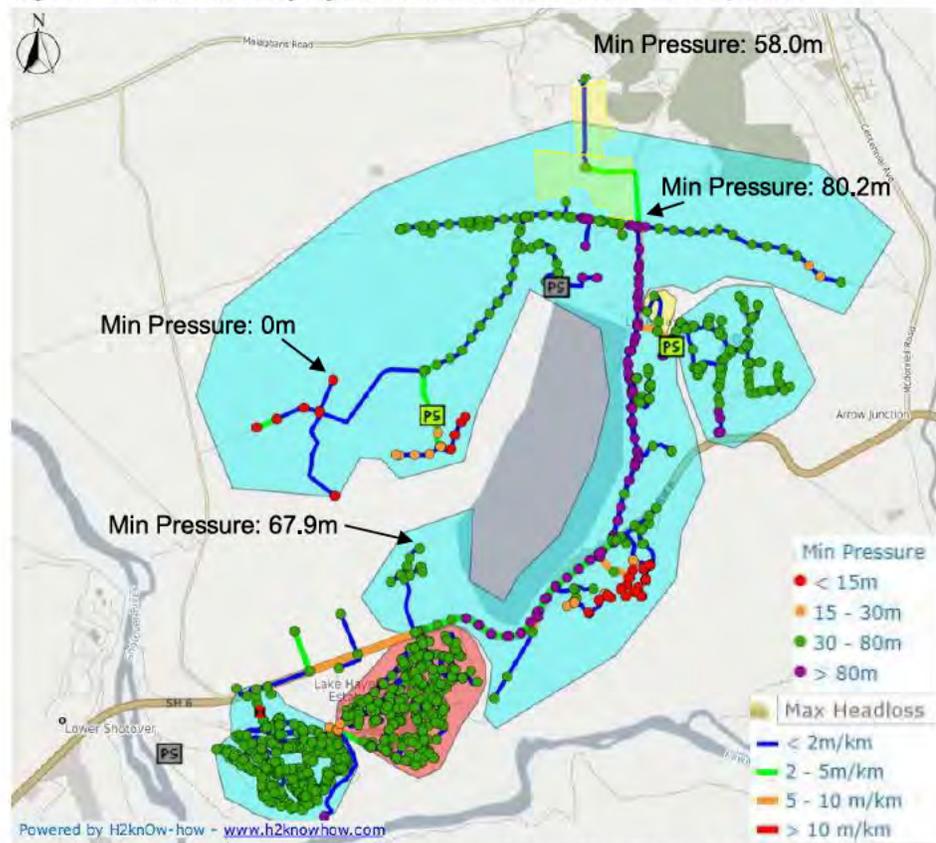


Figure 8 - 2058 Peak Day System Performance - Post Development

The table below summarises the maximum head losses in the existing 235mm ID pipe along Arrowtown Lake Hayes Rd and the minimum pressure forecasted at the supply point, before and after the proposed development:

Table 5 - Minimum Pressure at Supply Point

Demand	Min pressure before development (m)	Min pressure after development (m)	Pressure drop (m)
Current Peak Day	89.5	83.1	6.4
2028 Peak Day	89.2	82.2	7.0
2058 Peak Day	88.2	80.2	8.0

Table 6 - Maximum Head Losses in 235mm ID Pipe

Demand	Max head losses before development (m/km)	Max head losses after development (m/km)	Head losses increase (m/km)
Current Peak Day	0.4	6.0	5.6
2028 Peak Day	0.6	6.6	6.0
2058 Peak Day	1.1	7.8	6.7

As shown in the pictures and above tables, the proposed development is predicted to have a noticeable impact on the remaining of the water network with a maximum pressure drop of 8.0m. Pressures are generally high along Arrowtown Lake Hayes Rd and Speargrass Flat Rd, so pressure remains well above the recommended LOS in this area, for current and future scenarios. However, pressures below the recommended LOS are predicted in the properties located in the elevated areas of Slope Hill Rd and Threewood Rd. This is an existing LOS issue that needs to be addressed.

Head losses are predicted to increase by up to 6.7m/km reaching 7.8m/km in the 235mm (ID) along Arrowtown Lake Hayes Rd due to the additional demand. The predicted head losses exceed the recommended LOS, 5m/km. This LOS issue needs to be addressed.

5 Conclusions and Recommendations

Demand from the proposed Waterfall Park development has been added to the network for the current, future 2028 and 2058 peak day models to determine if suitable levels of service could be obtained.

Levels of service are expected to be met in terms of minimum pressure and head losses in the proposed development, however pressures higher than the recommended LOS are predicted in areas below 349m. The model predicts that fireflow requirements (FW2 – 25l/s and 16.6l/s sprinklers flow) can be provided with a residual pressure of 47m at RL 368m, for current and future scenarios. The highest elevation that would be serviceable for the residential development is 395m.

The system performance in the remaining of the network has been verified. The proposed development is predicted to cause a maximum pressure drop of 8m at the connection point. Since pressures are high in this area recommended LOS can still be met in terms of pressure. However, pressures dropping to zero are predicted in 2058 in properties located in the elevated areas of Slope Hill Rd and Threewood Rd due to the additional demand. These areas already experience pressures below the recommended LOS, the additional demand causes the pressure to deteriorate even further.

Maximum head losses greater than 5 m/km are predicted along Arrowtown Lake Hayes Rd for all scenarios. This system performance issue is related to the additional demand, the proposed development impact needs to be mitigated.

Diana Galindo
Hydraulic Engineer
[REDACTED]

Revision	Date	Originator	Checker	Approver	Description
A	23/02/2018	Diana Galindo	Julie Plessis	Julie Plessis	Draft for client review
B	19/03/2018	Diana Galindo	Julie Plessis	Julie Plessis	Draft for client review
C	30/05/2018	Diana Galindo	Nasrine Tomasi	Nasrine Tomasi	Final

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6 Appendix - Demand Calculation and proposed Pipe Layout

Waterfall Park Water Demand Estimate Summary
Table 1: Waterfall Park Hotel Complex - Water Demand Estimate

Hotel Facility	No. Facilities	Max no. People / Facility	Average Daily Water Demand (L/p/d)	Average Daily Water Demand (m3/day)	Average Daily Water Demand (L/s)	Peak Hour Peaking Factor	Peak Hour Demand (L/s)	Peak Hour Peaking Factor	Peak Hour Demand (L/s)	Peak Day Peaking Factor	Peak Day Demand (L/s)	Comment / Reference
Hotel Room	300	2	220	367.2	1.94	n/a	6.6	12.77	3.30	6.39	AS/NZS 1547:2012, Table H4.	
Conference Centre	1	600	30	38	0.21	5.6	1.38	3.70	0.85	Metcalf and Eddy, Table 3-2. Wedding can occur at some time at conference.		
Restaurants	1	1520	30	45.6	0.53	6.6	3.48	3.30	1.74	AS/NZS 1547:2012, Table H4. Restaurants can seat 270 people. Assume 100% full (700 people) assume each person eats two meals at hotel, total no. diners = 1520 over a day.		
Lounge Bar and bar	1	250	20	5	0.06	6.6	0.38	3.30	0.19	AS/NZS 1547:2012, Table H4. Lounge and bar can accommodate 112 people, assume 250 people max over a day.		
Chapel / wedding venue	1	100	40	4	0.05	6.6	0.31	3.30	0.15	Assume 40L/guest. Wedding can occur at some time at conference.		
Wellness centre - pool, gym, spa	1	100	40	4	0.05	6.6	0.31	3.30	0.15	Metcalf and Eddy Table 3-4 for swimming pools. Assume pool is filled overnight when irrigation is not running.		
Non-residential staff	1	220	30	3.6	0.04	6.6	0.28	3.30	0.14	AS/NZS 1547:2012, Table H4.		
Irrigation demand	1	n/a	n/a	125	1.45	n/a	n/a	n/a	4.35	Based on calculated irrigation requirements with irrigation over an eight hour period overnight.		
Total				372.59	4.31		18.90				13.80	

Table 2: Waterfall Park Residential Development - Water Demand Estimate

Hotel Facility	No. Dwellings	No. people/ dwelling	Average Daily Water Demand (L/p/d)	Average Daily Water Demand (m3/day)	Average Daily Water Demand (L/s)	Peak Hour Peaking Factor	Peak Hour Demand (L/s)	Peak Hour Peaking Factor	Peak Hour Demand (L/s)	Peak Day Peaking Factor	Peak Day Demand (L/s)	Comment / Reference
Primary Dwelling	125	3	700	262.5	3.02	6.6	20.05	3.30	30.03	Total of 225 lots	30.03	Assume each lot may also have a secondary dwelling. Assume average of 2 person occupancy per secondary dwelling, assume no irrigation requirements for secondary dwelling
Secondary Dwelling		2	350	87.5	1.01	6.6	6.68	3.30	3.34		3.34	
Total				350.00	4.05		26.74				13.37	

Notes:
 - Average day to peak hour peaking factor of 6.6 has been applied as per QUDC CoP Section 6.4.5.6
 - The average day to peak day peaking factor is assumed to be 50% of average day to peak hour peaking factor
 - It is assumed that each residential lot may have a primary dwelling and a secondary dwelling

References:
 Metcalf and Eddy, 2003, Wastewater Engineering: Treatment and Reuse, McGraw-Hill
 AS/NZS 1547:2012 - Onsite wastewater management
 QUDC Land Development and Subdivision Code of Practice, 2015

20. Annexure E

Fluent Report 2021

Waterfall Park Developments Ltd

Ayrburn Domain Extension

Water Supply and Wastewater
Infrastructure Assessment

December 2021

Waterfall Park Developments Ltd
Ayrburn Domain Extension
Water Supply and Wastewater Infrastructure Assessment

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Waterfall Park Developments Ltd
Ayrburn Domain Extension
Water Supply and Wastewater Infrastructure Assessment

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APPENDIX A

Wastewater Modelling Report

APPENDIX B

Wastewater Modelling Report Addendum

APPENDIX C

Water Modelling Report

APPENDIX D

Email Correspondence on Fire Fighting Requirements

APPENDIX E

Hydraulic Calculations

1.0 Executive Summary

This report covers a high level three-waters infrastructure overview of the proposed Ayrburn Domain Extension. It finds that all infrastructure requirements for the development can be met by existing and proposed new services.

Wastewater servicing will be met by internal gravity sewer networks that will run to the Ayrburn Domain pump station which then pumps via a rising main to the main Waterfall Park Wastewater Pumping Station (RM 180854). An existing wastewater rising main along Ayr Avenue will convey wastewater from the main Waterfall Park wastewater pumping station to the connection point with the existing sewer reticulation on Arrowtown-Lake Hayes Road. Due to the development staging, Ayrburn Domain is proposed to be constructed prior to construction of the main Waterfall Park wastewater pumping station. If required due to timing, an alternative route to the existing rising main will be used for the Ayrburn Domain Extension buildings until the main Waterfall Park wastewater pumping station is constructed. This alternative route is as approved under EA180584.04.

Water demand can be met by gravity supply from the Lake Hayes scheme via an existing main on Ayr Avenue and an existing connection from this main to the Ayrburn Domain development area.

2.0 Introduction

2.1 General

Fluent Infrastructure Solutions Limited (FS) has been engaged by Waterfall Park Developments Ltd to undertake a water supply and wastewater infrastructure assessment for the proposed Ayrburn Domain Extension.

Infrastructure for the Ayr Avenue and adjacent Waterfall Park Hotel developments were assessed in previous resource consent applications (RM171280 and RM180584), which included the development of the Stables and Annex buildings, Cart Shed and Dairy within the Ayrburn Domain Area.

This report has been prepared to support an application for resource consent for the Ayrburn Domain Extension.

2.2 Site Locality and Features

The Site is located at Ayrburn, between Lakes Hayes and Arrowtown (refer Figure 2.1). It is accessed by William Paterson Close via Arrowtown – Lake Hayes Road and Ayr Avenue.

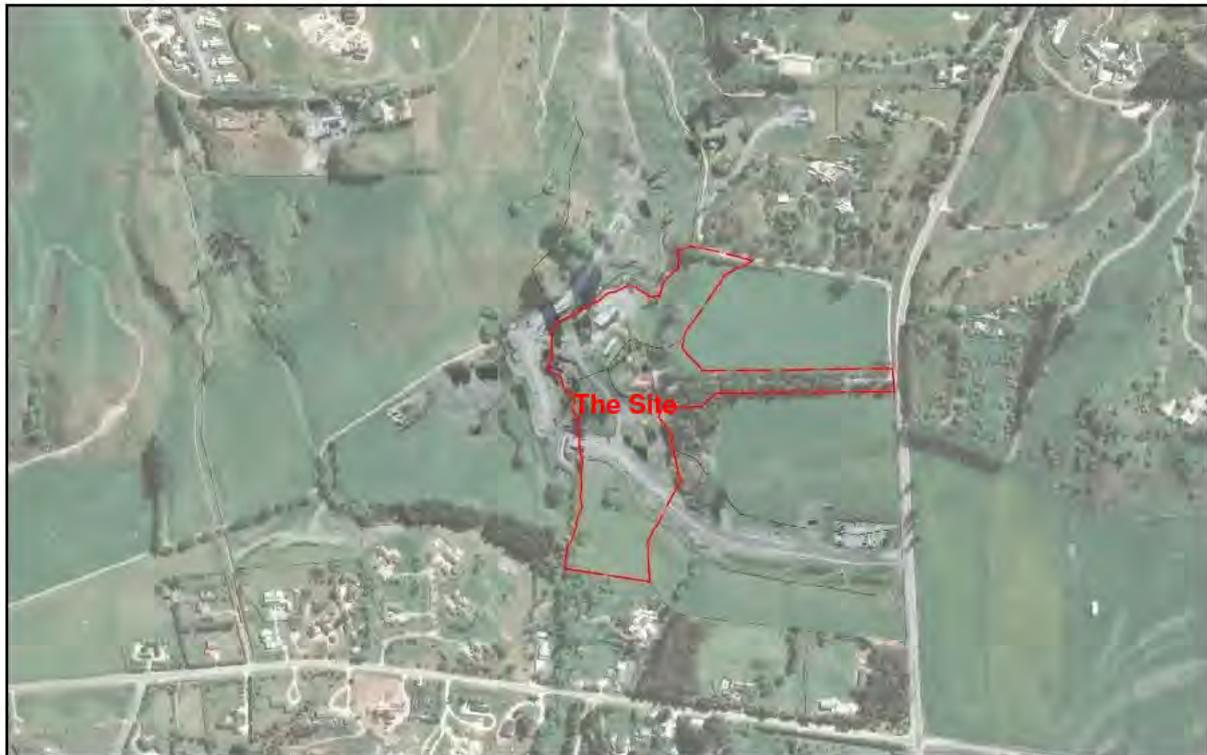


Figure 2.1: Site Location and Features

3.0 The Proposed Development Plan

The proposed development includes an extension to Ayrburn Domain consented under RM180584 (refer Figure 3.1). 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 Ayrburn Domain Extension includes:

1. The adaptive reuse of the Ayrburn Homestead (the Homestead) as a high-end restaurant, and the stone cookhouse (the Cookhouse) as an outdoor bar folly;
2. The construction of a café and office building (the Bakehouse), including the operational management of Ayrburn;
3. Allowance for 12 temporary activities a year including markets and small concerts (e.g.: 2-piece band); and
4. Ancillary activities such as carparking and a sprinkler valve room (SVR).



Figure 3.1: Existing Ayrburn Domain and buildings associated with the Ayrburn Domain Extension

4.0 Wastewater

4.1 Wastewater Collection and Conveyance System Design

The design, sizing, and layout of the wastewater collection and conveyance network to service the proposed Ayrburn Domain extension is related to the population served, the facilities to be provided, and the capacity of the existing QLDC wastewater network. The following aspects have been investigated to assess wastewater collection and conveyance requirements:

- Population (i.e.: the number of patrons of the other proposed facilities);
- Wastewater production – both peak wet weather and peak dry weather;
- Capacity of the existing QLDC infrastructure to convey the wastewater loads; and
- Wastewater pumping requirements.

4.2 Wastewater Flows

The following wastewater design flows have been established for the proposed Ayrburn Domain development as shown in Table 4.1 below.

Table 4.1: Wastewater Design Flows

	No. of Facilities	Max No. of People / Facility / Day	Average Per Capita Daily Wastewater Production (L/p/d)	Daily Wastewater Production (m ³ /d)	Dry Weather Diurnal Peaking Factor	Peak Dry Weather Flow (L/s)	Wet Weather Peaking Factor	Peak Wet Weather Wastewater Flow (L/s)
Ayrburn Domain - Stables Bar & Lounge (Previously consented RM180584)								
Restaurant	1	572	30	17.2	2.5	0.5	2	0.99
Bar	1	52	20	1.0	2.5	0.03	2	0.06
Non-residential Staff	1	19	30	0.6	2.5	0.02	2	0.03
		Sub Total		18.8		0.5		1.1
Ayrburn Domain - Consented Change of Use (RM210591 s95)								
Cart Shed	1	96	20	1.9	2.5	0.06	2	0.11
Dairy	1	48	15	0.7	2.5	0.02	2	0.04
		Sub Total		2.6		0.1		0.2
Ayrburn Extension - Additional Facilities								
The Bakehouse	1	240	20	4.8	2.5	0.14	2	0.28
The Bakehouse (office space)	1	24	35	0.8	2.5	0.02	2	0.05
Homestead	1	504	30	15.1	2.5	0.44	2	0.88
Future Capacity	1	350	30	10.5	2.5	0.30	2	0.61
Non residential staff	1	40	30	1.2	2.5	0.03	2	0.07
Outdoor Events	1	500	0	0.0	2.5	0.00	2	0.00
		Sub Total		32.5		0.9		1.9
Total for Ayrburn Domain				53.9		1.6		3.1

The building occupancies in Table 4.1 above reflect maximum estimated daily wastewater production. For the purpose of a conservative wastewater assessment this takes into consideration the operating hours of these facilities, estimated to be between 12-16 hours each per day.

Average dry weather design flows are estimated to be 15-30 litres per person per day (l/p/d) based on AS/NZS 1547:2012, depending on the type of services provided.

A peaking factor of 2.5 for the dry weather diurnal and a dilution / infiltration factor of 2 for wet weather has been applied.

Outdoor events will be organised with a provision of portable toilets, which will be emptied off site. These events will have no impact on the wastewater network.

4.3 Existing Infrastructure

A 160 OD PE100 PN12.5 wastewater rising main has been installed along Ayr Avenue under RM180584. The connection of the new rising main to the Arrowtown-Lake Hayes Road wastewater trunk main has also been installed (RM180584).

The proposed Waterfall Park Wastewater Pump Station (WP WWPS) will pump wastewater flows from the Waterfall Park and Ayrburn development area into the 160 OD PE100 PN12.5 main, as assessed in RM180584. The previously consented Ayrburn Domain buildings also convey wastewater to the WP WWPS via a 63 OD PE100 PN12.5 main, which has already been approved and installed. A small pump station (Ayrburn Domain WWPS) will be installed to convey the flows from Ayrburn Domain to the WP WWPS. Engineering Acceptance has been obtained for the Ayrburn Domain WWPS (refer RM180584.EA.00.04). The Ayrburn Domain WWPS has not been installed to date however the previously consented Ayrburn Domain buildings are currently under construction at the time of this report.

If required due to the timing of the installation of the main WP WWPS, the Ayrburn Domain WWPS will pump through a temporary rising main which connects directly into the 160 OD PE100 PN12.5 main on Ayr Avenue, shortly before the existing connection to Arrowtown-Lake Hayes Road trunk main. This rising main and temporary connection have received Engineering Acceptance (refer RM180584.EA.00.04) but have not been installed yet.

These features are indicated in Figure 4.1 below.

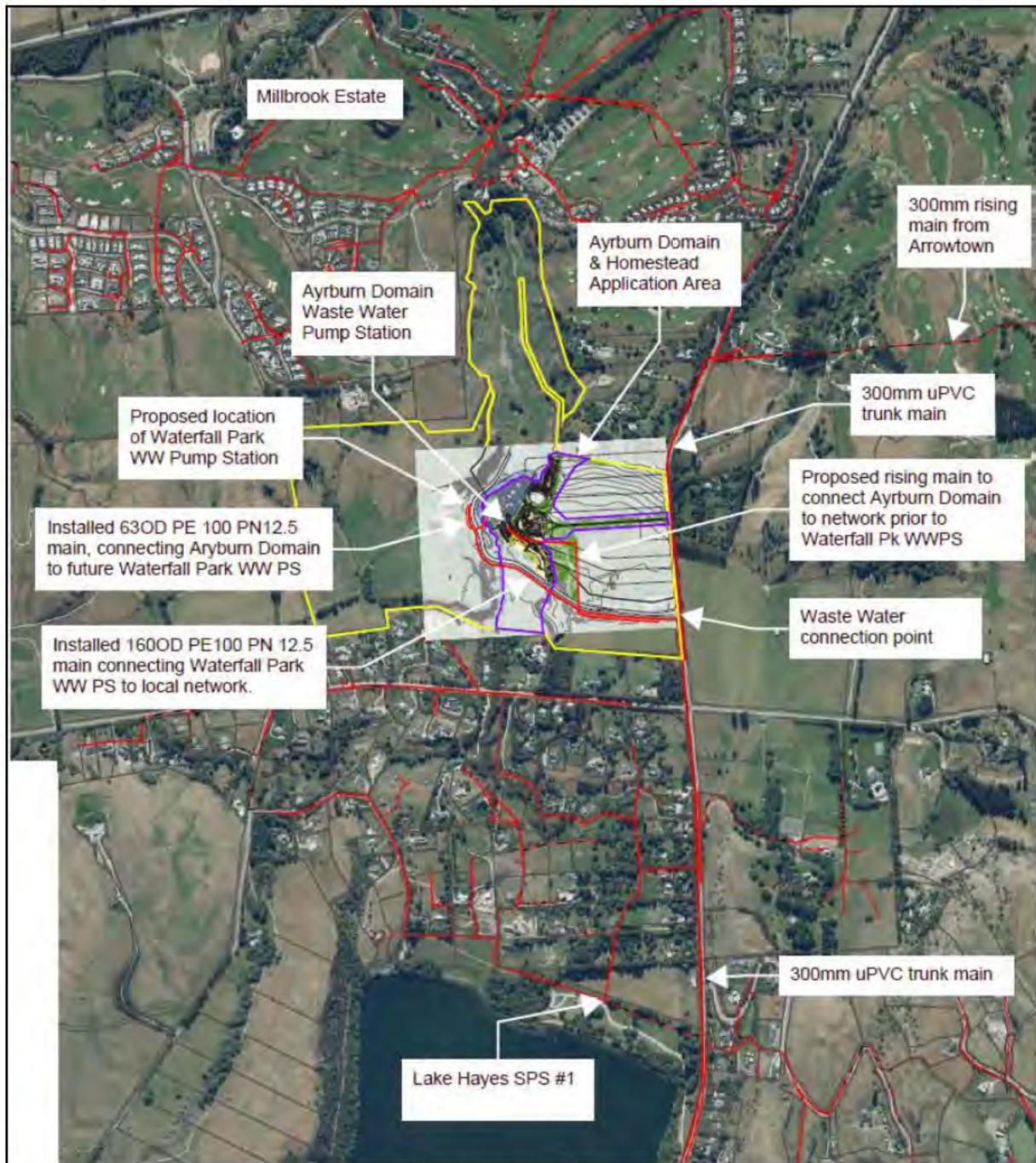


Figure 4.1: Schematic overview of existing sewer services in the vicinity of the Ayrburn Domain and Homestead development with the location of the sewer pump station indicated

4.3.1 Capacity of Existing Infrastructure

The capacity of the existing wastewater infrastructure to convey the additional flows from the proposed Waterfall Park Hotel and an adjacent residential development was modelled by QLDC's modelling consultants, BECA, during February 2018. An addendum to the report was provided by HAL consultants in January 2019. The reports are provided in the Appendices.

At the time of the wastewater modelling, Waterfall Park Developments Ltd was considering a residential development (referred to as Ayrburn Farm). This land is still subject to a rezoning appeal, and a future resource consent application will be required.

The results of the modelling found that the existing 300mm uPVC trunk main, has adequate capacity for the modelled load (23.4 l/s) without the need for any infrastructure upgrades. The breakdown of the wastewater flows by development area differ from those modelled in 2019, however the overall total flows are estimated to remain the same. This is shown in Table 4.2 below.

Table 4.2: Modelled wastewater flows compared to currently proposed wastewater flows

Development Area	Modelled (HAL January 2019)		Proposed Development	
	Peak Daily Volume (m ³)	PWWF (l/s)	Peak Daily Volume (m ³)	PWWF (l/s)
Waterfall Park Hotel	247.4	14.3	247.4	14.3
Ayrburn Domain (consented as part of RM180584)	-	-	18.8	1.1
Ayrburn Domain – change of use buildings			2.6	0.2
Ayrburn Extension – additional facilities	-	-	32.5	1.9
Ayrburn Farm (assessed as residential development)	150.0	9.0	-	-
Additional Future Capacity (subject to future RC application)	-	-	~114.9*	~6.0*
Total	416.2	23.4	416.2	23.4

* Future Capacity will be assessed for Peak Daily Volume and Peak Wet Weather Flow rate but is not currently anticipated to exceed the values indicated.

The proposed development comprises of Waterfall Park Hotel, Ayrburn Domain, the Ayrburn Domain additional facilities and a future development west of Mill Creek.

The current assessment for wastewater flows has retained a total outflow from the site at the modelled peak wet weather flow rate (23.4 l/s), which has previously been accepted by QLDC.

Therefore, the results of the modelling, which found that the existing 300mm uPVC trunk main running along Arrowtown-Lake Hayes Road has adequate capacity for both the current, 2028 and 2058 design horizons, are still applicable.

4.4 Wastewater Servicing for the Proposed Development

4.4 Wastewater Servicing for the Proposed Development

Based on the modelling undertaken and investigations to date, the existing 300mm uPVC trunk main along Arrowtown-Lake Hayes Road has adequate capacity to accept wastewater flows from Ayrburn Domain, the proposed Ayrburn Domain Extension, as well as other Waterfall Park developments. The installed 160 OD PE 100 PN12.5 rising main also has capacity to convey flows from the WP WWPS to the 300 uPVC trunk main in the Arrowtown-Lake Hayes Road.

Within the Ayrburn Domain site, two wastewater sub-catchments are proposed to service the consented and proposed buildings. Both of these sub-catchments will be pumped from two separate pump stations to the main WP WWPS via a 63 OD rising main. A significant portion of this 63 OD main is already installed across the bridge over Mill Creek and along Ayr Avenue.

The two wastewater sub-catchments are proposed to be divided as follows:

- Ayrburn Domain Pump Station Catchment
(Engineering Acceptance provided in RM180584.EA00.05)
 - Stables and annex building (bar, lounge and restaurant)
 - Cart Shed (deli)
 - Dairy (ice cream parlour)
 - Bakehouse (restaurant and office)
- Ayrburn Homestead Pump Station Catchment
 - Homestead Building (restaurant)
 - Additional future capacity

If required prior to the installation of the main WP WWPS, both the Ayrburn Domain WWPS and the Ayrburn Homestead Pump Station will pump through the temporary rising main which connects directly into the 160 OD PE100 PN12.5 main on Ayr Avenue, shortly before the existing connection to Arrowtown-Lake Hayes Road trunk main (refer RM180584.EA.00.04).

5.0 Water Supply

5.1 Water Supply System Design

The design, sizing and layout of the water supply network to service the proposed Ayrburn development is related to the population served, the facilities to be provided and the water required to maintain the site landscaping. The following aspects relating to the water supply have been investigated to assess water supply requirements:

- Population (i.e.: the number of patrons of the proposed facilities);
- Water demands – both peak and fire fighting requirements;
- Water supply availability;
- Water pressure requirements;
- Water storage requirements;
- Landscaping irrigation requirements; and
- Water quality requirements.

5.2 Water Demand Assessment

5.2.1 Domestic and Irrigation Water Demands

Table 5.1 below sets out the assessed water demands for the proposed development. The peaking factors provided in the QLDC COP 2020 have been used for the peak hour water demand.

Building occupancies in Table 5.1 below have been selected to reflect maximum estimated daily water demand. These occupancies may vary from building occupancies relevant to fire safety / vehicle numbers, etc.

Two peaking factor scenarios have been considered:

- Case 1 – peak hour, with controlled irrigation (i.e. daytime peak)
- Case 2 – peak hour (50% domestic peak) plus full irrigation over maximum 12 hours (i.e.: night-time peak)

During the daytime (Case 1), irrigation will be restricted to limited areas of dripline irrigation. Other elements of the irrigation network, such as sprinklers, etc will be controlled such that they do not occur during periods of peak domestic demand.

Case 2 assesses the use of full irrigation on a managed basis over an 8-12 hour period per day, generally overnight and more particularly avoiding peak domestic water demand periods during the day. The domestic peak hour has been reduced by 50% as it considers the night time peak which would be significantly lower than daytime peak.

Table 5.1: Assessed Water Supply Design Volumes and Flows

	No. of Facilities	Max No. of People / Facility / Day	Daily Water Demand (L/p/d)	Peak Daily Water Demand (m ³ /d)	Case 1: daytime peak flow with controlled irrigation		Case 2: nighttime peak flow (50% of daytime peak) with full irrigation	
					Peak Hour Peaking Factor	Peak Hour Demand (L/s)	Peak Hour Peaking Factor	Peak Hour Demand (L/s)
Ayrburn Domain - Stables Bar & Lounge (Previously consented RM180584)								
Restaurant	1	572	30	17.2	6.6	1.3	3.3	0.66
Bar	1	52	20	1.0	6.6	0.08	3.3	0.04
Non-residential Staff	1	19	30	0.6	6.6	0.04	3.3	0.02
Sub Total				18.8		1.4		0.7
Ayrburn Domain - Consented Change of Use (RM210591 s95)								
Cart Shed	1	96	20	1.9	6.6	0.15	3.3	0.07
Dairy	1	48	15	0.7	6.6	0.06	3.3	0.03
Sub Total				2.6		0.2		0.1
Ayrburn Extension - Additional Facilities								
The Bakehouse	1	240	20	4.8	6.6	0.37	3.3	0.18
The Bakehouse (office space)	1	24	35	0.8	6.6	0.06	3.3	0.03
Homestead	1	504	30	15.1	6.6	1.16	3.3	0.58
Future Capacity	2	350	30	21.0	6.6	1.60	3.3	0.80
Non residential staff	2	40	30	2.4	6.6	0.18	3.3	0.09
Outdoor Events	2	500	2	2.0	6.6	0.15	3.3	0.08
Sub Total				46.2		3.5		1.8
Additional Irrigation				130		1.6		6.0
Sub Total				130		1.6		6.0
Total for Additional Water Demand				178.8		5.3		7.9
Total for Ayrburn Domain				197.6		6.7		8.6

Specific irrigation demands are outlined further in Table 5.2 below.

The irrigation demands were provided by the irrigation designer (Waterforce) and were estimated based on an irrigation rate ranging from 3.4-5.5mm/m²/day over the landscaped area, as shown in Table 5.2 below. For Case 2 (night time irrigation), the total period of irrigation is up to 12 hours however each zone operates for less than 12 hours per night.

Any additional irrigation required during the early years of the development for plant establishment has not been included in the overall demand estimates in Table 5.2 as this irrigation will not occur when the buildings are occupied.

Table 5.2: Irrigation Assessment

Irrigation Zone	Landscaped Area (m ²)	Daily Irrigation Rate (avg) (mm / m ² / day)	Irrigation Demand (m ³ /day)	Case 1: Controlled irrigation (day time – drip lines only) (l/s)	Case 2: Full irrigation over 11 hour night time period (l/s)
Flood Plain Area	10,000	4.5	45	0.0	3.1
Lower Domain	9,200	5.0	45	1.1	1.2
Domain Extension	7,300	5.5	40	0.5	1.7
	26,500		130	1.6	6.0

From Tables 5.1 and 5.2, the following water demand requirements (excluding fire fighting) have been established:

- Peak Day Demand 197.6m³/day
- Domestic Peak Hour (daytime only, controlled irrigation) (Case 1) 6.7 l/s
- Domestic Peak Hour (overnight, with irrigation) (Case 2) 8.6 l/s

5.2.2 Fire Fighting Demands

The design of the water supply system is also required to meet the fire fighting flow and pressure requirements of *SNZ PAS 4509 – NZ Fire Service Firefighting Water Supplies Code of Practice 2013*. The fire fighting requirements for each building have been assessed by others. These requirements are summarised in Table 5.3 below.

Facilities that fall under the FW2 water supply classification require a minimum fire fighting supply of a total of 25 l/s from two hydrants, at a minimum pressure of 100kPa. An FW 3 water supply classification requires a building to have a minimum fire fighting supply of a total of 50 l/s from a maximum of three hydrants at a minimum pressure of 100kPa.

Table 5.3: Fire Fighting Requirements of Buildings

Building	Water Supply Classification	Sprinkler Protection
Stables Building	FW2	Yes
Cart Shed	FW2	Yes
Dairy	FW3	No
Homestead Building	FW2	Yes
Bakehouse Building	FW2	Yes
Future Capacity	FW2	Yes

The Fire Engineers, Oceania Fire Protection, identified that the maximum sprinkler demand for any of the buildings will not exceed 800 l/min (13.3 l/s) at a pressure of 300 kPa. A copy of the correspondence is in the Appendices. As the sprinkler system is in addition to the FW2 requirement, the total fire fighting demand of these buildings is estimated to be 38.3 l/s (13.3 l/s + 25 l/s) with a minimum residual pressure of 100kPa at the fire hydrants.

The ability of the existing water supply network to provide these firefighting demands is discussed in Section 5.3 below.

5.3 Existing Water Supply System

Properties south of the Waterfall Park Development area are supplied from the Lake Hayes water storage reservoir, located east of Lake Hayes. The Lake Hayes water storage reservoir has a minimum water level of 435m, compared to building levels of around 347-358m in the Waterfall Park Development area. These levels indicate that there should be adequate pressure available to supply the development from the Lake Hayes reservoir.

The existing water reticulation network in the vicinity of the proposed development is shown in Figure 5.1 below. A 315 OD PE100 PN12.5 water main has been installed along Ayr Avenue to service the consented Waterfall Park Hotel development (RM180584). A connection has been made from QLDC's DN225 water main in the Arrowtown-Lake Hayes Road to the new 315 OD water main in Ayr Ave. A 180 OD PE100 PN12.5 offtake has been installed to service Ayrburn Domain (as part of RM180584). As part of this, a pressure reducing valve has been installed close to the offtake from the 315 OD PE100 PN12.5 water main to account of the slightly higher building elevations on the terrace around the Ayrburn Domain.

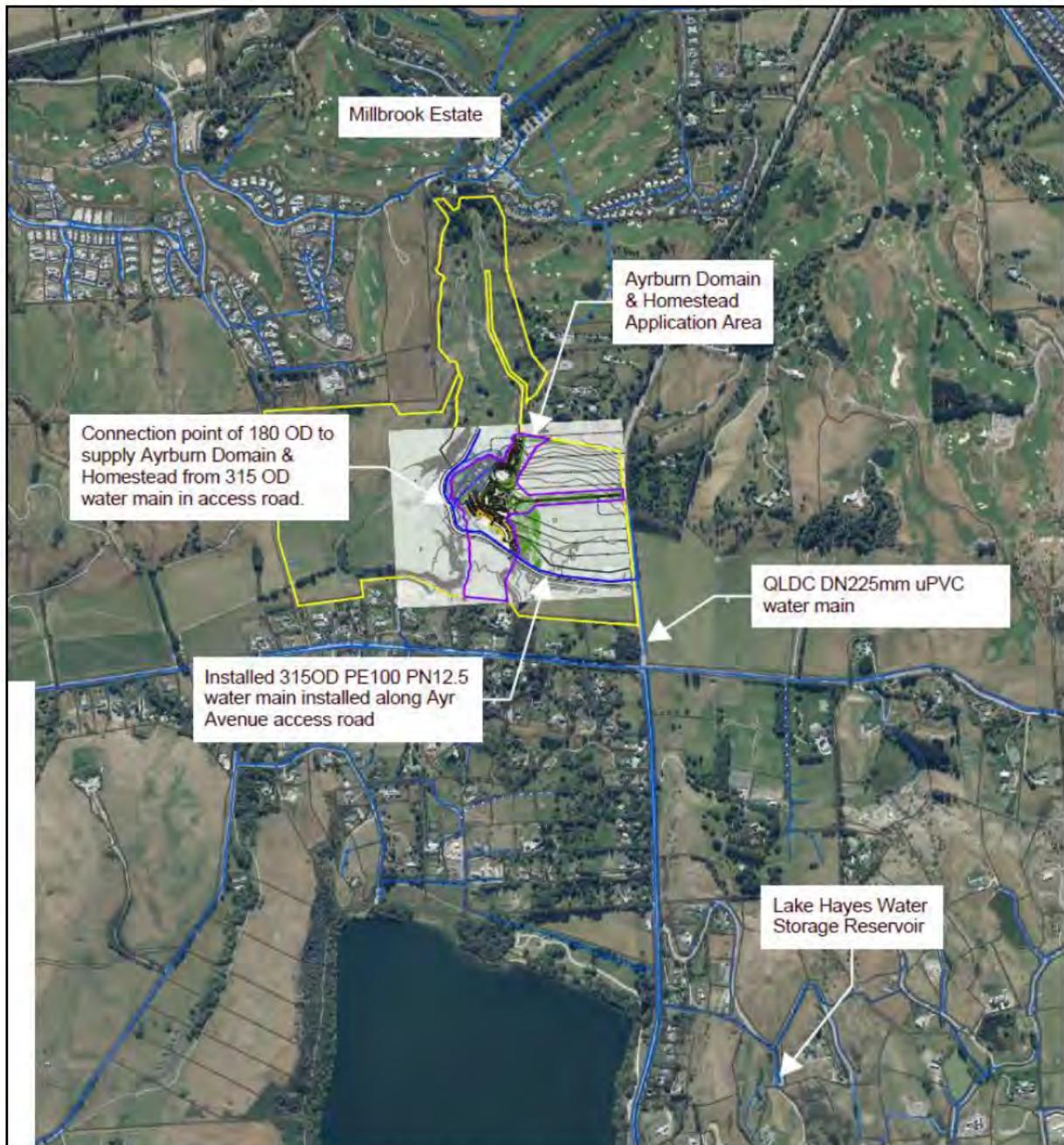


Figure 5.1: Schematic overview of existing water services in the vicinity of Ayrburn Domain Extension Area

5.3.1 Capacity of Existing Infrastructure – Peak Hour Demand

The capacity of the existing water supply infrastructure to service the Waterfall Park Hotel and an adjacent residential development was modelled by QLDC’s modelling consultants, Mott MacDonald, during March and April 2018. Their report is provided in Appendix B.

At the time of the water modelling, Waterfall Park Developments Ltd were considering a residential development, the Ayrburn Farm residential development to the west of Mill Creek. In 2018, Mott Macdonald modelled a combined peak flow of 45 l/s including 18.9 l/s for the Waterfall Park Hotel, 1.4 l/s for Ayrburn Domain and 24.7 l/s for the Ayrburn Farm residential development (refer to Table 5.4 below).

Table 5.4: Summary of peak hour flows modelled by Mott MacDonald in 2018 and updated peak hour flows considering the current Waterfall Park Development.

Development Area	Modelled (Mott McDonald – 2018) Peak Hour (l/s)	Current Proposed Development Peak Hour (l/s)
Waterfall Park Hotel	18.9	18.9
Ayrburn Domain (consented as part of RM180584)	1.4	1.4
Ayrburn Farm – residential	24.7	-
Ayrburn Domain – additional facilities	-	9.5
Subtotal (current proposal):	45.0	29.8
Future Capacity (subject to future RC applications)	-	15.2*
Total	45.0	45.0

* Future Capacity will be assessed for Peak Hour Flow, but is not currently anticipated to exceed the values indicated.

The combined estimated peak hour flows for the proposed Waterfall Park Hotel, Ayrburn Domain and Ayrburn Domain additional facilities is 29.8 l/s. An additional 15.2 l/s is allowed for future capacity. It is not anticipated that the total peak hour water demand for the Waterfall Park development will exceed the 45.0 l/s modelled in 2018.

Due to uncertainty of extent of demand and timing, we have assessed the peak hour demand based on the current proposal; a peak hour demand of 29.8 l/s.

Assessing the peak hour demand of 29.8 l/s does not preclude future resource consent applications to increase the peak hour flow to the previously modelled flows of 45.0 l/s.

The results of the 2018 modelling found that the existing DN225mm mPVC Arrowtown-Lake Hayes Road water main has adequate capacity for the additional demand for both the

Waterfall Park Hotel and proposed residential development (45.0 l/s), for both the current and the 2028 design horizons without the need for any infrastructure upgrades. The modelling also identified high headlosses in the DN225 Arrowtown-Lake Hayes Road water main during the 2058 design horizon that exceeded the QLDC levels of service.

A hydraulic review using the lower peak hour flow rate for the currently proposed peak hour demand of 2938 l/s, has found that the estimated headloss in the DN225 pipe along the Arrowtown-Lake Hayes Road reduces significantly during the 2058 design horizon and only slightly exceeds the QLDC levels of service. This is summarised in Table 5.5 below and the hydraulic calculations are provided in the Appendices.

Table 5.5: Summary of peak hour flows modelled by Mott MacDonald in 2018 and updated peak hour flows considering the proposed Ayrburn Domain Development

	Waterfall Park Hotel Peak Hour (l/s)	Ayrburn Farm Residential Peak Hour (l/s)	Ayrburn Domain Peak Hour (l/s)	Ayrburn Domain Peak Hour (l/s)	Combined Peak Hour Demand (l/s)	2058 Headloss in DN225 (m/km)
Original Flows Modelled by Mott MacDonald – 2018	18.9	24.7	1.4		45	7.8
Updated Flows with Ayrburn Domain	18.9	-	1.4	9.5	29.8	5.1*

**Assuming roughness coefficient k of 0.015mm. Headloss in DN225 is calculated based on Mott Macdonald's predicted 'existing' flows plus the additional flows from the Waterfall Park Hotel and Northbrook Retirement Village.*

The estimated 2058 headloss in the DN225 water main along the Arrowtown Lake Hayes Road is considered to be acceptable due to the high level of uncertainty associated with estimating flows 40 years in the future.

5.4 Water Servicing for the Proposed Development

From the investigations undertaken, it is clear that the existing DN225 mPVC water main in the Arrowtown-Lake Hayes Road and the 315 OD PE100 PN12.5 water main installed in Ayr Avenue to service the consented Waterfall Park Hotel development has adequate capacity to provide the combined demands to the proposed Waterfall Park Hotel, Ayrburn Domain (including the additional facilities) and other future developments.

Water servicing within the proposed Ayrburn Domain area will comprise of conventional water reticulation sized to ensure that domestic, fire, and irrigation flows can be maintained at adequate pressures meeting the QLDC COP.

Pressure reducing of the water supply will be required where it services some of the buildings in Ayrburn Domain as the pressure to these areas of the development has the potential to exceed the QLDC level of service of 90m due to their elevation, especially during periods of low demand. The pressure reducing valve has already been installed as part of the Access Road works.

11. Appendix B

11.1 Cosgroves Confirmation

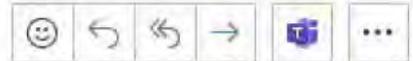
RE: Haybarn Consent - Fire Consultant Input



Martin Robertson <martin.rob@cosgroves.com>

To: Nicola Tristram

Cc: Daniel Jessop; Kylin Gunkel



Mon 22/05

Hi Nicola,

If a sprinkler system is to be installed in the building then the Firefighting Water Supply (FFWS) required is 25 L/s (1500 L/min) from two in ground fire hydrants plus 1000 L/min at 400 kPa for the sprinkler system.

If a sprinkler is not installed then FFWS will be at least FW5 which is 150 L/s (9000 L/min) from up to 6 in ground hydrants.

Regards

Martin Robertson

ASSOCIATE / ENGINEERING LEADER (FIRE) NZCE(Civil)

Auckland • Tauranga • Wellington • Christchurch • Queenstown

M [REDACTED] T [REDACTED]

cosgroves.com





MEMORANDUM

To	Nicola Tristram, Development Manager, Winton [REDACTED]
Project Name	Ayrburn – The Haybarn venue – Resource Consent Application
Date	9 June 2023

Introduction

Origin Consultants Ltd has been instructed by Ayrburn Precinct Ltd, to prepare a memorandum to accompany an application for resource consent for the construction of an events venue and ceremony area, known as ‘the Haybarn venue,’ with associated pedestrian access, on Lot 3 DP540788. Services access will be provided via the existing Homestead driveway.

Various resource consents have been granted for the development of the Lot 1-4 DP 540788 and the adaptive reuse of the historic buildings located within the wider site. Most relevant to this application is RM200791 which granted consent to establish a residential unit on Lot 3 DP540788, subject to design and landscape controls, within an identified residential building platform, with associated access and services.

The following documents have been reviewed by Origin:

- SA Studio, Haybarn Venue for Resource Consent, Revision H, 6 June 2023;
- Paterson Pitts Group, Ayrburn Precinct Ltd Haybarn Venue – Resource Consent Drawings, Revision A, 6 June 2023; and
- Winton, Ayrburn – Haybarn Venue Landscape Drawings, 6 June 2023.

In preparing this memorandum, the letter prepared by Origin Consultants (dated 7 July 2020) for the RM200791 application has also been reviewed.

The comprehensiveness and level of detail in this memorandum has been guided by the level of potential effects of the proposed works on the listed heritage features.

Assessment

Consent is not required under the heritage provisions of the Queenstown Lakes District Council Proposed District Plan (PDP).

No works are proposed to the heritage features themselves. As such, the only rule applicable to the proposed works would be Rule 26.5.9, which refers to the development within the setting or extent of place of a listed heritage feature. ‘Setting’ is defined in the PDP as “the area around and/or adjacent to a [listed] heritage feature... which is integral to its function, meaning, and relationships, and which is contained in the same legal title as the [listed] heritage feature” (emphasis added). ‘Development’ means “new buildings and

structures, earthworks requiring consent under Chapter 25, car park areas exceeding 15m² within the view from a building road, and car park areas exceeding 40m² located elsewhere." This rule does not apply to the use of buildings, structures, and land.

The heritage listing of the site comprises five historic buildings located on Lot 1 DP 540788 (stone farm buildings) and Lot 2 DP 540788 (Homestead and stone cookhouse). The proposed works are located within Lot 3 DP 540788, a different legal title to the listed heritage features. As such, Rule 26.5.9 is not triggered as the application of this rule is restricted to development within the same legal title as a listed heritage feature.

Regardless of the application of Rule 26.5.9, the proposed Haybarn venue is not considered to adversely affect the significant heritage values of the historic buildings that comprise the Ayrburn farmstead. The Ayrburn buildings have significance as a collection of buildings that represent their historic agricultural and residential functions, separated by the topography of the site. The key area of the farmstead is the central farmyard, located near Mill Creek, which would have historically formed the day-to-day hub of the site. The Haybarn venue is located outside this curtilage and does not affect the key connections between the historic buildings. It is also a reasonable distance from the Homestead building, approximately 60 meters. The design, characteristics, and materials of the Haybarn venue and landscaping are also considered to be appropriate within the wider historic environment.



Robin Miller
Director
Chartered & Registered Building Surveyor
RICS Certified Historic Building Professional
LBP Design Level 2 BP 133157



Lucy King
Heritage Consultant/Heritage Planner



For and on behalf of Origin Consultants Ltd

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Ayrburn Precinct Ltd
1 Ayr Avenue
Arrowtown 9371

Ref No: Ayrburn Trees R23.056

7/06/2023

RE: HAYBARN VENUE - ASSESSMENT OF TREES LOCATED WITHIN THE PROPOSED DRIVEWAY AND PEDESTRIAN ACCESS

Further to my site visit on 9 May 2023 to assess the five trees proposed to be removed, my observations and opinions are as follows.

Brief

The purpose of this assessment is to identify and assess five trees within the proposed driveway and pedestrian alignment for the proposed Haybarn venue located within the existing woodland at 339 Arrowtown-Lake Hayes Road, Arrowtown.

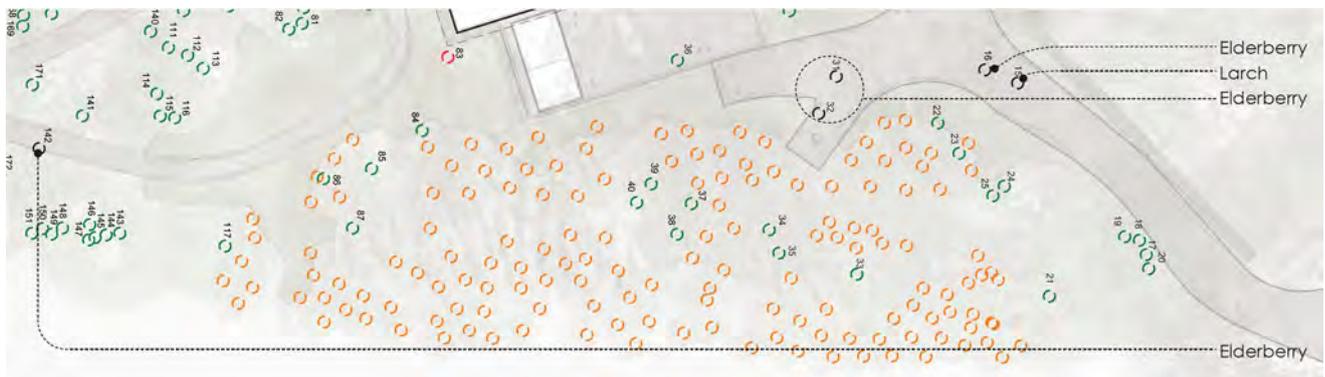
This assessment was carried out following recognized Visual Trees Assessment (VTA) guidelines endorsed by the International Society of Arboriculture (ISA).

Photos of the subject trees are contained within Appendix A of this report.

Tree Survey Plan (refer Landscape Drawings)



Tree Survey Plan locations (enlarged)



Tree Details

Tree 15

Larch (*Larix decidua*)

DBH 700mm, Height 25m

The Larch is a mature specimen, with a pronounced trunk lean to the northeast.

The upper canopy appears to have been damaged and lost at some point. The trunk has a large sweep (bend) with the remaining upper canopy growing into an adjacent Spruce tree.

Tree 16

Elderberry (*Sambucus nigra*)

DBH 250mm, Height 6m

The Elderberry is growing near (T15), causing it to be somewhat suppressed. Canopy has been affected by snow damage in the past.

The tree has developed basal sucker growth to support growth as the tree canopy is essentially in decline.

Tree 31

Elderberry (*Sambucus nigra*)

DBH 300mm, Height 5m

The Elderberry is in a similar state as T16.

Tree 32

Elderberry (*Sambucus nigra*)

DBH 300mm, Height 6m

The tree comprises of one main stem growing at an angle toward the northeast the tree has developed basal sucker growth to support growth.

The tree is going to suppress the canopy growth of the better-quality new plantings of Oak and Cypress.

Tree 142

Elderberry (*Sambucus nigra*)

DBH range 50- 100mm, Height 4m

The tree comprises of multiple stems (7) arising from the base with around 50% of these stems are dead, low value tree of poor general health.

General Comment

The proposed accesses as detailed in Appendix A, have been designed to minimise the impact to remaining Larch & Spruce trees that form the wooded area.

The removal of the Larch (T15) and the three Elderberry trees (T16, T31, T32 & T142) will facilitate the best alignment to provide improved access and provide an all-weather driveway. This will also benefit the

remaining trees by reducing the impact of tree root damage and further soil compaction which can have a long-term benefit on the remaining trees.

The Elderberry (T32) should be removed to allow the more recent quality tree plantings to develop unhampered by the leaning canopy of this tree.

The Elderberry (T142)

Is a low value multi stem tree with around 50% canopy already dead, recommend removal.

All the trees proposed to be removed are not within the avenue of protected trees along the Homestead driveway.

I hope this information is of value to you and should you require any more details please don't hesitate to contact me.

Yours sincerely,

A black rectangular redaction box covering the signature of David Finlin.

David Finlin (Director).
N Z Tree Care Ltd

Appendix A. Tree Photos



Larch tree (T15)



Elderberry tree (T16)



**Elderberry tree
(T31)**



**Elderberry tree
(T32)**



**Elderberry tree
(T142)**

PLEASE NOTE: New Zealand Tree Care Ltd has taken every effort to ensure that all statements in this report are accurate and correct at the time of the assessment. However, trees are a natural, dynamic living entity and as such it is not possible to fully guarantee growth characteristics etc. This report is supplied as guide to the management of the tree. All inspections have taken place from ground level unless advised and no samples have been taken. No internal decay diagnostic equipment was used. All dimensions and tree numbers have been estimated.