Appendix 'I'

Infrastructure Assessment

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THE CLYDE CLAIM LIMITED, HOULAHAN ENTERPRISES LTD, COLIN FOSTER, VICKI GILLIES & OSTEX CORPORATION LTD

REQUEST FOR A CHANGE TO THE OPERATIVE CENTRAL OTAGO DISTRICT PLAN INFRASTRUCTURE REPORT

PROJECT:	Mutton Town Road, Clyde, Request for a Change to the Operative Central Otago District Plan
PRINCIPAL:	The Clyde Claim Ltd, Houlahan Enterprises Ltd, Colin Foster, Vicki Gillies & Ostex Corporation Ltd
OUR REF:	A4702, A4723
DATE:	February 2020

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REVISION / APPROVAL PANEL

Rev:	Date:	Prepared By:	Reviewed By:	Comments:
0	1 Feb 2020	MG	PLD	Initial Draft
1	27.Feb 2020			Final

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Job No:	A4702 & A703
Date	27 February 2020
Report Prepared For	The Clyde Claim Ltd Houlahan Enterprises Ltd Colin Foster, Vicki Gillies & Ostex Corporation Ltd

Contents

1. Scope

Paterson Pitts Limited Partnership (PPLP) has been engaged by The Clyde Claim Ltd, Houlahan Enterprises Ltd, Colin Foster, Vicki Gillies & Ostex Corporation Ltd to provide an infrastructure report to support a private plan change request that seeks to re-zone 13ha of land at Mutton Town Road , Clyde from Rural Residential Resource Area to Residential Resource Area

A total of approximately 150 dwelling units is planned, with the opportunity for a possible retirement village.

This report covers the availability of the following infrastructure elements.

- Wastewater
- Stormwater
- Water Supply – Potable, Firefighting and Irrigation
- Network Utility Services (electricity and telecommunications)
- Road construction

2. Executive Summary

2.1 Stormwater

The site is underlain by a considerable depth of glacial out wash gravels, with depths to groundwater varying from 10-15 metres below ground level. Soakage tests have shown these gravels to be highly permeable. No issues are anticipated with the discharge of stormwater from roading, hand stand and roof-run off direct to ground via suitably designed soak pits, as is the norm for all land development within the Clyde – Alexandra area.

2.2 Wastewater

The Clyde Wastewater Project has been designed to be capable of servicing the site

2.3 Water Supply

Computer modelling of the Clyde water reticulation by Mott MacDonald NZ Ltd shows that the site can be adequately serviced from the existing Clyde town supply.

It is unlikely that any necessary public space irrigation requirements can economically be met by on site groundwater sources (i.e. bore supplies).

2.4 Network Utility Services

Chorus New Zealand Ltd have confirmed that a suitable telecommunications (fibre) supply can be made available to the proposed development of the site.

Aurora Energy Ltd have advised that a suitable power supply can be made available to serve the proposed development of the site

2.5 Road Construction

All roads will be constructed on sand and gravels. Bearing capacity tests on likely road subgrades were well in excess of the minimum requirements. No issues are expected with designing and constructing road pavements in compliance with the procedures of "Austroads" and the subdivisional pavement design standards of the Central Otago District Council. Road cross-section designs and geometry are anticipated to be in accordance with "Austroads" and NZS 4404:2010.

3. Stormwater

There is no reticulated stormwater system in the Clyde area.

Analysis of drill hole logs in the locality show that the site is underlain by a considerable depth of glacial outwash sand and gravel with depth to groundwater between 10-15 metres below the ground surface. Test pitting by Paterson Pitts shows near surface topology to be 0.2m of topsoil over outwash sands and gravel, down to the 5.0m depth of all test pits.

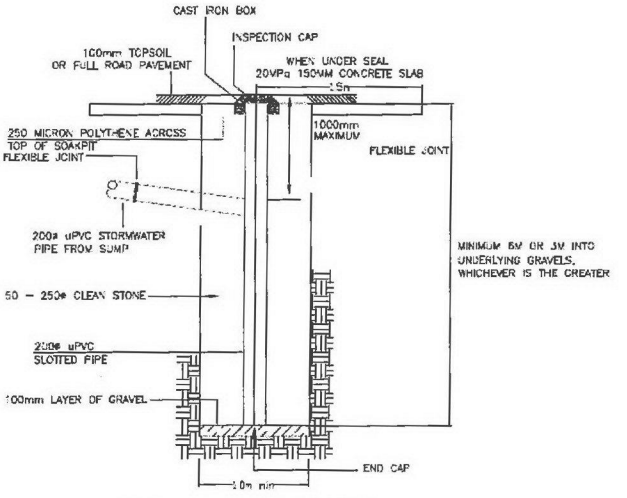
A location plan and test pit logs are attached in **Appendix (A).** Test pitting did not include Lot 1 DP525753 & Lot 2 DP 331535 because, at the time, the Requestors had not taken possession of the property. However, it is unlikely that ground conditions will differ in any material way from Lot 2 DP 525753 and Lot 2 DP 18990, albeit that there is a thin layer of imported topsoil over Lot 2 DP 331535 (see appended PSI/DSI)

Soakage tests were carried out on TP's 1, 3, 6 & 10. Infiltration rates of 5182mm/hr (1.44 litres/sec/m^2), 3069mm/hr (0.85 litres/sec/m^2), 6130mm/hr (1.75 litres/sec/m^2) & 3695mm/hr (1.03 litres/sec/m^2) respectively were recorded. This equates to an average soakage rate of a "Cauldwell" type soak pit of 25 litres/sec.

The NIWA HIRDS program was used to calculate a 2% Annual Exceeding Probability (AEP) short duration rainfall event of 56mm/hr using a 2 deg temperature risk factor to allow for climate change. This means that every 200m of an 8m wide road carriageway will be able to be drained by a single "Caudwell" type soak pit.

This is a very conservative assessment as Council's Engineering Standards require a pair of sumps to drain each 90m length of road. Soakage tests, infiltration calculations and rainfall intensity calculations are attached in **Appendix (B)**

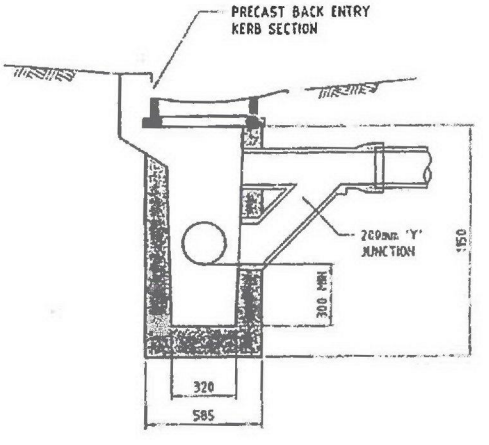
Direct discharge to ground for stormwater from roading, impermeable surfaces and roof run-off will therefore be possible. The standard solution acceptable to Council is a "Cauldwell type" soak pit, one per sump outlet. This method of stormwater disposal is universally used for land development over glacial outwash gravels in Cromwell, Alexandra and Clyde. See Fig 1.



CAULDWELL SOAKPIT DETAIL

Fig 1

In order to comply with the Regional Water Plan rules, a silt and debris trap is required before discharge of stormwater to a soak pit. This will be provided by a "inverted syphon" type mud tank. See Fig 2.



TYPICAL SUMP DETAIL

Fig 2

Where road swales are used, these provide a measure of pre-treatment of stormwater before discharge into mud tanks. There is a depth of at least 10m of gravel and sand below each soak pit, which will further filter stormwater before it is eventually discharged to groundwater. The inverted siphon mud tank/Caudwell soak pit system effectively provides for 3 stage treatment of stormwater. The mud tank (which is periodically sucked out by Council) removes silt, trash and gross pollutants, while the Caudwell soak pit (also periodically sucked out by Council) provides secondary treatment by removing finer silt and debris, with the 10m of sand and gravel below the soak pit providing tertiary filtration

For roof-run off, Council has a "rule of thumb" that 1m3 of soak pit is required for every 50m2 of roof area draining into the soak pit.

The site is relatively flat. This means there will be a lack of secondary flow paths. From a stormwater/road design aspect this means that most roads will need to be cut into the surrounding terrain by a least 150-300 mm in order to provide longitudinal road drainage and for dwellings to be able to comply with Building Code requirements (E1/AS1) for minimum floor levels above the road crown. See Fig 3

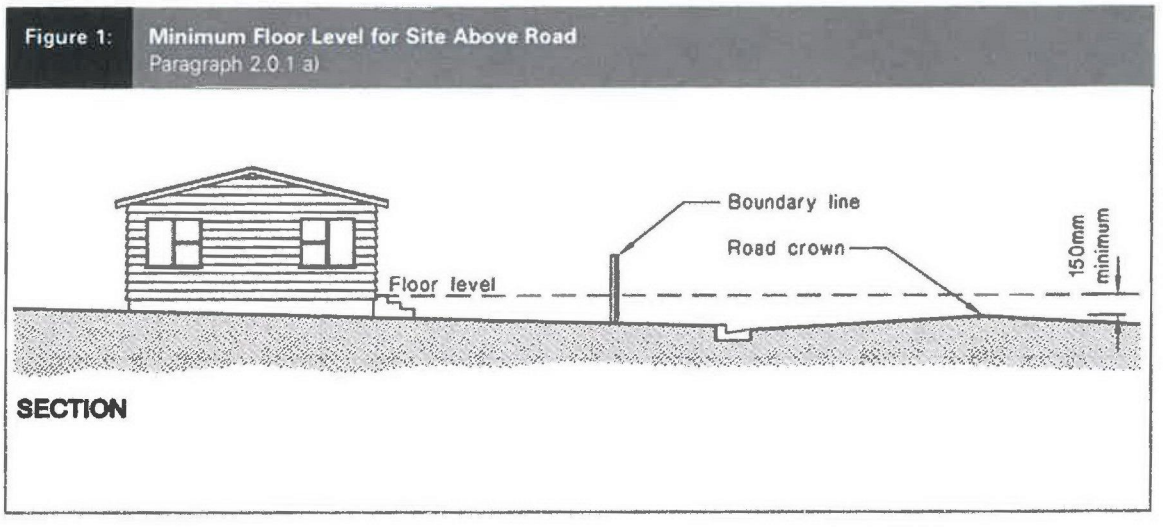


Figure 3

Essentially the roads act as temporary overflow ponding areas in the event of exceptional rain events and/or occasional blockage of mud tanks.

4. Wastewater

Council has confirmed that the Clyde Wastewater Project is being designed to serve future development along Muttontown Road with a connection available in the vicinity of Annan St / Sunderland St . See attached letter at **Appendix 'C'**

5. Water Supply

5.1 Irrigation

From the Otago Regional Council's "grow Otago" data base:

- "Dry summer rainfall" is 61-80mm for the Alexandra – Clyde Basin
- "Median potential evapotranspiration" (Jan-Feb) is 206-210mm for the Basin

Irrigation will therefore be essential to establish and maintain all landscaping within the development. This is particularly so given the very low Plant Available Water (PAW) of the site, due to its light sandy/gravelly soils.

The requirements for public open space landscape (road berms, walkway linkages SH8 buffer etc) irrigation over the site will be in the order of 5000m3/season (Oct-March). The Council's preferred option is that open public space irrigation be supplied from an independent bore, rather than the town reticulation.

The site is underlain by the Dunstan Flat Aquifer, so groundwater is a potential source of an irrigation and construction water supply. A maximum allocation limit has not been set for this aquifer in schedule 4A of the Regional Plan: Water. The ORC's study "Groundwater Allocation of the Alexandra Basin (Oct 2005 1 -877265-07-1)" found that the aquifer was likely to be over-allocated and relies heavily on extra water from irrigation losses . With a progressive switch to spray irrigation and to more efficient delivery systems, aquifer re-charge from irrigation losses will likely decrease in future. The study also found that water levels were declining in the aquifer, in addition to the decline caused by the deepening of the Clyde Dam tailrace in the early 1900s. A subsequent study by the ORC "Alexandra Groundwater Basin Allocation Study (Sept 2012)" found that it was possible that a small amount of water in the Dunstan Flat Aquifer could be available for allocation (0.4Mm3/yr), but that there were considerable uncertainties with this.

However, the economics of constructing, running and maintaining a bore , plus a duplicate reticulation system for a water application of only 0.005Mm3/yr are highly problematic.

In summary, the use a groundwater supply for public open space landscape irrigation does not appear to be a viable option.

Peak irrigation requirements for lawn and garden irrigation within private allotments will typically be in the order of 0.5-0.7m^3/day (Jan-Feb) with a metered supply. Experience in Central Otago (Cromwell/Clyde/Alexandra) is that this can only practicably be met out of the town reticulation. The demand factors considered in the below analysis factor in a suitable domestic irrigation allowance. Storage and recycling of roof run-off is not a particularly viable option, because of the very low and irregular rainfall (350mm-440mm/year). An on-site storage reserve in the order of 30-40m^3 would be required to get through the Jan/Feb peak irrigation period. Given the likely size of the proposed lots (300-650m^2), provision of this amount of storage within the lots is not practical.

5.2 Domestic and Firefighting

A Water Impact Assessment has been commissioned by Council from Mott MacDonald NZ Ltd, see **Appendix D**. Computer Modelling of the Clyde Township reticulation shows that the site can be adequately serviced , subject to duplicating the existing Sunderland Street main with a 200mm main from Annan Street to the site

6. Network Utility Services

6.1 Telecommunications

Chorus New Zealand Ltd have confirmed that a suitable Air Blown Fibre (ABF) reticulation can be supplied to the proposed development. See **Appendix E**

Individual home owners will also have the alternative option of the cellular network and several wi-fi providers for their telecommunications and computer media service

6.2 Electricity

Aurora Energy Ltd have confirmed that a suitable power supply can be made3 available to service development of the site See **Appendix F**

7. Road Construction

No difficulty is expected in designing and constructing suitable road pavements within the site, in compliance with "Austroads" and the subdivision engineering design standards of the Central Otago District Council.

All roads will be formed on sand and gravel. Laboratory Soaked California Bearing Ratio (CBR) tests were taken at the likely road subgrade at all test pits. See **Appendix G**. Soaked CBR's varied from 15%-40%, well above the normal minimum requirement of 7% for road pavement design in terms of the "Austroads" standard.

Council's current subdivisional roading engineering design standard is NZ 4404:2004 and its July 2008 amendments thereto. It is proposed that road designs on any subsequent subdivision and development of the site be in accordance with the updated version of this standard, being NZS 4404:2010. This updated version of the standard provides for a more innovative and flexible approach to road layout designs, in accordance with the contemporary urban design concepts proposed for this development. To quote from the forward to NZS 4404:2010:

- *Aims to encourage good urban design and remove road blocks to liveability and economic development in communities.*
- *Road design needs to allow 'context' or 'place' to be given significant emphasis, and to require roads to achieve safe (slower) operating speeds;*
- *Innovative subdivision has been discouraged to some extent under the 2004 version of NZS 4404.*
- *The review committee therefore challenged itself to produce a new Standard that:*
  - *Encourages sustainable and modern design;*
  - *Provides some certainty for designers and LAs; and*
  - *Prevents the outcomes that can arise when the sole focus is cost minimisation, and adherence to minimum standards.*

and from the outcome statement

- *This Standard provides local authorities, developers, and their professional advisors with standards for design and construction of land development and subdivision infrastructure. NZS 4404:2010 encourages sustainable development and modern design that emphasises liveability and environmental quality. It will also provide as much consistency as possible on*

land development and subdivision infrastructure while still allowing flexibility for local variations to suit local circumstances.

This is a matter that is best addressed at the subsequent resource consent and detailed engineering design stages , rather than at this initial plan change stage which simply seeks a "global" re-zoning of the site , instead of a detailed " master-planned" approach.

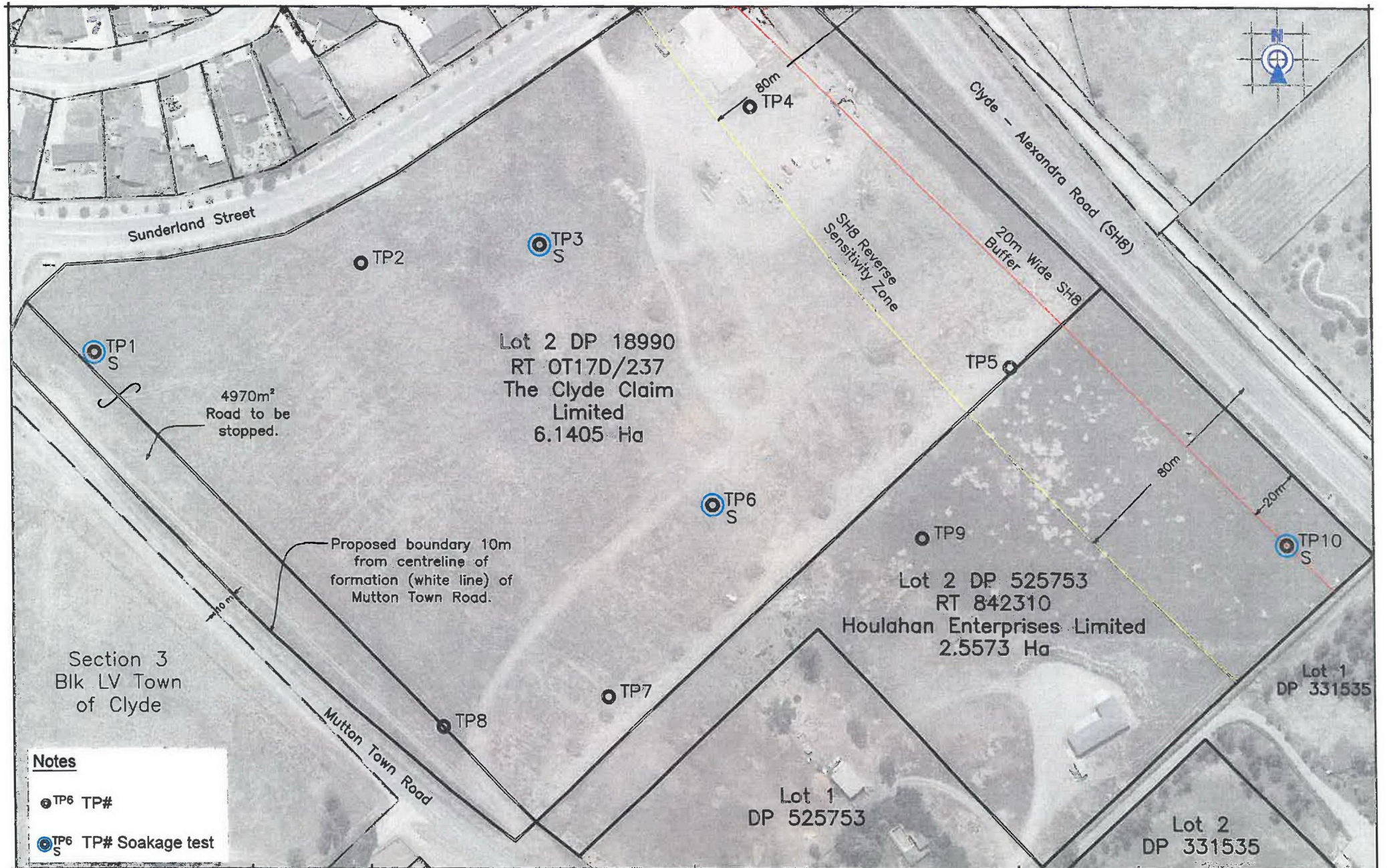
8. Conclusion

Suitable provision can be made for roading, stormwater, wastewater, water supply and network utility services to the proposed development.

Myles Garmonsway
Principal, B.Sc, Dip Mgt, R.P. Surv, MNZIS, CSNZ
Paterson Pitts Limited Partnership (Cromwell)

APPENDIX A

Location Plan of Test Pits & Test Pit Logs



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Client/Location: Mutton Town Road

Purpose/Drawing Title: Test Pit Locations

Surveyed by:	MG	Original Size:	Scale:
Designed by:		A3	1:1250
Drawn by:	KWG		DO NOT SCALE
Checked by:	MG		
Approved by	MG		
Job Ref: A4702_PLAN		Sheet No: 2	Revision No: A
			Date Created: 04/02/2020

PLOT DATE: 04 February, 2020 - 2:41 PM BY: Kathryn Germonsway

J:\A_4702 LAING & BRAID\CAD\A4702_PLAN_2A_TP.DWG

TEST PIT 1

Ground	0.00	
		Sandy topsoil
	-0.20	
		Compact, brown gravels. Fine to 100mm. Some erratics to 400mm
	-1.30	
		Clean, grey sandy gravels. Compact
	-1.70	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
7E+05	389425	4988404	1311981	TP 1

TEST PIT 2

Ground	0.00	
		Topsoil
	-0.20	
		Sandy gravels
	-0.40	
		Brown, weathered coarse sands and fine gravels
	-1.30	
		Medium to coarse brown, weathered gravels.
	-2.20	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
748362	389864	4988353	1312422	TP 2

TEST PIT 3

Ground 0.00

Topsoil, sandy

-0.20

Medium to fine brown sands

-0.50

Fine - coarse sandy gravels

Poor cohesion

-2.40

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
748362	389864	4988353	1312422	TP 3

TEST PIT 4

Ground	0.00
gravel cap / topsoil	
	-0.10
Coarse sands and free-flowing fine gravels	
minor sand lenses	
	-2.30

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
7E+05	389668	4988505	1312219	TP 4

TEST PIT 5

Ground 0.00

Sandy topsoil
with old roots

-0.30

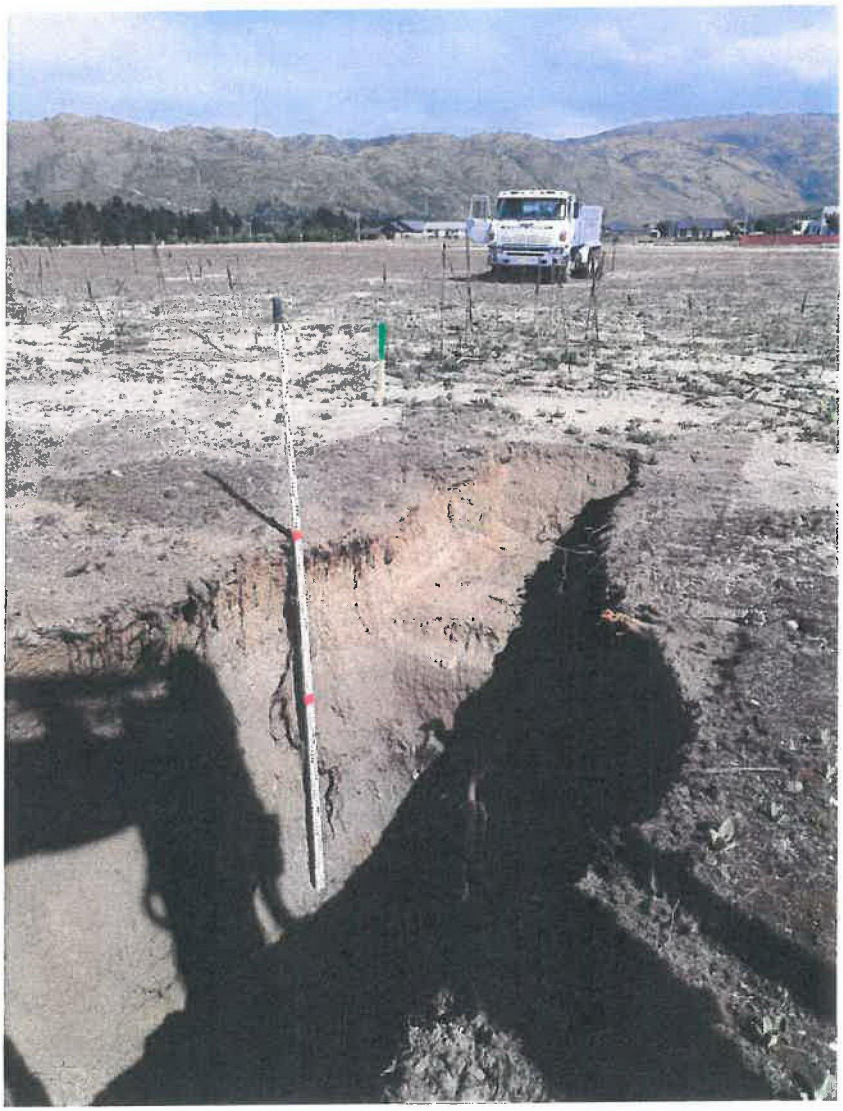
Meduim to
fine sandy gravels
Some old
tree roots

-0.70

Coarse
sands &
fine
gravels.

Poor
cohesion

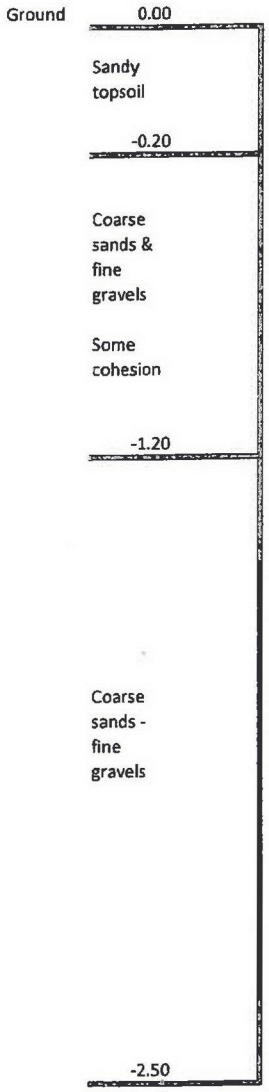
-2.00



LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
	748362	389864	4988353	1312422

TEST PIT 6



LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
748362	389864	4988353	1312422	TP 6

TEST PIT 7

Ground 0.00

Topsoil

-0.20

Brown, fine gravels

Some old roots

Cobbles to 250mm

-1.30

Medium - coarse grey sandy gravels

Poor cohesion

-2.70

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
748362	389864	4988353	1312422	TP 7

TEST PIT 8

Ground	0.00	
		Sandy topsoil
	-0.20	
		Compact fine gravels. Old roots
	-0.60	
		Coarse, compact gravels
	-1.40	
		Grey medium - coarse gravels in coarse sands Some erratices to 400mm
	-2.60	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
748362	389864	4988353	1312422	TP 8

TEST PIT 9

Ground	0.00
Topsoil	-0.15
Loose, brown peg gravels.	-0.40
Fine gravels in coarse sands. Poor cohesion. Sloping	-1.0 -to -1.3
Grey medium to coarse gravels and sands. Poor cohesion	-2.90

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
748362	389864	4988353	1312422	TP 9

TEST PIT 10

Ground	0.00	
		Topsoil
	-0.20	
		Sandy fine gravels. Some weathering
	-0.70	
		Fine grey gravels in coarse sands Poor cohesion
	-2.50	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
748362	389864	4988353	1312422	TP 10

APPENDIX B

Soakage Tests, Infiltration Calculations & Rainfall Intensity Calculations

Pit Dimensions			Area		Test Pit	1			A4702								
Length	3		3.3						Clyde								
Width	1.1																
Time (s)	Depth	dVolume	dTime (s)		Soakage (l/s)		l/s/m²										
0	0	-0.165	30		-5.5		-1.7										
30	0.05	-0.165	30		-5.5		-1.7										
60	0.1	-0.165	30		-5.5		-1.7										
90	0.15	-0.099	30		-3.3		-1.0										
120	0.18	-0.099	30		-3.3		-1.0										
150	0.21			Average	-4.62		-1.40				Soaking	Infiltration Rate			5040	mm/hr	
		0.693	150		4.6		1.4	For time period									
Note:	3000l poured in over 10 minutes to get to water depth of 0.35m																
	Soakage over 10 min = 2850			litres													
		=	4.75	(l/s)													
		=	1.44	l/s/m²							Filling	Infiltration Rate			5182	mm/hr	
															total volume		
	1 in 20 (RCP4.5)										area m2	2207.167			17.657333	m3	
	10	mm in 10 minutes		60.3 mm/hr		Q=2.78CiA					runoff	0.8			rate per second		
						A = Q/2.78iC		0.220717	ha		depth	10			29.4	l/s	
								2207.167			seconds	600					
													runoff per m2 per s		0.013333	l/s/m2	
Soakpit Base =			0.785398	m2							Soakage Capacity		2061.67	m2			
Effective soakage @ 2m deep			19.63495	m2	45 deg angle influence						metres of road		103.0835	206.16702	two sided		
			27.48894		Soakage Rate	l/s					(20m carriageway)						

Pit Dimensions			Area		Test Pit	3			A4702								
Length	3.1		3.41						Clyde								
Width	1.1																
Time (s)	Depth	dVolume	dTime (s)		Soakage (l/s)		l/s/m²										
0	0	-0.3069	30		-10.2		-3.0										
30	0.09	-0.1705	30		-5.7		-1.7										
60	0.14	-0.1364	30		-4.5		-1.3										
90	0.18	-0.1364	30		-4.5		-1.3										
120	0.22			Average	-6.25		-1.83										
		0.7502	120		6.3		1.8	For time period									
Note:	3000l poured in over 9 minutes to get to water depth of 0.42m																
	Soakage over 9 min =		1570	litres													
		=	2.91	(l/s)													
		=	0.85	l/s/m²													
	1 in 20 (RCP4.5)																
	10	mm in 10 minutes		60.3 mm/hr		Q=2.78CiA											
						A = Q/2.78iC		0.134418	ha								
								1344.184									
Soakpit Base =			0.785398	m2													
Effective soakage @ 2m deep			19.63495	m2	45 deg angle influence												
			16.741		Soakage Rate	l/s											
					Adjusted for soakage during filling												

Soaking	Infiltration Rate		6600	mm/hr	
Filling	Infiltration Rate		3069	mm/hr	
			total volume		
area m2	1344.184		10.753469	m3	
runoff	0.8		rate per second		
depth	10		17.9	l/s	
seconds	600				
		runoff per m2 per s		0.013333	l/s/m2
Soakage Capacity		1255.575	m2		
metres of road		62.77875	125.5575	two sided	
(20m carriageway)					

Pit Dimensions			Area		Test Pit	6			A4702								
Length	3		3.3						Clyde								
Width	1.1																
Time (s)	Depth	dVolume	dTime (s)		Soakage (l/s)		l/s/m²										
0	0	-0.33	30		-11.0		-3.3										
30	0.1			Average	-11.00		-3.33				Soaking	Infiltration Rate		12000	mm/hr		
		0.33	30		11.0		3.3	For time period									
Note:	3300l poured in over 8.5 minutes to get to water depth of 0.1m																
	Soakage over 8.5 min		2950	litres													
		=	5.78	(l/s)													
		=	1.75	l/s/m²							Filling	Infiltration Rate		6310	mm/hr		
														total volume			
	1 in 20 (RCP4.5)										area m2	2763.408		22.107262	m3		
	10	mm in 10 minutes		60.3 mm/hr		Q=2.78CiA					runoff	0.8		rate per second			
						A = Q/2.78iC		0.276341	ha		depth	10		36.8	l/s		
								2763.408			seconds	600					
													runoff per m2 per s		0.013333	l/s/m2	
Soakpit Base =			0.785398	m2													
Effective soakage @ 2m deep			19.63495	m2	45 deg angle influence						Soakage Capacity		2581.244	m2			
			34.41659		Soakage Rate	l/s					metres of road		129.0622	258.1244	two sided		
					Adjusted for soakage during filling						(20m carriageway)						

Pit Dimensions			Area		Test Pit	10			A4702								
Length	3.1		3.41						Clyde								
Width	1.1																
Time (s)	Depth	dVolume	dTime (s)		Soakage (l/s)		l/s/m²										
0	0	-0.682	30		-22.7		-6.7										
30	0.2	-0.341	30		-11.4		-3.3										
60	0.3			Average	-17.05		-5.00										
		1.023	60		17.1		5.0	For time period									
											Soaking	Infiltration Rate		18000	mm/hr		
Note:	3000l poured in over 7 minutes to get to water depth of 0.45m																
	Soakage over 7 min =		1470	litres													
		=	3.50	(l/s)													
		=	1.03	l/s/m²							Filling	Infiltration Rate		3695	mm/hr		
														total volume			
	1 in 20 (RCP4.5)										area m2	1618.157		12.945259	m3		
	10	mm in 10 minutes		60.3 mm/hr		Q=2.78CiA					runoff	0.8		rate per second			
						A = Q/2.78iC		0.161816	ha		depth	10		21.6	l/s		
								1618.157			seconds	600					
													runoff per m2 per s		0.013333	l/s/m2	
Soakpit Base =			0.785398	m2							Soakage Capacity		1511.488	m2			
Effective soakage @ 2m deep			19.63495	m2	45 deg angle influence						metres of road		75.57442	151.14884	two sided		
			20.15318		Soakage Rate	l/s					(20m carriageway)						

HIRDS V4 Depth-Duration-Frequency Results
Sitename: Custom Location
Coordinate system: WGS84
Longitude: 169.3364
Latitude: -45.1998

DDF Mode Parameter	c	d	e	f	g	h	i
Values:	-0.0202	0.475516	0.010093	-0.0065	0.328352	-0.00963	1.997551

Example:	Duration (h	ARI (yrs)	x	y	Rainfall Depth (mm)
	24	100	3.178054	4.600149	82.55506

Rainfall depths (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	3.37	4.46	5.33	7.37	10.3	17.2	23.1
2	0.5	3.85	5.07	6.04	8.3	11.5	19.1	25.6
5	0.2	5.7	7.39	8.73	11.8	16.1	26.1	34.4
10	0.1	7.29	9.36	11	14.7	19.9	31.6	41.2
20	0.05	9.14	11.6	13.6	18	24	37.6	48.6
30	0.033	10.4	13.1	15.2	20.1	26.7	41.4	53.1
40	0.025	11.3	14.2	16.5	21.6	28.7	44.2	56.5
50	0.02	12.1	15.1	17.5	22.9	30.3	46.4	59.2
60	0.017	12.7	15.9	18.4	24	31.6	48.3	61.4
80	0.012	13.8	17.2	19.9	25.8	33.8	51.3	65
100	0.01	14.7	18.3	21	27.2	35.6	53.8	67.9
250	0.004	18.8	23	26.3	33.7	43.4	64.3	80.1

Depth standard error (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	0.51	0.6	0.68	0.83	1.2	1.6	3.6
2	0.5	0.57	0.67	0.76	0.9	1.3	1.8	4
5	0.2	0.91	1.1	1.2	1.3	1.9	2.4	5.4
10	0.1	1.3	1.6	1.8	1.8	2.7	3	6.6
20	0.05	1.9	2.3	2.6	2.5	3.8	4	8.1
30	0.033	2.3	2.8	3.2	3.1	4.7	4.7	9.1
40	0.025	2.7	3.3	3.8	3.6	5.4	5.2	9.9
50	0.02	3	3.7	4.3	4	6.1	5.7	11
60	0.017	3.4	4.1	4.8	4.4	6.7	6.1	11
80	0.012	3.9	4.8	5.6	5.1	7.8	6.9	12
100	0.01	4.4	5.4	6.4	5.7	8.8	7.5	13
250	0.004	7.3	8.9	11	9.3	14	11	17

Rainfall depths (mm) :: RCP2.6 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	3.61	4.77	5.71	7.88	10.9	18.1	24.2
2	0.5	4.13	5.43	6.48	8.9	12.3	20.2	26.9
5	0.2	6.13	7.95	9.39	12.7	17.3	27.7	36.2
10	0.1	7.86	10.1	11.8	15.8	21.3	33.6	43.5
20	0.05	9.86	12.5	14.6	19.4	25.8	40.1	51.3
30	0.033	11.2	14.1	16.4	21.6	28.7	44.1	56.2
40	0.025	12.2	15.3	17.8	23.4	30.8	47.1	59.8
50	0.02	13	16.3	18.9	24.8	32.6	49.5	62.6
60	0.017	13.7	17.2	19.9	25.9	34	51.6	65
80	0.012	14.9	18.6	21.5	27.9	36.4	54.8	68.8

100	0.01	15.9	19.7	22.7	29.4	38.3	57.4	71.9
250	0.004	20.3	24.9	28.5	36.4	46.8	68.7	84.9

Rainfall depths (mm) :: RCP2.6 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	3.61	4.77	5.71	7.88	10.9	18.1	24.2
2	0.5	4.13	5.43	6.48	8.9	12.3	20.2	26.9
5	0.2	6.13	7.95	9.39	12.7	17.3	27.7	36.2
10	0.1	7.86	10.1	11.8	15.8	21.3	33.6	43.5
20	0.05	9.86	12.5	14.6	19.4	25.8	40.1	51.3
30	0.033	11.2	14.1	16.4	21.6	28.7	44.1	56.2
40	0.025	12.2	15.3	17.8	23.4	30.8	47.1	59.8
50	0.02	13	16.3	18.9	24.8	32.6	49.5	62.6
60	0.017	13.7	17.2	19.9	25.9	34	51.6	65
80	0.012	14.9	18.6	21.5	27.9	36.4	54.8	68.8
100	0.01	15.9	19.7	22.7	29.4	38.3	57.4	71.9
250	0.004	20.3	24.9	28.5	36.4	46.8	68.7	84.9

Rainfall depths (mm) :: RCP4.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	3.67	4.85	5.8	8.01	11.1	18.4	24.5
2	0.5	4.2	5.53	6.59	9.05	12.5	20.5	27.2
5	0.2	6.24	8.09	9.56	12.9	17.6	28.1	36.7
10	0.1	8	10.3	12.1	16.1	21.7	34.1	44.1
20	0.05	10	12.8	14.9	19.7	26.3	40.7	52.1
30	0.033	11.4	14.4	16.7	22	29.2	44.8	57
40	0.025	12.4	15.6	18.1	23.8	31.4	47.9	60.6
50	0.02	13.3	16.7	19.3	25.2	33.2	50.3	63.5
60	0.017	14	17.5	20.3	26.4	34.7	52.4	66
80	0.012	15.2	18.9	21.9	28.4	37.1	55.7	69.8
100	0.01	16.2	20.1	23.2	30	39	58.4	72.9
250	0.004	20.7	25.4	29	37.1	47.7	69.8	86.1

Rainfall depths (mm) :: RCP4.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	3.85	5.1	6.1	8.43	11.7	19.1	25.4
2	0.5	4.42	5.82	6.94	9.53	13.1	21.4	28.2
5	0.2	6.58	8.53	10.1	13.6	18.5	29.4	38.2
10	0.1	8.45	10.8	12.7	17	22.9	35.7	46
20	0.05	10.6	13.5	15.7	20.8	27.7	42.7	54.3
30	0.033	12.1	15.2	17.7	23.3	30.8	47	59.4
40	0.025	13.1	16.5	19.2	25.1	33.1	50.2	63.3
50	0.02	14	17.6	20.4	26.7	35	52.8	66.3
60	0.017	14.8	18.5	21.4	27.9	36.6	55	68.8
80	0.012	16.1	20	23.1	30	39.2	58.4	72.9
100	0.01	17.1	21.3	24.5	31.7	41.2	61.3	76.2
250	0.004	21.9	26.8	30.7	39.2	50.3	73.3	89.9

Rainfall depths (mm) :: RCP6.0 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	3.64	4.82	5.77	7.96	11.1	18.3	24.4
2	0.5	4.17	5.49	6.55	8.99	12.4	20.4	27.1
5	0.2	6.2	8.03	9.49	12.8	17.5	27.9	36.5
10	0.1	7.94	10.2	12	16	21.6	33.9	43.9

20	0.05	9.97	12.7	14.8	19.6	26.1	40.5	51.8
30	0.033	11.3	14.3	16.6	21.9	29	44.5	56.7
40	0.025	12.3	15.5	18	23.6	31.2	47.6	60.3
50	0.02	13.2	16.5	19.1	25	32.9	50	63.2
60	0.017	13.9	17.4	20.1	26.2	34.4	52.1	65.6
80	0.012	15.1	18.8	21.7	28.2	36.8	55.3	69.4
100	0.01	16.1	20	23	29.7	38.8	58	72.5
250	0.004	20.5	25.2	28.8	36.8	47.3	69.3	85.6

Rainfall depths (mm) :: RCP6.0 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	4.02	5.33	6.37	8.79	12.1	19.8	26.1
2	0.5	4.61	6.08	7.25	9.95	13.7	22.2	29.1
5	0.2	6.89	8.93	10.6	14.3	19.3	30.5	39.5
10	0.1	8.85	11.4	13.3	17.8	23.9	37.2	47.6
20	0.05	11.1	14.1	16.5	21.8	29	44.4	56.2
30	0.033	12.6	16	18.6	24.4	32.3	48.9	61.6
40	0.025	13.8	17.3	20.1	26.4	34.7	52.3	65.6
50	0.02	14.7	18.5	21.4	28	36.7	55	68.7
60	0.017	15.5	19.4	22.5	29.3	38.3	57.3	71.4
80	0.012	16.9	21	24.3	31.5	41	60.9	75.6
100	0.01	18	22.3	25.7	33.3	43.2	63.9	79
250	0.004	23	28.2	32.2	41.1	52.7	76.4	93.3

Rainfall depths (mm) :: RCP8.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	3.71	4.91	5.87	8.11	11.2	18.6	24.7
2	0.5	4.25	5.59	6.67	9.16	12.7	20.7	27.4
5	0.2	6.32	8.19	9.68	13.1	17.8	28.4	37.1
10	0.1	8.11	10.4	12.2	16.3	22	34.5	44.5
20	0.05	10.2	12.9	15.1	20	26.6	41.2	52.6
30	0.033	11.6	14.6	17	22.3	29.6	45.3	57.6
40	0.025	12.6	15.8	18.4	24.1	31.8	48.4	61.3
50	0.02	13.5	16.9	19.5	25.6	33.6	50.9	64.2
60	0.017	14.2	17.7	20.5	26.8	35.1	53	66.6
80	0.012	15.4	19.2	22.2	28.8	37.6	56.3	70.5
100	0.01	16.4	20.4	23.5	30.4	39.6	59	73.7
250	0.004	21	25.7	29.4	37.6	48.3	70.6	87

Rainfall depths (mm) :: RCP8.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	4.4	5.83	6.97	9.63	13.2	21.4	27.9
2	0.5	5.06	6.66	7.95	10.9	15	23.9	31.2
5	0.2	7.58	9.83	11.6	15.7	21.2	33.1	42.5
10	0.1	9.76	12.5	14.7	19.7	26.3	40.4	51.3
20	0.05	12.3	15.6	18.2	24.1	31.9	48.4	60.7
30	0.033	14	17.6	20.5	27	35.5	53.4	66.6
40	0.025	15.2	19.1	22.2	29.1	38.2	57.1	70.9
50	0.02	16.3	20.4	23.6	30.9	40.4	60	74.3
60	0.017	17.2	21.5	24.8	32.4	42.2	62.5	77.3
80	0.012	18.7	23.2	26.8	34.8	45.2	66.5	81.8
100	0.01	19.9	24.7	28.4	36.8	47.6	69.7	85.6
250	0.004	25.4	31.1	35.6	45.5	58.1	83.4	101

24h	48h	72h	96h	120h
30	37	40.7	42.9	44.3
33	40.6	44.5	46.8	48.2
43.7	52.8	57.3	59.9	61.4
51.8	62	66.9	69.6	71.1
60.4	71.6	76.8	79.6	81.1
65.7	77.4	82.8	85.5	87
69.6	81.6	87.1	89.9	91.2
72.7	84.9	90.5	93.2	94.6
75.2	87.7	93.2	96	97.3
79.3	92.1	97.7	100	102
82.6	95.5	101	104	105
96.2	110	116	118	119

24h	48h	72h	96h	120h
1.8	0.85	1.4	0.94	2.3
1.9	0.83	1.5	0.93	2.5
2.8	1.7	2.6	2	3.7
3.8	2.9	3.8	3.3	4.9
5.1	4.4	5.4	4.9	6.5
6	5.4	6.5	6.1	7.7
6.8	6.3	7.4	7.1	8.6
7.4	7	8.1	7.8	9.4
8	7.6	8.8	8.5	10
9	8.7	9.9	9.7	11
9.8	9.5	11	11	12
14	14	15	15	17

24h	48h	72h	96h	120h
31.2	38.3	41.9	44.1	45.5
34.4	42	45.9	48.2	49.6
45.7	54.9	59.4	61.9	63.4
54.3	64.5	69.5	72.1	73.5
63.4	74.6	79.8	82.5	83.8
69	80.7	86	88.7	90
73.1	85.1	90.6	93.2	94.5
76.3	88.7	94.1	96.7	97.9
79	91.5	97	99.6	101
83.3	96.2	102	104	105

86.7	99.8	105	108	109
101	115	120	122	123

24h	48h	72h	96h	120h
31.2	38.3	41.9	44.1	45.5
34.4	42	45.9	48.2	49.6
45.7	54.9	59.4	61.9	63.4
54.3	64.5	69.5	72.1	73.5
63.4	74.6	79.8	82.5	83.8
69	80.7	86	88.7	90
73.1	85.1	90.6	93.2	94.5
76.3	88.7	94.1	96.7	97.9
79	91.5	97	99.6	101
83.3	96.2	102	104	105
86.7	99.8	105	108	109
101	115	120	122	123

24h	48h	72h	96h	120h
31.6	38.6	42.3	44.4	45.8
34.8	42.4	46.3	48.5	49.9
46.2	55.4	59.9	62.4	63.9
54.9	65.2	70.1	72.7	74.1
64.1	75.4	80.5	83.2	84.5
69.8	81.6	86.9	89.5	90.8
73.9	86	91.5	94	95.3
77.2	89.6	95	97.6	98.8
80	92.5	98	101	102
84.3	97.2	103	105	106
87.8	101	106	109	110
102	116	121	124	124

24h	48h	72h	96h	120h
32.6	39.6	43.2	45.4	46.7
35.9	43.6	47.4	49.7	51
47.8	57.1	61.6	64	65.4
56.9	67.2	72.2	74.7	76
66.4	77.8	82.9	85.5	86.8
72.3	84.2	89.5	92.1	93.2
76.7	88.8	94.2	96.7	97.9
80.1	92.6	97.9	100	101
83	95.5	101	103	104
87.5	100	106	108	109
91.1	104	110	112	113
106	120	125	127	128

24h	48h	72h	96h	120h
31.4	38.5	42.1	44.3	45.7
34.7	42.2	46.1	48.4	49.8
46	55.2	59.7	62.2	63.7
54.7	64.9	69.8	72.4	73.9

63.8	75.1	80.2	82.9	84.3
69.5	81.2	86.5	89.2	90.5
73.6	85.7	91.1	93.7	95
76.8	89.2	94.6	97.3	98.4
79.6	92.1	97.6	100	101
83.9	96.8	102	105	106
87.4	100	106	108	109
102	116	121	123	124

24h	48h	72h	96h	120h
33.4	40.5	44.1	46.2	47.6
36.9	44.6	48.5	50.7	52
49.2	58.5	63.1	65.5	66.8
58.7	69	74	76.4	77.8
68.5	80	85.1	87.6	88.7
74.6	86.6	91.8	94.3	95.4
79.2	91.3	96.7	99.1	100
82.6	95.2	100	103	104
85.7	98.3	104	106	107
90.3	103	109	111	112
94.1	107	113	115	115
110	123	129	130	131

24h	48h	72h	96h	120h
31.8	38.9	42.5	44.6	46
35.1	42.7	46.5	48.8	50.2
46.6	55.8	60.3	62.8	64.3
55.4	65.7	70.6	73.2	74.6
64.7	75.9	81.1	83.8	85.1
70.4	82.2	87.5	90.1	91.4
74.6	86.7	92.1	94.7	95.9
77.9	90.3	95.7	98.3	99.4
80.7	93.2	98.7	101	102
85.1	98	103	106	107
88.6	102	107	110	110
103	117	122	124	125

24h	48h	72h	96h	120h
35.4	42.6	46.1	48.1	49.5
39.2	46.9	50.8	52.9	54.2
52.5	61.9	66.5	68.7	70
62.6	73.2	78.1	80.4	81.6
73.2	84.9	89.9	92.3	93.2
79.8	92	97.1	99.5	100
84.7	97	102	104	105
88.4	101	106	109	109
91.7	104	110	112	112
96.7	110	115	117	118
101	114	119	121	122
118	131	136	138	137

HIRDS V4 Intensity-Duration-Frequency Results
Sitename: Custom Location
Coordinate system: WGS84
Longitude: 169.3364
Latitude: -45.1998

DDF Mode Parameter	c	d	e	f	g	h	i
Values:	-0.0202	0.475516	0.010093	-0.0065	0.328352	-0.00963	1.997551

Example:	Duration (h	ARI (yrs)	x	y	Rainfall Rate (mm/hr)
	24	100	3.178054	4.600149	3.439794

Rainfall intensities (mm/hr) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	20.2	13.4	10.7	7.37	5.13	2.86	1.93
2	0.5	23.1	15.2	12.1	8.3	5.76	3.19	2.13
5	0.2	34.2	22.2	17.5	11.8	8.06	4.35	2.86
10	0.1	43.8	28.1	22	14.7	9.93	5.27	3.44
20	0.05	54.9	34.8	27.1	18	12	6.27	4.05
30	0.033	62.2	39.3	30.5	20.1	13.3	6.9	4.43
40	0.025	67.8	42.7	33	21.6	14.3	7.37	4.71
50	0.02	72.5	45.4	35.1	22.9	15.1	7.74	4.93
60	0.017	76.4	47.8	36.8	24	15.8	8.05	5.12
80	0.012	82.9	51.6	39.7	25.8	16.9	8.56	5.42
100	0.01	88.3	54.8	42.1	27.2	17.8	8.96	5.66
250	0.004	113	69.1	52.7	33.7	21.7	10.7	6.68

Intensity standard error (mm/hr) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	3	1.9	1.3	0.86	0.59	0.26	0.29
2	0.5	3.4	2.1	1.5	0.94	0.64	0.28	0.32
5	0.2	5.3	3.3	2.5	1.4	0.94	0.4	0.43
10	0.1	7.4	4.8	3.6	1.8	1.3	0.53	0.53
20	0.05	10	6.9	5.4	2.5	1.9	0.71	0.64
30	0.033	13	8.7	6.7	3.1	2.3	0.84	0.72
40	0.025	15	10	7.9	3.5	2.7	0.94	0.79
50	0.02	17	12	9	3.9	3	1	0.84
60	0.017	18	13	10	4.3	3.3	1.1	0.89
80	0.012	21	15	12	4.9	3.8	1.2	0.97
100	0.01	24	17	13	5.5	4.3	1.4	1
250	0.004	38	28	22	8.6	6.9	1.9	1.4

Rainfall intensities (mm/hr) :: RCP2.6 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	21.6	14.3	11.4	7.88	5.47	3.02	2.02
2	0.5	24.8	16.3	13	8.9	6.16	3.37	2.24
5	0.2	36.8	23.8	18.8	12.7	8.64	4.62	3.02
10	0.1	47.1	30.2	23.7	15.8	10.7	5.6	3.63
20	0.05	59.2	37.6	29.2	19.4	12.9	6.68	4.28
30	0.033	67.1	42.4	32.9	21.6	14.3	7.35	4.68
40	0.025	73.2	46	35.6	23.4	15.4	7.86	4.98
50	0.02	78.2	49	37.9	24.8	16.3	8.25	5.22
60	0.017	82.5	51.6	39.8	25.9	17	8.59	5.42
80	0.012	89.6	55.8	42.9	27.9	18.2	9.13	5.74

100	0.01	95.4	59.2	45.4	29.4	19.2	9.57	5.99
250	0.004	122	74.7	56.9	36.4	23.4	11.4	7.08

Rainfall intensities (mm/hr) :: RCP2.6 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	21.6	14.3	11.4	7.88	5.47	3.02	2.02
2	0.5	24.8	16.3	13	8.9	6.16	3.37	2.24
5	0.2	36.8	23.8	18.8	12.7	8.64	4.62	3.02
10	0.1	47.1	30.2	23.7	15.8	10.7	5.6	3.63
20	0.05	59.2	37.6	29.2	19.4	12.9	6.68	4.28
30	0.033	67.1	42.4	32.9	21.6	14.3	7.35	4.68
40	0.025	73.2	46	35.6	23.4	15.4	7.86	4.98
50	0.02	78.2	49	37.9	24.8	16.3	8.25	5.22
60	0.017	82.5	51.6	39.8	25.9	17	8.59	5.42
80	0.012	89.6	55.8	42.9	27.9	18.2	9.13	5.74
100	0.01	95.4	59.2	45.4	29.4	19.2	9.57	5.99
250	0.004	122	74.7	56.9	36.4	23.4	11.4	7.08

Rainfall intensities (mm/hr) :: RCP4.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	22	14.6	11.6	8.01	5.56	3.06	2.04
2	0.5	25.2	16.6	13.2	9.05	6.26	3.42	2.27
5	0.2	37.4	24.3	19.1	12.9	8.79	4.68	3.06
10	0.1	48	30.8	24.1	16.1	10.9	5.69	3.68
20	0.05	60.3	38.3	29.8	19.7	13.1	6.78	4.34
30	0.033	68.4	43.2	33.5	22	14.6	7.47	4.75
40	0.025	74.6	46.9	36.3	23.8	15.7	7.98	5.05
50	0.02	79.7	50	38.6	25.2	16.6	8.39	5.29
60	0.017	84	52.5	40.5	26.4	17.3	8.73	5.5
80	0.012	91.3	56.8	43.7	28.4	18.5	9.28	5.82
100	0.01	97.2	60.3	46.3	30	19.5	9.73	6.08
250	0.004	124	76.1	58	37.1	23.8	11.6	7.18

Rainfall intensities (mm/hr) :: RCP4.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	23.1	15.3	12.2	8.43	5.83	3.19	2.11
2	0.5	26.5	17.5	13.9	9.53	6.57	3.56	2.35
5	0.2	39.5	25.6	20.2	13.6	9.26	4.9	3.18
10	0.1	50.7	32.5	25.5	17	11.4	5.96	3.83
20	0.05	63.7	40.4	31.5	20.8	13.9	7.11	4.52
30	0.033	72.3	45.6	35.4	23.3	15.4	7.83	4.95
40	0.025	78.8	49.6	38.4	25.1	16.6	8.37	5.27
50	0.02	84.3	52.8	40.8	26.7	17.5	8.8	5.52
60	0.017	88.9	55.6	42.8	27.9	18.3	9.16	5.74
80	0.012	96.6	60.1	46.3	30	19.6	9.74	6.07
100	0.01	103	63.8	49	31.7	20.6	10.2	6.35
250	0.004	131	80.5	61.4	39.2	25.2	12.2	7.49

Rainfall intensities (mm/hr) :: RCP6.0 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	21.8	14.5	11.5	7.96	5.53	3.05	2.03
2	0.5	25	16.5	13.1	8.99	6.22	3.4	2.26
5	0.2	37.2	24.1	19	12.8	8.73	4.66	3.04
10	0.1	47.7	30.6	23.9	16	10.8	5.65	3.66

20	0.05	59.8	38	29.6	19.6	13.1	6.74	4.31
30	0.033	67.9	42.9	33.2	21.9	14.5	7.42	4.72
40	0.025	74	46.5	36	23.6	15.6	7.93	5.03
50	0.02	79.1	49.6	38.3	25	16.5	8.33	5.26
60	0.017	83.4	52.1	40.2	26.2	17.2	8.68	5.47
80	0.012	90.6	56.4	43.4	28.2	18.4	9.22	5.79
100	0.01	96.4	59.9	46	29.7	19.4	9.66	6.04
250	0.004	123	75.5	57.6	36.8	23.7	11.6	7.14

Rainfall intensities (mm/hr) :: RCP6.0 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	24.1	16	12.7	8.79	6.07	3.3	2.18
2	0.5	27.7	18.2	14.5	9.95	6.86	3.69	2.43
5	0.2	41.3	26.8	21.1	14.3	9.67	5.09	3.29
10	0.1	53.1	34.1	26.7	17.8	12	6.19	3.97
20	0.05	66.8	42.4	33	21.8	14.5	7.4	4.69
30	0.033	75.8	47.9	37.1	24.4	16.1	8.16	5.14
40	0.025	82.7	52	40.2	26.4	17.3	8.72	5.47
50	0.02	88.4	55.4	42.8	28	18.3	9.16	5.73
60	0.017	93.2	58.3	44.9	29.3	19.2	9.55	5.95
80	0.012	101	63.1	48.5	31.5	20.5	10.1	6.3
100	0.01	108	66.9	51.4	33.3	21.6	10.6	6.59
250	0.004	138	84.5	64.4	41.1	26.4	12.7	7.78

Rainfall intensities (mm/hr) :: RCP8.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	22.3	14.7	11.7	8.11	5.62	3.09	2.06
2	0.5	25.5	16.8	13.3	9.16	6.33	3.45	2.29
5	0.2	37.9	24.6	19.4	13.1	8.9	4.73	3.09
10	0.1	48.6	31.2	24.4	16.3	11	5.75	3.71
20	0.05	61.1	38.8	30.2	20	13.3	6.86	4.38
30	0.033	69.3	43.8	33.9	22.3	14.8	7.56	4.8
40	0.025	75.6	47.5	36.8	24.1	15.9	8.07	5.1
50	0.02	80.8	50.6	39.1	25.6	16.8	8.48	5.35
60	0.017	85.2	53.2	41.1	26.8	17.6	8.83	5.55
80	0.012	92.5	57.6	44.3	28.8	18.8	9.39	5.88
100	0.01	98.5	61.1	46.9	30.4	19.8	9.84	6.14
250	0.004	126	77.1	58.8	37.6	24.1	11.8	7.25

Rainfall intensities (mm/hr) :: RCP8.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h
1.58	0.633	26.4	17.5	13.9	9.63	6.62	3.56	2.33
2	0.5	30.4	20	15.9	10.9	7.5	3.99	2.6
5	0.2	45.5	29.5	23.2	15.7	10.6	5.52	3.54
10	0.1	58.5	37.6	29.4	19.7	13.2	6.73	4.28
20	0.05	73.7	46.8	36.4	24.1	16	8.06	5.06
30	0.033	83.7	52.9	41	27	17.8	8.89	5.55
40	0.025	91.3	57.4	44.4	29.1	19.1	9.51	5.91
50	0.02	97.7	61.2	47.3	30.9	20.2	9.99	6.19
60	0.017	103	64.4	49.7	32.4	21.1	10.4	6.44
80	0.012	112	69.7	53.7	34.8	22.6	11.1	6.82
100	0.01	119	74	56.8	36.8	23.8	11.6	7.13
250	0.004	152	93.4	71.2	45.5	29.1	13.9	8.42

24h	48h	72h	96h	120h
1.25	0.772	0.566	0.447	0.369
1.38	0.845	0.618	0.487	0.402
1.82	1.1	0.796	0.624	0.512
2.16	1.29	0.929	0.725	0.593
2.52	1.49	1.07	0.829	0.676
2.74	1.61	1.15	0.891	0.725
2.9	1.7	1.21	0.936	0.76
3.03	1.77	1.26	0.971	0.788
3.13	1.83	1.3	1	0.811
3.31	1.92	1.36	1.05	0.847
3.44	1.99	1.4	1.08	0.875
4.01	2.29	1.6	1.23	0.99

24h	48h	72h	96h	120h
0.073	0.018	0.019	0.0096	0.02
0.08	0.018	0.02	0.0094	0.022
0.12	0.037	0.034	0.021	0.033
0.16	0.06	0.051	0.034	0.044
0.21	0.091	0.074	0.052	0.059
0.25	0.11	0.09	0.065	0.07
0.28	0.13	0.1	0.074	0.078
0.3	0.14	0.11	0.083	0.085
0.32	0.16	0.12	0.09	0.091
0.36	0.18	0.14	0.1	0.1
0.39	0.2	0.15	0.11	0.11
0.54	0.28	0.22	0.16	0.15

24h	48h	72h	96h	120h
1.3	0.798	0.583	0.46	0.379
1.43	0.876	0.638	0.502	0.413
1.9	1.14	0.825	0.645	0.528
2.26	1.34	0.965	0.751	0.613
2.64	1.55	1.11	0.859	0.699
2.87	1.68	1.19	0.924	0.75
3.04	1.77	1.26	0.971	0.787
3.18	1.85	1.31	1.01	0.816
3.29	1.91	1.35	1.04	0.84
3.47	2	1.41	1.09	0.877

3.61	2.08	1.46	1.12	0.907
4.21	2.39	1.67	1.28	1.03

24h	48h	72h	96h	120h
1.3	0.798	0.583	0.46	0.379
1.43	0.876	0.638	0.502	0.413
1.9	1.14	0.825	0.645	0.528
2.26	1.34	0.965	0.751	0.613
2.64	1.55	1.11	0.859	0.699
2.87	1.68	1.19	0.924	0.75
3.04	1.77	1.26	0.971	0.787
3.18	1.85	1.31	1.01	0.816
3.29	1.91	1.35	1.04	0.84
3.47	2	1.41	1.09	0.877
3.61	2.08	1.46	1.12	0.907
4.21	2.39	1.67	1.28	1.03

24h	48h	72h	96h	120h
1.32	0.805	0.587	0.463	0.382
1.45	0.883	0.643	0.506	0.416
1.92	1.15	0.833	0.65	0.532
2.29	1.36	0.974	0.757	0.618
2.67	1.57	1.12	0.867	0.705
2.91	1.7	1.21	0.933	0.757
3.08	1.79	1.27	0.98	0.794
3.22	1.87	1.32	1.02	0.823
3.33	1.93	1.36	1.05	0.847
3.51	2.03	1.43	1.1	0.885
3.66	2.1	1.48	1.13	0.915
4.26	2.42	1.69	1.29	1.03

24h	48h	72h	96h	120h
1.36	0.826	0.601	0.473	0.39
1.5	0.907	0.659	0.517	0.425
1.99	1.19	0.856	0.667	0.545
2.37	1.4	1	0.778	0.634
2.77	1.62	1.15	0.891	0.723
3.01	1.75	1.24	0.959	0.777
3.2	1.85	1.31	1.01	0.816
3.34	1.93	1.36	1.05	0.845
3.46	1.99	1.4	1.08	0.87
3.65	2.09	1.47	1.13	0.909
3.8	2.17	1.52	1.17	0.94
4.43	2.5	1.74	1.33	1.06

24h	48h	72h	96h	120h
1.31	0.802	0.585	0.462	0.381
1.44	0.88	0.641	0.504	0.415
1.92	1.15	0.83	0.648	0.531
2.28	1.35	0.97	0.755	0.616

2.66	1.56	1.11	0.864	0.702
2.89	1.69	1.2	0.929	0.754
3.07	1.78	1.27	0.976	0.791
3.2	1.86	1.31	1.01	0.82
3.32	1.92	1.36	1.04	0.844
3.5	2.02	1.42	1.09	0.882
3.64	2.09	1.47	1.13	0.911
4.24	2.41	1.68	1.28	1.03

24h	48h	72h	96h	120h
1.39	0.845	0.613	0.481	0.397
1.54	0.929	0.673	0.528	0.433
2.05	1.22	0.877	0.682	0.557
2.44	1.44	1.03	0.796	0.648
2.86	1.67	1.18	0.913	0.739
3.11	1.8	1.27	0.983	0.795
3.3	1.9	1.34	1.03	0.835
3.44	1.98	1.4	1.07	0.865
3.57	2.05	1.44	1.1	0.89
3.76	2.15	1.51	1.15	0.931
3.92	2.23	1.56	1.2	0.962
4.57	2.57	1.79	1.36	1.09

24h	48h	72h	96h	120h
1.32	0.81	0.59	0.465	0.384
1.46	0.889	0.646	0.508	0.418
1.94	1.16	0.838	0.654	0.535
2.31	1.37	0.98	0.762	0.622
2.69	1.58	1.13	0.873	0.709
2.93	1.71	1.21	0.939	0.761
3.11	1.81	1.28	0.986	0.799
3.24	1.88	1.33	1.02	0.828
3.36	1.94	1.37	1.05	0.852
3.54	2.04	1.44	1.1	0.891
3.69	2.12	1.49	1.14	0.92
4.3	2.44	1.7	1.3	1.04

24h	48h	72h	96h	120h
1.48	0.887	0.64	0.501	0.412
1.63	0.978	0.705	0.551	0.452
2.19	1.29	0.923	0.716	0.583
2.61	1.52	1.08	0.837	0.68
3.05	1.77	1.25	0.961	0.777
3.33	1.92	1.35	1.04	0.835
3.53	2.02	1.42	1.09	0.878
3.69	2.11	1.48	1.13	0.91
3.82	2.18	1.53	1.17	0.936
4.03	2.29	1.6	1.22	0.98
4.2	2.38	1.66	1.26	1.01
4.9	2.73	1.89	1.43	1.15

APPENDIX C

Wastewater Impact Assessment

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VAL: 2846140802

CENTRAL OTAGO DISTRICT COUNCIL

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10/02/2020

Houlahan Enterprises Ltd
Clyde Claim Ltd
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Paterson Pitts Group
30 The Mall
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Dear Peter,

Please find attached the memo for the water modelling assessment carried out for the proposed development by Houlahan Enterprise and Clyde Claim Ltd at 11 Sunderland Street - Mutton Town Road Clyde.

Please note this is a high-level modelling assessment done only for the proposed re-zoning of the land and for 150 residential units as described in the modelling request.

Assessment report concludes that;

> *The system performance in the remainder of the network has been verified. It is predicted that the additional demand will cause pressure to drop by a maximum of 3.5m at the connection point. Properties serviced by the 40mm main connected to the 150mm main along Sunderland Street are currently receiving low pressure and will be affected by the pressure drop caused by the proposed development.*
>
> *Pipe head losses are predicted to deteriorate along Sunderland Street, increasing from 0.7m/km to 5.1 m/km, which is marginally higher than the recommended levels of service.*

The report also provides mitigating options for the above-mentioned pressure drops and head losses, however this would require further investigation in detail if required.

Additional you have also requested to confirm that Clyde Wastewater Project design will accommodate future growth along Mutton Town road.

Council can confirm that the Clyde Wastewater reticulation design will have allowance for the future population growth of Clyde. Details of pipe size, location or depth cannot be confirmed at this time as this work is still in detailed design phase. However, the reticulation will include provisions to enable the connection of future reticulation in the proximity of Annan St.

Regards

Quentin Adams

Water Services Manager

APPENDIX D

Water Impact Assessment

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Mutton Town Road Development– Water Impact Assessment

10/02/2020

This letter summarises the results of the assessment undertaken for the proposed residential development consisting of 150 residential lots. The residential blocks are located on a site adjacent to Sunderland Street, Mutton Town Road and Clyde-Alexandra Road. The development is to be serviced by the Clyde water network.

1 Background

Mott MacDonald has been commissioned by Central Otago District Council (CODC) to assess the system performance in terms of Level of Service (LOS) and firefighting capacity for the proposed development zone. The impact of this development on the remaining network has also been investigated. The results of the evaluation are detailed in this letter report.

2 Assumptions

The proposed development will be serviced via a 150mm diameter pipe reaching the end of the development extent off Hospital St/Sunderland St. The development location is shown in the figure below.

Figure 1- Development Location

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2.1 Demand Calculations

The development consists of 150 residential lots. The demand for the development has been calculated based on the CODC addendum to NZS4404-2004, considering the following:

- Daily consumption of 500l/person/day
- Peak hour factor of 5 (residential)
- Density: 3 people per lot

Based on these assumptions, the following demand has been considered in the proposed development:

Table 1 - Demand Calculations

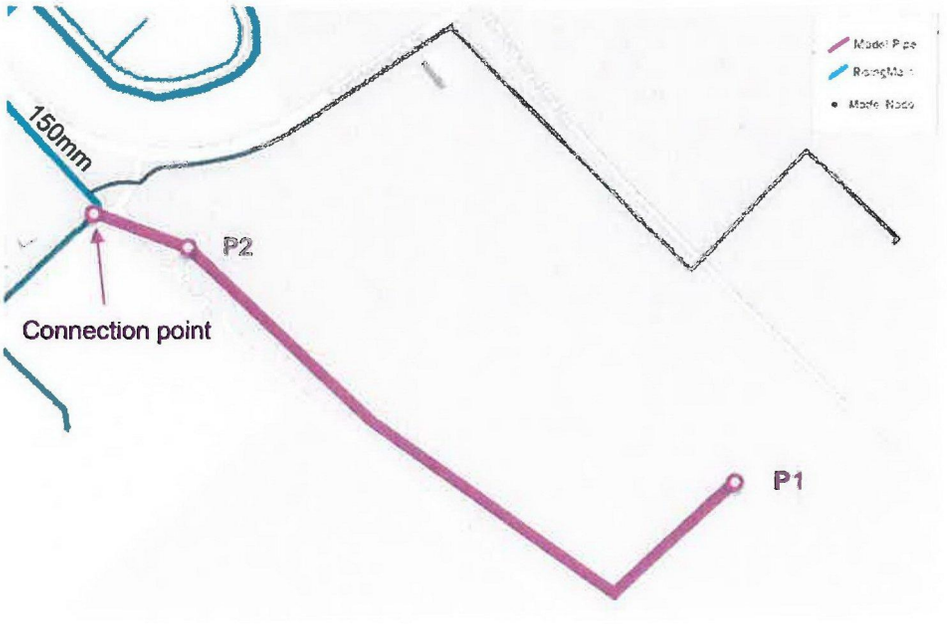
Development Stage	Average Daily Flow (l/s)	Peak Hour Flow (l/s)	Average Daily Flow (MLD)
Mutton Road Residential	2.6	13.0	0.225

2.2 Connection Point

The development elevation was derived from the contour (Appendix A) information provided by the CODC. The maximum elevation considered in this development was 167m.

It was assumed that the proposed development would be serviced from the 150mm diameter pipe off Hospital St/Sunderland St, as shown in Figure 2 below. A 150mm ID water main was modelled within the proposed development. The total residential demand was allocated to the point P1 (see Figure 2), which was placed the furthest from the connection point and given the highest elevation found within the development (167mRL). Minimum pressure was assessed at P1 and maximum pressure at P2 (the lowest elevation within the development).

Figure 2 – Proposed Development Connection Configuration



2.3 Scenarios Investigated

The scenario investigated was based on the Existing (2018) peak week scenario (Lake Dunstan model). The levels of service achieved in the proposed residential development were assessed in terms of pressure and fire flow. The impact of the proposed development was verified in terms of pressure and pipe head losses in the remaining of the network.

Fire flow was based on the NZ Fire Service Code of Practice (SNZ PAS 4509:2008).

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3 Model Results

3.1 System Performance Analysis in the Proposed Development

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 (150mm ID pipe) and fire flow capacity.

Table 2 - System Performance Results in Proposed Development

Demand	Node	Minimum Pressure (m)	Maximum Pressure (m)	Maximum Head Losses (m/km)	Fire Flow
Current Peak	P1	59.9	67.7	3.3	Can provide FW2 fire flow
	P2	68.8	74.7		

The design pressure set by NZS4404:2004 is 25 to 80m. As shown in the table above, minimum and maximum pressures in the proposed development are predicted to meet the recommended LOS for the current scenarios. FW2 was verified at the furthest point in the proposed development and FW2 can be provided with a residual pressure of 42.5m.

Maximum head losses are predicted to remain within the recommended LOS in the proposed development (generally 3 m/km for new pipes with a maximum of 5 m/km for existing pipes).

3.2 System Performance in the Remaining of the Network

Results have been analysed to verify that levels of service can be met in the Clyde network with the addition of the proposed development. Table 3 below summarises the minimum pressure forecasted at the supply point and maximum head losses along Sunderland St with and without the development; further illustrated in Figure 3 and Figure 4.

Table 3 System Performance Results in Clyde Network

	Minimum Pressure (m)		Maximum Head Losses (m/km)	
	Before	After	Before	After
Connection Point Hospital Street	72.0	68.5	0.7	5.1

The proposed development is predicted to have an impact on the existing Clyde network for current conditions, with a maximum forecast pressure drop of approximately 3.5m at the connection point. Pressure within the Clyde network are predicted to remain above 50m throughout most of the network. However, properties serviced by the 40mm line, connected to the 150mm water main on Sunderland St, currently receive low pressures, and will be affected by the pressure drop caused by the proposed development's additional demand. Any additional demand at the proposed development location will exacerbate the low-pressure issue along the 40mm watermain.

Peak head losses are predicted to increase to 5.1m/km directly upstream of the connection point along the 150mm pipe, near Sunderland Street. This is marginally higher than the recommended levels of service. Head losses are also affected further upstream in the network but remain within the recommended LOS.

MOTT MACDONALD

Figure 3: Existing Peak Day - Before Mutton Town Road Development

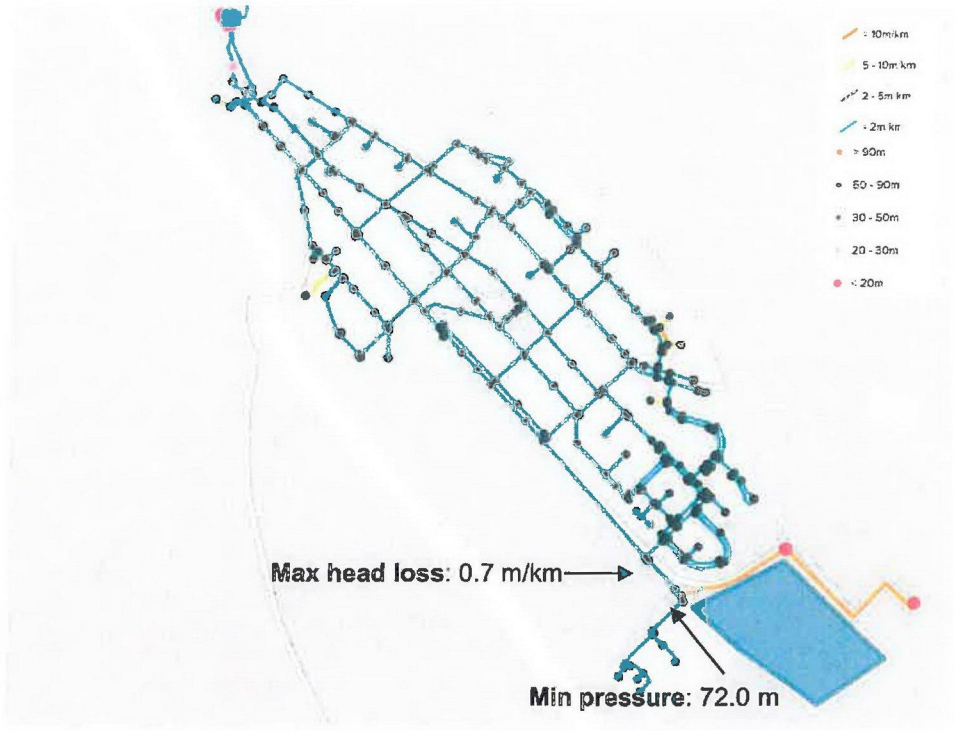
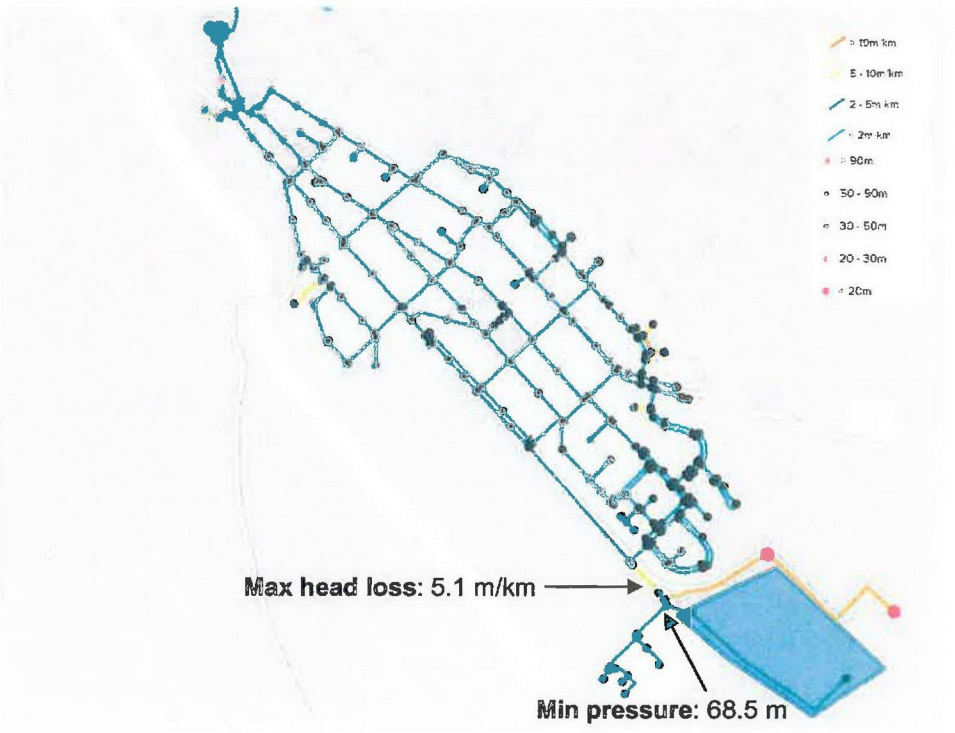


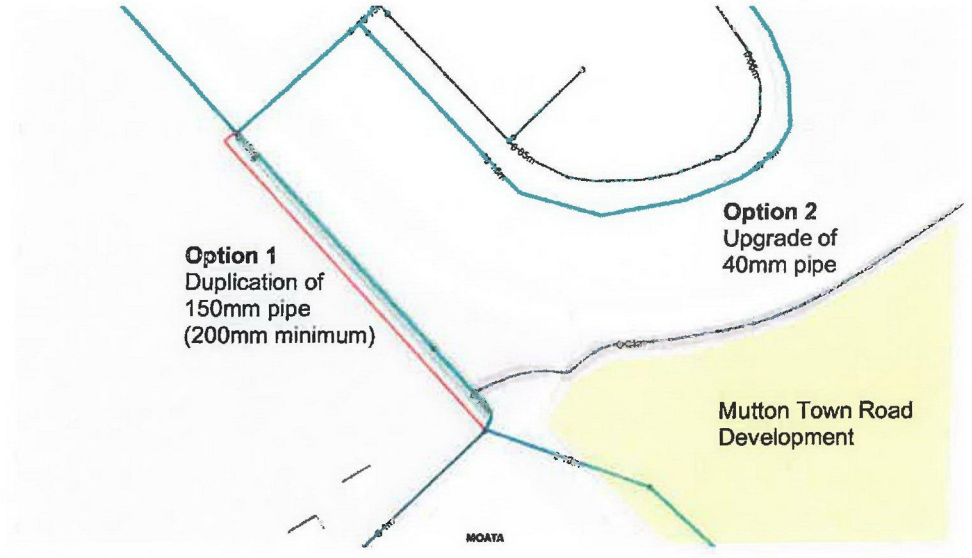
Figure 4 - Existing Peak Day - After Mutton Town Road Development



To mitigate the impact of the proposed development on the properties serviced by the 40mm main, an option consists in duplicating the 150mm line along Sunderland Street with a pipe no smaller than 200mm (see Option 1 in Figure 5 below). Alternatively, the 40mm pipe running parallel to the north-eastern boundary of the development could be upgraded to provide an equal measure of betterment (see Option 2 in Figure 5).

MOTT MACDONALD

Figure 5: Options Along Sunderland Street



Only high level optioneering has been undertaken as part of this study and further investigation is recommended with regards to providing the level of service required in the low-pressure area surrounding the development.

4 Conclusions and Recommendations

Demand from the proposed residential development has been added to the network for current peak conditions. The proposed development network was modelled to determine if suitable levels of service could be maintained.

Levels of service are expected to be met in terms of minimum pressure and head losses, whilst residential fire flow is available in the proposed development.

The system performance in the remainder of the network has been verified. It is predicted that the additional demand will cause pressure to drop by a maximum of 3.5m at the connection point. Properties serviced by the 40mm main connected to the 150mm main along Sunderland Street are currently receiving low pressure and will be affected by the pressure drop caused by the proposed development.

Pipe head losses are predicted to deteriorate along Sunderland Street, increasing from 0.7m/km to 5.1 m/km, which is marginally higher than the recommended levels of service.

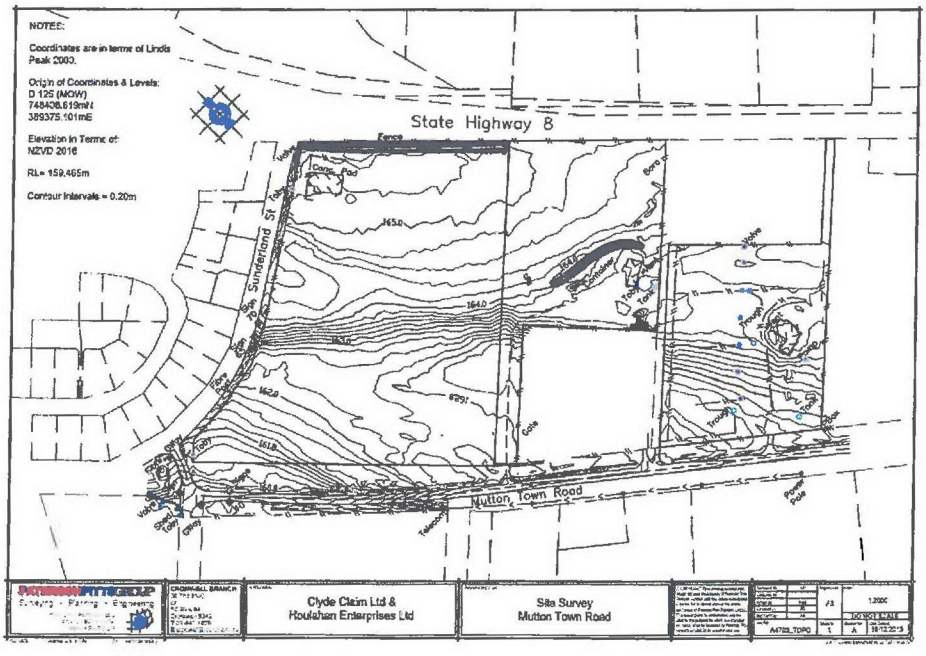
To mitigate the impact of the proposed development on the Clyde water supply network, it is recommended that the two options shown in Figure 5 above be investigated further (150mm main duplication or 40mm watermain upgrade).

The modelling results from this assessment are valid only for the information provided (150 residential lots and site contours). Any change to the type of utilisation, number of lots or fire flow category will require re-modelling.

Giulio Pozzuto
Hydraulic Modeller
giulio.pozzuto@mottmac.com

Revision	Date	Originator	Checker	Approver	Description
A	05/02/2020	David Burton	Tom Lecomte	Julie Plessis	Draft for client review
B	07/02/2020	Giulio Pozzuto	Tom Lecomte	Julie Plessis	Amendments to Section 3 and 4

Appendix A Contour map



APPENDIX E

Confirmation of Telecom Supply

Chorus Property Development Team
PO Box 9405
Waikato Mail Centre
Hamilton 3200
Telephone: 0800 782 386
Email: develop@chorus.co.nz

5 December 2019

Chorus Ref #: CYD55290
Your Ref #:

The Clyde Claim Ltd

Attention: **Peter Dymock**
Dear Sir / Madam

Property Development – CYD: Mutton Town Road, Clyde. 150 Lots - Estimate

Thank you for your enquiry regarding the above subdivision.

Chorus is pleased to advise that, as at the date of this letter, we would be able to provide ABF telephone reticulation for this property development. In order to complete this reticulation, we require a contribution from you to Chorus' total costs of reticulating the development. Chorus' costs include the cost of network design, supply of telecommunications specific materials and supervising installation. At the date of this letter, our estimate of the contribution we would require from you is $207,000.00 (including GST).

We note that (i) the contribution required from you towards reticulation of the development, and (ii) our ability to connect the subdivision to the Chorus network, may (in each case) change over time depending on the availability of Chorus network in the relevant area and other matters.

If you decide that you wish to undertake reticulation of this property development, you will need to contact Chorus (see the contact details for Chorus Property Development Team above). We would recommend that you contact us at least 3 months prior to the commencement of construction at the subdivision. At that stage, we will provide you with the following:

- confirmation of the amount of the contribution required from you, which may change from the estimate as set out above;

- a copy of the Contract for the Supply and Installation of Telecommunications Infrastructure, which will govern our relationship with you in relation to reticulation of this property development; and

- a number of other documents which have important information regarding reticulation of the property development, including - for example - Chorus' standard subdivision lay specification.

Yours faithfully

Rata Miller
Property Development Coordinator

APPENDIX F

Confirmation of Power Supply

AURORA ENERGY LIMITED
PO Box 5140, Dunedin 9058
PH 0800 22 00 05
WEB www.auroraenergy.co.nz

25 November 2019

Peter Dymock
Paterson Pitts Group

Sent via email only: peter.dymock@ppgroup.co.nz

Dear Peter,

ELECTRICITY SUPPLY AVAILABILITY FOR A PROPOSED 150 LOT SUBDIVISION.
MUTTON TOWN ROAD, CLYDE. LOT 2 DP 18990, LOT 2 DP 525753 AND LOT 2 DP331535.

Thank you for your inquiry outlining the above proposed development.

Subject to technical, legal and commercial requirements, Aurora Energy can make a Point of Supply[1] (PoS) available for this development.

Disclaimer

This letter confirms that a PoS **can** be made available. This letter **does not** imply that a PoS is available now, or that Aurora Energy will make a PoS available at its cost.

Next Steps

To arrange an electricity connection to the Aurora Energy network, a connection application will be required. General and technical requirements for electricity connections are contained in Aurora Energy's Network Connection Standard. Connection application forms and the Network Connection Standard are available from www.auroraenergy.co.nz.

Yours sincerely

NA Frear.

Niel Frear
CUSTOMER INITIATED WORKS MANAGER

[1] Point of Supply is defined in section 2(3) of the Electricity Act 1993.

APPENDIX G

CBR TESTS

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 19/3963

Date: 24 January 2020

TEST REPORT - LABORATORY SOAKED CBR'S

Client Details:	**Paterson Pitts Partners Ltd, 30 The Mall, Cromwell**	**Attention:**	**M. Garmonsway**
Job Description:	**The Clyde Claim / Braid / Houlahan Development, Mutton Town Road, Clyde**		
Sample Description:	**Subgrade – See Below**	**Client Order No:**	**N/A**
Sample Source:	**Insitu – See Locations Page 3**	**Sample Label No:**	**53678**
Date & Time Sampled:	**12-Dec-19 @ 1.43pm to 2.40pm**	**Sampled By:**	**N.P. Danischewski**
Sample Method:	**NZS 4407:2015, Test 2.4.2**	**Date Received:**	**12-Dec-19**
Test Method:	**NZS 4402:1986, Test 6.1.1**		

LABORATORY SOAKED CBR RESULTS					
Sample Source:	**Test Pit 1**	**Test Pit 2**	**Test Pit 3**	**Test Pit 4**	**Test Pit 5**
Sample Depth: (mm)	**500 - 800**	**550 - 850**	**550 - 850**	**550 - 850**	**650 - 950**
Sample Description:	**Sandy GRAVEL with trace of silt**	**SAND with minor / some gravel & trace of / minor silt**	**Sandy GRAVEL with trace of silt**	**Sandy GRAVEL with trace of silt**	**Sandy GRAVEL with trace of silt**
Condition of Sample:	**Soaked**	**Soaked**	**Soaked**	**Soaked**	**Soaked**
Surcharge Mass: (kg)	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**
Time Soaked:	**7 days**	**7 days**	**7 days**	**7 days**	**7 days**
Swell: (%)	**-0.2**	**0.2**	**0.0**	**0.0**	**0.0**
Water Content as Compacted: (%)	**3.0**	**8.9**	**4.1**	**3.9**	**4.6**
Water Content From Under Plunger: (%)	**5.1**	**13.2**	**9.5**	**6.5**	**10.7**
Dry Density As Compacted: (t/m^3)	**2.00**	**1.88**	**1.95**	**1.79**	**1.81**
CBR Value @ 2.5 mm Penetration:	**20**	**15**	**18**	**14**	**17**
CBR Value @ 5.0 mm Penetration:	**30**	**14**	**25**	**18**	**17**
Reported CBR Value:	**30**	**15**	**25**	**18**	**17**

Notes:

- ***The material was received in a natural state.***
- ***The material tested was the fraction passing the 19.0mm test sieve.***
- ***The sample was compacted to NZ Standard Compaction at the water content as received.***
- ***The rate of penetration was 1.10 mm / min.***
- ***Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005.***
- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith** **Date:** **16 to 24-Jan-20**

Checked By:

Tests indicated as Not Accredited are outside the scope of the laboratory's accreditation

IANZ
ACCREDITED LABORATORY
Accreditation No: 434

Central Testing Services
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Sample Method:	**NZS 4407:2015, Test 2.4.2**	**Date Received:**	**12-Dec-19**
Test Method:	**NZS 4402:1986, Test 6.1.1**		

LABORATORY SOAKED CBR RESULTS					
Sample Source:	**Test Pit 6**	**Test Pit 7**	**Test Pit 8**	**Test Pit 9**	**Test Pit 10**
Sample Depth: (mm)	**600 - 900**	**550 - 850**	**650 - 950**	**700 - 1000**	**600 - 900**
Sample Description:	**Gravelly SAND with trace of silt**	**Sandy GRAVEL with trace of silt**	**Gravelly SAND with trace of silt**	**Gravelly SAND with trace of silt**	**Gravelly SAND with minor / trace of silt**
Condition of Sample:	**Soaked**	**Soaked**	**Soaked**	**Soaked**	**Soaked**
Surcharge Mass: (kg)	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**
Time Soaked:	**6 days**	**6 days**	**6 days**	**6 days**	**6 days**
Swell: (%)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Water Content as Compacted: (%)	**4.5**	**3.6**	**3.9**	**4.5**	**3.0**
Water Content From Under Plunger: (%)	**7.5**	**4.6**	**9.0**	**10.5**	**11.9**
Dry Density As Compacted: (t/m³)	**1.85**	**1.87**	**2.02**	**1.91**	**1.78**
CBR Value @ 2.5 mm Penetration:	**14**	**12**	**25**	**25**	**40**
CBR Value @ 5.0 mm Penetration:	**16**	**18**	**25**	**25**	**30**
Reported CBR Value:	**16**	**18**	**25**	**25**	**40**

Notes:

- *The material was received in a natural state.*
- *The material tested was the fraction passing the 19.0mm test sieve.*
- *The sample was compacted to NZ Standard Compaction at the water content as received.*
- *The rate of penetration was 1.10 mm / min.*
- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005.*
- *This report may not be reproduced except in full.*

Tested By: **L.T. Smith** **Date:** **16 to 24-Jan-20**

Checked By:

Tests indicated as Not Accredited are outside the scope of the laboratory's accreditation

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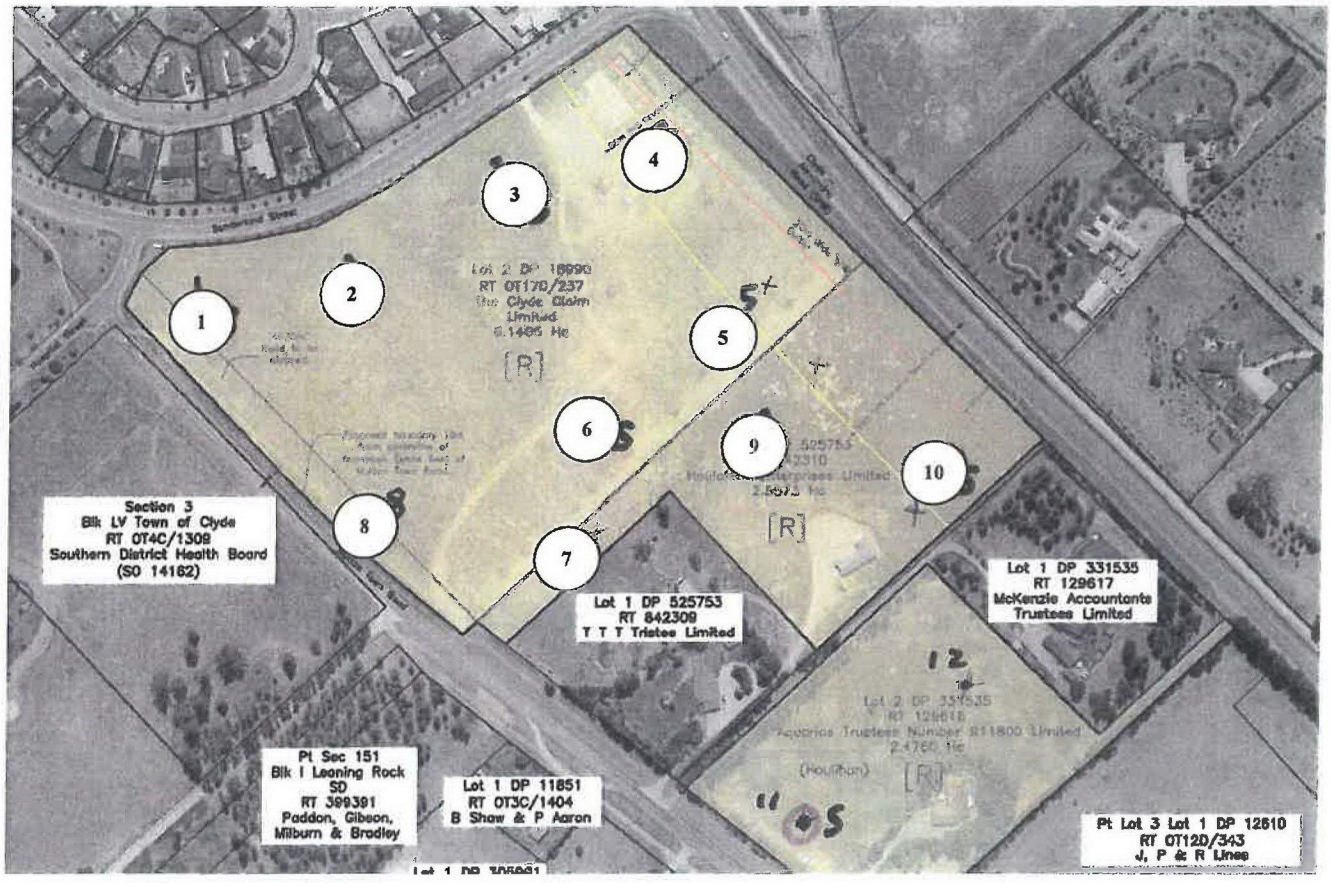

Tested By: L.T. Smith **Date:** 16 to 24-Jan-20

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

Tests indicated as Not Accredited are outside the scope of the laboratory's accreditation

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