GIBSON CIVIL CONSULTING LTD

Preliminary Geotechnical and Civil Engineering Investigation:

Suitability for Land Development

Location: 50 Hart Road, Richmond .

Clients: Chesham Estates Ltd & Oregon Land Ltd (jointly).

Date: 4th November 2020

Reference: 200825-1-B

Prepared By:

Rodney Gibson

BE CMEngNZ, CPEng.

Introduction

Gibson Civil Consulting Ltd has been engaged by the clients to conduct a preliminary geotechnical investigation and assessment of natural hazards with respect to the suitability of the land for development of residential titles.

Impacts from an increased rate of storm water runoff due to development have been partially offset by allowance for detention in previous stages of development. This report includes assessment of the feasibility of 'on site' storm water detention on a per title basis.

The purpose of the geotechnical investigation is to:

- Assess soil design bearing strengths at selected locations with respect to suitability for non-specific foundation design,
- Assess groundwater conditions and soil type at selected locations.
- Assess natural hazards with respect to section 106 of the Resource Management Act (RMA) 1991.
- Provide advice on specific constraints or conditions as appropriate for development.

Description

The site is currently accessed from 50 Hart Rd Richmond as shown in figure 1 below, comprising land from two entities, Chesham Estates Ltd and Oregon Land Ltd. Site topography is planar gently sloping to the west. The Chesham block is currently in mown grass with an existing residential dwelling and farm sheds. The Oregon Land block was in vineyard which has been retired to grazing, including a small shed to the western boundary.

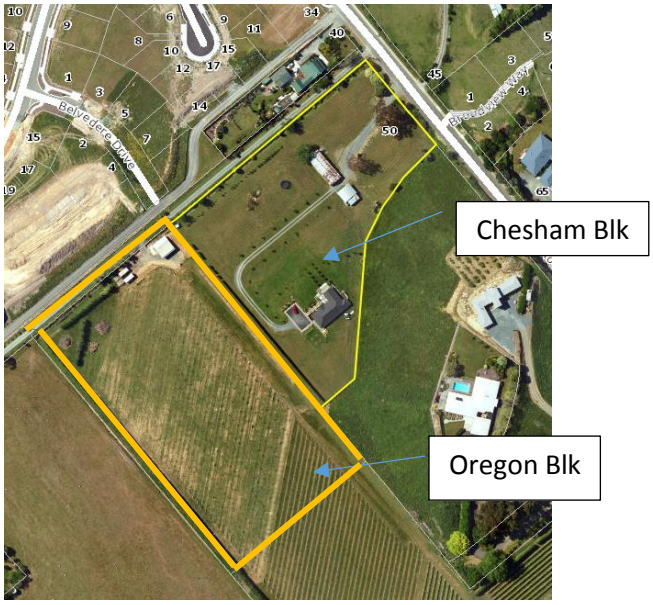


Figure 1: Aerial layout of Chesham and Oregon Blocks.

Whilst the Oregon Land block continues as a planar surface, the Chesham block is overlooked by a small elevated spur to the east.

Site Soils.

Published Geology

The 1:25,000 scale geological map of the area (Nelson Urban Area) generally indicates the site is underlain by alluvium and Moutere Gravel. The Waimea fault is conjectured to lie obscured by the alluvium approximately 150m south east of the site. We note Tasman District Planning maps indicate the Waimea Fault significantly further east.

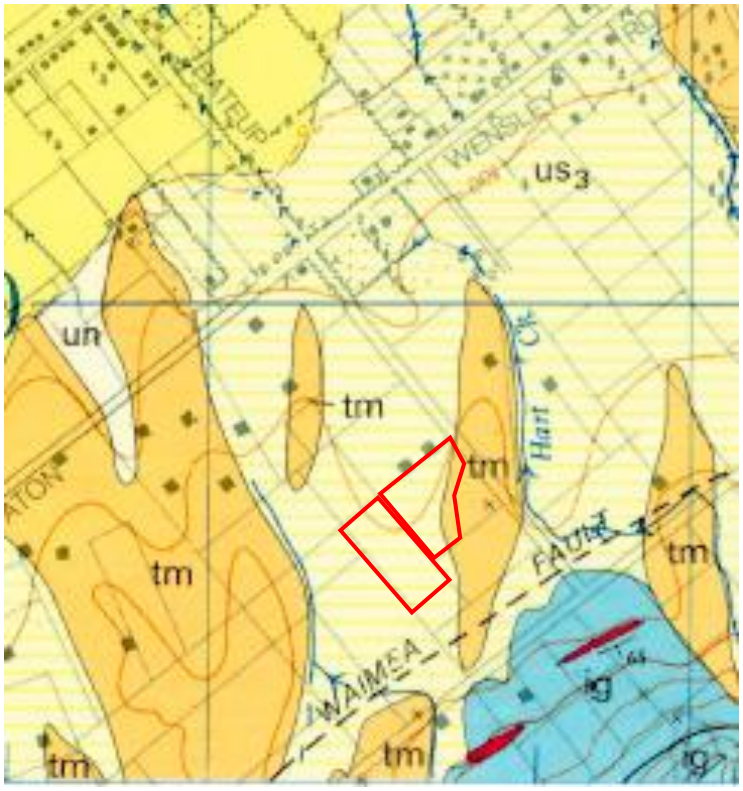


Figure 2: Geology Map (Extract) – approximate site shown in red.

Natural Hazards.

Natural hazards are considered under section 106 of the Resource Management Act (RMA) 1991 and amendments (June 2020). Natural hazards, (as they relate to this site), includes any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, landslip, subsidence, sedimentation, wind, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.

The location, geology and relatively gentle slopes on the site means that the site is not subject to significant erosion, landslip, subsidence, or sedimentation. The site is not in an extreme or very high wind zone. Tsunami modelling by Tasman District Council indicates the site as clear of Tsunami inundation. The site is not considered to be at risk from flooding however Tasman District Council should be contacted to confirm flood risk and required minimum floor level.

The nearest mapped fault lies to the east well clear of the site, consequently there does not appear to be a fault hazard beneath the site.

Cohesive outwash strata underlying the site suggests a low liquefaction potential and related subsidence effects.

In summary the site is assessed to be at low risk from natural hazards.

Shallow Subsoil Investigation

Site investigation comprised a detailed site walk over, five shallow test pits up to (1.8m) and four scala penetrometer probes.

Figure 3: Site investigation layout.

Test pit 5 is located adjacent to but clear of an old burning pile which we are advised may be subject to contamination. All test pitting was backfilled immediately and compacted in place by the excavator bucket.

Ground conditions encountered were alluvial outwash deposits, typical of Stoke Fan Gravels and Moutere Clay out wash. Test pits 1 and 2 encountered fill overlying topsoil. The area around TP1 appears modified to suit landscaping and Test pit 2 modifications are due to a prior residential dwelling. Soils may be generally described as fine grained, nominally non plastic, **silt, sand and clay** fractions with well-rounded gravel to cobble sized rock. Refer to the attached logs for more specific descriptions.

Ground water, was not encountered until 1.6~1.8m depth with little evidence of mottling above these levels. It must be appreciated that water levels will change with seasonal weather conditions.

Scala penetrometer tests were carried out adjacent to test pits 2-5. Design bearing strengths (q_{dbs}) have been estimated from Stockwell correlations. It must be noted that these correlations are based on a factor of safety approach (FOS=3) rather than a strength reduction factored approach as inherent in NZS1170 2004 and section B1 of the NZ building regulations. On this basis a design bearing strength of 100kPa or greater is required for non-specific foundation design of residential building foundations.

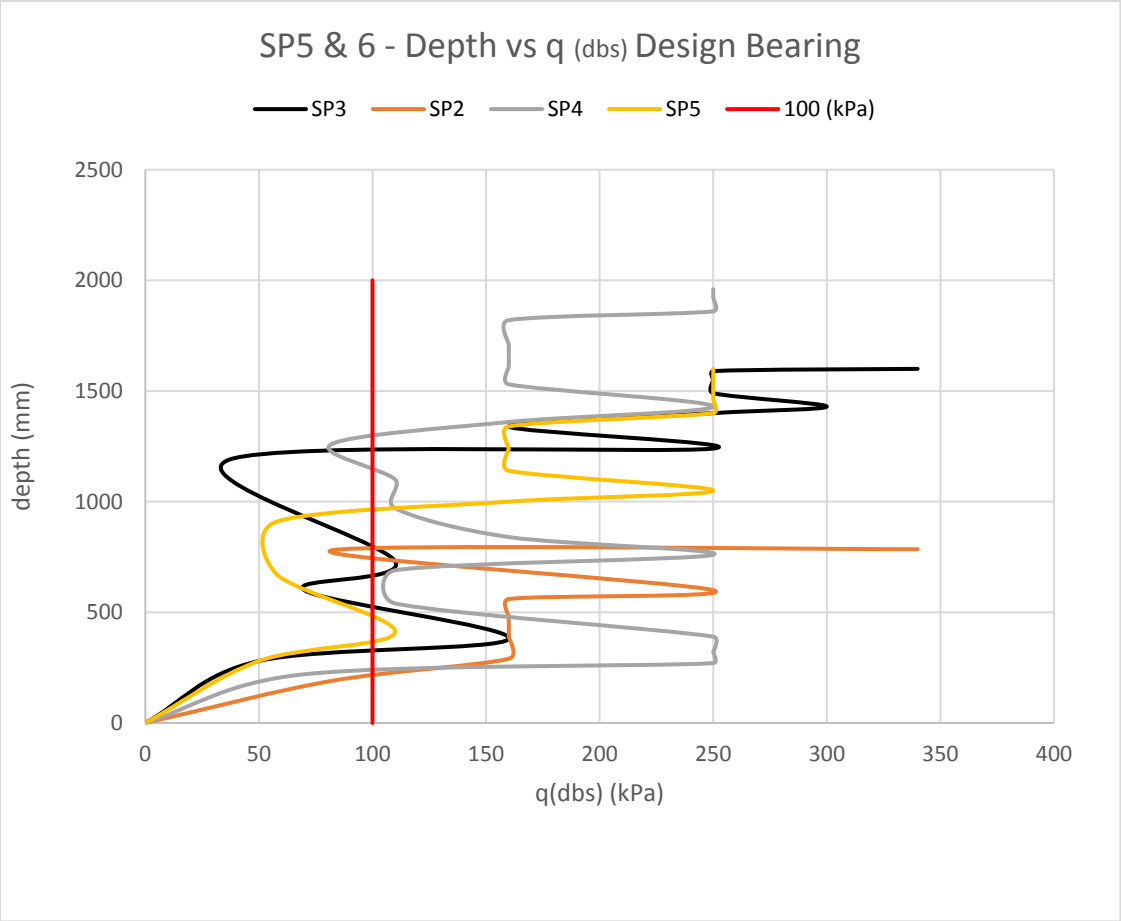


Figure4: Scala Penetrometer estimation of Design Bearing Strength vs Depth.

Test results indicate reasonable ground bearing with some soft layers at depths of 0.60m to 1.3m below present levels. Whilst variation in bearing strength is not preferred it is manageable through specific foundation design. Testing will be required on each title to improve the understanding of estimated bearing strength variation and it is likely that specific foundation design will be required for residential foundations.

Seismic subsoil classification in accordance with NZS1170.5 (suite of standards) is likely to be consistent with class D.

Building Regulations and Consent.

Residential building development must satisfy the requirements of the New Zealand Building code and associated regulations, specifically section B1 (structure). Section B1 defines NZS 3604:2011 as an acceptable solution. Given the variability in soil bearing strength with depth it is unlikely that the requirements of NZS3604:2011 will be met consistently across the site. Apart from bearing strength NZS3604:2011 excludes, organic soils, lose or compressible soils, expansive soils or land subject to creep or subsidence, shrink swell, and liquefaction amongst other aspects in considering what is defined as 'good ground'. Subject to further site testing during development it is likely that specific foundation design by a chartered professional engineer will be required as a condition on each title.

Regardless, all buried topsoil and uncontrolled fill should be removed and either reduced to natural ground or replaced with controlled engineered earth fill. Material cut from roads or trench excavation should be suitable as an earth fill subject to moisture control and blending. Laboratory testing will be required to verify target moisture content for optimum compaction.

In considering the field test pits, scala test results and the general land form we consider the suitability of the land is manageable for land development. Consent should be subject to normal engineering controls and conditions of consent as are normally applied by the regulatory authorities.

Appropriate conditions should relate to certification of any earth fill. Certification of suitability for erection of a residential dwelling on each title once the final layout has been determined. Control of surface water to minimise erosion and siltation risks and management of groundwater risks.

Storm water Detention.

Previous analysis.

We have been supplied with details of resource consent and copies of two reports from CGW (Cameron Gibson and Wells Ltd) relating to storm water runoff and the capacity of an existing storm water detention pond developed as part of the 2016 -2019 Arizona Lands Ltd development (RM160629V1), downslope of this current development.

These reports are: 18586-LET-003-A of 30th November 2019 and 17382-LET-002-A of 7th September 2018. (Appended).

In summary these reports address adjustments to the catchment storm water analysis as part of the original Arizona Lands development under resource consent RM160629V1 as amended:

RM160629V1 Consent Granted 3 Nov 2016 (Amended 11 Nov 2016 Objection Decision 10 July 2017)
Change of Conditions Granted 10 August 2018 (Amended 3 September 2018) Page 9

Relevant conditions of that consent and advice notes are:

Detention Basin (Lot 146)

50 A stormwater detention basin shall be constructed within Lot 146 in general accordance with the design concept presented in the Cameron Gibson & Wells report and attached to the consent as Plans F and G, subject to achieving the requirements of Conditions 51 and 52 below.

51 The off-line stormwater detention basin shall provide sufficient detention volume to detain the estimated increase in peak Q100 storm event flows of 0.65 cumecs resulting from the subdivision authorised by this consent and future residential development of Lot 100 and adjacent properties being Lot 2 DP 20243 and Lot 1 DP 450177.

Advice Notes:
The detention basin required by Condition 50 will provide stormwater detention for future residential development of areas additional to the detention volume required for the development authorised by this consent. Those additional areas are proposed Lot 100 as shown on Plan A attached to this consent, and adjacent properties to the east being Lot 1 DP 20243 and Lot 1 DP 450177. The detention required for the latter two areas is estimated at 15% of the total detention volume required. The Consent Holder has an agreement with the owners of Lot 2 DP 20243 to provide the detention required for development of that property.

The Chesham block is defined as Lot 1 DP450177 and is fully catered with respect to stormwater detention by the Arizona Lands detention pond developed under RM160629V1.

Adjustments to the detention capacity assessment arise from Arizona Lands Ltd choice to not undertake one hectare of comprehensive development. Calculations include criteria in the 2019 NTLDM.

- Allowance for increased rainfall intensity as estimated global warming scenario by HIRDS v4 RCP8.5 for the period 2081-2100.
- Revised rational 'C' factor of 0.4 pre development and 0.66 across the post developed land.
- Revised rainfall intensity (based on the catchment 't_c' of 52 minutes), of 81.16mm/hr for a 1%AEP.

The nett conclusion of increased rainfall intensity and amended catchment characteristics is 'spare' capacity in the existing detention for 0.38ha of residential development (approximately 5~6 lots) as part of the Fry block. Either a new detention facility or onsite per title detention will be required for the balance area. This report is to assess the feasibility of onsite detention per title.

In reference to these CGW reports we have not peer reviewed these in their entirety.

Storm water Detention Demand

Our assessments concur with the revised rainfall intensity of 81mm/hr. The critical storm risk is 1% AEP, 52minute time of concentration using the rational approach which is specific to this catchment.

We have also considered development in accordance with TDC RMP zone rules, ARC guidelines (GD01) and MBIE building regulations VM E1 /VM1. We have used the HIRDS projection of rainfall intensity as per RCP8.5 for the period 2081-2100.

Based on the title areas for the Chesham Lands Ltd block as a typical layout, this involves 20 titles over 12,248m^2 and 3,072m^2 area of road to vest. Average section size is 612m^2 with 154m^2 of road area associated with each title. As outlined in the CGW reports an average runoff coefficient of 0.66 has been agreed with TDC for a post development runoff coefficient. A pre development runoff coefficient of 0.4 is appropriate, for the heavier (more claylike) topsoil. The total increase in runoff to be detained is therefore **Q** = Post development runoff – pre development runoff, which is determined by the difference in runoff coefficients.

Q = (0.66-0.4) * 81 * 766/1000= 16.13m^3 for the critical storm duration peak.

In summary for an average 766m^2 area, C post dev – C pre dev= 0.26:

	Q for 10 minute = tc (m^3)	*i* (mm/hr)	Q for 52 minute = tc (m^3)	*i* (mm/hr)
10% AEP	3.6	107	12.2	61.1
1% AEP	5.8	174	16.13	81

Estimated volumes are significant based on the average lot size, site coverage and surface conditions. These will vary with each title development as outlined by building consent plans for which specific assessment would be required. For the purposes of feasibility we have considered the average. Once the layout of the Fry block is confirmed these calculations should be reassessed.

Detention and Infiltration Systems.

ARC guideline GD01 recommends discharge to a retention tank (prior to detention) to settle silt sediments and enable some reuse of non-potable water. At 5mm per (m^2) area of house this equates to approximately 1200~1000 litres. Restricted access and vermin proof provisions apply.

Infiltration

Detention volumes may be reduced by use of infiltration via galleries or soakage beds. Galleries also provide detention volume. For instance a small gallery, of readily available plastic forms with high voids (95%), beneath a sealed or concrete driveway of 15m^2 at a soakage rate of 3mm/hr over 24 hours will account for just over 1m^3 of soakage and 5.7m^3 of detention volume. Whilst this is not significant for the long duration 1%AEP storm it is relevant for short duration rainstorms where replenishment of subsoil moisture is beneficial. Soakage via the same system beneath 40m^2 of drive for instance could provide 15.2m^3 of detention volume and 2.88m^3 of soakage over 24 hours which in conjunction with retention of 1.2m^3 obviates the need for other forms of detention. We

recommend pre-treatment via a settlement tank or retention tank prior to soakage. The above examples use an infiltration rate of 3mm/hour which is considered conservative (low) for these alluvial deposits. We recommend specific site testing of long term permeability rates for use of infiltration galleries in combination with detention assessments.

Detention

Detention systems alone with a controlled discharge rate include above or below ground tanks which take up considerable space and excavation in an urban section. Alternative options are available such as standalone fence tank forms, under driveways or systems in conjunction with waffle type concrete foundations where interconnected pods form the void for both the ribbed waffle form and storage. For instance a 175mm effective void depth over a 200m^2 house accounts (at 50% effective coverage) for 17.5m^3 of detention volume. Specific design is required for these systems for both structural performance and storm water detention. A retention or settlement chamber in recommended prior to the detention system.

General.

Detention and infiltration systems are 'engineered' solutions subject to building regulations. Whilst the volumes are significant, we consider that systems are available to mitigate storm water impacts that as yet have not been provided for by the wider development. All engineered designs have limits and prudent design is required considering inflow, discharge and overflow provisions

Discharge rates should be based on pre development runoff flow rates.

Conclusions and Recommendations.

1. Risk from natural hazards is assessed as low. The site location is clear of modelled Tsunami inundation and flooding. The nearest earthquake fault line lies to the east well clear of the site, consequently there does not appear to be a fault hazard beneath the site.

2. Soil bearing strengths vary with depth below present levels and do not consistently meet the requirements of NZS3604 as regards nonspecific design of foundations. Subject to testing and certification for each Lot at the time of creating titles we consider that each title is likely to contain an area suitable for erection of a residential dwelling albeit with conditions appropriate to specific engineering foundation design.

3. We recommend a condition of consent, as is normally applied, requiring certification from a geo-professional regarding the suitability of soils for each title for the erection of a residential dwelling in accordance with NZS4404:2010.

4. Buried topsoil and uncontrolled fill should be removed or conditions of specific engineering foundation design should be applied to titles with these soils, specifically drawing the attention of designers to these deposits. Any earthworks filling should be carried out in accordance with NZS4431 and a condition to this effect should be applied to any resource consent, as is normally applied.

5. Given the planar topography we recommend that earthworks associated with each lot is minimised and that roads are cut into the existing levels. Existing soils (excluding topsoil) are suitable as onsite fill material for which optimum moisture content soil density testing will be required.

6. Mitigation of storm water impacts due to the proposed development by a combination of detention, retention and infiltration appears feasible subject to specific assessment of site development. We recommend infiltration rate estimates are carried out as part of title development but site coverage and layout and choice of detention or infiltration are determined by plans at building consent stage.

7. From previous reports prior detention pond development offsets storm water impacts for five titles and that on site storm water mitigation is not required for 0.38ha of residential development (5~6 titles) as part of the Fry block.

8. For storm water mitigation on the Fry block (excluding 5~6 Lots of stage 1) a condition should be applied to each title requiring specific design of a combination of storm water retention, detention or infiltration. The assessment of increased runoff per title should include an area of road apportioned to each title. Preliminary estimates based on averaging the typical layout suggests an allowance of 154m^2 of road area per title is appropriate, however this is subject to reassessment once final subdivision layout is confirmed.

9. We recommend pre-treatment via a settlement tank or retention tank prior to infiltration or detention. For infiltration we recommend specific site testing of long term permeability rates for use of infiltration galleries in combination with detention assessments.

10. In summary we recommend that approval to subdivide and develop residential titles can proceed on a low risk basis subject to the recommendations and mitigation measures outlined in this report.

Attached:

Test pit logs;

CGW Reports: 18586-LET-003-A of 30th November 2019 and 17382-LET-002-A of 7th September 2018.

Test Pit Logs:

GIBSON CIVIL CONSULTING LTD	Project / Client:		Chesham Estates Ltd, jointly with Oregon Land Ltd		TP	1
	Location:	50 Hart Rd Richomnd , Nelson				
	GL:	Natural	N: (co-ord):		Logged by:	RG
Date: 29 09 20	Method:	exc	E: (co-ord):		sheet:	1
Description				DEPTH (m)	Legend	Water
topsoil grass (pasture) organic				0		
				0.1		
				0.25		
light brown CLAY fill with some gravels and sands.				0.35		
				0.45		
FILL soft				0.55		
				0.65		
				0.8		
TOPSOIL soft				0.9		
				1		
				1.1		
Gravels in a CLAY matrix, with some sands and silts.				1.2		
Stoke Fan Gravels				1.3		
				1.4		
				1.5		
				1.6		
				1.7		
				1.8	end	at 1.8m
				1.9		
				2		
				2.1		
				2.2		
				2.3		
				2.4		
				2.5		
				2.6		

GIBSON CIVIL CONSULTING LTD	Project / Client:		Chesham Estates Ltd, jointly with Oregon Land Ltd		TP	2
	Location:	50 Hart Rd Richomnd , Nelson				
	GL:	Natural	N: (co-ord):		Logged by:	RG
Date: 29 09 20	Method:	exc	E: (co-ord):		sheet:	1

Description	DEPTH (m)	Legend	Water
Topsoil	0		
	0.1		
light brown CLAY fill, soft.	0.2		
	0.3		
Topsoil, soft	0.4		
	0.5		
light brown CLAY with some sands and gravels. Moutere Gravel outwash'	0.6		
	0.7		
	0.8		
	0.9		
	1		
	1.1		
	1.2	end	nil
	1.3		
	1.4		
	1.5		
	1.6		
	1.7		
	1.8		
	1.9		
	2		
	2.1		
	2.2		
	2.3		
	2.4		
	2.5		

GIBSON CIVIL CONSULTING LTD	Project / Client:		Chesham Estates Ltd, jointly with Oregon Land Ltd		TP	3
	Location:		50 Hart Rd Richomnd , Nelson			
	GL:	Natural	N: (co-ord):		Logged by:	RG
Date: 29 09 20	Method:	exc	E: (co-ord):		sheet:	1
Description				DEPTH (m)	Legend	Water
Topsoil organics				0		
				0.1		
				0.2		
				0.3		
Firm CLAY with some sands and gravels. Fragment of siltstone. STOKE FAN GRAVELS				0.4		
				0.5		
				0.6		
				0.7		
				0.8		
				0.9		
				1		
				1.1		
				1.2		
				1.3		
				1.4	end	1.4m
				1.5		
				1.6		
				1.7		
				1.8		
				1.9		
				2		
				2.1		
				2.2		
				2.3		
				2.4		
				2.5		

GIBSON CIVIL CONSULTING LTD	Project / Client:		Chesham Estates Ltd, jointly with Oregon Land Ltd		TP	4
	Location:	50 Hart Rd Richomnd , Nelson				
	GL:	Natural	N: (co-ord):		Logged by:	RG
Date: 29 09 20	Method:	exc	E: (co-ord):		sheet:	1

Description	DEPTH (m)	Legend	Water
topsoil and organics	0		
	0.1		
	0.2		
rounded cobbles and gravels in a CLAYlike matrix with sands and silts. light brown, firm, damp, low plasticity	0.3		
	0.4		
	0.5		
	0.6		
	0.7		
sandy GRAVEL, black, damp tightly, packed.	0.8		
	0.9		
Mottled light brown gravels in CLAY with sands.	1		
	1.1		
	1.2		
Light brown CLAY (like) with sands and silts,	1.3		
	1.4		
	1.5	end 1.4	no water
	1.6		
	1.7		
	1.8		
	1.9		
	2		
	2.1		
	2.2		
	2.3		
	2.4		
	2.5		

GIBSON CIVIL CONSULTING LTD	Project / Client:		Chesham Estates Ltd, jointly with Oregon Land Ltd		TP	5
	Location:	50 Hart Rd Richomnd , Nelson				
	GL:	Natural	N: (co-ord):		Logged by:	RG
Date: 29 09 20	Method:	exc	E: (co-ord):		sheet:	1

Description	DEPTH (m)	Legend	Water
	0		
topsoil and organics	0.1		
	0.2		
	0.3		
light brown silty sandy CLAY, mottled at 700mm.	0.4		
Minor well rounded gravels, with some rootletsto 700mm.	0.5		
Firm low plasticity.	0.6		
Stoke Gravels' poorly sorted CLAY bound gravels.	0.7		
	0.8		
light brown silty sandy CLAY (like), mottled.	0.9		
Firm low plasticity, water at 1.6m	1		
	1.1		
	1.2		
	1.3		
	1.4		
	1.5		
	1.6		1.6m
	1.7		
	1.8		
Poorly sorted, clay-bound, platy gravel forming present day fans (us_3) and fan remnants 2–8 m (us_2) and c.25 m (us_1) above present fans.	Stoke Fan Gravel (us)		
	2.2		
	2.3		
	2.4		
	2.5		

CGW Reports: 18586-LET-003-A of 30th November 2019 and 17382-LET-002-A of 7th September 2018.

CGW Ref: 17382-LET-002-A

Date: 7 September 2018

Arizona Land Limited
c/o Nalder Surveys Ltd
210 Princes Drive
Nelson

Attention: Nigel Nalder

Dear Nigel,

RE: 17382 – Hart Rise Estate: Development Comprehensive Area

The following email provides commentary of potential additional development area that could be included as part of the Hart Rise Estates detention basin capacity, based on a comprehensive development allowance but was never incorporated, for stormwater from the Arizona Land subdivision.

Based on our calculations an area of 1 hectare (ha) of comprehensive development was allowed for in the design of the detention basin.

This comprehensive area was assumed to have a Coefficient of Runoff (C)= 0.80

Based on a residential C= 0.66 (as agreed with TDC) this means that if the 1 ha of comprehensive is instead developed as standard residential, the extra area that could be developed with residential (C=0.66), without effecting the design can be determined from the change in CA (where CA is runoff coefficient x area):

Therefore the 'additional' CA = comprehensive CA - residential CA = 0.80(1ha) - 0.66(1ha)
= 0.14

The area will depend upon the where those extra lots were located in relation to 'zone'. As we have already assumed runoff from the land within the catchment, the change in runoff will only be the increase above the existing rural runoff (assumed to be C = 0.30 to 0.48 depending upon soil, slope and cover).

If it is in an area with mild sloping pasture on gravel outwash with C = 0.30 then the additional developable area would be:

Therefore the 'additional area' A = additional CA/(residential C - rural C)
= 0.14/(0.66-0.30)
= 0.39ha

If it is in an area with mild sloping pasture on gravel outwash with C = 0.48 then the additional developable area would be:

Therefore the 'additional area' A = additional CA/(residential C - rural C)
= 0.14/(0.66-0.48)
= 0.78ha

Once you have a potential development area we are only too happy to consider the topography and soil conditions so we can advise you on its inclusion in the detention basin capacity.

Yours faithfully,

Prepared by

Peter Born
Civil & Environmental Engineer
CGW CONSULTING ENGINEERS

Reviewed & Approved by

Ian Hussey
Senior Projects Engineer
CGW CONSULTING ENGINEERS

CGW Ref: 18586-LET-003-A
Date: 30 November 2019

Oregon Land Limited
c/- Nigel Nalder
210 Princes Drive
Nelson

Dear Nigel,

RE: 18586 – Sabine Drive, Richmond Subdivision

This letter it to take the items discussed our letter of September 2018 further in consideration of a specific development. Please note that since that letter a new Nelson-Tasman Land Development Manual has been released increasing some design requirements.

1. Introduction

CGW Consulting Engineers has been commissioned by Oregon Land Ltd to review post-development stormwater implications of developing 7 lots at the Sabine Drive development in Richmond. The lots to be developed are shown in Figure 1 below with a total area of 0.41ha. When surrounding reserve areas are included the total development area could be approximately 0.6ha.

These lots form a small portion of the overall Sabine Block that will eventually be developed.

Figure 1 Lots Proposed to be developed (highlighted in green)

2. Background

In 2016, CGW designed a detention pond that is offline from Bateup Drain. This pond was sized to detain post-development stormwater runoff from the Arizona Land Ltd development at Hart Rise Estates (11ha), Smith Property (1.4ha) and 1 hectare of Hana Property.

The Arizona development included 1ha of comprehensive development which has since been developed as standard residential. It is intended to use the detention volume difference between design flows from standard and comprehensive development to cater for the new residential lots as described in section 1 above.

Sizing of the pond is detailed in CGW calculations 14037-CAL-001-C dated

ost C
.30
.30
.48
.45
.25
.30
.80
.66
.66

Table 1 – Catchment Area and C value assessment from 2016
(refer to Figure 2 for locations)

ID	Description	Geology	Infiltration	cover	slope	Area A	Pre C	P
1	Barnicoat Range	fractured mudstone/ limestone	Medium	bush & scrub	>20%	63	0.30	0
2	Steep above Hill St	fractured mudstone/ limestone	Medium	bush & scrub	>20%	3.6	0.30	0
3	Developed above Hill St	Moutere gravels	low	grass, imperm (15%)	>20%	30.3	0.48	0
4	Hillside west of flats	Moutere gravels	low	Pasture & scrub	>20%	10	0.45	0
5	Future greenway	Gravel outwash	medium	Pasture & scrub	>10%	2	0.30	0
6	Flats north of Hill St (excl Arizona, Hana, Smith)	Gravel outwash	medium	Pasture & scrub	>10%	12.7	0.30	0
7	**Arizona**	Gravel outwash	medium	Pasture & scrub	>10%	**1**	**0.30**	0
8	Hana	Gravel outwash	medium	Pasture & scrub	>10%	1	0.30	0
9	Rest of Arizona, Smith	Gravel outwash	medium	Pasture & scrub	>10%	11.4	0.30	0

Rational method was used with pre and post development runoff coefficients ("C" values) assigned to each catchment. For the comprehensive development pre and post development C values of 0.3 and 0.8 respectively were assigned. The value of 0.3 was assigned assuming gravel outwash and medium infiltration rates. Nearby catchments with Moutere gravel subsoils of low infiltration combined with steeper slopes were assigned a higher c value of 0.45-0.48.

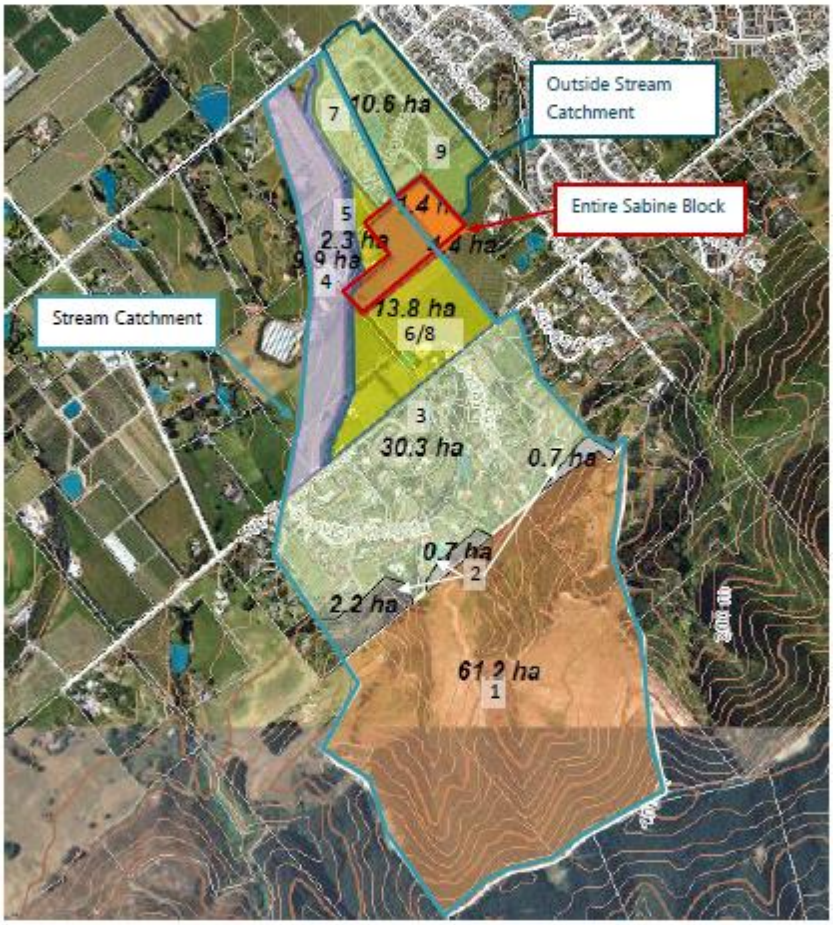


Figure 2 Catchment Area Plan

3. Analysis

3.1 Development Sub-catchment

If the difference between pre and post development products of C values, rainfall intensity (I) and sub-catchment areas (A) for the comprehensive development area match the same product (CIA) for the residential area plus the proposed new development area then all the detention and routing calculations done in 2016 will still apply.

Our assessment of the area that can be developed is therefore based on balancing the difference in CIA between the 2016 comprehensive development and the residential area developed plus the currently proposed residential development area.

As can be seen in Figure 2, part of the proposed development is within the stream and detention basin catchment and part is not. As the pond was designed as an offset to developments outside the catchment this does not affect our assessment.

3.2 Soil Type & Runoff Coefficients

The lots proposed for development are located near to the divide between the low permeability Moutere gravels and the medium permeability gravel outwash. According the New Zealand Geology Web Map the expected soil type for the proposed development is clay-bound gravel and weathered conglomerate with interbedded sandstone and mudstone. A site walkover and viewing of exposed faces validated clay bound gravels present in the development area.

Based on this soil type, the relief, surface features and land cover a C value of 0.4 is considered appropriate for predevelopment. Figure 3 substantiates a C value between 0.3-0.35 plus a rainfall intensity allowance for ground saturations in a high intensity storm event that could increase it to a maximum of 0.5.

Table 1 from NZBC VME1/VM1 table 1 states a C value of 0.40 for heavy clay soil types with pasture and scrub cover assuming saturated ground conditions.

Catchment Characteristics	Runoff-Producing Characteristics			
Rainfall Intensity	(0.15) 25-30 mm/hour	(0.10) 13-25 mm/hour	(0.05) 13 mm/hour	(0) Below 13 mm/hour
Relief	(0.10) Steep rugged country with average slopes above 20%	(0.05) Hilly with average slopes of 10-20%	(0) Rolling with average slopes of 5-10%	(0) Relatively flat with average slopes of 0-5%
Surface retention, stream and surface storage	(0.25) Negligible; few surface depressions, watercourses steep with thin film of overland flow	(0.15) Well defined system of small watercourses	(0.10) Considerable surface depressions; overland flow is significant; some farm ponds and swamps; some contour banks and furrows	(0.05) Poorly defined meandering stream course; large surface storage; water and soil conservation plan on 90% of catchment
Infiltration	(0.25) No effective soil cover; either solid rock or thin mantle of negligible infiltration capacity	(0.20) Slow water infiltration; e.g. solodic soils when surface sealed or saturated	(0.15) Loam soils or well structured clay soils, e.g. krasnozems	(0.10) Deep sands or well aggregated soil, e.g. chernozems
Cover	(0.30) No effective plant cover	(0.20) Sheet eroded native pasture; less than 10% of area under good native or improved pasture; clean cultivated crops	(0.15) Above 50% of area with improved cover; not more than 50% cultivation; open woodlands	(0.05) Above 90% of area with improved pastures; dry scherophyll-type forest

Figure 3 Estimation of the Runoff Coefficient C for use with the Rational Method (Turner 1960)

The residential development C value previously agreed with TDC is 0.66. The effect of increasing the predevelopment C value from 0.3 to 0.4 and reducing the post development C value from 0.8 to 0.66 is a 54% increase to the area that can be developed.

3.3 Rainfall Intensity

Since the offline detention pond was designed in 2016 the rainfall intensity values to be used for design have increased. It is expected that Tasman District Council will assess the development against the current Nelson-Tasman Land Development Manual 2019 (NTLDM). The previously assessed critical storm event was a Q_{100}[1] 52-minute duration storm. The rainfall intensity used was 57mm/hr. Using HIRDS v4 RCP8.5 rainfall data for the period 2081-2100 and linearly interpolating between values a Q_{100} 52-minute rainfall intensity is 81.16mm/hr. The percentage difference means that the relative detention volume for new development is 30% higher than the 2016 developments (or the area that can be developed is 30% less).

[1] Q_{100} is a 100 year return period storm event that statistically has a 1 in 100 chance of occurring in any given year and is also referred to as a 1% annual exceedance probability (AEP)

3.4 Result – Maximum Development Sub catchment Area

Based on the discussion above, the area that can be developed is calculated as follows:

Design CIA = 57 x 1 x (0.8 - 0.3) = 28.5

Actual CIA = 57 x 1 (0.66 – 0.3) = 20.52

Difference = 28.5 – 20.52 = 7.98

Area that can be developed = $\frac{7.98}{81.16(0.66-0.4)}$ = 0.38ha

Check: 1ha x 54% x 70% = 0.38ha

This allows for changes in C values and increases in design rainfall standards.

We consider that a development of 0.38 hectare residential area to current design standards is catered for by the current detention system. This assumes that both the 1ha Hana and 1.4ha Smith areas are developed.

This is adequate to cater for lots 1-4 and 23 along with associated reserve areas.

To develop the other two lots will require additional detention measures. If not doing a larger development that warrants a detention basin then onsite detention tanks are recommended. As a guide the minimum detention volume required by the NTLDM is 50 litres per m² of additional impervious area. Given the lot sizes a typical developed impermeable area per lot could be 300-400m² requiring a total tank volume per lot of 15-20m³.

4. Conclusion

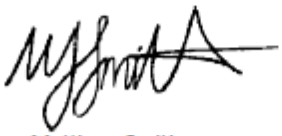
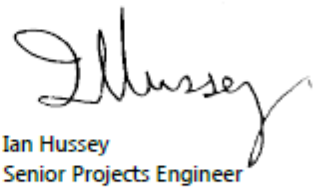
The offset detention basin serving Hart Rise has adequate capacity to cater for a further 0.38ha of residential development (to current design standards).

This caters for approximately 5 lots and associated reserve areas as described in section 3.4 above.

To develop the additional 2 lots proposed we recommend use of onsite detention tanks.

If there have been changes to the development areas on the Hana or Smith property potentially the detention volumes allocated to them could be reanalysed noting that the area that could be developed will be 30% less when applying current rainfall standards.

Yours faithfully,

Prepared by	Reviewed by	Approved by
		
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