



meadowlands
at halswell

Geotech Report

2020-08-11

Danne Mora Ltd
C/- Davie Lovell Smith
PO Box 679
Christchurch

Attn: Adam Lill

Dear Adam

Lateral Spreading Review
Our Ref 239575-005

1 Introduction

The Halswell Commons subdivision is being developed in the south west of Christchurch and as part of this development new stormwater infrastructure is proposed. The stormwater infrastructure will include re-alignment of Dunbars Drain, and new first flush and detention basins.

The Halswell Commons site has been previously assessed and identified as having liquefaction prone soils. The most recent assessment relevant to the stages where the proposed stormwater infrastructure is located are presented in the report *Halswell Commons Residential Subdivision – Liquefaction Assessment Review – Balance of Site*, Ref 239575-005, dated 14 November 2019.

Residential lots will be located adjacent to the stormwater infrastructure lots and may be affected by lateral spreading towards the drains/basins if the soils liquefy during a large earthquake. Lateral spreading occurs when subsoil liquefaction results in the surface soils moving downslope or toward a free edge, such as a riverbank or pond. Lateral spreading can occur during an earthquake under seismic loading and also following the earthquake until the excess pore water pressure is relieved and the soil regains strength.

Houses need to be set back a sufficient distance from proposed pond to avoid the lateral spreading hazard potential and Davie Lovell Smith has requested a lateral spreading assessment to confirm the required building setbacks. as the subdivision layout and stormwater infrastructure has been finalised.

The residential lots the proposed stormwater infrastructure will affect are as follows (see Appendix A for residential lot layout):

- First Flush Basin – Lots 1124 to 1138
- Dunbars Drain – Lots 1004 to 1030 and Lots 1053 to 1067

This letter summarises our lateral spreading assessment for the above lots and provides recommendations for the new residential building setbacks.

2 Drain/Basin Profiles

Based on discussions with Davie Lovell Smith (Civil Engineers) and information provided to us on the stormwater infrastructure the profiles are as follows:

- First Flush Basin – 1.2m deep with a slope of 4H:1V.
- Dunbars Drain – 1.25m deep at north western end with slopes of 4H:1V and 1.7m deep at the south eastern end with slopes of 4H:1V to.

3 Lateral Movement Limits

Lateral movement limits are defined in the MBIE Guidelines (MBIE, 2012), which indicate limits of less than 50mm under SLS level shaking and less than 100mm under ULS shaking for a TC2 classification.

4 Ground Conditions at Stormwater Ponds

When assessing lateral spreading it is generally considered reasonable to limit the depth of lateral spread to twice the free face height due to the confining effects of deeper soils (Idriss and Boulanger, 2008). Therefore, in defining the ground conditions relevant to lateral spreading assessment we have only reviewed the upper soil profile (i.e. to 4m depth).

Previous geotechnical assessments at Halswell Commons have included CPTs and boreholes. The relevant tests for the stormwater infrastructure are as follows:

- First Flush Basin – BH202, CPT449, CPT450, CPT517, CPT520, CPT522 and CPT523
- Dunbars Drain – BH203, CPT230, CPT231, CPT232, CPT458, CPT459, CPT462 and CPT527

Investigation logs and the liquefaction profile indicated by these CPTs are presented in the previous geotechnical reports. A summary of the ground profile relevant to the lateral spreading assessment is provided below:

- First Flush Basin – Typically, there is a layer of silt (i.e. Soil behaviour type index, $I_c > 2.6$) in the order of 1.5m to 2m thick overlying interbedded silts, silty sand and sand layers to at least 4m depth. The silts are typically non liquefiable while the silty sand and sand layers are liquefiable. Therefore, for the assessment we have assumed a 1.5m thick silt layer overlying a liquefiable layer to 3.5m depth, which is likely to be the most conservative soil profile to assess.
- Dunbars Drain - Testing in the south eastern part of the drain indicates that the ground comprises a predominantly silty soil (i.e. $I_c > 2.6$) to 2.4m to 3.5m depth. To the north west of the drain the testing indicates predominantly silt layer to 1.7m depth overlying interbedded silts, silty sand and sand layers to at least 4m depth. The silts are typically non liquefiable while the silty sand and sand layers are liquefiable. Therefore, for the assessment of Dunbars Drain we have assumed a 1.7m thick silt layer overlying a liquefiable layer, which is likely to be the most conservative soil profile to assess.

5 Method of Assessment

There are no procedures mandated or suggested by MBIE for assessing lateral spreading. New Zealand Transport Agency (NZTA) Research Report 553 (NZTA, 2014) outlines some of the available methods for assessing liquefaction induced slope deformations (i.e. lateral spread). The report states that the prediction of lateral ground movement is a difficult geotechnical problem and there is no generally accepted method for evaluating lateral displacement. Current methods for assessment include empirical, semi-empirical, analytical or numerical modelling to predict the lateral spread displacement. Section 4.4.3.3 of the NZTA Research Report 553 (NZTA, 2014) provides a brief introduction of analytical methods to predict the magnitude of slope displacement. An analytic analysis has been undertaken for assessing the displacements at the proposed stormwater ponds/waterways.

The Newmark Sliding Block method has been used to estimate the expected horizontal displacement during seismic shaking. These displacements are considered to be indices of slope movement rather than precise predictions of actual displacements. To estimate displacement using the Newmark method the following is required:

- Peak Ground Acceleration (a_{max}) – MBIE design accelerations for residential structures (0.35g for ULS and 0.13g for SLS)
- Yield, or critical, acceleration (a_c) – determined using the liquefied residual shear strengths (S_r/σ) and limit equilibrium analysis

It is generally considered reasonable (Idriss and Boulanger, 2008) to limit the depth of lateral spread to twice the free face height due to the confining effects of deeper soils. Therefore, the failure surface has been limited to a depth of twice the drain/basin depth.

6 Analysis

For both the First Flush Basin (FFB) and Dunbars Drain, as the depth of the assessment is limited the soil profile assessed comprised of a crust of silt overlying a liquefiable soil layer. For the crust, an undrained shear strength of 50kPa and unit weight of 18kN/m³ have been adopted. Typically, the crust was logged as stiff silt, so the adopted undrained shear strength is likely to be lower bound and hence conservative.

The shear strength of the liquefied soil is usually expressed in the form of normalised shear strength (S_r/σ) which for the potentially liquefiable sand soil is in the order of 0.08 to 0.1. A unit weight of 18kN/m³ has also been adopted for this layer.

For the FFB, the profile assessed comprised on a 1.2m deep basin with a slope of 4H:1V. For Dunbars Drain the profile assessed is based on the north west part of the drain where the liquefaction was higher in the soil profile, with a 1.25m deep drain and a slope of 4H:1V. It is noted that based on earthworks plans provided by Davie Lovell Smith the site will include varying amount of filling. At this stage we have not accounted for the filling and the assessment is based on the existing soil profile. Once the filling is in place it will increase the crust thickness and will reduce the depth of excavations with respect to the liquefiable layer. Hence, there will be a reduction in the lateral spreading potential for the residential lots.

The analysis has been carried out for different setbacks from the crest of the free face (i.e. crest of the drain/basin) to check sensitivity with a 10m maximum setback. The 10m is based on Caltrans (2012), which recommends limiting the failure surface to four times the height of free face, which for these drains will be typically less than 10m.

Limit equilibrium analyses, using the computer software Slope/W version 10, were used to estimate the yield acceleration using a S_r/σ of 0.08 to 0.1 for the potentially liquefiable soils overlain by a silt crust, based on the soil profile provided in Section 4. The results are discussed in the following section.

7 Results

The analysis indicates the yield acceleration derived to give a Factor of Safety approximately equal to one are provided in Table 1.

Table 1 – Yield accelerations for the stormwater infrastructure

Setback from Crest of Free Face	First Flush Basin	Dunbars Drain
3m	0.17g	0.35g
7m	0.135g	0.26g
10m	0.12g	0.21g

Lateral displacements based on the yield accelerations have been calculated using the methods below:

- Jibson (2007)
- Ambraseys & Menu (1988)
- Bray & Travasarou (2007)

The results of these methods are provided in Table 2.

Table 2 – Indicative calculated displacements for the stormwater infrastructure at ULS level of shaking

Stormwater Feature	Setback from Crest of Freeface	Jibson (2007)	Ambraseys & Menu (1988)	Bray & Travasarou (2007)
First Flush Basin	3m	20mm	30mm	25mm
	7m	40mm	65mm	40mm
	10m	55mm	90mm	50mm
Dunbars Drain	3m	<5mm	<5mm	<5mm
	7m	<5mm	<5mm	10mm
	10m	10mm	15mm	15mm

*Displacement reported to the nearest 5mm.

The results of this lateral spread analysis indicate that the land directly adjacent to the stormwater ponds may experience some lateral movement during a ULS event. However, the lateral movement calculated using the displacement methods is generally likely to be less than 100mm at ULS level shaking, which is consistent with a TC2 classification.

8 Conclusions

Based on the lateral spreading assessment results the lots adjacent to the FFB and Dunbars Drain meet the TC2 requirement, therefore residential house developed on these lots can use TC2 type enhanced raft foundations. In addition, it is recommended that the houses have a minimum setback from the drain/basin to limit the amount of potential ground damage affecting the house, if lateral spreading occurs. Given the depth of the stormwater infrastructure, residential houses should be set back 5m from the crest of the drain/basin.

9 Explanatory Statement

The recommendations in this letter are based on data collected at specific locations and by using suitable investigation techniques. Only a finite amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it must be appreciated that actual conditions could vary from the assumed model.

Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

Subsurface conditions, such as groundwater levels, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay. This report is not to be reproduced either wholly or in part without our prior written permission. For further information regarding this geotechnical assessment, please do not hesitate to contact Aurecon.

We trust that this letter satisfies the request for further information and if there are any queries please do not hesitate to contact the undersigned.

Yours faithfully



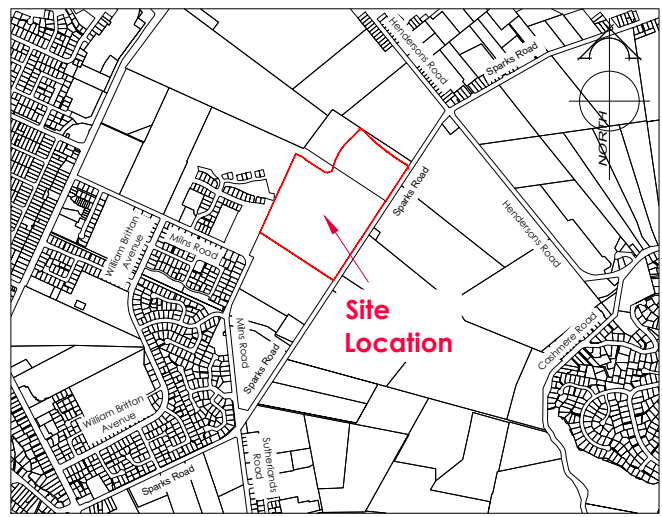
Prepared by
James Muirson
Senior Engineering Geologist



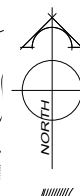
Approved by
Dr Jan Kupec CEngNZ CPEng IntPE
Technical Director – Ground Engineering

Appendix A

Civil Earthworks Plans

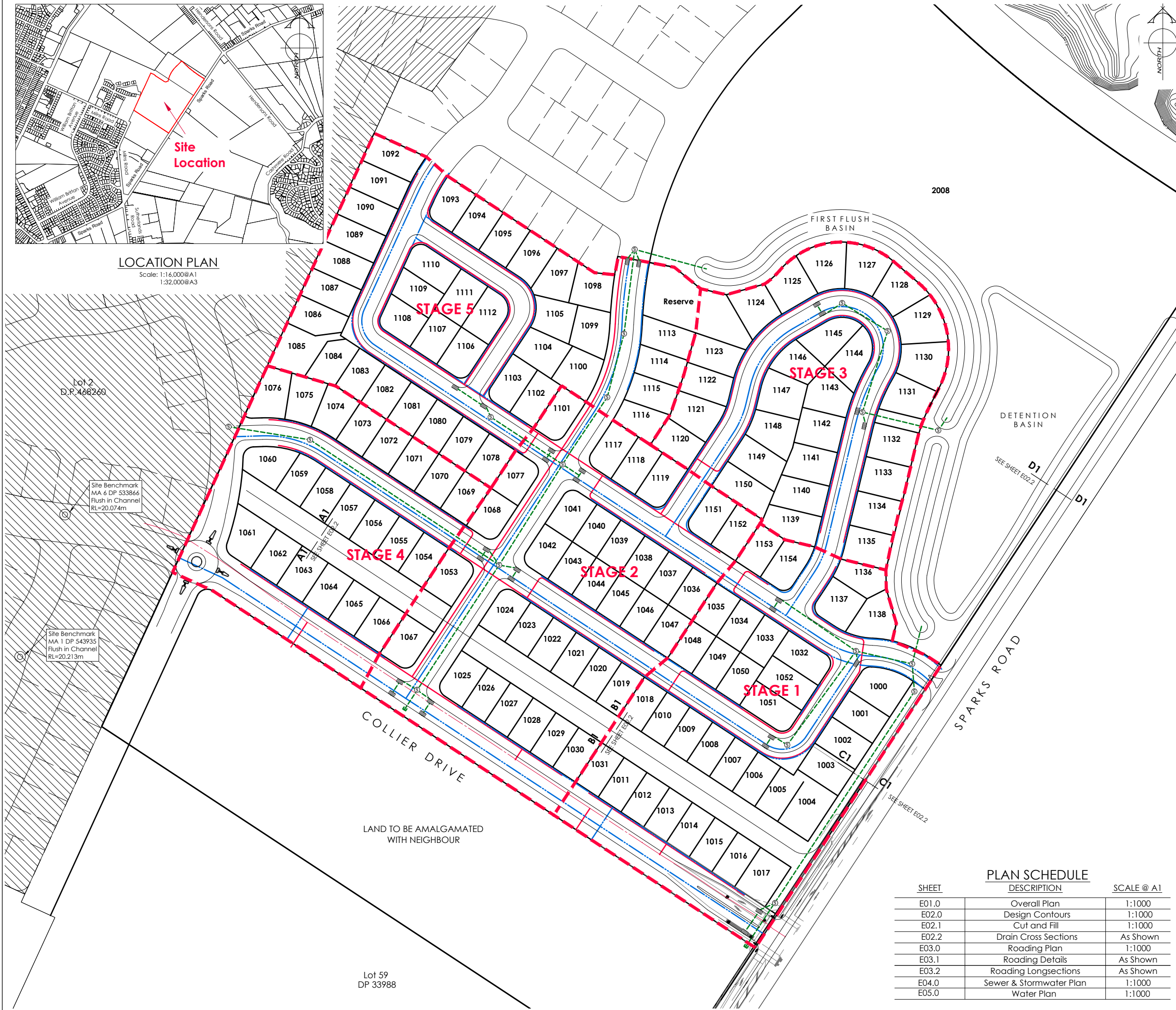


LOCATION PLAN
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1:32,000@A3



AMENDMENTS:		
AMENDMENT	DATE	DESCRIPTION

- NOTES:**
- 1) ALL WORKS IN ACCORDANCE WITH CCC IDS AND CSS PARTS 1-7 CURRENT ISSUE.
 - 2) ALL PLANS ARE TO BE READ AND DISTRIBUTED AS A COMPLETE SET. ANY DISCREPANCIES ARE TO BE BROUGHT TO THE ATTENTION OF THE ENGINEER FOR CLARIFICATION.
 - 3) ELECTRICITY & TELECOM SERVICES NOT SHOWN. REFER TO ELECTRICAL & COMMUNICATION PLANS FOR DUCT LOCATIONS.
 - 4) TRENCHING AND INSTALLATION OF POWER AND TELECOM SERVICES TO BE PROVIDED IN ACCORDANCE WITH SERVICE PROVIDERS PLANS AND SPECIFICATIONS.
 - 5) EXISTING SERVICES HAVE BEEN DIGITISED FROM SERVICE AUTHORITY PLANS; COMPLETENESS AND ACCURACY ARE NOT GUARANTEED. ALL SERVICES TO BE FULLY SEARCHED AND PILOTTED PRIOR TO TRENCHING.
 - 6) CONTOUR INTERVAL: _____m MINOR. _____m MAJOR.
 - 7) **ORIGIN OF LEVELS**
BM.144 [EHC2]
RL=23.52m MASONRY ANCHOR AND DISK FLUSH IN KERB, LOCATED CORNER CARDINAL DRIVE AND WOLSEY PLACE.
LEVELS ARE IN TERMS OF CHRISTCHURCH DRAINAGE DATUM, JANUARY 2012 ISSUE.
 - 8) CONTROL OF SW, SEDIMENT AND DUST ON SITE IS THE RESPONSIBILITY OF THE CONTRACTOR.
 - 9) ALL ROW AND DRIVEWAYS ARE TO HAVE 50mm DUCTS INSTALLED FOR COMMUNICATIONS AND POWER SUPPLY.



LEGEND:

EXISTING SERVICES	PROPOSED SERVICES
SANITARY SEWER STD. MH	SANITARY SEWER STD. MH
SANITARY SEWER VENTED MH	SANITARY SEWER VENTED MH
STORMWATER MH	STORMWATER MH
WATER FH VALVE	WATER FH VALVE
KERB	KERB

NAME	SIGNED	DATE
DESIGNED BY ADAM LILL		
CHECKED BY ANDY HALL		



116 Wrights Road P O Box 679 Christchurch 8140, New Zealand
Telephone: 03 379-0793 Website: www.dls.co.nz E-mail: office@dls.co.nz

JOB TITLE:
Sparks Road

SHEET TITLE:
Overall Plan

DRAWING STATUS:
For Engineering Concept

SCALE: 1:1000@A1
1:2000@A3 DATE: June 2020

DRAWING No:	SHEET No:	REVISION:
E.20114	E01.0	R0

PLAN SCHEDULE

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E02.1	Cut and Fill	1:1000
E02.2	Drain Cross Sections	As Shown
E03.0	Roading Plan	1:1000
E03.1	Roading Details	As Shown
E03.2	Roading Longsections	As Shown
E04.0	Sewer & Stormwater Plan	1:1000
E05.0	Water Plan	1:1000

Lot 59
DP 33988



AMENDMENTS :		
AMENDMENT	DATE	DESCRIPTION

NOTES :

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JANUARY 2012 ISSUE.
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- DESIGN CONTOUR INTERVAL: MAJOR 1.0m MINOR 0.1m.
- ALL EARTHFILL WORKS TO COMPLY WITH NZS 4431:1989 RELEVANT CERTIFICATION REQUIRED AS PROOF.
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- CONTRACTOR MUST READ ALL DISCHARGE CONSENTS PRIOR TO ANY EARTHWORKS.
- DRAWINGS TO BE DISTRIBUTED AND READ AS A COMPLETE SET. ANY DISCREPANCIES ARE TO BE BROUGHT TO THE ATTENTION OF THE ENGINEER FOR CLARIFICATION.

LEGEND :

EXISTING SERVICES		PROPOSED SERVICES	
KERB	_____	KERB	_____

DESIGNED BY	NAME	SIGNED	DATE
ADAM LILL			

CHECKED BY	NAME	SIGNED	DATE
ANDY HALL			



DAVIE LOVELL-SMITH
PLANNING SURVEYING ENGINEERING

116 Wrights Road P O Box 679 Christchurch 8140. New Zealand
Telephone: 03 379-0793 Website: www.dls.co.nz E-mail: office@dls.co.nz

JOB TITLE:

Sparks Road

SHEET TITLE:

Design Contours

DRAWING STATUS

For Engineering Concept

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AMENDMENTS :		
AMENDMENT	DATE	DESCRIPTION

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LEGEND :

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EXISTING SERVICES		PROPOSED SERVICES	
KERB	NAME	KERB	NAME

DESIGNED BY	NAME	SIGNED	DATE
	ADAM LILL		

CHECKED BY	NAME	SIGNED	DATE
	ANDY HALL		



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JOB TITLE:

Sparks Road

SHEET TITLE:

Cut Fill Plan

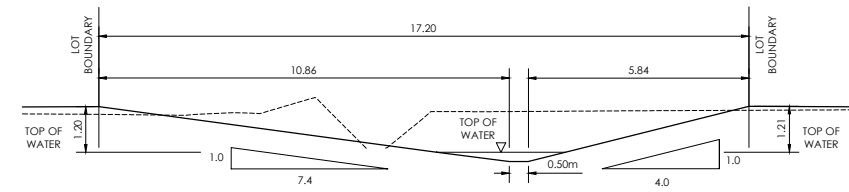
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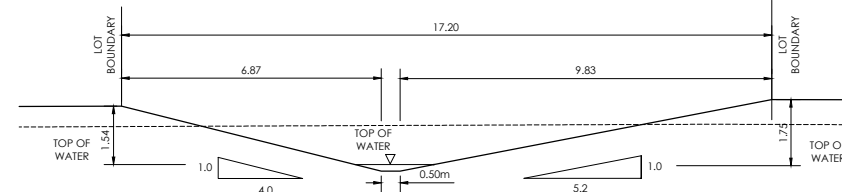
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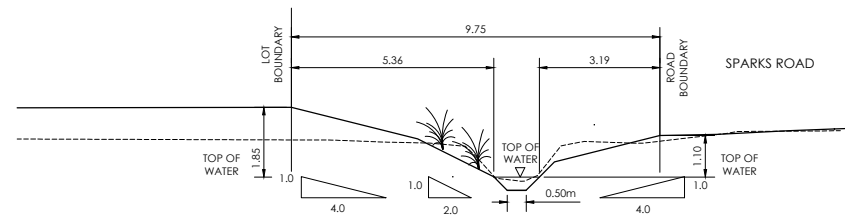
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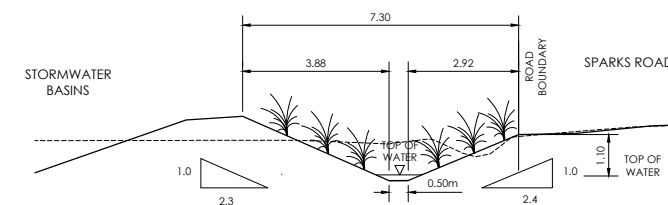
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D1-D1

AMENDMENTS :		
AMENDMENT	DATE	DESCRIPTION
R9	23/01/2019	NO CHANGE THIS SHEET
R10	05/02/2019	NO CHANGE THIS SHEET

- NOTES :
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LEGEND :

PROPOSED CONTOUR —————

EXISTING CONTOUR - - - - -

	NAME	SIGNED	DATE
DESIGNED BY			
CHECKED BY			



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Telephone: 03 379-0793 Website: www.dls.co.nz E-mail: office@dls.co.nz

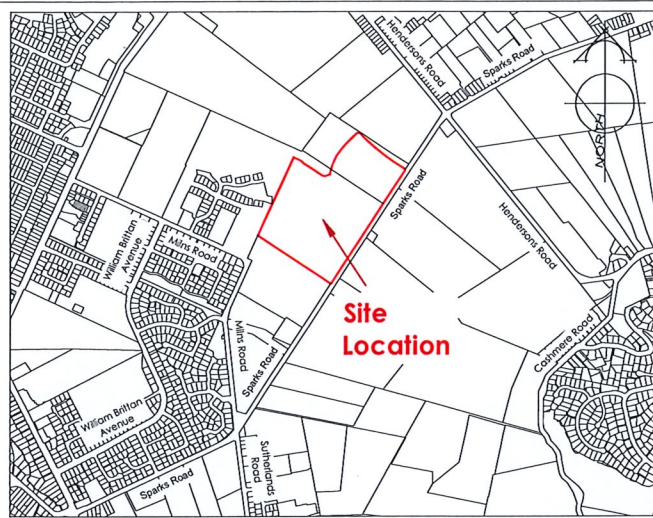
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Sparks Road

SHEET TITLE:
Drain Cross Sections Stage 1 and 1A

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For Engineering Concept

SCALE : As Shown DATE : June 2020

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LOCATION PLAN

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AMENDMENT	DATE	DESCRIPTION
R1	16/07/20	STAGE BOUNDARY UPDATED
R2	06/08/20	NO CHANGE THIS SHEET

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DRAFT

EXISTING SERVICES		PROPOSED SERVICES	
SANITARY SEWER	STD, MH	SANITARY SEWER	STD, MH
SANITARY SEWER	VENTED MH	SANITARY SEWER	VENTED MH
STORMWATER	MH	STORMWATER	MH
WATER	FH VALVE	WATER	FH VALVE
KERB		KERB	

NAME	SIGNED	DATE
DESIGNED BY ADAM LILL		
CHECKED BY ANDY HALL		



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JOB TITLE:
Sparks Road

SHEET TITLE:
Overall Plan

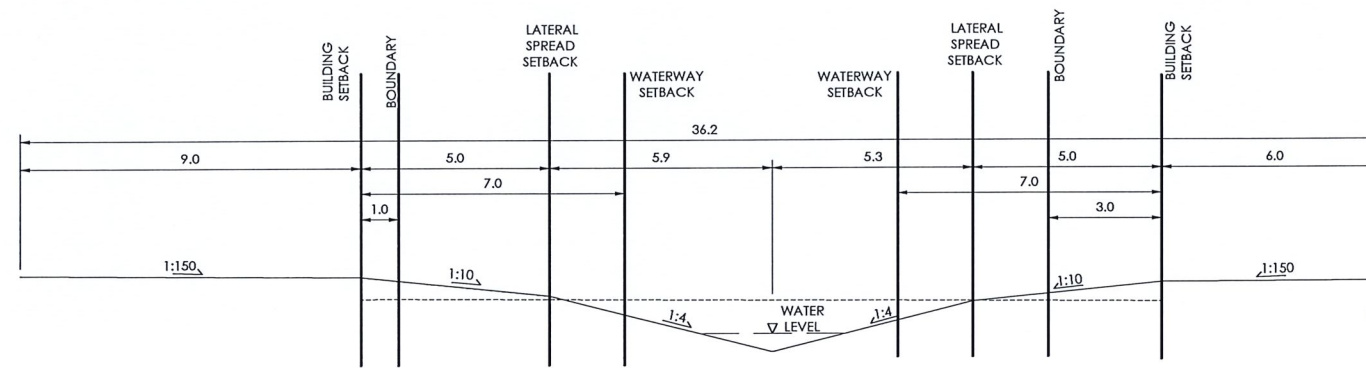
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E.20114 E01.0 R2

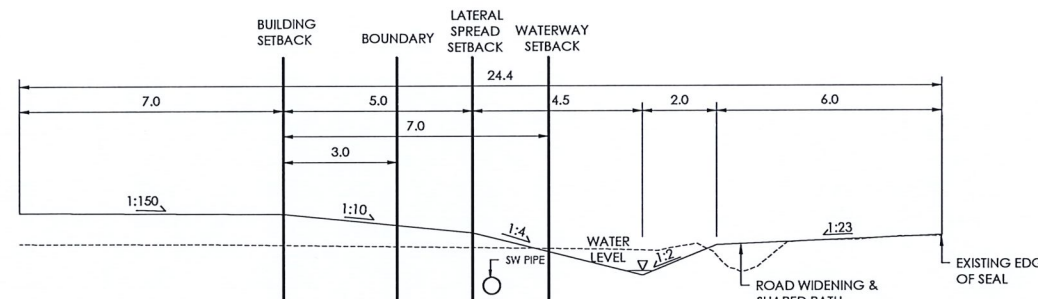
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E01.0	Overall Plan	1:1000
E02.0	Design Contours	1:1000
E02.1	Cut and Fill	1:1000
E02.2	Drain Cross Sections	As Shown
E03.0	Roading Plan	1:1000
E03.1	Roading Details	As Shown
E03.2	Roading Longsections	As Shown
E04.0	Sewer & Stormwater Plan	1:1000
E05.0	Water Plan	1:1000

Lot 59
DP 33988



SWALE LONGSECTION

A1-A1
 Scale 1:100 Horiz @A1
 1:100 Vert @A1
 1:200 Horiz @A3
 1:200 Vert @A3



SWALE LONGSECTION

B1-B1
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 1:100 Vert @A1
 1:200 Horiz @A3
 1:200 Vert @A3

AMENDMENTS :		
AMENDMENT	DATE	DESCRIPTION
R1	16/07/20	NO CHANGE THIS SHEET
R2	06/08/20	DRAIN CROSS SECTIONS UPDATED

- NOTES :
- 1) ALL WORKS IN ACCORDANCE WITH CCC IDS AND CSS PARTS 1-7 CURRENT ISSUE.
 - 2) METAL DEPTHS TO BE CONFIRMED OR INCREASED BY ENGINEER FOLLOWING CHECKING OF SUBGRADE CBR STRENGTH ONCE EXCAVATED.
 - 3) ALL BERMS TO BE COVER WITH A MINIMUM OF 150mm SCREENED TOPSOIL GRASSED WITH CCC BERM MIX
 - 4) EXISTING SERVICES HAVE BEEN DIGITISED FROM SERVICE AUTHORITY PLANS; COMPLETENESS AND ACCURACY ARE NOT GUARANTEED. ALL SERVICES TO BE FULLY SEARCHED & PILOTTED PRIOR TO TRENCHING.
 - 5) CLEARING TO INCLUDE REMOVAL OF ALL INTERNAL FENCING, ALL VEGETATION FROM LOTS, CLEARED AREA TO BE GRASSED AND FREE OF DEBRIS. ALL MATERIAL TO BE REMOVED FROM SITE.
 - 6) CONTOUR INTERVAL: MAJOR 1.0m MINOR 0.1m
 - 7) ALL EARTHFILL WORKS TO COMPLY WITH NZS 4431:1989 RELEVANT CERTIFICATION REQUIRED AS PROOF
 - 8) IF PEAT OR OTHER UNSUITABLE MATERIAL IS LOCATED IN THE SUBGRADE THE ENGINEER IS TO BE CONTACTED FOR INSTRUCTION
 - 9) ESCMP TO BE IN PLACE PRIOR TO ANY EARTHWORKS
 - 10) CONTRACTOR MUST READ ALL DISCHARGE CONSENTS PRIOR TO ANY EARTHWORKS
 - 11) DRAWINGS TO BE DISTRIBUTED AND READ AS A COMPLETE SET. ANY DISCREPANCIES ARE TO BE BROUGHT TO THE ATTENTION OF THE ENGINEER FOR CLARIFICATION

DRAFT

LEGEND :

PROPOSED CONTOUR	_____
EXISTING CONTOUR	-----

	NAME	SIGNED	DATE
DESIGNED BY			
CHECKED BY			



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 PLANNING SURVEYING ENGINEERING

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JOB TITLE:
Sparks Road

SHEET TITLE:
Drain Cross Sections

DRAWING STATUS:
For Engineering Concept

SCALE: As Shown DATE: August 2020

CAD FILE: J:\2011\4\Eng\Drawings\E20114 E020_R2.dwg DRAWN: DG

DRAWING No:	SHEET No:	REVISION:
E.20114	E02.2	R2