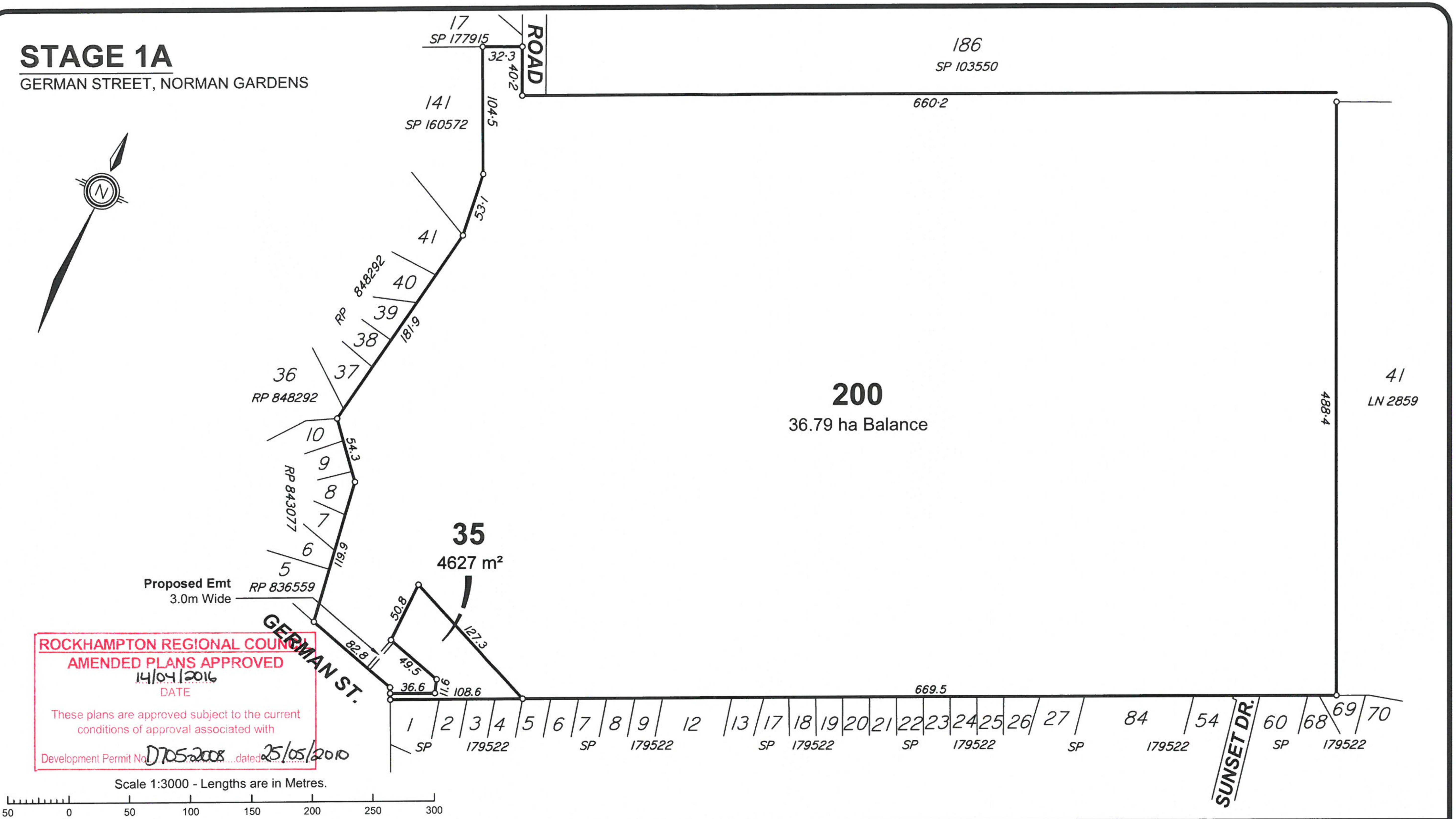
STAGE 1A

GERMAN STREET, NORMAN GARDENS



ROCKHAMPTON REGIONAL COUNCIL
AMENDED PLANS APPROVED
14/04/2016
DATE
These plans are approved subject to the current conditions of approval associated with
Development Permit No D705-2008 ...dated 25/05/2010

Scale 1:3000 - Lengths are in Metres.

50 0 50 100 150 200 250 300

Rev	Description	Drawn	Checked	Date
A	Original Issue	AD	BF	8/3/2016

This plan was prepared as a proposed subdivision and should not be used for any other purpose. The dimensions, areas and total number of lots shown hereon are subject to field survey and also to the requirements of Council and any other authority which may have requirements under any relevant legislation. In particular, no reliance should be placed on the information on this plan for any financial dealing involving the land. This note is an integral part of the plan.

PROPOSAL PLAN

PROJECT: Proposed Subdivision - Stage 1A

LOCATION: German Street, Norman Gardens

Real Property Description: Lot 2 on RP714467

CLIENT: Tony Grieve

Horiz. Datum:	MGA Zone 56
Vert. Datum:	N/A
Local Authority:	Whitsunday Regional
Contour Interval:	N/A

VISION SURVEYS QUEENSLAND

Airlie Beach | Mackay | Townsville | Rockhampton | Brisbane | Gold Coast

07 4948 3781 07 4951 0768 07 4721 0410 07 4927 1744 0418 154 535 07 5564 7295

Email: admin@visionsurveysqld.com.au

Scale:	1 : 3000 @ A3	Drawing No:	14227-PP-02
Drawn:	AD	Sheet:	1 of 1
Surveyor:	N/A	Revision:	A

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

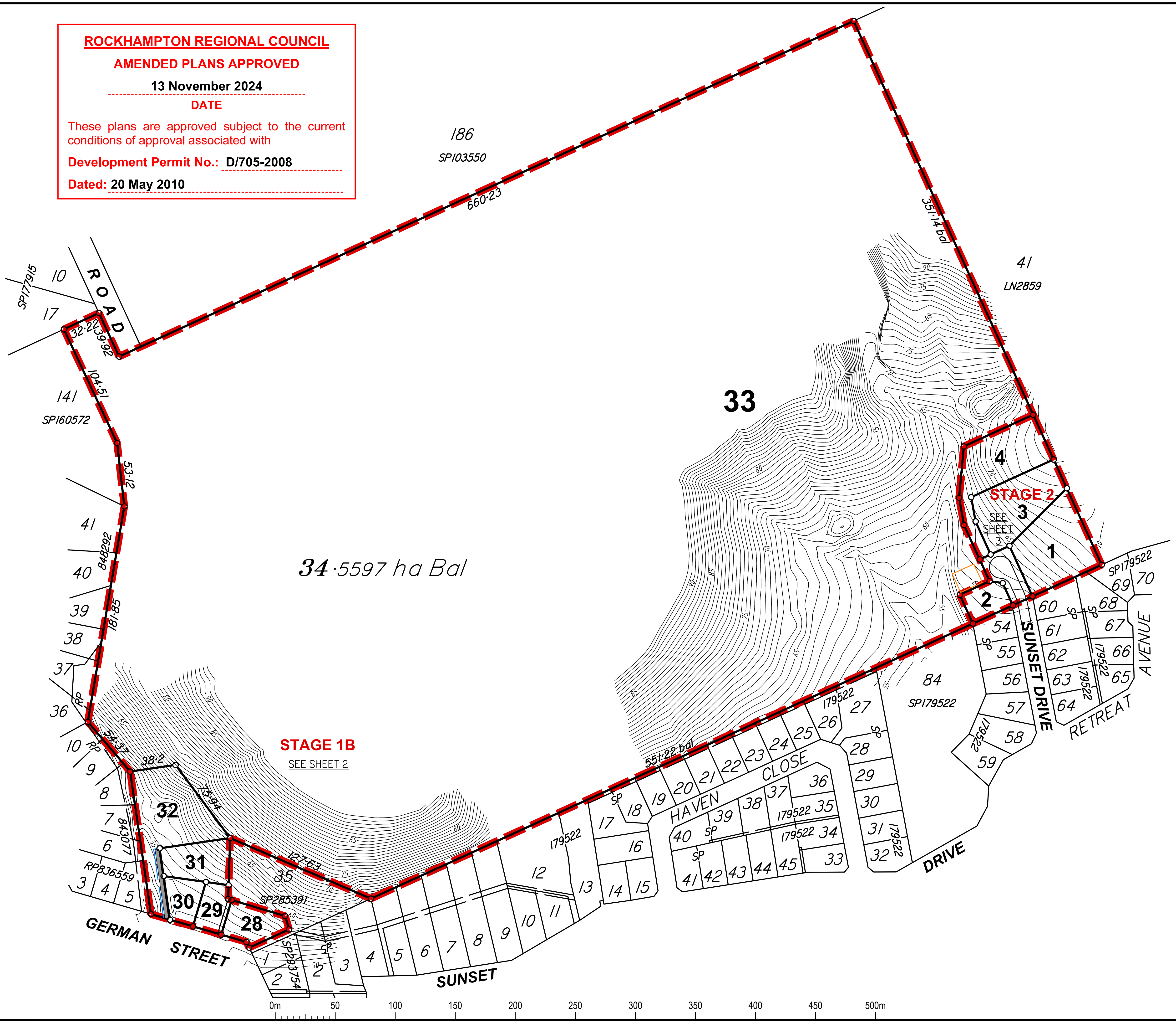
13 November 2024

DATE

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/705-2008

Dated: 20 May 2010



IMPORTANT NOTE

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client

R. & L. Perren

project

237 German Street (& Sunset Drive) Norman Gardens

plan of

Reconfiguration Plan

1 Lot into 10 Lots (With QLD Globe Underlay)

rpd

Lot 200 on SP285391

lga

Rockhampton Regional Council

issue	date	details	authorised
A	23-08-2024	Initial Issue	RJKF
-	-	-	-

created

capricornsurveygroupcq SURVEYING & PLANNING SOLUTIONS

07 4927 5199 | reception@csgcq.com.au | 132 Victoria Parade, Rockhampton QLD 4700

scale	datum
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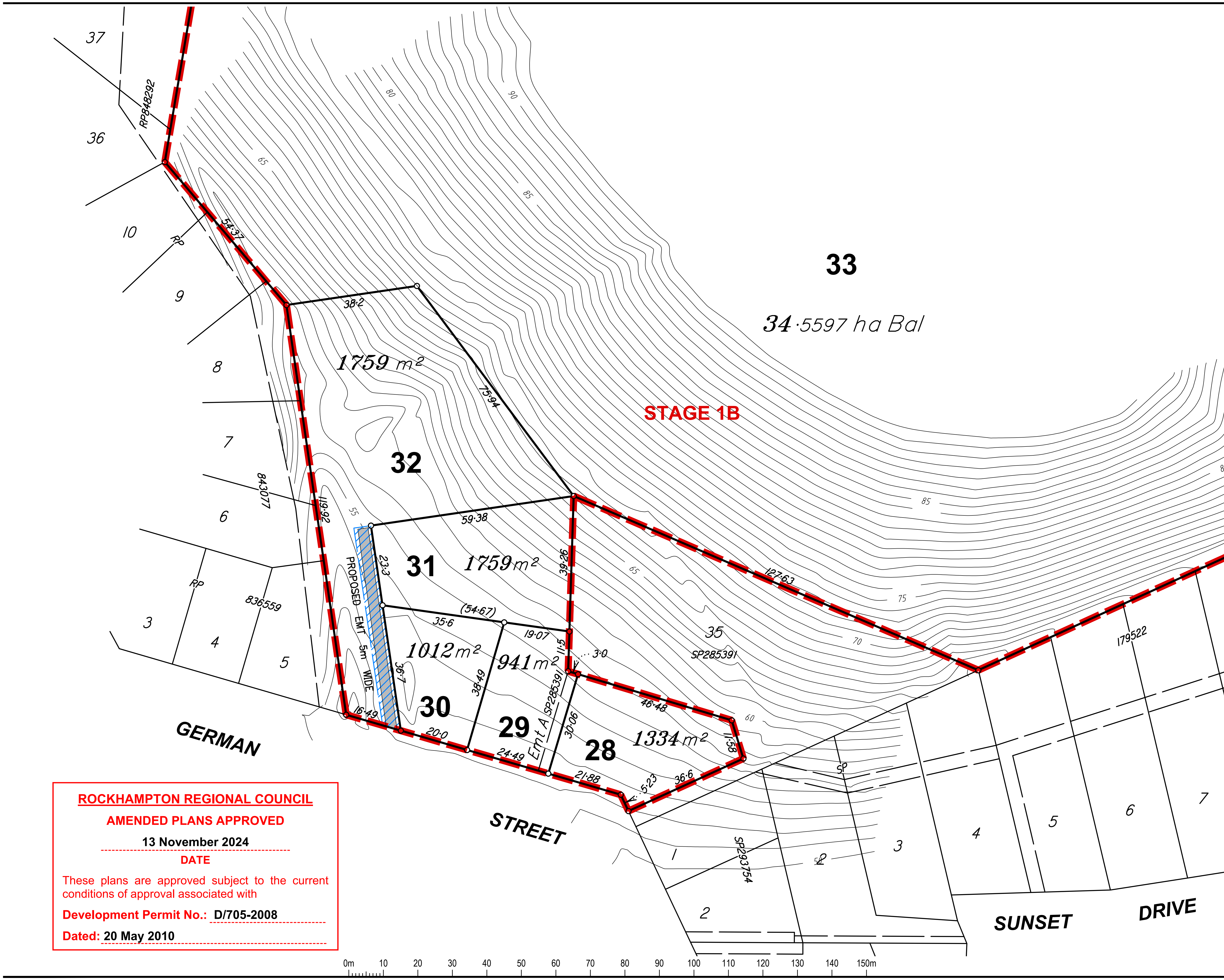
sheet no.	cad file
1 of 3	9362-01-ROL-A
plan no.	issue
9362-01-ROL	A



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scale	datum
1:1000 @ A3	AHD 1m Contours
sheet no.	cad file
2 of 3	9362-01-ROL-A
plan no.	issue
9362-01-ROL	A

ROCKHAMPTON REGIONAL COUNCIL

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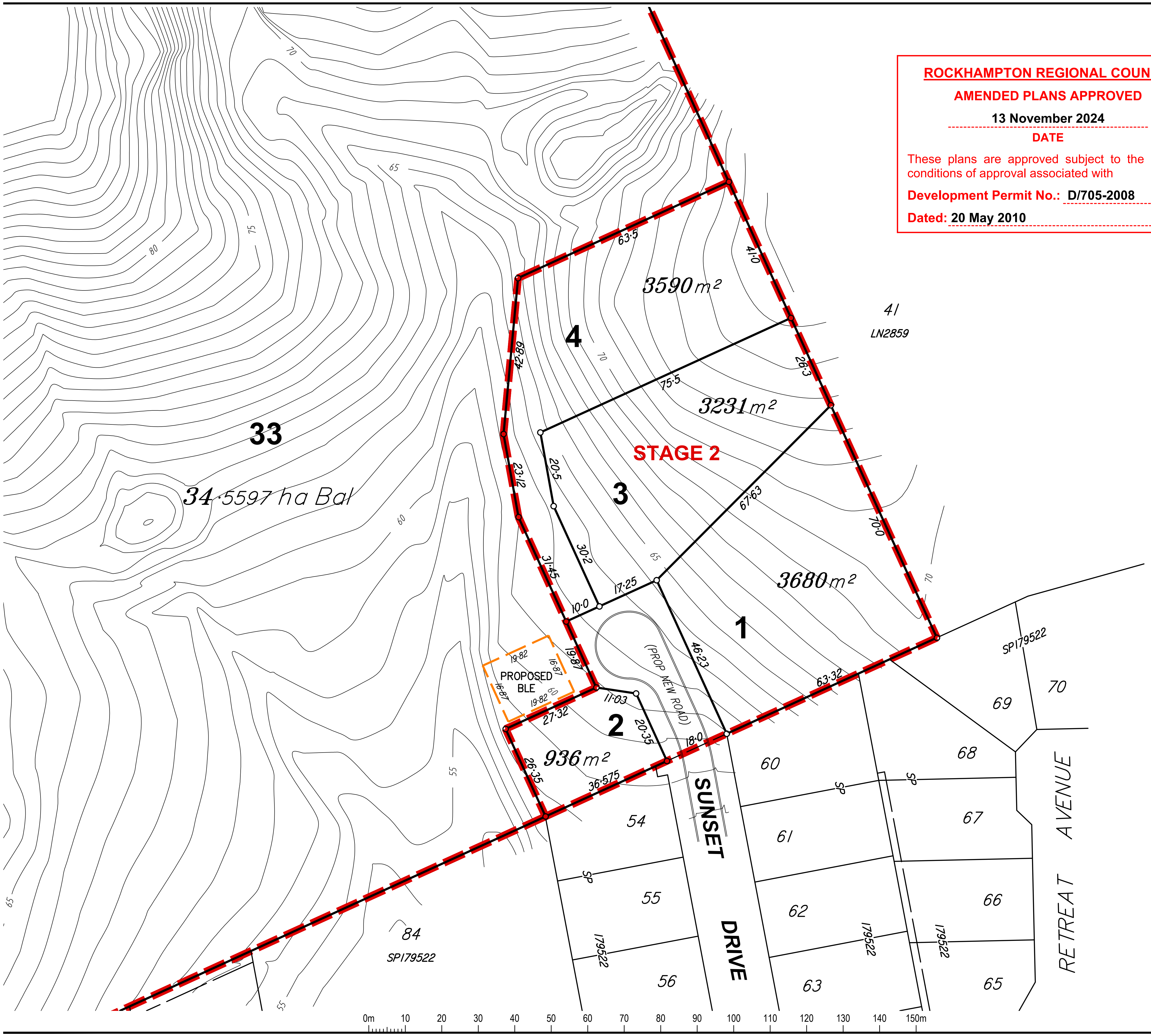
Dated: 20 May 2010



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1 Lot into 10 Lots

(With QLD Globe Underlay)

rpd

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scale: 1:1000 @ A3
datum: AHD 1m Contours
sheet no.: 3 of 3
cad file: 9362-01-ROL-A
plan no.: **9362-01-ROL**
issue: **A**

Stormwater Drainage Strategy

Naturelands Estate

Proposed 36 Lot Residential Subdivision On German Street and Sunset Drive Rockhampton.

Prepared for J H G Nominees Pty Ltd.

McMurtrie consulting engineers

0880708 Rev B

January 2010

Stormwater Drainage Strategy

Naturelands Estate

Proposed 36 Lot
Residential Subdivision
On German Street & Sunset Drive, Rockhampton.

For J H G Nominees Pty Ltd

Submission to:

Rockhampton Regional Council
(Rockhampton Office)
PO Box 1860
Rockhampton Qld 4700

Prepared by:

McMurtrie Consulting Engineers
63 Charles St
North Rockhampton, Qld 4701

Rev.	Description	Sig.	Date
B	Response to RRC RFI	MWW	10.12.09
A	Submitted for Approval	MWW	05.06.09
Revisions			

Authorised: ....
Ian McMurtrie
RPEQ 1347
For McMurtrie Consulting Engineers

TABLE OF CONTENTS

1.0	INTRODUCTION	1
2.0	CALCULATION PROCESS	2
3.0	RESULTS SUMMARY	3
4.0	CONCLUSION	8
5.0	ATTACHMENTS	10

1.0 INTRODUCTION

This Stormwater Drainage Strategy has been amended in accordance with Information Request of 17 August 2009 (D-R/2008-705) and in response to meeting minutes prepared by Michael Donaldson received 13 October 2009. Calculations prepared on behalf of our Client are also in response to Councils original Information Request of 22 October 2008 (D-705/2008). The following report has been prepared to detail an overall drainage strategy encompassing the entire stormwater catchment area contributing to stormwater flows on the subject site. Further to the Reconfiguration of Lot Application submitted to Rockhampton Regional Council in May 2008, major (Q_{100}) and minor (Q_{10}) rainfall event peak discharges for the pre-development and post-development scenarios have been presented.

2.0 CALCULATION PROCESS

Pre-development and Post Development calculations have been prepared using the Rational Method:

$$Q = K.C.I.A$$

In accordance with *QUDM* 4.06.6 Overland Flow, time of concentration (t) has been calculated for Sheet Flow and Concentrated Flow using Friends Equation and Bransby-Williams Equation respectively:

$t=(107n \times L^{1/3}) / s^{1/5}$ Friends Equation

$t=58L/(A^{0.1} \times S^{0.2})$ Bransby-Williams Equation

As a result of site inspections and DTM survey, Sheet Flow has been adopted for a maximum of 50m and accounts for a Horton's Roughness Coefficient for *Sparse Vegetation*.

Open channel drainage capacity has been calculated using Mannings Formula:

$$V = 1/n \,.\, R^{2/3} \,.\, S^{1/2}$$

$$Q = V.A$$

Existing concrete pipe capacity has been calculated using Colebrook-White formula:

$$1/\sqrt{f} = -2\log10 (k/3.7D + 2.51/Re. \sqrt{f}$$

Where k = 0.006

Existing cross drainage structure capacity has been calculated using CulvetW software.

3.0 RESULTS SUMMARY

The following results summary represents pre-development and post-development catchment discharge. All calculations and catchment plans can be referred to in Attachment A.

Stage 1: Proposed 7 Lots on German Street

(Refer Attachment A for all Stage 1 calculations and catchments)

1. Pre-development Q_{100} discharge from Catchment 7 to existing 1200 RCP cross drainage under German Street has been calculated at 8.0m^3/s. Refer *Attachment A - Catchment 7* calculations.

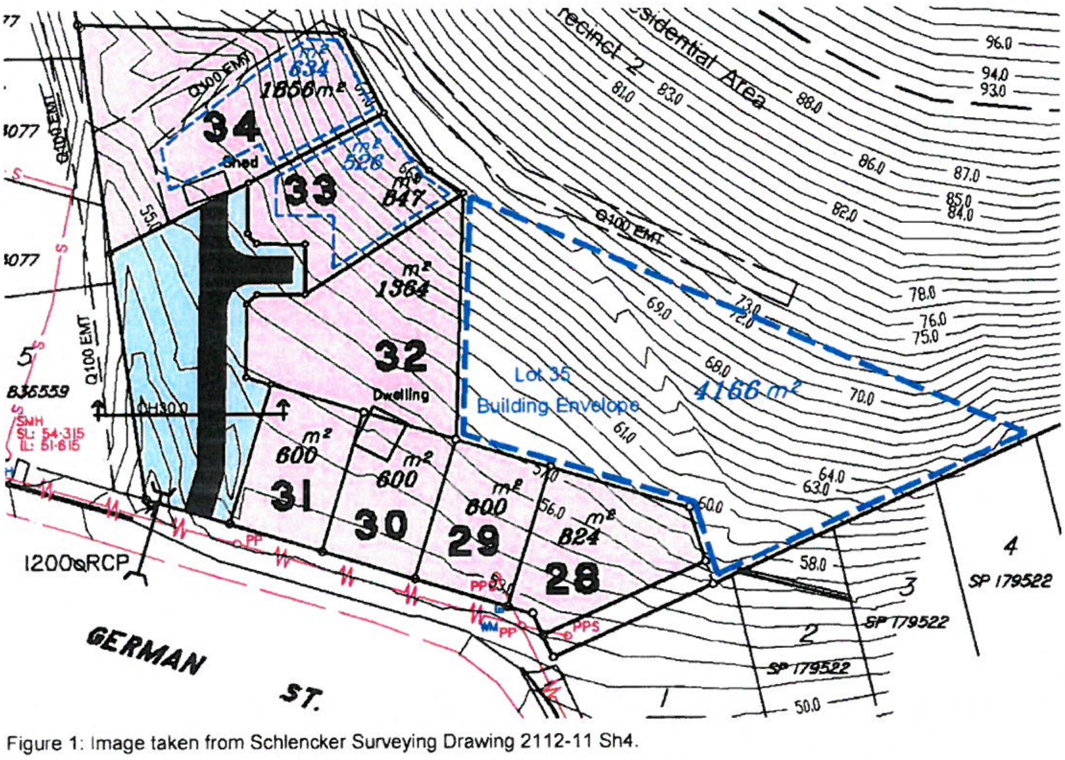


Figure 1: Image taken from Schlencker Surveying Drawing 2112-11 Sh4.

2. Using Colebrook-White's formula, the existing 1200 RCP at 3% grade has an existing capacity of approx 8.7m^3/s. This figure is conservative as it is demonstrates pipes flowing full but not under head.

3. The proposed stage 1 development will provide minor intensification of stormwater runoff as only Lots 32, 33 and 34 will discharge to the existing 1200 RCP. Lots 28 to 31 7 35 will discharge directly to German Street via kerb adaptor. The Post Development net discharge to the existing 1200 RCP is increased by only 0.2m^3/s to 8.2m^3/s. Refer Attachment A Catchment 8.
4. Depth of flow for the existing gully (post development) has been calculated at 810mm. Refer Attachment A - Mannings Calculations: Stage 1 Post Development Discharge and Figure 1 and 2.

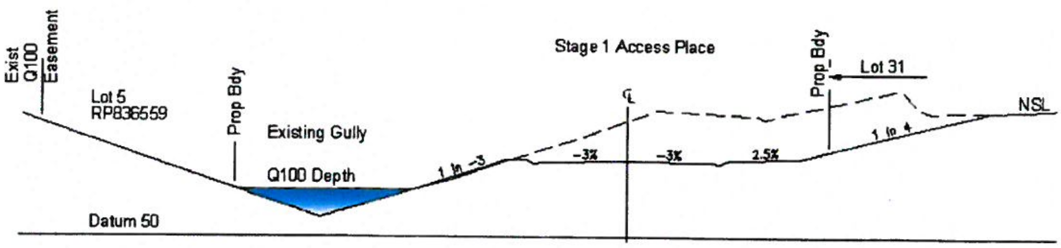


Figure 2: Cross Section through access to Stage 1.

5. Existing 1200mm cross drainage structures (under German Street) is suitably sized to cater for the proposed development. No amendment to the existing downstream structures is required.
6. With construction of proposed diversion drain at the back of Lots 28, 29, 32, 33 & 34, there will be no impact or modification to existing Catchment 8a. Catchment 8c also remains unchanged post development.

Stages 2 and 3: Proposed 27 Lots off Sunset Drive:

(Refer Attachment B for all Stage 1 calculations and catchments)

7. Lot 14 will maintain a trafficable access during a Q_{100} event with the installation of 900 x 750 RCBC. Refer *Attachment B - Catchment 1* calculations and CulvertW Design Case No 1 detailing trafficable access during a Q_{100} storm event and Figure 3 below.

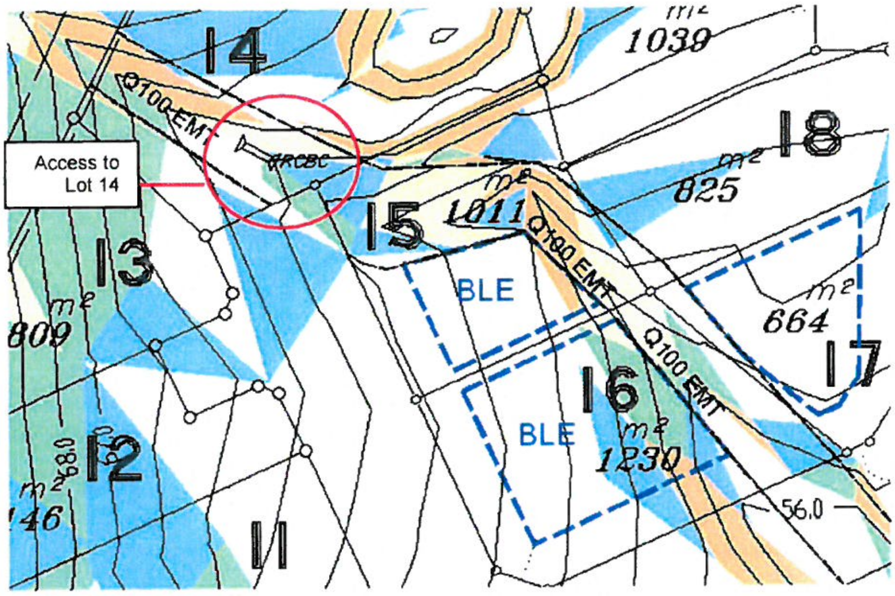


Figure 3: Image taken from Schlencker Surveying drawing 2112-11 Sh3

8. Major 'western' gully crossing will maintain trafficable cross over with the construction of 900 x 900 RCBC. Refer Catchment 2 calculations and CulvertW Design Case No 2 detailing trafficable cross over during a Q_{100} storm event.
9. Major 'eastern' gully crossing will maintain trafficable cross over with the construction of 2/750 x 750 RCBC. Refer *Attachment B - Catchment 3* calculations and CulvertW design Case 3 and Image 4 below.
10. The total pre-development catchment discharge (into the existing drainage reserve Lot 84 SP179522) is 20.2m^3/s during a Q_{100} event. Refer *Attachment B - Catchment 4* calculations and Image 4 below.

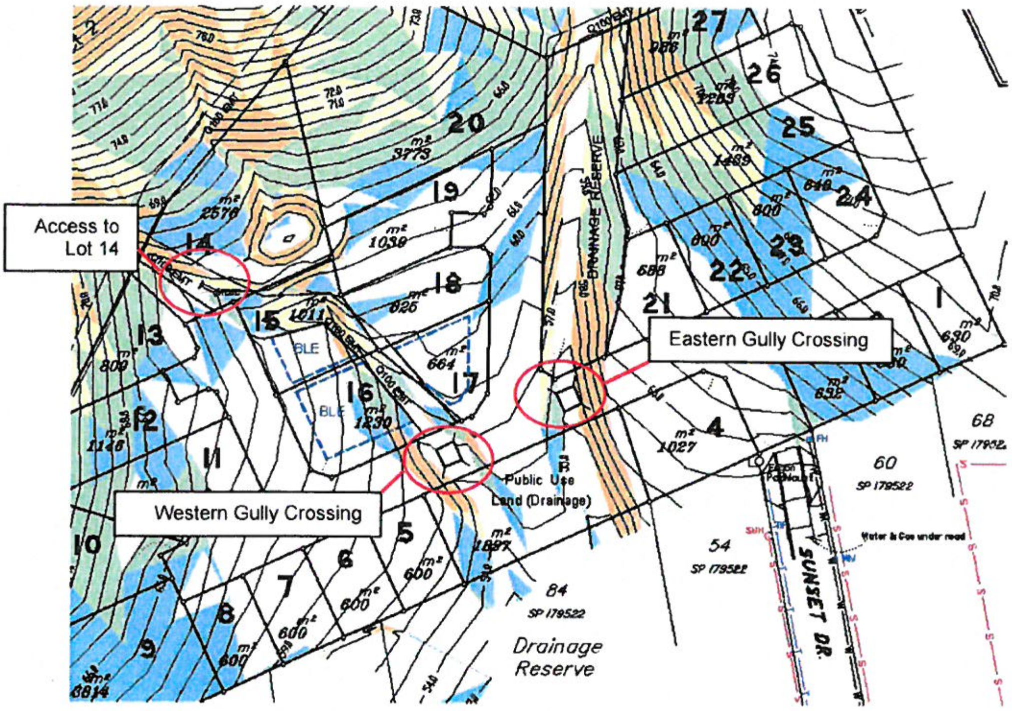


Figure 4: Image taken from Schlencker Surveying drawing 2112-11 Sh3.

11. The total post-development catchment discharge (into the existing drainage reserve Lot 84 SP179522) for stages 2 & 3 during a Q_{100} event is 23.4m^3/s. This figure represents the Q_{100} addition of discharge from Catchments 5, 6 and 6a.
12. The increase in Q_{100} runoff for Stages 2 and 3 due to proposed urban development is 3.2m^3/s
13. The post-development discharge from Catchment 6a into the existing concrete open channel is 1.2m^3/s in a Q_{100} event.
14. The capacity of the existing concrete channel is 1.267m^3/s and has sufficient capacity to cater for a Q_{100} event. Refer *Attachment B - Catchment 6a: Mannings Calculation.*
15. Pre-development discharge to existing downstream Sunset Drive 3/2700 x 900 RCBC structure is 22.9m^3/s (Refer Attachment F Drawing 030393/48). This pre-development discharge has been calculated from the addition of Catchments 4 and 5a (Refer Attachment B). CulvertW Design Case No 4 confirms sufficient existing culvert capacity (with only 94mm overtopping).

16. Proposed upstream development will increase discharge to the Sunset Drive 3/2700 x 900 RCBC in a Q_{100} event to 26.2m^3/s. This post-development discharge has been calculated from the addition of Catchments 5, 5a, 6 and 6a (Refer Attachment B).

17. The existing Sunset Drive RCBC structure has sufficient capacity to cater for an increase of 3.2m^3/s. Refer *Attachment B - CulvertW Design Case No 5* confirming sufficient existing culvert capacity (with only 167mm overtopping).

18. Cross sections through the open channel drainage reserve (Lot 84 SP179522) reveal that the depth of flow during pre-development Q_{100} storm event is approximately 344mm. Refer Attachment C for Mannings calculations and cross sections.

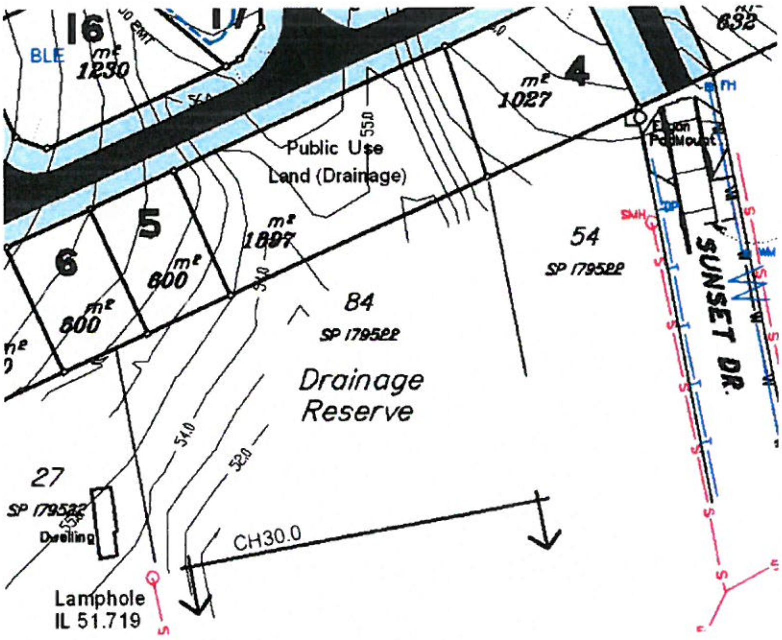


Image taken from Schlencker Surveying drawing 2112-11 Sh 5

19. For the same drainage reserve, the depth of flow would increase by less than 27mm in a post-development Q_{100} event. The existing reserve is highly suitable to cater for any increase in post-development catchment discharge. An increase in depth of less than 27mm (during a Q_{100} storm event) would provide no actionable nuisance to present of future downstream landowners.

4.0 CONCLUSION

Stage 1: Proposed 7 Lots on German Street:

Stage 1's lawful point of discharge in accordance with Section 3.02 of QUDM's 'two point test' is the existing 1200 RCP under German Street.

Modeling of stormwater flows in this report demonstrates that minor increase in runoff intensity as a result of proposed development is offset by the construction of open channel diversion drain resulting in a total Q100 runoff increase of only $0.2m^3/s$. All existing downstream stormwater structures will continue operating in their existing state.

Calculations shown herewith demonstrate that the existing 1200 RCP structure has been suitably sized for a fully developed upstream catchment.

Stages 2 and 3: Proposed 27 Lots off Sunset Drive:

Pre and Post-development stormwater discharge has been re-analysed for Stage 2 & 3 contributing catchments utilising both Sheet Flow and Concentrated Flow calculations.

Stage 2 & 3's lawful point of discharge in accordance with QUDM's 'two point test' is the existing drainage reserve Lot 84 SP179522.

While this Drainage Strategy reports an increase in stormwater runoff due to the proposed upstream development, the large cross sectional area of the existing drainage reserve equates to a 27mm increase in flow height during a Q100 storm event. A 27mm increase in height of discharge contained adequately within a dedicated drainage reserve is not foreseen to cause an actionable nuisance to present or future neighbouring property owners.

It is also confirmed through the attached calculations that 3/2700 x 900 RCBC has been designed to cater for a developed upstream catchment and has adequate capacity to cater for the proposed development. Post Development depth of flow across the existing culverts has been calculated at 167mm at 3.2m/s (Refer Culvert W Design Case 5). In accordance with QUDM Table 7.03.1 *Major System Design Criteria*, the product of flow depth and velocity is acceptable at ≤ 0.6m/s.

It is with these calculations that it is confirmed that no onsite detention or modification to existing downstream drainage structures is required.

5.0 ATTACHMENTS

Attachment A	Stage 1 Calculations and Catchment Plans.
Attachment B	Stage 2 Calculations and Catchment Plans.
Attachment C	Typical Section and Mannings Calculations for Existing Drainage Reserve Lot 84 SP179522
Attachment D	Typical Section and Mannings Calculations for Proposed Lots 14 through 17.
Attachment E	Existing Stormwater Network Data Rockhampton Regional Council
Attachment F	Existing Downstream Development Graham Scott & Associates

Attachment A

Catchment 7
Stage 1 Pre Development

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow *(Friend's Equation)*	$t=(107n \times L^{1/3}) / s^{1/5}$	***Where:*** *L = Length of slope (km)*
		A = Area (ha)
Concentrated Flow *(Bransby-Williams Equation)*	$t=58L/(A^{0.1} \times S^{0.2})$	*S = Stream Path Slope (%)*
		t = time of concentration 9min)

Sub-Catchment 1:

Catchment Area	1862	m2	0.2 Ha
Catchment Length	50	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.085		

Hortons Roughness Coefficient (QUDM Table 4.06.4)

Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type

◉ Sheet Flow ○ Concentrated Flow

Time of Concentration

t = **17.3 mins**

t = **0.29 hours**

Veloctiy Check (v=d/t):

v = 0.05 m/s [Check Suitability]

Sub-Catchment 2:

Catchment Area	169823	m2	17.0 Ha
Catchment Length	691	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.085		

Hortons Roughness Coefficient (QUDM Table 4.06.4)

Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type

○ Sheet Flow ◉ Concentrated Flow

Time of Concentration

t = **15.6 mins**

t = **0.26 hours**

Veloctiy Check (v=d/t):

v = 0.74 m/s [Suitable]

Rational Method of Calculation:

Q = K CIA

K

0.00278 (constant)

C

0.56 I_1	0.8 x I_{10}
0.67 I_5	0.95 x I_{10}
0.7 I_{10}	1 x I_{10}
0.74 I_{20}	1.05 x I_{10}
0.81 I_{50}	1.15 x I_{10}
0.84 I_{100}	1.2 x I_{10}

Rainfall Intensity for Sub-Catchment 1 at 17.3 mins:

I_1	64.23 mm/hr
I_5	107.19 mm/hr
I_{10}	122.11 mm/hr
I_{20}	142.03 mm/hr
I_{50}	169.24 mm/hr
I_{100}	190.71 mm/hr

Calculated Discharge

Q_1	0.019 m^3/sec
Q_5	0.037 m^3/sec
Q_{10}	**0.044 m^3/sec**
Q_{20}	0.054 m^3/sec
Q_{50}	0.071 m^3/sec
Q_{100}	**0.083 m^3/sec**

Rainfall Intensity for Sub-Catchment 2 at 15.6 mins:

I_1	67.20 mm/hr
I_5	112.33 mm/hr
I_{10}	128.06 mm/hr
I_{20}	149.03 mm/hr
I_{50}	177.70 mm/hr
I_{100}	200.32 mm/hr

Calculated Discharge

Q_1	1.777 m^3/sec
Q_5	3.527 m^3/sec
Q_{10}	**4.232 m^3/sec**
Q_{20}	5.171 m^3/sec
Q_{50}	6.753 m^3/sec
Q_{100}	**7.944 m^3/sec**

Total Combined Discharge

Q_1	1.795 m^3/sec
Q_5	3.564 m^3/sec
Q_{10}	**4.276 m^3/sec**
Q_{20}	5.225 m^3/sec
Q_{50}	6.824 m^3/sec
Q_{100}	**8.027 m^3/sec**

Catchment 8
Stage 1 Post Development

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow (*Friend's Equation*)	$t=(107n \times L^{1/3}) / s^{1/5}$	*Where:* *L = Length of slope (km)*
		A = Area (ha)
Concentrated Flow (*Bransby-Williams Equation*)	$t=58L/(A^{0.1} \times S^{0.2})$	*S = Stream Path Slope (%)*
		t = time of concentration 9min)

Sub-Catchment 1:

Catchment Area	1862	m2	0.2 Ha
Catchment Length	50	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.085		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: (●) Sheet Flow ( ) Concentrated Flow

Time of Concentration

t = 17.3 mins

t = 0.29 hours

Velocity Check (v=d/t):

v = 0.05 m/s — Check Suitability

Sub-Catchment 2:

Catchment Area	174141	m2	17.4 Ha
Catchment Length	691	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.085		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: ( ) Sheet Flow (●) Concentrated Flow

Time of Concentration

t = 15.6 mins

t = 0.26 hours

Velocity Check (v=d/t):

v = 0.74 m/s — Suitable

Rational Method of Calculation:

Q = K CIA

K

0.00278 (constant)

C

0.56 I_1	0.8 x I_{10}
0.67 I_5	0.95 x I_{10}
0.7 I_{10}	1 x I_{10}
0.74 I_{20}	1.05 x I_{10}
0.81 I_{50}	1.15 x I_{10}
0.84 I_{100}	1.2 x I_{10}

Rainfall Intensity for **Sub-Catchment 1** at 17.3 mins:

I_1	64.23 mm/hr
I_5	107.19 mm/hr
I_{10}	122.11 mm/hr
I_{20}	142.03 mm/hr
I_{50}	169.24 mm/hr
I_{100}	190.71 mm/hr

Calculated Discharge

Q_1	0.019 m^3/sec
Q_5	0.037 m^3/sec
Q_{10}	**0.044 m^3/sec**
Q_{20}	0.054 m^3/sec
Q_{50}	0.071 m^3/sec
Q_{100}	**0.083 m^3/sec**

Rainfall Intensity for **Sub-Catchment 2** at 15.6 mins:

I_1	67.28 mm/hr
I_5	112.46 mm/hr
I_{10}	128.21 mm/hr
I_{20}	149.20 mm/hr
I_{50}	177.90 mm/hr
I_{100}	200.55 mm/hr

Calculated Discharge

Q_1	1.824 m^3/sec
Q_5	3.620 m^3/sec
Q_{10}	**4.345 m^3/sec**
Q_{20}	5.309 m^3/sec
Q_{50}	6.933 m^3/sec
Q_{100}	**8.155 m^3/sec**

Total Combined Discharge

Q_1	1.842 m^3/sec
Q_5	3.657 m^3/sec
Q_{10}	**4.389 m^3/sec**
Q_{20}	5.363 m^3/sec
Q_{50}	7.004 m^3/sec
Q_{100}	**8.238 m^3/sec**

Catchment 8a
Stage 1 Pre Development

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow (Friend's Equation)	$t=(107n \times L^{1/3}) / s^{1/5}$	*Where:* L = Length of slope (km)
		A = Area (ha)
Concentrated Flow (Bransby-Williams Equation)	$t=58L/(A^{0.1} \times S^{0.2})$	S = Stream Path Slope (%)
		t = time of concentration 9min)

Sub-Catchment 1:

Catchment Area	422	m2	0.0 Ha
Catchment Length	50	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: (●) Sheet Flow ( ) Concentrated Flow

Time of Concentration
t = 20.4 mins
t = 0.34 hours

Velocity Check (v=d/t):
v = 0.04 m/s [Check Suitability]

Sub-Catchment 2:

Catchment Area	16212	m2	1.6 Ha
Catchment Length	186	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.059 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: ( ) Sheet Flow (●) Concentrated Flow

Time of Concentration
t = 5.3 mins
t = 0.09 hours

Velocity Check (v=d/t):
v = 0.58 m/s [Check Suitability]

Rational Method of Calculation:

Q = K CIA

K
0.00278 (constant)

C

0.56	I_1	$0.8 \times I_{10}$
0.67	I_5	$0.95 \times I_{10}$
0.7	I_{10}	$1 \times I_{10}$
0.74	I_{20}	$1.05 \times I_{10}$
0.81	I_{50}	$1.15 \times I_{10}$
0.84	I_{100}	$1.2 \times I_{10}$

Rainfall Intensity for Sub-Catchment 1 at 20.4 mins:

I_1	59.69 mm/hr
I_5	99.39 mm/hr
I_{10}	113.12 mm/hr
I_{20}	131.47 mm/hr
I_{50}	156.52 mm/hr
I_{100}	176.27 mm/hr

Calculated Discharge

Q_1	0.004 m^3/sec
Q_5	0.008 m^3/sec
Q_{10}	**0.009 m^3/sec**
Q_{20}	0.011 m^3/sec
Q_{50}	0.015 m^3/sec
Q_{100}	**0.017 m^3/sec**

Rainfall Intensity for Sub-Catchment 2 at 5.3 mins:

I_1	101.84 mm/hr
I_5	172.19 mm/hr
I_{10}	197.17 mm/hr
I_{20}	230.42 mm/hr
I_{50}	275.90 mm/hr
I_{100}	312.01 mm/hr

Calculated Discharge

Q_1	0.257 m^3/sec
Q_5	0.516 m^3/sec
Q_{10}	**0.622 m^3/sec**
Q_{20}	0.763 m^3/sec
Q_{50}	1.001 m^3/sec
Q_{100}	**1.181 m^3/sec**

Total Combined Discharge

Q_1	0.261 m^3/sec
Q_5	0.524 m^3/sec
Q_{10}	**0.631 m^3/sec**
Q_{20}	0.775 m^3/sec
Q_{50}	1.016 m^3/sec
Q_{100}	**1.199 m^3/sec**

Catchment 8c
Stage 1 Pre & Post Development

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow (Friend's Equation)	$t=(107n \times L^{1/3}) / s^{1/5}$	*Where:*	*L = Length of slope (km)*
			A = Area (ha)
			S = Stream Path Slope (%)
Concentrated Flow (Bransby-Williams Equation)	$t=58L/(A^{0.1} \times S^{0.2})$		*t = time of concentration 9min)*

Sub-Catchment 1:

Catchment Area	520	m2	0.1 Ha
Catchment Length	50	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphalt	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegetation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: ◉ Sheet Flow ○ Concentrated Flow

Time of Concentration

t = 20.4 mins

t = 0.34 hours

Velocity Check (v=d/t):

v = 0.04 m/s [Check Suitability]

Sub-Catchment 2:

Catchment Area	12763	m2	1.3 Ha
Catchment Length	250	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphalt	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegetation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: ○ Sheet Flow ◉ Concentrated Flow

Time of Concentration

t = 7.3 mins

t = 0.12 hours

Velocity Check (v=d/t):

v = 0.57 m/s [Check Suitability]

Rational Method of Calculation:

Q = K CIA

K

0.00278 (constant)

C

0.56 I_1	0.8 x I_{10}
0.67 I_5	0.95 x I_{10}
0.7 I_{10}	1 x I_{10}
0.74 I_{20}	1.05 x I_{10}
0.81 I_{50}	1.15 x I_{10}
0.84 I_{100}	1.2 x I_{10}

Rainfall Intensity for Sub-Catchment 1 at 20.4 mins:

I_1	59.69 mm/hr
I_5	99.39 mm/hr
I_{10}	113.12 mm/hr
I_{20}	131.47 mm/hr
I_{50}	156.52 mm/hr
I_{100}	176.27 mm/hr

Calculated Discharge

Q_1	0.005 m^3/sec
Q_5	0.010 m^3/sec
Q_{10}	0.011 m^3/sec
Q_{20}	0.014 m^3/sec
Q_{50}	0.018 m^3/sec
Q_{100}	0.021 m^3/sec

Rainfall Intensity for Sub-Catchment 2 at 7.3 mins:

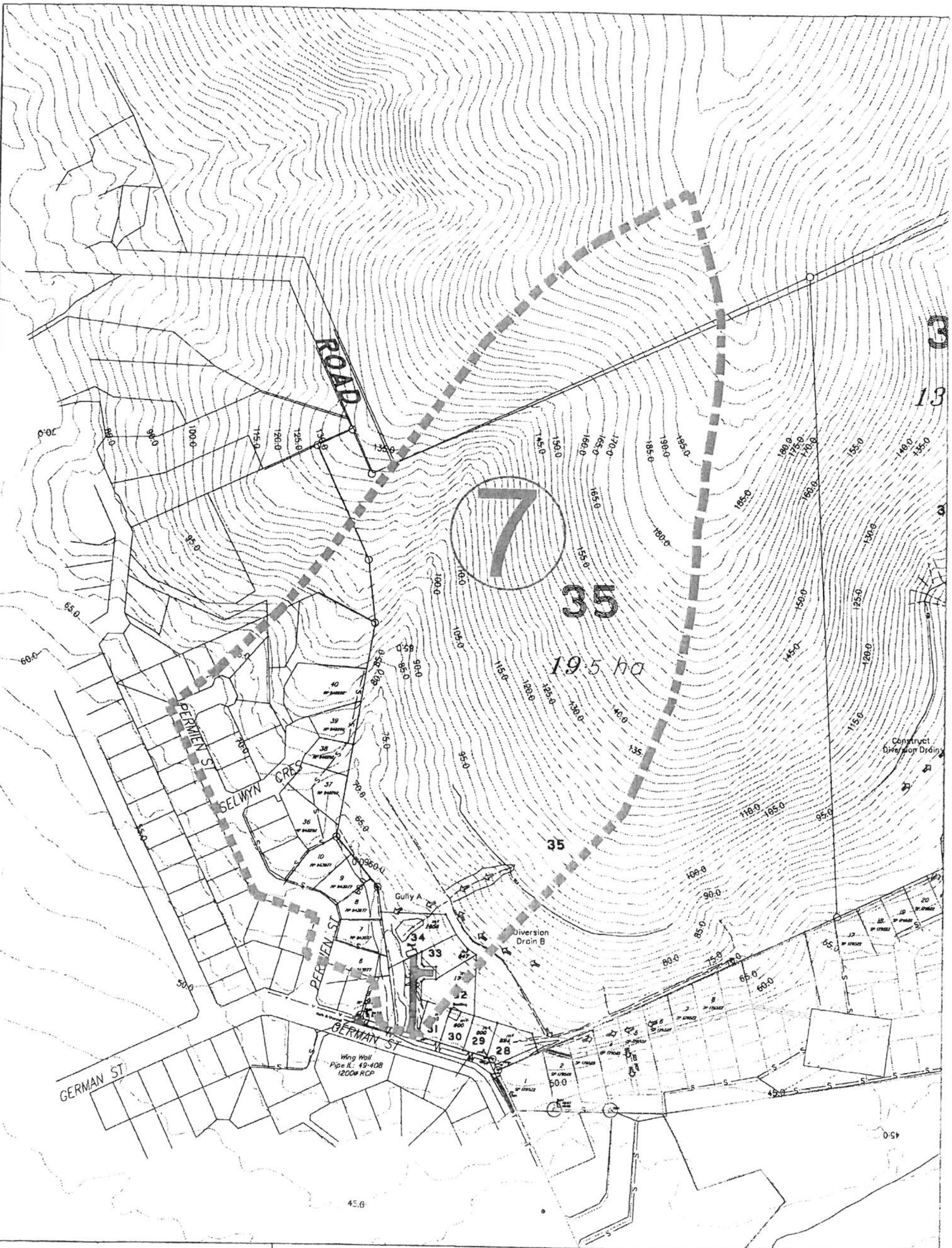
I_1	90.52 mm/hr
I_5	153.04 mm/hr
I_{10}	175.32 mm/hr
I_{20}	204.86 mm/hr
I_{50}	245.34 mm/hr
I_{100}	277.43 mm/hr

Calculated Discharge

Q_1	0.180 m^3/sec
Q_5	0.361 m^3/sec
Q_{10}	0.435 m^3/sec
Q_{20}	0.534 m^3/sec
Q_{50}	0.701 m^3/sec
Q_{100}	0.827 m^3/sec

Total Combined Discharge

Q_1	0.185 m^3/sec
Q_5	0.371 m^3/sec
Q_{10}	0.447 m^3/sec
Q_{20}	0.548 m^3/sec
Q_{50}	0.719 m^3/sec
Q_{100}	0.848 m^3/sec



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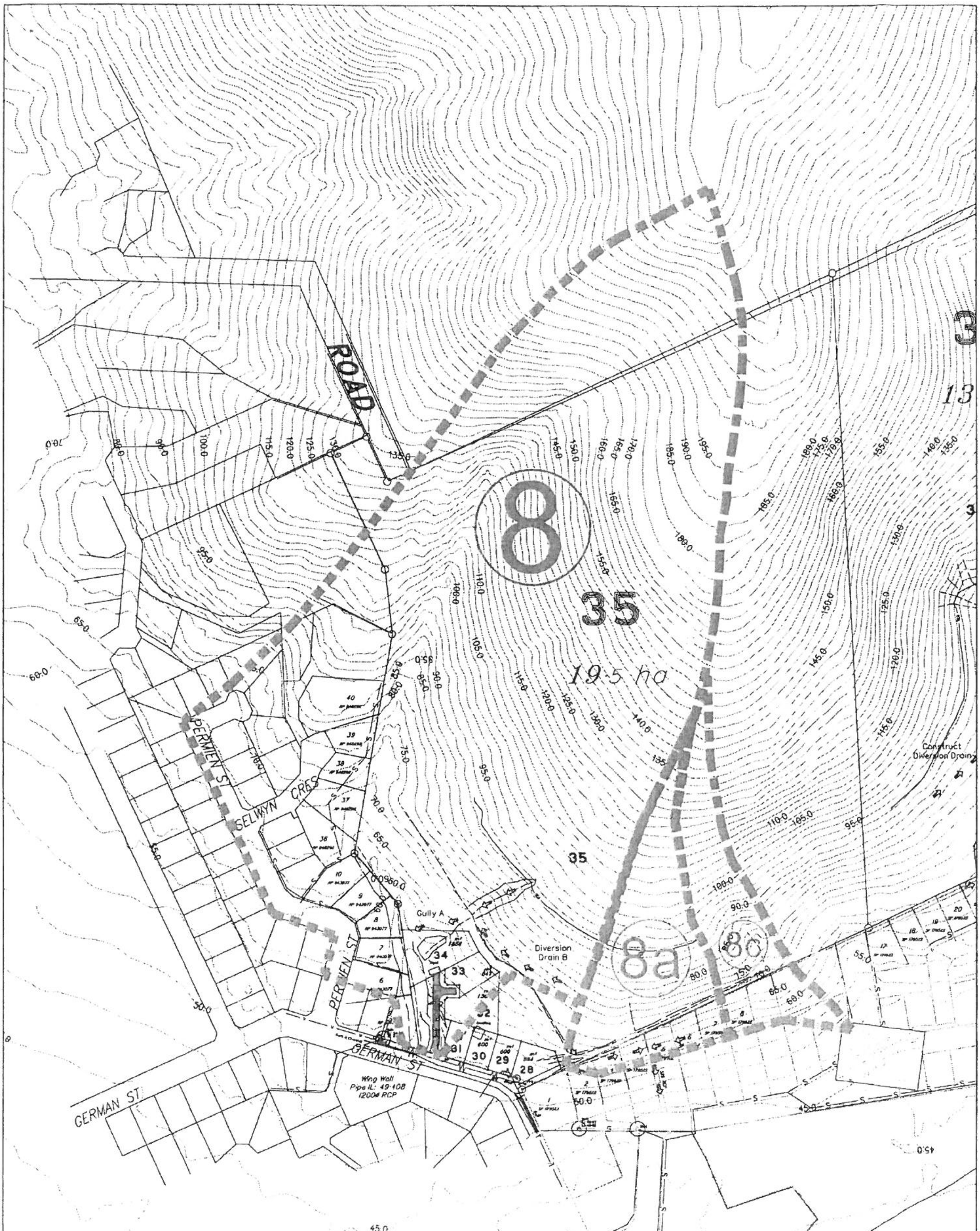
PROPOSED SUBDIVISION ON GERMAN ST
FOR MR T GRIEVES
CATCHMENT BOUNDARIES
CATCHMENT 7

Revision No: A

Drawing Number
0880708-08P

SCALE: 1:4000 (A4)



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PROPOSED SUBDIVISION ON GERMAN ST FOR MR T GRIEVES

CATCHMENT BOUNDARIES
CATCHMENT 8

Revision No: A

Drawing Number: 0880708-09P

SCALE: 1:4000 (A4)

Mannings Calculations
Stage 1: Post-development Discharge

Existing Gully

Typical Section A-A

A	2.07		Depth of Flow:	810 mm
WP	5.36			
R	0.386			
S	0.05	5%		

$$V = 1/n \times R^{2/3} \times S^{1/2}$$

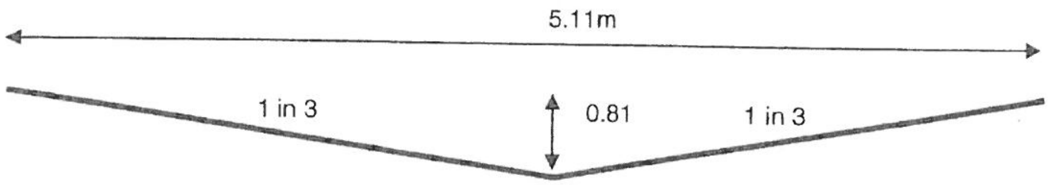
n	0.03	(Manngings: Grass Channel)
1/n	33.333	
$R^{2/3}$	0.530	
$S^{1/2}$	0.223607	

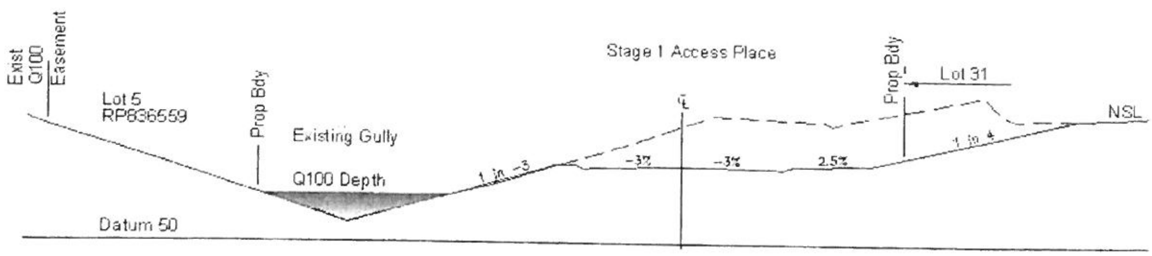
V 3.953 m/sec

Q=VA

Q **8.2 m^3/sec**

Typical section taken approx 30m into Stage 1 Access Place





Chainage 30.000

Attachment B

Catchment 1
Access to Lot 14

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow *(Friend's Equation)*	$t=(107n \times L^{1/3}) / s^{1/5}$	***Where:***	*L = Length of slope (km)*
			A = Area (ha)
Concentrated Flow *(Bransby-Williams Equation)*	$t=58L/(A^{0.1} \times S^{0.2})$		*S = Stream Path Slope (%)*
			t = time of concentration 9min)

Sub-Catchment 1:

Catchment Area	4253	m2	0.4 Ha
Catchment Length	58	m	
Catchment Grade	35	%	0.35 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.05.4)

Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type

◉ Sheet Flow ○ Concentrated Flow

Time of Concentration

t = **20.3 mins**

t = **0.34 hours**

Velocity Check (v=d/t):

v = 0.05 m/s [Check Suitability]

sdf;kasg

Sub-Catchment 2:

Catchment Area	73874	m2	7.4 Ha
Catchment Length	300	m	
Catchment Grade	35	%	0.35 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.05.4)

Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type

○ Sheet Flow ◉ Concentrated Flow

Time of Concentration

t = **7.0 mins**

t = **0.12 hours**

Velocity Check (v=d/t):

v = 0.71 m/s [Suitable]

Rational Method of Calculation:

Q = K CIA

K

0.00278 (constant)

C

0.56 I_1	0.8 x I_{10}
0.67 I_5	0.95 x I_{10}
0.7 I_{10}	1 x I_{10}
0.74 I_{20}	1.05 x I_{10}
0.81 I_{50}	1.15 x I_{10}
0.84 I_{100}	1.2 x I_{10}

Rainfall Intensity for **Sub-Catchment 1** at 20.3 mins:

I_1	59.76 mm/hr
I_5	99.50 mm/hr
I_{10}	113.25 mm/hr
I_{20}	131.62 mm/hr
I_{50}	156.70 mm/hr
I_{100}	176.48 mm/hr

Calculated Discharge

Q_1	0.040 m^3/sec
Q_5	0.078 m^3/sec
Q_{10}	**0.094 m^3/sec**
Q_{20}	0.114 m^3/sec
Q_{50}	0.149 m^3/sec
Q_{100}	**0.175 m^3/sec**

Rainfall Intensity for **Sub-Catchment 2** at 7.0 mins:

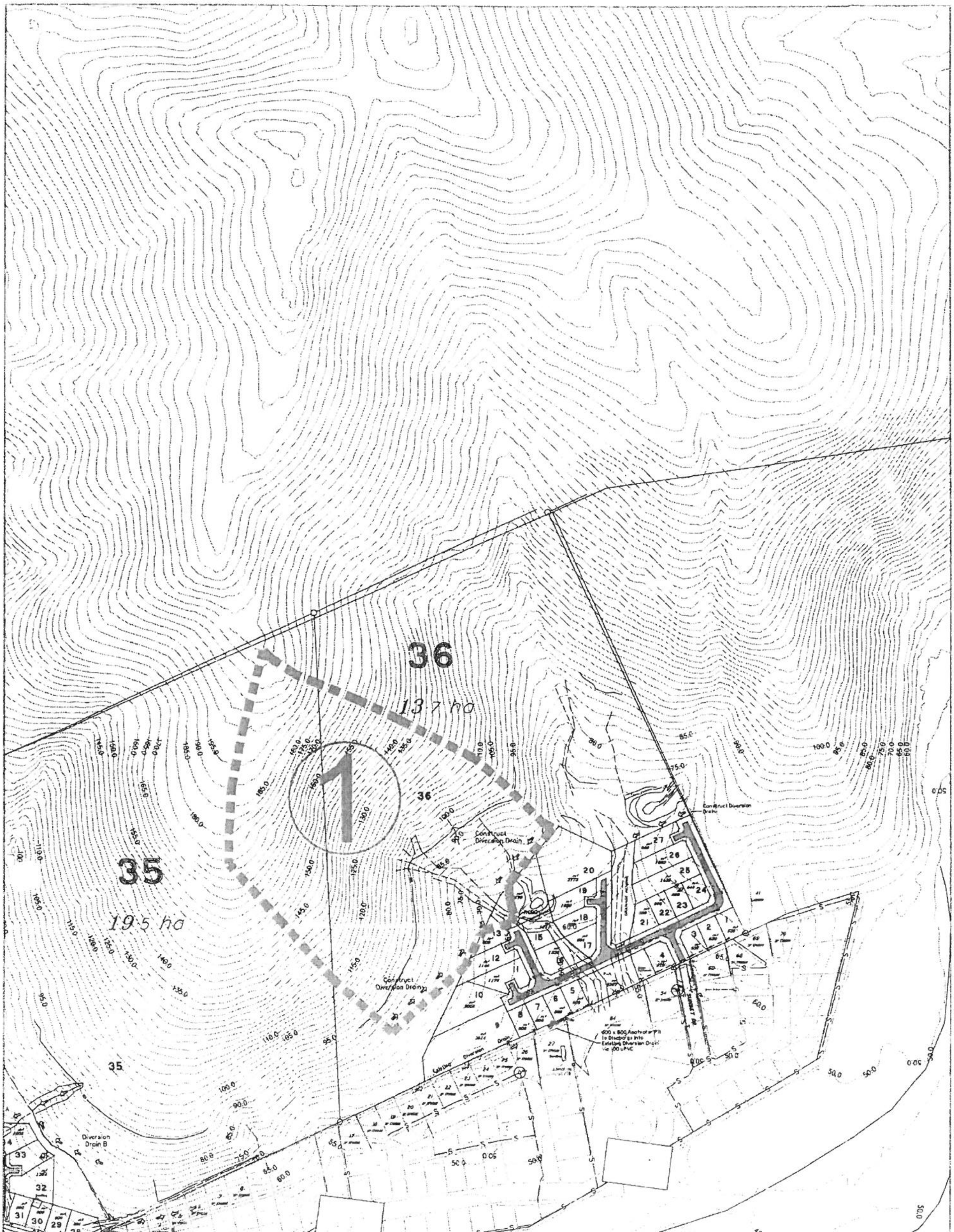
I_1	92.04 mm/hr
I_5	155.66 mm/hr
I_{10}	178.34 mm/hr
I_{20}	208.42 mm/hr
I_{50}	249.62 mm/hr
I_{100}	282.30 mm/hr

Calculated Discharge

Q_1	1.058 m^3/sec
Q_5	2.126 m^3/sec
Q_{10}	**2.564 m^3/sec**
Q_{20}	3.146 m^3/sec
Q_{50}	4.127 m^3/sec
Q_{100}	**4.870 m^3/sec**

Total Combined Discharge

Q_1	1.098 m^3/sec
Q_5	2.204 m^3/sec
Q_{10}	**2.658 m^3/sec**
Q_{20}	3.260 m^3/sec
Q_{50}	4.276 m^3/sec
Q_{100}	**5.045 m^3/sec**



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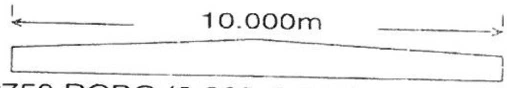
PROPOSED SUBDIVISION ON GERMAN ST
FOR MR T GRIEVES
CATCHMENT BOUNDARIES
CATCHMENT 1

Revision No:	A
Drawing Number	0880708-01P
SCALE:	1:4000 (A4)

CulvertW - Design Case No 1

(File: 088070~1.CUL - Date: 1-12-2009)



1 No 900x750 RCBC (0.908x0.762) at a slope= 1.0000%

Inlet RL 65.000m Outlet RL 64.900m

Culvert Data

Using Mannings 'n' = 0.013
Entrance Loss Coefficient 'k' = 0.500
Entrance - Wingwall flare 90-15 deg

Weir Data

Weir Length = 10.000m
Weir Coefficient = 0.577
Weir Crest Height = 1.600m (RL 66.500m)

No Channel Data specified to be used

Headwater

Approach Flow	= 5.045m3/s
Flow over weir	= 2.898m3/s (Head = 0.307m)
Critical Depth of Flow	= 0.20m (Velocity = 1.42m)
Tailwater depth	= 0.000m (RL 64.900m)
Using fixed Tailwater depth	
Critical depth at outlet	= 0.827m (RL 65.727m)
Effective tailwater depth	= 0.762m (RL 65.662m)
Head Loss in Culvert	= 0.864m
Depth at outlet adopted to calculate outlet velocity	= 0.722m (RL 65.622m)
Outlet Velocity	= 3.267m/s

INLET control

Headwater is 1.807m above culvert inlet invert
Headwater is at RL 66.807m - 0.307m above Weir Crest
Tailwater is at RL 64.900m - 0.000m above outlet invert

Catchment 2
Major Western RCBC

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow *(Friend's Equation)*	$t=(107n \times L^{1/3}) / s^{1/5}$	***Where:***	*L = Length of slope (km)*
			A = Area (ha)
			S = Stream Path Slope (%)
Concentrated Flow *(Bransby-Williams Equation)*	$t=58L/(A^{0.1} \times S^{0.2})$		*t = time of concentration 9min)*

Sub-Catchment 1:

Catchment Area	4200	m2	0.4 Ha
Catchment Length	50	m	
Catchment Grade	30	%	0.3 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type
- (●) Sheet Flow
- ( ) Concentrated Flow

Time of Concentration
t = 20.0 mins
t = 0.33 hours

Veloctiy Check (v=d/t):
v = 0.04 m/s | Check Suitability

sdf;kasg

Sub-Catchment 2:

Catchment Area	87716	m2	8.8 Ha
Catchment Length	384	m	
Catchment Grade	30	%	0.3 m/m
n (Hortons Value)	0.085		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type
- ( ) Sheet Flow
- (●) Concentrated Flow

Time of Concentration
t = 9.1 mins
t = 0.15 hours

Veloctiy Check (v=d/t):
v = 0.70 m/s | Suitable

Rational Method of Calculation:

Q = K CIA

K
0.00278 (constant)

C

0.56 I_1	0.8 x I_{10}
0.67 I_5	0.95 x I_{10}
0.7 I_{10}	1 x I_{10}
0.74 I_{20}	1.05 x I_{10}
0.81 I_{50}	1.15 x I_{10}
0.84 I_{100}	1.2 x I_{10}

Rainfall Intensity for Sub-Catchment 1 at 20.0 mins:

I_1	60.27 mm/hr
I_5	100.38 mm/hr
I_{10}	114.26 mm/hr
I_{20}	132.81 mm/hr
I_{50}	158.13 mm/hr
I_{100}	178.10 mm/hr

Calculated Discharge

Q_1	0.039 m^3/sec
Q_5	0.078 m^3/sec
Q_{10}	**0.093 m^3/sec**
Q_{20}	0.114 m^3/sec
Q_{50}	0.149 m^3/sec
Q_{100}	**0.175 m^3/sec**

Rainfall Intensity for Sub-Catchment 2 at 9.1 mins:

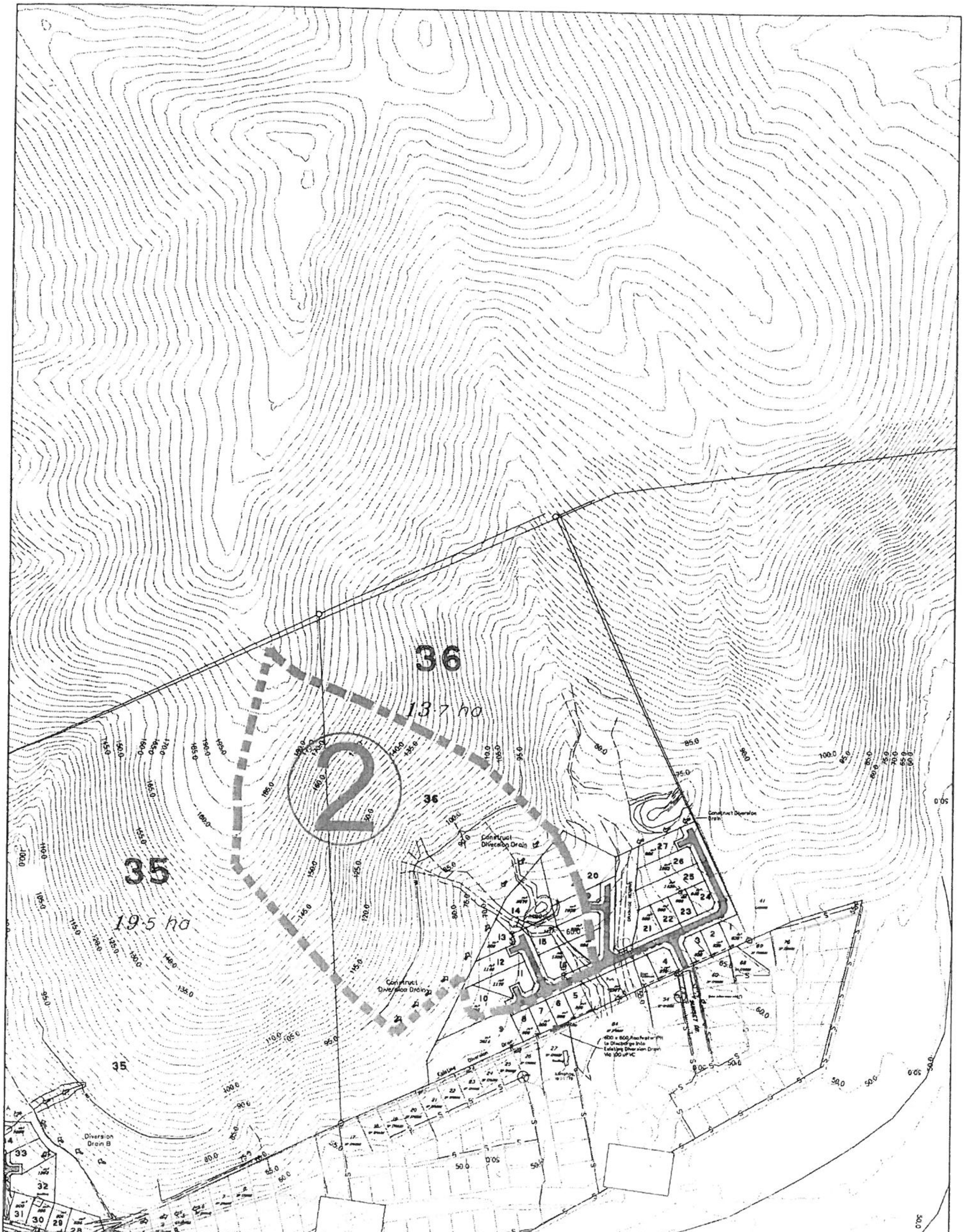
I_1	83.53 mm/hr
I_5	140.87 mm/hr
I_{10}	161.23 mm/hr
I_{20}	188.21 mm/hr
I_{50}	225.19 mm/hr
I_{100}	254.46 mm/hr

Calculated Discharge

Q_1	1.141 m^3/sec
Q_5	2.284 m^3/sec
Q_{10}	**2.752 m^3/sec**
Q_{20}	3.373 m^3/sec
Q_{50}	4.420 m^3/sec
Q_{100}	**5.212 m^3/sec**

Total Combined Discharge

Q_1	1.180 m^3/sec
Q_5	2.362 m^3/sec
Q_{10}	**2.845 m^3/sec**
Q_{20}	3.487 m^3/sec
Q_{50}	4.569 m^3/sec
Q_{100}	**5.387 m^3/sec**



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PROPOSED SUBDIVISION ON GERMAN ST
FOR MR T GRIEVES
CATCHMENT BOUNDARIES
CATCHMENT 2

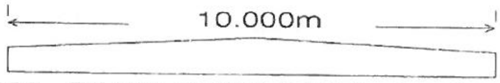
Revision No: A

Drawing Number 0880708-02P

SCALE: 1:4000 (A4)

CulvertW - Design Case No 2

(File: 088070~1.CUL - Date: 1-12-2009)



1 No 900x900 RCBC (0.908x0.914) at a slope= 1.0000%

Inlet RL 57.500m Outlet RL 57.400m

Culvert Data

Using Mannings 'n'	= 0.013
Entrance Loss Coefficient 'k'	= 0.500
Entrance - Wingwall flare 90-15 deg	

Weir Data

Weir Length = 15.000m
Weir Coefficient = 0.577
Weir Crest Height = 1.600m (RL 59.000m)

No Channel Data specified to be used

Headwater

Approach Flow	= 5.387m3/s
Flow over weir	= 3.008m3/s (Head = 0.240m)
Critical Depth of Flow	= 0.16m (Velocity = 1.25m)
Tailwater depth	= 0.000m (RL 57.400m)
Using fixed Tailwater depth	
Critical depth at outlet	= 0.885m (RL 58.285m)
Effective tailwater depth	= 0.899m (RL 58.299m)
Head Loss in Culvert	= 0.721m
Depth at outlet adopted to calculate outlet velocity	= 0.774m (RL 58.174m)
Outlet Velocity	= 3.371m/s

INLET control

Headwater is 1.740m above culvert inlet invert
Headwater is at RL 59.240m - 0.240m above Weir Crest
Tailwater is at RL 57.400m - 0.000m above outlet invert

Catchment 3
Major Eastern RCBC

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow *(Friend's Equation)*	$t=(107n \times L^{1/3}) / s^{1/5}$	***Where:*** *L = Length of slope (km)* *A = Area (ha)* *S = Stream Path Slope (%)* *t = time of concentration 9min)*
Concentrated Flow *(Bransby-Williams Equation)*	$t=58L/(A^{0.1} \times S^{0.2})$	

Sub-Catchment 1:

Catchment Area	2344	m2	0.2 Ha
Catchment Length	50	m	
Catchment Grade	35	%	0.35 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.05.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type

◉ Sheet Flow ○ Concentrated Flow

Time of Concentration

t = **19.4 mins**

t = **0.32 hours**

Velociy Check (v=d/t):

v = 0.04 m/s | Check Suitability

sdf;kasg

Sub-Catchment 2:

Catchment Area	344588	m2	34.5 Ha
Catchment Length	916	m	
Catchment Grade	35	%	0.35 m/m
n (Hortons Value)	0.085		

Hortons Roughness Coefficient (QUDM Table 4.05.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type

○ Sheet Flow ◉ Concentrated Flow

Time of Concentration

t = **18.3 mins**

t = **0.31 hours**

Velociy Check (v=d/t):

v = 0.83 m/s | Suitable

Rational Method of Calculation:

Q = K CIA

K

0.00278 (constant)

C	
0.56 I_1	0.8 x I_{10}
0.67 I_5	0.95 x I_{10}
0.7 I_{10}	1 x I_{10}
0.74 I_{20}	1.05 x I_{10}
0.81 I_{50}	1.15 x I_{10}
0.84 I_{100}	1.2 x I_{10}

Rainfall Intensity for **Sub-Catchment 1** at 19.4 mins:

I_1	61.12 mm/hr
I_5	101.85 mm/hr
I_{10}	115.95 mm/hr
I_{20}	134.79 mm/hr
I_{50}	160.52 mm/hr
I_{100}	180.80 mm/hr

Calculated Discharge

Q_1	0.022 m^3/sec
Q_5	0.044 m^3/sec
Q_{10}	**0.053 m^3/sec**
Q_{20}	0.065 m^3/sec
Q_{50}	0.084 m^3/sec
Q_{100}	**0.099 m^3/sec**

Rainfall Intensity for **Sub-Catchment 2** at 18.3 mins:

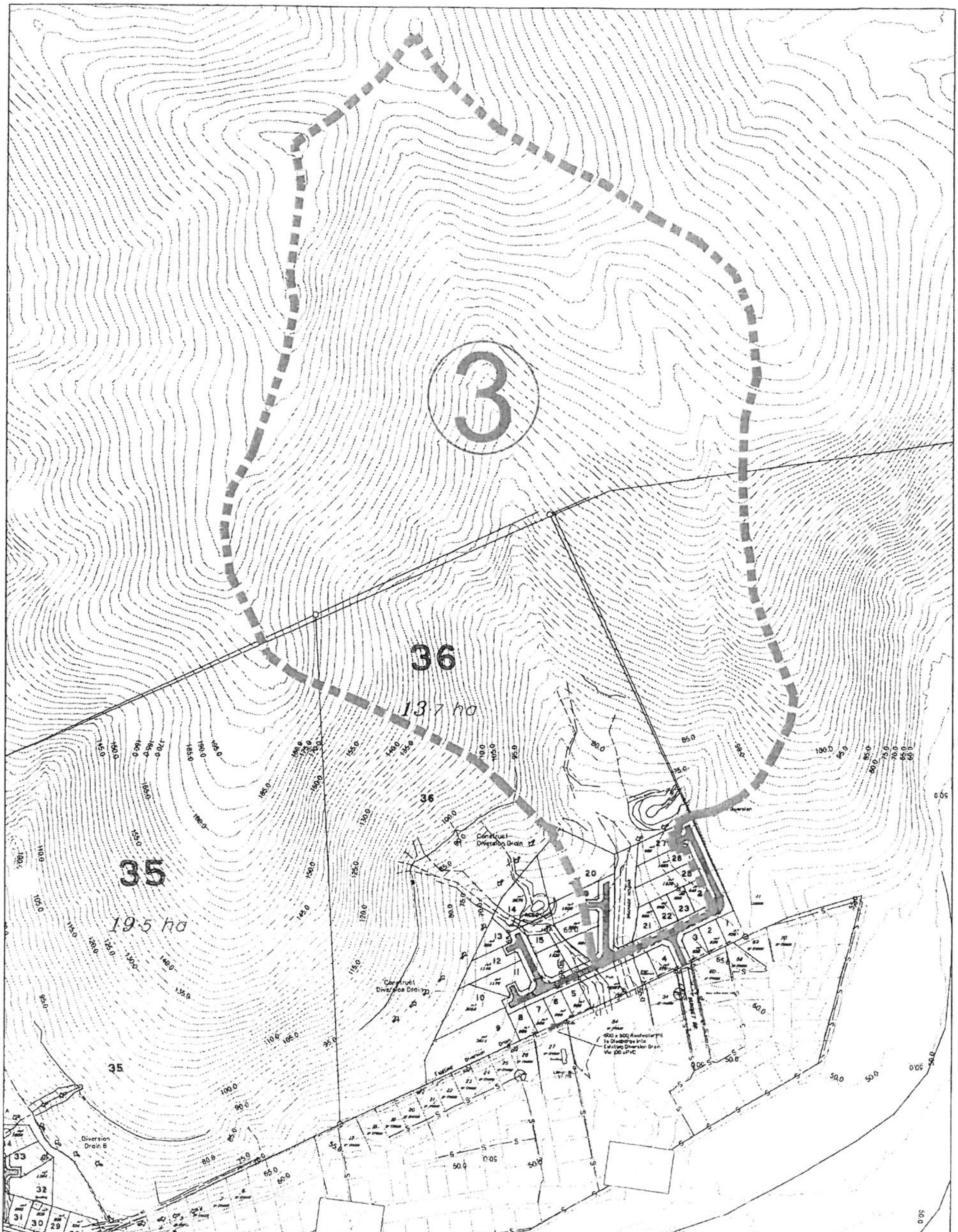
I_1	62.68 mm/hr
I_5	104.51 mm/hr
I_{10}	119.02 mm/hr
I_{20}	138.40 mm/hr
I_{50}	164.86 mm/hr
I_{100}	185.73 mm/hr

Calculated Discharge

Q_1	3.362 m^3/sec
Q_5	6.658 m^3/sec
Q_{10}	**7.981 m^3/sec**
Q_{20}	9.745 m^3/sec
Q_{50}	12.714 m^3/sec
Q_{100}	**14.946 m^3/sec**

Total Combined Discharge

Q_1	3.385 m^3/sec
Q_5	6.702 m^3/sec
Q_{10}	**8.034 m^3/sec**
Q_{20}	9.809 m^3/sec
Q_{50}	12.798 m^3/sec
Q_{100}	**15.045 m^3/sec**



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PROPOSED SUBDIVISION ON GERMAN ST
FOR MR T GRIEVES
CATCHMENT BOUNDARIES
CATCHMENT 3

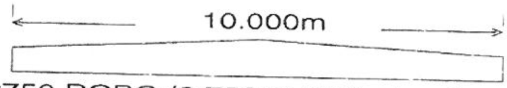
Revision No: A

Drawing Number: 0880708-03P

SCALE: 1:4000 (A4)

CulvertW - Design Case No 3

(File: 088070~1.CUL - Date: 1-12-2009)



2 No 750x750 RCBC (0.756x0.762) at a slope= 1.0000%

Inlet RL 57.500m Outlet RL 57.400m

Culvert Data

Using Mannings 'n' = 0.013
Entrance Loss Coefficient 'k' = 0.500
Entrance - Wingwall flare 90-15 deg

Weir Data

Weir Length = 50.000m
Weir Coefficient = 0.577
Weir Crest Height = 2.100m (RL 59.500m)

No Channel Data specified to be used

Headwater

Approach Flow	= 15.045m3/s
Flow in each Culvert	= 2.050m3/s
Flow over weir	= 10.945m3/s (Head = 0.255m)
Critical Depth of Flow	= 0.17m (Velocity = 1.29m)
Tailwater depth	= 0.000m (RL 57.400m)
Using fixed Tailwater depth	
Critical depth at outlet	= 0.906m (RL 58.306m)
Effective tailwater depth	= 0.762m (RL 58.162m)
Head Loss in Culvert	= 1.157m
Depth at outlet adopted to calculate outlet velocity	= 0.762m (RL 58.162m)
Outlet Velocity	= 3.547m/s

INLET control

Headwater is 2.255m above culvert inlet invert
Headwater is at RL 59.755m - 0.255m above Weir Crest
Tailwater is at RL 57.400m - 0.000m above outlet invert

Catchment 4
Total Pre Development

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow (Friend's Equation)	$t=(107n \times L^{1/3}) / s^{1.5}$	**Where:** L = Length of slope (km); A = Area (ha); S = Stream Path Slope (%); t = time of concentration 9min)
Concentrated Flow (Bransby-Williams Equation)	$t=58L/(A^{0.1} \times S^{0.2})$	

Sub-Catchment 1:

Catchment Area	2344	m2	0.2 Ha
Catchment Length	50	m	
Catchment Grade	30	%	0.3 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (OUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: (●) Sheet Flow ( ) Concentrated Flow

Time of Concentration
t = 20.0 mins
t = 0.33 hours

Velocity Check (v=d/t):
v = 0.04 m/s [Check Suitability]
sdf;kasg

Sub-Catchment 2:

Catchment Area	473237	m2	47.3 Ha
Catchment Length	955	m	
Catchment Grade	30	%	0.3 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (OUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: ( ) Sheet Flow (●) Concentrated Flow

Time of Concentration
t = 19.1 mins
t = 0.32 hours

Velocity Check (v=d/t):
v = 0.83 m/s [Suitable]

Rational Method of Calculation:

Q = K CIA

K
0.00278 (constant)

C	
0.56 I_1	0.8 x I_{10}
0.67 I_5	0.95 x I_{10}
0.7 I_{10}	1 x I_{10}
0.74 I_{20}	1.05 x I_{10}
0.81 I_{50}	1.15 x I_{10}
0.84 I_{100}	1.2 x I_{10}

Rainfall Intensity for Sub-Catchment 1 at 20.0 mins:

I_1	60.27 mm/hr
I_5	100.38 mm/hr
I_{10}	114.26 mm/hr
I_{20}	132.81 mm/hr
I_{50}	158.13 mm/hr
I_{100}	178.10 mm/hr

Calculated Discharge

Q_1	0.022 m³/sec
Q_5	0.043 m³/sec
Q_{10}	0.052 m³/sec
Q_{20}	0.064 m³/sec
Q_{50}	0.083 m³/sec
Q_{100}	0.097 m³/sec

Rainfall Intensity for Sub-Catchment 2 at 19.1 mins:

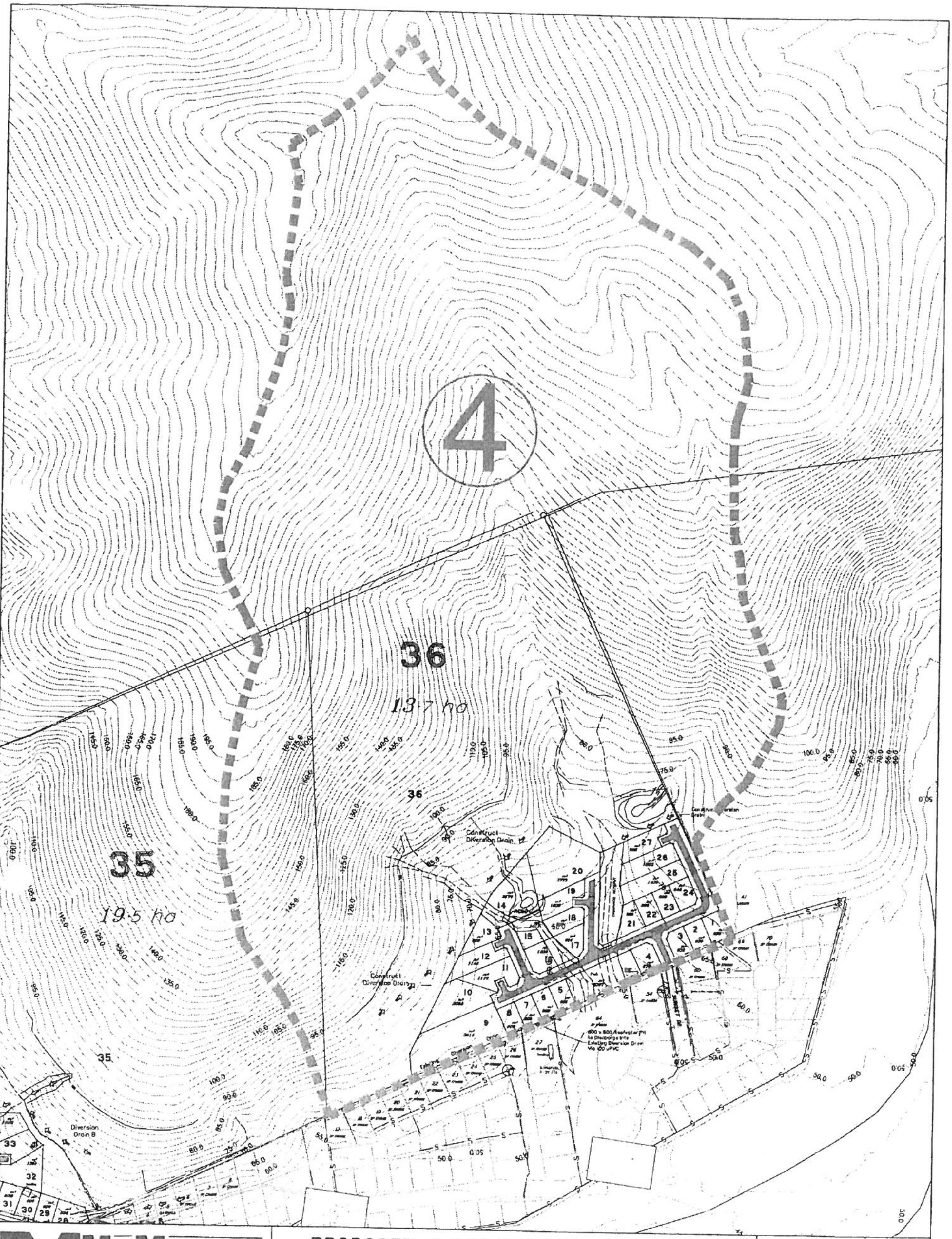
I_1	61.53 mm/hr
I_5	102.55 mm/hr
I_{10}	116.76 mm/hr
I_{20}	135.74 mm/hr
I_{50}	161.66 mm/hr
I_{100}	182.10 mm/hr

Calculated Discharge

Q_1	4.533 m³/sec
Q_5	8.972 m³/sec
Q_{10}	10.753 m³/sec
Q_{20}	13.126 m³/sec
Q_{50}	17.121 m³/sec
Q_{100}	20.124 m³/sec

Total Combined Discharge

Q_1	4.555 m³/sec
Q_5	9.015 m³/sec
Q_{10}	10.805 m³/sec
Q_{20}	13.190 m³/sec
Q_{50}	17.204 m³/sec
Q_{100}	20.222 m³/sec



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PROPOSED SUBDIVISION ON GERMAN ST
FOR MR T GRIEVES

CATCHMENT BOUNDARIES
CATCHMENT 4

Revision No: A

Drawing Number
0880708-04P

SCALE: 1:4000 (A4)

Catchment 5
Post Development Lots Only

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM) Click method required below:

Overland Flow Theory

Sheet Flow (Friend's Equation)	$t=(107n \times L^{1/3}) / s^{1/5}$	*Where: L = Length of slope (km)*
		A = Area (ha)
		S = Stream Path Slope (%)
Concentrated Flow (Bransby-Williams Equation)	$t=58L/(A^{0.1} \times S^{0.2})$	*t = time of concentration 9min)*

Sub-Catchment 1:

Catchment Area	39932	m2	4.0 Ha
Catchment Length	150	m	
Catchment Grade	10	%	0.1 m/m
n (Hortons Value)	0.069		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: ○ Sheet Flow ◉ Concentrated Flow

Time of Concentration
t = 4.8 mins
t = 0.08 hours

Velocity Check (v=d/t):
v = 0.52 m/s [Check Suitability]
sdf;kasg

Sub-Catchment 2:

Catchment Area	0	m2	0.0 Ha
Catchment Length	0.1	m	
Catchment Grade	0.1	%	0.001 m/m
n (Hortons Value)	1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: ◉ Sheet Flow ○ Concentrated Flow

Time of Concentration
t = 78.7 mins
t = 1.31 hours

Velocity Check (v=d/t):
v = 0.00 m/s [Check Suitability]

Rational Method of Calculation:

Q = K CIA

K
0.00278 (constant)

C

0.56	I_1	0.8 x	I_{10}
0.67	I_5	0.95 x	I_{10}
0.7	I_{10}	1 x	I_{10}
0.74	I_{20}	1.05 x	I_{10}
0.81	I_{50}	1.15 x	I_{10}
0.84	I_{100}	1.2 x	I_{10}

Rainfall Intensity for Sub-Catchment 1 at 4.8 mins:

I_1	106.00	mm/hr
I_5	178.95	mm/hr
I_{10}	204.70	mm/hr
I_{20}	239.10	mm/hr
I_{50}	286.09	mm/hr
I_{100}	323.40	mm/hr

Calculated Discharge

Q_1	0.659	m^3/sec
Q_5	1.321	m^3/sec
Q_{10}	1.591	m^3/sec
Q_{20}	1.951	m^3/sec
Q_{50}	2.557	m^3/sec
Q_{100}	3.016	m^3/sec

Rainfall Intensity for Sub-Catchment 2 at 78.7 mins:

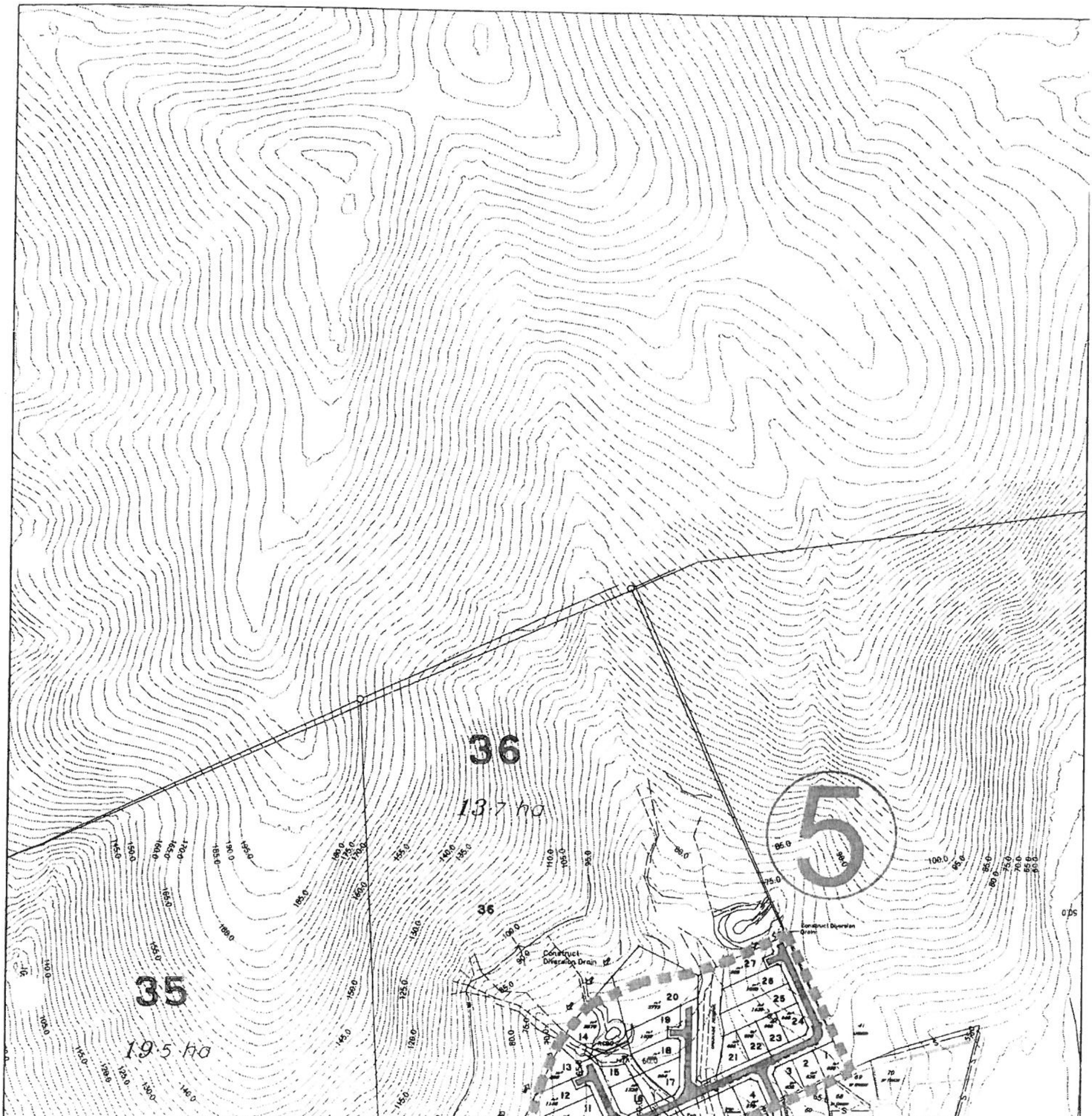
I_1	28.60	mm/hr
I_5	47.47	mm/hr
I_{10}	53.95	mm/hr
I_{20}	62.64	mm/hr
I_{50}	74.48	mm/hr
I_{100}	83.81	mm/hr

Calculated Discharge

Q_1	0.000	m^3/sec
Q_5	0.000	m^3/sec
Q_{10}	0.000	m^3/sec
Q_{20}	0.000	m^3/sec
Q_{50}	0.000	m^3/sec
Q_{100}	0.000	m^3/sec

Total Combined Discharge

Q_1	0.659	m^3/sec
Q_5	1.321	m^3/sec
Q_{10}	1.591	m^3/sec
Q_{20}	1.951	m^3/sec
Q_{50}	2.557	m^3/sec
Q_{100}	3.016	m^3/sec



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PROPOSED SUBDIVISION ON GERMAN ST
FOR MR T GRIEVES
CATCHMENT BOUNDARIES
CATCHMENT 5

Revision No: A

Drawing Number
0880708-05P

SCALE: 1:4000 (A4)

Catchment 6
Remaining Undeveloped

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow *(Friend's Equation)*	$t=(107n \times L^{1/3}) / s^{1.5}$	***Where:***	*L = Length of slope (km)*
			A = Area (ha)
Concentrated Flow *(Bransby-Williams Equation)*	$t=58L/(A^{0.1} \times S^{0.2})$		*S = Stream Path Slope (%)*
			t = time of concentration 9min)

Sub-Catchment 1:

Catchment Area	2344	m2	0.2 Ha
Catchment Length	50	m	
Catchment Grade	30	%	0.3 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphalt	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegetation	**0.053 - 0.130**
Short Grass Paddock	**0.100 - 0.200**
Lawns	0.170 - 0.480

Flow Type

(●) Sheet Flow ( ) Concentrated Flow

Time of Concentration

t = **20.0 mins**

t = **0.33 hours**

Velocity Check (v=d/t):

v = 0.04 m/s [Check Suitability]

sdf;kasg

Sub-Catchment 2:

Catchment Area	427234	m2	42.7 Ha
Catchment Length	850	m	
Catchment Grade	30	%	0.3 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphalt	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegetation	**0.053 - 0.130**
Short Grass Paddock	**0.100 - 0.200**
Lawns	0.170 - 0.480

Flow Type

( ) Sheet Flow (●) Concentrated Flow

Time of Concentration

t = **17.2 mins**

t = **0.29 hours**

Velocity Check (v=d/t):

v = 0.83 m/s [Suitable]

Rational Method of Calculation:

Q = K CIA

K	
0.00278 (constant)	

C	
0.56 I_1	0.8 x I_{10}
0.67 I_5	0.95 x I_{10}
0.7 I_{10}	1 x I_{10}
0.74 I_{20}	1.05 x I_{10}
0.81 I_{50}	1.15 x I_{10}
0.84 I_{100}	1.2 x I_{10}

Rainfall Intensity for Sub-Catchment 1 at 20.0 mins:

I_1	60.27 mm/hr
I_5	100.38 mm/hr
I_{10}	114.26 mm/hr
I_{20}	132.81 mm/hr
I_{50}	158.13 mm/hr
I_{100}	178.10 mm/hr

Calculated Discharge

Q_1	0.022 m^3/sec
Q_5	0.043 m^3/sec
Q_{10}	**0.052 m^3/sec**
Q_{20}	0.064 m^3/sec
Q_{50}	0.083 m^3/sec
Q_{100}	**0.097 m^3/sec**

Rainfall Intensity for Sub-Catchment 2 at 17.2 mins:

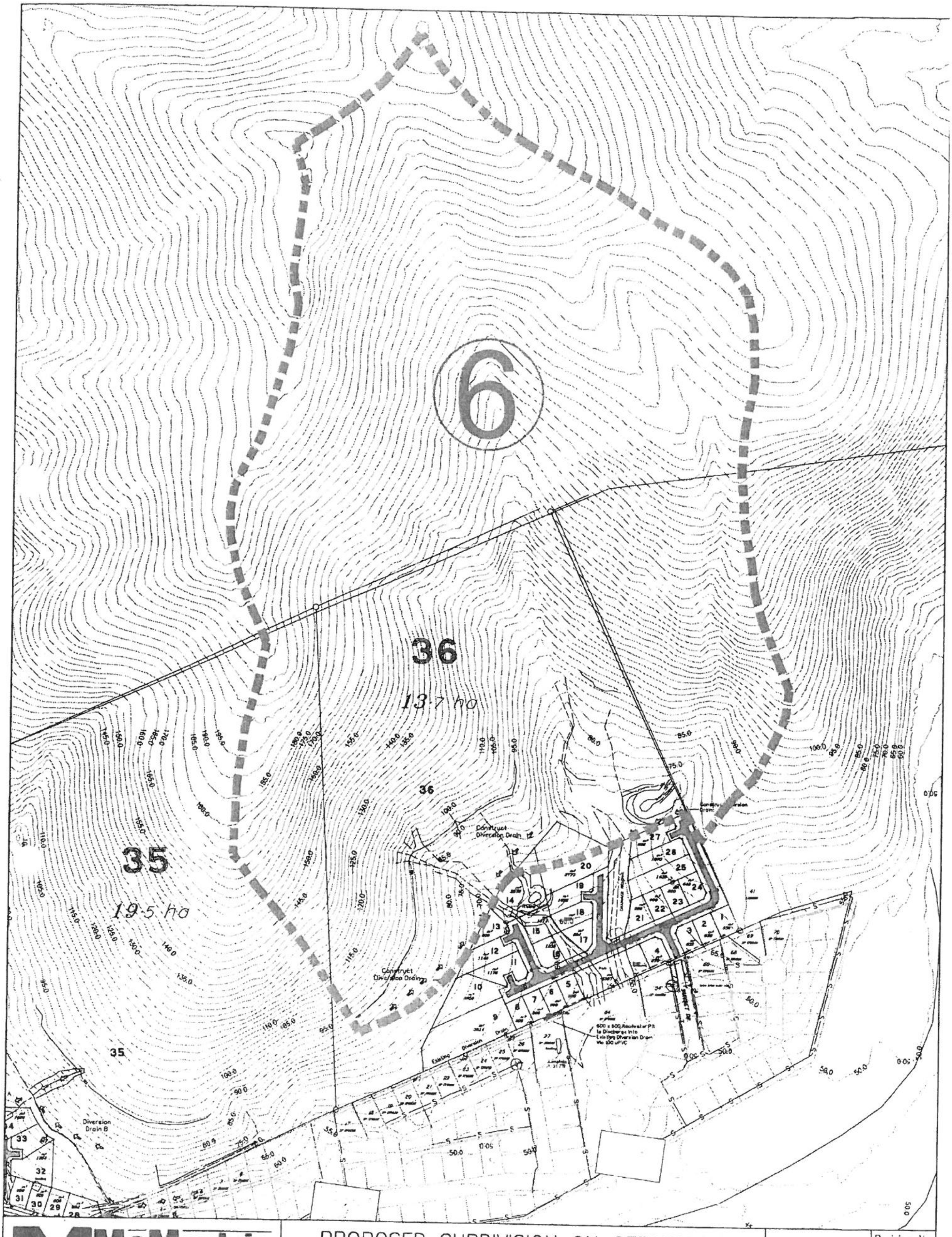
I_1	64.52 mm/hr
I_5	107.70 mm/hr
I_{10}	122.70 mm/hr
I_{20}	142.72 mm/hr
I_{50}	170.07 mm/hr
I_{100}	191.65 mm/hr

Calculated Discharge

Q_1	4.292 m^3/sec
Q_5	8.506 m^3/sec
Q_{10}	**10.201 m^3/sec**
Q_{20}	12.459 m^3/sec
Q_{50}	16.261 m^3/sec
Q_{100}	**19.120 m^3/sec**

Total Combined Discharge

Q_1	4.314 m^3/sec
Q_5	8.550 m^3/sec
Q_{10}	**10.253 m^3/sec**
Q_{20}	12.523 m^3/sec
Q_{50}	16.344 m^3/sec
Q_{100}	**19.218 m^3/sec**



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PROPOSED SUBDIVISION ON GERMAN ST
FOR MR T GRIEVES
CATCHMENT BOUNDARIES
CATCHMENT 6

Revision No: A

Drawing Number: 0880708-06P

SCALE: 1:4000 (A4)

Catchment 6a: Mannings Calculations

Existing Concrete Open Channel

Proposed Residential Subdivision on German Street

A	0.2356	
WP	1.52	
R	0.155	
S	0.05	5%

$$V = 1/n \times R^{2/3} \times S^{1/2}$$

n	0.012	(Manngings: Concrete - Finished)
1/n	83.333	
$R^{2/3}$	0.289	
$S^{1/2}$	0.223607	
V	5.377 m/sec	
Q=VA		
Q	**1.267 m^3/sec**	

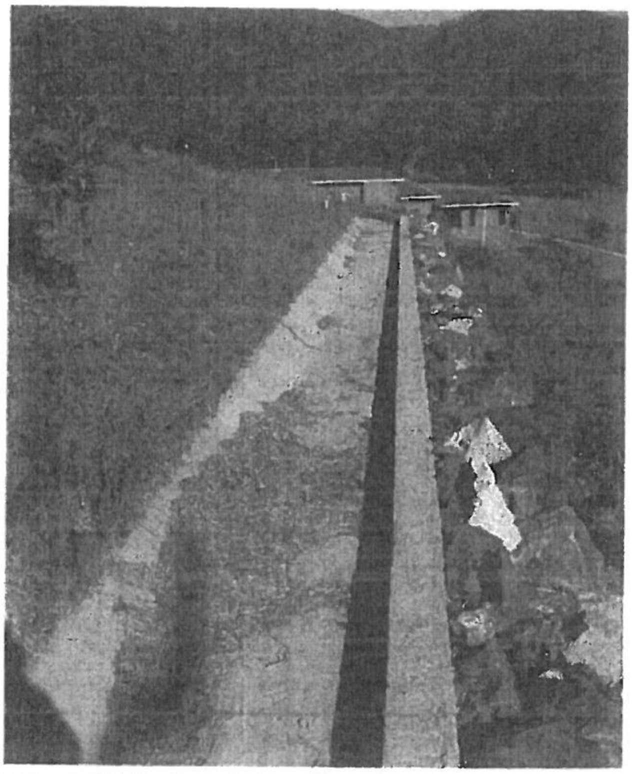
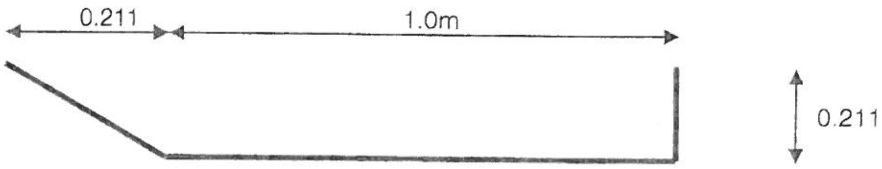


Image 1: Existing Concrete Open Channel



Measurements taken on site.

Catchment 6a
Total Contributing to Open Channel

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below.

Overland Flow Theory

Sheet Flow (*Friend's Equation*)	$t=(107n \times L^{1/3}) / s^{1.5}$	**Where:** *L = Length of slope (km)* *A = Area (ha)* *S = Stream Path Slope (%)* *t = time of concentration 9min)*
Concentrated Flow (*Bransby-Williams Equation*)	$t=58L/(A^{0.1} \times S^{0.2})$	

Sub-Catchment 1:

Catchment Area	594	m2	0.1 Ha
Catchment Length	50	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type

◉ Sheet Flow   ○ Concentrated Flow

Time of Concentration
t = 20.4 mins
t = 0.34 hours

Velocity Check (v=d/t):
v = 0.04 m/s   Check Suitablity

sdf;kasg

Sub-Catchment 2:

Catchment Area	18750	m2	1.9 Ha
Catchment Length	248	m	
Catchment Grade	27	%	0.27 m/m
n (Hortons Value)	0.1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegtation	0.052 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type

○ Sheet Flow   ◉ Concentrated Flow

Time of Concentration
t = 7.0 mins
t = 0.12 hours

Velocity Check (v=d/t):
v = 0.59 m/s   Check Suitability

Rational Method of Calculation:

Q = K CIA

K
0.00278 (constant)

C

0.56 I_1	0.8 x I_{10}
0.67 I_5	0.95 x I_{10}
0.7 I_{10}	1 x I_{10}
0.74 I_{20}	1.05 x I_{10}
0.81 I_{50}	1.15 x I_{10}
0.84 I_{100}	1.2 x I_{10}

Rainfall Intensity for Sub-Catchment 1 at 20.4 mins:

I_1	59.69 mm/hr
I_5	99.39 mm/hr
I_{10}	113.12 mm/hr
I_{20}	131.47 mm/hr
I_{50}	156.52 mm/hr
I_{100}	176.27 mm/hr

Calculated Discharge

Q_1	0.006 m^3/sec
Q_5	0.011 m^3/sec
Q_{10}	**0.013 m^3/sec**
Q_{20}	0.016 m^3/sec
Q_{50}	0.021 m^3/sec
Q_{100}	**0.024 m^3/sec**

Rainfall Intensity for Sub-Catchment 2 at 7.0 mins:

I_1	92.08 mm/hr
I_5	155.74 mm/hr
I_{10}	178.43 mm/hr
I_{20}	208.52 mm/hr
I_{50}	249.75 mm/hr
I_{100}	282.45 mm/hr

Calculated Discharge

Q_1	0.269 m^3/sec
Q_5	0.540 m^3/sec
Q_{10}	**0.651 m^3/sec**
Q_{20}	0.799 m^3/sec
Q_{50}	1.048 m^3/sec
Q_{100}	**1.237 m^3/sec**

Total Combined Discharge

Q_1	0.274 m^3/sec
Q_5	0.551 m^3/sec
Q_{10}	**0.664 m^3/sec**
Q_{20}	0.815 m^3/sec
Q_{50}	1.069 m^3/sec
Q_{100}	**1.261 m^3/sec**

Catchment 5a
Total Contributing to Open Channel

Travel time (t) for overland flow is calculated using either the Friend or Bransby Method (QUDM). Click method required below:

Overland Flow Theory

Sheet Flow (*Friend's Equation*)	$t=(107n \times L^{1/3}) / s^{1.5}$	**Where:** *L = Length of slope (km)* *A = Area (ha)*
Concentrated Flow (*Bransby-Williams Equation*)	$t=58L/(A^{0.1} \times S^{0.2})$	*S = Stream Path Slope (%)* *t = time of concentration 9min)*

Sub-Catchment 1:

Catchment Area	43213	m2	4.3 Ha
Catchment Length	250	m	
Catchment Grade	10	%	0.1 m/m
n (Hortons Value)	0.069		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: ○ Sheet Flow ◉ Concentrated Flow

Time of Concentration
t = 7.9 mins
t = 0.13 hours

Velocity Check (v=d/t):
v = 0.53 m/s [Check Suitability]
sdf;kasg

Sub-Catchment 2:

Catchment Area	0.1	m2	0.0 Ha
Catchment Length	1	m	
Catchment Grade	1	%	0.01 m/m
n (Hortons Value)	1		

Hortons Roughness Coefficient (QUDM Table 4.06.4)	
Concrete and Asphant	0.01 - 0.013
Bare Sand	0.01 - 0.016
Gravelled Surface	0.012 - 0.030
Bare Clay-Loam Soil	0.012 - 0.033
Sparse Vegitation	0.053 - 0.130
Short Grass Paddock	0.100 - 0.200
Lawns	0.170 - 0.480

Flow Type: ○ Sheet Flow ◉ Concentrated Flow

Time of Concentration
t = 0.2 mins
t = 0.00 hours

Velocity Check (v=d/t):
v = 0.09 m/s [Check Suitability]

Rational Method of Calculation:

Q = K CIA

K
0.00278 (constant)

C

0.56	I_1	0.8	$\times I_{10}$
0.67	I_5	0.95	$\times I_{10}$
0.7	I_{10}	1	$\times I_{10}$
0.74	I_{20}	1.05	$\times I_{10}$
0.81	I_{50}	1.15	$\times I_{10}$
0.84	I_{100}	1.2	$\times I_{10}$

Rainfall Intensity for Sub-Catchment 1 at 7.9 mins:

I_1	87.98 mm/hr
I_5	148.65 mm/hr
I_{10}	170.24 mm/hr
I_{20}	198.87 mm/hr
I_{50}	238.10 mm/hr
I_{100}	269.18 mm/hr

Calculated Discharge

Q_1	0.592 m^3/sec
Q_5	1.189 m^3/sec
Q_{10}	**1.432 m^3/sec**
Q_{20}	1.756 m^3/sec
Q_{50}	2.303 m^3/sec
Q_{100}	**2.716 m^3/sec**

Rainfall Intensity for Sub-Catchment 2 at 0.2 mins:

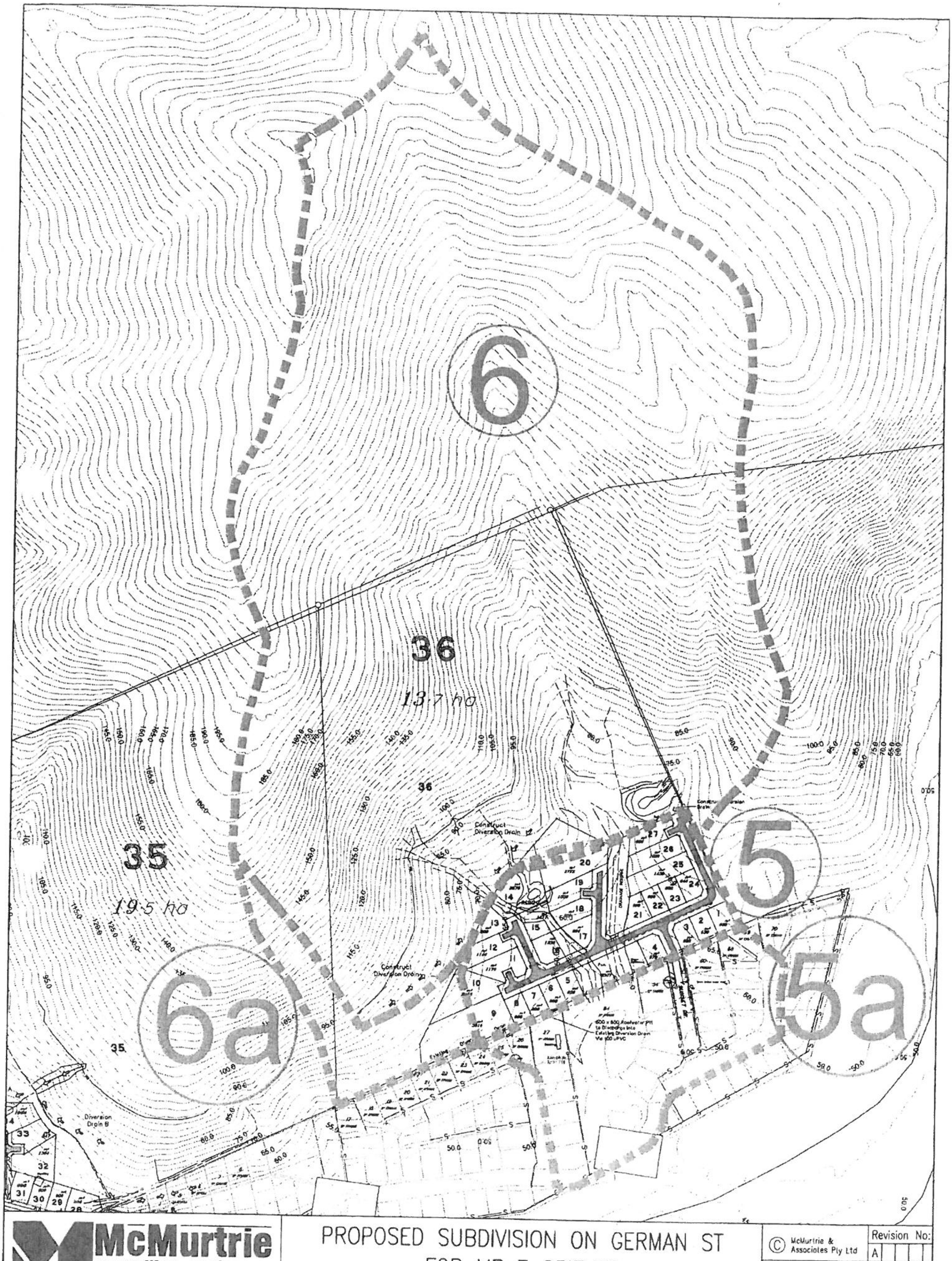
I_1	14505.67 mm/hr
I_5	1431.51 mm/hr
I_{10}	376.03 mm/hr
I_{20}	154.03 mm/hr
I_{50}	55.31 mm/hr
I_{100}	27.59 mm/hr

Calculated Discharge

Q_1	0.000 m^3/sec
Q_5	0.000 m^3/sec
Q_{10}	**0.000 m^3/sec**
Q_{20}	0.000 m^3/sec
Q_{50}	0.000 m^3/sec
Q_{100}	**0.000 m^3/sec**

Total Combined Discharge

Q_1	0.592 m^3/sec
Q_5	1.188 m^3/sec
Q_{10}	**1.432 m^3/sec**
Q_{20}	1.756 m^3/sec
Q_{50}	2.303 m^3/sec
Q_{100}	**2.716 m^3/sec**



McMurtrie consulting engineers
Address: 63 Charles Street NORTH ROCKHAMPTON QLD 4701
Postal: PO BOX 2149, WANDAL QLD 4700
E-mail: mail@mcmengineers.com
Phone: (07) 4921 1780
Mobile: 0407 631 066
Fax: (07) 4921 1790

PROPOSED SUBDIVISION ON GERMAN ST
FOR MR T GRIEVES
CATCHMENT BOUNDARIES
CATCHMENT 6a

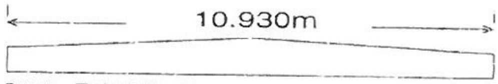
Revision No: A

Drawing Number: 0880708-07P

SCALE: 1:4000 (A4)

CulvertW - Design Case No 4

(File: 088070~1.CUL - Date: 1-12-2009)



3 No 2700x900 RCBC (2.743x0.914) at a slope= 0.4575%

Inlet RL 46.000m Outlet RL 45.950m

Culvert Data

Using Mannings 'n'	= 0.013
Entrance Loss Coefficient 'k'	= 0.500
Entrance - Wingwall flare 90-15 deg	

Weir Data

Weir Length = 35.000m
Weir Coefficient = 0.577
Weir Crest Height = 1.670m (RL 47.620m)

No Channel Data specified to be used

Headwater

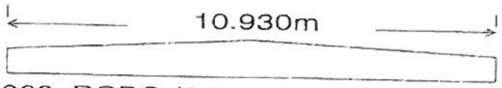
Approach Flow	= 22.938m3/s
Flow in each Culvert	= 7.077m3/s
Flow over weir	= 1.708m3/s (Head = 0.094m)
Critical Depth of Flow	= 0.06m (Velocity = 0.78m)
Tailwater depth	= 0.000m (RL 45.950m)
Using fixed Tailwater depth	
Critical depth at outlet	= 0.877m (RL 46.827m)
Effective tailwater depth	= 0.895m (RL 46.845m)
Head Loss in Culvert	= 0.667m
Depth at outlet adopted to calculate outlet velocity	= 0.794m (RL 46.744m)
Outlet Velocity	= 3.239m/s

INLET control

Headwater is 1.714m above culvert inlet invert
Headwater is at RL 47.714m - 0.094m above Weir Crest
Tailwater is at RL 45.950m - 0.000m above outlet invert

CulvertW - Design Case No 5

(File: 088070~1.CUL - Date: 1-12-2009)



3 No 2700x900 RCBC (2.743x0.914) at a slope= 0.4575%

Inlet RL 46.000m Outlet RL 45.950m

Culvert Data

Using Mannings 'n' = 0.013
Entrance Loss Coefficient 'k' = 0.500
Entrance - Wingwall flare 90-15 deg

Weir Data

Weir Length = 35.000m
Weir Coefficient = 0.577
Weir Crest Height = 1.670m (RL 47.620m)

No Channel Data specified to be used

Headwater

Approach Flow	= 26.211m3/s
Flow in each Culvert	= 7.382m3/s
Flow over weir	= 4.065m3/s (Head = 0.167m)
Critical Depth of Flow	= 0.11m (Velocity = 1.04m)
Tailwater depth	= 0.000m (RL 45.950m)
Using fixed Tailwater depth	
Critical depth at outlet	= 0.902m (RL 46.852m)
Effective tailwater depth	= 0.908m (RL 46.858m)
Head Loss in Culvert	= 0.727m
Depth at outlet adopted to calculate outlet velocity	= 0.818m (RL 46.768m)
Outlet Velocity	= 3.283m/s

INLET control

Headwater is 1.787m above culvert inlet invert
Headwater is at RL 47.787m - 0.167m above Weir Crest
Tailwater is at RL 45.950m - 0.000m above outlet invert

Attachment C

Mannings Calculations
Post-development Discharge

Existing Open Channel Drainage Reserve

Chainage 30

Lot 84 SP179522

Naturelands Estate

A	7.656	Depth of Flow:	371 mm
WP	24.58		
R	0.311		

S 0.05 5%

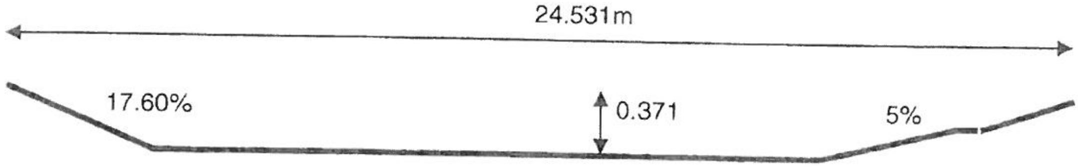
$V = 1/n \times R^{2/3} \times S^{1/2}$

n	0.03	(Manngings: Grass Channel)
1/n	33.333	
$R^{2/3}$	0.459	
$S^{1/2}$	0.223607	

V 3.425 m/sec

Q=VA

Q **26.221 m^3/sec**



Cross Section 30.0m downstream from Naturelands Estate's point of discharge

Measurements taken from survey.

Mannings Calculations
Pre-development Discharge

Existing Open Channel Drainage Reserve

Chainage 30

Lot 84 SP179522

Naturelands Estate

A	7.002		Depth of Flow:	344 mm
WP	23.978			
R	0.292			
S	0.05	5%		

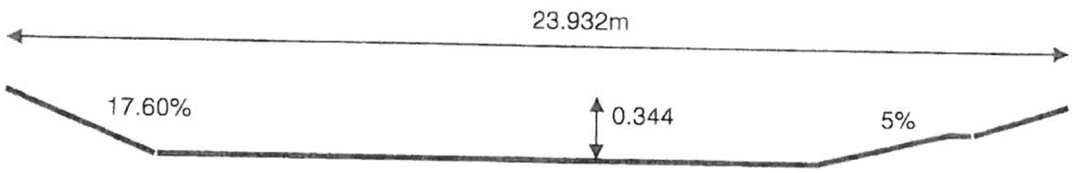
$$V = 1/n \times R^{2/3} \times S^{1/2}$$

n	0.03	(Manngings: Grass Channel)
1/n	33.333	
$R^{2/3}$	0.440	
$S^{1/2}$	0.223607	

V 3.281 m/sec

Q=VA

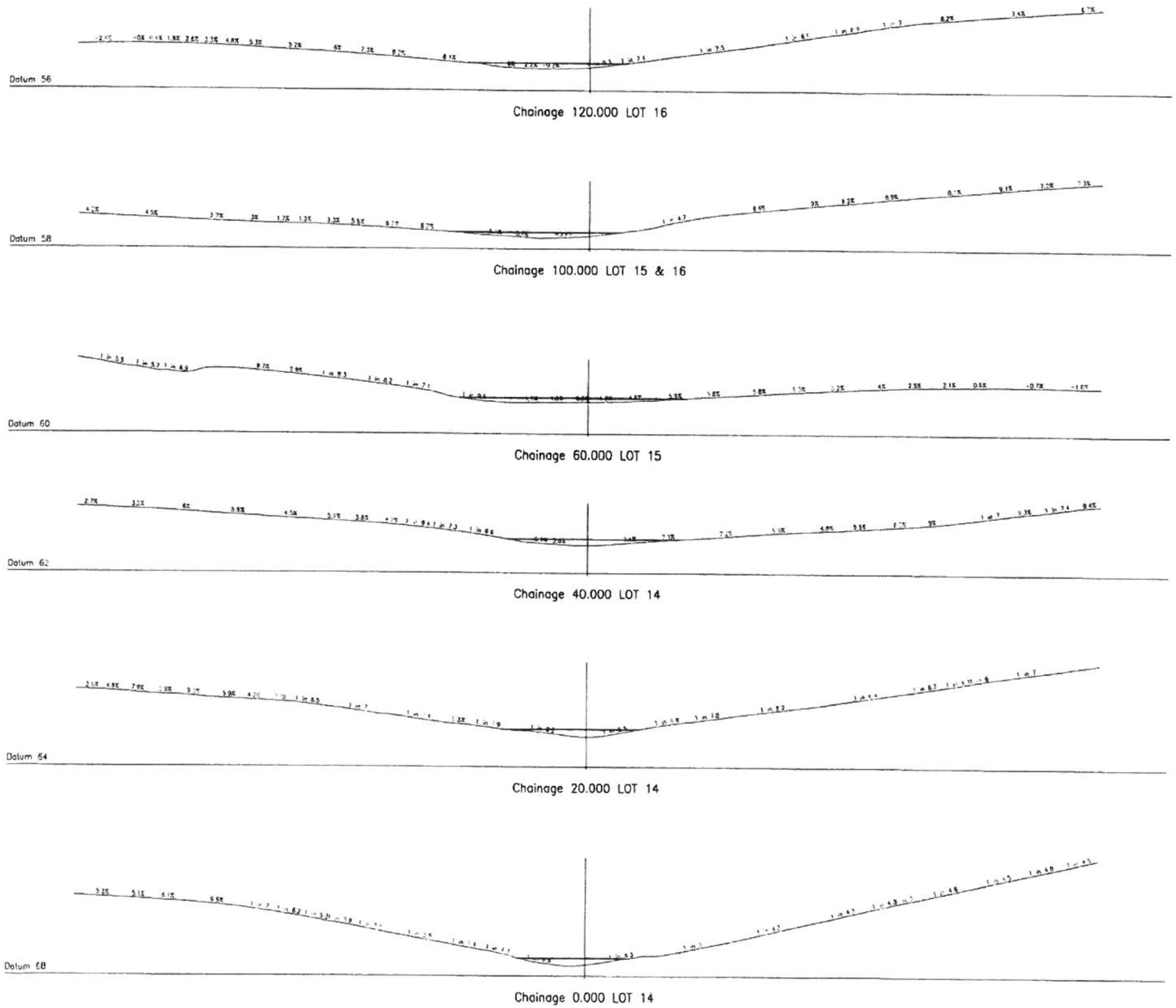
Q **22.972 m^3/sec**



Cross Section 30.0m downstream from Naturelands Estate's point of discharge

Measurements taken from survey.

Attachment D

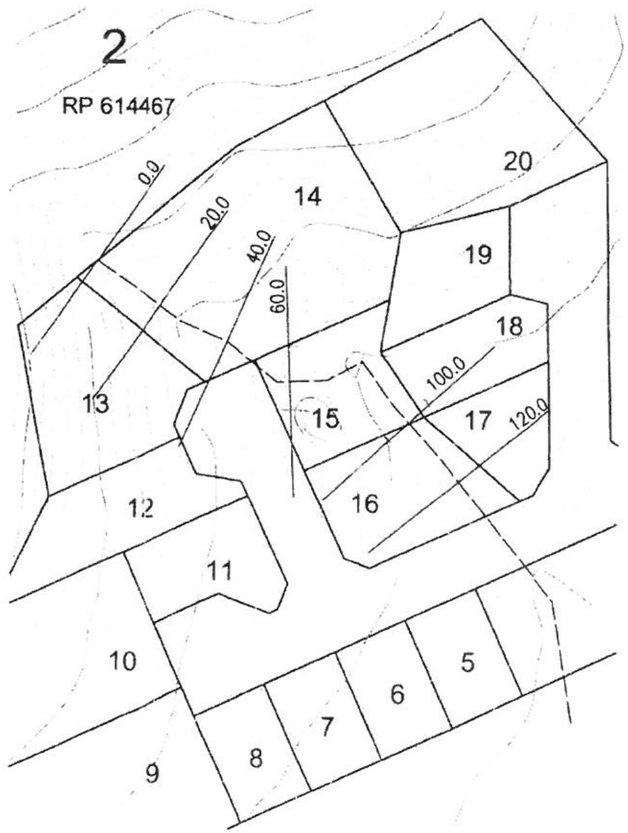


NATURELANDS ESTATE

Q100 FLOWPATH
FOR LOTS 14, 15 & 16
3 DECEMBER 2009

McMurtrie consulting engineers

SCALE: 1:4000 (A3)



Mannings Calculations
Post Development Discharge

Open Channel Q100 Calculations

Chainage 0 - LOT 14

For Lots 14, 15 & 16

A	1.725		Depth of Flow:	390 mm
WP	6.605			
R	0.261			
S	0.05	5%		

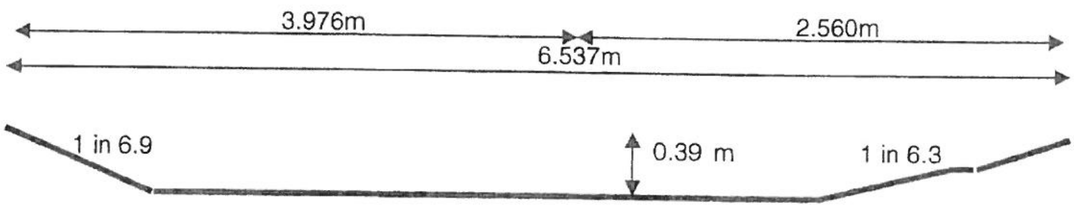
$V = 1/n \times R^{2/3} \times S^{1/2}$

n	0.03	(Manngings: Grass Channel)
1/n	33.333	
$R^{2/3}$	0.409	
$S^{1/2}$	0.223607	

V 3.045 m/sec

Q=VA

Q **5.3 m^3/sec** 5.387



Chainage 0.0

Measurements taken from survey.

Mannings Calculations
Post Development Discharge

Open Channel Q100 Calculations

Chainage 20 - LOT 14

For Lots 14, 15 & 16

A	1.889		Depth of Flow:	440 mm
WP	8.08			
R	0.234			
S	0.05	5%		

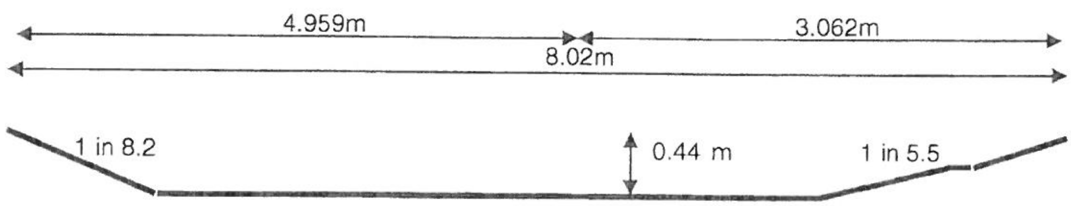
$$V = 1/n \times R^{2/3} \times S^{1/2}$$

n	0.03	(Manngings: Grass Channel)
1/n	33.333	
$R^{2/3}$	0.380	
$S^{1/2}$	0.223607	

V 2.829 m/sec

Q=VA

Q **5.3 m^3/sec** 5.387



Chainage 20.0

Measurements taken from survey.

Mannings Calculations
Post Development Discharge

Open Channel Q100 Calculations

Chainage 40 - LOT 14

For Lots 14, 15 & 16

A	2.07		Depth of Flow:	350 mm
WP	9.95			
R	0.208			
S	0.05	5%		

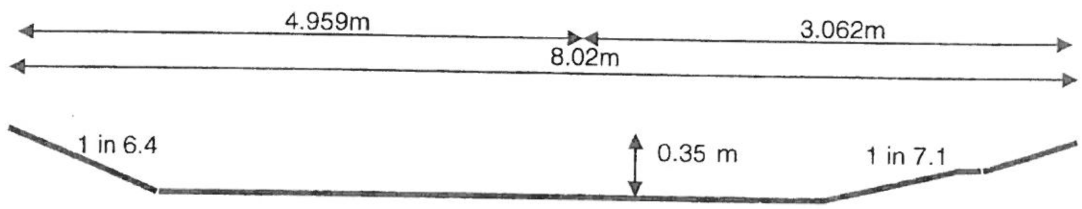
$V = 1/n \times R^{2/3} \times S^{1/2}$

n	0.03	(Manngings: Grass Channel)
1/n	33.333	
$R^{2/3}$	0.351	
$S^{1/2}$	0.223607	

V 2.617 m/sec

Q=VA

Q **5.4 m³/sec** 5.387



Chainage 40.0

Measurements taken from survey.

Mannings Calculations
Post Development Discharge

Open Channel Q100 Calculations

Chainage 60 - LOT 15

For Lots 14, 15 & 16

A	2.3		Depth of Flow:	220 mm
WP	13.3			
R	0.173			
S	0.05	5%		

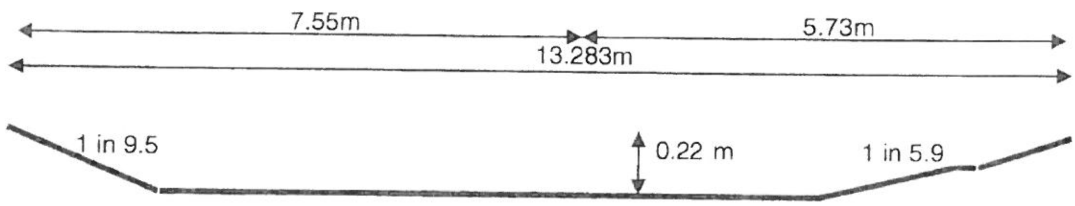
$V = 1/n \times R^{2/3} \times S^{1/2}$

n	0.03	(Manngings: Grass Channel)
1/n	33.333	
$R^{2/3}$	0.310	
$S^{1/2}$	0.223607	

V 2.314 m/sec

Q=VA

Q **5.3 m^3/sec**



Chainage 60.0

Measurements taken from survey.

Mannings Calculations
Post Development Discharge

Open Channel Q100 Calculations

Chainage 100 - LOTS 15 & 16

For Lots 14, 15 & 16

A	2.02		Depth of Flow:	220 mm
WP	9.69			
R	0.208			
S	0.05	5%		

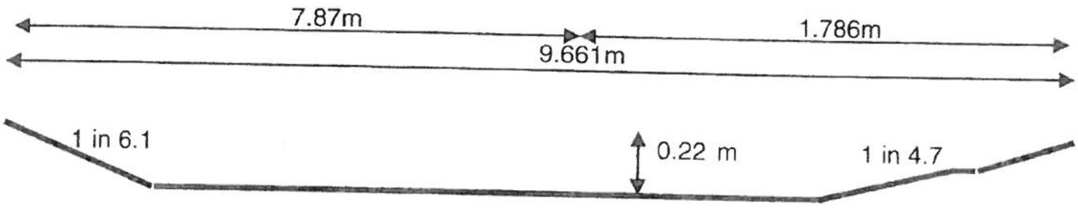
$$V = 1/n \times R^{2/3} \times S^{1/2}$$

n	0.03	(Manngings: Grass Channel)
1/n	33.333	
$R^{2/3}$	0.352	
$S^{1/2}$	0.223607	

V 2.620 m/sec

Q=VA

Q **5.3 m^3/sec** 5.387



Chainage 100.0

Measurements taken from survey.

Mannings Calculations
Post Development Discharge

Open Channel Q100 Calculations

Chainage 120 - LOT 16

For Lots 14, 15 & 16

A	2.02		Depth of Flow:	255 mm
WP	9.39			
R	0.215			
S	0.05	5%		

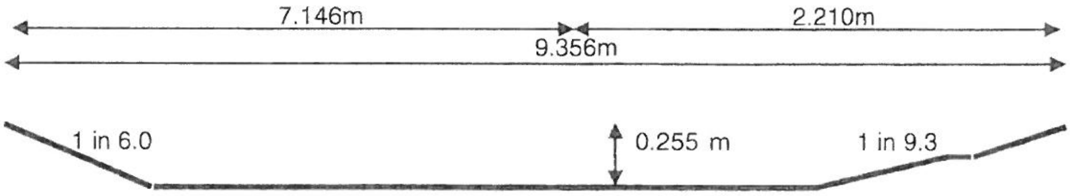
$V = 1/n \times R^{2/3} \times S^{1/2}$

n	0.03	(Manngings: Grass Channel)
1/n	33.333	
$R^{2/3}$	0.359	
$S^{1/2}$	0.223607	

V 2.676 m/sec

Q=VA

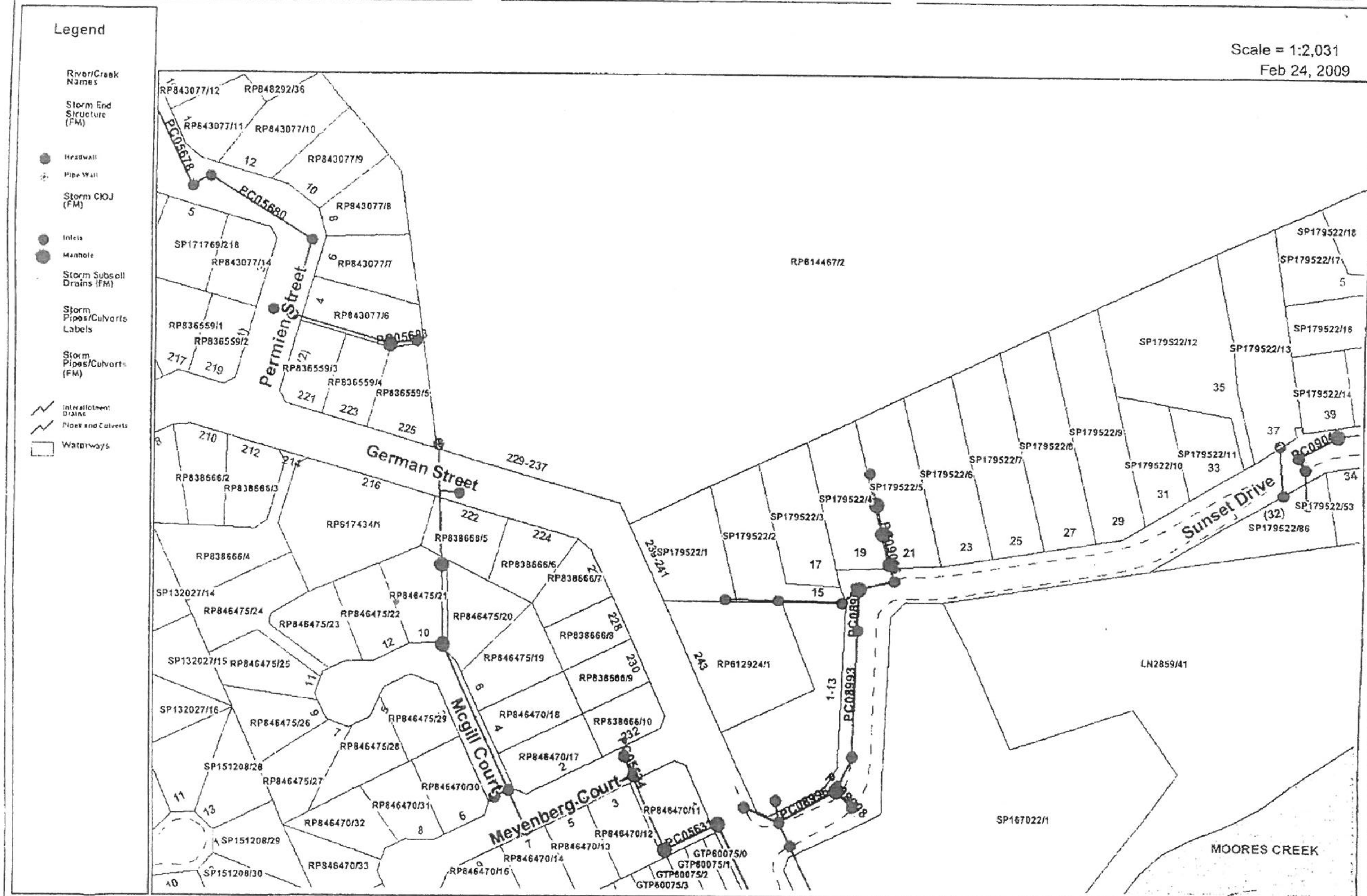
Q **5.4 m^3/sec** 5.387



Chainage 120.0

Measurements taken from survey.

Attachment E



City Hall, Bolsover Street
Rockhampton
Queensland

PO Box 1860
Rockhampton
4700 Australia

Telephone: 1300 22 55 77
Email: enquiries@rrc.qld.gov.au
Facsimile: 1300 22 55 78

Attachment F

GRAHAM, SCOTT & ASSOCIATES
CIVIL & STRUCTURAL ENGINEERS

ROCKHAMPTON
P.O. Box 1590
2 Victoria Parade
Rockhampton Q 4700

Telephone (07) 4931 0777
Facsimile (07) 4922 4856

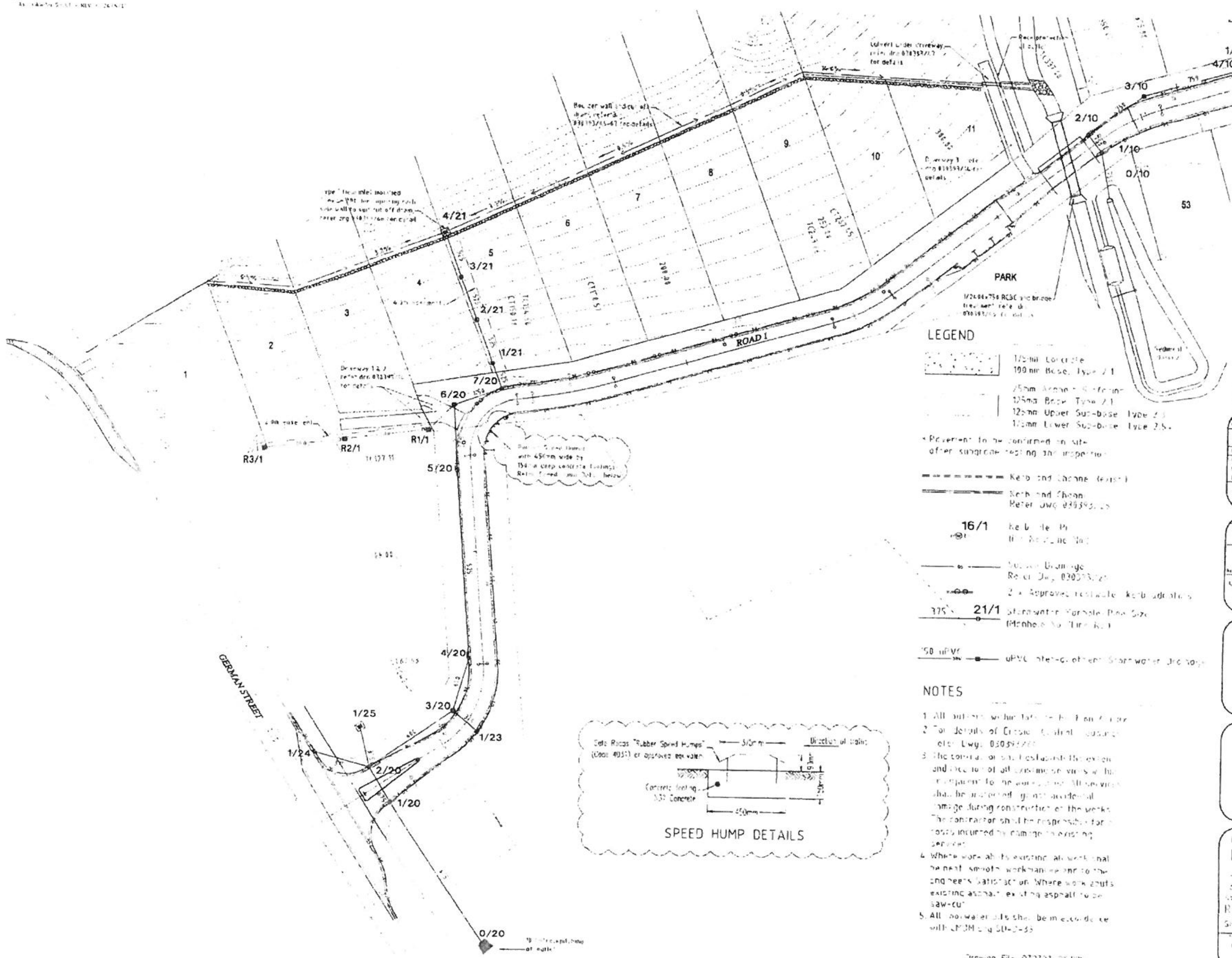
Revisions

0 — 20 — 40 — 60m

CITIMARK PROPERTIES P/L
THE SANCTUARY
LOT 5 ON RP618359
GERMAN STREET, ROCKHAMPTON
ALIGNMENT PLAN

030293 / 02

Drawing File: 030293-02.DWG



GRAHAM SCOTT & ASSOCIATES
CIVIL & STRUCTURAL ENGINEERS
ROCKHAMPTON
P.O. Box 1588
2 Victoria Parade,
Rockhampton Q 4700
Telephone (07) 4931 0777
Facsimile (07) 4921 4866

LEGEND

- 125mm Concrete, 100mm Base, Type 2.1
- 25mm Asphaltic Surfacing, 125mm Base Type 2.1, 125mm Upper Sub-base Type 2.3, 125mm Lower Sub-base Type 2.5
- * Pavement to be confirmed on site after subgrade testing and inspection
- Kerb and Channel (exist)
- Kerb and Channel, Refer Dwg 030393/25
- 16/1 Kerb Inlet Pit (Pit No./Line No.)
- Subsoil Drainage, Refer Dwg 030393/27
- 2 x Approved reflective kerb adaptors
- 375ø 21/1 Stormwater Manhole Pipe Size (Manhole No./Line No.)
- 150 uPVC uPVC Inter-allotment Stormwater Drainage

NOTES

1. All [illegible]
2. For details of Erosion Control [illegible] refer Dwg 030393/27
3. The contractor shall establish the extent and location of all existing services within or adjacent to the work site. All services shall be protected against accidental damage during construction of the works. The contractor shall be responsible for all costs incurred by damage to existing services.
4. Where work abuts existing, all work shall be neat, smooth workmanlike and to the engineer's satisfaction. Where work abuts existing asphalt, existing asphalt to be saw-cut.
5. All stormwater pits shall be in accordance with CMDM Dwg SD-[illegible]

Drawing File: 030393_05.DWG

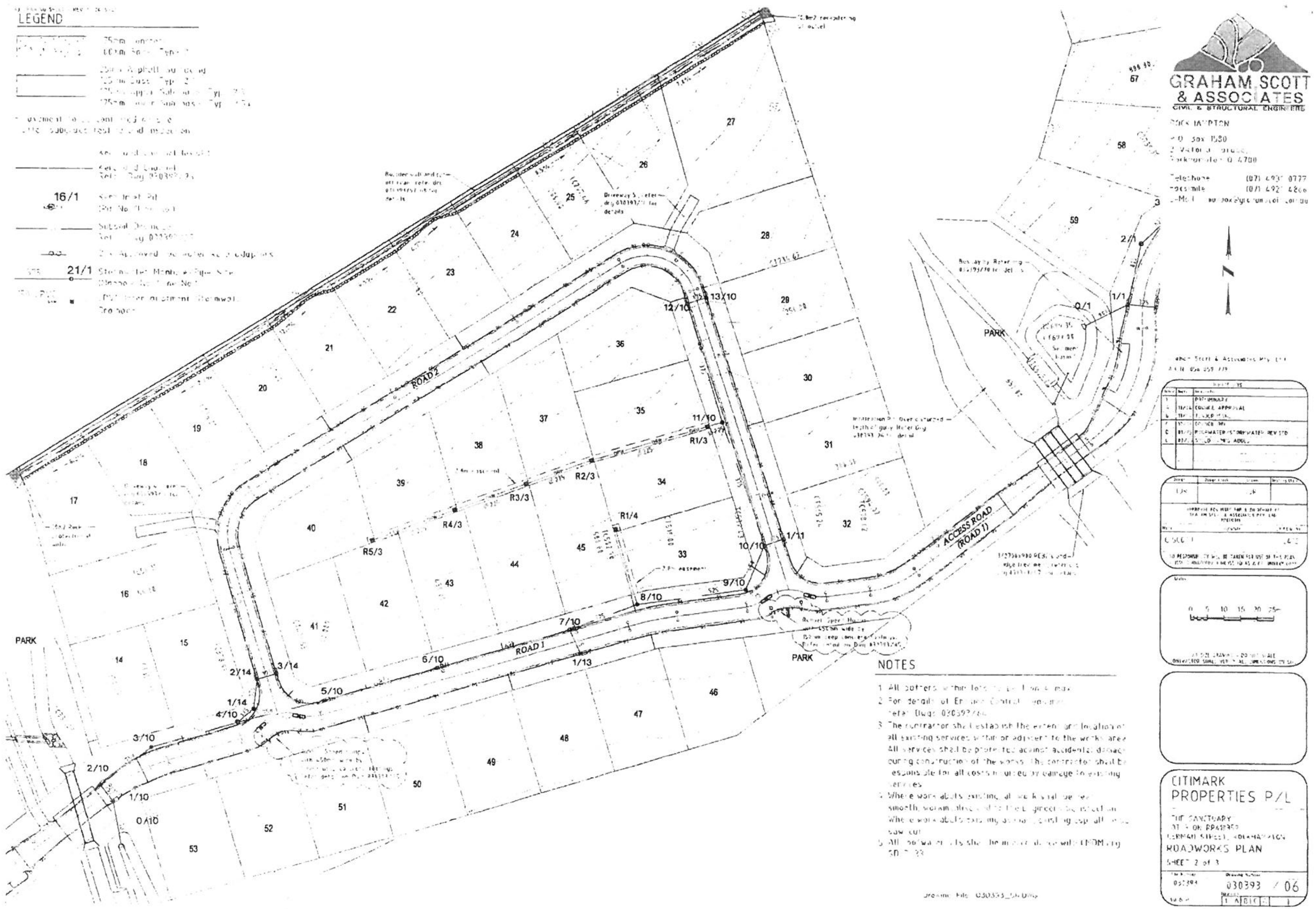
Graham Scott & Associates Pty Ltd

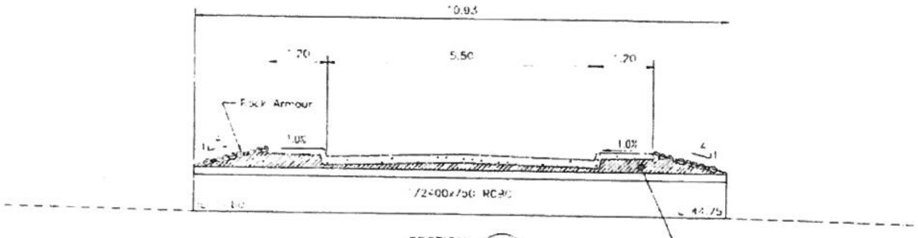
Revisions		
Rev	Date	Description
1		PRELIMINARY
A		COUNCIL APPROVAL
B		TENDER ISSUE
C		CONSTRUCTION
D		ROAD & STORMWATER REVISED
E		SPEED HUMPS ADDED

NO RESPONSIBILITY WILL BE TAKEN FOR USE OF THIS PLAN [illegible]

Scale: 0 5 10 15 20 25m
A3 SIZE DRAWING - DO NOT SCALE

CITIMARK PROPERTIES P/L
THE SANCTUARY
LOT 1 on RP618359
GERMAN STREET, ROCKHAMPTON
ROADWORKS PLAN
SHEET 1 of 1
Drawing Number 030393 / 05


LEGEND
NOTES
ROAD 1
ROAD 2
ACCESS ROAD
(ROAD 1)
PARK
PARK
PARK
GRAHAM SCOTT
& ASSOCIATES
CIVIL & STRUCTURAL ENGINEERS
ROCKHAMPTON
Telephone (07) 4931 0777
CITIMARK
PROPERTIES P/L
ROADWORKS PLAN
SHEET 2 of 3
030393 / 06



SECTION A
SCALE A

SETOUT TABLE CULVERTS

POINT	EASTING	NORTHING	LEVEL
A	[illegible]66.205	817.69	44.80
B	[illegible]69.005	818.51[illegible]	44.80
C	[illegible]73.182	[illegible]04.27[illegible]	44.75
D	[illegible]70.382	803.45	44.75
E	[illegible]45.30[illegible]	333.580	46.00
F	[illegible]48.725	334.87[illegible]	47.95

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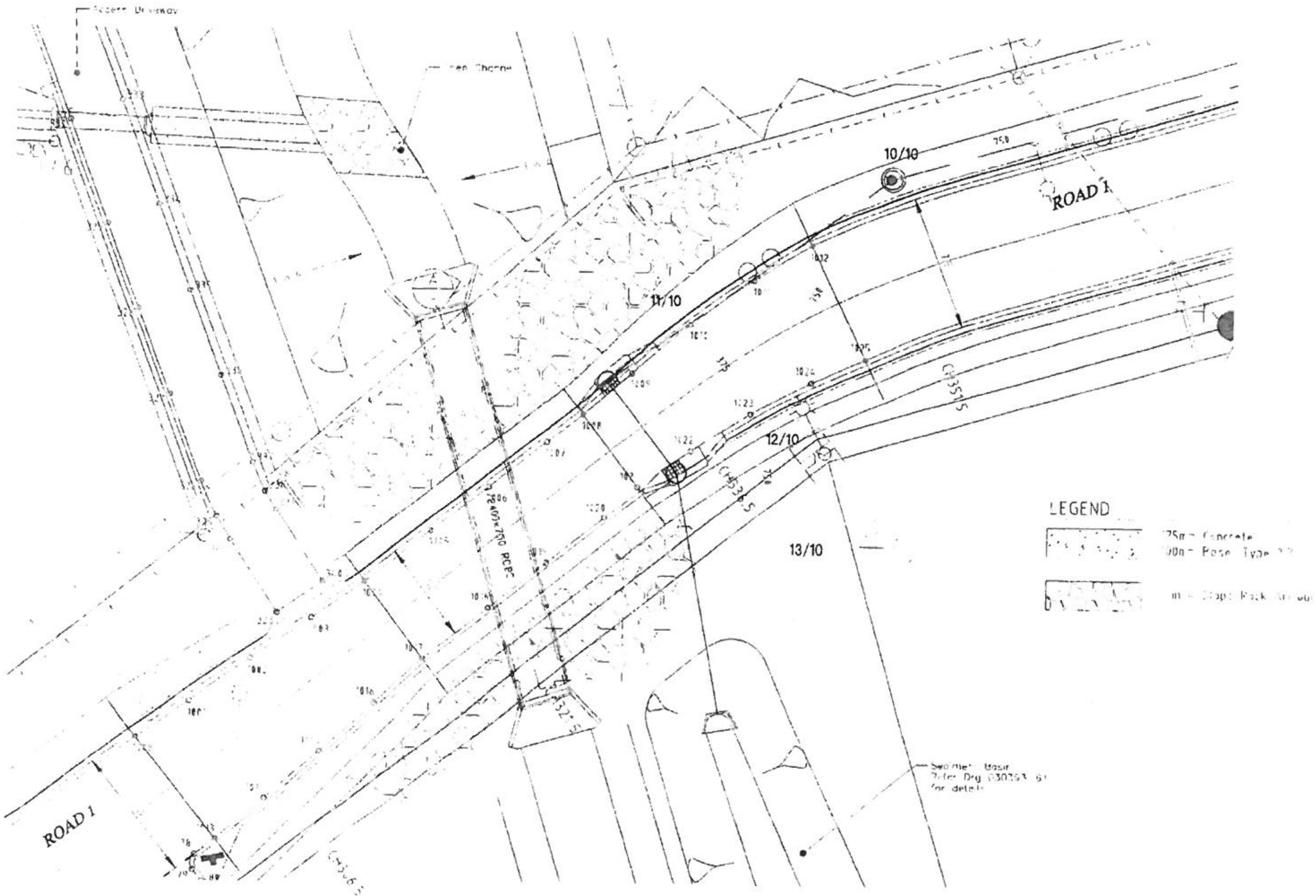


LEGEND

125mm Concrete
100mm Base Type 2.3

Revisions

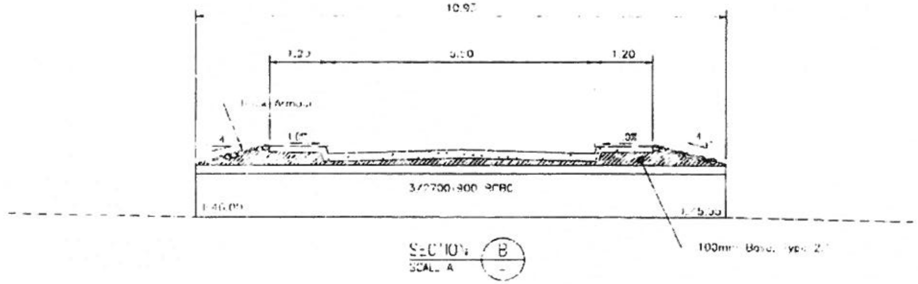
No.	Date	Description
1		PRE DELIVERY
4		COUNCIL APPROVAL
6		[illegible]

CITIMARK PROPERTIES P/L

THE SANCTUARY
ST 1 ON RP619350
CULVERT DETAILS
SHEET 1 of 1

Drawing Number 030393 47

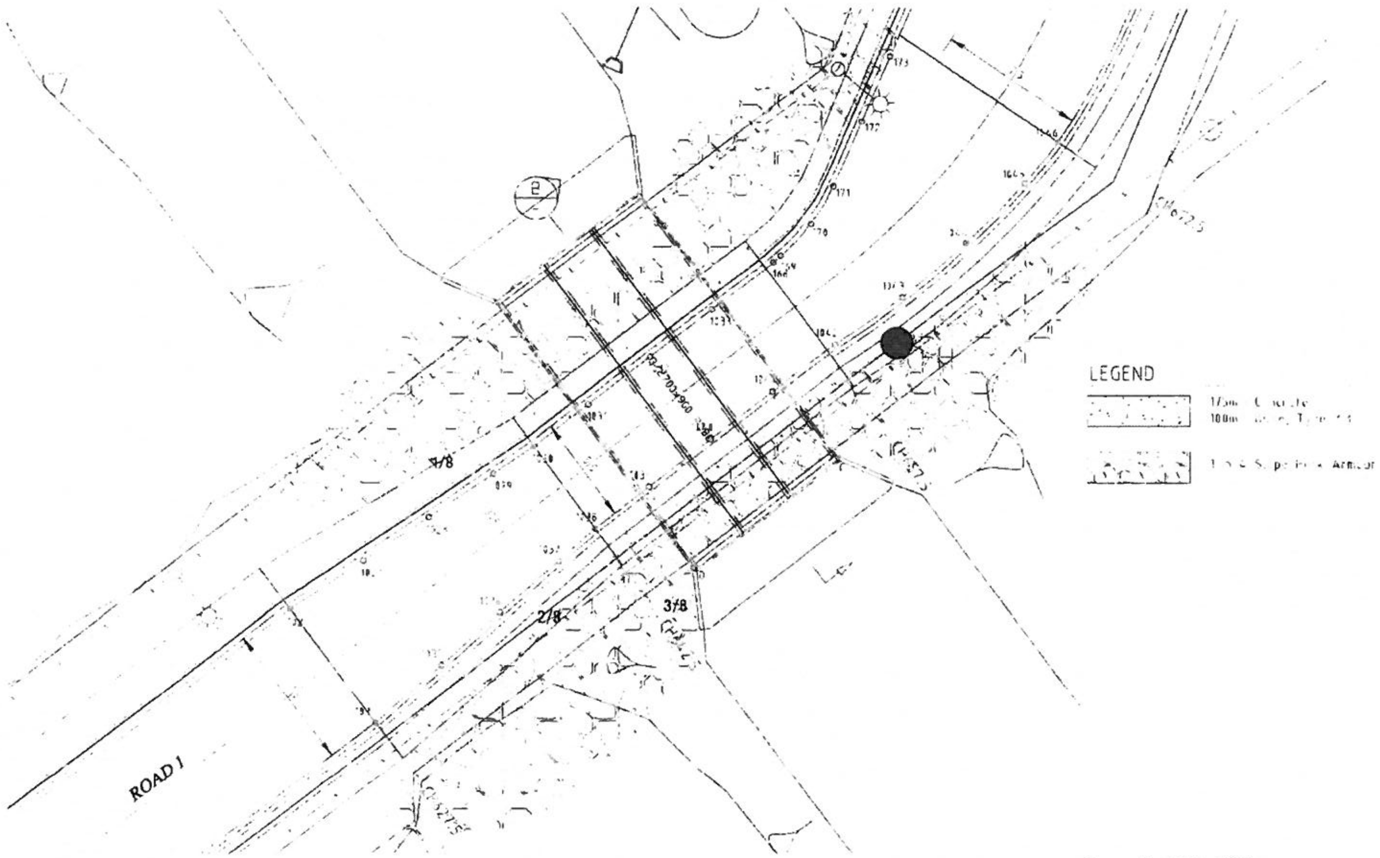
Drawing File 030393 46.DWG



SECTION B
SCALE A

SETOUT TABLE CULVERTS

POINT	EASTING	NORTHING	LEVEL
A	1459.402	[illegible]419	46.000
B	1466.86[illegible]	[illegible]27.053	46.0[illegible]
C	1475.91[illegible]	915.210	45.950
D	1468.35[illegible]	909.570	45.950



Drawing File: 030393-47.DWG

GRAHAM SCOTT & ASSOCIATES
CIVIL & STRUCTURAL ENGINEERS
ROCKHAMPTON
P.O. Box 1580
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Rockhampton Q 4700
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Facsimile (07) 4921 4???
E-Mail mailbox@grahamscott.com.au

Graham Scott & Associates Pty Ltd
A.C.N.

Revisions		
		PRELIMINARY
A		COUNCIL APPROVAL
B		TENDER ISSUE

APPROVED FOR ISSUE FOR & ON BEHALF GRAHAM SCOTT & ASSOCIATES PTY LTD

G SCOTT

NO RESPONSIBILITY WILL BE TAKEN FOR USE OF THIS PLAN UNLESS APPROVED FOR ISSUE AS A CERTIFIED COPY

A1 SIZE DRAWING - DO NOT SCALE

CITIMARK PROPERTIES P/L
THE SANCTUARY
ELPHINSTONE STREET ROCKHAMPTON
CULVERT DETAILS
SHEET 2 of 2

Job Number: 030393 | Drawing Number: 030393 / 48
Rev: 1 A B

Cardno Bowler
Shaping the Future

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cardnobowler@cardno.com.au
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Rockhampton
Bundaberg
Sunshine Coast
Geebung
Ipswich
Gold Coast
New South Wales
Sydney
Victoria
Melbourne
Bendigo
Dandenong
Geelong

Our Ref 8846sk.08

Contact SAMMY KWOK

10 May 2009

Mr Mark Wyer
McMurtrie Consulting Engineers

E: mail@mcmengineers.com

Dear Mark

SLOPE STABILITY ASSESSMENT
PROPOSED RESIDENTIAL SUBDIVISION
LOT 2 RP614467
229-237 GERMAN STREET, NORMAN GARDENS

Please find enclosed a copy of our slope stability assessment report for the above project.

Should you have any queries in relation to the enclosed report, please contact the undersigned on 3800 6446.

Yours faithfully

SAMMY KWOK
GEOTECHNICAL ENGINEER
for **Cardno Bowler**

ROCKHAMPTON REGIONAL COUNCIL
These plans are approved subject to the current conditions of approval associated with Development Permit No. D705/2008
Dated 20/05/2010

Cardno Bowler

Shaping the Future

Slope Stability Assessment Proposed Residential Subdivision Lot 2 RP614467 229-237 German Street, Norman Gardens

Job Number	8846sk.09
Prepared for	McMurtrie Consulting Engineers
Date of Report	10 May 2009

Cardno Bowler
Shaping the Future

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Document Control

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Table of Contents

1 INTRODUCTION 1

2 SITE DESCRIPTION 2

3 INVESTIGATION WORK 5

3.1 Background Search 5
3.2 Fieldwork 5

4 SUBSURFACE CONDITIONS 6

5 SLOPE STABILITY ASSESSMENT 8

6 CONSTRUCTION INSPECTIONS 11

7 CONCLUSIONS AND RECOMMENDATIONS 12

List of Tables

Table 1 Summary of Subsurface Strata 6
Table 2 Risk Level Implications 10

List of Figures

Figure 1A Site Investigation Location Plan of Eastern Block
Figure 1B Site Investigation Location Plan of Western Block
Figure 2A Slope Analysis Map of Eastern Block
Figure 2B Slope Analysis Map of Western Block
Figure 3 Geological Map

Information Sheets

General Notes
Important Information About Your Geotechnical Engineering Report

List of Annexes

Annex A Fieldwork Results
Annex B Hazard Rating Assessment

1 INTRODUCTION

A slope stability investigation was carried out for a proposed 34 lot residential subdivision at 229-237 German Street, Norman Gardens as requested by Mark Wyer representing McMurtrie Consulting Engineers.

It was understood that Rockhampton City Council required a site specific investigation report regarding slope stability in areas of the site where slopes were in excess of 15%. It was also requested that, if earthworks are being proposed, it does not cause or increase the risk of landslip occurring.

The following methodology was undertaken in order to achieve the objective above.

- To carry out a structural field mapping exercise.
- To collate and carry out stereographic interpretation from relevant aerial photographs.
- Check with Council to determine if there was any previous slope instability across the site.
- To carry out a slope stability assessment of the site.
- At the completion of the investigation work, an engineering report was prepared which included all the data gathered. The information was analysed and discussed, and conclusions and recommendations presented to satisfy the objectives of the investigation.

This report must be read in conjunction with our attached *'General Notes'*, the ASFE publication *'Important Information About Your Geotechnical Engineering Report'* and *'Guidelines for Hillside Construction'*, Australian Geomechanics Society Journal, Volume 37, No. 2, May 2002.

2 SITE DESCRIPTION

The subdivision consisted of two separate areas within Lot 2 of RP614467. One area was to the eastern side of this lot and the other to the west. The sites were located at the foot of the Mt Archer Mountain Range. Most of the site areas were a combination of grassland and bushland. It was noted that two disused old dams existed at the eastern block and an old demolished dwelling existed at the western block. Access to most part of the steeper areas of site was barely accessible by a 5 tonne excavator. Two major gullies were observed at the eastern block which diverged to one gully at the southern side.

The site was thickly grassed and sparsely treed. The site areas consisted of variable slopes which generally increased in steepness towards the northern part of the site. Most proposed allotments are to be situated on platforms with a slope of between 0% to 25% with several blocks having slopes in excess of 30%. Drainage of the area was good.

Refer to the following plates for typical views of the site:-

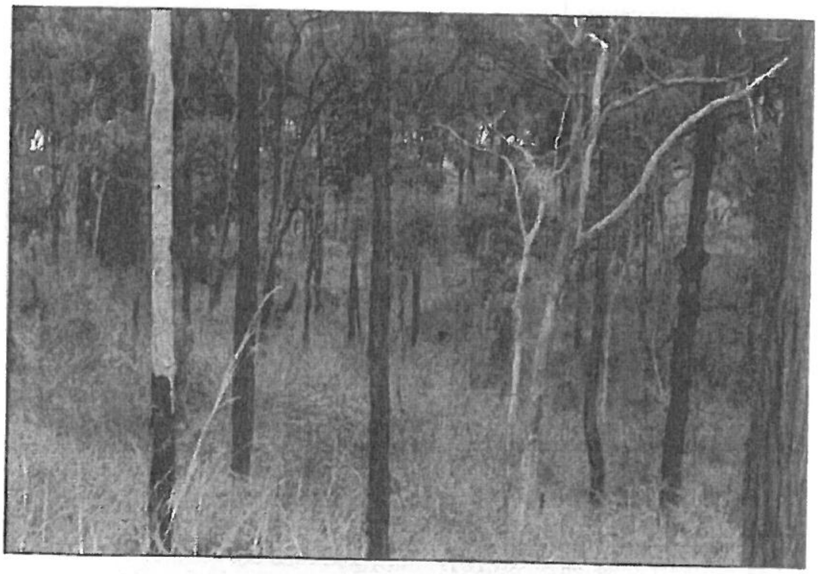

Plate 1: Typical bushland view of the eastern block

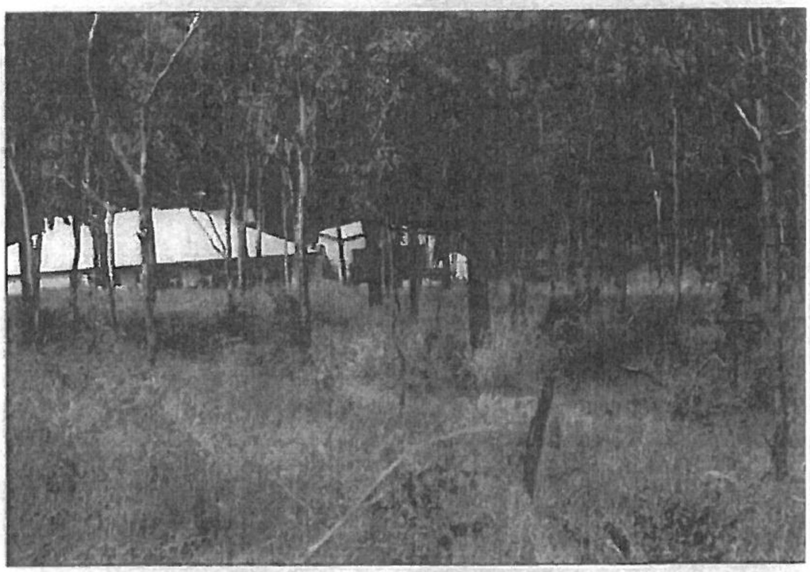

Plate 2: Typical view of the eastern block looking south

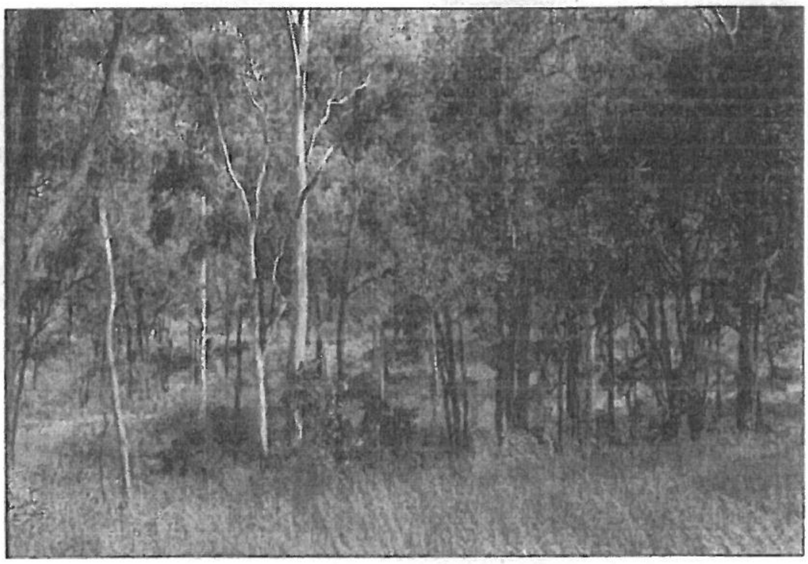

Plate 3: Typical bushland view of the eastern block

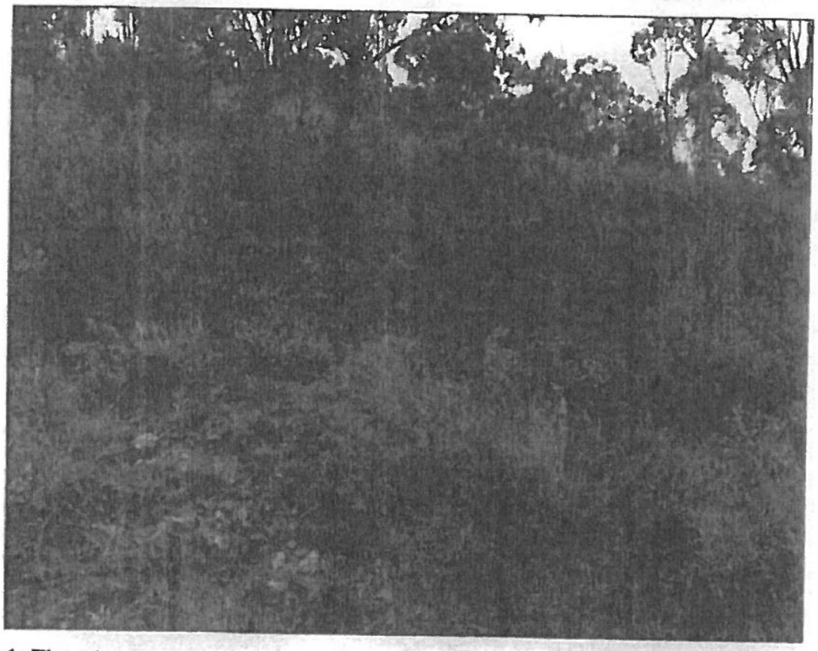

Plate 4: The steeper area of the western site. Rock at surface at some allotments.

3 INVESTIGATION WORK

3.1 Background Search

As part of the slope stability assessment for the site, Rockhampton City Council was liaised with to determine if there was any record of previous instability on site.

A historical aerial photographic interpretation at selected years, using stereographic projection, was carried out to assess if any physical evidence of previous landslips on the site could be observed.

3.2 Fieldwork

Fieldwork for the investigation was carried out on the 8 April 2009 and included the excavation of 12 test pits as shown on the attached site sketch, Figure 1A and 1B. The material encountered at each location is described on test pit log sheets included in Annex A.

A structural mapping exercise, *'site walkover'* was also carried out by a Geotechnical Engineer on the 8 April 2009.

Fieldwork was carried out in accordance with Australian Standard, AS1726-1993 *'Site Investigation Code'*, and the State Planning Policy 1/03 *'Mitigating the Adverse Impacts of Flood, Bushfire and Landslide'*.

4 SUBSURFACE CONDITIONS

Regional Geology

The Geological Survey of Queensland's 1:250,000 Series *'Rockhampton'* Geological map indicates that the site is underlain by the Berserker Beds which consist of acid lapilli tuff, vitric and crystal tuff, andesitic and acid flows, agglomerate, tuffaceous, conglomerate, mudstone and lithic arenite. Refer to Figure 3 for an extract of the site's geological map.

The weathered rock encountered during the fieldwork is considered typical of the Berserker Bed.

Fieldwork Results

The fieldwork indicated that, generally at the investigation locations, relatively similar subsurface strata was encountered.

Generally, a layer of topsoil was encountered overlying predominantly residual silty clay or clayey sand material. Extremely to distinctly weathered rock was encountered to test pit termination depths of between 0.5m and 1.5m.

Some of the residual soils were observed to be mixed with some weathered rock fragments. Suspected colluvium existed at TP8 to a depth of 0.6m.

The logs in Annex A should be referred to for the detailed description of material encountered at each investigation location. A summary of conditions encountered at each investigation location is detailed in Table 1 below.

Table 1 Summary of Subsurface Strata

TP No.	Topsoil	Natural				TD
	Silty Clay	Colluvium	Residual		XW/DW	
		Silty Clay	Silty Clay	Clayey Sand	Weathered Rock	
1	0.0-0.1	-	0.1-0.6	-	0.6-TD	1.1[1]
2	0.0-0.2	-	0.2-1.4	-	1.4-TD	1.5[1]
3	0.0-0.2	-	0.2-0.9	-	0.9-TD	1.5[1]
4	0.0-0.3	-	0.3-0.6	-	0.6-TD	1.1[1]
5	0.0-0.2	-	0.2-0.8	-	0.8-TD	1.3[1]
6	0.0-0.2	-	0.2-0.6	0.6-1.2	1.2-TD	1.5[1]
7	0.0-0.1	-	0.1-0.9	-	0.9-TD	1.5[1]
8	0.0-0.1	0.1-0.6	0.6-1.0	1.0-1.2	1.2-TD	1.4[1]
9	0.0-0.1	-	0.1-0.2	-	0.2-TD	0.5[1]
10	0.0-0.1	-	0.1-0.4	-	0.4-TD	0.8[1]
11	0.0-0.1	-	-	0.1-0.3	0.3-TD	0.7[1]
12	0.0-0.1	-	0.1-0.3	-	0.3-TD	0.8[1]

NOTES:

1. Bucket refusal with a 5 tonne excavator on weathered rock.
2. All depths measured in metres below ground level at the time of the investigation on the 8 April 2009.
3. TD = Termination Depth.

No groundwater was encountered in any of the test pits during the investigation. However, it is possible that seepage could occur along the sand-clay and soil-rock interfaces during and after periods of wet weather.

5 SLOPE STABILITY ASSESSMENT

The fieldwork exercise included a broadscale inspection, where possible, of the entire site to assess the following;

- Determine slope angle
- Observe vegetation
- Note any evidence of tension cracking
- Note any evidence of seepage
- Note any evidence of soil creep
- Note any evidence of previous slips
- Geological features
- Subsurface conditions
- Drainage issues

Based on the information provided by the client, we understood that a majority of the site will remain relatively unchanged. No major fill is proposed across the site except at the head of each proposed cul-de-sac where some fill and/or retaining wall may be constructed. Construction of sewer and roofwater trenching will be required in areas between 15% and 25%. A majority of the roads were proposed on areas less than 15% slope.

It was also noted that diversion drains will be constructed along the northern boundary of the sites to divert all stormwater originating up slope from the sites into the gully and not to the allotments.

The following drawings were supplied and used during our analysis:

Ref: 2112-08, Rev B – Slope Map of Eastern Block (Schlencker Surveying)

Ref: 2112-08, Rev B – Slope Map of Western Block (Schlencker Surveying)

Ref: 2112-07E Sh4 – Proposed Stormwater Diversion Map of Western Block (Schlencker Surveying)

Ref: 2112-07E Sh5 – Proposed Stormwater Diversion Map of Eastern Block. (Schlencker Surveying)

Aerial photographs were also obtained and analysed to determine if any obvious slip areas were evident. The following aerial photos were reviewed:

- Rockhampton, QAP6040, Run 10, Frame 64, 2004
- Ridgeland, QAP5222, Run 10, Frame 21, 1994
- Rockhampton, QAP4223, Run 1, Frame 53, 1983
- Rockhampton, Q1587, Run 1, Frame 3409, 1964
- Rockhampton, QAP615, Run 4, Frame 16, 1956

During our interpretation, no physical evidence was noted across the site to indicate that the site had undergone any previous instability. Vegetation across the sites varied over the years reviewed.

The slope angles on site varied. Most allotments are to be situated on platforms with a slope of between 0% to 25% with several blocks having slopes in excess of 30%.

Some minor soil creep within the steep drainage gullies was observed. However, no significant physical evidence of previous movement, seepage, soil creep etc was observed during the mapping exercise across the site in its current state.

Proposed earthworks levels and building house pad locations were not known at this time. However, it is recommended that any cut/filling construction be restricted to the area where **natural** slope angles are less than 25% and where residual soils/weathered rock existed. This cut and fill should be limited to heights not exceeding 1m without more detailed geotechnical investigation work. Where slopes exceed 25%, it is recommended that no cut/fill be undertaken without detailed geotechnical assessment. This includes areas at the end of the proposed cul-de-sac where slopes are to be greater than 25% and some fill and retaining walls will be constructed.

It is recommended that removal of vegetation (with the exception of topsoil stripping) be kept to a minimum and that any vegetation removal only be undertaken where it is necessary in order to construct building platforms.

Refer to Figure 2 for an overall view of the site in relation to slope percentage.

Background Search

Rockhampton City Council was contacted to determine if there are any record of instability at the subject site. We were informed that no record of instability was available from the Council regarding the site.

Drainage

The stability of individual lots will largely be a function of adequate drainage control on each individual site. Therefore, it is assumed that stormwater management will be designed and constructed in accordance with recognised building practices/standards to control all drainage issues.

Hazard Rating

An indicative quantitative hazard rating has been assigned to the sites based on the test pits excavated and site walkover, the results of which provided a range of relative frequencies of between 0.189 to 0.567. This indicates the site has a *'very low'* to *'low'* likelihood of instability for the site. Detailed calculations of frequency analysis for TP8 (worst) and TP9 (best) are attached in Annex B.

Refer to Table 2 below for typical implications with respect to *'risk'* level.

Table 2 Risk Level Implications

Risk Level		Example Implications (1)
VH	VERY HIGH RISK	Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to acceptable levels; may be too expensive and not practical
H	HIGH RISK	Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable levels
M	MODERATE RISK	Tolerable provided treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of treatment options.
L	LOW RISK	Usually accepted. Treatment requirements and responsibility to be defined to maintain or reduce risk.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures

Notes:

1. The implications for a particular situation are to be determined by all parties to the risk assessment; these are only given as a general guide.
2. Judicious use of dual descriptors for Likelihood, Consequence and Risk to reflect the uncertainty of the estimate may be appropriate in some cases.

Considering the investigation results, and provided that all the above measures are carried out, all lots would be considered suitable and feasible for development.

The development on the sites is not expected to adversely affect the current stability of adjoining properties provided the recommendations above are adhered to and adequate civil/hydraulic and structural issues are addressed.

It is recommended that all proposed cut/fill levels for individual building pad construction and major retaining walls (in particularly lots with a moderate to high risk of instability) be reviewed and analysed prior to the commencement of any earthworks to confirm that a theoretical stability factor of safety (FOS) against failure of ≥1.5 can be achieved. Further, during the construction phase of the project, A geotechnical consultant should be engaged to inspect the cut/fill batters and certify that the required FOS can be achieved or whether remediation works are required.

6 CONSTRUCTION INSPECTIONS

It is recommended that placement of all structural fill and cut/fill batters be inspected, tested and certified where necessary, to ensure recommendations made in this report have been adhered to.

Should subsurface conditions other than those described in this report be encountered, a geotechnical consultant should be consulted immediately and appropriate modifications developed and implemented if necessary.

7 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are made in regard to the slope stability investigation for the proposed residential subdivision at 229-237 German Street, Norman Gardens. However, the preceding sections of this report should be read for a full description of the conclusions and recommendations.

1. The subsurface conditions, at the investigation locations generally consisted of topsoil over residual silty clay or clayey sand material overlying weathered rocks at depth. Some colluvium was encountered to 0.6m at TP8.

2. Based on our site walkover, no signs of previous significant instability was observable. Only some minor soil creep within the steep draining gullies existed.

3. The background aerial photo search showed no physical evidence of previous slips or instability across the site.

4. Based on our indicative quantitative hazard rating assessment across the sites, the site varies in likelihood of instability from *'very low'* risk to *'low'* risk.

5. Effective drainage control at each lot will be critically important for slope stability. It is assumed that stormwater management will be designed and constructed in accordance with recognised building practices to control all drainage issues.

6. It is recommended that all proposed cut/fill levels and retaining walls, be reviewed and analysed by a geotechnical consultant prior to commencement of any earthworks.

Yours faithfully

SAMMY KWOK
GEOTECHNICAL ENGINEER

DAVID STIRLING
SENIOR GEOTECHNICAL ENGINEER

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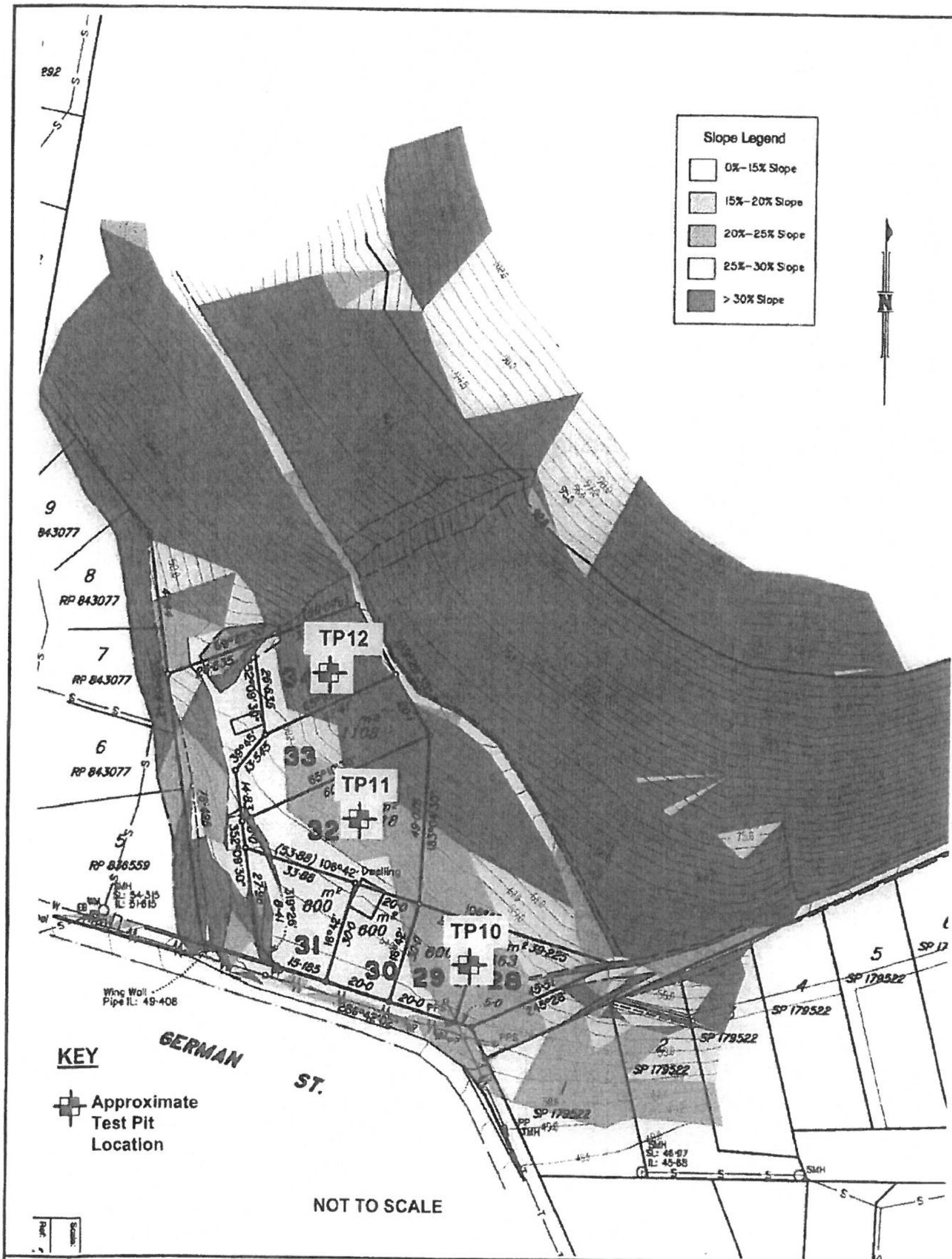
INVESTIGATION LOCATION PLAN OF EASTERN BLOCK

PROPOSED SUBDIVISION

229-237 GERMAN STREET, NORMAN GARDENS

JOB NO.: 8846

FIGURE 1A



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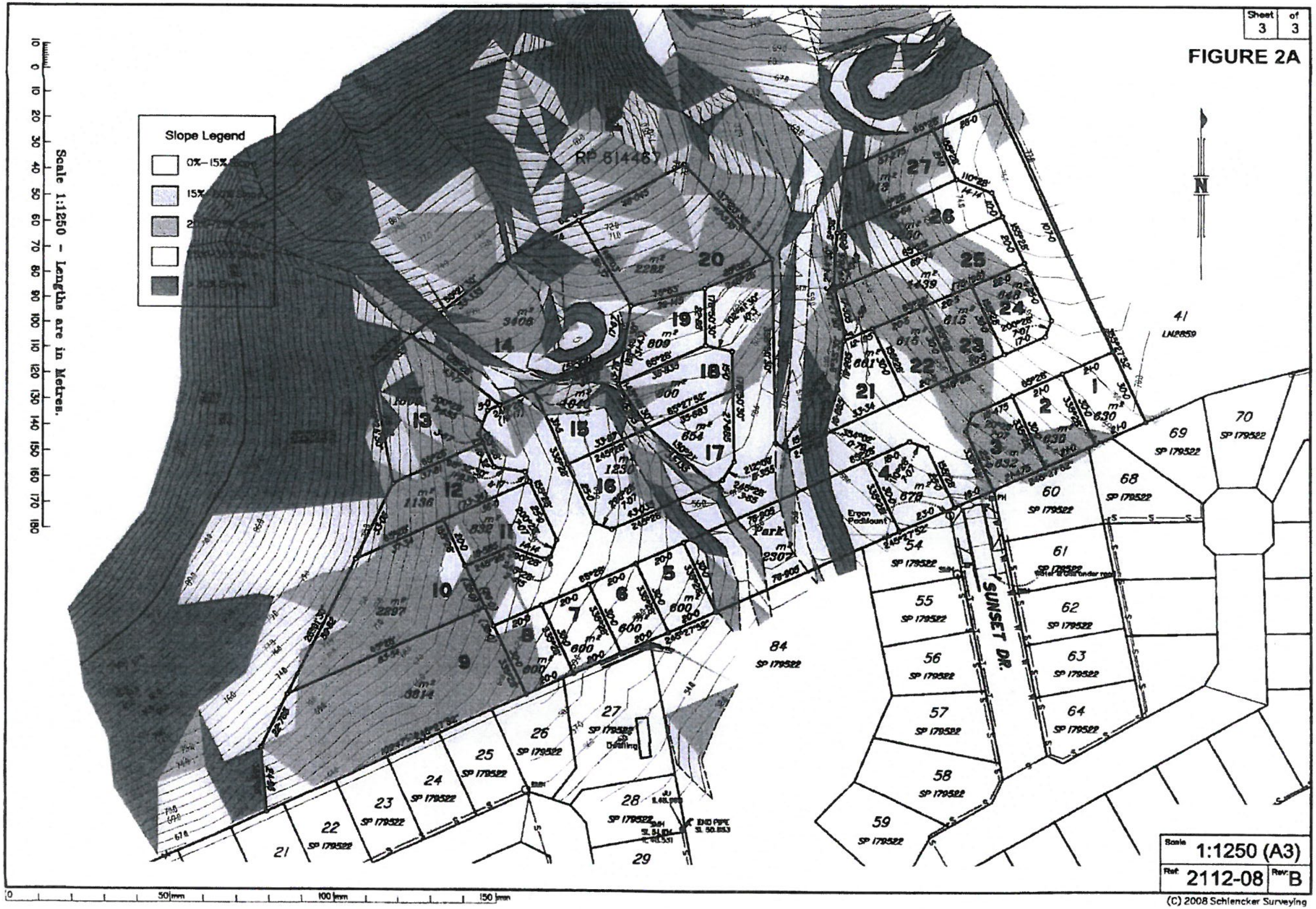
INVESTIGATION LOCATION PLAN OF WESTERN BLOCK	JOB NO.: 8846
PROPOSED SUBDIVISION	
229-237 GERMAN STREET, NORMAN GARDENS	FIGURE 1B


Sheet 3 of 3
FIGURE 2A
N
Slope Legend
0%-15%
15%
Scale 1:1250 - Lengths are in Metres.
10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
RP 814467
SUNSET DR.
Park
41
LN2859
84
SP 179522
1:1250 (A3)
Ref 2112-08
Rev B
(C) 2008 Schlencker Surveying

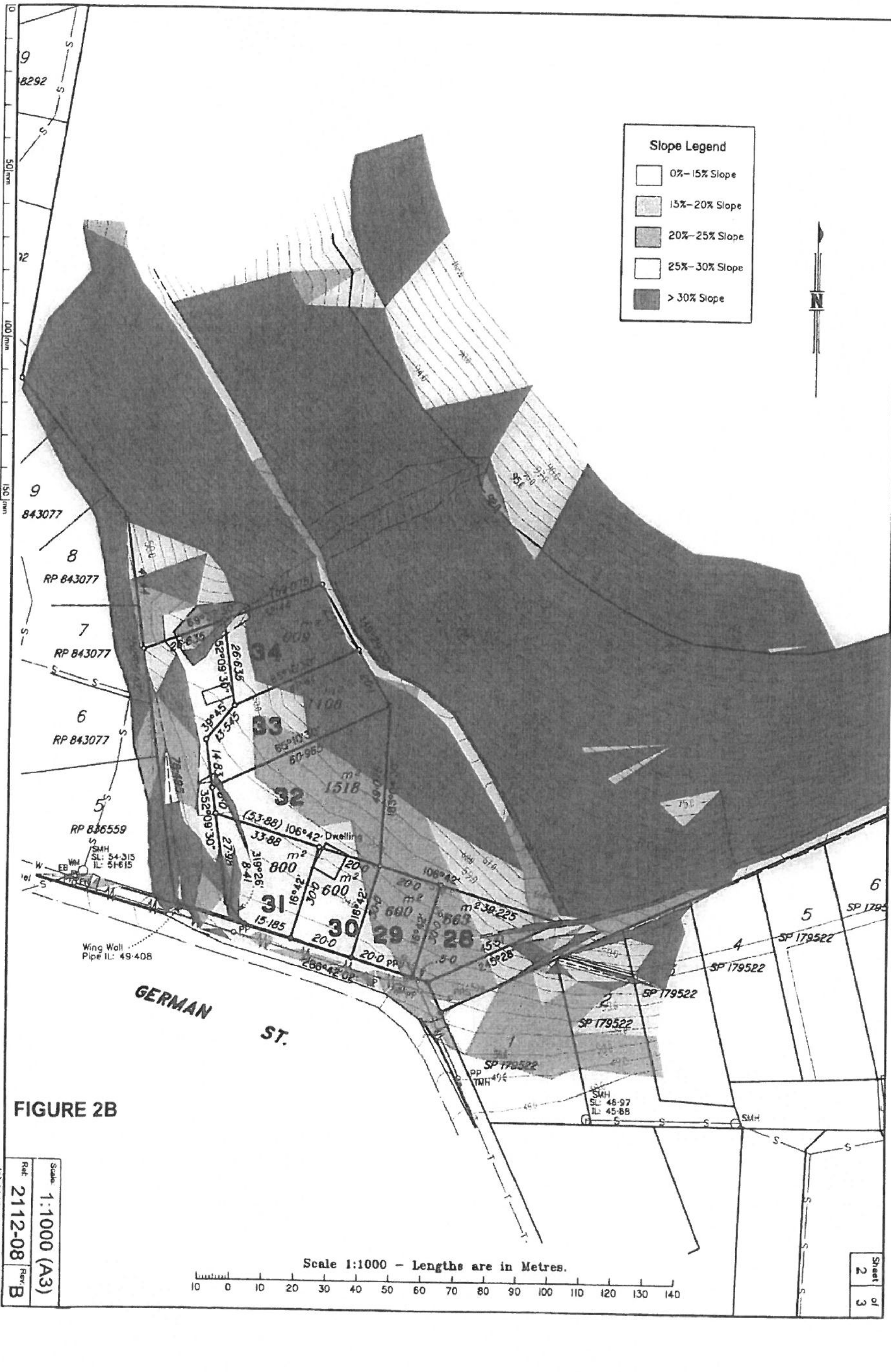
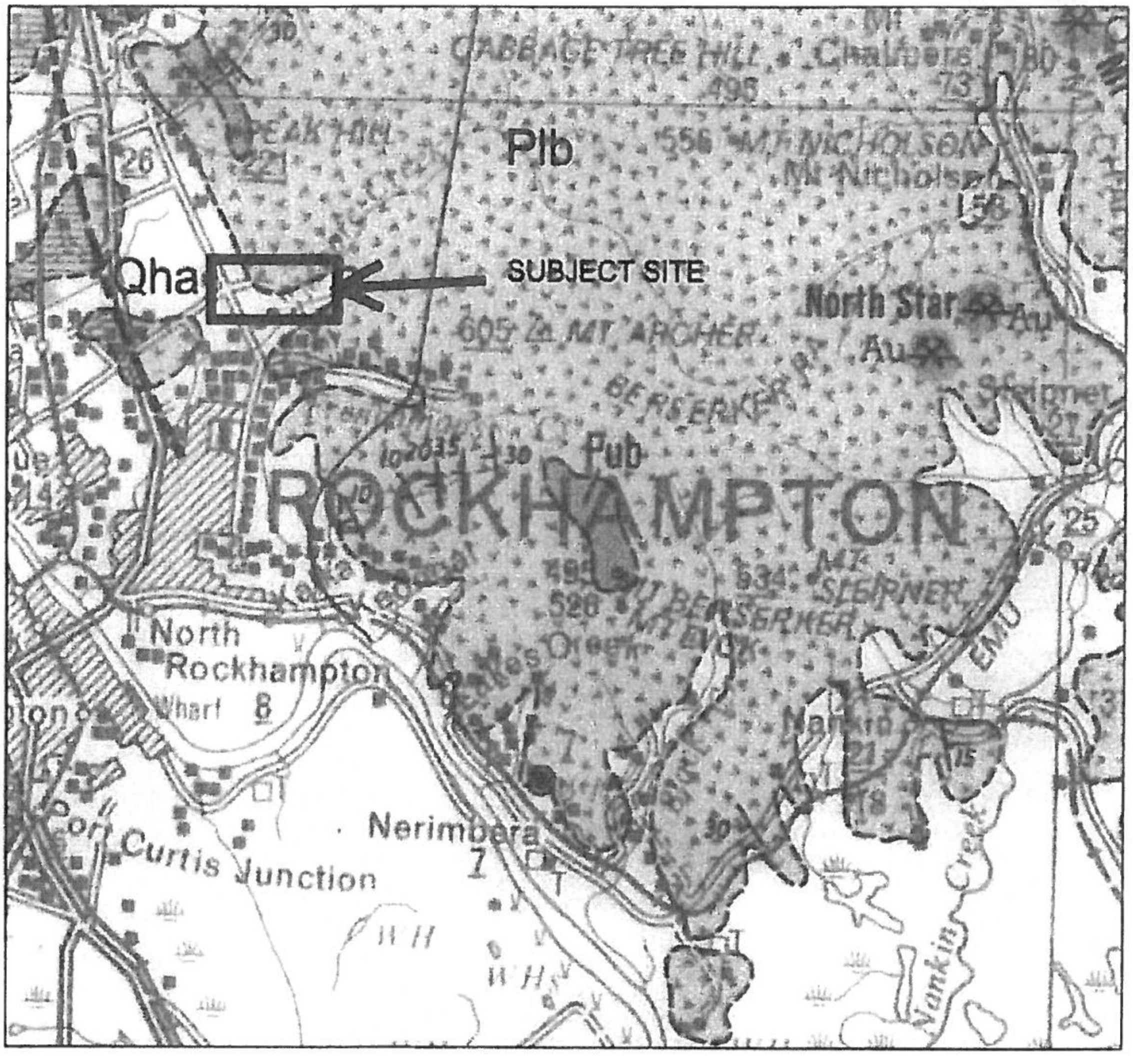

Slope Legend
0%–15% Slope
15%–20% Slope
20%–25% Slope
25%–30% Slope
> 30% Slope
N
GERMAN ST.
Dwelling
Wing Wall
Pipe IL: 49·408
Scale 1:1000 – Lengths are in Metres.
Sheet 2 of 3
Scale 1:1000 (A3)
Ref. 2112-08 Rev. B
(C) 2008 Schiencker Surveying

FIGURE 2B



LEGEND

Berserker Beds	Plb	*Acid lapilli tuff, vitric and crystal tuff, andesitic and acid flows, agglomerate, tuffaceous, conglomerate, mudstone, lithic arenite*

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GEOLOGICAL MAP	JOB NO.: 8846
PROPOSED SUBDIVISION	
229-237 GERMAN STREET, NORMAN GARDENS	FIGURE 3

GENERAL NOTES

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Shaping the Future

April 2005

GENERAL

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the introduction section(s) of the document. The report should not be used by other parties or for other purposes as it may not contain adequate or appropriate information.

TEST HOLE LOGGING

The information on the Test Hole Logs (Boreholes, Backhoe Pits, Exposures etc.) has been based on a visual and tactile assessment except at the discrete locations where test information is available (field and/or laboratory results).

Reference should be made to our standard sheets for the definition of our logging procedures (Soil and Rock Descriptions).

GROUNDWATER

Unless otherwise indicated the water levels given on the test hole logs are the levels of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeabilities. Further variations of this level could occur with time due to such effects as seasonal and tidal fluctuations or construction activities. Final confirmation of levels can only be made by appropriate instrumentation techniques and programmes.

INTERPRETATION OF RESULTS

The discussion and recommendations contained within this report are normally based on a site evaluation from discrete test hole data. Generalised or idealised subsurface conditions (including any cross-sections contained in the report) have been assumed or prepared by interpolation/extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions used for this report can occur, particularly between discrete test hole locations. Furthermore, certain design or construction procedures may have been assumed in assessing the soil structure interaction behaviour of the site.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed in this report should be referred to this firm for appropriate assessment and comment.

FOUNDATION DEPTH

Where referred to in the report, the recommended depth of any foundation (piles, caissons, footings, etc.) is an engineering estimate of the depth to which they should be constructed. The estimate is influenced and perhaps limited by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The depth remains, however, an estimate and therefore liable to variation. Footing drawings, designs and specifications based upon this report should provide for variations in the final depth depending upon the ground conditions at each point of support.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in this report for the inclusion in the contract documents or engineering specification of the subject development, such reproduction should include at least all the relevant test hole and test data, together with the appropriate standard description sheets and remarks made in the written report of a factual or descriptive nature.

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UDIA

IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions that any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE / The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predications. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimise their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional test are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use*. Those who do not provide such access may proceed under the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by The Institution of Engineers Australia, National Headquarters, Canberra, 1987.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

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OF ENGINEERING FIRMS
PRACTICING IN THE GEOSCIENCES

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SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical consultant at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminant bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	

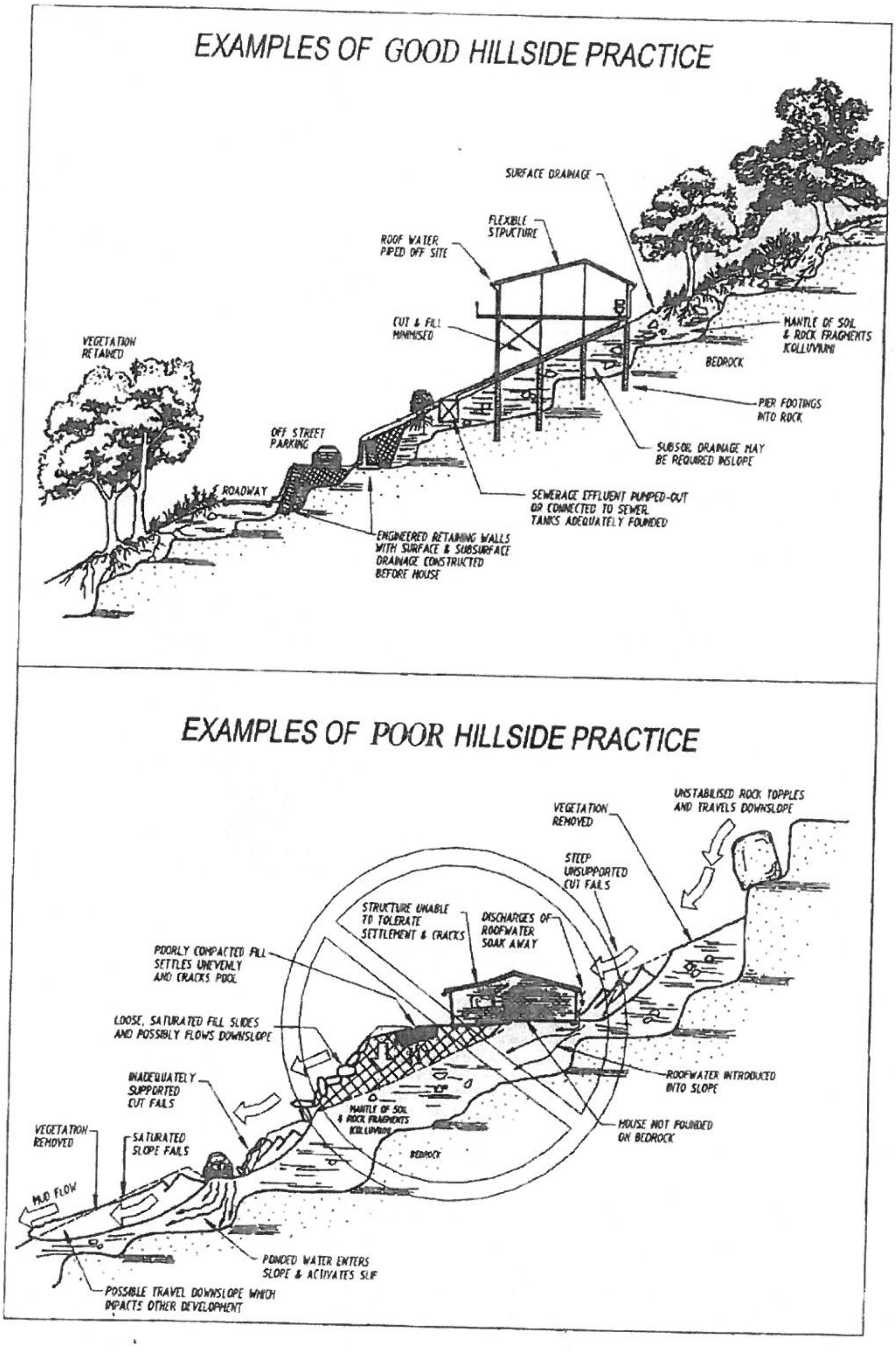

FIGURE J1: Illustrations of Good and Poor Hillside Practice

Annex A

Fieldwork Results

September, 2001

SOIL DESCRIPTION

This procedure involves the description of a soil in terms of its visual and tactile properties, and relates to both laboratory samples and field exposures as applicable. A detailed soil profile description, in association with local geology and experience, will facilitate the initial (and often complete) site assessment for engineering purposes.

The method involves an evaluation of each of the items listed below and is in general agreement with the Site Investigation Code AS1726-1993.

SOIL TYPE
The soil is described on the basis of the grain size composition of the constituent particles, and the plasticity of the fraction of material passing the 425μm sieve.

Furthermore, as most natural soils are part combinations of various constituents, the primary soil is described and modified by minor components. In brief, the system is as follows;

SILT OR CLAY AS MINOR COMPONENT		GRAVEL OR SAND AS MINOR COMPONENT	
% Fines	Modifier	% Coarse	Modifier
≤5 >5 ≤12 >12	omit, or use "trace" describe as "with clay/silt" as applicable prefix soil as "silty/clayey" as applicable	≤15 >15 ≤30 >30	omit, or use "trace" describe as "with sand/gravel" as applicable prefix soil as "sandy/gravelly' as applicable

Note: For soils containing both sand and gravel the minor coarse fraction is omitted if less than 15%, or described as "with sand/gravel" as applicable when greater than 15%.

The appropriate classification group symbol for soil classification is also given before the soil type description in accordance with AS1726-1993, Table A1.

For granular soils, an assessment of grading (well, uniform, gap or poor), particle size (fine, medium etc), angularity, shape and particle composition may also be given.

COLOUR
Colour is important for correlation of data between test holes and for subsequent excavation operations. The prominent colour is noted, followed by (spotted, mottled, streaked etc.) secondary colours as applicable. Colour should be described in the "moist" condition, though both wet and dry colours may also be appropriate.

MOISTURE
The moisture condition of the soil is described by the appearance and feel of the soil using one of the following terms:
Dry cohesive soils - hard, friable or powdery; granular soils - cohesionless, free funning.
Moist soil cool, darkened colour: cohesive soils - can be moulded; granular soils - tend to cohere.
Wet soil cool, darkened colour: cohesive soils - usually weakened, free water on hands when handling; granular soils - tend to cohere.

In addition, the presence of any seepage or free water is noted on all test hole logs.

CONSISTENCY/RELATIVE DENSITY
Granular soils are generally described in terms of relative density (density index) as listed in Table A5 AS1726. These soils are inherently difficult to assess and normally a penetration test procedure (SPT, DCP or CPT) is used in conjunction with published correlation tables. Alternatively, insitu density tests can be conducted in association with minimum and maximum densities performed in the laboratory.

Cohesive soils can be assessed by direct measurement (shear vane), or estimated approximately by tactile means and/or the aid of a geological pick as given on the following table. It is emphasised that a "design shear strength" must take cognisance of the insitu moisture content and the possible variations of moisture with time.

Term	Tactile Properties	Undrained Shear Strength (kPa)
Very Soft	Exudes between the fingers when squeezed in the hand.	≤12
Soft	Easily penetrated by thumb about 30-40mm. Pick head can be pushed in up to shaft. Moulded by light finger pressure.	>12 ≤25
Firm	Penetrated by thumb 20-30mm with moderate effort. Sharp end of pick pushed in some 30-40m. Moulded by strong finger pressure.	>25 ≤50
Stiff	Indented by thumb about 4mm with moderate effort. Pick pushed in up to 10mm. Cannot be moulded in fingers.	>50 ≤100
Very Stiff	Readily indented by thumb nail. Slight indentation produced by pushing pick into soil.	>100 ≤200
Hard	Difficult to indent with thumb nail. Requires power tools for excavation.	>200

STRUCTURE/OTHER FEATURES
The structure of the soil may be described with reference to: zoning, where soils consist of separate zones differing in colour, grain size or other properties; defects, including fissures, cracks, root-holes and the like; cementing, with the strength (weakly to strongly), and nature of the cementing agent; additional observations including geological origin, odour and the like. In addition, the presence of other features (ferricrete nodules, organic inclusions) should also be noted as applicable.

TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS
Project: PROPOSED RESIDENTIAL SUBDIVISION
Location: GERMAN STREET, ROCKHAMPTON

Job No: 8846

Hole No: TP1

Sheet: 1 of 1

Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD	
Date Started: 8/4/09 Date Completed: 8/4/09	Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
												CH	SILTY CLAY, high plasticity, dark grey, moist, with gravel, grass root zone, moist, TOPSOIL
0.5												CH	SILTY CLAY WITH SAND, high plasticity, brown, some rounded and angular cobbles, moist, RESIDUAL
1.0												XW-DW	WEATHERED ROCK, brown, low to medium strength, highly fractured, some round pieces, extremely weathered to distinctly weathered
1.5													BUCKET REFUSAL TEST PIT TERMINATED AT 1.10 m

See Standard Sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS
Project: PROPOSED RESIDENTIAL SUBDIVISION
Location: GERMAN STREET, ROCKHAMPTON
Job No: 8846

Hole No: TP2
Sheet: 1 of 1

Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD	
Date Started: 8/4/09 — Date Completed: 8/4/09	Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
												CL-CI	SILTY CLAY, low to intermediate plasticity, dark grey, trace of gravel, grass root zone, moist, TOPSOIL
0.5												CI	SILTY CLAY, intermediate plasticity, orange/brown, trace of fine to coarse grained gravel, moist, RESIDUAL
1.0												CH	SILTY CLAY WITH SAND, high plasticity, brown, some rounded and angular cobbles, moist, RESIDUAL
												XW/DW	WEATHERED ROCK, brown, low to medium strength, highly fractured, some round pieces, extremely weathered to distinctly weathered
1.5													BUCKET REFUSAL TEST PIT TERMINATED AT 1.50 m

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS
Project: PROPOSED RESIDENTIAL SUBDIVISION
Location: GERMAN STREET, ROCKHAMPTON

Job No: 8846

Hole No: TP3

Sheet: 1 of 1

Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD	
Date Started: 8/4/09 Date Completed: 8/4/09	Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
												CL-CI	SILTY CLAY, low to intermediate plasticity, dark grey, trace of gravel, mixed with cobbles, grass root zone, moist. TOPSOIL
0.5												CI	SILTY CLAY, intermediate plasticity, orange/brown, fine to coarse grained gravel, some cobbles, moist. RESIDUAL
1.0												XW-DW	WEATHERED ROCK, brown, low to medium strength, highly fractured, some round pieces, extremely weathered to distinctly weathered
1.5													BUCKET REFUSAL TEST PIT TERMINATED AT 1.50 m

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS
Project: PROPOSED RESIDENTIAL SUBDIVISION
Location: GERMAN STREET, ROCKHAMPTON

Job No: 8846

Hole No: TP4

Sheet: 1 of 1

Position: REFER SITE SKETCH FIGURE 1 | **Angle from Horizontal:** 90° | **Surface Elevation:**

Machine Type: 5 Tonne Excavator | **Excavation Method:** | **Operator:**

Excavation Dimensions: 4.50 m WIDE | **Contractor:** CARDNO BOWLER PTY LTD

Date Started: 8/4/09 | **Date Completed:** 8/4/09 | **Logged By:** SK | **Date Logged:** 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
												CL-CI	SILTY CLAY, low to intermediate plasticity, dark grey, trace of gravel, mixed with cobbles, grass zone, moist, TOPSOIL
0.5												CH	SILTY CLAY WITH SAND AND GRAVEL, high plasticity, mixed with cobbles, orange/brown, fine to coarse grained gravel, moist, RESIDUAL
1.0												XW-DW	WEATHERED ROCK, brown, extremely low to medium strength, some round pieces extremely to distinctly weathered
1.5													BUCKET REFUSAL TEST PIT TERMINATED AT 1.10 m

See Standard Sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS Project: PROPOSED RESIDENTIAL SUBDIVISION Location: GERMAN STREET, ROCKHAMPTON	Job No: 8846	**Hole No: TP5** Sheet: 1 of 1
Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD	
Date Started : 8/4/09 Date Completed: 8/4/09	Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
0.0–0.20												CH	SILTY CLAY, high plasticity, dark grey, moist, with gravel, grass root zone, moist, TOPSOIL
0.20–0.80 (0.5)												CI	SILTY CLAY, intermediate plasticity, red/orange, mixed with weathered rock, fine to coarse grained gravel, moist, RESIDUAL
0.80–1.30 (1.0)												DW	WEATHERED ROCK, fine grained, brown/grey, medium to high strength, highly fractured, distinctly weathered
1.30 (1.5)													BUCKET REFUSAL TEST PIT TERMINATED AT 1.30 m

See Standard Sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS
Project: PROPOSED RESIDENTIAL SUBDIVISION
Location: GERMAN STREET, ROCKHAMPTON

Hole No: TP6

Job No: 8846
Sheet: 1 of 1

Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD	
Date Started : 8/4/09 Date Completed: 8/4/09	Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
												CI	SILTY CLAY, intermediate plasticity, dark grey, moist, with gravel, grass root zone, moist. TOPSOIL
												CI	SILTY CLAY, intermediate plasticity, dark grey, moist, with gravel, some grass root, NATURAL
0.5												CI	SILTY CLAY, intermediate plasticity, red/orange, fine to coarse grained gravel, RESIDUAL
1.0												SC	CLAYEY SAND, fine grained, pale brown, low plasticity, moist, RESIDUAL Tending to weathered rock
1.5												XW-DW	WEATHERED ROCK (TUFF?), fine to medium grained, very low to low strength, extremely to distinctly weathered
													NEAR BUCKET REFUSAL TEST PIT TERMINATED AT 1.50 m

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See Standard Sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS Project: PROPOSED RESIDENTIAL SUBDIVISION Location: GERMAN STREET, ROCKHAMPTON	Job No: 8846	**Hole No: TP7** Sheet: 1 of 1
Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD	
Date Started: 8/4/09 Date Completed: 8/4/09	Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit / Auger 'TC' Bit / Washbore / Casing / Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
								CH	SILTY CLAY, high plasticity, dark grey, grass root zone, moist, TOPSOIL
								CH	SILTY CLAY, high plasticity, dark grey, moist, NATURAL
0.5								CH	SILTY CLAY WITH SAND, high plasticity, red/brown, fine grained sand, moist, NATURAL
								CH	SILTY CLAY WITH SAND, high plasticity, brown, fine grained sand, moist, NATURAL
1.0								SC-SM	SILTY CLAYEY SAND, fine to medium grained, brown, moist, RESIDUAL
								XW-DW	WEATHERED ROCK (TUFF), fine to medium grained, very low to low strength, extremely to distinctly weathered
1.5									NEAR BUCKET REFUSAL TEST PIT TERMINATED AT 1.50 m

See Standard Sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS
Project: PROPOSED RESIDENTIAL SUBDIVISION
Location: GERMAN STREET, ROCKHAMPTON

Job No: 8846

Hole No: TP8

Sheet: 1 of 1

Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD	
Date Started: 8/4/09 Date Completed: 8/4/09	Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
												CI	SILTY CLAY, intermediate plasticity, mixed with weathered rock, dark grey, moist, TOPSOIL
												CI	SILTY CLAY, intermediate plasticity, mixed with weathered rock, dark grey, moist, COLLUVIUM?
0.5												CI	SILTY CLAY, intermediate plasticity, with sand and gravel, mixed with weathered rock, moist, COLLUVIUM?
												CH	SILTY CLAY WITH SAND, high plasticity, brown, fine grained sand, moist, RESIDUAL
1.0												SC	CLAYEY SAND, fine to medium grained, brown, moist, RESIDUAL
												XW-DW	WEATHERED ROCK (TUFF), fine to medium grained, very low to low strength, extremely to distinctly weathered
1.5													BUCKET REFUSAL TEST PIT TERMINATED AT 1.40 m

See Standard Sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS Project: PROPOSED RESIDENTIAL SUBDIVISION Location: GERMAN STREET, ROCKHAMPTON	Job No: 8846	**Hole No: TP9** Sheet: 1 of 1
Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD	
Date Started: 8/4/09 Date Completed: 8/4/09	Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
												CI	SILTY CLAY, Intermediate plasticity, mixed with weathered rock, dark grey, moist, TOPSOIL
												CI	SILTY CLAY, Intermediate plasticity, mixed with weathered rock, dark grey, moist, NATURAL
												XW-DW	WEATHERED ROCK (TUFF), low to medium strength, extremely to distinctly weathered tuff
0.5													BUCKET REFUSAL TEST PIT TERMINATED AT 0.50 m
1.0													
1.5													

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See Standard Sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS
Project: PROPOSED RESIDENTIAL SUBDIVISION
Location: GERMAN STREET, ROCKHAMPTON

Job No: 8846

Hole No: TP10

Sheet: 1 of 1

Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90° / Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method: / Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD
Date Started: 8/4/09 / Date Completed: 8/4/09	Logged By: SK / Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
												CH	SILTY CLAY, high plasticity, with sand and gravel, some cobbles, brown, fine to coarse grained sand and gravel, grass root zone, moist, TOPSOIL
												CH	SILTY CLAY, high plasticity, with sand and gravel, some cobbles, brown, fine to coarse grained sand and gravel, moist, NATURAL
0.5												XW-DW	WEATHERED ROCK, fine grained, medium to high strength, highly fractured, some round weathered rock, extremely to distinctly
													BUCKET REFUSAL TEST PIT TERMINATED AT 0.80 m
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS Project: PROPOSED RESIDENTIAL SUBDIVISION Location: GERMAN STREET, ROCKHAMPTON	Job No: 8846	**Hole No: TP11** Sheet: 1 of 1
Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD	
Date Started : 8/4/09 Date Completed: 8/4/09	Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
												CI	SILTY CLAY, intermediate plasticity, brown, grass root zone, moist, TOPSOIL
												SC	CLAYEY SAND, fine to medium grained, some weathered rock fragments, brown, moist, RESIDUAL
0.5												XW-DW	WEATHERED ROCK, fine grained, very low to medium strength, extremely to distinctly weathered
													BUCKET REFUSAL TEST PIT TERMINATED AT 0.70 m
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: McMURTRIE CONSULTING ENGINEERS Project: PROPOSED RESIDENTIAL SUBDIVISION Location: GERMAN STREET, ROCKHAMPTON	Job No: 8846
	Hole No: TP12 Sheet: 1 of 1
Position: REFER SITE SKETCH FIGURE 1	Angle from Horizontal: 90°
	Surface Elevation:
Machine Type: 5 Tonne Excavator	Excavation Method:
	Operator:
Excavation Dimensions: 4.50 m WIDE	Contractor: CARDNO BOWLER PTY LTD
Date Started: 8/4/09	Date Completed: 8/4/09
Logged By: SK	Date Logged: 8/4/09

Depth (m)	Drilling: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Casing	Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture consistency, structure, ORIGIN)
												CI	SILTY CLAY, intermediate plasticity, brown, grass root zone, moist, TOPSOIL
												CI	SILTY CLAY, intermediate plasticity, brown, moist, NATURAL
0.5												XW-DW	WEATHERED ROCK, fine grained, very low to medium strength, extremely to distinctly weathered
													BUCKET REFUSAL TEST PIT TERMINATED AT 0.80 m
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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BG_LIB_03.GLB Log BG SOIL LOG 8846.GPJ <<DrawingFile>> 12/05/2009 09:13

Annex B

Hazard Rating Assessment

TP8

Appendix B1

LANDSLIDE FREQUENCY ANALYSIS

Analysis No.:

NATURAL SHALLOW LANDSLIDES

LOCATION: Site No. Site name:

1 Basic Frequency

2 Slope Angle

Site		Level	Factor
	Less than 5 degrees	L	0.1
	Between 5 and 15 degrees	M	0.5
X	Between 15 and 30 degrees	M	0.8
	Between 30 and 45 degrees	H	1.2
	More than 45 degrees	M	0.8

3 Slope Shape

Site		Level	Factor
	Crest or ridge	L	0.7
	Planar	M	0.9
X	Convex	M	0.9
	Concave	H	1.5

4 Site geology

Site		Level	Factor
	Volcanic rock	H	1.1
X	Sedimentary rock	M	1
	Low grade metamorphic rock	M	1
	High grade metamorphic rock	L	0.9
	Granitic rock	M	1

5 Material strength

Site		Level	Factor
	Rock at surface	VL	0.1
	Residual soil < 1 m deep	L	0.5
	Residual soil 1-3 m deep	M	0.9
	Residual soil >3 m deep	H	1.5
X	Colluvial soil < 1 m deep	H	1.5
	Colluvial soil 1-3 m deep	VH	2
	Colluvial soil > 3 m deep	VH	4
	Fill (slope regrading)	VH	5

6 Concentration of surface water

Site		Level	Factor
	Ridge	L	0.7
	Crest	M	0.8
	Upper slope	M	0.9
	Mid slope	H	1.2
X	Lower slope	H	1.5

7 Evidence of groundwater

Site		Level	Factor
X	None apparent	L	0.7
	Minor moistness	M	0.9
	Generally wet	H	1.5
	Surface springs	VH	3

8 Evidence of instability

Site		Level	Factor
X	No sign of instability	L	0.5
	Trees bent	H	1.5
	Minor irregularity	VH	2
	Major irregularity	VH	5
	Scarps	VH	10

Summary

		Factor
2	Slope Angle	0.8
3	Slope Shape	0.9
4	Site geology	1.0
5	Material strength	1.5
6	Concentration of surface water	1.5
7	Evidence of groundwater	0.7
8	Evidence of instability	0.5
9	Relative Frequency (2x3x4x5x6x7x8)	0.567

Site Frequency (1 x 9)

TP9

Appendix B1

LANDSLIDE FREQUENCY ANALYSIS

Analysis No.:

NATURAL SHALLOW LANDSLIDES

LOCATION:

Site No. Site name:

1 Basic Frequency

2 Slope Angle

Site		Level	Factor
	Less than 5 degrees	L	0.1
	Between 5 and 15 degrees	M	0.5
X	Between 15 and 30 degrees	M	0.8
	Between 30 and 45 degrees	H	1.2
	More than 45 degrees	M	0.8

3 Slope Shape

Site		Level	Factor
	Crest or ridge	L	0.7
	Planar	M	0.9
X	Convex	M	0.9
	Concave	H	1.5

4 Site geology

Site		Level	Factor
	Volcanic rock	H	1.1
X	Sedimentary rock	M	1
	Low grade metamorphic rock	M	1
	High grade metamorphic rock	L	0.9
	Granitic rock	M	1

5 Material strength

Site		Level	Factor
	Rock at surface	VL	0.1
X	Residual soil < 1 m deep	L	0.5
	Residual soil 1-3 m deep	M	0.9
	Residual soil >3 m deep	H	1.5
	Colluvial soil < 1 m deep	H	1.5
	Colluvial soil 1-3 m deep	VH	2
	Colluvial soil > 3 m deep	VH	4
	Fill (slope regrading)	VH	5

6 Concentration of surface water

Site		Level	Factor
	Ridge	L	0.7
	Crest	M	0.8
	Upper slope	M	0.9
	Mid slope	H	1.2
X	Lower slope	H	1.5

7 Evidence of groundwater

Site		Level	Factor
X	None apparent	L	0.7
	Minor moistness	M	0.9
	Generally wet	H	1.5
	Surface springs	VH	3

8 Evidence of instability

Site		Level	Factor
X	No sign of instability	L	0.5
	Trees bent	H	1.5
	Minor irregularity	VH	2
	Major irregularity	VH	5
	Scarps	VH	10

Summary

		Factor
2	Slope Angle	0.8
3	Slope Shape	0.9
4	Site geology	1.0
5	Material strength	0.5
6	Concentration of surface water	1.5
7	Evidence of groundwater	0.7
8	Evidence of instability	0.5
9	Relative Frequency (2x3x4x5x6x7x8)	0.189
	Site Frequency (1 x 9)	