DRAKENSTEIN MUNICIPALITY

PRELIMINARY CIVIL ENGINEERING SERVICES REPORT

FOR

THE PROPOSED DEVELOPMENT OF ERF 8378, Paarl, VLAKKELAND TOWNSHIP

SEPTEMBER 2014

Prepared for :

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ANNEXURES

1 INTRODUCTION AND SCOPE OF WORK

Lyners Consulting Engineers and Project Managers was appointed as part of Professional Resource Team (PRT) as Consulting Civil Engineers for the provision of a Preliminary Civil Engineering Services Report for the proposed development of erf 8378, Paarl (Vlakkeland Township). It is the intention to develop a mixed use (light industrial, commercial, retail and residential), mixed income, sustainable development.

The purpose of this report is to provide background information in terms of engineering services required, as well as the intended design methodology thereof and possible restrictions and options in terms of providing engineering services.

The result of this study will be used to inform representatives for the future development of the site that will feed into and align with the Human Settlement Plan (HSP), the Spatial Development Framework (SDF) and provincial government's strategic objectives.

This report is based on a draft town planning layout, the urban design, site inspections, and liaison with the local authority, previous studies and available existing services information.

2 LOCATION AND BACKGROUND

A locality plan is included in Annexure A. Erf 8378 (and surrounding erven included in the development); Paarl of approximately 100 ha is situated east of Jan van Riebeeck Drive (MR201) and west of Bo-Dal Road (DR1119). It is bordered in the south by erf 1341 and the north by erven 2569 and 361 as well as the Newton Residential area. The site is currently undeveloped and the intention is to develop approximately 3260 residential units with the following components:

- Subsidy housing (BNG);
- Mixed housing;
- Temporary relocation area (TRA);
- Affordable rental and GAP Housing;
- Enhanced serviced sites;
- Commercial and light industrial land uses;
- Crèche and worship facilities;
- Primary- and Secondary Schools; and
- Sports facilities

3 INFORMATION UTILIZED

The following information was used in the preparation of the report:

- Layout of proposed development by NuPlan Africa (2.552-S1-06);
- A detailed topographical survey of the entire site, including culverts and existing channels;
- Project meetings and reports completed by the project professional team;
- Site visits;
- 1:10 000 Ortho photo's (GIS Information);
- Aerial photograph;
- Drakenstein Municipality Sewer master plan (June 2012);
- Drakenstein Municipality Water master plan (June 2012):
- Vlakkeland Affordable Housing Development, Wellington: Capacity Analysis of the Bulk Water & Sewer Services (26 August 2014) by GLS Consulting.

4 PRELIMINARY DESIGN CRITERIA

The development will provisionally consist of 3260 residential units.

All design criteria will be based on the following:

- "Guidelines for Human Settlement Planning and Design" referred to as the "Red Book";
- the National Building Regulation (SANS 10400);

- the Code of Practice: Water Supply and Drainage for Buildings (Part 1 & 2) (SANS 10252);
- the Standards of the Civil Engineering Department of Drakenstein Municipality.

5 BULK EARTHWORKS

The site slopes in an east westerly direction at an average slope of approximately 1.5 %. The majority of the land is currently vacant and covered with grass. There is a small settlement of pig farmers located towards the western boundary. Visibility of the site is good from Jan van Riebeeck Road and Bo-Dal Road.

Due to the general slope of the site, the western area is very low and needs to be filled to allow for drainage away from the residential units. A slope of 0.75 % was used for the bulk earthworks. The proposed layout of the earthworks is shown on drawing no 0894/EW/001 included in Annexure B.

6 ACCESS AND ROADS

ITS (Pty) Ltd Engineers were appointed to conduct a Transport Impact Study and their report with reference ITS 3194.1 dated August 2013 and subsequent addendum to this report with reference ITS 3194.1 dated 21 August 2014 are included in Annexure C.

6.1 INTERNAL ROADS

6.1.1 Road widths

The road reserve widths of the internal roads vary between 10 m – 25 m.

Please refer to the proposed road and stormwater layout shown on drawing no 0894/RD/001 included in Annexure D.

6.1.2 Bellmouth radii

The bellmouth radii were kept as large as possible. The radii will vary between 8 m and 12 m.

6.2 PROVISIONAL ROAD LAYER WORKS

The structural design period of all pavement layers should be 20 years. Structural design of pavement layers will be in accordance of the TRH4 and the “Red Book” requirements and the envisaged traffic.

A preliminary geotechnical report was conducted (April 2008) and is attached in Annexure E. From this report it is estimated that the typically road layer works will be as described in Table 6.2.1.

Table 6.2.1: Provisional road layer works and details

Road Description	Kerbing		Layer works			
	High	Low	Road surface	G4 Base	G5 Subbase	Selected layer (sand/insitu)
High order roads (Bulk - 25 m)	BK2 & C1	BK2 & C1	40 mm premix	150 mm	150 mm	300 mm
Middle order roads (Link - 10 m & 20 m)	MK10	CK5	35 mm premix	150 mm	150 mm	300 mm
Lower order roads (Internal - 10 m & 13 m)	MK10	CK5	35 mm premix	150 mm	125 mm	200 mm

Typical road cross sections are also included in Annexure F.

6.3 ESTIMATED COSTS OF PROPOSED ROAD INFRASTRUCTURE

The following costs were estimated and exclude VAT, contingencies and professional fees.

Service	Description	Costs
Bulk	Road reserves	R 19 902 241
Link	Road reserves 10 m – 20 m	R 5 854 144
Internal	Road reserves 10 m – 13 m	R 35 903 085
TOTAL		**R 61 659 470**

The total costs for the proposed roads infrastructure are R 61 659 470.

7 WATER SUPPLY

7.1 EXISTING WATER SUPPLY

Currently there is no dedicated water supply system for the proposed development of Vlakkeland. However, this development lies within the Paarl/Wellington water distribution system and options were investigated where and how this development can connect onto the existing system.

GLS Consulting investigated the impact of this development on the existing water distribution system in their report 'Vlakkeland Affordable Housing Development, Wellington: Capacity Analysis of the Bulk Water & Sewer Services dated 26 August 2014 (GLS report) included in Annexure G.

7.2 WATER DEMAND

The water demand for this development is summarised in Table 1: Potential future land developments in the GLS report. The annual average daily demand (AADD) is 1522 kl/d.

7.3 BULK SERVICES

The GLS report stated that the existing bulk services (Leliefontein and Strawberry King pipelines) have insufficient capacity to accommodate the total Vlakkeland development.

The following items were identified for upgrading:

Item	Description
DWW.B5	Booster pump station on the Leliefontein pipeline (increase capacity from 182 l/s to 347 l/s).
DWW.B23, DWW.B24 & DWW.B25	Replace the existing Strawberry King pipeline with a new 560 mm diameter HDPE pipe.
DWW1.47 & DWW1.27	250 mm diameter pipe

7.4 LINK SERVICES

The following link services were identified:

Item	Description
DWW1.24a, DWW1.24b & DWW1.24c	315 mm diameter pipe

7.5 INTERNAL RETICULATION

The internal reticulation network will consist primarily of HDPE PE100 PN12.5 (110 mm diameter to 200 mm diameter) pipes with individual erf connections. It is the intention to provide a basic network of larger diameter pipes to fulfil the fire requirements with smaller diameter pipes to supply the normal domestic demand.

Pipes will be installed according to SANS 1200 with a minimum cover of 800 mm above pipes not constructed in roadways and 1000 mm for pipes constructed in roadways.

The preliminary water reticulation layout is shown on drawing no 0894/W/001 included in Annexure H.

7.6 ESTIMATED COSTS OF PROPOSED WATER INFRASTRUCTURE

The following costs were estimated and exclude VAT, contingencies and professional fees.

Service	Description	Costs
Bulk	Items DWW.B5, DWW.B23, DWW.B24 & DWW.B25. See Table 2 in the GLS report.	R 57 945 336
Link	Items DWW1.26, DWW1.27 & DWW1.47. See Table 2 in the GLS report.	R 1 246 327
Internal	All pipes 200 mm diameter and smaller	R 10 444 716
TOTAL		**R 69 636 379**

The total costs for the proposed water infrastructure are R 69 636 379.

8 SEWERAGE

8.1 EXISTING SERVICES

There are currently no bulk sewerage services available in the vicinity of the proposed development with adequate capacity to accommodate the flows from Vlakkeland. However, this development lies adjacent the Paarl sewer network and options were investigated where and how this development can connect onto the existing system.

GLS Consulting investigated the impact of this development on the existing sewer network in their report 'Vlakkeland Affordable Housing Development, Wellington: Capacity Analysis of the Bulk Water & Sewer Services dated 26 August 2014 (GLS report) included in Annexure G.

8.2 EXPECTED SEWAGE FLOW

The expected peak day dry weather flow (PDDWF) for this development is summarised in Table 1: Potential future land developments in the GLS report. The PDDWF is 1111 kl/d.

8.3 BULK SERVICES

Due to the topography of the development all sewage will flow towards the existing Mbekweni pumping station to the west. The GLS report stated that a new bulk sewer from Jan van Riebeeck Road to the existing Mbekweni pump station is required. This pump station also needs to be upgraded to accommodate the increased flow as well as a new rising main to the Paarl WWTW. The bulk sewer is shown on drawing no. 0894/BS/001 included in Annexure I.

The following items were identified for upgrading:

Item	Description
DPS1.3	275 m x 675 mm diameter pipe to replace existing 450 mm diameter sewer.
DPS1.4	Upgrade capacity of existing Mbekweni PS from 100 l/s to 185 l/s
DPS1.5	1420 m x 500 mm diameter rising main to upgrade existing 300 mm diameter rising main.
DPS1.6	1025 m x 450 mm diameter bulk sewer
DPS1.7	505 m x 400 mm diameter bulk sewer

8.4 LINK SERVICES

The following link services were identified:

Item	Description
DPS1.10	144 m x 315 mm diameter pipe
DPS1.11b	484 m x 200 mm diameter pipe
DPS1.11c & DPS1.11d	656 m x 160 mm diameter pipe

8.5 INTERNAL RETICULATION

A new sewerage system consisting of a minimum diameter of 160 mm PVC-U class 34 sewer pipes will be constructed to service all the units. Individual erf connections will also be provided. The sewerage system will drain towards the west from where it will flow under gravity towards the Mbekweni pumping station.

Please refer to the proposed sewer network layout shown on drawing no 0894/FS/001 included in Annexure I.

8.6 WASTEWATER TREATMENT WORKS

From discussions with Ronald Brown of Drakenstein Municipality it appears that the Paarl WWTW has sufficient capacity, but this needs to be confirmed in writing by Drakenstein Municipality.

8.7 ESTIMATED COSTS OF PROPOSED SEWER INFRASTRUCTURE

The following costs were estimated and exclude VAT, contingencies and professional fees.

Service	Description	Costs
Bulk	DPS1.3, DPS1.4, DPS1.5, DPS1.6, DPS1.7 & DPS1.8. See Table 3 in the GLS report.	R 7 467 330
Link	DPS1.10, DPS1.11b, DPS1.11c & DPS1.11d. See Table 3 in the GLS report.	R 1 093 085
Internal	All pipes 200 mm diameter and smaller	R 11 259 224
TOTAL		**R 19 819 639**

The total costs for the proposed sewer infrastructure are R 19 819 639.

9 STORMWATER

A Stormwater Management Plan was completed (October 2013) and is attached in Annexure J.

The proposed stormwater layout is shown on drawing no. 0894/RD/001 included in Annexure D.

9.1 STORMWATER DESIGN PRINCIPLES

The internal stormwater network for the proposed development will be accommodated in a major and minor system.

The minor system is for the convenience of the public and requires that the run-off be removed rapidly from the erven by means of a system of catchpits and manholes with spacing not more than 80 meters between structures, and a network of underground pipes or culverts. This system is usually designed for a design storm occurrence of 2 years for residential land uses, and 5 years for high value general commercial and industrial areas.

The major system will accommodate storms of higher occurrence intervals and consists of natural watercourses, large conduits, roads, stormwater storage facilities and floodplains. These systems are usually “open” or above ground systems, and usually accept stormwater from the minor system.

9.2 MINOR SYSTEM

The pipe network per sub-catchment will drain towards detention facilities located to the west of Beets Street. This pipe network will have a minimum diameter of 375 mm and a maximum diameter of 1200 mm diameter with minimum velocities of 0,7 m/s to ensure the clean flow of the system and a maximum velocity of 2.5 m/s to ensure the efficiency of the network. This network of pipes will be designed to accommodate the smaller floods.

Detention ponds will collect stormwater and slowly release it at a controlled rate so that downstream areas are not flooded or eroded. The ponds will be dry structures that can serve as open areas or parks during dry seasons and detention facilities during wet periods.

9.3 MAJOR SYSTEM

The major system will be able to accommodate larger floods by means of the proposed street network as well as shaped areas to convey stormwater safely away from properties. Part of the major storm event will be accommodated in the pipe network.

Detention ponds will collect the generated run-off from the minor storm system. Run-off will be slowly released at a controlled rate, to ensure that downstream areas and stormwater conduits are not being placed under pressure to deal with vast quantities of uncontrolled run-off. Ponds will normally be designed to retain the difference between pre- and post- development calculated run-off for various recurrences. Available capacities and constraints of the downstream conduits and reticulation will also be accommodated within the design.

The detention ponds will be designed to accommodate either sports grounds or public open spaces during the dry season, but act as detention facility during the wetter seasons, when run-off generated requires to be retained.

A low flow channel will also be installed to accommodate smaller flows and therefor provide a longer drier ‘sport or open space’ area during the year.

9.4 GLOBAL WARMING/CLIMATE CHANGE

The likely effect of climate change on storm intensities was included in the run-off calculations. It was found that the point storm rainfall figures used in the Sinske report are 12-51 % higher than the University of Kwazulu Natal storm rainfall data which includes a 15 % increase for climate change. See report no. MC160/1 Revision 0 dated 27 August 2014, Addendum to the Stormwater Plan prepared by Lyners Consulting Engineers and Project Managers, prepared by Graeme McGill Consulting included in Annexure J.

It is therefore concluded that no further adjustment needs to be made to the Sinske report or to the Stormwater Management Plan to allow for climate change effect.

9.5 ESTIMATED COSTS OF PROPOSED STORMWATER INFRASTRUCTURE

The following costs were estimated and exclude VAT, contingencies and professional fees.

Service	**Description**	**Costs**
Bulk	Channels to be constructed, detention ponds, construction of culverts and all diameter pipes greater than 750 mm diameter	R 30 291 320
Link	All 525 mm to 750 mm diameter pipes and subsurface drainage	R 1 409 840
Internal	All 375 mm diameter and 450 mm diameter pipes, subsurface drainage	R 15 082 753
TOTAL		**R 46 783 913**

The total estimated costs for the proposed stormwater infrastructure are R 46 783 913.

10 ELECTRICITY SERVICES

See report 'Erf Vlakkeland Development Framework Electrical Services' prepared by Eimac included in Annexure K for a preliminary investigation into the electrical services. Also include in Annexure K is a drawing on primary MV Cabling.

11 SUMMARY OF ESTIMATED COSTS

The cost of the civil infrastructure for the proposed development are summarised in the table below.

Description of civil service	Costs
Bulk	R 156 391 360
Link	R 14 080 148
Internal	R 133 108 397
Development cost	**R 303 579 904**

The cost of the civil infrastructure for the proposed development is estimated at approximately R 303 579 904 (excluding VAT, including professional fees (2012) and 10 % contingencies). A detailed cost estimate is attached in Annexure L.

It is estimated that a total number of 3260 erven could be developed on the proposed site. Therefore the estimated cost to develop one erf is approximately R 93 000.

* *Please note that the cost estimate merely provides indicative costs and final costing can only be determined after a detailed geotechnical study and final layout is confirmed and approved. All costs are determined on current costs – September 2014 and no escalation has been allowed for.*

12 CONCLUSION

It seems feasible in terms of the availability of civil engineering services to develop the property, albeit that further bulk services must be constructed to meet the demand of the proposed development. These bulk services are in accordance with the Service Master Plan of the Local Authority.

We are available to discuss any queries at your earliest convenience.

Yours faithfully

Fred Laker Pr Tech Eng Pr CPM MSAICE
for LYNERS

ANNEXURE A

LOCALITY PLAN : DRAWING NO 0894/C/000

ANNEXURE B :

EARTHWORKS :
DRAWING NO 0894/EW/001

ANNEXURE C :

ITS (PTY) LTD : TRANSPORT IMPACT STUDY

ANNEXURE D :

ROADS & STORMWATER LAYOUT : DRAWING NO 0894/RD/001

ANNEXURE E :

GEOTECHNICAL INVESTIGATION

ANNEXURE F :

TYPICAL ROAD CROSS SECTIONS

ANNEXURE G :

VLAKKELAND AFFORDABLE HOUSING DEVELOPMENT, WELLINGTON: CAPACITY ANALYSIS OF THE BULK WATER & SEWER SERVICES

ANNEXURE H :

WATER RETICULATION LAYOUT : DRAWING NO 0894/W/001

ANNEXURE I :

BULK SEWER LAYOUT

SEWER NETWORK LAYOUT

ANNEXURE J :

STORMWATER MASTERPLAN

ADDENDUM TO THE STORMWATER PLAN PREPARED BY LYNERS CONSULTING ENGINEERS AND PROJECT MANAGERS

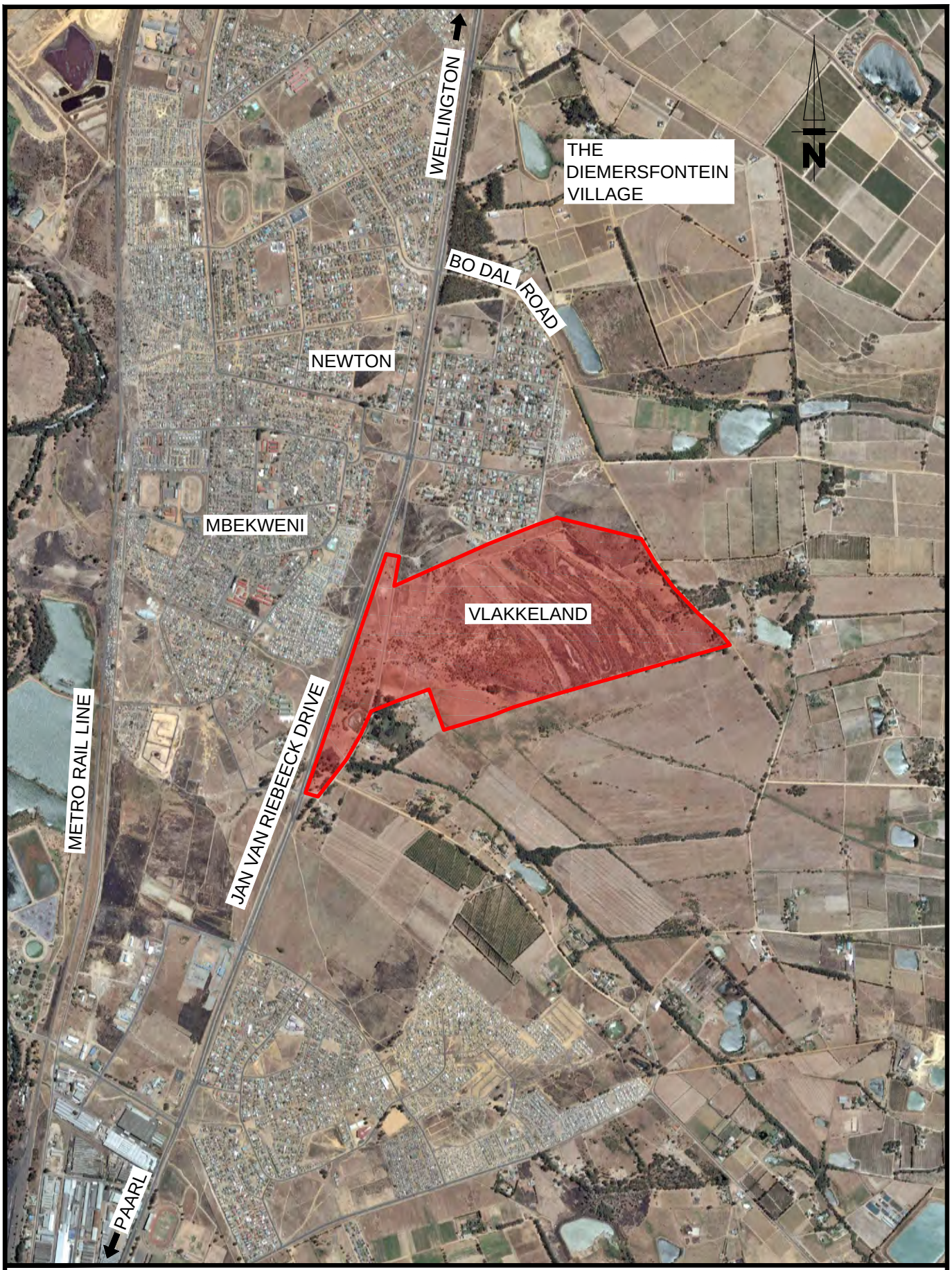
ANNEXURE K :

ERF VLAKKELAND DEVELOPMENT FRAMEWORK ELECTRICAL SERVICES

PROPOSED MEDIUM VOLTAGE LAYOUT
DRAWING NO: 2.552-S1-05

ANNEXURE L :

COST SUMMARY



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TITLE
VLAKKELAND, DRAKENSTEIN
LOCALITY PLAN

PROJECT No.	SCALE	DRAWING No.	REV
0894	N T S	0894/C/000	A

APPROVED :	DRAWN	DATE	CHECKED	DATE
	LO	2013-12-11	CW	2013-12-11

LAYERS:

EARTHWORKS (0894/EW/001)	: 2 9 25 60 100 210 217
ROADS/SW (0894/RD/001)	: 2 4 6 9 25 35 36 37 100-101 201 210 212 214 218-219
RD KERBS (0894/RD/002)	: 2 4 6 9 25 100 101 203 204 205 213 218 219
RD DIMS (0894/RD/003)	: 2 4 6 9 100 101 202 203 204 205 210 215
SEWERS (0894/FS/001)	: 2 4 6 9 20 27 100 101 201 206 210
SEW HC (0894/FS/002)	: 2 4 6 9 20 21 100 101 201 207 210
WATER (0894/W/001)	: 2 4 6 9 16 17 26 50 100 101 201 208 210
WAT HC (0894/W/002)	: 2 4 6 9 16 17 18 50 100 101 201 209 210
WAT DIMS (0894/W/003)	: 2 4 6 9 16 17 19 50 100 101 201 210 216
COMBINED (0894/CS/001)	: 2 4 6 9 16 17 20 25 100 101 201 210 211 218

SCALE BAR

0 50 100 150 200 m

Scale 1:2500

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CKD
A	ISSUED FOR PRELIMINARY DESIGN ONLY	SEP'14	DC	

REVISIONS

DESIGNED	DC
DRAWN	SB
CHECKED	

CONSULTING ENGINEERS

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APPROVED
CONSULTING ENGINEERS:
SIGNATURE: ____________________ DATE:

APPROVED
CLIENT REPRESENTATIVE:
SIGNATURE: ____________________ DATE:

CLIENT

DRAKENSTEIN
MUNISIPALITEIT • MUNICIPALITY • UMASIPALA WASE

PROJECT

PROPOSED DEVELOPMENT OF ERF 8378 PAARL
VLAKKELAND TOWNSHIP

TITLE

LAYOUT OF EARTHWORKS

SCALE (ON A0 DWG) 1:2000	SHEET 1 OF 1
CONTRACT No.	PROJECT No. 0894
DRAWING No. 0894/EW/001	REV A
DATE OF FIRST ISSUE:	

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Date: 21 August 2014
ITS Ref: 3194.1

Attention: Mr. Gerhard Nel

Dear Mr Nel,

TRANSPORT IMPACT OF COMBINED DEVELOPMENTS IN THE VICINITY OF THE VLAKKELAND DEVELOPMENT, IN PAARL

ITS Engineers compiled a Transport Impact Study (TIS) for the proposed Vlakkeland Development (ITS 3194) in Paarl, during August 2013. Although this is a comprehensive study, the Drakenstein Municipality requested an investigation for the combined transport impacts of various other developments planned in close proximity of the future Vlakkeland development. The purpose of this letter is to evaluate the transport related impacts of these combined developments and to identify the road upgrades required, over and above the road upgrades recommended for the Vlakkeland development.

The transport impacts of six developments were included in this investigation. These developments include Vlakkeland, Erf 553, Fynbos, Farm 1254 and Erf 16161 plus Erf 8398 Dal Josafat. All these developments will be mixed-use developments, however the majority will include residential land uses.

The locations of these developments relative to the Vlakkeland development are illustrated in **Figure 1** the Locality Plan. The expected vehicle trip generation for each of these developments are summarised below:

	A.M. Peak Hour			**P.M. Peak Hour**		
	In	**Out**	**Total**	**In**	**Out**	**Total**
1. Vlakkeland	992	1 021	2 013	792	564	1 356
2. Erf 553	211	258	469	266	213	479
3. Fynbos	18	34	52	25	27	52
4. Farm 1254	5	5	10	5	5	10
5. Erf 16161 Dal Josafat	797	1 243	2 040	1 202	947	2 149
6. Erf 8398 Dal Josafat	24	75	99	69	30	90
Total	**2 047**	**2 636**	**4 683**	**2 359**	**1 786**	**4 145**

The expected vehicle trips from the above developments are illustrated in **Figures 2.1 to 2.6**. It is expected that the combined vehicle trips will be less than the sum of these individual developments, due to the interaction between them. However, these trips were used in the analyses and should illustrate a more critical traffic impact scenario.

Only the total traffic conditions from these combined development trips were investigated as part of this letter, as illustrated in **Figure 3**. The intersection geometries used for these analyses are based on the upgraded intersection layouts as illustrated in **Figure 4**. This figure illustrates both the upgrades recommended as part of the Vlakkeland development as well as the additional upgrades required for the combined developments, over and above the upgrades recommended for the Vlakkeland development. These additional upgrades include the following:

Intersection 1: Jan Van Riebeeck Drive / Ring Road / Roggeland Road intersection:

- Construct a westbound left-turn lane.

Intersection 3: Jan Van Riebeeck Drive / Wamkelekile Road / Buitekant Street intersection:

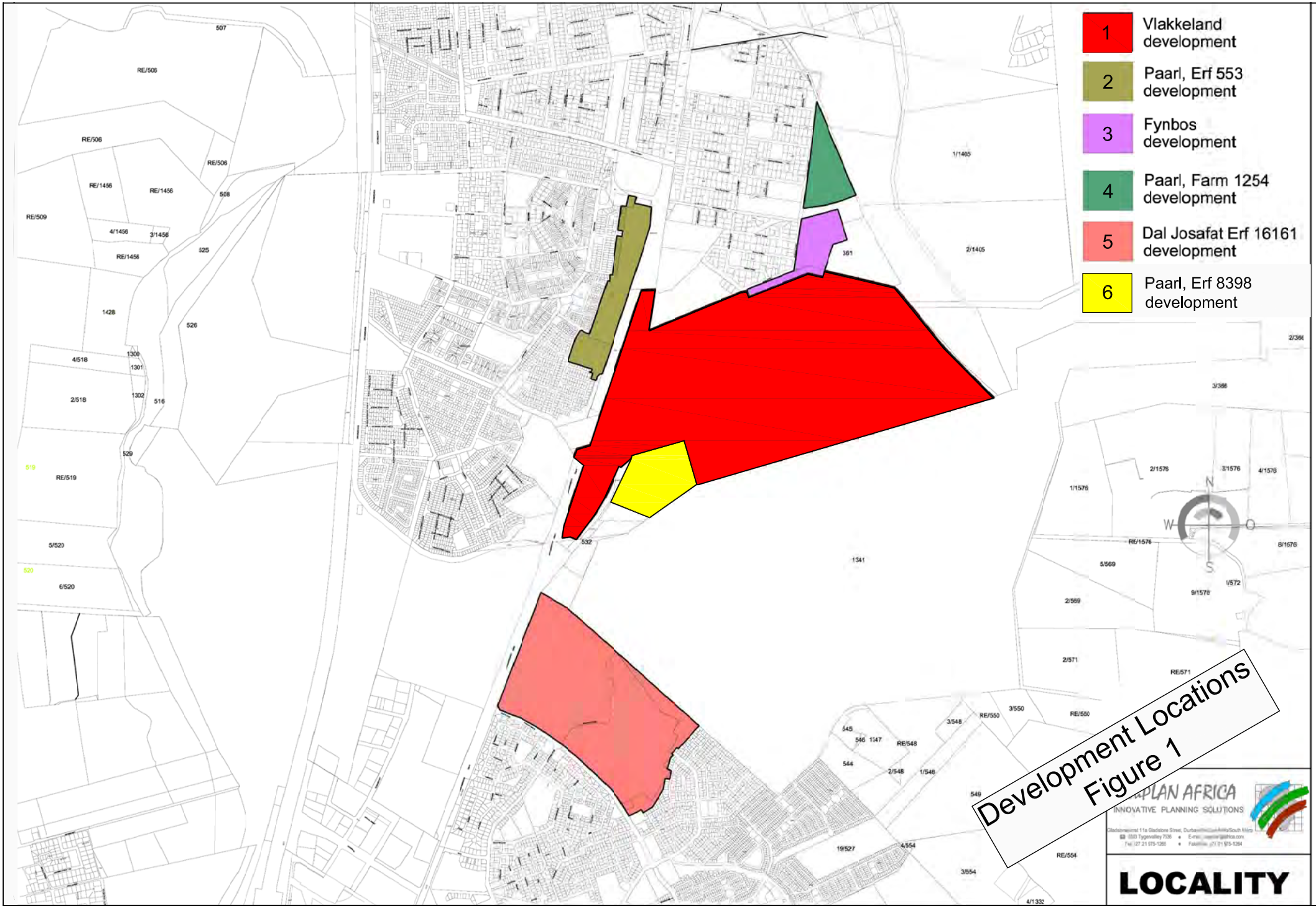
- Construct a westbound right-turn lane.

With the above upgrades in place all study intersections will continue to operate acceptably during the weekday a.m. and p.m. peak traffic periods of the 2018 Total Traffic conditions.

Annexure A

Figures

List of Figures



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TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
AM	211	258	469
PM	266	213	479

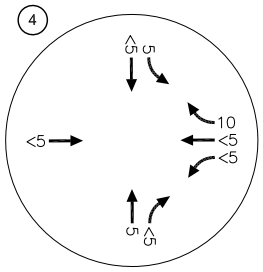
its Engineers

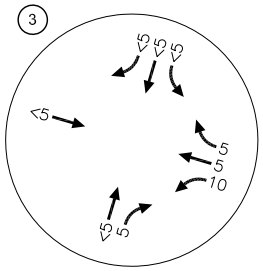
PROJECT:
VLAKKELAND RESIDENTIAL DEVELOPMENT
ERF 8378, PAARL

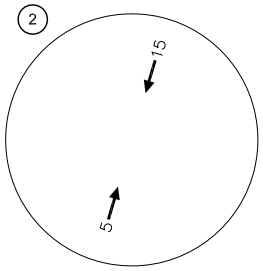
FIGURE:
EXPECTED DEVELOPMENT TRIPS
ERF 553 DEVELOPMENT, PAARL

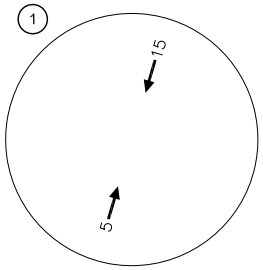
NUMBER:
2.1

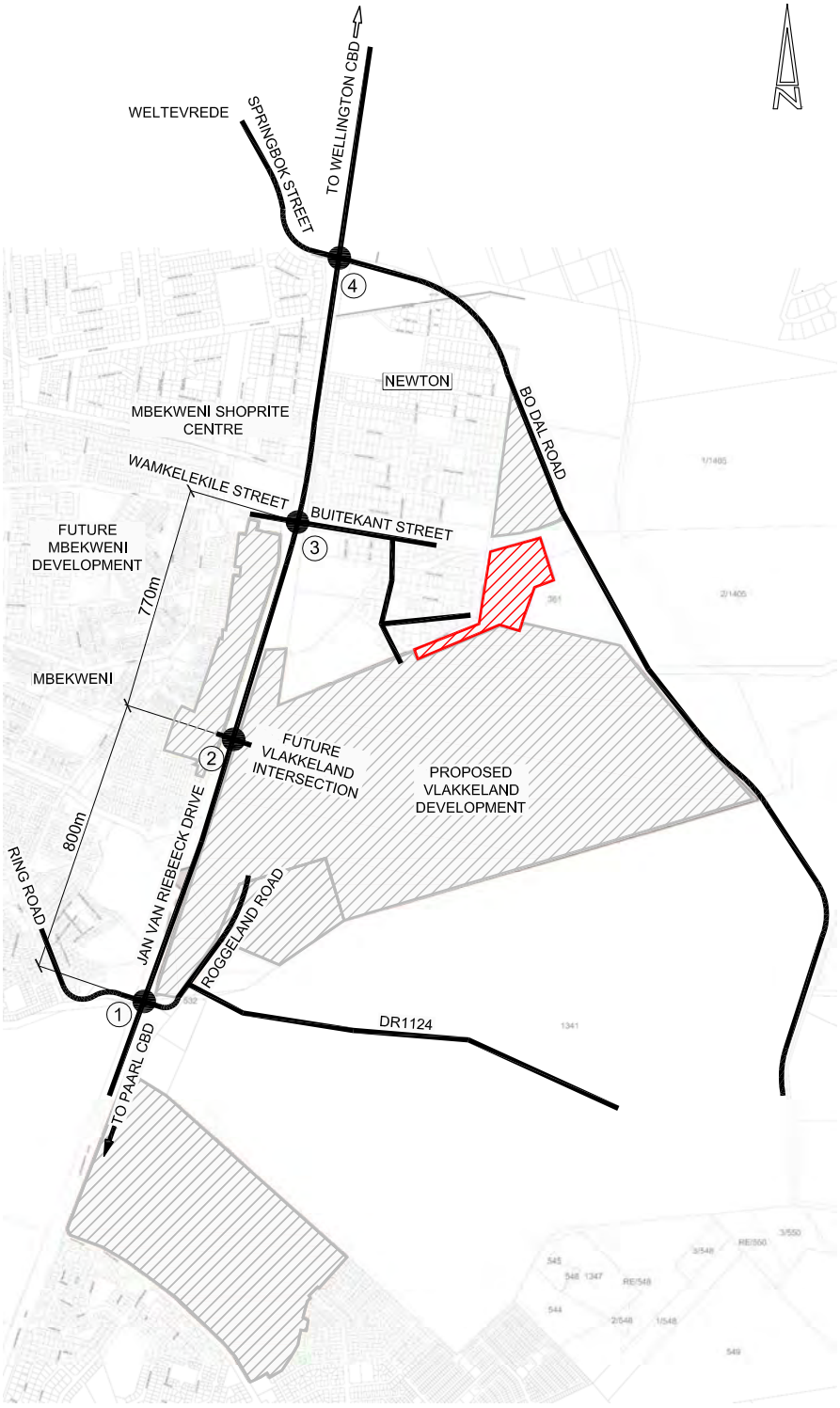
A.M. PEAK HOUR



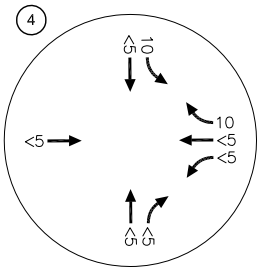


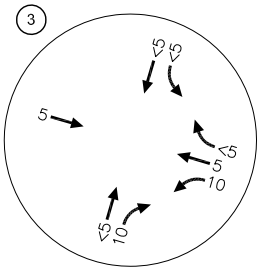


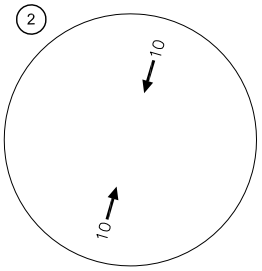


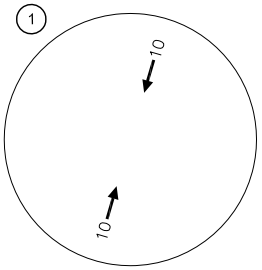


P.M. PEAK HOUR









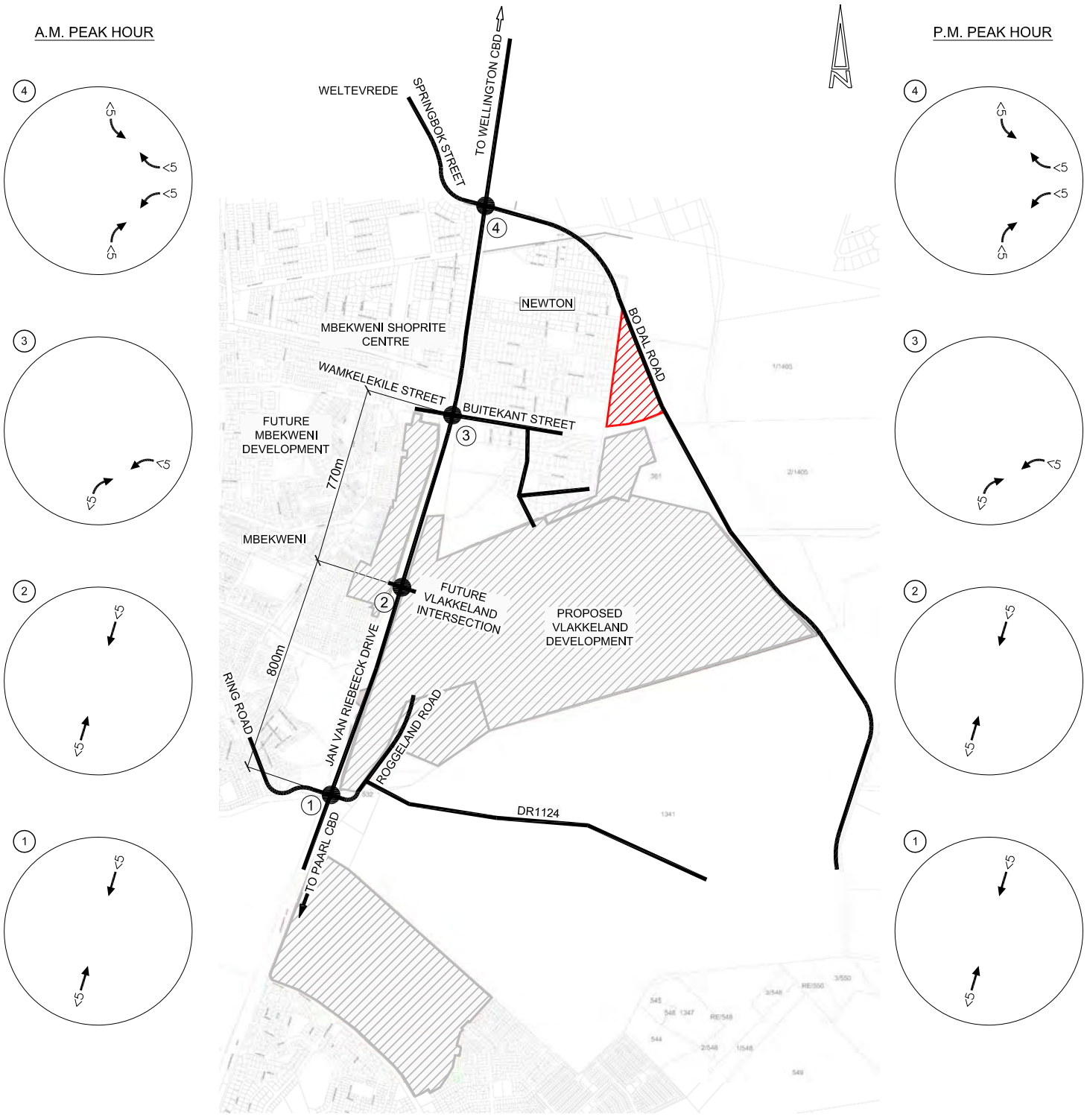
TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
AM	18	34	52
PM	25	27	52

its Engineers

PROJECT:
VLAKKELAND RESIDENTIAL DEVELOPMENT
ERF 8378, PAARL

FIGURE:
EXPECTED DEVELOPMENT TRIPS
FYNBOS DEVELOPMENT

NUMBER:
2.2



THE RESIDENTIAL COMPONENT OF THIS DEVELOPMENT WAS ALREADY BUILT AT THE TIME TRAFFIC COUNTS WAS DONE. THE BUSINESS AND CRECHE LAND USES STILL NEEDS TO BE CONSTRUCTED. HOWEVER MOST OF THESE TRIPS IS EXPECTED TO BE INTERNAL NEWTON TRIPS AND ONLY A SMALL PERCENTAGE WILL BE DISTRIBUTED ON THE LARGER ROAD NETWORK.

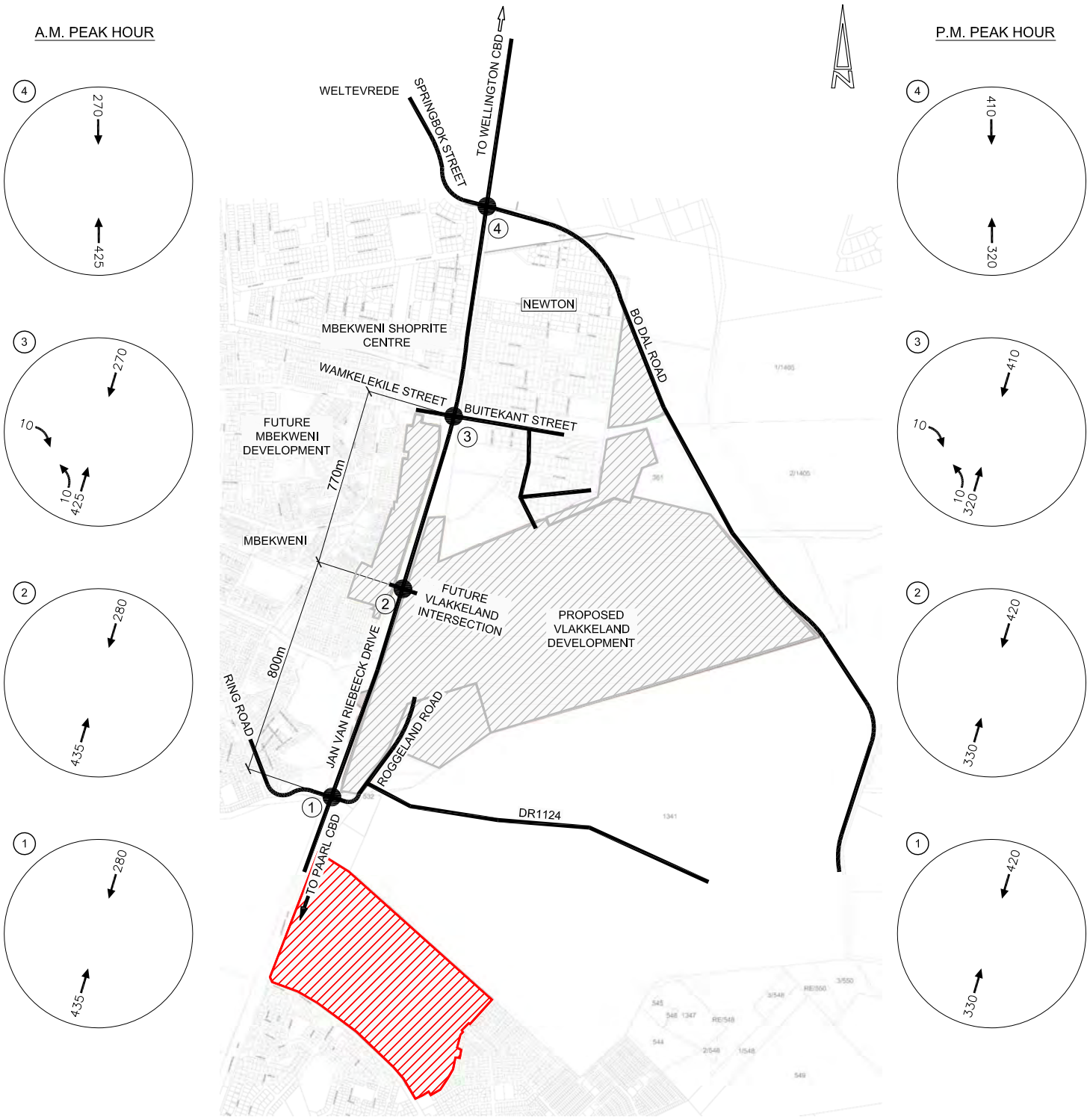
TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
AM	5	5	10
PM	5	5	10

its Engineers

PROJECT:
VLAKKELAND RESIDENTIAL DEVELOPMENT
ERF 8378, PAARL

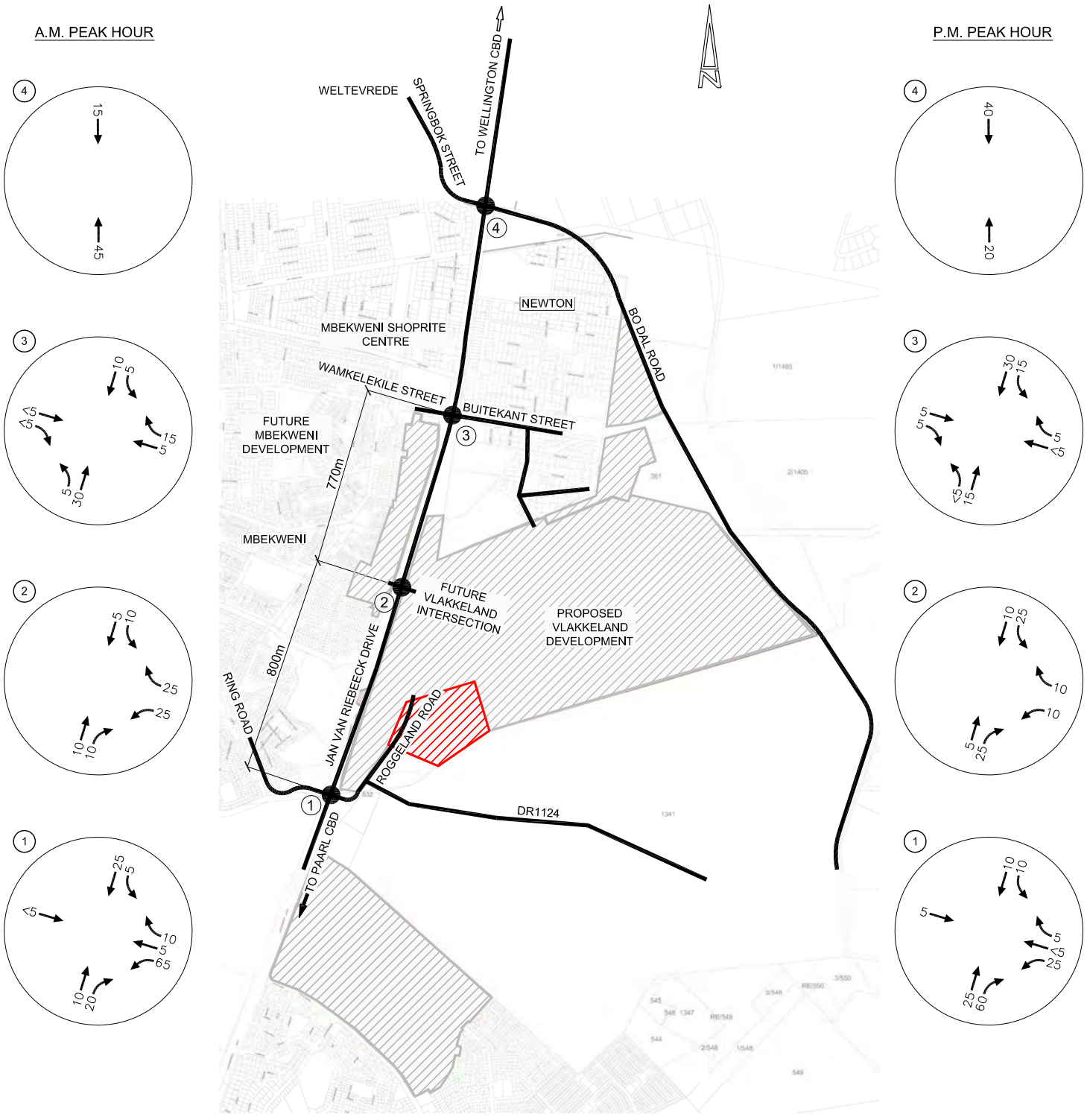
FIGURE:
EXPECTED DEVELOPMENT TRIPS
FARM 1254 (AURORA) DEVELOPMENT, PAARL

NUMBER:
2.3



TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
AM	797	1243	2040
PM	1202	947	2149

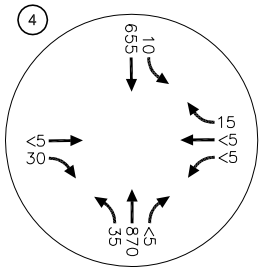
PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	EXPECTED DEVELOPMENT TRIPS ERF 16161 - DAL JOSAFAT DEVELOPMENT	2.4

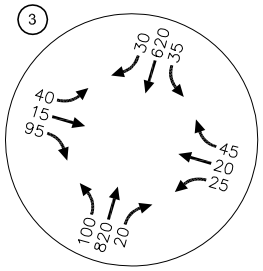


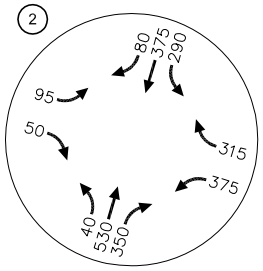
TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
AM	24	75	99
PM	69	30	99

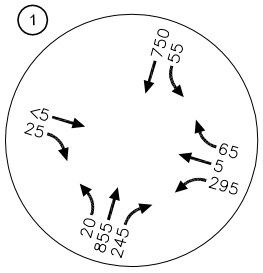
PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	EXPECTED DEVELOPMENT TRIPS ERF 8398 (ROYAL PALMS) - DAL JOSAFAT DEVELOPMENT	2.5

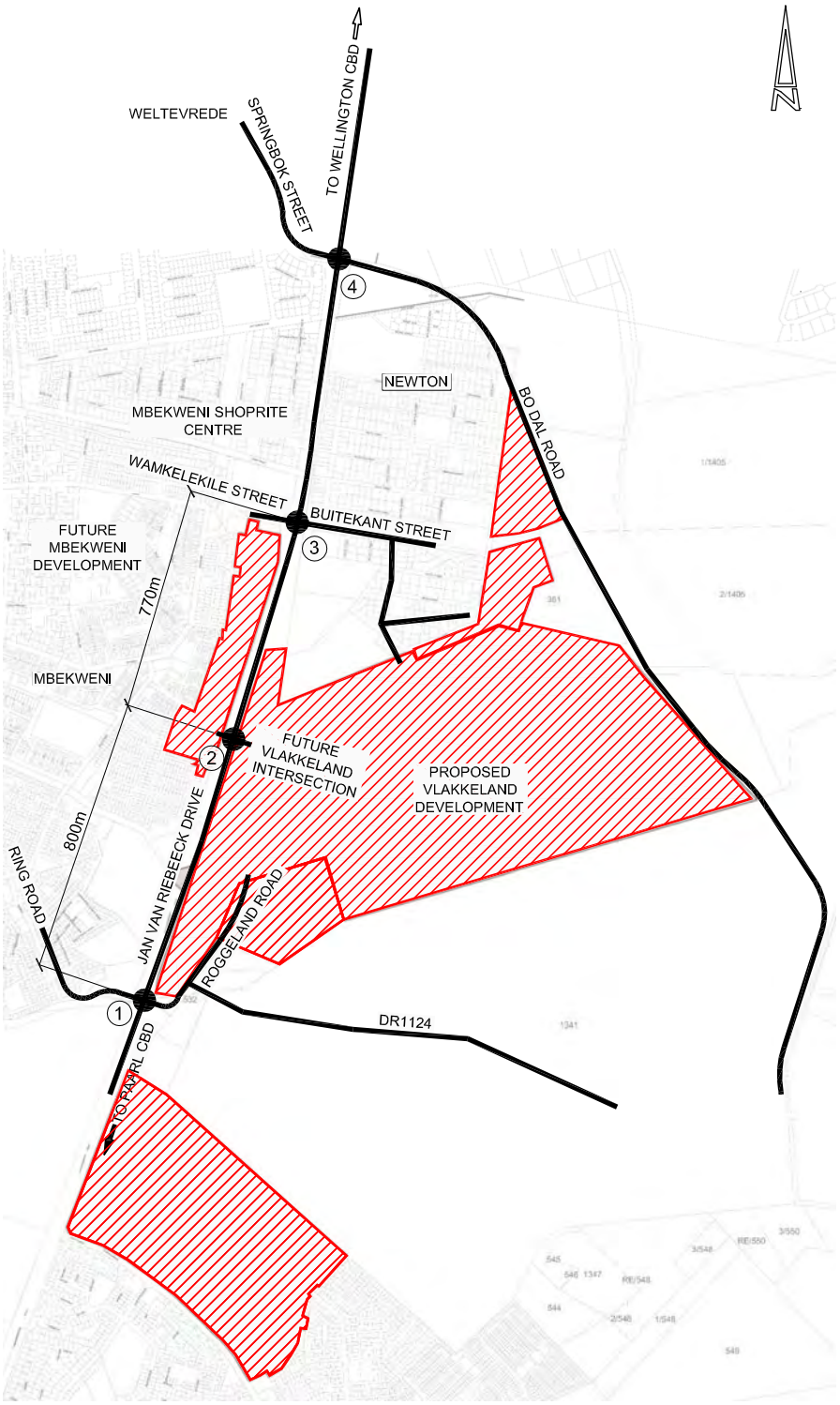
A.M. PEAK HOUR



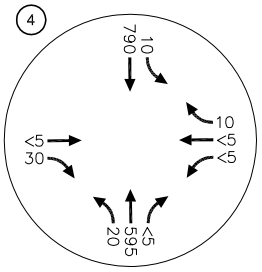


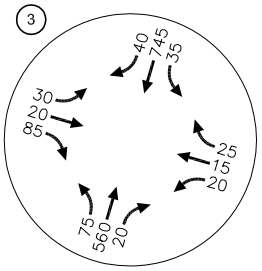


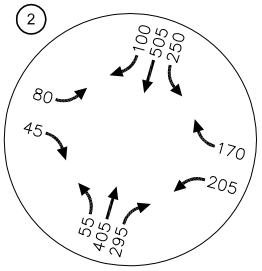


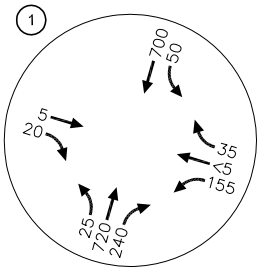


P.M. PEAK HOUR









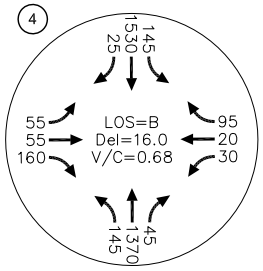
TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
AM	2047	2636	4683
PM	2359	1786	4145

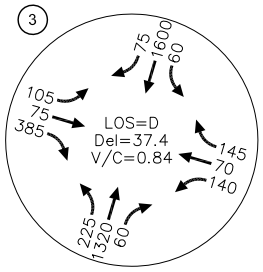
PROJECT:
VLAKKELAND RESIDENTIAL DEVELOPMENT
ERF 8378, PAARL

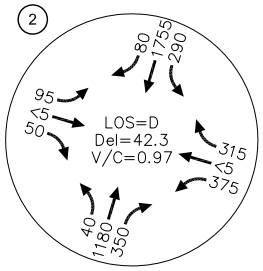
FIGURE:
EXPECTED DEVELOPMENT TRIPS
ALL PAARL / WELLINGTON FUTURE DEVELOPMENTS

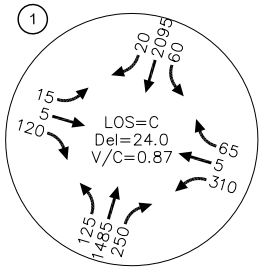
NUMBER:
2.6

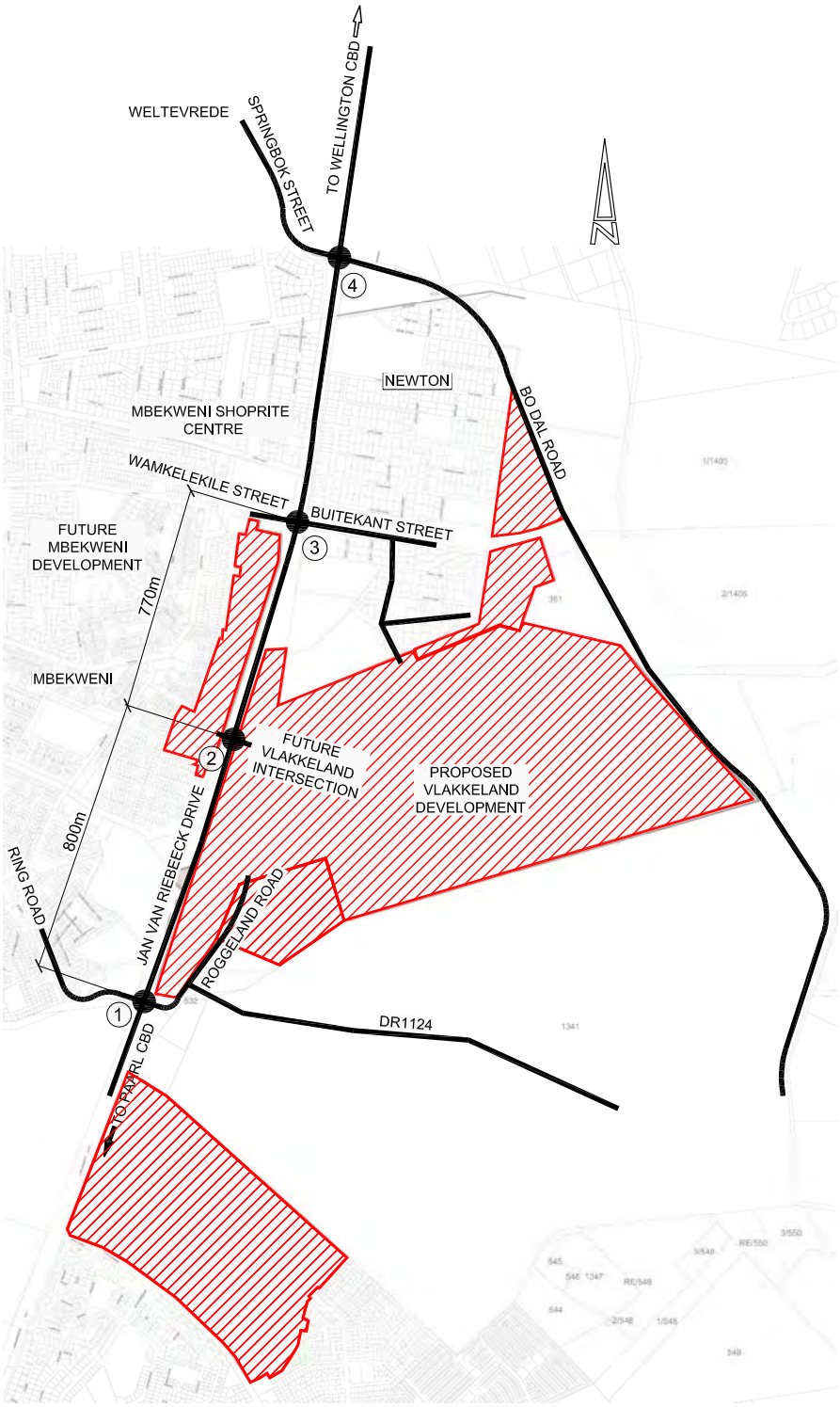
A.M. PEAK HOUR



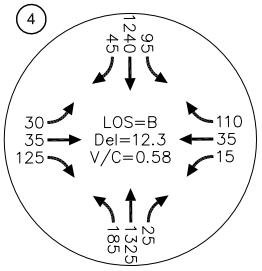


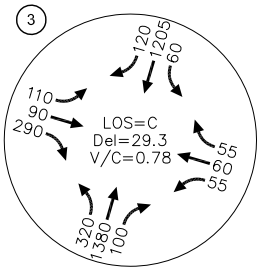


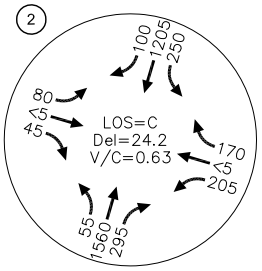


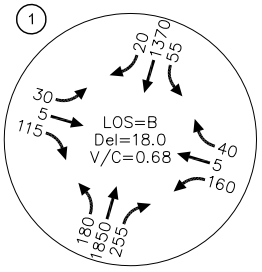


P.M. PEAK HOUR







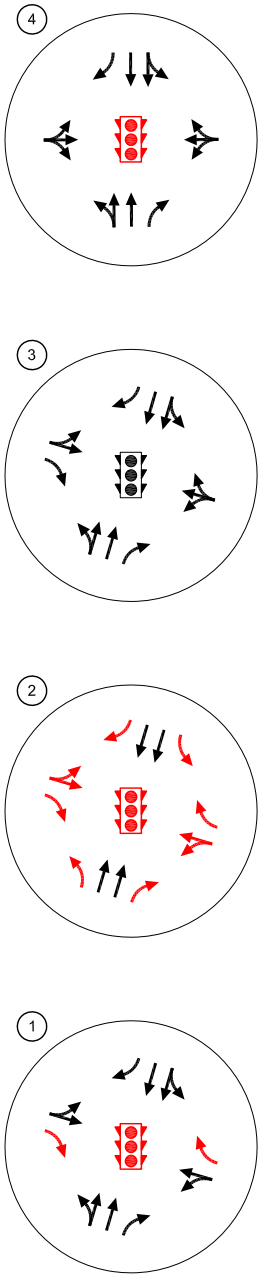


LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE (SIGNALISED) / CRITICAL MOVEMENT LEVEL OF SERVICE (UNSIGNALISED)
Del = INTERSECTION AVERAGE DELAY (SIGNALISED) / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

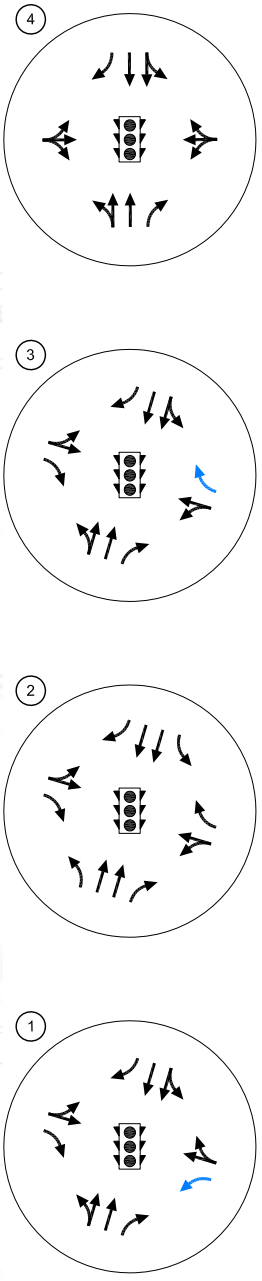
its Engineers

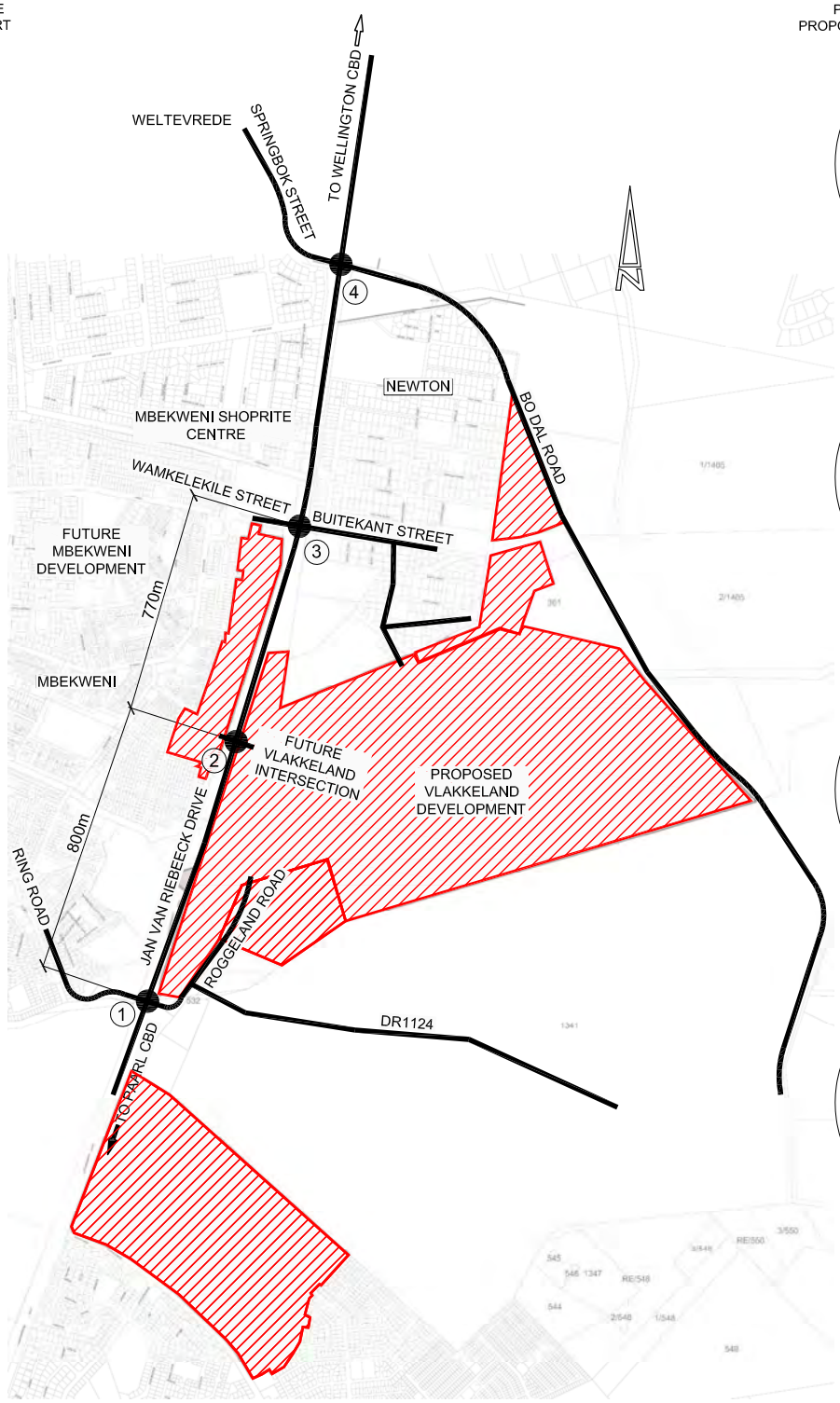
PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	2018 TOTAL TRAFFIC CONDITIONS *WITH FINAL UPGRADES*	3

UPGRADES PROPOSED AS PART OF THE VLAKKELAND TIA SECOND DRAFT REPORT



ADDITIONAL / CHANGED UPGRADES PROPOSED AS PART OF FULL PROPOSED DEVELOPMENT AREA TRIPS





LEGEND

- TRAFFIC SIGNAL
- STOP/ YIELD CONTROL
- TRAFFIC UPGRADES PROPOSED FOR VLAKKELAND DEVELOPMENT
- ADDITIONAL UPGRADES PROPOSED DUE TO ADDITIONAL DEVELOPMENTS

its Engineers

PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	PROPOSED UPGRADES - SCHEMATIC	4

Transport Impact Study

Vlakkeland Development

Paarl, Western Cape

August 2013

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Bank Terraces
Carl Cronje Drive
Tyger Waterfront
Bellville, 7550
Tel 021 914 6211
e-mail: mail@itse.co.za

Summary Sheet

Report Type	Transport Impact Study
Title	Vlakkeland Development
Location	Paarl, Western Cape
Client	Jubelie Projects
Ref. Number	ITS 3194.1
Project Team	Christoff Krogscheepers Hugo Engelbrecht Theodore Neels
Contact Number	Tel: 021 914 6211
Date	August 2013
Report Status	Second Draft
File Name:	G:\3194 Transport Impact Study for Vlakkeland, Paarl\12. Reports\3194_Vlakkeland_TransportStudy 2013_08_14.docx

This transport study was prepared in accordance with the South African National Department of Transport's 'Guidelines for Traffic Impact Studies' PR93/635 (1995) by a suitably qualified and registered professional traffic engineer. Details of any of the calculations on which the results in this report are based will be made available on request.

TABLE OF CONTENTS

Report - Summary Table

This transport impact study is reported in a summary table format instead of a lengthy report to assist review and interpretation of the results. This summary table contains all the relevant information that is contained in a report. It should be sufficient for review and interpretation of the expected traffic impacts as well as the comprehension of the required measures to mitigate the traffic impact. If any more detail is required please contact the authors.

Appendices

List of Figures

List of Tables

Transport Impact Study

Vlakkeland Development - Paarl, Western Cape

1. Background and Purpose	This study is an investigation of the expected transport related impacts of the Proposed Vlakkeland development on the surrounding road network. The purpose of the study is to identify constraints in the surrounding road network and to recommend appropriate mitigation measures that would support this planned development.
2. Locality	**Erf Number 8378, Paarl, Western Cape** The proposed development is located east of Jan van Riebeeck Drive (Provincial Main Road MR201), west of the Bo Dal Road (Provincial Divisional Road DR1119) and south of Rand Street in Newton, Paarl. Refer to Appendix A, **Figure 1** for the Locality Plan.
3. Existing/Proposed Land Use	**Existing Use: Vacant land with informal residential units** The proposed development area is mostly vacant land with a few informal houses along the edges of the property. **Proposed Future Land Use: Residential, Educational and Business** The development will consist of residential units, primary- and high schools as well as small business node. Although the development will generate many new vehicle trips to/from the surrounding road network, it is expected that a substantial proportion of these trips will be internal. The planned extent of these land uses are as follows: **Primary Schools** — **1 100 Pupils** **High Schools** — **1 200 Pupils** *Subsidy Housing* — *2 350 Units* *Gap Housing* — *704 Units* *Commercial Res Units* — *107 Units* **Total Residential Units** — **3 161 Units** **Businesses** — **5 342m^2 GLA** **Municipal Offices** — **4 313m^2 GLA** Refer to **Appendix A**, **Figure 2** for the Site Development Plan of the proposed development.
4. Existing Access	This site currently gains access from the Jan van Riebeeck Drive via the Roggeland Road / Ring Road intersection. This intersection is stop controlled on the Roggeland and Ring Road approaches and it is free flow along Jan van Riebeeck Drive.
5. Surrounding Roads	The major roads in the site vicinity are as follows: Jan van Riebeeck Drive (MR201): This is a typical Class 2 road with a 60km/h - 100km/h posted speed limit, two lanes per direction, a median island, shoulders on both sides and no sidewalks. MR201 is located to the west of the development.

5. Surrounding Roads (continued)	Bo Dal Road (DR1119): This is a typical Class 3 road with a 60km/h posted speed limit, one lane per direction, no shoulders and no sidewalks. DR1119 is located to the east of the development. Rand Street: Rand Street is a typical Class 5 residential street with no shoulders or sidewalks. Rand Street is located to the north of the development and it provides access between Vlakkeland and Newton. Roggeland Road/Ring Road: This is a typical Class 4 gravel road with one lane per direction and no shoulders or sidewalks. This road is located to the south of the development. The surrounding road network is show on the Locality Plan (**Figure 1** of **Appendix A**).
6. Analyses Hours	The proposed development will include residential units, schools, businesses and municipal offices. This type of developments typically generate vehicle trips in both the weekday a.m. and p.m. peak hours. The Vlakkeland development will also include "Places of worship". As these trips are mostly generated on Sundays, when the other development trips are at their lowest, it was not included in the analysis. Hence, the following peak hours were included in the analyses: • Weekday a.m. peak hour (Surveyed peak hour 07:00 – 08:00) • Weekday p.m. peak hour (Surveyed peak hour 16:45 – 17:45)
7. Scenarios Analysed	• 2013 Existing Traffic conditions (*Based on counted traffic volumes*) • 2018 Background Traffic conditions (*Existing counted traffic volumes plus a growth rate of 3% over five years plus the development trips from the Erf 557 Mbekweni development, as discussed with municipal officials*). • 2018 Total Traffic conditions (*Background Traffic volumes plus the expected Vlakkeland development trips*)
8. Study Intersections (existing control)	• Int. 1: Jan v Riebeeck / Ring Road / Roggeland (Stop Control) • Int. 2: Jan v Riebeeck / Mbekweni- / Vlakkeland Access (Future Int.) • Int. 3: Jan v Riebeeck / Buitekant Street (Traffic Signal) • Int. 4: Jan v Riebeeck / Bo Dal Road (Stop Control) Refer to **Figure 3** in **Appendix A** for the existing lane configuration and intersection controls.
9. 2013 Existing Traffic Conditions	The results of the existing intersection capacity analysis, based on existing traffic volumes and existing intersection geometry / control as indicated on **Figure 3 of Appendix A**, are as follows: *Jan van Riebeeck Drive / Roggeland Road / Ring Road intersection:* Operates at an acceptable Level-Of-Service (LOS C) during the a.m. peak hours and LOS D during the p.m. peak hours. *Jan van Riebeeck Drive / Buitekant Street intersection:* Operates at an acceptable LOS B during both peak hours.

9. 2013 Existing Traffic Conditions (continued)	*Jan van Riebeeck Drive / Bo Dal Road:* Operates at an acceptable LOS D during the a.m. peak hours and LOS C during the p.m. peak hours. Hence, all the study intersections are currently operating at acceptable Levels-of-Service and therefore NO road upgrades are proposed from an intersection capacity point-of-view. See **Figure 4** of **Appendix A** for the Existing Traffic conditions.
10. Approved Developments/ Latent Rights	The expected vehicle trips from the planned Erf 557 Mbekweni development were included in future traffic conditions analysis. This development should include the following land uses: Business zone 9 553 m^2 Community facility 3 171 m^2 Gap Housing 436 units Based on these land used and extent, it is expected that this Erf 557 Mbekweni development could generate approximately 480 total peak hour vehicle trips with a relatively balanced inbound and outbound trip distribution.
11. 2018 Background Traffic Conditions	The 2018 Background Traffic volumes were calculated by applying a 3 percent growth rate per annum to the existing / counted traffic volumes over a five year period plus the expected vehicle trips of Erf 557 Mbekweni development. Capacity analyses indicate that most study intersections will experience operational issues during the 2018 Background Traffic conditions, except the Jan van Riebeeck Drive / Buitekant Street intersection. Hence the following upgrades are proposed as part of the 2018 Background Traffic conditions. *Jan van Riebeeck Drive / Roggeland Road / Ring Road intersection*: Will operate at unacceptable LOS E during the a.m. peak hour and LOS F during the p.m. peak hour. • *Proposed Upgrade:* Install a Traffic Signal, if and when warranted. • *Operations after Mitigation:* Acceptable LOS A during both peak hours. *Jan van Riebeeck Drive / Mbekweni / Future Vlakkeland Access intersection:* Will operate at acceptable LOS D during the a.m. peak hour. However, it will operate an unacceptable LOS F during the p.m. peak hour. • *Proposed Upgrade:* Install a Traffic Signal, if and when warranted. Also provide turning lanes on the Jan van Riebeeck Road approaches. Based on the Road Access Guidelines (RAG), a dedicated northbound left-turn and southbound right-turn lanes are warranted. See **Figure 10** of **Appendix A**. • *Operations after Mitigation:* Acceptable LOS A during both peak hours. *Jan van Riebeeck Drive / Bo Dal Road*: Will operate at an unacceptable LOS F during both peak hours. • *Proposed Upgrade*: Install a Traffic Signal, if and when warranted. • *Operations after Upgrade:* Acceptable LOS B during both peak hours

12. Trip Generation Rates

The South African Trip Generation Rates (SATGR) manual from the Department of Transport were used to calculate the appropriate trip generation rates for the Vlakkeland development, as follows:

Land Use (Source Code)	a.m. rate/hour	p.m. rate/hour
Primary School (DoT)	*0.9 / Pupil*	*0.9 / Pupil*
High School (DoT)	*0.9 / Pupil*	*0.9 / Pupil*
Municipal Office (DOT)	*2.3 / 100m^2*	*2.3 / 100m^2*
Subsidy Housing (DOT)	*0.5 / 100m^2*	*0.5 / 100m^2*
Gap Housing (DOT)	*0.5 / 100m^2*	*0.5 / 100m^2*
Com Res Units (DOT)	*0.5 / 100m^2*	*0.5 / 100m^2*

The expected development trips were adjusted to include internal and public transport trips, as summarised in **Table 4** and **Table 5** of **Appendix B**.

13. Development Trips

It is expected that a significant percentage of the development trips will be internal. These are vehicle trips between the different land uses on the site. Hence, not all vehicle trips generated by this development were distributed to the external road network. The proposed Vlakkeland development is a low income residential area and a significant percentage of these trips would occur by means of public transport and/or walking.

Based on the expected trip generation rates as summarised above as well as the impact of internal and public transport trips, the Vlakkeland development is expected to generate the following peak hour trips on the external road network:

Peak Hour	In	Out	Total
Weekday a.m.	992	1 021	2 013
Weekday p.m.	792	564	1 356

These trips were used to determine the expected 2018 Total Traffic conditions. See **Figure 7** for the Expected Development Trips.

14. Trip Distribution

The following trip distribution was used:

- 30% of trips to/from the north along Jan van Riebeeck Drive towards Wellington
- 55% of trips to/from the south along Jan van Riebeeck Drive towards Paarl
- 5% trips to/from Newton via Rand Street
- 5% trips to/from Mbekweni via Wamkelekile Street
- 5% to/from Weltevrede, along Springbok Street

Refer to **Appendix A**, **Figure 7** for an illustration of the Trip Distribution.

15. Site Access/es

The main future access to the Vlakkeland development will be from a new intersection along Jan van Riebeeck Drive (MR201), approximately 770 meters south of Buitekant Street and 800 meters north of Roggeland Road/Ring Road. Other accesses to Jan van Riebeeck Drive will also be possible via Rand Street to the north and/or Roggeland Road/Ring Road to the south of the site.

15. Site Access/es (continued)	Three development accesses are proposed, as follows: • From the existing Jan van Riebeeck Drive / Buitekant Street intersection, through the north of the site via Rand Street and Newton Street. It is recommended that the vehicle demand through Rand Street and Newton Street be kept as low as possible and that no additional road improvements are done along this road section to discourage additional traffic. However, it is recommended that a pedestrian sidewalk of approximately 2 meters wide be provided from the commercial node within Vlakkeland, all the way along Rand Road and Newton Street to the Jan van Riebeeck Road / Buitekant Street intersection, to encourage pedestrian movement along this route. • A new traffic signal controlled intersection, located 770 meters south of Buitekant Street and 800 meters north of Roggeland Road/Ring Road. This is the main development access and most development trips should be encouraged to use this access to enter and exit the site. This intersection will also provide a future link into Mbekweni. This future signalised intersection will enable safer pedestrian crossing between Vlakkeland and Mbekweni. • From the existing Jan van Riebeeck Drive / Roggeland Road / Ring Road intersection, to the south of the site via Beets Street. Jan van Riebeeck Road is a Class 2 Road within a "Sub-Urban" Road Side Environment (RSE). The recommended intersection spacing in the Road Access Guidelines (RAG) is 800 meters for traffic signal controlled intersections, with the above criteria. The distance between the existing Buitekant Street and Roggeland Road intersections is 1 570 meters and there is also an open storm-water channel at the midpoint between these two intersections. Hence, the proposed new Vlakkeland Main Access have to be provided slightly north of the midpoint, at 770 meters south of the Buitekant Street intersection and 800 meters north of the Roggeland Road intersection. This intersection position was discussed and approved in principle with officials at the provincial government. See **Figure 12** for the proposed location of the future Van Riebeeck Drive/Vlakkeland Access intersection.
16. 2018 Traffic Conditions	The 2018 Total Traffic volumes were calculated by adding the Vlakkeland development trips to the 2018 Background traffic volumes. The analyses of the Total Traffic conditions are based on the upgrades recommended for the Background Traffic conditions. The following upgrades are proposed for the 2018 Total Traffic conditions. *Jan van Riebeeck Drive / Roggeland Road / Ring Road intersection*: Will operate over capacity during the a.m. peak hour with long side road queues. • *Proposed Upgrade:* Construct dedicated east- and westbound right-turn lanes and upgrade the traffic signal phases and settings to allow for turning phases from the side roads. • *Operations after Mitigation:* Acceptable LOS D during both peak hours.

<table>
<tr><td>16. 2018 Traffic Conditions (continued)</td><td><u>Jan van Riebeeck Drive / Mbekweni / Future Vlakkeland Access intersection:</u> The following geometry is recommended to ensure acceptable operations at this intersection as part of the proposed development.
<u>Proposed Upgrade:</u> Construct a southbound left-turn lane and northbound right-turn lane along Jan van Riebeeck Road. There turning lanes are warranted based on the Road Access Guidelines (RAG) requirements. See Figure 10 of Appendix A. Also provide a separate right-turn lane and a shared through and left-turn lane on the westbound approach.
<u>Operations after Mitigation:</u> Acceptable LOS D during the a.m. peak hour and LOS C during the p.m. peak hour.
The upgrades as discussed above should be funded by the developer, since it is directly related to the development.</td></tr>
<tr><td>17. Road Reserve widths and intersection spacing</td><td>There are two typical Class 3 roads within the Vlakkeland development. The one is the east-west road that enters the site from the new intersection on Jan van Riebeeck Drive and the other is the north-south Beets Street that connects Roggeland Road with this main east-west road. The recommended road reserve widths for these Class 3 roads are 25 meters. However, local widening, up to 30 meters wide, could be considered at major intersections to allow for turning lanes and other pedestrian and public transport facilities.

The road reserve widths for the Class 4 roads on-site should be minimum 16 meters, but it could range between 16 and 20 meters. The road reserve widths of the Class 5a roads should be minimum 13 meters wide. Any other Class 5 road reserve that is narrower than 10 meters should be negotiated with the municipal authorities, to illustrate that all municipal services can be accommodated within the specified road reserve space.

The road surface (“black top”) width for the Class 2 and 3 roads should be 7,4 meters wide and the Class 4 roads should be minimum 7.0 meters wide, but also preferably 7,4 meters to accommodate two-way traffic. The road width of the Class 5 roads could vary between 6 and 4 meters depending on the sub-class and function. This should be confirmed at the detail design stage with the municipal officials.

The intersections spacing for the internal roads, as specified in the Provincial Administration of the Western Cape Road Access Guidelines, should be as follows:<table><tr><th></th><th>Between Signals</th><th>Major Intersections</th><th>Driveway Access</th></tr><tr><td>Class 3</td><td>540 meters</td><td>180 meters</td><td>Not Recommended</td></tr><tr><td>Class 4</td><td>375 meters</td><td>120 meters</td><td>60 to 45 meters</td></tr></table></td></tr>
<tr><td>18. Pedestrians</td><td>Existing facilities: There are no existing pedestrian facilities along the Vlakkeland site frontages.

Proposed facilities: It is recommended that pedestrian signal heads and phases be provided at the future traffic signals proposed at the Jan van Riebeeck Drive / Vlakkeland Development Access intersection.</td></tr>
</table>

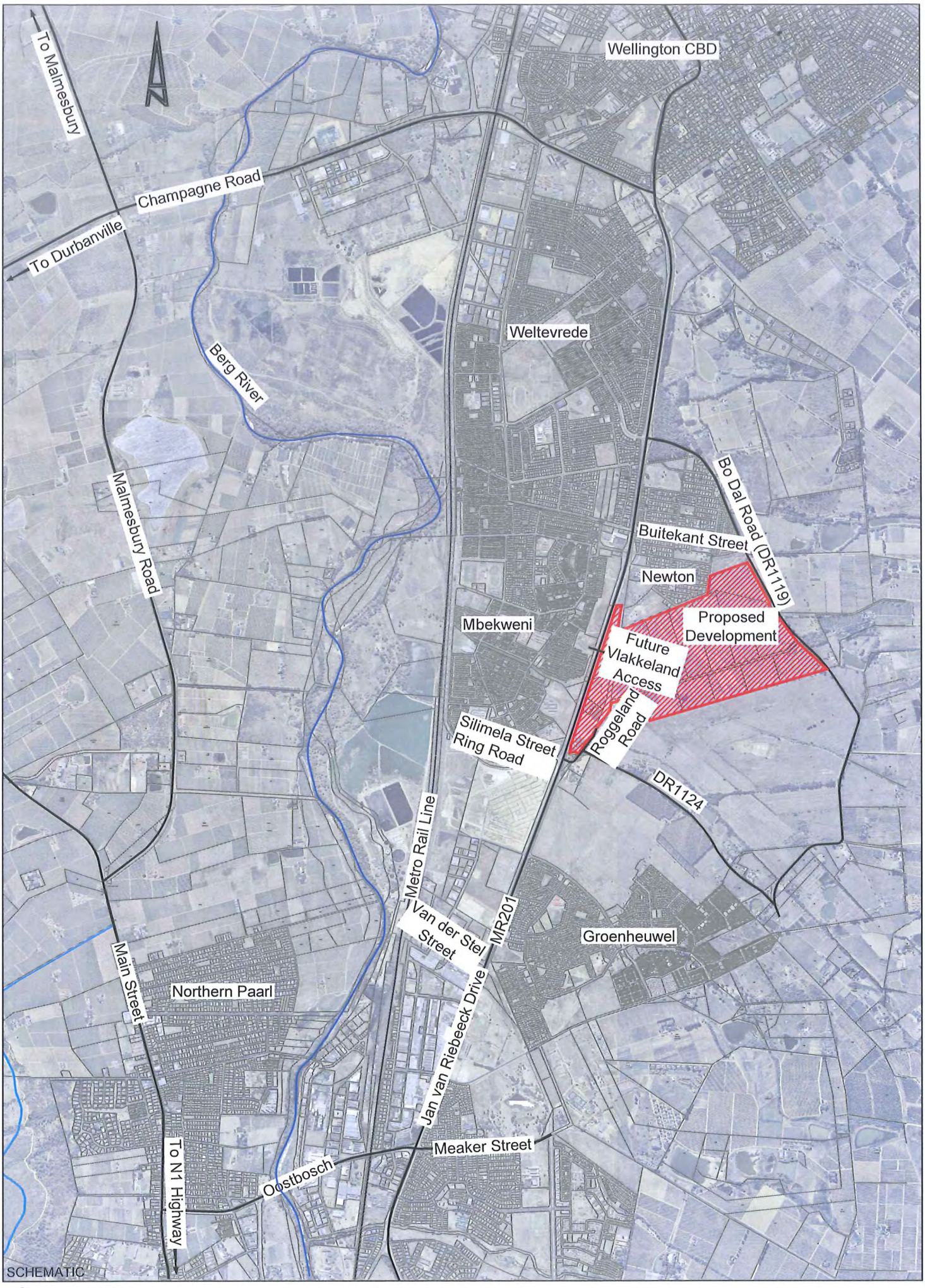
18. Pedestrians (continued)	From site observations it was also noted that pedestrians walk along Jan van Riebeeck Drive and cross Jan van Riebeeck Drive at various locations. Crossing Jan van Riebeeck Drive is unsafe due to excessive vehicle speeds. It is proposed that a fence be provided along the site frontage and that pedestrians should be encouraged to only cross at defined crossing locations. It is recommended that sidewalks of at least 2 meters wide be provided along the Class 3 and Class 4 roads on-site. It is also recommended that a pedestrian sidewalk of 2 meters wide be provided from the commercial node within Vlakkeland, all the way along Rand Road and Newton Street to the Jan van Riebeeck Road / Buitekant Street intersection, to encourage pedestrian movement along this route. Street lighting should be provided at the future Jan van Riebeeck Drive / Vlakkeland Development Access intersection. This should improve the visibility and safety of this intersection for pedestrians during early mornings and late afternoons.
19. Public Transport	**Existing facilities:** Currently there are no public transport facilities along Jan van Riebeeck Drive in the vicinity of the proposed development. **Proposed facilities:** It is recommended that bus / taxi embayment's be provided along Jan van Riebeeck Drive on the downstream side of the Vlakkeland Access intersection as illustrated in **Figure 12**, **Appendix A**. Bus / taxi embayment's should also be provided on-site along the typical Class 3 and Class 4 routes.
20. Parking	It is recommended that the parking rates for the various land uses within the Vlakkeland development should be as summarised below. These rates were obtained from the Road Access Guidelines (Table 8.8.2) and illustrate rates for a Public Transport Zone PT1 (high public transport dependency). **Land use** — **Rate** Residential Units — 1 bay / unit Business — 2 bays / 100m^2 This is a low income area and the expected parking demanded will be less than is typically required.
21. Conclusions and Recommendations	This report investigates the expected transport related impacts of the Vlakkeland development, located east of Jan van Riebeeck Drive, south of the residential area of Newton and west of Bo Dal Road, on Erf 8378, Paarl. This investigation resulted in the following recommendations: **Existing Traffic:** All study intersections are currently operating at acceptable Levels-Of-Service (LOS). Hence, no road upgrades are proposed from an intersection capacity point of view. **Background Traffic:** The following upgrades are proposed for this scenario: *Jan v. Riebeeck / Roggeland- / Ring Road intersection:* • Install a Traffic Signal, if and when warranted. *Jan v. Riebeeck / Mbekweni / (Future Vlakkeland access) intersection*: • Install a Traffic Signal, if/when warranted. Also construct northbound left-turn lane and southbound right-turn lane on Jan van Riebeeck Road plus provide an access road to Mbekweni.

21. Conclusions and Recommendations (Continued)	*Jan v. Riebeeck Drive / Bo Dal Road:* • Install a Traffic Signal, if and when warranted. **Development Trips:** The development is expected to generate 2 013 weekday a.m. peak hour trips (992/1 021, in-/outbound) and 1 356 p.m. peak hour trips (792/564, in-/outbound). **Access:** The main access to the Vlakkeland development will be from a new intersection along Jan van Riebeeck Drive (MR201), approximately 770 meters south of Buitekant Street and 800 meters north of Roggeland Road/Ring Road. Other accesses to Jan van Riebeeck Drive will also be possible via Rand Street to the north and/or Roggeland Road/Ring Road to the south of the site. **Total Traffic:** The following upgrades are proposed for this scenario: *Jan v. Riebeeck Drive / Roggeland Road / Ring Road intersection*: • Construct dedicated east- and westbound right-turn lanes and upgrade the traffic signal phases and settings to allow for turning phases from the side roads. *Jan v. Riebeeck Drive / Mbekweni / Vlakkeland Access intersection:* • Construct a southbound left-turn lane and northbound right-turn lane along Jan van Riebeeck Road. Provide a separate right-turn lane and a shared through and left-turn lane on the westbound / development approach and upgrade the traffic signal phases and settings. The upgrades should be funded by the developer, since it is directly related to the development. **Pedestrians:** Provide pedestrian signal heads and phases at the traffic signals of the Jan van Riebeeck Drive / Vlakkeland Development Access intersection. Also provide a fence along the site boundary / frontage to force pedestrians to only cross at intersections. Provide a sidewalk of at least 2 meters wide along all major roads on-site and provide a pedestrian sidewalk between the commercial node within Vlakkeland, all the way along Rand Road and Newton Street to the Jan van Riebeeck Road / Buitekant Street intersection. Street lighting should be provided at the future Jan van Riebeeck Drive / Vlakkeland Development Access intersection. This should improve the visibility and safety of this intersection for pedestrians during early mornings and late afternoons. **Public Transport**: It is recommended that bus / taxi embayment's be provided along Jan van Riebeeck Drive on the downstream side of the new Vlakkeland Access intersection. Bus / taxi embayment's should also be provided on-site along all the major routes on-site. **Parking**: To be provided at the rates recommended in Section 20 of this report. See **Figure 12, Appendix A** for a conceptual layout of the proposed upgrades along Jan van Riebeeck Road at the planned Vlakkeland development access. The impact of this development will be sufficiently mitigated if the upgrades recommended in this report are in place.

Appendix A

Figures

List of Figures



PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	LOCALITY PLAN	1

CIVIC NODE		
LAND USES	AREA (m²)	GLA (m²)
Business	6 181.2	4 945.0
Municipal	8 626.7	4 313.4
Parking	2 444.0	0.0
TOTAL	17 251.9	9 258.3
LOCAL BUSINESS NODE		
LAND USES	AREA (m²)	GLA (m²)
Business	793.8	396.9
TOTAL	793.8	396.9
TOTAL (both nodes)		9 655.2

RECEIVED 2013-07-18

PHASE 1 - PHASE 6						
ZONING	LAND USE	CONSENT USE	NR ERVEN	NR UNITS	AREA (ha)	%
Residential 1	Town houses Residential units	-	2350	2350	27,43	27,00
Residential 2	General residential building	-	3	704	4,65	4,58
Residential 2	Town houses	Businesses	137	137	1,29	1,27
Institutional 1	Place of instruction	-	15		14,33	14,11
Institutional 2	Place of worship	-	7		0,73	0,72
Business	Business General residential building / Hotel	Community facilities Place of instruction	15		1,38	1,36
Open space 1	Open spaces	-	14		11,07	10,89
Open space 1	Open spaces	Nature area	1		10,11	9,96
Open space 2	Sportsgrounds	Recreation facilities	3		6,98	6,87
Parking	Parking	-	2		0,24	0,24
Street	Street	-	15		23,37	23,00
TOTAL			2562	3191	101,58	100

RECEIVED 2013-07-25

NEWTON

Jan van Riebeeck Drive

PHASE 1
PHASE 2
PHASE 3
PHASE 4
PHASE 5
PHASE 6
PHASE 7

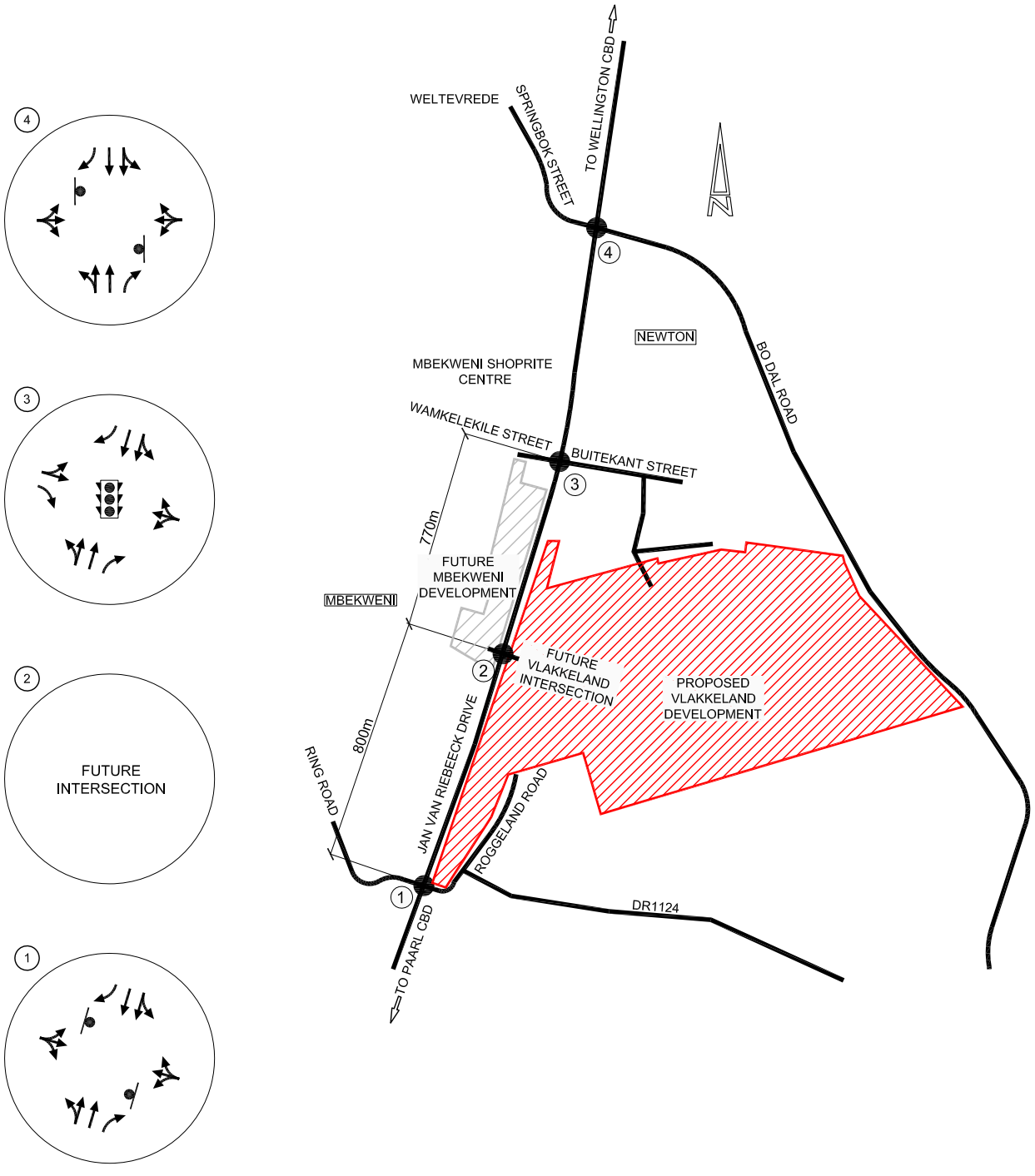
HOUSING TYPE
- Subsidy Housing
- GAP Housing
- TRA
- CRU'S

SECOND DRAFT

FIGURE 2
SITE DEVELOPMENT PLAN
RECEIVED 2013-07-18

NuPLAN AFRICA

NOTA: ALLE AFSTANDE BY BENADERING EN ONDERHEWIG AAN OPMETING
NOTE: ALL MEASUREMENTS APPROXIMATE AND SUBJECT TO SURVEYING



LEGEND

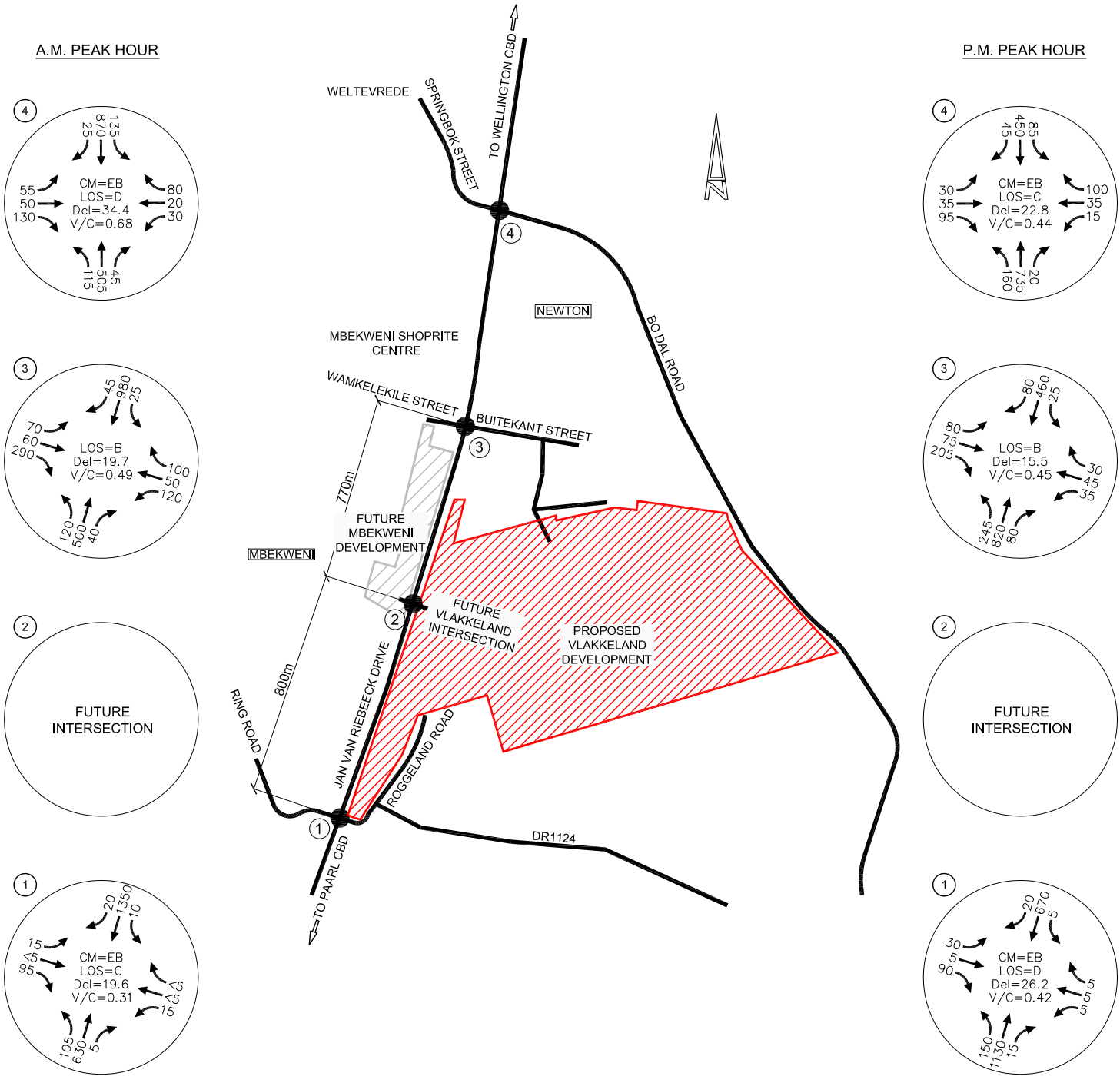
- ROUNDABOUT
- TRAFFIC SIGNAL
- STOP / YIELD CONTROL

its Engineers

PROJECT:
VLAKKELAND RESIDENTIAL DEVELOPMENT
ERF 8378, PAARL

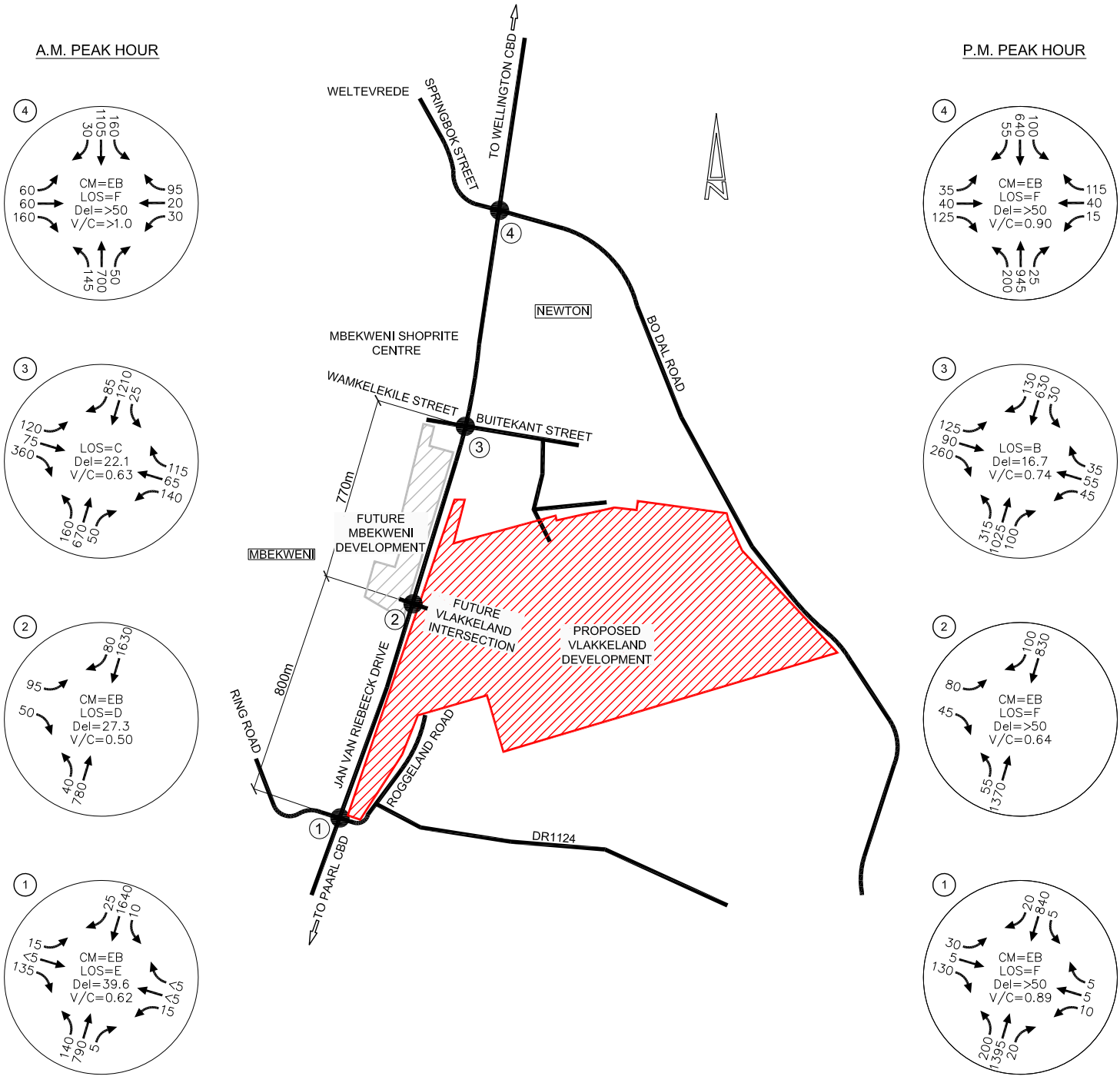
FIGURE:
EXISTING 2013 LANE CONFIGURATION

NUMBER:
3



LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE (SIGNALISED) / CRITICAL MOVEMENT LEVEL OF SERVICE (UNSIGNALISED)
Del = INTERSECTION AVERAGE DELAY (SIGNALISED) / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	EXISTING 2013 TRAFFIC CONDITIONS	4



LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
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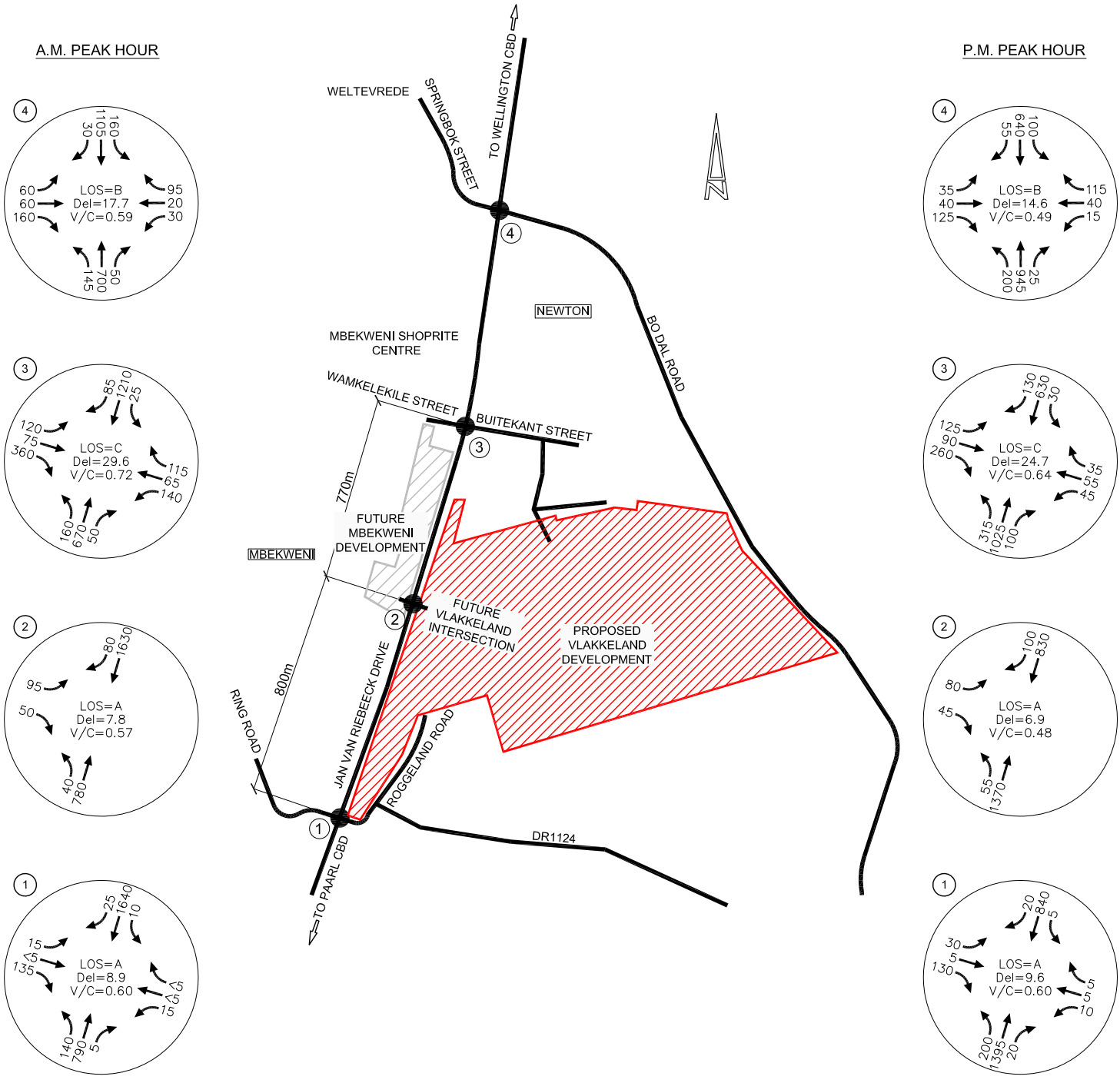
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	2018 BACKGROUND TRAFFIC CONDITIONS *EXISTING LANE CONFIGURATION*	5



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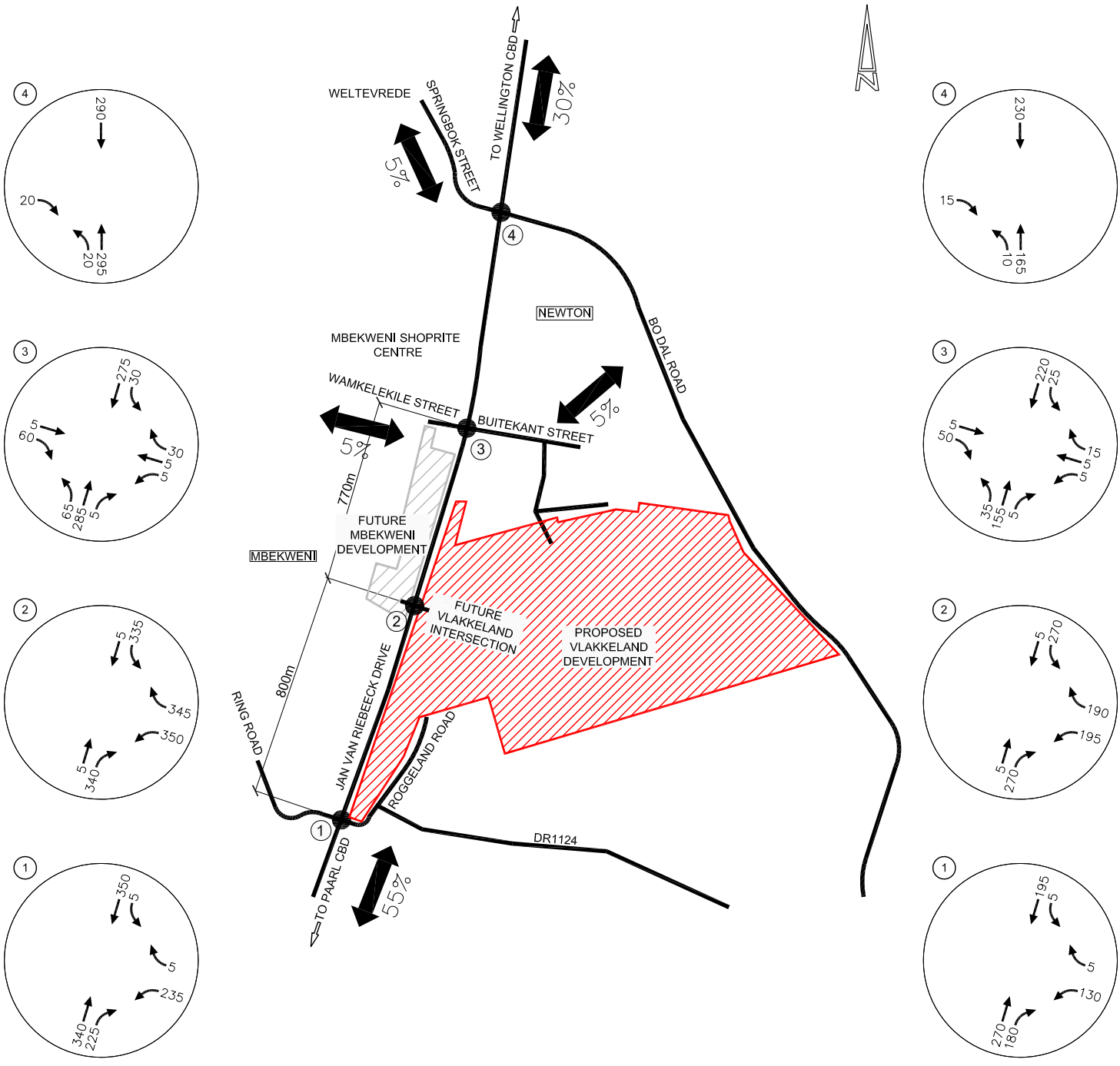
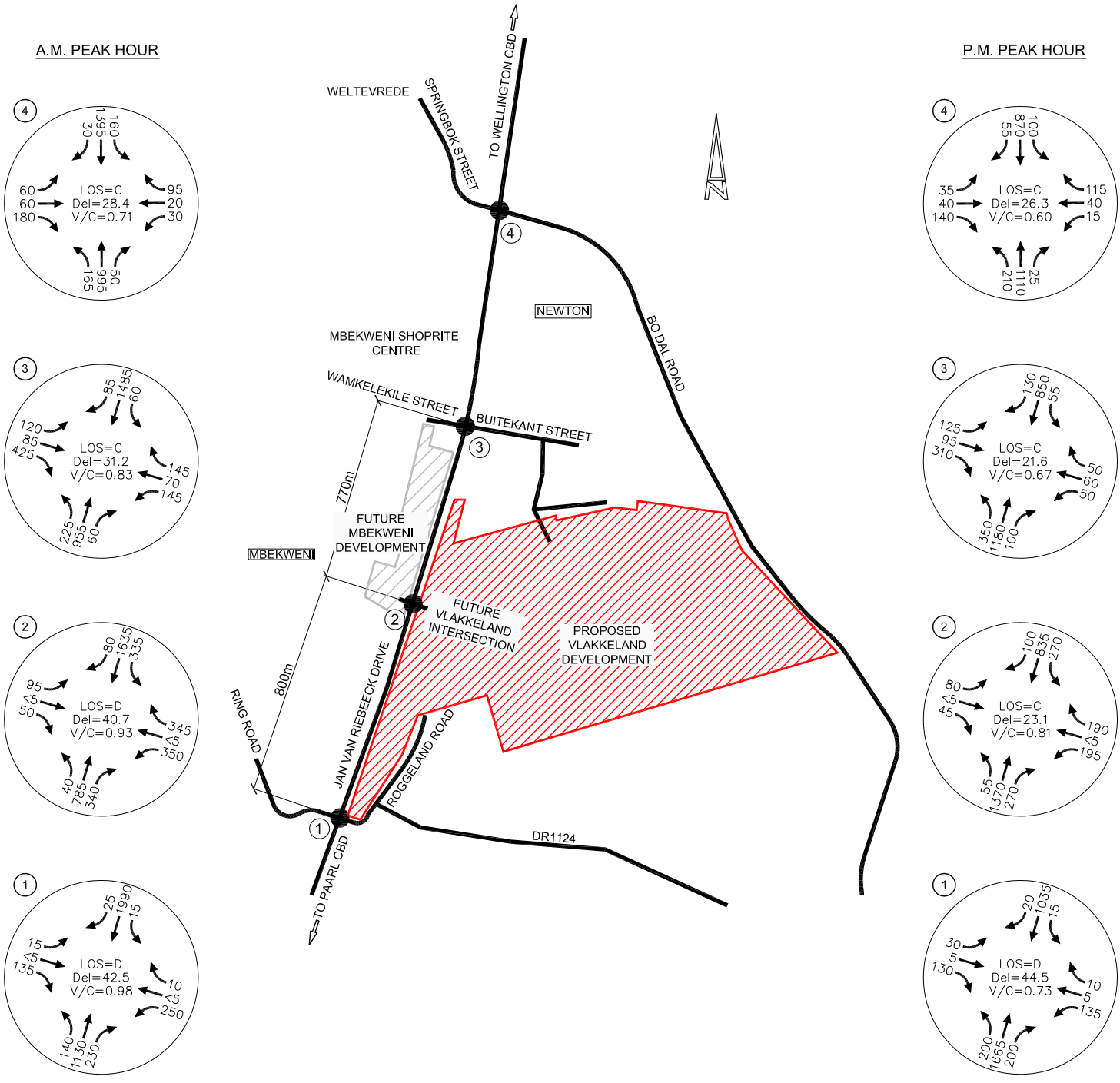
Del = INTERSECTION AVERAGE DELAY (SIGNALISED) / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	2018 BACKGROUND TRAFFIC CONDITIONS *WITH UPGRADES*	6



TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
AM	992	1021	2013
PM	792	564	1356

PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	TRIP DISTRIBUTION AND DEVELOPMENT TRIPS	7

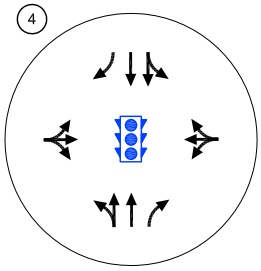


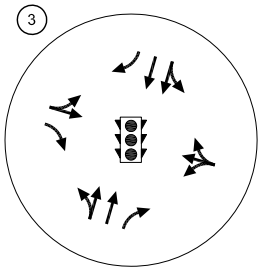
LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE (SIGNALISED) / CRITICAL MOVEMENT LEVEL OF SERVICE (UNSIGNALISED)
Del = INTERSECTION AVERAGE DELAY (SIGNALISED) / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

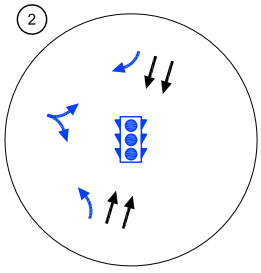
its Engineers

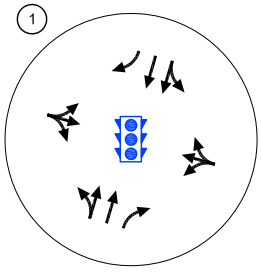
PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	2018 TOTAL TRAFFIC CONDITIONS *WITH FINAL UPGRADES*	8

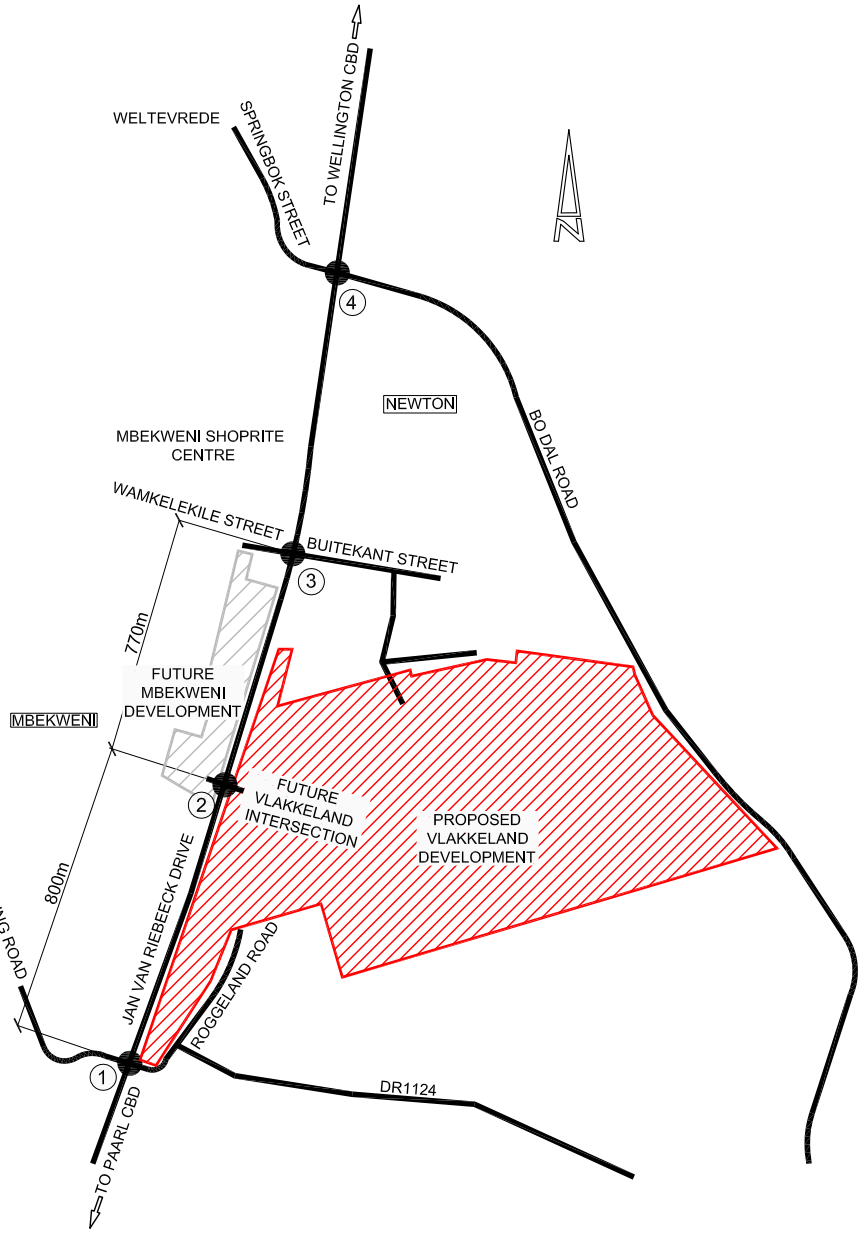
2018 BACKGROUND TRAFFIC LANE CONFIGURATION



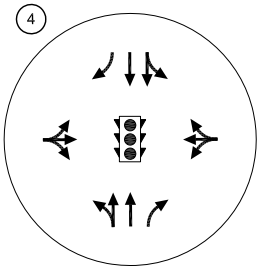


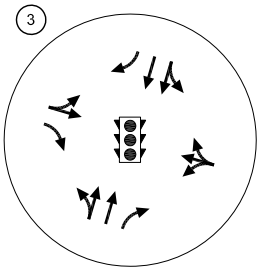


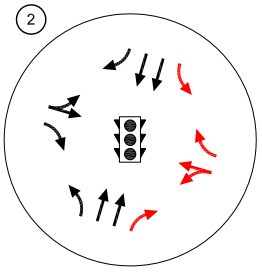


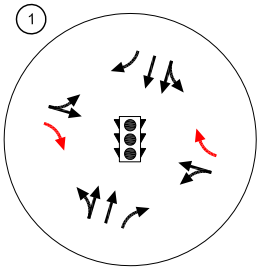


2018 TOTAL TRAFFIC LANE CONFIGURATION





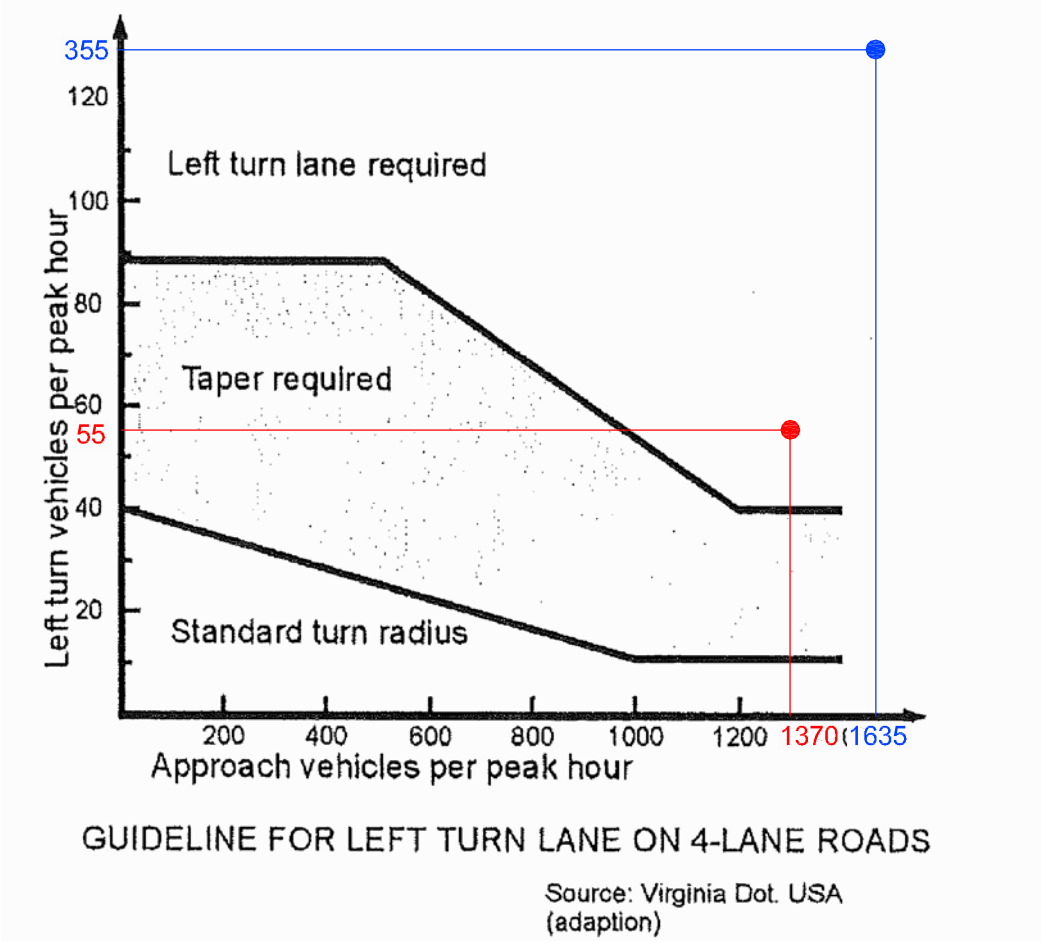




LEGEND

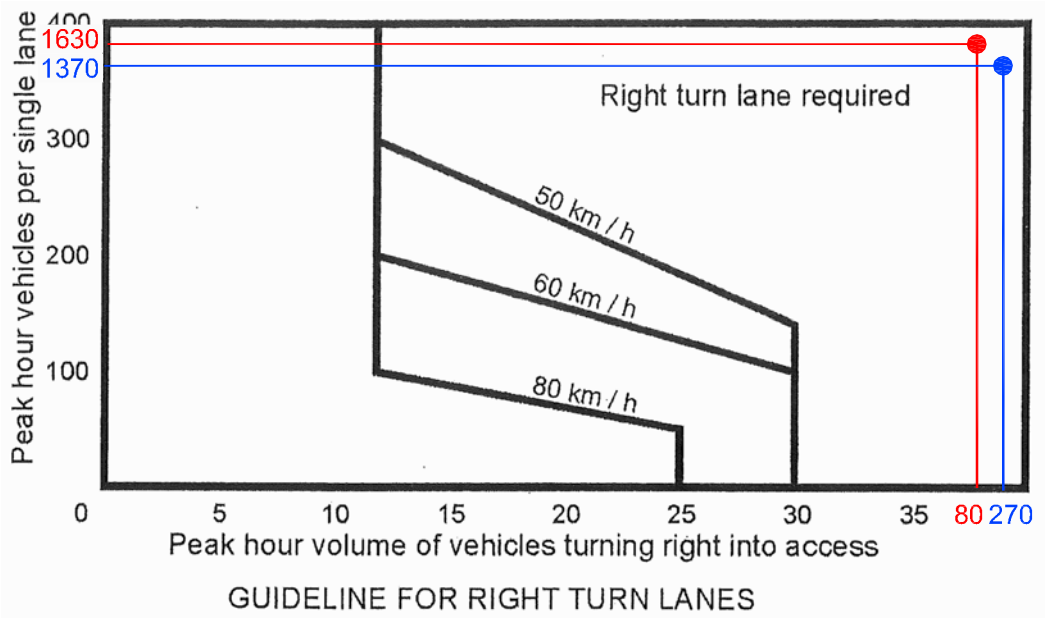
- TRAFFIC SIGNAL
- STOP/ YIELD CONTROL
- 2018 BACKGROUND TRAFFIC CONDITIONS UPGRADES
- 2018 TOTAL TRAFFIC CONDITIONS UPGRADES

PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	PROPOSED UPGRADES - SCHEMATIC	9



GUIDELINE FOR LEFT TURN LANE ON 4-LANE ROADS

Source: Virginia Dot. USA (adaption)



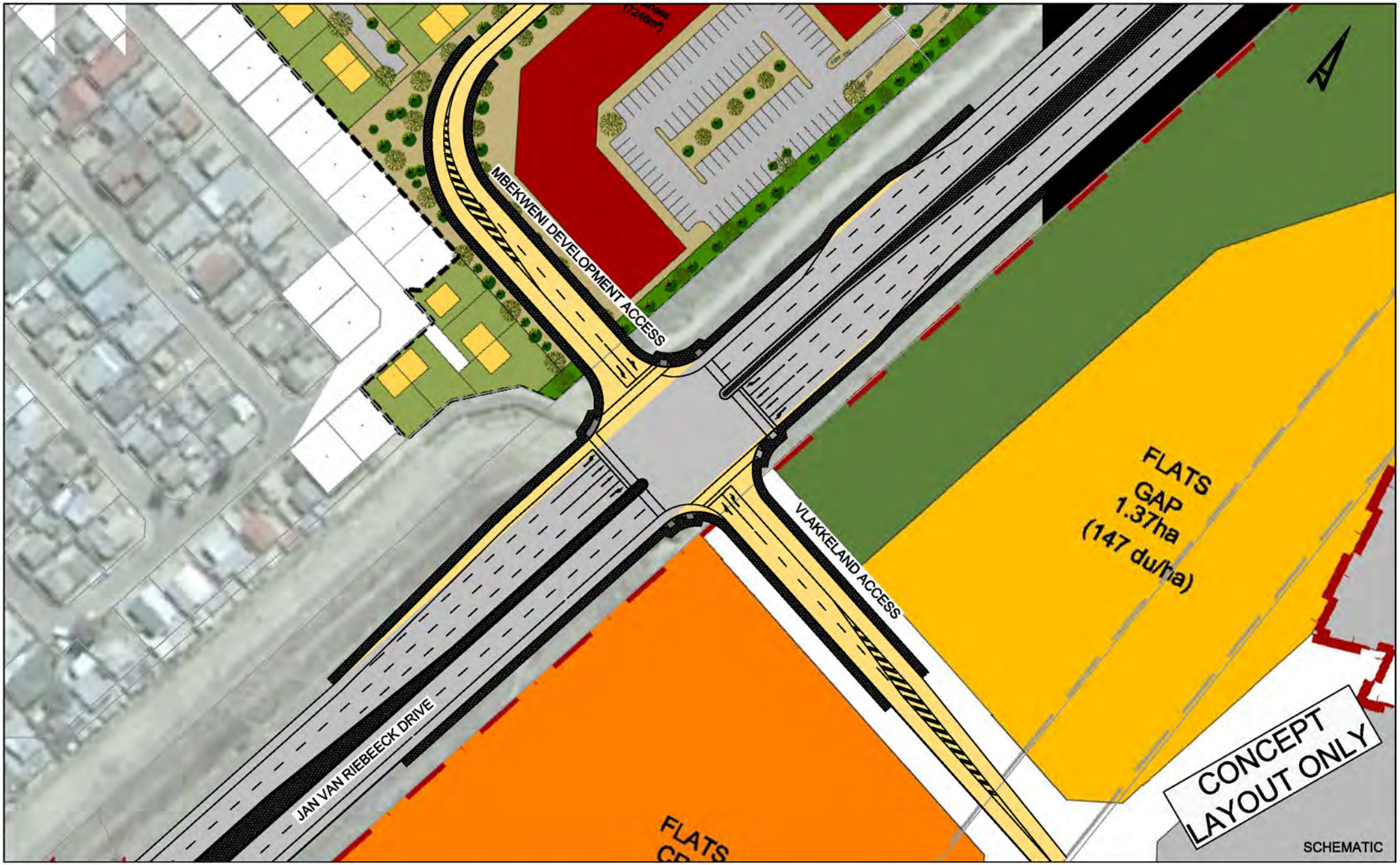
GUIDELINE FOR RIGHT TURN LANES

THE RED INDICATES THAT LEFT AND RIGHT TURN LANES ARE WARRANTED IN THE BACKGROUND CONDITIONS INTO ERF557, MBEKWENI.

THE BLUE INDICATES THAT LEFT AND RIGHT TURN LANES ARE WARRANTED IN THE TOTAL TRAFFIC CONDITIONS INTO THE PROPOSED VLAKKELAND RESIDENTIAL DEVELOPMENT.

SCHEMATIC

PROJECT:	FIGURE:	NUMBER:
Vlakkeland Residential Development ERF 8378, Paarl	Access Spacings	11



PROJECT:	FIGURE:	NUMBER:
VLAKKELAND RESIDENTIAL DEVELOPMENT ERF 8378, PAARL	PROPOSED VLAKKELAND / JAN VAN RIEBEECK DRIVE INTERSECTION	12

Appendix B

Tables

List of Tables

Table 1: Existing 2013 Traffic and 2018 Background Traffic

No	Intersection	2013 Existing Peak Hour						2018 Background Peak Hours (2013 Geometry)					
		AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
		LOS	Delay	V/C	LOS	Delay	v/c	LOS	Delay	V/C	LOS	Delay	V/C
1	Van Riebeeck DR/ Roggeland RD	C	19.6	0.31	D	26.2	0.42	E	39.6	0.62	F	>50	0.89
2	Van Riebeeck DR/ Future Access	Future Intersection			Future Intersection			D	27.3	0.50	F	>50	0.64
3	Van Riebeeck DR/ Wamkelekile RD	B	19.7	0.49	B	15.5	0.45	C	22.1	0.63	B	16.7	0.74
4	Van Riebeeck DR/ Springbok St	C	34.4	0.68	C	22.8	0.44	F	>50	>1.0	F	>50	0.90

Table 2: 2018 Background Traffic and 2018 Background Traffic (with upgrades).

No	Intersection	2018 Background Peak Hours (2013 Geometry)						2018 Background Peak hour (2018 Background Geometry)					
		AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
		LOS	Delay	V/C	LOS	Delay	v/c	LOS	Delay	V/C	LOS	Delay	V/C
1	Van Riebeeck DR/ Roggeland RD	E	39.6	0.62	F	>50	0.89	A	8.9	0.60	A	9.6	0.60
2	Van Riebeeck DR/ Future Access	D	27.3	0.50	F	>50	0.64	A	7.8	0.57	A	6.9	0.48
3	Van Riebeeck DR/ Wamkelekile RD	C	22.1	0.63	B	16.7	0.74	C	29.6	0.72	C	24.7	0.64
4	Van Riebeeck DR/ Springbok St	F	>50	>1.0	F	>50	0.90	B	17.7	0.59	B	14.6	0.49

Table 3: 2018 Background Traffic (with upgrades) and 2018 Total Traffic (with upgrades)

No	Intersection	2018 Background Peak hour (2018 Background Geometry)						2018 Total Traffic Conditions (2018 Total Traffic Geometry)					
		PM Peak Hour			SAT Peak Hour			PM Peak Hour			SAT Peak Hour		
		LOS	Delay	V/C	LOS	Delay	v/c	LOS	Delay	V/C	LOS	Delay	V/C
1	Van Riebeeck DR/ Roggeland RD	A	8.9	0.60	A	9.6	0.60	D	42.5	0.98	D	44.5	0.73
2	Van Riebeeck DR/ Future Access	A	7.8	0.57	A	6.9	0.48	D	40.7	0.93	C	23.1	0.81
3	Van Riebeeck DR/ Wamkelekile RD	C	29.6	0.72	C	24.7	0.64	C	31.2	0.83	C	21.6	0.67
4	Van Riebeeck DR/ Springbok St	B	17.7	0.59	B	14.6	0.49	C	28.4	0.71	C	26.3	0.60

Table 4: Proposed Trip Generation Rates

Land Use	Units	Source	Size/ Volume	Weekday AM Peak Hour				
				Rate	In	Out	Internal	Public Transport
Primary School	$100m^2$	DOT	1 100	0.90	54%	46%	50%	10%
High School	$100m^2$	DOT	1 200	0.90	71%	29%	50%	10%
Subsidy Housing	Units	DOT210	2 350	0.50	35%	65%	25%	15%
Gap Housing	Units	DOT210	704	0.50	35%	65%	25%	15%
Community residential Units	Units	DOT210	137	0.50	35%	65%	25%	15%
Business	$100m^2$	ITE815	5 342	5.25	51%	49%	25%	15%
Municipal Office	$100m^2$	DOT710	4 313	2.30	85%	15%	25%	15%
				Weekday PM Peak Hour				
Primary School	100m2	ITS Adj.	1 100	0.18	43%	57%	50%	10%
High School	100m2	ITS Adj.	1 200	0.18	46%	54%	50%	10%
Subsidy Housing	Units	DOT210	2 350	0.50	65%	35%	25%	15%
Gap Housing	Units	DOT210	704	0.50	65%	35%	25%	15%
Community residential Units	Units	DOT210	137	0.50	65%	35%	25%	15%
Business	$100m^2$	ITE815	5 342	5.43	50%	50%	25%	15%
Municipal Office	$100m^2$	DOT710	4 313	2.30	15%	85%	25%	15%

Table 5: Expected Development Trips

Total Driveway Trips						
Land Use	**Weekday AM Peak Hour**			**Weekday PM Peak Hour**		
	In	**Out**	**Total**	**In**	**Out**	**Total**
Primary School	535	455	990	85	113	198
High School	767	313	1080	99	117	216
Subsidy Housing	411	764	1175	764	411	1175
Gap Housing	123	229	352	229	123	352
Community residential Units	24	45	69	45	24	69
Business	143	137	280	145	145	290
Municipal Office	84	15	99	15	84	99
Total Driveway Trips	**2087**	**1958**	**4045**	**1381**	**1017**	**2399**
Internal Trips						
Land Use	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Primary School	267	228	495	43	56	99
High School	383	157	540	50	58	108
Subsidy Housing	103	191	294	191	103	294
Gap Housing	31	57	88	57	31	88
Community residential Units	6	11	17	11	6	17
Business	36	34	70	36	36	73
Municipal Office	21	4	25	4	21	25
Internal Trips	**847**	**682**	**1529**	**391**	**312**	**703**
Public Transport						
Land Use	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Primary School	53	46	99	9	11	20
High School	77	31	108	10	12	22
Subsidy Housing	62	115	176	115	62	176
Gap Housing	18	34	53	34	18	53
Community residential Units	4	7	10	7	4	10
Business	21	21	42	22	22	44
Municipal Office	13	2	15	2	13	15
Public Transport	**248**	**255**	**503**	**198**	**141**	**339**
Total Net New Trips						
Land Use	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Primary School	214	182	396	34	45	79
High School	307	125	432	40	47	86
Subsidy Housing	247	458	705	458	247	705
Gap Housing	74	137	211	137	74	211
Community residential Units	14	27	41	27	14	41
Business	86	82	168	87	87	174
Municipal Office	51	9	60	9	51	60
Total Net New Trips	**992**	**1021**	**2013**	**792**	**564**	**1356**

Appendix C

Photographs

Photo 1: Northbound view on the Western side of Jan van Riebeeck Drive

Photo 2: Southbound view on the Eastern Side of Jan van Riebeeck Drive

Photo 3: Informal Pedestrian pathways west of Jan van Riebeeck Drive

Photo 4: Pedestrian Pathways east of Jan van Riebeeck Drive

Photo 1: Roggeland Road / Jan van Riebeeck Drive intersection.

Photo 2: Jan van Riebeeck Drive / Buitekant Street intersection

Photo 3: Signalised Pedestrian Crossing on Jan van Riebeeck Drive

Photo 4: Jan van Riebeeck Drive / Springbok Street intersection

LEGEND

PROPOSED SERVICES

STORMWATER

Symbol	Description
MANHOLE/CATCHPIT	375mmØ
	450mmØ
	750mmØ
	1050mmØ
	STORMWATER CHANNEL

WATER

Symbol	Description
	110mmØ
	160mmØ
	200mmØ
	315mmØ

SEWER

Symbol	Description
	160mmØ
	200mmØ
	315mmØ

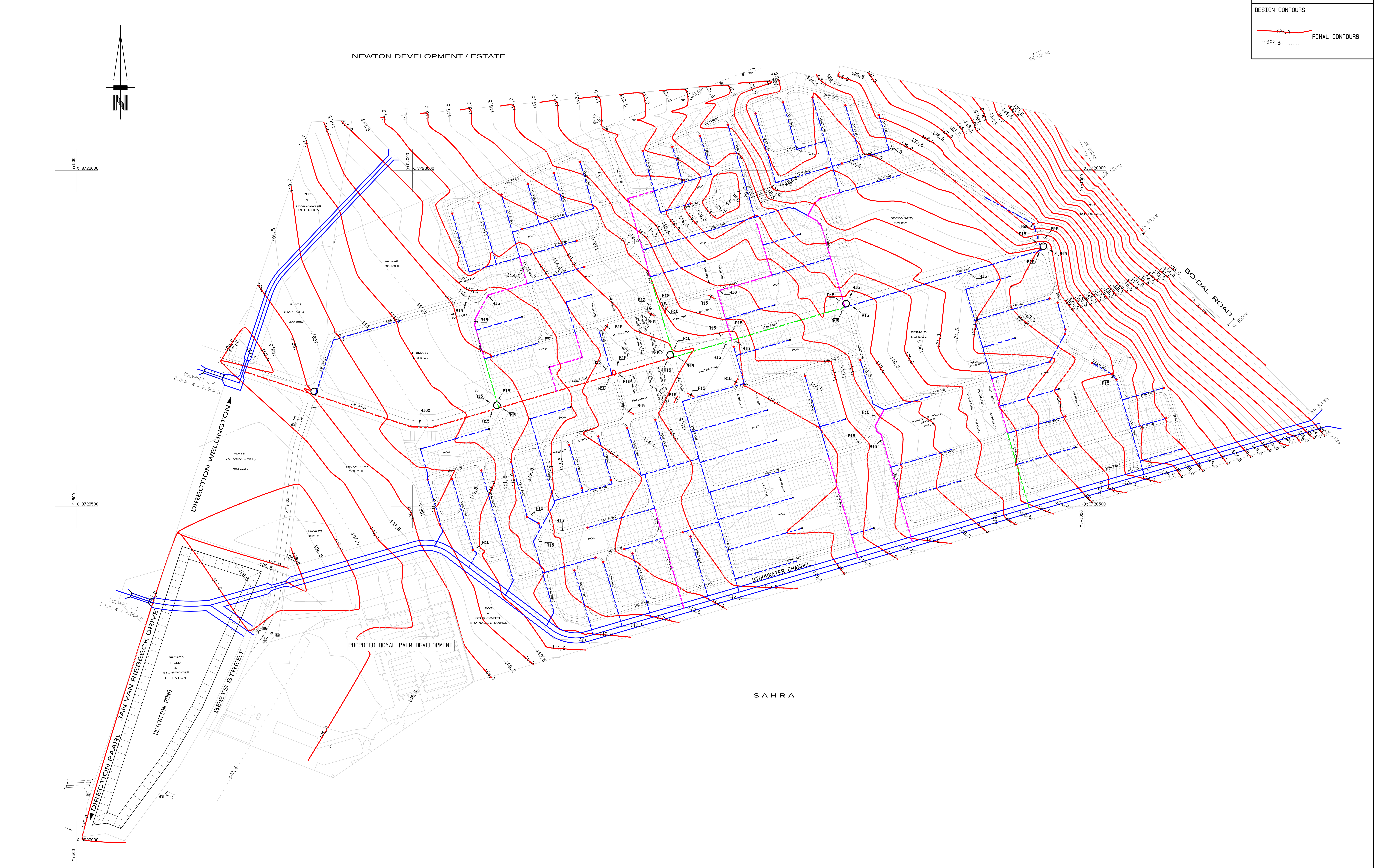
ALL RADII ARE 10m UNLESS OTHERWISE INDICATED

LEGEND

EXISTING SITE SURVEY INFORMATION

DESIGN CONTOURS

127,5 FINAL CONTOURS



LAYERS:

EARTHWORKS (0894/EW/001) : 2 9 25 60 100 210 217
ROADS/SW (0894/RD/001) : 2 4 6 9 25 35 36 37 100-101 201 210 212 214 218-219
RD KERBS (0894/RD/002) : 2 4 6 9 25 100 101 203 204 205 213 218 219
RD DIMS (0894/RD/003) : 2 4 6 9 100 101 202 203 204 205 210 215
SEWERS (0894/FS/001) : 2 4 6 9 20 27 100 101 201 206 210
SEW HC (0894/FS/002) : 2 4 6 9 20 21 100 101 201 207 210
WATER (0894/W/001) : 2 4 6 9 16 17 26 50 100 101 201 208 210
WAT HC (0894/W/002) : 2 4 6 9 16 17 18 50 100 101 201 209 210
WAT DIMS (0894/W/003) : 2 4 6 9 16 17 19 50 100 101 201 210 216
COMBINED (0894/CS/001) : 2 4 6 9 16 17 20 25 100 101 201 210 211 218

SCALE BAR

0 50 100 150 200 m

Scale 1:2500

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CKD
A	ISSUED FOR PRELIMINARY DESIGN ONLY	SEP14	DC	

REVISIONS

DESIGNED	DC	
DRAWN	SB	
CHECKED		

CONSULTING ENGINEERS

LYNERS

Tel: 021 872 0622
Fax: 021 872 0619
email: paarl@lyners.co.za

APPROVED

CONSULTING ENGINEERS:

SIGNATURE: ________ DATE:

APPROVED

CLIENT REPRESENTATIVE:

SIGNATURE: ________ DATE:

CLIENT

DRAKENSTEIN
MUNISIPALITEIT • MUNICIPALITY • UMASIPALE WASE

PROJECT

PROPOSED DEVELOPMENT OF ERF 8378 PAARL
VLAKKELAND TOWNSHIP

TITLE

LAYOUT OF ROADS AND ASSOCIATED STORMWATER

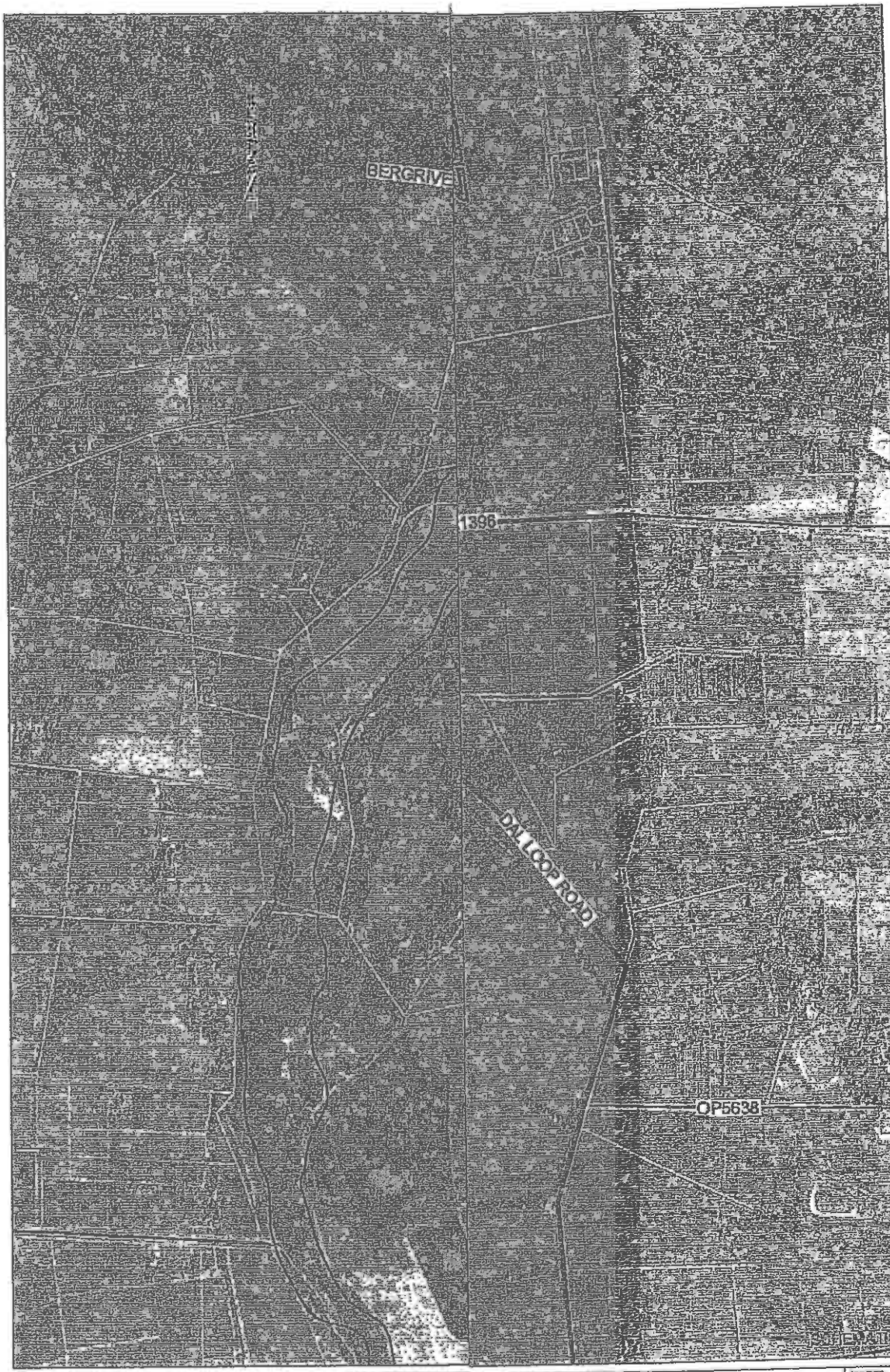
SCALE (ON A0 DWG) 1:2000	SHEET 1 OF 1
CONTRACT No.	PROJECT No. 0894
DRAWING No. 0894/RD/001	REV A
DATE OF FIRST ISSUE:	

iso a0 (841.00 x 1189.00 mm) Lyners_AutoCAD.ctb 2013-06-26

c:\users\sandra\documents\vlakke 1in2000 250814.drw

ANNEXURE I

GEOTECHNICAL INVESTIGATION



PROJECT:

VLAKKELAN

NUMBER:

1

VLAKKELAND LOW COST HOUSING PROJECT

WESTERN CAPE

COMBINED REPORT ON PRELIMINARY AND PHASE 1 GEOTECHNICAL INVESTIGATIONS

Ref. 1-89607
7 April 2008

R.A. Bradshaw
& Associates cc
Consulting Engineering
Geologists

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List of Drawings

Appendices

Executive Summary

This report describes the results of the combined preliminary and Phase 1 geotechnical investigations for the proposed Vlakkeland Low Cost Housing Project which is located between Paarl and Wellington in the Western Cape.

The geotechnical investigations were undertaken in accordance with the requirements of the Department of Housing's Generic Specification GFSH-2, Geotechnical Site Investigations for Housing Developments, and the NHBRC, and the report can be used, in the future as supplementary, statutory information to accompany applications for subsidised low cost housing.

The current investigation comprised a desk study followed by excavation of forty-six trial pits and sampling for laboratory testing. DCP testing was also undertaken next to the all the pits except those located in the embankment walls of old, abandoned evaporation ponds which cover large area of the central and eastern parts of the site.

Numerous soil types, with weathered bedrock at varying depths, are developed throughout the site. The multiplicity of soil types reflects a complex and variable colluvial and alluvial depositional environment, with pedogenic processes also occurring.

Categorisation of the natural soils into seven groups with similar properties is possible, and three generalised, natural soil profiles and their areas of occurrence can be identified. For descriptive purposes, the areas have been named the Northern Area, the Central Strip and the Southwestern Area. The cohesionless coarse soils forming the fill in the embankment walls of the evaporation ponds are superimposed on two of the natural profiles.

Shallow seasonal perched groundwater is expected in large parts of the site in and immediately after the wet period of the year. In addition, most of the area in the southwestern corner of the site is seasonally wet, with an attendant very shallow seasonal perched water table.

The soils are relatively dense or stiff and they are not significantly compressible except in the Southwestern Area where the estimated settlement is approximately 10mm when the soils are wet.

Active soils are predominantly developed in the Northern Area and the Central Strip and a maximum soil strain up to 15mm is possible.

The soils will not be subject to significant collapse consolidation or dispersion.

Seven terrain mapping units are recognised and the associated geotechnical classifications, in general, reflect that the presence of thin collapsible surficial soils layers, the expected presence of shallow groundwater, the low erodability of the soils, the generally shallow ground slopes, the presence or absence of compressible or active soils, and the seismic environment of the area.

Based on the guidelines in the NHBRC Home Building Manual, conventional strip footings or possibly raft foundations would be appropriate for single-storey houses in parts of the site, but lightly reinforced footings with ancillary structural measures will be required in the Northern Area and reinforcement of footings in probably 60% of the houses in the seasonally wet parts of the Southwestern Area will also be required. Good drainage around the houses is essential, and service/ plumbing precautions will be required, as relevant.

The 1 in 50 and 1 in 100 year floodlines of the Dal River lie within the extreme southwestern and western part of the Southwestern Area and the construction of the flood and inundation control measures appears necessary for the long-term serviceability of this area.

Sub surface drainage measures will be required in the Southwestern Area, if that area is to be developed, and they will also be required next to roads throughout the Southwestern Area. In addition subsurface drainage next to roads in other parts of the site should be considered to prevent saturation and 'mattressing' of the surficial soils.

The evaluation of the subsidy variation should consider the costs of dewatering some trenches in winter, deep services if they run sub parallel to contours, and the cost of non normal footings for the houses. Additional costs will include removal and reworking of the existing embankment walls, handling and spoiling of mixtures of excavated soils that contain clayey material, and over-excavation in service trenches to ensure their stability. The cost of possible flood control or inundation measures and sub surface drainage should also be reflected.

With exception of parts of the Southwestern Area where encroachment of floodlines occurs, and the presence of the embankment walls of the old evaporation ponds, no significant geotechnical constraints are apparent in the study area which is therefore generally considered generally suitable for human settlement and subsidy based housing.

2. INFORMATION USED IN THE STUDY

2.1 List of information used in this study

The Council for Geoscience (Pretoria and Bellville) and the National Home Builder's Registration Council (Bellville) were approached for geotechnical information for this area, but no geotechnical data base exists.

Because of the location of the site,- organisations such as the Government Mining Engineer and the Department of Water Affairs were not approached for information.

The following maps and associated supplementary information were used in the evaluation of the site:

- 1:50 000 topographic series maps 3319 CA Bain's Kloof and 3318 DB Paarl, Sixth Editions dated 2000.
- 1: 10 000 orthophoto maps. Published by the Director General of Surveys, Mowbray, Cape Town.
- Panchromatic aerial photographs (Job No. 1074, Strip 010, Photo No.'s 1036 and 1037 at a scale of 1:50 000, dated 12 November 2003).
- The Geological Series Map 3318, Cape Town and 3318 Worcester at a scale of 1:250 000 and the associated explanations for the maps entitled 'The Geology of the Cape Town Area' and 'The Geology of the Worcester Area', Geological Survey of South Africa, both dated 1992.
- Sub regional and local context plans were provided by Mr Lochner, including a survey plan which only covered approximately the eastern half of the site.
- A plan showing the contours at 1m intervals at the site was provided by the Drakenstein Municipality together with the 1 in 50 and 1 in 100 flood lines of the Dal River which runs through the extreme southwestern corner of the site.
- National Department of Housing. Project Linked Greenfield Subsidy Project Developments. Geotechnical Site Investigations for Housing Developments. Generic Specification GFSH-2, September 2002.
- National Department of Housing. Home Building Manual, Parts 1, 2 and 3. National Home Builders Registration Council, Revision 1, February 1999.
- A walk-over site inspection was conducted on 31 January, and the existing houses in the vicinity of the project were inspected for signs of structural distress which could be ascribed to geotechnical factors.

Discussions were also held with Mr J. Knaggs of the Drakenstein Municipality. The objectives of the discussions were to obtain information about the evaporation ponds in the eastern parts of the site, and other geotechnical and hydrological conditions at the site.

2.2 *Evaluation procedures used in this investigation*

The standard specifications GFSH-2 from the National Department of Housing have been followed during the investigations and associated preparatory desk study including sourcing of maps and other documentation. Guidelines from the NHBRC were also considered during compilation of this report.

The initial evaluations that were made were based on air photo interpretation and a study of the geological map and associated explanation. The planning of the investigations was based predominantly on the basic survey plan provided by Mr Lochner.

No exposures of rock outcrop generally occur on or near the site. Consequently the final geotechnical assessments in this report are based predominantly on the results of trial pitting and laboratory testing.

3. SITE DESCRIPTION

The site is located to the east of the R301 between Paarl and Wellington and approximately midway between the two towns.

The site is an irregular, polygonal shape and it is approximately 85 hectare in area. It is bounded to the west by a service road running parallel to the R301, and by vacant ground and existing housing to the north. Vacant ground abuts the northern third of the eastern boundary, with a gravel road running along the southern two-thirds. Mainly vacant ground lies to the south of the southern boundary, but the Dal River and associated dams and dam-like structures occur near the extreme western end of this boundary.

The overall slope of the ground is towards the southwest, with a typical gradient of approximately 1:75, but a strip along the northern boundary has a gradient of approximately 1:18.

Five, very large, abandoned evaporation ponds, which extend north-south almost across the entire width of the site, cover approximately 70% to 80% of the central and eastern parts of the site. Excavations for these ponds and the embankment walls themselves have changed the ground profile. The bases of the ponds, which range up to 100m in width and up to 300m long, are slightly dish-shaped and they have a very gentle fall to the east. Water is trapped in parts of these ponds in winter and reed vegetation occurs in places. The embankment walls vary in size and length, but typically they are 3m to 4m high with slopes at 1:3, and crest widths between 3m and 4m. The upper parts of the embankments have been subjected to wave erosion, and near vertical slopes, occur, in places, just below the crest. The embankment walls have been deliberately breached, in places, to ensure free outflow of stormwater.

The large diameter, cement pipes that previously formed the rising main and gravity pipelines from the sewage works to the west of the R301 to the evaporation ponds apparently run in a northeasterly direction through the centre of the site (only one was identified during site investigations). Outlets structures also occur, generally, in the southwestern corners of the ponds.

Most of the site has a grass cover, which is currently very sparse, in places, but relatively thickly developed in a floodplain or wet area in the southwestern corner of the site. Large gum trees grow along the central parts of the eastern boundary, and large pine trees grow in places in many other parts of the site outside of the evaporation pond area. Port Jackson scrub and trees grow in most areas of the site, but notably in the pond area and in the central parts of the site to the west of the ponds. Wattle and other large trees grow next to the dams and the Dal River in the extreme southwestern corner of the site.

An area, which is approximately 0.8 hectare in area and is located against the central part of the western boundary, is currently occupied by the largely abandoned shacks and informal livestock pens and paddocks of emergent farmers. Most of the structures have been abandoned, but a few of the shacks are still occupied, and livestock is still housed, in places.

Gravel tracks criss-cross many parts of the site, and there is still limited vehicular access along the tops of the embankment walls.

The remnants of old brick houses and structures occur near the southwestern corner of the property, and at least one of these is occupied. Paddocks also occur in this area.

Scattered rubble and rubbish has been dumped throughout the site, particularly in the southwestern corner and the extreme eastern parts and, in places, in the evaporation ponds.

4. NATURE OF THE INVESTIGATIONS

4.1 Desk study

Prior to conducting field investigations, a desk top study was undertaken using the information detailed in Section 2.1. In addition, discussions were held with personnel from the Municipality and a walk-over site inspection was also conducted. The contour plan provided by Mr Lochner was used to pre-plan the position of the trial pits for the current investigations.

4.2 Site investigations and associated laboratory testing

The site investigations were undertaken by Mr R. Bradshaw of R.A. Bradshaw & Associates cc during the period 31 January to 7 February 2008.

The soil testing was undertaken by Geoscience Laboratories (Pty) Ltd at their laboratory in Cape Town.

4.2.1 Trial pitting

A total of forty-six trial pits were excavated with a digger/loader at the locations shown on Figure 2. Because no site development plan currently exists, the trial pits were generally excavated on a 200m by 100m, staggered grid, but trial pits were specially excavated, in places, in the embankment walls. Some variation of this grid pattern was also required in the shack and livestock pen area where existing structures had to be avoided or access was not possible.

The objective of the trial pitting was to determine the soil profile to 3m depth as prescribed in GFSH-2, and to provide access for sampling.

The exposures in the trial pits were profiled according to the Jennings, Williams and Brink method, and the descriptions of the soil profiles in the trial pits are presented in Appendix A.

4.2.2 DCP testing

DCP (dynamic cone penetration) tests were undertaken next to all trial pits except those in the embankment walls. However, the probe commonly refused at shallow depths and the full potential depth of testing (2m) was seldom achieved.

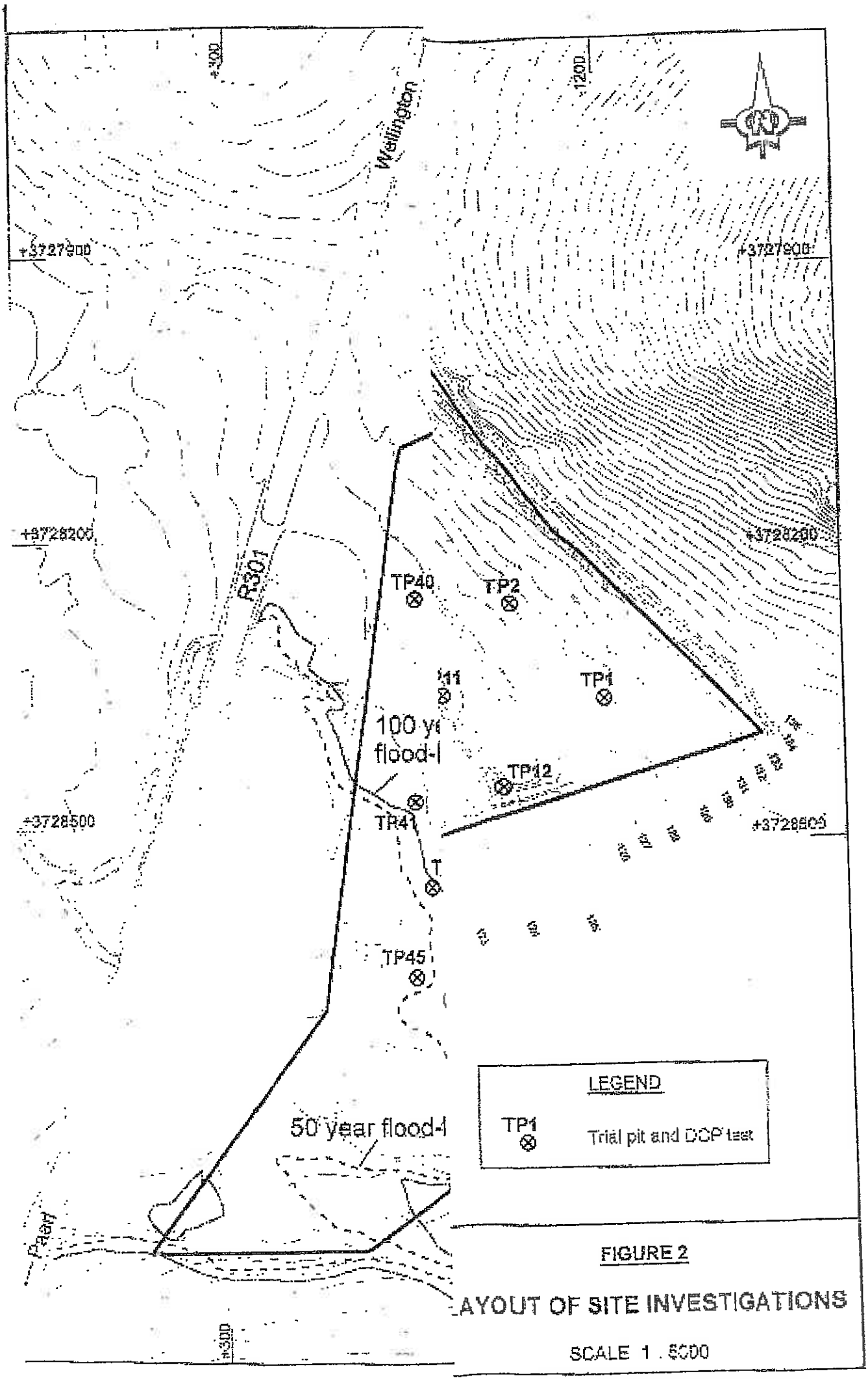


FIGURE 2

LAYOUT OF SITE INVESTIGATIONS

SCALE 1 : 5000

The objective of the testing was to determine the current relative density/consistency profile to a depth of 2m.

The plots of DCP penetration rates versus depth are also presented in Appendix A.

4.2.3 Laboratory testing

Foundation indicator tests were undertaken on seventeen representative soil samples, and mod/CBR tests were conducted on eight samples.

Oedometer tests were conducted on four undisturbed soil samples to determine the swell strain and swell pressures developed when the samples were saturated. The samples were nominally loaded, after which they were loaded to a pressure equivalent to the overburden pressure plus the expected foundation load. After consolidation had occurred at this pressure, the samples were saturated and allowed to swell freely. After swelling was complete, the samples were loaded until the sample had consolidated beyond its original height (void ratio) immediately prior to saturation.

pH and conductivity tests were also conducted on eight samples.

The results of the laboratory testing are presented in Appendix B.

5. SITE GEOLOGY AND GROUNDWATER CONDITIONS

5.1 General geology

Portions of the 1:250 000 Geological Series Maps, 3318 Cape Town and 3319 Worcester are shown at a scale of 1:125 000 on Figure 3.

Based on the Geological Series Maps, the area in the vicinity of the site is covered by undifferentiated, thin Quaternary sediments (Qs on Figure 3), overlying the Porterville Formation of the Malmesbury Group (Npo).

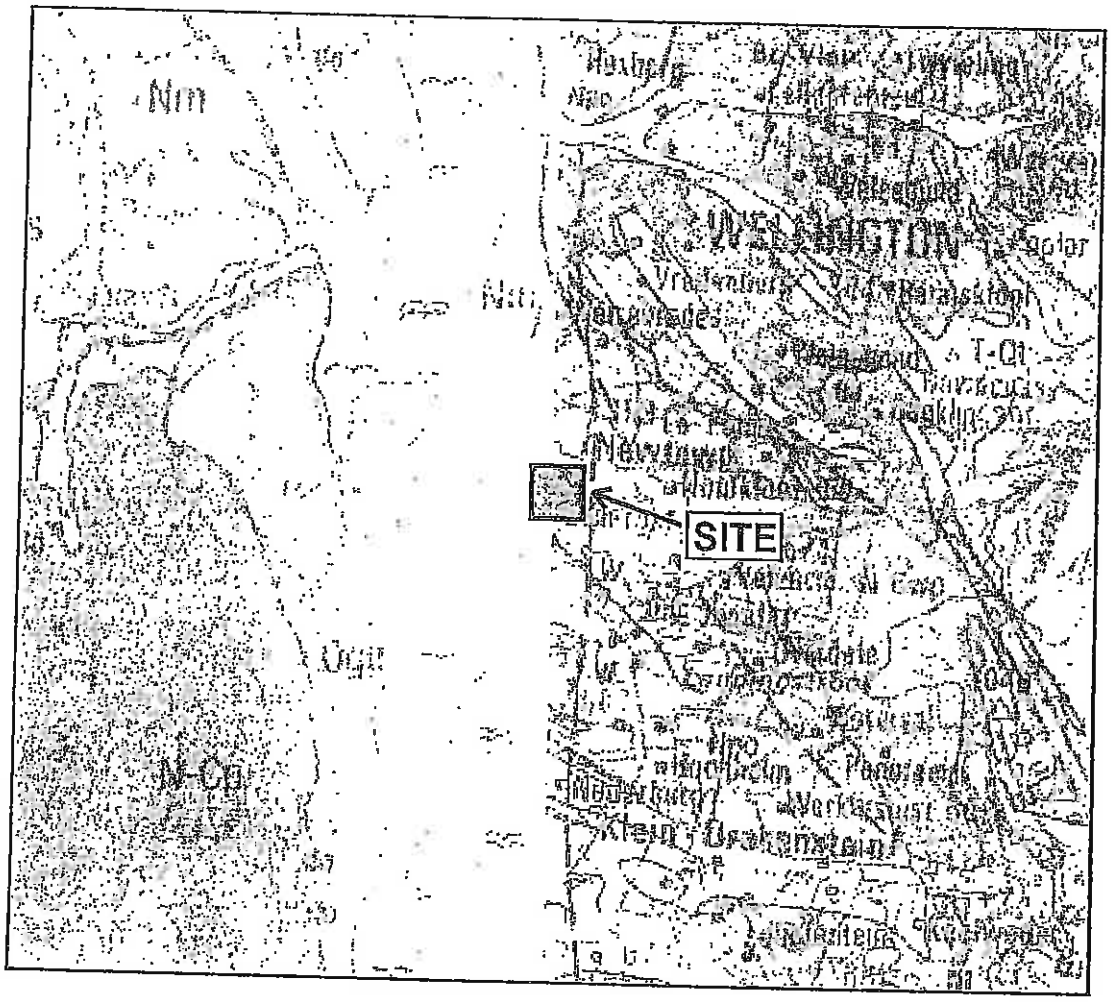
5.2 Site geology and soil profiles

Although the trial pitting confirmed the general geology described in Section 5.1, more than fifteen soil or material types were exposed in the trial pits, reflecting a complex and variable colluvial and alluvial depositional environment and pedogenic processes. Detailed descriptions of all the soil types are neither practical nor relevant, and the soils have been grouped into eight generalised soil types for descriptive purposes.

The schematic distribution of the generalized soil types in the forty-six trial pits are shown on Figures 4.1 and 4.2, and detailed descriptions of the soil profiles are presented in Appendix A. Summarised descriptions of the eight groupings of soil types are given below:

(i) **Made ground**

Made ground or fill material was almost exclusively encountered in those trial pits located in the embankment walls of the evaporation ponds.



LEGEND

Qgg, Qs	Undifferentiated Quaternary sediments
Ncp, Ncwp	Cape Granite Suite
Npo, Nm, Nn	Porterville, Malmesbury & Norree Formations, Malmesbury Group

FIGURE 3

REGIONAL GEOLOGY

SCALE 1 : 125 000

Source: 1:250 000 Geological Series Maps 3318 Cape Town and 3319 Worcester

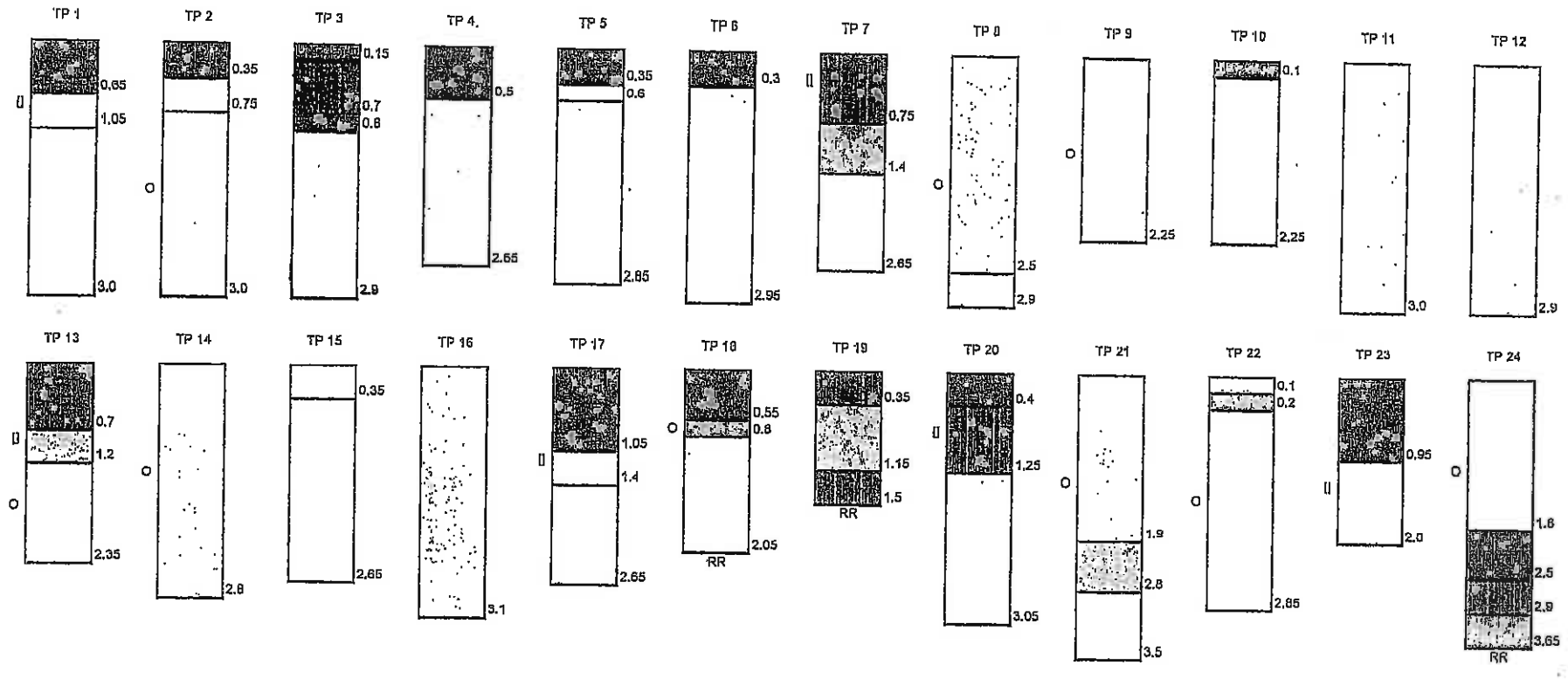
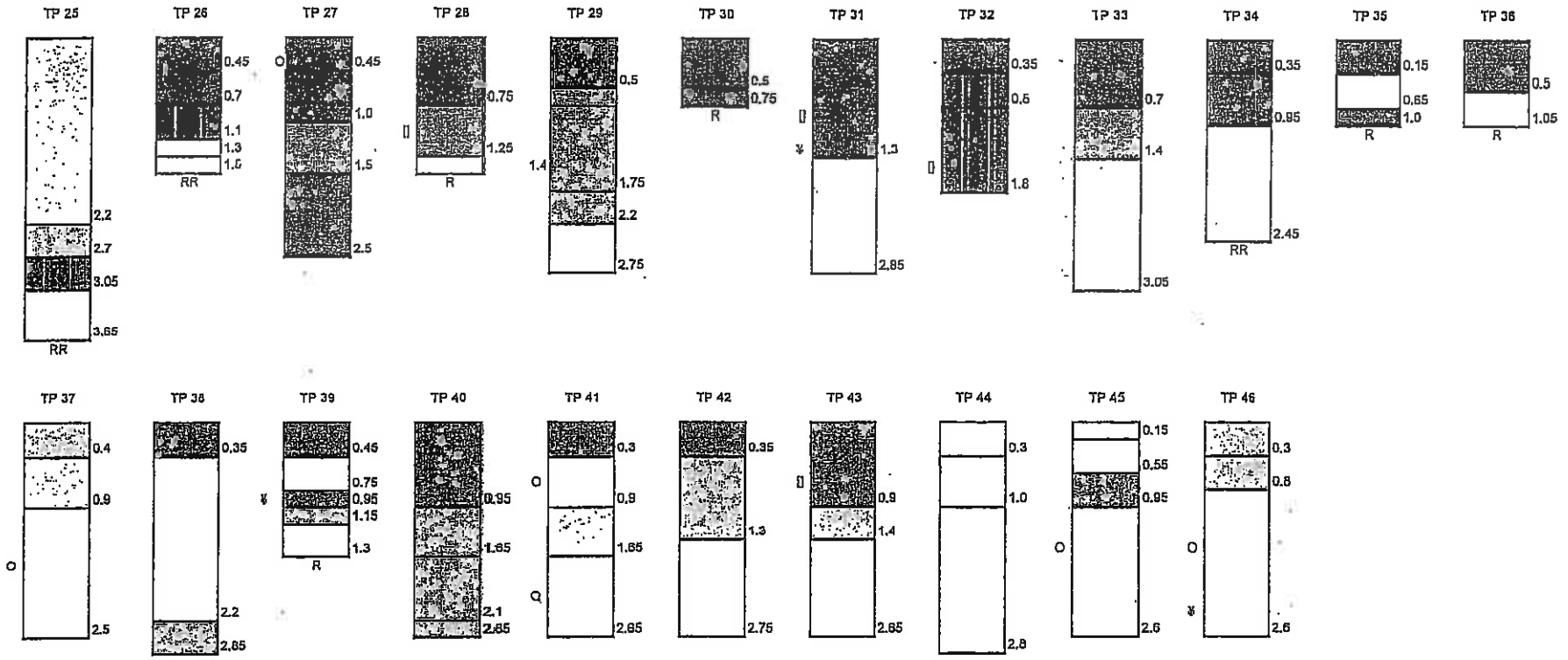


FIGURE 4.1
SOIL PROFILES IN TRIAL PITS - TP1 TO TP24



LEGEND

	Made ground		Ferricrete
	Cohesionless coarse soil		Residual Malmesbury soil or weathered rock
	Silty or clayey soil	O	Disturbed sample
	Gravelly clayey or silty soil	[]	Undisturbed sample
	Sandy soil	¥	Perched water table
	Cohesive coarse soil	RR	Refusing
		R	Refusal

FIGURE 4.2
SOIL PROFILES IN TRIAL PITS - TP25 TO TP46

The made ground is generally layered light grey, greyish brown and orange brown. The soil generally comprises a slightly clayey, silty fine to medium sand, but coarser sands occur in places, and fine to medium gravel is also present. These fill soils were derived from the surficial soils within the pond areas, and, where deep excavation occurred, some finer soils were also excavated which now occur as thin layers of cohesive fill within the general fill.

The thickness of the fill in the embankment walls is variable, but the contour plans indicate a thickness up to 4m.

(ii) Cohesionless coarse soils

These soils mask or masked most of the site with the exception of the southwestern corner.

They generally comprise slightly clayey silty sand with variable proportions of fine to medium sub rounded ferruginised gravel. These gravelly silty sands or silty sandy gravels are brownish grey and the gravel is concentrated towards the basal contact. The soils, which are colluvial in origin in the upper parts of the site and alluvial or alluvial wash in the lower parts, range in thickness from 0.3m to 1.3m. They are weakly cemented in places.

(iii) Silty or clayey soils

These soils are of colluvial origin in the upper parts of the site and alluvial in the lower parts.

They commonly occur below the surficial cohesionless coarse soils in the former areas where they are khaki brown and generally less than 0.4m thick. The alluvial varieties are commonly khaki grey and at least 1m thick, in places.

(iv) Gravelly silty or clayey soils

These slightly gravelly soils occur as thin layers (0.1m to 0.65m) in places in the upper and central parts of the site, but they are more strongly developed in the western central and northwestern parts of the site.

The soils display variable colours, but they are commonly characterised by blotching and mottling. They are often weakly cemented and contain very minor quantities of fine to medium gravel.

(v) Sandy soils

These soils are not strongly developed in the central and northern parts of the site, but they are concentrated in the southwestern parts where the sand layers range in thickness from 0.4m to 1m in the trial pits. The composition ranges from silty sand to sand, with the sand component commonly medium to coarse.

(vi) Cohesive coarse soils

This grouping includes clayey sandy gravel, gravelly clayey sand, clayey gravelly sand, clayey silty gravel, gravelly silty sand and clayey silty sand.

The soils are almost exclusively developed in the southern central and southwestern areas of the site, with the gravelly clayey silty and their slightly gravelly derivatives occurring exclusively in the Southwestern

Area. The gravel component of all the soils is commonly, but not exclusively scattered and fine to medium sized. The thickness of the soils varies from 0.35m to more than 1.85m.

(vii) Ferricrete

Dark orange brown and brownish grey, layered, coarse gravel-sized blocks of hardpan ferricrete in a minor coarse sandy matrix were encountered in TP 37 and TP 41 in the southwestern parts of the site. These layers of pedogenic soil were 0.5m and 0.75m thick respectively. It should be noted that fine ferricrete or ferruginised gravels occur in the cohesionless coarse soils in the other parts of the site, particularly the eastern parts.

(viii) Malmesbury soil and weathered rock

Residual Malmesbury soil (sandy clayey silty or sandy silty clay) was encountered in TP 1 where it occurred together with patches of very soft, generally ferruginised greywacke.

Grey, stained and mottled or blotched red or orange brown, highly weathered, very closely to closely jointed (sub vertical foliation and joints), very soft to generally soft greywacke occurs at shallow depth (generally less than 0.8m) in the eastern and northern parts of the site. The weathering is more extensive in places so that very soft rock to very stiff residual soil-like material occurs within the highly weathered rock mass.

Based on the above descriptions and the distribution of soils shown on Figure 4.1 and 4.2, the site can be broadly divided into three areas where the following generalised soil profiles occur:

Northern Area

The generalised soil profile comprises:

- thin cohesionless coarse soils
- over, in places, thin clayey or silty soils,
- over residual Malmesbury soil and mainly highly weathered Malmesbury greywacke

Central Strip

The generalised soil profile comprises:

- cohesionless coarse soils,
- over gravelly silty or clayey alluvium
- over highly weathered Malmesbury greywacke generally at depths of more than 1.5m

Southwestern Area

The generalised soils profile comprises:

- cohesionless coarse soil
- over cohesive coarse alluvial soils with layers of sand, clayey or silty soil and minor hardpan ferricrete

The interpreted distributions of these profiles are shown on Figure 5 from which it is apparent that the areas run sub parallel to the Dal River. The soils were probably deposited by that river and probably also by the Berg River whose broad ancient floodplain extends into the site.

Superimposed on the first two of the generalised soil profiles are the strips of fill that form the embankment walls of the old evaporation ponds. The soils were generally derived from the cohesionless coarse soils that previously masked the footprint of the pond area.

5.3 *Water table*

Site investigations were conducted towards the end of a dry summer and perched groundwater was only encountered in three trial pits (TP 31, TP 39 and TP 46).

The presence of weakly cemented layers, ferricrete and the juxtaposition of coarse soils over clayey or silty transported soils or weathered bedrock suggests that perched groundwater will be more widespread in and immediately after the wet period of the year.

Anecdotal information plus the vegetation evidence suggests that most of the area in the southwestern corner of the site is seasonally wet, with an attendant very shallow seasonal perched water table.

6. GEOTECHNICAL EVALUATION

6.1 *Engineering and material characteristics and constraints*

6.1.1 *Site topography*

Field observations

There is a 27m fall westwards across the site with gradients of approximately 1:18 along the eastern boundary, reducing to approximately 1:75 in the central and particularly western parts of the site.

The overall natural gradient of the site is interrupted by the embankment walls of the evaporation ponds which typically slope at 1:3.

Effect on the development

Because of the shallow ground gradient and the occurrence of local low areas, surface run-off will be poor and local ponding and flooding could occur, particularly in the southwestern part of the site. Shaping of the ground will be required to improve drainage and encourage run-off.

Deep stormwater and sewer lines will probably also be required in many areas to ensure that the pipelines have an adequate fall.

6.1.2 *Soil profiles*

Field observations

From the soil profiles in Appendix A and Figure 2, it is apparent that there are numerous soil types, with weathered bedrock at varying depths. However, it is possible to categorise the soils into groups with similar properties and to identify three generalized, natural soil profiles and their areas of occurrence (see Figure 5). The embankment fill is superimposed on the two of these natural profiles.

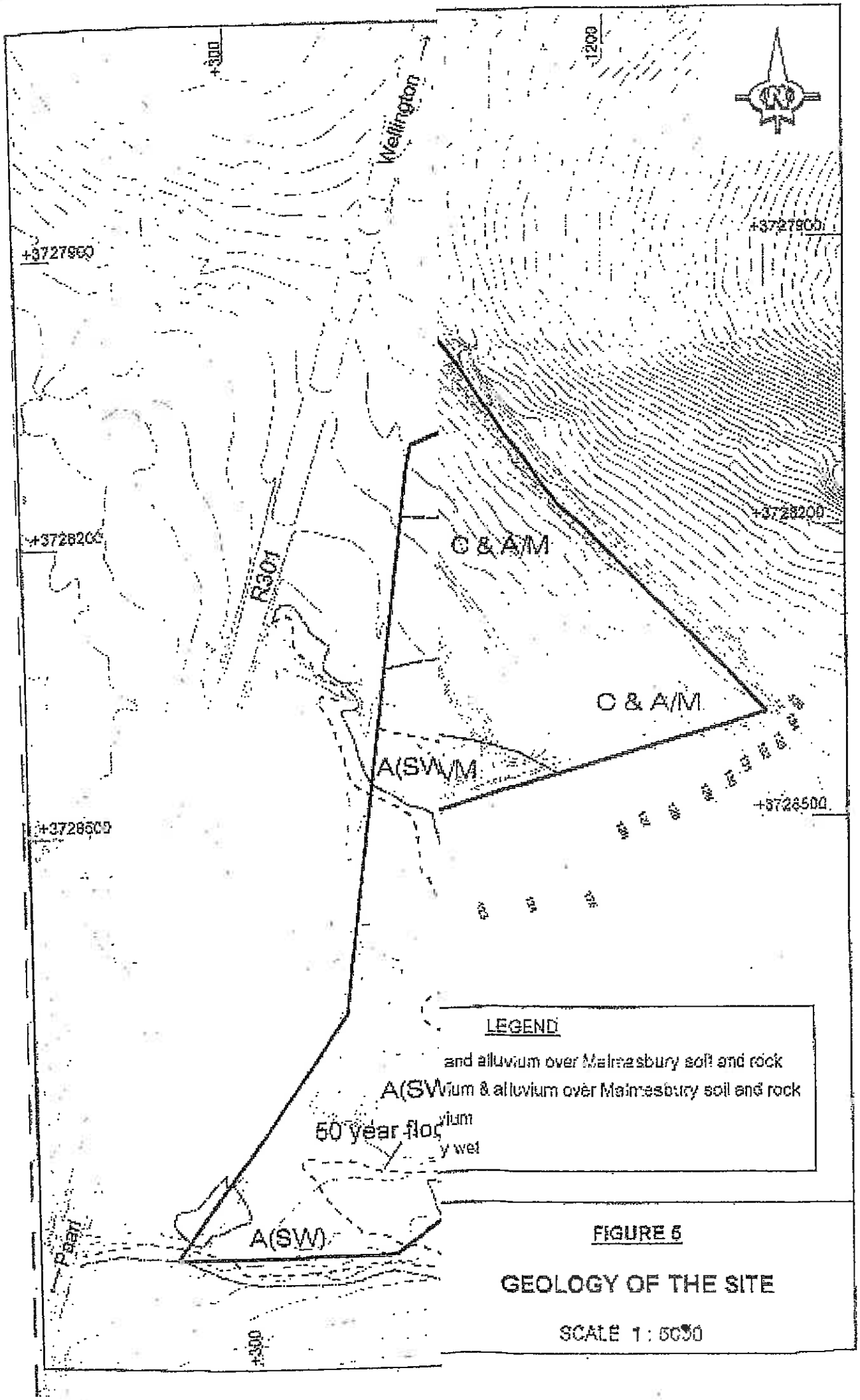


FIGURE 6

GEOLOGY OF THE SITE

SCALE 1 : 5000

Effect on the development

The following properties of the soil profile could potentially significantly influence the design and construction of houses for this project:

- The engineering properties and specifically the compressibility or heave characteristics of the silty or clayey soils and their slightly gravelly derivatives.
- The engineering properties and specifically the compressibility of the cohesionless and cohesive coarse soils and the sandy soils.
- The occurrence of weakly cemented layers, particularly in the Central Strip.
- The occurrence of bedrock and residual soils and specifically the potential swell characteristics of the latter.
- The occurrence of groundwater.

The above factors are discussed in the following sections.

6.1.3 Grading and Atterberg Limits

Laboratory results

The results of the foundation indicator tests on seventeen samples are presented in Table 1.

The made ground and the cohesionless coarse soils from which the made ground is derived have very low or negligible cohesion and are classified as SC, SW, SP-SW and SP soils.

The silty or clayey soils and their slightly gravelly derivatives are classified as CH and SC. They generally have high fines content (silt and clayey) and high liquid limits, plasticity indices and linear shrinkages.

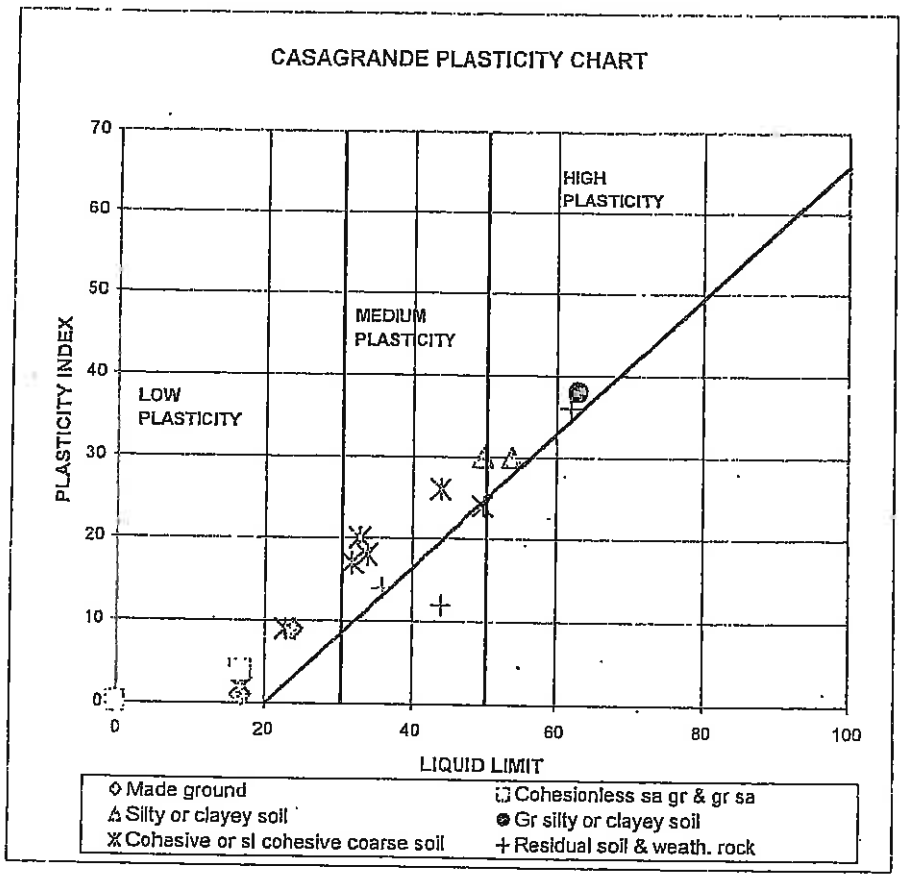
The cohesive coarse soils are generally classified as SC or CL soils. From Figure 6, they generally display medium plasticity.

The residual soils and highly weathered Malmesbury greywacke bedrock have a fines content of more than 50%, and they display medium to high plasticity with moderate to high linear shrinkages.

Effect on development

Figure 6 also suggests the silty or clayey soils and their slightly gravelly derivatives, the cohesive coarse soils and the residual soils and weathered bedrock display medium potential for expansiveness. Heave and compressibility of the soils could therefore influence founding conditions and the foundation layout for the houses.

Compressibility and heave are addressed in Sections 6.1.6 and 6.1.7.



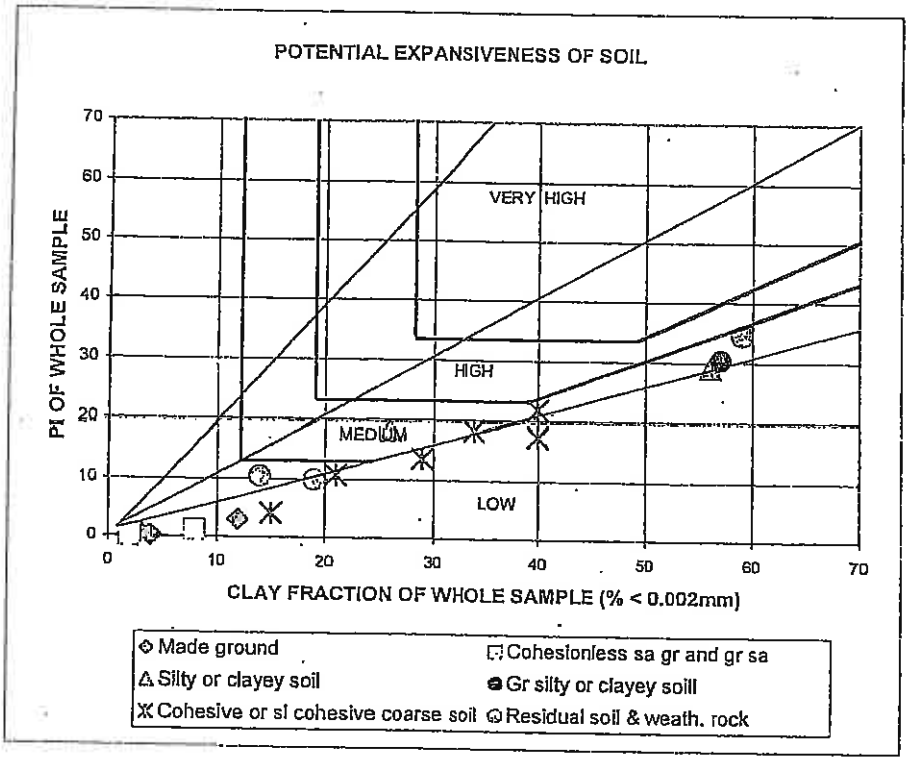


FIGURE 6: CASAGRANDE PLASTICITY CHART AND PLOT OF POTENTIAL EXPANSIVENESS

TABLE 1: SUMMARY OF GRADING ANALYSES

Soil Type	*Trial Pit*	*Depth (m)*	*Particle Size Distribution (%)**				*USC Classif.*	*Atterberg Limits*		
			Gravel	*Sand*	*Silt*	*Clay*		*LL*	*PI*	*LS*
Made Ground	TP8	0-2.5	7	71	9	12	SC	24	9	4.7
	TP21	0-1.9	4	87	6	4	SW		SP	
	TP24	0-1.8	9	80	7	4	SW		SP	
Cohesionless gr sand & sa gr	TP17	0-1.05	1	82	10	8	SP-SW	17	4	2.2
	TP31	0.6	3	90	5	2	SP		NP	
Silty & clayey soils	TP13	1.1-2.7	25	36	19	20	SC	33	14	7.1
	TP17	1.2	0	5	38	57	CH	54	30	9.5
Gr silty or clayey soil	TP28	1.0	3	28	12	58	CH	63	38	9.3
Cohesive or slightly cohesive gr sa, sa gr & sa soils	TP13	1.0	0	57	17	26	SC	50	30	9.2
	TP20	0.4-1.25	3	76	6	15	SC	23	9	4.8
	TP32	1.5	0	49	11	40	CL	44	26	9.0
	TP37	0.9-2.45	3	66	10	21	SC	34	18	4.9
	TP45	1.4-2.6	0	27	33	40	CL/CH	50	24	13.2
	TP46	0.8-2.6	0	45	24	31	CL	32	17	6.1
Residual soil & weath. rock	TP2	0.75-3.0	3	43	40	15	CL	36	14	6.7
	TP9	0.3-1.25	1	30	49	20	ML	44	12	5.7
	TP23	1.3	0	8	30	62	CH	62	36	11.3

* *Percentage of the soil by weight* NP *Non plastic* SP *Slightly plastic* USC *Unified Soil Classification System*

6.1.4 Moisture-density relationship and CBR

Laboratory results

The results of the mod/CBR tests on the soils are presented in Table 2.

The cohesionless coarse soils and the made ground derived from it have high maximum dry densities and low optimum moisture contents. According to COLTO, the soils would be classed as G6 or G7 soils.

Variable maximum dry densities and optimum moisture contents were recorded for the cohesive soils and their classification ranges from G7 to G10 materials.

The weathered Malmesbury greywacke rock and presumably the residual soils derived from it have negligible CBR strength on saturation.

TABLE 2: RESULTS OF CBR TESTS

Soil Type	*Trial Pit*	*Depth (m)*	*Mod. A.A.S.H.T.O. Data*		*C.B.R. at*					*Maximum Swell (%)*
			M.D.D. (kg/m^3)	O.M.C. (%)	100%	98%	95%	93%	90%	
Made ground	TP8	0-2.5	2144	7.0	60	42	26	18	10	0.2
	TP21	0-1.9	2145	6.6	178	108	56	36	18	0.0
	TP24	0-1.8	2251	5.5	109	86	55	44	30	0.2
Cohesionless coarse soils	TP17	0-1.05	2210	5.2	198	141	82	57	33	0.0
	TP27	0-1.0	2172	4.4	255	149	67	39	17	0.0
Cohesive coarse soils	TP20	0.4-1.25	2150	6.3	55	42	28	22	16	0.9
	TP45	1.4-2.6	1802	15.3	1	1	1	0	0	11.2
Weathered rock	TP9	0.3-1.25	1698	15.6	1	1	1	1	0	11.9

Effect on development

The cohesionless coarse soils in the Northern Area are thinly developed and the low saturated CBR of the underlying residual soils and bedrock will influence the design of the roads in that area.

Similarly, the cohesionless coarse soils are thinly developed in the Central Strip and in the Southwestern Area and the low CBR of the cohesive coarse soils will also influence layerwork design even though areas of sand or thicker cohesionless coarse sands with relatively high CBR also occur.

6.1.5 *Conductivity and pH*

Test results

The results of the chemical tests on eight soil samples are presented in Table 3.

TABLE 3: RESULTS OF CHEMICAL TESTS

Soil Type	*Trial Pit*	*Depth (m)*	*pH*	*Conductivity (mS/m)*
Silty & clayey soils	TP13	1.1-2.35	6.0	14.78
Cohesive coarse soils	TP20	0.4-1.25	6.5	40.40
	TP32	0.8-1.8	4.0	23.10
	TP37	0.9-2.45	6.2	55.00
	TP45	1.4-2.6	6.4	537.00
	TP46	0.8-2.6	5.3	40.60
Residual soil & weath. rock	TP2	0.75-3.0	5.0	22.90
	TP9	0.3-1.25	5.7	53.60

The results indicate that all the soils are acidic, generally with low to moderate conductivity.

Effect on development

In general, corrosion of metallic subsurface services is affected by the following physio-chemical properties of the soil: pH, conductivity and moisture content of the soil.

The combination of acidic soils and low to moderate conductivities indicates that mild corrosion of buried metallic services could occur with time.

6.1.6 *Compressibility of the soils*

Field observations and test results

The results of the DCP tests, which were conducted during summer when soil moisture contents were low, indicate that the soils are currently generally medium dense to dense or very stiff. However, loose conditions extended to more than 1m depth in places in the Central Strip and Southwestern Area.

The soils are likely to loosen/soften with increases in soil moisture content in winter.

Consolidation tests indicate that heave or swell of the cohesive soils is more likely than consolidation.

Effect on development

Consolidation settlement of engineered fill derived from soil from the embankment walls and the cohesionless coarse soils will occur, but the thickness of the soils is generally considerably less than 1m and settlements of less than 5mm are therefore expected.

Consolidation of the cohesive coarse soils in the Southwestern Area and particularly the seasonally wet parts of this area will occur and the estimated settlement of these soils when wet is approximately 10mm.

6.1.7 *Heave*

Field observations and test results

The silty or clayey soils and the cohesive coarse soils are fissured, but no widespread slickensiding was observed. However, linear shrinkages of the soils are commonly large, and Figure 6 suggests that they display medium potential for expansiveness.

TABLE 4: RESULTS OF SWELL STRAIN AND PRESSURE TESTS

Soil Type	*Trial Pit*	*Depth (m)*	*Swell Strain (%)*	*Swell Pressure (kPa)*
Silty or clayey soil	TP17	0.9	2.4	>219
Gravelly silty or clayey soil	TP28	1.0	1.8	110
Cohesive coarse soil	TP13	1.0	2.9	180
	TP32	1.5	5.5	420
Weathered rock	TP23	1.3	2.7	295

The results of swell strain and pressure tests on four undisturbed samples are presented in Table 4. The tests indicate that, for typical foundation plus overburden pressures of approximately 40kPa, soil strains of 2% to 3% are likely but this could increase to 5.5% in places. . The swell pressures are in excess of 100kPa.

Effect on development

The active soils include the silty or clayey transported soils and their slightly gravelly derivatives, cohesive coarse soils, and the weathered greywacke bedrock and its residual soils. The latter soils are predominantly developed in the Northern Area and the Central Strip, with residual soil and bedrock at shallow depth in the former area and parts of the latter.

Assuming initially that significant seasonal changes in moisture content extend to depths of 2m, the theoretical heave could be of the order of 40mm. In practice, the soils even in mid to late summer are moist at depth (see Appendix A) and they are partially saturated. The entire 2m theoretical depth is therefore unlikely to become saturated, and maximum soil strains up to 15mm are more likely, given that the upper part of the profile generally comprises relatively inactive cohesionless coarse soils.

6.1.8 *Collapse Potential*

Field observations and test results

The surficial cohesionless coarse soils are pinholed in places, but these layers are generally less than 0.7m thick and the most open fabric occurs in the upper 0.5m. No laboratory collapse potential tests were therefore undertaken.

Effect on development

The pinholed soils occur at surface and are thinly developed, and collapse consolidation of the soil is not considered a significant factor influencing the design and construction of houses.

6.1.9 *Dispersivity*

Field observations

Despite having impounded untreated sewage water, no evidence of dispersivity was observed in the embankment walls of the evaporation ponds. The walls are constructed with cohesionless coarse soils.

Effect on development

The silty or clayey soils and the cohesive coarse soils display no characteristics associated with dispersivity. No dispersivity testing was therefore undertaken.

6.1.10 *Permeability*

Field observation and laboratory results

The cohesionless coarse soils contain a small but significant proportion of fines and, in general, they would be classed as slightly to possibly moderately permeable with permeabilities probably less than 10^{-4}cm/sec.

All other soils, with the exception of the very minor occurrences of silty sand and sand, contain high proportions of fines and they are therefore slightly to effectively impermeable.

Effect on development

Some infiltration of surface water will occur but the majority will disperse through surface run-off and drainage measures will be required to control surface flows of stormwater.

Conditions also exist for the development of perched water tables where cohesionless coarse soils overlie less permeable soils.

6.1.11 Condition of houses in the adjacent developments

Field observations

Inspection of houses to the north of the site indicates that cracking is not generally developed. The houses do not appear to have been constructed as part of a group scheme and it is assumed that, in the absence of control joints, no extensive structural measures or non conventional foundation layouts were used to counter adverse ground conditions.

Effect on development

The general lack of extensive cranking in the houses to the north of the development contradicts the results of the laboratory testing and the assessments above which indicate that active soils could lead to structural problems in the houses. The lack of widespread cracking suggests that either comprehensive foundation design and ancillary structural measures were used to minimise the affects of heave (unlikely) or that, despite the evidence from testing and observations on the site itself, the soils in the existing residential area are only mildly active, or the soil profile below the existing houses differs from that in the Northern Area and Central Strip.

6.2 Slope stability, erosion and inundation

No natural, large-scale instability can occur on the relatively shallow sloping ground at the site.

Deep vertically excavated slopes in service trenches will be unstable and the following cut slope batters can be considered:

- 0 to 1.5m depth - vertical
- 1.5m to 2.5m - 1:0.75
- >2.5m - 1:1

These batters should be confirmed on site during construction and statutory provisions will be required to ensure the safety of workers in the trenches. These recommendations should be reviewed if groundwater is encountered, because flatter slopes and/or lateral support will be required.

Exposed surficial cohesionless coarse soils are potentially erodable by water and small shallow eroded channels occur in the mid central and western parts of the site. However, the extent of erosion is minimal and erosion of the surficial soils is not considered a significant factor in the construction of this project.

The 1:50 and 1 in 100 year floodlines are shown on Figures 2, 4, 7 and 8. The information, which was obtained from the Drakenstein Municipality, indicates that inundation of a significant portion of the southwestern corner of this site will occur. Floodlines for the 1 in 10 and 1 in 20 year events were not available, but the Dal River will presumably also cause more frequent inundation of smaller areas during those events.

6.3 Excavation classification with respect to services

According to Tables 2.1 and 2.2 of the Generic Specifications, excavation in the various soil types would be classified according to SABS 1200 D as follows:

Soft Excavation Class:	Made ground, cohesionless coarse sands, silty or clayey soils, slightly gravelly silty or clayey soils, sandy soils and cohesive coarse soils
Intermediate Excavation Class	Weakly cemented cohesive coarse soils, weakly cohesive coarse soils, ferricrete and weathered bedrock

In practice, excavation to 3m depth in the typical soil profile in the Northern Area would generally be classified as Soft Excavation Class with possibly 10% to 15% categorised as Intermediate Excavation.

Weakly cemented layers are commonly developed in the Central Strip and the percentages of Soft and Intermediate Excavation are probably of the order of 70% to 30% respectively.

Weakly cemented layers also occur in places in the Southwestern Area and the percentages of Soft and Intermediate Excavation are probably approximately 85% to 15% respectively.

The surficial sandy soils and possibly the cohesionless coarse soils in winter can be efficiently excavated manually, but all other soils will be difficult to excavate manually, particularly when the soils dry out in summer.

6.4 Impact of the geotechnical character of the site on subsidy housing development

6.4.1 *Land usage*

There is minimal vegetation cover, and with the correct preparation, site clearance and founding methods and removal of the embankment walls, the entire study area will be suitable for human settlement and subsidy based housing with the exception of the area in the extreme southwestern corner of the site which will be subject to periodic inundation and flooding, and also possibly the seasonally wet parts of the Southwestern Area.

6.4.2 *Subsidy variations*

In considering the entire site and using Annexure 1 of the General Specification, the following generic subsidy variations for the site and founding conditions are applicable:

II SITE CONDITIONS

1 Seepage/Groundwater

1. Category1 - Permanent or perched water table less than 1m below ground surface.

This condition is expected seasonally in the southwestern corner of the site, and probably in places, in other areas.

Service trenches would have to be dewatered during construction.

3 Difficulty of servicing land due to slopes

3.1 Type I site - average slope measured along a 100m line in any direction from any of the boundaries of the erf is flatter than 1:100

Because the ground contours run consistently northwest-southeast, any services that run consistently parallel or sub parallel to the contours will be located at depth, in places to facilitate free flow in the services.

III FOUNDING CONDITIONS

1 Expansive soils

1.1 Class H1

This condition occurs in the Northern Area. The masonry houses will require foundation design, building procedures and precautionary measures to be in accordance with Table 5 of Part 1, Section 2 of the NHBRC Coal Home Building Manual.

Additional factors that are not categorised in Annexure 1 but will affect construction costs include:

- The embankment walls for the old evaporation ponds must be removed and the soils placed as engineered fill within the basins of the ponds. The quantity of material to be moved is unknown to the Author. The cost of excavation and placing this material should also be reflected in the costing and subsidy variation.

- Material that is excavated from road beds, foundation trenches and some foundation trenches in the Northern Area might comprise a mixture of sandy and cohesive soils. Excavated material from deep (>1.25m) service trenches in all areas will also contain a mixture of soils. This material is unsuitable for structural fill and it should not be placed on adjacent erven or under surface beds. The cost of handling and spoiling the materials should be included in the assessment of subsidy variation.

- Over-excavation of trenches in the gravelly soils will be required to ensure stability of the sidewalls of the service trenches, particularly where groundwater is encountered. The cost of the extra excavation, the spoiling of additional quantities of material unsuitable for backfill and the additional importation of selected material for backfilling service trenches should be reflected in the costing and subsidy variation.

Although the site investigation coverage was extensive, the soil conditions may vary between trial holes. Consequently, subsidy variations could also vary depending on the ground conditions actually encountered.

7. SITE CLASSIFICATION

7.1 NHBRC Classification

According to Table 5 in the Generic Specifications and Table 1, Section 2 of the NHBRC Home Building Manual, Part 1, and based on the assessments given above, the following NHBRC classifications, whose distributions are shown on Figure 7, are applicable to the site:

Northern Area A:	Site Class H1 and H1 with S
Central Strip:	Site Class H and H with S
Southwestern Area:	Site Class S/S1

The 'S' classification in the first two areas currently refers to the fill in the embankment walls, but the classification will largely fall away when the walls are flattened and the material placed in engineered fill.

7.2 Geotechnical Classification for Urban Development

The areas containing the three generalised soil profiles described in Section 5.2, plus the seasonally wet area in southwestern corner, areas with different slope gradients and the area that will be subject to the 1 in 100 year flooding have been classified using the Geotechnical Classification for Urban Development in Table 3 of the GFSH-2 Generic Specifications. For ease of reference, the table from GFSH-2 is presented on the next page as Table 5 of this report.

The terrain mapping units were derived from the results of the site investigation and other data or activities referenced in Section 2 of this report. The extent of the mapping units was determined by extrapolation of information from the trial pits.

The distributions of the terrain mapping units are shown on Figure 8, and the mapping units can be described as follows:

(i) **Thin colluvium and alluvium over Malmesbury soils and weathered rock – 1ABEI 2C 3K:**

This mapping unit lies between the eastern edge of the evaporation pond area and the eastern boundary.

The classification reflects the presence of potentially slightly collapsible thin soils, perched groundwater more than 1.5 m below ground surface, the low erodability of the soils and ground sloping between 2° and 6°, all of which represent most favourable conditions.

Intermediate constraints include the moderate heave potential of the soil profile and the least favourable constraint is that the site occurs close to the epicentre of the 1969 'Tulbagh' earthquake and a natural seismicity of more than 100 cm/sec^2 will occur.

(ii) **Thin colluvium and alluvium over Malmesbury soil and weathered rock – shallower slopes – 1ABE 2CI 3K**

This unit is developed in the area between the northern side of the evaporation ponds and the northern boundary, and the remainder of the Northern Area to the west of the ponds.

The classification reflects the same features described in (i) above, but ground slopes of less than 2° represent an intermediate constraint.

(iii) **Thin colluvium and alluvium over Malmesbury soils and weathered rock – evaporation pond area – 1ABE 2CI 3K with 1D 3IK**

This unit occurs in that part of the Northern Area that falls within the evaporation ponds.

The 1ABE 2CI 3K classification reflects the conditions in the basal areas of the ponds and the explanation was presented in (ii) above.

The classification for the embankment walls is currently 1D 3IK which reflects low soil compressibility, but steep slopes and the seismicity of the region are also considered.

TABLE 5: GEOTECHNICAL CLASSIFICATION FOR URBAN DEVELOPMENT

CONSTRAINT		Most favourable (1)	Intermediate (2)	Least favourable (3)
A	Collapsible Soil	Any collapsible horizon or consecutive horizons totaling a depth of less than 750mm in thickness*	Any collapsible horizon or consecutive horizons with a depth of more than 750mm in thickness	A least favourable situation for this constraint does not occur
B	Seepage	Permanent or perched water table more than 1,5m below ground surface	Permanent or perched water table less than 1,5m below ground surface	Swamps and marshes
C	Active	Soil Low soil-heave potential anticipated*	Moderate soil heave potential anticipated	High soil-heave potential Anticipated
D	Highly compressible Soil	Low soil compressibility anticipated*	Moderate soil compressibility anticipated	High soil compressibility Anticipated
E	Erodability of soil	Low	Intermediate	High
F	Difficulty of excavation to 1,5m depth	Scattered or occasional boulders less than 10% of the total volume	Rock or hardpan pedocretes between 10 and 40% of the total volume	Rock or hardpan pedocretes more than 40% of the total volume
G	Undermined ground	Undermining at a depth greater than 240m below surface (except where total extraction mining has not occurred)	Old undermined areas to a depth of 90-240 m below surface where stope closure has ceased	Mining within less than 90-240m of surface or where total extraction mining has taken place
H	Stability: (Dolomite & Limestone)	Possibly stable. Areas of dolomite overlain by Karoo rocks or intruded by sills. Areas of Black Reef rocks. Anticipated Inherent Risk Class I	Potentially characterised by instability. Anticipated Inherent Risk Classes 2 – 5.	Known sinkholes and dolines. Anticipated Inherent Risk Classes 6 –8.
I	Steep slopes	Between 2° and 6° (all regions)	Slopes between 6° and 18° and less than 2° (Natal and Western Cape) Slopes between 6° and 12° and less than 2° (all other regions)	More than 18° (Natal and Western Cape) More than 12° (all other regions)
J	Areas of unstable natural slopes	Low risk	Intermediate risk	High risk (especially in areas subject to seismic activity)
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s² within 50 years	Mining-induced seismic activity more 100 cm/s²	Natural seismic activity more than 100 cm/s²
L	Areas subject to flooding	A "most favourable" situation for this constraint does not occur	Areas adjacent to a know drainage channel or floodplain with slope less than 1%	Areas within a known drainage channel or floodplain

* These areas are designated as 1A, 1C, 1D, or 1F where localised occurrences of the constraint may arise.

Example: A sub-area designated as Zone 2BF would be an intermediate class with anticipated seepage and excavation problems.
A sub-area designated as Zone 3B would be designated as least favourable and not recommended for development due to surface water inundation.

(iv) **Thin alluvium over Malmesbury soils and weathered rock – 1AE 2(B)CI 3K**

This unit occurs in the Central Strip.

The classification reflects similar conditions to those discussed in (ii) above, but there is greater likelihood of encountering shallower perched groundwater conditions in winter.

The classification for the embankment walls is currently 1D 3IK which reflects low soil compressibility, but steep slopes and the seismicity of the region are also considered.

(v) **Thick alluvium – 2B(D)I 3K**

This unit occurs in those parts of the Southwestern Area to the east (downstream) of the 1 in 100 year floodline.

The classification reflects the fact that there will be a perched water table less than 1.5m below ground surface, that the soils have borderline moderate compressibility when wet and the ground slopes are shallow, all of which are intermediate constraints. The seismicity of the region is also reflected.

It should be noted that the southern two-thirds of this area is seasonally wet and that it has a marginal 2L 3B classification.

(vi) **Thick alluvium within the 1 in 100 year flood line – 2B(D)I 3KL**

This unit occurs in those parts of the Southwestern Area to the West (upstream) of the 1 in 100 year floodline.

The explanation is as per the relevant parts of (iv) above, but the area has lies within a known floodplain.

(vii) **Dam area – 3BKL**

This unit occurs in the small dam in the extreme southwestern part of the Southwestern Area.

The classification indicates most unfavourable conditions including marshy conditions, its location within a floodplain and the seismicity of the area apply to this dam area.

8. FOUNDATION RECOMMENDATIONS AND SOLUTIONS

Based on the general NHBRC classifications in Section 7.1, and Part 1, Section 2, Tables 5 and 7 of the NHBRC Home Building Manual, the following foundation types are considered appropriate for the houses in the various areas:

(i) **Northern Area – Site Class H1**

Lightly reinforced strip footings with articulation joins at all internal/external doors and openings and light reinforcement in the masonry.

Site drainage and plumbing/service precautions will be necessary.

(ii) **Northern Area – evaporation pond area – Site Class H1 with S**

Once the material from the embankment walls has been removed and placed as thin engineered fill in the basal parts of the ponds, H1 conditions will occur, and the layout and measures described for (i) above are again considered appropriate.

(iii) **Central Strip – Site Class H**

Normal construction comprising strip footings founded at 0.6m depth are considered appropriate.

Site drainage and plumbing/service precautions are recommended.

(iv) **Central Strip – Site Class H/S**

Provided that the material from the embankment wall is placed and compacted according to specifications, normal strip footings founded at 0.6m depth are considered appropriate.

Site drainage and plumbing precautions are recommended.

(v) **Southwestern Area – non seasonally wet sub area – Site Class S**

Normal strip footings founded at 0.6m depth with foundation pressures not exceeding 50kPa are considered appropriate.

Good site drainage is essential.

(vi) **Southwestern Area – seasonally wet sub area – Site Class S/S1**

The soils are likely to soften/loosen seasonally with increases in soil moisture and the classification would be borderline Site Class S/S1.

Normal strip footings typically founded at 0.6m depth with foundation pressures not exceeding 50kPa will be appropriate for this area. However, allowance should be made for modified normal, lightly reinforced footings in, say, 60% of the houses.

It should be noted that special drainage measures and/or raising of the ground levels are essential in this seasonally wet area.

(vii) **Southwestern Area – sub area within the 1 in 100 year floodline – Site Class S/S1**

Unless special measures such as protective berms or raising ground levels are instituted, no construction should occur in this area. This restriction should also include the pond or dam in the extreme southwestern corner where the Site Class P (marshy area) occurs.

Raft foundations could be used in all the sub areas of the site with the exception of the seasonally wet parts of the Southwestern Area. The rafts should be carefully designed and constructed to ensure that settlement or heave of the soils are handled by the raft.

9. DRAINAGE

The general slope of the site is very shallow particularly in the Southwestern Area and most parts of the Central Strip. Careful attention to general surface drainage will therefore be required during design and construction. In this respect, extensive drainage measures will be required in the Southwestern Area if that area is to be developed.

Good drainage around the houses is also essential and careful local shaping of the ground and design of stormwater will be required to ensure that drainage is efficient and no ponding of stormwater occurs.

Subsurface drainage will be required next to roads throughout the Southwestern Area. In addition, because the surficial cohesionless coarse soils contain small amounts of fines and are underlain by less permeable soils, subsurface drainage next to roads in other parts of the site should be considered to prevent saturation and 'mattressing' of the surficial soils.

10. SITE CLEARANCE AND PREPARATION AND EARTHWORKS

Site clearance will be extensive and include the following:

- Removal of the large trees that grow in several parts of the site, particularly along the eastern boundary.
- Removal of the Port Jackson bush and trees.
- Demolition and removal of the shacks and livestock pens on the western side of the site.
- Demolition and removal of the old house and other structures in the Southwestern Area.
- Removal of the old feed and gravity lines from the neighbouring sewage works to the evaporation ponds.
- Removal of the outlet/inlet works structures in the ponds.
- Removal and spoiling off the site of the piles of rubble and rubbish scattered throughout most of the site.

Because the site layout is unknown, no specific comment can be made with regard to earthworks requirements with the exception and that the embankment walls will have to be removed and reworked.

It is assumed that the soils from the walls will be placed in the basal areas of the ponds. Irrespective of where it is placed, the areas to be filled must be cleared of vegetation and the small areas where the bases of large trees should be carefully cleared of remnant roots and loose material. The subgrade throughout the cleared areas should then be compacted to at least 90% of mod AASHTO maximum dry density with a ten-tonne, smooth drum, vibratory roller. The material from the embankment walls can then be placed in layers not exceeding 250mm in thickness, moistened to within 2% of optimum moisture content and rotivated, if necessary, to mix the soil and water, and then compacted to 98% of mod density.

Nuclear densimeter (troxler) tests should be undertaken on a routine basis as the layers are placed and at the intervals prescribed in SABS 1200 D.

It should be noted that the soils are moisture sensitive, and it will not be possible to achieve satisfactory compaction in, for example, winter when the soils are wet of optimum or when they are dry towards the end of summer.

Mixtures of sandy and clayey soils should not be placed in the engineered fill.

11. USE OF ON-SITE MATERIALS FOR CONSTRUCTION PURPOSES

The cohesionless coarse soils and the soils in the embankment walls will be suitable for engineered fill provided that the moisture content lies within 2% of optimum moisture content. If not they must be spoiled and imported materials substituted or they must be allowed to dry out.

It is unlikely that they will be suitable for pipe bedding, but they will be suitable for general fill in service trenches and for backfill below surface beds, provided that the soils are neither too wet nor too dry.

In general, the silty or clayey soils and their slightly gravelly derivatives, and the cohesive coarse soils will not be suitable for use as fill, and this material and particularly mixes of the soil types must be spoiled.

The residual and Malmesbury soil and weathered rock could probably be used in engineered fill where it should be compacted to 95% of mod density with a pad foot vibratory roller. It could also be used in the wide service trenches where a sufficiently large compactor can be used. These materials are also moisture sensitive, and mixtures of Malmesbury materials and other soils must be avoided.

Clean sand for bedding, and sub base and basecourse for road layer works should be imported.

12. ROAD CONSTRUCTION

Site preparation for the roads should include excavation of the road bed and removal of any vegetation (roots etc.). The subgrade conditions will then comprise thin remnant cohesionless coarse soils in the Northern Area, thin remnant cohesionless soils over silty or clayey soils in the Central Strip, and silty or clayey soils and cohesive coarse soils in the Southwestern Area.

Based on the results presented in Table 2, the cohesive coarse soils and the Malmesbury materials have very low, saturated CBR's, whereas the other materials have relatively high CBR's and fair to good subgrade properties.

The subgrade in the road bed should be compacted to at least 93% of mod density. The design of the roads and the road layer works should take cognisance of the very low saturated CBR's of the shallow oils in the Northern and Southwestern Areas.

Subsurface drainage will be required next to and probably below the roads in the Southwestern Area, and particularly in the seasonally wet parts. The comment in Section 9 on subsurface drainage next to roads in the other parts of the site should also been noted.

It should be noted that the trafficability over the cohesionless coarse soils will be difficult in winter because these soils will become saturated. Provision should therefore be made to pioneering temporary access roads with a gravel surfacing.

13. SPECIAL PRECAUTIONARY MEASURES

Special precautionary measures should include the following:

- Inspection of all foundation trenches and DCP testing in the trenches to ensure that the structural design is in accordance with the ground conditions actually encountered.
- Measures should be instituted to safeguard workers in service trenches from collapse of the sidewalls of the trenches.
- The ground should be shaped so that no ponding occurs against the houses.
- Subsurface services should be designed and constructed so that they are located sufficiently far from buildings that their backfilled trenches do not interfere with the foundations for houses and other structures.
- Excess soils from, for example, the road bed or service trenches should not be spoiled on the general site area otherwise the subgrade for the surface beds and possibly for footings will be adversely affected.
- The trial pit positions should be identified during the initial phases of development and special compaction or other special founding measures may be required to ensure the founding conditions for the future houses or roads are adequate.

14. CONCLUSIONS

a) Numerous soil types, with weathered bedrock at varying depths, are developed throughout the site. The multiplicity of soil types reflects a complex and variable colluvial and alluvial depositional environment, with pedogenic processes also occurring. Categorisation of the natural soils into seven groups with similar properties is possible and three generalised, natural soil profiles and their areas of occurrence can be identified. For descriptive purposes, the areas have been named the Northern Area, the Central Strip and the Southwestern Area.

b) The cohesionless coarse soils forming the fill in the embankment walls of the old evaporation ponds, which cover large parts of the central and eastern areas of the site, are superimposed on two of the natural profiles.

c) The presence of weakly cemented layers, ferricrete and the juxtaposition of coarse soils over clayey or silty transported soils or weathered bedrock suggests that seasonal perched groundwater is widespread in and immediately after the wet period of the year. In addition, most of the area in the southwestern corner of the site is seasonally wet, with an attendant very shallow seasonal perched water table.

d) Laboratory testing and field testing indicate that the soils are relatively dense or stiff and they are not significantly compressible except in the Southwestern Area where the estimated settlement is approximately 10mm when the soils are wet.

e) Active soils are predominantly developed in the Northern Area and the Central Strip and a maximum soil strain up to 15mm is possible.

f) The soils will not be subject to significant collapse consolidation or dispersion.

g) Seven terrain mapping units are recognised and the associated geotechnical classifications, in general, reflect that the presence of thin collapsible surficial soils layers, the possible presence of shallow groundwater, the low erodability of the soils, the generally shallow ground slopes, the presence or absence of compressible or active soils, and the seismic environment of the area.

h) Based on the guidelines in the NHBRC Home Building Manual, conventional strip footings or possibly raft foundations would be appropriate for single-storey houses in parts of the site, but lightly reinforced footings with ancillary structural measures will be required in the Northern Area and reinforcement of footings in probably 60% of the houses in the seasonally wet parts of the Southwestern Area will also be required. Good drainage around the houses is essential, and service/ plumbing precautions will be required, as relevant.

i) The 1 in 50 and 1 in 100 year floodlines of the Dal River lie within the extreme southwestern and western part of the Southwestern Area and the construction of the flood and inundation control measures appears necessary for the long-term serviceability of this area.

j) Careful attention to general surface drainage will be required. Sub surface drainage measures will be required in the Southwestern Area, if that area is to be developed, and they will also be required next to roads throughout the Southwestern Area. In addition, because the surficial cohesionless coarse soils contain small amounts of fines and are underlain by less permeable soils, subsurface drainage next to roads in other parts of the site should be considered to prevent saturation and 'mattressing' of the surficial soils.

k) The evaluation of the subsidy variation for low cost housing should consider the costs of dewatering some trenches in winter, deep services if they run sub parallel to contours, and the cost of non normal footings for the houses. Additional costs will include removal and reworking of the existing embankment walls, handling and spoiling of mixtures of excavated soils that contain clayey material, and over-excavation in service trenches to ensure their stability. The cost of possible flood control or inundation measures and sub surface drainage should also be reflected.

l) With exception of parts of the Southwestern Area where encroachment of floodlines occurs, and the presence of the embankment walls of the old evaporation ponds, no significant geotechnical constraints are apparent in the study area which is therefore generally considered generally suitable for human settlement and subsidy based housing.

R.A. BRADSHAW Pr.Sci. Nat.
for R.A. BRADSHAW & ASSOCIATES cc

Appendix A:

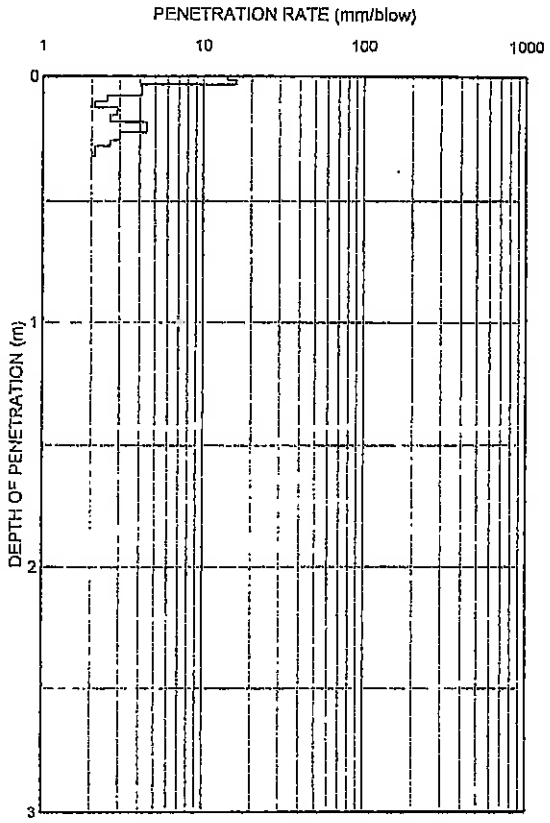
DESCRIPTION OF SOIL PROFILES IN TRIAL PITS AND RESULTS OF DCP TESTS

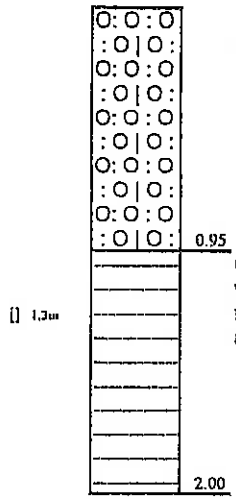
DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 1/2/2008

TEST NO: DCP 23 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP23 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728350 Y: -600





SILTY SANDY GRAVEL Dry, grey brown to orange brown, very dense (locally weakly cemented), layered, slightly silty, medium to coarse sandy fine gravel. Colluvium/pedogenic.

GREYWACKE Grey, stained and mottled red brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke, and very soft rock to very stiff soil.

NOTE: Machine excavating very slowly to 0.95m depth.
Depth of hole restricted by hardness of silty sandy gravel layer.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

▽ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 1/2/2008

TEST NO:

STARTING DEPTH:

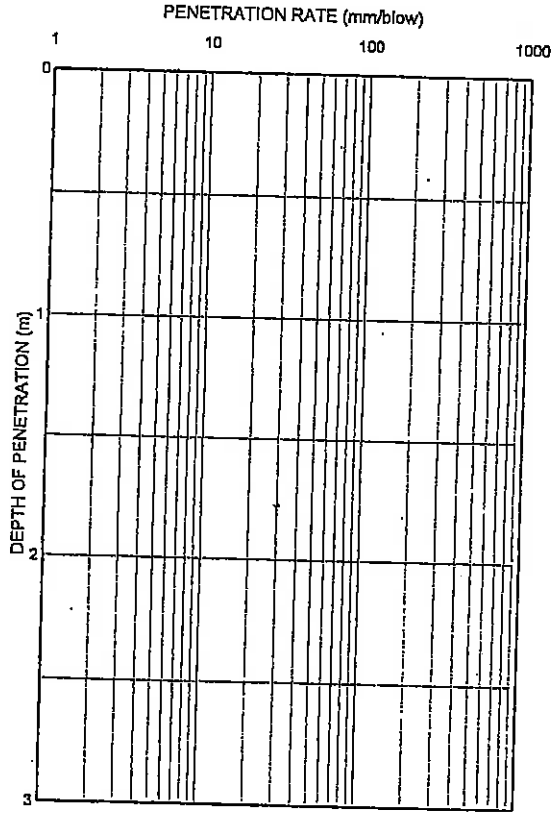
ELEVATION:

TRIAL PIT NO: TP24

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728444

Y: -713



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XXXXXX 1.80

MADE GROUND Dry becoming moist with depth, variably coloured, light grey, greyish brown and light orange brown, medium dense to dense, layered fill comprising different coloured layers of clayey silty medium to coarse sand with minor fine gravel. Embankment fill.

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:|: : o: |: :
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:|: : o: |: :
: o :|: o :
:|: : o: |: :
: o :|: o : 2.50

GRAVELLY SILTY SAND Moist, brownish grey, medium dense, slightly pinholed, slightly clayey silty fine to medium sand with minor fine gravel. Colluvium.

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O/:O:/:O
:/:O:/:O/: 2.90

CLAYEY SANDY GRAVEL Slightly moist, dark orange brown, very stiff, slightly fissured, clayey medium to coarse sandy fine gravel. Colluvium.

o/ o /o
/ o /o /
o/ o /o
/ o /o /
o/ o /o 3.35

GRAVELLY CLAYEY SILT Slightly moist, grey and mottled brown, very stiff/hard/weakly cemented, slightly fissured, clayey silt with scattered fine gravel. Colluvium/pedogenic.

NOTE: Trial pit excavated into side of embankment. Machine excavating very slowly between 2.9m and 3.35m No DCP test undertaken.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

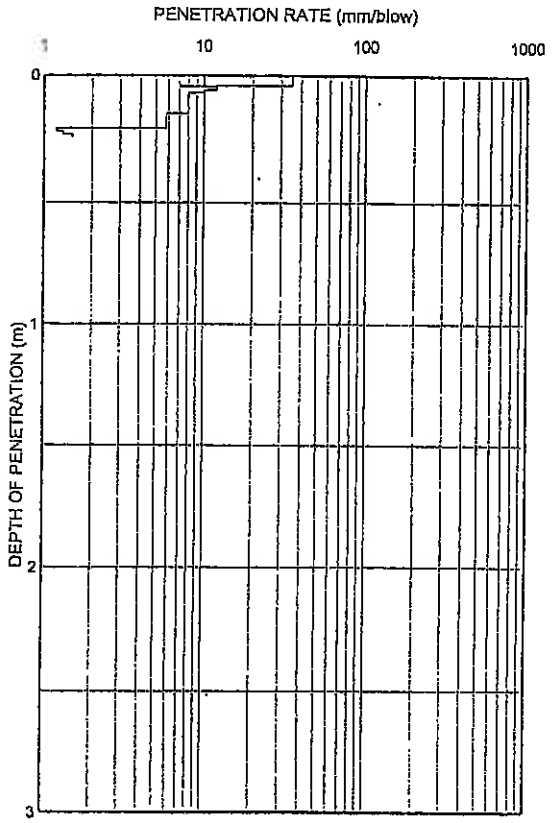
V PERCHED WATER TABLE

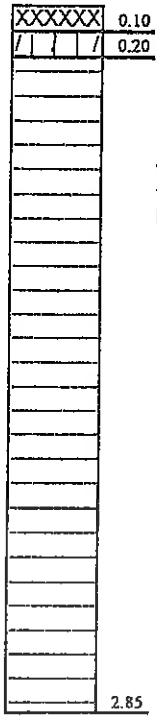
DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 1/2/2008

TEST NO: DCP 22 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP22 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728250 Y: -500





0.10 MADE GROUND Dry, brown grey, very dense, slightly clayey silty
0.20 sandy material probably washed into base of evaporation pond.
CLAYEY SILT Dry, yellow brown, very stiff, fissured, clayey silty. Pedogenically altered Malmesbury soil.

GREYWACKE Grey, stained and blotched orange brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke bedrock.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 1/2/2008

TEST NO:

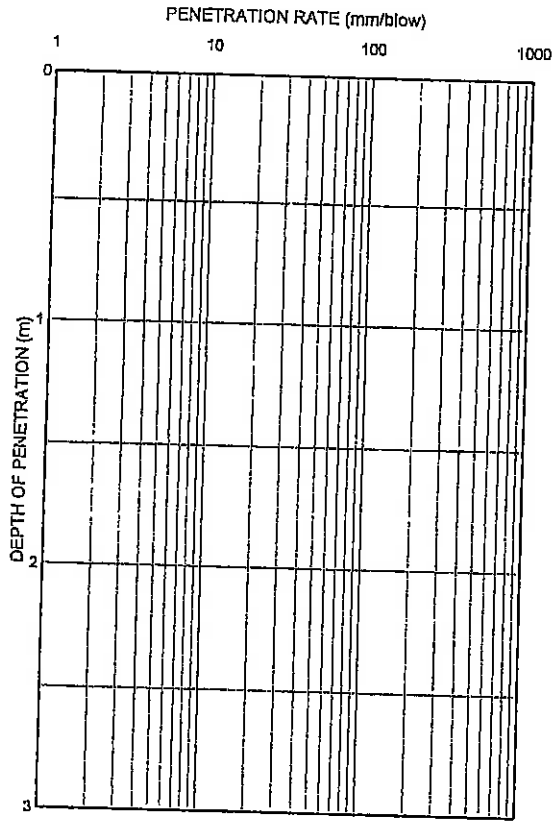
STARTING DEPTH:

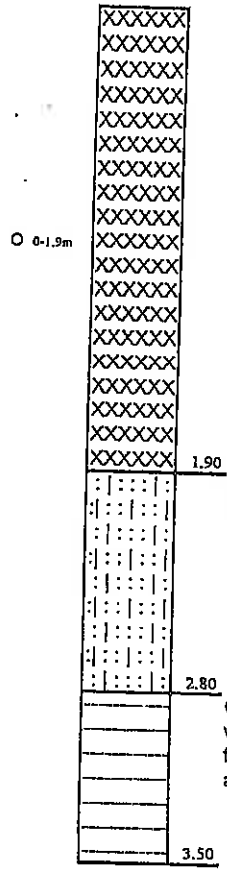
TRIAL PIT NO: TP21

METHOD OF INVESTIGATION : Digger/loader

ELEVATION:

COORDINATES: X: 3728148
Y: -405





MADE GROUND Dry becoming moist with depth, variably coloured, light grey, greyish brown and light orange brown, medium dense to dense, layered fill comprising different coloured layers of mainly clayey silty medium to coarse sand with minor fine gravel, but local clods of cohesive soil. Embankment fill.

SILTY SAND Moist, brownish grey, medium dense, slightly pinholed, slightly clayey silty fine to medium sand. Colluvium.

GREYWACKE Grey, stained and mottled red brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke, and very soft rock to very stiff soil.

NOTE: Trial pit excavated into side of embankment.
No DCP test undertaken.

Sandy Materials: (mm/blow)			Clayey Materials: (mm/blow)		
	Very loose	>75		Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

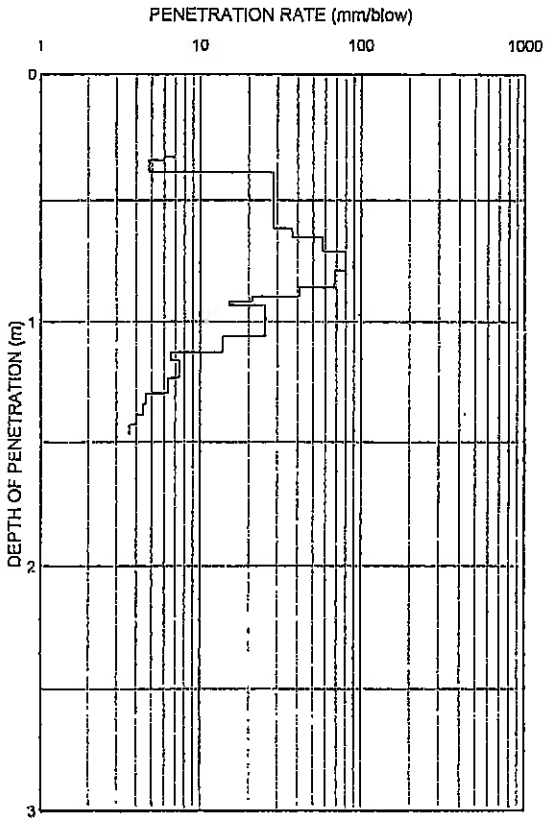
⊻ PERCHED WATER TABLE

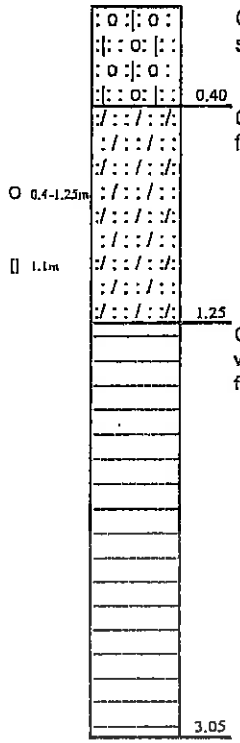
DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 1/2/2008

TEST NO: DCP 20 | STARTING DEPTH: In TP 20 at 0.25m depth. | TRIAL PIT NO: TP20 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728057 Y: -288





GRAVELLY SILTY SAND Dry, grey, very dense/hard, layered, slightly gravelly silty sand. Weakly cemented. Pedogenic.

CLAYEY SAND Moist, light grey, strongly blotched light brown, soft to firm fissured, clayey sand. Residual Malmesbury soil.

GREYWACKE Grey, stained and blotched orange brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock greywacke bedrock.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO: DCP 19

STARTING DEPTH: In TP 19 at 0.3m depth.

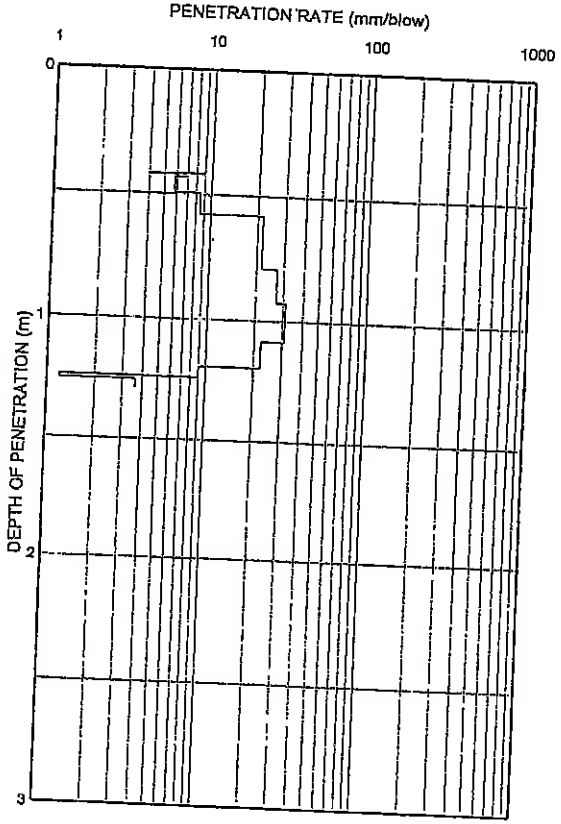
TRIAL PIT NO: TP19

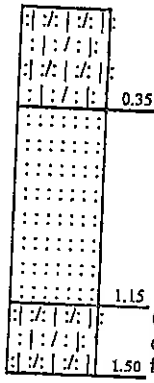
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3727850

Y: -500

ELEVATION:





0.35

CLAYEY SILTY SAND Dry, light grey brown, very dense/hard, pinholed, slightly clayey silty medium to coarse sand. Colluvium (?). Weakly cemented.

SAND Moist to very moist, grey brown, medium dense, intact, medium to coarse sand. Alluvial wash.

1.15

CLAYEY SILTY SAND Slightly moist, grey, stained brown, very dense/hard, intact, clayey silty medium to coarse sand with minor fine gravel. Pedogenic. Weakly cemented.

1.50

NOTE: Machine excavating very slowly at 1.5m depth.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO: DCP 17

STARTING DEPTH: Ground Surface

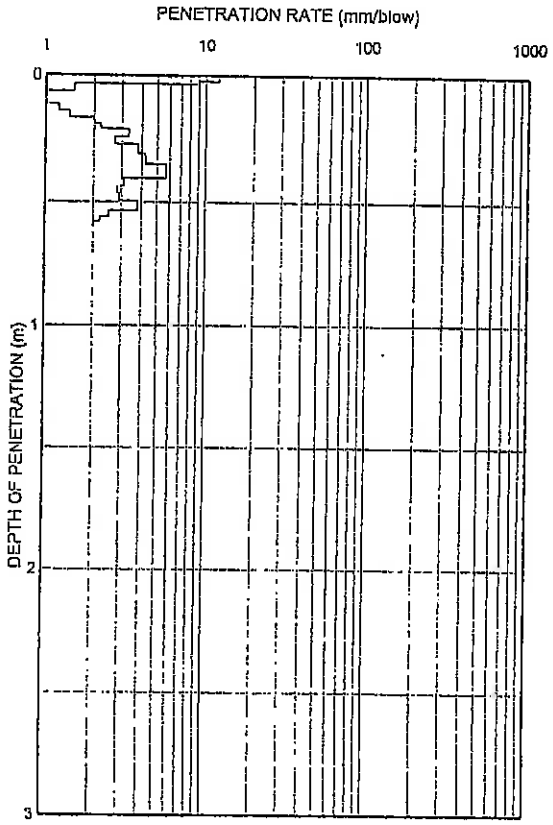
TRIAL PIT NO: TP17

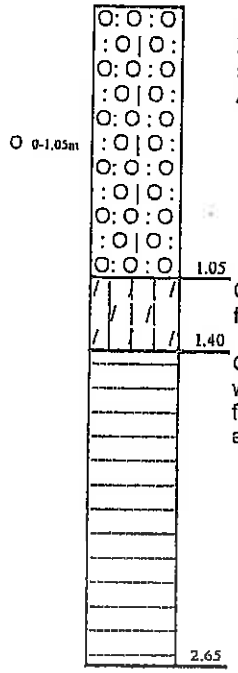
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728050

Y: -500

ELEVATION:





SILTY SANDY GRAVEL Dry, light greyish khaki becoming light orange brown with depth, very dense, layered, slightly silty fine to coarse sandy fine to medium gravel. Basal 250mm is weakly cemented. Alluvial wash (?).

CLAYEY SILT Slightly moist, grey blotched red brown, very stiff, fissured, clayey silt/silty clay. Colluvium.

GREYWACKE Grey, stained and mottled red brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke, and very soft rock to very stiff soil.

NOTE: Pit is located in evaporation pond.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO: DCP 18

STARTING DEPTH: Ground Surface

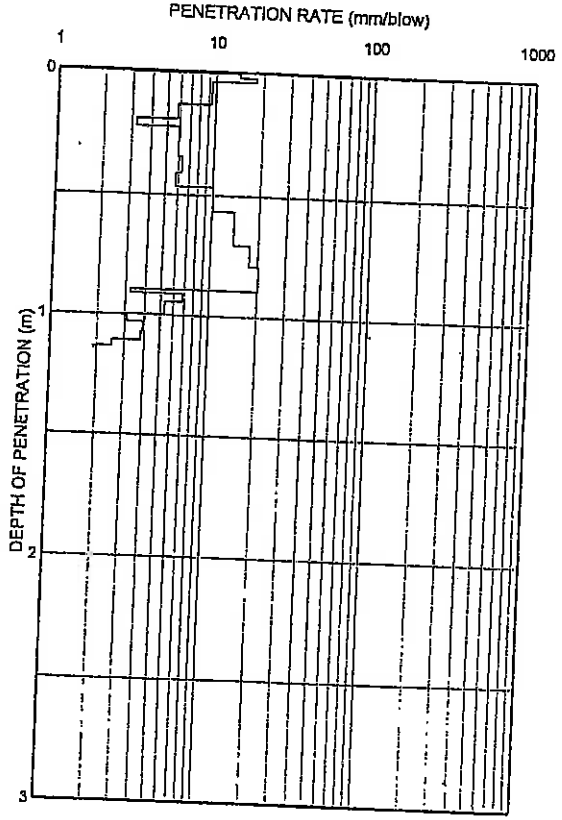
TRIAL PIT NO: TP18

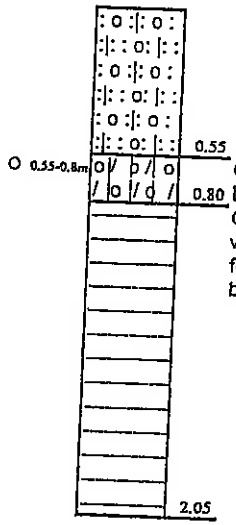
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3727950

Y: -400

ELEVATION:





SILTY GRAVELLY SAND Dry, light grey, dense, intact, slightly silty medium to coarse sand with fine gravel. Alluvial wash (?). Fine roots to 0.1m.

GRAVELLY CLAYEY SILT Slightly moist, khaki grey, mottled reddish brown, very stiff, fissured, clayey silt with scattered gravel. Alluvial wash (?

GREYWACKE Grey, stained and blotched orange brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke bedrock.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

U UNDISTURBED SAMPLE

▽ WATER TABLE

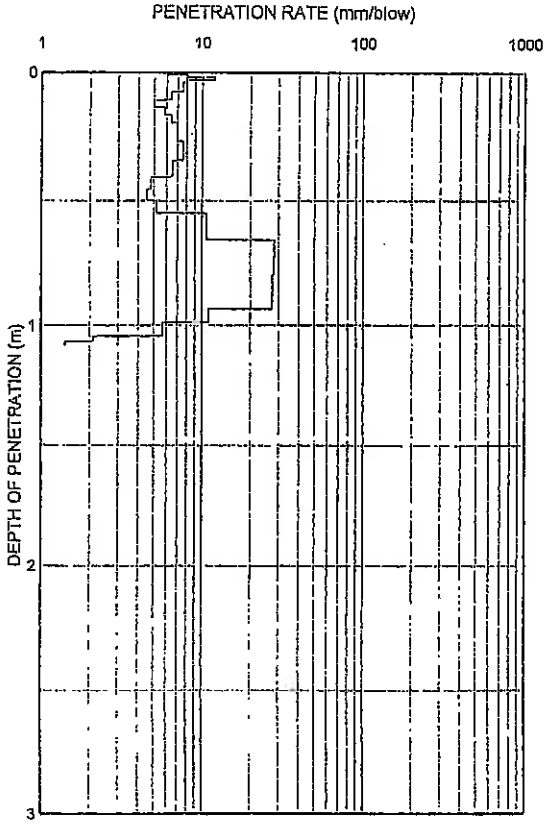
⊻ PERCHED WATER TABLE

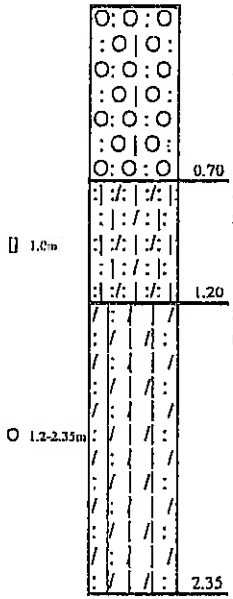
DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 31/1/2008

TEST NO: DCP 13 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP13 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728450 Y: -900





SILTY SANDY GRAVEL Dry to slightly moist, greyish brown, becoming orange brown with depth, dense, pinholed in upper 0.4m, then layered, slightly clayey silty and sandy, fine to medium, sub rounded ferruginised gravel increasing in concentration towards basal contact. Colluvium (?). Fine roots to 0.15m.

SILTY CLAYEY SAND Slightly moist, khaki grey, very stiff to stiff, fissured silty clayey sand. Colluvium.

SANDY CLAYEY SILT Slightly moist, khaki grey, fissured, sandy clayey silt with more sandy patches. Transported.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO:

STARTING DEPTH:

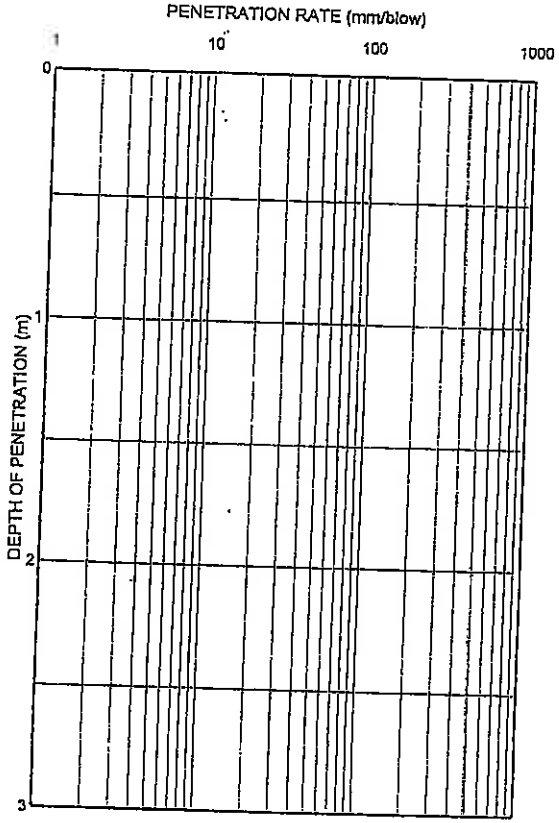
TRIAL PIT NO: TP14

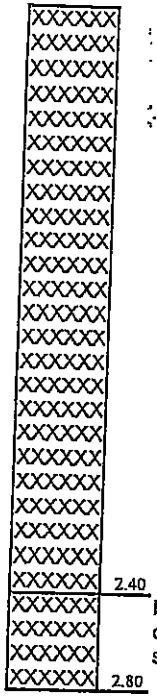
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728340

Y: -810

ELEVATION:





MADE GROUND Dry becoming slightly moist with depth, grey brown, yellow brown and khaki brown, medium dense and stiff, layered fill comprising layers of variable thickness of clayey silty sand, sandy clayey silt and gravelly derivatives of these soils. Embankment fill.

MADE GROUND Moist, dark khaki and reddish brown, very stiff fill comprising mainly clayey silt with minor irregular patches of silty sandy gravel. Embankment fill.

NOTE: No DCP test undertaken. Pit located in embankment fill.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

U UNDISTURBED SAMPLE

V WATER TABLE

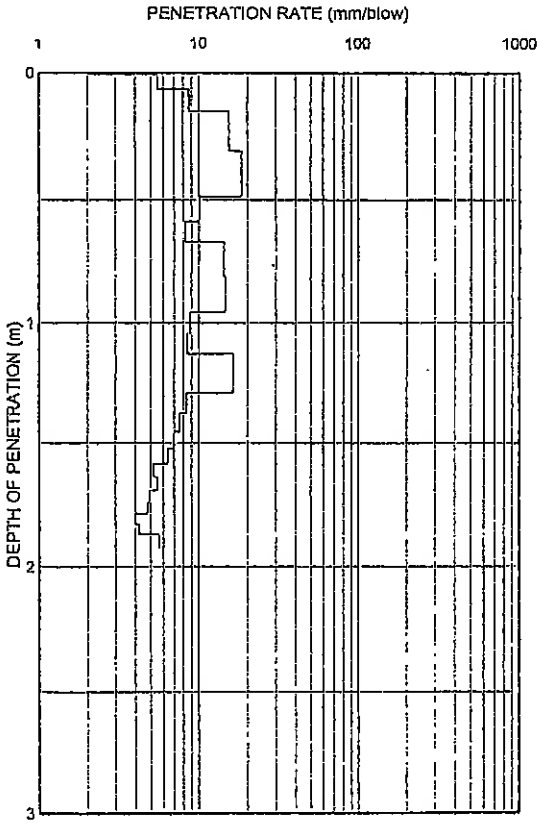
¥ PERCHED WATER TABLE

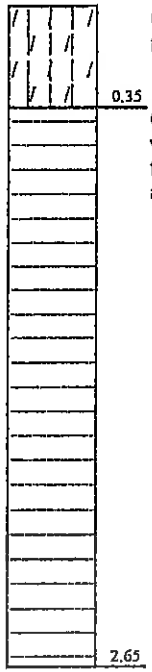
DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 31/1/2008

TEST NO: DCP 15 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP15 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728250 Y: -700





CLAYEY SILT Slightly moist, greyish yellow, very stiff, strongly fissured, clayey silt. Probably pedogenically altered Malmesbury soil.

GREYWACKE Light yellow brown, stained brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke, and very soft rock to very stiff soil.

Sandy Materials: (mm/blow)			Clayey Materials: (mm/blow)		
	Very loose	>75		Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

⧖ PERCHED WATER TABLE

NAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

TEST NO:

STARTING DEPTH:

DATE : 31/1/2008

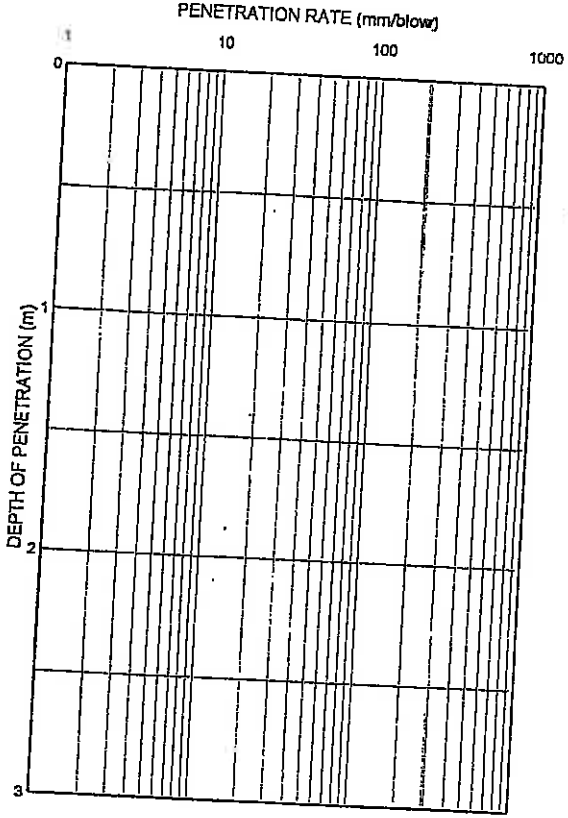
TRIAL PIT NO: TP16

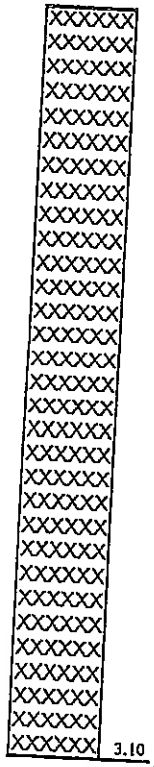
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728150

Y: -600

ELEVATION:





MADE GROUND Dry becoming moist at depth, light khaki becoming khaki orange with depth, medium dense to dense, layered fill comprising mainly slightly clayey silty fine to coarse sand with scattered gravel. Fine gravel more concentrated in upper 1m. Embankment fill.

NOTE: No DCP test undertaken. Pit located in embankment fill.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

U UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

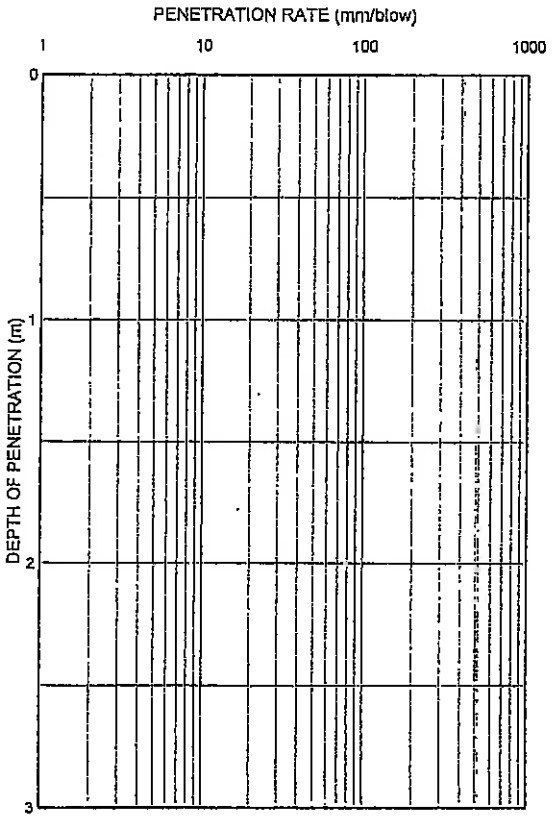
DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

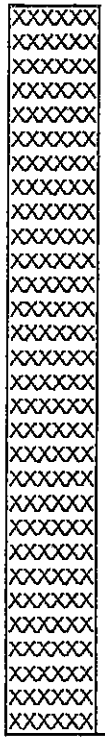
PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 31/1/2008

TEST NO: | STARTING DEPTH: | ELEVATION:

TRIAL PIT NO: TP12 | METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728541
Y: -1090





MADE GROUND Slightly moist, light brownish yellow, stiff to very stiff, layered, clayey sandy silt with fine to medium ferruginised gravel and rock fragments. Embankment fill.

NOTE: No DCP test undertaken. Pit located in embankment fill.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO:

STARTING DEPTH:

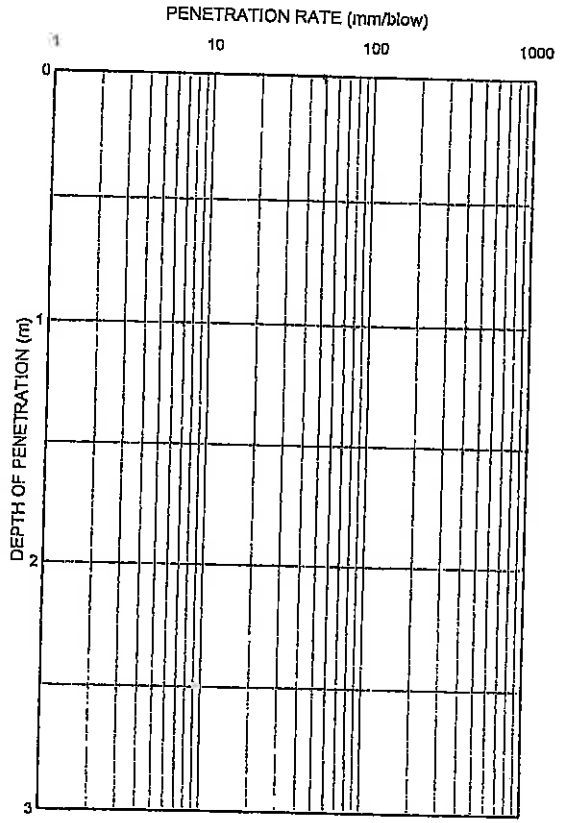
TRIAL PIT NO: TP11

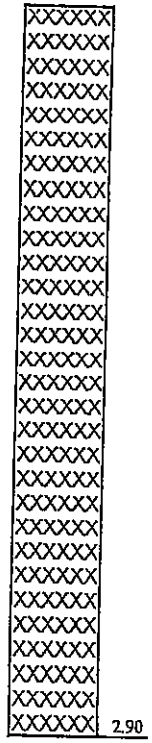
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728345

Y: -1026

ELEVATION:





MADE GROUND Slightly moist, light brownish yellow, stiff to very stiff, layered, clayey sandy silt with fine to medium ferruginised gravel and rock fragments. Embankment fill.

NOTE: No DCP test undertaken. Pit located in embankment fill.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO: DCP 10

STARTING DEPTH: Ground Surface

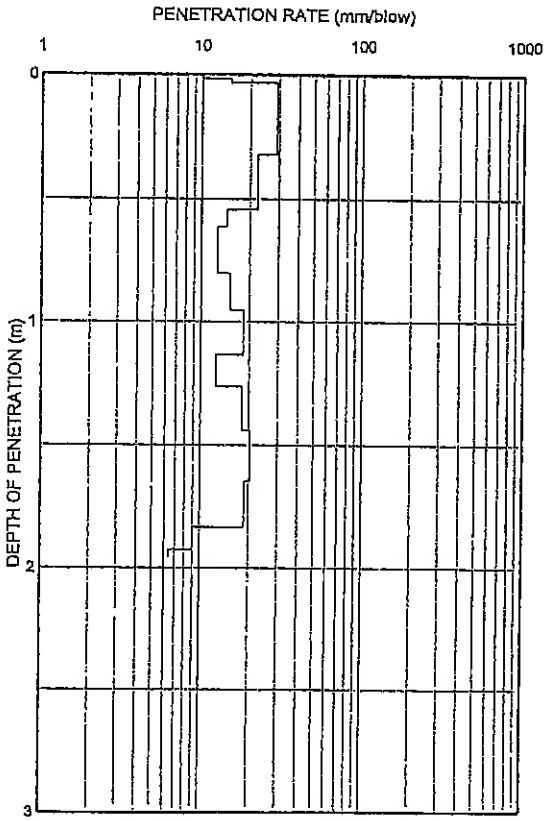
TRIAL PIT NO: TP10

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728250

Y: -900

ELEVATION:



SILTY GRAVELLY SAND Slightly moist, grey brown, medium dense, intact, slightly clayey silty fine gravelly sand. Possibly material washed into evaporation pond.

GREYWACKE Grey, stained and mottled red brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to soft rock greywacke, and very soft rock to stiff soil.

NOTE: Ground is moister than elsewhere.
Pit excavated in base of evaporation pond.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO: DCP 9

STARTING DEPTH: Ground Surface

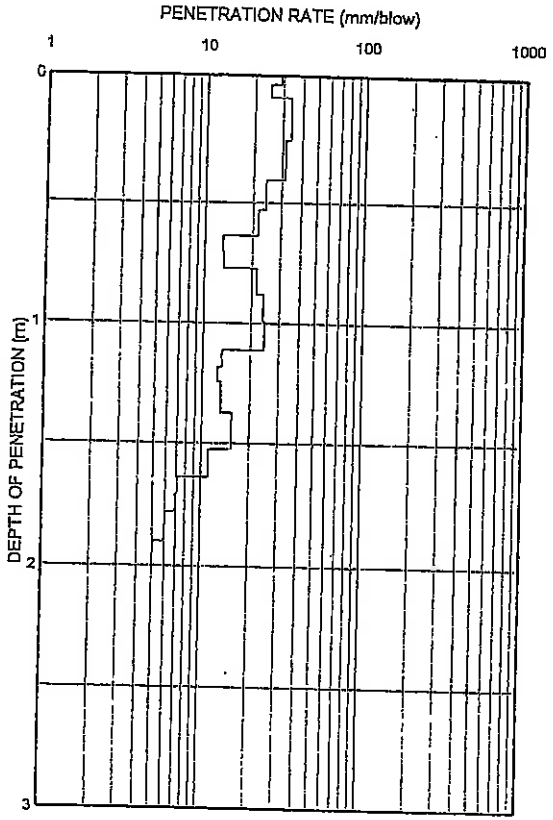
TRIAL PIT NO: TP9

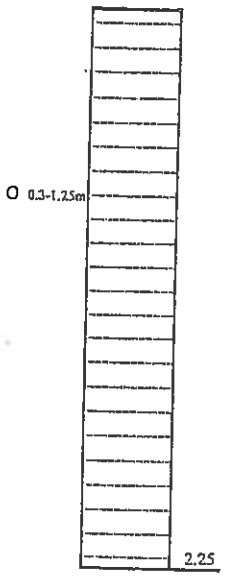
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728150

Y: -800

ELEVATION:





GREYWACKE Light yellow brown stained black locally, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to soft rock greywacke, and very soft rock to stiff soil.

NOTE: Ground is moister than elsewhere.
Pit excavated in base of evaporation pond.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 1/2/2008

TEST NO: DCP 7

STARTING DEPTH: Ground Surface

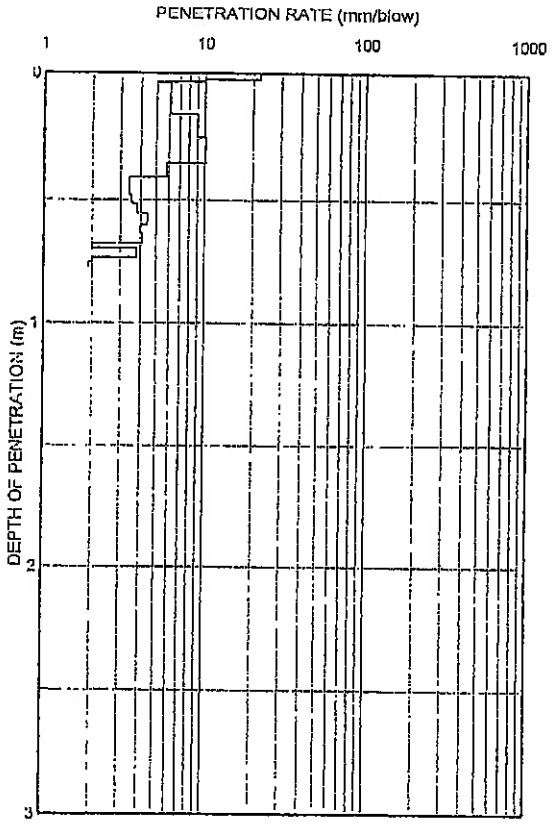
TRIAL PIT NO: TP7

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3727930

Y: -300

ELEVATION:



O 0-0.75m

GRAVELLY CLAYEY SAND Slightly moist to moist, dark orange and khaki brown, very stiff, fissured clayey medium to coarse sand with fine gravel. Colluvium.

0.75

GRAVELLY CLAYEY SILT Slightly moist, grey and mottled brown, very stiff/hard/weakly cemented, slightly fissured, clayey silt with scattered fine gravel. Colluvium/pedogenic.

1.40

SANDY CLAYEY SILT Slightly moist, khaki grey, fissured, sandy clayey silt with more sandy patches. Transported.

2.65

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

TEST NO:

STARTING DEPTH:

DATE : 31/1/2008

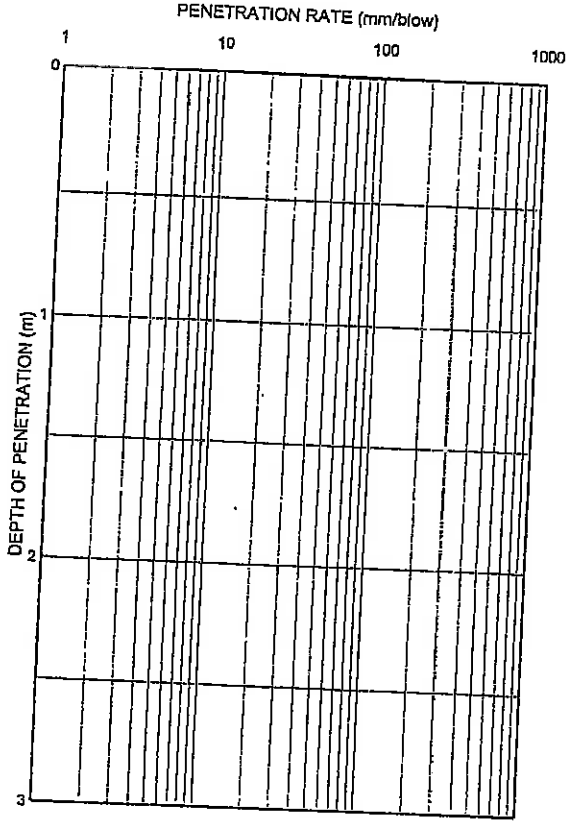
TRIAL PIT NO: TP8

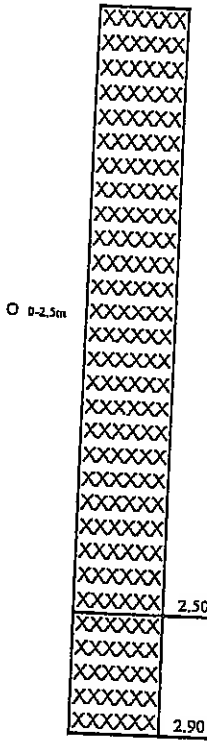
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728035

Y: -708

ELEVATION:





MADE GROUND Dry becoming moist with depth, medium dense, layered fill comprising mainly fine gravelly, clayey silty sand with clayey sandy silt with fine gravel. Embankment fill.

MADE GROUND Very moist, orange brown, stiff, layered fill comprising clayey medium to coarse sand with clods of khaki sandy clayey silt. Embankment fill.

NOTE: No DCP test undertaken. Pit located in embankment fill.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

U UNDISTURBED SAMPLE

▽ WATER TABLE

▼ PERCHED WATER TABLE

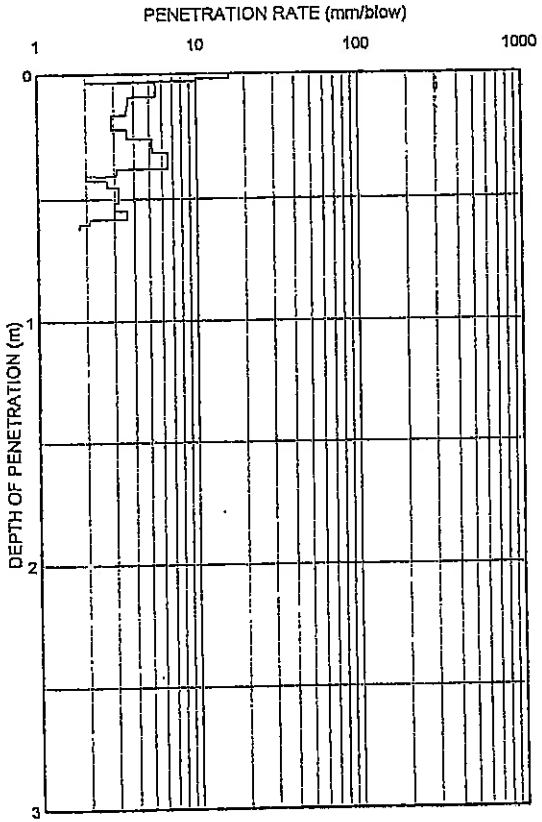
DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

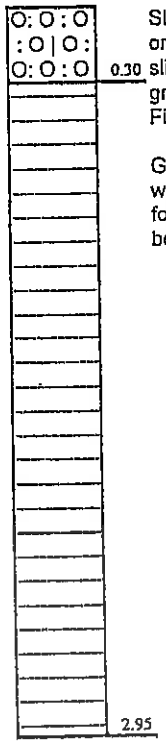
PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 31/1/2008

TEST NO: DCP 6 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP6 | METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3727950
Y: -800

ELEVATION:





SILTY SANDY GRAVEL Dry to slightly moist, greyish brown, becoming orange brown with depth, very dense, pinholed, then layered, slightly clayey silty and sandy, fine to medium, sub rounded ferruginised gravel increasing in concentration towards basal contact. Colluvium (?). Fine roots to 0.15m.

GREYWACKE Grey, stained and blotched orange brown; highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke bedrock. Pedogenically altered to 0.75m depth.

Sandy Materials: (mm/blow)			Clayey Materials: (mm/blow)	
	Very loose	>75	Very Soft	>110
	Loose	30 - 75	Soft	55 - 110
	Medium Dense	12.5 - 30	Firm	30 - 55
	Dense	5 - 12.5	Stiff	15 - 30
	Very Dense	2 - 5	Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO: DCP 5

STARTING DEPTH: Ground Surface

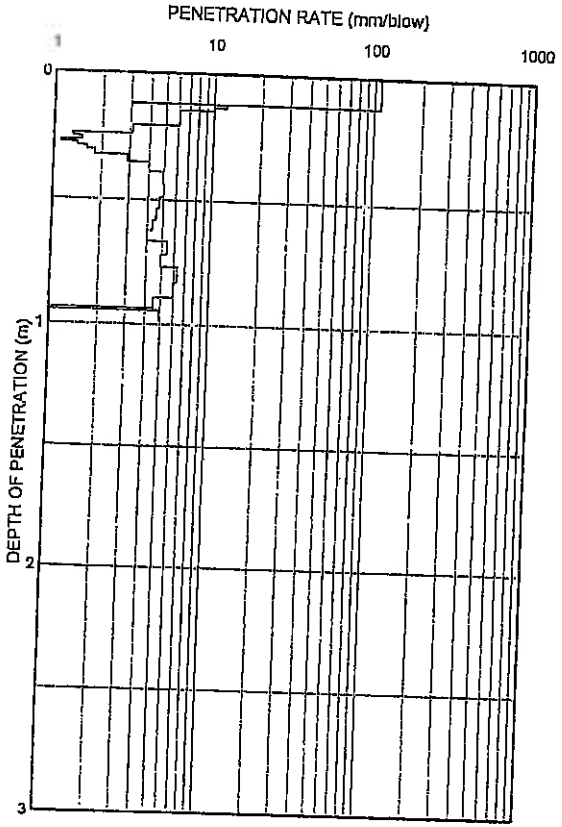
TRIAL PIT NO: TP5

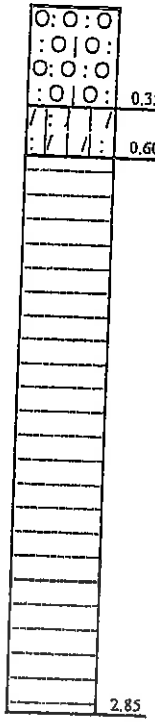
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3727950

Y: -950

ELEVATION:





SILTY SANDY GRAVEL Dry to slightly moist, greyish brown, becoming orange brown with depth, very loose to very dense, pinholed, then layered slightly clayey silty and sandy, fine to medium, sub rounded ferruginised gravel increasing in concentration towards basal contact. Colluvium (?). Fine roots to 0.15m.

CLAYEY SANDY SILT Slightly moist, khaki brown, very stiff, fissured, clayey sandy silt with scattered gravel. Colluvium.

GREYWACKE Grey, stained and blotched orange brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke bedrock.

NOTE: Machine excavating slowly at 2.85m depth.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

U UNDISTURBED SAMPLE

▽ WATER TABLE

▼ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO: DCP 4

STARTING DEPTH: Ground Surface

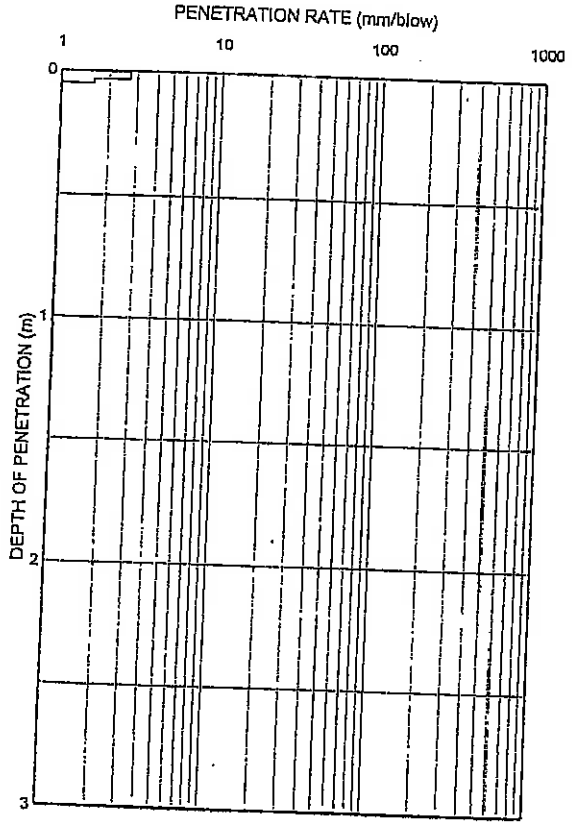
TRIAL PIT NO: TP4

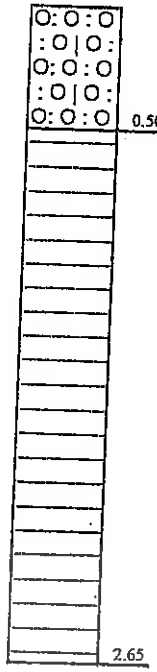
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728050

Y: -900

ELEVATION:





SILTY SANDY GRAVEL Dry to slightly moist, greyish brown, becoming orange brown with depth, dense to very dense, pinholed, then layered, slightly clayey silty and sandy, fine to medium, sub rounded ferruginised gravel increasing in concentration towards basal contact. Colluvium (?). Fine roots to 0.15m.

GREYWACKE Grey, stained and blotched orange brown, highly weathered becoming less weathered with depth, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke bedrock.

NOTE: Machine excavating slowly at 2.65m depth.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

▼ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

TEST NO: DCP 3

STARTING DEPTH: Ground Surface

DATE : 31/1/2008

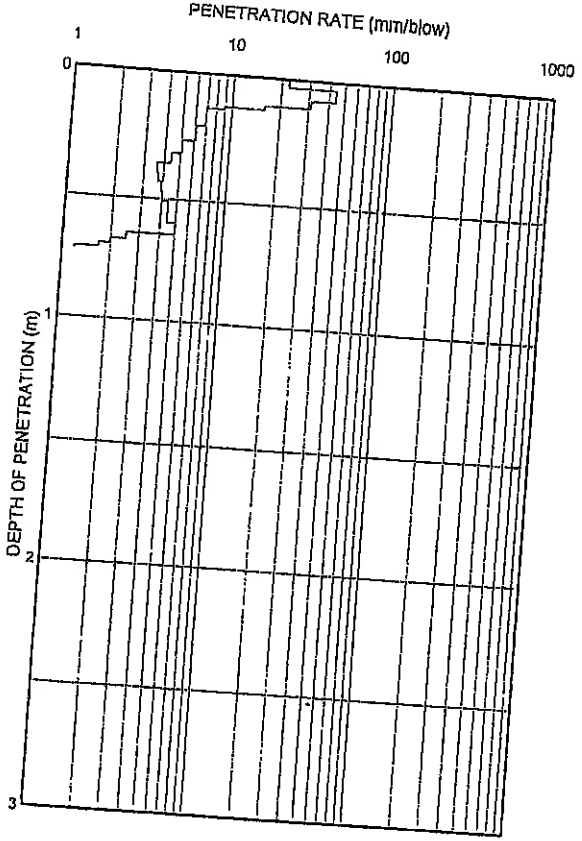
TRIAL PIT NO: TP3

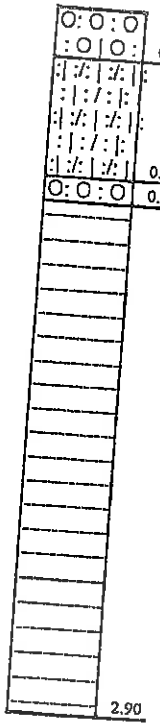
ELEVATION:

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728150

Y: -1000





0.15 SILTY SANDY GRAVEL Dry, grey brown, medium dense, pinholed, slightly clayey silty sandy fine to medium gravel. Colluvium (?). Fine roots

CLAYEY SILTY SAND Dry, light brownish yellow, dense, slightly pinholed, clayey silty fine to medium sand. Colluvium.

0.70

0.80 SILTY SANDY GRAVEL Slightly moist, orange brown, dense to very dense, intact slightly silty sandy fine gravel. Colluvium.

GREYWACKE Grey, stained and blotched orange brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke bedrock.

2.90

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

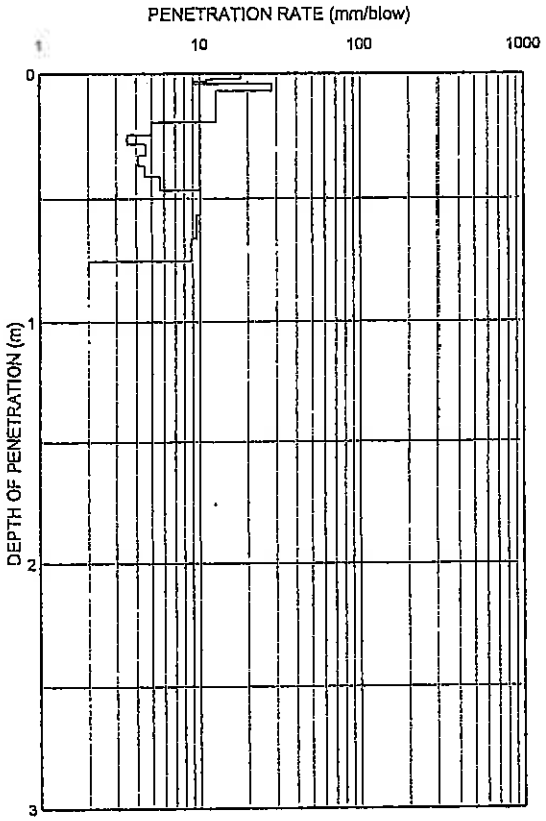
▼ PERCHED WATER TABLE

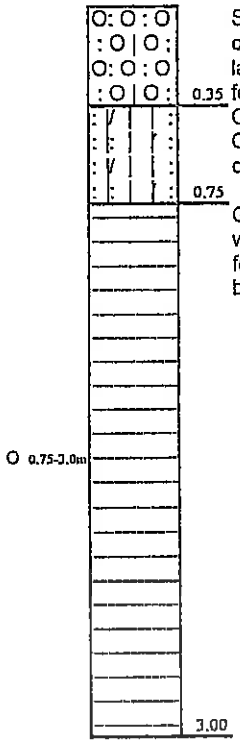
DYN CONE PENETRATION TEST AND SOIL PROFIL

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 31/1/2008

TEST NO: DCP 2 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP2 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728250 Y: -1100





SILTY SANDY GRAVEL Dry to slightly moist, greyish brown, becoming orange brown with depth, medium dense to dense, pinholed, then layered, slightly clayey silty and sandy, fine to medium, sub rounded ferruginised gravel increasing in concentration towards basal contact. Colluvium (?). Fine roots to 0.15m.

CLAYEY SANDY SILT Slightly moist, khaki brown, very stiff, fissured, clayey sandy silt. Colluvium.

GREYWACKE Grey, stained and blotched orange brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke bedrock.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 31/1/2008

TEST NO: DCP 1

STARTING DEPTH: Ground Surface

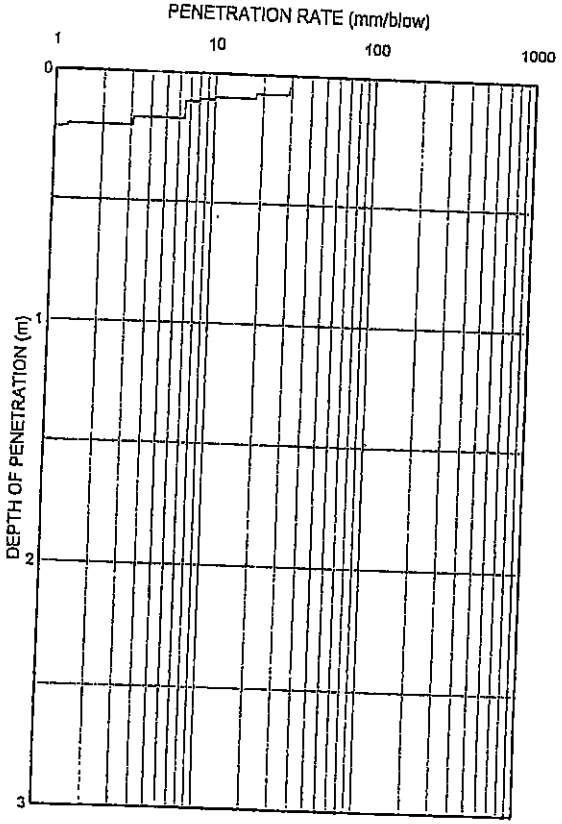
TRIAL PIT NO: TP1

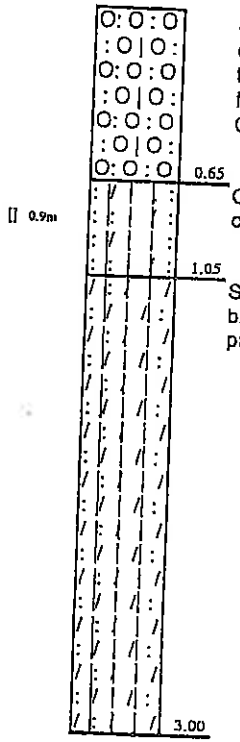
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728350

Y: -1200

ELEVATION:





SILTY SANDY GRAVEL Dry to slightly moist, greyish brown, becoming orange brown with depth, dense to very dense, pinholed in upper 0.4m, then layered, slightly clayey silty and sandy, fine to medium, sub rounded ferruginised gravel increasing in concentration towards basal contact. Colluvium (?). Fine roots to 0.15m.

CLAYEY SANDY SILT Slightly moist, khaki brown, very stiff, fissured, clayey sandy silt/clayey silty sand. Colluvium.

SANDY CLAYEY SILT Slightly moist to moist, light grey, blotched orange brown, very stiff, locally fissured and jointed, sandy clayey silt with patches of very soft greywacke rock (generally ferruginised).

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

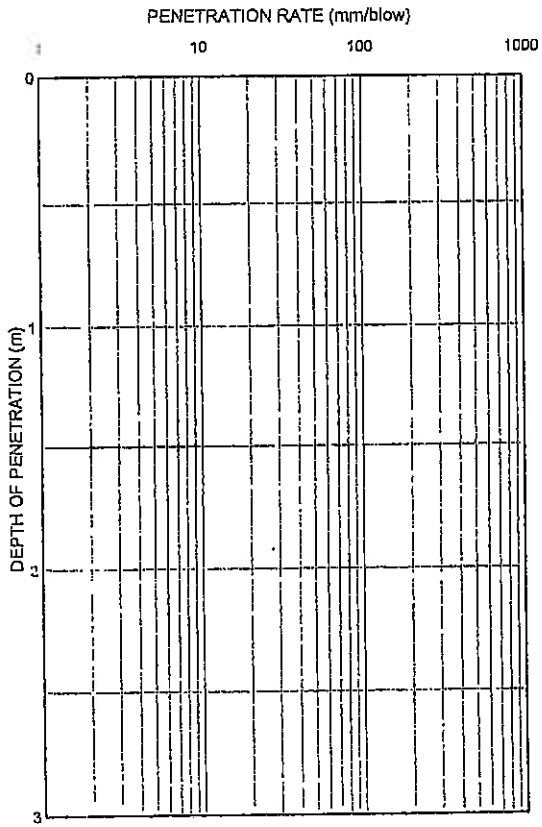
V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 1/2/2008

TEST NO: | STARTING DEPTH: | ELEVATION:

TRIAL PIT NO: TP25 | METHOD OF INVESTIGATION : Digger/loader
COORDINATES: X: 3728550
Y: -600



XXXXXX		MADE GROUND Dry becoming moist with depth, variably coloured, light grey, greyish brown and light orange brown, medium dense to dense, layered fill comprising different coloured layers of clayey silty medium to coarse sand with minor fine gravel. Embankment fill.
XXXXXX	2.20	
: o :|: o : :|: : o: |: : : o :|: o : :|: : o: |: : : o :|: o :	2.70	GRAVELLY SILTY SAND Moist, brownish grey, medium dense, slightly pinholed, slightly clayey silty fine to medium sand with minor fine gravel. Colluvium.
:/:O:/:O/: O/:O:/:O :/:O:/:O/:	3.05	CLAYEY SANDY GRAVEL Slightly moist, dark orange brown, very stiff, slightly fissured, clayey medium to coarse sandy fine gravel. Colluvium.
/ / / / / / / /	3.40	CLAYEY SILT Moist, dark khaki, very stiff, fissured, clayey silt. Alluvial wash.
/ / / / / / / /	3.65	CLAYEY SILT Slightly moist, grey and mottled brown, very stiff/hard/ weakly cemented, slightly fissured, clayey silt. Colluvium/[edogenic.

NOTE: Trial pit excavated into side of embankment.
Machine excavating very slowly between 3.45m and 3.65m

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 1/2/2008

TEST NO: DCP 26

STARTING DEPTH:

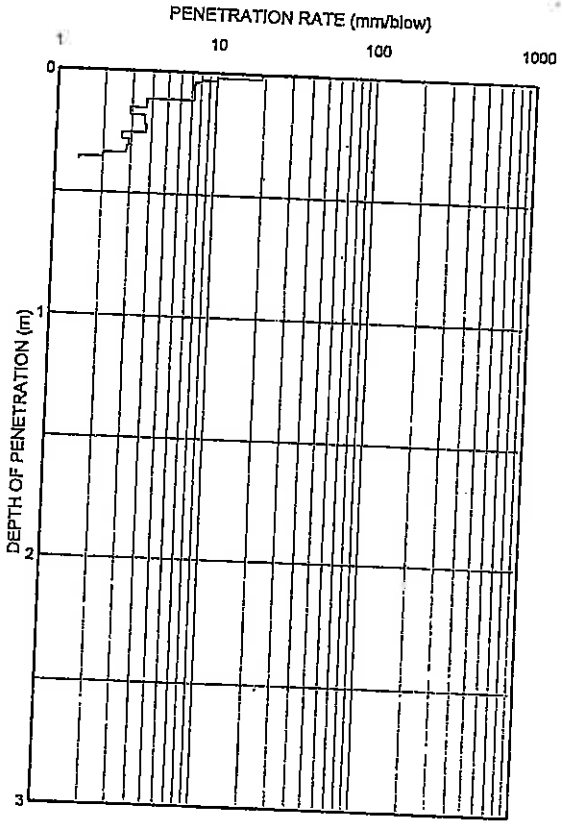
ELEVATION:

TRIAL PIT NO: TP26

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728450

Y: -500



: o :|: o : :|: : o: |: : : o :|: o : :|: : o: |: : : o :|: o :	0.45 GRAVELLY SILTY SAND Dry, brownish grey, very dense, slightly pinholed, slightly clayey and fine gravelly silty medium to coarse sand. Alluvial wash. Fine roots to 0.1m.
O: O : O : O | O :	0.70 SILTY SANDY GRAVEL Dry, orange brown, very dense, layered, very slightly clayey silty medium to coarse gravel. Alluvial wash.
O/:O:/:O :/:O:/:O/: O/:O:/:O :/:O:/:O/:	1.10 CLAYEY SANDY GRAVEL Slightly moist, dark orange brown, very stiff, slightly fissured, clayey medium to coarse sandy fine gravel. Colluvium.
/ / / / / / / /	1.30 CLAYEY SILT Moist, dark khaki, very stiff, fissured, clayey silt. Alluvial wash.
/ / / / / / / /	1.50 CLAYEY SILT Slightly moist, grey and mottled brown, very stiff/hard/ weakly cemented, slightly fissured, clayey silt. Colluvium/Eedogenic.

NOTE: Machine excavating very slowly throughout pit and beginning to refuse at 1.5m.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

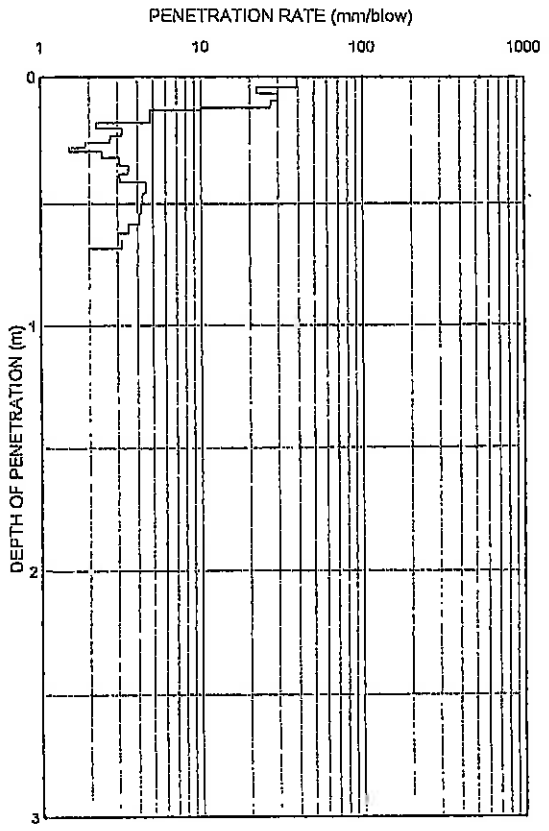
¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 1/2/2008

TEST NO: DCP 27 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP27 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728350 Y: -400



0.45	GRAVELLY SILTY SAND Dry, brownish grey, very dense, slightly pinholed. slightly clayey and fine gravelly silty medium to coarse sand. Alluvial wash. Fine roots to 0.1m.
1.00	SILTY SANDY GRAVEL Dry, orange brown, very dense, layered, very slightly clayey silty medium to coarse gravel. Alluvial wash.
1.50	GRAVELLY CLAYEY SILT Slightly moist, grey and mottled brown, very stiff/hard/weakly cemented, slightly fissured, gravelly clayey silt. Colluvium/Pedogenic.
2.50	GRAVELLY SILTY SAND Dry to slightly moist, light grey brown, very dense (locally weakly cemented), layered, gravelly silty sand with minor irregular thin layers of clayey silt. Alluvial wash/pedogenic.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

▽ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 1/2/2008

TEST NO: DCP 28

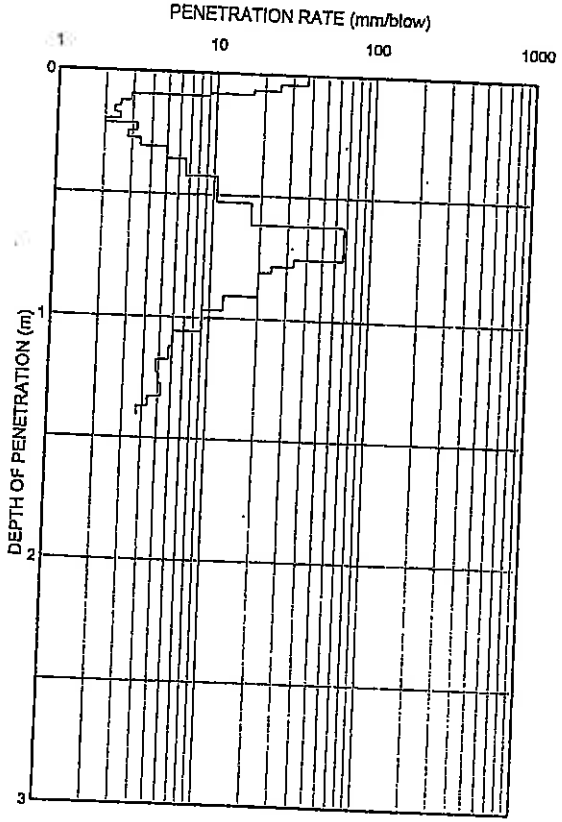
STARTING DEPTH: Ground Surface

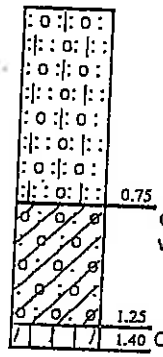
TRIAL PIT NO: TP28

METHOD OF INVESTIGATION : Digger/loader

ELEVATION:

COORDINATES: X: 3728250
Y: -300





[] 1.0m

SILTY GRAVELLY SAND Dry, brownish grey, very dense to loose, slightly pinholed, slightly clayey and fine silty gravelly medium to coarse sand. High concentrations of gravel, in places, near basal contact. Alluvial wash. Fine roots to 0.1m.

GRAVELLY SANDY CLAY Moist, red brown becoming yellow brown with depth, firm to stiff, fissured, gravelly sandy clay. Alluvial wash.

CLAYEY SILT Slightly moist, khaki grey, fissured, weakly cemented, sandy clayey silt with more sandy patches. Transported.

NOTE: Machine refused at 1.4m depth.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

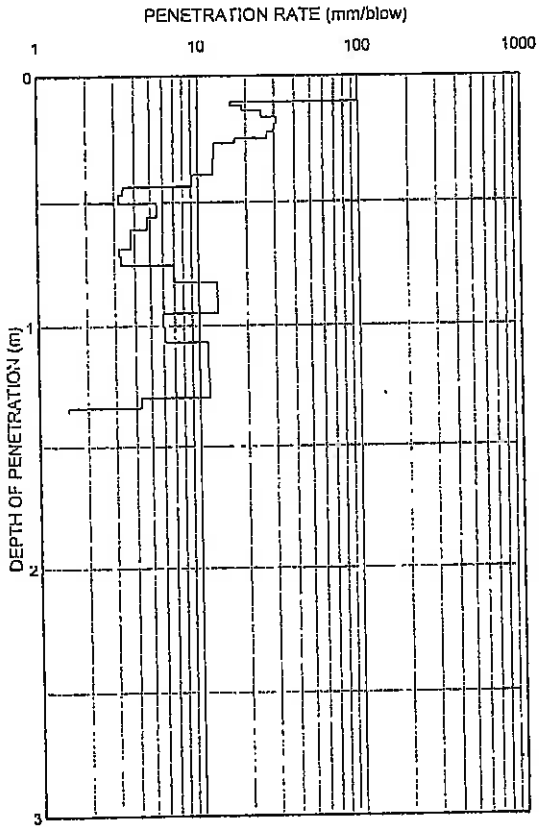
PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 1/2/2008

TEST NO: DCP 29 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP29 | METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728150

Y: -200

ELEVATION: -



0.50	SILTY GRAVELLY SAND Dry, brownish grey, medium dense, slightly pinholed, slightly clayey and fine silty gravelly medium to coarse sand. High concentrations of gravel, in places, near basal contact. Alluvial wash. Fine roots to 0.1m.	
1.75	GRAVELLY CLAYEY SILT Moist, red brown becoming yellow brown with depth, very stiff, fissured, gravelly clayey silt. Alluvial wash.	
2.20	CLAYEY SILT Slightly moist, khaki grey, fissured, weakly cemented, sandy clayey silt with more sandy patches. Transported.	
2.75	GREYWACKE Grey, stained and mottled red brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke, and very soft rock to very stiff soil.	

NOTE: Machine excavating very slowly through the cemented clayey silty layer.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

U UNDISTUREED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 1/2/2008

TEST NO:

STARTING DEPTH:

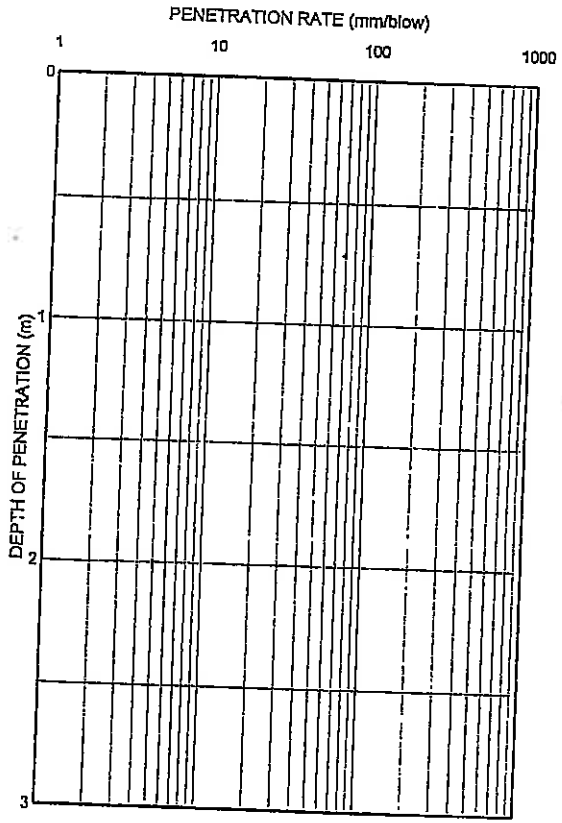
TRIAL PIT NO: TP30

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728050

Y: -100

ELEVATION:



O: O : O
: O | O :
O: O : O
: O | O :
O: O : O 0.50

SILTY GRAVELLY SAND Dry, brownish grey, very dense, slightly pinholed, slightly clayey and fine silty gravelly medium to coarse sand. Alluvial wash. Fine roots to 0.1m.

O: O : O
: O | O :
O: O : O 0.75

SILTY SANDY GRAVEL Dry, light grey, very dense/weakly cemented, silty sandy fine to medium gravel. Alluvial wash/pedogenic.

NOTE: Machine refused at 0.75m depth.
No DCP test undertaken.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

U UNDISTURBED SAMPLE

▽ WATER TABLE

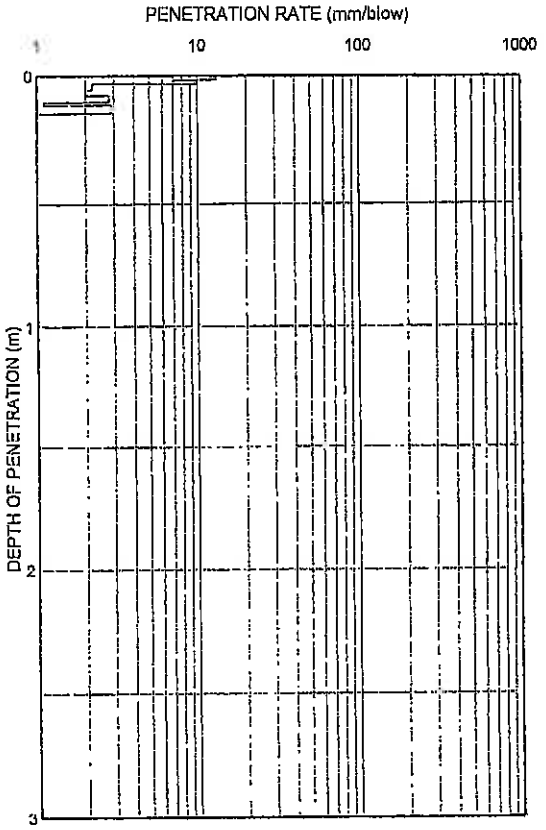
▼ PERCHED WATER TABLE

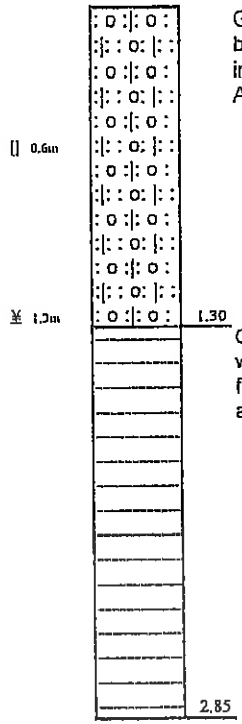
DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 1/2/2008

TEST NO: DCP 31 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP31 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728150 Y: 0





GRAVELLY SILTY SAND Dry becoming rapidly very moist to wet below 0.9m, very dense (weakly cemented) becoming looser with increasing moisture content, layered, gravelly silty coarse sand. Alluvial wash.

GREYWACKE Grey, stained and mottled red brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke, and very soft rock to very stiff soil.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 1/2/2008

TEST NO: DCP 32

STARTING DEPTH: Ground Surface

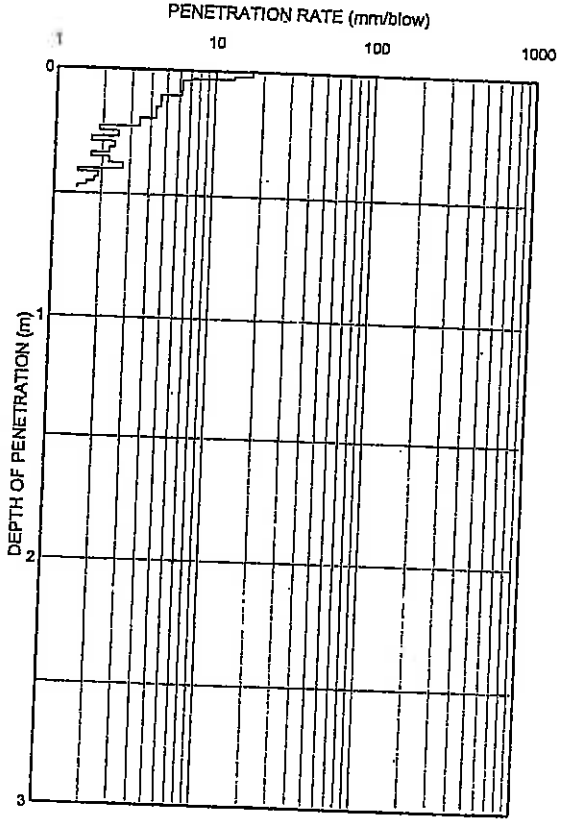
TRIAL PIT NO: TP32

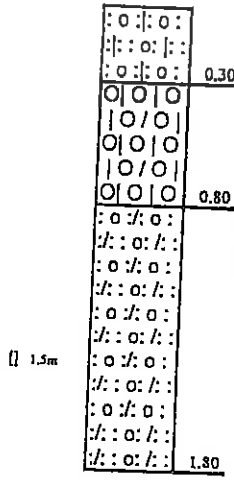
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728257

Y: 100

ELEVATION:





GRAVELLY SILTY SAND Dry, brownish grey, very dense, slightly pinholed, slightly clayey and fine silty gravelly medium to coarse sand. Coarser grained towards basal contact. Alluvial wash. Fine roots to 0.1m.

CLAYEY SILTY GRAVEL Slightly moist, reddish brown, very stiff, fissured, clayey silty fine gravel. Alluvial wash.

GRAVELLY CLAYEY SAND Slightly moist to moist, light grey, blotched red brown, very stiff and weakly cemented to 1.2m then very stiff, fissured, gravelly clayey medium to coarse sand. Alluvium.

NOTE: Weakly cemented layer restricted excavation and depth of pit.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

U UNDISTURBED SAMPLE

V WATER TABLE

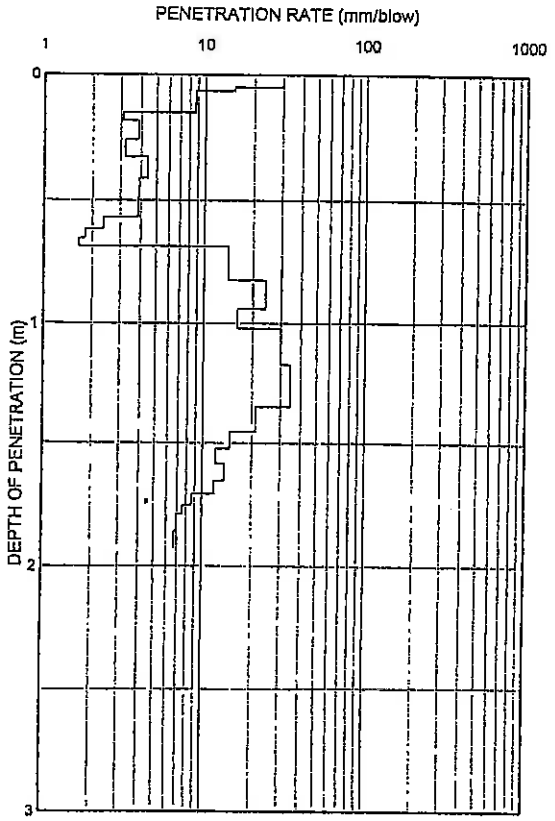
V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 7/2/2008

TEST NO: DCP 34 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP34 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728450 Y: -300



0.35	GRAVELLY SILTY SAND Dry, greyish brown, very dense, layered and locally slightly pinholed, slightly clayey medium to coarse sand with a fine gravel component. Numeous fine roots to 0.1m.
0.75	SILTY SANDY GRAVEL Dry, brownish grey, dense, layered, very slightly clayey and silty sandy fine gravel. Alluvium.
2.45	GRAVELLY CLAYEY SILTY SAND Slightly moist becoming moist with depth, khaki to 1.3m then light khaki grey, stiff to very stiff, fissured, clayey silty medium sand with scattered fine and medium gravel. Locally patches of clayey silt or weakly cemented soil. Alluvium.

NOTE: Machine excavating very slowly at 2.45m.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

▼ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 1/2/2008

TEST NO: DCP 33

STARTING DEPTH: Ground Surface

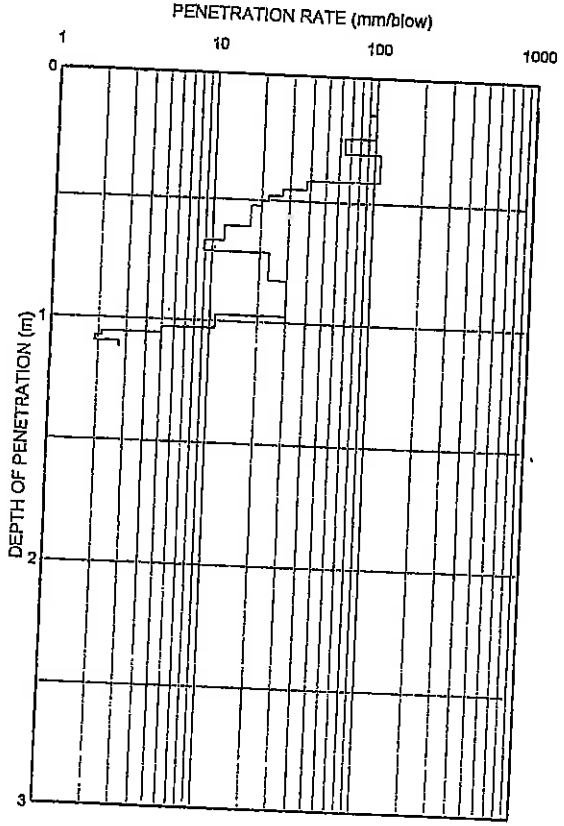
ELEVATION:

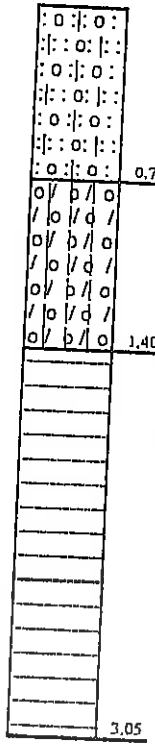
TRIAL PIT NO: TP33

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728350

Y: -200





GRAVELLY SILTY SAND Slightly moist, brownish grey, very loose, slightly pinholed, slightly clayey and fine silty gravelly medium to coarse sand. Coarser grained towards basal contact. Alluvial wash. Fine roots to 0.1m.

GRAVELLY CLAYEY SILT Moist, light khaki, blotched light brown, stiff to very stiff, fissured clayey silt with fine and scattered medium gravel. Alluvial wash.

GREYWACKE Light khaki, stained and mottled red brown, highly weathered, very fine grained, very closely to closely jointed (sub vertical foliation and joints), very soft rock to generally soft rock greywacke, and very soft rock to very stiff soil.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 7/2/2008

TEST NO: DCP 35

STARTING DEPTH: Ground Surface

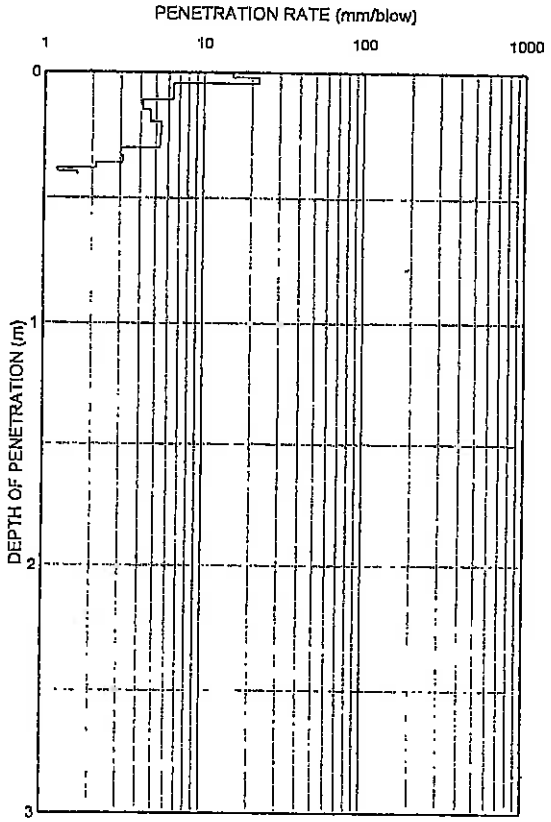
TRIAL PIT NO: TP35

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728546

Y: -387

ELEVATION:



: o :|: o : :|: : o: |: : 0.15	GRAVELLY SILTY SAND Dry, greyish brown, dense, layered and locally slighlty pinholed, slightly clayey medium to coarse sand with a fine gravel component. Numerous fine roots to 0.1m.
:o: :|: :o: :/ :o: /: : :o: :|: :o: :/ :o: /: : :o: :|: :o: 0.65	GRAVELLY CLAYEY SILTY SAND Dry, orange brown, very dense, layered, clayey silty fine to coarse sand with a very minor fine gravel component. Alluvium.
O: O : O : O | O : O: O : O 1.00	SILTY SANDY GRAVEL Dry, brownish grey, very dense/hard (weakly cemented), intact, sandy fine gravel with a minor slightly clayey and silty coarse sandy matrix. Alluvium/pedogenic.

NOTE: Machine refused at 1m depth.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

TEST NO: DCP 36

STARTING DEPTH: Ground Surface

DATE : 7/2/2008

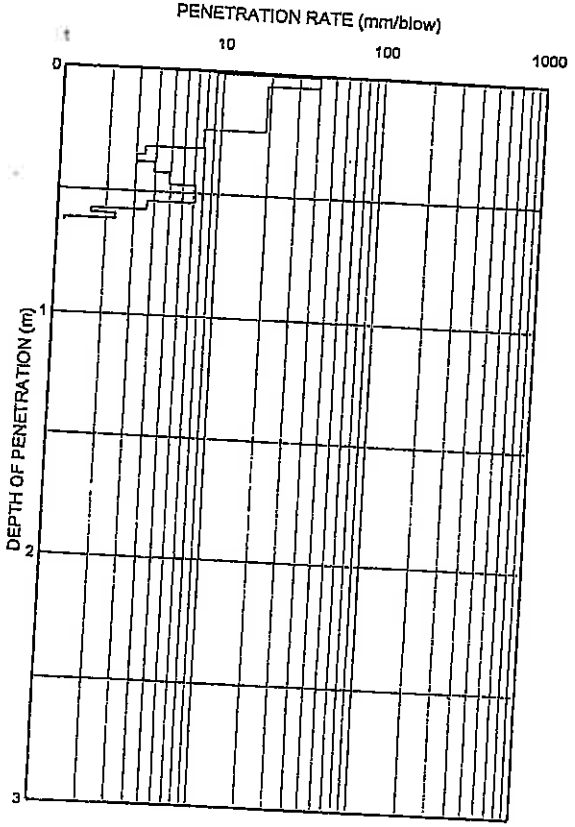
TRIAL PIT NO: TP36

ELEVATION:

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728650

Y: -300



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:o: :|: :o: :/ :o: /: : :o: :|: :o: :/ :o: /: : :o: :|: :o: :/ :o: /: :	1.05

GRAVELLY SILTY SAND Dry, greyish brown, medium dense, layered and locally slightly pinholed, slightly clayey medium to coarse sand with a fine gravel component. Numeous fine roots to 0.1m.

GRAVELLY CLAYEY SILTY SAND Dry, orange brown, very dense, layered, clayey silty fine to coarse sand with a very minor fine gravel component. Weakly cemented towards 1m depth. Alluvium.

NOTE: Machine refused at 1.05m depth.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

⧖ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 7/2/2008

TEST NO: DCP 37

STARTING DEPTH: Ground Surface

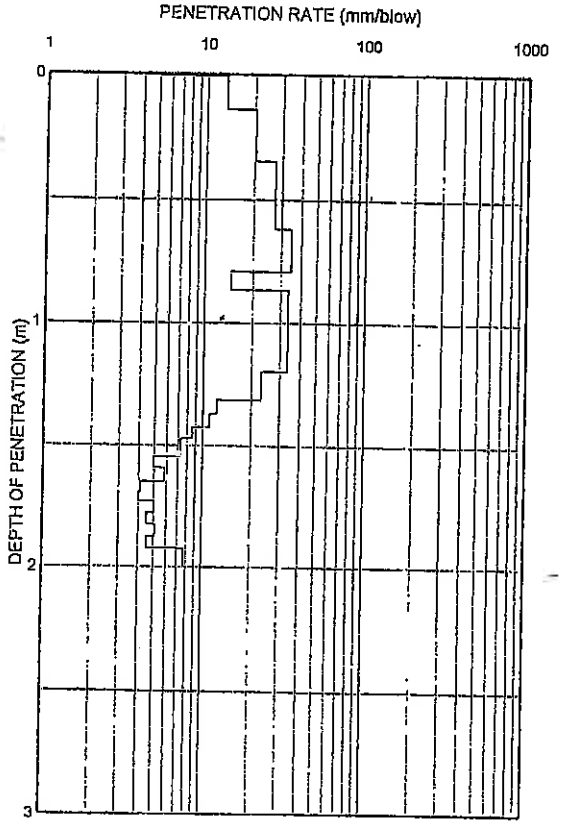
TRIAL PIT NO: TP37

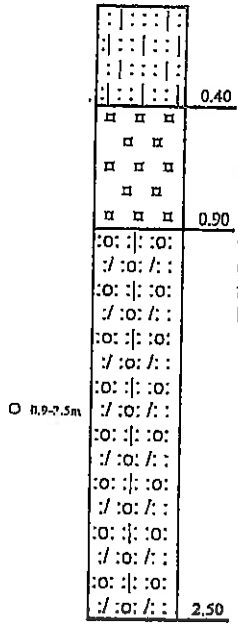
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728550

Y: -200

ELEVATION:





SILTY SAND Dry to slightly moist, brownish grey becoming greyish brown, medium dense, slightly pinholed, very slightly clayey, silty medium sand. Alluvial wash.

FERRICRETE Moist, dark orange brown and brownish grey, very dense/medium dense, layered, coarse gravel-size blocks of hardpan ferricrete in a minor coarse sandy matrix. Pedogenic.

GRAVELLY CLAYEY SILTY SAND Slightly moist becoming moist with depth, khaki, blotched orange brown, black and white, firm to very stiff, fissured, clayey silty medium sand with scattered fine and medium gravel. Locally patches of clayey silt or weakly cemented soil. Alluvium.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 7/2/2008

TEST NO: DCP 38

STARTING DEPTH: Ground Surface

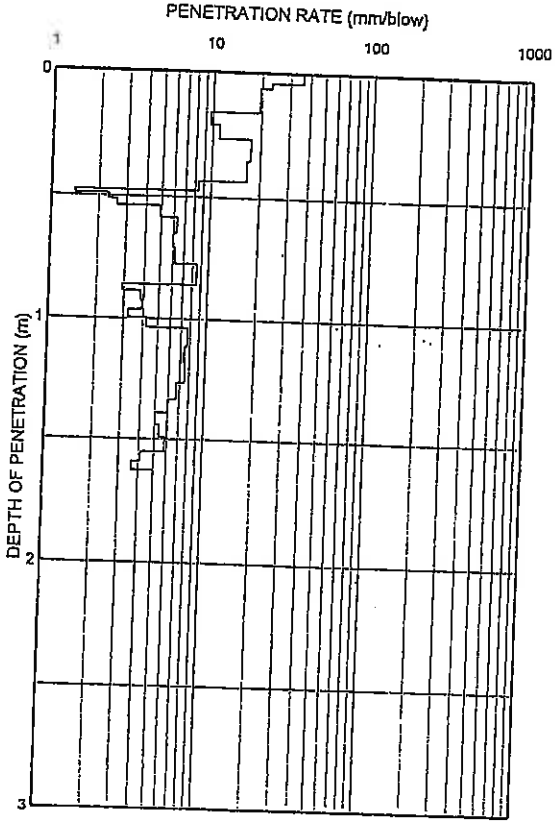
TRIAL PIT NO: TP38

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728450

Y: -100

ELEVATION:



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SILTY SANDY GRAVEL Dry, brownish grey, medium dense, layered, very slightly clayey and silty sandy fine gravel. Alluvium.

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GRAVELLY CLAYEY SILTY SAND Slightly moist becoming moist with depth, light khaki grey, very stiff, fissured, clayey silty medium sand with scattered fine and medium gravel. Locally patches of clayey silt or weakly cemented soil. Alluvium.

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GRAVELLY CLAYEY SILT Moist, light khaki grey, blotched and stained orange brown, very stiff, fissured and slightly slickensided, clayey silt with scattered fine to medium gravel. Alluvium.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

U UNDISTURBED SAMPLE

V WATER TABLE

¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

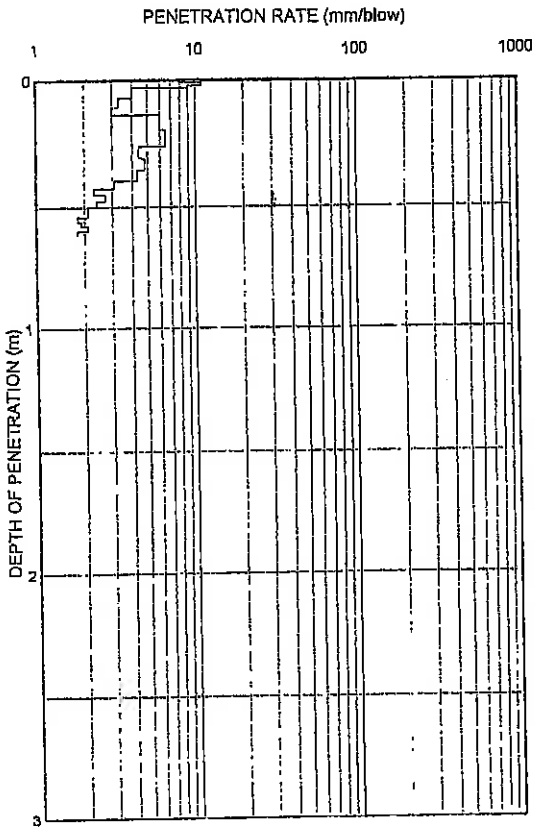
PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 1/2/2008

TEST NO: DCP 39 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP39 | METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728350

Y: 0

ELEVATION:



: o :|: o : :|: : o: |: : : o :|: o : :|: : o: |: : : o :|: o :	0.45	GRAVELLY SILTY SAND Dry, brownish grey, dense, slightly pinholed, slightly clayey and fine silty gravelly medium to coarse sand. Coarser grained towards basal contact. Alluvial wash. Fine roots to 0.1m
O| O | O | O / O | O| O | O	0.75	CLAYEY SILTY GRAVEL Slightly moist, reddish brown, very stiff, fissured, clayey silty fine gravel. Alluvial wash.
¥ 0.9m : o :|: o : :|: : o: |: :	0.95	GRAVELLY SILTY SAND Very moist to wet, brownish grey, medium dense, slightly, pinholed, slightly clayey and fine silty gravelly medium to coarse sand. Coarser grained towards basal contact. Alluvial wash.
o // o / o / o / o /	1.15	GRAVELLY CLAYEY SILT Moist, reddish brown, very stiff, fissured, clayey silt with fine and scattered medium gravel. Alluvial wash.
: o :/: o :	1.30	CLAYEY GRAVELLY SAND Slightly moist to moist, light grey, blotched red brown, very stiff and weakly cemented, fissured, clayey gravelly medium to coarse sand. Alluvium.

NOTE: Machine refused at 1.3m depth.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 1/2/2008

TEST NO: DCP 40

STARTING DEPTH: Ground Surface

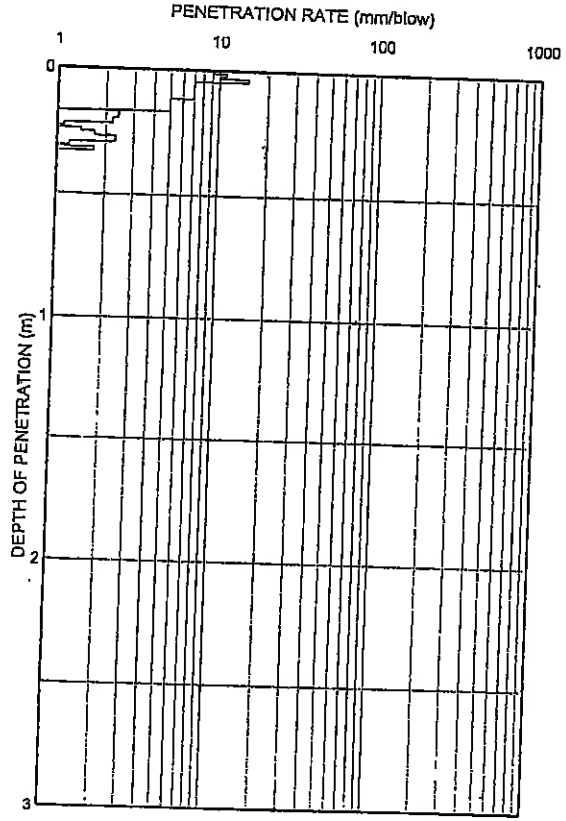
TRIAL PIT NO: TP40

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728257

Y: 100

ELEVATION:



0.95	SILTY GRAVELLY SAND Dry, brownish grey, very dense, slightly pinholed, slightly clayey and fine silty gravelly medium to coarse sand. Coarser grained towards basal contact. Alluvial wash. Fine roots to 0.1m
1.65	GRAVELLY CLAYEY SILT Moist, red brown becoming yellow brown with depth, firm to stiff, fissured, gravelly clayey silt. Alluvial wash.
2.10	GRAVELLY CLAYEY SILT Slightly moist, grey and mottled brown, very stiff/hard/weakly cemented, slightly fissured, clayey silt with scattered fine gravel. Colluvium/pedogenic.
2.65	GRAVELLY CLAYEY SILT Moist, light khaki, blotched light brown, very stiff, fissured clayey silt with fine and scattered medium gravel. Alluvial wash.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		V...	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

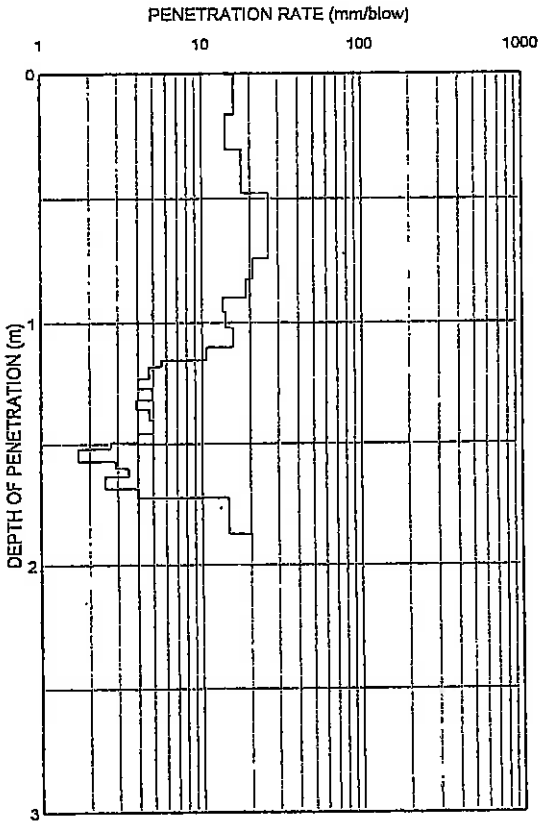
▼ PERCHED WATER TABLE

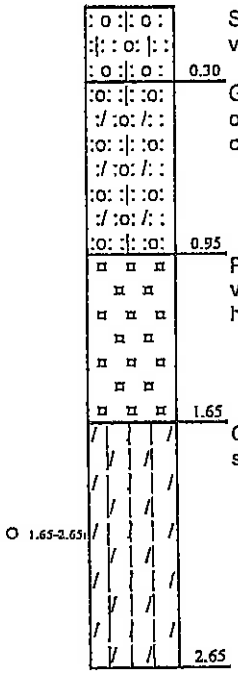
DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 7/2/2008

TEST NO: DCP 41 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP41 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728465 Y: -86





SILTY SANDY GRAVEL Dry, brownish grey, medium dense, layered, very slightly clayey and silty sandy fine gravel. Alluvium.

GRAVELLY CLAYEY SILTY SAND Slightly moist to moist, dark orange brown, medium dense, slightly fissured, clayey silty fine to coarse sand with a fine gravel component. Alluvium.

FERRICRETE Moist, dark orange brown and brownish grey, very dense/medium dense, layered, coarse gravel-size blocks of hardpan ferricrete in a minor coarse sandy matrix. Pedogenic.

CLAYEY SILT Moist, greenish grey, blotched pinkish brown, stiff to very stiff, fissured, clayey silt. Alluvium.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

DATE : 7/2/2008

TEST NO: DCP 42

STARTING DEPTH: Ground Surface

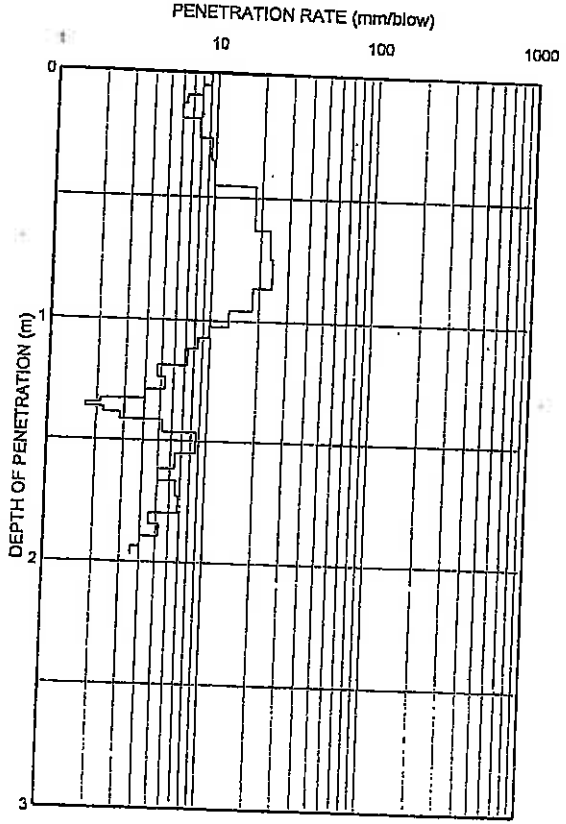
TRIAL PIT NO: TP42

METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728550

Y: 0

ELEVATION:



0.35		SILTY SANDY GRAVEL Dry, brownish grey, dense, layered, very slightly clayey and silty sandy fine gravel. Alluvium.
1.30		SAND Slightly moist to moist, greyish brown becoming brown, medium dense to dense, intact, very slightly silty medium to coarse sand. Alluvium.
2.75		GRAVELLY CLAYEY SILTY SAND Moist to very moist at depth, light khaki grey, blotched and stained orange brown, very stiff to stiff, fissured, clayey silty medium to coarse sand with scattered fine gravel. Locally very slightly clayey. Alluvium.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

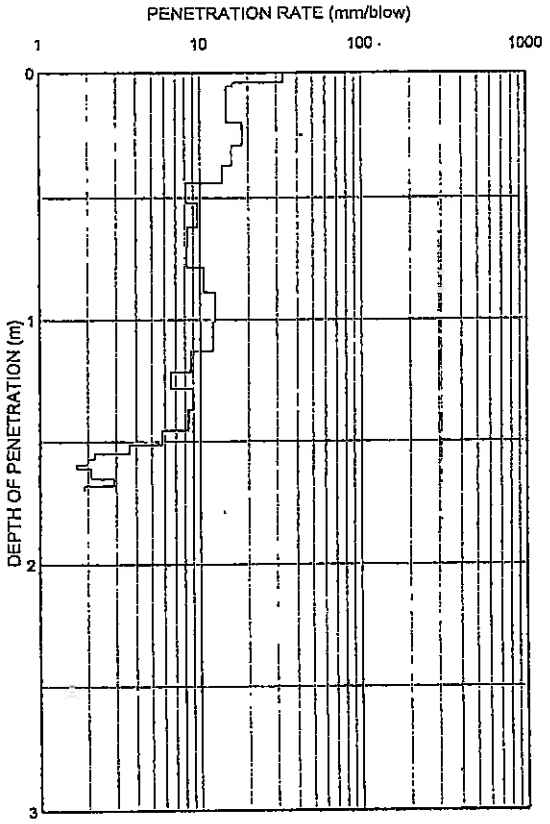
¥ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 7/2/2008

TEST NO: DCP 43 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP43 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728650 Y: -100



0.90	SILTY SANDY GRAVEL Dry, brownish grey, medium dense to dense, layered, very slightly clayey and silty sand with very minor fine gravel. Alluvium.	
1.40	SAND Slightly moist to moist, greyish brown becoming brown, medium dense to dense, intact, very slightly silty medium to coarse sand. Alluvium.	
2.65	CLAYEY SILTY SAND Slightly moist, orange brown, dense to very dense, intact, slightly silty clayey sand. Colluvium.	

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND

PROJECT NO: 89607

TEST NO: DCP 44

STARTING DEPTH: Ground Surface

DATE : 7/2/2008

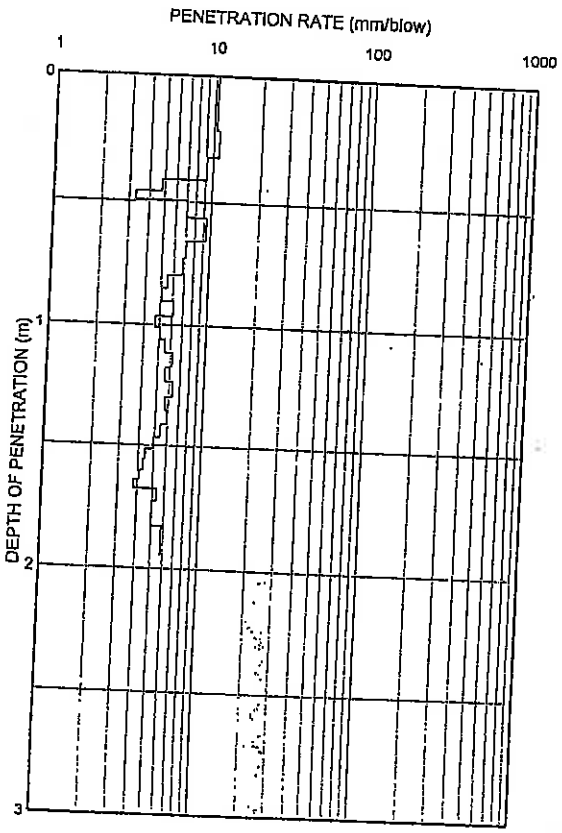
TRIAL PIT NO: TP44

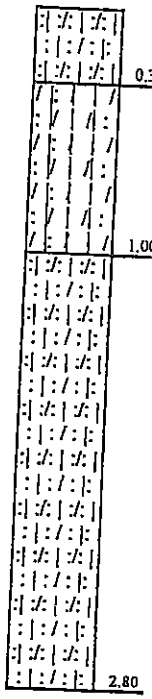
METHOD OF INVESTIGATION : Digger/loader

COORDINATES: X: 3728748

Y: 6

ELEVATION:





CLAYEY SILTY SAND Dry, dark grey, dense, slightly pinholed, organic, clayey silty fine sand. Alluvial wash. Fine roots to 0.1m.

SANDY CLAYEY SILT Dry to slightly moist, dark grey becoming orangy grey brown with depth, very stiff, fissured, sandy clayey silt. Alluvium.

CLAYEY SILTY SAND Slightly moist becoming moist at depth, light grey brown becoming orange brown stained with depth, very stiff, fissured to 1.8m then slightly fissured, slightly clayey, silty fine to medium sand. Alluvium.

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

▽ WATER TABLE

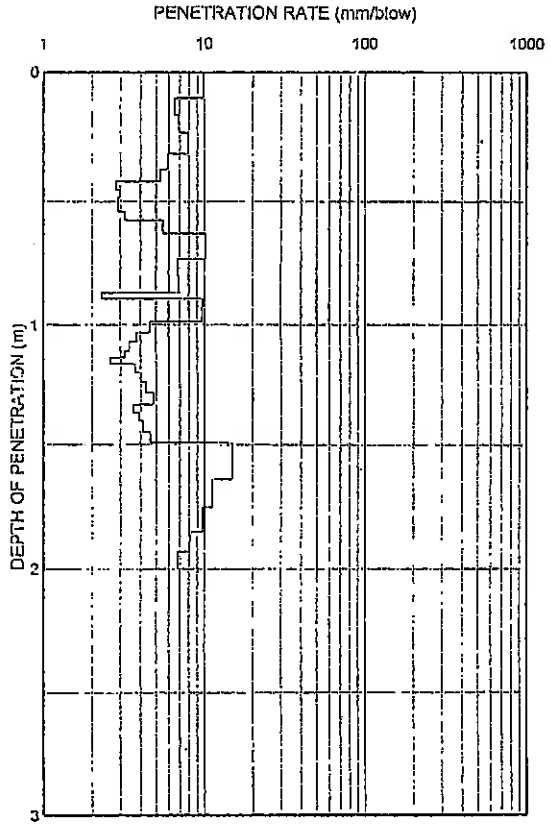
⊻ PERCHED WATER TABLE

DYNAMIC CONE PENETRATION TEST AND SOIL PROFILE

PROJECT: VLAKKELAND | PROJECT NO: 89607 | DATE : 7/2/2008

TEST NO: DCP 45 | STARTING DEPTH: Ground Surface | TRIAL PIT NO: TP45 | METHOD OF INVESTIGATION : Digger/loader

ELEVATION: | COORDINATES: X: 3728650 Y: 100



0.15	CLAYEY SILTY SAND Dry, dark grey, dense, slightly pinholed, organic, clayey silty fine sand. Alluvial wash. Fine roots to 0.1m.	
0.55	SANDY CLAYEY SILT Dry to slightly moist, dark grey becoming orangy grey brown with depth, very stiff, fissured, sandy clayey silt. Alluvium.	
0.95	SILTY GRAVELLY SAND Dry, brownish grey, dense (weakly cemented), layered, slightly clayey silty medium to coarse sand with a fine gravelly component. Alluvium/pedogenic.	
1.40	GRAVELLY CLAYEY SILT Dry to slightly moist, dark grey becoming brown with depth, very stiff, fissured, organic gravelly clayey silt. Alluvial wash.	
2.60	CLAYEY SILTY SAND Slightly moist to moist, grey, strongly stained orange brown, very stiff, fissured, slightly clayey to clayey, silty medium to coarse sand. Alluvium.	O 1.4-2.6m

Sandy Materials: (mm/blow)	Very loose	>75	Clayey Materials: (mm/blow)	Very Soft	>110
	Loose	30 - 75		Soft	55 - 110
	Medium Dense	12.5 - 30		Firm	30 - 55
	Dense	5 - 12.5		Stiff	15 - 30
	Very Dense	2 - 5		Very Stiff	7 - 15

O DISTURBED SAMPLE

[] UNDISTURBED SAMPLE

V WATER TABLE

V PERCHED WATER TABLE

Appendix B:

RESULTS OF LABORATORY TESTS

GEOSCIENCE
LABORATORIES (PTY) LTD
71 INDUSTRIAL RING ROAD PAROW INDUSTRIA 7499, P.O. BOX 288 PAROW 7499
TELEPHONE: (021) 933 8178 FAX: (021) 933 1078

CLIENT:	RA Bradshaw & Associates 17 Midwood Avenue Newlands 7700	PROJECT:	Vlakkeland
		DATE:	27-02-2008
ATT:	Dick Bradshaw	REF:	L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION :	dark yellow silty clayey sand	SAMPLE NO. :	9733
POSITION :	TP 2 @ 0.75-3.0m	CLIENT SAMPLE NO. :	

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	
	6.70	100
	4.75	97
	2.36	88
	2.00	87
	1.18	83
	0.600	78
	0.425	75
	0.300	72
	0.150	64
	0.0750	55

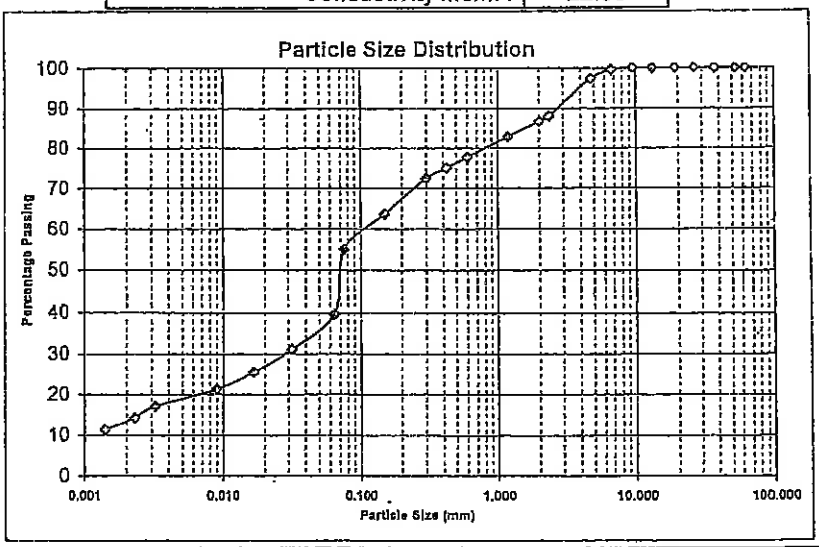
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0685	40
0.0353	31
0.0180	25
0.0095	21
0.0033	17
0.0024	14
0.0014	11

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	5.0
Conductivity mS/m :	22.90

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	36
Plastic Index	14
Linear Shrinkage	6.7

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	3
Sand : Percentage - 4.75mm and + 0.075mm	43
Silt : Percentage - 0.075mm and + 0.002mm	40
Clay : Percentage - 0.002mm	15

For Geoscience:

GEOSCIENCE
LABORATORIES (PTY) LTD
71 INDUSTRIAL RING ROAD PAROW INDUSTRIA 7499, P.O. BOX 209 PAROW 7499
TELEPHONE: (021) 933 5176 FAX (021) 933 1073

CLIENT: RA Bradshaw & Associates
17 Midwood Avenue
Newlands
7700
ATT: Dick Bradshaw

PROJECT: Vlakkeland
DATE: 27-02-2008
REF: L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : dark yellow clayey gravelly sand
POSITION : TP 8 @ 0-2.5m

SAMPLE NO. : 9734
CLIENT SAMPLE NO. :

Sieve Analysis	Percent Passing
75.00	
63.00	
53.00	
37.50	
26.50	
19.00	
13.20	100
9.50	98
6.70	96
4.75	93
2.36	76
2.00	73
1.18	59
0.600	40
0.425	34
0.300	31
0.150	25
0.0750	21

SIEVE SIZE (mm)

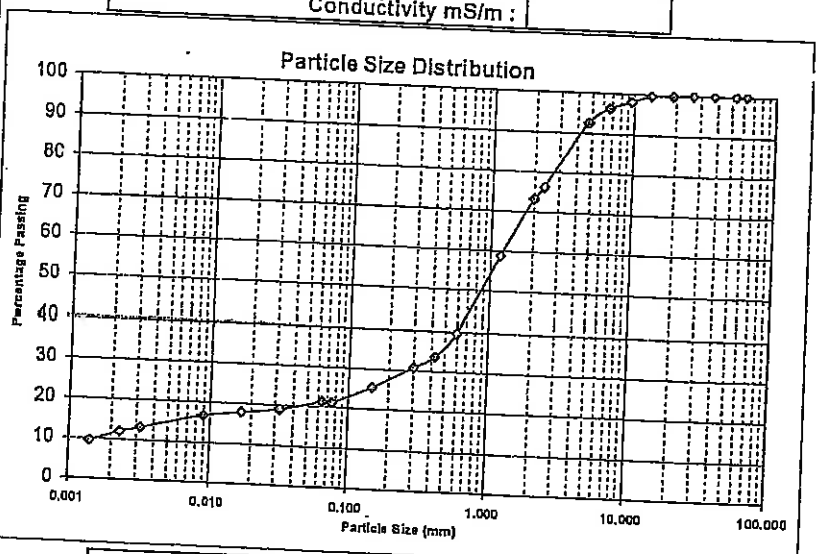
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0720	21
0.0364	19
0.0183	18
0.0095	17
0.0033	13
0.0024	12
0.0014	9

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	
Conductivity mS/m :	

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	24
Plastic Index	9
Linear Shrinkage	4.7

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	2144
O.M.C. (%)	7.0
C.B.R. @ 100% Comp.	60
C.B.R. @ 98 % Comp.	42
C.B.R. @ 95 % Comp.	26
C.B.R. @ 93 % Comp.	18
C.B.R. @ 90 % Comp.	10
Swell (max) %	0.20



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	7
Sand : Percentage - 4.75mm and + 0.075mm	71
Silt : Percentage - 0.075mm and + 0.002mm	9
Clay : Percentage - 0.002mm	12

For Geoscience:

GEOSCIENCE
LABORATORIES (PTY) LTD
71 INDUSTRIAL RING ROAD PAARDEN INDUSTRIA 7490, P.O. BOX 288 PAROW 7499
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CLIENT: RA Bradshaw & Associates
17 Midwood Avenue
Newlands
7700
ATT: Dick Bradshaw

PROJECT: Vlakkeland
DATE: 27-02-2008
REF: L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : dark yellow silty clay
POSITION : TP 9 @ 0.3-1.25m

SAMPLE NO. : 9735
CLIENT SAMPLE NO. :

Sieve Analysis	Percent Passing
75.00	
63.00	
53.00	
37.50	
26.50	
19.00	
13.20	
9.50	
6.70	100
4.75	99
2.36	95
2.00	94
1.18	90
0.600	85
0.425	83
0.300	82
0.150	79
0.0750	69

SIEVE SIZE (mm)

Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0649	59
0.0332	53
0.0171	43
0.0091	34
0.0033	22
0.0023	19
0.0014	12

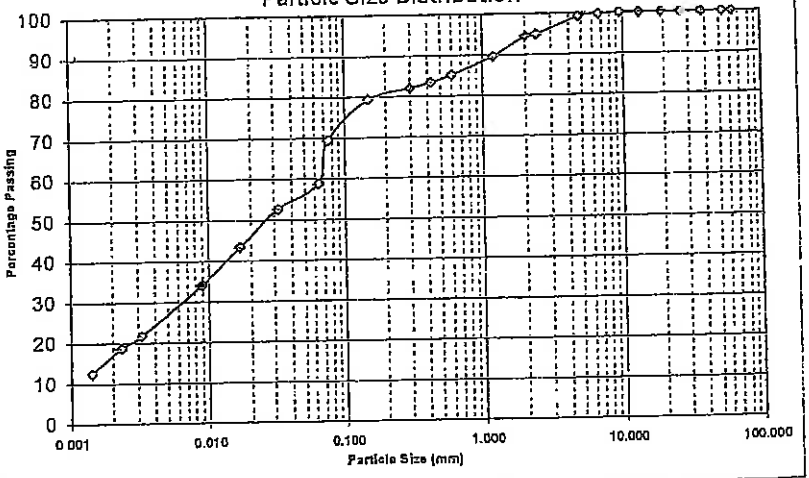
SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	5.7
Conductivity mS/m :	53.60

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	44
Plastic Index	12
Linear Shrinkage	5.7

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	1698
O.M.C. (%)	15.6
C.B.R. @ 100% Comp.	1
C.B.R. @ 98 % Comp.	1
C.B.R. @ 95 % Comp.	1
C.B.R. @ 93 % Comp.	1
C.B.R. @ 90 % Comp.	0
Swell (max) %	11.90

Particle Size Distribution



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	1
Sand : Percentage - 4.75mm and + 0.075mm	30
Silt : Percentage - 0.075mm and + 0.002mm	49
Clay : Percentage - 0.002mm	20

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PROJECT: Vlakkeland

DATE: 27-02-2008
REF: L80225

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : lt olive silty clayey sand
POSITION : TP 13 @ 1.0m

SAMPLE NO. : 9726
CLIENT SAMPLE NO. :

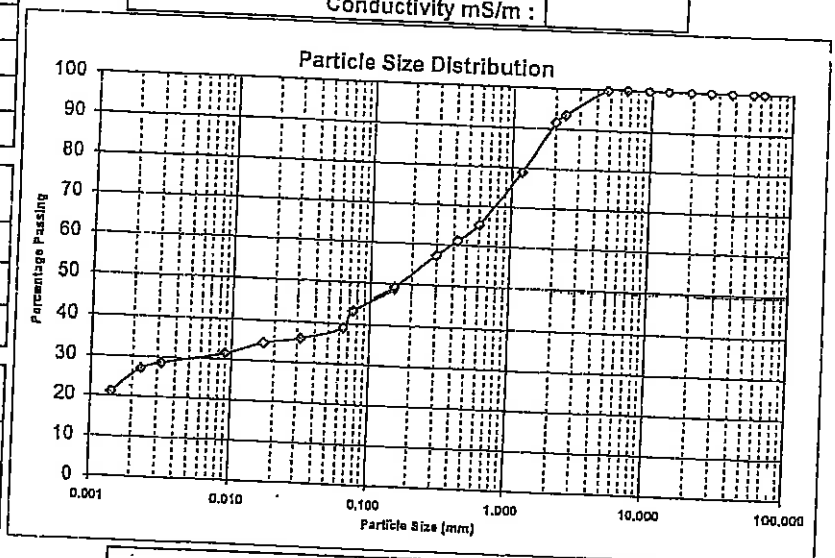
Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	
	6.70	
	4.75	100
	2.36	93
	2.00	91
	1.18	79
	0.600	65
	0.425	61
	0.300	57
	0.150	49
	0.0750	43

Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0702	39
0.0354	36
0.0179	34
0.0093	31
0.0032	28
0.0023	27
0.0013	21

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	
Conductivity mS/m :	

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	50
Plastic Index	30
Linear Shrinkage	9.2



MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	

Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	0
Sand : Percentage - 4.75mm and + 0.075mm	57
Silt : Percentage - 0.075mm and + 0.002mm	17
Clay : Percentage - 0.002mm	26

The above test results are pertinent to the samples received and tested only.
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		DATE:	27-02-2008
ATT:	Dick Bradshaw	REF:	L80225

ASTM D422 SIEVE ANALYSIS

DESCRIPTION :	lt olive sandy silty clay	SAMPLE NO. :	9727
POSITION :	TP 13 @ 1.2-2.35m	CLIENT SAMPLE NO. :	

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	
	6.70	
	4.75	100
	2.36	99
	2.00	99
	1.18	98
	0.600	95
	0.425	92
	0.300	88
	0.150	76
	0.0750	65

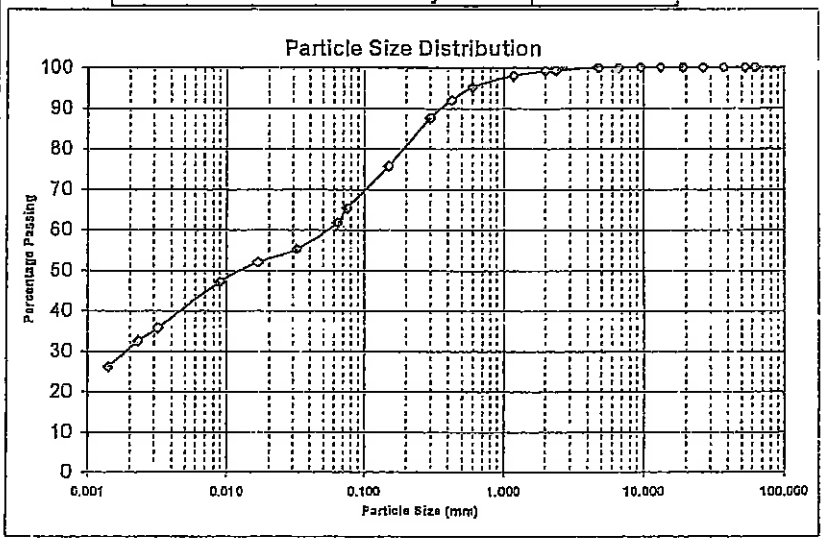
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0657	62
0.0336	55
0.0170	52
0.0090	47
0.0032	36
0.0023	32
0.0013	26

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	6.0
Conductivity mS/m :	14.78

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	33
Plastic Index	20
Linear Shrinkage	5.4

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	0
Sand : Percentage - 4.75mm and + 0.075mm	35
Silt : Percentage - 0.075mm and + 0.002mm	31
Clay : Percentage - 0.002mm	34

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7700
ATT: Dick Bradshaw

PROJECT: Vlakkeland
DATE: 27-02-2008
REF: L80225

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : lt olive & red silty clay
POSITION : TP 17 @ 0.9m

SAMPLE NO. : 9728
CLIENT SAMPLE NO. :

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	
	6.70	
	4.75	
	2.36	
	2.00	100
	1.18	98
	0.600	98
	0.425	97
	0.300	97
	0.150	96
	0.0750	95

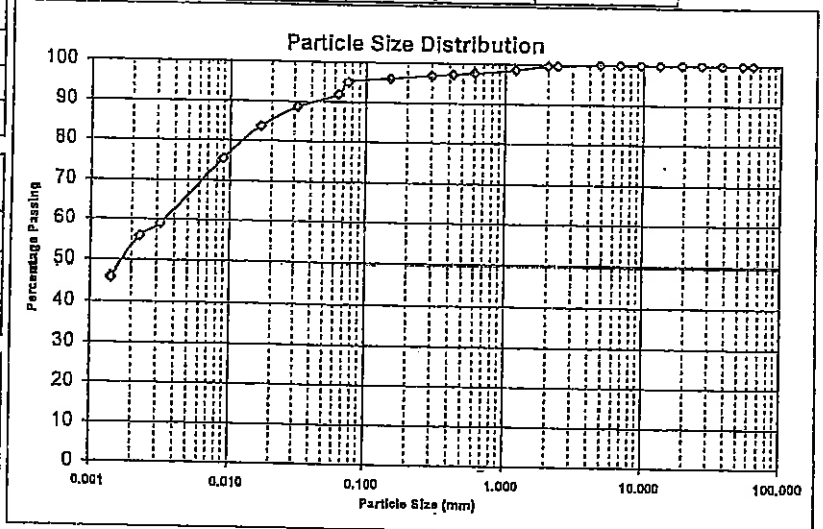
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0583	92
0.0296	88
0.0152	84
0.0083	75
0.0029	59
0.0021	56
0.0013	46

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	
Conductivity mS/m :	

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	54
Plastic Index	30
Linear Shrinkage	9.5

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	0
Sand : Percentage - 4.75mm and + 0.075mm	5
Silt : Percentage - 0.075mm and + 0.002mm	38
Clay : Percentage - 0.002mm	57

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ATT:	Dick Bradshaw	REF:	L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION :	yellow brown clayey sand	SAMPLE NO. :	9736
POSITION :	TP 17 @ 0-1.05m	CLIENT SAMPLE NO. :	

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	
	6.70	100
	4.75	99
	2.36	86
	2.00	82
	1.18	61
	0.600	39
	0.425	32
	0.300	29
	0.150	21
	0.0750	18

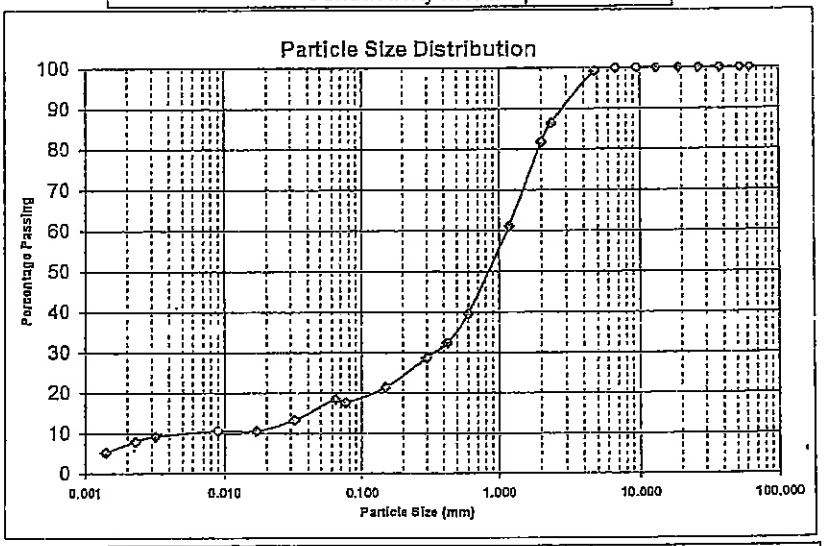
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0733	18
0.0374	13
0.0188	11
0.0097	11
0.0034	9
0.0024	8
0.0014	5

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	
Conductivity mS/m :	

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	17
Plastic Index	4
Linear Shrinkage	2.2

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	2210
O.M.C. (%)	5.2
C.B.R. @ 100% Comp.	198
C.B.R. @ 98 % Comp.	141
C.B.R. @ 95 % Comp.	82
C.B.R. @ 93 % Comp.	57
C.B.R. @ 90 % Comp.	33
Swell (max) %	0.00



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	1
Sand : Percentage - 4.75mm and + 0.075mm	82
Silt : Percentage - 0.075mm and + 0.002mm	10
Clay : Percentage - 0.002mm	8

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7700
ATT: Dick Bradshaw

PROJECT: Vlakkeland
DATE: 27-02-2008
REF: L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : It brown gravelly clayey sand
POSITION : TP 20 @ 0.4-1.25m

SAMPLE NO. : 9737
CLIENT SAMPLE NO. :

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	100
	6.70	99
	4.75	97
	2.36	82
	2.00	79
	1.18	69
	0.600	55
	0.425	47
	0.300	40
	0.150	27
	0.0750	21

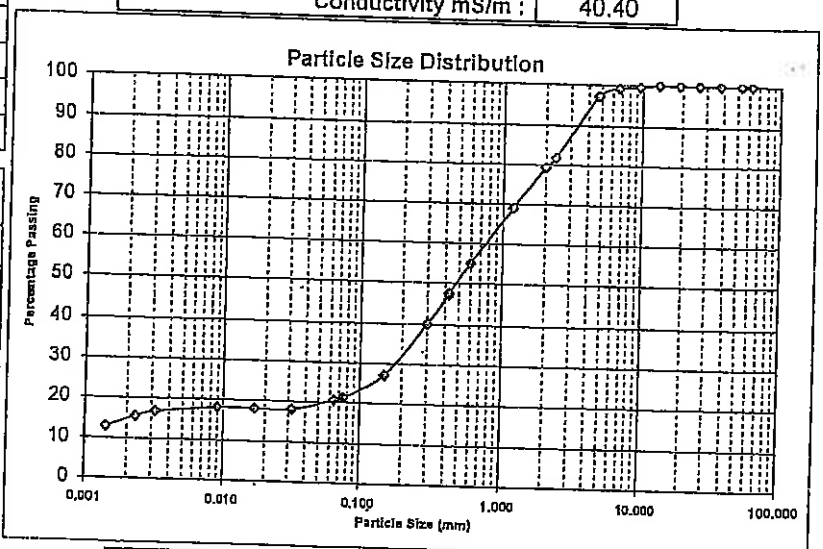
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0727	20
0.0366	18
0.0183	18
0.0095	18
0.0033	17
0.0023	15
0.0014	13

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	6.5
Conductivity mS/m :	40.40

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	23
Plastic Index	9
Linear Shrinkage	4.8

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	2150
O.M.C. (%)	6.3
C.B.R. @ 100% Comp.	55
C.B.R. @ 98 % Comp.	42
C.B.R. @ 95 % Comp.	28
C.B.R. @ 93 % Comp.	22
C.B.R. @ 90 % Comp.	16
Swell (max) %	0.90



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	3
Sand : Percentage - 4.75mm and + 0.075mm	76
Silt : Percentage - 0.075mm and + 0.002mm	6
Clay : Percentage - 0.002mm	15

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7700
ATT: Dick Bradshaw

PROJECT: Vlakkeland
DATE: 27-02-2008
REF: L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : yellow brown silty sand
POSITION : TP 21 @ 0-1.9m

SAMPLE NO. : 9738
CLIENT SAMPLE NO. :

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	100
	6.70	99
	4.75	96
	2.36	79
	2.00	74
	1.18	59
	0.600	38
	0.425	30
	0.300	25
	0.150	16
	0.0750	10

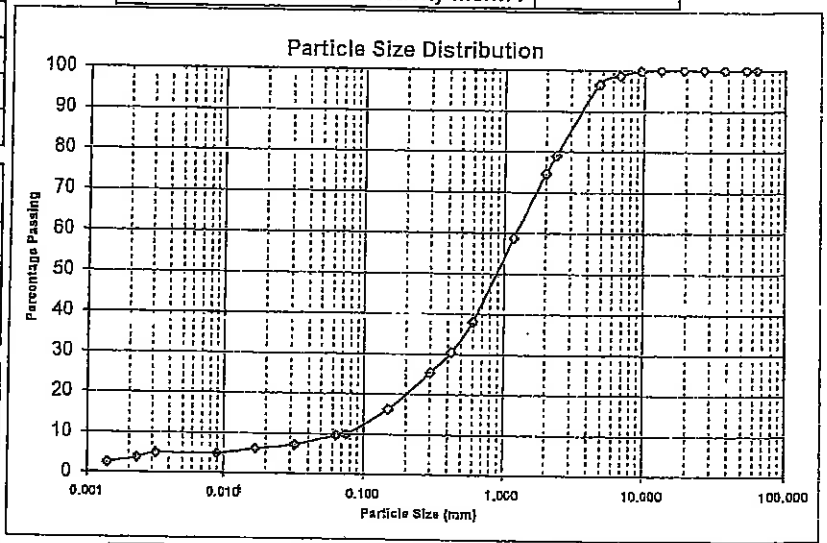
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0753	10
0.0380	7
0.0192	6
0.0099	5
0.0034	5
0.0024	4
0.0014	2

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	
Conductivity mS/m :	

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	
Plastic Index	S-P
Linear Shrinkage	

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	2145
O.M.C. (%)	6.6
C.B.R. @ 100% Comp.	178
C.B.R. @ 98 % Comp.	108
C.B.R. @ 95 % Comp.	56
C.B.R. @ 93 % Comp.	36
C.B.R. @ 90 % Comp.	18
Swell (max) %	0.00



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	4
Sand : Percentage - 4.75mm and + 0.075mm	87
Silt : Percentage - 0.075mm and + 0.002mm	6
Clay : Percentage - 0.002mm	4

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ATT: Dick Bradshaw

PROJECT: Vlakkeland
DATE: 27-02-2008
REF: L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : yellow brown gravelly silty sand
POSITION : TP 24 @ 0-1.8m

SAMPLE NO. : 9739
CLIENT SAMPLE NO. :

Sieve Analysis	Percent Passing
75.00	
63.00	
53.00	
37.50	
26.50	
19.00	
13.20	100
9.50	99
6.70	97
4.75	91
2.36	68
2.00	63
1.18	52
0.600	34
0.425	26
0.300	22
0.150	17
0.0750	11

SIEVE SIZE (mm)

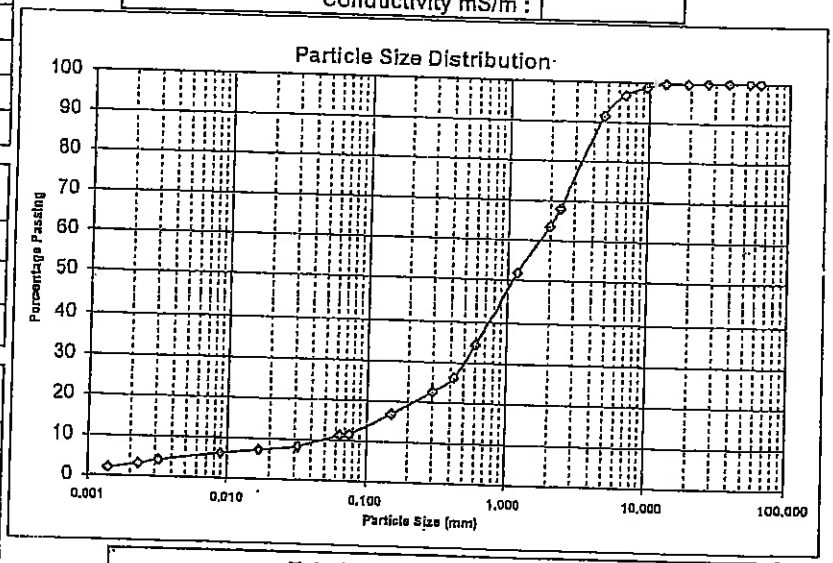
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0748	11
0.0376	8
0.0190	7
0.0098	6
0.0034	4
0.0024	3
0.0014	2

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	
Conductivity mS/m :	

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	
Plastic Index	S-P
Linear Shrinkage	

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	2251
O.M.C. (%)	5.5
C.B.R. @ 100% Comp.	109
C.B.R. @ 98 % Comp.	86
C.B.R. @ 95 % Comp.	55
C.B.R. @ 93 % Comp.	44
C.B.R. @ 90 % Comp.	30
Swell (max) %	0.20



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	9
Sand : Percentage - 4.75mm and + 0.075mm	80
Silt : Percentage - 0.075mm and + 0.002mm	7
Clay : Percentage - 0.002mm	4

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		DATE:	27-02-2008
ATT:	Dick Bradshaw	REF:	L80225

ASTM D422 SIEVE ANALYSIS

DESCRIPTION :	lt red silty clay	SAMPLE NO. :	9730
POSITION :	TP 28 @ 1.0m	CLIENT SAMPLE NO. :	

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	100
	13.20	99
	9.50	99
	6.70	98
	4.75	97
	2.36	93
	2.00	92
	1.18	87
	0.600	82
	0.425	80
	0.300	78
	0.150	73
	0.0750	70

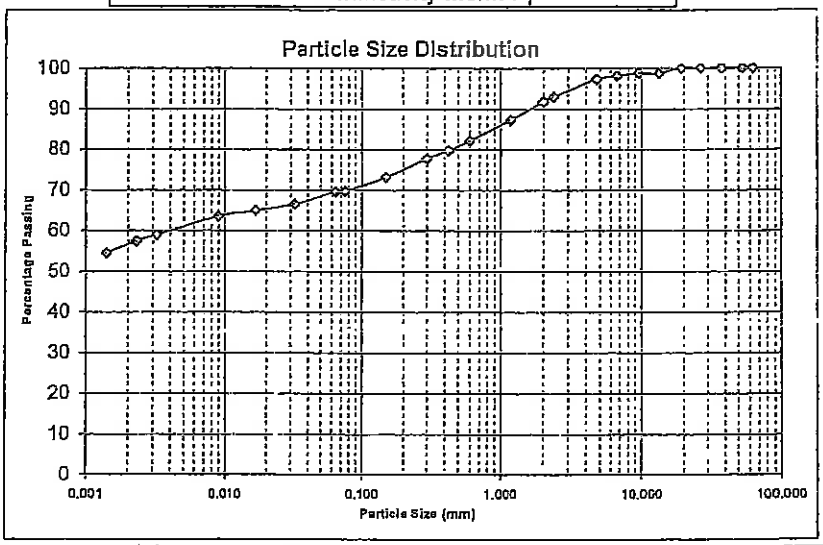
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0631	69
0.0320	66
0.0160	65
0.0083	63
0.0029	59
0.0021	57
0.0012	54

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	
Conductivity mS/m :	

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	63
Plastic Index	38
Linear Shrinkage	9.3

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	3
Sand : Percentage - 4.75mm and + 0.075mm	28
Silt : Percentage - 0.075mm and + 0.002mm	12
Clay : Percentage - 0.002mm	58

For Geoscience:

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17 Midwood Avenue
Newlands
7700

ATT: Dick Bradshaw

PROJECT: Vlakkeland

DATE: 27-02-2008

REF: L80225

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : lt grey sand
POSITION : TP 31 @ 0.6m

SAMPLE NO. : 9731
CLIENT SAMPLE NO. :

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	100
	6.70	99
	4.75	97
	2.36	71
	2.00	66
	1.18	46
	0.600	28
	0.425	22
	0.300	18
	0.150	11
	0.0750	7

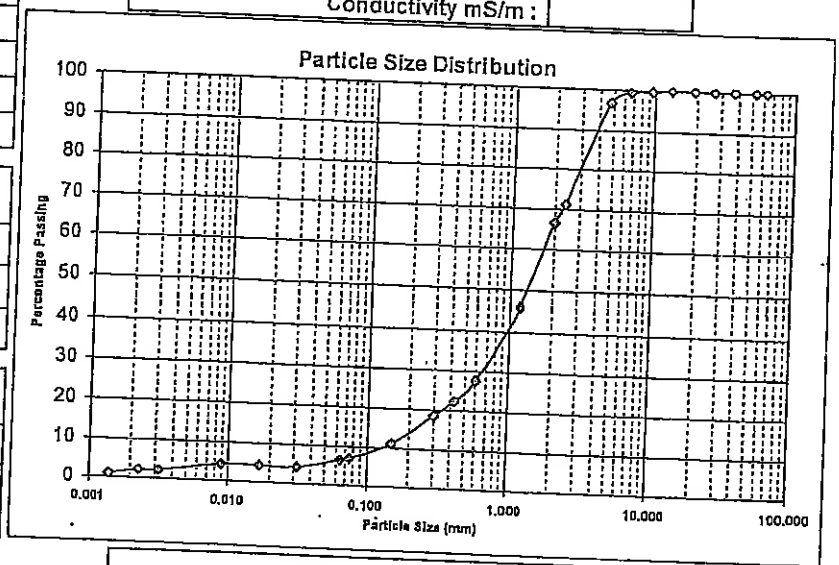
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0760	6
0.0384	4
0.0192	4
0.0099	4
0.0035	2
0.0024	2
0.0014	1

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	
Conductivity mS/m :	

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	
Plastic Index	N-P
Linear Shrinkage	

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	3
Sand : Percentage - 4.75mm and + 0.075mm	90
Silt : Percentage - 0.075mm and + 0.002mm	5
Clay : Percentage - 0.002mm	2

For Geoscience:

GEOSCIENCE
LABORATORIES (PTY) LTD
71 INDUSTRIAL RING ROAD PAROW INDUSTRIA 7499, P.O. BOX 298 PAROW 7499
TELEPHONE: (021) 933 3175 FAX: (021) 933 1078

CLIENT:	RA Bradshaw & Associates 17 Midwood Avenue Newlands 7700	PROJECT:	Vlakkeland
		DATE:	27-02-2008
ATT:	Dick Bradshaw	REF:	L80225

ASTM D422 SIEVE ANALYSIS

DESCRIPTION :	lt olive & red clayey sand	SAMPLE NO. :	9732
POSITION :	TP 32 @ 1.5m	CLIENT SAMPLE NO. :	

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	
	6.70	
	4.75	100
	2.36	92
	2.00	90
	1.18	82
	0.600	72
	0.425	67
	0.300	62
	0.150	55
	0.0750	51

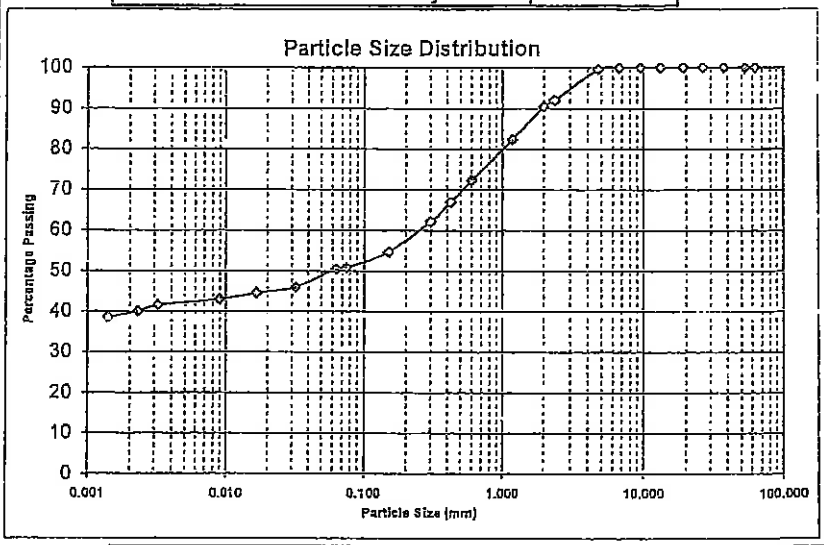
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0663	50
0.0339	46
0.0169	44
0.0088	43
0.0031	41
0.0022	40
0.0013	38

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	
Conductivity mS/m :	

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	44
Plastic Index	26
Linear Shrinkage	9.0

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	0
Sand : Percentage - 4.75mm and + 0.075mm	49
Silt : Percentage - 0.075mm and + 0.002mm	11
Clay : Percentage - 0.002mm	40

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71 INDUSTRIAL RING ROAD PAROW INDUSTRIA 7499, P.O. BOX 298 PAROW 7499
TELEPHONE: (021) 933 6176 FAX: (021) 933 1079

CLIENT: RA Bradshaw & Associates
17 Midwood Avenue
Newlands
7700
ATT: Dick Bradshaw

PROJECT: Vlakkeland
DATE: 27-02-2008
REF: L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : lt olive silty clayey sand
POSITION : TP 37 @ 0.9-2.45m

SAMPLE NO. : 9742
CLIENT SAMPLE NO. :

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	100
	9.50	99
	6.70	98
	4.75	97
	2.36	87
	2.00	86
	1.18	78
	0.600	67
	0.425	60
	0.300	52
	0.150	37
	0.0750	31

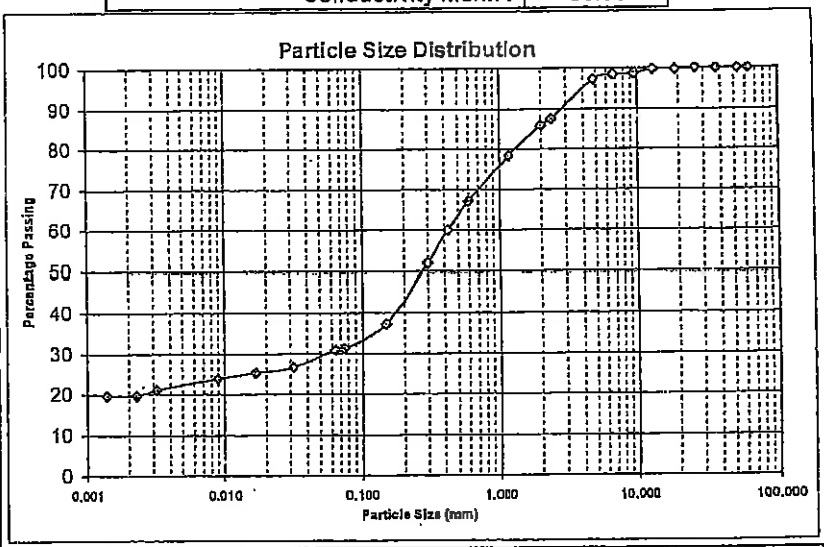
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0707	31
0.0360	27
0.0180	25
0.0094	24
0.0033	21
0.0023	20
0.0013	20

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	6.2
Conductivity mS/m :	55.00

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	34
Plastic Index	18
Linear Shrinkage	4.9

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	3
Sand ; Percentage - 4.75mm and + 0.075mm	66
Silt : Percentage - 0.075mm and + 0.002mm	10
Clay : Percentage - 0.002mm	21

For Geoscience:

GEOSCIENCE
LABORATORIES (PTY) LTD
71 INDUSTRIAL RING ROAD PAROW INDUSTRIA 7499, P.O. BOX 298 PAROW 7499
TELEPHONE: (021) 933 6176 FAX: (021) 933 1079

CLIENT:	RA Bradshaw & Associates 17 Midwood Avenue Newlands 7700	PROJECT:	Vlakkeland
ATT:	Dick Bradshaw	DATE: REF:	27-02-2008 L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION :	lt brown & yellow sandy silty clay	SAMPLE NO. :	9744
POSITION :	TP 46 @ 0.8-2.6m	CLIENT SAMPLE NO. :	

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75.00	
	63.00	
	53.00	
	37.50	
	26.50	
	19.00	
	13.20	
	9.50	
	6.70	
	4.75	100
	2.36	96
	2.00	95
	1.18	90
	0.600	83
	0.425	80
	0.300	76
	0.150	65
	0.0750	55

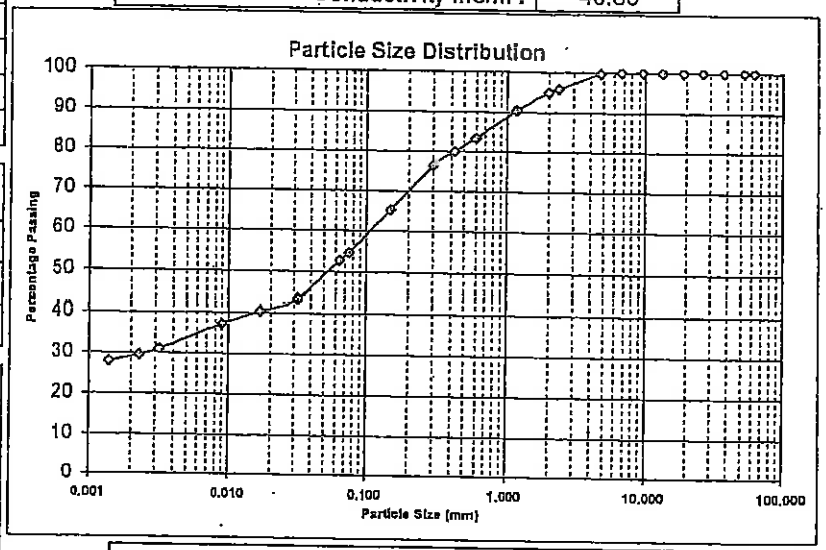
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0663	53
0.0343	43
0.0173	40
0.0090	37
0.0032	31
0.0022	29
0.0013	28

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	5.3
Conductivity mS/m :	40.60

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	32
Plastic Index	17
Linear Shrinkage	6.1

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	0
Sand : Percentage - 4.75mm and + 0.075mm	45
Silt : Percentage - 0.075mm and + 0.002mm	24
Clay : Percentage - 0.002mm	31

For Geoscience:

GEOSCIENCE
LABORATORIES (PTY) LTD
71 INDUSTRIAL RING ROAD PAROW INDUSTRIA 7493, P.O. BOX 295 PAROW 7499
TELEPHONE: (021) 933 6176 FAX: (021) 933 1079

CLIENT:	RA Bradshaw & Associates 17 Midwood Avenue Newlands 7700	PROJECT:	Vlakkeland
		DATE:	27-02-2008
ATT:	Dick Bradshaw	REF:	L80226

ASTM D422 SIEVE ANALYSIS

DESCRIPTION :	dark yellow silty clay	SAMPLE NO. :	9743
POSITION :	TP 45 @ 1.4-2.6m	CLIENT SAMPLE NO. :	

Sieve Analysis	Percent Passing
75.00	
63.00	
53.00	
37.50	
26.50	
19.00	
13.20	
9.50	
6.70	
4.75	100
2.36	99
2.00	99
1.18	96
0.600	93
0.425	91
0.300	89
0.150	80
0.0750	73

SIEVE SIZE (mm)

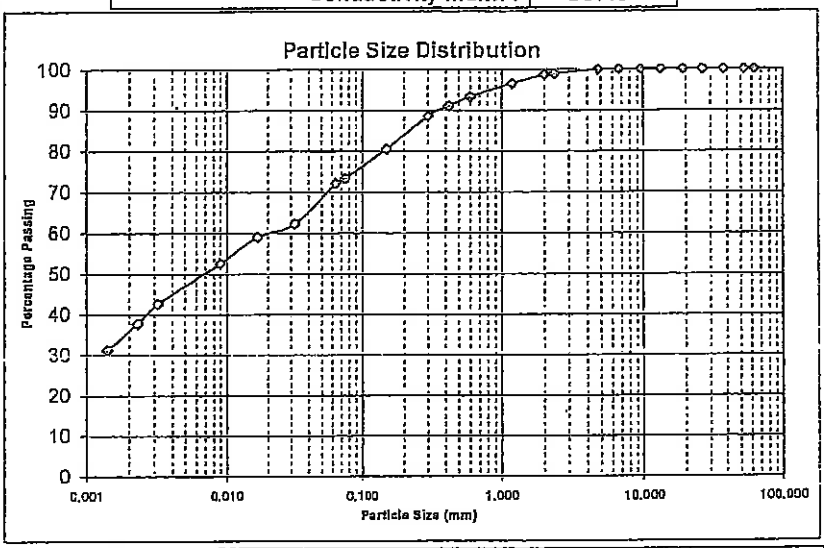
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0.0640	72
0.0324	62
0.0164	59
0.0087	52
0.0031	43
0.0022	38
0.0013	31

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

SCS Dispersion %:	
Initial Moisture Content (%) :	
pH :	6.40
Conductivity mS/m :	537.00

Atterberg Limits : TMH1 A2, A3 & A4	
Liquid Limit	50
Plastic Index	24
Linear Shrinkage	13.2

MOD AASHTO ; C.B.R. : A7 & A8	*TMH1*
MOD AASHTO (Kg/m³)	1802
O.M.C. (%)	15.3
C.B.R. @ 100% Comp.	1
C.B.R. @ 98 % Comp.	1
C.B.R. @ 95 % Comp.	1
C.B.R. @ 93 % Comp.	0
C.B.R. @ 90 % Comp.	0
Swell (max) %	11.20



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	0
Sand : Percentage - 4.75mm and + 0.075mm	27
Silt : Percentage - 0.075mm and + 0.002mm	33
Clay : Percentage - 0.002mm	40

For Geoscience:

GEOSCIENCE LABORATORIES

CONSOLIDATION TEST

SUMMARY OF READINGS

PROJECT : Vlakkeland

PROJECT NO : L80225
SAMPLE NO : 9726
POSITION: TP 13 @ 1.0m

INITIAL DIAL READING = 1.04 mm
RING DIAMETER = 76.2 mm
H1 = 18.75 mm
H_S = 13.11 mm

OEDOMETER NO : 1
BEAM RATIO : 11

BEAM LOAD	COMMENTS	PRESSURE	DIAL READING	UNCORRECTED DEFLECTION	MACHINE CORRECTION	CORRECTED DEFLECTION	HEIGHT CHANGE	VOID RATIO
(kg)		(Kpa)	(mm)	(mm)	(mm)	(mm)	(mm)	
0.0		0.00	1.040	1.040	0.000	0	18.750	0.4302
0.1		2.37	1.026	0.014	0.001	0.013	18.737	0.4292
1.0		23.66	0.950	0.090	0.013	0.077	18.673	0.4243
1.75		41.41	0.854	0.186	0.020	0.166	18.584	0.4175
1.75	SAT	41.41	1.384	-0.344	0.020	-0.364	19.114	0.4580
2.75		65.07	1.318	-0.278	0.026	-0.304	19.054	0.4534
4.75		112.40	1.104	-0.064	0.034	-0.098	18.848	0.4377
8.75		207.05	0.712	0.328	0.047	0.281	18.469	0.4088

GEOSCIENCE LABORATORIES

CONSOLIDATION TEST

SUMMARY OF READINGS

PROJECT : Vlakkeland

PROJECT NO : L80225
SAMPLE NO : 9730
POSITION: TP 28 @ 1.0m

INITIAL DIAL READING = 6.05 mm
RING DIAMETER = 76.4 mm
H1 = 19.2 mm
H_s = 11.43 mm

OEDOMETER NO : 2
BEAM RATIO : 11

BEAM LOAD (kg)	COMMENTS	PRESSURE (Kpa)	DIAL READING (mm)	UNCORRECTED DEFLECTION (mm)	MACHINE CORRECTION (mm)	CORRECTED DEFLECTION (mm)	HEIGHT CHANGE (mm)	VOID RATIO
0.0		0.00	6.050	6.050	0.000	0	19.200	0.6798
0.1		2.35	5.914	0.136	0.001	0.135	19.065	0.6680
1.0		23.54	5.530	0.520	0.012	0.508	18.692	0.6353
1.75		41.19	5.432	0.618	0.017	0.601	18.599	0.6272
1.75	SAT	41.19	5.758	0.292	0.017	0.275	18.925	0.6557
5		64.73	5.676	0.374	0.022	0.352	18.848	0.6490
.75		111.81	5.412	0.638	0.030	0.608	18.592	0.6266
8.75		205.96	4.900	1.150	0.043	1.107	18.093	0.5829

GEOSCIENCE LABORATORIES

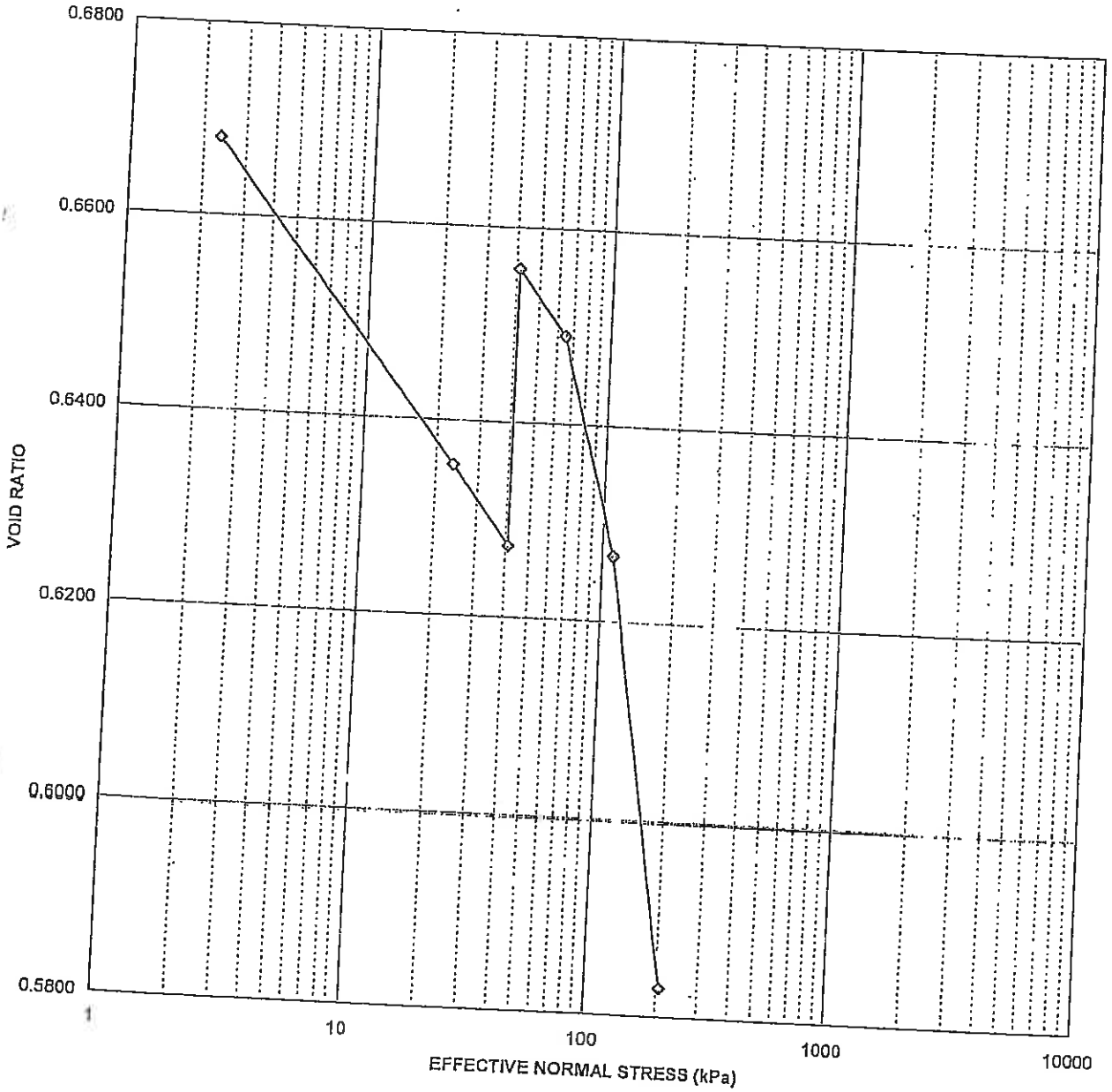
CONSOLIDATION TEST

PROJECT : Vlakkeland

PROJECT NO : L80225
SAMPLE NO : 9730
POSITION: TP 28 @ 1.0m

SAMPLE DESCRIPTION	:	lt red silty clay
STATE OF SAMPLE	:	UNDISTURBED
DRY DENSITY	=	1577 Kg/m3
INITIAL SATURATION	=	0.9
INITIAL MOISTURE CONTENT	=	23.13 %
INITIAL VOID RATIO	=	0.6798

SPECIFIC DENSITY	=	2.65
FINAL SATURATION	=	1.07
FINAL MOISTURE CONTENT	=	23.49 %
FINAL VOID RATIO	=	0.5829



EOSCIENCE LABORATORIES

ONSOLIDATION TEST

SUMMARY OF READINGS

PROJECT : Vlakkeland

PROJECT NO : L80225
SAMPLE NO : 9732
POSITION: TP 32 @ 1.5m

INITIAL DIAL READING = 1.083 mm
RING DIAMETER = 76.2 mm
H1 = 19.1 mm
H_s = 13.61 mm

OEDOMETER NO : 7
BEAM RATIO : 11

BEAM LOAD	COMMENTS	PRESSURE	DIAL READING	UNCORRECTED DEFLECTION	MACHINE CORRECTION	CORRECTED DEFLECTION	HEIGHT CHANGE	VOID RATIO
(kg)		(Kpa)	(mm)	(mm)	(mm)	(mm)	(mm)	
0.0		0.00	1.083	1.083	0.000	0	19.100	0.4034
0.1		2.37	1.068	0.015	0.006	0.009	19.091	0.4027
1.0		23.66	0.940	0.143	0.038	0.105	18.995	0.3957
2.0		47.33	0.892	0.191	0.052	0.139	18.961	0.3932
2.0	SAT	47.33	1.944	-0.861	0.052	-0.913	20.013	0.4705
[illegible]		94.65	1.816	-0.733	0.071	-0.804	19.904	0.4625
8.0		189.30	1.487	-0.404	0.093	-0.497	19.597	0.4399
16.0		378.60	1.014	0.069	0.118	-0.049	19.149	0.4070
32.0		757.20	0.549	0.534	0.157	0.377	18.723	0.3757

GEOSCIENCE LABORATORIES

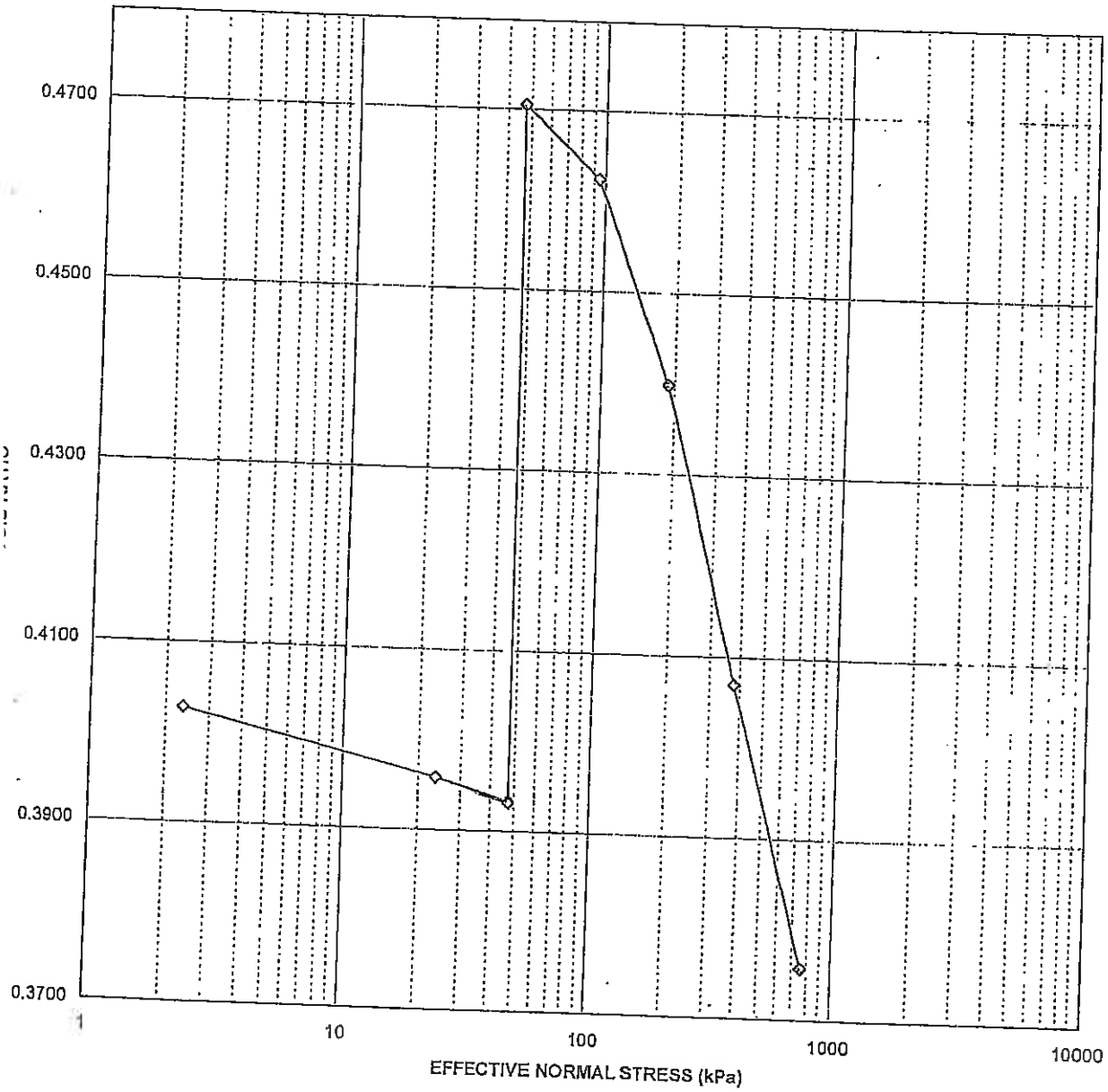
CONSOLIDATION TEST

PROJECT : Vlakkeland

PROJECT NO : L80225
SAMPLE NO : 9732
POSITION: TP 32 @ 1.5m

AMPLE DESCRIPTION	:	lt olive & red clayey sand
TATE OF SAMPLE	:	UNDISTURBED
RY DENSITY	=	1889 Kg/m3
ITIAL SATURATION	=	0.9
ITIAL MOISTURE CONTENT	=	13.74 %
ITIAL VOID RATIO	=	0.4034

SPECIFIC DENSITY	=	2.65
FINAL SATURATION	=	1.10
FINAL MOISTURE CONTENT	=	15.56 %
FINAL VOID RATIO	=	0.3757



GEOSCIENCE LABORATORIES

CONSOLIDATION TEST

SUMMARY OF READINGS

PROJECT : Vlakkeland

PROJECT NO : L80225
SAMPLE NO : 9729
POSITION: TP 23 @ 1.3m

INITIAL DIAL READING = 1.067 mm
RING DIAMETER = 76 mm
H1 = 19.3 mm
H_s = 11.32 mm

OEDOMETER NO : 1
BEAM RATIO : 11

BEAM LOAD (kg)	COMMENTS	PRESSURE (Kpa)	DIAL READING (mm)	UNCORRECTED DEFLECTION (mm)	MACHINE CORRECTION (mm)	CORRECTED DEFLECTION (mm)	HEIGHT CHANGE (mm)	VOID RATIO
0.0		0.00	1.067	1.067	0.000	0	19.300	0.7049
0.1		2.38	1.050	0.017	0.002	0.015	19.285	0.7036
1.0		23.79	0.895	0.172	0.015	0.157	19.143	0.6911
2.0		47.57	0.827	0.240	0.022	0.218	19.082	0.6857
2.0	SAT	47.57	1.342	-0.275	0.022	-0.297	19.597	0.7312
4.0		95.15	1.249	-0.182	0.032	-0.214	19.514	0.7239
8.0		190.30	1.025	0.042	0.045	-0.003	19.303	0.7052
16.0		380.60	0.643	0.424	0.064	0.360	18.940	0.6731

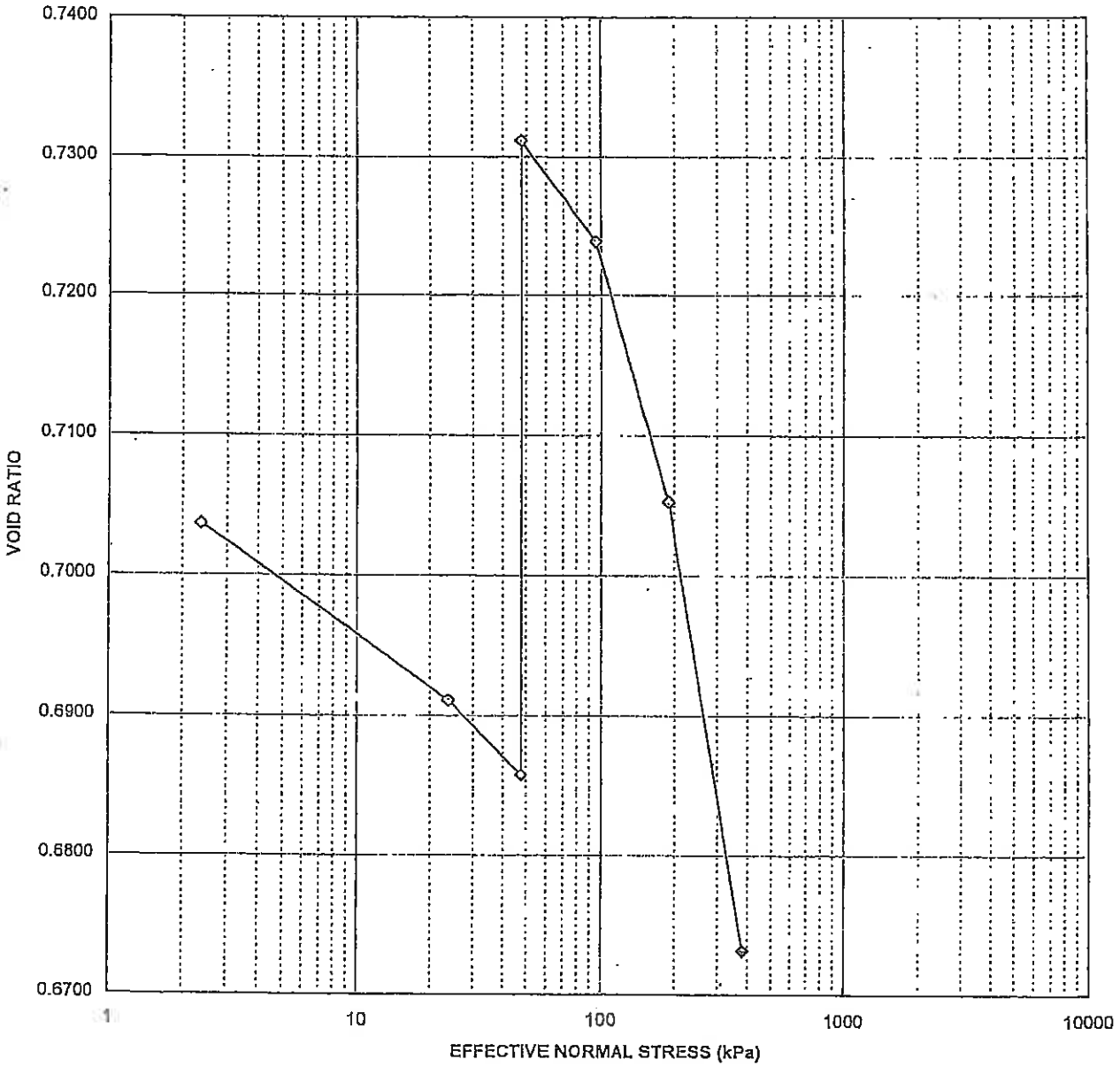
GEOSCIENCE LABORATORIES

CONSOLIDATION TEST

PROJECT : Vlakkeland

PROJECT NO : L80225
SAMPLE NO : 9729
POSITION: TP 23 @ 1.3m

SAMPLE DESCRIPTION	:	olive & yellow silty clay			
STATE OF SAMPLE	:	UNDISTURBED			
DRY DENSITY	=	1554 Kg/m3	SPECIFIC DENSITY	=	2.65
INITIAL SATURATION	=	0.96	FINAL SATURATION	=	1.04
INITIAL MOISTURE CONTENT	=	25.64 %	FINAL MOISTURE CONTENT	=	26.52 %
INITIAL VOID RATIO	=	0.7049	FINAL VOID RATIO	=	0.6731



ΞOSCIENCE LABORATORIES

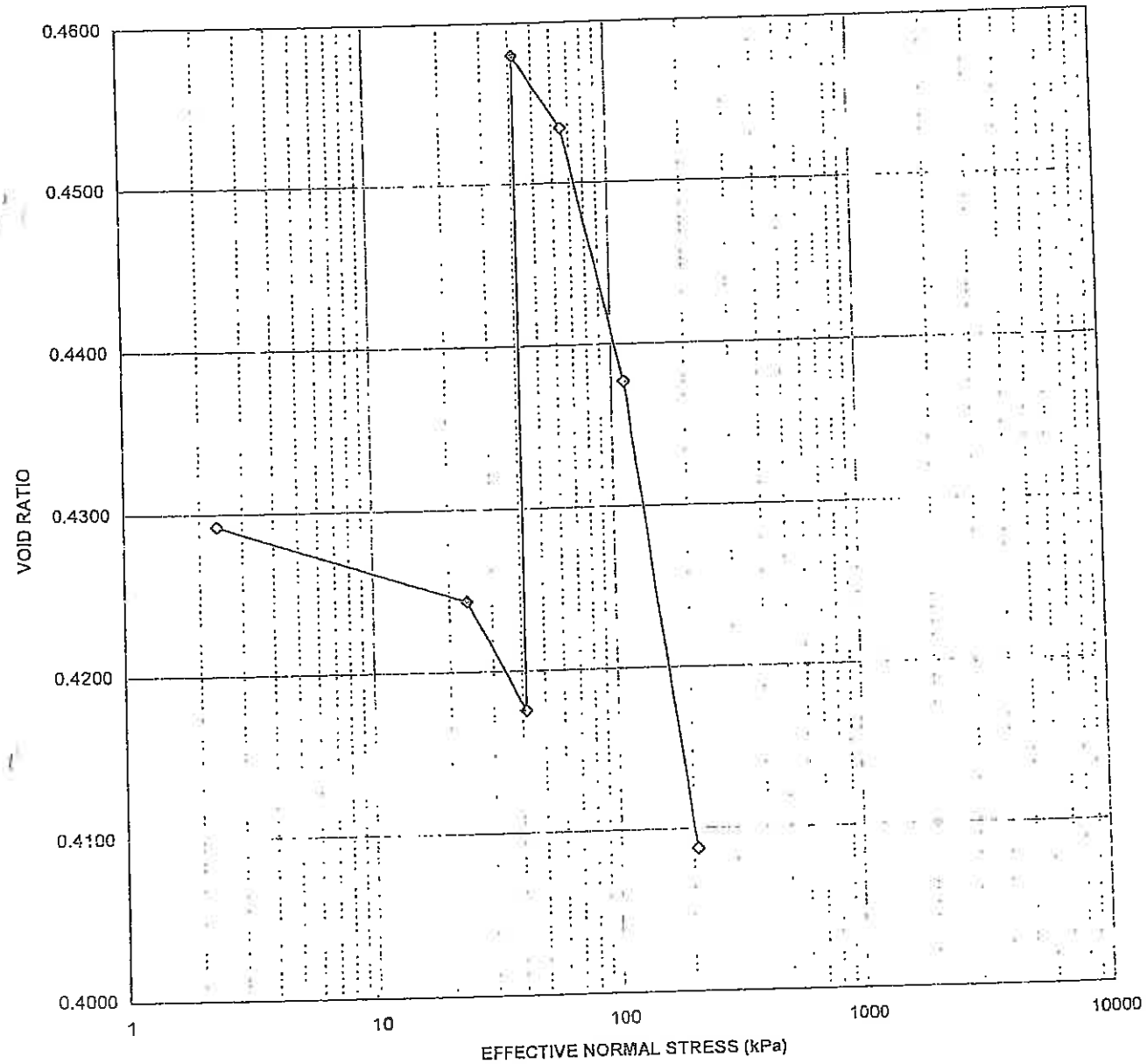
ONSOLIDATION TEST

PROJECT NO : L80225
SAMPLE NO : 9726
POSITION: TP 13 @ 1.0m

PROJECT : Vlakkeland

MPLE DESCRIPTION : light olive silty clayey sand
ATE OF SAMPLE : UNDISTURBED
Y DENSITY = 1853 Kg/m3
TIAL SATURATION = 0.68
TIAL MOISTURE CONTENT = 11.11 %
ITIAL VOID RATIO = 0.4302

SPECIFIC DENSITY = 2.65
FINAL SATURATION = 1.14
FINAL MOISTURE CONTENT = 17.51 %
FINAL VOID RATIO = 0.4088



EOSCIENCE LABORATORIES

ONSOLIDATION TEST

SUMMARY OF READINGS

PROJECT NO : L80225
SAMPLE NO : 9728
POSITION: TP 17 @ 0.9m

PROJECT : Vlakkeland

INITIAL DIAL READING = 1.143 mm
RING DIAMETER = 50.05 mm
H1 = 20.5 mm
H_s = 12.41 mm

OEDOMETER NO : 1
BEAM RATIO : 11

EAM OAD (kg)	COMMENTS	PRESSURE (Kpa)	DIAL READING (mm)	UNCORRECTED DEFLECTION (mm)	MACHINE CORRECTION (mm)	CORRECTED DEFLECTION (mm)	HEIGHT CHANGE (mm)	VOID RATIO
0.0		0.00	1.143	1.143	0.000	. 0	20.500	0.6519
.05		2.74	1.126	0.017	0.001	0.016	20.484	0.6506
0.5		27.42	0.961	0.182	0.014	0.168	20.332	0.6384
.75		41.14	0.890	0.253	0.021	0.232	20.268	0.6332
.75	SAT	41.14	1.371	-0.228	0.021	-0.249	20.749	0.6720
.0		109.70	1.295	-0.152	0.031	-0.183	20.683	0.6666
		219.39	1.088	0.055	0.044	0.011	20.489	0.6510

CLIENT: RA Bradshaw & Associates

PROJECT: Vlakkeland

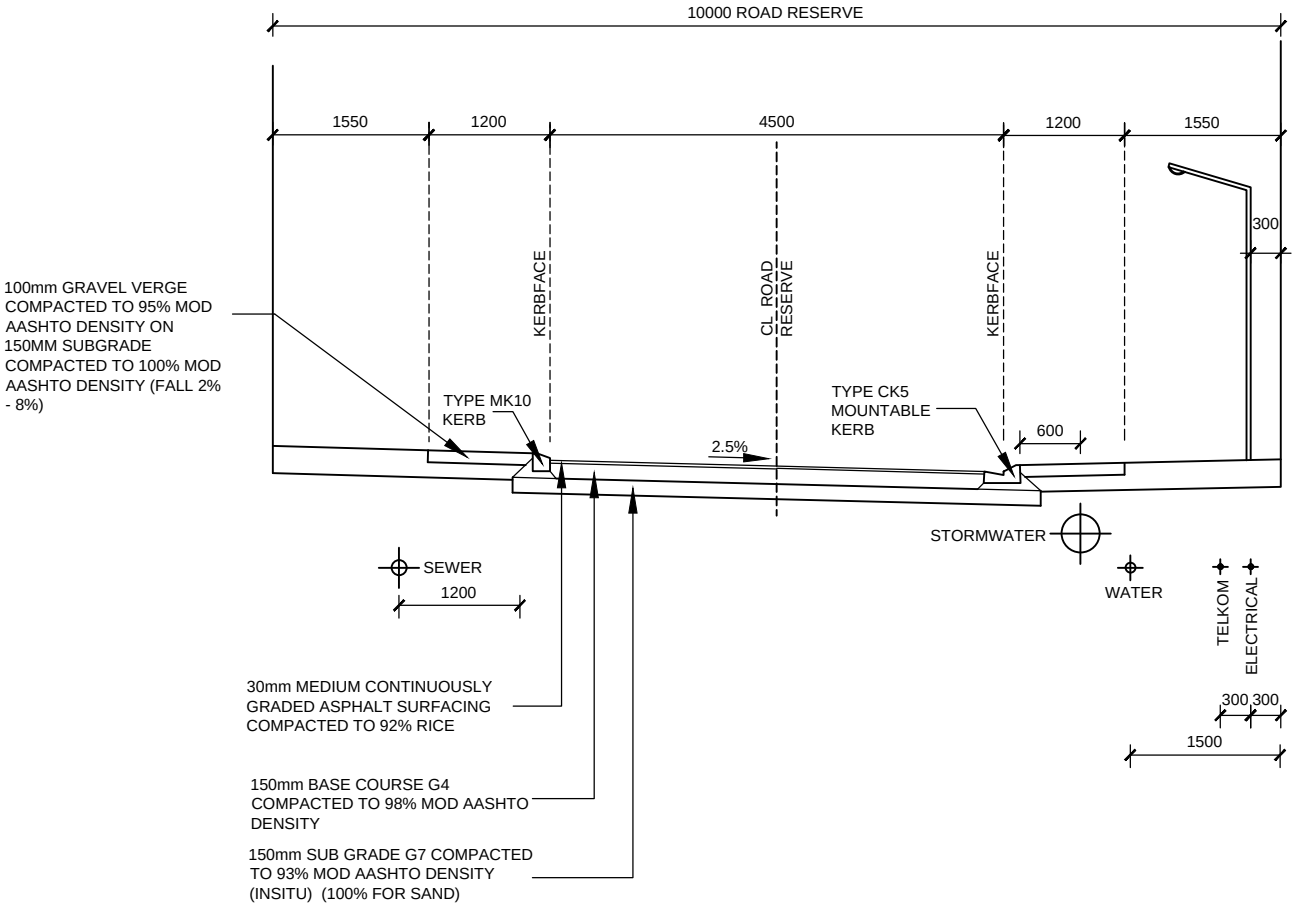
ATT : Dick Bradshaw

REF: L80226

CHEMICAL ANALYSIS RESULT SUMMARY

SAMPLE NO:	9740					
POSITION / CHAINAGE	TP 32					
DEPTH	0.8-1.8m					
DESCRIPTION:	olive & red					
	sandy					
	silty clay					

pH	4.0					
CONDUCTIVITY mS/m	23.10					



NOTE

1. ALL KERBING TO CONFORM TO SABS 927.
2. ALL CONCRETE TO BE 15 MPa / 19 mm

CONSULTING ENGINEERS
LYNERS
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MAIN ROAD
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TITLE: VLAKKELAND, PAARL - TYPICAL CROSS SECTION (10m ROAD RESERVE)

PROJECT No.	SCALE	DRAWING No.	REV
0894	NTS	0894/C/002-301	B

APPROVED :	DRAWN	DATE	CHECKED	DATE
	LO	2014-09-16	CW / DC	2014-09-16

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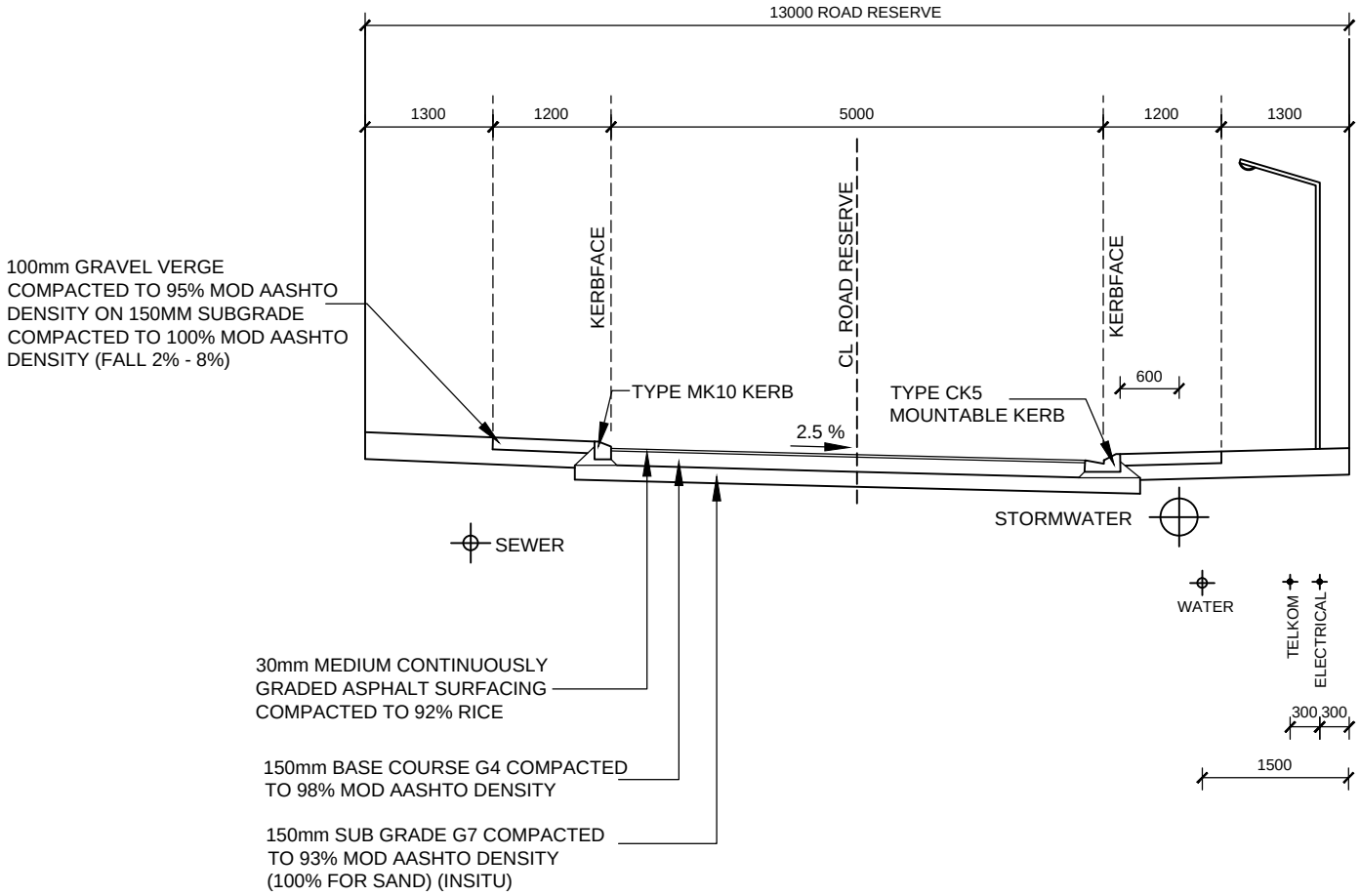

NOTE

1. ALL KERBING TO CONFORM TO SABS 927.
2. ALL CONCRETE TO BE 15 MPa / 19 mm

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TITLE: VLAKKELAND, PAARL - TYPICAL CROSS SECTION (13m ROAD RESERVE)

PROJECT No.	SCALE	DRAWING No.	REV
0894	NTS	0894/C/002-302	B

APPROVED :	DRAWN	DATE	CHECKED	DATE
	LO	2014-09-16	CW / DC	2014-09-16

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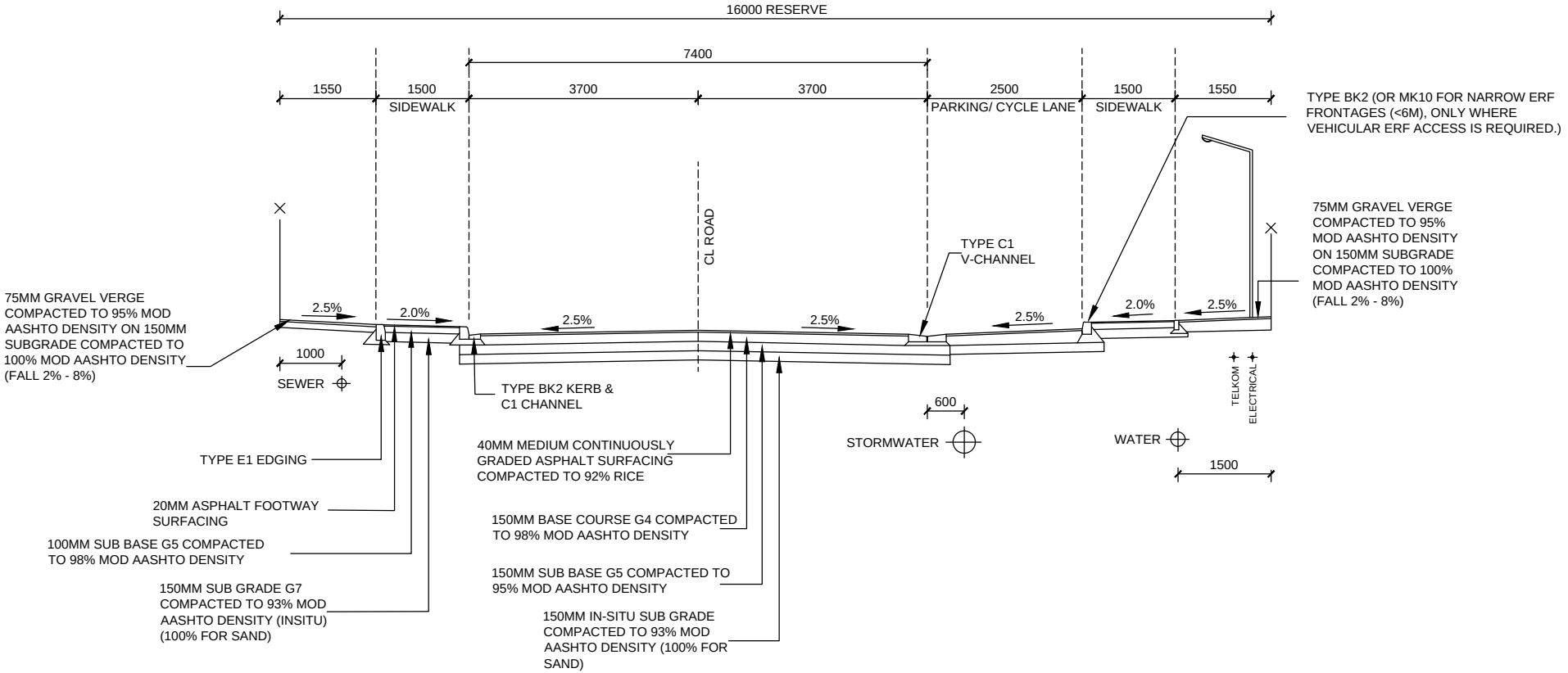

NOTE

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TITLE: VLAKKELAND, PAARL - TYPICAL CROSS SECTION (16m ROAD RESERVE)

PROJECT No.	SCALE	DRAWING No.	REV
0894	NTS	0894/C/002-303	B

APPROVED :	DRAWN	DATE	CHECKED	DATE
	LO	2014-09-16	CW / DC	2014-09-16

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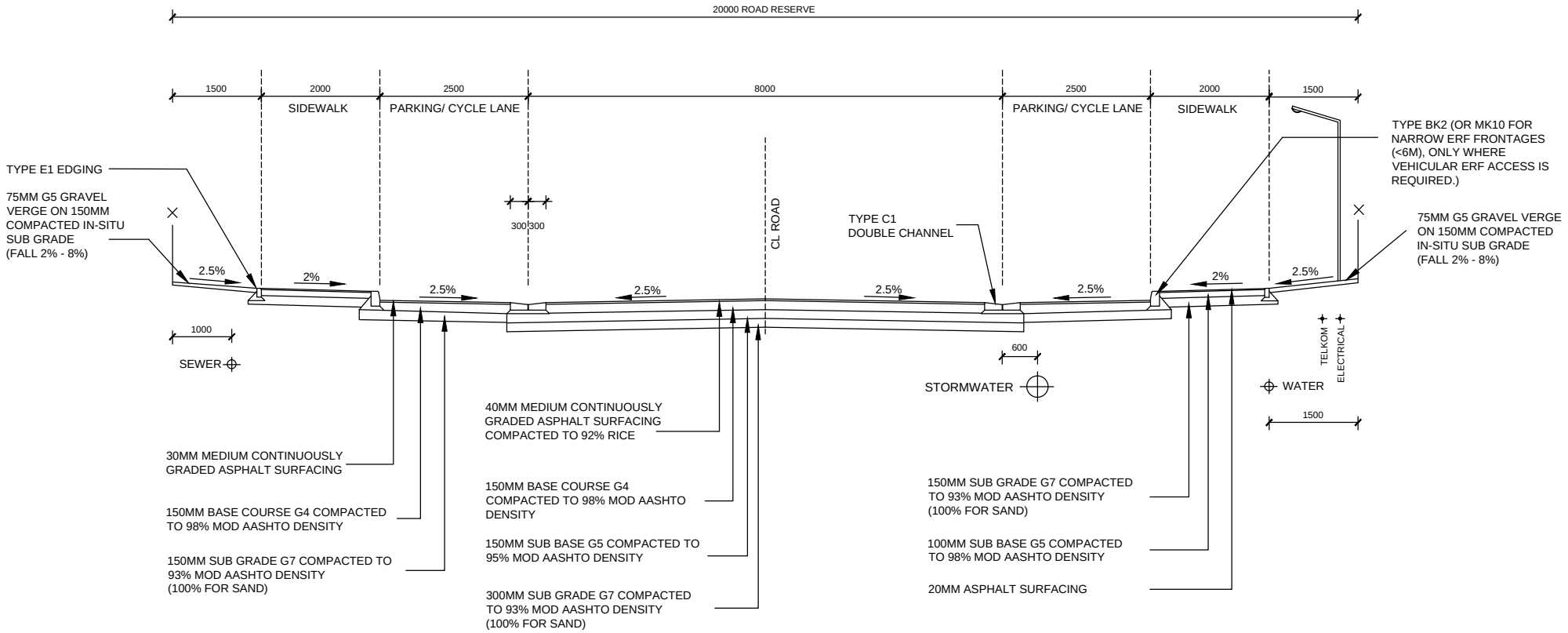

NOTE

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2. ALL CONCRETE TO BE 15 MPa / 19 mm

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TITLE: VLAKKELAND, PAARL - TYPICAL CROSS SECTION (20m ROAD RESERVE)

PROJECT No.	SCALE	DRAWING No.	REV
0894	NTS	0894/C/002-304	B

APPROVED :	DRAWN	DATE	CHECKED	DATE
	LO	2014-09-16	CW / DC	2014-09-16

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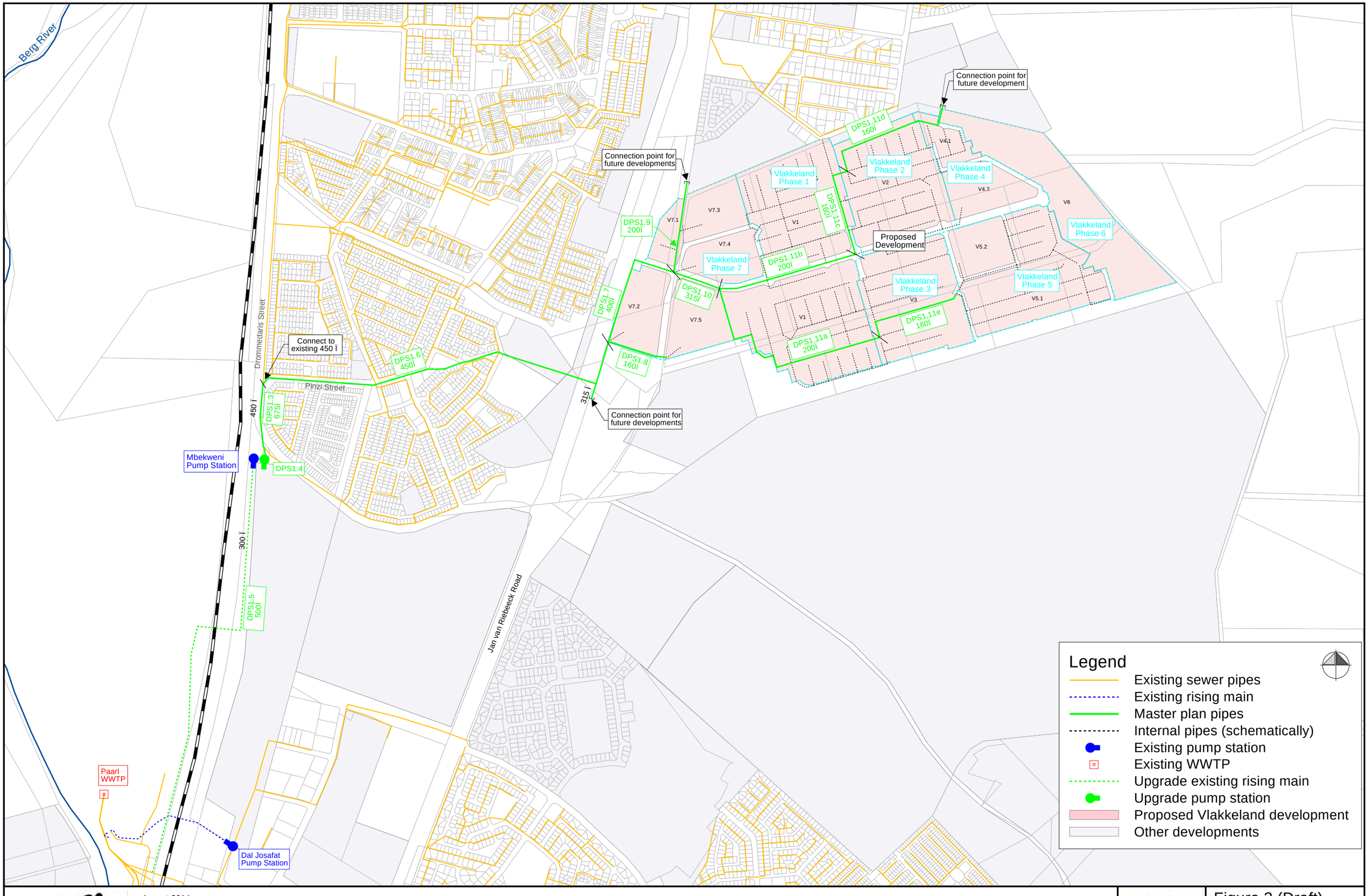

August 2014

Wellington - Vlakkeland affordable housing development

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gls consulting

Figure 3 (Draft)

Proposed Development
Vlakkeland
Sewer master plan

Table 2: Proposed works, cost estimates & phasing - Future Water System

Item No. (See Figures 1 & 2)	Description	Estimated cost * (R-yr 2013/14 value)	Comments
Vlakkeland - Wellington			
Distribution System Items			
DWW1.24a	690 m x 315 mm Ø Pipe to install	1 143 240	When Vlakkeland phase 1 develops.
DWW1.24b	275 m x 315 mm Ø Pipe to install	482 580	When Vlakkeland phase 2 develops.
DWW1.24c	440 m x 315 mm Ø Pipe to install	745 220	When Vlakkeland phase 4 develops.
DWW1.25a	455 m x 200 mm Ø Pipe to install	417 340	When Vlakkeland phase 1 develops.
DWW1.25b	595 m x 200 mm Ø Pipe to install	537 040	When Vlakkeland phase 1 develops.
DWW1.25c	210 m x 200 mm Ø Pipe to install	207 760	When Vlakkeland phase 1 develops.
DWW1.25d	425 m x 200 mm Ø Pipe to install	391 580	When Vlakkeland phase 2 develops.
DWW1.25e	660 m x 200 mm Ø Pipe to install	592 620	When Vlakkeland phase 3 develops.
DWW1.25f	445 m x 200 mm Ø Pipe to install	408 660	When Vlakkeland phase 5 develops.
DWW1.26	190 m x 160 mm Ø Pipe to install	156 800	When Vlakkeland phase 7 develops.
DWW1.27	945 m x 250 mm Ø Pipe to install	1 066 520	When Vlakkeland phase 7 develops.
DWW1.47	55 m x 250 mm Ø Pipe to install	97 440	When Vlakkeland phase 7 develops.
Sub-totals Distribution System Items		**6 246 800**	
Bulk Supply Items			
DWW.B5	New 347 l/s @ 50 m booster pump station on Leliefontein bulk pipeline	4 624 000	Required to augment bulk water supply to Wellington
DWW.B23	5420 m x 560 mm Ø Pipe to install	28 735 000	Replace existing 375 mm diameter pipe (existing pipe in bad condition)
DWW.B24	5625 m x 560 mm Ø Pipe to install	29 802 360	Replace existing 375 mm diameter pipe (existing pipe in bad condition)
DWW.B25	3155 m x 560 mm Ø Pipe to install	16 942 100	Replace existing 375 mm diameter pipe (existing pipe in bad condition)
Sub-totals Water Demand Management		**80 103 460**	
TOTALS		**86 351 000**	

*** Costs include P&G's, Contingencies & Fees, but exclude EIA studies, registration of servitudes and/or land acquisition and VAT.**

Table 3: Proposed works, cost estimates & phasing - Future Sewer System

Item No. (See Figure 3)	**Description**	**Estimated cost *** (R-yr 2013/14 value)	**Comments**
Vlakkeland - Wellington			
Distribution System Items			
DPS1.8	180 m x 160 mm Ø New Gravity	196 600	When Vlakkeland phase 7 develops.
DPS1.9	239 m x 200 mm Ø New Gravity	278 600	When Vlakkeland phase 7 develops.
DPS1.10	144 m x 315 mm Ø New Gravity	248 200	When Vlakkeland phase 1 develops.
DPS1.11a	609 m x 200 mm Ø New Gravity	658 900	When Vlakkeland phase 1 develops.
DPS1.11b	484 m x 200 mm Ø New Gravity	530 400	When Vlakkeland phase 1 develops.
DPS1.11c	289 m x 160 mm Ø New Gravity	296 900	When Vlakkeland phase 1 develops.
DPS1.11d	367 m x 160 mm Ø New Gravity	368 400	When Vlakkeland phase 2 develops.
DPS1.11e	310 m x 160 mm Ø New Gravity	316 200	When Vlakkeland phase 3 develops.
Sub-totals distribution system items		**2 894 200**	
Bulk supply items			
DPS1.3	275 m x 675 mm Ø replace existing 450 mm Ø bulk sewer	1 139 500	When Vlakkeland phase 7 develops.
DPS1.4	Upgrade capacity of existing Mbekweni PS from 100 l/s to 185 l/s	500 000	When Vlakkeland phase 2 develops.
DPS1.5	1420 m x 500 mm Ø upgrade existing 300 mm Ø rising main.	4 748 900	When Mbekweni PS is upgraded.
DPS1.6	1025 m x 450 mm Ø bulk sewer	3 255 900	New bulk sewer for Vlakkeland and surrounding future areas (including Jan van Riebeeck road-crossing).
DPS1.7	505 m x 400 mm Ø bulk sewer	1 179 600	New bulk sewer for Vlakkeland area.
Sub-totals Bulk supply items		**10 823 900**	
TOTALS		**13 718 100**	

*** Costs include P&G's, Contingencies & Fees, but exclude EIA studies, registration of servitudes and/or land acquisition and VAT.**

LEGEND

PROPOSED SERVICES

STORMWATER

- 375mmØ (MANHOLE/CATCHPIT)
- 450mmØ
- 750mmØ
- 1050mmØ
- STORMWATER CHANNEL

WATER

- 110mmØ
- 160mmØ
- 200mmØ
- 315mmØ

SEWER

- 160mmØ
- 200mmØ
- 315mmØ

LAYERS:

EARTHWORKS	(0894/EW/001)	: 2 9 25 60 100 210 217
ROADS/SW	(0894/RD/001)	: 2 4 6 9 25 35 36 37 100-101 201 210 212 214 218-219
RD KERBS	(0894/RD/002)	: 2 4 6 9 25 100 101 203 204 205 213 218 219
RD DIMS	(0894/RD/003)	: 2 4 6 9 100 101 202 203 204 205 210 215
SEWERS	(0894/FS/001)	: 2 4 6 9 20 27 100 101 201 206 210
SEW HC	(0894/FS/002)	: 2 4 6 9 20 21 100 101 201 207 210
WATER	(0894/W/001)	: 2 4 6 9 16 17 26 50 100 101 201 208 210
WAT HC	(0894/W/002)	: 2 4 6 9 16 17 18 50 100 101 201 209 210
WAT DIMS	(0894/W/003)	: 2 4 6 9 16 17 19 50 100 101 201 210 216
COMBINED	(0894/CS/001)	: 2 4 6 9 16 17 20 25 100 101 201 210 211 218

SCALE BAR

0 50 100 150 200m

Scale 1:2500

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CKD
A	ISSUED FOR PRELIMINARY DESIGN ONLY	SEP'14	DC	

REVISIONS

DESIGNED	DC
DRAWN	SB
CHECKED	

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APPROVED

CONSULTING ENGINEERS:

SIGNATURE: ______________ DATE:

APPROVED

CLIENT REPRESENTATIVE:

SIGNATURE: ______________ DATE:

CLIENT

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PROJECT

PROPOSED DEVELOPMENT OF ERF 8378 PAARL
VLAKKELAND TOWNSHIP

TITLE

LAYOUT OF WATER RETICULATION

SCALE (ON A0 DWG) 1:2000	SHEET 1 OF 1
CONTRACT No.	PROJECT No. 0894
DRAWING No. 0894/W/001	REV A
DATE OF FIRST ISSUE:	

iso a0 (841.00 x 1189.00 mm) Lyners_AutoCAD.ctb 2013-06-26 c:\users\sandra\documents\vlakke 1in2000 250814.drw

LEGEND

PROPOSED SERVICES

STORMWATER

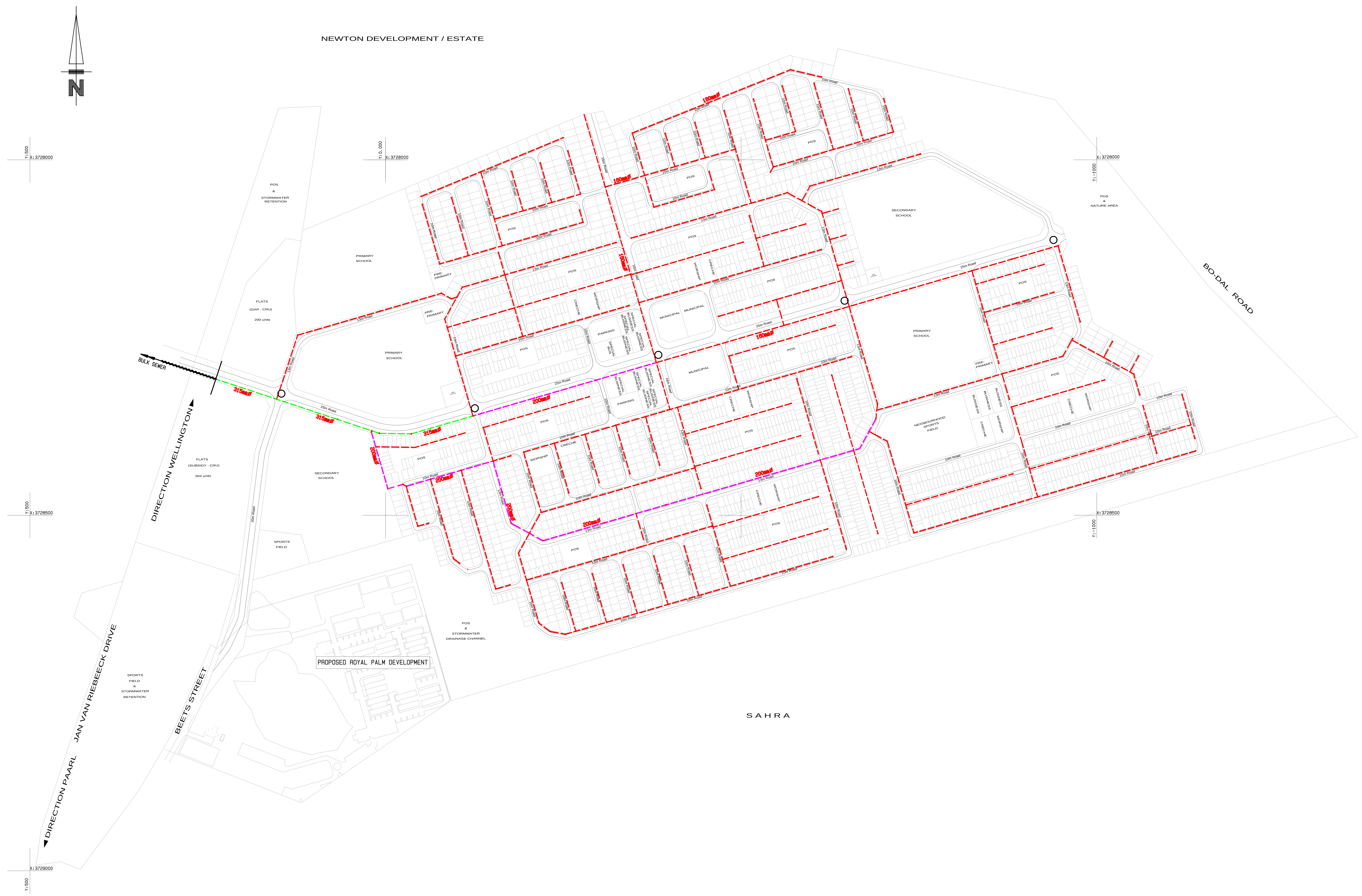
MANHOLE/CATCHPIT	375mmØ
	450mmØ
	750mmØ
	1050mmØ
	STORMWATER CHANNEL

WATER

	110mmØ
	160mmØ
	200mmØ
	315mmØ

SEWER

	160mmØ
	200mmØ
	315mmØ



LAYERS:

EARTHWORKS (0894/EW/001) : 2 9 25 60 100 210 217
ROADS/SW (0894/RD/001) : 2 4 6 9 25 35 36 37 100-101 201 210 212 214 218-219
RD KERBS (0894/RD/002) : 2 4 6 9 25 100 101 203 204 205 213 218 219
RD DIMS (0894/RD/003) : 2 4 6 9 100 101 202 203 204 205 210 215
SEWERS (0894/FS/001) : 2 4 6 9 20 27 100 101 201 206 210
SEW HC (0894/FS/002) : 2 4 6 9 20 21 100 101 201 207 210
WATER (0894/W/001) : 2 4 6 9 16 17 26 50 100 101 201 208 210
WAT HC (0894/W/002) : 2 4 6 9 16 17 18 50 100 101 201 209 210
WAT DIMS (0894/W/003) : 2 4 6 9 16 17 19 50 100 101 201 210 216
COMBINED (0894/CS/001) : 2 4 6 9 16 17 20 25 100 101 201 210 211 218

SCALE BAR

0 50 100 150 200m

Scale 1:2500

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CKD
A	ISSUED FOR PRELIMINARY DESIGN ONLY	SEP'14	DC	

REVISIONS

DESIGNED	DC	
DRAWN	SB	
CHECKED		

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CONSULTING ENGINEERS:

SIGNATURE:________________ DATE:

APPROVED

CLIENT REPRESENTATIVE:

SIGNATURE:________________ DATE:

CLIENT

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PROJECT

PROPOSED DEVELOPMENT OF ERF 8378 PAARL
VLAKKELAND TOWNSHIP

TITLE

LAYOUT OF SEWER

SCALE (ON A0 DWG) 1:2000	SHEET 1 OF 1
CONTRACT No.	PROJECT No. 0894
DRAWING No. 0894/FS/001	REV A
DATE OF FIRST ISSUE:	

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DRAKENSTEIN MUNICIPALITY

STORMWATER MANAGEMENT PLAN

FOR

THE PROPOSED DEVELOPMENT OF ERF 8378, PAARL, VLAKKELAND TOWNSHIP

OCTOBER 2013

Prepared for :

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TABLE OF CONTENTS

ANNEXURES

1 INTRODUCTION AND SCOPE OF WORK

Lyners was appointed by Drakenstein Municipality as part of the Jubelie Professional Resource Team (PRT) as Consulting Civil Engineers for the preparation of a Stormwater Management Plan for erf 8378, Paarl, Drakenstein.

This report is based on a draft town planning layout by Nuplan Africa dated 29 July 2013, site inspections, detailed survey, liaison with local authority, previous studies and available existing services information.

2 LOCATION AND BACKGROUND

A locality plan is attached in Annexure A. Erf 8378, Paarl is approximately 100ha and is situated east of Jan van Riebeeck Drive and west of Bo-Dal Road. It is bordered in the south by erf 1341 and the north by erven 2569 and 361 as well as Newton residential area.

During this study, a flood study and an Aquatics Assessment were completed by Sinske Consult and DH Environmental Consulting (DHEC) respectively to ensure that the correct design parameters were used during design and that no environmental issues could arise during the development of Vlakkeland.

After the aforementioned reports were completed, the PRT discussed the proposed house placement layout with Drakenstein Municipality for approval. During these discussions a report conducted by Ninham Shand (November 2002) was submitted to Lyners for assessment.

Drakenstein Municipality requested this study from the PRT to enable them to make an informed decision regarding the proposed layout.

3 INFORMATION UTILIZED

The following information was provided :

- Drommedaris Emergency Housing project report on bulk stormwater management by Ninham Shand Consulting Engineers (November 2002). Hereafter referred to as Shand Report. (Annexure A)

The following information was used in the preparation of this report :

- A detailed topographical survey of the entire site, including of existing culverts and existing channels,
- Site visits,
- Aerial photographs,
- A flood study Erf No 8378 (Vlakkeland), Paarl - Mbekweni, Kleinbosch and Dal Rivers by Sinske Consult, June 2013. Hereafter referred to as Sinske Report. (Annexure B)
- An Aquatics Assessment by DHEC, June 2013. (Annexure C)
- Layout of proposed development by Nuplan Africa (2.551-houseplacements-01)

4 GOALS OF THE STORMWATER MANAGEMENT PLAN

The goal of the stormwater management plan are to :

- Reduce possible flood damage including damage to life, property and the environment.
- Minimize, to the extent practical, any increase in stormwater runoff from the new development.
- Reduce soil erosion caused by new development.
- Assure the adequacy of existing stormwater infrastructure.
- Maintain and prevent further damage to existing stormwater canals.

- Maintain the integrity of stream channels for their biological functions, as well as for drainage.
- To minimize pollution in stormwater runoff from new and existing developments and enhance the physical and biological integrity of stormwater and aquatic life.
- To protect the public safety through a proper design and operation of existing stormwater and additional runoff as a result of the proposed development.

To achieve these goals this plan outlines specific stormwater design and performance for the proposed development.

5 EXISTING STORMWATER DRAINAGE AND SERVICES

As prescribed in detail in the flood study, completed by Sinske Consult, the Vlakkeland development is affected by four rivers, namely :

- Mbekweni River,
- Seven Springs,
- Kleinbosch River; and
- Dal River

In Annexure D the proposed stormwater layout and culverts are indicated. All the above streams flow in a westerly direction towards Jan van Riebeeck Drive and ultimately flow through the three culverts (C, G and I) under Jan van Riebeeck Drive. The flow of culverts C and G joins west of Jan van Riebeeck Drive and continue to flow in the northern channel in a westerly direction.

Stormwater flow through culvert H and I, drains via in the southern channel in a westerly direction.

In the Drommedaris emergency housing project report on bulk stormwater management, certain constraints are stipulated which limits the amount of stormwater released from the Vlakkeland development. Three scenarios were evaluated and analyzed during the aforementioned study.

6 CONCLUSION FROM STUDIES

6.1 DROMMEDARIS EMERGENCY HOUSING PROJECT REPORT ON BULK STORMWATER MANAGEMENT

6.1.1 Summary

The peak flow rate for the Mbekweni catchment was determined as follows:

Flood	**1:50**	**1:100**
Peak flow rate	119m^3/s	135m^3/s

Three scenarios were evaluated. Scenario 1 represents that two boxes of (southern culvert) Culvert I are blocked and one partially blocked with an invert level of approximately 104.23 masl. Scenario 2 assumed that sediment in one of the blocked boxes of the culvert I is removed to an invert level of approximately 104.23 masl (same level of partially blocked box); and scenario 3 assumes that the entire culvert I are cleared to provide three 3m span x 2.5m rise openings.

With reference to Table 4 : “Maximum routed outflow and headwater elevation at Jan van Riebeeck Road culvert system” from the above mentioned report, the following are calculated.

Return Period	Culvert	Maximum discharge (m^3/s)			Maximum headwater elevation (masl)			Overtopping level (masl)
		Scenario			Scenario			
		1	2	3	1	2	2	
1:50 Year	Northern (culvert C)	24.0	19.0	10.0	106.84	106.61	106.24	106.91-107.0
	Middel (culvert G)	64.0	56.0	42.0				
	Southern (culvert I)	21.0	36.0	68.0				
	Total	**109.0**	**111.0**	**120.0**				

For each of the scenarios certain upgrades were proposed for each constraint. The report recommended that Scenario 2 should be implemented to accommodate the 1:50 year flood.

As discussed with Mr J Knaggs of Drakenstein Municipality, he also recommended that Scenario 2 must be further investigated for design purposes.

Therefore the upgrades required (according to scenario 2) on the west side of Jan van Riebeeck Drive should include the following:

6.1.2 Proposed upgrades to be completed west of Jan van Riebeeck Drive.

6.1.2.1 Northern Channel

The northern channel requires the following upgrades.

Location	Additional culverts/raise bank or bridge
Northern branch	0.9
Relocation bridge between Jan van Riebeeck and Pinzi Road culverts	New clear span bridge
Pinzi Road culverts (4x3mx2m)	1 x 3.0m x 2.0m
Zingizani Road culvert (4x3.4mx1.7m)	1 x 3.4m x 1.7m
Railway culvert (3x3mx2m)	1 x 3.0m x 2.0m

6.1.2.2 Southern Channel

The following two alternatives were proposed for a section of the southern channel in the Shand Report:

Alternative 1

The installation of culverts would minimize the risk, safety and would have considerable social benefits of facilitating access between adjacent communities as they will be divided by a channel.

Alternative 2

The flow in this section of the channel for this alternative will reach velocities of up to 4m/s and will be lined with concrete blocks or 300mm thick RENO mattresses. This channel will be easily maintained but the high velocities in this open channel would present a possible health and safety risk although the channel would be fenced. Therefore alternative 1 would be preferable.

The following table summarizes the proposed amendments to the southern channel.

Location	**Proposed amendments**	
Reach between Jan van Riebeeck and Mbekweni Road	Trapezoidal channel with 1:2 side slopes and base width of 4m	
Mbekweni Road culverts	3 x (2.4m x 1.8m) box culverts (one additional culvert barrel)	
Steep reach between Mbekweni Road culvert and stilling basin	**Alternative 1**	**Alternative 2**
	1 x (3.6m x 2.4m) box culvert	Trapezoidal channel with 1:2 side slopes and base width of 4m
Reach between stilling basin and Drommedaris Road	Trapezoidal channel with 1:2 side slopes and bose width of 4m	
Drommedaris Road culvert	2 x (3.6m x 1.5m) box culverts (one additional culvert barred)	
Reach between Drommedaris Road and Railway culverts	Trapezoidal channel with 1:2 side slopes and base width of 8m	
Railway culverts	Existing 1 x (6m x 1.6m) box culvert	

6.1.3 Cost estimates

The capital cost estimates for scenario 2 are summarized in the table below. It should be noted that this cost estimate was conducted in November 2005 and should therefore be escalated.

Location	**Cost Scenario 2 (2005)**	**Total Cost Scenario 2 (2005)**	**Total Cost Scenario 2 (2013)**
Northern Channel	R 382 157.00	R 9 533 723.00	R 20 436 381.94
Southern Channel - Alternative 1	R 9 151 567.00		
Northern Channel	R 382 157.00	R 5 409 317.00	R 11 595 351.39
Southern Channel - Alternative 2	R 5 027 161.00		

The estimated cost to complete the upgrades of the Northern Channel and Southern Channel, Alternative 1 is R 9 533 723.00 and for Alternative 2 the estimated cost is R 5 409 317.00. These costs include contingencies and VAT, but exclude professional fees and disbursements. These costs escalated at 10% per annum to 2013 will be approximately R 20 436 381.94 and R 595 351.39 for alternative 1 and 2 respectively.

6.2 FLOOD STUDY ERF NO 8378 (VLAKKELAND), PAARL – MBEKWENI, KLEINBOSCH AND DAL RIVERS

6.2.1 Summary

The peak flow rates (Post development) that cross Jan van Riebeeck Drive was determined and summarized in the table below.

Flood	**1:50 Year**	**1:100 Year**
Peak flow rate	88.7m^3/s	113.1m^3/s

All the post developments peak flow rates and requirements were determined and are summarized in the table below.

Culvert/Inlet Location	1:50 Year (m^3/s)	1:100 Year (m^3/s)
A	10.6	13.0
B	10.6	13.0
C	10.6	13.0
D	7.2	9.2
E	10.8	13.8
F	29.1	36.4
G	39.9	50.2
H	38.2	49.9
I	38.2	49.9

For the proposed development of Vlakkeland, the culverts, inlet and outlet structures should be designed to accommodate the above mentioned flow rates.

Several upgrades to existing culverts was proposed and will be implemented during the detailed designed of the proposed development.

6.3 AQUATICS ASSESSMENT (VLAKKELAND, PAARL, WESTERN PROVINCE)

6.3.1 Summary

The site encompasses a reach of highly degraded streamlines passing through the south western corner of the proposed development. Given that the streamline is already so degraded, from recent and historical abuse, it may be an option well-worth considering re-aligning the streamline.

The proposed position of the detention facility in the south-western corner of the site will be in a degraded area where a small dam once existed. A managed stormwater ponding system would serve the shortcoming of ponds in the area between Vlakkeland and Klein Vlakkeland properties.

7 STORMWATER DRAINAGE AND CONTROL SYSTEM

7.1 PURPOSE AND DESIGN PRINCIPLES

Stormwater system can be categorized into two systems, namely minor and major stormwater systems. The purpose and principle of stormwater control for the proposed development will be accommodated in a single system that includes a major and minor system.

7.2 MINOR SYSTEM

The primary goal of the minor system is to ensure convenience and safety to residents during normal rainfall. The minor system usually consist of road drainage channels and kerbs, kerb inlets, grid inlets, manholes, pipes and open channels to discharge runoff towards the major drainage system. The preliminary sizing of these elements are determined on the basis of short a duration, high intensity rainfall taking into account a concentrated flow entering the minor system.

7.3 MAJOR SYSTEM

The major system will not often be utilized to its full capacity as its purpose is to convey and control large floods. During more severe storms the minor stormwater networks will be flooded and allowance shall be made in the layout and design of roads for escape routes towards bulk stormwater channels and detention ponds. Trapped low points in the layout and design will be avoided as far as possible. These escape routes will consist of larger diameter pipes and channels to ensure stormwater is conveyed in a safe and efficient manner.

8 ANALYSIS OF THE PROPOSED STORMWATER DRAINAGE SYSTEM

8.1 GENERAL

The proposed site will be defined in one catchment area. Additional runoff will be conveyed towards Channel 1 (Seven Springs).

The Mbekweni River will be accommodated in open channel towards culverts B and C where it will flow in a westerly direction.

Runoff entering the proposed development on the eastern boundary will be directed through the stormwater system to culvert E. Channel 1 is proposed to accommodate the flow starting at D and flowing in a westerly direction towards culvert E and ultimately to culvert G. the streamline entering the site in the south will also be accommodated in this channel as proposed in the Aquatics Assessment by DH Environmental Consulting..

The Kleinbosch River will flow through culvert F and join Channel 1 and flow towards culvert G.

The Dal River will flow through culvert H towards culvert I.

8.2 CONSTRAINTS

Due to the constraints stipulated in the Shand Report, the amount of that may be released west of Jan van Riebeeck are summarized in the table below.

Table 8.2.1 : Flow rate capacity of Jan van Riebeeck culverts

Culvert	1:50 Year flood (Scenario 2)
C	19m^3/s
G	56m^3/s
I	36m^3/s
Total	**111m^3/s**

The required capacity of the culverts C, G and I according to the Sinske Report should be as follows :

Table 8.2.1 : Required flow rate of Jan van Riebeeck culverts

Culvert	1:50 Year flood (m^3/s)	1:100 Year flood (m^3/s)
C	15.9	19.5
G	39.9	50.2
I	38.2	49.9
Total	**94.0**	**119.6**

As the upgrades to the west of Jan van Riebeeck will only be able to accommodate the 1:50 year flood, therefore only the flow rates indicated in table 8.2.1 can be released even in a 1:100 year flood.

8.3 MINOR SYSTEM

The design of the minor stormwater system will allow for smaller floods as previously stated. Design principles will take into account engineering, environmental, ecological health and safety, aquatic, social, construction and design objectives.

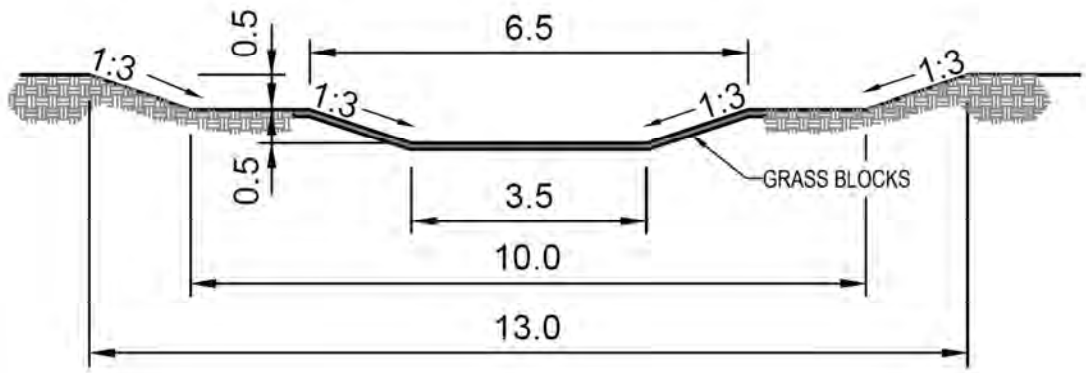
8.4 MAJOR SYSTEM

8.4.1 Preliminary design of channels

The following preliminary designs were prepared regarding the sizing of channels.

8.4.1.1 Channel 1

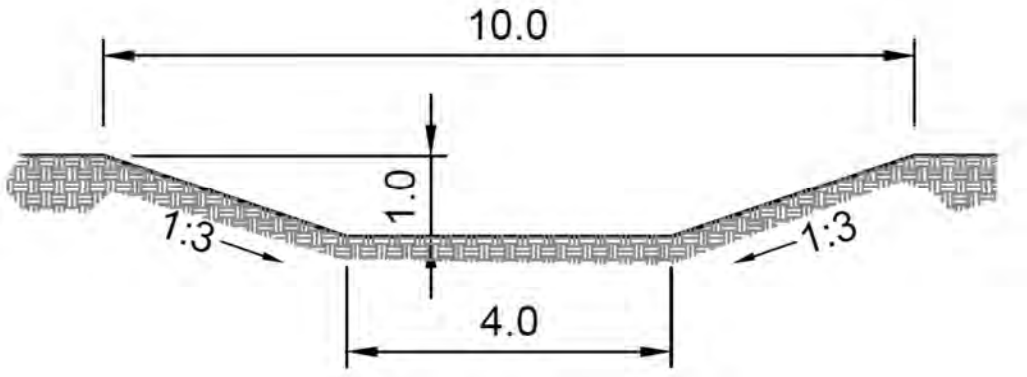
This channel flowing from culvert D towards culvert E and ultimately to culvert G will consists of a combined low flow channel and high flow channel. The channel will have the following estimated dimensions.



The maximum flow depth during a 1:100 year flood will approximately be 0.84m. The channel will mainly consist of grass and grass blocks to ensure a natural feel to the channel. Grass blocks will only be installed in the low flow channel to ensure soil protection during high flow rates.

8.4.1.2 Channel 2

This channel flowing from inlet A towards culvert B and through culvert C will have the following estimated dimensions.

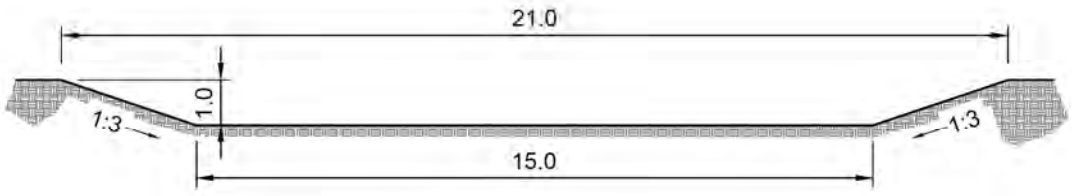


The channel will mainly consist of grass and grass blocks to ensure a natural feel to the channel.

The maximum flow depth of the proposed channel will approximately be 0.8m.

8.4.1.3 Channel 3

This channel flowing in a westerly direction from culvert H towards culvert I will have the following dimensions.



The channel will mainly consist of grass and grass blocks to ensure a natural feel to the channel.

The maximum flow depth of Channel 3 will be 0.88m.

8.4.2 Preliminary design of detention facilities

The Client requested that the additional runoff caused by the development of erf 2569 must also be accommodated by the Vlakkeland development. Currently the additional runoff caused by the development has not been confirmed, but is estimated at approximately 0.5m^3/s and 0.6m^3 for the 1:50 and 1:100 year floods. This additional detention was also accommodated in the design.

The detention ponds will accommodate the runoff and stormwater at two locations indicated on the layout in Annexure D.

Preliminary design calculations were carried out to determine the required volumes that will be required to return the 1:100 year flood for each detention pond. These calculations indicated that the 1:100 year flood can be accommodated in the detention ponds as described below.

8.4.2.1 Detention pond 1

Detention pond 1 situated to the north-western side of the proposed development next to Jan van Riebeeck Drive has an estimated 1:100 year peak inflow of (19.5 + 0.6 = 20.1m^3/s) and an maximum outflow of 19m^3/s.

The proposed detention pond will require to be able to retain approximately 358m^3 during a 1:100 year flood. The area available for detention is approximately 2.13ha (2130m^3). Therefore a water depth of approximately 0.2m can be expected during a 1:100 year flood in Pond 1. The overtopping level of Jan van Riebeeck Drive according to Ninham Shand report is approximately 106.94MSL. A freeboard of at least 300mm will be implemented.

8.4.2.2 Detention facility 2

Detention facility/pond is situated to the south west of proposed development next to Jan van Riebeeck Drive. As previously discussed in Section 8.2 will detention pond 2 have an maximum inflow (1:100 year flood) of 101.1m^3/s and an outflow of 92m^3/s.

The required capacity to accommodate the runoff and stormwater will be 4910m^3. An area of approximately 5.88ha (5880m^2) is available for detention. The maximum water depth of detention pond 2 will be approximately 0.8m.

The entire detention facility will be able to accommodate approximately 31 500m^3 before a level of 105.80MSL is achieved. The overtopping level of Jan van Riebeeck Drive according to Ninham Shand report is approximately 106.94MSL.

9 MANAGEMENT REQUIREMENTS

9.1 STORMWATER SYSTEM

Stormwater structures must be maintained and cleaned to remove silt and debris on a regular basis.

9.2 LITTER TRAPS

Liter traps should be cleaned on regular basis. Liter to be removed and disposed to municipal solid waste.

9.3 DETENTION FACILITIES AND CHANNELS

Detention facilities and channels should have a monthly maintenance program and must include moving of grass in ponds and channels as well asof alien vegetation if necessary. Rodding of drainage pipes must be conducted on a regular basis to ensure no debris are building up in the system.

10 CONCLUSOIN

This stormwater management plan gives a preliminary indication of how stormwater and runoff will be accommodated within the proposed development in terms of quantity and quality. It is however important to note that this report will have to be updated during the detail design phase as more information will be required and analyzed.

A possible Stormwater master plan must be conducted to ensure the assumption made during this report are acceptable.

Some of the existing structures and constraints (culverts, banks, ect) require to be upgraded west of Jan van Riebeeck. Some culverts on the proposed development can be removed while other must be replaced.

With reference to the Aquatics Assessment and the Flood study report there will be no insurmountable issues and constraints. Therefore is the proposed location, erf 8378, favorable for the development of Vlakkeland and will all requirements and constraints can be accommodated during the development thereof.

Fred Laker Pr Tech Eng Pr CPM MSAICE
for LYNERS

ANNEXURE A :

DROMMEDARIS EMERGENCY HOUSING PROJECT REPORT ON BULK STORMWATER MANAGEMENT (SHAND REPORT)

ANNEXURE B :

FLOOD STUDY ERF NO 8378 (VLAKKELAND), PAARL – MBEKWENI, KLEINBOSCH AND DAL RIVERS (SINSKE REPORT)

ANNEXURE C :

AQUATICS ASSESSMENT

ANNEXURE D :

PROPOSED STORMWATER LAYOUT

ANNEXURE E :

PROPOSED STORMWATER CHANNEL SECTIONS

ANNEXURE F :

ADDITIONAL CALCULATIONS

Report

THE PROPOSED DEVELOMENT OF ERF 8378, PAARL, VLAKKELAND TOWNSHIP

ADDENDUM TO THE STORMWATER PLAN PREPARED BY LYNERS CONSULTING ENGINEERS AND PROJECT MANAGERS

Report No.: MC160/1
Revision: 0
Date: 2014-08-27

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THE PROPOSED DEVELOMENT OF ERF 8378, PAARL, VLAKKELAND TOWNSHIP

ADDENDUM TO THE STORMWATER PLAN PREPARED BY LYNERS CONSULTING ENGINEERS AND PROJECT MANAGERS

CONTENTS

THE PROPOSED DEVELOMENT OF ERF 8378, PAARL, VLAKKELAND TOWNSHIP
ADDENDUM TO THE STORMWATER PLAN PREPARED BY LYNERS CONSULTING ENGINEERS AND PROJECT MANAGERS

1 PROPOSED DEVELOPMENT

The Western Cape Government plans to develop low cost housing on Erf 8378, Paarl, Vlakkeland. As may be seen in Figure 1, the area is impacted by the runoff from four catchments, viz. the Mbekweni, Seven Springs,Kleinbosch and Dal Rivers.

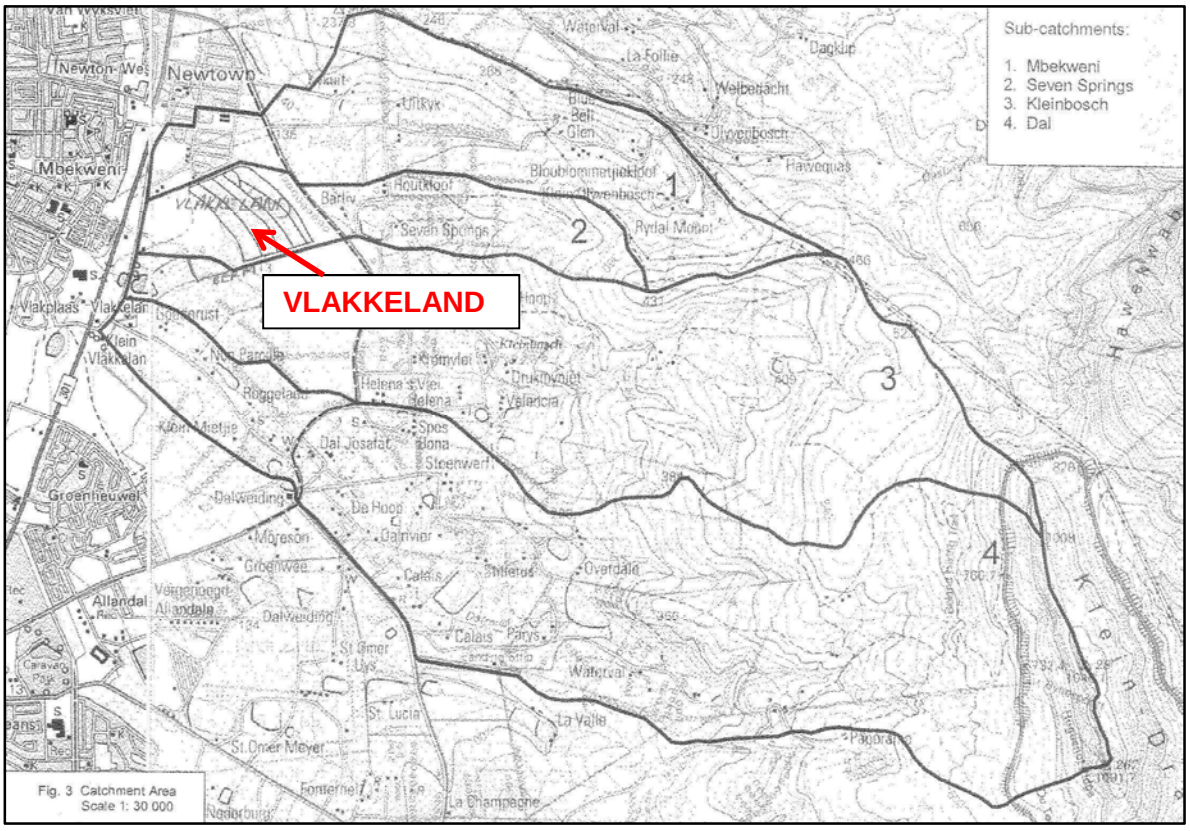

FIGURE 1: THE PROPOSED DEVELOPMENT AREA IN RELATION TO THE FOUR CATCHMENTS (SINSKE, 2013)

2 SCOPE OF THIS STUDY

This study is in the form an addendum to the Stormwater Management Plan, which has been prepared by Lyners Consulting Engineers and Project Managers.

The study is also supplementary to the flood study which was prepared by the late Dr B. H. Sinske and includes earlier flood studies also prepared by him:

- Flood study Erf no. 8378 (Vlakkeland), Paarl – Mbekweni, Kleinbosch and Dal Rivers – June 2013.

The Drakenstein Municipality has subsequently requested that cogniscance be taken of the possible effects of future climate change on storm rainfall intensities and hence on the stormwater management plan.

This study serves to show that sufficient allowance has been made for the climate change effect.

3 IMPACT OF CLIMATE CHANGE ON RAINFALL INTENSITY FOR VLAKKELAND

The City of Cape Town commisioned the University of Kwazulu Natal to investigate the likely effect of climate change on storm intensities in the Western Cape. The recommendation from this investigation was that an increase of 15% be allowed for. This was accepted by the City and a set of point storm rainfall depths has been prepared for a one minute by one minute grid covering the Western Cape

The point rainfall figures applicable to the Vlakkeland catchments have been extracted friom the Western Cape database and are set out in Table 1 and Figure 2 below.

TABLE 1: POINT STORM RAINFALL INTENSITIES FOR VLAKKELAND EXTRACTED FROM CCT DESIGN GRID INCORPORATING CLIMATE CHANGE FACTOR

Return Period y	Event Duration/Rainfall (inc CC Factor)							
	Min 5	Min 10	Min 15	Min 30	Min 45	Min 60	Min 90	Min 120
2	69.5	49.5	40.6	28.1	22.5	19.3	15.5	13.3
5	87.4	62.6	51.4	35.4	28.5	24.3	19.6	16.8
10	100.3	71.5	58.9	40.5	32.5	27.8	22.4	19.2
20	112.7	80.7	66.1	45.5	36.6	31.3	25.2	21.6
50	129.7	92.2	75.9	52.3	42.0	36.0	28.9	24.7
100	142.6	101.7	83.6	57.5	46.2	39.6	31.8	27.2
200	155.5	111.3	91.5	62.9	50.5	43.3	34.8	29.8

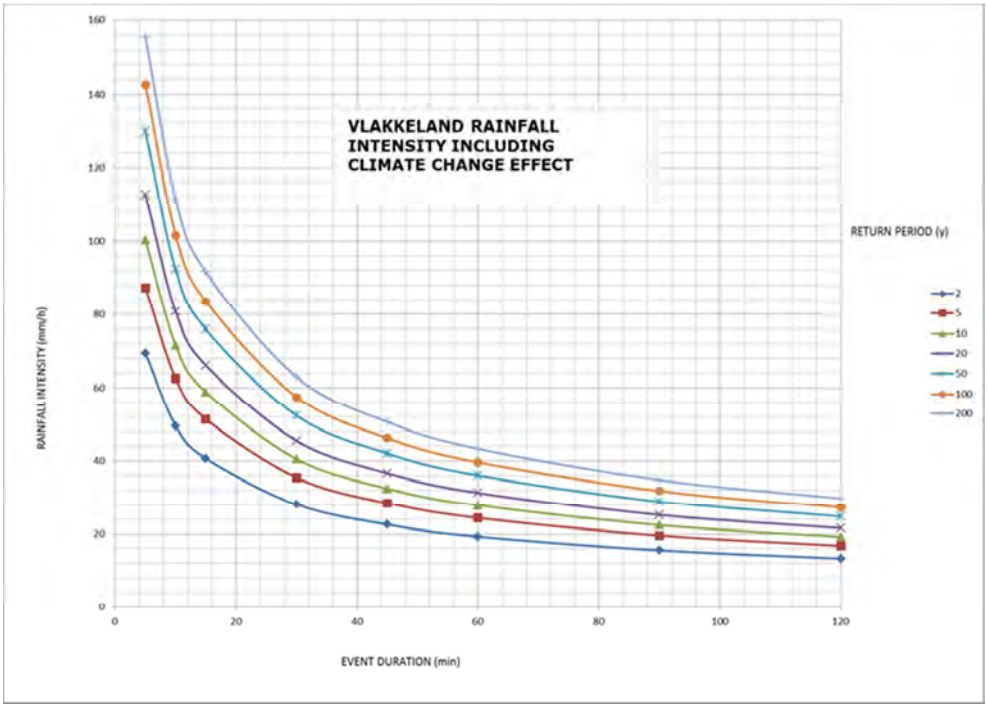

FIGURE 2: IDF CURVES FOR VLAKKELAND EXTRACTED FROM CCT DESIGN GRID INCORPORATING CLIMATE CHANGE FACTOR (DE WET, 2014)

4 EVALUATION OF THE STORM RAINFALL USED IN THE SINSKE REPORT

In the report prepared by Dr Sinske the Rational method was used with point rainfall figures extracted from hyetal maps produced by Dr Sinske (1982, 1993, 1999).

The time of concentration for the 4 main catchments. Mbekweni, Seven Springs, Kleinbosch and Dal Rivers range from approximately 0,5 hours to 1,5 hours.

Therefore in order to compare the storm rainfall used in the Sinske report with the figures from the UKZN investigation which included the climate change effect, a 1 hour storm event was evaluated. These data are listed in Table 2 and shown graphically in Figure 3.

It may be seen that the Sinske report point rainfalls are 12-51% higher than the UKZN's figures which includes the allowance for climate change increases.

TABLE 2: POINT STORM RAINFALL FOR VLAKKELAND EXTRACTED FROM CCT DESIGN GRID INCORPORATING CLIMATE CHANGE FACTOR

Return	Event Duration/Rainfall (inc CC Factor)							
Period	Min	Min	Min	Min	Min	Min	Min	Min
y	5	10	15	30	45	60	90	120
2	5.79	8.24	10.16	14.03	16.91	19.28	23.27	26.53
5	7.28	10.43	12.84	17.71	21.35	24.34	29.36	33.50
10	8.36	11.92	14.72	20.24	24.38	27.83	33.58	38.37
20	9.39	13.46	16.52	22.73	27.45	31.32	37.76	43.13
50	10.81	15.37	18.98	26.14	31.51	36.00	43.36	49.49
100	11.88	16.94	20.89	28.75	34.65	39.60	47.76	54.47
200	12.96	18.55	22.89	31.47	37.91	43.28	52.17	59.57

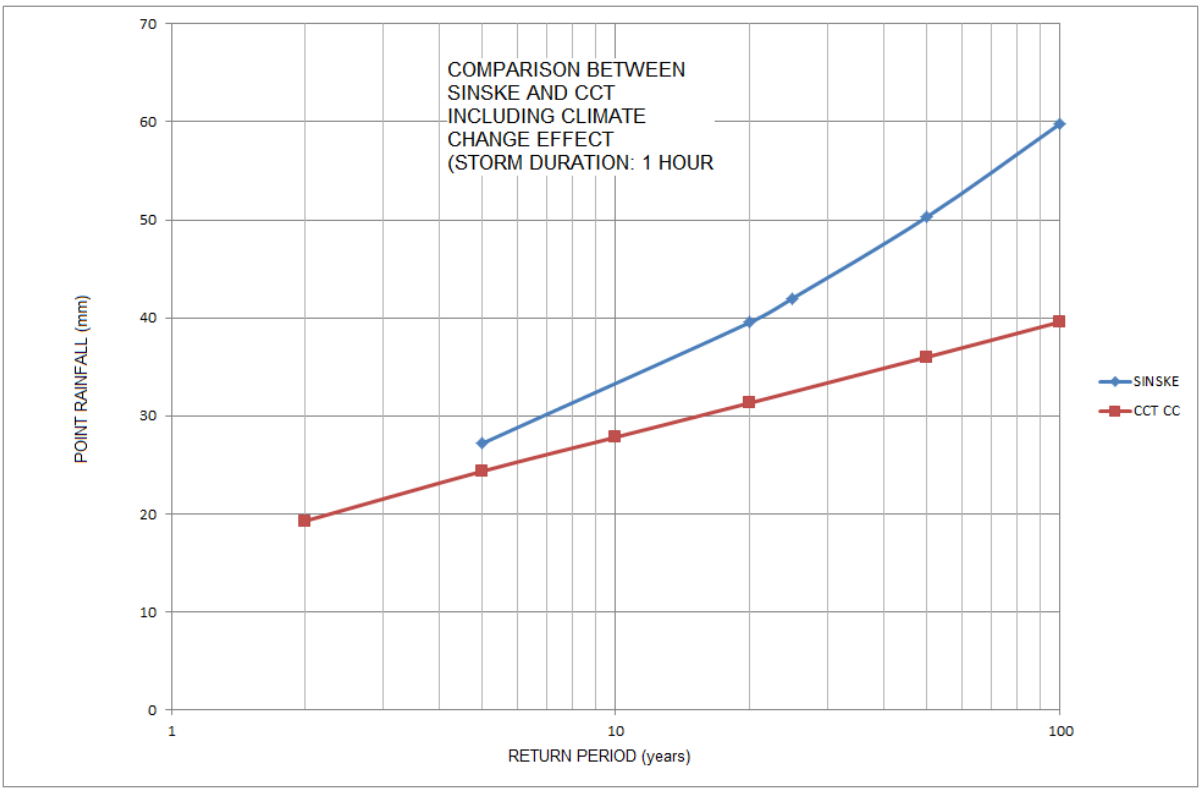

FIGURE 3: SINSKE STORM RAINFALL COMPARED TO CCT DESIGN GRID INCORPORATING CLIMATE CHANGE FACTOR

5 CONCLUSIONS

The point storm rainfall figures used in the Sinske report, which forms the basis of the stormwater management plan for Paarl, Vlakkeland are 12-51 % higher than the UKZN storm rainfall data which includes a 15% increase for climate change.

It is therefore concluded that no further adjustment needs to be made to the Sinske report or to the Stormwater Management Plan to allow for climate change effect.

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G A McGILL Pr Eng PrCPM

2014-08-27

Project :	Vlakkeland Channel 1	Project No:	894	Street Name:	N/A

R = A/P V = 1/n x R^⅔ x i^½ TRAPESIUM < 2,5

Flow Depth

CH from	0	to	Beets									
	Channel Width (m)	Side Slope S (1 :)	w (m)	d (m)	Area A (m²)	Wet Perimeter P	R	n	i (%)	Q (l/s)	V (m/s)	E	Fr
Low flow	6.00	3	3.5	0.41667	1.97917	6.13523	0.32259	0.025	1	3723.72	1.881457	0.507	1.04591
High flow	12.50	3	10	0.41667	4.68750	12.63523	0.37099	0.025	1	9989.70	2.085216	0.634	1.076751

Flood design	Flow (m³/s)
Q_5	4.8
Q_{50}	10.8
Q_{100}	13.5

Design Depth

CH from	0	to	Beets									
	Channel Width (m)	Side Slope S (1 :)	w (m)	d (m)	Area A (m²)	Wet Perimeter P	R	n	i (%)	Q (l/s)	V (m/s)	E	Fr
Low flow	6.50	3	3.5	0.50000	2.50000	6.66228	0.37525	0.025	1	5262.49	2.060997	0.721	1.071331
High flow	13.00	3	10	0.50000	5.75000	13.16228	0.43685	0.025	1	13241.96	2.30295	0.779	1.105574

Project :	Vlakkeland Channel 2	Project No:	894	Street Name:	N/A

R = A/P V = 1/n x R^⅔ x i^½ TRAPESIUM < 2,5

Flow Depth

CH from	0	to	150									
	Channel Width (m)	Side Slope S (1 :)	w (m)	d (m)	Area A (m²)	Wet Perimeter P	R	n	i (%)	Q (l/s)	V (m/s)	E	Fr
	8.75	3	4	0.79167	5.04688	9.00694	0.56033	0.025	1	13720.80	2.718672	1.108	1.142918

Flood design	Flow (m³/s)
Q_5	4
Q_{50}	10.6
Q_{100}	13

Design Depth

Channel Width (m)	Side Slope S (1 :)	w (m)	d (m)	Area A (m²)	Wet Perimeter P	R	n	i (%)	Q (l/s)	V (m/s)	E	Fr
10.00	3	4	1.00000	7.00000	10.32456	0.67800	0.025	1	21609.39	3.087056	1.480	1.178042

Project :	Vlakkeland Channel 3	Project No:	804	Street Name:	N/A

R = A/P V = 1/n x R^⅔ x I^½ **TRAPESIUM** < 2,5

Flow Depth

CH from	0	to	350									
Channel Width (m)	Side Slope S (1 :)	w (m)	d (m)	Area A (m²)	Wet Perimeter P	R	n	I (%)	Q (l/s)	V (m/s)	E	Fr
20.25	3	15	0.87500	15.42188	20.53399	0.75104	0.025	1	50969.04	3.304683	1.432	1.209146

Flood design	Flow (m³/s)
Q_5	17.6
Q_{50}	38.2
Q_{100}	49.9

Design Depth

CH from	0	to	350									
Channel Width (m)	Side Slope S (1 :)	w (m)	d (m)	Area A (m²)	Wet Perimeter P	R	n	I (%)	Q (l/s)	V (m/s)	E	Fr
21.00	3	15	1.00000	18.00000	21.32456	0.84410	0.025	1	64307.38	3.572632	1.651	1.232047

Project :	Vlakkeland Channel 4	Project No:	804	Street Name:	N/A

R = A/P V = 1/n x R^⅔ x I^½ **TRAPESIUM** < 2,5

Flow Depth

CH from	0	to	100									
Channel Width (m)	Side Slope S (1 :)	w (m)	d (m)	Area A (m²)	Wet Perimeter P	R	n	I (%)	Q (l/s)	V (m/s)	E	Fr
22.00	3	18	0.66667	13.33333	22.21637	0.60016	0.025	1	37946.86	2.846014	1.080	1.167196

Flood design	Flow (m³/s)
Q_5	17.6
Q_{50}	29.1
Q_{100}	36.4

Design Depth

CH from	0	to	100									
Channel Width (m)	Side Slope S (1 :)	w (m)	d (m)	Area A (m²)	Wet Perimeter P	R	n	I (%)	Q (l/s)	V (m/s)	E	Fr
22.50	3	18	0.75000	15.18750	22.74342	0.66778	0.025	1	46412.33	3.055956	1.226	1.187574

Detention Pond 1, 1:50 Year Flood

DETENTION DAM SIZE FOR SMALL CATCHMENT FOR Tc=T ie DURATION IS 3 TIMES Tc AND PEAK RUNOFF AT Tc

SIMPLE TRIANGULAR HYDROGRAPH WITH Tc=T ie MAX RUNOFF OCCURS AFTER Tc AND RUNOFF IS OVER 3 TIMES Tc

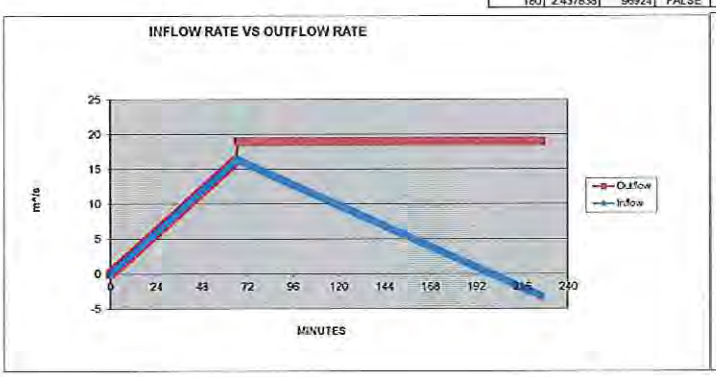
	hours
Tc(Post Development)=	1.11
Inflow (calculations conducted by Sinaka Consult 2013)	16.4
Max flood for detention pond sizing (Max discharge for scenario 2 from Nirham Shand report 2006)=	19

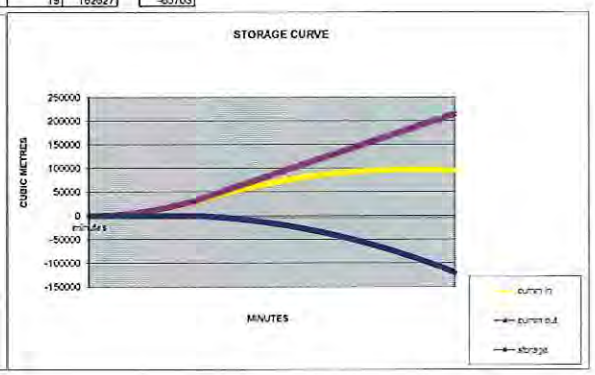
minutes	TEST
66.6	OK

	m3/s	m3	Theoretical			
minutes	inflow	Cumm in		out flow	Cumm out	Storage
0	0	0	TRUE	0	0	0
1	0.246246	14.77477	TRUE	0.246246	14.77477	0
2	0.492492	44.32432	TRUE	0.492492	44.32432	0
3	0.738739	88.64865	TRUE	0.738739	88.64865	0
4	0.984985	147.7477	TRUE	0.984985	147.7477	0
5	1.231231	221.6216	TRUE	1.231231	221.6216	0
6	1.477477	310.2703	TRUE	1.477477	310.2703	0
7	1.723724	413.6937	TRUE	1.723724	413.6937	0
8	1.96997	531.8919	TRUE	1.96997	531.8919	0
9	2.216216	664.8649	TRUE	2.216216	664.8649	0
10	2.462462	812.6126	TRUE	2.462462	812.6126	0
11	2.708709	975.1351	TRUE	2.708709	975.1351	0
12	2.954955	1152.432	TRUE	2.954955	1152.432	0
13	3.201201	1344.505	TRUE	3.201201	1344.505	0
14	3.447447	1551.351	TRUE	3.447447	1551.351	0
15	3.693694	1772.973	TRUE	3.693694	1772.973	0
16	3.93994	2009.369	TRUE	3.93994	2009.369	0
17	4.186186	2260.541	TRUE	4.186186	2260.541	0
18	4.432432	2526.486	TRUE	4.432432	2526.486	0
19	4.678679	2807.207	TRUE	4.678679	2807.207	0
20	4.924925	3102.703	TRUE	4.924925	3102.703	0
21	5.171171	3412.973	TRUE	5.171171	3412.973	0
22	5.417417	3738.018	TRUE	5.417417	3738.018	0
23	5.663664	4077.838	TRUE	5.663664	4077.838	0
24	5.90991	4432.432	TRUE	5.90991	4432.432	0
25	6.156156	4801.802	TRUE	6.156156	4801.802	0
26	6.402402	5185.946	TRUE	6.402402	5185.946	0
27	6.648649	5584.865	TRUE	6.648649	5584.865	0
28	6.894895	5998.559	TRUE	6.894895	5998.559	0
29	7.141141	6427.027	TRUE	7.141141	6427.027	0
30	7.387387	6870.27	TRUE	7.387387	6870.27	0
31	7.633634	7328.288	TRUE	7.633634	7328.288	0
32	7.87988	7801.081	TRUE	7.87988	7801.081	0
33	8.126126	8288.649	TRUE	8.126126	8288.649	0
34	8.372372	8790.991	TRUE	8.372372	8790.991	0
35	8.618619	9308.108	TRUE	8.618619	9308.108	0
36	8.864865	9840	TRUE	8.864865	9840	0
37	9.111111	10386.67	TRUE	9.111111	10386.67	0
38	9.357357	10948.11	TRUE	9.357357	10948.11	0
39	9.603604	11524.32	TRUE	9.603604	11524.32	0
40	9.84985	12115.32	TRUE	9.84985	12115.32	0
41	10.0961	12721.08	TRUE	10.0961	12721.08	0
42	10.34234	13341.62	TRUE	10.34234	13341.62	0
43	10.58859	13976.94	TRUE	10.58859	13976.94	0
44	10.83483	14627.03	TRUE	10.83483	14627.03	0
45	11.08108	15291.89	TRUE	11.08108	15291.89	0
46	11.32733	15971.53	TRUE	11.32733	15971.53	0
47	11.57357	16665.95	TRUE	11.57357	16665.95	0
48	11.81982	17375.14	TRUE	11.81982	17375.14	0
49	12.06607	18099.1	TRUE	12.06607	18099.1	0
50	12.31231	18837.84	TRUE	12.31231	18837.84	0
51	12.55856	19591.35	TRUE	12.55856	19591.35	0
52	12.8048	20359.64	TRUE	12.80480	20359.64	0
53	13.05105	21142.7	TRUE	13.05105	21142.7	0
54	13.2973	21940.54	TRUE	13.29729	21940.54	0
55	13.54354	22753.15	TRUE	13.54354	22753.15	0
56	13.78979	23580.54	TRUE	13.78979	23580.54	0
57	14.03604	24422.7	TRUE	14.03604	24422.7	0
58	14.28228	25279.64	TRUE	14.28228	25279.64	0
59	14.52853	26151.35	TRUE	14.52853	26151.35	0
60	14.77477	27037.84	TRUE	14.77477	27037.84	0
61	15.02102	27939.1	TRUE	15.02102	27939.1	0
62	15.26727	28855.14	TRUE	15.26727	28855.14	0
63	15.51351	29785.95	TRUE	15.51351	29785.95	0
64	15.75976	30731.53	TRUE	15.75976	30731.53	0
65	16.00601	31691.89	TRUE	16.00601	31691.89	0
66	16.25225	32667.03	TRUE	16.25225	32667.03	0
67	16.35075	33643.07	FALSE	19	33807.07	-158.955
68	16.22763	34621.73	FALSE	19	34947.07	-325.297
69	16.1045	35583	FALSE	19	36087.07	-499.027
70	15.98138	36545.88	FALSE	19	37227.07	-680.144
71	15.85826	37498.38	FALSE	19	38367.07	-868.649
72	15.73514	38442.49	FALSE	19	39507.07	-1064.54
73	15.61201	39378.21	FALSE	19	40647.07	-1267.82
74	15.48889	40305.54	FALSE	19	41787.07	-1478.49
75	15.36577	41224.49	FALSE	19	42927.07	-1696.54
76	15.24264	42135.05	FALSE	19	44067.07	-1921.98
77	15.11952	43052.22	FALSE	19	45207.07	-2154.81
78	14.9964	43952	FALSE	19	46347.07	-2395.03
79	14.87327	44844.4	FALSE	19	47487.07	-2642.63
80	14.75015	45729.41	FALSE	19	48627.07	-2897.62
81	14.62703	46607.03	FALSE	19	49767.07	-3160
82	14.5039	47477.26	FALSE	19	50907.07	-3429.77
83	14.38078	48340.11	FALSE	19	52047.07	-3706.92

minutes	inflow	Cumm in		out flow	Cumm out	Storage
84	14.25766	49195.57	FALSE	19	53187.03	-3991.45
85	14.13453	50043.64	FALSE	19	54327.03	-4283.39
86	14.01141	50884.32	FALSE	19	55467.03	-4582.7
87	13.88829	51717.62	FALSE	19	56607.03	-4889.41
88	13.76517	52543.53	FALSE	19	57747.03	-5203.5
89	13.64204	53362.05	FALSE	19	58887.03	-5524.97
90	13.51892	54173.19	FALSE	19	60027.03	-5853.84
91	13.3958	54976.94	FALSE	19	61167.03	-6190.09
92	13.27267	55773.3	FALSE	19	62307.03	-6533.73
93	13.14955	56562.27	FALSE	19	63447.03	-6884.76
94	13.02643	57343.86	FALSE	19	64587.03	-7243.17
95	12.9033	58118.05	FALSE	19	65727.03	-7608.97
96	12.78018	58884.86	FALSE	19	66867.03	-7982.16
97	12.65706	59644.29	FALSE	19	68007.03	-8362.74
98	12.53393	60396.32	FALSE	19	69147.03	-8750.7
99	12.41081	61140.97	FALSE	19	70287.03	-9146.05
100	12.28769	61878.23	FALSE	19	71427.03	-9548.79
101	12.16456	62608.11	FALSE	19	72567.03	-9958.92
102	12.04144	63330.59	FALSE	19	73707.03	-10376.4
103	11.91832	64045.69	FALSE	19	74847.03	-10801.3
104	11.7952	64753.41	FALSE	19	75987.03	-11233.6
105	11.67207	65453.73	FALSE	19	77127.03	-11673.3
106	11.54895	66146.67	FALSE	19	78267.03	-12120.4
107	11.42583	66832.22	FALSE	19	79407.03	-12574.8
108	11.3027	67510.38	FALSE	19	80547.03	-13035.6
109	11.17958	68181.15	FALSE	19	81687.03	-13505.9
110	11.05646	68844.54	FALSE	19	82827.03	-13982.5
111	10.93333	69500.54	FALSE	19	83967.03	-14466.5
112	10.81021	70149.15	FALSE	19	85107.03	-14957.9
113	10.68709	70790.38	FALSE	19	86247.03	-15456.6
114	10.56396	71424.22	FALSE	19	87387.03	-15962.8
115	10.44084	72050.67	FALSE	19	88527.03	-16476.4
116	10.31772	72669.73	FALSE	19	89667.03	-16997.3
117	10.19459	73281.41	FALSE	19	90807.03	-17525.6
118	10.07147	73885.69	FALSE	19	91947.03	-18061.3
119	9.948348	74482.59	FALSE	19	93087.03	-18604.4
120	9.825225	75072.11	FALSE	19	94227.03	-19154.9
121	9.702102	75654.23	FALSE	19	95367.03	-19712.8
122	9.578978	76228.97	FALSE	19	96507.03	-20278.1
123	9.455856	76796.32	FALSE	19	97647.03	-20850.7
124	9.332733	77356.29	FALSE	19	98787.03	-21430.7
125	9.20961	77908.86	FALSE	19	99927.03	-22018.2
126	9.086486	78454.05	FALSE	19	101067	-22613
127	8.963363	78991.85	FALSE	19	102207	-23215.2
128	8.84024	79522.27	FALSE	19	103347	-23824.8
129	8.717117	80045.3	FALSE	19	104487	-24441.7
130	8.593994	80560.94	FALSE	19	105627	-25066.1
131	8.470871	81069.19	FALSE	19	106767	-25697.8
132	8.347748	81570.05	FALSE	19	107907	-26337
133	8.224625	82063.53	FALSE	19	109047	-26983.5
134	8.101502	82549.62	FALSE	19	110187	-27637.4
135	7.978378	83028.32	FALSE	19	111327	-28298.7
136	7.855255	83499.64	FALSE	19	112467	-28967.4
137	7.732132	83963.57	FALSE	19	113607	-29643.5
138	7.609009	84420.11	FALSE	19	114747	-30326.9
139	7.485886	84869.26	FALSE	19	115887	-31017.8
140	7.362763	85311.03	FALSE	19	117027	-31716
141	7.23964	85745.41	FALSE	19	118167	-32421.6
142	7.116517	86172.4	FALSE	19	119307	-33134.6
143	6.993393	86592	FALSE	19	120447	-33855
144	6.87027	87004.22	FALSE	19	121587	-34582.8
145	6.747147	87409.05	FALSE	19	122727	-35318
146	6.624024	87806.49	FALSE	19	123867	-36060.5
147	6.500901	88196.54	FALSE	19	125007	-36810.5
148	6.377778	88579.21	FALSE	19	126147	-37567.8
149	6.254655	88954.49	FALSE	19	127287	-38332.5
150	6.131532	89322.38	FALSE	19	128427	-39104.6
151	6.008408	89682.88	FALSE	19	129567	-39884.1
152	5.885285	90036	FALSE	19	130707	-40671
153	5.762162	90381.73	FALSE	19	131847	-41465.3
154	5.639039	90720.07	FALSE	19	132987	-42267
155	5.515916	91051.03	FALSE	19	134127	-43076
156	5.392793	91374.59	FALSE	19	135267	-43892.4
157	5.26967	91690.77	FALSE	19	136407	-44716.3
158	5.146547	91999.57	FALSE	19	137547	-45547.5
159	5.023423	92300.97	FALSE	19	138687	-46386.1
160	4.9003	92594.99	FALSE	19	139827	-47232
161	4.777177	92881.62	FALSE	19	140967	-48085.4
162	4.654054	93160.86	FALSE	19	142107	-48945.2
163	4.530931	93432.72	FALSE	19	143247	-49814.3
164	4.407808	93697.19	FALSE	19	144387	-50689.8
165	4.284585	93954.27	FALSE	19	145527	-51572.8
166	4.161562	94203.96	FALSE	19	146667	-52463.1
167	4.038438	94446.27	FALSE	19	147807	-53360.8
168	3.915315	94681.19	FALSE	19	148947	-54265.8
169	3.792192	94908.72	FALSE	19	150087	-55178.3
170	3.669069	95128.86	FALSE	19	151227	-56098.2
171	3.545946	95341.62	FALSE	19	152367	-57025.4
172	3.422823	95546.99	FALSE	19	153507	-57960
173	3.2997	95744.97	FALSE	19	154647	-58902.1
174	3.176577	95935.57	FALSE	19	155787	-59851.5
175	3.053453	96118.77	FALSE	19	156927	-60808.3
176	2.93033	96294.59	FALSE	19	158067	-61772.4
177	2.807207	96463.03	FALSE	19	159207	-62744
178	2.684084	96624.07	FALSE	19	160347	-63723
179	2.560961	96777.73	FALSE	19	161487	-64709.3
180	2.437838	96924	FALSE	19	162627	-65703

minutes	inflow	Cumm in		out flow	Cumm out	Storage
181	2.314715	97062.68	FALSE	19	163767	-66704.1
182	2.191592	97194.38	FALSE	19	164907	-67712.6
183	2.068468	97318.49	FALSE	19	166047	-68728.5
184	1.945345	97435.21	FALSE	19	167187	-69751.8
185	1.822222	97544.54	FALSE	19	168327	-70782.5
186	1.699099	97646.49	FALSE	19	169467	-71820.5
187	1.575976	97741.05	FALSE	19	170607	-72866
188	1.452853	97828.22	FALSE	19	171747	-73918.8
189	1.32973	97908	FALSE	19	172887	-74979
190	1.206607	97980.4	FALSE	19	174027	-76046.6
191	1.083483	98045.41	FALSE	19	175167	-77121.6
192	0.96036	98103.03	FALSE	19	176307	-78204
193	0.837237	98153.26	FALSE	19	177447	-79293.8
194	0.714114	98196.11	FALSE	19	178587	-80390.9
195	0.590991	98231.57	FALSE	19	179727	-81495.5
196	0.467868	98259.64	FALSE	19	180867	-82607.4
197	0.344745	98280.32	FALSE	19	182007	-83726.7
198	0.221622	98293.62	FALSE	19	183147	-84853.4
199	0.098498	98299.53	FALSE	19	184287	-85987.5
200	-0.02462	98298.05	FALSE	19	185427	-87129
201	-0.14775	98289.19	FALSE	19	186567	-88277.8
202	-0.27087	98272.94	FALSE	19	187707	-89434.1
203	-0.39399	98249.3	FALSE	19	188847	-90597.7
204	-0.51712	98218.27	FALSE	19	189987	-91768.8
205	-0.64024	98179.86	FALSE	19	191127	-92947.2
206	-0.76336	98134.05	FALSE	19	192267	-94133
207	-0.88649	98080.86	FALSE	19	193407	-95326.2
208	-1.00961	98020.29	FALSE	19	194547	-96526.7
209	-1.13273	97952.32	FALSE	19	195687	-97734.7
210	-1.25586	97876.97	FALSE	19	196827	-98950.1
211	-1.37898	97794.23	FALSE	19	197967	-100173
212	-1.5021	97704.11	FALSE	19	199107	-101403
213	-1.62523	97606.59	FALSE	19	200247	-102640
214	-1.74835	97501.69	FALSE	19	201387	-103885
215	-1.87147	97389.41	FALSE	19	202527	-105138
216	-1.99459	97269.73	FALSE	19	203667	-106397
217	-2.11772	97142.67	FALSE	19	204807	-107664
218	-2.24084	97008.22	FALSE	19	205947	-108939
219	-2.36396	96866.38	FALSE	19	207087	-110221
220	-2.48709	96717.15	FALSE	19	208227	-111510
221	-2.61021	96560.54	FALSE	19	209367	-112806
222	-2.73333	96396.54	FALSE	19	210507	-114110
223	-2.85645	96225.15	FALSE	19	211647	-115422
224	-2.97958	96046.38	FALSE	19	212787	-116741
225	-3.1027	95860.22	FALSE	19	213927	-118067
226	-3.22583	95666.67	FALSE	19	215067	-119400
				Retention pond size=		0 m3





Detention Pond 1, 1:100 Year Flood

DETENTION DAM SIZE FOR SMALL CATCHMENT FOR Tc=T ie DURATION IS 3 TIMES Tc AND PEAK RUNOFF AT Tc

SIMPLE TRIANGULAR HYDROGRAPH WITH Tc=T ie MAX RUNOFF OCCURS AFTER Tc AND RUNOFF IS OVER 3 TIMES Tc

	hours
Tc(Post Development)=	1.11
Inflow (claculations conducted by Sinska Consult 2013)	20.1
Max flood for detention pond sizing (Max discharge for scenario 2 from Ninham Shand report 2006)=	19

minutes
66.6

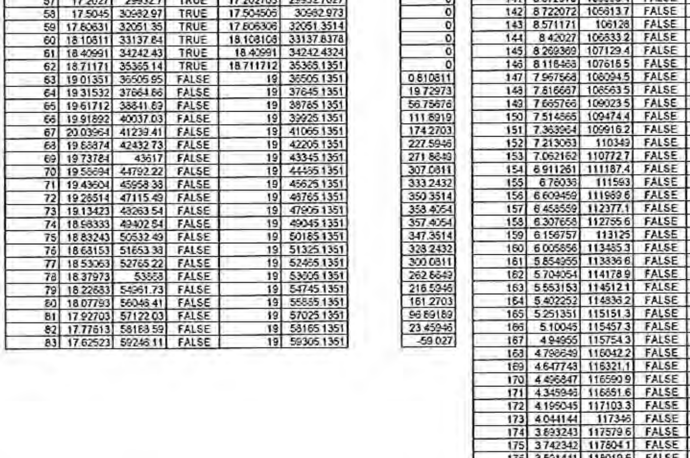
TEST
OK

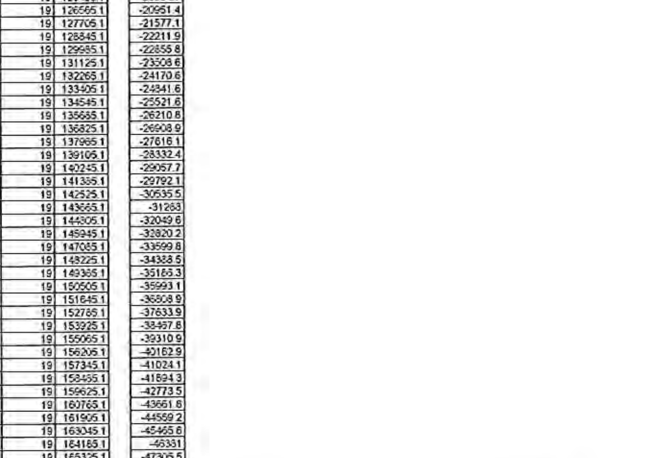
minutes	inflow (m3/s)	Cumm in (m3)		Theoretical out flow	Cumm out	Storage
0	0	0	TRUE	0	0	0
1	0.301802	18.10811	TRUE	0.3018018	18.1081081	0
2	0.603604	54.32432	TRUE	0.6036036	54.3243243	0
3	0.905405	108.6486	TRUE	0.9054054	108.648649	0
4	1.207207	181.0811	TRUE	1.2072072	181.081081	0
5	1.509009	271.6216	TRUE	1.509009	271.621622	0
6	1.810811	380.2703	TRUE	1.8108108	380.27027	0
7	2.112613	507.027	TRUE	2.1126126	507.027027	0
8	2.414414	651.8919	TRUE	2.4144144	651.891892	0
9	2.716216	814.8649	TRUE	2.7162162	814.864865	0
10	3.018018	995.9459	TRUE	3.018018	995.945946	0
11	3.31982	1195.135	TRUE	3.3198198	1195.13514	0
12	3.621622	1412.432	TRUE	3.6216216	1412.43243	0
13	3.923423	1647.838	TRUE	3.9234234	1647.83784	0
14	4.225225	1901.351	TRUE	4.2252252	1901.35135	0
15	4.527027	2172.973	TRUE	4.527027	2172.97297	0
16	4.828829	2462.703	TRUE	4.8288288	2462.7027	0
17	5.130631	2770.541	TRUE	5.1306306	2770.54054	0
18	5.432432	3096.486	TRUE	5.4324324	3096.48649	0
19	5.734234	3440.541	TRUE	5.7342342	3440.54054	0
20	6.036036	3802.703	TRUE	6.036036	3802.7027	0
21	6.337838	4182.973	TRUE	6.3378378	4182.97297	0
22	6.63964	4581.351	TRUE	6.6396396	4581.35135	0
23	6.941441	4997.838	TRUE	6.9414414	4997.83784	0
24	7.243243	5432.432	TRUE	7.2432432	5432.43243	0
25	7.545045	5885.135	TRUE	7.545045	5885.13514	0
26	7.846847	6355.946	TRUE	7.8468468	6355.94595	0
27	8.148649	6844.865	TRUE	8.1486486	6844.86486	0
28	8.45045	7351.892	TRUE	8.4504505	7351.89189	0
29	8.752252	7877.027	TRUE	8.7522523	7877.02703	0
30	9.054054	8420.27	TRUE	9.0540541	8420.27027	0
31	9.355856	8981.622	TRUE	9.3558559	8981.62162	0
32	9.657658	9561.081	TRUE	9.6576577	9561.08108	0
33	9.959459	10158.65	TRUE	9.9594595	10158.6486	0
34	10.26126	10774.32	TRUE	10.261261	10774.3243	0
35	10.56306	11408.11	TRUE	10.563063	11408.1081	0
36	10.86486	12060	TRUE	10.864865	12060	0
37	11.16667	12730	TRUE	11.166667	12730	0
38	11.46847	13418.11	TRUE	11.468468	13418.1081	0
39	11.77027	14124.32	TRUE	11.77027	14124.3243	0
40	12.07207	14848.65	TRUE	12.072072	14848.6486	0
41	12.37387	15591.08	TRUE	12.373874	15591.0811	0
42	12.67568	16351.62	TRUE	12.675676	16351.6216	0
43	12.97748	17130.27	TRUE	12.977477	17130.2703	0
44	13.27928	17927.03	TRUE	13.279279	17927.027	0
45	13.58108	18741.89	TRUE	13.581081	18741.8919	0
46	13.88288	19574.86	TRUE	13.882883	19574.8649	0
47	14.18468	20425.95	TRUE	14.184685	20425.9459	0
48	14.48649	21295.14	TRUE	14.486486	21295.1351	0
49	14.78829	22182.43	TRUE	14.788288	22182.4324	0
50	15.09009	23087.84	TRUE	15.09009	23087.8378	0
51	15.39189	24011.35	TRUE	15.391892	24011.3514	0
52	15.69369	24952.97	TRUE	15.693694	24952.973	0
53	15.9955	25912.7	TRUE	15.995495	25912.7027	0
54	16.2973	26890.54	TRUE	16.297297	26890.5405	0
55	16.5991	27886.49	TRUE	16.599099	27886.4865	0
56	16.9009	28900.54	TRUE	16.900901	28900.5405	0
57	17.2027	29932.7	TRUE	17.202703	29932.7027	0
58	17.5045	30982.97	TRUE	17.504505	30982.973	0
59	17.80631	32051.35	TRUE	17.806306	32051.3514	0
60	18.10811	33137.84	TRUE	18.108108	33137.8378	0
61	18.40991	34242.43	TRUE	18.40991	34242.4324	0
62	18.71171	35365.14	TRUE	18.711712	35365.1351	0
63	19.01351	36505.95	FALSE	19	36505.1351	0.810811
64	19.31532	37664.86	FALSE	19	37645.1351	19.72973
65	19.61712	38841.89	FALSE	19	38785.1351	56.75676
66	19.91892	40037.03	FALSE	19	39925.1351	111.6919
67	20.03964	41239.41	FALSE	19	41065.1351	174.2703
68	19.88874	42432.73	FALSE	19	42205.1351	227.5946
69	19.73784	43617	FALSE	19	43345.1351	271.8649
70	19.58694	44792.22	FALSE	19	44485.1351	307.0811
71	19.43604	45958.38	FALSE	19	45625.1351	333.2432
72	19.28514	47115.49	FALSE	19	46765.1351	350.3514
73	19.13423	48263.54	FALSE	19	47905.1351	358.4054
74	18.98333	49402.54	FALSE	19	49045.1351	357.4054
75	18.83243	50532.49	FALSE	19	50185.1351	347.3514
76	18.68153	51653.38	FALSE	19	51325.1351	328.2432
77	18.53063	52765.22	FALSE	19	52465.1351	300.0811
78	18.37973	53868	FALSE	19	53605.1351	262.8649
79	18.22883	54961.73	FALSE	19	54745.1351	216.5946
80	18.07793	56046.41	FALSE	19	55885.1351	161.2703
81	17.92703	57122.03	FALSE	19	57025.1351	96.89189
82	17.77613	58188.59	FALSE	19	58165.1351	23.45946
83	17.62523	59246.11	FALSE	19	59305.1351	-59.027

minutes	inflow	Cumm in		out flow	Cumm out	Storage
84	17.47432	60294.57	FALSE	19	60445.14	-150.568
85	17.32342	61333.97	FALSE	19	61585.14	-251.162
86	17.17252	62364.32	FALSE	19	62725.14	-360.811
87	17.02162	63385.62	FALSE	19	63865.14	-479.514
88	16.87072	64397.86	FALSE	19	65005.14	-607.27
89	16.71982	65401.05	FALSE	19	66145.14	-744.081
90	16.56892	66395.19	FALSE	19	67285.14	-889.946
91	16.41802	67380.27	FALSE	19	68425.14	-1044.86
92	16.26712	68356.3	FALSE	19	69565.14	-1208.84
93	16.11622	69323.27	FALSE	19	70705.14	-1381.86
94	15.96532	70281.19	FALSE	19	71845.14	-1563.95
95	15.81441	71230.05	FALSE	19	72985.14	-1755.08
96	15.66351	72169.86	FALSE	19	74125.14	-1955.27
97	15.51261	73100.62	FALSE	19	75265.14	-2164.51
98	15.36171	74022.32	FALSE	19	76405.14	-2382.81
99	15.21081	74934.97	FALSE	19	77545.14	-2610.16
100	15.05991	75838.57	FALSE	19	78685.14	-2846.57
101	14.90901	76733.11	FALSE	19	79825.14	-3092.03
102	14.75811	77618.59	FALSE	19	80965.14	-3346.54
103	14.60721	78495.03	FALSE	19	82105.14	-3610.11
104	14.45631	79362.41	FALSE	19	83245.14	-3882.73
105	14.30541	80220.73	FALSE	19	84385.14	-4164.41
106	14.1545	81070	FALSE	19	85525.14	-4455.14
107	14.0036	81910.22	FALSE	19	86665.14	-4754.92
108	13.8527	82741.38	FALSE	19	87805.14	-5063.76
109	13.7018	83563.49	FALSE	19	88945.14	-5381.65
110	13.5509	84376.54	FALSE	19	90085.14	-5708.59
111	13.4	85180.54	FALSE	19	91225.14	-6044.59
112	13.2491	85975.49	FALSE	19	92365.14	-6389.65
113	13.0982	86761.38	FALSE	19	93505.14	-6743.76
114	12.9473	87538.22	FALSE	19	94645.14	-7106.92
115	12.7964	88306	FALSE	19	95785.14	-7479.14
116	12.6455	89064.73	FALSE	19	96925.14	-7860.41
117	12.49459	89814.41	FALSE	19	98065.14	-8250.73
118	12.34369	90555.03	FALSE	19	99205.14	-8650.11
119	12.19279	91286.59	FALSE	19	100345.1	-9058.54
120	12.04189	92009.11	FALSE	19	101485.1	-9476.03
121	11.89099	92722.57	FALSE	19	102625.1	-9902.57
122	11.74009	93426.97	FALSE	19	103765.1	-10338.2
123	11.58919	94122.32	FALSE	19	104905.1	-10782.8
124	11.43829	94808.62	FALSE	19	106045.1	-11236.5
125	11.28739	95485.86	FALSE	19	107185.1	-11699.3
126	11.13649	96154.05	FALSE	19	108325.1	-12171.1
127	10.98559	96813.19	FALSE	19	109465.1	-12651.9
128	10.83468	97463.27	FALSE	19	110605.1	-13141.9
129	10.68378	98104.3	FALSE	19	111745.1	-13640.8
130	10.53288	98736.27	FALSE	19	112885.1	-14148.9
131	10.38198	99359.19	FALSE	19	114025.1	-14665.9
132	10.23108	99973.05	FALSE	19	115165.1	-15192.1
133	10.08018	100577.9	FALSE	19	116305.1	-15727.3
134	9.929279	101173.6	FALSE	19	117445.1	-16271.5
135	9.778378	101760.3	FALSE	19	118585.1	-16824.8
136	9.627477	102338	FALSE	19	119725.1	-17387.2
137	9.476577	102906.6	FALSE	19	120865.1	-17958.6
138	9.325676	103466.1	FALSE	19	122005.1	-18539
139	9.174775	104016.6	FALSE	19	123145.1	-19128.5
140	9.023874	104558	FALSE	19	124285.1	-19727.1
141	8.872973	105090.4	FALSE	19	125425.1	-20334.7
142	8.722072	105613.7	FALSE	19	126565.1	-20951.4
143	8.571171	106128	FALSE	19	127705.1	-21577.1
144	8.42027	106633.2	FALSE	19	128845.1	-22211.9
145	8.269369	107129.4	FALSE	19	129985.1	-22855.8
146	8.118468	107616.5	FALSE	19	131125.1	-23508.6
147	7.967568	108094.5	FALSE	19	132265.1	-24170.6
148	7.816667	108563.5	FALSE	19	133405.1	-24841.6
149	7.665766	109023.5	FALSE	19	134545.1	-25521.6
150	7.514865	109474.4	FALSE	19	135685.1	-26210.8
151	7.363964	109916.2	FALSE	19	136825.1	-26908.9
152	7.213063	110349	FALSE	19	137965.1	-27616.1
153	7.062162	110772.7	FALSE	19	139105.1	-28332.4
154	6.911261	111187.4	FALSE	19	140245.1	-29057.7
155	6.76036	111593	FALSE	19	141385.1	-29792.1
156	6.609459	111989.6	FALSE	19	142525.1	-30535.5
157	6.458559	112377.1	FALSE	19	143665.1	-31288
158	6.307658	112755.6	FALSE	19	144805.1	-32049.6
159	6.156757	113125	FALSE	19	145945.1	-32820.2
160	6.005856	113485.3	FALSE	19	147085.1	-33599.8
161	5.854955	113836.6	FALSE	19	148225.1	-34388.5
162	5.704054	114178.9	FALSE	19	149365.1	-35186.3
163	5.553153	114512.1	FALSE	19	150505.1	-35993.1
164	5.402252	114836.2	FALSE	19	151645.1	-36808.9
165	5.251351	115151.3	FALSE	19	152785.1	-37633.9
166	5.10045	115457.3	FALSE	19	153925.1	-38467.8
167	4.94955	115754.3	FALSE	19	155065.1	-39310.9
168	4.798649	116042.2	FALSE	19	156205.1	-40162.9
169	4.647748	116321.1	FALSE	19	157345.1	-41024.1
170	4.496847	116590.9	FALSE	19	158485.1	-41894.3
171	4.345946	116851.6	FALSE	19	159625.1	-42773.5
172	4.195045	117103.3	FALSE	19	160765.1	-43661.8
173	4.044144	117346	FALSE	19	161905.1	-44559.2
174	3.893243	117579.6	FALSE	19	163045.1	-45465.6
175	3.742342	117804.1	FALSE	19	164185.1	-46381
176	3.591441	118019.6	FALSE	19	165325.1	-47305.5
177	3.440541	118226	FALSE	19	166465.1	-48239.1
178	3.28964	118423.4	FALSE	19	167605.1	-49181.7
179	3.138732	118611.7	FALSE	19	[illegible]	[illegible]

minutes	inflow	Cumm in		out flow	Cumm out	Storage
181	2.836937	118961.2	FALSE	19	171025.1	-52063.9
182	2.686036	119122.4	FALSE	19	172165.1	-53042.8
183	2.535135	119274.5	FALSE	19	173305.1	-54030.6
184	2.384234	119417.5	FALSE	19	174445.1	-55027.6
185	2.233333	119551.5	FALSE	19	175585.1	-56033.6
186	2.082432	119676.5	FALSE	19	176725.1	-57043.6
187	1.931532	119792.4	FALSE	19	177865.1	-58072.8
188	1.780631	119899.2	FALSE	19	179005.1	-59105.9
189	1.62973	119997	FALSE	19	180145.1	-60148.1
190	1.478829	120085.7	FALSE	19	181285.1	-61199.4
191	1.327928	120165.4	FALSE	19	182425.1	-62259.7
192	1.177027	120236	FALSE	19	183565.1	-63329.1
193	1.026126	120297.6	FALSE	19	184705.1	-64407.5
194	0.875225	120350.1	FALSE	19	185845.1	-65495
195	0.724324	120393.6	FALSE	19	186985.1	-66591.6
196	0.573423	120428	FALSE	19	188125.1	-67697.2
197	0.422523	120453.3	FALSE	19	189265.1	-68811.8
198	0.271622	120469.6	FALSE	19	190405.1	-69935.5
199	0.120721	120476.9	FALSE	19	191545.1	-71068.3
200	-0.03018	120475.1	FALSE	19	192685.1	-72210.1
201	-0.18108	120464.2	FALSE	19	193825.1	-73360.9
202	-0.33198	120444.3	FALSE	19	194965.1	-74520.9
203	-0.48288	120415.3	FALSE	19	196105.1	-75689.8
204	-0.63378	120377.3	FALSE	19	197245.1	-76867.9
205	-0.78468	120330.2	FALSE	19	198385.1	-78054.9
206	-0.93559	120274.1	FALSE	19	199525.1	-79251.1
207	-1.08649	120208.9	FALSE	19	200665.1	-80456.3
208	-1.23739	120134.6	FALSE	19	201805.1	-81670.5
209	-1.38829	120051.3	FALSE	19	202945.1	-82893.8
210	-1.53919	119959	FALSE	19	204085.1	-84126.2
211	-1.69009	119857.6	FALSE	19	205225.1	-85367.6
212	-1.84099	119747.1	FALSE	19	206365.1	-86618
213	-1.99189	119627.6	FALSE	19	207505.1	-87877.5
214	-2.14279	119499	FALSE	19	208645.1	-89146.1
215	-2.29369	119361.4	FALSE	19	209785.1	-90423.7
216	-2.44459	119214.7	FALSE	19	210925.1	-91710.4
217	-2.5955	119059	FALSE	19	212065.1	-93006.1
218	-2.7464	118894.2	FALSE	19	213205.1	-94310.9
219	-2.8973	118720.4	FALSE	19	214345.1	-95624.8
220	-3.0482	118537.5	FALSE	19	215485.1	-96947.6
221	-3.1991	118345.5	FALSE	19	216625.1	-98279.6
222	-3.35	118144.5	FALSE	19	217765.1	-99620.6
223	-3.5009	117934.5	FALSE	19	218905.1	-100971
224	-3.6518	117715.4	FALSE	19	220045.1	-102330
225	-3.8027	117487.2	FALSE	19	221185.1	-103698
226	-3.9536	117250	FALSE	19	222325.1	-105075

Retention pond size= 358 m3





Detention Pond 2, 1:50 Year Flood

DETENTION DAM SIZE FOR SMALL CATCHMENT FOR Tc=T ie DURATION IS 3 TIMES Tc
AND PEAK RUNOFF AT Tc

SIMPLE TRIANGULAR HYDROGRAPH WITH Tc=T ie MAX RUNOFF OCCURS AFTER Tc
AND RUNOFF IS OVER 3 TIMES Tc

	hours
Tc(Post Development)=	1.11
Inflow (calculations conducted by Sinake Consult 2013)	78.1
Max flood for detention pond sizing (Max discharge for scenario 2 from Nirhans SHand report 2006)=	92

minutes
66.6

TEST
OK

minutes	m3/s Inflow	m3 Cumm in		Theoretical out flow	Cumm out	Storage
0	0	0	TRUE	0	0	0
1	1.172673	70.36036	TRUE	1.172727	70.3609604	0
2	2.345345	211.0811	TRUE	2.3453453	211.081081	0
3	3.518018	422.1622	TRUE	3.518018	422.162162	0
4	4.690691	703.6036	TRUE	4.6906907	703.603604	0
5	5.8633634	1055.405	TRUE	5.8633634	1055.40541	0
6	7.036036	1477.568	TRUE	7.036036	1477.56757	0
7	8.208709	1970.09	TRUE	8.2087087	1970.09009	0
8	9.3813814	2532.973	TRUE	9.3813814	2532.97297	0
9	10.554054	3166.216	TRUE	10.554054	3166.21622	0
10	11.72673	3869.82	TRUE	11.726727	3869.81982	0
11	12.8994	4643.784	TRUE	12.899399	4643.78378	0
12	14.072072	5488.108	TRUE	14.072072	5488.10811	0
13	15.244744	6402.793	TRUE	15.244745	6402.79279	0
14	16.417417	7387.838	TRUE	16.417417	7387.83784	0
15	17.59009	8443.243	TRUE	17.59009	8443.24324	0
16	18.76276	9569.009	TRUE	18.762763	9569.00901	0
17	19.93544	10765.14	TRUE	19.935435	10765.1351	0
18	21.108108	12031.62	TRUE	21.108108	12031.6216	0
19	22.28078	13368.47	TRUE	22.280781	13368.4685	0
20	23.453453	14775.68	TRUE	23.453453	14775.6757	0
21	24.626126	16253.24	TRUE	24.626126	16253.2432	0
22	25.7988	17801.17	TRUE	25.798799	17801.1712	0
23	26.971471	19419.46	TRUE	26.971471	19419.4595	0
24	28.144144	21108.11	TRUE	28.144144	21108.1081	0
25	29.316817	22867.12	TRUE	29.316817	22867.1171	0
26	30.489489	24696.49	TRUE	30.489489	24696.4865	0
27	31.662162	26596.22	TRUE	31.662162	26596.2162	0
28	32.834835	28566.31	TRUE	32.834835	28566.3063	0
29	34.007501	30606.76	TRUE	34.007508	30606.7568	0
30	35.18018	32717.57	TRUE	35.18018	32717.5676	0
31	36.352853	34898.74	TRUE	36.352853	34898.7387	0
32	37.525553	37150.27	TRUE	37.525526	37150.2703	0
33	38.6982	39472.16	TRUE	38.698158	39472.1622	0
34	39.870871	41864.41	TRUE	39.870871	41864.4144	0
35	41.043544	44327.03	TRUE	41.043544	44327.027	0
36	42.216216	46860	TRUE	42.216216	46860	0
37	43.388889	49463.33	TRUE	43.388889	49463.3333	0
38	44.561562	52137.07	TRUE	44.561562	52137.027	0
39	45.73423	54881.08	TRUE	45.734234	54881.0811	0
40	46.90691	57695.5	TRUE	46.906907	57695.4955	0
41	48.07958	60580.27	TRUE	48.07958	60580.2703	0
42	49.252252	63535.41	TRUE	49.252252	63535.4054	0
43	50.424925	66560.9	TRUE	50.424925	66560.9009	0
44	51.5976	69656.76	TRUE	51.597568	69656.7568	0
45	52.77027	72822.97	TRUE	52.77027	72822.973	0
46	53.942943	76059.55	TRUE	53.942943	76059.5495	0
47	55.115562	79366.49	TRUE	55.115516	79366.4955	0
48	56.28829	82743.78	TRUE	56.288288	82743.7838	0
49	57.460961	86191.44	TRUE	57.460961	86191.4414	0
50	58.633634	89709.46	TRUE	58.633634	89709.4595	0
51	59.806301	93297.84	TRUE	59.806306	93297.8378	0
52	60.978979	96956.58	TRUE	60.978979	96956.5766	0
53	62.151652	100685.7	TRUE	62.151652	100685.676	0
54	63.324324	104485.1	TRUE	63.324324	104485.135	0
55	64.497	108354	TRUE	64.496997	108354.955	0
56	65.66967	112295.1	TRUE	65.66967	112295.135	0
57	66.842342	116305.7	TRUE	66.842342	116305.676	0
58	68.015015	120386.6	TRUE	68.015015	120386.577	0
59	69.187688	124537.8	TRUE	69.187688	124537.838	0
60	70.36036	128759.5	TRUE	70.36036	128759.459	0
61	71.533033	133051.4	TRUE	71.533033	133051.441	0
62	72.705706	137413.8	TRUE	72.705706	137413.784	0
63	73.878378	141846.5	TRUE	73.878378	141846.486	0
64	75.051051	146349.5	TRUE	75.051051	146349.55	0
65	76.223723	150923	TRUE	76.223724	150922.973	0
66	77.3964	155568.8	TRUE	77.396396	155568.757	0
67	77.66547	160238.7	FALSE	92	161086.757	-848.072
68	77.27913	164875.4	FALSE	92	166606.757	-1731.32
69	76.69279	169477	FALSE	92	172126.757	-2649.76
70	76.10645	174043.4	FALSE	92	177646.757	-3603.37
71	75.52012	178574.6	FALSE	92	183166.757	-4592.16
72	74.93378	183070.6	FALSE	92	188686.757	-5616.14
73	74.34745	187531.5	FALSE	92	194206.757	-6675.29
74	73.76111	191957.1	FALSE	92	199726.757	-7769.62
75	73.17477	196347.6	FALSE	92	205246.757	-8899.14
76	72.58844	200702.9	FALSE	92	210766.757	-10063.8
77	72.0021	205023.1	FALSE	92	216286.757	-11263.7
78	71.41577	209308	FALSE	92	221806.757	-12498.8
79	70.82943	213557.8	FALSE	92	227326.757	-13769
80	70.24309	217772.4	FALSE	92	232846.757	-15074.4
81	69.65676	221951.8	FALSE	92	238366.757	-16415
82	69.07042	226096	FALSE	92	243886.757	-17790.8
83	68.48408	230205	FALSE	92	249406.757	-19201.7

minutes	inflow	Cumm in		out flow	Cumm out	Storage
84	67.89775	234278.9	FALSE	92	254926.8	-20647.9
85	67.31141	238317.6	FALSE	92	260446.8	-22129.2
86	66.72508	242321.1	FALSE	92	265966.8	-23645.7
87	66.13874	246289.4	FALSE	92	271486.8	-25197.4
88	65.5524	250222.5	FALSE	92	277006.8	-26784.2
89	64.96607	254120.5	FALSE	92	282526.8	-28406.2
90	64.37973	257983.3	FALSE	92	288046.8	-30063.5
91	63.79339	261810.9	FALSE	92	293566.8	-31755.9
92	63.20706	265603.3	FALSE	92	299086.8	-33483.4
93	62.62072	269360.6	FALSE	92	304606.8	-35246.2
94	62.03438	273082.6	FALSE	92	310126.8	-37044.1
95	61.44805	276769.5	FALSE	92	315646.8	-38877.2
96	60.86171	280421.2	FALSE	92	321166.8	-40745.5
97	60.27538	284037.7	FALSE	92	326686.8	-42649
98	59.68904	287619.1	FALSE	92	332206.8	-44587.7
99	59.1027	291165.2	FALSE	92	337726.8	-46561.5
100	58.51637	294676.2	FALSE	92	343246.8	-48570.5
101	57.93003	298152	FALSE	92	348766.8	-50614.7
102	57.34369	301592.6	FALSE	92	354286.8	-52694.1
103	56.75736	304998.1	FALSE	92	359806.8	-54808.7
104	56.17102	308368.4	FALSE	92	365326.8	-56958.4
105	55.58468	311703.4	FALSE	92	370846.8	-59143.3
106	54.99835	315003.3	FALSE	92	376366.8	-61363.4
107	54.41201	318268.1	FALSE	92	381886.8	-63618.7
108	53.82568	321497.6	FALSE	92	387406.8	-65909.2
109	53.23934	324692	FALSE	92	392926.8	-68234.8
110	52.653	327851.1	FALSE	92	398446.8	-70595.6
111	52.06667	330975.1	FALSE	92	403966.8	-72991.6
112	51.48033	334064	FALSE	92	409486.8	-75422.8
113	50.89399	337117.6	FALSE	92	415006.8	-77889.2
114	50.30766	340136.1	FALSE	92	420526.8	-80390.7
115	49.72132	343119.3	FALSE	92	426046.8	-82927.4
116	49.13498	346067.4	FALSE	92	431566.8	-85499.3
117	48.54865	348980.4	FALSE	92	437086.8	-88106.4
118	47.96231	351858.1	FALSE	92	442606.8	-90748.7
119	47.37598	354700.6	FALSE	92	448126.8	-93426.1
120	46.78964	357508	FALSE	92	453646.8	-96138.7
121	46.2033	360280.2	FALSE	92	459166.8	-98886.5
122	45.61697	363017.2	FALSE	92	464686.8	-101670
123	45.03063	365719.1	FALSE	92	470206.8	-104488
124	44.44429	368385.7	FALSE	92	475726.8	-107341
125	43.85796	371017.2	FALSE	92	481246.8	-110230
126	43.27162	373613.5	FALSE	92	486766.8	-113153
127	42.68529	376174.6	FALSE	92	492286.8	-116112
128	42.09895	378700.6	FALSE	92	497806.8	-119106
129	41.51261	381191.3	FALSE	92	503326.8	-122135
130	40.92628	383646.9	FALSE	92	508846.8	-125200
131	40.33994	386067.3	FALSE	92	514366.8	-128299
132	39.7536	388452.5	FALSE	92	519886.8	-131434
133	39.16727	390802.5	FALSE	92	525406.8	-134604
134	38.58093	393117.4	FALSE	92	530926.8	-137809
135	37.99459	395397.1	FALSE	92	536446.8	-141050
136	37.40826	397641.6	FALSE	92	541966.8	-144325
137	36.82192	399850.9	FALSE	92	547486.8	-147636
138	36.23559	402025	FALSE	92	553006.8	-150982
139	35.64925	404164	FALSE	92	558526.8	-154363
140	35.06291	406267.8	FALSE	92	564046.8	-157779
141	34.47658	408336.4	FALSE	92	569566.8	-161230
142	33.89024	410369.8	FALSE	92	575086.8	-164717
143	33.3039	412368	FALSE	92	580606.8	-168239
144	32.71757	414331.1	FALSE	92	586126.8	-171796
145	32.13123	416258.9	FALSE	92	591646.8	-175388
146	31.54489	418151.6	FALSE	92	597166.8	-179015
147	30.95856	420009.1	FALSE	92	602686.8	-182678
148	30.37222	421831.5	FALSE	92	608206.8	-186375
149	29.78589	423618.6	FALSE	92	613726.8	-190108
150	29.19955	425370.6	FALSE	92	619246.8	-193876
151	28.61321	427087.4	FALSE	92	624766.8	-197679
152	28.02688	428769	FALSE	92	630286.8	-201518
153	27.44054	430415.4	FALSE	92	635806.8	-205391
154	26.8542	432026.7	FALSE	92	641326.8	-209300
155	26.26787	433602.8	FALSE	92	646846.8	-213244
156	25.68153	435143.6	FALSE	92	652366.8	-217223
157	25.0952	436649.4	FALSE	92	657886.8	-221237
158	24.50886	438119.9	FALSE	92	663406.8	-225287
159	23.92252	439555.2	FALSE	92	668926.8	-229372
160	23.33619	440955.4	FALSE	92	674446.8	-233491
161	22.74985	442320.4	FALSE	92	679966.8	-237646
162	22.16351	443650.2	FALSE	92	685486.8	-241837
163	21.57718	444944.8	FALSE	92	691006.8	-246062
164	20.99084	446204.3	FALSE	92	696526.8	-250322
165	20.4045	447428.6	FALSE	92	702046.8	-254618
166	19.81817	448617.7	FALSE	92	707566.8	-258949
167	19.23183	449771.6	FALSE	92	713086.8	-263315
168	18.6455	450890.3	FALSE	92	718606.8	-267716
169	18.05916	451973.8	FALSE	92	724126.8	-272153
170	17.47282	453022.2	FALSE	92	729646.8	-276625
171	16.88649	454035.4	FALSE	92	735166.8	-281131
172	16.30015	455013.4	FALSE	92	740686.8	-285673
173	15.71381	455956.2	FALSE	92	746206.8	-290251
174	15.12748	456863.9	FALSE	92	751726.8	-294863
175	14.54114	457736.4	FALSE	92	757246.8	-299510
176	13.9543	458573.6	FALSE	92	762766.8	-304193
177	13.36847	459375.6	FALSE	92	768286.8	-308911
178	12.78213	460142.7	FALSE	92	773806.8	-313664
179	12.1958	460874.4	FALSE			

minutes	inflow	Cumm in		out flow	Cumm out	Storage
181	11.02312	462232.4	FALSE	92	790366.8	-328134
182	10.43679	462858.6	FALSE	92	795886.8	-333028
183	9.85045	463449.6	FALSE	92	801406.8	-337957
184	9.264114	464005.5	FALSE	92	806926.8	-342921
185	8.677778	464526.1	FALSE	92	812446.8	-347921
186	8.091441	465011.6	FALSE	92	817966.8	-352955
187	7.505105	465461.9	FALSE	92	823486.8	-358025
188	6.918769	465877.1	FALSE	92	829006.8	-363130
189	6.332432	466257	FALSE	92	834526.8	-368270
190	5.746096	466601.8	FALSE	92	840046.8	-373445
191	5.15976	466911.4	FALSE	92	845566.8	-378655
192	4.573423	467185.8	FALSE	92	851086.8	-383901
193	3.987087	467425	FALSE	92	856606.8	-389182
194	3.400751	467629	FALSE	92	862126.8	-394498
195	2.814414	467797.9	FALSE	92	867646.8	-399849
196	2.228078	467931.6	FALSE	92	873166.8	-405235
197	1.641742	468030.1	FALSE	92	878686.8	-410657
198	1.055405	468093.4	FALSE	92	884206.8	-416113
199	0.469069	468121.5	FALSE	92	889726.8	-421605
200	-0.11727	468114.5	FALSE	92	895246.8	-427132
201	-0.7036	468072.3	FALSE	92	900766.8	-432694
202	-1.28994	467994.9	FALSE	92	906286.8	-438292
203	-1.87628	467882.3	FALSE	92	911806.8	-443924
204	-2.46261	467734.6	FALSE	92	917326.8	-449592
205	-3.04895	467551.6	FALSE	92	922846.8	-455295
206	-3.63529	467333.5	FALSE	92	928366.8	-461033
207	-4.22162	467080.2	FALSE	92	933886.8	-466807
208	-4.80796	466791.7	FALSE	92	939406.8	-472615
209	-5.39429	466468.1	FALSE	92	944926.8	-478459
210	-5.98063	466109.2	FALSE	92	950446.8	-484338
211	-6.56697	465715.2	FALSE	92	955966.8	-490252
212	-7.1533	465286	FALSE	92	961486.8	-496201
213	-7.73964	464821.6	FALSE	92	967006.8	-502185
214	-8.32598	464322.1	FALSE	92	972526.8	-508205
215	-8.91231	463787.4	FALSE	92	978046.8	-514259
216	-9.49865	463217.4	FALSE	92	983566.8	-520349
217	-10.085	462612.3	FALSE	92	989086.8	-526474
218	-10.6713	461972.1	FALSE	92	994606.8	-532635
219	-11.2577	461296.6	FALSE	92	1000127	-538830
220	-11.844	460586	FALSE	92	1005647	-545061
221	-12.4303	459840.1	FALSE	92	1011167	-551327
222	-13.0167	459059.1	FALSE	92	1016687	-557628
223	-13.603	458243	FALSE	92	1022207	-563964
224	-14.1893	457391.6	FALSE	92	1027727	-570335
225	-14.7757	456505.1	FALSE	92	1033247	-576742
226	-15.362	455583.3	FALSE	92	1038767	-583183
				Retention pond size=		m3

Detention Pond 2, 1:100 Year Flood

DETENTION DAM SIZE FOR SMALL CATCHMENT FOR Tc=T ie DURATION IS 3 TIMES Tc
AND PEAK RUNOFF AT Tc

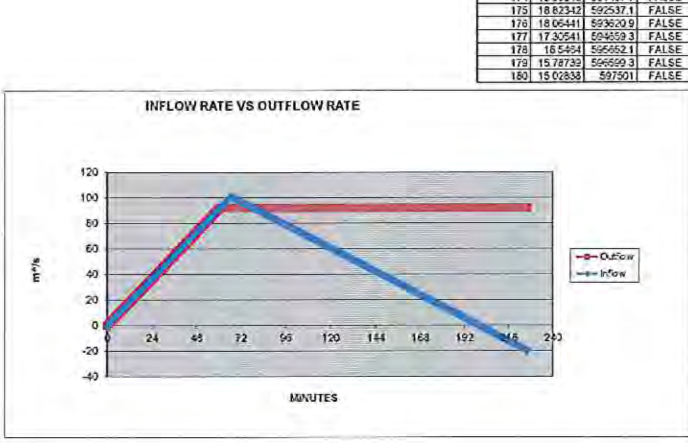
SIMPLE TRIANGULAR HYDROGRAPH WITH Tc=T ie MAX RUNOFF OCCURS AFTER Tc
AND RUNOFF IS OVER 3 TIMES Tc

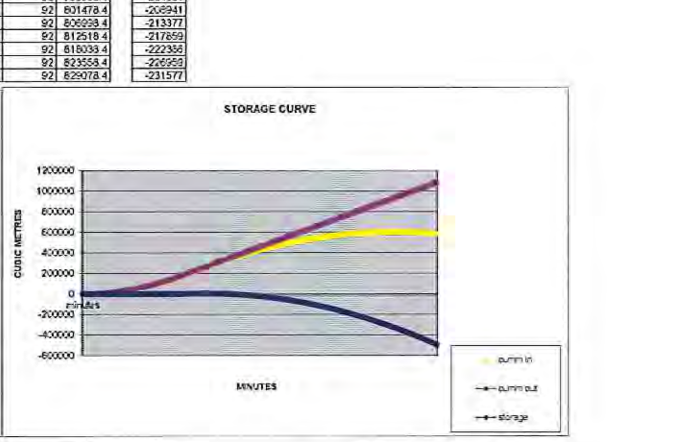
	hours	minutes	TEST
Tc (Sunny Springs, Kerby=	1.11	66.6	OK
Inflow (claculations conducted by Sinske Consult 2013)	101.1		
Max flood for detention pond sizing (Max discharge for scenario 2 from Ninham Shand report 2005)=	92		

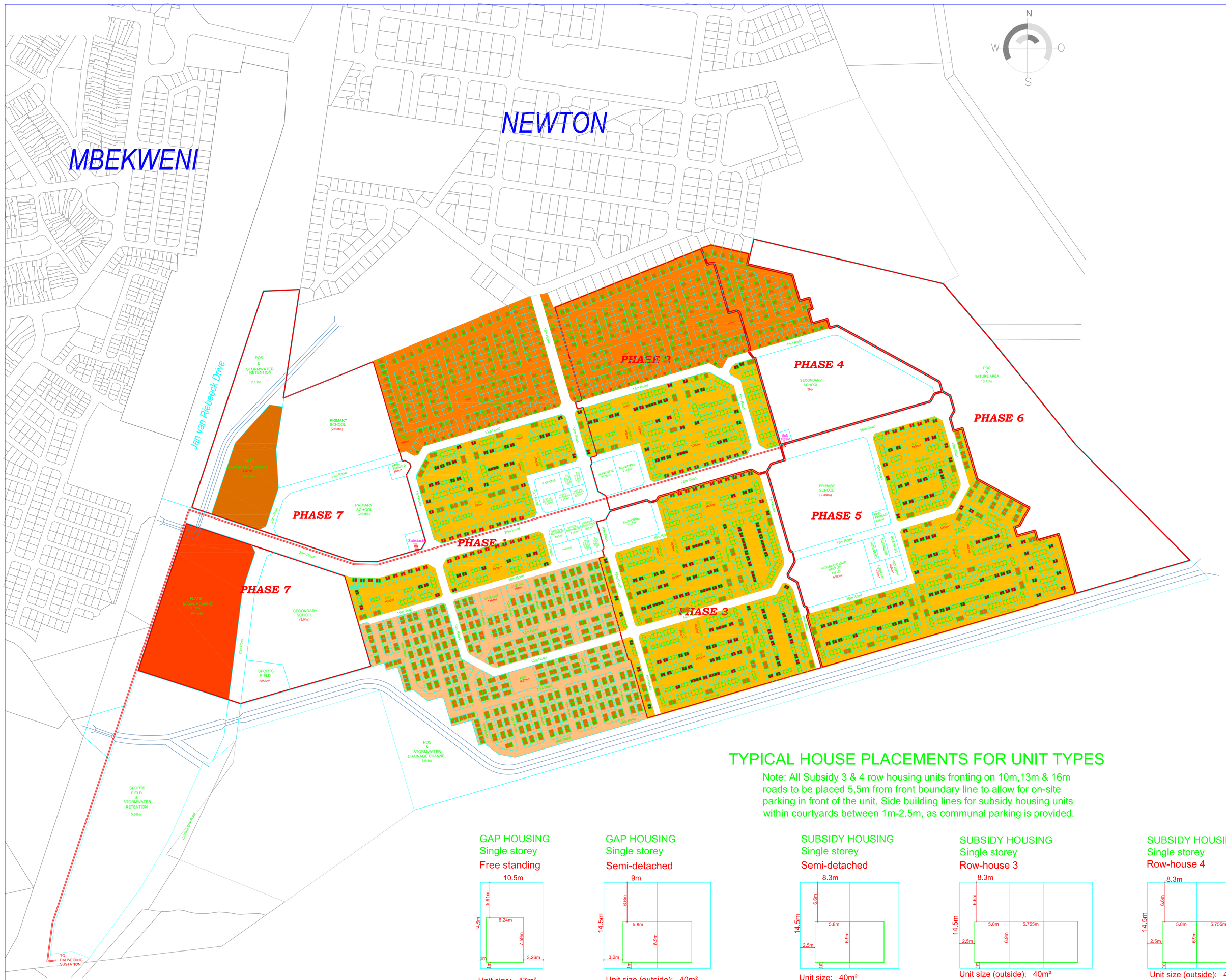
minutes	Inflow (m3/s)	Cumm in (m3)		Theoretical out flow	Cumm out	Storage
0	0	0	TRUE	0	0	0
1	1.518018	91.08108	TRUE	1.518018	91.0810811	0
2	3.036036	273.2432	TRUE	3.036036	273.243243	0
3	4.554054	546.4865	TRUE	4.5540541	546.486486	0
4	6.072072	910.8108	TRUE	6.0720721	910.810811	0
5	7.59009	1366.216	TRUE	7.5900901	1366.21622	0
6	9.108108	1912.703	TRUE	9.1081081	1912.7027	0
7	10.62613	2550.27	TRUE	10.626126	2550.27027	0
8	12.14414	3278.919	TRUE	12.144144	3278.91892	0
9	13.66216	4098.649	TRUE	13.662162	4098.64865	0
10	15.18018	5009.459	TRUE	15.18018	5009.45946	0
11	16.6982	6011.351	TRUE	16.698198	6011.35135	0
12	18.21622	7104.324	TRUE	18.216216	7104.32432	0
13	19.73423	8288.378	TRUE	19.734234	8288.37838	0
14	21.25225	9563.514	TRUE	21.252252	9563.51351	0
15	22.77027	10929.73	TRUE	22.77027	10929.7297	0
16	24.28829	12387.03	TRUE	24.288288	12387.027	0
17	25.80631	13935.41	TRUE	25.806306	13935.4054	0
18	27.32432	15574.86	TRUE	27.324324	15574.8649	0
19	28.84234	17305.41	TRUE	28.842342	17305.4054	0
20	30.36036	19127.03	TRUE	30.36036	19127.027	0
21	31.87838	21039.73	TRUE	31.878378	21039.7297	0
22	33.3964	23043.51	TRUE	33.396396	23043.5135	0
23	34.91441	25138.38	TRUE	34.914414	25138.3784	0
24	36.43243	27324.32	TRUE	36.432432	27324.3243	0
25	37.95045	29601.35	TRUE	37.95045	29601.3514	0
26	39.46847	31969.46	TRUE	39.468468	31969.4595	0
27	40.98649	34428.65	TRUE	40.986486	34428.6486	0
28	42.5045	36978.92	TRUE	42.504505	36978.9189	0
29	44.02252	39620.27	TRUE	44.022523	39620.2703	0
30	45.54054	42352.7	TRUE	45.540541	42352.7027	0
31	47.05856	45176.22	TRUE	47.058559	45176.2162	0
32	48.57658	48090.81	TRUE	48.576577	48090.8108	0
33	50.09459	51096.49	TRUE	50.094595	51096.4865	0
34	51.61261	54193.24	TRUE	51.612613	54193.2432	0
35	53.13063	57381.08	TRUE	53.130631	57381.0811	0
36	54.64865	60660	TRUE	54.648649	60660	0
37	56.16667	64030	TRUE	56.166667	64030	0
38	57.68468	67491.08	TRUE	57.684685	67491.0811	0
39	59.2027	71043.24	TRUE	59.202703	71043.2432	0
40	60.72072	74686.49	TRUE	60.720721	74686.4865	0
41	62.23874	78420.81	TRUE	62.238739	78420.8108	0
42	63.75676	82246.22	TRUE	63.756757	82246.2162	0
43	65.27477	86162.7	TRUE	65.274775	86162.7027	0
44	66.79279	90170.27	TRUE	66.792793	90170.2703	0
45	68.31081	94268.92	TRUE	68.310811	94268.9189	0
46	69.82883	98458.65	TRUE	69.828829	98458.6486	0
47	71.34685	102739.5	TRUE	71.346847	102739.459	0
48	72.86486	107111.4	TRUE	72.864865	107111.351	0
49	74.38288	111574.3	TRUE	74.382883	111574.324	0
50	75.9009	116128.4	TRUE	75.900901	116128.378	0
51	77.41892	120773.5	TRUE	77.418919	120773.514	0
52	78.93694	125509.7	TRUE	78.936937	125509.73	0
53	80.45495	130337	TRUE	80.454955	130337.027	0
54	81.97297	135255.4	TRUE	81.972973	135255.405	0
55	83.49099	140264.9	TRUE	83.490991	140264.865	0
56	85.00901	145365.4	TRUE	85.009009	145365.405	0
57	86.52703	150557	TRUE	86.527027	150557.027	0
58	88.04505	155839.7	TRUE	88.045045	155839.73	0
59	89.56306	161213.5	TRUE	89.563063	161213.514	0
60	91.08108	166678.4	TRUE	91.081081	166678.378	0
61	92.5991	172234.3	FALSE	92	172198.378	35.94595
62	94.11712	177881.4	FALSE	92	177718.378	162.973
63	95.63514	183619.5	FALSE	92	183238.378	381.0811
64	97.15315	189448.6	FALSE	92	188758.378	690.2703
65	98.67117	195368.9	FALSE	92	194278.378	1090.541
66	100.1892	201380.3	FALSE	92	199798.378	1581.892
67	100.7964	207428.1	FALSE	92	205318.378	2109.676
68	100.0374	213430.3	FALSE	92	210838.378	2591.919
69	99.27838	219387	FALSE	92	216358.378	3028.622
70	98.51937	225298.2	FALSE	92	221878.378	3419.784
71	97.76036	231163.8	FALSE	92	227398.378	3765.405
72	97.00135	236983.9	FALSE	92	232918.378	4065.486
73	96.24234	242758.4	FALSE	92	238438.378	4320.027
74	95.48333	248487.4	FALSE	92	243958.378	4529.027
75	94.72432	254170.9	FALSE	92	249478.378	4692.486
76	93.96532	259808.8	FALSE	92	254998.378	4810.405
77	93.20631	265401.2	FALSE	92	260518.378	4882.784
78	92.4473	270948	FALSE	92	266038.378	4909.622
79	91.68829	276449.3	FALSE	92	271558.378	4890.919
80	90.92928	281905.1	FALSE	92	277078.378	4826.676
81	90.17027	287315.3	FALSE	92	282598.378	4716.892
82	89.41126	292679.9	FALSE	92	288118.378	4561.568
83	88.65225	297999.1	FALSE	92	293638.378	4360.703

minutes	Inflow	Cumm in		out flow	Cumm out	Storage
84	87.89324	303272.7	FALSE	92	299158.4	4114.297
85	87.13423	308500.7	FALSE	92	304678.4	3822.351
86	86.37523	313683.2	FALSE	92	310198.4	3484.865
87	85.61622	318820.2	FALSE	92	315718.4	3101.838
88	84.85721	323911.6	FALSE	92	321238.4	2673.27
89	84.0982	328957.5	FALSE	92	326758.4	2199.162
90	83.33919	333957.9	FALSE	92	332278.4	1679.514
91	82.58018	338912.7	FALSE	92	337798.4	1114.324
92	81.82117	343822	FALSE	92	343318.4	503.5946
93	81.06216	348685.7	FALSE	92	348838.4	-152.676
94	80.30315	353503.9	FALSE	92	354358.4	-854.486
95	79.54414	358276.5	FALSE	92	359878.4	-1601.84
96	78.78514	363003.6	FALSE	92	365398.4	-2394.73
97	78.02613	367685.2	FALSE	92	370918.4	-3233.16
98	77.26712	372321.2	FALSE	92	376438.4	-4117.14
99	76.50811	376911.7	FALSE	92	381958.4	-5046.65
100	75.7491	381456.7	FALSE	92	387478.4	-6021.7
101	74.99009	385956.1	FALSE	92	392998.4	-7042.3
102	74.23108	390409.9	FALSE	92	398518.4	-8108.43
103	73.47207	394818.3	FALSE	92	404038.4	-9220.11
104	72.71306	399181.1	FALSE	92	409558.4	-10377.3
105	71.95405	403498.3	FALSE	92	415078.4	-11580.1
106	71.19506	407770	FALSE	92	420598.4	-12828.4
107	70.43604	411996.2	FALSE	92	426118.4	-14122.2
108	69.67703	416176.8	FALSE	92	431638.4	-15461.6
109	68.91802	420311.9	FALSE	92	437158.4	-16846.5
110	68.15901	424401.4	FALSE	92	442678.4	-18277
111	67.4	428445.4	FALSE	92	448198.4	-19753
112	66.64099	432443.9	FALSE	92	453718.4	-21274.5
113	65.88198	436396.8	FALSE	92	459238.4	-22841.6
114	65.12297	440304.2	FALSE	92	464758.4	-24454.2
115	64.36396	444166	FALSE	92	470278.4	-26112.4
116	63.60495	447982.3	FALSE	92	475798.4	-27816.1
117	62.84595	451753.1	FALSE	92	481318.4	-29565.3
118	62.08694	455478.3	FALSE	92	486838.4	-31360.1
119	61.32793	459157.9	FALSE	92	492358.4	-33200.4
120	60.56892	462792.1	FALSE	92	497878.4	-35086.3
121	59.80991	466380.7	FALSE	92	503398.4	-37017.7
122	59.0509	469923.7	FALSE	92	508918.4	-38994.6
123	58.29189	473421.2	FALSE	92	514438.4	-41017.1
124	57.53288	476873.2	FALSE	92	519958.4	-43085.2
125	56.77387	480279.6	FALSE	92	525478.4	-45198.7
126	56.01486	483640.5	FALSE	92	530998.4	-47357.8
127	55.25586	486955.9	FALSE	92	536518.4	-49562.5
128	54.49685	490225.7	FALSE	92	542038.4	-51812.7
129	53.73784	493450	FALSE	92	547558.4	-54108.4
130	52.97883	496628.7	FALSE	92	553078.4	-56449.7
131	52.21982	499761.9	FALSE	92	558598.4	-58836.5
132	51.46081	502849.5	FALSE	92	564118.4	-61268.8
133	50.7018	505891.6	FALSE	92	569638.4	-63746.7
134	49.94279	508888.2	FALSE	92	575158.4	-66270.2
135	49.18378	511839.2	FALSE	92	580678.4	-68839.1
136	48.42477	514744.7	FALSE	92	586198.4	-71453.6
137	47.66577	517604.7	FALSE	92	591718.4	-74113.7
138	46.90676	520419.1	FALSE	92	597238.4	-76819.3
139	46.14775	523187.9	FALSE	92	602758.4	-79570.4
140	45.38874	525911.3	FALSE	92	608278.4	-82367.1
141	44.62973	528589.1	FALSE	92	613798.4	-85209.3
142	43.87072	531221.3	FALSE	92	619318.4	-88097.1
143	43.11171	533808	FALSE	92	624838.4	-91030.4
144	42.3527	536349.2	FALSE	92	630358.4	-94009.2
145	41.59369	538844.8	FALSE	92	635878.4	-97033.6
146	40.83468	541294.9	FALSE	92	641398.4	-100104
147	40.07568	543699.4	FALSE	92	646918.4	-103219
148	39.31667	546058.4	FALSE	92	652438.4	-106380
149	38.55766	548371.9	FALSE	92	657958.4	-109587
150	37.79865	550639.8	FALSE	92	663478.4	-112839
151	37.03964	552862.2	FALSE	92	668998.4	-116136
152	36.28063	555039	FALSE	92	674518.4	-119479
153	35.52162	557170.3	FALSE	92	680038.4	-122868
154	34.76261	559256.1	FALSE	92	685558.4	-126302
155	34.0036	561296.3	FALSE	92	691078.4	-129782
156	33.24459	563290.9	FALSE	92	696598.4	-133307
157	32.48559	565240.1	FALSE	92	702118.4	-136878
158	31.72658	567143.7	FALSE	92	707638.4	-140495
159	30.96757	569001.7	FALSE	92	713158.4	-144157
160	30.20856	570814.2	FALSE	92	718678.4	-147864
161	29.44955	572581.2	FALSE	92	724198.4	-151617
162	28.69054	574302.6	FALSE	92	729718.4	-155416
163	27.93153	575978.5	FALSE	92	735238.4	-159260
164	27.17252	577608.9	FALSE	92	740758.4	-163149
165	26.41351	579193.7	FALSE	92	746278.4	-167085
166	25.6545	580733	FALSE	92	751798.4	-171065
167	24.8955	582226.7	FALSE	92	757318.4	-175092
168	24.13649	583674.9	FALSE	92	762838.4	-179163
169	23.37748	585077.5	FALSE	92	768358.4	-183281
170	22.61847	586434.6	FALSE	92	773878.4	-187444
171	21.85946	587746.2	FALSE	92	779398.4	-191652
172	21.10045	589012.2	FALSE	92	784918.4	-195906
173	20.34144	590232.7	FALSE	92	790438.4	-200206
174	19.58243	591407.7	FALSE	92	795958.4	-204551
175	18.82342	592537.1	FALSE	92	801478.4	-208941
176	18.06441	593620.9	FALSE	92	806998.4	-213377
177	17.30541	594659.3	FALSE	92	812518.4	-217859
178	16.5464	595652.1	FALSE	92	818038.4	-222386
179	15.78739	596599.3	FALSE	92	823558.4	-226959
180	15.02838	597501	FALSE	92	829078.4	-231577

minutes	Inflow	Cumm in		out flow	Cumm out	Storage
181	14.26937	598357.2	FALSE	92	834598.4	-236241
182	13.51036	599167.8	FALSE	92	840118.4	-240951
183	12.75135	599932.9	FALSE	92	845638.4	-245706
184	11.99234	600652.4	FALSE	92	851158.4	-250506
185	11.23333	601326.4	FALSE	92	856678.4	-255352
186	10.47432	601954.9	FALSE	92	862198.4	-260244
187	9.715315	602537.8	FALSE	92	867718.4	-265181
188	8.956306	603075.2	FALSE	92	873238.4	-270163
189	8.197297	603567	FALSE	92	878758.4	-275191
190	7.438288	604013.3	FALSE	92	884278.4	-280265
191	6.679279	604414.1	FALSE	92	889798.4	-285384
192	5.92027	604769.3	FALSE	92	895318.4	-290549
193	5.161261	605078.9	FALSE	92	900838.4	-295759
194	4.402252	605343.1	FALSE	92	906358.4	-301015
195	3.643243	605561.7	FALSE	92	911878.4	-306317
196	2.884234	605734.7	FALSE	92	917398.4	-311664
197	2.125225	605862.2	FALSE	92	922918.4	-317056
198	1.366216	605944.2	FALSE	92	928438.4	-322494
199	0.607207	605980.6	FALSE	92	933958.4	-327978
200	-0.1518	605971.5	FALSE	92	939478.4	-333507
201	-0.91081	605916.9	FALSE	92	944998.4	-339081
202	-1.66982	605816.7	FALSE	92	950518.4	-344702
203	-2.42883	605671	FALSE	92	956038.4	-350367
204	-3.18784	605479.7	FALSE	92	961558.4	-356079
205	-3.94685	605242.9	FALSE	92	967078.4	-361835
206	-4.70586	604960.5	FALSE	92	972598.4	-367638
207	-5.46486	604632.6	FALSE	92	978118.4	-373486
208	-6.22387	604259.2	FALSE	92	983638.4	-379379
209	-6.98288	603840.2	FALSE	92	989158.4	-385318
210	-7.74189	603375.7	FALSE	92	994678.4	-391303
211	-8.5009	602865.7	FALSE	92	1000198	-397333
212	-9.25991	602310.1	FALSE	92	1005718	-403408
213	-10.0189	601708.9	FALSE	92	1011238	-409529
214	-10.7779	601062.3	FALSE	92	1016758	-415696
215	-11.5369	600370.1	FALSE	92	1022278	-421908
216	-12.2959	599632.3	FALSE	92	1027798	-428166
217	-13.055	598849	FALSE	92	1033318	-434469
218	-13.814	598020.2	FALSE	92	1038838	-440818
219	-14.573	597145.8	FALSE	92	1044358	-447213
220	-15.332	596225.9	FALSE	92	1049878	-453653
221	-16.091	595260.4	FALSE	92	1055398	-460138
222	-16.85	594249.4	FALSE	92	1060918	-466669
223	-17.609	593192.9	FALSE	92	1066438	-473246
224	-18.368	592090.8	FALSE	92	1071958	-479868
225	-19.127	590943.2	FALSE	92	1077478	-486535
226	-19.886	589750	FALSE	92	1082998	-493248
				Retention pond size=		4910 m3







PHASE	HOUSING TYPE	N
PHASE 1:	SUBSIDY HOUSING	308
	GAP HOUSING	219
	TRA	512
		1039
PHASE 2:	SUBSIDY HOUSING	215
	GAP HOUSING	190
		405
PHASE 3:	SUBSIDY HOUSING	555
PHASE 4:	SUBSIDY HOUSING	-
	GAP	72
		72
PHASE 5:	SUBSIDY HOUSING	475
PHASE 6:	CONSERVATION AREA	-
PHASE 7:	FLATS (SOCIAL)	504
	FLATS (GAP/SOCIAL)	200
		704
TOTAL		3 250

LEGEND

- SUBSIDY UNITS
- GAP UNITS
- TRA
- SOCIAL HOUSING
- FLATS (GAP / SOCIAL HOUSING)
- SUBDIVISIONAL AREA BOUNDARY
- PHASE BOUNDARIES
- PROPOSED DRAINAGE CHANNEL
- PRIMARY MV CABLE ROUTE from DALWEIDING SUB TO SWITCHING SUBS OF PROPOSED DEVELOPMENT

TYPICAL HOUSE PLACEMENTS FOR UNIT TYPES

Note: All Subsidy 3 & 4 row housing units fronting on 10m,13m & 16m roads to be placed 5,5m from front boundary line to allow for on-site parking in front of the unit. Side building lines for subsidy housing units within courtyards between 1m-2.5m, as communal parking is provided.

GAP HOUSING
Single storey
Free standing

Unit size: 47m²
Erf size: 152.25m²

GAP HOUSING
Single storey
Semi-detached

Unit size (outside): 40m²
Erf size (outside): 130.5m²

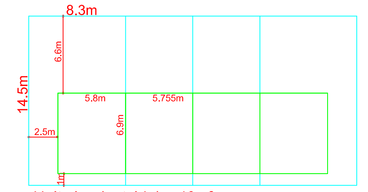
SUBSIDY HOUSING
Single storey
Semi-detached

Unit size: 40m²
Erf size: 120m²

SUBSIDY HOUSING
Single storey
Row-house 3

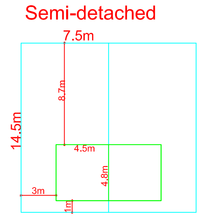
Unit size (outside): 40m²
Erf size (outside): 120m²
Unit size (inside): 40m²
Erf size (inside): 83m²

SUBSIDY HOUSING
Single storey
Row-house 4



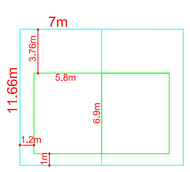
Unit size (outside): 40m²
Erf size (outside): 120m²
Unit size (inside): 40m²
Erf size (inside): 83m²

GAP HOUSING
Double storey
Semi-detached



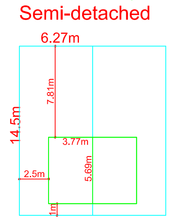
Unit size : 40m²
Erf size : 105m²

TRA
Single storey
Semi-detached



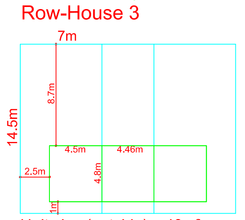
Unit size: 40m²
Erf size : 105m²

SUBSIDY HOUSING
Double storey
Semi-detached



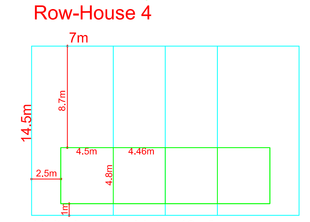
Unit size: 40m²
Erf size: 91m²
(Same unit for mixed use erven)

SUBSIDY HOUSING
Double storey
Row-House 3



Unit size (outside): 40m²
Erf size (outside): 102m²
Unit size (inside): 40m²
Erf size (inside): 65m²
(Same unit for mixed use erven)

SUBSIDY HOUSING
Double storey
Row-House 4



Unit size (outside): 40m²
Erf size (outside): 102m²
Unit size (inside): 40m²
Erf size (inside): 65m²

NOTA: ALLE AFSTANDE BY BENADERING EN ONDERHEWIG AAN OPMETING
NOTE: ALL MEASUREMENTS APPROXIMATE AND SUBJECT TO SURVEYING

HERSIENINGS • REVISIONS

NO	DATUM/DATE	BESKRYWING/DESCRIPTION
03	26 Aug 2013	Revisions to land use table / zonings
04	29 Nov 2013	Revise phase boudaries & table
04	10 Dec 2013	Revise Phase 1 & 7 boundaries
05	1 May 2014	Revise layout according to comments received

BASE INFORMATION & CONTOURS PROVIDED
BY JOUBERT & BRINK SURVEYS

NuPLAN AFRICA
INNOVATIVE PLANNING SOLUTIONS
Gladstonestraat 11a Gladstone Street, Durbanville,Suid-Afrika/South Africa
3603 Tygervalley 7536 • E-mail: steynlar@lafrica.com
Tel: +27 21 975-1265 • Faks/Fax: +27 21 975-1264

PAARL - VLAKKELAND
Proposed Subdivision Plan

DATUM DATE 29 July 2014	GETEKEN DRAWN AV
SKAAL SCALE A0 - 1:2500	ONTWERP DESIGNED TS & DJ

TEK.Nr DWG.No 2.552 - S1 - 05

Eimac (Pty)Ltd
Registration Number 90/01912/07

address Po Box 3615
Tyger Valley 7536

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15 September 2014

ERF VLAKKELAND
DEVELOPMENT FRAMEWORK
ELECTRICAL SERVICES

This report is a preliminary study and highlights the following aspects:

- Basis
- Electrical Authority
- Design Standards Imposed
- After Diversity Maximum Demand (ADMD)
- Bulk Connection and Methodology
- Capacity
- Metering
- Street lighting
- BICL
- Servitudes
- Primary MV Cable Routes
- Special Considerations

BASIS

The basis for this preliminary investigation is the drawing 2.552-S1-05, rev 1 May 2014 and related information.

ELECTRICAL AUTHORITY

The Electrical Authority as well as the Local Authority is the Electrical Department of Drakenstein Municipality with Offices in Paarl.

DESIGN STANDARDS IMPOSED

The design standards i.t.o. infrastructure design shall be those of the Electrical Department of Drakenstein Municipality.
The calculation methodology for the Electrical design is to be NRS034-1:2001 – Herman-Beta method and as amended by Drakenstein Municipal Tables.

AFTER DIVERSITY MAXIMUM DEMAND (ADMD)

Using the imposed calculation methodology, preliminary estimation of the ADMD requires a probable ADMD of 11.2MVA on a 7-year load profile and a probable ADMD of 14.8MVA on a 15-year load profile. These figures include the Civic and Business Nodes, Schools, Crèches, Sport Fields and Churches.

BULK CONNECTION AND METHODOLOGY

The preliminary Supply shall be at the existing Dalweiding S/S, to be upgraded to make provision for this development.

Additional switches and transmission equipment shall be required at the feeder Dalweiding S/S. Adequate space is available at the substation for such equipment.

The existing 185 mm^2 u/g cable running in a North-Easterly direction past the proposed development and feeding existing developments, can be used for an initial small phase of the development, but is inadequate for the total development.
New Bulk 185 mm^2 u/g transmission cables feeding from Dalweiding S/S shall therefore be required for this development. The total Bulk Infrastructure Upgrade Cost to be incurred by this proposed development shall be pro-rata calculated taking the ratio of required ADMD to Cable Capacity as basis for calculation.
CAPACITY

Adequate Capacity shall be available at the Main feeder Dalweiding S/S for this development.

Dalweide S/S shall be upgraded and renewed to cater for the full capacity of this development

Capacity is Inadequate on the existing 185 mm^2 feeder cable running past the proposed development and a new cable system from Dalweiding S/S shall be required.

A small initial sub-phase can be considered on the existing feeder cabling, but would be inadequate for the first phase as anticipated (3.6 MVA)

METERING

Metering Methodology shall be in accordance with Municipal Requirement, but shall consist of either a split-metering system or (where usage is less than 1000kW.h per month), prepayment metering.

STREET LIGHTING

Street lighting on Municipality-maintained roads to be:

- 12m bottom-entry and inner control gear chamber sectional steel poles with overhang luminaires, in accordance with Municipal specs on Class 2 distributors
- 9.5m bottom-entry and inner control gear chamber sectional steel poles with overhang luminaires, in accordance with Municipal specs on Class 3 and 4 distributors
- 6.5m bottom-entry and inner control gear chamber sectional steel poles with post-top luminaires, in accordance with Municipal specs on Class 5 distributors

All Lighting to be designed and specified in accordance with Municipal Specification, employing HPS Luminaires of various sizes and power.

BULK INFRASTRUCTURE CONTRIBUTION LEVY (BICL)

BICL shall be payable and is to be calculated in accordance with page 23 of the current Planning Department document.

Costs shall be incurred on upstream equipment at Dalweide S/S and on the upgrade of the feeder transmission cable system.

The total Bulk Infrastructure Upgrade Cost to be incurred by this proposed development shall be pro-rata calculated taking the ratio of required ADMD to Cable Capacity as basis for calculation.

The Pro-Rata Costs so incurred shall be for the account of the development, but is recoverable from the BICL.

Eimac (Pty)Ltd
Registration Number 90/01912/07

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Tyger Valley 7536

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e-mail info@eimac.co.za

PRIMARY MV CABLE ROUTES

The Primary MV Cables to be installed for this proposed development are intended to route in the road reserve (on the eastern side thereof) of Jan van Riebeeck Drive. From Jan van Riebeeck Drive it shall route in the road reserve as part of the sidewalks of the main feeder road into the proposed development to the first and second new Switching Substation sites
These Cables to consist of composite sets of 185mm^2 11kV underground cable.

SERVITUDES

The following Servitudes are required:

- For 2 Switching Substations - 2 Erven of approximately 20mx20m
- As part of Road Reserves or Public Open Spaces:
  - 6mx3m servitudes for minisubs
  - 3m line servitudes for MV Cabling
  - If Road Reserves are inadequate, servitudes must be registered.

SPECIAL CONSIDERATIONS

- **A warning flag:** The BICL to be paid shall in all probability be inadequate to cover the pro-rata cost of upgrades and the residue shall be for the account of the development.

JJ Veldsman
Pr Eng
For Eimac(Pty)Ltd

VLAKKELAND PAARL (ENTIRE PROPOSED SITE)

2014-09-15

COST ESTIMATE: ENGINEERING SERVICES				Internal		Link		Bulk		Total
		Unit	Rate	Quantity	Amount	Quantity	Amount	Quantity	Amount	TOTAL
Civil engineering services:										
Estimated construction period - months					50		5		58	
Preliminary and general			15,00%		14 737 609		1 507 908		17 340 934	33 586 452
Bulk Earthworks										
Site Clearance		R/ha	20 000,00	101	2 020 000		-		-	2 020 000
Demolish existing infrastructure		Sum	100 000,00	3	300 000	-	-	-	-	300 000
Bulk Earthworks : Cut to Fill		R/m3	35,00	530 000	18 550 000	-	-	-	-	18 550 000
Bulk Earthworks : Cut to Stockpile		R/m3	35,00	-	-		-	-	-	-
Bulk Earthworks : Cut to Spoil		R/m3	35,00	-	-	-	-	-	-	-
Water (Excl meters)									-	
110mm HDPE PE100 PN12.5		R/m	590,46	13 050	7 705 559		-	-	-	7 705 559
160mm HDPE PE100 PN12.5		R/m	580,27	1 500	870 411	-	-	-	-	870 411
200mm HDPE PE100 PN12.5		R/m	802,04	2 330	1 868 746	-	-	-	-	1 868 746
250mm HDPE PE100 PN12.5		R/m	745,34		-	-	-	-	-	-
315mm HDPE PE100 PN12.5		R/m	865,51		-	-	-	-	-	-
355mm HDPE PE100 PN12.5		R/m	1 234,95		-	-	-	-	-	-
525mm GRP		R/m	1 760,45		-	-	-	-	-	-
Water Master Plan Item DWW1.24a, DWW1.24b & DWW1.24c - 315 mm pipe		R/m	865,51			1 440	1 246 327			1 246 327
Water Master Plan Item (Possible/provisional upgrades to Network)		Sum	8 000 000,00		-	-	-	-	-	-
Water Master Plan Item DWW.B5 - Booster Pump		Sum	3 300 000,00					1	3 300 000	3 300 000
Water Master Plan Items DWW.B23, DWW.B24 & DWW.B25 - 14200 m x 560 mm pipe		Sum	53 900 000,00		-	-	-	1	53 900 000	53 900 000
Water Master Plan Items DWW1.27 & DWW1.47 - 1000 m x 250 mm pipe		R/m	745,34		-	-	-	1 000	745 336	745 336
		Sum			-	-	-		-	-
Sewer										
110mm PVC-U Class 34		R/m	640,20	-	-		-		-	-
160mm PVC-U Class 34		R/m	804,78	13 665	10 997 319	-	-		-	10 997 319
200mm PVC-U Class 34		R/m	855,90	306	261 905	-	-		-	261 905
250mm PVC-U Class 34		R/m	909,80		-	-	-		-	-
315mm PVC-U Class 34		R/m	1 047,87		-	-	-		-	-
355mm PVC-U Class 34		R/m	1 178,99		-	-	-	-	-	-
400mm GRP		R/m	1 791,50		-	-	-	-	-	-
450mm GRP		R/m	1 948,90		-		-	-	-	-
Water Master Plan Item (Possible upgrades to Network)		Sum	10 000 000,00		-	-	-	-	-	-
Water Master Plan Items (DPS1.10) 144 m x 315 mm pipe		R/m	1 047,87			144	150 893			150 893
Water Master Plan Items (DPS1.11b) 484 m x 200 mm pipe		R/m	855,90			484	414 256			414 256
Water Master Plan Items (DPS1.11c & DPS1.11d) 656 m x 160 mm pipe		R/m	804,78			656	527 936			527 936
Water Master Plan Items (DPS1.3) 275 m x 675 mm pipe		Sum	815 000,00					1	815 000	815 000
Water Master Plan Items (DPS1.4) Upgrade to Pumping Station		Sum	360 000,00		-	-	-	1	360 000	360 000
Water Master Plan Items (DPS1.5) 1420 m x 500 mm rising main		Sum	3 390 000,00		-	-	-	1	3 390 000	3 390 000
Water Master Plan Items (DPS1.6) 1025 m x 450 mm pipe		R/m	1 948,90		-	-	-	1 025	1 997 623	1 997 623
Water Master Plan Items (DPS1.7) 505 m x 400 mm pipe		R/m	1 791,50		-	-	-	505	904 708	904 708
		Sum			-	-	-	-	-	-
Stormwater										
300mm 100D		R/m	903,00		-		-		-	-
375mm 100D		R/m	1 068,75	9 150	9 779 063	-	-	-	-	9 779 063
450mm 100D		R/m	1 463,00	1 550	2 267 650	-	-	-	-	2 267 650
525mm 75D		R/m	1 528,75	-	-	-	-	-	-	-
600mm 75D		R/m	1 574,50	-	-	-	-	-	-	-
675mm 75D		R/m	1 790,25	-	-	-	-	-	-	-
750mm 75D		R/m	2 123,00	-	-	580	1 231 340	-	-	1 231 340
825mm 75D		R/m	2 308,75	-	-	-	-	-	-	-
900mm 75D		R/m	2 564,50	-	-	-	-	-	-	-
1050mm 75D		R/m	2 976,00	-	-	-	-	670	1 993 920	1 993 920
Subsurface drainage		R/m	210,00	14 124	2 966 040	850	178 500	1 300	273 000	3 417 540
Outlet Structures		Sum	5 000,00	14	70 000					70 000
Detention ponds		R/m3	50,00	-	-	-	-	250 000	12 500 000	12 500 000
Overland stormwater channel 1		Sum	9 524 400,00	-	-	-	-	1	9 524 400	9 524 400
Replace and construction of Culverts		Sum	1 500 000,00	-	-	-	-	4	6 000 000	6 000 000
Cable ducts									-	
Telkom ducts - 110mm single		R/m	354,60	4 220	1 496 412	425	150 705	-	-	1 647 117
Telkom ducts - 110mm double		R/m	594,60	4 220	2 509 212	255	151 623	-	-	2 660 835
Telkom ducts - 160mm single		R/m	497,60	-	-	170	84 592	-	-	84 592
Electrical ducts - 110mm single		R/m	223,00	844	188 212	85	18 955	-	-	207 167
Electrical ducts - 110mm double		R/m	589,00	844	497 116	51	30 039	-	-	527 155
Electrical ducts - 160mm single		R/m	394,50	-	-	34	13 413	-	-	13 413
Electrical cable		R/m	594,60	-	-	-	-	-	-	-
Misc Ducts		R/m	223,00	-	-	-	-	-	-	-
Roads										
Parking area		R/m2	42,53	-	-	-	-	-	-	-
8 m reserve - 4.5m premix		R/m	-	-	-	-	-	-	-	-
10 m reserve - 4.5m premix		R/m	2 456,37	11 066	27 182 135	-	-	-	-	27 182 135
13 m reserve - 5.0m premix		R/m	2 851,85	3 058	8 720 950	-	-	-	-	8 720 950
16 m reserve - 7.4m premix (with sidewalks 1.5m and 1 x 2.5m Parking)		R/m	6 238,45	-	-	450	2 807 301	-	-	2 807 301
20 m reserve - 8m premix (with sidewalks 2.0m and 2 x 2.5 Parkings)		R/m	7 617,11	-	-	400	3 046 843	-	-	3 046 843
25 m reserve - 8m premix (with sidewalks 2.0m and 2 x 2.5 Parkings)		R/m	7 617,11	-	-	-	-	1 300	9 902 241	9 902 241
Intersection and upgrades to existing infrastructure		Sum	10 000 000	-	-		-	1,00	10 000 000	10 000 000
Misc works										
Misc - Hard Landscaping feature		Sum	-		-		-		-	-
Subtotal					112 988 339		11 560 632		132 947 160	257 496 131
Contingencies (10%)			10,00%		11 298 834		1 156 063		13 294 716	25 749 613
Subtotal - Construction cost					124 287 173		12 716 695		146 241 877	283 245 744
Municipal levies (to be resolved)			-	-	-		-		-	-
Total for Civil engineering construction					**124 287 173**		**12 716 695**		**146 241 877**	**283 245 744**
Civil engineering construction cost per erf		**3260**			**38 125**		**3 901**		**44 859**	**86 885**
Electrical engineering services:										
Estimated construction period - months					-		-		-	-
Preliminary and general			-		-		-		-	-
Medium voltage network		Sum	-		-		-		-	-
Low voltage network		Sum	-		-		-		-	-
Street lighting & bollards		Sum	0		-		-		-	-
Subtotal					-		-		-	-
Contingencies	10%		10,00%		-		-		-	-
Subtotal - Construction cost					-		-		-	-
Misc electrical costs		Sum			-		-		-	-
Total for Electrical engineering construction					**-**		**-**		**-**	**-**
Electrical engineering construction cost per erf		3260			-		-		-	-
Civil and Electrical engineering construction cost - excl VAT					**124 287 173**		**12 716 695**		**146 241 877**	**283 245 744**
Professional fees - Disbursements										
Civil Engineering sevices (% value work)										
ECSA 2012 fees					8 019 294,50		1 239 502,55		9 226 803,21	18 485 600,26
Disbursements	10%				801 929,45		123 950,25		922 680,32	1 848 560,03
Total Fees for Civil engineering services					**8 821 223,95**		**1 363 452,80**		**10 149 483,53**	**20 334 160,28**
Electrical Engineering sevices										
ECSA 2012 fees					-		-		-	-
Disbursements										
Total Fees for Electrical engineering services					-		-		-	-
Development cost - inclusive of civil, electrical services and professional fees					**133 108 396,66**		**14 080 147,77**		**156 391 360,05**	**303 579 904,49**
Development cost per erf - inclusive of fees		**8280**			**16 075,89**		**1 700,50**		**18 887,85**	**36 664,24**

Note : Bulk services contributions, Supervision, Geotechnical investigations, survey etc - to be allowed for in the feasibility - No provision was made for VAT