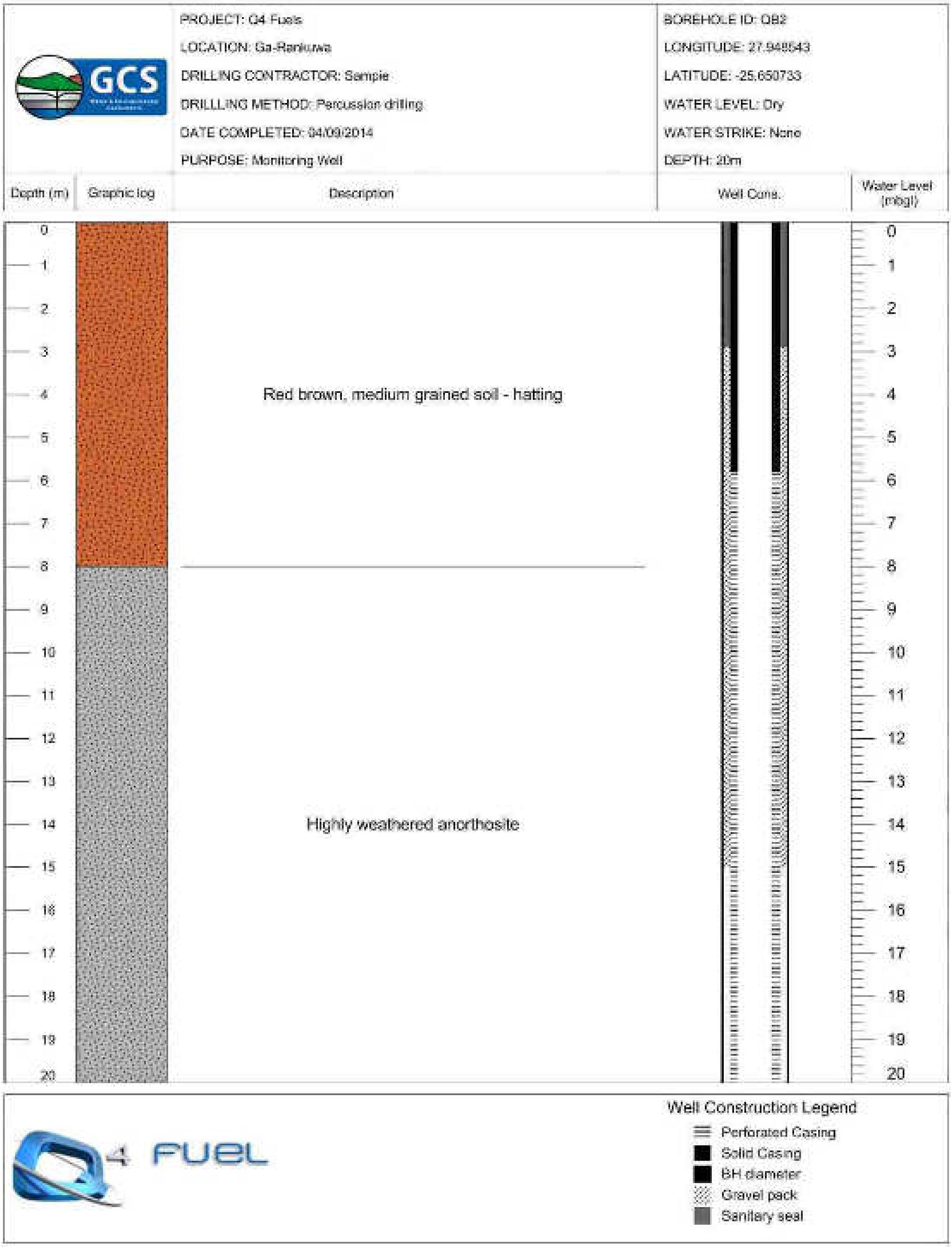
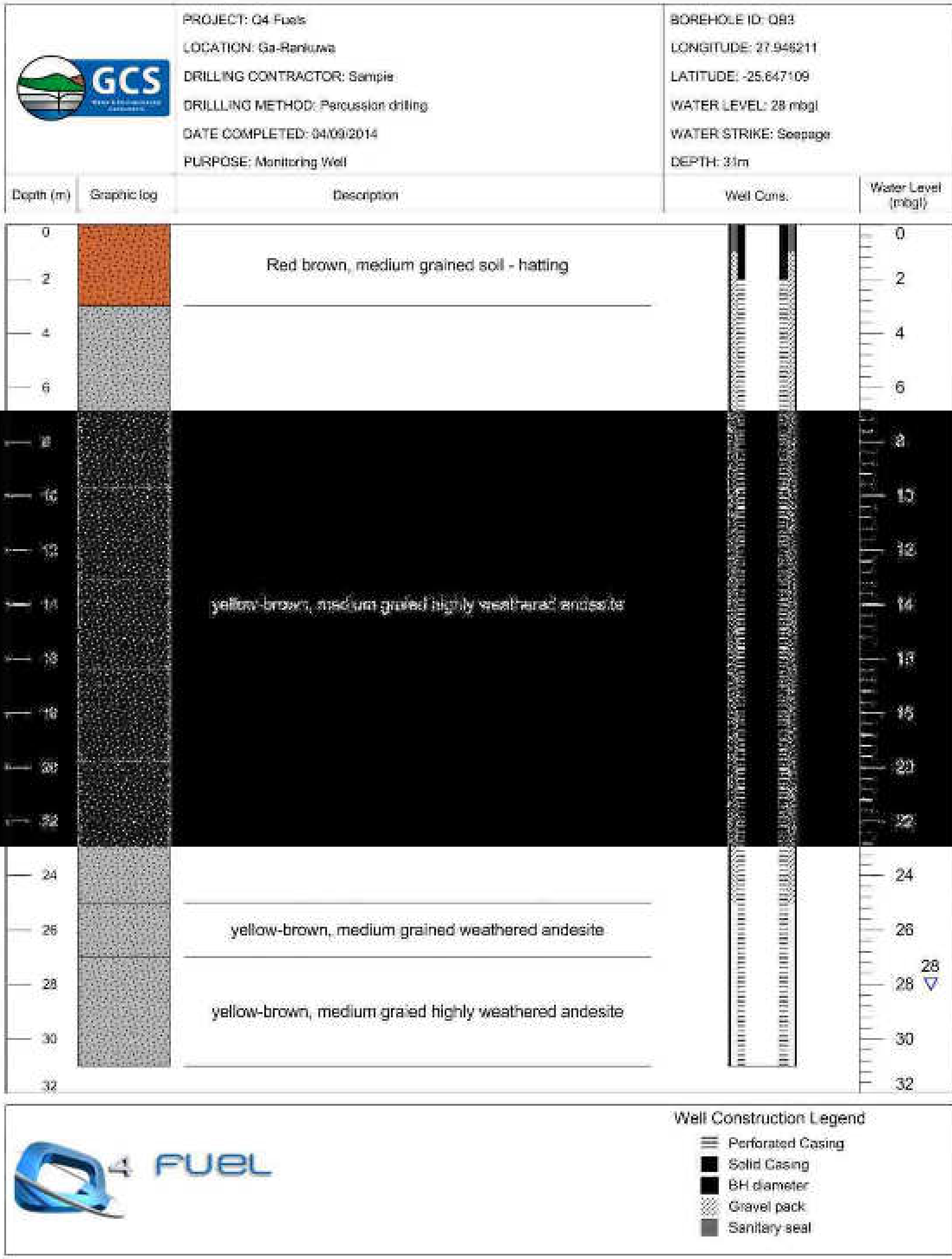
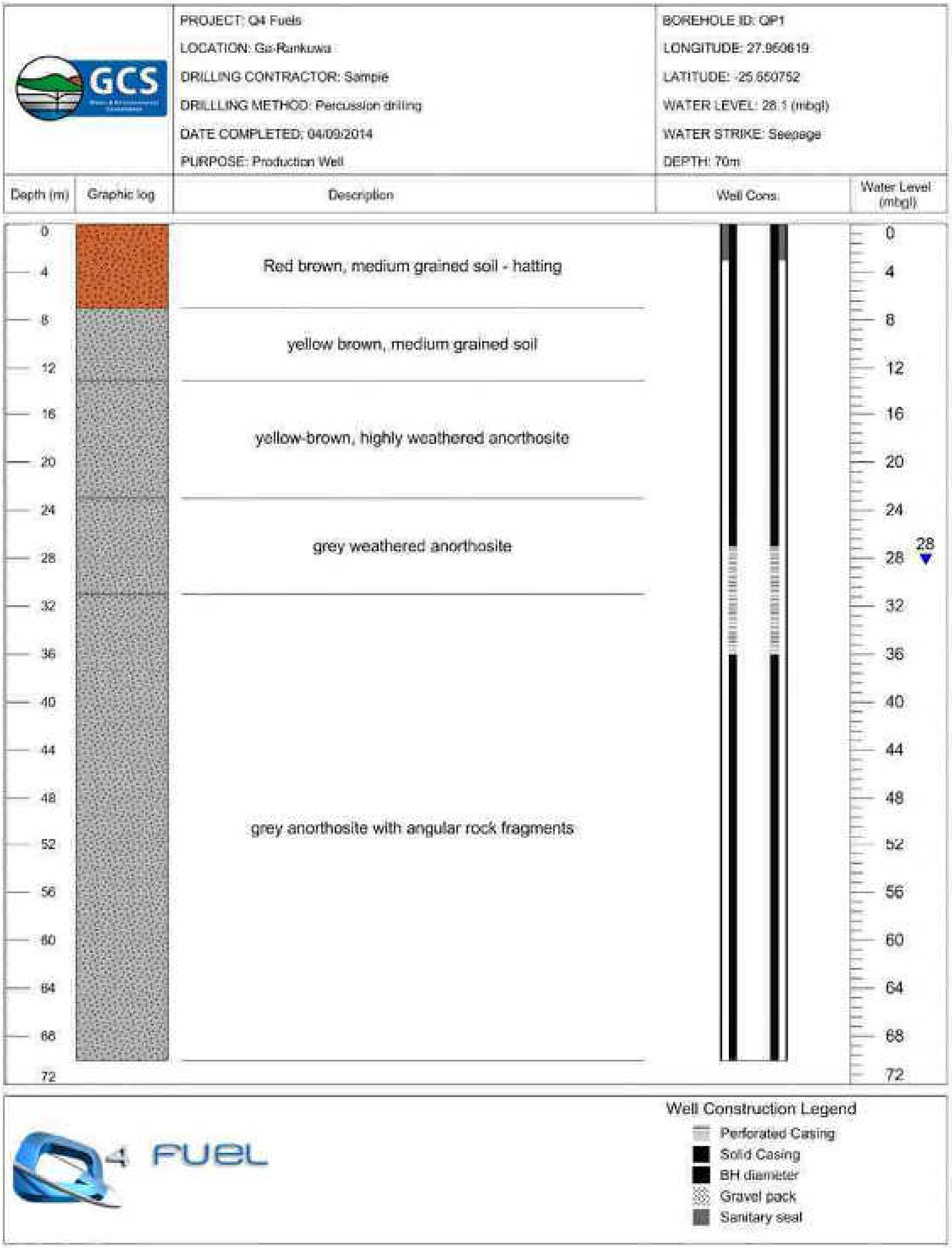
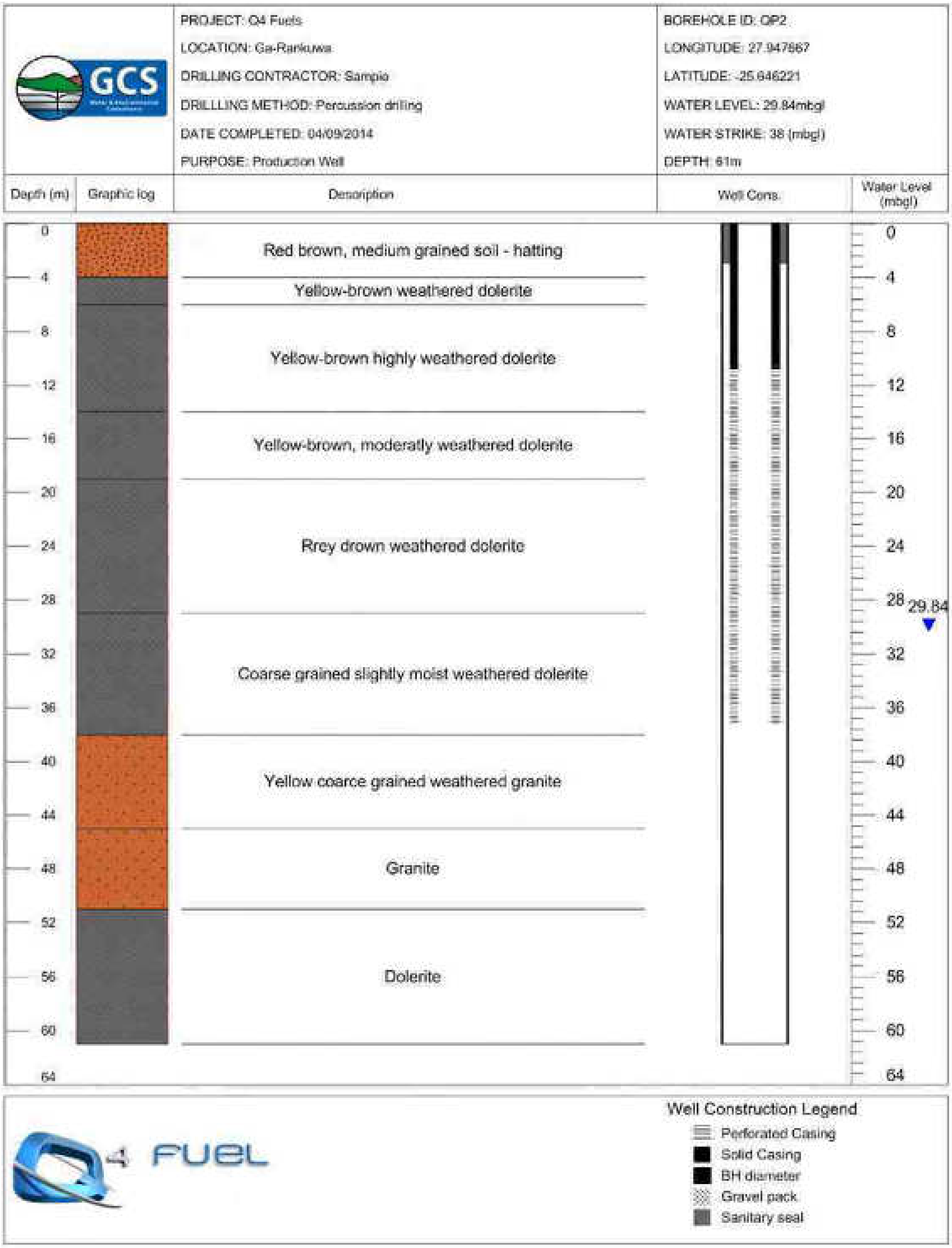

PROJECT: Q4 Fuels
LOCATION: Ga-Rankuwa
DRILLING CONTRACTOR: Sampie
DRILLLING METHOD: Percussion drilling
DATE COMPLETED: 04/09/2014
PURPOSE: Monitoring Well
BOREHOLE ID: QB2
LONGITUDE: 27.948543
LATITUDE: -25.650733
WATER LEVEL: Dry
WATER STRIKE: None
DEPTH: 20m
Depth (m)
Graphic log
Description
Well Cons.
Water Level (mbgl)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Red brown, medium grained soil - hatting
Highly weathered anorthosite
Well Construction Legend
Perforated Casing
Solid Casing
BH diameter
Gravel pack
Sanitary seal


PROJECT: Q4 Fuels
LOCATION: Ga-Rankuwa
DRILLING CONTRACTOR: Sampie
DRILLLING METHOD: Percussion drilling
DATE COMPLETED: 04/09/2014
PURPOSE: Monitoring Well
BOREHOLE ID: QB3
LONGITUDE: 27.946211
LATITUDE: -25.647109
WATER LEVEL: 28 mbgl
WATER STRIKE: Seepage
DEPTH: 31m
Depth (m)
Graphic log
Description
Well Cons.
Water Level (mbgl)
Red brown, medium grained soil - hatting
yellow-brown, medium graied highly weathered andesite
yellow-brown, medium grained weathered andesite
yellow-brown, medium graied highly weathered andesite
28
Well Construction Legend
Perforated Casing
Solid Casing
BH diameter
Gravel pack
Sanitary seal


GCS
PROJECT: Q4 Fuels
LOCATION: Ga-Rankuwa
DRILLING CONTRACTOR: Sampie
DRILLLING METHOD: Percussion drilling
DATE COMPLETED: 04/09/2014
PURPOSE: Production Well
BOREHOLE ID: QP1
LONGITUDE: 27.960619
LATITUDE: -25.650752
WATER LEVEL: 28.1 (mbgl)
WATER STRIKE: Seepage
DEPTH: 70m
Depth (m)
Graphic log
Description
Well Cons.
Water Level (mbgl)
Red brown, medium grained soil - hatting
yellow brown, medium grained soil
yellow-brown, highly weathered anorthosite
grey weathered anorthosite
grey anorthosite with angular rock fragments
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
28
Q4 FUEL
Well Construction Legend
Perforated Casing
Solid Casing
BH diameter
Gravel pack
Sanitary seal


PROJECT: Q4 Fuels
LOCATION: Ga-Rankuwa
DRILLING CONTRACTOR: Sampio
DRILLLING METHOD: Percussion drilling
DATE COMPLETED: 04/09/2014
PURPOSE: Production Well
BOREHOLE ID: QP2
LONGITUDE: 27.947867
LATITUDE: -25.646221
WATER LEVEL: 29.84mbgl
WATER STRIKE: 38 (mbgl)
DEPTH: 61m
Depth (m)
Graphic log
Description
Well Cons.
Water Level (mbgl)
Red brown, medium grained soil - halting
Yellow-brown weathered dolerite
Yellow-brown highly weathered dolerite
Yellow-brown, moderatly weathered dolerite
Rrey drown weathered dolerite
Coarse grained slightly moist weathered dolerite
Yellow coarce grained weathered granite
Granite
Dolerite
29.84
Well Construction Legend
Perforated Casing
Solid Casing
BH diameter
Gravel pack
Sanitary seal

APPENDIX C - AQUIFER TEST

CONSTANT DISCHARGE TEST DATA SHEET – QP2				
General Information				
Project No:		14-503		
Borehole No:		QP-2		
Site Name:		Q4 Fuels		
Section:		Section 2		
Latitude:		-25.646771		
Longitude:		27.947667		
Pumping Borehole Information				
Depth of Pump (m):		56		
Collar Height (m):		0.49		
BH diameter (m):		180mm		
Depth of BH (m):		61		
Static water level (m):		29.84		
Test Started				
Date:		12/09/2014		
Time:		14:34		
Test Ended				
Date:		13/09/2014		
Time:		13:34		
Duration (min):		1440		
Time	**Drawdown**	**Yield**	**Time**	**Recovery**
(min)	**s (m)**	**(l/s)**	**(min)**	**s' (m)**
1	34.37	1.4	1	36.63
2	34.57	1.4	2	33.9
3	34.67	1.4	3	32.47
4	34.8	1.4	4	31.47
5	34.87	1.4	5	31.64
6	35.13	1.4	6	31.37
7	35.25	1.4	7	31.15
8	35.39	1.4	8	31.07
9	35.58	1.4	9	31
10	35.65	1.4	10	30.98
11	35.88	1.4	11	30.97
12	35.97	1.4	12	30.96
13	36.02	1.4	13	30.95
14	36.17	1.4	14	30.94
15	36.28	1.4	15	30.93
16	36.39	1.4	16	30.92
17	36.56	1.4	17	30.91
18	36.68	1.4	18	30.9
19	36.8	1.4	19	30.89
20	36.9	1.4	20	30.88
25	37.6	1.6	25	30.84
30	38.17	1.6	30	30.81
40	38.9	2	40	30.81
50	39.44	2	50	30.8
60	39.74	2	60	30.8
75	40.38	2		
90	40.97	2.3		
120	41.75	2.3		
150	42.5	2.3		

180	43.5	2.3	
240	44.8	2.3	
300	46.2	2.3	
360	46.8	2.3	
420	47.15	2.3	
480	47.28	2.3	
600	47.4	2.3	
720	47.49	2.3	
900	47.5	2.3	
1080	47.54	2.3	
1440	47.59	2.3	
1800		1.785	

CONSTANT DISCHARGE TEST DATA SHEET – BH3				
General Information				
Project No:	14-503			
Borehole No:	BH3			
Site Name:	Q4 Fuels			
Section	Section 1			
Latitude:	-25.651373			
Longitude:	27.953246			
Pumping Borehole Information				
Depth of Pump (m):	40.35			
Collar Height (m):	0.2			
BH diameter (m):	0.12			
Depth of BH (m):	Fitted with pump			
Static water level (m):	33.56			
Test Started				
Date:	16/09/2014			
Time:	08h00			
Test Ended				
Date:	17/09/2014			
Time:	08h00			
Duration (min):	1440			
Remarks				
The test was undertaken using an existing pump				
Time	**Drawdown**	**Yield**	**Time**	**Recovery**
(min)	**s (m)**	**(l/s)**	**(min)**	**s' (m)**
1	35.11	0.5	1	36.28
2	35.25	0.5	2	35.89
3	35.47	0.5	3	35.68
4	35.55	0.5	4	35.52
5	35.67	0.5	5	35.4
6	35.71	0.5	6	35.29
7	35.78	0.5	7	35.23
8	35.83	0.5	8	35.15
9	35.88	0.5	9	35.09
10	35.94	0.5	10	35.05
11	35.96	0.5	11	35
12	36	0.5	12	34.96
13	36.02	0.5	13	34.91
14	36.05	0.5	14	34.88

15	36.09	0.5	15	34.84
16	36.17	0.5	16	34.81
17	36.14	0.5	17	34.8
18	36.16	0.5	18	34.78
19	36.17	0.5	19	34.75
20	36.18	0.5	20	34.73
25	36.24	0.5	25	34.64
30	36.3	0.5	30	34.57
40	36.4	0.5	40	34.47
50	36.48	0.5	50	34.38
60	36.58	0.5	60	34.3
75	36.68	0.5	75	34.27
90	36.73	0.5	90	34.21
120	36.81	0.5	120	34.13
150	36.83	0.5		
180	36.89	0.5		
240	36.93	0.5		
300	36.93	0.5		
360	36.93	0.5		
420	36.93	0.5		
480	36.93	0.5		
600	36.95	0.5		
720	37	0.5		
900	37.09	0.5		
1080	37.11	0.5		
1440	37.2	0.5		

CONSTANT DISCHARGE TEST DATA SHEET – BH4				
General Information				
Project No:	14-503			
Borehole No:	BH4			
Site Name:	Q4 Fuels			
Section:	Section 1			
Latitude:	-25.65069			
Longitude:	27.953783			
Pumping Borehole Information				
Depth of Pump (m):	45.5			
Collar Height (m):	0.2			
BH diameter (m):	180mm			
Depth of BH (m):	48m			
Static water level (m):	35.1			
Test Started				
Date:	10/09/2014			
Time:	16h00			
Test Ended				
Date:	11/09/2014			
Time:	6h00			
Duration (min):	1440			
Time	**Drawdown**	**Yield**	**Time**	**Recovery**
(min)	**s (m)**	**(l/s)**	**(min)**	**s' (m)**
1	36	0.81	1	39.71
2	36.61	0.81	2	39.78
3	37.13	0.81	3	39.07

4	37.26	0.81	4	38.97
5	37.49	0.81	5	38.82
6	37.64	0.81	6	38.75
7	37.77	0.81	7	38.69
8	37.89	0.81	8	38.63
9	37.9	0.81	9	38.6
10	38	0.81	10	38.56
11	38.04	0.81	11	38.54
12	38.14	0.81	12	38.5
13	38.17	0.81	13	38.46
14	38.19	0.81	14	38.4
15	38.2	0.81	15	38.38
16	38.25	0.81	16	38.36
17	38.27	0.81	17	38.34
18	38.32	0.81	18	38.37
19	38.36	0.81	19	38.3
20	38.4	0.81	20	38.29
25	38.57	0.81	25	38.22
30	38.67	0.81	30	38.18
40	38.97	0.81	40	38.08
50	39.11	0.81	50	38
60	39.29	0.81	60	37.95
75	39.42	0.81	75	37.85
90	39.56	0.81	90	37.76
120	39.84	0.81	120	37.65
150	39.96	0.81	150	37.53
180	40.04	0.81	180	37.47
240	40.37	0.81	240	37.27
300	40.52	0.81	300	37.15
360	40.65	0.81		
420	40.75	0.81		
480	40.78	0.81		
600	40.91	0.81		
720	40.92	0.81		
900	40.92	0.81		
1080	40.93	0.81		
1440	40.93	0.81		

APPENDIX D – LABORATORY RESULTS

UIS ORGANIC LABORATORY

UIS Organic Laboratory (Pty) Ltd ● Reg. No. 2007/001896/07
VAT No 4340243221
Unit 3 Carrera House ● 17 Sovereign Drive ● Route 21 Corporate Park
PO Box 9025 ● Centurion ● 0046
Tel. +27 12 3451004 ● Fax. +27 12 3451004
willieh@uisol.co.za ● http://www.uisol.co.za

CLIENT INFORMATION

GCS (Pty) Ltd
Claudia Brites
PO Box 2597
Rivonia

TEST REPORT

TEST INFORMATION **SCREENING FOR VOLATILE PETROLEUM HYDROCARBONS (VPH s)**

ANALYTICAL METHOD: SPME Extraction and GC-MS METHOD Number: UISOL-T-012

DATE RECEIVED 27/10/2014 **DATE COMPLETED** 27/10/2014 **DATE ISSUED** 27/10/2014

SAMPLE INFORMATION **Lab No :** 8709 A **Matrix:** Water

SAMPLE No **QB3 (water)** **Dilution Factor** No Dilution

Project number 14/503 **Project name** 14-503 Q4 Fuels

GASOLINE RANGE ORGANICS (GROs)

MTBE*	<5	µg/liter
TAME*	<5	µg/liter
Benzene	<1	µg/liter
Toluene	<10	µg/liter
Ethyl Benzene	<2	µg/liter
m+p-Xylene	<2	µg/liter
o-Xylene	<2	µg/liter
1,3,5 Trimethyl benzene	<2	µg/liter
1,2,4 Trimethyl benzene	<2	µg/liter
Naphthalene	<2	µg/liter

POLYCYCLIC AROMATIC COMPOUNDS

Acenaphthene *	<1	µg/liter
Acenaphthylene *	<1	µg/liter
Flourene *	<1	µg/liter
Phenanthrene *	<1	µg/liter
Anthracene *	<1	µg/liter
Fluoranthene *	<1	µg/liter
Pyrene *	<1	µg/liter

DIESEL RANGE ORGANICS (DROs)

C10 *	<1	µg/liter
C11 *	<1	µg/liter
C12 *	<1	µg/liter
C13 *	<1	µg/liter
C14 *	<1	µg/liter
C15 *	<1	µg/liter
C16 *	<1	µg/liter
C17 *	<1	µg/liter
C18 *	<1	µg/liter
C19 *	<1	µg/liter
C20 *	<1	µg/liter

DIAGNOSTIC RATIOS

1,3,5TMB : 1,2,4TMB	#Error
(B+T)/(E+X)	#Error

Total VPHs Identified	<10	µg/liter
Estimated VPHs Unidentified	<10	µg/liter
Estimated TOTAL VPHs	<10	µg/liter

Authorised Signatory that approved this report

Reinardt Cromhout

sanas
Testing Laboratory
T0419

DISCLAIMER: The results only relate to the test ite ms provided. This report may not be reproduced, except in full, witho ut the prior written approval of the laboratory.

Parameters marked " * " in this Report are not incl uded in the SANAS Schedule of Accreditation for this laboratory".

Results marked "A" - Concentration outside calibrat ion range, estimate only

27/10/2014

UIS ORGANIC LABORATORY

UIS Organic Laboratory (Pty) Ltd • Reg. No. 2007/001896/07
VAT No 4340243221
Unit 3 Carrera House • 17 Sovereign Drive • Route 21 Corporate Park
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Tel. +27 12 3451004 • Fax. +27 12 3451004
willieh@uisol.co.za • http://www.uisol.co.za

CLIENT INFORMATION

GCS (Pty) Ltd
Claudia Brites
PO Box 2597
Rivonia

TEST REPORT

TEST INFORMATION **SCREENING FOR VOLATILE PETROLEUM HYDROCARBONS (VPH s)**

ANALYTICAL METHOD: SPME Extraction and GC-MS METHOD Number: UISOL-T-012

DATE RECEIVED 27/10/2014 **DATE COMPLETED** 27/10/2014 **DATE ISSUED** 27/10/2014

SAMPLE INFORMATION **Lab No :** 8709 A **Matrix:** Water

SAMPLE No QP1 (water) **Dilution Factor** No Dilution

Project number 14/503 **Project name** 14-503 Q4 Fuels

GASOLINE RANGE ORGANICS (GROs)

MTBE*	<5 µg/liter
TAME*	<5 µg/liter
Benzene	<1 µg/liter
Toluene	<10 µg/liter
Ethyl Benzene	<2 µg/liter
m+p-Xylene	<2 µg/liter
o-Xylene	<2 µg/liter
1,3,5 Trimethyl benzene	<2 µg/liter
1,2,4 Trimethyl benzene	<2 µg/liter
Naphthalene	<2 µg/liter

POLYCYCLIC AROMATIC COMPOUNDS

Acenaphthene *	<1 µg/liter
Acenaphthylene *	<1 µg/liter
Flourene *	<1 µg/liter
Phenanthrene *	<1 µg/liter
Anthracene *	<1 µg/liter
Fluoranthene *	<1 µg/liter
Pyrene *	<1 µg/liter

DIESEL RANGE ORGANICS (DROs)

C10 *	<1 µg/liter
C11 *	<1 µg/liter
C12 *	<1 µg/liter
C13 *	<1 µg/liter
C14 *	<1 µg/liter
C15 *	<1 µg/liter
C16 *	<1 µg/liter
C17 *	<1 µg/liter
C18 *	<1 µg/liter
C19 *	<1 µg/liter
C20 *	<1 µg/liter

DIAGNOSTIC RATIOS

1,3,5TMB : 1,2,4TMB	#Error
(B+T)/(E+X)	#Error

Total VPHs Identified	<10 µg/liter
Estimated VPHs Unidentified	<10 µg/liter
Estimated TOTAL VPHs	<10 µg/liter

Authorised Signatory that approved this report

Reinardt Cromhout

sanas Testing Laboratory T0419

DISCLAIMER: The results only relate to the test ite ms provided. This report may not be reproduced, except in full, witho ut the prior written approval of the laboratory.

Parameters marked " * " in this Report are not incl uded in the SANAS Schedule of Accreditation for this laboratory".

Results marked "A" - Concentration outside calibrat ion range, estimate only

27/10/2014

Client Information

Company :	GCS (Pty) Ltd
Attention:	Claudia Brites
Tel:	(011) 803 5726
Fax:	
Address	63 Wessel Road
	Woodmead, Rivonia
	2128

Analysis Report

Lab No: 3842

SAMPLE INFORMATION

PROJECT NAME	Q4 Fuels	DATE RECEIVED	27/10/2014
PROJECT NUMBER	14-503	DATE COMPLETED	27/10/2014
PURCHASE ORDER	N/A	DATE ISSUED	27/10/2014

Sample ID	Hardness mg equivalent CaCO3/l	Bicarbonate [HCO3-] mg/l	Electrical Conductivity uS/cm
QP1	324.33	414.8	686
QB3	323.18	430.66	672

Authorized Signatory

WJ. HAVENGA

DISCLAIMER: The results only relate to the test items provided.

U.T.D. - Unable To Determine

CLIENT INFORMATION

GCS (Pty) Ltd
Attention: Claudia Brites
63 Wessel Road Woodmead
Rivonia

Water Test Report

LABORATORY NUMBER 3842 A **DATE RECEIVED** 2014/10/27

SAMPLE NUMBER QB3

REPORTING UNIT mg/l [ppm] **(unless elsely stated)**

TASK PO Nr 14-503 **TASK STARTING DATE** 2014/10/27

Cations and Metals

(Method UISSL-WL-007) [NA]

Ag	<0.05	**Cd**	<0.05	**Mn**	0.17	**Si**	26.02
Al	0.15	**Co**	<0.05	**Mo**	<0.05	**Sn**	<0.05
As	<1	**Cr**	<0.05	**Na**	19.9	**Sr**	<0.05
B	<0.05	**Cu**	<0.05	**Ni**	<0.05	**Tl**	<1
Ba	<0.05	**Fe**	0.09	**P**	<0.05	**Ti**	<1
Be	<0.05	**K**	0.8	**Pb**	<1	**V**	<0.05
Bi	<0.05	**Li**	<0.05	**Sb**	<1	**Zn**	<0.05
Ca	39.4	**Mg**	54.8	**Se**	<1		

Anions

(Method UISSL-WL-005) [A]

F	<0.4	**[NA]**
Cl	12.9	
Br	<0.25	**[NA]**
NO2	<2	**[NA]**
NO3	14.2	
NO2 + NO3 as N =	3.2	
SO4	20.4	
PO4	<4	

Other Parameters

TDS	(Method UISSL-WL-004 @ 110 deg C) [A]	399
P-Alk as CaCO3	(Method UISSL-WL-002) [A]	<0.6
M-Alk as CaCO3	(Method UISSL-WL-002) [A]	353
pH	(Method UISSL-WL-003 @ 25 deg C) [A]	7.07
Total Cation meq/l		7.39
Total Anion meq/l		7.60
Cation - Anion Difference in meq/l		-0.21
% Difference		-1.39

Results approved by *WJ Havenga (Approved Signatory)*

NOTE: [NA] = Indicate that the test is not accredited

Reporting date: ***27 October 2014***

Testing Laboratory
Facility No T 0584

CLIENT INFORMATION

GCS (Pty) Ltd
Attention: Claudia Brites
63 Wessel Road Woodmead
Rivonia

Water Test Report

LABORATORY NUMBER 3842 A **DATE RECEIVED** 2014/10/27

SAMPLE NUMBER QP1

REPORTING UNIT mg/l [ppm] **(unless elsely stated)**

TASK PO Nr 14-503 **TASK STARTING DATE** 2014/10/27

Cations and Metals

(Method UISSL-WL-007) [NA]

Ag	<0.05	**Cd**	<0.05	**Mn**	<0.05	**Si**	20.09
Al	<0.05	**Co**	<0.05	**Mo**	<0.05	**Sn**	<0.05
As	<1	**Cr**	<0.05	**Na**	10.8	**Sr**	<0.05
B	<0.05	**Cu**	<0.05	**Ni**	<0.05	**Tl**	<1
Ba	<0.05	**Fe**	0.30	**P**	<0.05	**Ti**	<1
Be	<0.05	**K**	1.6	**Pb**	<1	**V**	<0.05
Bi	<0.05	**Li**	<0.05	**Sb**	<1	**Zn**	<0.05
Ca	45.6	**Mg**	51.3	**Se**	<1		

Anions

(Method UISSL-WL-005) [A]

F	<0.4	**[NA]**
Cl	31.4	
Br	<0.25	**[NA]**
NO2	<2	**[NA]**
NO3	<2	

NO2 + NO3 as N = 0.0

SO4	5.4
PO4	<4

Other Parameters

TDS	(Method UISSL-WL-004 @ 110 deg C) [A]	452
P-Alk as CaCO3	(Method UISSL-WL-002) [A]	<0.6
M-Alk as CaCO3	(Method UISSL-WL-002) [A]	340
pH	(Method UISSL-WL-003 @ 25 deg C) [A]	7.47
Total Cation meq/l		7.02
Total Anion meq/l		7.20
Cation - Anion Difference in meq/l		-0.18
% Difference		-1.30

Results approved by *WJ Havenga (Approved Signatory)*

NOTE: [NA] = Indicate that the test is not accredited

Reporting date: *27 October 2014*

Facility No T 0584

UIS ORGANIC LABORATORY

UIS Organic Laboratory (Pty) Ltd • Reg. No. 2007/001896/07
VAT No 4340243221
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willieh@uisol.co.za • http://www.uisol.co.za

CLIENT INFORMATION

GCS (Pty) Ltd
Claudia Brites
PO Box 2597
Rivonia

TEST REPORT

TEST INFORMATION **SCREENING FOR VOLATILE PETROLEUM HYDROCARBONS (VPH s)**

ANALYTICAL METHOD: SPME Extraction and GC-MS METHOD Number: UISOL-T-012

DATE RECEIVED 18/09/2014 **DATE COMPLETED** 22/09/2014 **DATE ISSUED** 22/09/2014

SAMPLE INFORMATION **Lab No :** 8513 A **Matrix:** Water

SAMPLE No **BH3 (water)** **Dilution Factor** No Dilution

Project number 14-503 **Project name** Q4 Fuels

GASOLINE RANGE ORGANICS (GROs)

MTBE*	<5	µg/liter
TAME*	<5	µg/liter
Benzene	<1	µg/liter
Toluene	<10	µg/liter
Ethyl Benzene	<2	µg/liter
m+p-Xylene	<2	µg/liter
o-Xylene	<2	µg/liter
1,3,5 Trimethyl benzene	<2	µg/liter
1,2,4 Trimethyl benzene	<2	µg/liter
Naphthalene	<2	µg/liter

POLYCYCLIC AROMATIC COMPOUNDS

Acenaphthene *	<1	µg/liter
Acenaphthylene *	<1	µg/liter
Flourene *	<1	µg/liter
Phenanthrene *	<1	µg/liter
Anthracene *	<1	µg/liter
Fluoranthene *	<1	µg/liter
Pyrene *	<1	µg/liter

DIESEL RANGE ORGANICS (DROs)

C10 *	<1	µg/liter
C11 *	<1	µg/liter
C12 *	<1	µg/liter
C13 *	<1	µg/liter
C14 *	<1	µg/liter
C15 *	<1	µg/liter
C16 *	<1	µg/liter
C17 *	<1	µg/liter
C18 *	<1	µg/liter
C19 *	<1	µg/liter
C20 *	<1	µg/liter

DIAGNOSTIC RATIOS

1,3,5TMB : 1,2,4TMB	#Error
(B+T)/(E+X)	#Error

Total VPHs Identified	<10	µg/liter
Estimated VPHs Unidentified	<10	µg/liter
Estimated TOTAL VPHs	<10	µg/liter

Authorised Signatory that approved this report

Reinardt Cromhout

sanas
Testing Laboratory
T0419

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Results marked "A" - Concentration outside calibrat ion range, estimate only

22/09/2014

UIS ORGANIC LABORATORY

UIS Organic Laboratory (Pty) Ltd ● Reg. No. 2007/001896/07
VAT No 4340243221
Unit 3 Carrera House ● 17 Sovereign Drive ● Route 21 Corporate Park
PO Box 9025 ● Centurion ● 0046
Tel. +27 12 3451004 ● Fax. +27 12 3451004
willieh@uisol.co.za ● http://www.uisol.co.za

CLIENT INFORMATION

GCS (Pty) Ltd
Claudia Brites
PO Box 2597
Rivonia

TEST REPORT

TEST INFORMATION **SCREENING FOR VOLATILE PETROLEUM HYDROCARBONS (VPH s)**

ANALYTICAL METHOD: SPME Extraction and GC-MS METHOD Number: UISOL-T-012

DATE RECEIVED 18/09/2014 **DATE COMPLETED** 22/09/2014 **DATE ISSUED** 22/09/2014

SAMPLE INFORMATION **Lab No :** 8513 A **Matrix:** Water

SAMPLE No **BH4 (water)** **Dilution Factor** No Dilution

Project number 14-503 **Project name** Q4 Fuels

GASOLINE RANGE ORGANICS (GROs)

MTBE*	<5	µg/liter
TAME*	<5	µg/liter
Benzene	<1	µg/liter
Toluene	<10	µg/liter
Ethyl Benzene	<2	µg/liter
m+p-Xylene	<2	µg/liter
o-Xylene	<2	µg/liter
1,3,5 Trimethyl benzene	<2	µg/liter
1,2,4 Trimethyl benzene	<2	µg/liter
Naphthalene	<2	µg/liter

POLYCYCLIC AROMATIC COMPOUNDS

Acenaphthene *	<1	µg/liter
Acenaphthylene *	<1	µg/liter
Flourene *	<1	µg/liter
Phenanthrene *	<1	µg/liter
Anthracene *	<1	µg/liter
Fluoranthene *	<1	µg/liter
Pyrene *	<1	µg/liter

DIESEL RANGE ORGANICS (DROs)

C10 *	<1	µg/liter
C11 *	<1	µg/liter
C12 *	<1	µg/liter
C13 *	<1	µg/liter
C14 *	<1	µg/liter
C15 *	<1	µg/liter
C16 *	<1	µg/liter
C17 *	<1	µg/liter
C18 *	<1	µg/liter
C19 *	<1	µg/liter
C20 *	<1	µg/liter

DIAGNOSTIC RATIOS

1,3,5TMB : 1,2,4TMB	#Error
(B+T)/(E+X)	#Error

Total VPHs Identified	<10	µg/liter
Estimated VPHs Unidentified	<10	µg/liter
Estimated TOTAL VPHs	<10	µg/liter

Authorised Signatory that approved this report

Reinardt Cromhout

sanas
Testing Laboratory
T0419

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CLIENT INFORMATION

GCS (Pty) Ltd
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PO Box 2597
Rivonia

TEST REPORT

TEST INFORMATION **SCREENING FOR VOLATILE PETROLEUM HYDROCARBONS (VPH s)**

ANALYTICAL METHOD: SPME Extraction and GC-MS METHOD Number: UISOL-T-012

DATE RECEIVED 18/09/2014 **DATE COMPLETED** 22/09/2014 **DATE ISSUED** 22/09/2014

SAMPLE INFORMATION **Lab No :** 8513 A **Matrix:** Water

SAMPLE No **QP2 (water)** **Dilution Factor** No Dilution

Project number 14-503 **Project name** Q4 Fuels

GASOLINE RANGE ORGANICS (GROs)

MTBE*	<5	µg/liter
TAME*	<5	µg/liter
Benzene	<1	µg/liter
Toluene	<10	µg/liter
Ethyl Benzene	<2	µg/liter
m+p-Xylene	<2	µg/liter
o-Xylene	<2	µg/liter
1,3,5 Trimethyl benzene	<2	µg/liter
1,2,4 Trimethyl benzene	<2	µg/liter
Naphthalene	<2	µg/liter

POLYCYCLIC AROMATIC COMPOUNDS

Acenaphthene *	<1	µg/liter
Acenaphthylene *	<1	µg/liter
Flourene *	<1	µg/liter
Phenanthrene *	<1	µg/liter
Anthracene *	<1	µg/liter
Fluoranthene *	<1	µg/liter
Pyrene *	<1	µg/liter

DIESEL RANGE ORGANICS (DROs)

C10 *	<1	µg/liter
C11 *	<1	µg/liter
C12 *	<1	µg/liter
C13 *	<1	µg/liter
C14 *	<1	µg/liter
C15 *	<1	µg/liter
C16 *	<1	µg/liter
C17 *	<1	µg/liter
C18 *	<1	µg/liter
C19 *	<1	µg/liter
C20 *	<1	µg/liter

DIAGNOSTIC RATIOS

1,3,5TMB : 1,2,4TMB	#Error
(B+T)/(E+X)	#Error

Total VPHs Identified	<10	µg/liter
Estimated VPHs Unidentified	<10	µg/liter
Estimated TOTAL VPHs	<10	µg/liter

Authorised Signatory that approved this report

Reinardt Cromhout

sanas Testing Laboratory T0419

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22/09/2014

Results marked "A" - Concentration outside calibrat ion range, estimate only

Client Information

Company :	GCS (Pty) Ltd
Attention:	Claudia Brites
Tel:	(011) 803 5726
Fax:	
Address	63 Wessel Road
	Woodmead, Rivonia
	2128

Analysis Report

Lab No: 3836

SAMPLE INFORMATION

PROJECT NAME	Q4 Fuels	DATE RECEIVED	18/09/2014
PROJECT NUMBER	14-503	DATE COMPLETED	22/09/2014
PURCHASE ORDER	N/A	DATE ISSUED	22/09/2014

Sample ID	Hardness mg equivalent CaCO3/l	Bicarbonate [HCO3-] mg/l
BH 3	269.14	333.06
BH 4	256.43	290.36
QP 2	341.59	445.3

Authorized Signatory

WJ. HAVENGA

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U.T.D. - Unable To Determine

Water Test Report

CLIENT INFORMATION

GCS (Pty) Ltd
Attention: Claudia Brites
63 Wessel Road Woodmead
Rivonia

LABORATORY NUMBER	3836 A	**DATE RECEIVED**	2014/09/18
SAMPLE NUMBER	BH 4		
REPORTING UNIT	mg/l [ppm] **(unless elsely stated)**		
TASK PO Nr	14-503	**TASK STARTING DATE**	2014/09/18

Cations and Metals

(Method UISSL-WL-007) [NA]

Ag	<0.05	**Cd**	<0.05	**Mn**	<0.05	**Si**	23.08
Al	<0.05	**Co**	<0.05	**Mo**	<0.05	**Sn**	<0.05
As	<1	**Cr**	<0.05	**Na**	10.8	**Sr**	<0.05
B	<0.05	**Cu**	<0.05	**Ni**	<0.05	**Tl**	<1
Ba	<0.05	**Fe**	<0.05	**P**	<0.05	**Ti**	<1
Be	<0.05	**K**	0.2	**Pb**	<1	**V**	<0.05
Bi	<0.05	**Li**	<0.05	**Sb**	<1	**Zn**	<0.05
Ca	40.9	**Mg**	37.5	**Se**	<1		

Anions

(Method UISSL-WL-005) [A]

F	<0.4
Cl	12.4
Br	<0.25
NO2	<2
NO3	38.4
NO2 + NO3 as N =	8.7
SO4	4.4
PO4	<4

Other Parameters

TDS	(Method UISSL-WL-004 @ 110 deg C) [A]	366
P-Alk as CaCO3	(Method UISSL-WL-002) [A]	<0.6
M-Alk as CaCO3	(Method UISSL-WL-002) [A]	238
pH	(Method UISSL-WL-003 @ 25 deg C) [A]	7.10
Total Cation meq/l		5.60
Total Anion meq/l		5.64
Cation - Anion Difference in meq/l		-0.04
% Difference		-0.38

Results approved by *WJ Havenga (Technical Manager)*

NOTE: [A]= accredited and [NA] = Not accredited

Reporting date: *22 September 2014*

Facility No T 0584

CLIENT INFORMATION

GCS (Pty) Ltd
Attention: Claudia Brites
63 Wessel Road Woodmead
Rivonia

Water Test Report

LABORATORY NUMBER 3836 A **DATE RECEIVED** 2014/09/18

SAMPLE NUMBER BH 3

REPORTING UNIT mg/l [ppm] **(unless elsely stated)**

TASK PO Nr 14-503 **TASK STARTING DATE** 2014/09/18

Cations and Metals

(Method UISSL-WL-007) [NA]

Ag	<0.05	**Cd**	<0.05	**Mn**	<0.05	**Si**	27.83
Al	<0.05	**Co**	<0.05	**Mo**	<0.05	**Sn**	<0.05
As	<1	**Cr**	<0.05	**Na**	11.2	**Sr**	0.09
B	<0.05	**Cu**	<0.05	**Ni**	<0.05	**Tl**	<1
Ba	<0.05	**Fe**	<0.05	**P**	<0.05	**Ti**	<1
Be	<0.05	**K**	0.4	**Pb**	<1	**V**	<0.05
Bi	<0.05	**Li**	<0.05	**Sb**	<1	**Zn**	<0.05
Ca	38.0	**Mg**	42.8	**Se**	<1		

Anions

(Method UISSL-WL-005) [A]

F	<0.4
Cl	8.5
Br	<0.25
NO2	<2
NO3	25.4
NO2 + NO3 as N =	5.7
SO4	4.0
PO4	<4

Other Parameters

TDS	(Method UISSL-WL-004 @ 110 deg C) [A]	396
P-Alk as CaCO3	(Method UISSL-WL-002) [A]	<0.6
M-Alk as CaCO3	(Method UISSL-WL-002) [A]	275
pH	(Method UISSL-WL-003 @ 25 deg C) [A]	7.44
Total Cation meq/l		5.92
Total Anion meq/l		6.06
Cation - Anion Difference in meq/l		-0.14
% Difference		-1.19

Results approved by *WJ Havenga (Technical Manager)*

NOTE: [A]= accredited and [NA] = Not accredited

Reporting date: *22 September 2014*

Testing Laboratory
Facility No T 0584

CLIENT INFORMATION

GCS (Pty) Ltd
Attention: Claudia Brites
63 Wessel Road Woodmead
Rivonia

Water Test Report

LABORATORY NUMBER 3836 A **DATE RECEIVED** 2014/09/18

SAMPLE NUMBER QP 2

REPORTING UNIT mg/l [ppm] **(unless elsely stated)**

TASK PO Nr 14-503 **TASK STARTING DATE** 2014/09/18

Cations and Metals

(Method UISSL-WL-007) [NA]

Ag	<0.05	**Cd**	<0.05	**Mn**	<0.05	**Si**	30.40
Al	<0.05	**Co**	<0.05	**Mo**	<0.05	**Sn**	<0.05
As	<1	**Cr**	<0.05	**Na**	10.6	**Sr**	0.11
B	<0.05	**Cu**	<0.05	**Ni**	<0.05	**Tl**	<1
Ba	<0.05	**Fe**	<0.05	**P**	<0.05	**Ti**	<1
Be	<0.05	**K**	<0.05	**Pb**	<1	**V**	<0.05
Bi	<0.05	**Li**	<0.05	**Sb**	<1	**Zn**	<0.05
Ca	45.0	**Mg**	55.7	**Se**	<1		

Anions

(Method UISSL-WL-005) [A]

F	<0.4
Cl	6.1
Br	<0.25
NO2	<2
NO3	12.7
NO2 + NO3 as N =	2.9
SO4	<4
PO4	<4

Other Parameters

TDS	(Method UISSL-WL-004 @ 110 deg C) [A]	438
P-Alk as CaCO3	(Method UISSL-WL-002) [A]	<0.6
M-Alk as CaCO3	(Method UISSL-WL-002) [A]	365
pH	(Method UISSL-WL-003 @ 25 deg C) [A]	7.02
Total Cation meq/l		7.29
Total Anion meq/l		7.27
Cation - Anion Difference in meq/l		0.02
% Difference		0.12

Results approved by *WJ Havenga (Technical Manager)*

NOTE: [A]= accredited and [NA] = Not accredited

Reporting date: *22 September 2014*

sanas Testing Laboratory
Facility No T 0584

Wetland Delineation

Annexure F3

REPORT

WETLAND / WATER COURSE IDENTIFICATION AND MANAGEMENT REPORT:

PORTION 22 OF THE FARM SCHIETFONTEIN 437-JQ IN THE NORTH-WEST PROVINCE

12th May, 2014

Compiled by:
J.H. van der Waals
(PhD Soil Science, Pr.Sci.Nat)
Member of:
Soil Science Society of South Africa (SSSSA)

Accredited member of:
South African Soil Surveyors Organisation (SASSO)

Registered with:
The South African Council for Natural Scientific Professions
Registration number: 400106/08

Declaration

I, Johan Hilgard van der Waals, declare that I –

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

J.H. VAN DER WAALS
TERRA SOIL SCIENCE

TABLE OF CONTENTS

WETLAND / WATER COURSE IDENTIFICATION AND MANAGEMENT REPORT: PORTION 22 OF THE FARM SCHIETFONTEIN 437-JQ IN THE NORTH-WEST PROVINCE

1. INTRODUCTION

1.1 TERMS OF REFERENCE

Terra Soil Science was appointed by **Q4 Chemicals** to determine the presence and status of wetlands on Portion 22 of the Farm Schietfontein 437-JQ in the North-West Province.

1.2 PROBLEM STATEMENT

At present it is not clear whether a wetland occurs on the investigation site.

1.3 AIM OF THIS REPORT

The aim of this report is to provide a perspective on the requirements for the identification of a wetland as well as to address the presence and status of a wetland / water course on the site. In addition, this report aims to provide a hydropedological perspective on the site and broader area to aid in the identification and management of water impacts through the elucidation of broad surface hydrology and hydropedology principles.

1.4 METHODOLOGY

1.4.1 Brief Background

The identification and delineation of wetlands rest on several parameters that include topographic, vegetation and soil indicators. Apart from the inherent flaws in the wetland delineation process, as discussed later in this report, the concept of wetland delineation implies an emphasis on the wetlands themselves and very little consideration of the processes driving the functioning and presence of the wetlands. One discipline that encompasses a number of tools to elucidate landscape hydrological processes is “hydropedology” (Lin, 2012). The crux of the understanding of hydropedology lies in the fact that pedology is the description and classification of soil on the basis of morphology that is the result of soil and landscape hydrological, physical and chemical processes. But, the soils of which the morphology are described, also take part in and intimately influence the hydrology of the landscape. Soil is therefore both an indicator as well as a participator in the processes that require elucidation.

Wetlands are merely those areas in a landscape where the morphological indicators point to prolonged or intensive saturation near the surface to influence the distribution of wetland vegetation. Wetlands therefore form part of a larger hydrological entity that they cannot be separated from.

1.4.2 Proposed Methodology

In order to provide detailed pedohydrological information both detailed soil surveys and hydrological investigations are needed. In practice these intensive surveys are expensive and very seldom conducted. However, with the understanding of soil morphology, pedology and basic soil physics parameters as well as the collection and interpretation of existing soil survey information, assessments at different levels of detail and confidence can be conducted. In this sense four levels of investigation are proposed namely:

1. Level 1 Assessment: This level includes the collection and generation of all applicable remote sensing, topographic and land type parameters to provide a “desktop” product. This level of investigation rests on adequate experience in conducting such information collection and interpretation exercises and will provide a broad overview of dominant hydropedological parameters of a site. Within this context the presence, distribution and functioning of wetlands will be better understood than without such information.
2. Level 2 Assessment: This level of assessment will make use of the data generated during the Level 1 assessment and will include a reconnaissance soil and site survey to verify the information as well as elucidate many of the unknowns identified during the Level 1 assessment.
3. Level 3 Assessment: This level of assessment will build on the Level 1 and 2 assessments and will consist of a detailed soil survey with sampling and analysis of representative soils. The parameters to be analysed include soil physical, chemical and mineralogical parameters that elucidate and confirm the morphological parameters identified during the field survey.
4. Level 4 Assessment: This level of assessment will make use of the data generated during the previous three levels and will include the installation of adequate monitoring equipment and measurement of soil and landscape hydrological parameters for an adequate time period. The data generated can be used for the building of detailed hydrological models (in conjunction with groundwater and surface hydrologists) for the detailed water management on specific sites.

For most wetland delineation exercises a Level 2 or Level 3 assessment should be adequate.

1.4.3 Methodology Employed in this Investigation

The report was generated through:

1. The collection and presentation of baseline land type and topographic data for the site;
2. The thorough consideration of the statutory context of wetlands and the process of wetland delineation;
3. The identification of water related landscape parameters (conceptual and real) for the site for the generation of Level 1 hydropedology information;
4. Aerial photograph interpretation of the site to aid in the Level 1 hydropedology assessment;

5. Assessment of historical impacts and changes on the site through the accessing of various historical aerial photographs and topographic maps;
6. Reconnaissance soil and site survey in terms of soil properties as well as drainage feature properties to generate a Level 2 hydrology assessment; and
7. Presentation of the findings of the various components of the investigation.

2. SITE LOCALITY AND DESCRIPTION

2.1 SURVEY AREA BOUNDARY

The site lies between 25° 38' 39'' and 25° 39' 02'' south and 27° 56' 03'' and 27° 56' 56'' east 15 km west of the town of Brits in the North-West Province (**Figure 1**).

2.2 GENERALISED GEOLOGY

The area surrounding and including the site consists predominantly of basic igneous geology (ferrogabbro, ferrodiorite, diorite, gabbro, norite and anorthosite) with limited and enclosed quartzite, hornfels and shale. The implications of the specific geology on the identification of wetlands and hydromorphy in soils will be discussed later in the report.

2.3 LAND TYPE DATA

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (Soil Classification Working Group, 1991).

The Schietfontein site is situated in the **Ae21** land type (Land Type Survey Staff, 1972 - 2006) with **Figure 2** providing the land type distribution for the area. Below follows a brief description of the land type in terms of soils as well as expected hydromorphic indicators.

<u>Land Type Ae21</u>
<u>Land Type – General</u>: Ae dominantly red high base status (mesotrophic and lime containing) apedal soils, without dunes, that are deeper than 300 mm.
<u>Soils</u>: Soils are predominantly deep and high clay content red apedal and red structured soils from crests to footslope positions with structured swelling soils dominating in valley bottom and drainage depression positions. Due to the geology and local variation structured swelling soils can occur in any level terrain area even if this is in higher lying parts of the landscape.
<u>Indicators of Hydromorphy</u>: Due to the specific geology and other soil forming factors and processes soils in basic igneous geology environments express no signs of wetness in the form of mottles. The

only reliable indicator of saturation in the soils is grey low chroma matrix colours, which occur in drainage depressions only. The specific challenges regarding these landscapes are discussed in more detail later in the report

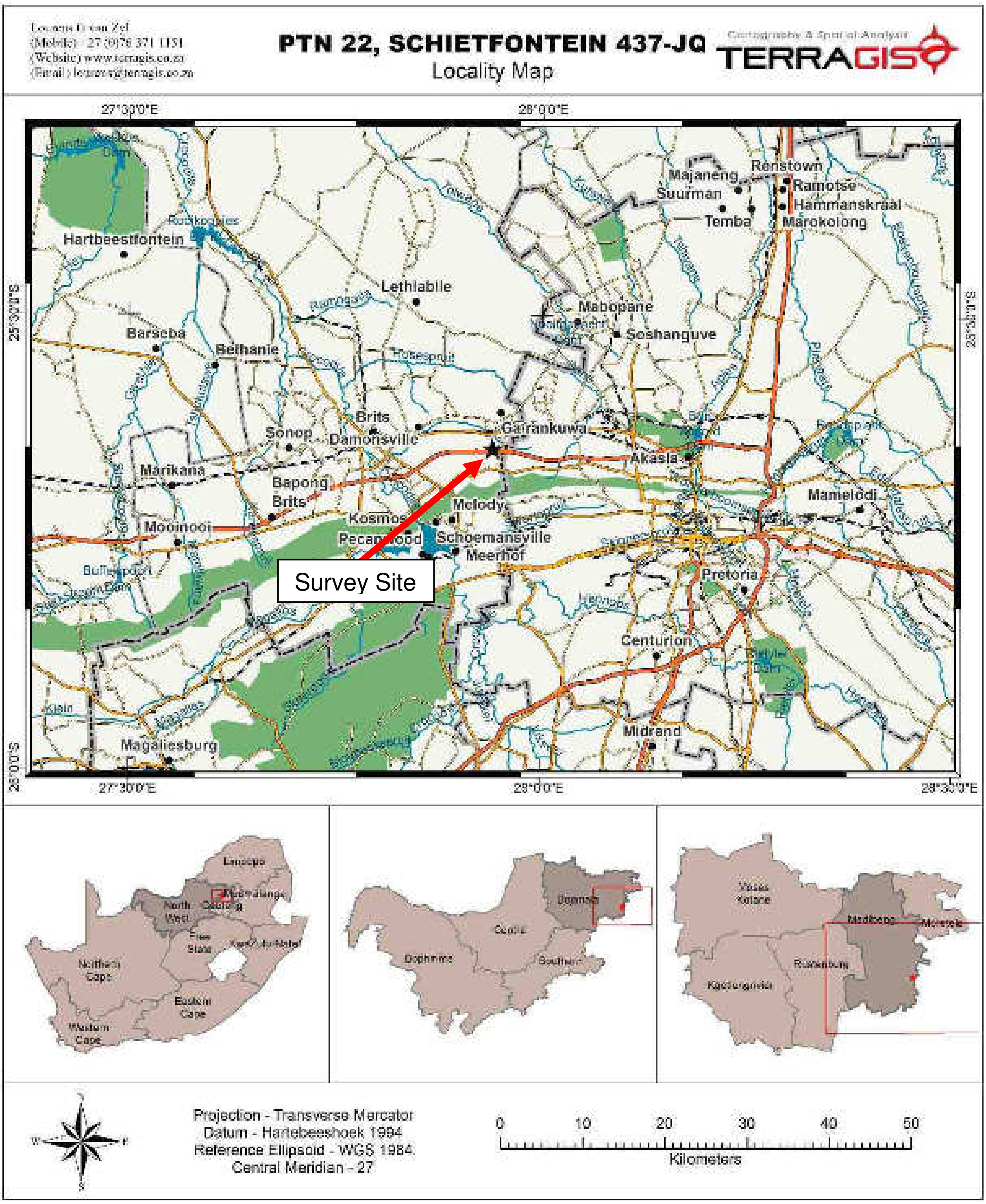

Figure 1 Locality of the survey site

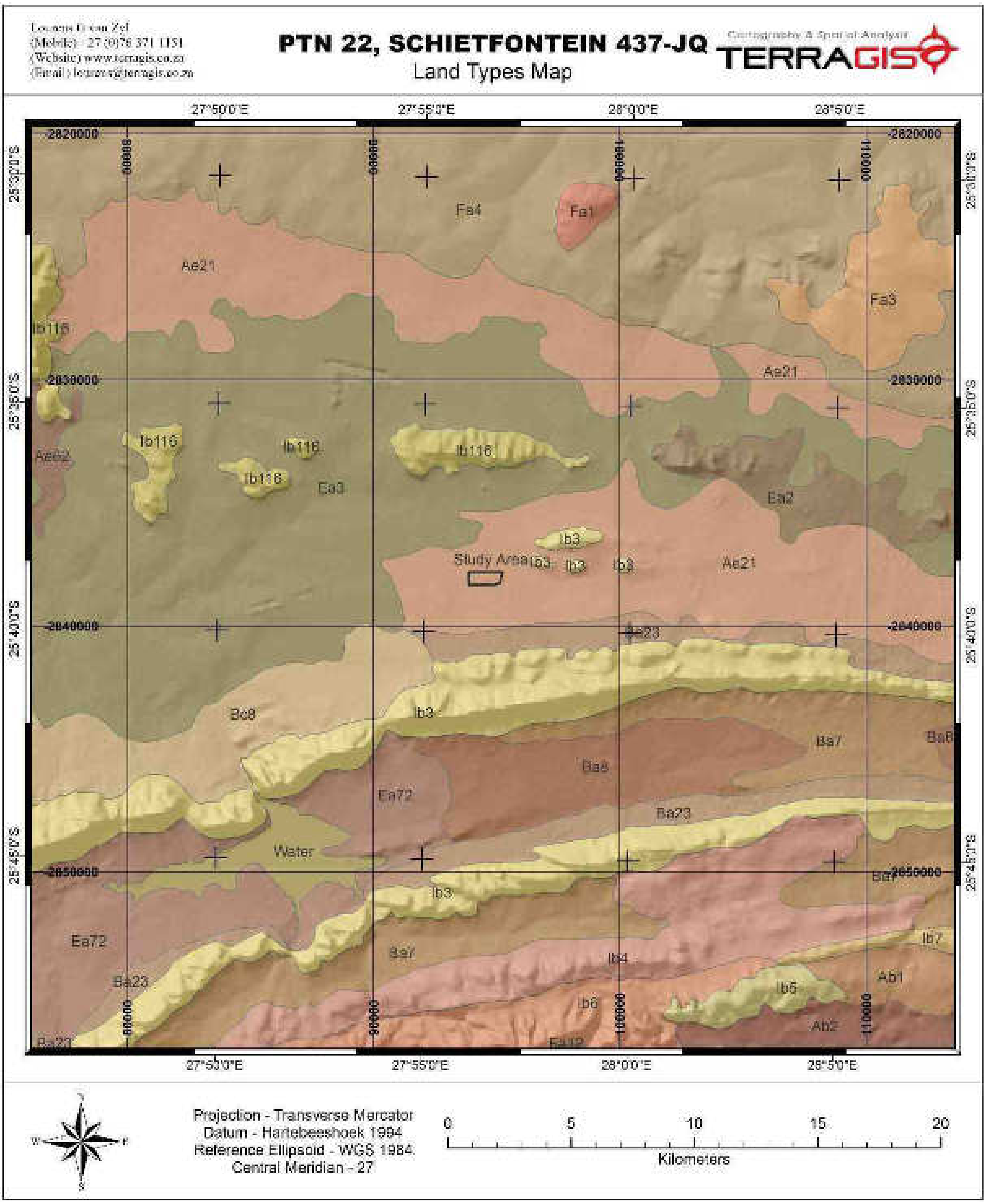

Figure 2 Land type map of the survey site

2.4 TOPOGRAPHY

The topography of the site is flat with a very slight slope towards the north-west (**Figure 3**).

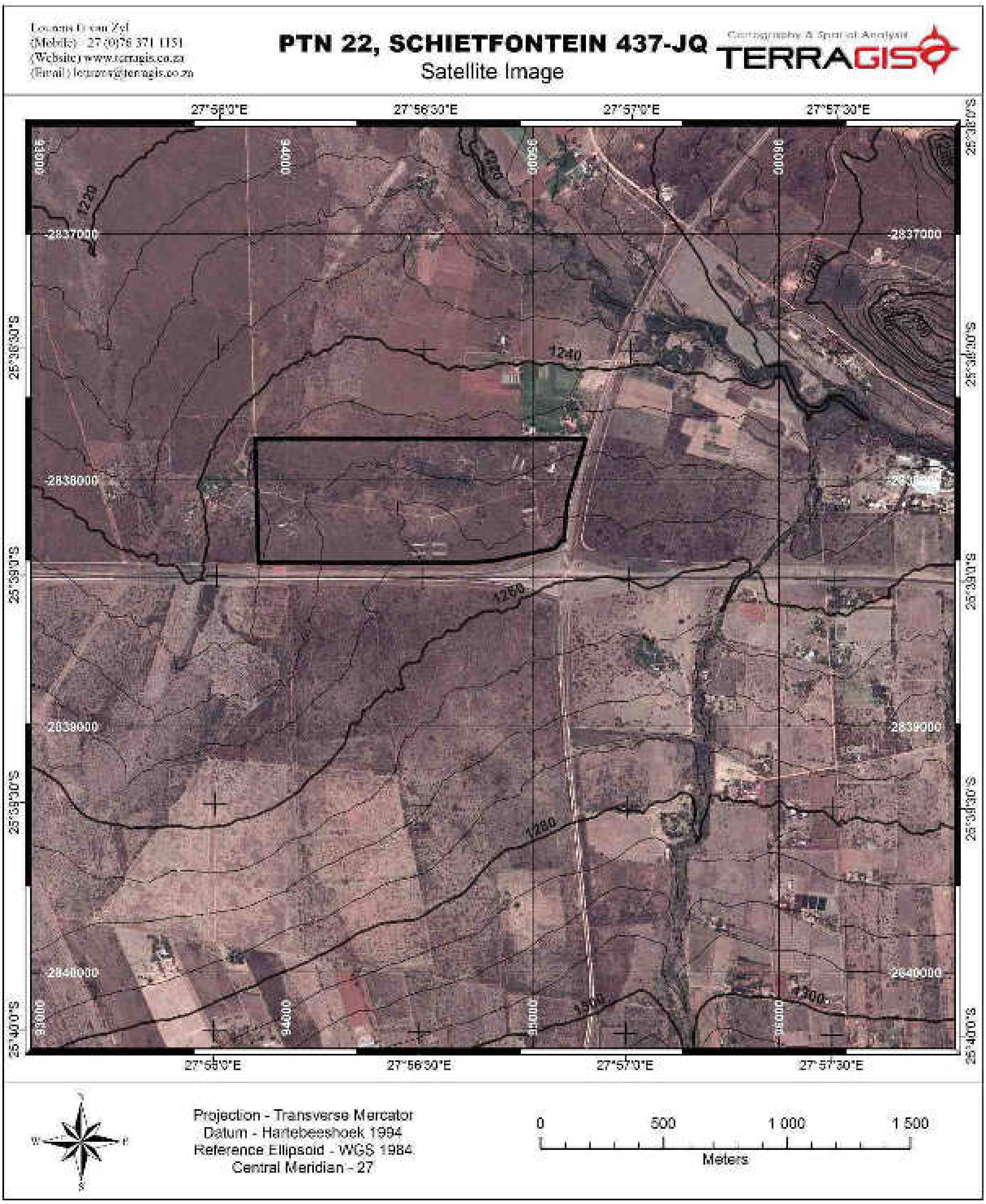

Figure 3 Contours of the general area superimposed on a satellite image

From the contour data a digital elevation model (DEM) was generated for the area and site (**Figure 4**).

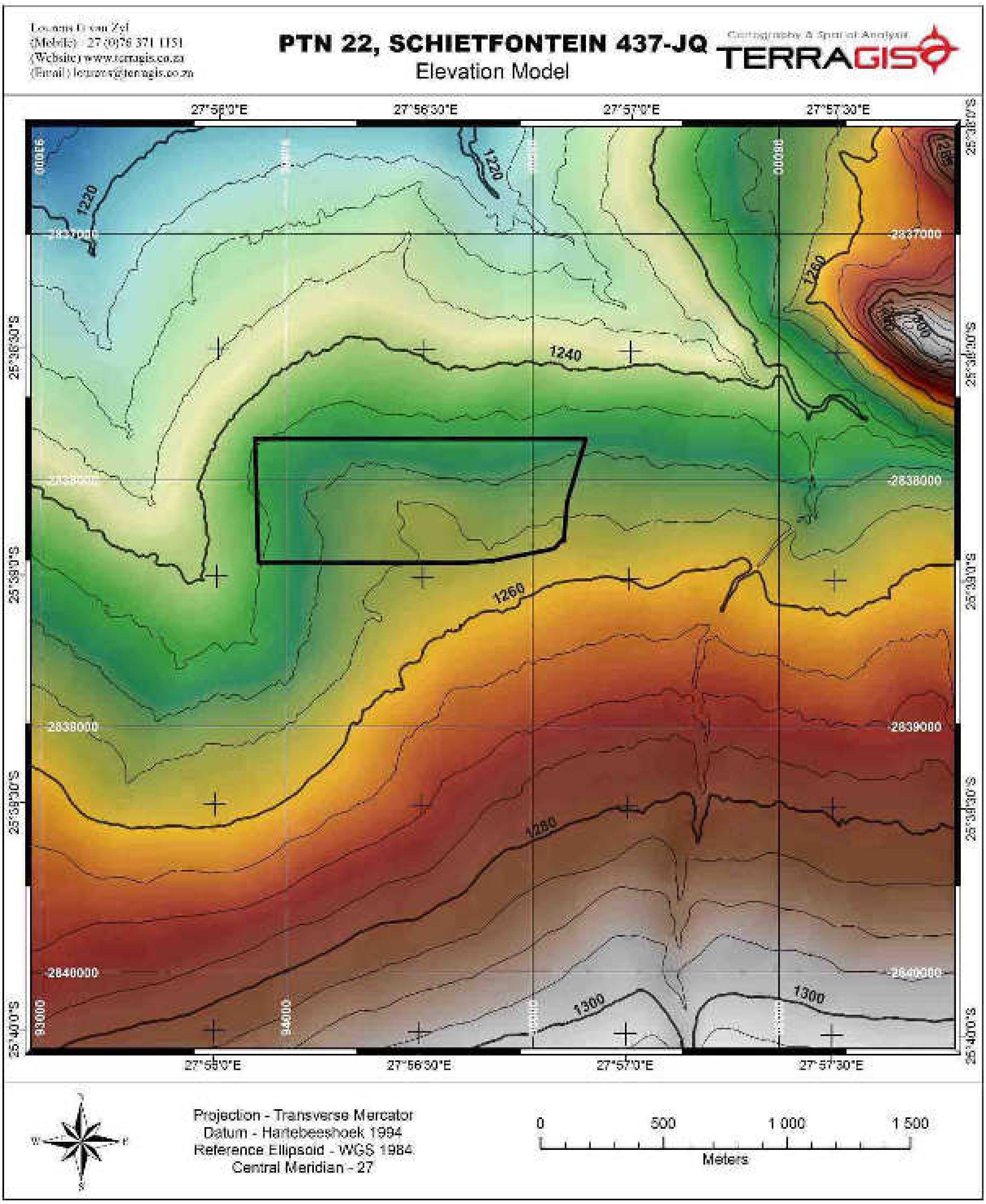

Figure 4 DEM of the survey site and surrounding area

From the contour data a slope map was generated (**Figure 5**) and from this data in turn a topographic wetness index (TWI) was calculated for the site and general area (**Figure 6**). The TWI provides a very accurate indication of water flow paths and areas of water accumulation, which is a function of the topography of the site. On the specific site no distinct drainage depressions were identified.

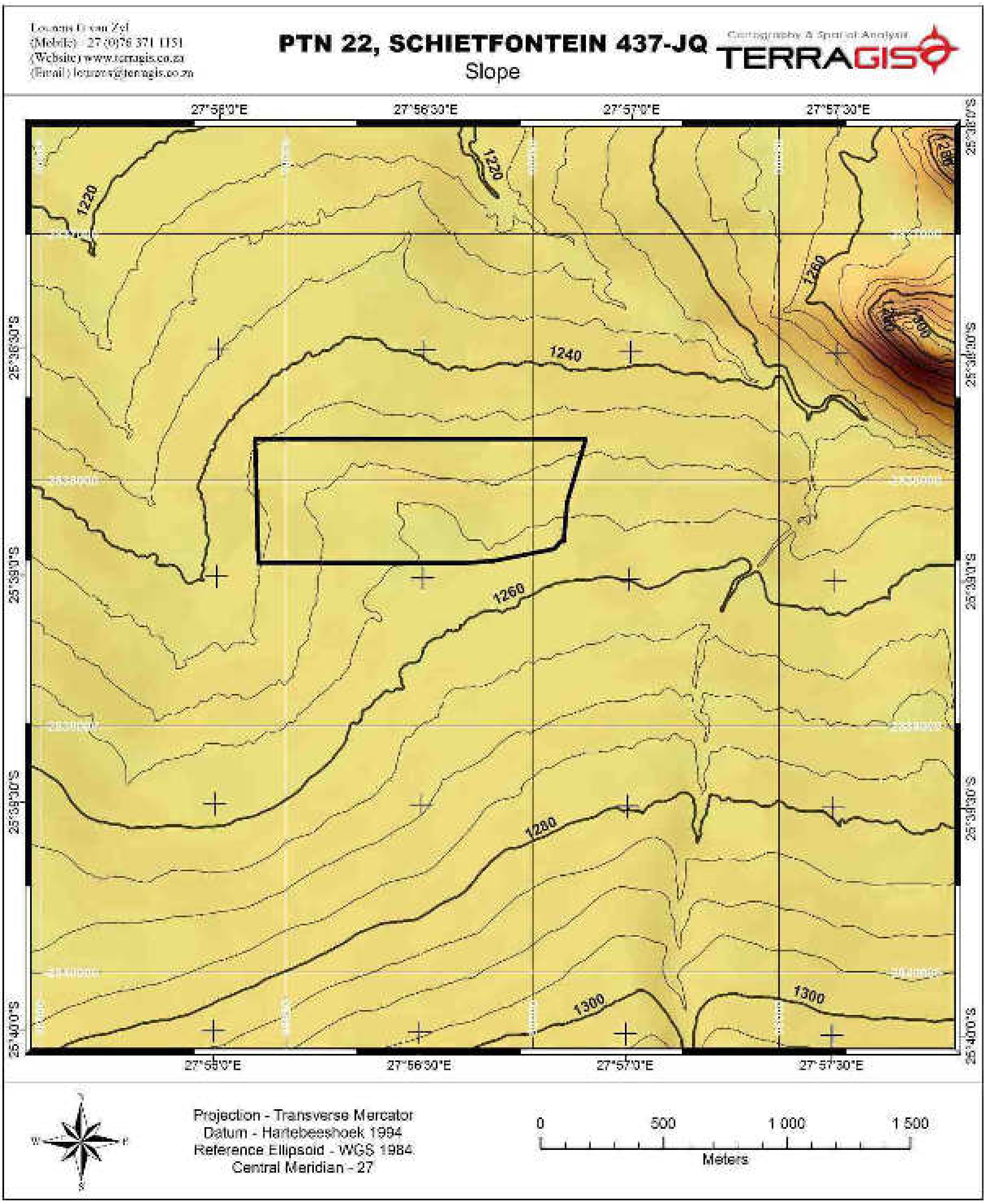

Figure 5 Slope map of the survey site and general area

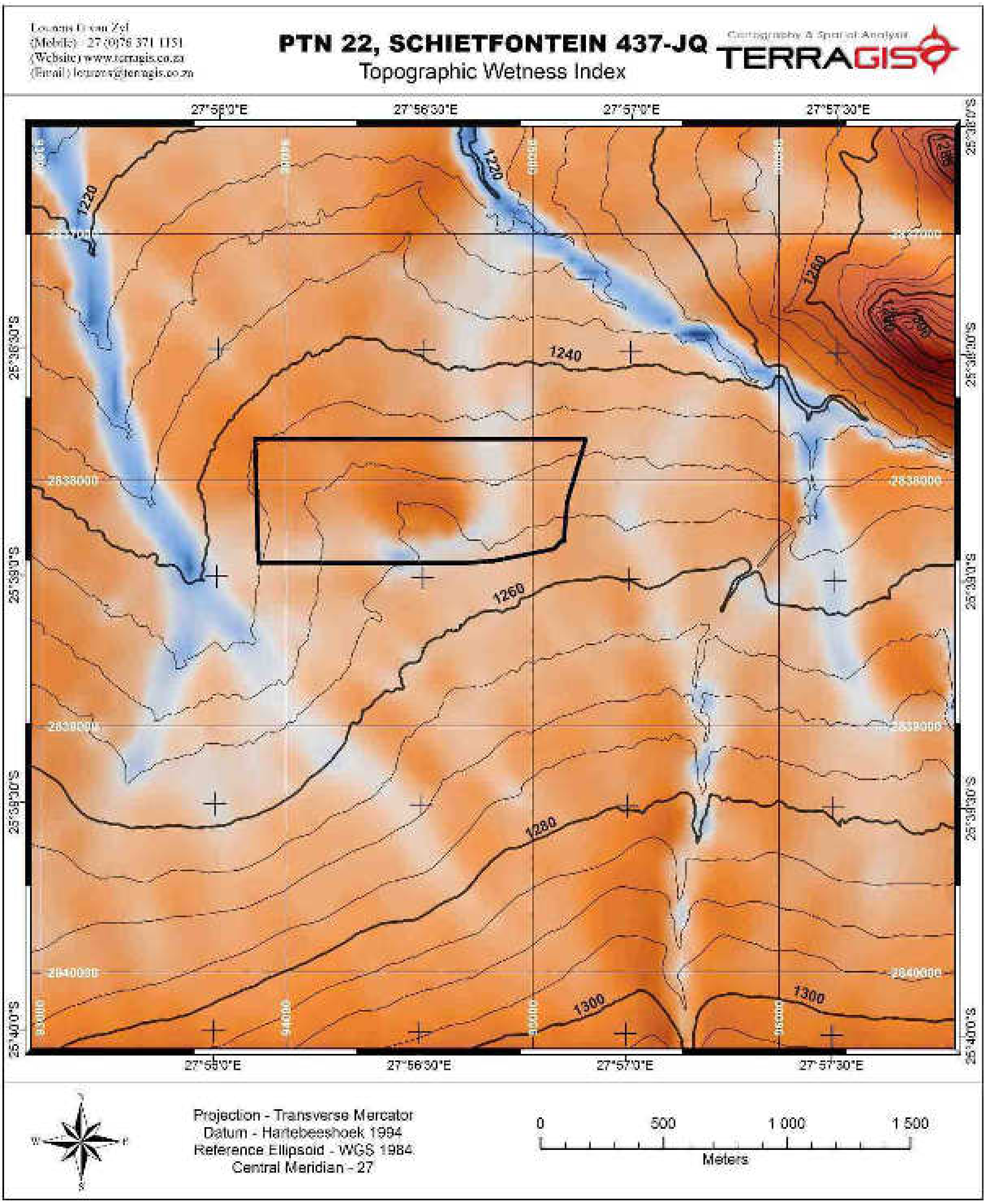

Figure 6 Topographic wetness index (TWI) for the survey site and surrounding area

2.5 AERIAL PHOTOGRAPH INTERPRETATION

An aerial photograph interpretation exercise was conducted through the use of Google Earth images of the site. Historical images spanning the period from 2004 to 2012 were used for the purpose of identifying land use characteristics associated with the site. In addition, the images were used to identify possible wetland areas that could be targeted for investigation during the field survey (addressed in the next section).

2.6 SITE VISIT AND SOIL SURVEY

A site visit and soil survey was conducted on the 26th of March 2014. The site was traversed on foot and soil characteristics were assessed in terms of soil form and hydromorphy (morphological signs of signs of wetness).

Disclaimer: The following sections (3 and 4) represents sections of a discussion that I use as standard in describing the challenges regarding wetland delineation and management in a range of landscapes. This implies that the section is predominantly verbatim the same as in other reports provided to clients and the authorities. Copyright is strictly reserved.

3. WETLANDS: STATUTORY CONTEXT

3.1 WETLAND DEFINITION

Wetlands are defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

From a scientific, practical and legal perspective the interpretation of the definition poses a number of challenges. In order to address the challenges it is necessary to disaggregate the definition and discuss the challenges as follows:

1. "Land which is transitional between terrestrial and aquatic systems …": this implies areas with variable hydrological and ecological characteristics of which the variation can be described as the linear (assumed) transition from one pole (terrestrial/dry) to another (aquatic/wet).
2. "… where the water is usually at or near the surface …": Although the regular condition is implied there is no reference to any empirical interpretation. This aspect therefore introduces uncertainty and the potential for significantly variable interpretation.
3. "… or the land is periodically covered with shallow water …": This statement introduces and alternative to the above statement but, again there is no reference to any empirical interpretation and it therefore introduces uncertainty and the potential for significantly variable interpretation

4. "and which land in normal circumstances …": Normal circumstances are not defined with a subsequent introduction of uncertainty and variability in interpretation. According to Mernewecke and Kotze (1999) "normal circumstances" in the definition refers to "without human modifications".
5. "… supports or would support vegetation typically adapted …": Vegetation species and communities can be described and named and can provide distinctly measurable indicators of wetland conditions. This is therefore a clear indicator if the requisite scientific knowledge is available.
6. "… to life in saturated soil.": Soil saturation (degree, intensity and duration) can be measured empirically (although at significant financial and time cost) or deduced from the soil morphology to varying degrees of certainty. The soil morphological indictors (all functions of soil forming factors and processes) have been studied and described extensively in the soil science literature.

An evaluation of the disaggregation above yields that the only certain descriptors, from a scientific, practical and legal perspective, are vegetation and soil indicators. In this sense the then Department of Water Affairs and Forestry (DWAF) generated "Resource Directed Measures for the Protection of Water Resources" (DWAF, 1999). In Appendix W6 of the document guidelines for the delineation of wetlands are provided (Mernewecke and Kotze, 1999). In this document distinct emphasis is placed on the use of soil characteristics in conjunction with vegetation characteristics (if present) for the delineation of wetlands. The document also refers specifically to the fact that a certain degree of proficiency in terms of soil classification with the SA Taxonomic System (Soil Classification Working Group, 1991) is required for such surveys. In the event of challenging sites it advises that qualified soils scientists conduct the delineation exercises.

Additionally, from the definition and the purpose of the water act it can be assumed that wetlands are merely the expression of wetness in landscapes and that the water resource can occur in landscapes in many other forms. One form that is not explicitly mentioned is seasonally perched water tables and their associated vadose zones that are instrumental in the "feeding" of wetlands through lateral flow mechanisms in the landscape. From the purpose of the NWA it is assumed that these water resources are included explicitly in the NWA.

3.2 WATERCOURSE DEFINITION

"Catchment" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"…, in relation to a watercourse or watercourses or part of a watercourse, means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points;"

"Watercourse" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"*(a)* a river or spring;

(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the *Gazette*, declare to be a water course,
and a reference to a watercourse includes, where relevant, its bed and banks;"

3.3 THE RESOURCE DIRECTED MEASURES FOR PROTECTION OF WATER RESOURCES.

The following are specific quotes from the "Resource Directed Measures for Protection of Water Resources. Volume 4: Wetland Ecosystems" as published by DWAF (1999).

From the Introduction:

"This set of documents on Resource Directed Measures (RDM) for protection of water resources, issued in September 1999 in Version 1.0, presents the procedures to be followed in undertaking **preliminary determinations of the class, Reserve and resource quality objectives for water resources**, as specified in sections 14 and 17 of the South African National Water Act (Act 36 of 1998).

The development of procedures to determine RDM was initiated by the Department of Water Affairs and Forestry in July 1997. Phase 3 of this project will end in March 2000. Additional refinement and development of the procedures, and development of the full water resource classification system, will continue in Phase 4, until such time as the detailed procedures and full classification system are ready for publication in the Government Gazette.

It should be noted that until the final RDM procedures are published in the Gazette, and prescribed according to section 12 of the National Water Act, all determinations of RDM, whether at the rapid, the intermediate or the comprehensive level, will be considered to be preliminary determinations."

The following components of the RDM document has bearing on this report and these will be discussed in more detail later.

In Appendix W6 the methodology is provided for the delineation of wetland boundaries and zones. The emphasis in this document is on the interpretation of soil characteristics for the identification of the wetland boundaries. This document was the precursor of the wetland delineation guidelines as published by DWAF (2005).

3.4 WETLAND DELINEATION GUIDELINES

In 2005 the Department of Water Affairs and Forestry published a manual entitled "A practical field procedure for identification and delineation of wetland and riparian areas" (DWAF, 2005). The "…manual describes field indicators and methods for determining whether an area is a wetland or riparian area, and for finding its boundaries." The definition of a wetland in the guidelines is that of the NWA and it states that wetlands must have one or more of the following attributes:

- "**Wetland (hydromorphic) soils** that display characteristics resulting from prolonged saturation"
- "The presence, at least occasionally, of **water loving plants (hydrophytes)**"
- "A **high water table** that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil."

The guidelines further list four indicators to be used for the finding of the outer edge of a wetland. These are:

- <u>Terrain Unit Indicator</u>. The terrain unit indicator does not only identify valley bottom wetlands but also wetlands on steep and mild slopes in crest, midslope and footslope positions.
- <u>Soil Form Indicator</u>. A number of soil forms (as defined by MacVicar et al., 1991) are listed as indicative of permanent, seasonal and temporary wetland zones.
- <u>Soil Wetness Indicator</u>. Certain soil colours and mottles are indicated as colours of wet soils. The guidelines stipulate that this is the primary indicator for wetland soils. (Refer to the guidelines for a detailed description of the colour indicators.) In essence, the reduction and removal of Fe in the form of "bleaching" and the accumulation of Fe in the form of mottles are the two main criteria for the identification of soils that are periodically or permanently wet.
- <u>Vegetation Indicator</u>. This is a key component of the definition of a wetland in the NWA. It often happens though that vegetation is disturbed and the guidelines therefore place greater emphasis on the soil form and soil wetness indicators as these are more permanent whereas vegetation communities are dynamic and react rapidly to external factors such as climate and human activities.

The main emphasis of the guidelines is therefore the use soils (soil form and wetness) as the criteria for the delineation of wetlands."

3.5 WETLAND INDICATORS

The wetland indicators discussed above are limited to a degree in the following manner:

1. The topographic indicator is limited to wetlands that are associated with surface topographical variation and it is therefore limited to specific landscape positions. The topographic indicator does not make allowance for variation in physical properties below the soil surface. In this sense aspects such as return-flow zones and interflow zones (that often occur in midslope or footslope positions) are not accommodated. In practice these areas prove the most problematic in terms of interpretation and delineation.
2. The vegetation indicator is limited predominantly by regional and local variation in edaphic and climatic conditions. The regionalization of vegetation guidelines should address this aspect satisfactorily.
3. The soil form indicator suffers from a number of limitations namely:

a. Soil forms present in an area do not necessarily indicate wetlands. Soil forms have to be viewed in wider context as their classification is also not an auditable process. (Unfortunately pedologists often have significant variation in interpretation!) The presence of a specific soil form may indicate the presence of a wetland though but this aspect will have to be confirmed on the site through additional indicators.
b. Certain soil forms are erroneously assigned to specific wetland conditions viz. the Rensburg that is assigned to permanent wetland areas but which is actually characterized by dominance of smectite clay minerals that can only form in seasonal wetland conditions. This discussion warrants a report in itself and will therefore not be further elucidated in this report.
c. Improved elucidation of the presence of soil forms in landscapes is required. This is especially relevant as the roles of the soils in wetlands and wetland functioning is often poorly understood. On this topic there are current research projects underway that focus on the description of hillslope hydrology and the soil morphological indicators of such hydrology. Linked to this is the established concept of soil variation along a topographic sequence (catena concept) for specific environments or land types. This aspect links up to the concept of soil formation (pedogenesis) and hydropedology which is finding new and very relevant application in the elucidation of environmental processes.

4. The soil wetness indicator is in all probability the most problematic as there are numerous physical and chemical determinants. The main indicator of reduction is the very handy redox morphological variation of Fe – and this is the assumption that most wetland delineation exercises are based upon. (A dedicated discussion of this aspect is provided later in the report.) There is a distinct variability in expression of the quantity / intensity parameters of mottles in different soil environments. This variation is in most cases linear for simple parameters but soils always exhibit combinations of variable parameters that make linear interpretation highly suspect and problematic. A brief elucidation of the problem components include:
   a. The Fe content and reserve of soils and parent material vary significantly and impart varying expression of Fe redox morphology with consequent challenges in interpretation. This aspect induces variation between landscapes with homogenous parent materials (within the specific landscape) or within landscapes where variation in parent materials is found within the landscape.
   b. The Mn content of soils influence redox poise processes that in turn influence the expression of Fe redox morphology. Additional sources of variation include:
      i. Textural influences on expression of mottles;
      ii. Climatic / rainfall gradients; and
      iii. Variation in pH gradients linked to electron activity (Eh). The redox morphology changes linearly with these parameters with the distinct expression of mottles (intensity, colour, contrast) decreasing linearly with increasing pH (even if Eh remains constant).
      iv. In neutral to low pH soils the dominant Fe minerals are Fe oxides and hydroxides – all with bright colours leading to the expression of discernible

mottling. In high pH soils the dominant secondary Fe mineral is siderite ($FeCO_3$) which is white in colour that is often associated with lime accumulations (also white). Therefore, alkaline soil environments often do not exhibit distinctly discernible Fe redox morphology. Linked to this is the fact that lime accumulation is also a factor of climate and aridity and lime accumulations can therefore not be used as an indication of reduction even though there are distinct links.

c. Soil colour varies significantly between different chemical and physical environments (even if pH and Eh remains relatively similar) and as such one set of wetness criteria cannot be applied universally.
d. With the advancement of science concepts that were accepted to be true 30 years ago are now considered erroneous. A distinct example of this is references to "blue green colouration" in soils classification texts that indicate conditions of distinct saturation in those texts. This colouration has, with recent research, been proven to occur under very specific redox conditions that indicate only intermediate reduction, even though the soil may be saturated. The historically held conviction that "saturation equals reduction" has been proven to not apply religiously in all environments. It is therefore imperative that the application (wetland delineation) keeps up with the science.

3.6 PROPOSED IMPROVEMENTS

Having indicated that there are numerous limitations to the current wetland delineation approach it is important to focus on dedicated improvements that can implemented/incorporated easily. These improvements include:

1. Updating of the current delineation guidelines (including the draft version from 2008) to serve as a national standard document indicating variability in SA (broadly) through:
    a. Improvement of the landscape indicator to include seepage (including interflow, seepage and return-flow wetlands)
    b. Improvement and correction of the soil form indicator description. Introduction of the concept of "driest soils on crests and wettest soils in depressions" as a method of determining the range of soil variation in specific landscapes.
    c. Improvement and correction of the soil wetness indicator description to reflect differing pH/Eh/parent material environments. Linking of soil wetness indicators to the concept of "driest soils on crests and wettest soils in depressions" as a method of determining range of soil variation in different landscapes.
    d. Introduction of measuring and inference tools for generation of empirical data on wetness.
    e. Introduction of regional and/or land type based detailed guidelines that will include:
        i. Localized topographic indicators and pointers / aids;
        ii. Localized soil form sequences (catena) and soil form variability. (Utilize method of soil form variation range in land type); and

iii. Localized variation in terms of soil wetness indicators. (Utilize method of soil form variation range in land type).

2. Correction of scientific inaccuracies and inconsistencies in the current documents and improvement of the principles and guidelines to a proper standard through focused research, peer review and formal publication.

4. CHALLENGES REGARDING WETLAND DELINEATION IN ALKALINE SOILS

In order to discuss the procedures followed and the results of the wetland identification exercise it is necessary at the outset to provide some theoretical background on soil forming processes, soil wetness indicators, water movement in soils and topographical sequences of soil forms (catena).

4.1 PEDOGENESIS

Pedogenesis is the process of soil formation. Soil formation is a function of five (5) factors namely (Jenny, 1941):

- Parent material;
- Climate;
- Topography;
- Living Organisms; and
- Time.

These factors interact to lead to a range of different soil forming processes that ultimately determine the specific soil formed in a specific location. Central to all soil forming processes is water and all the reactions (physical and chemical) associated with it. The physical processes include water movement onto, into, through and out of a soil unit. The movement can be vertically downwards, lateral or vertically upwards through capillary forces and evapotranspiration. The chemical processes are numerous and include dissolution, precipitation (of salts or other elements) and alteration through pH and reduction and oxidation (redox) changes. In many cases the reactions are promoted through the presence of organic material that is broken down through aerobic or anaerobic respiration by microorganisms. Both these processes alter the redox conditions of the soil and influence the oxidation state of elements such as Fe and Mn. Under reducing conditions Fe and Mn are reduced and become more mobile in the soil environment. Oxidizing conditions, in turn, lead to the precipitation of Fe and Mn and therefore lead to their immobilization. The dynamics of Fe and Mn in soil, their zones of depletion through mobilization and accumulation through precipitation, play an important role in the identification of the dominant water regime of a soil and could therefore be used to identify wetlands and wetland conditions.

4.2 WATER MOVEMENT IN THE SOIL PROFILE

In a specific soil profile, water can move upwards (through capillary movement), horizontally (owing to matric suction) and downwards under the influence of gravity.

The following needs to be highlighted in order to discuss water movement in soil:

- Capillary rise refers to the process where water rises from a deeper lying section of the soil profile to the soil surface or to a section closer to the soil surface. Soil pores can be regarded as miniature tubes. Water rises into these tubes owing to the adhesion (adsorption) of water molecules onto solid mineral surfaces and the surface tension of water.

  The height of the rise is inversely proportional to the radius of the soil pore and the density of the liquid (water). It is also directly proportional to the liquid's surface tension and the degree of its adhesive attraction. In a soil-water system the following simplified equation can be used to calculate this rise:

  $$\text{Height} = 0.15/\text{radius}$$

  Usually the eventual height of rise is greater in fine textured soil, but the rate of flow may be slower (Brady and Weil, 1999; Hillel, 1983).

- Matric potential or suction refers to the attraction of water to solid surfaces. Matric potential is operational in unsaturated soil above the water table while pressure potential refers to water in saturated soil or below the water table. Matric potential is always expressed as a negative value and pressure potential as a positive value.

  Matric potential influences soil moisture retention and soil water movement. Differences in the matric potential of adjoining zones of a soil results in the movement of water from the moist zone (high state of energy) to the dry zone (low state of energy) or from large pores to small pores.

  The maximum amount of water that a soil profile can hold before leaching occurs is called the field capacity of the soil. At a point of water saturation, a soil exhibits an energy state of 0 $J.kg^{-1}$. Field capacity usually falls within a range of -15 to -30 $J.kg^{-1}$ with fine textured soils storing larger amounts of water (Brady and Weil, 1999; Hillel, 1983).

- Gravity acts on water in the soil profile in the same way as it acts on any other body; it attracts towards earth's centre. The gravitational potential of soil water can be expressed as:

  $$\text{Gravitational potential} = \text{Gravity} \times \text{Height}$$

  Following heavy rainfall, gravity plays an important part in the removal of excess water from the upper horizons of the soil profile and recharging groundwater sources below.

  Excess water, or water subject to leaching, is the amount of water that falls between soil saturation (0 $J.kg^{-1}$) or oversaturation (> 0 $J.kg^{-1}$), in the case of heavy rainfall resulting in a pressure potential, and field capacity (-15 to -30 $J.kg^{-1}$). This amount of water differs according to soil type, structure and texture (Brady and Weil, 1999; Hillel, 1983).

- Under some conditions, at least part of the soil profile may be saturated with water, resulting in so-called saturated flow of water. The lower portions of poorly drained soils are often saturated, as are well-drained soils above stratified (layers differing in soil texture) or impermeable layers after rainfall.

  The quantity of water that flows through a saturated column of soil can be calculated using Darcy's law:

  $$Q = Ksat.A.\Delta P/L$$

  Where Q represents the quantity of water per unit time, Ksat is the saturated hydraulic conductivity, A is the cross sectional area of the column through which the water flows, ΔP is the hydrostatic pressure difference from the top to the bottom of the column, and L is the length of the column.

  Saturated flow of water does not only occur downwards, but also horizontally and upwards. Horizontal and upward flows are not quite as rapid as downward flow. The latter is aided by gravity (Brady and Weil, 1999; Hillel, 1983).

- Mostly, water movement in soil is ascribed to the unsaturated flow of water. This is a much more complex scenario than water flow under saturated conditions. Under unsaturated conditions only the fine micropores are filled with water whereas the macropores are filled with air. The water content, and the force with which water molecules are held by soil surfaces, can also vary considerably. The latter makes it difficult to assess the rate and direction of water flow. The driving force behind unsaturated water flow is matric potential. Water movement will be from a moist to a drier zone (Brady and Weil, 1999; Hillel, 1983).

The following processes influence the amount of water to be leached from a soil profile:

- Infiltration is the process by which water enters the soil pores and becomes soil water. The rate at which water can enter the soil is termed infiltration tempo and is calculated as follows:

  $$I = Q/A.t$$

  Where I represents infiltration tempo ($m.s^{-1}$), Q is the volume quantity of infiltrating water (m^3), A is the area of the soil surface exposed to infiltration (m^2), and t is time (s).

  If the soil is quite dry when exposed to water, the macropores will be open to conduct water into the soil profile. Soils that exhibit a high 2:1 clay content (swelling-shrinking clays) will exhibit a high rate of infiltration initially. However, as infiltration proceeds, the macropores will become saturated and cracks, caused by dried out 2:1 clay, will swell and close, thus leading to a decline in infiltration (Brady and Weil, 1999; Hillel, 1983).

- Percolation is the process by which water moves downward in the soil profile. Saturated and unsaturated water flow is involved in the process of percolation, while the rate of percolation is determined by the hydraulic conductivity of the soil.

During a rain storm, especially the down pouring of heavy rain, water movement near the soil surface mainly occurs in the form of saturated flow in response to gravity. A sharp boundary, referred to as the wetting front, usually appears between the wet soil and the underlying dry soil. At the wetting front, water is moving into the underlying soil in response to both matric and gravitational potential. During light rain, water movement at the soil surface may be ascribed to unsaturated flow (Brady and Weil, 1999; Hillel, 1983).

The fact that water percolates through the soil profile by unsaturated flow has certain ramifications when an abrupt change in soil texture occurs (Brady and Weil, 1999; Hillel, 1983). A layer of course sand, underlying a fine textured soil, will impede downward movement of water. The macropores of the coarse textured sand offer less attraction to the water molecules than the macropores of the fine textured soil. When the unsaturated wetting front reaches the coarse sand, the matric potential is lower in the sand than in the overlying material. Water always moves from a higher to a lower state of energy. The water can, therefore, not move into the coarse textured sand. Eventually, the downward moving water will accumulate above the sand layer and nearly saturate the fine textured soil. Once this occurs, the water will be held so loosely that gravitational forces will be able to drag the water into the sand layer (Brady and Weil, 1999; Hillel, 1983).

A coarse layer of sand in an otherwise fine textured soil profile will also inhibit the rise of water by capillary movement (Brady and Weil, 1999; Hillel, 1983).

Field observations and laboratory based analysis can aid in assessing the soil-water relations of an area. The South African soil classification system (Soil Classification Working Group, 1991.) comments on certain field observable characteristics that shed light on water movement in soil. The more important of these are:

- Soil horizons that show clear signs of leaching such as the E-horizon – an horizon where predominantly lateral water movement has led to the mobilisation and transport of sesquioxide minerals and the removal of clay material;
- Soil horizons that show clear signs of a fluctuating water table where Fe and Mn mottles, amongst other characteristics, indicate alternating conditions of reduction and oxidation (soft plinthic B-horizon);
- Soil horizons where grey colouration (Fe reduction and redox depletion), in an otherwise yellowish or reddish matrix, indicate saturated (or close to saturated) water flow for at least three months of the year (Unconsolidated/Unspecified material with signs of wetness);
- Soil horizons that are uniform in colouration and indicative of well-drained and aerated (oxidising) conditions (e.g. yellow brown apedal B-horizon).

4.3 WATER MOVEMENT IN THE LANDSCAPE

Water movement in a landscape is a combination of the different flow paths in the soils and geological materials. The movement of water in these materials is dominantly subject to gravity and as such it will follow the path of least resistance towards the lowest point. In the landscape there are a number of factors determining the paths along which this water moves. **Figure 7** provides a simplified schematic representation of an idealised landscape (in “profile curvature”. The total precipitation (rainfall) on the landscape from the crest to the lowest part or valley bottom is taken as 100 %. Most geohydrologists agree that total recharge, the water that seeps into the underlying geological strata, is less than 4 % of total precipitation for most geological settings. Surface runoff varies considerably according to rainfall intensity and distribution, plant cover and soil characteristics but is taken as a realistic 6 % of total precipitation for our idealised landscape. The total for surface runoff and recharge is therefore calculated as 10 % of total precipitation. If evapotranspiration (from plants as well as the soil surface) is taken as a very high 30 % of total precipitation it leaves 60 % of the total that has to move through the soil and/or geological strata from higher lying to lower lying areas. In the event of an average rainfall of 750 mm per year it results in 450 mm per year having to move laterally through the soil and geological strata. In a landscape there is an accumulation of water down the slope as water from higher lying areas flow to lower lying areas.

To illustrate: If the assumption is made that the area of interest is 100 m wide it follows that the first 100 m from the crest downwards has 4 500 m^3 (or 4 500 000 litres) of water moving laterally through the soil (100 m X 100 m X 0.45 m) per rain season. The next section of 100 m down the slope has its own 4 500 m^3 of water as well as the added 4 500 m^3 from the upslope section to contend with, therefore 9 000 m^3. The next section has 13 500 m^3 to contend with and the following one 18 000 m^3. It is therefore clear that, the longer the slope, the larger the volume of water that will move laterally through the soil profile.

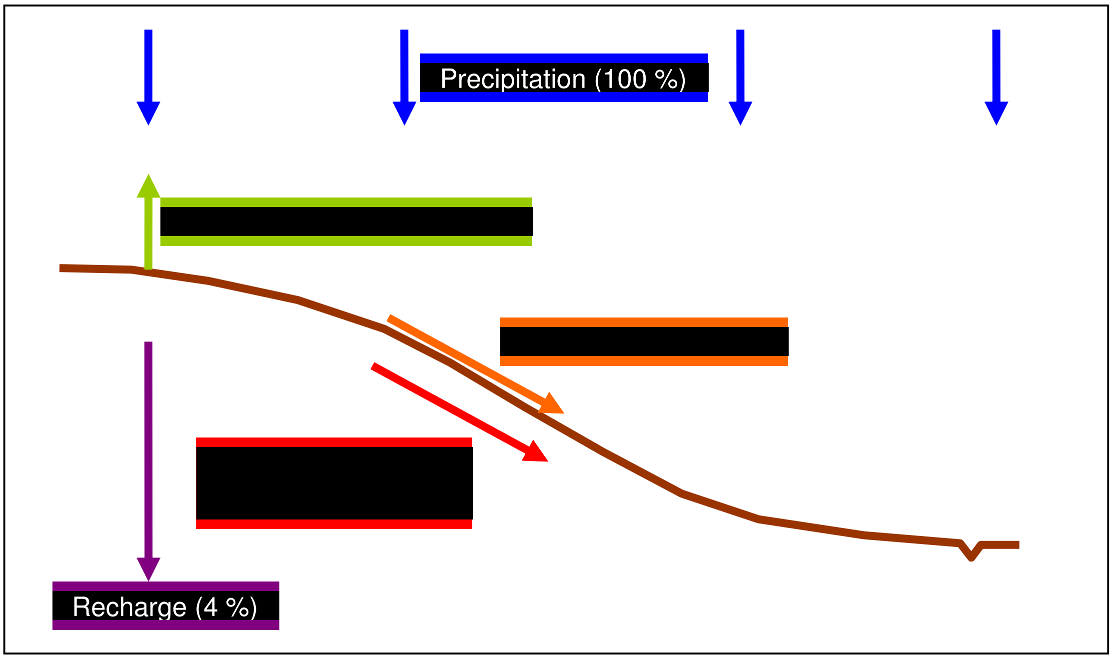

Figure 7 Idealised landscape with assumed quantities of water moving through the landscape expressed as a percentage of total precipitation (100 %).

Flow paths through soil and geological strata, referred to as "interflow" or "hillslope water", are very varied and often complex due to difficulty in measurement and identification. The difficulty in identification stems more from the challenges related to the physical determination of these in soil profile pits, soil auger samples and core drilling samples for geological strata. The identification of the morphological signs of water movement in permeable materials or along planes of weakness (cracks and seams) is a well-established science and the expression is mostly referred to as "redox morphology". In terms of the flow paths of water large variation exists but these can be grouped into a few simple categories. **Figure 8** provides a schematic representation of the different flow regimes that are usually encountered. The main types of water flow can be grouped as 1) recharge (vertically downwards) of groundwater; 2) lateral flow of water through the landscape along the hillslope (interflow or hillslope water); 3) return flow water that intercepts the soil/landscape surface; and 4) surface runoff. Significant variation exists with these flow paths and numerous combinations are often found. The main wetland types associated with the flow paths are: a) valley bottom wetlands (fed by groundwater, hillslope processes, surface runoff, and/or in-stream water); b) hillslope seepage wetlands (fed by interflow water and/or return flow water); and wetlands associated with surface runoff, ponding and surface ingress of water anywhere in the landscape.

Amongst other factors, the thickness of the soil profile at a specific point will influence the intensity of the physical and chemical reactions taking place in that soil. **Figure 9** illustrates the difference between a dominantly thick and a dominantly thin soil profile. If all factors are kept the same except for the soil profile thickness it can be assumed with confidence that the chemical and physical reactions associated with water in the landscape will be much more intense for the thin soil profile than for the thick soil profile. Stated differently: The volume of water moving through the soil per surface area of an imaginary plane perpendicular to the direction of water flow is much higher for the thin soil profile than for the thick soil profile. This aspect has a significant influence on the expression of redox morphology in different landscapes of varying soil/geology/climate composition.

4.4 THE CATENA CONCEPT

Here it is important to take note of the "catena" concept. This concept is one of a topographic sequence of soils in a homogenous geological setting where the water movement and presence in the soils determine the specific characteristics of the soils from the top to the bottom of the topography. **Figure 10** illustrates an idealised topographical sequence of soils in a catena for a quartz rich parent material. Soils at the top of the topographical sequence are typically red in colour (Hutton and Bainsvlei soil forms) and systematically grade to yellow further down the slope (Avalon soil form). As the volume of water that moves through the soil increases, typically in midslope areas, periodic saturated conditions are experienced and consequently Fe is reduced and removed in the laterally flowing water. In the event that the soils in the midslope positions are relatively sandy the resultant soil colour will be bleached or white due to the colour dominance of the sand quartz particles. The soils in these positions are typically of the Longlands and Kroonstad forms. Further down the slope there is an accumulation of clays and leaching products from higher lying soils and this leads to typical illuvial and clay rich horizons. Due to the regular presence of water the dominant conditions are anaerobic and reducing and the soils exhibit grey colours often with bright yellow and grey mottles (Katspruit soil form). In the event that there is a large depositional environment with prolonged saturation soils of the Champagne form may develop (typical peat land). Variations on this sequence (as is often found on the Mpumalanga Highveld) may include the presence of hard plinthic materials instead of soft plinthite with a consequent increase in the occurrence of bleached soil profiles. Extreme examples of such landscapes are discussed below.

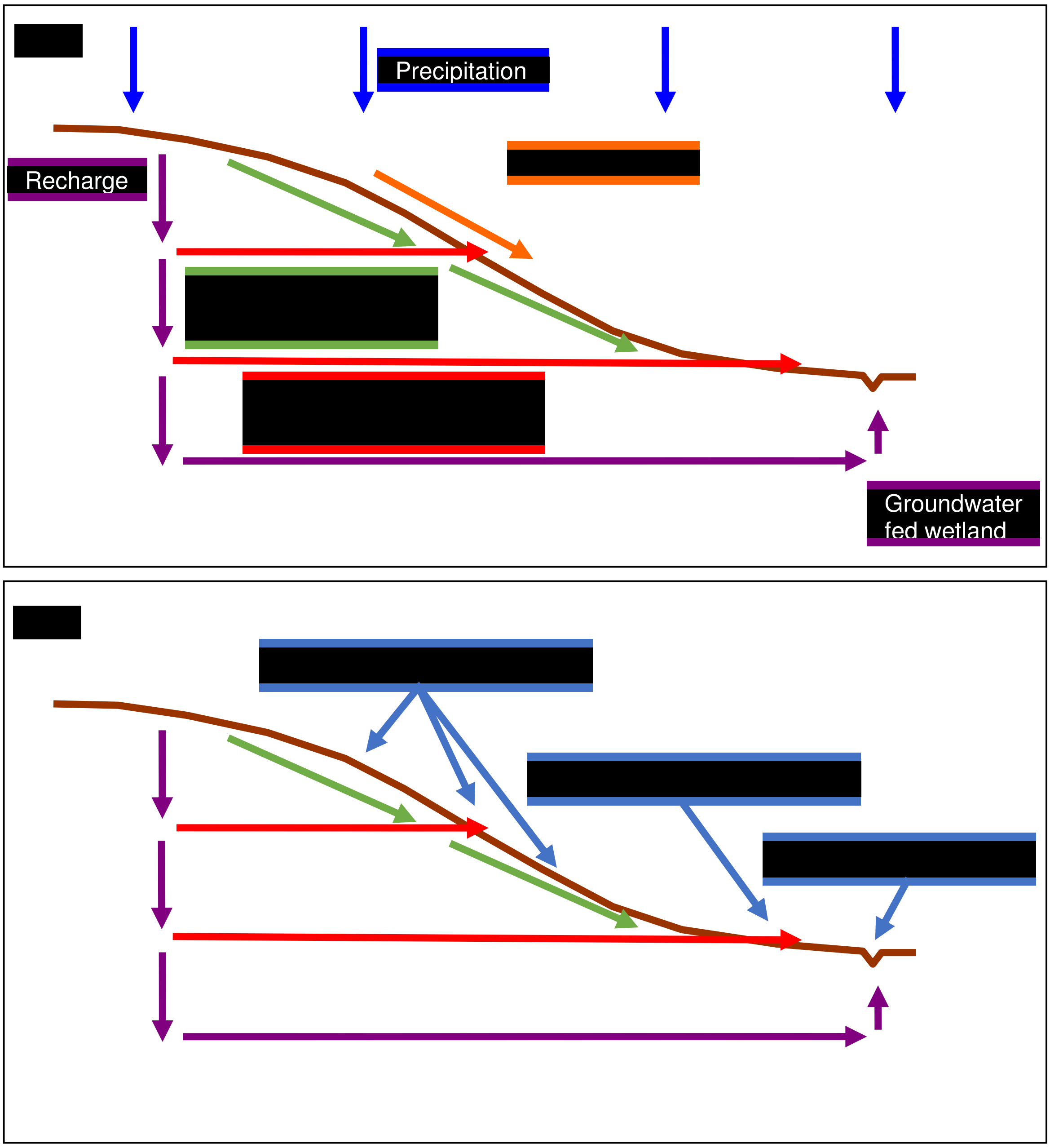

Figure 8 Different flow paths of water through a landscape (a) and typical wetland types associated with the water regime (b)

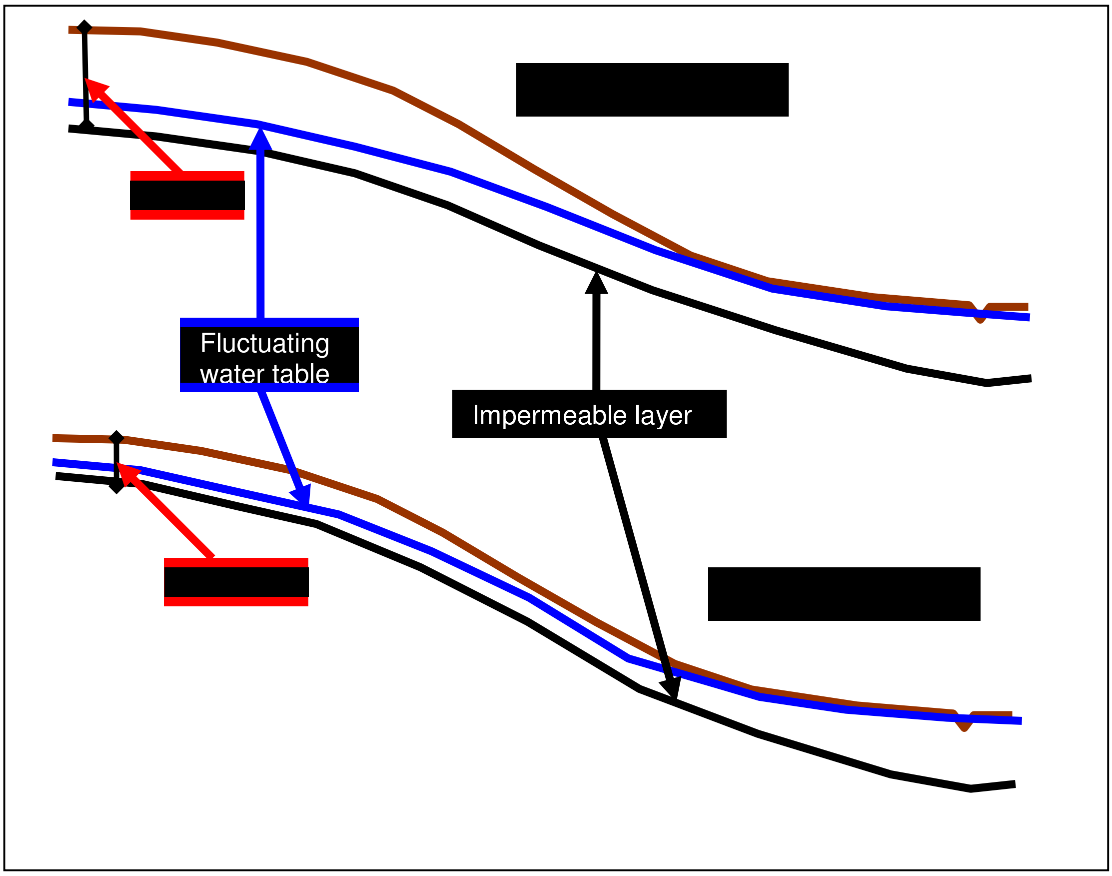

Figure 9 The difference in water flow between a dominantly thick and dominantly thin soil profile.

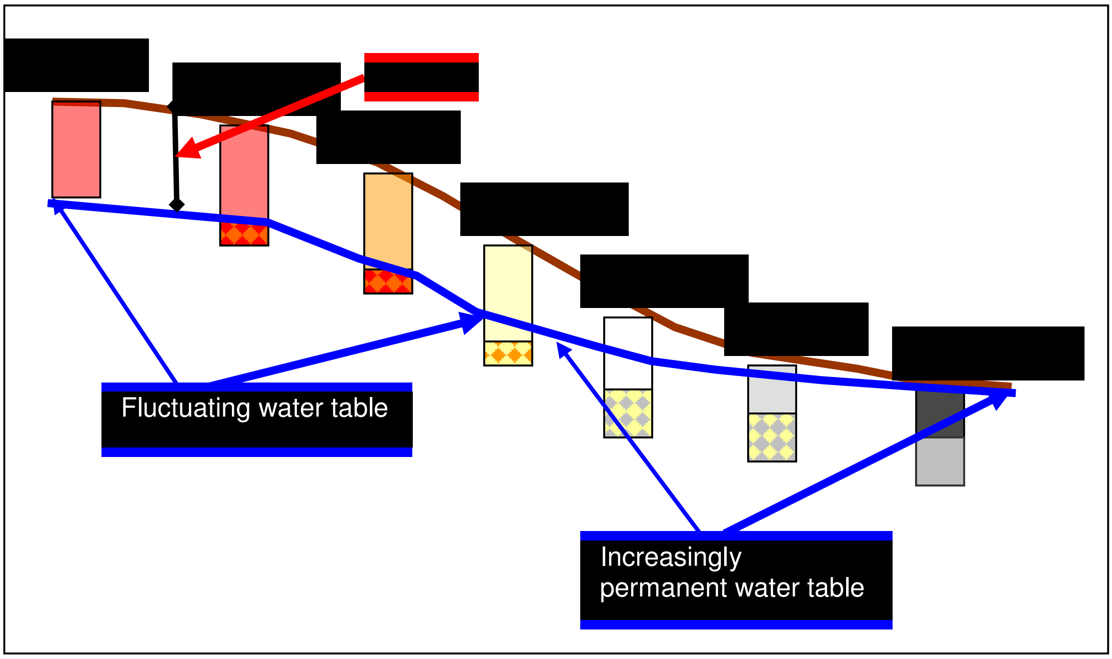

Figure 10 Idealised catena on a quartz rich parent material.

4.5 CONVEX VERSUS CONCAVE LANDSCAPES IN AN IDEALISED CATENA

An additional factor of variation in all landscapes is the shape of the landscape along contours (referred to a “plan curvature”). Landscapes can be either concave or convex, or flat. The main difference between these landscapes lies in the fact that a convex landscape is essentially a watershed with water flowing in diverging directions with a subsequent occurrence of “dryer” soil conditions. In a concave landscape water flows in converging directions and soils often exhibit the wetter conditions of “signs of wetness” such as grey colours, organic matter and subsurface clay accumulation. **Figure 11** presents the difference between these landscapes in terms of typical soil forms encountered in an idealised catena. In the convex landscape the subsurface flow of water removes clays and other weathering products (including Fe) in such a way that the midslope position soils exhibit an increasing degree of bleaching and relative accumulation of quartz (E-horizons).

In the concave landscapes clays and weathering products are transported through the soils into a zone of accumulation where soils start exhibiting properties of clay and Fe accumulation. In addition, coarse sandy soils in convex environments tend to be thinner due to the removal of sand particles through erosion and soils in concave environments tend to be thicker due to colluvial accumulation of material transported from upslope positions. Similar patterns are observed for other geological areas with the variation being consistent with the soil variation in the catena.

Often these concave and convex topographical environments occur in close proximity or in one topographical sequence of soils. This is often found where a convex upslope area changes into a concave environment as a drainage depression is reached (**Figure 12**). The processes in this landscape are the same as those described for the convex and concave landscapes above.

4.6 THE AE21 LAND TYPE CATENA

The typical catena that forms in the **Ae21** land type (**Figure 13**) differs from the idealised one discussed above in that this land type is characterised by high clay content and often structured soils with a high base status with above neutral pH values. The subsoils are structured and grading into weathered rock. The lower landscape positions are characterised by similar soils but with darker A horizons as well as an increase in the clay content and degree of structure development. The specific clay minerals (2:1 swelling and non-swelling clays) that occur in these landscapes form under above neutral pH conditions. This aspect has very specific implications for the identification of morphological signs of wetness. Wetlands are invariably associated with the lowest points in the landscape and as such this aspect is critical (and therefore addressed in more detail later). Due to the high clay content (and often swelling nature) the soils are characterised predominantly by surface flow of water with very slow percolation rates through the profiles. Lateral flow of water on impervious layers is therefore not encountered with the exception being planes of weakness in the underlying weathered and hard rock. The drainage depressions in these landscapes often exhibit signs of high energy flow events in the form of eroded soils as well as young recently transported soil material.

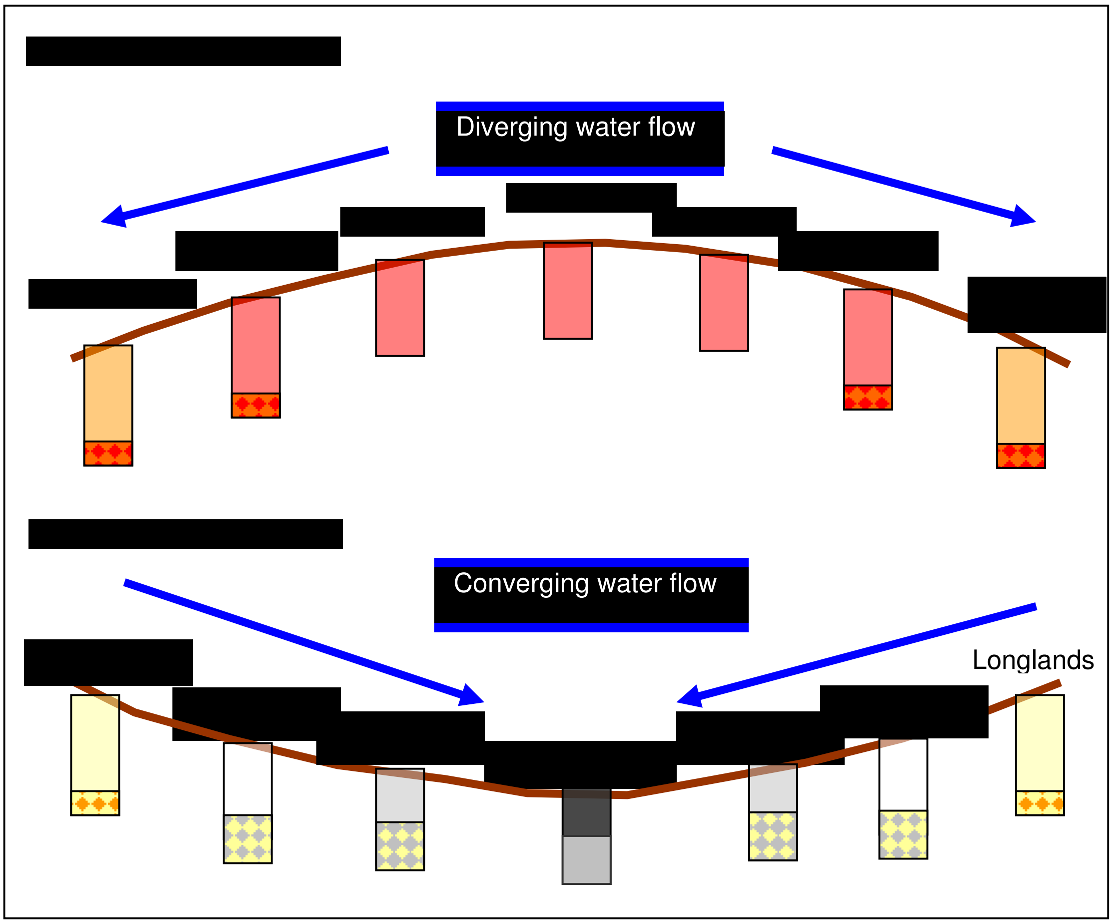

Figure 11 Schematic representation of the soils in convex and concave landscapes in an idealised catena

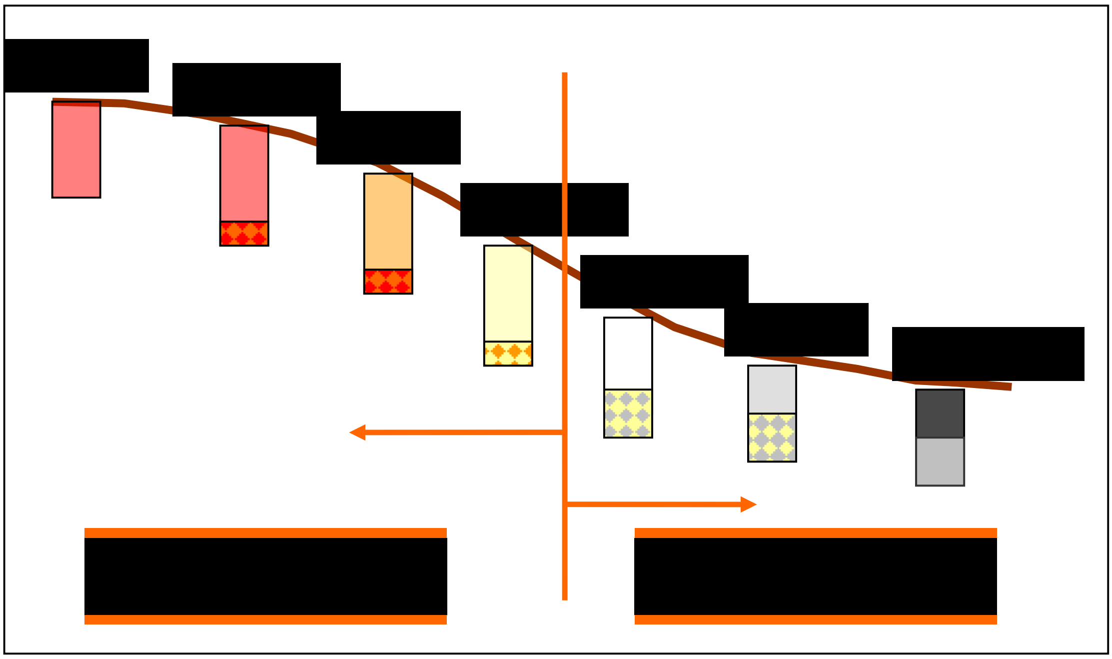

Figure 12 Schematic representation of the soils in a combined convex and concave landscape in an idealised catena.

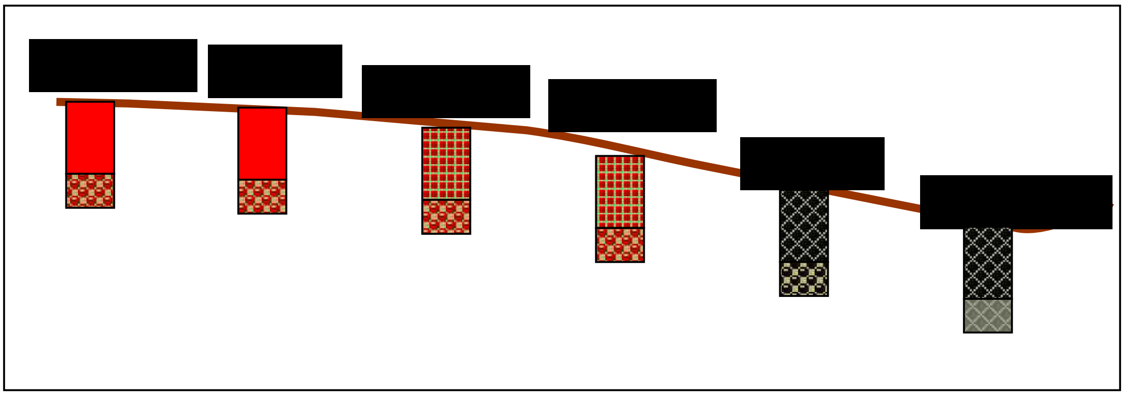

Figure 13 Idealised catena in the Ae21 land type

4.7 Redox Morphology in Alkaline Soils

Wetland delineation is a very challenging exercise in areas dominated by alkaline soils such as lime containing and/or vertic/melanic soils. This is mainly due to the almost complete absence of Fe-mottles in the soils that grade from the terrestrial to the wetland areas. There are a number of reasons that will be explained in more detail below.

In order to illustrate the stability and distribution of Fe minerals in soils the figure provided below (**Figure 14**) was copied from page 124 of a book entitled "Soil Chemistry" by Bohn, et al., (1990). The essence is that when reduction and oxidation reactions of Fe (in this case) are considered in soils both the electron activity (driver of reducing conditions) and pH have to be considered as they are intimately linked and dependent on each other. Suffice to say that for redox and mineral stability purposes they are indicated on the same graph. From Figure 4.6 (**Figure 14**) it is clear that as the Eh decreases (increasing reducing conditions) the dominant Fe species in solution changes from Fe^{3+} (insoluble and forming brightly coloured minerals) to Fe^{2+} (soluble and essentially colourless). Once pH is included in the observation it is clear that distinct Fe minerals come into play. Applying the decreasing Eh values to Fe minerals at high pH it is clear that the dominant Fe mineral under oxidizing conditions is FeOOH (Goethite – predominantly yellow). As the conditions become more reducing the equilibrium shifts to $FeCO_3$ (Siderite – white) and thereafter to FeS_2 (Pyrite). Whereas goethite has a distinct colour in soil, siderite and pyrite are less conspicuous in small quantities. It follows therefore that Fe minerals are much less visible in high pH reduced soils than in oxidised soils. In addition, vertic and melanic soils are dark coloured and it is therefore also clear that this dark colour will mask the presence of the above mentioned Fe minerals.

Another factor related to pH is the degree of reduction that is required to reduce Fe from its oxidised to its reduced state. From the graph it is clear that there is a steep decreasing gradient as the pH of the soil increases. This implies that much more intensive reducing conditions are required for the same degree of Fe reduction when high pH conditions (as those experienced in vertic and melanic soils) are compared to low pH conditions.

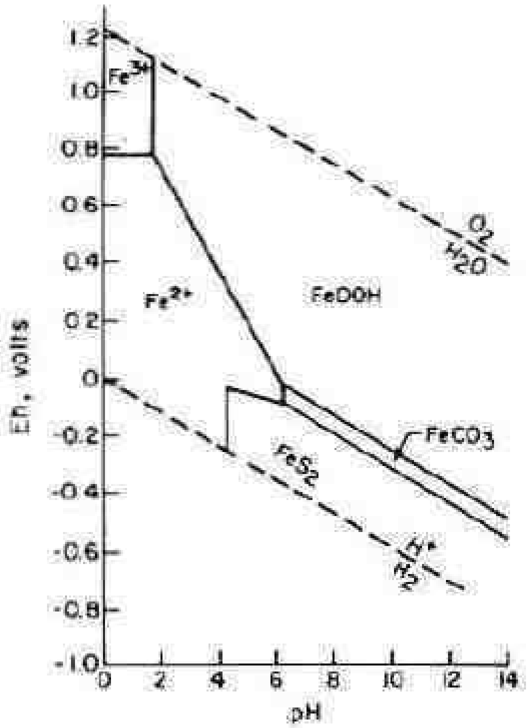

FIGURE 4.6. The *Eh*–pH diagram of various iron ions and compounds.

Figure 14 Eh pH diagram as sourced from Bohn, et al., (1990) p124

The situation becomes even more complex as other intermediate Fe minerals (blue green rusts) come into play. The essence of the presence of blue-green rusts is that they are tints that occur extensively in poorly drained and poorly aerated soils such as G-horizons under vertic and/or melanic A-horizons. These minerals are not stable and often disappear within a few minutes of exposure to the atmosphere. They in all probability form some of the most important Fe phases in vertic soils but disappear rapidly. Before they disappear it is also evident that these minerals are visible against a grey matrix but poorly visible against a black or dark background.

In essence therefore, a number of factors, including degree of reduction, soil pH and dominant Fe minerals, conspire against the use of Fe indicators in vertic, melanic and lime containing soils for the delineation of wetlands. There is no quick solution to this problem and delineators should use as many other indicators of wetland conditions in such soils as they can.

One word of caution: The wetland delineation guidelines (DWAF, 2005) indicate the Rensburg and Willowbrook soil forms as occurring in the permanent wetland zone. This is somewhat erroneous. Although these can occur in permanent wetland zones their formation is dependent on distinct cycling between wet and dry seasons. The development of 2:1 clays (found in these soils) depends on the accumulation of weathering products and clays in lower lying landscape positions. These clays are, depending on a range of factors, either swelling or non-swelling and their formation requires a distinct time (seasonally) where evaporation exceeds precipitation, with consequent drying of the soil, to lead to a concentration of bases (Ca and Mg). These clay minerals (such as smectite) often express themselves in the form of distinct cracks in Vertic soils. From this discussion it follows that the Rensburg and Willowbrook soils could only have formed in conditions that resemble a **seasonal wetland**. Drainage lines on the site can, if dominated by Rensburg or Willowbrook soils, therefore not be classified as permanent wetlands unless there are other characteristics indicating conditions of permanent saturation.

5. SITE SURVEY RESULTS AND DISCUSSION

The soils encountered on the site were of the Hutton, Shortlands and Arcadia forms. None of the soils exhibited any morphological signs of wetness (hydromorphism) – an aspect that is ascribed to the processes described above.

No distinct drainage features were observed on the site.

From the above it is stated with confidence that there is no wetland on the site. The surrounding area outside the site is characterised by two drainage depressions that qualify as water courses with associated riparian zones. Due to the geology and specific soils these features also do not exhibit distinct signs of wetness (hydromorphism).

6. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that there is no wetland on the site.

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REPORT

WETLAND / WATER COURSE IDENTIFICATION AND MANAGEMENT REPORT:

PORTION 41 OF THE FARM SCHIETFONTEIN 437-JQ IN THE NORTH-WEST PROVINCE

12th May, 2014

Compiled by:
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Registration number: 400106/08

Declaration

I, Johan Hilgard van der Waals, declare that I –

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

J.H. VAN DER WAALS
TERRA SOIL SCIENCE

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WETLAND / WATER COURSE IDENTIFICATION AND MANAGEMENT REPORT: PORTION 41 OF THE FARM SCHIETFONTEIN 437-JQ IN THE NORTH-WEST PROVINCE

1. INTRODUCTION

1.1 TERMS OF REFERENCE

Terra Soil Science was appointed by **Q4 Chemicals** to determine the presence and status of wetlands on Portion 41 of the Farm Schietfontein 437-JQ in the North-West Province.

1.2 PROBLEM STATEMENT

At present it is not clear whether a wetland occurs on the investigation site.

1.3 AIM OF THIS REPORT

The aim of this report is to provide a perspective on the requirements for the identification of a wetland as well as to address the presence and status of a wetland / water course on the site. In addition, this report aims to provide a hydropedological perspective on the site and broader area to aid in the identification and management of water impacts through the elucidation of broad surface hydrology and hydropedology principles.

1.4 METHODOLOGY

1.4.1 Brief Background

The identification and delineation of wetlands rest on several parameters that include topographic, vegetation and soil indicators. Apart from the inherent flaws in the wetland delineation process, as discussed later in this report, the concept of wetland delineation implies an emphasis on the wetlands themselves and very little consideration of the processes driving the functioning and presence of the wetlands. One discipline that encompasses a number of tools to elucidate landscape hydrological processes is "hydropedology" (Lin, 2012). The crux of the understanding of hydropedology lies in the fact that pedology is the description and classification of soil on the basis of morphology that is the result of soil and landscape hydrological, physical and chemical processes. But, the soils of which the morphology are described, also take part in and intimately influence the hydrology of the landscape. Soil is therefore both an indicator as well as a participator in the processes that require elucidation.

Wetlands are merely those areas in a landscape where the morphological indicators point to prolonged or intensive saturation near the surface to influence the distribution of wetland vegetation. Wetlands therefore form part of a larger hydrological entity that they cannot be separated from.

1.4.2 Proposed Methodology

In order to provide detailed pedohydrological information both detailed soil surveys and hydrological investigations are needed. In practice these intensive surveys are expensive and very seldom conducted. However, with the understanding of soil morphology, pedology and basic soil physics parameters as well as the collection and interpretation of existing soil survey information, assessments at different levels of detail and confidence can be conducted. In this sense four levels of investigation are proposed namely:

1. Level 1 Assessment: This level includes the collection and generation of all applicable remote sensing, topographic and land type parameters to provide a “desktop” product. This level of investigation rests on adequate experience in conducting such information collection and interpretation exercises and will provide a broad overview of dominant hydropedological parameters of a site. Within this context the presence, distribution and functioning of wetlands will be better understood than without such information.
2. Level 2 Assessment: This level of assessment will make use of the data generated during the Level 1 assessment and will include a reconnaissance soil and site survey to verify the information as well as elucidate many of the unknowns identified during the Level 1 assessment.
3. Level 3 Assessment: This level of assessment will build on the Level 1 and 2 assessments and will consist of a detailed soil survey with sampling and analysis of representative soils. The parameters to be analysed include soil physical, chemical and mineralogical parameters that elucidate and confirm the morphological parameters identified during the field survey.
4. Level 4 Assessment: This level of assessment will make use of the data generated during the previous three levels and will include the installation of adequate monitoring equipment and measurement of soil and landscape hydrological parameters for an adequate time period. The data generated can be used for the building of detailed hydrological models (in conjunction with groundwater and surface hydrologists) for the detailed water management on specific sites.

For most wetland delineation exercises a Level 2 or Level 3 assessment should be adequate.

1.4.3 Methodology Employed in this Investigation

The report was generated through:

1. The collection and presentation of baseline land type and topographic data for the site;
2. The thorough consideration of the statutory context of wetlands and the process of wetland delineation;
3. The identification of water related landscape parameters (conceptual and real) for the site for the generation of Level 1 hydropedology information;
4. Aerial photograph interpretation of the site to aid in the Level 1 hydropedology assessment;

5. Assessment of historical impacts and changes on the site through the accessing of various historical aerial photographs and topographic maps;
6. Reconnaissance soil and site survey in terms of soil properties as well as drainage feature properties to generate a Level 2 hydrology assessment; and
7. Presentation of the findings of the various components of the investigation.

2. SITE LOCALITY AND DESCRIPTION

2.1 SURVEY AREA BOUNDARY

The site lies between 25° 38' 58'' and 25° 39' 24'' south and 27° 56' 49'' and 27° 57' 14'' east 15 km west of the town of Brits in the North-West Province (**Figure 1**).

2.2 GENERALISED GEOLOGY

The area surrounding and including the site consists predominantly of basic igneous geology (ferrogabbro, ferrodiorite, diorite, gabbro, norite and anorthosite) with limited and enclosed quartzite, hornfels and shale. The implications of the specific geology on the identification of wetlands and hydromorphy in soils will be discussed later in the report.

2.3 LAND TYPE DATA

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (Soil Classification Working Group, 1991).

The Schietfontein site is situated in the **Ae21** land type (Land Type Survey Staff, 1972 - 2006) with **Figure 2** providing the land type distribution for the area. Below follows a brief description of the land type in terms of soils as well as expected hydromorphic indicators.

Land Type Ae21
Land Type – General: Ae dominantly red high base status (mesotrophic and lime containing) apedal soils, without dunes, that are deeper than 300 mm.
Soils: Soils are predominantly deep and high clay content red apedal and red structured soils from crests to footslope positions with structured swelling soils dominating in valley bottom and drainage depression positions. Due to the geology and local variation structured swelling soils can occur in any level terrain area even if this is in higher lying parts of the landscape.
Indicators of Hydromorphy: Due to the specific geology and other soil forming factors and processes soils in basic igneous geology environments express no signs of wetness in the form of mottles. The

only reliable indicator of saturation in the soils is grey low chroma matrix colours, which occur in drainage depressions only. The specific challenges regarding these landscapes are discussed in more detail later in the report

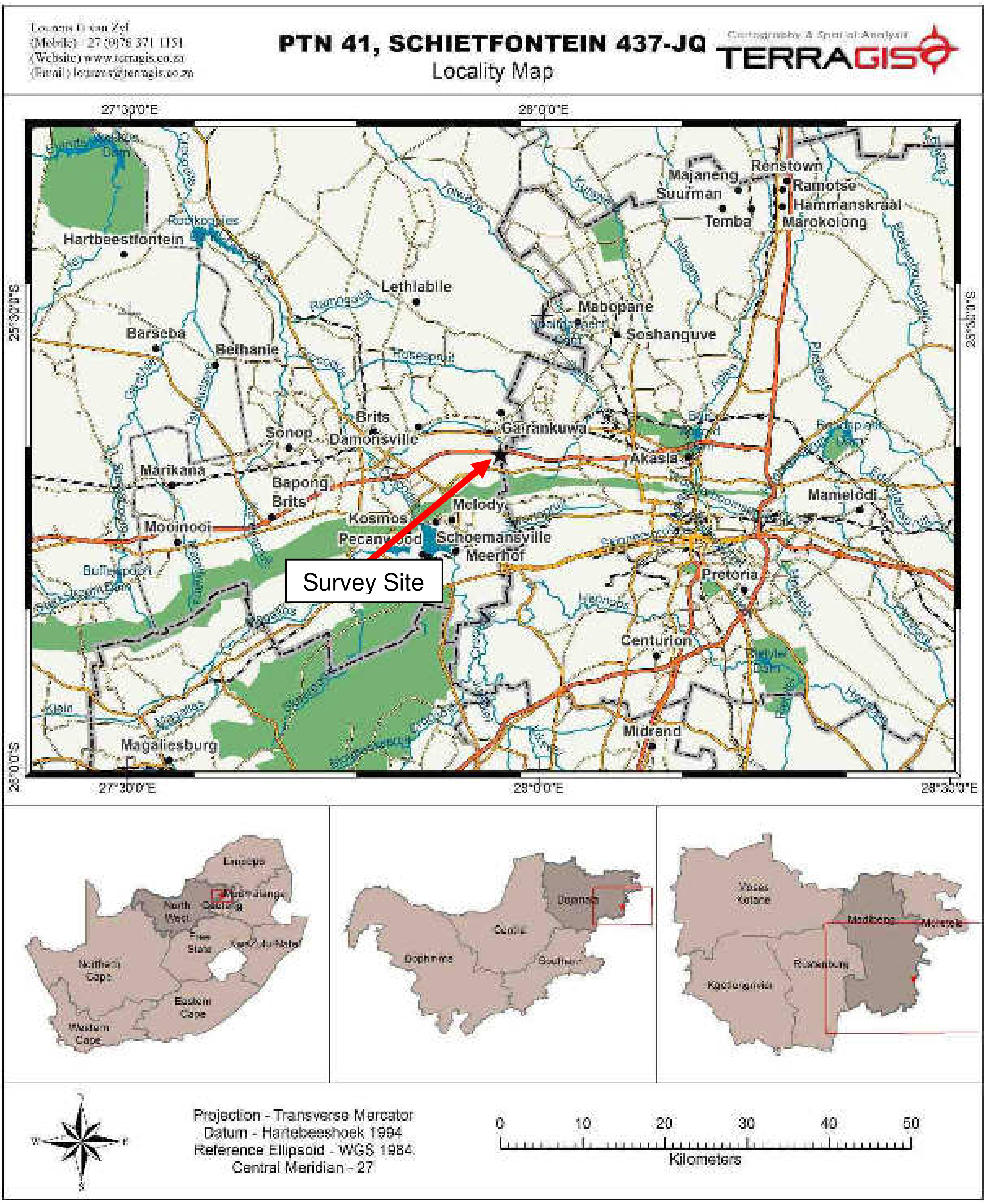

Figure 1 Locality of the survey site

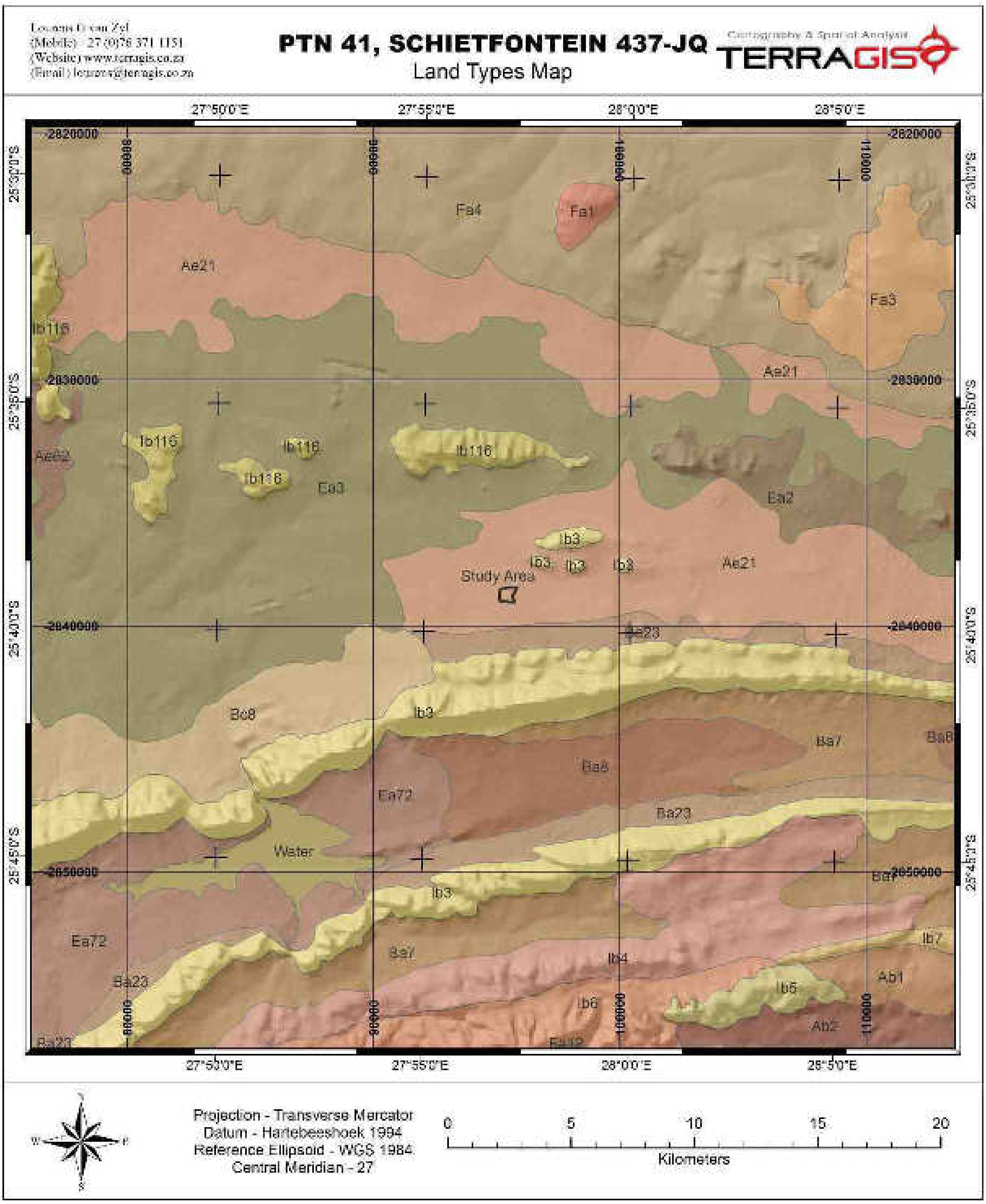

Figure 2 Land type map of the survey site

2.4 TOPOGRAPHY

The topography of the site is flat with a very slight slope towards the north-west (**Figure 3**).

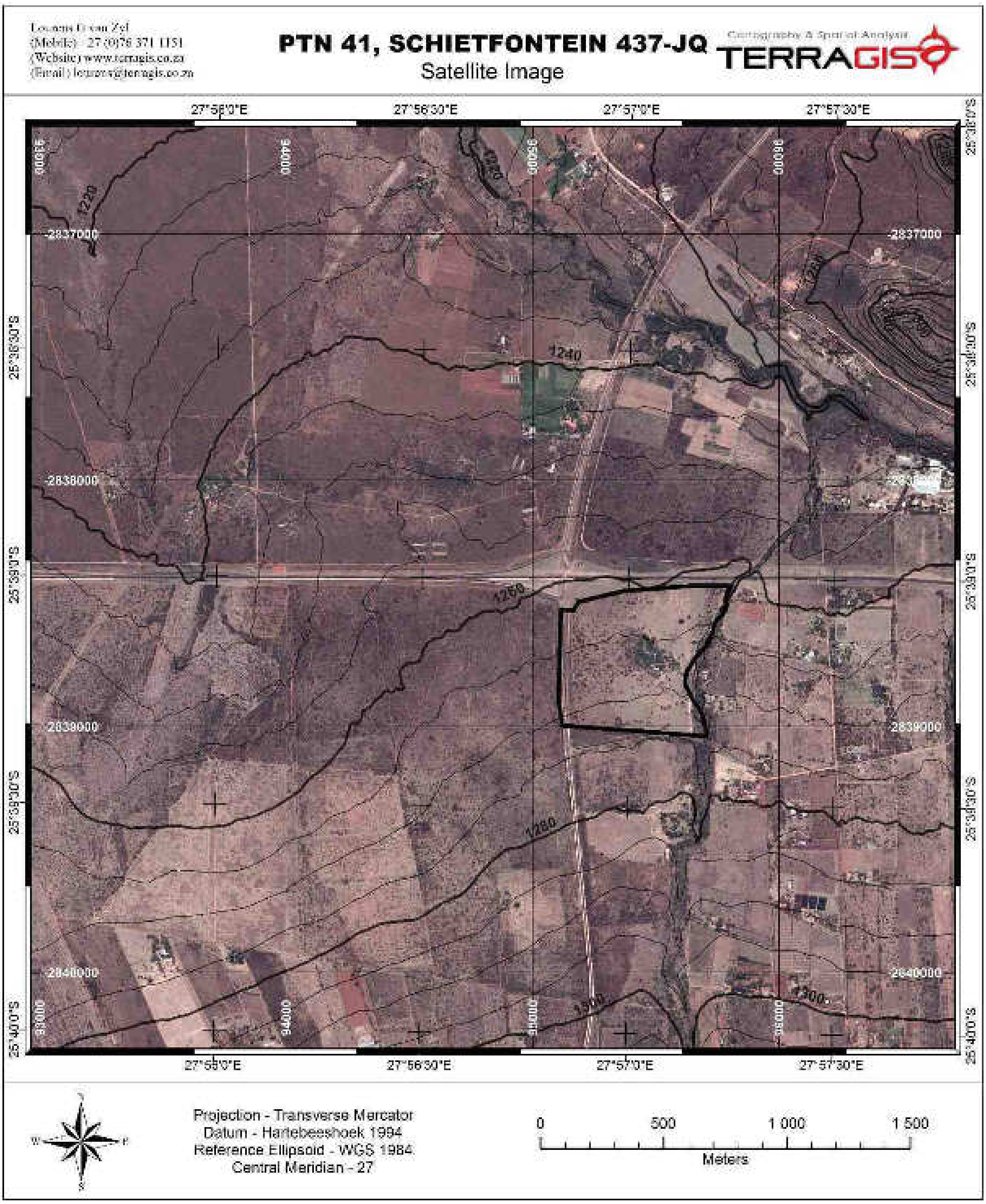

Figure 3 Contours of the general area superimposed on a satellite image

From the contour data a digital elevation model (DEM) was generated for the area and site (**Figure 4**).

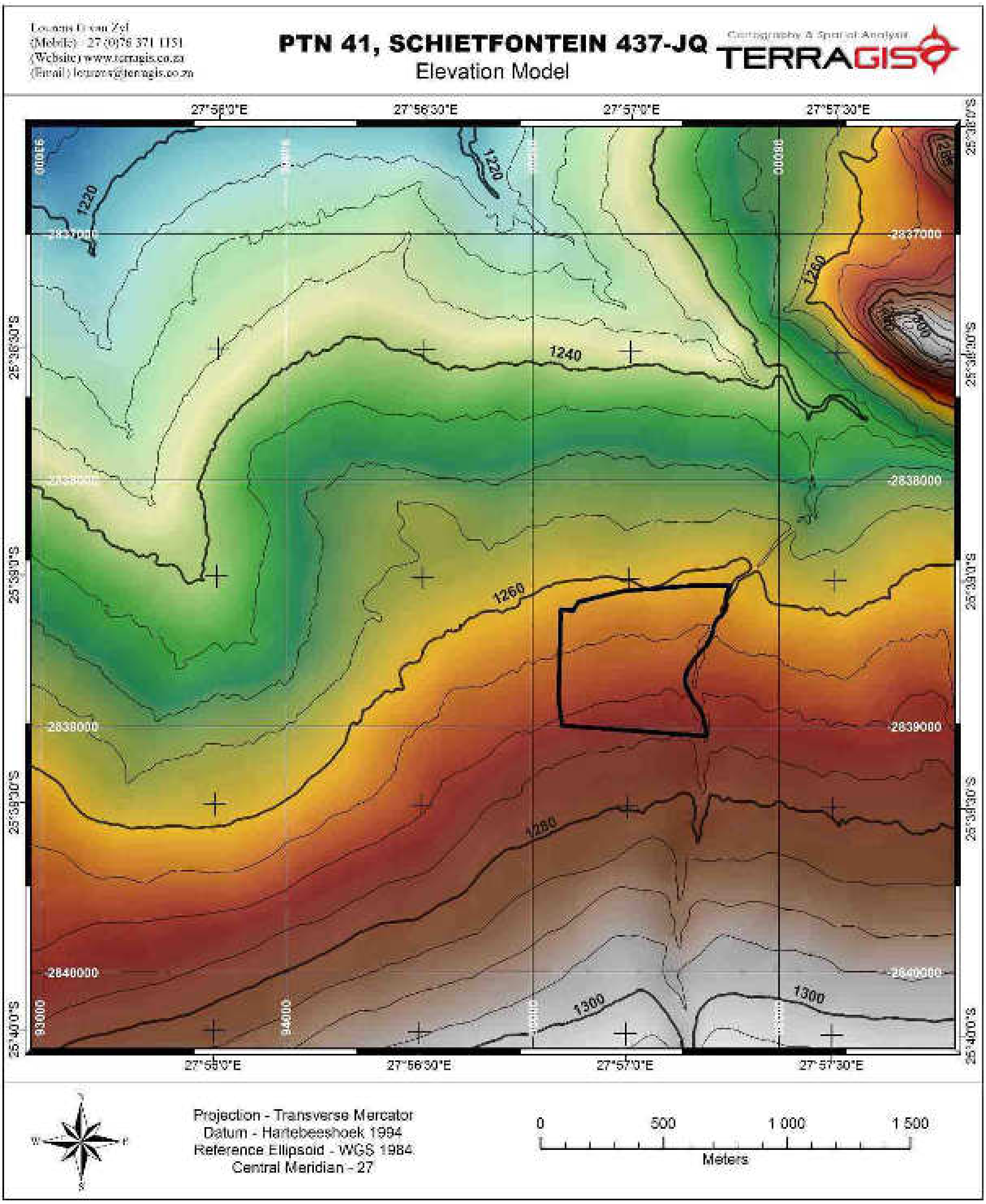

Figure 4 DEM of the survey site and surrounding area

From the contour data a slope map was generated (**Figure 5**) and from this data in turn a topographic wetness index (TWI) was calculated for the site and general area (**Figure 6**). The TWI provides a very accurate indication of water flow paths and areas of water accumulation, which is a function of the topography of the site. On the specific site no distinct drainage depressions were identified.

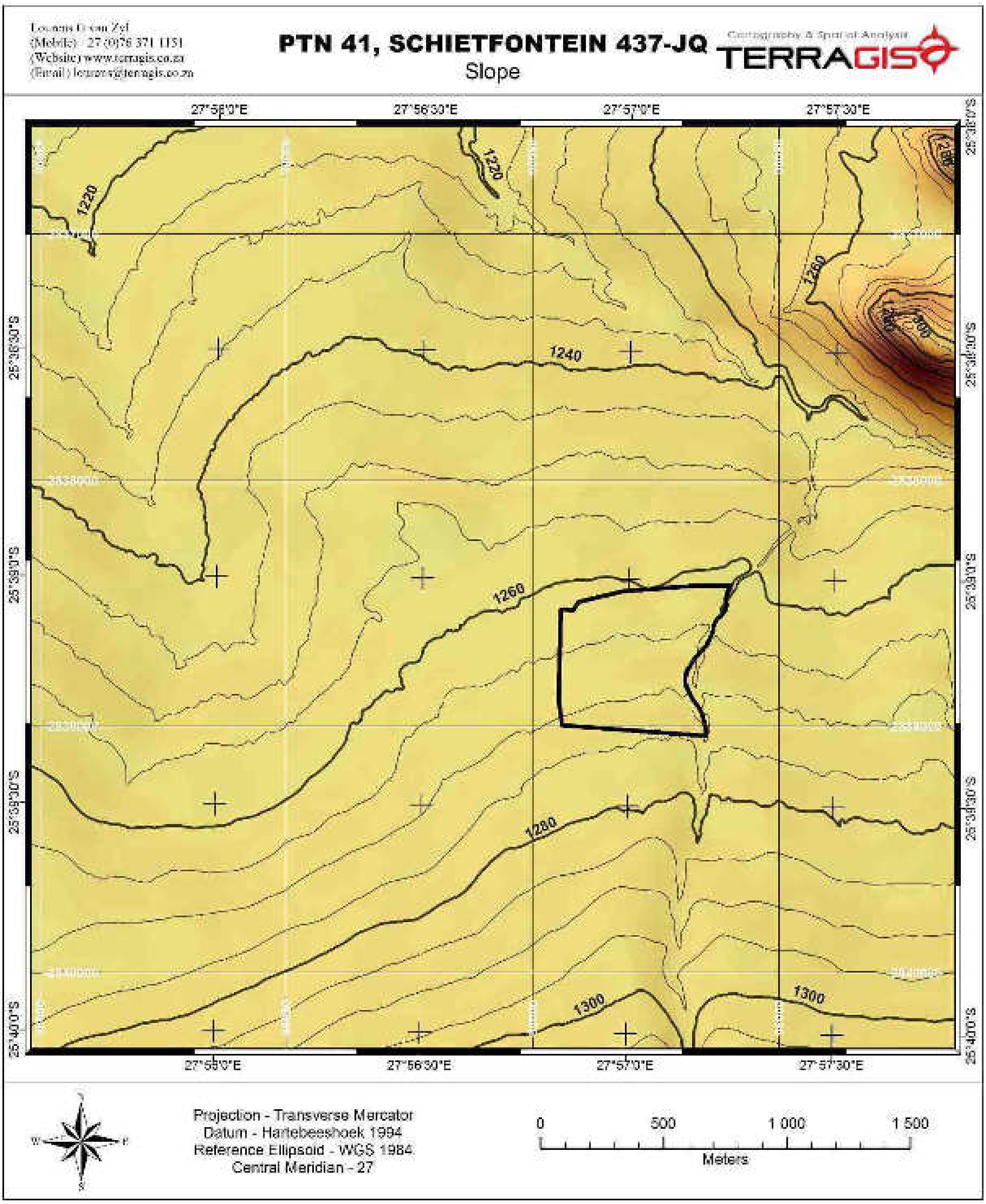

Figure 5 Slope map of the survey site and general area

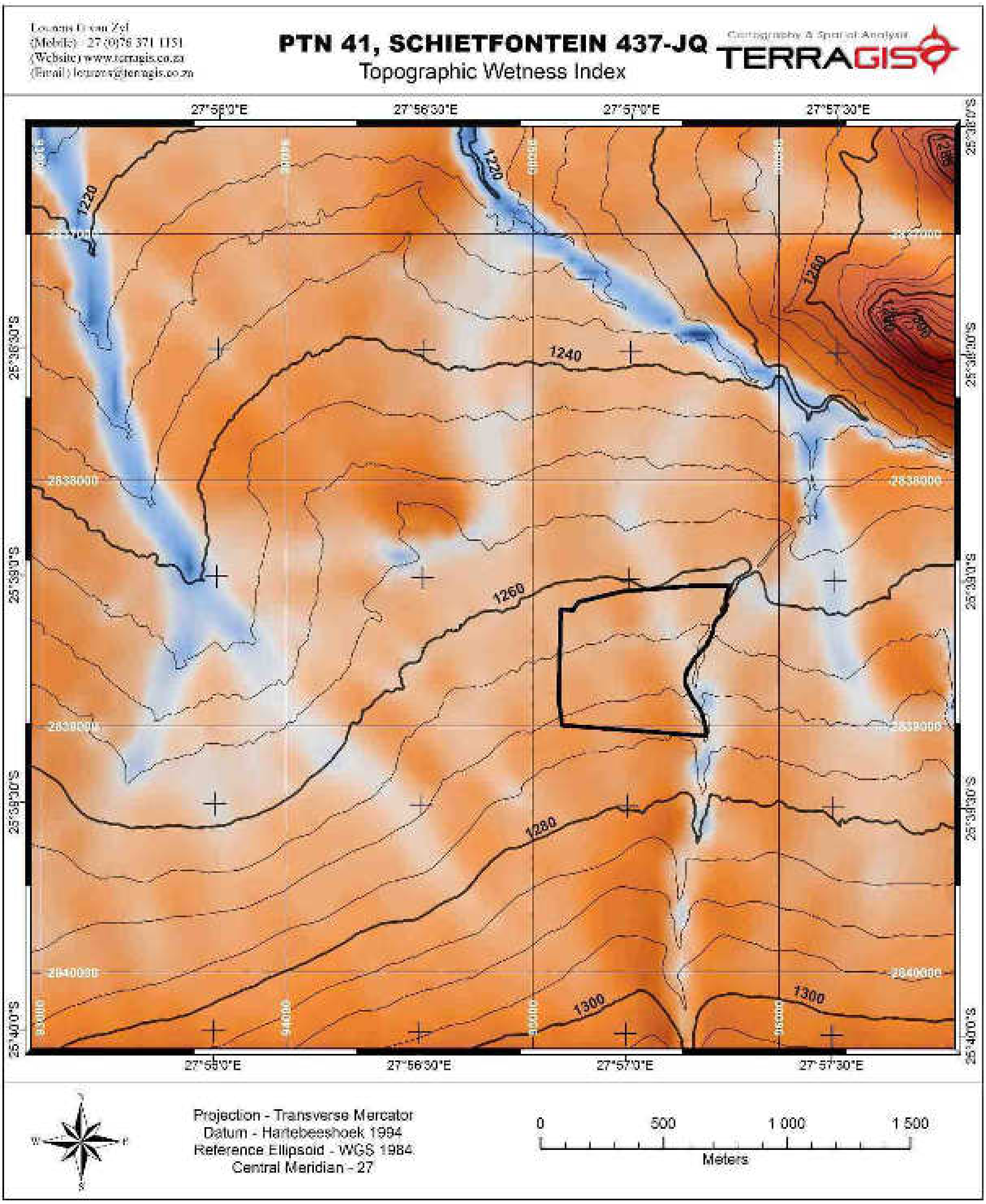

Figure 6 Topographic wetness index (TWI) for the survey site and surrounding area

2.5 AERIAL PHOTOGRAPH INTERPRETATION

An aerial photograph interpretation exercise was conducted through the use of Google Earth images of the site. Historical images spanning the period from 2004 to 2012 were used for the purpose of identifying land use characteristics associated with the site. In addition, the images were used to identify possible wetland areas that could be targeted for investigation during the field survey (addressed in the next section).

2.6 SITE VISIT AND SOIL SURVEY

A site visit and soil survey was conducted on the 26th of March 2014. The site was traversed on foot and soil characteristics were assessed in terms of soil form and hydromorphy (morphological signs of signs of wetness).

Disclaimer: The following sections (3 and 4) represents sections of a discussion that I use as standard in describing the challenges regarding wetland delineation and management in a range of landscapes. This implies that the section is predominantly verbatim the same as in other reports provided to clients and the authorities. Copyright is strictly reserved.

3. WETLANDS: STATUTORY CONTEXT

3.1 WETLAND DEFINITION

Wetlands are defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

From a scientific, practical and legal perspective the interpretation of the definition poses a number of challenges. In order to address the challenges it is necessary to disaggregate the definition and discuss the challenges as follows:

1. "Land which is transitional between terrestrial and aquatic systems …": this implies areas with variable hydrological and ecological characteristics of which the variation can be described as the linear (assumed) transition from one pole (terrestrial/dry) to another (aquatic/wet).
2. "… where the water is usually at or near the surface …": Although the regular condition is implied there is no reference to any empirical interpretation. This aspect therefore introduces uncertainty and the potential for significantly variable interpretation.
3. "… or the land is periodically covered with shallow water …": This statement introduces and alternative to the above statement but, again there is no reference to any empirical interpretation and it therefore introduces uncertainty and the potential for significantly variable interpretation
4. "and which land in normal circumstances …": Normal circumstances are not defined with a subsequent introduction of uncertainty and variability in interpretation. According to

Mernewecke and Kotze (1999) “normal circumstances” in the definition refers to “without human modifications”.

5. “… supports or would support vegetation typically adapted …”: Vegetation species and communities can be described and named and can provide distinctly measurable indicators of wetland conditions. This is therefore a clear indicator if the requisite scientific knowledge is available.
6. “… to life in saturated soil.”: Soil saturation (degree, intensity and duration) can be measured empirically (although at significant financial and time cost) or deduced from the soil morphology to varying degrees of certainty. The soil morphological indictors (all functions of soil forming factors and processes) have been studied and described extensively in the soil science literature.

An evaluation of the disaggregation above yields that the only certain descriptors, from a scientific, practical and legal perspective, are vegetation and soil indicators. In this sense the then Department of Water Affairs and Forestry (DWAF) generated “Resource Directed Measures for the Protection of Water Resources” (DWAF, 1999). In Appendix W6 of the document guidelines for the delineation of wetlands are provided (Mernewecke and Kotze, 1999). In this document distinct emphasis is placed on the use of soil characteristics in conjunction with vegetation characteristics (if present) for the delineation of wetlands. The document also refers specifically to the fact that a certain degree of proficiency in terms of soil classification with the SA Taxonomic System (Soil Classification Working Group, 1991) is required for such surveys. In the event of challenging sites it advises that qualified soils scientists conduct the delineation exercises.

Additionally, from the definition and the purpose of the water act it can be assumed that wetlands are merely the expression of wetness in landscapes and that the water resource can occur in landscapes in many other forms. One form that is not explicitly mentioned is seasonally perched water tables and their associated vadose zones that are instrumental in the “feeding” of wetlands through lateral flow mechanisms in the landscape. From the purpose of the NWA it is assumed that these water resources are included explicitly in the NWA.

3.2 WATERCOURSE DEFINITION

“Catchment” is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

“…, in relation to a watercourse or watercourses or part of a watercourse, means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points;”

“Watercourse” is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

“*(a)* a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the *Gazette*, declare to be a water course,
and a reference to a watercourse includes, where relevant, its bed and banks;”

3.3 THE RESOURCE DIRECTED MEASURES FOR PROTECTION OF WATER RESOURCES.

The following are specific quotes from the "Resource Directed Measures for Protection of Water Resources. Volume 4: Wetland Ecosystems" as published by DWAF (1999).

From the Introduction:

"This set of documents on Resource Directed Measures (RDM) for protection of water resources, issued in September 1999 in Version 1.0, presents the procedures to be followed in undertaking **preliminary determinations of the class, Reserve and resource quality objectives for water resources**, as specified in sections 14 and 17 of the South African National Water Act (Act 36 of 1998).

The development of procedures to determine RDM was initiated by the Department of Water Affairs and Forestry in July 1997. Phase 3 of this project will end in March 2000. Additional refinement and development of the procedures, and development of the full water resource classification system, will continue in Phase 4, until such time as the detailed procedures and full classification system are ready for publication in the Government Gazette.

It should be noted that until the final RDM procedures are published in the Gazette, and prescribed according to section 12 of the National Water Act, all determinations of RDM, whether at the rapid, the intermediate or the comprehensive level, will be considered to be preliminary determinations."

The following components of the RDM document has bearing on this report and these will be discussed in more detail later.

In Appendix W6 the methodology is provided for the delineation of wetland boundaries and zones. The emphasis in this document is on the interpretation of soil characteristics for the identification of the wetland boundaries. This document was the precursor of the wetland delineation guidelines as published by DWAF (2005).

3.4 WETLAND DELINEATION GUIDELINES

In 2005 the Department of Water Affairs and Forestry published a manual entitled "A practical field procedure for identification and delineation of wetland and riparian areas" (DWAF, 2005). The "…manual describes field indicators and methods for determining whether an area is a wetland or riparian area, and for finding its boundaries." The definition of a wetland in the guidelines is that of the NWA and it states that wetlands must have one or more of the following attributes:

- "**Wetland (hydromorphic) soils** that display characteristics resulting from prolonged saturation"
- "The presence, at least occasionally, of **water loving plants (hydrophytes)**"
- "A **high water table** that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil."

The guidelines further list four indicators to be used for the finding of the outer edge of a wetland. These are:

- Terrain Unit Indicator. The terrain unit indicator does not only identify valley bottom wetlands but also wetlands on steep and mild slopes in crest, midslope and footslope positions.
- Soil Form Indicator. A number of soil forms (as defined by MacVicar et al., 1991) are listed as indicative of permanent, seasonal and temporary wetland zones.
- Soil Wetness Indicator. Certain soil colours and mottles are indicated as colours of wet soils. The guidelines stipulate that this is the primary indicator for wetland soils. (Refer to the guidelines for a detailed description of the colour indicators.) In essence, the reduction and removal of Fe in the form of "bleaching" and the accumulation of Fe in the form of mottles are the two main criteria for the identification of soils that are periodically or permanently wet.
- Vegetation Indicator. This is a key component of the definition of a wetland in the NWA. It often happens though that vegetation is disturbed and the guidelines therefore place greater emphasis on the soil form and soil wetness indicators as these are more permanent whereas vegetation communities are dynamic and react rapidly to external factors such as climate and human activities.

The main emphasis of the guidelines is therefore the use soils (soil form and wetness) as the criteria for the delineation of wetlands."

3.5 WETLAND INDICATORS

The wetland indicators discussed above are limited to a degree in the following manner:

1. The topographic indicator is limited to wetlands that are associated with surface topographical variation and it is therefore limited to specific landscape positions. The topographic indicator does not make allowance for variation in physical properties below the soil surface. In this sense aspects such as return-flow zones and interflow zones (that often occur in midslope or footslope positions) are not accommodated. In practice these areas prove the most problematic in terms of interpretation and delineation.
2. The vegetation indicator is limited predominantly by regional and local variation in edaphic and climatic conditions. The regionalization of vegetation guidelines should address this aspect satisfactorily.
3. The soil form indicator suffers from a number of limitations namely:
   a. Soil forms present in an area do not necessarily indicate wetlands. Soil forms have to be viewed in wider context as their classification is also not an auditable process. (Unfortunately pedologists often have significant variation in interpretation!) The presence of a specific soil form may indicate the presence of a wetland though but this aspect will have to be confirmed on the site through additional indicators.
   b. Certain soil forms are erroneously assigned to specific wetland conditions viz. the Rensburg that is assigned to permanent wetland areas but which is actually characterized by dominance of smectite clay minerals that can only form in seasonal wetland conditions. This discussion warrants a report in itself and will therefore not be further elucidated in this report.

c. Improved elucidation of the presence of soil forms in landscapes is required. This is especially relevant as the roles of the soils in wetlands and wetland functioning is often poorly understood. On this topic there are current research projects underway that focus on the description of hillslope hydrology and the soil morphological indicators of such hydrology. Linked to this is the established concept of soil variation along a topographic sequence (catena concept) for specific environments or land types. This aspect links up to the concept of soil formation (pedogenesis) and hydropedology which is finding new and very relevant application in the elucidation of environmental processes.

4. The soil wetness indicator is in all probability the most problematic as there are numerous physical and chemical determinants. The main indicator of reduction is the very handy redox morphological variation of Fe – and this is the assumption that most wetland delineation exercises are based upon. (A dedicated discussion of this aspect is provided later in the report.) There is a distinct variability in expression of the quantity / intensity parameters of mottles in different soil environments. This variation is in most cases linear for simple parameters but soils always exhibit combinations of variable parameters that make linear interpretation highly suspect and problematic. A brief elucidation of the problem components include:
    a. The Fe content and reserve of soils and parent material vary significantly and impart varying expression of Fe redox morphology with consequent challenges in interpretation. This aspect induces variation between landscapes with homogenous parent materials (within the specific landscape) or within landscapes where variation in parent materials is found within the landscape.
    b. The Mn content of soils influence redox poise processes that in turn influence the expression of Fe redox morphology. Additional sources of variation include:
        i. Textural influences on expression of mottles;
        ii. Climatic / rainfall gradients; and
        iii. Variation in pH gradients linked to electron activity (Eh). The redox morphology changes linearly with these parameters with the distinct expression of mottles (intensity, colour, contrast) decreasing linearly with increasing pH (even if Eh remains constant).
        iv. In neutral to low pH soils the dominant Fe minerals are Fe oxides and hydroxides – all with bright colours leading to the expression of discernible mottling. In high pH soils the dominant secondary Fe mineral is siderite ($FeCO_3$) which is white in colour that is often associated with lime accumulations (also white). Therefore, alkaline soil environments often do not exhibit distinctly discernible Fe redox morphology. Linked to this is the fact that lime accumulation is also a factor of climate and aridity and lime accumulations can therefore not be used as an indication of reduction even though there are distinct links.
    c. Soil colour varies significantly between different chemical and physical environments (even if pH and Eh remains relatively similar) and as such one set of wetness criteria cannot be applied universally.
    d. With the advancement of science concepts that were accepted to be true 30 years ago are now considered erroneous. A distinct example of this is references to "blue green colouration" in soils classification texts that indicate conditions of distinct saturation in those texts. This colouration has, with recent research, been proven to

occur under very specific redox conditions that indicate only intermediate reduction, even though the soil may be saturated. The historically held conviction that “saturation equals reduction” has been proven to not apply religiously in all environments. It is therefore imperative that the application (wetland delineation) keeps up with the science.

3.6 Proposed Improvements

Having indicated that there are numerous limitations to the current wetland delineation approach it is important to focus on dedicated improvements that can implemented/incorporated easily. These improvements include:

1. Updating of the current delineation guidelines (including the draft version from 2008) to serve as a national standard document indicating variability in SA (broadly) through:
    a. Improvement of the landscape indicator to include seepage (including interflow, seepage and return-flow wetlands)
    b. Improvement and correction of the soil form indicator description. Introduction of the concept of “driest soils on crests and wettest soils in depressions” as a method of determining the range of soil variation in specific landscapes.
    c. Improvement and correction of the soil wetness indicator description to reflect differing pH/Eh/parent material environments. Linking of soil wetness indicators to the concept of “driest soils on crests and wettest soils in depressions” as a method of determining range of soil variation in different landscapes.
    d. Introduction of measuring and inference tools for generation of empirical data on wetness.
    e. Introduction of regional and/or land type based detailed guidelines that will include:
        i. Localized topographic indicators and pointers / aids;
        ii. Localized soil form sequences (catena) and soil form variability. (Utilize method of soil form variation range in land type); and
        iii. Localized variation in terms of soil wetness indicators. (Utilize method of soil form variation range in land type).
2. Correction of scientific inaccuracies and inconsistencies in the current documents and improvement of the principles and guidelines to a proper standard through focused research, peer review and formal publication.

4. CHALLENGES REGARDING WETLAND DELINEATION IN ALKALINE SOILS

In order to discuss the procedures followed and the results of the wetland identification exercise it is necessary at the outset to provide some theoretical background on soil forming processes, soil wetness indicators, water movement in soils and topographical sequences of soil forms (catena).

4.1 PEDOGENESIS

Pedogenesis is the process of soil formation. Soil formation is a function of five (5) factors namely (Jenny, 1941):

- Parent material;
- Climate;
- Topography;
- Living Organisms; and
- Time.

These factors interact to lead to a range of different soil forming processes that ultimately determine the specific soil formed in a specific location. Central to all soil forming processes is water and all the reactions (physical and chemical) associated with it. The physical processes include water movement onto, into, through and out of a soil unit. The movement can be vertically downwards, lateral or vertically upwards through capillary forces and evapotranspiration. The chemical processes are numerous and include dissolution, precipitation (of salts or other elements) and alteration through pH and reduction and oxidation (redox) changes. In many cases the reactions are promoted through the presence of organic material that is broken down through aerobic or anaerobic respiration by microorganisms. Both these processes alter the redox conditions of the soil and influence the oxidation state of elements such as Fe and Mn. Under reducing conditions Fe and Mn are reduced and become more mobile in the soil environment. Oxidizing conditions, in turn, lead to the precipitation of Fe and Mn and therefore lead to their immobilization. The dynamics of Fe and Mn in soil, their zones of depletion through mobilization and accumulation through precipitation, play an important role in the identification of the dominant water regime of a soil and could therefore be used to identify wetlands and wetland conditions.

4.2 WATER MOVEMENT IN THE SOIL PROFILE

In a specific soil profile, water can move upwards (through capillary movement), horizontally (owing to matric suction) and downwards under the influence of gravity.

The following needs to be highlighted in order to discuss water movement in soil:

- Capillary rise refers to the process where water rises from a deeper lying section of the soil profile to the soil surface or to a section closer to the soil surface. Soil pores can be regarded as miniature tubes. Water rises into these tubes owing to the adhesion (adsorption) of water molecules onto solid mineral surfaces and the surface tension of water.

  The height of the rise is inversely proportional to the radius of the soil pore and the density of the liquid (water). It is also directly proportional to the liquid's surface tension and the degree of its adhesive attraction. In a soil-water system the following simplified equation can be used to calculate this rise:

$$\text{Height} = 0.15/\text{radius}$$

Usually the eventual height of rise is greater in fine textured soil, but the rate of flow may be slower (Brady and Weil, 1999; Hillel, 1983).

- Matric potential or suction refers to the attraction of water to solid surfaces. Matric potential is operational in unsaturated soil above the water table while pressure potential refers to water in saturated soil or below the water table. Matric potential is always expressed as a negative value and pressure potential as a positive value.

  Matric potential influences soil moisture retention and soil water movement. Differences in the matric potential of adjoining zones of a soil results in the movement of water from the moist zone (high state of energy) to the dry zone (low state of energy) or from large pores to small pores.

  The maximum amount of water that a soil profile can hold before leaching occurs is called the field capacity of the soil. At a point of water saturation, a soil exhibits an energy state of 0 $J.kg^{-1}$. Field capacity usually falls within a range of -15 to -30 $J.kg^{-1}$ with fine textured soils storing larger amounts of water (Brady and Weil, 1999; Hillel, 1983).

- Gravity acts on water in the soil profile in the same way as it acts on any other body; it attracts towards earth's centre. The gravitational potential of soil water can be expressed as:

  $$\text{Gravitational potential} = \text{Gravity} \times \text{Height}$$

  Following heavy rainfall, gravity plays an important part in the removal of excess water from the upper horizons of the soil profile and recharging groundwater sources below.

  Excess water, or water subject to leaching, is the amount of water that falls between soil saturation (0 $J.kg^{-1}$) or oversaturation (> 0 $J.kg^{-1}$), in the case of heavy rainfall resulting in a pressure potential, and field capacity (-15 to -30 $J.kg^{-1}$). This amount of water differs according to soil type, structure and texture (Brady and Weil, 1999; Hillel, 1983).

- Under some conditions, at least part of the soil profile may be saturated with water, resulting in so-called saturated flow of water. The lower portions of poorly drained soils are often saturated, as are well-drained soils above stratified (layers differing in soil texture) or impermeable layers after rainfall.

  The quantity of water that flows through a saturated column of soil can be calculated using Darcy's law:

  $$Q = Ksat.A.\Delta P/L$$

  Where Q represents the quantity of water per unit time, Ksat is the saturated hydraulic conductivity, A is the cross sectional area of the column through which the water flows, ΔP is the hydrostatic pressure difference from the top to the bottom of the column, and L is the length of the column.

Saturated flow of water does not only occur downwards, but also horizontally and upwards. Horizontal and upward flows are not quite as rapid as downward flow. The latter is aided by gravity (Brady and Weil, 1999; Hillel, 1983).

- Mostly, water movement in soil is ascribed to the unsaturated flow of water. This is a much more complex scenario than water flow under saturated conditions. Under unsaturated conditions only the fine micropores are filled with water whereas the macropores are filled with air. The water content, and the force with which water molecules are held by soil surfaces, can also vary considerably. The latter makes it difficult to assess the rate and direction of water flow. The driving force behind unsaturated water flow is matric potential. Water movement will be from a moist to a drier zone (Brady and Weil, 1999; Hillel, 1983).

The following processes influence the amount of water to be leached from a soil profile:

- Infiltration is the process by which water enters the soil pores and becomes soil water. The rate at which water can enter the soil is termed infiltration tempo and is calculated as follows:

  $$I = Q/A.t$$

  Where I represents infiltration tempo ($m.s^{-1}$), Q is the volume quantity of infiltrating water (m^3), A is the area of the soil surface exposed to infiltration (m^2), and t is time (s).

  If the soil is quite dry when exposed to water, the macropores will be open to conduct water into the soil profile. Soils that exhibit a high 2:1 clay content (swelling-shrinking clays) will exhibit a high rate of infiltration initially. However, as infiltration proceeds, the macropores will become saturated and cracks, caused by dried out 2:1 clay, will swell and close, thus leading to a decline in infiltration (Brady and Weil, 1999; Hillel, 1983).

- Percolation is the process by which water moves downward in the soil profile. Saturated and unsaturated water flow is involved in the process of percolation, while the rate of percolation is determined by the hydraulic conductivity of the soil.

  During a rain storm, especially the down pouring of heavy rain, water movement near the soil surface mainly occurs in the form of saturated flow in response to gravity. A sharp boundary, referred to as the wetting front, usually appears between the wet soil and the underlying dry soil. At the wetting front, water is moving into the underlying soil in response to both matric and gravitational potential. During light rain, water movement at the soil surface may be ascribed to unsaturated flow (Brady and Weil, 1999; Hillel, 1983).

  The fact that water percolates through the soil profile by unsaturated flow has certain ramifications when an abrupt change in soil texture occurs (Brady and Weil, 1999; Hillel, 1983). A layer of course sand, underlying a fine textured soil, will impede downward movement of water. The macropores of the coarse textured sand offer less attraction to the water molecules than the macropores of the fine textured soil. When the unsaturated wetting front reaches the coarse sand, the matric potential is lower in the sand than in the overlying material. Water always moves from a higher to a lower state of energy. The water can, therefore, not move into the coarse textured sand. Eventually, the downward moving water will accumulate above the sand layer and nearly saturate the fine textured soil. Once this occurs, the water will be held so loosely that gravitational forces will be able to drag the water into the sand layer (Brady and Weil, 1999; Hillel, 1983).

A coarse layer of sand in an otherwise fine textured soil profile will also inhibit the rise of water by capillary movement (Brady and Weil, 1999; Hillel, 1983).

Field observations and laboratory based analysis can aid in assessing the soil-water relations of an area. The South African soil classification system (Soil Classification Working Group, 1991.) comments on certain field observable characteristics that shed light on water movement in soil. The more important of these are:

- Soil horizons that show clear signs of leaching such as the E-horizon – an horizon where predominantly lateral water movement has led to the mobilisation and transport of sesquioxide minerals and the removal of clay material;
- Soil horizons that show clear signs of a fluctuating water table where Fe and Mn mottles, amongst other characteristics, indicate alternating conditions of reduction and oxidation (soft plinthic B-horizon);
- Soil horizons where grey colouration (Fe reduction and redox depletion), in an otherwise yellowish or reddish matrix, indicate saturated (or close to saturated) water flow for at least three months of the year (Unconsolidated/Unspecified material with signs of wetness);
- Soil horizons that are uniform in colouration and indicative of well-drained and aerated (oxidising) conditions (e.g. yellow brown apedal B-horizon).

4.3 WATER MOVEMENT IN THE LANDSCAPE

Water movement in a landscape is a combination of the different flow paths in the soils and geological materials. The movement of water in these materials is dominantly subject to gravity and as such it will follow the path of least resistance towards the lowest point. In the landscape there are a number of factors determining the paths along which this water moves. **Figure 7** provides a simplified schematic representation of an idealised landscape (in “profile curvature”. The total precipitation (rainfall) on the landscape from the crest to the lowest part or valley bottom is taken as 100 %. Most geohydrologists agree that total recharge, the water that seeps into the underlying geological strata, is less than 4 % of total precipitation for most geological settings. Surface runoff varies considerably according to rainfall intensity and distribution, plant cover and soil characteristics but is taken as a realistic 6 % of total precipitation for our idealised landscape. The total for surface runoff and recharge is therefore calculated as 10 % of total precipitation. If evapotranspiration (from plants as well as the soil surface) is taken as a very high 30 % of total precipitation it leaves 60 % of the total that has to move through the soil and/or geological strata from higher lying to lower lying areas. In the event of an average rainfall of 750 mm per year it results in 450 mm per year having to move laterally through the soil and geological strata. In a landscape there is an accumulation of water down the slope as water from higher lying areas flow to lower lying areas.

To illustrate: If the assumption is made that the area of interest is 100 m wide it follows that the first 100 m from the crest downwards has 4 500 m^3 (or 4 500 000 litres) of water moving laterally through the soil (100 m X 100 m X 0.45 m) per rain season. The next section of 100 m down the slope has its own 4 500 m^3 of water as well as the added 4 500 m^3 from the upslope section to contend with, therefore 9 000 m^3. The next section has 13 500 m^3 to contend with and the following one 18 000 m^3. It is therefore clear that, the longer the slope, the larger the volume of water that will move laterally through the soil profile.

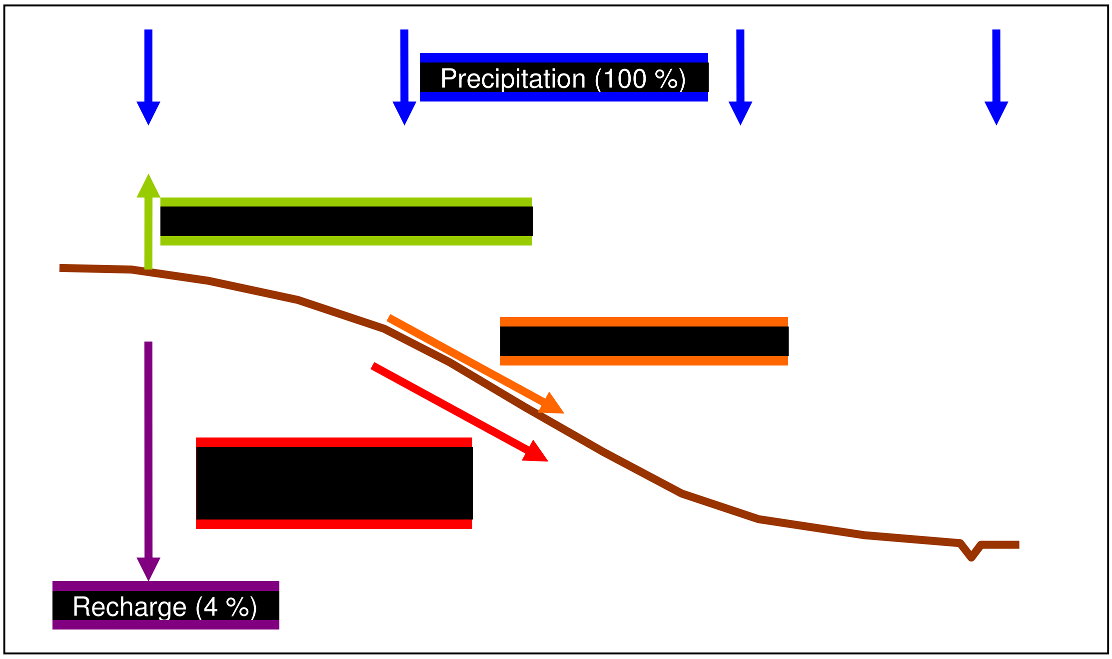

Figure 7 Idealised landscape with assumed quantities of water moving through the landscape expressed as a percentage of total precipitation (100 %).

Flow paths through soil and geological strata, referred to as “interflow” or “hillslope water”, are very varied and often complex due to difficulty in measurement and identification. The difficulty in identification stems more from the challenges related to the physical determination of these in soil profile pits, soil auger samples and core drilling samples for geological strata. The identification of the morphological signs of water movement in permeable materials or along planes of weakness (cracks and seams) is a well-established science and the expression is mostly referred to as “redox morphology”. In terms of the flow paths of water large variation exists but these can be grouped into a few simple categories. **Figure 8** provides a schematic representation of the different flow regimes that are usually encountered. The main types of water flow can be grouped as 1) recharge (vertically downwards) of groundwater; 2) lateral flow of water through the landscape along the hillslope (interflow or hillslope water); 3) return flow water that intercepts the soil/landscape surface; and 4) surface runoff. Significant variation exists with these flow paths and numerous combinations are often found. The main wetland types associated with the flow paths are: a) valley bottom wetlands (fed by groundwater, hillslope processes, surface runoff, and/or in-stream water); b) hillslope seepage wetlands (fed by interflow water and/or return flow water); and wetlands associated with surface runoff, ponding and surface ingress of water anywhere in the landscape.

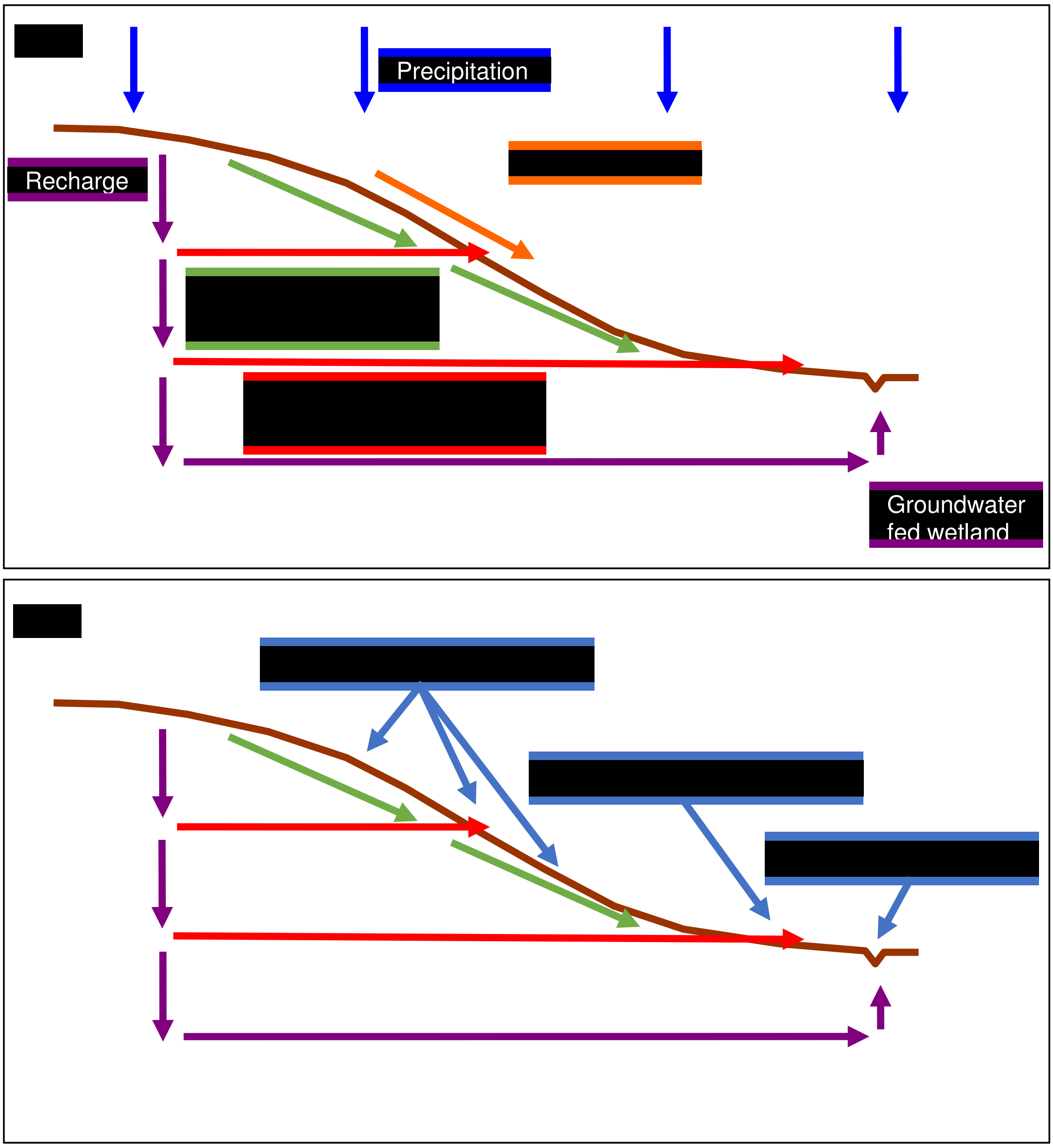

Figure 8 Different flow paths of water through a landscape (a) and typical wetland types associated with the water regime (b)

Amongst other factors, the thickness of the soil profile at a specific point will influence the intensity of the physical and chemical reactions taking place in that soil. **Figure 9** illustrates the difference between a dominantly thick and a dominantly thin soil profile. If all factors are kept the same except for the soil profile thickness it can be assumed with confidence that the chemical and physical reactions associated with water in the landscape will be much more intense for the thin soil profile than for the thick soil profile. Stated differently: The volume of water moving through the soil per surface area of an imaginary plane perpendicular to the direction of water flow is much higher for the thin soil profile than for the thick soil profile. This aspect has a significant influence on the expression of redox morphology in different landscapes of varying soil/geology/climate composition.

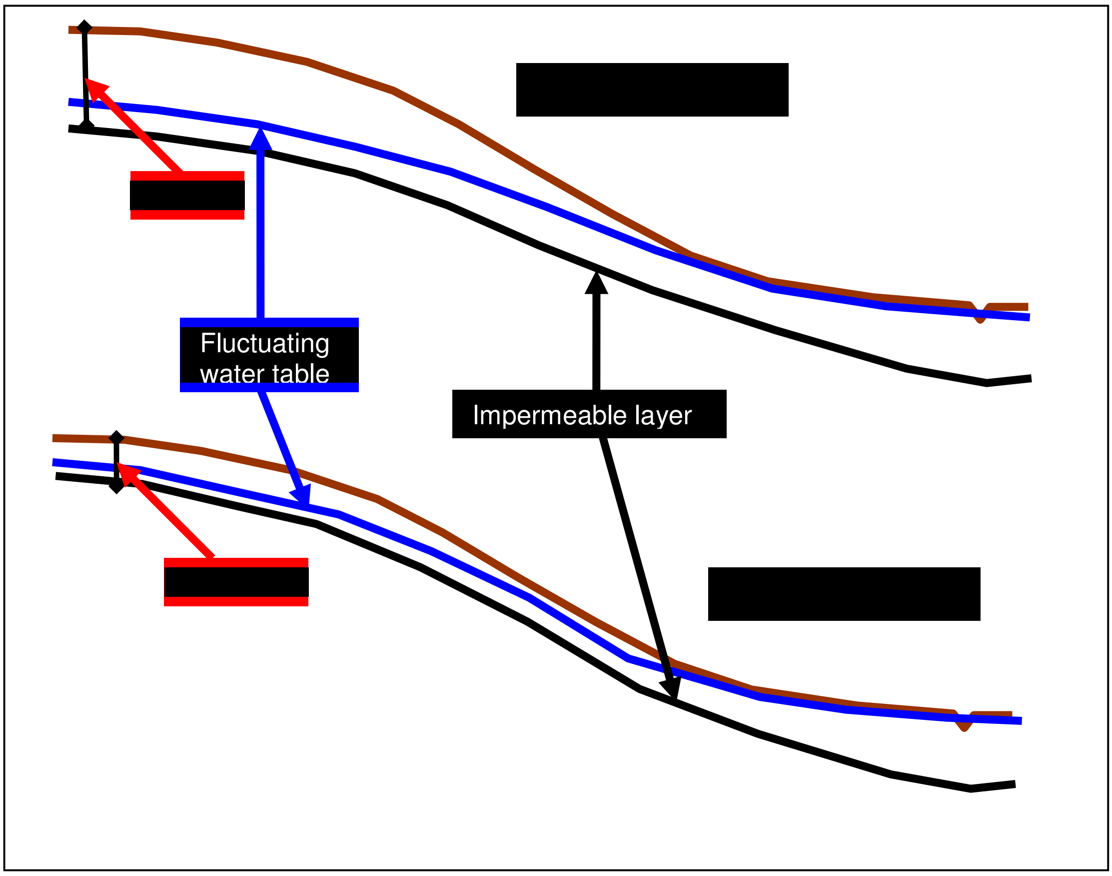

Figure 9 The difference in water flow between a dominantly thick and dominantly thin soil profile.

4.4 THE CATENA CONCEPT

Here it is important to take note of the "catena" concept. This concept is one of a topographic sequence of soils in a homogenous geological setting where the water movement and presence in the soils determine the specific characteristics of the soils from the top to the bottom of the topography. **Figure 10** illustrates an idealised topographical sequence of soils in a catena for a quartz rich parent material. Soils at the top of the topographical sequence are typically red in colour (Hutton and Bainsvlei soil forms) and systematically grade to yellow further down the slope (Avalon soil form). As the volume of water that moves through the soil increases, typically in midslope areas, periodic saturated conditions are experienced and consequently Fe is reduced and removed in the laterally flowing water. In the event that the soils in the midslope positions are relatively sandy the resultant soil colour will be bleached or white due to the colour dominance of the sand quartz particles. The soils in these positions are typically of the Longlands and Kroonstad forms. Further down the slope there is an accumulation of clays and leaching products from higher lying soils and this leads to typical illuvial and clay rich horizons. Due to the regular presence of water the dominant conditions are anaerobic and reducing and the soils exhibit grey colours often with bright yellow and grey mottles (Katspruit soil form). In the event that there is a large depositional environment with prolonged saturation soils of the Champagne form may develop (typical peat land). Variations on this sequence (as is often found on the Mpumalanga Highveld) may include the presence of hard plinthic materials instead of soft plinthite with a consequent increase in the occurrence of bleached soil profiles. Extreme examples of such landscapes are discussed below.

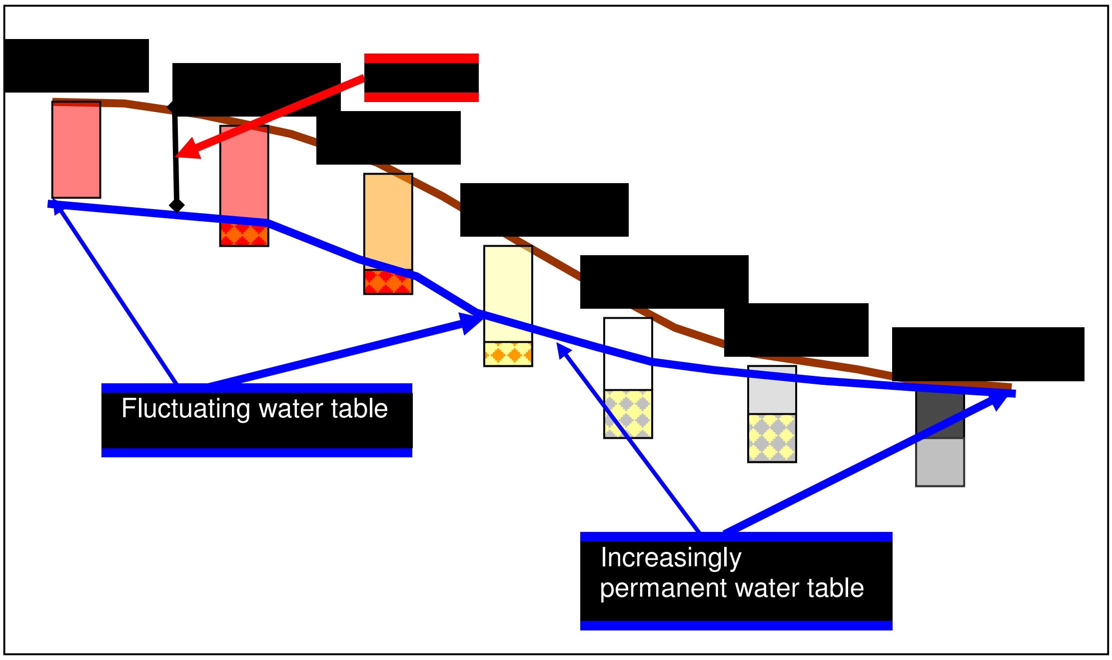

Figure 10 Idealised catena on a quartz rich parent material.

4.5 Convex Versus Concave Landscapes in an Idealised Catena

An additional factor of variation in all landscapes is the shape of the landscape along contours (referred to a "plan curvature"). Landscapes can be either concave or convex, or flat. The main difference between these landscapes lies in the fact that a convex landscape is essentially a watershed with water flowing in diverging directions with a subsequent occurrence of "dryer" soil conditions. In a concave landscape water flows in converging directions and soils often exhibit the wetter conditions of "signs of wetness" such as grey colours, organic matter and subsurface clay accumulation. **Figure 11** presents the difference between these landscapes in terms of typical soil forms encountered in an idealised catena. In the convex landscape the subsurface flow of water removes clays and other weathering products (including Fe) in such a way that the midslope position soils exhibit an increasing degree of bleaching and relative accumulation of quartz (E-horizons).

In the concave landscapes clays and weathering products are transported through the soils into a zone of accumulation where soils start exhibiting properties of clay and Fe accumulation. In addition, coarse sandy soils in convex environments tend to be thinner due to the removal of sand particles through erosion and soils in concave environments tend to be thicker due to colluvial accumulation of material transported from upslope positions. Similar patterns are observed for other geological areas with the variation being consistent with the soil variation in the catena.

Often these concave and convex topographical environments occur in close proximity or in one topographical sequence of soils. This is often found where a convex upslope area changes into a concave environment as a drainage depression is reached (**Figure 12**). The processes in this landscape are the same as those described for the convex and concave landscapes above.

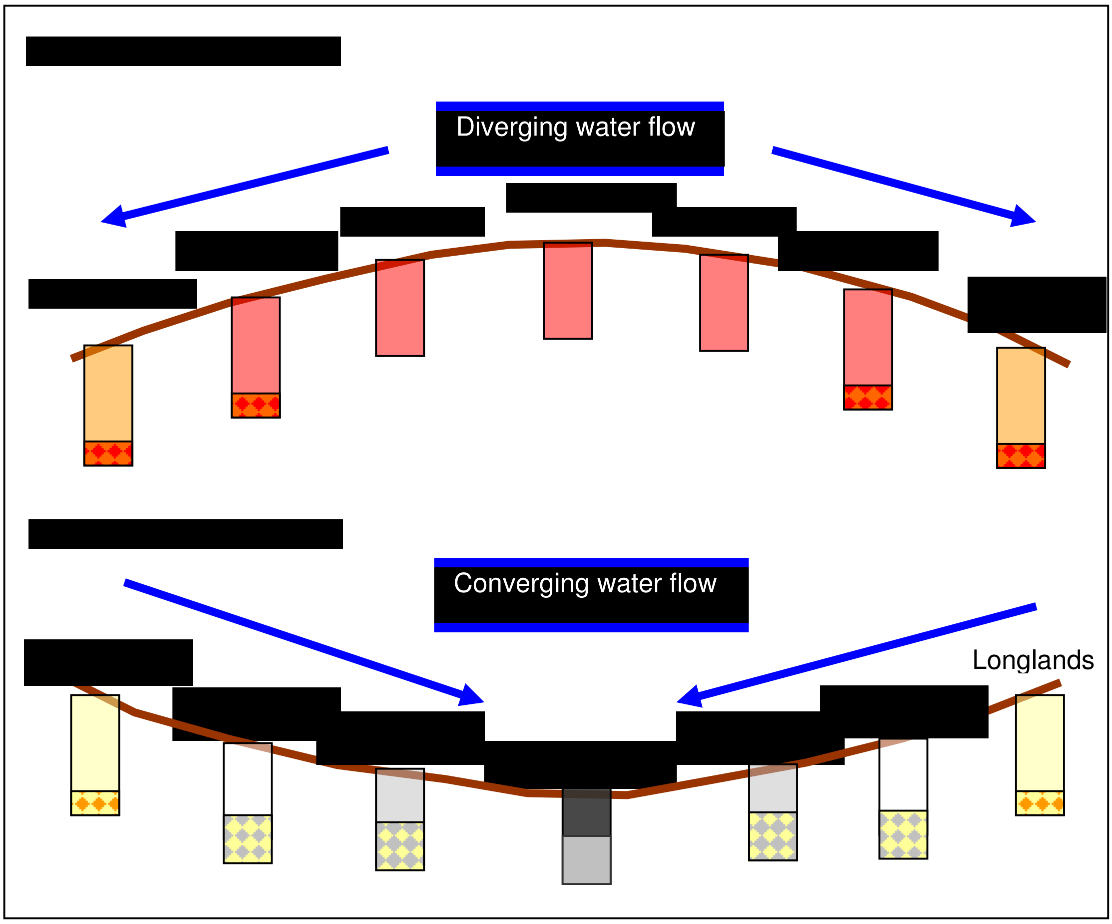

Figure 11 Schematic representation of the soils in convex and concave landscapes in an idealised catena

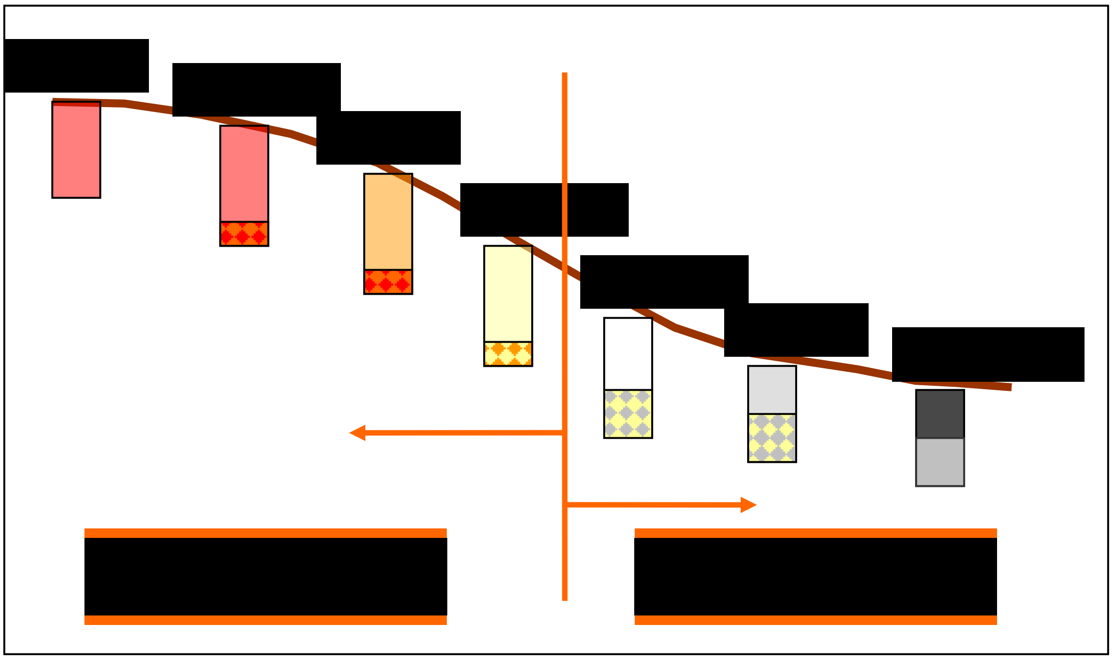

Figure 12 Schematic representation of the soils in a combined convex and concave landscape in an idealised catena.

4.6 THE AE21 LAND TYPE CATENA

The typical catena that forms in the **Ae21** land type (**Figure 13**) differs from the idealised one discussed above in that this land type is characterised by high clay content and often structured soils with a high base status with above neutral pH values. The subsoils are structured and grading into weathered rock. The lower landscape positions are characterised by similar soils but with darker A horizons as well as an increase in the clay content and degree of structure development. The specific clay minerals (2:1 swelling and non-swelling clays) that occur in these landscapes form under above neutral pH conditions. This aspect has very specific implications for the identification of morphological signs of wetness. Wetlands are invariably associated with the lowest points in the landscape and as such this aspect is critical (and therefore addressed in more detail later). Due to the high clay content (and often swelling nature) the soils are characterised predominantly by surface flow of water with very slow percolation rates through the profiles. Lateral flow of water on impervious layers is therefore not encountered with the exception being planes of weakness in the underlying weathered and hard rock. The drainage depressions in these landscapes often exhibit signs of high energy flow events in the form of eroded soils as well as young recently transported soil material.

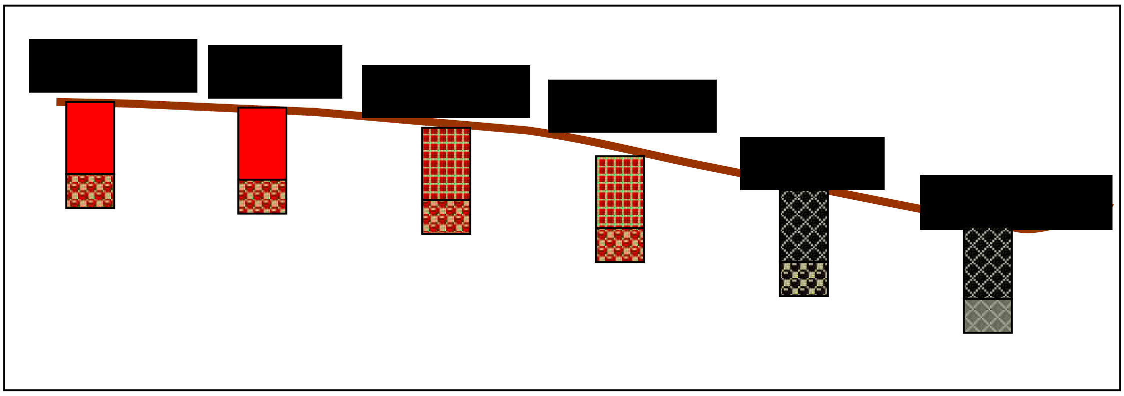

Figure 13 Idealised catena in the Ae21 land type

4.7 REDOX MORPHOLOGY IN ALKALINE SOILS

Wetland delineation is a very challenging exercise in areas dominated by alkaline soils such as lime containing and/or vertic/melanic soils. This is mainly due to the almost complete absence of Fe-mottles in the soils that grade from the terrestrial to the wetland areas. There are a number of reasons that will be explained in more detail below.

In order to illustrate the stability and distribution of Fe minerals in soils the figure provided below (**Figure 14**) was copied from page 124 of a book entitled "Soil Chemistry" by Bohn, et al., (1990). The essence is that when reduction and oxidation reactions of Fe (in this case) are considered in soils both the electron activity (driver of reducing conditions) and pH have to be considered as they are intimately linked and dependent on each other. Suffice to say that for redox and mineral stability purposes they are indicated on the same graph. From Figure 4.6 (**Figure 14**) it is clear that as the Eh decreases (increasing reducing conditions) the dominant Fe species in solution changes from Fe^{3+} (insoluble and forming brightly coloured minerals) to Fe^{2+} (soluble and essentially colourless).

Once pH is included in the observation it is clear that distinct Fe minerals come into play. Applying the decreasing Eh values to Fe minerals at high pH it is clear that the dominant Fe mineral under oxidizing conditions is FeOOH (Goethite – predominantly yellow). As the conditions become more reducing the equilibrium shifts to $FeCO_3$ (Siderite – white) and thereafter to FeS_2 (Pyrite). Whereas goethite has a distinct colour in soil, siderite and pyrite are less conspicuous in small quantities. It follows therefore that Fe minerals are much less visible in high pH reduced soils than in oxidised soils. In addition, vertic and melanic soils are dark coloured and it is therefore also clear that this dark colour will mask the presence of the above mentioned Fe minerals.

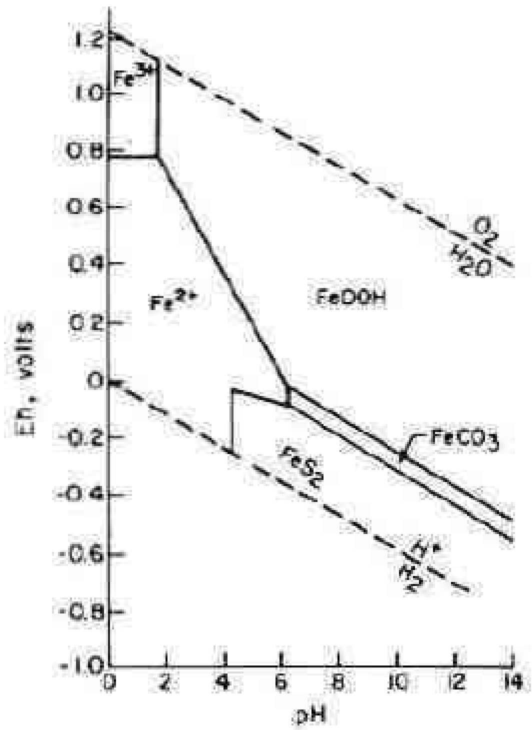

FIGURE 4.6. The *Eh*–pH diagram of various iron ions and compounds.

Figure 14 Eh pH diagram as sourced from Bohn, et al., (1990) p124

Another factor related to pH is the degree of reduction that is required to reduce Fe from its oxidised to its reduced state. From the graph it is clear that there is a steep decreasing gradient as the pH of the soil increases. This implies that much more intensive reducing conditions are required for the same degree of Fe reduction when high pH conditions (as those experienced in vertic and melanic soils) are compared to low pH conditions.

The situation becomes even more complex as other intermediate Fe minerals (blue green rusts) come into play. The essence of the presence of blue-green rusts is that they are tints that occur extensively in poorly drained and poorly aerated soils such as G-horizons under vertic and/or melanic A-horizons. These minerals are not stable and often disappear within a few minutes of exposure to the atmosphere. They in all probability form some of the most important Fe phases in vertic soils but disappear rapidly. Before they disappear it is also evident that these minerals are visible against a grey matrix but poorly visible against a black or dark background.

In essence therefore, a number of factors, including degree of reduction, soil pH and dominant Fe minerals, conspire against the use of Fe indicators in vertic, melanic and lime containing soils for the delineation of wetlands. There is no quick solution to this problem and delineators should use as many other indicators of wetland conditions in such soils as they can.

One word of caution: The wetland delineation guidelines (DWAF, 2005) indicate the Rensburg and Willowbrook soil forms as occurring in the permanent wetland zone. This is somewhat erroneous. Although these can occur in permanent wetland zones their formation is dependent on distinct cycling between wet and dry seasons. The development of 2:1 clays (found in these soils) depends on the accumulation of weathering products and clays in lower lying landscape positions. These clays are, depending on a range of factors, either swelling or non-swelling and their formation requires a distinct time (seasonally) where evaporation exceeds precipitation, with consequent drying of the soil, to lead to a concentration of bases (Ca and Mg). These clay minerals (such as smectite) often express themselves in the form of distinct cracks in Vertic soils. From this discussion it follows that the Rensburg and Willowbrook soils could only have formed in conditions that resemble a **seasonal wetland**. Drainage lines on the site can, if dominated by Rensburg or Willowbrook soils, therefore not be classified as permanent wetlands unless there are other characteristics indicating conditions of permanent saturation.

5. SITE SURVEY RESULTS AND DISCUSSION

The soils encountered on the site ranged from red apedal profiles in the north-west to soils with yellow-brown apedal profiles with quartzite rocks in the south – indicating a transition from igneous geology in the north to more quartzite dominated geology in the south. This aspect in itself imposes a colour gradient that is not associated with wetness (hydromorphy) but rather parent material differences in terms of Fe reserve and redox buffering (as a function of soil physical processes and pH). Within this context the only wetland feature that could be identified is the drainage depression on the eastern boundary of the site (**Figure 15**). The soils fit the description provided above under section 4.6 with the added variation of yellower colours in the terrestrial soils to the south. The feature fits the description of a “watercourse” with a riparian zone as wetland signs in the form of mottles and wetland vegetation are sporadic in the more recently transported alluvial soils in channel. The limitations regarding expression of wetland signs as discussed above in terms of alkaline soil environments applies to this site. No sign of lateral feeding mechanisms through the soils could be observed and it is therefore deduced that the main driver of the wetland/watercourse feature is surface runoff water from the site as well as upslope in the feature’s catchment.

A buffer was not included in **Figure 15** as the best buffer concept on the site is adequate storm water management measures for any developments to take place on the site. An ecological buffer can be included and this should be the outcome of any ecological assessment of the site.

6. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are drawn from the investigation:

1. The soils on the site consist of a grading between soils derived from basic igneous geology in the north and sedimentary (quartz dominated) geology in the south.

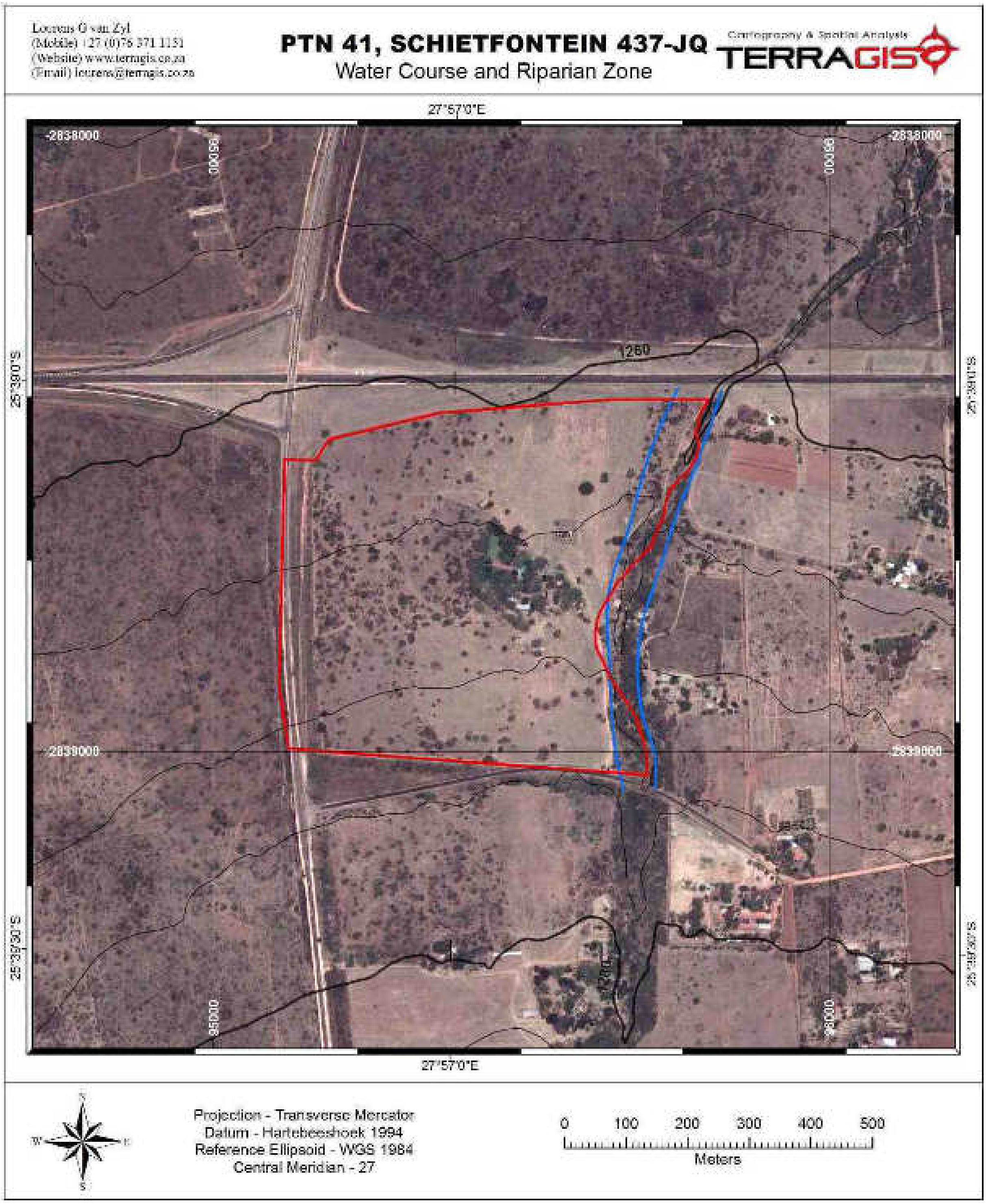

Figure 15 Eh pH diagram as sourced from Bohn, et al., (1990) p124

2. The site has a drainage feature on the eastern edge with a distinct riparian character, even though the vegetation is altered and consisting of numerous exotics.
3. The expression of wetness in the form of mottles or soil forms indicating wetland conditions is limited due to the basic igneous geology leading to high pH values in the soil as well as high clay content that limits lateral flow of water through the soil profiles. The dominant water movement is therefore surface flow from the site as well as from the upslope areas in the catchment.
4. The drainage feature is considered to qualify as a water course as large areas do not have the required expression of hydromorphy indicating long periods of saturation. The feature can therefore not be considered to be a permanent wetland but rather indicates event driven high energy flows of water through the system with persistence of water only in man-made containment structures.

It is recommended that adequate storm water management structure be included for developments on the site in order to protect the drainage feature against erosion. Soil environments with swelling clays are readily susceptible to erosion as the clays are inherently dispersive in nature, therefore leading to rapid erosion and degradation once vegetation cover is altered.

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Fauna and Flora Assessments

Annexure F4

[redacted]
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Biodiversity Habitat Assessment

of

Portions 22 and 41 of the farm Schietfontein 437-JQ (Q4 City)

May 2014

Report Compiled and edited by:	Ms. Vanessa Marais of Galago Environmental
Report authors:	Dr. I.L. Rautenbach (Pr.Sci.Nat: Ph.D, T.H.E.D.),
	Mr J.C.P van Wyk (Pr.Sci.Nat: M.Sc),
	Mrs. P. Lemmer (Cert.Sci.Nat: B.Sc.)
	Mr. R.F. Geyser
Avifauna Report verified by:	Dr. Alan C. Kemp (Pr.Sci.Nat.)
Botany Report verified by:	Dr J.V. Van Greuning (D.Sc., Pr.Sci.Nat.)

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FIGURES:

1. Introduction:

Galago Environmental was appointed to survey the vegetation, mammals, herpetofauna and avifauna on Portions 22 and 41 of the farm Schietfontein 437-JQ (also known as Q4 City), scheduled for development into 1 stop filling stations.

2. Location of the study site:

The study site lies at the crossing of the N4 highway and Road M21 (Lucas Mangope Drive) on the farm Schietfontein 437-JQ with portion 22 located in the northwestern quadrant of the crossing and portion 41 located diagonally opposite in the southeastern quadrant of the crossing.

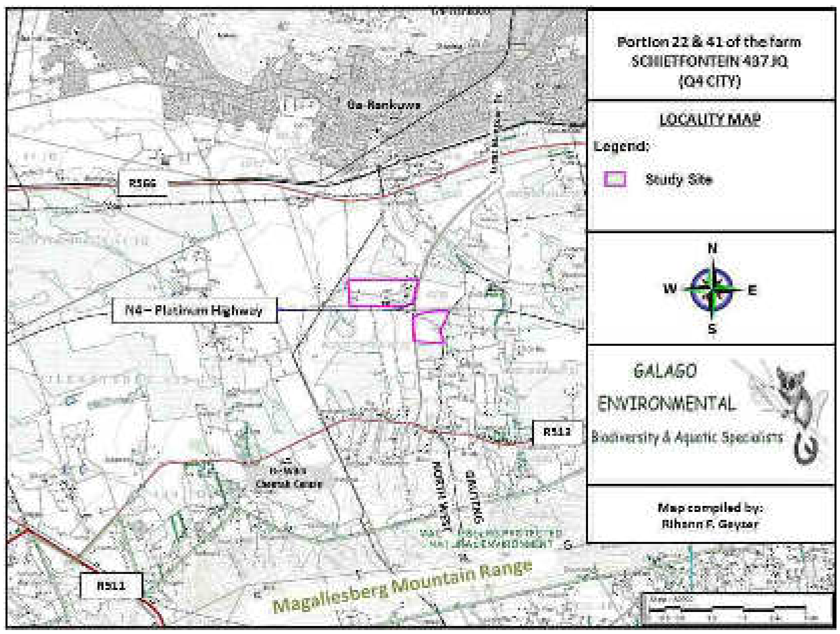

Figure 1: Locality map of the study area

3. Participating Specialists

This investigation was conducted by the following specialists:

Specialists	Aspect Investigated	Qualifications	Prof. Registration	Date of Field Survey
Rautenbach, I.L.	Mammalogy	Ph.D., T.H.E.D.	Pr. Nat. Sci.	14 March 2014, 22 March 2014
Van Wyk, J.C.P.	Herpetology & Mammology	M.Sc. (Zoology)	Pr.Nat.Sci.	14 March 2014
Geyser, R.	Avifauna		Pending	14 March 2014
Lemmer, P.	Botany	B.Sc.	Cert.Sci.Nat	14 March 2014
Van Greuning, J.V.	Botany Review	D.Sc.	Pr.Nat.Sci.	
Kemp, A.C.	Avifauna review	Ph.D.	Pr.Nat.Sci.	
Marais, V.	Environmental Impacts and maps	BL Landscape Architecture		14 March 2014

5. Vegetation assessment:

Mucina & Rutherford (2006) classified the area as Marikana Thornveld, with open *Acacia karroo* woodland occurring in valleys and slightly undulating plains and lowland hills. Shrubs are denser along drainage lines, on termitaria and rocky outcrops or in other fire-protected habitat. Most of the area is underlain by mafic intrusive rocks such as gabbro, norite, pyroxenite and anorthosite. The shales and quartzites of the Pretoria group also contribute. This unit falls within a summer-rainfall region with very dry winters and frequent winter frosts. The Marikana Thornveld vegetation unit is considered endangered.

Five vegetation study units were identified:

- *Peltophorum – Dichrostachys* thicket;
- *Acacia robusta – Clerodendrum* savanna;
- Mixed alien and indigenous vegetation;
- *Eragrostis – Digitaria* fields; and
- Drainage line vegetation.

The flora study found that the *Peltophorum – Dichrostachys* thicket study unit on portion 22 of the study site and the Drainage line vegetation are deemed sensitive and should be excluded from development and where possible, these areas must be connected to other natural vegetation areas on the neighbouring properties to facilitate connectivity.

To lessen the impact of the proposed development on the vegetation of the site, great care should be taken to locate the filling station and its associated buildings as close to the N4 highway as possible, rather than spreading them out over large areas. Access roads, footpaths, services etc should be constructed with great care.

The Marula trees and the *Harpagophytum zeyheri* subsp. *zeyheri* are protected trees and should be conserved in situ and the damaged Marula trees treated by a tree surgeon to ensure their survival. **See Appendix A for the Flora report.**

6. Fauna assessment:

The **mammal** study found that the proposed development will spatially be modest, with the major portion of the two Portions to be excluded from development. The developments will entirely displace terrestrial mammals, but relatively speaking this will be modest, apart from consisting mostly of common species. The conservation status of no endangered species will be jeopardized. From a mammal perspective, the site has a low sensitivity. **See Appendix B for the Mammal report.**

The **avifaunal** study found that the proposed development will not have a negative effect on any Red Data avifaunal species recorded for the 2527DB q.d.g.c. None of these Red Data avifaunal species are likely to occur within the study area due to lack of suitable habitat. The Woodland areas can be regarded as medium sensitive in terms of habitat for general avifaunal biodiversity and the disturbed and transformed areas as low sensitive. **See Appendix C for the Avifauna report.**

The **herpetological** study found that the drainage line and its 32m buffer zone should be considered as ecologically sensitive. There is a possibility that one or two Southern African pythons may occur on the study site from time to time.

If the development should go ahead, a very important indirect effect would be the likely impact that the proposed development might have on the surface water runoff and water quality of the drainage line. This could have a negative impact on the herpetofaunal species on site.

The biological damage caused by the filling stations will be relatively small, *albeit* absolute. Given due care, the proposed development will not result in a loss of ecologically sensitive and important habitat units, ecosystem function (e.g. reduction in water quality, soil pollution), notable loss of herpetofauna habitat, nor of significant loss/displacement of threatened or protected species. **See Appendix D for the Herpetological report.**

7. Mitigation:

Mitigation proposed is:

- Where possible, trees naturally growing on the site should be retained as part of the landscaping, with specific emphasis on *Sclerocarya birrea* subsp. *caffra* (Marula). Measures to ensure that these trees survive the physical disturbance from the development should be implemented. A tree surgeon should be consulted in this regard.
- Dumping of builders' rubble and other waste in the areas earmarked for exclusion must be prevented, through fencing or other management measures. These areas must be properly managed throughout the lifespan of the project in terms of fire, eradication of exotics etc. to ensure continuous biodiversity.
- All Declared Weeds and invaders must be removed from the site.
- Should any Southern African hedgehog or any other mammal be encountered or exposed during the construction phase, they should be removed and relocated to natural areas in the vicinity. The contractor must ensure that no mammal species are disturbed, trapped, hunted or killed during the construction phase.
- The contractor must ensure that no faunal species are disturbed, trapped, hunted or killed during the construction phase. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for non-compliance.
- The Southern African python or any herpetological species that are encountered or exposed during the construction phase should be removed and relocated to natural areas in the vicinity. This remedial action requires the employment of a herpetologist to oversee the removal of any herpetofauna during the initial ground clearing phase of construction (i.e. initial ground-breaking by earthmoving equipment
- During the construction phase there will be increased surface runoff and a decreased water quality (with increased silt load and pollution). Completing construction during the winter months would mitigate the environmental impact.

There are other general mitigation measures in the different specialist reports that are prescribed by the GDARD Minimum requirements for biodiversity assessments, 2012 that must be adhered to.

8. Conclusion:

The biodiversity studies have shown the site mostly has a low sensitivity, but there are some wetland areas and Marikana thornveld that are sensitive and must be conserved. It is proposed that the development be located as near to the N4 as possible.

9. Environmental sensitivity:

Figure 2: Combined environmental sensitivity map

Sensitivity mapping rules:

BIODIVERSITY ELEMENT	SENSITIVITY MAPPING RULE
Flora communities	Sensitive flora communities
Fauna habitat	Sensitive fauna habitat
Wetland	Wetlands and 32m buffers

APPENDIX A: FLORA REPORT

[redacted]

[redacted]

[redacted]
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Flora Assessment

of

Portions 22 and 41 of the farm Schietfontein 437-JQ (Q4 City)

May 2014

Report author: Mrs. P. Lemmer (Cert. Sci. Nat: B.Sc.)
Report verified/reviewed by: Dr. J.V. van Greuning (D.Sc.,Pr.Sci.Nat)

DECLARATION OF INDEPENDENCE

I, Petro Lemmer (440129 0025 085) declare that I:

- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate the opportunity to also learn through the processes of constructive criticism and debate, I reserve the right to form and hold my own opinions and therefore will not willingly submit to the interests of other parties or change my statements to appease them

- abide by the Code of Ethics of the S.A. Council for Natural Scientific Professions

- act as an independent specialist consultant in the field of botany

- am subcontracted as specialist consultant by Galago Environmental CC for the proposed Schietfontein Q4 City development project described in this report

- have no financial interest in the proposed development other than remuneration for work performed

- have or will not have any vested or conflicting interests in the proposed development

- undertake to disclose to Galago Environmental CC and its client as well as the competent authority any material information that have or may have the potential to influence the decision of the competent authority required in terms of the Environmental Impact Assessment Regulations, 2006.

Petro Lemmer

VERIFICATION STATEMENT

Petro Lemmer is a Certified Natural Scientist with the S.A. Council for Natural Scientific Professions. This communication serves to verify that the flora report compiled by Petro Lemmer has been prepared under my supervision, and I have verified the contents thereof.

Declaration of Independence: I, Dr. J.V. van Greuning (400168/08) declare that I:

- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate the opportunity to also learn through the processes of constructive criticism and debate, I reserve the right to form and hold my own opinions and therefore will not willingly submit to the interests of other parties or change my statements to appease them

- abide by the Code of Ethics of the S.A. Council for Natural Scientific Professions

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Dr. J.V. van Greuning

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FIGURES:

TABLES:

1. INTRODUCTION

Galago Environmental was appointed to conduct a vegetation survey on Portions 22 and 41 of the farm Schietfontein 437-JQ (also known as Q4 City), scheduled for development into 1 stop filling stations. The objective was to determine which species occur on the site. Special attention had to be given to possible habitats of all the threatened species, the species of conservation concern and the protected species that may occur in the area. This survey focuses on the current status of threatened plant species, the plant species of conservation concern and the protected plant species occurring, or which are likely to occur on the study site, and a description of the available and sensitive habitats on the site and within 200 meters of the boundary of the site.

2. OBJECTIVES OF THE STUDY

- To assess the current status of the habitat component and current general conservation status of the area;
- To list the perceptible flora of the site and to recommend steps to be taken should threatened plant species, plant species of conservation concern and protected plant species be found;
- To highlight potential impacts of the development on the flora of the proposed site; and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.

3. SCOPE OF STUDY

This report:

- Pertains to the study site as described in subsection 4.2 and is not meant as a report of the general vegetation of the area (subsection 4.1).
- Lists the more noticeable trees, shrubs, herbs, geophytes and grasses observed during the study and offers recommendations about the preservation of the sensitive areas and protected species on the site;
- Indicates medicinal plants recorded and lists alien species;
- Comments on connectivity with natural vegetation on adjacent sites;
- Comments on ecological sensitive areas;
- Evaluates the conservation importance and significance of the site with special emphasis on the current status of resident threatened species; and
- Offers recommendations to reduce or minimise impacts, should the proposed development be approved

4. STUDY AREA

4.1 Regional vegetation

The study ±100ha site lies in the quarter degree square 2527DB (Brits). Mucina & Rutherford (2006) classified the area as Marikana Thornveld, with open *Acacia karroo* woodland occurring in valleys and slightly undulating plains and lowland hills. Shrubs are denser along drainage lines, on termitaria and rocky outcrops or in other fire-protected habitat. Most of the area is underlain by mafic intrusive rocks such as gabbro, norite, pyroxenite and anorthosite. The shales and quartzites of the Pretoria group also contribute. The soil mainly vertic, dark clays with leached layers of compressed particles and some freely-drained, deep soils. This unit falls within a summer-rainfall region with very dry winters and frequent winter frosts.

The Marikana Thornveld vegetation unit is considered endangered. Its conservation target is 19%. Less than 1% is conserved in statutory reserves such as Magaliesberg Nature Area and De Onderstepoort Nature Reserve. The unit is considerably impacted, with 48% transformed, mainly by urbanization and cultivation. Towards the west this unit is transformed by agriculture while in the east industrial development is the greater threat.

4.2 The study site

The study site lies at the crossing of the N4 highway and Road M21 (Lucas Mangope Drive) on the farm Schietfontein 437-JQ with portion 22 located in the northwestern quadrant of the crossing and portion 41 located diagonally opposite in the southeastern quadrant of the crossing.

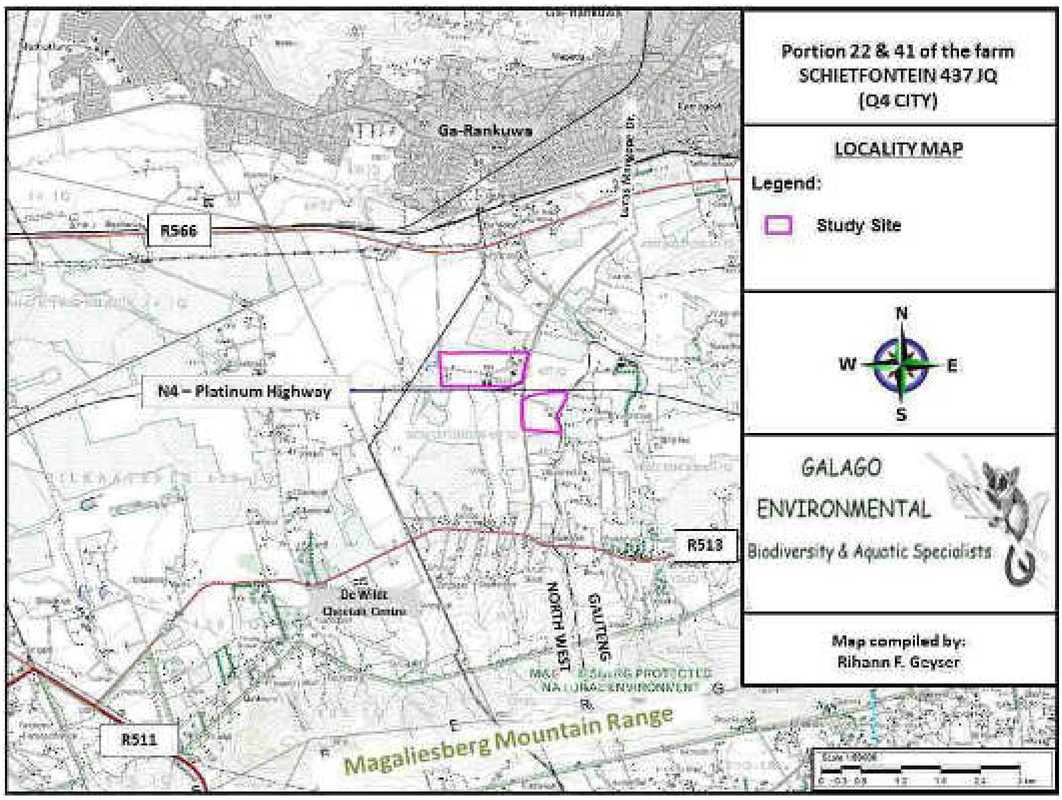

Figure 1: Locality map of the study area

5. METHOD

A desktop study of the habitats of the species that are considered threatened and those that are considered not threatened but of conservation concern that are known to occur in the area was done before the site visit. Information about these species was obtained from SANBI. Various Acts and Ordinances were consulted about the protected plant species and species of special concern that might occur on the site (Section 11). The various publications (Section 11) as well as the Pretoria herbarium were consulted about the habitat preferences of the species concerned.

The list of plants recorded in the 2527DB quarter degree square was obtained from SANBI and consulted to verify the record of occurrence of the plant species seen on the site. The important taxa listed by Mucina and Rutherford (2006) were also taken into account.

The study site was visited on 14 March 2014 and again on 22 March 2014 to determine whether suitable habitat for the species that are considered threatened and those that are considered not threatened but of conservation concern in the area existed and to survey the flora present on the site.

Various study units were identified (Figure 2) and one or more plots, depending on the size and composition of the study unit, were selected at random from each study unit for detailed study. Each plot, which measured about 10m x 10m, was surveyed in a random crisscross fashion and the plants recorded. Areas where the study unit has suitable habitat for the species that are considered threatened and those that are considered not threatened but of conservation concern were examined in detail. The entire site was examined for the presence of protected tree species and their positions recorded.

Suitable habitat for species that are considered threatened or those that are considered not threatened but of conservation concern on the neighbouring properties, where accessible, was examined to a distance of 200 m from the boundaries of the site for the presence of such species.

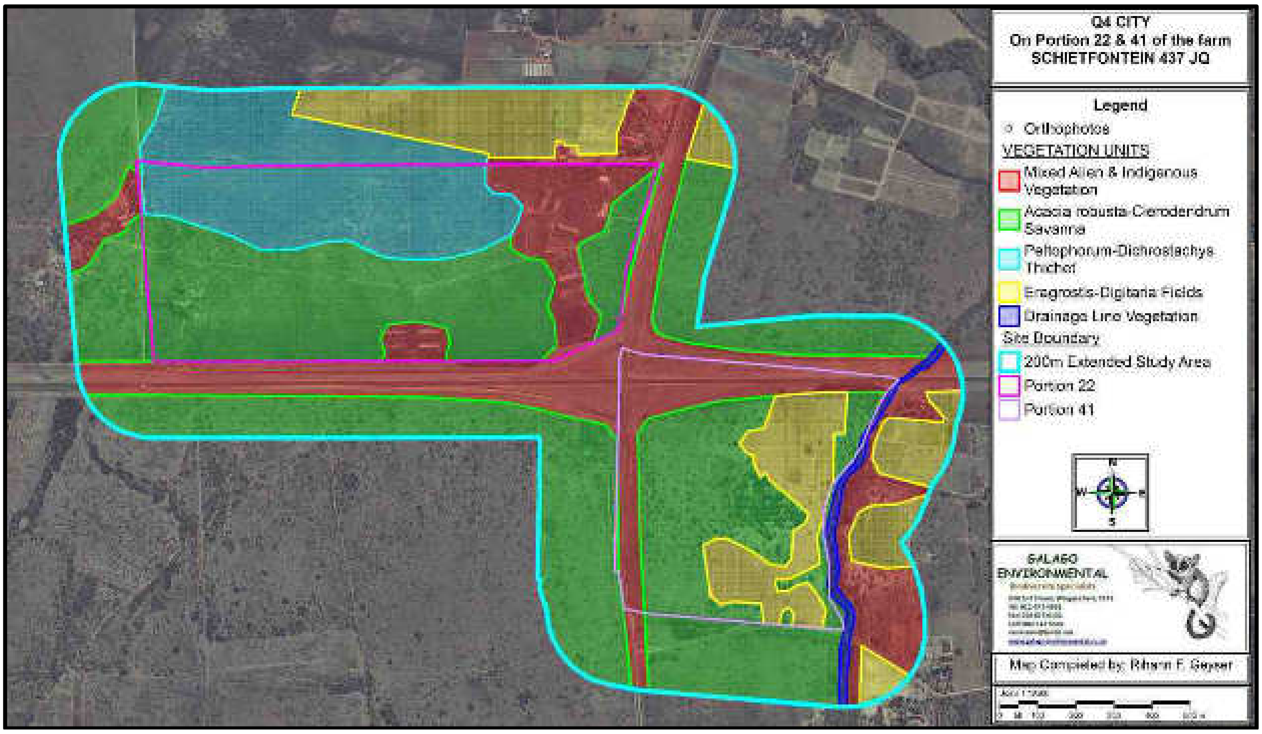

Figure 2: Vegetation study units identified on the study site

6. RESULTS

6.1 Vegetation study units

Five vegetation study units were identified:
- *Peltophorum – Dichrostachys* thicket;
- *Acacia robusta – Clerodendrum* savanna;
- Mixed alien and indigenous vegetation;
- *Eragrostis – Digitaria* fields; and
- Drainage line vegetation.

Tables 3 to 7 list the plants found on each of the surveyed areas of the study site.

6.2. Medicinal plants

The names of known medicinal plants are marked with numbers in Tables 3 to 7 and the numbers appear as footnotes at the end of the last table. Of the 174 plant species recorded on the site, 32 species with medicinal properties were found. The distribution of the medicinal species in the study units is as follows:

Table 1: Number of medicinal species in the various study units

STUDY UNIT	TOTAL NO. OF SPECIES IN STUDY UNIT	NO. OF MEDICINAL SPECIES IN STUDY UNIT
Peltophorum – Dichrostachys thicket	77	20
Acacia robusta – Clerodendrum savanna	118	23
Mixed alien and indigenous vegetation	36	1
Eragrostis – Digitaria fields	19	1
Drainage line vegetation	31	2

6.3. Alien plants

Alien plants are not listed separately, but are included in the lists as they form part of each particular study unit. Their names are marked with an asterisk in Tables 3 to 7. Twenty-six alien plant species, of which eight species are Category 1 Declared weeds, two are Category 2 Declared invaders and two are Category 3 Declared invaders, were recorded on the site. The number of alien species in each study unit is reflected in Table 2.

Table 2: Number of Alien species in each study unit

STUDY UNIT	NO. OF ALIEN SPECIES	CAT 1	CAT 2	CAT 3	NOT DECLARED
Peltophorum – Dichrostachys thicket	7	4	0	0	3
Acacia robusta – Clerodendrum savanna	13	4	1	1	7
Mixed alien and indigenous vegetation	19	4	1	2	12
Eragrostis – Digitaria fields	5	0	0	0	5
Drainage line vegetation	10	2	2	1	5

The removal of Category 1 Declared Weeds is ***compulsory*** in terms of the regulations formulated under "The Conservation of Agricultural Resources Act" (Act No. 43 of 1983), as amended. In terms of these regulations, Category 2 Declared invaders may not occur on any land other than a demarcated area and should likewise be removed.

Although the regulations under the above Act require that Category 3 Declared invader plants may not occur on any land or inland water surface other than in a biological control reserve, these provisions shall not apply in respect of category 3 plants already in existence at the time of the commencement of said regulations. If this is the case, a land user must take all reasonable steps to curtail the spreading of propagating material of Category 3 plants.

6.4. Species on the study site that are considered threatened

Species listed in the Red List of South African plants (2009) as Critically endangered, Endangered and Vulnerable are considered threatened species.

No species that are considered threatened species are known to occur in the 2527DB quarter degree square.

6.5. Species on the study site that are considered not threatened but of conservation concern

Species listed in the Red List of South African plants (2009) as Near Threatened, Declining, Rare and Data Deficient are considered not threatened but of conservation concern.

Seven plant species that are considered not threatened but of conservation concern are known to occur in the 2527DB quarter degree square. The *Acacia robusta – Clerodendrum* savanna study unit has suitable habitat for one of these species, but none was found.

6.6. Protected tree species

One protected tree species listed in terms of the National Forests Act, 1998 (Act No. 84 of 1998) is known to occur in the 2527DB quarter-degree square. Eight specimens of this species were found on the site (subsections 6.8.3 and 6.9.3 and Annexure B).

6.7. Other Protected species

One protected species listed in terms of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) is known to occur in the 2527DB q.d.s. (Annexure C).

6.8. *Peltophorum – Dichrostachys* thicket

6.8.1. Compositional aspects and Connectivity

This study unit is located on portion 22 and comprises natural woodland that forms thickets with dense understorey shrubs. Open areas between the trees contains some grass species, geophytes and herbaceous plants. Connectivity with natural vegetation existsd to the northwest. Of the 174 plant species recorded on the site 77 were recorded in the *Peltophorum – Dichrostachys* thicket study unit. Of these 70 are indigenous species. The following number of species in each growth form was noted:

GROWTH FORM	NUMBER OF SPECIES
Annual & perennial herbaceous species	24
Tree species	15
Shrubs and dwarf shrubs	13
Grasses	8
Geophytes	5
Sedges	2
Succulents	10
Total number of species	77

6.8.2 Species in the study unit that are considered threatened, or not threatened, but of conservation concern

The *Peltophorum – Dichrostachys* thicket study unit does not have suitable habitat for any of the threatened species, or for those that are considered not threatened but of conservation concern.

6.8.3 Protected trees and other protected species

One small damaged specimen of the protected tree, *Sclerocarya birrea* subsp. *caffra,* was found in the *Peltophorum – Dichrostachys* thicket study unit.

The Protected species *Harpagophytum zeyheri* subsp. *zeyheri* was found in this study unit.

6.8.4 Medicinal and alien species

Twenty of the 32 medicinal species recorded on the site and seven of the 26 alien species recorded on the site were found in the *Peltophorum – Dichrostachys* thicket study unit. Of the alien species, four are Category 1 Declared weeds. The alien species occurred sparsely in the study unit.

6.8.5 Sensitivity

Owing to the unspoilt nature of this study unit and the presence of the protected species *Harpagophytum zeyheri* subsp. *zeyheri* and the protected tree *Sclerocarya birrea* subsp. *caffra* the *Peltophorum – Dichrostachys* thicket study unit is considered sensitive and should be excluded from development.

Figure 3: *Peltophorum – Dichrostachys* thicket.

Table 3: Plants recorded in the *Peltophorum – Dichrostachys* thicket

SCIENTIFIC NAME	INV CAT	COMMON NAMES
Acacia caffra		Common hook thorn / Gewone haakdoring
Acacia mellifera subsp. *detinens*		Black thorn / Swarthaak
Acacia robusta subsp. *robusta*		Broad-pod robust thorn / Enkeldoring
Aloe greatheadii var. *davyana*[1,2]		Kleinaalwyn
Aloe marlothii subsp. *marlothii*[1,2,4]		Mountain aloe / Bergaalwyn
Andropogon chinensis		Hairy blue grass / Harige blougras
Aristida junciformis subsp. *junciformis*		Ngongoni three-awn / Ngongoni Aristida
Asparagus cooperi		
Asparagus suaveolens		Wild asparagus / Katdoring
Asparagus transvaalensis		
Barleria obtusa		
Bewsia biflora		False love grass / Vals Eragrostis
Brachiaria serrate		Velvet grass / Fluweelgras
Bulbostylis burchellii		Biesie
Burkea africana[4]		Wild syringa / Wildesering
Carissa bispinosa		Num-num / Noemnoem
*Cereus jamacaru**	1	Queen of the night / Nagblom
Chascanum hederaceum var. *hederaceum*		
Cleome monophylla		Spindle pod / Rusperbossie
Cleome rubella		Pretty lady / Mooinooientjie
Combretum molle[4]		Velvet bushwillow / Fluweel boswilg
Combretum zeyheri[4]		Large-fruited bushwillow / Raasblaar
Commelina africana var. *krebsiana*		
*Commelina benghalensis**		Wandering jew / Wandelende jood
Crabbea hirsuta[2,3]		Prickle head
Cucumis zeyheri		Wild cucumber / Wilde agurkie
Cyathula uncinulata		
Cyperus obtusiflorus var. *obtusiflorus*		Witbiesie
Dichrostachys cinerea subsp. *africana* var. *africana*		Small-leaved sickle bush / Kleinblaar sekelbos
Ehretia rigida subsp. *rigida*[2,4]		Puzzle bush / Deurmekaarbos
Eragrostis chloromelas		Curly leaf / Krulblaar
Eragrostis nindensis		Wether love grass / Hamelgras
Euclea crispa subsp. *crispa*[4]		Blue guarri / Blou-ghwarrie
Euclea undulata[1,2]		Small-leaved guarri / Fynblaarghwarrie
Euphorbia ingens[4]		Naboom / Naboom
Felicia muricata subsp. *muricata*[1,2,3]		White felicia / Blouheuning karooblom
Geigeria burkei subsp. *burkei*		Vermeersiektebossie

SCIENTIFIC NAME	INV CAT	COMMON NAMES
Gisekia pharnacioides var. *pharnacioides*		
Gladiolus permeabilis subsp. *edulis*		Kleinaandblom
Grewia monticola		Silver raisin / Vaalrosyntjie
Gymnosporia buxifolia[2]		Spike-thorn / Pendoring
Gymnosporia polyacantha subsp. *vaccinifolia*		Northern spike thorn / Noordelike kraalpendoring
Hibiscus engleri		
Hypoxis obtusa		
Ipomoea obscura var. *obscura*		Wild petunia / Wilde patat
Ipomoea sp.		
Kalanchoe rotundifolia[2,3]		Nentabos
*Lantana camara**	1	Lantana
Lantana rugosa[2,3]		Bird's brandy / Voëlbrandewyn
Ledebouria marginata		
Ledebouria ovatifolia		
Nuxia congesta		Wild elder / Wildevlier
*Opuntia ficus-indica**	1	Sweet prickly pear / Boereturksvy
Panicum maximum		Guinea grass / Gewone buffelsgras
Pappea capensis[4]		Jacket plum / Doppruim
Pavonia burchellii		
Peltophorum africanum		African wattle / Huilboom
Pentarrhinum insipidum		Donkieperske
Portulaca sp.		
Psiadia punctulata		Resin-leaved yellow-head / Harpuisblaar geelkoppie
Rhynchosia nervosa var. *nervosa*		
*Richardia brasiliensis**		Tropical richardia / Tropiese richardia
Sansevieria aethiopica[1,2]		Bowstring hemp / Aambeiwortel
Sarcostemma viminale subsp. *viminale*		Caustic vine / Melktou
Scadoxus puniceus[1,2]		Red paintbrush / Rooikwas
Sclerocarya birrea subsp. *caffra*[1,2]		Marula / Maroela
Searsia leptodictya forma *leptodictya*		Mountain karee / Bergkaree
Searsia pyroides var. *pyroides*[4]		Common wild currant / Taaibos
Senecio barbertonicus		
Senecio pleistocephalus		
Setaria sphacelata var. *sphacelata*		Commn bristle grass / Gewone mannagras
Sida dregei		Spider-leg
Solanum panduriforme		Poison apple / Gifappel
Solanum seaforthianum var. *disjunctum**	1	Potato creeper / Aartappelranker
*Tagetes minuta**		Tall khaki weed / Lang kakiebos
Vangueria infausta subsp. *infausta*[2]		Wild medlar / Wildemispel
Waltheria indica		Meidebossie

INV CAT = Invader category

6.9. *Acacia robusta – Clerodendrum* savanna

6.9.1. Compositional aspects and Connectivity

This study unit that is located on both portions 22 and 41 consists of natural savanna with a high percentage of grasses and herbaceous species. Connectivity with natural vegetation exists to the northwest. The species diversity of this study unit is high with 68% of all species recorded on the site found in this unit. Of the 174 plant species recorded on the site 118 were recorded in the *Acacia robusta – Clerodendrum* savanna study unit. Of these 105 are indigenous species. The following number of species in each growth form was noted:

GROWTH FORM	NUMBER OF SPECIES
Annual & perennial herbaceous species	46
Tree species	23
Shrubs and dwarf shrubs	15
Grasses	25
Geophytes	2
Sedges	1
Succulents	6
Total Number of species	118

6.9.2 Species in the study unit that are considered threatened, or not threatened, but of conservation concern

The study unit does not have suitable habitat for any of the threatened species, but has suitable habitat for *Boophone disticha,* a species that is considered not threatened but of conservation concern. None was, however, found.

6.9.3 Protected trees and other protected species

In the *Acacia robusta – Clerodendrum* savanna study unit on portion 22 five small specimens, most of them damaged, of the protected tree *Sclerocarya birrea* subsp. *caffra* were found. A sixth, much larger undamaged specimen was recorded in the southeastern corner of this study unit on portion 22.

On portion 41 one specimen of *Sclerocarya birrea* subsp. *caffra,* was found in the *Acacia robusta – Clerodendrum* savanna study unit.

This study unit does not have suitable habitat for any of the protected species listed in terms of the NEMBA Act.

6.9.4 Medicinal and alien species

Twenty-three of the 32 medicinal species recorded on the site and 13 of the 26 alien species recorded on the site were found in this study unit. Of the alien species four are Category 1 Declared weeds, one is a Category 2 Declared invader and one is a Category 3 Declared invader.

6.9.5 Sensitivity

The *Acacia robusta – Clerodendrum* savanna study unit is not considered sensitive.

The *Sclerocarya birrea* subsp. *caffra* (Marula) trees are protected trees in terms of section 15(1) of the National Forests Act, 1998, and should be preserved *in situ*.

Figure 4: ***Acacia robusta – Clerodendrum*** **savanna**

Table 4: Plants recorded in the *Acacia robusta – Clerodendrum* savanna

SCIENTIFIC NAME	INV CAT	COMMON NAMES
Acacia caffra		Common hook thorn / Gewone haakdoring
Acacia karroo[1,2]		Sweet thorn / Soetdoring
*Acacia mearnsii**	2	Black wattle / Swartwattel
Acacia nilotica subsp. *kraussiana*		Scented pod / Lekkerruikpeul
Acacia robusta subsp. *robusta*		Broad-pod robust thorn / Enkeldoring
Acacia tortilis subsp. *heteracantha*		Umbrella thorn / Haak-en-steek
Aloe greatheadii var. *davyana*[1,2]		Kleinaalwyn
Alysicarpus rugosus subsp. *perennirufus*		Pioneer fodder plant
Andropogon schirensis		Stab grass / Tweevingergras
Anthospermum rigidum subsp. *rigidum*		
Aptosimum procumbens		Wild violet
Aristida adscensionis		Annual three-awn / Eenjarige steekgras
Aristida canescens subsp. *canescens*		Pale three-awn / Vaalsteekgras
Aristida congesta subsp. *barbicollis*		Spreading three-awn grass / Witsteekgras
Asparagus laricinus		Wild asparagus / Katbos
Barleria macrostegia		
Berchemia zeyheri[4]		Red ivory / Rooi ivoor
Berkheya zeyheri subsp. *zeyheri*		
Bewsia biflora		False love grass / Vals Eragrostis
*Bidens pilosa**		Blackjack / Knapsekêrel
Bonatea antennifera		Terrestrial orchid / Grondorgidie
Brachiaria nigropedata		Black-footed grass / Swartvoetjiegras
Brachiaria serrate		Velvet grass / Fluweelgras
Bulbostylis burchellii		Biesie
Burkea africana[4]		Wild syringa / Wildesering
Celtis africana		White stinkwood / Witstinkhout
*Cereus jamacaru**	1	Queen of the night / Nagblom
Chascanum hederaceum var. *hederaceum*		
*Chenopodium carinatum**		Green goosefoot / Groen hondebossie
Clematis brachiata[2]		Traveler's joy / Klimop
Cleome rubella		Pretty lady / Mooinooientjie
Clerodendrum glabrum		Tinderwood / Tontelhout
Combretum zeyheri[4]		Large-fruited bushwillow / Raasblaar
Commelina africana var. *krebsiana*		
Convolvulus sagittatus		
Crabbea hirsuta[2,3]		Prickle head
Cynodon dactylon		Couch grass / Kweek
Dicerocaryum senecioides		Devil's thorn / Elandsd vr ellipties
Dichrostachys cinerea subsp. *africana* var.		Small-leaved sickle bush / Kleinblaar sekelbos

SCIENTIFIC NAME	INV CAT	COMMON NAMES
africana		
Dicoma anomala subsp. *anomala* [1,2,3]		Maagbitterwortel
Dicoma anomala subsp. *gerrardii*[2]		Maagbitterwortel
Digitaria eriantha		Finger grass / Vingergras
Diheteropogon amplectens var. *amplectens*		Broad-leaved bluestem / Breëblaar blougras
Diospyros lycioides subsp. *lycioides*		Karoo bluebush / Karoo-bloubos
Dodonaea viscosa var. *angustifolia*[1,2,4]		Sand olive / Sandolien
Eragrostis chloromelas		Curly leaf / Krulblaar
Eragrostis nindensis		Wether love grass / Hamelgras
Eragrostis rigidior		Broad-leaved curly leaf / Breëkrulgras
Eragrostis superba		Sawtooth love grass / Weeluisgras
Euclea crispa subsp. *crispa*[4]		Blue guarri / Blou-ghwarrie
Euclea undulata[1,2]		Small-leaved guarri / Fynblaarghwarrie
Euphorbia ingens[4]		Naboom / Naboom
Evolvulus alsinoides		
Ficus burkei		Common wild fig / Gewone wildevy
*Gomphrena celosiodes**		Bachelor’s button / Mierbossie
Grewia monticola		Silver raisin / Vaalrosyntjie
Harpagophytum zeyheri subsp. *zeyheri*[1,2]		Devil’s claw / Duiwelsklou
Helichrysum dasymallum		
Heteropogon contortus		Spear grass / Assegaaigras
Hibiscus engleri		
Hyparrhenia hirta		Common thatching grass / Dekgras
Hyperthelia dissoluta		Yellow thatching grass / Geeltamboekiegras
Indigofera daleoides var. *daleoides*		
*Jacaranda mimosifolia**	3	Jakaranda
Kalanchoe paniculata		Loco disease bush / Krimpsiektebossie
Kyphocarpa angustifolia		
*Lantana camara**	1	Lantana
Lantana rugosa[2,3]		Bird’s brandy / Voëlbrandewyn
Leucas martinicensis		
Lippia javanica[1,2,3]		Fever tea / Koorsbossie
Melinis repens subsp. *repens*		Red top grass
Monsonia burkeana		Naaldebossie
Mundulea sericea subsp. *sericea* [4]		Cork bush / Kurkbos
Nidorella hottentotica		
Ochna pulchra		Peeling plane / Lekkerbreek
*Opuntia ficus-indica**	1	Sweet prickly pear / Boereturksvy
Ornithogalum sp.		
Ozoroa paniculosa var. *paniculosa*		Resin tree / Harpuisboom
Pappea capensis[4]		Jacket plum / Doppruim
Parinari capensis subsp. *capensis*		Dwarf mobola / Grysappeltjie
Pavetta gardeniifolia var. *gardeniifolia*		Common bride’s bush / Gewone bruidsbos
Pellaea calomelanos var. *calomelanos* [1,2]		Black cliff brake / Swart kransruigtevaring
Peltophorum africanum		African wattle / Huilboom
Pentarrhinum insipidum		Donkieperske
Perotis patens		Cat’s tail / Katstertgras
Phyllanthus parvulus var. *parvulus*		Dye bush / Kleurbossie
Pogonarthria squarrosa		Herring bone grass / Sekelgras
Pollichia campestris		Waxberry / Teesuikerbossie
Polycarpaea corymbosa var. *corymbosa**		
Polydora poskeana		
Portulaca sp.		
Rotheca louwalbertsii		
Schizachyrium sanguineum		Red autumn grass / Rooi herfsgras
*Schkuhria pinnata**		Dwarf marigold / Klein kakiebos
Sclerocarya birrea subsp. *caffra*[1,2]		Marula / Maroela
Searsia lancea		Karee
Searsia leptodictya forma *leptodictya*		Mountain karee / Bergkaree

SCIENTIFIC NAME	INV CAT	COMMON NAMES
Searsia pyroides var. *pyroides*[4]		Common wild currant / Taaibos
Sesamum triphyllum var. *triphyllum*		Sesame bush / Sesambos
Sida rhombifolia subsp. *rhombifolia*		
Solanum panduriforme		Poison apple / Gifappel
Solanum seaforthianum var. *disjunctum**	1	Potato creeper / Aartappelranker
Sphedamnocarpus pruriens subsp. *pruriens*		
Sphenostylis angustifolia		Wild sweetpea bush / Wilde ertjie
Stylosanthes fruticosa		
*Tagetes minuta**		Tall khaki weed / Lang kakiebos
Tephrosia lupinifolia		
Terminalia sericea[1,2,4]		Silver cluster leaf / Vaalboom
Themeda triandra		Red grass / Rooigras
Trachypogon spicatus		Giant spear grass / Bokbaardgras
Tricholaena monachne		Blue seed grass / Blousaadgras
Trichoneura grandiglumis		Small rolling grass / Klein rolgras
Triumfetta sonderi		
Wahlenbergia cf *undulata*		
Waltheria indica		Meidebossie
*Zinnia peruviana**		Redstar zinnia / Wildejakobregop
Ziziphus mucronata subsp. *mucronata*[1,2,4]		Buffalo-thorn / Blinkblaar-wag-'n-bietjie
Zornia milneana		

INV CAT = Invader Category

6.10 Mixed alien and indigenous vegetation

6.10.1. Compositional aspects

The Mixed alien and indigenous vegetation study unit comprises ornamental garden vegetation and disturbed vegetation containing alien invader species surrounding the ruins of animal housing. Of the 174 plant species recorded on the site 36 were recorded in the Mixed alien and indigenous vegetation study unit. Of these 17 are indigenous species. The following number of species in each growth form was noted:

GROWTH FORM	NUMBER OF SPECIES
Annual & perennial herbaceous species	18
Tree species	7
Shrubs and dwarf shrubs	3
Grasses	5
Geophytes	0
Sedges	0
Succulents	3
Total Number of species	36

6.10.2 Species in the study unit that are considered threatened, or not threatened, but of conservation concern

This study unit does not have suitable habitat for any of the species that are considered threatened, or for those that are considered not threatened, but of conservation concern.

6.10.3 Protected trees and other protected species

No protected trees or other protected species were found in the Mixed alien and indigenous vegetation study unit.

6.10.4 Medicinal and alien species

One medicinal species was recorded in this study unit. Nineteen of the 26 alien species recorded on the site were found in this study unit. Of these, four are Category 1 Declared weeds, one is a Category 2 Declared invader and two are Category 3 Declared invaders.

6.10.5 Sensitivity

This study unit is not considered sensitive.

Figure 5: Mixed alien and indigenous vegetation on portion 41.

Figure 6: Ruins of animals housing on portion 22.

Table 5: Plants recorded in the Mixed alien and indigenous vegetation

SCIENTIFIC NAME	INV CAT	COMMON NAMES
*Acacia mearnsii**	2	Black wattle / Swartwattel
Acacia robusta subsp. *robusta*		Broad-pod robust thorn / Enkeldoring
Aristida canescens subsp. *canescens*		Pale three-awn / Vaalsteekgras
Asparagus laricinus		Wild asparagus / Katbos
Asparagus suaveolens		Wild asparagus / Katdoring
Berchemia zeyheri[4]		Red ivory / Rooi ivoor
*Bidens pilosa**		Blackjack / Knapsekêrel
Celtis africana		White stinkwood / Witstinkhout

SCIENTIFIC NAME	INV CAT	COMMON NAMES
*Chenopodium carinatum**		Green goosefoot / Groen hondebossie
Chloris virgata		Feathertop chloris / Witpluim chloris
Cleome monophylla		Spindle pod / Rusperbossie
*Commelina benghalensis**		Wandering jew / Wandelende jood
Cynodon dactylon		Couch grass / Kweek
*Datura ferox**	1	Large thorn apple / Groot stinkblaar
*Durantha erecta**		Forget-me-not tree / Vergeet-my-nie-boom
Eragrostis rigidior		Broad-leaved curly leaf / Breëkrulgras
*Euphorbia heterophylla**		Wild poinsettia / Wilde poinsettia
*Harrisia martini**	1	Moon cactus / Toukaktus
Hibiscus engleri		
*Hylocereus undatus**		Dragon fruit
Indigofera daleoides var. *daleoides*		
*Jacaranda mimosifolia**	3	Jakaranda
*Lantana camara**	1	Lantana
*Melia azedarach**	3	Syringa / Sering
Momordica balsamina		Laloentjie
Oxygonum dregeanum subsp. *canescens* var. *canescens*		Starstalk
*Pennisetum clandestinum**		Kikuyu / Kikoejoe
Pentarrhinum insipidum		Donkieperske
*Portulaca oleracea**		
*Richardia brasiliensis**		Tropical richardia / Tropiese richardia
*Schkuhria pinnata**		Dwarf marigold / Klein kakiebos
Searsia lancea		Karee
Solanum panduriforme		Poison apple / Gifappel
*Tagetes minuta**		Tall khaki weed / Lang kakiebos
*Tithonia rotundifolia**	1	
*Zinnia peruviana**		Redstar zinnia / Wildejakobregop

INV CAT = Invader Category

6.11 *Eragrostis – Digitaria* fields

6.11.1 Compositional aspects and Connectivity

The *Digitaria – Eragrostis* fields are located on portion 41 and comprise a mixture of planted pasture and grassland that was mown over a long period of time and was used as pasture for animals. Of the 174 plant species recorded on the site 19 were recorded in the *Eragrostis – Digitaria* fields study unit. Of these, 11 are annual & perennial herbaceous species and eight species are grasses.

6.11.2 Species in the study unit that are considered threatened, or not threatened, but of conservation concern

This study unit does not have suitable habitat for any of the species that are considered threatened, or for those that are considered not threatened, but of conservation concern.

6.11.3 Protected trees and other protected species

No protected trees or other protected species were found in the *Eragrostis – Digitaria* fields study unit.

6.11.4 Medicinal and alien species

One medicinal species and five alien species were recorded in the *Eragrostis – Digitaria* fields study unit. None of the alien species are declared invaders.

6.11.5 Sensitivity

This study unit is not considered sensitive.

Figure 7: *Eragrostis – Digitaria* fields on portion 41.

Table 6: Plants recorded in the *Eragrostis – Digitaria* fields

SCIENTIFIC NAME	COMMON NAMES
Aristida adscensionis	Annual three-awn / Eenjarige steekgras
Aristida congesta subsp. *barbicollis*	Spreading three-awn grass / Witsteekgras
*Bidens pilosa**	Blackjack / Knapsekêrel
Brachiaria serrata	Velvet grass / Fluweelgras
Cleome monophylla	Spindle pod / Rusperbossie
Convolvulus sagittatus	
Cynodon dactylon	Couch grass / Kweek
Digitaria eriantha	Finger grass / Vingergras
Eragrostis chloromelas	Curly leaf / Krulblaar
Eragrostis rigidior	Broad-leaved curly leaf / Breëkrulgras
*Euphorbia heterophylla**	Wild poinsettia / Wilde poinsettia
Felicia muricata subsp. *muricata*[1,2,3]	White felicia / Blouheuning karooblom
*Gomphrena celosiodes**	Bachelor's button / Mierbossie
Hyparrhenia hirta	Common thatching grass / Dekgras
Ipomoea obscura var. *obscura*	Wild petunia / Wilde patat
Pentarrhinum insipidum	Donkieperske
*Schkuhria pinnata**	Dwarf marigold / Klein kakiebos
Solanum panduriforme	Poison apple / Gifappel
*Tagetes minuta**	Tall khaki weed / Lang kakiebos

6.12. Drainage line vegetation

6.12.1. Compositional aspects

This study unit lies along the eastern boundary of portion 41 and comprises drainage line vegetation that is invaded by various alien species. Of the 174 plant species recorded on the site 31 were recorded in the Drainage line vegetation study unit. Of these 21 are indigenous species. The following number of species in each growth form was noted:

GROWTH FORM	NUMBER OF SPECIES
Annual & perennial herbaceous species	8
Tree species	9
Shrubs and dwarf shrubs	3
Grasses	11
Total Number of species	31

6.12.2 Species in the study unit that are considered threatened, or not threatened, but of conservation concern

This study unit does not have suitable habitat for any of the species that are considered threatened, or for those that are considered not threatened, but of conservation concern.

6.12.3 Protected trees and other protected species

No protected trees or other protected species were found in the Drainage line vegetation study unit.

6.12.4 Medicinal and alien species

Two medicinal species were recorded in this study unit. Ten of the 26 alien species recorded on the site were found in this study unit. Of these, two are Category 1 Declared weeds, two are Category 2 Declared invaders and one is a Category 3 Declared invader.

6.12.5 Sensitivity

As drainage lines form corridors for the movement of species, which include pollinators of plant species, this study unit is considered sensitive and should be excluded from development.

Figure 8: Drainage line vegetation.

Table 7: Plants recorded in the Drainage line vegetation

SCIENTIFIC NAME	INV CAT	COMMON NAMES
*Acacia mearnsii**	2	Black wattle / Swartwattel
Acacia robusta subsp. *robusta*		Broad-pod robust thorn / Enkeldoring
Aristida canescens subsp. *canescens*		Pale three-awn / Vaalsteekgras
Asparagus laricinus		Wild asparagus / Katbos
*Bidens pilosa**		Blackjack / Knapsekêrel
Brachiaria nigropedata		Black-footed grass / Swartvoetjiegras
Celtis africana		White stinkwood / Witstinkhout
Combretum zeyheri[4]		Large-fruited bushwillow / Raasblaar

SCIENTIFIC NAME	INV CAT	COMMON NAMES
Cynodon dactylon		Couch grass / Kweek
Digitaria eriantha		Finger grass / Vingergras
Eragrostis chloromelas		Curly leaf / Krulblaar
Eragrostis rigidior		Broad-leaved curly leaf / Breëkrulgras
Eucalyptus sp.*	2	Gum tree / Bloekom
*Euphorbia heterophylla**		Wild poinsettia / Wilde poinsettia
Ficus burkei		Common wild fig / Gewone wildevy
Hyparrhenia hirta		Common thatching grass / Dekgras
Hyperthelia dissoluta		Yellow thatching grass / Geeltamboekiegras
*Lantana camara**	1	Lantana
*Melia azedarach**	3	Syringa / Sering
Melinis repens subsp. *repens*		Red top grass
Panicum maximum		Guinea grass / Gewone buffelsgras
Pentarrhinum insipidum		Donkieperske
*Schkuhria pinnata**		Dwarf marigold / Klein kakiebos
Searsia lancea		Karee
Searsia pyroides var. *pyroides*[4]		Common wild currant / Taaibos
*Sesbania punicea**	1	Red sesbania / Rooisesbania
Setaria sphacelata var. *sphacelata*		Commn bristle grass / Gewone mannagras
Sida dregei		Spider-leg
Solanum panduriforme		Poison apple / Gifappel
*Tagetes minuta**		Tall khaki weed / Lang kakiebos
*Zinnia peruviana**		Redstar zinnia / Wildejakobregop

INV CAT = Invader Category
[1)] Van Wyk, B-E., Van Oudtshoorn, B. & Gericke, N. 2002.
[2)] Watt, J.M. & Breyer-Brandwijk, M.G. 1962.
[3)] Pooley, E. 1998.
[4)] Van Wyk, B. & Van Wyk P. 1997.

7. LIMITATIONS, ASSUMPTIONS AND GAPS IN KNOWLEDGE

Sufficient information was received and sufficient rain had fallen to accomplish the survey that was done during optimum growing conditions.

8. FINDINGS AND POTENTIAL IMPLICATIONS

A small damaged Marula tree that is a protected tree in terms of the National Forests Act, 1998 (Act No. 84 of 1998) and a plant that was considered a protected plant species in terms of NEMBA, 2004 (Act No. 10 of 2004) were found in the *Peltophorum – Dichrostachys* thicket study unit on portion 22 of the study site. Both these species should be conserved *in situ*. This study unit is considered sensitive owing to its near pristine state. Development of this part of the site might destroy these two protected species.

The six Marula trees that occur in the *Acacia robusta – Clerodendrum* savanna study unit on portion 22 and the Marula on portion 41 must be conserved *in situ*.

9. RECOMMENDED MITIGATION MEASURES

The following mitigation measures are proposed by the specialist:

- Where possible, trees naturally growing on the site should be retained as part of the landscaping, with specific emphasis on *Sclerocarya birrea* subsp. *caffra* (Marula). Measures to ensure that these trees survive the physical disturbance from the development should be implemented. A tree surgeon should be consulted in this regard.

- Dumping of builders' rubble and other waste in the areas earmarked for exclusion must be prevented, through fencing or other management measures. These areas must be properly monitored during the operational phase of the development.
- All Declared Weeds and invaders must be removed from the site.

The following mitigation measures were developed by GDARD 2012 (Department of Agriculture and Rural Development, Directorate of Nature Conservation) and are applicable to the study site. Where appropriate, Galago Environmental's specific elaborations are given in brackets.

- An appropriate management authority (e.g. the body corporate) that must be contractually bound to implement the Environmental Management Plan (EMP) and Record of Decision (ROD) during the operational phase of the development should be identified and informed of their responsibilities in terms of the EMP and ROD.
- All areas designated as sensitive in a sensitivity mapping exercise should be incorporated into an open space system. Development should be located on the areas of lowest sensitivity.
- Development structures should be clustered as close as possible to existing development. **(The filling station and its accociated buildings should be located as close as possilble to the N4 highway.)**
- The open space system should be managed in accordance with an Ecological Management Plan that complies with the *Minimum Requirements for Ecological Management Plans* and forms part of the EMP.
- The Ecological Management Plan should:
    - include a fire management programme to ensure persistence of grassland
    - include an ongoing monitoring and eradication programme for all non-indigenous species, with specific emphasis on invasive and weedy species
    - include a comprehensive surface runoff and storm water management plan, indicating how all surface runoff generated as a result of the development (during both the construction and operational phases) will be managed (e.g. artificial wetlands / storm water and flood retention ponds) prior to entering any natural drainage system or wetland and how surface runoff will be retained outside of any demarcated buffer/flood zones and subsequently released to simulate natural hydrological conditions
    - ensure the persistence of all Red and Orange List species (Species that are considered threatened, or not threatened, but of conservation concern, as well as protected trees and other protected plants.)
    - include a monitoring programme for all Red and Orange List species (Species on the study site that are considered threatened, or not threatened, but of conservation concern)
    - facilitate/augment natural ecological processes
    - provide for the habitat and life history needs of important pollinators
    - minimize artificial edge effects (e.g. water runoff from developed areas & application of chemicals)
    - include a comprehensive plan for limited recreational development (trails, bird hides etc.) within the open space system
    - result in a report back to the Directorate of Nature Conservation on an annual basis (Report back to Mpumalanga Tourism and Parks Agency)
- The open space system should be fenced off prior to construction commencing (including site clearing and pegging). All construction-related impacts (including service roads, temporary housing, temporary ablution, disturbance of natural habitat, storing of equipment/building materials/vehicles or any other activity) should be excluded from the open space system. Access of vehicles to the open space system should be prevented and access of people should be controlled, both during the construction and operational phases. Movement of indigenous fauna should however be allowed (i.e. no solid walls, e.g. through the erection of palisade fencing).
- Information boards should be erected within the development to inform residents of the presence of Red / Orange List species, their identification, conservation status and

importance, biology, habitat requirements and management requirements. (Species that are considered threatened, or not threatened, but of conservation concern, as well as protected trees and other protected plants.)

- Only indigenous plant species, preferably species that are indigenous to the natural vegetation of the area, should be used for landscaping in communal areas. As far as possible, plants naturally growing on the development site, but would otherwise be destroyed during clearing for development purposes, should be incorporated into landscaped areas. Forage and host plants required by pollinators should also be planted in landscaped areas.
- In order to minimize artificially generated surface stormwater runoff, total sealing of paved areas such as parking lots, driveways, pavements and walkways should be avoided. Permeable material should rather be utilized for these purposes.

10. CONCLUSION

To reduce the impact of the proposed development on the vegetation of the site, great care should be taken to locate the filling station and its associated buildings as close to the N4 highway as possible, rather than spreading them out over large areas. Access roads, footpaths, services etc should be constructed with great care.

The *Peltophorum – Dichrostachys* thicket study unit on portion 22 of the study site and the Drainage line vegetation are deemed sensitive and should be excluded from development and where possible, corridors must be created to other natural vegetation areas on the neighbouring properties to facilitate connectivity.

The Marula trees and the *Harpagophytum zeyheri* subsp. *zeyheri* should be conserved in situ and the damaged Marula trees treated by a tree surgeon to ensure their survival.

Figure 9: Vegetation sensitivity map

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ANNEXURE A: SPECIES OF CONSERVATION CONCERN

Species of the 2527DB q.d.s. that are considered not threatened but of conservation concern in terms of the 2009 Red List

Species	Flower time	Conserv status	Presence on site
Adromischus umbraticola subsp. *umbraticola**	Sep-Jan	NT	Habitat not suitable
*Boophone disticha**	Oct-Jan	Declining	Habitat suitable
Commelina bella	Nov-Jan	DDT	Habitat not suitable
Crinum macowanii	Oct-Jan	Declining	Habitat not suitable
Ilex mitis var. *mitis**	Oct-Dec	Declining	Habitat not suitable
*Myrothamnus flabellifolius**	Nov-May	DDT	Habitat not suitable
*Stenostelma umbelluliferum**	Sep-Mar	NT	Habitat not suitable

*Can be identified outside flowering time

ANNEXURE B: PROTECTED TREES

Trees of the 2922AC q.d.s. and surrounding areas that are protected trees in terms of section 15(1) of the National Forests Act, 1998

Species	Presence on site
Sclerocarya birrea subsp. *caffra*	**FOUND**

ANNEXURE C: OTHER PROTECTED SPECIES

Species of the 2527DB q.d.s. that are Protected* species in terms of the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).

Species	Presence on site
Harpagophytum zeyheri subsp. *zeyheri*	**FOUND**

* Indigenous species of high conservation value or national importance that require national protection

APPENDIX B: MAMMAL REPORT

GALAGO ENVIRONMENTAL

Biodiversity & Aquatic Specialists

638 Turf Street

Wingate Park, 0181

Tel: 012-345 4891

Mammal Species Richness and Habitat Assessment

of

Portions 22 and 41 of the farm Schietfontein 437 JQ

May 2014

Report author: I.L. Rautenbach (Pr.Sci.Nat., T.H.E.D., Ph.D)

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Declaration of Professional Standing and Independence:

I, Ignatius Lourens Rautenbach (421201 5012 08 8) declare that I:

- hold a Ph.D. in the biological sciences, which allowed registration by SACNASP (SA Council for National Scientific Professions) as a Professional Zoologist and sanction me to function independently as a specialist scientific consultant
- declare that as per prerequisites of the Natural Scientific Professions Act No. 27 of 2003 this project was my work from inception and reflects exclusively my observations and unbiased scientific interpretations, and executed to the best of my ability
- abide by the Code of Ethics of the SACNASP
- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate opportunities to learn through constructive criticism and debate, I reserve the right to form and hold my own opinions within the constraints of my training and experience, and therefore will not submit willingly to the interests of other parties or change my statements to appease them
- am subcontracted as a specialist consultant by Galago Environmental CC for the project entitled “Mammal Species Richness and Habitat Evaluation of Schietfontein 437 JQ, Portions 22 and 41“, as described in this report
- have no financial interest in the proposed development other than remuneration for the work performed
- do not have, and will not have in the future, any vested or conflicting interests in the proposed development
- undertake to disclose to Galago Environmental CC and its client(s) as well as to the competent authority any material information that may have the potential to influence any decisions by the competent authority, as required in terms of the Environmental Impact Assessment Regulations 2006
- reserve the right to only transfer my intellectual property contained in this report to the client(s), (party or company that commissioned the work) on full payment of the contract fee. Upon transfer of the intellectual property, I recognise that written consent from the client will be required for me to release of any part of this report to third parties.

I.L. Rautenbach

1. INTRODUCTION

Galago Environmental CC. was appointed to assess mammal species richness and mammal habitat on Portions 22 and 41 of the Farm Schietfontein 437 JQ, North West Province. A small area of each portion will be developed as a Q4 Comfort Station for motorists on the N4 Platinum Highway.

This report focuses on the reigning status of threatened and sensitive mammals likely to occur on the proposed development site, and whose conservation status should be considered in the decision-making process. Special attention was paid to the qualitative and quantitative habitat conditions for Red Data species deemed present on the site, and mitigation measures to ameliorate the effect of the development that is suggested. The secondary objective of the investigation was to gauge which mammals might still reside on the site and compile a complete list of mammal diversity of the study area.

This assignment is in accordance with the 2010 EIA Regulations (No. R. 543-546, Department of Environmental Affairs and Tourism, 18 June 2010) emanating from Chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998).

2. SCOPE AND OBJECTIVES OF THE STUDY

- To qualitatively and quantitatively assess the significance of the mammal habitat components and current general conservation status of the properties;
- Identify and comment on ecological sensitive areas;
- Comments on connectivity with natural vegetation and habitats on adjacent sites;
- To provide a list of mammals that occur or might occur, and to identify species of conservation importance;
- To highlight potential impacts of the proposed development on the mammals of the study site, and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.

3. STUDY AREA

The study site is located at the junction of the N4 (Platinum Highway) and the Lucas Mangope Drive in the North-West Province. It is proposed to build Q4 refuelling and comfort stations for motorists travelling eastwards and westwards on the N4 dual highway. Portion 22 (25º 38' 50"S; 27º 56' 28"E) will provide services to eastbound traffic and is located on the north-western corner of the N4 - Mangope junction and is 63.7 hectares in extend. Portion 41 (25º 39'10"E; 27º 57' 01"S) is situated on the south-eastern corner of the junction and comprises 33.3 hectares. In each case the footprint of the development will comprise a small (but undisclosed) area of the Portions in question, and will be located close to the junction.

Both Portions are located in the Marikana Thornveld vegetation unit as defined by Mucina and Rutherford (2006). Portion 22 is ecologically in a largely undisturbed condition, with a few ruins of former habitation. Exotic invasions are limited to odd lantanas and tall Queens-of-the-Night specimens. However, sickle bush show signs of unnatural invasion and in places form thickets. Natural basal cover was in a good condition during the site survey.

Portion 41 lies just west of the border between the North-West Province and Gauteng that is formed by a dry wash receiving water during heavy rains. The depression of the drainage line has several mature bluegum and seringa trees. The floral composition on Portion 41 has been largely transformed by clearing smaller shrubs and trees to favour larger indigenous trees and thus to create parkland. Basal cover in the parkland portion is lush and kept short by grazing by horses and re-introduced species such as zebra, blesbok and nyala. Buildings serving the desiderata of an executive training facility are located towards the centre of this property and will not be affected by the proposed development.

The topography of both subsections of the site is flat terrain in the valley north of the Magaliesberg Mountain range. The substrate on both properties range from red sandy soil, in places imbedded with gravel and even localised rock. No termitaria were recorded on either site.

Other than the Lucas Mangope Drive and the N4, the 500 meters zone of surrounding properties are rural in nature, but contain no ecological features worthy of note.

Neither of the portions have natural caves suitable for cave-dwelling bats. However, some of the buildings and culverts may be occupied by roosting bats. The building on Portion 41 and ruins on Portion 22 most likely provide daytime roosts for less discerning bats such as the free-tailed and vesper bats listed.

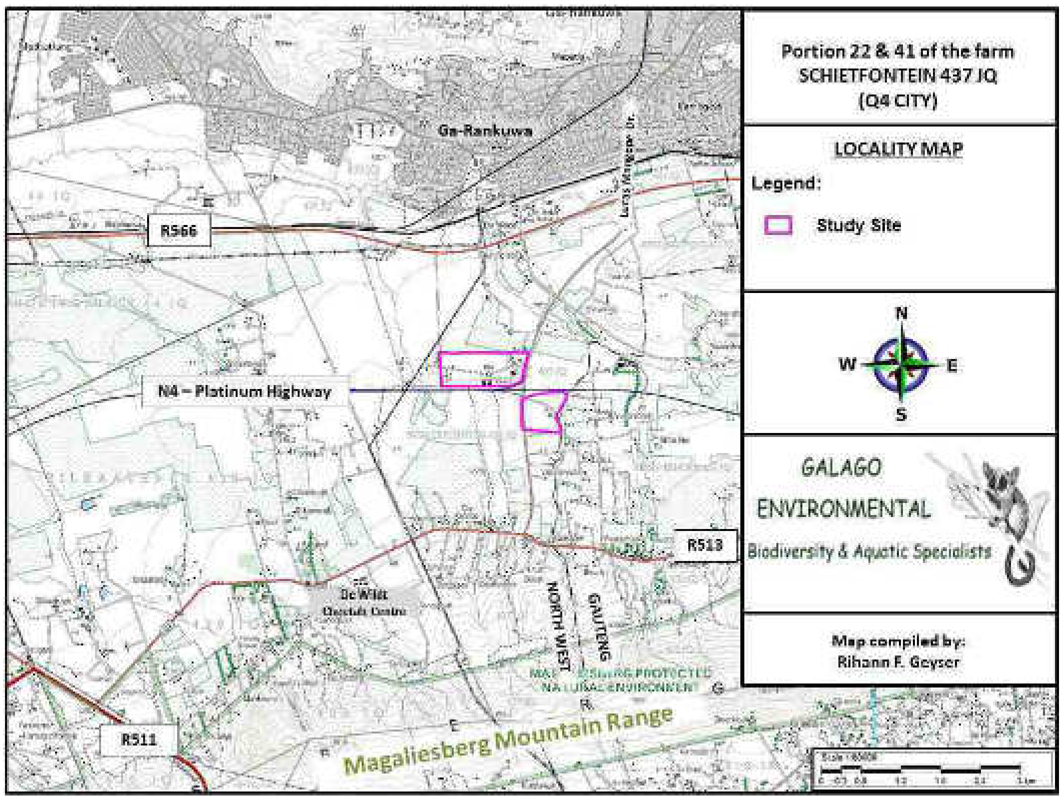

Figure 1: Locality map of the study area

4. METHODS

A four hour site visit was conducted on 14 March 2014. During this visit the observed and derived presence of mammals associated with the recognized habitat types of the study site, were recorded. This was done with due regard to the well recorded global distributions of Southern African mammals, coupled to the qualitative and quantitative nature of recognized habitats.

The 500 meters of adjoining properties were scanned for important faunal habitats.

4.1 Field Surveys

During the site visit mammals were identified by visual sightings through random transect walks. No trapping or mist netting was conducted, as the terms of reference did not require such intensive (and costly) work. In addition, mammals were also identified by means of spoor, droppings, burrows or roosting sites.

Three criteria were used to gauge the probability of occurrence of mammals on the study site. These include known distribution range, habitat preference and the qualitative and quantitative presence of suitable habitat.

4.2 Desktop Surveys

As the majority of mammals are secretive, nocturnal, hibernators, migrators and/or seasonal, distributional ranges and the presence of suitable habitats were used to deduce the presence or absence of these species based on authoritative tomes, scientific literature, field guides, atlases and databases. This can be done irrespective of season. During the field work phase of the project, this derived list of occurrences is audited.

The probability of occurrences of mammal species was based on their respective geographical distributional ranges and the suitability of on-site habitat. In other words, *high* probability would be applicable to a species with a distributional range overlying the study site as well as the presence of prime habitat occurring on the study site. Another consideration for inclusion in this category is the inclination of a species to be common, i.e. normally occurring at high population densities.

Medium probability pertains to a mammal species with its distributional range peripherally overlapping the study site, or required habitat on the site being sub-optimal. The size of the site as it relates to its likelihood to sustain a viable breeding population, as well as its geographical isolation is also taken into consideration. Species categorised as *medium* normally do not occur at high population numbers, but cannot be deemed as rare.

A *low* probability of occurrence will mean that the species' distributional range is peripheral to the study site and habitat is sub-optimal. Furthermore, some mammals categorised as *low* are generally deemed rare.

4.3 Specific Requirements

During the visit the site was surveyed and assessed for the potential occurrence of Red Data and/or wetland-associated species such as Juliana's golden mole (*Neamblosomus juliana*), Highveld golden mole (*Amblysomus septentrionalis*), Rough-haired golden mole (*Chrysospalax villosus*), African marsh rat (*Dasymys incomtus*), Angoni vlei rat (*Otomys angoniensis*), Vlei rat (*Otomys irroratus*), White-tailed rat (*Mystromys albicaudatus*), a nember of shrews such as the Forest shrew (*Myosorex varius*), Southern African hedgehog *(Atelerix frontalis), a number of bats such as the* Short-eared trident bat (*Cloeotis percivali*), African clawless otter (*Aonyx capensis*), Spotted-necked otter (*Lutra maculicollis*), Marsh mongoose (*Atilax paludinosus*), Brown hyena (*Parahyaena brunnea*), etc.

5. RESULTS

5.1 Mammal Habitat Assessment

The local occurrences of mammals are closely dependent on broadly defined habitat types, in particular terrestrial, arboreal (tree-living), rupiculous (rock-dwelling) and wetland-associated vegetation cover. A grasp of the habitat diversity and conservation condition of a site is therefore of fundamental importance. It is thus possible to deduce the presence or absence of mammal species by evaluating the habitat types within the context of global distribution ranges.

Only the terrestrial and arboreal major habitat types is present on the study site.

The rolling landscape of both disjunct Portions fails to offer well-defined ridges or boulders offering nooks and crannies as refuge for rupiculous mammals.

The streambed on Portion 41 locally forms the border between the North-West Province and Gauteng. It is seasonal and therefore lacks well-developed semi-aquatic vegetation on its banks, although moisture-reliant plants grow in the streambed. It consequently is concluded to fail largely to provide refuge and nourishment for wetland-reliant small mammals. The streambed can, however, be expected to serve as refuge and a dispersal corridor along its short course for terrestrial mammals, but the many larger exotic trees and saplings are unsuitable for arboreal mammals.

The terrestrial habitat suffered a variety of ecological modifications on Portion 41, varying from invasion by exotics such as bluegums and seringa trees, Kikuyu and a number of declared weeds (viz. blackjacks). A major area of this portion is being mowed and grazed by horses, blesbok, nyala and Burchell's zebra. Several chalets, stores, structures, culverts etc. are present on the site, all of whom have the potential to serve as daytime roosts for the bats listed. The small area in the north-west corner targeted for development is ecologically transformed.

Both the arboreal and terrestrial habitat on Portion 22 is in good ecological condition, partly due to the fact that it is lightly grazed by cattle. Lantana and Queen-of-the-night specimens are present and will require assertive action in the near future. A measure of sickle bush invasion is visible, suggesting that Portion 22 will benefit from enlightened range management. Only the south-easterly small portion of the site will be developed, the rest will remain unaffected.

The conservation status of portion 41 is rated as 'very poor' as a result of large-scale ecological intervention. However, the conservation status of Portion 22 is rated as 'good', and only minimal intervention would be necessary to remove noxious plants.

Figure 2: Generally Portion 22 consist of dense woodland interspersed with patches of dense grassland

Figure 3: A view of the dense woodland terrain on Portion 22, with some invasions of sickle bush

Figure 4: Remains for past settlement on Portion 22, probably before division of the farm into smaller subunits

Figure 5: The seasonal stream forming the boundary between Gauteng and the Schietfontein Portion 41 just inside North-West Province

Figure 6: A major portion of Portion 41 has been subjected to bush clearing to form artificially maintained parkland

Figure 7: The main economic activity on Portion 41 is an executive training centre. Pictured here is the student accommodation

5.2 Expected and Observed Mammal Species Richness

All large mammals (viz. elephant, rhino species, buffalo, black wildebeest, plain's zebra, impala, lion, cheetah, leopard, *et al.*) have a century or more ago been hunted out for sport or to favour farming practices. Kudu may still occur naturally in the district but lacking substantial evidence for its occurrence, it is not listed. More recently progressively intensive land-use practices systematically displaced medium-sized mammals such as baboons, vervet monkeys, pangolins, impala, aardwolves, honey badgers etc. Some species are probably on the edge of disappearing from Portion 41, such as the ubiquitous black-backed jackal, duiker and steenbok that may by now probably are mere vagrants.

All rupiculous and most moisture-reliant mammals were *a priori* omitted from the list of possible occurrences, since these habitats are absent. The seasonal drainage line along the eastern perimeter of Portion 41 may support vlei rats – in concordance with the point of departure for this report (see Section 7), vlei rats are regarded as possible occupants.

Of the 43 mammal species expected to occur on the study site (Table 1), five were confirmed during the site visit (Table 2). The three introduced herbivores distort the species richness of the site, especially since they were released in areas alien to their historical distribution ranges. All feral mammal species expected to occur on the study site (e.g. house mice, house rats, dogs and cats) were omitted from the assessment since these cannot be considered when estimating the conservation value of the site.

It should be noted that potential occurrences is interpreted as to be possible over a period of time as a result of environmentally induced expansion and contractions of population densities and ranges which stimulate migration.

Most of the species of the resident diversity (Table 1) are common, robust and widespread. Some have strong pioneering capabilities. The reason for their survival success is predominantly seated in their remarkable reproduction potential (viz. multimammate mice species capable of producing ca. 12 pups per litter at intervals of three weeks), and to a lesser extent their reticent and cryptic nature (scrub hares, genets and mongooses).

The listed bats showed remarkable adaptivity by expanding their population numbers significantly by capitalizing on the roosting opportunities offered be manmade structures. Whispering bats (Rhinolophidae, Hipposideridae and Nycteridae) are reliant on the cool and moist interiors of deep caves (or similar manmade structures) to avoid desiccation of their wing membranes and for physiological reasons; species belonging to these families are deemed absent.

The small carnivores listed have high probabilities of surviving in an area as long as they remain within the constraints of sustainable prey densities; the latter is deemed likely. Of note is the predicted presence of banded mongooses that are endemic to woodlands.

Duiker and steenbok can withstand high hunting pressure and are thus virtually a standard feature of the species richness backdrop of a site.

The species richness is high, especially when accounting for historical extirpations. This can be ascribed to the relatively extensive nature of the surrounding wooded properties largely only disturbed by cattle grazing, excellent connectivity and the relatively good state of conservation of Portion 22.

5.3 Threatened and Red Listed Mammal Species

The two Red Listed shrews cited in Table 1 are not necessarily endangered. These have not been adequately studied to provide quantitative field data to accurately assign a conservation ranking, and are thus as a precaution considered as 'Data Deficient'. Shrews function at the apex of the food pyramid, which means that their population numbers are inevitably significantly lower than that of similar-sized herbivorous and especially of their prey species. Because of the diet of these vociferous little insectivores, they are furthermore not readily trapped with conventional bait or traps, which may mean that their numbers are under-estimated. Results obtained with drift fences and pitfalls support the latter statement.

It is not clear why short-snouted elephant shrews are assigned to the 'Data Deficient' Red Data species ranking. These insectivorous creatures occur in dense wooded plains and take refuge at the bases of dense shrubs – a resource abundantly available in the form of sickle bush. The rationale for their conservation rating must be exactly the same as for shrews.

Why bushveld gerbils are regarded as 'Data Deficient' is an enigma.

Unfortunately hedgehogs attained their 'Near Threatened' status as result of direct intervention by humans and their pets. Considering the low incidence of both humans and domestic pets on site, the likelihood of hedgehogs persisting is rated as 'good'.

African weasels thus far also failed to receive attention from field biologists, as a consequence of which they are as a precautionary measure regarded as "Data Deficient'. Brown hyenas are indeed ruthlessly prosecuted, but due to their reticent behaviour and wide ranging inclination they retain a 'Near Threatened" Red Data assignment outside conservation areas.

Table 1: The mammals which were observed or deduced to occupy the site
(Systematics and taxonomy as proposed by Bronner et.al [2003] and Skinner and Chimimba [2005])

	SCIENTIFIC NAME	ENGLISH NAME
DD	*Elephantulus brachyrhynchus*	Short-snouted elephant shrew
?	*Orycteropus afer*	Aardvark
√	*Lepus saxatilis*	Scrub hare
√	*Cryptomys hottentotus*	African mole rat
*	*Hystrix africaeaustralis*	Cape porcupine
?	*Pedetes capensis*	Springhare
?	*Paraxerus cepapi*	Tree squirrel
?	*Graphiurus murinus*	Woodland dormouse
*	*Mus minutoides*	Pygmy mouse
√	*Mastomys natalensis*	Natal multimammate mouse
√	*Mastomys coucha*	Southern multimammate mouse
*	*Thallomys paedulcus*	Acacia rat
*	*Thallomys nigricauda*	Black-tailed tree rat
√	*Aethomys ineptus*	Tete veld rat
?	*Otomys angoniensis*	Angoni vlei rat
?	*Otomys irroratus*	Vlei rat
DD√	*Gerbilliscus leucogaster*	Bushveld gerbil
*	*Saccostomus campestris*	Pouched mouse
*	*Dendromus melanotis*	Grey pygmy climbing mouse
*	*Dendromus mesomelas*	Brants' climbing mouse
*	*Dendromus mystacalis*	Chestnut climbing mouse
*	*Galago moholi*	South African galago
DD√	*Crocidura cyanea*	Reddish-grey musk shrew

	SCIENTIFIC NAME	ENGLISH NAME
DD√	*Crocidura hirta*	Lesser red musk shrew
NT?	*Atelerix frontalis*	Southern African hedgehog
*	*Tadarida aegyptiaca*	Egyptian free-tailed bat
√	*Neoromicia capensis*	Cape serotine bat
√	*Scotophilus dinganii*	African yellow house bat
√	*Scotophilus viridis*	Greenish yellow house bat
NT?	*Parahyaena brunnea*	Brown hyena
*	*Felis silvestris*	African wild cat
√	*Genetta genetta*	Small-spotted genet
√	*Genetta tigrina*	SA large-spotted genet
√	*Cynictis penicillata*	Yellow mongoose
√	*Galerella sanguinea*	Slender mongoose
*	*Mungos mungo*	Banded mongoose
√	*Canis mesomelas*	Black-backed jackal
DD?	*Poecilogale albinucha*	African weasel
*	*Ictonyx striatus*	Striped polecat
√	*Equus quagga*	Plains zebra
√	*Tragelaphus angasii*	Nyala
√	*Damaliscus pygargus phillipsi*	Blesbok
*	*Sylvicapra grimmia*	Common duiker
*	*Raphicerus campestris*	Steenbok

√ Definitely there or have a *high* probability to occur;
***** *Medium* probability to occur based on ecological and distributional parameters;
? *Low* probability to occur based on ecological and distributional parameters.

Red Data species rankings as defined in Friedmann and Daly's S.A. Red Data Book / IUCN (World Conservation Union) (2004) are indicated in the first column: CR= Critically Endangered, En = Endangered, Vu = Vulnerable, LR/cd = Lower risk conservation dependent, LR/nt = Lower Risk near threatened, DD = Data Deficient. All other species are deemed of Least Concern.

Table 2: Mammal species positively confirmed from the study site, observed indicators and habitat

SCIENTIFIC NAME	ENGLISH NAME	OBSERVATION INDICATOR	HABITAT
L. saxatilis	Scrub hare	Faecal pellets	Short grassveld
C. hottentotus	African mole rat	Tunnel systems	Universal
Equus quagga	Plains zebra	Sight record	Unnatural occurrence
T. angasii	Nyala	Sight record	Unnatural occurrence
D. pygargus	Blesbok	Sight record	Unnatural occurrence

Scrub hares and the mole rats are outstandingly widespread and common within their distribution ranges and both are reproductively fecund. The scrub hare thrive on short grass (which is normally the result of overgrazing or environmental manipulation such as on Portion 41), and is rarely seen since they are nocturnal and are exceptionally cryptic during day where they lie up in forms constructed at the base of grass clumps or shrubs. The suburban life-style of rodent moles renders them virtually untouchable by humans.

A few Burchell's zebra, Nyalas and Blesbok were re-introduced, in all instances outside their normal distributional ranges.

6. FINDINGS AND POTENTIAL IMPLICATIONS

The proposed developments will spatially be limited to only a small area of each Portion. The rest of the study area will remain as is. The biological damage caused by the comfort stations will thus be relatively small, *albeit* absolute. Given due care, the proposed development will not result in a loss of ecological sensitive and important habitat units, ecosystem function (e.g. reduction in water quality, soil pollution), notable loss of mammal habitat, nor of significant loss/displacement of threatened or protected species.

<u>Species richness</u>: This ecological facet is concluded to have suffered a downwards spiral but has now reached a stabilized stage. The species assemblage of both Portions is robust and some species in fact has the potential to become house pests.
<u>Endangered species</u>: It is contended that the two *Crocidura* species are not endangered, and they are often found in lush gardens. Given the relative small footprints of the two developments within an extensive area with a high conservation profile, the conservation profile of endangered species are unlikely to change.
<u>Sensitive species and/or areas (Conservation ranking)</u>: Vlei rats <u>may</u> be present along the short drainage line along the eastern boundary of Portion, but these are regarded as robust species with restrictive habitat reliances. No sensitive ecological systems are flagged, which include the streambed and small dams constructed as water sources for cattle on Portion 22.
<u>Habitat(s) quality and extent</u>: The entire Portion 42 is severely transformed, whereas Portion 22 north of the N4 consists largely of a good stand of relatively undisturbed woodland that answers to the definition of Marikana Thornveld.
<u>Impact on species richness and conservation</u>: The proposed developments will comprise of small footprints consisting of the entire destruction of any vestige of wild life. However, the largest portion of the Portions under contention will remain unchanged.
<u>Connectivity</u>: Connectivity is near natural.
<u>Management recommendation</u>: Considering the projected severity of transformation of the development footprint, no management precautions are possible. However, the rest of the two Portions will benefit from a scientifically-based range management plan, and the immediate eradication of alien vegetation.

7. LIMITATIONS, ASSUMPTIONS AND GAPS IN INFORMATION

The Galago Environmental team has sufficient experience and ample access to information sources to confidently compile lists of biota such as presented herein to support conclusions and suggested mitigation measures based on a site visit. In instances where doubt exists, a species is assumed to be a possible occupant (viz. vlei rat species); -this approach renders the conclusions to be robust. In instances where the possible occurrence has significant ecological implications, an intensive survey is recommended. In view of the latter, it is highly unlikely that an intensive survey to augment the data base of site visit will add significantly to the data base, and the additional costs are unlikely to warrant the effort.

Even though every care is taken to ensure the accuracy of this report, environmental assessment studies are limited in scope, time and budget. Discussions and proposed mitigations are to some extent made on reasonable and informed assumptions built on *bone fide* information sources, as well as deductive reasoning. Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage. Galago Environmental can thus not accept responsibility for conclusions and mitigation measures made in good faith based on own databases or on the information provided at the time of the directive. This report should therefore be viewed and acted upon with these limitations in mind.

8. RECOMMENDED MITIGATION MEASURES

- Should hedgehogs be encountered during the construction phase of the development, these should be relocated to natural grassland areas in the vicinity.
- The contractor must ensure that no mammal species are disturbed, trapped, hunted or killed during the construction phase. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for non-compliance.

It is assumed that the proposed development will be similar in design to other motorists' comfort stations country-wide. These invariably entail 'wall-to-wall' buildings, structures, concrete and paving, with patches of lawn. There will therefore ultimately be no biological elements that can benefit from mitigation. The remainder of the two Portions not targeted for development, will benefit from range management plans. Walls isolating the developments from surrounding natural areas will serve to safeguard wandering terrestrial wild life from being run over by traffic.

9. CONCLUSIONS

The proposed development will spatially be modest, with the major portion of the two Portions to be excluded from development. The developments will entirely displace terrestrial mammals, but relatively speaking this will be modest, apart from consisting mostly of common species. The conservation status of no endangered species will be jeopardized.

From a mammal perspective, the site has a low sensitivity.

Figure 8: Mammal Sensitivity map

10. LITERATURE SOURCES

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APPENDIX C: AVIFAUNA REPORT

GALAGO ENVIRONMENTAL

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Avifaunal Habitat Assessment

of

PORTIONS 22 AND 41 OF THE FARM SCHIETFONTEIN 437 JQ (Q4 CITY)

May 2014

Report author: Mr. R.F. Geyser
Report verified/reviewed by: Dr. A.C. Kemp (Ph.D., Pr.Sci. Nat. (Zoology & Ecology))

DECLARATION OF INDEPENDENCE:

I, Rihann F. Geyser (690304 5248 084), declare that I:

- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate the opportunity to also learn through the processes of constructive criticism and debate, I reserve the right to form and hold my own opinions and therefore will not willingly submit to the interests of other parties or change my statements to appease them
- act as an independent specialist consultant in the field of ornithology
- am subcontracted as specialist consultant by Galago Environmental CC for the proposed Q4 City on Portions 22 & 41 of the farm Schietfontein 437 JQ development described in this report
- have no financial interest in the proposed development other than remuneration for work performed
- neither have nor will have any vested or conflicting interests in the proposed development
- undertake to disclose to Galago Environmental CC and its client, and the competent authority, any material information that has or may have the potential to influence decisions by the competent authority as required in terms of the Environmental Impact Assessment Regulations 2006

Rihann F. Geyser

VERIFICATION STATEMENT
Mr R. Geyser is not registered as a Professional Natural Scientist with the S.A. Council for Natural Scientific Professions. This communication serves to verify that the bird report compiled by Mr R.F. Geyser has been prepared under my supervision, and I have verified the contents thereof.

Declaration of Independence: I, Alan Charles Kemp (4405075033081), declare that I:

- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate the opportunity to also learn through the processes of constructive criticism and debate, I reserve the right to form and hold my own opinions and therefore will not willingly submit to the interests of other parties or change my statements to appease them
- abide by the Code of Ethics of the S.A. Council for Natural Scientific Professions
- act as an independent specialist consultant in the fields of zoology and ecology
- am subcontracted as specialist consultant by Galago Environmental CC for the proposed Q4 City on Portions 22 & 41 of the farm Schietfontein 437 JQ described in this report
- have no financial interest in the proposed development other than remuneration for work performed
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Dr. A.C. Kemp

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1. INTRODUCTION

Galago Environmental CC. was appointed to undertake an avifaunal habitat survey for the proposed Q4 City on Portions 22 & 41 of the farm Schietfontein 437 JQ (hereinafter referred to as the study site). The study site and the 500 m extended study area are hereafter referred to as the study area. This is in accordance with the 2010 EIA Regulations (No. R. 543-546, Department of Environmental Affairs and Tourism, 18 June 2010) emanating from Chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998).

The primary objective was to determine the presence of Red Data avifaunal species and to identify suitable habitat for these species. Direct observations and published data apart, qualitative and quantitative habitat assessments were used to derive the presence / absence of Red Data avifaunal species. A list of avifaunal species likely to be affected by the new development is compiled.

2. SCOPE AND OBJECTIVES OF THE STUDY

- To qualitatively and quantitatively assess the significance of the avifaunal habitat components, and current general conservation status of the property;
- To comment on ecologically sensitive areas;
- To comment on connectivity with natural vegetation and habitats on adjacent sites;
- To provide a list of avifauna that occur or that are likely to occur, and to identify species of conservation importance;
- To highlight potential impacts of the proposed development on the avifauna of the study site, and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.

3. STUDY AREA

3.1 Locality

The study site consist of Portion 22, ±63.7524 ha in extent and Portion 41 ±33.2511 ha in extent and is situated within the 2527DB (Brits) quarter degree grid cell (q.d.g.c.) and 2535_2755 pentad (SABAP2 protocol). It is located at the Lucas Mangope Drive / N4 Platinum Highway intersection, within the Northwest Province (25º38'50.19" S 27º56'28.57" E and 25º39'10.10" S 27º57'00.85" E). The study site is situated at an altitude of about 1 260 metres above sea level (m a.s.l.)(Figure 1)

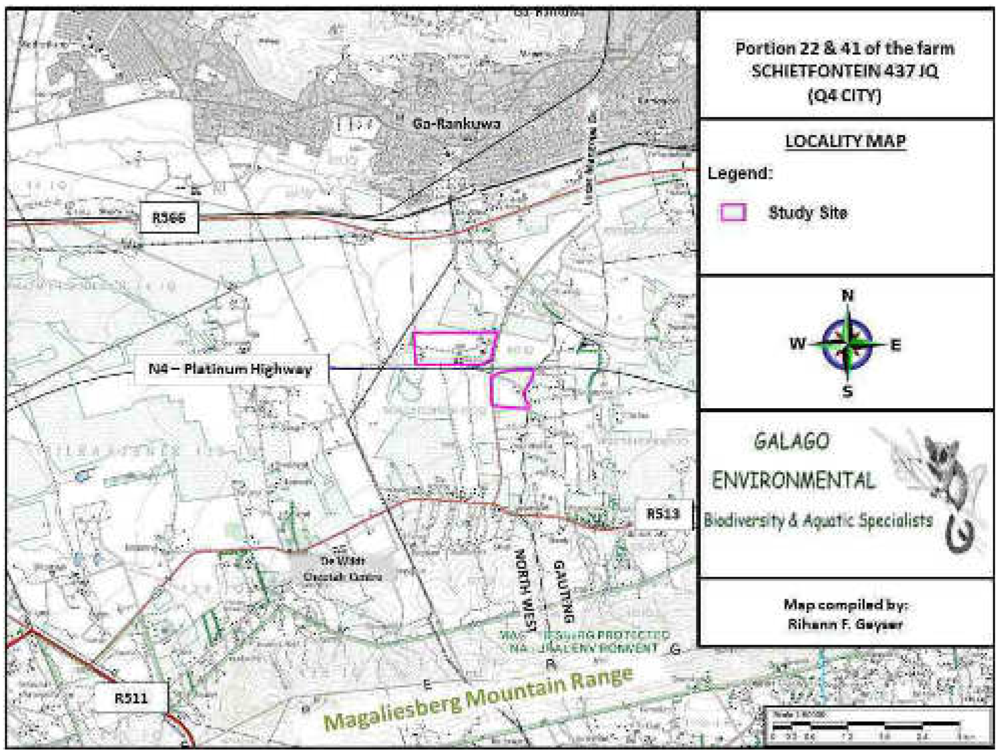

Figure 1: Locality map of the study area

3.2 Land Use

The primary land use is grazing by free-roaming livestock.

3.3 Biophysical Information

3.3.1 Vegetation type and landscape

The study site is situated within the Central Bushveld Bioregion of the Savanna Biome and more specifically within the **Marikana Thornveld** (SVcb 6) vegetation type according to Mucina and Rutherford (2006).

The Marikana Thornveld consists of open *Acacia karroo* dominated woodland growing in valleys and on slightly undulating plains, and some lowland hills. Shrubs are denser along drainage lines, and on termitaria and rocky outcrops or other areas that are protected from fire (Mucina and Rutherford 2006).

3.3.2 Climate

The study site is situated in a summer rainfall region with very dry winters. The rainfall varies between 600 and 750 mm. Frost occurs frequently in winter but less commonly on the ridges and hills. Temperatures vary between 32.8°C in summer (January) and -1.8°C in winter (July) (Mucina and Rutherford 2006).

3.3.3 Conservation status of habitat

Marikana Thornveld is considered endangered (Mucina and Rutherford 2006).

4. METHODS

A four-hour site visit was conducted on 14 March 2014 to record the presence of avifaunal species associated with the habitat systems on the study site and within the study area and to identify possible sensitive areas. During this visit the observed and derived presence of avifaunal species associated with the recognized habitat types of the study site, were recorded. This was done with due regard to the well recorded global distributions of Southern African avifauna, coupled to the qualitative and quantitative nature of recognized habitats.

4.1 Field Surveys

Avifaunal species were identified visually, using 10X42 Bushnell Legend binoculars and a 20X-60X Pentax spotting scope, and by call, and where necessary were verified from Sasol Birds of Southern Africa (Sinclair *et al*., 2011) and Southern African Bird Sounds (Gibbon, 1991).

The 500 m of adjoining properties or extended study area was scanned or surveyed for important avifaunal species and habitats.

During the site visit, avifaunal species were identified by visual sightings or aural records along random transect walks. No trapping or mist netting was conducted, since the terms of reference did not require such intensive work. In addition, avifaunal species were also identified by means of feathers, nests, signs, droppings, burrows or roosting sites. Locals were interviewed to confirm occurrences or absences of species.

4.2 Desktop Surveys

The presence of suitable habitats was used to deduce the likelihood of presence or absence of avifaunal species, based on authoritative tomes, scientific literature, field guides, atlases and databases. This can be done irrespective of season.

The likely occurrence of key avifaunal species was verified according to distribution records obtained during the Southern African Bird Atlas Project 1 (SABAP1) period from 1981 to 1993 (Harrison *et al.* 1997). Earlier records of only Red Data avifaunal species were obtained from the period between 1974 and 1987 according to Tarboton *et al.* (1987). The most recent avifaunal distribution data were obtained from the current SABAP2 project which commenced on 1 July 2007.

The occurrence and historic distribution of likely avifaunal species, especially all Red Data avifaunal species recorded for the q.d.g.c. 2527DB, were verified from SABAP1 (southern Africa Bird Atlas Project 1) data (Harrison *et al.* 1997), Tarboton *et al.* (1987) and the current SABAP2 project (SABAP2 data for the 2527DB q.d.g.c. and for the 2535_2755 pentad). The reporting rate for each avifaunal species likely to occur on the study site, based on Harrison *et al*. (1997), was scored between 0 – 100% and was calculated as follows: Total number of cards on which a species was reported during the Southern African Bird Atlas SABAP1 and, Red Data species only, the current SABAP2 project period X 100 ÷ total number of cards for the particular q.d.g.c. (Harrison *et al*., 1997) and pentad(s) (SABAP2). It is important to note that a q.d.g.c. (SABAP1 Protocol) covers a large area: for example, q.d.g.c. 2527DB covers an area of ±27 X 25 km (±693 km^2) (15 minutes of latitude by 15 minutes of longitude, 15’ x 15’) and a pentad (SABAP2 Protocol) and area of ±8 X 7.6 km (5 minutes of latitude by 5 minutes of longitude, 5’ x 5’) (Figure 2) and it is possible that suitable habitat will exist for a certain Red Data avifaunal species within this wider area surrounding the study site. However, the specific habitat(s) found on site may not suit the particular Red Data species, even though it has been recorded for the q.d.g.c. or pentad. For example, the Cape Vulture occurs along the Magaliesberg but will not favour the habitat found within the Pretoria CBD, both of which are in the same q.d.g.c. Red Data bird species were selected and categorised according to Barnes (2000).

An avifaunal biodiversity index (ABI), which gives an indication of the habitat system on the study site that will hold the richest avifaunal species diversity, was calculated as the sum of the probability of occurrence of avifaunal species within a specific habitat system on site. For each species and habitat, the probability of occurrence was ranked as: 5 = present on site, 4 = not observed on site but has a high probability of occurring there, 3 = medium probability, 2 = low probability, 1 = very low probability and 0 = not likely to occur.

5. RESULTS

5.1 Avifaunal Habitat Assessment:

Three major avifaunal habitat systems were identified within the study area. A short description of each habitat type follows, ranked from most to least important. Figure 2 illustrates the major habitat systems identified as likely to be used by bird species expected to occur on the study site.

Figure 2: **Avifaunal species habitat systems identified on the study site and within the study area.**

River and riparian vegetation:
1% of the total surface area of the study area consists of a narrow and shallow non-perennial river with sparse, mainly alien, riparian vegetation that grows on its banks (Figure 3).

Figure 3: River and Riparian vegetation of the non-perennial drainage line

The river probably only flows during times of good rainfall but it never dries out completely. Birds such as bishops, weavers, cisticolas and warblers will breed in the reeds growing in the spruit and feeding on insects that live within the reeds and semi-aquatic vegetation. Due to the nature of the spruit, no fishes are likely to be found and it will thus not attract any birds that feed on fish. Frogs and crabs are more likely to be found and will attract bird species, such as Hadeda Ibis, herons and Hamerkop.

Mixed woodland:
62% of the total surface area of the study area (including the 500 m extended study area) consists of mixed *Acacia* and broadleaf woodland with *Acacia* trees that remain dominant (Figure 4).

Figure 4: Mixed Woodland

This habitat will favour species typically associated with a dense woodland habitat and more specifically mixed broadleaf and *Acacia* woodland. This habitat generally include a great variety of arboreal passerines such as drongos, warblers, flycatchers, shrikes, sunbirds, waxbills and weavers and arboreal non-passerines such as doves, cuckoos, woodpeckers. Many of these species make use of the thorny nature of these trees to build their nests. *Acacia* trees generally attract many insects and in turn attract a good diversity of typical “Bushveld” bird species.

Disturbed and Transformed Areas:
37% of the total surface area of the study area has been transformed by past and present human activities such as road construction, agricultural crop lands, most of which have become fallow and overgrown by grass and weeds, as well as housing development surrounded by mainly garden vegetation.

Rural and suburban gardens have created an evergreen habitat for many bird species, where birds can hide, breed and forage for food. Natural predators such as snakes and smaller wild-cat species, which largely are persecuted by man, have been driven out of these areas, making it a relatively safe environment for birds apart from domestic cats and dogs. Many bird species have adapted to human-altered areas and these species are mainly the more common bird species found within southern Africa.

Large gardens, parks, sport fields and golf courses with open lawns also create ideal habitat for ground-feeding birds. These lawns are usually well watered and the ground soft, making it easy for birds that probe in the ground with their beaks in search of worms and other ground-living insects. There is usually water present, in the form of irrigation systems, ponds, man-made dams such as at golf courses, water features and/or swimming pools. The interest in birds among the public has grown and bird feeders are today a normal feature in most gardens. Certain exotic trees reach considerable heights in gardens, which allow birds to nest in them and thereby be protected from predators.

The presence and abundance of avifaunal species within the fallow fields will vary from season to season - lush and green in summer after summer rains and dry, brown, frosted or burnt during winter. The habitat favours ground-living bird species, such as lapwings, francolins, pipits, longclaws, larks and chats. These birds hunt for insects and/or breed on the ground, in burrows in the ground, or between the grasses. Weavers and widowbirds make use of such habitat for feeding on ripe seeds during late summer and early winter when the grass is not burnt, and widowbirds and cisticolas will also breed in the tall grass during summer. Species such as weavers and bishops that breed in the wetland habitat during summer will also make use of the open grassland habitat for feeding during winter after the grasses have seeded. Aerial feeding birds such as martins, swifts and swallows will also hunt for insects over the grasslands.

5.2 Observed and Expected Species Richness

Of the 315 avifaunal species recorded for the 2527DB q.d.g.c. during the SABAP1 period (Harrison *et al.* 1997), 154 (49 %) are likely to occur on the study site and 64 (42 %) of these avifaunal species were actually observed within the study area during the time of the survey.

The avifaunal biodiversity index (ABI) indicates that the largest avifaunal species diversity is likely to occur within the mixed woodland vegetation habitat system on and within 500m surrounding the study site, with an avifaunal biodiversity index (ABI) of 570, followed by the disturbed and transformed areas (ABI 513) and the river and riparian vegetation (ABI 453).

The avifaunal species listed in Table 1 are in the species order according to *Roberts - Birds of Southern Africa* VIIth edition (Hockey *et al*, 2005). These comprise the 154 species that are likely to occur within the specific habitat systems on and within 500 m extended study area, with those actually observed in **bold**. This does not include overflying birds or rare vagrants. The reporting rate for each species is the percentage for the q.d.g.c. according to the SABAP 1 atlas (Harrison *et al.* 1997) and is represented by colour codes as follows: Yellow = Very Low, Light Orange = Low, Dark Orange = Medium and Red = High. The habitat preference scores for each species are shown under the recognised habitat types on site: **RR = River and Riparian vegetation, MW = Mixed woodland** and **DT = Disturbed and Transformed,** with their possibility of occurrence in these specific habitats rated as 5 = present, 4 = High, 3 = Medium, 2 = Low, 1 = Very low, and 0 = Not likely to occur.

Table 1: Avifaunal species observed and that are likely to occur on the study site.

SCIENTIFIC NAMES	ENGLISH NAMES	R rate(%)	HABITAT PREFERENCE		
		2527DB	RR	MW	DT
Dendroperdix sephaena	**Crested Francolin**	23	3	5	0
Pternistis swainsonii	Swainson's Spurfowl	54	4	4	4
Numida meleagris	**Helmeted Guineafowl**	57	4	4	4
Indicator indicator	Greater Honeyguide	<1	2	3	0
Indicator minor	Lesser Honeyguide	8	4	4	3
Campethera bennettii	Bennett's Woodpecker	1	0	2	2
Campethera abingoni	Golden-tailed Woodpecker	7	3	4	4
Dendropicos fuscescens	**Cardinal Woodpecker**	29	4	5	4
Dendropicos namaquus	Bearded Woodpecker	2	2	3	1
Pogoniulus chrysoconus	**Yellow-fronted Tinkerbird**	13	4	5	2
Tricholaema leucomelas	**Acacia Pied Barbet**	29	3	5	2
Lybius torquatus	**Black-collared Barbet**	77	4	5	4
Trachyphonus vaillantii	**Crested Barbet**	87	5	5	4
Tockus nasutus	**African Grey Hornbill**	56	4	5	3
Upupa africana	**African Hoopoe**	69	0	5	4
Phoeniculus purpureus	Green Wood-Hoopoe	51	4	4	4
Rhinopomastus cyanomelas	Common Scimitarbill	3	0	3	2
Coracias caudatus	**Lilac-breasted Roller**	18	0	4	5
Halcyon albiventris	Brown-hooded Kingfisher	68	4	4	4
Halcyon chelicuti	Striped Kingfisher	3	1	2	0
Merops pusillus	Little Bee-eater	13	2	3	1
Merops albicollis	White-throated Bee-eater	9	3	3	2
Merops apiaster	**European Bee-eater**	13	3	4	3
Colius striatus	Speckled Mousebird	67	4	4	4
Urocolius indicus	**Red-faced Mousebird**	48	4	5	5
Clamator jacobinus	Jacobin Cuckoo	4	3	3	0
Clamator levaillantii	Levaillant's Cuckoo	1	2	2	0
Cuculus solitarius	Red-chested Cuckoo	27	4	4	4
Cuculus clamosus	Black Cuckoo	3	3	4	1
Chrysococcyx klaas	Klaas's Cuckoo	1	2	3	1
Chrysococcyx caprius	Diderick Cuckoo	29	4	4	4
Centropus burchellii	Burchell's Coucal	63	4	4	4
Cypsiurus parvus	**African Palm-Swift**	21	5	5	5
Apus affinis	Little Swift	26	4	4	4
Apus caffer	White-rumped Swift	4	4	4	4
Corythaixoides concolor	**Grey Go-away-bird**	77	5	5	5
Tyto alba	Barn Owl	35	2	4	4
Bubo africanus	Spotted Eagle-Owl	17	3	4	4
Glaucidium perlatum	Pearl-spotted Owlet	17	3	4	2
Columba livia	Rock Dove	26	0	0	4

SCIENTIFIC NAMES	ENGLISH NAMES	R rate(%)	HABITAT PREFERENCE		
		2527DB	RR	MW	DT
Columba guinea	Speckled Pigeon	**76**	3	4	4
Streptopelia senegalensis	**Laughing Dove**	**95**	5	5	5
Streptopelia capicola	Cape Turtle-Dove	**51**	4	4	4
Streptopelia semitorquata	**Red-eyed Dove**	**57**	5	5	5
Turtur chalcospilos	Emerald-spotted Wood-Dove	**3**	3	4	2
Burhinus capensis	Spotted Thick-knee	**49**	0	4	4
Vanellus armatus	**Blacksmith Lapwing**	**66**	3	0	4
Vanellus senegallus	**African Wattled Lapwing**	**19**	3	1	4
Vanellus coronatus	**Crowned Lapwing**	**67**	0	3	4
Elanus caeruleus	**Black-shouldered Kite**	**59**	3	5	5
Milvus migrans	Black Kite	**23**	2	2	2
Accipiter minullus	Little Sparrowhawk	**2**	2	3	3
Buteo vulpinus	Steppe Buzzard	**11**	1	4	4
Ardea melanocephala	Black-headed Heron	**35**	3	2	4
Bubulcus ibis	**Cattle Egret**	**76**	4	5	5
Bostrychia hagedash	**Hadeda Ibis**	**75**	5	5	5
Oriolus larvatus	Black-headed Oriole	**19**	4	4	4
Dicrurus adsimilis	**Fork-tailed Drongo**	**55**	4	4	4
Terpsiphone viridis	African Paradise-Flycatcher	**35**	4	4	4
Nilaus afer	**Brubru**	**3**	2	5	3
Dryoscopus cubla	Black-backed Puffback	**38**	4	4	4
Tchagra senegalus	Black-crowned Tchagra	**24**	3	4	4
Tchagra australis	**Brown-crowned Tchagra**	**9**	3	4	4
Laniarius ferrugineus	**Southern Boubou**	**45**	4	5	4
Laniarius atrococcineus	Crimson-breasted Shrike	**22**	2	4	4
Telophorus zeylonus	**Bokmakierie**	**18**	0	1	2
Telophorus sulfureopectus	**Orange-breasted Bush-Shrike**	**<1**	2	3	2
Malaconotus blanchoti	Grey-headed Bush-Shrike	**3**	3	3	3
Batis molitor	Chinspot Batis	**29**	4	4	4
Corvus albus	**Pied Crow**	**63**	2	3	4
Lanius collurio	**Red-backed Shrike**	**14**	2	5	2
Lanius minor	Lesser Grey Shrike	**3**	1	3	1
Lanius collaris	Common Fiscal	**87**	4	4	4
Corvinella melanoleuca	Magpie Shrike	**16**	0	3	2
Campephaga flava	**Black Cuckooshrike**	**<1**	3	5	1
Parus niger	Southern Black Tit	**5**	2	4	1
Hirundo rustica	Barn Swallow	**24**	4	4	4
Hirundo albigularis	White-throated Swallow	**25**	4	4	4
Hirundo dimidiata	Pearl-breasted Swallow	**1**	4	4	4
Hirundo cucullata	**Greater Striped Swallow**	**17**	4	5	5
Hirundo abyssinica	Lesser Striped Swallow	**41**	4	4	4
Hirundo semirufa	Red-breasted Swallow	**3**	3	4	3
Hirundo fuligula	Rock Martin	**22**	2	3	4
Delichon urbicum	Common House-Martin	**3**	3	3	3
Pycnonotus tricolor	**Dark-capped Bulbul**	**93**	5	5	5
Stenostira scita	Fairy Flycatcher	**3**	3	4	4
Sylvietta rufescens	**Long-billed Crombec**	**26**	3	4	4
Phylloscopus trochilus	**Willow Warbler**	**8**	4	4	4
Turdoides bicolor	Southern Pied Babbler	**10**	0	2	1

SCIENTIFIC NAMES	ENGLISH NAMES	R rate(%)	HABITAT PREFERENCE		
		2527DB	RR	MW	DT
Turdoides jardineii	Arrow-marked Babbler	**49**	4	4	4
Parisoma subcaeruleum	**Chestnut-vented Tit-Babbler**	**36**	3	4	4
Sylvia borin	Garden Warbler	**2**	3	3	3
Zosterops virens	**Cape White-eye**	**69**	5	5	4
Cisticola chiniana	**Rattling Cisticola**	**21**	3	5	3
Cisticola tinniens	Levaillant's Cisticola	**6**	2	0	0
Cisticola fulvicapilla	**Neddicky**	**12**	4	4	4
Cisticola juncidis	Zitting Cisticola	**7**	4	3	4
Prinia subflava	**Tawny-flanked Prinia**	**35**	5	5	4
Prinia flavicans	**Black-chested Prinia**	**28**	3	5	4
Apalis thoracica	Bar-throated Apalis	**12**	3	4	2
Camaroptera brevicaudata	**Grey-backed Camaroptera**	**2**	5	3	1
Mirafra africana	Rufous-naped Lark	**4**	0	3	4
Calendulauda sabota	**Sabota Lark**	**16**	2	5	4
Psophocichla litsitsirupa	Groundscraper Thrush	**20**	0	3	4
Turdus libonyanus	Kurrichane Thrush	**32**	3	4	4
Turdus smithi	Karoo Thrush	**64**	4	4	4
Bradornis pallidus	Pale Flycatcher	**5**	2	2	1
Bradornis mariquensis	Marico Flycatcher	**8**	0	3	3
Melaenornis pammelaina	Southern Black Flycatcher	**8**	0	3	3
Sigelus silens	Fiscal Flycatcher	**44**	2	4	4
Muscicapa striata	**Spotted Flycatcher**	**5**	4	5	4
Cossypha caffra	Cape Robin-Chat	**56**	4	4	4
Cossypha humeralis	**White-throated Robin-Chat**	**15**	0	5	0
Cercotrichas leucophrys	**White-browed Scrub-Robin**	**30**	2	5	3
Lamprotornis nitens	Cape Glossy Starling	**45**	4	4	4
Cinnyricinclus leucogaster	**Violet-backed Starling**	**12**	4	4	4
Creatophora cinerea	Wattled Starling	**<1**	2	2	2
Acridotheres tristis	**Common Myna (INT)**	**4**	4	3	5
Chalcomitra amethystina	**Amethyst Sunbird**	**36**	4	5	4
Cinnyris talatala	**White-bellied Sunbird**	**69**	5	5	4
Cinnyris mariquensis	Marico Sunbird	**22**	3	4	4
Ploceus intermedius	**Lesser Masked-Weaver**	**1**	2	5	3
Ploceus capensis	Cape Weaver	**6**	2	3	3
Ploceus velatus	**Southern Masked-Weaver**	**75**	5	5	5
Quelea quelea	Red-billed Quelea	**20**	4	4	4
Euplectes orix	Southern Red Bishop	**38**	4	4	4
Euplectes albonotatus	White-winged Widowbird	**32**	4	4	4
Euplectes ardens	Red-collared Widowbird	**8**	4	3	4
Sporaeginthus subflavus	Orange-breasted Waxbill	**7**	1	0	1
Ortygospiza atricollis	African Quailfinch	**3**	1	0	0
Amadina erythrocephala	Red-headed Finch	**21**	3	4	4
Amadina fasciata	Cut-throat Finch	**38**	4	4	4
Estrilda erythronotos	**Black-faced Waxbill**	**12**	2	5	3
Estrilda astrild	Common Waxbill	**18**	4	3	4
Granatina granatina	Violet-eared Waxbill	**14**	2	3	2
Uraeginthus angolensis	**Blue Waxbill**	**67**	4	4	4
Pytilia melba	Green-winged Pytilia	**8**	3	3	3

SCIENTIFIC NAMES	ENGLISH NAMES	R rate(%)	HABITAT PREFERENCE		
		2527DB	RR	MW	DT
Lagonosticta senegala	Red-billed Firefinch	**11**	4	4	4
Lagonosticta rhodopareia	Jameson's Firefinch	**15**	4	4	4
Spermestes cucullatus	Bronze Mannikin	**41**	4	4	4
Vidua macroura	Pin-tailed Whydah	**28**	4	4	4
Vidua paradisaea	Long-tailed Paradise-Whydah	**20**	2	3	4
Vidua regia	Shaft-tailed Whydah	**5**	0	2	2
Vidua purpurascens	Purple Indigobird	**2**	2	2	2
Passer domesticus	House Sparrow	**81**	0	0	4
Passer melanurus	Cape Sparrow	**77**	4	4	4
Passer diffusus	**Southern Grey-headed Sparrow**	**35**	5	5	5
Motacilla capensis	Cape Wagtail	**81**	4	0	4
Macronyx capensis	Cape Longclaw	**15**	2	0	3
Anthus cinnamomeus	African Pipit	**11**	0	2	3
Crithagra mozambicus	**Yellow-fronted Canary**	**32**	4	4	4
Crithagra atrogularis	**Black-throated Canary**	**35**	5	5	5
Crithagra gularis	**Streaky-headed Seedeater**	**8**	4	5	3
Emberiza tahapisi	**Cinnamon-breasted Bunting**	**10**	0	5	2
Emberiza flaviventris	**Golden-breasted Bunting**	**17**	2	5	3
	Avifaunal Biodiversity Index		**453**	**570**	**513**

*The reporting rate is calculated as follows: Total number of cards on which a species was reported X 100 ÷ total number of cards for a particular quarter degree grid cell. **INT** = Introduced or alien birds species to Southern Africa.

Red Data Species Categories for the birds (Barnes, 2000)
RE = Regionally extinct, **CR** = Critically Endangered **EN** = Endangered, **VU** = Vulnerable, **NT** = Near-threatened.

The Avifaunal biodiversity index gives an indication of which habitat will hold the richest avifaunal diversity within the study area. The colour codes for each species are represented as follows: The colour codes for each species are represented as follows: Yellow = Very Low, Light Orange = Low, Dark Orange = Medium and Red = High. The likelihood of occurrence of each species in the specific habitat systems on the study site are as follow: 5 = present, 4 = High, 3 = Medium, 2 = Low, 1 = very low, and 0 = Not likely to occur.

5.3 Threatened and Red Listed Bird Species

The following Red Data avifaunal species were recorded for the 2527DB q.d.g.c. according to Tarboton *et al* (1987), the SABAP1 data (Harrison *et al.* 1997) and the SABAP2 data for the 2527DB q.d.g.c. and more specifically the 2535_2755 pentad (Table 2).

Table 2: Red Data avifaunal species recorded for the 2527DB q.d.g.c.

SCIENTIFIC NAMES	ENGLISH NAMES	Reporting Rate (%)*		
		SABAP 1	SABAP 2	Pentad
Alcedo semitorquata	Half-collared Kingfisher (**NT**)	**1**	**0.3**	**0**
Tyto capensis	African Grass-Owl (**VU**)	**<1**	**0**	**0**
Anthropoides paradiseus	Blue Crane (**VU**)	**1**	**0**	**0**
Pterocles gutturalis	Yellow-throated Sandgrouse (**NT**)	**<1**	**0**	**0**
Sterna caspia	Caspian Tern (**NT**)	**0**	**1.9**	**0**
Gyps africanus	White-backed Vulture (**VU**)	**10**	**0.3**	**0**
Gyps coprotheres	Cape Vulture (**VU**)	**31**	**8.6**	**0**

SCIENTIFIC NAMES	ENGLISH NAMES	Reporting Rate (%)*		
		SABAP 1	SABAP 2	Pentad
Aquila ayresii	Ayres's Hawk-Eagle (**NT**)	**<1**	**0**	**0**
Polemaetus bellicosus	Martial Eagle (**VU**)	**1**	**0**	**0**
Sagittarius serpentarius	Secretarybird (**NT**)	**13**	**0**	**0**
Falco biarmicus	Lanner Falcon (**NT**)	**1**	**3.2**	**0**
Falco peregrinus	Peregrine Falcon (**NT**)	**0**	**0.6**	**0**
Phoenicopterus ruber	Greater Flamingo (**NT**)	**2**	**0.3**	**0**
Phoenicopterus minor	Lesser Flamingo (**NT**)	**1**	**0**	**0**
Pelecanus rufescens	Pink-backed Pelican (**VU**)	**<1**	**0**	**0**
Mycteria ibis	Yellow-billed Stork (**NT**)	**2**	**0.6**	**0**
Ciconia nigra	Black Stork (**NT**)	**9**	**0.6**	**0**
Buphagus erythrorhynchus	Red-billed Oxpecker (**NT**)	**1**	**0.6**	**0**
	TOTAL:	**16**	**10**	**0**

*The reporting rate of SABAP1 and SABAP2 is calculated as follows: Total number of cards on which a species was reported X 100 ÷ total number of cards for a particular quarter degree grid cell. The colour codes for each species are represented as follows: yellow = very low, light orange = low, dark orange = medium and red = high with reference to the specific habitat systems found on site.

Red Data Species Categories for the birds (Barnes, 2000)
RE = Regionally extinct, **CR** = Critically Endangered **EN** = Endangered, **VU** = Vulnerable, **NT** = Near-threatened.

A total of sixteen (16) Red Data avifaunal species have been recorded within the 2527DB q.d.g.c. (Table 2). Cape Vulture indicated a high reporting rate for the 2527DB q.d.g.c. and this is as a result of favourable breeding habitat along the Magaliesberg which is situated in the same q.d.g.c. as that of the study site. Ten (10) of the Red Data avifaunal species recorded for the 2527DB q.d.g.c. were recorded for the q.d.g.c. during the current SABAP2 period and none for the 2535_2755 pentad.

5.4 Summary of the Red Data avifaunal species

Table 3 provides a list of the Red Data avifaunal species recorded for the 2527DB q.d.g.c. according to Harrison *et al.* (1997) and an indication of their likelihood of occurrence within the study area based on actual sightings, habitat and food availability.

Table 3: Red Data avifaunal species assessment for the study area according to the SABAP1 and SABAP2 data for the 2527DB q.d.g.c.

SCIENTIFIC NAME	PRESENCE OF SUITABLE HABITAT AND HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE ON STUDY SITE
Alcedo semitorquata (Half-collared Kingfisher) (**NT**)	None on site: Requires fast-flowing streams, rivers and estuaries, usually with dense marginal vegetation (Maclean, 1993), especially perennial streams and smaller rivers with overhanging riparian vegetation on their banks. Nests in sand/earth banks (Tarboton *et al.* 1987) and requires riverbanks in which to excavate nest tunnels (Harrison *et al.* 1997a). Most typically occurs along fast-flowing streams with clear water and well-wooded riparian growth, often near rapids. It most frequently favours broken escarpment terrain and requires at least 1 km up and down stream of undisturbed river and riparian vegetation while breeding. It occurs from sea-level to 2000 m a.s.l. in southern Africa. Usually perches low down on the banks of rivers and streams, often on	Highly unlikely Due to a lack of suitable habitat. The non-perennial river will not favour this species

SCIENTIFIC NAME	PRESENCE OF SUITABLE HABITAT AND HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE ON STUDY SITE
	exposed roots, as well as exposed rock and low overhanging tree branches.	
Tyto capensis (African Grass-Owl) (**VU**)	None on site: Occurs predominately in rank grass, typically but not always at fairly high altitudes. Breeds mainly in permanent and seasonal vleis, which it vacates while hunting or during post-breeding although it will sometimes breed in any area of long grass, sedges or even weeds (Van Rooyen, pers comm.) and not necessarily associated with wetlands (Tarboton *et al*. 1987) although this is more the exception than the rule. Foraging mainly confined to tall grassland next to their wetland vegetation and rarely hunts in short grassland, wetlands or croplands nearby (Barnes, 2000). Mainly restricted to wet areas (marshes and vleis) where tall dense grass and/or sedges occur. Prefers permanent or seasonal vleis and vacates the latter when these dried up or are burnt. Roosts and breeds in vleis but often hunt elsewhere e.g. old lands and disturbed grassland although this is suboptimal habitat conditions (Tarboton *et al*. 1987). May rarely occur in sparse *Acacia* woodland where patches of dense grass cover are present (Harrison *et al*. 1997a).	Highly unlikely No suitable breeding, roosting and foraging habitat were identified on and surrounding the study site
Anthropoides paradiseus (Blue Crane) (**VU**)	None on site: Midlands and highland grassland, edge of karoo, cultivated land and edges of vleis (Maclean, 1993). Nests in both moist situations in vleis which have short grass cover and in dry sites far from water, usually exposed places such as on hillsides; forages in grassland and cultivated and fallow lands; roosts communally in the shallow water of pans and dams (Tarboton *et al*. 1987). Short dry grassland, being more abundant and evenly disturbed in the eastern "sour" grassland, where natural grazing of livestock is the predominant land use. Prefers to nest in areas of open grassland (Barnes, 2000) In the fynbos biome it inhabit cereal croplands and cultivated pastures and avoids natural vegetation. By contrast, it is found in natural vegetation in the Karoo and grassland biomes, but it also feeds in crop fields (Harrison *et al*. 1997a).	Highly unlikely Due to the small Due to a lack of suitable.
Sterna caspia (Caspian Tern) (**NT**)	None on site: Occurs along coast, mostly in sheltered bays and estuaries. Inland, at large water bodies, both natural and man-made, with preference for saline pans and large impoundments. Coastal breeding habitat primarily offshore islands, but with increasing use of sandy beaches and islands in saltworks, where protection is offered. Inland, breeds on small, low islets in pans and dams (Hockey *et al*. 2005).	Highly unlikely Due to a lack of suitable foraging and breeding habitat.
Pterocles gutturalis (Yellow-throated Sandgrouse) (**NT**)	None on site: Inhabits short, open grassy plains, particularly on relatively moist, black/cotton clay-like soils, usually near seasonal rivers or swamps, or on seasonal flood plains where pioneer plant communities provide an abundant source of seeds for food. Also, readily occupies fallow fields in cultivated areas and recently burnt ground (Hockey *et al*. 2005).	Highly unlikely Due to a lack of suitable foraging and breeding habitat.

SCIENTIFIC NAME	PRESENCE OF SUITABLE HABITAT AND HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE ON STUDY SITE
	Short open grassveld, fallow fields and recently burnt veld on black clay soils, but avoid coarser soils derived from quartzite, granite or felsite, and also avoids natural, pristine *Acacia* savanna, preferring agricultural fields (Tarboton, *et al.* 1999).	
Gyps africanus (White-backed Vulture) (**VU**)	None on site: Their presence is dependent on the availability of food. Lightly wooded arid savanna, including Mopane *Colophospernum mopane* woodland; but absent from forest, true deserts, and the treeless grass- and shrubland of the south and central Karoo (Hockey *et al.* 2005).	Highly unlikely Due to a lack of suitable foraging and breeding habitat.
Gyps coprotheres (Cape Vulture) (**VU**)	They mostly occur in mountainous country, or open county with inselbergs and escarpments; less commonly as visitors to savannah or desert (Maclean, 1993). Forage over open grassland, woodland and agricultural areas; usually roosts on cliffs, but will also roost on trees and pylons (Barnes, 2000). It is reliant on tall cliffs for breeding but it wanders widely away from these when foraging. It occurs and breeds from sea level to 3 100 m.a.s.l. Current distribution is closely associated with subsistence communal grazing areas characterised by high stock losses and low use of poisons and, to a lesser extent, with protected areas (Harrison *et al.* 1997a), but their presence is ultimately dependent on the availability of food.	Highly unlikely Due to a lack of suitable foraging and breeding habitat. Breeds in Magaliesberg
Aquila ayresii (Ayres's Hawk-Eagle) (**NT**)	None on site: Non-breeding summer visitor to South Africa, favouring dense woodland and forest edge, often in hilly country. Regular in larger northern cities and towns (Johannesburg, Pretoria, Mokopane/Pietersburg), where it often roosts in *Eucalyptus* stands or other tall trees within its prime distribution range (Hockey *et al.* 2005).	Highly unlikely There is no suitable habitat for this species on the study site.
Polemaetus bellicosus (Martial Eagle) (**VU**)	None on site: Tolerates a wide range of vegetation types, being found in open grassland, scrub, Karoo, agricultural lands and woodland, It relies on large trees (or electricity pylons) to provide nest sites (Barnes, 2000) as well as windmills and even cliffs in treeless areas . It occurs mainly in flat country and is rarer in mountains, and it also avoids extreme desert, and densely wooded and forested areas (Harrison *et al.* 1997a & Barnes, 2000).	Highly unlikely Due to a lack of suitable habitat.
Sagittarius serpentarius (Secretarybird) (**NT**)	None on site: Open grassland with scattered trees, shrubland, open *Acacia* and *Combretum* savanna (Hockey *et al.* 2005). Restricted to large conservation areas in the region. Avoids densely wooded areas, rocky hills and mountainous areas (Hockey *et al.* 2005 & Barnes, 2000). Requires small to medium-sized trees with a flat crown for nesting, and often roosts in similar locations. Nesting density only about 150 km^2/pair (n = 4, Kemp, 1995).	Highly unlikely Due to the small extent of the study site and the disturbance surrounding it.
Falco biarmicus (Lanner Falcon) (**NT**)	None on site: Most frequent in open grassland, open or cleared woodland, and agricultural areas. Breeding pairs generally favour habitats where cliffs are available as nest and roost sites, but will use	Highly unlikely Due to a lack of suitable breeding habitat.

SCIENTIFIC NAME	PRESENCE OF SUITABLE HABITAT AND HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE ON STUDY SITE
	alternative sites such as trees, electricity pylons and building ledges if cliffs are absent (Hockey *et al.* 2005). Mountains or open country, from semi desert to woodland and agricultural land, also cities (Maclean, 1993), even on forest-grassland ecotones. Generally a cliff nesting species and its wider distribution is closely associated with mountains with suitable cliffs. Able to breed on lower rock faces than Peregrine Falcon *Falco peregrinus* and also utilises the disused nests of other species, such as crows, other raptors and storks, on cliffs, in trees and on power pylons, and also quarry walls (Tarboton *et al.* 1987). Generally prefers open habitats e.g. alpine grassland and the Kalahari, but exploits a wide range of habitats – grassland, open savanna, agricultural lands, suburban and urban areas, rural settlements – in both flat and hilly or mountainous country. Also breeds in wooded and forested areas where cliffs occur (Harrison *et al.* 1997a).	
Falco peregrinus (Peregrine Falcon) (**NT**)	None on site: Resident *F. p. minor* mostly restricted to mountainous riparian or coastal habitats, where high cliffs provides breeding and roosting sites. Breeding pairs prefer habitats that favour specialised, high speed, aerial hunting, e.g. high cliffs overhanging vegetation with raised and/or discontinuous canopy (e.g. forest, fynbos, woodland), or expanses of open water. Also uses quarries and dam walls, and frequents city centres, e.g. Cape Town, where tall buildings substitute for rock faces. Migrant *F. p. calidus* in more open country, often coastal, even roosting on ground on almost unvegetated salt flats.	Highly unlikely Due to a lack of suitable breeding habitat.
Phoenicopterus ruber (Greater Flamingo) (**NT**)	None on site: Breeds at recently flooded, large, eutrophic wetlands (favoured foraging habitat), shallow salt pans; at other times, at coastal mudflats, inland dams, sewage treatments works, small ephemeral pans and river mouths (Hockey *et al.* 2005). Usually breeds colonially on mudflats in large pans (Harrison *et al.* 1997a). Shallow pans, especially saline pans when they have water; also occasionally on other bodies of shallow water such as dams and vleis (Tarboton *et al.* 1987). Large bodies of shallow water, both inland and coastal; prefers saline and brackish water (Maclean 1993). Occasionally forages along sandy coasts.	Highly unlikely Due to a lack of suitable foraging and breeding habitat.
Phoenicopterus minor (Lesser Flamingo) (**NT**)	None on site: Primarily open, shallow eutrophic, wetlands and coastal lagoons and may occur on water bodies which are more saline and more alkaline than those used by *Phoenicopterus ruber* (Greater Flamingo). Breeds on saline lakes, salt pans and mudflats far out in pans and lakes (Harrison *et al.* 1997a). Non-breeding birds aggregate at coastal mudflats, salt works and sewage treatment works where salinities are high. Small, ephemeral freshwater wetlands very important for birds dispersing from breeding grounds (Hockey *et al.*, 2005). Shallow pans, especially saline pans when they contain water (Tarboton *et al.*, 1987). Large brackish or saline inland and coastal	Highly unlikely Due to a lack of suitable foraging and breeding habitat.

SCIENTIFIC NAME	PRESENCE OF SUITABLE HABITAT AND HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE ON STUDY SITE
	waters (Maclean, 1993).	
Pelecanus rufescens (Pink-backed Pelican) (**VU**)	None on site: Wide range of wetlands, including lakes, dams and slow-flowing rivers, saline pools, lagoons, estuaries and sheltered bays; rarely on open sea but sometimes forages close to shore at low tide in areas such as southern Mozambique (Hockey *et al*., 2005). Nests in colonies in trees bordering larger wetlands, but only known from a few sites.	Highly unlikely Due to a lack of suitable habitat.
Mycteria ibis (Yellow-billed Stork) (**NT**)	None on site: Utilises diverse wetlands and permanent and seasonal habitats, including alkaline and freshwater lakes, river, dams, pans, flood plains, large marshes, swamps, estuaries, margins of lakes or rivers, flooded grassland and small pools or streams where there are areas of shallow water free of emergent vegetation (Tarboton *et al.,* 1987); less often marine mudflats and estuaries (Hockey *et al*., 2005). Nests colonially on large trees adjacent to productive wetlands, but only locally and erratically during ideal conditions.	Highly unlikely Due to a lack of suitable habitat
Ciconia nigra (Black Stork) (**NT**)	None on site/: Dams, pans, flood plains, shallows of rivers, pools in dry riverbeds, estuaries and sometimes on marshland and flooded grassland; uncommon at seasonal pans lacking fish. Associated with mountainous regions (Hockey *et al*., 2005) where they nest (Maclean, 1993) on cliffs (Harrison *et al*. 1997a). Feeds in shallow water, but occasionally on dry land, in streams and rivers, marshes, floodplains, coastal estuaries and large and small dams; it is typically seen at pools in large rivers.	Highly unlikely Due to a lack of suitable breeding and foraging habitat
Buphagus erythrorhynchus (Red-billed Oxpecker) (**NT**)	None on site: Open savanna, up to 3 000 m a.s.l. (Hockey *et al*., 2005). Uses mammal feeding hosts in a variety of woodlands, all in rainfall zones of more than 400 mm/annum. Needs holes in trees for nesting and uses Ilala Palms, tree Aloes, reed beds and rarely larger game to roost on at night (Harrison *et al.* 1997a). Their presence is highly dependent on the availability of tick on large game species and cattle.	Unlikely Only on rare occasions

6. FINDINGS AND POTENTIAL IMPLICATIONS

6.1 Red Data avifaunal species confirmed from the study area for which suitable foraging, breeding and roosting habitat was confirmed:

None

6.2 Red Data avifaunal species for which suitable habitat was confirmed from the study area:

None

7. LIMITATIONS, ASSUMPTIONS AND GAPS IN KNOWLEDGE

The Galago Environmental team has appropriate training and registration, as well as extensive practical experience and access to wide-ranging data bases to consider the derived species lists with high limits of accuracy. In this instance the biodiversity of all Alignments has to a greater or lesser extent been jeopardized, which renders the need for field surveys unnecessary. In instances where uncertainty exists regarding the presence of a species it is listed as a potential occupant, which renders the suggested mitigation measures and conclusions more robust.

Even though every care is taken to ensure the accuracy of this report, environmental assessment studies are limited in scope, time and budget. Discussions and proposed mitigations are to some extent made on reasonable and informed assumptions built on *bone fide* information sources, as well as deductive reasoning. Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage. Galago Environmental can thus not accept responsibility for conclusions and mitigation measures made in good faith based on own databases or on the information provided at the time of the directive. This report should therefore be viewed and acted upon with these limitations in mind.

The site surveys was done during several hours in one day and not on a regular basis during several season over a period of time thus the avifaunal biodiversity could change slightly as more species are confirmed from the various habitat system within the study area. The general assessment of species rests mainly on the 1987 atlas for birds of the then-Transvaal (Tarboton *et al*. 1987), the 1997 SABAP1 atlas data (Harrison et al. 1997) and the current data for the SABAP2 period for comparison, so any limitations in either of those studies will by implication also affect this survey and conclusions.

The general assessment of species rests mainly on the 1997 SABAP1 atlas data (Harrison et al. 1997) for comparison with the current SABAP2 atlas, so any limitations in either of those studies will by implication also affect this survey and conclusions.

Furthermore the number of atlas cards received and the diversity of habitat systems surveyed for avifaunal species within a q.d.g.c. or pentad or lack thereof could also have an effect on the avifaunal diversity that could potentially occur on the study site.

8. RECOMMENDED MITIGATION MEASURES

The following mitigation measures are proposed by the specialist:

- Where possible, **work should be restricted to one area at a time**, as this will give the smaller birds, mammals and reptiles a chance to weather the disturbance in an undisturbed zone close to their natural territories.
- Where possible the construction of the proposed development should take place during the winter months during the time when most avifaunal species are not breeding.
- **No vehicles should be allowed to move in or across the wet areas or drainage lines and possibly get stuck.** This leaves visible scars and destroys habitat, and it is important to conserve areas where there are tall reeds or grass, or areas where there is short grass and mud.

- The contractor must ensure that no fauna is disturbed, trapped, hunted or killed during the construction phase. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for non-compliance.
- It is suggested that where work is to be done close to the drainage lines, these areas **be fenced off during construction,** to prevent heavy machines and trucks from trampling the plants, compacting the soil and dumping in the system.
- During the construction phase, noise must be kept to a minimum to reduce the impact of the development on the fauna residing on the site.
- Alien and invasive plants must be removed.

9. CONCLUSIONS

The proposed development will not have a negative effect on any Red Data avifaunal species recorded for the 2527DB q.d.g.c. None of these Red Data avifaunal species are likely to occur within the study area due to lack of suitable habitat. The Woodland areas can be regarded as of medium sensitivity in terms of habitat for general avifaunal biodiversity, mainly because of the endangered status of the Marikana Thornveld vegetation unit, and the disturbed and transformed areas as low sensitive (Figure 5).

Figure 5: Avifaunal Sensitivity Map

10. LITERATURE SOURCES

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APPENDIX D: HERPETOFAUNA REPORT

[redacted]
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Herpetofauna Habitat Assessment

of

Portion 22 & 41 of the farm Schietfontein 437 JQ (Q4 CITY)

May 2014

Report author: **Mr. J.C.P van Wyk** (Pr.Sci.Nat: M.Sc)

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Declaration of Independence:

I, Jacobus Casparus Petrus van Wyk (68080450410845) declare that I:

- hold a MSc in the biological sciences, which allowed registration by SACNASP (SA Council for National Scientific Professions) as a Professional Zoologist and sanction me to function independently as a specialist scientific consultant
- declare that as per prerequisites of the Natural Scientific Professions Act No. 27 of 2003 this project was my work from inception and reflects exclusively my observations and unbiased scientific interpretations, and executed to the best of my ability
- abide by the Code of Ethics of the SACNASP
- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate the opportunity to also learn through the processes of constructive criticism and debate, I reserve the right to form and hold my own opinions and therefore will not willingly submit to the interests of other parties or change my statements to appease them
- abide by the Code of Ethics of the S.A. Council for Natural Scientific Professions
- act as an independent specialist consultant in the field of zoology
- am subcontracted as specialist consultant by Galago Environmental CC for the project "Herpetofauna Habitat Assessment of Portion 22 & 41 of the farm Schietfontein 437 JQ (Q4 City)" described in this report
- have no financial interest in the proposed development other than remuneration for work performed
- have or will not have any vested or conflicting interests in the proposed development
- undertake to disclose to the Galago Environmental CC and its client as well as the competent authority any material information that have or may have the potential to influence the decision of the competent authority required in terms of the Environmental Impact Assessment Regulations 2006
- Our intellectual property in this report will only be transferred to the client (the party/ company that commissioned the work) on full payment of the contract fee. Upon transfer of the intellectual property, we recognise that written consent of the client will be required for release of any part of this report to third parties.

J.C.P. van Wyk

1. INTRODUCTION

Galago Environmental CC was appointed to undertake a Herpetofaunal (reptile and amphibian) habitat survey of Portions 22 & 41 on the farm Schietfontein 437 also known as Q4 City (elsewhere referred to as the study site), scheduled for the construction of a Filling Station.

The objective was to determine which herpetofauna species might still reside on the site. Special attention had to be given to the habitat requirements of all the Red Data species, which may occur in the area. This survey focuses on the current status of threatened herpetofauna species occurring, or which are likely to occur on the proposed development site, and a description of the available and sensitive habitats on the site.

This assignment is in accordance with the 2010 EIA Regulations (No. R. 543-546, Department of Environmental Affairs and Tourism, 18 June 2010) emanating from Chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998).

2. SCOPE AND OBJECTIVES OF THE HABITAT STUDY

- To qualitatively and quantitatively assess the significance of the herpetofaunal habitat components and current general conservation status of the property;
- Identify and comment on ecological sensitive areas;
- Comments on connectivity with natural vegetation and habitats on adjacent sites;
- To provide a list of herpetofauna which occur or might occur, and to identify species of conservation importance;
- To highlight potential impacts of the proposed development on the herpetofauna of the study site, and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.

3. STUDY AREA

The study site is located at the junction of the N4 (Platinum Highway) and the Lucas Mangope Drive in the North-West Province. It is proposed to build Q4 refuelling and comfort stations for motorists travelling eastwards and westwards on the N4 dual highway. Portion 22 (25º 38’ 50”S; 27º 56’ 28”E) will provide services to eastbound traffic and is located on the north-western corner of the N4 - Mangope junction and is 63.7 hectares in extend. Portion 41 (25º 39’10”E; 27º 57’ 01”S) is situated on the south-eastern corner of the junction and comprises 33.3 hectares. In each case the footprint of the development will comprise a small (but undisclosed) area of the Portions in question, and will be located close to the junction.

Both Portions are located in the Marikana Thornveld vegetation unit as defined by Mucina and Rutherford (2006). Portion 22 is ecologically in a largely undisturbed condition, with a few ruins of former habitation. Exotic invasions are limited to odd lantanas and tall Queens-of-the-Night specimens. However, sickle bush show signs of unnatural invasion and in places form thickets. Natural basal cover was in a good condition during the site survey.

Portion 41 lies just west of the border between the North-West Province and Gauteng that is formed by a dry wash receiving water during heavy rains. The depression of the drainage line has several mature bluegum and seringa trees. The floral composition on Portion 41 has been largely transformed by clearing smaller shrubs and trees to favour larger indigenous trees and thus to create parkland. Basal cover in the parkland portion is lush and kept short by grazing by horses and re-introduced species such as zebra, blesbok and nyala. Buildings serving the desiderata of an executive training facility are located towards the centre of this property and will not be affected by the proposed development.

The topography of both subsections of the site is flat terrain in the valley north of the Magaliesberg Mountain range. The substrate on both properties range from red sandy soil, in places imbedded with gravel and even localised rock. No termitaria were recorded on either site.

Other than the Lucas Mangope Drive and the N4, the 500 meters zone of surrounding properties are rural in nature, but contain no ecological features worthy of note.

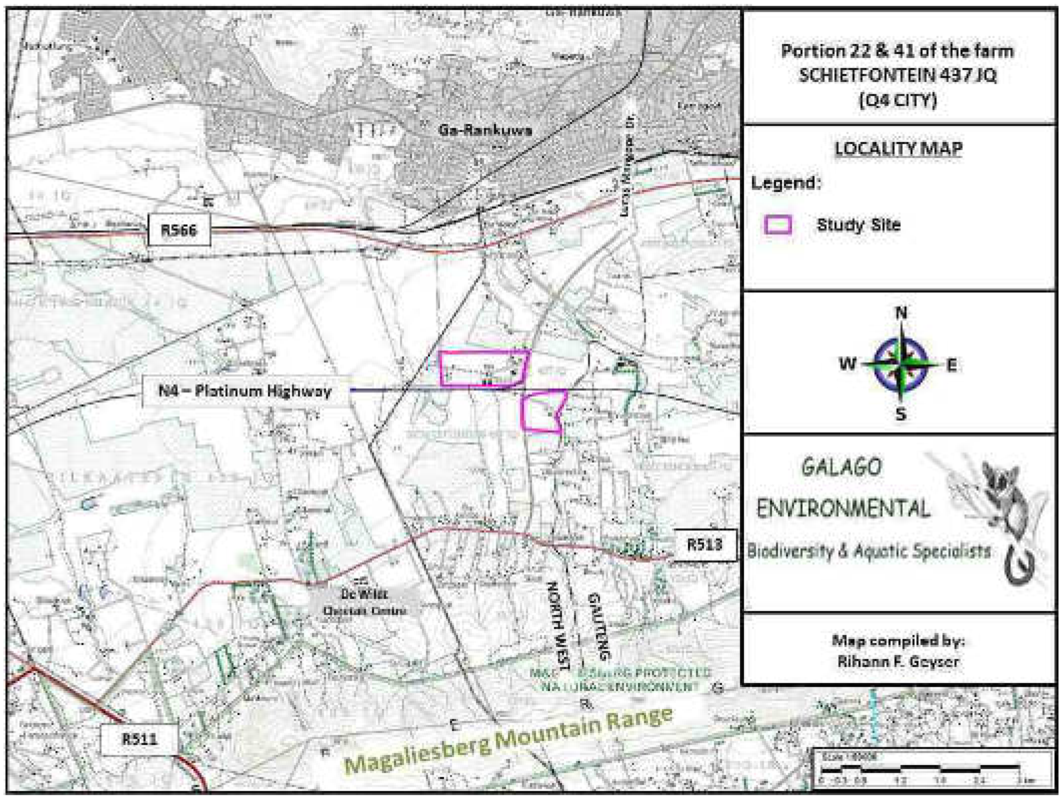

Figure 1: Locality map of the study site

4. METHOD

A four hour site visit was conducted on 14 March 2014. During this visit the observed and derived presence of reptiles and amphibians associated with the recognised habitat types of the study site were recorded. This was done with due regard to the well-recorded global distributions of Southern African herpetofauna, coupled with the qualitative and quantitative nature of recognised habitats.

The 500 m of adjoining properties were scanned for important fauna habitats.

4.1 Field Surveys

During the site visits, reptiles and amphibians were identified by visual sightings through random transect walks. Amphibian diversity was also established by means of acoustic identification. No trapping was conducted, as the terms of reference did not require such intensive work.

4.2 Desktop Surveys

As the majority of reptiles and amphibians are secretive, nocturnal and/or poikilothermic or seasonal, distributional ranges and the presence of suitable habitats were used to deduce the presence or absence of these species based on authoritative tomes, scientific literature, field guides, atlases and databases. This can be done irrespective of season.

The probability of the occurrence of reptile and amphibian species was based on their respective geographical distributional ranges and the suitability of on-site habitats. In other words, high probability would be applicable to a species with a distributional range overlying the study site as well as the presence of prime habitat occurring on the study site. Another consideration for inclusion in this category is the inclination of a species to be common to the area, i.e. normally occurring at high population densities.

Medium probability pertains to a herpetofaunal species with its distributional range peripherally overlapping the study site, or required habitat on the site being sub-optimal. The size of the site as it relates to its likelihood to sustain a viable breeding population, as well as its geographical isolation is taken into consideration. Species categorised as *medium* normally do not occur at high population numbers, but cannot be deemed as rare.

A low probability of occurrence would imply that the species' distributional range is peripheral to the study site and habitat is sub-optimal. Furthermore, some reptiles and amphibians categorised as low are generally deemed to be rare.

Based on the impressions gathered during the site visit, as well as publications, such as FitzSimons' Snakes of Southern Africa (Broadley, 1990), Field Guide to Snakes and other Reptiles of Southern Africa (Branch, 1998), A Guide to the Reptiles of Southern Africa (Alexander and Marais, 2007), Amphibians of Central and Southern Africa (Channing 2001), Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland (Minter, et al, 2004) and A Complete Guide to the Frogs of Southern Africa (Du Preez & Carruthers, 2009), a list of species which may occur on the site was compiled. The latest taxonomic nomenclature was used and the vegetation type was defined according to the standard handbook by Mucina and Rutherford (eds) (2006).

4.3 Specific Requirements

During the visit the site was surveyed and assessed for the potential occurrence of current or past Red Data species in the North-West Province (Alexander and Marais, 2007; Minter, et al, 2004 and Du Preez & Carruthers, 2009), such as:

- Giant Bullfrogs (*Pyxicephalus adspersus*);
- The Nile Crocodile (*Crocodylus niloticus*);
- The Striped Harlequin Snake (*Homoroselaps dorsalis*); and
- The Southern African Python (*Python natalensis*).

5. RESULTS

The vegetation types of the site were analysed according to Mucina and Rutherford (2006).

Herpetofauna Habitat Assessment:
The local occurrences of reptiles and amphibians are closely dependent on broadly defined habitat types, in particular terrestrial, arboreal (tree-living), rupiculous (rock-dwelling) and wetland-associated vegetation cover. It is thus possible to deduce the presence or absence of reptile and amphibian species by evaluating the habitat types within the context of global distribution ranges. From a herpetological habitat perspective, it was established that three of the four major habitats are naturally present on the study site, namely terrestrial, arboreal and wetland-associated vegetation cover habitat. Many manmade places of rupiculous habitat are present on the study site.

Noticeable absentees from the study site are termitaria. Moribund termitaria normally provide ideal retreats for reptiles and amphibians. Accordingly, it is estimated that the reptile and amphibian diversity and population density of the study site is lower. At the time of the site visit the basal cover was lush in many places and would provide adequate cover for small terrestrial herpetofauna (Figure 2).

The terrestrial habitat of Portion 41 suffered a variety of ecological modifications varying from invasion by exotics such as *Eucalyptus* and Syringa trees (*Melia azedarach*), Kikuyu and a number of declared weeds. A major portion of this site is being mowed and grazed by horses, Blesbok, Nyala blue wildebeest and Burchell's zebra. Several chalets, stores, structures, culverts etc. are present on the site. The small area in the north-west corner targeted for development is already ecologically transformed.

Both the terrestrial and arboreal habitat on Portion 22, are in good ecological condition, partly due to the fact that it is lightly grazed by cattle. Lantana and Queen-of-the-night specimens are present and will require assertive action in the near future. A measure of sickle bush invasion is visible, suggesting that Portion 22 will benefit from enlightened range management. Only the small south-easterly portion of the site will be developed, the rest will remain unaffected.

Figure 2: A southerly view of the study site (Portion 22). Note the good grass cover in the foreground and the Magaliesberg Mountain Range in the background

Natural arboreal habitat (Figure 3) consists of indigenous *Acacia* trees such as *A. karroo* in various stages of development. The larger *Acacia* trees may offer refuge to tree-living reptiles such as Tree Agamas and Flap-neck Chameleons. Other indigenous trees recorded are karee (*Searsia lancea*), mountain karee (*S. Leptodictya*), Highveld cabbage tree (*Cussonia paniculata*), common tree euphorbia (*Euphorbia ingens*), Marula (*Sclerocarya birrea*), Red ivory (*Berchemia zeyheri*), common wild fig (*Ficus burkei*), silver clusterleaf (*Terminalia sericea*) and wild seringa (*Burkea africana*). The exotic trees and shrubs, such as seringa and *Eucalyptus* grow mostly along the drainage line. There are many dead logs, which provide shelter and food for some herpetofauna.

Figure 3: Arboreal habitat for some reptile species on Portion 22

There is no natural rupiculous habitat on the study site, but excellent man-made rupiculous habitat exists in a large number of buildings (Figure 4), building rubble piles (Figure 5) and building ruins (Figure 6). These man-made habitats offer nooks and crannies as refuge for rupiculous herpetofauna. Due to the absence of natural rupiculous habitat, some species such as Yellow-throated Plated Lizard, Transvaal Girdled Lizard and Rock Agama were omitted from the species list in Table 1.

Figure 4: Manmade rupiculous habitat in the form of buildings on Portion 41

Figure 5: Manmade rupiculous habitat in the form of building rubble on Portion 22

Figure 6: Manmade rupiculous habitat in the form of building ruins on Portion 22

Permanent and temporary water sources occur on the study site. The drainage line, which forms the border between Gauteng and North-West Province, was flowing strongly during the site visit (Figure 7). It is seasonal and therefore lacks well-developed semi-aquatic vegetation on its banks although moisture-reliant plants grow in the streambed. It is consequently concluded that the drainage line fails to provide year round refuge and nourishment for wetland-reliant reptiles. The streambed can, however, be expected to serve as refuge and a dispersal corridor along its short course. A water feature containing water was found near an old ruin on Portion 22 (Figure 8). The cattle on Portion 22 may drink water from this feature. These cattle use mainly artificial water points, which are raised and are of no use to water–dependent herpetofauna. This drainage line and water feature provide breeding habitat for frogs.

Figure 7: The drainage line on Portion 41 which forms the boundary between Gauteng and North-West Provinces

Figure 8: A view of the water feature which provides some aquatic habitat for frogs on Portion 22

The drainage line is protected and is regarded as sensitive.

With the exception of the N4 - Platinum Highway and Lucas Mangope Drive, connectivity is fair to good. Real opportunities for migration exist, also along the drainage line.

Sight records were also used to compile this herpetofauna report.

Threatened and Red listed Reptile and Amphibian Species:

The study site falls inside the natural range of the Southern African python. According to Bradley (1990), Southern African pythons favour moist, rocky, well-wooded valleys, plantations or bush country, but seldom if ever stray far from permanent water. The study site thus provides suitable habitat for the Southern African python, but the study site is far too small to support a viable population. It is often estimated that a single python needs at least a 100ha area to forage. The occasional Southern African Python may venture onto the study site.

The striped harlequin snake has not been recorded on this quarter degree square (TVL Museum Records or Ditsong Museum of Natural History), and no moribund termitaria, where this species is most likely to be found, are present on the study site. It is very difficult to confirm whether this cryptic snake is present on any study site, but this species should not occur on this particular study site.

The study site contains no temporary pans/dams, which are potential breeding places for giant bullfrogs. Giant bullfrogs prefer these temporary breeding sites in order to avoid predation from fish. The stream flow is season bound and does not contain any water when it dries up and when in flow, it is too fast flowing. Giant bullfrogs prefer warm, stagnant water, which giant bullfrog tadpoles need for rapid development (Van Wyk, Kok & Du Preez, 1992).

Many areas of the study site consist of sandy soil and are suitable as a dispersal area, which combines feeding and aestivation. It is essential that the soil be suitable for burrowing on a daily basis during the short activity period at the beginning of the rainy season and for deeper retreats during the resting periods.

It is important to note that in the latest literature (Measey (ed.) 2011 and Carruthers & Du Preez 2011); the giant bullfrog's status has changed officially from Near Threatened (Minter *et al*, 2004) to Least Concern in South Africa.

Expected and Observed Herpetofauna Species Richness:
Of the 52 reptile species which may occur on the study site (Table 1), none was confirmed during the site visit and of the possible 16 amphibian species which may occur on the study site (Table 1) two were confirmed during the site visit.

Table 1 lists the reptiles & amphibians which were observed on or deduced to occupy the site.

The American red-eared terrapin (*Trachemys scripta elegans*) and the Brahminy blind snake (*Ramphotyphlops braminus*) are the only two feral reptile or amphibian species known to occur in South Africa (De Moor and Bruton, 1988; Picker and Griffiths, 2011), but with only a few populations, they are not expected to occur on this particular site.

The species assemblage is typical of what can be expected of habitat that is severely disturbed, but with sufficient habitat to sustain populations. Most of the species of the resident diversity (Table 1) are fairly common and widespread (viz. leopard tortoise, the brown house snake, mole snake, montane speckled skink, Transvaal gecko, rock monitor, guttural toad, red toad, common caco, common platanna and the common river frog).

The species richness is fair due to the three habitat types occurring on the study site.

Table 1: **The Reptile and Amphibian species observed on or deduced to occupy the site**

	SCIENTIFIC NAME	ENGLISH NAME
	CLASS: REPTILIA	**REPTILES**
	Order: TESTUDINES	**TORTOISES & TERRAPINS**
	Family: Pelomedusidae	**Side-necked Terrapins**
?	*Pelomedusa subrufa*	Marsh or Helmeted Terrapin
?	*Stigmochelys pardalis*	Leopard Tortoise
	Order: SQUAMATA	**SCALE-BEARING REPTILES**
	Suborder:LACERTILIA	**LIZARDS**
	Family: Gekkonidae	**Geckos**
√	*Hemidactylus mabouia*	Moreau's Tropical House Gecko
√	*Lygodactylus capensis*	Cape Dwarf Gecko
√	*Pachydactylus affinis*	Transvaal Thick-toed or Transvaal Gecko
*	*Pachydactylus capensis*	Cape Thick-toed or Cape Gecko
	Family: Agamidae	**Agamas**
?	*Agama aculeate*	Ground Agama
√	*Acanthocerus atricollis*	Southern Tree Agama
	Family: Chamaeleonidae	**Chameleons**
√	*Chamaeleo dilepis*	Flap-neck Chameleon
	Family: Scincidae	**Skinks**
√	*Trachylepis capensis*	Cape Skink
√	*Trachylepis punctatissima*	Montane Speckled Skink
√	*Trachylepis varia*	Variable Skink
√	*Panaspis wahlbergii*	Wahlberg's Snake-eyed Skink
?	*Acontias gracilicauda*	Thin-tailed Legless Skink
	Family:Lacertidae	**Old World Lizards or Lacertids**
?	*Pedioplanis lineoocellata*	Spotted Sand Lizard
?	*Ichnotropis squamulosa*	Common Rough-scaled Lizard
?	*Nucras ornate*	Ornate Sandveld Lizard
	Family: Varanidae	**Monitors**
?	*Varanus niloticus*	Water Monitor
√	*Varanus albigularis*	Rock Montor
	Suborder: SERPENTES	**SNAKES**
	Family: Typhlopidae	**Blind Snakes**
?	*Typhlops bibronii*	Bibron's Blind Snake
?	*Rhinotyphlops lalandei*	Delalande's Beaked Blind Snake
	Family: Leptotyphlopidae	**Thread Snakes**
*	*Leptotyphlops conjunctus*	Cape Thread or Worm Snake
*	*Leptotyphlops scutifrons*	Peter's Thread or Worm Snake
	Family: Atractaspididae	**African burrowing Snakes**
?	*Atractapis bibronii*	Southern Stiletto Snake
*	*Aparallactus capensis*	Cape or Black-headed Centipede Eater
	Family: Colubridae	**Typical Snakes**
?	*Lycodonomorphus rufulus*	Common Brown Water Snake
√	*Boaedon capensis*	Brown House Snake
?	*Lamprophis aurora*	Aurora House Snake

	SCIENTIFIC NAME	ENGLISH NAME
?	*Lamprophis inornatus*	Olive House Snake
?	*Lycophidion capense*	Cape or Common Wolf Snake
?	*Mehelya capensis*	Southern or Cape File Snake
*	*Duberria lutrix*	Common Slug Eater
√	*Pseudaspis cana*	Mole Snake
?	*Prosymna sundevallii*	Sundevall's Shovel-snout
*	*Psammophylax rhombeatus*	Spotted Skaapsteker
?	*Psammophylax tritaeniatus*	Striped Skaapsteker
*	*Psammophis mossambicus*	Olive Grass Snake
?	*Psammophis angolensis*	Dwarf Whip Snake
√	*Psammophis brevirostris*	Short-snouted Grass or Sand Snake
√	*Psammophis crucifer*	Crossed Whip Snake
?	*Philothamnus hoplogaster*	Green Water Snake
√	*Dasypeltis scabra*	Common or Rhombic Egg Eater
√	*Crotaphopeltis hotamboeia*	Herald Snake
*	*Telescopus semiannulatus*	Eastern or Common Tiger Snake
*	*Dispholidus typus*	Boomslang
?	*Thelotornis capensis*	Southern Vine Snake
	Family: Elapidae	**Cobras, Mambas and Others**
?	*Elapsoidea sunderwallii*	Sundevall's Garter Snake
√	*Naja mossambica*	Mozambique Spitting Cobra or M'fezi
?	*Dendroaspis polylepis*	Black Mamba
	Family: Viperidae	**Adders**
√	*Causus rhombeatus*	Rhombic Night Adder
√	*Brits arietans*	Puff Adder
?	*Bitis caudalis*	Horned Adder
	Family: Pythonidae	**Pythons**
NT ?	*Python natalensis*	Southern African Python
	CLASS: AMPHIBIA	**AMPHIBIANS**
	Order: ANURA	**FROGS**
	Family: Pipidae	**Clawed Frogs**
√	*Xenopus laevis*	Common Platanna
	Family: Bufonidae	**Toads**
√	*Amietaophrynus gutturalis*	Guttural Toad
?	*Amietaophrynus poweri*	Western Olive toad
√	*Schismaderma carens*	Red Toad
	Family: Breviceptidae	**Rain Frogs**
?	*Breviceps adspersus*	Bushveld Rain Frog
	Family: Hyperoliidae	**Reed Frogs**
?	*Kassina senegalesis*	Bubbling Kassina
	Family: Microhylidae	Rubber Frogs
?	*Phrynomantis bifasciatus*	Banded Rubber Frog
	Family Phrynobatrachidae	**Puddle Frog**
*	*Phrynobatrachus natalensis*	Snoring Puddle Frog
	Family: Ptychadenidae	Grass Frogs
?	*Ptychadena anchietae*	Plain Grass Frog
?	*Ptychadena porosissima*	Strip Grass Frog
	Family: Pyxicephalidae	

	SCIENTIFIC NAME	ENGLISH NAME
√	*Amietia angolensis*	Common River Frog
?	*Amieta fuscigula*	Cape River Frog
?	*Strongylopus fasciatus*	Striped Stream Frog
√	*Cocosternum boettgeri*	Boettger's Caco or Common Caco
√	*Tomopterna cryptotis*	Tremolo Sand Frog
√	*Tomopterna natalensis*	Natal Sand Frog

Systematic arrangement and nomenclature according to Branch (1998), Alexander and Marais (2007), Minter, *et.al* (2004) & Du Preez and Carruthers (2009).

√ Definitely there or have a *high* probability of occurring;
***** *Medium* probability of occurring based on ecological and distributional parameters;
? *Low* probability of occurring based on ecological and distributional parameters.

Red Data species rankings as defined in Branch, The Conservation Status of South Africa's threatened Reptiles': 89 – 103..In:- G.H.Verdoorn & J. le Roux (editors), 'The State of Southern Africa's Species (2002) and Minter, *et.al*, Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland (2004) are indicated in the first column: CR= Critically Endangered, En = Endangered, Vu = Vulnerable, NT = Near Threatened, DD = Data Deficient. All other species are deemed of Least Concern**.**

Table 2: Reptile and Amphibian species positively confirmed on the study site, observed indicators and habitat

SCIENTIFIC NAME	ENGLISH NAME	OBSERVATION INDICATOR	HABITAT
Schismaderma carens	Red Toad	Sight record of two individuals	In veld of terrestrial habitat
Amietia angolensis	Common River Frog	Sight record	Next to stream

Both frog species (Red Toad and Common River Frog), listed in Table 2, should be abundant on the study site and elsewhere in its range.

6. FINDINGS AND POTENTIAL IMPLICATIONS

Portion 41 of the study site has one important topographical feature in the form of the drainage line which forms the border between the North-West and Gauteng Provinces. The study site contains three herpetofaunal habitats, namely terrestrial, arboreal and wetlands.

Spatially the proposed developments will be limited to only a small section of each Portion. The rest of the study area will remain as is.

Species richness: Due to the presence of three habitat types, the study site should have a fair number of species, but it must be emphasised that the species richness is for the general area and NOT for the study site itself.
Endangered species: There is a possibility that one or two Southern African pythons may use the study site as part of their range.
Sensitive species and/or areas (Conservation ranking): The drainage line on Portion 41 and the 32 metres buffer zone around the aquatic habitat is a sensitive ecological system.
Habitat(s) quality and extent: The entire Portion 41 is severely transformed (grass cutting, bush clearing, buildings and invasive plants), whereas Portion 22 north of the N4 consists largely of a good stand of relatively undisturbed woodlands, except for some

building rubble and ruins of buildings, that answers to the definition of Marikana Thornveld.
Impact on species richness and conservation: The construction of the filling stations will have a significant and lasting effect on species richness and conservation, because of the construction of new buildings and new roads carrying more vehicles. These structures and roads will form an even larger barrier for herpetofauna movement and it will result in a decrease in connectivity. The development will have a small but permanent footprint, the entire destruction of any natural habitat. However, the largest part of the Portions under contention will remain unchanged.

If the development should go ahead, a very important indirect effect would be the likely impact that the proposed development might have on the surface water runoff and water quality of the drainage line. This could have a negative impact on the herpetofauna.
Connectivity: With the exception of the N4 - Platinum Highway and Lucas Mangope Drive, connectivity is fair to good. Real opportunities for migration exist, also along the drainage line.
Management recommendation: Considering the projected severity of transformation of the development footprint, no management precautions are possible. However, the rest of the two Portions will benefit from a scientifically-based range management plan, and the immediate eradication of alien vegetation. A measure of sickle bush invasion is visible, suggesting that Portion 22 will benefit from enlightened range management.
General: The integrity of the drainage line should not be jeopardised in any way by the proposed development. The biological damage caused by the comfort stations will thus be relatively small, *albeit* absolute. Given due care, the proposed development will not result in a loss of ecologically sensitive and important habitat units, ecosystem function (e.g. reduction in water quality, soil pollution), notable loss of herpetofaunal habitat, nor of significant loss/displacement of threatened or protected species.

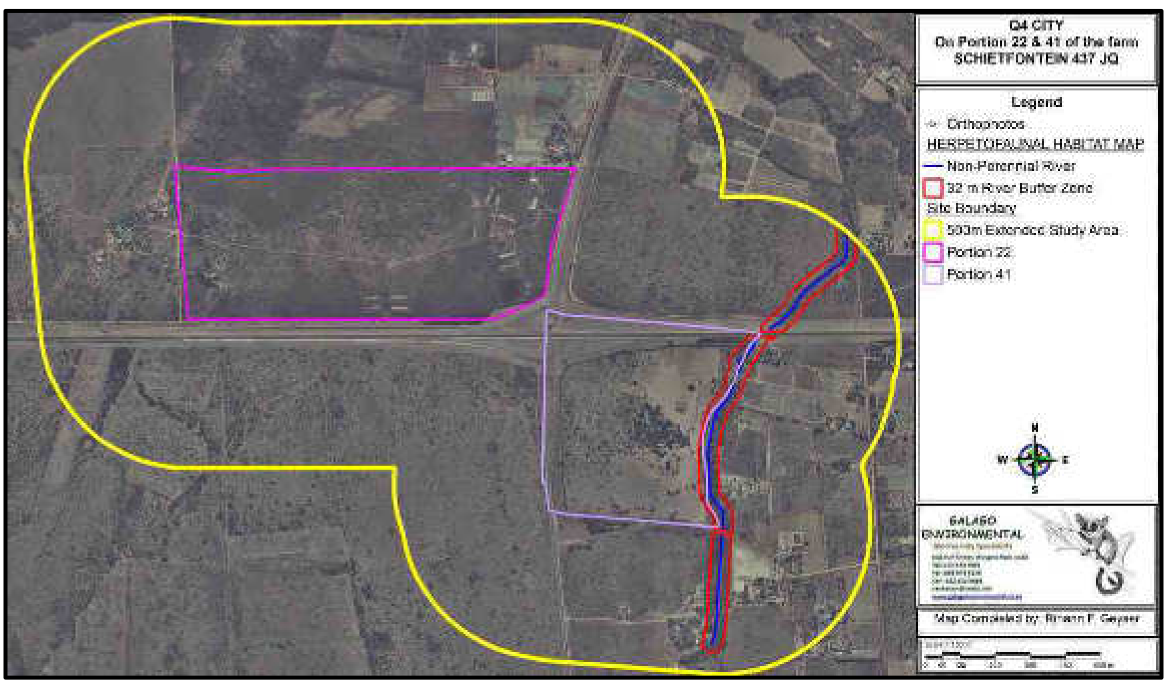

Figure 9: Herpetofauna Habitat Map

7. LIMITATIONS, ASSUMPTIONS AND GAPS IN KNOWLEDGE

Galago Biodiversity and Aquatic Specialists are committed to the conservation of biodiversity but concomitantly recognise the need for economic development. Whereas we appreciate the opportunity to learn through the processes of constructive criticism and debate, we reserve the right to form and hold our own opinions and therefore will not willingly submit to the interest of other parties or change statements to appease them.

Even though every care is taken to ensure the accuracy of this report, environmental assessment studies are limited in scope, time and budget. To some extent discussions and proposed mitigations are made on reasonable and informed assumptions built on *bone fide* information sources, as well as deductive reasoning. Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems, additional information may come to light at a later stage. Galago Biodiversity and Aquatic Specialists can therefore not accept responsibility for conclusions and mitigation measures made in good faith based on own databases or on the information provided at the time of the directive. This report should therefore be viewed and acted upon with these limitations in mind.

8. RECOMMENDED MITIGATION MEASURES

Protection of the drainage line:

- Every effort should be made to retain the linear integrity, flow dynamics and water quality of the drainage line.

The following mitigation measures are proposed by the specialist:

- The Southern African python or any herpetological species that are encountered or exposed during the construction phase should be removed and relocated to natural areas in the vicinity. This remedial action requires the employment of a herpetologist to oversee the removal of any herpetofauna during the initial ground clearing phase of construction (i.e. initial ground-breaking by earthmoving equipment). The contractor must ensure that no herpetofauna species are disturbed, trapped, hunted or killed during the construction phase. Any herpetofauna that are inadvertently killed during earthmoving operations should be preserved as museum voucher specimens. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for non-compliance.
- Alien and invasive plants must be removed.
- The remainder of the portions that will not be developed must be managed in terms of game and fire.
- During the construction phase there will be increased surface runoff and a decreased water quality (with increased silt load and pollution). Completing construction during the winter months would mitigate the environmental impact.

It is finally strongly recommended that suitable conservation and management structures are put into place to improve the conservation profiles of the drainage line.

9. CONCLUSION

The drainage line and its 32m buffer zone should be considered as ecologically sensitive. There is a possibility that one or two Southern African pythons may occur on the study site from time to time.

If the development should go ahead, a very important indirect effect would be the likely impact that the proposed development might have on the surface water runoff and water quality of the drainage line. This could have a negative impact on the herpetofaunal species on site.

The biological damage caused by the filling stations will thus be relatively small, *albeit* absolute. Given due care, the proposed development will not result in a loss of ecologically sensitive and important habitat units, ecosystem function (e.g. reduction in water quality, soil pollution), notable loss of herpetofauna habitat, nor of significant loss/displacement of threatened or protected species.

Figure 10: Herpetofaunal Sensitivity Map

10. LITERATURE SOURCES

Alexander, G. & Marais J. 2007. *A Guide to the Reptiles of Southern Africa*. Struik Publishers, Cape Town 408pp.

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Heritage Impact Assessment

Annexure F5

PHASE 1 HERITAGE IMPACT ASSESSMENT (HIA) FOR THE PROPOSED Q4 CITY NORTH FILLING STATION ON PORTION 22 OF THE FARM SCHIETFONTEIN 437 JQ, CLOSE TO BRITS, NORTHWEST PROVINCE

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BA, BA (Hons), DTO, NDM, MA (Archaeology) [UP], MA (Culture History) [US], DPhil (Archaeology) [UP], Man Dip [TUT], DPhil (History)[US], L Akad [SA]	*BA (Cultural History and Archaeology) (UP), BA (Hons) Cultural History (UP), Post Grad Dip Museology (UP), Cert Conservation of Traditional Buildings (Univ of Canberra) Post Grad Dip: Heritage (Wits)*
Accredited member: SA Society for Cultural History (CH001) *Accredited member: ASAPA*	*Accredited member: SA Society for Cultural History (CH002)*

For:

Bokamoso Environmental
PO Box 11375
MAROELANA
0161

REPORT NO.: AE01439V

May 2014

SUBMISSION OF REPORT

Please note that the South African Heritage Resources Agency (SAHRA) or one of its subsidiary bodies needs to comment on this report.

It is the client's responsibility to do the submission via the SAHRIS System on the SAHRA website.

Clients are advised not to proceed with any action before receiving the necessary comments from SAHRA.

DISCLAIMER

Although all possible care is taken to identify all sites of cultural importance during the survey of study areas, the nature of archaeological and historical sites are as such that it always is possible that hidden or subterranean sites could be overlooked during the study. Leonie Marais-Botes/Archaetnos CC and its personnel will not be held liable for such oversights or for costs incurred as a result thereof.

SUMMARY

Leonie Marais-Botes/Archaetnos cc was requested by Bokamoso Environmental to conduct a Phase 1 Heritage Impact Assessment (HIA) for the proposed Q4 City North filling station on Portion 22 of the Farm Schietfontein 437 JQ. This is on the N4, close to Brits in the Northwest Province.

A survey of the available literature was undertaken in order to obtain background information regarding the proposed project area and the surrounding environment. This was followed by the field survey which was conducted according to generally accepted HIA practices.

One site was identified during the survey. The site is of a low cultural heritage significance and therefore the report is seen as ample mitigation. The proposed development may continue.

It should be noted however that the subterranean presence of archaeological and/or historical sites, features or artefacts is always a possibility. As such, care should be taken during any work in the entire area, that if any historical sites, features or artefacts are discovered, a qualified archaeologist should be commissioned to investigate.

It is also important to take cognisance of the applicant's responsibility to submit this report via the SAHRIS System on the South African Heritage Resource Agency (SAHRA) website. No work on site may commence before receiving the necessary comments from the SAHRA.

CONTENTS

1. INTRODUCTION

Leonie Marais-Botes/Archaetnos CC was requested by Bokamoso Environmental to conduct a Phase 1 Heritage Impact Assessment (HIA) for the Q4 City North filling station. This is on the N4, close to Brits in the Northwest Province (Figure 1-3).

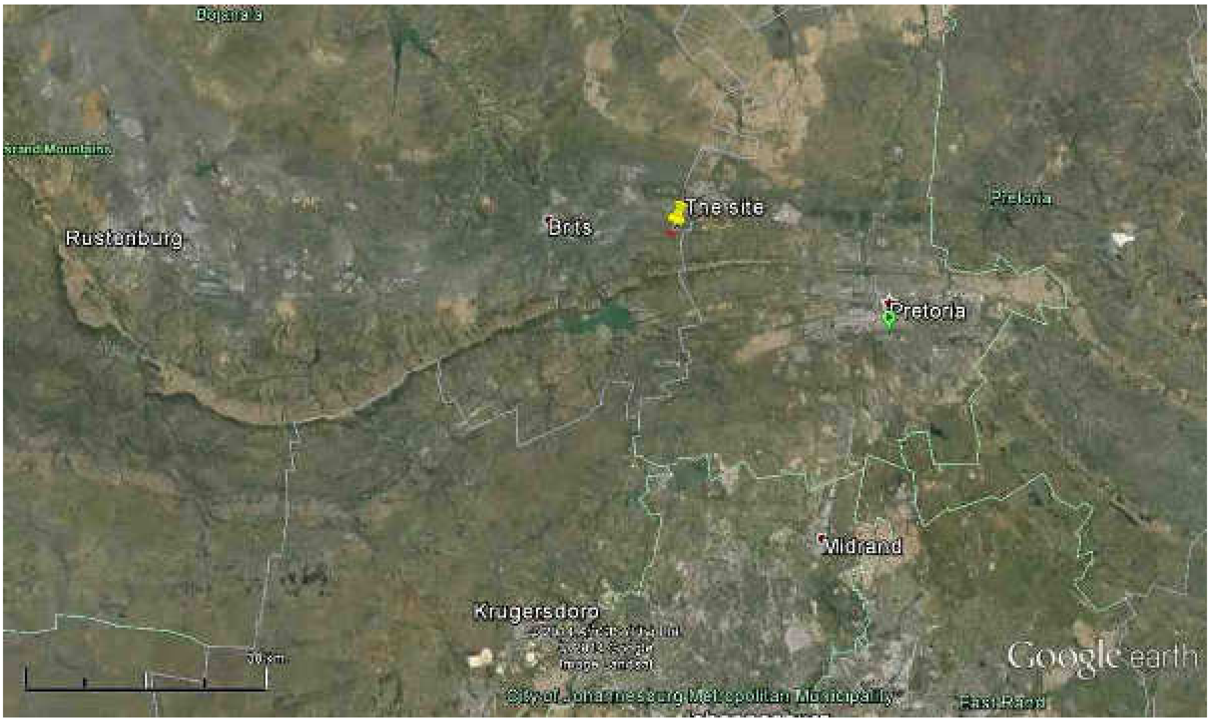

Figure 1: Location of Brits in the Northwest Province. North reference is to the top.

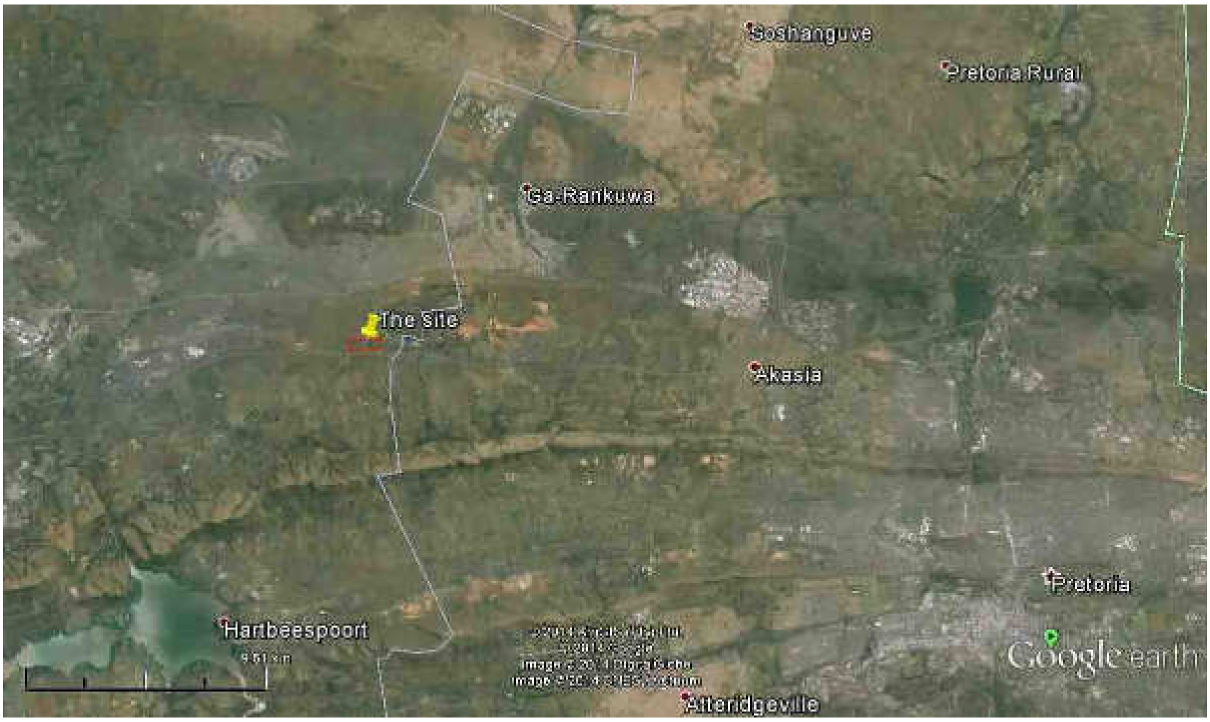

Figure 2: Location of the surveyed site, close to Brits. North reference is to the top.

Figure 3: Google image indicating the site boundary. North reference is to the top.

2. TERMS OF REFERENCE

The Terms of Reference for the survey were to:

1. Identify objects, sites, occurrences and structures of an archaeological or historical nature (cultural heritage sites) located on the property (see Appendix A).

2. Study background information on the area to be developed.

3. Assess the significance of the cultural resources in terms of their archaeological, historical, scientific, social, religious, aesthetic and tourism value (see Appendix B).

4. Describe the possible impact of the proposed development on these cultural remains, according to a standard set of conventions.

5. Recommend suitable mitigation measures to minimize possible negative impacts on the cultural resources by the proposed development.

6. Review applicable legislative requirements.

3. CONDITIONS & ASSUMPTIONS

The following conditions and assumptions have a direct bearing on the survey and the resulting report:

1. Cultural Resources are all non-physical and physical man-made occurrences, as well as natural occurrences associated with human activity (Appendix A). These include all sites, structure and artefacts of importance, either individually or in groups, in the history, architecture and archaeology of human (cultural) development. Graves and cemeteries are included in this.

2. The significance of the sites, structures and artefacts is determined by means of their historical, social, aesthetic, technological and scientific value in relation to their uniqueness, condition of preservation and research potential. The various aspects are not mutually exclusive, and the evaluation of any site is done with reference to any number of these aspects.

3. Cultural significance is site-specific and relates to the content and context of the site. Sites regarded as having low cultural significance have already been recorded in full and require no further mitigation. Sites with medium cultural significance may or may not require mitigation depending on other factors such as the significance of impact on the site. Sites with a high cultural significance require further mitigation (see Appendix C).

4. The latitude and longitude of any archaeological or historical site or feature, is to be treated as sensitive information by the developer and should not be disclosed to members of the public.

5. All recommendations are made with full cognizance of the relevant legislation.

6. It has to be mentioned that it is almost impossible to locate all the cultural resources in a given area, as it will be very time consuming. Developers should however note that the report should make it clear how to handle any other finds that might occur.

7. In this case there were certain areas where the vegetation cover was medium to high in length and the under footing was reasonably dense which had a negative effect on archaeological visibility.

4. LEGISLATIVE REQUIREMENTS

Aspects concerning the conservation of cultural resources are dealt with primarily through two Acts, namely the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

4.1 The National Heritage Resources Act

According to the National Heritage Resources Act (NHRA) the following are considered protected as heritage resources:

a. Archaeological artefacts, structures and sites older than 100 years;
b. Ethnographic art objects (e.g. prehistoric rock art) and ethnography;
c. Objects of decorative and visual arts;
d. Military objects, structures and sites older than 75 years;
e. Historical objects, structures and sites older than 60 years;
f. Proclaimed heritage sites;
g. Grave yards and graves older than 60 years;
h. Meteorites and fossils; and
i. Objects, structures and sites or scientific or technological value.

The national estate (see Appendix D) includes the following:

a. Places, buildings, structures and equipment of cultural significance;
b. Places to which oral traditions are attached or which are associated with living heritage;
c. Historical settlements and townscapes;
d. Landscapes and features of cultural significance;
e. Geological sites of scientific or cultural importance;
f. Archaeological and paleontological importance;
g. Graves and burial grounds;
h. Sites of significance relating to the history of slavery; and
i. Movable objects (e.g. archaeological, paleontological, meteorites, geological specimens, military, ethnographic, books etc.).

An HIA is the process to be followed in order to determine whether any heritage resources are located within the area proposed for development as well as the potential impact of the proposed development thereon. An Archaeological Impact Assessment only looks at archaeological resources. The different phases of the HIA process are described further in Appendix E. An HIA should be undertaken under the following circumstances:

a. The construction of a linear development (road, wall, power line canal etc.) exceeding 300m in length;
b. The construction of a bridge or similar structure exceeding 50m in length;
c. Any development or other activity that will change the character of a site and exceed 5 000m^2 or involve three or more existing erven or subdivisions thereof;
d. Re-zoning of a site exceeding 10 000 m^2; and
e. Any other category provided for in the regulations of South African Heritage Resource Agency (SAHRA) or a provincial heritage authority.

Structures

Section 34 (1) of the mentioned act states that no person may demolish any structure or part thereof which is older than 60 years without a permit issued by the relevant provincial heritage resources authority.

The act defines a structure as any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith.

According to the act alter means any action affecting the structure, appearance or physical properties of a place or object, whether by way of structural or other works, by painting, plastering or the decoration or any other means.

Archaeology, palaeontology and meteorites

Section 35(4) of this act deals with archaeology, palaeontology and meteorites. The NHRA states that no person may, without a permit issued by the responsible heritage resources authority (national or provincial):

a. Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or paleontological site or any meteorite;
b. Destroy, damage, excavate, remove from its original position, collect or own any archaeological or paleontological material or object or any meteorite;
c. Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or paleontological material or object, or any meteorite;
d. Bring onto or use at an archaeological or paleontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and paleontological material or objects, or use such equipment for the recovery of meteorites; and/or
e. Alter or demolish any structure or part of a structure which is older than 60 years as protected.

The above mentioned may only be disturbed or moved by a registered archaeologist, after receiving a permit from the SAHRA. In order to demolish such a site or structure, a destruction permit from SAHRA is required.

Human remains

Graves and burial grounds are divided into the following:

a. Ancestral graves;
b. Royal graves and graves of traditional leaders,;
c. Graves of victims of conflict;
d. Graves designated by the Minister;
e. Historical graves and cemeteries; and
f. Human remains.

In terms of Section 36(3) of the NHRA, no person may, without a permit issued by the SAHRA:

a. Destroy, damage, alter, exhume or remove from its original position of otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
b. Destroy, damage, alter, exhume or remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; and/or
c. Bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation, or any equipment which assists in the detection or recovery of metals.

Unidentified/unknown graves are also handled as older than 60 until proven otherwise.

Human remains that are less than 60 years old are subject to provisions of the Human Tissue Act (Act 65 of 1983) (HTA) and to local regulations. Exhumation of graves must conform to the standards set out in the **Ordinance on Excavations** (**Ordinance no. 12 of 1980**) (replacing the old Transvaal Ordinance no. 7 of 1925).

Permission must also be gained from the descendants (where known), the National Department of Health, Provincial Department of Health, Premier of the Province and local police. Furthermore, permission must also be gained from the various landowners (i.e. where the graves are located and where they are to be relocated) before exhumation can take place. Human remains can only be handled by a registered undertaker or an institution declared under the **HTA**.

4.2 The National Environmental Management Act

The National Environmental Management Act (Act 107 of 1998) states that a survey and evaluation of cultural resources must be done in areas where development projects, that will change the face of the environment, will be undertaken. The impact of the development on these resources should be determined and proposals for the mitigation thereof are made.

Environmental management should also take the cultural and social needs of people into account. Any disturbance of landscapes and sites that constitute the nation's cultural heritage should be avoided as far as possible and where this is not possible the disturbance should be minimised and remedied.

5. THE INTERNATIONAL FINANCE CORPORATIONS' PERFORMANCE STANDARD FOR CULTURAL HERITAGE

This standard recognizes the importance of cultural heritage for current and future generations. It aims to ensure that clients protect cultural heritage in the course of their project activities.

This is done by clients abiding to the law and having heritage surveys done in order to identify and protect cultural heritage resources via field studies and the documentation of such resources. These need to be done by competent professionals (e.g. archaeologists and cultural historians). Possible chance finds, encountered during the project development, also needs to be managed by not disturbing it and by having it assessed by professionals.

Impacts on the cultural heritage should be minimized. This include the possible maintenance of such sites in situ, or when impossible, the restoration of the functionality of the cultural heritage in a different location. When cultural historical and archaeological artefacts and structures need to be removed is should be done by professionals and by abiding to the applicable legislation. The removal of cultural heritage resources may however only be considered if there are no technically or financially feasible alternatives. In considering the removal of cultural resources, it should be outweighed by the benefits of the overall project to the effected communities. Again professionals should carry out the work and adhere to the best available techniques.

It is necessary to engage into consultation with affected communities. This entails that access to such communities should be granted to their cultural heritage if this is applicable. Compensation for the loss of cultural heritage should only be given in extra-ordinary circumstances.

Critical cultural heritage may not be impacted on. Professionals should be used to advise on the assessment and protection thereof. Utilization of cultural heritage resources should always be done in consultation with the effected communities in order to be consistent with their customs and traditions and to come to agreements with relation to possible equitable sharing of benefits from commercialization.

6. METHODOLOGY

6.1 Survey of literature

A review of literature was undertaken in order to obtain background information regarding the area. Sources consulted in this regard are indicated in the list of references.

6.2 Field survey

The survey was conducted according to generally accepted HIA practices. However, it was not aimed at locating all possible objects, sites and features of cultural significance in the area in which the Project is proposed as known sites, identified during a previous survey had to visited and re-assessed.

If required, the location/position of any objects, sites and features of cultural significance was determined by means of a Global Positioning System (GPS)[1], while photographs were also taken where needed. The site survey was undertaken by means of a foot survey and using an off-road vehicle (Figure 4). The size of the surveyed area is approximately 8 Ha and took two hours to complete.

Figure 4: GPS track of the surveyed area.

6.3 Oral histories

People from local communities are interviewed in order to obtain information relating to the surveyed area. However, it should be understood that this is activity is not

[1] A Garmin Oregon 550 with an accuracy factor of between 3 and 5 meters.

required under all circumstances as it only comes to the fore once a specific community is directly involved. When applicable, this information obtained is included in the report write-up and linked to the information sources.

6.4 Documentation

All sites, objects features and structures identified are documented according to the general minimum standards accepted by the archaeological profession. This includes photographic documentation, description of the sites and taking GPS co-ordinates.

6.5 Evaluation of Heritage sites

The evaluation of heritage sites is undertaken by applying a field rating to each (see Appendix C) using the following criteria:

- The unique nature of a site;
- The integrity of the archaeological deposit;
- The wider historic, archaeological and geographic context of the site;
- The location of the site in relation to other similar sites or features;
- The depth of the archaeological deposit (when it can be determined or is known);
- The preservation condition of the site;
- Uniqueness of the site; and
- Potential to answer present research questions.

7. DESCRIPTION OF THE ENVIRONMENT

The proposed area to be developed is located on portion 22 of the farm Schietfontein 437 JQ. Accordingly many signs of disturbance by agricultural means are present. This includes farm infrastructure such as concrete floors (which could have had many functions), piles of brick, roads, ruins of buildings and dams (Figure 5-6).

In general areas with vegetation have a grass cover of medium to high in length with a dense under footing. The existence of pioneer species such as grass, weeds, candelabra trees and sickle bush, indicate former disturbance (Figure 7-8). Accordingly the archaeological visibility is influenced negatively. The site is bordered by the N4 highway in the south, a provincial road in the east, a farm road in the west and agricultural fields to the north.

The topography of the area is reasonably flat, but there is a small hill in the centre of the site. No natural water sources are found on the site. The nearest river is found about two kilometres to the east.

Figure 5: View of one of many concrete floors found in the surveyed area.

Figure 6: Farm infrastructure in ruins inside of the surveyed area.

Figure 7: Dense vegetation, consisting mostly of pioneer species in the surveyed area.

Figure 8: General view of grass cover in the surveyed area.

8. HISTORICAL CONTEXT

In order to place the one site identified and other possible finds that could be unearthed during construction activities, in context, it is necessary to give a background regarding the different phases of human history.

8.1 Stone Age

The Stone Age is the period in human history when lithic material was mainly used to produce tools (Coertze & Coertze 1996: 293). In South Africa the Stone Age can be divided in three periods. It is, however, important to note that dates are relative and only provide a broad framework for interpretation. The division for the Stone Age according to Korsman & Meyer (1999: 93-94) is as follows:

- Early Stone Age (ESA) 2 million – 150 000 years ago;
- Middle Stone Age (MSA) 150 000 – 30 000 years ago; and
- Late Stone Age (LSA) 40 000 years ago – 1850 - A.D.

The closest known Stone Age site in the vicinity of Brits is a rock art site to the northwest. Rock engravings are found to the south and east of Rustenburg (the latter lying to the west of the surveyed area). These date back to the Late Stone Age (Bergh 1999: 5).

Although no natural shelter was identified during the survey, the close proximity to a river makes the area very suitable for human habitation. The area probably provided good grazing and therefore it is possible that Stone Age people may have utilized the site for hunting purposes. One may therefore find Stone Age material lying around in the area.

8.2 Iron Age

The Iron Age is the name given to the period of human history when metal was mainly used to produce metal artefacts (Coertze & Coertze 1996: 346). In South Africa it can be divided in two separate phases according to Van der Ryst & Meyer (1999: 96-98), namely:

- Early Iron Age (EIA) 200 – 1000 A.D; and
- Late Iron Age (LIA) 1000 – 1850 A.D.

Huffman (2007: xiii) however, indicates that a Middle Iron Age should be included. His dates, which now seem to be widely accepted in archaeological circles, are:

- Early Iron Age (EIA) 250 – 900 A.D.;
- Middle Iron Age (MIA) 900 – 1300 A.D.; and
- Late Iron Age (LIA) 1300 – 1840 A.D.

Many Late Iron Age sites have been identified in the area around the towns of Brits and Rustenburg as well as in the Waterberg Mountains. This includes the surveyed area (Bergh 1999: 7-8). During earlier times the area was inhabited by Tswana groups, namely the Fokeng and Hurutshe. In the 19th century and even today, the area is inhabited by other Tswana groups, namely the Kwena, Tlokwa, Phiring, Taung and the Fokeng (Bergh 1999: 9-10). During the Difaquane these people moved further to the north and south, but they returned later on (Bergh 1999: 11).

The subterranean presence of archaeological material is something that should however always be kept in mind. It also should be realized that the area may not have been surveyed before and therefore the possibility of finding new sites is always a reality.

The type of environment is suitable for human habitation. There is ample water sources and good grazing. One would therefore expect that Iron Age people may have utilized the area. This is the same reason why white settlers later on moved into this environment.

8.3 Historical Age

The historical age began with the first recorded oral histories in the area. It includes the moving into the area of people that were literate. This era is often referred to as the Colonial era or the recent past.

Due to factors such as population growth and a decrease in mortality rates, more people inhabited the country during the recent historical past. Therefore, much more cultural heritage resources from this era have been left on the landscape. It is important to note that all cultural resources older than 60 years are potentially regarded as part of the heritage and that detailed studies are required in order to determine whether these indeed have cultural significance. Factors to be considered include aesthetic, scientific, cultural and religious value of such resources.

Early travellers have moved through this part of the Northwest Province. This included Coenraad de Buys in 1821 and 1825, David Hume in 1825, Robert Scoon and William McLuckie in 1827 and 1829 and Dr. Robert Moffat and Reverend James Archbell in 1829 (Bergh 1999: 12, 117-119).

Hume again moved through this area in 1830 followed by the expedition of Dr. Andrew Smith in 1835 (Bergh 1999: 13, 120-121). Hume again moved through the area with Scoon in 1835. In 1836 William Cornwallis Harris visited the area. The well-known explorer Dr. David Livingston passed through this area in 1847 (Bergh 1999: 13, 119-122).

In 1837 the Voortrekkers also moved through the Swartruggens area (Bergh 1999: 11), but this is much further to the west. During this year a Voortrekker commando moved out against Mzilikazi and was engaged in a battle with his impi to the north of Swartruggens. The area surveyed was inhabited by white settlers as early as 1839 (Bergh 1999: 14-15).

The greater Magaliesberg and Rustenburg area saw much action during the Anglo-Boer War (1899-1902). British troops reached Rustenburg on 14 June 1900. Three battles were fought here during the War, being the one at Buffelspoort on 3 December

1900, the one at Nooitgedacht on 13 December 1900 and the one at Vlakfontein on 29 May 1901 (Bergh 1999: 51-52).

Historical structures, such as farm houses and infrastructure may therefore be found in the larger geographical area. The surveyed area however is very flat meaning that it would not have had any military advantage and therefore it may not have been utilized for this purpose during wars.

Historical structures, such as farm houses and infrastructure relating to these times, may be found in the surveyed area. It is also possible that graves, associated with the above, may be present.

9. DISCUSSION OF SITES IDENTIFIED DURING THE SURVEY

As indicated one cultural heritage site was identified during the survey.

9.1 Site 1 - Old kraal

This is the remains of a historical livestock enclosure with a rectangular form. It has sides of approximately 8 x 12 m and is built from stone with mortar (Figure 9). It is part of a farm yard, but apart from a brick built dam, not much remains of the other structures. The kraal itself is not in a good condition.

GPS: 25°38.881'S
27°56.178'E

Figure 9: Remains of a historical cattle enclosure (kraal).

The site is regarded as having a low cultural heritage significance. It is rewarded a field rating of general protection grade C (IVC). The report is seen as ample mitigation and the site may be demolished.

10. CONCLUSION AND RECOMMENDATIONS

The survey of the indicated area was completed successfully. Only one site of cultural heritage significance was identified during the survey. It should also be indicated that a local farmer, Mr Johan Strydom, indicated that he does not know of any graves on the property.

The following is recommended:

- The site is of a low cultural significance and the report is therefore seen as ample mitigation.
- The proposed development may continue.
- It should be noted that the subterranean presence of archaeological and/or historical sites, features or artefacts is always a distinct possibility. Care should therefore be taken when development commences that if any of these are discovered, a qualified archaeologist be called in to investigate the occurrence.

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APPENDIX A

DEFINITION OF TERMS:

Site: A large place with extensive structures and related cultural objects. It can also be a large assemblage of cultural artefacts, found on a single location.

Structure: A permanent building found in isolation or which forms a site in conjunction with other structures.

Feature: A coincidental find of movable cultural objects.

Object: Artefact (cultural object).

(Also see Knudson 1978: 20).

APPENDIX B

DEFINITION/ STATEMENT OF HERITAGE SIGNIFICANCE:

Historic value:	Important in the community or pattern of history or has an association with the life or work of a person, group or organization of importance in history.
Aesthetic value:	Important in exhibiting particular aesthetic characteristics valued by a community or cultural group.
Scientific value:	Potential to yield information that will contribute to an understanding of natural or cultural history or is important in demonstrating a high degree of creative or technical achievement of a particular period
Social value:	Have a strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.
Rarity:	Does it possess uncommon, rare or endangered aspects of natural or cultural heritage.
Representivity:	Important in demonstrating the principal characteristics of a particular class of natural or cultural places or object or a range of landscapes or environments characteristic of its class or of human activities (including way of life, philosophy, custom, process, land-use, function, design or technique) in the environment of the nation, province region or locality.

APPENDIX C

SIGNIFICANCE AND FIELD RATING:

Cultural significance:

- Low	A cultural object being found out of context, not being part of a site or without any related feature/structure in its surroundings.
- Medium	Any site, structure or feature being regarded less important due to a number of factors, such as date and frequency. Also any important object found out of context.
- High	Any site, structure or feature regarded as important because of its age or uniqueness. Graves are always categorized as of a high importance. Also any important object found within a specific context.

Heritage significance:

- Grade I	Heritage resources with exceptional qualities to the extent that they are of national significance
- Grade II	Heritage resources with qualities giving it provincial or regional importance although it may form part of the national estate
- Grade III	Other heritage resources of local importance and therefore worthy of conservation

Field ratings:

i.	National Grade I significance	should be managed as part of the national estate
ii.	Provincial Grade II significance	should be managed as part of the provincial estate
iii.	Local Grade IIIA	should be included in the heritage register and not be mitigated (high significance)
iv.	Local Grade IIIB	should be included in the heritage register and may be mitigated (high/ medium significance)
v.	General protection A (IV A)	site should be mitigated before destruction (high/ medium significance)
vi.	General protection B (IV B)	site should be recorded before destruction (medium significance)
vii.	General protection C (IV C)	phase 1 is seen as sufficient recording and it may be demolished (low significance)

APPENDIX D

PROTECTION OF HERITAGE RESOURCES:

Formal protection:

National heritage sites and Provincial heritage sites – grade I and II
Protected areas - an area surrounding a heritage site
Provisional protection – for a maximum period of two years
Heritage registers – listing grades II and III
Heritage areas – areas with more than one heritage site included
Heritage objects – e.g. archaeological, paleontological, meteorites, geological specimens, visual art, military, numismatic, books, etc.

General protection:

Objects protected by the laws of foreign states
Structures – older than 60 years
Archaeology, paleontology and meteorites
Burial grounds and graves
Public monuments and memorials

APPENDIX E

HERITAGE IMPACT ASSESSMENT PHASES

1. Pre-assessment or scoping phase – establishment of the scope of the project and terms of reference.
2. Baseline assessment – establishment of a broad framework of the potential heritage of an area.
3. Phase I impact assessment – identifying sites, assess their significance, make comments on the impact of the development and makes recommendations for mitigation or conservation.
4. Letter of recommendation for exemption – if there is no likelihood that any sites will be impacted.
5. Phase II mitigation or rescue – planning for the protection of significant sites or sampling through excavation or collection (after receiving a permit) of sites that may be lost.
6. Phase III management plan – for rare cases where sites are so important that development cannot be allowed.

PHASE 1 HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED Q4 FILLING STATION SOUTH ON PORTION 41 OF THE FARM SCHIETFONTEIN SITUATED ON THE N4 CLOSE TO BRITS IN THE NORTH WEST PROVINCE

Archaetnos Archaeologists and Heritage Consultants Dr A.C. van Vollenhoven PO Box 55 GROENKLOOF 0027 Mobile: 083 291 6104 E-mail: antonv@archaetnos.co.za	Leonie Marais-Botes Heritage Practitioner 868 Endeman Street Wonderboom South Pretoria 0084 Mobile: 082 576 6253 E-mail: leoniembotes@gmail.com
BA, BA (Hons), DTO, NDM, MA (Archaeology) [UP], MA (Culture History) [US], DPhil (Archaeology) [UP], Man Dip [TUT], DPhil (History)[US], L Akad [SA]	*BA (Cultural History and Archaeology) (UP), BA (Hons) Cultural History (UP), Post Grad Dip Museology (UP), Cert Conservation of Traditional Buildings (Univ of Canberra) Post Grad Dip: Heritage (Wits)*
Accredited member: SA Society for Cultural History (CH001) *Accredited member: ASAPA* REPORT NO.: AE01440V	*Accredited member: SA Society for Cultural History (CH002)*

For:

Bokamoso Environmental
PO Box 11375
MAROELANA
0161

REPORT: 01440V

May 2014

SUBMISSION OF REPORT

Please note that the South African Heritage Resources Agency (SAHRA) or one of its subsidiary bodies needs to comment on this report.

It is the client's responsibility to do the submission via the SAHRIS System on the SAHRA website.

Clients are advised not to proceed with any action before receiving the necessary comments from SAHRA.

DISCLAIMER

Although all possible care is taken to identify all sites of cultural importance during the survey of study areas, the nature of archaeological and historical sites are as such that it always is possible that hidden or subterranean sites could be overlooked during the study. Leonie Marais-Botes/Archaetnos CC and its personnel will not be held liable for such oversights or for costs incurred as a result thereof.

SUMMARY

Leonie Marais-Botes/Archaetnos CC was requested by Bokamoso Environmental to conduct a Phase 1 Heritage Impact Assessment (HIA) for the Q4 City South filling station on Portion 41 of the Farm Schietfontein 41 JQ. This is on the N4, close to Brits in the Northwest Province.

A survey of the available literature was undertaken in order to obtain background information regarding the proposed project area and the surrounding environment. This was followed by the field survey which was conducted according to generally accepted HIA practices.

No sites were identified during the survey. Therefore the report is seen as ample mitigation. The proposed development may continue.

It should be noted however that the subterranean presence of archaeological and/or historical sites, features or artefacts is always a possibility. As such, care should be taken during any work in the entire area, that if any historical sites, features or artefacts are discovered, a qualified archaeologist should be commissioned to investigate.

It is also important to take cognisance of the applicant's responsibility to submit this report via the SAHRIS System on the South African Heritage Resource Agency (SAHRA) website. No work on site may commence before receiving the necessary comments from the SAHRA.

CONTENTS

1. INTRODUCTION

Leonie Marais-Botes/Archaetnos CC was requested by Bokamoso Environmental to conduct a Heritage Impact Assessment (HIA) for the Q4 City South filling station. This is on the N4, close to Brits in the Northwest Province (Figure 1-3).

The client indicated the area to be surveyed. It was surveyed by means of an off road vehicle and a foot survey.

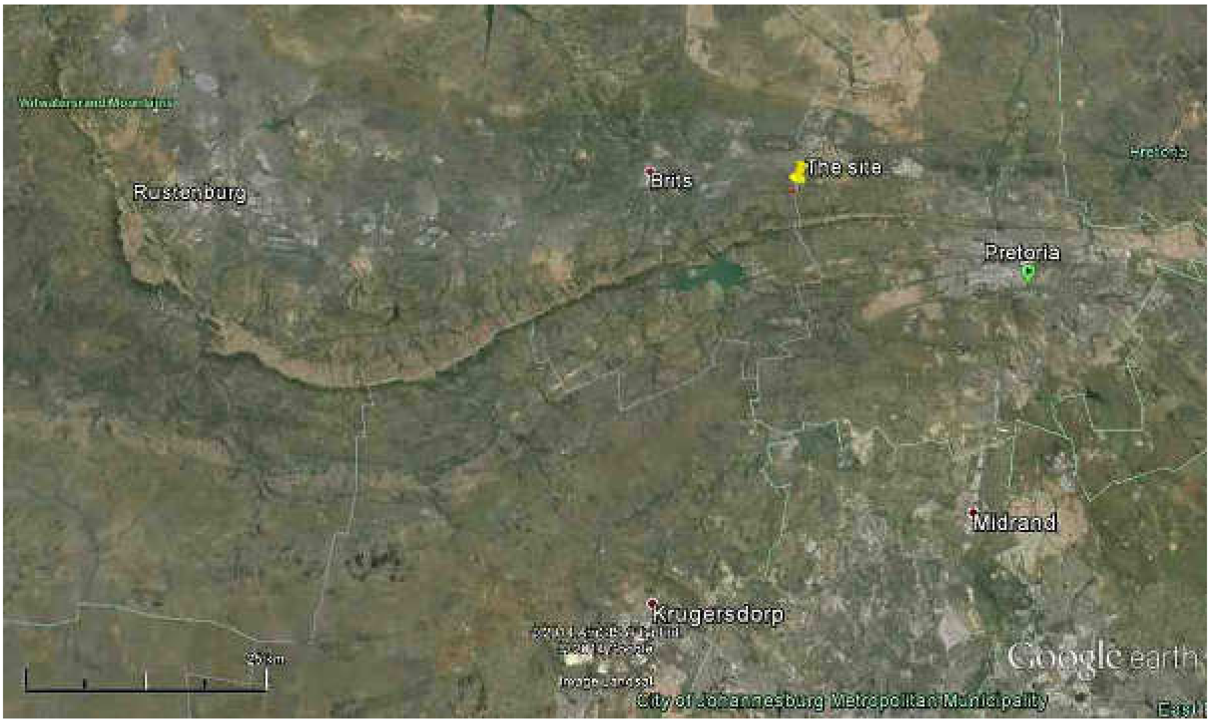

Figure 1: Location of Brits in the Northwest Province. North reference is to the top.

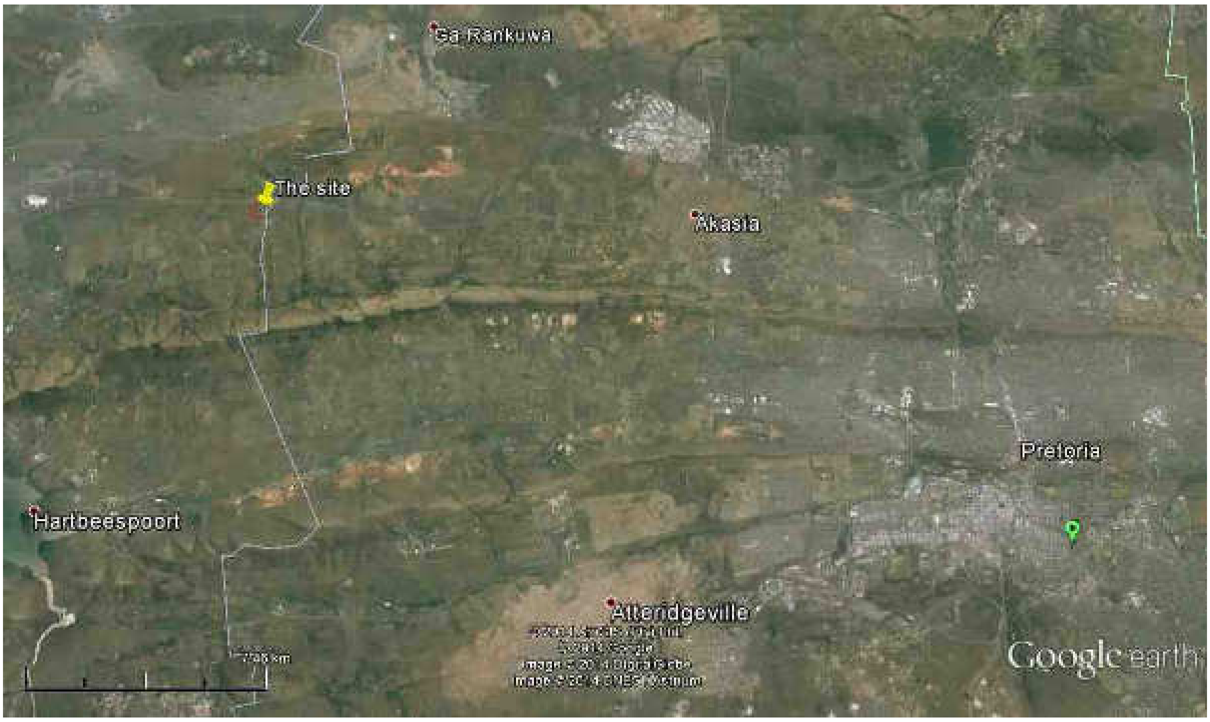

Figure 2: Location of the surveyed site, close to Brits. North reference is to the top.

Figure 3: Google image indicating the site boundary. North reference is to the top.

2. TERMS OF REFERENCE

The Terms of Reference for the survey were to:

1. Identify objects, sites, occurrences and structures of an archaeological or historical nature (cultural heritage sites) located on the property (see Appendix A).

2. Study background information on the area to be developed.

3. Assess the significance of the cultural resources in terms of their archaeological, historical, scientific, social, religious, aesthetic and tourism value (see Appendix B).

4. Describe the possible impact of the proposed development on these cultural remains, according to a standard set of conventions.

5. Recommend suitable mitigation measures to minimize possible negative impacts on the cultural resources by the proposed development.

6. Review applicable legislative requirements.

3. CONDITIONS & ASSUMPTIONS

The following conditions and assumptions have a direct bearing on the survey and the resulting report:

1. Cultural Resources are all non-physical and physical man-made occurrences, as well as natural occurrences associated with human activity (Appendix A). These include all sites, structure and artefacts of importance, either individually or in groups, in the history, architecture and archaeology of human (cultural) development. Graves and cemeteries are included in this.

2. The significance of the sites, structures and artefacts is determined by means of their historical, social, aesthetic, technological and scientific value in relation to their uniqueness, condition of preservation and research potential. The various aspects are not mutually exclusive, and the evaluation of any site is done with reference to any number of these aspects.

3. Cultural significance is site-specific and relates to the content and context of the site. Sites regarded as having low cultural significance have already been recorded in full and require no further mitigation. Sites with medium cultural significance may or may not require mitigation depending on other factors such as the significance of impact on the site. Sites with a high cultural significance require further mitigation (see Appendix C).

4. The latitude and longitude of any archaeological or historical site or feature, is to be treated as sensitive information by the developer and should not be disclosed to members of the public.

5. All recommendations are made with full cognizance of the relevant legislation.

6. It has to be mentioned that it is almost impossible to locate all the cultural resources in a given area, as it will be very time consuming. Developers should however note that the report should make it clear how to handle any other finds that might occur.

7. In this case there were certain areas where the vegetation cover was medium to high in length and the under footing was reasonably dense which had a negative effect on archaeological visibility.

4. LEGISLATIVE REQUIREMENTS

Aspects concerning the conservation of cultural resources are dealt with primarily through two Acts, namely the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

4.1 The National Heritage Resources Act

According to the National Heritage Resources Act (NHRA) the following are considered protected as heritage resources:

a. Archaeological artefacts, structures and sites older than 100 years;
b. Ethnographic art objects (e.g. prehistoric rock art) and ethnography;
c. Objects of decorative and visual arts;
d. Military objects, structures and sites older than 75 years;
e. Historical objects, structures and sites older than 60 years;
f. Proclaimed heritage sites;
g. Grave yards and graves older than 60 years;
h. Meteorites and fossils; and
i. Objects, structures and sites or scientific or technological value.

The national estate (see Appendix D) includes the following:

a. Places, buildings, structures and equipment of cultural significance;
b. Places to which oral traditions are attached or which are associated with living heritage;
c. Historical settlements and townscapes;
d. Landscapes and features of cultural significance;
e. Geological sites of scientific or cultural importance;
f. Archaeological and paleontological importance;
g. Graves and burial grounds;
h. Sites of significance relating to the history of slavery; and
i. Movable objects (e.g. archaeological, paleontological, meteorites, geological specimens, military, ethnographic, books etc.).

An HIA is the process to be followed in order to determine whether any heritage resources are located within the area proposed for development as well as the potential impact of the proposed development thereon. An Archaeological Impact Assessment only looks at archaeological resources. The different phases of the HIA process are described further in Appendix E. An HIA should be undertaken under the following circumstances:

a. The construction of a linear development (road, wall, power line canal etc.) exceeding 300m in length;
b. The construction of a bridge or similar structure exceeding 50m in length;
c. Any development or other activity that will change the character of a site and exceed 5 000m^2 or involve three or more existing erven or subdivisions thereof;
d. Re-zoning of a site exceeding 10 000 m^2; and
e. Any other category provided for in the regulations of South African Heritage Resource Agency (SAHRA) or a provincial heritage authority.

Structures

Section 34 (1) of the mentioned act states that no person may demolish any structure or part thereof which is older than 60 years without a permit issued by the relevant provincial heritage resources authority.

The act defines a structure as any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith.

According to the act alter means any action affecting the structure, appearance or physical properties of a place or object, whether by way of structural or other works, by painting, plastering or the decoration or any other means.

Archaeology, palaeontology and meteorites

Section 35(4) of this act deals with archaeology, palaeontology and meteorites. The NHRA states that no person may, without a permit issued by the responsible heritage resources authority (national or provincial):

a. Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or paleontological site or any meteorite;
b. Destroy, damage, excavate, remove from its original position, collect or own any archaeological or paleontological material or object or any meteorite;
c. Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or paleontological material or object, or any meteorite;
d. Bring onto or use at an archaeological or paleontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and paleontological material or objects, or use such equipment for the recovery of meteorites; and/or
e. Alter or demolish any structure or part of a structure which is older than 60 years as protected.

The above mentioned may only be disturbed or moved by a registered archaeologist, after receiving a permit from the SAHRA. In order to demolish such a site or structure, a destruction permit from SAHRA is required.

<u>Human remains</u>

Graves and burial grounds are divided into the following:

a. Ancestral graves;
b. Royal graves and graves of traditional leaders,;
c. Graves of victims of conflict;
d. Graves designated by the Minister;
e. Historical graves and cemeteries; and
f. Human remains.

In terms of Section 36(3) of the NHRA, no person may, without a permit issued by the SAHRA:

a. Destroy, damage, alter, exhume or remove from its original position of otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
b. Destroy, damage, alter, exhume or remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; and/or
c. Bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation, or any equipment which assists in the detection or recovery of metals.

Unidentified/unknown graves are also handled as older than 60 until proven otherwise.

Human remains that are less than 60 years old are subject to provisions of the Human Tissue Act (Act 65 of 1983) (HTA) and to local regulations. Exhumation of graves must conform to the standards set out in the **Ordinance on Excavations** (**Ordinance no. 12 of 1980**) (replacing the old Transvaal Ordinance no. 7 of 1925).

Permission must also be gained from the descendants (where known), the National Department of Health, Provincial Department of Health, Premier of the Province and local police. Furthermore, permission must also be gained from the various landowners (i.e. where the graves are located and where they are to be relocated) before exhumation can take place. Human remains can only be handled by a registered undertaker or an institution declared under the **HTA**.

4.2 The National Environmental Management Act

The National Environmental Management Act (Act 107 of 1998) states that a survey and evaluation of cultural resources must be done in areas where development projects, that will change the face of the environment, will be undertaken. The impact of the development on these resources should be determined and proposals for the mitigation thereof are made.

Environmental management should also take the cultural and social needs of people into account. Any disturbance of landscapes and sites that constitute the nation's cultural heritage should be avoided as far as possible and where this is not possible the disturbance should be minimised and remedied.

5. THE INTERNATIONAL FINANCE CORPORATIONS' PERFORMANCE STANDARD FOR CULTURAL HERITAGE

This standard recognizes the importance of cultural heritage for current and future generations. It aims to ensure that clients protect cultural heritage in the course of their project activities.

This is done by clients abiding to the law and having heritage surveys done in order to identify and protect cultural heritage resources via field studies and the documentation of such resources. These need to be done by competent professionals (e.g. archaeologists and cultural historians). Possible chance finds, encountered during the project development, also needs to be managed by not disturbing it and by having it assessed by professionals.

Impacts on the cultural heritage should be minimized. This include the possible maintenance of such sites in situ, or when impossible, the restoration of the functionality of the cultural heritage in a different location. When cultural historical and archaeological artefacts and structures need to be removed is should be done by professionals and by abiding to the applicable legislation. The removal of cultural heritage resources may however only be considered if there are no technically or financially feasible alternatives. In considering the removal of cultural resources, it should be outweighed by the benefits of the overall project to the effected communities. Again professionals should carry out the work and adhere to the best available techniques.

It is necessary to engage into consultation with affected communities. This entails that access to such communities should be granted to their cultural heritage if this is applicable. Compensation for the loss of cultural heritage should only be given in extra-ordinary circumstances.

Critical cultural heritage may not be impacted on. Professionals should be used to advise on the assessment and protection thereof. Utilization of cultural heritage resources should always be done in consultation with the effected communities in order to be consistent with their customs and traditions and to come to agreements with relation to possible equitable sharing of benefits from commercialization.

6. METHODOLOGY

6.1 Survey of literature

A review of literature was undertaken in order to obtain background information regarding the area. Sources consulted in this regard are indicated in the list of references.

6.2 Field survey

The survey was conducted according to generally accepted HIA practices. However, it was not aimed at locating all possible objects, sites and features of cultural significance in the area in which the Project is proposed as known sites, identified during a previous survey had to visited and re-assessed.

If required, the location/position of any objects, sites and features of cultural significance was determined by means of a Global Positioning System (GPS)[1], while photographs were also taken where needed. The site survey was undertaken by means of a foot survey and using an off-road vehicle (Figure 4). The size of the surveyed area is approximately 6 Ha and took two hours to complete.

Figure 4: GPS track of the surveyed area.

6.3 Oral histories

People from local communities are interviewed in order to obtain information relating to the surveyed area. However, it should be understood that this is activity is not

[1] A Garmin Oregon 550 with an accuracy factor of between 3 and 5 meters.

required under all circumstances as it only comes to the fore once a specific community is directly involved. When applicable, this information obtained is included in the report write-up and linked to the information sources.

6.4 Documentation

All sites, objects features and structures identified are documented according to the general minimum standards accepted by the archaeological profession. This includes photographic documentation, description of the sites and taking GPS co-ordinates.

6.5 Evaluation of Heritage sites

The evaluation of heritage sites is undertaken by applying a field rating to each (see Appendix C) using the following criteria:

- The unique nature of a site;
- The integrity of the archaeological deposit;
- The wider historic, archaeological and geographic context of the site;
- The location of the site in relation to other similar sites or features;
- The depth of the archaeological deposit (when it can be determined or is known);
- The preservation condition of the site;
- Uniqueness of the site; and
- Potential to answer present research questions.

7. DESCRIPTION OF THE ENVIRONMENT

The proposed area to be developed is located on portion 41 of the farm Schietfontein 437 JQ. Many signs of disturbance by agricultural means are present. This mainly includes old fields and roads. A lodge, including huts, offices and a boma is also situated on the property.

The vegetation cover in general consists of grass cover of medium to high length with a dense under footing. The existence of pioneer species such as grass and weeds indicate former disturbance (Figure 5-6). Only a few trees were seen, mostly concentrated around the lodge area. Accordingly the archaeological visibility is influenced negatively. The site is bordered by the N4 highway in the north, a provincial road in the west, a farm road in the south and a river on the east which also forms the boundary between the Northwest and Gauteng Provinces.

The topography of the area is reasonably flat. As indicated a small river is found towards the east.

Figure 5: General view of the surveyed area.

Figure 6: Another view of vegetation in the surveyed area.

8. HISTORICAL CONTEXT

In order to place possible finds that could be unearthed during construction activities, in context, it is necessary to give a background regarding the different phases of human history.

8.1 Stone Age

The Stone Age is the period in human history when lithic material was mainly used to produce tools (Coertze & Coertze 1996: 293). In South Africa the Stone Age can be divided in three periods. It is, however, important to note that dates are relative and only provide a broad framework for interpretation. The division for the Stone Age according to Korsman & Meyer (1999: 93-94) is as follows:

- Early Stone Age (ESA) 2 million – 150 000 years ago;
- Middle Stone Age (MSA) 150 000 – 30 000 years ago; and
- Late Stone Age (LSA) 40 000 years ago – 1850 - A.D.

The closest known Stone Age site in the vicinity of Brits is a rock art site to the northwest. Rock engravings are found to the south and east of Rustenburg (the latter lying to the west of the surveyed area). These date back to the Late Stone Age (Bergh 1999: 5).

Although no natural shelter was identified during the survey, the close proximity to a river makes the area very suitable for human habitation. The area probably provided good grazing and therefore it is possible that Stone Age people may have utilized the site for hunting purposes. One may therefore find Stone Age material lying around in the area.

8.2 Iron Age

The Iron Age is the name given to the period of human history when metal was mainly used to produce metal artefacts (Coertze & Coertze 1996: 346). In South Africa it can be divided in two separate phases according to Van der Ryst & Meyer (1999: 96-98), namely:

- Early Iron Age (EIA) 200 – 1000 A.D; and
- Late Iron Age (LIA) 1000 – 1850 A.D.

Huffman (2007: xiii) however, indicates that a Middle Iron Age should be included. His dates, which now seem to be widely accepted in archaeological circles, are:

- Early Iron Age (EIA) 250 – 900 A.D.;
- Middle Iron Age (MIA) 900 – 1300 A.D.; and
- Late Iron Age (LIA) 1300 – 1840 A.D.

Many Late Iron Age sites have been identified in the area around the towns of Brits and Rustenburg as well as in the Waterberg Mountains. This includes the surveyed area (Bergh 1999: 7-8). During earlier times the area was inhabited by Tswana groups, namely the Fokeng and Hurutshe. In the 19th century and even today, the area is inhabited by other Tswana groups, namely the Kwena, Tlokwa, Phiring, Taung and the Fokeng (Bergh 1999: 9-10). During the Difaquane these people moved further to the north and south, but they returned later on (Bergh 1999: 11).

The subterranean presence of archaeological material is something that should however always be kept in mind. It also should be realized that the area may not have been surveyed before and therefore the possibility of finding new sites is always a reality.

The type of environment is suitable for human habitation. There is ample water sources and good grazing. One would therefore expect that Iron Age people may have utilized the area. This is the same reason why white settlers later on moved into this environment.

8.3 Historical Age

The historical age began with the first recorded oral histories in the area. It includes the moving into the area of people that were literate. This era is often referred to as the Colonial era or the recent past.

Due to factors such as population growth and a decrease in mortality rates, more people inhabited the country during the recent historical past. Therefore, much more cultural heritage resources from this era have been left on the landscape. It is important to note that all cultural resources older than 60 years are potentially regarded as part of the heritage and that detailed studies are required in order to determine whether these indeed have cultural significance. Factors to be considered include aesthetic, scientific, cultural and religious value of such resources.

Early travellers have moved through this part of the Northwest Province. This included Coenraad de Buys in 1821 and 1825, David Hume in 1825, Robert Scoon and William McLuckie in 1827 and 1829 and Dr. Robert Moffat and Reverend James Archbell in 1829 (Bergh 1999: 12, 117-119).

Hume again moved through this area in 1830 followed by the expedition of Dr. Andrew Smith in 1835 (Bergh 1999: 13, 120-121). Hume again moved through the area with Scoon in 1835. In 1836 William Cornwallis Harris visited the area. The well-known explorer Dr. David Livingston passed through this area in 1847 (Bergh 1999: 13, 119-122).

In 1837 the Voortrekkers also moved through the Swartruggens area (Bergh 1999: 11), but this is much further to the west. During this year a Voortrekker commando moved out against Mzilikazi and was engaged in a battle with his impi to the north of Swartruggens. The area surveyed was inhabited by white settlers as early as 1839 (Bergh 1999: 14-15).

The greater Magaliesberg and Rustenburg area saw much action during the Anglo-Boer War (1899-1902). British troops reached Rustenburg on 14 June 1900. Three battles were fought here during the War, being the one at Buffelspoort on 3 December

1900, the one at Nooitgedacht on 13 December 1900 and the one at Vlakfontein on 29 May 1901 (Bergh 1999: 51-52).

Historical structures, such as farm houses and infrastructure may therefore be found in the larger geographical area. The surveyed area however is very flat meaning that it would not have had any military advantage and therefore it may not have been utilized for this purpose during wars.

Historical structures, such as farm houses and infrastructure relating to these times, may be found in the surveyed area. It is also possible that graves, associated with the above, may be present.

9. IMPACT ASSESSMENT

Since no sites of cultural heritage significance were identified, no impact is to be expected. Farm workers also indicated that there are no graves on the property.

10. CONCLUSION AND RECOMMENDATIONS

The survey of the indicated area was completed successfully. No sites of cultural heritage significance were identified during the survey.

The following is recommended:

- The report is seen as ample mitigation.
- The proposed development may continue.
- It should be noted that the subterranean presence of archaeological and/or historical sites, features or artefacts is always a distinct possibility. Care should therefore be taken when development commences that if any of these are discovered, a qualified archaeologist be called in to investigate the occurrence.

11. REFERENCES

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APPENDIX A

DEFINITION OF TERMS:

Site: A large place with extensive structures and related cultural objects. It can also be a large assemblage of cultural artefacts, found on a single location.

Structure: A permanent building found in isolation or which forms a site in conjunction with other structures.

Feature: A coincidental find of movable cultural objects.

Object: Artefact (cultural object).

(Also see Knudson 1978: 20).

APPENDIX B

DEFINITION/ STATEMENT OF HERITAGE SIGNIFICANCE:

Historic value:	Important in the community or pattern of history or has an association with the life or work of a person, group or organization of importance in history.
Aesthetic value:	Important in exhibiting particular aesthetic characteristics valued by a community or cultural group.
Scientific value:	Potential to yield information that will contribute to an understanding of natural or cultural history or is important in demonstrating a high degree of creative or technical achievement of a particular period
Social value:	Have a strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.
Rarity:	Does it possess uncommon, rare or endangered aspects of natural or cultural heritage.
Representivity:	Important in demonstrating the principal characteristics of a particular class of natural or cultural places or object or a range of landscapes or environments characteristic of its class or of human activities (including way of life, philosophy, custom, process, land-use, function, design or technique) in the environment of the nation, province region or locality.

APPENDIX C

SIGNIFICANCE AND FIELD RATING:

Cultural significance:

- Low	A cultural object being found out of context, not being part of a site or without any related feature/structure in its surroundings.
- Medium	Any site, structure or feature being regarded less important due to a number of factors, such as date and frequency. Also any important object found out of context.
- High	Any site, structure or feature regarded as important because of its age or uniqueness. Graves are always categorized as of a high importance. Also any important object found within a specific context.

Heritage significance:

- Grade I	Heritage resources with exceptional qualities to the extent that they are of national significance
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Field ratings:

i. National Grade I significance	should be managed as part of the national estate
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iii. Local Grade IIIA	should be included in the heritage register and not be mitigated (high significance)
iv. Local Grade IIIB	should be included in the heritage register and may be mitigated (high/ medium significance)
v. General protection A (IV A)	site should be mitigated before destruction (high/ medium significance)
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6. Phase III management plan – for rare cases where sites are so important that development cannot be allowed.

Town Planning Memorandums

Annexure F6

MEMORANDUM

APPLICATION FOR THE ESTABLISHMENT OF A TOWNSHIP IN TERMS OF SECTION 96 OF THE TOWN PLANNING AND TOWNSHIPS ORDINANCE 15 OF 1986

PROPERTY:

Part of the Remainder of Portion 22 (Portion of Portion 2) of the farm Schietfontein 437 JQ

TOWNSHIP NAME

Q4 CITY

VAN ZYL & BENADE
TOWN- AND REGIONAL PLANNERS
STADS- EN STREEKBEPLANNERS

1. INTRODUCTION

Instruction has been received from the owner of the Remainder of Portion 22 and the Remainder of Portion 41 of the farm Schietfontein 437 JQ to apply to the relevant authorities for the establishment of a township(s) on parts of the properties.

During our pre-application discussions the planning officials of the Madibeng Local Municipality insisted that two separate applications, one on each property, be submitted instead of one application. This application should therefore be considered/evaluated together with the application for the establishment of Q4 City Extension 1 on part of the Remainder of Portion 41 of the farm Schietfontein. Some of the technical and specialist reports attached to the application have been done for both sites and should be read with this in mind.

A Resolution and Power of Attorney from the registered owner are attached for information.

The primary goal of the application is to establish a township providing for a filling station and service area and purposes incidental thereto on the property.

2. PARTICULARS OF THE PROPERTY

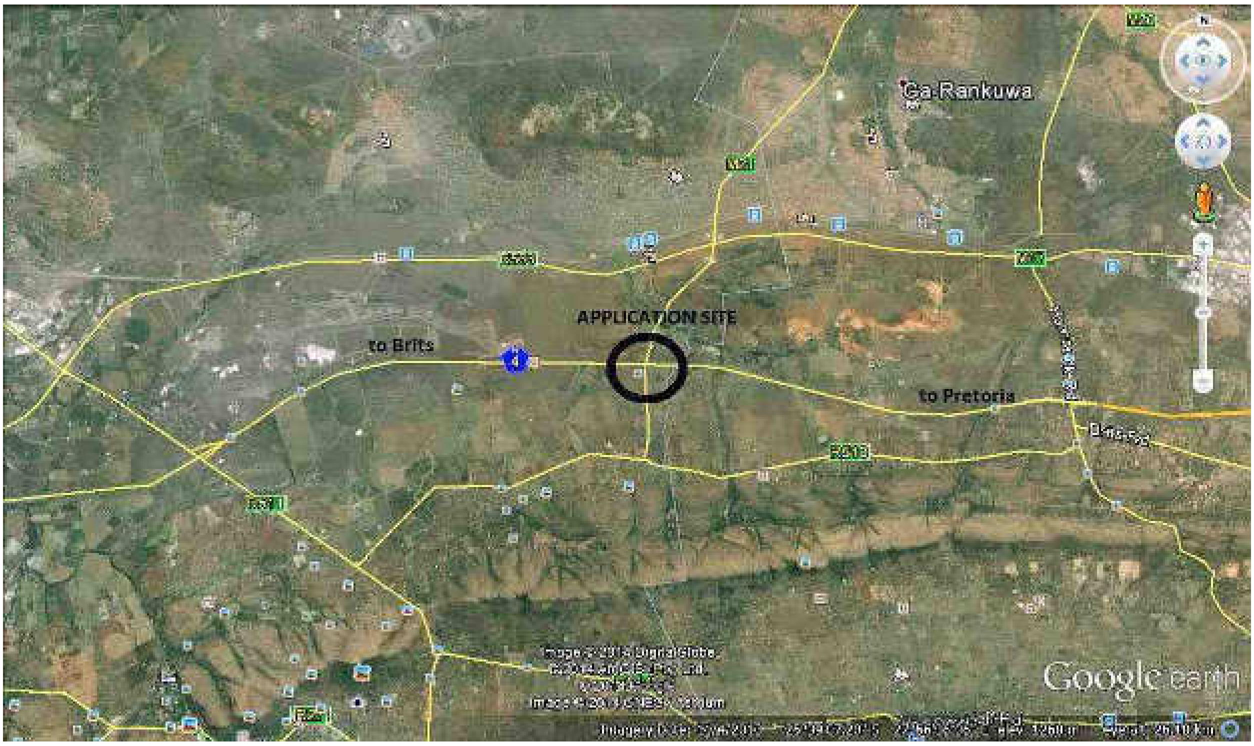
Description	The township is to be established on part of the Remainder of Portion 22 (a Portion of Portion 2) of the farm Schietfontein 437 JQ.
Owner	The property is registered in the name of Q4COMMERCIAL-PROPERTIES (PTY) LTD.
Area	Although the Remainder of Portion 22 is 63,0746 ha in extent the township will be established on only ±7,55 ha of the property.
Bond	A bond is registered against the property and the consent of the bondholder is attached.
Local Authority	The property is situated within the area of jurisdiction of the Madibeng Local Municipality.

3. LOCALITY

The property is located on the N-4 Highway, in the north/western quadrant of the interchange with the Garankuwa Road (Road D2726, planned K-25), approximately 17 km east of Brits and ±2,5 km east of the Brits Toll Plaza.

The locality of the application site complies with the minimum SANRAL requirement of 30km for facilities that serve traffic in the range of 5 000 – 50 000 vehicles per day.

The locality is indicated on the image below.



The locality of the application site is ideal to cater for the passing traffic on the N-4 Highway.

4. TOWN PLANNING SCHEME

The property is zoned Undetermined in terms of the Peri-Urban Areas Town Planning Scheme, 1975.

5. TITLE DEED

The Remainder of Portion 22 is held under Deed of Transfer T26882/2014. A copy of the Deed of Transfer is attached.

Conveyancer's and landsurveyor's reports are attached to the application for information.

No conditions are registered against the property.

According to the reports no conditions are registered against the property that prohibits the opening of a township register.

A bond is registered over the property in favour of Standard Bank. The applicable Continuing Mortgage Bond is attached.

6. PROPOSED DEVELOPMENT

It is envisaged to develop a filling station and service area on both sides of the N-4 Highway as indicated on the accompanied layout plan of the township. The primary goal of the filling station and service area is to cater for the passing traffic on the N-4 Highway.

For the purpose of this memorandum a filling station and service area is *"a rest/service area, travel plaza, rest stop, or service area for the travelling public, located next to a main road such as a highway or freeway at which drivers and passengers can rest, eat, and/or refuel without* *exiting onto secondary roads. Facilities may include fuel stations, convenient shop, restaurants, truck stops and uses related thereto."*

The proposed development will provide for the following facilities (see attached site plan):

FACILITY	**FLOOR AREA (m^2)**	**COVERAGE (m^2)**
Fuel Sales (Forecourt)		494
Shop (Convenience Store)	285	285
Restaurant and Take-aways	387	387
Public Areas (Ablutions)	139	139
Service Areas	104	104
Staff Ablutions	99	99
Truck stop (Canteen and Kitchen)	213	213
Truck stop (ablutions)	116	116
Managers Residential Units	154	154
TOTAL	**1 497**	**1 991**

In the light of the above the following zoning and development control measures are proposed for the township:

Erven 1 and 2

Zoning	Special
Land uses	Filling station and service area and purposes incidental thereto.
Definition	For the purpose of this scheme a filling station and service area shall mean the storage and retail selling of vehicle fuels and lubricants; working bay for emergency repairs to vehicles; shop/convenience store; restaurant; confectionary; place of refreshment; take-away facility and drive-thru facility; automatic teller machines; administrative offices; ablution facilities; and refuse/service yard, and shall include a parking site for buses and trucks including a canteen and kitchen and two residential units for management.
Height	1 storey
FAR	0,05 provided that the total floor area of all buildings shall not exceed 1 600m².
Coverage	5%
Parking	Parking shall be provided on the site to the satisfaction of the Municipality and SANRAL. The following minimum parking shall be provided: Parking for light vehicles: 120 bays Parking for buses: 5 bays Parking for heavy vehicles: 35 bays
Building lines	N4: 20 m Provincial Road: 16 m All other boundaries: In accordance with the approved Site Development Plan.
Access	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of SANRAL and the Municipality.
Landscaping	To the satisfaction of the local authority.
Loading facilities	To the satisfaction of the local authority.
Physical barriers	To the satisfaction of the local authority.

Detail of the development controls are set out in the attached draft conditions of establishment. We will mainly refer in this memorandum to the development as a filling station and service area with the understanding that it will have the meaning as set out in the definition above and entails the full development.

Although the two filling stations and service areas (Q-4 City and Q-4 City Extension 1) will be developed simultaneously and could be regarded as a single project the planners of the local authority insisted that two applications be submitted, one on each property either side of the

N-4. It is subsequently important that the two applications should be considered together. Please note that some of the specialist reports have been compiled for the project as a whole and should be read and considered as also being applicable to the individual applications.

A site plan of the proposed filling station and service area is attached to the application for information.

7. PLANNING POLICIES

MADIBENG SPATIAL DEVELOPMENT FRAMEWORK 2009

This document has been handed to us by the planning officials of the local municipality as the official approved SDF for Madibeng.

In terms of this document the application property is earmarked as "Mining Focus Area" which in essence acknowledges the importance of mining in the area and accordingly specific provision has been made in the SDF to accommodate mining development at the source. The SDF is inserted below for easy reference.

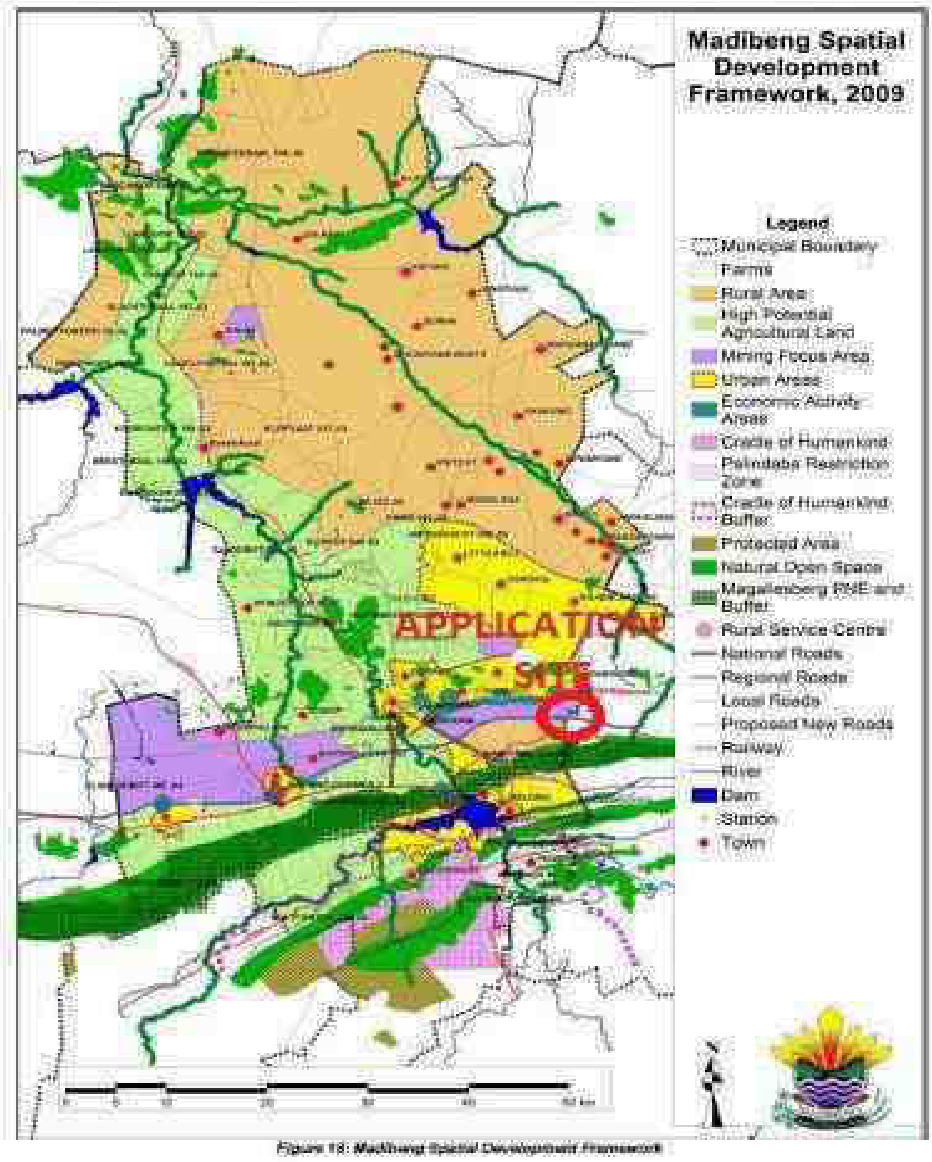


Figure 18: Madibeng Spatial Development Framework

The Bakwena Highway (N-4) is one of the elements identified which influence spatial development in Madibeng. The highway increases accessibility to Madibeng, especially between Tshwane and Rustenburg. According to the SDF this route provides the municipality with a number of development opportunities, especially at the points of access to Madibeng.

The Bakwena Highway has also been identified as an economic corridor which, according to the SDF, presents a degree of economic development potential.

Individual and detailed land uses such as filling stations are not addressed on SDF level and should be evaluated on its merits and on town planning principles.

It is our submission that the application is not inconsistent with the proposals of the Madibeng SDF.

8. NEED

The need for an application is determined by the demand for the land use in a given area.

The establishment of business enterprises along highways is driven mainly by market forces and in the case of filling station and service area specifically by the vehicular traffic passing the site. Retailers and developers will consider and invest in locations where profits are to be generated and sustained. The subject property is such a site mainly due to:
- The locality of the site
- The visibility of the site
- The accessibility of the site
- Existing and future traffic volumes passing the site.

A Traffic Report and Financial Viability Investigation for the filling station and service area have been done by Techworld Consulting Engineers. The following aspects of the study are highlighted:
- The application sites are located ±30 km from the ENGEN Doornpoort One-Stop in the east and ±33 km from the TOTAL Magalies Petroport in the west, subsequently complying with the SANRAL policy guideline of 30km minimum spacing between facilities.
- The location and spacing of existing facilities is a practical indication of the requirement for viability; i.e. combination of spacing, prevailing traffic demand, layout and cost. Based on these factors it is expected that the planned filling station and service area will be financially viable.
- Although the primary income for service facilities along highways is obtained from fuel sales, income is also derived from the convenience shop and the restaurant/fast food.
- The expected fuel sales from the operational date will be approximately 900 000 litres per month

The study concluded that the proposed filling station and service area are both technically and financially viable, and that it is unlikely that the application will impact detrimentally on the sustainability of existing facilities in the area and corridor.

Apart from fuel sales the filling station and service area also provide express convenience shopping for the commuters and passing trade. The retail facility consist of a store (285m²) offering a variety of mainly daily consumer goods. A restaurant, take-away and bakery facilities (387m²) will also be offered for consumption on and off the site. These facilities will be operated on a 24-hour basis. According to the investigation by Techworld the convenience store restaurant and take-away will result in substantial complimentary revenue.

The planned development will provide convenient fuel, food, goods, rest area, restrooms (ablution) facilities and services to road users along the N4 Highway. These services will be provided to the occupants of both light and heavy vehicles.

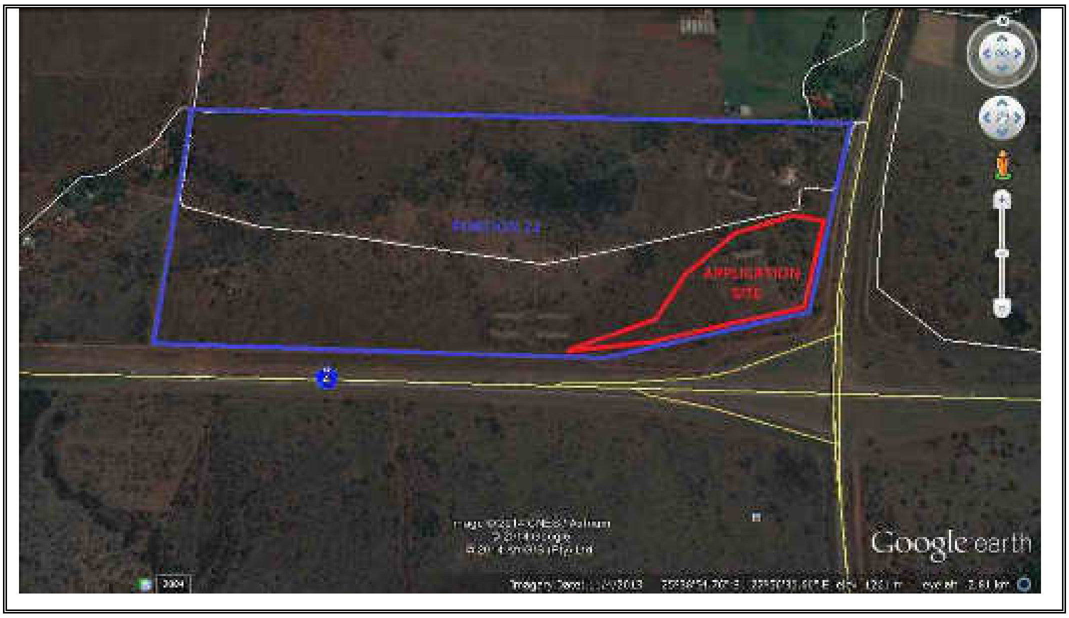
Overnight parking facilities will be provided to trucks. The need for overnight facilities is indicated by the large number of trucks that currently overnight along the N4 at the Brits Toll Plaza and the number of trucks passing the site daily.

The two residential units for management are needed for managerial reasons to conduct proper management control and supervision over the operation of the activities. On site security will also be enhanced with the provision of permanent accommodation facilities on the property. Housing is not readily and conveniently available close to the application site hence the need to provide the two residential units on site.

9. DESIRABILITY

9.1 Site Evaluation

As mentioned in the report only ±7,550 ha of the total area of 63,075 ha will be used for the proposed development. The township area in relation to the rest of the property is indicated on the image below.



With the evaluation of the site it is clear that the location is excellent and many factors are in favour of the site to develop a proper filling station and service area at this location. These factors include inter alia the following:

- A suitable land parcel is available to provide for a filling station and service area to cater for the passing traffic together with ample parking, movement, landscaping and associated facilities.
- Geographically the site is well located with regards to passing traffic and proper access to the filling station and service area is available.
- The regional locality of the site is ideal for the proposed filling station and service area.
- The locality of the site complies with the minimum SANRAL requirement of 30km for filling station and service area facilities.
- Topographically the site is ideal for development and the provision of services (refer to attached services reports)
- The site is well located with regard to N-4 Highway and access to the filling station and service area can be provided (see attached reports and site plans).
- High traffic volumes pass the site.
- The site enjoys a high level of exposure and visibility.
- The site is not close to any existing dwelling houses, ±400m away from the closest residence.
- Subject to the required mitigation measures no geo-technical problems exist to hamper development.

- The proposed land uses are compatible with the existing surrounding land uses and will not impact negatively on the immediate surroundings.
- Environmentally, no "fatal flaws" that could prevent the project from happening have been identified.

From the above it is concluded that the application site is suitable for the development of a filling station and service area.

9.2 Land Use

9.2.1 The Site

The application site is situated on the northern side of the N-4 freeway in the north-western quadrant of the intersection with the Garankuwa Road (Road D2726/M21).

The N-4 forms the southern boundary of the site and the M21 the eastern boundary.

The site has a very gentle slope to the north and the gradient is ideal for the proposed land use. The site is not affected by a flood line and/or natural streams.

The site is covered by veld grass and medium size trees.

The application site is vacant at present.

9.2.2 Surrounding land uses

The application site is surrounded by farm portions which are mainly used for rural residential purposes.

The surroundings of the application site are indicated in the image below.

The nearest dwelling house is approximately 400m to the north of the proposed filling station and service area.

There are no land uses in the vicinity of the application site that prohibits the development of a filling station and service area on the property.

9.2.3 Compatibility

Only part (±7,55 ha of 63 ha) of the property will be used for the proposed filling station and service area, the application site does not border on any property other than that of SANRAL, the Provincial Road and the applicant's own property.

The proposed filling station and service area is more than 400m away from the nearest dwelling house and the activities will not impact negatively on such dwelling. The impact on the living conditions and the privacy of the occupants of the neighbouring property will be negligible. This compares favourably with Engen Doornpoort where the filling station is less than 200m from dwelling houses in a residential township.

The extent of buildings and structures will be ±2 000m² resulting in a coverage of only 2,65% of the township area.

Filling stations and service areas are a common sight along highways in South Africa and are visually acceptable developments.

It is highly unlikely that the application will generate any additional traffic that may affect the neighbouring properties.

From a land use point of view the proposed filling station and service area is isolated from other properties and will have little or no impact on neighbouring properties and occupants.

9.2.4 Site Layout

From the attached site plans it could be ascertained that the placing of buildings and infrastructure is centrally in the township area with the result that ample building lines and interface with the adjacent land is possible. The placing of the activities is such that it will have no impact on neighbouring properties. Access will be provided according to SANRAL standards and requirements.

The outline of the township area has been done to include boreholes in order for the township to be self dependent for the provision of water.

9.3 Traffic considerations

According to the report by Techworld Consulting Engineers, filling stations and rest areas along highways are not trip generators but are intercepting existing traffic along the roads. The typical peak hour demand is also low from a capacity and operational point of view.

Access and Linkages

Access to the site will be directly from the N4 Highway as discussed in the report by Techworld Consulting Engineers.

A service road will be provided to the filling station and service area to provide access for service and delivery from Road D2726. This arrangement will also provide linkage between the two filling station and service area sites. This service road will not be available for the public.

On-Site Circulation

Accepted and appropriate traffic engineering principles will be applied to design and traffic circulation on site.

Pedestrian Movement

Sidewalks and safe pedestrian crossings of vehicular roadways will be provided on the site. Raised pedestrian crossings and traffic calming measures will be implemented where necessary.

On-Site Parking

The following minimum number of parking bays is recommended for the site (according to the Techworld report):

TYPE OF VEHICLES	NUMBER OF PARKING TO BE PROVIDED
Light vehicles	120 bays
Buses	5 bays
Heavy vehicles	35 bays

The above-mentioned parking requirements will be imposed as conditions in the draft conditions of establishment for the township.

9.4 Services

Apart from electricity, no municipal services are available and the development will have to be self dependent in this regard. VIP Consulting Engineers and Cupro Consulting have been appointed to investigate the provision of civil and electrical engineering services to the proposed development respectively. Services reports from the consulting engineers are attached to the application.

9.4.1 Water

As there are no municipal water supply sources available in the area the water supply will be provided by means of boreholes. The proposal is to service the filling station and service area with its own borehole and elevated storage tank.

The calculated water demand for the development is as follows:

Land use	Unit	Qty	Unit demand (kl/day)	Total (kl/day
Garage/Filling station	100m²	10	1,2	12,0
Other buildings	100m²	6	1,2	7,2
Annual Average Daily Demand				19,2
Peak Daily Demand (excl fire flow) (1,5 XAADD)				28,8

An elevated water tank will be provided on site for the storage of water.

According to the engineering report, sufficient water is available for the proposed filling station and service area.

9.4.2 Sanitation

According to the civil engineers report there is no waste water treatment works in the area, a purification plant will be constructed on site. The purification plant will be a 16m³/day package plant situated at the lowest area of the property.

The effluent generated by the purification process conforms to all standards specified by DWA.

The estimation of the instantaneous peak dry weather flow is shown in the table below.

Land use	Unit	Qty	Unit demand (kl/day)	Total (kl/day
Garage/Filling station	100m²	10	1	10
Other Buildings	100m²	6	1	6
Total Annual Average Demand (AADD)				16
Instantaneous sewage flow rate (excluding peak				0,185l/s

9.4.3 Streets and Stormwater

As mentioned in previous paragraphs access to the facility will be from the N-4 Highway and no new streets are required for the township. The access to the township from the N-4 will be designed and provided to the satisfaction of SANRAL and the local authority. No access will be allowed from the township area to the existing provincial road.

Stormwater will be provided to the satisfaction of SANRAL and the local authority. The provision of stormwater reticulation to the proposed development is described in the services report.

The application site is not affected by any 1:50 and 1:100 year flood lines.

9.4.4 Electricity

According to the services report the power supply to the proposed filling station can be made available either from the Tshwane network, using alternative sources such as solar power, gas and diesel generators or a combination of the two options.

The City of Tshwane has confirmed that capacity is available for the proposed development.

9.4.5 Solid waste

The solid waste generated from the sites will be accumulated and stored on site in the prescribed bins provided by a contracted private waste removal company. These bins will be collected at regular intervals and or on request and disposed off.

Chemicals and hazardous waste will be catered for according to the prescribed requirements in terms of the applicable legislation.

9.4.6 General

The customary arrangements and agreements will be made and entered into with the local and/or district municipality and other relevant service providers.

The eventual services agreements will set out the responsibilities of the different role players and the contributions required by the authorities.

9.5 Geo-technical report

A geo-technical report was prepared by Holland-Muter and Associates, Engineering and Environmental Geologists, and is attached to the application.

The site falls within Land Use Zone A and has good land use potential and can be utilised for any type of development.

The report concluded that the proposed development is supported from a geotechnical perspective provided that all the recommendations and precautions, as presented in the report are adhered to.

This recommendation will be inscribed in the conditions of establishment of the township and eventually in the zoning conditions applicable to the erven in the township.

10. DFA PRINCIPLES

Even as the application is lodged in terms of the Town Planning and Township Ordinance No 15 of 1986, it is important to acknowledge the development principles set out in the Development Facilitation Act of 1995. The extent to which the application complies with the relevant principles contained in Chapter 1 of the Act is discussed in the following table:

PRINCIPLE	COMPLIANCE WITH PRINCIPLE
PRINCIPLE 3(1) (a): Policy, administrative practice and laws should provide for urban and rural land development and should facilitate the development of formal and in- formal, existing and new settlements.	The proposed development represents a new formal filling station and service area in an extensive rural area and constitutes land development in rural and urban area. Due to the nature of the proposed development, aspects relating to informal processes do not apply in this instance. The application complies with this principle.
PRINCIPLE 3(1) (b): Policy, administrative practices and laws should discourage the illegal occupation of land, with due recognition of informal land development processes.	The land is not occupied illegally. With the envisaged development of the property the illegal occupation of the land will be discouraged. The application complies with this principle.
PRINCIPLE 3(1) (c): "POLICY, ADMINISTRATIVE PRACTICE AND LAWS SHOULD PROMOTE EFFICIENT AND INTEGRATED LAND DEVELOPMENT IN THAT THEY- ***(i) promote the integration of the social, economic, institutional and physical aspects of land development;***	 The application will create social and economic benefits in the sense that it will create job opportunities and skills development. It will further more create an economic investment to procure an asset in the area.

	The development is not inconsistent with the policy of the Municipality and the institutional aspect of land development has been addressed. The application is to secure land development rights and the only legislative route at present to ensure that the social, economic, institutional and physical aspects of land development are integrated is by means of township establishment. In terms of the Town Planning and Townships Ordinance 15 of 1986, various role players participated in the application process, in this instance the local authority, roads authorities and various government departments, institutions and interested and affected parties. The provision of a filling station and service area will benefit a much wider area and will contribute to the social, economic and physical aspects of land development The application complies with this principle.
(ii) promote integrated land development in rural and urban areas in support of each other;	The proposed development is located in a rural area and will serve passing traffic to different destinations, including urban areas. Contractors and labourers from the local rural areas shall be solicited during the construction phase and permanent jobs shall be created. The application complies with this principle.
(iii) promote the availability of residential and employment opportunities in close proximity to or integrated with each other;	As already stated in paragraph (ii) this application could be regarded as an opportunity to provide facilities and employment opportunities close to residential areas including Brits and Garankuwa. The application complies with this principle.
(iv) optimise the use of existing resources including such resources relating to agricultural land, minerals, bulk infrastructure, roads, transportation and social facilities;	Save for a dominant road infrastructure no existing of resources are presently available. Adequate engineering infrastructure shall be installed for the proposed development. The application complies with this principle.
(v) promote a diverse combination of land uses, also at the level of individual erven or subdivision of land;	The application site is for a filling station and service area in a predominant rural area and will contribute to a more diverse combination of land uses. The application complies with this principle.
(vi) discourage the phenomenon of "urban sprawl" in urban areas and contribute to the development of more compact towns and cities;	Filling station and service area s along national roads are a common feature in South Africa and by nature are located in isolation to render a convenience service to passing traffic. The area of the proposed development is clearly depicted on the layout plan and cannot develop

	into a node. Urban sprawl is not an issue in this instance and the application complies with this principle.
(vii) contribute to the correction of historically distorted spatial patterns of settlement in the Republic and to the optimum use of existing infrastructure in excess of current needs;	The subject property is located in a rural area with no distorted spatial patterns of settlement present. The proposed development is an isolated free standing development with no physical links to other erven/properties. This principle does not apply in this application. As set out above, apart from the N-4 highway, there cannot be talk of existing infrastructure. The development shall be selfsustained.
(viii) encourage environmentally sustainable land development practices and processes"	The approach of the planning team was from the outset to provide an environmentally sustainable development. Consultants have been appointed to undertake environmental studies for the application site and to comply with all environmental legislation. According to the appointed environmental consultants no "fatal flaws" that could prevent the project from happening have been identified by any of the specialists or registered interested and affected parties.
Principle 3(1)(d): Members of communities affected by land development should actively participate in the process of land development.	The Ordinance in terms of which this application has been lodged, provides for a comprehensive public participation process and notification process for all interested and affected parties and departments, to take cognisance of this application and to submit objections and/or representations in that regard. Participation in this process will consequently be achieved.
Principle 3(1)(e): The skills and capacities of disadvantaged persons involved in land development should be developed	The proposed development will create employment opportunities and will stimulate the economy. The development will also broaden the tax base of the local authority in terms of which more money will be available for improvements elsewhere in the area. The development will also contribute to skills development.
Principle 3(1)(f): Policy, administrative practices and laws should encourage and optimise the contributions of all sectors of the economy (government and non-government) to land development so as to maximise the Republic's capacity to undertake land development and to this end, and without derogating from the generality of this principle-	This application represents an opportunity for the private sector to contribute to land development. In this particular case the local authority will also contribute to development especially in the evaluation of the application and the provision of services to the development. This application is launched in terms of Provincial Legislation within the jurisdiction of a local authority which has the authority to function as executive planning authority. Comments and representations will be solicited from authorities representing all spheres of government and the list of specified

(i) national, provincial and local governments should strive clearly to define and make known the required functions and responsibilities of all sectors of the economy in relation to land development as well as the desired relationship between such sectors; and **(ii) a competent authority in national, provincial or local government responsible for the administration of any law relating to land development shall provide particulars of the identity of legislation administered by it, the posts and names of persons responsible for the administration of such legislation and the addresses and the locality of the offices of such person who requires such information.**	interested and affected parties has been determined in conjunction with the Municipality to procure input from all the responsible persons in such departments. This application consequently complies with this requirement.
Principle 3(1)(g): Laws, procedures and administrative practice relating to land development should- **(i) be clear and generally available to those likely to be affected thereby;** **(ii) in addition to serving as regulatory measures, also provide guidance and information to those affected thereby;** **(iii) be calculated to promote trust and acceptance on the part of those likely to be affected thereby; and** **(iv) give further content to the fundamental rights set out in the Constitution.**	This principle is primarily applicable to the government sector. The Town Planning and Townships Ordinance No 15 of 1986 is the only legislation at present available for an application of this nature, and in the circumstance complies with this principle of the DFA. The application moreover has been informed by the development principles contained in the town planning documents of the Municipality with jurisdiction and ultimately upon approval shall comply therewith. Due to the fact that no inconsistencies with such policies are involved, the proposed development fall within the ambit of "trust and acceptance" which must be derived from such documents. No fundamental rights of any party, who may be affected by this development are encroached upon.
Principle 3(1)(h): Policy, administrative practice and laws should promote sustainable land development at the required scale in that they should- **(i) promote land development**	It has been illustrated in this memorandum and by the expert reports attached hereto, that the proposed development shall be sustainable from a social, infrastructural, institutional, environmental and economical point of view. These principles are fully complied with. The viability report as well as the engineering services

which is within the fiscal, institutional and administrative means of the Republic;	reports concluded that this application constitutes a viable project which will add value to the area.
(ii) promote the establishment of viable communities;	The proposed facilities will cater for passing traffic and will benefit all communities involved.
(iii) promote sustained protection of the environment;	No "fatal flaws" that could prevent the project from happening have been identified by any of the specialists or registered interested and affected parties.
(iv) meet the basic needs of all citizens in an affordable way; and	The need for a filling station and service area development has been addressed in this report and it is our submission that this application will meet the basic needs of the people in the area in an affordable way.
(v) ensure the safe utilisation of land by taking into consideration factors such as geological formations and hazardous undermined areas.	All factors with regard to the safe utilisation of land have been taken into account and specialist reports are attached.
Principle 3(1)(i): Policy, administrative practice and laws should promote speedy land development.	The applicant shall diligently comply with all time periods and restrictions contained in the Ordinance by virtue of which comments should be submitted, replies should be filed and information should be provided. It is expected from the Municipality to do the same in order to procure compliance with this principle.
Principle 3(1)(j): Each proposed land development area should be judged on its own merits and no particular use of land, such as residential, commercial, conservational, industrial, community facility, mining, agricultural or public use should in advance or in general be regarded as being less important or desirable than any other use of land"	The subject property is located along a main traffic corridor in a rural area, remote from any intense urbanisation. The current and adjacent land uses, at best, entail insignificant agricultural activities, vacant land and rural residential. The intended filling station and rest area facility on merit shall be compatible with these uses and its location should therefore not derogate from the merits of this application. Approval of this application will therefore comply with this principle.
Principle 3(1)(k): Land development should result in security of tenure, provide for the widest possible range of tenure alternatives, including individual and communal tenure, and in cases where land development takes the form of upgrading and existing settlement, not deprive beneficial occupiers of homes or land or, where it is necessary for land or homes occupied by them to be utilised for other purposes, their interest in such land or homes should be reasonably accommodated in	The registered land owner is represented by the applicant. Save for full dominium, no other alternative for ownership is therefore applicable. Save for two necessary residential units provided for, this development would not create residential opportunities. Consequently no residential settlement or alternative ranges of tenure shall aply.

some other manner.	
Principle 3(1)(l): A competent authority at national, provincial and local government level should co-ordinate the interests of the various sectors involved in or affected by land development so as to minimise conflicting demands on scarce resources.	This principle is endorsed by the applicant. Township establishment procedures make provision for a consultation process where the inputs of all spheres of Government and role players will be considered and assessed.
Principle 3(1)(m): Policy, administrative practice and laws relating to land development should stimulate the effective functioning of a land development market based on open competition between suppliers of goods and services.	The intended filling station and rest area facility shall render an important convenience service to the threshold traffic on a main corridor. Despite the location of other competing facilities on the same rout, albeit some distance from the subject property, such existence per se can therefore not derogate from the merits of this application. Pure competitive objections which have no town planning merit can therefore not serve as an impediment against the approval of this application, despite the fact that the goods and services offered may in essence be similar.

11. ECONOMIC DEVELOPMENT

- The proposed development will lead to job creation during the construction and operational phases of the filling station and service area. The proposed development will have permanent economic benefits for the surrounding area and for the local municipality.
- The increase in revenue generated for the local authority through rates and taxes will contribute to the income of the local authority with the resultant economic benefits for the municipal area.
- The proposed development will benefit road users because they can utilise facilities such as refuel, rest, buy food and refreshments without exiting the highway. The so-called road user benefits resulting from savings in travel time, accident costs and operation costs.
- The rest area for heavy vehicles will contribute to road safety as a much needed resting place will be provided.

12. LAYOUT OF THE TOWNSHIP

The township is situated on approximately 7,55 ha and provision is made for 2 erven as indicated on the layout plan. The intention is that the two erven shall be consolidated to create a single erf for development and a condition in this regard has been inscribed in the draft conditions of establishment.

The N-4 Highway runs adjacent and directly to the south of the township. Access will be obtained from the N-4 to serve only the passing traffic.

A line of no access is provided on the Provincial Road, a service entrance will however be provide to the said provincial road and will not be open to the patrons of the filling station and service area (see traffic report). This service entrance is located outside the township area and will be provided according to the standards of the Provincial Roads Authority.

The internal planning of the site, placing of buildings, access roads, parking and other facilities are indicated on the attached site plan.

13. ENVIRONMENTAL IMPACT

The EIA and Water-Use License Applications have already been submitted and the necessary specialist studies have already been completed and considered by the project team during the project planning process. A copy of the Scoping Report (already supplied to the local authority for scrutiny and inputs by the EIA Consultant) is attached hereto. Copies of the specialist reports that were conducted for purpose of the town planning application, the EIA application and the S21WUL application processes are also attached hereto.

The scoping report identifies the construction and operational phase related issues which will be assessed, analyzed and where possible, mitigated in more detail during the EIA process.

According to the appointed environmental consultants no "fatal flaws" that could prevent the project from happening have been identified by any of the specialists or registered interested and affected parties.

Furthermore, it is anticipated that it will be possible to mitigate all the environmental related impacts (ecological, social, institutional and economical impacts) to levels that are acceptable.

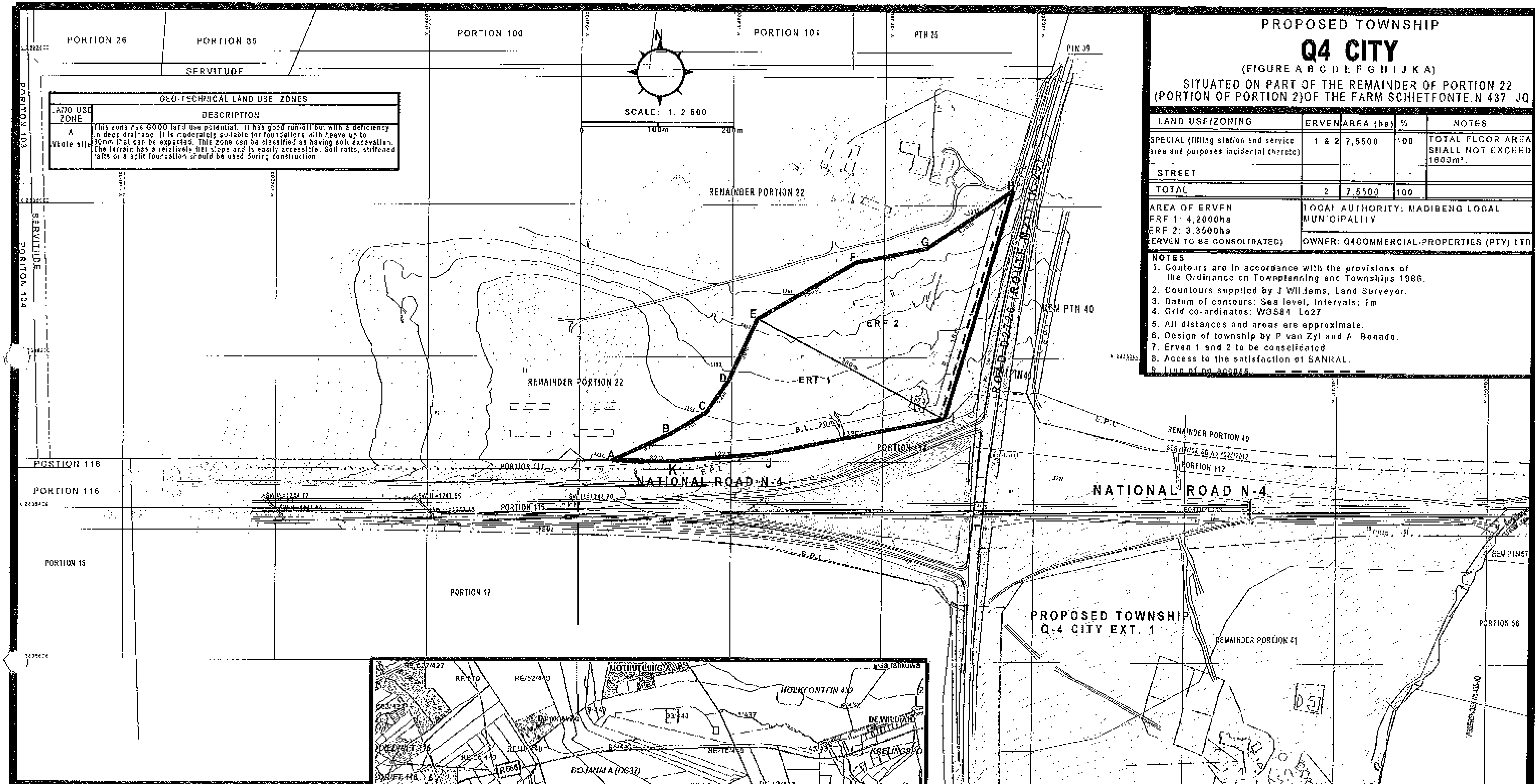
A report titled Environmental Findings compiled by Bokamoso Environmental Consultants is attached to the application for information.

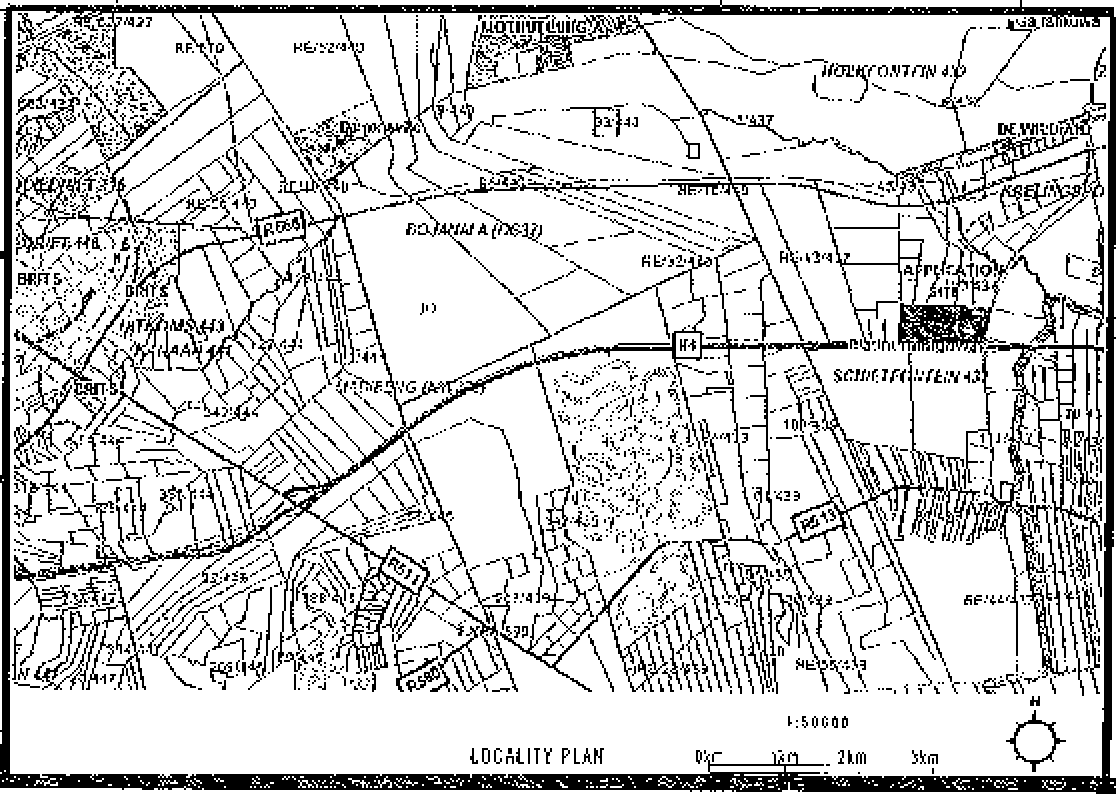
14. CONCLUSION

- There is a substantial need for the proposed rights and this application will meet with this demand.
- The site is well located in the trade area and complies with the general principles of accessibility and visibility.
- Economic and consumer market conditions are favourable for the establishment of the township.
- The application is compatible with the environment.
- The proposed rights will not have a negative impact on the environment.
- The property is ideally suited for the proposed uses.

The favourable consideration of the application will be appreciated.

VAN ZYL & BENADÉ **June 2015**





PROPOSED TOWNSHIP

Q4 CITY

(FIGURE A B C D E F G H I J K A)

SITUATED ON PART OF THE REMAINDER OF PORTION 22 (PORTION OF PORTION 2) OF THE FARM SCHIETFONTEIN 437 JQ

LAND USE/ZONING	ERVEN	AREA (ha)	%	NOTES
SPECIAL (filling station and service area and purposes incidental thereto)	1 & 2	7,5500	100	TOTAL FLOOR AREA SHALL NOT EXCEED 1800m².
STREET		-	-	
TOTAL	2	7,5500	100	

AREA OF ERVEN
ERF 1: 4,2000ha
ERF 2: 3.3500ha
(ERVEN TO BE CONSOLIDATED)

LOCAL AUTHORITY: MADIBENG LOCAL MUNICIPALITY

OWNER: Q4COMMERCIAL PROPERTIES (PTY) LTD

NOTES
1. Contours are in accordance with the provisions of the Ordinance on Townplanning and Townships 1986.
2. Countours supplied by J Willems, Land Surveyor.
3. Datum of contours: Sea level, Intervals: 1m
4. Grid co-ordinates: WGS84 Lo27
5. All distances and areas are approximate.
6. Design of township by P van Zyl and A Benade.
7. Erven 1 and 2 to be consolidated
8. Access to the satisfaction of SANRAL.
9. Line of no access.

GEO-TECHNICAL LAND USE ZONES

LAND USE ZONE	DESCRIPTION
A Whole site	This zone has GOOD land use potential. It has good runoff but with a deficiency in deep drainage. It is moderately suitable for foundations with heave up to 30mm that can be expected. This zone can be classified as having soft excavation. The terrain has a relatively flat slope and is easily accessible. Soil rafts, stiffened rafts or a split foundation should be used during construction

FLOOD LINES
It is hereby certified in terms of Section 144 of the Water Act (Act 36 of 1998), that this township is not affected by floodlines representing the maximum flood level likely to be reached with an expected frequency of 1 every 50 years and once every 100 years

HENK VILJOEN ECSA REG. 2013/0327

VAN ZYL EN BENADE
TOWN AND REGIONAL PLANNERS
STADS- EN STREEKBEPLANNERS
PO BOX 32709
GLENSTANTIA
0010
TEL. 012 348 1835
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e-mail: vzb@mweb.co.za

PLAN NO: Q4/1
DATE: JUNE 2015

MEMORANDUM

APPLICATION FOR THE ESTABLISHMENT OF A TOWNSHIP IN TERMS OF SECTION 96 OF THE TOWN PLANNING AND TOWNSHIPS ORDINANCE 15 OF 1986

PROPERTY:

Part of the Remainder of Portion 41 (Portion of Portion 2) of the farm Schietfontein 437 JQ

TOWNSHIP NAME

Q4 CITY EXTENSION 1

VAN ZYL & BENADE
TOWN- AND REGIONAL PLANNERS
STADS- EN STREEKBEPLANNERS

1. INTRODUCTION

Instruction has been received from the owner of the Remainder of Portion 22 and the Remainder of Portion 41 of the farm Schietfontein 437 JQ to apply to the relevant authorities for the establishment of a township(s) on parts of the properties.

During our pre-application discussions the planning officials of the Madibeng Local Municipality insisted that two separate applications, one on each property, be submitted instead of one application. This application should therefore be considered/evaluated together with the application for the establishment of Q4 City on part of the Remainder of Portion 22 of the farm Schietfontein. Some of the technical and specialist reports attached to the application have been done for both sites and should be read with this in mind.

A Resolution and Power of Attorney from the registered owner are attached for information.

The primary goal of the application is to establish a township providing for a filling station and service area and purposes incidental thereto on the property.

2. PARTICULARS OF THE PROPERTY

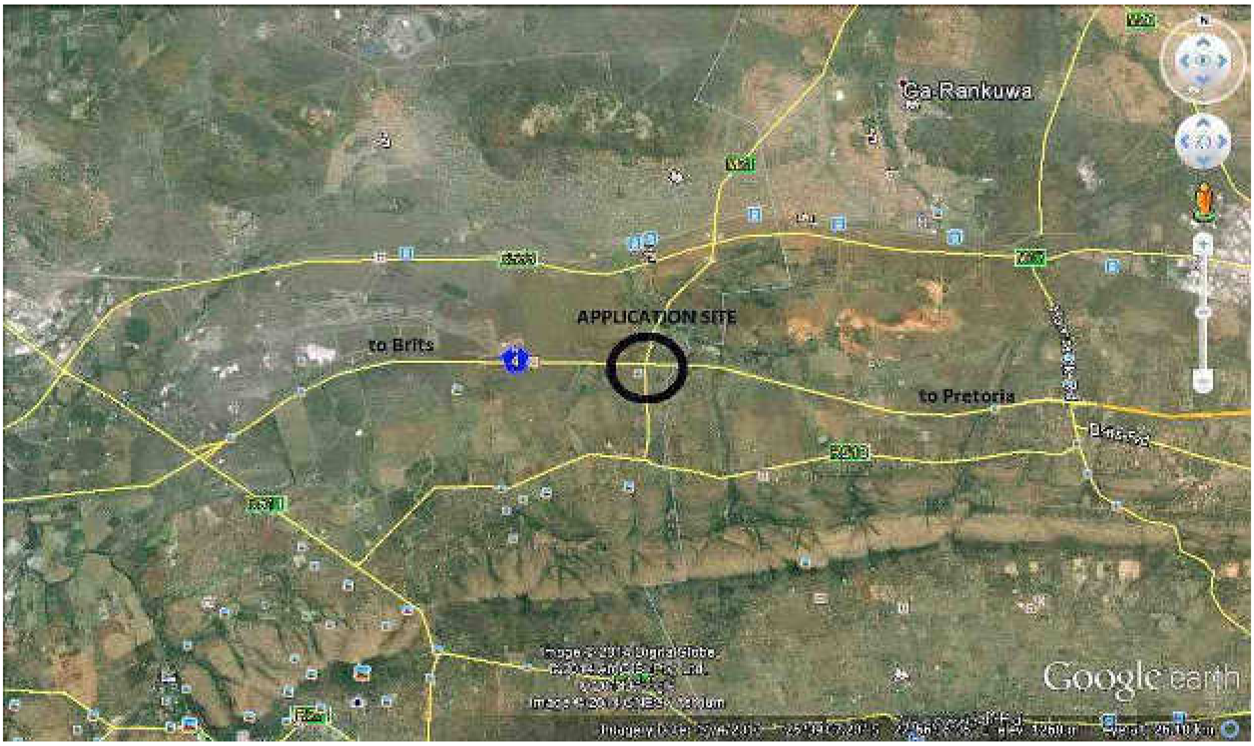
Description	The township is to be established on part of the Remainder of Portion 41 (a Portion of Portion 2) of the farm Schietfontein 437 JQ.
Owner	The property is registered in the name of Q4COMMERCIAL-PROPERTIES (PTY) LTD.
Area	Although the Remainder of Portion 41 is 33,2015 ha in extent the township will be established on only ±8,50 ha of the property.
Bond	A bond is registered against the property and the consent of the bondholder is attached.
Local Authority	The property is situated within the area of jurisdiction of the Madibeng Local Municipality.

3. LOCALITY

The property is located on the N-4 Highway, in the south-eastern quadrant of the interchange with the Garankuwa Road (Road D2726, planned K-25), approximately 17 km east of Brits and ±2,5 km east of the Brits Toll Plaza.

The locality of the application site complies with the minimum SANRAL requirement of 30km for facilities that serve traffic in the range of 5 000 – 50 000 vehicles per day.

The locality is indicated on the image below.



The locality of the application site is ideal to cater for the passing traffic on the N-4 Highway.

4. TOWN PLANNING SCHEME

The property is zoned Undetermined in terms of the Peri-Urban Areas Town Planning Scheme 1975.

5. TITLE DEED

The Remainder of Portion 41 is held under Deed of Transfer T15914/2014. A copy of the Deed of Transfer is attached.

Conveyancer's and landsurveyor's reports are attached to the application for information.

The following condition is registered against the property:

"By virtue of Section 40(1)a of South African National Roads Agency Limited and National Roads Act 7/1998 a portion of the within property has been declared National Route N4, Section 12A from Pretoria to Lobatse.

According to the reports no conditions are registered against the property that prohibits the opening of a township register.

A bond is registered over the property in favour of Standard Bank. The applicable Continuing Mortgage Bond is attached. 1`

6. PROPOSED DEVELOPMENT

It is envisaged to develop a filling station and service area on both sides of the N-4 Highway as indicated on the accompanied layout plan of the township. The primary goal of the filling station and service area is to cater for the passing traffic on the N-4 Highway.

For the purpose of this memorandum a filling station and service area is "*a rest/service area, travel plaza, rest stop, or service area for the travelling public, located next to a main road such as a highway or freeway at which drivers and passengers can rest, eat, and/or refuel without exiting onto secondary roads. Facilities may include fuel stations, convenient shop, restaurants, truck stops and uses related thereto.*"

The proposed development will provide for the following facilities (see attached site plan):

FACILITY	FLOOR AREA (m²)	COVERAGE (m²)
Fuel Sales (Forecourt)		494
Shop (Convenience Store)	285	285
Restaurant and Take-aways	387	387
Public Areas (Ablutions)	139	139
Service Areas	104	104
Staff Ablutions	99	99
Truck stop (Canteen and Kitchen)	213	213
Truck stop (ablutions)	116	116
Managers Residential Units	154	154
TOTAL	**1 497**	**1 991**

In the light of the above the following zoning and development control measures are proposed for the township:

Erven 1 and 2

Zoning	Secial for a filling station and service area .
Definition	For the purpose of this scheme a filling station and service area shall mean the storage and retail selling of vehicle fuels and lubricants; working bay for emergency repairs to vehicles; shop/convenience store; restaurant; confectionary; place of refreshment; take-away facility and drive-thru facility; automatic teller machines; administrative offices; ablution facilities; and refuse/service yard, and shall include a parking site for buses and trucks including a canteen and kitchen and two residential units for management.
Height	1 storey
FAR	0,5provided that the total floor area of all buildings shall not exceed 1 600m².
Coverage	5%
Parking	Parking shall be provided on the site to the satisfaction of the Municipality and SANRAL. The following minimum parking shall be provided: Parking for light vehicles: 120 bays Parking for buses: 5 bays Parking for heavy vehicles: 35 bays
Building lines	N4: 20 m Provincial Road: 16 m All other boundaries: In accordance with the approved Site Development Plan.
Access	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of SANRAL and the Municipality.

Landscaping	To the satisfaction of the local authority.
Loading facilities	To the satisfaction of the local authority.
Physical barriers	To the satisfaction of the local authority.

Detail of the development controls are set out in the attached draft conditions of establishment. We will mainly refer in this memorandum to the development as a filling station and service area with the understanding that it will have the meaning as set out in the definition above and entails the full development.

Although the two filling stations and service areas (Q-4 City and Q-4 City Extension 1) will be developed simultaneously and could be regarded as a single project the planners of the local authority insisted that two applications be submitted, one on each property either side of the N-4. It is subsequently important that the two applications should be considered together. Please note that some of the specialist reports have been compiled for the project as a whole and should be read and considered as also being applicable to the individual applications.

A site plan of the proposed filling station and service area is attached to the application for information.

7. PLANNING POLICIES

MADIBENG SPATIAL DEVELOPMENT FRAMEWORK 2009

This document has been handed to us by the planning officials of the local municipality as the official approved SDF for Madibeng.

In terms of this document the application property is earmarked as "Rural Area." The SDF is inserted below for easy reference.

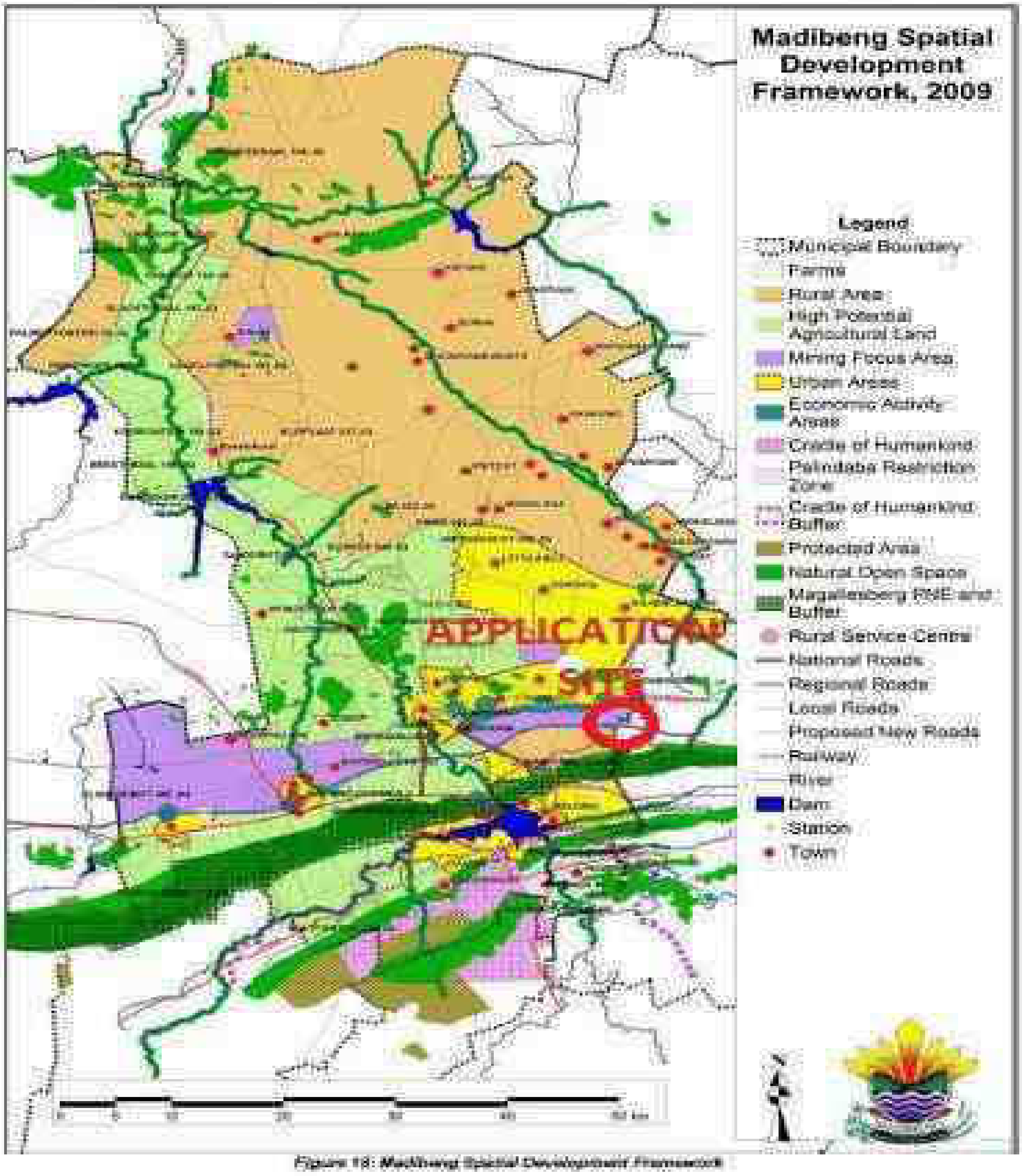


Figure 18: Madibeng Spatial Development Framework

In addition to the above this area has also been earmarked for future urban area which basically means that this area may be developed over the longer term. The plan indicating the future urban area is depicted below.

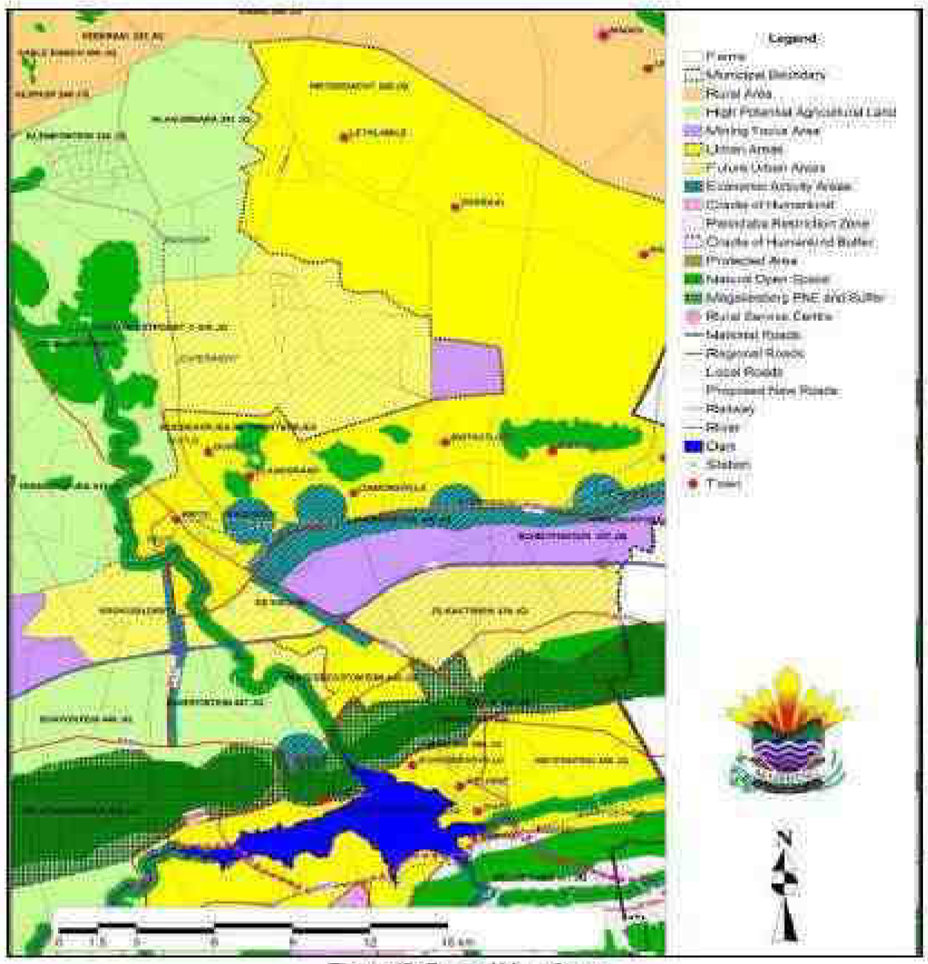


Figure 13: Future Urban Areas

The Bakwena Highway (N-4) is one of the elements identified which influence spatial development in Madibeng. The highway increases accessibility to Madibeng, especially between Tshwane and Rustenburg. According to the SDF this route provides the municipality with a number of development opportunities, especially at the points of access to Madibeng.

The Bakwena Highway has also been identified as an economic corridor which, according to the SDF, presents a degree of economic development potential.

Individual and detailed land uses such as filling stations are not addressed on SDF level and should be evaluated on its merits and on town planning principles.

It is our submission that the application is not inconsistent with the proposals of the Madibeng SDF.

8. NEED

The need for an application is determined by the demand for the land use in a given area.

The establishment of business enterprises along highways is driven mainly by market forces and in the case of filling station and service area specifically by the vehicular traffic passing the site. Retailers and developers will consider and invest in locations where profits are to be generated and sustained. The subject property is such a site mainly due to:

- The locality of the site
- The visibility of the site
- The accessibility of the site
- Existing and future traffic volumes passing the site.

A Traffic Report and Financial Viability Investigation for the filling station and service area have been done by Techworld Consulting Engineers. The following aspects of the study are highlighted:
- The application sites are located ±30 km from the ENGEN Doornpoort One-Stop in the east and ±33 km from the TOTAL Magalies Petroport in the west, subsequently complying with the SANRAL policy guideline of 30km minimum spacing between facilities.
- The location and spacing of existing facilities is a practical indication of the requirement for viability; i.e. combination of spacing, prevailing traffic demand, layout and cost. Based on these factors it is expected that the planned filling station and service area s will be financially viable.
- Although the primary income for service facilities along highways is obtained from fuel sales, income is also derived from the convenience shop and the restaurant/fast food.
- The expected fuel sales from the operational date will be approximately 900 000 litres per month

The study concluded that the proposed filling station and service area are both technically and financially viable, and that it is unlikely that the application will impact detrimentally on the sustainability of existing facilities in the area and corridor.

Apart from fuel sales the filling station and service area also provide express convenience shopping for the commuters and passing trade. The retail facility consist of a store (285m²) offering a variety of mainly daily consumer goods. A restaurant, take-away and bakery facilities (387m²) will also be offered for consumption on and off the site. These facilities will be operated on a 24-hour basis. According to the investigation by Techworld the convenience store restaurant and take-away will result in substantial complimentary revenue.

The planned development will provide convenient fuel, food, goods, rest area, restrooms (ablution) facilities and services to road users along the N4 Highway. These services will be provided to the occupants of both light and heavy vehicles.

Overnight parking facilities will be provided to trucks. The need for overnight facilities is indicated by the large number of trucks that currently overnight along the N4 at the Brits Toll Plaza and the number of trucks passing the site daily.

The two residential units for managements are needed for managerial reasons to conduct proper management control and supervision over the operation of the activities. On site security will also be enhanced with the provision of permanent accommodation facilities on the property. Housing is not readily and conveniently available close to the application site hence the need to provide the two residential units on site.

9. DESIRABILITY

9.1 Site Evaluation

As mentioned in the report only ±8,5 of the total area of 33,2015ha will be used for the proposed development. The township area in relation to the rest of the property is indicated on the image below.

With the evaluation of the site it is clear that the location is excellent and many factors are in favour of the site to develop a proper filling station and service area at this location. These factors include inter alia the following:

- A suitable land parcel is available to provide for a filling station and service area to cater for the passing traffic together with ample parking, movement, landscaping and associated facilities.
- Geographically the site is well located with regards to passing traffic and proper access to the filling station and service area is available.
- The regional locality of the site is ideal for the proposed filling station and service area.
- The locality of the site complies with the minimum SANRAL requirement of 30km for filling station and service area facilities.
- Topographically the site is ideal for development and the provision of services (refer to attached services reports)
- The site is well located with regard to N-4 Highway and access to the filling station and service area can be provided (see attached reports and site plans).
- High traffic volumes pass the site.
- The site enjoys a high level of exposure and visibility.
- The site is not close to any existing dwelling houses, ±400m away from the closest residence.
- Subject to the required mitigation measures no geo-technical problems exist to hamper development.
- The proposed land uses are compatible with the existing surrounding land uses and will not impact negatively on the immediate surroundings.
- Environmentally, no "fatal flaws" that could prevent the project from happening have been identified.

From the above it is concluded that the application site is suitable for the development of a filling station and service area.

9.2 Land Use

9.2.1 The Site

The application site is situated on the southern side of the N-4 freeway in the south-eastern quadrant of the interchange with the Garankuwa Road (Road D2726/M21).

The N-4 forms the northern boundary of the site and the M21 the western boundary.

The site has a very gentle slope to the north and the gradient is ideal for the proposed land use. The site is drained towards the stream that forms the eastern boundary of the property.

The site is affected by the 1:100 flood line as indicated on the layout plan.

Although a lodge, dwelling house and outbuildings exist on portion 41 at present, the application site as such is vacant at present.

The part of the property that forms the subject of the application is covered by veld grass.

9.2.2 Surrounding land uses

The application site is surrounded by farm portions which are used for residential and agricultural purposes. Apart from the residential and agricultural land uses, a primary school is located ±1km south east of the application site.

The surroundings of the application site are indicated in the image below.

The nearest dwelling house is approximately 450m to the east of the proposed filling station and service area.

There are no land uses in the vicinity of the application site that prohibits the development of a filling station and service area on the property.

9.2.3 Compatibility

Only part (±8,5 ha of 33 ha) of the property will be used for the proposed filling station and service area. The application site borders on only on private property namely Portion 56 of the farm Vissershoek on the eastern border. On all other border the owners are either SANRAL to the north and the Provincial Roads authority to the west.

The proposed filling station and service area is more than 450m away from the nearest dwelling house and the activities will not impact negatively on such dwelling. The impact on the living conditions and the privacy of the occupants of the neighbouring property will be negligible. This compares favourably with Engen Doornpoort where the filling station is less than 200m from dwelling houses in a residential township.

The extent of buildings and structures will be ±2 000m² resulting in a coverage of only 2,3% of the township area.

Filling station and service area are a common sight along highways in South Africa and are visually acceptable developments.

It is highly unlikely that the application will generate any additional traffic that may affect the neighbouring properties.

From a land use point of view the proposed filling station and service area is isolated from other properties and will have little or no impact on neighbouring properties and occupants.

9.2.4 Site Layout

From the attached site plans it could be ascertained that the placing of buildings and infrastructure is centrally in the township area with the result that ample building lines and interface with the adjacent land is possible. The placing of the activities is such that it will have no impact on neighbouring properties. The proposed development is ±450m away from the nearest dwelling house.

Access will be provided according to SANRAL standards and requirements.

The outline of the township area has been done to include boreholes in order for the township to be self dependent for the provision of water.

9.3 Traffic considerations

According to the report by Techworld Consulting Engineers, filling stations and rest areas along highways are not trip generators but are intercepting existing traffic along the roads. The typical peak hour demand is also low from a capacity and operational point of view

Access and Linkages

Access to the site will be directly from the N4 Highway as discussed in the report by Techworld Consulting Engineers.

A service road will be provided to the filling station and service area to provide access for service and delivery from Road D2726. This arrangement will also provide linkage between the two filling station and service area sites. This service road will not be available for the public.

On-Site Circulation

Accepted and appropriate traffic engineering principles will be applied to design and traffic circulation on site.

Pedestrian Movement

Sidewalks and safe pedestrian crossings of vehicular roadways will be provided on the site. Raised pedestrian crossings and traffic calming measures will ne implemented where necessary.

On-Site Parking

The following minimum number of parking bays is recommended for the site (according to the Techworld report):

TYPE OF VEHICLES	NUMBER OF PARKING TO BE PROVIDED
Light vehicles	120 bays
Buses	5 bays
Heavy vehicles	35 bays

The above-mentioned parking requirements will be imposed as conditions in the draft conditions of establishment for the township.

9.4 Services

Apart from electricity, no municipal services are available and the development will have to be self dependent in this regard. VIP Consulting Engineers and Cupro Consulting have been appointed to investigate the provision of civil and electrical engineering services to the proposed development respectively. Services reports from the consulting engineers are attached to the application.

9.4.1 Water

As there are no municipal water supply sources available in the area the water supply will be provided by means of boreholes. The proposal is to service the filling station and service area with its own borehole and elevated storage tank.

The calculated water demand for the development is as follows:

Land use	Unit	Qty	Unit demand (kl/day)	Total (kl/day
Garage/Filling station	100m²	10	1,2	12,0

Other buildings	100m²	6	1,2	7,2
Annual Average Daily Demand				19,2
Peak Daily Demand (excl fire flow) (1,5 XAADD)				28,8

An elevated water tank will be provided on site for the storage of water.

According to the engineering report, sufficient water is available for the proposed filling station and service area .

9.4.2 Sanitation

According to the civil engineers report there is no waste water treatment works in the area, a purification plant will be constructed on site. The purification plant will be a 16m³/day package plant situated at the lowest area of the property.

The effluent generated by the purification process conforms to all standards specified by DWA.

The estimation of the instantaneous peak dry weather flow is shown in the table below.

Land use	Unit	Qty	Unit demand (kl/day)	Total (kl/day
Garage/Filling station	100m²	10	1	10
Other Buildings	100m²	6	1	6
Total Annual Average Demand (AADD)				16
Instantaneous sewage flow rate (excluding peak				0,185l/s

9.4.3 Streets and Stormwater

As mentioned in previous paragraphs access to the facility will be from the N-4 Highway and no new streets are required for the township. The access to the township from the N-4 will be designed and provided to the satisfaction of SANRAL and the local authority. No access will be allowed from the township area to the existing provincial road.

Stormwater will be provided to the satisfaction of SANRAL and the local authority. The provision of stormwater reticulation to the proposed development is described in the services report.

The application site is affected by a flood line as indicated on the layout plan.

9.4.4 Electricity

According to the services report the power supply to the proposed filling station can be made available either from the Tshwane network, using alternative sources such as solar power, gas and diesel generators or a combination of the two options.

The City of Tshwane has confirmed that capacity is available for the proposed development.

9.4.5 Solid waste

The solid waste generated from the sites will be accumulated and stored on site in the prescribed bins provided by a contracted private waste removal company. These bins will be collected at regular intervals and or on request and disposed off.

Chemicals and hazardous waste will be catered for according to the prescribed requirements in terms of the applicable legislation.

9.4.6 General

The customary arrangements and agreements will be made and entered into with the local and/or district municipality and other relevant service providers.

The eventual services agreements will set out the responsibilities of the different role players and the contributions required by the authorities.

9.5 Geo-technical report

A geo-technical report was prepared by Holland-Muter and Associates, Engineering and Environmental Geologists, and is attached to the application.

The site falls within Land Use Zones A and C and has good land use potential and can be utilised for any type of development.

The report concluded that the proposed development is supported from a geotechnical perspective provided that all the recommendations and precautions, as presented in the report are adhered to.

This recommendation will be inscribed in the conditions of establishment of the township and eventually in the zoning conditions applicable to the erven in the township.

10. DFA PRINCIPLES

Even as the application is lodged in terms of the Town Planning and Township Ordinance No 15 of 1986, it is important to acknowledge the development principles set out in the Development Facilitation Act of 1995. The extent to which the application complies with the relevant principles contained in Chapter 1 of the Act is discussed in the following table:

PRINCIPLE	COMPLIANCE WITH PRINCIPLE
PRINCIPLE 3(1) (a): Policy, administrative practice and laws should provide for urban and rural land development and should facilitate the development of formal and in- formal, existing and new settlements.	The proposed development represents a new formal filling station and service area in an extensive rural area and constitutes land development in rural and urban area. Due to the nature of the proposed development, aspects relating to informal processes do not apply in this instance. The application complies with this principle.
PRINCIPLE 3(1) (b): Policy, administrative practices and laws should discourage the illegal	The land is not occupied illegally. With the envisaged development of the property the

occupation of land, with due recognition of informal land development processes.	illegal occupation of the land will be discouraged. The application complies with this principle.
PRINCIPLE 3(1) (c): "POLICY, ADMINISTRATIVE PRACTICE AND LAWS SHOULD PROMOTE EFFICIENT AND INTEGRATED LAND DEVELOPMENT IN THAT THEY-	
(i) promote the integration of the social, economic, institutional and physical aspects of land development;	The application will create social and economic benefits in the sense that it will create job opportunities and skills development. It will further more create an economic investment to procure an asset in the area. The development is not inconsistent with the policy of the Municipality and the institutional aspect of land development has been addressed. The application is to secure land development rights and the only legislative route at present to ensure that the social, economic, institutional and physical aspects of land development are integrated is by means of township establishment. In terms of the Town Planning and Townships Ordinance 15 of 1986, various role players participated in the application process, in this instance the local authority, roads authorities and various government departments, institutions and interested and affected parties. The provision of a filling station and service area will benefit a much wider area and will contribute to the social, economic and physical aspects of land development The application complies with this principle.
(ii) promote integrated land development in rural and urban areas in support of each other;	The proposed development is located in a rural area and will serve passing traffic to different destinations, including urban areas. Contractors and labourers from the local rural areas shall be solicited during the construction phase and permanent jobs shall be created. The application complies with this principle.
(iii) promote the availability of residential and employment opportunities in close proximity to or integrated with each other;	As already stated in paragraph (ii) this application could be regarded as an opportunity to provide facilities and employment opportunities close to residential areas including Brits and Garankuwa. The application complies with this principle.
(iv) optimise the use of existing resources including such	Save for a dominant road infrastructure no existing resources are presently available. Adequate

resources relating to agricultural land, minerals, bulk infrastructure, roads, transportation and social facilities;	engineering infrastructure shall be installed for the proposed development. The application complies with this principle.
(v) promote a diverse combination of land uses, also at the level of individual erven or subdivision of land;	The application site is for a filling station and service area in a predominant rural area and will contribute to a more diverse combination of land uses. The application complies with this principle.
(vi) discourage the phenomenon of "urban sprawl" in urban areas and contribute to the development of more compact towns and cities;	Filling station and service area s along national roads are a common feature in South Africa and by nature are located in isolation to render a convenience service to passing traffic. The area of the proposed development is clearly depicted on the layout plan and cannot develop into a node. Urban sprawl is not an issue in this instance and the application complies with this principle.
(vii) contribute to the correction of historically distorted spatial patterns of settlement in the Republic and to the optimum use of existing infrastructure in excess of current needs;	The subject property is located in a rural area with no distorted spatial patterns of settlement present. The proposed development is an isolated free standing development with no physical links to other erven/properties. This principle does not apply in this application. As set out above, apart from the N-4 highway, there cannot be talk of existing infrastructure. The development shall be selfsustained.
(viii) encourage environmentally sustainable land development practices and processes"	The approach of the planning team was from the outset to provide an environmentally sustainable development. Consultants have been appointed to undertake environmental studies for the application site and to comply with all environmental legislation. According to the appointed environmental consultants no "fatal flaws" that could prevent the project from happening have been identified by any of the specialists or registered interested and affected parties.
Principle 3(1)(d): Members of communities affected by land development should actively participate in the process of land development.	The Ordinance in terms of which this application has been lodged, provides for a comprehensive public participation process and notification process for all interested and affected parties and departments, to take cognisance of this application and to submit objections and/or representations in that regard. Participation in this process will consequently be achieved.
Principle 3(1)(e): The skills and capacities of disadvantaged persons involved in land development should be	The proposed development will create employment opportunities and will stimulate the economy. The development will also broaden the tax base of the local authority in terms of which more money will

developed	be available for improvements elsewhere in the area. The development will also contribute to skills development.
Principle 3(1)(f): Policy, administrative practices and laws should encourage and optimise the contributions of all sectors of the economy (government and non-government) to land development so as to maximise the Republic's capacity to undertake land development and to this end, and without derogating from the generality of this principle- **(i) national, provincial and local governments should strive clearly to define and make known the required functions and responsibilities of all sectors of the economy in relation to land development as well as the desired relationship between such sectors; and** **(ii) a competent authority in national, provincial or local government responsible for the administration of any law relating to land development shall provide particulars of the identity of legislation administered by it, the posts and names of persons responsible for the administration of such legislation and the addresses and the locality of the offices of such person who requires such information.**	This application represents an opportunity for the private sector to contribute to land development. In this particular case the local authority will also contribute to development especially in the evaluation of the application and the provision of services to the development. This application is launched in terms of Provincial Legislation within the jurisdiction of a local authority which has the authority to function as executive planning authority. Comments and representations will be solicited from authorities representing all spheres of government and the list of specified interested and affected parties has been determined in conjunction with the Municipality to procure input from all the responsible persons in such departments. This application consequently complies with this requirement.
Principle 3(1)(g): Laws, procedures and administrative practice relating to land development should- **(i) be clear and generally available to those likely to be affected thereby;** **(ii) in addition to serving as regulatory measures, also provide guidance and information to those affected thereby;**	This principle is primarily applicable to the government sector. The Town Planning and Townships Ordinance No 15 of 1986 is the only legislation at present available for an application of this nature, and in the circumstance complies with this principle of the DFA. The application moreover has been informed by the development principles contained in the town planning documents of the Municipality with jurisdiction and ultimately upon approval shall comply therewith. Due to the fact that no inconsistencies with such policies are involved, the

(iii) be calculated to promote trust and acceptance on the part of those likely to be affected thereby; and **(iv) give further content to the fundamental rights set out in the Constitution.**	proposed development fall within the ambit of "trust and acceptance" which must be derived from such documents. No fundamental rights of any party, who may be affected by this development are encroached upon.
Principle 3(1)(h): Policy, administrative practice and laws should promote sustainable land development at the required scale in that they should- **(i) promote land development which is within the fiscal, institutional and administrative means of the Republic;** **(ii) promote the establishment of viable communities;** **(iii) promote sustained protection of the environment;** **(iv) meet the basic needs of all citizens in an affordable way; and** **(v) ensure the safe utilisation of land by taking into consideration factors such as geological formations and hazardous undermined areas.**	It has been illustrated in this memorandum and by the expert reports attached hereto, that the proposed development shall be sustainable from a social, infrastructural, institutional, environmental and economical point of view. These principles are fully complied with. The viability report as well as the engineering services reports concluded that this application constitutes a viable project which will add value to the area. The proposed facilities will cater for passing traffic and will benefit all communities involved. No "fatal flaws" that could prevent the project from happening have been identified by any of the specialists or registered interested and affected parties. The need for a filling station and service area development has been addressed in this report and it is our submission that this application will meet the basic needs of the people in the area in an affordable way. All factors with regard to the safe utilisation of land have been taken into account and specialist reports are attached.
Principle 3(1)(i): Policy, administrative practice and laws should promote speedy land development.	The applicant shall diligently comply with all time periods and restrictions contained in the Ordinance by virtue of which comments should be submitted, replies should be filed and information should be provided. It is expected from the Municipality to do the same in order to procure compliance with this principle.
Principle 3(1)(j): Each proposed land development area should be judged on its own merits and no particular use of land, such as residential, commercial, conservational, industrial, community facility, mining, agricultural or public use should in advance or in general be regarded as being less important	The subject property is located along a main traffic corridor in a rural area, remote from any intense urbanisation. The current and adjacent land uses, at best, entail insignificant agricultural activities, vacant land and rural residential. The intended filling station and rest area facility on merit shall be compatible with these uses and its location should therefore not derogate from the merits of this application. Approval of this application will therefore comply

or desirable than any other use of land"	with this principle.
Principle 3(1)(k): Land development should result in security of tenure, provide for the widest possible range of tenure alternatives, including individual and communal tenure, and in cases where land development takes the form of upgrading and existing settlement, not deprive beneficial occupiers of homes or land or, where it is necessary for land or homes occupied by them to be utilised for other purposes, their interest in such land or homes should be reasonably accommodated in some other manner.	The registered land owner is represented by the applicant. Save for full dominium, no other alternative for ownership is therefore applicable. Save for two necessary residential units provided for, this development would not create residential opportunities. Consequently no residential settlement or alternative ranges of tenure shall aply.
Principle 3(1)(l): A competent authority at national, provincial and local government level should co-ordinate the interests of the various sectors involved in or affected by land development so as to minimise conflicting demands on scarce resources.	This principle is endorsed by the applicant. Township establishment procedures make provision for a consultation process where the inputs of all spheres of Government and role players will be considered and assessed.
Principle 3(1)(m): Policy, administrative practice and laws relating to land development should stimulate the effective functioning of a land development market based on open competition between suppliers of goods and services.	The intended filling station and rest area facility shall render an important convenience service to the threshold traffic on a main corridor. Despite the location of other competing facilities on the same rout, albeit some distance from the subject property, such existence per se can therefore not derogate from the merits of this application. Pure competitive objections which have no town planning merit can therefore not serve as an impediment against the approval of this application, despite the fact that the goods and services offered may in essence be similar.

11. ECONOMIC DEVELOPMENT

- The proposed development will lead to job creation during the construction and operational phases of the filling station and service area. The proposed development will have permanent economic benefits for the surrounding area.

- The increase in revenue generated for the local authority through rates and taxes will contribute to the income of the local authority with the resultant economic benefits for the municipal area.

- The proposed development will benefit road users because they can utilise facilities such as refuel, rest, buy food and refreshments without exiting the highway. The so-called road user benefits resulting from savings in travel time, accident costs and operation costs.

- The rest area for heavy vehicles will contribute to road safety as a much needed resting place will be provided.

12. LAYOUT OF THE TOWNSHIP

The township is situated on approximately 8,50 ha and provision is made for 2 erven as indicated on the layout plan. The intention is that the two erven shall be consolidated to create a single erf for development and a condition in this regard has been inscribed in the draft conditions of establishment.

The N-4 Highway runs adjacent and directly to the north of the township. Access will be obtained from the N-4 to serve only the passing traffic.

A line of no access is provided on the Provincial Road, a service entrance will however be provide to the said provincial road and will not be open to the patrons of the filling station and service area (see traffic report). This service entrance is located outside the township area and will be provided according to the standards of the Provincial Roads Authority.

The internal planning of the site, placing of buildings, access roads, parking and other facilities are indicated on the attached site plan.

13. ENVIRONMENTAL IMPACT

The EIA and Water-Use License Applications have already been submitted and the necessary specialist studies have already been completed and considered by the project team during the project planning process. A copy of the Scoping Report (already supplied to the local authority for scrutiny and inputs by the EIA Consultant) is attached hereto. Copies of the specialist reports that were conducted for purpose of the town planning application, the EIA application and the S21WUL application processes are also attached hereto.

The scoping report identifies the construction and operational phase related issues which will be assessed, analysed and where possible, mitigated in more detail during the EIA process.

According to the appointed environmental consultants no "fatal flaws" that could prevent the project from happening have been identified by any of the specialists or registered interested and affected parties.

Furthermore, it is anticipated that it will be possible to mitigate all the environmental related impacts (ecological, social, institutional and economical impacts) to levels that are acceptable.

14. CONCLUSION

- There is a substantial need for the proposed rights and this application will meet with this demand.
- The site is well located in the trade area and complies with the general principles of accessibility and visibility.
- Economic and consumer market conditions are favourable for the establishment of the township.
- The application is compatible with the environment.
- The proposed rights will not have a negative impact on the environment.
- The property is ideally suited for the proposed use.

The favourable consideration of the application will be appreciated.

VAN ZYL & BENADÉ **June 2015**

PROPOSED TOWNSHIP
Q4 CITY EXTENSION 1

(FIGURE A B C D E F G H I J K L)
SITUATED ON PART OF THE REMAINDER OF PORTION 41
(PORTION OF PORTION 2) OF THE FARM SCHIETFONTEIN 437 JQ

LAND USE/ZONING	ERVEN	AREA (ha)	%	NOTES
SPECIAL (filling/service station and purposes incidental thereto)	1 X 2	8,6000	100	TOTAL FLOOR AREA SHALL NOT EXCEED 1000m².
STREET		-----	----	
TOTAL	2	8,5000	100	

AREA OF ERVEN
ERF 1: 3,7000ha
ERF 2: 4,8000ha
ERVEN TO BE CONSOLIDATED)

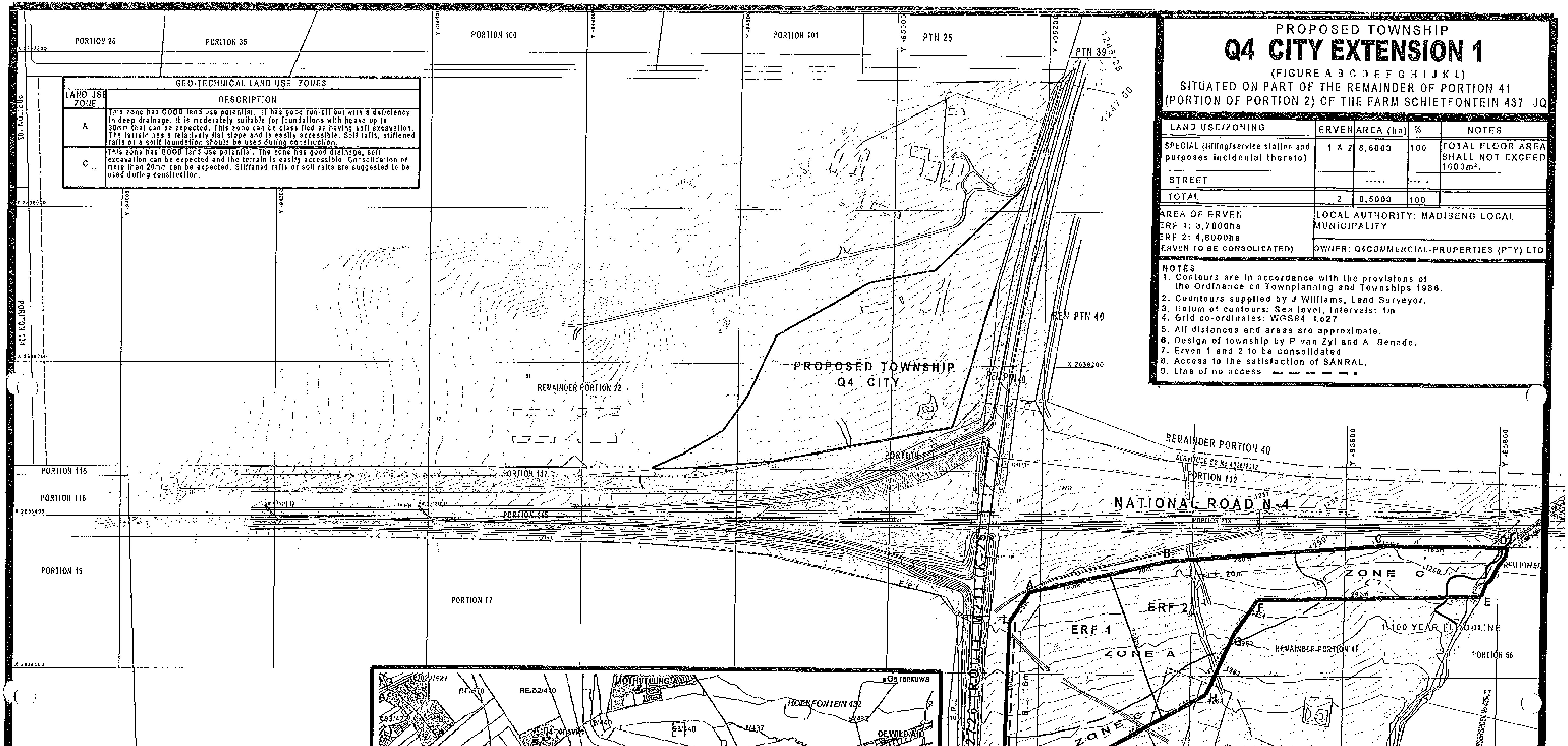
LOCAL AUTHORITY: MADIBENG LOCAL MUNICIPALITY

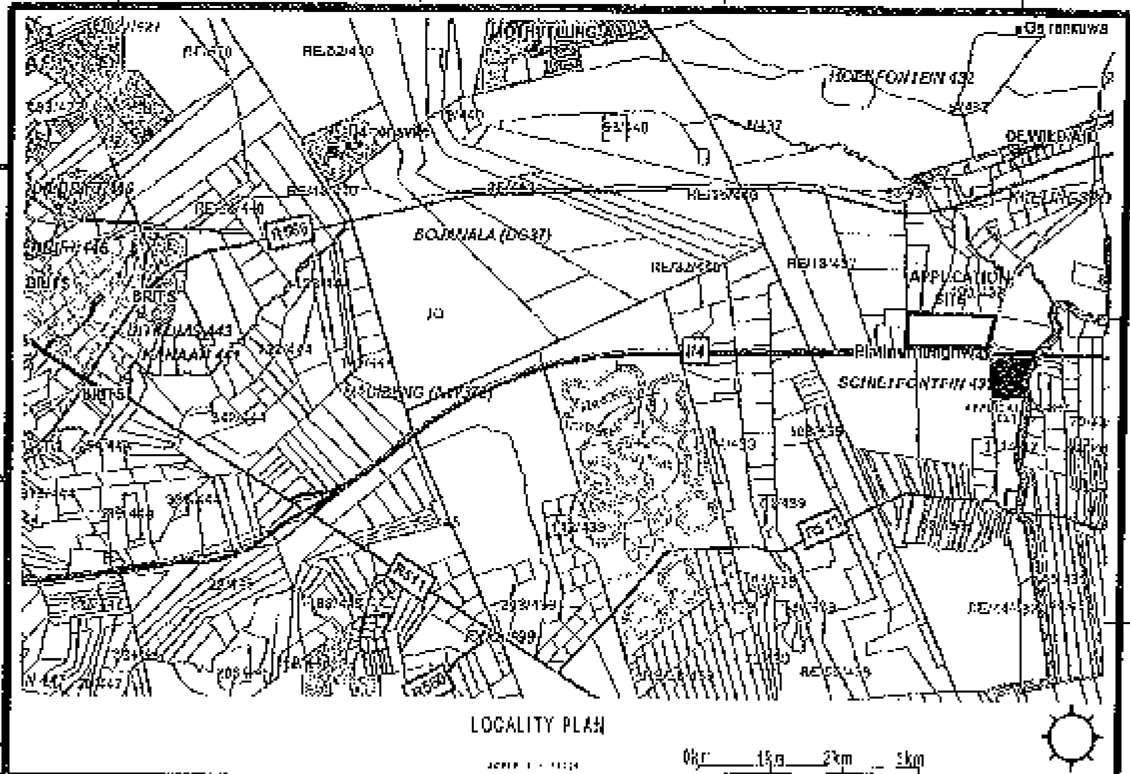
OWNER: Q4COMMERCIAL-PROPERTIES (PTY) LTD

NOTES
1. Contours are in accordance with the provisions of the Ordinance on Townplanning and Townships 1986.
2. Countours supplied by J Williams, Land Surveyor.
3. Datum of contours: Sea level, Intervals: 1m
4. Grid co-ordinates: WGS84 Lo27
5. All distances and areas are approximate.
6. Design of township by P van Zyl and A Benade.
7. Erven 1 and 2 to be consolidated
8. Access to the satisfaction of SANRAL.
9. Line of no access

GEO-TECHNICAL LAND USE ZONES

LAND USE ZONE	DESCRIPTION
A	This zone has GOOD land use potential. It has good run-off but with a deficiency in deep drainage. It is moderately suitable for foundations with heave up to 30mm that can be expected. This zone can be classified as having soft excavation. The terrain has a relatively flat slope and is easily accessible. Soil rafts, stiffened rafts or a solid foundation should be used during construction.
C	This zone has GOOD land use potential. The zone has good drainage, soft excavation can be expected and the terrain is easily accessible. Consolidation of more than 20mm can be expected. Stiffened rafts or soil rafts are suggested to be used during construction.





LOCALITY PLAN

The 1:100 year floodline determined and certified by:

HENK VILJOEN ECSA REG. 201370027

VAN ZYL EN BENADE
TOWN AND REGIONAL PLANNERS
STADS- EN STREEKBEPLANNERS

PO BOX 32709
GLENSTANTIA
0010

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PLAN NO: Q4X1/1

DATE: JUNE 2015

Traffic Report & Viability Investigation

Annexure F7

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consulting ENGINEERS

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Hatfield
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South Africa

Traffic Engineering
Transportation Planning
Transport Economy
Project Management
Project Financing & Viability

TRAFFIC REPORT & FINANCIAL VIABILITY INVESTIGATION:

PROPOSED Q4 CITY ALONG N4 PLATINUM HIGHWAY

January 2015

TITLE OF REPORT: TRAFFIC REPORT & FINANCIAL VIABILITY INVESTIGATION: PROPOSED Q4 CITY ALONG N4 PLATINUM HIGHWAY	
DATE: January 2015	**STATUS OF REPORT:** Final Report
CLIENT: FUEL (Pty) Ltd P.O. Box 90549 Garsfontein, Pretoria, 0042 Tel: (012) 361 5151 Fax: (012) 361 5150 **CONTACT PERSON:** Carien de Klerk – Project Manager	
PROJECT NUMBER: TW619	**REPORT NUMBER:** Traffic & Viability Study_Q4 City along N4_02Apr15
PREPARED BY: TECHWORLD P O Box 12530 Hatfield 0028 Tel: (012) 348 – 0386	
DESCRIPTION OF PROJECT: This traffic report and viability investigation is done in support of the township applications for the proposed Q4 City along the N4 Platinum Highway.	
PROJECT TEAM: AUTHOR (S) OF REPORT: P Kruger CHECKED AND DISTRIBUTION APPROVAL: P Kruger	

20 January 2015

Our Ref: REF/TW619/20Jan15

The Manager

Madibeng Local Municipality

PO Box 106

Brits, 0250

Dear Sir / Madam

PROPOSED FILLING STATIONS AND SERVICE AREA FACILITIES – Q4 CITY – ALONG THE N4 PLATINUM HIGHWAY

New Class 3 Service Area Facilities are planned by Q4 Fuel (Pty) Ltd (hence referred to as Q4 City) on the Farm Schietfontein 437-JQ at the existing interchange between the N4 Freeway and Road D2726 (Planned K25) Route M21.

Refer to *Appendix A* (attached).

The traffic and viability investigations have shown that the proposed Service Area Facilities (Highway Sites) are both technically and financially viable, and that it is very unlikely that the applications will impact detrimentally on the sustainability of existing facilities in the area and in the corridor.

Both BAKWENA and SANRAL have provided their approval-in-principle for the preliminary and detailed design to commence (*Appendix B*).

Kind Regards

P Kruger

For TECHWORLD

TABLE OF CONTENTS

TABLE OF ANNEXURES

1 INTRODUCTION

1.1 BACKGROUND

New Class 3 Service Area Facilities are planned by Q4 Fuel (Pty) Ltd (hence referred to as Q4 CITY) on the Farm Schietfontein 437-JQ at the existing interchange between the N4 Freeway and Road D2726 (Planned K25) Route M21. The existing interchange is a diamond configuration with ramps only in a western direction. The N4 Freeway currently has a two-lane single carriageway cross-section in the vicinity of the application site; i.e. only the southern carriageway is currently constructed.

The application sites are located in the North-West Province and falls under the jurisdiction of the Madibeng Local Municipality.

The Locality Map is attached as *Appendix A*.

An application for preliminary approval by BAKWENA (concessionaire for the N4 Route) and SANRAL, for direct access to the facilities from the N4 Freeway, was subsequently approved by BAKWENA (5 May 2014) and by SANRAL (20 May 2014). Refer to *Appendix B*.

1.2 DEVELOPER / APPLICANT

The applicant / developer is Q4 Fuel (Pty) Ltd which is a wholesale fuel distributor. The directors of the company is Mssgrs Thabo Ratune, Dreyer Van Niekerk, and Francois Du Preez.

1.3 PROPERTY DESCRIPTION

The applicant has purchased all the necessary land to construct the service area facilities and to expand the existing national road reserve as required by the design.

The service area facilities will be located on a part of the Remainder of Portion 41 (a portion of Portion 2) of the Farm Schietfontein 437-JQ in the south-eastern quadrant of the interchange and a part of the Remainder of Portion 22 (a Portion of Portion 2) of the farm Schietfontein 437-JQ in the north-western quadrant of the interchange.

Two new townships will be established for the planned highway sites namely Q4 City and Q4 City Extension 1. Refer to *Appendix C* (attached).

2 DESCRIPTION OF LOCATION AND RELEVANT SPACING REQUIREMENTS

The planned Service Area Facilities (Q4 City) are located about 30km from the ENGEN Doornpoort One-Stop at Doornpoort in the east and about 33km from the TOTAL Petroport at Magalies in the west.

The location is about 2.6km east of the Brits Toll Plaza and about 4.5km east of the Planned PWV6 Route. Refer to *Appendix A*; i.e. the Locality Map (attached).

The location of the proposed facilities comply with the minimum SANRAL requirements of 30km for facilities that serve traffic in the range 5,000 to 50,000 vehicles per day (see next section on current 2013 AADT).

3 2014 TRAFFIC DEMAND (AADT)

The latest available traffic information is for the 2014 calendar year. A permanent traffic counting station – CTO 2560 – is located at the neighbouring Brits Mainline Toll Plaza to the west of the application site.

This CTO station shows that the current 2014 ADT (total traffic) is 12,099 vehicles per day that includes an ADTT (truck traffic) of 1,856 vehicles per day, which translates into 15.3% heavy vehicles.

The heavy vehicles are weighed towards longer trucks; i.e. a truck split of 30 / 16 / 54 between short / medium / long with an estimated average of 5.2 axles per truck.

The split between day traffic (06:00 – 20:00) and night traffic (20:00 – 06:00) is ±88% versus ±12%.

The 30th highest hour traffic volume on the road was ±1,500 compared with the average weekday peak hour traffic of ±1,090 vehicles per hour in 2014.

The historical traffic growth rates at the Brits Mainline Toll Plaza – comparison between 2004 and 2014 traffic information – was 6.7% p.a. in total vehicles, 6.0% p.a. in light vehicles, and 12.0% p.a. in heavy vehicles.

The traffic information of CTO 2560 Station at the Brits Toll Plaza west of the application sites as well as CTO 1618 Station at the M17 (K67) Ga-Rankuwa Interchange east of the application sites was used to determine the traffic demand that bypasses the application sites.

Appendix C (attached) contains the Highlight Sheets for CTO 2560 and CTO 1618.

4 DESCRIPTION OF PROPOSED CONFIGURATION AND LAYOUT OF INTERCHANGE AND SERVICE AREAS

Both the Short Term and Long Term Development Plans are attached as *Appendix E* and *Appendix F*.

The Short Term Development Plan depicts the situation BEFORE the construction of the 2nd carriageway of the N4 and the eastern ramps at the interchange while the Long Term Development Plan depicts the situation AFTER their construction.

The proposed dual service area facilities – upstream of the M21 / N4 interchange in eastbound and westbound directions respectively – will be located <u>outside the national road reserve</u> of the N4 Freeway.

Both the off- and on-ramps of the service area facilities will be combined with those of the interchange by using typical SANRAL design standards in this regard. A single off-ramp taper / nose will diverge into a second off-ramp taper / nose after 300m to serve the service areas. The on-ramps from the service area will cross under the off-ramps of the interchange and the D2726 (K25) M21 bridge to merge with the on-ramps of the interchange before a single on-ramp taper / nose connects to the N4 Freeway.

The crossing of the off-ramps of the interchange will be by means of new culvert type structures (8.0m wide) while the crossing of the D2726 (K25) M21 bridge will be behind the piers of the two-portal bridge by replacing the land abutments with retaining walls.

The existing two western ramps must be partially reconstructed to accommodate the ramps that will serve the proposed facilities.

Although the construction of the interchange eastern ramps is not planned by either Bakwena or SANRAL at this stage, the design of the new configuration will make provision for the construction of these ramps in future. The apparent traffic demand for these ramps is low and their construction may have significant toll implications (opportunity to avoid the Brits Toll Plaza).

The design of the service areas and ramp configurations will furthermore also make provision for the construction of the second carriageway of the N4 Freeway in the near future.

Only the construction of one culvert type structure in the north-western quadrant of the interchange is required at this stage (i.e. to cross underneath the existing off-ramp) but the developer will enter into an agreement with SANRAL in terms of the construction of the second culvert type structure in the south-eastern quadrant of the interchange when this planned off-ramp is constructed in the long term.

The on-ramp from the eastbound service area can furthermore be constructed in the interim to join the freeway at an earlier position in the absence of the planned on-ramp from the interchange. Refer to the *Development Plans* which are attached.

5 TRAFFIC IMPACT ASSESSMENT OF PROPOSED FILLING STATIONS AND REST AREAS

5.1 INTRODUCTION

It is generally accepted that filling stations and rest areas along highways are not trip generators but are intercepting existing traffic along these highways. The typical peak hour demand – at the accesses and on the internal circulation routes – is also low from a capacity and operational point of view.

Traffic Impact Assessments for filling stations and rest areas should therefore address the following:

1. Geometric design of accesses to minimise friction and ensure traffic safety;
2. On-site circulation from a safety and efficiency / convenience point of view;
3. Pedestrian movements from a safety and convenience point of view;
4. On-site parking from a demand point of view;

All these issues will be addressed in more detail during the SDP and detailed design phases of the project. At this stage it is however necessary to comply with the guidelines of SANRAL in this regard. These guidelines are based on standards of the Department of Transport in this regard.

Appendix G (attached) shows the conceptual layout of the planned facilities. These sketch plans were prepared by Theunissen Jankowitz Architects and although they clearly show the intentions of the developer, they still have to undergo a comprehensive iterative design process in terms of traffic, structural, and civil engineering services before the finalisation of the Site Development Plans (SDP).

5.2 ACCESSES AND LINKAGES

The direct accesses to the sites from the N4 Freeway were discussed in detail in *Section 4* and are shown in *Appendix E* and *Appendix F*.

A Service Road will be provided to each of the respective facilities from existing access roads / intersections along Road D2726 to provide access to the facilities for Service and Delivery Vehicles (not the public) and to link the two facilities via Road D2726. Pedestrian movements between the facilities can be accommodated via the existing bridge crossing of Road D2726.

5.3 ON-SITE CIRCULATION

Generally accepted and appropriate traffic engineering principles and standards will be applied to design the traffic circulation on the sites:

- The circulation system and parking areas of the light vehicles will be separated from the circulation system and parking areas of the heavy vehicles;
- Appropriate geometric design guidelines and standards for vehicle paths, turning radii, and intersection of roadways for both light vehicles and heavy vehicles;

5.4 PEDESTRAIN MOVEMENTS

Sidewalks and safe pedestrian crossings of vehicular roadways will be provided on the sites. Raised pedestrians crossings and traffic calming measures will be implemented where necessary.

5.5 ON-SITE PARKING

The parking requirements of the sites will increase with the growth in traffic and patrons in future.

The following minimum number of parking bays – per site - is recommended during the initial construction of the sites:

- Light vehicles 120 bays
- Buses 5 bays
- Heavy vehicles 35 bays

Table 1 shows the parking estimates.

Table 1: Recommended Number of Parking Bays

SITE	VEHICLE TYPE	EXPECTED DAILY ATTRACTION IN VEHICLES (2017 – 2037)	SUPPLY FACTOR	PARKING BAYS REQUIRED		RECOMMEN-DED INITIAL NO OF PARKING BAYS
				2017	2037	
EASTBOUND SITE	Light Vehicles	±700 - ±1600	10%	70	160	120
	Buses	±10 - ±25	30%	3	8	5
	Heavy Vehicles	±100 – ±270	15%	15	40	35
WESTBOUND SITE	Light Vehicles	±700 - ±1600	10%	70	160	120
	Buses	±10 - ±25	30%	3	8	5
	Heavy Vehicles	±100 – ±270	15%	15	40	35

6 EXPECTED VIABILITY OF PROPOSED FILLING STATIONS AND REST AREAS

6.1 INTRODUCTION

The expected viability of a highway site depends on a multitude of parameters of which the bypassing traffic, interception rates, and average fill determines the fuel sales which must be adequate to cover the development cost (i.e. to repay loans and to provide a return on equity invested) and to ensure acceptable margins on the operation of the facilities.

However the type of transaction and the structuring of the development, and the specific operational arrangements are also important and influences the development of the financial model to evaluate the viability.

6.2 IMPLEMENTATION OF REGULATORY ACCOUNTING SYSTEM (RAS)

The Department of Energy (DoE) has recently (2013) introduced the Regulatory Accounting System (RAS) for the petroleum sector which is used to determine appropriate margins for petrol and diesel at wholesale, retail, secondary storage and secondary distribution level. According to the Department of Energy (DoE), RAS seeks to introduce transparency into the market as well as root out inefficiencies, cross subsidization and uncontrolled costs.

The current price structure is composed of three main elements, namely retail margin, wholesale margin and service differential. The retail margin is the return on investment and cost recovery for retail service stations; the wholesale margin is the return on investment and cost recovery in the wholesaling of petroleum products; and service differential is the return on investment and cost recovery in the secondary storage and secondary distribution of petroleum products to the final consumer.

Although the RAS does not encourage vertical integration in the petroleum market; it does allow a licensed wholesaler to own a retail business for training purposes. The legislation allows one retail license for the first 100 sites and one retail license for every additional 200 sites supplied with petroleum products by the wholesaler but no more than nine retail licenses in total.

6.3 TYPE OF TRANSACTIONS

The required capital for a filling station development is either provided by an oil company (in case of an outright purchase) or financed by a financial institution based on the expected rental income stream (guaranteed by an oil company) normally over a 10-year period. Back-to-back rental agreements is then concluded between the oil company and the developer / owner on the one hand over a period of 20-25 years, and the oil company and the operator on the other hand over a period of 10-15 years.

Although various types of transactions are possible in the development of a new filling station, the most common roles of the developer/owner, oil company, and the operator are subsequently described.

Developers, operators, and oil companies are compensated for the development and operation of filling stations through the retail margin on fuel (regulated for petrol but not for diesel) which comprises of two components, namely an activity margin for the operations and a capital margin for the development. The total retail margin on petrol was about R1.50 / litre at the end of 2014.

6.3.1 DEVELOPER / OWNER

The developer / owner of a highway site can either sell the site to an oil company (preferred option from an oil company's point of view) or can conclude a long-term rental agreement for a monthly rental. These rental agreements are typically for a 20-25 year period during which the rental income of the first 10 years are used to service and repay the financing cost.

In both instances a rebate is sometimes negotiated on the wholesale price of fuel that is an additional source of income for the developer / owner. This rebate reduces the wholesale margin on fuel.

The developer / owner is sometimes required to invest equity in the project if there is a shortfall between the financing cost over a 10-year period and the rental income during the same period, and/or to show his commitment in the project.

6.3.2 OIL COMPANY

The oil company can either purchase the site outright or pays a monthly rental to the developer / owner. In addition, it is sometimes agreed to pay an additional rebate to assist with the development cost.

The oil company can either provide the funding to develop the site (in case of an outright purchase) or can guarantee the monthly rental to enable the developer / owner to secure the funding (in case of a rental agreement).

The oil company subsequently appoints an operator that pays a monthly rental to operate the site.

6.3.3 OPERATOR

The operator pays a monthly rental to the oil company. The operator receives the retail activity margin on fuel sales.

The operator also receives a mark-up on the turnover of the C-store and Fast Food outlets or alternatively a rental income from a third party.

6.4 FINANCIAL MODELLING

The type of transaction and contractual arrangements between the developer, owner, operator, and the fuel company influence the revenue streams and the cost streams for the development and operations of a filling station. The financial model must therefore take cognisance of the type of transaction and the contractual arrangements.

The Regulatory Accounting System (RAS) is based on the Retailer Owned Retailer Operated (RORO) site, in line with the policy that prohibits (i.e. restrict to only a few training sites) vertical integration. Under the RORO site, the retailer owns all the assets and the entire margin would accrue to the retailer.

In reality oil companies owns approximately 65% of all retail sites, known as Company Owned Retailer Operated (CORO) sites.

Since the detail of the contractual arrangements – developer versus oil company versus operator – is not known at this stage, a Financial Model was developed from the perspective of all the parties involved; namely the developer/owner, the oil company, and the operator. This Financial Model is suitable to assess the viability of the development of the highway sites from all the above-mentioned perspectives.

7 EXPECTED FUEL SALES

7.1 TRAFFIC DEMAND AND TRAFFIC GROWTH

7.1.1 AVERAGE DAILY TRAFFIC AND HISTORIC TRAFFIC GROWTH

The Brits Toll Plaza has been in operation from December 2003 and is the most accurate source of traffic data for the proposed highway sites. The traffic in an eastbound direction through the toll plaza represents the bypassing traffic for the proposed highway site in an eastbound direction while the traffic on the on-ramp of the M21 (K25) interchange must first be deducted from the traffic in a westbound direction through the toll plaza to obtain the bypassing traffic in a westbound direction.

Table 2 shows the historic traffic data and growth rates between 2004 and 2014 at the application sites, while *Table 3* shows the current bypassing traffic.

Although very high traffic growth rates are evident between 2004 and 2014, it is not expected that these high rates will be sustained into the future. The historic high traffic growth rates are linked to the initial establishment and development of the corridor which was initiated by the construction of the N4 Platinum Highway.

Table 2: Historic Traffic Data at the Brits Toll Plaza (2004 – 2014)

DESCRIPTION	VEHICLE TYPE	2004	2014
AVERAGE DAILY TRAFFIC DEMAND	TOTAL TRAFFIC	6,317	12,099
	Light Vehicle Traffic	5,720	10,243
	Heavy Vehicle Traffic	597	1,856
AVERAGE ANNUAL TRAFFIC GROWTH RATE	TOTAL TRAFFIC	6.7%	
	Light Vehicle Traffic	6.0%	
	Heavy Vehicle Traffic	12.0%	

Table 3: Current Average Daily Bypassing Traffic at proposed Highway Sites (2014)

DESCRIPTION	EASTBOUND	WESTBOUND	TOTAL
TOTAL TRAFFIC	6,353	6,027	12,380
Light Vehicle Traffic	5,404	5,216	10,620
Heavy Vehicle Traffic	949	811	1,760

7.1.2 FORECASTED TRAFFIC GROWTH RATES

Although there are many factors that influence the growth of traffic on a road segment or in a corridor; the majority of these factors are related to the growth in the economy as represented by the growth in the GDP.

AECOM has done an analysis to forecast traffic growth in the corridor by using regression analysis based on historic traffic information – referred to as trend regression analysis – and regression analysis based on GDP growth rates. These analyses were done separately for Toll Class 1 (light vehicles) and Toll Classes 2-4 (heavy vehicles).

AECOM has recommended that the average of the trend analysis and the GDP regression analysis be used to forecast future traffic growth in the corridor specifically at the Brits Toll Plaza.

These recommended annual traffic growth rates of 4.60% and 5.90% were subsequently also used in the viability study for the proposed highway sites during the analysis period (2-year planning and construction period and 20-year operation period) for light vehicles and heavy vehicles respectively. Refer to *Table 4*.

Table 4: Forecasted Traffic Growth Rates (2014 – 2036)

YEAR	LIGHT VEHICLES	HEAVY VEHICLES
2014 - 2036	4.60%	5.90%

7.2 INTERCEPTION RATES AND AVERAGE FILLS

The average interception rates and average fills for different fuel and vehicle types, in combination with the extent of bypassing traffic, determine the expected fuel sales of a filling station. These parameters however are related to the type of traffic and type of market that are served.

7.2.1 TYPE OF MARKET

Typically three distinct markets can be identified for filling stations:

- Local Market - Residential Traffic – serving residents that typically make regular short distance trips;
- Urban / Inter-urban Market - Commuting Traffic – serving commuters and otherwise business traffic that travels medium distances on a daily basis often during peak periods;
- Transient Market – Long Distance Traffic – serving long distance traffic that travels less frequently;

Highway sites typically serves a combination of commuting and long distance traffic; that varies from mostly commuting traffic in metropolitan areas or between metro poles, and mostly transient traffic in rural areas between towns.

The interception rates and the average fills for long distance traffic (transient market) is much larger compared to commuting and residential traffic. This is explained by fewer fuel stops that are made given fewer filling opportunities (less frequent stops with larger fills) compared to commuting and residential traffic that are making more fuel stops given more filling opportunities (more frequent stops with smaller fills).

Filling stations rarely serve only a single market but rather a combination of the three distinctive markets which are described above.

7.2.2 TYPICAL INDICATIONS OF INTERCEPTION RATES AND AVERAGE FILLS

The expected interception rates and fills of a new filling station is generally determined based on empirical evidence of interception rates and fills under similar conditions; i.e. same market, same accessibility, and same road network conditions.

It is important to note the following in this regard:

- Interception rates and fills are time-dependent and will change over time with the growth in bypassing traffic, changes in the road network, and based on competition in the market. For this reason the interception rates and average fills that are given for reference purposes are only used in an indicative way.
- The interception rate of a highway site includes a large component which is not fuel related; i.e. interception for comfort and food purposes. Research by some has shown that the total interception rate of a highway facility is often double the fuel related interception rate.
- The interception rates quoted in this viability study however refers strictly to fuel related interception rates which were mostly calculated by using known fuel sales and known traffic demand.

Table 5, *Table 6*, and *Table 7* that follows show typical trends for interception rates and average fills in the market.

Table 5: Comparison between Markets (INFRAGEN, 2005)

MARKET	AVERAGE FILLS (litre per vehicle)			INTERCEPTION RATES (%)	
	PETROL	DIESEL ON MAIN FORE-COURT	REMOTE DIESEL	LIGHT VE-HICLES	HEAVY VEHICL ES
<u>URBAN / INTERURBAN</u> TOTAL Petroport (dual), SASOL The Rose (dual), SHELL Ben Schoeman (dual), CALTEX Ben Schoeman (dual)	29.0	36.3	205.6	4.8%	1.6%
<u>TRANSIENT</u> ENGEN Vaal (dual), ENGEN Blockhouse (dual), ENGEN Grasmere (dual), ENGEN Olifantsfontein (dual)	32.7	49.1	205.1	8.5%	4.1%

Table 6: Change in Average Fills (INFRAGEN, 2005 and 2010)

MARKET	SOURCE	DIRECTION	AVERAGE FILL (litre per vehicle)	
			PETROL	REMOTE DIESEL
TOTAL Petroport, EXEL The Rose, SHELL Middelburg, CALTEX Milly's, TOTAL Wonderboom	INFRAGEN, 2005	Both	35.1	137.6
MARKET	SOURCE	DIRECTION	PETROL	SAMPLE SIZE
TOTAL Petroport, ENGEN Kranskop, SHELL Polokwane	INFRAGEN, 2010	Northbound	47.6	168
		Southbound	41.5	151
		Both	44.7	319

Table 7: Interception Rates for Various Routes (Techworld Report, March 2010)

ROUTE	DATE	LIGHT VEHICLES	HEAVY VEHICLES
<u>N1 TSHWANE TO MOKOPANE</u> TOTAL Petroport, ENGEN Kranskop, SASOL Nyl	2008	6.8%	3.4%
<u>N1 KROONSTAD TO COLESBERG</u> ENGEN Kroonvaal, ENGEN Bloem 1-Stop, ENGEN Merino 1-Stop	2008	11.8%	6.2%
<u>N3 VILLIERS TO LADYSMITH</u> ENGEN Villiers 1-Stop, SHELL Balmoral Ultra City, ENGEN Bergview 1-Stop, TOTAL Mountainview Petroport (Swinburne), SHELL Montrose Whistle Stop (Swinburne), CALTEX Van Reenen Drakensberg, ENGEN Tugela 1-Stop	2008	6.8%	4.7%
<u>N4 TSHWANE TO NELSPRUIT</u> SASOL The Rose, SHELL Middelburg, TOTAL Wonderfontein, ENGEN Belfast 1-Stop, CALTEX Milly's, SHELL Machadodorp, ENGEN Ngodwana, SHELL Halls	2005	6.2%	4.4%
<u>N12</u> N12 East Petroport	2005	7.6%	4.6%

Table 8 that follows shows the assumptions on average fills and interception rates for three recent applications namely N1 Irrigation (not yet constructed), N4 TOTAL Alzu (operational), and N4 ENGEN Doornpoort (operational).

Table 8: Assumptions Used for Recent Applications (i.e. Highway Sites)

APPLICATION	ROUTE	SOURCE	DIRECTION	ASSUMPTIONS				
				AVERAGE FILL (litre per vehicle)			INTERCEPTION RATE (%)	
				PETROL	DIESEL LV	DIESEL HV	LV	HV
IRRIGATION APPLICATION	N1	WSP, 2012	NB	32.5	32.5	140.0	5.0%	2.0%
			SB	32.5	32.5	140.0	4.5%	2.0%
ENGEN KRANSKOP 2011 Data	N1	Techworld, 2012	NB	32.5	32.5	140.0	4.5%	4.6%
			SB	32.5	32.5	140.0	6.6%	6.0%
ALZU 2011 Data	N4	ICE, 2012	BOTH	35.0			4.1%	
ENGEN DOORNPOORT APPLICATION	N4	WSP, 2009	EB	30.0			7.5%	
			EB LOCAL	18.0			3.0%	
			WB	30.0			9.0%	
			WB LOCAL	18.0			3.0%	

7.2.3 SURVEYS CONDUCTED AT EXISTING HIGHWAY SITES

The current interception rates of the ENGEN One-Stop at Doornpoort and the TOTAL Petroport at Magalies were surveyed during a 12-hour period on 31 July 2014 (Thursday), 01 August 2014 (Friday), and on 02 August 2014 (Saturday).

The total interception rates – for fuel and other purposes – was recorded per direction and for light vehicles and heavy vehicles separately and are indicated in *Table 9*.

The average interception rate of the ENGEN One-Stop at Doornpoort in an eastbound direction is also available on an annual basis from CTO1640. *Table 10* shows that 12.8% of the light vehicles and 18.6% of the heavy vehicles were intercepted during the period 1 November 2013 to 31 October 2014.

There is a relatively large discrepancy between the interception rate for heavy vehicles indicated by the CTO Station (18.6%) and the rate that was surveyed (10.9%) which is partly explained by the short survey period.

Table 9: Surveyed Interception Rates for ENGEN Doornpoort and TOTAL Magalies

TYPE	DESCRIP -TION	TIME PERIOD	THURSDAY 31-Jul-14	FRIDAY 01-Aug-14	SATURDAY 02-Aug-14	SUM AVE
ENGEN DOORNPOORT EASTBOUND						
Light Vehicles	Demand	06:00 - 18:00	11171	11971	10083	33225
	Attraction	06:00 - 18:00	1201	1409	840	3450
	Rate		11%	12%	8%	10.4%
Heavy Vehicles	Demand	06:00 - 18:00	1399	1707	1348	4454
	Attraction	06:00 - 18:00	104	203	180	487
	Rate		7%	12%	13%	10.9%
ENGEN DOORNPOORT WESTBOUND						
Light Vehicles	Demand	06:00 - 18:00	13201	6483	7220	26904
	Attraction	06:00 - 18:00	1455	713	802	2970
	Rate		11%	11%	11%	11.0%
Heavy Vehicles	Demand	06:00 - 18:00	1493	682	649	2824
	Attraction	06:00 - 18:00	120	93	107	320
	Rate		8%	14%	16%	11.3%
TOTAL PETROPORT MAGALIES WESTBOUND						
Light Vehicles	Demand	06:00 - 18:00	6173	7171	5084	18428
	Attraction	06:00 - 18:00	476	731	524	1731
	Rate		8%	10%	10%	9.4%
Heavy Vehicles	Demand	06:00 - 18:00	1095	648	392	2135
	Attraction	06:00 - 18:00	37	57	20	114
	Rate		3%	9%	5%	5.3%
AVERAGE INTERCEPTION RATES						
ENGEN	Light Vehicles					10.7%
	Heavy Vehicles					11.1%
TOTAL	Light Vehicles					9.4%
	Heavy Vehicles					5.3%

Table 10: ENGEN Doornpoort - Average Interception Rate for Eastbound Traffic (2014 CTO1640)

VEHICLE TYPE	DESCRIPTION	AVERAGE DAILY TRAFFIC
Light Vehicles	N4 Bypassing Traffic	13016
	On-Ramp from 1-Stop	1661
	Interception Rate	12.8%
Heavy Vehicles	N4 Bypassing Traffic	1692
	On-Ramp from 1-Stop	314
	Interception Rate	18.6%

7.2.4 MARKET AND EXPECTED FUEL PARAMETERS FOR APPLICATION SITES

The proposed highway facilities will serve long distance traffic along the N4 Platinum Highway between origins / destinations in the east (along the N1 National Freeway and the City of Tshwane) and in the west (in the North-West Province up to the Border with Botswana).

Although the proposed facilities will primarily serve a transient market with long distance traffic; the location between the Tshwane Metropolitan Area in the east and Brits (Madibeng Local Municipality) in the west and Rustenburg in the far west will also result in commuting traffic patronizing the facilities.

The fuel demand characteristics of the proposed facilities are expected to be indicative of a transient market; i.e. relatively higher average fills and attraction rates.

Table 11: Assumed Fuel parameters for proposed Highway Site

DIRECTION	AVERAGE FILLS (litre per vehicle)			INTERCEPTION RATES (%)	
	PETROL	DIESEL ON MAIN FORECOURT	REMOTE DIESEL	LIGHT VEHICLES	HEAVY VEHICLES
EASTBOUND	30.0	45.0	150.0	5.5%	4.0%
WESTBOUND	30.0	45.0	150.0	5.5%	4.0%

7.3 EXPECTED FUEL SALES

The full potential of a filling station is generally only realized after an initial ramp-up period. Ramp-up percentages of 85%, 90%, and 95% were assumed during the first three years of operation.

It is expected that the planned highway site will be operational from 01 January 2017. The expected total fuel sales after the opening will be approximately 0.90 million litres per month. A breakdown between petrol and diesel sales to light and heavy vehicles respectively are shown in *Table 12*.

Table 12: Expected Average Monthly Fuel Sales After Opening (January 2017)

DIRECTION	AVERAGE MONTHLY FUEL SALES IN 2017		
	WITHOUT RAMP-UP	RAMP-UP	WITH RAMP-UP
PETROL Light Vehicles	487 700	85%	414 550
DIESEL Light Vehicles	182 900	85%	155 450
DIESEL Heavy Vehicles	381 300	85%	324 100
TOTAL AVERAGE MONTHLY FUEL SALES	1 051 900	85%	894 100

The expected average monthly fuel sales will increase in future based on the expected growth in traffic:

- 1.28 million litres in year 5,
- 1.64 million litres in year 10, and
- 2.11 million litres in year 15.

8 ESTIMATED DEVELOPMENT COST

8.1 INTRODUCTION

The development cost of the proposed highway facilities comprises of all the required expenditure to build, to equip, and to start operating the facilities. The development cost will be financed through a loan from a financial institution and through equity investment by the owner / developer.

The development cost comprises of the following items:

- Acquisition of land;
- Construction of facilities;
- Provision of equipment (pump & tank);
- Provision of signage;
- Obtaining rights and licenses;
- Professional fees; and
- Profit for developer;

The above mentioned items are referred to as capital cost. Additional investment however is necessary to commence with operations which are referred to as the operational start-up cost.

8.2 LAND ACQUISITION COST

The owner / developer of the proposed highway sites has purchased the Remainder of Portion 22 (63.0749ha) and the Remainder of Portion 41 (33.2015ha) of the farm Schietfontein 437 JQ for this purpose. The required land for the facilities – on which new townships will be established - will be subdivided and the excess land will be sold.

Table 13 shows that 96.3 ha was purchased for the project at a total cost of about R 13.7m. Since only about 16.84 ha is required for the project, the excess land will be sold at an estimated cost of about R 4.0m. The land cost typically forms part of the equity investment by the owner / developer.

Table 13: Acquisition of Land

DESCRIPTION	PURCHASE		RESELL
PORTION 22		63.0749 ha	
Portion A	55.1349 ha		R 2 750 000
Portion B	7.9400 ha		
PORTION 41		33.2015 ha	
Portion A	8.9000 ha		
Portion B	24.3015 ha		R 2 150 000
TOTAL AREA		96.2764 ha	79.4364 ha
COST		R 13 700 000	R 4 000 000
COST / SQM		R 14.23 / m^2	R ±5.00 / m^2

8.3 COST OF CIVIL WORKS AND ENGINEERING SERVICES

The construction cost of the project in terms of all the civil works and engineering services was estimated by VIP Consulting Engineers as shown in *Table 14*.

The total cost of civil works and engineering services is estimated at about R 61.0m. This cost excludes building cost, professional fees, contingencies and VAT.

Table 14: Civil Works and Engineering Services (2014 Rand) (VIP Consulting Engineers)

DESCRIPTION	EASTBOUND FACILITY	WESTBOUND FACILITY	BOTH
ROADS AND STORMWATER			56 576 000
Access Road	4 210 500	3 227 000	
Heavy vehicle apron	8 892 000	8 568 000	
Light vehicle apron	3 702 500	3 475 000	
Egress Road	4 816 000	2 394 000	
Service Road	1 060 000	2 356 000	
Concrete Barriers	1 400 000	1 435 000	
Concrete Kerbs	270 000	270 000	
Stormwater Pond	300 000	300 000	
Retaining Structure	250 000	250 000	
Bridge Structure	9 400 000	0	
Sub-Total	34 301 000	22 275 000	
WATER AND SEWER INFRASTRUCTURE			4 366 012
TOTAL CONSTRUCTION COST			60 942 012

8.4 TOTAL DEVELOPMENT COST

The total development cost in terms of capital cost, operational start-up cost, and land acquisition cost is summarised in *Table 15*. The estimated cost to develop the facilities is about R152m. This cost comprises of about R111m capital cost, about R15m operational start-up cost, an expected escalation of 10% in costs, and the R13.7m cost for the land.

Table 15: Summary of Development Cost

TYPE	DESCRIPTION	COST (2014 RAND)	
CAPITAL COST	Civils	61 000 000	110 745 000
	Building Cost	20 000 000	
	Professional Fees	3 500 000	
	Rights and Licenses	1 800 000	
	Pumps & Tanks	5 000 000	
	Developers Profit	0	
	Signage	5 000 000	
	Contingency of 15%	14 445 000	
OPERATIONAL START-UP COST	Start-up Store Stock	3 000 000	15 000 000
	Start-up Fuel Stock	4 000 000	
	Initial Training	400 000	
	Miscellaneous Start-up Costs	600 000	
	Key Money	7 000 000	
COST ESCALATION	Capital and Start-up Cost	125 745 000	138 319 500
	Cost Escalation of 10.0%	12 574 500	
LAND ACQUISITION COST	Purchase Price		13 700 000
TOTAL DEVELOPMENT COST			152 019 500

9 ESTIMATED OPERATIONAL COST AND REVENUE

9.1 OPERATIONAL EXPENSES

9.1.1 TYPICAL EXPENSE ITEMS

The operational expenses for a highway sites comprises of numerous items shown in *Table 16*:

9.1.2 EXPECTED OPERATIONAL COST

The total operational cost for both facilities is based on the known operational cost of similar facilities and amounts to about R 12,000,000 (2014 Rand) per annum.

Table 16: Typical Operational Expense Items

OPERATIONAL EXPENSE ITEMS		
➢ Convenience Store Royalties; ➢ Restaurant Royalties; ➢ Electricity, Water & Waste; ➢ Account Fees; ➢ Advertisements; ➢ Bank Charges / Cash Collection; ➢ Cleaning & Consumables; ➢ Computer Expenses;	➢ Entertainment; ➢ Garden Maintenance; ➢ Insurance Premium; ➢ Legal Fees; ➢ Management Fees; ➢ Lease of Equipment; ➢ Printing & Stationary; ➢ Repairs & Maintenance;	➢ Salaries: Forecourt & Stores; ➢ Staff Welfare; ➢ Security; ➢ Telephone & Fax; ➢ Subscriptions; ➢ Uniforms; ➢ Annual Interest; ➢ Miscellaneous Expenses; ➢ SANRAL Levies;

9.1.3 ROYALTIES AND LEVIES

The operator of the highway sites will have to pay the following levies and royalties to third parties for branding and advertising (franchisor) and as compensation for direct access from the N4 freeway (SANRAL).

Table 17: Summary of Levies and Royalties

THIRD PARTY	TYPE	LEVY	BASIS FOR CALCULATION
BRANDED / LICENSED STORES	C-Store Advertising & Royalties	8.5%	Turnover of C-Store
	Restaurant Advertising & Royalties	9.0%	Turnover of Restaurant
SANRAL	Fuel Levy	0.5%	Turnover of Fuel Sales
	C-Store Levy	1.0%	Turnover of C-Store and Restaurant

9.2 ESTIMATED OPERATING REVENUE

9.2.1 FUEL SALES AND COMPLIMENTARY SALES

The fuel sales and the complimentary sales – C-store and restaurant – are calculated as follows:

❖ The expected monthly fuel sales:

[Fuel Sales (l)] = [average daily traffic] X [interception rate] X [average fill (l)] X 30

- The expected complimentary C-Store sales:

  [C-Store Sales (R)] = [Fuel Sales (l)] X [R1.50]

- The expected complimentary Restaurant sales:

  [Restaurant Sales (R)] = [Fuel Sales (l)] X [R1.30]

9.2.2 FUEL MARGINS

The current published (December 2014) retail fuel margin for petrol is 151.1 cent/litre while the wholesale fuel margin is 33.5 cent/litre for petrol and 64.7 cent/litre for diesel. Since diesel is not regulated the retail fuel margin is determined by the service station operator.

The developer (owner) has indicated that the fuel margins shown in *Table 18* will be available to fund the development and operations of the sites.

Table 18: Recent Published (November 2014) and Assumed Fuel Margins

DIRECTION	RETAIL MARGIN (*cent per litre*)	WHOLESALE MARGIN (*cent per litre*)	
		TOTAL	AVAILABLE FOR RETAIL PURPOSES
PETROL	**151.1**	**33.5**	*33.5*
DIESEL Light Vehicles	*151.1*	**64.7**	*36.5*
DIESEL Heavy Vehicles	*100.0*	**64.7**	*36.5*

Note: PUBLISHED margins in "**bold**" and ASSUMED margins in "*italic*"

The operating revenue from the fuel margins are thus

9.2.3 COMPLIMENTARY REVENUE

Complimentary sales of R1.50 and R1.30 (2014 Rand) per litre fuel sold with net margins of 25% and 40% for the C-Store and Restaurant respectively were assumed based on typical industry averages in this regard.

10 IMPACT ON VIABILITY OF COMPETING FILLING STATION SITES

10.1 SCOPE OF SERVICES AND FACILITIES

The planned highway sites will provide convenient fuel, food, rest area, and restroom (ablution) facilities and services to road users along the N4 Platinum Highway. These essential services will be provided to the occupants of both light and heavy vehicles. Overnight parking facilities will furthermore be provided to trucks. The need for overnight parking facilities are indicated by the large number of trucks that currently overnight along the N4 at the neighbouring Brits Toll Plaza.

The services that will be provided are not only important from a convenience point of view but is also essential from a road safety perspective.

10.2 IMPACT ON COMPETING SITES

10.2.1 COMPETING FILLING STATION SITES

The planned highway facilities will not have a significant impact on the viability of any competing filling station:

- ➢ Since any given traffic stream is generally served by several filling stations the addition of another filling station can at most have a modest impact on the fuel sales of the other filling stations;
- ➢ Numerous other filling stations are located in the larger area / corridor but these filling stations are serving different markets and different traffic streams;
- ➢ The existing highway sites along the N4 Platinum Highway are located more than 30km from the planned highway sites; and
- ➢ Existing traffic growth of about 4.6% p.a. for light vehicles and about 5.9% p.a. for heavy vehicles in the corridor continuously increases the traffic demand and thus demand for fuel sales that allows new entries into the market without significantly affecting the fuel sales of existing filling stations;

Appendix H shows the location of other filling station sites in the corridor; i.e. existing filling stations, properties with existing filling station land use rights, and applications received by the Madibeng Town Planning Division.

10.2.2 LOCAL MARKET

The typical interception rate of 3% for local filling stations implies that about 5 filling stations are required to serve a single traffic stream since motorists typically fill once per week [100 /

(3% X 7 days)]. This is based on an average annual mileage of 15,000 km (288 km per week), an average fuel consumption of 10 litres/km, and thus an average fill of 29 litres once per week.

It follows – all other things being equal – that the worst case scenario will occur if another filling station is constructed that serves exactly the same traffic stream as the existing 5 filling stations. In this worst case scenario the maximum impact that can be expected is thus an average reduction of 17% [1 – 1 / (6/5)] in the fuel sales of the existing 5 filling stations. This however assumes no growth in traffic (which is unrealistic) and exactly the same traffic stream that bypasses all 5 filling stations plus the application site (which is very unlikely).

The "competing" local filling stations – refer to *Appendix H* – is located along different routes that serves different markets and different traffic streams. The likely maximum impact will thus be insignificant.

It should furthermore be considered that these "competing" local filling stations cannot provide the same range of facilities and services to the road user compared with the application sites (i.e. fuel, food, rest area, restrooms (ablution), and overnight parking for trucks).

The "competing" local filling stations are generally located in two clusters namely in the Pretoria North area and in the Brits area. Both clusters are located more than 15km from the application sites and are clearly serving different markets since these filling stations are located along local streets and provincial roads.

A few "competing" local filling stations are located closer to the application sites, most notably the CALTEX at Skietfontein along the R513 and the SASOL at Schoemansville at the R511 / R560 intersection. A very small percentage shared traffic is expected between the application sites and these two filling stations since the application sites cannot serve traffic on the crossroad (D2726 / M21) or any turning movements from the N4 Freeway to the M21 and vice versa.

It is hence concluded that the likely impact of the new highway sites on the sustainability of the "competing" local filling stations will be small – i.e. single digit figures - and is not an important consideration given firstly that the general growth in traffic volumes justifies new entries into the market and secondly very different markets will be served by the application sites compared with the local filling stations.

10.2.3 URBAN AND INTER-URBAN AND LONG DISTANCE MARKET

The ENGEN One Stop at Doornpoort and the TOTAL Petroport at Magalies highway sites are located approximately 30km and 33km east and west of the planned highway sites respectively. The expected impact of the new highway sites on these two existing highway sites is directly related to the percentage shared traffic between these sites; i.e. the maximum possible impact is defined by the percentage shared traffic.

The percentage shared traffic between the highway sites can be determined by using the available traffic information along the N4 Platinum Highway in combination with long term and 12-hour traffic counts on the respective off- and on-ramps between these facilities.

It is noted that although some assumptions are required and that traffic volumes cannot be balanced perfectly (due to normal traffic variations especially in short-term traffic counts), the investigation nevertheless gives a reasonable indication of the expected shared traffic.

The percentage shared traffic – and thus expected potential loss in existing fuel sales due to the new application sites - was calculated separately for the ENGEN One-Stop at Doornpoort and for the TOTAL Petroport at Magalies.

10.2.3.1 ENGEN One-Stop at Doornpoort

The ENGEN One-Stop at Doornpoort comprises of dual facilities that is located directly west of the Doornpoort Mainline Plaza in the interchange with Route K99 (Dr Swanepoel Road) with direct access from the N4 Freeway. Recent traffic surveys showed very high interception rates of more than 10% for both light vehicles and heavy vehicles in both directions.

Table 19 shows that only about 14% of the current traffic volumes that bypasses the ENGEN One-Stop at Doornpoort will be shared by the application sites.

Table 19: ENGEN One Stop Doornpoort - Estimated Exclusive versus Shared Traffic Markets

DIREC-TION	TYPE OF VEHICLE	DESCRIPTION	AVERAGE DAILY VEHICLES		PERCENTAGE SPLIT	
			ENGEN	APPLICA-TION	ENGEN	APPLICA-TION
Westbound Direction	Light Vehicles	Bypassing Traffic	12 309	5 195		
		Off-Ramps	11 686			
		On-Ramps		4 587		
		On- & Off-Ramps	1 000	1 000		
		Exclusive Market	10 686	3 587	87%	69%
		Shared Market	1 623	1 608	13%	31%
	Heavy Vehicles	Bypassing Traffic	1 704	806		
		Off-Ramps	1 480			
		On-Ramps		646		
		On- & Off-Ramps	100	100		
		Exclusive Market	1 380	546	81%	68%
		Shared Market	324	260	19%	32%

DIREC-TION	TYPE OF VEHICLE	DESCRIPTION	AVERAGE DAILY VEHICLES		PERCENTAGE SPLIT	
			ENGEN	APPLICA-TION	ENGEN	APPLICA-TION
Eastbound Direction	Light Vehicles	Bypassing Traffic	13 016	5 433		
		Off-Ramps		4 728		
		On-Ramps	12 243			
		On- & Off-Ramps	1 000	1 000		
		Exclusive Market	11 243	3 728	86%	69%
		Shared Market	1 773	1 704	14%	31%
	Heavy Vehicles	Bypassing Traffic	1 692	824		
		Off-Ramps		640		
		On-Ramps	1 597			
		On- & Off-Ramps	100	100		
		Exclusive Market	1 497	540	88%	66%
		Shared Market	195	283	12%	34%
Both Directions	Light Vehicles	Exclusive Market	21 930	7 315	87%	69%
		Shared Market	3 396	3 312	13%	31%
		Total LV Traffic	25 325	10 628	100%	100%
	Heavy Vehicles	Exclusive Market	2 877	1 087	85%	67%
		Shared Market	519	543	15%	33%
		Total HV Traffic	3 396	1 630	100%	100%
	All Vehicles	Exclusive Market	24 807	8 402	86%	69%
		Shared Market	3 915	3 855	14%	31%
		Total Traffic	28 722	12 257	100%	100%

However this does not imply that the ENGEN One-Stop will lose 14% of its current fuel sales:

- The shared traffic stream is most likely served by several filling stations and any potential loss in fuel sales will be shared between several of these filling stations;
- Even if the shared traffic stream is only served by the two competing highway sites the shared volumes will probably be divided between the two sites all other things being equal;

Table 20 shows that the expected potential loss in fuel sales due to the new application sites will be single digit figures which will not threaten the sustainability of the ENGEN One-Stop at Doornpoort.

Two scenarios were investigated, namely one scenario assumes that all the existing fuel sales comes from the shared traffic stream (which is highly unlikely) while the second scenario assumes that only 50% of the existing fuel sales comes from the shared traffic stream (more realistic assumption). It is furthermore assumed that the first facility in a particular direction will intercept a higher percentage of the shared traffic stream than the facility that follows (65% / 35% assumed).

Table 20: ENGEN One Stop Doornpoort – Expected Potential Loss in Existing Fuel Sales (as a result of new highway sites)

COMPETING FACILITY	DIRECTION	TYPE	SHARED TRAFFIC STREAM	ASSUMED LOSS IN VOLUMES FROM SHARED TRAFFIC STREAM	% OF EXISTING FUEL SALES THAT COMES FROM SHARED TRAFFIC	
					100%	50%
ENGEN	EASTBOUND	LV	14%	65%	8.9%	4.4%
		HV	12%	65%	7.5%	3.7%
	WESTBOUND	LV	13%	35%	4.6%	2.3%
		HV	19%	35%	6.7%	3.3%
	BOTH	LV	13%	50%	6.7%	3.4%
		HV	15%	50%	7.6%	3.8%
		ALL	14%	50%	6.8%	3.4%

10.2.3.2 TOTAL Petroport at Magalies

The TOTAL Petroport at Magalies is a single facility west of the interchange with the R556 (Bapong Interchange) on the southern side of the N4 with direct access in the westbound direction and indirect access in the eastbound direction. Recent traffic surveys showed very high interception rates of about 10% for light vehicles and about 5% for heavy vehicles.

Table 21 shows that only about 23% of the current traffic volumes that bypasses the TOTAL Petroport at Magalies will be shared by the application sites.

Table 21: TOTAL Petroport Magalies - Estimated Exclusive versus Shared Traffic Markets

DIREC-TION	TYPE OF VEHICLE	DESCRIPTION	AVERAGE DAILY VEHICLES		PERCENTAGE SPLIT	
			TOTAL	APPLICA-TION	TOTAL	APPLICA-TION
Eastbound Direction	Light Vehicles	Bypassing Traffic	7 162	5 433		
		Off-Ramps	5 801			
		On-Ramps		3 990		
		On- & Off-Ramps	200	200		
		Exclusive Market	5 601	3 790	78%	70%
		Shared Market	1 561	1 642	22%	30%

DIREC-TION	TYPE OF VEHICLE	DESCRIPTION	AVERAGE DAILY VEHICLES		PERCENTAGE SPLIT	
			TOTAL	APPLICA-TION	TOTAL	APPLICA-TION
	Heavy Vehicles	Bypassing Traffic	827	824		
		Off-Ramps	461			
		On-Ramps		435		
		On- & Off-Ramps	20	20		
		Exclusive Market	441	415	53%	50%
		Shared Market	386	408	47%	50%
Westbound Direction	Light Vehicles	Bypassing Traffic	7 261	5 195		
		Off-Ramps		3 824		
		On-Ramps	5 732			
		On- & Off-Ramps	200	200		
		Exclusive Market	5 532	3 624	76%	70%
		Shared Market	1 729	1 571	24%	30%
	Heavy Vehicles	Bypassing Traffic	871	806		
		Off-Ramps		284		
		On-Ramps	343			
		On- & Off-Ramps	20	20		
		Exclusive Market	323	264	37%	33%
		Shared Market	548	542	63%	67%
Both Directions	Light Vehicles	Exclusive Market	11 133	7 414	77%	70%
		Shared Market	3 290	3 213	23%	30%
		Total LV Traffic	14 423	10 628	100%	100%
	Heavy Vehicles	Exclusive Market	764	680	45%	42%
		Shared Market	934	950	55%	58%
		Total HV Traffic	1 698	1 630	100%	100%
	All Vehicles	Exclusive Market	11 898	8 094	77%	70%
		Shared Market	4 223	4 164	23%	30%
		Total Traffic	16 121	12 257	100%	100%

However this does not imply that the TOTAL Petroport will lose 23% of its current fuel sales:

- The shared traffic stream is most likely served by several filling stations and any potential loss in fuel sales will be shared between several of these filling stations;

- Even if the shared traffic stream is only served by the two competing highway sites the shared volumes will probably be divided between the two sites all other things being equal;

Table 22 shows that the expected potential loss in fuel sales due to the new application sites will be single digit figures – except for heavy vehicles - which will not threaten the sustainability of the TOTAL Petroport at Magalies.

Two scenarios were investigated, namely one scenario assumes that all the existing fuel sales comes from the shared traffic stream (which is highly unlikely) while the second scenario assumes that only 50% of the existing fuel sales comes from the shared traffic stream (more realistic assumption). It is furthermore assumed that the first facility in a particular direction will intercept a higher percentage of the shared traffic stream than the facility that follows (65% / 35% assumed).

Table 22: TOTAL Petroport Magalies – Expected Potential Loss in Existing Fuel Sales (as a result of new highway sites)

COMPETING FACILITY	DIRECTION	TYPE	SHARED TRAFFIC STREAM	ASSUMED LOSS IN VOLUMES FROM SHARED TRAFFIC STREAM	% OF EXISTING FUEL SALES THAT COMES FROM SHARED TRAFFIC	
					100%	50%
ENGEN	EASTBOUND	LV	22%	35%	7.6%	3.8%
		HV	47%	35%	16.3%	8.2%
	WESTBOUND	LV	24%	65%	15.5%	7.7%
		HV	63%	65%	40.9%	20.4%
	BOTH	LV	23%	50%	11.4%	5.7%
		HV	55%	50%	27.4%	13.7%
		ALL	23%	50%	11.7%	5.8%

11 FINANCIAL VIABILITY OF PLANNED HIGHWAY SITES

11.1 INTRODUCTION

Financial analyses are generally done from the viewpoint of either the fuel company / owner of the facility or the operator.

Since the detail of the contractual arrangements – developer versus oil company versus operator – is not known at this stage, a Financial Model was developed from the perspective of all the parties involved; namely the developer/owner, the oil company, and the operator. This Financial Model is suitable to assess the viability of the development of the highway sites from all the above-mentioned perspectives.

A Financial Model was subsequently developed that calculates financial indicators or measures of performance based on the following primary components:

- Forecasted traffic;
- Intercepted traffic;
- Fuel and complimentary sales per month;
- Operating revenue per annum;
- Expenses per annum;
- Capital cost and repayment;
- Net Profit/loss after tax and Capital Repayment;

The financial indicators of interest are the following:

- Return on Equity;
- Net Present Value of Project;
- Positive cash flow throughout project;
- Acceptable repayment period for equity

11.2 ASSUMPTIONS

The financial model is based on the following assumptions:

1. Financing structure of 83.5% debt and 16.5% equity (which already includes the cost of the land that was acquired);
2. CPI escalation of 5.0% p.a. in terms of all the revenue and expense items;
3. Excess land will be resold during year 1 and year 2 of operations;
4. Debt financing can be obtained from a financial institution at a margin of 1.0% below the prime lending rate and must be repaid within 10 years;
5. Shaping of Capital Repayment Profile is acceptable during first three years of operations to ensure a positive cash flow (i.e. net profit) after taxation and capital repayment;
6. Return on Equity (ROE) and Net Present Value (NPV) of project must be sufficient to compensate developer for risk and capital investment in terms of equity;
7. Reasonable repayment period of equity investment;

11.3 RESULTS

The financial indicators in *Table 23* shows that the project is financially viable:

- Return on equity (ROE) that is much larger than the weighted average cost of capital (WACC) of the development company;
- Net Present Value of project (at WACC) that is three times the equity amount that was invested;
- Repayment period of equity investment of less than 8 years;

Table 23: Results of Financial Model

DIRECTION	REAL	NOMINAL
Return on Equity (ROE)	*21.9%*	*28.0%*
Weighted Average Cost of Capital (WACC)	*12.0%*	*17.6%*
Equity Investment	*± R25.1 million*	
Net Present Value (NPV)	*± R75.5 million*	
Repayment period for Equity	*Less than 8 years*	

The financial model is attached as *Appendix J*.

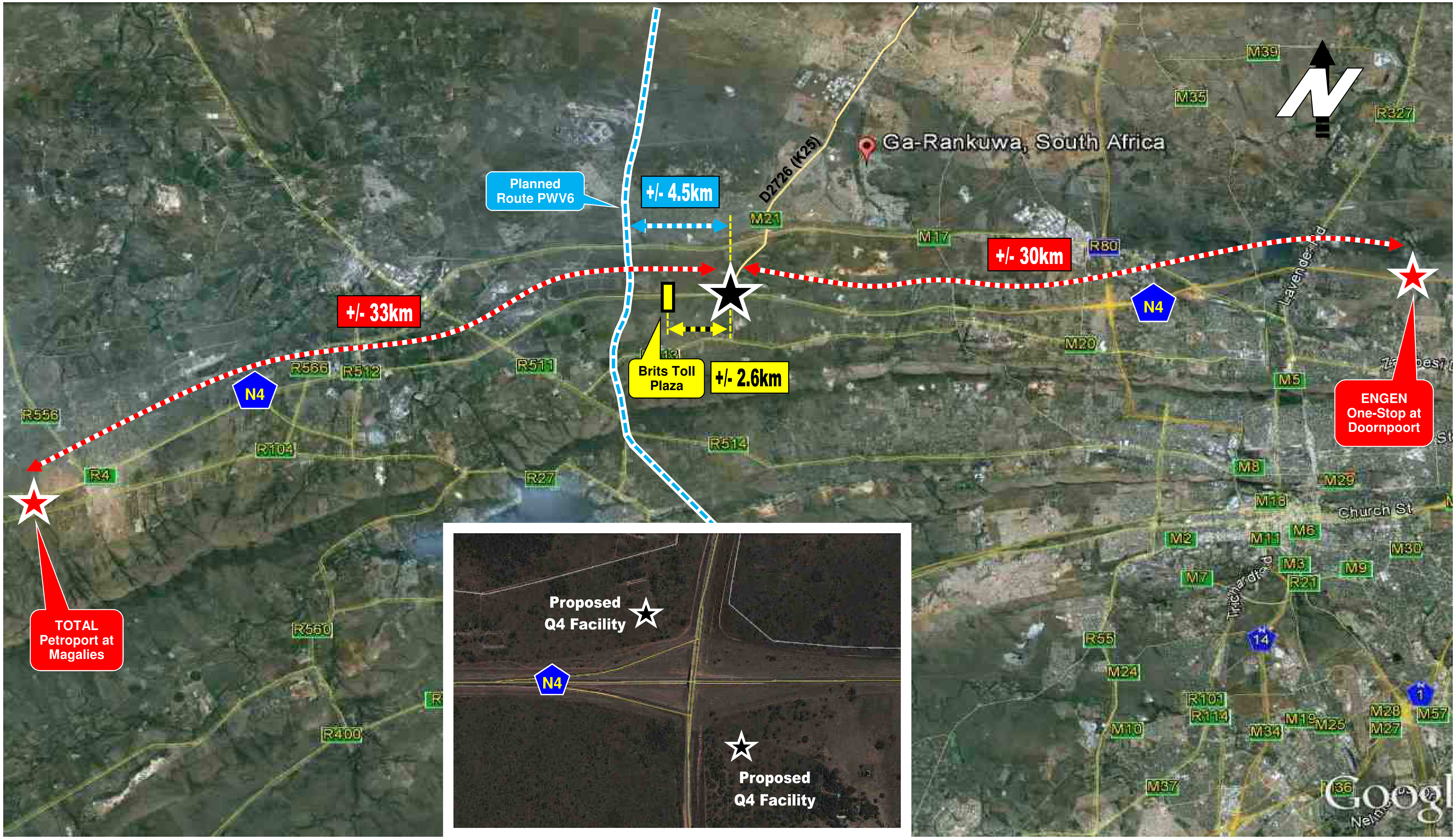
12 CONCLUSIONS

The traffic and viability investigations have shown that the proposed Service Area Facilities (Highway Sites) are both technically and financially viable, and that it is very unlikely that the new application will impact detrimentally on the sustainability of existing facilities in the area and corridor.

BAKWENA and SANRAL have already provided their approval-in-principle for the preliminary and detailed design to commence (*Appendix B*).

ANNEXURES

Appendix A: Locality Plan



	N4 / D2726 (K25) M21 INTERCHANGE Farm Schietfontein 437-JQ	Locality Plan	APPENDIX A

Appendix B: Approval-In-Principle from Road Authorities

THE SOUTH AFRICAN NATIONAL
ROADS AGENCY SOC LTD
Reg. No.1998/009584/06

Northern Region
38 Ida Street, Menlo Park, Pretoria
Private Bag X17, Lynnwood Ridge, 0040, South Africa
Tel +27 (0) 12 426 6200 Fax +27 (0) 12 348 1680/ 0883/ 1512
Offices in Val de Grace – Pretoria (Head Office), Cape Town, Pietermaritzburg, Port Elizabeth

Creating wealth through infrastructure

Reference:	N11/2/3-4/9-5	**Fax Number:**	+27 (0) 12 348 1512
Date:	20 May 2014	**Direct Line:**	+27 (0) 12 426-6227
Contact Person:	Mike Yorke Hart	**Website:**	www.nra.co.za
Email:	yorkehm@nra.co.za		

Bakwena Platinum Corridor Concessionaire (Pty) Ltd
Postnet Suite 151
Private Bag X26
SUNNINGHILL
2157

Attention: Danie Verwey

Dear Sir

PROPOSED CLASS 3 DOUBLE SERVICE AND REST FACILITY ON THE N4

Your letter dated 5 May 2014 has reference.

The South African National Roads Agency SOC Limited has no objection to the applicant proceeding with the preliminary and detail design process.

Yours sincerely

For REGIONAL MANAGER: SANRAL NORTHERN REGION
#501936-v1

Bakwena
N1N4 toll

Bakwena Platinum Corridor Concessionaire (Pty) Ltd
Company Reg No: 1998/004523/07

Physical Address
24 Sunninghill Office Park
Peltier Road, Sunninghill, 2147
Johannesburg
South Africa

Postal Address
Postnet Suite 151
Private Bag X26
Sunninghill, 2157
South Africa

Tel: +27 11 519 0400 - Fax: +27 11 519 0414
Email: info@bakwena.co.za - www.bakwena.co.za

5 May 2014

SANRAL
Private Bag X17
Lynnwood Ridge
0040

Attention: **Mr. Michael Yorke-Hart**

Dear Sir,

Re: Proposed Class 3 Double Service and Rest Facility on the N4 – Bakwena Application No.34

Please find attached the layout drawings No's TW619/17/03/14 (sheet 1 and 2) for your perusal.

Bakwena has evaluated the application and it is recommended that the Applicant continue with the preliminary and detail design process.

It can be noted that the Application has been tested in terms of spacing requirements and geometric standards.

We trust that you will find the above in order. Please do not hesitate to contact us in case of any uncertainties or queries.

Yours sincerely,

Danie Verwey
Senior Engineer

Appendix C: Q4 City Township Layout Plans

PROPOSED TOWNSHIP
Q4 CITY EXTENSION 1

(FIGURE A B C D L E F G H I J K L)
SITUATED ON PART OF THE REMAINDER OF PORTION 41
OF THE FARM SCHIETFONTEIN 437 JQ

LAND USE/ZONING	ERVEN	AREA (ha)	%	NOTES
SPECIAL (filling/service station and purposes incidental thereto)	1 & 2	8,5000	100	TOTAL FLOOR AREA SHALL NOT EXCEED 1500m²
STREET		-----	-----	
TOTAL	2	8,5000	100	

AREA OF ERVEN
ERF 1: 3,7000ha
ERF 2: 4,8000ha
(ERVEN TO BE CONSOLIDATED)

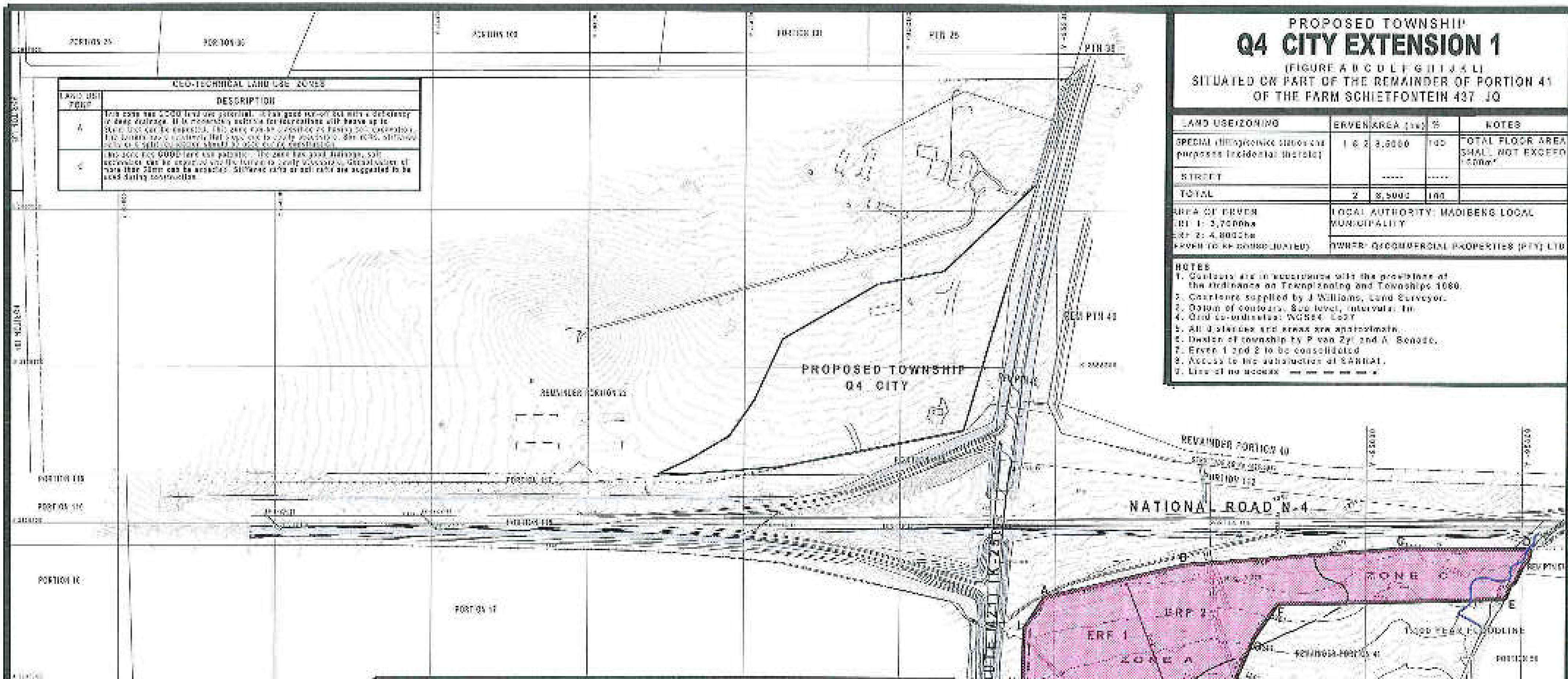
LOCAL AUTHORITY: MADIBENG LOCAL MUNICIPALITY

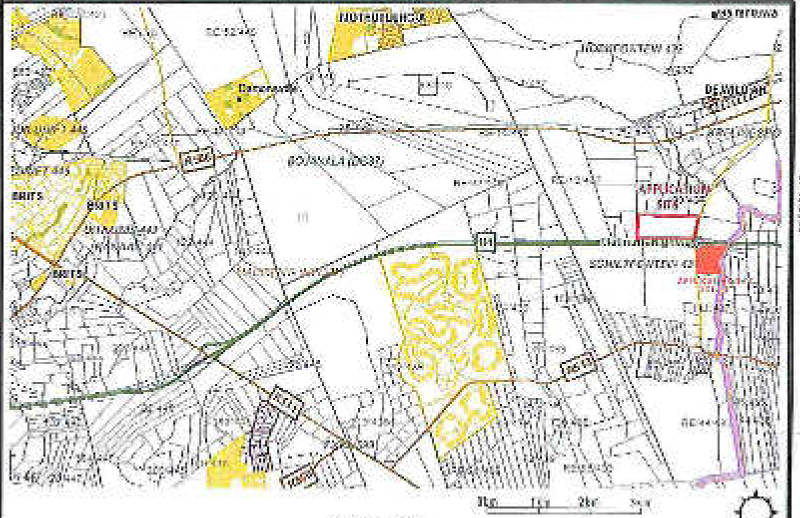
OWNER: Q4COMMERCIAL PROPERTIES (PTY) LTD

NOTES
1. Contours are in accordance with the provisions of the Ordinance on Townplanning and Townships 1986.
2. Contours supplied by J Williams, Land Surveyor.
3. Datum of contours: Sea level, intervals: 1m.
4. Grid co-ordinates: WGS84 Lo27
5. All distances and areas are approximate.
6. Design of township by P van Zyl and A. Benade.
7. Erven 1 and 2 to be consolidated
8. Access to the satisfaction of SANRAL.
9. Line of no access — — — — —

GEO-TECHNICAL LAND USE ZONES

LAND USE ZONE	DESCRIPTION
A	This zone has GOOD land use potential. It has good run-off but with a deficiency in deep drainage. It is moderately active for foundations with heave up to [illegible] can be expected. [illegible]
C	This zone has GOOD land use potential. The zone has good drainage, soil [illegible] can be expected [illegible]. [illegible] values of more than 20mm can be expected. Stiffened rafts or soil rafts are suggested to be used during construction.





LOCALITY PLAN

The 1:100 year floodline determined and certified by:

HENK VILJOEN ECSA REG. 201370027

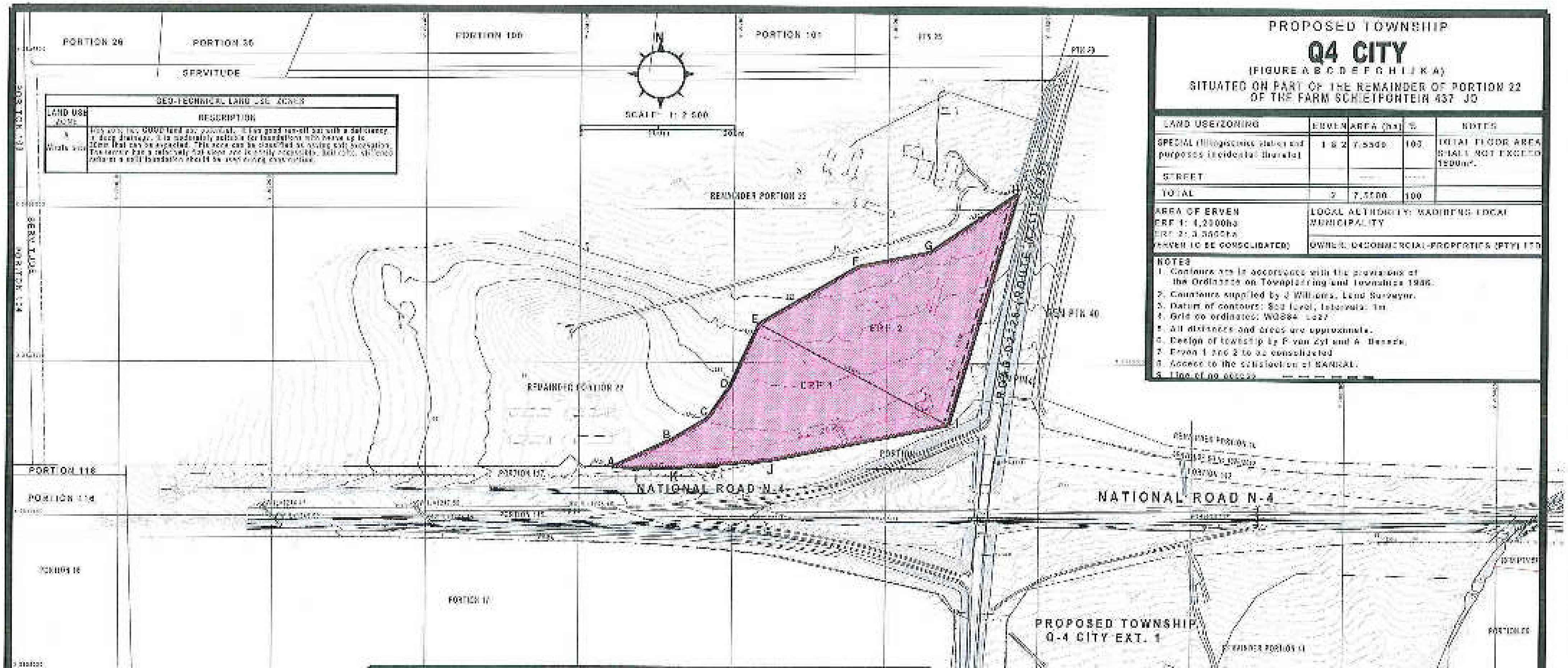
VAN ZYL EN BENADE
TOWN AND REGIONAL PLANNERS
STADS- EN STREEKBEPLANNERS

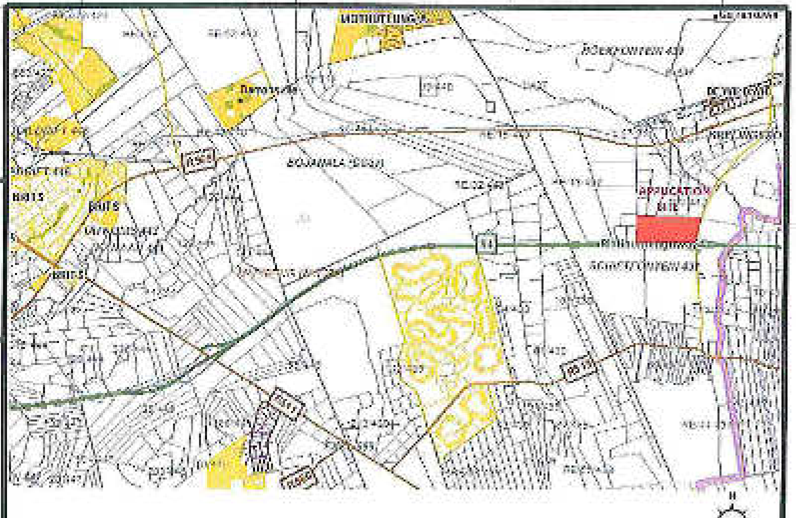
PO BOX 32709
GLENSTANTIA
0010

TEL. 012 348 1806
FAX 012 348 1818
e-mail: vzb@esnet.co.za

PLANNO: Q4X1/1

DATE: MARCH 2015





LOCALITY PLAN

PROPOSED TOWNSHIP

Q4 CITY

(FIGURE A B C D E F G H I J K A)

SITUATED ON PART OF THE REMAINDER OF PORTION 22 OF THE FARM SCHIETFONTEIN 437 JQ

LAND USE/ZONING	ERVEN	AREA (ha)	%	NOTES
SPECIAL (filling station and purposes incidental thereto)	1 & 2	7,5500	100	TOTAL FLOOR AREA SHALL NOT EXCEED 1500m².
STREET		----	----	
TOTAL	2	7,5500	100	

AREA OF ERVEN
ERF 1: 4,2000ha
ERF 2: 3,3500ha
(ERVEN TO BE CONSOLIDATED)

LOCAL AUTHORITY: MADIBENG LOCAL MUNICIPALITY

OWNER: Q4COMMERCIAL-PROPERTIES (PTY) LTD

NOTES
1. Contours are in accordance with the provisions of the Ordinance on Townplanning and Townships 1986.
2. Contours supplied by J Williams, Land Surveyor.
3. Datum of contours: Sea level, Intervals: 1m
4. Grid co ordinates: WGS84 Lo27
5. All distances and areas are approximate.
6. Design of township by P van Zyl and A. Benade.
7. Erven 1 and 2 to be consolidated
8. Access to the satisfaction of SANRAL.
9. Line of no access

GEO-TECHNICAL LAND USE ZONES	
LAND USE ZONE	DESCRIPTION
A Whole site	[illegible] GOOD land use potential. [illegible] deep drainage. [illegible] for foundations with heave up to 30mm that can be expected. This zone can be classified as [illegible]. The terrain has a relatively flat slope and is easily accessible. [illegible] foundation should be used during construction.

FLOOD LINES
It is hereby certified in terms of Section 144 of the Water Act [illegible] of 1998, that this township [illegible] by floodlines [illegible] the maximum flood level likely to be reached with an expected frequency of [illegible] 50 years and once every 100 years

HENK VILJOEN [illegible]

VAN ZYL EN BENADE
TOWN AND REGIONAL PLANNERS
STADS- EN STREEKBEPLANNERS

PO BOX 32709
GLENSTANTIA
0010
TEL. 012 346 1805
FAX 012 346 1819
e-mail: vzb@osnet.co.za

PLAN NO: Q4/1 DATE: MARCH 2015

Appendix D: CTO 2560 and CTO 1618 – Highlight Sheets

TRAFFIC HIGHLIGHTS OF SITE 2560				
1.1	Site Identifier			2560
1.2	Site Name			Brits Plaza
1.3	Site Description			Between Brits and Pretoria
1.4	Road Description	Route : N004	Road : N004 Section : 10	Distance : 3.7km
1.5	GPS Position			27.917694E -25.650139S
1.6	Number of Lanes			4
1.7	Station Type			Permanent Toll
1.8	Requested Period			2013/01/01 - 2013/12/31
1.9	Length of record requested (hours)			8760
1.10	Actual First & Last Dates			2013/01/01 - 2013/12/31
1.11	Actual available data (hours)			8759
1.12	Percentage data available for requested period			100.0
		To Pretoria	To Zeerust	Total
2.1	Total number of vehicles	2332268	2285291	4617559
2.2	Average daily traffic (ADT)	6390	6262	12652
2.3	Average daily truck traffic (ADTT)	911	894	1805
2.4	Percentage of trucks	14.3	14.3	14.3
2.5	Truck split % (short:medium:long)	30 : 16 : 54	28 : 16 : 56	29 : 16 : 55
2.6	Percentage of night traffic (20:00 - 06:00)	11.6	12.3	12.0
3.1	Speed limit (km/hr)			120
3.2	Average speed (km/hr)	87.9	88.9	88.4
3.3	Average speed - light vehicles (km/hr)	90.6	93.1	91.8
3.4	Average speed - heavy vehicles (km/hr)	71.5	63.6	67.6
3.5	Average night speed (km/hr)	82.6	84.3	83.5
3.6	15th centile speed (km/hr)	71.6	71.7	71.6
3.7	85th centile speed (km/hr)	105.9	105.9	105.9
3.8	Percentage vehicles in excess of speed limit	2.0	1.9	2.0
4.1	Percentage vehicles in flows over 600 vehicles/hr	18.0	9.6	80.3
4.2	Highest volume on the road (vehicles/hr)		2013/04/26 16:00:00	1755
4.3	Highest volume in the East (vehs/hr)		2013/08/11 13:00:00	1028
4.4	Highest volume in the West (vehs/hr)		2013/08/08 16:00:00	913
4.5	Highest volume in a lane (vehicles/hr)		2013/08/11 13:00:00	568
4.6	15th highest volume on the road (vehicles/hr)		2013/09/20 15:00:00	1577
4.7	15th highest volume in the East direction (vehs/hr)		2013/06/17 15:00:00	874
4.8	15th highest volume in the West direction (vehs/hr)		2013/09/20 15:00:00	780
4.9	30th highest volume on the road (vehicles/hr)		2013/09/06 16:00:00	1518
4.10	30th highest volume in the East direction (vehs/hr)		2013/04/26 17:00:00	840
4.11	30th highest volume in the West direction (vehs/hr)		2013/09/06 16:00:00	743
5.1	Percentage of vehicles less than 2s behind vehicle ahead	17.0	5.4	11.3
6.1	Total number of heavy vehicles	332408	326249	658657
6.2	Estimated average number of axles per truck	5.2	5.3	5.2
6.3	Estimated truck mass (Ton/truck)	30.0	30.4	30.2
6.4	Estimated average E80/truck	1.7	1.8	1.7
6.5	Estimated daily E80 on the road			3135
6.6	Estimated daily E80 in the East direction			1571
6.7	Estimated daily E80 in the West direction			1564
6.8	Estimated daily E80 in the worst East lane			1460
6.9	Estimated daily E80 in the worst West lane			1504
6.10	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
6.11	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
6.12	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.6 : 2.5 : 2.1)

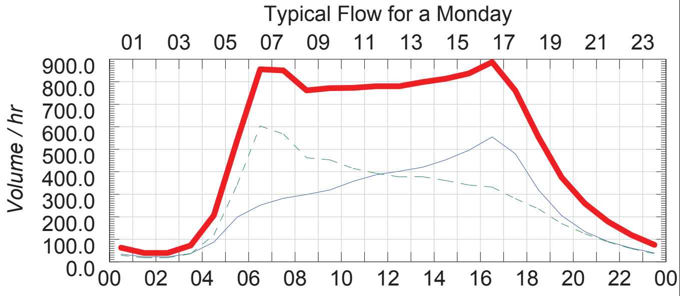
Typical Week Volume Report

Site	: 2560 - Brits Plaza
Region	: North West
Actual Period	: 2013/01/01 to 2013/12/31
Classification	: RSA Vehicle
Day Type	: Normal Day&Fixed Public Holiday+

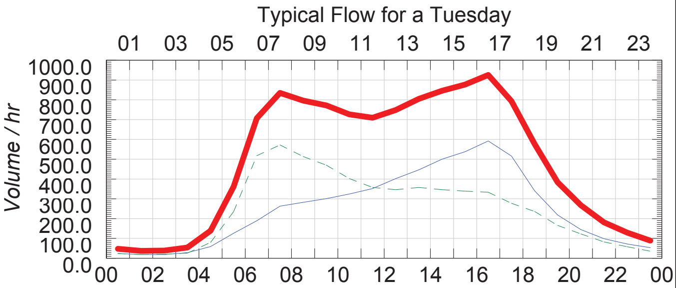
Total
To Pretoria
To Zeerust

Total
Light
Heavy

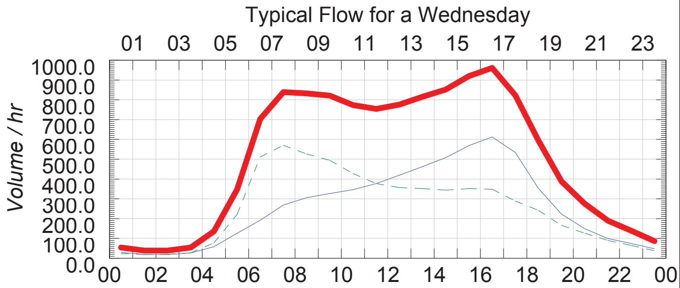
Typical Flow for a Monday



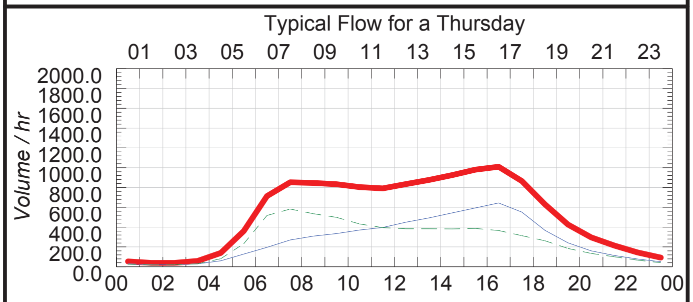
Typical Flow for a Tuesday



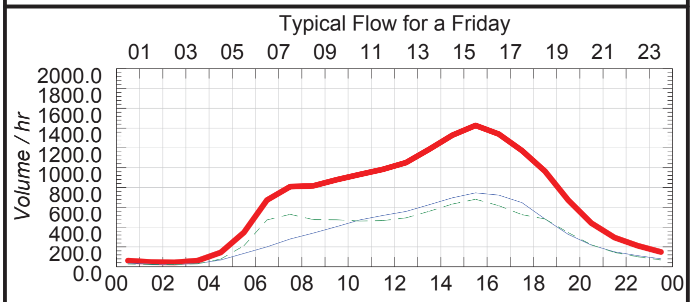
Typical Flow for a Wednesday



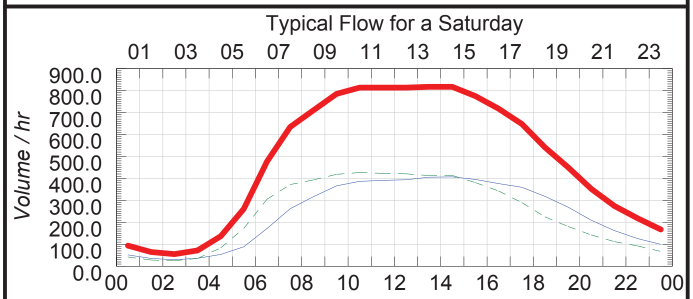
Typical Flow for a Thursday



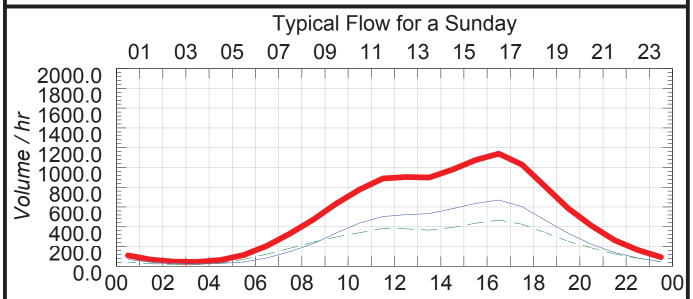
Typical Flow for a Friday



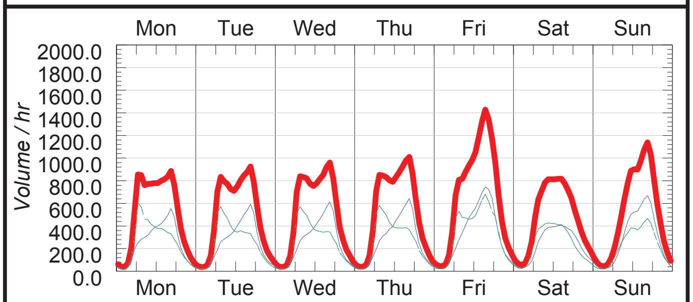
Typical Flow for a Saturday



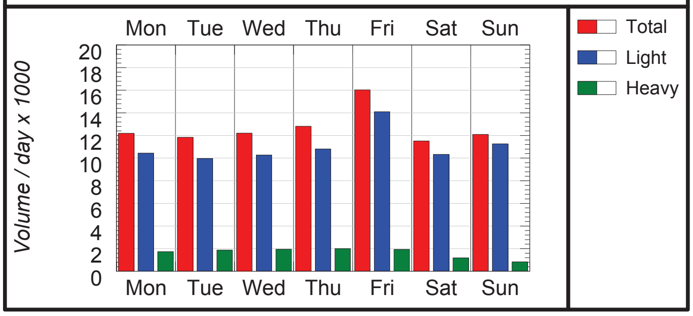
Typical Flow for a Sunday



TYPICAL FLOW FOR A WEEK



TYPICAL DAILY Light/Heavy/Total VARIATIONS



TRAFFIC HIGHLIGHTS OF SITE 1618				
1.1	Site Identifier			1618
1.2	Site Name			BAKWENA Ga-Rankuwa
1.3	Site Description			Eastern Side of M17 Ga-Rankuwa I/C
1.4	Road Description			Route : N004 Road : N004 Section : 09 Distance : 23.0km
1.5	GPS Position			28.050060E -25.655724S
1.6	Number of Lanes			6
1.7	Station Type			Permanent
1.8	Requested Period			2013/01/01 - 2013/12/31
1.9	Length of record requested (hours)			8760
1.10	Actual First & Last Dates			2013/01/01 - 2013/12/31
1.11	Actual available data (hours)			8168
1.12	Percentage data available for requested period			93.2
		To Pretoria	To Rustenburg	Total
2.1	Total number of vehicles	2721609	2731572	5453181
2.2	Average daily traffic (ADT)	7996	8026	16022
2.3	Average daily truck traffic (ADTT)	924	980	1904
2.4	Percentage of trucks	11.6	12.2	11.9
2.5	Truck split % (short:medium:long)	28 : 21 : 51	28 : 19 : 53	28 : 20 : 52
2.6	Percentage of night traffic (20:00 - 06:00)	11.1	11.7	11.4
3.1	Speed limit (km/hr)			120
3.2	Average speed (km/hr)	108.2	110.2	109.2
3.3	Average speed - light vehicles (km/hr)	111.1	113.3	112.2
3.4	Average speed - heavy vehicles (km/hr)	86.3	88.1	87.2
3.5	Average night speed (km/hr)	107.1	110.2	108.7
3.6	15th centile speed (km/hr)	81.7	87.8	85.8
3.7	85th centile speed (km/hr)	132.0	129.9	129.9
3.8	Percentage vehicles in excess of speed limit	31.9	33.0	32.4
4.1	Percentage vehicles in flows over 600 vehicles/hr	34.5	31.2	85.6
4.2	Highest volume on the road (vehicles/hr)		2013/04/26 16:00:00	2088
4.3	Highest volume in the East (vehs/hr)		2013/08/11 16:00:00	1149
4.4	Highest volume in the West (vehs/hr)		2013/08/08 16:00:00	1042
4.5	Highest volume in a lane (vehicles/hr)		2013/08/07 17:00:00	562
4.6	15th highest volume on the road (vehicles/hr)			
4.7	15th highest volume in the East direction (vehs/hr)			
4.8	15th highest volume in the West direction (vehs/hr)			
4.9	30th highest volume on the road (vehicles/hr)			
4.10	30th highest volume in the East direction (vehs/hr)			
4.11	30th highest volume in the West direction (vehs/hr)			
5.1	Percentage of vehicles less than 2s behind vehicle ahead	15.4	7.8	11.6
6.1	Total number of heavy vehicles	314545	333657	648202
6.2	Estimated average number of axles per truck	5.2	5.2	5.2
6.3	Estimated truck mass (Ton/truck)	29.9	30.1	30.0
6.4	Estimated average E80/truck	1.8	1.8	1.8
6.5	Estimated daily E80 on the road			3353
6.6	Estimated daily E80 in the East direction			1632
6.7	Estimated daily E80 in the West direction			1721
6.8	Estimated daily E80 in the worst East lane			1278
6.9	Estimated daily E80 in the worst West lane			1334
6.10	ASSUMPTION on Axles/Truck (Short:Medium:Long)			(2.0 : 5.0 : 7.0)
6.11	ASSUMPTION on Mass/Truck (Short:Medium:Long)			(10.9 : 31.5 : 39.8)
6.12	ASSUMPTION on E80s/Truck (Short:Medium:Long)			(0.6 : 2.5 : 2.1)

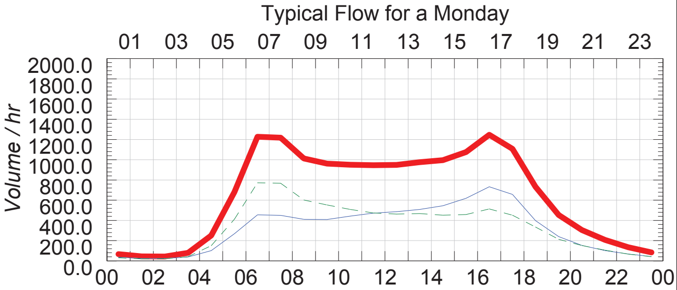
Typical Week Volume Report

Site	: 1618 - BAKWENA Ga-Rankuwa
Region	: Gauteng
Actual Period	: 2013/01/01 to 2013/12/31
Classification	: RSA Ext Lgt/Hvy
Day Type	: Normal Day&Fixed Public Holiday+

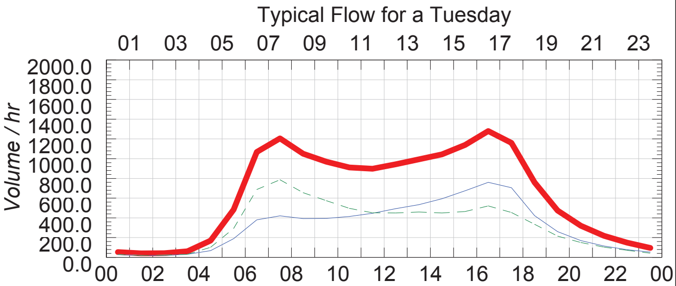
Total
To Pretoria
To Rustenburg

Total
Light
Heavy

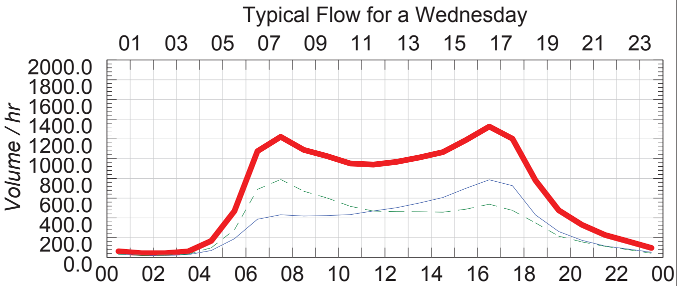
Typical Flow for a Monday



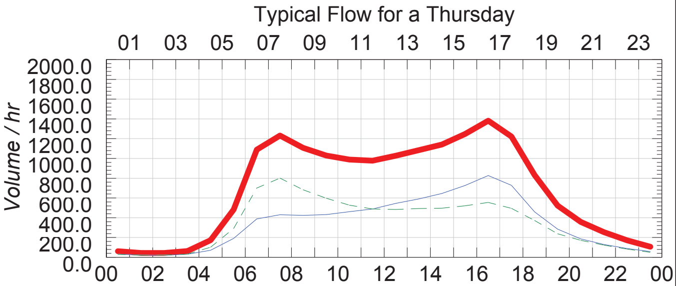
Typical Flow for a Tuesday



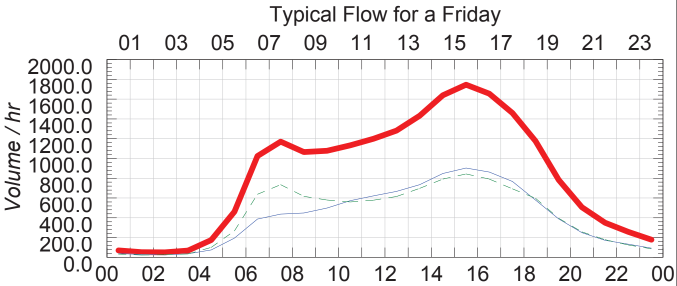
Typical Flow for a Wednesday



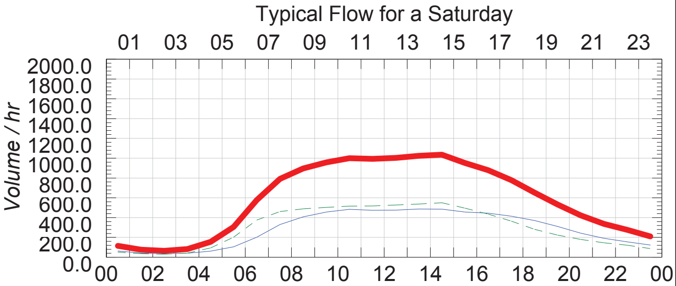
Typical Flow for a Thursday



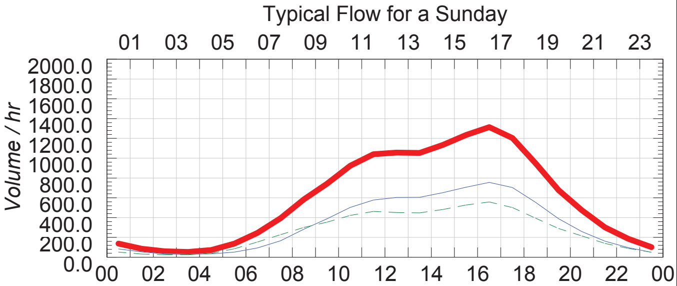
Typical Flow for a Friday



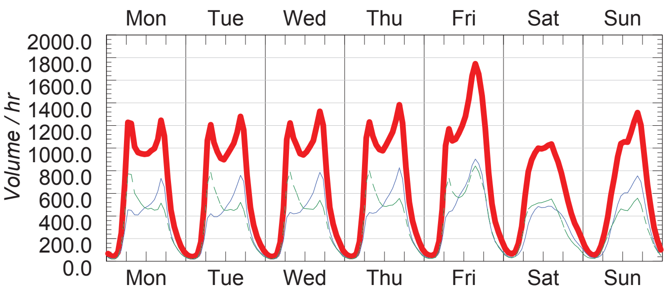
Typical Flow for a Saturday



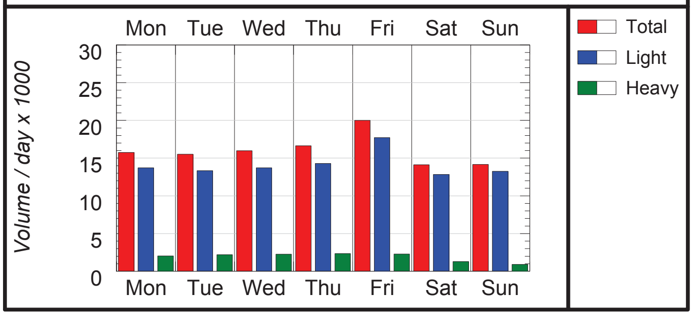
Typical Flow for a Sunday



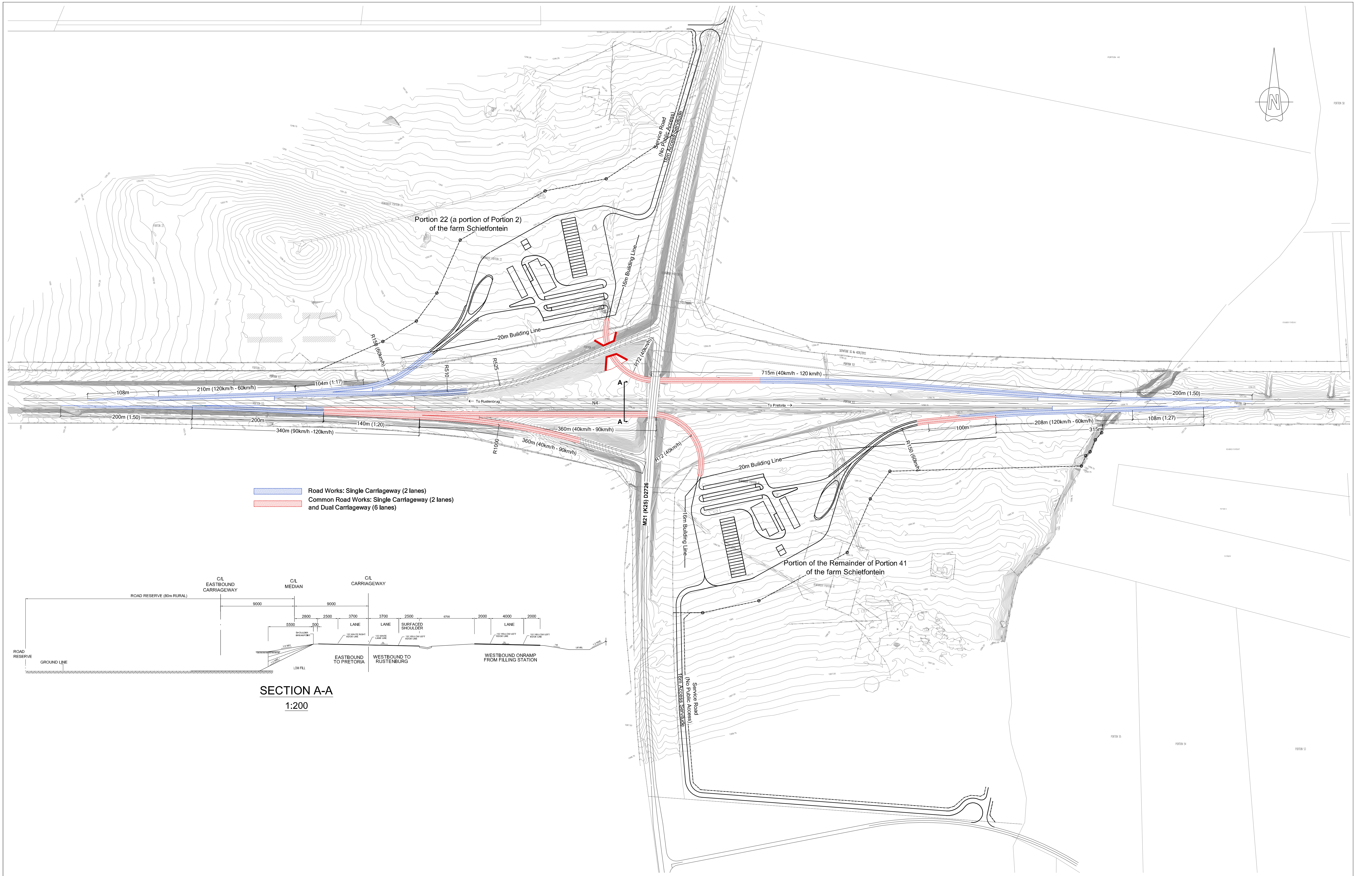
TYPICAL FLOW FOR A WEEK



TYPICAL DAILY Light/Heavy/Total VARIATIONS



Appendix E: Short Term Development Plan - TW619 / 17 / 03 / 14 – Sheet 1 of 2



SECTION A-A

1:200

No.	DATE	REVISION	CONSULT.	I Eng

DESIGNED BY	J. DALING
CHECKED BY	P. KRUGER
DRAWN BY	J. DALING
CHECKED BY	P. KRUGER

Bakwena

TECHWORLD
SUNBIRD PARK
Cnr. Delfi & Sunbird Ave
Garsfontein Ext 15
TEL(012) 998-3541
FAX(012) 993-5506
E-MAIL: admin@techworld.co.za

THE SOUTH AFRICAN NATIONAL ROADS AGENCY LTD
NORTHERN REGION
PO Box 415
Pretoria
0001
Tel (012) 426 6200

Consulting Engineer — Date

BPCC — Date

NATIONAL ROUTE	N4	SECTION	10/0.72

Project Discription

APPLICATION FOR PRELIMINARY APPROVAL:
SERVICE AREA FACILITIES AT D2726 (K25) M21 ALONG N4

Drawing Name

SHORT TERM – DEVELOPMENT PLAN

FOR CONSTRUCTION
(Full signature)

20 / /
Independent Engineer

20 / /
For : Consulting Engineer

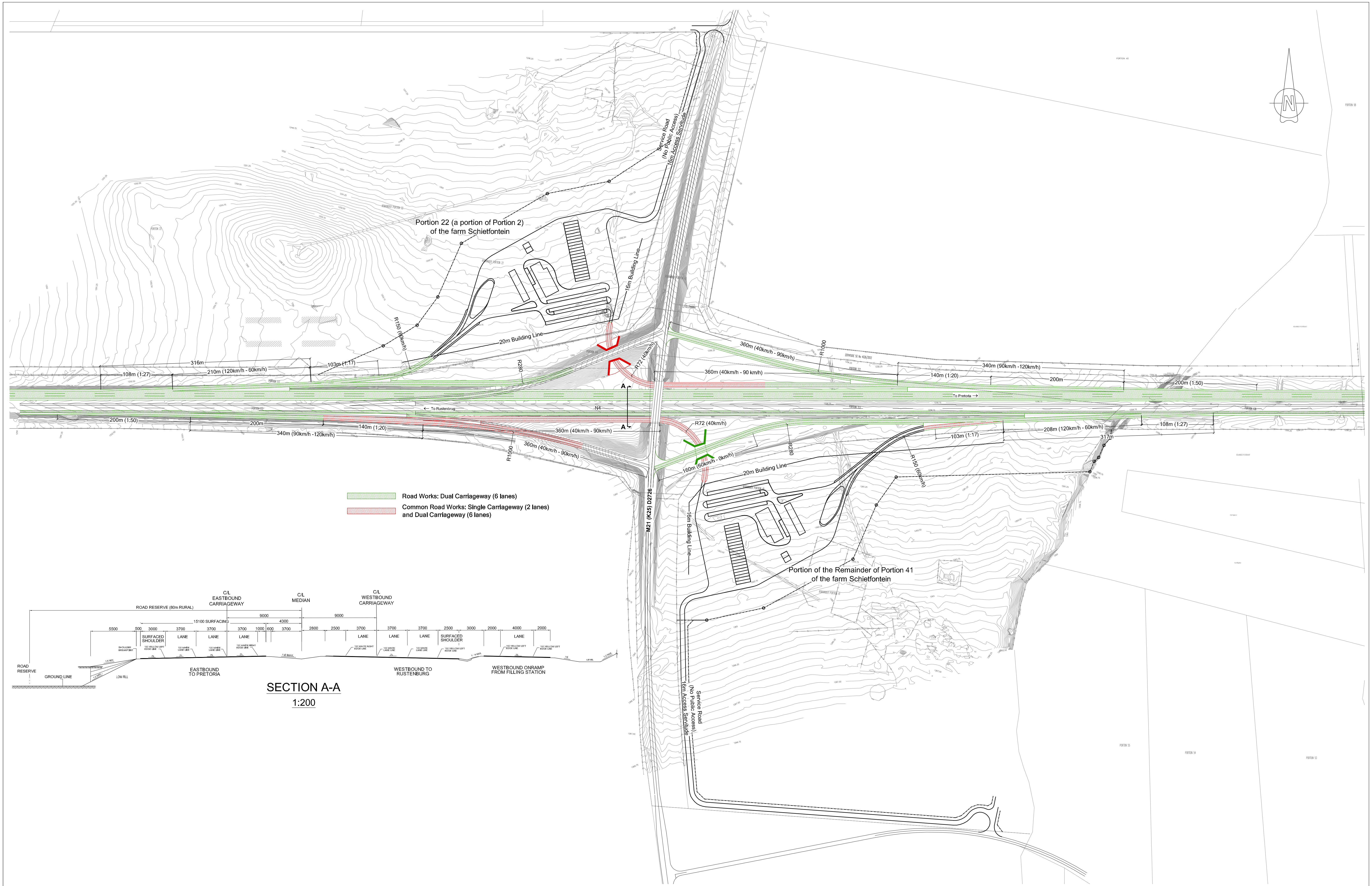
PLAN No.
TW619/17/03/14

SHEET 1 OF 2

SCALE
1:2500

PROJECT PLAN No.

Appendix F: Long Term Development Plan - TW619 / 17 / 03 / 14 – Sheet 2 of 2



No.	DATE	REVISION	CONSULT.	I Eng

DESIGNED BY	J. DALING
CHECKED BY	P. KRUGER
DRAWN BY	J. DALING
CHECKED BY	P. KRUGER

Bakwena

TECHWORLD
SUNBIRD PARK
Cnr. Delfi & Sunbird Ave
Garsfontein Ext 15
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THE SOUTH AFRICAN NATIONAL ROADS AGENCY LTD
NORTHERN REGION
PO Box 415
Pretoria
0001
Tel (012) 426 6200

Consulting Engineer — Date

BPDC — Date

NATIONAL ROUTE	N4	SECTION	10/0.72

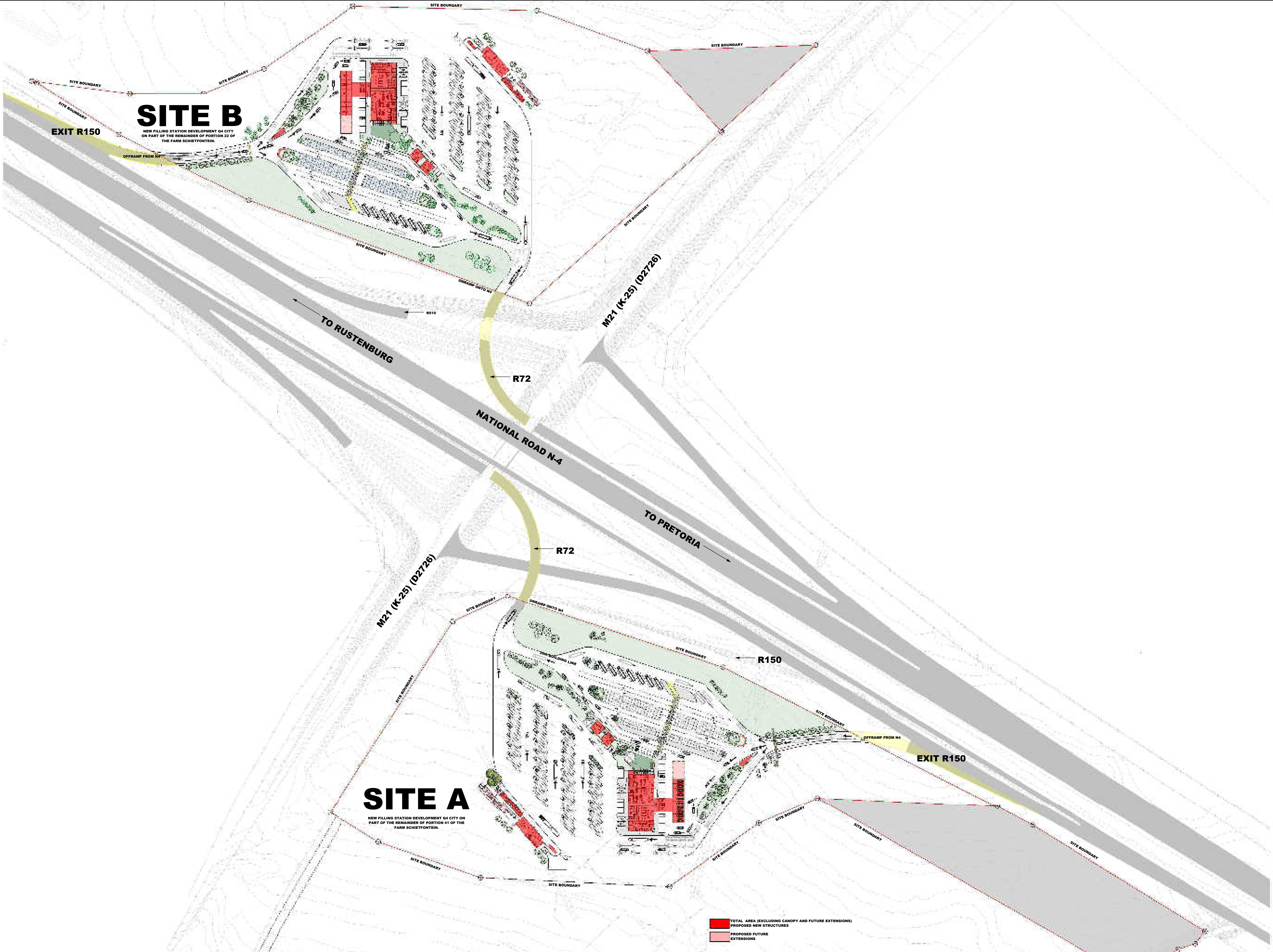
Project Discription
APPLICATION FOR PRELIMINARY APPROVAL:
SERVICE AREA FACILITIES AT D2726 (K25) M21 ALONG N4

Drawing Name
LONG TERM – DEVELOPMENT PLAN

FOR CONSTRUCTION
(Full signature)
Independent Engineer 20 / /
For : Consulting Engineer 20 / /
PLAN No.
TW619/17/03/14

SHEET 2 OF 2
SCALE
1:2500
PROJECT PLAN No.

Appendix G: Conceptual Design / Sketchplans by Theunissen Jankowitz Architects



LOCALITY PLAN

SCALE 1 : 1000

NOTES:

SITE DATA - SITE A

ERF NO.	REMAINDER OF PROTION 41 OF THE FARM SCHIETFONTEIN	
ZONING		
SITE AREA	83 433.61m²	
BUILDING LINES	AS PER CONDITIONS OF ESTABLISHMENT	
BUILDING AREA	GROSS AREA	COVERAGE
STAFF ABLUTIONS	98.9m²	98.9m²
PUBLIC AREAS	138.7m²	138.7m²
RESTAURANT AND TAKE-AWAY F.O.H & B.O.H AREAS	386.6m²	386.6m²
SERVICE AREAS	103.27m²	103.27m²
MANAGER'S UNITS	153.2m²	153.2m²
CONVENIENCE STORE	284.7m²	284.7m²
FORECOURT (CANOPY & LINK)		494m²
TOKEN ABLUTIONS	115.3m²	115.3m²
TRUCKS - CANTEEN AND KITCHEN	212.2m²	212.2m²
TOTAL	1 492.87m²	1 986.87m²
URBAN PLANNING REQUIREMENTS	ALLOWED	ACTUAL
COVERAGE	UNKNOWN%	2.34%
FLOOR-AREA RATIO	TO ZONING CERTIFICATE	
PARKING	REQUIRED	PROVIDED
		144 CAR PARKING BAYS FOR SHOP INCLUDING 2No. 'DISABLED' PARKING SPACES AND 4No. COVERED PARKING BAYS
		35 TRUCK PARKING BAYS
		7 BUS PARKING BAYS
		TOTAL 186 PARKING BAYS PROVIDED
HEIGHT RESTRICTIONS	ALLOWED	ACTUAL
BUILDING	-	-

SITE DATA - SITE B

ERF NO.	REMAINDER OF PROTION 41 OF THE FARM SCHIETFONTEIN	
ZONING		
SITE AREA	75 229.234m²	
BUILDING LINES	AS PER CONDITIONS OF ESTABLISHMENT	
BUILDING AREA	GROSS AREA	COVERAGE
STAFF ABLUTIONS	98.9m²	98.9m²
PUBLIC AREAS	138.7m²	138.7m²
RESTAURANT AND TAKE-AWAY F.O.H & B.O.H AREAS	386.6m²	386.6m²
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TOTAL	1 492.87m²	1 986.87m²
URBAN PLANNING REQUIREMENTS	ALLOWED	ACTUAL
COVERAGE	UNKNOWN%	2.64%
FLOOR-AREA RATIO	TO ZONING CERTIFICATE	
PARKING	REQUIRED	PROVIDED
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		7 BUS PARKING BAYS
		TOTAL 186 PARKING BAYS PROVIDED
HEIGHT RESTRICTIONS	ALLOWED	ACTUAL
BUILDING	-	-

WYSIGINGS - REVISIONS

No. NR.	DATUM DATE	BESKRYWING - DESCRIPTION

HIERDIE TEK. VERVANG TEK. No.
THIS DWG. REPLACE DWG No.

34 BOUVARDIA STREET
LYNWOODRIDGE
0081
PO BOX 75874
LYNNWOOD RIDGE
0040
PRETORIA

TEL: (012)361 1223/6
FAX: (012) 361 1228
E-MAIL : mail @ theunjan.co.za

THEUNISSEN JANKOWITZ ARCHITECTS

SKEMA - PROJECT
NEW FILLING STATION DEVELOPMENT Q4 CITY ON PART OF THE REMAINDER OF PORTION 22 & 41 OF THE FARM SCHIETFONTEIN.

TEKENING - DRAWING
LOCALITY PLAN

SKETCHPLANS

PLOT INFO		TEK. No. / DWG. No.
2015/05/06 02:03:42 PM		14-01 / 100
GETEKEN/DRAWN	NAGESIEN/CHECKED	
L.VDW / R.C	R.C	

REGISTERED ARCHITECT:
H.L.BOTHA SACAP Regno: 3755

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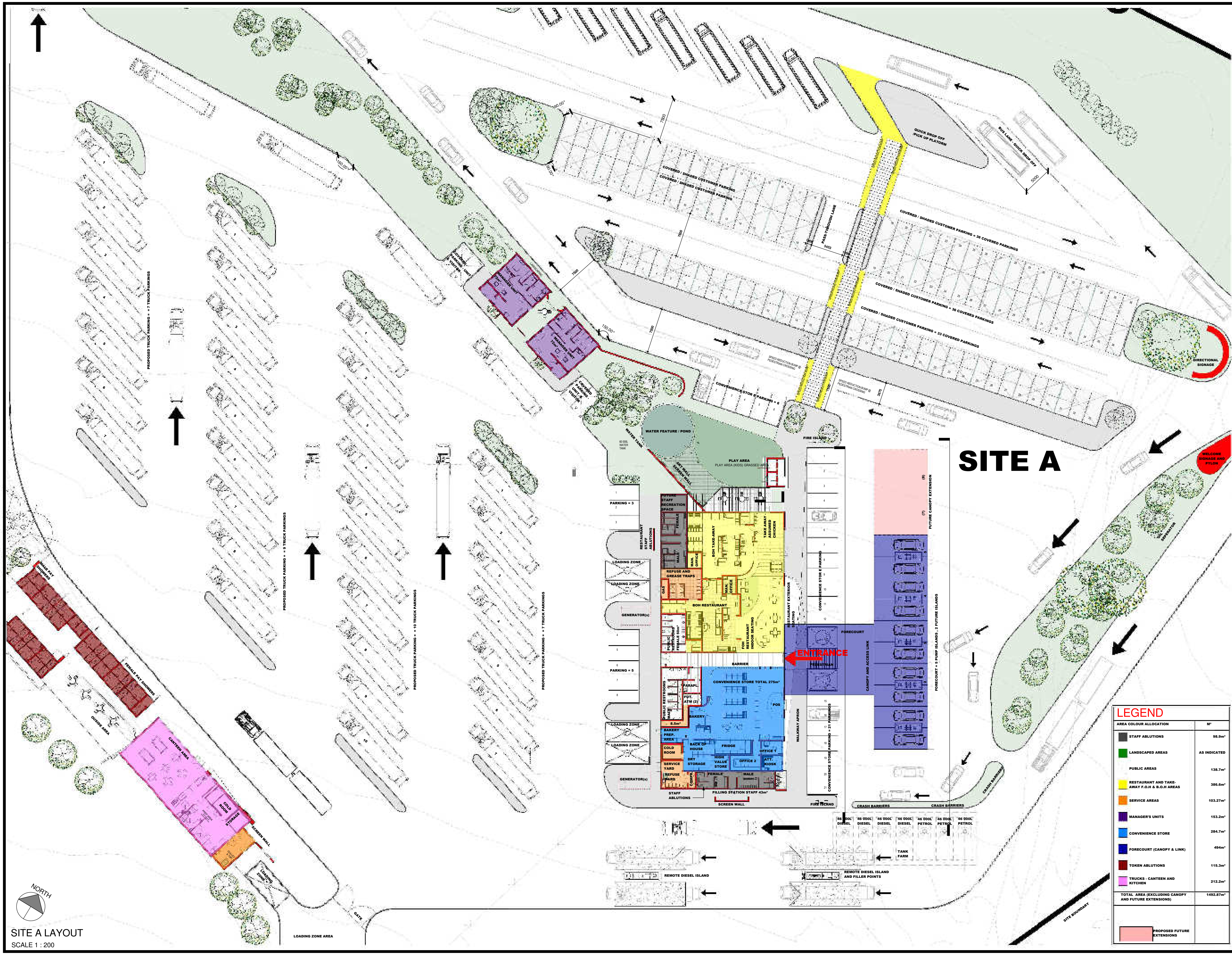

SITE A LAYOUT
SCALE 1 : 200

ALLE TEKENINGE EN MATES MOET NAGESIEN EN VERGELYK WORD VOORDAT MATERIAAL BESTEL OF MET ENIGE BOUWERK BEGIN WORD. ENIGE VERSKILLE MOET DADELIK ONDER DIE AANDAG VAN DIE ARGITEK GEBRING WORD. KOPIE-REG WORD VOORBEHOU OP ALLE TEKENINGE EN ONTWERPE.

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NOTES:

SITE DATA - SITE A

ERF NO.	REMAINDER OF PROTION 41 OF THE FARM SCHIETFONTEIN
ZONING	
SITE AREA	83 433.61m²
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BUILDING AREA	GROSS AREA	COVERAGE
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		7 BUS PARKING BAYS
		TOTAL 186 PARKING BAYS PROVIDED
HEIGHT RESTRICTIONS	ALLOWED	ACTUAL
BUILDING	-	-

WYSIGINGS - REVISIONS

No NR.	DATUM DATE	BESKRYWING - DESCRIPTION

LEGEND

AREA COLOUR ALLOCATION	M²
STAFF ABLUTIONS	98.9m²
LANDSCAPED AREAS	AS INDICATED
PUBLIC AREAS	138.7m²
RESTAURANT AND TAKE-AWAY F.O.H & B.O.H AREAS	386.6m²
SERVICE AREAS	103.27m²
MANAGER'S UNITS	153.2m²
CONVENIENCE STORE	284.7m²
FORECOURT (CANOPY & LINK)	494m²
TOKEN ABLUTIONS	115.3m²
TRUCKS - CANTEEN AND KITCHEN	212.2m²
TOTAL AREA (EXCLUDING CANOPY AND FUTURE EXTENSIONS)	1492.87m²
PROPOSED FUTURE EXTENSIONS	

HIERDIE TEK. VERVANG TEK. No.
THIS DWG. REPLACE DWG No.

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PRETORIA

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THEUNISSEN JANKOWITZ ARCHITECTS

SKEMA - PROJECT
NEW FILLING STATION DEVELOPMENT Q4 CITY ON PART OF THE REMAINDER OF PORTION 41 OF THE FARM SCHIETFONTEIN.

TEKENING - DRAWING
PROVISIONAL SITE LAYOUT - SITE A

SKETCHPLANS

PLOT INFO
2015/05/06 02:00:10 PM

GETEKEN/DRAWN	NAGESIEN/CHECKED	TEK. No. / DWG. No.
L.VDW / R.C	R.C	14-01 / 101

REGISTERED ARCHITECT:
H.L.BOTHA SACAP Regno: 3755

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LEGEND

AREA COLOUR ALLOCATION	M²
STAFF ABLUTIONS	98.9m²
LANDSCAPED AREAS	AS INDICATED
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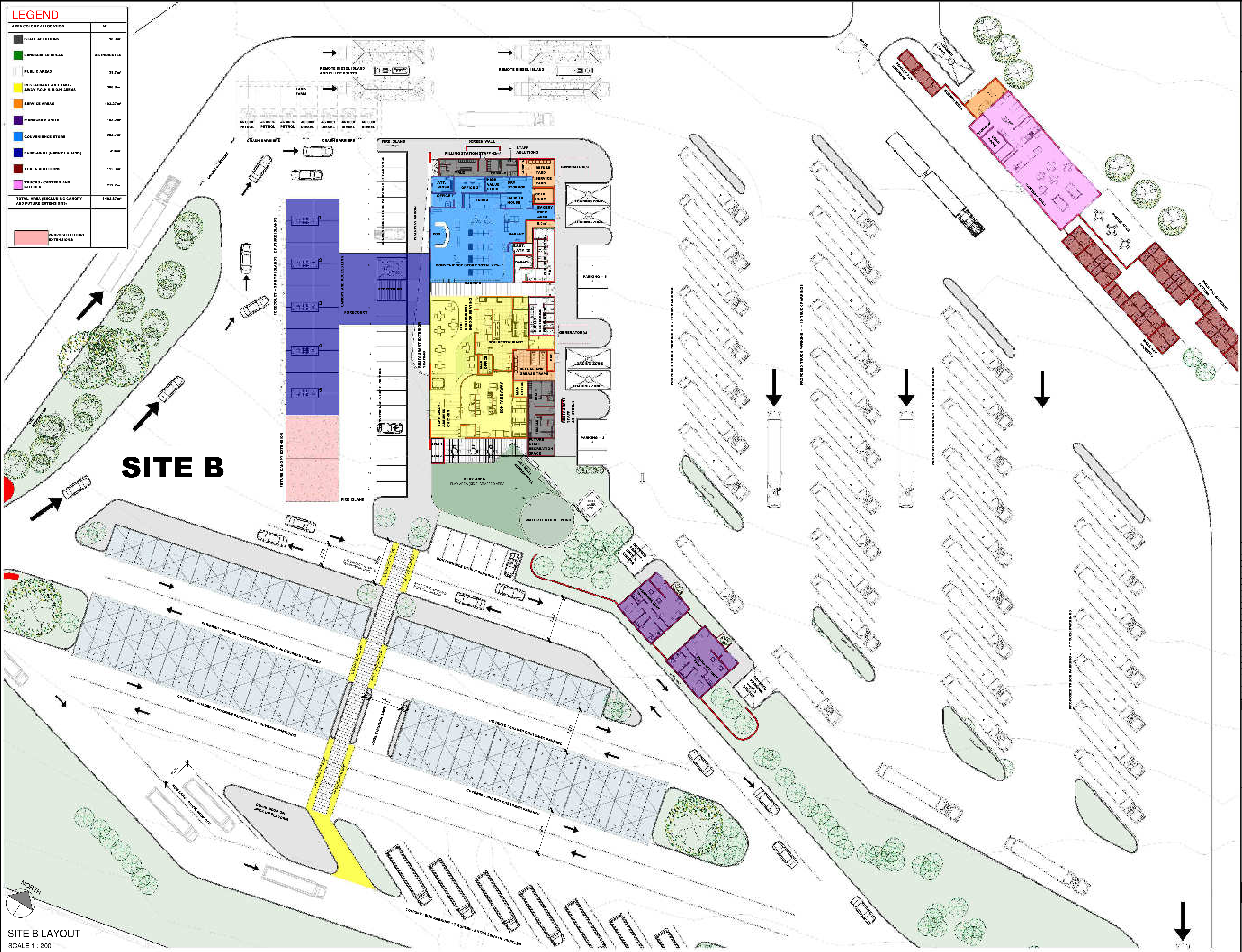
PROPOSED FUTURE EXTENSIONS	



SITE B LAYOUT

SCALE 1 : 200

ALLE TEKENINGE EN MATES MOET NAGESIEN EN VERGELYK WORD VOORDAT MATERIAAL BESTEL OF MET ENIGE BOUWERK BEGIN WORD. ENIGE VERSKILLE MOET DADELIK ONDER DIE AANDAG VAN DIE ARGITEK GEBRING WORD. KOPIE-REG WORD VOORBEHOU OP ALLE TEKENINGE EN ONTWERPE.

NOTES:

SITE DATA - SITE B

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		7 BUS PARKING BAYS
		TOTAL 186 PARKING BAYS PROVIDED
HEIGHT RESTRICTIONS	ALLOWED	ACTUAL
BUILDING	-	-

WYSIGINGS - REVISIONS

No NR.	DATUM DATE	BESKRYWING - DESCRIPTION

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THEUNISSEN JANKOWITZ ARCHITECTS

SKEMA - PROJECT

NEW FILLING STATION DEVELOPMENT Q4 CITY ON PART OF THE REMAINDER OF PORTION 22 OF THE FARM SCHIETFONTEIN.

TEKENING - DRAWING

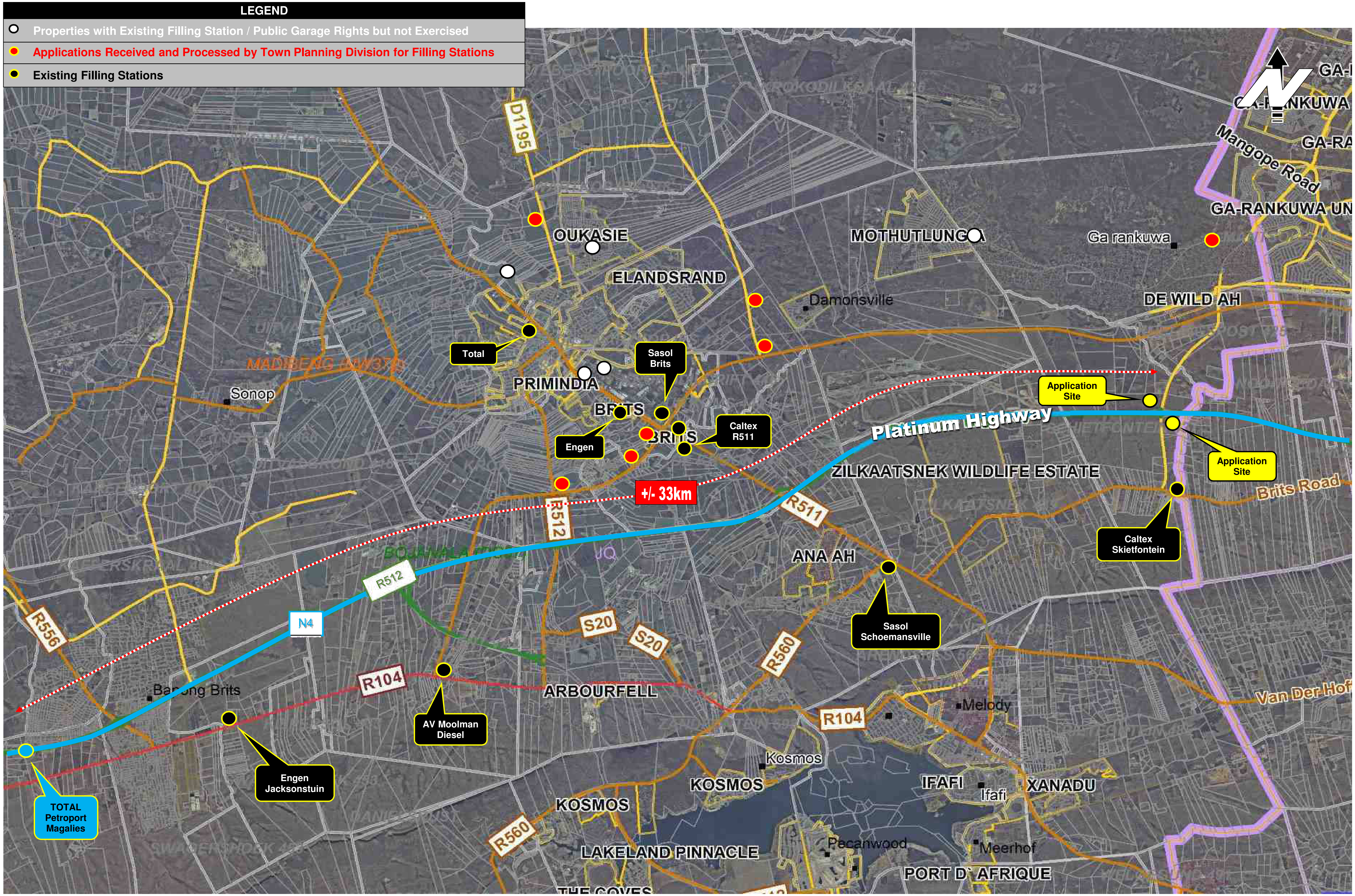
PROVISIONAL SITE LAYOUT - SITE B

SKETCHPLANS

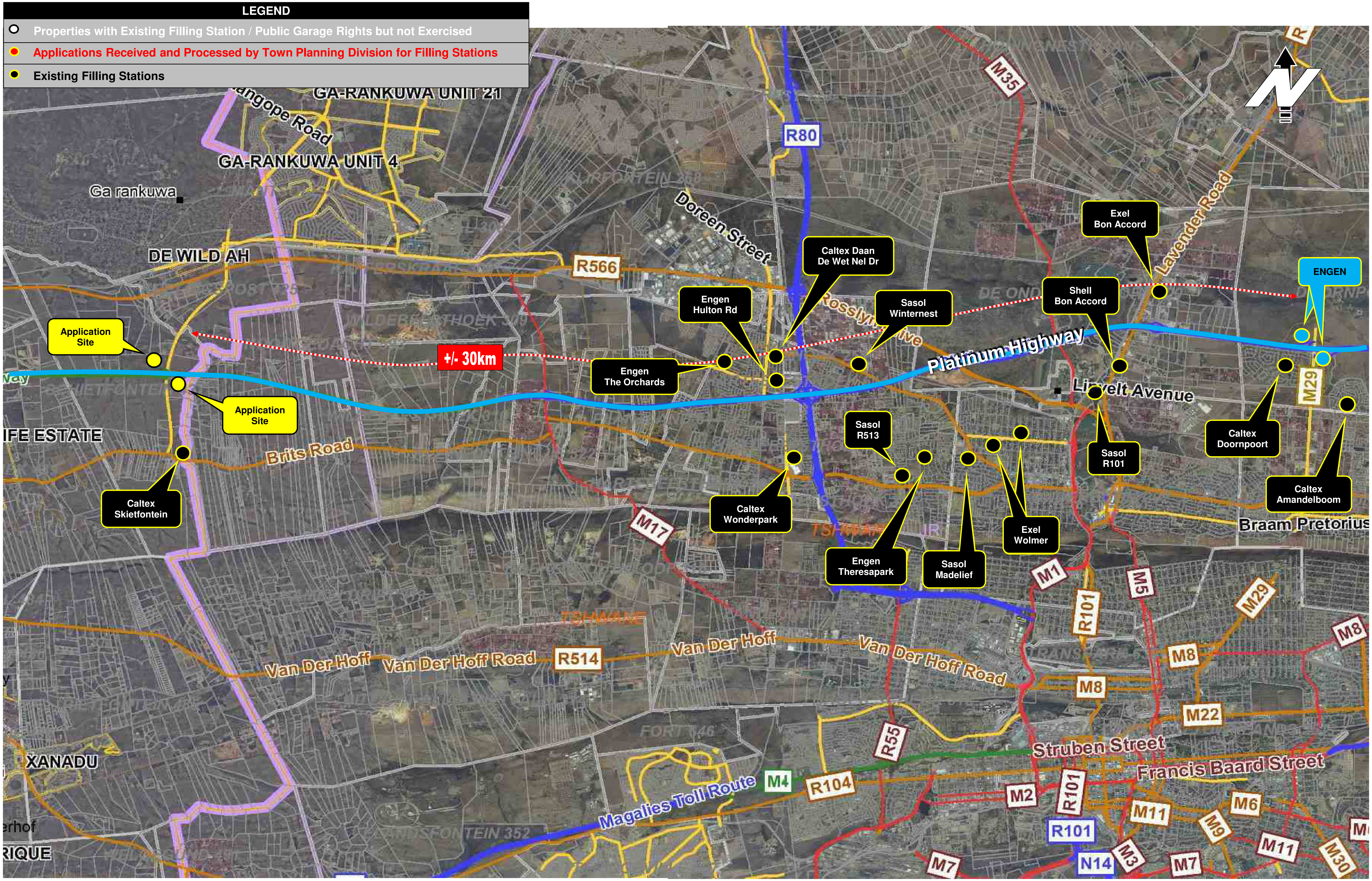
PLOT INFO		TEK. No. / DWG. No.
2015/05/06 02:02:14 PM		14-01 / 102
GETEKEN/DRAWN	NAGESIEN/CHECKED	
L.VDW / R.C	R.C	

REGISTERED ARCHITECT:
H.L.BOTHA SACAP Regno: 3755

Appendix H: Other Filling Station Sites in Corridor

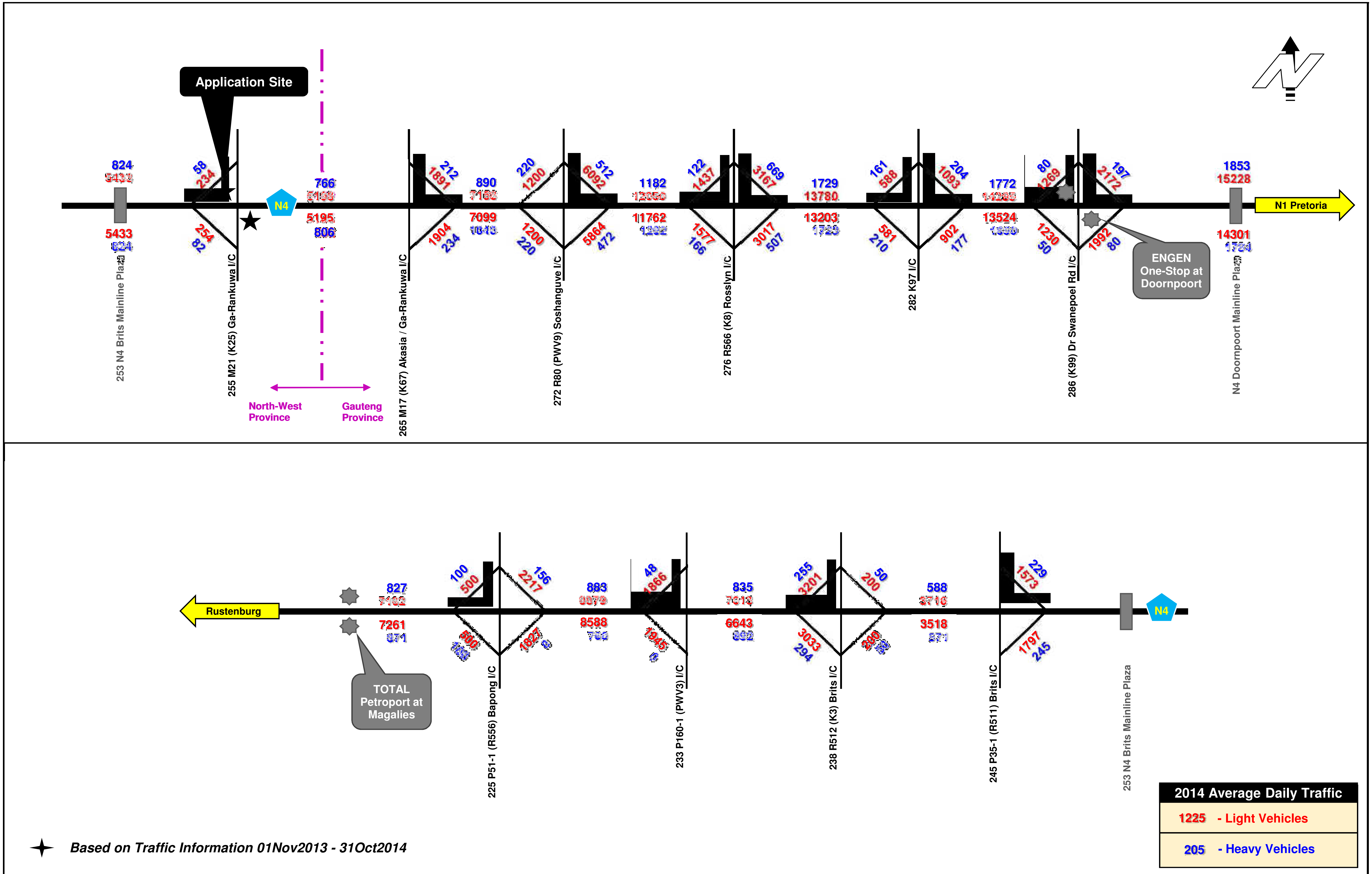


N4 / D2726 (K25) M21 INTERCHANGE Farm Schietfontein 437-JQ	Other Filling Station Sites in Corridor - Western Section	APPENDIX H1



	N4 / D2726 (K25) M21 INTERCHANGE Farm Schietfontein 437-JQ	Other Filling Station Sites in Corridor - Eastern Section	APPENDIX H2

Appendix I: Estimated Existing (2014) Average Daily Traffic Demand in N4 Corridor



	N4 / D2726 (K25) M21 INTERCHANGE Farm Schietfontein 437-JQ	Estimated Existing (2014) Average Daily Traffic Demand in N4 Corridor	APPENDIX I

Appendix J: Financial Model

APPENDIX J: INDICATIVE FINANCIAL MODEL FOR Q4 CITY ALONG N4 PLATINUM HIGHWAY

YEAR		**2004**	**Actual Growth**	**2014**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
OPERATIONS			**2004 to 2014**					**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ESCALATION						**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
TRAFFIC GROWTH	ADT Growth	6317	6.7%	12099													
	ADLT Growth	5720	6.0%	10243		**4.60%**	**4.60%**	**4.60%**	**4.60%**	**4.60%**	**4.60%**	**4.60%**	**4.60%**	**4.60%**	**4.60%**	**4.60%**	**4.60%**
	ADTT Growth	597	12.0%	1856		**5.90%**	**5.90%**	**5.90%**	**5.90%**	**5.90%**	**5.90%**	**5.90%**	**5.90%**	**5.90%**	**5.90%**	**5.90%**	**5.90%**
EASTBOUND	ADLT				5 404	5 653	5 913	6 185	6 469	6 767	7 078	7 404	7 744	8 100	8 473	8 863	9 270
	ADTT				949	1 005	1 064	1 127	1 194	1 264	1 339	1 418	1 501	1 590	1 684	1 783	1 888
WESTBOUND	ADLT				5 216	5 456	5 707	5 969	6 244	6 531	6 832	7 146	7 475	7 818	8 178	8 554	8 948
	ADTT				811	859	910	963	1 020	1 080	1 144	1 211	1 283	1 359	1 439	1 524	1 614
TOTAL	ADT				12 380	12 972	13 593	14 244	14 927	15 642	16 392	17 178	18 003	18 867	19 773	20 723	21 720
INTERCEPTED TRAFFIC																	
EASTBOUND	ADLT	**5.5%**	rate				LT veh / day	340	356	372	389	407	426	446	466	487	510
	ADTT	**4.0%**	rate				TT veh / day	45	48	51	54	57	60	64	67	71	76
WESTBOUND	ADLT	**5.5%**	rate				LT veh / day	328	343	359	376	393	411	430	450	470	492
	ADTT	**4.0%**	rate				TT veh / day	39	41	43	46	48	51	54	58	61	65
FUEL AND COMPLIMENTARY SALES PER MONTH																	
FUEL SALES (litres/month) BEFORE RAMP-UP	PETROL for Light Vehicles	**30**	litre/veh	**80%**	**30.4**	days/month	litres per month	487 716	510 151	533 618	558 164	583 840	610 697	638 789	668 173	698 909	731 059
	Diesel for Light Vehicles	**45**	litre/veh	**20%**	**30.4**	days/month	litres per month	182 894	191 307	200 107	209 312	218 940	229 011	239 546	250 565	262 091	274 147
	Diesel for Heavy Vehicles	**150**	litre/veh		**30.4**	days/month	litres per month	381 264	403 758	427 580	452 807	479 523	507 815	537 776	569 504	603 105	638 688
RAMP UP	Ramp-up						% of potential	**85%**	**90%**	**95%**							
FUEL SALES (litres/month) AFTER RAMP-UP	PETROL						litres per month	414 559	459 136	506 937	558 164	583 840	610 697	638 789	668 173	698 909	731 059
	Diesel 50ppm						litres per month	155 460	172 176	190 101	209 312	218 940	229 011	239 546	250 565	262 091	274 147
	Diesel 500ppm						litres per month	324 074	363 382	406 201	452 807	479 523	507 815	537 776	569 504	603 105	638 688
	Total Fuel Sales						litres per month	894 092	994 694	1 103 239	1 220 283	1 282 303	1 347 522	1 416 110	1 488 242	1 564 105	1 643 894
FUEL PRICE	PETROL	**12.00**	2014 Rand/litre		escalation	**5.0%**	Rand / litre	13.89	14.59	15.32	16.08	16.89	17.73	18.62	19.55	20.52	21.55
	Diesel	**12.00**	2014 Rand/litre		escalation	**5.0%**	Rand / litre	13.89	14.59	15.32	16.08	16.89	17.73	18.62	19.55	20.52	21.55
FUEL SALES (Rand/month)	PETROL						Rand / month	5 758 842	6 696 991	7 763 933	8 975 924	9 858 258	10 827 324	11 891 650	13 060 600	14 344 456	15 754 517
	Diesel						Rand / month	4 501 875	5 300 322	6 221 121	7 281 658	8 096 840	9 003 281	10 011 199	11 131 952	12 378 174	13 763 911
RATE FOR COMPLIMENTARY SALES	C-STORE	**1.50**	2014 Rand sales/litre		escalation	**5.0%**	Rand t/o pm	1.74	1.82	1.91	2.01	2.11	2.22	2.33	2.44	2.57	2.69
	RESTAURANT	**1.30**	2014 Rand sales/litre		escalation	**5.0%**	Rand t/o pm	1.50	1.58	1.66	1.74	1.83	1.92	2.02	2.12	2.22	2.33
COMPLIMENTARY SALES	C-STORE						Rand / month	1 282 590	1 499 664	1 748 132	2 032 198	2 244 387	2 478 826	2 737 856	3 024 069	3 340 329	3 689 803
	RESTAURANT						Rand / month	1 111 578	1 299 709	1 515 048	1 761 238	1 945 136	2 148 316	2 372 809	2 620 860	2 894 952	3 197 830
TOTAL OPERATING REVENUE PER ANNUM								**30 010 569**	**35 046 515**	**40 802 602**	**47 374 119**	**52 255 627**	**57 642 134**	**63 586 099**	**70 145 447**	**77 384 155**	**85 372 871**
		RETAIL	WHOLESALE	AVAILABLE													
FUEL MARGINS	- PETROL (cent/litre)	**151.1**	**33.5**	**33.5**	escalation	**5.0%**	Rand / litre	213.7	224.4	235.6	247.4	259.8	272.7	286.4	300.7	315.7	331.5
	- Diesel (cent/litre) 50ppm	**151.1**	**64.7**	**36.5**	escalation	**5.0%**	Rand / litre	217.2	228.0	239.4	251.4	264.0	277.2	291.0	305.6	320.9	336.9
	- Diesel (cent/litre) 500ppm	**100.0**	**64.7**	**36.5**	escalation	**5.0%**	Rand / litre	158.0	165.9	174.2	182.9	192.1	201.7	211.8	222.3	233.5	245.1
FUEL REVENUE	PETROL						Rand / annum	10 630 822	12 362 646	14 332 221	16 569 556	18 198 344	19 987 241	21 951 986	24 109 867	26 479 867	29 082 838
	- Diesel (cent/litre) 50ppm						Rand / annum	4 051 345	4 711 333	5 461 927	6 314 563	6 935 284	7 617 023	8 365 776	9 188 132	10 091 325	11 083 302
	- Diesel (cent/litre) 500ppm						Rand / annum	6 145 060	7 234 940	8 491 830	9 939 464	11 052 187	12 289 479	13 665 286	15 195 115	16 896 208	18 787 739
TOTAL FUEL REVENUE							Rand / annum	**20 827 227**	**24 308 919**	**28 285 978**	**32 823 583**	**36 185 815**	**39 893 742**	**43 983 049**	**48 493 114**	**53 467 400**	**58 953 879**
COMPLIMENTARY REVENUE	C-Store	**25%**	net margin				Rand / annum	3 847 769	4 498 993	5 244 395	6 096 594	6 733 162	7 436 477	8 213 568	9 072 207	10 020 987	11 069 410
	Restaurants	**40%**	net margin				Rand / annum	5 335 573	6 238 603	7 272 228	8 453 943	9 336 651	10 311 915	11 389 481	12 580 127	13 895 768	15 349 582
TOTAL COMPLIMENTARY REVENUE							Rand / annum	**9 183 342**	**10 737 596**	**12 516 624**	**14 550 537**	**16 069 812**	**17 748 392**	**19 603 050**	**21 652 334**	**23 916 755**	**26 418 993**
TOTAL EXPENSES PER ANNUM								**-27 872 578**	**-28 732 140**	**-29 490 019**	**-30 022 219**	**-30 327 699**	**-30 652 420**	**-30 997 759**	**-31 365 259**	**-31 756 663**	**-32 173 934**
OPERATIONAL EXPENSES	Operational Expenses	**12 000 000**	2014 Rand / annum		escalation	**5.0%**	2014 Rand / annum	-13 891 500	-14 586 075	-15 315 379	-16 081 148	-16 885 205	-17 729 465	-18 615 939	-19 546 736	-20 524 072	-21 550 276
ROYALTIES & LEVIES	C-Store Advertising & Royalties	**8.5%**	t/o C-store				2014 Rand / annum	-1 308 241	-1 529 657	-1 783 094	-2 072 842	-2 289 275	-2 528 402	-2 792 613	-3 084 550	-3 407 135	-3 763 600
	Restaurants Advertising & Royalties	**9.0%**	t/o Restaurants				2014 Rand / annum	-1 200 504	-1 403 686	-1 636 251	-1 902 137	-2 100 746	-2 320 181	-2 562 633	-2 830 529	-3 126 548	-3 453 656
	SANRAL Fuel Levy	**0.5%**	t/o fuel sales				2014 Rand / annum	-615 643	-719 839	-839 103	-975 455	-1 077 306	-1 189 836	-1 314 171	-1 451 553	-1 603 358	-1 771 106
	SANRAL C-Store Levy	**1.0%**	t/o C-store & Restaurants				2014 Rand / annum	-287 300	-335 925	-391 582	-455 212	-502 743	-555 257	-613 280	-677 391	-748 234	-826 516
TOTAL OPERATIONAL EXPENSES							2014 Rand / annum	**-17 303 188**	**-18 575 182**	**-19 965 409**	**-21 486 794**	**-22 855 275**	**-24 323 142**	**-25 898 636**	**-27 590 759**	**-29 409 347**	**-31 365 153**
REPAYMENT OF INTEREST ON CAPITAL							2014 Rand / annum	**-10 569 390**	**-10 156 958**	**-9 524 610**	**-8 535 425**	**-7 472 424**	**-6 329 279**	**-5 099 123**	**-3 774 500**	**-2 347 316**	**-808 781**
CAPITAL COST AND REPAYMENT																	
CAPITAL COST	Capital Cost	**96 300 000**			REPAYMENT OF DEBT FUNDING		2014 Rand	-18 682 882	-18 682 882	-18 682 882	-18 682 882	-18 682 882	-18 682 882	-18 682 882	-18 682 882	-18 682 882	-18 682 882
	Contingency	**14 445 000**	**15%**		Annual Interest Payments		2014 Rand	-10 154 552	-9 423 742	-8 630 306	-7 768 879	-6 833 635	-5 818 248	-4 715 850	-3 518 985	-2 219 558	-808 781
	Start up Cost	**15 000 000**	110 745 000		Interest on Shaped Capital Profile		2014 Rand	-414 837	-733 216	-894 304	-766 546	-638 788	-511 031	-383 273	-255 515	-127 758	0
	Total Capital Cost	**125 745 000**			**Total Interest Payments**		2014 Rand	**-10 569 390**	**-10 156 958**	**-9 524 610**	**-8 535 425**	**-7 472 424**	**-6 329 279**	**-5 099 123**	**-3 774 500**	**-2 347 316**	**-808 781**
	Escalated Capital Cost	**138 319 500**	**10%**	Escalation	Annual Capital Payments		2014 Rand	-8 528 329	-9 259 140	-10 052 576	-10 914 003	-11 849 247	-12 864 634	-13 967 032	-15 163 897	-16 463 324	-17 874 101
	Land Cost	**13 700 000**			**Total Shaped Capital Profile**		2014 Rand	**-3 500 000**	**-5 400 000**	**-8 100 000**	**-12 462 580**	**-13 397 825**	**-14 413 212**	**-15 515 610**	**-16 712 475**	**-18 011 902**	**-19 422 679**
		152 019 500			Cum Outstanding Postponed Capital		2014 Rand	-5 028 329	-8 887 470	-10 840 046	-9 291 468	-7 742 890	-6 194 312	-4 645 734	-3 097 156	-1 548 578	0
NET PROFIT/LOSS AFTER TAX AND CAPITAL REPAYMENT								**19 353**	**46 350**	**45 060**	**30 787**	**2 390 284**	**5 019 382**	**7 947 995**	**11 209 261**	**14 839 892**	**18 880 556**
TOTAL OPERATING REVENUE							Rand / annum	30 010 569	35 046 515	40 802 602	47 374 119	52 255 627	57 642 134	63 586 099	70 145 447	77 384 155	85 372 871
REVENUE FROM SALE OF LAND							Rand / annum	**2 750 000**	**1 250 000**								
TOTAL REVENUE	Operating Revenue plus Sale of Land						Rand / annum	32 760 569	36 296 515	40 802 602	47 374 119	52 255 627	57 642 134	63 586 099	70 145 447	77 384 155	85 372 871
TOTAL EXPENSES	Operating Expenses and Debt Service						Rand / annum	-27 872 578	-28 732 140	-29 490 019	-30 022 219	-30 327 699	-30 652 420	-30 997 759	-31 365 259	-31 756 663	-32 173 934
EBIT	Earnings Before Interest and Taxes						Rand / annum	4 887 991	7 564 375	11 312 583	17 351 900	21 927 928	26 989 714	32 588 340	38 780 188	45 627 492	53 198 937
TAXATION	Company Taxation	**28%**					Rand / annum	-1 368 637	-2 118 025	-3 167 523	-4 858 532	-6 139 820	-7 557 120	-9 124 735	-10 858 453	-12 775 698	-14 895 702
NET PROFIT/LOSS AFTER TAX	EBIT - Taxation						Rand / annum	3 519 353	5 446 350	8 145 060	12 493 368	15 788 108	19 432 594	23 463 605	27 921 735	32 851 794	38 303 235
REPAYMENT OF CAPITAL							Rand / annum	-3 500 000	-5 400 000	-8 100 000	-12 462 580	-13 397 825	-14 413 212	-15 515 610	-16 712 475	-18 011 902	-19 422 679
FINANCIAL INDICATORS																	
FINANCING STRUCTURE	Debt	**83.5%**	126 936 283	Rand	ROE nominal	**28.0%**	-25 083 218	19 353	46 350	45 060	30 787	2 390 284	5 019 382	7 947 995	11 209 261	14 839 892	18 880 556
	Equity	**16.5%**	25 083 218	Rand	ROE real	**21.9%**											
	Prime Interest Rate	**9.25%**			WACC nominal	**17.6%**		4 000 000	5.035474921								
KEY FINANCIAL INDICATORS	Margin on Lending Rate	**-1.00%**			WACC real	**12.0%**											
	CPI	**5.0%**			NPV	**75 472 693**		19 353	46 350	45 060	30 787	2 390 284	5 019 382	7 947 995	11 209 261	14 839 892	18 880 556
REPAYMENT PERIOD FOR EQUITY								**19 353**	**65 703**	**110 763**	**141 550**	**2 531 834**	**7 551 216**	**15 499 211**	**26 708 471**		

APPENDIX J: INDICATIVE FINANCIAL MODEL FOR Q4 CITY ALONG N4 PLATINUM HIGHWAY

YEAR		2004	Actual Growth	2014	2014	2015	2016	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
OPERATIONS			2004 to 2014					11	12	13	14	15	16	17	18	19	20
ESCALATION						1	2	13	14	15	16	17	18	19	20	21	22
TRAFFIC GROWTH	ADT Growth	6317	6.7%	12099													
	ADLT Growth	5720	6.0%	10243		4.60%	4.60%	4.60%	4.60%	4.60%	4.60%	4.60%	4.60%	4.60%	4.60%	4.60%	4.60%
	ADTT Growth	597	12.0%	1856		5.90%	5.90%	5.90%	5.90%	5.90%	5.90%	5.90%	5.90%	5.90%	5.90%	5.90%	5.90%
EASTBOUND	ADLT				5 404	5 653	5 913	9 697	10 143	10 609	11 097	11 608	12 142	12 700	13 285	13 896	14 535
	ADTT				949	1 005	1 064	1 999	2 117	2 242	2 375	2 515	2 663	2 820	2 987	3 163	3 349
WESTBOUND	ADLT				5 216	5 456	5 707	9 359	9 790	10 240	10 711	11 204	11 719	12 259	12 822	13 412	14 029
	ADTT				811	859	910	1 709	1 810	1 916	2 029	2 149	2 276	2 410	2 552	2 703	2 862
TOTAL	ADT				12 380	12 972	13 593	22 764	23 860	25 008	26 213	27 476	28 800	30 189	31 646	33 174	34 776
INTERCEPTED TRAFFIC																	
EASTBOUND	ADLT	5.5%	rate				LT veh / day	533	558	584	610	638	668	699	731	764	799
	ADTT	4.0%	rate				TT veh / day	80	85	90	95	101	107	113	119	127	134
WESTBOUND	ADLT	5.5%	rate				LT veh / day	515	538	563	589	616	645	674	705	738	772
	ADTT	4.0%	rate				TT veh / day	68	72	77	81	86	91	96	102	108	114
FUEL AND COMPLIMENTARY SALES PER MONTH																	
FUEL SALES (litres/month) BEFORE RAMP-UP	PETROL for Light Vehicles	30	litre/veh	80%	30.4	days/month	litres per month	764 687	799 863	836 657	875 143	915 399	957 508	1 001 553	1 047 625	1 095 815	1 146 223
	Diesel for Light Vehicles	45	litre/veh	20%	30.4	days/month	litres per month	286 758	299 949	313 746	328 179	343 275	359 065	375 582	392 859	410 931	429 834
	Diesel for Heavy Vehicles	150	litre/veh		30.4	days/month	litres per month	676 371	716 277	758 537	803 291	850 685	900 876	954 027	1 010 315	1 069 923	1 133 049
RAMP UP	Ramp-up						% of potential										
	PETROL						litres per month	764 687	799 863	836 657	875 143	915 399	957 508	1 001 553	1 047 625	1 095 815	1 146 223
FUEL SALES (litres/month) AFTER RAMP-UP	Diesel 50ppm						litres per month	286 758	299 949	313 746	328 179	343 275	359 065	375 582	392 859	410 931	429 834
	Diesel 500ppm						litres per month	676 371	716 277	758 537	803 291	850 685	900 876	954 027	1 010 315	1 069 923	1 133 049
	Total Fuel Sales						litres per month	1 727 816	1 816 089	1 908 940	2 006 612	2 109 359	2 217 449	2 331 163	2 450 799	2 576 670	2 709 105
FUEL PRICE	PETROL	12.00	2014 Rand/litre		escalation	5.0%	Rand / litre	22.63	23.76	24.95	26.19	27.50	28.88	30.32	31.84	33.43	35.10
	Diesel	12.00	2014 Rand/litre		escalation	5.0%	Rand / litre	22.63	23.76	24.95	26.19	27.50	28.88	30.32	31.84	33.43	35.10
FUEL SALES (Rand/month)	PETROL						Rand / month	17 303 186	19 004 089	20 872 191	22 923 927	25 177 349	27 652 282	30 370 502	33 355 922	36 634 809	40 236 011
	Diesel						Rand / month	15 304 781	17 018 151	18 923 333	21 041 800	23 397 430	26 016 772	28 929 350	32 167 990	35 769 197	39 773 559
RATE FOR COMPLIMENTARY SALES	C-STORE	1.50	2014 Rand sales/litre		escalation	5.0%	Rand t/o pm	2.83	2.97	3.12	3.27	3.44	3.61	3.79	3.98	4.18	4.39
	RESTAURANT	1.30	2014 Rand sales/litre		escalation	5.0%	Rand t/o pm	2.45	2.57	2.70	2.84	2.98	3.13	3.29	3.45	3.62	3.80
COMPLIMENTARY SALES	C-STORE						Rand / month	4 075 996	4 502 780	4 974 440	5 495 716	6 071 847	6 708 632	7 412 481	8 190 489	9 050 501	10 001 196
	RESTAURANT						Rand / month	3 532 530	3 902 409	4 311 182	4 762 954	5 262 268	5 814 148	6 424 151	7 098 424	7 843 767	8 667 703
TOTAL OPERATING REVENUE PER ANNUM								**94 189 627**	**103 920 605**	**114 660 993**	**126 515 935**	**139 601 570**	**154 046 191**	**169 991 524**	**187 594 132**	**207 026 985**	**228 481 182**
		RETAIL	WHOLESALE	AVAILABLE													
FUEL MARGINS	- PETROL (cent/litre)	151.1	33.5	33.5	escalation	5.0%	Rand / litre	348.1	365.5	383.8	403.0	423.1	444.3	466.5	489.8	514.3	540.0
	- Diesel (cent/litre) 50ppm	151.1	64.7	36.5	escalation	5.0%	Rand / litre	353.7	371.4	390.0	409.5	430.0	451.5	474.1	497.8	522.6	548.8
	- Diesel (cent/litre) 500ppm	100.0	64.7	36.5	escalation	5.0%	Rand / litre	257.4	270.3	283.8	298.0	312.9	328.5	344.9	362.2	380.3	399.3
	PETROL						Rand / annum	31 941 680	35 081 548	38 530 064	42 317 569	46 477 386	51 046 113	56 063 946	61 575 032	67 627 858	74 275 676
FUEL REVENUE	- Diesel (cent/litre) 50ppm						Rand / annum	12 172 791	13 369 376	14 683 586	16 126 983	17 712 265	19 453 381	21 365 648	23 465 891	25 772 588	28 306 034
	- Diesel (cent/litre) 500ppm						Rand / annum	20 891 026	23 229 776	25 830 350	28 722 057	31 937 492	35 512 894	39 488 562	43 909 307	48 824 954	54 290 907
TOTAL FUEL REVENUE							Rand / annum	**65 005 497**	**71 680 700**	**79 044 000**	**87 166 609**	**96 127 143**	**106 012 388**	**116 918 156**	**128 950 230**	**142 225 400**	**156 872 617**
COMPLIMENTARY REVENUE	C-Store	25%	net margin				Rand / annum	12 227 987	13 508 340	14 923 321	16 487 148	18 215 542	20 125 895	22 237 444	24 571 467	27 151 502	30 003 589
	Restaurants	40%	net margin				Rand / annum	16 956 143	18 731 565	20 693 672	22 862 178	25 258 885	27 907 908	30 835 923	34 072 434	37 650 083	41 604 976
TOTAL COMPLIMENTARY REVENUE							Rand / annum	**29 184 130**	**32 239 905**	**35 616 994**	**39 349 326**	**43 474 427**	**48 033 804**	**53 073 367**	**58 643 902**	**64 801 585**	**71 608 565**
TOTAL EXPENSES PER ANNUM								**-33 469 939**	**-35 736 574**	**-38 179 150**	**-40 813 099**	**-43 655 334**	**-46 724 391**	**-50 040 603**	**-53 626 273**	**-57 505 883**	**-61 706 310**
OPERATIONAL EXPENSES	Operational Expenses	12 000 000	2014 Rand / annum		escalation	5.0%	2014 Rand / annum	-22 627 790	-23 759 179	-24 947 138	-26 194 495	-27 504 220	-28 879 431	-30 323 402	-31 839 572	-33 431 551	-35 103 129
ROYALTIES & LEVIES	C-Store Advertising & Royalties	8.5%	t/o C-store				2014 Rand / annum	-4 157 516	-4 592 836	-5 073 929	-5 605 630	-6 193 284	-6 842 804	-7 560 731	-8 354 299	-9 231 511	-10 201 220
	Restaurants Advertising & Royalties	9.0%	t/o Restaurants				2014 Rand / annum	-3 815 132	-4 214 602	-4 656 076	-5 143 990	-5 683 249	-6 279 279	-6 938 083	-7 666 298	-8 471 269	-9 361 120
	SANRAL Fuel Levy	0.5%	t/o fuel sales				2014 Rand / annum	-1 956 478	-2 161 334	-2 387 731	-2 637 944	-2 914 487	-3 220 143	-3 557 991	-3 931 435	-4 344 240	-4 800 574
	SANRAL C-Store Levy	1.0%	t/o C-store & Restaurants				2014 Rand / annum	-913 023	-1 008 623	-1 114 275	-1 231 040	-1 360 094	-1 502 734	-1 660 396	-1 834 670	-2 027 312	-2 240 268
TOTAL OPERATIONAL EXPENSES							2014 Rand / annum	**-33 469 939**	**-35 736 574**	**-38 179 150**	**-40 813 099**	**-43 655 334**	**-46 724 391**	**-50 040 603**	**-53 626 273**	**-57 505 883**	**-61 706 310**
REPAYMENT OF INTEREST ON CAPITAL							2014 Rand / annum	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
CAPITAL COST AND REPAYMENT																	
CAPITAL COST	Capital Cost	96 300 000			REPAYMENT OF DEBT FUNDING		2014 Rand										
	Contingency	14 445 000	15%		Annual Interest Payments		2014 Rand										
	Start up Cost	15 000 000	110 745 000		Interest on Shaped Capital Profile		2014 Rand										
	Total Capital Cost	125 745 000			**Total Interest Payments**		2014 Rand										
	Escalated Capital Cost	138 319 500	10%	Escalation	Annual Capital Payments		2014 Rand										
	Land Cost	13 700 000			**Total Shaped Capital Profile**		2014 Rand										
		152 019 500			Cum Outstanding Postponed Capital		2014 Rand										
NET PROFIT/LOSS AFTER TAX AND CAPITAL REPAYMENT								**43 718 176**	**49 092 502**	**55 066 927**	**61 706 042**	**69 081 290**	**77 271 696**	**86 364 663**	**96 456 858**	**107 655 194**	**120 077 907**
TOTAL OPERATING REVENUE							Rand / annum	94 189 627	103 920 605	114 660 993	126 515 935	139 601 570	154 046 191	169 991 524	187 594 132	207 026 985	228 481 182
REVENUE FROM SALE OF LAND							Rand / annum										
TOTAL REVENUE	Operating Revenue plus Sale of Land						Rand / annum	94 189 627	103 920 605	114 660 993	126 515 935	139 601 570	154 046 191	169 991 524	187 594 132	207 026 985	228 481 182
TOTAL EXPENSES	Operating Expenses and Debt Service						Rand / annum	-33 469 939	-35 736 574	-38 179 150	-40 813 099	-43 655 334	-46 724 391	-50 040 603	-53 626 273	-57 505 883	-61 706 310
EBIT	Earnings Before Interest and Taxes						Rand / annum	60 719 689	68 184 031	76 481 844	85 702 836	95 946 236	107 321 800	119 950 921	133 967 858	149 521 102	166 774 871
TAXATION	Company Taxation	28%					Rand / annum	-17 001 513	-19 091 529	-21 414 916	-23 996 794	-26 864 946	-30 050 104	-33 586 258	-37 511 000	-41 865 909	-46 696 964
NET PROFIT/LOSS AFTER TAX	EBIT - Taxation						Rand / annum	43 718 176	49 092 502	55 066 927	61 706 042	69 081 290	77 271 696	86 364 663	96 456 858	107 655 194	120 077 907
REPAYMENT OF CAPITAL							Rand / annum	0	0	0	0	0	0	0	0	0	0
FINANCIAL INDICATORS																	
FINANCING STRUCTURE	Debt	83.5%	126 936 283	Rand	ROE nominal	**28.0%**	-25 083 218	43 718 176	49 092 502	55 066 927	61 706 042	69 081 290	77 271 696	86 364 663	96 456 858	107 655 194	120 077 907
	Equity	16.5%	25 083 218	Rand	ROE real	**21.9%**											
	Prime Interest Rate	9.25%			WACC nominal	**17.6%**											
KEY FINANCIAL INDICATORS	Margin on Lending Rate	-1.00%			WACC real	12.0%											
	CPI	5.0%			NPV	75 472 693		43 718 176	49 092 502	55 066 927	61 706 042	69 081 290	77 271 696	86 364 663	96 456 858	107 655 194	120 077 907
REPAYMENT PERIOD FOR EQUITY																	

Services Outline Scheme Report

Annexure F8

OUTLINE SCHEME REPORT
FOR THE CONSTRUCTION OF WATER, SEWER AND STORMWATER SYSTEMS FOR THE PROPOSED DEVELOPMENT
Q4 FUEL CITY

DATE : April 2015

REPORT NO. : 2357/01

PRETORIA	2nd Floor Building 88A Tijger Vallei Office Park Silverlakes, 0081	PO Box 11211 **SILVER LAKES** 0054	☎ : **Fax** : **Email** :	(012) 809 0010 (012) 809 1435 **pretoria@vipconsulting.co.za**
BENONI	Reef House Top Floor West Wing, Cnr Mowbrayi & Bunyan Str, Benoni	PO Box 3108 **BENONI** 1500	☎ : **Fax** : **Email** :	(011) 421 7233 (011) 420 0120 **benoni@vipconsulting.co.za**

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FIGURES

TABLES

ANNEXURES

1. INTRODUCTION

1.1 TERMS OF REFERENCE

VIP Consulting Engineers (Pty) Ltd has been appointed by Q4 Fuel (Pty) Ltd as Consulting Civil Engineers for the preliminary planning of bulk water and sewer connections for the proposed Q4 Fuel City on the N4 between Pretoria and Brits.

The appointment includes :

- Investigation and report for bulk water and sewer connections,
- Attendance of planning meetings as and when requested by the client.

1.2 DEVELOPER

The developer of the proposed Q4 Fuel City is Q4 Fuel (Pty) Ltd.

The information of the developer is as follows :

Physical address: 269 Annette van Zyl Street
Garsfontein
PRETORIA
0042

Postal address: PO Box 90549
Garsfontein
PRETORIA
0042

Telephone number: (012) 361 5151

Fax number: (012) 361 5150

The appointment letter is attached in **Annexure A.**

1.3 LOCALITY AND EXTENT

The proposed site is situated approximately 19 km east of Brits, at the intersection of the N4 highway and M21 secondary road.

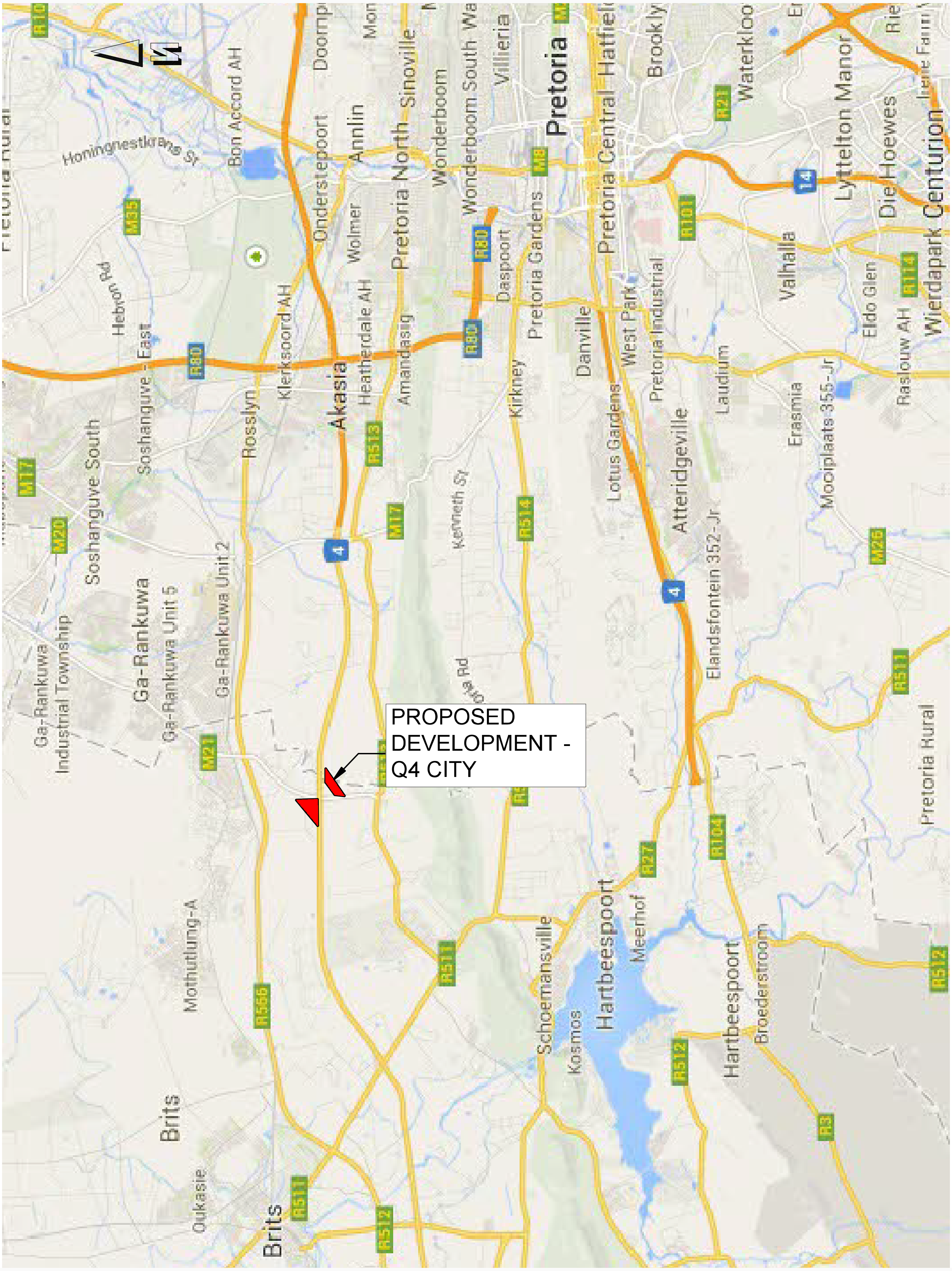
The development would take place in two parts, one in the North-Western quadrant of the intersection (on the Remainder of portion 22 a Portion of Portion 2 of the Farm Schietfontein 437), and the other in the South-Eastern quadrant (on the Remainder of portion 41 a Portion of Portion 2 of the Farm Schietfontein 437).

The locality of the proposed development is shown on **Figure 1.**

1.4 LOCAL AUTHORITY

The proposed development falls within the area of jurisdiction of the Madibeng Local Municipality.

The entire civil engineering infrastructure required for the proposed development will be installed to the required standards of the Madibeng Local Municipality.



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OTHER OFFICES :
BENONI

VIP CONSULTING ENGINEERS (Pty) Ltd
Consulting Civil and Structural Engineers
Reg No 97/05698/07

PROJECT : **PROPOSED DEVELOPMENT FOR Q4 CITY**		SCALE : **1 : 200 000**
SERVICE DETAIL : **LOCALITY MAP**		DRAWING No. : **FIGURE 1**

2. PHYSICAL PROPERTIES

2.1 TOPOGRAPHY

The site on the North-Western quadrant of the N4 and M21 intersection (on the Remainder of Portion 22) is trapezoidal in shape, with a gradual slope towards the North with short veld grass and some medium sized trees. It is currently used as grazing for livestock.

The portion on the South-Eastern quadrant (on the Remainder of Portion 41) is triangular in shape, sloping towards the North-East, with a small river running to the east of the site. It currently forms part of a game lodge with an outcrop of trees around the buildings, and short veld grass as grazing for the game.

2.2 CLIMATE

The Brits – Pretoria area generally has moderate temperatures with low unreliable rainfall which varies between 400 – 600 mm/y. The rainfall usually occurs in the form of thunderstorms in summer. Frost is common in winter.

2.3 ENGINEERING GEOLOGY

2.3.1 Regional Geology

The Geotechnical report as prepared by Holland-Muter & Associates cc, describe the area as: "The terrain is situated in an area that overlies the contact region between the sedimentary rocks of the Pretoria group, which are located to the south of the terrain and the igneous rocks of the Bushveld complex which are located to the north of the terrain. Further to the west, two major faults run parallel through the Pretoria group and continue through the Bushveld complex in a north-south direction. A few small scale faults also manifest in areas surrounding the terrain."

The mean annual precipitation is in the region of 550mm on average per year. Precipitation generally occurs in the form of conventional thunderstorms that deliver up to 90 percent of the annual rainfall during the warmer summer months (October to March of successive years). Winters are typically dry and cold with frost.

The Weinert N-value of 2.4 for the area under investigation implies that it is in a humid warm area, where chemical decomposition is the predominant rock weathering mode.

2.3.2 Soil Profile

According to the geotechnical report, the underlying rock formations of Norite and Quartzite are at a considerable depth. The report further states that: "The general soil profile consists of thick horizons of transported soils that have been derived from the nearby Magaliesberg mountain ridge and have textures varying between sandy clay and clayey sand. Alluvial deposits occur on the floodplain area of the river that runs on the eastern side of the investigated site on Portion 41."

The outcome of the soil tests indicates that the soils have potential heave, collapsible or compressible characteristics.

2.3.3 Water Table

During the geotechnical investigation no seepage water was encountered in any of the trial pits, but during periods of higher rainfall shallow water tables may exist in areas where ferricrete horizons are present.

Water & Environmental Consultants GCS has prepared a report – Water Supply and Baseline Risk Assessment, where they found during their investigation "that the static water level of the area is situated between 32 – 34 meters below surface. It was also determined that all of the boreholes are more than 90m deep from interviews with the owners and from the depth that the pumps were installed."

2.3.4 Drainage

Both areas are drained by means of surface drainage towards the north. The area to the south of the N4 has a slight slope towards the east as well, where it drains into the river which crosses the highway by means of a culvert.

2.3.5 Installation of Underground Services

Most sections of the site are underlain by soils with a general assessment of "fair" to "good" as natural sub grade materials.

SANS 1200D "Intermediate" excavation conditions should be anticipated in sections of the site where there is possibly some shallow rockhead, but "Soft" excavation conditions should be encountered over the majority of the site.

If shallow standing water and spring conditions occurs in excavation works during and after periods of heavy rain appropriate drainage measures should be taken.

Selected granular bedding and selected fill may need to be imported for these Works; however, on-site processing of excavated material may provide a significant resource of these category soils, subject to verification tests.

3. BULK INFRASTRUCTURE

3.1 PRIMARY ELEMENTS

The primary elements of the bulk water and sewer structures are shown on Drawing No 2357-VO1. Comprising of boreholes, bulk water, sewage treatment and irrigation pond.

3.1.1 Source

The water supply to these sites is by means of boreholes only as there are no municipal water supply sources available in the area. Due to the lack of municipal water supply two options of borehole supply was investigated. One where both facilities are services by one borehole and one elevated storage tank and the other where each facility is serviced by a borehole and storage tank.

The first option is complicated by having to cross the N4 National Highway by means of pipe jacking or horizontal drilling.

For this report the proposal is to service each facility with its own borehole and elevated storage tank. The proposed water network is shown on Drawing No **2357-V01 (Annexure B).**

The investigation by GCS yielded the following information with regards to the water availability and quality :

The existing borehole on the northern portion (on the Remainder of Portion 22) currently provides water to the livestock. It is suspected that the farm to the north use water from the same aquifer for irrigation to grass lands, which requires large amounts of water. Only limited testing could be done on this borehole as the existing pump was welded to the casing to prevent theft, and the pump was installed only approximately 15m below the static water level.

A new production borehole (QP2) was drilled and has a safe yield of 1.5 ℓ/s over as 12 hour period, thus delivering a total safe yield of 64.8kℓ/day.

Borehole QP2 will be used as the production borehole for the Remainder of Portion 22 (A Portion of Portion 2).

There are five existing boreholes in close proximity to the southern development area, of which only two are in use. These supply water to the game lodge and the animals. GCS are of the opinion that one of the boreholes would suffice for water supply for the existing usage, and the other can then be dedicated to the new development. The borehole earmarked for delivering water to the development (BH 4) has been tested and "can be pumped at 1 l/s for a period of 12 hours followed by a 12 hour recovery period." Safe yield = 1 x 12 x 3.6 kℓ/day = 43.2 kℓ/day.

Borehole BH4 will be utilized as the production for the Remainder of Portion 41 (A Portion of Portion 2).

The combined safe yield for both boreholes will be 108 kℓ/day.

Water from both of the boreholes was tested and compared against the DWA drinking water standards and the SANS 241-1:2011 Drinking Water Guideline. For complete GCS Report, see attached **Annexure C.**

The water samples from the boreholes have however indicated that the groundwater is fresh, clean and relatively young with no contamination present.

Based on a normal requirement of 48 hours AADD + an emergency storage equivalent to 24 hours AADD a 60 kℓ elevated water tank will be provided on each site.

3.1.2 Water Demand

The water demand expressed as annual average daily demand (AADD) for the proposed development is estimated at 38.4 kℓ/day for both facilities combined.

The determination of the annual average daily demand is shown in **Table 1**.

TABLE 1 : WATER DEMAND (PORTION 22)

LAND USE	**UNIT**	**QTY**	**UNIT DEMAND (kℓ/day)**	**TOTAL (kℓ/day)**
Garage / Filling Station	$100m^2$	10	1,2	12,0
Outside Buildings	$100m^2$	6	1,2	7,2
Annual average daily demand				**19,2**
Peak Daily Demand (excl fire flow) (1.5 x AADD)				28,8

TABLE 2 : WATER DEMAND (PORTION 41)

LAND USE	**UNIT**	**QTY**	**UNIT DEMAND (kℓ/day)**	**TOTAL (kℓ/day)**
Garage / Filling Station	$100m^2$	10	1,2	12,0
Outside Buildings	$100m^2$	6	1,2	7,2
Annual average daily demand				**19,2**
Peak Daily Demand (excl fire flow) (1.5 x AADD)				28,8

3.1.3 Fire Requirements

Fire Requirements will be catered for by an external fire specialist and is therefore not included in this report.

3.2 BULK SANITATION

3.2.1 Regional Facility

There is no Waste Water Treatment Works in the area.

3.2.2 Purification Plant

The option of only one purification plant was investigated but due to the same reason as with the water supply it was decided to supply a purification plant for each facility.

A purification plant will be constructed on each site by the developer and will consist of a $16m^3$/day package plant. The plant will be constructed on the lowest portion of each facility as indicated on the attached drawing.

The operational process of the plant is simple and comprises of a primary combined settlement tank and anaerobic digester, a secondary aerobic process comprising of the Becon Bio-Filter RBC fixed film reactor units, followed by a humus settlement and a disinfection tank. Reactor tanks are normally RC structures.

`The effluent generated by the purification process conforms to all standards specified by DWA.

Water from the purification plant can be used as irrigation water for the gardens, which will be pumped to the dedicated areas. The package plant is described in **Annexure D**.

The operations and maintenance of the plant can be done by the Supplier on appointment.

3.2.3 Sewer Discharge

The estimation of the instantaneous peak dry weather sewage flow rate is shown in **Table 3**.

TABLE 3 : SEWAGE EFFLUENT (PORTION 22)

LAND USE	UNIT	QTY	UNIT DEMAND (kℓ/day)	TOTAL (kℓ/day)
Garage/Filling Station	100m^2	10	1	10
Outside Buildings	100m^2	6	1	6
Sub Total				**16**
Total annual average demand (AADD)				**16 kℓ/d**
Instantaneous sewage flow rate (excl Peak)				0.185 ℓ/s

TABLE 4 : SEWAGE EFFLUENT (PORTION 41)

LAND USE	UNIT	QTY	UNIT DEMAND (kℓ/day)	TOTAL (kℓ/day)
Garage/Filling Station	100m^2	10	1	10
Outside Buildings	100m^2	6	1	6
Sub Total				**16**
Total annual average demand (AADD)				**16 kℓ/d**
Instantaneous sewage flow rate (excl Peak)				0.185 ℓ/s

The proposed sewer network is shown on Drawing No **2357-V01 (Annexure B)**, indicating gravitational drainage towards the lowest point of each development where the purification plant would be incorporated.

3.3 ACCESS ROUTES

Both of the sites can be accessed via the M21 and the N4.

Access routes are discussed in the Traffic Impact Study and will form part of a separate report.

3.4 STORMWATER

The stormwater from both facilities will be catered for on each site separately.

The main storm water management objectives and criteria that are considered to be relevant to the design and planning of storm water drainage systems include :

- Minimising the threat of flooding;
- Minimising public inconvenience caused by frequent storms;
- Protecting the public and preventing the loss of life due to severe storms and/or malfunctioning drainage systems;
- Preventing erosion and siltation;
- Protection of receiving water bodies;

- Minimising costs;
- Sustainability of storm water management systems; and
- Environmental and water pollution considerations.

3.4.1 Modeling

3.4.1.1 Model Selection

Simulation of stormwater runoff and evaluation of the proposed stormwater management system for the site was performed using the United States Environmental Protection Agency Stormwater Management Model (SWMM) Version 5.

The model was selected on strength of the following considerations:

i) The model is widely used throughout the world for planning analysis and design related to stormwater runoff and drainage systems in urban areas.
ii) The model provides an integrated environment for editing study area input data, running hydrologic and hydraulic simulations and viewing the results in a variety of formats.
iii) The model accounts for various hydrological processes including infiltration of rainfall into unsaturated soil layers and non-linear routing of overland flow and reservoir routing of storage units.

The model has the capability to perform reservoir routing and applies user defined control rules to simulate the operation of orifice openings and weir crest levels.

3.4.2 Rainfall Data

The rainfall data used for the simulation of stormwater runoff for 5 and 25 year recurrence intervals are shown in **Table 5**.

TABLE 5 : RAINFALL DATA

DURATION (hr : min)	DEPTH (mm)		INTENSITY (mm/hr)	
	1:5 year	1:25 year	1:5 year	1:25 year
Most Critical Duration	78	108	126	174

3.4.3 Pre-Development

3.4.3.1 Pre-development Modeling Parameters

The model parameters used for the pre-development runoff simulation are shown in **Table 6**.

TABLE 6 : MODEL PARAMETERS FOR PRE-DEVELOPMENT RUNOFF SIMULATION

PARAMETER DESCRIPTION		WIDTH (m)	SLOPE (%)	AREA (ha)
Catchment Area	Portion 22	324	1,53	7,5
	Portion 41	303	1,467	8,4

PARAMETER DESCRIPTION	UNIT	VOLUME
Impervious area	%	25%
Manning - n for impervious areas	number	0.020

PARAMETER DESCRIPTION	UNIT	VOLUME
Manning - n overland flow	number	0.200
Depth of depression storage for pervious areas	mm	20
Horton infiltration parameters		
• Maximum infiltration rate	mm / hr	75
• Minimum infiltration rate	mm / hr	25
• Infiltration decay constant	1 / hour	4
• Drying time	days	7

3.4.4 Pre-development Modeling Results

The peak discharge rates for the pre-development condition for 5 and 25 year recurrence intervals (RI) are shown in **Table 7**.

TABLE 7 : PEAK DISCHARGE RATES FOR PRE-DEVELOPMENT CONDITION

CATCHMENT AREA	RI (yr)	PEAK DISCHARGE (m^3 / s)	EQUIVALENT RUNOFF COEFFICIENT
Portion 22	**5**	0.592	0.239
	25	0.844	0.243
Portion 41	**5**	0.641	0.239
	25	0.920	0.243

3.4.5 Post Development Scenario

3.4.5.1 Post Development Modeling Parameters

The model parameters used for the post development runoff simulation are shown in **Table 8**.

TABLE 8 : MODEL PARAMETERS FOR POST DEVELOPMENT RUNOFF SIMULATION

PARAMETER DESCRIPTION	UNIT	VOLUME
Impervious Area	%	80
Manning - n for impervious areas	number	0.020
Manning - n for pervious areas (overland flow)	number	0.200
Depth of depression storage for impervious areas	mm	10
Depth of depression for pervious areas	mm	20
Percent of impervious areas with no depression storage	%	25
Horton infiltration parameters		
• Maximum infiltration rate	mm / hr	75
• Minimum infiltration rate	mm / hr	25
• Infiltration decay constant	1 / hour	4
• Drying time	days	7

3.4.6 Model Results

The peak discharge for post development scenario with and without stormwater management for 5 and 25 year recurrence intervals are shown in **Table 9**.

TABLE 9 : PEAK DISCHARGE RATES FOR POST DEVELOPMENT SCENARIO

CATCHMENT AREA	RI (yr)	PEAK DISCHARGE NO MANAGEMENT (m^3/s)	EQUIVALENT RUNOFF COEFFICIENT
Portion 22	5	1.42	0.718
	25	2.11	0.741
Portion 41	5	1.478	0.716
	25	2.213	0.740

3.4.7 Conclusion

A minor stormwater reticulation system for the development will consist of standard grid inlets and underground stormwater pipes. The parking area will be designed to form part of this system and will intercept the major part of surface water for rainfall events of up to a 1:5 year occurrence interval.

Intercepted run-off is conveyed through the underground pipe system (and along the paved surfaces) and will discharge into the retention pond that is situated on the lowest portion of each development.

The rate of discharge from the retention ponds will be at a rate not more than the 1:5 year Pre-Development discharge.

The North-western site (Portion 22) will discharge into an open channel next to the M21 (R25) and drain to the existing stream to the North of the site. The South-eastern site (Portion 41) will discharge into the existing open channel next to the N4 draining to the existing culvert crossing the N4.

Stormwater should be regularly tested before exiting the site and entering the exiting streams, to ensure that the quality of Stormwater outflow complies to General Limit Values of the National Water Act (No.36 of 1998) (NWA).

3.4.8 Separation of Potentially Contaminated Stormwater

3.4.8.1 Bulk Refuelling Area

As part of the normal operations for this facility, a fuel tanker will be required to fill the fuel stocks in the underground fuel tanks located on each site. The risks of pollution during this procedure should a spill incident occur are considered significant. Therefore appropriate design standards to afford mitigation are considered essential.

As part of the refuelling procedure, a dished refuelling station is to be provided within the lay by area located on the site, on which the tanker will park while decanting fuel to the underground fuel storage tanks.

The dished refuelling station will consist of a reinforced concrete apron with positive falls towards centrally located catch-pits.

These catch-pits will drain to an underground storm water pollution containment chamber. An isolation valve will be provided downstream of this chamber. During all refuelling events, the operator is to close the isolation valve to ensure that should a major spillage occur, all fuel is then contained within the chamber for later cleaning up operations.

In all other circumstances besides refuelling events, the isolation valve is to remain open to convey stormwater (due to the area being uncovered) to a Calcamite sand, oil and grease trap. Once the containment chamber has been "cleaned" the valve downstream of the chamber is opened and any residual spillage on the apron or in the chamber will be piped with the runoff to the Calcamite sand, oil and grease trap located downstream of the isolation valve.

The residual hydrocarbons will be separated out from the clean water based on the principal of specific gravity in the Calcamite sand, oil, and grease trap. The outlet pipe of the trap is to connect to the nearest sewer manhole of the existing sewer system which discharges to the wastewater treatment works (Package Plant). There must be regular maintenance and inspections in accordance with the Operational Environmental Management Program (EMP).

3.4.8.2 Forecourt Dispensing Area

The forecourt is to be covered and any wash water from this area will be directed via a concrete graded slab, with positive falls towards a centrally located catch-pits.

The centrally located catch-pits shall drain into a pollution containment chamber i.e. an approved oil/water separator system. Once the wash water has passed through the system, the separated oil must be collected regularly by an approved waste contractor and removed to an approved hazardous waste disposal facility. The remaining effluent water is to discharge to the sewer system which discharges to the wastewater treatment works (Package Plant).

4. TOWN PLANNING

Both properties will be zoned special for the purpose of a filling/service station and purposes incidental thereto.

5. SOLID WASTE MANAGEMENT

The solid waste generated from the convenience store and other on site amenities will be accumulated and stored on site in the prescribed bins provided by a Contracted Private Waste Removal Company. These bins will be collected at regular intervals and or on request and disposed of at registered landfill facility with the required capacity.

Chemicals and hazardous waste will be catered for according to the prescribed requirements in legislation. See **Annexure E** for The Waste Group permits to transport waste.

6. ELECTRICITY SUPPLY

The electricity supply will be dealt with in a separate report.

7. COST ESTIMATES

The total estimated costs for the provision of the water and sewer infrastructure are shown in **Table 10**.

TABLE 10 : COST ESTIMATES

DESCRIPTION	**AMOUNT**	
Preliminary & General	R	725 896.56
Water Network	R	2 354 760.64
Sewer Network	R	2 182 092.87
SUB-TOTAL	**R**	**5 262 750.07**
Contingency Allowance (15%)	R	789 412.51
Professional Fees	R	574 955.45
TOTAL WATER AND SEWER INFRASTRUCTURE COST (Excl. VAT)	**R**	**6 627 118.03**

The above mentioned amounts do not include any escalation.

8. CONCLUSION

We herewith recommend that Q4 Fuel (Pty) Ltd submit the draft Layout plans to the Madibeng Local Municipality in order to get the layout plan approved.

We trust that the Services Report will meet your approval. We still remain open for any proposals or feedback.

H VILJOEN Pr Tech Eng
DIRECTOR
HV/hv

ANNEXURE A

APPOINTMENT LETTER

Q4 Chemicals (Proprietary) Limited - Reg no: 2000/012825/07
P.O. Box 90549, Garsfontein, Pretoria, 0042
269 Annette van Zyl Street, Garsfontein
Vat Reg: 4130201611 - Wholesale no: 9/2006/09/12/0042

September 30, 2013

VIP Consulting Engineers (Pty) Ltd
PO Box 11211
Silver Lakes
0054

ATTENTION : MR IW HENNING

Dear Sir

LETTER OF APPOINTMENT AS CONSULTING CIVIL ENGINEERS FOR THE PRELIMINARY PLANNING OF BULK WATER AND SEWER CONNECTIONS FOR THE PROPOSED Q4 FUEL CITY (N4)

Q4 Fuel (Pty) Ltd hereby appoints VIP Consulting Engineers as consulting civil engineers for the preliminary planning of bulk water and sewer connections for the proposed Q4 Fuel City on the N4. The appointment will include :

(i) Investigation and report for bulk water and sewer connections;

(ii) Attendance of planning meetings as and when requested by Q4 Fuel.

The remuneration for the abovementioned service will be **R80 000.00** (excl VAT).

The fee excludes other investigations for which outside consultants have to be appointed.

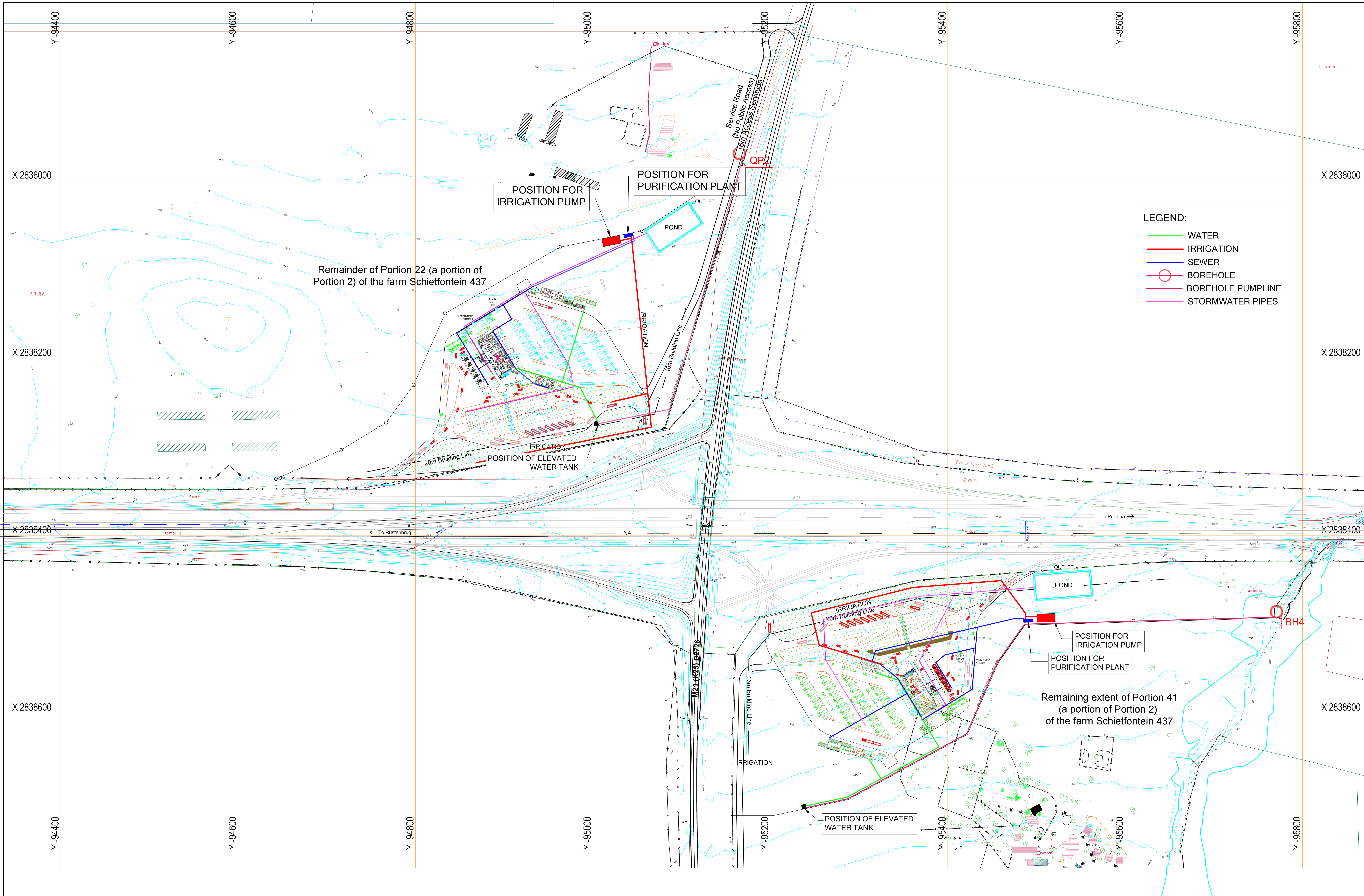
This letter of appointment together with VIP Consulting Engineers Standard Conditions of Appointment forms the basis of the agreement between the parties.

Yours faithfully

for Q4 CHEMICALS (PTY) LTD

ANNEXURE B

DRAWINGS



DATE	MAY 2014	No.	REVISION	DRAWN	CHECKED	DATE	PROJECT: Q4 FUEL CITY
DESIGNED	H VILJOEN						SERVICE DETAIL: BULK WATER AND SEWER SERVICES
DRAWN	H VON WIELLIGH						
CHECKED	H VILJOEN						

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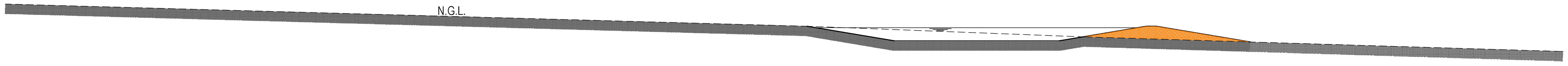
Consulting Civil and Structural Engineers
Reg No 97/05698/07

4 FUEL

CONSULTING ENGINEER

DIRECTOR

ENG. DRAWING NUMBER
2357-V01



LONGITUDINAL SECTION THROUGH POND

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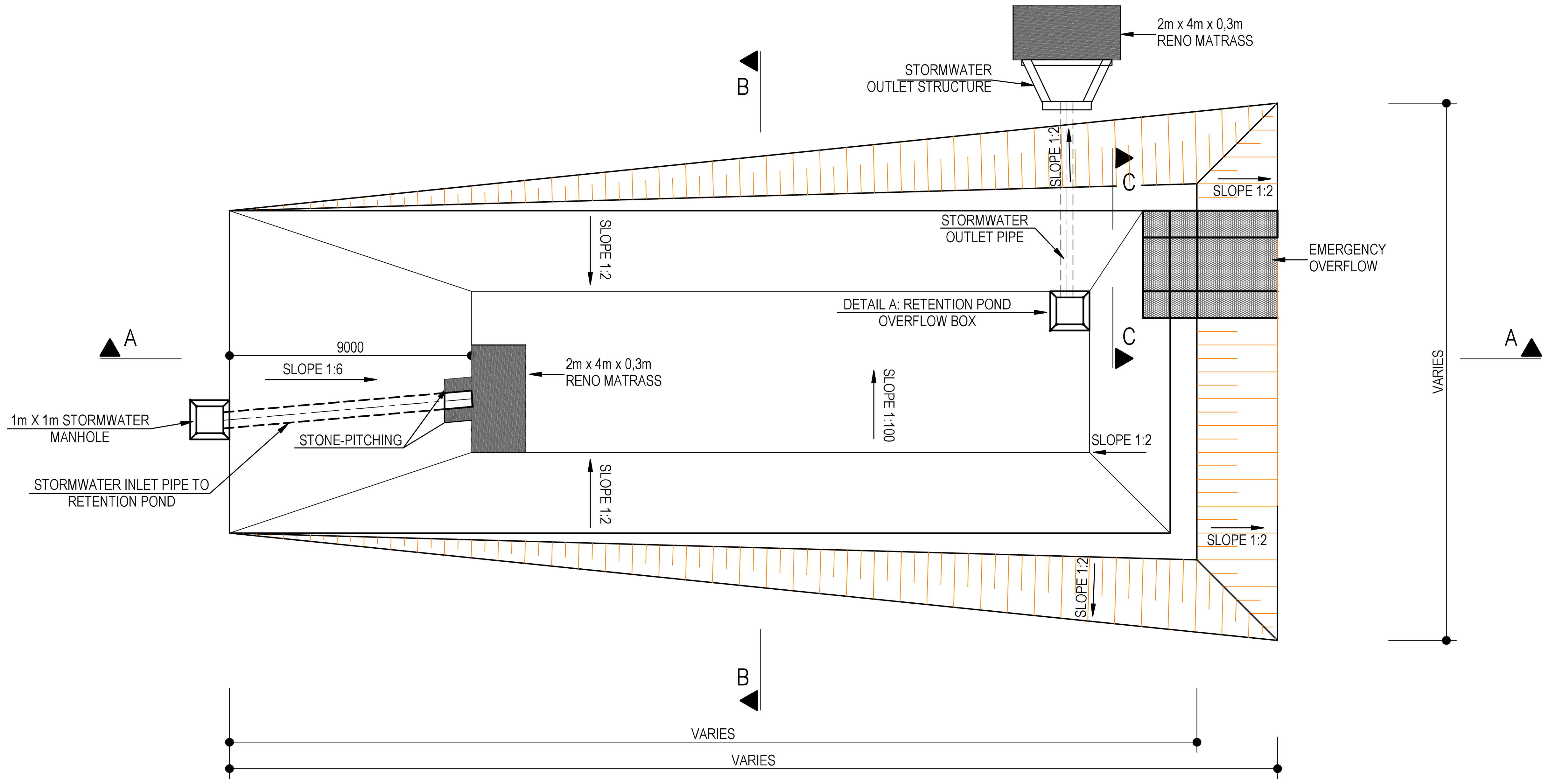
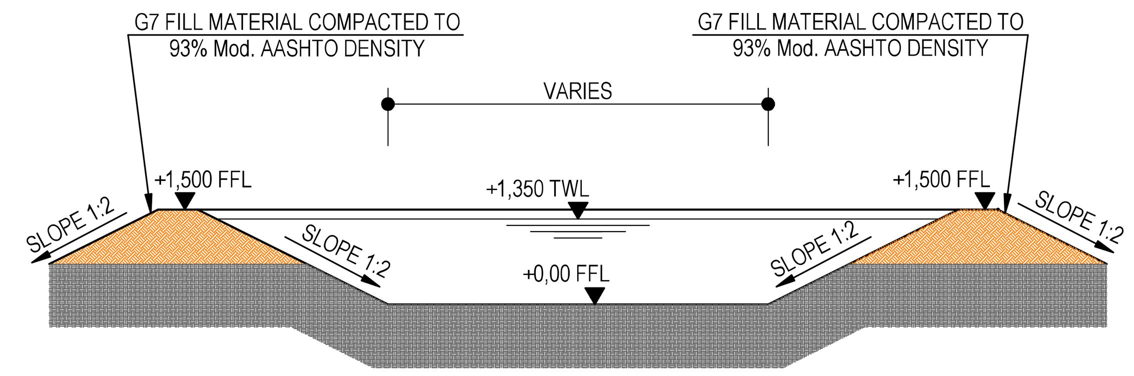


PLAN: RETENTION POND

SCALE 1:150



SECTION B-B

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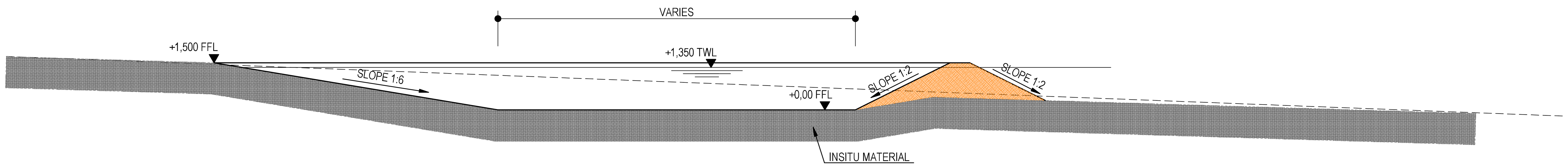

SECTION A-A

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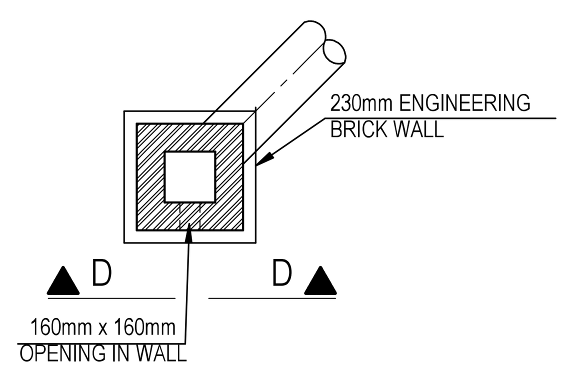
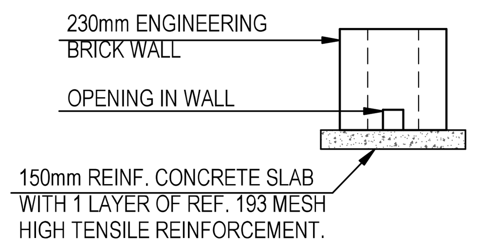


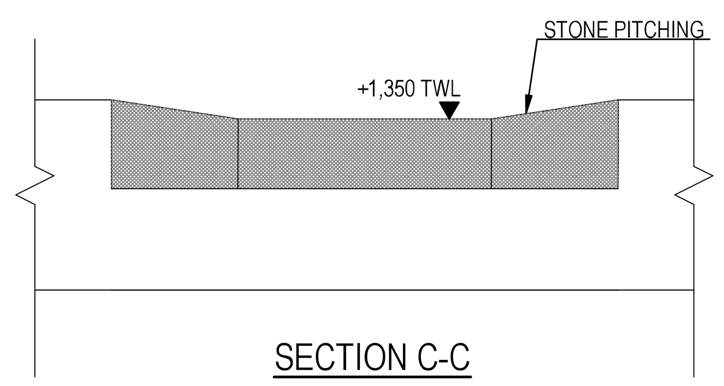
DETAIL A: PLAN OF OVERFLOW BOX

SCALE 1:50



DETAIL A: ELEVATION D-D

SCALE 1:50



SECTION C-C

SCALE 1:50

DATE	APRIL 2015	PRETORIA 2nd Floor, Building 88A, Pony Street Tijger Vallei Office Park P.O.Box 11211, Silver Lakes 0054 Tel : +27 (0) 12 809 0010 Fax : +27 (0) 12 809 1435 E-Mail : pretoria@vipconsulting.co.za OTHER OFFICES : **BENONI**	No.	REVISION	DRAWN	CHECKED	DATE	PROJECT	SERVICE DETAIL
DESIGNED	H VILJOEN							Q4 FUEL CITY	TYPICAL DETAILS OF RETENTION POND
DRAWN	J. v. R.								
CHECKED	H VILJOEN	VIP CONSULTING ENGINEERS (Pty) Ltd Consulting Civil and Structural Engineers Reg No 97/05698/07							

Q4 FUEL

CONSULTING ENGINEER

DIRECTOR

ENG. DRAWING NUMBER
2357-V02

ANNEXURE C

WATER SUPPLY AND BASELINE RISK ASSESSMENT REPORT AS PER GCS WATER & ENVIRONMENTAL CONSULTANTS

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Hydrogeological Investigation as part of the WULA application - Q4 Fuels, North West Province

Report

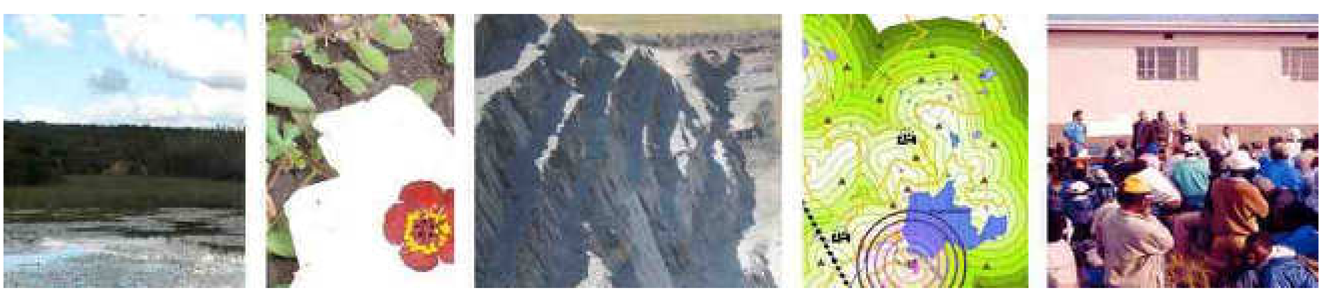
Version - 1

May 2015

Q4 Fuels

GCS Project Number: 14-503

Client Reference: Q4 Fuel City



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GEOPHYSICAL AND HYDROGEOLOGICAL INVESTIGATION - Q4 FUEL

Report

Version - 1

May 2015

Q4 Fuels

14-503

DOCUMENT ISSUE STATUS

Report Issue	**1**		
GCS Reference Number	GCS Ref - 14-503		
Client Reference	Q4 Fuel City		
Title	Q4 Fuel - Geophysical and Hydrogeological Investigation as part of the WULA application		
	Name	Signature	Date
Author 1	Marietjie Leenen		May 2015
Document Reviewer	Claudia du Plessis		May 2015
Document Reviewer	Kobus Troskie		May 2015
Document Authorisation	Alkie Marias		May 2015

LEGAL NOTICE

EXECUTIVE SUMMARY

Introduction

GCS (Pty) Ltd was contracted by Ms. Carien de Klerk from Q4 Fuel to conduct a geophysical and hydrogeological investigation in order to comply with the Water Use License Application (WULA) process for the development of the Q4 Fuel city.

Environmental Setting

The topography of the area slope in a north westerly direction, with the groundwater flow direction from south east to north-west across the site. One non-perennial river is located 400m east of Section 1 while two non-perennial rivers are located 900m north and 1km west of Section 2.

The site is underlain by the Rustenburg Layered Suite of the Bushveld Igneous Complex, and consists of pyroxenite and norite. Diabase and dolerite formations may also be encountered in or around the site due to later geological activity. Section 1 and 2 is mostly covered with colluvium sediments eroded from the Transvaal Supergroup. Colluvium can often be composed of a wide range of sediments ranging from silt to rock fragments of various sizes.

Hydrocensus

During the initial site investigation conducted in April 2014 by GCS, 6 hydrocensus boreholes were identified within close proximity to the site. BH3 and BH4 are located approximately 300m east of Section 1 and are mainly used for potable and irrigational purposes. BH1, BH2 and BH5 are not in use. One hydrocensus borehole, BH6 located 250m north of Section 2, supplies drinking water for cattle. Groundwater levels within BH1, BH3 – BH6 ranged from 28.14 to 35.1mbgl confirming the absence of a shallow (perched) aquifer within close proximity of the site.

Monitoring Well & Production Borehole Installation

Based on the interpretation of the geophysical investigation data, the most suitable groundwater targets were identified. Two monitoring wells, QB1 and QB2, and one production borehole, QP1 were installed on Section 1, while one monitoring well, QB3 and one production borehole, QP2 were installed at Section 2.

Aquifer Tests

Aquifer testing was conducted on hydrocensus boreholes, BH3 and BH4 as well as the newly drilled production borehole, QP2. Based on the aquifer tests, the recommended sustainable borehole yield for BH3, BH4 and QP2 are 0.5l/s, 1l/s and 1.5l/s, respectively.

Water Demand

The water demand calculated for Q4 Fuel City (both Section 1 & 2) was calculated by Mr. Henk Viljoen from VIP consulting to be approximately 0.44l/s (38.4kL/day) for a 24 hour abstraction cycle.

Laboratory Analysis

Groundwater samples were collected from two hydrocensus boreholes, BH3 and BH4 as well as the newly drilled monitoring well, QB3 and production boreholes QP1 and QP2. No volatile petroleum hydrocarbons were detected in the samples collected.

Calcium concentrations recorded in BH3, BH4, QB3, QP1 and QP2 were non-compliant with the DWA water quality standards, while BH4, QP1 and QP2 indicated non-compliant magnesium concentrations. According to the DWA drinking water standards the total hardness (in terms of CaCO3) recorded in BH3 and BH4 is considered hard, while total hardness in QB3, QP1 and QP2 are considered very hard. This may cause scale on heat exchange surfaces or may result in an increase in soap required to produce lather when bathing and in household cleaning.

According to the Piper and Durov diagram all water samples are indicative of recently recharged groundwater rich in calcium, magnesium and bicarbonate.

Source – Pathway – Receptor

No source was identified on site, due to the site being in pre-construction phase and based on the laboratory results which confirmed the absence of contamination within BH3, BH4, QB3, QP1 and QP2.

The average ground water level measured on site ranged between 28 and 29.84 metres below ground level (mbgl), confirming the absence of any shallow (perched) aquifers on site and reduces the aquifer vulnerability due to the barrier (thickness of the formation and the elongated travel time for contaminants) between a potential source (filling station and the waste water discharge areas) and the aquifer underlying the site

Sensitive receptors are present in the form of groundwater users and surface water bodies within close proximity to the site. Six boreholes were identified during the hydrocensus conducted within a 2km radius of Section 1 and Section 2. Hydrocensus boreholes, BH3, BH4 and BH6 are currently in use. A non-perennial river is located 400m east, upgradient of Section 1, while two non-perennial rivers are located 900m north and 1km west, downgradient of Section 2. Based on this, the source-pathway-receptor is incomplete based on the absence of a source found on site.

Recommendations

The following recommendations are made:

- Adherence to the sustainable yield of the production boreholes is crucial to ensure long-term utilisation of the groundwater resource;
- Accurate weekly monitoring of the groundwater levels in the boreholes are recommended when abstraction occurs. If any significant fluctuation in water level occurs, immediate action needs to be taken. The conservative calculations for recharge and proper monitoring plan should prevent over-utilisation of the aquifer;
- Groundwater quality analysis must be done on a quarterly basis, once operational phase has commenced, in order to detect any contamination to the aquifer.

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LIST OF APPENDICES

1 INTRODUCTION

GCS Pty (Ltd) was requested by Ms. Carien de Klerk from Q4 Fuel to conduct a hydrogeological investigation in order to comply with the Water Use License Application process for the development of the Q4 Fuel city.

2 SCOPE OF WORK

The following components are proposed as the scope of work and in accordance with the requirements from the DWA for a Water Use License Application:

- Geophysical investigations for both Section 1 and Section 2 of the proposed developments (Resistivity);
- Drilling of two production boreholes on each Section of the facility as well as two monitoring wells on Section 1 and one monitoring well on Section 2;
- 24 Hour aquifer testing of production borehole, QP2 located on Section 2 and two hydrocensus boreholes, BH3 and BH4, located on Section 1;
- A review of the tank farms and the drilling of 2 x 20meter groundwater monitoring wells on Section 1 and 1 x 30meter groundwater monitoring well downgradient of the proposed tank farm on Section 2;
- Sampling, analysis and evaluation of the existing groundwater quality on site and hydrocensus boreholes;
- Update the Groundwater Reserve;
- Compilation of a hydrogeological report, with initial recommendations for resource development, management and monitoring and relevant information still required for Water Use License Application.

3 METHOLDOLOGY

3.1 Site Inspection & Data Review

An initial site inspection was undertaken to obtain information about the current status of the site, which included site layout and drainage, adjacent property land use and identifying possible drilling locations.

All topographical, geological and information, available from the public domain was accumulated.

Public domain data included:

- Google satellite images;
- 1: 50 000 Topographical Maps;
- 1: 250 000 Geological Maps;
- 1: 500 000 Hydrogeological Map;
- Groundwater Databases, NGA (National Groundwater Archive).

3.2 Site Investigation

Subsequent to completion of the data review and initial site visit, the site investigation was undertaken. This included the following:

3.2.1 Hydrocensus and Receptor Survey

A detailed hydrocensus was conducted within a 1km radius of the site to identify the presence and use of existing boreholes. Well depths were determined and static water levels were recorded.

3.2.2 Geophysical investigation

Electrical resistivity is the geophysical method that is least affected by power line noise and infrastructure. DC current is directly injected into the ground through 2 current electrodes and the potential difference measured by the 2 potential electrodes. Up to 64 electrodes are inserted at a time and measured in various arrays of potential and current pairs to produce an image of the sub-surface electrical properties which in turn can be interpreted in terms of the local geology and contaminant plume locations. This is the electrical method with the highest resolution for mapping the near surface (app. 0 - 50m) by using a dense electrode distribution. Based on the interpretation of the geophysical investigation data, the most suitable targets will be identified for drilling.

3.2.3 Production Borehole and Monitoring Well Installation

The drilling and construction of two production boreholes as well as three monitoring wells will be conducted by means of an air percussion drill rig. This will consist of 8” boreholes, 30 meters of casing allowed for, and the remainder of the borehole will be drilled 6.5” up to a depth of 80 meters below ground level (or 10m below groundwater level).

3.2.4 Groundwater Sampling and Analyses

The newly drilled monitoring wells and production boreholes were inspected. The static water levels and total depth were recorded. The following parameters were analysed for:

- Anion and cations;
- pH, Total Dissolved Solids (TDS), Bicarbonates, Electrical Conductivity (EC), and Total Hardness;
- Gasoline Range Organics (GRO) - BTEXN - fully speciated (including o- and m,p-Xylenes), MTBE, TAME, Trimethylbenzene (fully speciated 1,2,4 and 1,3,5-trimethylbenzenes);
- Diesel Range Organics (DRO) (C_{10}-C_{20}); and
- Polycyclic Aromatic Compounds (PAH).

4 SITE DESCRIPTION

The site is located between Pretoria and Brits, on the N4 highway where it intersects the M21 secondary road. The proposed sites are on opposite sides of the N4 and are demarcated as Section 1 and Section 2 (Figure 5-1)

Section 1 is situated on a portion of a game lodge and occupies about half of the property. This area contains 5 boreholes of which 4 already have pumps installed and only 2 boreholes are used for water supply to the dam on the property and to a holding tank for the game lodge (refer to Appendix A - Photographic Log). The owner of Section 1 had no previous recorded data for any of the boreholes.

Section 2 is less developed with the area mainly used for grazing of livestock. The site however has running water supplied by the single borehole on site. The pump system is welded to the borehole casing as a preventative measure against theft. The pump is installed to approximately 15 meters below the static water level (swl). The property to the north adjacent to the proposed site, farms with grass which requires large amounts of water.

5 ENVIRONMENTAL SETTING

5.1 Topography

The topography of the area surrounding the site slopes in a north westerly direction according to the observations on site as well as the 1:50 000 topographical map. The presumed groundwater flow direction for the site is from south east to north-west across the site.

5.2 Hydrology

The surface water features identified from the 1:50 000 topographical map as well as the latest Google Earth Imagery have been tabulated below in Table 5-1.

Table 5-1: Hydrological Features in Close Proximity to the Site

Hydrological Feature	Distance from site	Direction
Non-perennial river	400m	East, upgradient of Section 1, flows in a northerly direction
Non-perennial river	900m	North, downgradient of Section 2, flows in a north westerly direction
Non-perennial river	1km	West, downgradient of Section 2, flows in a northerly direction

5.3 Geology & Hydrogeology

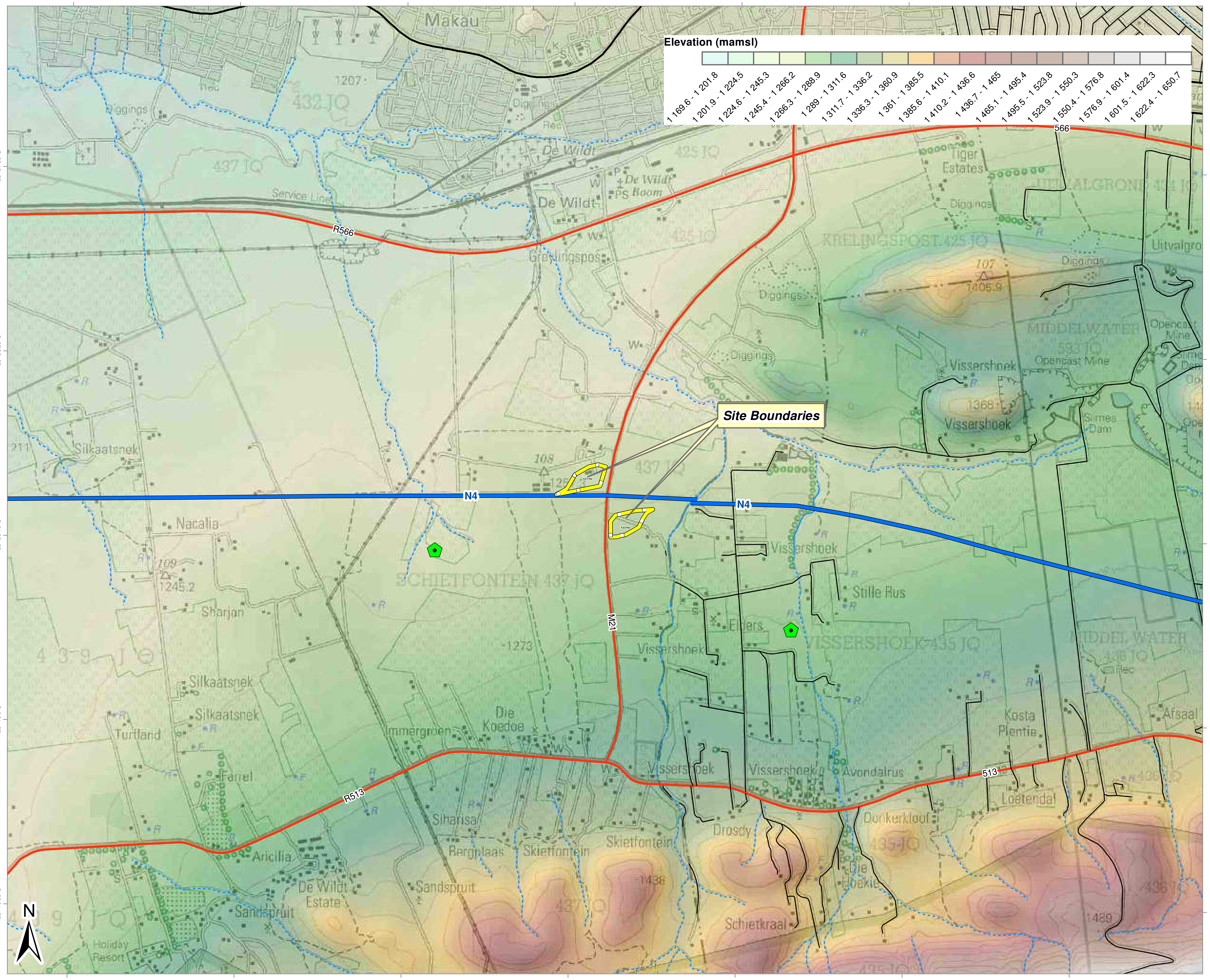
The site is underlain by the Rustenburg Layered Suite of the Bushveld Igneous Complex, and consists of pyroxenite and norite (Figure 5-2). Diabase and dolerite formations may also be encountered in or around the site due to later geological activity. Section 1 and 2 is mainly covered with colluvium sediments eroded from the Transvaal Supergroup. Colluvium is a general name for loose, unconsolidated sediments that have been deposited at the base of hillslopes. Colluvium can be composed of often a wide range of sediments ranging from silt to rock fragments of various sizes.

An evaluation of the geological map sheet Rustenburg (2526), 1:250 000 (Council for Geoscience, 1978 2nd edition) revealed the presence of an contact zone approximately 600m north west of Section 2 consisting of quartzite of Rooiberg Group.

According to the 1:500 000 Hydrogeological map series Johannesburg (2526), the site is underlain by an intergranular and fractured aquifer (ultramafic/mafic intrusive rocks – dolerite, diabase, gabbro, norite, carbonatite, anorthosite and pyroxenite) with an average borehole yield between 0.5 and 2l/s.

Two NGA (National Groundwater Archive) boreholes are located within a 2km radius of the site.

FIGURE 5.1: TOPOGRAPHY



LEGEND

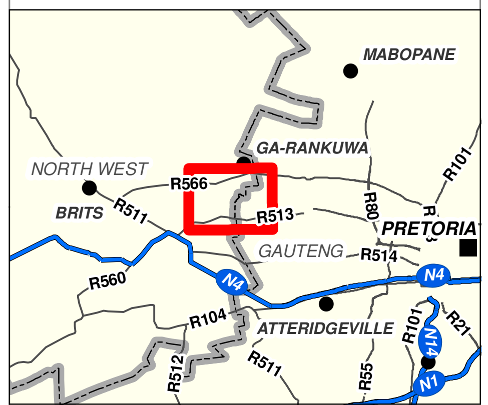
- NGA Boreholes

Road Network

- National Route
- Main Road
- Secondary Road
- Street

Rivers and Streams

- Non-Perennial
- Perennial
- Site Boundary



DATA SOURCES:
RSA National Geospatial Institute
1:50 000 Topographical Series: 2527BD

0 0.25 0.5 1 Kilometers

SCALE: 1:30 000

FIGURE NO.:	-	MAP NUMBER:	14-503-02
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DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	29 SEPTEMBER 2014
PROJECT:	Q4 FUEL CITY - WATER SUPPLY (FUEL CITY N4)		
CLIENT:	Q4 FUELS		

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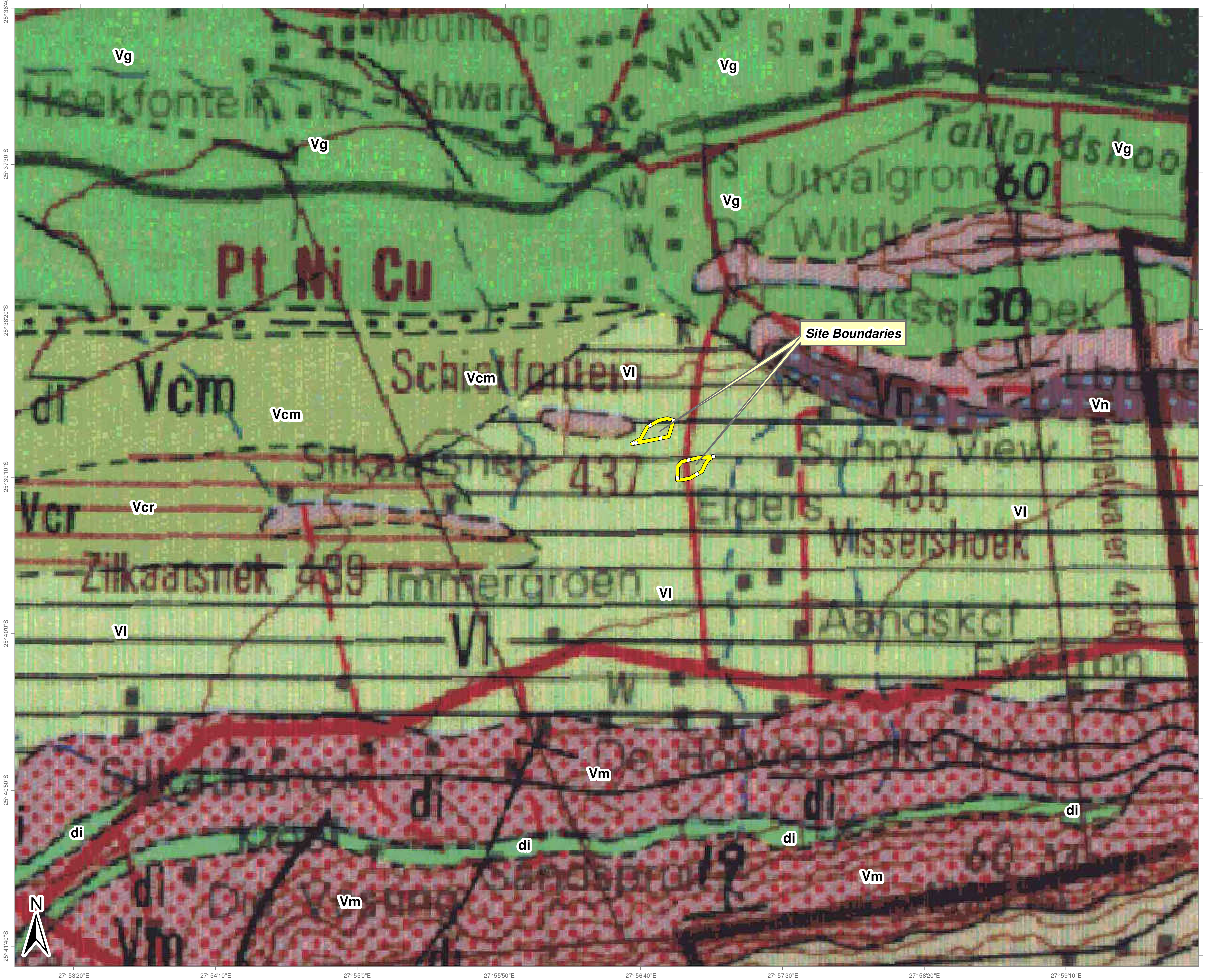
FIGURE 5.2: GEOLOGY



LEGEND

Site Boundary

Lithology

di = Diabase

Vcm = Norite,Anorthosite

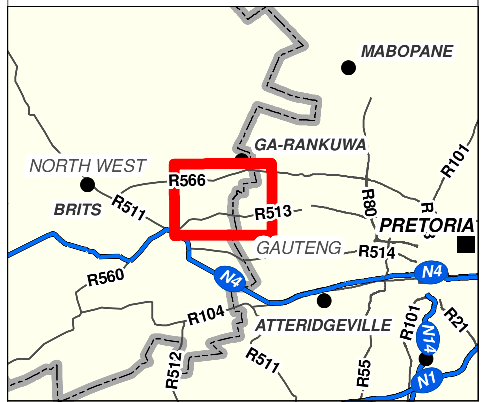
Vcr = Pyroxenite,Lower chromitite
Vl = Hybrid gabbro, gabbro, norite

Vr = Quartzite, shale, subgraywacke

Vg = Gabbro, norite, anorthosite

Vm = Quartzite, minor hornfels

Vn = Norite Hybrid rocks, diabase,epidiorite



DATA SOURCES:

Council for Geoscience
1:250 000 Geological Series: 2526

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SCALE: 1:35 000

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PROJECT:	Q4 FUEL CITY - WATER SUPPLY (FUEL CITY N4)		
CLIENT:	Q4 FUELS		

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6 DETAILED SITE INVESTIGATION

This investigation, conducted during September 2014, entailed a site walkover, monitoring well installation, groundwater sampling and aquifer testing. A detailed hydrocensus was conducted by GCS in April 2014.

6.1 Neighbouring land survey

A neighbouring land survey was conducted for the site in order to prepare a list of adjacent land use as detailed in Table 6-1 below.

Table 6-1: Neighbouring Land Use

Locality with regards to site	Land Use
North	Agriculture
East	Open land
South	Residential and open land
West	Residential and open land

6.2 Hydrocensus

During the initial site investigation conducted by GCS in April 2014, 6 hydrocensus boreholes were identified within close proximity to the site. The static water level ranged from 28.14 to 35.1 meters below ground level (mbgl). It was also determined that all of the boreholes are more than 90m deep from interviews with the owners and from the depth that the pumps were installed. The hydrocensus borehole details are tabulated in Table 6-2 below.

Table 6-2: Hydrocensus Borehole Details

Borehole ID	Coordinates		Depth (m)	SWL (mbgl)	Use	Comments
	S	E				
Section 1						
BH1	-25.653596	27.951410	-	33.8	Not in use	Fitted with a submersible pump
BH2	-25.653246	27.951275	-	-	Not in use	
BH3	-25.651373	27.953246	-	33.56	Water supply for lodge, used for both potable and irrigational purposes	
BH4	-25.650690	27.953283	48	35.1		
BH5	-25.653386	27.952118	100m+	32.7	Not in use	No pump installed
Section 2						
BH6	-25.644970	27.946754	-	28.14	Drinking water for cattle	Fitted with a submersible pump

Section 1 is located on a game lodge, which contains a variety of antelope species which depends on the local vegetation and water supplied from the boreholes on site. Currently borehole, BH3 and BH4 are being used simultaneously to provide water to the game lodge.

Section 2 is used for cattle grazing which is dependent on the local vegetation and water supplied to the cattle from a single borehole on site (BH6). This borehole has a pump installed, which, according to the owner (Jannie), is installed about 15 meters below the static water level. The location of all hydrocensus boreholes are presented in Figure 6-4.

6.3 Electrical Resistivity Tomography Method and Survey Design

The ERT was performed with a standard ABEM SAS1000 Lund imaging system with four 100m multicore cables each with 21 electrode take-outs. Three electrical resistivity survey traverses (Q4003, Q4004, Q4005 and Q4006), with electrode spacing of 5m, were surveyed using the standard Wenner protocol around the selected target areas (sections 1 and 2) on the site (Figure 6-1). Traverses Q4003, Q4004 were surveyed around section 1 while the Q4005 and Q4006 were surveyed around section 2. The traverses Q4004 and Q4005 were surveyed 400m almost north-south orientation while Q4003 and Q4006 were surveyed east-west. The traverses Q4004, Q4005 and Q4006 were all 400m long while Q4003 was 600m long.

Once the ERT survey was completed, the 2D measured resistivity data were accordingly edited, processed and ultimately inverted using a 2D inversion algorithm RES2Dinvx64 software package by Geotomo Software. The RES2DINV inversion routines involves a cell-based inversion technique where it automatically divides the 2D pseudo-section into a large number of rectangular blocks that are loosely tied to the distribution of the data points in the pseudo-section. Then an iterative non-linear smoothness-constrained least-squares optimisation technique is used to calculate the resistivity of the model blocks that provide a model response which agrees with the observed data (deGroot-Hedlin and Constable 1990). The resultant 2D tomographs were then interpreted based on the scientifically proven link between apparent resistivity characteristics and subsurface material properties in order to delineate favourable areas to place the production and monitoring targets to be drilled.

FIGURE 6.1: ERT Traverses

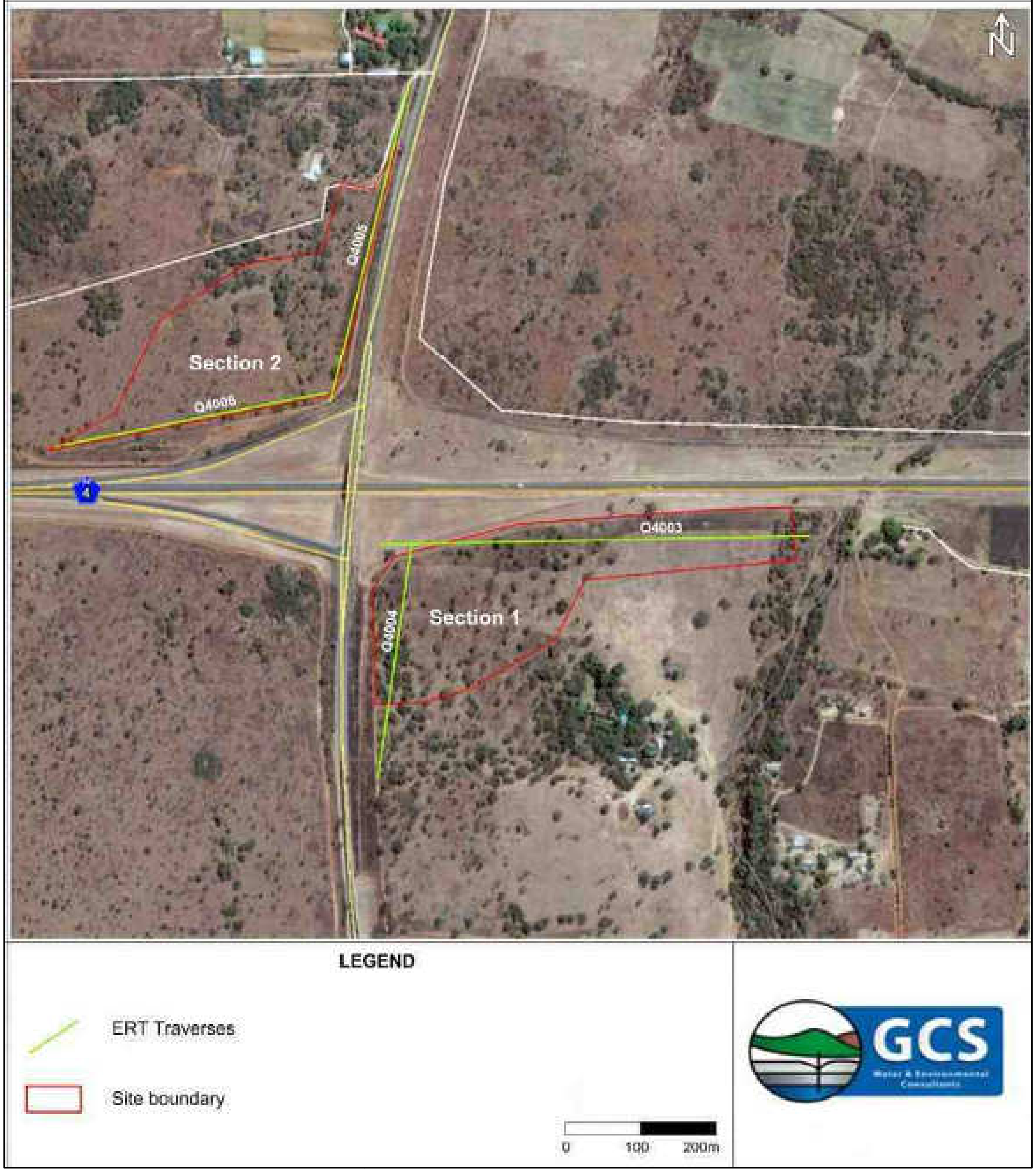


Figure 6-1: Location map showing ERT traverses.

6.3.1 Visualisation and Interpretation

The results of the ERT survey profiles for traverses Q004 and Q003 are shown in Figure 6-2. The resistivity model for Q004 exhibit two distinct apparent resistivity ranges, the first (>554 Ωm) being 37.2 mbgl deep. This upper zone represents a weathered lithology underlying which is a more resistive (≈554 Ωm) substratum.

The weathered formation usually serves as a preferred area to place groundwater yielding wells; however, the weathered zone in this case is not deep enough to serve as economical revenue for groundwater over this survey profile. Nevertheless, two low confidence monitoring wells namely QB1 and QB2 are proposed at ≈x=195 m and 215 m respectively.

The 2D resistivity model for Q003 similarly exhibiting two distinct apparent resistivity ranges, the first being ≤554 Ωm overlying a more resistive (>554 Ωm) substratum. The weathered zone is shallower (27.4mbgl) from the start of the model before it begins (at ≈x=240m) to slightly deepen to about 31.3mbgl. The weathered zone is in this case still not adequately deep enough to serve as an economical avenue for groundwater over this survey profile. However, a low confidence production well is proposed at ≈x= 300m where the weathering is relatively deeper.

The results of the ERT survey profiles for traverses Q005 and Q006 are shown in Figure 6-3 shows a 2D resistivity model for Q005 on which large variations in the resistivities of the subsurface materials are apparent giving a good insight on the possible areas to drill a required production well. A very prominent zone of low resistivity (≤67Ωm) is observed at 15.84 mbgl underlain by quite resistive values (≥67Ωm) bedrock. From the start of the model to ≈x=170m, the high resistivity zone degrades to reduced resistivity values (119Ωm-377Ωm) possibly due to the fracturing or deep weathering which may provide perfect avenues for groundwater flow. As a result, a high confidence production well is recommended for drilling at ≈x=170m.

The 2D resistivity model for Q006 is characterised by a relatively resistive (≥554 Ωm) substratum at an average depth of 15.7mbgl. Overtop is a zone with relatively suppressed resistivity values (<554 Ωm) interpreted as a 15.7m thick weathered zone. As indicated earlier, the weathered formation usually serves as a preferred area to place groundwater yielding wells if deep enough. With the shallow weathered zone shown on the model however, neither a production well nor an observation well is proposed along the survey line.

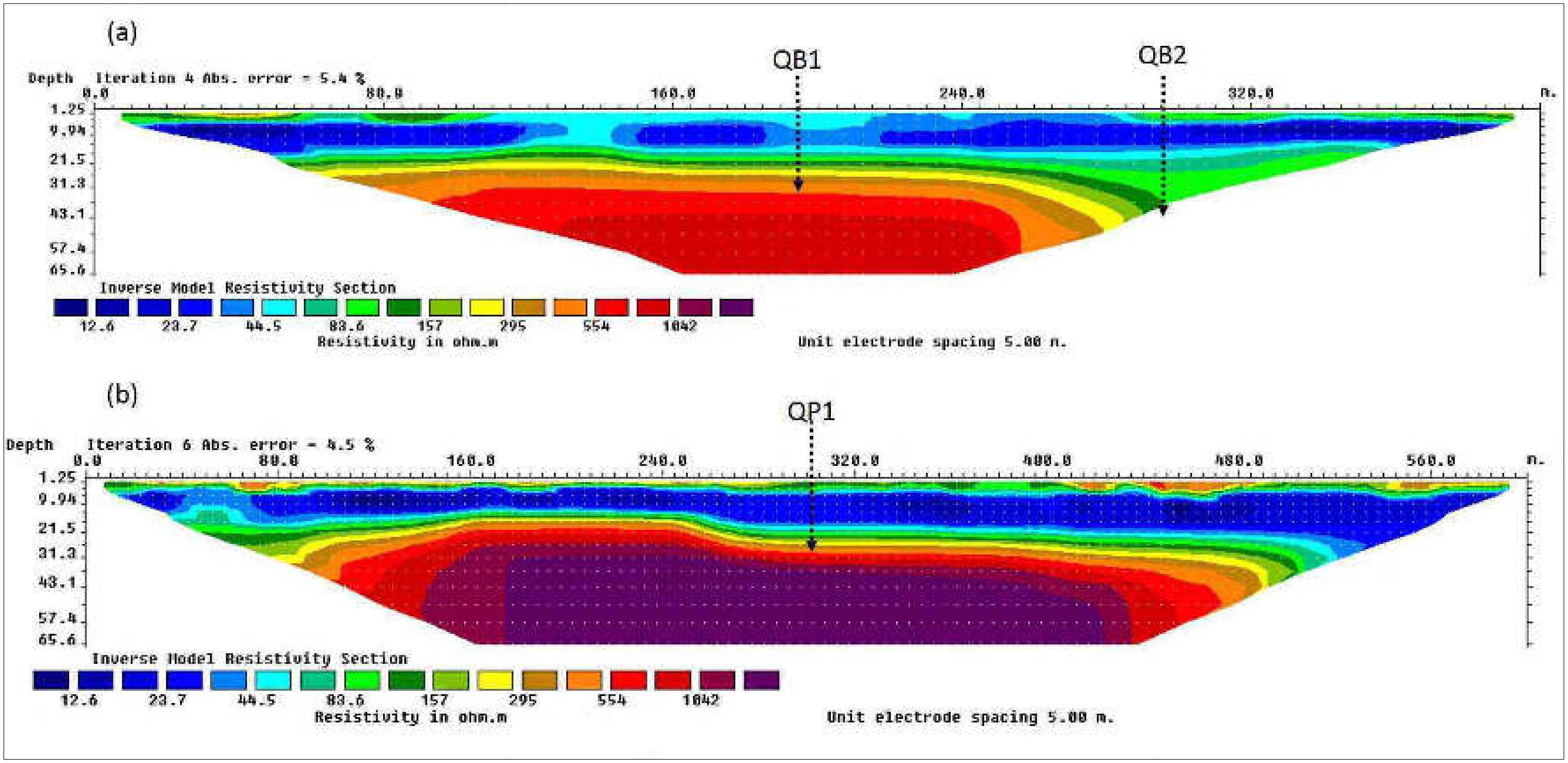


Figure 6-2: A 2D inverted resistivity data for (a) Q004 and (b) Q003 survey lines.

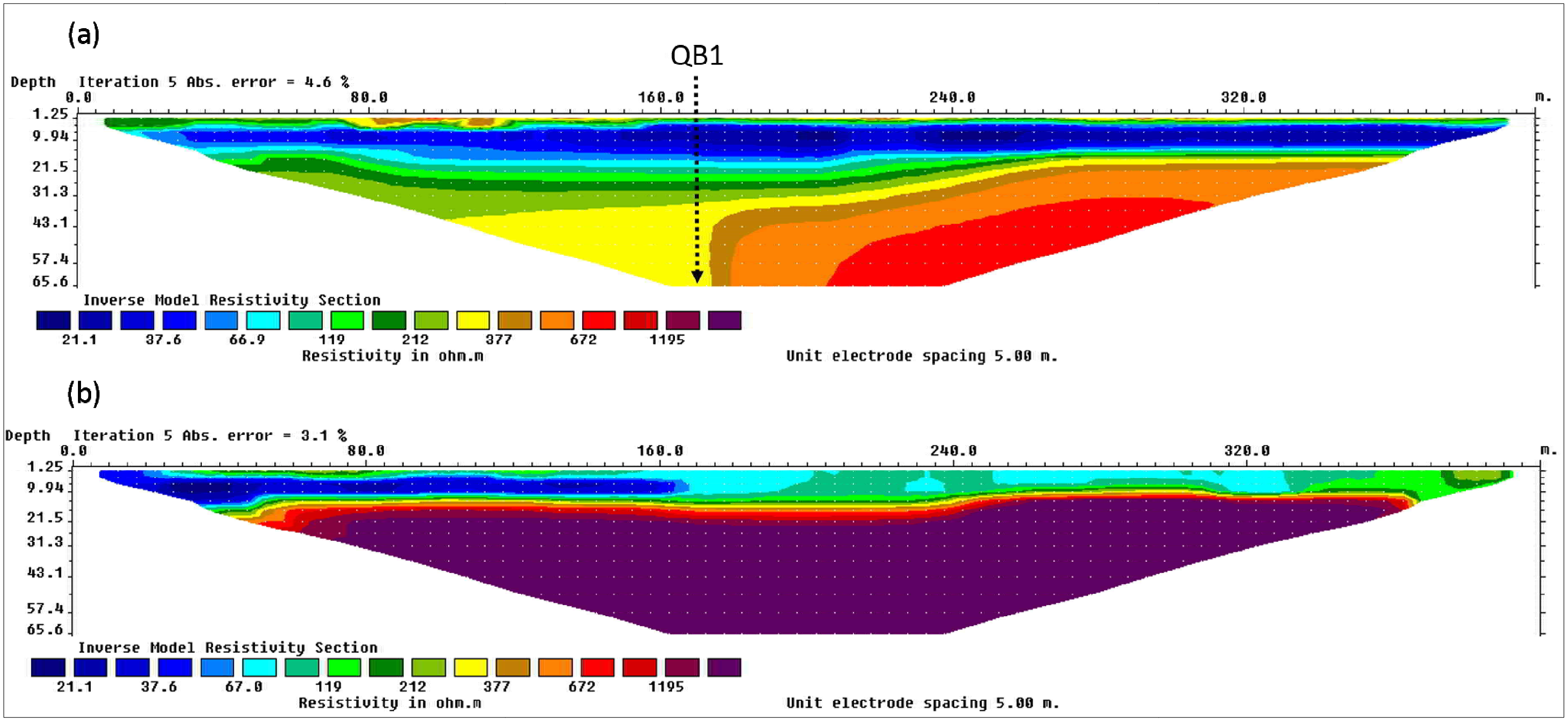


Figure 6-3: A 2D inverted resistivity data for (a) Q005 and (b) Q006 survey lines.

6.4 Borehole Installation

Based on the interpretation of the geophysical data, the most suitable groundwater targets were identified. The drilling and construction of three monitoring wells as well as two production boreholes were conducted during September 2014 by means of air percussion drilling. The borehole logs are compiled in Appendix B. The localities of the monitoring boreholes are illustrated in Figure 6-4. Groundwater was encountered in monitoring well QB3 and production boreholes, QP1 and QP2 at 28 and 29.84mbgl. The monitoring well details are presented in Table 6-3.

Table 6-3: Monitoring well details

Borehole ID	Coordinates (WGS 84, Geographic)		Depth (m)	SWL (mbgl)	Comments
	S	E			
Section 1					
QB1	-25.651795	27.948825	21	Dry	No shallow perched water level
QB2	-25.650733	27.948543	20	Dry	No shallow perched water level
QP1	-25.650752	27.950619	70	28.1	Water encountered
Section 2					
QB3	-25.647109	27.946211	31	28	Water encountered
QP2	-25.646221	27.947667	61	29.84	Water strike at 38m

Groundwater sampling was conducted in September 2014. Groundwater samples were collected from QB3, QP1 and QP2. The samples were analysed for anions, cations, pH, Total Dissolved Solids (TDS), bicarbonates, Electrical Conductivity (EC), total hardness and Volatile Petroleum Hydrocarbons (GRO’s, DRO’s, PAH, MTBE and TAME).

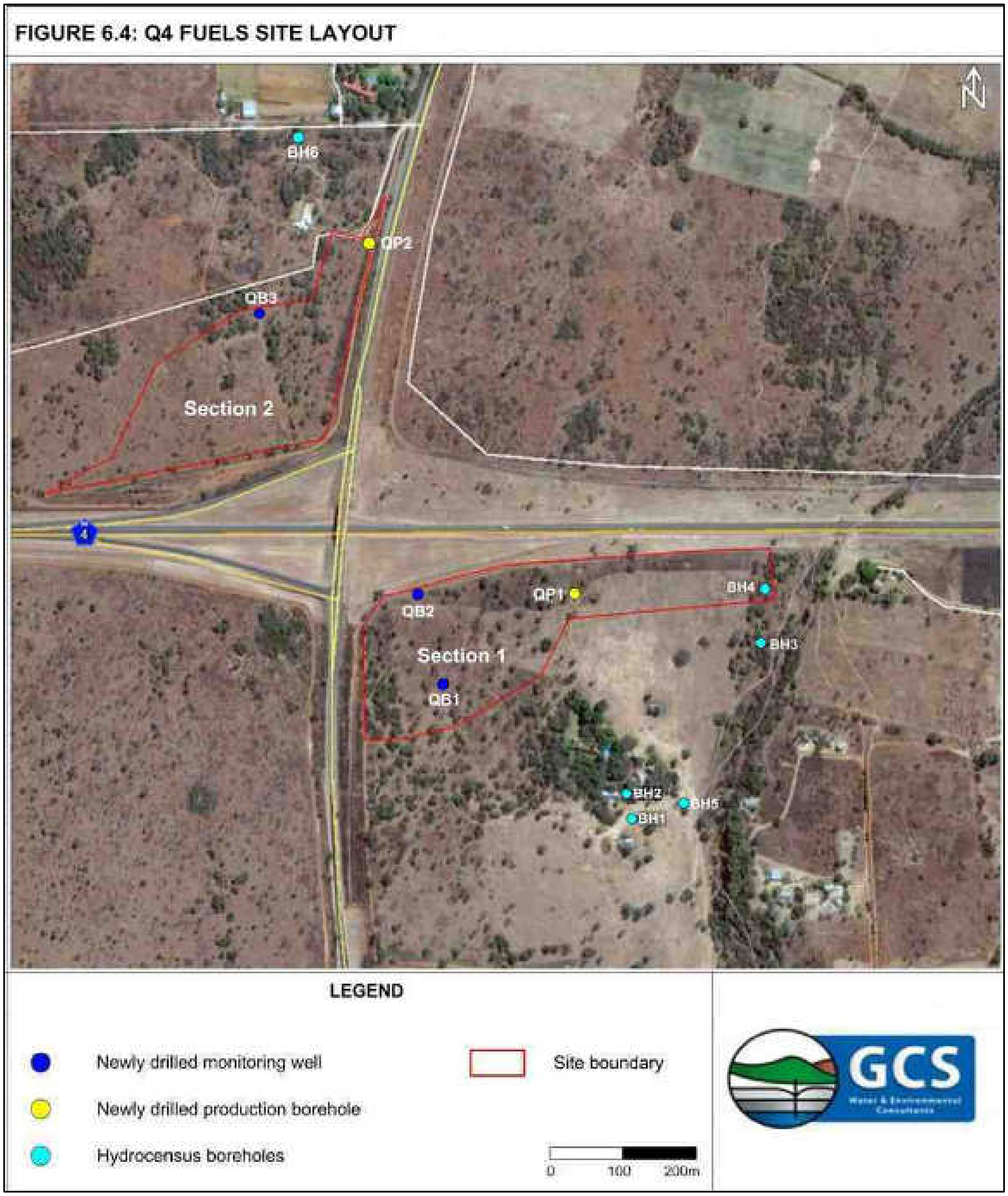


Figure 6-4: Site Layout and Hydrocensus Borehole Locality

6.5 Aquifer Testing

Aquifer testing allows for a better understanding of the hydraulic characteristics of the geological formations. One type of aquifer test, i.e. a constant rate pump test, was conducted on two of the boreholes, BH3 and BH4 as well as the newly drilled production borehole, QP2.

The aquifer testing included the following:

- A twenty four (24) hour constant rate pump test where water is abstracted at a constant rate (determined during the calibration test) and water level measurements were taken at set time intervals;
- Once the constant rate pump test was completed the borehole water level was allowed to recover to at least 90% with measurements being taken at set time intervals.

6.5.1 Borehole 3 - Section 1

The data collected from borehole 3 on Section 1 are compiled in Appendix C. The drawdown in total was 3.64 meters with a recovery time of 2 hours. The borehole was fitted with a pump, thus the test was carried out with the current pump that was installed. Figure 6-5 illustrates the drawdown/recovery versus time recorded in the borehole. According to the pump test data and subsequent analysis, the borehole can be pumped at 0.5l/s over a 24 hour period.

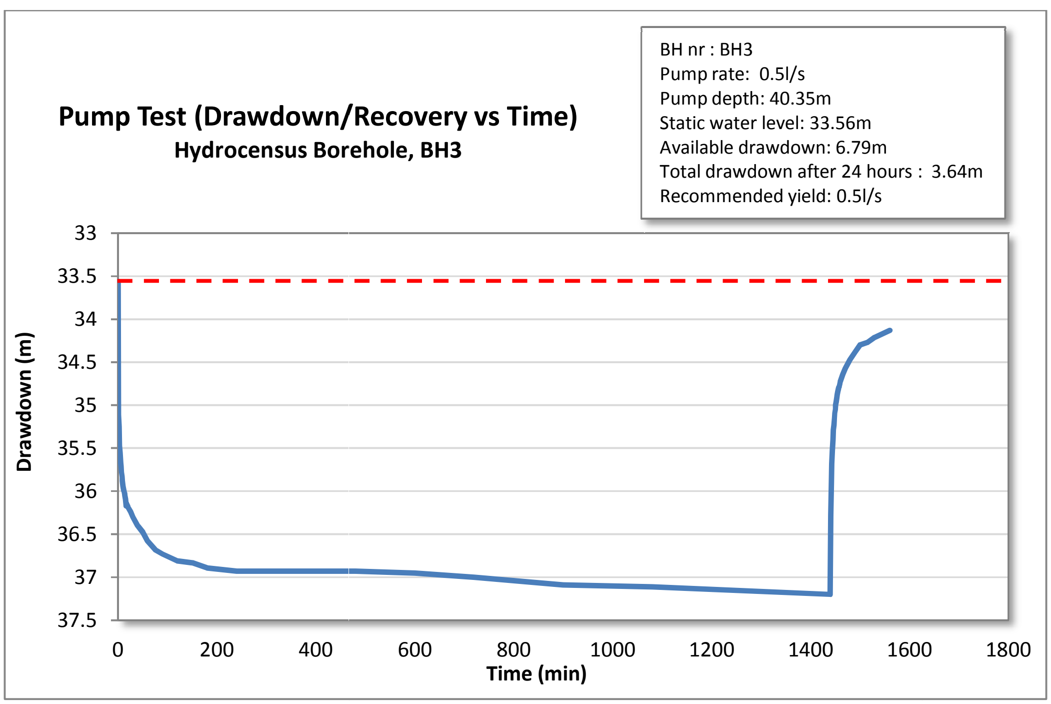


Figure 6-5: Aquifer Test for BH3

6.5.2 Borehole 4 - Section 1

The data collected from borehole 4 on Section 1 are compiled in Appendix C. The drawdown in total was 5.82 meters with a recovery time of 5 hours. Figure 6-6 illustrates the drawdown/recovery versus time recorded in the borehole. According to the pump test data and subsequent analysis, the recommended borehole yield is 1l/s over a 24 hour period.

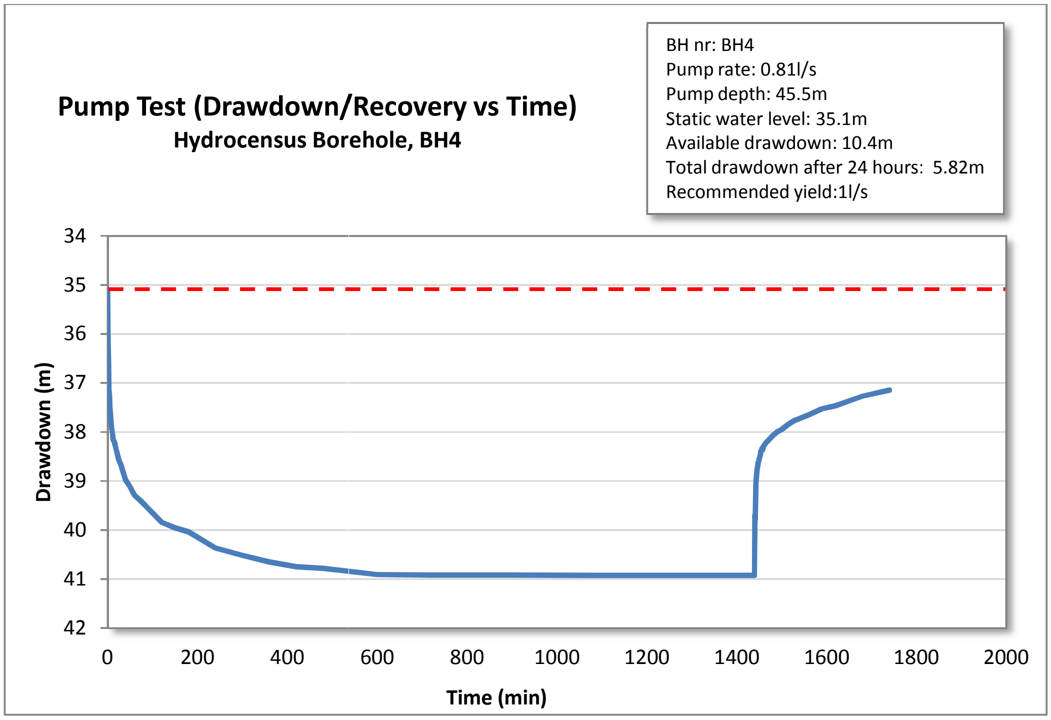


Figure 6-6: Aquifer Test for BH4

6.5.3 Production borehole, QP2 - Section 2

The data collected from the newly drilled production borehole, QP2 on Section 2 are compiled in Appendix C. The drawdown in total was 17.8 meters with a recovery time of 1 hour. The available drawdown is 26.16m measured from the static water level. Figure 6-7 illustrates the drawdown/recovery versus time recorded in the borehole. According to the pump test data and subsequent analysis, the recommended borehole yield is 1.5l/s over a 24 hour period, since the 90% recovery takes 1 hour.

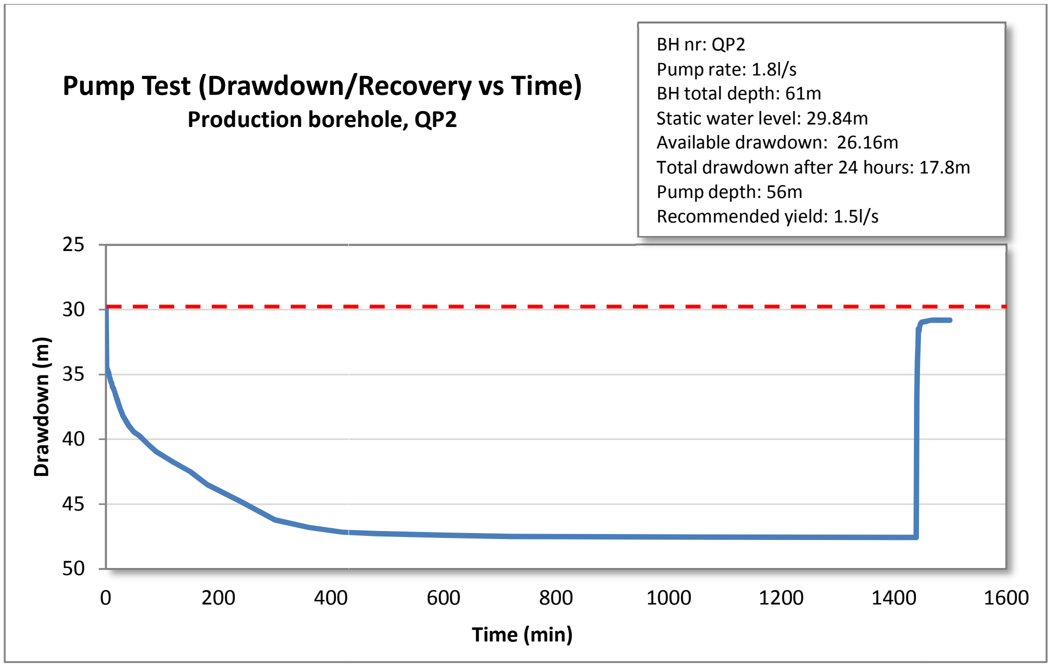


Figure 6-7: Aquifer Test for Production Borehole, QP2

6.5.4 Aquifer test results and abstraction schedules

A summary of the 24 hour pump test results are compiled in Table 6-4 below.

Table 6-4: Pumping Test Results for BH3, BH4 and QP2

Borehole ID	Drawdown (24hr)	SWL (mbgl)	Pumping Rate (l/s)	Pump Depth (m)	Transmissivity (m^2/day)	Aquifer Characterisation
BH3	3.64	33.56	0.5	40.35	**6.61**	Weathered aquifer
BH4	5.82	35.1	0.81	45.5	**8.25**	
QP2	17.75	29.84	1.8	56	**15.5**	Good fracture zone with bilinear flow

L/s - Litres per second
mbgl – Meters below ground level

The sustainable borehole yield is calculated using the FC method over a 12 hour period as tabulated in Table 6-5 below. In total 111.6m^3/day can be abstracted from BH3, BH4 and QP2 as water supply for the Q4 Fuel site.

Table 6-5: Sustainable Borehole Yield from aquifer

Borehole ID	Recommended sustainable yield from FC method 18 hour abstraction *	Daily abstraction m3/day
BH3	0.5l/s for 18 hours	32.4
BH4	1l/s for 18 hours	64.8
QP2	1.5l/s for 18 hours	97.2

7 INTERMEDIATE RESERVE DETERMINANTION

The Intermediate Groundwater Reserve Determination takes into account the following parameters:

- Effective Recharge from Rainfall and specific geological conditions;
- Area of the sub-catchment delineated for the site;
- Basic Human needs for the site;
- Groundwater contribution to surface water (baseflow);
- Existing abstraction (hydrocensus borehole data was used);
- Surplus if any available for abstraction.

7.1 Rainfall Recharge

The effective groundwater recharge from rainfall is the portion of rainfall that reaches the groundwater. The remainder of the rainfall comprises surface water runoff, evapotranspiration and soil moisture.

The effective rainfall-recharge is dependent on the catchment geology, soils, surface run-off and stream morphology but most importantly for the study area, the effective storage.

7.1.1 Literature Review

Data from relevant hydrogeological databases including, the Groundwater Resource Directed Measures (GRDM) was obtained from the Department of Water Affairs. The proposed site area fall within quaternary catchment: A21J, as indicated in Table 7-1 (and Figure 7-2).

Table 7-1: Summarized Quaternary Catchment Information (GRDM, 2012)

Quaternary Catchment	Total Area (km^2)	Recharge mm/a	Current use Mm^3/a	Exploitation Potential Mm^3/a	Rainfall mm/a
A21J	1150.2	26.01	4.64	8	637

According to Brendenkamp et al (1995) the rainfall recharge for the Bushveld Igneous Complex in the quaternary catchment, is between 2-5% of the MAP (Mean Annual Precipitation). However, the aquifer conditions are site specific and need to be recognized for the site.

The entire delineated sub-catchment falls within the A21J quaternary drainage area, therefore the rainfall is seen to be equal across the site, i.e. 637mm/annum. The groundwater recharge is taken as 2.5% of MAP (based on literature review).

Therefore, recharge for the delineated sub-catchment can be calculated as:

2.5% of MAP (637 mm) = 0.015925 m/annum.

Rainfall recharge = 0.015925m x ± 23km^2 (size of the sub-catchment as delineated)

The rainfall recharge to the sub catchment = ±1 003.5m^3/day or 366 275m^3/a.

7.2 Sub-catchment delineation

In order to delineate a sub-catchment within the A21J quaternary catchment the following principles were used in ArcGIS, which provides a method to describe the physical characteristics of a surface. Using a digital elevation model as input, it is possible to delineate a drainage system and then quantify the characteristics of that system. The tools in the extension let you determine, for any location in a grid, the upslope area contributing to that point and the down slope path water would follow.

When delineating watersheds or defining stream networks, you proceed through a step process (see Figure 7-1). Flow across a surface will always be in the steepest down slope direction. Once the direction of flow out of each cell is known, it is possible to determine which and how many cells flow into any given cell. This information can be used to define watershed boundaries and stream networks. The following flowchart shows the process of extracting hydrologic information, such as watershed boundaries and stream networks, from a digital elevation model (DEM).

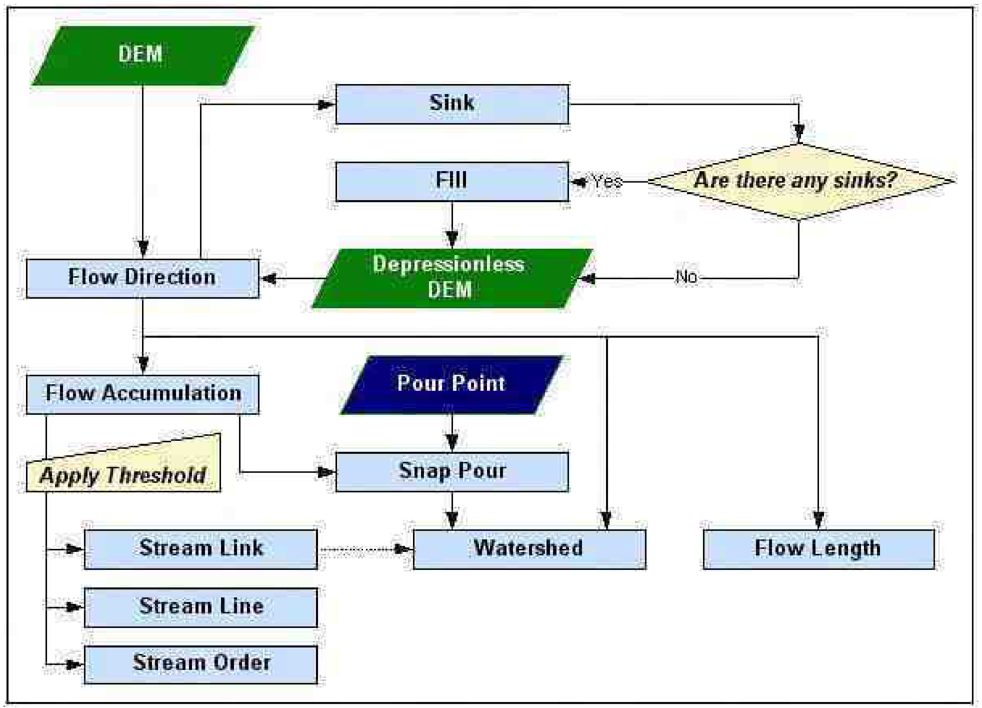


Figure 7-1: Steps to derive surface characteristics from a DEM.

From the DEM you find out the flow direction between cells. However, if there are errors in the DEM there may be some cell locations that are lower than all the surrounding cells. If this is the case, all water travelling into the cell will not travel out. These depressions are called sinks. The hydrologic analysis extension allows you to identify the sinks and gives you tools to fill them. The result is a depressionless DEM. You then determine the flow direction on this depressionless DEM.

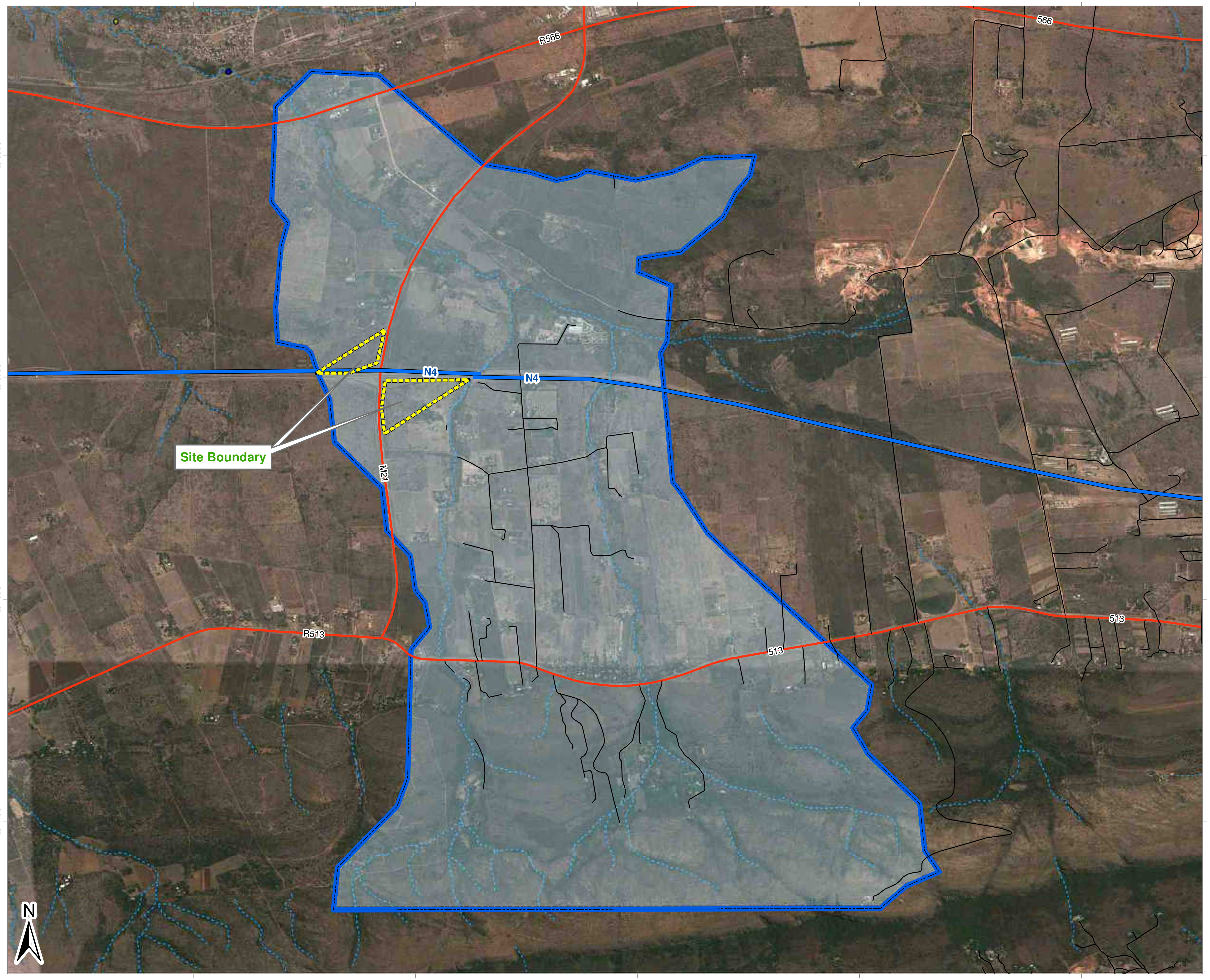
If you are delineating watersheds, you then need to identify pour points, which are locations where you wish to know the contributing watershed. Usually these locations are mouths of streams or some other hydrologic point of interest. In the hydrologic analysis extension, you can specify your pour points or you can use of the stream network as the pour points. In the latter case, to create the stream network you must first calculate the flow accumulation for each cell location.

The next step is to delineate the watershed. A watershed is the up slope area contributing flow to a given location. The watershed is also referred to as a basin, catchment, subwatershed, or contributing area. A subwatershed is simply part of a hierarchy implying that a given watershed is part of a larger watershed.

The input to the “watershed dialog” (tool within the hydrologic analysis extension) defining how the watersheds will be delineated is either by a flow accumulation threshold or pour points in a shapefile. When the threshold is used to define a watershed the pour points for the watershed will be the junctions of a stream network derived from flow accumulation. Therefore, a flow accumulation raster must be specified as well as the minimum number of cells that constitute a stream. The result would be a spatial raster dataset representing the watersheds within the project area with the minimum surface area as specified.

Figure 7-2 shows the sub-catchment, which contains the proposed Q4 Fuels site localities. The sub-catchment covers an area of approximately 23km^2.

FIGURE 5.3: SUB-CATCHMENT



LEGEND

Rivers and Streams

Non-Perennial

Perennial

Road Network

National Route

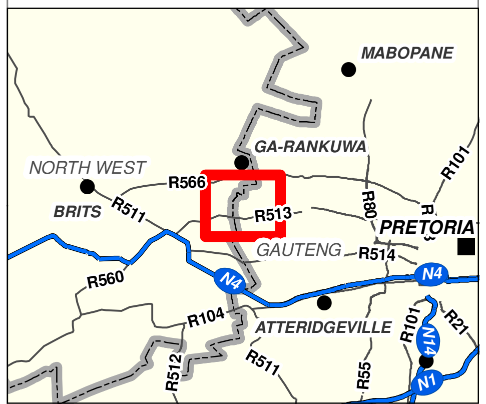
Main Road

Secondary Road

Street

Sub-Catchment Area

Q4 Fuel Sites



Data Sources:Google Earth™ mapping service: 2014
Imagery Date:26-10-2013

0 0.25 0.5 1 Kilometers

SCALE: 1:30 000

FIGURE NO.:	-	MAP NUMBER:	14-503-04
DRAWN BY:	NK NDALA GIS TECHNICIAN	REVIEWED BY:	A.J. MAIN GIS SPECIALIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	07 OCTOBER 2014
PROJECT: CLIENT:	SASOL PE PHASE I TANK REMOVAL (PORT ELIZABETH) SASOL		

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7.3 Basic Human Need

The basic human needs are set by the Water Services Act (Act No. 108 of 1997) at 25l per person per day. The reserve is calculated by multiplying the number of people living within the confines of a source unit by 25l/day.

The existing abstraction per household (approximately 73 identified) within the sub-catchment is 2.5m^3/day, this equals to 182.5m^3/day.

7.4 Groundwater Contribution to Baseflow

Baseflow is the low flow in a river during dry or fair weather conditions, but not necessarily all contributing to groundwater, baseflow includes contributions from delayed interflow and groundwater discharge. The baseflow of groundwater into surface water bodies in the study area is recognized to be negligible; around 3mm/a thus 25.185m^3/day (GRDM, 2012).

7.5 Proposed Abstraction

The proposed abstraction at the Q4 Fuel City is 0.44ℓ/s or 1598.4ℓ/hour, which amounts to 38 361.6ℓ if pumped for 24 hours, thus an average of 38.4m^3/day will be used by the Q4 Fuel site. According to the aquifer tests the recommended sustainable abstraction for the Q4 Fuel site is 111.6m^3/day.

7.6 Existing Abstraction

Low scale abstraction is present within the sub-catchment with small scale stock watering taking place on Section 2. The abstraction for approximately 50 cattle is 1000l/day thus 1m^3/day.

The average abstraction for water supply on the game lodge is 15m^3/day.

Based on the Department of Water Affairs and Forestry’s “Requirements for Water Use License Application: Groundwater Abstraction [S21(a)]”, GCS have revised their hydrogeological report to provide all required data. The Recommended Required Information includes:

- An Initial Regional assessment to determine the amount of information necessary for each new Water Use License Application for abstraction from groundwater, based on the amount of recharge that is used by the applicant in relation to the specified property.

- Categories A, B and C with the applicable list of information requirements for the license application, as should be provided by the applicant to the Department of Water Affairs & Forestry (DWAF).

Regional - Initial

- Size sub-catchment (AREAPROP)
- Recharge - HP (RE)
- Existing use volume (ABSEX)
- New use volume (ABSNEW)
- Scale of abstractions (ABSSCALE)

CALCULATION
AREAPROP * RE – REAREA (m^3/a)
ABSEX + ABSNEW = ABSTOTAL (m3/a)
ABSSCALE = (ABSTOTAL / REAREA) * 100

Small scale abstraction (<60% recharge on catchment) **Category A**

Medium scale abstraction (60-100% recharge on property) **Category B**

Large scale abstraction (>100% of recharge on property) **Category C**

Size of sub-catchment (AREAPROP)	2300 ha = 23 km^2
Recharge - HP (RE) 2.5% of the Annual precipitation (637mm)	= 1 003.5m^3/day
New use volume (ABSNEW)	= 38.4m^3/day
Existing use volume (ABSEX)	= 198.5m^3/day
Scale of abstractions (ABSSCALE)	= 23.61%

Small scale abstraction - Category A: 23.61% of the recharge.

7.7 Summary of Water Balance Calculations

Rainfall Recharge:	+1 003.5m^3/day
Existing Abstraction and Basic Human Need:	-198.5m^3/day
Groundwater Contribution to Baseflow:	-25.185m^3/day
Recommended Abstraction for the Q4 Fuel site:	-38.4m^3/day
Surplus Amount:	**+741.4m^3/day**

From the water balance calculation it is evident that groundwater can be abstracted as a viable source for water supply to the Q4 Fuel station.

8 GROUNDWATER ANALYSIS

Groundwater samples were collected from two hydrocensus boreholes, BH3 and BH4 as well as the newly drilled monitoring well, QB3 and production boreholes QP1 and QP2. These samples were transported to UIS Organics laboratories located in Centurion. The laboratory results are presented in Appendix D.

The results obtained from the laboratory were compared against the RBCA (Risk-Based Corrective Action) Tier 1 Exposure Scenario for each complete or potentially complete exposure pathway and compared to the appropriate representative contaminant concentrations.

The term Risk-Based Corrective Action (RBCA) refers to a consistent, methodical decision-making process used to assess actual or likely human and/or environmental risk of exposure to a chemical release and determine appropriate remedial actions in response to such releases. Petroleum releases vary considerably in their potential risk based on a number of variables, including, but not limited to, the type of petroleum product, amount of released product, duration of the release, extent of the release, site geology/hydrogeology, number and type of exposure pathways and location of human receptors relative to the source.

The laboratory results obtained for groundwater for Volatile Petroleum Hydrocarbons (GRO's, DRO's and PAH's) are presented in Table 8-1 for the hydrocensus boreholes, monitoring well and production boreholes which were sampled.

These results were compared against the Aquatic Water Quality standard adapted from the Department of Environmental Affairs, May 2010 (Framework for the Management of Contaminated Land. Government Printer. Republic of South Africa). However, where published values were not available, values were obtained from United Kingdom Environmental Quality Standards for Salmonoid (2010); British Columbia Aquatic Guidelines (2006) and National Oceanic and Atmospheric Administration (2008).

Table 8-1: Groundwater Laboratory Results – Volatile Petroleum Hydrocarbons

Determinant (µg/l)	Aquatic Water Quality	BH3	BH4	QB3	QP1	QP2
Gasoline Range Organics (GRO's)						
Benzene	30 [ii]	<1	<1	<1	<1	<1
Toluene	50 [ii]	<10	<10	<10	<10	<10
Ethylbenzene	200 [i]	<2	<2	<2	<2	<2
m,p-Xylene		<2	<2	<2	<2	<2
o-Xylene	30 [ii]	<2	<2	<2	<2	<2
1,3,5-Trimethylbenzene	-	<2	<2	<2	<2	<2

1,2,4-Trimethylbenzene	-	<2	<2	<2	<2	<2
Naphthalene	1.1[iii]	<2	<2	<2	<2	<2
Polycyclic Aromatic Compounds (PAH's)						
Acenaphtene	-	<1	<1	<1	<1	<1
Acenaphtylene	-	<1	<1	<1	<1	<1
Flourene	-	<1	<1	<1	<1	<1
Phenanthrene	-	<1	<1	<1	<1	<1
Anthracene	-	<1	<1	<1	<1	<1
Fluoranthene	-	<1	<1	<1	<1	<1
Pyrene	0.0025[iii]	<1	<1	<1	<1	<1
Volatile Organic Hydrocarbons (VOH's)						
MTBE	3400[i]	<5	<5	<5	<5	<5
TAME	-	<5	<5	<5	<5	<5
Diesel Range Organics (DRO's)						
C10	-	<1	<1	<1	<1	<1
C11	-	<1	<1	<1	<1	<1
C12	-	<1	<1	<1	<1	<1
C13	-	<1	<1	<1	<1	<1
C14	-	<1	<1	<1	<1	<1
C15	-	<1	<1	<1	<1	<1
C16	-	<1	<1	<1	<1	<1
C17	-	<1	<1	<1	<1	<1
C18	-	<1	<1	<1	<1	<1
C19	-	<1	<1	<1	<1	<1
C20	-	<1	<1	<1	<1	<1

NS – Not Specified
[i] BC Aquatics, 2006
[ii] UK EQS Salmonid, Current
[iii] NOAA, 2008

8.1.1 Volatile Petroleum Hydrocarbons

No Gasoline Range Organics (GRO's), Diesel Range Organics (DRO's) or Polycyclic Aromatic Compounds (PAH's) were detected in the groundwater samples collected from BH3, BH4, QB3, QP1 and QP2.

8.1.2 Groundwater Ingestion – RBCA

All constituents analyzed for as tabulated in Table 8-1 indicated compliance with the RBCA Tier 1 Risk Based Screening Level (RBSL) for groundwater ingestion.

8.1.3 Groundwater Volatilization to Air Inhalation

Benzene readily volatilises from surface soil given its high vapour pressure and high air-water partition coefficient. Vapour release and inhalation is thus the most important exposure pathway for benzene and benzene is listed as a Hazardous Air Pollutant.

The all constituents analysed were compliant with the RBCA Tier 1 Risk Based Screening Level (RBSL) for the indoor and outdoor air inhalation exposure pathways.

8.1.4 Inorganic Groundwater Analysis

Table 8-2 below, tabulates the results for the anions, cations and selected metals for each groundwater sample collected.

Table 8-2: Groundwater Chemical Analysis

Parameter (mg/l)	DWA Drinking Water	SANS 241-1 (2011)	BH3	BH4	QB3	QP1	QP2
TDS [mg/l]	450	<1200	396	366	399	389	438
P Alkalinity. [mg/l $CaCO_3$]	NS	NS	<0.6	<0.6	<0.6	<0.6	<0.6
M Alkalinity. [mg/l $CaCO_3$]	NS	NS	275	238	353	312	365
pH at 25°C	6-9	5 - 9.7	7.44	7.1	7.07	7.3	7.02
Total Cation [meq/l]	NS	NS	5.92	5.6	7.39	5.6	7.29
Total Anion [meq/l]	NS	NS	6.06	5.64	7.6	6.7	7.27
Cation – Anion difference [meq/l]	NS	NS	-0.14	-0.04	-0.21	-0.04	0.02
% Difference	NS	Ns	-1.19	-0.38	-1.39	-0.8	0.12
Hardness [mg equivalent $CaCO_3$/l]	<150	NS	269.14	256.43	323.18	324.33	341.59
Bicarbonate [HCO_3^-]	NS	NS	333.06	290.36	430.66	414.8	445.3
CATIONS AND METALS							
Silver, Ag	NS	NS	<0.05	<0.05	<0.05	<0.05	<0.05
Aluminium, Al	NS	<0.3	<0.05	<0.05	0.15	<0.05	<0.05
Arsenic, As	<0.01	<0.01	<1	<1	<1	<1	<1
Boron, B	NS	NS	<0.05	<0.05	<0.05	<0.05	<0.05
Barium, Ba	NS	NS	<0.05	<0.05	<0.05	<0.05	<0.05
Beryllium, Be	NS	NS	<0.05	<0.05	<0.05	<0.05	<0.05
Bismuth, Bi	NS	NS	<0.05	<0.05	<0.05	<0.05	<0.05
Calcium, Ca	<32	NS	38	40.9	39.4	45.6	45
Cadmium, Cd	<5	<0.003	<0.05	<0.05	<0.05	<0.05	<0.05
Cobalt, Co	NS	<500	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium, Cr	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Parameter (mg/l)	DWA Drinking Water	SANS 241-1 (2011)	BH3	BH4	QB3	QP1	QP2
Copper, Cu	**<1**	**<2**	<0.05	<0.05	<0.05	<0.05	<0.05
Iron, Fe	**<0.1**	**<0.3**	<0.05	<0.05	0.09	0.3	<0.05
Potassium, K	**<50**	**NS**	0.4	0.2	0.8	1.6	<0.05
Lithium, Li	**NS**	**NS**	<0.05	<0.05	<0.05	<0.05	<0.05
Magnesium, Mg	**<30**	**NS**	8.5	37.5	54.8	51.3	55.7
Manganese, Mn	**<0.05**	**<0.5**	<0.05	<0.05	0.17	<0.05	<0.05
Molybdenum, Mo	**NS**	**NS**	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium, Na	**<100**	**<200**	11.2	10.8	19.9	10.8	10.6
Nickel, Ni	**NS**	**<0.07**	<0.05	<0.05	<0.05	<0.05	<0.05
Phosphorus, P	**NS**	**NS**	<0.05	<0.05	<0.05	<0.05	<0.05
Lead, Pb	**<0.01**	**0.001**	<1	<1	<1	<1	<1
Antimony, Sb	**NS**	**<0.02**	<1	<1	<1	<1	<1
Selenium, Se	**<0.05**	**<0.01**	<1	<1	<1	<1	<1
Silicate, Si	**NS**	**NS**	27.83	23.08	26.02	20.09	30.4
Tin, Sn	**NS**	**NS**	<0.05	<0.05	<0.05	<0.05	<0.05
Strontium, Sr	**NS**	**NS**	0.09	<0.05	<0.05	<0.05	0.11
Thallium, Tl	**NS**	**NS**	<1	<1	<1	<1	<1
Titanium, Ti	**NS**	**NS**	<1	<1	<1	<1	<1
Vanadium, V	**<0.1**	**<0.2**	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc, Zn	**<3**	**<5**	<0.05	<0.05	<0.05	<0.05	<0.05
ANIONS							
Fluoride, F	**<1**	**1.5**	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride, Cl	**<100**	**<300**	8.5	12.4	12.9	31.4	6.1
Bromine, Br	**NS**	**NS**	<0.25	<0.25	<0.25	<0.25	<0.25
Nitrite as NO_2	**NS**	**NS**	<2	<2	<2	<2	<2
Nitrite as NO_3	**NS**	**NS**	25.4	38.4	14.2	<2	12.7
Sulphate, SO_4	**<200**	**<250**	4	4.4	20.4	5.4	<4
Phosphate, PO_4	**NS**	**NS**	<4	<4	<4	<4	<4

BH3: The hardness concentration of 269.14 $CaCO_3$/l recorded in BH3 is considered hard and may cause scale on heat exchange surfaces or may result in an increase in soap required to produce lather when bathing and in household cleaning. A calcium concentration if 38mg/l marginally exceeded the DWA water quality standard of 32mg/l, however was below the SANS 2006 standards. The SANS 241-1:2011 drinking water standards do not specify a standard for magnesium or calcium.

BH4: The hardness concentration of 256.43 $CaCO_3$/l recorded in BH4 is also considered hard. Non-compliant calcium and magnesium were recorded, which marginally exceeded the DWA water quality standards.

QB3: The hardness concentration of 323.18 $CaCO_3$/l recorded in QB3 is considered very hard. Non-compliant calcium, magnesium and manganese concentrations were recorded, which marginally exceeded the DWA and SANS 241-1:2011 drinking water quality standards.

QP1: The hardness concentration of 324.33 $CaCO_3$/l recorded in QP1 is considered very hard. Non-compliant calcium, iron and magnesium were recorded, which marginally exceeded the DWA water quality standards.

QP2: The hardness concentration of 341.59 $CaCO_3$/l recorded in QP2 is considered very hard. Non-compliant calcium and magnesium were recorded, which exceeded the DWA water quality standards. Bicarbonate salts of calcium and magnesium precipitate on heating and cause scaling in hot water systems and appliances.

8.1.5 Piper Diagram

According to the Piper Diagram below (Figure 8-1), all water samples are indicative of recently recharged groundwater rich in calcium, magnesium and bicarbonate.

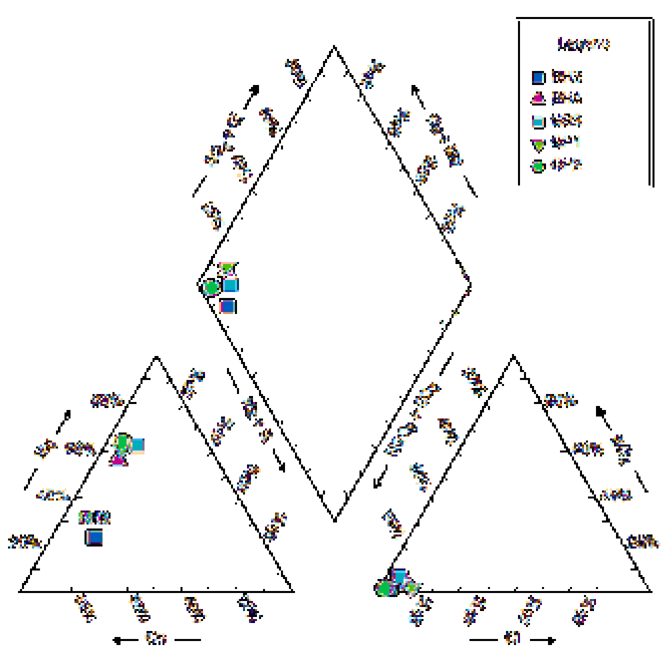

Figure 8-1: Piper Diagram

8.1.6 Durov Diagram

According to the Durov diagram below (Figure 8-2), water samples are indicative of fresh, clean, relatively young groundwater recently recharged with HCO^{3-} dominated ions and that has started to undergo magnesium ion exchange.

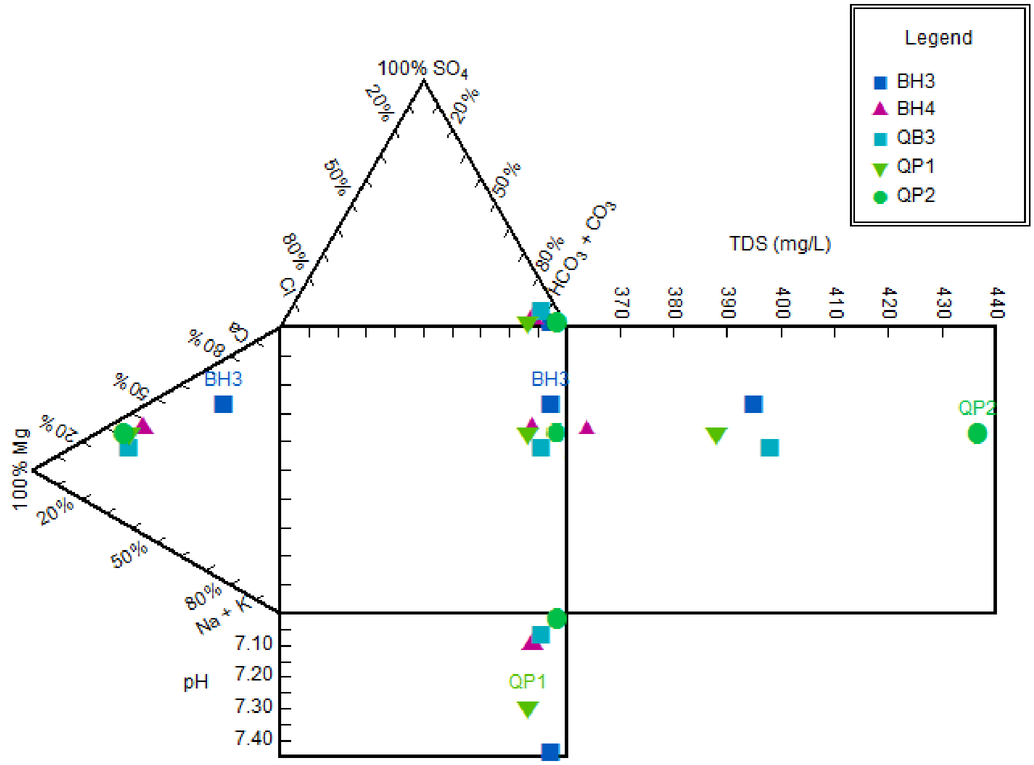

Figure 8-2: Durov Diagram

9 RISK PROFILE

A first order vulnerability profile was established for the site based on environmental and human receptors and also by means of incorporation of the source-pathway-receptor principle and with data as obtained during the scope of work set out as part of the risk matrix screening evaluation.

9.1 Source

During the site investigation conducted in September 2014, no source was identified on site, due to the site being in pre-construction phase and based on the laboratory results which confirmed the absence of contamination (ambient groundwater quality) within boreholes BH3, BH4, QB3, QP1 and QP2.

9.2 Pathway

The average ground water level measured on site ranged between 28 and 29.84 metres below ground level (mbgl), confirming the absence of any shallow perched aquifers on site and reduces the aquifer vulnerability due to the barrier (thickness of the formation and the elongated travel times) between a potential source (filling station and the waste water discharge areas) and the aquifer underlying the site.

9.3 Receptor

Sensitive receptors are present in the form of groundwater users and surface water bodies within close proximity to the site. Six boreholes were identified during the hydrocensus conducted within a 2km radius of Section 1 and Section 2. Hydrocensus boreholes, BH3, BH4 and BH6 are currently in use. A non-perennial river is located 400m east, upgradient of Section 1, while two non-perennial rivers are located 900m north and 1km west, downgradient of Section 2. Based on this, the source-pathway-receptor is incomplete based on the absence of a source found on site (refer to Figure 9-1).

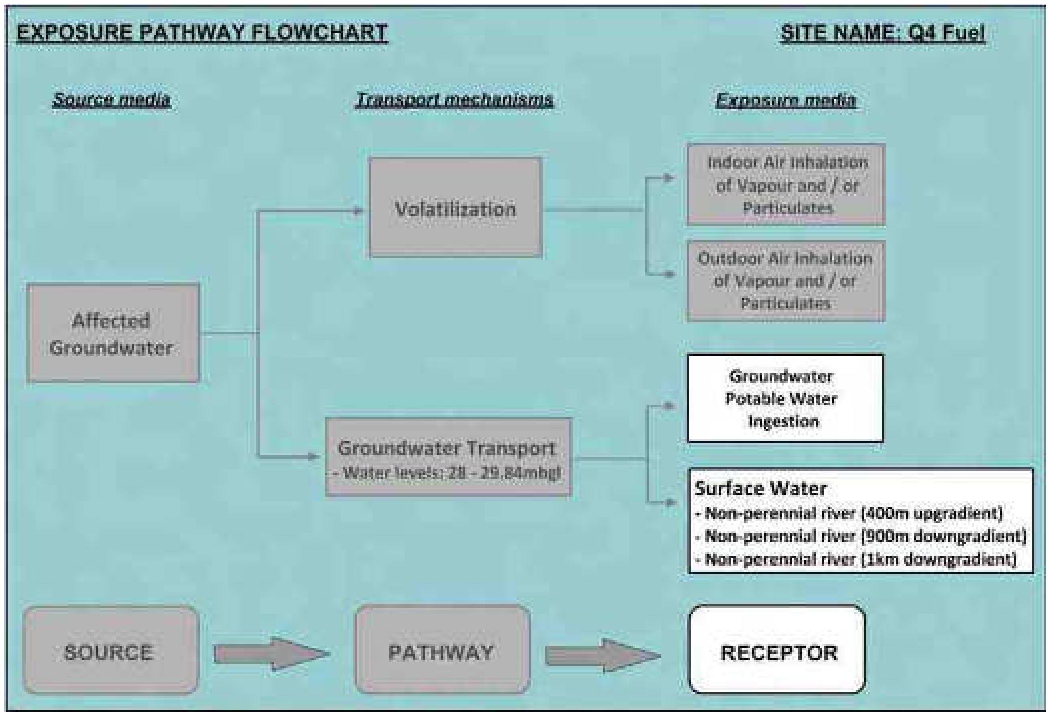

Figure 9-1: Exposure Pathway Flowchart

9.3.1 Monitoring Strategy

It is recommended that a monitoring strategy be implemented which include the monitoring of the three newly drilled monitoring wells and two production boreholes located on site as tabulated in Table 9-1 below. Quarterly monitoring should be conducted once operational phase has commenced.

Table 9-1: Monitoring Strategy

Borehole ID	Coordinates		Type of monitoring	Monitoring frequency	Analysis
	S	E			
Monitoring wells					
QB1	-25.651795	27.948825	Vapour measurements	Quarterly	-
QB2	-25.650733	27.948543	Vapour measurements	Quarterly	-
QB3	-25.647109	27.946211	Groundwater sampling	Quarterly	- Anions and cations - Volatile Petroleum Hydrocarbons (GRO, DRO and PAH) - pH, TDS, bicarbonates, EC and total hardness
Production Boreholes					
QP1	-25.650752	27.950619	Groundwater sampling	Quarterly	- Anions and cations - Volatile Petroleum