ANNEXURE TO THE EKURHULENI TOWN PLANNING SCHEME, 2014

USE ZONE NUMBER	18
LAND USE CATEGORY (ZONING)	"PUBLIC SERVICES"
PRIMARY RIGHTS	"As per Scheme"
SECONDARY RIGHTS	"As per Scheme"
NO RIGHTS OR RIGHTS EXCLUDED	"As per Scheme"
DENSITY	"As per Scheme"
HEIGHT	"As per Scheme"
COVERAGE	"As per Scheme"
FLOOR AREA RATIO (FAR)	"As per Scheme"
PARKING REQUIREMENTS	"As per Scheme"
LOADING REQUIREMENTS	"As per Scheme"
SITE DEVELOPMENT PLAN (SDP)	Not required
BUILDING LINES	"As per Scheme"
SPECIAL BUILDING LINES	Street Boundary: "As per Scheme" (0m) Other Boundary: "As per Scheme" (0m)
LINES OF NO ACCESS	"As per Scheme"

ADDITIONAL CONDITIONS / SPECIAL RIGHTS / RESTRICTIONS:

CITY PLANNING OFFICE:

BOKSBURG

AMENDMENT SCHEME

PROPERTY DESCRIPTION:

Erven

Leeuwpoort South

situated on a part of the

Remaining Extent of the Farm

Leeuwpoort **No** 113IR

COMPILED BY AREA PLANNER:

.....

CHECKED BY AREA MANAGER:

.....

APPROVED BY:

.....

DATE:.....

Ekurhuleni
METROPOLITAN MUNICIPALITY

ANNEXURE TO THE EKURHULENI TOWN PLANNING SCHEME, 2014

USE ZONE NUMBER	21
LAND USE CATEGORY (ZONING)	"TRANSPORTATION"
PRIMARY RIGHTS	"As per Scheme"
SECONDARY RIGHTS	"As per Scheme"
NO RIGHTS OR RIGHTS EXCLUDED	"As per Scheme"
DENSITY	Not applicable
HEIGHT	As per Site Development Plan
COVERAGE	As per Site Development Plan
FLOOR AREA RATIO (FAR)	Not Applicable
PARKING REQUIREMENTS	As per Site Development Plan
LOADING REQUIREMENTS	"As per Scheme"
SITE DEVELOPMENT PLAN (SDP)	Required
BUILDING LINES	Street Boundary: 0 meters Other Boundaries: 0m
SPECIAL BUILDING LINES	Not Applicable
LINES OF NO ACCESS	

ADDITIONAL CONDITIONS / SPECIAL RIGHTS / RESTRICTIONS:

CITY PLANNING OFFICE:

BOKSBURG

AMENDMENT SCHEME

PROPERTY DESCRIPTION:

Erven
Leeuwpoort South
situated on a part of the
Remaining Extent of the Farm
Leeuwpoort No 113IR

COMPILED BY AREA PLANNER:

.....

CHECKED BY AREA MANAGER:

.....

APPROVED BY:

.....

DATE:.....

Ekurhuleni
METROPOLITAN MUNICIPALITY

ANNEXURE TO THE EKURHULENI TOWN PLANNING SCHEME, 2014

USE ZONE NUMBER	22
LAND USE CATEGORY (ZONING)	"SPECIAL"
PRIMARY RIGHTS	Retirement Village, frail care facility
SECONDARY RIGHTS	Any other use
NO RIGHTS OR RIGHTS EXCLUDED	"As per Scheme"
DENSITY	A total of 278 units
HEIGHT	"As per Scheme" (2 Storeys)
COVERAGE	"As per Scheme" (60%)
FLOOR AREA RATIO (FAR)	Not Applicable
PARKING REQUIREMENTS	"As per Scheme"
LOADING REQUIREMENTS	"As per Scheme"
SITE DEVELOPMENT PLAN (SDP)	Required
BUILDING LINES	16m along Provincial Road Street Boundary: 3 meters Other Boundaries: 3 meters
SPECIAL BUILDING LINES	Not Applicable
LINES OF NO ACCESS	

ADDITIONAL CONDITIONS / SPECIAL RIGHTS / RESTRICTIONS:

CITY PLANNING OFFICE:

BOKSBURG

AMENDMENT SCHEME

PROPERTY DESCRIPTION:

Erven
Leeuwpoort South
situated on a part of the
Remaining Extent of the Farm
Leeuwpoort No 113IR

COMPILED BY AREA PLANNER:

.....

CHECKED BY AREA MANAGER:

.....

APPROVED BY:

.....

DATE:.....

Ekurhuleni
METROPOLITAN MUNICIPALITY

ANNEXURE TO THE EKURHULENI TOWN PLANNING SCHEME, 2014

USE ZONE NUMBER	22
LAND USE CATEGORY (ZONING)	"SPECIAL"
PRIMARY RIGHTS	Clinic, Hospital
SECONDARY RIGHTS	Any other use
NO RIGHTS OR RIGHTS EXCLUDED	"As per Scheme"
DENSITY	Not applicable
HEIGHT	"As per Scheme" (3 Storeys)
COVERAGE	"As per Scheme" (60%)
FLOOR AREA RATIO (FAR)	0.8
PARKING REQUIREMENTS	"As per Scheme"
LOADING REQUIREMENTS	"As per Scheme"
SITE DEVELOPMENT PLAN (SDP)	Required
BUILDING LINES	Street Boundary: 3 meters Other Boundaries: 3 meters
SPECIAL BUILDING LINES	Not Applicable
LINES OF NO ACCESS	

ADDITIONAL CONDITIONS / SPECIAL RIGHTS / RESTRICTIONS:

CITY PLANNING OFFICE:

BOKSBURG

AMENDMENT SCHEME

PROPERTY DESCRIPTION:

Erven

Leeuwpoort South

situated on a part of the Remaining Extent of the Farm Leeuwpoort No 113IR

COMPILED BY AREA PLANNER:

.....

CHECKED BY AREA MANAGER:

.....

APPROVED BY:

.....

DATE:.....

Ekurhuleni
METROPOLITAN MUNICIPALITY

ANNEXURE TO THE EKURHULENI TOWN PLANNING SCHEME, 2014

USE ZONE NUMBER	22
LAND USE CATEGORY (ZONING)	"SPECIAL"
PRIMARY RIGHTS	Gate House, Access Control, Access
SECONDARY RIGHTS	Any other use
NO RIGHTS OR RIGHTS EXCLUDED	"As per Scheme"
DENSITY	Not applicable
HEIGHT	2 Storeys
COVERAGE	100%
FLOOR AREA RATIO (FAR)	Not Applicable
PARKING REQUIREMENTS	"As per Scheme"
LOADING REQUIREMENTS	"As per Scheme"
SITE DEVELOPMENT PLAN (SDP)	Required
BUILDING LINES	Street Boundary: 0 meters Other Boundaries: 0 meters
SPECIAL BUILDING LINES	Not Applicable
LINES OF NO ACCESS	

ADDITIONAL CONDITIONS / SPECIAL RIGHTS / RESTRICTIONS:

CITY PLANNING OFFICE:

BOKSBURG

AMENDMENT SCHEME

PROPERTY DESCRIPTION:

Erven

Leeuwpoort South

situated on a part of the Remaining Extent of the Farm Leeuwpoort No 113IR

COMPILED BY AREA PLANNER:

.....

CHECKED BY AREA MANAGER:

.....

APPROVED BY:

.....

DATE:.....

Ekurhuleni
METROPOLITAN MUNICIPALITY

ANNEXURE TO THE EKURHULENI TOWN PLANNING SCHEME, 2014

USE ZONE NUMBER	22
LAND USE CATEGORY (ZONING)	"SPECIAL"
PRIMARY RIGHTS	Agricultural and uses by consent
SECONDARY RIGHTS	Any other use
NO RIGHTS OR RIGHTS EXCLUDED	"As per Scheme"
DENSITY	Not Applicable
HEIGHT	2 Storeys
COVERAGE	10%
FLOOR AREA RATIO (FAR)	Not Applicable
PARKING REQUIREMENTS	"As per Scheme"
LOADING REQUIREMENTS	"As per Scheme"
SITE DEVELOPMENT PLAN (SDP)	Required
BUILDING LINES	16m along Provincial Road Street Boundary: 10 meters Other Boundaries: 10 meters
SPECIAL BUILDING LINES	Not Applicable
LINES OF NO ACCESS	

ADDITIONAL CONDITIONS / SPECIAL RIGHTS / RESTRICTIONS:

CITY PLANNING OFFICE:

BOKSBURG

AMENDMENT SCHEME

PROPERTY DESCRIPTION:

Erven
Leeuwpoort South
situated on a part of the
Remaining Extent of the Farm
Leeuwpoort No 113IR

COMPILED BY AREA PLANNER:

.....

CHECKED BY AREA MANAGER:

.....

APPROVED BY:

.....

DATE:.....

Ekurhuleni
METROPOLITAN MUNICIPALITY

ANNEXURE E

URBAN DYNAMICS

TITLE DEED

\IN-DEED\D-DOCS\TLODGE.COM

DEED OF TRANSFER

in favour of

THE GREATER EAST RAND METRO

over

THE REMAINING EXTENT OF THE FARM OF LEEUWPOORT NO. 113 I.R.

MALHERBE, RIGG & RANWELL INC

ATTORNEYS, NOTARIES & CONVEYANCERS & ADMINISTRATORS OF ESTATES
PROKUREURS, NOTARISSE, AKTE- &
TRANSPORTBESORGERS & BOEDELBEREDDERAARS

650 TRICHARDTS ROAD/WEG
BEYERS PARK, BOKSBURG
TEL (011) 918-4116

26873 EAST RAND 1462
DX 4 BOKSBURG
FAX/FAKS: (011) 918-3439

LIN-DEED1.DEFD
Prepared by me,

Conveyancer
COOKE P D

T 000082017/2001

DEED OF TRANSFER NO:

BE IT HEREBY MADE KNOWN

THAT CHRISTOFFEL ZANDSPRUIT LOMBARD

appeared before me, the REGISTRAR OF DEEDS at Pretoria he, the said Appearer, being duly authorised thereto by virtue of a Power of Attorney signed at BOKSBURG on the

25th July 2001

and granted to him by -

HORIZON COASTAL PROPS (PROPRIETARY) LIMITED
NO. 1998/013909/07

For endorsements see
P1.

AND the said Appearer declared that his said principal had truly and legally sold and that he, in his capacity as aforesaid, did by these presents cede and transfer to and on behalf of-

THE GREATER EAST RAND METRO

its successors in title or assigns

in full and free property

THE REMAINING EXTENT OF THE FARM OF LEEUWPOORT NO. 113 I R
Registration Division I.R., The Province of Gauteng
IN EXTENT 1361,0679 (One Three Six One Comma Zero Seven Nine) ~~3427727 (ONE THREE FOUR TWO COMMA ONE SEVEN TWO SEVEN)~~ Hectares;

FIRST transferred by Deed of Transfer T3051/1896 with Diagram relating thereto and held by Deed of Transfer T37934/2000

SUBJECT to the following conditions: -

1. The former remaining extent of the said Farm Leeuwpoort 113, measuring 3252,9503 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K1349/59S subject to a servitude in perpetuity for the purpose of erecting an electricity substation with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

2. The former remaining extent of the said Farm Leeuwpoort 113, measuring 3228,0373 hectares (a portion where of is hereby transferred) is by virtue of Notarial Deed K1080/67S is subject to a servitude for the conveyance of electricity and substation with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

3. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2618,6550 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K668/73S dated 24th August 1972 subject to right in perpetuity to construct, reconstruct, use, maintain, repair, lay, re-lay, alter, inspect and remove overhead electric power lines in favour of the Electricity Supply Commission, as shown by the letters ABCDE and FGHJ and KLMNOP on Diagram S.G. No. A6438/78 together with ancillary rights, as will more fully appear from the said Notarial Deed and Diagram.

4. The former remaining extent of the Farm Leeuwpoort 113, measuring 2133,4632 hectares, of which the property transferred forms a portion is by virtue of Notarial Deed K2077/80S subject to a servitude in perpetuity to convey electricity across the said property by means of one transmission line consisting of wires or cables and/or other appliances underground or overhead in favour of ESKOM together with ancillary rights

5. The former remaining extent of the said Farm Leeuwpoort 113, measuring

2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3132/84S subject to a servitude to convey electricity in favour of Eskom together with ancillary rights and subject to conditions, as will more fully appear from the reference to the said Notarial Deed.

6 By virtue of Notarial Deed of Route Description K5562/1999S, the exact Route of the right in favour of ESKOM to convey electricity as reserved vide K3132/84S is now defined as follows:

The centre line of the overhead transmission line with underground cables traverses the abovementioned property along the route indicated by the line A B C D on the annexed Diagram S.G. No. A3530/98, the extent and width of the servitude being 11 (ELEVEN) metres on each side of the said line as will more fully appear from the said Notarial Deed of Route Description with the Diagram annexed thereto.

7. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3133/84S subject to a servitude to convey electricity in favour of Eskom, together with ancillary rights, and subject to conditions, as will more fully appear on reference to the said Notarial Deed.

8. The former remaining extent of the said Farm Leeuwpoort 113 in extent 1942,7660 hectares (of which the property hereby transferred forms a part) is by virtue of Notarial Deed K1065/[illegible] subject to a servitude in favour of Eskom, its successors and assigns of licensees the right in perpetuity to convey electricity across the said property by means of underground cables or other appliances laid under the surface of the ground, together with ancillary rights, as defined by the line AB on diagram S.G. No. A7493/82 as will more fully appear from reference to the said Notarial Deed.

9. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1931,2940 hectares (a portion where of is hereby transferred) is by virtue of Notarial Deed K445b/875 subject to a servitude to convey electricity in favour of Eskom, together with ancillary rights and subject to conditions as will more fully appear with reference to the said Notarial Deed.

10. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1918,6408 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K2213/90S subject to a servitude to convey electricity in favour of Eskom together with ancillary rights and subject to conditions, as will more fully appear on reference to the said Notarial Deed.

11. By virtue of Notarial Deed of Route Description K3814/93S, the exact route to convey electricity as reserved in favour of ESKOM vide Notarial Deed K2213/90S is now indicated by the figure ABCDEFA on Diagram S.G. No. A2602/90 which area is 34 (THIRTY FOUR) Square Metres as will more fully appear from the said Notarial Deed of Route Description with the Diagram annexed thereto.

12. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1811,9393 hectares (a portion whereof is hereby transferred is by virtue of Notarial Deed No. K5731/93S, subject to a perpetual right of way servitude for water main purposes and other municipal services in favour of the City Council of Boksburg, 3 metres wide as shown on Diagram S.G. No. A11280/92 outlined by the lines ABC, DE, FG, HJ together with ancillary rights, and subject to conditio[illegible], as will more fully appear from reference to the said Notarial Deed.

13 The former remaining extent of the said Farm Leeuwpoort 113, measuring

1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed No. K4132/94S, subject to a powerline servitude in favour of Eskom with ancillary rights and subject to conditions as will more fully appear from reference to the said Notarial Deed.

14. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed No. K4133/94S, subject to a powerline servitude in favour of Eskom with ancillary rights and subject to conditions as will more fully appear from reference to the said Notarial Deed.

15. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed No. K4134/94S, subject to a powerline servitude in favour of Eskom with ancillary rights and subject to conditions as will more fully appear from reference to the said Notarial Deed

16. By Notarial Deed of Servitude No. K3354/96S the withinmentioned property is subject to a servitude for electrical purposes in favour of the Council together with ancillary rights, 2 metres wide, the centre line of which being indicated by the line xy on Diagram S.G. No. 7523/1995 annexed thereto.

17. By Notarial Deed of Servitude No. K1042/93S the withinmentioned property is subject to a servitude in favour of Eskom to convey electricity over the property, together with ancillary rights, and subject to conditions as will more fully appear from reference to the said Notarial Deed

18. By Notarial Deed of Servitude No. K1041/93S the withinmentioned property is subject to a servitude for sewerage purposes, 2 (TWO) metres wide as indicated by ABCDEFGHJKLMNPQRSTUVWXYZ on Diagram S.G. No. A5636/91 with ancillary rights.

19. Subject to Deed of Servitude No. K788/1976 represented by the figures ABCDEFG on Diagram S.G No. A6297/1974.

20. By virtue of Notarial Deed K1636/71S the withinmentioned property is subject to a servitude in perpetuity in favour of the Transitional Local Council of Boksburg to use a strip of ground for sewerage purposes which strip is defined by the letters ABCDEFGHJKLMNOPQRSTUVWX on Diagram S.G. No. A6440/70 annexed thereto.

21. By Notarial Deed K1637/71S the withinmentioned property is subject to a servitude in favour of the City Council of Greater Germiston in perpetuity to use a strip of ground for sewerage, stormwater and municipal purposes which strip is more fully described by the letters ABCDEFGHJKLMNOPQRSTUV on Diagram S.G. No. A6439/70 which Diagram is annexed to the said Notarial Deed.

22. By Notarial Deed K184/73S the remaining extent of the Farm Leeuwpoort is subject to a servitude in favour of the RAND WATER BOARD for the right to convey and transmit water by way of pipelines laid across a strip of ground, 16 (SIXTEEN) metres wide, the centre line of which is represented by the figure ABCDE on Diagram S.G. No. 6437/70 annexed thereto.

23. By Notarial Deed K509/58S the withinmentioned property is subject to a servitude in perpetuity in favour of the Transitional Local Council of Boksburg for the construction of a transformer house over an area 900 (NINE HUNDRED) square metre on the Northern Boundary adjoining Bigwood Avenue, Cinderella Township as will more fully appear from the figure ABCD on Diagram S.G. No.

A3185/57 which Diagram is annexed to the said Notarial Deed.

24 By Notarial Deed of Servitude K2713/76S the withinmentioned property is subject to a servitude in favour of the SUID AFRIKAANSE GASDISTRIBUSIEKORPORASIE BEPERK for perpetual right to transmit gas by means of a pipeline or pipelines within a strip of ground 5 214 (FIVE THOUSAND TWO HUNDRED AND FOURTEEN) square metres which area is indicated by the letters ABCD on Diagram S.G. No. A5224/75 annexed to the said Notarial Deed.

25 By virtue of Notarial Deed of Servitude K2440/87S the withinmentioned property is subject to a servitude in perpetuity in favour of the Transitional Local Council of Boksburg for stormwater drainage by means of an open trench and/or open canal and/or open canal and subterranean piping which servitude is indicated by the letters ABCDEF on Diagram S.G. No. A5439/86 which diagram is annexed to the said Notarial Deed.

26 Subject to Deed of Servitude No. K1414/1973 represented by the figures NPRO on Diagram S.G. No. A6441/1970.

27. The Remaining Extent of the Farm Leeuwpoort 113, Registration Division I.R. The Province of Gauteng, measuring 1 597 7994 (ONE FIVE NINE SEVEN COMMA SEVEN NINE NINE FOUR) Hectares is subject to the servitude in perpetuity, along a strip of ground, 4 467 (FOUR THOUSAND FOUR HUNDRED AND SIXTY SEVEN) square metres in extent, indicated on Servitude Diagram No. S.G. No. 8120/1997, to convey and transmit water by means of pipelines already laid or to be laid, with ancillary rights in favour of RAND WATER BOARD, as will more fully appear from Notarial Deed of Servitude K1747/2000S.

SUBJECT to such conditions as are mentioned in the aforesaid deed

WHEREFORE the Appearer, renouncing all the right and title the said

HORIZON COASTAL PROPS (PROPRIETARY) LIMITED
NO. 1998/013909/07

heretofore had to the premises, did, in consequence also acknowledge it to be entirely dispossessed of, and disentitled to the same, and that, by virtue of these presents, the said

THE GREATER EAST RAND METRO

its successors in title or assigns, now is and henceforth shall be entitled thereto, conformably to local custom, the State, however reserving its rights, and finally acknowledging the purchase price to be the sum of R15 492 600.00 (FIFTEEN MILLION FOUR HUNDRED AND NINETY TWO THOUSAND SIX HUNDRED RAND) and the date of sale 18th JULY 2001

IN WITNESS WHEREOF I, the said Registrar, together with the Appearer q.q. have subscribed to these presents and have caused the Seal of Office to be affixed thereto.

THUS DONE AND EXECUTED at the Office of the REGISTRAR OF DEEDS at Pretoria on

01 08 001

In my presence.

REGISTRAR OF DEEDS

BLADSY/PAGE 1
T8207/2001

ENDORSEMENT IN TERMS OF SECTION 14(4)(a) OF THE LOCAL GOVERNMENT MUNICIPALITY STRUCTURES ACT 117/1998

In terms of Notice No: 5215/2001

In Provincial Gazette No: 130

Dated 24 August 2001 the within property is now

Transferred to and vest in EKURHULENI METROPOLITAN

MUNICIPALITY

05 032602

Certificate and application filed with T _____ (1)

Date: 17 3 05
Datum

REGISTRAR OF DEEDS
REGISTRATEUR VAN AKTES

Vir verdere endossemente sien
For further endorsements see
PR

BLADSY PAGE 8

T 82051/2001

Plan 131 Farm LEEUWPOORT NO 113 = 1050M²

GETRANSPORTEER AAN TRANSFERRED TO

HORIZON COASTAL PROPS (PTY) LTD

NO 1998/039097

REMAINING EXTENT 274, 1726H.

T 05 032603

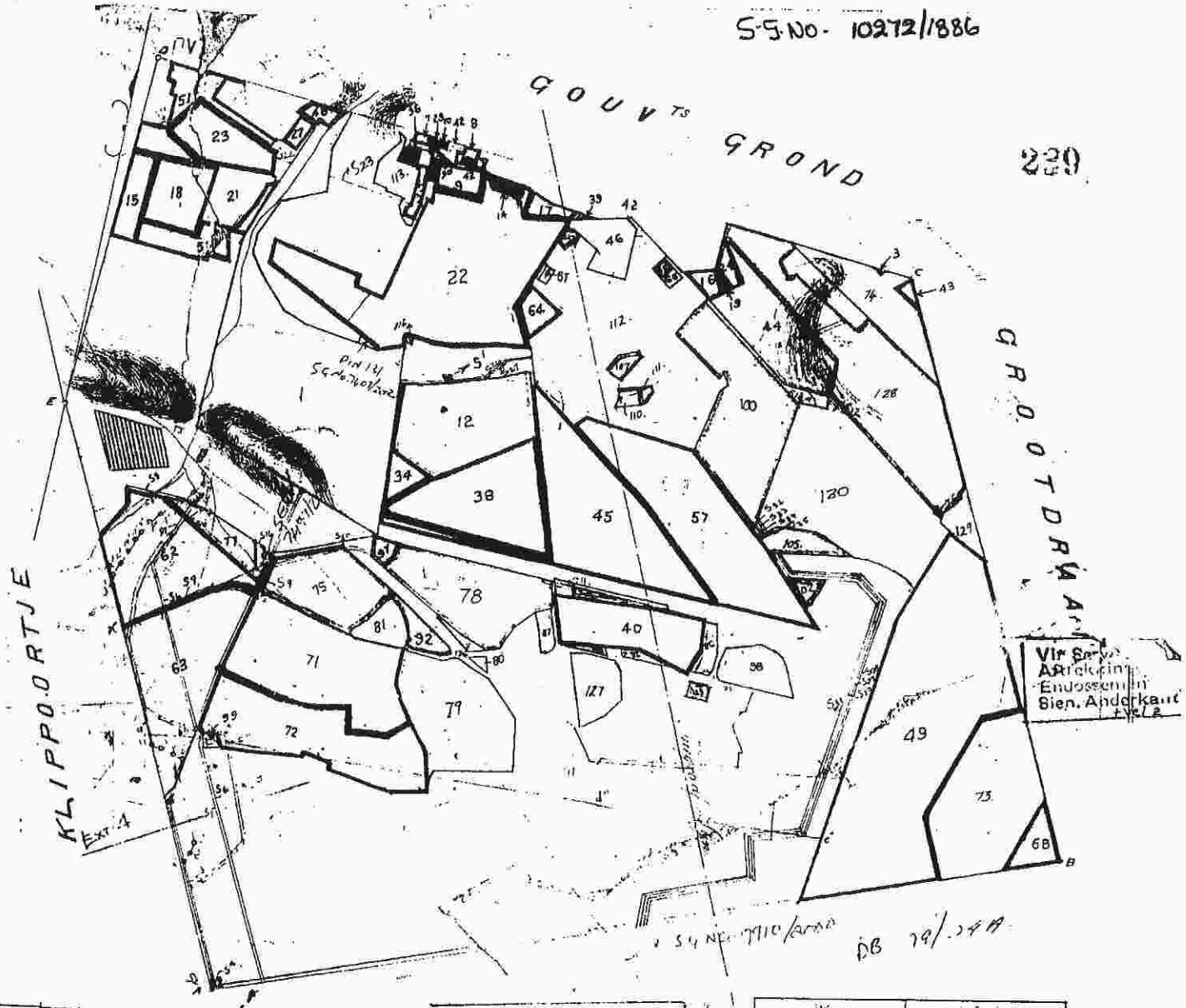
17 03 05

ANNEXURE F

URBAN DYNAMICS

SG FARM DIAGRAMS

S-G NO- 10272/1886



Die figuur ... 5 ... is 1 voor 'n Serwituut
van ..... wyd
groot 900 Vierkante voet ..... volgens
Kaart L.G. Nr. A. 3185/57. en Nr. 509/86.

Landmeter-Generaal.

Tans geregistreer onder :
Now registered under :
No. 113
REGISTRASIE AFDELING
REGISTRATION DIVISION IR

Zyden		Hoeken		
A.B.	1753.45	A.	91	45
B.C.	1210.51	B.	55	0
C.D.	1591.26	C.	120	7
D.E.	1249.59	D.	90	10
E.A.	1232.29	E.	150	1

Kaapsche Voetmaate Roeden.

Bovenstaande Figuur A tot E stelt voor de plaats genaamd

— LEEUWPOORT — No 4

bevattende 4518 Morgen 532 Vierkante Roeden Engelsche Maat

Gelegen in het Distrikt Heidelberg Wijk Wijnrivier in de Republiek

Transvaal en grenzende als hierboven vermeld Geregistreerd onder No 284

De baken zijn aangewezen door den Eigenaar en zijn behoorlijk opgerigt volgens wet

Gemeten door den Heer F. Leerbagel in Oct 1886 door mij

Afstand van het Dorp Heidelberg omtrent 30 mijlen

Beëedigd Landmeter

No 0 Goedgekeurd. De zijden, hoeken en grootte op deze kaart aangegeven zijn onderling volkomen bestaanbaar.

Goedgekeurd.

Deze kaart is uitgegeven ten fatsoene van

IR

B

Landmeter-Generaal

Landmeter

10272/1886

Die figuur S³ a S⁴ stel voor 'n Serwituut
van ... wyd/
groot 2·9958 M. ... volgens
Kaart L.G. Nr. A. 5538/64 Serw. Nr. 1080/67
7-9-67 namens Landmeter-Generaal.

Die lyn a b c d e stel voor 'n Serwituut
van 16 meter wyd
Kaart L.G. Nr. A 6127/70 Serw. Nr. 1414/73
16.2.1973 namens Landmeter-Generaal.

Die lyne Sa Sa Sb stel voor die middellyn van 'n Serwituut
Kaart L.G. Nr. A 6127/70 Serw. Nr. 1414/73
25.4.73 namens Landmeter-Generaal.

Die lyne a' b' c' d' e' f' g' h' i' j' k' l' m' n' o' p' q' r' ... stel voor 'n Serwituut
Kaart L.G. Nr. A. 6435/70 ... 1637/1972
...7.72 namens Landmeter-Generaal.

Die figuur S5 stel voor 'n Serwituut
van 3,00 meter wyd/
groot ... volgens
Kaart L.G. Nr. A. 6441/70 Serw. Nr. 1414/73
24-10-73 namens Landmeter-Generaal.

Die figuur S⁶ stel voor 'n Serwituut
van 9 m wyd/
groot ... volgens
Kaart L.G. Nr. A. 5542/70 Serw. No. 1685/1972
...1.1972 namens Landmeter-Generaal.

Die lyn x y stel voor die middellyn van 'n serwituut 15,24 meter wyd
Kaart L.G. Nr. A. 6624/72 Serw. Nr. 1015/73
24-10-1973 namens Landmeter-Generaal.

The figure S¹¹ represents a servitude
of 3 m wide/in extent vide Diag.
S.G. No. A 8884/75 Serv. No. K371/1983
23-5-76 for Surveyor-General.

The lines S11 and S12 represents the centre line of an Electric Power Line Servitude.
Diag. S.G. No. A 2693/82 Serv. No. K 1665/1985
1985 07 12 for SURVEYOR-GENERAL

		AFGETREK		RESTANT			
No.	Ged.	Kaart No.	Hektaar	Hektaar	Transport		Datum
50/	79	514/83	66,0850		43825/1984		1985-01-02
	80	3148/83	9503 m²		43826/1984		
	81	2860/83	10,2299	1942,7660	43827/1984	[signature]	1984-01-02
51	92	10249/85	11,4120 ha	1931,2940	T3083/1987	[signature]	1987-03-12
52	82	12296/84	2,8395		T10794/1989		
	83	12297/84	2,1659		T10794/1989		
	86	2021/85	5,3012	1922,2300	T10794/1989	[signature]	1989.05.11
53	97	5537/88	3,5892	1918,6408	T[illegible]	[signature]	1989.08.08
54	99	1147/90	1,3525	1917,2883	T62319/1990	[signature]	1990.11.01
55	98	8511/1988	18,0841		T81960/1992		
	100	7683/1990	75,5558		T81961/1992		
	104	2714/1992	10,8001	1811,9353	T81962/1992	[signature]	1992-11-06
56	105	10628/1992	9,0593		T3891/1993		
	107	2201/1993	3,5340	1799,5660	T9892/1994	[signature]	1993-06-14
57	110	8375/1994	1,4528		T43382/1996		1994-06-14
	111	8376/1994	0,9620		T43383/1996		1996-05-06
	112	8561/1994	160,3714		T43379/1996		"
	113	7623/1995	10,0399	1626,7799	T43380/1996		"
58	115	14147/1996	1,9211 ha	1624,8588 ha	T51.../1997	[signature]	1996-05-06 / 1997-03-??

Die lyne S⁸ S⁹ S¹⁰ S¹¹ stel voor die hartlyn van 'n Serwituut 3,00 meter wyd
Kaart L.G. Nr. A. 11288/1993 Serw. Nr. K5731/1993 S
1993 10 14 nms. LANDMETER-GENERAAL

Die lyne S22 u S23 stel voor die middellyne van 'n serwituut 3,00 meter wyd
Kaart L.G. Nr. A 4853/1987 Serw. Nr. K3354/1996
1996-08-06 nms. LANDMETER-GENERAAL

Die figuur S¹⁷ stel voor 'n Serwituut
van ... wyd/
groot 36 vierkante meter volgens
Kaart L.G. Nr. A 2603/1990 Serw. Nr. K 2014/1993 S
1993-07-13 nms. LANDMETER-GENERAAL

Die lyn S¹⁵ stel voor die middellyn van 'n Elektriese Kraglyn Serwituut. Volgens Kaart L.G. Nr. A 3092/1992 Serw. Nr. K 1042/1993 S
1993 03 19 nms. LANDMETER-GENERAAL

Die lyn S¹⁶ stel voor die middellyn van 'n Serwituut 2,00 meter wyd
Kaart L.G. Nr. A 6538/1991 Serw. Nr. K 1041/1993 S
1993 03 19 nms. LANDMETER-GENERAAL

The figure S14 represents a servitude
of ... wide/in extent 293 square metre vide Diag.
S.G. No. A 6429/86 Serv. No. K 2440/1987 S
1987-09-10 for SURVEYOR-GENERAL

ZK – 113

SG No. 10272/1886

AFGETREK				RESTANT			
No.	Ged.	Kaart No.					Datum
1)	1	—		247M 2925	427M 2405	(Get.) A. Gilfillan	12-11-02
2)	2	3548/14	0 · 278	4270 · 562		" W.M. Edwards	11-3-15

Fo.	Ged.	Kaart No.	Morg.	Morg.			Datum
29)	29	5762/55					Tr 1922/69
	30	" 3 "					
	31	" 4 "					
25)	32	1045/56					
26)	33	2877/61					
27)	38	3198/63					
28)	40	2903/61					
29	44	5572/62					
	45	6411/63					
(30)	46	5929/64					
31)	49	1044/66					
32)	51	1043/66					
	52	7044/66					
33)	45	6898/65					
34)	56	6326/68					
	57	8055/69					
(35)	65	5760/69					
36)	63	5174/72					
37)	62	5153/72					
38)	65	6844/73					
39)	64	368/73					
40)	66	3905/73					
41	66	7629/73					

(3)										
4)										
5)										
(6)										

AFGETREK				RESTANT			
No.	Ged.	Kaart No.	M.	Vk. Vl.	M	Vk. Vl.	Datum
(7)							

AFGETREK				RESTANT			
No.	Ged.	Kaart No.	Morge	Morgen			Datum
(8)							
(9)							
10)							
(11)							
(12)							
(13)							
(14)							
(15)							
(16)							
(17)							
(18)							
(19)							
(20)							
(21)							
(22)							
(23)							

AFGETREK				RESTANT			
No.	Ged.	Kaart No.	Hektaar Morge	Hektaar Morgen			Datum
(42)	71	6723/74	32,1905	2335,2664			6-1-76 Tr. 41827/1975
43)	67	844/73	3387 sq m.	2334,8767			22-8-76 T. 9724/76.
44)	73	845/77	81,1890				T. 25961/77.
	74	1246/77	35,2158	2218,5019			8-9-77
45	61	3837/39	2432 Sq m	2183,0687			5-12-1979 T 38834/1979
46	78	8108/78	84,1068	2135,4632			3-4-1980 T 7848/1980
47	75	3564/80	42,7416	2092,7216			1981-02-06 T 24958/1980
48	77	7930/80	12,6364	2078,0852			1981-12-08 T 50205/1981
49	78	7903/81	58,0540	2020,0312			1983-06-31 T 20410/1983

113–IR S.G.No 10272/1886

No.	Ged.	Kaart No.	Hektaar	Hektaar	Transport		Datum
59	117	12603/[illegible]	4,0093	1620,6488	16749/1997	[signature]	1997.04.14
60	116	11830/[illegible]	2135	1620,6353	12546/1997	Thatte	1998.02.02
61	124	1844/1987	1,3125	1619,3227	20074/1997	Klaarhou	1998.02.12
62	102	3741/1991	2,6281	1616,6946	13884/1998	Klaarhou	1998.03.20

This ... 517 ... represents the centre line of an Eskom Power Line Servitude.

Reg. S.G. No. K 3580/1998 Gen. No. K5562/1998

2000.01.19 ... for Surveyor-General

ANNEXURE H

URBAN DYNAMICS

LAND USE PLAN & ZONING PLAN

LEEUWPORT SOUTH

Ekurhuleni Metro South Region

Land Use

Legend

- Site
- Townships
- Stands

Land Use

- Agriculture
- Church
- Cluster Complex
- Residential
- Offices
- Public Open Space
- Parking
- Private Open Space
- Railroad
- Road
- School
- Shops
- Sport Facility
- Vacant

1:24 000

Coordinate System: SALO
Projection: Transverse Mercator
Datum: Hartebeesthoek 1994
False Easting: 0,0000
False Northing: 0,0000
Central Meridian: 29,0000
Scale Factor: 1,0000
Latitude Of Origin: 0,0000
Units: Meter

Date: Thursday, 12 May 2016

Urban Dynamics Gauteng Inc.
37 Empire Road,
Parktown West, 2193
Tel: +27 (11) 482-4131
Fax: +27(11) 482-9959
www.urbandynamics.co.za

LEEUWPOORT SOUTH

Ekurhuleni Metro
South Region

Zoning

Legend

Zoning
ZONING
- Aerodrome
- Agricultural
- Amusement
- Business 2
- Business 3
- Business 4
- Business 5
- Business 1
- Cemetery
- Commercial 1
- Community Facility
- ECCLESIASTIC
- Educational
- Existing Public Road
- General
- GENERAL BUS
- GENERAL IND
- GENERAL RES
- GOVERNMENT
- Industrial
- Industrial 1
- Industrial 2
- Industrial 3
- Industrial 4
- Institutional
- Mining Land
- Municipality
- PARKING
- PRIVATE OPEN SPACE
- PRIVATE ROAD
- Proclaim Mining Land
- Proposed Road
- Public Garage
- Public Open Space
- Residential 2
- Residential 3
- Residential 4
- Residential 6
- Residential 1
- Reservoir
- Restricted Business
- S.A.R
- Sewage Farm
- Special
- SPLIT ZONING
- TRANSNET
- Undetermined

1:31 122

Coordinate System: SALO
Projection: Transverse Mercator
Datum: Hartebeesthoek 1994
False Easting: 0.0000
False Northing: 0.0000
Central Meridian: 28.0000
Scale Factor: 1.0000
Latitude Of Origin: 0.0000
Units: Meter

Date: Thursday, 07 April 2016

Urban Dynamics Gauteng Inc.
37 Empire Road,
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ANNEXURE I

URBAN DYNAMICS

CONVEYANCER CERTIFICATE

NEGOTA SSH

Attorneys Notaries & Conveyancers

Our ref:	*Your Ref*	*Date*
Gert Minnaar/Hazel		*30 October 2006*

CONVEYANCER'S CERTIFICATE
IN RESPECT OF THE PROPOSED LEEUWPOORT DEVELOPMENT

I, the undersigned,

JOHANNES GERHARDUS STEPHANUS MINNAAR

hereby certify that :

I am a duly qualified and admitted conveyancer and I sign this certificate in order to indicate:

General

1. the description of the land on which the proposed township establishment will take place;
2. the various title conditions contained in the title deeds relating to the land on which the proposed township will be established;
3. the way in which these title conditions must be disposed of for township establishment purposes;
4. the particulars of the registered owner of the land;
5. the particulars of the township applicant;
6. the particulars of the local authority;
7. the particulars of the holder of the rights to minerals
8. conveyancing steps to be followed before or simultaneously with the opening of the township register.

Directors:
George Negota *LLB MCom, H Dip Tax, H Dip Co*
Stanley Mathekga *LLB* Gert Minnaar *BLC. LLB*
Deon Plenaar *B.Com LLB* Tinus van der Berg *B. Proc, CFM MBA*

Professional Assistants:
Natalie Fouche *B.Proc LLB;* Petro Louw *BA (Law) LLB*
Salinah Naledzani *Bluris LLB*

Consultants:
Charl Spies *B.Proc;* D. Joe Malherbe *B.Proc*
Deon Haasbroek *BA, B. Proc*

Office Manager:
Keith Hippolyte

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Phone (011) 369-0500 (X 2004)
Fax (011) 781-6584
Direct Fax 0866 186 705 (Gert Minnaar)

Email: gert.minnaar@negotassh.co.za
hazel.mothasedi@negotassh.co.za

1. Property Description

From information received from Urban Dynamics, Town and Regional Planners, it appears that the proposed township will be established on a consolidation of the following properties:

1.1 Remaining Extent of the farm LEEUWPOORT 113
Registration Division IR, Gauteng Province
Measuring 1340,1747 (One Thousand Three Hundred and Forty Comma One Seven Four Seven) hectares
Held by virtue of Deed of Transfer T82017/2001

1.2 Remaining Extent of Portion 51 of the farm LEEUWPOORT 113
Registration Division IR., Gauteng Province
Measuring 12,1194 (Twelve comma One One Nine Four) hectares
Held by Deed of Transfer T44389/1967

1.3 Remaining Extent of Portion 52 of the farm LEEUWPOORT 113
Registration Division IR., Gauteng Province
Measuring 4,1973 (Four comma One Nine Seven Three) hectares
Held by Deed of Transfer T44389/1967

1.4 Portion 102 of the farm LEEUWPOORT 113
Registration Division IR., Gauteng Province
Measuring 2,6281 (Two comma Six Two Eight One) hectares
Held by Deed of Transfer T3884/1998

2. Title Conditions

2.1 **The following title conditions are recorded against Deed of Transfer T82017/2001 in respect of the Remaining Extent of the farm LEEUWPOORT 113, Registration Division IR, Gauteng Province:**

1. The former remaining extent of the said Farm Leeuwpoort 113, measuring 3252,9503 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K1349/1959S subject to a servitude in perpetuity for the purpose of erecting an electricity substation with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

2. The former remaining extent of the said Farm Leeuwpoort 113, measuring 3226,0373 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K1080/1967S subject to a servitude for the conveyance of electricity and substation with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

3. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2616,6550 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K568/1973S subject to right in perpetuity to construct, reconstruct, use, maintain, repair, lay, re-lay, alter, inspect and remove overhead electric power lines in favour of ESKOM as shown by the letters ABCDE and FGHJ and KLMNOP on Diagram S.G. No. A6438/1970 together with ancillary rights, as will more fully appear from the said Notarial Deed and Diagram.

4. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2133,4632 hectares, of which the property transferred forms a portion, is by virtue of Notarial Deed K2077/1980S subject to a servitude in perpetuity to convey electricity across the said property by means of one transmission line consisting of wires or cables and/or other appliances underground or overhead in favour of ESKOM together with ancillary rights.

5. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3132/1984S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights and subject to conditions, as will more fully appear from reference to said Notarial Deed.

6. By virtue of Notarial Deed of Route Description K5562/1999S, the exact Route of the right in favour of ESKOM to convey electricity as reserved vide K3132/1984S is now defined as follows:

   The centre line of the overhead transmission line with underground cables traverses the abovementioned property along the route indicated by the line ABCD on the annexed Diagram S.G. No. A3530/1998, the extent and width of the servitude being 11 (ELEVEN) metres on each side of the said line as will more fully appear from the said Notarial Deed of Route Description with the Diagram annexed thereto.

7. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3133/1984S subject to a servitude to convey electricity in favour of ESKOM, together with ancillary rights, subject to conditions, as will more fully appear on reference to the said Notarial Deed.

8. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1942,7660 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K1665/1985S subject to a servitude in favour of ESKOM, its successors and assigns of licencees the right in perpetuity to convey electricity across the said property by means of underground cables or other appliances laid under the surface of the ground, together with ancillary rights as defined by the line AB on diagram S.G. No. A7493/1982 as will more fully appear from reference to the said Notarial Deed.

9. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1931,2940 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K4455/1987S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights and subject to conditions as will more fully appear on reference to the said Notarial Deed.

10. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1918,6408 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K2213/1990S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights subject to conditions, as will more fully appear on reference to the said Notarial Deed.

11. By virtue of Notarial Deed of Route Description K3814/1993S, the exact Route to convey electricity as reserved in favour of ESKOM vide Notarial Deed K2213/1990S is now indicated by the figure ABCDEFA on Diagram S.G. No. A2620/1990 which area is 34 (THIRTY FOUR) Square Metres as will more fully appear from the said Notarial Deed of Route Description with the Diagram annexed thereto.

12. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1811,9393 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K5731/1993S, subject to perpetual right of way servitude for water main purposes and other municipal services in favour of the City Council of Boksburg, 3 metres wide as shown on Diagram S.G. No. A11288/1992 defined by the lines ABC, DE, FG, HJ together with ancillary rights, and subject to the conditions, as will more fully appear from reference to the said Notarial Deed.

13. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K4132/1994S subject to a powerline servitude in favour of ESKOM with ancillary rights and subject to the conditions as will more fully appear from reference to the said Notarial Deed.

14. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K4133/1994S subject to a powerline servitude in favour of ESKOM with ancillary rights and subject to the conditions as will more fully appear from reference to the said Notarial Deed.

15. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K4134/1994S subject to a powerline servitude in favour of ESKOM with ancillary rights and subject to the conditions as will more fully appear from reference to the said Notarial Deed.

16. By Notarial Deed of Servitude No. K3354/1996S the withinmentioned property is subject to a servitude for electrical purposes in favour of the Council, together with ancillary rights, 2 meters, the centre line of which being indicated by the line xy on Diagram S.G. No. 7523/1995 annexed thereto.

17. By Notarial Deed of Servitude No. K1042/1993S the withinmentioned property is subject to a servitude in favour of ESKOM to convey electricity over the property together with ancillary rights and subject to conditions as will more fully appear from reference to the said Notarial Deed.

18. By Notarial Deed of Servitude No. K1041/1993S the withinmentioned property is subject to a servitude for sewerage purposes 2 (TWO) meters wide as indicated by ABCDEFGHJKLMNOPQRSTUVWXYZ on Diagram S.G. No. 5838/1991 with ancillary rights.

19. Subject to Deed of Servitude No. K788/1976 in favour of the RAND WATER BOARD represented by the figures ABCDEFG on Diagram S.G. No. A6297/1974.

20. By virtue of Notarial Deed K1636/1971S the withinmentioned property is subject to a servitude in perpetuity in favour of the Transitional Local Council of Boksburg to use a strip of ground for sewerage purposes which strip is defined by the letters ABCDEFGHJKLMNOPQRSTUVWX on Diagram S.G. No. A6440/1970 annexed thereto.

21. By Notarial Deed K1637/1971S the withinmentioned property is subject to a servitude in favour of the City Council of Greater Germiston in perpetuity to use a strip of ground for sewerage, stormwater and municipal purposes which strip is more fully described by the letters ABCDEFGHJKLMNOPQRSTUV on Diagram S.G. No. A6439/1970 which diagram is annexed to the said Notarial Deed. .

22. By Notarial Deed K184/1973S the remaining extent of the Farm Leeuwpoort is subject to a servitude in favour of RAND WATER BOARD for the right to convey and transmit water by way of pipelines laid across a strip of ground, 16 (SIXTEEN) metres wide, the centre line of which is represented by the figure ABCDE on Diagram S.G. No. A6437/1970 annexed thereto.

23. By Notarial Deed K509/1958S the withinmentioned property is subject to a servitude in perpetuity in favour of the Transitional Local Council of Boksburg for the construction of a transformer house over an area 900 (NINE HUNDRED) square metres on the Northern Boundary adjoining Bigwood Avenue, Cinderella Township as will more fully appear from the figure ABCD on Diagram S.G. No. A3185/1957 which Diagram is annexed to the said Notarial Deed.

24. By Notarial Deed K2713/1976S the withinmentioned property is subject to a servitude in favour of DIE SUID AFRIKAANSE GASDISTRIBUSIEKORPORASIE BEPERK for perpetual right to transmit gas by means of a pipeline or pipelines within a strip of ground 5214 (FIVE THOUSAND TWO HUNDRED AND FOURTEEN) square metres which area is indicated by the letters ABCD on Diagram S.G. No. A6224/1975 annexed to the said Notarial Deed.

25. By virtue of a Notarial Deed of Servitude K2440/1987S the withinmentioned property is subject to a servitude in perpetuity in favour of the Transitional Local Council of Boksburg for stormwater drainage by means of an open trench and/or open canal and/or subterranean piping which servitude is indicated by the letters ABCDEF on Diagram S.G. No. A5439/1986 which diagram is annexed to the said Notarial Deed.

26. Subject to Deed of Servitude No. K1414/1973 in favour of DIE SUID AFRIKAANSE GASDISTRIBUSIEKORPORASIE BEPERK represented by the figures NPRQ on Diagram S.G. No. A6441/1970

27. The Remaining Extent of the Farm Leeuwpoort 113, Registration Division I.R. The Province of Gauteng measuring 1597,7994 (ONE FIVE NINE SEVEN COMMA SEVEN NINE NINE FOUR) Hectares is subject to a servitude in perpetuity along a strip of ground 4467 (FOUR THOUSAND FOUR HUNDRED AND SIXTY SEVEN) square metres in extent, indicated on Servitude Diagram No. S.G. No. 8120/1997, to convey and transmit water by means of pipelines already laid or to be laid, with ancillary rights in favour of RAND WATER BOARD, as will more fully appear from Notarial Deed of Servitude K1747/2000S.

2.2 **The following title conditions are recorded against Deed of Transfer T44389/1967 in respect of the Remaining Extent of Portion 51 of the farm LEEUWPOORT 113, Registration Division IR, Gauteng Province:**

A. The former Remaining Extent measuring as such 3271,3006 hectares is subject to a servitude in perpetuity in favour of the Town Council of Boksburg for the purpose of erecting an Electricity Sub-station together with ancillary rights as will more fully appear from Notarial Deed of Servitude No. 509/1958S.

B. The former Remaining Extent measuring as such 3252,9504 hectares is subject to a servitude in perpetuity in favour of the Town Council of Boksburg for the purpose of erecting an Electricity sub-station together with ancillary rights as will more fully appear from Notarial Deed of Servitude No. 1349/1959S.

C. The former Remaining Extent measuring as such 2764,9172 hectares is subject to a servitude for the conveyance of electricity and electricity sub-station in favour of the Town Council of Boksburg together with ancillary rights as will more fully appear from Notarial Deed No. 1080/1967S.

D. (1) All rights to minerals, metals and mineral substances of every kind whatsoever, whether precious or base, nothing excepted and without in any way limiting the generality thereof, including those of vegetable and animal origin such as coal, oil shale, torbanite, lime and limestone, and also including sand, stone and clay, and precious and semi-precious stones in, on and under the land, together with all such ancillary and other rights as may attach or accrue thereto or to the holder thereof under the common law and/or statute law, shall be and they are hereby reserved to JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED, and its successors-in-title to such rights or to its or their assigns, including the rights to any mynpacht or any mining lease in respect of the mining exploitation and/or removal of the said minerals, metals and mineral substances, and including further all rights, royalties and accruals which are or may be made or allowed by law to the holder of the mineral rights; as will more fully appear from reference to Certificate of Rights to Minerals K643/1967 RM

(2) Should the freehold owner or its successors in title or assigns or its or their tenants or any others claiming by, through or under it or them, suffer any loss, damage or injury by reason of any subsidence, settlement, shocks or cracking arising from past, present or future mining operations on or under the land, or in the vicinity thereof, or in the event of there being any disturbance or interference in the peaceful and quiet enjoyment of the land due to any such mining operations, then none of them shall have any recourse, remedy, action or claim whatsoever against JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED and/or its successors-in-title or assigns, or any other persons conducting mining operations on or under the land, for such loss, damage or injury, the freehold owner, on behalf of itself, its successors-in-title or assigns, and its or their tenants and/or any others claiming by, through or under it or them, hereby accepting all risk of such loss, damage or injury, and JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors-in-title and its or their

assigns, lessees, licencees or tributors, subject to compliance G with any law governing mining operations, shall not be prevented, by reason of any such loss, damage or injury from continuing mining operations on or under the land, or in the vicinity thereof.

(3) All rights which may be or become vested in the freehold owner of the land to receive or to share in any income or proceeds which may accrue to the State from or in respect of the disposal or working of any of the undermining rights of the land or in terms of any law, and without limiting the generality thereof, including any share of claim or other licence monies, rentals, profits or dues which may accrue to any such owner under or by virtue of any mineral lease, mining lease or mynpacht or the like granted in respect of the land or the minerals therein, shall be and they are hereby reserved to JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY and its successors in title to such rights and its or their assigns as will more fully appear from reference to Certificate of Real Rights K1613/1967S

(4) The aforegoing conditions D (1) to (3) are made and imposed for the benefit of and shall be enforceable, or may be waived or relaxed by JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors in title to the rights as contained therein, or to the right to enforce the said conditions, and its or their assigns and it/they shall at all times in their absolute discretion be entitled to allow any third party/ies to participate either jointly or severally in the said rights, and JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors-in-title and its or their assigns shall furthermore, be entitled at all times to lease, cede and assign its/their rights wholly or in part to any third party/ies, either jointly or severally.

E. By virtue of Notarial Deed K5601/1990S the withinmentioned property is subject to a right in perpetuity to an area indicated by the figure ABCDEFGHJKLMA on diagram SG No. A2603/1990 in favour of ESKOM for the purpose of erecting powerlines, access roads and/or to lay cables, and all works necessary or ancillary thereto, as will more fully appear from reference to the said Notarial Deed.

2.3 **The following title conditions are recorded against Deed of Transfer T44389/1967 in respect of the Remaining Extent of Portion 52 of the farm LEEUWPOORT 113, Registration Division IR, Gauteng Province:**

A. The former Remaining Extent measuring as such 3271,3006 hectares is subject to a servitude in perpetuity in favour of the Town Council of Boksburg for the purpose of erecting an Electricity Sub-station together with ancillary rights as will more fully appear from Notarial Deed of Servitude No. 509/1958S.

B. The former Remaining Extent measuring as such 3252,9504 hectares is subject to a servitude in perpetuity in favour of the Town Council of Boksburg for the purpose of erecting an Electricity sub-station together with ancillary rights as will more fully appear from Notarial Deed of Servitude No. 1349/1959S.

C. The former Remaining Extent measuring as such 2764,9172 hectares is subject to a servitude for the conveyance of electricity and electricity sub-station in favour of the Town Council of Boksburg together with ancillary rights as will more fully appear from Notarial Deed No. 1080/1967S.

D. (1) All rights to minerals, metals and mineral substances of every kind whatsoever, whether precious or base, nothing excepted and without in any way limiting the generality thereof, including those of vegetable and animal origin such as coal, oil shale, torbanite, lime and limestone, and also including sand, stone and clay, and precious and semi-precious stones in, on and under the land, together with all such ancillary and other rights as may attach or accrue thereto or to the holder thereof under the common law and/or statute law, shall be and they are hereby reserved to JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED, and its successors-in-title to such rights or to its or their assigns, including the rights to any mynpacht or any mining lease in respect of the mining exploitation and/or removal of the said minerals, metals and mineral substances, and including further all rights, royalties and accruals which are or may be made or allowed by law tot eh holder of the mineral rights, as will more fully appear from reference to Certificate of Rights to Minerals K643/1969 R.M.

(2) Should the freehold owner or its successors in title or assigns or its or their tenants or any others claiming by, through or under it or them, suffer any loss, damage or injury by reason of any subsidence, settlement, shocks or cracking arising from past, present or future mining operations on or under the land, or in the vicinity thereof, or in the event of there being any disturbance or interference in the peaceful and quiet enjoyment of the land due to any such mining operations, then none of them shall have any recourse, remedy, action or claim whatsoever against JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED and/or its successors-in-title or assigns, or any other persons conducting mining operations on or under the land, for such loss, damage or injury, the freehold owner, on behalf of itself, its successors-in-title or assigns, and its or their tenants and/or any others claiming by, through or under it or them, hereby accepting all risk of such loss, damage or injury, and JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors-in-title and its or their assigns, lessees, licencees or tributors, subject to compliance with any law governing mining operations, shall not be prevented, by reason of any such loss, damage or injury from continuing mining operations on or under the land, or in the vicinity thereof.

(3) All rights which may be or become vested in the freehold owner of the land to receive or to share in any income or proceeds which may accrue to the State from or in respect of the disposal or working of any of the undermining rights of the land or in terms of any law, and without limiting the generality thereof, including any share of claim or other licence monies, rentals, profits or dues which may accrue to any such owner under or by virtue of any mineral lease, mining lease or mynpacht or the like granted in respect of the land or the minerals therein, shall be and they are hereby reserved to JOHANNESBURG

CONSOLIDATED INVESTMENT COMPANY and its successors in title to such rights and its or their assigns as will more fully appear from reference to Certificate of Real Rights K1613/1967 S.

(4) The aforegoing conditions D (1) to (3) are made and imposed for the benefit of and shall be enforceable, or may be waived or relaxed by JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors in title tot eh rights as contained therein, or to the right to enforce the said conditions, and its or their assigns and it/they shall at all times in their absolute discretion be entitled to allow any third party/ies to participate either jointly or severally in the said rights, and JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors-in-title and its or their assigns shall furthermore, be entitled at all times to lease, cede and assign its/their rights wholly or I part to any third party/ies, either jointly or severally.

E. **SUBJECT** to the condition that Portion of the property hereby transferred, represented by the figure lettered D E F G H J S K on diagram S.G. No. A. 7044/1966 in respect of Portion 52 of the aforesaid farm and which is attached hereto shall not, without the written consent of JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors-in-tite to the right to enforce this condition, or its or their assigns, first had and obtained, be used for any purpose whatsoever other than as a public park and/or for recreation facilities under the control of the Local Authority in perpetuity

F. By virtue of Notarial Deed K5601/1990S the withinmentioned property is subject to a right perpetuity to an area indicated by the figure ABCDEFGHJKLMA on diagram SG No. A2603/1990 in favour of ESKOM for the purpose of erecting powerlines, access roads and/or to lay cables, and all works necessary or ancillary thereto, as will more fully appear from reference to the said Notarial Deed.

2.4 **The following title conditions are recorded against Deed of Transfer T3884/1998 in respect of Portion 102 of the farm LEEUWPOORT 113, Registration Division IR, Gauteng Province:**

1. By virtue of Certificate of Rights to Minerals No. K155/1998 R.M. the reservation of all rights to minerals, metals and mineral substances of every kind whatsoever, whether precious or base, nothing excepted and without in any way limiting the generality thereof, including those of vegetable and animal origin such as coal, oil, oil shale, torbanite, lime and limestone and also including fire-clay, sand, stone or clay, precious and semi-precious stones as also the rights of working them, provided that the freehold owner of the land shall be entitled to use such reasonable quantities of sand stone and brickmaking clay as it may from time to time bona fide require for building purposes on the land , but subject always to such use not in any way restricting or interfering with the exercise by the transferor and its successors in title to such rights, or its or their assigns of its/their said rights, which shall at all times have and enjoy priority over the rights of the freehold owner, and other ancillary rights necessary and incidental to such workings, including the right to any Mynpacht or any Mining Lease in respect of the mining, exploitation and/or removal of the said minerals, metals and mineral substances, and including further all rights, royalties and accruals which are or may be made or allowed by

law to the holder of the mineral rights, in favour of JOHNNIES INDUSTRIAL CORPORATION LIMITED, its successors in title or assigns.

2. By virtue of Certificate of Real Rights No. K295/1998S, all rights which may be or become vested in the Freehold Owner to share in any income or proceeds which may accrue to the State or in respect of the disposal or working of any of the undermining rights of the property or in terms of any law and without limiting the generality thereof, including any share of claim or other licence moneys, rentals profits or dues which may accrue under or by virtue of any Mineral Lease, Mining Lease, Mynpacht or the like granted in respect of the property or the minerals in and upon the land are reserved to Johnnies Industrial Corporation Limited, its successors in title or assigns.

3. The former remaining extent of the said farm Leeuwpoort 113, measuring 3271,3106 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K509/1958S subject to a servitude in perpetuity over an area of land 89 square metres in favour of the Town Council of Boksburg for purposes of constructing a Transformer house, as will more fully appear from reference to the said Notarial Deed.

4. The former remaining extent of the said farm Leeuwpoort 113 measuring 3252,9503 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K1349/1959S subject to a servitude in perpetuity for the purpose of erecting an electricity substation with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

5. The former remaining extent of the said farm Leeuwpoort 113, measuring 3228,0373 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K108/1967S subject to a servitude for the conveyance of electricity and substation, with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

6. The former remaining extent of the said farm Leeuwpoort 113, measuring 2616,6550 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K184/1973S subject to a servitude in perpetuity to convey and transmit water by means of pipelines in favour of the Rand Water Board as will more fully appear from reference to the said Notarial Deed and diagram.

7. The former remaining extent of the said farm Leeuwpoort 113, measuring 2616,6550 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K568/1973S subject to a servitude in perpetuity to construct, reconstruct, use, maintain, repair, lay, re-lay, alter, inspect and remove overhead electric power lines in favour of ESKOM, as shown by the letters ABCDE and FGHJ and KLMNOP on Diagram S.G. No. A6438/1970, together with ancillary rights, as will more fully appear from the said Notarial Deed and Diagram.

8. The former remaining extent of the said farm Leeuwpoort 113, measuring 2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3132/1984S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights and subject to conditions, as will more fully appear from reference to the said Notarial Deed.

9. The former remaining extent of the said farm Leeuwpoort 113, measuring 2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3133/1984S subject to a servitude to convey electricity in favour of ESKOM, together with ancillary rights, and subject to conditions, as will more fully appear on reference to the said Notarial Deed.

10. The former remaining extent of the said farm Leeuwpoort 113, measuring 1931,2949 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K4455/1987S subject to a servitude to convey electricity in favour of ESKOM, together with ancillary rights, and subject to conditions as will more fully appear on reference to the said Notarial Deed.

11. The former remaining extent of the said farm Leeuwpoort 113, measuring 1918,6408 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K2213/1990S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights and subject to conditions, as will more fully appear from reference to the said Notarial Deed and Diagram

12. The former remaining extent of the said farm Leeuwpoort 113, measuring 1811,9393 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K5731/1993S subject to a perpetual right of way servitude for water main purposes and other municipal services, in favour of the City Council of Boksburg, 3 metres wide, as shown on Diagram S.G. No. A11288/1992 defined by the lines ABC, DE, FG, HJ, together with ancillary rights, and subject to conditions, as will more fully appear from reference to the said Notarial Deed.

13. The former remaining extent of the said farm Leeuwpoort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deeds K4132/1994S, K4133/1994S, and K4134/1994S subject to a powerline servitude in favour of ESKOM with ancillary rights and subject to conditions as will more fully appear from reference to the said Notarial Deed.

14. Aangesien die grond deel vorm van 'n gebied wat ondermyn staan te word en onderhewig mag wees aan versakking, vassakking, skokke en krake weens, mynbedrywighede in die verlede, die hede of in die toekoms aanvaar die eienaar alle verantwoordelikheid vir enige skade aan die grond of geboue daarop as gevolg van sodanige versakking, vassakking, skokke of krake.

15. Aangesien hierdie erf (standplaas, grond, ens.) in die nabyheid van 'n verkende mynskag geleë is, aanvaar die eienaar daarvan dat daar 'n mate van ongerief soverdit stofbesoedeling en geraas betref, as gevolg van die werking van die skag, ondervind mag word.

SUBJECT FURTHER to the following conditions imposed and enforceable by JOHNNIES INDUSTRIAL CORPORATION LIMITED NO. 1901/000429/06

16. The said property is proclaimed land and as such is subject to the provisions of Act 20 of 1967 (Mining Rights Act) now or hereafter to be in force affecting the said property, and subject to all mining titles and all rights attaching to them and issued or held under Act 20 of 1967, on and under the area of the said property.

17. Should the owner or their successors in title or assigns or its tenants or any other claiming by, through or under it suffer any loss, damage or injury by reason of any subsidence, settlement, shocks or cracking arising from the past, present or future mining operations on or under the land, or in the vicinity thereof, or in the event of there being any disturbance or interference in the peaceful and quiet enjoyment of the land due to any such mining operations, then none of them shall have any recourse, remedy, action or claim whatsoever against JOHNNIES INDUSTRIAL CORPORATION LIMITED (No. 1901/000429/06) and/or its successors in title or assigns, or any other person conducting mining operations on or under the property, for such loss, damage or injury, the owner on behalf of itselves, its successors in title or assigns and its

tenants and/or any other claiming by, through or under it or then, hereby accepting all risks or such loss, damage or injury, and the transferor or its successors in title and its or their assigns, lessees, licensees or tributors subject to compliance with any law governing mining operations, shall not be prevented, by reason of any such loss, damage or injury, from continuing mining operations on or under the property, or in the vicinity thereof.

18. No noxious industry of any nature shall be established or conducted on the property. "Noxious industry" shall mean anything injurious to the health of or offensive or a nuisance to other registered owners or occupiers of property in the vicinity.

19. The transferor reserves to itself, as owner of the Remaining Extent of the said Farm Leeuwpoort No. 113, Registration Division I.R., the Province of Gauteng of which the property hereby transferred forms part, and its successors in title thereto or its or their assigns, the sole and exclusive right to any servitudes or other privileges, whether registered or not, which may at any time have been imposed on any property in favour of the owner of the said Remaining Extent , and by benefits derived thereon, and the freehold owner and his heirs, executors, administrators or assigns shall not be entitled to participate therein except to the extent , if any, as may from time to time be permitted by the transferor or its successors in title or its or their assigns in its/their absolute discretion.

20. (a) The said transferee shall not without the prior written consent of the transferor use the said property for any purposes other than that of a water supply reservoir.

(b) Should the transferee at some future date desire to remove the restrictive conditions set out in clause 20(a) above and should the transferor consent thereto, then an additional consideration shall be payable by the transferee to the transferor equal to the difference between the purchase price as set out in the Deed and the market value that the said property would have after the removal of the said restrictive conditions. If the transferor and transferee should fail to agree upon the said market value, the market value shall be the average of two valuations by registered valuers one of whom shall be appointed by the transferor and one by the transferee.

21. The transferor includes it Successors in Title or Assigns.

22. The conditions contained in the aforegoing paragraphs 16 to 20 inclusive are imposed for the benefit of and shall be enforceable by the transferor or its successors in title or assigns to the rights as contained therein and they shall at all times in its/their absolute discretion be entitled to allow any person, company or concern jointly or severally to participate in the said rights and the transferor or its successors in title shall in addition at all times be entitled to cede or assign the said rights wholly or in part to any person, company or concern, either jointly or severally.

23. The former remaining extent of the Farm Leeuwpoort 113, measuring 3271,3106 hectares, a portion whereof is hereby transferred is subject to Mynpacht Brief 385 in terms of Section 21(c) of Act 35 of 1908.

3. Disposal of title conditions

The land surveyor attending to the general plan for the proposed township must plot the servitudes and issue a certificate to determine -

- which servitudes affect the land
- which servitudes do not affect the land through the situation thereof

If the servitudes affect the land through the situation thereof, this fact must be disclosed in the conditions of establishment for this township and the stands in the township affected thereby, must be made subject to these servitudes.

If the servitudes do not affect the land through the situation thereof, this fact must be disclosed in the conditions of establishment for this township and these servitudes will then not be carried forward to the title deeds of the erven in this township.

3.1 **Disposal of the title conditions relating to the Remaining Extent of the farm Leeuwpoort 113, Registration Division I.R., Gauteng Province as depicted in Deed of Transfer T82017/2001:**

3.1.1 Conditions 1, 2, 16 and 23 relate to servitudes in favour of the Ekurhuleni Metropolitan Municipality in perpetuity for the purpose of erecting electric substations, conveyance of electricity and the construction of a transformer house.

If these servitudes affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by these servitudes.

If these servitudes do not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that these title conditions will not be carried forward to the title deeds of the erven in the township.

3.1.2 Conditions 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, and 17 relate to servitudes over the property in favour of ESKOM to convey electricity over the property.

If these servitudes affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by these servitudes.

It these servitudes do not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that these title condition will not be carried forward to the title deeds of the erven in the township.

3.1.3 Conditions 12, 18, 20, 21 and 25 relate to servitudes for water main purposes, sewerage purposes as well as stormwater and municipal purposes in favour of the Ekurhuleni Metropolitan Municipality

If these servitudes affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by these servitudes.

If these servitude do not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that these title conditions will not be carried forward to the title deeds of the erven in the township

3.1.4 Conditions 19, 22 and 27 relate to servitudes in favour of RAND WATER BOARD to convey and transmit water over the property.

If these servitudes affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by this servitude.

If these servitudes do not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that these title conditions will not be carried forward to the title deeds of the erven in the township.

3.1.5 Conditions 24 and 26 relate to servitudes in favour of DIE SUID AFRIKAANSE GASDISTRIBUSIEKORPORASIE BEPERK to transmit gas by means of a pipeline or pipelines over the property.

If these servitudes affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by these servitudes.

If these servitudes do not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that these title conditions will not be carried forward to the title deeds of the erven in the township

3.2 **Disposal of the title conditions relating to the Remaining Extent of Portion 51 of the farm Leeuwpoort 113, Registration Division I.R., Gauteng Province as depicted in Deed of Transfer T44389/1967:**

3.2.1 Conditions A, B, and C relate to servitudes in favour of the Ekurhuleni Metropolitan Municipality in perpetuity for the purpose of erecting electric substations, conveyance of electricity and the construction of a transformer house.

Deed of Transfer T44389/1967 was endorsed on page 8 thereof to indicate that conditions A,B and C have lapsed by merger because these servitudes, which were registered in favour of the local authority, are reflected in a title deed where the local authority is also the owner of the land. Despite this fact, these servitudes must still be considered and accommodated for township establishment purposes.

If these servitudes affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by these servitudes.

If these servitudes do not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that these title conditions will not be carried forward to the title deeds of the erven in the township.

3.2.2 Conditions D (1) to D (4) relate to the reservation of rights to minerals and real rights in favour of JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED.

These title conditions must be carried forward to the title deeds of the erven in the proposed township establishment area.

3.2.3 Condition E relates to a servitude in favour of ESKOM to convey electricity over the property.

If this servitude affects the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by this servitude.

It this servitude does not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that this title condition will not be carried forward to the title deeds of the erven in the township.

3.3 **Disposal of the title conditions relating to the Remaining Extent of Portion 52 of the farm Leeuwpoort 113, Registration Division I.R., Gauteng Province as depicted in Deed of Transfer T44389/1967:**

3.3.1 Conditions A, B and C relate to servitudes in favour of the Ekurhuleni Metropolitan Municipality in perpetuity for the purpose of erecting electric substations, conveyance of electricity and the construction of a transformer house.

If these servitudes affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by these servitudes.

If these servitudes do not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that these title conditions will not be carried forward to the title deeds of the erven in the township.

3.3.2 Conditions D (1) to D (4) relate to the reservation of rights to minerals and real rights in favour of JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED.

These title conditions must be carried forward to the title deeds of the erven in the proposed township establishment area.

3.3.3 Condition E relates to a servitude that limits the use of the property to the use as a public park and/or for recreational facilities

The written consent of the JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors-in-title to enforce this title condition must be obtained to use the property for a purpose other than that of a public place and/or for recreational purposes.

3.3.4 Condition F relates to a servitude in favour of ESKOM to erect powerlines, access roads and to lay cables.

If this servitude affects the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by this servitude.

If this servitude does not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that this title condition will not be carried forward to the title deeds of the erven in the township.

3.4 **Disposal of the title conditions relating to Portion 102 of the farm Leeuwpoort 113, Registration Division I.R., Gauteng Province as depicted in Deed of Transfer T3884/1998:**

3.4.1 Conditions 1 and 2 relate to the reservation of rights to minerals and real rights in favour of JOHNNIES INDUSTRIAL CORPORATION LIMITED

These title conditions must be carried forward to the title deeds of the erven in the proposed township establishment area.

3.4.2 Conditions 3,4,5 and 12 relate to servitudes over the property in favour of the EKURHULENI METROPOLITAN MUNICIPALITY for an electrical substation, conveying of electricity, right of way and other municipal purposes.

If these servitudes affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by these servitudes.

If these servitudes do not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that these title conditions will not be carried forward to the title deeds of the erven in the township.

3.4.3 Condition 6 relates to a servitude to convey and transmit water by means of pipelines in favour of RAND WATER BOARD.

If this servitude affects the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by this servitude.

If this servitude does not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that this title condition will not be carried forward to the title deeds of the erven in the township.

3.4.4 Condition 7, 8, 9, 10, 11 and 13 relate to servitudes in favour of ESKOM to convey electricity over the property.

If these servitudes affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate which erven are affected by these servitudes.

If these servitudes do not affect the proposed township establishment area through the situation thereof, the conditions of establishment must indicate that these title conditions will not be carried forward to the title deeds of the erven in the township.

3.4.5 Conditions 14, 15, 16, 17, 18, 19, 20, 21 and 22 relate to servitudes regarding inconvenience caused by mining activities.

These title conditions must be carried forward to the title deeds of the erven in the proposed township establishment area.

However, condition 20(a) relates to the fact that the property can only be used for a water supply reservoir. If the property will be required for any other purpose, JOHNNIES INDUSTRIAL CORPORATION LIMITED must give its consent to the new use of the property.

3.4.6 Condition 23 relates to a Mynpacht Brief.

This title condition must be dealt with as indicated in the letter to be issued by the Mining Rights Title Office in Pretoria.

4. Particulars of the Registered Owner

4.1 EKURHULENI METROPOLITAN MUNICIPALITY is the registered owner of:

4.1.1 Remaining Extent of the farm LEEUWPOORT 113
Registration Division IR, Gauteng Province
Measuring 1340,1747 (One Thousand Three Hundred and Forty Comma One Seven Four Seven) hectares
Held by virtue of Deed of Transfer T82017/2001

4.1.2 Remaining Extent of Portion 51 of the farm LEEUWPOORT 113
Registration Division IR., Gauteng Province
Measuring 12,1194 (Twelve comma One One Nine Four) hectares
Held by Deed of Transfer T44389/1967

4.1.3 Remaining Extent of Portion 52 of the farm LEEUWPOORT 113
Registration Division IR., Gauteng Province
Measuring 4,1973 (Four comma One Nine Seven Three) hectares
Held by Deed of Transfer T44389/1967

4.1.4 Portion 102 of the farm LEEUWPOORT 113
Registration Division IR., Gauteng Province
Measuring 2,6281 (Two comma Six Two Eight One) hectares
Held by Deed of Transfer T3884/1998

5. Particulars of the Township Applicant

EKURHULENI METROPOLITAN MUNICIPALITY

6. Particulars of the Local Authority

EKURHULENI METROPOLITAN MUNICIPALITY

7. Holder of the Rights of Minerals

Section 3(1) of the Mineral and Petroleum Resources Development Act, 2002 (No 28 of 2002) states that from 1 May 2004 the State became the custodian of all mineral resources.

The State, acting through the Minister of Minerals and Energy, must consent to this township development and Ms Thandiwe Biyela (Tel (011) 358-9791 / 082 586 6203) of the Department of Minerals and Energy in Braamfontein must be approached in this regard.

8. Conveyancing steps to be followed before or simultaneously with the opening of the township register

8.1 Registration of a Certificate of Registered Title in respect of each of the subdivisions of the affected portions of land.

8.2 Registration of a Certificate of Consolidated Title in respect of all the subdivision of the affected portions of land and other components that compose the total of the land on which the township will be established.

8.3 Application for the opening of the township register and the registration of the General Plan

SIGNED at RANDBURG on the 30 October 2006

CONVEYANCER

ANNEXURE J

URBAN DYNAMICS

LAND SURVEYOR CERTIFICATE

URBAN DYNAMICS
LAND SURVEYORS

Our Ref: 1882 Your Ref: Date: 8 November 2006

SERVITUDE CERTIFICATE

In respect of the proposed Leeuwpoort Development, situated on the Remainder of the Farm Leeuwpoort 113 JR, Portions 51, 52 and 102 of the farm Leeuwpoort 113 IR.

1 <u>The Remainder of the farm Leeuwpoort 113 IR, held by Deed of Transfer No. T8201/2001</u>

Servitudes which affect the land and the township:

1. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3132/1984S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights and subject to conditions, as will more fully appear from reference to said Notarial Deed.

2. By virtue of Notarial Deed of Route Description K5562/1999S, the exact Route of the right in favour of ESKOM to convey electricity as reserved vide K3132/1984S is now defined as follows:

   The centre line of the overhead transmission line with underground cables traverses the abovementioned property along the route indicated by the line ABCD on the annexed Diagram S.G. No. A3530/1998, the extent and width of the servitude being 11 (ELEVEN) metres on each side of the said line as will more fully appear from the said Notarial Deed of Route Description with the Diagram annexed thereto.

3. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3133/1984S subject to a servitude to convey electricity in favour of ESKOM, together with ancillary rights, subject to conditions, as will more fully appear on reference to the said Notarial Deed.

4. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1931,2940 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K4455/1987S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights and subject to conditions as will more fully appear on reference to the said Notarial Deed.

5. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1918,6408 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K2213/1990S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights subject to conditions, as will more fully appear on reference to the said Notarial Deed.

Xan Swart Land Surveyors (PTY) LTD Reg. No. 97/13130/07
X Swart B Landm. (PTA) L.S.A.L.L.
P O Box 17324 GROENKLOOF 0027; Tel: 012-346 3787/8; Fax: 012-346 2308
e-mail: landplan@mweb.co.za

6. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K4132/1994S subject to a power line servitude in favour of ESKOM with ancillary rights and subject to the conditions as will more fully appear from reference to the said Notarial Deed.

7. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K4133/1994S subject to a power line servitude in favour of ESKOM with ancillary rights and subject to the conditions as will more fully appear from reference to the said Notarial Deed.

8. The former remaining extent of the said Farm Leadwort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notaries Deed K4134/1994S subject to a power line servitude in favour of ESKOM with ancillary rights and subject to the conditions as will more fully appear from reference to the said Notaries Deed.

9. By Notaries Deed of Servitude No. K3354/1996S the withinmentioned property is subject to a servitude for electrical purposes in favour of the Council, together with ancillary rights, 2 meters, the centre line of which being indicated by the line xy on Diagram S.G. No. 7523/1995 annexed thereto.

10. By Notarial Deed of Servitude No. K1042/1993S the withinmentioned property is subject to a servitude in favour of ESKOM to convey electricity over the property together with ancillary rights and subject to conditions as will more fully appear from reference to the said Notarial Deed.

11. By Notarial Deed of Servitude No. K1041/1993S the withinmentioned property is subject to a servitude for sewerage purposes 2 (TWO) meters wide as indicated by ABCDEFGHJKLMNOPQRSTUVWXYZ on Diagram S.G. No. 5838/1991 with ancillary rights.

12. By virtue of Notarial Deed K1636/1971S the withinmentioned property is subject to a servitude in perpetuity in favour of the Transitional Local Council of Boksburg to use a strip of ground for sewerage purposes which strip is defined by the letters ABCDEFGHJKLMNOPQRSTUVWX on Diagram S.G. No. A6440/1970 annexed thereto.

13. By Notarial Deed K184/1973S the remaining extent of the Farm Leeuwpoort is subject to a servitude in favour of RAND WATER BOARD for the right to convey and transmit water by way of pipelines laid across a strip of ground, 16 (SIXTEEN) metres wide, the centre line of which is represented by the figure ABCDE on Diagram S.G. No. A6437/1970 annexed thereto.

Servitudes which affect the land but not the township:

1. The former remaining extent of the said Farm Leeuwpoort 113, measuring 3252,9503 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K1349/1959S subject to a servitude in perpetuity for the purpose of erecting an electricity substation with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

2. The former remaining extent of the said Farm Leeuwpoort 113, measuring 3226,0373 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K1080/1967S subject to a servitude for the conveyance of electricity and substation with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

3. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2616,6550 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K568/1973S subject to right in perpetuity to construct, reconstruct, use, maintain, repair, lay, re-lay, alter, inspect and remove overhead electric power lines in favour of ESKOM as shown by the letters ABCDE and FGHJ and KLMNOP on Diagram S.G. No. A6438/1970 together with ancillary rights, as will more fully appear from the said Notarial Deed and Diagram.

4. The former remaining extent of the said Farm Leeuwpoort 113, measuring 2133,4632 hectares, of which the property transferred forms a portion, is by virtue of Notarial Deed K2077/1980S subject to a servitude in perpetuity to convey electricity across the said property by means of one transmission line consisting of wires or cables and/or other appliances underground or overhead I in favour of ESKOM together with ancillary rights.

5. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1942,7660 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K1665/1985S subject to a servitude in favour of ESKOM, its successors and assigns of licensees the right in perpetuity to convey electricity across the said property by means of underground cables or other appliances laid under the surface of the ground, together with ancillary rights as defined by the line AB on diagram S.G. No. A7493/1982 as will more fully appear from reference to the said Notarial Deed.

6. By virtue of Notarial Deed of Route Description K3814/1993S, the exact Route to convey electricity as reserved in favour of ESKOM vide Notarial Deed K2213/1990S is now indicated by the figure ABCDEFA on Diagram S.G. No. A2620/1990 which area is 34 (THIRTY FOUR) Square Metres as will more fully appear from the said Notarial Deed of Route Description with the Diagram annexed thereto.

7. The former remaining extent of the said Farm Leeuwpoort 113, measuring 1811,9393 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K5731/1993S, subject to perpetual right of way servitude for water main purposes and other municipal services in favour of the City Council of Boksburg, 3 metres wide as shown on Diagram S.G. No. A11288/1992 defined by the lines ABC, DE, FG, HJ together with ancillary rights, and subject to the conditions, as will more fully appear from reference to the said Notarial Deed.

8. Subject to Deed of Servitude No. K788/1976 in favour of the RAND WATER BOARD represented by the figures ABCDEFG on Diagram S.G. No. A6297/1974.

9. By Notarial Deed K1637/1971S the withinmentioned property is subject to a servitude in favour of the City Council of Greater Germiston in perpetuity to use a strip of ground for sewerage, stormwater and municipal purposes which strip is more fully described by the letters ABCDEFGHJKLMNOPQRSTUV on Diagram S.G. No. A6439/1970 which diagram is annexed to the said Notarial Deed.

2 **Portion 51, held by Deed of Transfer No. 44389/1967**

Servitudes which affect the land and the township:

1. The former Remaining Extent measuring as such 3271,3006 hectares is subject to a servitude in perpetuity in favour of the Town Council of Boksburg for the purpose of erecting an Electricity Sub-station together with ancillary rights as will more fully appear from Notarial Deed of Servitude No. 509/1958S.

2. The former Remaining Extent measuring as such 3252,9504 hectares is subject to a servitude in perpetuity in favour of the Town Council of Boksburg for the purpose of erecting an Electricity sub-station together with ancillary rights as will more fully appear from Notarial Deed of Servitude No. 1349/1959S.

3. The former Remaining Extent measuring as such 2764,9172 hectares is subject to a servitude for the conveyance of electricity and electricity sub-station in favour of the Town Council of Boksburg together with ancillary rights as will more fully appear from Notarial Deed No. 1080/1967S.

4. By virtue of Notarial Deed K5601/1990S the withinmentioned property is subject to a right in perpetuity to an area indicated by the figure ABCDEFGHJKLMA on diagram SG No. A2603/1990 in favour of ESKOM for the purpose of erecting powerlines, access roads and/or to lay cables, and all works necessary or ancillary thereto, as will more fully appear from reference to the said Notarial Deed.

Servitudes which affect the land but not the township:

1. All rights to minerals, metals and mineral substances of every kind whatsoever, whether precious or base, nothing excepted and without in any way limiting the generality thereof, including those of vegetable and animal origin such as coal, oil shale, torbanite, lime and limestone, and also including sand, stone and clay, and precious and semi-precious stones in, on and under the land, together with all such ancillary and other rights as may attach or accrue thereto or to the holder thereof under the common law and/or statute law, shall be and they are hereby reserved to JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED, and its successors-in-title to such rights or to its or their assigns, including the rights to any mynpacht or any mining lease in respect of the mining exploitation and/or removal of the said minerals, metals and mineral substances, and including further all rights, royalties and accruals which are or may be made or allowed by law to the holder of the mineral rights; as will more fully appear from reference to Certificate of Rights to Minerals K643/1967 RM

2. Should the freehold owner or its successors in title or assigns or its or their tenants or any others claiming by, through or under it or them, suffer any loss, damage or injury by reason of any subsidence, settlement, shocks or cracking arising from past, present or future mining operations on or under the land, or in the vicinity thereof, or in the event of there being any disturbance or interference in the peaceful and quiet enjoyment of the land due to any such mining operations, then none of them shall have any recourse, remedy, action or claim whatsoever against JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED and/or its successors-in-title or assigns, or any other persons conducting mining operations on or under the land, for such loss, damage or injury, the freehold owner, on behalf of itself, its successors-in-title or assigns, and its or their tenants and/or any others claiming by, through or under it or them, hereby accepting all risk of such loss, damage or injury, and

JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors-in-title and its or their assigns, lessees, licensees or tributors, subject to compliance with any law governing mining operations, shall not be prevented, by reason of any such loss, damage or injury from continuing mining operations on or under the land, or in the vicinity thereof.

3. All rights which may be or become vested in the freehold owner of the land to receive or to share in any income or proceeds which may accrue to the State from or in respect of the disposal or working of any of the undermining rights of the land or in terms of any law, and without limiting the generality thereof, including any share of claim or other licence monies, rentals, profits or dues which may accrue to any such owner under or by virtue of any mineral lease, mining lease or mynpacht or the like granted in respect of the land or the minerals therein, shall be and they are hereby reserved to JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY and its successors in title to such rights and its or their assigns as will more fully appear from reference to Certificate of Real Rights K1613/1967S

4. The aforegoing conditions D (1) to (3) are made and imposed for the benefit of and shall be enforceable, or may be waived or relaxed by JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors in title to the rights as contained therein, or to the right to enforce the said conditions, and its or their assigns and it/they shall at all times in their absolute discretion be entitled to allow any third party/ies to participate either jointly or severally in the said rights, and JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors-in-title and its or their assigns shall furthermore, be entitled at all times to lease, cede and assign its/their rights wholly or in part to any third party/ies, either jointly or severally.

3 <u>Portion 52 held by Deed of Transfer No. Y44389/1967</u>

Servitudes which affect the land and the township:

None.

Servitudes which affect the land but not the township:

SUBJECT to the condition that Portion of the property hereby transferred, represented by the figure lettered D E F G H J S K on diagram S.G. No. A. 7044/1966 in respect of Portion 52 of the aforesaid farm and which is attached hereto shall not, without the written consent of JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY LIMITED or its successors-in-tite to the right to enforce this condition, or its or their assigns, first had and obtained, be used for any purpose whatsoever other than as a public park and/or for recreation facilities under the control of the Local Authority in perpetuity

4 <u>Portion 102 of the farm Leeuwpoort held by Deed of Transfer T3884/1998</u>

Servitudes which affect the land and the township:

1. Aangesien die grond deel vorm van 'n gebied wat ondermyn staan te word en onderhewig mag wees aan versakking, vassakking, skokke en krake weens, mynbedrywighede in die verlede, die hede of in die toekoms aanvaar die eienaar alle verantwoordelikheid vir enige skade aan die grond of geboue daarop as gevolg van sodanige versakking, vassakking, skokke of krake.

2. Aangesien hierdie erf (standplaas, grond, ens.) in die nabyheid van 'n verkende mynskag geleë is, aanvaar die eienaar daarvan dat daar 'n mate van ongerief soverdit stofbesoedeling en geraas betref, as gevolg van die werking van die skag, ondervind mag word.

Servitudes which affect the land but not the township:

1. The former remaining extent of the said farm Leeuwpoort 113, measuring 3271,3106 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K509/1958S subject to a servitude in perpetuity over an area of land 89 square metres in favour of the Town Council of Boksburg for purposes of constructing a Transformer house, as will more fully appear from reference to the said Notarial Deed.

2. The former remaining extent of the said farm Leeuwpoort 113 measuring 3252,9503 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K1349/1959S subject to a servitude in perpetuity for the purpose of erecting an electricity substation with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

3. The former remaining extent of the said farm Leeuwpoort 113, measuring 3228,0373 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K108/1967S subject to a servitude for the conveyance of electricity and substation, with ancillary rights in favour of the Town Council of Boksburg as will more fully appear from reference to the said Notarial Deed.

4. The former remaining extent of the said farm Leeuwpoort 113, measuring 2616,6550 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K184/1973S subject to a servitude in perpetuity to convey and transmit water by means of pipelines in favour of the Rand Water Board as will more fully appear from reference to the said Notarial Deed and diagram.

5. The former remaining extent of the said farm Leeuwpoort 113, measuring 2616,6550 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K568/1973S subject to a servitude in perpetuity to construct, reconstruct, use, maintain, repair, lay, re-lay, alter, inspect and remove overhead electric power lines in favour of ESKOM, as shown by the letters ABCDE and FGHJ and KLMNOP on Diagram S.G. No. A6438/1970, together with ancillary rights, as will more fully appear from the said Notarial Deed and Diagram.

6. The former remaining extent of the said farm Leeuwpoort 113, measuring 2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3132/1984S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights and subject to conditions, as will more fully appear from reference to the said Notarial Deed.

7. The former remaining extent of the said farm Leeuwpoort 113, measuring 2020,0312 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K3133/1984S subject to a servitude to convey electricity in favour of ESKOM, together with ancillary rights, and subject to conditions, as will more fully appear on reference to the said Notarial Deed.

8. The former remaining extent of the said farm Leeuwpoort 113, measuring 1931,2949 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K4455/1987S subject to a servitude to convey electricity in favour of ESKOM, together with ancillary rights, and subject to conditions as will more fully appear on reference to the said Notarial Deed.

9. The former remaining extent of the said farm Leeuwpoort 113, measuring 1918,6408 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K2213/1990S subject to a servitude to convey electricity in favour of ESKOM together with ancillary rights and subject to conditions, as will more fully appear from reference to the said Notarial Deed and Diagram

10. The former remaining extent of the said farm Leeuwpoort 113, measuring 1811,9393 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deed K5731/1993S subject to a perpetual right of way servitude for water main purposes and other municipal services, in favour of the City Council of Boksburg, 3 metres wide, as shown on Diagram S.G. No. A11288/1992 defined by the lines ABC, DE, FG, HJ, together with ancillary rights, and subject to conditions, as will more fully appear from reference to the said Notarial Deed.

11. The former remaining extent of the said farm Leeuwpoort 113, measuring 1799,5460 hectares (a portion whereof is hereby transferred) is by virtue of Notarial Deeds K4132/1994S, K4133/1994S, and K4134/1994S subject to a powerline servitude in favour of ESKOM with ancillary rights and subject to conditions as will more fully appear from reference to the said Notarial Deed.

XAN SWART
PROFESSIONAL LAND SURVEYOR

ANNEXURE D1b
PROPOSED TOWNSHIP LAYOUT

PROJECT

PROPOSED TOWNSHIP

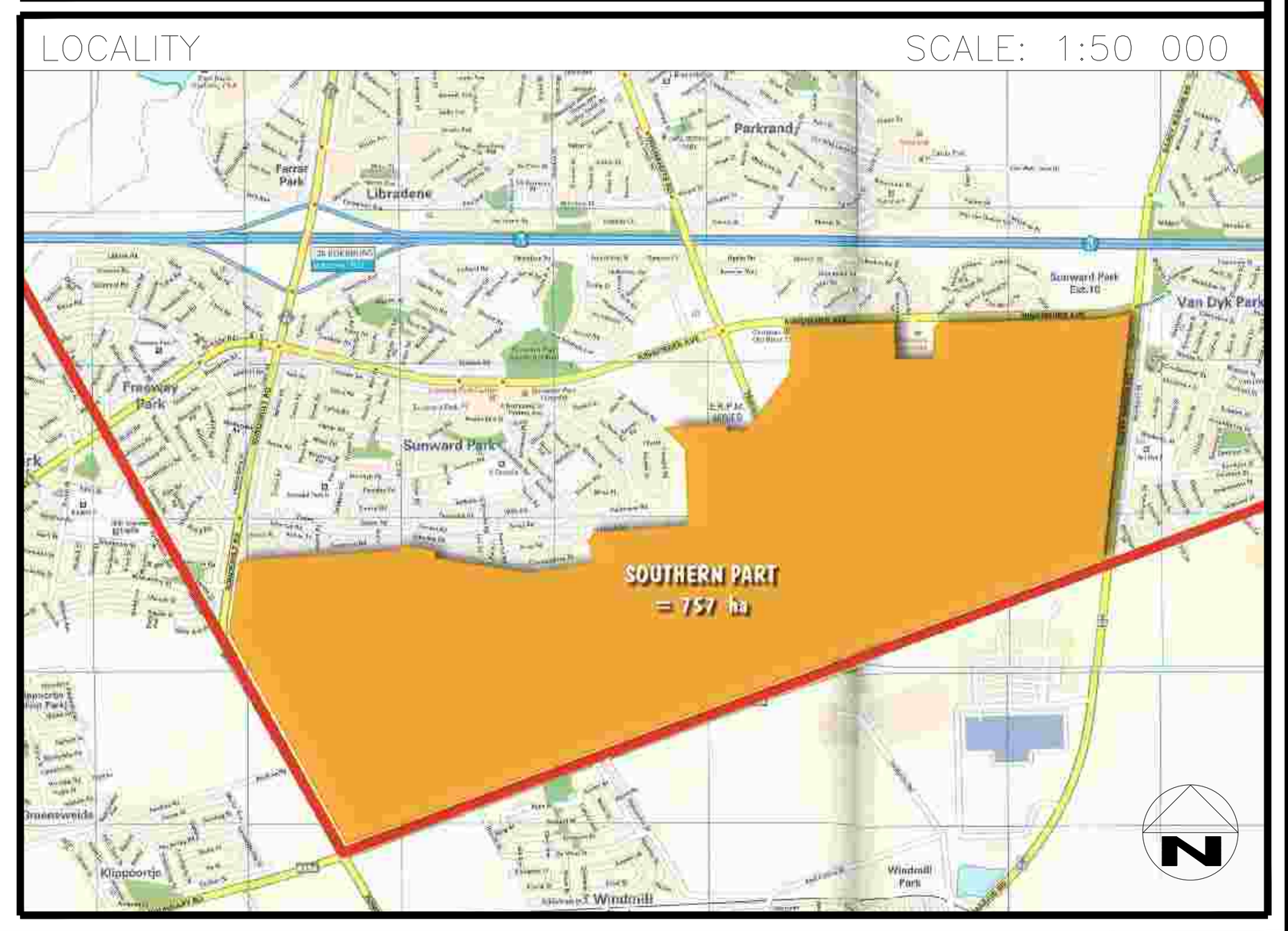
SUNWARD PARK EXTENSIONS 24 TO 29

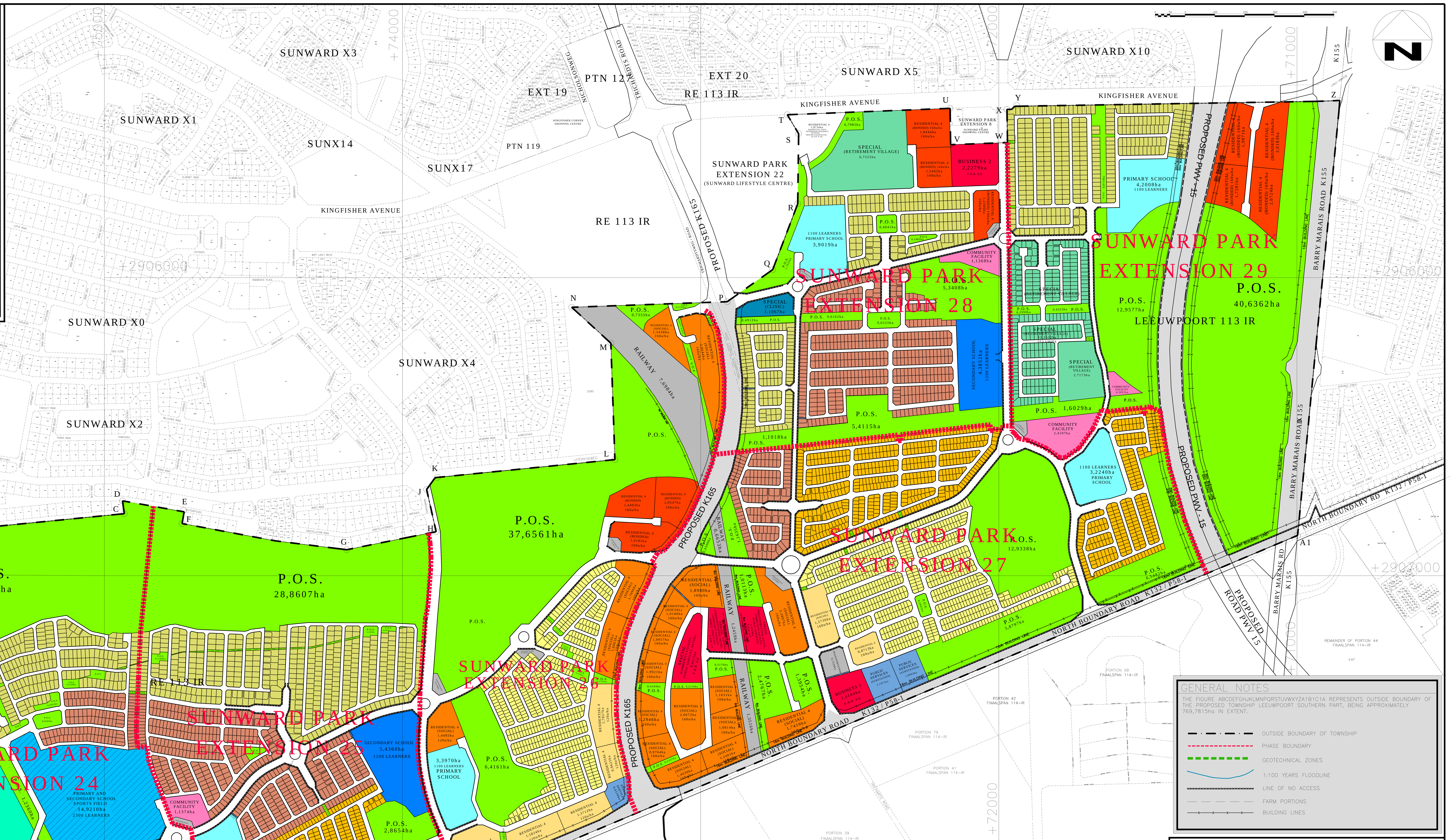
SITUATED ON THE REMAINDER OF THE FARM LEEUWPOORT 113 IR

LOCAL AUTHORITY : EKURHULENI METROPOLITAN MUNICIPALITY

GEODETICAL SYSTEM : WG 29

LOCALITY SCALE: 1:50 000





GENERAL NOTES

RESIDENTIAL SITES

The minimum width of panhandle accesses is 3m. Splays on panhandle erven are 3mx3m.

ROADS

Reserve widths of all internal streets are indicated on the plan. Splays on all Class 5 streets are 5mx5m, and a class 4 streets are 10 x 10m.

Maximum slope on roads is 1:28
Minimum slope on roads is 1:131

CONTOURS

The contours on this plan are in accordance with the stipulations of Regulation 18(1)(a)(1) of the Town Planning– and Townships Ordinance, Ord. 15 of 1986. The contours on this plan were obtained from

XAN SWART 4/8/16

CO-ORDINATES

The Co–ordinate reference is based on WG 29 system. Baseplan mapping was done by

XAN SWART .... date 4/8/16

DIMENSION AND SIZES

All dimensions shown on the plan are approximate, scaled in meters and subject to final survey.

FLOODWATER

It is hereby certified that in accordance with section 144 of the national water act (Act 36 of 1998) that the floodline shown indicates the maximum level likely to be reached by floodwater on average once every 100 years.

.... CONSULTING ENGINEER BIGEN AFRICA .... date

GEOLOGICAL

It is hereby certified that the layout of the township complies with the recommendations and requirements set out in the geotechnical report no. IR801 Soils & IR801R dated November 2006.

Engineering Geologist ..... DAVE BUTTRICK

Firm ..... INTRACONSULT

DOLOMITE STABILITY ZONE	APPROPRIATE DEVELOPMENT
D1	Residential (no density constraints), commercial or light (dry) industrial development.
D2	Residential (max. 40–60 units/ha), commercial or light (dry) industrial development.
D3	Residential, commercial or light (dry) industrial development. Minimum stand size 300m².
D4	Selected commercial or light (dry) industrial. No residential development. SANS10400 only allows for very selected commercial development in this risk class.

DOLOMITE AREA DESIGNATION D	DESCRIPTION
D1	No precautionary measures are required to permit the construction of housing units due to the geological setting.
D2	The risk of sinkhole and doline formation is adjudged to be such that only general precautionary measures, which are intended to prevent the concentrated ingress of water into the ground, are required to permit the construction of housing units.
D3	The risk of sinkhole and doline formation is adjudged to be such that precautionary measures, in addition to those pertaining to the prevention of concentrated ingress of water into the ground, are required to permit the construction of housing units
D4	The risk of sinkhole and doline formation is such that precautionary measures cannot adequately reduce the risk to acceptable limits so as to permit the construction of housing units, or the precautionary measures which are required impracticable to implement.

GFSH-2 PHASE 1 SITE CLASS (DRAWING IR801/S)	COMMENTARY ON NEAR-SURFACE (SOIL) CONDITIONS
3W	No development: Land areas below 1:100 year floodlines (note: floodlines require verification, 3W areas shown in blue).
2/3E	Old borrow areas. Require rehabilitation (usually extensive) prior to development.
2(R3)[H–H1/C–C1/S]	Developable with precautions: Anticipate potentially active and collapsible soils and near surface (occasional) difficult excavation conditions (0,0 to 1,5m profile).
2(H–2H3/C/S1–S2)	Developable with precautions: Anticipate variable thickness of potential (highly) active and compressible soils.
3D4	Dolomitic Sub–Area: No Residential Development
2PD3(R3) [H1–H2/C/S]	Developable with precaution: Dolomitic Sub–Area (see IR801/R). Anticipate variable thickness of potentially heave/shrink soils and near–surface (occasional) difficult excavation conditions (0,0 – 1,5m profile).
2PD2/D3(R3) {H1–H2/C/S)	Developable with precaution: Dolomitic Sub–Area (see IR801/R). Anticipate variable thickness of potentially heave/shrink soils and near–surface (occasional) difficult excavation conditions (0,0 – 1,5m profile).
2(R3)[H1–H2/C/S]	Developable with precautions. Anticipate variable thickness of potentially heave/shrink soils and near surface (occasional) difficult excavation conditions (0,0 – 1, 5m) profile.
2(R3)[H1/C/S]	Developable with precautions. Near surface difficult excavation conditions in 0.0 to 1.5m profile.
2(R3)[H1/C/S]	Developable with precautions. Anticipate potentially heave/shrink soils and near–surface (occasional) difficult excavation conditions in 0.0 to 1.5m profile.
3BP	Extensive and deep borrow pits with limited development potential. Possible use as materials sites for new townships. Subject to detail/footprint investigations
3V	Pan features with vlei areas (with the pans). Limited development potential. Possible incorporation as stormwater attenuation ponds in new townships.

LAND USE

ZONING	LAND USE	NUMBER OF UNITS/ERVEN	No. OF STANDS	AREA OF STANDS& STREETS	% OF AREA
RESIDENTIAL 1	400m² BONDED		1404	57,5640	7,48
	300m² FLISP		1212	37,5720	4,88
	220m² FLISP		981	22,5630	2,93
	200m² SUBSIDISED		1334	28,0140	3,64
RESIDENTIAL 4	SUBSIDY 120u/ha (1809 UNITS) 3 Storeys	10797 UNITS	11	15,0780	1,96
	SOCIAL HOUSING 120u/ha (1693 UNITS) 3 Storeys		10	14,1162	1,83
	SOCIAL HOUSING 160u/ha (4208 UNITS) 4 Storeys		18	26,2987	3,42
	BONDED 160u/ha (2862 UNITS) 4 Storeys		10	17,8879	2,32
	BONDED 120u/ha (225 UNITS) 3 Storeys & GROUND FLOOR RETAIL (F.A.R. 0,10)		1	1,8754	0,24
SPECIAL	COMMUNITY FACILITY, RETAIL, PUBLIC SERVICES. F.A.R. 0,6		1	0,6611	0,08
	COMMUNITY FACILITY, RETAIL, PUBLIC SERVICES, TRANSPORTATION F.A.R. 0,6		2	2,4808	0,32
BUSINESS 2	BUSINESS PURPOSES, SHOPS, PLACES OF PUBLIC WORSHIP, PLACES OF INSTRUCTION, PLACES OF EDUCATION, DWELLING UNITS, RESIDENTIAL BUILDINGS, RESTAURANTS, MEDICAL CONSULTING ROOMS, GYMNASIUM, PLANT NURSERIES, SERVICE INDUSTRIES, PARKING BAYS, PARKING GARAGES F.A.R. 0,6		3	6,3082	0,82
	BUSINESS PURPOSES, SHOPS, PLACES OF PUBLIC WORSHIP, PLACES OF INSTRUCTION, PLACES OF EDUCATION, DWELLING UNITS, RESIDENTIAL BUILDINGS, RESTAURANTS, MEDICAL CONSULTING ROOMS, GYMNASIUM, PLANT NURSERIES, SERVICE INDUSTRIES, PARKING BAYS, PARKING GARAGES F.A.R. 0,6. 120U/HA (2056 UNITS)	1933 UNITS	5	16,1064	2,09
SPECIAL	CLINIC F.A.R. 0,8		1	1,1067	0,14
	RETIREMENT VILLAGE, FRAIL CARE AND ASSOCIATED USES	639 UNITS	256	19,3067	2,51
	AGRICULTURE & USES BY CONSENT (NOT DEVELOPABLE)		1	11,2798	1,47
PUBLIC SERVICES	ELECTRICAL SUBSTATION		4	2,4491	0,32
COMMUNITY FACILITY	COMMUNITY FACILITY F.A.R. 0,6		7	7,6585	0,99
	PRIMARY SCHOOL 4500 LEARNERS		5	18,8558	2,45
	SECONDARY SCHOOL 2700 LEARNERS		2	9,8962	1,29
	PRIMARY AND SECONDARY SCHOOL		1	14,9473	1,94
PUBLIC OPEN SPACE	PARK		84	244,6586	31,78
TRANSPORTATION	RAILWAY, STATION, TAXI, PARKING		17	14,8082	1,92
ROADS	PROVINCIAL ROADS			55,4800	7,21
	STREETS			122,8805	15,97
TOTAL			5370	769,8531	100%

GENERAL NOTES

THE FIGURE ABCDEFGHJKLMNPQRSTUVWXYZA1B1C1A REPRESENTS OUTSIDE BOUNDARY OF THE PROPOSED TOWNSHIP LEEUWPOORT SOUTHERN PART, BEING APPROXIMATELY 769,7815ha IN EXTENT.

- OUTSIDE BOUNDARY OF TOWNSHIP
- PHASE BOUNDARY
- GEOTECHNICAL ZONES
- 1:100 YEARS FLOODLINE
- LINE OF NO ACCESS
- FARM PORTIONS
- BUILDING LINES

AMENDMENTS

D9	LAND USE TABLE UPDATED, BUS 1 TO BUS 2 & FAR. ADDED	C. Putter	2016.04.01
D10	WETLAND DATA ADDED	C. Putter	2016.04.13
D11	ENVIRONMENTAL SENSITIVITY – ECOLOGICAL INFO ADDED	C. Putter	2016.04.15
D12	20X20 SWITCHING STATION ADDED	C. Putter	2016.05.12
D13	ADDED NEW ENVIRONMENTAL SENSITIVITY AREA	J. Pienaar	2016.05.17
D14	AMENDED LAYOUT FOR ENGINEERING COMMENTS	C. Putter	2016.07.08
D15	AMENDED LAYOUT FOR ENGINEERING COMMENTS	C. Putter	2016.07.20
D16	AMEND GEOTECHNICAL REFERENCE BLOCK FOR ZONE 3BP	C. Putter	2016.08.22
D17	AMEND LAND USE TABLE.	C. Putter	2016.09.22
D18	ADD SERVITUDE AREAS FOR SUBSTATIONS.	C. Putter	2017.01.30
D19	ADD EXTRA ERF FOR SUBSTATION.	C. Mason	2017.02.10
D20	AMEND SPLAYS ACCORDING TO ENGINEERS.	C. Mason	2017.02.14

CLIENT

LEEUWPOORT DEVELOPMENTS (PTY)LTD

TOWN PLANNER: D. vd Merwe

SCALE 1 : 5 000

DRAWING No. SunwardPark_Comp D20/2017.02.14

LAYOUT PLAN STATUS DRAFT

URBAN DYNAMICS
37 EMPIRE ROAD
PARKTOWN
P.O. BOX 291803
MELVILLE
2109
TEL: (+27 11) 482–4131
TEL: (+27 11) 482–9959
E–MAIL: danie@urbandynamics.co.za

ANNEXURE D2
PHASE 1 GEOTECHNICAL STUDY

GFSH –2, PHASE 1 SOILS INVESTIGATIONS OF THE PROPOSED LEEUWPOORT DEVELOPMENT

IR801 SOILS

VOLUME 1

INTRACONSULT ASSOCIATES
P O. BOX 604
FOURWAYS
2055

TEL: (011 469 0854
FAX: 086 689 2847

IR801 SOILS
NOVEMBER 2006

Consulting Engineering Geologists

Intraconsult

Intraconsult Associates
P.O. Box 604
Fourways
2055

Telephone : (011) 469 0854
Fax : 086 689 2847

URBAN DYNAMICS
P O BOX 49
BEDFORDVIEW
2008

Attention: Mr Pieter Cloete

Your reference	Our reference	Date
	IR801/S	NOVEMBER 2006

GFSH – 2, PHASE 1 SOILS INVESTIGATIONS OF THE PROPOSED LEEUWPOORT DEVELOPMENT

EXECUTIVE SUMMARY

This report presents and comments on the results and observations of GFSH – 2 Phase 1 geotechnical investigations carried out for township establishment and planning purposes on designated land parcels within the Leeuwpoort Development Area.

This report should be read in conjunction with INTRACONSULT report IR801R, the results of this dolomite stability report have been incorporated into the preliminary NHBRC Site classifications for these land parcels. Geotechnical investigations of the total study area has involved the assimilation and evaluation of available geotechnical, geomorphological and geological data and additional detailed field investigations. These investigations comprised field scouting and the profiling and sampling of trial holes in order to gather further information for the evaluation of the general engineering geological conditions that exist beneath the delineated land parcels.

Based on this detailed field work, soil profiles, dolomite risk analysis and the soil laboratory test results, the designated land parcels have been sub-divided into (preliminary) NHBRC Site Class Sub-Areas. These preliminary Sub-Areas are designated in terms of the statutory composite Site Classes to highlight potential planning and development constraints for near surface-soils. The procedure adopted is presented, the methodology classifies founding horizons for light residential structures (at natural ground gradients) according to their potential to cause foundation movements in terms of the sizes and loadings outlined in the NHBRC Guidelines. Recommendations are given for foundation design: preference is given to raft type foundation solutions in view of the variable foundation support problems anticipated across these designated land parcels. A broad commentary on near surface conditions and their potential impact on planning is provided. Correspondence with the DME is appended to this report: Attention is also drawn to potential GDACE requirements regarding dust impact (from neighbouring slimes dam facilities) and also the need for specialist investigations with Ra, Th and U contamination in land parcels affected by earlier mining activities.

VOLUME 1

FIGURE

TABLES

APPENDICES

DRAWING

VOLUME 2

1. INTRODUCTION AND TERMS OF REFERENCE

This report presents and comments on the results and observations of GFSH – 2 Phase 1 geotechnical investigations carried out to check aspects of the near surface soils for the planning and formalisation of nine parcels of land designated for the proposed Leeuwpoort Development Project. The total site area investigation comprised some 1 360 hectares of which 226 ha. are dolomitic lands. A full dolomitic stability investigation of these dolomitic lands (in the south western sector of the proposed development) has been carried out by INTRACONSULT and reported in IR801R dated November 2006. This IR801R report should be read in conjunction with this near surface soils document which incorporates the dolomitic evaluation in the Soil Map for this development.

The terms of reference and scope of the work to be undertaken were discussed with Mr Hannes Potgieter of Urban Dynamics. Intraconsult outlined proposals in letter IR801p2 dated 15th July 2006 and was instructed to proceed with the investigations on the 28th August 2006.

2. INFORMATION USED IN THIS STUDY

The following information has been used in the investigation and assessment of the site:

- INTRACSONULT report IR801R entitled: "GFSH – 2, Phase 1 Dolomitic Stability Investigations of 226 hectares in the south western sector of the Leeuwpoort Development", dated November 2006..
- Geological Map issued by the Director of Geological Survey: Sheet 2628 EAST RAND at a scale of 1:250 000.
- Selected orthophotograph and ground contours of the study area, provided through the Professional Team Leader.
- National Home Builders Registration Council: Home Builders Manual: Parts 1 and 2, Revision 1, February 1999.
- SAIEG and SAICE. "Guidelines for urban Engineering Geological investigations"..
- Soil Survey for Engineering : Brink, Partridge and Williams (1982).
- Expansive Roadbed Treatment for Southern Africa: D J Weston (1980) 4th Int. Conf. for Expansive Soil Vol. 1 Denver pp339-360.
-
- National Department of Housing Generic Spec. GFSH – 2, September 2002.

3. SITE DESCRIPTION

The designated site area is approximately 1 360 hectares in extent located on the Remainder of the Farm Leeuwpoort 113 IQ and is shown on the locality plan at the end of this written report. Nine separate land parcels comprise the total site area. For description purposes these land parcels have been labelled A,B,C,D,E,F,G,H and I on the Soil Map IR801/S.

3.1 Land Parcels F&G

Land Parcels F&G cover a site area of approximately 685 ha. The site area is bounded in the east by Rondebult road (R21), in the west by Barry Marais road, in the south by the North Boundary road (R554) and in the south by the Sunward Park residential neighbourhood. These land parcels are situated on gently undulating terrain on the southern site of a broad open valley. Existing land use is agricultural. A number of servitudes cross these areas including bulk water supply pipelines, overhead electricity powerlines and an ore slurry pipeline.

A number of pans, typical of terrain on the East Rand, were encountered on the upper reaches of the slope on eastern portions of land parcel F. Two deep borrow pits have been excavated adjacent to the R554 in the south western sector of Land Parcel F.

3.2 Land Parcels H&I

Land Parcels H&I cover a combined site area of approximately 15 ha. They are bounded by Van Wyk Louw Drive to the north, by Barry Marais Road to the east, by the N17 national road to the north and by a residential neighbourhood to the west. These two land parcels are separated by a bowl-shaped depression formed by a discussed borrow pitting area (previously used for road construction materials). Both sites are essentially flat-lying, devoid of trees and vegetated by grass. Major electrical (overhead) power servitudes occupy nearly half of the available site areas.

3.3 Land Parcels E&D

Land Parcels E&D cover a site area of approximately 50 ha. The two sites straddle the N17 national road and are bisected by the wetland of the Elsburg Spruit. Land Parcel E is situated predominately in the floodplain of this stream, with only a minor portion of the site on the sideslope above the floodplain and wetland. Land Parcel E is bounded by an ERPM slimes dam to the north west and a slimes tailings filled quarry/borrow pit to the west. The eastern half of this site is highly disturbed and characterised by borrow and unconsolidated backfill areas.

3.4 Land Parcels A, B & C

Land Parcels A,B&C cover a site area of approximately 140 ha. These sites are areas of vacant land between Reiger Park and Parkdene and generally comprise disturbed near surface lands used for indiscriminate borrowing and illegal dumping. Land parcel B has existing (disused) buildings and a soccer filed on the site. The northern sector of Land parcel A appears to have been the site of a slimes dam. The central sector of Land Parcel C is occupied by the ERPM hostel complex. Land Parcel C is also bisected by a private mine railway service line which is still in use.

4. NATURE OF INVESTIGATIONS

These investigations have involved the following :

4.1 Desk Study

A desk study has been carried out to review data collected in the general environs of the site.

4.2 Field Inspections

Field inspections were completed during the early stages of these investigations in order to develop a clearer perspective of current site conditions. The object of these field inspections was to evaluate access, geomorphology, geology, stormwater runoff, etc.

4.3 Trial Holes

Where access was possible, trial holes were opened across the site using 75kW power TLB excavators. Each trial hole was entered and inspected by a geotechnical engineer who also described the soil profiles using the visual and tactile procedures advocated by Jennings et al (1973). Detailed descriptions of the trial hole profiles from this investigation are given in Volulme 2 (Appendix 1) and their positions shown on Drawing IR801/S in the pocket at the end of this report.

4.4 Soil Sampling and Testing

For accurate classification and identification purposes, particle size distributions and Atterberg Limit tests have been carried out on samples recovered from the various soil unit horizons uncovered during these investigations. Select soil unit samples were also tested for moisture content and soil chemistry. Where practically possible, undisturbed samples were taken to check the laboratory oedometer and direct shear test characteristics of these soils. These test results are provided in Appendix 2 of this report and summarised in Tables 2 and 3 below.

5. SITE GEOLOGY AND GROUNDWATER CONDITIONS

note: "GEOLOGY & GEOHYDROLOGY" is covered in detail in INTRACONSULT companion report IR801/R. The following commentary briefly extends this information for the full Leeuwpoort Development Area.

According to the available geological map for Leeuwpoort Development Area, rock formations generally dip to the south and south west. The oldest geological formation comprises quartzites and conglomerates of the Turffontein Subgroup of the Witwatersrand Supergroup. The northern parts of Land Parcel D, and of Land Parcels A,B&C (and a small sliver in the north-central sector of F) and underlain by this formation. These older formations are conformably overlain by the basaltic lavas of the Klipriviersberg Group of the Ventersdorp Supergroup. The southern part of Land Parcel D, all of Land Parcel B and the eastern parts of Land Parcel F are underlain by this formation. The south western sector of Land Parcel F is characterised by quartzites and shales of the Black Formation and dolomites of the Malmani Subgroup of the Transvaal Supergroup in the geological succession. These formations uncomformably overlie the Klipriviersberg Group rocks (IR801/R). Tillites of the Dwyka Group and mudrocks and sandstones of the Ecca Group of the Karoo Supergroup drape the abovementioned older rock formations in the east of Land Parcel F

Remnants of dolerite intrusions of Karoo age have been recorded in dykes and sills in the eastern sectors of Land Parcels F,G,H&I. Recent alluvial deposits of Quaternary age occur from place to place in the wetlands and pan areas in the Development Area.

6. GEOTECHNICAL EVALUATION

This Geotechnical evaluation is based on our interpretation of field scouting, the ground contour information, geology, the soil profiles and the laboratory test results.

6.1 Engineering and Materials Characteristics

- **Evaluation of the Collapse Potential of soils within 1,0 m from natural ground level.**

  The visual and tactile soil profiling procedures adopted in the open test holes indicate that potentially collapsible soils are likely to be problematic on certain land parcels These insitu soil conditions are discussed more fully in Section 7 below.

- **Evaluation of the activity (heave/shrink) of soils within 3,0m from natural ground level.**

  Colloidal substances in soils possess a large surface area and are known to expand on absorption of water and to contract on drying out. Webb (1959) showed that it is the surface area of colloids that causes heave/shrink of soils (and not necessarily) their expanding – lattice clay minerals. Weston (1980) utilised weighted liquid limit tests to provide an empirical equation to index potential soil behaviour. Analyses carried out on the weighted liquid limit laboratory test results from samples of the soil units uncovered in the trial holes across this site confirm the presence of potential heave/shrink soil behaviour. These results and analysis are discussed more fully in Section 7 below.

- **Evaluation of the potentially compressible soils within 1.0m from natural ground surface.**

  The laboratory oedometer tests carried out on undisturbed samples of soil units and their distribution across the site indicates that long-term compressibility could affect light (NHBRC) structures in certain sub areas across these land parcels. These results and analyses are discussed more fully in Section 7 below.

- **Evaluation of surficial materials for roads construction** :

  Disturbed samples of the transported and residual soils encountered in the opened trial holes across this site were subjected to particle size and Atterberg Limit tests. These test results are summarised in Table 2. Our evaluation of these natural insitu materials for potential use in pavement subgrade design is provided as follows:-

Soil Unit	Group Classification	General Rating as Sub-Grade	Grading Modulus (Range)	Workability Rating
COLLUVIUM	A-2-6 to A-7-5	good to poor	1,64 to 0,19	excellent to v. poor
ALLUVIUM	A-2-6 to A-7-6	good to poor	1,19 to 0,31	fair to v. poor
FERRICRETE	A-2-6 to A-7-6	good to poor	1,65 to 0,.50	excellent to v. poor
RES. QUARTZITE	A-2-6 to A-6	good fair	1,58 to 0,59	excellent to v. poor
RES. SANDSTONE	A-2-4	good	1,18	good
RES. ANDESITE	A-2-4 to A-7-6	good to poor	1,38 to 0,49	good to v. poor
RES. TILLITE	A-6 to A-7-6	poor	1,38 to 0,81	good to fair
RES. MUDROCK	A-6 TO A-7-6	poor	1,26 to 0,22	good to v. poor
RES. DOLERITE	A-4 to A-6	fair to poor	0,97 to 0,50	fair to v. poor

- **Evaluation of surficial materials for possible use for pipe bedding: (SABS 1200 DB & LB)**

  (i) Select Granular Bedding – i.e. naturally occurring non-cohesive singularly graded gravel-soils between 0.6 and 19.0 mm are not available on these land parcels and will need to be imported.

  (ii) Select Fill – i.e. the laboratory tests results confirm that natural soils with a PI less than 6 are only available on these land parcels with careful selection.

  (iii) General fill: materials recovered from trench excavation works may be considered for General Fill purposes after removal of any larger cobble and boulder size fractions.

- **Evaluation of Potential aggressiveness of interparticulate groundwaters**:

  Disturbed samples of the transported and residual soils encountered in the opened trial holes across this site were subjected to chemical tests. The test results are provided in Table 2. Our assessment of these values is as follows:-

Soil Unit	pH	Comment	Resistivity Ohm.cm	Corrosivity *
COLLUVIUM	5,29 to 6,51	slightly acidic	555 to 59	v. corrosive
ALLUVIUM	5,40 to 5,42	slightly acidic	909	v. corrosive
FERRICRETE	5,52 to 6,43	slightly acidic	555 to 263	v. corrosive
RES. QUARTZITE	4,53	mod. acidic	1 000	v. corrosive
RES. SANDSTONE	4,50	mod. acidic	1 000	v. corrosive
RES. ANDESITE	4,72 to 5,41	mod. acidic	2 500 to 1 670	corrosive
RES. TILLITE	4,98	mod. acidic	3 333	corrosive
RES. MUDROCK	5,90 to 6,46	slightly acidic	417 to 68	v. corrosive
RES. DOLERITE	5,30 to 5,40	slightly acidic	555 to 625	v. corrosive

*potential corrosivity – ref. Messrs ARMCO 1977

These results indicate the potential aggressiveness of interparticulate groundwater on this site and the need to utilise non-ferrous metals for underground services.

- **Dumping of refuse**: Dumped refuse and general waste have been noted in sub-surface (covered) pits and on open ground in many sections of this site and should be anticipated as a general hazard potentially influencing housing foundations.

- **Evaluation of the shallow soil profiles recorded in the open trial holes:** Our evaluation of the shallow soil profiles in general is that residential structures could be impacted by 'rising damp' in service: special attention to membrane/dampcourse measures is required when building structures on this site (for example, the use of 'water-proof' concretes in slab/raft foundation designs).

- **Evaluation of Potential erosion and piping (dispersive soils) when soils are subjected to a hydraulic gradient.**

  Sodium - based clay minerals are susceptible to erosion or piping in the insitu soil profile. The electrical conductivity of the soil paste provides an indicator of the salinity and potential dispersive behaviour. The conductivity results are provided in Table 2. Our assessment of these values is as follows:-

Soil Unit	Conductivity Sm	Dispersive Characteristic[1]
COLLUVIUM	0.13-1.69	associated
ALLUVIUM	0.11	non-associated
FERRICRETE	0.18-0.38	non-associated
RES. QUARTZITE	0.10	non-associated
RES. SANDSTONE	0.10	non-associated
RES. ANDESITE	0.04-0.06	non-associated
RES. TILLITE	0.03	non-associated
RES. MUDROCK	0.24-1.48	associated
RES. DOLERITE	0.16 TO 0.18	non-associated
[1]Note: Conductivities in excess of 0.5 Sm may be associated with dispersive characteristics.		

  These results indicate potential dispersive characteristics in the colluvial and residual mudrock soil units on these land parcels.

6.2 Slope Stability and Erosion

Our opinion is that slope stability should not present a major hazard for (light) residential structures on these land parcels. However, the fine nature of many, if not most, of the soil units encountered during investigations is such that after removal of natural cover they present a potential erosion problem during periods of heavy rain and also dust removal by high winds in the dry season. **Proper stormwater management systems with erosion control measures will be required on this site.**

6.3 Earthworks classifications for service trenches

Many of the excavated trial holes uncovered 'hand excavation intermediate' and 'medium hard rock' classes of materials in the lower sections of the ground surface (0.0m to minus l.5m profile across this site). The material 'refusal depths' and types are summarised in Table(s) 1 below, i.e. GFSH-2 'Class A' materials are above these 'refusal' depths. Our evaluation of these refusal depths is that materials below the Class A soils could be reduced with the use of pneumatic tools before removal by hand excavation.

6.4 Permeability

The shallow soils uncovered across the site have been subjected to weathering, erosion, pedogenic and other processes in the geological past. The shallow (soil) portion of the profile consists of layers of transported materials, unweathered and completely weathered insitu material, and poorly to well developed pedogenic soils. This range of materials with a variety of physical properties can significantly impact on spatial permeability values. The following table is provided for the purposes of estimating the potential saturated hydraulic conductivities of the USCS soil groups profiled (and tested) in the investigations.

USCS soil groups (identified in Atterberg tests)	Hydraulic conductivity m/s after Badenhorst, 1998
SM	$10^{-9} - 10^{-5}$
SC	$10^{-10} - 10^{-6}$
ML	$10^{-10} - 10^{-6}$
CL	$10^{-10} - 10^{-8}$

6.5 Impact of Geotechnical Character of the Site on Housing Developments

The procedures utilised in this report for the *broad* geotechnical zonation of the site are derived from the modification and integration of various classification systems and follow the SAIEG's "Guidelines for Urban Geological Investigations" with appropriate adaptations. Based on the geological, geohydrological, hydrological, geomorphological and soils information gathered during geotechnical investigations, sites may be divided into three primary Geotechnical Sub-Areas. These Sub-Areas broadly reflect the development potential of sites and delineate Sub-Areas of similar characteristics such as wet areas and terrain (see also Table 3 in the GFSH-2 generic specification).

These broad geotechnical Sub-Areas are summarised below:-

Geotechnical Sub-Area	**Definition**
1 "Most favourable"	The geotechnical conditions are such that urban development can take place without any special precautionary/remedial measures for geotechnical conditions.
2 "Intermediate" (prefix "2" on the NHBRC Soil Map)	Geotechnical conditions are such that the area may be developed for urban use but appropriate remedial and/or precautionary measures are required in the context of the geotechnical constraints.
3 "Least favourable" (prefix "3" on the NHBRC Soil Map)	Geotechnical conditions are such that urban development is not recommended.

Based on our evaluation of the available geotechnical data, the site area has been delineated into these Primary Geotechnical Sub-Areas.

These Primary Sub-Areas are shown on Drawing IR801/S. (See also the GFSH-2 phase 1 commentary in Section 10 below.)

7. SITE CLASSIFICATION (IN TERMS OF THE NHBRC GUIDELINES)

For the purposes of this report the broad geotechnical characteristics of the primary geotechnical Sub-Areas outlined in Section 6.5 are further described in terms of several 'geotechnical category designations' in terms of the NHBRC Guidelines as defined below:-

GEOTECHNICAL CATEGORY AND SITE CLASS DESIGNATION	GEOTECHNICAL CHARACTERISTICS
Inundated areas w	Wet area, drainage line, seepage zone.
Active soils (heave/shrink) H H1 H2 H3	Expected range of total movements at surface: < 7.5 mm 7.5 – 15 mm 15 – 30 mm > 30 mm
Collapsible soils C C1 C2	Expected range of total movement at surface: < 5 mm 5 – 10 mm > 10 mm
Compressible soils S S1 S2	Expected range of total movement at surface: < 10 mm 10 – 20 mm > 20 mm
Excavation E	Abandoned borrow areas, dump rock, waste sites, exploration pits or adits, and uncontrolled fill, erosion gully.
P	Steep slope
R R1 R2 R3	Rock : Outcrop Scattered outcrop Sub-outcrop (i.e. in 0.0 – 1.5 m profile)

These designations are added to the selected Primary Geotechnical Sub-Areas in order to describe the generalised geotechnical conditions that lead to that particular characterisation. For example, Sub-Area 2(R3)(H-H1/C-C1/S) describes Sub-Areas of the site suitable for development '2' where precautions must be taken for the occurrence of potentially active 'H1' and collapsible 'C1' soils; potentially difficult excavation conditions 'R3' are also recorded in the soil profiles in this Sub-Area, see also Table 1.

The 'H', 'C' and 'S' designations in the NHBRC Guidelines imply that a quantitative approach is required when analysing each open trial hole profile and before allocating it to a selected soil site class Sub-Area. A broad overview of the assumptions made and the analytical processes adopted regarding potential in-service soil behaviour beneath shallow foundations is presented below. Most importantly, potential soil behaviour in the Trial Holes has been evaluated and characterised when abstractly subjected to loading and moisture conditions beneath a structure where bearing pressures do not exceed 50 kPa and rest on 0.5m wide strip footings (see NHBRC Guidelines). In practical terms and for stress related behaviour (the 'C' and 'S' Flags) only the top 1 metre of profiled materials has been considered, while for the moisture-related behaviour (the 'H' Flag) only the top 3 metres.

(i) **Soils uncovered that can change in volume with changes in moisture conditions – potentially active soils (i.e., NHBRC Site Class H/H1/H2/H3).**

Seasonal variations in the moisture condition of any colloidal size particles in soils can induce volume changes which could translate into vertical 'movement' under the foundations of houses placed on these particular soil profiles. In an attempt to quantify these movements for this report, our experience with similar soils, together with Weston's empirical swell equation, has been adapted to provide an indication of the swell difference between the projected 'driest' and 'wettest' moisture conditions anticipated in the field, see Footnote[2].

The laboratory testing of soil samples taken across the site provides characteristic* liquid limit (whole) values for the various soil units. These values, together with the weighted potential volume changes (swell difference between the presumed 'driest' and 'wettest' field moisture conditions) are tabulated below :-

SOIL UNIT	WEIGHTED LL CHARACTERISTIC* VALUES	MOISTURE CONTENT %		SWELL DIFF. VOL. CHANGE %
		'DRIEST'	'WETTEST'	
COLLUVIUM	57,0	22,8	45,6	1,9
ALLUVIUM	45,0	18,0	36,0	1,3
FERRICRETE	30,6	12,2	24,4	0,7
RES. QUARTZITE	21,5	8,6	17,2	0,3
RES. SANDSTONE	20,5	8,2	16,4	0,2
RES. ANDESITE	28,4	11,4	22,7	0,6
RES. TILLITE	28,3	11,3	22,6	0,6
RES. MUDROCK	51,0	20,4	40,8	1,6
RES. DOLERITE	28,5	11,4	22,8	0,6

*characteristic value = mean plus one standard deviation.

Laboratory oedometer swell tests were also carried out on samples of the residual mudrock soil units. In these tests samples at their natural moisture content were loaded in the oedometer to 11 kPa and then soaked. The samples were then incrementally loaded so as to maintain constant volume. These laboratory tests provide an indication of "swelling pressures" as these soil samples become fully saturated. The results are fully reported in Appendix 2 and summarised below:-

Footnote [2]: Weston's swell per cent = $0{,}000411L^{+4.17} \times p^{-0.386} \times Wi^{-2.33}$

where L = Liquid Limit (whole) (ie. Liquid Limit x % passing 425 microns)

P = overburden pressure (10kPa adopted for this report)

Wi = initial moisture content.

From CSIR research experience (for 'red' soils), the 'driest' field moisture condition has been taken as 0,4 L, and the 'wettest' field moisture condition as 0,8 L : For the 'dark grey' and 'black' soils 'driest' and 'wettest' conditions have been taken at 0,2L and 0,7L respectively.

SOIL UNIT (TP)	Saturation %		Dry Density kg/m^3	Swell pressure kPa
	Initial	Final		
RES. ANDESITE (9)	49,8	99,6	1 833	Zero
RES. ANDESITE (8)	69,3	99,6	1 860	58
RES. ANDESITE (27)	67,1	99,5	1 802	50
RES. MUDROCK (128)	81,9	99,6	1 265	25
RES. MUDROCK (130)	72,6	99,5	1 563	66

These test results confirm the potential "swelling pressure" of these partially saturated soils.

(ii) Soils uncovered that could rapidly reduce in volume when loaded and wetted – potential 'collapsible' soils (i.e., NHBRC Site Classes C/C1/C2).

'Loose' soils have been uncovered in a number of the trial holes opened across this site. For the purposes of this report a 1 per cent collapse/reduction in profile has been applied in the assessment of these loose and/or open textured materials for the purposes of preparation of the Soil Map (Drawing IR801/S).

(iii) Very moist and fine grained soils uncovered that could (slowly) reduce in volume when loaded – potentially 'compressible' soils (i.e. NHBRC Site Classes S/S1/S2).

Sections of the site are occupied by varying thicknesses of very fine-grained soils with a low coefficient of permeability. The laboratory oedometer tests on undisturbed samples taken from these soil units are fully reported in Appendix 2 and the test values summarised in Table 3. These test results provide typical characteristic values for analysing their potential compressibility for imposed loadings up to 50 kPa. Using the assumptions and procedures outlined in Footnote[3] below, the values used in assessing the trial hole profiles are summarised as follows:-

Soil Unit	Recompression Index C_r	Initial Void ratio	Bulk density kg/m^3	Thickness of Soil Unit, mm		
				S	S1	S2
Res. Mudrock	0,05	1,150	1 703	<500	500-1 000	-
Res. Andesite	0,01	0,626	2 025	ALL	-	-
Alluvium	0,18	0,941	1 932	<140	140-280	>280

Footnote [3]: The consolidation settlement, dc, can be expressed as

$$dc = \frac{Cr}{(1 + eo)} \times H \log_{10} \frac{Po' + Ap'}{Po'}$$

For the purposes of these analyses:

- Cc & eo estimated from lab. test results.
- Zone of influence taken to 1m below surface.
- Initial effective pressure, po', at middle of this layer (i.e. bulk density x 9.81 x 10^{-3} x 0.5).
- Additional effective pressure, Ap: owing to applied loading taken as 50kPa (NHBRC max. permitted)
- 'H', thickness of soil in profile, provided by substituting dc = 10mm & 20mm)

Once analysed according to the assumptions and data provided, the individual trial hole designations have been transferred onto the site plan provided and reviewed in conjunction with other geotechnical information including the (solid) geology, engineering judgement and the results of field scouting.

A Soils Map (Drawing IR801/S) has been compiled reflecting this total conceptual Site Class Sub-Area characterisation.

8. FOUNDATION RECOMMENDATIONS AND SOLUTIONS

These investigations have confirmed that potentially problematic soils mantle the bedrocks over the site area. The occupance of these soils and their anticipated in-service behaviour has been analysed and broad zonation provided on the Soil Map, Drawing IFS112.

Possible foundation solutions for housing structures are further complicated by the possible presence of 'hard' and 'soft' materials immediately beneath individual house footprints as a consequence of local rock sub outcrop and refuse pits, respectively. Therefore the individual erf 'Site Class' designations will need to be confirmed during the construction phase.

Recommended alternate foundation design solutions for single storey masonry structures are provided in the NHBRC 'Standards and Guidelines'. Appropriate selected recommendations are tabulated below in order to assist budgetary costing for the foundations on this project (and to be covered in the NHBRC housing warranty scheme).

Sub-Area	**Construction Type**	**Selected Foundation Designs and Building Procedures.**
All	Stiffened or Cellular rafts	• Stiffened or cellular rafts with lightly reinforced and articulated masonary • Bearing pressure not to exceed 50kPa • Mesh reinforcement in floor slabs • Measures to ameliorate 'rising damp' problems (e.g. use of 'water proofed' concretes)

Notes:

Site Specific Investigations must be conducted on all erven planned for major structures (for example, schools, halls, shops, churches, etc.) prior to design finalisation and construction.

9. DRAINAGE

Stormwaters falling onto the Development Area are likely to flow rapidly (i.e. with little top-soil penetration), away from the higher topographical areas towards the natural drainage channels near or crossing these land parcels.

A number of these natural drainage features were observed in land parcel F, the most significant of which is the cast to west flowing wetland in the northern sectors of this site. A number of short non-perennial tributaries drain into this wetland from the south.

A complete drainage system design plan, that provides drainage for the convenience of the communities as well as the provision of drainage to control runoff from major stormwater events will be required for the Development Area. The possibility of incorporating the natural pan features (evident in land parcels F&G) as potential attenuation ponds should be considered.

When building structures in this area it is generally accepted good practice to avoid any accumulation of surface waters near to buildings by appropriate surface drainage design. This should also include the (minimum) 150mm freeboard, i.e. top of floor slab to top of ground level and proper attention to 'damp course' provisions, as required in the NHBRC Guidelines.

10. SPECIAL PRECAUTIONARY MEASURES

As outlined in Section 9, a complete drainage system design plan will be required in the Development Area in order to remove stormwaters in a speedy and efficient manner and to prevent any accumulation of surface water against or near buildings. Where possible, areas around buildings should be landscaped and provided with 1.5m wide perimeter concrete slabs/aprons to lead stormwaters away from foundations. Efforts should be made to avoid planting flower beds (or shrubs) against or near buildings, unless these are placed in waterproofed containers, placed on the perimeter slabs/aprons appropriately constructed to facilitate runoff away from the structures.

For the anticipated (light) residential structures to be provided in this development, the following outline commentary is noted for the Site (soils) Class delineated on Drawing IR801/S

GFSH-2 phase 1 Site Class (Drawing IR801/S)	Land Parcel	Commentary on near-surface (soil) conditions
3W	A,C,D,E,F	No development: Land areas below 1:100 year floodlines (note: floodlines require verification, 3W areas shown in blue).
2/3E	A,B,C,D,E,F	Old borrow areas. Require rehabilitation (usually extensive) prior to development.
2(R3)[H-H1/C-C1/S]	A,B	Developable with precautions: Anticipate potentially active and collapsible soils and near surface (occasional) difficult excavation conditions (0,0 to 1,5m profile).
2/3(Ra/Th/U) [H1/C1/S]	D,E,A	Possible radiation contamination (Ra, Th & U). Also potentially active and collapsible soils.

GFSH-2 phase 1 Site Class (Drawing IR801/S)	Land Parcel	Commentary on near-surface (soil) conditions
2(H2-H3/C/S1-S2)	D,E,F	Developable with precautions: Anticipate variable thicknesses of potential (highly) active and compressible soils.
3D4	F	Dolomitic Sub-Area: No Residential Development.
2PD3(R3) [H1-H2/C/S)	F	Developable with precautions. Dolomitic Sub-Area (see IR801/R). Anticipate variable thicknesses of potentially heave/shrink soils and near-surface (occasional) difficult excavation conditions (0,0-1,5m profile).
2PD2/D3(R3) [H1-H2/C/S)	F	Developable with precautions. Dolomitic Sub-Area (see IR801/R). Anticipate variable thicknesses of potentially heave/shrink soils and near-surface (occasional) difficult excavation conditions (0,0-1,5m profile).
2(R3)[H1-H2/C/S]	F&G	Developable with precautions. Anticipate variable thicknesses of potentially heave/shrink soils and near surface (occasional) difficult excavation conditions (0,0-1,5m profile).
2(R3)[H/C/S]	F	Developable with precautions. Near surface difficult excavation conditions in 0.0 to 1.5m profile.
2(R3)[H1/C/S]	F,H,I	Developable with precautions. Anticipate potentially heave/shrink soils and near-surface (occasional) difficult excavation conditions in 0.0 to 1.5m profile.
3BP	F	Extensive and deep borrow pits with limited development potential. Possible use as materials sites for new townships.
3V	F	Pan features with vlei areas (with the pans). Limited development potential. Possible incorporation as stormwater attenuation ponds in new townships.

Special care will be required for the design (and drainage) of services in close proximity to the steeper slopes on this site, as spring/seepage conditions may be expected to occur immediately adjacent to such locations during periods of heavy or continuous rain.

11. CONCLUSIONS & RECOMMENDATIONS

The following notes are intended as general recommendations/guidance for the development of these land parcels:-

11.1 Improvement of Drainage

Drainage systems should be planned with the urban layout and aimed at managing flood peaks (1 : 100 year design storm Return Period) as well as being sensitive to the convenience of the community in controlling the runoff from more frequent storms (1:5 and 1:20 year design storm Return Periods).

11.2 Foundation Works

Broad recommendations are provided in Section 8. Care must be exercised to ensure special foundations where erven straddle contacts with any sub outcropping rock encountered as these Works are opened.

Site specific investigations must be conducted on any sites planned for major structures.

11.3 Road Construction and Installation of Underground Services.

Most sections of the site are underlain by soils with a general (i.e., TRB) assessment of 'poor' to 'fair' as natural sub-grade materials.

Hand excavation class 'Intermediate' and SABS 1200D 'medium hard rock' excavation conditions should be anticipated in many sections of the site. The impermeable nature of many of materials near-surface over large sections of the site could cause shallow standing water and spring conditions in excavation works during and after periods of heavy rain.

Pavement materials and selected granular materials for pipe bedding will need to be imported to these Works.

11.4 General Commentary on the Development of these Land Parcels

Land Parcels	Constraints and Opportunities
F&G	• 1:100 year Floodlines require certification/verification. • possible use of natural pan features as stormwater attenuation ponds. • the two deep borrow pit areas in the south western sector of F should be either (i) re-examined as possible sources of construction materials for the Works, or (ii) appropriately fenced off from the Development Area. • nb.: possible impact of existing major services servitudes on the planning layouts across these land parcels.

Land Parcels	Constraints and Opportunities
I&H	• nb.: possible impact of existing (electrical) servitudes on the planning layouts across these land parcels.
D	• Severely disrupted lands from mining activities for example requires (i) major rehabilitation in sub-areas marked '2/3E', (ii) Ra/Th/U Clearances. • GDACE 'dust shadow' ruling. • 1:100 year floodlines requires certification/verification.
E	• 1:100 year floodlines require certification/verification.
B	• nb.: Possible impact of existing servitudes on planning layouts. • Severely disrupted lands from mining activities, major rehabilitation of surface areas prior to developments.
A	• Severely disrupted lands from mining activities for example requires (i) major rehabilitation works-areas marked '2/3E', (ii) Ra/Th/U Clearances in sectors of the land parcel. • 1:100 year floodlines requires certification/verification.
C	• 1:100 year floodlines require certification/verification. • Rehabilitation works in sub areas marked '2/3 E'.

11.5 General Recommendation

The Sub-Area Site Class presumed boundaries are shown on INTRACONSULT Drawing IR801/S It is recommended that all layout plans for this development are finally certified by the geotechnical specialist as being in accordance with the findings detailed in this report.

These findings are based upon our interpretation of the data assessed during this study. While every effort has been made to determine overall ground conditions on this site, poorer sub-areas may have been missed. For this reason, it is recommended that a competent specialist is always invited to inspect excavation works for services, etc. during the development of this site in order to confirm the findings described in this report.

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TABLE 1

SUMMARY OF REFUSAL AND GROUNDWATER DETAILS FROM TRIAL HOLES — LEEUWPOORT IR801

Test pit no.	Depth (m)	Depth of groundwater perched/See page (m)	Depth to base of (m)		Hard rock excavation from (m)	Boulder encountered in profile	Material at base of test pit
			Soft excavation	Intermediate Excavation			
TP1177/001	2.7	2.55	0-2.7	-	-	-	Residual andesite
TP1177/002	3.1	-	0-3.1	-	-	-	Residual andesite
TP1177/003	2.9	-	0-2.9	-	-	-	Residual andesite
TP1177/004	3.1	-	0-3.1	-	-	0-0.4	Residual andesite
TP1177/005	2.7	-	0-2.7	-	-	0-0.9 (Fill)	Residual andesite
TP1177/007	1.1	-	0.5	0.5-1.1	1.1+	-	Hardpan ferricrete
TP1177/008	2.4	-	0-2.4	-	-	1.0-1.4	Residual andesite
TP1177/009	2.9	-	0-2.9	-	-	-	Residual andesite
TP1177/010	1.1	-	0-1.1	-	1.1+	0.6-1.1	Residual andesite
TP1177/011	2.0	-	0-2.0	-	2.0+	0-0.2	Ferricrete
TP1177/013	1.5	-	0-1.0	1.0-1.5	1.5+	-	Ferricrete
TP1177/014	2.9	-	0-2.9	-	-	-	Residual andesite
TP1177/015	2.5	-	0-2.5	-	-	-	Residual andesite
TP1177/016	2.7	-	0-2.7	-	-	-	Residual andesite
TP1177/017	2.5	-	0-2.5	-	-	-	Residual andesite
TP1177/018	1.0	-	0-0.2	0.2-1.0	1.0+	0-0.2	Mudrock
TP1177/020	0.8	-	0-0.4	0.4-0.8	0.8+	-	Hardpan ferricrete
TP1177/021	2.6	-	0-2.6	-	-	0.4-0.5	Residual andesite
TP1177/022	3.0	-	0-3.0	-	-	-	Residual andesite
TP1177/023	2.7	-	0-2.7	-	-	2.4-2.7	Residual andesite
TP1177/024A	0.5	-	-	0-0.5	-	0-0.5	Quartzite
TP1177/025	2.8	-	0-2.8	-	-	0.6-1.3	Residual tillite
TP1177/027	2.7	-	0-2.7	-	-	1.2-2.7	Alluvium
TP1177/028	2.1	-	0-1.6	1.6-2.1	2.1+	-	Residual andesite
TP1177/029	1.6	-	0-1.6	-	-	-	Residual andesite
TP1177/030	2.4	-	0-2.4	-	-	-	Residual andesite
TP1177/031	2.5	-	0-2.5	-	-	0-2.5	Residual tillite
TP1177/032	2.3	-	0-2.3	-	-	0-2.5	Residual

Test pit no.	Depth (m)	Depth of groundwater perched/See page (m)	Depth to base of (m)		Hard rock excavation from (m)	Boulder encountered in profile	Material at base of test pit
			Soft excavation	Intermediate Excavation			
TP1177/033	2.4	-	0-2.4	-	-	-	Residual
TP1177/035	0.7	-	0-0.3	0.3-0.7	0.7+	-	Hardpan ferricrete
TP1177/036	1.8	-	0-1.8	-	-	-	Residual andesite
TP1177/037	1.7	-	0-1.7	-	-	-	Hardpan ferricrete
TP1177/038	1.1	-	-	0-1.1	-	0-1.1	Quartzite
TP1177/039	1.5	-	0-1.5	-	-	-	Ferricrete
TP1177/040	2.6	-	0-2.6	-	-	1.8-2.6	Residual tillite
TP1177/041	2.7	-	0-2.7	-	-	-	Residual
TP1177/043	2.9	-	0-2.9	-	-	-	Residual andesite
TP1177/044	1.6	-	0-1.6	-	-	-	Residual andesite
TP1177/045	3.0	-	0-3.0	-	-	-	Residual andesite?
TP1177/046	2.5	-	0-1.7	1.7-2.5	-	-	Residual quartzite
TP1177/047	2.5	-	0-2.5	-	-	-	Residual tillite?
TP1177/048	2.1	-	0-2.1	-	-	-	Residual - ferricrete
TP1177/049	2.5	-	0-2.5	-	-	-	Residual
TP1177/050	2.8	-	0-2.8	-	-	-	Residual
TP1177/052	0.8	-	0-0.4	0.4-0.8	0.8+	-	Hardpan ferricrete
TP1177/053	1.1	-	0-1.0	1.0-1.1	1.1+	-	Hardpan ferricrete
TP1177/054	1.6	-	0-1.4	1.4-1.6	1.6+	-	Residual quartzite
TP1177/055	1.9	-	0-1.8	1.8-1.9	-	1.8-1.9-	Residual tillite
TP1177/056	2.4	-	0-2.4	-	-	-	Residual
TP1177/057	2.0	-	0-2.0	-	-	-	Residual
TP1177/058	2.4	2.1	0-2.4	-	-	-	Residual andesite
TP1177/060	1.2	-	0-0.85	0.85-1.2	1.2+	-	Hardpan ferricrete
TP1177/061	3.1	-	0-3.1	-	-	-	Residual andesite
TP1177/062	2.5	-	0-2.05	2.05-2.5	2.5+	-	Hardpan ferricrete
TP1177/063	3.0	2.9	0-2.7	2.7-3.0	-	-	Residual mudrock/andesite?
TP1177/064	1.05	-	0-0.9	0.9-1.05	1.05+	-	Hardpan ferricrete
TP1177/065	2.6	2.1	0-2.6	-	-	-	Residual andesite
TP1177/067	2.4	-	0-2.2	2.2-2.4	-	-	Residual mudrock

Test pit no.	Depth (m)	Depth of groundwater perched/See page (m)	Depth to base of (m)		Hard rock excavation from (m)	Boulder encountered in profile	Material at base of test pit
			Soft excavation	Intermediate Excavation			
TP1177/068	2.35	2.1	0-2.35	-	-	-	Alluvium
TP1177/069	2.75	2.65	0-2.75	-	-	-	Residual mudrock
TP1177/070	1.35	-	0-1.15	1.15-1.35	1.35+-	-	Hardpan ferricrete
TP1177/071	2.1	-	0-2.1	-	2.1+	-	Residual mudrock
TP1177/073	2.8	-	0-2.8	-	-	-	Residual andesite?
TP1177/074	2.7	2.3	0-2.7	-	-	-	Residual mudrock
TP1177/075	0.85	-	0-0.65	0.65-0.85	0.85+	-	Hardpan ferricrete
TP1177/076	1.6	-	0-1.6	1.6+	-	-	Residual sandstone
TP1177/077	2.45	2.0	0-2.45	-	-	-	Residual
TP1177/078	0.65	-	0-0.55	0.55-0.65	0.65+	-	Hardpan ferricrete
TP1177/079	0.5	-	0-0.3	0.3-0.5	0.5+	-	Hardpan ferricrete
TP1177/080	2.85	1.80	0-2.85	-	-	-	Residual
TP1177/081	1.4	-	0-1.4	1.4+	-	-	Residual sandstone
TP1177/082	1.0	-	0-0.7	0.7-1.0	1.0+-	-	Hardpan ferricrete
TP1177/083	2.65	-	0-2.65	-	-	-	Residual mudrock?
TP1177/084	2.7	-	0-2.7	2.7+	-	-	Residual tillite
TP1177/085	2.65	-	0-2.65	-	-	-	Residual tillite
TP1177/086	2.55	-	0-2.55	-	-	-	Residual tillite
TP1177/087	2.75	-	0-2.75	-	-	-	Residual tillite
TP1177/088	3.05	-	0-3.05	-	-	-	Residual tillite
TP1177/089	2.85	-	0-2.85	2.85+	-	-	Residual tillite
TP1177/090	2.8	-	0-2.8	-	-	-	Residual tillite
TP1177/091	1.15	-	0-1.10	1.10-1.15	1.15+	-	Hardpan ferricrete
TP1177/092	1.45	-	0-1.3	1.3-1.45	1.45+	-	Hardpan ferricrete
TP1177/093	1.25	-	0-1.05	1.05-1.25	1.25+	-	Hardpan ferricrete
TP1177/096	2.4	2.2	0-2.4	-	-	-	Residual tillite
TP1177/097	1.95	1.65	0-1.95	-	1.95+	-	Hardpan ferricrete
TP1177/098	2.1	-	0-2.1	-	-	-	Residual tillite?
TP1177/100	2.4	2.2	0-2.4	-	-	-	Residual
TP1177/101	1.25	-	0-1.05	1.05-1.25	1.25+	-	Hardpan ferricrete

Test pit no.	Depth (m)	Depth of groundwater perched/See page (m)	Depth to base of (m)		Hard rock excavation from (m)	Boulder encountered in profile	Material at base of test pit
			Soft excavation	Intermediate Excavation			
TP1177/104A	1.55	-	0-0.75	0.75-1.55	1.55+	-	Hardpan ferricrete
TP1177/106	2.25	1.65	0-2.25	-	-	-	Alluvium
TP1177/107	1.95	-	0-1.8	1.8-1.95	1.95+	-	Hardpan ferricrete
TP1177/108	0.9	-	0-0.9	-	0.9+	-	Hardpan ferricrete
TP1177/109	2.6	0.85	0-2.6	-	-	-	Alluvium
TP1177/110	0.45	-	0-0.45	-	-	-	Quartzitic conglomerate
TP1177/111	1.1	-	0-1.1	-	-	-	Quartzitic conglomerate
TP1177/112	1.1	1.0	0-1.0	1.0-1.1	1.1+	-	Hardpan ferricrete
TP1177/113	1.35	-	0-0.9	0.9-1.35	1.35+	-	Hardpan ferricrete
TP1177/114	1.65	-	0-1.65	-	-	-	Hillwash
TP1177/115	1.8	-	0-1.7	1.7-1.80	1.80+	-	Hardpan ferricrete
TP1177/116	2.7	-	0-2.7	-	-	-	Residual
TP1177/117	2.65	-	0-2.55	2.55-2.65	2.65+	-	Hardpan ferricrete
TP1177/118	2.55	-	0-2.55	-	-	-	Residual
TP1177/119	1.3	-	0-1.2	1.2-1.3	1.30+	-	Hardpan ferricrete
TP1177/120	1.65	1.2	0-1.55	1.55-1.65	1.65+	-	Hardpan ferricrete
TP1177/121	2.2	2.1	0-2.1	2.1-2.2	2.2+	-	Hardpan ferricrete
TP1177/122	2.7	-	0-2.27	-	-	-	Residual mudrock
TP1177/123	1.7	-	0-1.7	1.7+	-	-	Residual mudrock
TP1177/124	1.8	1.75	0-1.7	1.7-1.80	1.80+	-	Hardpan ferricrete
TP1177/125	1.7	-	0-1.7	1.7+	-	-	Residual mudrock
TP1177/126	2.55	2.50	0-2.45	2.45-2.55	2.55+	-	Hardpan ferricrete
TP1177/127	1.5	-	0-1.5	1.5-1.55	1.55+	-	Hardpan ferricrete
TP1177/128	2.65	-	0-2.65	-	-	-	Residual mudrock
TP1177/129	0.85	-	0-0.75	0.75-0.85	0.85+	-	Hardpan ferricrete
TP1177/130	2.6	2.6	0-2.6	-	-	-	Residual mudrock
TP1177/131	1.7	1.65	0-1.7	-	-	0.9-1.7	Residual?
TP1177/132	1.0	-	0-0.75	0.75-0.85	0.85+	-	Hardpan ferricrete
TP1177/133	1.85	-	0-1.75	1.75-1.85	1.85+	-	Hardpan ferricrete
TP1177/134	2.15	-	0-2.05	2.05-2.15	2.15+	-	Hardpan ferricrete

Test pit no.	Depth (m)	Depth of groundwater perched/See page (m)	Depth to base of (m)		Hard rock excavation from (m)	Boulder encountered in profile	Material at base of test pit
			Soft excavation	Intermediate Excavation			
TP1177/135	0.75	-	0-0.55	0.55-0.75	0.75+	-	Hardpan ferricrete
TP1177/136	2.5	-	0-2.4	2.4-2.5	2.5+	-	Hardpan ferricrete
TP1177/137	1.6	-	0-1.45	1.45-1.6	1.6+	-	Hardpan ferricrete
TP1177/138	1.3	-	0-1.3	-	1.3+	-	Hardpan ferricrete
TP1177/139	2.4	2.0	0-2.3	2.3-.4	2.4+	-	Hardpan ferricrete (tillite)
TP1177/140	1.95	-	0-1.95	-	-	-	Hillwash
TP1177/141	1.8	-	0-1.8	-	-	-	Residual dolerite
TP1177/142	1.85	-	0-1.85	-	-	-	Residual dolerite
TP1177/143	1.85	-	0-1.85	-	-	-	Residual dolerite
TP1177/144	1.75	-	0-1.7	1.7-1.75	1.75+	-	Hardpan ferricrete
TP1177/145	0.7	-	0-0.55	0.55-0.7	0.7+	-	Hardpan ferricrete
TP1177/146	1.75	-	0-1.7	1.7-1.75	1.75+	-	Hardpan ferricrete
TP1177/147	1.05	-	0-0.95	0.95-1.05	1.05+	-	Hardpan ferricrete
TP1177/148	1.85	-	0-1.8	1.8-1.85	1.85+	-	Hardpan ferricrete
TP1177/149	2.75	-	0-2.7	2.7-2.75	2.75+	-	Hardpan ferricrete
TP1177/150	1.45	-	0-1.3	1.3-1.45	1.45+	-	Hardpan ferricrete
TP1177/151	1.35	-	0-1.2	1.2-1.35	1.35+	-	Hardpan ferricrete
TP1177/152	1.2	-	0-1.1	1.1-1.2	1.2+	-	Hardpan ferricrete
TP1177/154	1.1	-	0-0.85	0.85-1.1	1.1+	-	Hardpan ferricrete
TP1177/155	2.6	-	0-2.5	2.5-2.6	2.6+	-	Hardpan ferricrete
TP1177/156	1.8	-	0-1.7	1.7-1.8	1.8+	-	Hardpan ferricrete
TP1177/157	1.85	-	0-1.75	1.75-1.85	1.85+	-	Hardpan ferricrete
TP1177/158	1.45	-	0-1.3	1.3-1.45	1.45+	-	Hardpan ferricrete
TP1177/159	1.2	-	0-0.75	0.75-1.2	1.2+	-	Hardpan ferricrete
TP1177/160	1.6	-	0-1.5	1.5-1.6	1.6+	-	Hardpan ferricrete
TP1177/161	2.3	-	0-2.3	2.3+	-	-	Residual
TP1177/162	1.35	-	0-1.3	1.3-1.35	1.35+	-	Hardpan ferricrete
TP1177/163	1.95	-	0-1.85	1.85-1.95	1.95+	-	Hardpan ferricrete
TP1177/164	2.2	-	0-2.2	-	-	-	Residual dolerite
TP1177/165	1.8	-	0-1.7	1.7-1.8	1.8+	-	Hardpan ferricrete

Test pit no.	Depth (m)	Depth of groundwater perched/See page (m)	Depth to base of (m)		Hard rock excavation from (m)	Boulder encountered in profile	Material at base of test pit
			Soft excavation	Intermediate Excavation			
TP1177/166	1.7	-	0-1.65	1.65-1.7	1.7+	-	Hardpan ferricrete
TP1177/167	2.1	-	0-2.2	-	-	-	Nodular ferricrete
TP1177/168	1.7	-	0-1.7	-	-	-	Residual dolerite
TP1177/169	1.65	-	0-1.65	-	1.65+	-	Hardpan ferricrete
TP1177/170	2.15	-	0-2.15	-	-	-	Alluvium
TP1177/171	1.3	-	0-0.85	0.85-1.3	1.3+	-	Hardpan ferricrete
TP1177/172	1.3	-	0-0.95	0.95-1.3	1.3+	-	Hardpan ferricrete
TP1177/173	1.9	1.5	0-1.9	-	-	-	Residual mudrock?
TP1177/174	2.5	-	0-2.3	2.3-2.5	2.5+	-	Hardpan ferricrete
TP1177/175	1.6	1.6	0-1.5	1.5-1.6	1.6+	-	Hardpan ferricrete
TP1177/176	0.8	-	0-0.7	0.7-0.8	0.8+	-	Hardpan ferricrete
TP1177/177	2.15	-	0-2.0	2.0-2.15	2.15+	-	Hardpan ferricrete
TP1177/178	1.8	1.5	0-1.8	-	-	-	Residual mudrock?
TP1177/179	2.5	2.2	0-2.4	2.4-2.5	2.5+	-	Hardpan ferricrete
TP1177/180	2.85	-	0-2.85	-	-	-	Hardpan ferricrete
TP1177/181	1.9	-	0-1.9	-	1.9+	-	Hardpan ferricrete
TP1177/182	2.4	1.65	0-2.4	-	-	-	Alluvium
TP1177/183A	3.05	-	0-3.05	-	-	-	Residual dolerite
TP1177/184A	2.9	-	0-2.9	-	-	-	Residual dolerite
TP1177/185A	2.8	-	0-2.8	-	-	-	Residual dolerite
TP1177/186A	2.55	-	0-2.55	-	-	-	Residual dolerite
TP1177/187A	2.6	-	0-2.6	-	-	-	Residual dolerite
TP1177/188A	2.35	-	0-2.35	2.35+	-	-	Hardpan ferricrete
TP1177/189A	2.8	-	0-2.8	-	-	-	Residual dolerite
TP1177/190A	2.05	-	0-2.05	-	-	-	Residual dolerite
TP1177/191A	2.8	-	0-2.8	-	-	-	Residual dolerite
TP1177/192A	2.7	-	0-2.7	-	-	-	Residual dolerite
TP1177/193A	2.15	-	0-2.15	-	-	-	Residual dolerite
TP1177/194A	2.9	-	0-2.9	-	-	-	Residual dolerite
TP1177/195A	2.2	-	0-2.2	-	-	-	Residual dolerite

Test pit no.	Depth (m)	Depth of groundwater perched/See page (m)	Depth to base of (m)		Hard rock excavation from (m)	Boulder encountered in profile	Material at base of test pit
			Soft excavation	Intermediate Excavation			
TP1177/196A	1.8	-	0-1.8	-	-	-	Nodular ferricrete
TP1177/197	2.45	-	0-2.45	-	-	-	Residual lava
TP1177/198	1.7	-	0-1.7	-	1.7+	0.9-1.7	Cobbles
TP1177/199A	0.55	-	0-0.55	-	0.55+	0.5-0.55	Boulders and cobbles
TP1177/200A	2.1	2.05	0-2.1	-	2.1+	1.35-2.1	Cobbles
TP1177/201A	2.05	-	0-2.05	-	-	-	Residual lava
TP1177/203A	2.0	2.0	0-2.0	-	-	1.05-2.0	Alluvium
TP1177/204A	2.8	2.75	0-2.8	-	-	-	Alluvium
TP1177/205	2.5	1.85	0-2.5	-	-	-	Alluvium
TP1177/206	2.25	-	0-2.25	-	-	-	Nodular ferricrete
TP1177/207	1.7	-	0-1.7	-	-	-	Backfill
TP1177/208	0.75	-	0-0.75	-	0.75+	-	Quartzite rock
TP1177/210	0.35	-	0-0.35	-	0.35+	-	Quartzite rock
TP1177/211	0.3	-	0-0.3	-	0.3+	-	Quartzite rock
TP1177/213A	0.7	-	0-0.7	-	0.7+	-	Quartzite rock
TP1177/214	2.5	-	0-2.5	-	-	-	Residual lava
TP1177/215	2.15	-	0-2.15	-	-	-	Residual lava
TP1177/217	1.25	-	0-0.8	0.8-1.25	1.25+	-	Quartzite rock
TP1177/218	0.15	-	0-0.15	-	0.15+	-	Quartzite rock
TP1177/220	1.0	-	0-0.5	0.5-1.0	1.0+	-	Quartzite rock
TP1177/222	2.3	-	0-2.3	-	-	-	Residual quartzite
TP1177/223	1.74	1.4	0-1.8	-	-	-	Nodular ferricrete
TP1177/224	2.0	1.8	0-2.0	-	-	-	Residual quartzite
TP1177/225	1.8	1.65	0-1.7	1.7-1.8	1.8+	-	Hardpan ferricrete
TP1177/226	1.8	-	0-1.8	-	-	-	Nodular ferricrete
TP1177/227	2.6	-	0-2.5	2.5-2.6	2.6+	-	Hardpan ferricrete
TP1177/228	1.7	-	0-1.45	1.45-1.7	1.7+	-	Hardpan ferricrete
TP1177/229	1.14	-	0-1.02	1.02-1.14	1.14+	-	Hardpan ferricrete
TP1177/230	1.45	-	0-1.45	-	-	-	Residual quartzite
TP1177/231	2.35	-	0-2.35	-	-	-	Residual quartzite

Test pit no.	Depth (m)	Depth of groundwater perched/See page (m)	Depth to base of (m)		Hard rock excavation from (m)	Boulder encountered in profile	Material at base of test pit
			Soft excavation	Intermediate Excavation			
TP1177/232	1.17	-	0-0.93	0.93-1.17	1.17+	-	Hardpan ferricrete
TP1177/233	1.9	-	0-1.9	-	-	-	Residual quartzite
TP1177/234	2.36	-	0-2.36	-	-	-	Residual quartzite
TP1177/235	2.6	2.6	0-2.6	-	-	-	Residual quartzite
TP1177/236	1.13	-	0-0.93	0.93-1.13	1.13+	-	Hardpan ferricrete
TP1177/237	2.3	-	0-2.3	-	-	-	Transported
TP1177/238	0.97	-	0-0.97	-	0.97+	-	Residual quartzite
TP1177/239	1.1	-	0-1.1	-	-	-	Waste backfill
TP1177/240	1.76	1.66	0-1.18	1.18-1.76	1.76+	-	Residual quartzite
TP1177/241	1.05	-	0-0.7	0.7-1.05	1.05	-	Residual quartzite
TP1177/242	1.78	-	0-0.96	0.96-1.78	1.78+	-	Residual quartzite
TP1177/243	2.24	2.24	0-2.24	-	-	-	Transported
TP1177/244	2.25	1.85	0-2.25	-	-	-	Transported
TP1177/245	2.0	1.4	0-2.0	-	-	-	Residual quartzite
TP1177/246	0.5	-	0-0.5	-	0.5+	-	Quartzite rock
TP1177/247	1.76	-	0-1.76	-	-	0-1.0	Residual mudrock
TP1177/248	2.23	-	0-2.23	-	-	-	Residual mudrock
TP1177/249	1.91	-	0-1.91	-	-	-	Residual mudrock
TP1177/250	1.1	-	0-1.1	1.1+	-	-	Quartzite rock
TP1177/251	1.8	-	0-1.8	1.8+	-	-	Residual quartzite
TP1177/252	1.23	-	0-1.23	1.23+	-	-	Residual quartzite
TP1177/253	1.5	-	0-1.5	1.5+	-	-	Residual quartzite
TP1177/254	0.87	-	0-0.87	0.87+	-	-	Quartzite rock
TP1177/255	1.25	-	0-1.25	-	1.25+	-	Quartzite rock
TP1177/256	2.15	-	0-1.9	1.9-2.15	2.15+	-	Hardpan ferricrete
TP1177/257	1.15	1.05	0-0.85	0.85-1.15	1.15+	-	Quartzite rock
TP1177/258	1.25	-	0-0.95	0.95-1.25	1.25+	-	Quartzite rock
TP1177/259	1.35	-	0-1.25	1.25-1.35	1.35+	-	Quartzite rock
TP1177/260	0.95	-	0-0.75	0.75-0.85	0.85+	-	Quartzite rock
TP1177/261	1.90	-	0-1.2	1.2-1.9	1.9+	-	Residual quartzite

Test pit no.	Depth (m)	Depth of groundwater perched/See page (m)	Depth to base of (m)		Hard rock excavation from (m)	Boulder encountered in profile	Material at base of test pit
			Soft excavation	Intermediate Excavation			
TP1177/262	1.0	-	0-0.64	0.64-1.0	1.0+	-	Quartzite rock
TP1177/263	0.85	-	0-0.1	0.1-0.85	0.85+	-	Quartzite rock
TP1177/264	0.85	-	0-0.6	0.6-0.85	0.85+	-	Quartzite rock
TP1177/265	0.75	-	0-0.6	0.6-0.75	0.75+	-	Quartzite rock
TP1177/266	0.4	-	0-0.1	0.1-0.4	0.4+	-	Quartzite rock
TP1177/267	2.05	1.90	0-1.3	1.3-2.05	2.05+	-	Quartzite rock
TP1177/268	1.07	-	0-0.78	0.78-1.07	1.07+	-	Quartzite rock
TP1177/269	1.28	-	0-0.84	0.84-1.28	1.28+	-	Quartzite rock
TP1177/270	1.75	-	0-1.35	1.35-1.75	1.75+	-	Quartzite rock
TP1177/271	1.58	-	0-0.8	0.8-1.58	1.58+	-	Quartzite rock
TP1177/272	2.05	-	0-2.0	2.0-2.05	2.05+	-	Quartzite rock
TP1177/273	1.8	-	0-1.8	-	1.8+	-	Quartzite rock
TP1177/274	1.56	-	0-0.96	0.96-1.56	1.56+	-	Quartzite rock
TP1177/275	1.65	-	0-1.6	1.6-1.65	1.65+	-	Quartzite rock
TP1177/276	1.1	-	0-1.63	1.63-1.1	1.1+	-	Quartzite rock

LEEUWPOORT

TABLE 2/1 : SUMMARIES OF LABORATORY TEST RESULTS (DISTURBED SAMPLES) IR801

TP No.	Depth (m)	Soil Unit	LL	PI (425)	LS %	GM	NMC (%)	PI_w	LL_w	425 %	002 %	pH	Cond	Resis. Ohm. Cm	PRA	USC
116	1,8	Colluvium	29,2	9,9	4,7	0,60		8,7	25,9	89	13				A-4	CL
117	1,5	Colluvium	28,9	5,1	2,7	0,50	18,9	4,6	26,0	90	9	5,37	0,18	555	A-4	ML/OL
121	1,4	Colluvium	29,4	8,4	4,0	0,98		6,1	21,5	73	10				A-4	SC
134	1,5	Colluvium	30,7	8,6	4,0	0,93		6,4	22,7	74	11				A-4	CL
136	1,7	Colluvium	27,7	10,8	6,0	1,64	11,2	5,0	12,7	46	6	5,29	0,13	769	A-2-6	SC
140	1,6	Colluvium	27,8	10,5	5,3	0,66		9,0	23,9	86	12				A-6	CL
161	1,6	Colluvium	26,4	6,8	3,3	0,68		5,7	22,2	84	12				A-4	CL-ML
178	1,2	Colluvium	28,8	10,1	6,7	0,75		8,8	25,1	87	9				A-6	SC
196A	1,8	Colluvium	29,0	10,7	6,0	0,54		9,6	25,8	89	16				A-6	CL
237	1,7	Colluvium	79,5	31,2	14,7	0,24	38,9	29,2	73,9	93	31	6,51	1,69	59	A-7-5	MH/OH
237	1,0	Colluvium	70,8	33,4	16,7	0,19		31,6	67,3	95	27				A-7-5	MH/OH
237	1,0	Colluvium	79,5	31,2	14,7	0,24		29,2	73,9	93	31				A-7-5	MH/OH
49	1,0	Alluvium	28,0	8,0	4,0	0,61	0,95	7,3	25,5	91	13	5,42	0,11	909	A-4	SC
50	1,9/2,8	Alluvium	34,5	10,4	5,3	0,69		8,3	27,6	80	12				A-6	ML/OL
56	1,2	Alluvium	25,4	5,6	3,3	0,56	14,7	5,1	22,9	90	9	5,40	0,11	909	A-4	CL/ML
68	1,2	Alluvium	63,5	28,1	14,0	0,31		25,9	58,4	92	23				A-7-5	MH/OH
182	1,5	Alluvium	40,2	11,6	6,7	0,72		9,2	31,7	79	11				A-7-6	ML/OL
205	1,8	Alluvium	52,1	21,4	10,7	0,51		18,0	43,8	84	20				A-7-5	MH/OH
243	1,0/1,5	Alluvium	23,3	9,7	4,7	0,78		7,6	18,2	78	9				A-4	SC
245	0,5/1,0	Alluvium	16,0	4,9	2,7	1,19		2,9	9,6	60	3				A-2-4	SC/SM

LL : Liquid Limit
PI (425) : Plasticity index of sample fine portion
LS : Linear shrinkage
075 : Percent passing 75 µ.m.
425 : Percent passing 425 µ.m.
002 : Percent passing 2 µ.m.
LL_w : Liquid Limit of whole sample (LL x passing 425)

GM : Grading modulus
PI_w : Plasticity index of whole sample (PI x passing 425)
NMC(%) : Natural moisture content
PRA : Public Roads Administration Classification
USC : Unified Soil Classification
Cond. : Conductivity Sm
Resis. : Resistivity ohm.cm

LEEUWPOORT

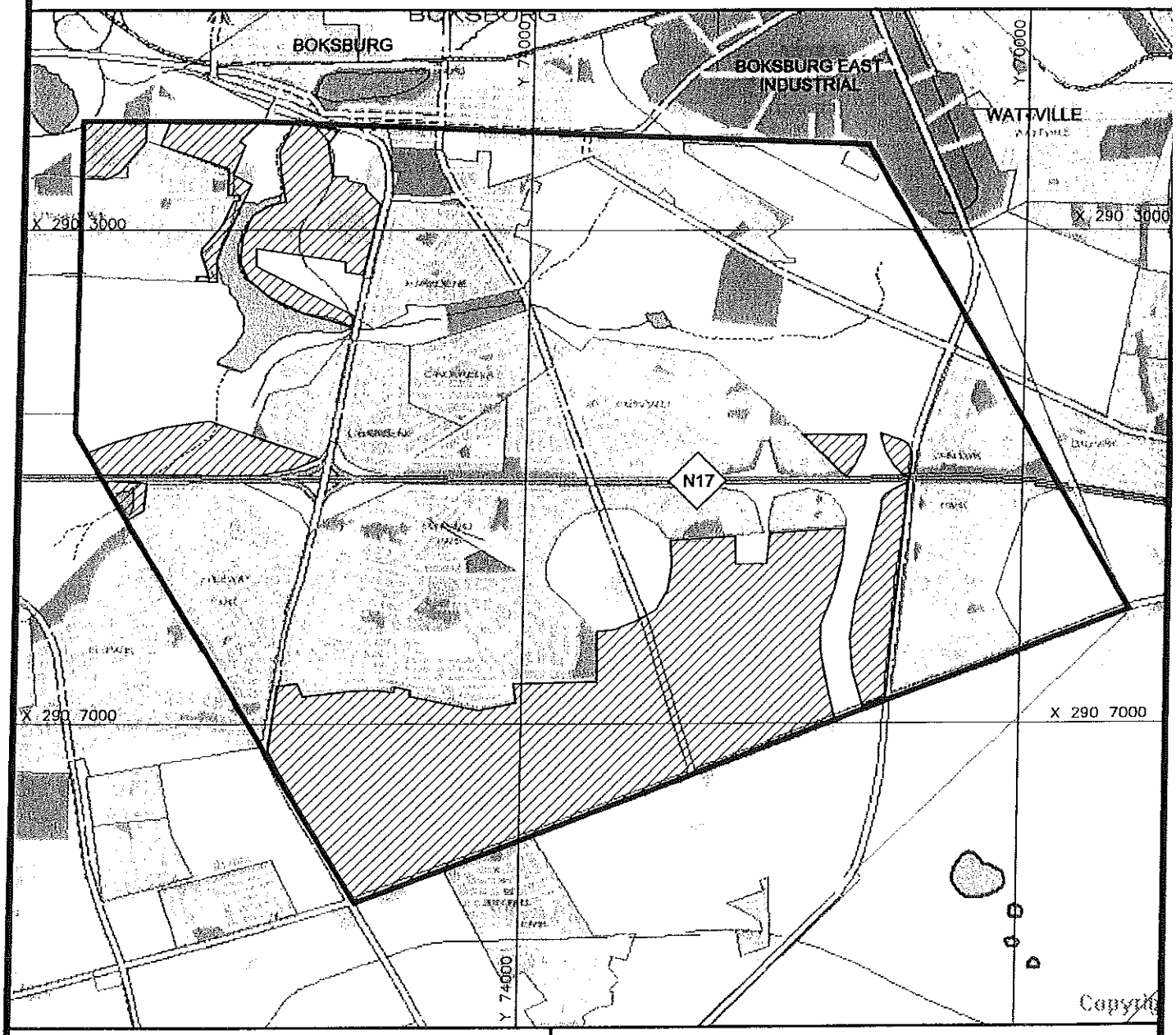
TABLE 2/2 : SUMMARIES OF LABORATORY TEST RESULTS (DISTURBED SAMPLES) IR801

TP No.	Depth (m)	Soil Unit	LL	PI (425)	LS %	GM	NMC (%)	PI_w	LL_w	425 %	002 %	pH	Cond	Resis. Ohm. Cm	PRA	USC
2	1,0/2,7	Ferricrete	26,5	10,2	5,3	1,55		4,8	12,7	48	3				A-2-6	SC
97	1,5	Ferricrete	42,1	20,0	10,0	1,22		11,5	24,4	58	10				A-7-6	SC
100	1,8	Ferricrete	48,2	19,9	10,0	0,50		16,8	40,9	85	18				A-7-6	ML/OL
107	1,5	Ferricrete	34,0	10,7	5,3	1,60		5,2	16,3	48	8				A-2-6	SC
146	1,3	Ferricrete	27,1	8,2	4,0	1,65		3,9	12,7	47	7	5,52	0,18	555	A-2-4	SC
157	1,5	Ferricrete	28,9	9,1	4,7	1,49		5,0	15,9	55	6				A-2-4	SC
166	1,4	Ferricrete	34,9	11,0	6,0	1,16		7,0	21,9	63	9				A-6	SM
228	1,3	Ferricrete	25,6	9,4	4,7	0,93		7,0	19,2	75	8				A-4	SC
230	0,6/1,0	Ferricrete	26,2	9,4	4,7	0,69		7,3	20,4	78	13				A-4	CL
179	1,6	Ferricrete	31,0	10,5	5,3	1,25		6,4	18,9	61	10				A-6	SC
125	1,7	Ferricrete	42,7	18,1	9,3	1,43		9,5	22,6	53	11				A-7-6	SC
225	1,6	Ferricrete	33,3	14,7	7,3	0,79		11,0	24,9	75	11	6,43	0,38	263	A-6	CL
192A	1,8	Ferricrete	47,9	16,4	8,0	0,65		13,5	39,3	82	18				A-7-5	ML/OL
133	1,4	Ferricrete	33,7	10,5	6,7	1,32		6,1	19,9	59	8				A-6	SC
46	1,7/2,3	Res.Quartzite	35,1	10,6	5,3	0,78		8,3	27,4	78	11	4,53	0,10	1000	A-6	ML/OL
222	1,0/2,0	Res.Quartzite	28,2	13,6	6,7	0,59		11,9	24,5	87	17				A-6	CL
240	0,8/1,1	Res.Quartzite	27,7	10,2	5,3	1,58		4,6	12,5	45	7				A-2-6	SC
81	1,5	Res.Sandstone	29,3	9,6	4,7	1,18		6,7	20,5	70	10	4,50	0,10	1000	A-2-4	SC

LL : Liquid Limit
PI (425) : Plasticity index of sample fine portion
LS : Linear shrinkage
075 : Percent passing 75 µ.m.
425 : Percent passing 425 µ.m.
002 : Percent passing 2 µ.m.
LL_w : Liquid Limit of whole sample (LL x passing 425)

GM : Grading modulus
PI_w : Plasticity index of whole sample (PI x passing 425)
NMC(%) : Natural moisture content
PRA : Public Roads Administration Classification
USC : Unified Soil Classification
Cond. : Conductivity Sm
Resis. : Resistivity ohm.cm

RE OF LEEUWPOORT 113-I.R.
LOCALITY PLAN



AREA FOR FULL INVESTIGATION
TOTAL AREA = 1835 ha

INTRACONSULT
CONSULTING ENGINEERING
GEOLOGISTS

P.O.Box 604, Fourways 2055
TEL. (011) 469-0854

scale	date	drawn	rev.no	ref.no
1 :50000	SEPT.2006	MAPTECH	0	IR 801

APPENDIX 2

SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	116	**Depth**	1.8m
Sample	(D) Colluvium		

SIEVE ANALYSIS

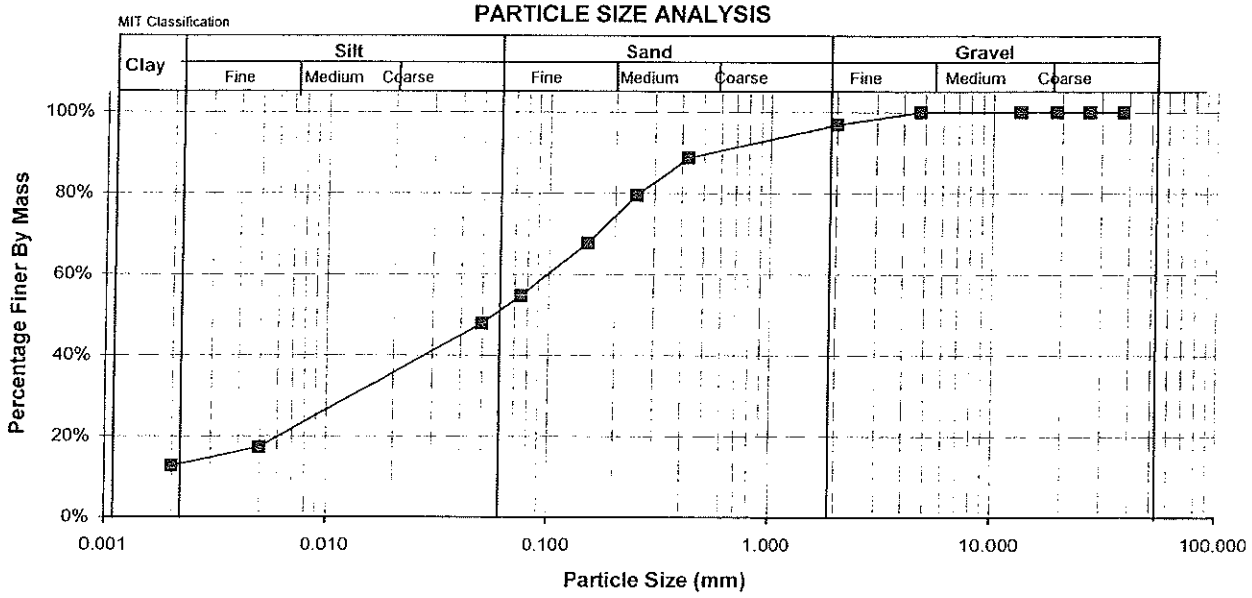
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	79%
26.500	100%	0.150	68%
19.000	100%	0.075	55%
13.200	100%	0.050	48%
4.750	100%	0.005	17%
2.000	97%	0.002	13%
0.425	89%		

ATTERBERG LIMITS

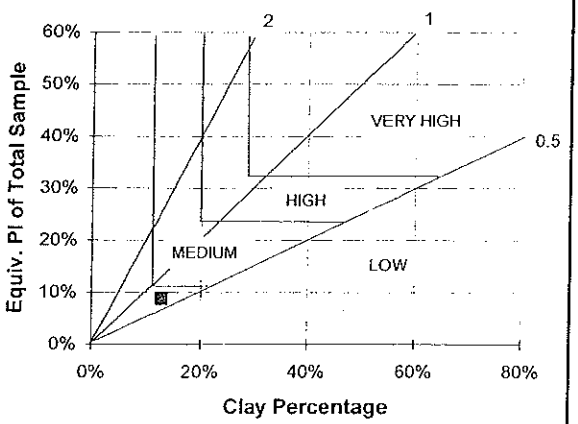
	Test 1	Test 2
Liquid Limit	28.7%	29.7%
Average	**29.2%**	
Plastic Limit	19.4%	19.3%
Average	**19.3%**	
Plasticity Index (PI)	9.9%	
Linear Shrinkage	4.7%	
Grading Modulus	0.60	

PRA Classification	A-4 [4]
Unified Classification	CL
PI of whole sample	8.7%
% Gravel	3.2%
% Sand	45.9%
% Silt	38.2%
% Clay	12.6%

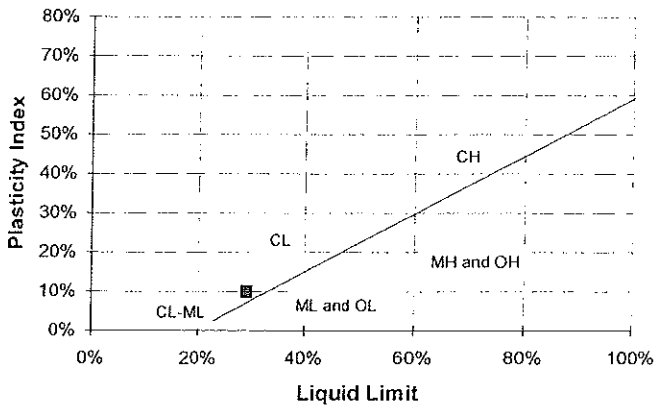
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/08
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	117	Depth	1.5m
Sample	Colluvium		

SIEVE ANALYSIS

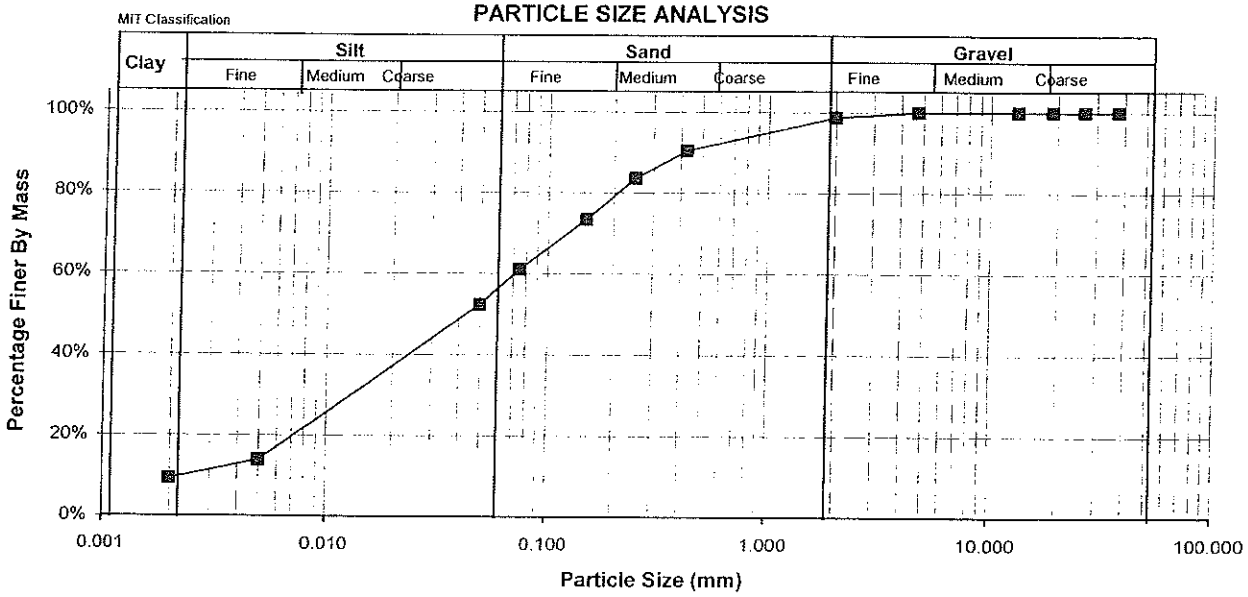
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	83%
26.500	100%	0.150	73%
19.000	100%	0.075	61%
13.200	100%	0.050	52%
4.750	100%	0.005	14%
2.000	99%	0.002	9%
0.425	90%		

ATTERBERG LIMITS

	Test 1	Test 2
Liquid Limit	28.5%	29.4%
Average	28.9%	
Plastic Limit	24.0%	23.7%
Average	23.8%	
Plasticity Index (PI)	5.1%	
Linear Shrinkage	2.7%	
Grading Modulus	0.50	

PRA Classification	A-4 [5]
Unified Classification	ML/OL
PI of whole sample	4.6%
% Gravel	1.4%
% Sand	42.5%
% Silt	46.8%
% Clay	9.3%

PARTICLE SIZE ANALYSIS



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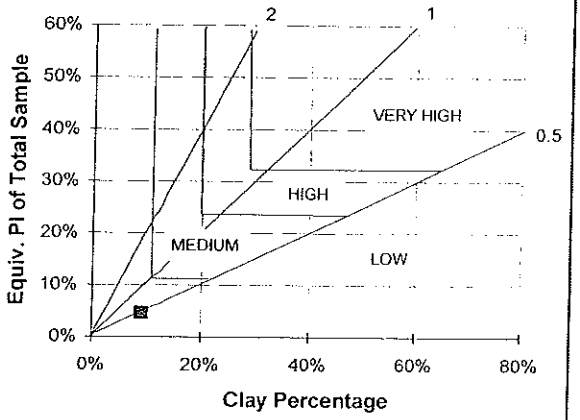

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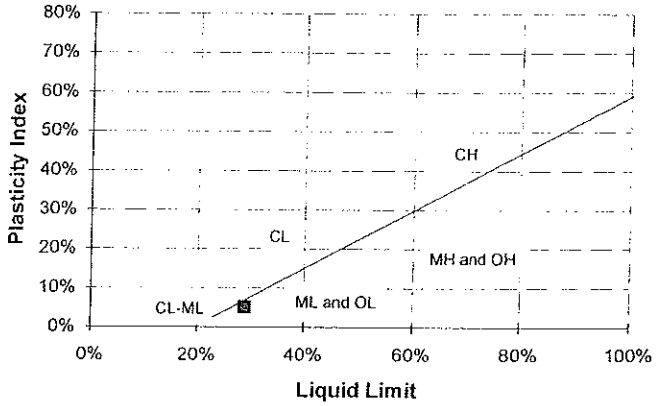


SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	121	**Depth**	1.4m
Sample	(D) Colluvium		

SIEVE ANALYSIS

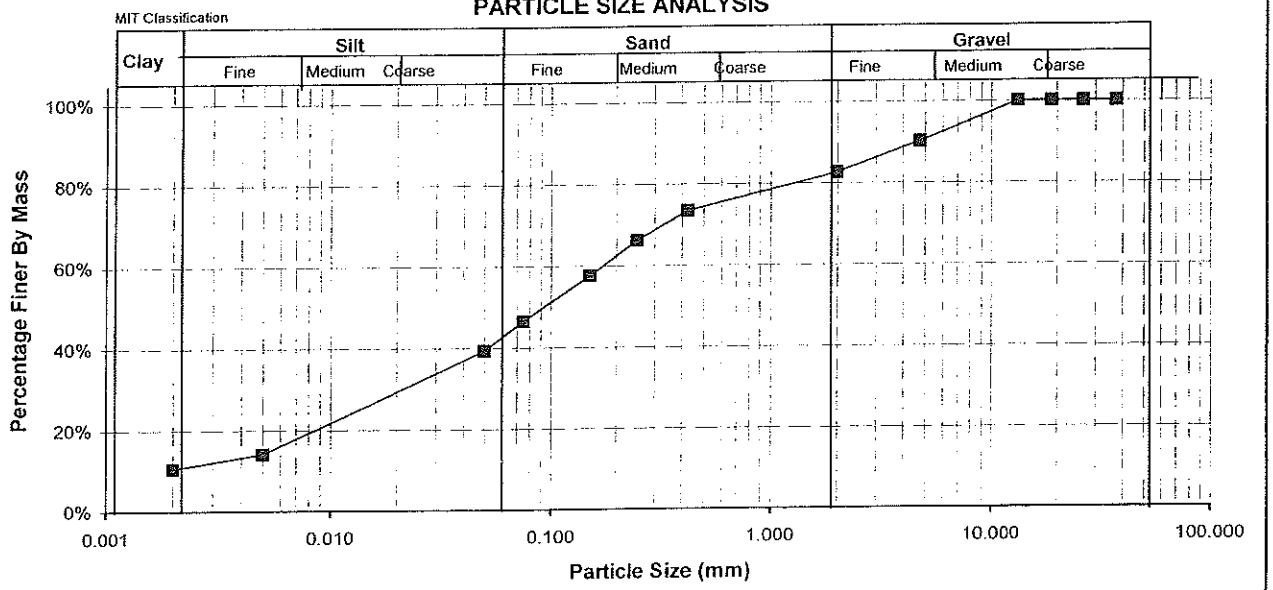
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	66%
26.500	100%	0.150	58%
19.000	100%	0.075	46%
13.200	100%	0.050	39%
4.750	90%	0.005	14%
2.000	83%	0.002	10%
0.425	73%		

ATTERBERG LIMITS

	Test 1	Test 2
Liquid Limit	29.2%	29.6%
Average	**29.4%**	
Plastic Limit	21.5%	20.5%
Average	**21.0%**	
Plasticity Index (PI)	8.4%	
Linear Shrinkage	4.0%	
Grading Modulus	0.98	

PRA Classification	A-4 [2]
Unified Classification	SC
PI of whole sample	6.1%
% Gravel	17.4%
% Sand	40.1%
% Silt	32.0%
% Clay	10.5%

PARTICLE SIZE ANALYSIS



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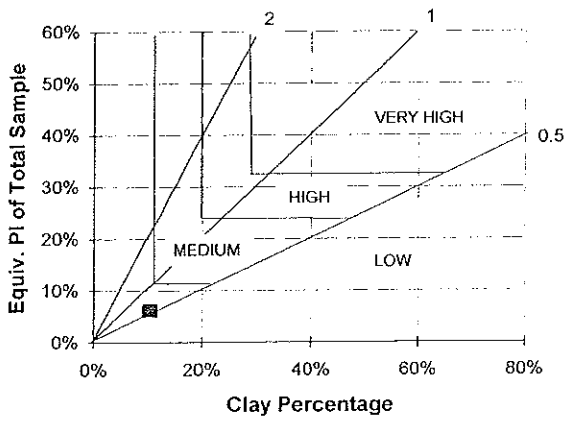

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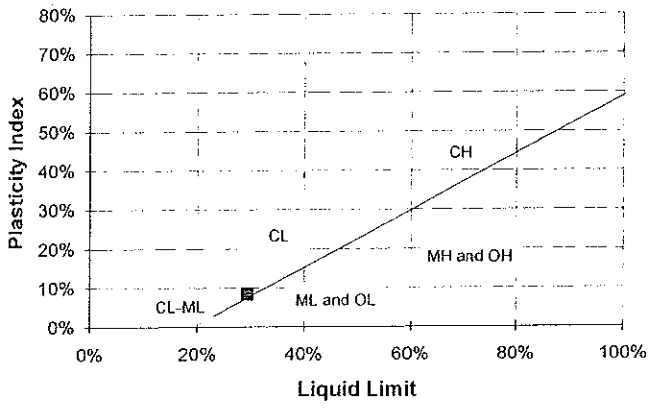


SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/08
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	134	Depth	1.5m
Sample	(D) Colluvium		

SIEVE ANALYSIS

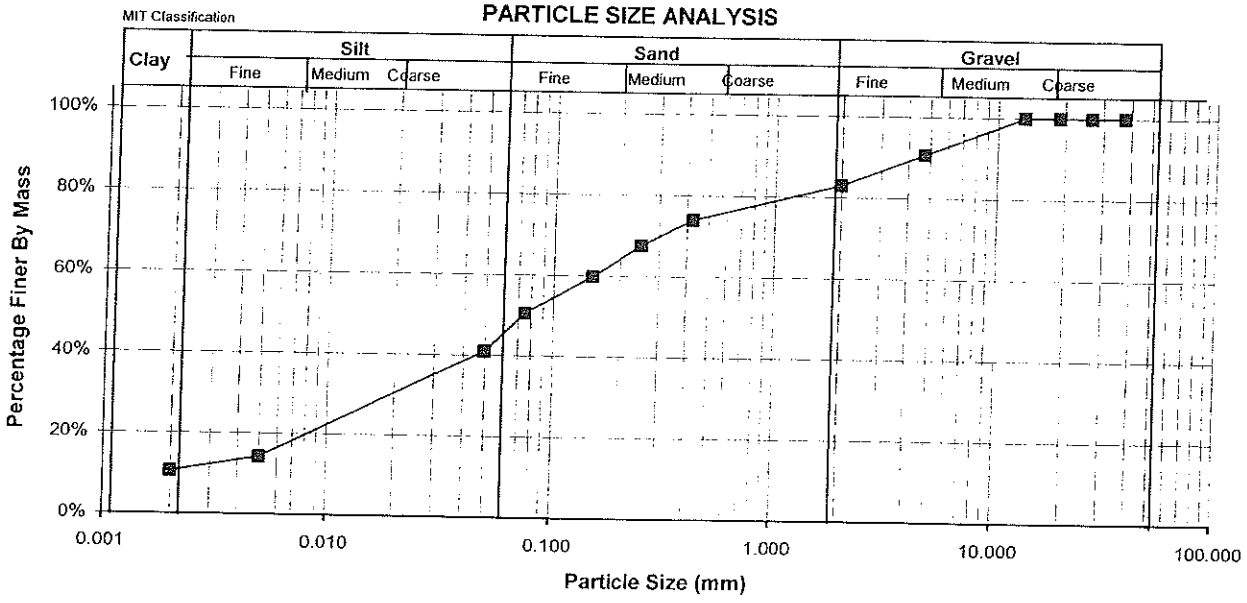
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	67%
26.500	100%	0.150	60%
19.000	100%	0.075	51%
13.200	100%	0.050	41%
4.750	91%	0.005	14%
2.000	83%	0.002	11%
0.425	74%		

ATTERBERG LIMITS

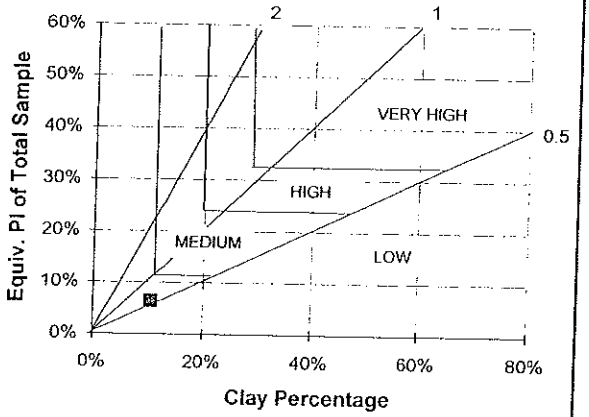
	Test 1	Test 2
Liquid Limit	30.8%	30.7%
Average	**30.7%**	
Plastic Limit	21.6%	22.7%
Average	**22.1%**	
Plasticity Index (PI)	8.6%	
Linear Shrinkage	4.0%	
Grading Modulus	0.93	

PRA Classification	A-4 [3]
Unified Classification	CL
PI of whole sample	6.4%
% Gravel	17.1%
% Sand	37.6%
% Silt	34.7%
% Clay	10.5%

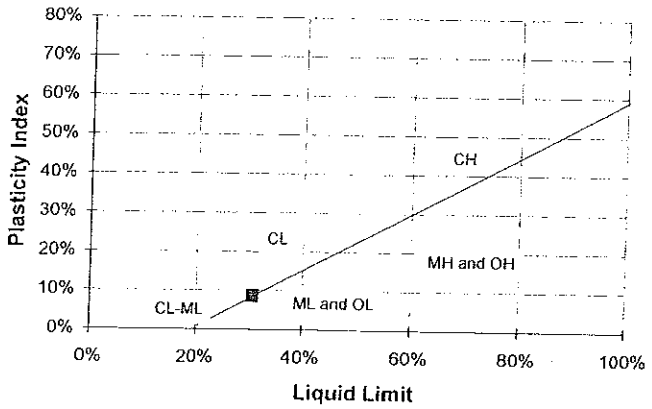
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	136	**Depth**	1.7m
Sample	Colluvium		

SIEVE ANALYSIS

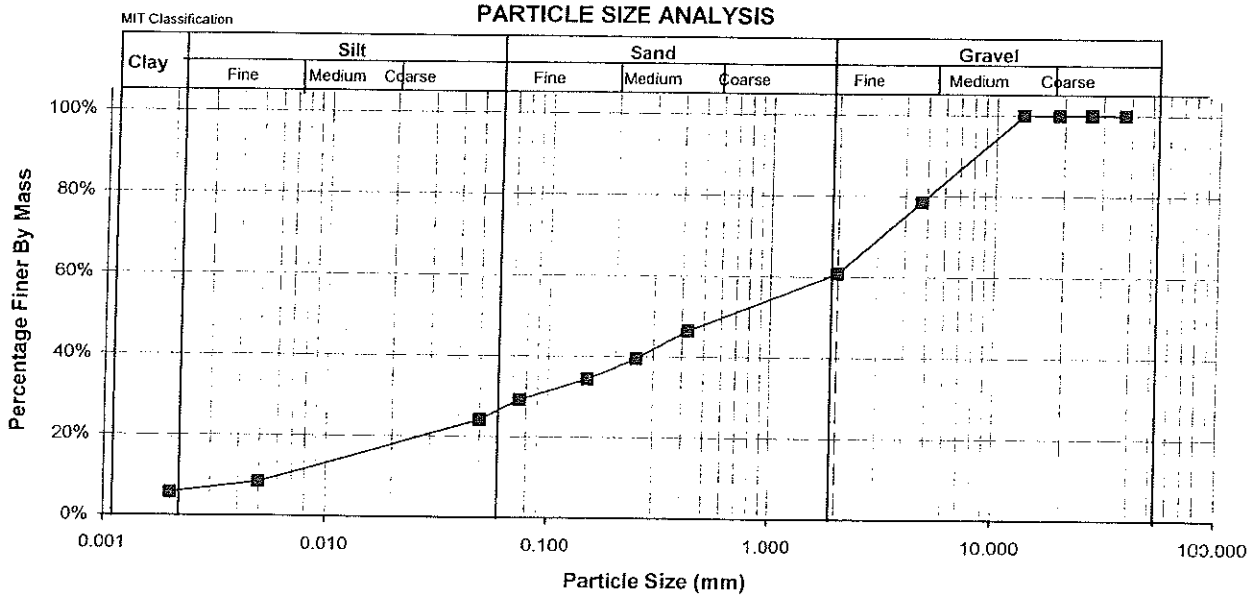
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	39%
26.500	100%	0.150	34%
19.000	100%	0.075	29%
13.200	100%	0.050	24%
4.750	78%	0.005	8%
2.000	61%	0.002	6%
0.425	46%		

ATTERBERG LIMITS

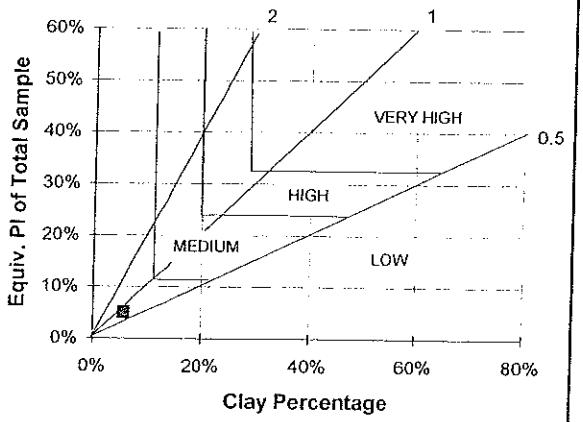
	Test 1	Test 2
Liquid Limit	27.9%	27.6%
Average	**27.7%**	
Plastic Limit	16.7%	17.0%
Average	**16.9%**	
Plasticity Index (PI)	10.8%	
Linear Shrinkage	6.0%	
Grading Modulus	1.64	

PRA Classification	A-2-6 [0]
Unified Classification	SC
PI of whole sample	5.0%
% Gravel	39.2%
% Sand	34.4%
% Silt	20.6%
% Clay	5.7%

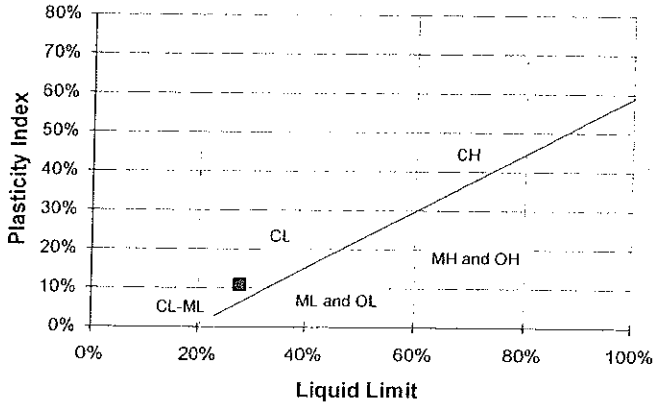
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/08
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	140	Depth	1.6m
Sample	(D) Colluvium		

SIEVE ANALYSIS

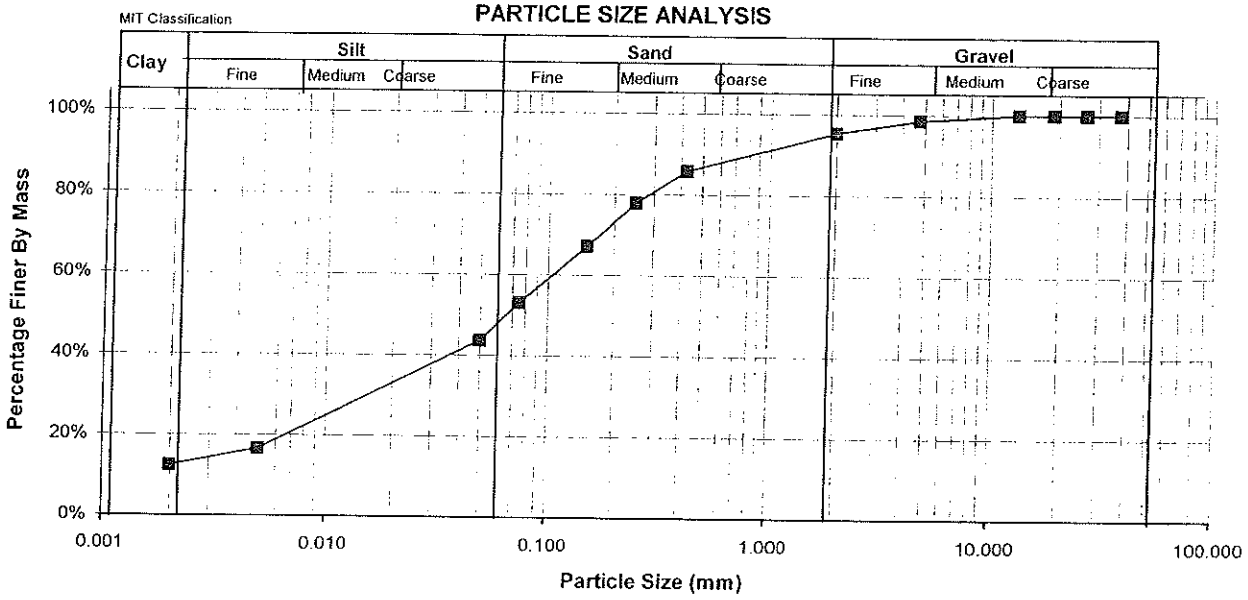
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	78%
26.500	100%	0.150	67%
19.000	100%	0.075	53%
13.200	100%	0.050	44%
4.750	98%	0.005	17%
2.000	95%	0.002	12%
0.425	86%		

ATTERBERG LIMITS

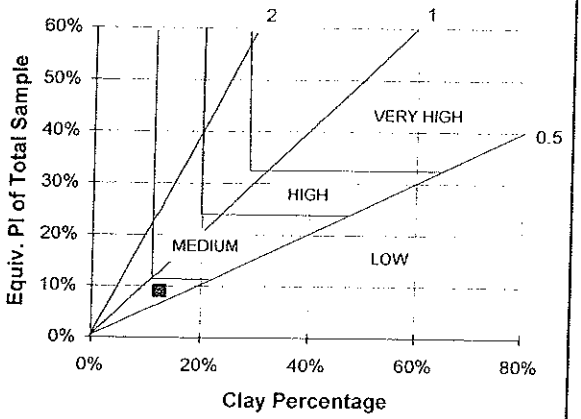
	Test 1	Test 2
Liquid Limit	27.9%	27.7%
Average	**27.8%**	
Plastic Limit	17.1%	17.5%
Average	**17.3%**	
Plasticity Index (PI)	10.5%	
Linear Shrinkage	5.3%	
Grading Modulus	0.66	

PRA Classification	A-6 [4]
Unified Classification	CL
PI of whole sample	9.0%
% Gravel	4.7%
% Sand	47.5%
% Silt	35.4%
% Clay	12.5%

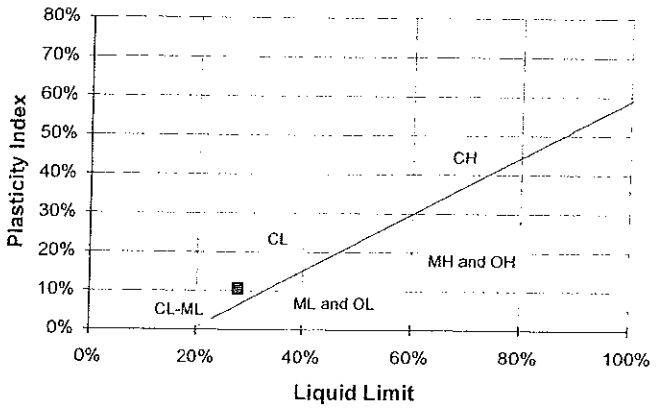
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	161	**Depth**	1.6m
Sample	(D) Colluvium		

SIEVE ANALYSIS

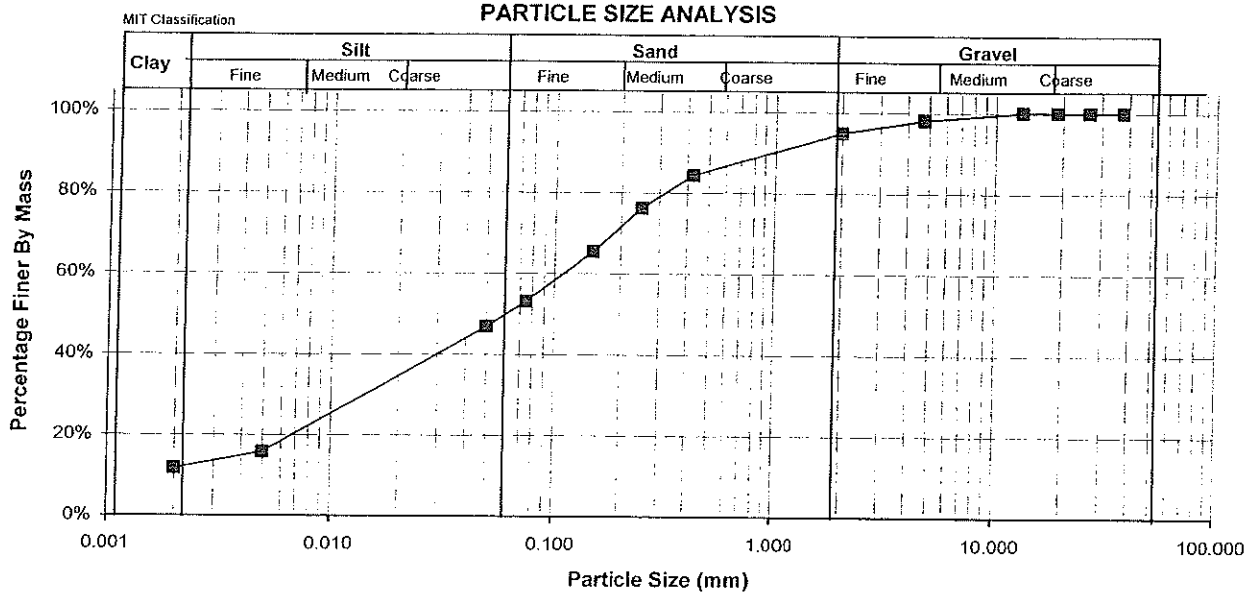
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	76%
26.500	100%	0.150	65%
19.000	100%	0.075	53%
13.200	100%	0.050	47%
4.750	98%	0.005	16%
2.000	95%	0.002	12%
0.425	84%		

ATTERBERG LIMITS

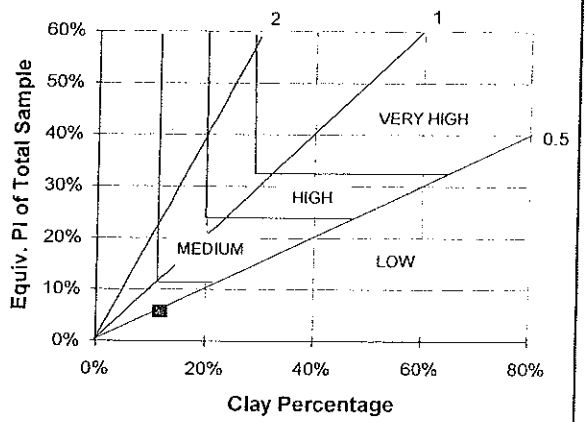
	Test 1	Test 2
Liquid Limit	26.5%	26.4%
Average	**26.4%**	
Plastic Limit	19.8%	19.4%
Average	**19.6%**	
Plasticity Index (PI)	6.8%	
Linear Shrinkage	3.3%	
Grading Modulus	0.68	

PRA Classification	A-4 [4]
Unified Classification	CL-ML
PI of whole sample	5.7%
% Gravel	5.1%
% Sand	45.2%
% Silt	37.9%
% Clay	11.7%

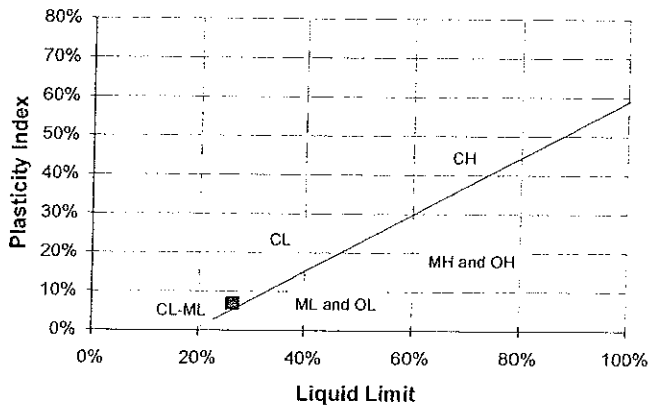
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/09
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	178	Depth	1.2m
Sample	(D) Colluvium		

SIEVE ANALYSIS

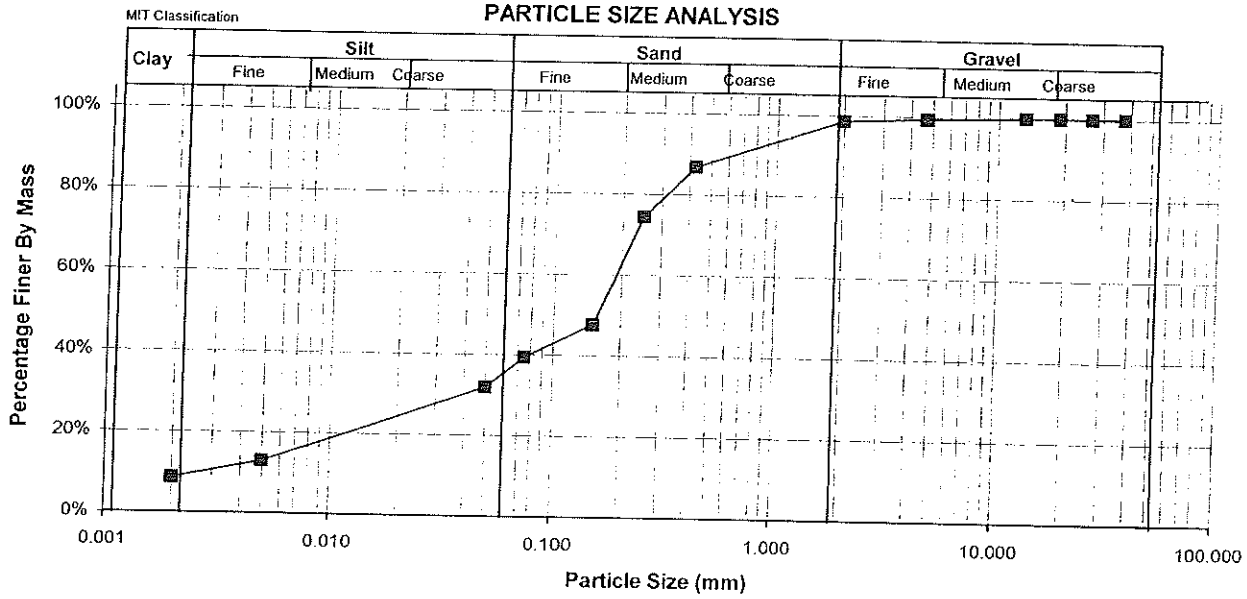
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	74%
26.500	100%	0.150	48%
19.000	100%	0.075	39%
13.200	100%	0.050	32%
4.750	99%	0.005	13%
2.000	99%	0.002	9%
0.425	87%		

ATTERBERG LIMITS

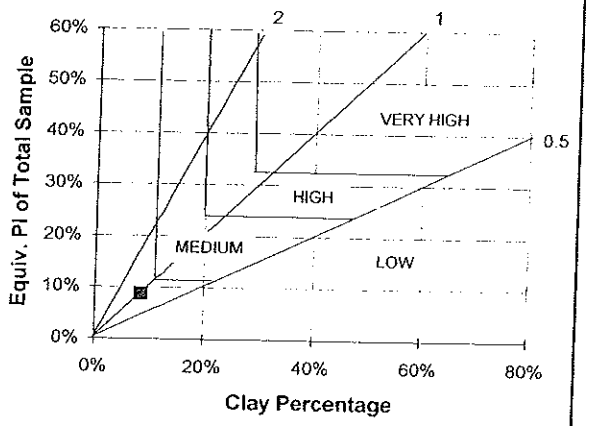
	Test 1	Test 2
Liquid Limit	28.7%	28.8%
Average	**28.8%**	
Plastic Limit	18.6%	18.8%
Average	**18.7%**	
Plasticity Index (PI)	10.1%	
Linear Shrinkage	6.7%	
Grading Modulus	0.75	

PRA Classification	A-6 [1]
Unified Classification	SC
PI of whole sample	8.8%
% Gravel	1.4%
% Sand	63.4%
% Silt	26.7%
% Clay	8.6%

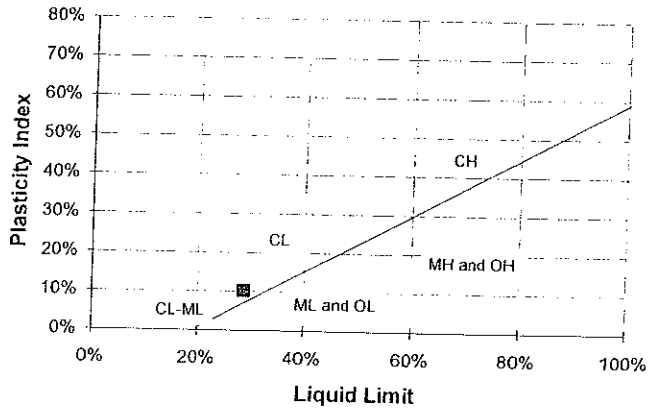
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/09
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	196A	**Depth**	1.8m
Sample	(D) Colluvium		

SIEVE ANALYSIS

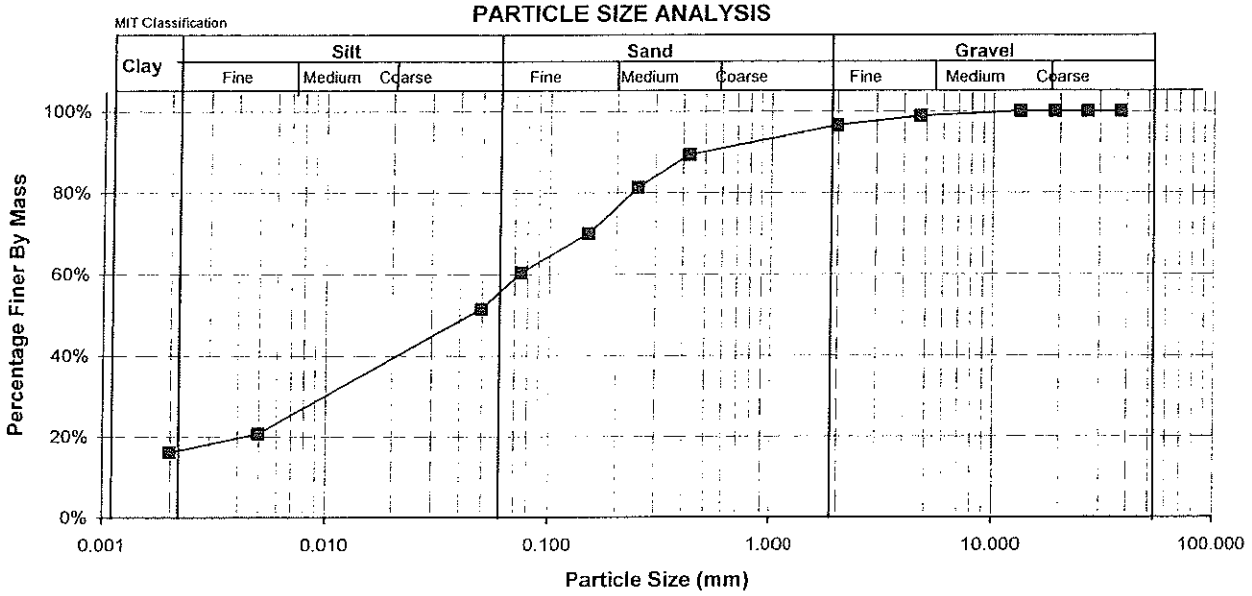
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	81%
26.500	100%	0.150	70%
19.000	100%	0.075	60%
13.200	100%	0.050	52%
4.750	99%	0.005	21%
2.000	97%	0.002	16%
0.425	89%		

ATTERBERG LIMITS

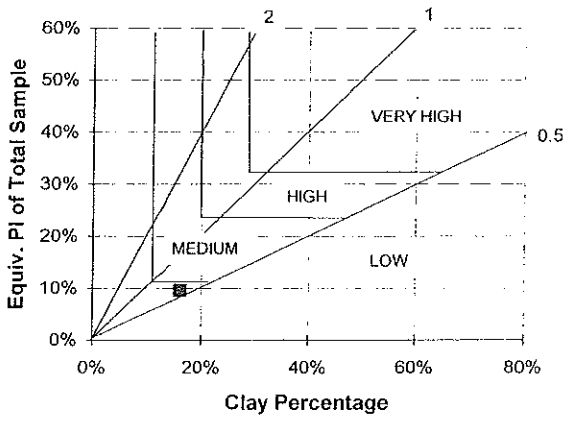
	Test 1	Test 2
Liquid Limit	28.8%	29.2%
Average	**29.0%**	
Plastic Limit	18.5%	18.1%
Average	**18.3%**	
Plasticity Index (PI)	10.7%	
Linear Shrinkage	6.0%	
Grading Modulus	0.54	

PRA Classification	A-6 [5]
Unified Classification	CL
PI of whole sample	9.6%
% Gravel	3.5%
% Sand	41.0%
% Silt	39.4%
% Clay	16.1%

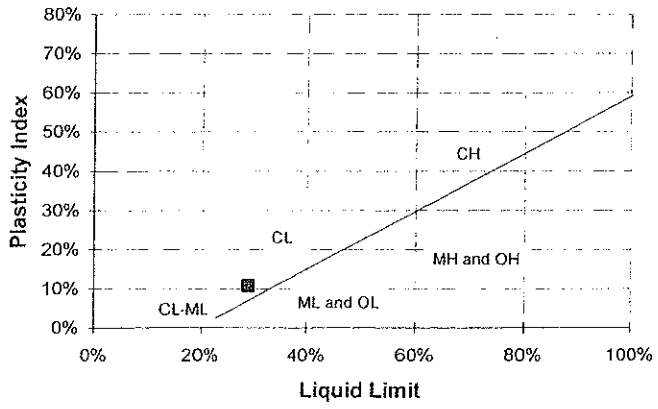
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	237	**Depth**	1.7m
Sample	(D) Colluvium		

SIEVE ANALYSIS

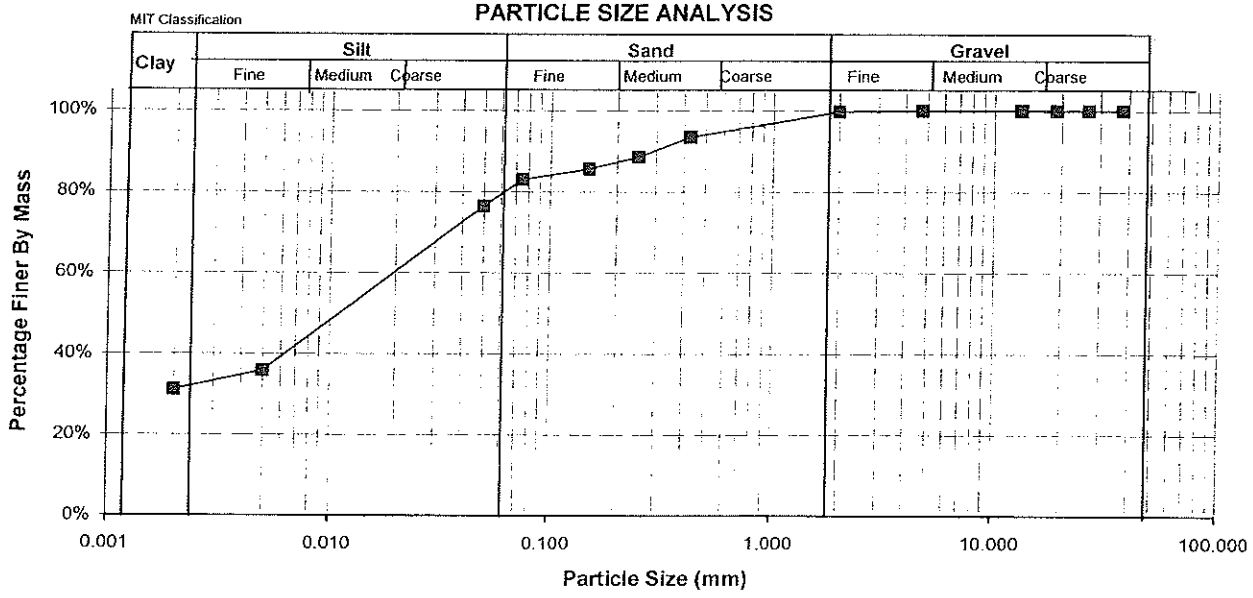
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	89%
26.500	100%	0.150	86%
19.000	100%	0.075	83%
13.200	100%	0.050	76%
4.750	100%	0.005	36%
2.000	100%	0.002	31%
0.425	93%		

ATTERBERG LIMITS

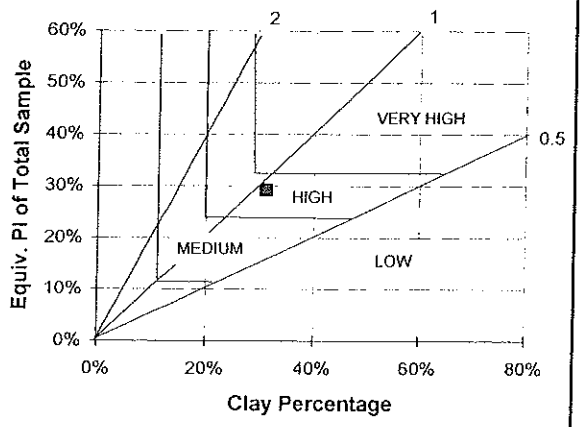
	Test 1	Test 2
Liquid Limit	79.9%	79.1%
Average	79.5%	
Plastic Limit	48.3%	48.3%
Average	48.3%	
Plasticity Index (PI)	31.2%	
Linear Shrinkage	14.7%	
Grading Modulus	0.24	

PRA Classification	A-7-5 [20]
Unified Classification	MH/OH
PI of whole sample	29.2%
% Gravel	0.3%
% Sand	20.4%
% Silt	48.2%
% Clay	31.1%

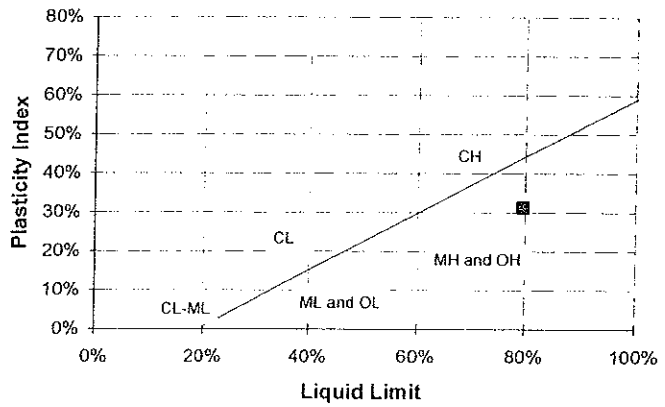
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	Leeuw Poort	**Job #**	26559
Site	Leeuw Poort		
Test Pos	237	**Depth**	1.0m
Sample	Colluvium		

SIEVE ANALYSIS

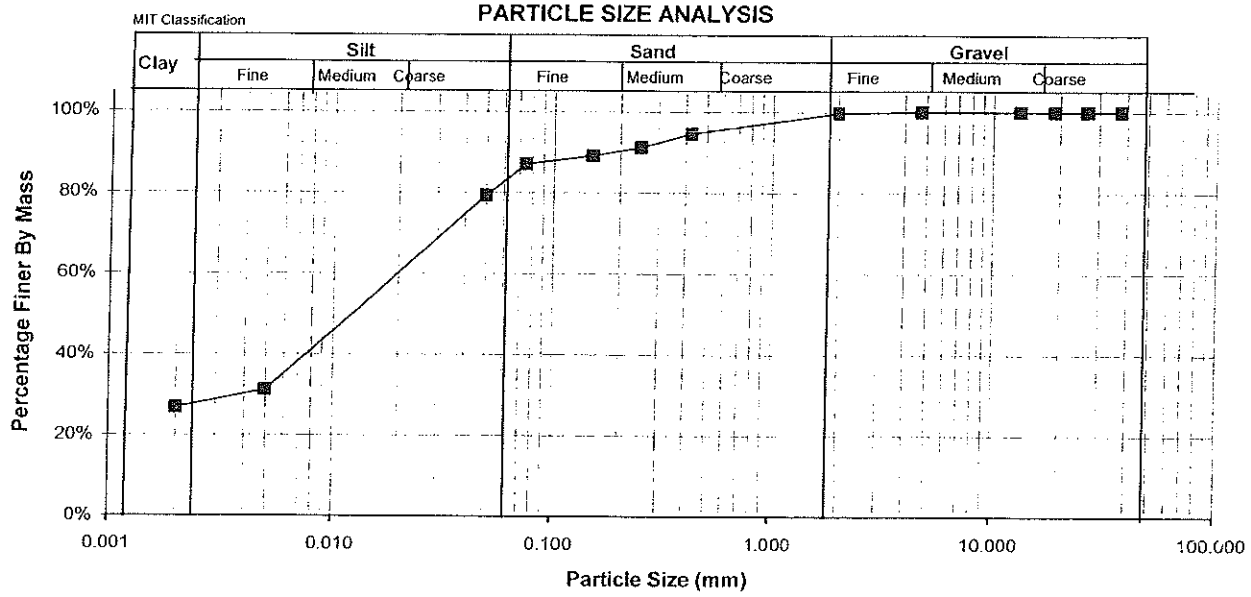
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	91%
26.500	100%	0.150	89%
19.000	100%	0.075	87%
13.200	100%	0.050	79%
4.750	100%	0.005	31%
2.000	100%	0.002	27%
0.425	95%		

ATTERBERG LIMITS

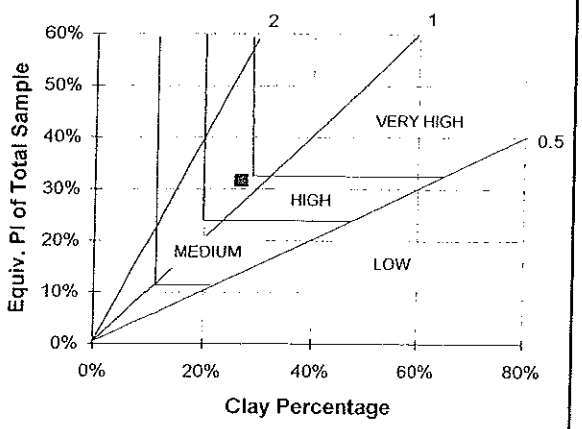
	Test 1	Test 2
Liquid Limit	70.1%	71.5%
Average	**70.8%**	
Plastic Limit	37.7%	37.0%
Average	**37.4%**	
Plasticity Index (PI)	33.4%	
Linear Shrinkage	16.7%	
Grading Modulus	0.19	

PRA Classification	A-7-5 [20]
Unified Classification	MH/OH
PI of whole sample	31.6%
% Gravel	0.3%
% Sand	17.0%
% Silt	55.9%
% Clay	26.8%

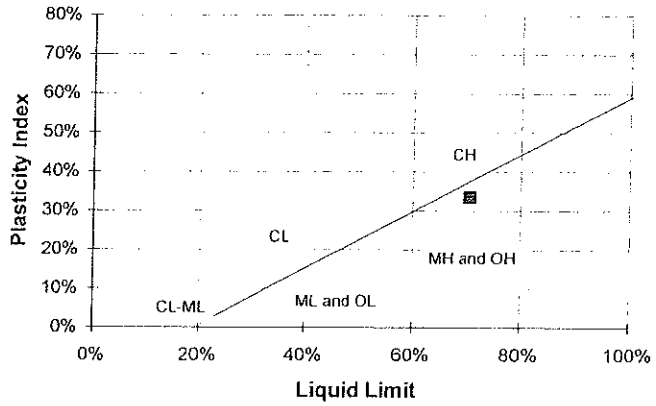
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	237	**Depth**	1.0m
Sample	(D) Colluvium		

SIEVE ANALYSIS

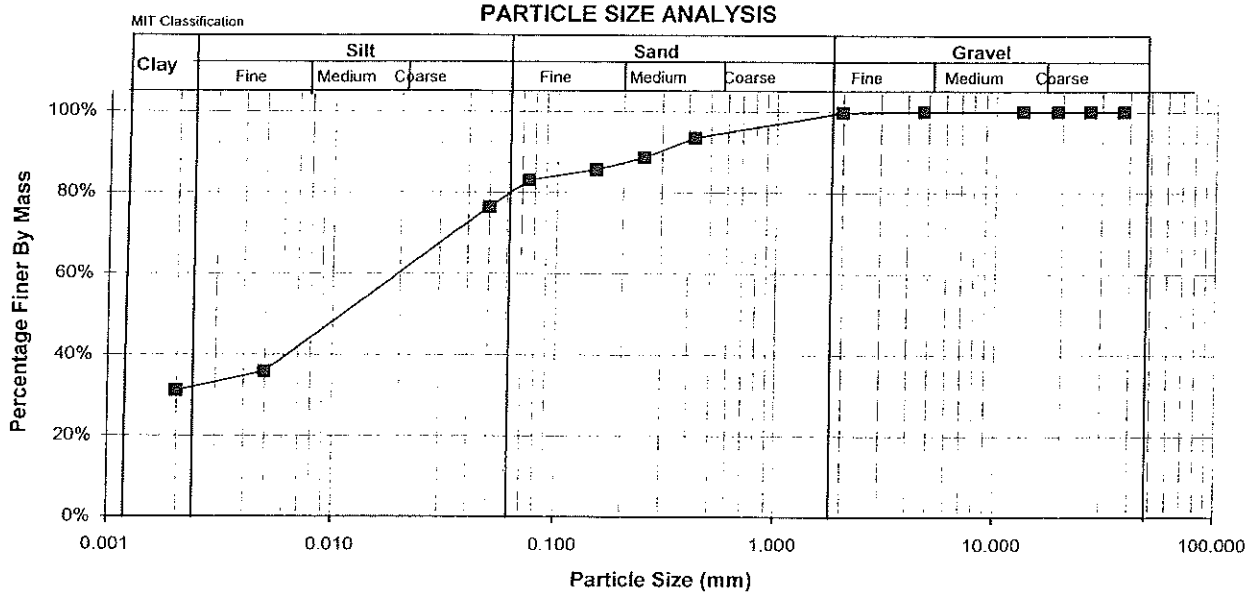
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	89%
26.500	100%	0.150	86%
19.000	100%	0.075	83%
13.200	100%	0.050	76%
4.750	100%	0.005	36%
2.000	100%	0.002	31%
0.425	93%		

ATTERBERG LIMITS

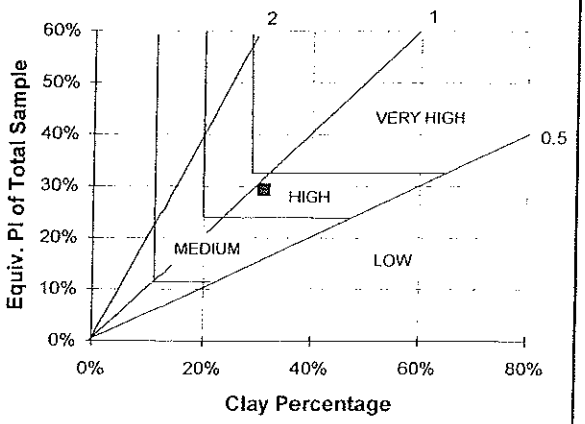
	Test 1	Test 2
Liquid Limit	79.9%	79.1%
Average	**79.5%**	
Plastic Limit	48.3%	48.3%
Average	**48.3%**	
Plasticity Index (PI)	31.2%	
Linear Shrinkage	14.7%	
Grading Modulus	0.24	

PRA Classification	A-7-5 [20]
Unified Classification	MH/OH
PI of whole sample	29.2%
% Gravel	0.3%
% Sand	20.4%
% Silt	48.2%
% Clay	31.1%

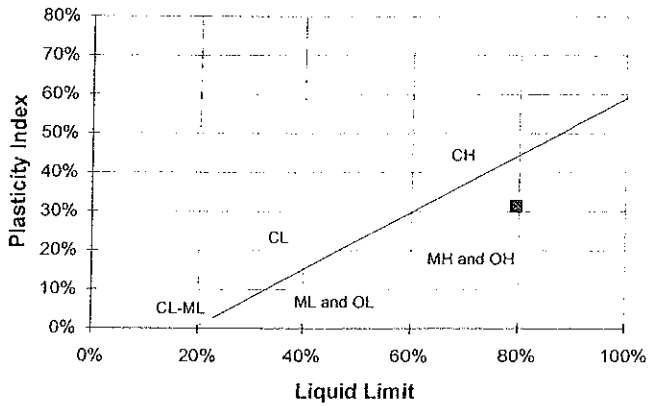
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/08
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	49	Depth	1.0m
Sample	Alluvium		

SIEVE ANALYSIS

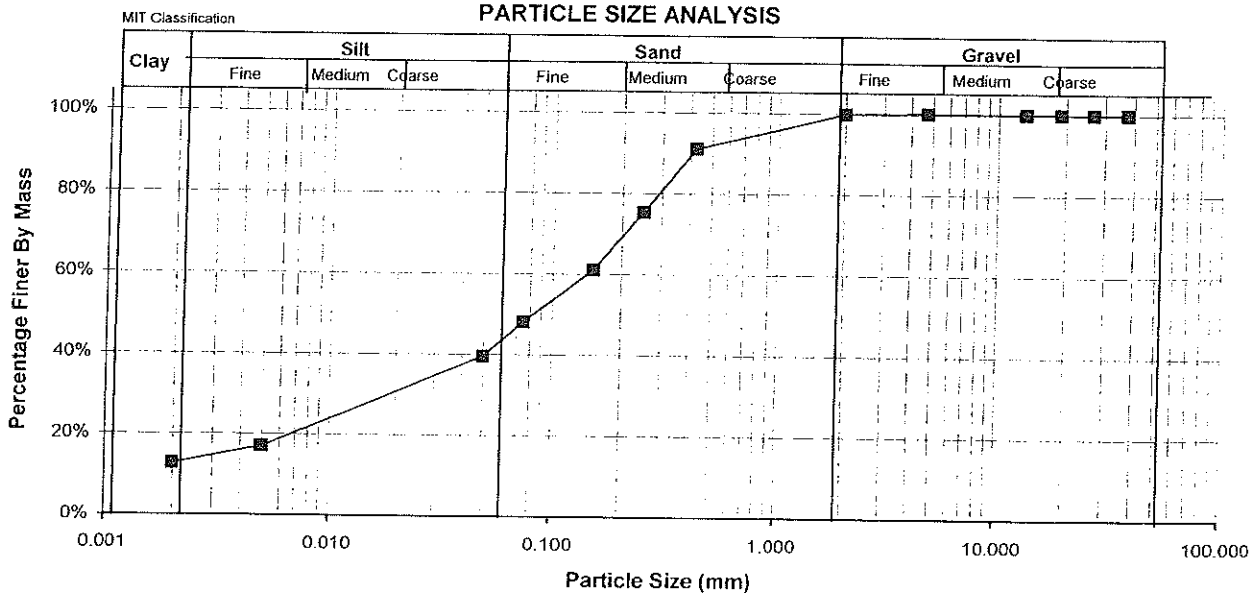
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	75%
26.500	100%	0.150	61%
19.000	100%	0.075	48%
13.200	100%	0.050	39%
4.750	100%	0.005	17%
2.000	100%	0.002	13%
0.425	91%		

ATTERBERG LIMITS

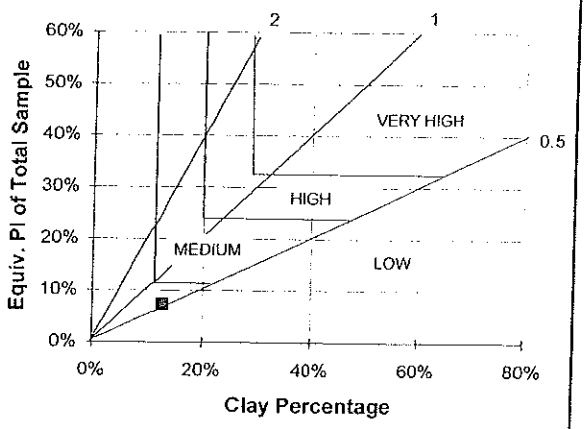
	Test 1	Test 2
Liquid Limit	28.0%	28.0%
Average	**28.0%**	
Plastic Limit	19.5%	20.4%
Average	**20.0%**	
Plasticity Index (PI)	8.0%	
Linear Shrinkage	4.0%	
Grading Modulus	0.61	

PRA Classification	A-4 [3]
Unified Classification	SC
PI of whole sample	7.3%
% Gravel	0.2%
% Sand	56.5%
% Silt	30.7%
% Clay	12.7%

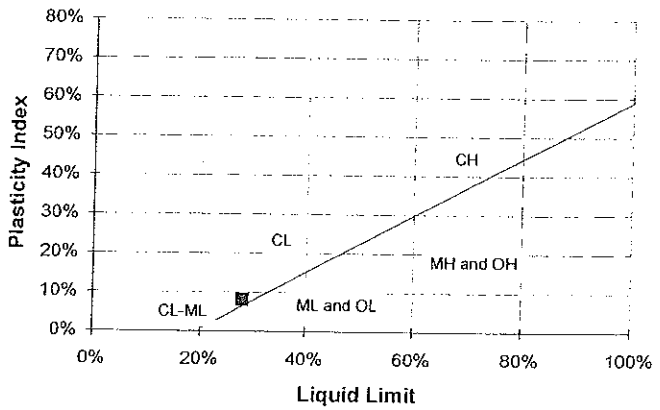
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/08
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	50	Depth	1.9-2.8m
Sample	(D) Alluvium		

SIEVE ANALYSIS

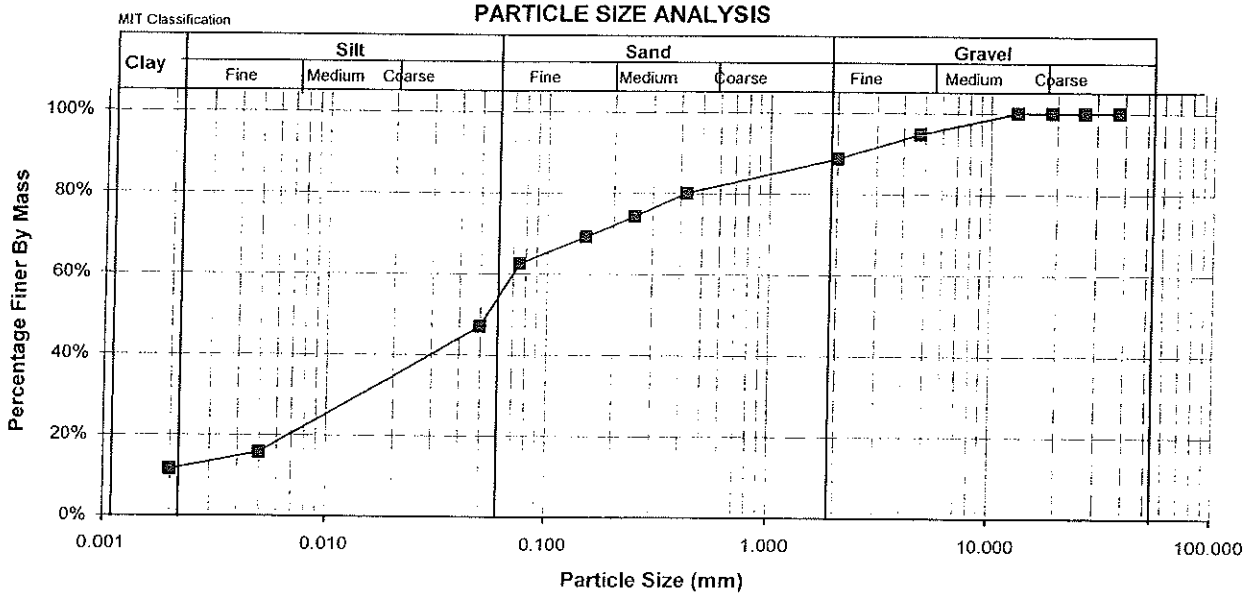
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	74%
26.500	100%	0.150	69%
19.000	100%	0.075	62%
13.200	100%	0.050	47%
4.750	95%	0.005	16%
2.000	89%	0.002	12%
0.425	80%		

ATTERBERG LIMITS

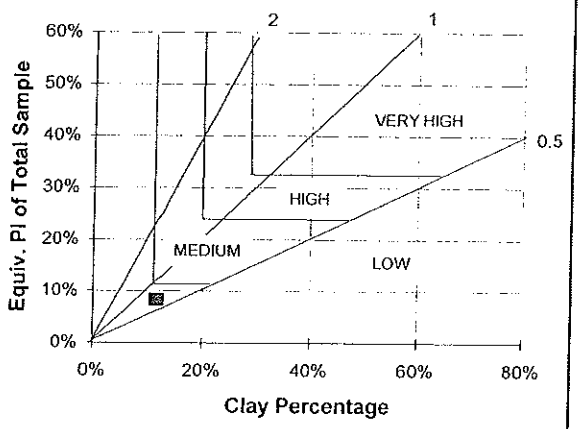
	Test 1	Test 2
Liquid Limit	34.5%	34.5%
Average	**34.5%**	
Plastic Limit	24.2%	24.1%
Average	**24.2%**	
Plasticity Index (PI)	10.4%	
Linear Shrinkage	5.3%	
Grading Modulus	0.69	

PRA Classification	A-6 [5]
Unified Classification	ML/OL
PI of whole sample	8.3%
% Gravel	11.3%
% Sand	34.7%
% Silt	42.4%
% Clay	11.6%

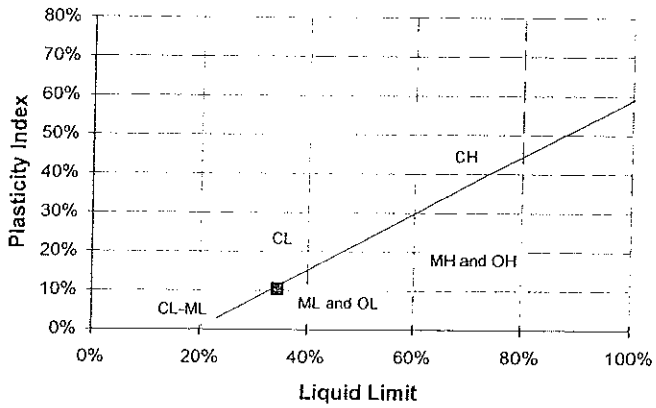
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/08
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	56	Depth	1.2m
Sample	Alluvium		

SIEVE ANALYSIS

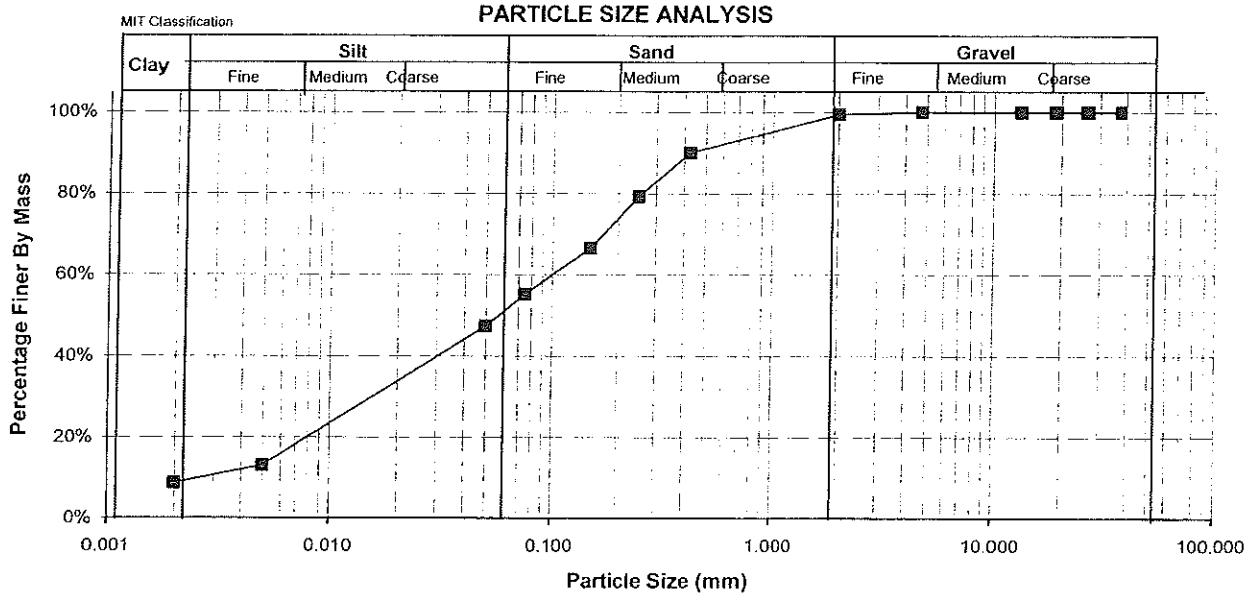
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	79%
26.500	100%	0.150	66%
19.000	100%	0.075	55%
13.200	100%	0.050	47%
4.750	100%	0.005	13%
2.000	99%	0.002	9%
0.425	90%		

ATTERBERG LIMITS

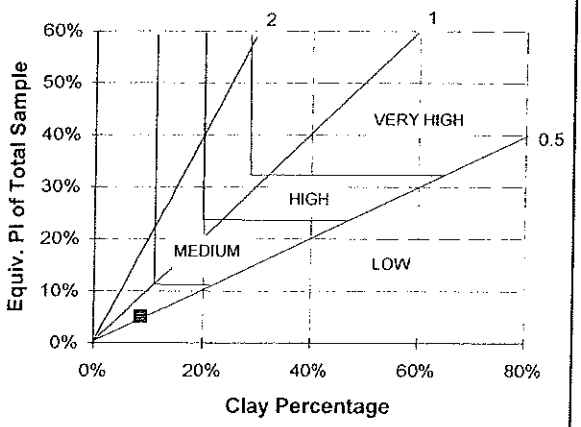
	Test 1	Test 2
Liquid Limit	25.2%	25.5%
Average	**25.4%**	
Plastic Limit	19.7%	19.7%
Average	**19.7%**	
Plasticity Index (PI)	5.6%	
Linear Shrinkage	3.3%	
Grading Modulus	0.56	

PRA Classification	A-4 [4]
Unified Classification	CL-ML
PI of whole sample	5.1%
% Gravel	0.6%
% Sand	48.6%
% Silt	42.1%
% Clay	8.7%

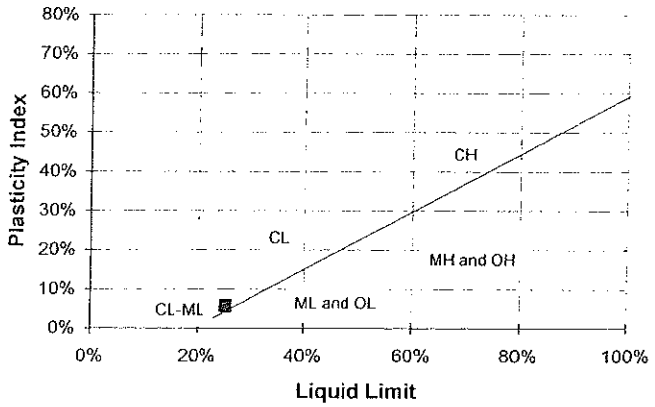
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	68	**Depth**	1.2m
Sample	(D) Alluvium		

SIEVE ANALYSIS

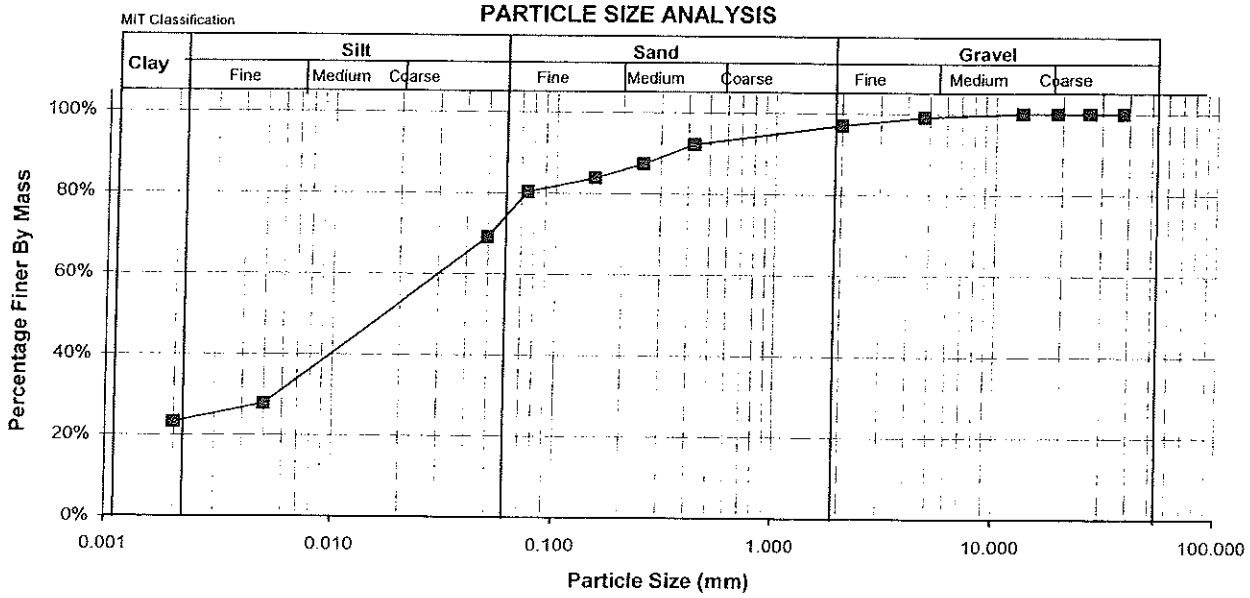
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	87%
26.500	100%	0.150	84%
19.000	100%	0.075	80%
13.200	100%	0.050	69%
4.750	99%	0.005	28%
2.000	97%	0.002	23%
0.425	92%		

ATTERBERG LIMITS

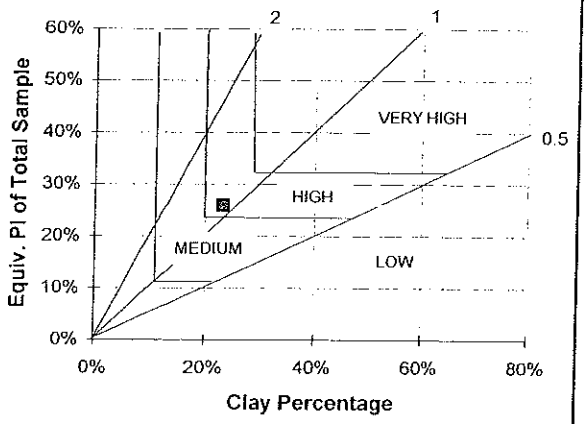
	Test 1	Test 2
Liquid Limit	63.3%	63.8%
Average	**63.5%**	
Plastic Limit	35.7%	35.1%
Average	**35.4%**	
Plasticity Index (PI)	28.1%	
Linear Shrinkage	14.0%	
Grading Modulus	0.31	

PRA Classification	A-7-5 [19]
Unified Classification	MH/OH
PI of whole sample	25.9%
% Gravel	3.0%
% Sand	22.9%
% Silt	50.8%
% Clay	23.2%

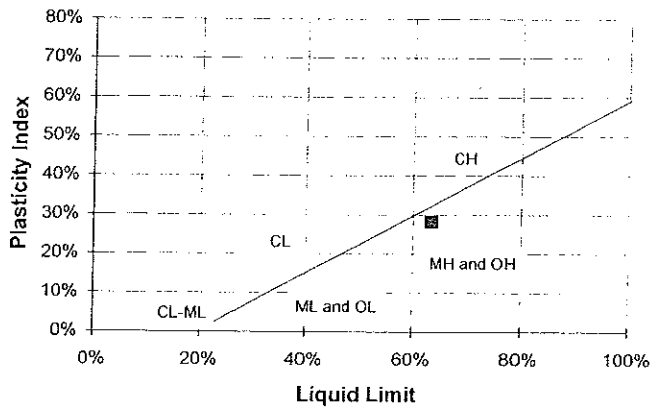
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	182	**Depth**	1.5m
Sample	(D) Alluvium		

SIEVE ANALYSIS

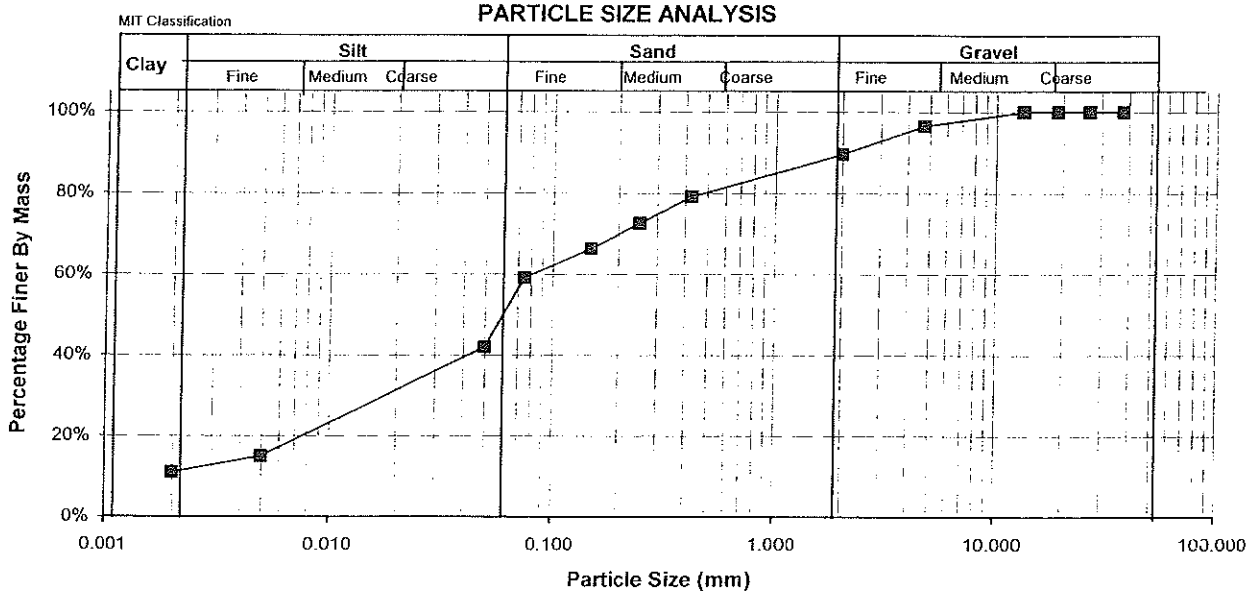
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	73%
26.500	100%	0.150	66%
19.000	100%	0.075	59%
13.200	100%	0.050	42%
4.750	97%	0.005	15%
2.000	90%	0.002	11%
0.425	79%		

ATTERBERG LIMITS

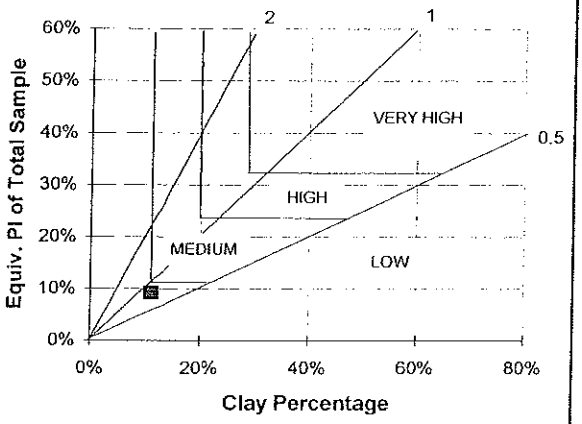
	Test 1	Test 2
Liquid Limit	40.6%	39.8%
Average	**40.2%**	
Plastic Limit	28.8%	28.3%
Average	**28.6%**	
Plasticity Index (PI)	11.6%	
Linear Shrinkage	6.7%	
Grading Modulus	0.72	

PRA Classification	A-7-6 [6]
Unified Classification	ML/OL
PI of whole sample	9.2%
% Gravel	10.4%
% Sand	39.9%
% Silt	38.6%
% Clay	11.1%

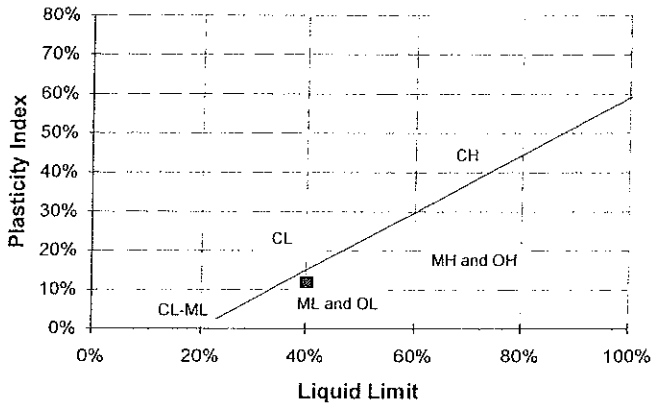
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	205	**Depth**	1.8m
Sample	(D) Alluvium		

SIEVE ANALYSIS

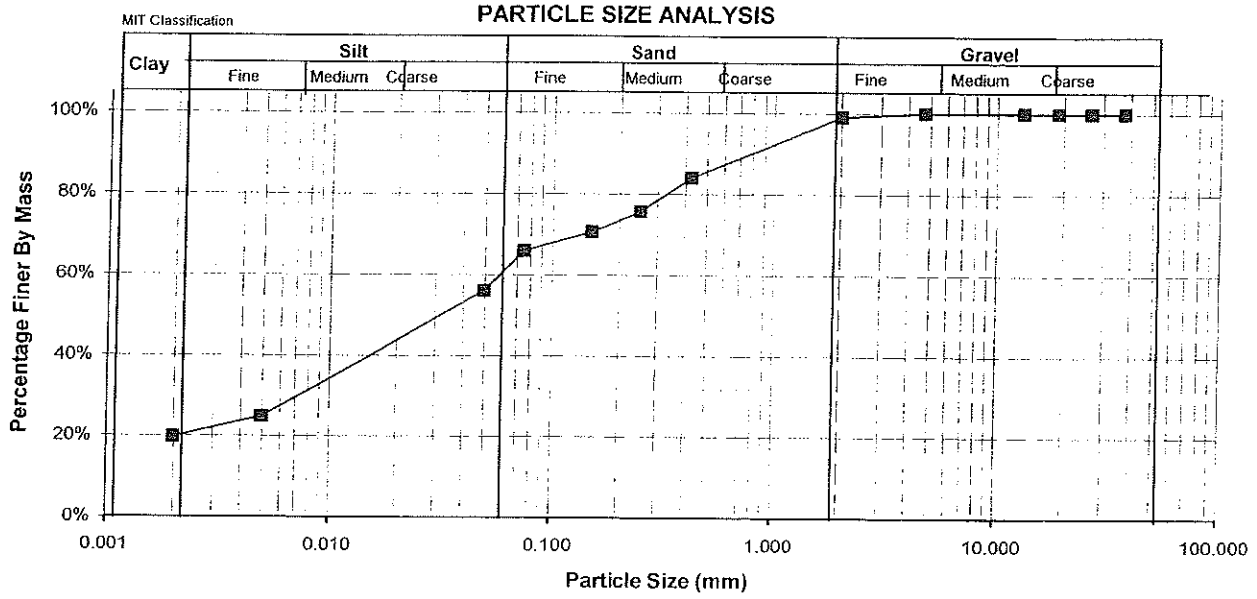
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	76%
26.500	100%	0.150	71%
19.000	100%	0.075	66%
13.200	100%	0.050	56%
4.750	100%	0.005	25%
2.000	99%	0.002	20%
0.425	84%		

ATTERBERG LIMITS

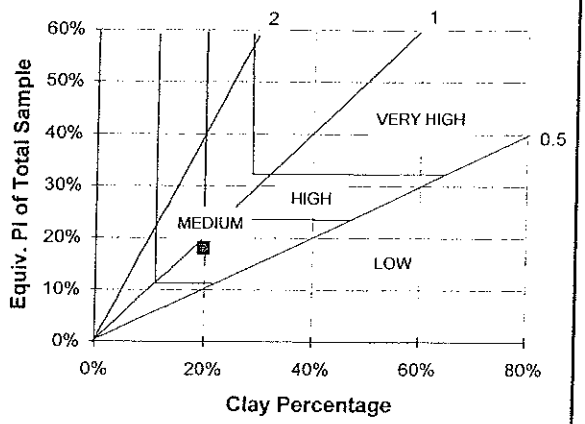
	Test 1	Test 2
Liquid Limit	52.3%	51.9%
Average	**52.1%**	
Plastic Limit	30.4%	30.9%
Average	**30.7%**	
Plasticity Index (PI)	21.4%	
Linear Shrinkage	10.7%	
Grading Modulus	0.51	

PRA Classification	A-7-5 [12]
Unified Classification	MH/OH
PI of whole sample	18.0%
% Gravel	1.0%
% Sand	38.5%
% Silt	40.7%
% Clay	19.8%

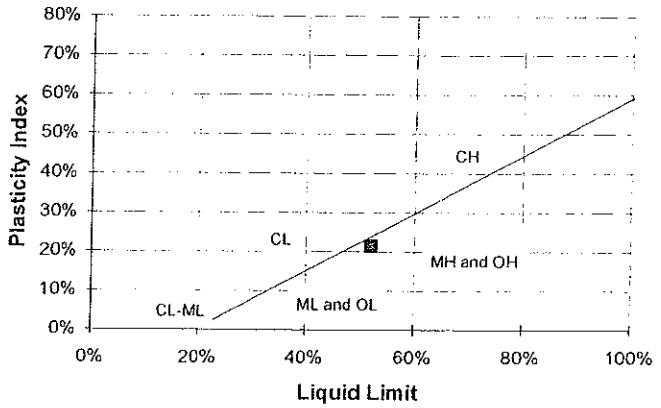
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/08
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	243	Depth	1.0-1.5m
Sample	(D) Alluvium		

SIEVE ANALYSIS

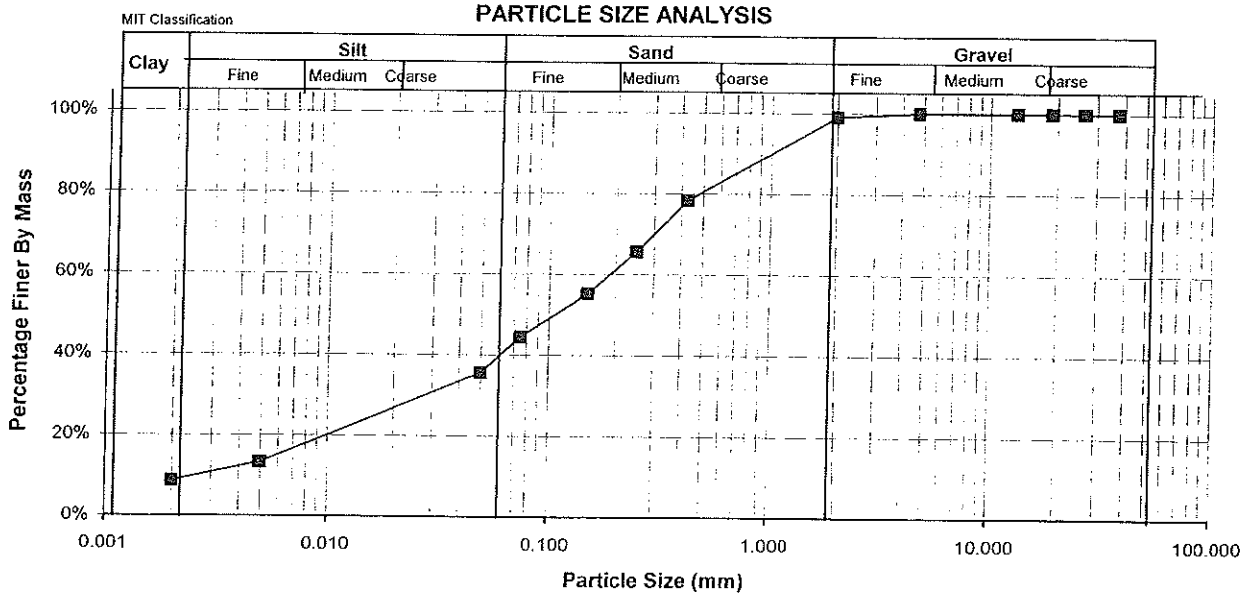
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	66%
26.500	100%	0.150	55%
19.000	100%	0.075	44%
13.200	100%	0.050	36%
4.750	100%	0.005	13%
2.000	99%	0.002	9%
0.425	78%		

ATTERBERG LIMITS

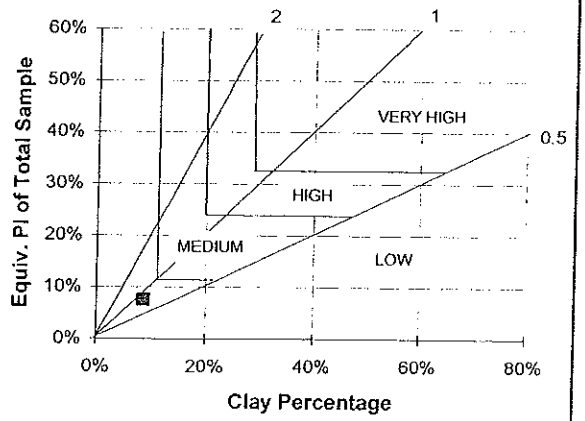
	Test 1	Test 2
Liquid Limit	23.2%	23.4%
Average	23.3%	
Plastic Limit	13.3%	13.9%
Average	13.6%	
Plasticity Index (PI)	9.7%	
Linear Shrinkage	4.7%	
Grading Modulus	0.78	

PRA Classification	A-4 [2]
Unified Classification	SC
PI of whole sample	7.6%
% Gravel	1.0%
% Sand	59.5%
% Silt	30.9%
% Clay	8.6%

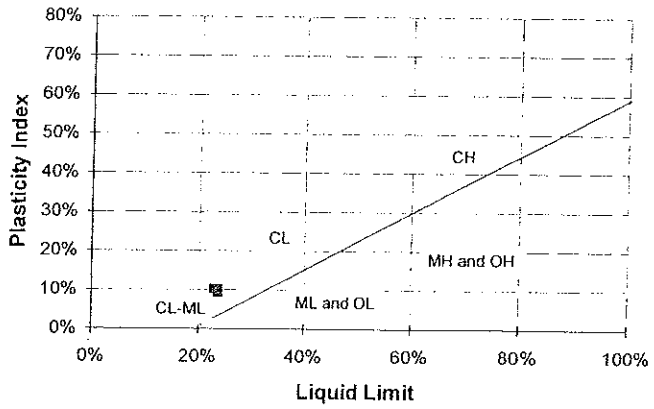
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	245	**Depth**	0.5-1.0m
Sample	(D) Alluvium		

SIEVE ANALYSIS

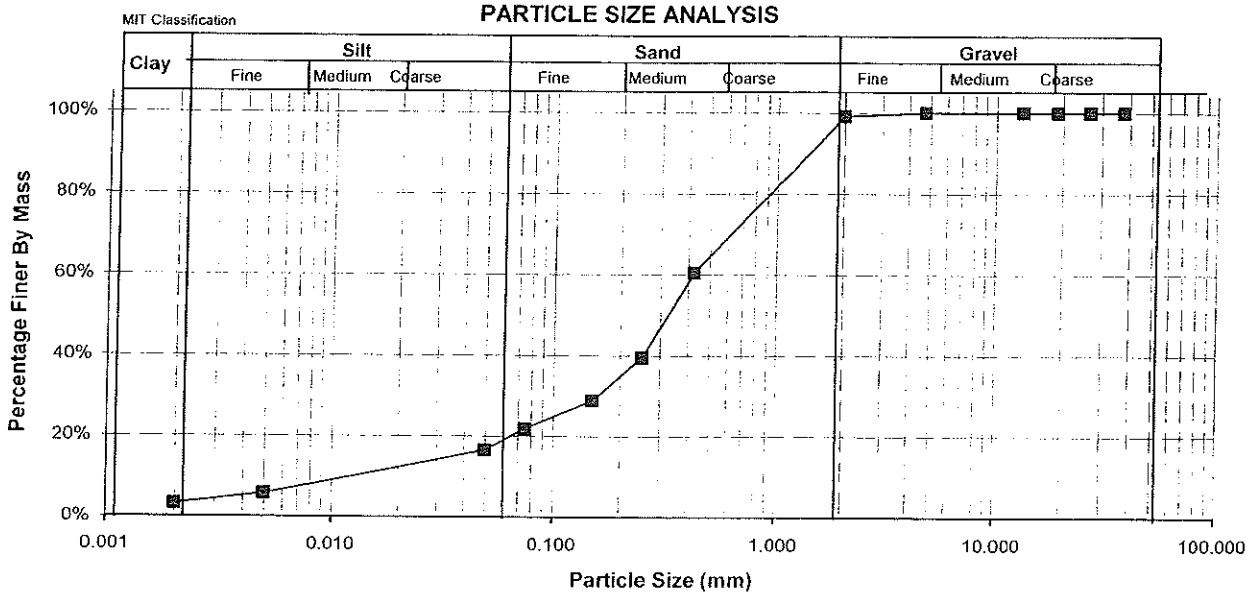
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	39%
26.500	100%	0.150	29%
19.000	100%	0.075	22%
13.200	100%	0.050	17%
4.750	100%	0.005	6%
2.000	99%	0.002	3%
0.425	60%		

ATTERBERG LIMITS

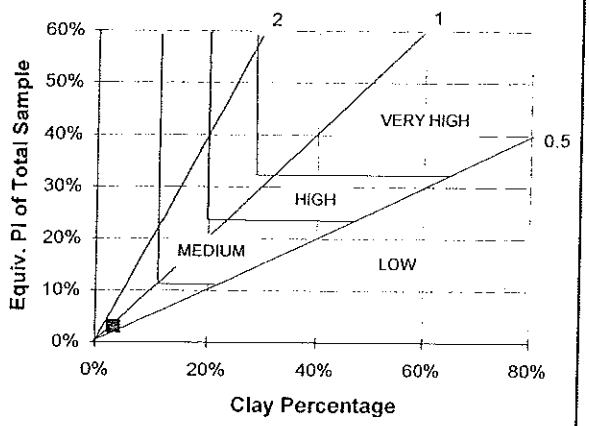
	Test 1	Test 2
Liquid Limit	15.0%	16.9%
Average	**16.0%**	
Plastic Limit	11.0%	11.2%
Average	**11.1%**	
Plasticity Index (PI)	4.9%	
Linear Shrinkage	2.7%	
Grading Modulus	1.19	

PRA Classification	A-2-4
Unified Classification	SC/SM
PI of whole sample	2.9%
% Gravel	0.9%
% Sand	80.2%
% Silt	15.7%
% Clay	3.2%

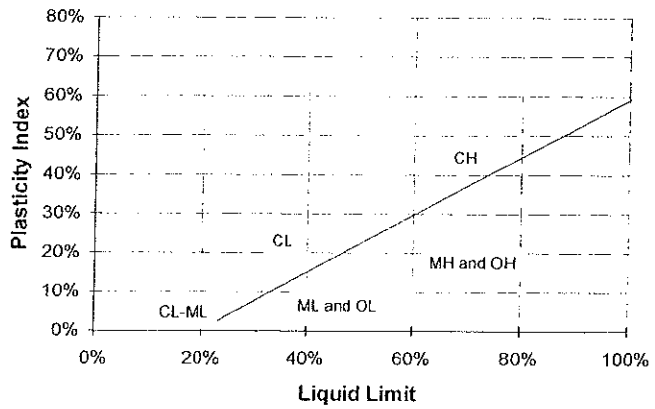
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	2	**Depth**	1.0-2.7m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

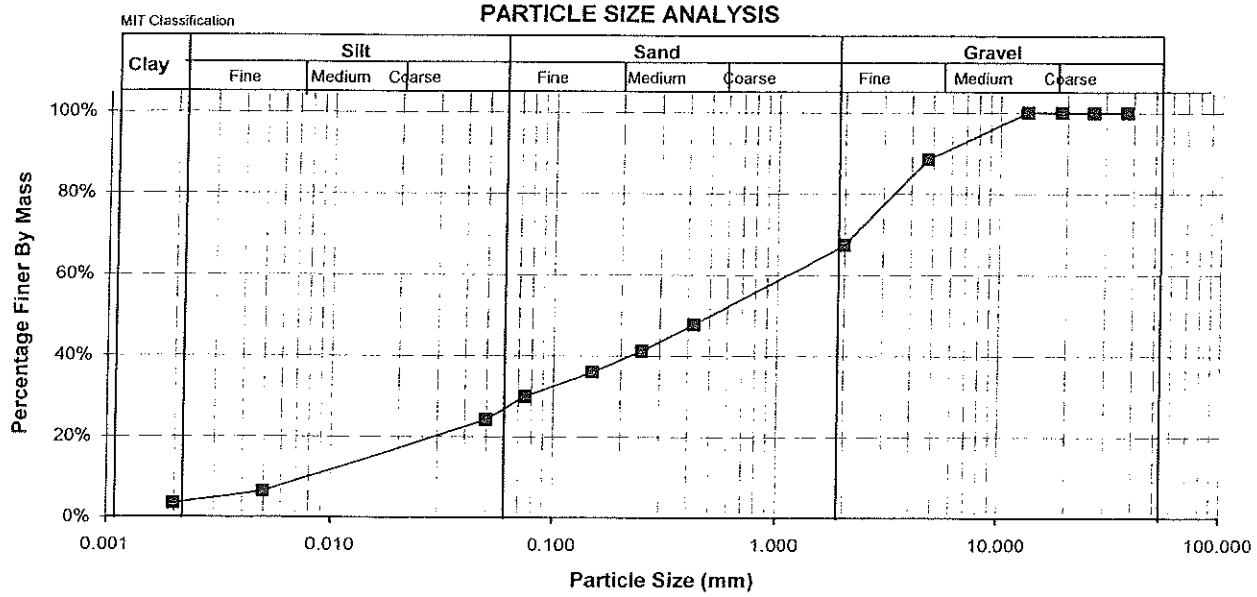
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	41%
26.500	100%	0.150	36%
19.000	100%	0.075	30%
13.200	100%	0.050	24%
4.750	88%	0.005	6%
2.000	67%	0.002	3%
0.425	48%		

ATTERBERG LIMITS

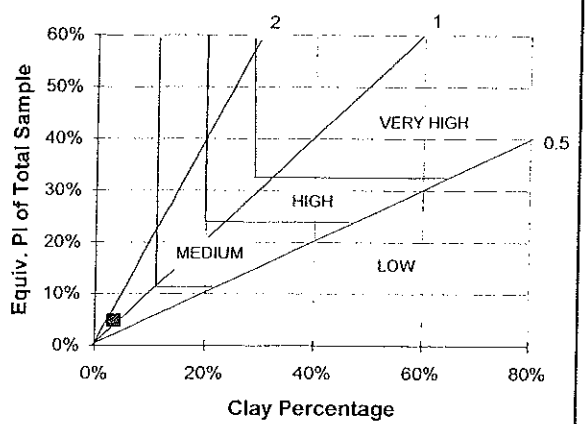
	Test 1	Test 2
Liquid Limit	26.6%	26.4%
Average	**26.5%**	
Plastic Limit	16.3%	16.4%
Average	**16.3%**	
Plasticity Index (PI)	10.2%	
Linear Shrinkage	5.3%	
Grading Modulus	1.55	

PRA Classification	A-2-6 [0]
Unified Classification	SC
PI of whole sample	4.8%
% Gravel	32.7%
% Sand	40.5%
% Silt	23.3%
% Clay	3.4%

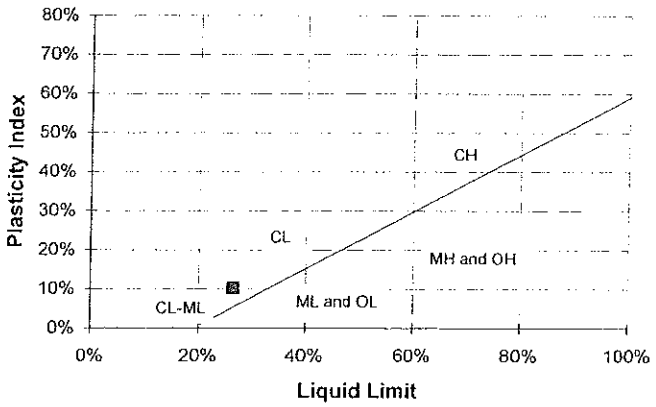
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	97	**Depth**	1.5m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

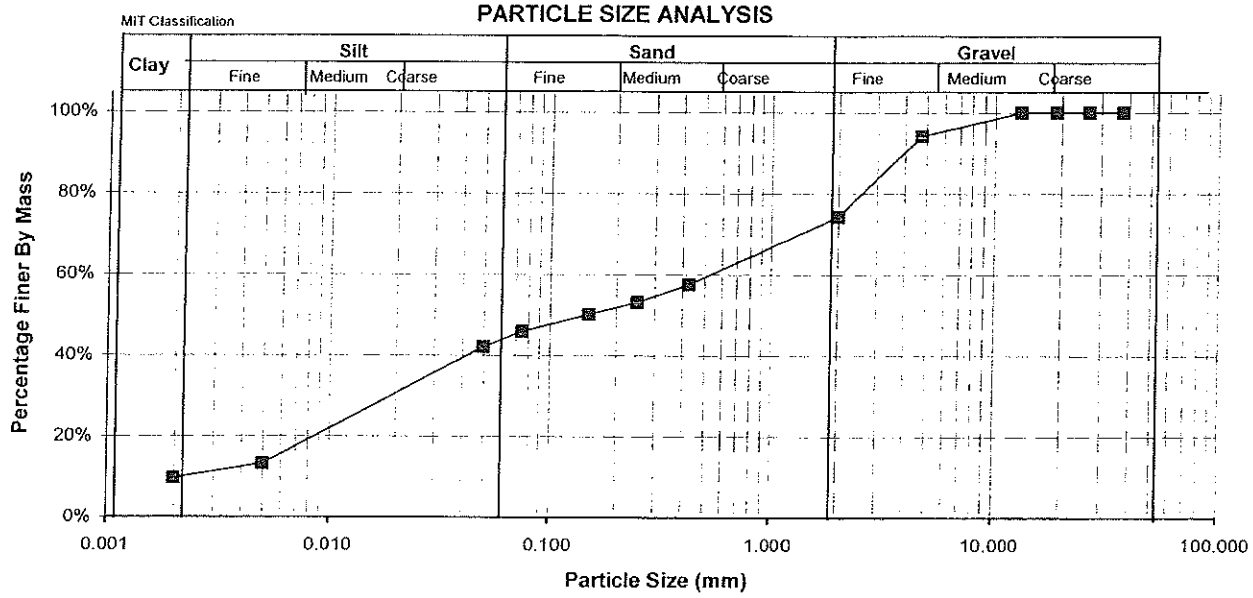
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	53%
26.500	100%	0.150	50%
19.000	100%	0.075	46%
13.200	100%	0.050	42%
4.750	94%	0.005	13%
2.000	74%	0.002	10%
0.425	58%		

ATTERBERG LIMITS

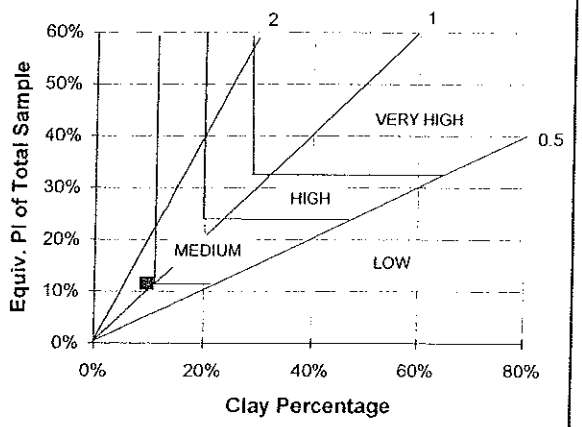
	Test 1	Test 2
Liquid Limit	42.0%	42.3%
Average	**42.1%**	
Plastic Limit	22.1%	22.1%
Average	**22.1%**	
Plasticity Index (PI)	20.0%	
Linear Shrinkage	10.0%	
Grading Modulus	1.22	

PRA Classification	A-7-6 [5]
Unified Classification	SC
PI of whole sample	11.5%
% Gravel	25.7%
% Sand	30.5%
% Silt	34.1%
% Clay	9.7%

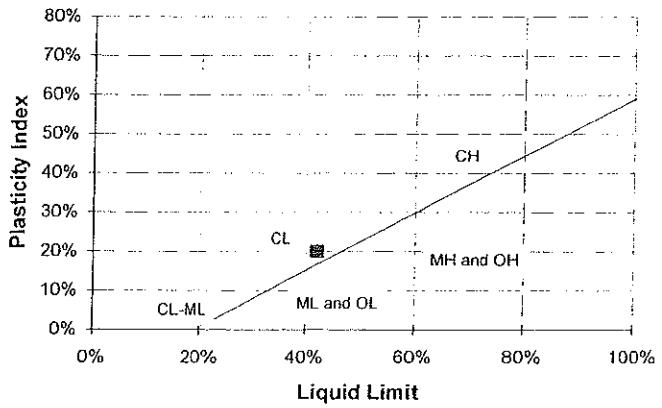
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	100	**Depth**	1.8m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

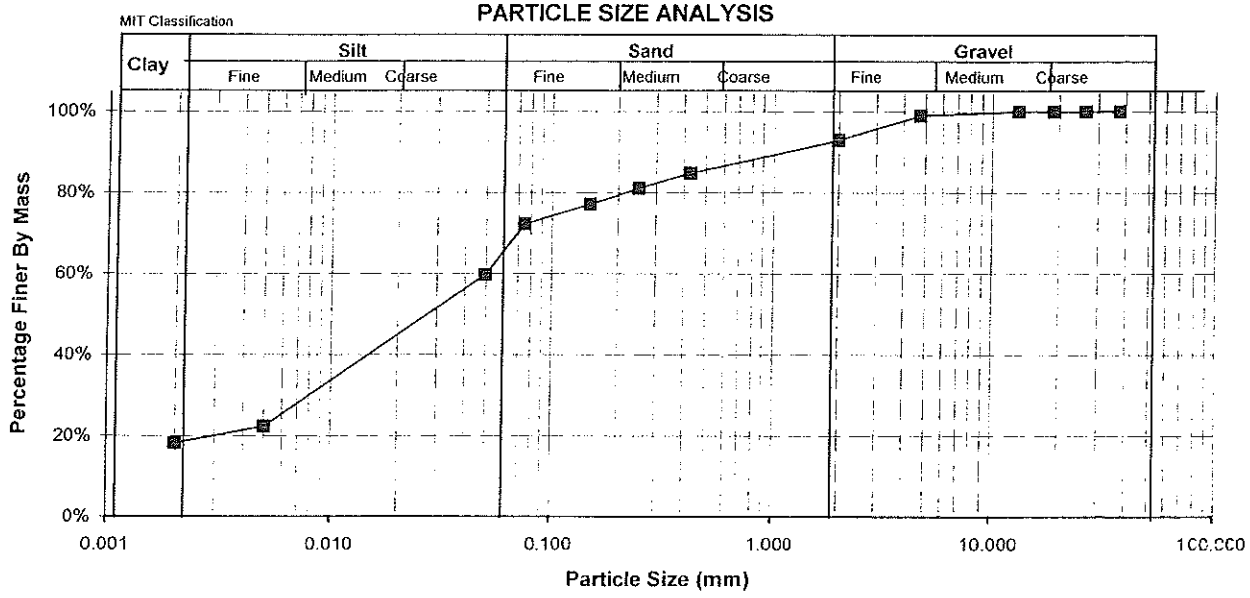
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	81%
26.500	100%	0.150	77%
19.000	100%	0.075	72%
13.200	100%	0.050	60%
4.750	99%	0.005	22%
2.000	93%	0.002	18%
0.425	85%		

ATTERBERG LIMITS

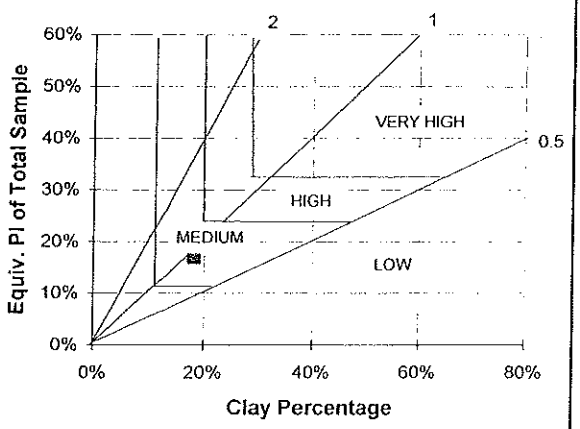
	Test 1	Test 2
Liquid Limit	48.0%	48.4%
Average	**48.2%**	
Plastic Limit	28.1%	28.5%
Average	**28.3%**	
Plasticity Index (PI)	19.9%	
Linear Shrinkage	10.0%	
Grading Modulus	0.50	

PRA Classification	A-7-6 [13]
Unified Classification	ML/OL
PI of whole sample	16.8%
% Gravel	7.1%
% Sand	27.6%
% Silt	47.1%
% Clay	18.2%

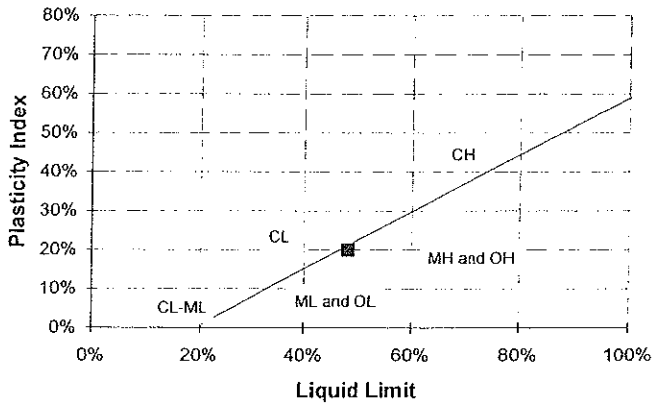
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/08
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	107	Depth	1.5m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

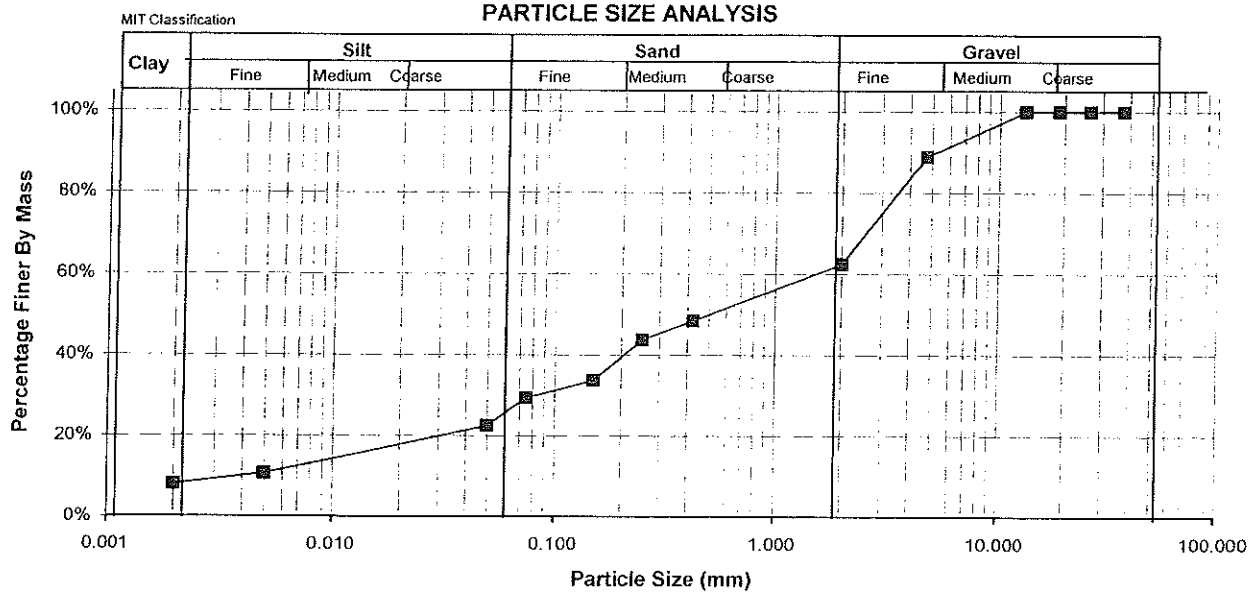
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	44%
26.500	100%	0.150	34%
19.000	100%	0.075	29%
13.200	100%	0.050	22%
4.750	89%	0.005	11%
2.000	62%	0.002	8%
0.425	48%		

ATTERBERG LIMITS

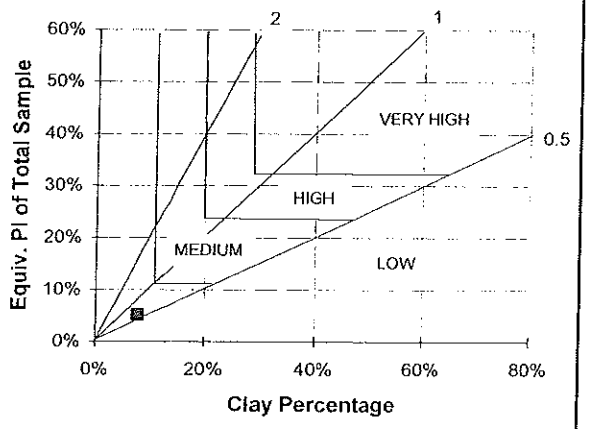
	Test 1	Test 2
Liquid Limit	33.8%	34.2%
Average	**34.0%**	
Plastic Limit	23.0%	23.5%
Average	**23.2%**	
Plasticity Index (PI)	10.7%	
Linear Shrinkage	5.3%	
Grading Modulus	1.60	

PRA Classification	A-2-6 [0]
Unified Classification	SC
PI of whole sample	5.2%
% Gravel	37.7%
% Sand	36.8%
% Silt	17.6%
% Clay	7.9%

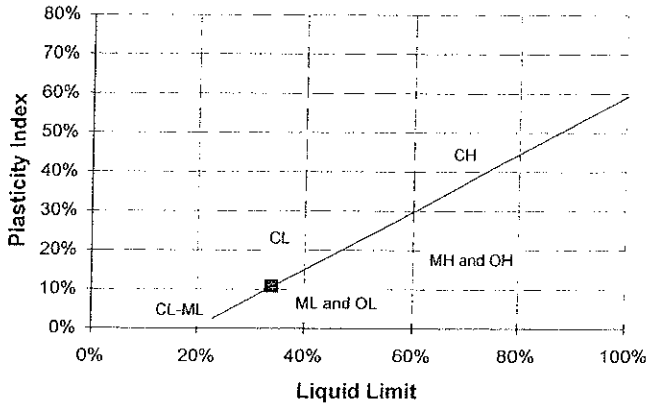
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/09
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	146	**Depth**	1.3m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

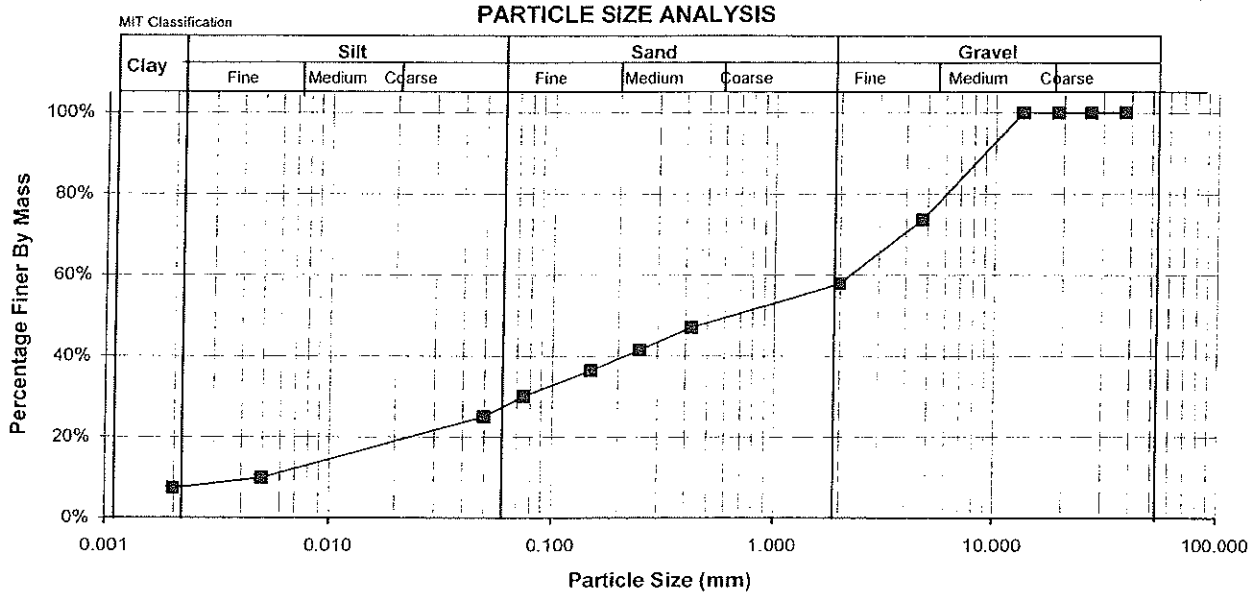
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	41%
26.500	100%	0.150	36%
19.000	100%	0.075	30%
13.200	100%	0.050	25%
4.750	74%	0.005	10%
2.000	58%	0.002	7%
0.425	47%		

ATTERBERG LIMITS

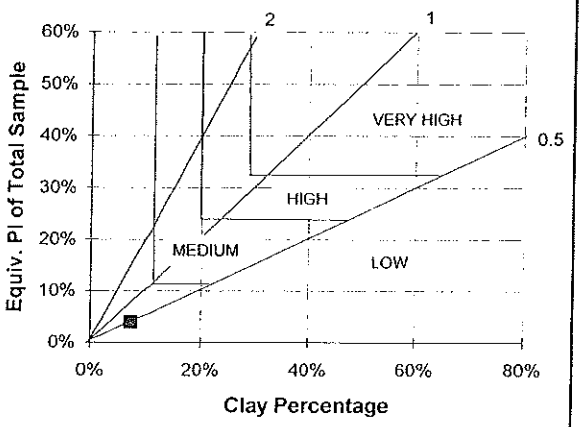
	Test 1	Test 2
Liquid Limit	27.0%	27.3%
Average	**27.1%**	
Plastic Limit	19.1%	18.7%
Average	**18.9%**	
Plasticity Index (PI)	8.2%	
Linear Shrinkage	4.0%	
Grading Modulus	1.65	

PRA Classification	A-2-4
Unified Classification	SC
PI of whole sample	3.9%
% Gravel	42.2%
% Sand	30.6%
% Silt	19.9%
% Clay	7.3%

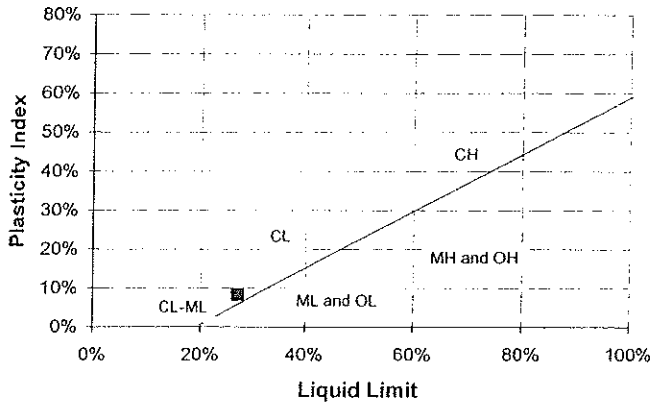
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/09
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	157	Depth	1.5m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

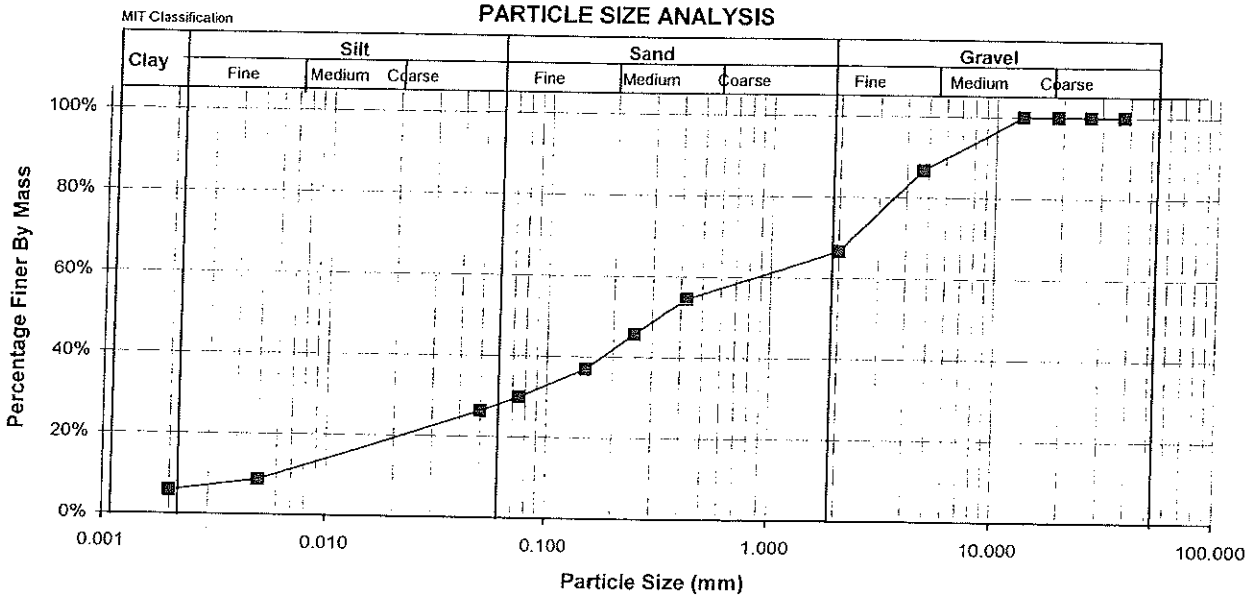
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	46%
26.500	100%	0.150	37%
19.000	100%	0.075	30%
13.200	100%	0.050	26%
4.750	87%	0.005	9%
2.000	66%	0.002	6%
0.425	55%		

ATTERBERG LIMITS

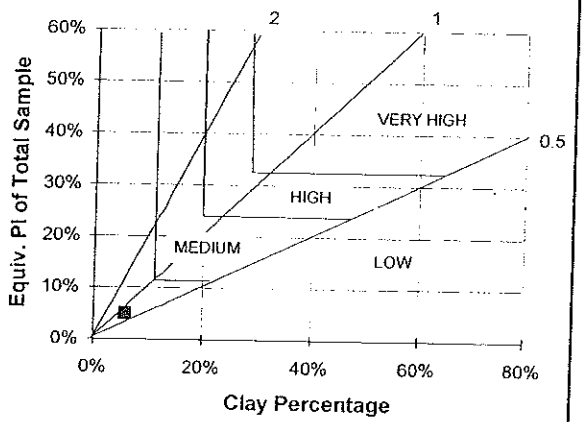
	Test 1	Test 2
Liquid Limit	28.9%	29.0%
Average	28.9%	
Plastic Limit	19.7%	19.9%
Average	19.8%	
Plasticity Index (PI)	9.1%	
Linear Shrinkage	4.7%	
Grading Modulus	1.49	

PRA Classification	A-2-4
Unified Classification	SC
PI of whole sample	5.0%
% Gravel	33.5%
% Sand	38.6%
% Silt	22.1%
% Clay	5.8%

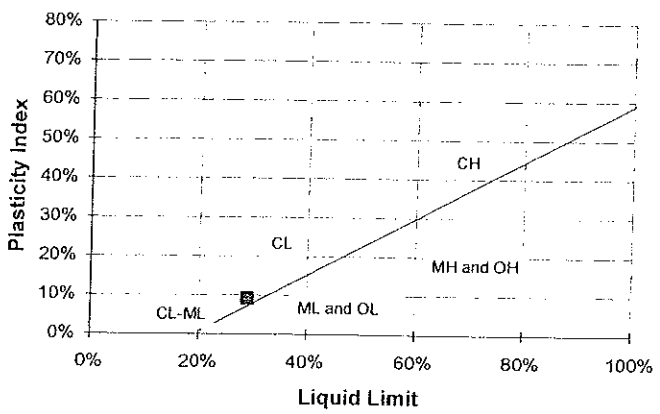
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	166	**Depth**	1.4m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

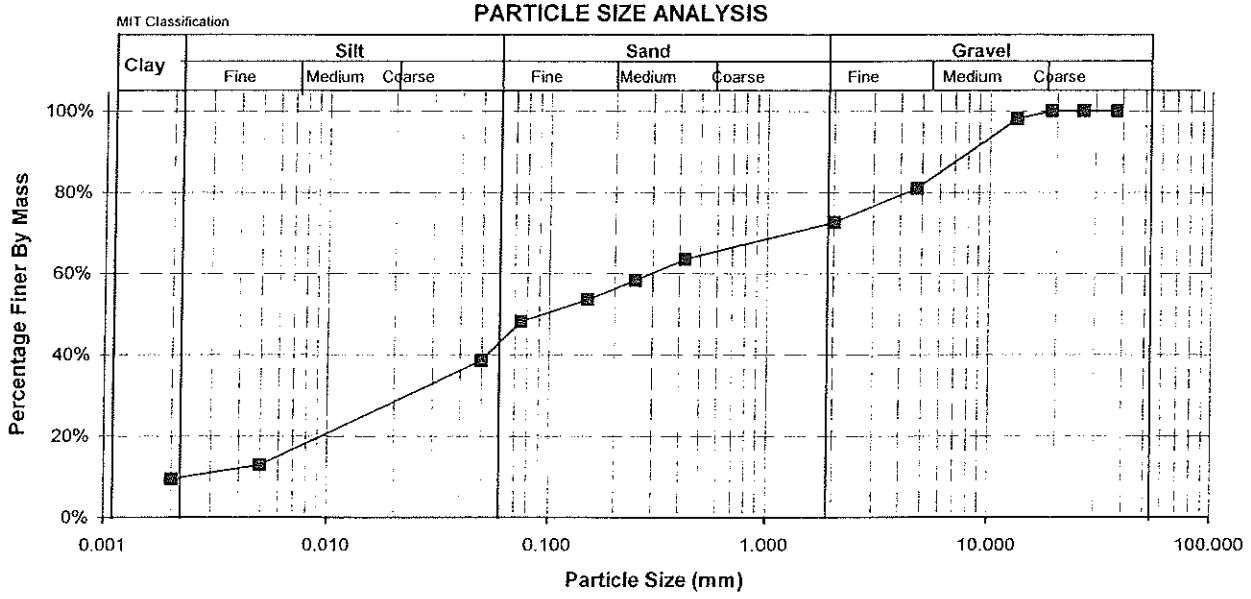
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	58%
26.500	100%	0.150	54%
19.000	100%	0.075	48%
13.200	98%	0.050	38%
4.750	81%	0.005	13%
2.000	73%	0.002	9%
0.425	63%		

ATTERBERG LIMITS

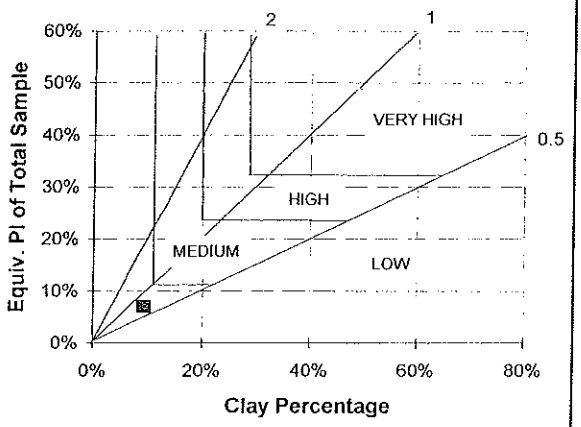
	Test 1	Test 2
Liquid Limit	34.1%	35.6%
Average	**34.9%**	
Plastic Limit	24.5%	23.4%
Average	**23.9%**	
Plasticity Index (PI)	11.0%	
Linear Shrinkage	6.0%	
Grading Modulus	1.16	

PRA Classification	A-6 [3]
Unified Classification	SM
PI of whole sample	7.0%
% Gravel	27.4%
% Sand	29.8%
% Silt	33.3%
% Clay	9.5%

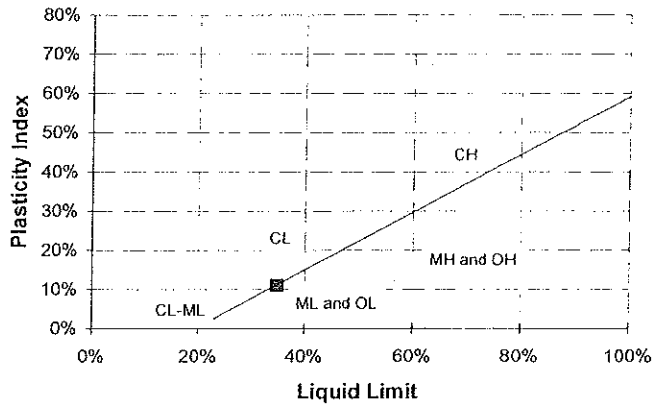
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/09
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	228	**Depth**	1.3m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

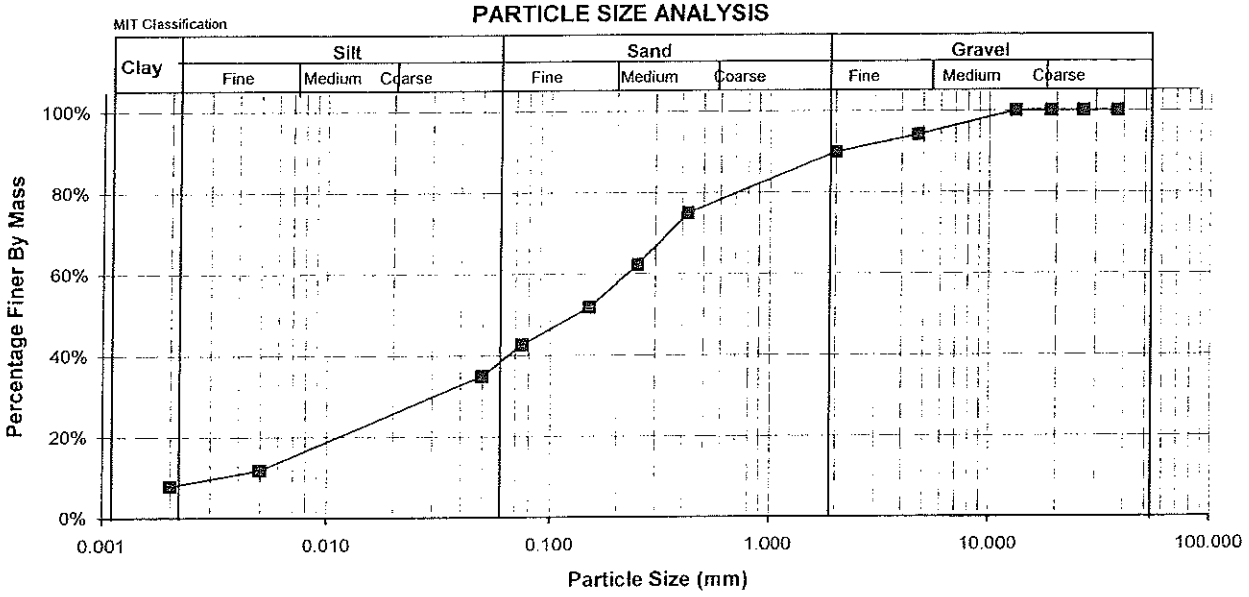
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	62%
26.500	100%	0.150	52%
19.000	100%	0.075	43%
13.200	100%	0.050	35%
4.750	94%	0.005	12%
2.000	90%	0.002	8%
0.425	75%		

ATTERBERG LIMITS

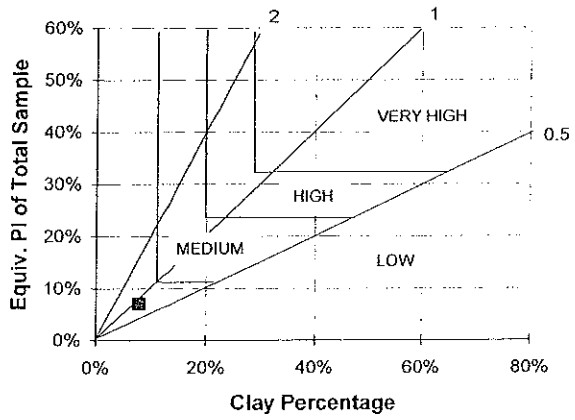
	Test 1	Test 2
Liquid Limit	25.4%	25.8%
Average	**25.6%**	
Plastic Limit	16.9%	15.6%
Average	**16.2%**	
Plasticity Index (PI)	9.4%	
Linear Shrinkage	4.7%	
Grading Modulus	0.93	

PRA Classification	A-4 [2]
Unified Classification	SC
PI of whole sample	7.0%
% Gravel	10.2%
% Sand	51.5%
% Silt	30.5%
% Clay	7.8%

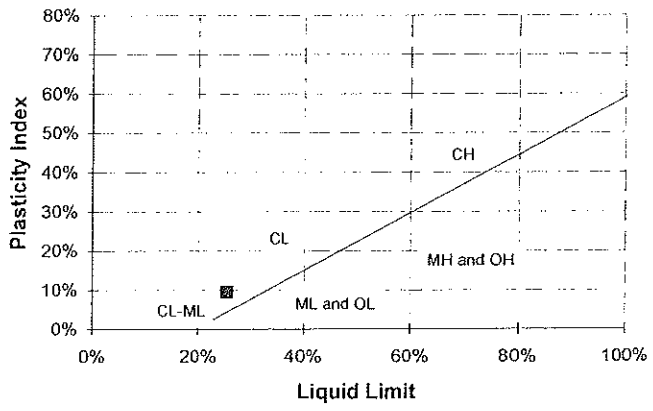
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	230	**Depth**	0.6-1.0m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

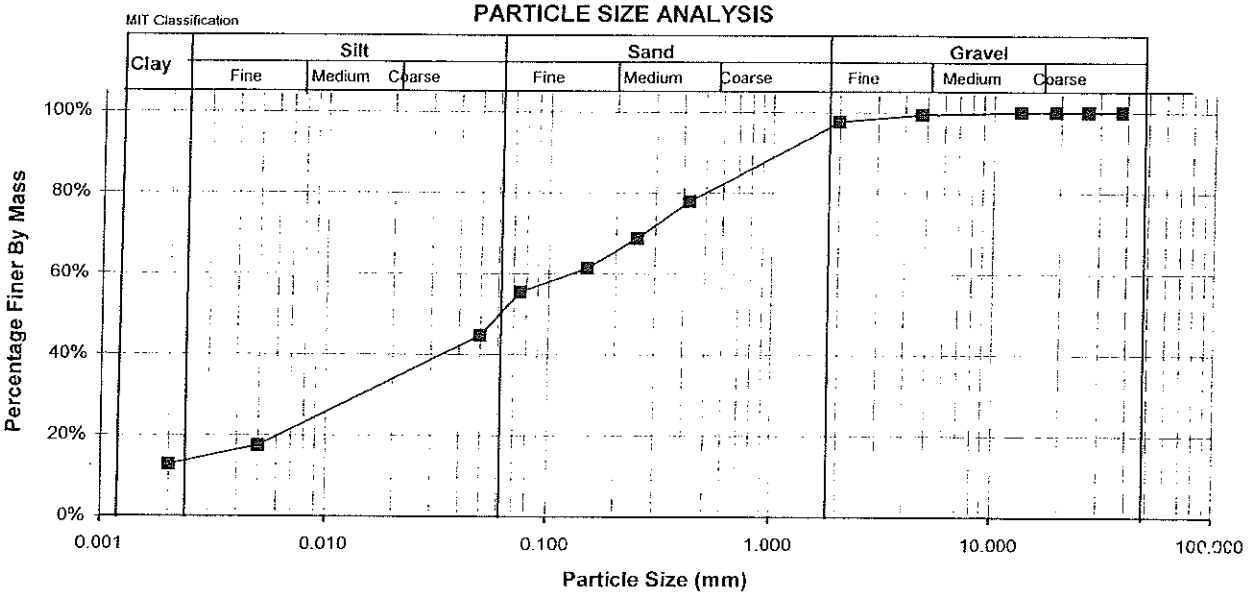
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	69%
26.500	100%	0.150	61%
19.000	100%	0.075	55%
13.200	100%	0.050	45%
4.750	99%	0.005	17%
2.000	98%	0.002	13%
0.425	78%		

ATTERBERG LIMITS

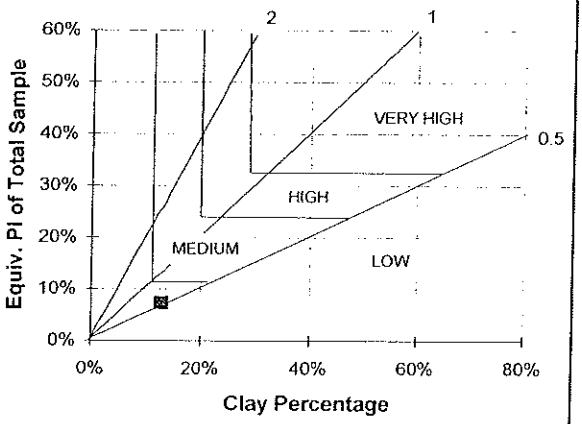
	Test 1	Test 2
Liquid Limit	25.8%	26.5%
Average	**26.2%**	
Plastic Limit	16.8%	16.8%
Average	**16.8%**	
Plasticity Index (PI)	9.4%	
Linear Shrinkage	4.7%	
Grading Modulus	0.69	

PRA Classification	A-4 [4]
Unified Classification	CL
PI of whole sample	7.3%
% Gravel	2.4%
% Sand	48.1%
% Silt	36.7%
% Clay	12.8%

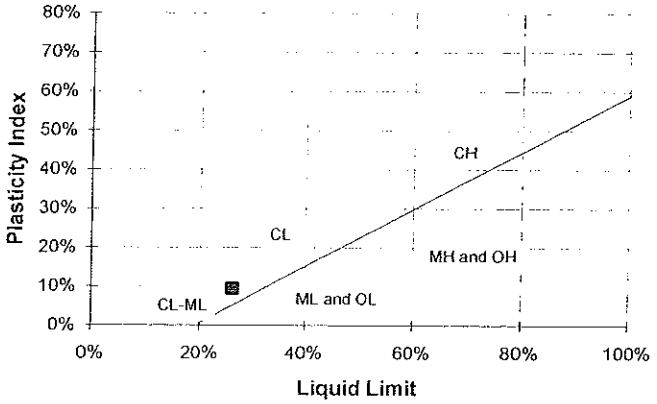
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	179	**Depth**	1.6m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

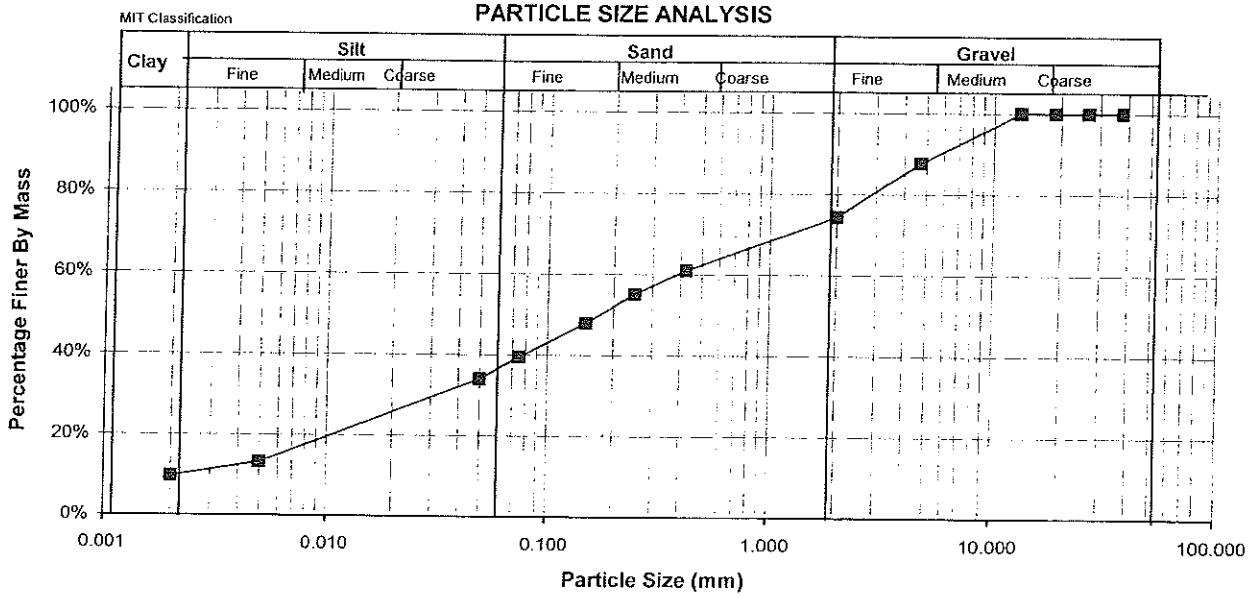
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	55%
26.500	100%	0.150	48%
19.000	100%	0.075	39%
13.200	100%	0.050	34%
4.750	88%	0.005	13%
2.000	74%	0.002	10%
0.425	61%		

ATTERBERG LIMITS

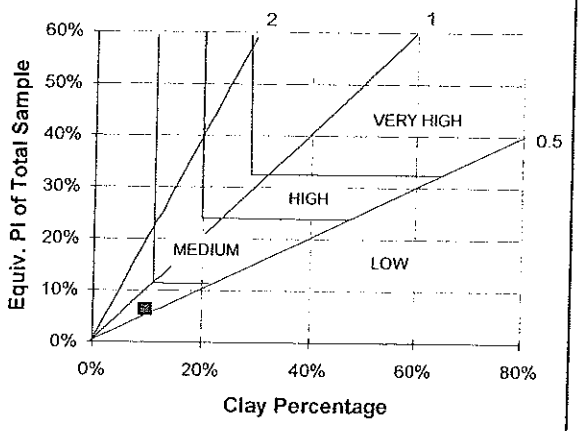
	Test 1	Test 2
Liquid Limit	31.1%	30.8%
Average	**31.0%**	
Plastic Limit	20.1%	20.9%
Average	**20.5%**	
Plasticity Index (PI)	10.5%	
Linear Shrinkage	5.3%	
Grading Modulus	1.25	

PRA Classification	A-6 [1]
Unified Classification	SC
PI of whole sample	6.4%
% Gravel	25.7%
% Sand	37.9%
% Silt	26.7%
% Clay	9.7%

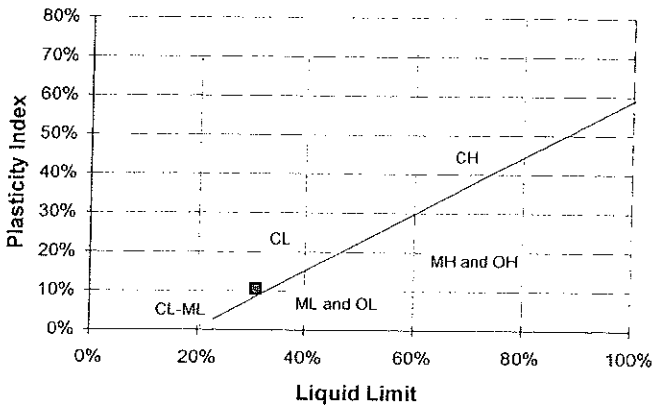
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/08
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	125	**Depth**	1.7m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

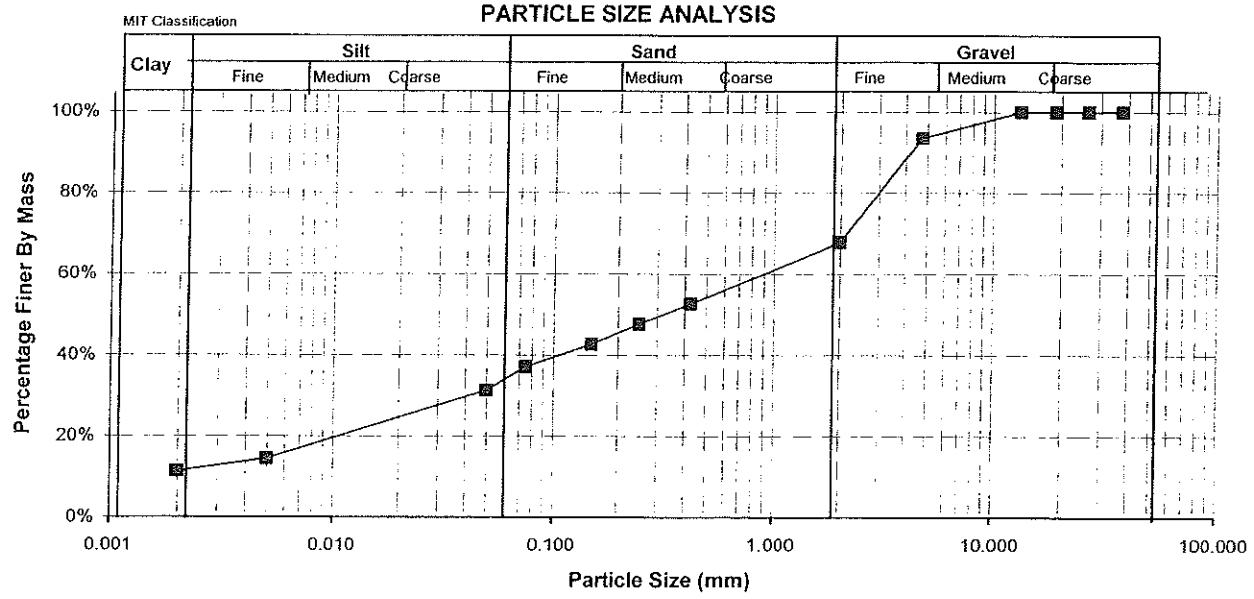
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	48%
26.500	100%	0.150	43%
19.000	100%	0.075	37%
13.200	100%	0.050	31%
4.750	94%	0.005	15%
2.000	68%	0.002	11%
0.425	53%		

ATTERBERG LIMITS

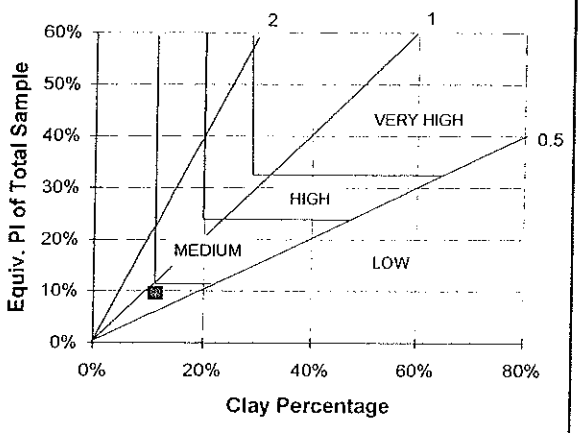
	Test 1	Test 2
Liquid Limit	43.4%	42.1%
Average	**42.7%**	
Plastic Limit	24.6%	24.6%
Average	**24.6%**	
Plasticity Index (PI)	18.1%	
Linear Shrinkage	9.3%	
Grading Modulus	1.43	

PRA Classification	A-7-6 [2]
Unified Classification	SC
PI of whole sample	9.5%
% Gravel	32.2%
% Sand	33.9%
% Silt	22.6%
% Clay	11.3%

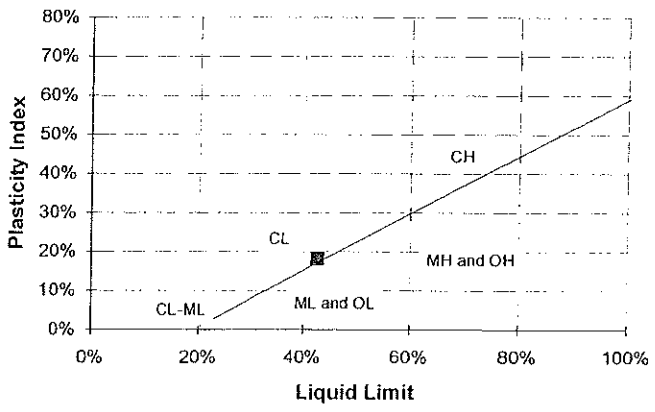
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	225	**Depth**	1.6m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

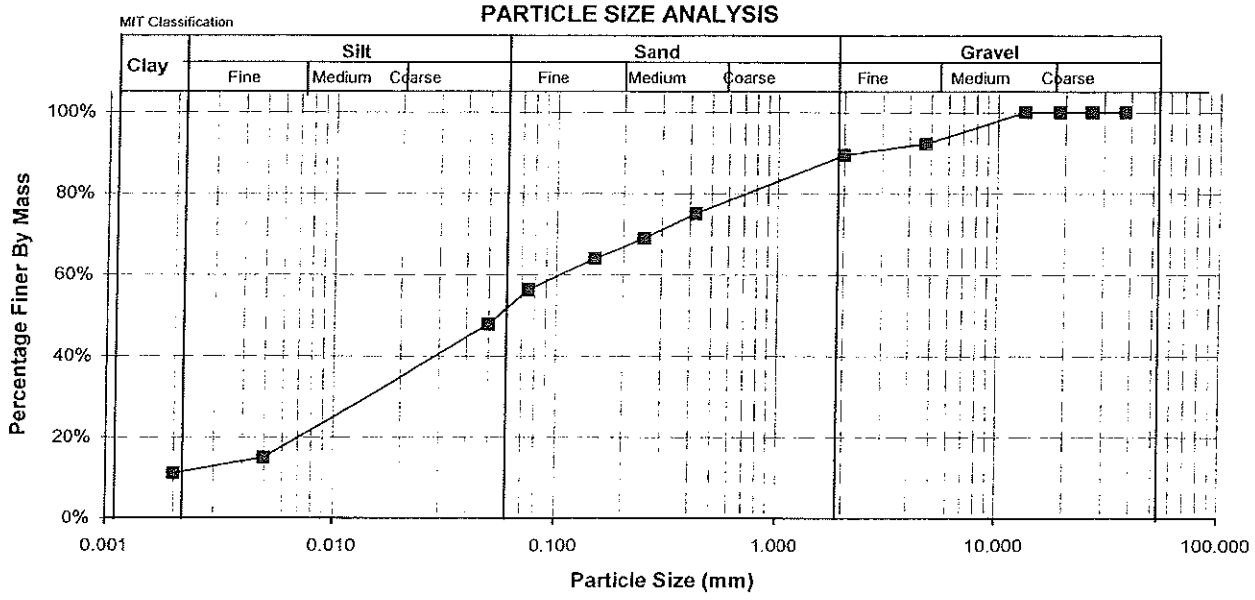
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	69%
26.500	100%	0.150	64%
19.000	100%	0.075	56%
13.200	100%	0.050	48%
4.750	92%	0.005	15%
2.000	90%	0.002	11%
0.425	75%		

ATTERBERG LIMITS

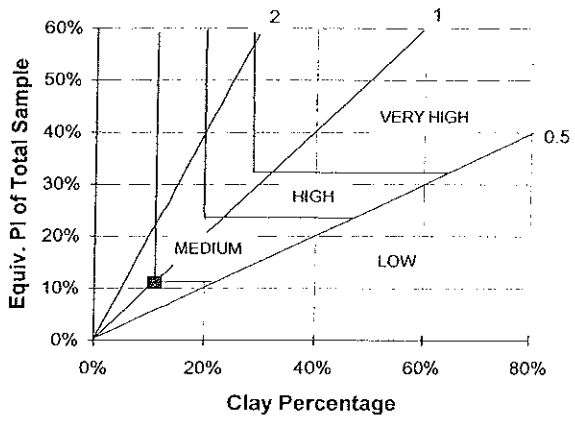
	Test 1	Test 2
Liquid Limit	33.1%	33.5%
Average	**33.3%**	
Plastic Limit	18.2%	19.0%
Average	**18.6%**	
Plasticity Index (PI)	14.7%	
Linear Shrinkage	7.3%	
Grading Modulus	0.79	

PRA Classification	A-6 [6]
Unified Classification	CL
PI of whole sample	11.0%
% Gravel	10.5%
% Sand	37.9%
% Silt	40.5%
% Clay	11.0%

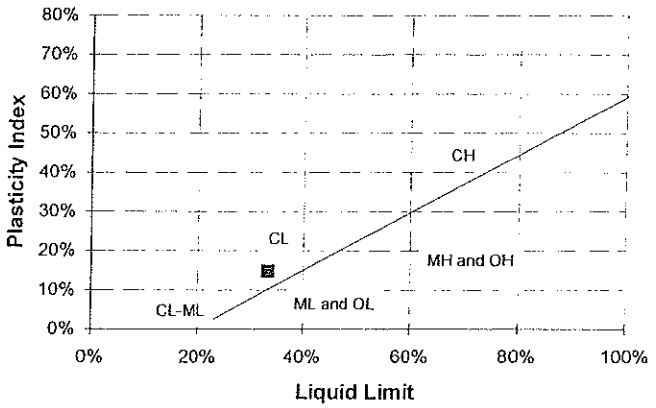
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	192A	**Depth**	1.8m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

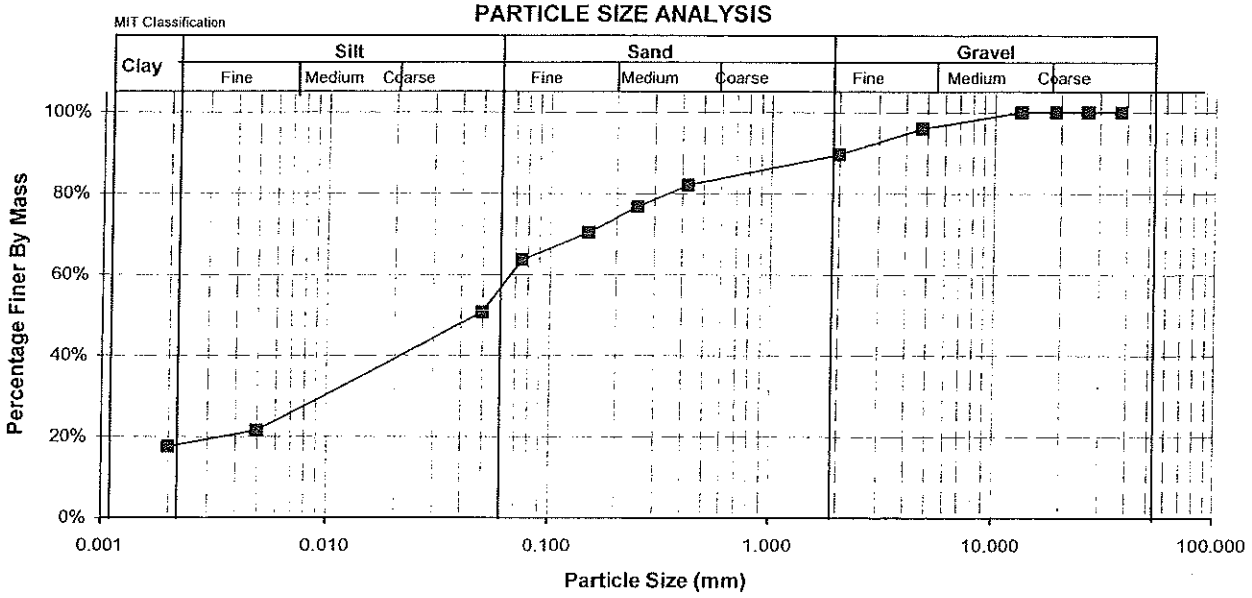
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	77%
26.500	100%	0.150	70%
19.000	100%	0.075	64%
13.200	100%	0.050	51%
4.750	96%	0.005	21%
2.000	90%	0.002	18%
0.425	82%		

ATTERBERG LIMITS

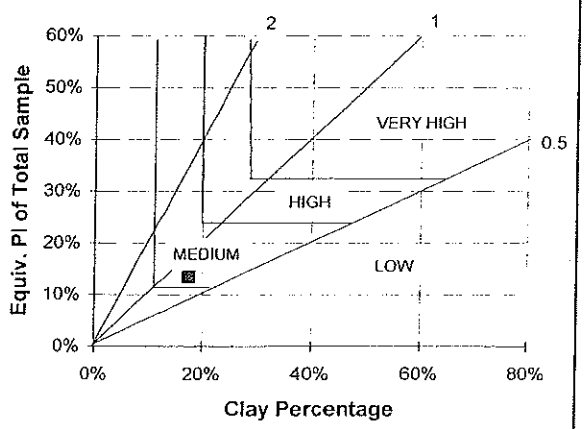
	Test 1	Test 2
Liquid Limit	47.5%	48.2%
Average	**47.9%**	
Plastic Limit	31.7%	31.2%
Average	**31.4%**	
Plasticity Index (PI)	16.4%	
Linear Shrinkage	8.0%	
Grading Modulus	0.65	

PRA Classification	A-7-5 [9]
Unified Classification	ML/OL
PI of whole sample	13.5%
% Gravel	10.5%
% Sand	33.0%
% Silt	39.0%
% Clay	17.6%

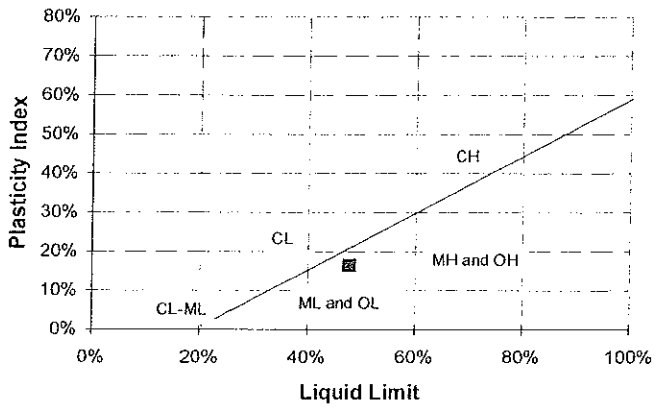
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/10
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	133	Depth	1.4m
Sample	(D) Ferricrete		

SIEVE ANALYSIS

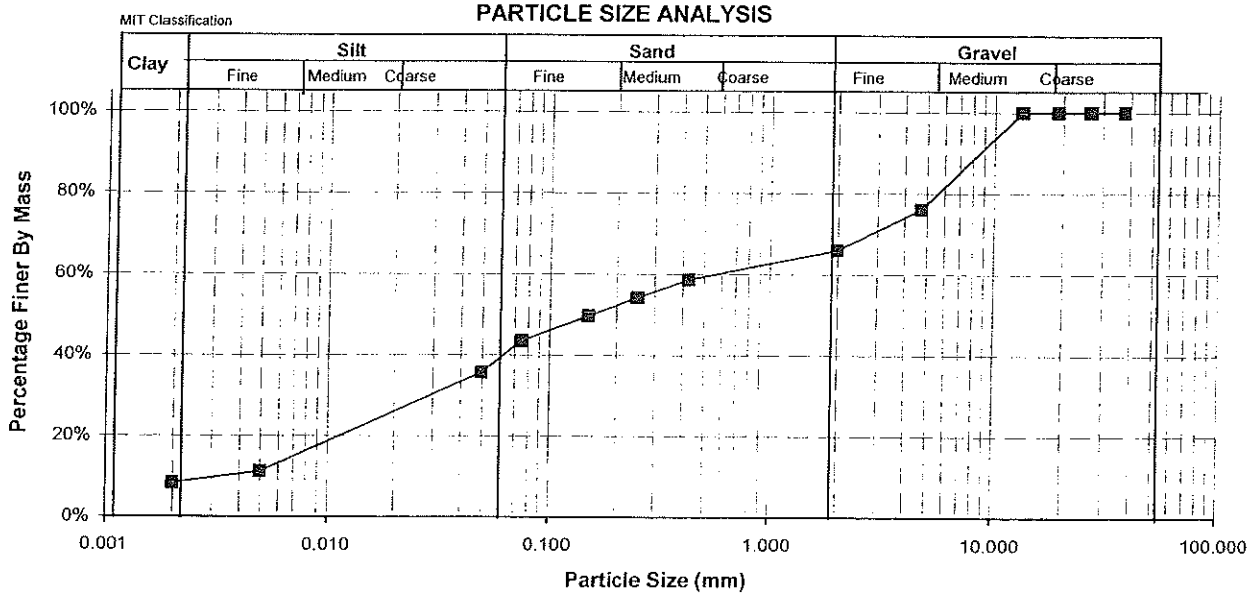
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	54%
26.500	100%	0.150	50%
19.000	100%	0.075	43%
13.200	100%	0.050	36%
4.750	76%	0.005	11%
2.000	66%	0.002	8%
0.425	59%		

ATTERBERG LIMITS

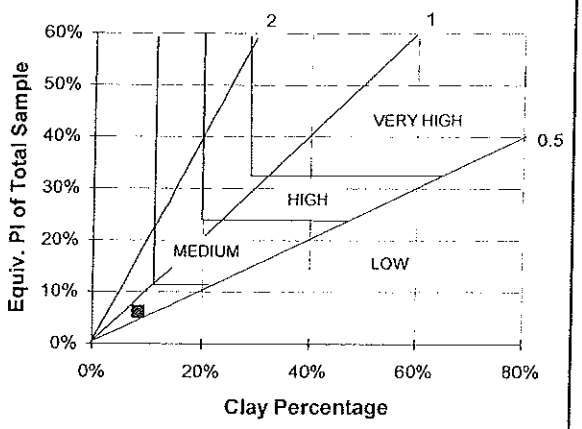
	Test 1	Test 2
Liquid Limit	33.7%	33.8%
Average	**33.7%**	
Plastic Limit	23.3%	23.3%
Average	**23.3%**	
Plasticity Index (PI)	10.5%	
Linear Shrinkage	6.7%	
Grading Modulus	1.32	

PRA Classification	A-6 [2]
Unified Classification	SC
PI of whole sample	6.1%
% Gravel	34.0%
% Sand	26.8%
% Silt	30.8%
% Clay	8.4%

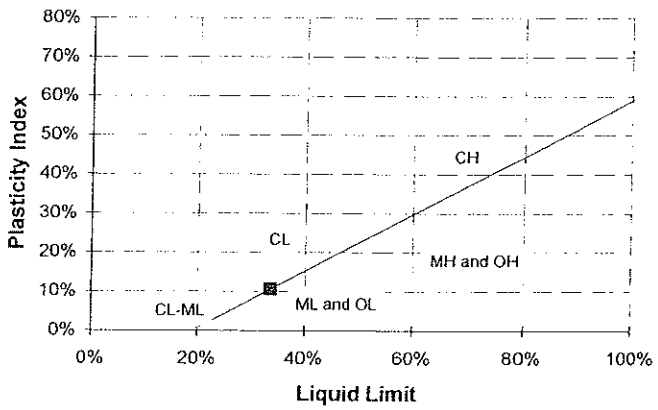
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/09
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	46	**Depth**	1.7-2.3m
Sample	(D) Quartzite		

SIEVE ANALYSIS

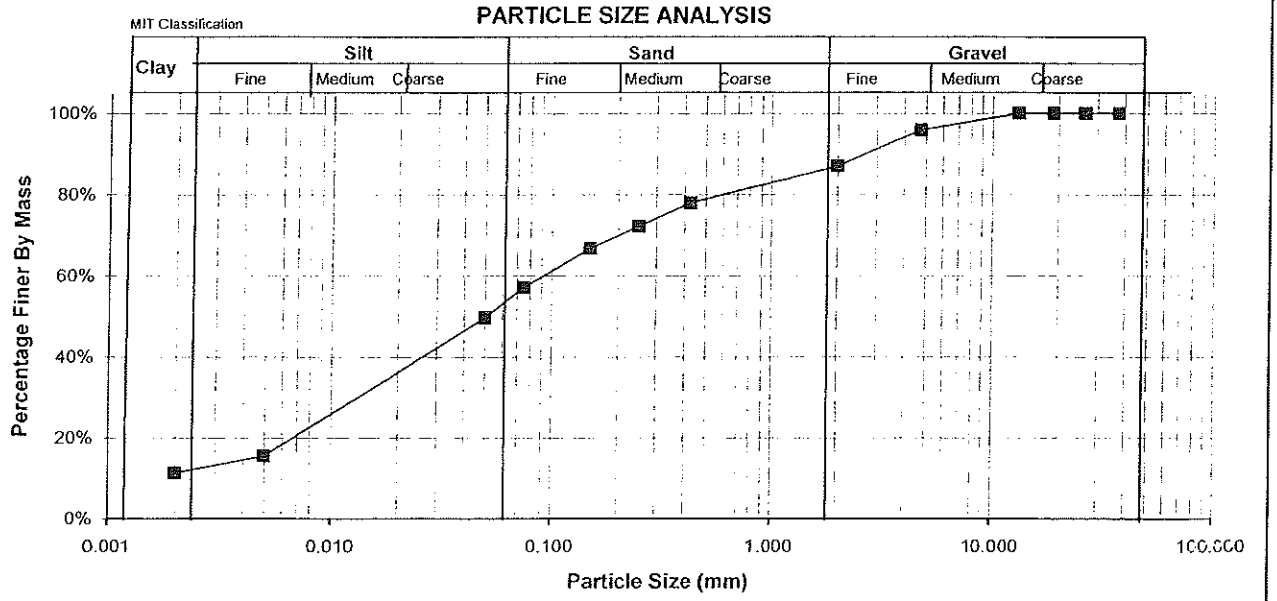
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	72%
26.500	100%	0.150	67%
19.000	100%	0.075	57%
13.200	100%	0.050	50%
4.750	96%	0.005	15%
2.000	87%	0.002	11%
0.425	78%		

ATTERBERG LIMITS

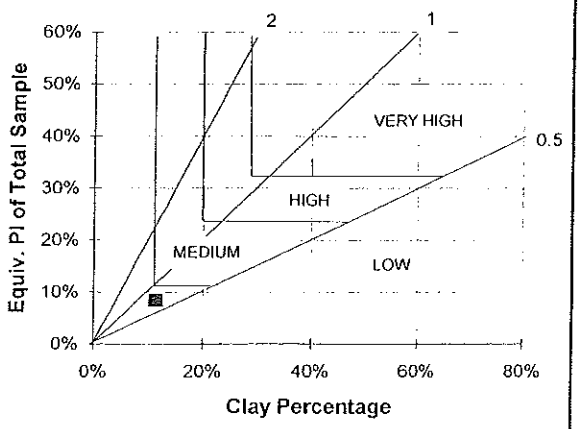
	Test 1	Test 2
Liquid Limit	35.2%	35.0%
Average	**35.1%**	
Plastic Limit	24.2%	24.6%
Average	**24.4%**	
Plasticity Index (PI)	10.6%	
Linear Shrinkage	5.3%	
Grading Modulus	0.78	

PRA Classification	A-6 [5]
Unified Classification	ML/OL
PI of whole sample	8.3%
% Gravel	13.0%
% Sand	34.0%
% Silt	41.6%
% Clay	11.4%

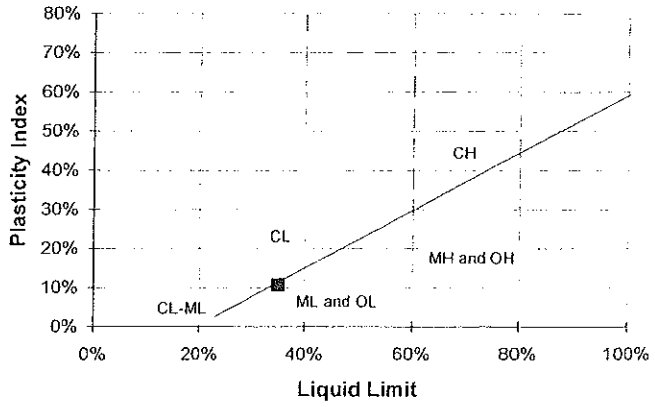
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/09
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	222	**Depth**	1.0-2.0m
Sample	(D) Res. Quartzite		

SIEVE ANALYSIS

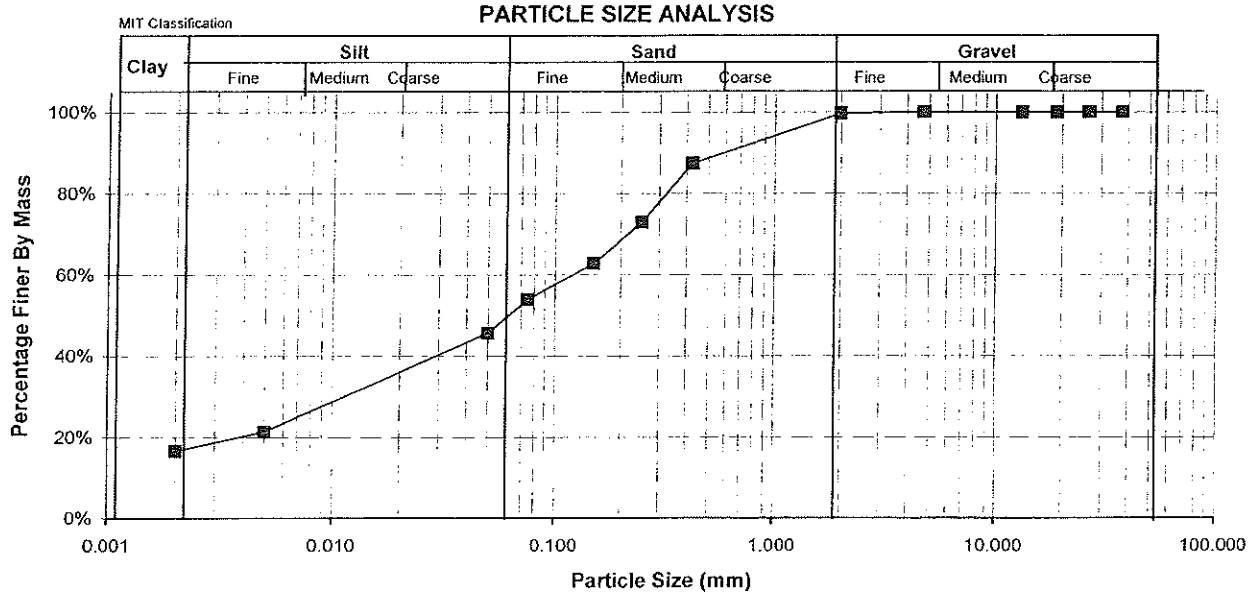
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	73%
26.500	100%	0.150	63%
19.000	100%	0.075	54%
13.200	100%	0.050	46%
4.750	100%	0.005	21%
2.000	100%	0.002	17%
0.425	87%		

ATTERBERG LIMITS

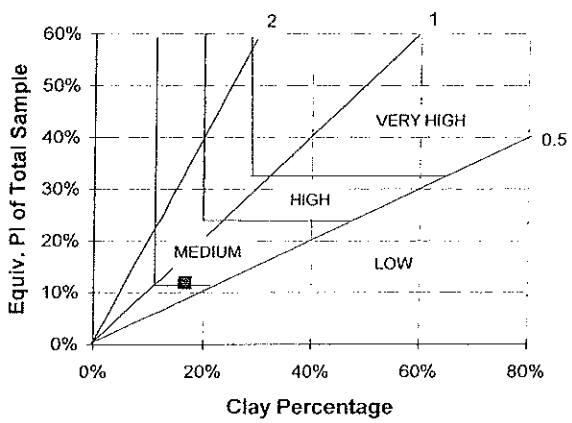
	Test 1	Test 2
Liquid Limit	27.7%	28.7%
Average	**28.2%**	
Plastic Limit	14.9%	14.3%
Average	**14.6%**	
Plasticity Index (PI)	13.6%	
Linear Shrinkage	6.7%	
Grading Modulus	0.59	

PRA Classification	A-6 [5]
Unified Classification	CL
PI of whole sample	11.9%
% Gravel	0.4%
% Sand	50.4%
% Silt	32.7%
% Clay	16.6%

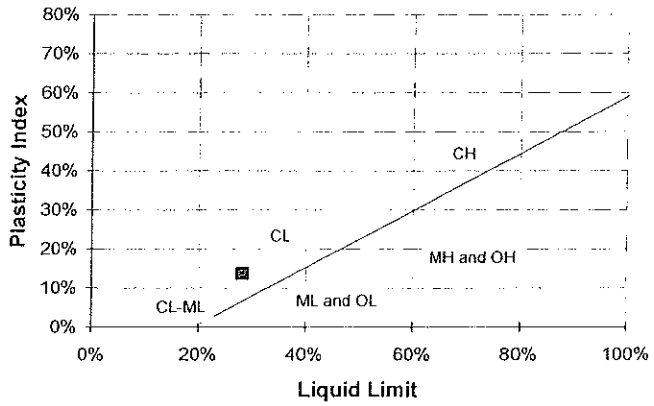
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/10
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	240	Depth	0.8-1.1m
Sample	BC Quartzite		

SIEVE ANALYSIS

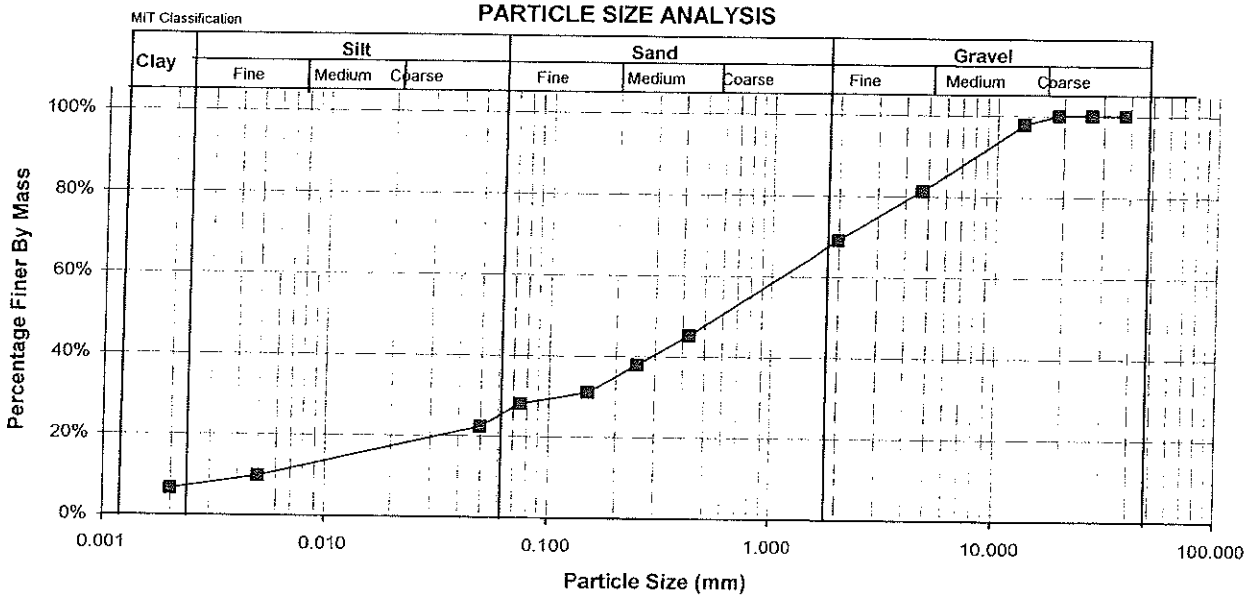
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	38%
26.500	100%	0.150	31%
19.000	100%	0.075	28%
13.200	98%	0.050	22%
4.750	81%	0.005	10%
2.000	69%	0.002	7%
0.425	45%		

ATTERBERG LIMITS

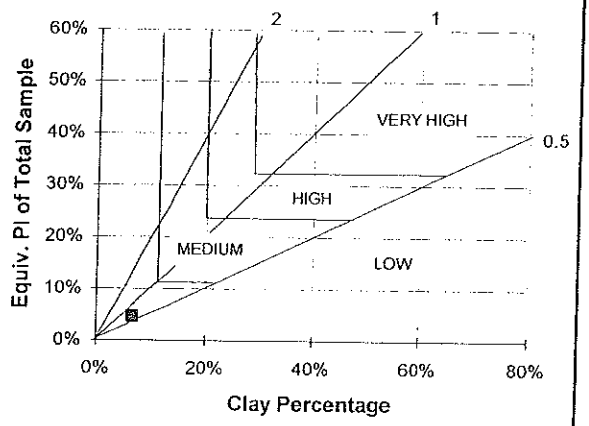
	Test 1	Test 2
Liquid Limit	28.2%	27.2%
Average	27.7%	
Plastic Limit	17.1%	17.8%
Average	17.5%	
Plasticity Index (PI)	10.2%	
Linear Shrinkage	5.3%	
Grading Modulus	1.58	

PRA Classification	A-2-6 [0]
Unified Classification	SC
PI of whole sample	4.6%
% Gravel	31.0%
% Sand	44.1%
% Silt	18.4%
% Clay	6.5%

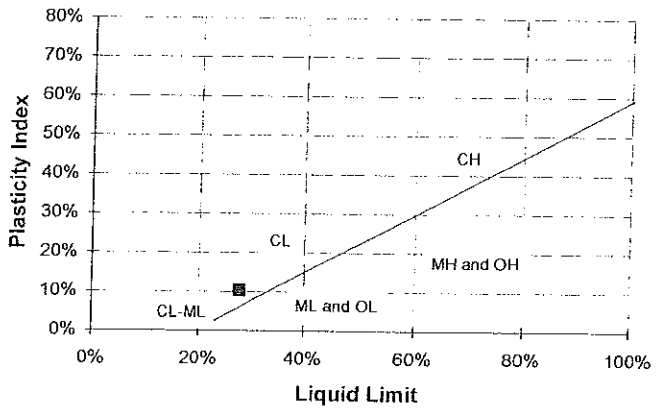
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/09
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	81	**Depth**	1.5m
Sample	(D) Res. Sandstone		

SIEVE ANALYSIS

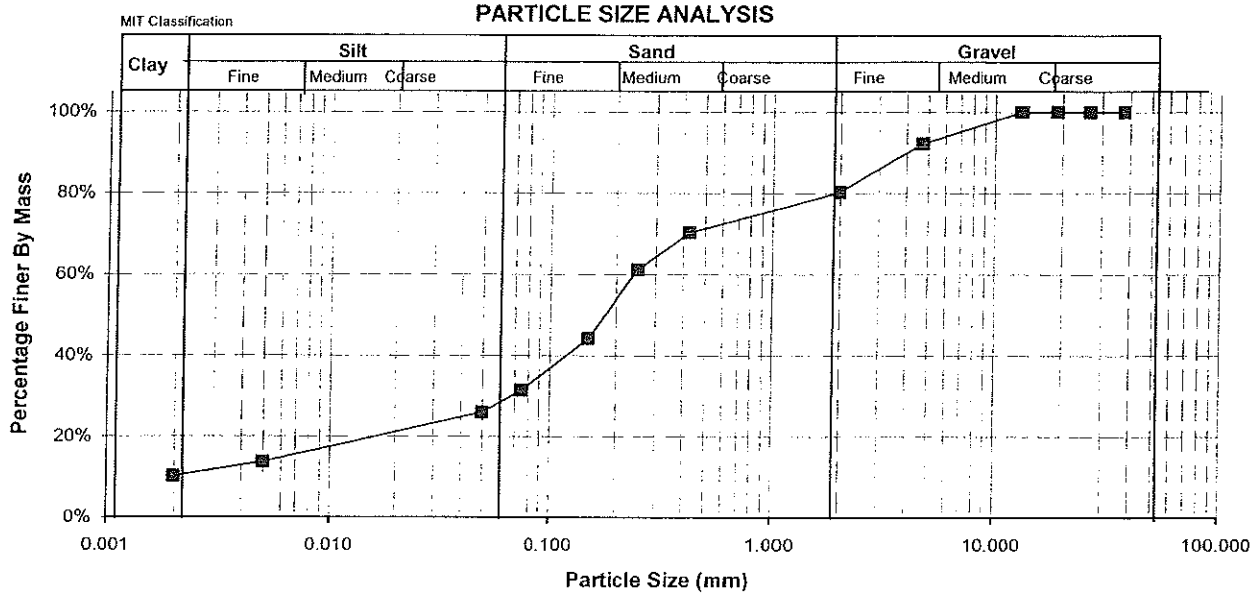
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	61%
26.500	100%	0.150	44%
19.000	100%	0.075	31%
13.200	100%	0.050	26%
4.750	92%	0.005	14%
2.000	80%	0.002	10%
0.425	70%		

ATTERBERG LIMITS

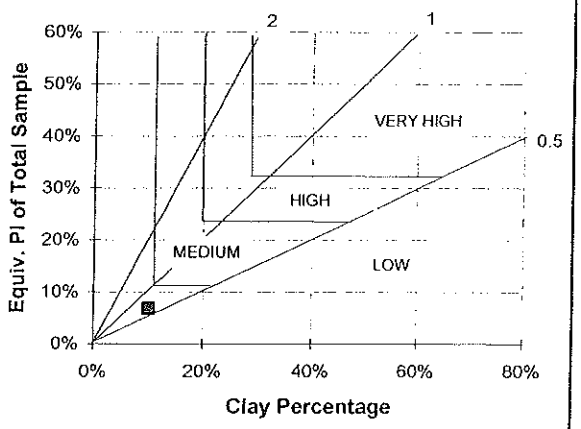
	Test 1	Test 2
Liquid Limit	29.2%	29.5%
Average	**29.3%**	
Plastic Limit	19.5%	19.9%
Average	**19.7%**	
Plasticity Index (PI)	9.6%	
Linear Shrinkage	4.7%	
Grading Modulus	1.18	

PRA Classification	A-2-4
Unified Classification	SC
PI of whole sample	6.7%
% Gravel	19.8%
% Sand	51.9%
% Silt	18.2%
% Clay	10.2%

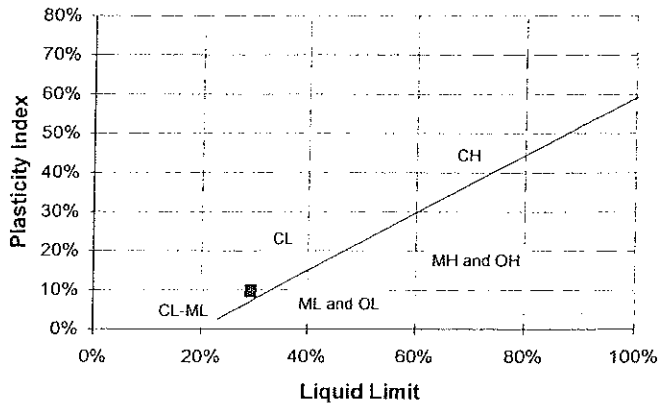
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	86	**Depth**	1.6m
Sample	RES. TILLITE		

SIEVE ANALYSIS

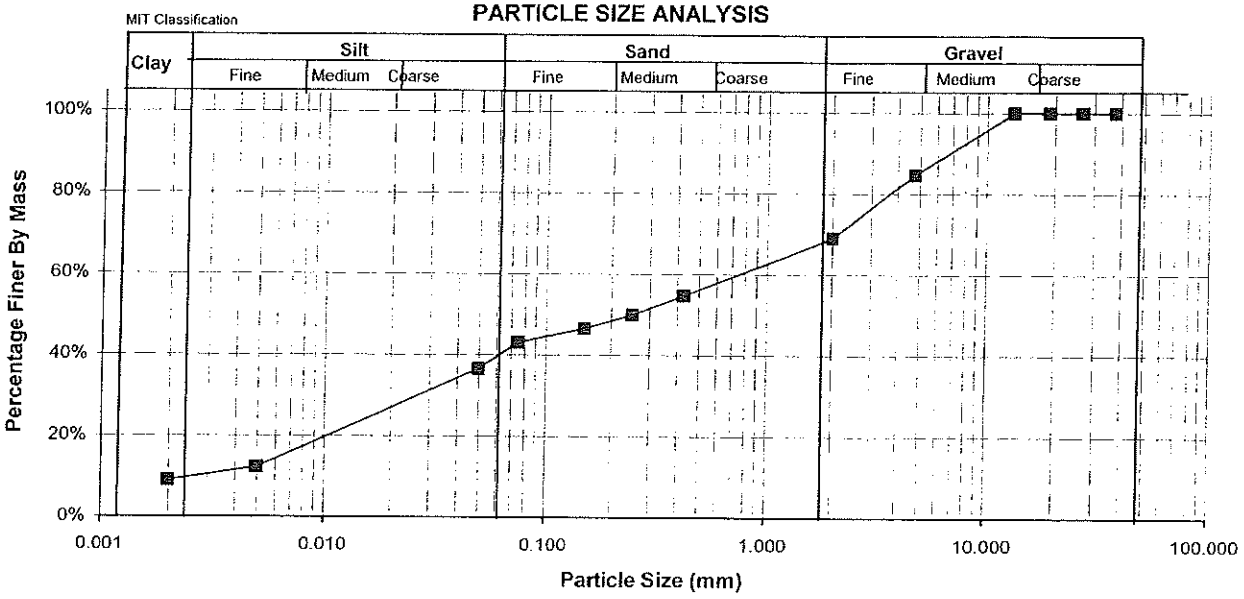
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	50%
26.500	100%	0.150	47%
19.000	100%	0.075	43%
13.200	100%	0.050	37%
4.750	85%	0.005	12%
2.000	69%	0.002	9%
0.425	55%		

ATTERBERG LIMITS

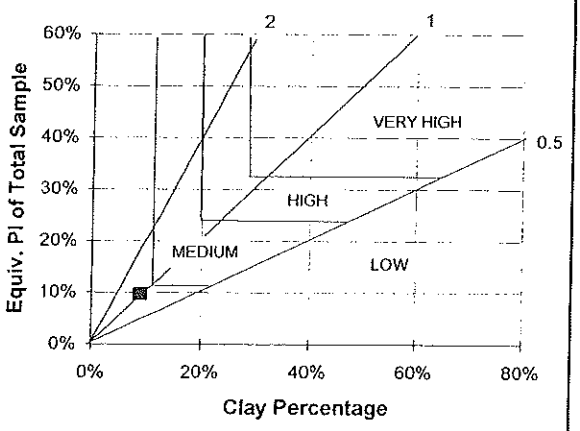
	Test 1	Test 2
Liquid Limit	48.0%	48.0%
Average	**48.0%**	
Plastic Limit	30.1%	30.3%
Average	**30.2%**	
Plasticity Index (PI)	17.8%	
Linear Shrinkage	8.7%	
Grading Modulus	1.33	

PRA Classification	A-7-5 [4]
Unified Classification	SM
PI of whole sample	9.7%
% Gravel	31.0%
% Sand	29.5%
% Silt	30.4%
% Clay	9.0%

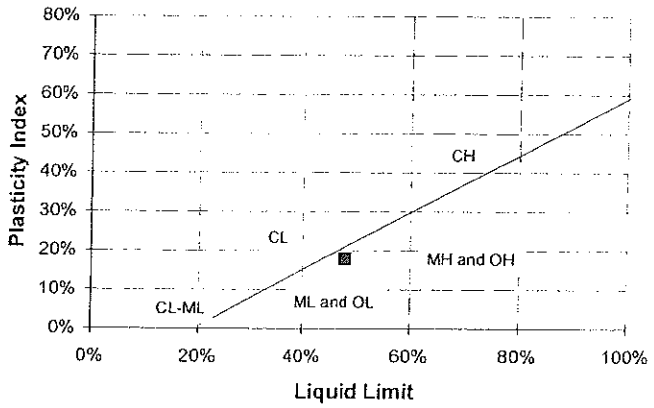
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	88	**Depth**	1.8m
Sample	RES TILLITE		

SIEVE ANALYSIS

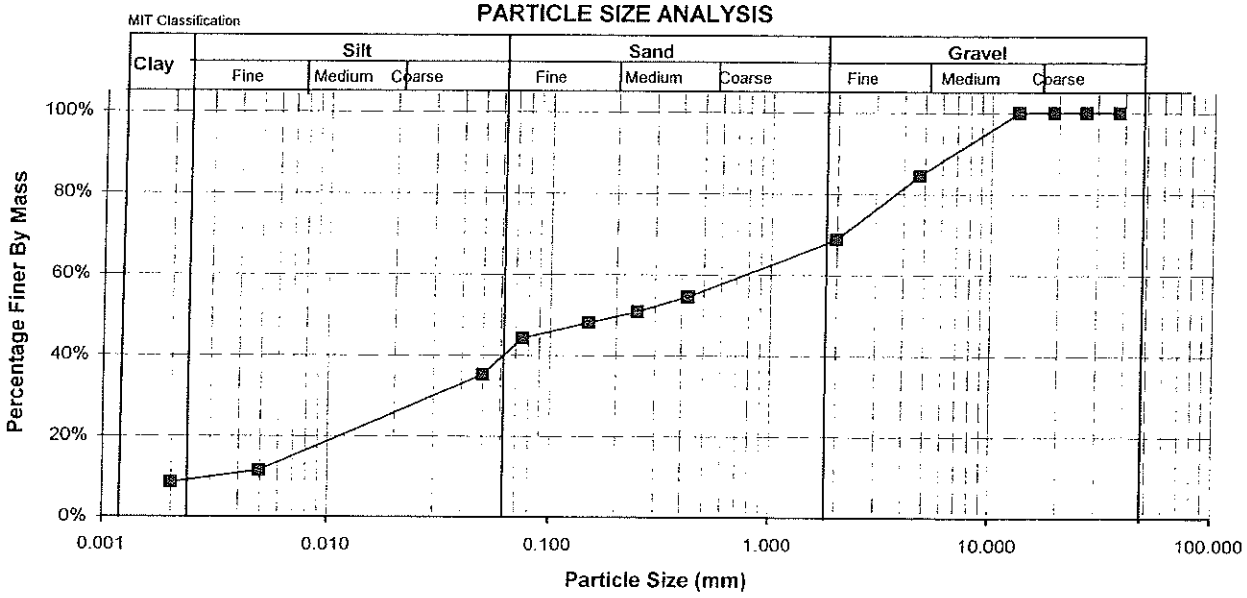
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	51%
26.500	100%	0.150	48%
19.000	100%	0.075	44%
13.200	100%	0.050	35%
4.750	84%	0.005	11%
2.000	69%	0.002	8%
0.425	54%		

ATTERBERG LIMITS

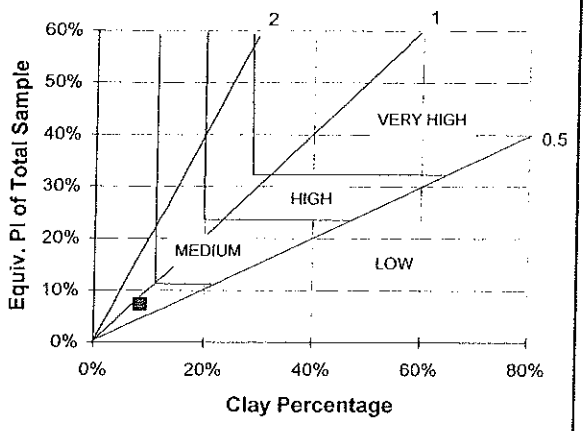
	Test 1	Test 2
Liquid Limit	40.7%	40.9%
Average	**40.8%**	
Plastic Limit	27.9%	27.0%
Average	**27.5%**	
Plasticity Index (PI)	13.3%	
Linear Shrinkage	6.7%	
Grading Modulus	1.33	

PRA Classification	A-7-6 [3]
Unified Classification	SM
PI of whole sample	7.2%
% Gravel	31.2%
% Sand	29.6%
% Silt	30.7%
% Clay	8.5%

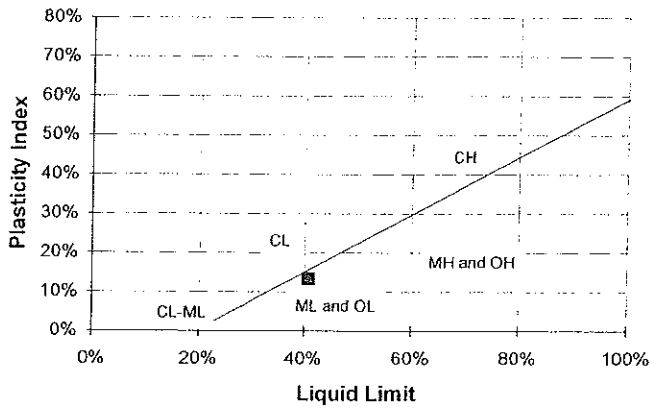
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/09
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	90	Depth	1.5m
Sample	RES TILLITE		

SIEVE ANALYSIS

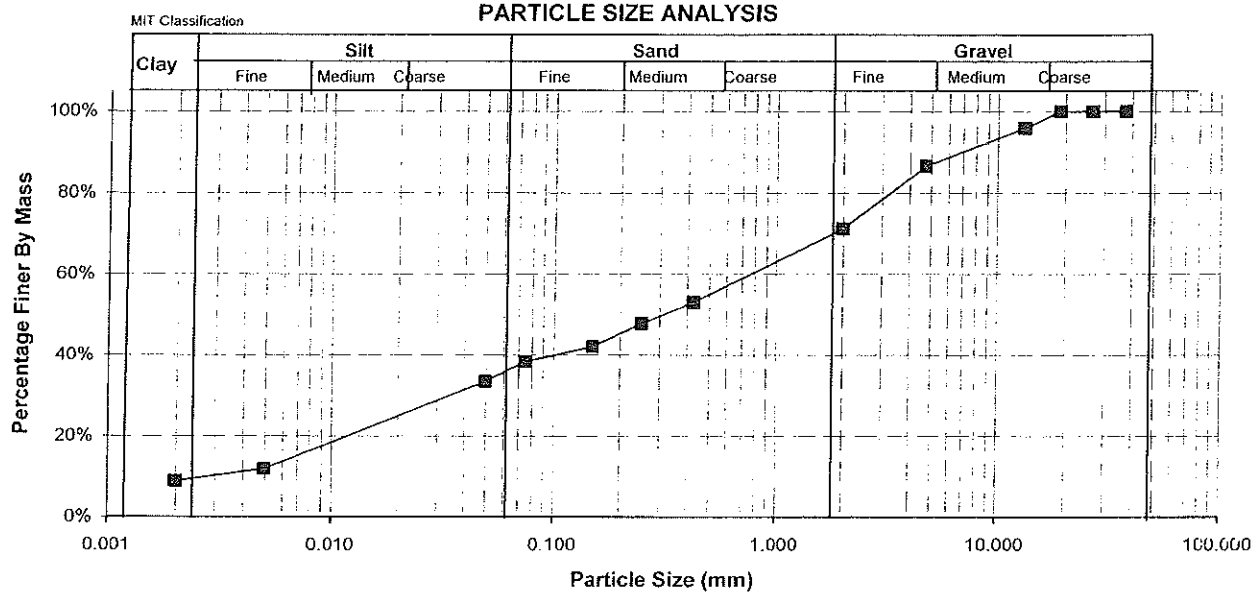
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	48%
26.500	100%	0.150	42%
19.000	100%	0.075	38%
13.200	96%	0.050	33%
4.750	86%	0.005	12%
2.000	71%	0.002	9%
0.425	53%		

ATTERBERG LIMITS

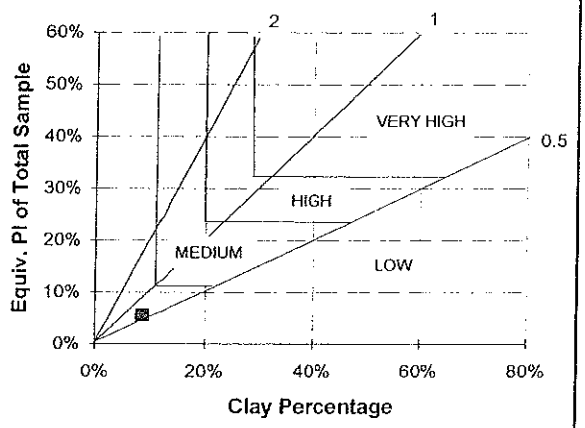
	Test 1	Test 2
Liquid Limit	46.2%	46.7%
Average	**46.5%**	
Plastic Limit	36.2%	35.9%
Average	**36.1%**	
Plasticity Index (PI)	10.4%	
Linear Shrinkage	6.7%	
Grading Modulus	1.38	

PRA Classification	A-7-5 [1]
Unified Classification	SM
PI of whole sample	5.5%
% Gravel	28.8%
% Sand	35.6%
% Silt	26.8%
% Clay	8.8%

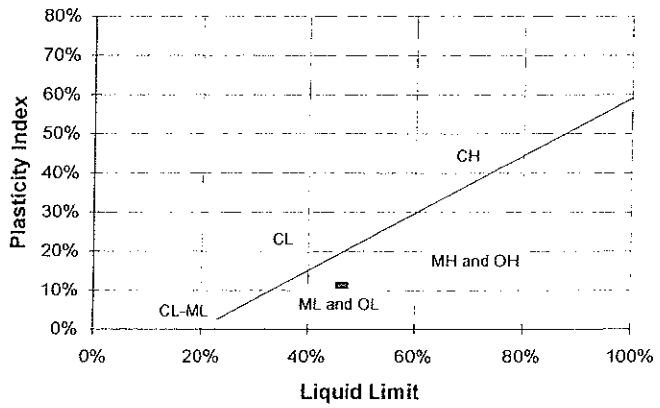
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/10
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	98	Depth	1.7m
Sample	RES TILLITE		

SIEVE ANALYSIS

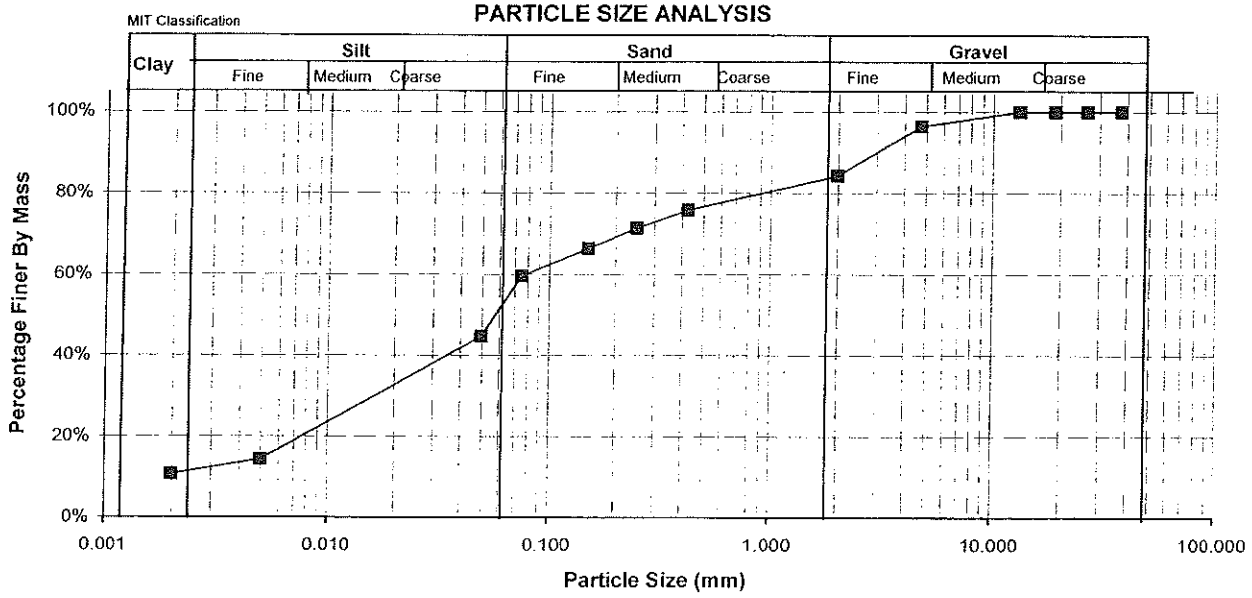
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	71%
26.500	100%	0.150	66%
19.000	100%	0.075	59%
13.200	100%	0.050	45%
4.750	96%	0.005	14%
2.000	84%	0.002	11%
0.425	76%		

ATTERBERG LIMITS

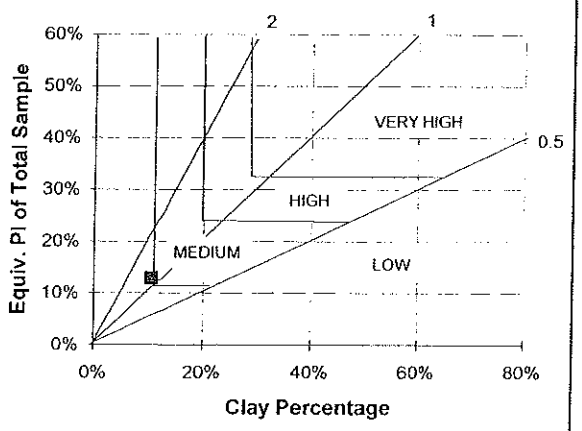
	Test 1	Test 2
Liquid Limit	37.8%	38.0%
Average	**37.9%**	
Plastic Limit	21.1%	20.8%
Average	**20.9%**	
Plasticity Index (PI)	17.0%	
Linear Shrinkage	8.7%	
Grading Modulus	0.81	

PRA Classification	A-6 [8]
Unified Classification	CL
PI of whole sample	12.9%
% Gravel	15.8%
% Sand	32.9%
% Silt	40.6%
% Clay	10.7%

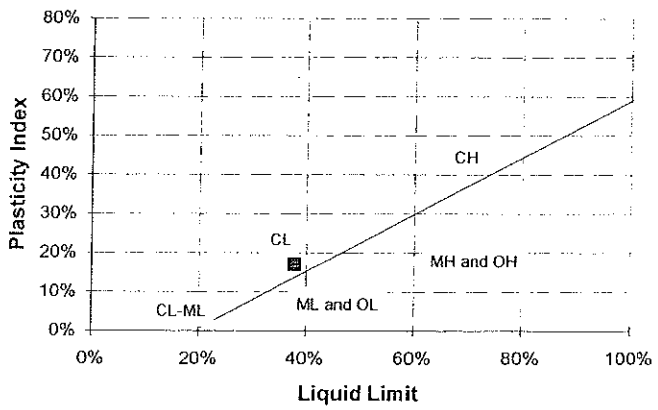
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	74	**Depth**	1.6m
Sample	(D) Res. Mudrock		

SIEVE ANALYSIS

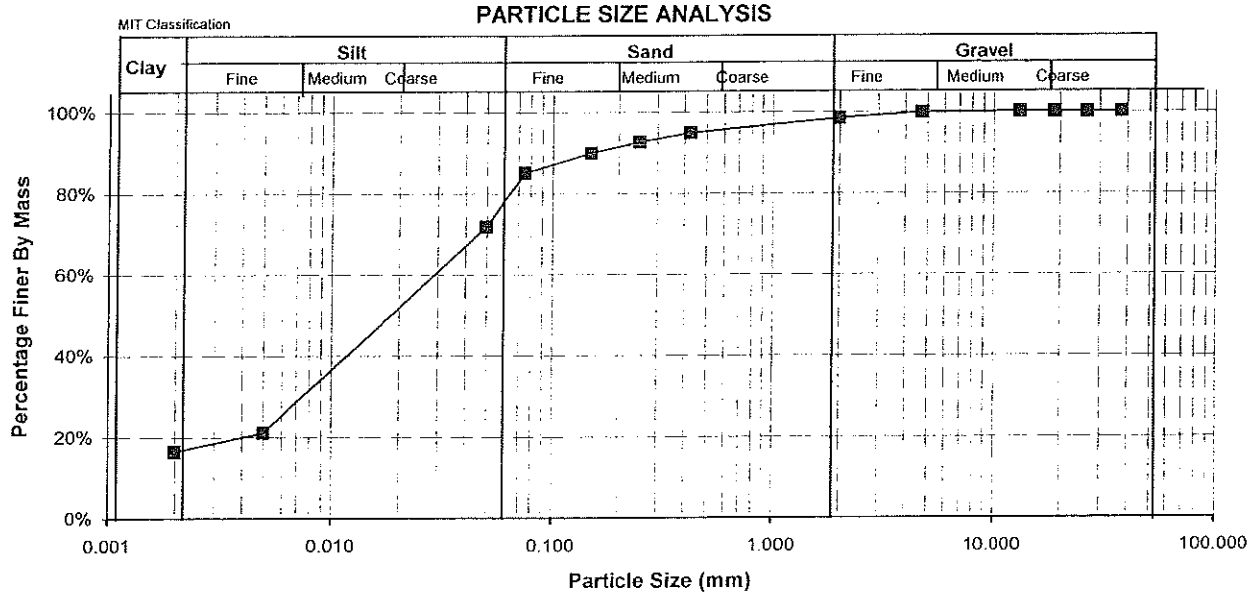
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	93%
26.500	100%	0.150	90%
19.000	100%	0.075	85%
13.200	100%	0.050	72%
4.750	100%	0.005	21%
2.000	98%	0.002	16%
0.425	95%		

ATTERBERG LIMITS

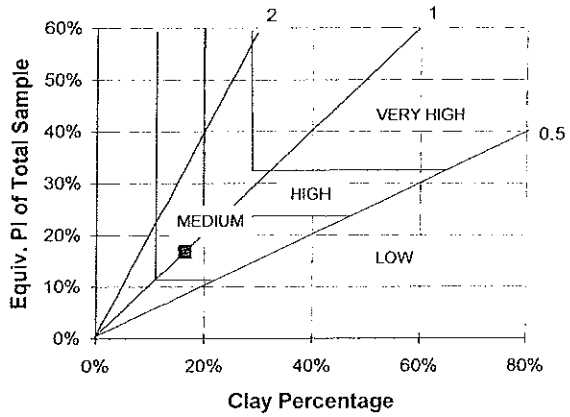
	Test 1	Test 2
Liquid Limit	50.8%	50.6%
Average	**50.7%**	
Plastic Limit	34.0%	32.0%
Average	**33.0%**	
Plasticity Index (PI)	17.7%	
Linear Shrinkage	8.7%	
Grading Modulus	0.22	

PRA Classification	A-7-5 [13]
Unified Classification	MH/OH
PI of whole sample	16.8%
% Gravel	1.6%
% Sand	20.7%
% Silt	61.3%
% Clay	16.4%

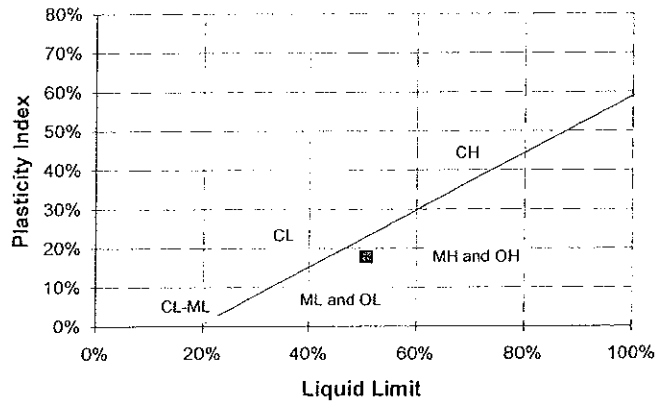
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	83	**Depth**	1.6m
Sample	(D) Res. Mudrock		

SIEVE ANALYSIS

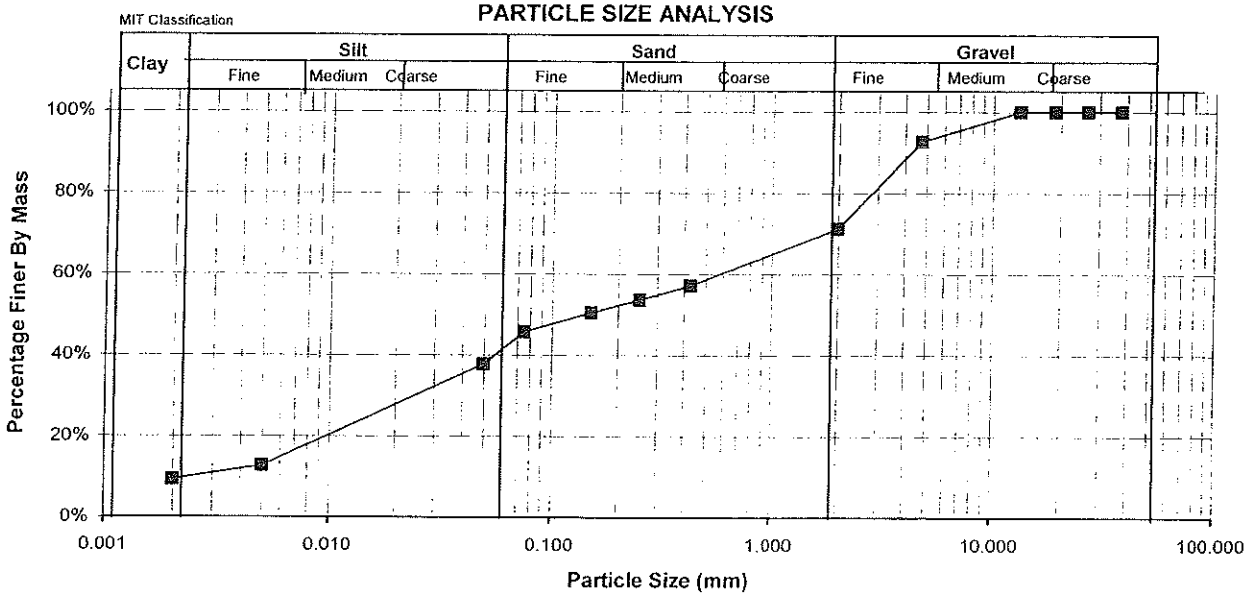
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	54%
26.500	100%	0.150	50%
19.000	100%	0.075	46%
13.200	100%	0.050	38%
4.750	93%	0.005	13%
2.000	71%	0.002	9%
0.425	57%		

ATTERBERG LIMITS

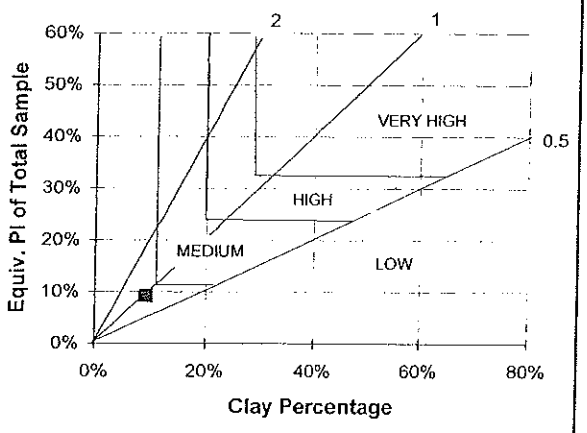
	Test 1	Test 2
Liquid Limit	39.9%	40.2%
Average	**40.1%**	
Plastic Limit	24.9%	23.3%
Average	**24.1%**	
Plasticity Index (PI)	16.0%	
Linear Shrinkage	8.0%	
Grading Modulus	1.26	

PRA Classification	A-7-6 [4]
Unified Classification	SC
PI of whole sample	9.1%
% Gravel	28.8%
% Sand	29.9%
% Silt	32.0%
% Clay	9.3%

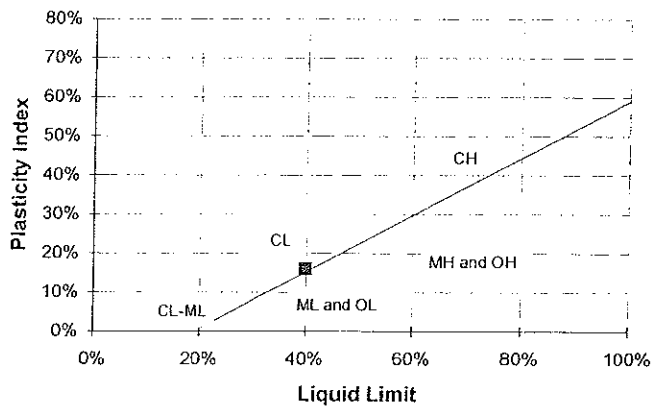
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/10
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	122	Depth	1.6m
Sample	(D) Res. Mudrock		

SIEVE ANALYSIS

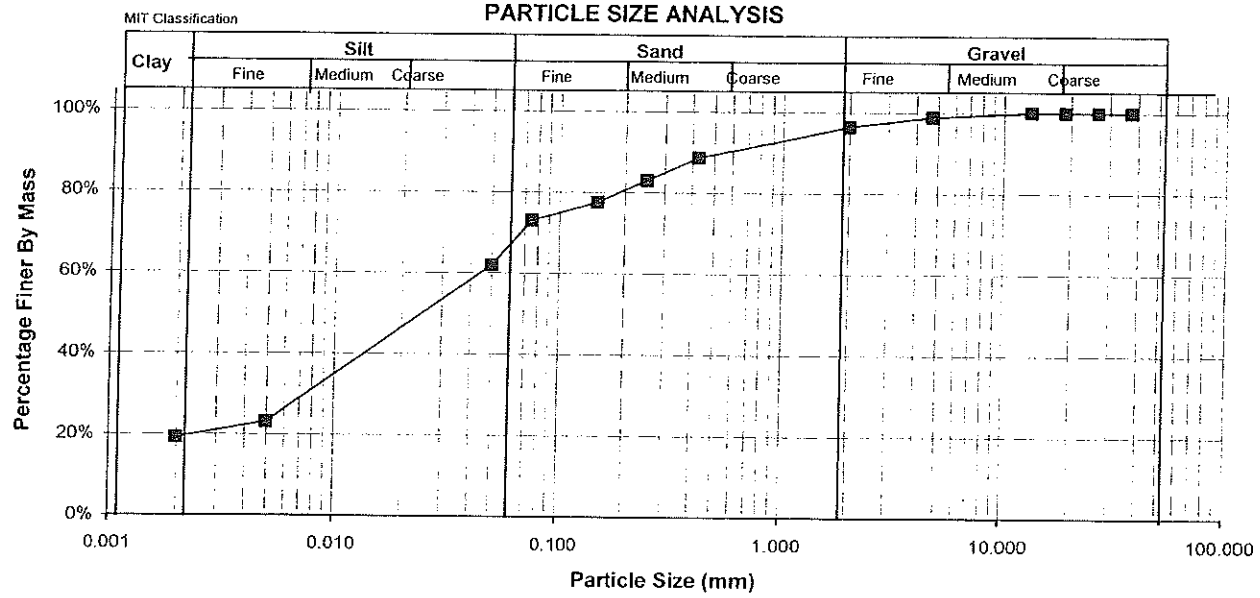
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	83%
26.500	100%	0.150	77%
19.000	100%	0.075	73%
13.200	100%	0.050	62%
4.750	99%	0.005	23%
2.000	96%	0.002	19%
0.425	89%		

ATTERBERG LIMITS

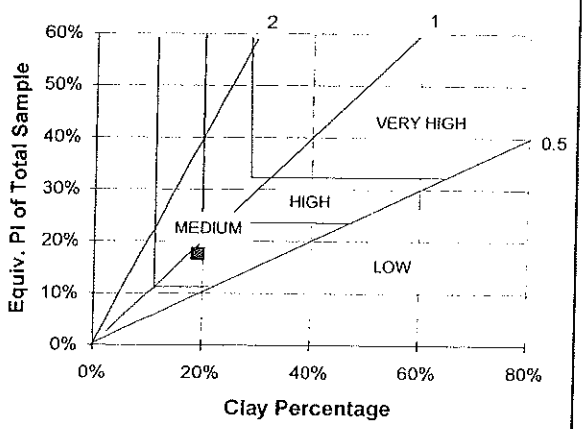
	Test 1	Test 2
Liquid Limit	45.2%	46.1%
Average	**45.7%**	
Plastic Limit	25.9%	25.9%
Average	**25.9%**	
Plasticity Index (PI)	19.8%	
Linear Shrinkage	10.0%	
Grading Modulus	0.42	

PRA Classification	A-7-6 [13]
Unified Classification	CL
PI of whole sample	17.5%
% Gravel	3.7%
% Sand	29.4%
% Silt	47.7%
% Clay	19.2%

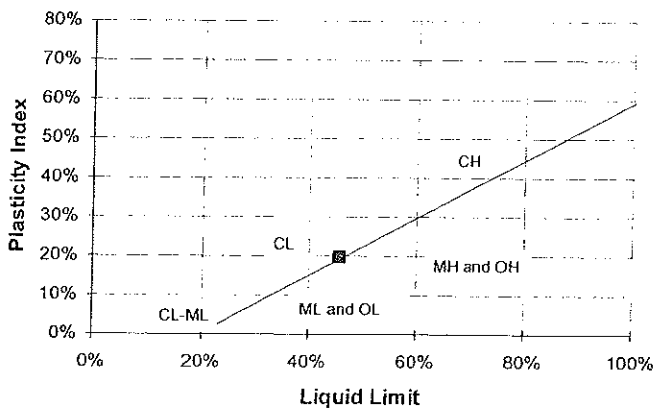
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/07
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	128	**Depth**	1.6m
Sample	Res. Mudrock		

SIEVE ANALYSIS

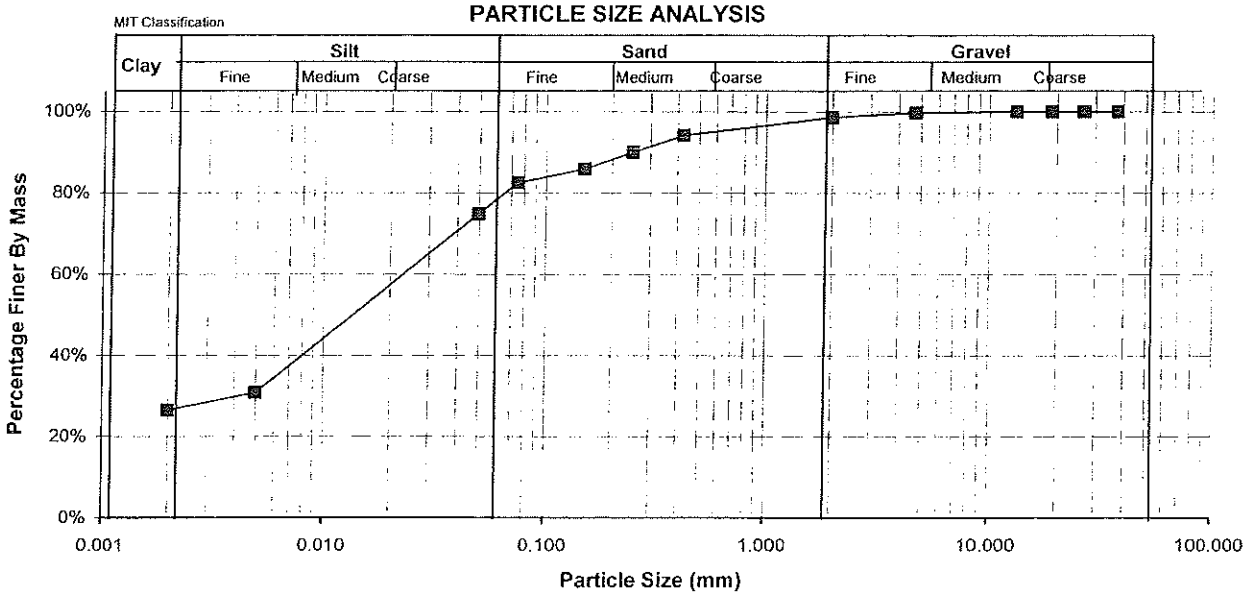
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	90%
26.500	100%	0.150	86%
19.000	100%	0.075	82%
13.200	100%	0.050	75%
4.750	100%	0.005	31%
2.000	99%	0.002	26%
0.425	94%		

ATTERBERG LIMITS

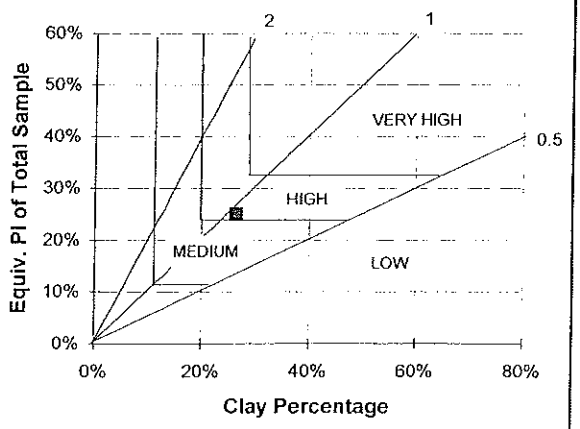
	Test 1	Test 2
Liquid Limit	63.5%	62.3%
Average	**62.9%**	
Plastic Limit	36.1%	36.7%
Average	**36.4%**	
Plasticity Index (PI)	26.5%	
Linear Shrinkage	13.3%	
Grading Modulus	0.25	

PRA Classification	A-7-5 [19]
Unified Classification	MH/OH
PI of whole sample	25.0%
% Gravel	1.4%
% Sand	20.3%
% Silt	51.8%
% Clay	26.5%

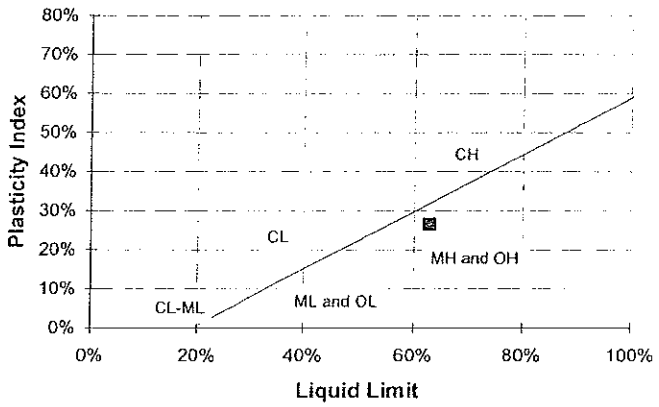
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/07
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	130	**Depth**	2.1m
Sample	Res. Mudrock		

SIEVE ANALYSIS

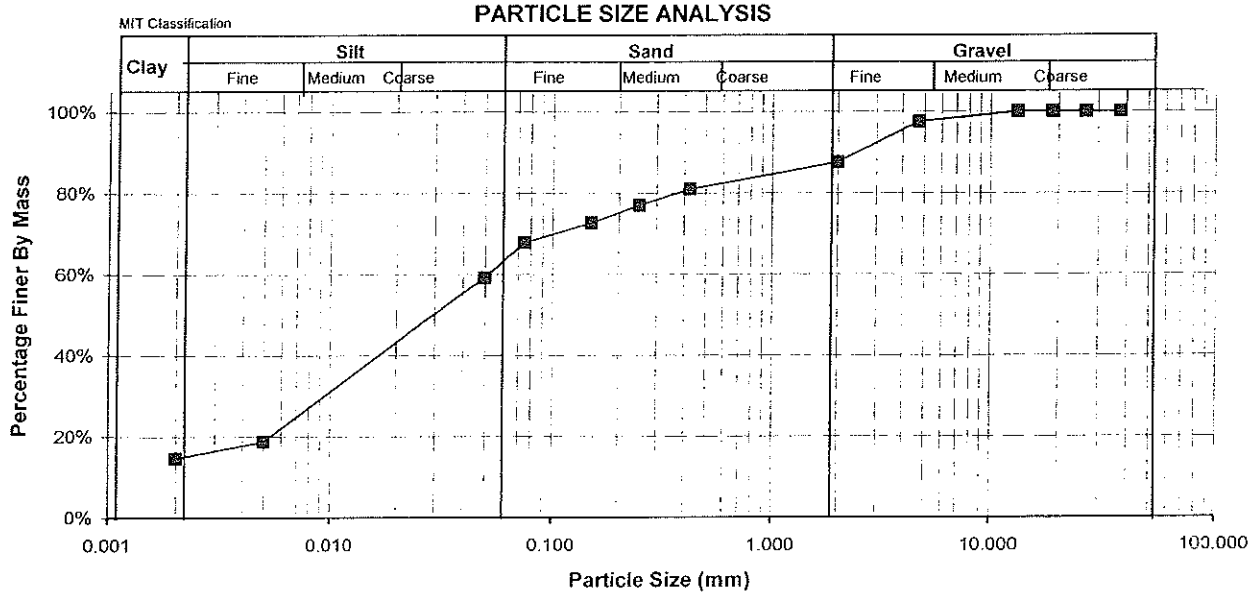
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	77%
26.500	100%	0.150	73%
19.000	100%	0.075	68%
13.200	100%	0.050	59%
4.750	97%	0.005	19%
2.000	88%	0.002	15%
0.425	81%		

ATTERBERG LIMITS

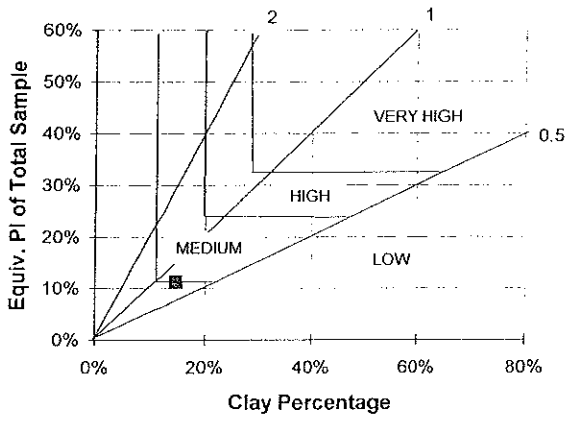
	Test 1	Test 2
Liquid Limit	50.3%	49.5%
Average	**49.9%**	
Plastic Limit	35.7%	36.2%
Average	**36.0%**	
Plasticity Index (PI)	13.9%	
Linear Shrinkage	7.3%	
Grading Modulus	0.64	

PRA Classification	A-7-5 [10]
Unified Classification	ML/OL
PI of whole sample	11.3%
% Gravel	12.5%
% Sand	24.5%
% Silt	48.4%
% Clay	14.6%

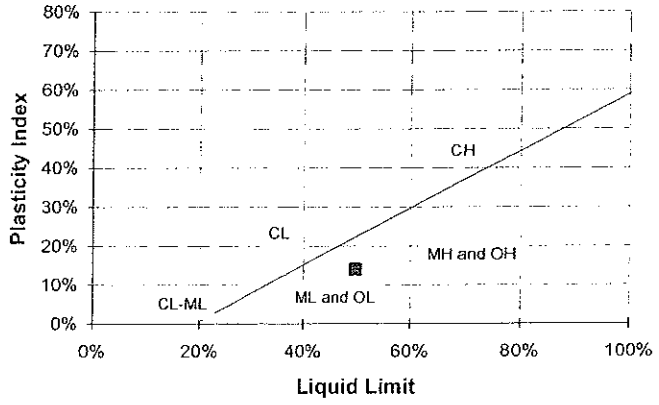
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	69	**Depth**	1.8m
Sample	(D) Res. Mudrock		

SIEVE ANALYSIS

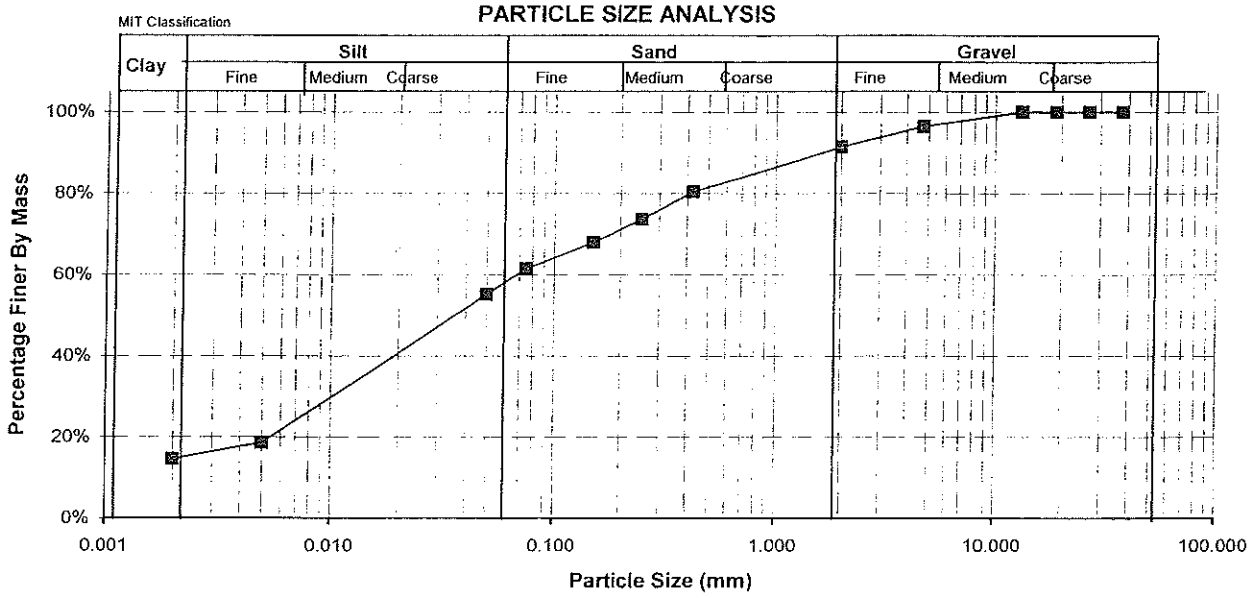
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	74%
26.500	100%	0.150	68%
19.000	100%	0.075	61%
13.200	100%	0.050	55%
4.750	96%	0.005	19%
2.000	91%	0.002	15%
0.425	80%		

ATTERBERG LIMITS

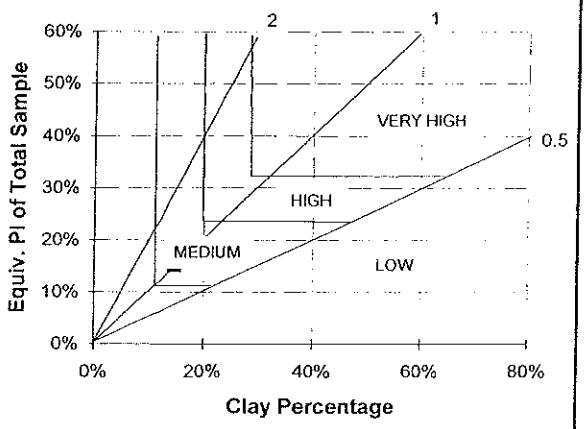
	Test 1	Test 2
Liquid Limit	35.7%	35.5%
Average	**35.6%**	
Plastic Limit	16.1%	17.8%
Average	**16.9%**	
Plasticity Index (PI)	18.7%	
Linear Shrinkage	9.3%	
Grading Modulus	0.67	

PRA Classification	A-6 [9]
Unified Classification	CL
PI of whole sample	15.0%
% Gravel	8.6%
% Sand	33.5%
% Silt	43.3%
% Clay	14.6%

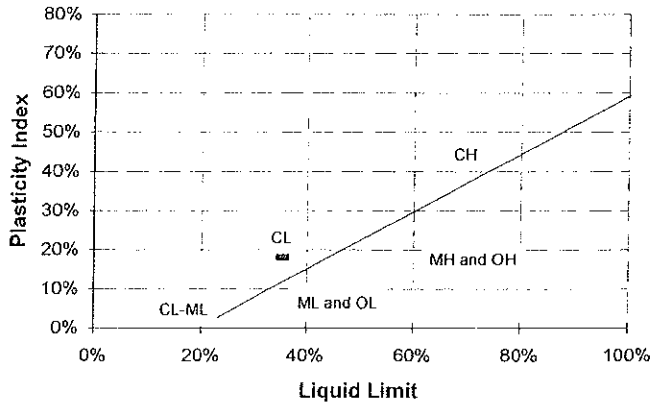
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/09
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	67	Depth	1.5m
Sample	(D) Res. Mudrock		

SIEVE ANALYSIS

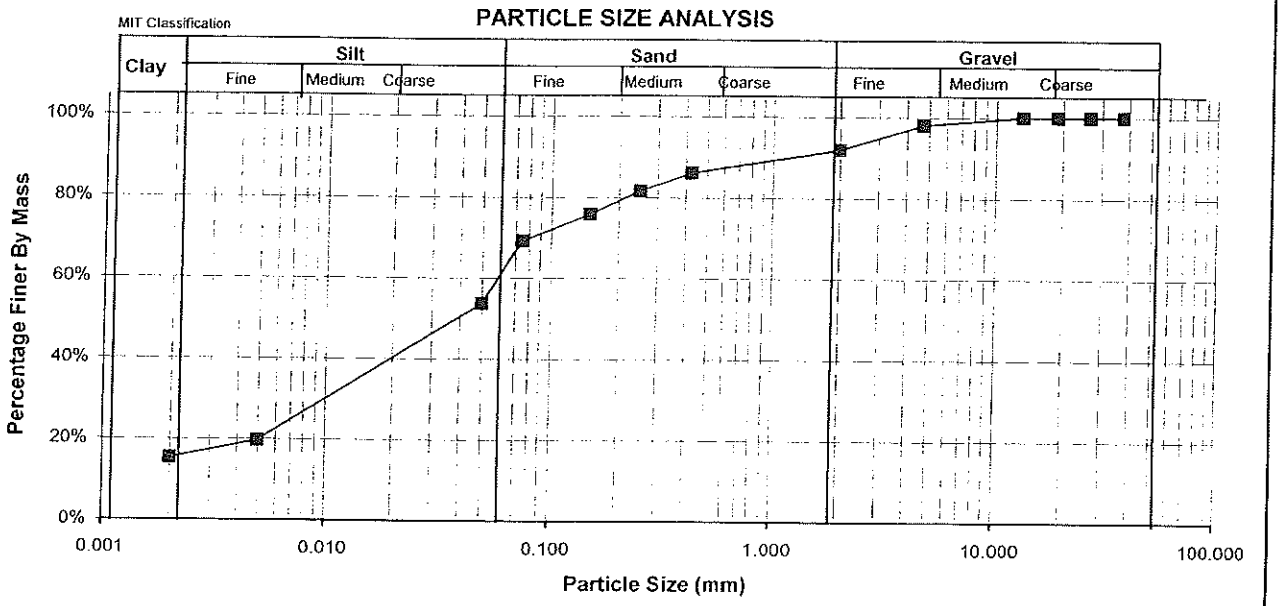
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	82%
26.500	100%	0.150	76%
19.000	100%	0.075	69%
13.200	100%	0.050	54%
4.750	98%	0.005	20%
2.000	92%	0.002	15%
0.425	86%		

ATTERBERG LIMITS

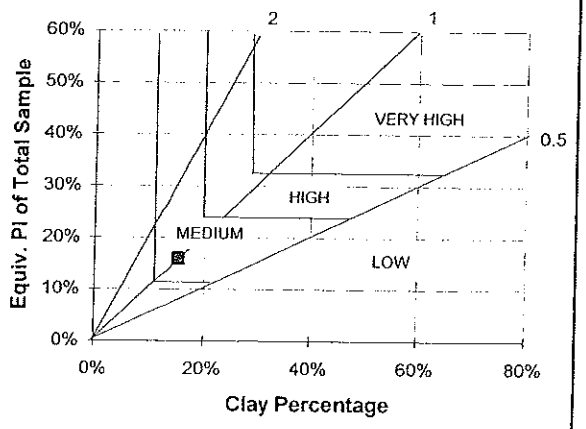
	Test 1	Test 2
Liquid Limit	32.9%	33.1%
Average	33.0%	
Plastic Limit	14.7%	14.2%
Average	14.4%	
Plasticity Index (PI)	18.6%	
Linear Shrinkage	9.3%	
Grading Modulus	0.53	

PRA Classification	A-6 [10]
Unified Classification	CL
PI of whole sample	16.0%
% Gravel	8.2%
% Sand	31.2%
% Silt	45.3%
% Clay	15.3%

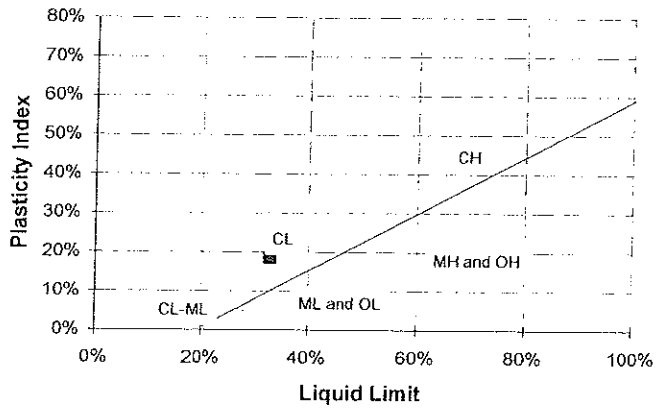
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/10
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	142	Depth	1.8m
Sample	(D) Res. Dolerite		

SIEVE ANALYSIS

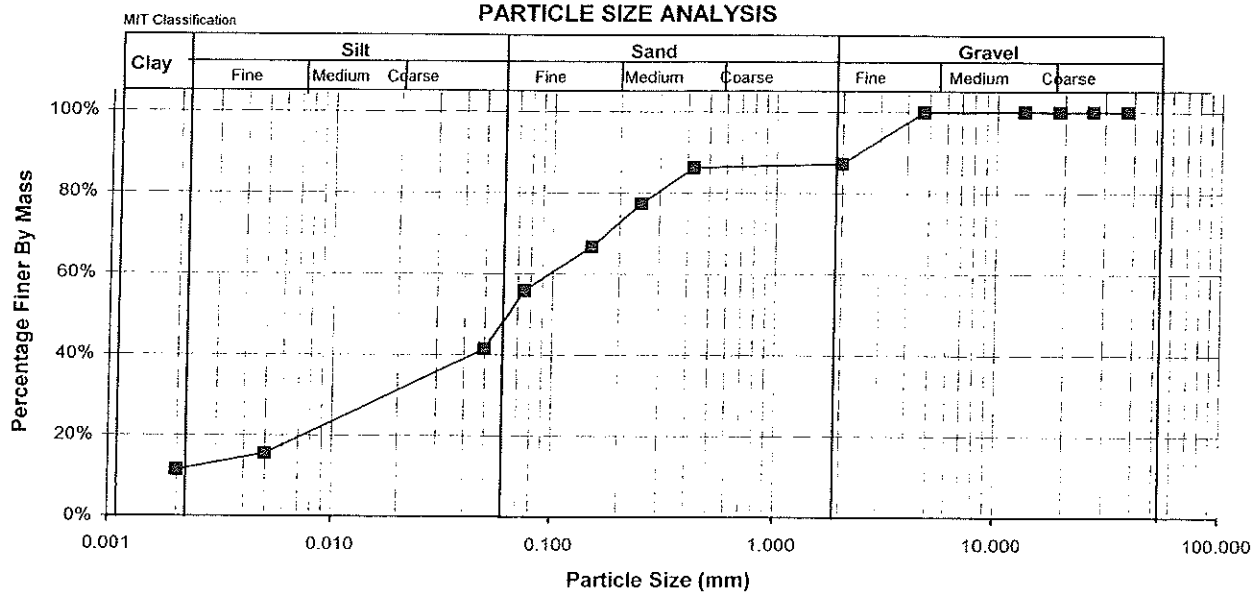
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	77%
26.500	100%	0.150	67%
19.000	100%	0.075	56%
13.200	100%	0.050	41%
4.750	100%	0.005	15%
2.000	87%	0.002	11%
0.425	86%		

ATTERBERG LIMITS

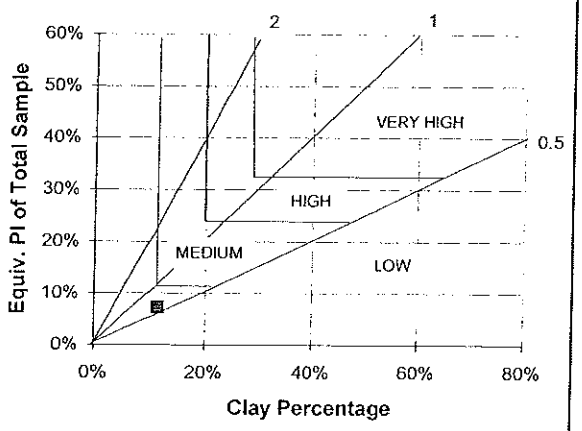
	Test 1	Test 2
Liquid Limit	26.5%	26.4%
Average	**26.4%**	
Plastic Limit	18.4%	17.7%
Average	**18.1%**	
Plasticity Index (PI)	8.4%	
Linear Shrinkage	4.0%	
Grading Modulus	0.71	

PRA Classification	A-4 [4]
Unified Classification	CL
PI of whole sample	7.2%
% Gravel	12.9%
% Sand	39.2%
% Silt	36.5%
% Clay	11.4%

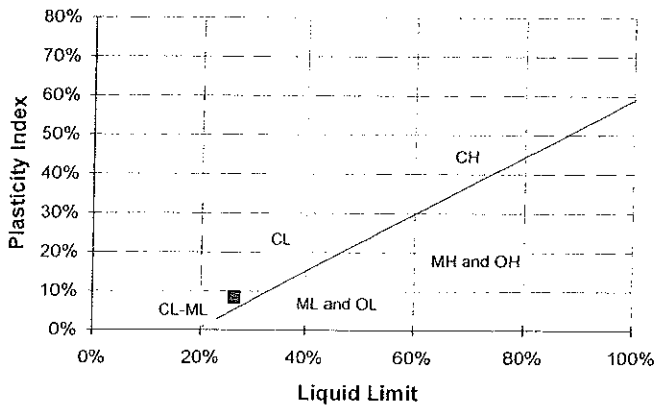
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	143	**Depth**	1.4m
Sample	(D) Res. Dolerite		

SIEVE ANALYSIS

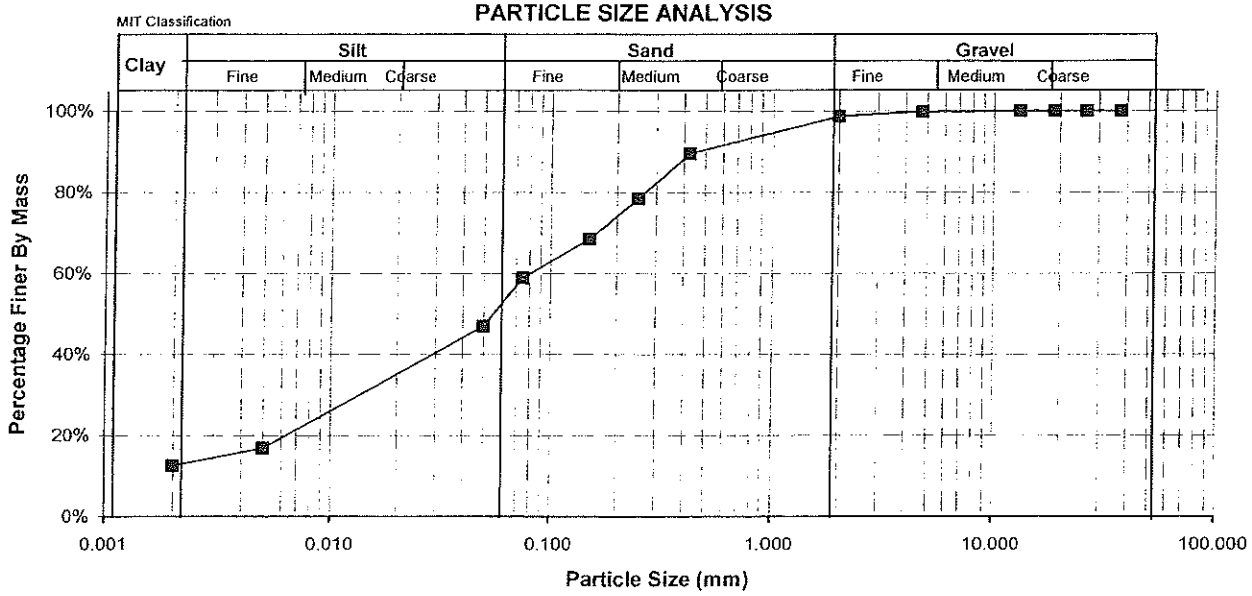
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	78%
26.500	100%	0.150	68%
19.000	100%	0.075	59%
13.200	100%	0.050	47%
4.750	100%	0.005	17%
2.000	99%	0.002	13%
0.425	89%		

ATTERBERG LIMITS

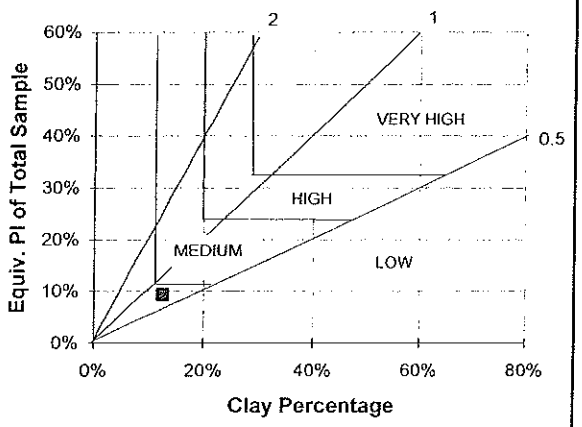
	Test 1	Test 2
Liquid Limit	29.6%	29.8%
Average	**29.7%**	
Plastic Limit	19.8%	18.8%
Average	**19.3%**	
Plasticity Index (PI)	10.4%	
Linear Shrinkage	5.3%	
Grading Modulus	0.53	

PRA Classification	A-6 [5]
Unified Classification	CL
PI of whole sample	9.3%
% Gravel	1.4%
% Sand	46.3%
% Silt	39.8%
% Clay	12.5%

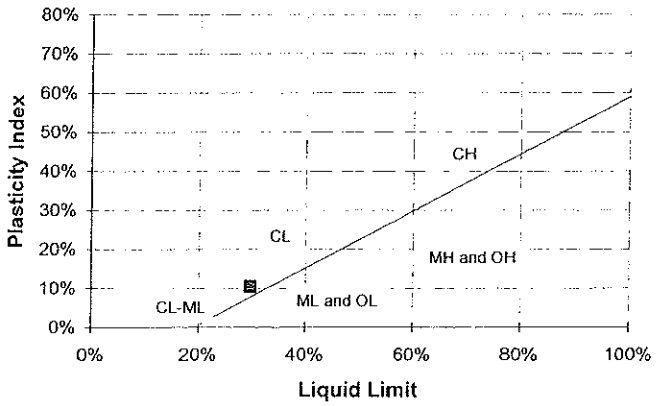
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/13
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	149	**Depth**	1.9m
Sample	(D) Res. Dolerite		

SIEVE ANALYSIS

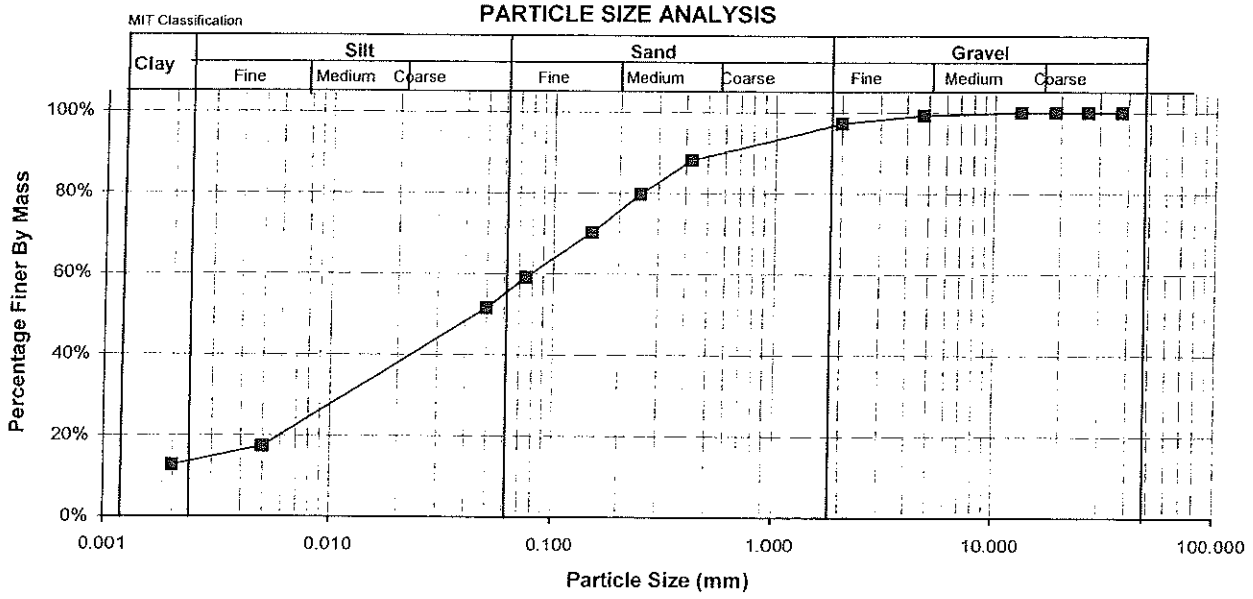
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	80%
26.500	100%	0.150	70%
19.000	100%	0.075	59%
13.200	100%	0.050	52%
4.750	99%	0.005	17%
2.000	97%	0.002	13%
0.425	88%		

ATTERBERG LIMITS

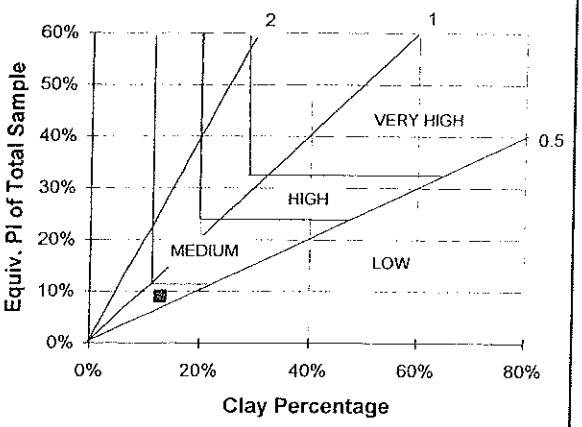
	Test 1	Test 2
Liquid Limit	28.4%	28.3%
Average	**28.4%**	
Plastic Limit	18.1%	18.1%
Average	**18.1%**	
Plasticity Index (PI)	10.3%	
Linear Shrinkage	6.0%	
Grading Modulus	0.56	

PRA Classification	A-6 [5]
Unified Classification	CL
PI of whole sample	9.1%
% Gravel	2.8%
% Sand	42.3%
% Silt	42.2%
% Clay	12.7%

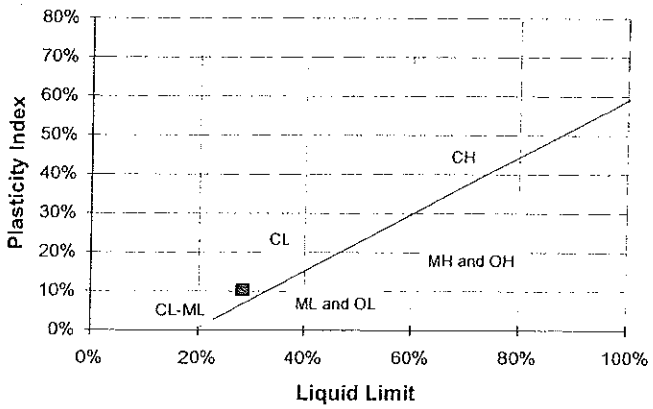
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	164	**Depth**	1.6m
Sample	(D) Res. Dolerite		

SIEVE ANALYSIS

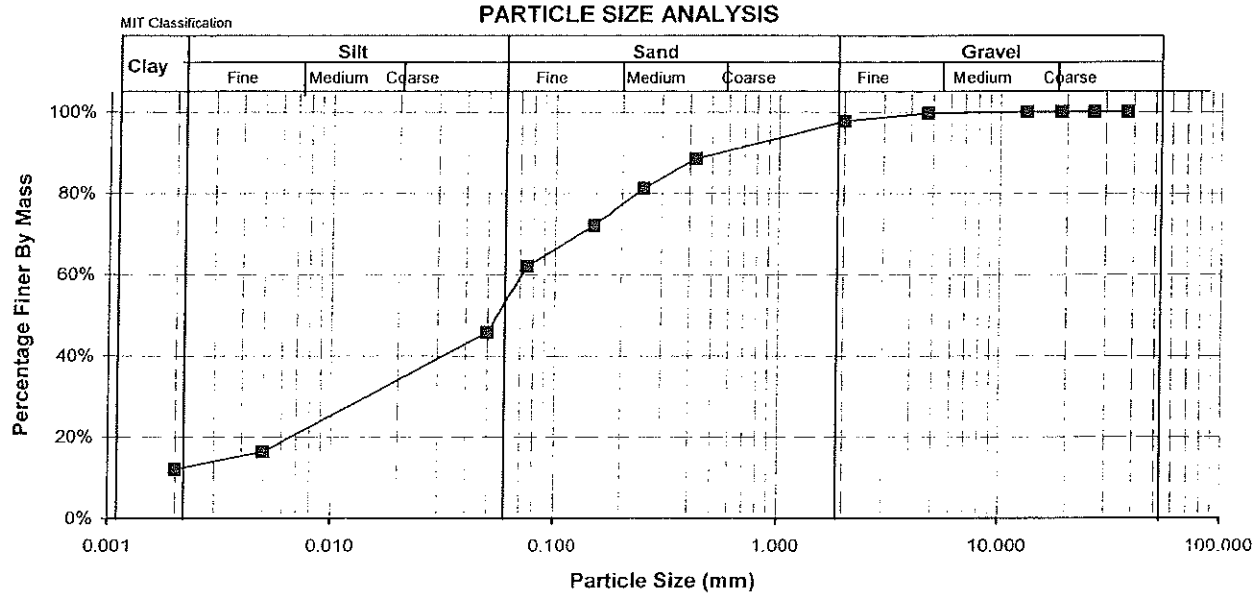
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	81%
26.500	100%	0.150	72%
19.000	100%	0.075	62%
13.200	100%	0.050	46%
4.750	100%	0.005	16%
2.000	98%	0.002	12%
0.425	88%		

ATTERBERG LIMITS

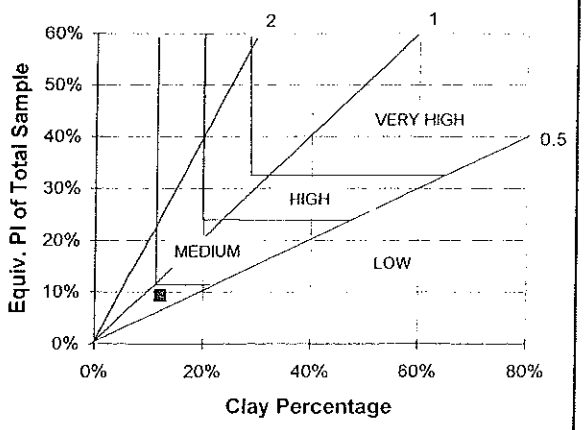
	Test 1	Test 2
Liquid Limit	27.1%	26.8%
Average	**26.9%**	
Plastic Limit	16.4%	16.3%
Average	**16.4%**	
Plasticity Index (PI)	10.6%	
Linear Shrinkage	5.3%	
Grading Modulus	0.52	

PRA Classification	A-6 [6]
Unified Classification	CL
PI of whole sample	9.3%
% Gravel	2.3%
% Sand	44.7%
% Silt	41.0%
% Clay	12.1%

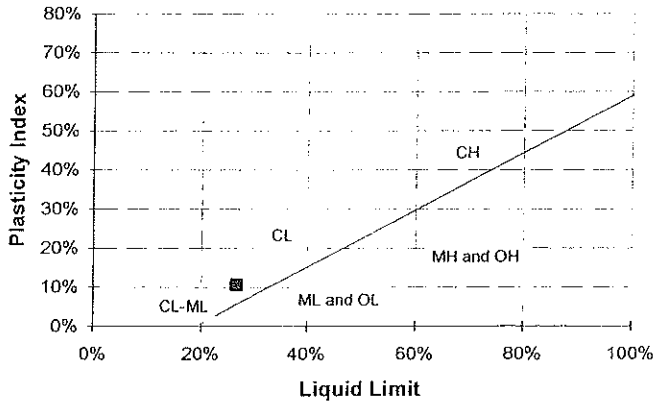
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/13
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	183	**Depth**	1.8m
Sample	(D) Res. Dolerite		

SIEVE ANALYSIS

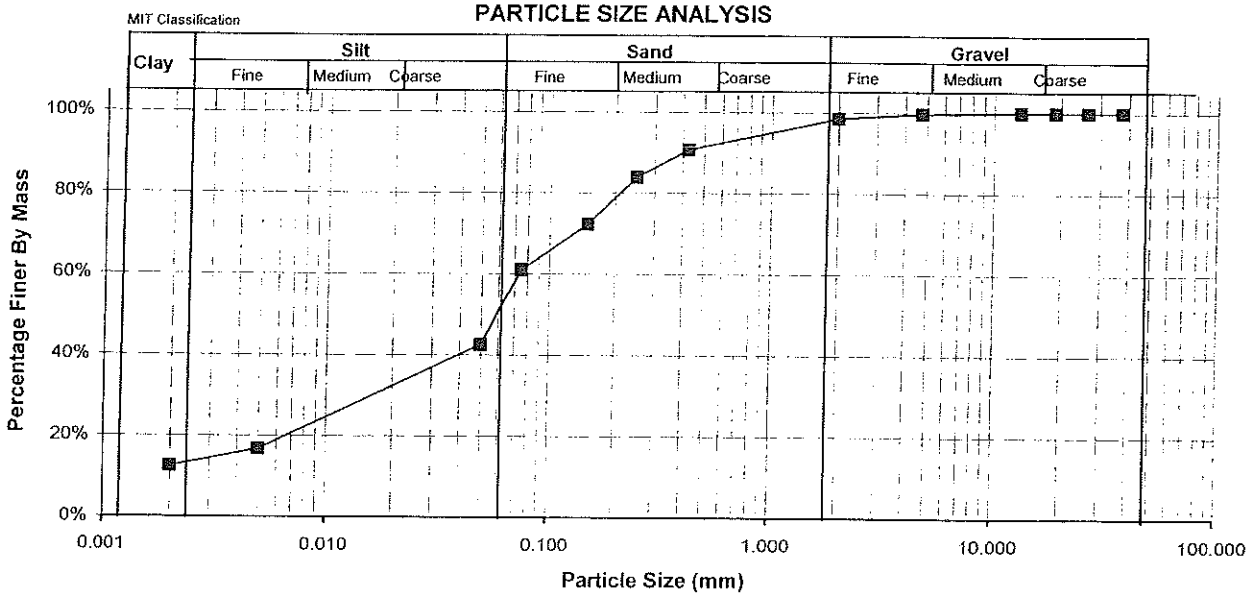
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	84%
26.500	100%	0.150	72%
19.000	100%	0.075	61%
13.200	100%	0.050	43%
4.750	100%	0.005	17%
2.000	98%	0.002	13%
0.425	91%		

ATTERBERG LIMITS

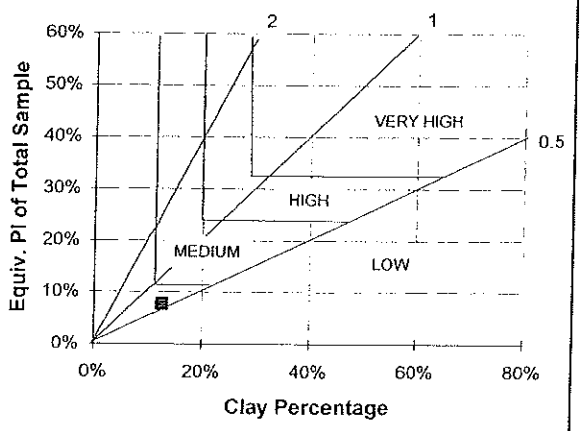
	Test 1	Test 2
Liquid Limit	30.4%	30.8%
Average	**30.6%**	
Plastic Limit	22.2%	22.0%
Average	**22.1%**	
Plasticity Index (PI)	8.5%	
Linear Shrinkage	4.7%	
Grading Modulus	0.50	

PRA Classification	A-4 [5]
Unified Classification	CL
PI of whole sample	7.7%
% Gravel	1.5%
% Sand	47.6%
% Silt	38.3%
% Clay	12.5%

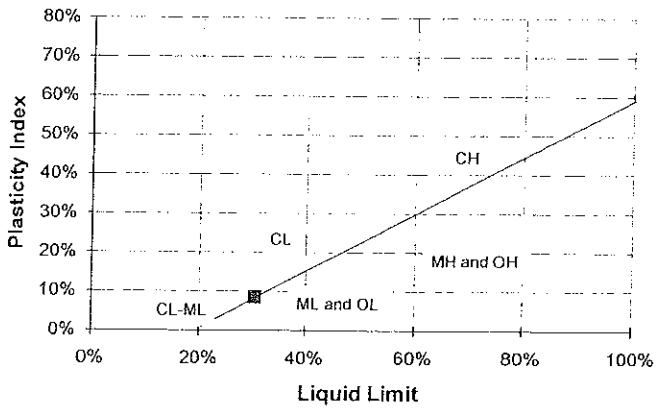
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/10
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	186A	Depth	1.5m
Sample	(D) Res. Dolerite		

SIEVE ANALYSIS

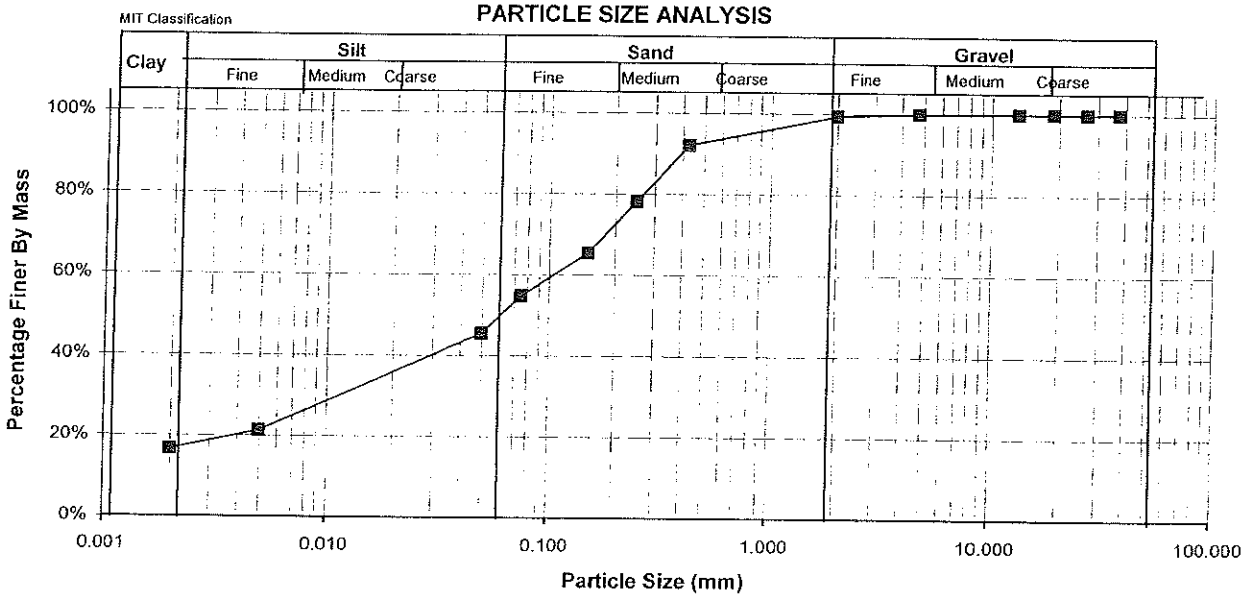
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	78%
26.500	100%	0.150	65%
19.000	100%	0.075	55%
13.200	100%	0.050	45%
4.750	100%	0.005	21%
2.000	99%	0.002	17%
0.425	92%		

ATTERBERG LIMITS

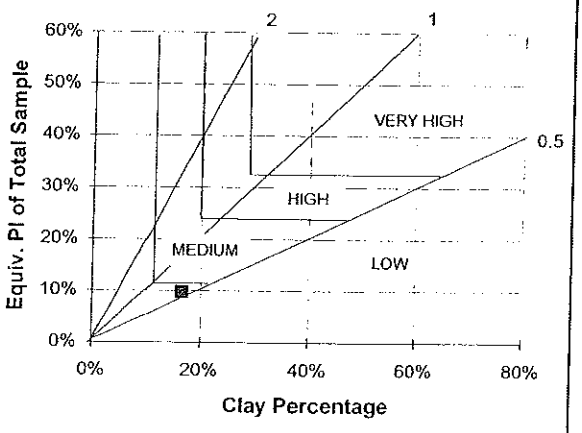
	Test 1	Test 2
Liquid Limit	30.9%	30.5%
Average	**30.7%**	
Plastic Limit	20.2%	20.1%
Average	**20.1%**	
Plasticity Index (PI)	10.6%	
Linear Shrinkage	6.0%	
Grading Modulus	0.54	

PRA Classification	A-6 [4]
Unified Classification	CL
PI of whole sample	9.7%
% Gravel	0.8%
% Sand	49.7%
% Silt	33.0%
% Clay	16.6%

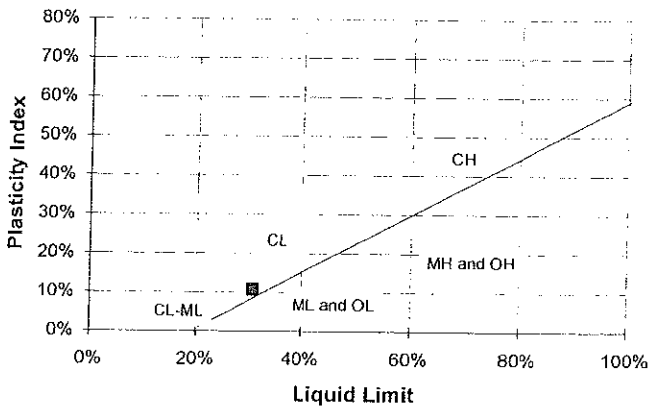
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/10
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	256	**Depth**	1.7m
Sample	(D) Rew. Dolerite		

SIEVE ANALYSIS

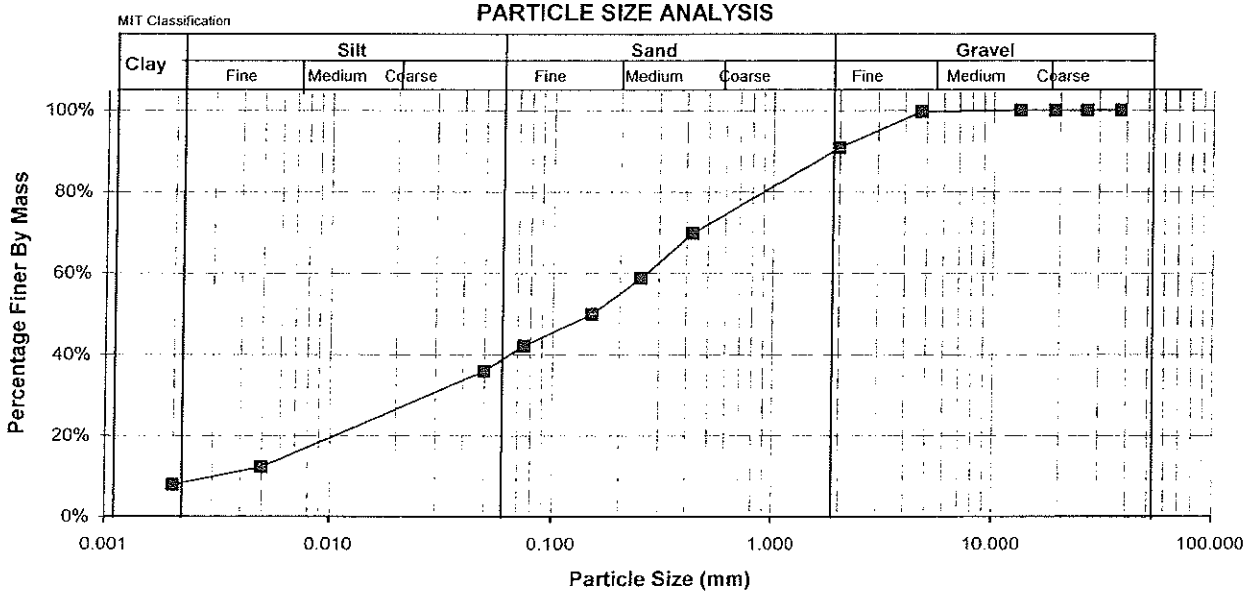
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	59%
26.500	100%	0.150	50%
19.000	100%	0.075	42%
13.200	100%	0.050	36%
4.750	100%	0.005	12%
2.000	91%	0.002	8%
0.425	70%		

ATTERBERG LIMITS

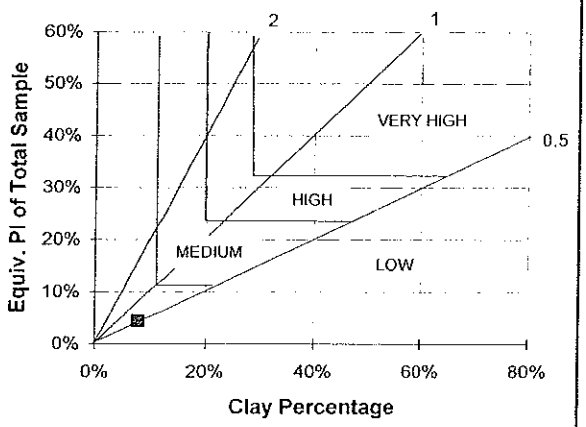
	Test 1	Test 2
Liquid Limit	22.3%	22.3%
Average	**22.3%**	
Plastic Limit	15.8%	16.0%
Average	**15.9%**	
Plasticity Index (PI)	6.4%	
Linear Shrinkage	3.3%	
Grading Modulus	0.97	

PRA Classification	A-4 [1]
Unified Classification	SC/SM
PI of whole sample	4.4%
% Gravel	9.2%
% Sand	52.1%
% Silt	30.8%
% Clay	7.9%

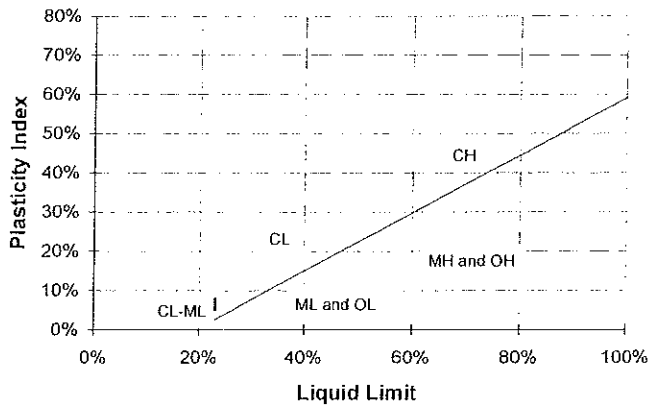
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/13
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	49	**Depth**	2.2-2.5m
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

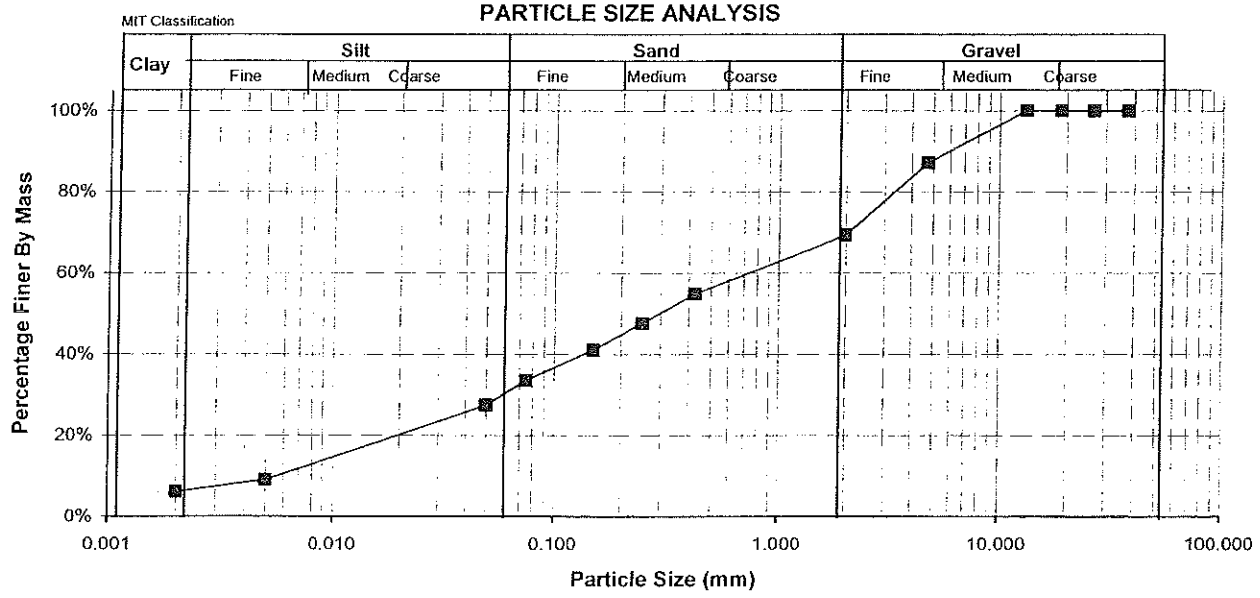
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	48%
26.500	100%	0.150	41%
19.000	100%	0.075	34%
13.200	100%	0.050	27%
4.750	87%	0.005	9%
2.000	69%	0.002	6%
0.425	55%		

ATTERBERG LIMITS

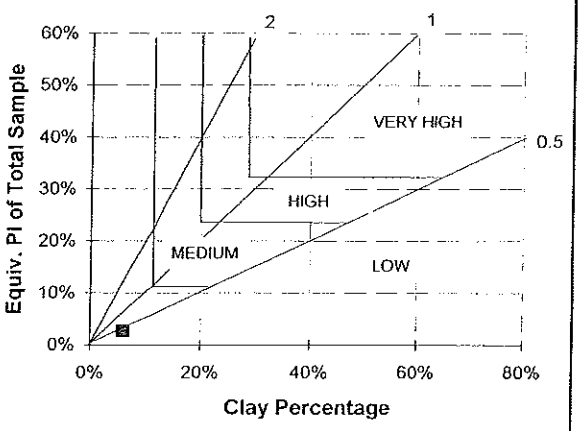
	Test 1	Test 2
Liquid Limit	31.5%	32.0%
Average	**31.7%**	
Plastic Limit	26.9%	26.8%
Average	**26.9%**	
Plasticity Index (PI)	4.9%	
Linear Shrinkage	2.7%	
Grading Modulus	1.42	

PRA Classification	A-2-4
Unified Classification	SM
PI of whole sample	2.7%
% Gravel	30.7%
% Sand	39.1%
% Silt	24.1%
% Clay	6.0%

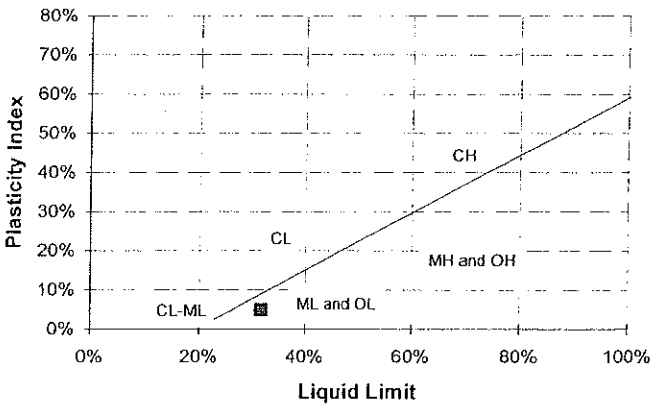
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/13
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	56	**Depth**	1.0-1.4m
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

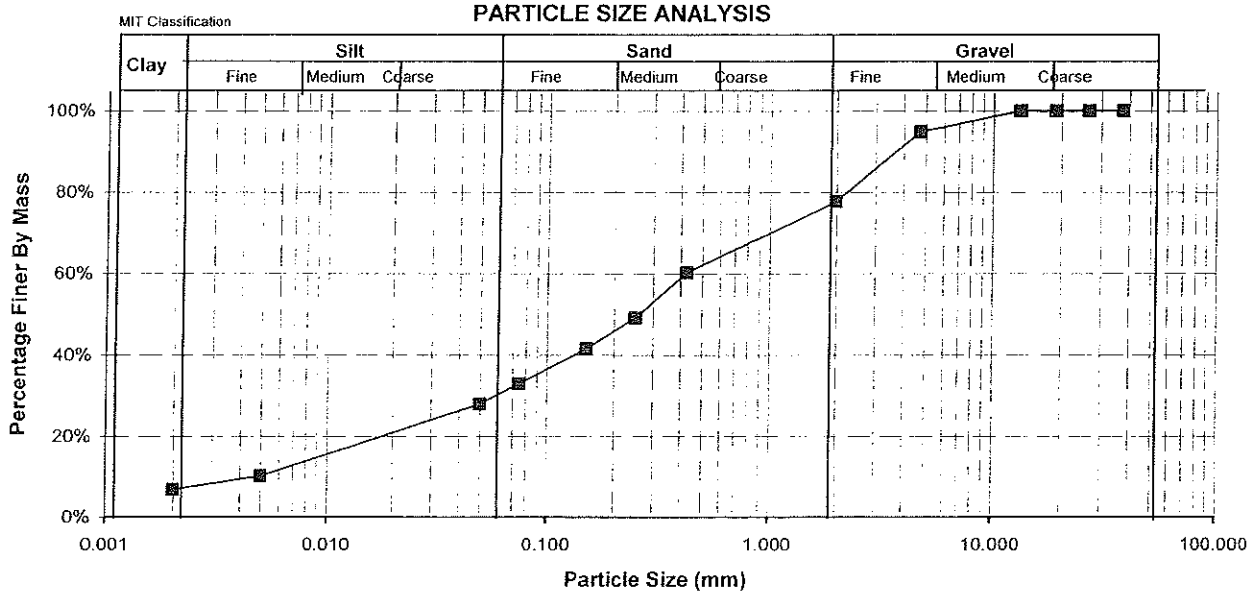
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	49%
26.500	100%	0.150	42%
19.000	100%	0.075	33%
13.200	100%	0.050	28%
4.750	95%	0.005	10%
2.000	78%	0.002	7%
0.425	60%		

ATTERBERG LIMITS

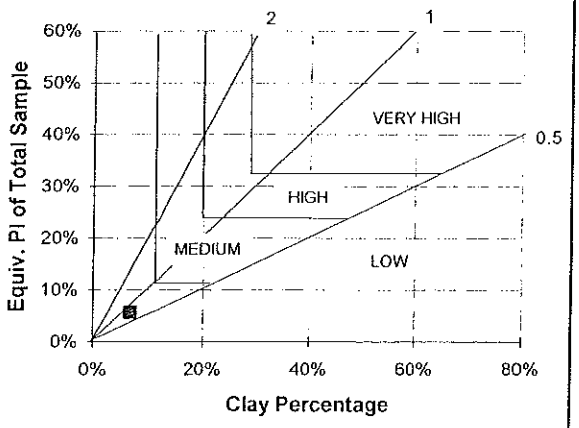
	Test 1	Test 2
Liquid Limit	30.8%	30.6%
Average	**30.7%**	
Plastic Limit	21.4%	21.3%
Average	**21.4%**	
Plasticity Index (PI)	9.4%	
Linear Shrinkage	4.7%	
Grading Modulus	1.29	

PRA Classification	A-2-4
Unified Classification	SC
PI of whole sample	5.7%
% Gravel	22.3%
% Sand	47.5%
% Silt	23.4%
% Clay	6.8%

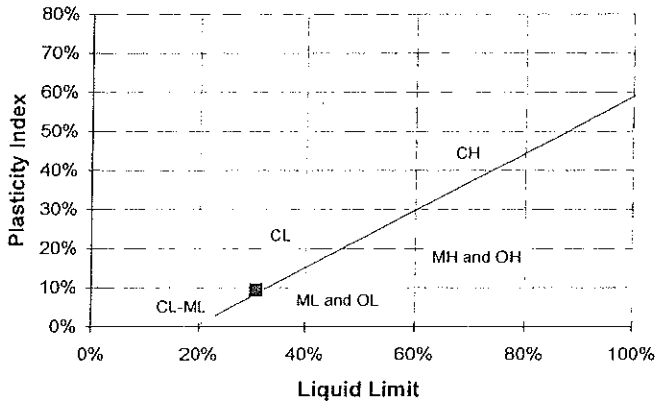
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/13
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	201A	**Depth**	1.5m
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

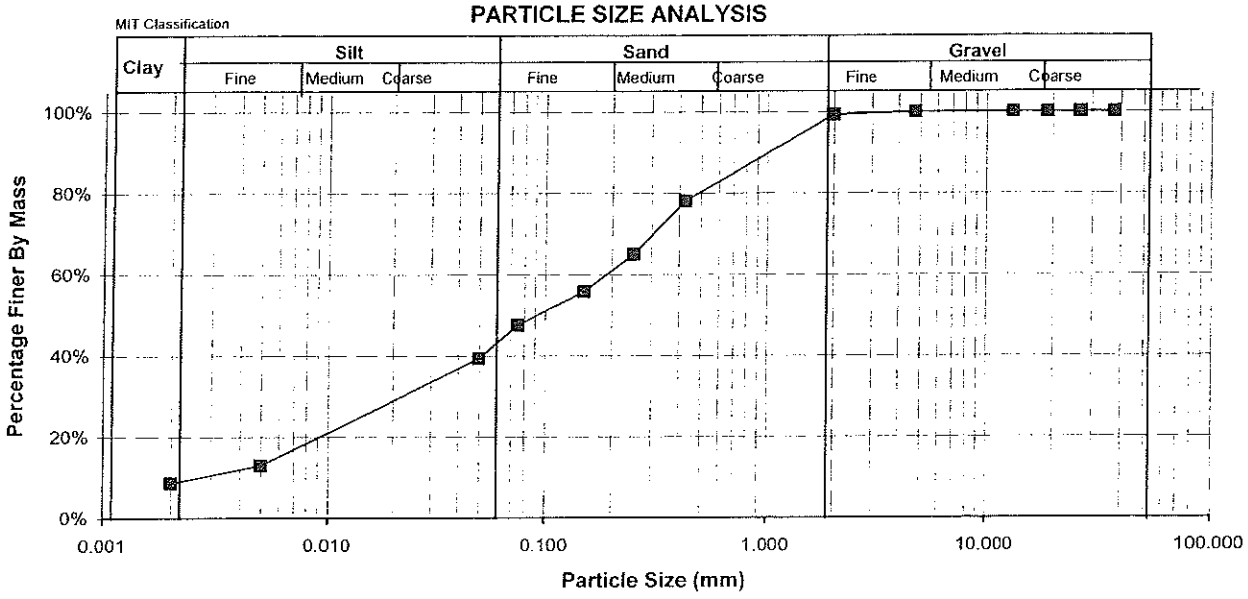
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	65%
26.500	100%	0.150	56%
19.000	100%	0.075	47%
13.200	100%	0.050	39%
4.750	100%	0.005	13%
2.000	99%	0.002	9%
0.425	78%		

ATTERBERG LIMITS

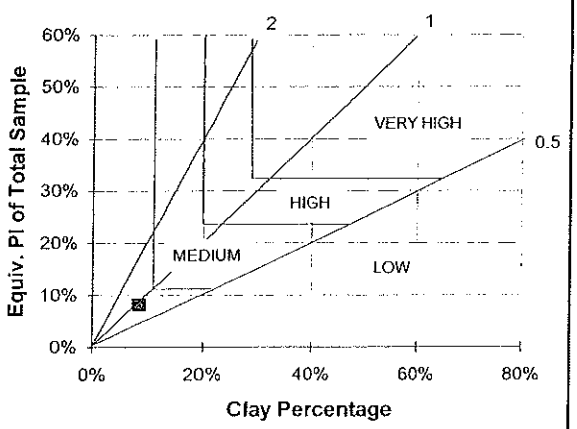
	Test 1	Test 2
Liquid Limit	26.0%	25.6%
Average	**25.8%**	
Plastic Limit	15.8%	15.0%
Average	**15.4%**	
Plasticity Index (PI)	10.4%	
Linear Shrinkage	6.0%	
Grading Modulus	0.75	

PRA Classification	A-6 [2]
Unified Classification	SC
PI of whole sample	8.1%
% Gravel	0.7%
% Sand	56.3%
% Silt	34.3%
% Clay	8.6%

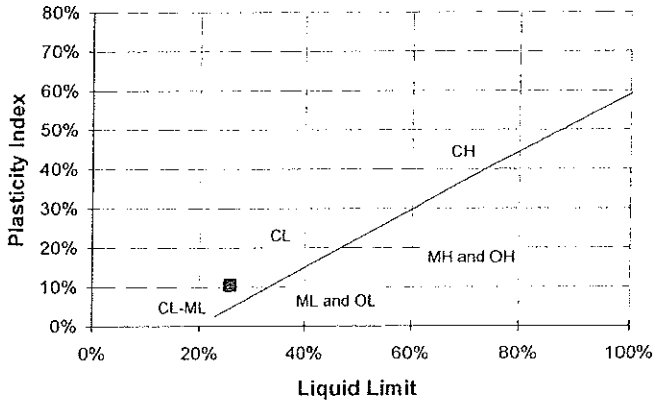
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/13
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	25	**Depth**	1.5-2.3m
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

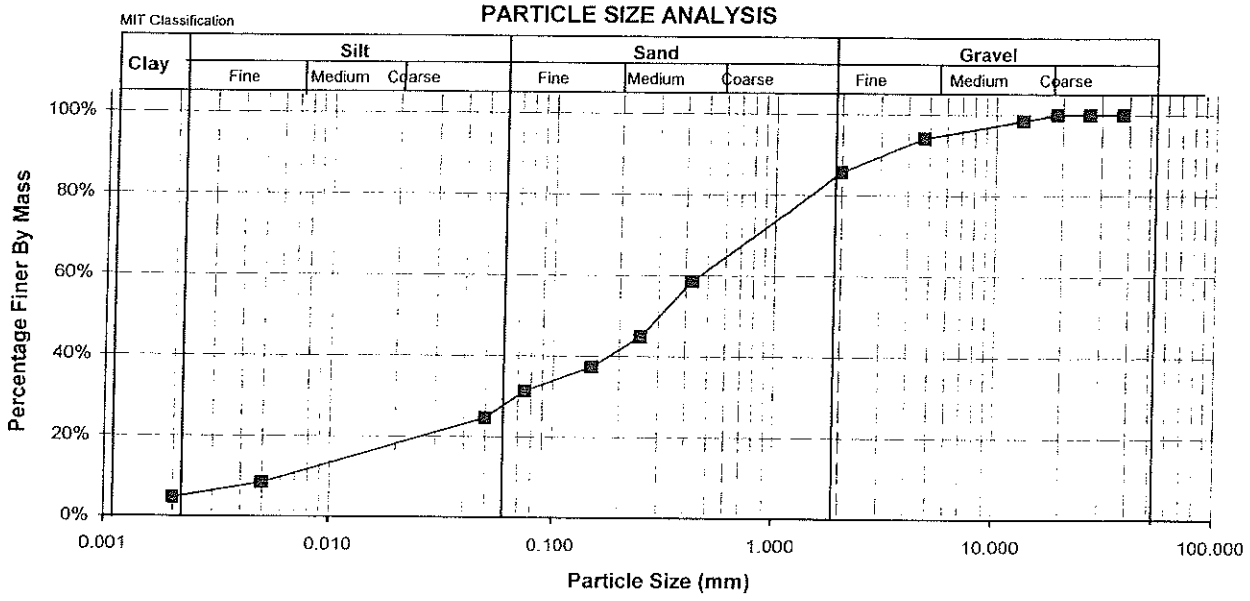
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	45%
26.500	100%	0.150	37%
19.000	100%	0.075	31%
13.200	98%	0.050	25%
4.750	94%	0.005	8%
2.000	86%	0.002	5%
0.425	58%		

ATTERBERG LIMITS

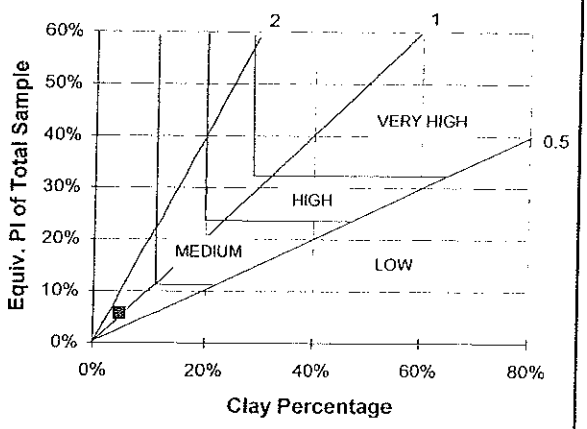
	Test 1	Test 2
Liquid Limit	31.5%	30.1%
Average	**30.8%**	
Plastic Limit	21.1%	21.2%
Average	**21.2%**	
Plasticity Index (PI)	9.6%	
Linear Shrinkage	4.7%	
Grading Modulus	1.25	

PRA Classification	A-2-4
Unified Classification	SC
PI of whole sample	5.6%
% Gravel	14.5%
% Sand	58.0%
% Silt	22.9%
% Clay	4.7%

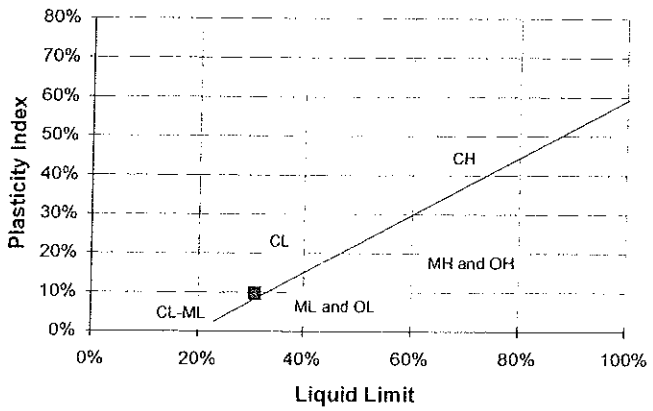
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/13
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	30	**Depth**	0.7-1.1
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

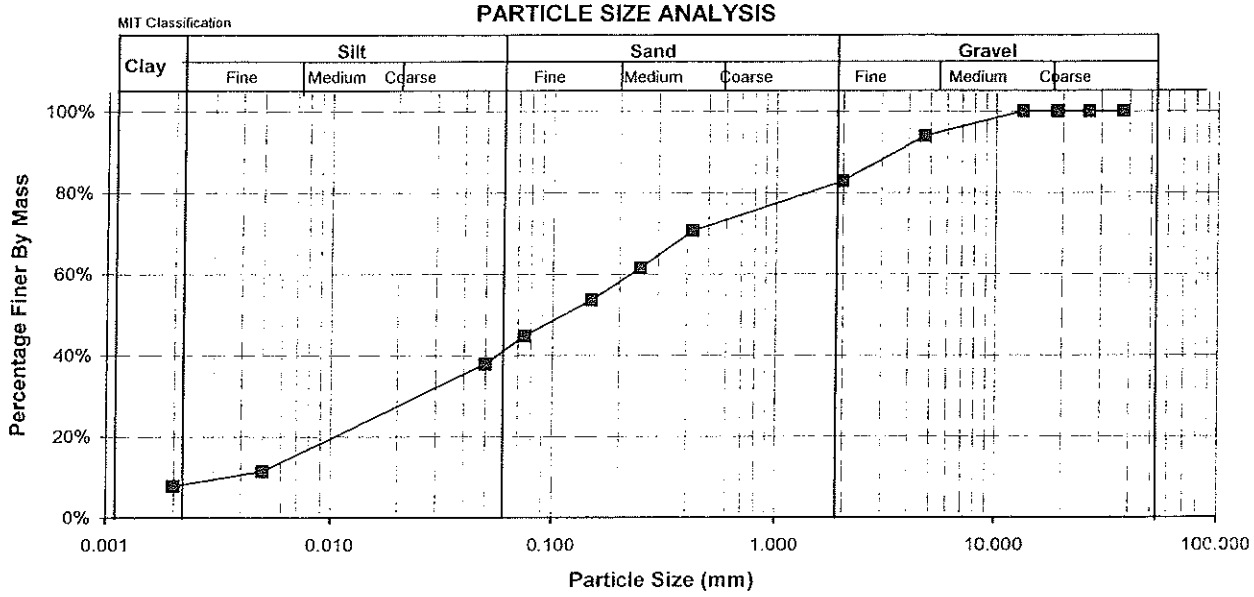
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	61%
26.500	100%	0.150	54%
19.000	100%	0.075	45%
13.200	100%	0.050	38%
4.750	94%	0.005	11%
2.000	83%	0.002	8%
0.425	71%		

ATTERBERG LIMITS

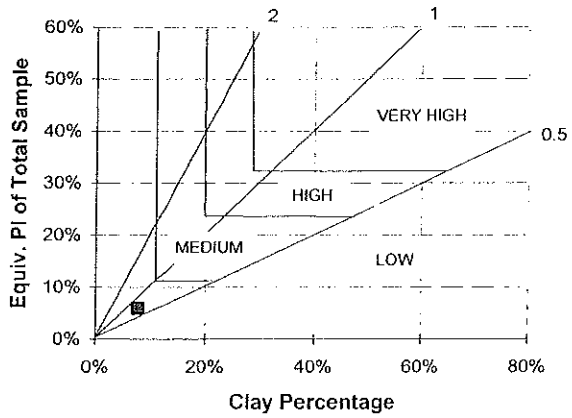
	Test 1	Test 2
Liquid Limit	33.0%	33.3%
Average	**33.1%**	
Plastic Limit	25.3%	24.3%
Average	**24.8%**	
Plasticity Index (PI)	8.3%	
Linear Shrinkage	4.0%	
Grading Modulus	1.02	

PRA Classification	A-4 [2]
Unified Classification	SM
PI of whole sample	5.9%
% Gravel	17.2%
% Sand	41.8%
% Silt	33.2%
% Clay	7.8%

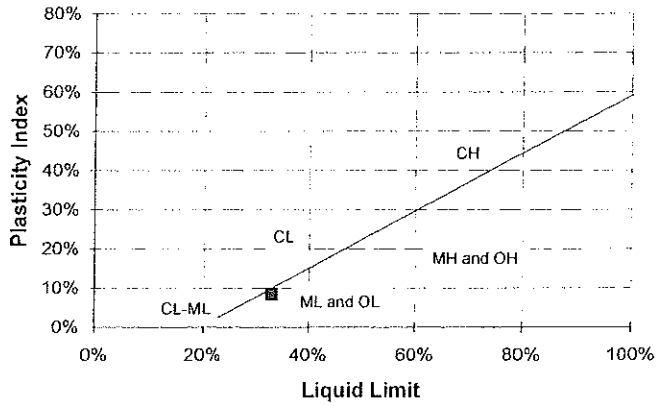
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/13
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	27	Depth	1.2-1.6m
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

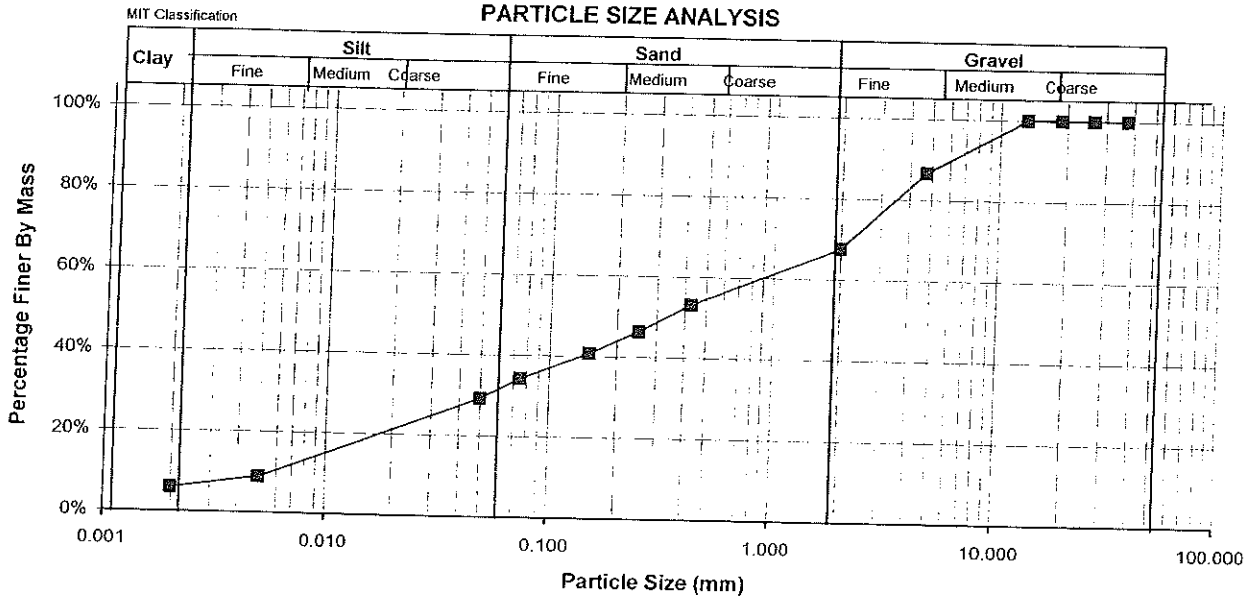
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	46%
26.500	100%	0.150	41%
19.000	100%	0.075	34%
13.200	100%	0.050	29%
4.750	87%	0.005	9%
2.000	68%	0.002	6%
0.425	53%		

ATTERBERG LIMITS

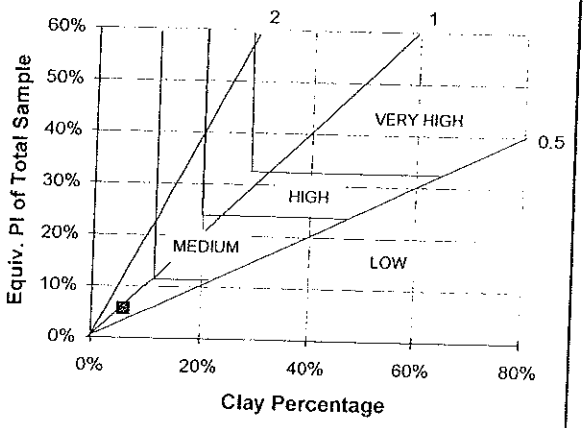
	Test 1	Test 2
Liquid Limit	32.5%	33.0%
Average	**32.8%**	
Plastic Limit	22.1%	22.2%
Average	**22.1%**	
Plasticity Index (PI)	10.6%	
Linear Shrinkage	6.0%	
Grading Modulus	1.45	

PRA Classification	A-2-6 [0]
Unified Classification	SC
PI of whole sample	5.6%
% Gravel	32.5%
% Sand	36.1%
% Silt	25.6%
% Clay	5.9%

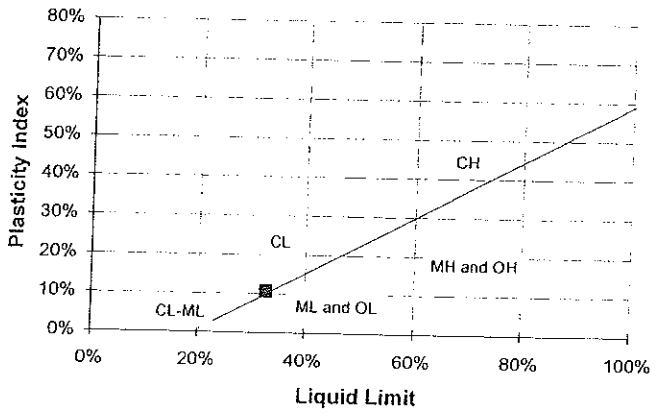
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/13
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	15	**Depth**	2-2.2m
Sample	(D) Res. ~~Dolorite~~ Andesite		

SIEVE ANALYSIS

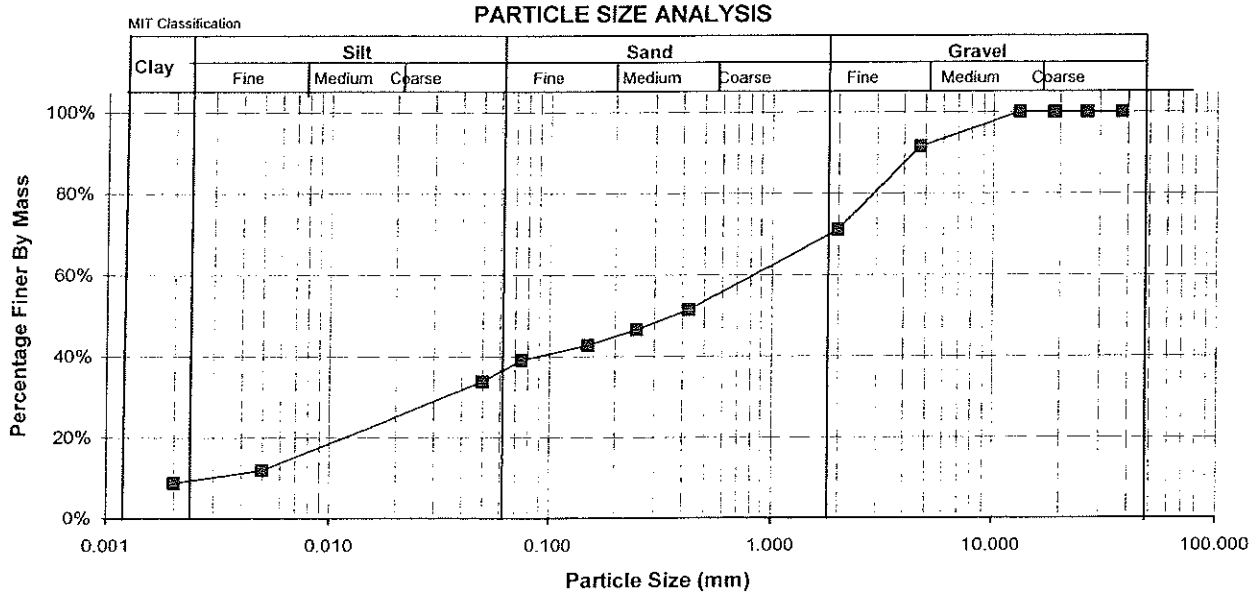
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	47%
26.500	100%	0.150	43%
19.000	100%	0.075	39%
13.200	100%	0.050	34%
4.750	91%	0.005	12%
2.000	71%	0.002	9%
0.425	51%		

ATTERBERG LIMITS

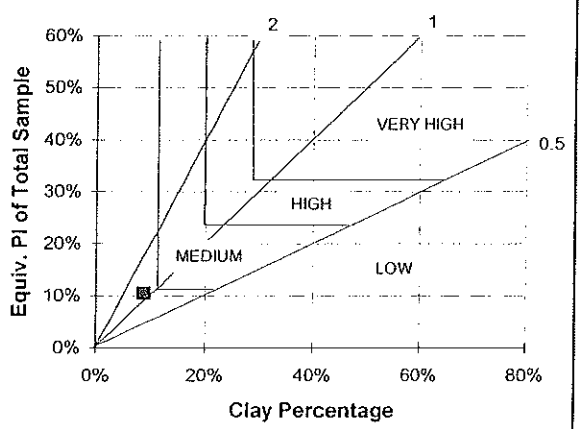
	Test 1	Test 2
Liquid Limit	43.0%	42.6%
Average	**42.8%**	
Plastic Limit	22.5%	22.4%
Average	**22.4%**	
Plasticity Index (PI)	20.4%	
Linear Shrinkage	10.0%	
Grading Modulus	1.39	

PRA Classification	A-7-6 [3]
Unified Classification	SC
PI of whole sample	10.5%
% Gravel	29.0%
% Sand	34.8%
% Silt	27.4%
% Clay	8.8%

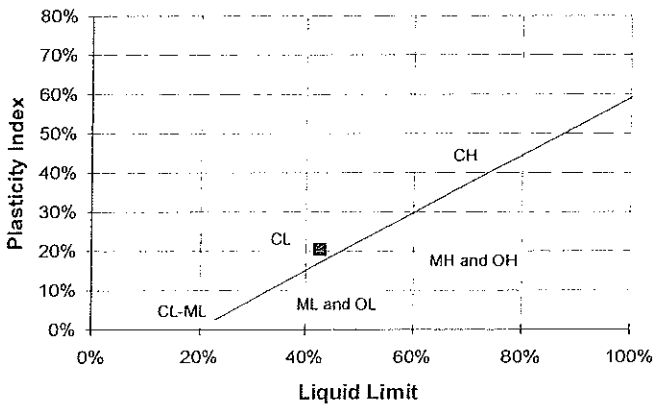
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/13
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	45	Depth	1.3-3.0m
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

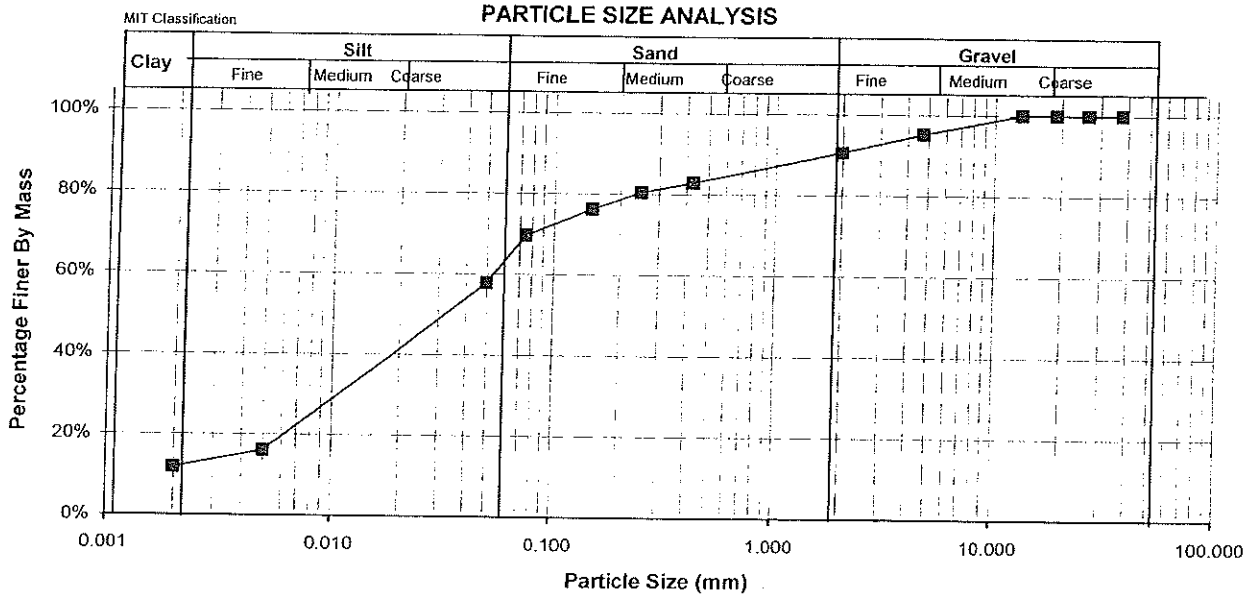
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	80%
26.500	100%	0.150	76%
19.000	100%	0.075	70%
13.200	100%	0.050	58%
4.750	95%	0.005	16%
2.000	90%	0.002	12%
0.425	83%		

ATTERBERG LIMITS

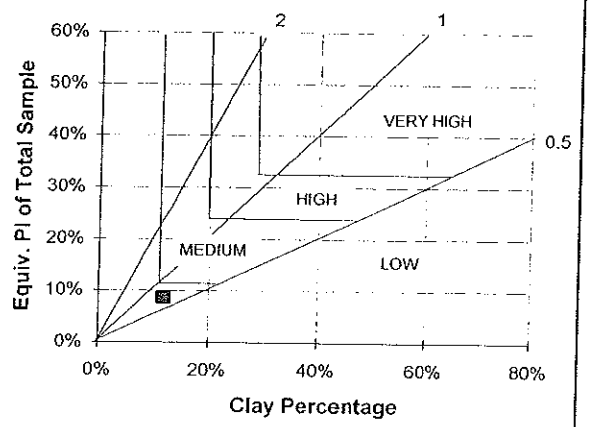
	Test 1	Test 2
Liquid Limit	42.7%	43.0%
Average	**42.8%**	
Plastic Limit	32.7%	32.1%
Average	**32.4%**	
Plasticity Index (PI)	10.4%	
Linear Shrinkage	6.7%	
Grading Modulus	0.57	

PRA Classification	A-7-5 [8]
Unified Classification	ML/OL
PI of whole sample	8.6%
% Gravel	9.5%
% Sand	27.4%
% Silt	51.3%
% Clay	11.8%

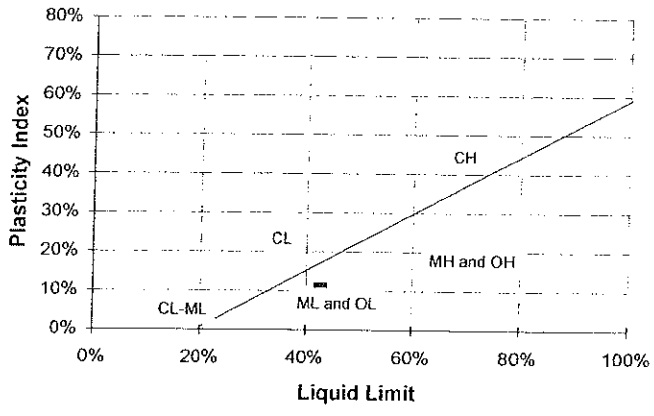
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/13
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	41	Depth	2.4-2.7m
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

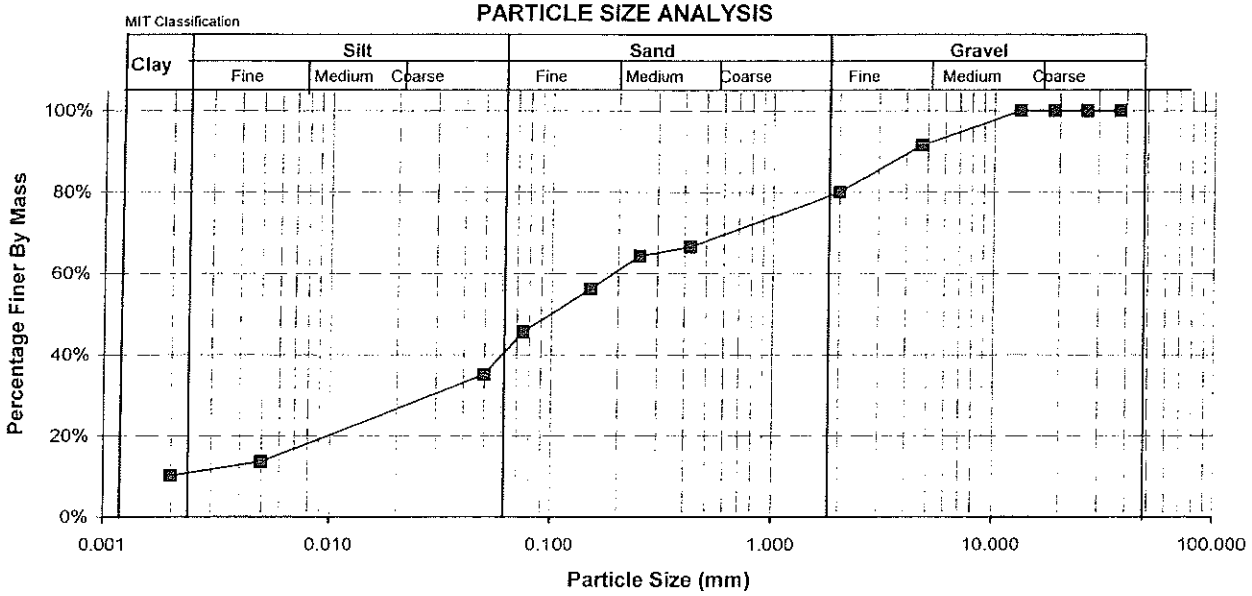
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	64%
26.500	100%	0.150	56%
19.000	100%	0.075	46%
13.200	100%	0.050	35%
4.750	91%	0.005	14%
2.000	80%	0.002	10%
0.425	66%		

ATTERBERG LIMITS

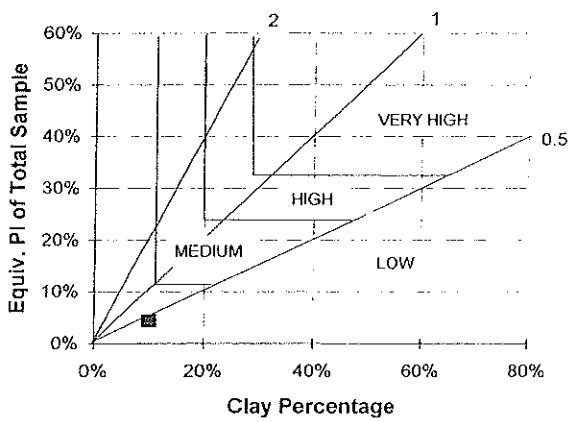
	Test 1	Test 2
Liquid Limit	32.2%	33.7%
Average	**33.0%**	
Plastic Limit	26.7%	26.3%
Average	**26.5%**	
Plasticity Index (PI)	6.5%	
Linear Shrinkage	3.3%	
Grading Modulus	1.08	

PRA Classification	A-4 [2]
Unified Classification	SM
PI of whole sample	4.3%
% Gravel	20.1%
% Sand	40.1%
% Silt	29.7%
% Clay	10.2%

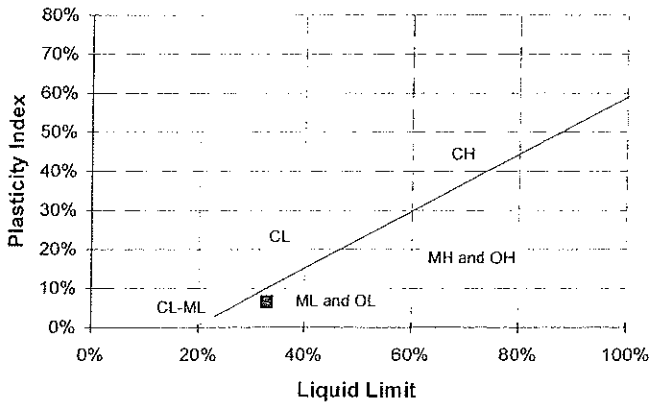
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/13
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	9	**Depth**	1.5m
Sample	Res. Andesite		

SIEVE ANALYSIS

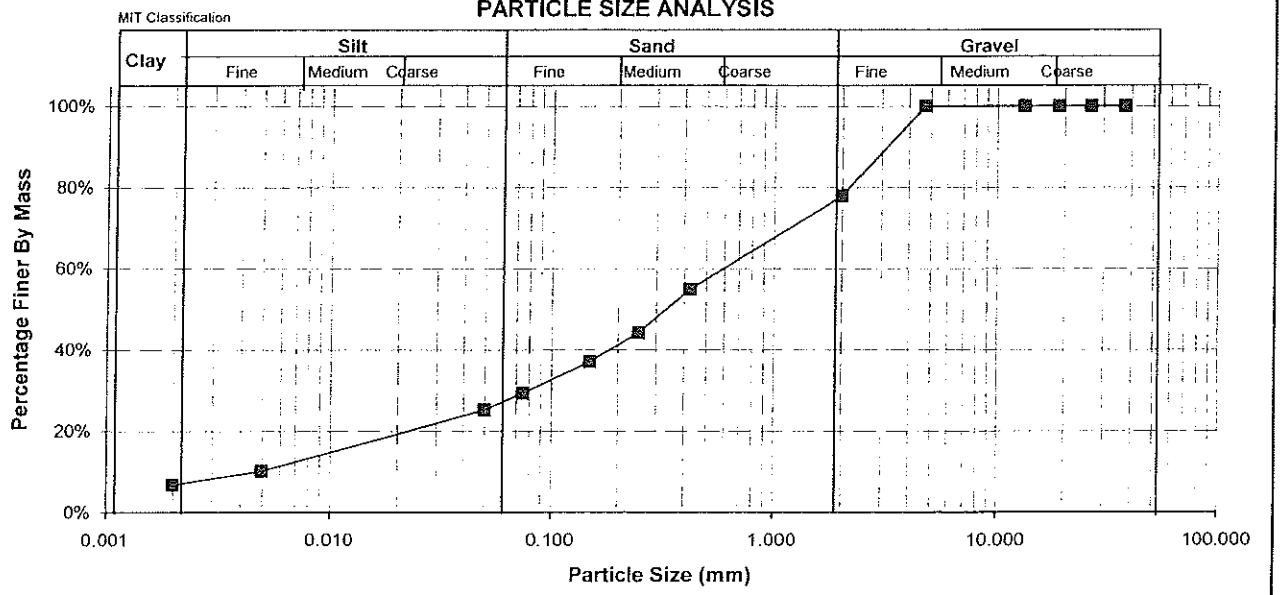
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	44%
26.500	100%	0.150	37%
19.000	100%	0.075	29%
13.200	100%	0.050	25%
4.750	100%	0.005	10%
2.000	78%	0.002	7%
0.425	55%		

ATTERBERG LIMITS

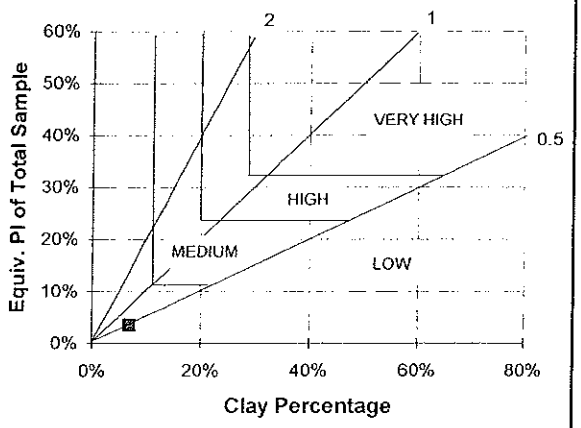
	Test 1	Test 2
Liquid Limit	34.7%	34.8%
Average	**34.7%**	
Plastic Limit	28.6%	28.2%
Average	**28.4%**	
Plasticity Index (PI)	6.3%	
Linear Shrinkage	3.3%	
Grading Modulus	1.38	

PRA Classification	A-2-4
Unified Classification	SM
PI of whole sample	3.5%
% Gravel	22.1%
% Sand	50.9%
% Silt	20.2%
% Clay	6.8%

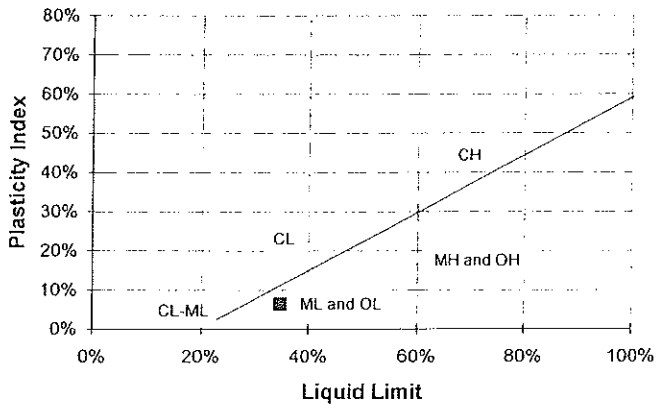
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/07
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	27	**Depth**	2.0m
Sample	Res. Andesite		

SIEVE ANALYSIS

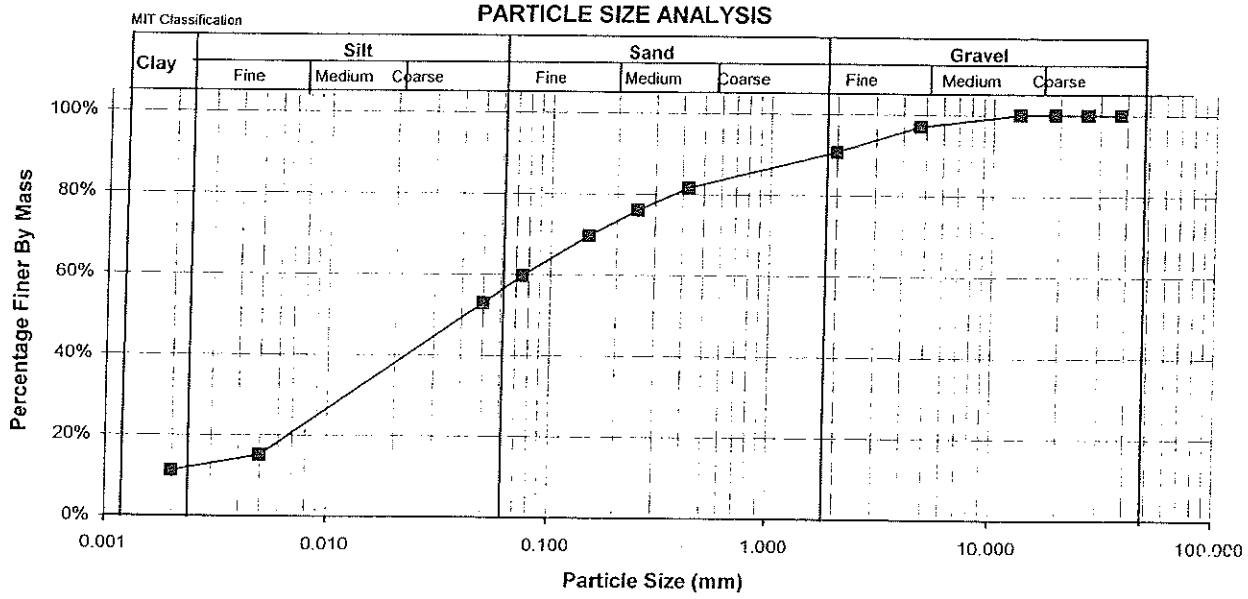
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	76%
26.500	100%	0.150	70%
19.000	100%	0.075	60%
13.200	100%	0.050	53%
4.750	97%	0.005	15%
2.000	91%	0.002	11%
0.425	82%		

ATTERBERG LIMITS

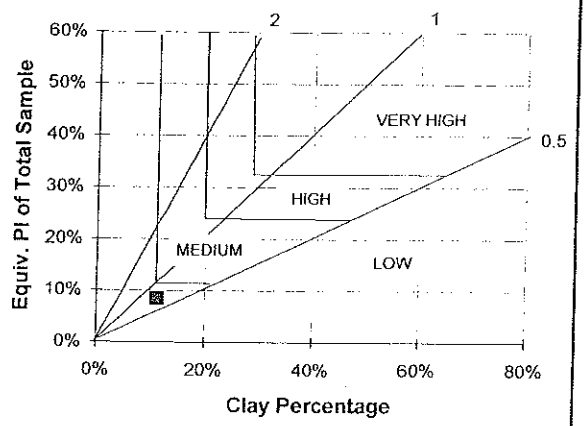
	Test 1	Test 2
Liquid Limit	28.3%	29.0%
Average	**28.7%**	
Plastic Limit	18.4%	18.2%
Average	**18.3%**	
Plasticity Index (PI)	10.3%	
Linear Shrinkage	6.0%	
Grading Modulus	0.68	

PRA Classification	A-6 [5]
Unified Classification	CL
PI of whole sample	8.4%
% Gravel	9.4%
% Sand	34.6%
% Silt	44.8%
% Clay	11.2%

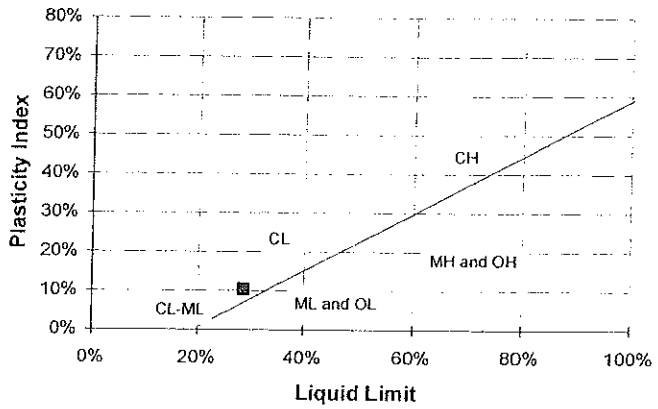
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/10
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	9	Depth	1.6-2.7m
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

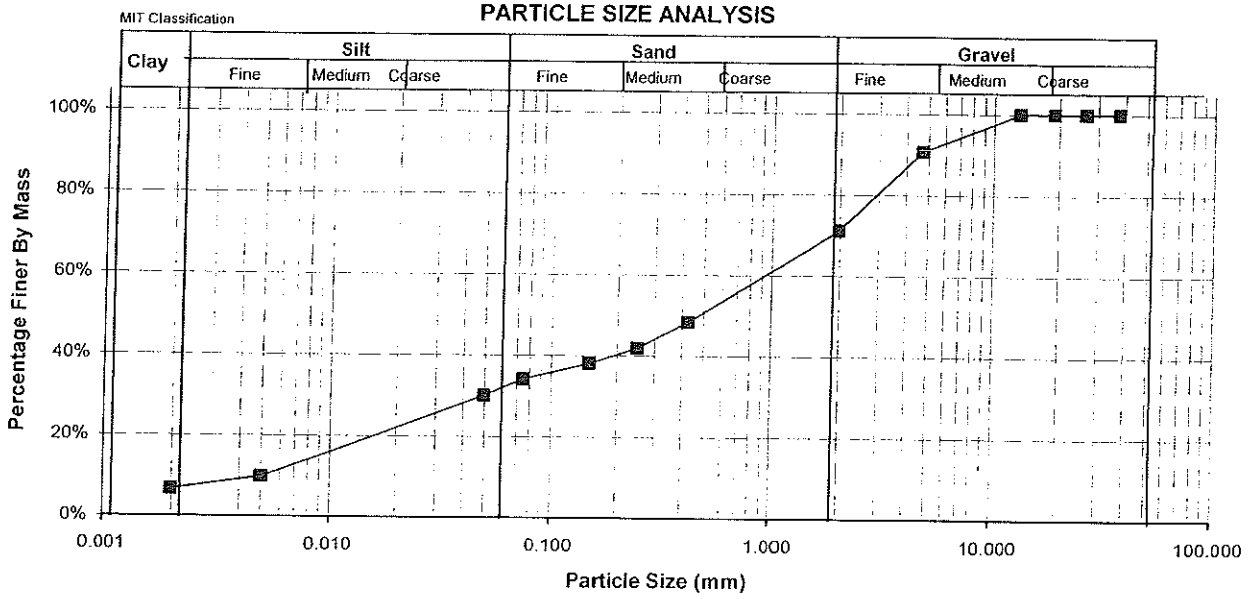
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	42%
26.500	100%	0.150	38%
19.000	100%	0.075	34%
13.200	100%	0.050	30%
4.750	91%	0.005	10%
2.000	71%	0.002	7%
0.425	48%		

ATTERBERG LIMITS

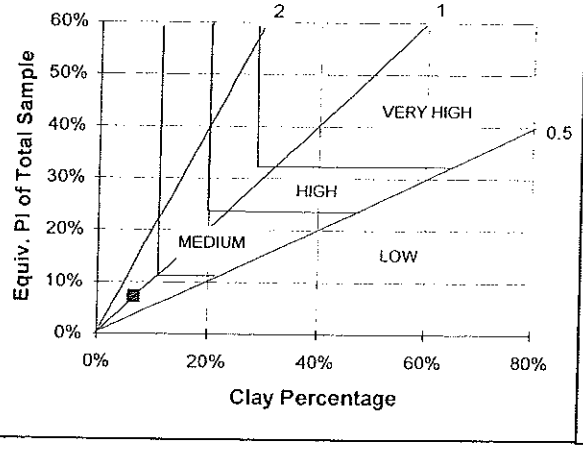
	Test 1	Test 2
Liquid Limit	42.0%	42.6%
Average	**42.3%**	
Plastic Limit	27.0%	27.7%
Average	**27.3%**	
Plasticity Index (PI)	14.9%	
Linear Shrinkage	7.3%	
Grading Modulus	1.46	

PRA Classification	A-2-6 [1]
Unified Classification	SM
PI of whole sample	7.2%
% Gravel	28.8%
% Sand	39.4%
% Silt	25.1%
% Clay	6.7%

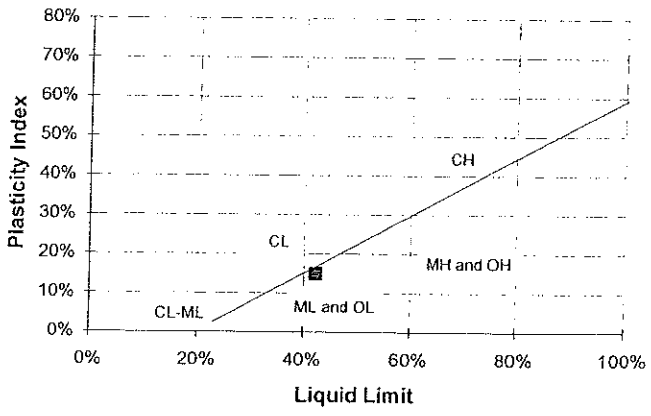
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	**Date**	2006/11/07
Project	IR 801	**Job #**	26559
Site	Leeuw Poort		
Test Pos	8	**Depth**	1.6m
Sample	Res. Andesite		

SIEVE ANALYSIS

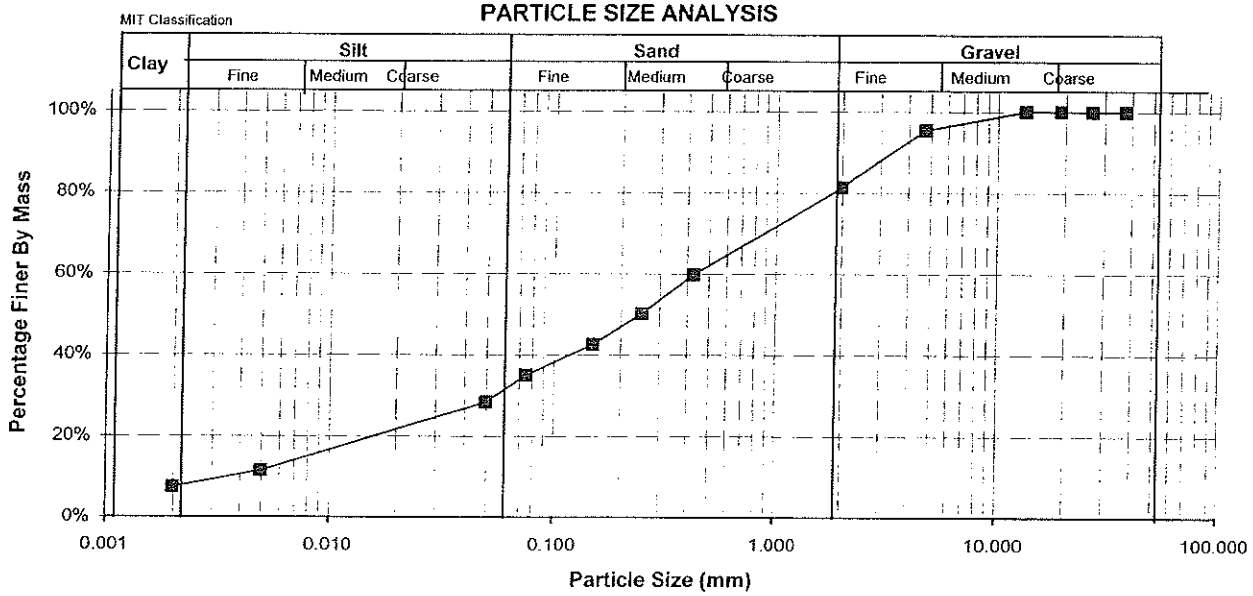
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	50%
26.500	100%	0.150	43%
19.000	100%	0.075	35%
13.200	100%	0.050	28%
4.750	95%	0.005	12%
2.000	81%	0.002	7%
0.425	60%		

ATTERBERG LIMITS

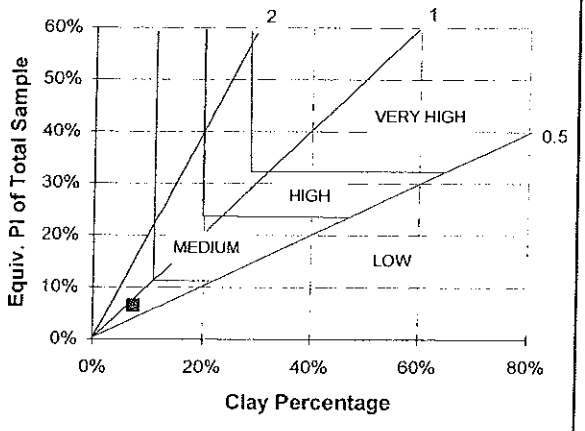
	Test 1	Test 2
Liquid Limit	33.9%	34.2%
Average	**34.1%**	
Plastic Limit	23.1%	23.5%
Average	**23.3%**	
Plasticity Index (PI)	10.7%	
Linear Shrinkage	5.3%	
Grading Modulus	1.24	

PRA Classification	A-2-6 [0]
Unified Classification	SC
PI of whole sample	6.4%
% Gravel	18.7%
% Sand	50.0%
% Silt	23.9%
% Clay	7.4%

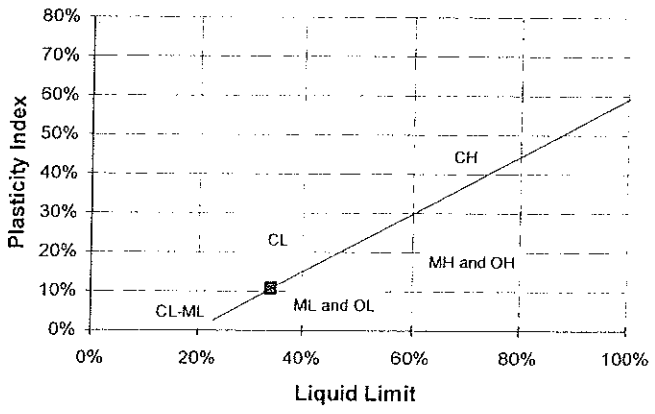
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



SOILTECH

FOUNDATION INDICATOR

Client	Intraconsult Associates	Date	2006/11/10
Project	IR 801	Job #	26559
Site	Leeuw Poort		
Test Pos	1	Depth	1.6-2.0m
Sample	(D) Res. Andesite		

SIEVE ANALYSIS

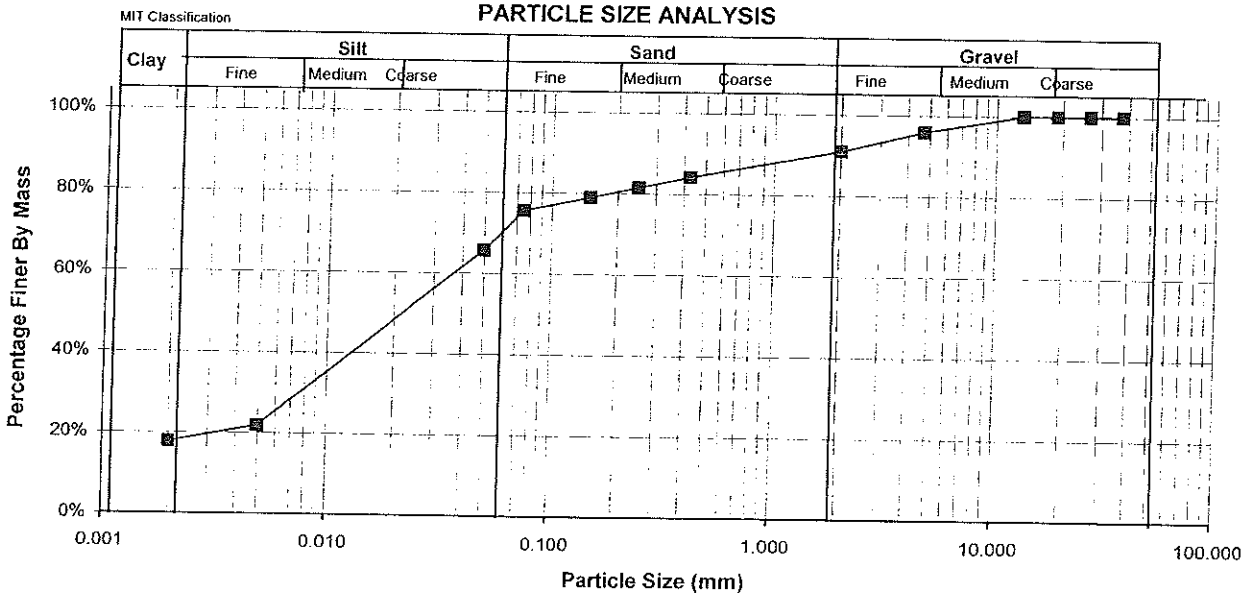
Sieve(mm)	% Passing	Sieve(mm)	% Passing
37.500	100%	0.250	81%
26.500	100%	0.150	79%
19.000	100%	0.075	76%
13.200	100%	0.050	66%
4.750	96%	0.005	22%
2.000	91%	0.002	18%
0.425	84%		

ATTERBERG LIMITS

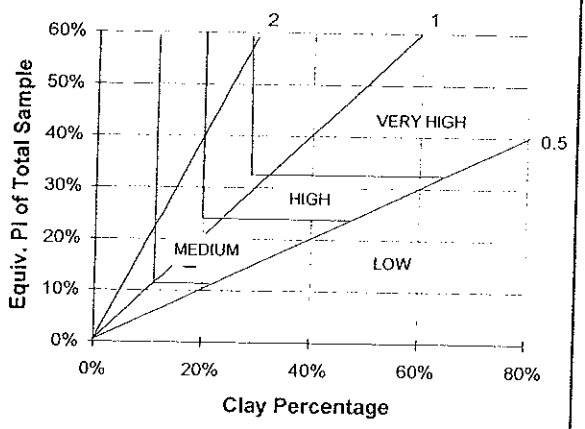
	Test 1	Test 2
Liquid Limit	43.6%	42.5%
Average	**43.0%**	
Plastic Limit	24.1%	24.9%
Average	**24.5%**	
Plasticity Index (PI)	18.5%	
Linear Shrinkage	9.3%	
Grading Modulus	0.49	

PRA Classification	A-7-6 [12]
Unified Classification	CL
PI of whole sample	15.6%
% Gravel	9.1%
% Sand	20.8%
% Silt	52.3%
% Clay	17.8%

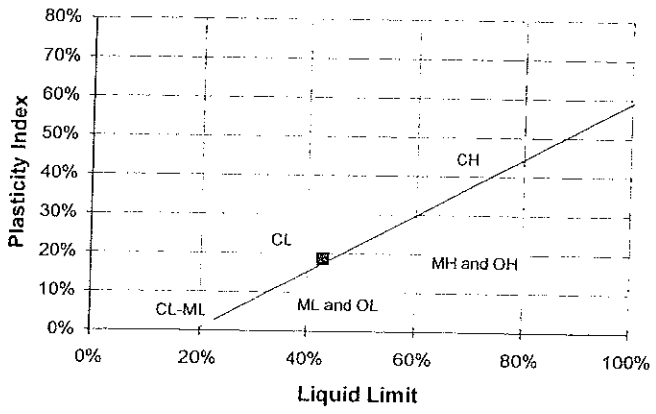
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



CASAGRANDE 'A' LINE



FRANKI **SOILTECH**

CLIENT : Intraconsult Associates **DATE :** 2006/10/23

PROJECT : Ref. #: IR 801, **JOB #** 26559

SITE : Leeuwpoort

CONDUCTIVITY & pH VALUES

TEST HOLE NO.	DEPTH (m)	CONDUCTIVITY (S.m)	pH VALUE	RESISTIVITY (Ohm.cm)
TP 8	1,60	0.05	4.72	2000.0
TP 9	1,50	0.04	4.97	2500.0
TP 27	2,00	0.06	5.41	1666.7
TP 46	1,70 - 2,30	0.10	4.53	1000.0
TP 49	1,00	0.11	5.42	909.1
TP 56	1,20	0.11	5.40	909.1
TP 81	1,50	0.10	4.50	1000.0
TP 88	1,80	0.03	4.98	3333.3
TP 117	1,50	0.18	5.37	555.6
TP 128	1,60	1.48	5.90	67.6
TP 130	2,10	0.24	6.46	416.7
TP 136	1,70	0.13	5.29	769.2
TP 142	1,80	0.18	5.46	555.6
TP 143	1,40	0.16	5.30	625.0
TP 146	1,30	0.18	5.52	555.6
TP 225	1,60	0.38	6.43	263.2
TP 237	1,70	1.69	6.51	59.2

Remarks:

TEST DONE BY:- TONIC

CLIENT Intraconsult | DATE 10-11-2006

PROJECT IR 801 | JOB No

SITE Leeuwpoort Res. Andesite | TEST No 9

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster: / Depth of Sample: 1.5 m

Monster: Onversteurd: / Sample: Undisturbed

Monster Beskrywing: / Sample Description

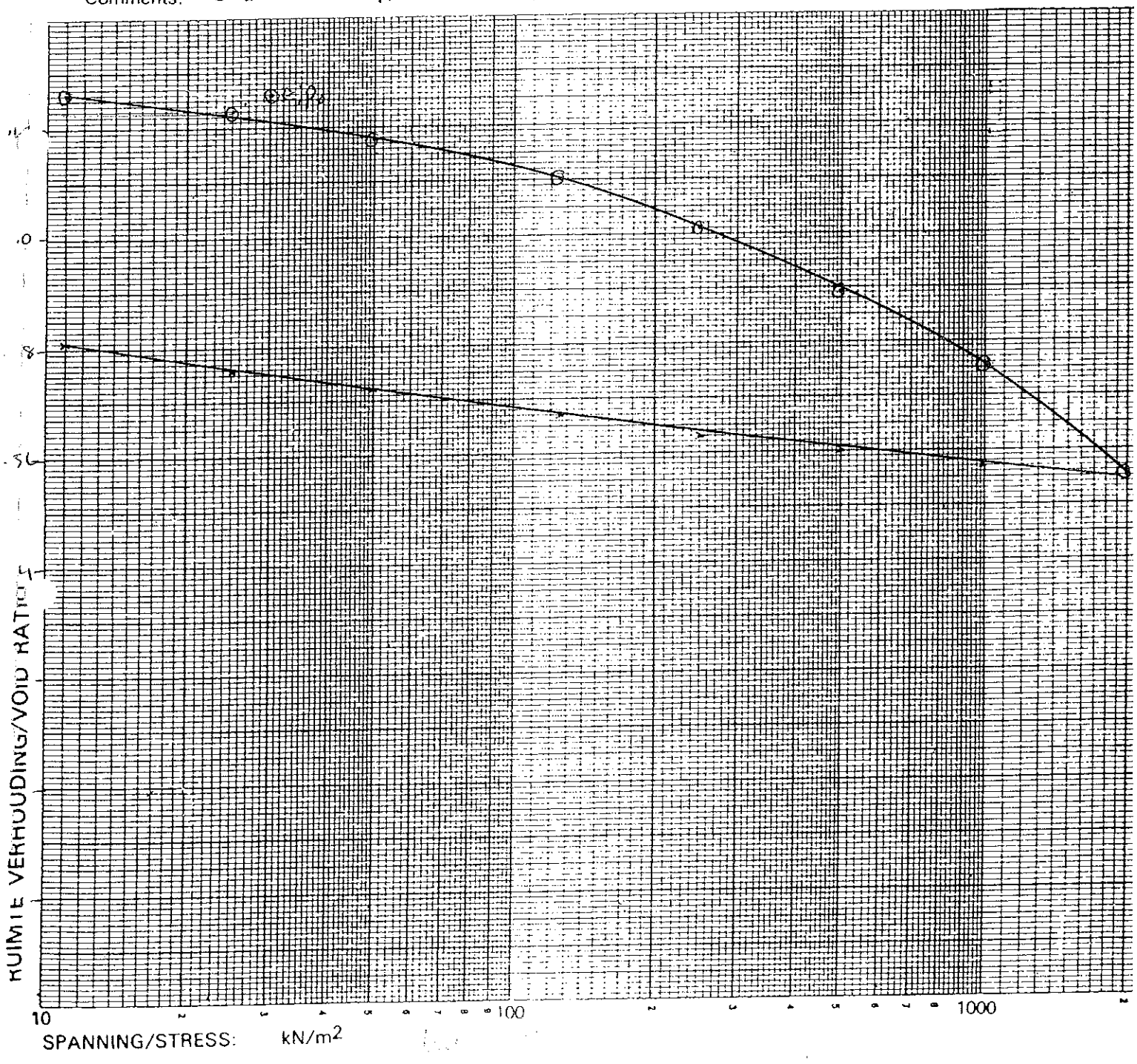
Opmerkings: / Comments: Soaked at 11 kpa

Soortlike Gewig: / Specific Gravity: 2.98

Aanvanklike Droë Digtheid: / Initial Dry Density: 1893 kg/m3

Aanvanklike Voggehalte: / Initial Moisture Content: 10.47 %

Finale Voggehalte: / Final Moisture Content: 19.42 %



CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	9

FRANKI

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 1.5m

Volg No.: Serial No.: 6097

Toets Nr. Test No. 6

Opmerkings: Remarks: Soaked at 11 kpa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20.000	7.698	.626
11	-.008		20.008		.626
25	.030		19.970		.627
50	.096		19.904		.618
125	.198		19.802		.610
250	.308		19.692		.601
500	.448		19.552		.589
1000	.630		19.370		.575
2000	.876		19.124		.555
1000	.846		19.154		.557
500	.810		19.190		.560
250	.770		19.230		.562
125	.726		19.274		.567
50	.666		19.334		.572
25	.612		19.388		.576
11	.546		19.454		.581
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME vaste stowwe solids			$eo = \frac{ei - e}{\log_{10}\sigma - \log_{10}\sigma_i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$Av = \frac{ei - e}{\sigma - \sigma_i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$Mv = \frac{\Delta e}{1 + ei} \times \frac{1}{\Delta\sigma}$	
eo.	e st.Po	30kPa		

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	9

FRANKI

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Diepte van Monster: / Depth of Sample: 1.5m

Opmerkings: / Remarks: **Soaked at 11 kpa**

Toets Nommer: / Test Number: 6

Volgnommer: / Serial Number: 6097

TYD-VERSAKKINGS LESINGS / TIME-SETTLEMENT READINGS

Lading / Load kN/m2		25		50		125		250		500		1000		2000	
Korreksie / Correction		1 7		2 11		3 16		4 22		5 29		6 38		7 52	
Tyd / Time (min - t)		Meter Lesing		Dial Reading		Meter Lesing		Dial Reading		Meter Lesing		Dial Reading		Meter Lesing	
√t	t	δ	δh	δ	δh	δ	δh	δ	δh	δ	δh	δ	δh	δ	δh
0.0	.00	-4	-4	22	15	59	48	115	99	176	154				
0.2	.04	14	7	50	39	103	87	161	139	235	206	252	224	353	315
0.3	.09	15	8	51	40	104	88	162	140	237	208	328	290	453	401
0.4	.16	15	8	51	40	105	89	163	141	238	209	330	292	457	405
0.5	.25	16	9	52	41	105	89	164	142	239	210	332	294	459	407
0.6	.36	16	9	52	41	106	90	165	143	239	210	334	296	461	409
0.8	.64	16	9	53	42	107	91	166	144	240	211	335	297	463	411
1.0	1.	17	10	53	42	107	91	167	145	241	212	336	298	466	414
1.5	2.25	17	10	54	43	108	92	168	146	243	214	337	299	468	416
2.0	4.	18	11	54	43	109	93	169	147	244	215	338	300	471	419
2.5	6.25	18	11	55	44	110	94	170	148	245	216	339	301	473	421
3.0	9.	18	11	55	44	110	94	170	148	246	217	340	302	475	423
3.5	12.25	19	12	56	45	111	95	171	149	247	218	341	303	476	424
4.	16.	19	12	56	45	111	95	171	149	247	218	342	304	477	425
5.0	25.	19	12	56	45	112	96	172	150	248	219	342	304	478	426
6.0	36.	20	13	57	46	112	96	172	150	249	220	343	305	479	427
7.0	49.	20	13	57	46	112	96	173	151	250	221	344	306	480	428
8.0	64.	20	13	57	46	113	97	173	151	250	221	345	307	481	429
9.0	81.	20	13	58	47	113	97	174	152	251	222	346	308	482	430
10.0	100.	21	14	58	47	113	97	174	152	251	222	346	308	483	431
15.0	225.	21	14	59	48	114	98	175	153	252	223	347	309	483	431
20.0	400.	22	15	59	48	115	99	176	154	252	224	349	311	485	433
38.0	1444.											350	312	487	435
Final Cons	mm		.070		.096		.198		.208		.448	353	315	490	438
													.620		.876

1		11kPa	(24)	25kPa	(28)	50kPa	(31)	125kPa	(34)	250kPa	(37)	500kPa	(41)	~~1000kPa~~	(46)
	Ontlaai/Rebound	297	334	306	364	333	397	363	422	385	446	405	469	423
2	Lading/Loading	273												
2														
	Ontlaai/Rebound													

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort Res. Andesite	TEST No	8

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster: / Depth of Sample: 1.6 m

Monster: Onversteurd: / Sample: Undisturbed

Monster Beskrywing: / Sample Description

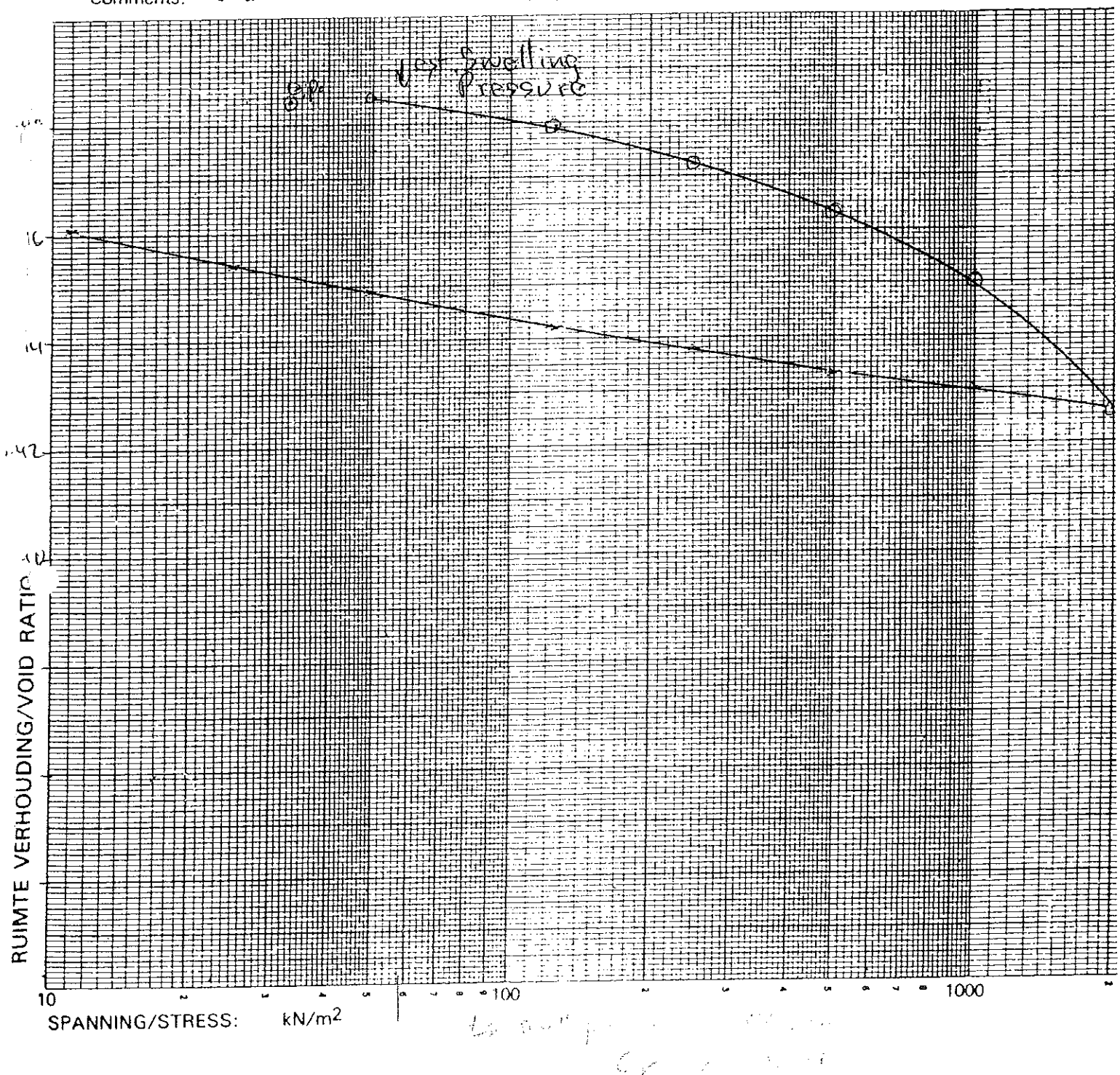
Opmerkings: / Comments: Soaked at 11 kpa

Soortlike Gewig: / Specific Gravity: 2.76

Aanvanklike Droë Digtheid: / Initial Dry Density: 1860 kg/m3

Aanvanklike Voggehalte: / Initial Moisture Content: 12.16 %

Finale Voggehalte: / Final Moisture Content: 16.63 %



CLIENT Intraconsult	DATE 10.11.2006	FRANKI
PROJECT IR 801	JOB No	
SITE Leeuwpoort	TEST No 8	

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 1.6m

Volg No.: Serial No.: 6098

Toets Nr. Test No. 7

Opmerkings: Remarks: Soaked at 11 kpa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20.000	6.522	.484
11					
25					
50	-.016		20.016		.485
125	.070		19.930		.479
250	.162		19.838		.472
500	.286		19.714		.463
1000	.452		19.548		.450
2000	.774		19.226		.426
1000	.730		19.270		.430
500	.680		19.320		.423
250	.624		19.376		.438
125	.562		19.438		.442
50	.476		19.524		.449
25	.400		19.600		.454
11	.306		19.694		.461
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME vaste stowwe solids			$e_o = \frac{e_i - e}{\log_{10}\sigma' - \log_{10}\sigma'_i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$A_v = \frac{e_i - e}{\sigma' - \sigma'_i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$M_v = \frac{\Delta e}{1 + e_i} \times \frac{1}{\Delta\sigma'}$	
e_o	e st.Po	33 kPa		

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	8

FRANKI

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Dieptevan Monster: / Depth of Sample: 1.6m

Opmerkings: / Remarks: **Soaked at 11 kpa**

Toets Nommer: / Test Number: 7

Volgnommer: / Serial Number: 6098

TYD-VERSAKKINGS LESINGS / TIME-SETTLEMENT READINGS

Loding / Load kN/m²		25		50		125		250		500		1000		2000	
Korreksie / Correction		1 7		2 11		3 16		4 22		5 29		6 38		7 52	
Tyd / Time (min - t)		Meter Lesing		Dial Reading		Meter Lesing		Dial Reading		Meter Lesing		Dial Reading		Meter Lesing	
√t	t	6	6h	6	6h	6	6h	6	6h	6	6h	6	6h	6	6h
0.0	.00														
0.2	.04					7	-8	51	35	107	81	172	143	264	226
0.3	.09					37	21	86	64	152	123	235	197	389	337
0.4	.16					38	22	87	65	154	125	237	199	393	341
0.5	.25					39	23	88	66	155	126	239	201	396	344
0.6	.36					39	23	89	67	156	127	240	202	398	346
0.8	.64					40	24	90	68	156	127	241	203	400	348
1.0	1.					41	25	91	69	157	128	243	205	403	351
1.5	2.25					41	25	92	70	158	129	244	206	406	354
2.0	4.					42	26	93	71	160	131	246	208	410	358
2.5	6.25					43	27	94	72	161	132	248	210	413	361
3.0	9.					44	28	95	73	162	133	249	211	415	363
3.5	12.25					44	28	95	73	163	134	250	212	417	365
4.	16.					45	29	96	74	163	134	251	213	419	367
5.0	25.					45	29	96	74	164	135	252	214	420	368
6.0	36.					46	30	97	75	165	136	253	215	422	370
7.0	49.					46	30	97	75	166	137	254	216	424	372
8.0	64.					46	30	98	76	167	138	255	217	426	374
9.0	81.					47	31	98	76	167	138	256	218	427	375
10.0	100.					47	31	99	77	168	139	256	218	428	376
15.0	225.					47	31	99	77	168	139	257	219	429	377
20.0	400.					48	32	100	78	169	140	259	221	433	381
38.0	1444.					49	33	101	79	170	141	261	223	435	383
Final Cons. mm				7	-8	51	35	103	81	172	143	264	226	439	387
					-.016		.070		.162		.286		.452		.774

1	11kPa	(24)	25kPa	(28)	50kPa	(31)	125kPa	(34)	250kPa	(37)	500kPa	(41)	~~1000kPa~~ (46)
Ontlaai/Rebound	177	228	200	269	228	215	281	249	212	281	240	411	265
2 Lading/Loading	150												
2													
Ontlaai/Rebound													

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR801	JOB No	
SITE	Leeuwpoort Flat Dodaile	TEST No	27

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster: / Depth of Sample: 2.0 m

Monster: Onversteurd: / Sample: Undisturbed

Monster Beskrywing: / Sample Description

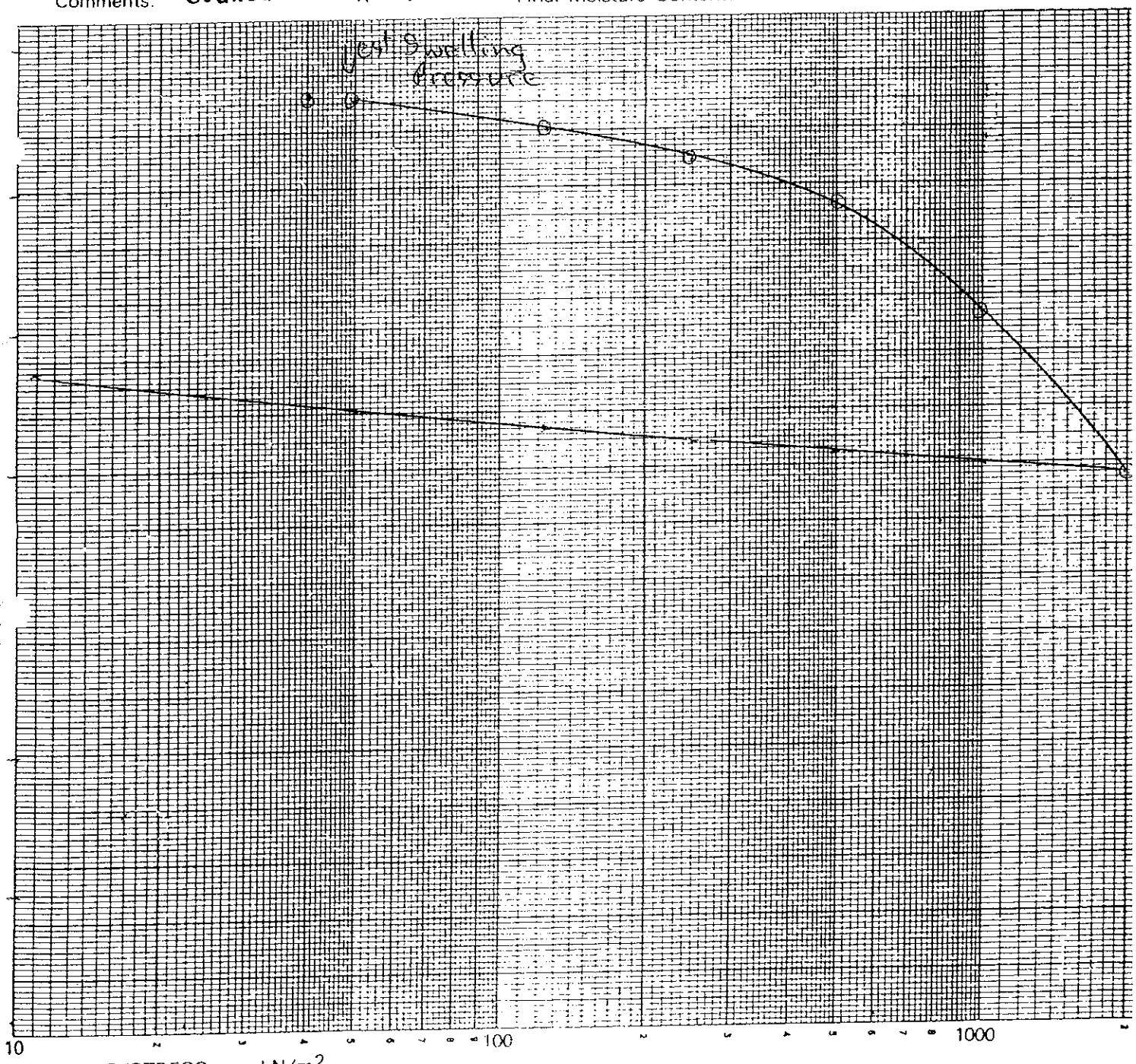
Opmerkings: / Comments: Soaked at 11 kpa

Soortlike Gewig: / Specific Gravity: 2.67

Aanvanklike Droë Digtheid: / Initial Dry Density: 1802 kg/m3

Aanvanklike Voggehalte: / Initial Moisture Content: 12.11 % 67,1

Finale Voggehalte: / Final Moisture Content: 14.35 % 99,5



CLIENT Intracongull	DATE 10.11.2006
PROJECT IR 801	JOB No
SITE Leeuwpoort	TEST No 27

FRANKI

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 2.0m

Volg No.: Serial No.: 6099

Toets Nr. Test No. 8

Opmerkings: Remarks: Soaked at 11 kpa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20.000	6.503	.482
11					
25					
50	.010		19.990		.481
125	.156		19.844		.470
250	.302		19.698		.459
500	.522		19.478		.443
1000	1.068		18.932		.403
2000	1.828		18.172		.346
1000	1.780		18.220		.350
500	1.724		18.276		.354
250	1.662		18.338		.359
125	1.594		18.406		.364
50	1.498		18.502		.371
25	1.414		18.586		.377
11	1.310		18.690		.385
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME vaste stowwe solids			$e_o = \frac{e_i - e}{\log_{10}\sigma - \log_{10}\sigma_i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$Av = \frac{e_i - e}{\sigma - \sigma_i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$Mv = \frac{\Delta e}{1 + e_i} \times \frac{1}{\Delta\sigma}$	
e_o	e st. Po	40 kPa		

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR901	JOB No	
SITE	Leeuwpoort	TEST No	27

FRANKI

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Dieptevan Monster: 2.0m
Depth of Sample:

Opmerkings: Soaked at 11 kpa
Remarks:

Toets Nommer: 8
Test Number:

Volgnommer: 6099
Serial Number:

Loading Load kN/m2		25	50	125	250	500	1000	2000
Korreksie Correction		1 7	2 11	3 16	4 22	5 29	6 38	7 52
Tyd Time (min - t)	√t	Meter Lesing / Dial Reading 6 / 6h	6 / 6h	6 / 6h	6 / 6h	6 / 6h	6 / 6h	6 / 6h
0.0	0.00							
0.2	.04							
0.3	.09							
0.4	.16							
0.5	.25							
0.6	.36							
0.8	.64							
1.0	1							
1.5	2.25							
2.0	4							
2.5	6.25							
3.0	9							
3.5	12.25							
4	16							
5.0	25							
6.0	36							
7.0	49							
8.0	64							
9.0	81							
10.0	100							
15.0	225							
20.0	400							
38.0	1444							
Final Comp mm			.010	.156	.207	.522	1.068	1.828

		11kPa (24)	25kPa (23)	50 kPa (21)	125kPa (19)	250kPa (37)	500 kPa (41)	1000 kPa (46)	
2	Ontlaai/Rebound	679	735	780	849	868	921	903	876
2	Lading/Loading	455	707	749	807	867	907	872	876
1	Ontlaai/Rebound								890

TYD-VERSAKKINGS LESINGS
TIME-SETTLEMENT READINGS

SOILTECH

CLIENT Intraconsult

DATE 10-11-2006

PROJECT IR 801

JOB No

SITE Leeuwpoort Ben Alexander

TEST No 128

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster:
Depth of Sample: 1.6 m

Monster: Onversteurd:
Sample: Undisturbed

Monster Beskrywing:
Sample Description

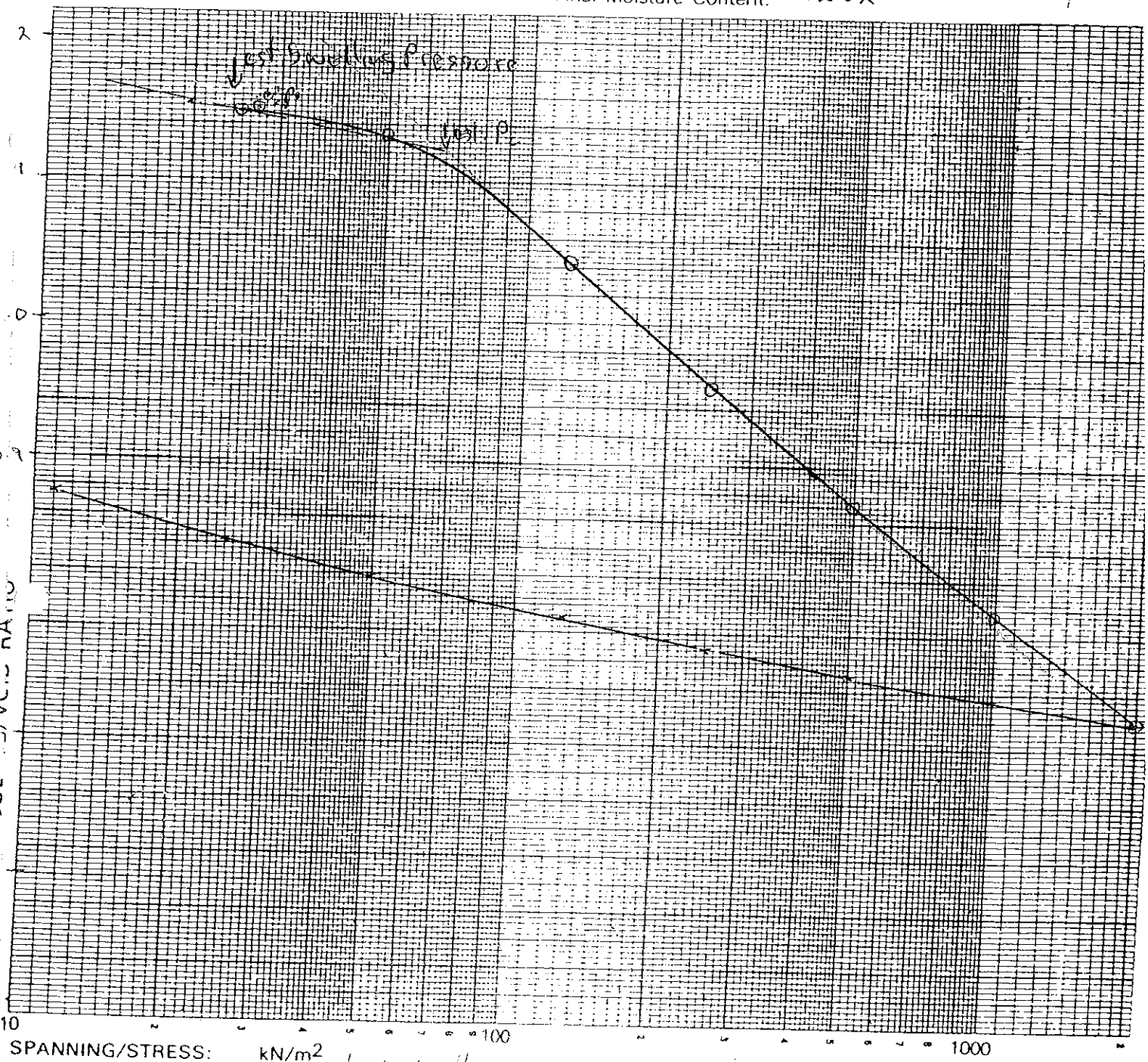
Opmerkings:
Comments: **Soaked at 11 kpa**

Soortlike Gewig: 2.72
Specific Gravity:

Aanvanklike Droë Digtheid: 1265 kg/m³
Initial Dry Density:

Aanvanklike Voggehalte: 34.62 %
Initial Moisture Content:

Finale Voggehalte: 32.02 %
Final Moisture Content:



CLIENT Intraconsult	DATE 10.11.2006
PROJECT IR 801	JOB No
SITE Leeuwpoort	TEST No 128

FRANKI

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 1.6m

Volg No.: Serial No.: 6100

Toets Nr. Test No. 9

Opmerkings: Remarks: Soaked at 11 kpa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20.000	10.699	1.150
11					
25	.008		19.992		1.149
50	.166		19.834		1.132
125	1.010		18.990		1.042
250	1.814		18.186		.955
500	2.592		17.408		.872
1000	3.328		16.672		.792
2000	4.006		15.994		.720
1000	3.872		16.128		.734
500	3.718		16.282		.751
250	3.546		16.454		.769
125	3.354		16.646		.790
50	3088		16.912		.818
25	2.856		17.144		.843
11	2.568		17.432		.874
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME vaste stowwe solids			$eo = \frac{ei - e}{\log_{10}\sigma - \log_{10}\sigma i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$Av = \frac{ei - e}{\sigma - \sigma i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$Mv = \frac{\Delta e}{1 + ei} \times \frac{1}{\Delta\sigma}$	
eo.	est. Po	27 kPa		

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	128

FRANKI

5

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Dieplevan Monster: 1.6m
Depth of Sample:

Opmerkings: Soaked at 11 kpa
Remarks:

Toets Nommer: 9
Test Number:

Volgnommer: 6100
Serial Number:

Loading / Load kN/m²		25	50	125	250	500	1000	2000
Korreksie / Correction		1	2	3	4	5	6	7
Tyd / Time (min-tt)	√t	Meter Lesing / Dial Reading						
		δ	δh	δ δh	δ δh	δ δh	δ δh	δ δh
0.0	0.00							
0.2	0.04		11 4	94 82	521 505	929 907	1725 1696	1702 1664
0.3	0.09		58 47	238 221	680 658	1065 1036	1791 1757	1722 1670
0.4	0.16		64 51	257 241	695 672	1079 1050	1801 1767	1725 1672
0.5	0.25		57 54	270 254	707 685	1081 1052	1809 1771	1728 1676
0.6	0.36		67 56	280 264	717 695	1092 1062	1816 1778	1730 1678
0.8	0.64		68 57	288 272	725 703	1101 1072	1822 1784	1732 1680
1.0	1		70 59	400 284	728 716	1115 1086	1827 1795	1737 1685
1.5	2.25		72 61	409 293	749 727	1127 1098	1842 1804	1742 1690
2.0	4		75 64	426 410	770 748	1150 1121	1859 1824	1754 1702
2.5	6.25		77 66	428 422	785 763	1166 1137	1872 1835	1765 1714
3.0	9		79 68	447 427	797 775	1179 1150	1886 1848	1778 1726
3.5	12.25		81 70	454 428	807 785	1190 1161	1898 1860	1790 1738
4	16		82 71	459 447	816 794	1200 1171	1909 1871	1802 1750
5.0	25		85 74	464 448	824 802	1209 1180	1919 1881	1814 1762
6.0	36		86 75	477 457	828 816	1225 1196	1928 1900	1826 1784
7.0	49		87 76	480 464	850 828	1228 1209	1936 1898	1836 1796
8.0	64		88 77	486 470	860 838	1249 1220	1943 1905	1845 1806
9.0	81		88 78	491 475	869 847	1259 1230	1950 1912	1854 1815
10.0	100		89 78	495 479	877 855	1268 1239	1960 1922	1870 1828
15.0	225		91 80	498 482	884 862	1276 1247	1976 1938	1888 1850
20.0	400		92 81	508 492	896 884	1290 1271	1988 1950	1949 1906
38.0	1444	11	94 82	521 505	929 907	1325 1296	2002 1964	2045 1977
Final Comp mm		.008	.166	1.010	1.814	2.592	3.228	4.006

1	1kPa (24)	25kPa (28)	50 kPa (31)	125kPa (34)	250kPa (37)	500 kPa (41)	1000kPa (46)	2000kPa (52)						
	Ontlaai / Rebound	1308	1456	1428	1575	1544	1711	1677	1810	1777	1900	1859	1982	1976
2	Lading / Loading	1284												
2														
	Ontlaai / Rebound													

TIME-SETTLEMENT READINGS

SOILTECH

CLIENT Intraconsult

PROJECT IR 801

SITE Leeuwpoort Res. Mudbrick

DATE 10-11-2006

JOB No

TEST No 130

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster:
Depth of Sample: 2.1 m

Monster: Onversteurd:
Sample: Undisturbed

Monster Beskrywing:
Sample Description

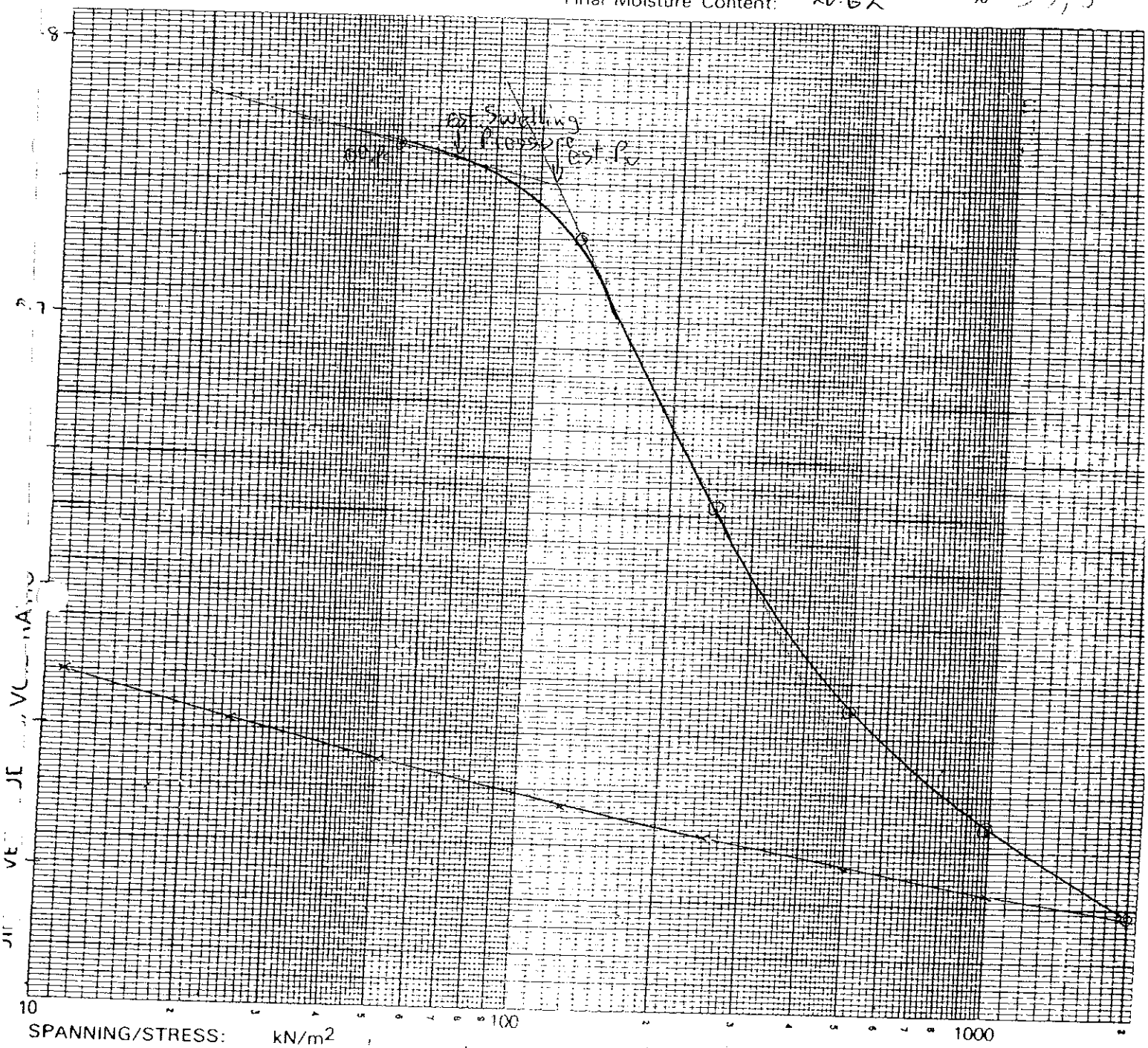
Opmerkings:
Comments: **Soaked at 11 kpa**

Soortlike Gewig:
Specific Gravity: 2.75

Aanvanklike Droë Digtheid:
Initial Dry Density: 1563 kg/m³ 1876

Aanvanklike Voggehalte:
Initial Moisture Content: 20.04 % 74,6

Finale Voggehalte:
Final Moisture Content: 20.62 % 99,5



66 kPa

C_v = 0.03

CLIENT	Intraconsult	DATE	10 11 2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	130

FRANKI

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 21m

Volg No.: Serial No.: 6101

Toets Nr. Test No. 10

Opmerkings: Remarks: Soaked at 11 kpa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20.000	8.633	.759
11					
25					
50	-.038		20.038		.763
125	.332		19.668		.730
250	1.552		18.448		.623
500	2.280		17.720		.559
1000	2.750		17.250		.518
2000	3.102		16.898		.487
1000	3.014		16.986		.494
500	2.912		17.088		.503
250	2.800		17.200		.513
125	2.674		17.326		.524
50	2.498		17.502		.540
25	2.346		17.654		.553
11	2.156		17.844		.570
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME Vaste stowwe solids			$eo = \frac{ei - e}{\log_{10}\sigma - \log_{10}\sigma_i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$Av = \frac{ei - e}{\sigma - \sigma_i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$Mv = \frac{\Delta e}{1 + ei} \times \frac{1}{\Delta\sigma}$	
eo.	e st. Po	39 kPa		

SOILTECH

CLIENT	Intraconsult	DATE	10 11 2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	130

FRANKI

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Dieptevan Monster: Depth of Sample: 2.1

Toets Nommer: Test Number: 10

Volgnommer: Serial Number: 6101

Opmerkings: Remarks: **Soaked at 11 kpa**

IYU-VERSAKKINGS LESINGS
TIME-SETTLEMENT READINGS

Lading Load kN/m2		25	50	125	250	500	1000	2000
Korreksie Correction		1	2	3	4	5	6	7
Tyd Time (min - t)	√t	Meter Lesing δ	Dial Reading δh	Meter Lesing δ	Dial Reading δh	Meter Lesing δ	Dial Reading δh	Meter Lesing δ	Dial Reading δh	Meter Lesing δ	Dial Reading δh	Meter Lesing δ	Dial Reading δh
0.0	0.00	7	11	16	22	29	38	52					
0.2	.04			-8	-19	182	166	798	776	1169	1140	1413	1375
0.3	.09			100	84	580	558	967	928	1228	1200	1450	1298
0.4	.16			110	94	604	582	987	958	1251	1213	1458	1404
0.5	.25			117	101	621	599	1001	972	1261	1222	1465	1417
0.6	.36			121	106	634	612	1014	982	1269	1229	1471	1419
0.8	.64			176	110	645	623	1021	992	1276	1238	1477	1425
1.0	1			172	116	662	640	1026	1007	1288	1250	1487	1435
1.5	2.25			196	120	675	657	1048	1019	1298	1260	1495	1447
2.0	4.			143	127	698	676	1069	1040	1311	1279	1510	1458
2.5	6.25			148	132	712	691	1084	1055	1321	1292	1522	1470
3.0	9.			152	136	725	707	1096	1067	1342	1304	1529	1479
3.5	12.25			155	139	734	712	1105	1076	1350	1312	1538	1486
4.	16.			158	142	741	719	1112	1083	1356	1318	1544	1492
5.0	25.			160	144	747	725	1118	1089	1362	1324	1550	1498
6.0	36.			162	147	756	734	1127	1098	1371	1332	1559	1507
7.0	49.			166	150	762	741	1134	1105	1378	1340	1566	1514
8.0	64.			168	152	768	746	1139	1110	1383	1345	1571	1519
9.0	81.			170	154	772	750	1143	1114	1387	1349	1575	1522
10.0	100.			171	155	775	753	1146	1117	1390	1352	1578	1526
15.0	225.			172	156	777	755	1148	1119	1392	1354	1580	1528
20.0	400.			175	159	784	762	1155	1126	1399	1361	1588	1536
30.0	1444.			177	161	789	767	1160	1131	1404	1366	1594	1542
Final Comp mm		-8	-19	182	166	798	776	1169	1140	1412	1375	1602	1551
		-.028		.222		1.552		2.280		2.750		2.102	
Ontlaai/Rebound													
Lading/Loading													
Ontlaai/Rebound													

1 kPa (24) 25 kPa (28) 50 kPa (31) 125 kPa (34) 250 kPa (37) 500 kPa (41) 1000 kPa (46)

2 2 2

Ontlaai/Rebound 1182 1201 1173 1280 1249 1271 1337 1407 1400 1497 1457 1557 1507

Lading/Loading 1078

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	117

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster: / Depth of Sample: 1.5 m

Monster: Onversteurd: / Sample: Undisturbed

Monster Beskrywing: / Sample Description CP_{200}: 0.89 %

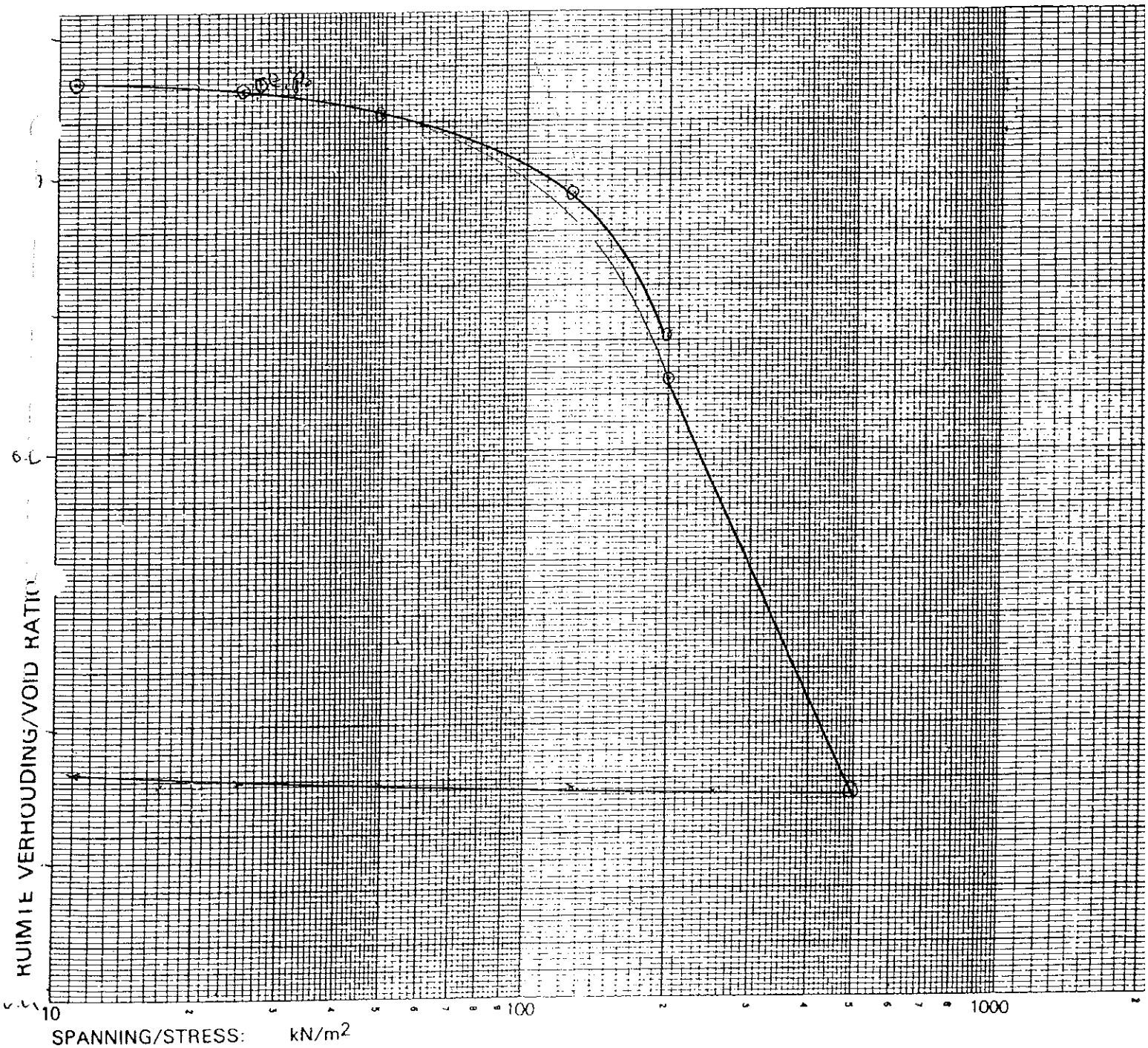
Opmerkings: / Comments: **Soaked at 200 kpa**

Soortlike Gewig: / Specific Gravity: 2.63

Aanvanklike Droë Digtheid: / Initial Dry Density: 1517 kg/m3

Aanvanklike Voggehalte: / Initial Moisture Content: 18.89 %

Finale Voggehalte: / Final Moisture Content: 18.27 %



CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	117

FRANKI

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 1.5m

Volg No.: Serial No.: 6092

Toets Nr. Test No. 1

Opmerkings: Remarks: Soaked at 200 kpa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20.000	8.468	.734
11	.006		19.994		.734
25	.040		19.960		.731
50	.142		19.858		.722
125	.476		19.524		.693
250	1.080 / 1.258		18.920 / 18.742		.641 / .625
500	3.000		17.000		.474
1000					
2000					
1000					
500					
250	2.988		17.012		.475
125	2.972		17.028		.477
50	2.952		17.048		.478
25	2.936		17.064		.480
11	2.914		17.086		.482
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME vaste stowwe solids			$e_o = \frac{e_i - e}{\log_{10}\sigma - \log_{10}\sigma_i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$Av = \frac{e_i - e}{\sigma - \sigma_i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$Mv = \frac{\Delta e}{1 + e_i} \times \frac{1}{\Delta\sigma}$	
e_o	e st. P_o	27 kPa		

SOILTECH

CLIENT	Intraconsult	DATE	10-11-2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	117

FRANKI

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Dieptevan Monster: 1.5 m
Depth of Sample:

Opmerkings: Soaked at 200 kpa
Remarks:

Toets Nommer: 1
Test Number:

Volgnommer: 6092
Serial Number:

TYD-VERSAKKINGS LESINGS
TIME-SETTLEMENT READINGS

Lading Load kN/m²		25	50	125	200	500	1000	2000	
Korreksie Correction		1	2	3	4	5	6	7	
Tyd Time (min - t)	√t	Meter Lesing	Dial Reading	Meter Lesing	Dial Reading	Meter Lesing	Dial Reading	Meter Lesing	
		δ	δh	δ	δh	δ	δh	δ	δh
0.0	0.								
0.2	.00	7	47	84	254	629			
0.3	.04	19	57	187	428	1260			
0.4	.09	20	60	196	450	1291			
0.5	.16	20	62	202	465	1317			
0.6	.25	21	62	206	476	1329			
0.8	.36	21	64	209	485	1341			
1.0	.64	21	66	214	498	1358			
1.5	1.	21	68	218	507	1369			
2.0	2.25	21	71	220	512	1386			
2.5	4.	22	73	222	516	1395			
3.0	6.25	23	74	223	521	1405			
3.5	9.	22	76	226	520	1401			
4.	12.25	24	76	240	541	1465			
5.0	16.	24	77	242	544	1507			
6.0	25.	24	78	245	546	1509			
7.0	36.	25	78	247	549	1512			
8.0	49.	25	79	248	551	1514			
9.0	64.	25	79	249	552	1516			
10.0	81.	25	80	250	553	1517			
15.0	100.	26	80	251	554	1518			
20.0	225.	26	81	252	555	1519			
30.0	400.	27	82	254	558	1523			
	1444.				560	1525			
Final Cons.		.060	.412	.476	1.080	1529			
						2.000			

1	11kPa (12)	25kPa (17)	50kPa (20)	125kPa (22)	250kPa (24)						
	Ontlaai/Rebound	1478	1485	1498	1496	1476	1509	1486	1520	1494	
2	Lading/Loading	1457									
2											
	Ontlaai/Rebound										

CLIENT Intra consult

PROJECT IR 801

SITE Leeuwpoort Collection

DATE 10.11.2006

JOB NO

TEST NO 136

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster:
Depth of Sample: 1.7 m

Monster: Onversteurd:
Sample: Undisturbed

Monster Beskrywing:
Sample Description CP_{200}: 0.01%

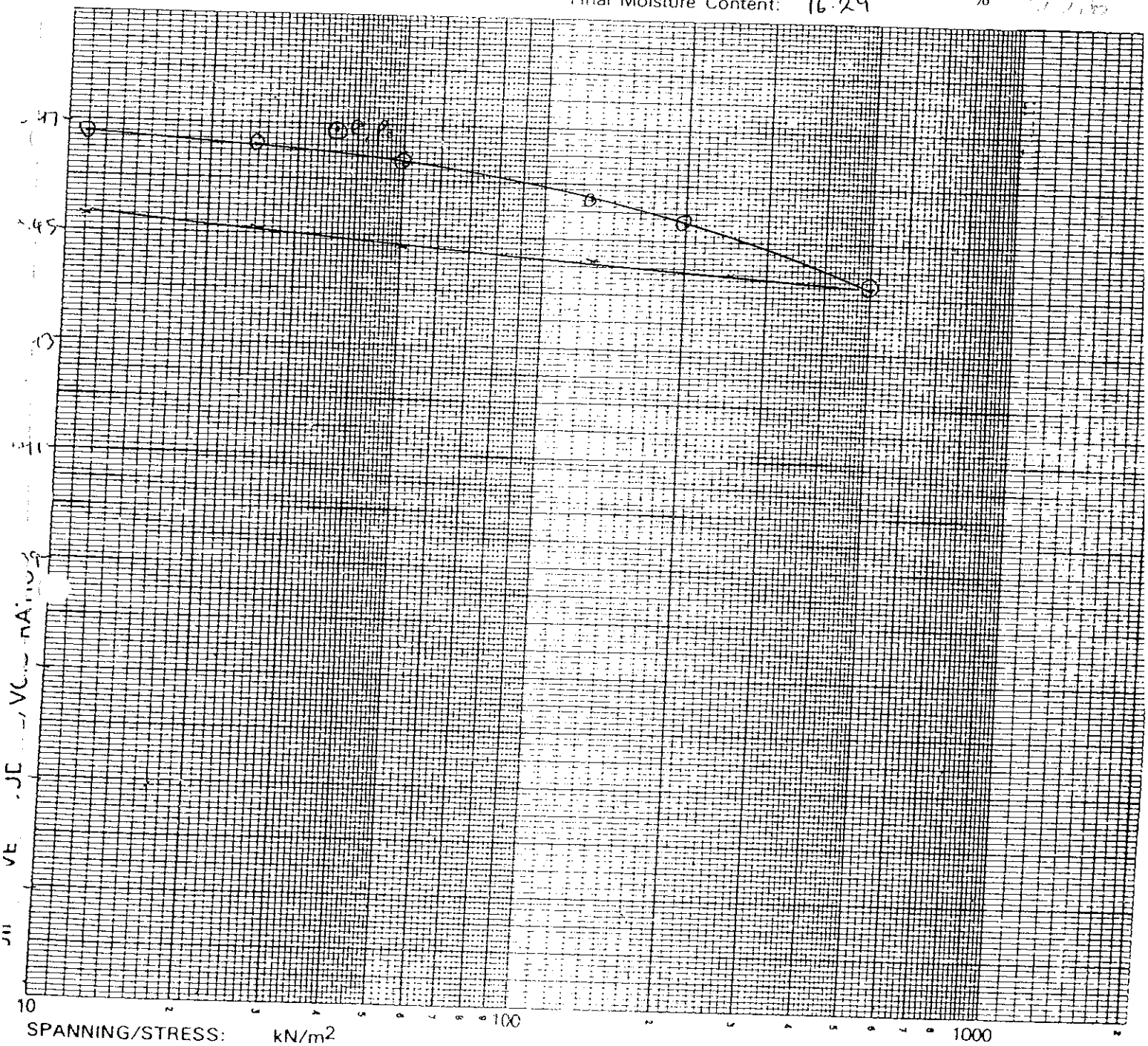
Opmerkings:
Comments: **Soaked at 200 kpa**

Soortlike Gewig:
Specific Gravity: 2.77

Aanvanklike Droë Digtheid:
Initial Dry Density: 1886 kg/m³ 2006

Aanvanklike Voggehalte:
Initial Moisture Content: 11.15 % 6,15

Finale Voggehalte:
Final Moisture Content: 16.29 % 12,6



CLIENT	Intra consult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	136

FRANKI

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 1.7m

Volg No.: Serial No.: 6093

Toets Nr. Test No. 2

Opmerkings: Remarks: Soaked at 200 kPa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20.000	6.084	.469
11	.006		19.994		.468
25	.034		19.966		.466
50	.076		19.924		.463
125	.158		19.842		.457
200	.220 222		19.780 19.778		.453
500	.364		19.636		.442
1000					
2000					
1000					
500					
250	.340		19.660		.444
125	.316		19.684		.446
50	.280		19.720		.448
25	.248		19.752		.451
11	.210		19.790		.453
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME vaste stowwe solids			$eo = \frac{ei - e}{\log_{10}\sigma - \log_{10}\sigma_i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$Av = \frac{ei - e}{\sigma - \sigma_i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$Mv = \frac{\Delta e}{1 + ei} \times \frac{1}{\Delta\sigma}$	
eo.	e st.Po	36 kPa		

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	136

FRANKI

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Dieptevan Monster: 1-7 s
Depth of Sample:

Opmerkings: Soaked at 200 kpa
Remarks:

Toets Nommer: 2
Test Number:

Volgnommer: 6093
Serial Number:

TYD-VERSAKKINGS LESINGS
TIME-SETTLEMENT READINGS

Lading Load kN/m²		25	50	125	200	500	1000	2000
Korreksie Correction		1	2	3	4	5	6	7
Tyd Time (min - t)	√t	Meter Lesing 6	Meter Lesing 6h	Dial Reading 6	Dial Reading 6h	Meter Lesing 6	Meter Lesing 6h	Meter Lesing 6	Meter Lesing 6h	Dial Reading 6	Dial Reading 6h	Meter Lesing 6	Meter Lesing 6h
0.0	.00	7	7	24	17	49	28	95	79	171	111		
0.2	.04	18	11	41	20	86	70	118	98	192	162		
0.3	.09	19	12	42	21	87	71	119	99	193	164		
0.4	.16	19	12	42	21	87	71	120	100	194	165		
0.5	.25	19	12	43	22	88	72	120	100	195	166		
0.6	.36	19	12	43	22	88	72	121	101	196	167		
0.8	.64	20	12	43	22	89	73	122	102	197	168		
1.0	1.	20	13	44	23	89	73	122	102	198	169		
1.5	2.25	21	14	44	23	90	74	122	103	199	170		
2.0	4.	21	14	45	24	90	74	124	104	200	171		
2.5	6.25	21	14	45	24	91	75	125	105	201	172		
3.0	9.	21	14	45	24	91	75	125	105	202	173		
3.5	12.25	21	15	46	25	92	76	126	106	202	174		
4.	16.	22	15	46	25	92	76	126	106	202	174		
5.0	25.	22	15	46	25	92	76	126	107	204	175		
6.0	36.	22	16	47	26	92	77	127	107	204	175		
7.0	49.	22	16	47	26	92	77	127	107	205	176		
8.0	64.	22	16	47	26	93	77	128	108	205	176		
9.0	81.	22	16	47	26	94	78	128	108	206	177		
10.0	100.	23	16	48	27	94	78	128	108	206	177		
15.0	225.	24	17	48	27	93	79	129	109	208	179		
20.0	400.	24	17	49	28	95	79	130	110	209	180		
38.0	1444.	Final Cons. reading	.026		.026		.158		.220	211	182		
										.264			

		1		2		3		4		5		6		7	
		11kPa (13)		25kPa (17)		50kPa (20)		125kPa (22)		250kPa (24)					
1	Ontlaai/Rebound	118		141		160		158		196					
2	Lading/Loading	105		124		140		138		170					
2	Ontlaai/Rebound														

CLIENT Intraconsult

DATE 10.11.2006

PROJECT IR 801

JOB No

SITE Leeuwpoort Collector

TEST No 237

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster: / Depth of Sample: 1.7 m

Monster: Onversteurd: / Sample: Undisturbed

Monster Beskrywing: / Sample Description C_{p200}: 0,10%

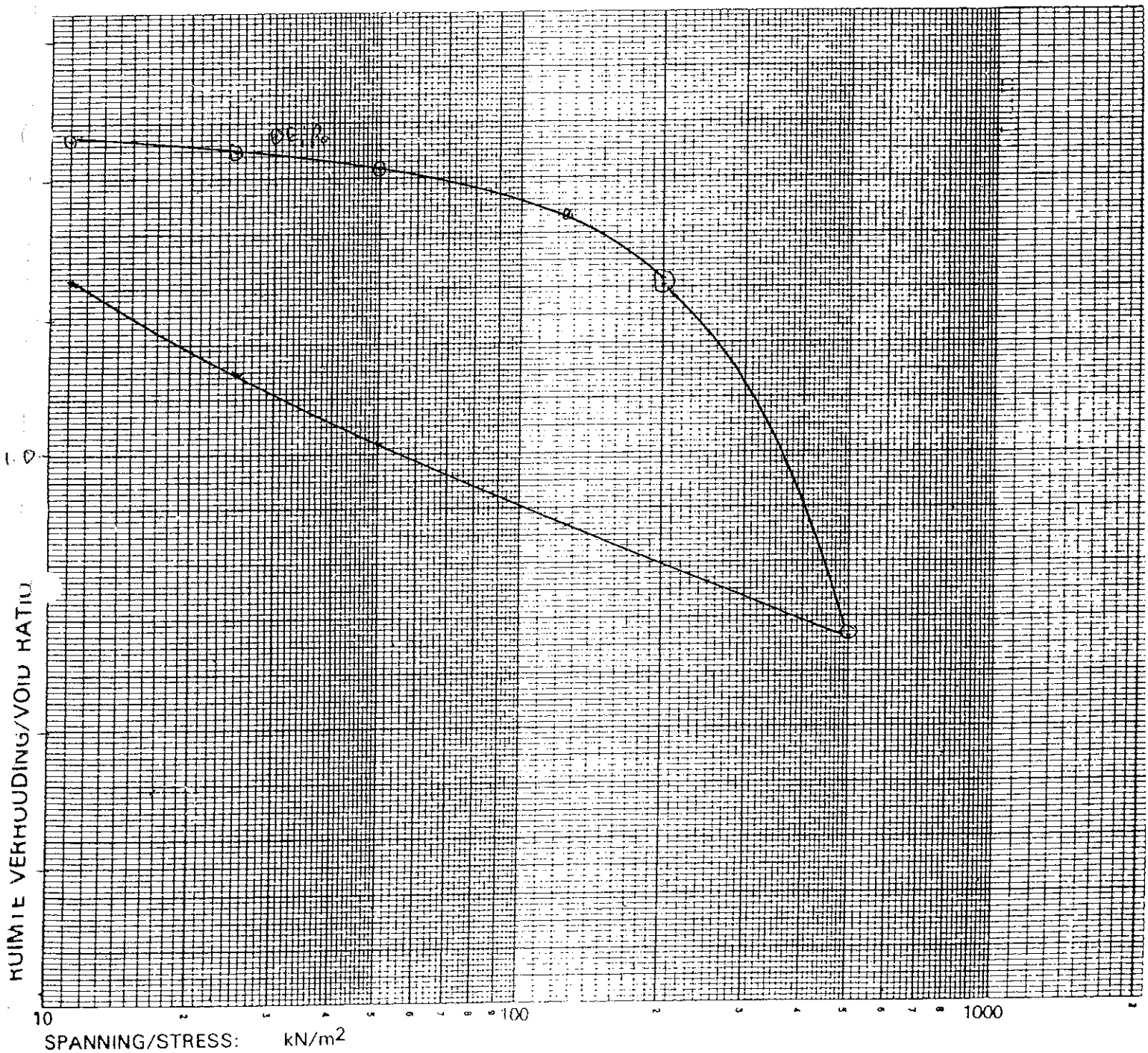
Opmerkings: / Comments: **Soaked at 200 kpa**

Soortlike Gewig: / Specific Gravity: 2.67

Aanvanklike Droë Digtheid: / Initial Dry Density: 1262 kg/m3 — 1755

Aanvanklike Voggehalte: / Initial Moisture Content: 38.87 % — 32,9

Finale Voggehalte: / Final Moisture Content: 39.68 % — 39,3



CLIENT Intraconsult	DATE 10·11·2006	FRANKI
PROJECT IR 801	JOB No	
SITE Leeuwpoort	TEST No 237	

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 1·7m

Volg No.: Serial No.: 6094

Toets Nr. Test No. 3

Opmerkings: Remarks: Soaked at 200 kpa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20·000	10·546	1·116
11	·012		19·988		1·114
25	·056		19·944		1·110
50	·122		19·878		1·103
125	·276		19·724		1·086
200	·496 / ·516		19·504 / 19·484		1·067 / 1·061
500	1·722		18·278		·933
1000					
2000					
1000					
500					
250	1·540		18·460		·953
125	1·338		18·662		·974
50	1·058		18·942		1·004
25	·812		19·188		1·030
11	·508		19·492		1·062
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME vaste stowwe solids			$e_o = \frac{e_i - e}{\log_{10}\sigma - \log_{10}\sigma_i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$a_v = \frac{e_i - e}{\sigma - \sigma_i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$M_v = \frac{\Delta e}{1 + e_i} \times \frac{1}{\Delta\sigma}$	
e_o	e st. Po	20 kPa		

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR801	JOB No	
SITE	Leeuwpoort	TEST No	237

FRANKI

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Dieptevan Monster: / Depth of Sample: 1.7m

Opmerkings: / Remarks: Soaked at 200 kpa

Toets Nommer: / Test Number: 3

Volgnommer: / Serial Number: 6094

TYD-VERSAKKINGS LESINGS
TIME-SETTLEMENT READINGS

Lading / Load kN/m²		25		50		125		200		500		1000		2000	
Tyd / Time (min-t)	Korreksie / Correction	1	7	2	11	3	16	4	20	5	29	6	Dial Reading	7	Meter Lesing
√t		6	6h	6	6h	6	6h	6	6h	6	6h	6	6h	6	6h
0.0	/.	6	6	25	28	72	61	154	128	278	258				
0.2	.00	20	12	50	39	105	99	202	182	512	484				
0.3	.04	21	14	52	41	108	96	205	185	516	497				
0.4	.09	22	15	52	42	110	94	207	187	516	501				
0.5	.16	22	16	54	42	112	96	209	189	541	515				
0.6	.25	22	16	55	44	113	97	211	191	551	522				
0.8	.36	24	17	56	45	115	99	213	193	562	527				
1.0	.64	24	17	56	45	117	101	215	195	571	542				
1.5	1.	25	18	57	46	120	104	219	199	591	562				
2.0	2.25	26	19	58	47	122	107	223	203	609	580				
2.5	4.	27	20	59	48	125	109	224	204	625	596				
3.0	6.25	27	20	60	49	127	111	229	209	629	610				
3.5	9.	28	21	61	50	129	113	221	211	651	622				
4.	12.25	28	21	61	50	130	114	227	217	662	632				
5.0	16.	29	22	62	51	132	117	227	217	682	654				
6.0	25.	30	23	62	52	135	119	241	221	702	674				
7.0	36.	31	24	64	53	137	121	245	225	722	693				
8.0	49.	31	24	65	54	139	123	248	226	740	711				
9.0	64.	32	25	66	55	141	125	251	231	756	727				
10.0	81.	32	25	67	56	143	127	252	232	770	741				
15.0	100.	34	27	70	59	150	134	262	242	829	800				
20.0	225.	35	28	72	61	154	138	268	248	859	830				
38.0	400.	1444.								890	861				
Final Cons. mm			.056		.127		.276		.496		1.727				

		1		2		3		4		5		6		7	
1	1kPa (13)	25kPa (17)		50kPa (20)		125kPa (24)		250kPa (27)							
	Ontlaai/Rebound	267	427	405	549	525	692	669	796	770					
2	Lading/Loading	254													
2	Ontlaai/Rebound														

SOILTECH

CLIENT Intraconsult | DATE 10·11·2006

PROJECT IR 801 | JOB No

SITE Leeuwpoort ALLUVIUM | TEST No 49

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster: / Depth of Sample: 1 m

Monster: Onversteurd: / Sample: Undisturbed

Monster Beskrywing: / Sample Description

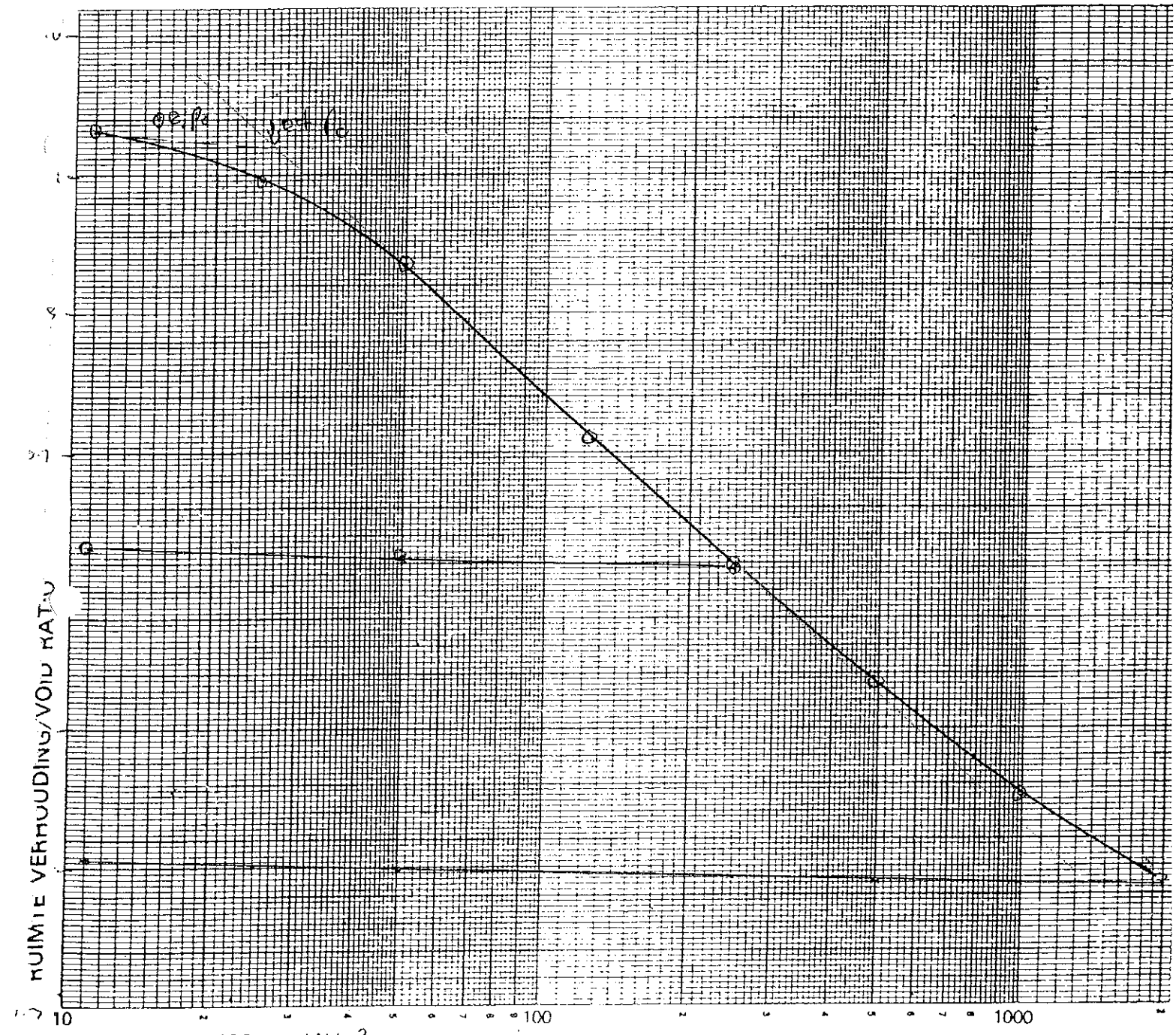
Opmerkings: / Comments: Soaked at 11 kpa

Soortlike Gewig: / Specific Gravity: 2.65

Aanvanklike Droë Digtheid: / Initial Dry Density: 1765 kg/m³

Aanvanklike Voggehalte: / Initial Moisture Content: 9.45 %

Finale Voggehalte: / Final Moisture Content: 15.54 %



CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	49

FRANKI

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 1m

Volg No.: Serial No.: 6095

Toets Nr. Test No. 4

Opmerkings: Remarks: Soaked at 11 kpa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20.000	9.698	.941
11	.096		19.904		.932
25	.470		19.530		.896
50	1.090		18.910		.836
125	2.394		17.606		.709
250	3.324		16.676		.619
500	4.230		15.770		.531
1000	5.058		14.942		.450
2000	5.726		14.274		.386
1000	5.708		14.292		.387
500	5.686		14.314		.389
250	5.662		14.338		.392
125	5.636		14.364		.394
50	5.598		14.402		.398
25	5.566		14.434		.401
11	5.526		14.474		.405
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME Vaste stowwe solids			$e_o = \frac{e_i - e}{\log_{10}\sigma - \log_{10}\sigma_i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$Av = \frac{e_i - e}{\sigma - \sigma_i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$Mv = \frac{\Delta e}{1 + e_i} \times \frac{1}{\Delta\sigma}$	
e_o	e st. Po	15 kPa		

SOILTECH

CLIENT	Intraconsult
PROJECT	IR 801
SITE	Leeuwpoort
DATE	10.11.2006
JOB No	
TEST No	49

FRANKI

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Dieptevan Monster: / Depth of Sample: 1.0m

Toets Nommer: / Test Number: 4

Volgnommer: / Serial Number: 6095

Opmerkings: / Remarks:

250 kPa : 1684 - 22 : 1662 · .619
50 .. : 1651 - 16 : 1635 · .627
11 .. : 1617 - 9 : 1604 · .630
50 .. : 1646 - 16 : 1630 · .625
250 .. : 1696 - 22 : 1674 · .616

TYD-VERSAKKINGS LESINGS / TIME-SETTLEMENT READINGS

Lading / Load kN/m²		25		50		125		250		500		1000		2000	
Korreksie / Correction		1 7		2 11		3 16		4 22		5 29		6 38		7 52	
Tyd / Time (min - t)		Meter Lesing		Dial Reading		Meter Lesing		Dial Reading		Meter Lesing		Dial Reading		Meter Lesing	
√t	t	δ	δh	δ	δh	δ	δh	δ	δh	δ	δh	δ	δh	δ	δh
0.0	.00	48	48	242	235	556	545	1213	1197	1696	1674	2144	2115	2567	2529
0.2	.04	170	163	439	428	1056	1040	1536	1514	2001	1972	2436	2398	2792	2740
0.3	.09	183	176	459	448	1086	1070	1564	1542	2028	1999	2461	2423	2815	2763
0.4	.16	191	184	472	461	1105	1089	1582	1560	2045	2016	2477	2439	2830	2778
0.5	.25	196	189	481	470	1117	1101	1593	1571	2055	2026	2486	2448	2838	2786
0.6	.36	200	193	488	477	1126	1110	1601	1579	2062	2033	2493	2455	2844	2792
0.8	.64	205	198	497	486	1139	1123	1613	1591	2073	2044	2503	2465	2853	2801
1.0	1.	209	202	504	493	1148	1132	1621	1599	2081	2052	2510	2472	2859	2807
1.5	2.25	217	210	516	505	1162	1146	1635	1613	2095	2066	2523	2485	2871	2819
2.0	4.	222	215	524	513	1171	1155	1644	1622	2104	2075	2531	2493	2879	2827
2.5	6.25	225	218	529	518	1177	1161	1650	1628	2110	2081	2536	2498	2884	2832
3.0	9.	227	220	533	522	1182	1166	1655	1633	2115	2086	2540	2502	2888	2836
3.5	12.25	229	222	536	525	1186	1170	1658	1636	2118	2089	2543	2505	2891	2839
4.	16.	231	224	539	528	1189	1173	1660	1638	2120	2091	2545	2507	2893	2841
5.0	25.	233	226	543	532	1193	1177	1664	1642	2124	2095	2548	2510	2896	2844
6.0	36.	235	228	546	535	1196	1180	1667	1645	2127	2098	2550	2512	2898	2846
7.0	49.	236	229	548	537	1198	1182	1669	1647	2129	2100	2552	2514	2900	2848
8.0	64.	237	230	549	538	1200	1184	1671	1649	2131	2102	2554	2516	2902	2850
9.0	81.	238	231	550	539	1201	1185	1672	1650	2132	2103	2555	2517	2903	2851
10.0	100.	239	232	551	540	1202	1186	1673	1651	2133	2104	2556	2518	2904	2852
15.0	225.	241	234	554	543	1206	1190	1677	1655	2137	2108	2560	2522	2908	2856
20.0	400.	242	235	556	545	1209	1193	1680	1658	2140	2111	2567	2525	2911	2859
38.0	1444.					1213	1197	1684	1662	2144	2115	2567	2529	2915	2863
Final Cons mm			.470		1.090		2.394		3.724		4.230		5.058		5.726

!		11kPa	(24)	25kPa	(28)	50kPa	(31)	125kPa	(34)	250kPa	(37)	500kPa	(41)	1000kPa	(46)
2	Ontlaai/Rebound	2787	2811	2783	2830	2799	2852	2818	2868	2831	2884	2843	2900	2854
	Lading/Loading	2763												
2														
	Ontlaai/Rebound													

SOILTECH

CLIENT	Intraconsult	DATE	10-11-2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort Alluvium	TEST No	56

FRANKI

KONSOLIDASIETOETS — CONSOLIDATION TEST

Diepte van Monster: / Depth of Sample: 1·2 m

Monster: Onversteurd: / Sample: Undisturbed

Monster Beskrywing: / Sample Description

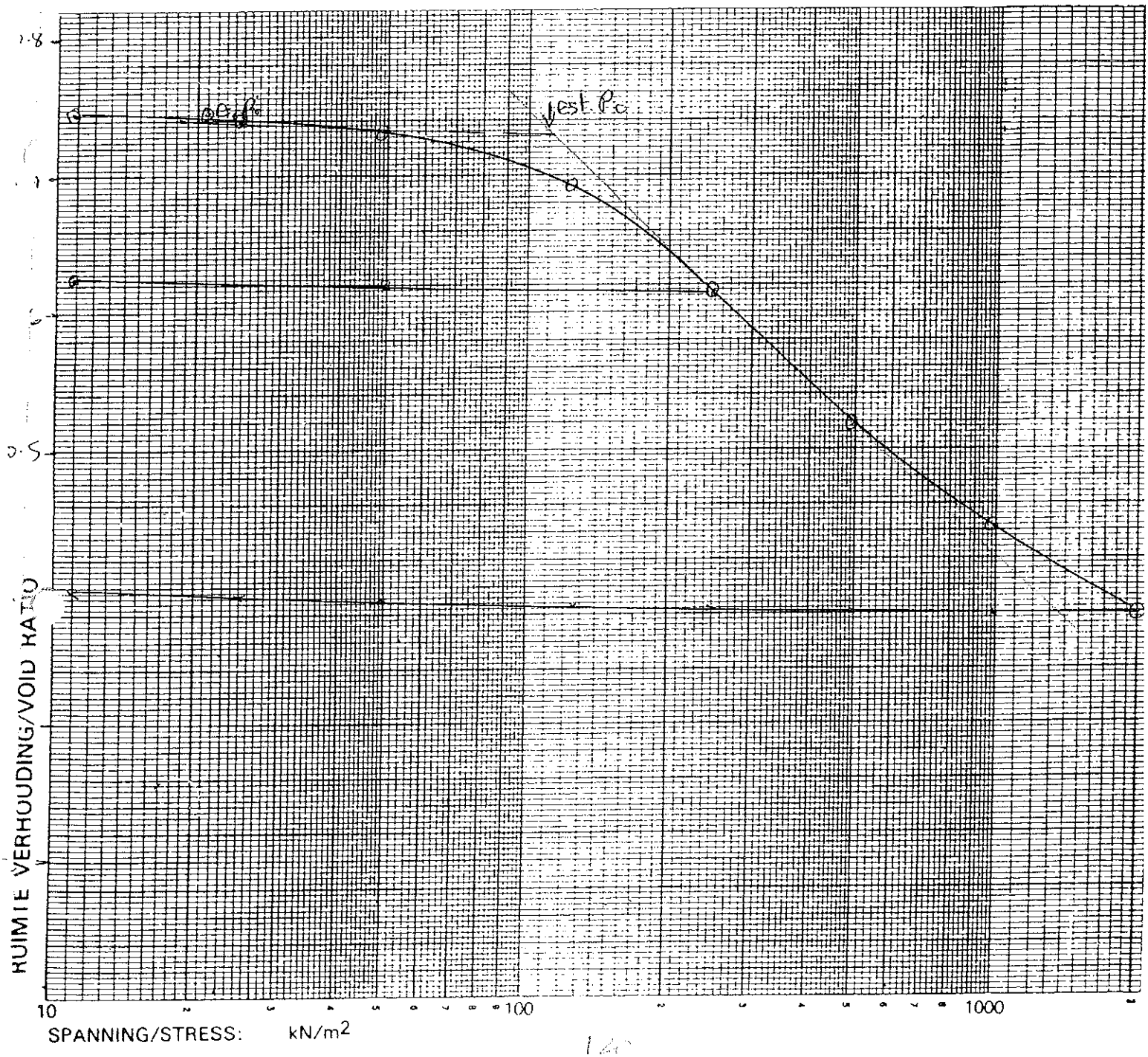
Opmerkings: / Comments: Soaked at 11 kpa

Soortlike Gewig: / Specific Gravity: 2.65

Aanvanklike Droë Digtheid: / Initial Dry Density: 1519 kg/m³

Aanvanklike Voggehalte: / Initial Moisture Content: 14.75 %

Finale Voggehalte: / Final Moisture Content: 14.85 %



VUIMTE VERHOUDING/VOID RATIO

CLIENT Intraconsult	DATE 10.11.2006
PROJECT IR 801	JOB No
SITE Leeuwpoort	TEST No 56

FRANKI

KONSOLIDASIE TOETS – CONSOLIDATION TEST

Diepte van Monster: Depth of Sample: 1.2m

Volg No.: Serial No.: 6096

Toets Nr. Test No. 5

Opmerkings: Remarks: Soaked at 11 kpa

Aangewende Druk Applied Pressure kN / m²	Finale Meterlesing Final Dial Reading mm	Dikte Verandering Change in Thickness ΔH mm	Monster Hoogte Sample Thickness H mm	Ruimte Hoogte Height of Voids H-Hs mm	Ruimte VERhouding Void Ratio $e = \frac{H - Hs}{Hs}$
0	0		20.000	8.599	.745
11	.014		19.986		.744
25	.068		19.932		.739
50	.156		19.844		.731
125	.614		19.386		.691
250	1.506		18.494		.614
500	2.602		17.398		.518
1000	3.478		16.522		.442
2000	4.200		15.800		.379
1000	4.182		15.818		.380
500	4.160		15.840		.382
250	4.136		15.864		.384
125	4.110		15.890		.386
50	4.072		15.928		.390
25	4.040		15.960		.393
11	4.000		16.000		.396
0					
11					
25					
50					
125					
250					
500					
1000					
2000					

KONSOLIDASIE PARAMETERS – CONSOLIDATION PARAMETERS

	Terrein Monster Field Sample	Toets Monster Test Sample		
VOLUME vaste stowwe solids			$e_o = \frac{e_i - e}{\log_{10}\sigma - \log_{10}\sigma_i}$	
VOLUME Ruimte Voids				
Ruimte Verhouding Void Ratio			$Av = \frac{e_i - e}{\sigma - \sigma_i}$	
0,42 e				
Gemiddelde Digtheid Average Density			$Mv = \frac{\Delta e}{1 + e_i} \times \frac{1}{\Delta\sigma}$	
e_o.	est. Po	21 kPa		

SOILTECH

CLIENT	Intraconsult	DATE	10.11.2006
PROJECT	IR 801	JOB No	
SITE	Leeuwpoort	TEST No	56

FRANKI

KONSOLIDASIE TOETS - CONSOLIDATION TEST

Dieptevan Monster: / Depth of Sample: 1.2m

Toets Nommer: / Test Number: 5

Volgnommer: / Serial Number: 6096

Opmerkings: / Remarks: **Soaked at 11 kpa**

250 kPa: 775 -22 : 753 .614
50 .. : 742 -16 : 726 .618
11 .. : 704 -9 : 695 .624
50 .. : 739 -16 : 723 .619
250 .. : 789 -22 : 767 .611

TYD-VERSAKKINGS LESINGS / TIME-SETTLEMENT READINGS

Lading / Load kN/m²		25		50		125		250		500		1000		2000	
Korreksie / Correction		1 7		2 11		3 16		4 22		5 29		6 38		7 52	
Tyd / Time (min - t)		Meter Lesing		Dial Reading		Meter Lesing		Dial Reading		Meter Lesing		Dial Reading		Meter Lesing	
√t	t	6	6h	6	6h	6	6h	6	6h	6	6h	6	6h	6	6h
0.0	.00	7	7	41	34	89	78	737	707	789	767	1330	1301	1777	1739
0.2	.04	29	22	66	55	233	217	637	615	1179	1150	1644	1606	2031	1979
0.3	.09	30	23	68	57	245	229	658	636	1199	1170	1662	1624	2048	1996
0.4	.16	31	24	70	59	253	237	672	650	1213	1184	1675	1637	2060	2008
0.5	.25	31	24	72	61	259	243	682	660	1223	1194	1684	1646	2068	2016
0.6	.36	32	25	73	62	264	248	690	668	1231	1202	1691	1653	2074	2022
0.8	.64	33	26	75	64	272	256	701	679	1242	1214	1702	1664	2084	2032
1.0	1.	33	25	76	65	278	262	709	687	1252	1223	1710	1672	2091	2039
1.5	2.25	34	27	78	67	287	271	723	701	1268	1239	1725	1687	2105	2053
2.0	4.	35	28	80	69	293	277	732	710	1279	1250	1735	1697	2114	2062
2.5	6.25	36	29	81	70	297	281	738	716	1287	1258	1741	1703	2119	2067
3.0	9.	36	29	82	71	300	284	743	721	1292	1263	1745	1707	2123	2071
3.5	12.25	37	30	83	72	303	287	746	724	1296	1267	1749	1711	2126	2074
4.	16.	37	30	83	72	305	289	749	727	1300	1271	1752	1714	2129	2077
5.0	25.	38	31	84	73	308	292	754	732	1305	1276	1756	1718	2133	2081
6.0	36.	38	31	85	74	310	294	757	735	1309	1280	1759	1721	2136	2084
7.0	49.	38	31	86	75	312	296	759	737	1312	1283	1762	1724	2138	2086
8.0	64.	39	32	86	75	313	297	761	739	1314	1285	1764	1726	2140	2088
9.0	81.	39	32	87	76	314	298	763	741	1316	1287	1765	1727	2141	2089
10.0	100.	39	32	87	76	315	299	765	743	1317	1288	1766	1728	2142	2090
15.0	225.	40	33	88	76	318	302	769	747	1322	1292	1770	1732	2146	2094
20.0	400.	41	34	89	78	320	304	771	749	1325	1296	1773	1735	2148	2096
38.0	1444.					323	307	775	753	1330	1301	1777	1739	2152	2100
Final Cons	mm		.068		.156		.614		1.506		2.602		3.478		4.200

1	11kPa	(24)	25kPa	(23)	50kPa	(31)	125kPa	(34)	250kPa	(37)	500kPa	(41)	~~1000kPa~~	(46)
	Ontlaai/Rebound	2024	2048	2020	2067	2036	2089	2055	2105	2068	2121	2080	2137	2091
2	Lading/Loading	2000												
2														
	Ontlaai/Rebound													

SOILTECH

APPENDIX 3

APPENDIX 3

Consulting Engineering Geologists

Intraconsult

Intraconsult Associates

P O Box 2022
RIVONIA 2128
Johannesburg

Telephone Direct: (011) 802 0079 and (011) 804 2084
Fax : (011) 469 0961

THE PRINCIPAL INSPECTOR HEALTH & SAFETY
DEPT. OF MINERAL AND ENERGY AFFAIRS
PRIVATE BAG X6 TOTAL HOUSE
209 SMIT STREET CNR SMIT/RISSIK STREETS
BRAAMFONTEIN 2017

ATTENTION: MR PETER KELLY
FAX NO: (011) 339 1858

Your reference	Our reference	Date
	IR801	**23 September 2006**

PROPOSED TOWN PROCLAMATIONS: PORTIONS ON THE FARM LEEUWPOORT 113-IR

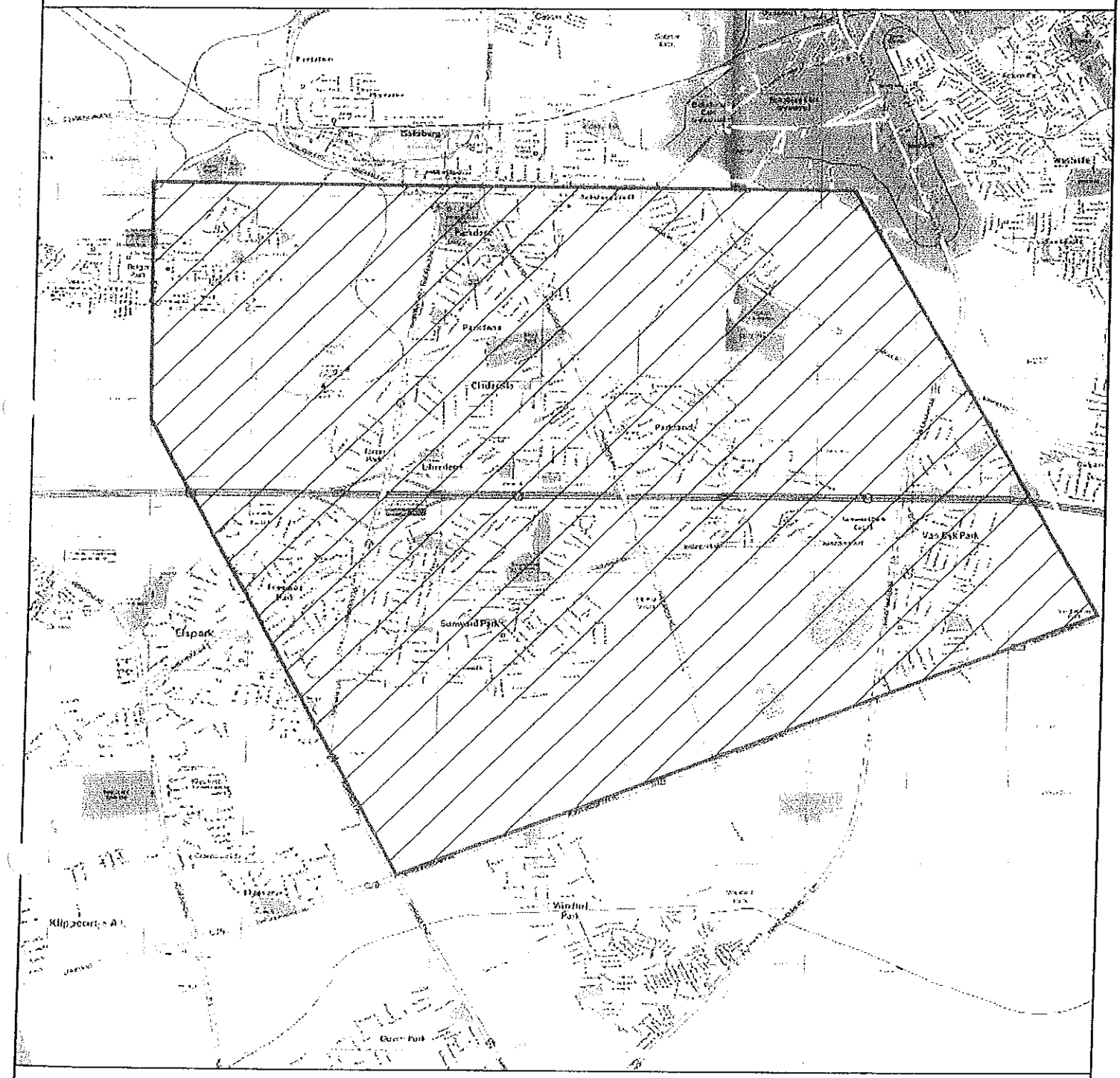
We have been appointed to complete geotechnical studies across the portions of land shown on the attached locality plan to support an application to develop residential properties. In this regard could you please kindly advise if you can foresee any surface or undermining constraints which could impact on this scheme, for example:-

- Is the DME aware of any rezoning applications in these areas?
- Does the DME foresee any surface or undermining constraints which could impact on planning in these areas?
- Would the DME advise inclusion of a 'shock clause' (due to potential seismic activity) for any new structures to be erected in these areas?

Yours sincerely,

Graham Hall
INTRACONSULT Associates

LEEUWPOORT 113 I.R.
LOCALITY PLAN



THE SITE

NOT TO SCALE

URBAN DYNAMICS
37 EMPIRE ROAD
PARKTOWN
P.O. BOX 291603
MELVILLE
2109
TEL: (+27 11) 482-4131
TEL: (+27 11) 482-9959

the dme
Department:
Minerals and Energy
REPUBLIC OF SOUTH AFRICA

PRINCIPAL INSPECTOR OF MINES
MINE HEALTH AND SAFETY
GAUTENG REGION

Private Bag X5
Braamfontein
2017
Tel: (011) 358-9700
Fax: (011) 339-1858

Messrs Intraconsult
P O Box 2022
RIVONIA
2128

Enquiries: PB Kelly Tel No: X227

Date: 3/10/2006 Ref No: PWV 11/1/1

Attention: Dr G Hall

Dear Sir

PROPOSED TOWNSHIP PROCLAMATION ON PORTION OF THE FARM LEEUWPOORT 113 IR: DISTRICT OF BOKSBURG.

Your letter referenced IR 801 dated 23 September 2006 refers.

The area that has been demarcated on the 1:50000 scale locality plan referenced IR 801 that was attached to your letter encompasses the major portion of the surface area of ERPM Gold Mine and most of it is undermined ,albeit at a substantial depth.

The general area is subjected to ground vibrations as a result of the mining activity and it is recommended that the 'shock warning' clause be included in the title deeds of the erven. The clause reads as follows:

"As this erf (stand, land, etc.) forms part of land which is, or may be, undermined and liable to subsidence, settlement, shock and cracking due to mining operations past, present or future, the owner (applicant, grantee, as the case may be) thereof accepts all liability for any damage thereto or to any structure thereon, which may result from such subsidence, settlement, shock or cracking".

Our office does not keep records of any rezoning that may have taken place in these areas.

There is no objection to any development in the demarcated area from a mining point of view.

Yours faithfully,

kelly

M L CEMANE
ACTING PRINCIPAL INSPECTOR OF MINES
GAUTENG REGION

Intraconsult

Consulting Engineers & Geologists

GFSH-2, PHASE 1 DOLOMITE STABILITY INVESTIGATIONS OF 226 HECTARES IN THE SOUTH WESTERN SECTOR OF THE LEEUWPOORT DEVELOPMENT.

IR801R

INTRACONSULT
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DAINFERN VALLEY
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FOURWAYS
2055

TEL: (011) 469 0854
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IR801R
NOVEMBER 2006

Consulting Engineering Geologists

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URBAN DYNAMICS
P.O. BOX 49
BEDFORDVIEW
2008

ATTENTION: MR PIETER CLOETE

Your reference	Our reference	Date
	IR801R	16 NOVEMBER 2006

GFSH-2, PHASE 1 DOLOMITE STABILITY INVESTIGATIONS OF 226 HECTARES IN THE SOUTH WESTERN SECTOR OF THE LEEUWPOORT DEVELOPMENT.

SUMMARY

This report presents the results of dolomite stability investigations carried out on approximately 226 hectares of land comprising the southwestern sector of the Leeuwpoort Development project. The site is bound in the south by North Boundary Road, in the west by Rondebult Road and in the north by Sunward Park. The proposed development includes multiple bonded products, lower level bonded products, social housing, subsidised products project linked, commercial development, schools and public open space

This report should be read in conjunction with Intraconsult report IR801 Soils, dated 10 November 2006, entitled: "GFSH-2, Phase 1 Soils investigations of the proposed Leeuwpoort Development."

The site is underlain by dolomite of the Chuniespoort Group and rocks of the Black Reef Formation. Ventersdorp Supergroup rocks encroach on the eastern margins of the site. Karoo and dolerite rocks cover these older rocks in sub-areas of the site. These investigations have been undertaken to comply with the requirements of:

- The NHBRC Home Building Manual, Parts 1,2 and 3. Revision 1, February 2003.
- Generic Specification GFSH – 2 of the National Department of Housing, dated September 2002, entitled: Geotechnical site investigations for housing developments".

These investigations involved field inspections, a review of available data, undertaking a gravity survey, a borehole drilling programme based on the gravity survey, analysis and reporting.

Based on the gathered geological, geophysical, geohydrological and soils data, the stability of the site is described in terms of four Dolomite Stability Zones, namely:

- ***Dolomite Stability Zone 1:*** Area characterised as reflecting no to low Inherent Risk of sinkhole and doline formation with respect to ingress of water and ground water level draw down i.e. No to Inherent Risk Class 1.

- ***Dolomite Stability Zone 2***: Area characterised as reflecting a low Inherent Risk of sinkhole and doline formation with respect to ingress of water and ground water level draw down i.e. Inherent Risk Class 1.

- ***Dolomite Stability Zone 3:*** Area characterised as reflecting a low to medium Inherent Risk of medium size sinkhole and doline formation with respect to ingress of water and a low Inherent Risk with respect to ground water level draw down i.e. Inherent Risk Class 1-4.

- ***Dolomite Stability Zone 4***: Area characterised as reflecting a high Inherent Risk of large to very large sinkhole and doline formation with respect to ingress of water and ground water level draw down i.e. Inherent Risk Class 7-8.

The southwestern sector of the site is located on the Natalspruit aquifer. Groundwater level monitoring is required as part of the Dolomite Risk Management Strategy required in terms of Section 12 of Act 95 of 1998.

This report documents recommendations on appropriate development types and related water precautionary measures in relation to the risk characterisation of the site. The NHBRC Dolomite Area Designations are provided with respect to each of the Dolomite Stability Zones and Inherent Risk Classes.

The Council for Geoscience and NHBRC requires further detailed work on all Residential 2 and 3 sites. In addition, detailed dolomite stability and soils investigations will be required on the footprint areas of all proposed commercial or light (dry) industrial structures. These additional investigations are required for final approval, design of precautionary measures and foundation specification.

The requisite Generic Specification GFSH-2, Phase 2 investigations will be required on this site.

GFSH-2, PHASE 1 DOLOMITE STABILITY INVESTIGATIONS OF 226 HECTARES IN THE SOUTH WESTERN SECTOR OF THE LEEUWPOORT DEVELOPMENT.

APPENDICES:

1. INTRODUCTION.

This report presents and comments on the results and observations of geotechnical investigations carried out on a sub-area of the proposed Leeuwpoort Development Project. This report documents the terms of reference, available data used in the study, investigation procedures, geophysical survey, drilling programme, risk characterisation methodology, geology, geohydrology, dolomite risk zonation, conclusions and recommendations (Appendices 1 and 2).

2. TERMS OF REFERENCE AND SCOPE OF WORK.

The terms of reference and scope of the work to be undertaken were discussed with Mr H. Potgieter of Urban Dynamics. Intraconsult outlined proposals in letter IR801p2, dated 15 July 2006. Intraconsult was instructed to proceed with the investigations on the 28 August 2006.

3. EXISTING INFORMATION

The following information has been used in the investigation and assessment of the site:

- 1:250 000 scale, sheet 2628 East Rand: Geological Mapping issued by the Geological Survey.
- Topographic map of the Director of Surveys at scale of 1:50 000: Sheets 2628 AC Alberton and 2628AD Springs.
- National Home Builders Registration Council: Home Builders Manual: Parts 1 and 2, Revision 1, February 1999.
- SAIEG and SAICE: "Guidelines for Urban Engineering Geological Investigations".
- "Proposed method for dolomite land hazard and risk assessment in South Africa." by Buttrick, Van Schalkwyk, Kleywegt and Watermeyer 2001, Journal of the South African Institution of Civil Engineering, Volume 43, Number 2.
- Generic specification GFSH-2, National Department of housing Specification, "Geotechnical site investigations for housing development."
- Department of Water Affairs and Forestry report, reference GH3408, dated July 1986 and entitled: "The hydrogeology of the dolomite aquifer in the Klipriver-Natalspruit basin."

4. GENERAL LOCATION AND DESCRIPTION OF THE SITE.

The delineated area of investigation constitutes approximately 226 hectares located in the south western sector of the greater Leeuwpoort Development Area of 1 360 hectares. The site is bound by:

- North Boundary Road in the south,
- Sunward Park in the north and
- Rondebult Road in the west.

The site is located on the Remainder of the Farm Leeuwpoort 113 IQ. The site slopes towards the north and is currently fallow.

5. PROCEDURES USED IN THESE INVESTIGATIONS

These investigations have involved the following:

5.1 Gathering of existing data.

During the early stages of this investigation available information pertaining to the area and immediate environs was gathered and studied to obtain a preliminary perspective of the urbanisation potential of the area. This information includes existing geological, geotechnical, geohydrological, topographical, orthophotographic, geotechnical reports of surrounding developments, geophysical, sinkhole and stability data, etc.

5.2 Field mapping.

To develop a clearer perspective of the actual site conditions, field mapping was undertaken following the assimilation of preliminary data. The object of this work was to evaluate accessibility, geomorphology, geology (outcrop/scattered outcrop etc), storm water runoff, gather data on sinkholes, etc.

5.3 Gravity survey.

The gravity survey was conducted according to prevailing practice. Firstly, the station positions were set out and tagged on a 30m grid spacing. Positions were established using a differential GPS. Gravity readings were taken using a Scintrex Autograv. Data reduction followed the typical procedures for dolomite studies. The gravity data were reduced to relative Bouguer values using elevation and latitude correction factors of 0.21 and 0,00065 mGals per metre respectively (Appendix 2). A plane was fitted to and then removed from the Bouguer data, the plane was taken to represent the regional gravity trend and the residual data obtained after removal of the plane a better indication of local density variations. Another regional, this time a second–order polynomial, was constructed after the drilling results were received. The

residual data set was also adjusted so that the average difference between predicted and actual bedrock depths is zero (Appendix 2).

5.4 Rotary Percussion Boreholes.

Boreholes were set out according to the gravity survey data of the site. These boreholes were drilled to develop a perspective of the subsurface and geohydrological conditions on the site (Appendix 1).

The drilling work was undertaken using a down-the-hole rotary percussion rig and a 950 c.f.m compressor delivering 308 psi to a 165mm diameter button bit or scraper. Chip samples were retrieved from the return air stream through each metre drilled, while the penetration times per metre were recorded (when using the button bit) with an electronic stopwatch. The retrieved samples are described according to current practice (Appendix 1).

The summarised borehole information recorded during these investigations is provided in Tables 1 to 3. The positions of the boreholes are indicated on Drawing IR801/1. This borehole information is discussed in greater detail in sections below.

6. GEOLOGY AND GEOHYDROLOGY.

The delineated area of investigation is underlain by the following geology:

a) Dolomite of the Chuniespoort Group
b) Black Reef Formation
c) Karoo Supergroup overlying Chuniespoort dolomite
d) Karoo Supergroup over Black Reef Formation.

The eastern margin of the area of investigation impinges on andesite of the Ventersdorp Supergroup. Dolerite typically covers older rocks in areas of the site. The residual profile is mantle in areas by a variable thickness of colluvial materials.

A major period of erosion in post-Ventersdorp Supergroup times, resulted in the development of a large Transvaal basin. Detritus and sediment that was to form the Black Reef Formation, were laid down in this basin followed by the carbonates that today constitute the Chuniespoort Group dolomites. The underlying floor of the basin was irregular, characterised by an undulating landscape. Eroding down of the deposits over time has exposed a complex geological environments. This site is characterised by the presence of exposures of "islands" of Ventersdorp andesite, referred to as inliers, completely surrounded by dolomite. Essentially this site straddles a transition zone from Ventersdorp, non-carbonate rocks in the east (off the basin) to carbonate rocks in the west (on the basin). Consequently the conditions on site in this transition zone are highly variable with andesite and deeply leached dolomite occurring within a short horizontal distance (<50m to 100m) of each

other. Faulting may have further complicated the geological environment in this transition zone.

The various lithological units are as follows:

LITHOSTRATIGRAPHIC UNIT	LITHOLOGY
Recent Deposits	Colluvium and alluvium
Jurassic	Dolerite
Karoo Supergroup	Shale and sandstone and weathered soil derivatives,
Chuniespoort Group, Transvaal Supergroup (Primarily the Oaktree Formation)	Dolomite and chert and weathered soil derivatives
Ventersdorp Supergroup	Andesite and weathered soil derivatives

The most predominant features observed during the drilling programme the on the site are as follows (Tables 1 to 3):

- The colluvial materials are typically variable in thickness e.g. Boreholes 3517 (2m), 4025 (2m), 4630 (4m), 5025 (2m), 5611 (3m), 6405 (5m), 6615 (4m), 6711 (1m), 7022 (3m), 7225 (2m). Alluvium is also intercepted e.g. a thick horizon is intercepted in Borehole 7220 (16m), etc, Tables 1 to 3 and Drawing IR801/1.

- A single borehole intercepted chert residuum, namely Borehole 6917 (5m to 10m below ground surface), Tables 3.

- Dolomite residuum (wad) is intercepted many of the boreholes drilled e.g. Borehole 5815 (10m), 6219 (9m), 6405 (9m), 6615 (8m), etc. Dolomite residuum is not recorded in some of the boreholes drilled e.g. Boreholes 5719, 6626, 6309, 6615, 7225, etc, Tables 1 to 3, Drawing IR801/1.

- Problematic conditions, including sample loss, air loss and cavitation are recorded in three of the boreholes drilled on site e.g. Boreholes 6219, 6720 and 7022, etc, Tables 1 to 3, Drawing IR800/1.

- Dolomite bedrock is typically intercepted at depths in excess of 12m and typically below 20m e.g. Boreholes 4312 (27m), 5605 (32m), 5815 (21m), 6124 (34m), 6313 (24m), 6405 (27m), 6711 (27m) etc, Tables 1 to 3.

- Dolerite is intercepted over large sections of the site e.g. Boreholes 4318, 4312, 4616, 4426, 5528, 5719, etc, Table 1 to 3.

- Karoo rocks are intercepted in a number of boreholes e.g. 5108, 5132, 5632, 5815, 6309, 6405, 6711, etc.

- Rocks of the Black Reef Formation are intercepted two boreholes, namely Boreholes 5014 and 5522.

- Borehole 6219 intercepts 5m of fill material e.g. Appendix 1 and Drawing IR793/1.

- All boreholes were dry. No groundwater was intercepted. The regional ground water is anticipated at approximately 1560m amsl on the site according to the Department of Water Affairs and Forestry data (refer Section 3). Consequently the ground water level is typically anticipated at 20m to 30m below ground surface.

7. DOLOMITE STABILITY CHARACTERISATION (Refer to Tables 1 to 3).

7.1 Characterisation Procedure used to analyse data.

The available information, including field data, borehole data and geohydrological information gathered during this investigation has been pooled and reviewed permitting the determination of the potential risk characterisation of the delineated site.

The method of risk characterisation utilised during this study is contained in the paper: "Proposed method for dolomite land hazard and risk assessment in South Africa." Journal of the South African Institution of Civil Engineering, Volume 43, Number 2, 2001.

The predominant mobilising agencies considered in this investigation are major groundwater level fluctuations (>6m), ingress water, ground vibrations and gravity.

Use is made of a generalised list of evaluation factors to evaluate the risk of sinkhole and doline formation. These factors are as follows:

- Receptacle development;
- Mobilising agencies, particularly ingress water from leaking services;
- Potential sinkhole development space;
- Nature of the blanketing layer;
- Mobilisation potential of the blanketing layer;
- Bedrock morphology.

Receptacles or disseminated receptacles refer to any voids or cavities in the dolomite bedrock or in the overburden capable of receiving mobilised materials. *Receptacles are assumed to be present as no reliable geophysical tool exists to determine the location of these features.*

The potential sinkhole development space, where used, refers to the expected maximum size sinkhole that conservatively can be expected to be generated if sustained ingress of water were to occur. This factor is related to the depth of the receptacles or disseminated receptacles.

The gravity survey, combined with borehole information strongly guides the appraisal of this factor. The nature of the material covering the receptacles, be they above or in the bedrock, determines the susceptibility of the subsurface material to erosion by ingress water. The presence of materials such as thick, clayey colluvial, alluvial and hillwash deposits, shales or intrusives, which can act as aquitards, serve to reduce the mobilisation potential and enhance the stability. In the case of dramatic groundwater level fluctuations the susceptibility of the soil material to mobilisation (i.e. consolidation settlement - doline formation, or ravelling and arch failure - sinkhole formation, due to pore pressure changes in soils), is strongly influenced by the position of the original groundwater level in the subsurface profile.

In view of the factors discussed above the following characteristics have been extracted from the gathered information during the assessment process:

- borehole position.
- collar elevation.
- depth to present groundwater level.
- depth to dolomite bedrock.
- position of the bedrock with respect to the groundwater level.
- nature and thickness of blanketing layer i.e. material type, penetration times, etc (Tables 1 to 3).
- thickness and nature of the soil materials above the groundwater level (original) i.e. type soil and potential geotechnical characteristics.
- thickness and nature of the soil materials below the present groundwater level.
- depth to potential receptacles (Tables 1 to 3).

The risk of sinkhole and doline formation is expressed in three broad categories, namely low, medium and high risk areas. The following reference to incidences, gives a perspective of the magnitude of problems encountered in each of the of risk zones in research areas. It is important to note that these figures are largely derived from developments that were not effectively and appropriately designed or maintained.

RISK CHARACTERISATION	GROUND-MOVEMENT EVENTS ANTICIPATED PER HECTARE IN A 20 YEAR PERIOD (STATISTICS BASED ON INAPPROPRIATE AND POOR SERVICE DESIGN AND MAINTENANCE)
LOW	0 up to and including 0.1 events per hectare anticipated but occurrence of events cannot be totally excluded.
MEDIUM	Greater than 0.1 and less than and equal to 1.0 events per hectare
HIGH	Greater than 1.0 events per hectare.

Based on the geotechnical information gathered, the site is zoned in the context of 8 Inherent Risk Classes. The eight standard Inherent Risk Classes used are as follows:

Class 1 Areas: Areas characterised as reflecting a low Inherent Risk of sinkhole and doline formation (all sizes) with respect to ingress of water.

Class 2 Areas: Areas characterised as reflecting a medium Inherent Risk of small sinkhole and doline formation with respect to ingress of water.

Class 3 Areas: Areas characterised as reflecting a medium Inherent Risk of medium sinkhole and doline formation with respect to ingress of water.

Class 4 Areas: Areas characterised as reflecting a medium Inherent Risk of large size sinkhole and doline formation with respect to ingress of water.

Class 5 Areas: Areas characterised as reflecting a high Inherent Risk of small sinkhole and doline formation (all sizes) with respect to ingress of water.

Class 6 Areas: Areas characterised as reflecting a high Inherent Risk of medium size sinkhole and doline formation with respect to ingress of water.

Class 7 Areas: Areas characterised as reflecting a high Inherent Risk of large sinkhole and doline formation with respect to ingress of water.

Class 8 Areas: Areas characterised as reflecting a high Inherent Risk of very large size sinkhole and doline formation with respect to ingress of water.

In some instances, the Inherent Risk Classes are indicated with the primary zone description given first followed by a suffix in brackets. The primary Inherent Risk Class describes the predominant characterisation of the zone and the suffix describes the characterisation of anticipated sub-areas within the zone. As an example a designation of 8(4) indicates that the zone predominantly displays a high Inherent Risk for very large sinkhole and doline formation with anticipated pockets or small areas of Class 4 i.e. displaying a medium risk for medium size sinkhole and doline formation

7.2 Stability Characterisation of the site (See Tables 1 to 3, Drawing IR801/1).

The borehole data and geohydrological information gathered during this investigation of the site has been pooled and reviewed, permitting the formulation of a perspective of the subsurface conditions on the site. As indicated in Section 7.1, ingress of water and groundwater level draw down should be viewed as the primary triggering mechanisms for sinkhole and doline formation.

Dolomite Stability Zone 1: Area characterised as reflecting no to low Inherent Risk of sinkhole and doline formation with respect to ingress of water and ground water level draw down, i.e. No to Inherent Risk Class 1.

This zone is characterised by the following subsurface conditions:

- Gravity gradient area primarily falling from east to west. It is anticipated that this zone represents an interfacies area where the Ventersdorp Lava and the Chuniespoort dolomite underlain by the Black Reef Formation are in contact. The contact zone is complex and three-dimensional, with faulting resulting in complex spatial interrelationships. "Islands" of Ventersdorp lava i.e. inliers "protrude" through the area of Chuniespoort dolomite.
- Boreholes in this zone intercept thick horizons of dolerite or Karoo overlying either Chuniespoort Group dolomite, Black Reef quartzite or Ventersdorp andesite e.g. Boreholes 4426, 4630, 5025, etc, Tables 1 to 3.
- Andesite is intercepted at shallow depth in a number of boreholes drilled e.g. Boreholes 3517, 4025, 5025, etc.
- A variable, but generally thin horizon of colluvium covers the residual materials e.g. 4m in Boreholes 4630 and 4426, 2m in Boreholes 3517, 5025 and 4025, Tables 1 to 3, Drawings IR801/1 and 2.
- The subsurface profile represents a transition zone from a non-carbonate rock in the east to a carbonate rock in the west. Where Black Reef dolomite residuum (wad) is present or Oaktree Formation dolomite and weathered soil derivatives, the profile may show a low mobilisation potential. Where the underlying rock type is andesite, no risk of sinkhole or doline formation exists. Consequently this transition zones is designated as reflecting no to

low risk of sinkhole and doline formation with respect to ingress of water and ground water level draw down i.e. No-Inherent Risk Class 1.

Dolomite Stability Zone 2: Area characterised as reflecting a low Inherent Risk of sinkhole and doline formation with respect to ingress of water and ground water level draw down i.e. Inherent Risk Class 1. This zone is characterised by following subsurface conditions:

- This zone occupies gravity gradient areas (Drawings IR801/1).
- Variable thickness of Karoo sandstone and shale cover the residual dolomite profile e.g. 3m to 50m in Borehole 5108, 1m to 47m in Borehole 5132, 3m to 50m in Borehole 5611, Table 1 to 3 and Drawings IR801/1 and 2.
- Typically thick, but variable, horizons of dolerite may overlie the dolomite e.g. 4m to 22m in Borehole 4318, 8m to 27m in Borehole 4312, 1m to 50m in Borehole 4616, 1m to 24m in Borehole 4919, 2m to 50m in Borehole 5528, etc, Tables 1 to 3.
- Colluvium of variable thickness blankets the Karoo and dolerite e.g. 4m in Borehole 4318, 8m in Borehole 4312, 1m in Boreholes 4616, 4919, 5132, 5522 and 6124, 3m in Borehole 5611, Tables 1 to 3.
- Depth to dolomite bedrock is typically deep, e.g. 27m in Borehole 4312, 32m in Borehole 5605, >50m in Boreholes 4616, 5528, 5611 and 5632, Drawings IR801/1 and 2.
- The groundwater level is anticipated to be located within dolerite, Karoo or dolomite rock.
- All boreholes drilled in this zone were dry.
- The Karoo rocks, dolerite and weathered soil derivatives are anticipated to act as aquitards. These materials have low permeability's and poor internal drainage characteristics. The underlying dolomite and chert (limited in occurrence) residuum is typically characterised by good internal drainage characteristics. Infiltrating stormwater and water from leaking services is not able to trigger subsurface erosion as the Karoo/dolerite materials serve to retard or preclude rapid water infiltration. Consequently, the mobilisation potential of the blanketing layer is assessed as low and the PDS as very large due to the depth of potential receptacles. This zone is characterised as reflecting a low Inherent Risk for sinkhole and doline formation with respect to water ingress i.e. Inherent Risk Class 1.

Dolomite Stability Zone 3: Area characterised as reflecting a low to medium Inherent Risk of medium size sinkhole and doline formation with respect to ingress of water and a low Inherent Risk with respect to ground water level draw down i.e. Inherent Risk Class 1-4.

Typical sub-surface conditions:

- This zone occupies a gravity trough and gradient area (Drawing IR801/1).
- Colluvial cover is variable in thickness e.g. Boreholes 5719 (2m), 5815 (0m), 6309 (2m), 6313 (4m), 6405 (5m), 6615 (4m), 6626 (4m), etc, Tables 1 to 3 and Drawing IR801/1.

- Chert residuum only constitutes part of the blanketing layer around Borehole 6917, Table 3. Chert residuum is absent elsewhere in this zone.
- Dolomite residuum (wad) is intercepted in the majority of boreholes in this zone e.g. Boreholes 5815 (11m to 21m), 6313 (20m to 24m), 6405 (18m to 27m), 6615 (12m to 20m), etc, Tables 1 to 3, Drawing IR801/1.
- No problematic conditions are recorded in the boreholes drilled in this zone.
- Karoo or dolerite is intercepted in boreholes in this zone e.g. Boreholes 6309 (2m to 50m), 6313 (4m to 20m), 6405 (5m to 18m), 6615 (4m to 12m), 6711 (1m to 33m), etc, Table 1 to 3.
- Dolomite bedrock occurs at intermediate depths e.g. Boreholes 5815 (21m), 6313 (24m), 6405 (27m), 6711 (33m), 7225 (26m) etc, Tables 1 to 3.
- All boreholes drilled in this zone were dry. Boreholes often terminated within aquicludes such a dolerite or Karoo. However, the projected OWL is anticipated to generally be within the dolomite bedrock.
- Where the blanketing layer consists of colluvium, dolomite residuum and in isolated areas, chert residuum, the layer is anticipated to be characterised by good internal drainage characteristics. Aquitards or aquicludes occur extensively in this zone in the form of horizons of dolerite or Karoo. The mobilisation potential of the blanketing layer consisting of colluvium, chert and chert residuum is anticipated to be medium and that where the aquitards (Karoo and dolerite) are present low. The PDS is estimated as large, with potential receptacles within the dolomite residuum and in the deeper dolomite. Boreholes are typically recorded as dry or fluctuations are anticipated within rock. Consequently this zone is characterised as reflecting a low to medium Inherent Risk of sinkhole and doline formation with respect to water ingress and a low Inherent Risk with respect ground water level draw down i.e. Inherent Risk Class 1-4.

Dolomite Stability Zone 4: Area characterised as reflecting a high Inherent Risk of large to very large sinkhole and doline formation with respect to ingress of water and ground water level draw down i.e. Inherent Risk Class 7-8.

This zone is characterised by the following subsurface conditions:

- Gravity low and gradient areas in the western sectors of the site (Drawings IR801/1 and 2).
- Colluvial cover is present e.g. 5m in Boreholes 6917, 3m in Borehole 7022, 16m in Borehole 7220, Tables 1 to 3 and Drawings IR801/1 and 2).
- Dolerite and Karoo is essentially absent in the blanketing layer e.g. 0m in Boreholes 6720, 6917 and 7022.
- The dolomite bedrock is typically located at greater depths than in the Zone 1 area e.g. 32m in Borehole 2, 22m in Borehole 66, 21m in Borehole 194, 46m in Borehole 364, 29m in Borehole 1073, etc Tables 1 to 5, Drawings IR793/1 and 2.

- The blanketing layer largely consists of thick horizons of dolomite residuum (wad) e.g. 5m to 14m in Borehole 6219, 5m to 18m in Borehole 6720, 10m to 16m in Borehole 6917, 3m to 17m in Borehole 7220, etc, Tables 1 to 3.
- Problematic conditions are encountered in boreholes in this zone e.g. Boreholes 6720 (5m to 18m), 6917(10m to 16m), 7022 (3m to 17m), 7220 (16m to 27m), etc, Appendix 1.
- All the boreholes drilled in this zone were dry. The projected OWL is anticipated within and above the dolomite bedrock in this zone
- Where the blanketing layer consists of dolomite residuum (wad) particularly at shallow depth or in substantial horizons, very good internal drainage characteristics are anticipated. Consequently it is anticipated that ingress of water will most likely result in subsurface erosion and sinkhole or doline formation. The mobilisation potential of the dolomite residuum (wad) rich blanketing layer is assessed as medium to high. The presence of problematic conditions and cavitation at shallow depth may indicate incipient sinkhole formation. The PDS is anticipated to be large due to the anticipated depth of potential receptacles. Consequently this zone is characterised as reflecting a high Inherent Risk of sinkhole with respect to water ingress i.e. Inherent Risk Class 7-8.

8. CONCLUSIONS

8.1 Risk Characterisation (Drawings IR801/1 and 2, Tables 1 to 3).

These investigations have been carried out in accordance with the standards and requirements set out in Generic specification GFSH-2, National Department of Housing Specification, "Geotechnical site investigations for housing development." Based on the criteria discussed in Section 7 of this report, the stability of the site has been characterised in terms of four 'Dolomite Stability Zones'. The characterisation of the stability of site provides valuable information for township and service design and maintenance. Urban development normally results in a disturbance of the metastable conditions in the dolomite environment. Consequently, factors such as the basic design of services, the final township layout, construction and service installation procedures, and ongoing infrastructure maintenance programmes are key elements in the overall strategy to reduce the probability of generating ground movement events and ensuring safe and sustainable development. These zones are defined as follows:

- ***Dolomite Stability Zone 1:*** Area characterised as reflecting no to low Inherent Risk of sinkhole and doline formation with respect to ingress of water and ground water level draw down, i.e. No to Inherent Risk Class 1.

- ***Dolomite Stability Zone 2***: Area characterised as reflecting a low Inherent Risk of sinkhole and doline formation with respect to

ingress of water and ground water level draw down i.e. Inherent Risk Class 1.

- ***Dolomite Stability Zone 3:*** Area characterised as reflecting a low to medium Inherent Risk of medium size sinkhole and doline formation with respect to ingress of water and a low Inherent Risk with respect to ground water level draw down i.e. Inherent Risk Class 1-4.

- ***Dolomite Stability Zone 4***: Area characterised as reflecting a high Inherent Risk of large to very sinkhole and doline formation with respect to ingress of water and ground water level draw down i.e. Inherent Risk Class 7-8.

8.2 NHBRC Dolomite area Designations

The NHBRC Dolomite Area Designations for the dolomite stability zones identified on the site are as follows:

DOLOMITE STABILITY ZONE	NHBRC D DESIGNATION (RESIDENTIAL)
1	D2
2	D2/D3 (Density related)
3	D3
4	D4

The D designation as referred to above, is defined in Table 8, Section 2, Part 1 of the NHBRC Home Building Manual, Part 1 and 2, Revision 1, dated February 1999. The definition of the selected Dolomite area Designations are as follows:

Dolomite Area Designation D	Description
D1	No precautionary measures are required to permit the construction of housing units due to the geological setting.
D2	The risk of sinkhole and doline formation is adjudged to be such that only general precautionary measures, which are intended to prevent the concentrated ingress of water into the ground, are required to permit the construction of housing units.

D3	The risk of sinkhole and doline formation is adjudged to be such that precautionary measures, in addition to those pertaining to the prevention of concentrated ingress of water into the ground, are required to permit the construction of housing units.
D4	The risk of sinkhole and doline formation is such that precautionary measures cannot adequately reduce the risk to acceptable limits so as to permit the construction of housing units, or the precautionary measures which are required are impracticable to implement.

9. RECOMMENDATIONS

9.1 *Appropriate development in relation to the risk characterisation.*

Recommendations on appropriate development of the site and water precautionary measures are provided in relation to the risk characterisation as part of the Dolomite Risk Management on the site. Based on the stability zonation of the site, alternative land uses may typically be considered in each delineated sub-area or Inherent Risk Class Area provided that appropriate remedial and exceptionally stringent water precautionary measures, as outlined in this report are followed. The recommendations with respect to Building Classes and Inherent Risk Classes as reflected in Section 4.4 of SANS10400B are as follows:

Building classes[1)]	Inherent Risk Class
All classes	1
A, B (light only), C, D (light (dry) only), E, F, G, H, J	2
A, B (light only), C, D, (light (dry) only), E, F, G, H, J	3
A, B (light only), C, D (light (dry) only), E, F, G, H, J	4
A, B (light only), C, D (light (dry) only), E (if no safer alternative available), F,G,H (depending upon densities and mitigation measures that are adopted.), J	5
A5, B (light only), D (light (dry) only), G1 (with appropriate remedial measures), J	6
J3, J4	7
No classes	8
1) Refer Table 1 of Part A of the National Building Regulations	

Based on the above-listed contents of the "Application of the National Building Regulations", the following recommendations are made with respect to the Dolomite Stability Zones identified on this site:

DOLOMITE STABILITY ZONE	APPROPRIATE DEVELOPMENT
1	Residential (no density constraints), commercial or light (dry) industrial development.
2	Residential (max. 40-60 units/ha), commercial or light (dry) industrial development
3	Residential, commercial or light (dry) industrial development. Minimum stand size 300m^2
4	Selected commercial or light (dry) industrial. No residential development. SANS10400 only allows for very selected commercial development in this risk class.

9.2 The Council for Geoscience and NHBRC requires further detailed work on all Residential 2 and 3 sites as follows:

- Utilise existing 30m grid gravity to position boreholes.
- Drill additional boreholes based on geophysics and proposed placement of structures.
- Determine/confirm the dolomite risk characterisation, appropriate layout and services design.
- Determine Dolomite Area Designations and Soil Site Classes.
- Determine acceptable development coverage or density.
- Develop a Dolomite Risk Management Strategy specifically for a Residential 2 and 3 developments. This strategy is to be provided to a future body corporate.

9.3 Commercial and light (dry) industrial development may be planned in the Dolomite Stability Zone 1 to 3 areas and only selected commercial uses in Dolomite Stability Zone 4 areas. New commercial and light (dry) industrial sites are subject to individual detailed dolomite stability and soils investigations to:

- Detailed footprint investigations are required for design purposes. It should be understood that such footprint investigation may prove negative.
- Provide appropriate water precautionary measures.
- Provide appropriate foundation design measures.
- Outline risk management requirements.

9.4 The Department of Mineral and Energy Affairs (DME) must comment on the mining constraints on this site.

9.5 The following additional recommendations are made:

- A Dolomite Risk Specialist should actively assist in the process of developing an appropriate master plan for the site.
- In addition, the Specialist is required to sign confirming that final layouts for the various new townships established on the site conform to the stability zonation contained in this report.
- All service trenches in the development must be inspected during construction to permit further detailed verification of soil and stability conditions e.g. attention must be paid to the presence of potential paleosinkhole conditions in trenches and open works.
- The Specialist must document the findings of the geotechnical monitoring process in a Construction or Completion Report. This work must be executed in accordance with the scope of work for Phase 2 investigations outlined in the Generic Specification GFSH-2.
- It should be clearly understood that during the geotechnical monitoring process (GFSH-2, Phase 2 work) the securing of additional infill data may lead to the identification of geotechnically problematic sub-areas, necessitating:
  - Additional precautionary measures.
  - Additional remedial measures.
  - Changing the D Designation of certain stands from D3 to D4 or D2 to D3, etc.

9.6 *Monitoring of ground water levels.*

Ground water management must form an integral part of Ekurhuleni's Dolomite Risk Management Strategy. The OWL is located at less than 20m to 30m below ground surface. Experience indicates that where the OWL is located at shallow depth (less than 30m), ground water level draw down may generate the most severe ground subsidence.

Consequently the short, medium and long-term risk management of the site requires monitoring of the ground water situation.

9.7 *Water precautionary measures* ***for residential areas***

The general precautionary measures given below apply all residential developments and represent the minimum recommendations of the NHBRC for the Dolomite Stability Zones delineated on the site (Drawing IR801/2).

General

a. The site and surrounding area shall be shaped to permit the ready drainage of surface water and to prevent ponding.

Drainage ports should be incorporated in boundary walls particularly at the lowest point of the site, to permit the passage of surface runoff.

b. Natural ponds and watercourses shall be rendered impervious.

c. Sanitation systems shall not incorporate soak aways.

d. Backwash and other water from swimming pools, shall be discharged into either the storm water or drainage systems as required by the local authority.

The dolomitic stability over the route of any bulk water-bearing service should be evaluated.

Township services

e. Underground services shall be designed and constructed so as to minimise maintenance requirements and any potential leakage points in wet services and shall, as far as possible, be designed to avoid possible disturbance of the underground environment.

f. The relevant provision of SABS 1200 DB, L, LB, LC, LD and LE shall be observed in the installation of all underground services. No rocks in top layer.

g. The backfilling to service trenches and other excavations shall, except in rock, not be more permeable than the surrounding material.

h. The stormwater drainage and sewerage system shall incorporate measures to ensure watertightness of conduits and other compartments. Whenever possible, storm water should be channelled in lined, surface canals.

Concrete non-pressure pipes should be of the spigot and socket type with rubber ring seals. Joints in box culverts, channels, etc. should be sealed.

i. Storm water drainage conduits shall be constructed at gradients, which will not permit the deposition of silt, or sand, of the type present in the catchment area.

j. Water mains shall be laid only in road reserves.

k. All stormwater sewerage and water pipes and channels must be watertight. All laid drainage and sanitary sewer pipes

should be tested for leakage using the air test (see NBRI Info. Sheet X/BOU 2-34) on installation. The responsible local authority should have a system whereby follow-up tests for leakage are carried out and the results monitored.

l. The NHBRC recommends that water piping materials should be one or more of the following:

- pipes of 75mm and larger diameter:
  - high impact PVC pipes with vitaulic joints.
  - steel pipes with internal and external corrosion protection or other flexible (as defined in SABS 0102 Part 1) water pipes with flexible, self anchoring connections.

- pipes having a diameter of less than 75mm:
  - HDPE type IV piping
  - polypropylene piping

The piping used in mains and communication pipes should be flexible, joints should be minimal in number and, be of the flexible, self anchoring type, i.e. not reliant on thrust blocks or friction for their anchorage.

m. Where feasible, provision for future connections shall be made in order to minimise the cutting into pipes to provide such connections.

n. Provision shall be made in all water-bearing pipelines to accommodate any potential differential movements without causing the pipeline or joints to leak. Also use flexible coupling either side of manholes.

o. Road surfaces shall be located sufficiently low so as to permit the drainage of erven onto them.

p. Roadways, which have a gradient of less than 1:80, shall be surfaced/sealed.

q. Where un-surfaced roads are the sole storm water system in a township, the roadways, which act as major storm water collectors, shall be surfaced.

r. The velocity of the 1 in 20 year storm water, flowing along un-surfaced roadways shall not exceed 1,5 m/s.

s. Ensure that roadways are in fact placed below site level so as to facilitate drainage.

t. During construction excavations should be opened and closed as rapidly as possible. Avoid leaving trenches open over weekends or holidays.

u. Berms should be constructed on either side of the trenches to prevent the inflow of water during storms.

Plumbing

v. Water pipe entries into the buildings shall be in accordance with Figure S3 in Parts 1 and 2, NHBRC Home Builders Manual, Revision 1, February 1999.

w. All sewer and water pipes and fittings shall be provided with flexible, watertight joints.

x. No plumbing and drainage pipes shall be placed under floor slabs, as far as is practicable.

y. The fall of the trenches shall be away from the buildings.

z. Pipes through walls shall be sleeved to permit relative movement.

aa. WC pans shall be provided with a flexible connection at the junction with the outlet pipe.

bb. The selection of piping material shall take cognisance of corrosion (both external and internal).

cc. Water pipes shall have a minimum cover of 500mm.

dd. Wherever practical, the fall of trenches shall be away from buildings and shall not be excavated along the length of housing units within the first 3,0m beyond the perimeter of such units.

Site precautions

ee. A 1,5m wide impervious apron slab shall be provided around the houses.

Water should be distributed away from the foundations and should drain freely, without ponding, into the stormwater system.

ff. In order to deal with rain water run off from the roofs of structures the following is recommended:

- If guttering is required by the local authority, then the down pipes should discharge into a lined or precast furrow. This furrow should discharge the water at least 1,5 m away from the structure, where it should drain freely, without ponding to the storm water system.

- If no guttering is to be utilised then it is recommended that an 1,0 m sealed surface be cast along those walls of the structure where water will be discharged from the

roof. Water will cascade off the sloping roof onto the slab and be distributed away from the foundations and should drain freely, without ponding, into the storm water system.

gg. The ground immediately around buildings shall be shaped to fall in excess of 75mm over the first 1,5m beyond the perimeter of the building. Apron slabs, shall have the same fall (NHBRC recommendation).

hh. Brick and precast concrete walls must be so designed as to provide drainage ports at ground level to permit the passage of water.

ii. Placement of wet services below the footprint of structures must be avoided.

jj. Encasement of pipes in concrete or soilcrete should preferably be avoided. Place pipes in sleeves or lined channels.

kk. As many services as possible should be placed within a single trench.

ll. The installation of swimming pools may only be considered with the permission of the Town Council.

mm. Experience on dolomite indicates that blasting may lead to severe disturbance of the metastable dolomite environment giving rise to sinkhole formation. Consequently, if blasting is necessary it is essential that appropriately experienced blasters be approached to determine the particular method specification for blasting, regarded as appropriate in the context of the geological conditions.

Boreholes for groundwater abstraction

nn. Permission of the local authority should be sought prior to sinking boreholes for groundwater abstraction. (Careful consideration of permission to sink boreholes as a control on dewatering. If the watertable is above bedrock, a blanket ban on exploitation of the groundwater should be imposed. Approval should be subject to an evaluation of the implications by a Dolomite Risk Specialist).

9.8 Water Precautionary Measures for Commercial and light dry industrial development.

The measures outlined above plus the following measures will pertain to commercial and light (dry) industrial development. The SANS 1936 standard that will be utilised on dolomite areas is currently being compiled. It is recommended that Competent Persons (Civils) responsible for services design in this development also consult the minimum standards outlined in the **Department of Public Works'**

Consultants Manual (Reference PW344) entitled: "Department of Public Works: Appropriate development of infrastructure on dolomite: Guidelines for consultants", dated August 2004 and more recently July 2006. These measures apply to design, construction and maintenance work. The precautionary measures with respect to high risk areas are of particular relevance. An extract of the primary, current standard precautionary measures contained in the Manual are provided in Appendix 4 of this report for easy reference and to ensure that those reading this report are aware of the minimum standards of work required in the Inherent Risk Class identified on the site. However, it is re-iterated that the all professionals and technical personnel involved in the design, construction and maintenance of this development should read and be fully aware of the contents of the Manual.

Water is a triggering mechanism, in the majority of cases, of distress in dolomite/limestone areas. It is therefore imperative that the concentrated ingress of water into the ground be avoided at all times, including the construction period.

9.9 *This development should be included in the Dolomite Risk Management Strategy of the Ekurhuleni Council. The Council for Geoscience and the NHBRC will require proof of the existence of such a Risk Management Strategy.*

9.10 Pro-active maintenance of waterbearing services and other infrastructure.

The generally variable subsurface conditions noted during these investigations, necessitates the introduction of a pro-active maintenance strategy for waterbearing infrastructure. This maintenance strategy and precautionary measures provided above in this report should be adhered to in order to reduce the probability of the occurrence of ground movement events. *It should be emphasised that the formation of sinkholes and dolines can only be prevented by the implementation of a strict maintenance system.*

The waterbearing infrastructure, i.e. the water reticulation, sewers and stormwater systems should be superimposed on the stability risk characterisation map of the township area. Priority in terms of vigilance, general maintenance, repair of leaks and expenditure of funds on upgrading or service replacement should be as follows:

- Priority 1 Areas: Zone 4.
- Priority 2 Areas: Zone 3.
  Priority 3 Areas: Zone 2.
- Priority 4 Areas: Zone 1.

In this manner a prioritised, co-ordinated and proactive strategy for the maintenance and review of water infrastructure can be developed for the site area. Although the primary objective of such a maintenance

strategy is to reduce the probability of ground movement there are other important benefits, inter alia:

- a reduction in bulk water wastage by timeous maintenance,
- avoiding crises expenditure
- reducing pollution of the aquifer
- involving the community in order to enhance the exchange of information
- developing and evaluating performance criteria in conjunction with the potential stability characterisation, permitting the identification of sub-areas in the township which should be prioritised for service maintenance or replacement.

9.11 Data base of ground movement events and structural damage

In view of ground movement events (sinkholes/dolines) reported in the areas surrounding the site, it is strongly recommended that a data base of these events and any structural damage that may occur in future, should be established. Detailed historical records of this nature are most useful in developing a clearer perspective on the stability situation in the town and the installation and management of a pro-active maintenance strategy. This data should be incorporated in Ekurhuleni's Dolomite Risk Management Strategy.

9.12 Site specific investigations must be conducted on sites earmarked for major structures (commercial structures, shops etc) prior to design finalisation and construction.

9.13 Blasting during construction and service installation.

Experience elsewhere on dolomite indicates that blasting may lead to severe disturbance of the metastable dolomite environment giving rise to sinkhole formation. Consequently, if blasting proves essential the following recommendation is made: Emphasis should be placed on minimal disturbance of the environment in order to reduce the likelihood of triggering events. It is essential that appropriately experienced blasters or companies are approached to determine the particular method specification for blasting, regarded as appropriate in the context of the geological conditions.

9.14 Old excavations, borrow areas, rubbish pits, french drains, etc.

Old excavations, rubbish pits, etc., may exist on site. These must be marked, if exposed during construction and will require special rehabilitation works to be programmed into the main development programme. Particular attention must be paid to the delineation of such features during the GFSH-2, Phase 2 investigation in new developments on this site.

9.15 The following generic recommendation is provided as a **general guideline** for the design of foundations for residential structures in the Dolomite Stability Zone 3 areas and in instances in the Dolomite

Stability Zone 2 (D3) areas. Final design parameters will be determined after completion of the footprint investigations for non-residential structures.

The footprint of each structure should be subjected to specific geotechnical investigations, including both dolomite stability and surficial founding medium assessments for appropriate foundation and precautionary measures design. It should be anticipated that such investigations may encounter problematic conditions of some footprint areas. Consequently it is essential that a dolomite specialist be involved in the detailed footprint investigations to ensure that appropriate remedial actions or measures are selected. These recommendations are to be adapted in accordance with footprint-specific conditions:

- It is generally recommended, as a minimum, that structures be placed on rationally designed concrete re-inforced raft foundations. These foundations should have the following Performance Requirements:
  - A sinkhole having a **nominal** diameter 5 m occurring anywhere beneath, the or adjacent to, the building will not envelop the building or result in toppling or sliding failure of the building (or portion of the building) into such a sinkhole.
  - The design is such that in the event of catastrophic loss of support, there is sufficient time for occupants to safely escape from the buildings after the occurrence of the sinkhole, and the level of expected damage associated with soil movements unrelated to sinkhole formation in near-surface horizons is kept within reasonable limits.
  - Design principles:
    - The reinforced concrete foundation shall be designed and constructed in such a manner that the building satisfies the performance requirements listed above.
    - The walls and floor of the structure shall withstand loss of support without collapsing into a sinkhole occurring anywhere within the footprint of the building over an area having a **minimum diameter** of 5 m.
    - The reinforced concrete foundation should, when subjected to a loss of support due to a **minimum diameter** 5m sinkhole and carry the proposed loads within that section of the structure and have deflection limits not more severe than 1:250, permitting safe evacuation of people. It must be noted that these deflection limits will result in severe structural damage. This limit is provided for safety reasons. From a financial risk control and structural insurance perspective the Code of Practice and/or NHBRC requirements on acceptable Level of Damage must be followed, provided these are not less conservative than the above requirements.

- It should be understood that sinkholes are typically surrounded by an outer peripheral zone of less catastrophic ground subsidence.
- The intention of these rationally designed foundations is to permit safe evacuation of people.

In addition:

- Services are not to be placed below the footprint area of any buildings.
- Storm water should be kept above ground in watertight stormwater canals.

9.16 If sites are to be sold to other parties for development, it is recommended that an 'escape clause or substantive clause' be inserted in the agreement of sale. The purchasers of commercial/industrial sites should be advised that the area is located on dolomite and that detailed footprint and design investigations may reveal complex or problematic conditions requiring remedial work or indicating a level of risk unacceptable to the seller or the purchaser. It is essential that perspective purchasers of **residential properties** clearly understand that further phases of work (e.g. GFSH-2, Phase 2) are required that may change the Dolomite Area Designation from D2 to D3 or from D3 to D4. Agreements should only be ratified in the event of the purchaser being satisfied that the land bears the approval of the NHBRC in the case of residential development.

9.17 This report should be read in conjunction with Intraconsult report IR801 Soils, dated 10 November 2006, entitled: "GFSH-2, Phase 1 Soils investigations of the proposed Leeuwpoort Development."

10. GENERAL RECOMMENDATION

These findings are based upon our interpretation of the data recovered during these investigations. While every effort has been made to determine overall ground conditions on this site, poorer sub-areas may have been missed. For this reason, it is recommended that a Dolomite Risk Specialist should undertake the Phase 2 work required in accordance with the Generic Specification GFSH-2. The specialist should have access to open works and excavation works for services, etc. during the development of this site in order to confirm the findings described in this report.

INTRACONSULT ASSOCIATES
2 MULBERRY HILL OFFICE PARK
DAINFERN VALLEY
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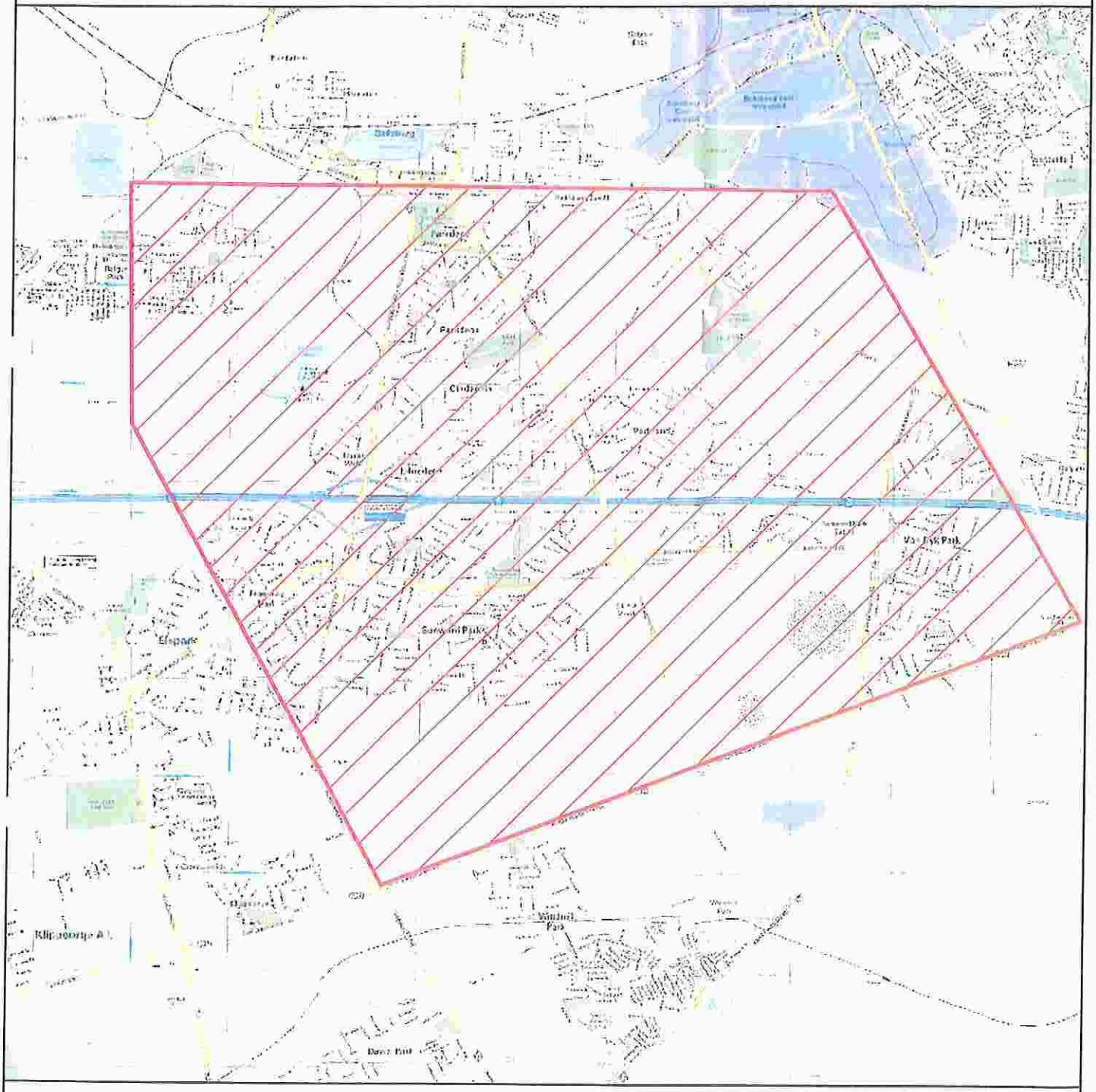
TEL: 011-469-0854
FAX: 011-469-0961
e-mail: <intrac@mweb.co.za>

FIGURE 1

LEEUWPOORT 113 I.R.
LOCALITY PLAN



THE SITE

NOT TO SCALE

URBAN DYNAMICS
37 EMPIRE ROAD
PARKTOWN
P.O. BOX 291803
MELVILLE
2109
TEL: (+27 11) 482-4131
TEL: (+27 11) 482-9959

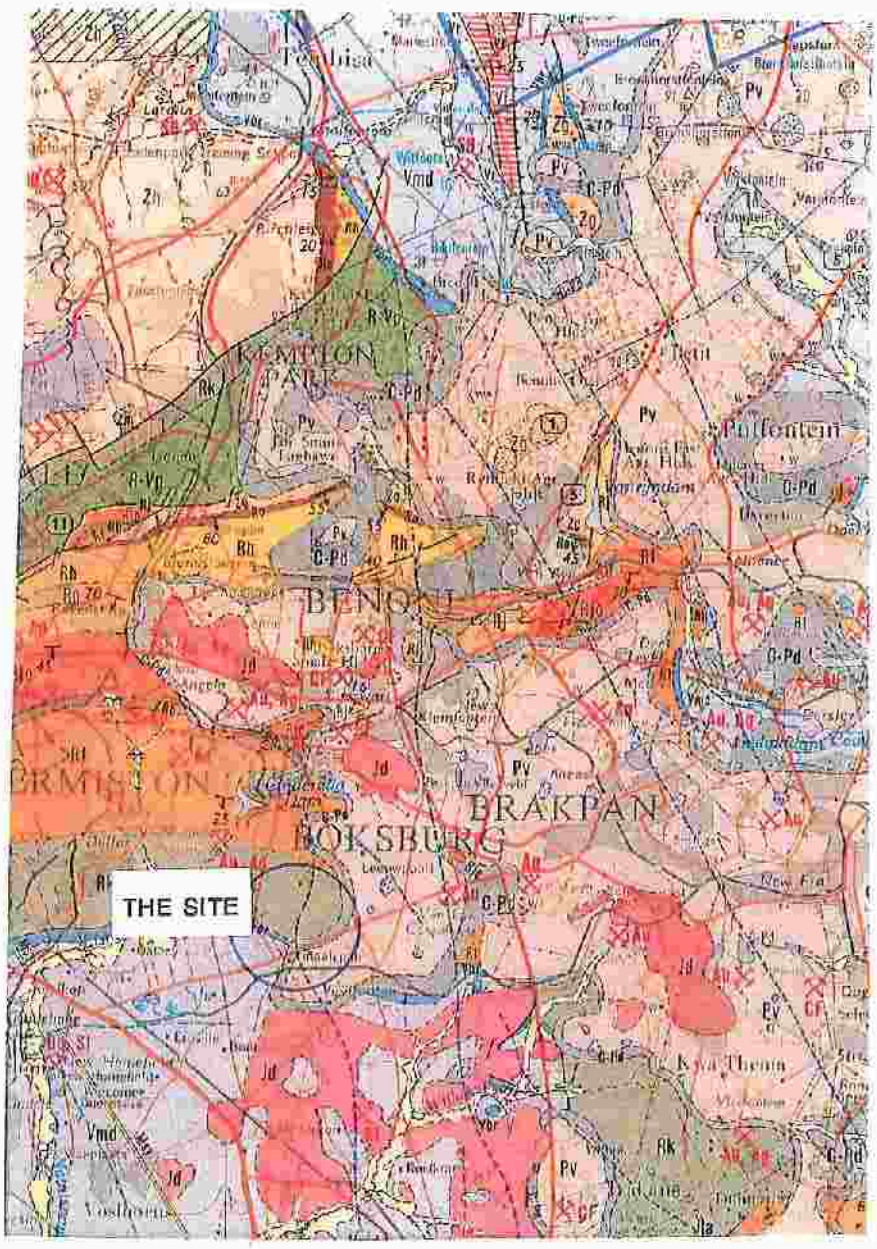
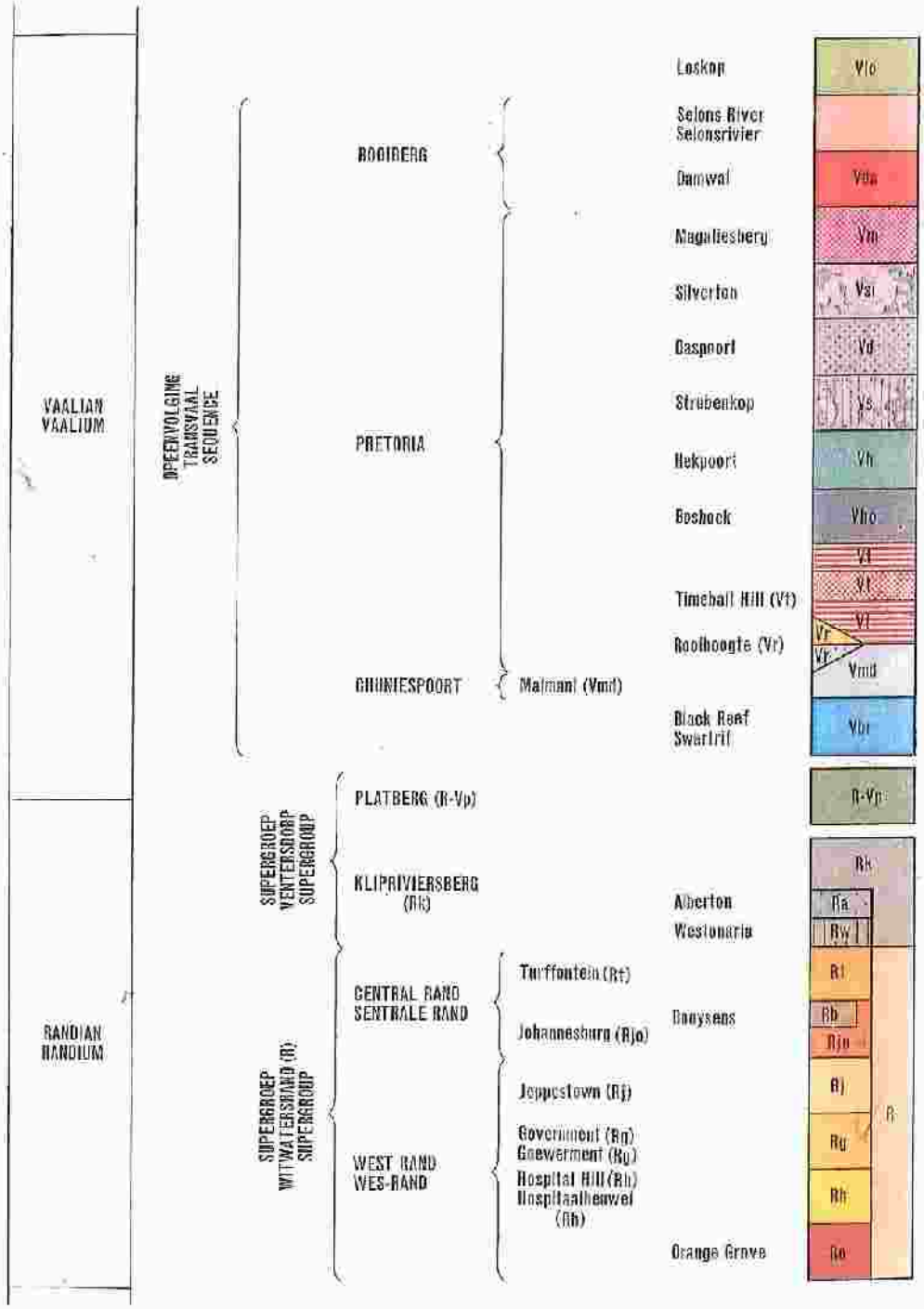
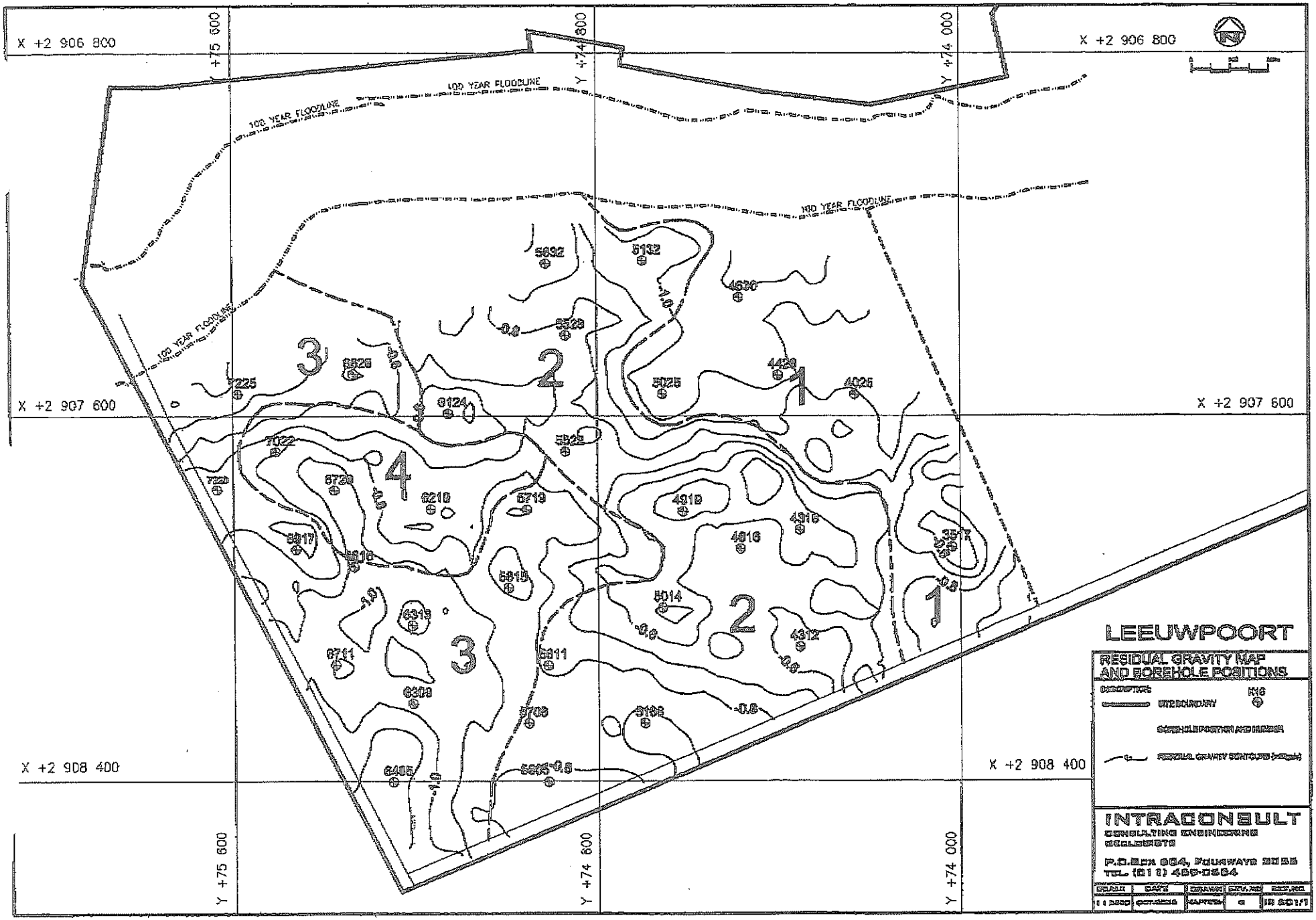
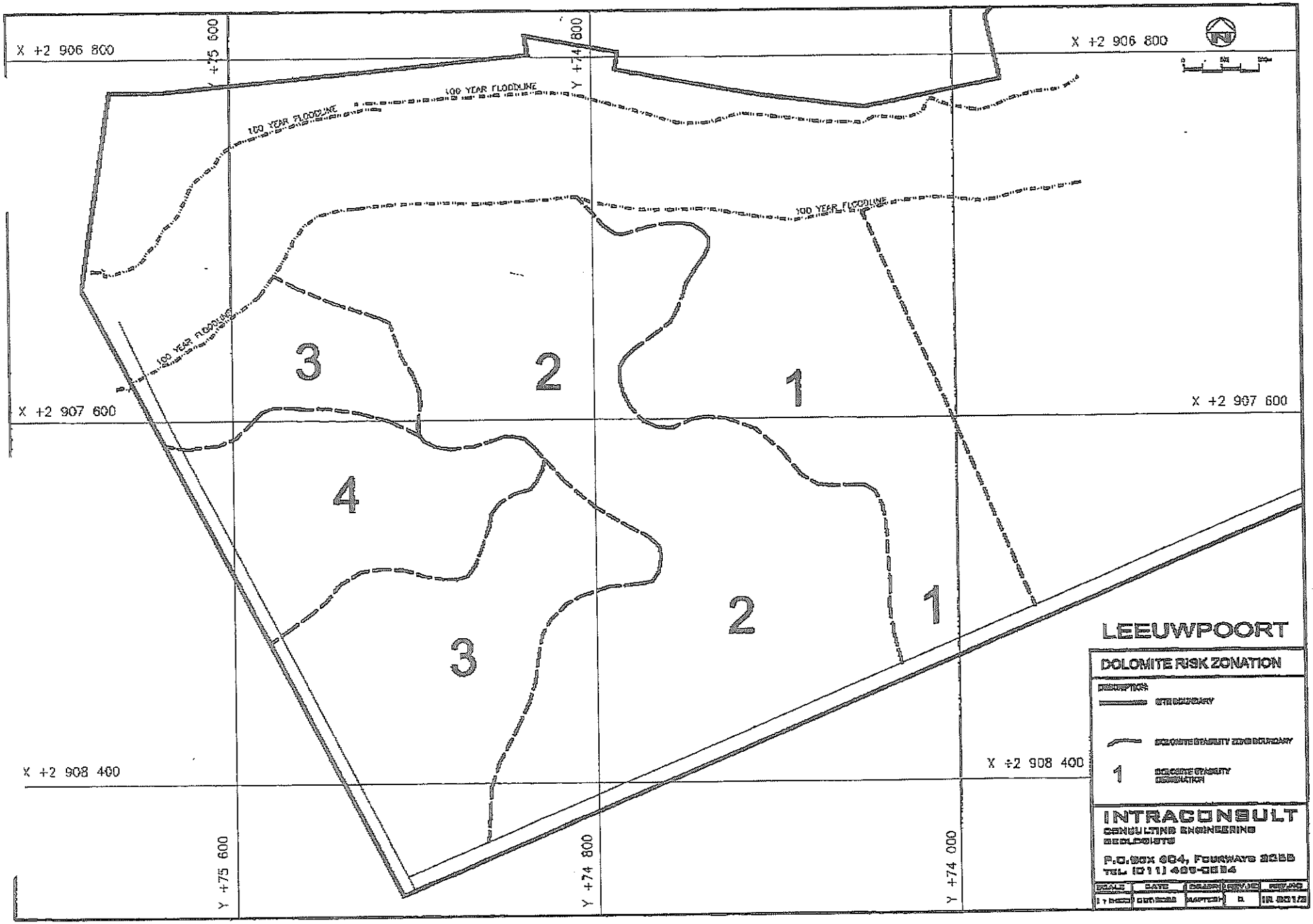


FIGURE 2 : REGIONAL GEOLOGY – 1:250 000 GEOLOGICAL SERIES - SHEET 2628 EAST RAND LEEUWPOORT

IR801R


VAALIAN
VAALIUM
RANDIAN
RANDIUM
OPEENVOLGING TRANSVAAL SEQUENCE
SUPERGROEP VENTERSDORP SUPERGROUP
SUPERGROEP WITWATERSBAND (R) SUPERGROUP
ROOIBERG
PRETORIA
CHUNIESPOORT
PLATBERG (R-Vp)
KLIPRIVIERSBERG (Rk)
CENTRAL RAND SENTRALE RAND
WEST RAND WES-RAND
Malmani (Vmd)
Turffontein (Rt)
Johannesburg (Rjo)
Jeppestown (Rj)
Government (Rg)
Gouvernement (Rg)
Hospital Hill (Rh)
Hospitaalheuwel (Rh)
Loskop
Selons River
Selonsrivier
Damwal
Magaliesberg
Silverton
Daspoort
Strubenkop
Hekpoort
Boshoek
Timeball Hill (Vt)
Rooihoogte (Vr)
Black Reef
Swartrif
Alberton
Westonaria
Booysens
Orange Grove
Vlo
Vda
Vm
Vsi
Vd
Vs
Vh
Vho
Vt
Vr
Vmd
Vbr
R-Vp
Rk
Ra
Rw
Rt
Rb
Rjo
Rj
Rg
Rh
Ro
R


X +2 906 800
X +2 907 600
X +2 908 400
Y +75 600
Y +74 800
Y +74 600
Y +74 000
100 YEAR FLOODLINE
LEEUWPOORT
RESIDUAL GRAVITY MAP AND BOREHOLE POSITIONS
INTRACONSULT
CONSULTING ENGINEERING GEOLOGISTS
P.O.BOX 664, POLOKWANE 0699
TEL (015) 295-0564


X +2 906 800
Y +75 600
Y +74 800
100 YEAR FLOODLINE
100 YEAR FLOODLINE
100 YEAR FLOODLINE
X +2 907 600
3
2
1
4
3
2
1
X +2 908 400
Y +75 600
Y +74 800
Y +74 000
LEEUWPOORT
DOLOMITE RISK ZONATION
DESCRIPTION
SITE BOUNDARY
DOLOMITE STABILITY ZONE BOUNDARY
1 DOLOMITE STABILITY DESIGNATION
INTRACONSULT
CONSULTING ENGINEERING
GEOLOGISTS
P.O.BOX 604, FOURWAYS 2055
TEL (011) 465-0514
SCALE
DATE
DRAWN
CHECKED
REVISION
A
IR 8017/3

BH NO.	Colluvium (m)	Black Reef, Andesite (m)	Karoo, Dolerite, Intrusive (m)	Chert & Chert Residuum		Dolomite Residuum (m)	Dolomite Bedrock (m)	Ground water level (m)	Risk Characterisation			
				Fines subordinate (m)	Fines predominant (m)				Ingress Water		Groundwater Drawdown	
									Doline Formation	Sinkhole Formation	Doline Formation	Sinkhole Formation
3517	0-2	2-39 A						DRY	NR	NR	NR	NR
4025	0-2	2-37 A						DRY	NR	NR	NR	NR
4318	0-4		4-22 DOLERITE					DRY	LOW	LOW	LOW	LOW
4312	0-8		8-27 DOLERITE				27	DRY	LOW	LOW	LOW	LOW
4616	0-1		1-50 DOLERITE					DRY	LOW	LOW	LOW	LOW
4426	0-4		4-50 DOLERITE					DRY	LOW	LOW	LOW	LOW
4630	0-4	38-50 ANDESITE	4-50 KAROO					DRY	LOW	LOW	LOW	LOW
4919	0-1		1-24 DOLERITE					DRY	LOW	LOW	LOW	LOW
5014		0-20 BR						DRY	LOW	LOW	LOW	LOW
5025	0-2	2-29 A						DRY	NR	NR	NR	NR
5108	0-3		3-50 K					DRY	LOW	LOW	LOW	LOW
5132	0-1		1-47 K & I					DRY	LOW	LOW	LOW	LOW

TABLE 1: RISK CHARACTERISATION OF BOREHOLE DATA: LEEUWPOORT

IR801t Leeuwpoort

BH NO.	COLLUVIUM (m)	Black Reef, Andesite (m)	Karoo, Intrusive (m)	Chert & Chert Residuum		Dolomite Residuum (m)	Dolomite Bedrock (m)	Ground water level (m)	Risk Characterisation			
				Fines subordinate (m)	Fines predominant (m)				Ingress Water		Groundwater Drawdown	
									Doline Formation	Sinkhole Formation	Doline Formation	Sinkhole Formation
5522	0-1	1-38 ANDESITE						DRY	NR	NR	NR	NR
5528	0-2		2-50 DOLERITE					DRY	LOW	LOW	LOW	LOW
5605	0-8		8-32 KAROO				32	DRY	LOW	LOW	LOW	LOW
5611	0-3		3-50 KAROO					DRY	LOW	LOW	LOW	LOW
5632	0-3		3-50 KAROO					DRY	LOW	LOW	LOW	LOW
5708	0-4		4-37 KAROO				37	DRY	LOW	LOW	LOW	LOW
5719	0-2		2-33 DOLERITE					DRY	LOW-MEDIUM	LOW-MEDIUM	LOW	LOW
5815	0-2		2-11 K			11-21	21	DRY	LOW-MEDIUM	LOW-MEDIUM	LOW	LOW
6124	0-1		1-34 DOLERITE				34	DRY	LOW	LOW	LOW	LOW
6219	0-5 FILL					5-14	14	DRY	HIGH	HIGH	LOW	LOW
6309	0-2		2-50 K					DRY	LOW	LOW		
6313	0-4		4-20 K			20-24	24	DRY	LOW-MEDIUM	LOW-MEDIUM	LOW	LOW
6405	0-5		5-18 K			18-27	27	DRY	LOW-MEDIUM	LOW-MEDIUM	LOW	LOW

TABLE 2: RISK CHARACTERISATION OF BOREHOLE DATA: LEEUWPOORT

BH NO.	Colluvium (m)	Black Reef, Andesite (m)	Karoo, Intrusive (m)	Chert & Chert Residuum		Dolomite Residuum (m)	Dolomite Bedrock (m)	Ground water level (m)	Risk Characterisation			
				Fines subordinate (m)	Fines predominant (m)				Ingress Water		Groundwater Drawdown	
									Doline Formation	Sinkhole Formation	Doline Formation	Sinkhole Formation
6615	0-4		4-12 KAROO		12-20 WITH WAD			DRY	MEDIUM	MEDIUM	MEDIUM	MEDIUM
6626	0-6	6-39 ANDESITE						DRY	NR	NR	NR	NR
6711	0-1		1-33 K				33	DRY	LOW	LOW	LOW	LOW
6720	1-5		5-14 K			5-14, 14-27 NSR	18	DRY	HIGH	HIGH		
6917	0-5			5-10		10-16	16	DRY	HIGH	HIGH	LOW	LOW
7022	0-3					3-13, 13-17 NSR	17	DRY	HIGH	HIGH	LOW	LOW
7220	0-16 ALLUV.					16-27NSR	27 NSR	DRY	HIGH	HIGH	LOW	LOW
7225	0-2		2-26				26	DRY	LOW	LOW	LOW	LOW

TABLE 3: RISK CHARACTERISATION OF BOREHOLE DATA: LEEUWPOORT

APPENDIX 1

PERCUSSION DRILLING REPORT	BOREHOLE NO : 3517 SHEET : 1 OF 1
LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT	
CO-ORDINATES : X = -2907885 Y = - 74330.	COLLAR ELEV : 1597 mamsl WATER REST LEVEL : Dry
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 16/10/2006	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE Casing Air Loss Static water level DESCRIPTION
1.47		0-2m: Reddish orange brown SANDY CLAYEY SILT with traces of subangular quartz gravel: COLLUVIUM.
2.29		
1.58		2-4m: Reddish orange CLAYEY SILT: RESIDUAL RESIDUAL ANDESITE.
0.49		
0.28	5	4-32m: Orange SILT: RESIDUAL ANDESITE.
0.34		
1.21		
1.16		
1.07		
1.24	10	
1.31		
0.59		
0.54		
0.51		
1.06	15	
1.04		
0.49		
0.38		
0.41		
0.33	20	
0.36		
0.50		
0.59		
0.37		
0.46	25	
0.52		
.42		
0.41		
0.48		
1.07	30	
1.06		
1.38		
2.14		32-39m: Angular olive grey stained orange and yellow highly weathered HARD ROCK ANDESITE.
3.51		
4.56	35	
5.12		
4.33		
4.18		
4.45		
	40	

PROFILED BY **DB/BB** ON 16/10/2006 1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE **750cfm delivering 250psi to a 155mm diameter button bit** 2. WATER ENCOUNTERED Nil 3. AIR LOSSES Nil	**LEEUWPOORT DEVELOPMENT PROJECT** Intraconsult Consulting Engineers & Geologists Tel : (011) 469-0854	REF NO. FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4025
SHEET : 1 OF 1

LOCALITY : LEEUWPORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907592
Y = - 74225

COLLAR ELEV : 1592 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 11/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.34		0-2m: Reddish brown SILTY SAND with traces of angular orange and yellow highly weathered ANDESITE and QUARTZ GRAVEL; COLLUVIUM
1.25		
1.16		
1.29		2-11m: Reddish orange slightly CLAYEY SILT; RESIDUAL ANDESITE
1.14	5	
1.18		
1.06		
08		
1.53		
1.46	10	
2.01		
2.21		11-24m: Yellow blotched orange CLAYEY SILT; RESIDUAL ANDESITE
2.43		
3.01		
2.52	15	
3.04		
2.19		
1.51		
1.27		
1.09	20	
1.36		
1.24		
0.54		
1.08		
1.21	25	24-37m: Angular olive grey blotched yellow stained black[joints] medium and highly weathered hard ROCK ANDESITE
1.34		
1.06		
0.54		
1.24		
1.41	30	
2.47		
5.15		
45.29		
4.53		
4.56	35	
5.18		
5.09		
	40	

PROFILED BY **DB/BB** ON 11/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469-0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4312
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2908144
Y = - 74354

COLLAR ELEV : 1596mamsl
OWL : 1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED :

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION	
1.24				Casing Air Loss Static water level	
1.08				0-8m: Reddish orange mottled yellow CLAYEY SILT with traces of subrounded and subangular quartz gravel: COLLUVIUM.	
1.17					
1.24					
1.03		5			
0.51					
0.49					
^ 53					
..58				8-22m: Orange blotched yellow CLAYEY SILT: RESIDUAL DOLERITE.	
1.41		10			
1.28					
1.07					
0.59					
1.03					
0.57		15			
1.16					
1.11					
1.09					
1.52					
0.51		20			
0.47					
1.05					
1.21				22-27m: Orange CLAYEY SILT with minor olive silt and traces of angular olive very soft rock DOLERITE.	
1.25					
0.59		25			
' 30					
.46					
1.19				27-35m: Angular blue grey slightly weathered HARD ROCK DOLOMITE.	
2.21					
4.09		30			
3/57					
4.36					
5.13					
4.36					
4.42		35			
		40			

PROFILED BY **DB/BB** ON 14/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4318
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = -2907886
Y = - 74350

COLLAR ELEV : 1598 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 16/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
		Casing **Air Loss** **Static water level**
		0-4m: Reddish brown mottled yellow CLAYEY SILTY SAND; FERRUGINISED HILLWASH.
	5	4-22m: Reddish orange CLAYEY SILT; RESIDUAL DOLORITE.
	10	
	15	
	20	
	25	
	30	
	35	
	40	

PROFILED BY **DB/BB** ON 16/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469-0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4426
SHEET : 1 OF 2

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907549
Y = - 74395

COLLAR ELEV : 1590 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.56		0-1m: Reddish orange brown SILTY SAND with traces of angular QUARTZ GRAVEL; HILLWASH
1.03		
0.51		1-4m: As above with minor angular and subangular QUARTZ and yellow completely weathered ANDESITE GRAVEL; COLLUVIUM
0.59		
1.16	5	
1.23		4-50m: Orange CLAYEY SILT; residual DOLORITE
1.08		
0.47		
0.51		
0.54	10	
0.59		
1.00		
1.06		
0.55		
0.53	15	
0.50		
1.02		
0.57		
0.59		
1.18	20	
1.16		
1.21		
1.05		
1.07		
1.20	25	
1.34		
1.15		
1.36		
1.21		
1.46	30	
1.38		
1.34		
1.50		
1.27		
1.36	35	
1.05		
1.24		
1.35		
1.27		
1.18	40	

Key reference: Casing; Air Loss; Static water level

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 – 0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4426
SHEET : 2 OF 2

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907380 Y = - 74480	COLLAR ELEV : 1590 mamsl WATER REST LEVEL :Dry
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 12/10/2006	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY / REFERENCE / DESCRIPTION	
				KEY: Casing; Air Loss; Static water level	
1.15				4-50m: Orange CLAYEY SILT; residual DOLORITE	
1.32					
1.06					
1.41					
1.54		45			
1.39					
2.02					
56					
2.12					
1.49		50			
		55			
		60			
		65			
		70			
		75			
		80			

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 – 0854

FIG NO.

PERCUSSION DRILLING REPORT | **BOREHOLE NO : 4616** | **SHEET : 1 OF 2**

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2907973
Y = - 74478

COLLAR ELEV : 1599mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 14/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)	KEY REFERENCE / DESCRIPTION
	Casing Air Loss Static water level
	0-1m: Reddish brown CLAYEY SAND with minor angular and subangular quartz and quartzite gravel: COLLUVIUM.
5	1-6m: Reddish orange mottled yellow CLAYEY SANDY SILT with traces of angular quartzite gravel: slightly FERRUGINISED COLLUVIUM.
10	6-21m: Reddish orange CLAYEY SILT: RESIDUAL DOLERITE.
15	
20	
25	21-50m: Orange blotched olive SANDY SILT with minor angular olive completely weathered very soft rock dolerite: RESIDUAL DOLERITE.
30	
35	
40	

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4616
SHEET : 2 OF 2

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2907973
Y = - 74478

COLLAR ELEV : 1599mamsl
WATER REST LEVEL :Dry

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 14/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION	
		45		21-50m: Orange blotched olive SANDY SILT with minor angular olive completely weathered very soft rock dolerite: RESIDUAL DOLERITE.	Casing Air Loss Static water level
		50			
		55			
		60			
		65			
		70			
		75			
		80			

PROFILED BY DB/BB ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4630
SHEET : 1 OF 2

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = -2907380
Y = - 74480

COLLAR ELEV : 1585 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.19		0-2m: Reddish brown mottled yellow and black SILTY SAND with minor FERRICRETE nodules; FERRICRETE.
1.48		
2.12		2-4m: Reddish orange CLAYEY SILT; KAROO.
2.04		
2.11	5	4-21m: Khaki CLAYEY SILT; KAROO.
1.50		
1.06		
1.11		
1.04		
0.55	10	
0.58		
0.46		
0.49		
0.49		
0.54	15	
0.36		
0.44		
0.42		
0.42		
0.48	20	
0.41		
0.36		21-29m: Yellow blotched orange CLAYEY SILT with abundant subangular, subround and angular GRAVEL of mixed origin; KAROO.
0.39		
0.4		
0.43	25	
0.47		
0.58		
0.51		
0.49		
0.46	30	29-31m: Yellow brown blotched dark brown SANDY CLAYEY SILT with traces of FERRICRETE concretions; ferruginised KAROO.
1.10		
1.02		31-38m: Yellow CLAYEY SILT; RESIDUAL DOLERITE.
0.56		
0.43		
0.45	35	
0.59		
1.03		
1.06		
1.02		38-50m: Angular olive stained black [joints] completely weathered very soft rock DOLERITE with abundant olive
0.57	40	

Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT — **BOREHOLE NO : 4630** — **SHEET : 2 OF 2**

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907380
Y = -74480

COLLAR ELEV : 1585 mamsl
WATER REST LEVEL :Dry

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 11/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION
				Casing Air Loss Static water level
0.51				mottled yellow and grey CLAYEY SANDY SILT; RESIDUAL DOLERITE.
0.55				
0.53				
0.46				
0.49		45		
0.58				
1.04				
1.21				
07				
1.16		50		
		55		
		60		
		65		
		70		
		75		
		80		

PROFILED BY **DB/BB** ON 11/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4919
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2967850
Y = - 74604

COLLAR ELEV : 1595 mamsl
WATER REST LEVEL : dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 10/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
		Casing Air Loss Static water level
1.23		0-1m: Reddish brown SANDY CLAYEY SILT with traces of angular brown highly weathered QUARTZITE.
0.59		
1.01		1-3m: Reddish orange CLAYEY SILT: RESIDUAL ANDESITE.
0.48		
0.50	5	3-8m: Orange CLAYEY SILT: RESIDUAL ANDESITE.
0.57		
1.12		
1.04		
1.51		8-16m: As above with traces of angular blue grey slightly weathered HARD ROCK ANDESITE.
1.26	10	
1.19		
1.02		
0.51		
0.56		
0.48	15	
1.19		
2.31		16-24m: Angular grey slightly weathered HARD ROCK ANDESITE.
4.08		
5.36		
5.51	20	
5.07		
5.12		
5.43		
5.19		
	25	
	30	
	35	
	40	

PROFILED BY **DB/BB** ON 10/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 5014
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907973
Y = - 74653.

COLLAR ELEV : 1596 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 09/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.14		0-1m: Reddish orange SILTY SAND with traces of angular orange and white highly weathered QUARTZITE.
0.59		
0.53		1-11m: Buff blotched orange fine SANDY SILT: RESIDUAL QUARTZITE. BLACK REEF FORMATION
0.44		
0.41	5	
0.50		
.53		
0.47		
0.48		
0.56	10	
0.39		11-20m: Angular grey slightly weathered HARD ROCK QUARTZITE. BLACK REEF FORMATION
4.39		
4.56		
4.41		
5.33	15	
5.28		
5.14		
5.50		
5.33		
4.59	20	
5.21		
	25	
	30	
	35	
	40	

Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 09/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT — **BOREHOLE NO : 5025** — **SHEET : 1 OF 1**

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907593	**COLLAR ELEV : 1588 mamsl**
Y = - 74649	**WATER REST LEVEL :Dry**
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 10/10/2006	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION
1.25				0-2m: Reddish orange brown mottled black CLAYEY SANDY SILT with traces of ferricrete nodules and angular quartz gravel: HILLWASH.
1.12				
1.06				
1.39				2-6m: Angular white vein QUARTZ with traces of reddish orange clayey silt: QUARTZ vein in RESIDUAL ANDESITE.
1.18		5		
1.50				
1.33				6-21m: Reddish orange slightly CLAYEY SILT: RESIDUAL ANDESITE.
1.29				
1.56				
2.19		10		
2.21				
2.04				
1.53				
1.21				
1.08		15		
1.36				
1.52				
1.43				
1.40				
1.29		20		
1.58				
3.50				21-29m: Angular grey slightly weathered HARD ROCK ANDESITE.
4.21				
5.09				
4.14		25		
5.02				
4.51				
4.29				
4.56				
		30		
		35		
		40		

PROFILED BY **DB/BB** ON 10/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE **750cfm delivering 250psi to a 155mm diameter button bit**
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 5132
SHEET : 1 OF 2

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = -2907291
Y = -71692

COLLAR ELEV : 1580 mamsl
OWL : 1560 mamsl:

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.04		0-1m: Reddish brown CLAYEY SILTY SAND; HILLWASH
0.22		1-3m: Reddish brown mottled grey and yellow CLAYEY SANDY SILT; KAROO
0.29		
0.38		3-8m: Yellow brown SLTY SAND with abundant subrounded, subangular and angular white and brown highly weathered sandstone gravel: KAROO.
0.46	5	
1.05		
.44		
0.51		
0.43		8-20m: Reddish brown blotched grey and dark brown CLAYEY SILT: KAROO.
0.41	10	
0.40		
0.37		
0.38		
0.41		
0.29	15	
0.26		
0.31		
0.40		
0.30		
0.31	20	
0.28		20-26m: Light brown SAND with abundant subrounded, subangular and angular white and brown sandstone gravel: KAROO.
0.26		
0.27		
0.27		
.30	25	
0.29		26-30m: Orange SANDY CLAYEY SILT with traces of gravel as above: KAROO
0.25		
0.31		
0.29		
0.34	30	
0.33		30-34m: Orange brown SILT: RESIDUAL INTRUSIVE.
0.46		
0.51		
0.54		
0.35	35	34-47m: Angular olive completely and highly weathered SOFT ROCK INTRUSIVE with traces of grey stained black highly weathered . INTRUSIVE
0.51		
0.59		
1.30		
1.35		
1.06	40	

Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 5132
SHEET : 2 OF 2

LOCALITY : LEEUPOORT

CO-ORDINATES : X = - 2907291
Y = - 71692

COLLAR ELEV : 1580m amasl
WATER REST LEVEL :1560mamsl

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION
				Casing Air Loss Static water level
2.43			X X X	34-47m: Angular olive completely and highly weathered SOFT ROCK INTRUSIVE with traces of grey stained black highly weathered HARD ROCK INTRUSIVE.
3.51			X X X	
4.09			X X X	
4.51			X X X	
4.36		45	X X X	
4.45			X X X	
5.10				
		50		
		55		
		60		
		65		
		70		
		75		
		80		

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 5522
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907632
Y = - 74862.

COLLAR ELEV : 1587 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 10/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
		Casing Air Loss Static water level
1.15		0-1m: Reddish brown SILTY SAND; HILLWASH
0.47		1-4m: Yellow blotched reddish orange CLAYEY SILT; RESIDUAL ANDESITE
0.51		
0.59		
1.03	5	4-7m: Reddish orange CLAYEY SILT; RESIDUAL ANDESITE
1.19		
1.28		
51		7-17m: Yellow SILT; RESIDUAL ANDESITE
1.36		
1.33	10	
1.34		
1.05		
0.56		
0.38		
0.51	15	
0.52		
0.59		
0.36		17-31m: Angular yellow completely weathered very soft ROCK ANDESITE
0.44		
0.51	20	
0.49		
1.04		
1.19		
1.15		
1.08	25	
58		
0.57		
1.12		
0.58		
0.54	30	
1.38		
2.24		31-38m: Angular grey stained yellow medium and highly weathered hard ROCK ANDESITE
3.59		
4.16		
5.23	35	
5.10		
5.14		
5.26		
	40	

PROFILED BY **DB/BB** ON 10/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 5528
SHEET : 1 OF 2

LOCALITY : LEEUWPOORT DEVELOPMENT RPOJECT

CO-ORDINATES : X = - 2907461
Y = - 74862.

COLLAR ELEV : 1583 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.25		0-2m: Reddish orange CLAYEY SANDY SILT with traces of FERRICRETE NODULES; HILLWASH
1.05		
1.16		2-50m: Yellow CLAYEY SILT with traces of angular olive and grey highly weathered medium hard rock DOLORITE from 40-43m; RESIDUAL DOLORITE
0.39		
0.32	5	
0.25		
0.44		
0.639		
0.25		
0.26	10	
0.28		
0.35		
0.36		
0.31		
0.28	15	
0.24		
0.24		
0.29		
0.38		
0.33	20	
0.26		
0.41		
0.43		
1.08		
0.49	25	
0.35		
0.30		
0.27		
0.34		
0.37	30	
0.35		
0.42		
0.51		
0.55		
0.51	35	
0.59		
0.49		
1.08		
0.52		
0.56	40	

Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 5528
SHEET : 2 OF 2

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907461
Y =- 74862.

COLLAR ELEV : 1583 mamsl
WATER REST LEVEL :Dry

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
0.35		Casing Air Loss Static water level 2-50m: Yellow CLAYEY SILT with traces of angular olive and grey highly weathered medium hard rock DOLORITE from 40-43m; RESIDUAL DOLORITE.
0.49		
0.41		
0.38		
0.34	45	
0.25		
0.36		
0.29		
0.31		
0.25	50	
	55	
	60	
	65	
	70	
	75	
	80	

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 5605
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2908435
Y = - 74907.

COLLAR ELEV : 1595 mamsl
OWL: 1560 mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 09/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
0.40		0-2m: Reddish brown CLAYEY SAND: HILLWASH.
0.19		
0.22		
0.39		2-4m: As above with traces of firm angular QUARTZ gravel: HILLWASH.
1.51	5	4-8m: Reddish brown mottled yellow, grey and black CLAYEY SILT: HILLWASH.
1.36		
6		
08		
1.31		8-32m: Orange blotched yellow brown fine SAND: KAROO SANDSTONE.
1.15	10	
1.40		
1.12		
0.45		
0.49		
0.52	15	
1.00		
0.42		
0.36		
0.29		
0.25	20	
0.28		
0.26		
0.35		
0.31		
0.29	25	
0.28		
.36		
0.20		
0.24		
0.21	30	
0.24		
0.18		
0.09		32-40m: Angular grey, brown and white highly weathered SOFT ROCK DOLOMITE with abundant dark brown CLAYEY SILT (WAD). DOLOMITE BEDROCK.
1.56		
3.41	35	
4.26		
4.05		
4.08		
4.51		
4.22	40	

KEY REFERENCE
Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 09/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 5611
SHEET : 1 OF 2

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2908187
Y = - 74905.

COLLAR ELEV : 1593 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 14/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
2.12		0-3m: Reddish brown CLAYEY SAND with minor angular and subangular quartz and quartzite gravel: COLLUVIUM.
1.36		
1.25		
1.08		3-11m: Reddish orange CLAYEY SILTY SAND with minor subrounded and subangular quartz gravel: KAROO.
1.14	5	
1.16		
1.19		
.07		
0.54		
0.52	10	
0.51		
0.56		11-50m: Yellow brown mottled grey and orange CLAYEY SILTY SAND with minor subrounded, subangular and angular chert, quartzite and shale gravel: DIAMICTITE?
1.04		
0.59		
1.28	15	
1.05		
1.12		
1.16		
1.18		
1.07	20	
1.13		
1.01		
0.59		
1.04		
1.10	25	
0.52		
0.51		
0.56		
0.44		
0.55	30	
1.08		
1.27		
1.13		
1.11		
0.57	35	
0.48		
0.52		
0.53		
0.56		
1.10	40	

Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 14/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
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FIG NO.

PERCUSSION DRILLING REPORT — **BOREHOLE NO : 5611** — **SHEET : 2 OF 2**

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2908187
Y = - 74905.

COLLAR ELEV : 1593 mamsl
WATER REST LEVEL :Dry

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 14/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION	
0.54				11-50m: Yellow brown mottled grey and orange CLAYEY SILTY SAND with minor subrounded, subangular and angular chert, quartzite and shale gravel: DIAMICTITE?	
0.58					
1.12					
1.21					
1.26		45			
1.33					
1.29					
1.07					
1.08					
1.23		50			
		55			
		60			
		65			
		70			
		75			
		80			

PROFILED BY **DB/BB** ON 14/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 5632
SHEET : 1 OF 2

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907295
Y = - 74904.

COLLAR ELEV : 1580 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION
1.26				0-1m: Reddish orange brown SILTY SAND; Hillwash
1.14				1-3m: Reddish brown mottled yellow and black clayey silty with minor ferricrete nodules; FERRICRETE
1.00				
0.59				3-24m: Grey sand with abundant angular grey and brown highly weathered sandstone gravel; KAROO SANDSTONE
1.12		5		
1.09				
0.54				
0.51				
0.37				
0.33		10		
0.45				
0.41				
0.49				
1.13				
1.00		15		
0.56				
0.51				
0.39				
0.34				
0.45		20		
0.49				
1.05				
1.13				
1.02				
0.55		25		24-50m: Yellow brown blotched orange sandy clayey silt with abundant subround, subangular and angular gravel of mixed o origin; KAROO?
0.55				
0.46				
1.05				
1.12				
0.49		30		
1.08				
1.34				
1.15				
1.06				
1.22		35		
0.51				
0.55				
1.09				
1.06				
1.24		40		

KEY REFERENCE
Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 5632
SHEET : 2 OF 2

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2907295
Y = - 74904.

COLLAR ELEV : 1580 mamsl
WATER REST LEVEL :Dry

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION
1.31				Casing Air Loss Static water level 24-50m: Yellow brown blotched orange sandy clayey silt with abundant subround, subangular and angular gravel of mixed o origin; KAROO?
1.15				
1.03				
1.18				
1.07		45		
1.21				
'.35				
1.41				
1.09				
1.25		50		
		55		
		60		
		65		
		70		
		75		
		80		

PROFILED BY DB/BB ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT — **BOREHOLE NO : 5708** — **SHEET : 1 OF 2**

LOCALITY : LEEUPOORT

CO-ORDINATES : X = - 2907295	**COLLAR ELEV : 1593 mamsl**
Y = - 74904	**OWL : 1560 mamsl**
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 09/10/2006	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)			KEY REFERENCE / DESCRIPTION	
0.30			0-4m: Reddish brown CLAYEY SAND with minor sub-angular quartz and quartzite gravel: COLLUVIUM.	Casing Air Loss Static water level
0.46				
1.13				
1.42				
1.15		5	4-8m: Reddish orange CLAYEY SILT: KAROO.	
1.37				
1.18				
.12				
0.50			8-37m: Orange SANDY CLAYEY SILT with minor sub-rounded, subangular and angular gravel of mixed origin: KAROO.	
0.54		10		
0.51				
1.02				
0.46				
0.38				
0.39		15		
0.45				
1.00				
0.52				
0.51				
0.47		20		
0.50				
0.35				
0.41				
0.47				
0.41		25		
40				
0.44				
0.36				
0.38				
0.38		30		
0.49				
0.40				
0.41				
0.36				
0.39		35		
0.43				
0.51				
0.28			37-44m: Angular blue grey slightly weathered HARD ROCK DOLOMITE with minor dark brown clayey silt (wad) DOLOMITE BEDROCK.	
3.22				
3.56		40		

PROFILED BY **DB/BB** ON 09/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 5708
SHEET : 2 OF 2

LOCALITY : LEEUPOORT

CO-ORDINATES : X = - 2907295
Y = - 74904

COLLAR ELEV : 1593 mamsl
OWL :1560 mamsl

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 09/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)			KEY REFERENCE / DESCRIPTION
3.19			37-44m: Angular blue grey slightly weathered HARD ROCK DOLOMITE with minor dark brown clayey silt (wad) DOLOMITE BEDROCK.
3.42			
4.05			
4.19			
	45		
	50		
	55		
	60		
	65		
	70		
	75		
	80		

Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 09/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 5719
SHEET : 1 OF 1

LOCALITY : LEEUPOORT

CO-ORDINATES : X = - 2907846
Y = - 74949

COLLAR ELEV : 1590 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)			KEY REFERENCE / DESCRIPTION
1.28			0-2m: Reddish brown SILTY SAND with abundant angular and subangular white ,grey and brown highly weathered QUARTZITE GRAVEL; COLLUVIUM
1.37			
1.11			
1.02			2-23m: Reddish orange CLAYEY SILT; RESIDUAL ANDESITE
0.51		5	
0.54			
1.38			
23			
1.16			
1.09		10	
1.24			
1.13			
1.16			
1.25			
1.08		15	
1.01			
1.07			
1.11			
1.34			
0.56		20	
1.05			
1.14			
1.19			
1.24			23-25m: Yellow SILT; RESIDUAL ANDESITE
1.07		25	
1.15			25-27m: Yellow SILTY and angular blue grey unweathered hard ROCK ANDESITE
1.36			
4.01			27-33m: Angular blue grey blotched red brown slightly weathered hard ROCK ANDESITE
5.23			
5.10		30	
4.25			
4.51			
4.39			
		35	
		40	

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 5815
SHEET : 1 OF 1

LOCALITY : LEEUPOORT

CO-ORDINATES : X = - 2908016
Y = - 74988

COLLAR ELEV : 1589mamsl
WATER REST LEVEL : 1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 10/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)			KEY REFERENCE / DESCRIPTION	
0.36			0-2m: Reddish brown CLAYEY SILTY SAND; HILLWASH	
0.49				
1.12			2-11m: Yellow mottled reddish orange CLAYEY SILT with abundant subround, subangular and angular medium and highly weathered QUARTZITE, SHALE and CHERT GRAVEL; DIAMICTITE?	
1.03				
0.54		5		
0.51				
0.51				
0.48				
1.00				
0.57		10		
0.52				
0.38			11-21m: Dark brown blotched reddish brown CLAYEY SILT (WAD);DOLOMITE RESIDUUM	
0.26				
0.19				
0.15		15		
0.09				
0.11				
0.09				
0.12				
0.13		20		
1.46				
3.43			21-27m : Angular blue grey stained white[joints] medium and highly weathered hard rock DOLOMITE; DOLOMITE. BEDROCK.	
3.51				
4.00				
3.38		25		
.29				
3.56				
		30		
		35		
		40		

Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 10/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT — **BOREHOLE NO : 6124** — **SHEET : 1 OF 2**

LOCALITY : LEEUPOORT

CO-ORDINATES : X = - 2907637
Y = - 75117

COLLAR ELEV : 1583 mamsl
OWL : 1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 10/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.56		0-1m: Reddish brown CLAYEY SILTY SAND; HILLWASH
2.12		1-2m: Reddish orange brown CLAYEY SILT with traces of FERRICRETE nodules and concretions; ferruginised reworked RESIDUAL DOLERITE
1.49		
1.35		
1.36	5	2-10m: Reddish orange mottled yellow CLAYEY SILTY SAND with traces of QUARTZ GRAVEL and FERRICRETE nodules; ferruginised residual DOLERITE and QUARTZ vein
1.29		
1.13		
1.59		
1.02		
1.16	10	
0.59		10-17m: Reddish orange CLAYEY SILT; RESIDUAL DOLERITE
0.51		
0.48		
0.51		
0.50	15	
0.56		
0.44		
1.21		
0.50		17-32m: Yellow blotched orange CLAYEY SILT; RESIDUAL DOLERITE
1.11	20	
1.04		
0.45		
0.37		
0.49		
1.00	25	
1.01		
0.56		
0.50		
1.08		
1.02	30	
0.55		
1.06		
1.31		32-34m: Angular olive speckled black highly weathered soft rock DOLERITE and angular yellow, orange and black completely weathered very soft ROCK DOLERITE
1.38		
2.43	35	
2.21		34-42m: Angular blue grey and olive grey medium weathered hard rock DOLOMITE; DOLOMITE BEDROCK.
4.29		
3.56		
5.14		
5.19	40	

KEY REFERENCE
Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 10/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
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Tel : (011) 465-0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 6124
SHEET : 2 OF 2

LOCALITY : LEEUPOORT

CO-ORDINATES : X = - 2907637
Y = - 75117

COLLAR ELEV : 1583mamsl
OWL :1560mamsl

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 10/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION	
				Casing Air Loss Static water level	
5.03				34-42m: Angular blue grey and olive grey medium	
4.55				weathered hard rock DOLOMITE; DOLOMITE BEDROCK	
		45			
		50			
		55			
		60			
		65			
		70			
		75			
		80			

PROFILED BY **DB/BB** ON 10/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 6219
SHEET : 1 OF 1

LOCALITY : LEEUPOORT

CO-ORDINATES : X = - 2908268
Y = - 75159

COLLAR ELEV : 1585mamsl
OWL: 1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 14/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)			KEY REFERENCE / DESCRIPTION
0.35			0-1m: Reddish brown SILTY SAND with traces of subangular and angular white and grey highly weathered chert: INFILL.
0.20			
0.22			1-5m: Dark reddish brown SANDY CLAYEY SILT with traces of ferricrete nodules: HILLWASH.
0.49			
1.10	5		
0.54			5-22m: Angular grey occasionally blotched white slightly weathered HARD ROCK DOLOMITE with traces of calcite. DOLOMITE BEDROCK.
0.48			
0.36			
0.29			
0.21	10		
0.25			
0.20			
0.34			
0.29			
1.41	15		
3.10			
4.41			
4.08			
4.27			
4.22	20		
5.14			
4.56			
	25		
	30		
	35		
	40		

Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 14/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
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Tel : (011) 465-0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 6309
SHEET : 1 OF 2

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2908268
Y = - 75202

COLLAR ELEV : 1587mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 13/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE Casing Air Loss Static water level DESCRIPTION
1.30		0-2m: Reddish brown SILTY SAND; HILLWASH
1.11		
1.42		2-7m: Reddish brown mottled orange and black CLAYEY SILTY SAND with traces of subangular QUARTZITE and CHERT GRAVEL; HILLWASH
1.37		
1.50	5	
1.07		
0.59		
..02		7-12m: Reddish orange Clayey Silt; KAROO
1.18		
1.34	10	
0.56		
1.19		
1.26		12-50m: yellow brown mottled grey and orange CLAYEY SILTY SAND with abundant subround, subangular and angular CHERT, QUARTZITE and SHALE GRAVEL; DIAMICTIE?
1.06		
1.13	15	
0.35		
0.49		
0.48		
0.41		
0.37	20	
0.40		
0.48		
0.51		
1.05		
1.27	25	
.15		
1.11		
1.09		
1.34		
1.16	30	
1.14		
1.02		
0.56		
0.59		
0.51	35	
1.12		
1.07		
1.07		
1.05		
1.11	40	

PROFILED BY **DB/BB** ON 13/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 6309
SHEET : 2 OF 2

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2908268
Y = - 75202

COLLAR ELEV : 1587mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 13/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION
1.02				12-50m: yellow brown mottled grey and orange CLAYEY SILTY SAND with abundant subround,. subangular and angular CHERT, QUARTZITE and SHALE GRAVEL; DIAMICTIE?
1.14				
1.26				
1.27				
1.14		45		
1.09				
1.15				
1.18				
1.35				
1.24		50		
		55		
		60		
		65		
		70		
		75		
		80		

PROFILED BY **DB/BB** ON 13/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

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FIG NO.

PERCUSSION DRILLING REPORT | **BOREHOLE NO : 6313** | **SHEET : 1 OF 1**

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 298098 | **COLLAR ELEV : 2908098**
Y = - 75202 | **OWL : 75202**

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 10/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)			KEY REFERENCE / DESCRIPTION	
			KEY REFERENCE: Casing / Air Loss / Static water level	
0.29			0-2m: Reddish brown slightly CLAYEY SILTY SAND; HILLWASH	
0.20				
0.59			2-4m : As above with minor subangular and angular highly weathered QUARTZITE GRAVEL; COLLUVIUM	
1.36				
1.51	5		4-20m: Orange brown SANDY CLAYEY SILT with minor subangular and angular highly weathered QUARTZITE and CHERT GRAVEL; KAROO	
1.29				
1.04				
10				
.56				
0.31	10			
0.25				
0.29				
0.22				
0.29				
0.21	15			
0.34				
0.16				
0.08				
0.09				
0.08	20			
0.07			20-24m: Dark brown CLAYEY SILT (WAD) with traces of the above; transition to DOLOMITE RESIDUUM. DOLOMITE RESIDUUM.	
0.08				
0.09				
0.04				
3.21	25		24-30m: No sample return. Driller reports hard rock. DOLOMITE BEDROCK ?	
15				
.26				
3.08				
3.47				
3.51	30			
	35			
	40			

PROFILED BY **DB/BB** ON 10/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : >24m

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 6405
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2908441
Y = - 75244

COLLAR ELEV : 1588mamsl
WATER REST LEVEL : 1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 09/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
0.29		0-5m: Orange brown CLAYEY SAND with traces of ferricrete nodules: HILLWASH.
0.16		
0.15		
0.33		
0.46	5	
1.25		5-11m: Orange brown CLAYEY SILTY SAND with minor angular and subangular quartzite and quartz gravel, also contains traces of ferricrete nodules: FERRUGINISED COLLUVIUM.
1.56		
19		
2.06		
1.27	10	
1.19		
0.47		11-18m: Buff mottled reddish orange and grey SANDY CLAYEY SILT with traces of quartzite gravel: KAROO.
0.33		
0.38		
1.06	15	
0.59		
1.02		
1.15		
0.29		18-27m: Dark brown CLAYEY SILT (WAD) with traces of the above: DOLOMITE RESIDUUM.
0.54	20	
0.22		
0.14		
0.10		
0.18		
0.15	25	
0.16		
0.10		
3.56		27-34m: Angular grey stained white [joints] blotched light brown highly weathered and leached HARD ROCK DOLOMITE with traces of (WAD). DOLOMITE BEDROCK.
4.51		
4.23	30	
4.31		
4.06		
3.39		
	35	
	40	

PROFILED BY **DB/BB** ON 09/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 6615
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2908013
Y = - 75329

COLLAR ELEV : 1582mamsl
OWL : ±1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 13/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)	KEY REFERENCE / DESCRIPTION
0.55	0-1m: Reddish orange CLAYEY SILT: HILLWASH.
1.16	1-4m: Dark brown SILTY SAND with traces of angular white and translucent highly weathered chert and quartz: COLLUVIUM.
0.51	
0.47	
1.09	4-11m: Brown and white SAND with traces of angular completely weathered sandstone: KAROO
1.13	
1.06	
0.54	
0.51	
0.59	
1.18	
1.26	11-12m: Reddish brown CLAYEY SANDY SILT with minor subangular and subrounded chert and sandstone gravel: KAROO.
1.03	
1.08	
1.23	12-20m: Dark brown CLAYEY SILT (WAD) and angular white and grey highly weathered chert: DOLOMITE RESIDUUM.
1.51	
1.49	
0.54	
1.06	
1.19	Boreholes terminated due to ravelling. Hammer jamming.

5 10 15 20 25 30 35 40

Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 13/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 0854

FIG NO.

PERCUSSION DRILLING REPORT — **BOREHOLE NO : 6626** — **SHEET : 1 OF 1**

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2907547
Y = - 75330

COLLAR ELEV : 1579mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 13/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.36		0-6m: Reddish brown mottled orange and black CLAYEY SILTY SAND with minor ferricrete concretions and traces of subangular QUARTZITE GRAVEL; FERRUGINISED COLLUVIUM
1.04		
0.51		
0.51		
0.47	5	
0.43		
1.18		6-28m: Yellow blotched reddish orange CLAYEY SILT; KAROO.
0.47		
0.58		
1.09	10	
1.12		
1.15		
1.37		
1.28		
1.21	15	
1.09		
1.13		
1.25		
1.39		
1.51	20	
1.06		
1.23		
1.06		
1.15		
1.31	25	
1.08		
1.07		
0.55		
1.21		28-39m: angular olive stained dark brown highly weathered medium hard and soft ROCK ANDESITE with minor angular yellow completely weathered very soft ROCK ANDESITE ?
1.18	30	
1.10		
1.42		
2.18		
4.15		
4.26	35	
4.41		
4.23		
4.19		
4.58		
	40	

PROFILED BY **DB/BB** ON 13/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 6711
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2908185
Y = - 75371

COLLAR ELEV : 1584mamsl
OWL : 1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 13/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.13		0-1m: Reddish brown SILTY SAND; HILLWASH
0.51		1-10m: Reddish orange mottled yellow and grey CLAYEY SILTY SAND with traces of subangular gravel of mixed origin: FERRUGINISED KAROO
0.54		
1.06		
1.33	5	
1.42		
1.38		
5		
1.09		
0.39	10	
0.46		10-20m: Reddish orange blotched yellow CLAYEY SILTY fine SAND with traces of subangular QUARTZITE GRAVEL; KAROO
0.32		
0.29		
0.35		
0.46	15	
0.47		
0.40		
0.48		
0.33		
0.36	20	
0.44		20-33m: Subround, subangular and angular gravel of mixed origin and abundant yellow brown CLAYEY SILTY SAND; DIAMICTITE
0.51		
0.58		
1.01		
1.42	25	
96		
1.02		
0.59		
0.51		
1.13	30	
1.21		
0.54		
0.23		33-40m: Angular grey stained white highly weathered medium hard ROCK DOLOMITE with traces of minor dark brown CLAYEY SILT (WAD) DOLOMITE BEDROCK
1.39		
2.51	35	
3.15		
2.57		
3.04		
3.18		
3.32	40	

PROFILED BY **DB/BB** ON 13/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 6720
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2907803
Y = - 75371

COLLAR ELEV : 1580mamsl
WATER REST LEVEL : 1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 11/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE Casing Air Loss Static water level DESCRIPTION
1.15		0-1m: Reddish brown slightly CLAYEY SILT: HILLWASH FILL?
1.27		
1.04		1-4m: Reddish brown SILTY SAND: HILLWASH.
1.18		
1.05	5	4-5m: Reddish brown mottled black and yellow CLAYEY SANDY SILT with abundant manganocrete nodules: FERRICRETE. DOLOMITE RESIDUUM
0.56		
0.30		
21		5-14m: Dark brown blotched reddish brown CLAYEY SILT with traces of manganocrete nodules. DOLOMITE RESIDUUM
0.16		
0.14	10	
0.12		
0.11		
0.13		
0.10		
0.04	15	14-18m: No sample return. Driller reports air loss, sample loss and rapid penetration times. DOLOMITE RESIDUUM ?
0.04		
0.18		
1.22		
3.57		18-24m: No sample return. Driller reports hard rock. DOLOMITE BEDROCK.
3.13	20	
3.39		
3.51		
3.25		
3.36		
	25	
	30	
	35	
	40	

PROFILED BY **DB/BB** ON 11/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : 14 to 24m

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 6917
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2907932
Y = - 75458

COLLAR ELEV : 1579mamsl
OWL : 1560 mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 11/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)			KEY REFERENCE / DESCRIPTION
1.00			0-1m: Reddish brown CLAYEY SILTY SAND: HILLWASH.
1.26			1-5m: Reddish brown CLAYEY SAND with minor sub-rounded and subangular quartz and quartzite gravel: COLLUVIUM.
1.15			
1.19			
0.54	5		
1.03			5-10m: Dark yellow brown CLAYEY SILT with abundant angular brown and white highly weathered chert and shale: CHERT RESIDUUM.
0.50			
6			
0.39			
0.14	10		
0.04			10-16m: No sample return. Rapid penetration rates. DOLOMITE RESIDUUM ?
0.04			
0.09			
0.06			
0.08	15		
0.12			
2.11			16-23m: Dark brown CLAYEY SILT (WAD) with traces of angular blue grey blotched brown highly weathered slightly leached HARD ROCK DOLOMITE. DOLOMITE BEDROCK
3.43			
5.02			
4.14	20		
4.09			
4.16			
3.55			
	25		
	30		
	35		
	40		

Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 13/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : 10m to 23m

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 7022
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2907719
Y = - 75500

COLLAR ELEV : 1575mamsl
OWL : 1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 13/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.37		0-1m: Orange brown CLAYEY SAND: HILLWASH.
1.15		1-3m: Dark brown mottled black and yellow brown CLAYEY SILTY SAND with abundant ferricrete nodules and traces of angular quartz gravel: FERRUGINISED COLLUVIUM.
1.09		
0.54		
1.08	5	3-13m: Dark brown blotched reddish brown CLAYEY SILT (WAD). DOLOMITE RESIDUUM
0.27		
0.22		
38		
0.21		
0.24	10	
0.09		
0.11		
0.11		
0.08		13-22m: No sample return. Rapid penetration times. Cavitation DOLOMITE RESIDUUM.
0.06	15	
0.09		
1.39		
4.16		
5.23		
4.09	20	
3.56		
4.18		
5.05		22-23m: No sample return. Hard rock. DOLOMITE BEDROCK.
	25	
	30	
	35	
	40	

Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 13/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : 13m to 23m

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

FIG NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 7220
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2907803
Y = - 75585

COLLAR ELEV : 1576mamsl
OWL : 1560mamsl

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 13/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION
1.11				0-2m: Orange brown CLAYEY SILTY SAND: HILLWASH.
0.54				
1.05				2-4m: Dark orange brown mottled orange CLAYEY SILTY SAND with minor ferricrete nodules: FERRUGINISED HILLWASH.
0.59				
0.36		5		
0.41				4-16m: Dark orange brown SANDY CLAYEY SILT with minor subrounded and subangular chert, quartz and andesite gravel also contains traces of ferricrete nodules: ALLUVIUM/ COLLUVIUM
0.53				
10				
0.48				
1.02		10		
1.16				
1.43				
2.10				
1.04				
1.36		15		
1.51				
0.38				16-23m: Dark brown blotched reddish orange CLAYEY SILT (WAD) with traces of DOLERITE? DOLOMITE RESIDUUM
0.41				
0.50				
0.28		20		
0.18				
0.09				
0.06				
0.04				23-27m: No sample return. Rapid penetration times and cavitation. DOLOMITE RESIDUUM.
0.04		25		
12				
.31				
2.59				27-33m: No sample return. Hard Rock. DOLOMITE BEDROCK.
3.11				
3.52		30		
3.06				
3.49				
3.35				
		35		
		40		

Key: Casing / Air Loss / Static water level

PROFILED BY **DB/BB** ON 13/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : 23m-33m

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 7225
SHEET : 1 OF 1

LOCALITY : LEEUWPOORT

CO-ORDINATES : X = - 2967590
Y = - 75585.

COLLAR ELEV : 1574mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 11/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.06		0-2m: Dark brown CLAYEY SILTY SAND with minor angular and subangular quartz gravel and ferricrete concretions: FERRUGINISED COLLUVIUM.
1.24		
0.39		
0.51		2-26m: Orange blotched yellow SILT: RESIDUAL DOLERITE
0.55	5	
1.04		
1.26		
13		
0.54		
1.06	10	
1.19		
0.49		
1.00		
0.37		
0.41	15	
0.29		
0.44		
0.52		
0.46		
0.39	20	
0.41		
0.37		
0.36		
0.41		
0.40	25	
^ 45		26-27m: As above with minor angular medium weathered HARD ROCK DOLOMITE.
1.50		
3.39		27-34m: Angular blue grey stained brown medium and highly weathered HARD ROCK DOLOMITE with traces of leaching. DOLOMITE BEDROCK
5.16		
5.33	30	
5.15		
5.40		
5.37		
5.52		
	35	
	40	

Key: Casing / Air Loss / Static water level

PROFILED BY **DB/BB** ON

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED : Nil
3. AIR LOSSES : Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 469 0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 5108
SHEET : 1 OF 2

LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT

CO-ORDINATES : X = - 2908312
Y = - 74691.

COLLAR ELEV : 1597 mamsl
WATER REST LEVEL : Dry

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12/10/2006

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE / DESCRIPTION
1.45				0-3m: Reddish orange SILTY SAND with traces of ferricrete concretions and subangular quartzite gravel: COLLUVIUM.
1.32				
1.36				
1.09				3-50m: Orange blotched yellow brown CLAYEY SANDY SILT with abundant to minor in places subrounded, subangular and angular gravel of mixed origin: KAROO.
1.15		5		
0.49				
0.55				
52				
0.51				
0.45		10		
1.00				
0.57				
0.51				
0.49				
0.52		15		
0.51				
0.45				
0.42				
0.38				
0.43		20		
0.46				
0.45				
1.02				
0.53				
0.51		25		
0.56				
0.57				
0.40				
0.48				
0.42		30		
0.47				
1.08				
1.12				
0.59				
0.53		35		
0.50				
0.43				
0.37				
0.48				
0.41		40		

Casing
Air Loss
Static water level

PROFILED BY **DB/BB** ON 12/10/2006

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750cfm delivering 250psi to a 155mm diameter button bit
2. WATER ENCOUNTERED Nil
3. AIR LOSSES Nil

LEEUWPOORT DEVELOPMENT PROJECT

REF NO.

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 465-8706

FIG NO.

PERCUSSION DRILLING REPORT	BOREHOLE NO : 5108 SHEET : 2 OF 2
LOCALITY : LEEUWPOORT DEVELOPMENT PROJECT	
CO-ORDINATES : X = - 2908312 Y =- - 74649	COLLAR ELEV : 1597 mamsl WATER REST LEVEL :Dry
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED :	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE Casing Air Loss Static water level DESCRIPTION	
0.45				3-50m: Orange blotched yellow brown CLAYEY SANDY SILT with abundant to minor in places subrounded, subangular and angular gravel of mixed origin: KAROO.	
0.45					
0.46					
0.49					
1.02		45			
0.53					
0.56					
0.51					
0.50					
0.43		50			
		55			
		60			
		65			
		70			
		75			
		80			

PROFILED BY **DB/BB** ON 12/10/2006 1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE **750cfm delivering 250psi to a 155mm diameter button bit** 2. WATER ENCOUNTERED NIL 3. AIR LOSSES Nil	**LEEUWPOORT DEVELOPMENT PROJECT** Intraconsult Consulting Engineers & Geologists Tel : (011) 460-0854	REF NO. FIG NO.

APPENDIX 2

ENGINEERING & EXPLORATION GEOPHYSICAL SERVICES cc
CK94/10526/23 Geophysical Contractors

170, Jakaranda Street,
Doringkloof, 0157
012 - 6673369 (tel) 6675186(fax)
E-mail: eegs@iafrica.com
16th November 2006

Intraconsult Associates,
P O Box 604,
Fourways 2055.

Attn: Dr D.Buttrick.

Dear Sir,

GRAVITY SURVEY ON A PORTION OF LEEUWPOORT 113-IR

Details are given here of a gravity survey that was conducted as part of a dolomite-stability of part of the farm Leeuwpoort 113-IR. The survey covered an area bounded by the Rondebult, North Boundary and Trichardts roads in the west, south and east respectively, and a stream in the north.

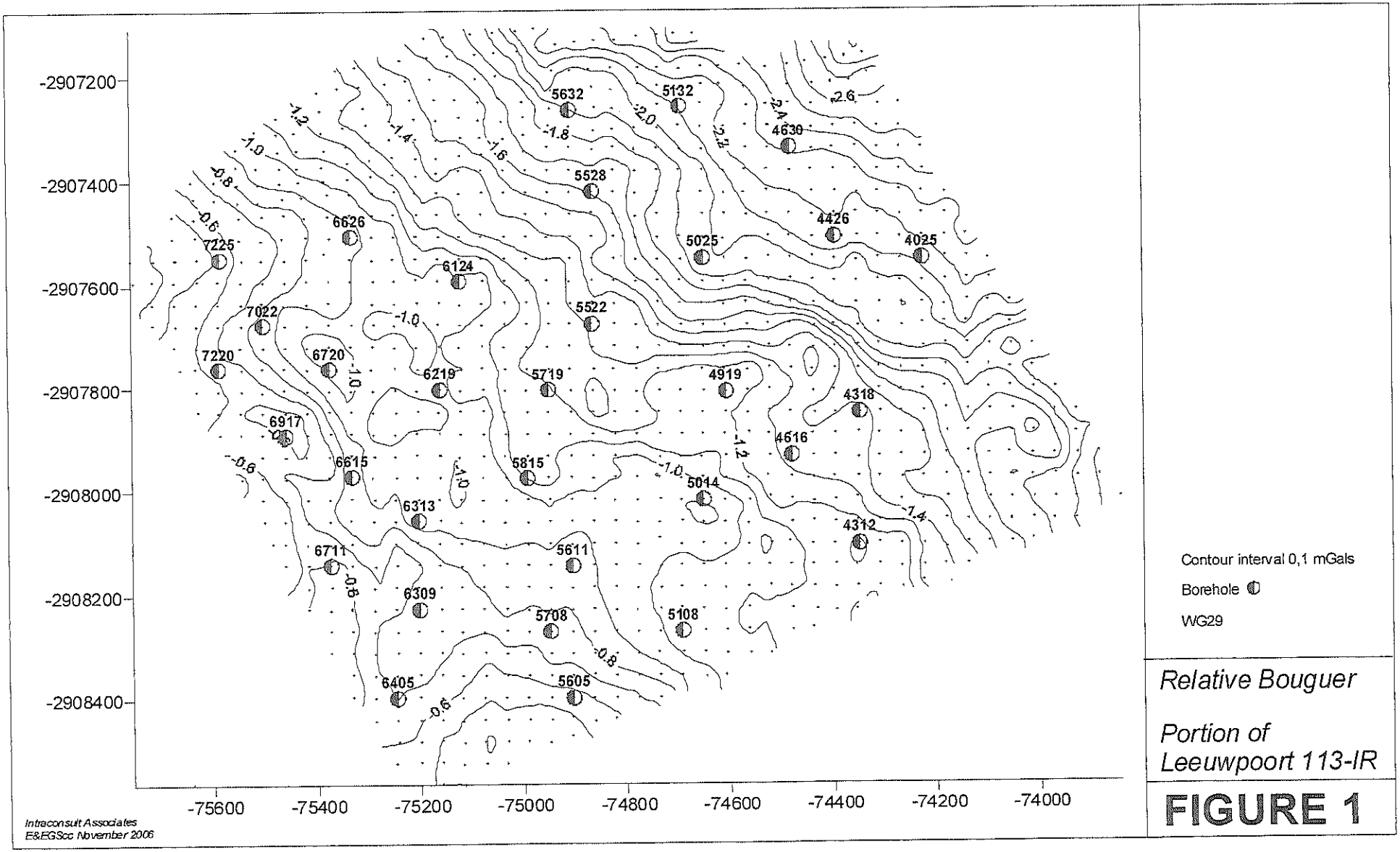
Most of the fieldwork was carried out from the 19th to 21st September, this was followed by an extension on the 7th November. A 30 metre station spacing was employed and 1058 gravity stations were laid out. Gravity was observed with a Scintrex Autograv whilst navigation and positioning information were supplied by a differential GPS.

Data reduction followed the usual procedures for dolomite studies. The gravity data were reduced to relative Bouguer values using elevation and latitude correction factors of 0,21 and 0,00065 mGals per metre respectively (Figure 1). A plane was fitted to and then removed from the relative Bouguer data to obtain a residual gravity data set. The residual data were adjusted by a constant after the drilling results were received so that the gravity values agree on average with proven bedrock depths (Figure 2).

The regional field, whose effect can be readily seen in the relative Bouguer data (Figure 1), rises towards the south west, a direction that follows the regional geological dip. Its removal leaves a ridge with a north west orientation lying across the centre of the area. This ridge, apart from being parallel to the geological strike, has a strong correlation with a sub-outcrop of dolerite determined by drilling. The gravity low to the north-east of the ridge seems devoid of dolomite as drilling only encountered andesite, dolerite and Karoo sedimentary rock. Dolomite bedrock, however, was intersected from 14 to 37 meters below surface on the opposite side of the gravity ridge. It is probable that the dolerite intrudes the Black Reef formation, and thus the gravity ridge also marks the north-eastern margin of the dolomite. Less prominent than the ridge is a rectilinear gravity low that extends from the south-western corner of the site across to the north-eastern corner. The cause of this low is unknown; it does not appear related to any particular rock type or thickness but it may arise from preferential weathering of a fracture zone.

Yours sincerely,

R.W.Day.Pr.Sci.Nat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5605
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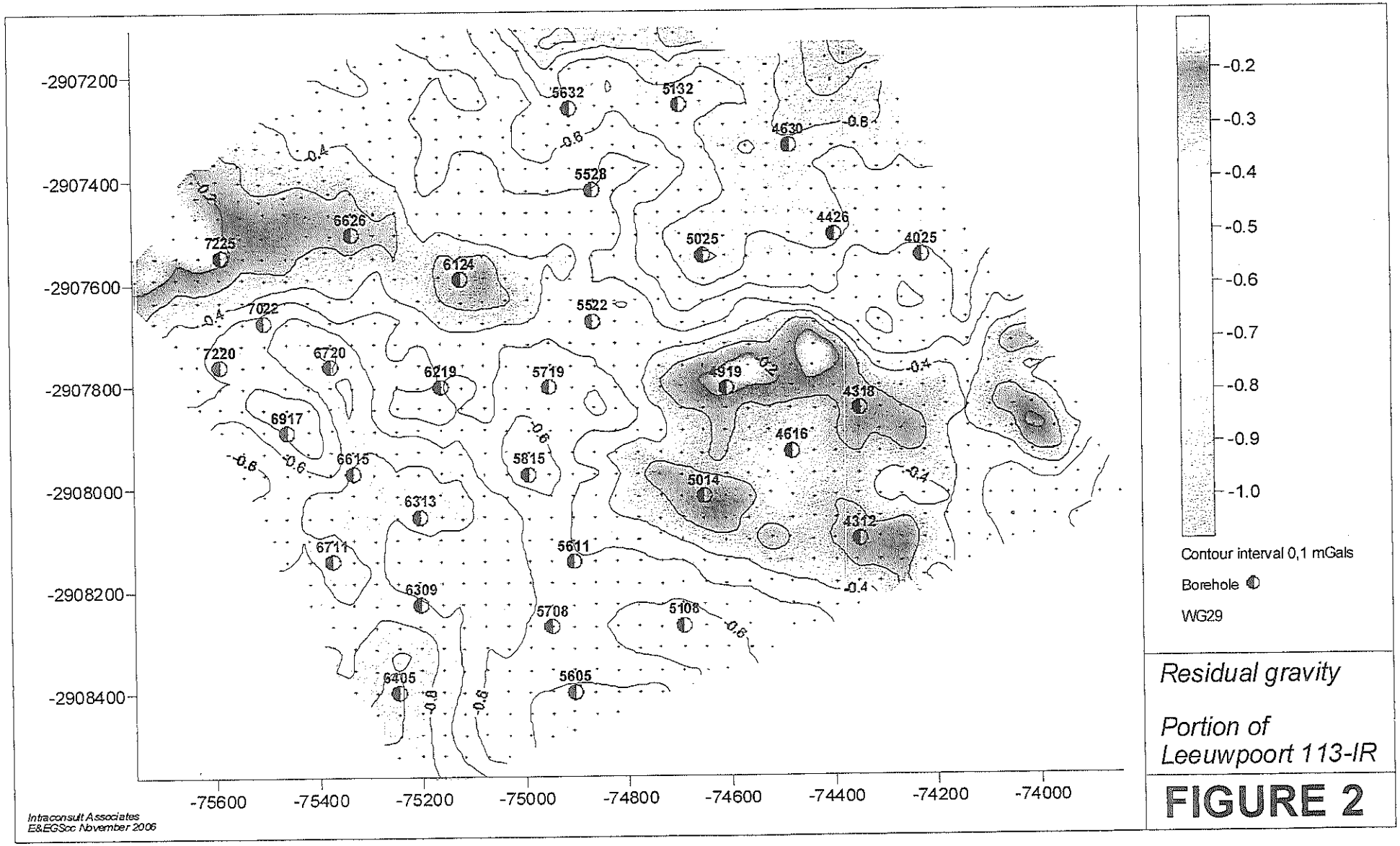
-1.4
-1.6
-1.8
-2.0
-2.2
-2.4
-2.6
-1.0
-0.8
-0.6
Contour interval 0,1 mGals
Borehole
WG29
Relative Bouguer
Portion of
Leeuwpoort 113-IR
FIGURE 1
Intraconsult Associates
E&EGScc November 2006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6219
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4318
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4616
6615
5815
5014
6313
4312
6711
5611
6309
5708
5108
6405
5605
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
Contour interval 0,1 mGals
Borehole
WG29
Residual gravity
Portion of
Leeuwpoort 113-IR
FIGURE 2
Intraconsult Associates
E&EGScc November 2006

APPENDIX 3

PW 344

DEPARTMENT OF PUBLIC WORKS

APPROPRIATE DEVELOPMENT OF INFRASTRUCTURE ON DOLOMITE:

GUIDELINES FOR CONSULTANTS

AUGUST 2004

DEPARTMENT OF PUBLIC WORKS

APPROPRIATE DEVELOPMENT OF INFRASTRUCTURE ON DOLOMITE: GUIDELINES FOR CONSULTANTS

CONTENTS

APPROPRIATE DEVELOPMENT OF INFRASTRUCTURE ON DOLOMITE: GUIDELINES FOR CONSULTANTS.

1. INTRODUCTION

This document serves as a guideline on appropriate development and risk management of infrastructure located on dolomite in South Africa. These guidelines are aimed at informing principal agents and other consultants of the minimum requirements of the Department of Public Works concerning the upgrading, extension and development of new infrastructure on dolomite, thereby promoting safe, sustainable development.

The objective of applying a risk management strategy to infrastructure is to ensure the safety of personnel and visitors, protection of property and to avoid fruitless expenditure. Avoiding sinkholes is not only important from a safety point of view, rehabilitating sinkholes and repairing buildings/infrastructure is costly.

In a climate of increasing awareness of individual rights, it is apparent that failure to pro-actively manage dolomite risk may constitute dereliction of duty and may expose the Department of Public Works, its officials, its principal agents and other consultants involved, to recourse through a number of avenues, including the Occupational Health and Safety Act of 1993. It should be clearly understood that principal agents and consultants are not absolved of their responsibilities and cannot claim ignorance in the event of damage or loss of life in a sinkhole.

In terms of bona mores, the criterion of reasonableness, it is essential that the Department of Public Works and its consultants "act" and are seen to act positively in order to prevent harm. Infrastructure must be appropriately designed, constructed, and serviced to facilitate management of the dolomite risk. To this end the Department of Public Works has adopted a Centralised Dolomite Risk Management Strategy for infrastructure located on all dolomitic land. This strategy aims to ensure appropriate:

- site selection,
- development design
- building design
- design of services, material selection, maintenance friendly systems etc.
- ongoing risk management.

The principal agent and other consultants play a crucial role in ensuring that this strategy is successfully implemented. Background information and appropriate planning, water precautionary and remedial measures are outlined below.

2. BACKGROUND INFORMATION

This section is devoted to providing a rudimentary background perspective on the dolomite issue.

2.1 Definition of dolomitic land

The term 'dolomitic land' is used to describe areas in South Africa underlain directly or at shallow depth (i.e. <100m) by the rock type dolomite. Dolomitic rock is composed of the mineral dolomite, which is a carbonate of calcium and magnesium.

2.2 Why is dolomitic land problematical?

Dolomite is soluble, i.e. dissolves in water. Rainwater and percolating ground water gradually dissolve the rock over time as it seeps through joints, fractures and fault zones in the rock. The dissolution of the dolomite gives rise to cave systems and voids in the rock. Soils covering the rock can collapse into these caves or voids resulting in catastrophic ground movement on the surface such as sinkholes or dolines.

2.2.1 Sinkholes

Sinkholes result from the hollowing out of a space below the earth surface which eventually breaks through and 'daylights' at the surface. Sinkholes are usually cylindrical to conical in shape and can be 1 m to 100 m in diameter and 1 m to 150 m deep. Sinkholes are catastrophic and can cause property damage or loss of life. See figure 2 (page 35) for mechanism of sinkhole formation and plates 1 to 7 (page 38 to 41) for typical sinkholes.

Sinkholes:

- may be catastrophic, as they occur unexpectedly with little or no warning.
- may cause property damage or loss of life, if they are sufficiently large.
- are usually precipitated by human activity such as:
  - dewatering, due to mining activity,
  - water extraction from aquifers,
  - leakage of wet services such as water and sewer bulk services, reticulation and connections,
  - interference with natural drainage patterns by development and disturbance of superficial soil materials leading to concentrated water ingress.

2.2.2 Dolines

Dolines are less sharply defined than sinkholes, occur slowly and not catastrophically (see doline effect on structures in Plates 8 and 9 on page 42). These features may be large ranging from tens of metres to kilometres in diameter or length. Typical visual observations at small dolines are shallow earth depressions and surface cracks in a circular or semi circular pattern.

It should be noted that in South Africa the terms sinkhole and doline are currently used to refer to geomorphological features and are no longer distinguished by the mechanism of formation.

2.2.3 Triggering mechanisms for sinkhole and doline formation

Sinkholes and dolines are mostly caused by water seepage or a lowering of the ground water table. Seepage of water most commonly occurs from leaking water bearing services such as sewers, waters pipes, storm water systems etc. The leaking water erodes the soil covering the dolomite rock and carries the material down into the underlying cave systems resulting in a hollowing out of a space (cavity) below ground surface. When this void daylights, a sinkhole results. (See Figure 2 on page 35).

The ground water level drops when boreholes are used to pump water from below ground surface. The ground water level can also be lowered when mines pump water out of ground water compartments to keep their underground workings dry. Ground water level lowering leads to lowering of pore water pressure which lowers ground bearing capacities or draining of subsurface cavities which may result in sinkhole or doline formation.

2.2.3.1 Sinkholes are generated by a change in the moisture regime in the soils constituting the arch over the upward migrating void. This change in the state of the soil leads to the arch ravelling and the void moving towards ground surface. Eventually the void will daylight and manifesting in a sinkhole. Often paleo sinkholes are re-activated by groundwater level draw down. Paleo sinkholes are ancient features, in

filled over time by transported soil material, e.g. wind blown, aeolian sands. These materials may extend below the original ground water level. In such instances a fall in the ground water level leads to a change in the moisture regime of the soils that re-activates the sinkhole.

The dolomitic environment is often characterised by zones of deep weathering and preferential leaching. This process of preferential weathering is particularly well advanced within the shear zones of faults. Subsurface karst valleys up to 200 m in depth may develop in these shear zones. Spectacular representations of these features can be seen on the Far West Rand.

In many of these areas, the water table is located above the bedrock, in residual soils. These residual materials are essentially composed of wad and ferroan soil. The artificial lowering of the water table may produce significant ground movement at the surface. This process manifests as a doline at ground surface.

2.3 Negative Consequences of Inappropriate Development on Dolomite

To date 38 people have died in sinkholes that have occurred under sports clubs, factories and homes and financial losses have exceeded R1,0 billion. In excess of 1000 sinkholes have occurred on the West Rand, 800 south of Pretoria, Centurion and Atteridgeville and approximately 150 on the East Rand.

Sinkholes and dolines may occur immediately after installation of services because of poor workmanship or use of inferior materials or after a period of time due to deterioration of the materials. Obviously, as the water bearing services deteriorate, the frequency of leaks increases and so does the likelihood of a sinkhole occurring.

2.4 Risk Characterisation of Dolomite Land

Broadly, the geotechnical investigation of the dolomite site culminates in the expression of the stability of the area in three risk categories, namely low, medium and high risk.

The following reference to incidences, gives a perspective of the magnitude of problems encountered in each of the risk zones in research areas. It is important to note that these figures are largely derived from developments not effectively and appropriately designed or maintained.

RISK CHARACTERISATION	GROUND MOVEMENT EVENTS ANTICIPATED PER HECTARE IN A 20 YEAR PERIOD (STATISTICS BASED ON INAPPROPRIATE AND POOR SERVICE DESIGN AND MAINTENANCE)
LOW	Typically 0 events per hectare anticipated but occurrence of events cannot be totally excluded therefore up to 0,1 events/hectare
MEDIUM	0,1 to 1 events per hectare
HIGH	> 1,0 events or more anticipated per hectare

Table 1: Dolomite Risk Characterisation Zone definition

2.5 Distribution of Dolomite in South Africa

Dolomite land occupies up to 25 percent of Gauteng and underlies some of the most densely populated areas such as Bekkersdal, Katorus, Centurion, Dobsonville, Deapmeadow etc. The distribution of dolomitic land in South Africa is shown on the attached Figure 1. See appendix 9 (page 164) for a list of provinces, magisterial districts, municipalities and towns located on dolomite in South Africa.

3. DEPARTMENTAL REQUIREMENTS FOR DEVELOPING SITES ON DOLOMITE

In order to prevent costly development of inappropriate sites it is proposed that the Department institute a strict land acquisition and development policy.

3.1 Appropriate Development Planning

The safe development of a site involves careful geotechnical assessment of the delineated area, appropriate planning and appropriate design of structures and services. These aspects are elaborated on below.

3.1.1 Proclamation Stage Circulation or purchase of new property

At the Proclamation Stage Circulation of a new township layout to the department or in the event of purchasing new properties in a dolomitic region the following information should be sought:

- Consult a dolomite risk specialist and the Dolomite Risk Management database of the department to establish whether the property is located on dolomite or close to the dolomite contact zone.
- The full proclamation stage geotechnical report for the township in which the property is located.
- The developer/land owner should be required to submit a standard form completed by the geotechnical consultant who undertook the township/property investigation. This form should request information concerning the broadly anticipated geotechnical conditions on the proposed sites. A pro forma of this document is enclosed in appendix 1 on page 44.
- Consult the departmental Dolomite Risk Manager as well as a dolomite risk specialist for a review of the above report. Written recommendations on the feasibility to develop the site economically needs to be obtained prior to acceptance or purchase of the property.
- The above relevant information, reports and recommendations must be forwarded to the departmental Dolomite Risk Manager for capturing on the dolomite geographical information system (GIS). It should also be forwarded, with written confirmation of receipt, to the division responsible for further development of the site. This information should be refer to in any future procurement instruction (PI) issued.
- See also section 3.1.2.2 below and PRM 011 in Appendix 8 on page 162

3.1.2 Design of additions to existing infrastructure and planning of new infrastructure by departmental officials or consultants.

The following section contains a brief outline of the responsibilities and

prerequisite actions for the development of infrastructure on dolomite.

3.1.2.1 Briefing of Principal Agent by Project Managers

On being appointed to undertake the design and construction of new infrastructure or upgrading of existing infrastructure the principal agent/project manager (engineer, architect or quantity surveyor) must undertake the following actions ensuring that the general criteria outlined below are applied (To be read in conjunction with standard departmental investigation, briefing and reporting formats as per PRM 006, 007, 011, 012, 017 and 018 as per Appendix 8). Particular attention is to be given to inception Check List (PRM007) to ensure that the consultant is properly briefed

- Consult a dolomite risk specialist and the Dolomite Risk Management database of the department to establish:
  - whether the infrastructure is located on dolomite or close to the dolomite contact zone,
  - in the case of existing infrastructure, establish the anticipated risk characterisation.
- A dolomite risk specialist should brief the principal agent with regard to:
  - available information of the area in general
  - site-specific information as well as
  - the need for and minimum requirements of detailed site investigations
- Once it is confirmed that the site is located on dolomite, the principal agent shall ensure that a geotechnical investigation is conducted and that the consultant team (all disciplines) are briefed in writing thereof. This site-specific detail geotechnical report shall be referred to a dolomite risk specialist for comments and each discipline shall be informed of the results. The dissemination of this information will ensure that services and structures are designed and routed according to the recommendations of the geotechnical report and ensure that departmental precautionary measures as outlined below are applied. (See Section 4 below).

3.1.2.2 Site selection and development criteria

The principal agent shall inform the department after completion of the geotechnical investigation if the following criteria are met and whether it is financially feasible to continue with the project:

- All new sites should have at least an anticipated or extrapolated yield of 50 % medium or low risk land. This medium or low risk portion of the total area must be sufficient in extent for the erection of all structures and related facilities of the proposed new development. If this yield is not feasible, due to the widespread occurrence of high risk land, then from the outset it should be noted that stringent remedial and water precautionary measures will be required, as well as rationally designed sub- and superstructures. The financial implications of such measures may place the cost of the project outside the norms and standards of the department. The appointed

principal agent should immediately discuss this aspect with the project manager of the Department of Public Works. The principal agent needs to furnish the department with expected extraordinary cost estimates, based on geotechnical constraints of sites, before detail design work commences. Revision of the standard cost units (SCU) should be based on this additional information if applicable.

- It is essential that the Department follow a policy of not developing/purchasing sites until it is sure that such sites can be developed economically.

3.1.2.3 Geotechnical investigation

A site-specific geotechnical investigation, involving both a dolomite stability and soils assessment, should be carried out on a site to ensure appropriate planning and design of the development. Such an investigation must meet minimum requirements and the requested format (refer to Appendix 2 on page 47) including:

- Infrastructure located within 1000 m of the dolomite outcrop contact should be carefully evaluated to assess the need for a full dolomite stability assessment.
- The completion of geophysical work, usually gravity.
- The drilling of boreholes on anomalies.
- The logging and presentation of boreholes according to current practice.
- The excavation, profiling and sampling of representative test holes. Where necessary samples should be appropriately tested in a soils laboratory. This aspect of work should conform to current practice, i.e. Profiling according to Jennings, Brink and Williams 1973. Also follow Guidelines for Urban Engineering Geological Investigations and the SAICE Code of Practice (1995).
- The inherent dolomite stability of the site must be described in terms of the 8 classes in accordance with current practice. These inherent risk classes are described in table 6 of **Proposed method for dolomite land hazard and risk assessment in South Africa**, SAICE Journal Vol 43(2) 2001, paper 462 pages 27-36, Buttrick et.al. (current industry standard document).
- The report drawings (preferably on a scale of 1:500) should clearly indicate the following:

  Site information.

  - site locality map (scale: not smaller than 1:50 000),
  - site boundary (superimposed on current cadastral grid),
  - relevant area features such as drainage, neighbouring developments, roads, etc.,
  - site contours – if available,
  - existing services – water, sewer, storm water,

electricity etc
- existing water boreholes.

Geotechnical investigation information of current and all past investigations:

- sinkholes, dolines, paleo features, areas of fill, areas of borrow, rock outcrop etc.,
- existing and new boreholes,
- existing and new soil testing trial holes,
- residual gravity contours in mgals (indicate also survey station grid).

Dolomite risk zonation:

- demarcate low, medium and high risk areas with specific development notes of each,
- other geotechnical problematic areas with specific descriptions thereof.

Proposed site development:

- indicate proposed best site for erection of structures,
- areas for limited development,
- areas for no development.

3.1.2.4 Conclusion and recommendation of the geotechnical report

The geotechnical investigator must indicate:

- in which zones the erection of structures are permissible
- where sports facilities/parking lots/parade grounds/radio masts, etc. (structures and wet services) may be developed
- provide appropriate (site specific) comments of subsurface remedial work
- anticipated foundation problems
- water precautionary measures for each stability zone.
- Comment in general on earthworks to be conducted (borrow/fill/surficial soil disturbances, etc.)

3.1.2.5 General principals to be incorporated in the conclusions of the geotechnical report and the principal agent's site development plan

- Wherever feasible avoid high-risk areas. Locate buildings on low and medium risk areas and place sports facilities/parking lots/parade grounds/radio masts, etc. on medium to high-risk land with the exception of swimming pools. Grassed facilities to be placed on the most favourable portions of medium to high risk land whilst dry facilities such as surfaced parking etc., can be placed on most problematic land, providing no structures are erected and depending on the specific geological conditions. Swimming pools may only be placed on low risk or medium risk land with special precautions.

- Additions to existing infrastructure or buildings, particularly in high-risk areas, require the same level of investigation procedures as for new infrastructure. When linking structures, potential differential settlement between old and new components must not be permitted as it may induce failure of or leaks in any linking wet services. (NB - see also section 4.1.12 for blasting requirements)

- Where an entire site is located in a high-risk area and the development of a high-risk site is unavoidable, stringent water precautionary and remedial measures will be applied.

- It is essential that the Preliminary Site Investigation of the principal agent and his proposed development site plan (sketch plan: see PRM 017/1 for check list in Appendix 8 on page 162) be compared with the Geotechnical Report. Matters such as topographical constraints, position of service connections and building restrictions should be compared with the stability zones on the site. The geotechnical dolomite stability risk zones must be indicated on the site plan and the principal agent shall call for written comments from all members of the consultant team to indicate the influence thereof on the design, construction and cost of services and structures. The combination of these various factors will determine the suitability of a site for development.

See Appendix 3 on page 50 for compulsory information to be indicated on the Principal Agent's development site plan. The geotechnical report, site development plan and services criteria to be implemented as well as budgeting thereof shall be referred to a dolomite specialist for comment.

3.1.2.6 When designing infrastructure on dolomitic land in general

Avoid:
- gardens within 5m of buildings
- water features such as garden or fish ponds within 15 metres of buildings. Water features with automatic replenishment systems should not be permitted
- courtyards that necessitate sub-floor level drainage systems
- construction of buildings or services over natural watercourses
- construction of buildings over wet services
- creating unlined rerouting of natural drainage paths
- concentration or disposal of storm water onto high risk land
- avoid wet services running parallel and close to buildings
- high concentrations of subsurface services near buildings
- using rigid, short length piping (promote long, unjointed, flexible piping)
- subsurface water storage tanks
- disturbance of surficial soil whenever feasible (ensure disturbed areas are properly compacted and reinstated)
- septic tanks, soak-aways or pit latrines
- boreholes for water abstraction
- site features with poor drainage characteristics

Incorporate:
- Appropriate water precautionary measures as outlined below (see Section 4 below)

4. APPROPRIATE WATER PRECAUTIONARY MEASURES FOR DEVELOPMENT ON DOLOMITIC LAND

Water precautionary measures are outlined below in the context of the minimum standards required with respect to each dolomite stability zone (see table 1 on page 3). In general discourage placing of buildings on and traversing of high-risk areas with wet services. The cost implication of routing wet services around high-risk areas should be motivated in addition to normal cost norms as part of the site development cost.

4.1 Low Risk Areas

The risk of sinkhole and doline formation is adjudged to be such that only general water precautionary measures, which are intended to prevent the concentrated ingress of water into the ground, are required.

4.1.1 General design of services

a. Underground wet services shall be designed and constructed so as to minimise maintenance requirements and to avoid potential leakage points. In addition liquids shall be contained in watertight structures to avoid possible disturbance of the underground environment.

b. The relevant specifications of SABS 1200 DB, L, LB, LC, LD and LE shall be observed in the installation of all underground services.

c. The backfilling to service trenches and other excavations shall, except in rock, be less permeable than the surrounding material. General minimum compaction standard to be 93 % Mod AASHTO, provided permeability requirements are met. The use of non-cohesive single size graded sand or crusher sand for bedding, surround blankets and backfill shall not be allowed.

d. Water, sewer and non-concrete storm water pipes shall have a minimum cover of 600 mm outside vehicle traffic areas and a minimum cover of 1000mm in vehicle traffic areas. Where required, protect pipes with appropriately designed concrete slabs above the pipe work.

e. Water, sewer and storm water piping should, wherever possible, not be placed parallel to buildings unless it is at least 5 meters away from the structure. Single direct connections to buildings are preferred. This precaution also applies to electricity and communication cables.

f. Where feasible, provisions for future connections to all services should be made in order to minimize cutting into pipes to provide such connections at a later stage.

g. Provision should be made in all water bearing pipelines to accommodate potential differential movements without causing pipelines or joints to leak.

4.1.2 General construction activities

a. All trenches and open works are to be inspected by a competent person to assess if adverse ground conditions are present. This procedure allows for the adjustment of construction methods, i.e. special bedding requirements, additional excavation and compaction, or pipe protection measurements.

b. Construction excavations should be opened and closed as rapidly as

possible. Avoid leaving trenches open over weekends or holidays.

c. Berms should be constructed on either side of the trenches to prevent the inflow of water during rainstorms.

d. Provisions shall be made in Tender documentation for the supply of pumping equipment to keep excavations dry.

e. Construction site camp services shall also be subject to the precautionary measures as above and below.

4.1.3 Storm water

a. The site and surrounding area shall be shaped (if required) to permit the rapid drainage of surface water and to prevent ponding on the site. Careful attention is to be given to the drainage of areas with gradients less than 1:100.

b. Drainage ports should be incorporated in boundary walls, particularly at the lowest point of the site, to permit the passage of surface runoff. Drainage ports shall be provided with a concrete apron slab, 1,0 m wide and 100 mm thick, on both the inlet and outlet sides of the wall or fence. The slab needs to be extended 400 mm beyond the sides of the port to prevent vegetation growth. The minimum slope on the slab is to be 1:15. Security outlet grids need to be designed not to clog.

c. Drainage onto the property shall not be allowed to accumulate against boundary walls. Drainage towards the site shall preferably be diverted away from the site by means of earth berms. Unlined cut-off trenches should be avoided if possible.

d. Natural ponds and watercourses located within 10 m of any structure shall be rendered impervious within and to a distance of 30 m from the building. (Design criteria: 1 in 5 year flood capacity minimum). The complete diversion of natural watercourses to a minimum distance of 30 m away from buildings is advised.

e. Storm water drainage around buildings and up to 10 metets away shall preferably be kept on the surface or in open canals at slopes of not less than 1:50 for surfaced areas and canals, and 1:20 minimum for unsurfaced areas. All surfaces shall slope away from buildings. Drainage in passages or between buildings needs to slope away from structures and drain along the centre of the open space. No drainage toward a structure is to be allowed. The placing of small diameter (300 mm) concrete storm water canals next to and parallel to buildings is not recommended. Preferably use 1,0 m or wider v-shaped concrete drains.

f. To facilitate drainage, grassed areas such as sports fields should have a minimum slope of 1:80.

g. Storm water drainage conduits and open canals shall be constructed at gradients that will not permit the deposition of soil from the catchment area (Design criteria: 1 in 5 year flood capacity minimum, depending on the local conditions. Additional specific infrastructure design requirements are outlined in Section 6)

h. The storm water drainage system shall incorporate measures to ensure water tightness of conduits, canals and other compartments. All

pipes should be tested for leakage using standard SABS air or water tests. All pipes and structures shall be constructed to show zero percent leakage, when tested as prescribed.

i. Concrete non-pressure pipes should be of the spigot and socket type with rubber ring seals. Joints in box culverts and manholes etc. should be sealed. Ensure sufficient compaction of foundation excavations to preclude any consolidation settlement. Allow for 200 mm thick 1:12 soilcrete slab extending 200 mm beyond the structure foundation if unusually soft soil conditions are encountered. Inlet grids to subsurface systems shall preferably be locked and not allow the passing of any item larger than 40 mm in diameter. Minimum internal pipe size to be 400 mm.

j. Open drains are preferably to be shallow, 1000 mm (min) wide, cast in-situ, V-shaped drains with seated key type construction and expansion joints. Steel reinforcement (if applicable) is to be continuous over joints to preclude horizontal displacement.

k. Subsurface materials should be as follow:

Pipe: Concrete with spigot and socket rubber ring joint **only if approved by departmental Engineer.**

SABS 677/SANS 667 PVC with spigot and socket rubber ring joint **only if approved by departmental Engineer.**

HDPE: Structured wall pipes with ring stiffness of 8,0 kN/m^2 or solid wall pipes of class PN 10 minimum. Pipe material to conform to type PE 100 in terms of SABS ISO 4427/SANS 4427. Supply pipe in 12 m (minimum) lengths. To ensure water tightness, use hot-gas welding (SABS 0268/SANS 10268 – Part 3) or hot-gas extrusion welding (SABS 0268/SANS 10268 – Part 4) internally and externally, or butt-welded joints (SABS 0268/SANS 10268– Part 1) for small diameter pipes, or electro-fusion welding (SABS 0268/SANS 10268 – Part 2) where gas or butt-welding is impossible. All internal burrs (welding bead) shall be specified to be removed from pipes with an internal diameter up to 400 mm. Where it is impossible, Tenderers shall state so in their Tenders and shall in this instance state the maximum internal burr height for each diameter of pipe not deburred. Purpose made industrial equipment, as proposed and approved by the various pipe manufacturers are to be used for this purpose. De-burring is to be executed from an upstream direction. Each removed bead must be numbered with the corresponding joint number and kept for the Engineer's inspection. The Tender shall allow for camera inspection of de-burred joints. Joints of solid or structured wall pipes with a diameter of 400 mm or larger could be improved by means of 300 mm wide HDPE collar (to manufacturers specification) fitted over the joint and welded to both pipes. Alternatively, this collar can be factory fitted. The use of long-sleeve spigot and socket joints with rubber rings are to be approved by

SABS ISO 4427/SANS 4427. Supply pipe in 12 m (minimum) lengths.
Joints: To ensure water tightness, use butt-welded joints (SABS 0268/SANS 10268 – Part 1) in general or electro-fusion welding (SABS 0268 SANS 10268 – Part 2) where butt-welding is impossible. All internal burrs (welding beads) shall be specified to be removed. Where it is impossible, Tenderers shall state so in their Tenders, and shall in this instance state the maximum internal burr height for each diameter of pipe not de-burred. Purpose made industrial equipment, as proposed and approved by the various pipe manufacturers are to be used for this purpose. De-burring is to be executed from an upstream direction. Each removed bead must be numbered with the corresponding joint number and kept for the Engineer's inspection. The Tender shall allow for camera inspection of de-burred joints. Joints of solid or structured wall pipes with a diameter of 400 mm or larger could be improved by means of 300 mm wide HDPE collar (to manufacturers specification) fitted over the joint and welded to both pipes. Alternatively can this collar be factory fitted. The use of long-sleeve spigot and socket joints with rubber rings for pipes larger than 300 mm are to be **approved by departmental Engineer.** Use a manhole when linking different pipe material types.
Manholes: The use of pre-manufactured HDPE manholes is advised. Alternatively use concrete manholes, designed as water retaining structures, **if approved by departmental Engineer.**
HDPE manholes: All material for HDPE manholes to conform to HDPE: Type PE 100 SABS ISO 4427/SANS 4427 specifications and all welding to SABS 0268/ SANS10268, SABS 0269/ SANS 10269, SABS 0270/ SANS 10270, SABS 1655/SANS 1655 and SABS 1671/SANS 1671. Manhole shafts to be structured or solid wall HDPE pipes with:

- 4,0 kN/m^2 ring stiffness for depths not exceeding 1,5 m and,
- 8,0 kN/m^2 ring stiffness for depths exceeding 1,5 m or,

alternatively manufactured to same standard. Engineer to ensure design of manholes are appropriate for soil conditions. See detail TYPE NO DT 04/D and TYPE DT 09/D. HDPE pipes to be welded to manholes.
Concrete manholes: Design as water retaining structures **if departmental Engineer approves use.** Inlet pipes to be provided with puddle flange or key joint (detail TYPE NO DT 12/W) to ensure watertight fixing into walls or construct structure with flexible watertight inlets.

- PVC **Only to be used beyond 15 m from structures.**
Pipe: SABS 791/SANS 791 Heavy duty - Class 34 (solid wall).
Use of PVC to be approved by departmental Engineer.

departmental Engineer. Use a manhole when linking different pipe material types.

Manholes: The use of pre-manufactured HDPE manholes is advised near buildings and structures or areas not trafficked by vehicles. Alternatively use concrete manholes **if approved by departmental Engineer.** Such concrete manholes must be designed as water retaining structures.
HDPE manholes: All material for HDPE manholes to conform to HDPE: Type PE 100 SABS ISO 4427/SANS 4427 specifications and all welding to SABS 0268/SANS 10268, SABS 0269/SANS 10269, SABS 0270/SANS10270, SABS 1655/SANS1655 and SABS 1671/SANS 1671. Manhole shafts to be structured or solid wall HDPE pipes with:

- 4,0 kN/m^2 ring stiffness for depths not exceeding 1,5 m and,
- 8,0 kN/m^2 ring stiffness for depths exceeding 1,5 m or,

alternatively manufactured to same standard. Engineer to ensure design of manholes are appropriate for soil conditions. HDPE pipes to be welded to manhole. Manhole to be similar to HDPE sewer manholes (detail TYPE NO DT 04/D) and welding details as per included detail (TYPE NO DT 20/ST).
Concrete manholes and inlet structures: Design as water retaining structures. Inlet pipes to be provided with puddle flange (detail TYPE NO DT 12/W) or key joint (detail TYPE NO DT 12/W) to ensure watertight fixing into walls or construct structure with flexible watertight inlets.

4.1.4 Sewer

a. Sanitation systems shall not incorporate soakaways. Use conservancy tanks with low flush volumes where sewer connections are not available. If no alternative is available, pit latrines may be utilized in low risk areas provided that the implementation is approved by means of a geotechnical investigation. The pit latrines must be correctly constructed to preclude storm water gaining access. Example: Construct a 0.5 m high earth berm around the up slope side of the pit latrine or place floor slab 500 mm proud of natural ground level with the door facing down slope. The pit latrine should be placed as far away as possible from any permanent structures. Annual relocation of pit latrines is advised. Obviously other matters such as pollution of water resources should be considered e.g. where infrastructure relies on a borehole for its water supply. The utilization of PVC or HDPE holding tanks with chemical digestion for pit latrines should be investigated. Design and material selection for such tanks to be in accordance with relevant material specifications and **approved by the departmental Engineer.**

b. Subsurface pipe materials should be as follow:

- HDPE: **Within 15 m of building.**

Pipe: HDPE: Type PE 100, PN 10 pipes to

c. All connections to manholes shall be flexible and watertight.

d. All sewerage pipes and fittings must be watertight. All laid drainage and sanitary sewer pipes should be tested for leakage using the standard SABS water test on installation. Welded HDPE pipe systems to be pressure tested to relevant pipe pressure class and manufacturer's specification. The welding on of purpose made end-cap sections with feed and bleed valves as well as a pressure gauge can be used for this purpose to test welded pipe sections between manholes, prior to welding on of manholes.

e. All sewers and structures to be tested to zero percent leakage for water tests.

f. Avoid using rodding and cleaning eyes and rather use small HDPE manholes (multi directional collecting pots) that are pre-manufactured small size (300, 500 and 700 mm diameter) manholes with factory fitted HDPE benching. Piping from the manhole to surface level shall consist of HDPE pipes and long radius bends with electro fusion/butt welded connections. All HDPE material to be Type PE 100 as per SABS ISO 4427/SANS 4427 and all welding to conform to SABS 0268/SANS 10268, SABS 0269/SANS 10269, SABS 1269/SANS 1269, SABS 0270/SANS 10270, SABS 1655/SANS 1655 and SABS 1671/SANS 1671. Manhole shafts to be structured or solid wall HDPE pipes with 8,0 kN/m^2 ring stiffness or alternatively manufactured to same standard.

g. The planting of trees or general gardening within 5 meters of sewer lines should be avoided.

4.1.5 Swimming pools

a. Backwash and other water from swimming pools, shall be discharged via HDPE (HDPE: Type PE 100, PN 10 as per SABS ISO 4427/SANS 4427) piping into either the storm water or drainage systems as required by the local authority. Discharge points shall not to be closer than 20 meter from the pool or any other structure.

b. The area surrounding the swimming pool shall be totally impervious (concrete paving) for a distance of at least 5 meters with provision of a drainage canal to collect splashed water.

c. The pool shall not have an automatic water replenishment system.

d. A Dolomite Risk Specialist should advise on the placing of the pool (not closer than 40 meters from buildings).

4.1.6 Electricity and Communication

a. The sleeve and draw box systems for electrical and communication cables shall also be water tight, flexible and constructed to avoid water entering the system. HDPE piping and small diameter manholes as described for sewers above are ideally suited for this purpose. Design and material selection to be similar as for sewer reticulation described above.

b. Trenching, backfilling and compaction of trenches to be similar as for wet services.

c. The use of non-cohesive, single size, graded sand or crusher sand for bedding, surround blankets and backfilling of trenches is not permitted. Construction details are to be similar to water and sewer pipes.

4.1.7 Water

a. The piping used in bulk supply, ring mains and secondary reticulation should be flexible. Joints should be minimal in number and of the flexible, self anchoring type, i.e. not reliant on thrust blocks or friction for their anchorage.

b. Subsurface pipe materials should be one or more of the following:

- Pipes of 75 mm and larger diameter:

  * **Preferred pipe type: HDPE**

    Pipe: HDPE: Type PE 100, PN 12,5 (or higher pressure class if required) to SABS ISO 4427/SANS 4427.
    Supply lengths: Supply pipe in 12 m (minimum) lengths.
    Joints: Butt-welded joints (SABS 0268/SANS 10268 – Part 1) in general or electro-fusion welding (SABS 0268/SANS 10268 – Part 2) where butt-welding is impossible.
    Fittings: Manufactured from HDPE: Type PE 100, PN 12,5 (or higher, as may be required) to SABS ISO 4427/SANS 4427.
    Welding: All welding to relevant SABS 0268/SANS 10268, SABS 0269/SANS 10269, SABS 0270/SANS 10270, SABS 1655/SANS 1655 and SABS 1671/SANS 1671 codes. All internal burrs (welding beads) shall be removed. Where it is impossible, Tenderers shall state so in their Tenders and shall in this instance state the maximum internal burr height for each diameter of pipe not deburred. Purpose made industrial equipment, as proposed and approved by the various pipe manufacturers are to be used for this purpose. De-burring is to be executed from an upstream direction. Each removed bead must be numbered with the corresponding joint number and kept for the Engineer's inspection. The Tender shall allow for camera inspection of de-burred joints.

  * Alternative: High Impact PVC pipes (SABS 966/SANS 966, class 12) with victaulic joints only if approved by **departmental Engineer.**

  * Exceptional circumstances and in above ground installations: Steel pipes with suitable internal and external corrosion protection and flexible, self-anchoring connections. **Reasons for use to be approved by departmental Engineer.**

- Pipes having a diameter of less than 75mm:

  * **Preferred pipe type: HDPE**

Pipe: HDPE: Type PE 100, PN 16 (or higher pressure class if required) to SABS ISO 4427/SANS 4427.
Supply lengths: Supply pipe in 100 m (minimum) lengths.
Joints: Butt-welded joints (SABS 0268/SANS 10268 - Part 1) in general or electrofusion welding (SABS 0268/SANS 10268 – Part 2) where butt-welding is impossible. No compression fittings are allowed except if in watertight manholes. The use of underground joints are allowed only with approval of the departmental Engineer. The use of unjointed pipes between inspection chambers is mandatory.
Welding: All welding to relevant SABS 0268/SANS 10268, SABS 0269/SANS 10269, SABS 0270/SANS 10270, SABS 1655/SANS 1655 and SABS 1671/SANS1671 codes.

c. Piping from main reticulation to the building shall be **unjointed** HDPE: Type- PE 100, PN 16 (or higher class if required) pipes to SABS ISO 4427/SANS 4427.

d. Underground valves are to be placed in watertight concrete or HDPE manholes. HDPE manholes are to be manufactured to same standard as sewer manholes described above. Concrete manholes for valves are to be designed as water retaining structures.

e. No high-pressure compression connections are to be allowed below ground level. All such connections are to be placed in watertight manholes.

f. Shut-off valves and water meters shall be supplied at main supply with permanently fixed pressure gauge on the building side of the main shut-off valve (for regular systems testing).

g. All site services to be tested to zero per cent leakage.

4.1.8 Roads

a. Roadways, which have a gradient of less than 1:80, shall be surfaced/sealed.

b. The velocity of the 1 in 20 year storm water, flowing along un-surfaced roadways shall not exceed 1,5 m/s.

c. Ensure that surfaced roadways and parking areas are in fact placed below site level so as to facilitate drainage.

4.1.9 Plumbing

a. Unjointed flexible HDPE (HDPE: Type PE 100, PN 16, or higher pressure class if required, to SABS ISO 4427/SANS 4427.) water piping from the main supply to 100 mm above natural ground level for entry into the buildings. Place 1,0 x 1,0 m concrete slab at entry point if area is not paved.

b. Pipes through walls, at entry points to buildings, shall be sleeved to permit relative movement up to 25 mm. Seal annulus with water tight, compressible and rodent resistant material.

c. All connections between flexible and rigid pipes shall be provided with flexible, self-anchoring joints. Such connections must be in watertight structures or above ground level.

d. No water pipes shall be placed under floor slabs. If unavoidable, provide service ducts, which are watertight and can be inspected, above or below floor slab.

e. The use of surface mounted GMS water pipes on external walls and from the roof downward is preferred for all building water reticulation. The chasing of water piping into walls should be kept to a minimum. The placing, protection and support of exposed pipes are to be designed to ensure serviceability during fires.

f. The selection of piping material shall take cognisance of corrosion (both external and internal). Preferably use welded HDPE or alternatively PVC with victaulic joints if approved by departmental Engineer.

4.1.10 Drainage

a. The collection of sewer and waste pipes from multiple adjoining toilets or washbasins should be externally surface mounted. These pipes should feed into a single down pipe draining into the subsurface systems.

b. Areas of high concentrations of sewer outlets on buildings should be surfaced with concrete or paving bricks to avoid later covering of services with soil or vegetation growth and to ensure that blockages are detected early.

c. All sewer pipes and fittings shall be provided with flexible, watertight joints.

d. No sewer or waste pipes shall be placed under floor slabs. If unavoidable provide above or below floor slab level service ducts which are watertight and can be inspected.

e. Pipes through walls shall be sleeved to permit relative movement up to 25 mm. Seal annulus with water tight, compressible and rodent resistant material

f. WC pans shall be provided with a flexible connection at the junction with the outlet pipe.

4.1.11 Storm water/rainwater drainage

a. Downpipes, if provided, shall discharge into concrete lined drainage channels, which discharge the water at least 5m away from buildings. Discharge area shall have a slope of 1:20 minimum to a point 15 meters away from the building.

b. V-shaped concrete canals should be used to route all storm water towards and from buildings to an area where natural surface drainage will allow free drainage away from structures. These canals should be placed at least 5 m away from structures.

c. Construct a 2m wide impervious apron slab around the building where

guttering is not provided.

d. The ground immediately against buildings shall be shaped to fall in excess of 75 mm over the first 1,5 m beyond the perimeter of the buildings, from where it will drain freely away from the structures. Concrete apron slabs or brick paving shall have a minimum of 1:20 fall away from buildings.

e. Drainage canals traversing walkways shall not be piped under walkways. Use impervious canals and grids.

f. Brick and precast concrete courtyard walls etc. must be so designed as to provide drainage ports at ground level to permit the passage of water.

4.1.12 Blasting

a. Experience on dolomite indicates that blasting may lead to severe disturbance of the metastable dolomite environment, giving rise to sinkhole formation. Consequently, if blasting is necessary it is essential that appropriately experienced blasters be approached to determine the particular method and specification for blasting, regarded as appropriate in the context of the geological conditions.

b. PPV to be recorded for each blasting sequence.

4.1.13 Boreholes for ground water abstraction

a. Careful consideration, as a control on dewatering, to be given before permission is granted to sink boreholes for water abstraction. If the water table is above bedrock, a blanket ban on exploitation of the ground water should be imposed. Approval should be subject to an evaluation of the implications by an engineering geologist specialising in dolomitic related matters.

b. Where data is available concerning existing boreholes, for water abstraction within 50 meters of the site, comment should be made concerning this data in the geotechnical report and on the site plan.

4.1.14 Foundations

a. Foundation excavations need to be inspected to ascertain if surficial soil problems such as collapsible soil materials and geotechnical conditions such as shallow rock outcrops, sharp soil strata changes, paleo structures etc. are present. A dolomite specialist should conduct this inspection.

b. Ensure backfilling around structures are properly backfilled with suitable material that will have a density after compaction of not less than the in-situ soil (no building rubble or course aggregate exceeding 63 mm in diameter shall be allowed). Compact to a minimum of 93 % Mod AASHTO density.

c. Termite poisoning shall be introduced around all structures

d. Sub structure design shall be appropriate in terms of the surficial soil condition and the dolomite stability conditions.

Water is a triggering mechanism, in the majority of cases, of distress in dolomitic/limestone areas. It is therefore imperative that the concentrated ingress of water into the ground be avoided at all times, including the construction period.

4.2 Medium Risk Areas

The risk of sinkhole and doline formation is adjudged to be such that stringent water precautionary measures, which are intended to prevent the concentrated ingress of water into the ground, are required to permit the construction of the infrastructure.

4.2.1 The precautionary measures as detailed above for Low Risk areas shall apply as well as amendments thereof and additional requirements listed below.

a. Discourage the construction of any ponds, water features and swimming pools. (Departmental approval required)

b. All water retaining structures are to have foundations on 250 mm thick soilcrete raft (1:8 mix) extended 300 mm beyond the structure. Introduce backwater stops and internal water stops to all expansion and construction joints (not only those below water level)

c. Sanitation systems shall not incorporate soakaways or pit latrines. Use watertight conservancy tanks where sewer connections are not available. .

d. Backwash and other water from swimming pools, shall only be discharged into either an impervious storm water or drainage systems as required by the local authority (HDPE piping or lined discharge systems to be provided).

e. Earth backfilling compaction standards are to be observed and SABS 1200 requirements must be fully met.

f. Earthworks on pipes: SABS 1200 LB: Bedding and selected fill - Clause 3.1 is amended to allow the maximum aggregate size, not to exceed 6 mm. Material should not be free draining as described in this particular clause. The compacted bedding and fill material shall be less permeable than the in-situ soil.

g. Special attention is to be given to drainage of all areas with gradients less than 1:80. Absolutely no ponding of water on site shall be allowed.

h. No piped storm water systems are allowed within 15 meters of buildings or under any structure. Open culverts with grating covers should be used to traverse any trafficked area in or around buildings.

i. Storm water canals should have a 250 micron HDPE lining and continuous light steel mesh reinforcement over sealed key construction and expansion joints that preclude any vertical movement.

j. The placing of small diameter storm water gulleys parallel to buildings is not allowed. Use 1,2m wide V-shaped concrete drains where drainage parallel and close to buildings is required. Joints between structures and canals to be sealed as in the case of canal expansion joints.

k. All roadways, which act as storm water collectors, shall be surfaced.

l. All brick paving shall incorporate a 250 micron HDPE lining.

m. All courtyards or narrow (< 4 m) spaces between structures are to be paved with brick paving or concrete apron slabs and 2,5 metre wide paving shall be introduced around all structures with no gutters.

n. All storm water from down pipes shall discharge into concrete lined channels which in turn will discharge the water at least 10 metres away from structures onto areas that permit free surface drainage away from structures.

o. Where necessary, use earth berms to enhance site drainage.

p. All concentrated storm water entering the site shall be diverted away from any structure or developed area by means of concrete lined channels.

q. The use of welded HDPE piping systems for water, sewer and storm water is required as the material is more tolerant of movement. The above ground mounting of a GMS water reticulation on steel pedestals is preferred. **Alternative materials only to be used if approved by departmental Engineer.** All material for HDPE pipes, structures and fittings must be in accordance with SABS ISO 4427/SANS 4427 for type PE 100 and all welding and manufacturing to be in accordance with SABS 0268/ SANS 10268, SABS 0269/SANS 10269, SABS 0270/SANS 10270, SABS 1655/SANS 1655 and SABS 1671/SANS 1671 codes. All joints to be welded, unless joint is installed for future dismantling. Such joints are to be installed in water retaining structures that can be inspected.

r. No groundwater abstraction will be allowed.

s. The responsible regional manager should have a system whereby follow up tests for leakages of wet services are carried out and the results monitored.

t. The need for reinforced foundation design, building articulation and special foundation earth works (i.e. extended excavation and compacted backfilling, soil rafts etc.) should be investigated and reported on in the context of the site geotechnical report.

4.3 High Risk Areas

The risk of sinkhole and doline formation is adjudged to be such that precautionary measures, in addition to those pertaining to the prevention of concentrated ingress of water into the ground are required to permit the construction of the infrastructure.

4.3.1 The water precautionary measures listed above for Low and Medium Risk areas as well as additional measures and amendments outlined below are applicable in High Risk areas. These measures are also applicable where development on high risk areas is unavoidable e.g. where the additions are made to existing infrastructure in a high risk area or where an entire site is regarded as a high risk area.

a. Use only HDPE piping for water (Class PN 12,5 and higher), sewer (Class PN 10 minimum) and storm water (8 kN/m^2 ring stiffness) in

high-risk areas or where services traverse high-risk areas. All material for HDPE pipes, structures and fittings must be in accordance with SABS ISO 4427/SANS 4427 for type PE 100 and all welding and manufacturing to be in accordance with SABS 0268/SANS 10268, SABS 0269/SANS 10269, SABS 0270/SANS 10270, SABS 1655/SANS 1655 and SABS 1671/SANS 1671 codes.

b. In extremely problematic areas water reticulation may be placed above ground or all services may be placed in ducts or sleeves where within fifteen metres of a building. Sleeves to be provided with inspection chambers at both ends and must comply with the requirements of a sewer system for high risk areas. All sleeve systems must be constructed to designed slopes that permit drainage to predetermined inspection manholes.

c. Ablution facilities should not be included in the principal buildings or infrastructure. These facilities should be isolated in such a manner as to avoid damage to other parts of the development in the event of service failure and sinkhole/doline formation.

d. Use aprons of large (5.0 m min width) impervious paved areas around structures to enhance drainage. If rapid drainage (slopes 1:15 and steeper) away from structures is possible apron slabs may be reduced to 3,0 m width.

e. Blanketing of geotechnical problematic areas with impervious material (clayey soil and/or HDPE sheeting), concrete or paving bricks need to be introduced if such areas could influence the structural integrity of buildings.

f. Contouring of site to achieve a fall of least 1:40 in general and to 1:15 away from structures within a distance of 8m of a structure are required.

4.3.2 Proposed remedial and General Precautionary Measures for Consideration on High Risk Sites.

a. In areas of very poor stability with historical evidence of ground movement, especially in ground water compartments undergoing dewatering, monitor points shall be installed on buildings and at strategic locations on the property, e.g. on towers, plinths, manholes, etc. Accurate levels of these points should be gathered and kept as baseline data (e.g. three cycles of data). At any stage when concerns arise with respect to the stability of the site or portions thereof new levels can be taken for comparative purposes permitting the identification of problem areas.

b. In areas of shallow dolomite bedrock the highly susceptible nature of the subsurface profile to erosion necessitates the consideration of using a mattress of enhanced earth. This mattress has the dual purpose of improving founding conditions (negating differential movement) and reducing the permeability of the subsurface profile. This method involves the removal and replacement of incompetent, problematic soil beneath and for 3m beyond the periphery of buildings. The specification for the earth mattress/soil raft will be dependent on bedrock depth and the nature of the local soil materials.

c. In high-risk areas use should preferably be made of the following structure types:

- Light raft (e.g. waffle raft) foundations.
- Prefabricated or lightweight designed superstructure (PWD approved prefabricated building system).

d. Fencing of high-risk areas where sinkholes or dolines have already occurred. Personnel should not be allowed to traverse such areas.

e. No gardens are to be created within a distance of 5 m of any structure or service.

f. Water bearing services should be inspected at least twice per year preferably before and towards the end of the rainy season.

5. APPROPRIATE ENGINEERING DESIGN DETAILS AND CONDITIONS OF CONTRACT FOR WORK ON DOLOMITIC LAND

Typical, minimum standard, details for engineering designs are included in Appendix 5 and relevant Particular Specifications are given in Appendix 6. These details and specifications are to be extended/improved to suit the site-specific conditions. All drawings and specifications used, shall be the responsibility of the appointed project Engineer. Typical information to be gathered/observed during site investigations of engineering services on dolomitic land is outlined in Appendix 4

The latest revision of the Special Conditions of Contract (as issued by the Department of Public Works) forming the Annexure to the General Conditions of Contract for use in connection with Works of Civil Engineering Construction – Latest edition (available from SAICE) and in particular clauses referring to work in the dolomitic environment should be discussed with the departmental Engineer. Particular attention is to be given to Special Risk Insurance, particularly if the work involves excavation, demolition, blasting and/or sinkhole related repairs.

The design Engineer must specify, in detail, all precautionary and safety measures to be taken in the event of work related to sinkhole and doline repairs.

6. DESIGN AND TENDER DOCUMENT STANDARDS FOR UPGRADING OF INFRASTRUCTURE ON DOLOMITIC LAND (Revision 5 of 21 August 2003)

6.1 General

The designs shall be based on the documents listed in Table 2 hereunder.

The Design Criteria for Dolomitic areas: Appropriate Development of Infrastructure on Dolomite: Guidelines for Consultants (THIS DOCUMENT)	PW344 June 2004
Civil Engineering Manual	PW 347 May 2004
Standard specification for domestic and fire water storage and fire water supply for public buildings	PW345 dated May 2004
Guidelines for the design of small sewerage treatment works for isolated DPW developments	To be issued in future
Guidelines for design of civil services for new generation prisons	PW342 March 2004
Human Settlement Planning and Design	CSIR April 2000

(Red Book)	
Water Supply and Drainage for Buildings (Part 1 and Part 2)	SANS 10252-1, SANS 10252-2
Code of Practice for Community Protection against Fire	SANS 10090
The Application of the National Building Regulations	SANS 10400
Specifications of Materials and Methods to be used	PW 371 1993
All documents referenced in Section F, paragraph F.2 of Civil Engineering Manual	PW 347 May 2004

Table 2: List of documents for design of engineering services in dolomitic areas.

6.2 **Status of Documents**

6.2.1 Should there be any conflict between the requirements of the various documents, they shall have preference in the order as listed.

6.2.2 The Consultant's attention is specifically drawn to the fact that his/her practice will accept ***full responsibility*** for the design, detail(s), specifications and drawings. The Department's input is given to ensure basic compliance with minimum statutory-, regulatory- and legislative requirements, with the specific aim of achieving best practice details/specifications in conjunction with the Consultant's expertise.

6.3 **Project Standards**

6.3.1 General

New infrastructure shall be located as far as possible on the lowest risk dolomitic soil.

The Project Requirements below have preference above all the listed documents.

The prescriptions of the local fire fighting authority shall prevail.

The basic design standards of the Department are as follows (in addition to the requirements of the documents listed in item 6.1).

6.3.2 Water Supply

6.3.2.1 Replace all waterlines with:
HDPE - Type PE 100, Class PN 16 for 63 mm diameter and smaller.
HDPE - Type PE 100, Class PN 12,5 for 75 mm diameter and larger.
(If the design requires pressures in excess of the above, such class shall be specified)

6.3.2.2 HDPE pipe material is to be in accordance to SABS ISO 4427/SANS 4427.

6.3.2.3 All water pipes, of 160 mm diameter and smaller, traversing

High Risk Dolomite Zones, must be placed in welded HDPE sleeve pipes that terminate in HDPE manholes. Sleeve pipes shall be HDPE Type PE 100 Class PN 10.

6.3.2.4 All manholes and valve chambers to be watertight heavy duty welded HDPE (material type PE 100) with minimum ring stiffness 8 kN/m^2 or cast in-situ watertight reinforced concrete manholes (if approved by departmental Engineer) with HDPE puddle flanges welded to the HDPE pipes. (See details TYPE DT 11-1/W, TYPE DT 12/W, TYPE DT 04/D, TYPE DT 09/D.

6.3.2.5 All HDPE pipes to be butt-welded (SABS 0268/SANS 10268 – Part 1) unless specifically otherwise approved by the Department. Electrofusion welding (SABS 0268/SANS 10268 – Part 2) will only be allowed in special circumstances.

6.3.2.6 Primary and secondary water loops shall be closed as far as feasible except where otherwise approved by the Department.

6.3.2.7 Design water monitoring system with bulk supply flow meters and flow meters at each secondary branch. Logging shall be facilitated by means of a portable logger for all automatic water meters to be supplied under the Contract(s).

6.3.2.8 The layout of secondary mains is to be in accordance with The South African Standard Code of Practice: The Management of Potable Water in Distribution Systems SABS 0306/ SANS 10306.

6.3.2.9 Old mains that are to be abandoned must be removed and the trenches backfilled and compacted to permeability of less than the in-situ soil. Where old mains are under surfacing and where removal would be uneconomical, pipes are to be grouted using a suitably designed soil-cement (12:1) mixture.

6.3.2.10 Water pipes, where permitted above ground shall be of hot dipped heavy-duty galvanized steel pipes to SABS EN 10240/SANS 32. Screw threads shall be cut as far as possible prior to galvanizing. No welding will be permitted after galvanizing. All screw threads, pipe ends and joints shall be treated with a mastic compound in accordance with the manufacturer's specifications on completion of the installation.

6.3.2.11 All valves on water mains to be clockwise closing.

6.3.2.12 Valves shall be flanged resilient seal gate valves and fitted to flange adaptors. They are also to be housed in watertight manholes.

6.3.2.13 Standard water meters shall be installed at each house, building, facility etc.

6.3.2.14 Pipelines are to be designed to ensure zero percent leakage and shall be hydraulically tested to a pressure of between 1.50 and 1.75 times the maximum designed working pressure for a minimum period of three hours.

6.3.2.15 Fire Fighting Design shall be in accordance with the National Building Regulations, SABS 0400/SANS10400 and as required by the appropriate Metropolitan Council and shall be officially approved by the local fire fighting authority.

6.3.2.16 Fire hydrants are to be above ground, tamper proof, right angled and in accordance with SABS 1128 and the local fire fighting authority's requirements.

6.3.2.17 Domestic and fire water requirements shall be calculated in accordance with the "Standard specification for domestic and fire water storage and fire water supply for public buildings, PW345 dated May 2004" Obtain latest version of these guidelines from the departmental Engineer.

6.3.2.18 The minimum distance of mains from buildings, is as follows:

a	High and medium risk dolomite areas	15 m
b	Low risk dolomite areas	5 m

6.3.2.19 Minimum cover to water pipes

a	Average	0,75 m
b	Outside traffic areas	0,60 m (min)
c	In traffic areas	1,0 m (min)

6.3.2.20 All buildings are assumed to be fully occupied for hydraulic design.

6.3.2.21 No direct connections shall be allowed on primary mains, unless approved by the Department.

6.3.2.22 All valves, meters, fire hydrants, pressure reducing valves, manholes and junction boxes shall be clearly marked with numbers to be supplied by the project manager. Marking shall be by numbering cast into the concrete on top of structures. Marking symbols and numbers are to be approved by the Department.

6.3.3 Sewerage Design

6.3.3.1 Replace all sewers with Type PE 100, PN 10 HDPE pipes to SABS ISO 4427/SANS 4427.

6.3.3.2 All manholes to be watertight heavy duty welded HDPE (Type PE 100) with minimum ring stiffness 8 kN/m^2 and with sewer pipes welded to the manholes. Where approved by the Department, cast in-situ watertight dolomite aggregate reinforced concrete manholes with HDPE puddle-flanges welded to the HDPE pipes may be used. (See details TYPE DT 11-1/W, TYPE DT 12/W, TYPE DT 04/D, and TYPE DT 09/D)

6.3.3.3 HDPE pipes are to be joined by butt-welding unless otherwise approved by the Department. Electrofusion welding will only be allowed in special circumstances.

6.3.3.4 Where possible, all pump stations and septic tanks are to be eliminated.

6.3.3.5 Designs are to ensure zero percent leakage and sewers shall be water pressure tested at a pressure of between 100 and 150 kPa for a minimum period of two hours. Testing to be as otherwise specified in Clause 7 of SABS 1200/SANS 1200 LD. HDPE pipes to be pressure tested to same standard as HDPE water pipes.

6.3.3.6 All existing buildings are assumed to be fully occupied for hydraulic design.

6.3.3.7 Provide special measuring manholes suitable for installation of portable sewage flow meters where sewage enters municipal areas or feeds into local sewage treatment works. (Venturi type is preferred for average flows in excess of approximately 10 *l*/s.)

6.3.3.8 Sewerage flows shall be calculated in accordance with the "Guidelines for the design of small sewerage treatment works for isolated DPW developments". This document will be released in future. Obtain latest version of these guidelines from the departmental Engineer.

6.3.3.9 Where contours permit, the minimum gradient for any sewer shall be such that a minimum velocity of 0,7 *m/s* is obtained at peak design flow.

6.3.3.10 In flatter terrain, the sewer gradient may be reduced to obtain a minimum velocity of 0,7 m/s at full bore flow.

6.3.3.11 Maximum spacing between manholes.....80 m

6.3.3.12 Cover to pipes

a	Average	0,75 m
b	Outside traffic areas	0,60m (min)
c	Inside traffic areas	1,0 m (min)

6.3.3.13 Minimum sewer diameter (nominal diameter).....160 mm

6.3.3.14 Minimum diameter for sewer house connections (nominal diameter) .....160 mm

6.3.3.15 Minimum diameter for pump station rising mains (nominal diameter).....110 mm

6.3.3.16 Minimum pump flow velocity in rising mains.....0,7m/s

6.3.3.17 Maximum pump flow velocity in rising mains.....2,5m/s

6.3.3.18 Sewage pump stations shall be equipped with dry well sewage pumps, a "Muncher" and a diesel electric emergency standby generator and an alarm system as approved by the Department.

6.3.3.19 Storm water infiltration into sewers.....0 *l/s*

6.3.4 Storm water Design

6.3.4.1 When existing concrete pipes are to be sleeved internally, HDPE Type PE 100, class PN10 SABS ISO 4427/SANS 4427 pipes should be used.

6.3.4.2 Replace all other concrete storm water pipes with either HDPE (Type PE 100) solid (class PN10) or structured wall (8 kN/m^3) pipes up to 900 mm diameter or suitable, protected open channels where approved by the Department.

6.3.4.3 Provide items to repair or replace storm water pipes larger than 900 mm with HDPE or concrete spigot and socket pipes with rubber rings. Include both types in Schedule of Quantities in 30:70 ratio.

6.3.4.4 Existing concrete pipes with rubber rings larger than 900 mm diameter that have sagged are to be replaced with HDPE or open channels as approved by the Department.

6.3.4.5 It is critically important that open areas be reshaped and areas of ponding be identified to ensure positive storm water drainage.

6.3.4.6 Joint seals in concrete channels, box culverts and manholes are to be cleaned and re-sealed watertight with polysulphide to manufacturer's specifications.

6.3.4.7 Cable ducts shall be provided in accordance with user requirements. Draw boxes and sleeves shall be similarly watertight constructed and tested as for sewers.

6.3.4.8 Old abandoned civil engineering services and sleeves without cables are to be removed or grouted with suitably designed soil-cement (12:1) mixture to prevent the ingress of water.

6.3.4.9 All HDPE pipes shall be butt-welded unless otherwise approved by the Department. Electrofusion welding will only be allowed in special circumstances.

6.3.4.10 Storm water manholes and junction boxes shall be of welded HDPE (Type PE 100) with ring stiffness 8kN/m^2. Where approved by the Department, watertight cast-in-situ reinforced concrete manholes with HDPE puddle flanges welded to the HDPE pipes may be used. Storm water manholes and junction boxes are to be sealed and tested for 0 % leakage. See also item 8.9.

6.3.4.11 Where pipe directions change under trafficked areas, a junction box is to be used. If it occurs outside trafficked areas, manholes are to be used.

6.3.4.12 Open channels in residential areas and near traffic zones shall be properly covered/protected as approved by the Department.

6.3.4.13 The Rational Method is to be used for design flood

calculations.

6.3.4.14 Design minor systems for a storm with recurrence time of..... .....1:2 years

6.3.4.15 Design major systems for a storm with recurrence time of..... .....1:25 years

6.3.4.16 Minimum pipe diameter (excluding gutter and similar connections).....450mm

6.3.4.17 Slopes of storm water pipes shall preferably be steeper than. .....1 %

6.3.4.18 Cover to pipes:

a	Average	0.75 m
b	Outside traffic areas	0,60m (min)
c	Inside traffic areas	1,0 m (min)

6.3.4.19 Friction coefficients:

a	Colebrook White friction coefficient (including secondary losses)	
i	Plastic pipes	k = 0.6 mm
ii	Concrete pipes	k = 1.5 mm

b	Manning friction coefficient (including secondary losses)	
i	Plastic pipes	0,012
ii	Concrete pipes	0,013

6.3.5 Pipe work design at or near buildings

Water pipe work above ground shall be of Hot Dipped Galvanized Heavy Duty steel to SABS EN 10240/SANS 32 and be fixed above ground against the building. Manifold(s) shall be above ground with single HDPE feeds from below ground, where applicable.

The sewer pipe work above ground shall be solid wall class 34 heavy-duty uPVC to SABS 791/SANS 791 fixed against the building. Manifold(s) shall be above ground connecting with Kimberly Sockets to below ground HDPE pipes.

6.4 **Requirements for HDPE piping and fittings**

6.4.1 Scope

This material specification outlines the requirements for the manufacture of PE-HD (High Density Polyethylene) Pipes & Fittings to be utilised.

6.4.2 Quality assurance

It is the responsibility of the manufacturer/supplier to establish Quality Assurance by means of quality control procedures, which shall ensure that the product will meet the requirements of this specification. The

manufacturer/supplier shall maintain a quality system that conforms to the requirements of the SABS ISO 9001:2000 / SANS 9001 or national equivalent. Applicable standard for manufacture of pipe shall be SABS ISO 4427/SANS 4427.

It is the responsibility of the design Engineer to ensure that all material and manufacturing details of all pipes, fittings and structures are appropriately specified in terms of the relevant SABS (or equivalent) specifications in the Tender documents and that the Contractor supply and install all material to the required SABS standards on site. Tender documentation must include or refer to all relevant requirements, certification or testing that may be necessary for quality insurance of raw material supply, manufacturing standards, equipment used in manufacturing or tests to ensure standards are met. Refer to SABS ISO 4427/SANS 4427, SABS 0268/SANS 10268, SABS 0269/SANS 10269, SABS 0270/SANS 10270, SABS 1655/SANS 1655, SABS 1671/SANS 1671 and relevant specifications. Tender documentation must allow for relevant quality control testing either by means of an appropriate clause (stating type of test and quantity) or by inclusion (specific stipulation of test requirements) in the price of the manufactured/installed item.

6.4.3 Inspection

The design Engineer must ensure that pre-delivery tests are conducted at the manufacturer's/supplier's works.

Tender documentation must stipulate that the Contractor will arrange with the supplier access to his works for the purpose of inspecting either during the course of manufacturing or when completed and shall permit the design Engineer all reasonable access to conduct such inspections.

Copies of all test schedules and manufacturer's quality control records as called for in the relevant SABS (or similar) specifications and Tender specifications shall be submitted by the Contractor for examination by the design Engineer.

6.4.4 General product requirements

The finished product shall be free from cracks, voids, foreign inclusions and other defects, which would impair the overall performance. It shall be smooth walled on inside and outside and shall conform to the requirements (characteristics) outlined below.

6.4.5 Characteristics

Raw material composition for pipes, fittings (e.g. stubs) and other elements (e.g. sheeting for benching) shall be **PE 100 pre-compounded black.**

6.4.5.1 Technical considerations for raw material and finished product:

Physical/Chemical Property	Standard	Value	Unit
Density	ISO 1183	0.949-0.960	g/cm^3
Melt Flow Index (190°C/5Kg)	ISO 1133	0.25-0.35	g/10min.
Vicat Softening Point	ISO 306	64-68	°C
Crystalline Melting Range	ISO 3146-85	130-135	°C

Viscosity Number	ISO 1628-3	390	cm^3/g

Mechanical Property	Standard	Value	Unit
Shore D, Hardness	ISO 868	61	-
Elastic Modulus	ISO 527	≈900	MPa
Tensile Yield strength	ISO 527 / ISO 6259	24	MPa
Ultimate Tensile	ISO 527 / ISO 6259	35	MPa
Ultimate Elongation	ISO 527 / ISO 6259	>600	%
Flexural Stress (3.5% Deflection)	ISO 178	19	MPa
Thermal Stability (OIT @ 210°C)	ISO 10837	>40	minutes
Carbon Black Content	ASTM D 1603 / ISO 6964	2.25 +/- 0.25	%

6.4.5.2 Pipe characteristics

Characteristics	Applicable Standard
Outer Diameter	ISO 11922-1 (Grade B)
Min Wall Thickness at any point	ISO 11922-1 (Grade U) -- ISO 4065
Ovality	ISO 11922-1 (Grade N)

6.4.6 Welding requirements

PE-HD pipes and fittings welders to be certified under the Thermoplastics Welding Institute of South Africa (TWISA)

The following standards shall apply:

SABS 0268/SANS 10268 Part 1	Welding of thermoplastics - Welding processes - Heated tool welding
SABS 0268/SANS 10268 Part 2	Welding of thermoplastics - Welding processes - Electrofusion welding
SABS 0268/SANS 10268 Part 3	Welding of thermoplastics - Welding processes - Hot gas welding
SABS 0268/SANS 10268 Part 4	Welding of thermoplastics - Welding processes - Hot-gas extrusion welding
SABS 0268/SANS 10268 Part 10	Welding of thermoplastics - Welding processes - Weld defects
SABS 0269/SANS 10269	Welding of thermoplastics - Testing & approval of welders
SABS 0270/SANS 10270	Welding of thermoplastics - Approval of welding procedures and welds
SABS method 1269	Welding of thermoplastics -- Test methods for welded joints
SABS 1655/SANS 1655	Welding of thermoplastics -- Weding rods, fillers and solvents
SABS 1671/SANS 1671 Part 1	Welding of thermoplastics -- Machines and equipment -- Heated tool welding
SABS 1671/SANS 1671 Part 2	Welding of thermoplastics -- Machines and equipment -- Electrofusion welding

SABS 1671/SANS 1671 Part 3	Welding of thermoplastics – Machines and equipment – Hot-gas welding
SABS 1671/SANS 1671 Part 4	Welding of thermoplastics – Machines and equipment – Hot-gas extrusion welding

6.4.7 Raw material acceptance tests:

The material used for the production of the pipe and fittings or structures shall be a high-density polyethylene (PE-HD) PE 100. To ascertain the quality of this product the following tests shall be performed.

- Density
- Melt Flow Index
- Carbon Black Content
- Thermal Stability

6.4.8 Testing of pipes

Testing as contained in the SABS ISO 4427 /SANS 4427 specification shall apply. Tests shall also be conducted ad-hoc by a registered and authorised testing body as determined by the Department of Public Works.

6.4.9 Documents to be submitted by pipe manufacturer:

Certificate of Registration – SABS ISO 9001:2000 / SANS 9001 or National Equivalent
Permit Certification – SABS ISO 4427/SANS 4427 for PE 100
Quality Control Plan (QCP shall include Raw Material and Product Test Certificates)
SABS or National Equivalent Quality Systems Audit Reports – Last 2 Audits

6.4.10 Pipe marking

All PE-HD Pipes shall be indelibly marked at 1 meters intervals with the following details:

Reference item	Mark printed
Trade name	Manufacturer/Supplier Name
Specification	SABS ISO 4427/SANS 4427
Pipe OD	e.g. 160
Pipe OD tolerance	Grade B
Wall thickness	e.g. 7.7
Nominal pressure	e.g. PN 10
Material designation	PE 100
Batch no.	Manufacturer/Supplier Trace ability

Typical example: * SUPPLIER-A SABS ISO 4427 160 B X 7.7 PN 10 PE 100 BATCH NO. 123456

7. GENERAL CONTRACT CONDITIONS, APPENDICES AND ANNEXURES

These shall be strictly in accordance with the Department of Public Works requirements in letter, format and sequence. This also applies to the Contract document cover and index. See Civil Engineering Manual, PW 347 dated May 2004 or revision.

8. SPECIFICATIONS, CONSTRUCTION REQUIREMENTS AND SCHEDULE OF QUANTITIES

8.1 The General Conditions of Contract for Civil Engineering Construction: Latest eddition shall be applicable. Refer to latest copy of specials/amendments.

8.2 Tender document and Schedule of Quantities shall be drawn up in accordance with SABS 1200/SANS1200 Specification except where amended by the Department.

8.3 No dumping is allowed on Site other than at the designated and approved fill areas. Dumping will only be allowed for filling sinkholes and dolines and may not be detrimental to the natural storm water drainage of the area. Only soil, rock and clean masonry and concrete rubble may be dumped in the designated dump areas.

8.4 No borrow pits are allowed on Site.

8.5 No overhaul is payable on any material whether on site or off site.

8.6 All backfill for trenches, manholes etc, shall be composed of material which, after compaction, will be less permeable than the in-situ soil. This applies to pipe bedding, blanket and surround material as well.

8.7 Rate-only items shall as far as possible not be used. Balance quantities out to allow a reasonable quantity of each item, which may be required on Site.

8.8 All storm water pipe work shall also be HDPE pipes except where otherwise approved by the Department. Provide therefore also items with quantities for HDPE storm water pipes up to the maximum available in the RSA, in addition to concrete pipes with rubber rings for the larger storm water pipes.

8.9 The inlets and outlets of each manhole and junction box shall be sealed, the structures then filled to the brim and water tight covered against evaporation, where after they are independently tested for zero leakage over a minimum period of 48 hours.

8.10 No contingency sums/items are allowed.

8.11 Where trench excavated material is utilized for bedding, surround and backfill materials, the materials shall be compacted to at least 93 % Mod AASHTO or the density of the in-situ soil, whichever is higher. Where imported materials are used for trench bedding, surround or backfill materials, laboratory permeability and density tests shall be conducted on both the in-situ trench material and the imported materials to ensure that the bedding, surround and backfill materials are less permeable than the in-situ soil after placement and compaction to at least 93 % Mod AASHTO. Suitable bill items shall be provided in the Schedule of Quantities for all the above work.

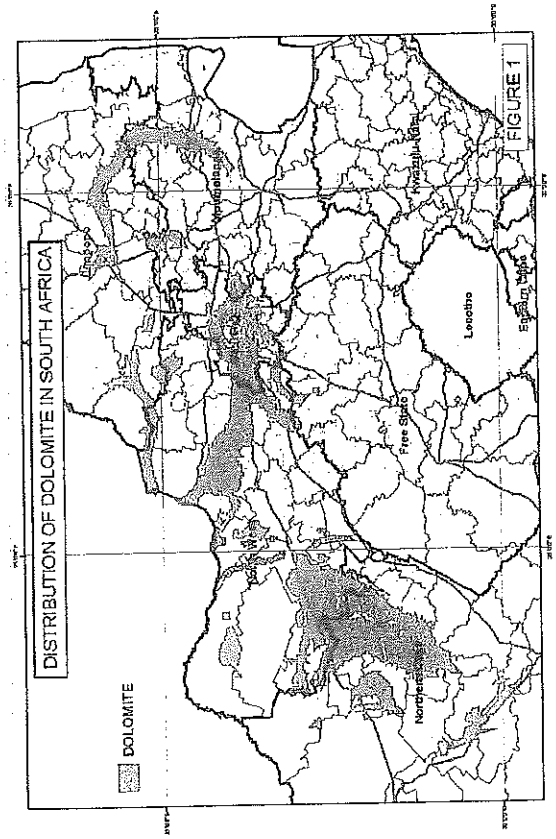
8.12 Bedding material shall conform to SABS 1200/SANS1200 LB subject to the maximum aggregate not exceeding 6mm and the permeability to be lower than the in-situ soil.

8.13 Tender specifications in terms of HDPE pipes, fittings and structures shall include or refer to all relevant specifications as per this document. Please specify the pipe materials, supply lengths, joining methods, removing of internal welding bead (de-burring), camera inspections of finished joints as well as the specific pressure testing requirements and methods. The Tender must specifically state that the tender acceptance shall be subject to the submission (one submission only) and approval of the HDPE product manufacturer/s or supplier/s to be used by the Tenderer. Such submission may be called for during evaluation of Tenders. The Department reserves the right to reject a Tender if the proposed manufacturer or supplier of HDPE products does not meet the requirements as stipulated in the relevant SABS (or similar) specifications.

8.14 The latest revision of the Occupational Health and Safety Act shall be applicable to this contract. Consultants to note the reference to this Act and the execution thereof as per the standard forms of appointment, related to professional service providers, as issued by the Department.

8.15 Preliminary Bills of Quantities are attached as Appendix 11 of this document. These bills serve as a guideline and must be verified and checked by consultant for correctness and appropriateness.

FIGURES



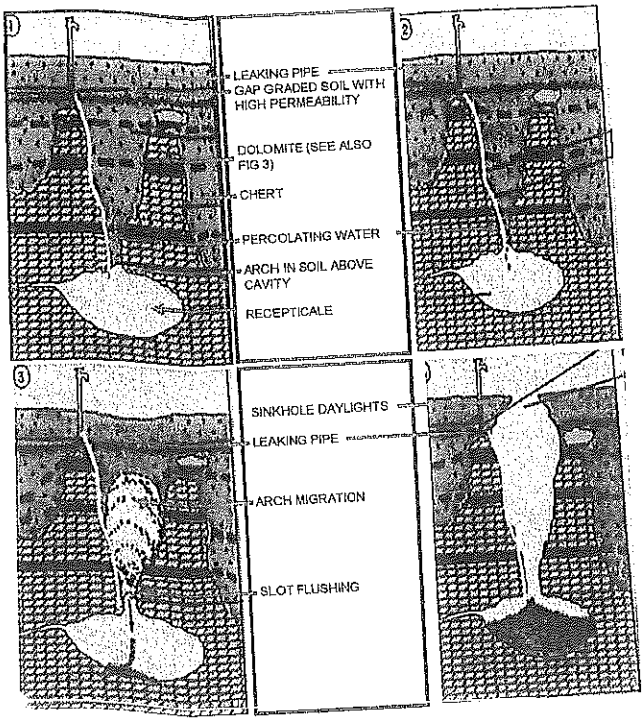


FIGURE 2: MECHANISM OF SINKHOLE FORMATION

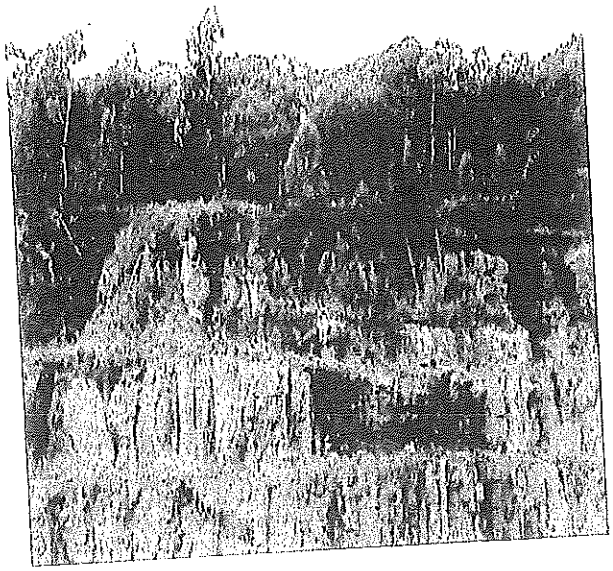


FIGURE 3: SUBSURFACE DOLOMITE PROFILE SHOWING PINNACLES AND SOIL FILLED FRACTURE ZONES

PLATES

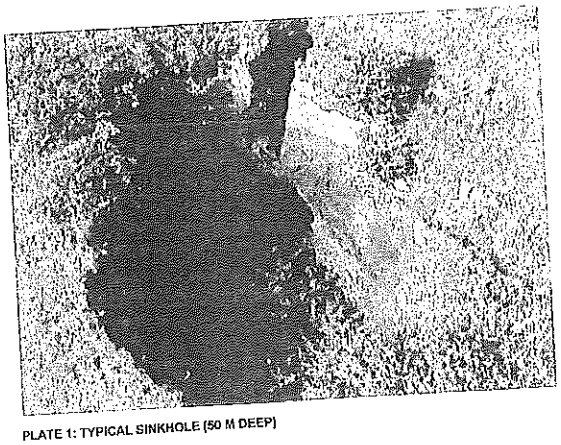


PLATE 1: TYPICAL SINKHOLE (50 M DEEP)

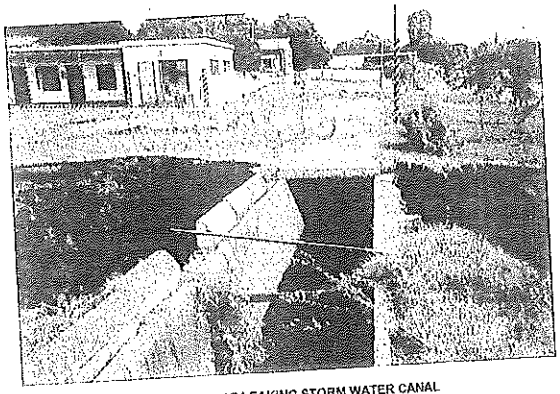


PLATE 2: SINKHOLE AS RESULT OF LEAKING STORM WATER CANAL

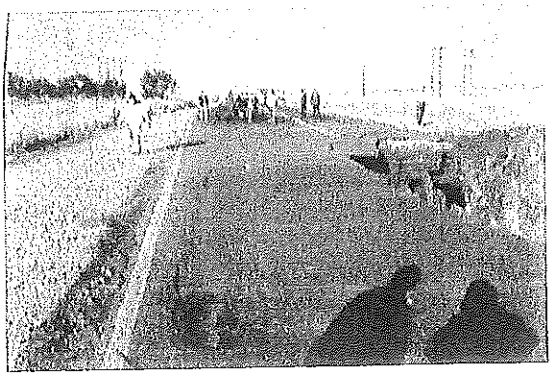


PLATE 3: SINKHOLE ON HIGHWAY (AS RESULT OF LEAKING WATER PIPE)

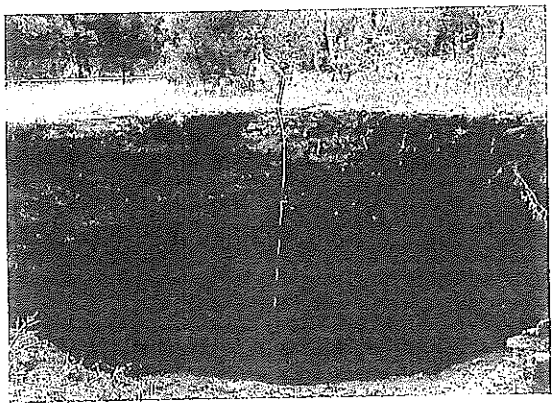


PLATE 4: SINKHOLE AS RESULT OF STORM WATER INGRESS

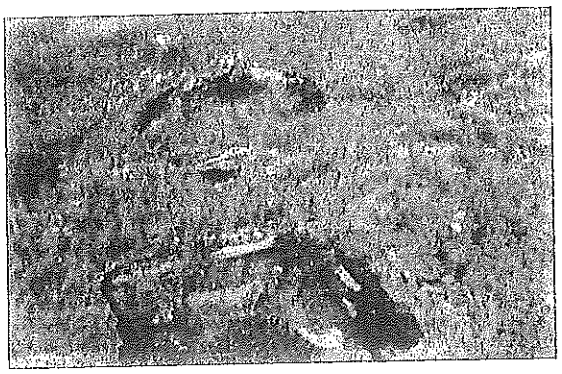


PLATE 5: SINKHOLE AS RESULT OF LEAKING WATER MAINS

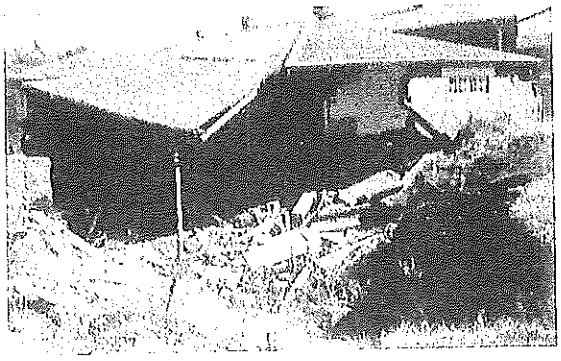


PLATE 6: SINKHOLE AS RESULT OF LEAKING WET SERVICE

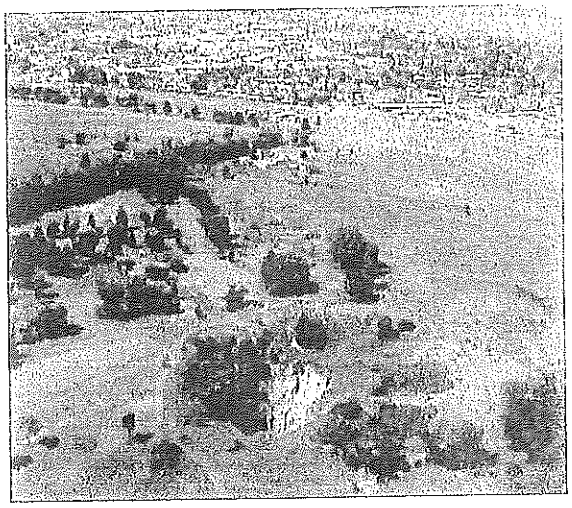


PLATE 7: LARGE SINKHOLE AS RESULT OF DEWATERING

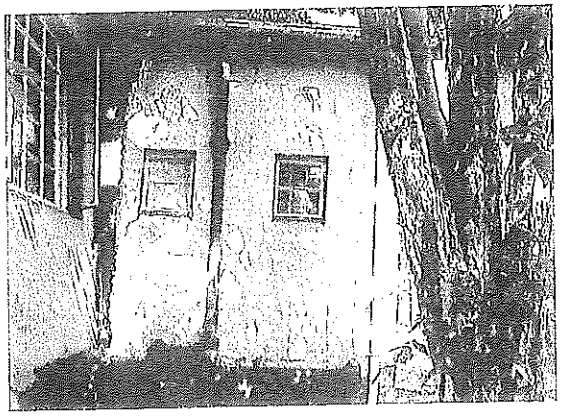


PLATE 8: BUILDING MOVEMENT AS RESULT OF DOLINE

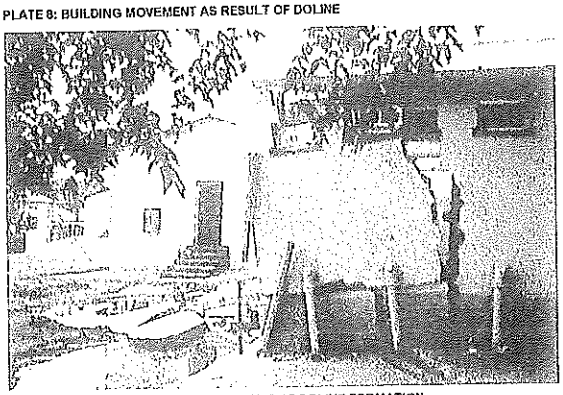


PLATE 9: BUILDING MOVEMENT AS RESULT OF DOLINE FORMATION

PRO FORMA GEOTECHNICAL INFORMATION SHEET FOR TOWNSHIP PROCLAMATION STAGE CIRCULATION OR PROCUREMENT OF NEW SITES

The following format and relevant clauses are to be incorporated in the documentation to be submitted by any developer seeking approval for proclamation or wishing to sell property to GOVERNMENT DEPARTMENTS for the purpose of erecting police/court/community or other state facilities on dolomitic land.

PROPOSED GENERAL PLAN OF ..... (township name) FOR TOWNSHIP ESTABLISHMENT

PROVIDE TITLE / REFERENCE NO / DATE / AND AUTHOR OF GEOTECHNICAL REPORT FOR TOWNSHIP PROCLAMATION OR SITE TO BE SOLD:

_____

_____

STANDS ALLOCATED FOR THE DEPARTMENTS OF CORRECTIONAL SERVICES/ JUSTICE/POLICE/DEFENCE OR PUBLIC WORKS FOR ERECTION OF FACILITIES

GEOTECHNICAL CONDITIONS ON PROPOSED SITE

The township applicant/seller hereby certifies that the geotechnical engineer/engineering geologist has certified that the layout and land allocation complies with the recommendations set out in his/her geotechnical report, which was compiled in terms of current engineering geological practice. (see section 3.1.2.3 of this document)

ALLOCATED STANDS

1. **POLICE** (stand no:_____/ size _____)
   * Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:.....%, Inherent Risk Class 2,3 and 4:.....%, Inherent Risk Class 5,6,7 and 8:.....%
2. **JUSTICE** (stand no:_____/ size _____)
   * Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:.....%, Inherent Risk Class 2,3 and 4:.....%, Inherent Risk Class 5,6,7 and 8:.....%
3. **DEFENCE** (stand no:_____/ size _____)
   * Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:.....%, Inherent Risk Class 2,3 and 4:.....%, Inherent Risk Class 5,6,7 and 8:.....%
4. **CORRECTIONAL SERVICES** (stand no:_____/ size _____)
   * Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:.....%, Inherent Risk Class 2,3 and 4:.....%, Inherent Risk Class 5,6,7 and 8:.....%
5. **PUBLIC WORKS** (stand no:_____/ size _____)
   * Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:.....%, Inherent Risk Class 2,3 and 4:.....%, Inherent Risk Class 5,6,7 and 8:.....%

* Refer to Section 3 Item 3.1.2.3

DRAWINGS ATTACHED

Township layout and site with dolomite risk zoning indicated as well as position of boreholes and test pits.

DOCUMENT ATTACHED

Detail geotechnical report compiled in terms of current practice.

SPECIAL DEVELOPMENT CONDITIONS OR SITE SPECIFIC COMMENTS

Comments to be furnished by geotechnical engineer.

SPECIAL CLAUSES TO FORM PART OF CONDITIONS

The developer shall ensure that no borrow, fill or surficial soil disturbances occur during the township construction/development phase.

Storm water alterations due to development shall not negatively impact on current natural drainage of the proposed property.

No site camp for construction purposes shall be allowed on the property.

Special conditions as stated above shall form part of the township construction/development phase construction Contract documentation.

.....	.....	.....	.....
DEVELOPER	DATE	TEL	FAX

APPENDIX 2

MINIMUM REQUIREMENTS FOR A GEOTECHNICAL INVESTIGATION ON A DOLOMITIC SITE

1. THE GEOTECHNICAL INVESTIGATION TO BE UNDERTAKEN SHALL INCORPORATE AND REPORT ON THE:

- geophysical investigation
- borehole work
- geological investigation
- geohydrological data
- Dolomite risk characterisation procedure
- surficial soils mantling the site and comment on the immediate environs
- Dolomite stability zonation

2. THE SITE SHALL BE DEMARCATED INTO RISK ZONES ACCORDING TO CURRENT PRACTICE.

3. OTHER FEATURES TO BE INCORPORATED AND COMMENTED ON WITH REGARD TO SPECIAL SITE CONDITIONS ARE:

- Previous investigations
- Old borrow pits
- Rehabilitated areas
- Dumpsites
- Water boreholes
- Permanent or temporary natural water drainage features traversing the site

4. REPORT FORMAT

The geotechnical report shall be structured as follows:

4.1 Terms of reference

4.2 Existing information

4.3 General location and description of site

4.4 Procedures used in the investigation:

- Desk studies
- Gravity survey
  (Note: Only drilling will be required if the footprint of building is fixed).
- Drilling programme
- Trail holes
- The visual inspection procedures used shall be referenced, i.e. Jennings et al (1973).
- Laboratory Testing. The original lab reports shall be incorporated in the report

4.5 Geology and geohydrology

4.6 Dolomite stability characterisation:

- Describe and reference the methodology used in the risk characterisation of the site.
- Current practice requires discussion of stability conditions in terms of: **Proposed method for dolomite land hazard and risk assessment in South Africa**, SAICE Journal Vol 43(2) 2001, paper 462 pages 27-36,. Buttrick et al.).

- Provide the risk characterisation of the site
- Outline the motivation for the risk characterisation of each zone.

4.7 Additional Geotechnical Considerations

- Potential problematic soils at surface level
- Active soils
- Collapsible soils
- Disturbed natural profiles (borrow, fill)

4.8 Conclusions and recommendations

- Risk characterisation
- Indicate remedial Work
- Indicate specific/special site development criteria
- Recommendation concerning appropriate development of site.
- Precautionary measures.

5.0 DATA CAPTURING IN REPORTS

The Department requires standardised data capturing forms as to ease evaluation of consultants information. The following information needs to be provided in standardised format:

- Site layout: 1:500 scale drawings showing the exact positions of:
  - Test pits
  - Boreholes (old and new)
  - Gravimetric survey
  - Specific site features
  - Risk zones
  - Proposed optimum location of buildings
  - Boreholes for water
  - Site contours (if available)
- The following information (where applicable) needs to be provided on departmental soil laboratory standardised formats:
  - Characterisation of borehole data
  - Percussion borehole drilling report
  - Test pit profiling report
  - Foundation indicator report
  - Consolidation test report
  - CBR reports

  Note: Consultant to contact departmental soil laboratory to obtain standard forms for the above.

APPENDIX 3

APPENDIX 3

PRELIMINARY SITE INVESTIGATION BY THE PRINCIPAL AGENT: DOLOMITE STABILITY RELATED MATTERS

Reports presented to the Department for the development of a site (as per PRM 17) should on a minimum have the following information:

- Cadastral information
- Site contours
- Services
  - Existing services that traverse the site
  - Comprehensive reporting on condition and upgrading requires or shifting thereof
- Roads
  - Township roads (surfaced/gravel/non existing)
- Water
  - Municipal connection
    Size
    Pressure
    Type
    Exact location of connection
- Storm water
  - Natural drainage features
  - Drainage of the surrounding area
  - Canals (lined, unlined, general condition, possible connection)
  - Stormwater pipes (size, type, possible connection)
- Sewer
  - Municipal connection
    Location
    Size
    Material and jointing
    Manholes (type, material, joint sealing)
    Possible connections
- Electricity and communication
- Geotechnical risk zonation

ENGINEERING SITE INVESTIGATION OF INFRASTRUCTURE ON DOLOMITE: SCOPE OF WORK

CONTENTS:

1. SITE LAYOUT DRAWINGS

Base information
Water - Drawing number.....
Sewer - Drawing number.....
Storm water - Drawing number.....
Roads - Drawing number.....
Paving - Drawing number.....
Building Layout - Drawing number.....

2. GENERAL INVESTIGATION INFORMATION

Building number:	
Base / unit	
Responsible person	
Alternative building name	
Previous name (if any)	
Physical location	
Stand number	
Farm portion	
x-y coordinates (if known)	
Age	

General comments from site representative (with relevant dates) regarding the following:

Ponding of storm water on the site.
Repairs to water pipes, during the last ..... years.
Blockages of sewer system , during the last ..... years.
Cracks in buildings.
Known incidences of dolines or sinkholes on the site or in the surrounding area

Names of all Contractors that do regular maintenance on the site:

Service	Contractor	Tel. no
Water		
Sewer		
General Building		
Storm water		

Information of occupants (date / /).

Description	Now	Future
Number of persons normally present		
Normal number of staff.		
Maximum person capacity under normal conditions (including staff)		
Maximum staff capacity		
Maximum number of persons during special events (including staff).		

Information regarding services.

- Monthly water consumption for the last 12 months.
- Municipal account number
- Reasons for abnormal high water consumption

3. GENERAL INFORMATION REGARDING SURROUNDING AREA

Indicate the following on site layout drawing:
- General drainage of surrounding area onto the site.
- Type of roads surrounding the site.
- Type of storm water system surrounding the site.

4. WATER

Position of water meter
- Indicate on site layout (type, condition, shut-off valve, leakages and valve box, lockable, condition)

Pressure test
- Results, pressure and leakages

Approximate route of main water supply.
- Inspect routes for:
  - Depressions
  - Trees (5m zone)
  - Unnatural green grass patches
  - Wet patches
  - Excavate and report on condition of pipe

External reticulation
- Fire hydrants
- Garden taps
- Sports fields (size, type of irrigation, frequency of irrigation and flow rate, if metered)

Building reticulation
- Indicate position of pipe distribution around building and inspect this route for any visible leakages, depressions etc.

Internal fittings (Check for leakages, damages and general condition)
- Washbasins
- Toilets
- Urinals
- Drinking fountains (excess water drainage facility)
- Fire hose reels

Pipes above natural ground level for entry into the buildings
- Pipes through walls (allowance for movement)
- All connections between flexible and rigid pipes shall be provided with flexible, self-anchoring joints.
- Pipes under floor slabs (service ducts, inspectable)

The selection of piping material and corrosion factors (both external and internal as well as between different materials - i.e. galvanised to copper etc.).

5. SEWER

Pit latrines
- Indicate position, number, can storm water ingress, type of structure, position of previous pit latrines, duration in use.

Soak-away
- Describe condition and size of septic tank and indicate position. Indicate position of subsurface soak-away, evidence of overflowing)

Conservancy tank
- Position, size, general condition, empty cycle, Contractor currently employed to empty, evidence of overflowing)

Sewage treatment works
- Type, condition, age
- Discharge
- Reed beds, maturation ponds etc.

Water borne sewerage system
- Pipe (position, type, condition, depth)
- Manholes (position, type, condition, depth, connection details, indicate regular overflowing, silt deposits etc.)
- Route (type of pipe, recent modifications, inspect line for depressions or unnatural green patches and trees or vegetation on the route).

Drains from buildings
- Position, accumulation route, cleaning and rodding eyes, valleys, inspect for general condition and indicate which portion is above and which below ground level, leakages, regular overflowing, general condition of surrounding area, paving, grass, etc.
- Pipes above natural ground level for exit from buildings
- Pipes through walls (allowance for movement)
- All connections between flexible and rigid pipes shall be provided with flexible, self-anchoring joints.
- Pipes under floor slabs (service ducts, inspection possible)
- Area of high concentration of sewer outlets out of buildings (condition)
- WC pans (provided with a flexible connection).

6. STORM WATER

General drainage onto site
- Water courses, location, ponding against boundary, entry at drive ways etc., canals, general slopes, position, etc.

Drainage system of surrounding area

The diversion of drainage onto the site
- Earth berms, cut off trenches etc.

Diversions of natural watercourses on the site

Natural ponds and watercourses located within 30m of any structure.
- Type, lining material, etc.

Drainage of site and surrounding area
- Free drainage of surface water
- Areas of ponding on the site
- Indicate any areas with gradients less than 1:100

Site fence
- Type of fence, position of storm water in/outlets, conditions of outlets, ease of draining, clogging, vegetation etc.

Lowest point of the site.

Storm water canals on the site, further than 10m from buildings.
- Gradients, type, size, position, condition, joint sealant, cracking, displacement, panel lengths, expansion joints, depositing of silt or sand

Storm water pipes
- Gradients, type, position, size, location, age, general condition, inlet structures, jointing, condition of seals.

Storm water drainage around buildings and up to 10 metres away.
- Detail of surfacing and open canals, joint sealants, panel dimensions cracking, displacement joint sealant and condition.

Sloping of surfaces around buildings.

Drainage in passages or between buildings
- Slope and direction of flow

Drainage towards a structure.

Storm water pipes and gulleys next to, under or parallel to buildings.

Drainage of grassed areas such as sports fields (minimum of 1:80)

Water tightness of all conduits.
- Tests for leakage.

Concrete non-pressure pipes
- Type, size, condition, jointing.

Joints in box culverts, manholes and inlet grids to subsurface systems

Gutters
- Condition of gutters
- Position of down pipes
- Canals from down pipes

Drainage away from structure
- No gutters
- Investigate the site drainage efficiency.
- Apron slabs (type width, position, condition)

7. GARDENING

Indicate all gardening and flower boxes in between or around structures

Inspect for type of gardening activity
- Excessive watering, algae, moss growth, type gardening and general condition

8. PAVED AREAS

Indicate on drawings all paved areas (e.g. drive ways and parking areas)

Type and current state

Accumulation of debris

Gradients

Purpose to facilitate drainage.

9. FOUNDATIONS

Foundation type

Exposed foundation or lowering of surrounding ground is causing exposure.

Termite activity

10. BUILDINGS

Building (original structure) (Indicate in black ink)

Date of additions or alterations (indicate in red ink)

Comment on each structure individually and if known on the type foundation, bricks used etc.)
Inspect each individual structure and indicate on drawings exact positions of all cracks and magnitudes of deformation.
- Mark origin and end of all cracks on date of inspection and give indication of size.
- All cracks in excess of 1 mm and longer than 1 metre must be inspected on a regular basis and propagation thereof reported immediately.

Indicate all construction and expansion joints in buildings.

Indicate whether cracks are related to normal stress relieve, foundation settlement or heave, inadequate design or originate where different material types match, etc.

Compile exact diagrams of crack survey.

11. SWIMMING POOLS AND FISH PONDS/WATER FEATURES

Location, size, type, age, general condition

Replenishment system,

Surrounding paving

Waste/backwash and other water from swimming pools discharged system (piping or open drainage systems).

Splash drainage (Impervious, brick paving, concrete paving, grass, distance). Drainage canal to collect splashed water.

Discharge point (not closer than 20 metres from pool)

Storm water drainage of area surrounding the swimming pool

Gardening of area surrounding the swimming pool

12. WATER TANKS

Type, location, condition, depth, height.

13. ELECTRICITY AND COMMUNICATION

Sleeve and draw box systems
- Condition and type. (watertight?)

Routes

Trenching, backfilling and compaction of trenches

14. SITE MAINTENANCE

General condition of site and building surrounds (general upkeep)

Presence of ash/dump pits and storm water drainage in that area

Sandpits or areas of soil removal

15. BOREHOLES FOR GROUND WATER ABSTRACTION

Position

Permission to sink boreholes as a control on dewatering.

Capacity (pump equipment).

16. GEOLOGICAL

Risk classification of the site

Indicate the known geological zones on the layout drawings.

Note site conditions (surficial soils, rock outcrop, sudden changes in soil profile, and soil consistency/type)

Sinkholes, dolines or any other depression

APPENDIX 5

TYPICAL ENGINEERING DETAILS FOR SERVICES ON DOLOMITIC LAND

Typical, minimum standard, details for engineering designs on dolomitic land are included in this section. These details and specifications are to be extended/improved to suit the site-specific conditions. All drawings and specifications are to be checked by the design Engineer.

CONTENTS:

WATER DETAILS

WATER DETAILS: LIST OF DRAWINGS

DT 01/W	FIRE HYDRANT TYPE 1
DT 02/W	FIRE HYDRANT TYPE 2
DT 03/W	FIRE HYDRANT LAYOUT FROM OVERHEAD WATERMAIN. TYPE 3
DT 04/W	DETAIL OF FIRE HYDRANT KEY
DT 05/W	DETAIL OF HDPE WATERPIPING NEXT TO BUILDINGS.
DT 06/W	OPEN PIPE DUCT IN ROAD AND WALKWAYS WITH STANDARD RECTANGULAR, HORIZONTAL GRATING COVER.
DT 07/W	COLUMN, SUPPORT, BRACKETS AND FOUNDATION DETAILS FOR OVERHEAD WATER RETICULATION.
DT 08/W	PIPE BRACKET TO SECURE WATERPIPING TO BUILDINGS.
DT 11-1/W	CONCRETE VALVE BOX DETAILS.
DT 11-2/W	TYPICAL PIPE SCHEDULE SHEET
DT 12/W	JUNCTION OF HDPE PIPE IN SIDEWALL
DT 16/W	CONCRETE VALVE BOX TYPE 2
DT 17/W	CONCRETE VALVE BOX TYPE 3
DT 18/W	VALVE BOX LID DETAILS FOR TYPE 1, 2 & 3

DEPARTMENT OF PUBLIC WORKS Private Bag X65 Pretoria 0001 Tel (012) 337 2000	departmental DIAGRAMMATIC CIVIL ENGINEERING DETAILS FOR DOLOMITIC SOILS.	title WATER: WATER DETAILS LIST OF DRAWINGS.	scale N.A.	date 10/27/2004
			drawing number / type number TYPE NO DT 00/W	

DEPARTMENT OF PUBLIC WORKS
Private Bag X65
Pretoria
Tel (012) 337 2000

DESCRIPTION: DIAGRAMMATIC CIVIL ENGINEERING DETAILS FOR DOLOMITIC SOILS.

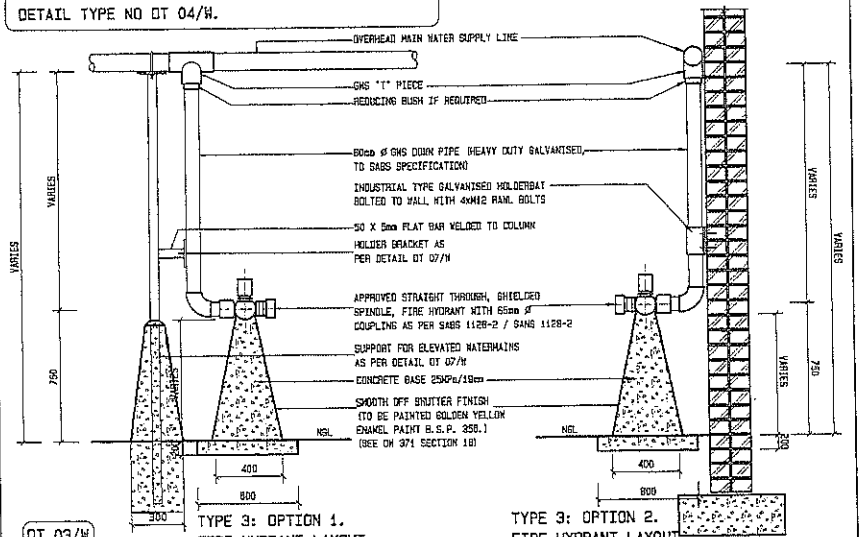
TITLE: WATER: FIRE HYDRANT LAYOUT FROM OVERHEAD WATERMAIN. TYPE 3. (DIAGRAMMATIC)

DRAWING NUMBER / TYPE NUMBER: TYPE NO DT 03/W

SCALE: 1 : 20

DATE: 10/27/2004

NOTE:
-COMPLETE UNIT TO BE HOT DIPPED GALVANISED AFTER MANUFACTURING. HEAVY DUTY (SANS 32)
-SUPPLY EACH SITE WITH THREE HYDRANT KEYS AS PER DETAIL TYPE NO DT 04/W.



DT 03/W

DEPARTMENT OF PUBLIC WORKS
Private Bag X65
Pretoria
Tel (012) 337 2000

DESCRIPTION: DIAGRAMMATIC CIVIL ENGINEERING DETAILS FOR DOLOMITIC SOILS.

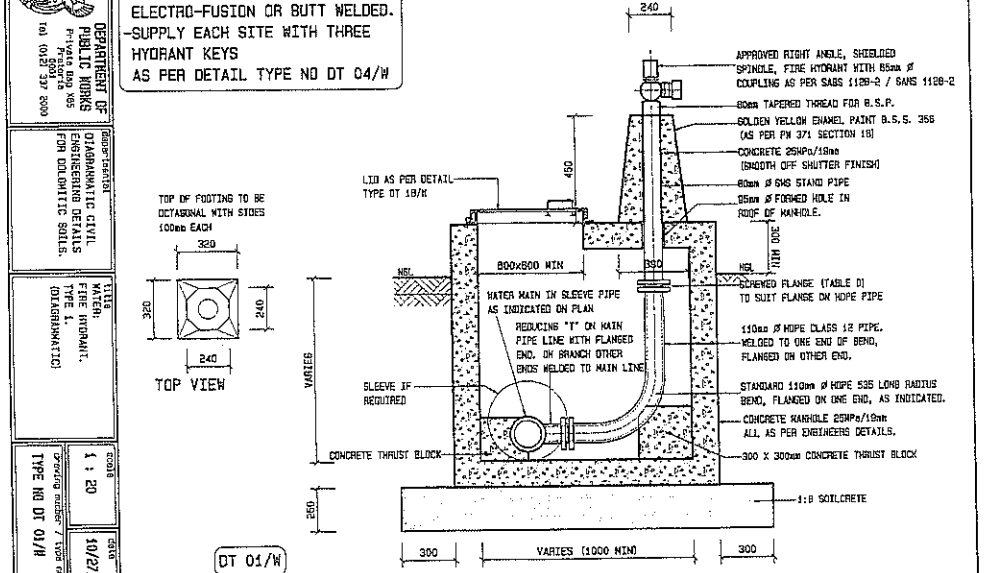
TITLE: WATER: FIRE HYDRANT. TYPE 1. (DIAGRAMMATIC)

DRAWING NUMBER / TYPE NUMBER: TYPE NO DT 01/W

SCALE: 1 : 20

DATE: 10/27/2004

NOTE:
-ALL HDPE CONNECTIONS TO BE ELECTRO-FUSION OR BUTT WELDED.
-SUPPLY EACH SITE WITH THREE HYDRANT KEYS AS PER DETAIL TYPE NO DT 04/W



DT 01/W

DEPARTMENT OF PUBLIC WORKS
Private Bag X65
Pretoria
Tel (012) 337 2000

DESCRIPTION: DIAGRAMMATIC CIVIL ENGINEERING DETAILS FOR DOLOMITIC SOILS.

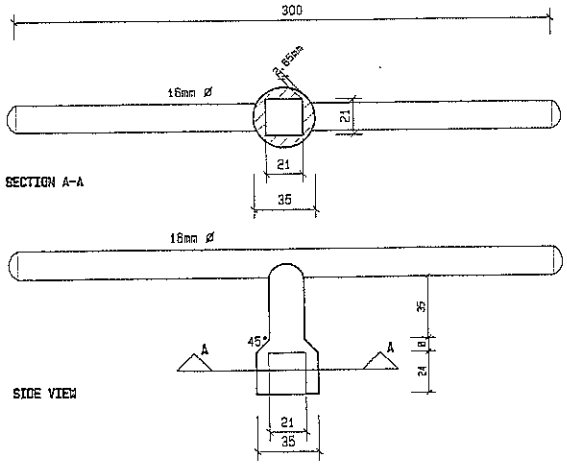
TITLE: WATER: DETAIL OF FIRE HYDRANT KEY. (DIAGRAMMATIC)

DRAWING NUMBER / TYPE NUMBER: TYPE NO DT 04/W

SCALE: 1 : 2

DATE: 10/27/2004

NOTE:
-COMPLETE UNIT TO BE HOT DIPPED GALVANIZED AFTER MANUFACTURING HEAVY DUTY(SANS 32).



DT 04W

DEPARTMENT OF PUBLIC WORKS
Private Bag X65
Pretoria
Tel (012) 337 2000

DESCRIPTION: DIAGRAMMATIC CIVIL ENGINEERING DETAILS FOR DOLOMITIC SOILS.

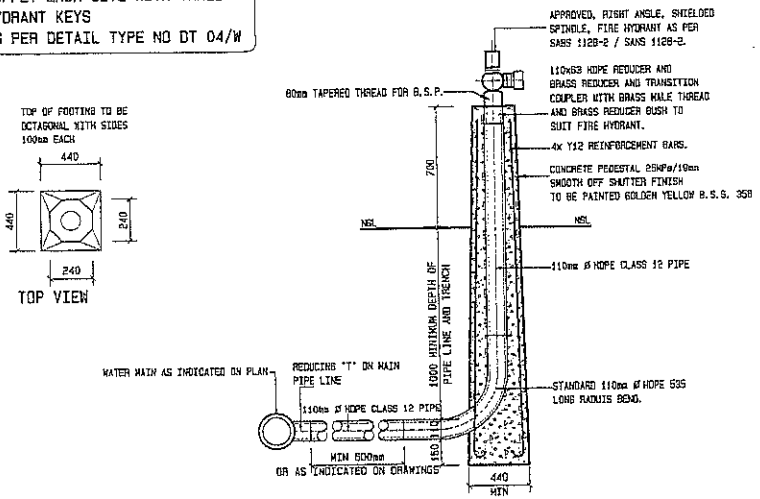
TITLE: WATER: FIRE HYDRANT. TYPE 2. (DIAGRAMMATIC)

DRAWING NUMBER / TYPE NUMBER: TYPE NO DT 02/W

SCALE: 1 : 20

DATE: 10/27/2004

NOTE:
-ALL HDPE CONNECTIONS TO BE ELECTRO-FUSION OR BUTT WELDED.
-SUPPLY EACH SITE WITH THREE HYDRANT KEYS AS PER DETAIL TYPE NO DT 04/W



DT 02/W