

**PSP CONTRACT PS – HS 23 - 2013
GFSH-2 PHASE 1 NEAR SURFACE
GEOTECHNICAL INVESTIGATION : MACSTEEL STANDS
1357 &1356 TAMBOEKIESFONTEIN 173 IR**

GG2084/S

**GEOGROUP
P.O. BOX 604
FOURWAYS
2055**

JUNE 2015

**TEL: (011) 469 0854
FAX: (011) 469 0961
EMAIL: intrac@mweb.co.za**

**BIGEN AFRICA SERVICES (PTY) LTD
PO BOX 29
THE INNOVATION HUB
PRETORIA
0087**

Intraconsult cc
Registration Number CK/86/12311/23

P.O. Box 604,
Fourways
2055
Gauteng

ATTENTION: MR T SANDE

Telephone : (011) 469 0854
Fax : (011) 469 0961
Email : intrac@mweb.co.za

Your reference

Our reference
GG2084/S

Date
26 JUNE 2015

**PSP CONTRACT PS-HS 23 - 2013
GFSH-2 PHASE 1 NEAR SURFACE GEOTECHNICAL INVESTIGATION: STANDS 1357 &
1356 TAMBOEKIESFONTEIN 173 IR**

EXECUTIVE SUMMARY

This report presents and comments on the results and observations of near surface soil geotechnical investigations carried out on Stands 1357 and 1356 of the farm Tamboekiesfontein 173 IR.

This current near surface soils report covers a site area of approximately 11.43ha and has involved the assimilation and evaluation of available geotechnical, geomorphological, and geological data and additional field investigations. These investigations comprised field scouting and the profiling of trial holes in order to gather further information for an evaluation of the *near surface* geotechnical conditions across this site.

Based on this detailed field work, the soil profiles and analyses of the laboratory soil test results, the site area has been further sub-divided into (preliminary) soil Site Class Sub-Areas in terms of the Code of Practice composite Site Classes (H,C & S). A Soil Map is provided with our interpretation of the near surface conditions. This map is intended to assist with the future planning and development of the site.

EXECUTIVE SUMMARY

Preface

CONTENTS

PAGE

1.	INTRODUCTION AND TERMS OF REFERENCE	1
2.	INFORMATION USED IN THE STUDY	1
3.	SITE DESCRIPTION	1
4.	NATURE OF INVESTIGATIONS	1
5.	SITE GEOLOGY AND SHALLOW GROUNDWATER CONDITIONS	2
6.	GEOTECHNICAL EVALUATION	2
7.	SITE CLASSIFICATIONS	5
8.	FOUNDATION RECOMMENDATIONS AND SOLUTIONS	7
9.	DRAINAGE	7
10.	CONCLUSIONS AND RECOMMENDATIONS	8

TABLES

SUMMARY OF REFUSAL AND GROUNDWATER DETAILS FROM TRIAL HOLES	TABLE 1
SUMMARIES OF LABORATORY TEST RESULTS: (DISTURBED)	TABLE 2

FIGURE

LOCALITY PLAN:	FIGURE 1
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DRAWING

SOIL MAP	DRAWING GG2084/1
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APPENDICES

SOIL AND BOREHOLE PROFILES	APPENDIX 1
LABORATORY TEST REPORTS	APPENDIX 2

1. INTRODUCTION AND TERMS OF REFERENCE

This report presents and comments on the results and observations of near surface soils geotechnical investigations carried out on Stands 1357 and 1356 of the farm Tamboekiesfontein 173 IR.

The terms of reference and scope of work to be undertaken were discussed with Mr Taka Sande of Bigen Africa Services. Intraconsult was instructed to proceed with the investigations on the 13 April 2015 by Bigen Services Africa (Pty) Ltd. Letter reference 2201/16/00/C/Magagula NHBRC Geotech Phase 1- Macsteel Land.

2. INFORMATION USED IN THIS STUDY

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

- Geological Map of the Geological Survey (Council for Geoscience): Sheet 2628 East-Rand, Scale 1: 250 000, dated 1986.
- Generic specification GFSH-2, National Department of Housing Specification, "Geotechnical site investigations for housing development." Dated September 2002.
- Expansive Roadbed Treatment of Southern Africa. D.J. Watson (1980) 4th Int. Conf. For Expansive Soil Vol. 1 Denver pp. 339-360.
- Contoured plan of the site (with floodlines) provided by Messrs Bigen Africa Services (Pty) Ltd.

3. SITE DESCRIPTION

The proposed site is located in Magagula Heights, just off the R550. The surrounding townships on the western portion are Tiestsi and Zonkizizwe. The co-ordinates for the proposed site are 26 25 40.23S/28 1140.43E. The site is surrounded by the existing housing development of the Magagula Heights township on the northern and western portion. The southern portion has vacant land and the eastern portion is bounded by the existing tar road. The terrain of the site currently flows in a northerly direction. Most parts of the site are covered by velt grass. An informal sports field is occupied towards the northern middle portion of the site. Some vegetable gardening is also seen at the western portion of the site. The southern portion of the site has numerous stockpiles of dumping material. These materials consist of mainly soil and rock. No water and surface ponding areas were noted on site. An existing pegged pipeline is seen at the southern portion of the site (this could be a sewer pipeline).

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 earlier studies on 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 and near surface features across the site.

4.3 Trial Holes

Where access was possible, trial holes were opened across the site using a 75KW backhoe machine. Each trial hole was entered and inspected by a geospecialist 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 Appendix 1 and their positions shown on Drawing GG2084/1 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 have also been tested for moisture content and soil chemistry. Where practically possible, undisturbed samples were taken to check the laboratory oedometer (compressibility and collapse) 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 SHALLOW GROUNDWATER CONDITIONS

5.1 General

Available geological maps show the site to be underlain by basaltic lava, agglomerates and tufts of the Klipriversberg Group of the Ventersdorp Supergroup and their weathered derivatives. A generally thin cover of partially colluvium occurs across this area.

5.2 Soil Profile

Reference should be made to the appended soil profiles for detailed descriptions of the in-situ soils uncovered during these investigations. Table 1 summarises the base depths of the opened test holes. The following general comments are made on the near surface soil conditions across this site: Variable thickness of transported soils blanket these stands comprising colluvium consisting of loose to medium dense silty sands and alluvium comprising firm to stiff silty clays. These transported soils directly overlies residual soil materials that have been ferruginised to varying degrees and bouldery and sub-outcropping bedrock conditions across this site.

5.3 Water Table

All the near surface trial pits opened across the site were dry at the time of these investigations. Ferruginised materials have developed in the near surface soil horizons in sectors of the site denoting variable to poor internal drainage conditions and where shallow groundwater conditions may occur during or after the rainy season.

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 of this and earlier geotechnical investigations across this site.

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 together with the laboratory oedometer tests carried out on undisturbed samples of the soil units uncovered across this site confirm the presence of potentially problematic soil conditions. These results are discussed fully in Section 7 below.

- **Evaluation of the activity (swell/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 swell/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 indicate “generally low” potential swell/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.**

Field profile inspections of the soil units and their distribution across the site indicates that medium and long-term compressibility is unlikely to affect (light) residential structures on this site. However, detailed geotechnical foundation investigations will be required once the SDP layouts have been approved for the proposed multi storey structures.

- **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 sub-grade design is provided as follows:

Soil Unit	Group Classification	General rating as sub-grade	Grading Modulus	Workability Rating
Cemented ferricrete	A-2-6	good	1.63	excellent
Res conglomeratrae	A-2-7	good	1.77	excellent
Saprolite conglomerate	A-7-6	very.poor	0.45	very.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 this site 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 with careful selection from the ferruginised soil units on this site.
 - (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 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.m	Potential Corrosivity*
Cemented ferricrete	6.3	Neutral	22.7	corrosive
Res conglomeratae	6.2	Neutral	8.8	v.corrosive
Saprolite conglomerate	6.2	Neutral	6.2	v.corrosive

* potential corrosivity – ref Messrs ARMCO 1977

- **Dumping of refuse:** Dumped refuse and building rubble has been noted on this site and should be anticipated as a general hazard potentially influencing development in these (small) sectors.
- **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 Characteristics*
Cemented ferricrete	0.04	Non-associated
Res. conglomerate	0.11	Non-associated
Saprolite conglomerate	0.16	Non-associated.

Note: conductivities in excess of 0.5 Sm may be associated with dispersion

6.2 Erosion

The fine nature of many, if not most, of the soil units encountered during investigations is such that after removal of natural cover they will present a potential erosion problem during periods of heavy rain and also dust removal by high winds in the dry season.

6.3 Earthworks classifications for service trenches

Many of the excavated trial holes uncovered excavation 'intermediate' and 'medium hard rock' classes of materials in the lower sections of the ground surface (0.0m) to minus 1.5m profile across this site. The material 'refusal depths' and types are summarised in Table 1. Our evaluation of these refusal depths is that generally materials below the soils could be removed by higher classes of excavators.

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	Hydraulic conductivity m/s after Badenhorst, 1998
SC	$10^{-10} - 10^{-6}$
CL	$10^{-10} - 10^{-5}$

Note: Although laboratory tests are more objective as a means of obtaining geotechnical data, estimated hydraulic conductivities from systematically described soil profiles may be more accurate. This is because of the large variations in hydrogeological properties within the many of the USCS soils groups.

7. SITE CLASSIFICATION

7.1 Impact of Geotechnical Character of the Site on Housing Developments

The procedures utilized 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).

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. GG2084/1 (See also the GFSH-2 Phase 1 commentary at the end of Section 7.2 below).

7.2 Site Classification (in terms of the NHBRC Guidelines for single storey masonry structures)

For the purposes of this report the broad geotechnical characteristics of the primary geotechnical Sub-Areas 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)	Expected range of total movement at surface:
H	<7.5 mm
H1	7.5 – 15 mm
H2	15 – 30 mm
H3	>30 mm

GEOTECHNICAL CATEGORY AND SITE CLASS DESIGNATION	GEOTECHNICAL CHARACTERISTICS
Collapsible soils	Expected range of total movement at surface:
C	<5 mm
C1	5 – 10 mm
C2	>10 mm
Compressible soils	Expected range of total movement at surface:
S	<10 mm
S1	10 – 20mm
S2	>20mm
Excavation E	Abandoned borrow areas, dump rock, waste sites, exploration pits or adits, and uncontrolled fill, erosion gully
P	Dolomite area
R	Rock
R1	Outcrop
R2	Scattered outcrop
R3	Sub-outcrop (i.e. 0.1 – 1.5 m profile)

These designations are added to the selected Primary Geotechnical Sub-Areas in order to describe the generalized geotechnical conditions that lead to that particular characterization.

The 'H', 'C' and 'S' designations tabulated 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 Footnote¹.

Footnote 1: Weston's swell per cent = $0,000411L^{*4,17} \times p^{-0,386} \times W_i^{-2,33}$
where L = Liquid Limit (whole) (ie. Liquid Limit x % passing 425 microns)
P = overburden pressure (10kPa adopted for this report)
W_i = 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.

The laboratory testing of soil samples taken across the site provides mean 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	L.L. WHOLE VALUES (mean)	MOISTURE CONTENT %		SWELL DIFF. VOL. CHANGE %
		'DRIEST'	'WETTEST'	
Cemented ferricrete	16	6.4	12.8	<0.1
Res. conglomerate	29	11.6	23.2	0.6
Soprolitic conglomerate	41	16.4	32.8	1.1

(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' and open textured soils have been uncovered in a number of the trial holes opened across this site. The 'loose' nature of these materials and their collapse potential have been checked in the laboratory CP₂₀₀ tests indicating "severe trouble" conditions. For the purposes of this report a 2 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 GG2084/1).

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, the dolomite classifications, engineering judgment and the results of field scouting.

A Soils Map (Drawing GG2084/1 has been compiled reflecting this total conceptual Site Class Sub-Area characterization.

For (light) residential structures provided in this site area, the following outline commentary is noted for the Site Classes provisionally given for this site:

8. FOUNDATION RECOMMENDATIONS AND SOLUTIONS

These investigations have confirmed that potentially problematic soils mantle the bedrocks over large sections of 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 GG2084/1.

It is recommended that the proposed multi storey structures be placed on rationally designed foundations. Specific foundation investigations should be completed once the SDP for this site has been approved.

9. DRAINAGE

Careful stormwater controls are mandatory to the safe and secure development of the site, stormwater management plans should be closely linked to the planning of this township.

Sections of the site area is mantled by (variable) thicknesses of open textured 'collapsible' colluvial soils. It is generally accepted good practice to avoid any accumulation of surface waters near to buildings by appropriate surface drainage design.

10. CONCLUSIONS AND RECOMMENDATIONS

The following notes are intended as general recommendations/guidance for the development of this site based upon the near surface data and observations recorded in this report:

10.1 Near surface conditions recorded on the Soil Map (GG2084/1)

SUB AREA DESIGNATIONS	COMMENTARY
2[H(H1)/C-C1/S]	Anticipate pockets of potentially swell/shrink (H1) and 'collapsible' C-C1 near surface soils.

10.2 Road Construction and Installation of underground services

Most sections of the site are underlain by soils with a general (i.e. PRA) assessment of 'poor'; natural sub-grade materials.

SABS 1200 D 'intermediate' and 'rock' should be anticipated in some sections of the site, see Table 1.

Selected granular pipe bedding and select fill will need to be imported to this development.

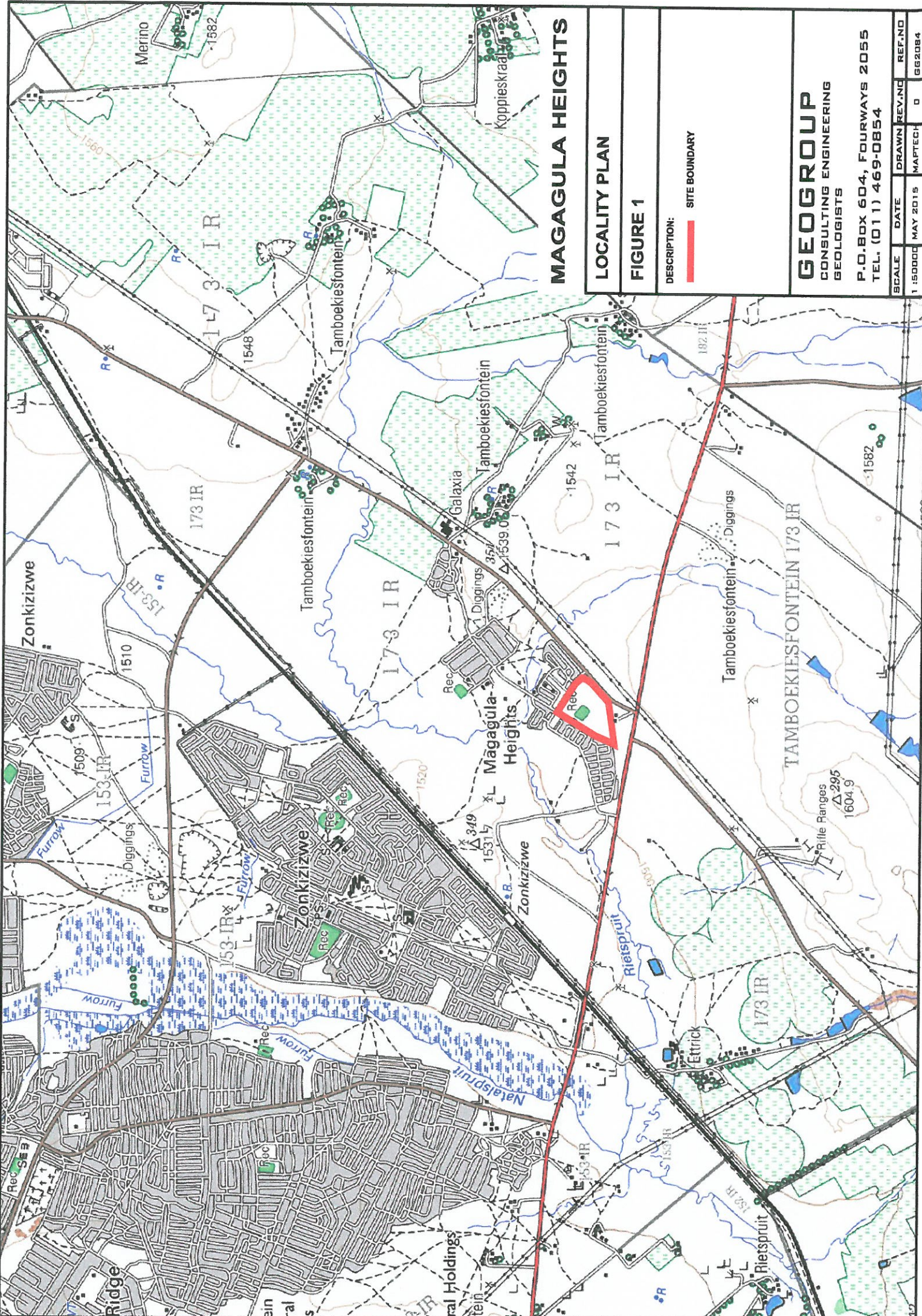
10.3 General Recommendations

Presumed Sub-Area site boundaries for this site are shown on the Soil Map GG2084/1 and are based upon our interpretation of the findings detailed in this report. It is recommended that all layout plans for this development are revised on an ongoing basis and finally certified by the geotechnical specialist. While ever effort has been made to determine overall ground conditions on this site, poorer sub areas may have been missed. For this reason, it is further recommended that a competent specialist is always invited to inspect opened workings during the development of this site in order to confirm the findings described in this report.

FIGURES

LOCALITY PLAN:

FIGURE 1



MAGAGULA HEIGHTS

LOCALITY PLAN

FIGURE 1

DESCRIPTION:
— SITE BOUNDARY

GEOGROUP
 CONSULTING ENGINEERING
 GEOLOGISTS

P.O. BOX 604, FOURWAYS 2055
 TEL. (011) 469-0854

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TABLES

SUMMARY OF REFUSAL AND GROUNDWATER DETAILS
FROM TRIAL HOLES

TABLE 1

SUMMARIES OF LABORATORY TEST RESULTS: (DISTURBED)

TABLE 2

TABLE 1 : SUMMARY OF REFUSAL & GROUNDWATER DEPTHS FOR EXCAVATION IN 0.0 TO 2.4M PROFILE

Test Pit No.	Depth (m)	Depth of Groundwater ,m (Potential Perched m)	0.0 to 2.4m PROFILE		Hard Rock Excavation from (m)	Boulder Encountered In Profile	Material at base of Test Pit
			Soft Excavation	Intermediate Excavation			
TPMH 1	2.0	NIL	2.0	>2.0		YES	VERY SOFT ROCK AGGLOMERATE
TPMH 2	2.2	NIL	2.2			NO	RESIDUAL AGGLOMERATE
TPMH 3	2.3	NIL	2.3			NO	RESIDUAL TO SAPROLITIC TUFF
TPMH 4	1.35	NIL	0.35	>1.35		NO	HIGHLY CEMENTED FERRICRETE
TPMH 5	2.4	NIL	0.6	>1.2		NO	RESIDUAL AGGLOMERATE
TPMH 6	1.6	NIL	0.35	>1.3		NO	RESIDUAL AGGLOMERATE
TPMH 7	0.8	NIL	0.5	0.8		YES	FILL
TPMH 8	1.7	NIL	1.7	>1.7		NO	RESIDUAL AGGLOMERATE
TPMH 9	1.5	NIL	1.5	>1.5		NO	RESIDUAL AGGLOMERATE
TPMH 10	2.3	NIL	1.8	>2.3		NO	VERY SOFT ROCK AGGLOMERATE

MAGAGULA HEIGHTS
 TABLE 2 : SUMMARIES OF LABORATORY TEST RESULTS (DISTURBED/UNDISTURBED SAMPLES)

TP No	Depth (m)	Soil Unit	LL	PI -425	LS (%)	GM	75 (%)	P _w	LL _w	425 (%)	002 (%)	pH	Reading (µS/cm)	Cond. (S/m)	Resistivity Ohm.m	PRA	UCS
TPMH 1	0.6 - 1.0	Med Cemented Ferricrete	31	16	8	1.17	43	10	20	64	15	6.27	440	0.044	22.73	A-6(3)	SC
TPMH 6	0.35 - 1.3	Med Cemented Ferricrete	38	20	10	1.82	31	8	15	39	15					A-2-6(2)	SC
TPMH 4	1.2 - 1.35	Highly Cemented Ferricrete	35	19	10	1.71	31	8	15	42	14					A-2-6(1)	SC
TPMH 7	0.5 - 0.8	Highly Cemented Ferricrete	35	18	9.5	1.8	28	8	15	42	14					A-2-6(1)	SC
TPMH 5	1.8	Residual Conglomerate	72	44	14.5	1.77	35	18	29	40	25					A-2-7(4)	SC
TPMH 3	1.5	Residual Conglomerate										6.24	1138	0.1138	8.79		
TPMH 1	1.0 - 2.0	Saprolitic to Highly Weathered Conglomerate	43	19	10	0.71	56	16	36	83	17	6.22	1612	0.1612	6.2	A-7-6(8)	CL
TPMH10	1.8 - 2.3	Highly Weathered Conglomerate	49	22	10.5	0.19	89	21	46	94	21					A-7-6(20)	CL

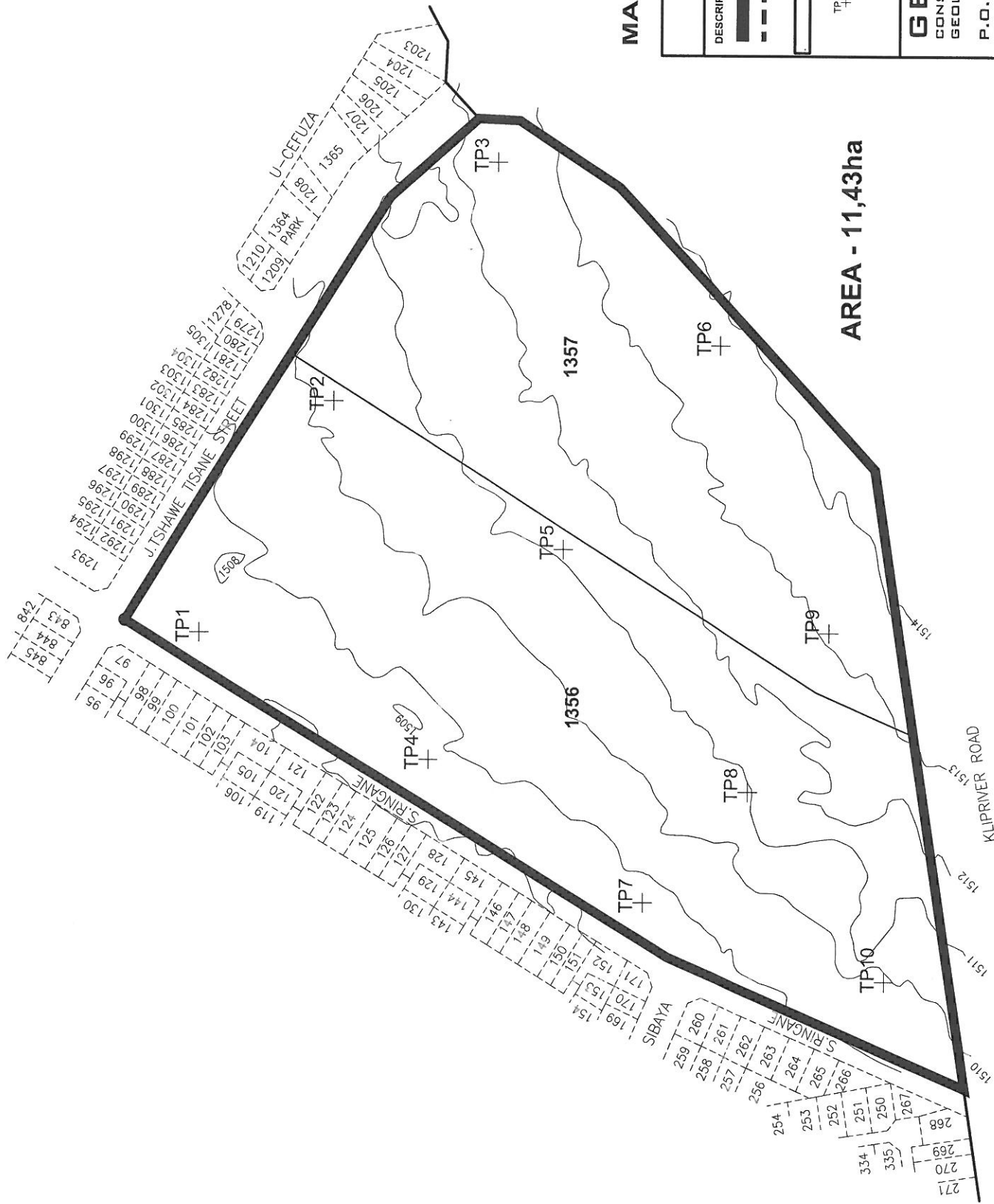
KEY

- LL : Liquid limit
- PI(425) : Plasticity Index of sample fine portion
- LS : Linear Shrinkage
- 425 (%) : Percentage passing 425
- UCS : Unified Soil Classification
- LL_w : Liquid Limit of whole sample (LL x passing 425)
- 002 (%) : Percentage passing 2µ.m
- SP : Slightly Plastic
- GM : Grading Modulus
- P_w : Plasticity Index of whole sample (PI x passing 425)
- NMC : Natural moisture content
- PRA : Public Roads Administration Classification
- Resistivity : Ohm.m
- Cond. : Conductivity Sm
- D₈₅/D₁₅ : Ratio of particle diameter corresponding to 85% and 15%
- NP : None Plastic

DRAWINGS

SOIL MAP

DRAWING GG2084/1



AREA - 11,43ha

MAGAGULA HEIGHTS

SOIL MAP [NHBC] (AT NATURAL GROUND GRADIENTS)			
DESCRIPTION:			
	SITE BOUNDARY		
	PRESUMED BOUNDARY OF SITE CLASS SUB-AREA		
	PRELIMINARY NHBC SITE CLASS		
	TRIAL HOLES POSITION AND NUMBER		
	TP1		
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APPENDICES

SOIL PROFILES

APPENDIX 1

LABORATORY TEST RESULTS

APPENDIX 2

APPENDIX 1

Soil Profiles

GEOGROUP

Consulting Engineers & Geologists

Tel : (011) 469-0854





Fax : (011) 460-0961

MAGAGULA HEIGHTS

Hole No: TP1

Sheet 1 of 1

Job Number:GG2084

Scale		0.0-0.25m: Slightly <u>moist</u> , grey brown, <u>loose to medium dense</u> , gravely silty sand. TOPSOIL.
0.5		0.25-0.6m: Slightly <u>moist</u> , grey brown, <u>dense</u> , clayey silty sand with scattered roots. TRANSPORTED.
1.0		0.6-1.0m: Slightly <u>moist</u> , grey brown, mottled orange, speckled black, <u>dense</u> , silty sandy gravel. Gravel consists of +/- 2-15mm, sub-angular to irregular, highly ferruginised nodules. MEDIUMLY CEMENTED FERRICRETE LAYER.
1.5		0.1-2.0m: Light orange yellowish, blotched grey brown, saprolitic to highly weathered, intact with fissured joints, <u>very soft rock</u> Agglomerate with AGGLOMERATE CORESTONES.
2.0		
2.5		1. No groundwater seepage. 2. Final depth 2.0m 3. Refusal on Intermediate ground conditions 4. Samples: 0.6-1.0m (disturbed); 1.0-2.0m (disturbed).
3.0		
3.5		
4.0		

Contractor: P Rambally
 Machine: JCB
 Drilled by:
 Profiled by: GAH
 Type set by
 Date: 02/02/2015

Elevation:
 X-COORD:
 Y-COORD:

Hole No. TP1

GEOGROUP

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



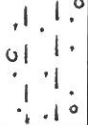
MAGAGULA HEIGHTS

Hole No: TP2

Sheet 1 of 1

Job Number:GG2084

Scale

		0.0-0.3m: Dry to slightly <u>moist</u> , <u>dense</u> , slightly clayey, gravely silty sand with roots. TOPSOIL.
0.5		0.3-0.9m: Slightly <u>moist</u> , orange brown, <u>medium dense to dense</u> , pinholed, slightly gravely, silty sand with roots. TRANSPORTED.
1.0		0.9-1.3m: Slightly <u>moist</u> , yellowish orange brown, speckled black, <u>dense</u> , mediumly cemented, silty gravely sand with ferruginised nodules. REWORKED RESIDUAL AGGLOMERATE.
1.5		1.3-2.2m: Slightly <u>moist</u> , reddish brown, mottled yellowish and black, <u>dense</u> , clayey silty gravely sand with gravels of +/-2 – 30mm sub-angular various fragments. RESIDUAL AGGLOMERATE.
2.0		
2.5		<ol style="list-style-type: none"> 1. No groundwater seepage. 2. Final depth 2.2m 3. No refusal.
3.0		
3.5		
4.0		

Contractor: P Rambally
Machine: JCB
Drilled by:
Profiled by: GAH
Type set by
Date: 02/02/2015

Elevation:
X-COORD:
Y-COORD:

Hole No. TP2

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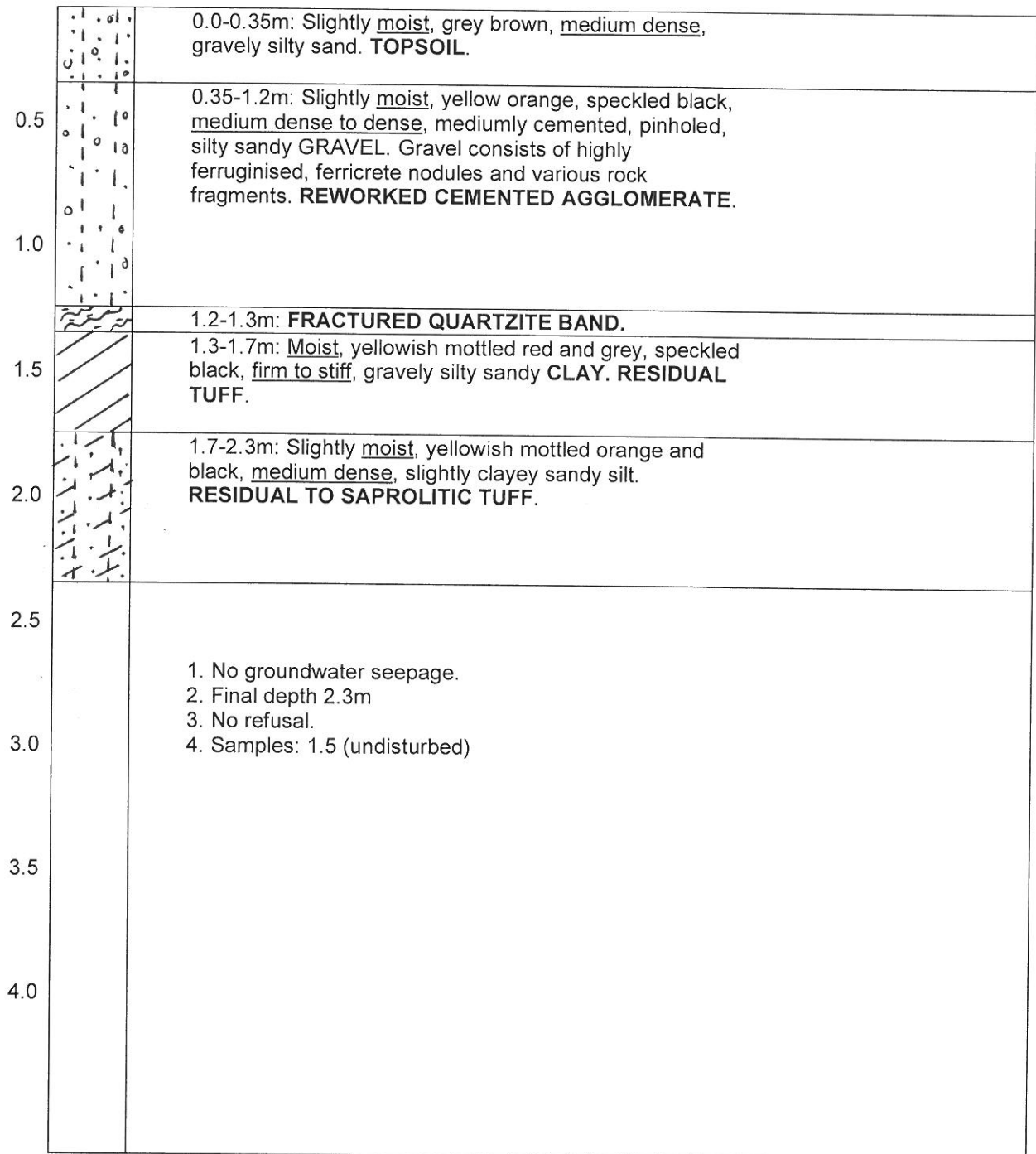
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MAGAGULA HEIGHTSHole No: TP3
Sheet 1 of 1

Job Number:GG2084

Scale



Contractor: P Rambally
 Machine: JCB
 Drilled by:
 Profiled by: GAH
 Type set by
 Date: 02/02/2015

Elevation:
 X-COORD:
 Y-COORD:

Hole No. TP3

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MAGAGULA HEIGHTS

Hole No: TP4

Sheet 1 of 1

Job Number:GG2084

Scale		0.0-0.17m: Slightly <u>moist</u> , grey brown, <u>medium dense</u> , gravelly silty sand. TOPSOIL.
0.5		0.17-0.35m: Slightly <u>moist</u> , orange brown, <u>medium dense to dense</u> , pinholed, slightly gravelly, silty sand with roots. TRANSPORTED.
1.0		0.35-1.2m: Slightly <u>moist</u> , grey brown, mottled orange, speckled black, <u>dense to very dense</u> , silty sandy GRAVEL. Gravel consists of +- 2-15mm, sub-angular to irregular, highly ferruginised nodules. CEMENTED FERRICRETE LAYER.
1.5		1.2-1.35m: Slightly <u>moist</u> , greenish grey, mottled orange, speckled black, <u>dense to very dense</u> , silty sandy gravel. Gravel consists of +- 2-15mm, sub angular to irregular, highly ferruginised nodules. CEMENTED FERRICRETE LAYER.
2.0		
2.5		1. No groundwater seepage. 2. Final depth 1.35m 3. Refusal on Intermediate ground conditions 4. Samples: 1.2-1.35m (disturbed)
3.0		
3.5		
4.0		

Contractor: P Rambally

Machine: JCB

Drilled by:

Profiled by: GAH

Type set by

Date: 02/02/2015

Elevation:

X-COORD:

Y-COORD:

Hole No. TP4

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MAGAGULA HEIGHTS

Hole No: TP5

Sheet 1 of 1

Job Number:GG2084

Scale

0.5		0.0-0.6m: Slightly <u>moist</u> , grey brown, <u>medium dense to dense</u> , gravely silty sand. TRANSPORTED.
1.0		0.6-1.2m: Slightly <u>moist</u> , grey brown, mottled orange, speckled black, <u>dense</u> , silty sandy GRAVEL. Gravel consists of +- 2-15mm, sub-angular to irregular, highly ferruginised nodules. CEMENTED FERRICRETE LAYER.
1.5		1.2-2.4m: <u>Moist</u> , greenish mottled orange, speckled black, <u>soft to firm</u> , silty sandy gravely clay with gravels consisting of various rock fragments. RESIDUAL AGGLOMERATE.
2.5		<ol style="list-style-type: none"> 1. No groundwater seepage. 2. Final depth 1.1m 3. Refusal on Intermediate ground conditions 4. Samples: 1.8m (undisturbed)
3.0		
3.5		
4.0		

Contractor: P Rambally
Machine: JCB
Drilled by:
Profiled by: GAH
Type set by
Date: 02/02/2015

Elevation:
X-COORD:
Y-COORD:

Hole No. TP5

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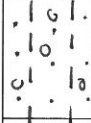
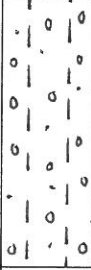


Fax : (011) 460-0961

MAGAGULA HEIGHTS

Hole No: TP6

Sheet 1 of 1

Job Number: GG2084

Scale		0.0-0.35m: Slightly <u>moist</u> , grey brown, <u>medium dense</u> , gravely silty sand with roots. TOPSOIL.
0.5		0.35-1.3m: Slightly <u>moist</u> , yellow orange, speckled black, <u>dense to very dense</u> , mediumly cemented, pinholed, ferruginised, silty sandy gravel. Gravel consists of sub-rounded to sub-angular various rock fragments and ferruginised nodules. MEDIUMLY CEMENTED REWORKED RESIDUAL AGGLOMERATE.
1.0		1.3-1.6m: <u>Moist</u> , yellowish mottled red and grey, speckled black, <u>medium dense</u> , clayey gravely sand. RESIDUAL AGGLOMERATE.
1.5		
2.0		1. No groundwater seepage. 2. Final depth 1.6m 3. Refusal on Intermediate ground conditions 4. Samples: 0.35-1.3m (disturbed)
2.5		
3.0		
3.5		
4.0		

Contractor: P Rambally
 Machine: JCB
 Drilled by:
 Profiled by: GAH
 Type set by
 Date: 02/02/2015

Elevation:
 X-COORD:
 Y-COORD:

Hole No. TP6

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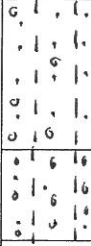

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MAGAGULA HEIGHTS

Hole No: TP7

Sheet 1 of 1

Job Number:GG2084

Scale		0.0-0.5m: Slightly <u>moist</u> , grey brown, <u>medium dense</u> , silty gravely sand. TRANSPORTED.
0.5		0.5-0.8m: <u>Moist</u> , greyish, mottled orange, <u>dense to very dense</u> , silty sandy gravel. Gravel consists of ferruginised cemented ferricrete nodules. POSSIBLY FILL.
1.0		0.8-0.8+m: Unweathered Chert boulders. POSSIBLY FILL.
1.5		
2.0		<ol style="list-style-type: none"> 1. No groundwater seepage. 2. Final depth 0.8m 3. Refusal on Intermediate ground conditions 4. Samples: 0.5-0.8m (disturbed)
2.5		
3.0		
3.5		
4.0		

Contractor: P Rambally

Machine: JCB

Drilled by:

Profiled by: GAH

Type set by

Date: 02/02/2015

Elevation:

X-COORD:

Y-COORD:

Hole No. TP7

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MAGAGULA HEIGHTS

Hole No: TP8

Sheet 1 of 1

Job Number:GG2084

Scale

0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
0.0-0.15m: Slightly <u>moist</u> , grey brown, <u>medium dense</u> , gravely silty sand with roots. TOPSOIL.							
0.15-0.45m: <u>Moist</u> , greyish, mottled orange, <u>dense to very dense</u> , silty sandy GRAVEL. Gravel consists of ferruginised cemented ferricrete nodules. POSSIBLY FILL.							
0.45-1.1m: Slightly <u>moist</u> , grey brown, mottled orange, speckled black, <u>dense</u> , silty sandy GRAVEL. Gravel consists of +/- 2-15mm, sub-angular to irregular, highly ferruginised nodules. CEMENTED FERRICRETE LAYER.							
1.1-1.7m: Slightly <u>moist</u> , yellow orange speckled black, <u>stiff</u> , gravely silty sandy clay. RESIDUAL AGGLOMERATE.							
<ol style="list-style-type: none"> 1. No groundwater seepage. 2. Final depth 1.7m 3. Refusal on Intermediate ground conditions 4. Samples: 1.5m (undisturbed) 							

Contractor: P Rambally

Machine: JCB

Drilled by:

Profiled by: GAH

Type set by

Date: 02/02/2015

Elevation:

X-COORD:

Y-COORD:

Hole No. TP8

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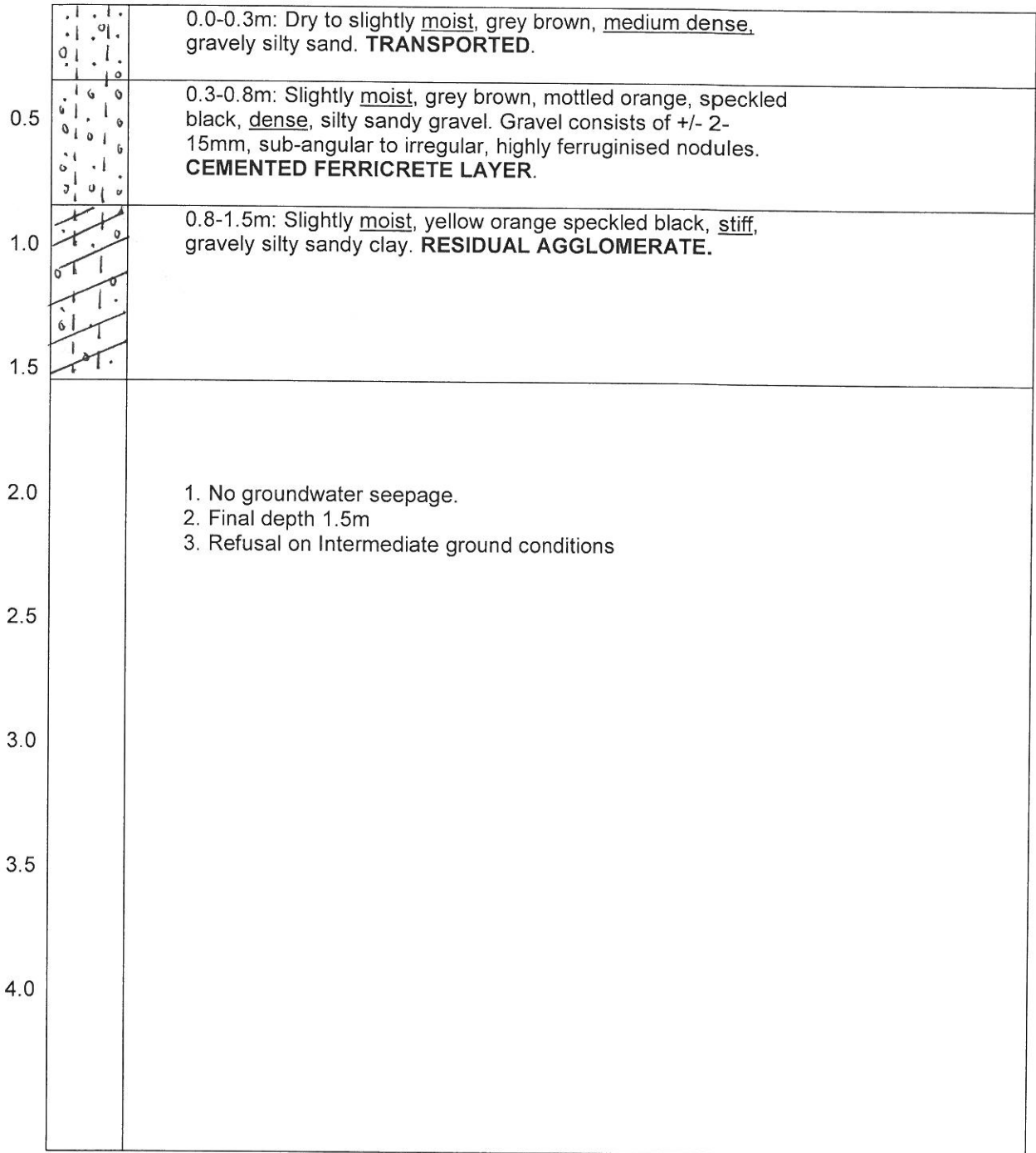
MAGAGULA HEIGHTS

Hole No: TP9

Sheet 1 of 1

Job Number:GG2084

Scale



Contractor: P Rambally
Machine: JCB
Drilled by:
Profiled by: GAH
Type set by
Date: 02/02/2015

Elevation:
X-COORD:
Y-COORD:

Hole No. TP9

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MAGAGULA HEIGHTS

Hole No: TP10

Sheet 1 of 1

Job Number:GG2084

Scale		0.0-0.3m: Slightly <u>moist</u> , grey brown, <u>medium dense</u> , gravely silty sand with roots. TOPSOIL.
0.5		0.3-0.7m: Dry to slightly <u>moist</u> , grey brown, <u>medium dense</u> , gravely silty sand. TRANSPORTED.
1.0		0.7-1.2m: Slightly <u>moist</u> , grey brown, mottled orange, speckled black, <u>dense</u> , silty sandy gravel. Gravel consists of +/- 2-15mm, sub-angular to irregular, highly ferruginised nodules. CEMENTED FERRICRETE LAYER.
1.5		1.2-1.8m: Slightly <u>moist</u> , yellow orange speckled black, <u>stiff</u> , gravely silty sandy clay. RESIDUAL AGGLOMERATE.
2.0		1.8-2.3m: Orange yellowish, mottled black, saprolitic to highly weathered, fissured joints with roots, <u>very soft rock</u> . HIGHLY TO SAPROLITIC AGGLOMERATE.
2.5		
3.0		<ol style="list-style-type: none"> 1. No groundwater seepage. 2. Final depth 1.5m 3. Refusal on Intermediate ground conditions Samples: 0.7-1.2m (disturbed); 1.8-2.3m (disturbed)
3.5		
4.0		

Contractor: P Rambally
 Machine: JCB
 Drilled by:
 Profiled by: GAH
 Type set by
 Date: 02/02/2015

Elevation:
 X-COORD:
 Y-COORD:

Hole No. TP10

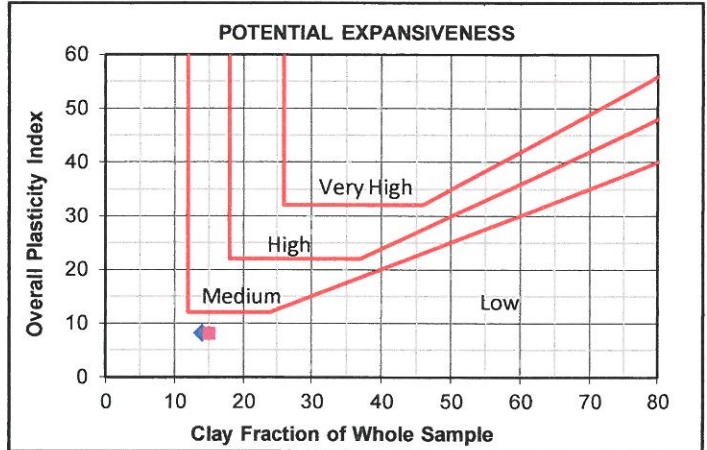
APPENDIX 2
Laboratory Test Results

Client : INTRACONSULT CC
 Project : Magagula Heights
 Project No : 2015-B-1065

Date Received: 20/05/2015
 Date Reported: 30/06/2015
 Page No. : 3 of 5

FOUNDATION INDICATOR

Laboratory Number	3	4
Field Number	TPMH4	TPMH6
Client Reference		
Depth (m)	1.20-1.35	0.35-1.35
Position		
Coordinates	X Y	
Description		
Additional Information		
Calcrete / Crushed Stabilizing Agent		

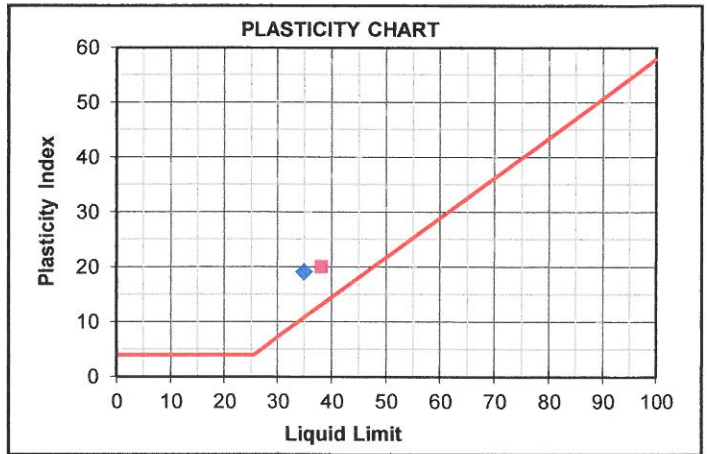


Moisture Content & Relative Density - TMH1 Method A12T

Moisture Content (%)		
Relative Density (S.G.)		

Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100	100
63.0 mm	100	100	100
53.0 mm	100	100	100
37.5 mm	100	100	100
26.5 mm	100	100	100
19.0 mm	100	100	100
13.2 mm	100	95	95
4.75 mm	85	71	71
2.00 mm	56	48	48
0.425 mm	42	39	39
0.075 mm	31	31	31
Grading Modulus	1.71	1.82	1.82



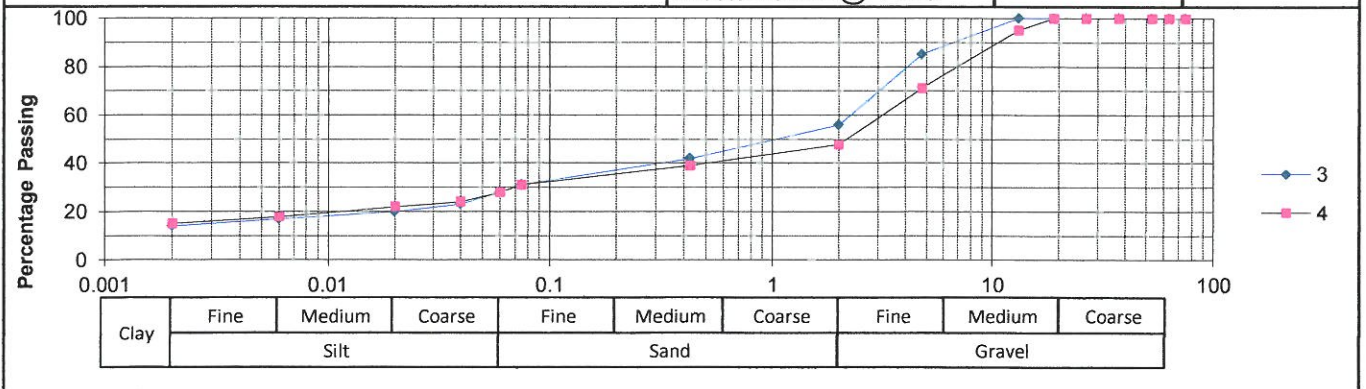
Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	28	28
0.040 mm	23	24	24
0.020 mm	20	22	22
0.006 mm	17	18	18
0.002 mm	14	15	15
Gravel	%	44	52
Sand	%	28	20
Silt	%	14	13
Clay	%	14	15

Laboratory Number	3	4
Atterberg Limits - TMH1 Method A2, A3 & A4		
Liquid Limit %	35	38
Plasticity Index %	19	20
Linear Shrinkage %	10.0	10.0
Overall PI %	8	8

Classifications

HRB	A-2-6(1)	A-2-6(2)
Unified	SC	SC
Weston Swell @ 1 kPa		

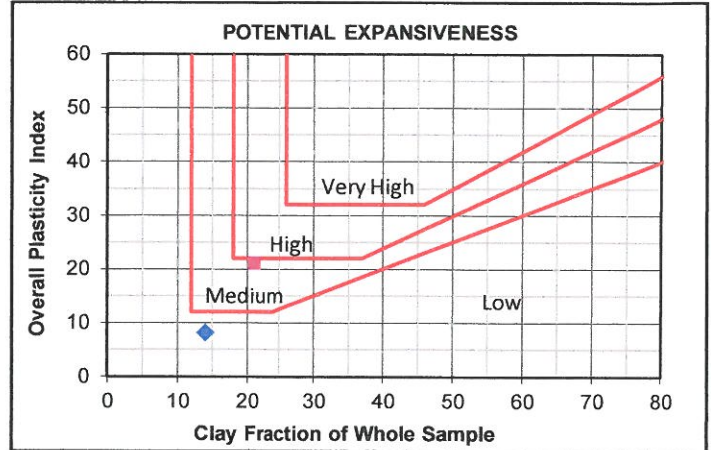


Client : INTRACONSULT CC
 Project : Magagula Heights
 Project No : 2015-B-1065

Date Received: 20/05/2015
 Date Reported: 30/06/2015
 Page No. : 4 of 5

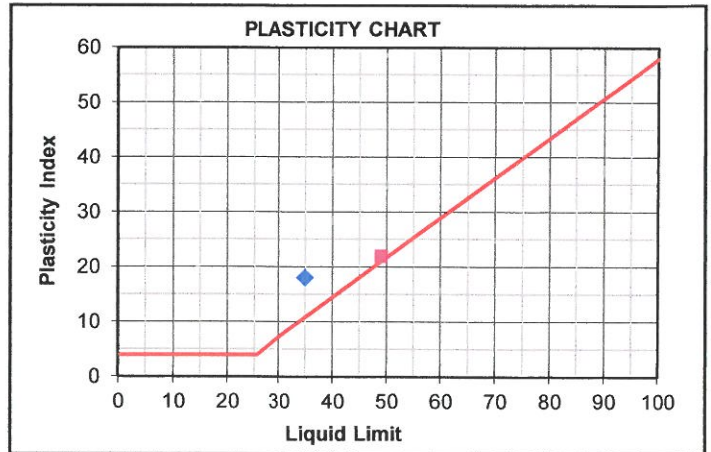
FOUNDATION INDICATOR

Laboratory Number	5	7
Field Number	TPMH7	TPMH10
Client Reference		
Depth (m)	0.5-0.8	1.8-2.3
Position		
Coordinates X		
Coordinates Y		
Description		
Additional Information		
Calcrete / Crushed Stabilizing Agent		



Moisture Content & Relative Density - TMH1 Method A12T

Moisture Content (%)		
Relative Density (S.G.)		



Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100	100
	63.0 mm	100	100
	53.0 mm	100	100
	37.5 mm	100	100
	26.5 mm	100	100
	19.0 mm	100	100
	13.2 mm	93	100
	4.75 mm	64	100
	2.00 mm	50	98
	0.425 mm	42	94
	0.075 mm	28	89
Grading Modulus		1.8	0.19

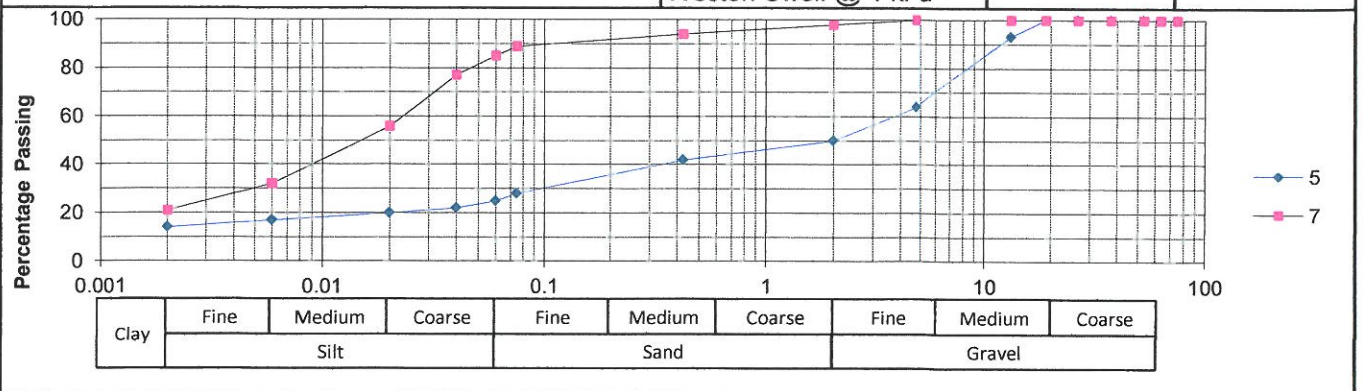
Laboratory Number	5	7
Atterberg Limits - TMH1 Method A2, A3 & A4		
Liquid Limit %	35	49
Plasticity Index %	18	22
Linear Shrinkage %	9.5	10.5
Overall PI %	8	21

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	25	85
	0.040 mm	22	77
	0.020 mm	20	56
	0.006 mm	17	32
	0.002 mm	14	21
Gravel %		50	2
Sand %		25	13
Silt %		11	64
Clay %		14	21

Classifications

HRB	A-2-6(1)	A-7-6(20)
Unified	SC	CL
Weston Swell @ 1 kPa		

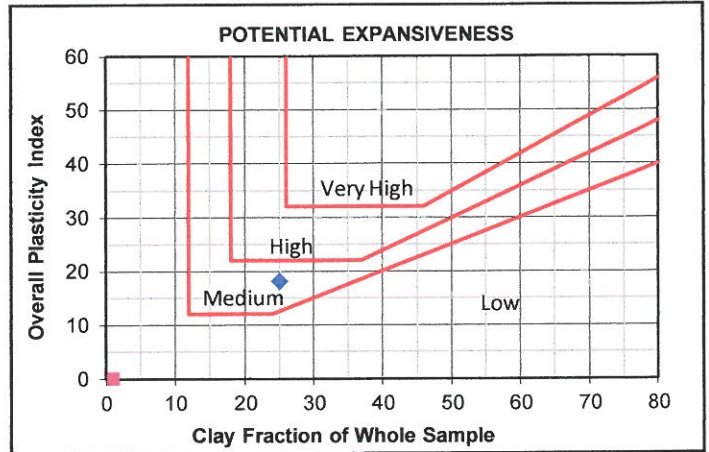


Client : INTRACONSULT CC
 Project : Magagula Heights
 Project No : 2015-B-1065

Date Received: 20/05/2015
 Date Reported: 30/06/2015
 Page No. : 5 of 5

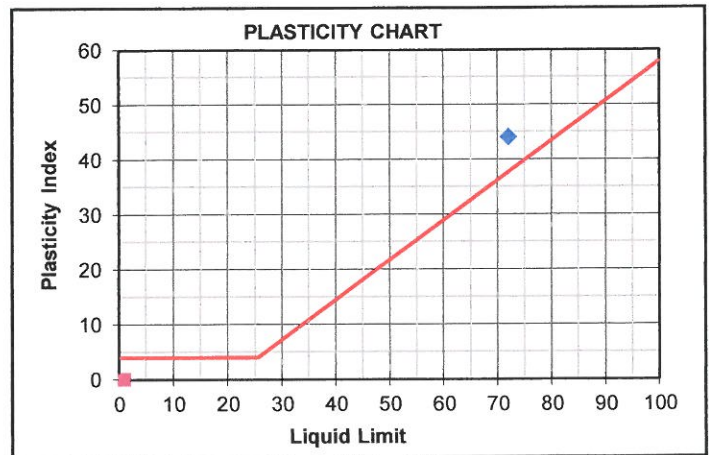
FOUNDATION INDICATOR

Laboratory Number	9	
Field Number	TPMH5	
Client Reference		
Depth (m)	1.8	
Position		
Coordinates	X	
	Y	
Description		
Additional Information		
Calcrete / Crushed		
Stabilizing Agent		



Moisture Content & Relative Density-TMH1 Metod A12T

Moisture Content (%)	
Relative Density (S.G.)	2.718



Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100
	63.0 mm	100
	53.0 mm	100
	37.5 mm	100
	26.5 mm	100
	19.0 mm	100
	13.2 mm	100
	4.75 mm	83
	2.00 mm	48
	0.425 mm	40
	0.075 mm	35
Grading Modulus		1.77

Atterberg Limits - TMH1 Method A2, A3 & A4

Laboratory Number	9
Liquid Limit (%)	72
Plasticity Index (%)	44
Linear Shrinkage (%)	14.5
Overall PI (%)	18

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	34
	0.040 mm	31
	0.020 mm	28
	0.006 mm	27
	0.002 mm	25
Gravel (%)		52
Sand (%)		14
Silt (%)		9
Clay (%)		25

Classifications

HRB	A-2-7(4)
Unified	SC
Weston Swell @ 1 kPa	

