Consulting Engineering Geologists **Intraconsult**

Intraconsult cc
Registration Number CK/86/12311/23

VALUMAX
P O BOX 78772
SANDTON
2145

P.O. Box 604,
Fourways
2055
Gauteng

ATTENTION: MR H SLABBERT

Telephone : **(011) 469 0854**
Fax : **(011) 469 0961**
086 689 2847

Email: **intrac@mweb.co.za**

Your reference	Our reference	Date
	IR1121	**29 JUNE 2012**

A GEOTECHNICAL REPORT (GFSH – 2 PHASE 1) TO VALUMAX ON DIEPSLOOT EXT. 8

EXECUTIVE SUMMARY

This report presents and comments on the results and observations of additional geotechnical investigations carried out on Diepsloot Ext. 8, a total area of approximately 197 ha.

This study has involved the assimilation and evaluation of available geotechnical and geological data and additional field and laboratory investigations. These investigations involved the profiling and sampling of open trial holes in order to gather further information on the general engineering geological conditions that exist beneath the designated site area. The laboratory test results have been analysed and the soil profiles assessed in order to confirm the perspectives formulated in the field concerning the geotechnical characteristics of the soils occurring across the site.

Based on these and previous geotechnical investigations, the site has been sub-divided into (soil) Site Class Sub-Areas. These Sub-Areas are designated in terms of the S.A. Code of Practice into composite Site class (i.e. the 'H', 'C' and 'S' series).

Geotechnical evaluations are provided for the development of this site together with broad recommendations for building foundations.

A GEOTECHNICAL REPORT (GFSH – 2 PHASE 1) TO VALUMAX ON DIEPSLOOT EXT. 8

CONTENTS **PAGE**

1. INTRODUCTION AND TERMS OF REFERENCE

This report presents and comments on the results and observations of geotechnical investigations carried out for project planning purposes for the (demarcated) area known as Diepsloot Ext. 8.

The terms of reference and scope of the work to be undertaken were discussed with Helgardt Slabbert of Valumax and outlined in the Intraconsult cc proposal reference IR1121p dated 18 May 2012

In outline this study surveys the portions of this site excluded from the earlier (ARQ) but consolidates all data into one report with NHBRC Site Classifications for the whole site.

2. INFORMATION USED IN THIS STUDY

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

- Topographical map issued by the surveyor general: 2527DD and 2528CC at a scale of 1:50 000
- Geological Map issued by the Director of Geological Survey :2526 and 2528 (Scale 1:250 000).
- Various google images of the site.
- A report entitled “Johannesburg Northern Farms Diepsloot 355IR” prepared by ARQ (Pty) Ltd, reference 4357/10142 dated March 2006.
- Guidelines for engineering geological investigation on non dolomitic areas for the purpose of township development – TPA Department of Local Government.
- Home Builders Manual February 1999. National Home Builders Registration Council (NHBRC). Reference 3.
- National Dept. of Housing Generic Spec. GFSH-2 Sept. 2002.
- Contoured drawing provided by Messrs Valumax which serves as the base plan for the IR1121 soil map.

3. SITE DESCRIPTION

Extension 8 is part of a township established on portions of the farm Diepsloot 388IR. The township is located west of the R511 (K46) and borders Riverglen and Dainfern to the south.

A locality map is provided in Figure 1.

Natural vegetation consists of veld grasses. There are areas of medium hard rock and hard rock and sub-outcrop in sectors of this site which falls in a northerly direction to a tributary stream of the Jukskei River. The Johannesburg Northern outfall sewer runs northwards across the site as do numerous overhead power lines through and around the site boundaries. An Eskom substation is situated in the south eastern corner of the

site. Photographs depicting the general area proposed for developments are given in Appendix 3.

4. NATURE OF INVESTIGATIONS

These investigations have involved the review and analysis of the available data listed in Section 2 including:-

- Trial Hole Profiles and
- Laboratory Test Data from ARQ 2006 report.

In addition a further series of soil profiles, together with soil samples for laboratory testing, have been taken from the trial holes opened across this site in general accordance with the GFSH-2 Phase 1 requirements.

Trial Holes were opened across the site using a 75 kw TLB/backhole machine. Each trial hole was entered and inspected by an engineering geologist who also described the soil profiles using the visual tactile procedures advocated by Jennings et al (1973). Detailed descriptions of the trial hole profiles from this investigation are provided in Appendix 1 and their positions shown on Drawing IR1121.

Particle size distributions and Atterberg limit tests have been carried out on disturbed samples recovered from the various soil units uncovered during these investigations for accurate classification and identification purposes. Soil unit samples were also selected and tested for moisture content and soil chemistry. Where practically possible, undisturbed samples were taken to check the potential collapse and compressibility characteristics of these soils.

5. SITE GEOLOGY AND GROUNDWATER CONDITIONS

The site us underlain by granite-gneiss bedrock of the Johannesburg-Pretoria granite inlier. The residual soils of these Basement Complex granites are typically silty and clayey sands and sandy silts frequently open-textured and having collapse potential: **Sub-angular joint blocks and weathered core-stores are also a common feature in Basement Complex granites.**

The surficial colluvial materials contain thin horizons of hardpan ferricrete. Degrees of ferruginisation are also present in the underlying residual silty and clayey sands that originate from decomposition of the granite-gneiss bedrock. Extensive areas of (soft) rock sub outcrop a characteristic of the bedrock underlying this site.

Perched seasonal groundwater conditions should be anticipated to develop on horizons of reworked residual granite and ferricrete soil units on this site. The seasonal nature of these shallow groundwater regimes is confirmed by the general absence of shallow groundwater seepage during the earlier detailed trial hole investigation programme and the noted presence of such conditions during the current surveys. The groundwater under the sites lies in an unconfined aquifer, that is the groundwater will be generally contained in a variety of secondary structures within the bedrock such as joints, cracks, fissures and faults. The bedrock in this area are (generally) poor yielders of water and would be classed as ‘minor’ aquifers. However, any containment liquids entering the bedrock structures are likely to flow comparatively rapidly through the secondary features with hardly any attenuation of pollutants.

6. GEOTECHNICAL EVALUATION

This Geotechnical Evaluation is based on our interpretation of field scouting, 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**.

  Significant 'collapse' settlement should be anticipated in the soil profiles on the site based on our field assessments and also the laboratory oedometer test results. These results and analyses are discussed fully in Section 7.

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

  Analyses carried out on disturbed samples of the soils types uncovered in the trial holes confirm 'normal' (H) potential heave/shrink soil conditions. These results and analyses are discussed fully in Section 7, below.

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

  Consolidometer tests carried out on undisturbed samples of very fine grained and low permeability soil units indicate that compressibility is unlikely to be problematic on this site

  These tests results are summarised in Table 3 and fully discussed in Section 7 below.

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

  Disturbed samples of the transported and residual soils uncovered in the opened trenches across this site were subjected to particle size and Atterberg Limit tests. These test results are summarised in Table 1. Our evaluation of these natural insitu materials for potential use in pavement subgrade design is provided as follows:-

Material	Group Classification	Grading Modulus (Range)	Workability Rating
Topsoil	G5	2.2	Excellent
Colluvium	G5 to G6	1.5 to 2.2	Excellent
Residual Granite	G5 to G6	1.4 to 1.6	Good
Very Soft Rock Granite	G6 to G9+	1.4 to 1.6	Good

- **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 available with selection from all horizons in the soil profile except in the slightly ferruginised reworked residual granite soils.

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

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

  Disturbed samples of the reworked and residual soils encountered in the opened trenches across this site were subjected to chemical tests. Our assessment of these values is as follows:-

Material	pH	Comment	Resistivity ohm.m (range)	Comment[1]
Topsoil	5.4-7.2	slightly acidic to neutral	96	mildly corrosive
Colluvium	5.3-7.6	slightly acidic to neutral	22-256	v. corrosive to not
Alluvium	8.3	slightly alkali	8	very corrosive
Res. Granite	6.3-6.6	neutral	19-151	very corrosive to not
Very Soft Rock Granite	6.3-6.7	neutral	21-114	very corrosive to not
[1]Comment : ref. Messrs. ARMCO 1977				

  The results indicate that the near-surface soils have a tendency to be corrosive to any ferrous materials placed in them.

- **Illegal dumping of refuse**: Dumped refuse and unconsolidated fill should be anticipated as a general hazard potentially influencing housing foundations.

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

  Sodium-based clay minerals are prone to rapid dispersion in water and are susceptible to erosion or piping in the soil profile. The electrical conductivity of the soil paste provides an indicator of the salinity and likely dispersive behaviour.

Our assessment of these values is as follows:

Material	Conductivity S.m.	Dispersive characteristic[1]
Topsoil	<0.01	non-associated
Colluvium	<0.1	non-associated
Alluvium	0.12	non-associated
Res. Granite	<0.1	non-associated
Very Soft Rock Granite	<0.1	non-associated
[1] note: conductivities in excess of 0.5 S.m. may be associated with dispersive characteristics.		

- **Evaluation of perched and seepage groundwater conditions noted in open trial holes:**

  Perched groundwater conditions can occur on the pedocrete/ferricrete horizons and also on shallow bedrock. Such soil profiles could be impacted by 'rising damp' in service: in general, special attention to membrane/dampcourse measures is required when building on this site.

6.2 Slope Stability and Erosion

With an approximate average site gradient around 5-12 per cent, slope stability should not present a major problem with regard to erven development on this site. However, the fine nature of many of the soil types that will be exposed after the removal of the natural vegetation cover will present a potential erosion problem during periods of heavy rain and also dust removal by high winds in the dry season.

6.3 Excavation Classification with respect to Services

A number of the opened trenches uncovered 'intermediate' and 'hard rock' excavation materials (SABS 1200D) in the lower sections of the ground surface to minus 1.5m profile see Table 1. Our evaluation is that such materials generally could be removed by a more powerful (tracked) type of excavator or (more locally) with the use of explosives before removal by a machine capable of removing the loosened material.

6.4 Impact of Geotechnical Character of the Site on Urban 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) and do not necessarily reflect a typical (singular) soil profile overlying the bedrock.

These broad geotechnical Sub-Areas are defined below:-

Geotechnical Sub-Area	Definition
1 (or prefix "1")	The geotechnical conditions are such that urban development can take place without any special precautionary/remedial measures for geotechnical conditions.
2 (or prefix "2")	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 (or prefix "3")	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 broad Sub-Areas.

These broad Sub-Areas are shown on the Soil Map IR1121, as follows:

- Sub-Areas prefixed "2"
  Development permitted with precautions.

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

The broad geotechnical characteristics of the primary geotechnical Sub-Area outlined in Section 6.4 are further described in terms of several 'geotechnical category designations' 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 – 30mm > 30 mm
Collapsible soils C C1 C2	Expected range of total movement at surface: < 5mm 5 – 10mm > 10mm
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.
Steep slope T	> 15 degrees
P	Unconsolidated fill.
R R1 R2 R3	Rock Outcrop Scattered outcrop Sub-outcrop (i.e. pre-development ground surface to minus 1.5m)

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.

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 NHBRC 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 fine and very fine soils can induce volume changes which would 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 per cent 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 average liquid limit (whole) values for the various soil units. These values, together with the potential volume changes (swell difference between the presumed 'driest' and 'wettest' field moisture conditions) are tabulated below :-

SOIL UNIT	AVERAGE L.L. WHOLE	MOISTURE CONTENT %		SWELL DIFF. VOL. CHANGE %
		'DRIEST'	'WETTEST'	
Topsoil	7	2.8	5.6	<0.1
Colluvium	7	2.8	5.6	<0.1
Alluvium	11	4.4	8.8	<0.1
Res. Granite	12	4.8	9.6	<0.1
Very Soft Rock Granite	11	4.4	8.8	<0.1

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

Thicknesses of open-textured (and/or 'loose') hillwash and residual granite soil units were uncovered in the trial holes opened and profiled on this site. The CP_{200} test results on select samples indicate 'moderate trouble' to 'trouble' with these soils. A 1 percent collapse in profile has been adopted in the assessment of these materials.

Once analysed according to the assumptions and data provided, the individual profile 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.

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.

(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 moist, very fine grained residual granite soil units with a low coefficient of permeability. The Laboratory consolidometer tests on undisturbed samples taken from these materials and reported in Table 3 and indicates only small amounts of compressibility once these soils have been compacted.

A Soil Map (Drawings IR1121) has been compiled reflecting this total conceptual Site Class Sub-Area characterisation. Our characterisation of the near surface conditions for the Sub-Areas shown on the Soil Map is as follows:-

Sub Area	Commentary
C1-C1/S	• Developable with precautions. • Potential collapsible soils overlying granite/gneiss bedrocks.
2(R2-R3)[H/C(C1)/S]	• Developable with precautions. • Anticipate scattered medium and hard rock outcrop and sub outcrop also pockets (C1) of collapsible soils.
2/3W	• Requires drainage provision

8. RECOMMENDATIONS

8.1 Foundation Recommendations and Solutions

These investigations have confirmed that potentially problematic soils mantle the bedrocks over the site area. The locality of these soils and their anticipated in-service behaviour has been analysed and broad zonation provided on the soil maps, Drawing IR1121.

Possible foundation solutions are further complicated by the possible presence of 'hard' and 'soft' materials immediately beneath individual footprints as a consequence of local rock sub outcrop. It is recommended that all soils are precompacted below foundation works.

Recommended alternate foundation design solutions for single storey masonry structures are provided in the NHBRC 'Standards and Guidelines'. However, as many of these erven are likely to be developed with double storey structures. It is recommended that engineered rationally designed foundations are adopted on this site.

Notes:

- Site Specific Investigations must be conducted on all erven planned for major structures prior to design finalisation and construction in order to prove 'solid' granite bedrock in this potentially deeply weathered rock profile.

8.2. Drainage

Signs of potential seepage and perched water tables were noted in many of the opened trenches and are probably associated with the impermeable nature of the underlying pedocrete soils and bedrock across this site.

As most of the site area is mantled by varying thicknesses of colluvial (i.e., transported) materials, care should be taken to avoid any accumulation of surface water near to future building sites by appropriate surface stormwater drainage design.

The seepage zone designated as Zone 2/3W and centered on Test Pits B64, B66, B67, TP40 and TP41 (Drawing IR1121 attached), located in the central area of Diepsloot Extension 8, requires particular attention. The following comments and recommendations apply:

- The subsurface profile typically consists of a thin horizon of hillwash, overlying hardpan ferricrete grading into soft and hard rock granite.
- During the rainy season ground water accumulation and lateral seepage occurs within the soils horizons, on the soil-ferricrete/granite interface. This water gathers upslope of the seepage zone and migrates downslope until it is forced to "daylight" by the outcropping or dramatic shallowing of the granite or ferricrete.
- Our opinion is that the area may be developed from a geotechnical perspective provided certain precautionary measures are implemented, including:
  - Use of cutoff drains topographically immediately above the delineated area.
  - Subsurface drains are located strategically to capture the groundwater seepage e.g. below the sewer pipeline in sewer trenches. These drains will remove the water and discharge it downslope.
  - Placing roads on improved foundation materials and making use of the road network to facilitate drainage of the area.
  - All structures and walls are to have adequate freeboard and appropriate damp proofing, to preclude rising damp.
- Alternatively parts of the delineated area can be considered for use as school sites, with the sports fields and part of the open space located in the seepage area.

8.3 Special Precautionary Measures

As outlined in Section 9 above, careful stormwater management will be required across this site in order to remove stormwater in a speedy and efficient manner and to prevent any accumulation of surface water against or near buildings.

Special care will be required for the design (and drainage) of services in close proximity to any of the existing natural drainage paths that occupy sectors of this site, as spring/seepage conditions may be expected to occur in such locations during periods of heavy or continuous rain.

8.4 General Site Clearance/Preparatory Works

Provision should be made to reinstate any general areas of unconsolidated fill that may be uncovered during the installation of individual foundations on this site.

8.5 Foundation Works

Broad recommendations are provided in Section 8. Site specific investigations must be conducted on any sites planned for major structures.

8.6 Road Construction and Installation of Underground Services.

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

'Intermediate' excavation (SABS 1200D) conditions should be anticipated in sections of the site as well as some degree of hard rock where outcrop conditions exist.

Selected granular bedding will need to be imported to these Works.

8.7 General Recommendation

The Sub-Area Site Class presumed boundaries are shown on Intraconsult Soil Map Drawing IR1121. It is recommended that all layout plans for this development are reviewed on an ongoing basis and 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 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.

INTRACONSULT cc
P.O. BOX 604
FOURWAYS
2055

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

A GEOTECHNICAL REPORT
(GFSH-2 PHASE 1)
TO VALUMAX ON
DIEPSLOOT EXT. 8

IR1121

INTRACONSULT cc
P.O. BOX 604
FOURWAYS
2055

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

JUNE 2012

FIGURES

LOCALITY MAP FIGURE 1

TABLES

DRAWINGS

SOILS MAP IR1121

APPENDICES

APPENDIX 1
TRIAL HOLE PROFILES

APPENDIX 2
LABORATORY TEST RESULTS

APPENDIX 3
PHOTOGRAPHIC RECORDS