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Report to Siyamthanda Projects cc on a Pre-Feasibility Geotechnical Desktop Appraisal of the Mbulwane Rural Housing Project (Ward 1), Umzinyathi District Municipality

Reference: 219-13.MRHP.R02

Dated: 17 July 2014

Siyamthanda projects c.c. Reg.No. 2001/059699/23

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1. TERMS OF REFERENCE

In response to a fee proposal dated 19 February 2013 (reference GS 8/13/P DoHS House Sector Plans Tender/Geotech/Fee Proposal), Geosure Pty (Ltd) was authorised by Siyamthanda Projects cc to proceed with conducting pre-feasibility geotechnical desktop appraisals of Human Settlements Projects within KwaZulu-Natal.

The geotechnical appraisals refer to a provisional 244 housing projects within 10 (ten) district municipalities in KwaZulu-Natal.

The purpose of the geotechnical desktop appraisals is to appraise the feasibility of each housing project from a regional geotechnical perspective.

The appointment of Geosure by Siyamthanda Projects cc to carry out the pre-feasibility appraisals as proposed is set down in correspondence dated 25 August 2013.

The **Mbulwane Rural Housing Project Ward 1** site forms part of the above geotechnical authorisation.

2. SCOPE OF WORK

This report sets out the results of a pre-feasibility geotechnical desktop appraisal carried out for the proposed **Mbulwane Rural Housing Project Ward 1** site located in the Umzinyathi District Municipality, KwaZulu-Natal, hereafter referred to as the *site*.

3. SOURCES OF INFORMATION

The following information was consulted:

- Regional geological series map titled "Durban" *(Sheet 2930)* prepared by The Council for Geoscience;
- GIS Data and maps provided by Siyamthanda Projects cc;
- Report by Udidi Environmental Planning and Development Consultants[1];
- Google Earth imagery from the internet.

[1] Town Planning Feasibility Analysis for the Umvoti Local Municipality, Umzinyathi District Municipality "4.1 Mbulwane Rural Housing Project (Ward 1)"

4. DESCRIPTION OF SITE

The site is located approximately 50 kilometres southeast of the town of Greytown in Ward 1 of the Umvoti Local Municipality in northern KwaZulu-Natal.

Information supplied by Siyamthanda Projects cc indicates a site area measuring 4 640 hectares in extent.

With reference to Figure 2 overleaf, position A plots approximately as latitude 30˚50’ 00” (East)/longitude 29˚13’30” (South).

Inferring from aerial imagery, the area appears to comprise steep to rugged slopes over the majority of the site. Relatively moderately sloping terrain is generally apparent across the extreme southern and central portions of the site.

A number of drainage routes traverse the site.

The regional and local contexts of the site are shown below and overleaf in Figures 1 and 2.

<u>Figure 1</u>: Regional context of site (Source: Google Earth imagery)

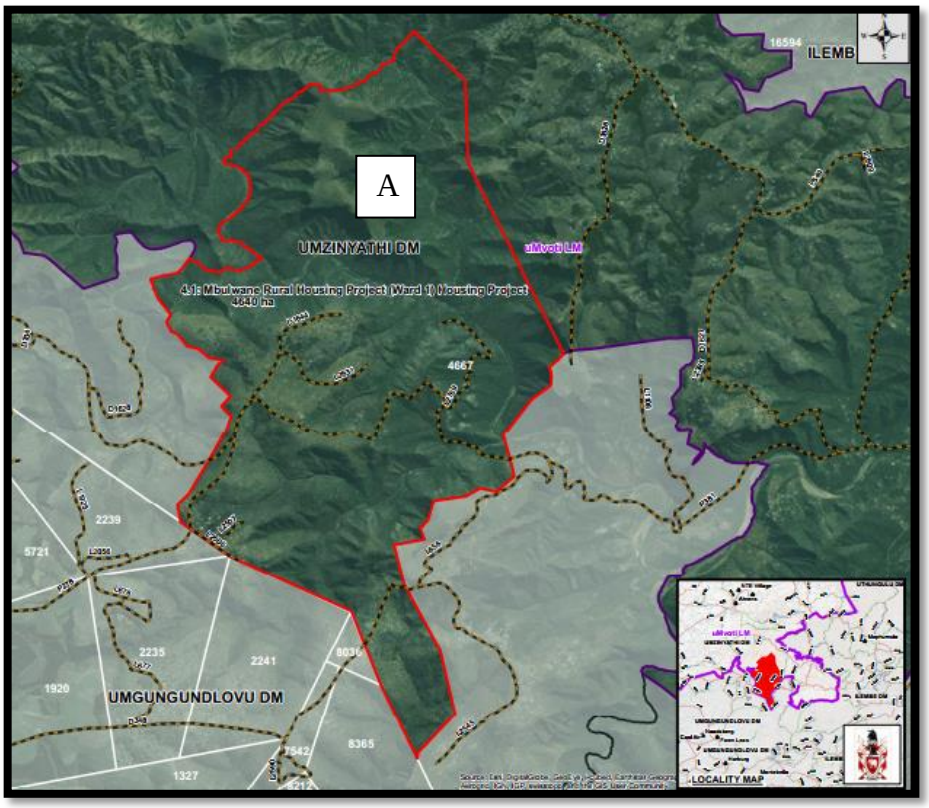


Figure 2: Plan showing local context of site (Source: Maps, Siyamthanda Projects cc)

The site accommodates traditional settlements which are shown in aerial imagery in the central and southern portions of the site generally.

5. INFERRED GEOLOGY AND SUBSOIL CONDITIONS

According to the 1:250 000 scale geological map sheet No 2930 ("Durban"), the inferred regional geology comprises the following mapping units listed in order of increasing age:

- **Sandstone** and associated sedimentary bedrocks of the Natal Group (O-Sn);
- The central portion of the site shows **igneous bedrocks of the Natal Structural and Metamorphic Province**, comprising leucocratic granite (Nn).

Active silty and clayey subsoils are commonly associated with weathering of granites. This phenomenon manifests as volumetric changes in response to cyclical fluctuations in soil moisture content.

Subsoils derived from weathering of sandstone are generally sandy in nature with some gravel and occasional sandy clays. Loosely consolidated and weakly cohesive sandy profiles tend to be compressible and collapsible when wet up under applied load.

A potentially active condition is associated with any residual clay subsoils present.

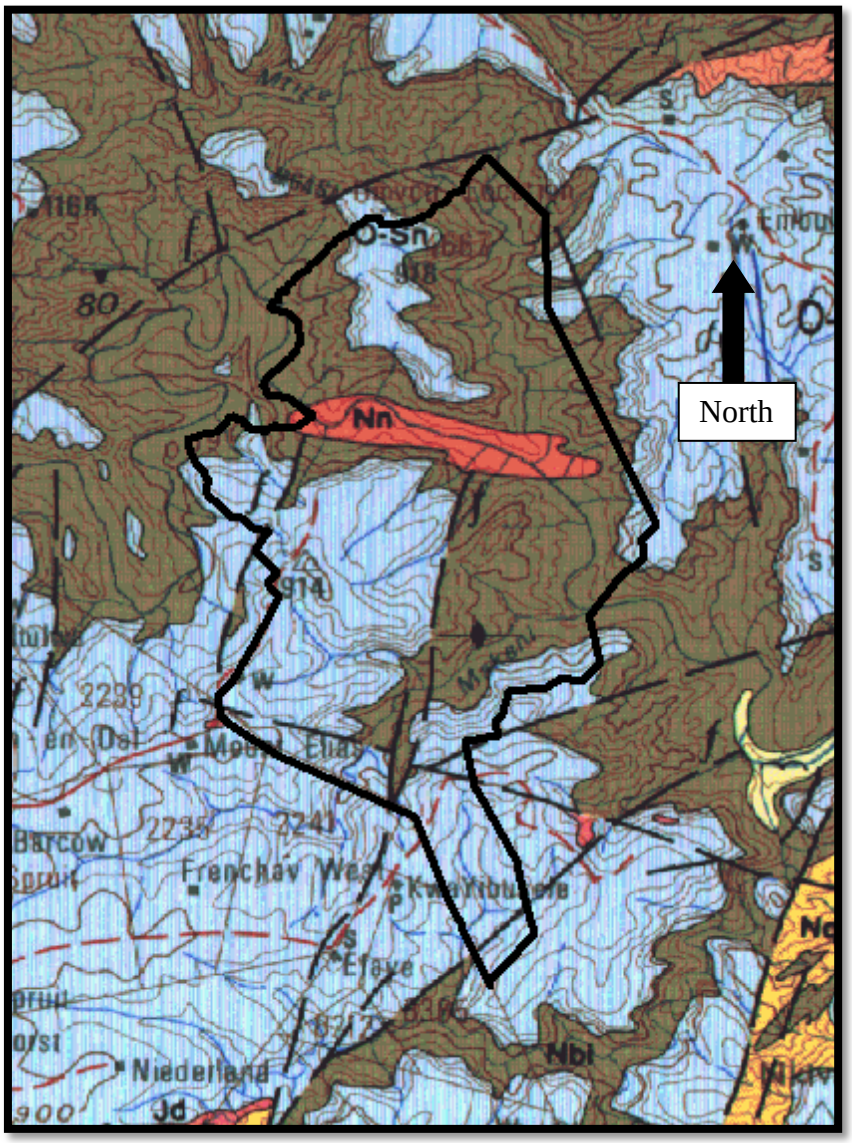


Figure 3: Regional geological map of site (Source: Geoscience sheet 2930)

Regional mapping indicates at least four geological faults traverse the site.

6. GROUNDWATER SEEPAGE

Desktop records indicate that the site consists predominantly of terrain showing sharp relief over the greater majority of the site, moderating over the central and extreme southern site areas.

The site is drained by the Mtizo River and tributaries which form part of the Mvoti system.

Satisfactory slope drainage patterns are inferred to apply to the hilltops and upper to mid hillsides of planar to convex slope conformation.

Weak to poor drainage is apparent along weakly drained valley (head and bottom) terrain where there is the potential for the presence of wetland habitat.

A flood risk applies to the valley bottom areas.

Separate to the topographical variations outlined above, a perched groundwater table may develop at shallow depths both during and after periods of heavy and prolonged rainfall and/or during the high rainfall season generally across the site.

7. DOMESTIC SEWAGE

In a report[1] by Udidi Environmental Planning and Development Consultants dated July 2014, the following is indicated regarding the level of sanitation for this site:

"Sanitation is available but limited within the proposed study area. The most common forms of sanitation used in this area are pit toilets and ventilated pit latrines (VIP). The Bulk Water and Sanitation Strategy developed by the municipality will look at appropriate interventions for upgrade and development of effective sanitation infrastructure."

Variable subsoil conditions are inferred for the site and the suitability for on-site disposal of wastewater effluent by subsoil percolation should be verified by detailed geotechnical investigation.

Given the rural context of the site and that the report[1] above indicates that formal waterborne sanitation facilities for the site is not in place, it appears that consideration be given to the employment of a ventilated improved pit (VIP) toilet option is necessary.

Variations in the major geotechnical and geohydrological conditions will be one of the major determinants for the planning and use of on-site sanitation systems.

In the absence of a waterborne sewer connection, an alternative solution for disposal of household sewage where subsoil conditions are unfavourable for a flush toilet option usually comprises a Ventilated Improved Pit (VIP) toilet system.

It is inferred at a pre-feasibility level that the inferred geotechnical site conditions away from weakly drained terrain should generally suit the use of a V.I.P. toilet system to engineer's detail.

Engineer's design should be based on a Groundwater Protocol Evaluation in accordance with requirements set down by the Department of Water Affairs.

8. SUITABILITY OF SITE FOR HOUSING DEVELOPMENT

Information provided indicates that the site is earmarked for a low income type housing development.

The overall suitability of the site has been evaluated by broadly classifying the site into geotechnical zones in accordance with the "*Terrain Classification System for Geotechnical Constrains on Development*"[2], as shown in Table 1 below:

[2] Geotechnical Terrain Classification Table (Adapted from Partridge T. C., Wood C. K. and Brink A. B. A.)

Table 1

Mbulwane Rural Housing Project Ward 1: Geotechnical Terrain Classification Table
(Adapted from Partridge T. C., Wood C. K. and Brink A. B. A.)

Constraint		Most Favourable (1)	Intermediate (2)	Least Favourable (3)
A	**Collapsible Soil**	Any collapsible horizon or consecutive horizons totalling a depth of less than 750mm in thickness.	Any collapsible horizon or consecutive horizons totalling a depth more than 750mm in thickness	A "least" situation for this situation does not occur.
B	**Seepage**	Permanent or perched water table more than 1.5m below ground surface.	Permanent or perched water table less than 1.5m below ground surface.	Swamps and marshes.
C	**Active Soil**	Low soil-heave potential anticipated	Moderate soil-heave potential anticipated e.g. granite	High soil-heave Potential anticipated
D	**Highly compressible soil**	Low soil compressibility anticipated.	Moderate soil compressibility anticipated.	High soil compressibility anticipated
E	**Erodability of soil**	Low	Intermediate	High
F	**Difficulty of excavation to 1.5m depth**	Scattered or occasional boulders less than 10% of the total volume.	Rock or hardpan pedocretes between 10% and 40% of the total volume.	Rock or hardpan pedocretes more than 40% of the total volume.
I	**Steep slopes**	Between 2 and 6 degrees	Slopes between 6 and 18 degrees and less than 2 degrees.	More than 18 degrees
J	**Areas of unstable natural slope**	Low risk	Intermediate risk	High risk
L	**Areas subject to flooding**	A "most favourable" situation for this constraint does not occur.	Areas adjacent to a known drainage channel or floodplain with slope less than 1%.	Areas with a known drainage channel or floodplain (Tributaries)

In terms of Table 1 above, the suitability of the site mostly classifies as "*Low*" to "*Intermediate*".

Four categories are classified as "*Least Favourable"*, namely, Seepage/Steep slopes/Areas subject to Flooding.

The current pre-feasibility desktop exercise has indicated that the site appears to be characterised in the main by the following geotechnical factors:

- Slope Stability: At this pre-feasibility stage, signs of slope instability affecting large areas are not apparent. Notwithstanding this, certain of the prevailing geological mapping units are associated with poor slope stability e.g. areas underlain by sandstone. A detailed subsurface geotechnical investigation is therefore required to verify slope stability in greater detail.
- Geology: Comprising sedimentary (sandstone) and igneous bedrocks (granite) and derived soils.

- Topography: Comprises mostly steep to rugged terrain moderating where settled.
- Site drainage: Part of the Mvoti system and includes the Mtizo River and tributaries.
- Sewage Disposal: The feasibility of adopting an on-site V.I.P. toilet and/or flush toilet system shall be subject to the findings of a Groundwater Protocol Evaluation.

On the basis of the above desktop observations at a pre-feasibility level, it is considered that there do not appear at this stage to be "fatal flaws" from a geotechnical slope stability perspective over the greater majority of the site.

Suitable detailed geotechnical site investigations, groundwater protocol evaluation, floodline study, and environmental determination of potential wetland habitat are however required to inform final planning and civil engineering design.

9. GEOTECHNICAL PLANNING CONSIDERATIONS

Geotechnical and geohydrological guidelines are set down below to assist with the macro planning of a low income housing project at the site.

9.1 Geotechnical and Geohydrological Site Investigations

As part of the urban planning exercise for a low income housing development, it is law that provision be made for conducting the following stages of geotechnical and geohydrological investigations as described in documents by the National Department of Housing[3] and DWA.

- Phase 1 Geotechnical Site Investigation

  This is both a feasibility and detailed geotechnical design report to guide detailed planning and engineering design of civil infrastructure and foundation.

  It is important that engineering design is based on geotechnical recommendations arising from *Phase 1 Geotechnical Site Investigation*.

- Groundwater Protocol Evaluation

  In the event that a V.I.P. toilet programme is adopted, the geotechnical and geohydrological planning requirements to define and manage the potential for groundwater contamination should be determined by means of conducting a "*Groundwater Protocol Evaluation*[4]" in accordance with DWA requirements.

- Phase 2 Geotechnical Site Investigation

  This stage of geotechnical studies follows on from a Phase 1 Site Investigation to enable verification of soil classes, referencing guidelines set down by the National Home Builders Registration Council (N.H.B.R.C.).

[3] Geotechnical Site Investigations for Housing Developments-Project Linked Greenfield Subsidy Project Developments-Generic Specification GFSH-2, September 2002

[4] A Protocol to Manage the Potential of Groundwater Contamination From Onsite Sanitation dated March 2005 (Edition 2)

The verification exercise is usually carried out once a building contractor commences with site earthworks and installing infrastructure.

9.2 Slope Stability

The yield of the site based on areas suitable for development in terms of stable slopes requires to be established by conducting a *Phase 1 Geotechnical Site Investigation.*

9.3 Oversteep and Rugged Slopes

As a rule, economic development of land steeper than 1 vertical: 3 horizontal (>18˚) for RDP housing purposes is general not feasible.

Signs of steep/rugged terrain are apparent from aerial imagery over the majority of the site. The extent of oversteep terrain across the entire site should therefore be determined on the basis of a slope analysis by the urban planner.

The presence of rugged landscape is likely to prelude low income housing from practical budgetary and engineering limitations.

9.4 Environmentally Sensitive Areas

Planning for development should take account of the presence of any of the following environmentally sensitive features:

- Wetland habitat e.g. in vicinity of drainage courses;
- Floodline e.g. valley bottom areas;
- Protected vegetation.

10. CONCLUSIONS

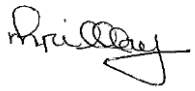
This report sets out the results of a prefeasibility geotechnical desktop appraisal carried out for Siyamthanda Projects cc for the proposed **Mbulwane Rural Housing Project (Ward 1)** site located approximately 50 kilometres southeast of the town of Greytown, Umvoti Local Municipality, Umzinyathi District Municipality, northern KwaZulu-Natal.

On the basis of the current pre-feasibility exercise, it is considered that the majority of the site does not display adverse geotechnical features in general.

Accordingly, it is considered that the majority of the site appears at this pre-feasibility stage to be suitable from a geotechnical perspective to proceed with the macro planning of a low income type housing development.

Suitable detailed geotechnical site investigations and a groundwater protocol evaluation are required to inform final planning and civil engineering design. In this regard, allowance should be made for conducting a *Phase 1 Geotechnical Site Investigation and Phase 2 Geotechnical Site Investigation* in accordance with a planning document[1] from the National Department of Housing. These studies will inform the engineering design of the civil infrastructure and housing foundations.

Planning and engineering design of an on-site sanitation disposal system should be based upon the positive findings of a *Groundwater Protocol Evaluation*.



17 July 2014

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