REPORT TO ILEMBE CONCRETE (PTY) LTD ON THE
RESULTS OF A GEOTECHNICAL FEASIBILITY STUDY
FOR A PROPOSED NEW BORROW PIT NEAR
MANDENI, KWAZULU-NATAL

REPORT REFERENCE: SGE-083-2013.REP01

Author: S. Pather (Pr.Sci.Nat.)
Practice No.: 400020/08 (South African Council for Natural Scientific Professions)
Date: 25 November 2013
### Physical Address:

Unit 417, Mazars House  
197 Peter Mokaba (North Ridge) Road  
Morningside  
Durban  
4001

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone No.:</td>
<td>031-207 1383</td>
</tr>
<tr>
<td>Fax No.:</td>
<td>031-207 1349</td>
</tr>
<tr>
<td>Mobile No.:</td>
<td>084-500 5095</td>
</tr>
<tr>
<td>Administration E-Mail:</td>
<td><a href="mailto:admin@syncline.co.za">admin@syncline.co.za</a></td>
</tr>
<tr>
<td>Director E-Mail:</td>
<td><a href="mailto:sundras@syncline.co.za">sundras@syncline.co.za</a></td>
</tr>
<tr>
<td>Website</td>
<td><a href="http://www.synclinegeo.co.za">www.synclinegeo.co.za</a></td>
</tr>
</tbody>
</table>
REPORT TO ILEMBE CONCRETE (PTY) LTD ON THE RESULTS OF A GEOTECHNICAL FEASIBILITY STUDY FOR A PROPOSED NEW BORROW PIT NEAR MANDENI, KWAZULU-NATAL

REPORT REFERENCE: SGE-083-2013.REP01

TABLE OF CONTENTS

1. TERMS OF REFERENCE .................................................................................................................. 1
2. SCOPE OF REPORT ......................................................................................................................... 1
3. INFORMATION SUPPLIED ............................................................................................................... 1
4. SITE DESCRIPTION .......................................................................................................................... 1
5. NATURE OF INVESTIGATION.......................................................................................................... 3
  5.1 INSPECTION PITS .......................................................................................................................... 3
  5.2 SEISMIC REFRACTION SURVEY .................................................................................................. 3
6. SITE GEOLOGY ..................................................................................................................................... 3
7. GROUNDWATER CONDITIONS ....................................................................................................... 4
8. DISCUSSION...................................................................................................................................... 5
  8.1 PURPOSE OF PROPOSED BORROW PIT ...................................................................................... 5
  8.2 GENERAL STABILITY OF THE SITE ............................................................................................. 5
  8.3 EXCAVATABILITY AND RIPPABILITY ......................................................................................... 5
  8.4 GEOTECHNICAL FEASIBILITY OF SITE ....................................................................................... 6
  8.5 DETAILED PHASE 2 GEOTECHNICAL INVESTIGATION ................................................................. 6
  8.6 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ......................................................................... 7
9. CONCLUSION ..................................................................................................................................... 7

Appendix A: Inspection Pit Log Profiles
Appendix B: Results of Seismic Refraction Tests

Figure 1: Locality Plan of Study Area
Figure 2: Site Plan (showing field tests positions)
1. TERMS OF REFERENCE

Syncline Geotechnical Engineering (Pty) Ltd (hereafter referred to as SGE) was requested by Mr A. Govender (on behalf of Ilembe Concrete (Pty) Ltd) to provide a proposal and cost estimate to carry out a geotechnical feasibility study for a “Proposed New Borrow Pit near Mandeni, KwaZulu-Natal”.

SGE provided this proposal and cost estimate in an electronic message referenced “Proposal 195-2013” and dated 17 October 2013. SGE was subsequently appointed to carry out the investigation as per an electronic mail received from Mr Govender, dated 08 November 2013.

2. SCOPE OF REPORT

This report sets out the results of a Geotechnical Feasibility Study carried out for the “Proposed New Borrow Pit near Mandeni, KwaZulu-Natal”.

The subsoil and geological conditions beneath the site are described and comment is made on the feasibility of establishing a borrow pit in the study area, from a geotechnical perspective.

3. INFORMATION SUPPLIED

For the purposes of assisting with this investigation, Mr Govender provided SGE with Global Positioning System (GPS) coordinates of the study area.

SGE also made reference to the 1:250 000 Geological Map titled “2930 Durban” as published by the Geological Survey.

4. SITE DESCRIPTION

The study area is situated approximately 4km south of Mandeni, at latitude S29°11’56.75” and longitude E031°24’23.16”.

The site occurs west of the R102 main road and is characterised by hilltops, gentle to moderate hillsides and gravel access roads. Certain portions of the study area are currently being utilised for sugarcane farming. A stream/river runs through the central portion of the study area and drains towards the east, into the Tugela River.

Figure 1 below shows the locality of the study area.
Figure 1: Locality of study area

Plates 1 and 2 below provide an indication of the study area.

Plate 1 Plate 2

Plates 1 and 2: General views across the study area
5. **NATURE OF INVESTIGATION**

The fieldwork for the investigation was conducted in November 2013 and comprised the following:

- Terrain Appraisal and Geological Mapping;
- Inspection Pits; and
- Seismic Refraction Tests.

5.1 **Inspection Pits**

Ten pits, designated IP1 through IP10, were excavated by tractor loader backhoe (TLB) at the approximate positions indicated in Figure 2. The inspection pits were extended to machine refusal or to a final depth of 3.5 metres below existing ground level, and were profiled using the “Guidelines for Soil and Rock Logging in South Africa”, (2001)\(^1\). Copies of the detailed profiles are given in Appendix A.

5.2 **Seismic Refraction Survey**

Two seismic refraction surveys, designated ST1 and ST2, were carried out at the approximate positions given in Figure 2 (conducted by Soilco (Pty) Ltd). The results of the seismic tests are given in Appendix B and discussed in Section 8.3 of this report.

6. **SITE GEOLOGY**

The site is underlain by clayey colluvial and residual soils and tillite bedrock of the Dwyka Group. In general, the following subsoil horizons can be recognised across the study area:

- Moist, dark greyish brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY – **COLLUVIUM**.

- Moist, yellowish brown, mottled orange brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY – **RESIDUAL**.

- Yellowish brown to greyish brown, stained red and orange brown, moderately to highly weathered, highly fractured, soft to medium hard rock – **TILLITE BEDROCK**.

Tillite bedrock occurs at depths generally less than 1.0 metre below existing ground level in the hilltop areas and uppermost slopes of the site. The depths to tillite bedrock progressively increase on mid and lower slopes, up to 3.2 metres below existing ground level. Dark, bluish grey tillite also occurs sporadically as outcrops across hilltops and upper slopes in the study area.

Plates 3 through 6 below provide an indication of the typical subsoils and bedrock encountered in the study area.

---


*Syncline Geotechnical Engineering (Pty) Ltd*
7. GROUNDWATER CONDITIONS

Groundwater seepage was encountered in IP5 at a depth of 1.5 metres below existing ground level. As such, it is anticipated that a perched water table will occur at depths generally less than 2.0 metres below existing ground level during rainy periods. The permanent water table is expected at depths generally greater than 5.0 metres below existing ground level.
8. DISCUSSION

8.1 Purpose of Proposed Borrow Pit

It is understood that the proposed borrow pit will be mined for aggregate, for use in concrete. The purpose of aggregates within the concrete mixture is to provide a rigid skeletal structure and to reduce the space occupied by the cement paste.

Both coarse aggregates (particle sizes of 20mm to 4mm) and fine aggregates (particle sizes less than 4mm) are required but the proportions of different sizes of coarse aggregate will vary depending on the particular mix required for each individual end use.

8.2 General Stability of the Site

No signs of inherent ground instability such as slip scars, tension cracks or sloughing of the mantle of transported soils were evident during the fieldwork. As such, it is considered that the site is stable and suitable for development, subject to the outcome of a detailed Phase 2 Geotechnical Investigation.

Where the tillite bedrock joints combine unfavourably with proposed cut/bench faces on slopes, slope failures could result, particularly where clay gouge and water seepage is present along joints. The combination of clay gouge filled joints and high hydrostatic forces induced by rainwater could give rise to slope stability problems. It should be noted that while no problematic areas were identified in the inspection pits put down during the fieldwork phase, it is possible that localised, potentially unstable areas can become exposed during mine development.

It is important to allow for onsite inspections and evaluations by an experienced engineering geologist/geotechnical engineer so that stability problems can be timeously identified and remedied.

8.3 Excavatability and Rippability

A seismic refraction survey was conducted by Soilco (Pty) Ltd across the study area.

Taking into consideration the inspection pits conducted across the site by TLB during the geotechnical feasibility study, it is anticipated that the rippability and excavatability assessment (indicated in Table 1 below) would likely apply to the study area.
Table 1: Rippability and excavability assessment

<table>
<thead>
<tr>
<th>Depth (m) Below Existing Ground Level</th>
<th>Rippability Assessment</th>
<th>Material Hardness</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 – 0.5</td>
<td>Easy ripping</td>
<td>Very soft</td>
<td>Easy excavation by pick and spade. Material can easily be ripped and excavated with a TLB.</td>
</tr>
<tr>
<td>0.5 – 1.5</td>
<td>Easy ripping</td>
<td>Very soft to soft</td>
<td>Difficult and slow excavation by pick and spade. Material can be ripped and excavated with a TLB.</td>
</tr>
<tr>
<td>1.5 – 3.0</td>
<td>Hard ripping</td>
<td>Soft</td>
<td>Cannot be excavated by pick and spade. Excavation will be slow with TLB and machine will likely refuse +/- 1.0m into weathered bedrock. Material can be easily ripped and excavated with a 30T tracked excavator.</td>
</tr>
<tr>
<td>&gt;3.0</td>
<td>Very hard to extremely hard ripping and blasting</td>
<td>Hard to very hard</td>
<td>Allowance for use of pneumatic tools e.g. woodpecker attached to 30T excavators and DD9/D9 tractors. Blasting will likely be required at depths generally greater than 5.0 metres.</td>
</tr>
</tbody>
</table>

8.4 Geotechnical Feasibility of Site

Following a Phase 1 Geotechnical Feasibility Study of the site, it is expected that mining for stone aggregate in the study area will be possible. The presence of bluish grey, slightly weathered, tillite outcrops across the study area bears testament to this.

The upper 3.0 to 5.0 metres of tillite bedrock is anticipated to range from highly to moderately weathered. Tillite bedrock below these depths is likely to range from moderately to slightly weathered, and therefore more conducive for use as stone aggregate.

8.5 Detailed Phase 2 Geotechnical Investigation

Figure 2 provides an indication of the areas regarded as being most feasible for mining. However, it is imperative that a detailed Phase 2 Geotechnical Investigation be carried out across these portions of the study area, to determine the quality of bedrock at depth and limits of development. The Phase 2 investigation will likely comprise the following:

- Detailed geological mapping of the study area;
- Drilling of 4 – 6No. boreholes across the study area, each to a depth of approximately 30 metres below existing ground level;
Laboratory testing of bedrock samples, which will include (but not restricted to) particle size distribution, flakiness index, resistance to wear and fragmentation, particle density and water absorption, polished stone value and magnesium sulphate tests; and

Groundwater measurements in boreholes and mapping/assessment of surface water bodies in study area.

The Phase 2 Geotechnical Investigation will provide a more detailed picture of the study area and clear indication of the suitability of the materials for use as concrete aggregate.

### 8.6 Environmental Impact Assessment (EIA)

An Environmental Impact Assessment (EIA) is a statutory process for assessing and reporting the effects of a project on the environment in order to aid decision makers when determining whether consent for a project will be given.

It is likely that an EIA will be required for the study area prior to mining and development, and the Phase 2 Geotechnical Investigation will be a specialist study which forms part of this requirement.

### 9. CONCLUSION

This report sets out the results of a Geotechnical Feasibility Study carried out for the “Proposed New Borrow Pit near Mandeni, KwaZulu-Natal”.

The site is underlain by clayey colluvial and residual soils and tillite bedrock of the Dwyka Group. Tillite bedrock occurs at depths generally less than 1.0 metre below existing ground level in the hilltop areas and uppermost slopes of the site. The depths to tillite bedrock progressively increase on mid and lower slopes, up to 3.2 metres below existing ground level. Dark, bluish grey tillite also occurs sporadically as outcrops across hilltops and upper slopes in the study area.

Groundwater seepage was encountered in IP5 at a depth of 1.5 metres below existing ground level. As such, it is anticipated that a perched water table will occur at depths generally less than 2.0 metres below existing ground level during rainy periods. The permanent water table is expected at depths generally greater than 5.0 metres below existing ground level.

No signs of inherent ground instability such as slip scars, tension cracks or sloughing of the mantle of transported soils were evident during the fieldwork. As such, it is considered that the site is stable and suitable for development, subject to the outcome of a detailed Phase 2 Geotechnical Investigation.

Following a Phase 1 Geotechnical Feasibility Study of the site, it is expected that mining for stone aggregate in the study area will be possible. The presence of bluish grey, slightly weathered, tillite outcrops across the study area bears testament to this.
The upper 3.0 to 5.0 metres of tillite bedrock is anticipated to range from highly to moderately weathered. Tillite bedrock below these depths is likely to range from moderately to slightly weathered, and therefore more conducive for use as stone aggregate.

It is imperative that a detailed Phase 2 Geotechnical Investigation be carried out across the study area, to determine the quality of bedrock at depth and limits of development. It is likely that an EIA will be required for the study area prior to mining and development, and the Phase 2 Geotechnical Investigation will be a specialist study which forms part of this requirement.

The ground conditions given in this report refer specifically to the field tests carried out on site. It is therefore, quite possible that conditions at variance with those given in this report can be encountered elsewhere on site during construction. It is therefore important that Syncline Geotechnical Engineering (Pty) Ltd be appointed to carry out periodic inspections during construction. Any change from the anticipated ground conditions could then be taken into account to avoid unnecessary expense.

Author: S Pather (Pr.Sci.Nat.)  Date
INSPECTION PIT LOG PROFILES
Moist, dark greyish brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY - Colluvium.

Moist, yellowish brown, mottled orange brown, soft becoming firm with depth, intact, SANDY SILTY CLAY to silty sandy CLAY - Residual Tillite.

Yellowish brown, stained red and pinkish brown, highly weathered, very fine grained, highly fractured, soft rock - TILLITE.

NOTES

1) Depth of water table: Not encountered.

2) Final depth to 3.50m.
Greyish brown, mottled rusty orange, stained orange brown, highly to moderately weathered, very fine grained, moderately fractured, soft to medium hard rock - TILLITE.

NOTES

1) Depth of water table: Not encountered.

2) Refusal depth at 0.50m.
Moist, dark greyish brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY - Colluvium.

Yellowish brown, stained red and pinkish brown, highly weathered, very fine grained, highly fractured, soft rock - TILLITE.

**NOTES**

1) Depth of water table: Not encountered.

2) Refusal depth at 1.00m.
Greyish brown, mottled rusty orange, stained orange brown, highly to moderately weathered, very fine grained, moderately fractured, soft to medium hard rock - TILLITE.

NOTES

1) Depth of water table: Not encountered.
2) Refusal depth at 0.10m.
Moist, dark greyish brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY - Colluvium.

Yellowish/orange brown, mottled orange brown, completely weathered, very fine grained, highly fractured, very soft rock - TILLITE.

NOTES
1) Depth of water table: 1.50m.
2) Refusal depth at 2.00m.

CONTRACTOR: Excavated by TLB
MACHINE: 
DRILLED BY: Y. Hansa
PROFILED BY: K. Govender
TYPE SET BY: K. Govender
SETUP FILE: STANDARD.SET
INCLINATION: 
DIAM: 12 November 2013
DATE: 12 November 2013
DATE: 26/11/2013 11:33
ELEVATION:
X-COORD: 29° 11' 51.49" S
Y-COORD: 31° 24' 25.37" E
TEXT: C\LOGS\PITS1.TXT
HOLE No: IP 5

Ilembe Concrete (Pty) Ltd
Mandeni Borrow Pit

HOLE No: IP 5
Sheet 1 of 1

JOB NUMBER: SGE-083-2013
Moist, dark greyish brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY - Colluvium.

Moist, yellowish brown, mottled orange brown, soft becoming firm with depth, intact, SANDY SILTY CLAY to silty sandy CLAY - Residual Tillite.

Greyish brown, mottled and stained yellowish and orange brown, highly to moderately weathered, fine grained, highly to moderately fractured, soft becoming medium hard rock with depth - TILLITE.

### NOTES

1) Depth of water table: Not encountered.

2) Refusal depth at 2.50m.
Moist, dark greyish brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY - Colluvium.

Moist, yellowish brown, mottled orange brown, soft becoming firm with depth, intact, SANDY SILTY CLAY to silty sandy CLAY - Residual Tillite.

Yellowish brown, stained red and pinkish brown, highly weathered, very fine grained, highly fractured, soft rock - TILLITE.

NOTES

1) Depth of water table: Not encountered.

2) Refusal depth at 1.80m.
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Moist, dark greyish brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY - Colluvium.</td>
</tr>
<tr>
<td>0.50</td>
<td>Moist, yellowish brown, mottled orange brown, soft becoming firm with depth, intact, SANDY SILTY CLAY to silty sandy CLAY - Residual Tillite.</td>
</tr>
<tr>
<td>0.70</td>
<td>Yellowish brown, stained red and pinkish brown, highly weathered, very fine grained, highly fractured, soft rock - TILLITE.</td>
</tr>
<tr>
<td>2.50</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES**

1) Depth of water table: Not encountered.

2) Refusal depth at 2.50m.

**CONTRACTOR:** Excavated by TLB

**MACHINE:**

**DRILLED BY:** Y. Hansa

**PROFILED BY:** K. Govender

**TYPE SET BY:** K. Govender

**SETUP FILE:** STANDARD.SET

**DATE:** 12 November 2013

**TEXT:** C/LOGS/PITS1.TXT

**HOLE No:** IP 8

**ELEVATION:**

**X-COORD:** 29° 11' 58.59" S  
**Y-COORD:** 31° 24' 21.24" E

**INCLINATION:**

**DIAM:**

**DATE:** 12 November 2013

**DATE:** 26/11/2013 11:33
Moist, dark greyish brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY - Colluvium.

Yellowish brown, stained red and pinkish brown, highly weathered, very fine grained, highly fractured, soft rock - TILLITE.

NOTES

1) Depth of water table: Not encountered.

2) Refusal depth at 2.00m.
Moist, dark greyish brown, soft to firm, intact, SANDY SILTY CLAY to silty sandy CLAY - Colluvium.

Moist, yellowish brown, mottled orange brown, soft becoming firm with depth, intact, SANDY SILTY CLAY to silty sandy CLAY - Residual Tillite.

Yellowish brown, stained red and pinkish brown, highly weathered, very fine grained, highly fractured, soft rock - TILLITE.

NOTES

1) Depth of water table: Not encountered.

2) Refusal depth at 2.50m.
RESULTS OF SEISMIC REFRACTION TESTS
Date : 2013-11-14

For the Attention of : Mr Sundras Pather

Syncline Geotechnical Engineering
Unit 417 Mazar House
197 Peter Mokaba Road
Durban
4001

Project Details : Mandeni Borrow Pit Site
Job Card Number : 172265
Sample Number / s : 

Dear Sir,

Herewith, please find the original report / s, pertaining to the above-mentioned project. All tests conducted are in accordance with prescribed test method. Information herein consists of the following :-

<table>
<thead>
<tr>
<th>Materials Report and Reference No.</th>
<th>Test Conducted</th>
<th>Prescribed Method</th>
<th>No. of Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic Plots</td>
<td>Seismic Survey</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

We thank you for your valued support and look forward to assisting you in the near future.

Yours faithfully,

For Soilco (Technical Signatory)

Information contained herein is confidential to Soilco Materials Investigations and the addressees. The following results pertain only to the area or samples tested. Whilst every precaution is taken to ensure accurate testing and reporting, Soilco Materials Investigations (Pty) Ltd will not be held responsible for any erroneous testing or reporting thereon. Reports shall not be reproduced, except in full, without the prior consent of Soilco Materials Investigations (Pty) Ltd. Should there be any deviation from the prescribed test method, comments will be made thereof, pertaining to the test on the relevant materials report.
SOILCO MATERIALS INVESTIGATIONS (PTY) LTD.
SEISMIC SURVEY

Client : Syncline Geotechnical Engineering
Project : Maneni Borrow Pit Site
Bearing (mag) : 148.6E

Date : 14-11-13
Traverse No.: 1
Position : As per clients
Job Card No.: 172265

Forward (A) ———— Reverse (B) ————

Distance in metres from A
A ———— B

Time in milliseconds

Time

0 3 6 9 12 15 18 21 24 27 30

Time in milliseconds

0 20 40

Distance

VELOCITY

DEPTH

RESULT SUMMARY

N.B. For 30m traverse:
If no V3 is recorded V2 will extend to +/- 10m and if no V2 is recorded V1 will extend to +/- 10m.

V1 m/sec 523 813
V2 m/sec 1455 1499
V3 m/sec 1100

D1m 1.42 1.74
D2m 1.58
Mean V1 m/sec 568
True V2 m/sec 1460

Midpoint D1m
Apparent DIP Angle -2.9

Co-Ordinates: S29 11' 41.8" E31 24' 33.8"
SOILCO MATERIALS INVESTIGATIONS (PTY) LTD.
SEISMIC SURVEY

Client : Syncline Geotechnical Engineering
Project : Mandeni Borrow Pit Site
Bearing (mag) : 290 NW
Date : 14-11-13
Traverse No.: 2
Position : As per clients
Job Card No.: 172265

Forward (A) ---

Reverse (B) ---

Time in milliseconds

Distance in metres from A

A --- B

Co-Ordinates : S29 12' 00.6" E31 24' 21.7"

Velocity

V1
V2
V3

Depth

//\\\\\\\\ N.G.L.

N.B. For 30m traverse:
If no V3 is recorded:
V2 will extend to +/- 10m and if no V2 is recorded V1 will extend to +/- 10m.

Result Summary

A    B
V1 m/sec 522  714
V2 m/sec 1185 1250

D1m  1.39  1.31

Mean V1 m/sec 622
True V2 m/sec 1214

Midpoint D1m  1.35
Apparent DIP Angle 0.2
SITE PLAN
(showing field tests positions)
IP1 – Approximate position of Inspection Pit Test

ST1 – Approximate position of Seismic Refraction Survey Test

Areas considered most feasible for stone aggregate mining

(subject to the outcome of a detailed Phase 2 Geotechnical Investigation)