

**REPORT TO
IBHONGO CONSULTING
ON THE RESULTS OF A
GEOTECHNICAL INVESTIGATION
FOR THE NKUNZANA AND MKUZE
RIVER BRIDGES**

**VOLUME 2:
MKUZE RIVER BRIDGE**

This Report comprises the following VOLUMES AND CONTENTS

Volume 1	Nkunzana River Bridge
Volume 2	Mkuze River Bridge
Volume 3	Approach Roads, Culverts and Road Cuttings

Reference
N8812

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Date
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TABLE OF CONTENTS

1.	TERMS OF REFERENCE	1
2.	INFORMATION SUPPLIED	1
3.	SCOPE OF REPORT	1
4.	FIELDWORK	2
5.	SITE DESCRIPTION	2
6.	GEOLOGY AND SUBSOILS	3
6.1	OVERVIEW	3
6.2	ALLUVIUM	3
6.3	COBBLE/BOULDER HORIZON	3
6.4	DOLERITE	3
7.	EXCAVATABILITY	4
8.	PROPOSED NEW BRIDGE STRUCTURE	4
8.1	FOUNDING CONDITIONS - WESTERN ABUTMENT (NONGOMA)	4
8.2	FOUNDING CONDITIONS – EASTERN ABUTMENT (PONGOLA)	4
8.3	FOUNDING CONDITIONS AT THE PIER POSITIONS	5
8.4	FOUNDING RECOMMENDATIONS	5
9.	GENERAL	7

APPENDICES

Appendix 1	Borehole Logs
Appendix 2	Laboratory Test Results

DRAWINGS

2203-SGL001-REV A *Site Plan provided by Ibhongo Consulting*

REVISION HISTORY

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1. TERMS OF REFERENCE

In response to a request from Ibhongo Consulting, Davies Lynn & Partners (Pty) Ltd (DLP) prepared a quotation to carry out a geotechnical investigation for the proposed new Nkunzana and Mkuze River Bridges on Provincial Road P52/3, near Nongoma, KwaZulu-Natal. The quotation was submitted to Ibhongo Consulting in a letter dated 6th July 2021 and referenced N8812. DLP were subsequently informed that the quotation had been accepted in a Letter dated 30th July 2021 and were given authorization to proceed with the investigation.

This Report documents the findings of the detailed geotechnical investigation carried out at the site of the Mkuze River Bridge.

2. INFORMATION SUPPLIED

The following information was supplied to Davies Lynn & Partners (Pty) Ltd to assist with the Nkunzana River Bridge investigation:

- One (1No.) drawing was provided by Ibhongo Consulting, titled “*Proposed Mkuze River Bridge General Arrangement*”, Drawing Number 2203-SGL001-REV A, dated 01/10/2020.

3. SCOPE OF REPORT

This Report documents the findings of geotechnical investigation carried out at the site of the proposed Mkuze River Bridge on Provincial Road P52/3 near Pongola.

The fieldwork undertaken is outlined and the methodology of field testing provided, the results of the field investigation are presented, the subsoil geology and founding conditions are assessed, and recommendations relating to excavatability, earthworks and stable founding are made based on an interpretation of the findings of this investigation as well as other relevant geotechnical and development information.

4. FIELDWORK

The fieldwork for the geotechnical investigation comprised the following:

- Terrain appraisal and geomorphological evaluation of the site.
- Drilling of a total of fourteen (14No.) boreholes, labelled BH 1 to BH 7 and BH 11 to BH 17, to depths ranging between approximately 10.05m and 15.59m below existing ground levels.
- On-site and off-site logging of the borehole material recovered in terms of the AEG/SAICE/SAIEG (2002). Guidelines for Soil and Rock Logging in South Africa, 2nd Impression, Brink, A.B.A. and Bruin, R.M.H. (eds.), *Proceedings of the Geoterminology Workshop*, 1990.
- A total of ten (10No.) rock core samples were submitted for Uniaxial Compressive Strength (UCS) testing and three (3No.) samples were submitted for Point Load testing.

The logs of the boreholes are presented in Appendix 1 of this Report.

Ibhongo Consulting provided the locations of the fourteen (14No.) boreholes (BH 1 to BH 7 and BH 11 to BH 17) and which were set out by an independent surveyor appointed by Ibhongo Consulting. As Boreholes BH 8, BH 9 and BH 10 were located within the Mkuze River and were inaccessible, these boreholes were not drilled.

The locations of the boreholes are indicated on the attached drawing provided by Ibhongo Consulting and included in the Drawings section of this Report.

5. SITE DESCRIPTION

The proposed new Mkuze River Bridge is located along the existing P52/3 Provincial Road alignment and situated at km 27.3 between Nongoma and Pongola in KwaZulu-Natal.

The new proposed Mkuze River bridge site is located adjacent to the existing bridge within the floodplain of the Mkuze River. The river has incised into the surrounding floodplain resulting in a total width of river, at the site of the

proposed bridge, of approximately 120m from the western riverbank crest to the eastern riverbank crest.

6. GEOLOGY AND SUBSOILS

6.1 Overview

The geology of the site is characterised by Alluvial subsoils and River Terrace deposits associated with the Mkuze River which is underlain by intrusive Post-Karoo Dolerite.

6.2 Alluvium

Alluvial soils deposited by the Mkuze River blanket the area surrounding the site of the proposed bridge and are typically described as *dry to slightly moist to moist, medium brown to pale yellowish brown, slightly clayey, fine to medium grained SAND to SANDY CLAY* with abundant cobbles extending to depths ranging between approximately 3.3m and 8m below existing ground levels.

6.3 Cobble/Boulder Horizon

Underlying the alluvium, there occurs a cobble/boulder horizon typically comprising, *dark grey, very hard to hard rock, angular cobbles/boulders of dolerite* ranging between 50mm and 500mm in diameter which ranges in thickness between approximately 2.5m to 4.4m in thickness. The cobble/boulder horizon typically overlies the Dolerite bedrock.

6.4 Dolerite

The alluvial subsoils and cobble/boulder horizon are entirely underlain by (W2/W1) *dark grey speckled pale grey, slightly weathered to unweathered, moderately to highly fractured, hard to very hard rock, DOLERITE*, which is typically encountered at depths ranging between approximately 5.2m and 10.62m below existing ground levels.

7. EXCAVATABILITY

In terms of SANS 1200 DA criteria, only excavations within the alluvial subsoils beneath the site are considered to classify as 'soft excavation' whilst the presence of boulders and cobbles requires that "Boulder Class A" classifications be considered for excavations within this material horizon.

Excavations into the hard rock Dolerite should be classified as 'hard excavations'. Depending on the joint spacing, excavations into the Dolerite bedrock are likely to result in the excavatability becoming hard to very hard, and this may require removal by a heavy-duty hydraulic jackhammer (or similar method) or blasting.

8. PROPOSED NEW BRIDGE STRUCTURE

According to the drawings provided for by Ibhongo Consulting the proposed new Mkuze Bridge structure will comprise a completely new realignment and construction of a dual carriage way bridge structure.

8.1 Founding Conditions - Western Abutment (Nongoma)

The anticipated founding conditions at the site of the western abutment towards Nongoma, is represented by Boreholes BH1, BH2 and BH3. The western abutment is typically underlain by alluvium and a cobble/boulder horizon overlying Dolerite bedrock at depths ranging between approximately 6.40m and 8.32m below existing ground levels. RQD values become fair from approximately 7.5m to 9.5m below existing ground levels.

8.2 Founding Conditions – Eastern Abutment (Pongola)

The anticipated founding conditions at the site of the eastern abutment (towards Pongola) is represented by Boreholes BH15, BH16 and BH17. A thick alluvial and boulder/cobble horizon directly overlies Dolerite bedrock, encountered at depths ranging between approximately 9.09m to 10.62m below existing ground levels. RQD values are fair from depths ranging between approximately 11.5m to 12m (for BH 16 and BH17, BH 15 has poor RQD values to 15.59m below EGL) below existing ground levels.

8.3 Founding Conditions at the Pier Positions

The anticipated founding conditions at the sites of the Pier Positions are represented by Boreholes BH 4 to BH 7 and BH 11 to BH 14. An alluvial and cobble/boulder horizon was found to occur across all the drilled boreholes, which in turn directly overlies competent Dolerite bedrock at depth. Competent Dolerite bedrock was encountered at depths ranging between approximately 5.2m to 9.05m below existing ground levels. RQD values are fair from depths ranging between approximately 7m to 10m (BH 11 has poor RQD values to 11.38m below EGL) below existing ground levels.

8.4 Founding Recommendations

The results of the geotechnical investigation indicate that the proposed new Mkuze Bridge site is likely underlain by a relatively thick alluvium and boulder/cobble horizon with Dolerite bedrock encountered at depths. The Dolerite bedrock was typically encountered at depths ranging between approximately 5.20m and 10.62m below existing ground levels.

It is clear that the founding depths ranging between approximately 5.20m and 10.62m below EGL will require a pile type that can penetrate hard rock dolerite boulders typically 50mm to 500mm diameter and moderately to highly fractured insitu Dolerite bedrock.

It is considered that an Oscillator Pile is a suitable pile type which can penetrate difficult conditions and form a rock socket within the less fractured Dolerite bedrock. It is however an expensive pile type requiring a large working platform. The details of this pile type are set out in Table 1 below.

Table 1: Pile Details

Pile Details	Diameters		
	1080mm	1200mm	1500mm
Typical working load (kN)	6500	8000	13000
Maximum depth (m)	25	25	25
Minimum Pile Spacing (m) (2,5 * diameter)	2,7	3,0	3,75
Maximum rake	1:4	1:4	1:4
Typical main bar reinforcing	15x25mm	15*32mm	18*32mm
Typical spiral reinforcing	8mm	8mm	10mm
Nominal cover to reinforcing	75mm	75mm	75mm
ID of piling tube (mm)	980	1100	1400

The above working loads are based on a shaft stress of 7,5MPa. The pile's tension capacity will obviously depend on the calculated value of shaft friction within the rock socket and the length of the rock socket.

On river bridges the pile excavation is invariably full of water. The concrete has to be placed under water using a tremie pipe. A high slump concrete is used for casting the rock socket and pile shaft as it has to flow down the tremie pipe and then self-compact.

The workability of the concrete is of major importance in the construction of the pile shafts, with temporary liners as concrete which has lost its workability, tends to arch in the pile casing during extraction.

Table 2 below indicates the approximate depths to Dolerite bedrock below existing ground level:

REPORT TO IBHONGO CONSULTING ON THE RESULTS OF A GEOTECHNICAL INVESTIGATION FOR THE PROPOSED MKUZE RIVER BRIDGE ON PROVINCIAL ROAD P52/3

Table 2: Estimated Depth to Dolerite Bedrock

BH Number	Location	Depth to Bedrock (m)	UCS Depth (m)	UCS (MPa)
1	Left Abutment (N)	8.32	8.45	31.5
2	Left Abutment (Centre)	7.82	8.78	91.5
3	Left Abutment (S)	6.40	*9.69	*98.14
4	Pier P 01 (N)	9.05	*9.42	*56.83
5	Pier P 02 (S)	7.59	8.33	60.4
6	Pier P 03 (N)	8.84	13.36	41.1
7	Pier P 04 (S)	6.60	8.95	44
11	Pier P 06 (N)	5.87	*8.86	*53.26
12	Pier P 07 (S)	8.00	9.77	100.7
13	Pier P 08 (N)	5.20	8.75	100.2
14	Pier P 09 (S)	6.00	9.15	98.5
15	Right Abutment (N)	10.62	-	-
16	Right Abutment (Centre)	9.09	13.3	98.5
17	Right Abutment (S)	10.50	11.82	64

*Point Load Tests conducted due to the smaller LD core ratio of the highly fractured core.

9. GENERAL

Once the foundation loads have been calculated there may be merit in reviewing the founding proposals in terms of bearing pressures, settlement tolerances and potential scour and erosion during extreme or flood events.

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Compiled By:
A. Krebs (Pr.Sci.Nat ; MSAIEG)

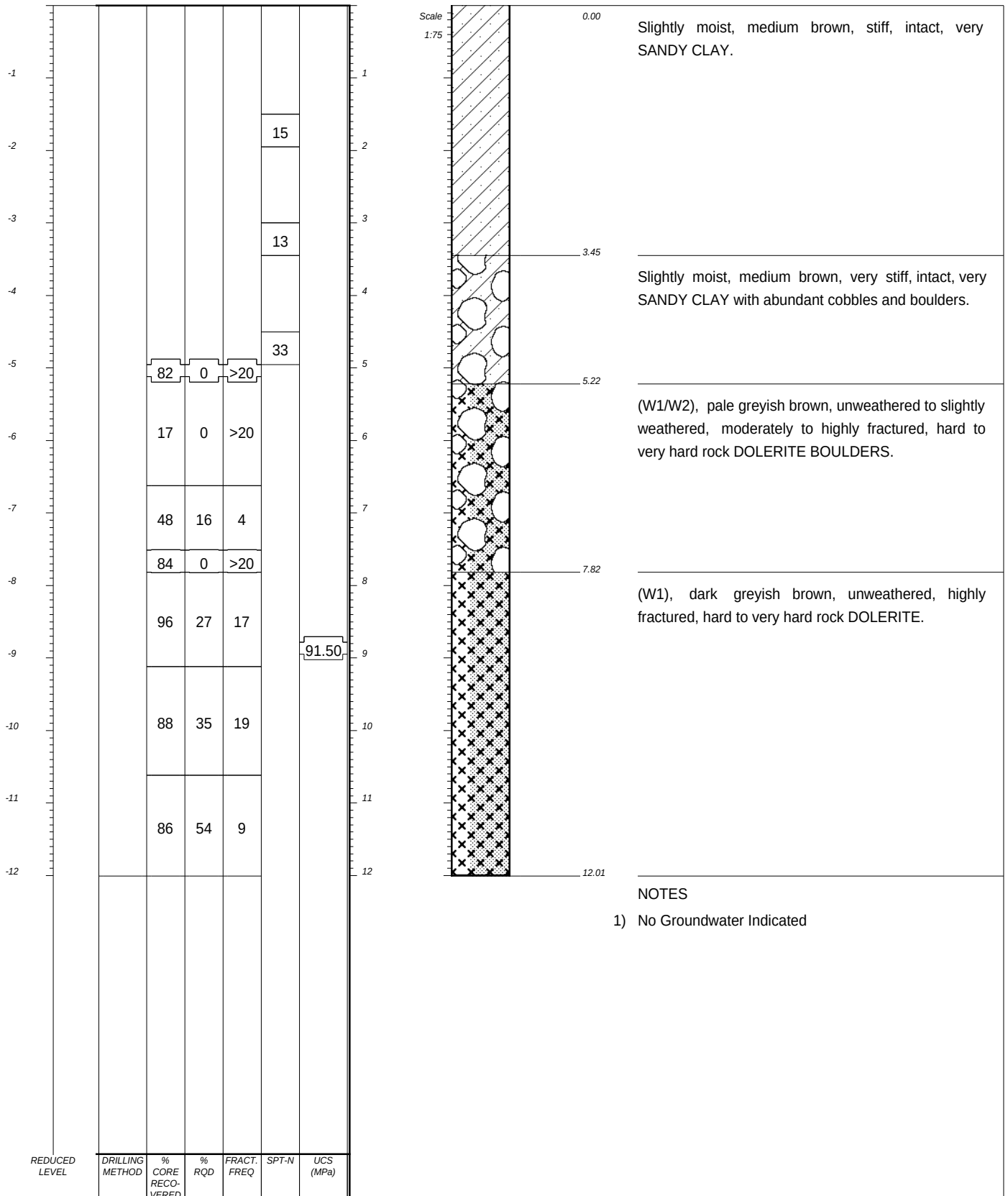


Reviewed By:
A. Greet (Pr.Sci.Nat ; MSAIEG)

APPENDIX 1

Borehole Profiles





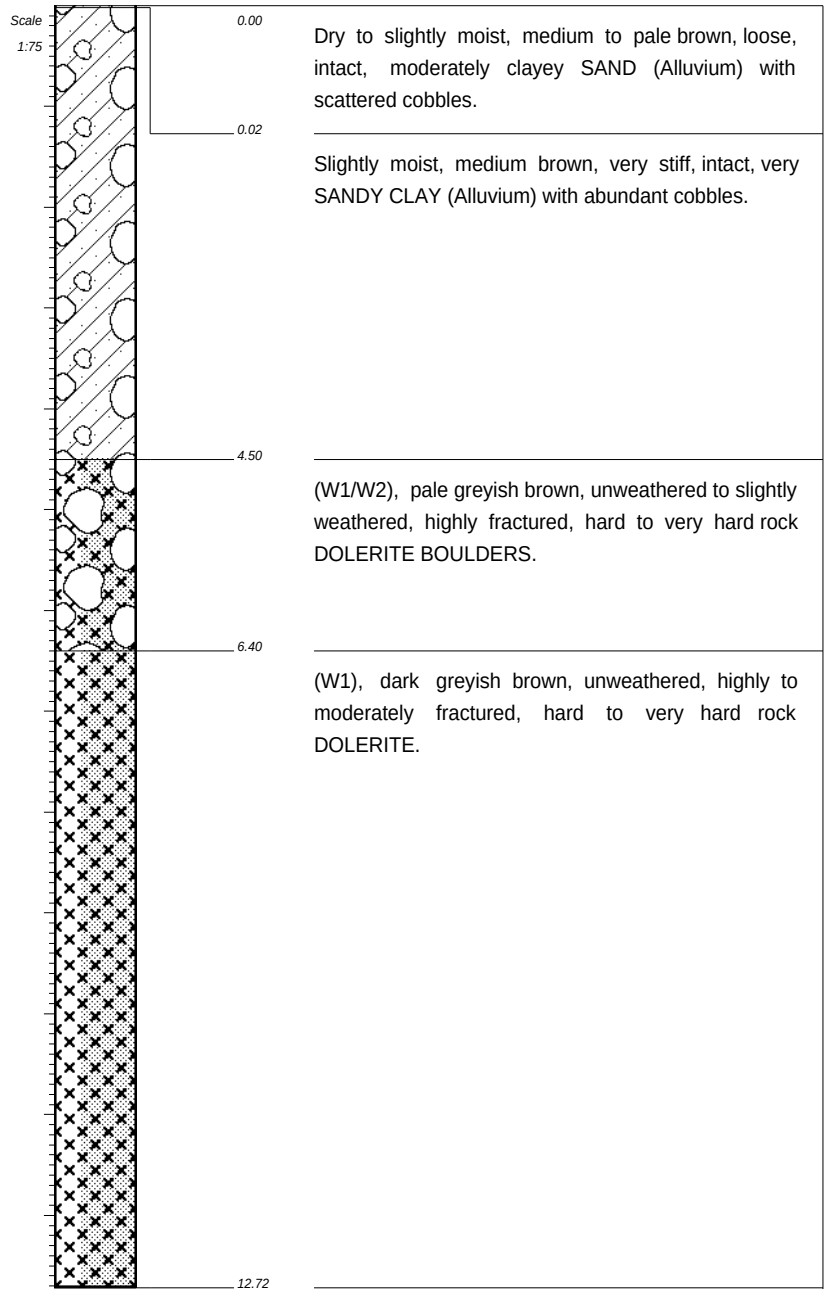
CONTRACTOR :
MACHINE : ROTARY CORE
DRILLED BY : Geopractica
PROFILED BY : A.Krebs
TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION : Vertical
DIAM : 76mm
DATE :
DATE : 12th-14th October 2021
DATE : 14/12/2021 10:03
TEXT : ..uzeRiverBridgeBHLogs.txt

ELEVATION :
X-COORD :
Y-COORD :



-1						
-2					29	
-3						
-4					27	
-5		65	49	>20	R	
-6		64	0	>20		
-7		72	0	8		
-8		67	16	25		
-9		100	62	19		
-10		100	0	6		
-11		97	93	3		
-12		100	66	12		
		100	91	4		
REDUCED LEVEL	DRILLING METHOD	% CORE RECOVERED	% RQD	FRACT. FREQ	SPT-N	UCS (MPa)



NOTES

- 1) No Groundwater Indicated

CONTRACTOR :
MACHINE : ROTARY CORE
DRILLED BY : Geopractica
PROFIED BY : A.Krebs
TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION : Vertical
DIAM : 76mm
DATE :
DATE : 12th-14th October 2021
DATE : 14/12/2021 10:03
TEXT : ..uzeRiverBridgeBHLLogs.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **BH 3**

























	BOULDERS	{SA01}
	GRAVELS	{SA02}
	SAND	{SA04}
	SANDY	{SA05}
	CLAY	{SA08}
	CLAYEY	{SA09}
	DOLERITE	{SA18}{SA42}
	COBBLES	{SA58}

CONTRACTOR :

MACHINE :

DRILLED BY :

PROFILED BY :

TYPE SET BY :

SETUP FILE : BH1PG-A4.SET

INCLINATION :

DIAM :

DATE :

DATE :

DATE : 14/12/2021 10:03

TEXT : ..uzeRiverBridgeBHLLogs.txt

ELEVATION :

X-COORD :

Y-COORD :

LEGEND

SUMMARY OF SYMBOLS

APPENDIX 2

Laboratory Test Results

WEBSITE: www.geosure.co.za

Our Ref.No.: 55294

Your Ref.No.: -

Date Reported: 04.11.2021

Date Received: 14.10.2021

TEST REPORT - UNCONFINED COMPRESSIVE STRENGTH ON ROCK CORES - METHOD (ASTM D7012)

This report relates only to sample(s) received. This report shall not be reproduced, except in full, without the prior consent of GEOSURE (PTY) LTD. While every care is taken to ensure the correctness of all tests and reports, neither Geosure (Pty) Ltd or its employees shall be liable in any way whatsoever for any error made in the execution or reporting of tests or any erroneous conclusions drawn there from or any consequence thereof.

Mode of Failure	Failure Code
Axial Splitting	AS (Axial-Simple)
Shear along single plane	AC (Axial-Complex)
Double Shear	Shear S
Multiple Fracturing	Shear D
Along foliation	MF
Y-Shaped Failure	AF
	YF

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Our ref:	55294
Client ref:	-
Date Reported :	11.10.2021
Date Tested:	10.11.2021

DETERMINATION OF POINT LOAD STRENGTH ON ROCK
(ASTM D5731-02)

[illegible]

Remarks: Test results are indicative based on the irregularity of the specimens.

Is - Point Load Strength Index

** Calculated using values from table 1 in the ASTM D5731-02

Tests highlighted in red did not meet conform to the recommended dimension tolerances specified.

***Classification of Rock Hardness in accordance with COLTO Table 6113/1

We would like to take this opportunity of thanking you for your continued support.

Should you have any queries please do not hesitate to contact me.

We would like to take this opportunity of thanking you for your continued support.

Should you have any queries please do not hesitate to contact me.

Yours faithfully



Bradley Hariram for Geosure (Pty) Ltd.

DRAWINGS

