P WMA 12/T30/00/5212/10

water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

DIRECTORATE: OPTIONS ANALYSIS

FEASIBILITY STUDY FOR THE MZIMVUBU WATER PROJECT

GEOTECHNICAL INVESTIGATIONS:

NTABELANGA, SOMABADI AND THABENG DAM SITES

APPENDICES

OCTOBER 2014

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Record of Implementation Decisions: Ntabelanga Dam and Associated Infrastructure	P WMA 12/T30/00/5212/17
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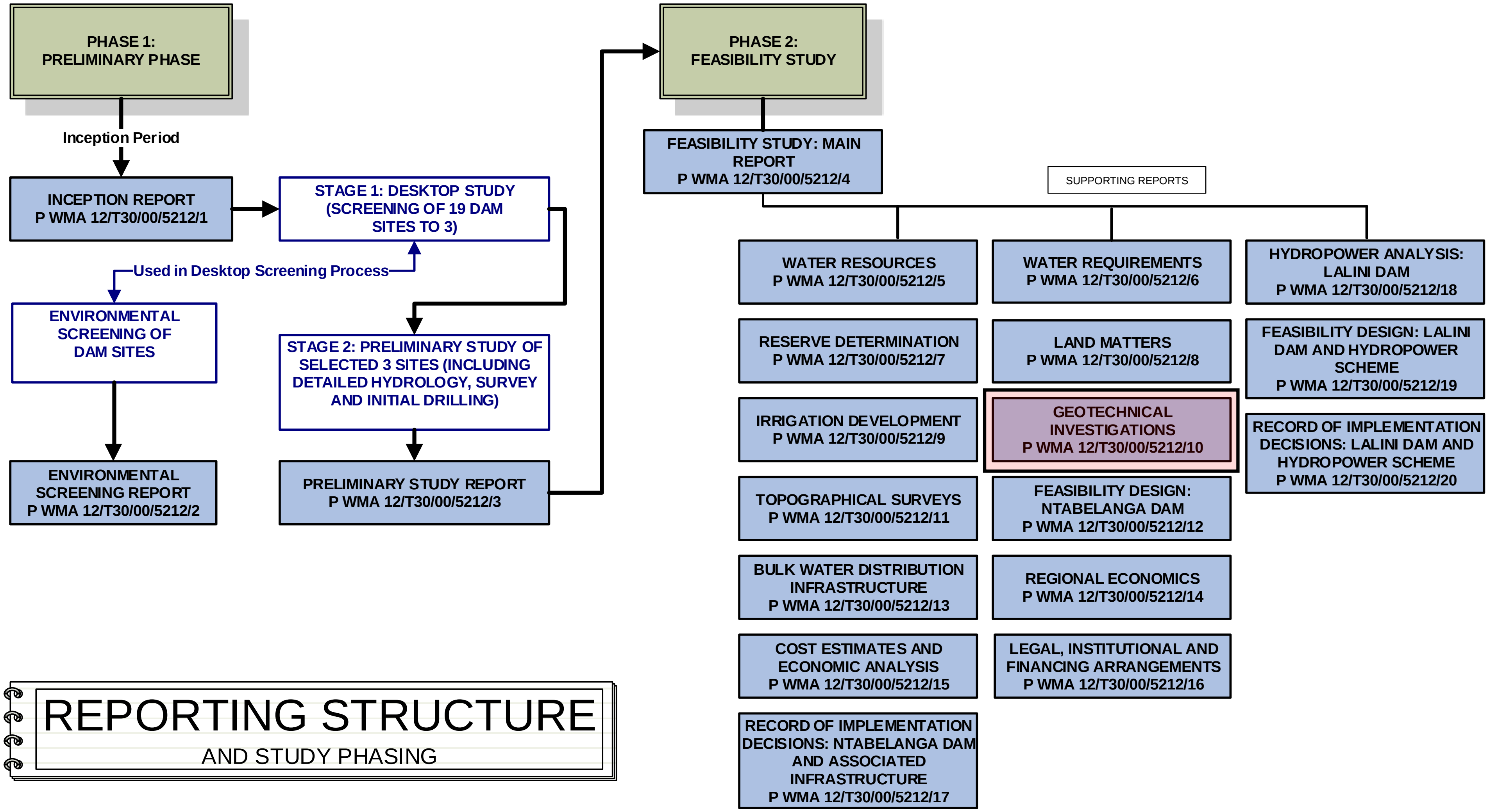
Feasibility Design: Lalini Dam and Hydropower Scheme	P WMA 12/T30/00/5212/19
Record of Implementation Decisions: Lalini Dam and Hydropower Scheme	P WMA 12/T30/00/5212/20



REPORTING STRUCTURE
AND STUDY PHASING

REFERENCE

This report is to be referred to in bibliographies as:

Department of Water and Sanitation (2014). ***Feasibility Study for the Mzimvubu Water Project: Geotechnical Investigations: Ntabelanga, Somabadi and Thabeng Dam Sites: Appendices***

DWS Report No: P WMA 12/T30/00/5212/10

Prepared for: Directorate – Options Analysis

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Note on Departmental Name Change:

In 2014, the Department of Water Affairs changed its name to the Department of Water and Sanitation, which happened during the course of this study. In some cases this was after some of the study reports had been finalized. The reader should therefore kindly note that references to the Department of Water Affairs and the Department of Water and Sanitation herein should be considered to be one and the same.

Note on Spelling of Laleni:

The settlement named Laleni on maps issued by the Surveyor General is locally known as Lalini and both names therefore refer to the same settlement.

TABLE OF APPENDICES

APPENDIX A

PHASE 1 SITE PLANS

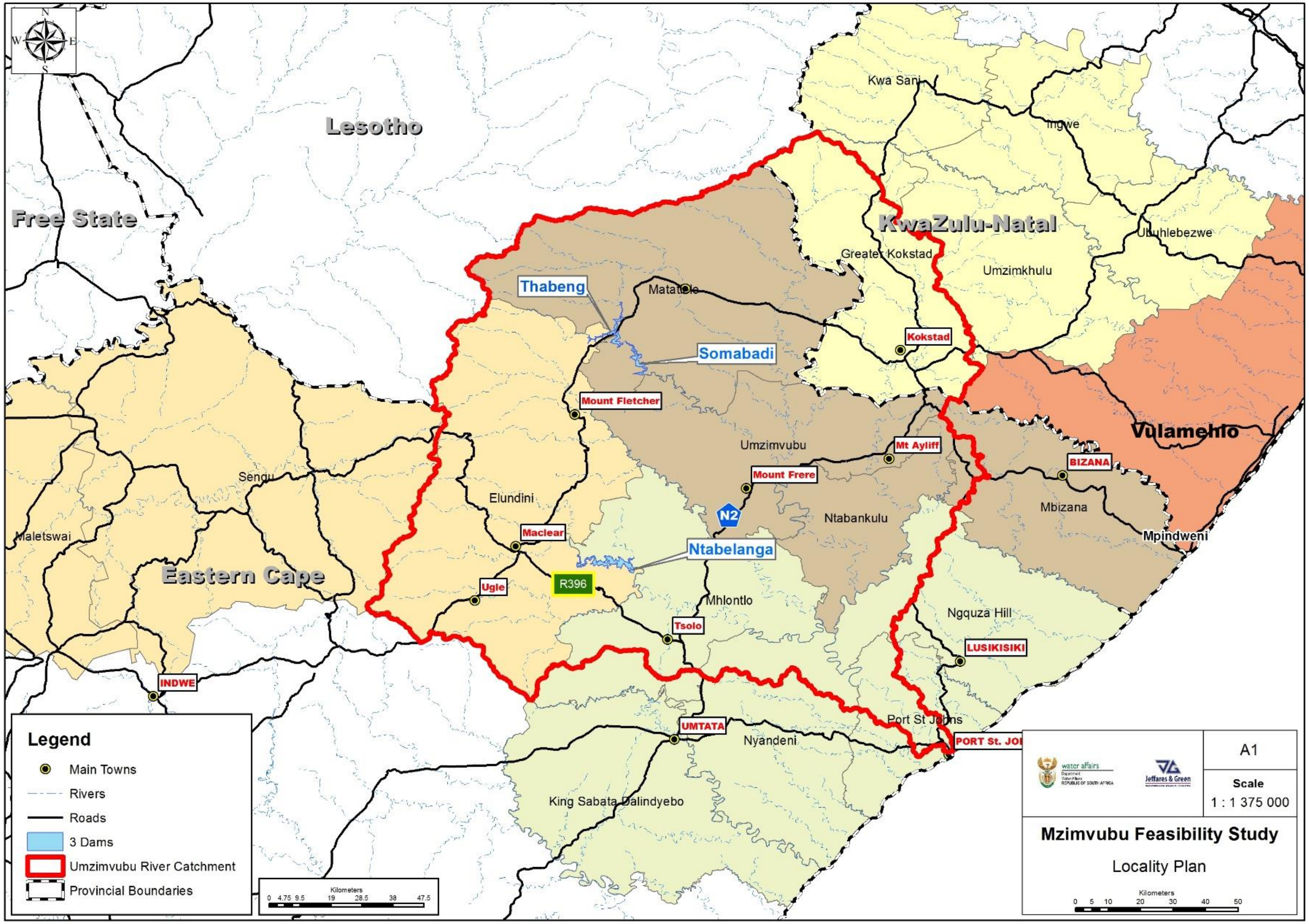
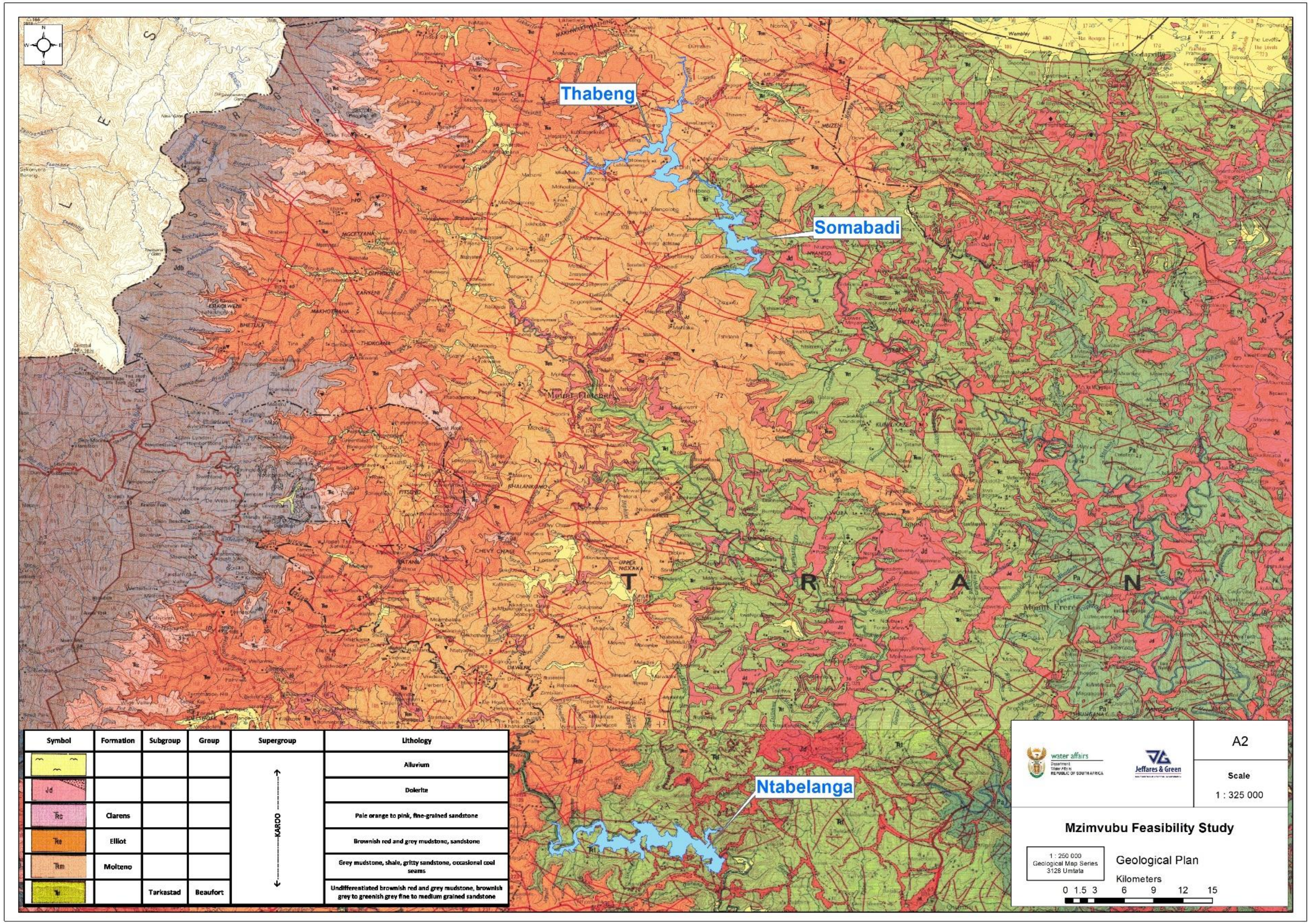


Fig A-1: Locality Plan



Symbol	Formation	Subgroup	Group	Supergroup	Lithology
				←-- KAROO --→	Alluvium
Jd					Dolerite
Ŧrc	Clarens				Pale orange to pink, fine-grained sandstone
Ŧre	Elliot				Brownish red and grey mudstone, sandstone
Ŧrm	Molteno				Grey mudstone, shale, gritty sandstone, occasional coal seams
Ŧrt		Tarkastad	Beaufort		Undifferentiated brownish red and grey mudstone, brownish grey to greenish grey fine to medium grained sandstone

Fig A-2: Geological Plan

Fig A-3: Thabeng Dam Site Plan

Fig A-4: **Somabadi Dam Site Plan**

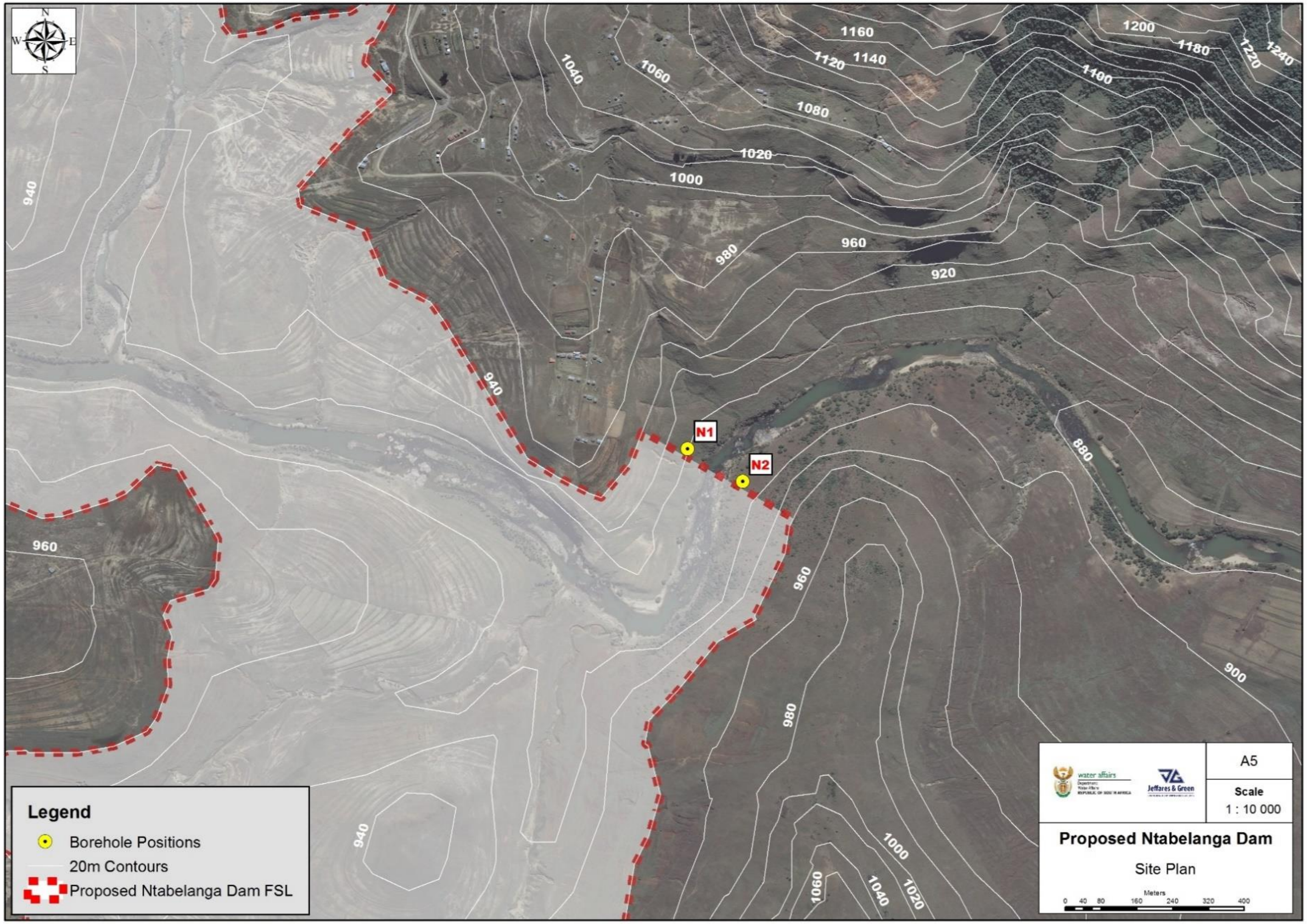


Fig A-5: Ntabelanga Dam Site Plan

APPENDIX B

PHASE 1 DAM SITE VISUAL APPRAISALS

B1:

THABENG DAM SITE

STAGE 1 GEOTECHNICAL ASSESSMENT

DAM SITE NAME: Thabeng **RIVER**: Kinira

DAM LENGTH: Approx. 280m **DAM HEIGHT**: Approx. 53m

GPS CO-ORD ON RIVER: S 30º29'45.51"; E 28º38'22.49"; ELEV. 1347m

APPROX C/L ORIENTATION: NW – SE

TOPOGRAPHY (valley shape, steepness)

LEFT FLANK:

Very steep to precipitous in places

RIVER SECTION:

Steep U-shaped profile. Both flanks rise steeply from the river.

RIGHT FLANK:

Steep, consistent to slightly convex slope.

GEOLOGICAL INFLUENCE:

Dolerite sill through river section and up the right flank. Dolerite on left flank is thinner and not as prevalent so that founding is likely to be in both dolerite and sandstone.

BASIN MORPHOLOGY:

Just upstream of the dam the river flows in a steep sided valley. Further upstream in the mid to upper backwater reaches the topography moderates. The geology comprises predominantly sandstone, as well as mudrock of the Molteno Formation.

GEOLOGY

OUTCROP:

Dolerite outcrop in the river section.

JOINTS (no, condition, spacing, orientation):

Orthogonal joints sets, two sub-vertical and one sub-horizontal. Comprise moderate and high angle subvertical joints that dip upstream and downstream respectively. Major strike direction is NW – SE.

STRUCTURAL FEATURES (dykes, faults, lineaments)

AERIAL PHOTOS, MAPS:

No apparent linear features suggesting faults or other structural lineaments. Stereoscopic aerial photographic interpretation was not undertaken, as the other information was deemed adequate.

OBSERVED:

Dolerite strike is NW – SE.

SOIL COVER:

Thin soil cover with sub-outcrop on the flanks.

FOUNDING, STABILITY, PROBLEM AREAS, OTHER:

Good founding on dolerite through the river section and right flank. The left flank is underlain by dolerite as well as by sandstone and intercalated mudrock. Pronounced bedding in the sedimentary rocks, whilst appearing tight, could lead to higher grout takes on the left flank.

BASIN GEOL:

Mainly sandstone with intercalated mudrock. Occasional dolerite dykes in the basin. Dolerite sills were only evident in the upper reaches of the basin.

CONSTRUCTION MATERIALS

CLAY:

No source of core material identified in the impoundment basin during this initial assessment, but the presence of mudrock of the Molteno Formation in the basin suggests that suitable core material is likely to be available. Mudrock of the Tarkastad Formation is plentiful downstream of the dam site. In addition, reddish brown, clayey colluvial soils associated with dolerite occur downstream of the dam.

SOIL / ROCK FILL:

Core trench excavation and dolerite rock quarry

SAND (concrete, filter):

River sand. Extensive deposits of sand occur upstream of the dam near to Kinira Drift.

ROCK (concrete, rip-rap):

Dolerite quarry. Initial indications suggest a paucity of suitable dolerite quarry sites in the basin, but there is an extensive body of dolerite downstream of the dam.

PROBLEM AREAS:

At this stage indications are that the most suitable sources of core and rock aggregate occur downstream of the dam, consequently with higher environmental impacts effecting their exploitation, as they would ultimately not be inundated following impoundment and would require rehabilitation.

INFRASTRUCTURE

ROADS:

A number of roads will be inundated including the R56, the Kinira Drift road and the road to Pontseng / Lekhalaneng.

HOUSES:

A water treatment works being constructed near Kinira Drift, as well as associated pipelines would be inundated. There is also a weir and gauging station at Kinira Drift.

CULTIVATION:

Due to the relatively narrow impoundment basin and limited cultivation, inundation of cultivated areas in the lower reaches would be limited. Inundation of cultivation would occur around Kinira Drift and possibly upstream of the main road.

FURTHER INVESTIGATIONS

BOREHOLES (where, access):

Rotary core drilling will be required along the dam centre-line, spillway, appurtenant structures and to prove a rock quarry. Access along the dam axis is difficult due to the steep topography.

TRIAL PITS (where, access):

Access for mechanical excavating equipment will be restricted along the dam centre-line due to the steep topography, especially along the left flank. This will be a limiting factor to the undertaking of centre-line trial pitting. Trial pits would be required to prove construction material volumes and quality.

GEOPHYSICS:

A seismic refraction survey is recommended along the dam axis, with transverse traverses at the positions of structures and to pick up stratigraphic dip.

OTHER:

Joint orientation surveys, stability analyses, aerial photographic interpretation if deemed necessary, rock strength testing, materials testing, water pressure testing and analysis of grouting requirements, dam and basin mapping.

Quarry and borrow pit investigations.

ADVANTAGES OF SITE:

Good valley profile, which lends itself to either earth-fill, rockfill or concrete dam construction.

Good founding on dolerite in the river section and right flank. The cut-off on the left flank is likely to be in a combination of dolerite and sedimentary rocks.

Joints in the dolerite appear to be tight, resulting in low seepage losses and low grout takes.

The basin topography contributes to a high storage to area ratio thereby minimising evaporation losses.

DISADVANTAGES OF SITE:

Difficult access due to steep valley sides, particularly along the left flank.

Based upon this initial assessment potential sources of core and rock aggregate do not appear to be readily available in the basin, although they occur a short distance downstream.

Inundation of infrastructure in the basin would occur, including a water treatment works currently under construction.

GENERAL

No fatal flaws were identified in respect of the dam site and founding conditions.

The valley profile is suitable for an earth embankment, rockfill or concrete dam.

This suitability assessment is based solely on geotechnical parameters and does not consider the other interrelated criteria such as hydrology, engineering or socio-economic factors. It also does not consider the site location relative to end user requirements.

B2:

SOMABADI DAM SITE

STAGE 1 GEOTECHNICAL ASSESSMENT

DAM SITE NAME: Somabadi

RIVER: Kinira

DAM LENGTH: Approx. 630m

DAM HEIGHT: Approx. 59m

GPS CO-ORD ON RIVER: S 30º34'59.79"; E 28º41'35.5"; ELEV. 1276m

APPROX C/L ORIENTATION: NE – SW

TOPOGRAPHY (valley shape, steepness)

LEFT FLANK:
Initially steep and then a wide terrace and again becoming steep

RIVER SECTION:
U-shaped. Steep banks.

RIGHT FLANK:
Very steep, consistent slope

GEOLOGICAL INFLUENCE:
Sandstone outcrop in the riverbed and in the river banks. Sub-outcrop of sandstone on the right flank and a major proportion of the left flank. Dolerite occurs on the upper left flank.

BASIN MORPHOLOGY:
Variable, ranging from steep valley sides to moderately flat.

GEOLOGY

OUTCROP:
Sandstone outcrop in the river section.

JOINTS (no, condition, spacing, orientation):
Pronounced bedding in the sandstone dipping at a low angle in a downstream direction.

STRUCTURAL FEATURES (dykes, faults, lineaments)

AERIAL PHOTOS, MAPS: No observed linear features to suggest faults or structural lineaments.

OBSERVED: None.

SOIL COVER: Generally thin

FOUNDING, STABILITY, PROBLEM AREAS, OTHER:
Good founding on sandstone. Pronounced bedding partings are potentially conducive to seepage losses and may result in relatively high grout takes.

BASIN GEOL:
Tarkastad Formation sandstone and mudrock, with intrusive dolerite.

CONSTRUCTION MATERIALS

CLAY:
Mudrock occurs in abundance in the basin. Red-brown colluvial soils of doleritic oroigin occur in abundance on the high lying area to the north-east of the dam.

SOIL / ROCK FILL:
Sandstone and dolerite from foundation excavations and a rock quarry. An elevated saddle on the left flank could be excavated to create an off-channel spillway and to generate dolerite material.

SAND (concrete, filter):
River sand from upstream, of which there are a number of deposits

ROCK (concrete, rip-rap):
Dolerite quarry.

PROBLEM AREAS:
No apparent problems in respect of materials.

INFRASTRUCTURE

ROADS:
A number of roads would be inundated.

HOUSES:
This was not ascertained in this assessment.

CULTIVATION:
Extensive areas of cultivation in the basin would be inundated.

BOREHOLES (where, access):
Rotary core drilling would be required along the dam axis, spillway, appurtenant structures and to prove potential rock quarry sites. Drilling could possibly also be undertaken in the saddle area adjacent to the upper left flank to prove the feasibility of creating an off-channel spillway, which could duplicate as a rock quarry.

TRIAL PITS (where, access):
Difficult access along most of the dam axis, especially the right flank may curtail the successful undertaking of trial pits along the entire dam axis. Trial pits would be required to investigate appurtenant works and to prove borrow pits.

GEOPHYSICS:
Seismic refraction traverses along and transverse to the dam axis.

OTHER:
Joint orientation surveys, stability analyses, rock strength testing, materials testing, water pressure testing, dam and basin mapping, aerial photographic interpretation if deemed necessary, quarry and borrow pit investigations.

ADVANTAGES OF THE SITE:
Good valley profile.
Good founding on sandstone.
A saddle adjacent to the upper left flank has the potential to be excavated as a rock quarry and to serve as an off-channel spillway. Further investigation would be required to verify the feasibility of this.

Construction materials appear to be readily available within relatively close proximity to the dam.

DISADVANTAGES OF THE SITE:
There is difficult access along the dam axis due to steep valley sides.
Pronounced bedding planes imply possible high grout takes.
Inundation of roads and cultivation would occur.

GENERAL

No fatal flaws identified.

The valley profile and founding conditions are suitable for a number of dam alternatives including earth embankment, rockfill and concrete.

This assessment entailed a suitability assessment based solely on geotechnical parameters. It does not consider the other inter-related criteria, such as hydrology, engineering and socio-economic aspects that will ultimately influence the feasibility of this site. It also does not consider the site location relative to end-user requirements.

B3:

NTABELANGA DAM SITE

STAGE 1 GEOTECHNICAL ASSESSMENT

DAM SITE NAME: Ntabelanga **RIVER:** Tsitsa

DAM LENGTH: Approx. 350m **DAM HEIGHT:** Approx. 53m

GPS CO-ORD ON RIVER: S31º07'01.18"; E 28º40'20.7"; ELEV. 898m

APPROX C/L ORIENTATION: NW – SE

TOPOGRAPHY (valley shape, steepness)

LEFT FLANK:
Steep consistent to slightly convex slope rising from the river

RIVER SECTION:
U-shaped profile with the channel skewed towards the left flank. Dolerite outcrop across the river and in the left bank. Steep incline up the left flank. Gentle to moderately sloping terrace extends from the right bank, thereafter steepening up the right flank.

RIGHT FLANK:
There is a narrow terrace extending from the river bank, steepening into a concavo-convex slope at the bottom becoming convex, at a generally steep gradient.

GEOLOGICAL INFLUENCE:
Dolerite sill outcropping in the river section. Dolerite outcrop and sub-outcrop up the right flank. Dolerite on the left flank occurs beneath a cover of soil. The top of the left flank is underlain by sandstone.

BASIN MORPHOLOGY:
Variable topography comprising mainly sedimentary rocks of the Tarkastad Formation, with dolerite intrusions generally forming positive relief features.

GEOLOGY

OUTCROP:
Dolerite outcrops in the river section and on the mid to upper right flank

JOINTS (no, condition, spacing, orientation):
Three main orthogonal joints sets, two sub-vertical and one sub-horizontal. Sub-vertical joints comprise an obliquely striking joint dipping steeply upstream and a diagonal, near-vertical joint. The sub-horizontal joint dips moderately from right to left.

STRUCTURAL FEATURES (dykes, faults, lineaments)

AERIAL PHOTOS, MAPS:
No observed linear features to suggest faults or structural lineaments. Stereoscopic aerial photo interpretation on stereo-pairs was not undertaken, as the existing information was deemed adequate.

OBSERVED:
There is a cross-cutting dolerite sill and valley constriction at the dam site. No linear features observed in the vicinity of the dam.

SOIL COVER:
Thin to moderate soil cover on the left flank. The river terrace on the right flank is covered by alluvium, comprising soil and boulders of unknown thickness. The mid to upper right flank is characterised by dolerite outcrop and sub-outcrop.

FOUNDING, STABILITY, PROBLEM AREAS, OTHER:
Founding conditions appear to be good. Based upon the surface indications it is presumed that the cut-off will be in dolerite bedrock at relatively shallow depth. Foundations on the upper left flank will be in sandstone. Inundation and resultant saturation could induce small-scale slope instability in the left hand side river bank a few hundred metres upstream of the dam.

BASIN GEOLOGY:
Mainly sedimentary rocks, comprising mudrock and sandstone.

CONSTRUCTION MATERIALS

CLAY:
Purple mudrock occurs in abundance in the basin just upstream of the dam. Reddish brown colluvial soil of doleritic origin are also evident in the basin just upstream of the dam.

SOIL / ROCK FILL:
Dolerite rock / weathered dolerite from the dam foundations, as well as from potential dolerite quarry sites in the basin upstream of the dam. Sandstone and possibly mudrock could be considered for use as embankment fill.

SAND (concrete, filters):
River sand from upstream. Whilst high river flow at the time of the assessment prevented a detailed assessment, there appears to be a potential source of alluvial sand upstream of the dam in the vicinity of the low level bridge crossing. A further reconnaissance is required during periods of low flow to optimise location.

ROCK (concrete, rip-rap, filters):
Dolerite occurs in relative abundance in the basin and it is recommended that further reconnaissance be undertaken to identify a potential dolerite quarry within the basin. There also appears to be potential for forming the top of the right flank into an off-channel spillway with the excavation duplicating as a rock quarry.

PROBLEM AREAS:
No apparent problems in respect of materials.

INFRASTRUCTURE

ROADS:
Roads, including an upstream river crossing would be inundated.

HOUSES:
The effect on houses was not ascertained as the FSL had not been delineated.

CULTIVATION:
Extensive areas of cultivation would be inundated.

BOREHOLES (where, access):
Rotary core drilling would be required along the dam axis, at the spillway, structures and to prove a rock quarry. Both flanks are steep, necessitating difficult skid set-ups.

TRIAL PITS (where, access):
Trial pits by means of an excavator / TLB along the dam centre-line and in potential borrow pits. Machine access to both flanks, particularly the left flank, will be extremely difficult and may preclude trial pits along sections of the dam axis.

GEOPHYSICS:
A seismic refraction survey with traverses orientated parallel and transverse to the dam centre-line and to include the positions of the spillway, intake and outlet works.

OTHER:
Joint orientation surveys, stability analyses, possibly aerial photographic interpretation if subsequently deemed necessary, dam and basin mapping to identify potential problems and influence factors, rock strength testing, materials testing, water pressure testing and analysis of grouting requirements.

Quarry and borrow pit investigations.

ADVANTAGES OF THE SITE:

Good valley profile.
Good founding on dolerite, with indications of a relatively shallow cut-off.
Whilst joints are high angle, they appear tight, so that seepage losses and grout takes are not expected to be excessive.
Whilst requiring further assessment, excavating an off-channel spillway into the right flank could double as a rock quarry.
Construction materials appear to be readily available in the basin.

DISADVANTAGES OF THE SITE:

Access along the dam axis for mechanical plant will generally be difficult due to steep valley sides.
There will be inundation of cultivation and roads in the basin.

GENERAL

No fatal flaws identified.

The observed conditions in respect of the site cross-sectional profile and the apparent founding conditions appear to lend themselves to a number of dam options, namely earthfill, rockfill or concrete.

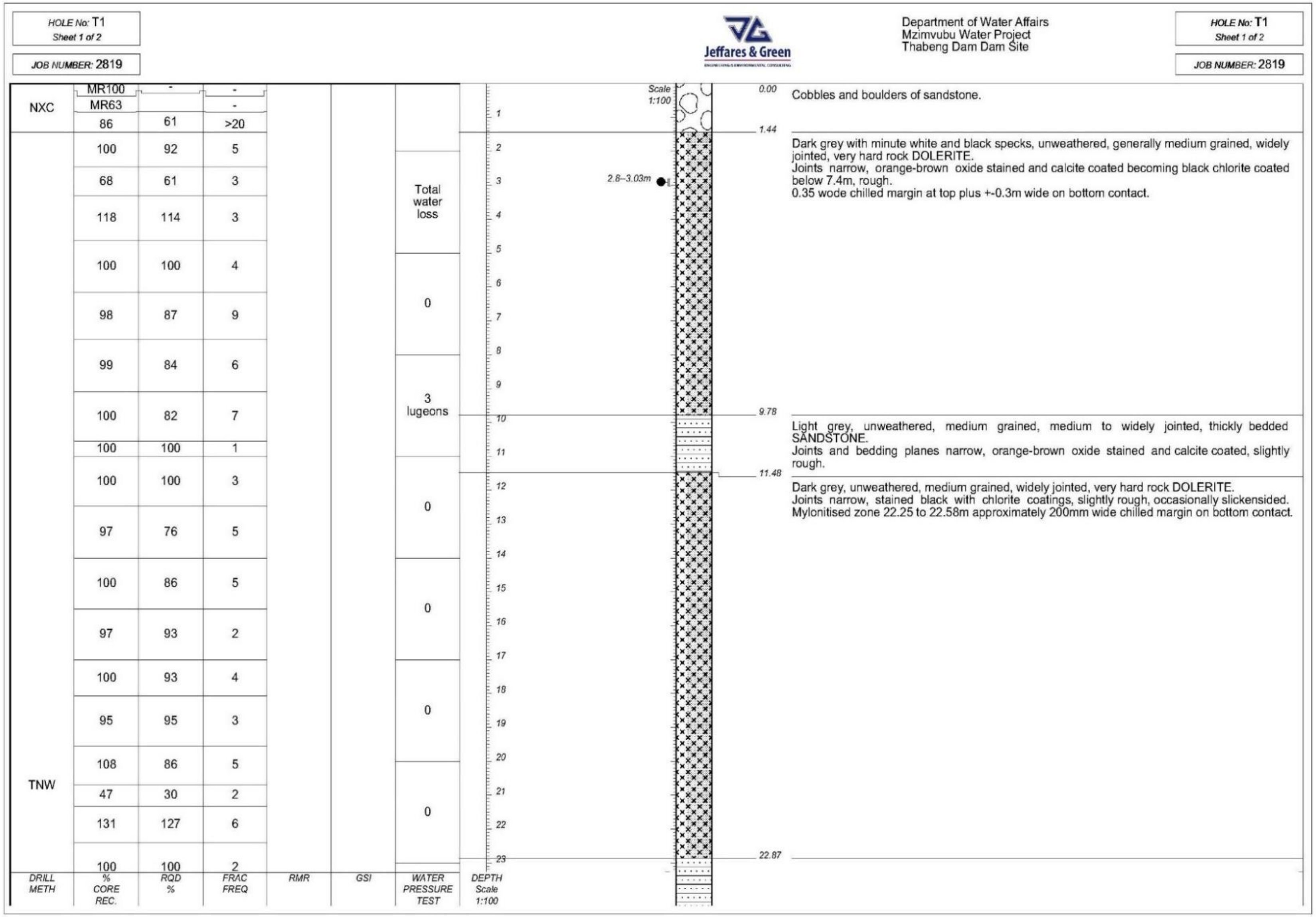
This assessment entailed a suitability assessment based solely on geotechnical parameters. It does not consider the other inter-related criteria, such as hydrology, engineering and socio-economic aspects that will ultimately influence the feasibility of this site. It also does not consider the site location relative to end-user requirements.

APPENDIX C

PHASE 1 ROTARY CORE DRILLING INVESTIGATION

C1:

THABENG DAM SITE



HOLE No: T1
Sheet 1 of 2

JOB NUMBER: 2819

Department of Water Affairs
Mzimvubu Water Project
Thabeng Dam Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	RMR	GSI	WATER PRESSURE TEST
NXC	MR100	-	-			
	MR63		-			
	86	61	>20			
TNW	100	92	5			Total water loss
	68	61	3			
	118	114	3			
	100	100	4			0
	98	87	9			
	99	84	6			3 lugeons
	100	82	7			
	100	100	1			
	100	100	3			0
	97	76	5			
	100	86	5			0
	97	93	2			
	100	93	4			0
	95	95	3			
	108	86	5			0
	47	30	2			
	131	127	6			
	100	100	2			

DEPTH Scale 1:100

Scale 1:100

2.8–3.03m

0.00 Cobbles and boulders of sandstone.

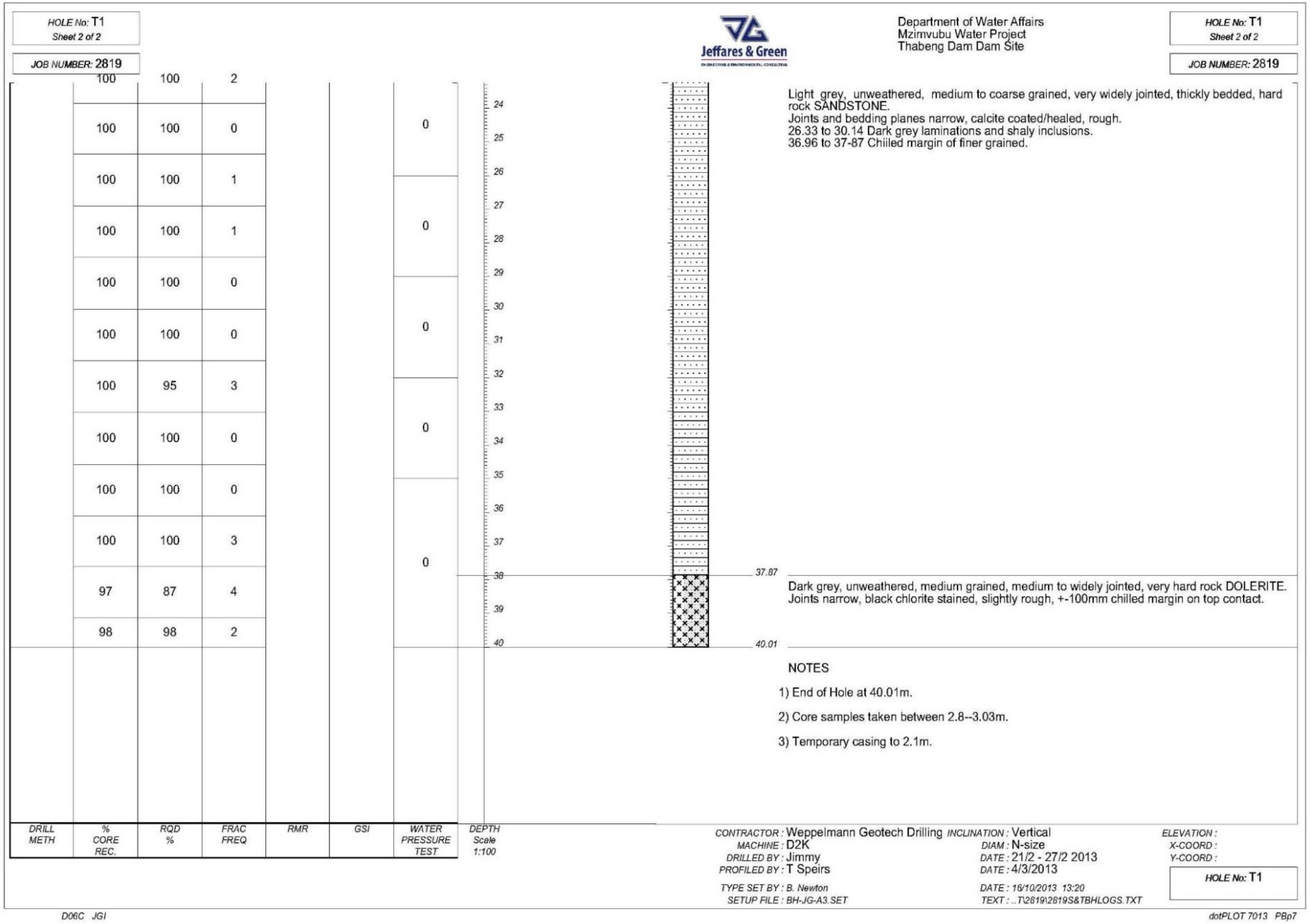
1.44 Dark grey with minute white and black specks, unweathered, generally medium grained, widely jointed, very hard rock DOLERITE.
Joints narrow, orange-brown oxide stained and calcite coated becoming black chlorite coated below 7.4m, rough.
0.35 wode chilled margin at top plus +-0.3m wide on bottom contact.

9.78 Light grey, unweathered, medium grained, medium to widely jointed, thickly bedded SANDSTONE.
Joints and bedding planes narrow, orange-brown oxide stained and calcite coated, slightly rough.

11.48 Dark grey, unweathered, medium grained, widely jointed, very hard rock DOLERITE.
Joints narrow, stained black with chlorite coatings, slightly rough, occasionally slickensided.
Mylonitised zone 22.25 to 22.58m approximately 200mm wide chilled margin on bottom contact.

22.87

Fig C-1.1: Borehole Logs (T1)



HOLE No: T1
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Thabeng Dam Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	RMR	GSI
	100	100	2		
	100	100	0		
	100	100	1		
	100	100	1		
	100	100	0		
	100	100	0		
	100	95	3		
	100	100	0		
	100	100	0		
	100	100	3		
	97	87	4		
	98	98	2		

WATER PRESSURE TEST: 0, 0, 0, 0, 0

Light grey, unweathered, medium to coarse grained, very widely jointed, thickly bedded, hard rock SANDSTONE.
Joints and bedding planes narrow, calcite coated/healed, rough.
26.33 to 30.14 Dark grey laminations and shaly inclusions.
36.96 to 37-87 Chiiled margin of finer grained.

Dark grey, unweathered, medium grained, medium to widely jointed, very hard rock DOLERITE.
Joints narrow, black chlorite stained, slightly rough, +-100mm chilled margin on top contact.

NOTES

1) End of Hole at 40.01m.

2) Core samples taken between 2.8--3.03m.

3) Temporary casing to 2.1m.

CONTRACTOR : Weppelmann Geotech Drilling
MACHINE : D2K
DRILLED BY : Jimmy
PROFILED BY : T Speirs
INCLINATION : Vertical
DIAM : N-size
DATE : 21/2 - 27/2 2013
DATE : 4/3/2013
ELEVATION :
X-COORD :
Y-COORD :

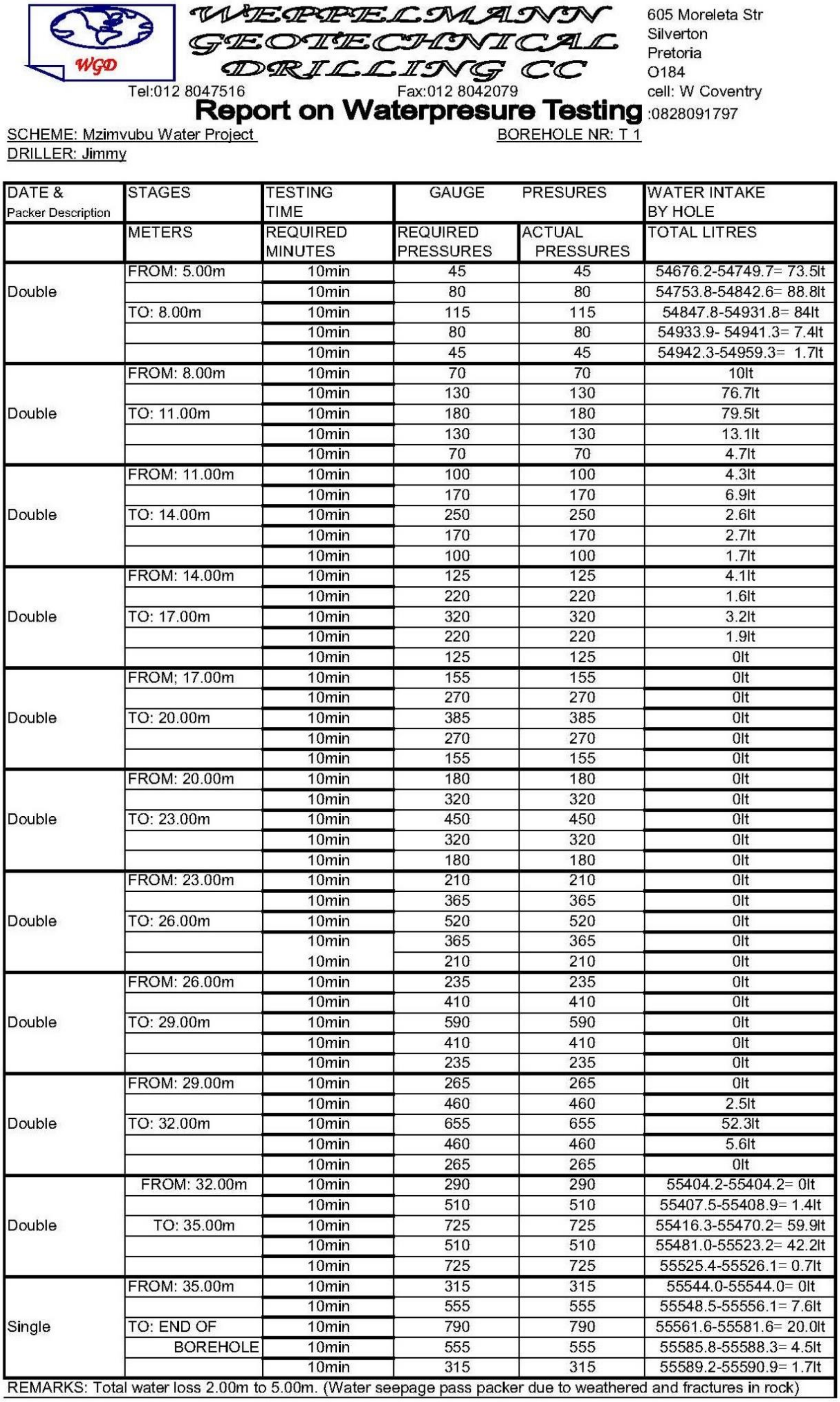
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET
DATE : 16/10/2013 13:20
TEXT : ..T\2819\2819S&TBHLOGS.TXT

HOLE No: T1

D06C JGI

dotPLOT 7013 PBp7

Fig C-1.2: Borehole Logs (T1)



WEPPELMANN GEOTECHNICAL DRILLING CC

605 Moreleta Str
Silverton
Pretoria
O184
cell: W Coventry
:0828091797

Tel:012 8047516 Fax:012 8042079

Report on Waterpresure Testing

SCHEME: Mzimvubu Water Project BOREHOLE NR: T 1
DRILLER: Jimmy

DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
Double	FROM: 5.00m	10min	45	45	54676.2-54749.7= 73.5lt
		10min	80	80	54753.8-54842.6= 88.8lt
	TO: 8.00m	10min	115	115	54847.8-54931.8= 84lt
		10min	80	80	54933.9- 54941.3= 7.4lt
		10min	45	45	54942.3-54959.3= 1.7lt
Double	FROM: 8.00m	10min	70	70	10lt
		10min	130	130	76.7lt
	TO: 11.00m	10min	180	180	79.5lt
		10min	130	130	13.1lt
		10min	70	70	4.7lt
Double	FROM: 11.00m	10min	100	100	4.3lt
		10min	170	170	6.9lt
	TO: 14.00m	10min	250	250	2.6lt
		10min	170	170	2.7lt
		10min	100	100	1.7lt
Double	FROM: 14.00m	10min	125	125	4.1lt
		10min	220	220	1.6lt
	TO: 17.00m	10min	320	320	3.2lt
		10min	220	220	1.9lt
		10min	125	125	0lt
Double	FROM; 17.00m	10min	155	155	0lt
		10min	270	270	0lt
	TO: 20.00m	10min	385	385	0lt
		10min	270	270	0lt
		10min	155	155	0lt
Double	FROM: 20.00m	10min	180	180	0lt
		10min	320	320	0lt
	TO: 23.00m	10min	450	450	0lt
		10min	320	320	0lt
		10min	180	180	0lt
Double	FROM: 23.00m	10min	210	210	0lt
		10min	365	365	0lt
	TO: 26.00m	10min	520	520	0lt
		10min	365	365	0lt
		10min	210	210	0lt
Double	FROM: 26.00m	10min	235	235	0lt
		10min	410	410	0lt
	TO: 29.00m	10min	590	590	0lt
		10min	410	410	0lt
		10min	235	235	0lt
Double	FROM: 29.00m	10min	265	265	0lt
		10min	460	460	2.5lt
	TO: 32.00m	10min	655	655	52.3lt
		10min	460	460	5.6lt
		10min	265	265	0lt
Double	FROM: 32.00m	10min	290	290	55404.2-55404.2= 0lt
		10min	510	510	55407.5-55408.9= 1.4lt
	TO: 35.00m	10min	725	725	55416.3-55470.2= 59.9lt
		10min	510	510	55481.0-55523.2= 42.2lt
		10min	725	725	55525.4-55526.1= 0.7lt
Single	FROM: 35.00m	10min	315	315	55544.0-55544.0= 0lt
		10min	555	555	55548.5-55556.1= 7.6lt
	TO: END OF	10min	790	790	55561.6-55581.6= 20.0lt
	BOREHOLE	10min	555	555	55585.8-55588.3= 4.5lt
		10min	315	315	55589.2-55590.9= 1.7lt
REMARKS: Total water loss 2.00m to 5.00m. (Water seepage pass packer due to weathered and fractures in rock)					

Fig C-2: Water Pressure Testing Report (T1)

Fig C-3: Borehole T1 Core Box 1 of 6

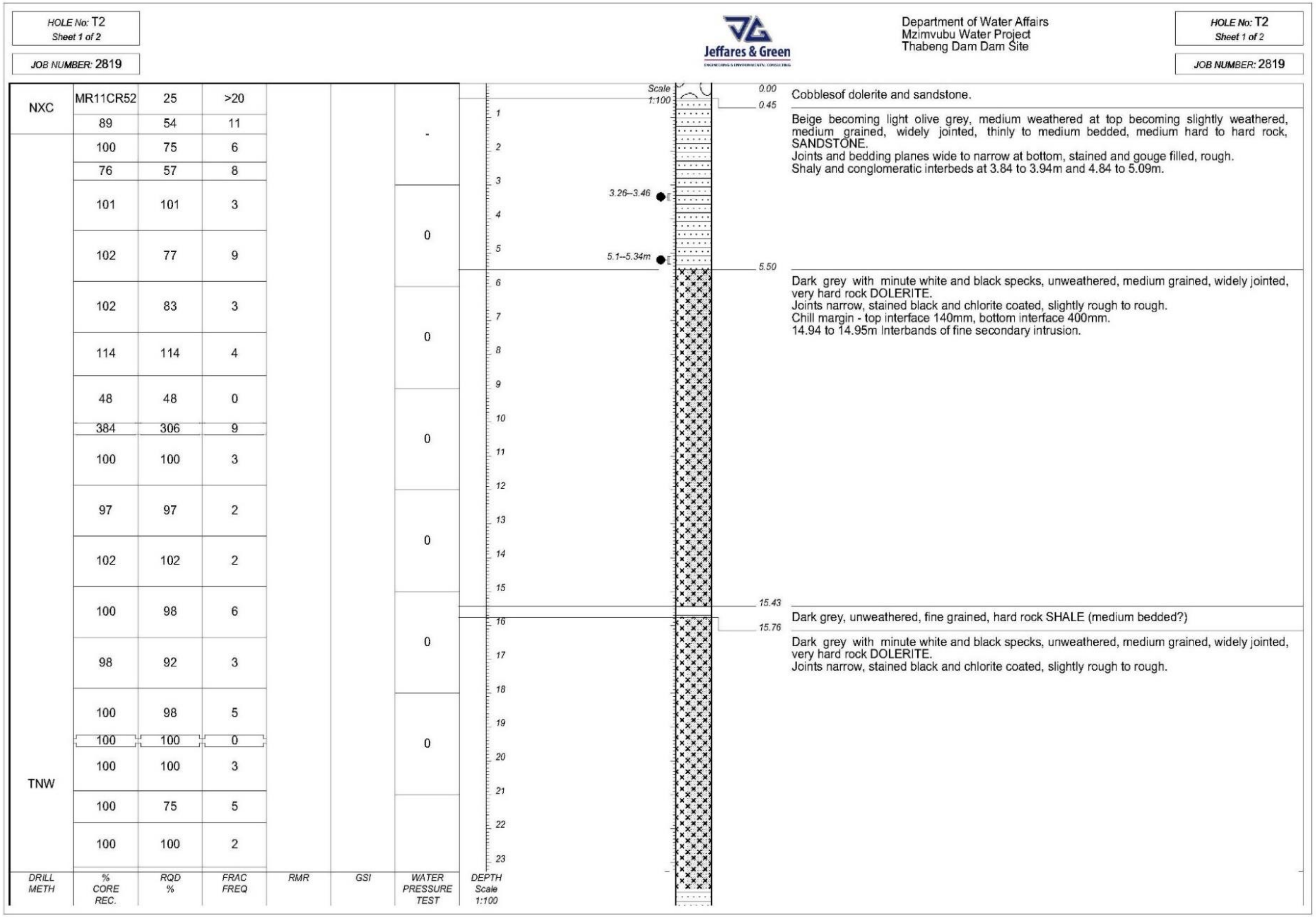
Fig C-4: Borehole T1 Core Box 2 of 6

Fig C-5: Borehole T1 Core Box 3 of 6

Fig C-6: Borehole T1 Core Box 4 of 6

Fig C-7: Borehole T1 Core Box 5 of 6

Fig C-8: Borehole T1 Core Box 6 of 6



HOLE No: T2
Sheet 1 of 2

JOB NUMBER: 2819

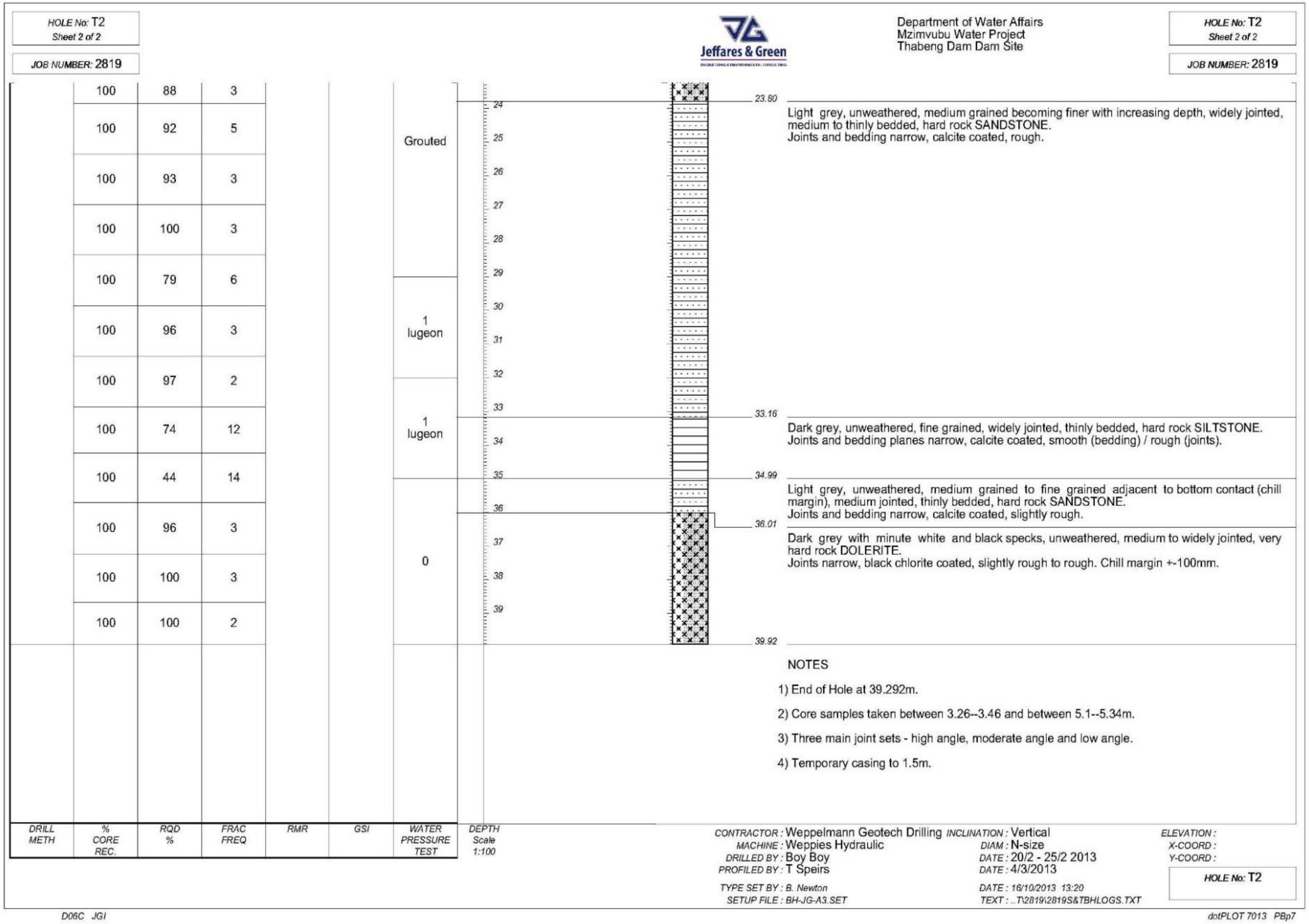
Department of Water Affairs
Mzimvubu Water Project
Thabeng Dam Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	RMR	GSI	WATER PRESSURE TEST
NXC	MR11CR52	25	>20			-
	89	54	11			
TNW	100	75	6			
	76	57	8			
	101	101	3			0
	102	77	9			
	102	83	3			0
	114	114	4			
	48	48	0			0
	384	306	9			
	100	100	3			
	97	97	2			0
	102	102	2			
	100	98	6			0
	98	92	3			
	100	98	5			0
	100	100	0			
	100	100	3			
	100	75	5			
	100	100	2			

DEPTH Scale 1:100

0.00	Cobblesof dolerite and sandstone.
0.45	Beige becoming light olive grey, medium weathered at top becoming slightly weathered, medium grained, widely jointed, thinly to medium bedded, medium hard to hard rock, SANDSTONE. Joints and bedding planes wide to narrow at bottom, stained and gouge filled, rough. Shaly and conglomeratic interbeds at 3.84 to 3.94m and 4.84 to 5.09m.
5.50	Dark grey with minute white and black specks, unweathered, medium grained, widely jointed, very hard rock DOLERITE. Joints narrow, stained black and chlorite coated, slightly rough to rough. Chill margin - top interface 140mm, bottom interface 400mm. 14.94 to 14.95m Interbands of fine secondary intrusion.
15.43	Dark grey, unweathered, fine grained, hard rock SHALE (medium bedded?)
15.76	Dark grey with minute white and black specks, unweathered, medium grained, widely jointed, very hard rock DOLERITE. Joints narrow, stained black and chlorite coated, slightly rough to rough.

Fig C-9.1: **Borehole Logs (T2)**



HOLE No: T2
Sheet 2 of 2
JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Thabeng Dam Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	RMR	GSI
	100	88	3		
	100	92	5		
	100	93	3		
	100	100	3		
	100	79	6		
	100	96	3		
	100	97	2		
	100	74	12		
	100	44	14		
	100	96	3		
	100	100	3		
	100	100	2		

WATER PRESSURE TEST:
Grouted
1 lugeon
1 lugeon
0

DEPTH Scale 1:100

Depth	Description
23.80	Light grey, unweathered, medium grained becoming finer with increasing depth, widely jointed, medium to thinly bedded, hard rock SANDSTONE. Joints and bedding narrow, calcite coated, rough.
33.16	Dark grey, unweathered, fine grained, widely jointed, thinly bedded, hard rock SILTSTONE. Joints and bedding planes narrow, calcite coated, smooth (bedding) / rough (joints).
34.99	Light grey, unweathered, medium grained to fine grained adjacent to bottom contact (chill margin), medium jointed, thinly bedded, hard rock SANDSTONE. Joints and bedding narrow, calcite coated, slightly rough.
36.01	Dark grey with minute white and black specks, unweathered, medium to widely jointed, very hard rock DOLERITE. Joints narrow, black chlorite coated, slightly rough to rough. Chill margin +-100mm.
39.92	

NOTES

1) End of Hole at 39.292m.

2) Core samples taken between 3.26--3.46 and between 5.1--5.34m.

3) Three main joint sets - high angle, moderate angle and low angle.

4) Temporary casing to 1.5m.

CONTRACTOR : Weppelmann Geotech Drilling
MACHINE : Weppies Hydraulic
DRILLED BY : Boy Boy
PROFILED BY : T Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 20/2 - 25/2 2013
DATE : 4/3/2013
DATE : 16/10/2013 13:20
TEXT : ..T\2819\2819S&TBHLOGS.TXT

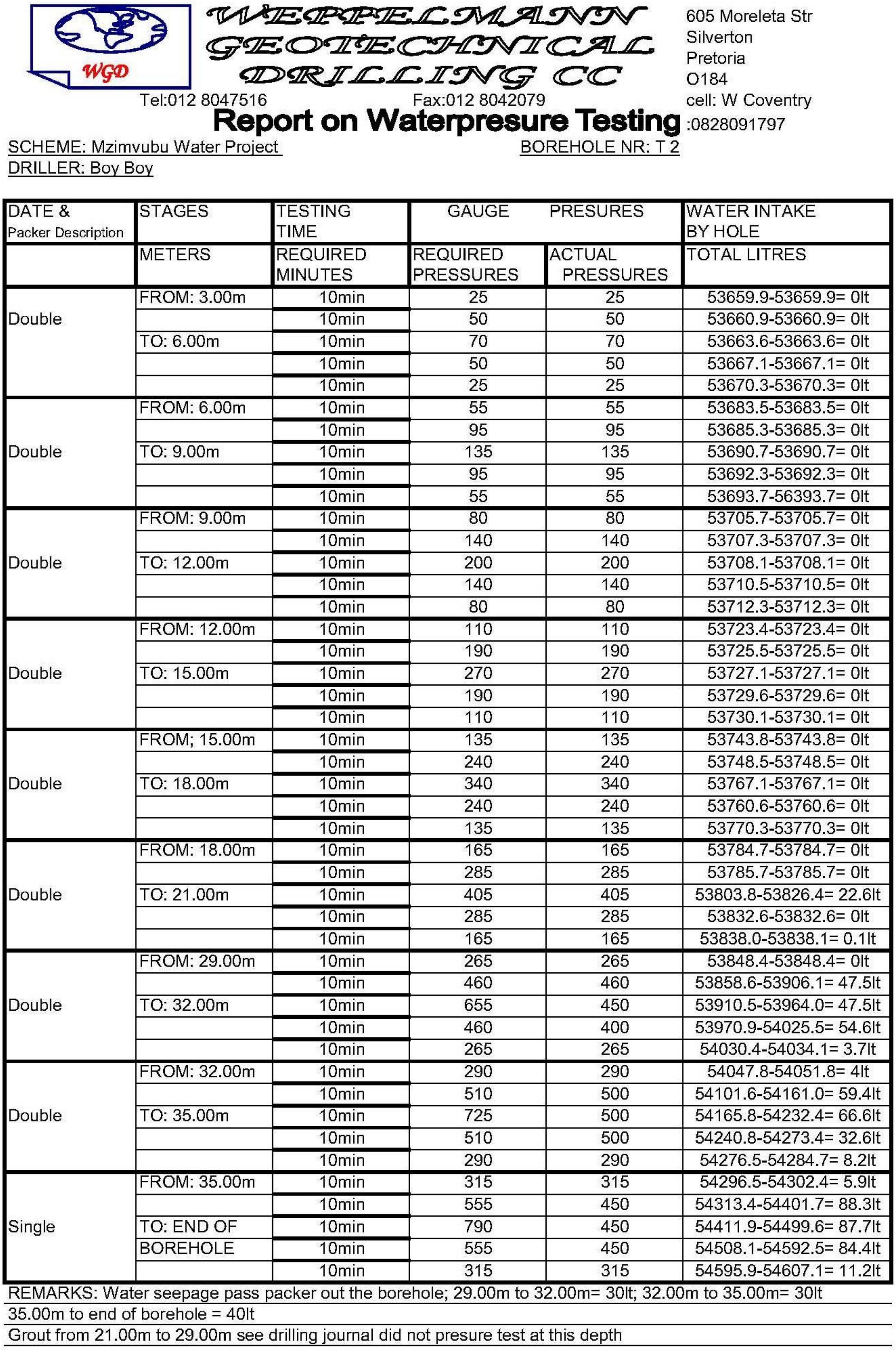
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: T2

D06C JGI

dotPLOT 7013 PBp7

Fig C-9.2: **Borehole Logs (T2)**



WEPPELMANN GEOTECHNICAL DRILLING CC

605 Moreleta Str
Silverton
Pretoria
0184
cell: W Coventry
:0828091797

Tel:012 8047516 Fax:012 8042079

Report on Waterpresure Testing

SCHEME: Mzimvubu Water Project BOREHOLE NR: T 2
DRILLER: Boy Boy

DATE & Packer Description	STAGES	TESTING TIME	GAUGE PRESURES		WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
Double	FROM: 3.00m	10min	25	25	53659.9-53659.9= 0lt
		10min	50	50	53660.9-53660.9= 0lt
	TO: 6.00m	10min	70	70	53663.6-53663.6= 0lt
		10min	50	50	53667.1-53667.1= 0lt
		10min	25	25	53670.3-53670.3= 0lt
Double	FROM: 6.00m	10min	55	55	53683.5-53683.5= 0lt
		10min	95	95	53685.3-53685.3= 0lt
	TO: 9.00m	10min	135	135	53690.7-53690.7= 0lt
		10min	95	95	53692.3-53692.3= 0lt
		10min	55	55	53693.7-56393.7= 0lt
Double	FROM: 9.00m	10min	80	80	53705.7-53705.7= 0lt
		10min	140	140	53707.3-53707.3= 0lt
	TO: 12.00m	10min	200	200	53708.1-53708.1= 0lt
		10min	140	140	53710.5-53710.5= 0lt
		10min	80	80	53712.3-53712.3= 0lt
Double	FROM: 12.00m	10min	110	110	53723.4-53723.4= 0lt
		10min	190	190	53725.5-53725.5= 0lt
	TO: 15.00m	10min	270	270	53727.1-53727.1= 0lt
		10min	190	190	53729.6-53729.6= 0lt
		10min	110	110	53730.1-53730.1= 0lt
Double	FROM; 15.00m	10min	135	135	53743.8-53743.8= 0lt
		10min	240	240	53748.5-53748.5= 0lt
	TO: 18.00m	10min	340	340	53767.1-53767.1= 0lt
		10min	240	240	53760.6-53760.6= 0lt
		10min	135	135	53770.3-53770.3= 0lt
Double	FROM: 18.00m	10min	165	165	53784.7-53784.7= 0lt
		10min	285	285	53785.7-53785.7= 0lt
	TO: 21.00m	10min	405	405	53803.8-53826.4= 22.6lt
		10min	285	285	53832.6-53832.6= 0lt
		10min	165	165	53838.0-53838.1= 0.1lt
Double	FROM: 29.00m	10min	265	265	53848.4-53848.4= 0lt
		10min	460	460	53858.6-53906.1= 47.5lt
	TO: 32.00m	10min	655	450	53910.5-53964.0= 47.5lt
		10min	460	400	53970.9-54025.5= 54.6lt
		10min	265	265	54030.4-54034.1= 3.7lt
Double	FROM: 32.00m	10min	290	290	54047.8-54051.8= 4lt
		10min	510	500	54101.6-54161.0= 59.4lt
	TO: 35.00m	10min	725	500	54165.8-54232.4= 66.6lt
		10min	510	500	54240.8-54273.4= 32.6lt
		10min	290	290	54276.5-54284.7= 8.2lt
Single	FROM: 35.00m	10min	315	315	54296.5-54302.4= 5.9lt
		10min	555	450	54313.4-54401.7= 88.3lt
	TO: END OF	10min	790	450	54411.9-54499.6= 87.7lt
	BOREHOLE	10min	555	450	54508.1-54592.5= 84.4lt
		10min	315	315	54595.9-54607.1= 11.2lt

REMARKS: Water seepage pass packer out the borehole; 29.00m to 32.00m= 30lt; 32.00m to 35.00m= 30lt
35.00m to end of borehole = 40lt
Grout from 21.00m to 29.00m see drilling journal did not presure test at this depth

Fig C-10 Water Pressure Testing Report (T2)

Fig C-11: Borehole T2 Core Box 1 of 6

Fig C-12: Borehole T2 Core Box 2 of 6

Fig C-13: Borehole T2 Core Box 3 of 6

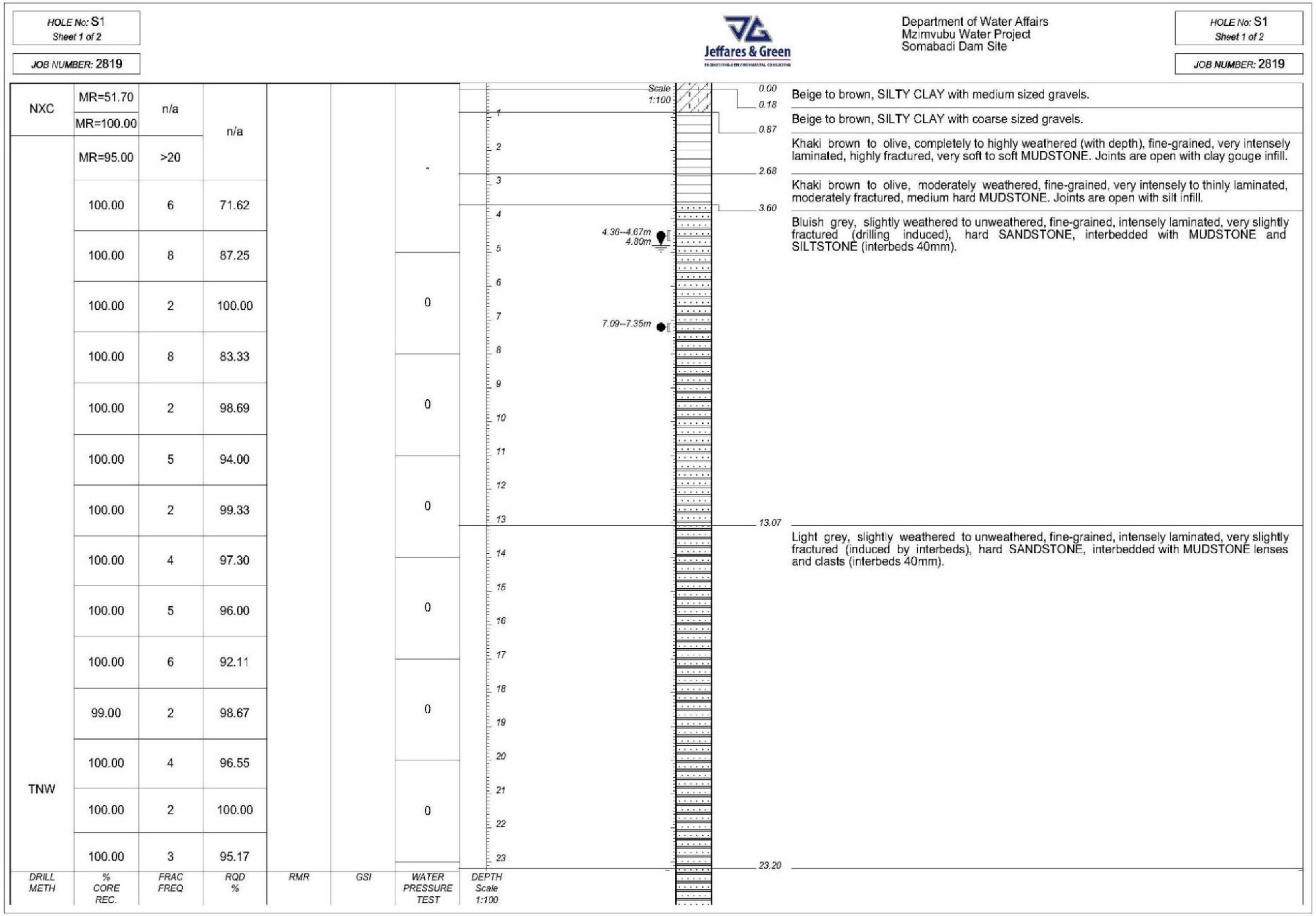
Fig C-14: Borehole T2 Core Box 4 of 6

Fig C-15: Borehole T2 Core Box 5 of 6

Fig C-16: Borehole T2 Core Box 6 of 6

C2:

SOMABADI DAM SITE



HOLE No: S1
Sheet 1 of 2
JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Somabadi Dam Site

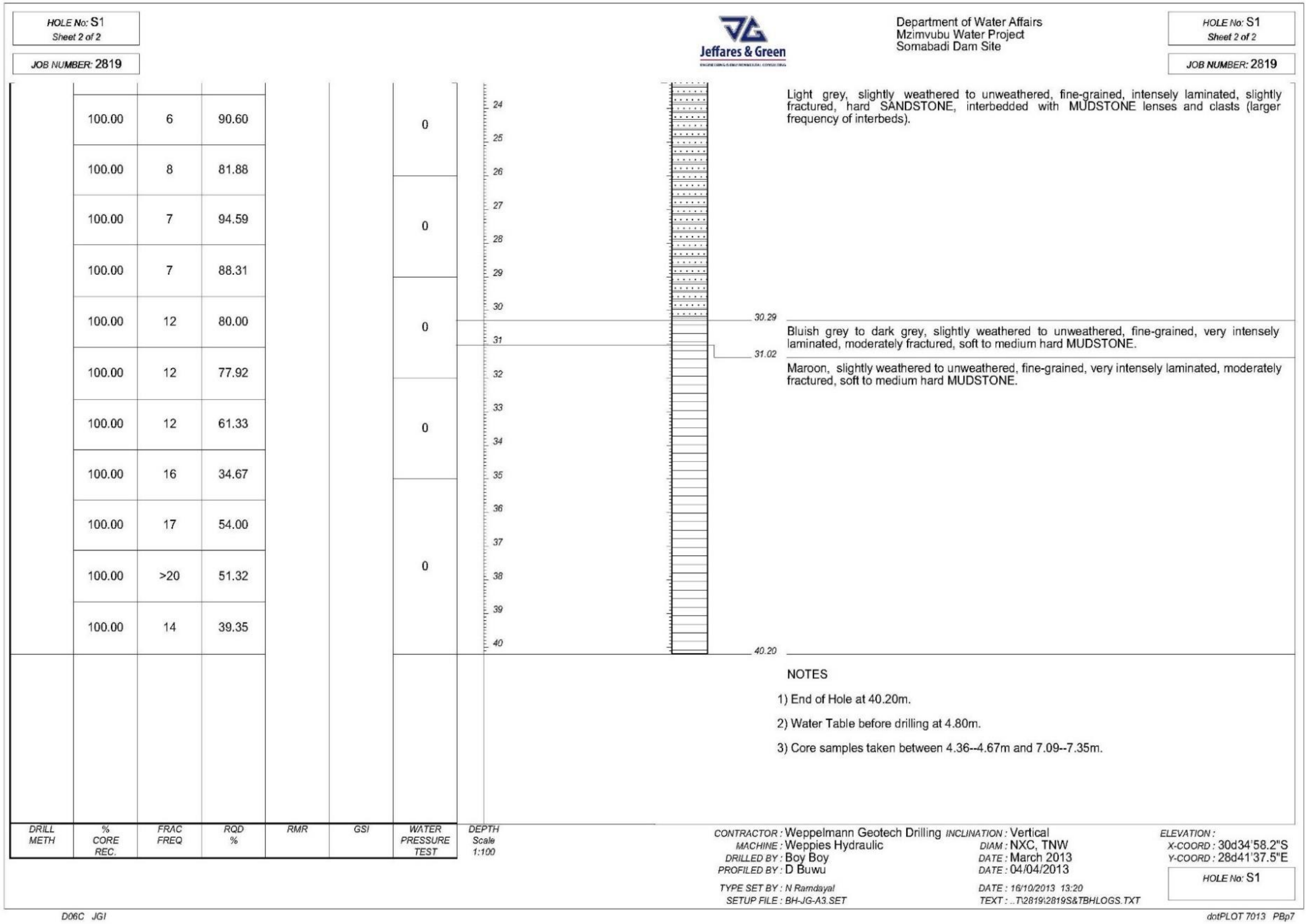
HOLE No: S1
Sheet 1 of 2
JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	RMR	GSI	WATER PRESSURE TEST
NXC	MR=51.70	n/a	n/a			-
	MR=100.00					
TNW	MR=95.00	>20				
	100.00	6	71.62			
	100.00	8	87.25			
	100.00	2	100.00			0
	100.00	8	83.33			
	100.00	2	98.69			0
	100.00	5	94.00			
	100.00	2	99.33			0
	100.00	4	97.30			
	100.00	5	96.00			0
	100.00	6	92.11			
	99.00	2	98.67			0
	100.00	4	96.55			
	100.00	2	100.00			0
	100.00	3	95.17			

DEPTH Scale 1:100

0.00	Beige to brown, SILTY CLAY with medium sized gravels.
0.18	Beige to brown, SILTY CLAY with coarse sized gravels.
0.87	Khaki brown to olive, completely to highly weathered (with depth), fine-grained, very intensely laminated, highly fractured, very soft to soft MUDSTONE. Joints are open with clay gouge infill.
2.68	Khaki brown to olive, moderately weathered, fine-grained, very intensely to thinly laminated, moderately fractured, medium hard MUDSTONE. Joints are open with silt infill.
3.60	Bluish grey, slightly weathered to unweathered, fine-grained, intensely laminated, very slightly fractured (drilling induced), hard SANDSTONE, interbedded with MUDSTONE and SILTSTONE (interbeds 40mm).
13.07	Light grey, slightly weathered to unweathered, fine-grained, intensely laminated, very slightly fractured (induced by interbeds), hard SANDSTONE, interbedded with MUDSTONE lenses and clasts (interbeds 40mm).
23.20	

Fig C-17.1: Borehole Logs (S1)



HOLE No: S1
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JOB NUMBER: 2819

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Department of Water Affairs
Mzimvubu Water Project
Somabadi Dam Site

HOLE No: S1
Sheet 2 of 2

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	RMR	GSI	WATER PRESSURE TEST
	100.00	6	90.60			0
	100.00	8	81.88			
	100.00	7	94.59			0
	100.00	7	88.31			
	100.00	12	80.00			0
	100.00	12	77.92			
	100.00	12	61.33			0
	100.00	16	34.67			
	100.00	17	54.00			0
	100.00	>20	51.32			
	100.00	14	39.35			

DEPTH Scale 1:100

24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Light grey, slightly weathered to unweathered, fine-grained, intensely laminated, slightly fractured, hard SANDSTONE, interbedded with MUDSTONE lenses and clasts (larger frequency of interbeds).

30.29

Bluish grey to dark grey, slightly weathered to unweathered, fine-grained, very intensely laminated, moderately fractured, soft to medium hard MUDSTONE.

31.02

Maroon, slightly weathered to unweathered, fine-grained, very intensely laminated, moderately fractured, soft to medium hard MUDSTONE.

40.20

NOTES

1) End of Hole at 40.20m.

2) Water Table before drilling at 4.80m.

3) Core samples taken between 4.36--4.67m and 7.09--7.35m.

CONTRACTOR : Weppelmann Geotech Drilling
MACHINE : Weppies Hydraulic
DRILLED BY : Boy Boy
PROFILED BY : D Buwu
TYPE SET BY : N Ramdayal
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : NXC, TNW
DATE : March 2013
DATE : 04/04/2013
DATE : 16/10/2013 13:20
TEXT : ..T\2819\2819S&TBHLOGS.TXT

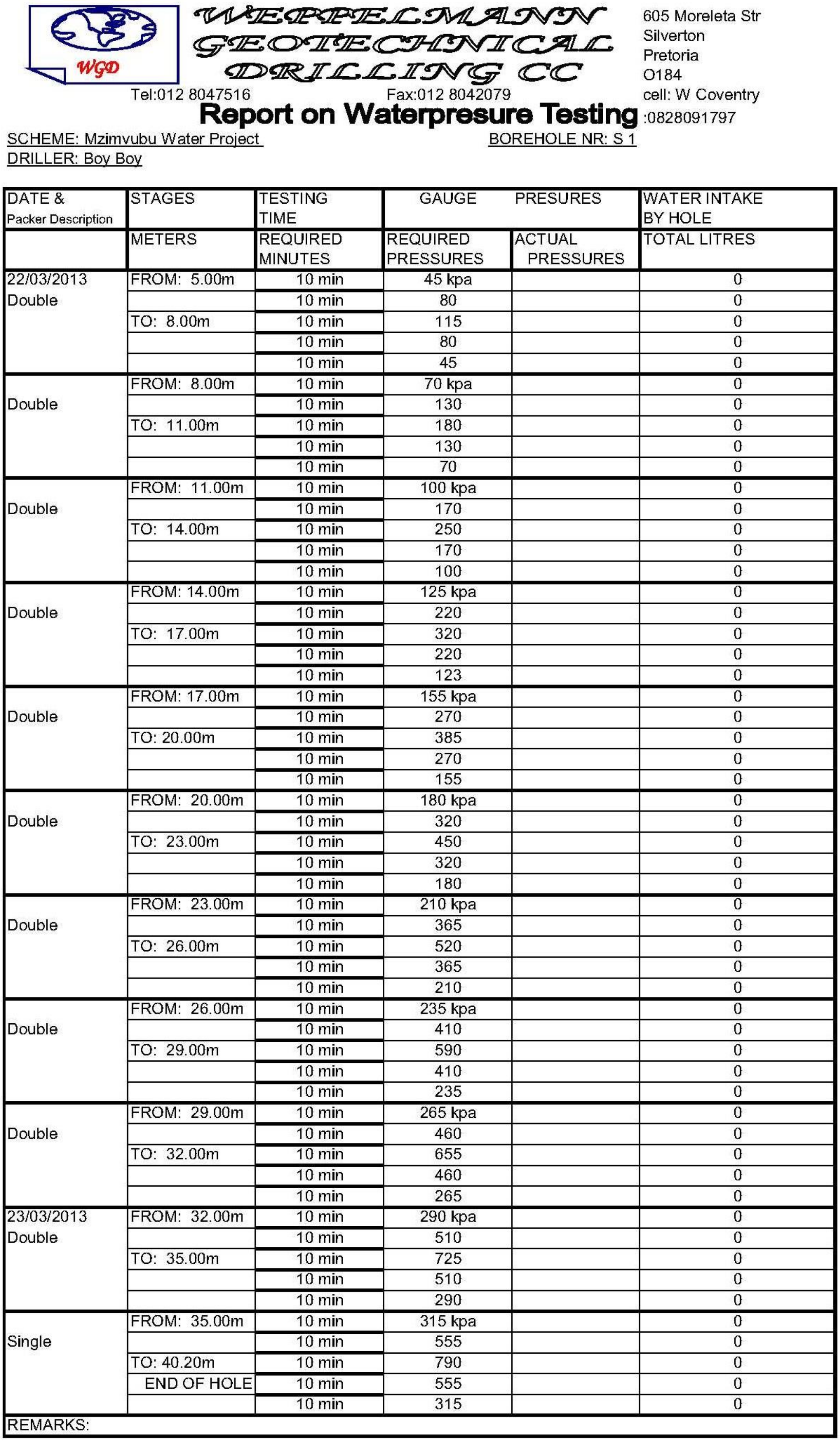
ELEVATION :
X-COORD : 30d34'58.2"S
Y-COORD : 28d41'37.5"E

HOLE No: S1

D06C JGI

dotPLOT 7013 PBp7

Fig C-17.2: Borehole Logs (S2)



WEPPELMANN GEOTECHNICAL DRILLING CC
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Tel:012 8047516 Fax:012 8042079

Report on Waterpresure Testing

SCHEME: Mzimvubu Water Project
DRILLER: Boy Boy
BOREHOLE NR: S 1

DATE & Packer Description	STAGES	TESTING TIME	GAUGE PRESURES		WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
22/03/2013 Double	FROM: 5.00m	10 min	45 kpa		0
		10 min	80		0
	TO: 8.00m	10 min	115		0
		10 min	80		0
		10 min	45		0
Double	FROM: 8.00m	10 min	70 kpa		0
		10 min	130		0
	TO: 11.00m	10 min	180		0
		10 min	130		0
		10 min	70		0
Double	FROM: 11.00m	10 min	100 kpa		0
		10 min	170		0
	TO: 14.00m	10 min	250		0
		10 min	170		0
		10 min	100		0
Double	FROM: 14.00m	10 min	125 kpa		0
		10 min	220		0
	TO: 17.00m	10 min	320		0
		10 min	220		0
		10 min	123		0
Double	FROM: 17.00m	10 min	155 kpa		0
		10 min	270		0
	TO: 20.00m	10 min	385		0
		10 min	270		0
		10 min	155		0
Double	FROM: 20.00m	10 min	180 kpa		0
		10 min	320		0
	TO: 23.00m	10 min	450		0
		10 min	320		0
		10 min	180		0
Double	FROM: 23.00m	10 min	210 kpa		0
		10 min	365		0
	TO: 26.00m	10 min	520		0
		10 min	365		0
		10 min	210		0
Double	FROM: 26.00m	10 min	235 kpa		0
		10 min	410		0
	TO: 29.00m	10 min	590		0
		10 min	410		0
		10 min	235		0
Double	FROM: 29.00m	10 min	265 kpa		0
		10 min	460		0
	TO: 32.00m	10 min	655		0
		10 min	460		0
		10 min	265		0
23/03/2013 Double	FROM: 32.00m	10 min	290 kpa		0
		10 min	510		0
	TO: 35.00m	10 min	725		0
		10 min	510		0
		10 min	290		0
Single	FROM: 35.00m	10 min	315 kpa		0
		10 min	555		0
	TO: 40.20m	10 min	790		0
	END OF HOLE	10 min	555		0
		10 min	315		0
REMARKS:					

Fig C-18: Water Pressure Testing Report (S1)

Fig C-19: Borehole S1 Core Box 1 of 6

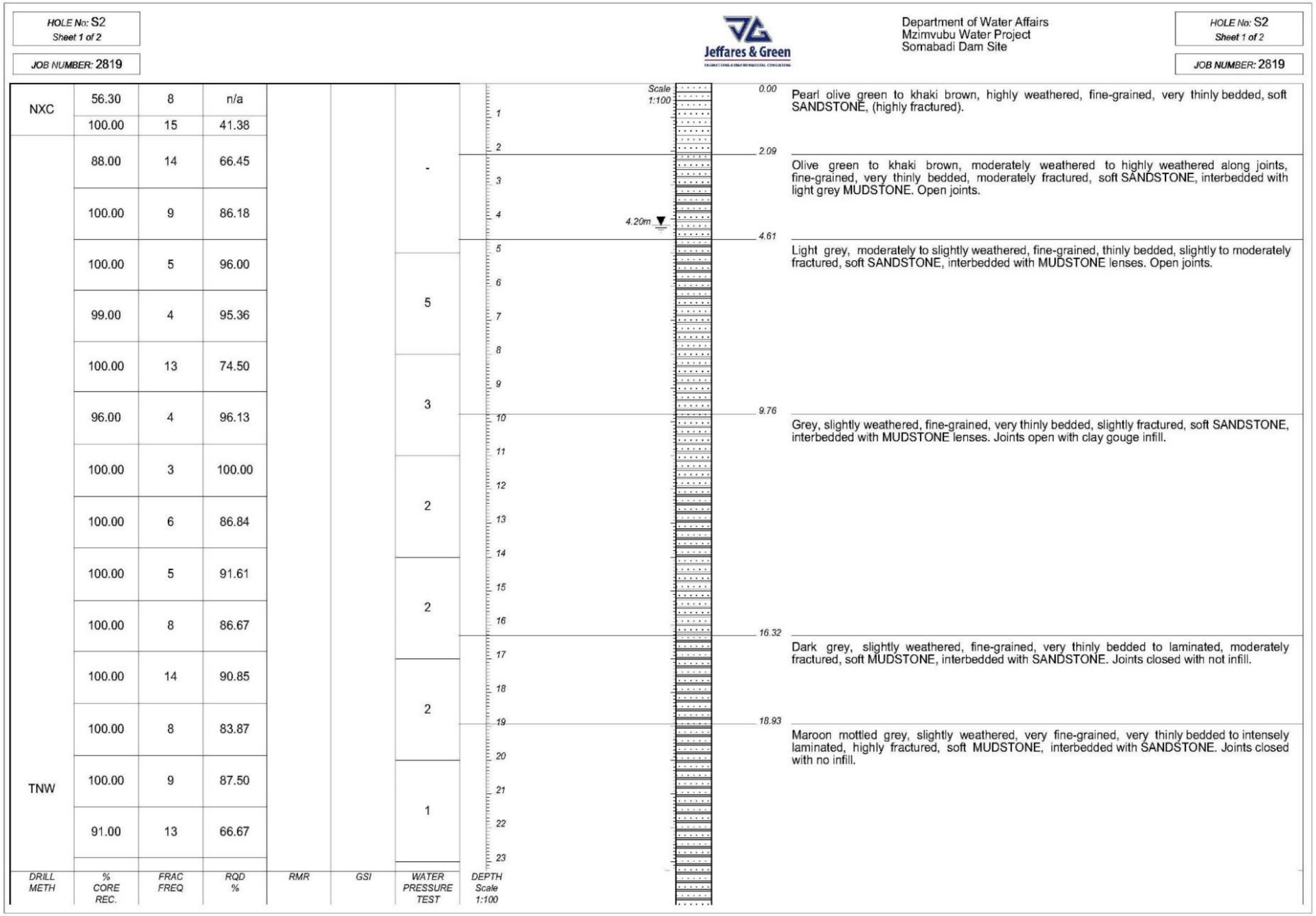
Fig C-20: Borehole S1 Core Box 2 of 6

Fig C-21: Borehole S1 Core Box 3 of 6

Fig C-22: Borehole S1 Core Box 4 of 6

Fig C-23: Borehole S1 Core Box 5 of 6

Fig C-24: Borehole S1 Core Box 6 of 6



HOLE No: S2
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Somabadi Dam Site

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	RMR	GSI	WATER PRESSURE TEST
NXC	56.30	8	n/a			-
	100.00	15	41.38			
TNW	88.00	14	66.45			
	100.00	9	86.18			
	100.00	5	96.00			5
	99.00	4	95.36			
	100.00	13	74.50			3
	96.00	4	96.13			
	100.00	3	100.00			2
	100.00	6	86.84			
	100.00	5	91.61			2
	100.00	8	86.67			
	100.00	14	90.85			2
	100.00	8	83.87			
	100.00	9	87.50			1
	91.00	13	66.67			

DEPTH Scale 1:100

Scale 1:100

4.20m

0.00	Pearl olive green to khaki brown, highly weathered, fine-grained, very thinly bedded, soft SANDSTONE, (highly fractured).
2.09	Olive green to khaki brown, moderately weathered to highly weathered along joints, fine-grained, very thinly bedded, moderately fractured, soft SANDSTONE, interbedded with light grey MUDSTONE. Open joints.
4.61	Light grey, moderately to slightly weathered, fine-grained, thinly bedded, slightly to moderately fractured, soft SANDSTONE, interbedded with MUDSTONE lenses. Open joints.
9.76	Grey, slightly weathered, fine-grained, very thinly bedded, slightly fractured, soft SANDSTONE, interbedded with MUDSTONE lenses. Joints open with clay gouge infill.
16.32	Dark grey, slightly weathered, fine-grained, very thinly bedded to laminated, moderately fractured, soft MUDSTONE, interbedded with SANDSTONE. Joints closed with not infill.
18.93	Maroon mottled grey, slightly weathered, very fine-grained, very thinly bedded to intensely laminated, highly fractured, soft MUDSTONE, interbedded with SANDSTONE. Joints closed with no infill.

Fig C-25.1: Borehole Logs (S2)

HOLE No: S2
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

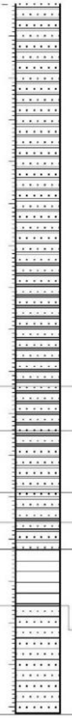
Department of Water Affairs
Mzimvubu Water Project
Somabadi Dam Site

HOLE No: S2
Sheet 2 of 2

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	RMR	GSI	WATER PRESSURE TEST
	100.00	8	76.60			
	100.00	11	42.28			1
	99.00	16	39.07			
	95.00	13	36.67			1
	100.00	4	71.93			
	47.00	4	40.66			
	100.00	13	100.00			1
	100.00	9	86.09			
	100.00	>20	60.00			1
	100.00	17	36.67			
	99.00	16	71.90			
	97.00	13	80.65			0
	100.00	4	86.26			

DEPTH Scale 1:100



32.35	
	Grey, slightly weathered, very fine-grained, very thinly bedded to intensely laminated, highly fractured, soft MUDSTONE, interbedded with SANDSTONE. Joints closed with no infill.
33.42	
	Maroon, slightly weathered, very fine-grained, very thinly bedded to intensely laminated, highly fractured, soft MUDSTONE, interbedded with SANDSTONE. Joints closed with no infill.
34.90	
	Grey, slightly weathered, very fine-grained, very thinly bedded to intensely laminated, highly fractured, soft MUDSTONE, interbedded with SANDSTONE. Joints closed with no infill.
35.60	
	Maroon, slightly weathered, very fine-grained, very thinly bedded to intensely laminated, highly fractured, soft MUDSTONE, interbedded with SANDSTONE. Joints closed with no infill.
36.24	
	Dark grey, slightly weathered, very fine-grained, intensely laminated, moderately fractured, soft to medium hard MUDSTONE.
37.58	
	Grey, slightly weathered, very fine-grained, very thinly bedded, slightly fractured, medium hard SANDSTONE.
40.18	

NOTES

1) End of Hole at 40.18m.

2) Water Table before drilling at 4.20m.

3) Not sampled.

CONTRACTOR : Weppelmann Geotech Drilling
MACHINE : D2K
DRILLED BY : Jimmy
PROFILED BY : D Buwu

TYPE SET BY : N Ramdayal
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : NXC, TNW
DATE : March 2013
DATE : 05/04/2013

DATE : 16/10/2013 13:20
TEXT : ..T\2819\2819S&TBHLOGS.TXT

ELEVATION :
X-COORD : 30d35'02.2"S
Y-COORD : 28d41'35.8"E

HOLE No: S2

D06C JGI

dotPLOT 7013 PBp7

Fig C-25.2: Borehole Logs (S2)

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Pretoria
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cell: W Coventry :0828091797

Report on Waterpresure Testing

SCHEME: Mzimvubu Water Project BOREHOLE NR: S 2
DRILLER: Jimmy

DATE & Packer Description	STAGES	TESTING TIME	GAUGE PRESURES		WATER INTAKE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
25/03/2013 Double	FROM: 5.00m	10 min	45 kpa		0
		10 min	80		0
	TO: 8.00m	10 min	115		0
		10 min	80		0
		10 min	45		0
Double	FROM: 8.00m	10 min	70 kpa		0
		10 min	130		0
	TO: 11.00m	10 min	180		0
		10 min	130		0
		10 min	70		0
Double	FROM: 11.00m	10 min	100 kpa		0
		10 min	170		0
	TO: 14.00m	10 min	250		0
		10 min	170		0
		10 min	100		0
Double	FROM: 14.00m	10 min	125 kpa		0
		10 min	220		0
	TO: 17.00m	10 min	320		0
		10 min	220		0
		10 min	125		0
Double	FROM: 17.00m	10 min	155 kpa		0
		10 min	270		0
	TO: 20.00m	10 min	385		0
		10 min	270		0
		10 min	155		0
Double	FROM: 20.00m	10 min	180 kpa		0
		10 min	320		0
	TO: 23.00m	10 min	450		0
		10 min	320		0
		10 min	180		0
Double	FROM: 23.00m	10 min	210 kpa		0
		10 min	365		0
	TO: 26.00m	10 min	520		0
		10 min	365		0
		10 min	210		0
Double	FROM: 26.00m	10 min	235 kpa		0
		10 min	410		0
	TO: 29.00m	10 min	590		0
		10 min	410		0
		10 min	235		0
Double	FROM: 29.00m	10 min	265 kpa		0
		10 min	460		0
	TO: 32.00m	10 min	655		0
		10 min	460		0
		10 min	265		0
26/03/2013 Double	FROM: 32.00m	10 min	290 kpa	290 kpa	88
		10 min	510	290	84.2
	TO: 35.00m	10 min	775	290	107.3
		10 min	510	290	80.5
		10 min	290	290	70.1
Single	FROM: 35.00m	10 min	315 kpa	200 kpa	104.8
		10 min	555	200	123.8
	TO: 40.18m	10 min	790	200	158.5
	END OF HOLE	10 min	555	200	115
		10 min	315	200	112
REMARKS:					

Fig C-26: Water Pressure Testing Report (S2)

Fig C-27: Borehole S2 Core Box 1 of 6

Fig C-28: Borehole S2 Core Box 2 of 6

Fig C-29: **Borehole S2 Core Box 3 of 6**

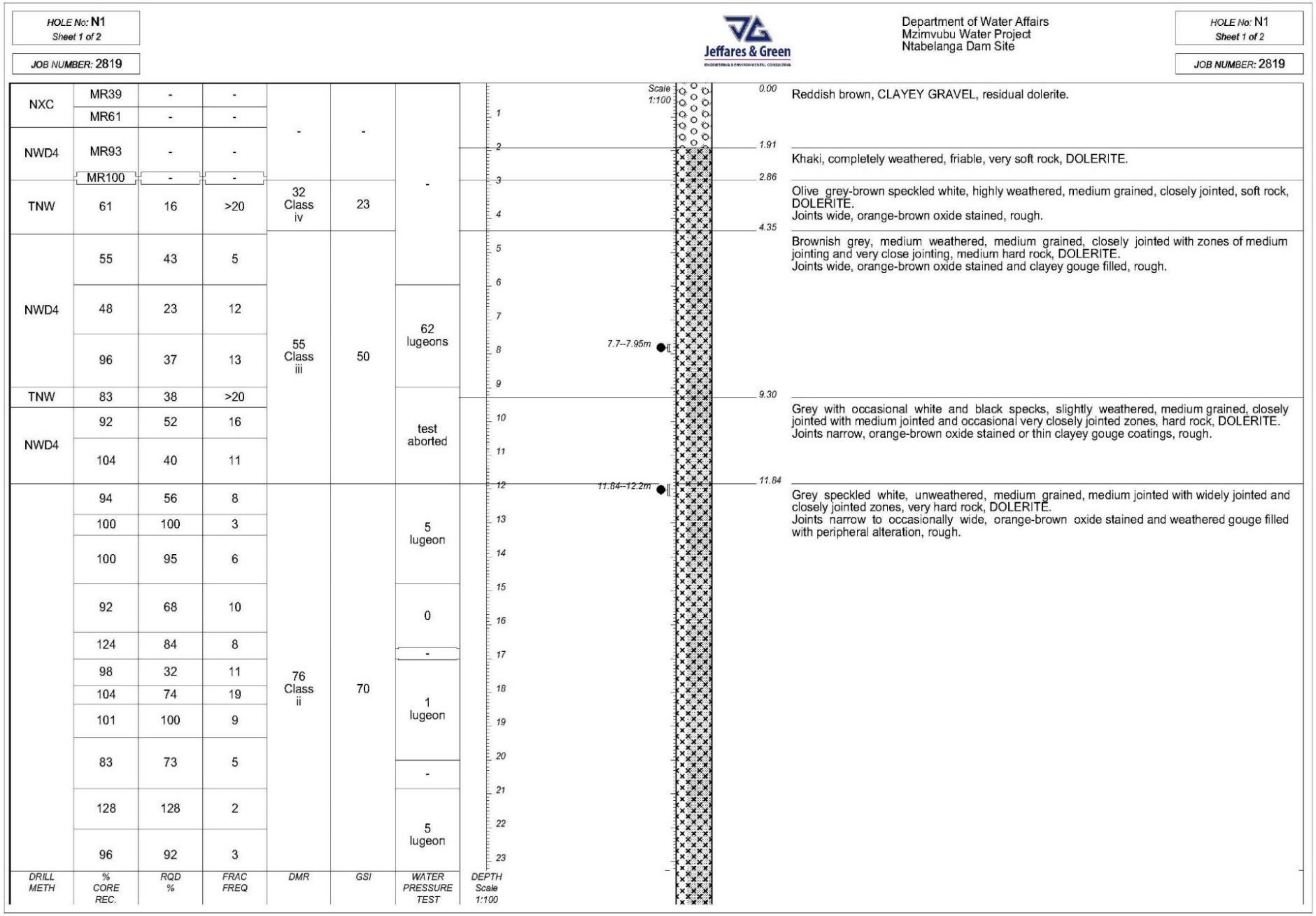
Fig C-30: **Borehole S2 Core Box 4 of 6**

Fig C-31: Borehole S2 Core Box 5 of 6

Fig C-32: Borehole S2 Core Box 6 of 6

C3:

NTABELANGA DAM SITE



HOLE No: **N1**
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	MR39	-	-	-	-	-
	MR61	-	-			
NWD4	MR93	-	-			
	MR100	-	-			
TNW	61	16	>20	32 Class iv	23	
NWD4	55	43	5	55 Class iii	50	
	48	23	12			62 lugeons
	96	37	13			
TNW	83	38	>20			test aborted
NWD4	92	52	16			
	104	40	11			
	94	56	8	76 Class ii	70	5 lugeon
	100	100	3			
	100	95	6			
	92	68	10			0
	124	84	8			-
	98	32	11			1 lugeon
	104	74	19			
	101	100	9			
	83	73	5			-
	128	128	2			5 lugeon
	96	92	3			

DEPTH Scale 1:100

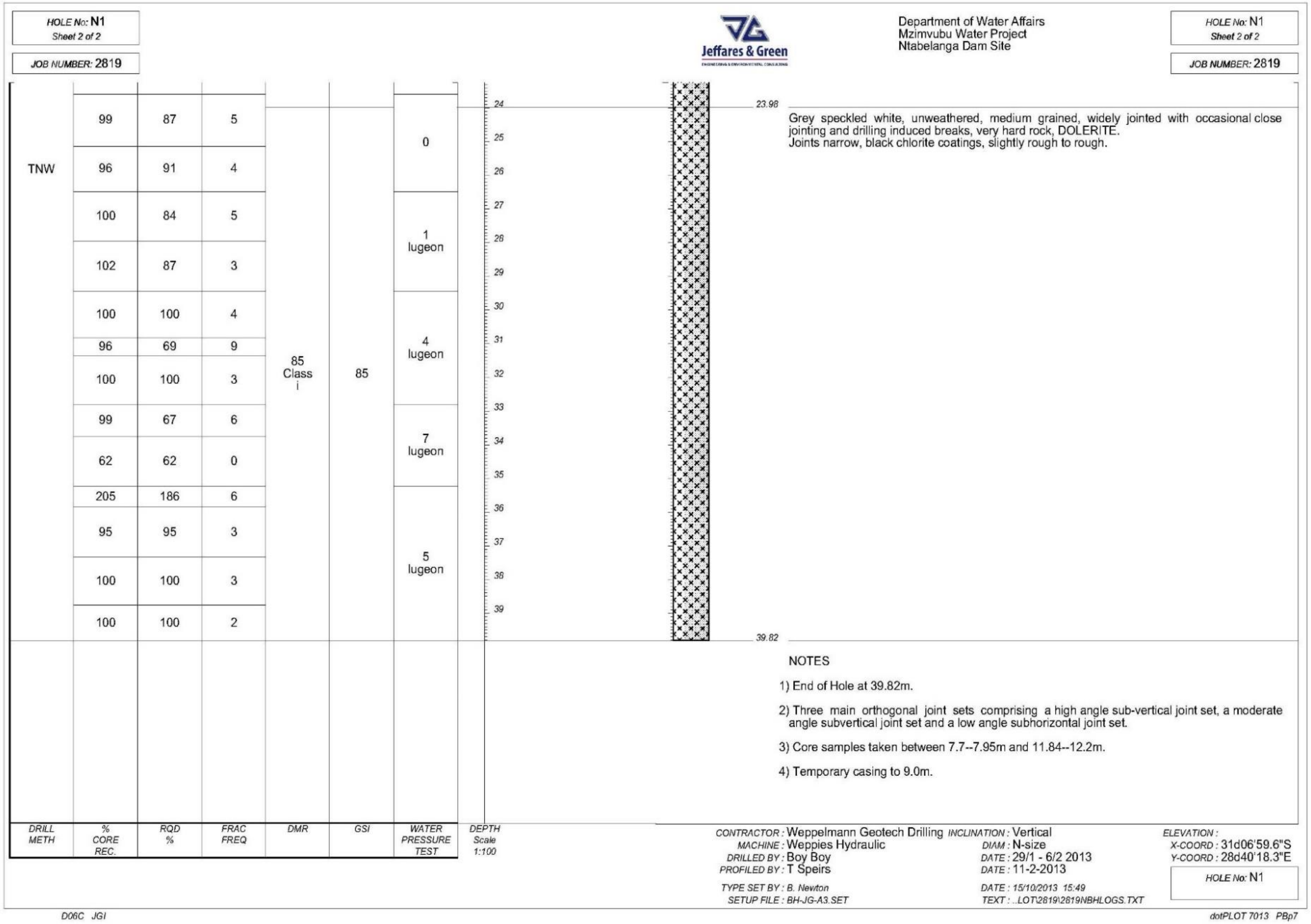
Scale 1:100

7.7–7.95m

11.84–12.2m

0.00	Reddish brown, CLAYEY GRAVEL, residual dolerite.
1.91	Khaki, completely weathered, friable, very soft rock, DOLERITE.
2.86	Olive grey-brown speckled white, highly weathered, medium grained, closely jointed, soft rock, DOLERITE. Joints wide, orange-brown oxide stained, rough.
4.35	Brownish grey, medium weathered, medium grained, closely jointed with zones of medium jointing and very close jointing, medium hard rock, DOLERITE. Joints wide, orange-brown oxide stained and clayey gouge filled, rough.
9.30	Grey with occasional white and black specks, slightly weathered, medium grained, closely jointed with medium jointed and occasional very closely jointed zones, hard rock, DOLERITE. Joints narrow, orange-brown oxide stained or thin clayey gouge coatings, rough.
11.84	Grey speckled white, unweathered, medium grained, medium jointed with widely jointed and closely jointed zones, very hard rock, DOLERITE. Joints narrow to occasionally wide, orange-brown oxide stained and weathered gouge filled with peripheral alteration, rough.

Fig C-33.1: Borehole Logs (N1)



HOLE No: N1
Sheet 2 of 2

JOB NUMBER: 2819

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Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
TNW	99	87	5	85 Class i	85	0
	96	91	4			
	100	84	5			1 lugeon
	102	87	3			
	100	100	4			4 lugeon
	96	69	9			
	100	100	3			
	99	67	6			7 lugeon
	62	62	0			
	205	186	6			5 lugeon
	95	95	3			
	100	100	3			
	100	100	2			

DEPTH Scale 1:100

23.98

Grey speckled white, unweathered, medium grained, widely jointed with occasional close jointing and drilling induced breaks, very hard rock, DOLERITE.
Joints narrow, black chlorite coatings, slightly rough to rough.

39.82

NOTES

1) End of Hole at 39.82m.

2) Three main orthogonal joint sets comprising a high angle sub-vertical joint set, a moderate angle subvertical joint set and a low angle subhorizontal joint set.

3) Core samples taken between 7.7--7.95m and 11.84--12.2m.

4) Temporary casing to 9.0m.

CONTRACTOR : Weppelmann Geotech Drilling
MACHINE : Weppies Hydraulic
DRILLED BY : Boy Boy
PROFILED BY : T Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 29/1 - 6/2 2013
DATE : 11-2-2013
DATE : 15/10/2013 15:49
TEXT : ..LOT\2819\2819NBHLOGS.TXT

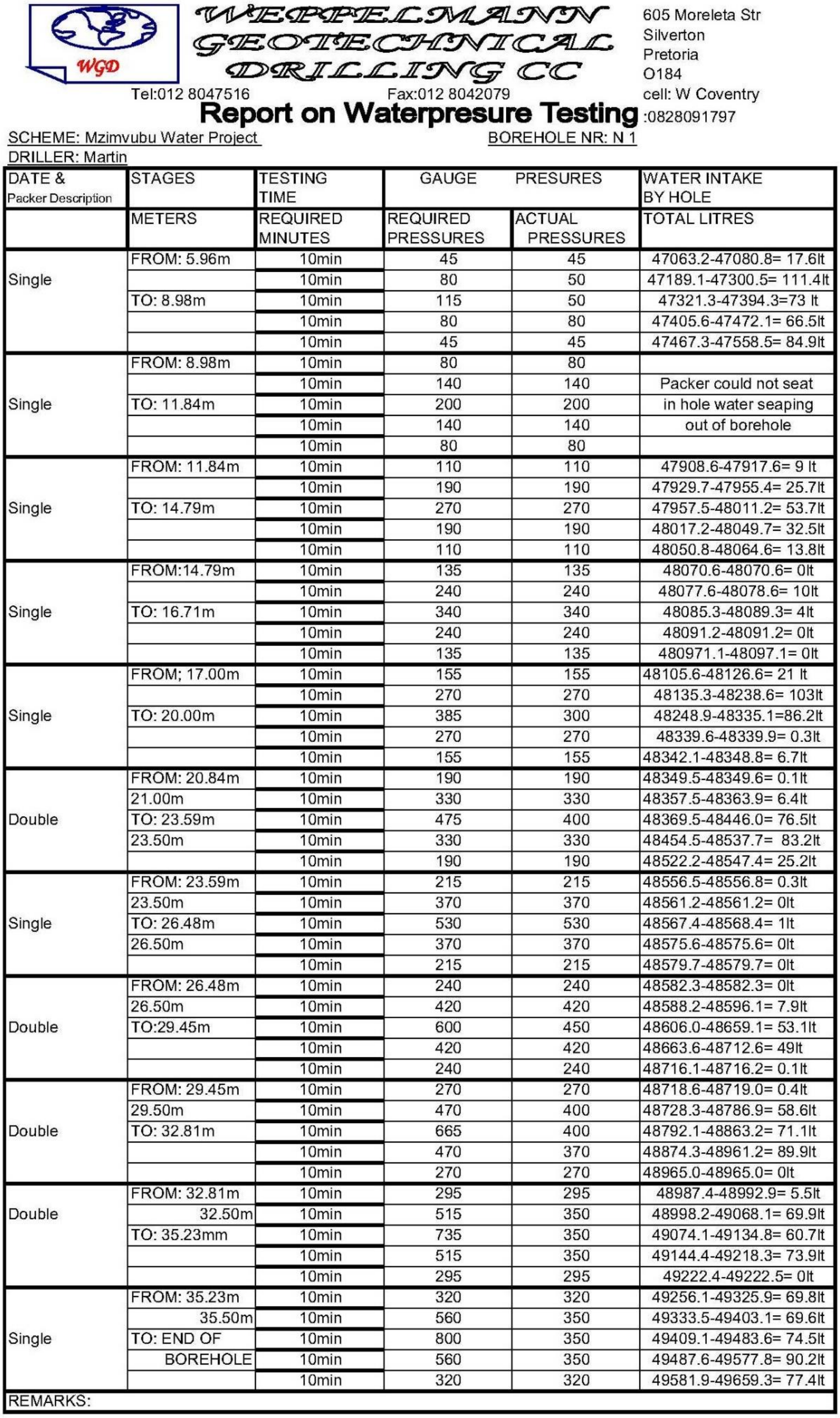
ELEVATION :
X-COORD : 31d06'59.6"S
Y-COORD : 28d40'18.3"E

HOLE No: N1

D06C JGI

dotPLOT 7013 PBp7

Fig C-33.2: Borehole Logs (N1)



WEPPELMANN GEOTECHNICAL DRILLING CC

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Report on Waterpresure Testing

SCHEME: Mzimvubu Water Project BOREHOLE NR: N 1
DRILLER: Martin

DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
Single	FROM: 5.96m	10min	45	45	47063.2-47080.8= 17.6lt
		10min	80	50	47189.1-47300.5= 111.4lt
	TO: 8.98m	10min	115	50	47321.3-47394.3=73 lt
		10min	80	80	47405.6-47472.1= 66.5lt
		10min	45	45	47467.3-47558.5= 84.9lt
Single	FROM: 8.98m	10min	80	80	
		10min	140	140	Packer could not seat
	TO: 11.84m	10min	200	200	in hole water seaping
		10min	140	140	out of borehole
		10min	80	80	
Single	FROM: 11.84m	10min	110	110	47908.6-47917.6= 9 lt
		10min	190	190	47929.7-47955.4= 25.7lt
	TO: 14.79m	10min	270	270	47957.5-48011.2= 53.7lt
		10min	190	190	48017.2-48049.7= 32.5lt
		10min	110	110	48050.8-48064.6= 13.8lt
Single	FROM:14.79m	10min	135	135	48070.6-48070.6= 0lt
		10min	240	240	48077.6-48078.6= 10lt
	TO: 16.71m	10min	340	340	48085.3-48089.3= 4lt
		10min	240	240	48091.2-48091.2= 0lt
		10min	135	135	480971.1-48097.1= 0lt
Single	FROM; 17.00m	10min	155	155	48105.6-48126.6= 21 lt
		10min	270	270	48135.3-48238.6= 103lt
	TO: 20.00m	10min	385	300	48248.9-48335.1=86.2lt
		10min	270	270	48339.6-48339.9= 0.3lt
		10min	155	155	48342.1-48348.8= 6.7lt
Double	FROM: 20.84m	10min	190	190	48349.5-48349.6= 0.1lt
	21.00m	10min	330	330	48357.5-48363.9= 6.4lt
	TO: 23.59m	10min	475	400	48369.5-48446.0= 76.5lt
	23.50m	10min	330	330	48454.5-48537.7= 83.2lt
		10min	190	190	48522.2-48547.4= 25.2lt
Single	FROM: 23.59m	10min	215	215	48556.5-48556.8= 0.3lt
	23.50m	10min	370	370	48561.2-48561.2= 0lt
	TO: 26.48m	10min	530	530	48567.4-48568.4= 1lt
	26.50m	10min	370	370	48575.6-48575.6= 0lt
		10min	215	215	48579.7-48579.7= 0lt
Double	FROM: 26.48m	10min	240	240	48582.3-48582.3= 0lt
	26.50m	10min	420	420	48588.2-48596.1= 7.9lt
	TO:29.45m	10min	600	450	48606.0-48659.1= 53.1lt
		10min	420	420	48663.6-48712.6= 49lt
		10min	240	240	48716.1-48716.2= 0.1lt
Double	FROM: 29.45m	10min	270	270	48718.6-48719.0= 0.4lt
	29.50m	10min	470	400	48728.3-48786.9= 58.6lt
	TO: 32.81m	10min	665	400	48792.1-48863.2= 71.1lt
		10min	470	370	48874.3-48961.2= 89.9lt
		10min	270	270	48965.0-48965.0= 0lt
Double	FROM: 32.81m	10min	295	295	48987.4-48992.9= 5.5lt
	32.50m	10min	515	350	48998.2-49068.1= 69.9lt
	TO: 35.23mm	10min	735	350	49074.1-49134.8= 60.7lt
		10min	515	350	49144.4-49218.3= 73.9lt
		10min	295	295	49222.4-49222.5= 0lt
Single	FROM: 35.23m	10min	320	320	49256.1-49325.9= 69.8lt
	35.50m	10min	560	350	49333.5-49403.1= 69.6lt
	TO: END OF	10min	800	350	49409.1-49483.6= 74.5lt
	BOREHOLE	10min	560	350	49487.6-49577.8= 90.2lt
		10min	320	320	49581.9-49659.3= 77.4lt

REMARKS:

Fig C-34: Water Pressure Testing Report (N1)

Fig C-35: Borehole N1 Core Box 1 of 6

Fig C-36: Borehole N1 Core Box 2 of 6

Fig C-37: **Borehole N1 Core Box 3 of 6**

Fig C-38: **Borehole N1 Core Box 4 of 6**

Fig C-39: Borehole N1 Core Box 5 of 6

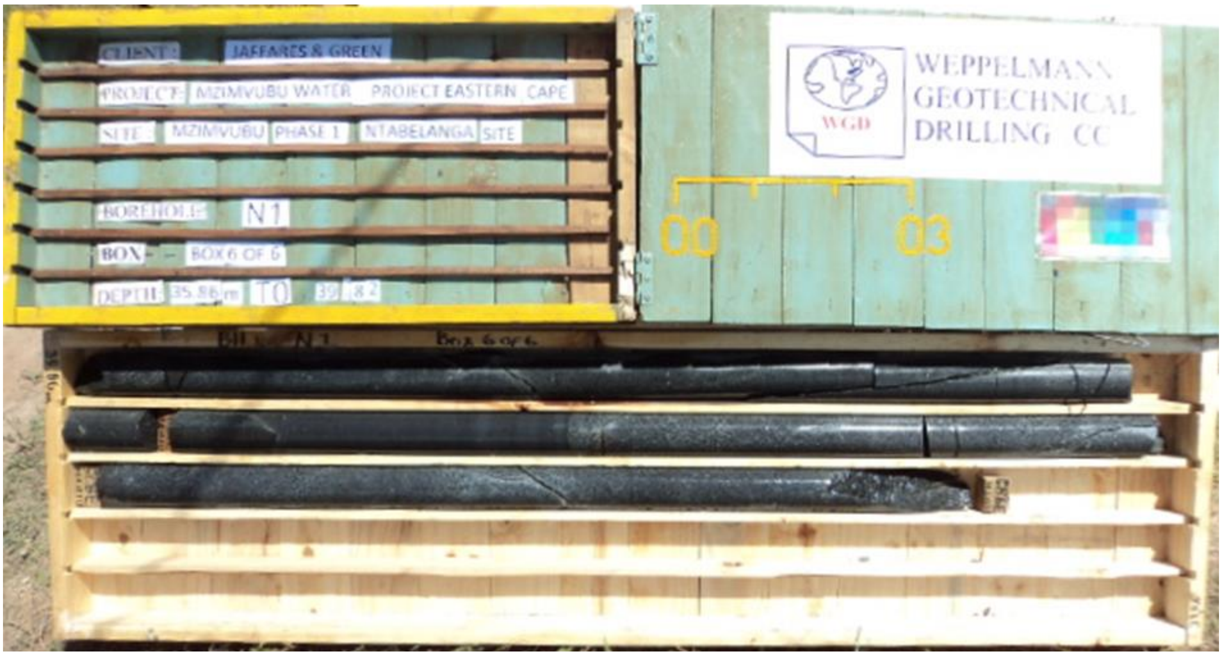
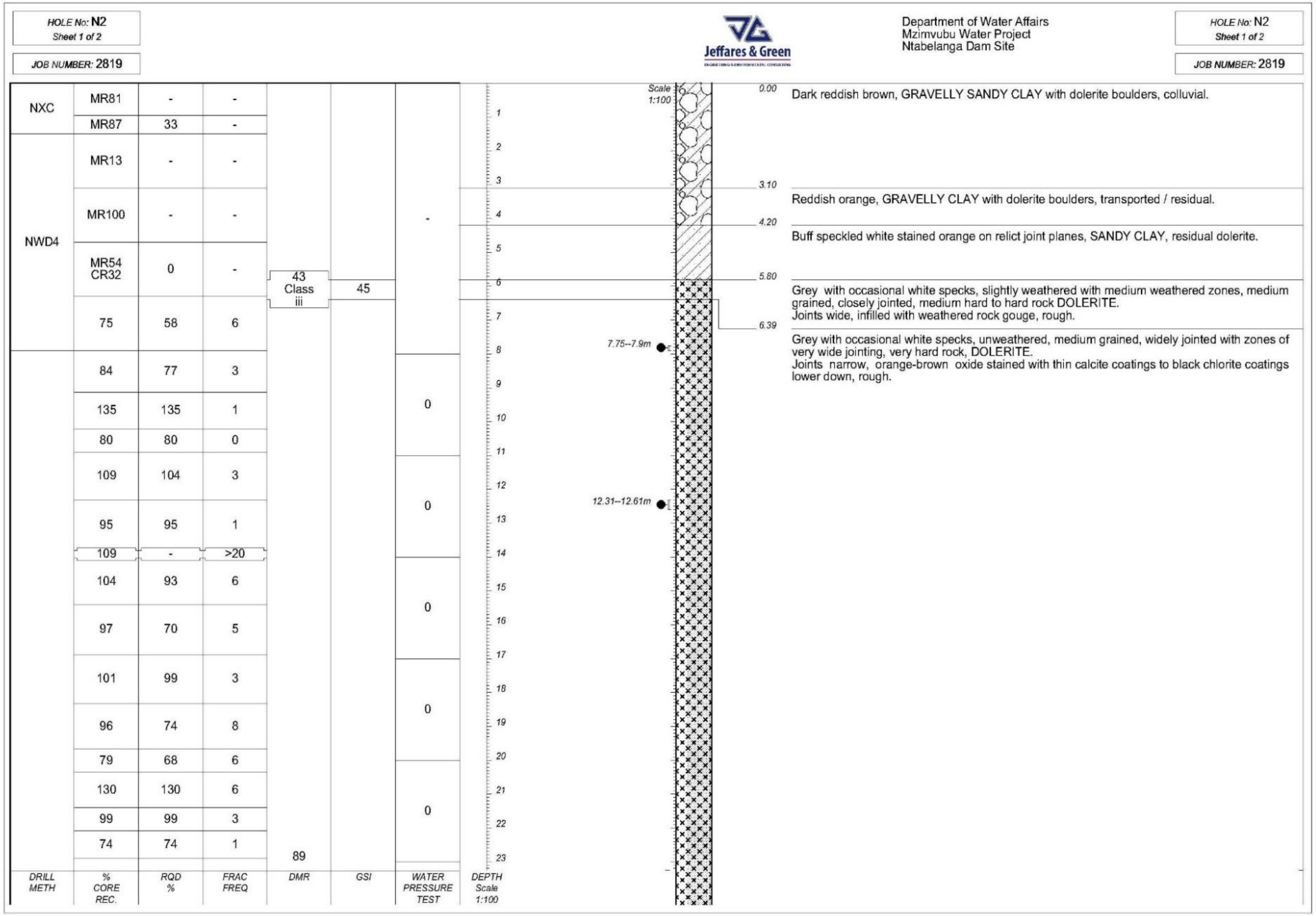


Fig C-40: Borehole N1 Core Box 6 of 6



HOLE No: N2
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

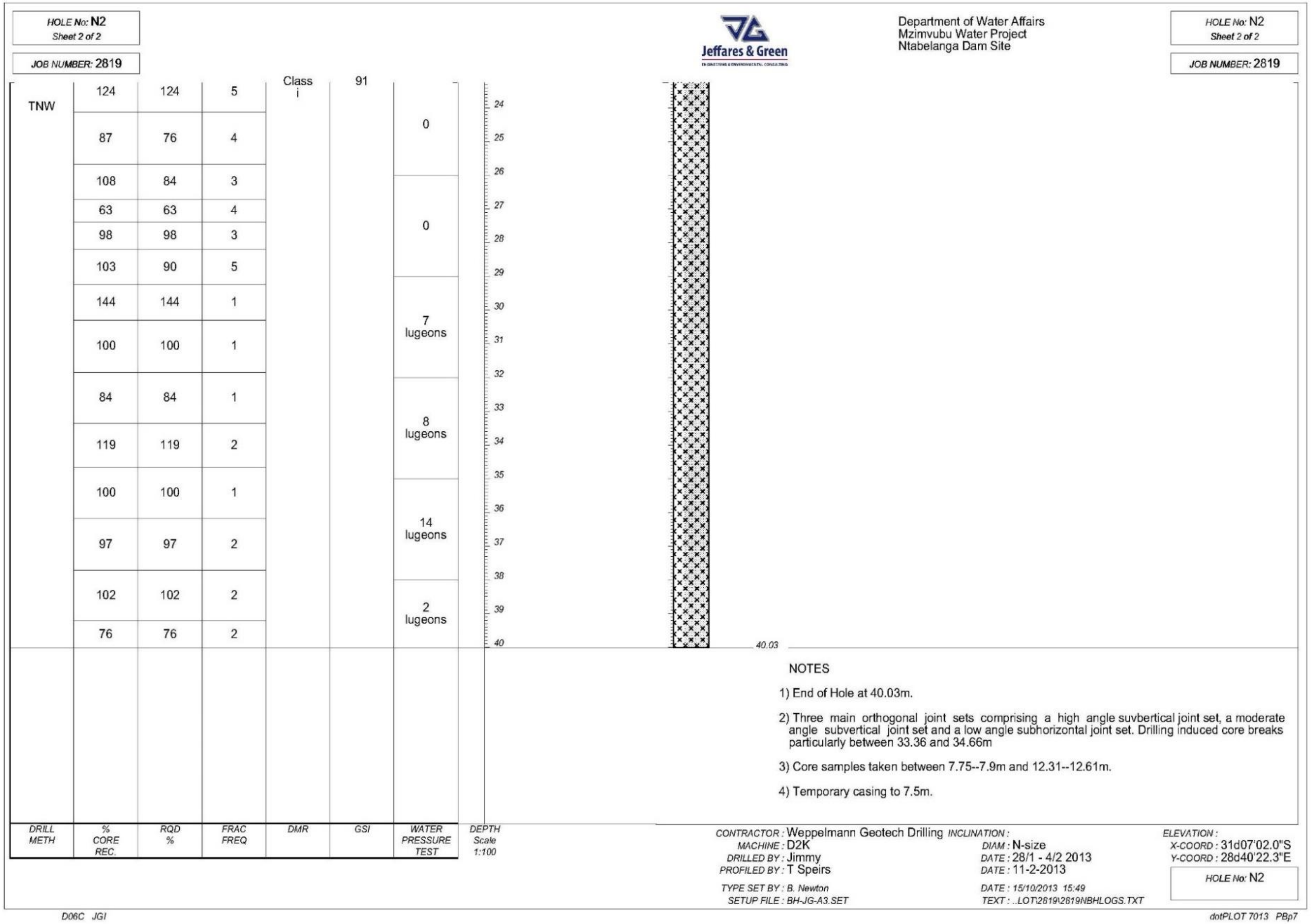
Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	MR81	-	-			
	MR87	33	-			
NWD4	MR13	-	-			
	MR100	-	-			-
	MR54 CR32	0	-	43 Class iii	45	
	75	58	6			
	84	77	3			
	135	135	1			0
	80	80	0			
	109	104	3			
	95	95	1			0
	109	-	>20			
	104	93	6			
	97	70	5			0
	101	99	3			
	96	74	8			0
	79	68	6			
	130	130	6			
	99	99	3			0
	74	74	1	89		

DEPTH Scale 1:100

0.00	Dark reddish brown, GRAVELLY SANDY CLAY with dolerite boulders, colluvial.
3.10	Reddish orange, GRAVELLY CLAY with dolerite boulders, transported / residual.
4.20	Buff speckled white stained orange on relict joint planes, SANDY CLAY, residual dolerite.
5.80	Grey with occasional white specks, slightly weathered with medium weathered zones, medium grained, closely jointed, medium hard to hard rock DOLERITE. Joints wide, infilled with weathered rock gouge, rough.
6.39	Grey with occasional white specks, unweathered, medium grained, widely jointed with zones of very wide jointing, very hard rock, DOLERITE. Joints narrow, orange-brown oxide stained with thin calcite coatings to black chlorite coatings lower down, rough.

Fig C-41.1: Borehole Logs (N2)



HOLE No: N2
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

HOLE No: N2
Sheet 2 of 2

JOB NUMBER: 2819

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
TNW	124	124	5	Class i	91	0
	87	76	4			
	108	84	3			0
	63	63	4			
	98	98	3			
	103	90	5			
	144	144	1			7 lugeons
	100	100	1			
	84	84	1			8 lugeons
	119	119	2			
	100	100	1			14 lugeons
	97	97	2			
	102	102	2			2 lugeons
	76	76	2			

NOTES

1) End of Hole at 40.03m.

2) Three main orthogonal joint sets comprising a high angle suvbertical joint set, a moderate angle subvertical joint set and a low angle subhorizontal joint set. Drilling induced core breaks particularly between 33.36 and 34.66m

3) Core samples taken between 7.75--7.9m and 12.31--12.61m.

4) Temporary casing to 7.5m.

CONTRACTOR : Weppelmann Geotech Drilling
MACHINE : D2K
DRILLED BY : Jimmy
PROFILED BY : T Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION :
DIAM : N-size
DATE : 28/1 - 4/2 2013
DATE : 11-2-2013
DATE : 15/10/2013 15:49
TEXT : ..LOT\2819\2819NBHLOGS.TXT

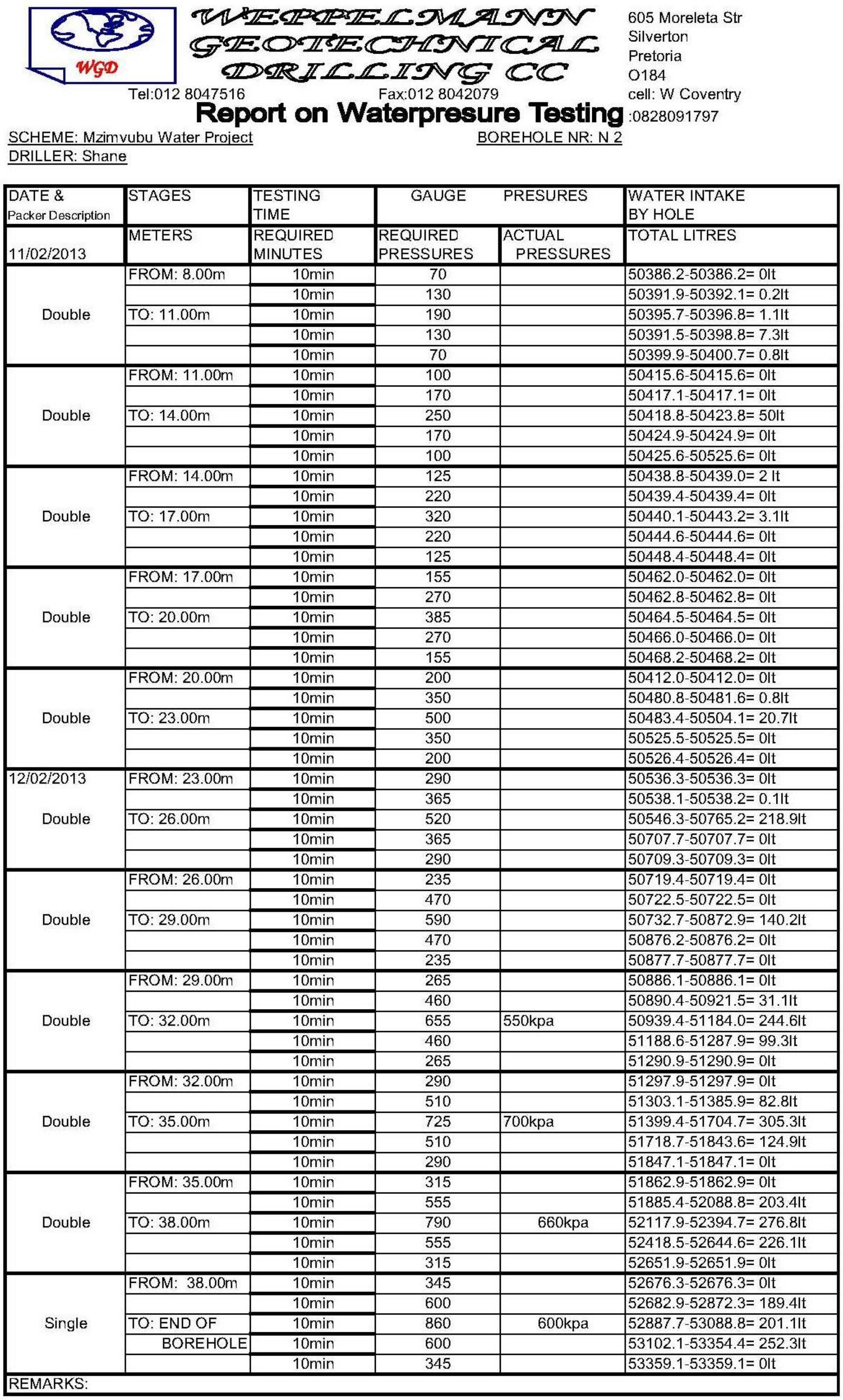
ELEVATION :
X-COORD : 31d07'02.0"S
Y-COORD : 28d40'22.3"E

HOLE No: N2

D06C JGI

dotPLOT 7013 PBp7

Fig C-41.2: Borehole Logs (N2)



WGD

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Report on Waterpresure Testing

SCHEME: Mzimvubu Water Project BOREHOLE NR: N 2
DRILLER: Shane

DATE & Packer Description	STAGES	TESTING TIME	GAUGE PRESURES		WATER INTAKE BY HOLE
11/02/2013	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
Double	FROM: 8.00m	10min	70		50386.2-50386.2= 0lt
		10min	130		50391.9-50392.1= 0.2lt
	TO: 11.00m	10min	190		50395.7-50396.8= 1.1lt
		10min	130		50391.5-50398.8= 7.3lt
		10min	70		50399.9-50400.7= 0.8lt
Double	FROM: 11.00m	10min	100		50415.6-50415.6= 0lt
		10min	170		50417.1-50417.1= 0lt
	TO: 14.00m	10min	250		50418.8-50423.8= 50lt
		10min	170		50424.9-50424.9= 0lt
		10min	100		50425.6-50525.6= 0lt
Double	FROM: 14.00m	10min	125		50438.8-50439.0= 2 lt
		10min	220		50439.4-50439.4= 0lt
	TO: 17.00m	10min	320		50440.1-50443.2= 3.1lt
		10min	220		50444.6-50444.6= 0lt
		10min	125		50448.4-50448.4= 0lt
Double	FROM: 17.00m	10min	155		50462.0-50462.0= 0lt
		10min	270		50462.8-50462.8= 0lt
	TO: 20.00m	10min	385		50464.5-50464.5= 0lt
		10min	270		50466.0-50466.0= 0lt
		10min	155		50468.2-50468.2= 0lt
Double	FROM: 20.00m	10min	200		50412.0-50412.0= 0lt
		10min	350		50480.8-50481.6= 0.8lt
	TO: 23.00m	10min	500		50483.4-50504.1= 20.7lt
		10min	350		50525.5-50525.5= 0lt
		10min	200		50526.4-50526.4= 0lt
12/02/2013 Double	FROM: 23.00m	10min	290		50536.3-50536.3= 0lt
		10min	365		50538.1-50538.2= 0.1lt
	TO: 26.00m	10min	520		50546.3-50765.2= 218.9lt
		10min	365		50707.7-50707.7= 0lt
		10min	290		50709.3-50709.3= 0lt
Double	FROM: 26.00m	10min	235		50719.4-50719.4= 0lt
		10min	470		50722.5-50722.5= 0lt
	TO: 29.00m	10min	590		50732.7-50872.9= 140.2lt
		10min	470		50876.2-50876.2= 0lt
		10min	235		50877.7-50877.7= 0lt
Double	FROM: 29.00m	10min	265		50886.1-50886.1= 0lt
		10min	460		50890.4-50921.5= 31.1lt
	TO: 32.00m	10min	655	550kpa	50939.4-51184.0= 244.6lt
		10min	460		51188.6-51287.9= 99.3lt
		10min	265		51290.9-51290.9= 0lt
Double	FROM: 32.00m	10min	290		51297.9-51297.9= 0lt
		10min	510		51303.1-51385.9= 82.8lt
	TO: 35.00m	10min	725	700kpa	51399.4-51704.7= 305.3lt
		10min	510		51718.7-51843.6= 124.9lt
		10min	290		51847.1-51847.1= 0lt
Double	FROM: 35.00m	10min	315		51862.9-51862.9= 0lt
		10min	555		51885.4-52088.8= 203.4lt
	TO: 38.00m	10min	790	660kpa	52117.9-52394.7= 276.8lt
		10min	555		52418.5-52644.6= 226.1lt
		10min	315		52651.9-52651.9= 0lt
Single	FROM: 38.00m	10min	345		52676.3-52676.3= 0lt
		10min	600		52682.9-52872.3= 189.4lt
	TO: END OF	10min	860	600kpa	52887.7-53088.8= 201.1lt
	BOREHOLE	10min	600		53102.1-53354.4= 252.3lt
		10min	345		53359.1-53359.1= 0lt
REMARKS:					

Fig C-42: Water Pressure Testing Report (N2)

Fig C-43: Borehole N2 Core Box 1 of 6

Fig C-44: Borehole N2 Core Box 2 of 6

Fig C-45: Borehole N2 Core Box 3 of 6

Fig C-46: Borehole N2 Core Box 4 of 6

Fig C-47: Borehole N2 Core Box 5 of 6

Fig C-46: Borehole N2 Core Box 6 of 6

APPENDIX D

PHASE 2 SITE PLANS

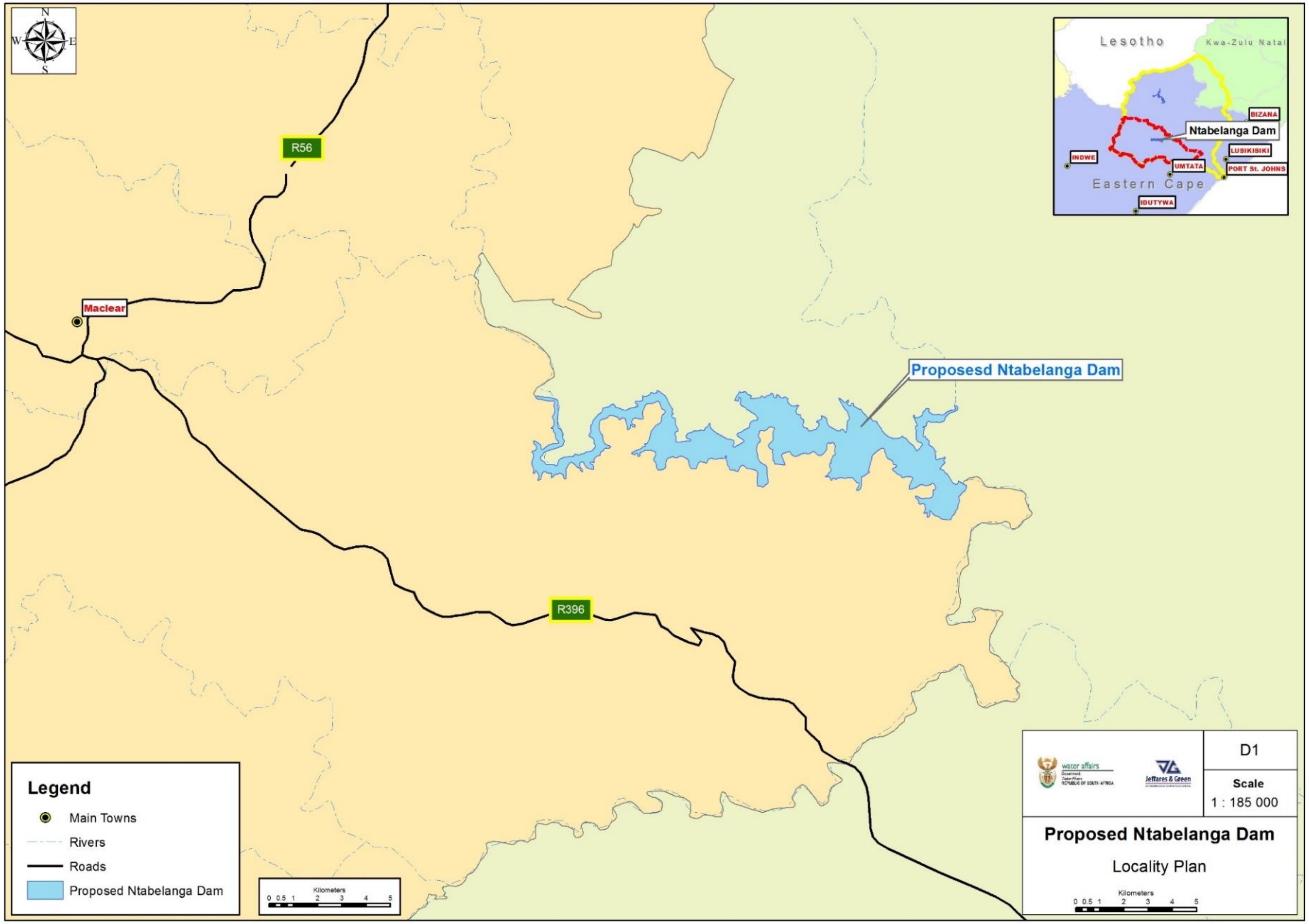


Fig D-1: Ntabelanga Locality Plan

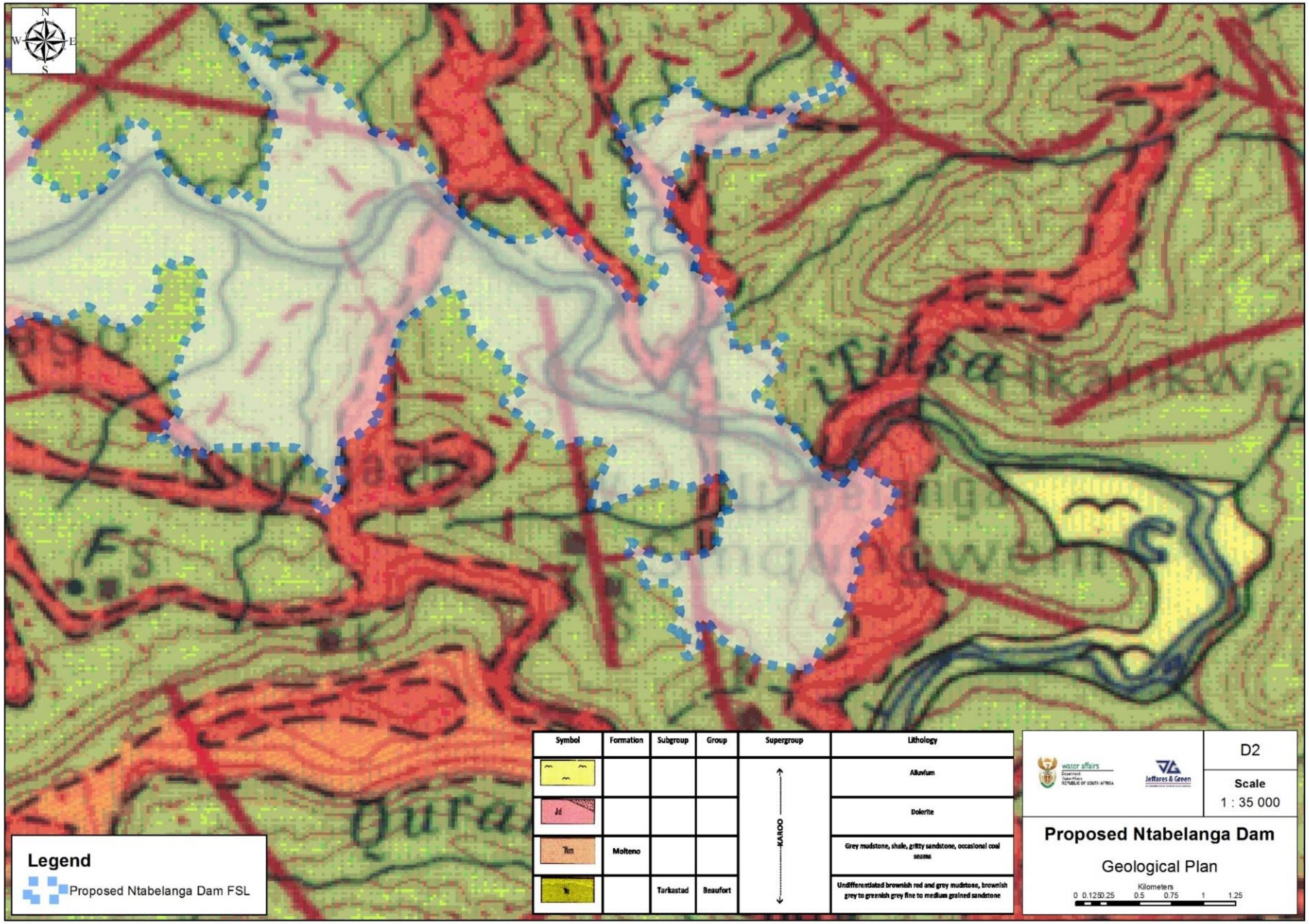
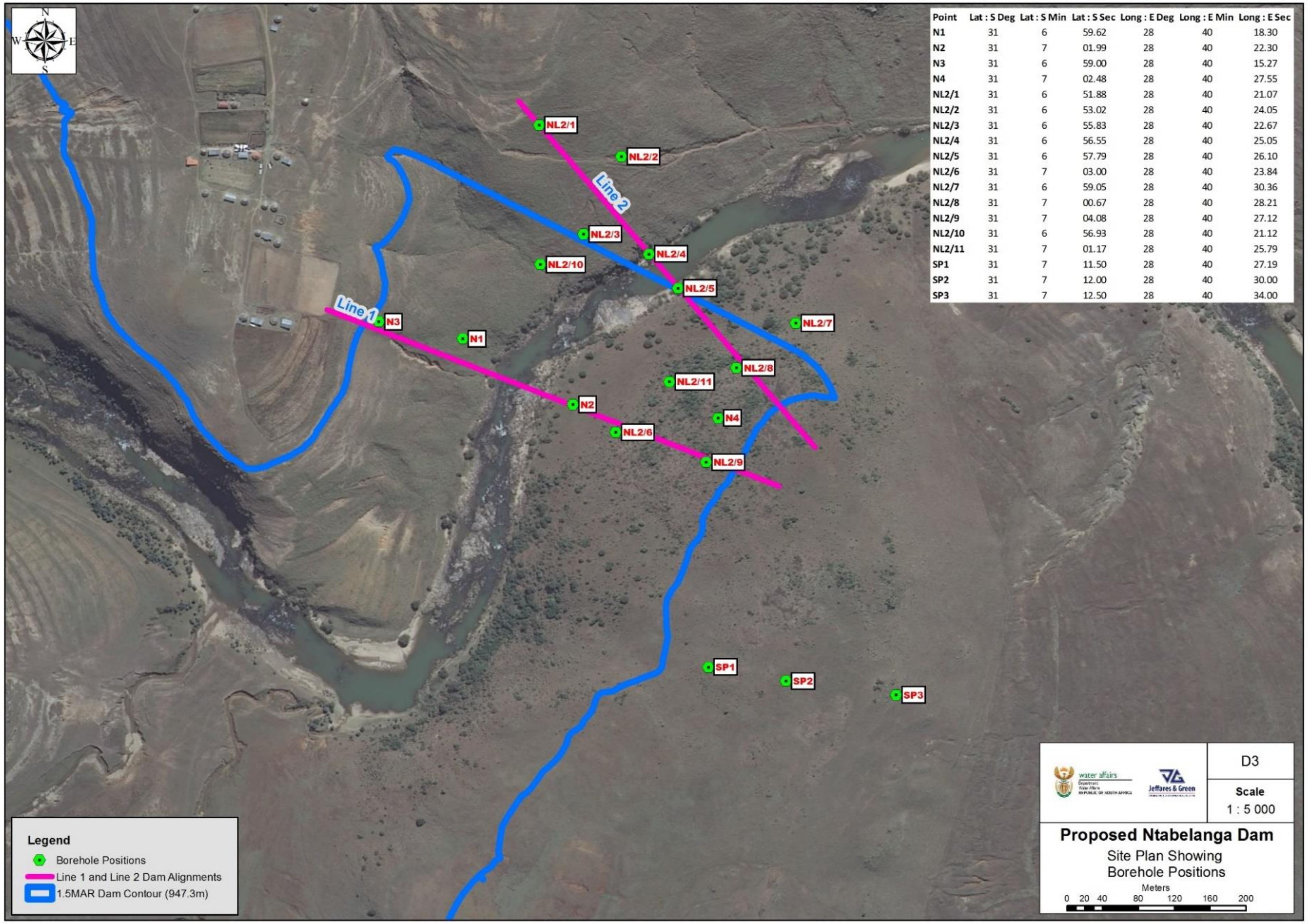
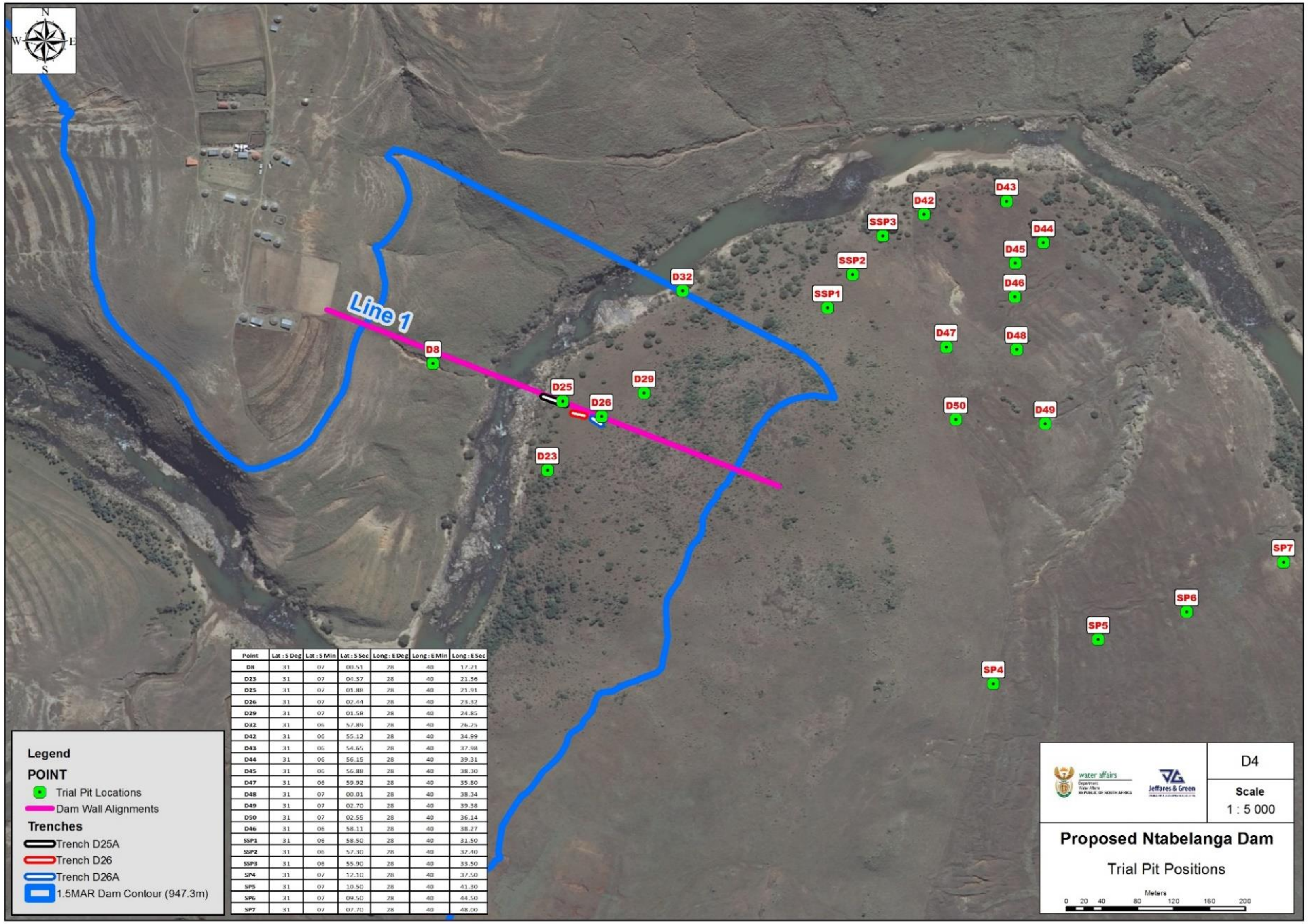


Fig D-2: **Ntabelanga Geological Plan**



Point	Lat : S Deg	Lat : S Min	Lat : S Sec	Long : E Deg	Long : E Min	Long : E Sec
N1	31	6	59.62	28	40	18.30
N2	31	7	01.99	28	40	22.30
N3	31	6	59.00	28	40	15.27
N4	31	7	02.48	28	40	27.55
NL2/1	31	6	51.88	28	40	21.07
NL2/2	31	6	53.02	28	40	24.05
NL2/3	31	6	55.83	28	40	22.67
NL2/4	31	6	56.55	28	40	25.05
NL2/5	31	6	57.79	28	40	26.10
NL2/6	31	7	03.00	28	40	23.84
NL2/7	31	6	59.05	28	40	30.36
NL2/8	31	7	00.67	28	40	28.21
NL2/9	31	7	04.08	28	40	27.12
NL2/10	31	6	56.93	28	40	21.12
NL2/11	31	7	01.17	28	40	25.79
SP1	31	7	11.50	28	40	27.19
SP2	31	7	12.00	28	40	30.00
SP3	31	7	12.50	28	40	34.00

Fig D-3: Site Plan Showing Borehole Positions



Point	Lat : S Deg	Lat : S Min	Lat : S Sec	Long : E Deg	Long : E Min	Long : E Sec
D8	31	07	00.51	28	40	17.21
D23	31	07	04.37	28	40	21.36
D25	31	07	01.88	28	40	21.91
D26	31	07	02.44	28	40	23.32
D29	31	07	01.58	28	40	24.85
D32	31	06	57.89	28	40	26.25
D42	31	06	55.12	28	40	34.99
D43	31	06	54.65	28	40	37.98
D44	31	06	56.15	28	40	39.31
D45	31	06	56.88	28	40	38.30
D47	31	06	59.92	28	40	35.80
D48	31	07	00.01	28	40	38.34
D49	31	07	02.70	28	40	39.38
D50	31	07	02.55	28	40	36.14
D46	31	06	58.11	28	40	38.27
SSP1	31	06	58.50	28	40	31.50
SSP2	31	06	57.30	28	40	32.40
SSP3	31	06	55.90	28	40	33.50
SP4	31	07	12.10	28	40	37.50
SP5	31	07	10.50	28	40	41.30
SP6	31	07	09.50	28	40	44.50
SP7	31	07	07.70	28	40	48.00

Fig D-4: **Site Plan Showing Trial Pit Positions**

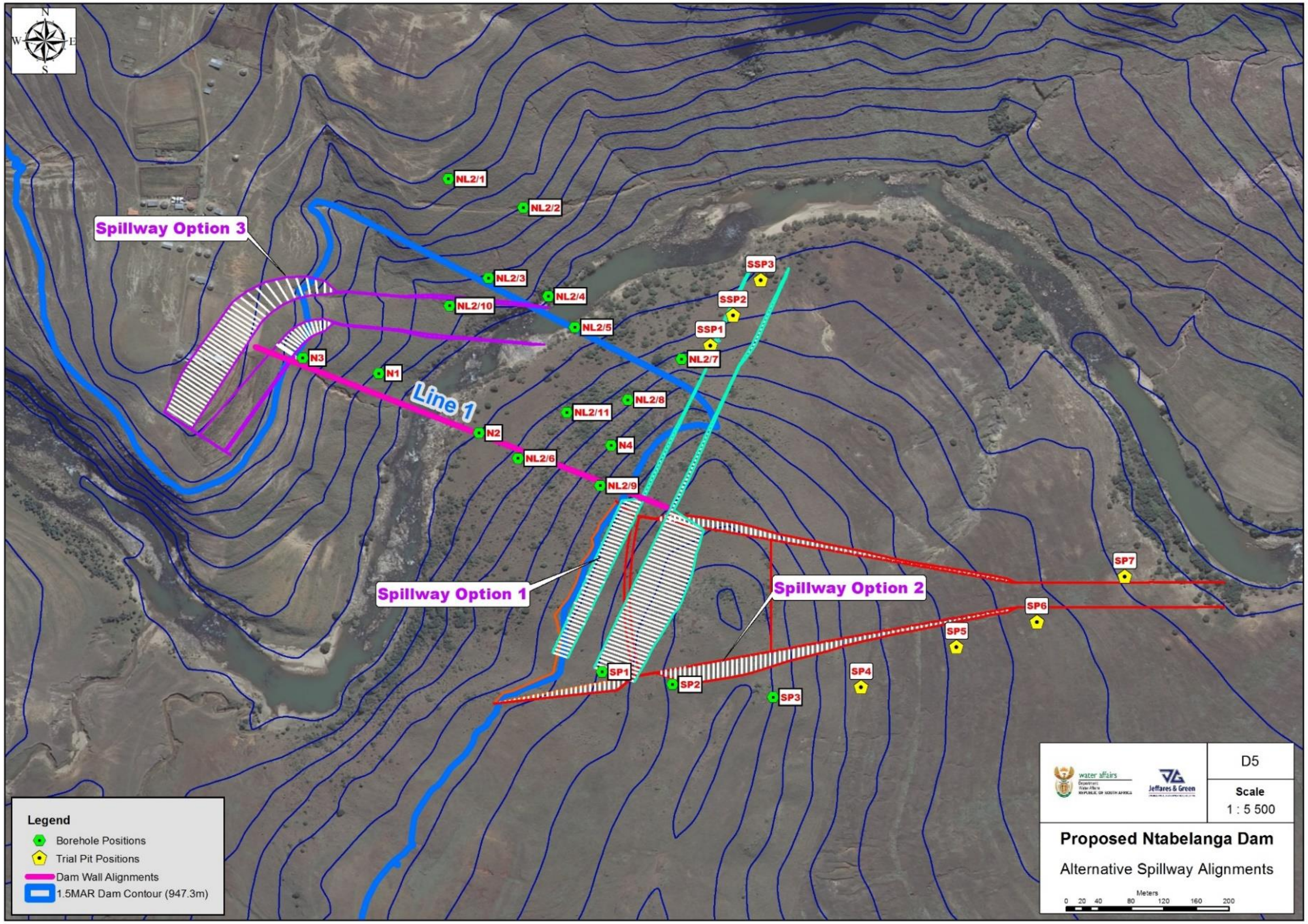


Fig D-5: **Site Plan Showing Alternative Spillway Alignments**

Fig D-6: **Plan of Saddle Dam Showing Trial Pit Positions**

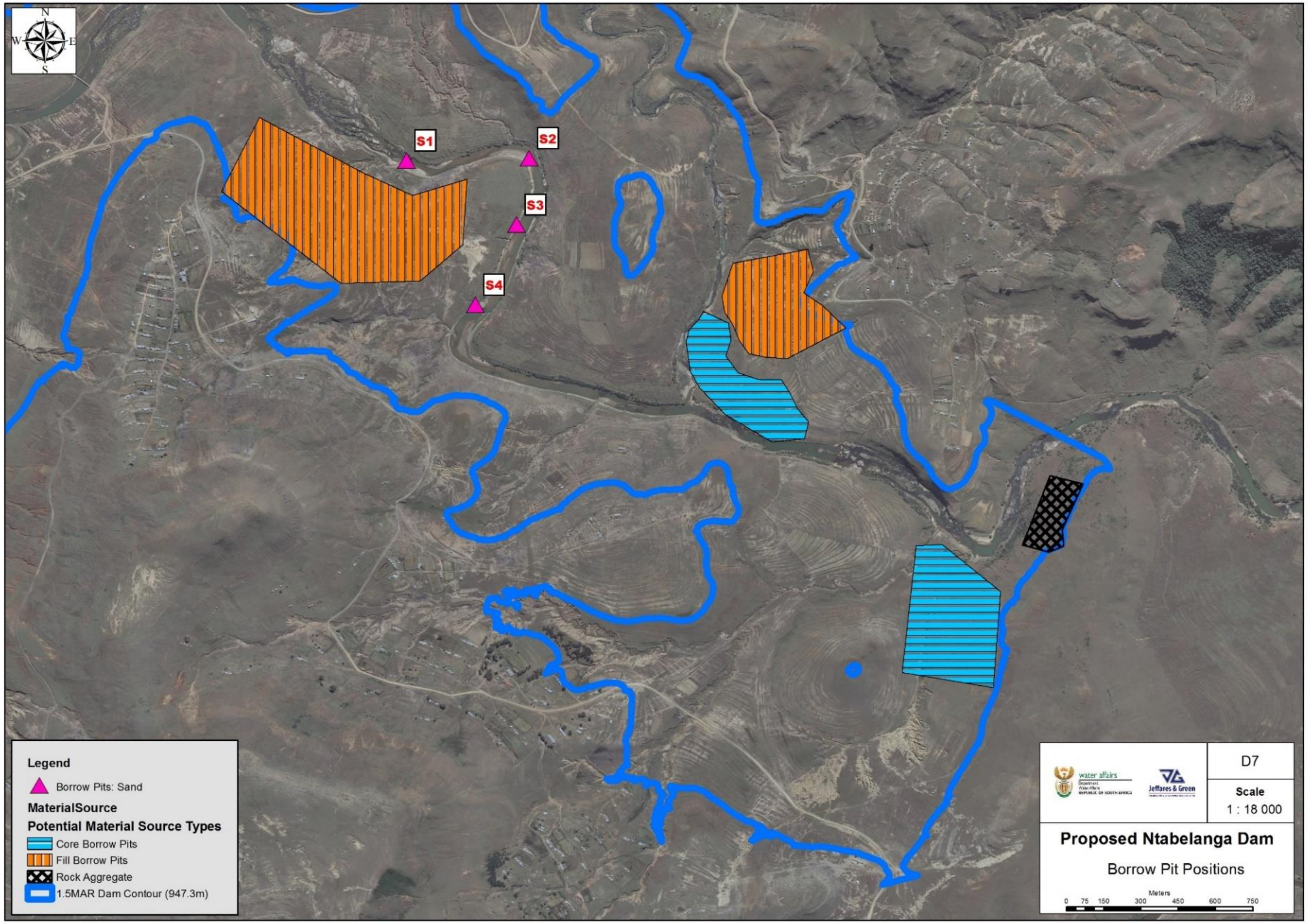


Fig D-7: **Plan Showing Borrow Pit Locations**

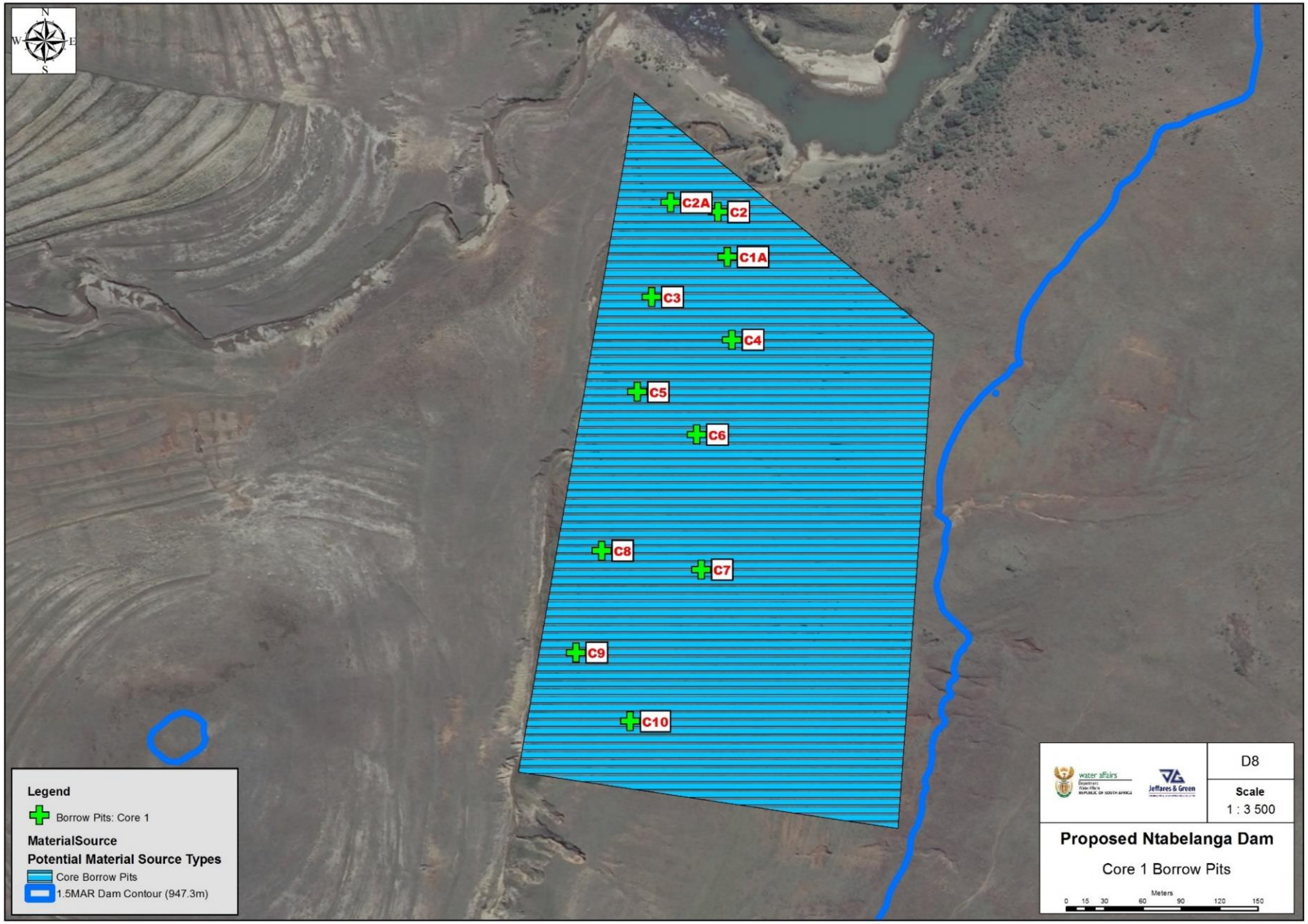


Fig D-8: **Core Borrow Pit 1 Site Plan**

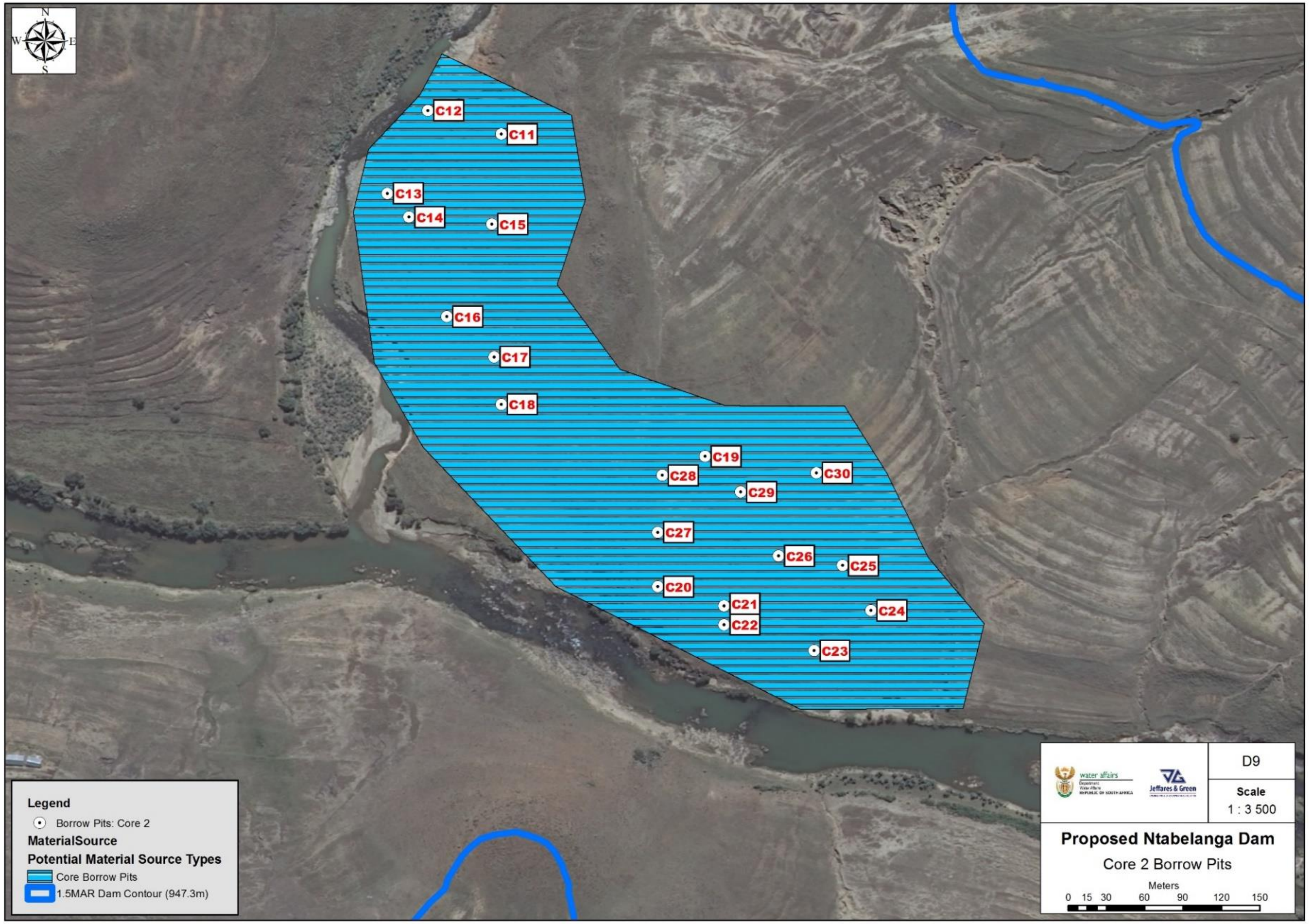


Fig D-9: **Core Borrow Pit 2 Site Plan**

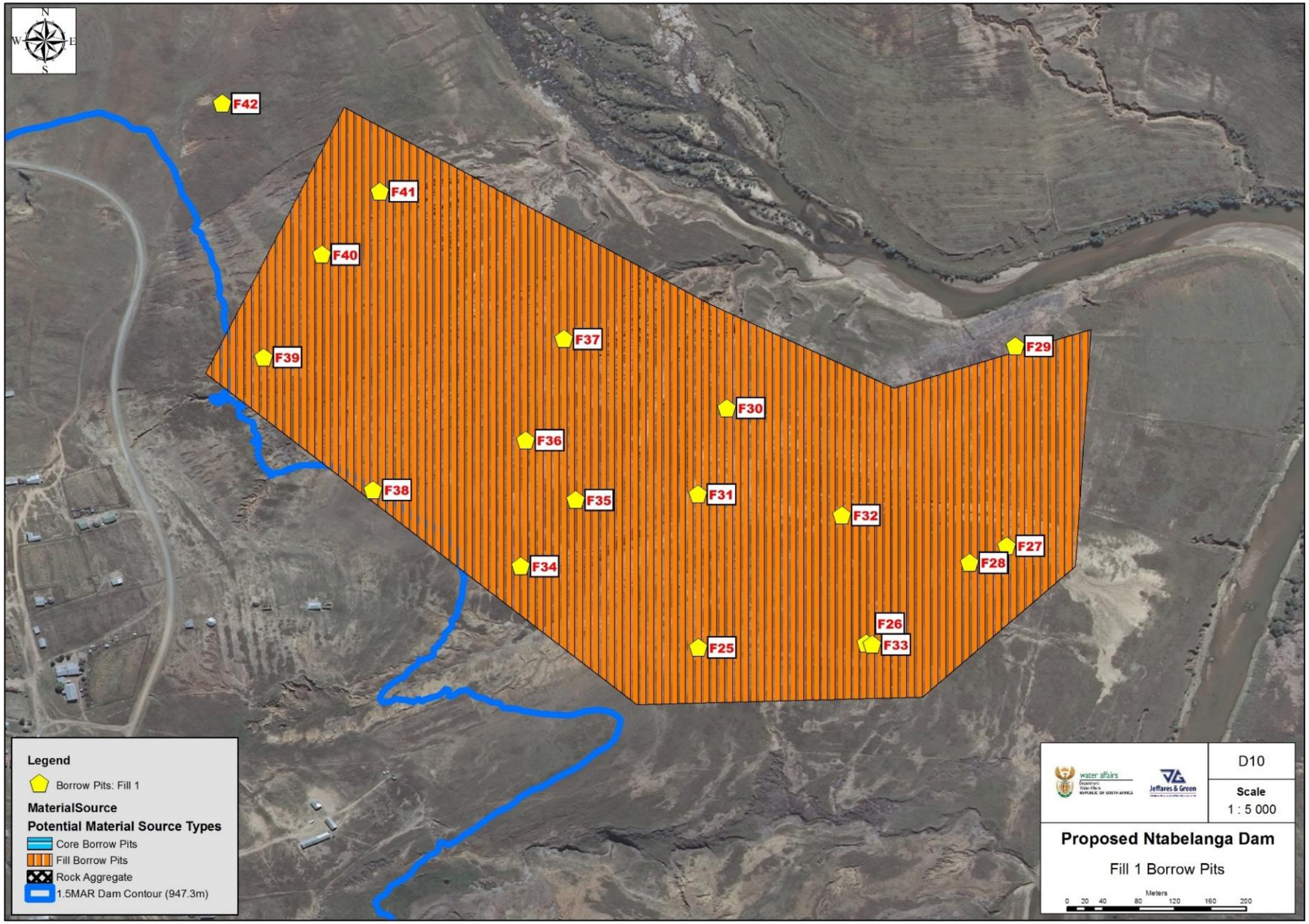


Fig D-10: **Fill Borrow Pit 1 Site Plan**

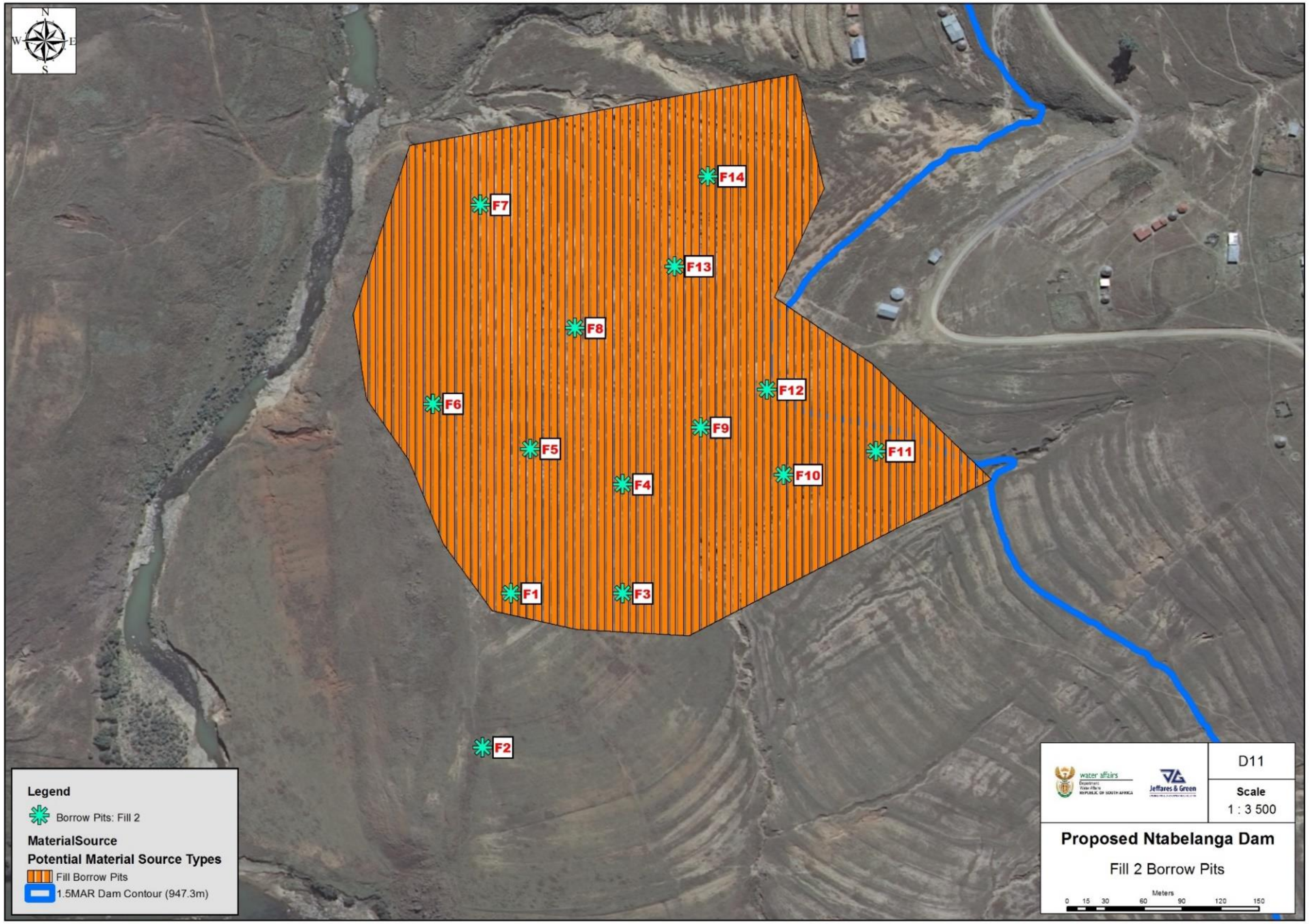
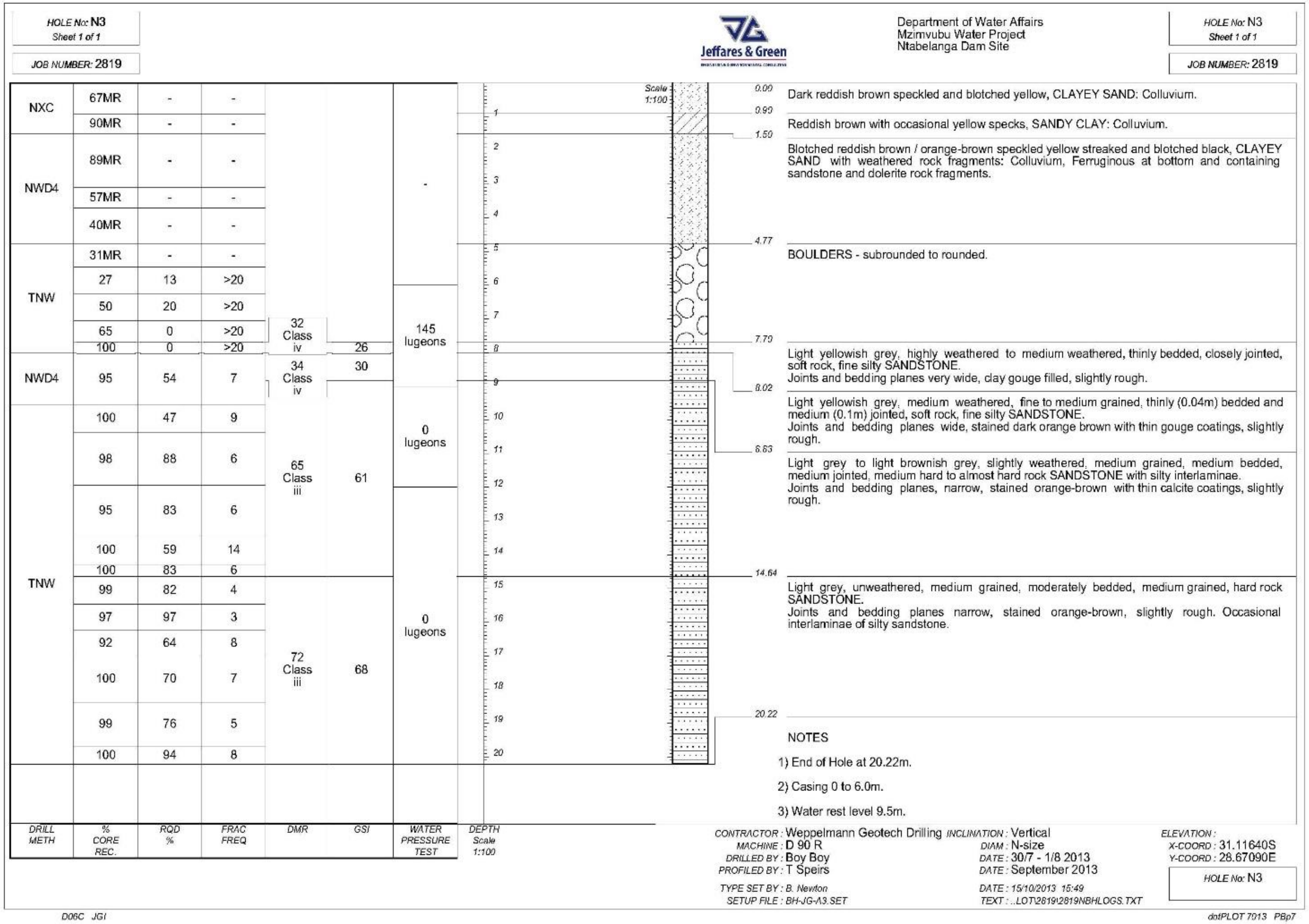


Fig D-11: **Fill Borrow Pit 2 Site Plan**

APPENDIX E

PHASE 2 BOREHOLE LOGS



HOLE No: N3
Sheet 1 of 1
JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	67MR	-	-			-
	90MR	-	-			
NWD4	89MR	-	-			
	57MR	-	-			
	40MR	-	-			
TNW	31MR	-	-			
	27	13	>20			145 lugeons
	50	20	>20			
	65	0	>20	32 Class iv		
	100	0	>20		26	
NWD4	95	54	7	34 Class iv	30	
TNW	100	47	9	65 Class iii	61	0 lugeons
	98	88	6			
	95	83	6			0 lugeons
	100	59	14			
	100	83	6			
	99	82	4	72 Class iii	68	
	97	97	3			
	92	64	8			
	100	70	7			
	99	76	5			
	100	94	8			

DEPTH Scale 1:100

0.00	Dark reddish brown speckled and blotched yellow, CLAYEY SAND: Colluvium.
0.90	Reddish brown with occasional yellow specks, SANDY CLAY: Colluvium.
1.50	Blotched reddish brown / orange-brown speckled yellow streaked and blotched black, CLAYEY SAND with weathered rock fragments: Colluvium, Ferruginous at bottom and containing sandstone and dolerite rock fragments.
4.77	BOULDERS - subrounded to rounded.
7.70	Light yellowish grey, highly weathered to medium weathered, thinly bedded, closely jointed, soft rock, fine silty SANDSTONE. Joints and bedding planes very wide, clay gouge filled, slightly rough.
8.02	Light yellowish grey, medium weathered, fine to medium grained, thinly (0.04m) bedded and medium (0.1m) jointed, soft rock, fine silty SANDSTONE. Joints and bedding planes wide, stained dark orange brown with thin gouge coatings, slightly rough.
8.63	Light grey to light brownish grey, slightly weathered, medium grained, medium bedded, medium jointed, medium hard to almost hard rock SANDSTONE with silty interlaminae. Joints and bedding planes, narrow, stained orange-brown with thin calcite coatings, slightly rough.
14.64	Light grey, unweathered, medium grained, moderately bedded, medium grained, hard rock SANDSTONE. Joints and bedding planes narrow, stained orange-brown, slightly rough. Occasional interlaminae of silty sandstone.
20.22	

NOTES

1) End of Hole at 20.22m.

2) Casing 0 to 6.0m.

3) Water rest level 9.5m.

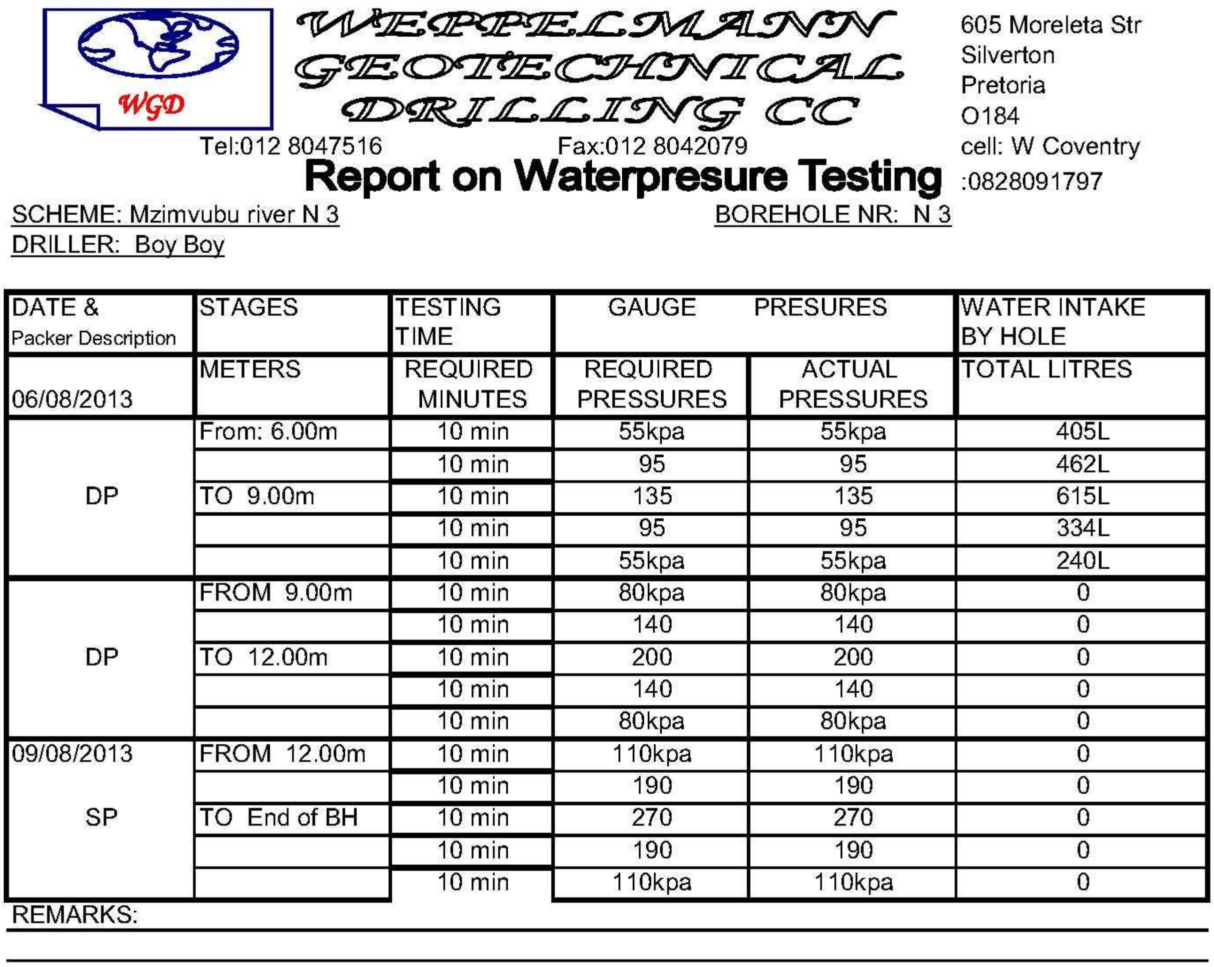
CONTRACTOR :	Weppelmann Geotech Drilling	INCLINATION :	Vertical	ELEVATION :	
MACHINE :	D 90 R	DIAM :	N-size	X-COORD :	31.11640S
DRILLED BY :	Boy Boy	DATE :	30/7 - 1/8 2013	Y-COORD :	28.67090E
PROFILED BY :	T Speirs	DATE :	September 2013		
TYPE SET BY :	B. Newton	DATE :	15/10/2013 15:49		
SETUP FILE :	BH-JG-A3.SET	TEXT :	..LOT\2819\2819NBHLOGS.TXT		

HOLE No: N3

D06C JGI

dotPLOT 7013 PBp7

Fig E-1: Borehole Logs (N3)



WEPPELMANN GEOTECHNICAL DRILLING CC

605 Moreleta Str
Silverton
Pretoria
O184
cell: W Coventry
:0828091797

Tel:012 8047516 Fax:012 8042079

Report on Waterpresure Testing

SCHEME: Mzimvubu river N 3
BOREHOLE NR: N 3
DRILLER: Boy Boy

DATE & Packer Description	STAGES	TESTING TIME	GAUGE PRESURES		WATER INTAKE BY HOLE
06/08/2013	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
DP	From: 6.00m	10 min	55kpa	55kpa	405L
		10 min	95	95	462L
	TO 9.00m	10 min	135	135	615L
		10 min	95	95	334L
		10 min	55kpa	55kpa	240L
DP	FROM 9.00m	10 min	80kpa	80kpa	0
		10 min	140	140	0
	TO 12.00m	10 min	200	200	0
		10 min	140	140	0
		10 min	80kpa	80kpa	0
09/08/2013 SP	FROM 12.00m	10 min	110kpa	110kpa	0
		10 min	190	190	0
	TO End of BH	10 min	270	270	0
		10 min	190	190	0
		10 min	110kpa	110kpa	0

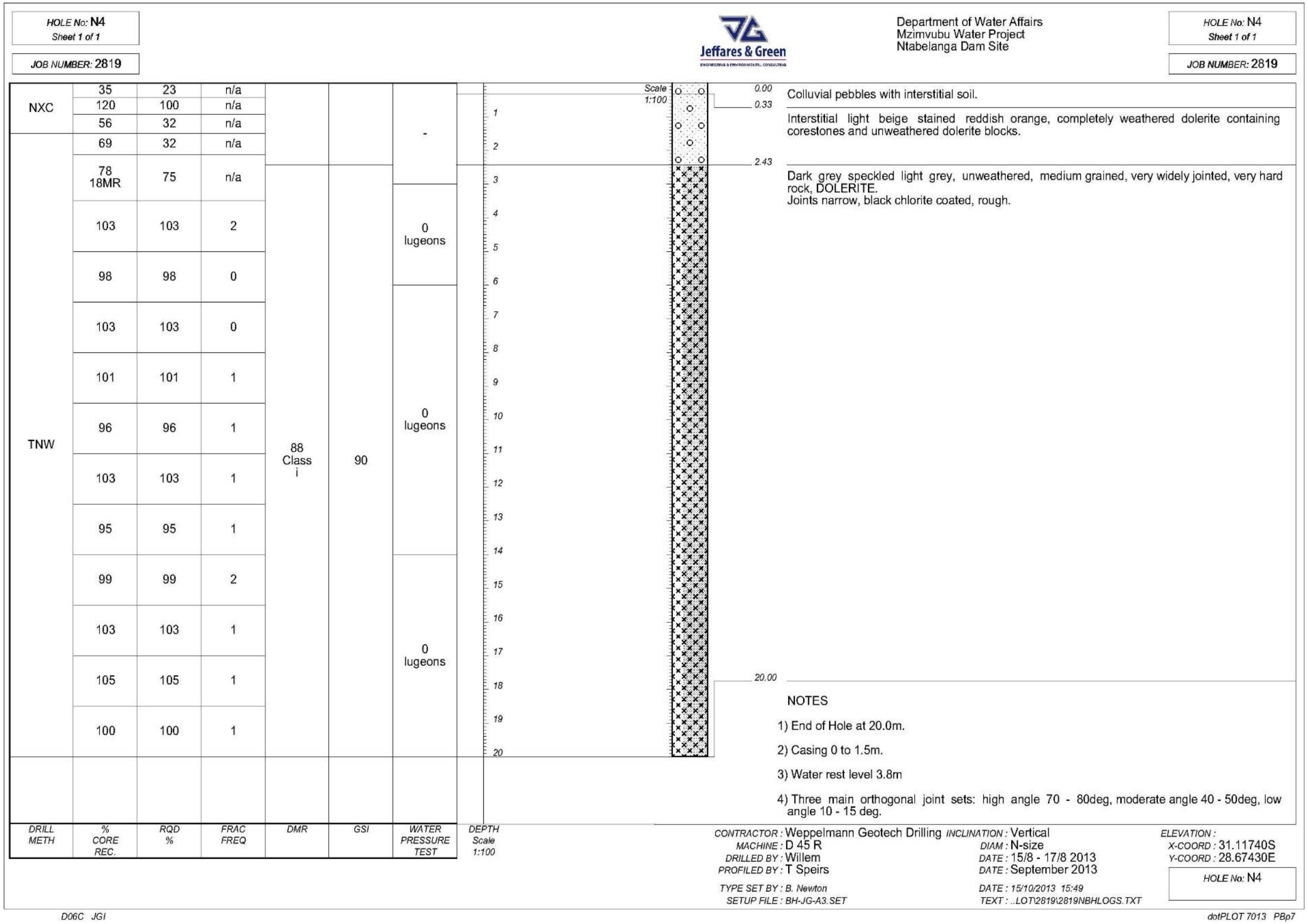
REMARKS:

Fig E-2: Water Pressure Testing Report (N3)

Fig E-3: Borehole N3 Core Box 1 of 3

Fig E-4: Borehole N3 Core Box 2 of 3

Fig E-5: Borehole N3 Core Box 3 of 3



HOLE No: N4
Sheet 1 of 1

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	35	23	n/a			-
	120	100	n/a			
	56	32	n/a			
TNW	69	32	n/a			
	78 18MR	75	n/a	88 Class i	90	0 lugeons
	103	103	2			
	98	98	0			0 lugeons
	103	103	0			
	101	101	1			
	96	96	1			
	103	103	1			
	95	95	1			
	99	99	2			0 lugeons
	103	103	1			
	105	105	1			
	100	100	1			

DEPTH Scale 1:100

Scale 1:100

0.00 Colluvial pebbles with interstitial soil.

0.33 Interstitial light beige stained reddish orange, completely weathered dolerite containing corestones and unweathered dolerite blocks.

2.43 Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE.
Joints narrow, black chlorite coated, rough.

20.00

NOTES

1) End of Hole at 20.0m.

2) Casing 0 to 1.5m.

3) Water rest level 3.8m

4) Three main orthogonal joint sets: high angle 70 - 80deg, moderate angle 40 - 50deg, low angle 10 - 15 deg.

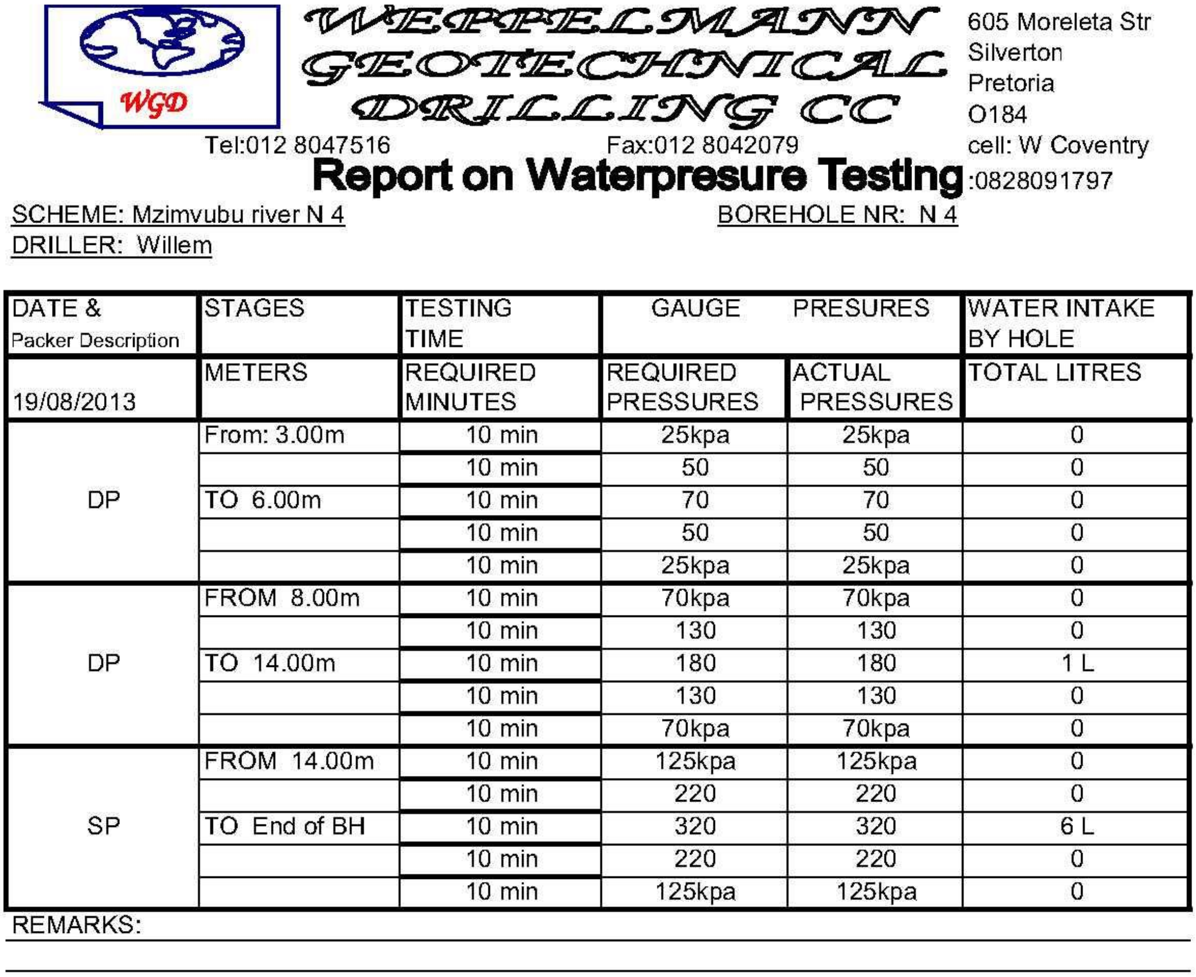
CONTRACTOR :	Weppelmann Geotech Drilling	INCLINATION :	Vertical	ELEVATION :	
MACHINE :	D 45 R	DIAM :	N-size	X-COORD :	31.11740S
DRILLED BY :	Willem	DATE :	15/8 - 17/8 2013	Y-COORD :	28.67430E
PROFILED BY :	T Speirs	DATE :	September 2013		
TYPE SET BY :	B. Newton	DATE :	15/10/2013 15:49		
SETUP FILE :	BH-JG-A3.SET	TEXT :	..LOT\2819\2819NBHLOGS.TXT		

HOLE No: N4

D06C JGI

dotPLOT 7013 PBp7

Fig E-6: **Borehole Logs (N4)**



WGD

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Report on Waterpresure Testing

SCHEME: Mzimvubu river N 4 BOREHOLE NR: N 4
DRILLER: Willem

DATE & Packer Description	STAGES	TESTING TIME	GAUGE PRESURES		WATER INTAKE BY HOLE
19/08/2013	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
DP	From: 3.00m	10 min	25kpa	25kpa	0
		10 min	50	50	0
	TO 6.00m	10 min	70	70	0
		10 min	50	50	0
		10 min	25kpa	25kpa	0
DP	FROM 8.00m	10 min	70kpa	70kpa	0
		10 min	130	130	0
	TO 14.00m	10 min	180	180	1 L
		10 min	130	130	0
		10 min	70kpa	70kpa	0
SP	FROM 14.00m	10 min	125kpa	125kpa	0
		10 min	220	220	0
	TO End of BH	10 min	320	320	6 L
		10 min	220	220	0
		10 min	125kpa	125kpa	0

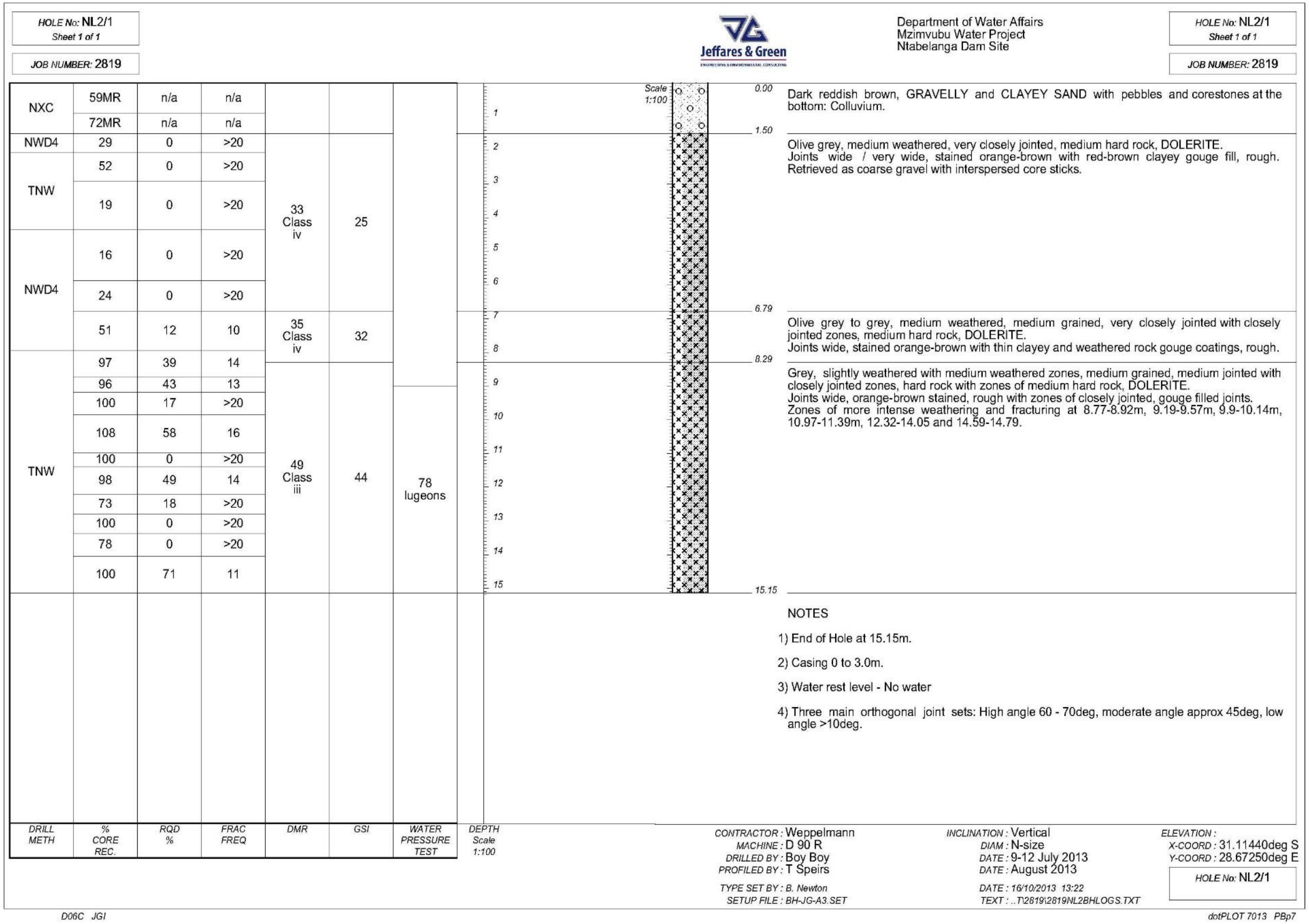
REMARKS:

Fig E-7: Water Pressure Testing Report (N4)

Fig E-8: **Borehole N4 Core Box 1 of 3**

Fig E-9: **Borehole N4 Core Box 2 of 3**

Fig E-10: Borehole N4 Core Box 3 of 3



HOLE No: NL2/1
Sheet 1 of 1

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	59MR	n/a	n/a			
	72MR	n/a	n/a			
NWD4	29	0	>20	33 Class iv	25	
TNW	52	0	>20			
	19	0	>20			
NWD4	16	0	>20			
	24	0	>20			
	51	12	10	35 Class iv	32	
TNW	97	39	14	49 Class iii	44	
	96	43	13			
	100	17	>20			78 lugeons
	108	58	16			
	100	0	>20			
	98	49	14			
	73	18	>20			
	100	0	>20			
	78	0	>20			
	100	71	11			

DEPTH Scale 1:100

0.00 Dark reddish brown, GRAVELLY and CLAYEY SAND with pebbles and corestones at the bottom: Colluvium.

1.50 Olive grey, medium weathered, very closely jointed, medium hard rock, DOLERITE.
Joints wide / very wide, stained orange-brown with red-brown clayey gouge fill, rough. Retrieved as coarse gravel with interspersed core sticks.

6.79 Olive grey to grey, medium weathered, medium grained, very closely jointed with closely jointed zones, medium hard rock, DOLERITE.
Joints wide, stained orange-brown with thin clayey and weathered rock gouge coatings, rough.

8.29 Grey, slightly weathered with medium weathered zones, medium grained, medium jointed with closely jointed zones, hard rock with zones of medium hard rock, DOLERITE.
Joints wide, orange-brown stained, rough with zones of closely jointed, gouge filled joints.
Zones of more intense weathering and fracturing at 8.77-8.92m, 9.19-9.57m, 9.9-10.14m, 10.97-11.39m, 12.32-14.05 and 14.59-14.79.

15.15

NOTES

1) End of Hole at 15.15m.

2) Casing 0 to 3.0m.

3) Water rest level - No water

4) Three main orthogonal joint sets: High angle 60 - 70deg, moderate angle approx 45deg, low angle >10deg.

CONTRACTOR : Weppelmann
MACHINE : D 90 R
DRILLED BY : Boy Boy
PROFILED BY : T Speirs

TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 9-12 July 2013
DATE : August 2013

DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

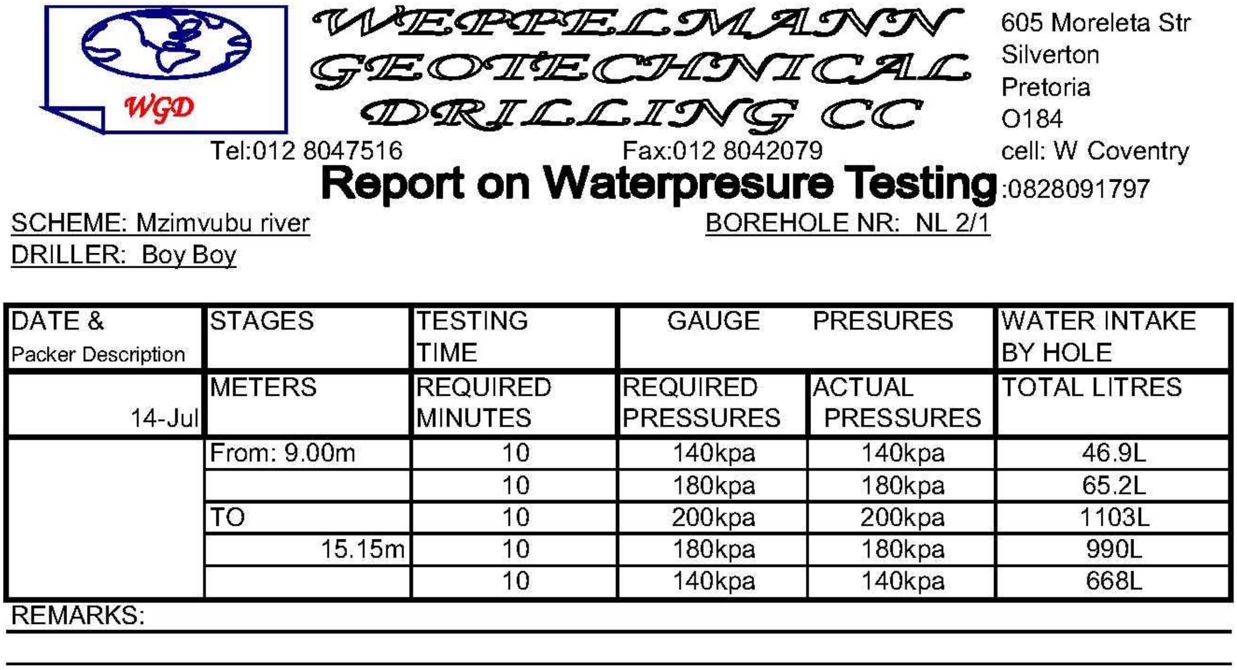
ELEVATION :
X-COORD : 31.11440deg S
Y-COORD : 28.67250deg E

HOLE No: NL2/1

D06C JGI

dotPLOT 7013 PBp7

Fig E-11: Borehole Logs (NL2/1)



WGD

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Report on Waterpresure Testing

SCHEME: Mzimvubu river
BOREHOLE NR: NL 2/1
DRILLER: Boy Boy

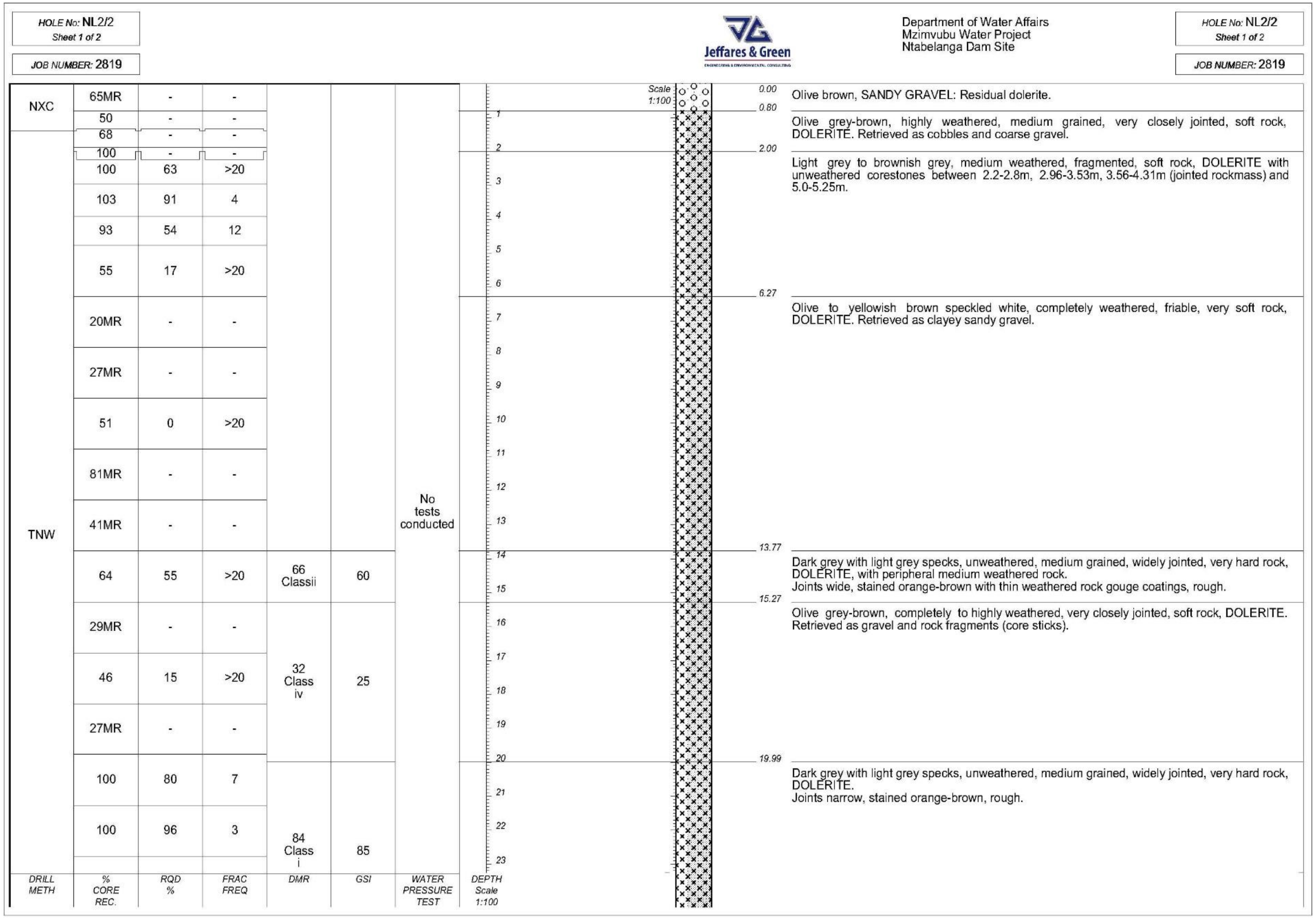
DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
14-Jul	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
	From: 9.00m	10	140kpa	140kpa	46.9L
		10	180kpa	180kpa	65.2L
	TO	10	200kpa	200kpa	1103L
	15.15m	10	180kpa	180kpa	990L
		10	140kpa	140kpa	668L

REMARKS:

Fig E-12: Water Pressure Testing Report (NL 2/1)

Fig E-13: **Borehole NL 2/1 Core Box 1 of 2**

Fig E-14: **Borehole NL 2/1 Core Box 2 of 2**



HOLE No: NL2/2
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

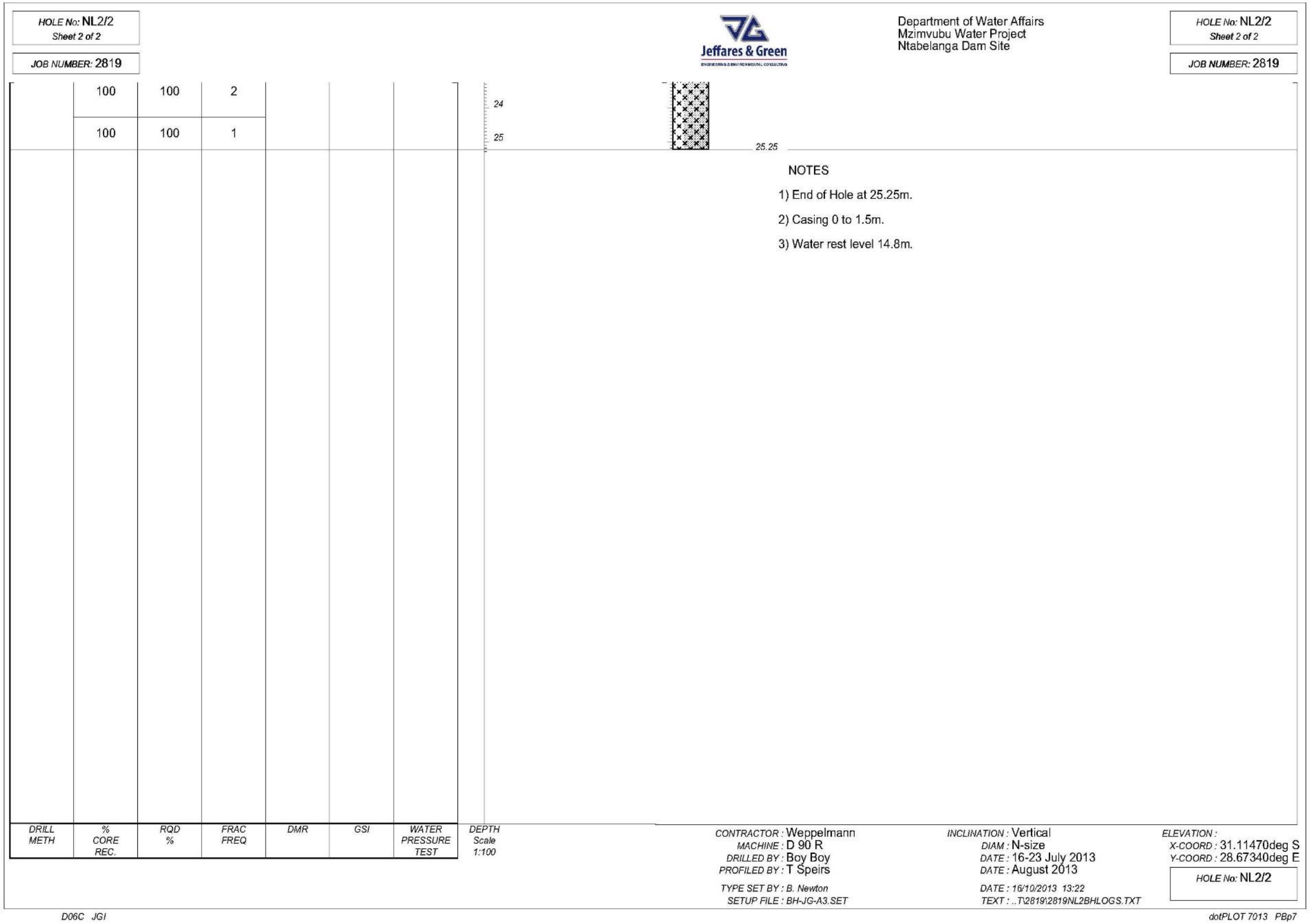
DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	65MR	-	-			No tests conducted
	50	-	-			
TNW	68	-	-			
	100	-	-			
	100	63	>20			
	103	91	4			
	93	54	12			
	55	17	>20			
	20MR	-	-			
	27MR	-	-			
	51	0	>20			
	81MR	-	-			
	41MR	-	-			
	64	55	>20	66 Classii	60	
	29MR	-	-	32 Class iv	25	
	46	15	>20			
	27MR	-	-			
	100	80	7	84 Class i	85	
	100	96	3			

DEPTH Scale 1:100

Scale 1:100

0.00	Olive brown, SANDY GRAVEL: Residual dolerite.
0.80	Olive grey-brown, highly weathered, medium grained, very closely jointed, soft rock, DOLERITE. Retrieved as cobbles and coarse gravel.
2.00	Light grey to brownish grey, medium weathered, fragmented, soft rock, DOLERITE with unweathered corestones between 2.2-2.8m, 2.96-3.53m, 3.56-4.31m (jointed rockmass) and 5.0-5.25m.
6.27	Olive to yellowish brown speckled white, completely weathered, friable, very soft rock, DOLERITE. Retrieved as clayey sandy gravel.
13.77	Dark grey with light grey specks, unweathered, medium grained, widely jointed, very hard rock, DOLERITE, with peripheral medium weathered rock. Joints wide, stained orange-brown with thin weathered rock gouge coatings, rough.
15.27	Olive grey-brown, completely to highly weathered, very closely jointed, soft rock, DOLERITE. Retrieved as gravel and rock fragments (core sticks).
19.99	Dark grey with light grey specks, unweathered, medium grained, widely jointed, very hard rock, DOLERITE. Joints narrow, stained orange-brown, rough.

Fig E-15-1: Borehole Logs (NL 2/2)



HOLE No: NL2/2
Sheet 2 of 2

JOB NUMBER: 2819

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST	DEPTH Scale 1:100
	100	100	2				24
	100	100	1				25

25.25

NOTES

1) End of Hole at 25.25m.

2) Casing 0 to 1.5m.

3) Water rest level 14.8m.

CONTRACTOR : Weppelmann
MACHINE : D 90 R
DRILLED BY : Boy Boy
PROFILED BY : T Speirs

TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 16-23 July 2013
DATE : August 2013

DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

ELEVATION :
X-COORD : 31.11470deg S
Y-COORD : 28.67340deg E

HOLE No: NL2/2

D06C JGI

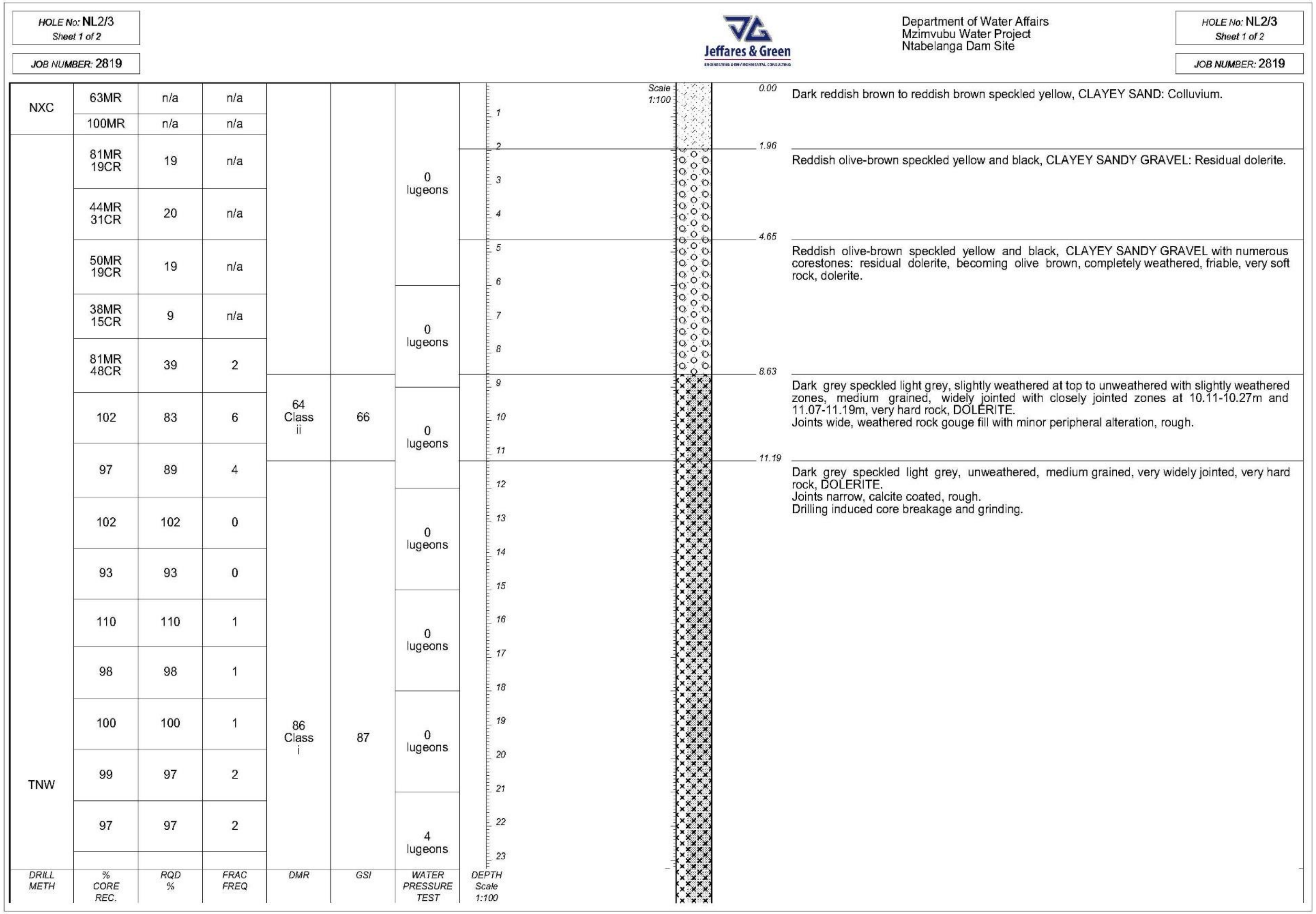
dotPLOT 7013 PBp7

Fig E-15-2: Borehole Logs (NL 2/2)

Fig E-16: Borehole NL 2/2 Core Box 1 of 3

Fig E-17: Borehole NL 2/2 Core Box 2 of 3

Fig E-18: **Borehole NL 2/2 Core Box 3 of 3**



HOLE No: NL2/3
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

HOLE No: NL2/3
Sheet 1 of 2

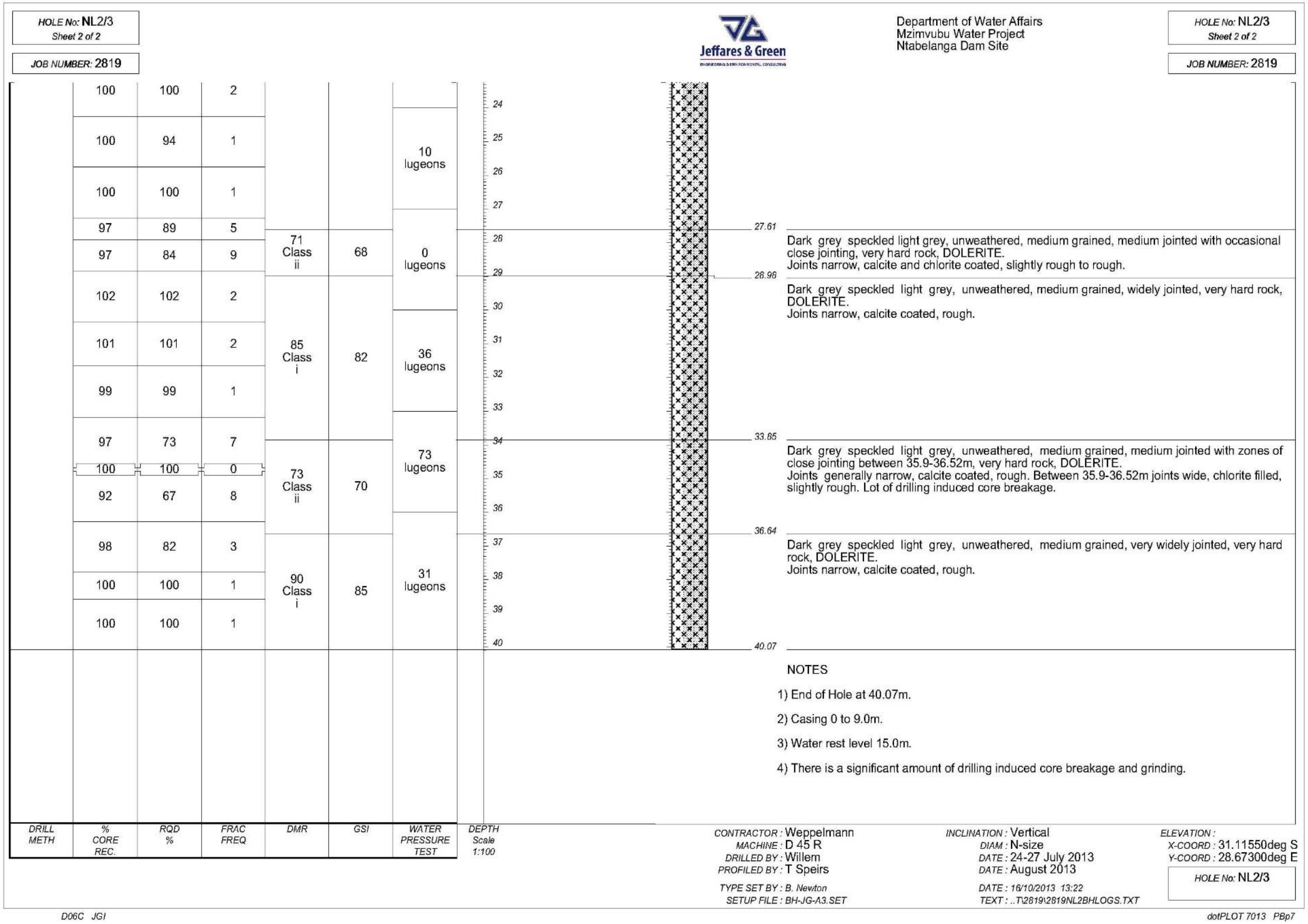
JOB NUMBER: 2819

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	63MR	n/a	n/a			0 lugeons
	100MR	n/a	n/a			
TNW	81MR 19CR	19	n/a			
	44MR 31CR	20	n/a			
	50MR 19CR	19	n/a			
	38MR 15CR	9	n/a			0 lugeons
	81MR 48CR	39	2			
	102	83	6	64 Class ii	66	0 lugeons
	97	89	4			
	102	102	0	86 Class i	87	0 lugeons
	93	93	0			
	110	110	1			0 lugeons
	98	98	1			
	100	100	1			0 lugeons
	99	97	2			
	97	97	2			4 lugeons

DEPTH Scale 1:100

0.00	Dark reddish brown to reddish brown speckled yellow, CLAYEY SAND: Colluvium.
1.96	Reddish olive-brown speckled yellow and black, CLAYEY SANDY GRAVEL: Residual dolerite.
4.65	Reddish olive-brown speckled yellow and black, CLAYEY SANDY GRAVEL with numerous corestones: residual dolerite, becoming olive brown, completely weathered, friable, very soft rock, dolerite.
8.63	Dark grey speckled light grey, slightly weathered at top to unweathered with slightly weathered zones, medium grained, widely jointed with closely jointed zones at 10.11-10.27m and 11.07-11.19m, very hard rock, DOLERITE. Joints wide, weathered rock gouge fill with minor peripheral alteration, rough.
11.19	Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE. Joints narrow, calcite coated, rough. Drilling induced core breakage and grinding.

Fig E-19-1: Borehole Logs (NL 2/3)



HOLE No: NL2/3
Sheet 2 of 2

JOB NUMBER: 2819

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Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
	100	100	2			
	100	94	1			10 lugeons
	100	100	1			
	97	89	5			0 lugeons
	97	84	9	71 Class ii	68	
	102	102	2	85 Class i	82	
	101	101	2			36 lugeons
	99	99	1			
	97	73	7			73 lugeons
	100	100	0	73 Class ii	70	
	92	67	8			
	98	82	3	90 Class i	85	31 lugeons
	100	100	1			
	100	100	1			

DEPTH Scale 1:100

24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

27.61

Dark grey speckled light grey, unweathered, medium grained, medium jointed with occasional close jointing, very hard rock, DOLERITE.
Joints narrow, calcite and chlorite coated, slightly rough to rough.

28.96

Dark grey speckled light grey, unweathered, medium grained, widely jointed, very hard rock, DOLERITE.
Joints narrow, calcite coated, rough.

33.85

Dark grey speckled light grey, unweathered, medium grained, medium jointed with zones of close jointing between 35.9-36.52m, very hard rock, DOLERITE.
Joints generally narrow, calcite coated, rough. Between 35.9-36.52m joints wide, chlorite filled, slightly rough. Lot of drilling induced core breakage.

36.64

Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE.
Joints narrow, calcite coated, rough.

40.07

NOTES

1) End of Hole at 40.07m.
2) Casing 0 to 9.0m.
3) Water rest level 15.0m.
4) There is a significant amount of drilling induced core breakage and grinding.

CONTRACTOR : Weppelmann
MACHINE : D 45 R
DRILLED BY : Willem
PROFILED BY : T Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

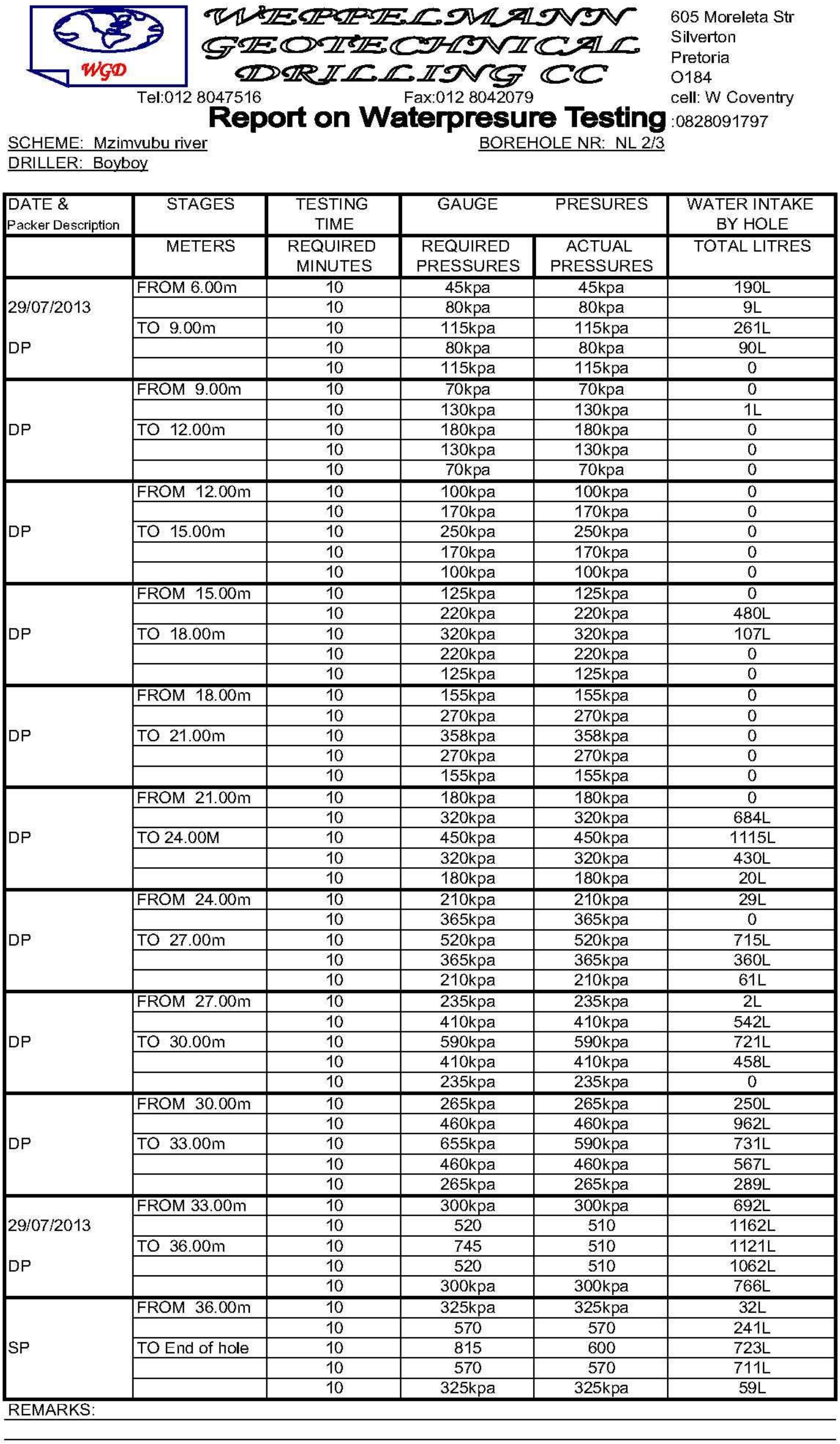
INCLINATION : Vertical
DIAM : N-size
DATE : 24-27 July 2013
DATE : August 2013
DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

ELEVATION :
X-COORD : 31.11550deg S
Y-COORD : 28.67300deg E
HOLE No: NL2/3

D06C JGI

dotPLOT 7013 PBp7

Fig E-19-2: Borehole Logs (NL 2/3)



WGD

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605 Moreleta Str
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Tel:012 8047516 Fax:012 8042079

Report on Waterpresure Testing

SCHEME: Mzimvubu river BOREHOLE NR: NL 2/3
DRILLER: Boyboy

DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
	FROM 6.00m	10	45kpa	45kpa	190L
29/07/2013		10	80kpa	80kpa	9L
	TO 9.00m	10	115kpa	115kpa	261L
DP		10	80kpa	80kpa	90L
		10	115kpa	115kpa	0
	FROM 9.00m	10	70kpa	70kpa	0
		10	130kpa	130kpa	1L
DP	TO 12.00m	10	180kpa	180kpa	0
		10	130kpa	130kpa	0
		10	70kpa	70kpa	0
	FROM 12.00m	10	100kpa	100kpa	0
		10	170kpa	170kpa	0
DP	TO 15.00m	10	250kpa	250kpa	0
		10	170kpa	170kpa	0
		10	100kpa	100kpa	0
	FROM 15.00m	10	125kpa	125kpa	0
		10	220kpa	220kpa	480L
DP	TO 18.00m	10	320kpa	320kpa	107L
		10	220kpa	220kpa	0
		10	125kpa	125kpa	0
	FROM 18.00m	10	155kpa	155kpa	0
		10	270kpa	270kpa	0
DP	TO 21.00m	10	358kpa	358kpa	0
		10	270kpa	270kpa	0
		10	155kpa	155kpa	0
	FROM 21.00m	10	180kpa	180kpa	0
		10	320kpa	320kpa	684L
DP	TO 24.00M	10	450kpa	450kpa	1115L
		10	320kpa	320kpa	430L
		10	180kpa	180kpa	20L
	FROM 24.00m	10	210kpa	210kpa	29L
		10	365kpa	365kpa	0
DP	TO 27.00m	10	520kpa	520kpa	715L
		10	365kpa	365kpa	360L
		10	210kpa	210kpa	61L
	FROM 27.00m	10	235kpa	235kpa	2L
		10	410kpa	410kpa	542L
DP	TO 30.00m	10	590kpa	590kpa	721L
		10	410kpa	410kpa	458L
		10	235kpa	235kpa	0
	FROM 30.00m	10	265kpa	265kpa	250L
		10	460kpa	460kpa	962L
DP	TO 33.00m	10	655kpa	590kpa	731L
		10	460kpa	460kpa	567L
		10	265kpa	265kpa	289L
	FROM 33.00m	10	300kpa	300kpa	692L
29/07/2013		10	520	510	1162L
	TO 36.00m	10	745	510	1121L
DP		10	520	510	1062L
		10	300kpa	300kpa	766L
	FROM 36.00m	10	325kpa	325kpa	32L
		10	570	570	241L
SP	TO End of hole	10	815	600	723L
		10	570	570	711L
		10	325kpa	325kpa	59L

REMARKS:

Fig E-20: Water Pressure Testing Report (NL 2/3)

Fig E-21: **Borehole NL 2/3 Core Box 1 of 6**

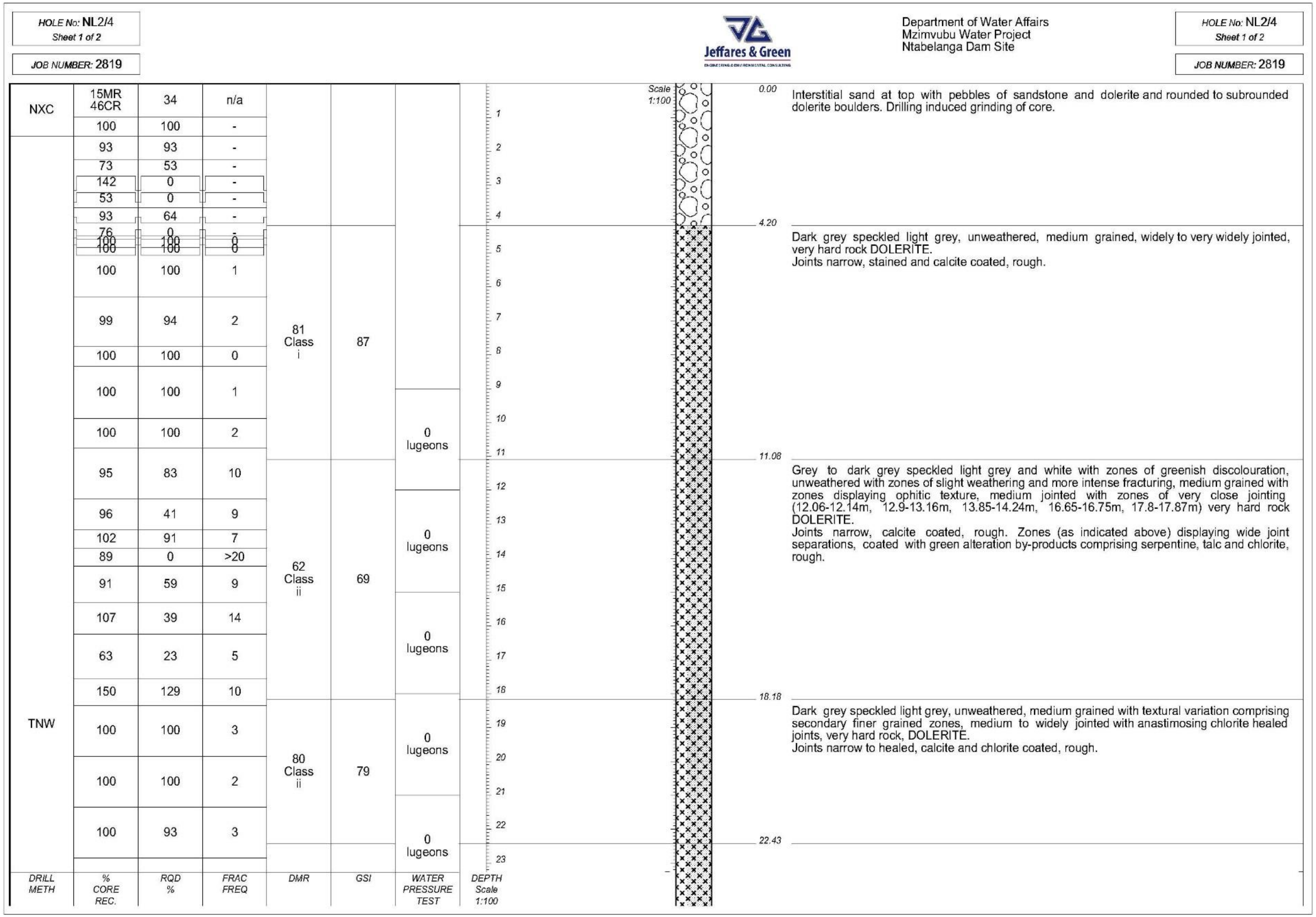
Fig E-22: **Borehole NL 2/3 Core Box 2 of 6**

Fig E-23: Borehole NL 2/3 Core Box 3 of 6

Fig E-24: Borehole NL 2/3 Core Box 4 of 6

Fig E-25: **Borehole NL 2/3 Core Box 5 of 6**

Fig E-26: **Borehole NL 2/3 Core Box 6 of 6**



HOLE No: NL2/4
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

HOLE No: NL2/4
Sheet 1 of 2

JOB NUMBER: 2819

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	15MR 46CR	34	n/a			
	100	100	-			
TNW	93	93	-			
	73	53	-			
	142	0	-			
	53	0	-			
	93	64	-			
	76	0	-	81 Class i	87	
	100	100	0			
	100	100	0			
	100	100	1			
	99	94	2			
	100	100	0			
	100	100	1			0 lugeons
	100	100	2			
	95	83	10	62 Class ii	69	
	96	41	9			0 lugeons
	102	91	7			
	89	0	>20			
	91	59	9			
	107	39	14			0 lugeons
	63	23	5			
	150	129	10			
	100	100	3	80 Class ii	79	0 lugeons
	100	100	2			
	100	93	3			0 lugeons

DEPTH Scale 1:100

Scale 1:100

0.00 Interstitial sand at top with pebbles of sandstone and dolerite and rounded to subrounded dolerite boulders. Drilling induced grinding of core.

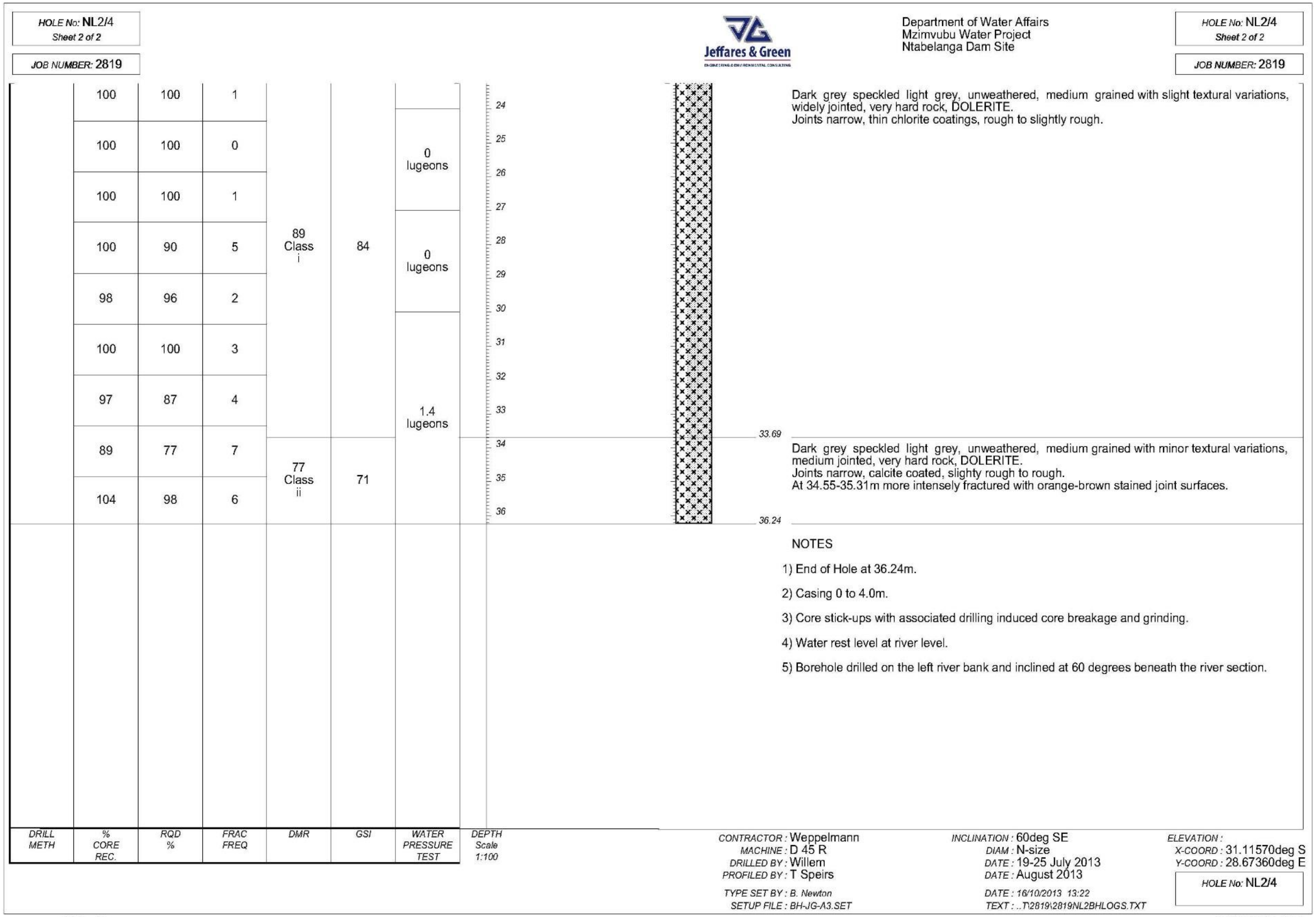
4.20 Dark grey speckled light grey, unweathered, medium grained, widely to very widely jointed, very hard rock DOLERITE.
Joints narrow, stained and calcite coated, rough.

11.08 Grey to dark grey speckled light grey and white with zones of greenish discolouration, unweathered with zones of slight weathering and more intense fracturing, medium grained with zones displaying ophitic texture, medium jointed with zones of very close jointing (12.06-12.14m, 12.9-13.16m, 13.85-14.24m, 16.65-16.75m, 17.8-17.87m) very hard rock DOLERITE.
Joints narrow, calcite coated, rough. Zones (as indicated above) displaying wide joint separations, coated with green alteration by-products comprising serpentine, talc and chlorite, rough.

18.18 Dark grey speckled light grey, unweathered, medium grained with textural variation comprising secondary finer grained zones, medium to widely jointed with anastimosing chlorite healed joints, very hard rock, DOLERITE.
Joints narrow to healed, calcite and chlorite coated, rough.

22.43

Fig E-27-1: Borehole Logs (NL 2/4)



HOLE No: NL2/4
Sheet 2 of 2

JOB NUMBER: 2819

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Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
	100	100	1			
	100	100	0			0 lugeons
	100	100	1			
	100	90	5	89 Class i	84	0 lugeons
	98	96	2			
	100	100	3			1.4 lugeons
	97	87	4			
	89	77	7	77 Class ii	71	
	104	98	6			

DEPTH Scale 1:100

24 25 26 27 28 29 30 31 32 33 34 35 36

Dark grey speckled light grey, unweathered, medium grained with slight textural variations, widely jointed, very hard rock, DOLERITE.
Joints narrow, thin chlorite coatings, rough to slightly rough.

33.69

Dark grey speckled light grey, unweathered, medium grained with minor textural variations, medium jointed, very hard rock, DOLERITE.
Joints narrow, calcite coated, slighty rough to rough.
At 34.55-35.31m more intensely fractured with orange-brown stained joint surfaces.

36.24

NOTES

1) End of Hole at 36.24m.

2) Casing 0 to 4.0m.

3) Core stick-ups with associated drilling induced core breakage and grinding.

4) Water rest level at river level.

5) Borehole drilled on the left river bank and inclined at 60 degrees beneath the river section.

CONTRACTOR : Weppelmann
MACHINE : D 45 R
DRILLED BY : Willem
PROFILED BY : T Speirs

TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : 60deg SE
DIAM : N-size
DATE : 19-25 July 2013
DATE : August 2013

DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

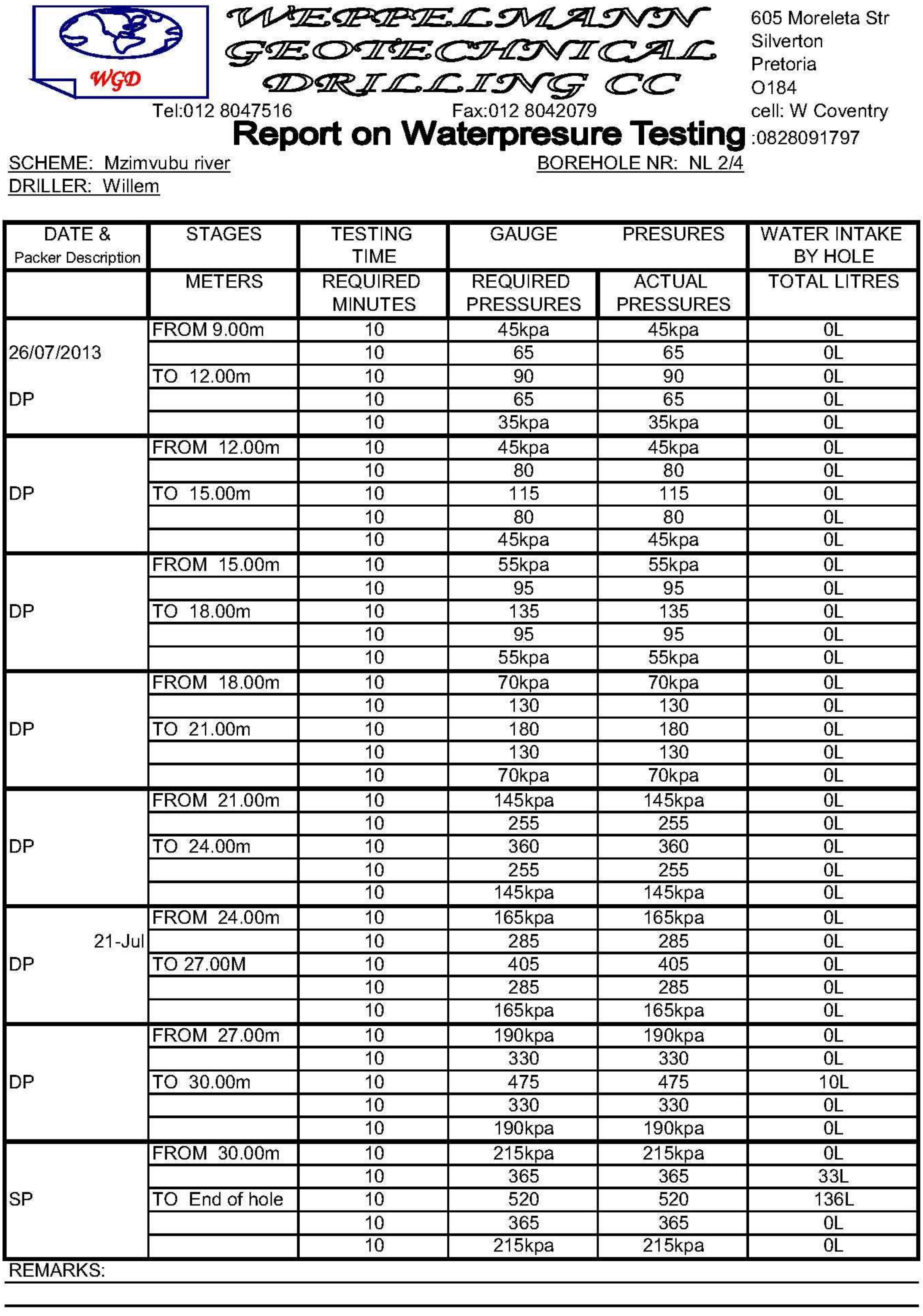
ELEVATION :
X-COORD : 31.11570deg S
Y-COORD : 28.67360deg E

HOLE No: NL2/4

D06C JGI

dotPLOT 7013 PBp7

Fig E-27-2: Borehole Logs (NL 2/4)



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Report on Waterpresure Testing

SCHEME: Mzimvubu river BOREHOLE NR: NL 2/4
DRILLER: Willem

DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
	FROM 9.00m	10	45kpa	45kpa	0L
26/07/2013		10	65	65	0L
	TO 12.00m	10	90	90	0L
DP		10	65	65	0L
		10	35kpa	35kpa	0L
	FROM 12.00m	10	45kpa	45kpa	0L
		10	80	80	0L
DP	TO 15.00m	10	115	115	0L
		10	80	80	0L
		10	45kpa	45kpa	0L
	FROM 15.00m	10	55kpa	55kpa	0L
		10	95	95	0L
DP	TO 18.00m	10	135	135	0L
		10	95	95	0L
		10	55kpa	55kpa	0L
	FROM 18.00m	10	70kpa	70kpa	0L
		10	130	130	0L
DP	TO 21.00m	10	180	180	0L
		10	130	130	0L
		10	70kpa	70kpa	0L
	FROM 21.00m	10	145kpa	145kpa	0L
		10	255	255	0L
DP	TO 24.00m	10	360	360	0L
		10	255	255	0L
		10	145kpa	145kpa	0L
	FROM 24.00m	10	165kpa	165kpa	0L
21-Jul		10	285	285	0L
DP	TO 27.00M	10	405	405	0L
		10	285	285	0L
		10	165kpa	165kpa	0L
	FROM 27.00m	10	190kpa	190kpa	0L
		10	330	330	0L
DP	TO 30.00m	10	475	475	10L
		10	330	330	0L
		10	190kpa	190kpa	0L
	FROM 30.00m	10	215kpa	215kpa	0L
		10	365	365	33L
SP	TO End of hole	10	520	520	136L
		10	365	365	0L
		10	215kpa	215kpa	0L

REMARKS:

Fig E-28: Water Pressure Testing Report (NL 2/4)

Fig E-29: **Borehole NL 2/4 Core Box 1 of 6**

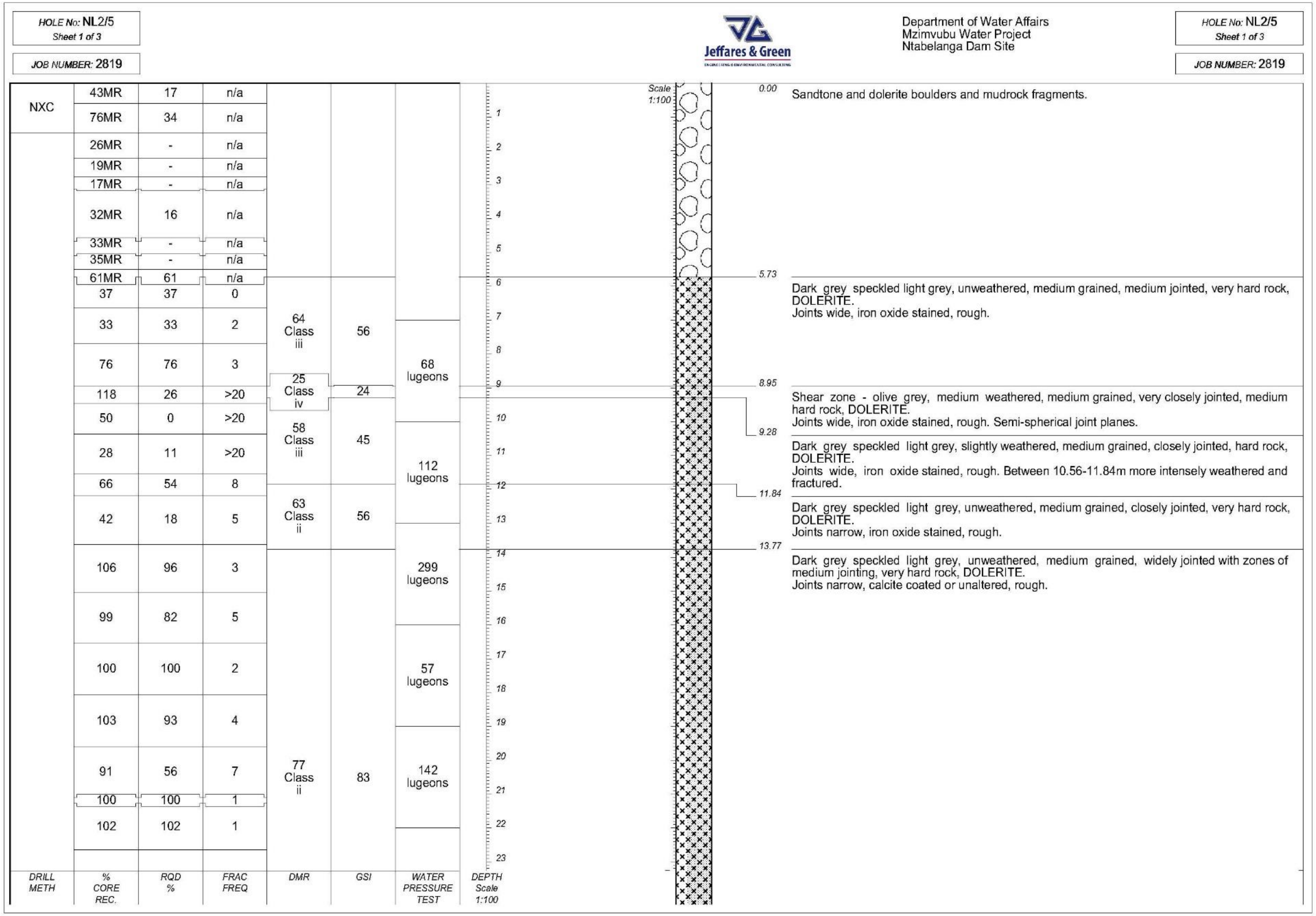
Fig E-30: **Borehole NL 2/4 Core Box 2 of 6**

Fig E-31: **Borehole NL 2/4 Core Box 3 of 6**

Fig E-32: **Borehole NL 2/4 Core Box 4 of 6**

Fig E-33: **Borehole NL 2/4 Core Box 5 of 6**

Fig E-34: **Borehole NL 2/4 Core Box 6 of 6**



HOLE No: NL2/5
Sheet 1 of 3

JOB NUMBER: 2819

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Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

HOLE No: NL2/5
Sheet 1 of 3

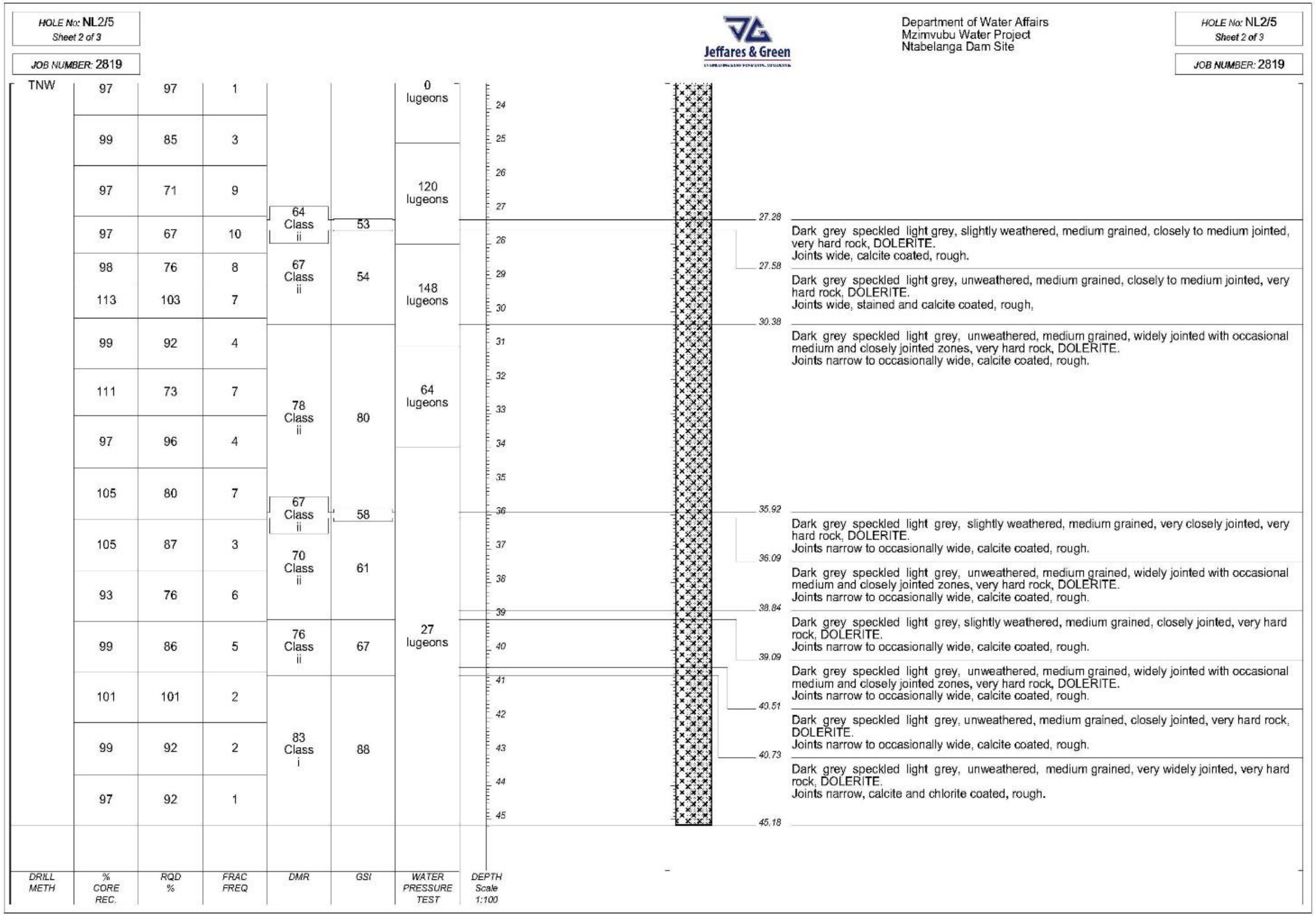
JOB NUMBER: 2819

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	43MR	17	n/a			
	76MR	34	n/a			
	26MR	-	n/a			
	19MR	-	n/a			
	17MR	-	n/a			
	32MR	16	n/a			
	33MR	-	n/a			
	35MR	-	n/a			
	61MR	61	n/a			
	37	37	0	64 Class iii	56	
	33	33	2			68 lugeons
	76	76	3			
	118	26	>20	25 Class iv	24	
	50	0	>20	58 Class iii	45	112 lugeons
	28	11	>20			
	66	54	8	63 Class ii	56	
	42	18	5			299 lugeons
	106	96	3	77 Class ii	83	
	99	82	5			57 lugeons
	100	100	2			
	103	93	4			142 lugeons
	91	56	7			
	100	100	1			
	102	102	1			

DEPTH Scale 1:100

0.00	Sandtone and dolerite boulders and mudrock fragments.
5.73	Dark grey speckled light grey, unweathered, medium grained, medium jointed, very hard rock, DOLERITE. Joints wide, iron oxide stained, rough.
8.95	Shear zone - olive grey, medium weathered, medium grained, very closely jointed, medium hard rock, DOLERITE. Joints wide, iron oxide stained, rough. Semi-spherical joint planes.
9.28	Dark grey speckled light grey, slightly weathered, medium grained, closely jointed, hard rock, DOLERITE. Joints wide, iron oxide stained, rough. Between 10.56-11.84m more intensely weathered and fractured.
11.84	Dark grey speckled light grey, unweathered, medium grained, closely jointed, very hard rock, DOLERITE. Joints narrow, iron oxide stained, rough.
13.77	Dark grey speckled light grey, unweathered, medium grained, widely jointed with zones of medium jointing, very hard rock, DOLERITE. Joints narrow, calcite coated or unaltered, rough.

Fig E-35-1: Borehole Logs (NL 2/5)



HOLE No: NL2/5
Sheet 2 of 3

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ
TNW	97	97	1
	99	85	3
	97	71	9
	97	67	10
	98	76	8
	113	103	7
	99	92	4
	111	73	7
	97	96	4
	105	80	7
	105	87	3
	93	76	6
	99	86	5
	101	101	2
	99	92	2
	97	92	1

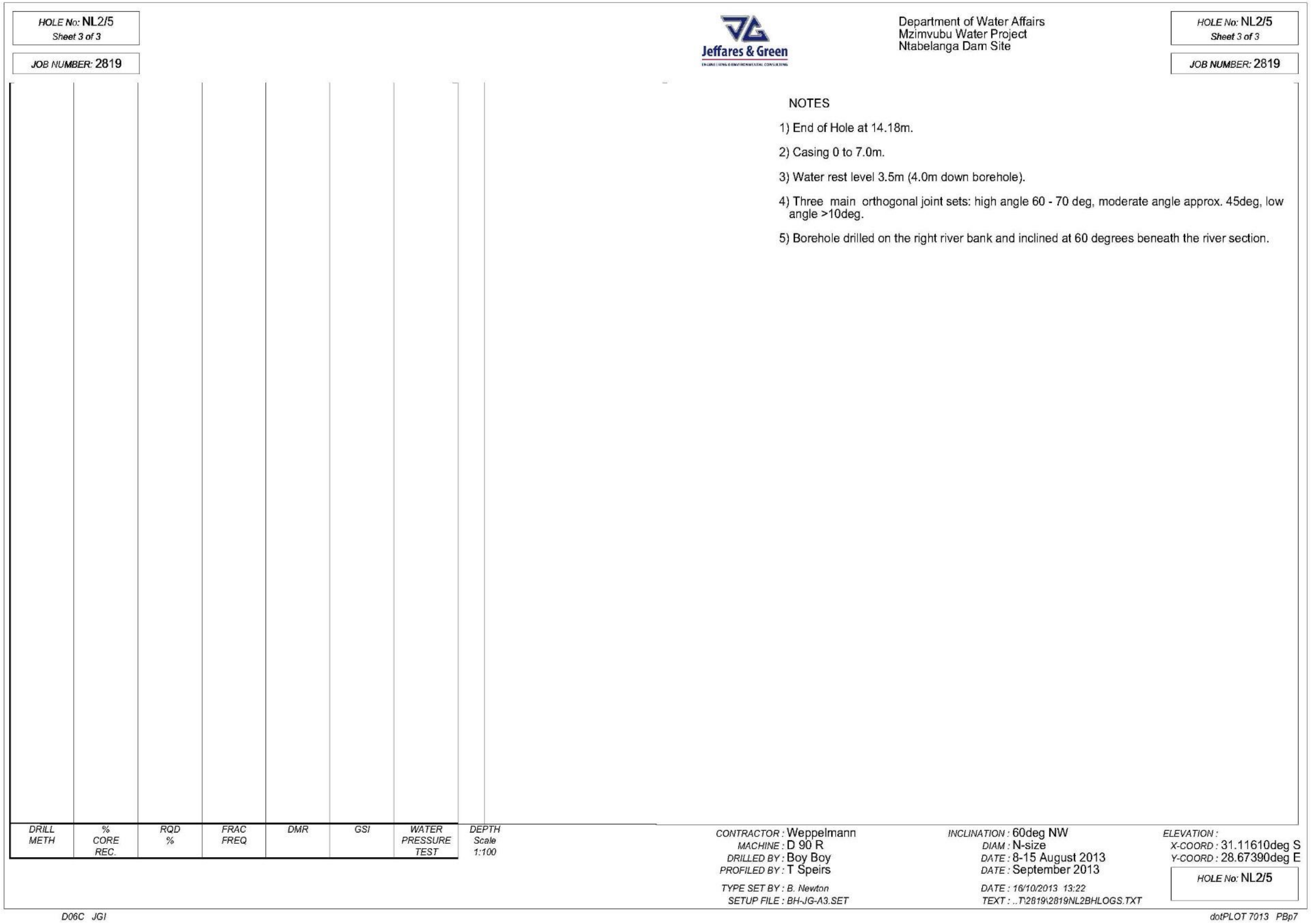
DMR	GSI
64 Class ii	53
67 Class ii	54
78 Class ii	80
67 Class ii	58
70 Class ii	61
76 Class ii	67
83 Class i	88

WATER PRESSURE TEST
0 lugeons
120 lugeons
148 lugeons
64 lugeons
27 lugeons

DEPTH Scale 1:100

27.28	Dark grey speckled light grey, slightly weathered, medium grained, closely to medium jointed, very hard rock, DOLERITE. Joints wide, calcite coated, rough.
27.58	Dark grey speckled light grey, unweathered, medium grained, closely to medium jointed, very hard rock, DOLERITE. Joints wide, stained and calcite coated, rough,
30.38	Dark grey speckled light grey, unweathered, medium grained, widely jointed with occasional medium and closely jointed zones, very hard rock, DOLERITE. Joints narrow to occasionally wide, calcite coated, rough.
35.92	Dark grey speckled light grey, slightly weathered, medium grained, very closely jointed, very hard rock, DOLERITE. Joints narrow to occasionally wide, calcite coated, rough.
36.09	Dark grey speckled light grey, unweathered, medium grained, widely jointed with occasional medium and closely jointed zones, very hard rock, DOLERITE. Joints narrow to occasionally wide, calcite coated, rough.
38.84	Dark grey speckled light grey, slightly weathered, medium grained, closely jointed, very hard rock, DOLERITE. Joints narrow to occasionally wide, calcite coated, rough.
39.09	Dark grey speckled light grey, unweathered, medium grained, widely jointed with occasional medium and closely jointed zones, very hard rock, DOLERITE. Joints narrow to occasionally wide, calcite coated, rough.
40.51	Dark grey speckled light grey, unweathered, medium grained, closely jointed, very hard rock, DOLERITE. Joints narrow to occasionally wide, calcite coated, rough.
40.73	Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE. Joints narrow, calcite and chlorite coated, rough.
45.18	

Fig E-35-2: Borehole Logs (NL 2/5)



HOLE No: NL2/5
Sheet 3 of 3

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

HOLE No: NL2/5
Sheet 3 of 3

JOB NUMBER: 2819

NOTES

1) End of Hole at 14.18m.

2) Casing 0 to 7.0m.

3) Water rest level 3.5m (4.0m down borehole).

4) Three main orthogonal joint sets: high angle 60 - 70 deg, moderate angle approx. 45deg, low angle >10deg.

5) Borehole drilled on the right river bank and inclined at 60 degrees beneath the river section.

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST	DEPTH Scale 1:100

CONTRACTOR : Weppelmann
MACHINE : D 90 R
DRILLED BY : Boy Boy
PROFILED BY : T Speirs

TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : 60deg NW
DIAM : N-size
DATE : 8-15 August 2013
DATE : September 2013

DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

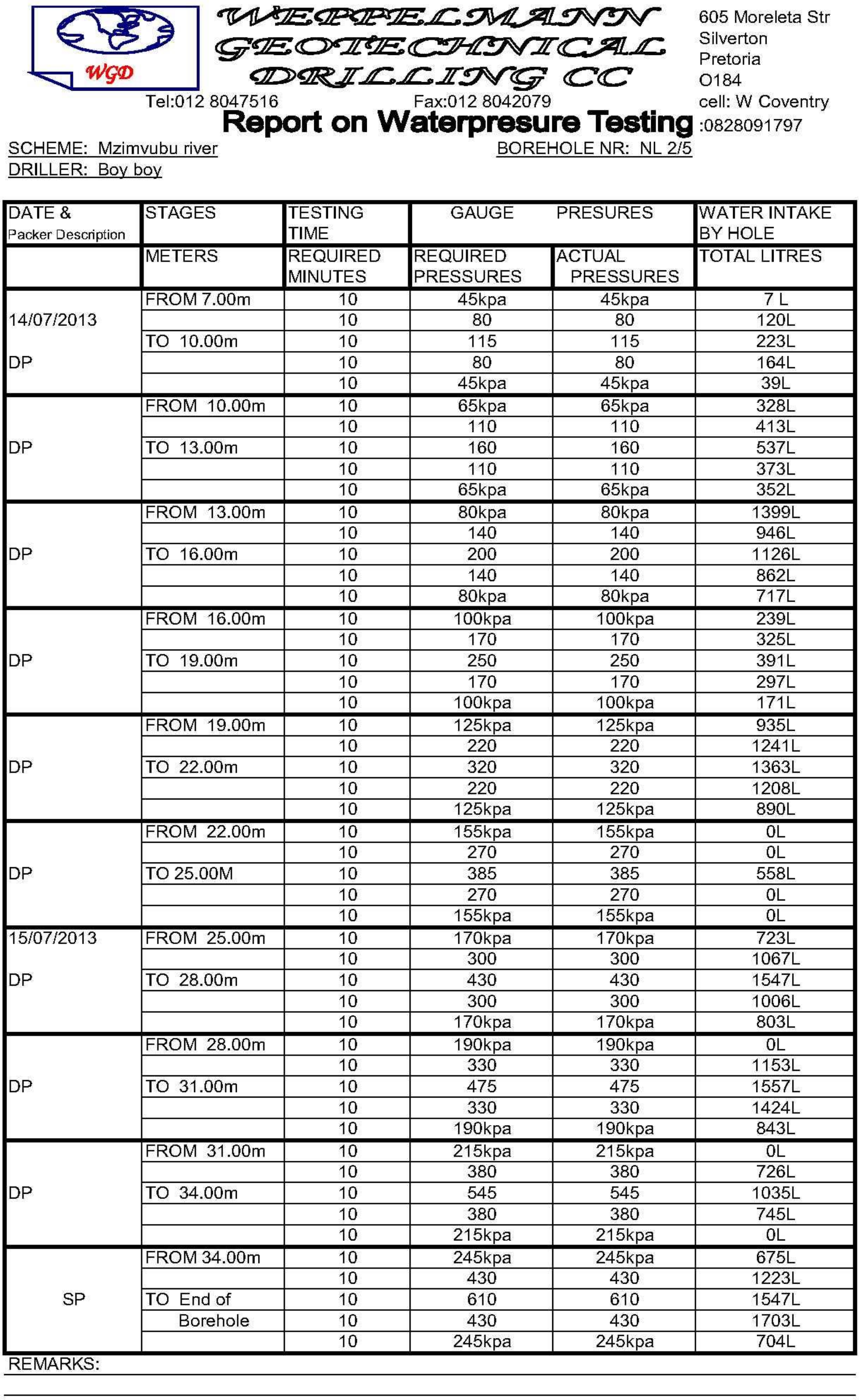
ELEVATION :
X-COORD : 31.11610deg S
Y-COORD : 28.67390deg E

HOLE No: NL2/5

D06C JGI

dotPLOT 7013 PBp7

Fig E-35-3: Borehole Logs (NL 2/5)



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Report on Waterpresure Testing

SCHEME: Mzimvubu river

BOREHOLE NR: NL 2/5

DRILLER: Boy boy

DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
	FROM 7.00m	10	45kpa	45kpa	7 L
14/07/2013		10	80	80	120L
	TO 10.00m	10	115	115	223L
DP		10	80	80	164L
		10	45kpa	45kpa	39L
	FROM 10.00m	10	65kpa	65kpa	328L
		10	110	110	413L
DP	TO 13.00m	10	160	160	537L
		10	110	110	373L
		10	65kpa	65kpa	352L
	FROM 13.00m	10	80kpa	80kpa	1399L
		10	140	140	946L
DP	TO 16.00m	10	200	200	1126L
		10	140	140	862L
		10	80kpa	80kpa	717L
	FROM 16.00m	10	100kpa	100kpa	239L
		10	170	170	325L
DP	TO 19.00m	10	250	250	391L
		10	170	170	297L
		10	100kpa	100kpa	171L
	FROM 19.00m	10	125kpa	125kpa	935L
		10	220	220	1241L
DP	TO 22.00m	10	320	320	1363L
		10	220	220	1208L
		10	125kpa	125kpa	890L
	FROM 22.00m	10	155kpa	155kpa	0L
		10	270	270	0L
DP	TO 25.00M	10	385	385	558L
		10	270	270	0L
		10	155kpa	155kpa	0L
15/07/2013	FROM 25.00m	10	170kpa	170kpa	723L
		10	300	300	1067L
DP	TO 28.00m	10	430	430	1547L
		10	300	300	1006L
		10	170kpa	170kpa	803L
	FROM 28.00m	10	190kpa	190kpa	0L
		10	330	330	1153L
DP	TO 31.00m	10	475	475	1557L
		10	330	330	1424L
		10	190kpa	190kpa	843L
	FROM 31.00m	10	215kpa	215kpa	0L
		10	380	380	726L
DP	TO 34.00m	10	545	545	1035L
		10	380	380	745L
		10	215kpa	215kpa	0L
	FROM 34.00m	10	245kpa	245kpa	675L
		10	430	430	1223L
SP	TO End of	10	610	610	1547L
	Borehole	10	430	430	1703L
		10	245kpa	245kpa	704L

REMARKS:

Fig E-36: Water Pressure Testing Report (NL 2/5)

Fig E-37: Borehole NL 2/5 Core Box 1 of 6

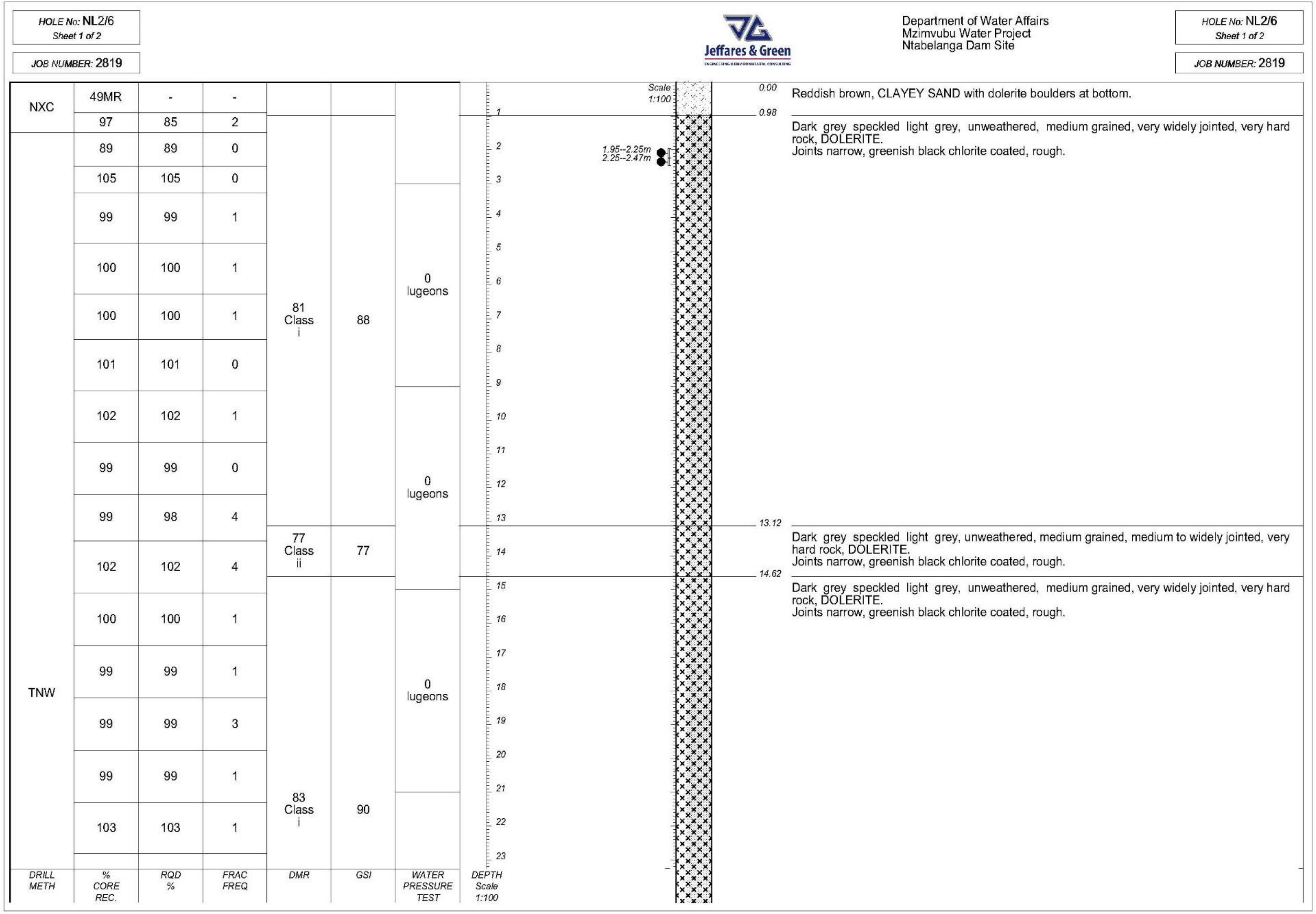
Fig E-38: Borehole NL 2/5 Core Box 2 of 6

Fig E-39: Borehole NL 2/5 Core Box 3 of 6

Fig E-40: Borehole NL 2/5 Core Box 4 of 6

Fig E-41: **Borehole NL 2/5 Core Box 5 of 6**

Fig E-42: **Borehole NL 2/5 Core Box 6 of 6**



HOLE No: NL2/6
Sheet 1 of 2

JOB NUMBER: 2819

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	49MR	-	-			
	97	85	2	81 Class i	88	
TNW	89	89	0			
	105	105	0			
	99	99	1			0 lugeons
	100	100	1			
	100	100	1			
	101	101	0			
	102	102	1			0 lugeons
	99	99	0			
	99	98	4			
	102	102	4	77 Class ii	77	
	100	100	1	83 Class i	90	0 lugeons
	99	99	1			
	99	99	3			
	99	99	1			
	103	103	1			

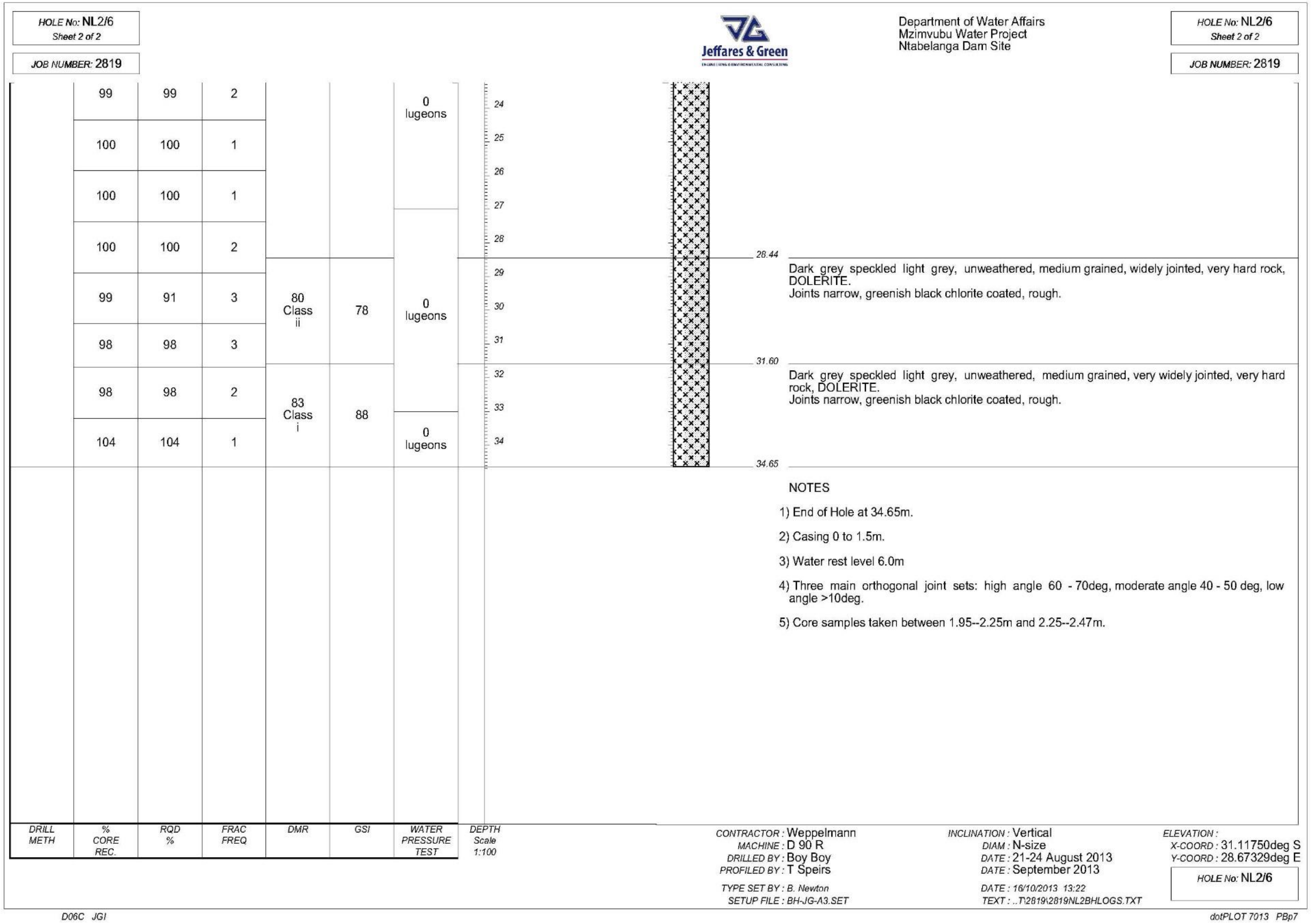
0.00 Reddish brown, CLAYEY SAND with dolerite boulders at bottom.

0.98 Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE.
Joints narrow, greenish black chlorite coated, rough.

13.12 Dark grey speckled light grey, unweathered, medium grained, medium to widely jointed, very hard rock, DOLERITE.
Joints narrow, greenish black chlorite coated, rough.

14.62 Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE.
Joints narrow, greenish black chlorite coated, rough.

Fig E-43-1: Borehole Logs (NL 2/6)



HOLE No: NL2/6
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

HOLE No: NL2/6
Sheet 2 of 2

JOB NUMBER: 2819

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST	DEPTH Scale 1:100
	99	99	2			0 lugeons	24
	100	100	1				25
	100	100	1				26 27
	100	100	2				28
	99	91	3	80 Class ii	78	0 lugeons	29 30
	98	98	3				31
	98	98	2	83 Class i	88		32 33
	104	104	1			0 lugeons	34

28.44
Dark grey speckled light grey, unweathered, medium grained, widely jointed, very hard rock, DOLERITE.
Joints narrow, greenish black chlorite coated, rough.

31.60
Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE.
Joints narrow, greenish black chlorite coated, rough.

34.65

NOTES

1) End of Hole at 34.65m.

2) Casing 0 to 1.5m.

3) Water rest level 6.0m

4) Three main orthogonal joint sets: high angle 60 - 70deg, moderate angle 40 - 50 deg, low angle >10deg.

5) Core samples taken between 1.95--2.25m and 2.25--2.47m.

CONTRACTOR : Weppelmann
MACHINE : D 90 R
DRILLED BY : Boy Boy
PROFILED BY : T Speirs

TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 21-24 August 2013
DATE : September 2013

DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

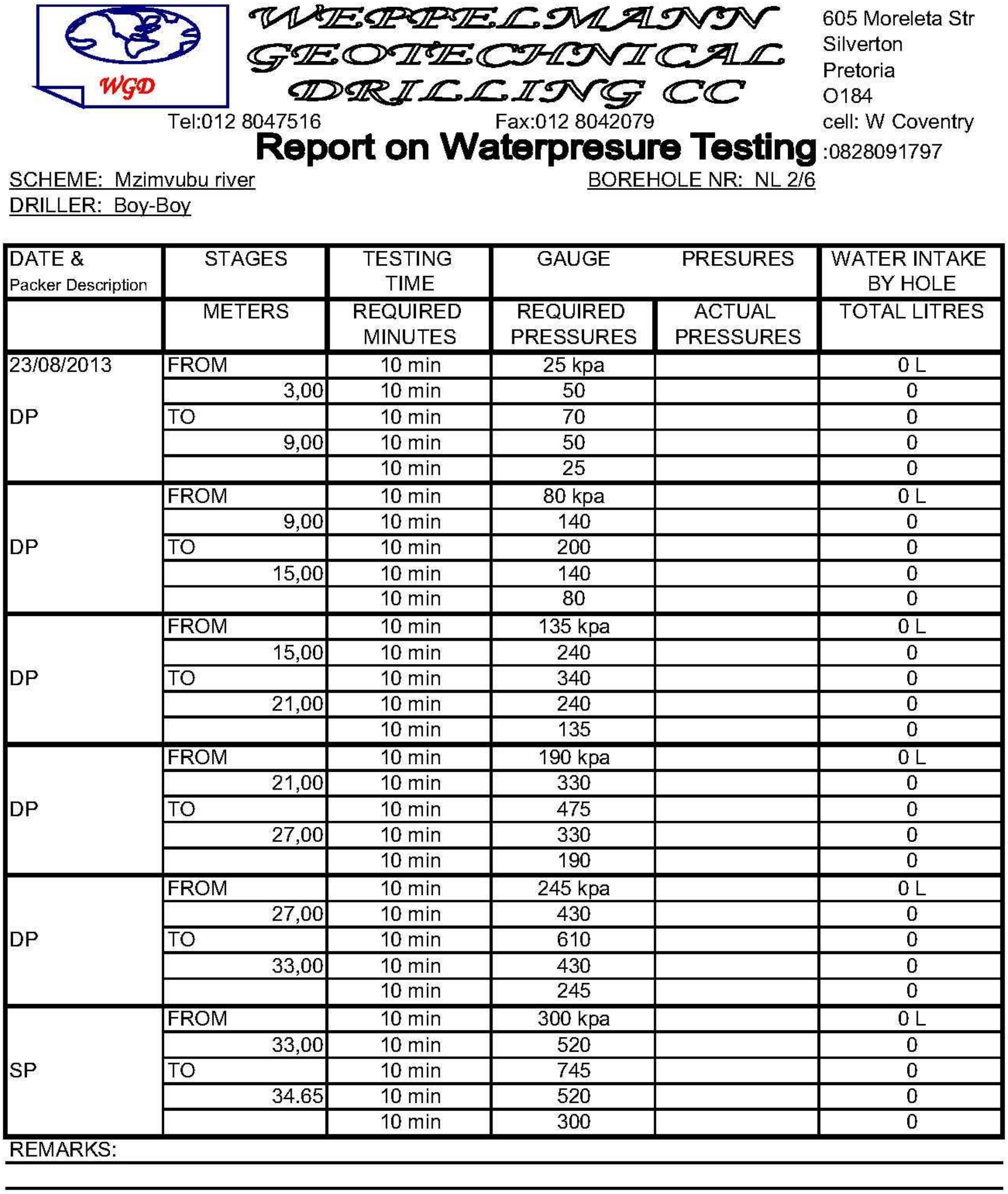
ELEVATION :
X-COORD : 31.11750deg S
Y-COORD : 28.67329deg E

HOLE No: NL2/6

D06C JGI

dotPLOT 7013 PBp7

Fig E-43-1: Borehole Logs (NL 2/6)



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Report on Waterpresure Testing

SCHEME: Mzimvubu river
BOREHOLE NR: NL 2/6
DRILLER: Boy-Boy

DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
23/08/2013	FROM	10 min	25 kpa		0 L
	3,00	10 min	50		0
DP	TO	10 min	70		0
	9,00	10 min	50		0
		10 min	25		0
	FROM	10 min	80 kpa		0 L
	9,00	10 min	140		0
DP	TO	10 min	200		0
	15,00	10 min	140		0
		10 min	80		0
	FROM	10 min	135 kpa		0 L
	15,00	10 min	240		0
DP	TO	10 min	340		0
	21,00	10 min	240		0
		10 min	135		0
	FROM	10 min	190 kpa		0 L
	21,00	10 min	330		0
DP	TO	10 min	475		0
	27,00	10 min	330		0
		10 min	190		0
	FROM	10 min	245 kpa		0 L
	27,00	10 min	430		0
DP	TO	10 min	610		0
	33,00	10 min	430		0
		10 min	245		0
	FROM	10 min	300 kpa		0 L
	33,00	10 min	520		0
SP	TO	10 min	745		0
	34.65	10 min	520		0
		10 min	300		0

REMARKS:

Fig E-44: Water Pressure Testing Report (NL 2/6)

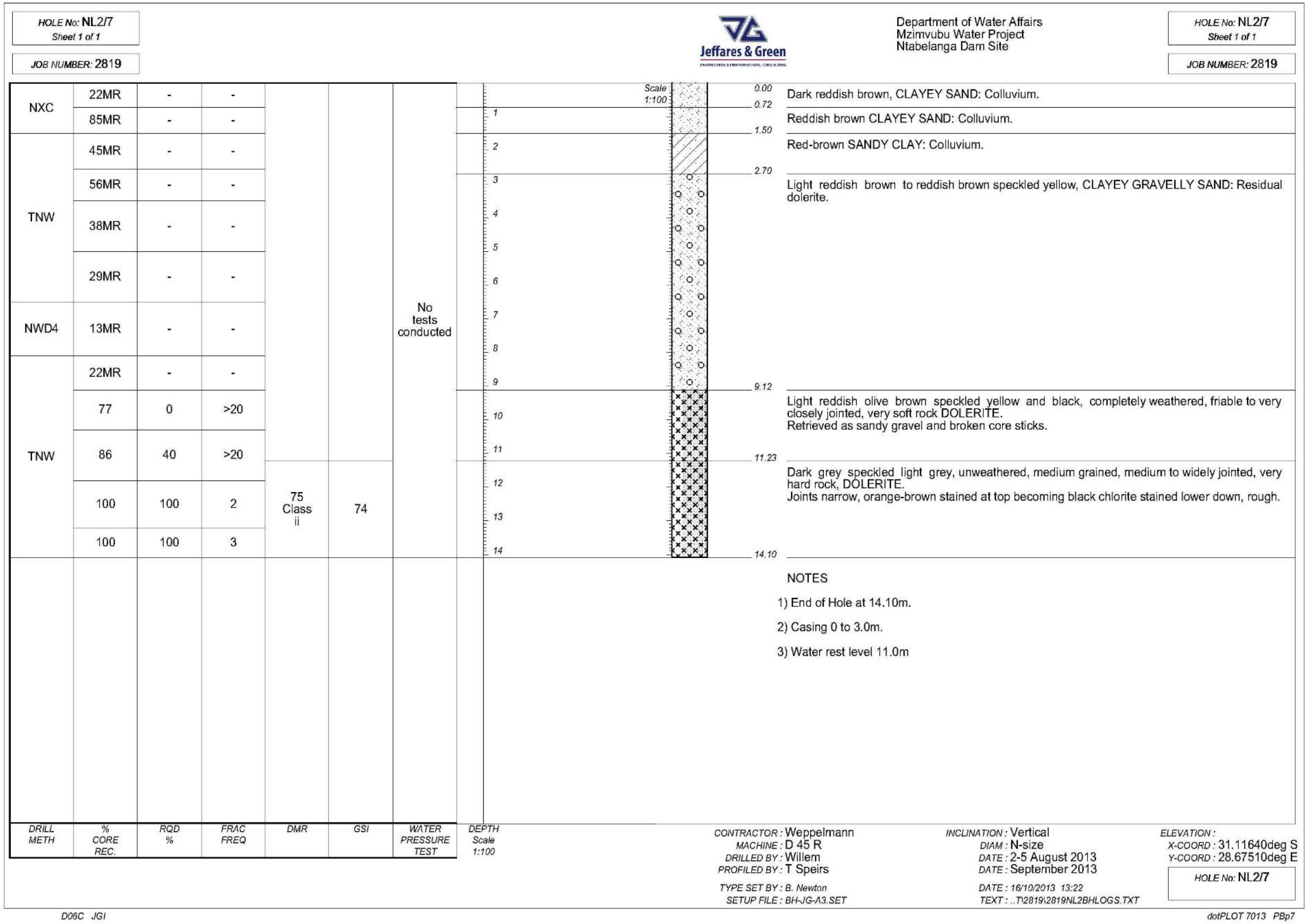
Fig E-45: **Borehole NL 2/6 Core Box 1 of 5**

Fig E-46: **Borehole NL 2/6 Core Box 2 of 5**

Fig E-47: **Borehole NL 2/6 Core Box 3 of 5**

Fig E-48: **Borehole NL 2/6 Core Box 4 of 5**

Fig E-49: **Borehole NL 2/6 Core Box 5 of 5**



HOLE No: NL2/7
Sheet 1 of 1

JOB NUMBER: 2819

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	22MR	-	-			No tests conducted
	85MR	-	-			
TNW	45MR	-	-			
	56MR	-	-			
	38MR	-	-			
	29MR	-	-			
NWD4	13MR	-	-			
TNW	22MR	-	-			
	77	0	>20			
	86	40	>20			
	100	100	2	75 Class ii	74	
	100	100	3			

DEPTH Scale 1:100

Depth (m)	
0.00 – 0.72	Dark reddish brown, CLAYEY SAND: Colluvium.
0.72 – 1.50	Reddish brown CLAYEY SAND: Colluvium.
1.50 – 2.70	Red-brown SANDY CLAY: Colluvium.
2.70 – 9.12	Light reddish brown to reddish brown speckled yellow, CLAYEY GRAVELLY SAND: Residual dolerite.
9.12 – 11.23	Light reddish olive brown speckled yellow and black, completely weathered, friable to very closely jointed, very soft rock DOLERITE. Retrieved as sandy gravel and broken core sticks.
11.23 – 14.10	Dark grey speckled light grey, unweathered, medium grained, medium to widely jointed, very hard rock, DOLERITE. Joints narrow, orange-brown stained at top becoming black chlorite stained lower down, rough.

NOTES

1) End of Hole at 14.10m.

2) Casing 0 to 3.0m.

3) Water rest level 11.0m

CONTRACTOR : Weppelmann
MACHINE : D 45 R
DRILLED BY : Willem
PROFILED BY : T Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 2-5 August 2013
DATE : September 2013
DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

ELEVATION :
X-COORD : 31.11640deg S
Y-COORD : 28.67510deg E

HOLE No: NL2/7

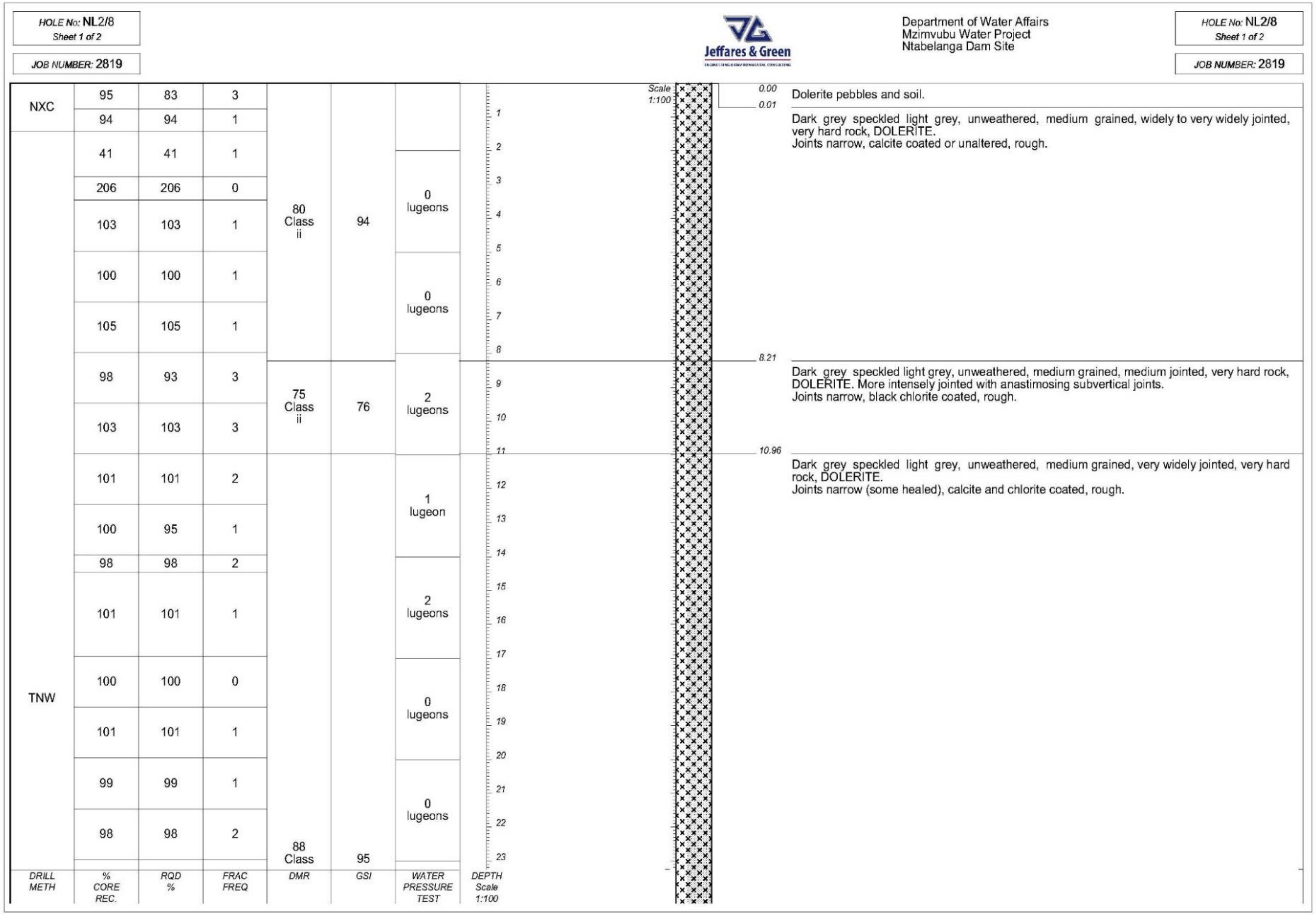
D06C JGI

dotPLOT 7013 PBp7

Fig E-50: Borehole Logs (NL 2/7)

Fig E-51: **Borehole NL 2/7 Core Box 1 of 2**

Fig E-51: **Borehole NL 2/7 Core Box 2 of 2**



HOLE No: NL2/8
Sheet 1 of 2

JOB NUMBER: 2819

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Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	95	83	3	80 Class ii	94	
	94	94	1			
TNW	41	41	1			
	206	206	0			0 lugeons
	103	103	1			
	100	100	1			0 lugeons
	105	105	1			
	98	93	3	75 Class ii	76	2 lugeons
	103	103	3			
	101	101	2	88 Class	95	1 lugeon
	100	95	1			
	98	98	2			2 lugeons
	101	101	1			
	100	100	0			0 lugeons
	101	101	1			
	99	99	1			0 lugeons
	98	98	2			

DEPTH Scale 1:100

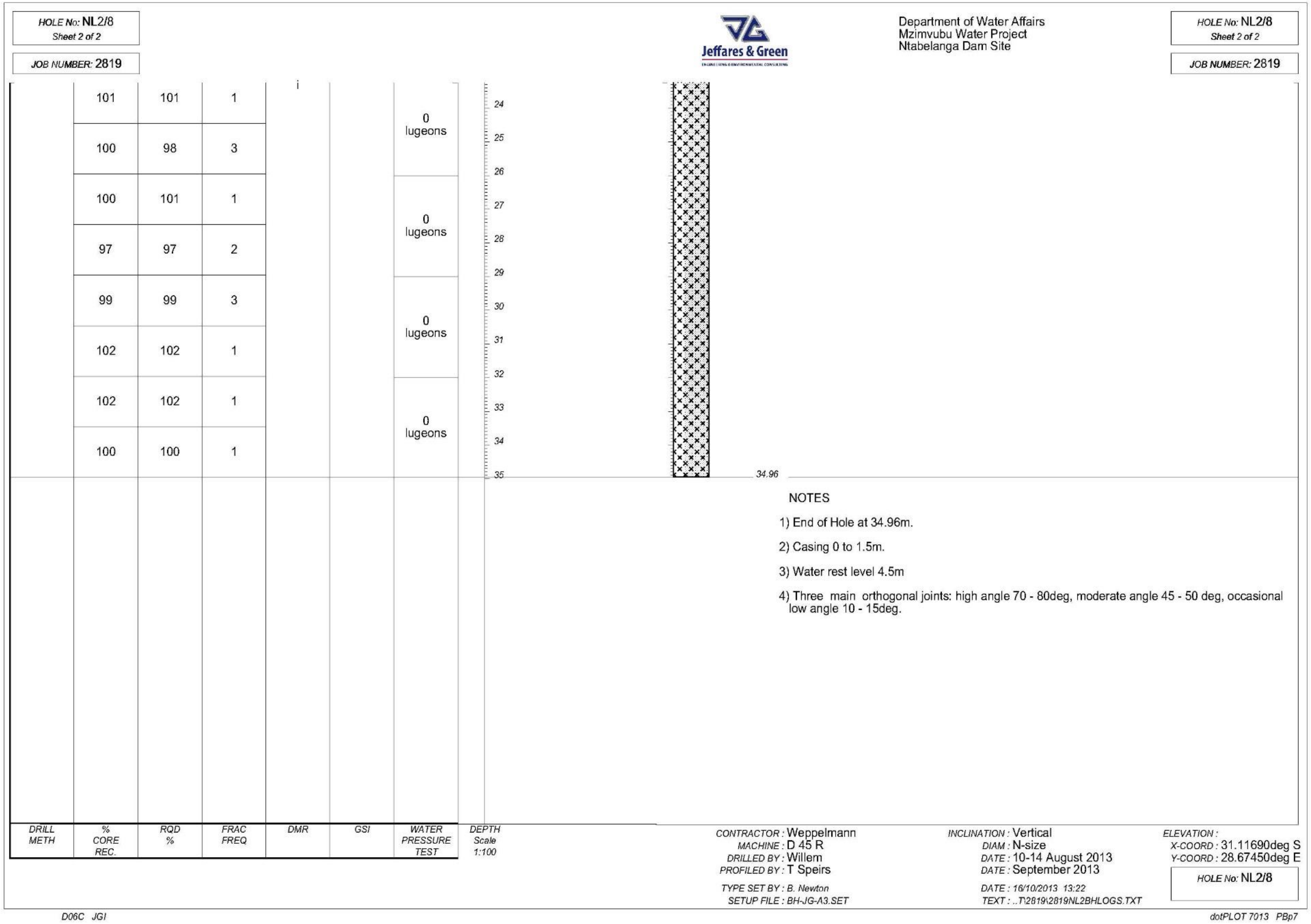
0.00 Dolerite pebbles and soil.

0.01 Dark grey speckled light grey, unweathered, medium grained, widely to very widely jointed, very hard rock, DOLERITE.
Joints narrow, calcite coated or unaltered, rough.

8.21 Dark grey speckled light grey, unweathered, medium grained, medium jointed, very hard rock, DOLERITE. More intensely jointed with anastimosing subvertical joints.
Joints narrow, black chlorite coated, rough.

10.96 Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE.
Joints narrow (some healed), calcite and chlorite coated, rough.

Fig E-52-1: Borehole Logs (NL 2/8)



HOLE No: NL2/8
Sheet 2 of 2
JOB NUMBER: 2819

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
	101	101	1			0 lugeons
	100	98	3			
	100	101	1			0 lugeons
	97	97	2			
	99	99	3			0 lugeons
	102	102	1			
	102	102	1			0 lugeons
	100	100	1			

DEPTH Scale 1:100

NOTES

1) End of Hole at 34.96m.

2) Casing 0 to 1.5m.

3) Water rest level 4.5m

4) Three main orthogonal joints: high angle 70 - 80deg, moderate angle 45 - 50 deg, occasional low angle 10 - 15deg.

CONTRACTOR : Weppelmann
MACHINE : D 45 R
DRILLED BY : Willem
PROFILED BY : T Speirs

TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 10-14 August 2013
DATE : September 2013

DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

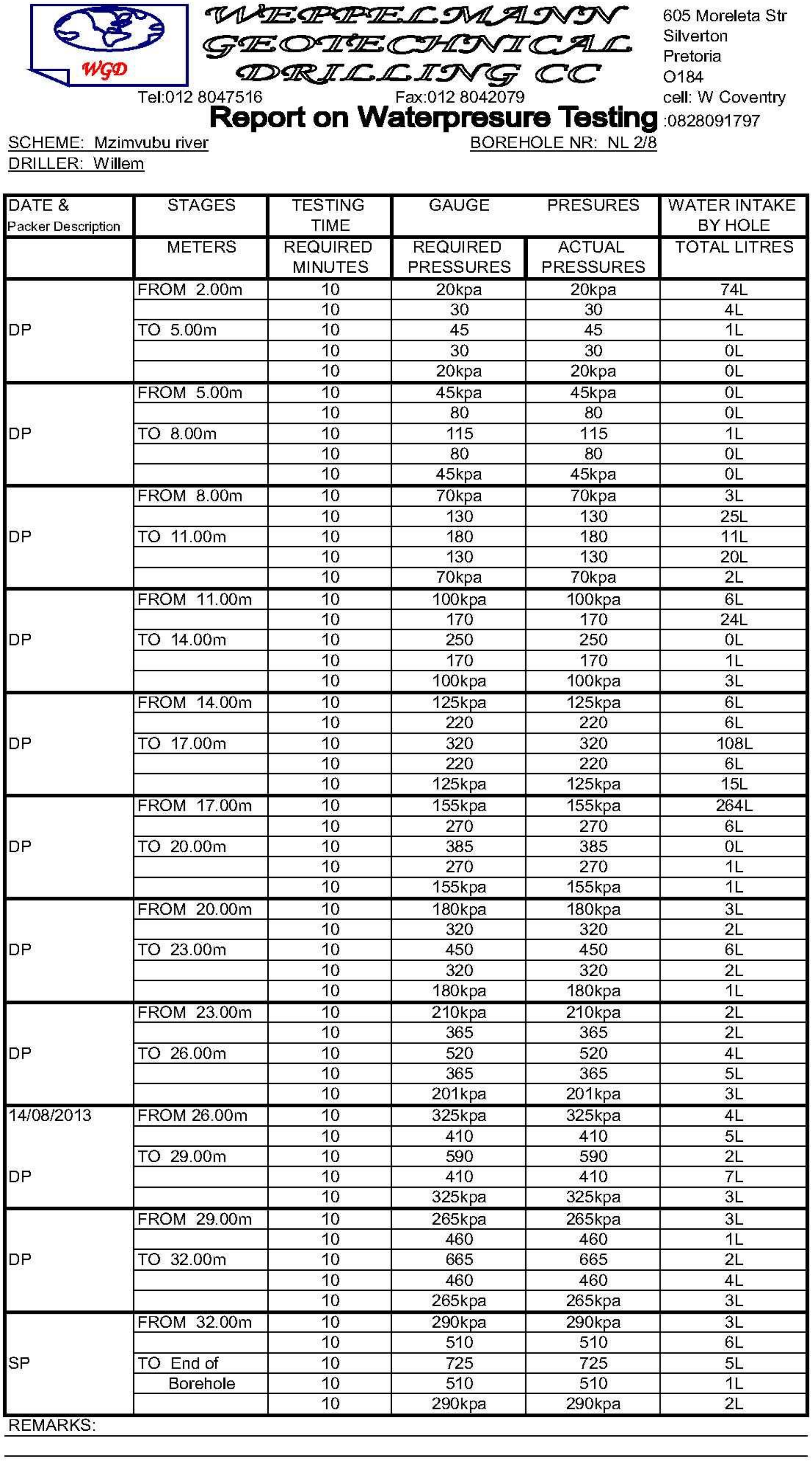
ELEVATION :
X-COORD : 31.11690deg S
Y-COORD : 28.67450deg E

HOLE No: NL2/8

D06C JGI

dotPLOT 7013 PBp7

Fig E-52-2: Borehole Logs (NL 2/8)



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Report on Waterpresure Testing

SCHEME: Mzimvubu river
DRILLER: Willem
BOREHOLE NR: NL 2/8

DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
DP	FROM 2.00m	10	20kpa	20kpa	74L
		10	30	30	4L
	TO 5.00m	10	45	45	1L
		10	30	30	0L
		10	20kpa	20kpa	0L
DP	FROM 5.00m	10	45kpa	45kpa	0L
		10	80	80	0L
	TO 8.00m	10	115	115	1L
		10	80	80	0L
		10	45kpa	45kpa	0L
DP	FROM 8.00m	10	70kpa	70kpa	3L
		10	130	130	25L
	TO 11.00m	10	180	180	11L
		10	130	130	20L
		10	70kpa	70kpa	2L
DP	FROM 11.00m	10	100kpa	100kpa	6L
		10	170	170	24L
	TO 14.00m	10	250	250	0L
		10	170	170	1L
		10	100kpa	100kpa	3L
DP	FROM 14.00m	10	125kpa	125kpa	6L
		10	220	220	6L
	TO 17.00m	10	320	320	108L
		10	220	220	6L
		10	125kpa	125kpa	15L
DP	FROM 17.00m	10	155kpa	155kpa	264L
		10	270	270	6L
	TO 20.00m	10	385	385	0L
		10	270	270	1L
		10	155kpa	155kpa	1L
DP	FROM 20.00m	10	180kpa	180kpa	3L
		10	320	320	2L
	TO 23.00m	10	450	450	6L
		10	320	320	2L
		10	180kpa	180kpa	1L
DP	FROM 23.00m	10	210kpa	210kpa	2L
		10	365	365	2L
	TO 26.00m	10	520	520	4L
		10	365	365	5L
		10	201kpa	201kpa	3L
14/08/2013 DP	FROM 26.00m	10	325kpa	325kpa	4L
		10	410	410	5L
	TO 29.00m	10	590	590	2L
		10	410	410	7L
		10	325kpa	325kpa	3L
DP	FROM 29.00m	10	265kpa	265kpa	3L
		10	460	460	1L
	TO 32.00m	10	665	665	2L
		10	460	460	4L
		10	265kpa	265kpa	3L
SP	FROM 32.00m	10	290kpa	290kpa	3L
		10	510	510	6L
	TO End of	10	725	725	5L
	Borehole	10	510	510	1L
		10	290kpa	290kpa	2L

REMARKS:

Fig E-53: Water Pressure Testing Report (NL 2/8)

Fig E-54: Borehole NL 2/8 Core Box 1 of 5

Fig E-55: Borehole NL 2/8 Core Box 2 of 5

Fig E-56: **Borehole NL 2/8 Core Box 3 of 5**

Fig E-57: **Borehole NL 2/8 Core Box 4 of 5**

Fig E-58: **Borehole NL 2/8 Core Box 5 of 5**

HOLE No: NL2/9
Sheet 1 of 1

JOB NUMBER: 2819

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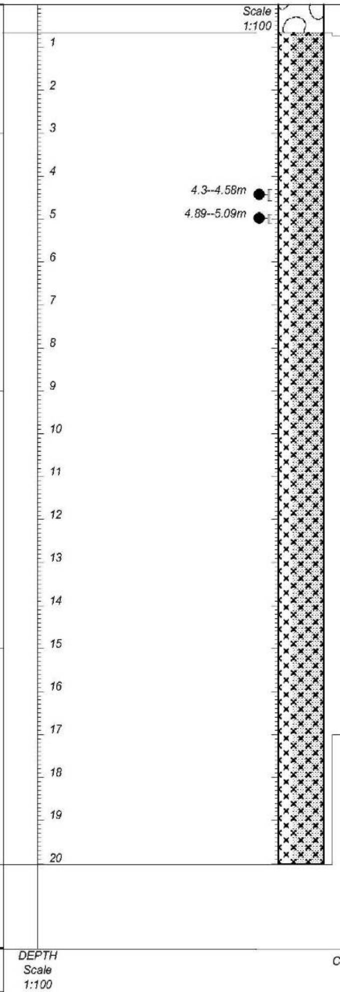
Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

HOLE No: NL2/9
Sheet 1 of 1

JOB NUMBER: 2819

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	73	32	n/a			
	100	100	1	90 Class i	94	-
TNW	94	82	2			
	75	75	0			0 lugeons
	110	110	2			
	83	83	0			
	121	121	1			
	99	9	1			
	83	83	0			0 lugeons
	101	101	2			
	98	98	1			
	100	100	2			
	100	100	1			
	100	100	1			0 lugeons
	104	104	1			
	93	93	1			



0.00 Dolerite boulders.

0.66 Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE.
Joints narrow, chlorite and calcite coated, rough.

20.03

NOTES

1) End of Hole at 20.03m.

2) Casing 0 to 1.5m.

3) Water rest level 11.0m.

4) Three main orthogonal joint sets: high angle approx. 70deg, moderate angle approx. 45deg, low angle >10deg.

5) Core samples taken between 4.3--4.58m and 4.89--5.09m.

CONTRACTOR : Weppelmann
MACHINE : D 45 R
DRILLED BY : Willem
PROFILED BY : T Speirs

TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 19-20 August 2013
DATE : September 2013

DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

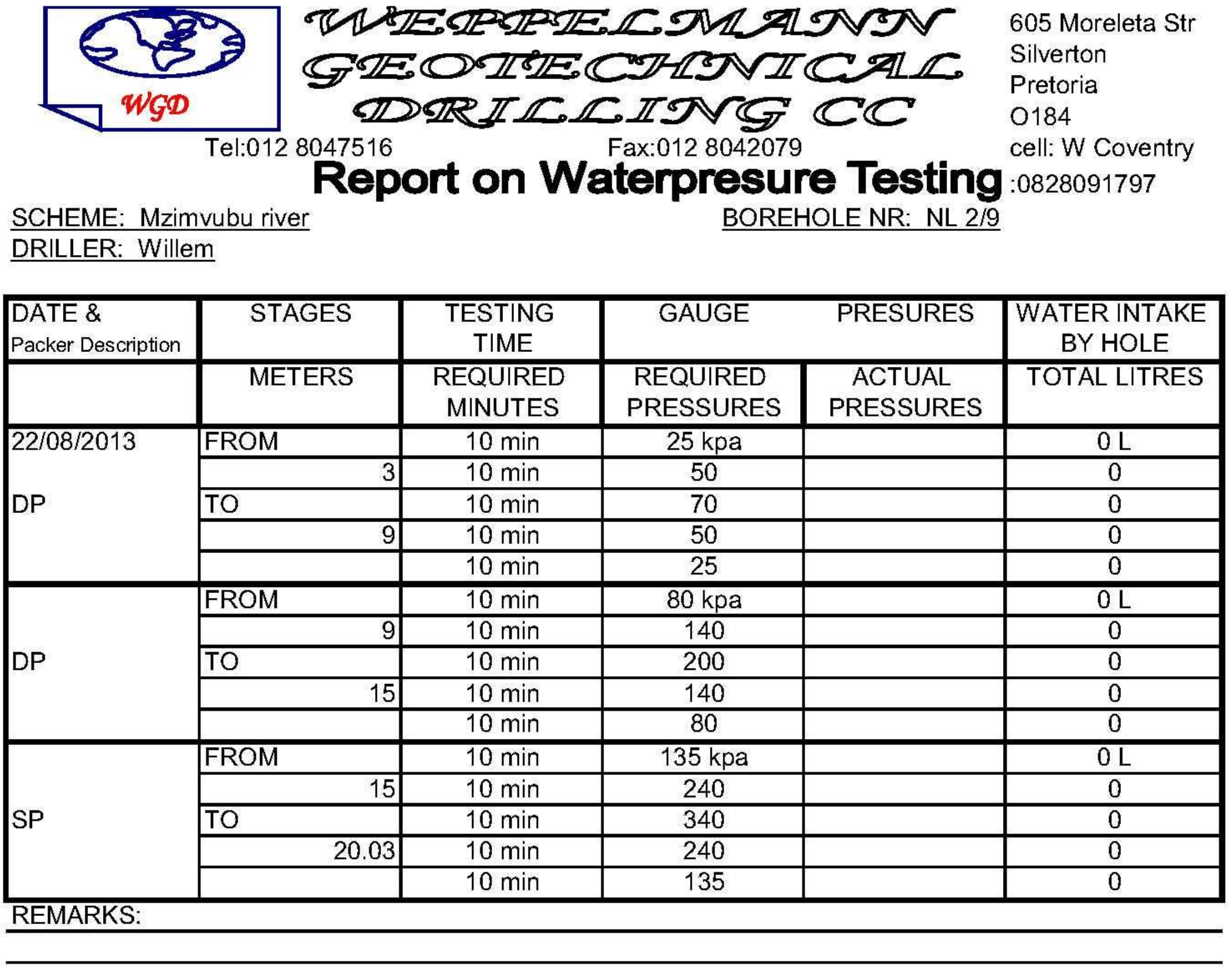
ELEVATION :
X-COORD : 31.11780deg S
Y-COORD : 28.67420deg E

HOLE No: NL2/9

D06C JGI

dotPLOT 7013 PBp7

Fig E-59: Borehole Logs (NL 2/9)



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Report on Waterpresure Testing

SCHEME: Mzimvubu river
BOREHOLE NR: NL 2/9
DRILLER: Willem

DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
22/08/2013	FROM	10 min	25 kpa		0 L
	3	10 min	50		0
DP	TO	10 min	70		0
	9	10 min	50		0
		10 min	25		0
	FROM	10 min	80 kpa		0 L
	9	10 min	140		0
DP	TO	10 min	200		0
	15	10 min	140		0
		10 min	80		0
	FROM	10 min	135 kpa		0 L
	15	10 min	240		0
SP	TO	10 min	340		0
	20.03	10 min	240		0
		10 min	135		0

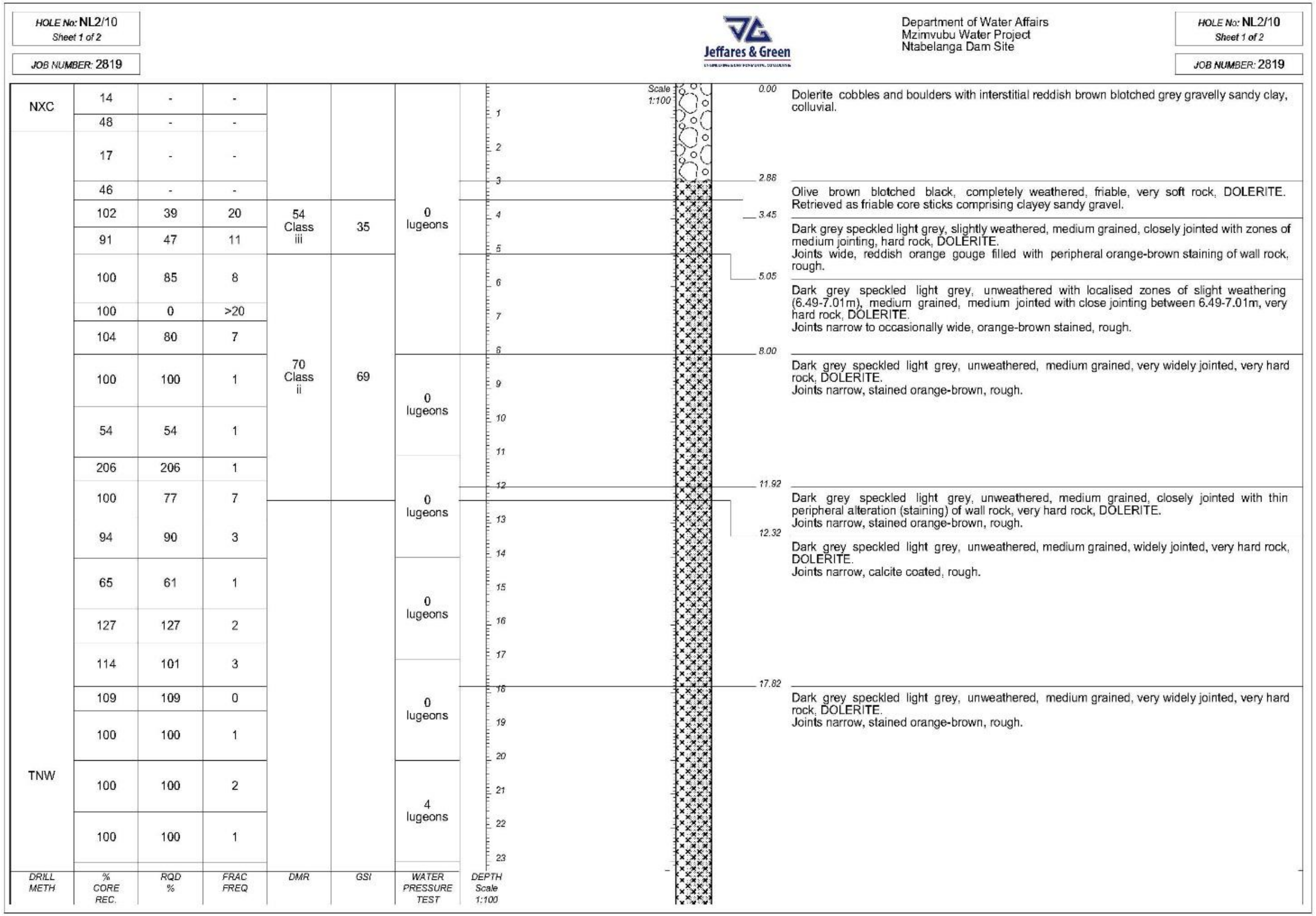
REMARKS:

Fig E-60: Water Pressure Testing Report (NL 2/9)

Fig E-61: **Borehole NL 2/9 Core Box 1 of 3**

Fig E-62: **Borehole NL 2/9 Core Box 2 of 3**

Fig E-63: **Borehole NL 2/9 Core Box 3 of 3**



HOLE No: **NL2**/10
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

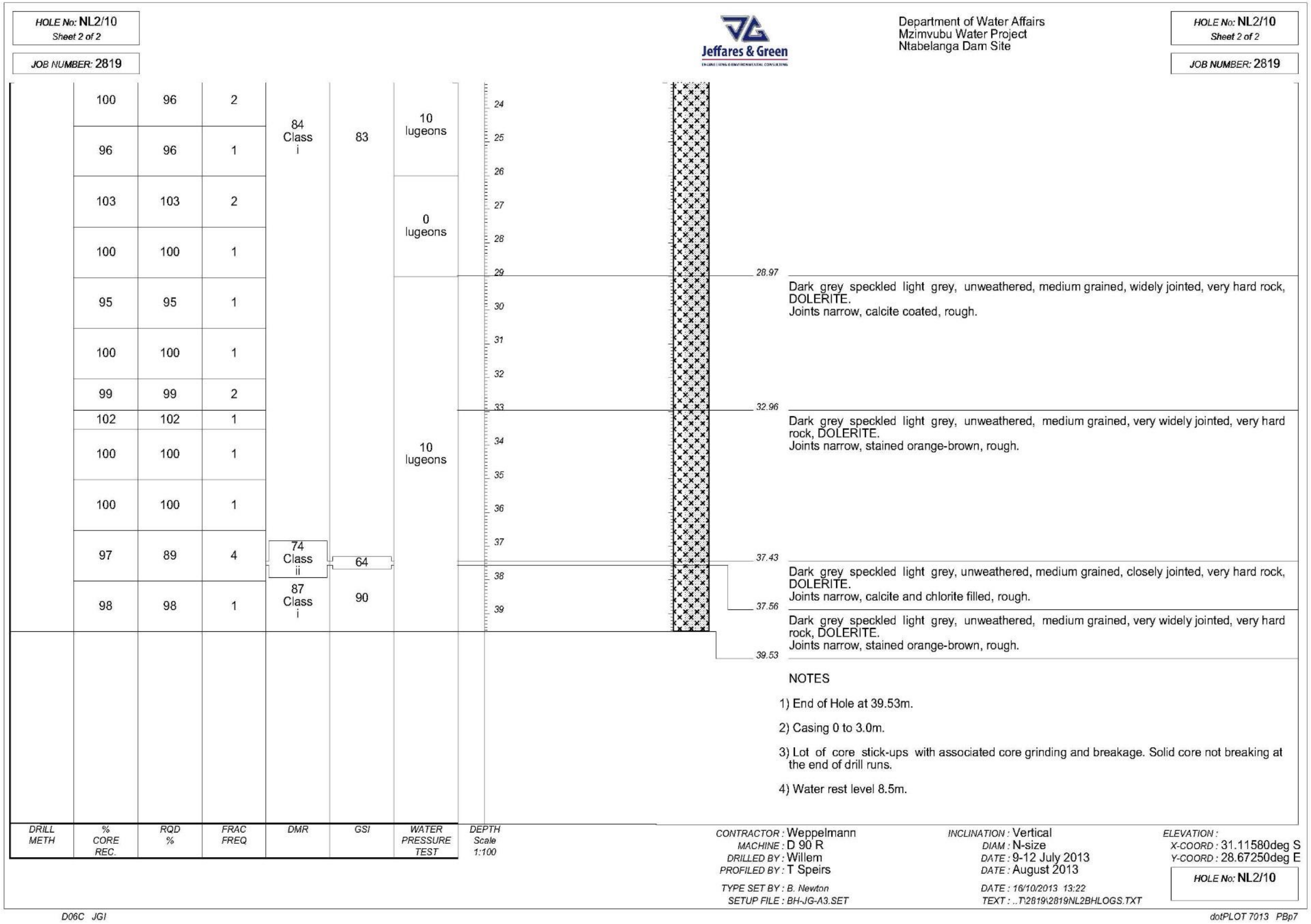
DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	14	-	-			
	48	-	-			
TNW	17	-	-			
	46	-	-			
	102	39	20	54 Class iii	35	0 lugeons
	91	47	11			
	100	85	8	70 Class ii	69	
	100	0	>20			
	104	80	7			
	100	100	1			0 lugeons
	54	54	1			
	206	206	1			0 lugeons
	100	77	7			
	94	90	3			
	65	61	1			0 lugeons
	127	127	2			
	114	101	3			
	109	109	0			0 lugeons
	100	100	1			
	100	100	2			4 lugeons
	100	100	1			

DEPTH Scale 1:100

Scale 1:100

0.00	Dolerite cobbles and boulders with interstitial reddish brown blotched grey gravelly sandy clay, colluvial.
2.88	Olive brown blotched black, completely weathered, friable, very soft rock, DOLERITE. Retrieved as friable core sticks comprising clayey sandy gravel.
3.45	Dark grey speckled light grey, slightly weathered, medium grained, closely jointed with zones of medium jointing, hard rock, DOLERITE. Joints wide, reddish orange gouge filled with peripheral orange-brown staining of wall rock, rough.
5.05	Dark grey speckled light grey, unweathered with localised zones of slight weathering (6.49-7.01m), medium grained, medium jointed with close jointing between 6.49-7.01m, very hard rock, DOLERITE. Joints narrow to occasionally wide, orange-brown stained, rough.
8.00	Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE. Joints narrow, stained orange-brown, rough.
11.92	Dark grey speckled light grey, unweathered, medium grained, closely jointed with thin peripheral alteration (staining) of wall rock, very hard rock, DOLERITE. Joints narrow, stained orange-brown, rough.
12.32	Dark grey speckled light grey, unweathered, medium grained, widely jointed, very hard rock, DOLERITE. Joints narrow, calcite coated, rough.
17.82	Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE. Joints narrow, stained orange-brown, rough.

Fig E-64-1: Borehole Logs (NL 2/10)



HOLE No: NL2/10
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
	100	96	2	84 Class i	83	10 lugeons
	96	96	1			
	103	103	2			0 lugeons
	100	100	1			
	95	95	1			10 lugeons
	100	100	1			
	99	99	2			
	102	102	1			
	100	100	1			
	100	100	1			
	97	89	4	74 Class ii	64	
	98	98	1	87 Class i	90	

DEPTH Scale 1:100

28.97
Dark grey speckled light grey, unweathered, medium grained, widely jointed, very hard rock, DOLERITE.
Joints narrow, calcite coated, rough.

32.96
Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE.
Joints narrow, stained orange-brown, rough.

37.43
Dark grey speckled light grey, unweathered, medium grained, closely jointed, very hard rock, DOLERITE.
Joints narrow, calcite and chlorite filled, rough.

37.56
Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE.
Joints narrow, stained orange-brown, rough.

39.53

NOTES

1) End of Hole at 39.53m.

2) Casing 0 to 3.0m.

3) Lot of core stick-ups with associated core grinding and breakage. Solid core not breaking at the end of drill runs.

4) Water rest level 8.5m.

CONTRACTOR : Weppelmann
MACHINE : D 90 R
DRILLED BY : Willem
PROFILED BY : T Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 9-12 July 2013
DATE : August 2013
DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

ELEVATION :
X-COORD : 31.11580deg S
Y-COORD : 28.67250deg E

HOLE No: NL2/10

D06C JGI

dotPLOT 7013 PBp7

Fig E-64-2: Borehole Logs (NL 2/10)

WEPPELMANN
GEOTECHNICAL
DRILLING CC
Tel:012 8047516 Fax:012 8042079

605 Moreleta Str
Silverton
Pretoria
O184
cell: W Coventry
:0828091797

Report on Waterpresure Testing

SCHEME: Mzimvubu river BOREHOLE NR: NL 2/10
DRILLER: Willem

DATE & Packer Description	STAGES	TESTING TIME	GAUGE	PRESURES	WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
	FROM 5.00m	10	45kpa	45kpa	190L
20-Jul		10	80kpa	80kpa	9L
	TO 8.00m	10	115kpa	115kpa	261L
DP		10	80kpa	80kpa	90L
		10	115kpa	115kpa	0
	FROM 8.00m	10	70kpa	70kpa	0
		10	130kpa	130kpa	1L
DP	TO 11.00m	10	180kpa	180kpa	0
		10	130kpa	130kpa	0
		10	70kpa	70kpa	0
	FROM 11.00m	10	100kpa	100kpa	0
		10	170kpa	170kpa	0
DP	TO 14.00m	10	250kpa	250kpa	0
		10	170kpa	170kpa	0
		10	100kpa	100kpa	0
	FROM 14.00m	10	125kpa	125kpa	0
		10	220kpa	220kpa	480L
DP	TO 17.00m	10	320kpa	320kpa	107L
		10	220kpa	220kpa	0
		10	125kpa	125kpa	0
	FROM 17.00m	10	155kpa	155kpa	0
		10	270kpa	270kpa	0
DP	TO 20.00m	10	358kpa	358kpa	0
		10	270kpa	270kpa	0
		10	155kpa	155kpa	0
	FROM 20.00m	10	180kpa	180kpa	0
21-Jul		10	320kpa	320kpa	684L
DP	TO 23.00M	10	450kpa	450kpa	1115L
		10	320kpa	320kpa	430L
		10	180kpa	180kpa	20L
	FROM 23.00m	10	210kpa	210kpa	29L
		10	365kpa	365kpa	0
DP	TO 26.00m	10	520kpa	520kpa	715L
		10	365kpa	365kpa	360L
		10	210kpa	210kpa	61L
	FROM 26.00m	10	235kpa	235kpa	2L
		10	410kpa	410kpa	542L
DP	TO 29.00m	10	590kpa	590kpa	721L
		10	410kpa	410kpa	458L
		10	235kpa	235kpa	0
	FROM 29.00m	10	265kpa	265kpa	250L
		10	460kpa	460kpa	962L
SP	TO	10	655kpa	590kpa	731L
		10	460kpa	460kpa	567L
		10	265kpa	265kpa	289L

REMARKS: Single packer used from 29.00m to bottom of BH. Due to bubble packer not advancing closure of BH

Fig E-65: Water Pressure Testing Report (NL 2/10)

Fig E-66: **Borehole NL 2/10 Core Box 1 of 6**

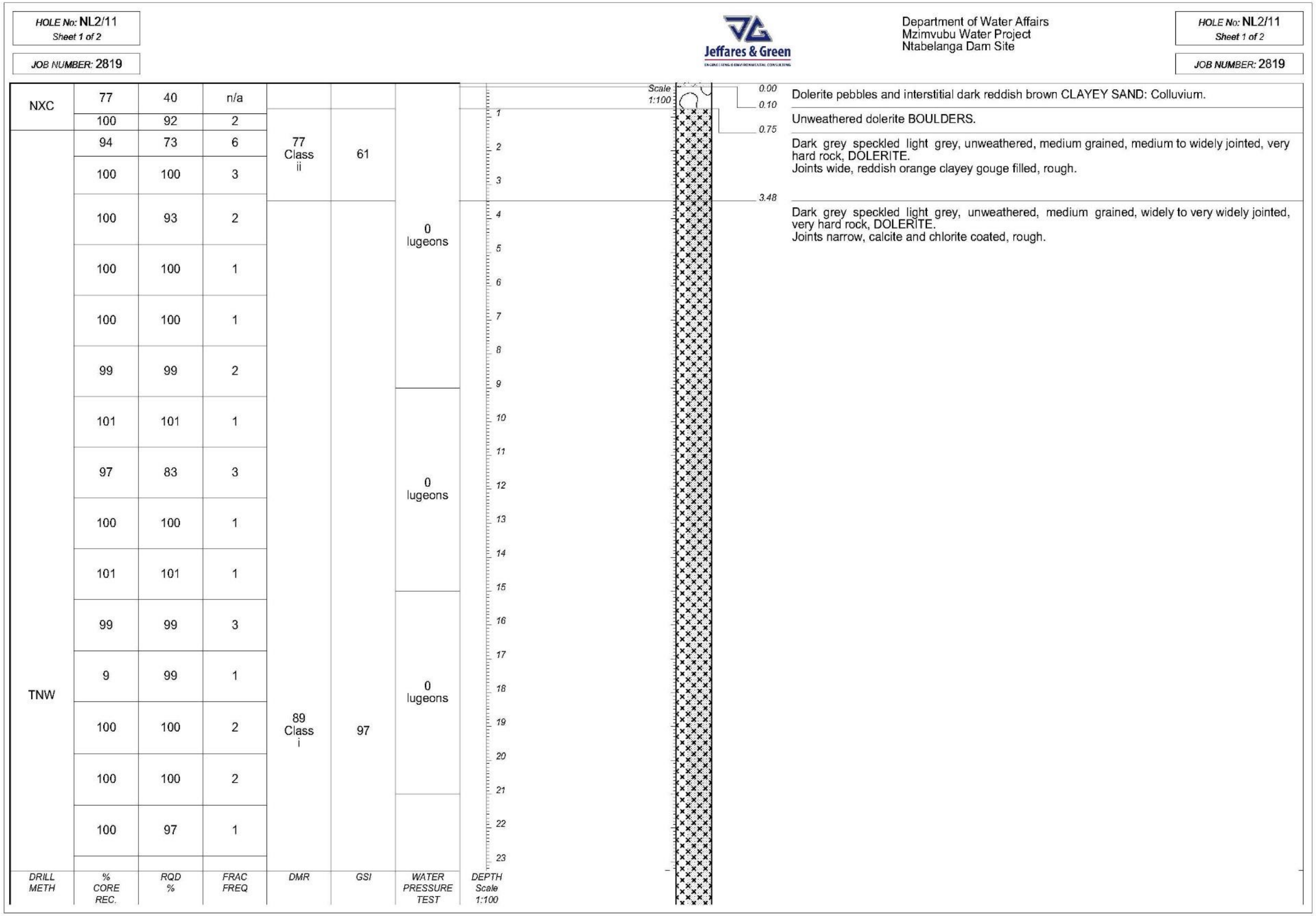
Fig E-67: **Borehole NL 2/10 Core Box 2 of 6**

Fig E-68: **Borehole NL 2/10 Core Box 3 of 6**

Fig E-69: **Borehole NL 2/10 Core Box 4 of 6**

Fig E-70: **Borehole NL 2/10 Core Box 5 of 6**

Fig E-71: **Borehole NL 2/10 Core Box 6 of 6**



HOLE No: NL2/11
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

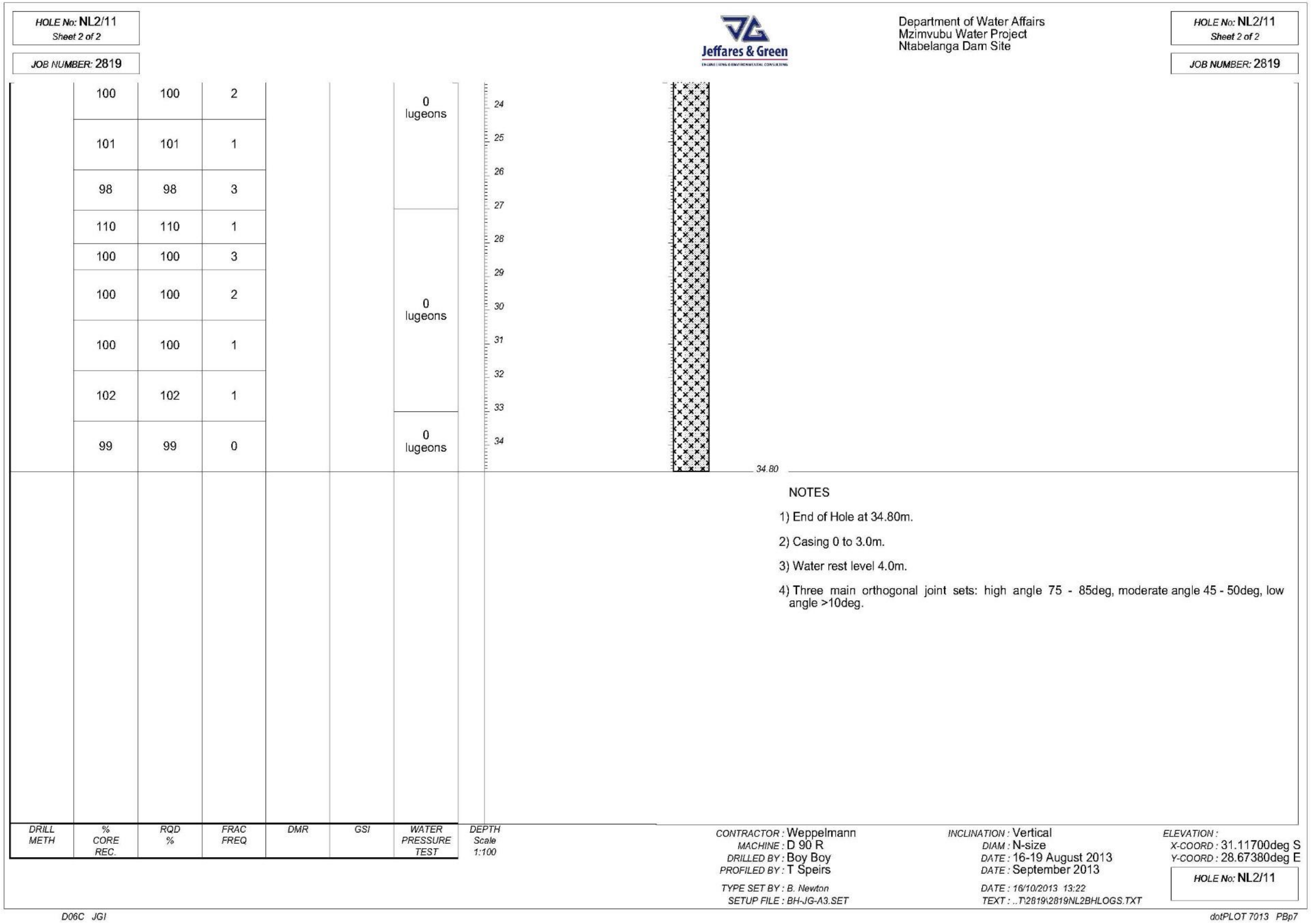
Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	77	40	n/a			0 lugeons
	100	92	2			
TNW	94	73	6	77 Class ii	61	
	100	100	3			
	100	93	2	89 Class i	97	
	100	100	1			
	100	100	1			
	99	99	2			
	101	101	1			0 lugeons
	97	83	3			
	100	100	1			
	101	101	1			
	99	99	3			0 lugeons
	9	99	1			
	100	100	2			
	100	100	2			
	100	97	1			

DEPTH Scale 1:100

Depth	Description
0.00 – 0.10	Dolerite pebbles and interstitial dark reddish brown CLAYEY SAND: Colluvium.
0.10 – 0.75	Unweathered dolerite BOULDERS.
0.75 – 3.48	Dark grey speckled light grey, unweathered, medium grained, medium to widely jointed, very hard rock, DOLERITE. Joints wide, reddish orange clayey gouge filled, rough.
3.48	Dark grey speckled light grey, unweathered, medium grained, widely to very widely jointed, very hard rock, DOLERITE. Joints narrow, calcite and chlorite coated, rough.

Fig E-72-1: Borehole Logs (NL 2/11)



HOLE No: NL2/11
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST	DEPTH Scale 1:100
	100	100	2			0 lugeons	24
	101	101	1				25
	98	98	3				26
	110	110	1			0 lugeons	27
	100	100	3				28
	100	100	2				29
	100	100	1				30
	102	102	1				31
	99	99	0			0 lugeons	34

NOTES

1) End of Hole at 34.80m.

2) Casing 0 to 3.0m.

3) Water rest level 4.0m.

4) Three main orthogonal joint sets: high angle 75 - 85deg, moderate angle 45 - 50deg, low angle >10deg.

CONTRACTOR : Weppelmann
MACHINE : D 90 R
DRILLED BY : Boy Boy
PROFILED BY : T Speirs

TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 16-19 August 2013
DATE : September 2013

DATE : 16/10/2013 13:22
TEXT : ..T\2819\2819NL2BHLOGS.TXT

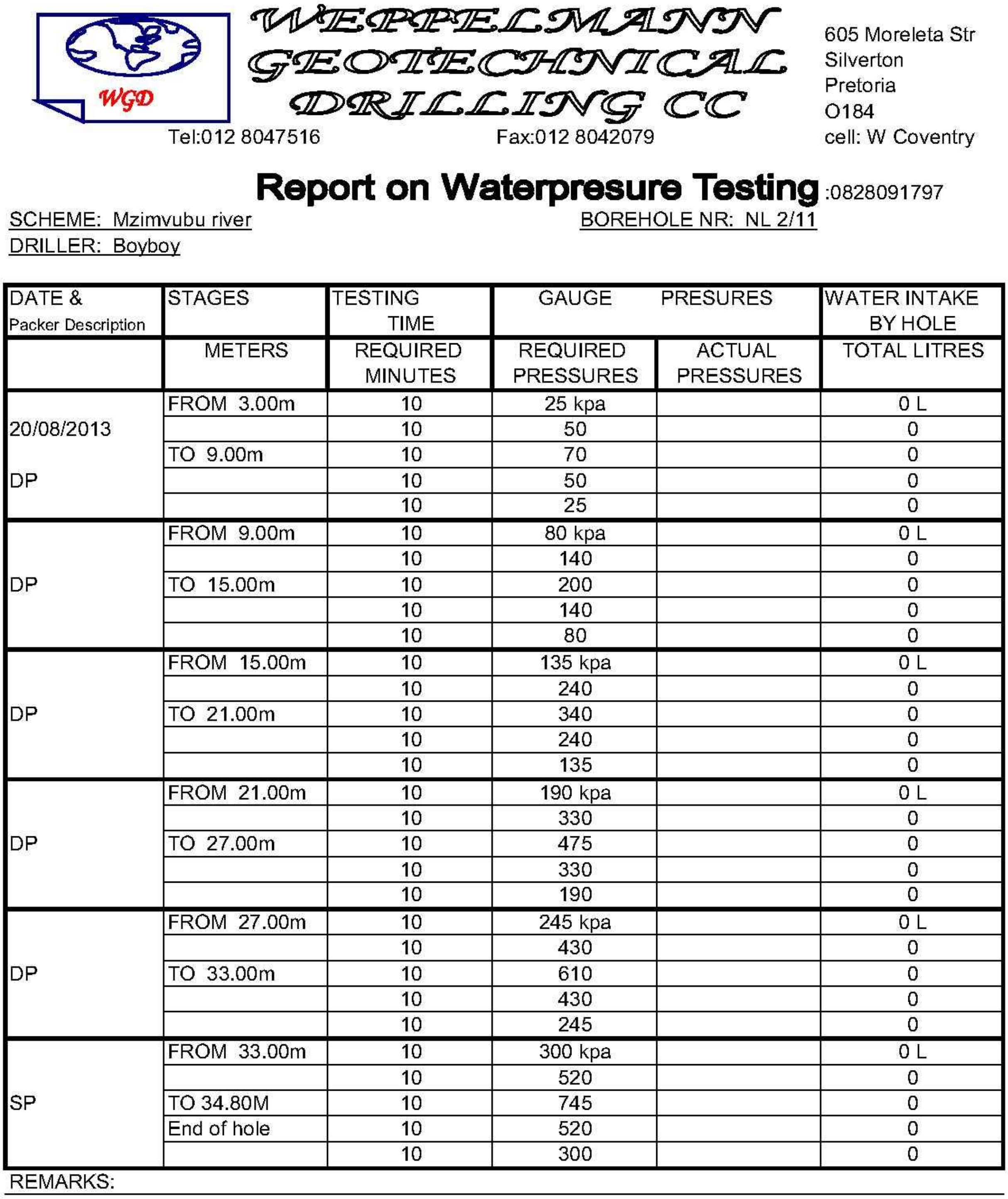
ELEVATION :
X-COORD : 31.11700deg S
Y-COORD : 28.67380deg E

HOLE No: NL2/11

D06C JGI

dotPLOT 7013 PBp7

Fig E-72-2: Borehole Logs (NL 2/11)



WGD

WEPPELMANN
GEOTECHNICAL
DRILLING CC

605 Moreleta Str
Silverton
Pretoria
O184
cell: W Coventry

Tel:012 8047516 Fax:012 8042079

Report on Waterpresure Testing :0828091797

SCHEME: Mzimvubu river
BOREHOLE NR: NL 2/11
DRILLER: Boyboy

DATE & Packer Description	STAGES	TESTING TIME	GAUGE PRESURES		WATER INTAKE BY HOLE
	METERS	REQUIRED MINUTES	REQUIRED PRESSURES	ACTUAL PRESSURES	TOTAL LITRES
	FROM 3.00m	10	25 kpa		0 L
20/08/2013		10	50		0
	TO 9.00m	10	70		0
DP		10	50		0
		10	25		0
	FROM 9.00m	10	80 kpa		0 L
		10	140		0
DP	TO 15.00m	10	200		0
		10	140		0
		10	80		0
	FROM 15.00m	10	135 kpa		0 L
		10	240		0
DP	TO 21.00m	10	340		0
		10	240		0
		10	135		0
	FROM 21.00m	10	190 kpa		0 L
		10	330		0
DP	TO 27.00m	10	475		0
		10	330		0
		10	190		0
	FROM 27.00m	10	245 kpa		0 L
		10	430		0
DP	TO 33.00m	10	610		0
		10	430		0
		10	245		0
	FROM 33.00m	10	300 kpa		0 L
		10	520		0
SP	TO 34.80M	10	745		0
	End of hole	10	520		0
		10	300		0

REMARKS:

Fig E-73: Water Pressure Testing Report (NL 2/11)

Fig E-74: **Borehole NL 2/11 Core Box 1 of 6**

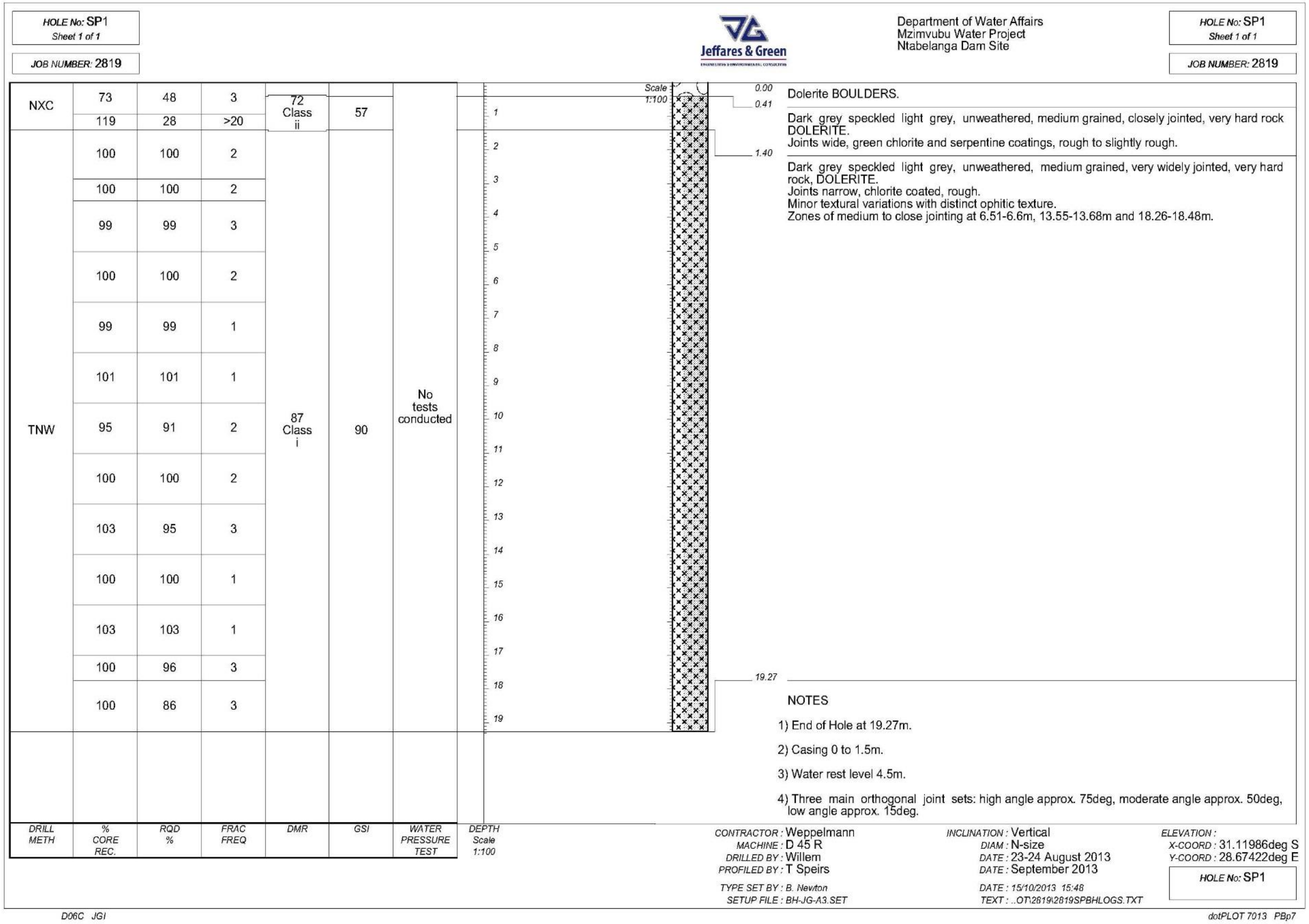
Fig E-75: **Borehole NL 2/11 Core Box 2 of 6**

Fig E-76: Borehole NL 2/11 Core Box 3 of 6

Fig E-77: Borehole NL 2/11 Core Box 4 of 6

Fig E-78: Borehole NL 2/11 Core Box 5 of 6

Fig E-79: Borehole NL 2/11 Core Box 6 of 6



HOLE No: SP1
Sheet 1 of 1

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	73	48	3	72 Class ii	57	No tests conducted
	119	28	>20			
TNW	100	100	2	87 Class i	90	
	100	100	2			
	99	99	3			
	100	100	2			
	99	99	1			
	101	101	1			
	95	91	2			
	100	100	2			
	103	95	3			
	100	100	1			
	103	103	1			
	100	96	3			
	100	86	3			

DEPTH Scale 1:100

Scale 1:100

0.00	Dolerite BOULDERS.
0.41	Dark grey speckled light grey, unweathered, medium grained, closely jointed, very hard rock DOLERITE. Joints wide, green chlorite and serpentine coatings, rough to slightly rough.
1.40	Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE. Joints narrow, chlorite coated, rough. Minor textural variations with distinct ophitic texture. Zones of medium to close jointing at 6.51-6.6m, 13.55-13.68m and 18.26-18.48m.
19.27	

NOTES

1) End of Hole at 19.27m.

2) Casing 0 to 1.5m.

3) Water rest level 4.5m.

4) Three main orthogonal joint sets: high angle approx. 75deg, moderate angle approx. 50deg, low angle approx. 15deg.

CONTRACTOR : Weppelmann
MACHINE : D 45 R
DRILLED BY : Willem
PROFILED BY : T Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 23-24 August 2013
DATE : September 2013
DATE : 15/10/2013 15:48
TEXT : ..OT\2819\2819SPBHLOGS.TXT

ELEVATION :
X-COORD : 31.11986deg S
Y-COORD : 28.67422deg E

HOLE No: SP1

D06C JGI

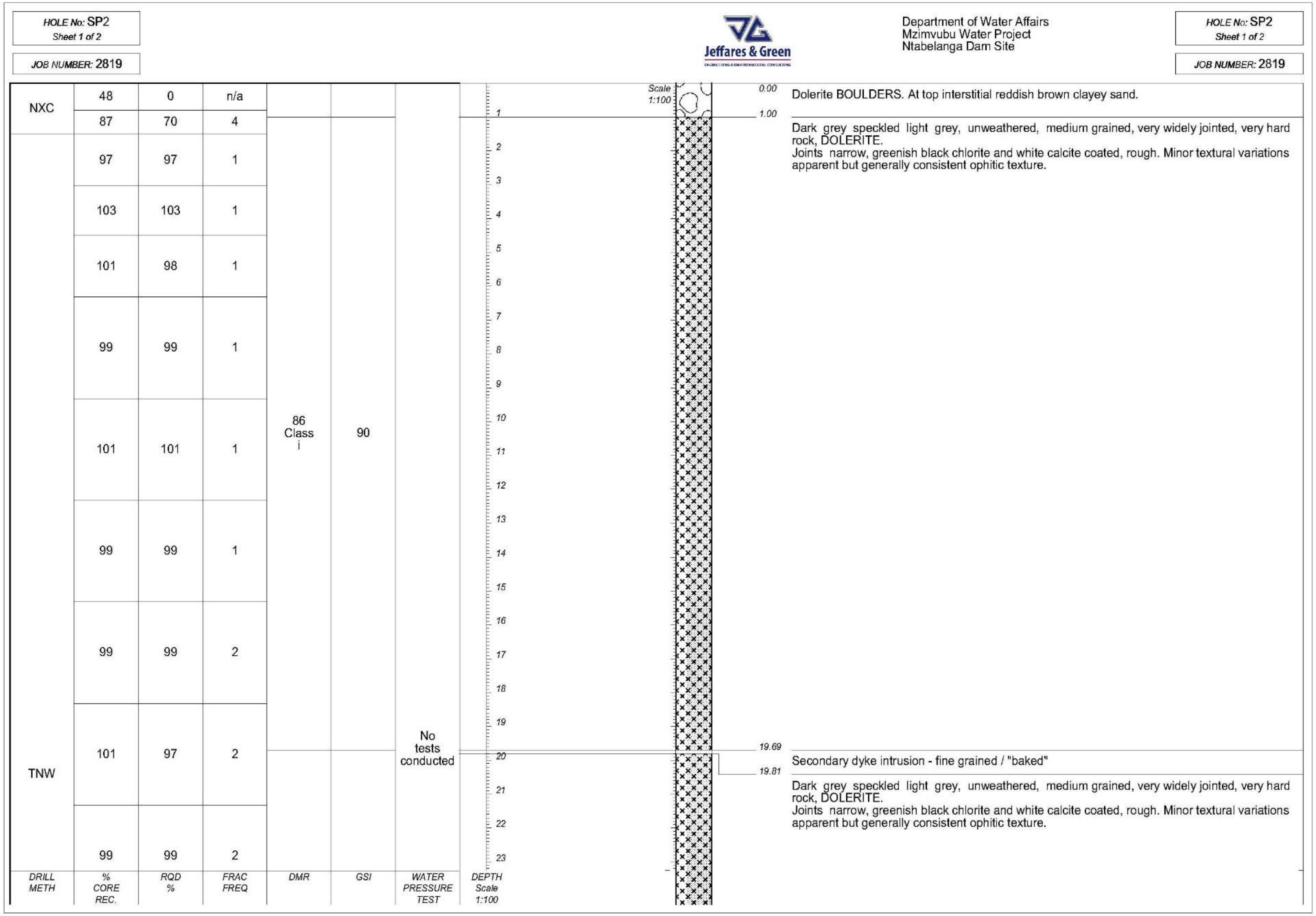
dotPLOT 7013 PBp7

Fig E-80: Borehole Logs (SP 1)

Fig E-81: **Borehole SP 1 Core Box 1 of 3**

Fig E-82: **Borehole SP 1 Core Box 2 of 3**

Fig E-83: Borehole SP 1 Core Box 3 of 3



HOLE No: SP2
Sheet 1 of 2
JOB NUMBER: 2819

Jeffares & Green

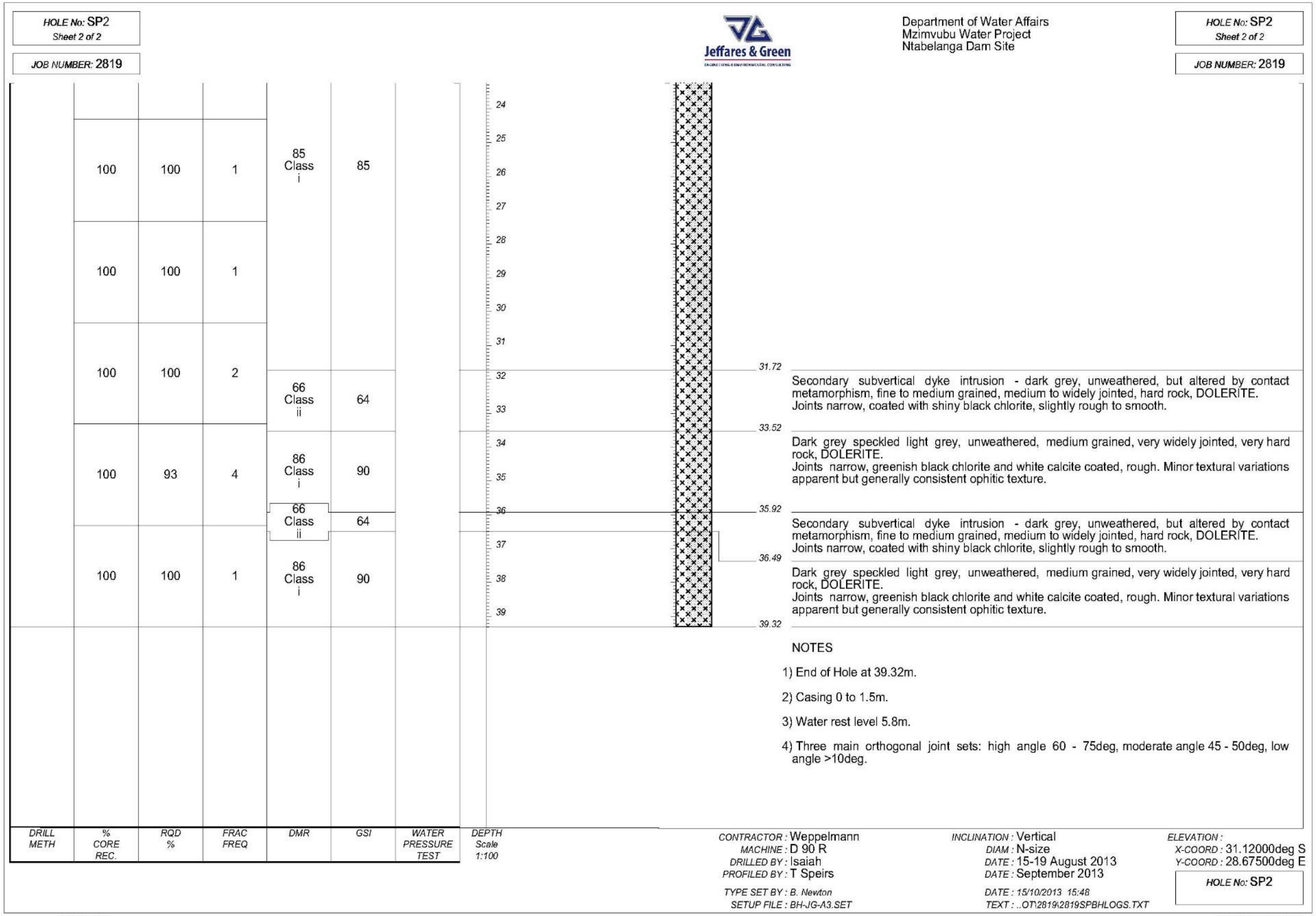
Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	48	0	n/a			No tests conducted
	87	70	4	86 Class i	90	
	97	97	1			
	103	103	1			
	101	98	1			
	99	99	1			
	101	101	1			
	99	99	1			
	99	99	2			
TNW	101	97	2			
	99	99	2			

DEPTH Scale 1:100

Depth	Description
0.00	Dolerite BOULDERS. At top interstitial reddish brown clayey sand.
1.00	Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE. Joints narrow, greenish black chlorite and white calcite coated, rough. Minor textural variations apparent but generally consistent ophitic texture.
19.69	Secondary dyke intrusion - fine grained / "baked"
19.81	Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE. Joints narrow, greenish black chlorite and white calcite coated, rough. Minor textural variations apparent but generally consistent ophitic texture.

Fig E-84-1: Borehole Logs (SP 2)



HOLE No: SP2
Sheet 2 of 2
JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
	100	100	1	85 Class i	85	
	100	100	1			
	100	100	2	66 Class ii	64	
	100	93	4	86 Class i	90	
				66 Class ii	64	
	100	100	1	86 Class i	90	

DEPTH Scale 1:100

31.72	Secondary subvertical dyke intrusion - dark grey, unweathered, but altered by contact metamorphism, fine to medium grained, medium to widely jointed, hard rock, DOLERITE. Joints narrow, coated with shiny black chlorite, slightly rough to smooth.
33.52	Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE. Joints narrow, greenish black chlorite and white calcite coated, rough. Minor textural variations apparent but generally consistent ophitic texture.
35.92	Secondary subvertical dyke intrusion - dark grey, unweathered, but altered by contact metamorphism, fine to medium grained, medium to widely jointed, hard rock, DOLERITE. Joints narrow, coated with shiny black chlorite, slightly rough to smooth.
36.49	Dark grey speckled light grey, unweathered, medium grained, very widely jointed, very hard rock, DOLERITE. Joints narrow, greenish black chlorite and white calcite coated, rough. Minor textural variations apparent but generally consistent ophitic texture.
39.32	

NOTES

1) End of Hole at 39.32m.
2) Casing 0 to 1.5m.
3) Water rest level 5.8m.
4) Three main orthogonal joint sets: high angle 60 - 75deg, moderate angle 45 - 50deg, low angle >10deg.

CONTRACTOR : Weppelmann
MACHINE : D 90 R
DRILLED BY : Isaiah
PROFILED BY : T Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 15-19 August 2013
DATE : September 2013
DATE : 15/10/2013 15:48
TEXT : ..OT\2819\2819SPBHLOGS.TXT

ELEVATION :
X-COORD : 31.12000deg S
Y-COORD : 28.67500deg E
HOLE No: SP2

D06C JGI

dotPLOT 7013 PBp7

Fig E-84-2: Borehole Logs (SP 2)

Fig E-85: Borehole SP 2 Core Box 1 of 6

Fig E-86: Borehole SP 2 Core Box 2 of 6

Fig E-87: **Borehole SP 2 Core Box 3 of 6**

Fig E-88: **Borehole SP 2 Core Box 4 of 6**

Fig E-89: **Borehole SP 2 Core Box 5 of 6**

Fig E-90: **Borehole SP 2 Core Box 6 of 6**

HOLE No: SP3
Sheet 1 of 1

JOB NUMBER: 2819

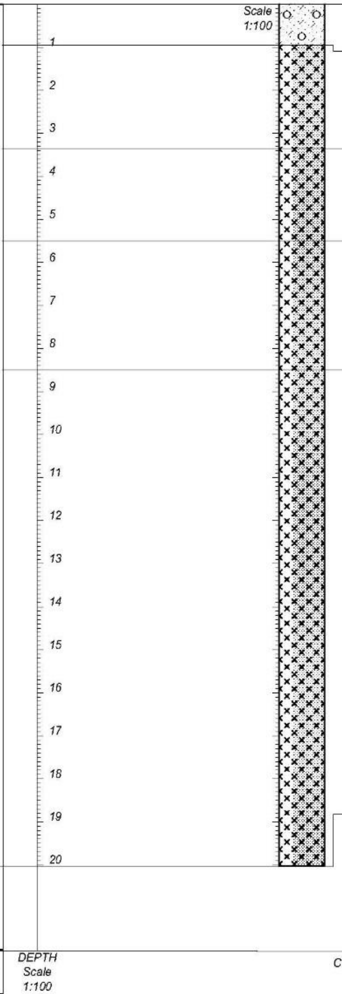
Jeffares & Green

Department of Water Affairs
Mzimvubu Water Project
Ntabelanga Dam Site

HOLE No: SP3
Sheet 1 of 1

JOB NUMBER: 2819

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	48MR	-	-			No tests conducted
	30MR	-	-			
TNW	73	0	>20			
NWD4	81	0	>20			
	9	0	>20			
	100	0	>20			
	100	0	>20	42 Class iii	34	
	91	0	>20			
	94	0	>20			
	98	0	>20			
	98	91	9	81 Class i	84	
	97	79	5			
TNW	110	106	4			
	102	95	4			
	100	83	9			
	99	99	2			
	100	100	3			



0.00	Colluvial soil transitional to reddish orange speckled / blotched yellow, CLAYEY GRAVELLY SAND: Resudial dolerite.
0.95	Olive grey-brown, completely weathered, friable, very soft rock, DOLERITE.
3.35	Olive grey, highly weathered, closely jointed, very soft rock, DOLERITE.
5.50	Grey, medium weathered to slightly weathered, medium grained, very closely jointed, medium hard becoming hard rock, DOLERITE. Joints wide, stained with thin gouge fill, rough.
8.50	Dark grey speckled light grey, unweathered, medium grained, widely jointed, very hard rock, DOLERITE. Joints narrow, iron oxide stained, calcite and chlorite coated, rough. Between 13.79-13.99m and 16.13-16.19m zones of more intense weathering and fracturing.
20.04	

NOTES

1) End of Hole at 20.04m.

2) Casing 0 to 6.0m.

3) Water rest level - No water

CONTRACTOR : Weppelmann
MACHINE : D 90 R
DRILLED BY : Isaiah
PROFILED BY : T Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 21-23 August 2013
DATE : September 2013
DATE : 15/10/2013 15:48
TEXT : ..OT\2819\2819SPBHLOGS.TXT

ELEVATION :
X-COORD : 31.12014deg S
Y-COORD : 28.67611deg E

HOLE No: SP3

D06C JGI

dotPLOT 7013 PBp7

Fig E-91: Borehole Logs (SP 3)

Fig E-92: **Borehole SP 3 Core Box 1 of 3**

Fig E-93: **Borehole SP 3 Core Box 2 of 3**

Fig E-94: Borehole SP 3 Core Box 3 of 3

APPENDIX F

COUNCIL FOR GEOSCIENCE REPORT ON SEISMIC REFRACTION AND ELECTRICAL RESISTIVITY SURVEYS

Council for Geoscience

Report on the Refraction Seismic and Electrical Resistivity surveys

Prepared for

Jeffares & Green (Pty) Ltd for the Ntabelanga dam site feasibility study.

By

M. Sethobya, P. Nyabeze and R. Legotlo.

Council for Geoscience, South Africa

Project No: C0- 2010-5122

Report No:2013-0257

Confidential

Table of Contents

Table of Figures

Executive Summary

Refraction seismic and Electrical Resistivity tomography(ERT) surveys were conducted as part of the Mzimbuvu water project at the Ntabelanga Dam site along the Tsitsa river, by the Council for Geoscience on behalf of Jefferson and Green(Pty) Ltd as part of their geotechnical investigations. The main aims of the surveys were to accurately determine;

1. the thickness of the overburden (transported and residual soils) that overly the bedrock
2. the depth to bedrock and
3. Determine the rippability of the profile at the dam site

The surveys were carried out at predetermined lines at each side of the river. For purposes of easy data management, each portion (spread of measured line) was treated as an individual line. A total of 4 lines were surveyed. See figure 1.All the lines were sampled at 5m intervals for both the Seismics and ERT surveys. Data was collected at exactly the same points/stations for the two techniques to ensure accuracy in comparing the results. The 24 channel Seistronox seimograph was used to do the seismic surveys. A sledge hammer and base plate were used as a source of energy.

Very high quality shots were observed with stacking and repeat shots being taken for quality control purposes. For the ERT surveys, an IRIS automated resistivity meter-Syscal Pro Switch 72 was employed to aquire ground resitivity data.The lines were then marked with a handheld Garmin SCx60.The topography for data processing was surveyed using a submeter accuracy Leica RS20 differential GPS.

1 INTRODUCTION

1.1 BACKGROUND

The Council for Geoscience was appointed by Jeffares & Green (Pty) Ltd in August 2013 to conduct Geophysical Seismic and multi-Electrode Resistivity Tomography (ERT) Investigations. The investigations were to be carried out at specifically selected lines at the intended Ntabelanga Dam site along the Tsitsa river,for the Mzimbuvu Water project near the town of Tsolo, Eastern Cape province. The seismic surveys were meant to augment the drilling being carried out by the client and to allow interpolation between and extrapolation from borehole data in order to determine overburden thickness, depth to bedrock and to determine the rippability of the profile at the dam site location as part of the engineering properties classification for the dam design.

The specified survey areas as per the terms of refence are summarized in Table 1 with a total of 810m having been marked for the Seismic and ERT surveys.

Table 1

Location	**Line Length**	**Measured length(Seismics)**	**Measured length(ERT)**	**Borehole/s intersected**
Line 1	180m	180m	180m	NL29, NL26 & N2.
Line 2	180m	180m	270m	N2
Line 3	180m	180m	180m	N3
Line 4	180m	180m	180m	N1

1.2 OBJECTIVES

As part of the augmentation of the drilling program information, the main aims of the seismic investigations were to accurately determine;

1. the thickness of the overburden (transported and residual soils) that overly the bedrock
2. the depth to bedrock and
3. Determine the rippability of the profile at the dam site location
4.

The seismic and ERT survey results are also to be used for interpolation between and extrapolation from borehole data.

2 GEOLOGY OF THE AREA.

The area falls within the Ntabene formation of the Molteno subgroup in the main Karoo sequence. Predominant lithological bodies are the sandstones, red mudstones and shale, with dolerite intrusions(Johnson et al,2006),which are clearly mapped around the survey area. Position of the survey area follows a dolerite outcrop on the south-eastern side of the river and a relatively thick mudstone cover overlying sandtone beds in the western side of the river(figure 1). As a dam design strategy, excavation is envisaged to reach depths of the competent dolerite body to ensure support of the foundation structure.

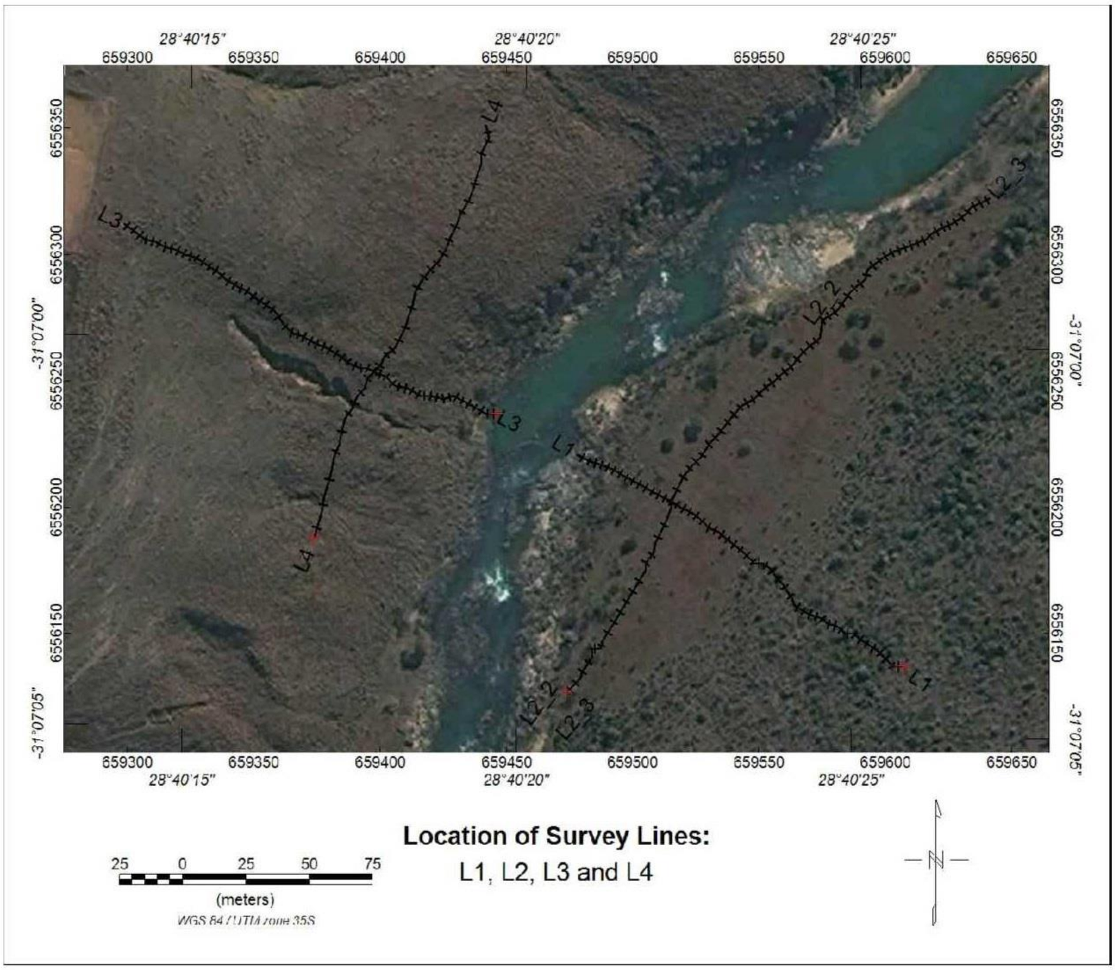


Figure 1 :The survey area showing location of the surveyed lines. The red marks indicate the start positions of the Seismics and ERT lines

3 METHODOLOGY

3.1 SEISMIC METHOD OVERVIEW

Seismic methods measure the velocity of energy transmitted through the soil and rocks. Inferences can be made from observed velocities and then be used to determine subsurface information that include depth to bedrock, bedrock topography, rippability of geological layers as well as other geological information such as the presence of faults, fractures, shear zones and water. The method has an advantage of less interference common with other methods as it can be applied to investigations located near power lines, ferrous objects and areas with saturated clays and those with topographic irregularities.

3.2 SEISMIC DATA ACQUISITION AND QUALITY CONTROL

The Ras-24 is an exploration seismograph that is manufactured by Seistronix in the USA. This instrument is designed to carry out seismic refraction surveys and has the capability of using up to 24 channels to collect data in the field. The Ras 24 uses two seismic cables that are connected to a set of 24 geophones. The maximum distance between the géophones is 5m (as specified by the cable), with the maximum length being 115m. Distance between the geophones depends on the depth of investigation and the objectives of the survey. The Ras-24 permits the user to stack multiple shots on top of each other, which in-turn increase the data quality and minimise the noise. The acquisition parameters (sample interval, record length, delay, filters, stack mode and stack polarity) are chosen by looking at the geology of the area. If the parameters do not seem suitable when the survey is started, the parameters can be changed on site.Figure 2 shows the Seistronix Ras 24 seismograph with the trigger cable and the battery source connected to it.

To improve data quality stacking of shots was used per shot location in order to increase the signal to noise ratio. Depending on the signal strength of the arrivals a minimum of two signals were stacked if the arrival breaks were clear and distinct and in some cases up to twenty signals or more were stacked in order to amplify the signal to noise ratio especially for the off-set shots. For every shot location at least one or more repeat shot records were taken as an additional quality control measure for use during the data processing.

The Leica RS20 Differential GPS was used to take the coordinates of each geophone location and where poor satellite reception was encountered interpolation using the Leica program was done.

Figure 2. The seistronix Ras-24 seismograph with a battery source connected to it.

3.3 ELECTRIC RESISTIVITY TOMOGRAPHY (ERT)- METHOD OVERVIEW

Multi-electrode resistivity tomography (ERT) surveys deduce the subsurface resistivity distribution by making measurements on the ground surface. From these measurements, the true resistivity of the subsurface can be estimated. The main principle of ground electrical resistivity is based on that, the distribution of electrical potential in the ground around a current-carrying electrode depends on the electrical resistivity and distribution of surrounding soils and rocks. The resistivity survey consist of current and potential electrodes, the current is directly injected into the ground by two electrodes (C1 and C2) and the voltage measured by two potential electrodes (P1and P2) as illustrated in Figure 3.

The true resistivity of the subsurface can be determined by inversion of the measured apparent resistivity values using a computer program. The current and potential electrodes are arranged in a linear array like Schlumberger, Wenner and dipole-dipole arrays. Each array is capable of performing a certain objective of the study; therefore the choice of the array is dependent on the nature of the study and the efficiency in acquiring data.

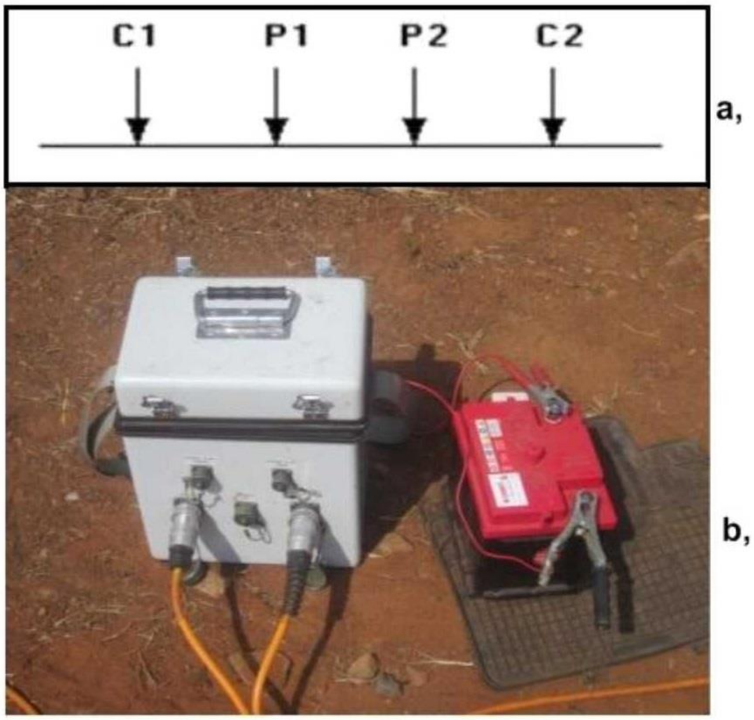


Figure 3. a, Illustration of the dipole-dipole electrode configuration as used in resistivity survey to measure subsurface resistivity. b, The IRIS Syscal Pro Switch 72 multi electrode resistivity instrument with a battery source.

3.4 ERT DATA ACQUISITION AND QUALITY CONTROL

ERT data was acquired using Syscal Pro Switch 72 multi electrode resistivity instrument (Figure 3). The instrument uses multi-core cables for controlling a set of 72 electrodes connected in a line. Resistivity data is measured automatically and stored in an internal memory. It has an internal 12V battery and an option to use an external battery for increased operation hours.

Dipole-dipole array was used to acquire data at 5 m electrode spacing to ensure more detailed data is acquired and maximum depth coverage at high lateral resolution.

4 DATA SUMMARY

4.1 SEISMICS

All lines were measured to a length of 180m owing to the nature of the seismic cables being used. Each cable measures a length of 60m(a single spread), thereby allowing 3 spreads per line. Efforts were made to measure lines at their exact locations and to cover the area closest to the river as best as possible.

4.2 ERT

All lines were measured to a distance of 180m using both the dipole dipole and Schlumbegger arrays.The ERT lines were measured at the same positions where seismic data was collected, barring line 2, which had a 90m extension in the Northeastern direction(Figure 9).

A summary of the survey lines and coodinates is given in table 1.

Table 1: Summary of seismic and ERT traverses details as picked by the Leica DGPS.

Line	**Length**	**Start Coordinates**		**End Coordinates**	
Name	**(m)**	**Lat**	**Long**	**Lat**	**Long**
Line 1	180	-31.11781°	28.673819°	-31.11709°	28.6724991°
Line 2	180	-31.11793°	28.672465°	-31.11663°	28.673464°
Line 3	180	-31.116922°	28.672119°	-31.116267°	28.670562°
Line 4	180	-31.117380°	28.671368°	-31.115903°	28.672053°
Line 2_ext	270	-31.11793°	28.672465°	-31.11611°	28.674196°

5 DATA PROCESSING AND INTERPRETATION

5.1 SEISMICS

Data was dumped onto a PC from the Seismograph on a daily basis after field work. Shots were analysed for obvious noise and each shot was compared with its duplicate since 2 shots were taken per every shot location as a quality control procedure. At each shot location , multiple stacks were taken to ensure that high data quality is maintained. A method called the Plus-Minus method whereby the forward and reverse travetimesare used to determine the depth to bedrock under each geophone was then used to do interpretation. This method entails entering the first arrivals for all shot configurations along the spread, plotting of traveltime curves (using the spreadsheet plotting function), selection of the seismic velocities, and some simple column manipulation (Fourie and Odgers, 1995). The spreadsheet will then automatically calculate the parameters needed to determine the depth to the refractors and allows for elevation corrections.

Forward and reverse traveltimes are plotted against offset, from which the seismic velocity of the weathering layer and the refractor(s) may be determined. These velocities are then used to calculate the geometrical factor known as the k- factor for the refraction spread. The k-factor is then multiplied by the ‘Plus’ values to provide the depth to the refractor at each receiver location.

The ‘Plus’ values are obtained by adding the forward and reverse traveltimes at each receiver and subtracting the total traveltime from the sum whilst the ‘Minus’ values calculated by substracting the forward from the reverseat each receiver station. A plot of the minus versus the offset provides information on the refractor velocity given by:

(Refractor velocity = 2 x the slope of the Minus curve)

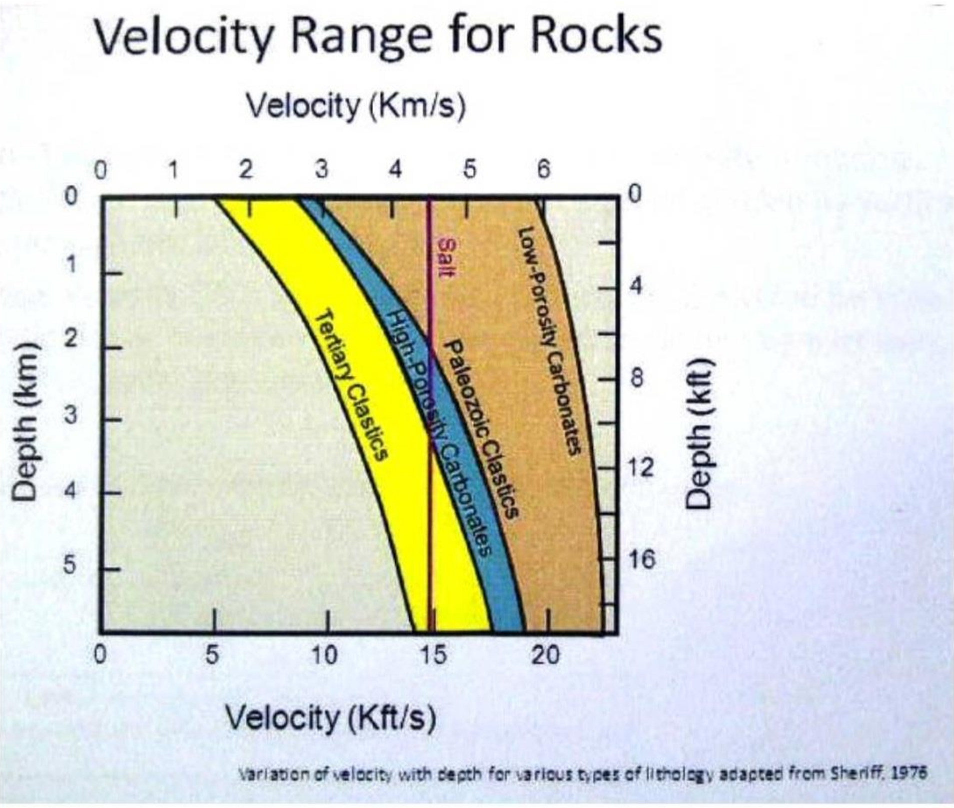
A reference velocity range plot is used to differenciate and interpret different rock types and formation based on their responses to seimic wave propagation.(figure 4)

5.2 ERT

After the data acquisition phase, data is stored in the internal memory of the instrument and downloaded onto a computer. The resistivity measurements are reduced to apparent resistivity values using the Prosys 11 software. The data is then interpreted using a 2D model that consists of a large number of rectangular blocks. A computer program (RES2DINV) is used to determine the resistivity of the blocks for the calculated apparent resistivity values to agree with the field measured values. Using the modeling program, 2D models of the subsurface resistivity are generated. The modeled results are then exported to “XYZ” format and geo-referenced for 2D gridding in Geosoft software.

6 RESULTS

The results will be presented and discussed per specific line for both the techniques.The tables included in this section will represent the relative results comparims for each line and deduced interpretations. Seismics results will be presented as 2D sections along the measured lines. ERT survey results are presented as 2D resistivity-depth models with the location of boreholes projected onto the models where applicable.



Variation of velocity with depth for various types of lithology adapted from Sheriff, 1976

Figure 4. Reference seismic velocity range plot for rocks.(Adopted from Sheriff 1978, American Association of petroleum geologists.)

6.1 Line 1

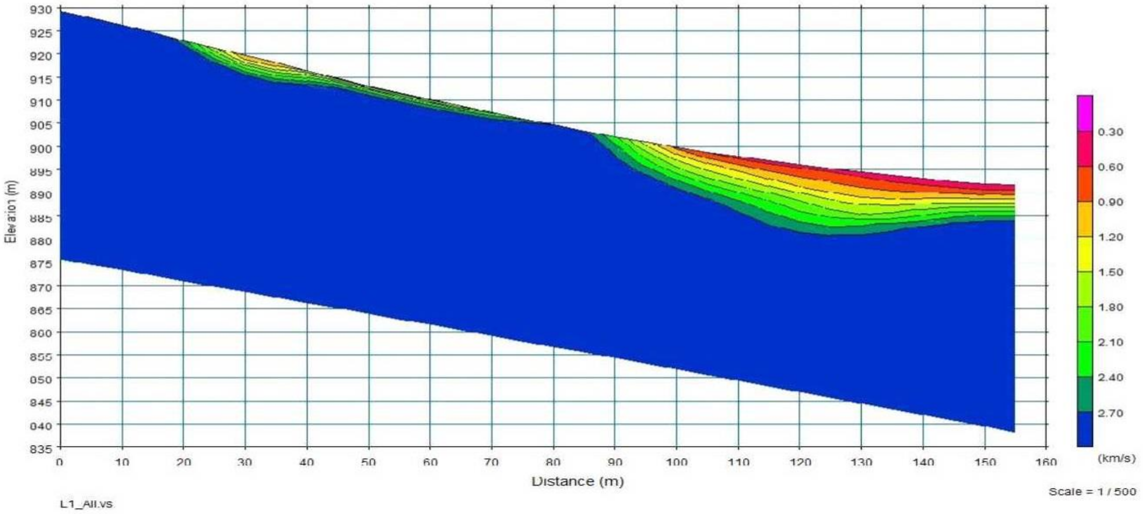


Figure 5. Seimics section along line 1.

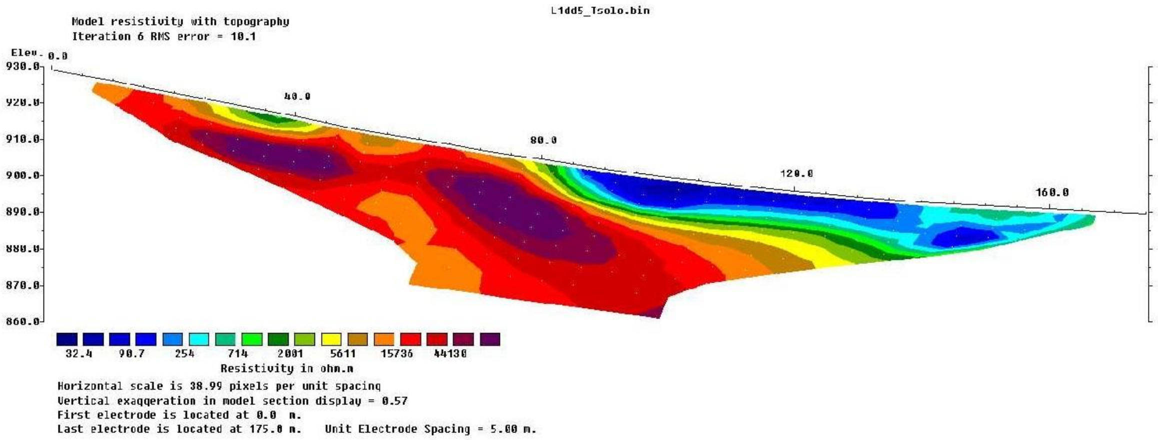


Figure 6. ERT section along line 1 (Dipole dipole array)

Results discussions-Line 1

The sections on this line shows a competent and well exposed dolerite outcrop that extent from the start of line to the river. Closer to the river the dolerite is covered by thin overburden comprising some clayey gravel and partly saturated residium.The sections concurs well with results from the logged borehole (N2) which is intersected by this line. The dorerite exhibits high resistivities and high seismic velocities in the range ±2.5km/h or higher, which is usual for hard rocks. The loose and unconsolidated material (gravel and residium) closer to the river at line 1 will be easily excavatable, the dolerite will present some challenges as it is a hard competent rock. Interpretations of the results acquired with both the techniques on line 1 are presented in table 2.

Table 2

Layer	**Model velocity (km/s)**	**Model Resistivity (Ohm.m)**	**Depth range (m)**	**Soil/rock type**
Layer 1	0.3-0.9	(Layer 1) 32-300	0 – 6(@120-180m)	clayey gravel and partially saturated residium
Layer 2	0.9-2.9	(Layer 2) 300-44000	0-(>)40(@0-90m)	Hard, competent dolerite

Boreholes:

NL29 is positioned at -30m from start of line 1.

NL26 is intersected at 75m on line 1.

N2 is intersected at 135m on line 1.

6.2 Line 2

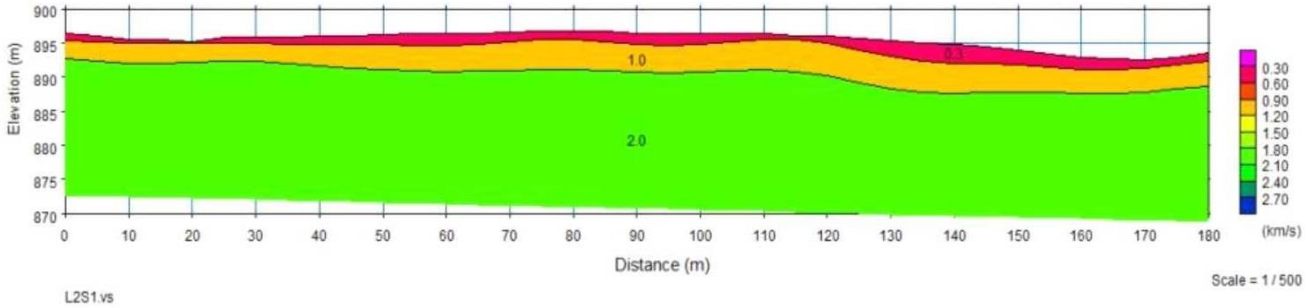


Figure 7. Modelled Seismic section along line 2.

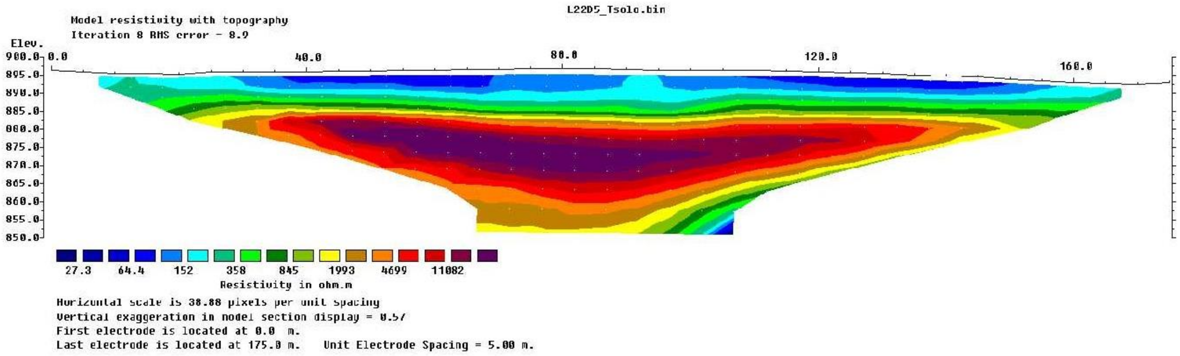


Figure 8. ERT section along line 2.

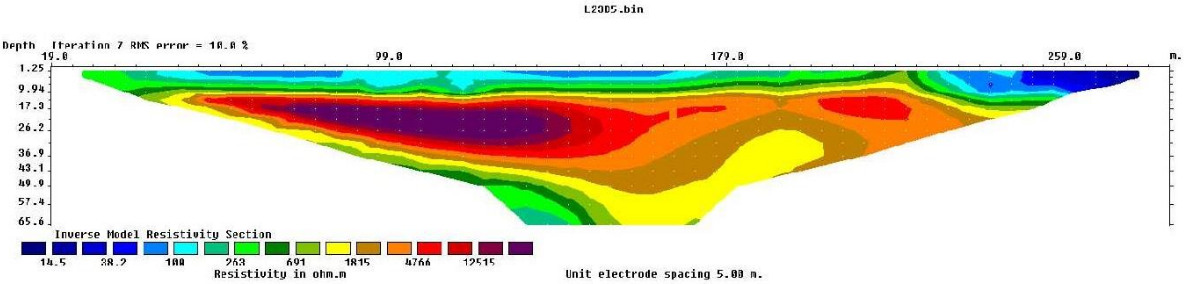


Figure 9. ERT section along line 2, with the extended portion.(270m)

Results discusions- Line 2

Along line 2, the overlying clayey gravel overburden varies in thickness depending on the close proximity of the measured position to the river. At the start of the line, the top material is thin, but along the remainder of the stretch it varies between 5-6m.The dolerite body is totally covered along this spread of the line and it stretches in depth thoughout the line. Line 2 follows the direcion of the river and thus the overlying material is partially saturated, exhibiting low resistivity,while the dorerite exhibits high resistivities and high seismic velocities in the range ±2.5km/h or higher. The overlying loose material (gravel and residium) closer to the river along line 2 will be easily excavatable, the dolerite will present some challenges as it is a hard competent rock .Figure 9 shows the extended portion of line 2, with very little changes from the original spread. Interpretations of the results acquired with both the techniques on line 2 are presented in table 3.

Line 2 intersects borehole N2 at position 87m. The borehole log concurs with the results of the seismic and ERT techiniques applied across it.

Table 3

Layer	**Model velocity (km/s)**	**Model Resistivity (Ohm.m)**	**Depth range (m)**	**Soil/rock type**
Layer 1	0.1-0.6	90-300	0-6	Reddish Sandy clay, Colluvial
Layer 2	0.6-1.5	300-656	6-7	Gravells, dolerite residuals
Layer 3	1.5- 3	656-70000	7-(>)40	Dolerite, hard and competent

6.3 Line 3

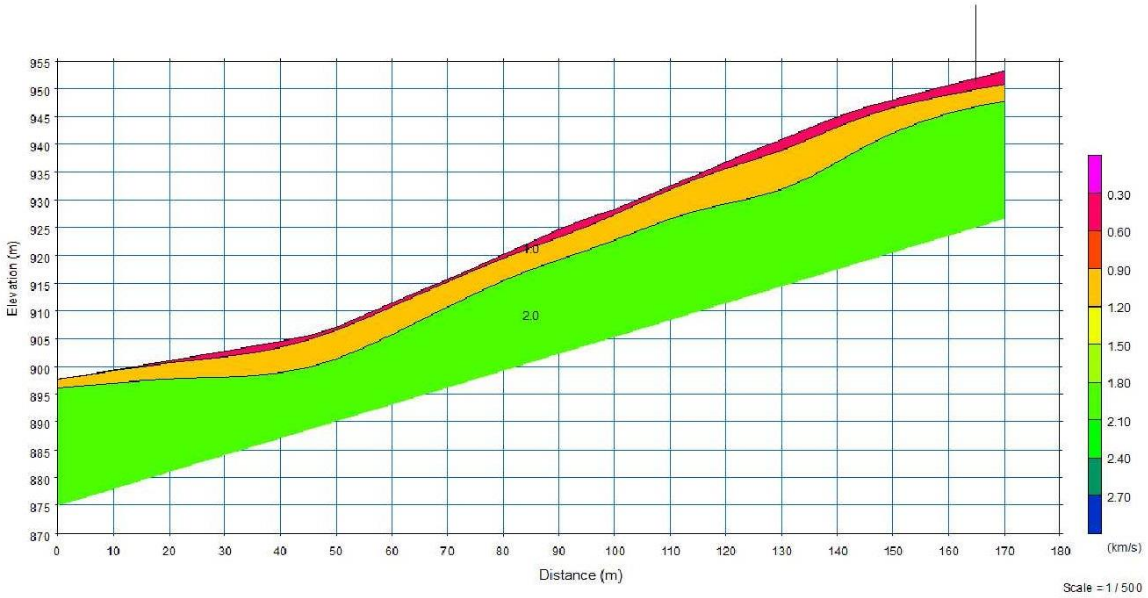


Figure 10. Modelled seismic setion along line 3.

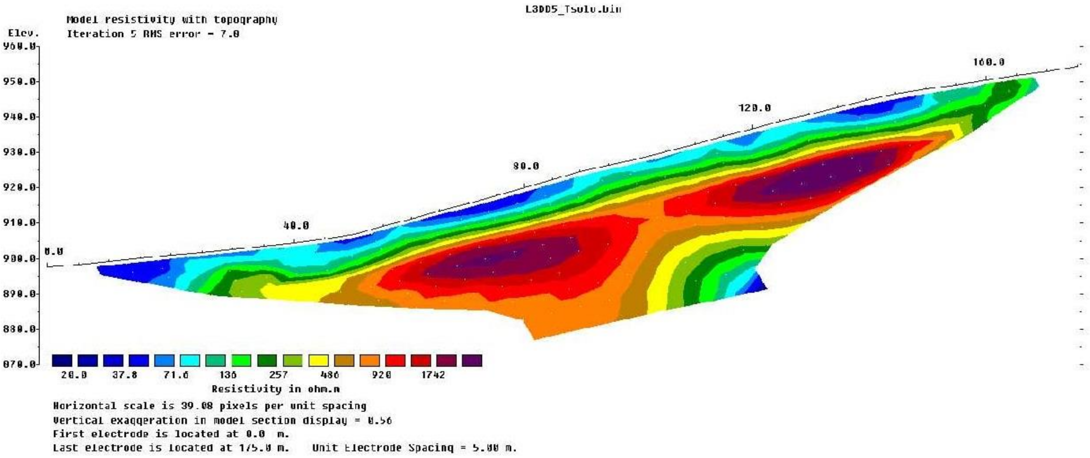


Figure 11. ERT section along line 3 (dipole-dipole)

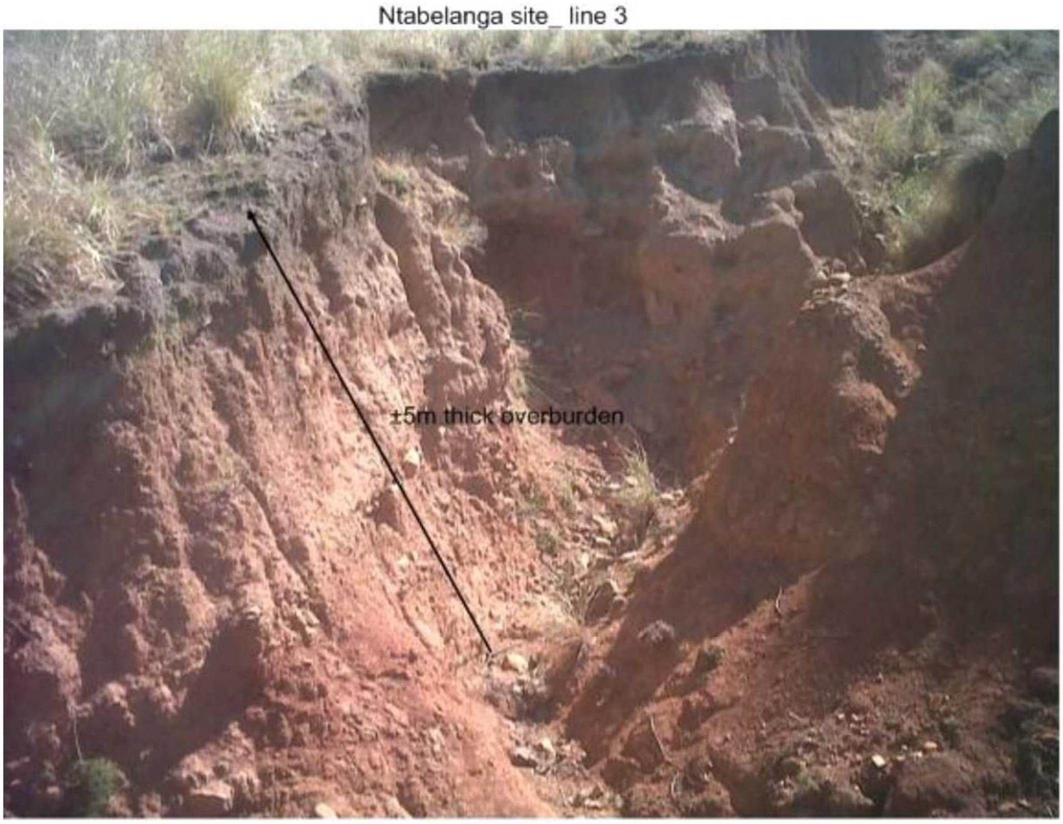


Figure 12. An image showing the relative depth extend of the thick overlying material, some dark grey-brownish colluvium and highly metamorphosed sandtones in an exposure zone along the position of line 3.

Results Discusions-Line 3

Line 3 starts at the river and climbing on the steeply sided ridge oriented NW of the river.The ERT and seismic sections at this location depicts a fairly conductive layer of moist clayey sand or colluvium extending to depths ±1.5m covering most parts of this line. Figure 14 indicate clearly the depth of the residual material overlying the sandstones/dolerite along line 3. The dark coloured clayey sand at the top is thin and loose, followed by some subrounded to rounded thick coubles/boulders of weathered sandstone that extend to approximately 7m.The thickness of the overburden is almost constant thoughout the line, except for the area nearby the river, where the sandtone is nearly exposed. The competent and resistive sandstone bedrock is found below 7m along whole length of the line, extending deep. Interpretations of the results acquired with both the techniques on line 3 are presented in table 4.

Table 4

Layer	**Model velocity (km/s)**	**Model Resistivity (Ohm.m)**	**Depth range (m)**	**Soil/rock type**
Layer 1	0.1-0.9	20-37.8	0-1.5	Clay,sand
Layer 2	0.9-1.5	37.8-71.6	1.5-7	Weathered sandstone
Layer 3	2-3	71.8-3000	7-(>)40	Hard, competent sandstone

Line 3 intersects borehole N3 at around 135m.

6.4 Line 4

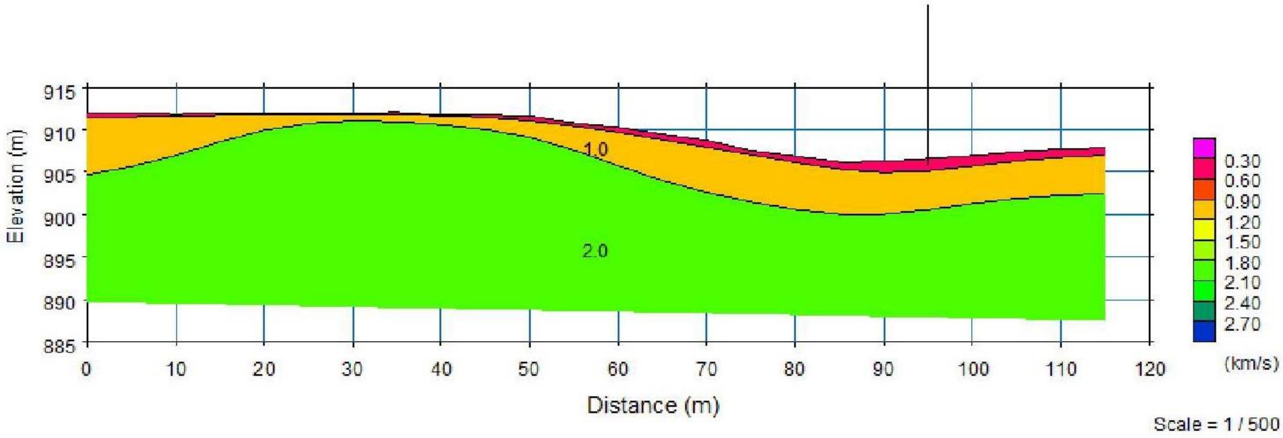


Figure 13.Modelled seismic section along line 4.

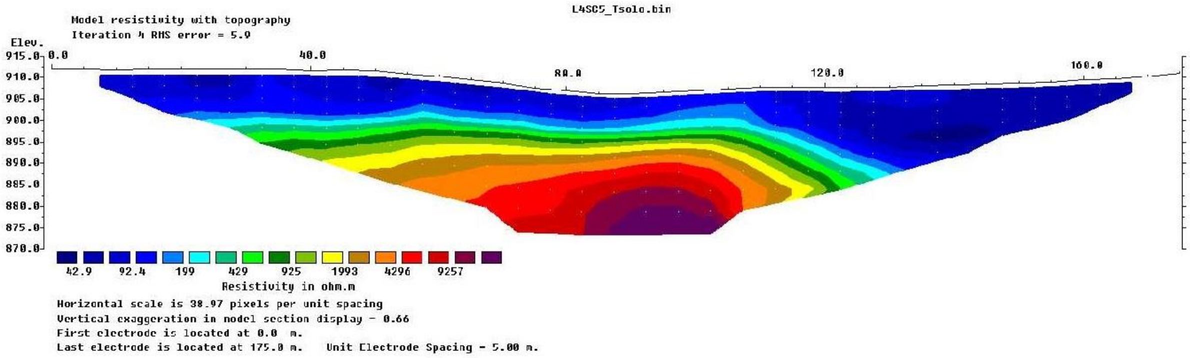


Figure 14.An ERT section along line 4.

Results discussions- Line 4

Line 4 lies parallel to line 2, but on other side of the river(west) trending SW-N.The results along this line shows a relatively thick overburden cover at the start of the line, thinning in the middle and becoming increasingly thick again towards the end of the spread.The sections shows presence of a lowly resistive layer covering the total length of the spread of probably clayey sand and loose residium.These layers are followed by a relatively hard and competent bedrock with high seismic velocities, ranging around 1.5km/s to ±2.7km/s.The highly resistive layer with corresponding high seismic velocity layer is interpreted to be either a fresh sandstone or an extension of the dolerite to the west,which also extends deep . Interpretations of results acquired with both the techniques on line 4 are presented in table 5.

Table 5

Layer	**Model velocity (km/s)**	**Model Resistivity (Ohm.m)**	**Depth range (m)**	**Soil/rock type**
Layer 1	0.3-0.9	25-50	0-0.5	Reddish brown clay, Colluvium
Layer 2	0.9-1.5	50-400	0.5-6	Dolerite/sandstone residium
Layer 3	1.5-2.7	400-9000	6-(>)40	Dolerite/Sandstone

Line 4 intersects borehole N1 at 110m.

7 CONCLUSIONS AND RECOMMENDATIONS

Seismic refraction data and Electrical Resistivity tomography(ERT) surveys of a high signal to noise ratio was collected along the four(4) lines. The results of the seismic data interpretation shows a strong and precise correlationship between the thickness of the low velocity layer and the depth of weathering as observed in the existing boreholes at all the surveyed lines. The obtained low velocities and low resistivity results ranging between about 0.3km/s and 0.9km/s and low resisivities values may be interpreted as indicating presence of loose and unconsolidated material overying the bedrock at this locations.The highly resistive areas with corresponding high seimic velocities above 1.0km/s or higher, indicate hard competent rock, of either dolerite or fresh sandstone material. The Seismics and ERT results collected at this area correlates very well with the borehole data and thus can be used for correctly determining engineering properties for dam design purposes at this location.

8 REFERENCES

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Johnson M.R.,Visser J.N.J.,Wickens H.de V.,Christie A.D.M., Roberts D.L and Brandl G. Sedimentary rocks of the Karoo Supergroup in: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (Eds.) The Geology of South Africa, Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria,2006.

Sheriff Y.,1976. Refference seismic velocity range plot for rocks, in O.Yilmaz,. Seismic Data Analysis: Processing, Inversion and Interpretation of seismic data. Volume 1, 2008.

Iris Instruments :_http://www.iris-instruments.com/

Seistronix website : http://www.seistronix.com/ras_g.htm

APPENDIX G

TRIAL PIT PROFILE DESCRIPTIONS

G1:

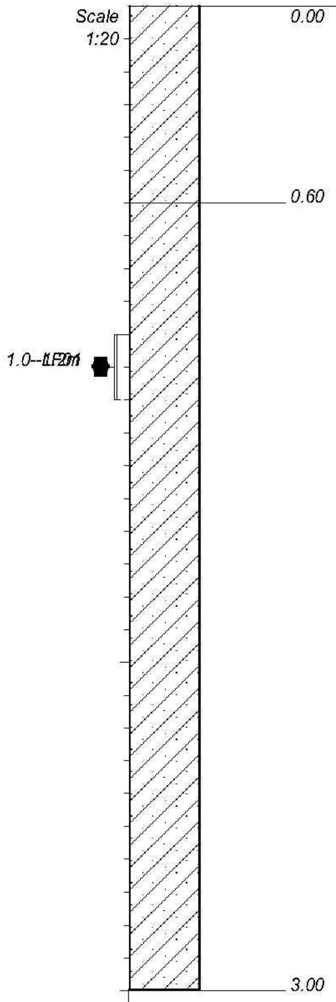
DAM TRIAL PITS

Jeffares & Green
ENGINEERING & ENVIRONMENTAL CONSULTING

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: D8
Sheet 1 of 1

JOB NUMBER: 2819



0.00 Brown, Colluvial, gravely sandy clay.

0.60 Reddish brown blotched and speckled yellow, gravely sandy clay, residual dolerite.

3.00

NOTES

1) Exposure - erosion channel

2) No water seepage observed.

3) Undisturbed sample LF01 taken between 1.0--1.2m.

4) Disturbed sample LFo1 taken between 1.0--1.2m.

5) Dolerite / sandstone contact at 31deg07'00.5"S; 28deg40'16.7"E

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

ELEVATION :
X-COORD : 31d06'59.6" S
Y-COORD : 28d40'15.1" E

HOLE No: D8

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G-1: Dam Trial Pits Hole No: D8

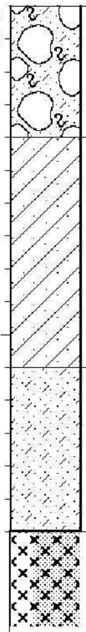
Jeffares & Green
ENGINEERING & ENVIRONMENTAL CONSULTING

Mzimvubu Water Project
Ntabelanga Dam Phase 2

HOLE No: D23
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00
Slightly moist, dark brown, loose, intact (dessicated), CLAYEY fine SAND with boulders and roots: Colluvium.

0.40
Moist, red-brown, medium dense, intact, fine SANDY CLAY: Colluvium.

1.10
Moist, dark brown, medium dense, intact, CLAYEY SAND with dolerite corestones and boulders: Residual.

1.60
Buff, completely weathered, friable, very soft rock, DOLERITE with corestones.

NOTES

1) No water seepage observed.

2) Refusal at 1.6m on corestones.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D23

D06C JGI
dotPLOT 7013 PBp7

Fig G-2: Dam Trial Pits Hole No: D23

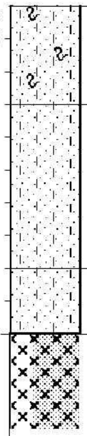
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D25
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, brown to reddish brown, loose to medium dense, intact, SILTY SAND with roots: Alluvium.
0.30	Moist, dark reddish brown, loose to medium dense, intact, SILTY fine SAND: Alluvium.
0.80	Moist, reddish brown, loose, intact, slightly clayey SILTY SAND with dolerite boulders.
1.00	Bedrock / large boulder.

NOTES

1) No water seepage observed.

2) Refusal at 1.0m on boulders or bedrock.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D25

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DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

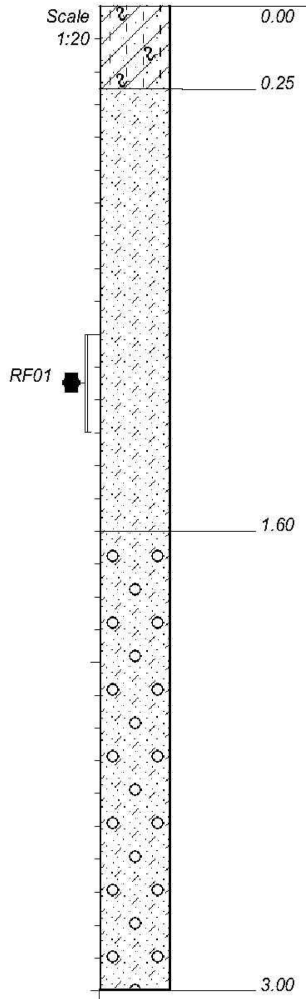
dotPLOT 7013 PBp7

Fig G-3: Dam Trial Pits Hole No: D25

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: D26
Sheet 1 of 1

JOB NUMBER: 2819



Moist, dark brown, firm, intact, SILTY SANDY CLAY with numerous roots: Colluvium.

Moist, red brown, loose, intact, CLAYEY SAND with occasional dolerite fragments: Colluvium.

Very moist, reddish to orange brown, GRAVELLY CLAYEY SAND with numerous densly packed dolerite corestone boulders: Residual.

NOTES

1) No water seepage observed.

2) Refusal at 3.0m on boulder / rock

3) Undisturbed sample RF01 taken between 1.0--1.3m.

4) Disturbed sample RF01 taken between 1.0--1.3m

5) Trench (31deg07'02.3"S; 28deg40'22.3"E to 31deg07'02.4"S; 28deg40'22.7"E)

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

ELEVATION :
X-COORD : 31d07'02.3" S
Y-COORD : 28d40'22.3" E

HOLE No: D26

D06C JGI

dotPLOT 7013 PBp7

Fig G-4: Dam Trial Pits Hole No: D26

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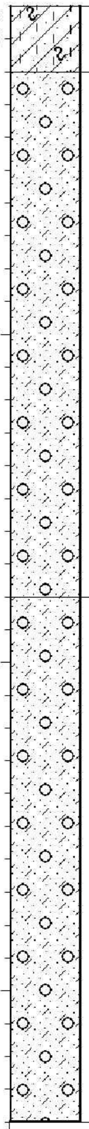
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: D26A
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Moist, dark brown, firm, intact, SILTY SANDY CLAY with numerous roots: Colluvium.
0.20	Moist, reddish brown, loose, intact, GRAVELLY CLAYEY SAND: Colluvium.
1.80	Very moist, reddish to orange brown, GRAVELLY CLAYEY SAND with numerous densly packed dolerite corestone boulders: Residual.
3.40	

NOTES

1) No water seepage observed

2) Weathered sandstone in eastern corner.

3) Trench (31deg07'02.5"S; 28deg40'23.0"E to 31deg07'02.7"S; 28deg40'23.3"E)

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013
DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

ELEVATION :
X-COORD : 31d07'02.5" S
Y-COORD : 28d40'23.0" E

HOLE No: D26A

D06C JGI

dotPLOT 7013 PBp7

Fig G-5: Dam Trial Pits Hole No: D26A

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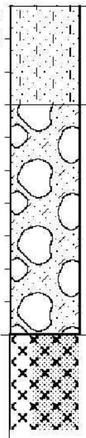
Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D29
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, brown to reddish brown, medium dense, intact, SILTY SAND: Colluvium.
0.30	Moist, red-brown, medium dense, intact, fine CLAYEY SAND with numerous dolerite boulders: Colluvium.
1.00	Dolerite boulders.

NOTES

1) No water seepage observed.

2) Refusal at 1.0m on boulders.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D29

D06C JGI

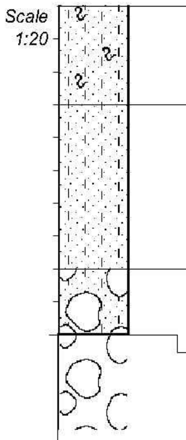
dotPLOT 7013 PBp7

Fig G-6: Dam Trial Pits Hole No: D29

Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D32
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Slightly moist, brown to reddish brown, loose to medium dense, intact, SILTY SAND with numerous roots: Alluvium.
0.30	Moist, dark reddish brown, loose to medium dense, intact, SILTY fine SAND: Alluvium.
0.80	Moist, reddish brown, loose, intact, slightly clayey SILTY SAND with numerous boulders.
1.00	Boulders.

NOTES

1) No water seepage observed.

2) Refusal at 1.0m on boulders.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D32

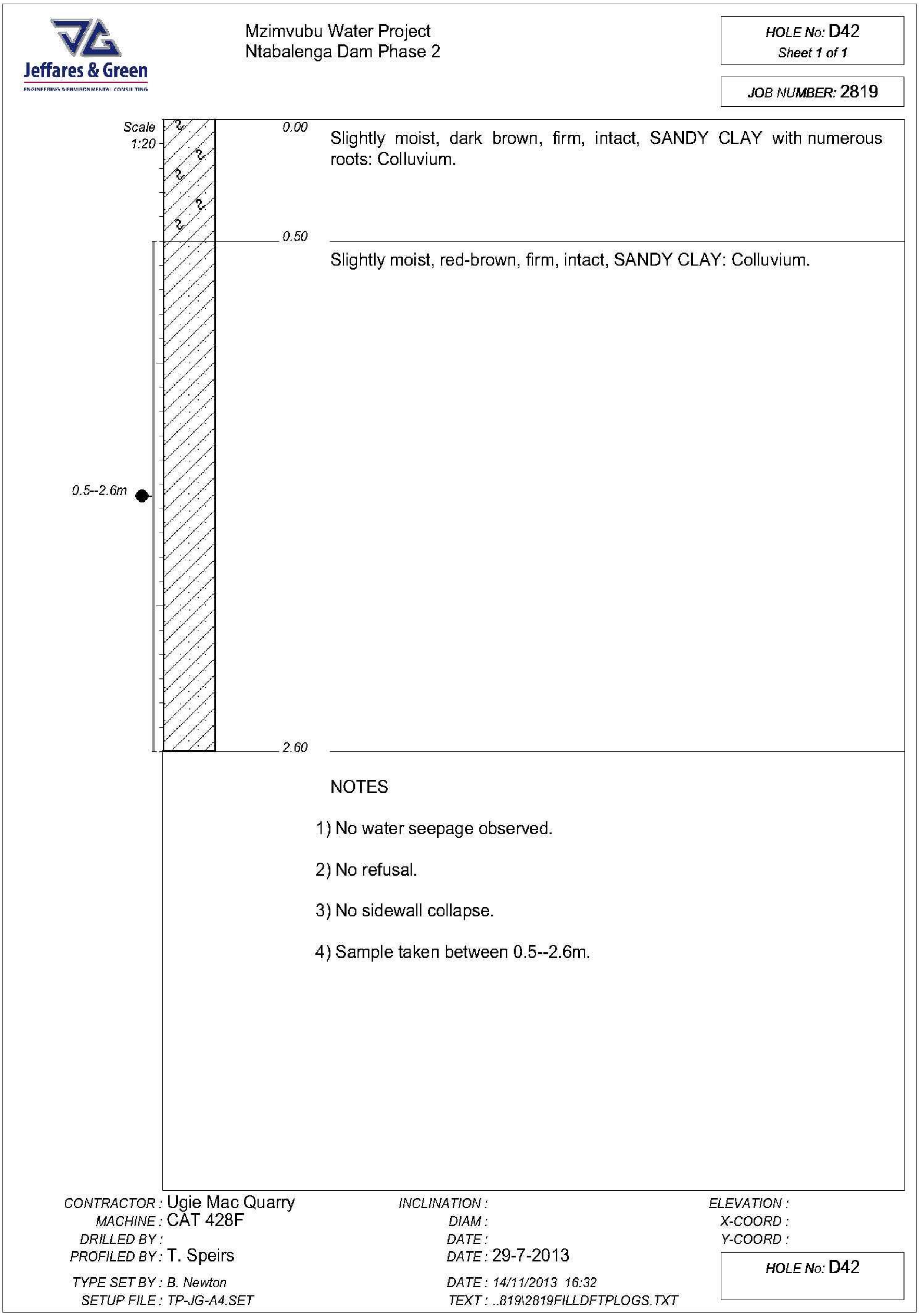
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G-7: Dam Trial Pits Hole No: D32



Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D42
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00 Slightly moist, dark brown, firm, intact, SANDY CLAY with numerous roots: Colluvium.

0.50 Slightly moist, red-brown, firm, intact, SANDY CLAY: Colluvium.

0.5--2.6m

2.60

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Sample taken between 0.5--2.6m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

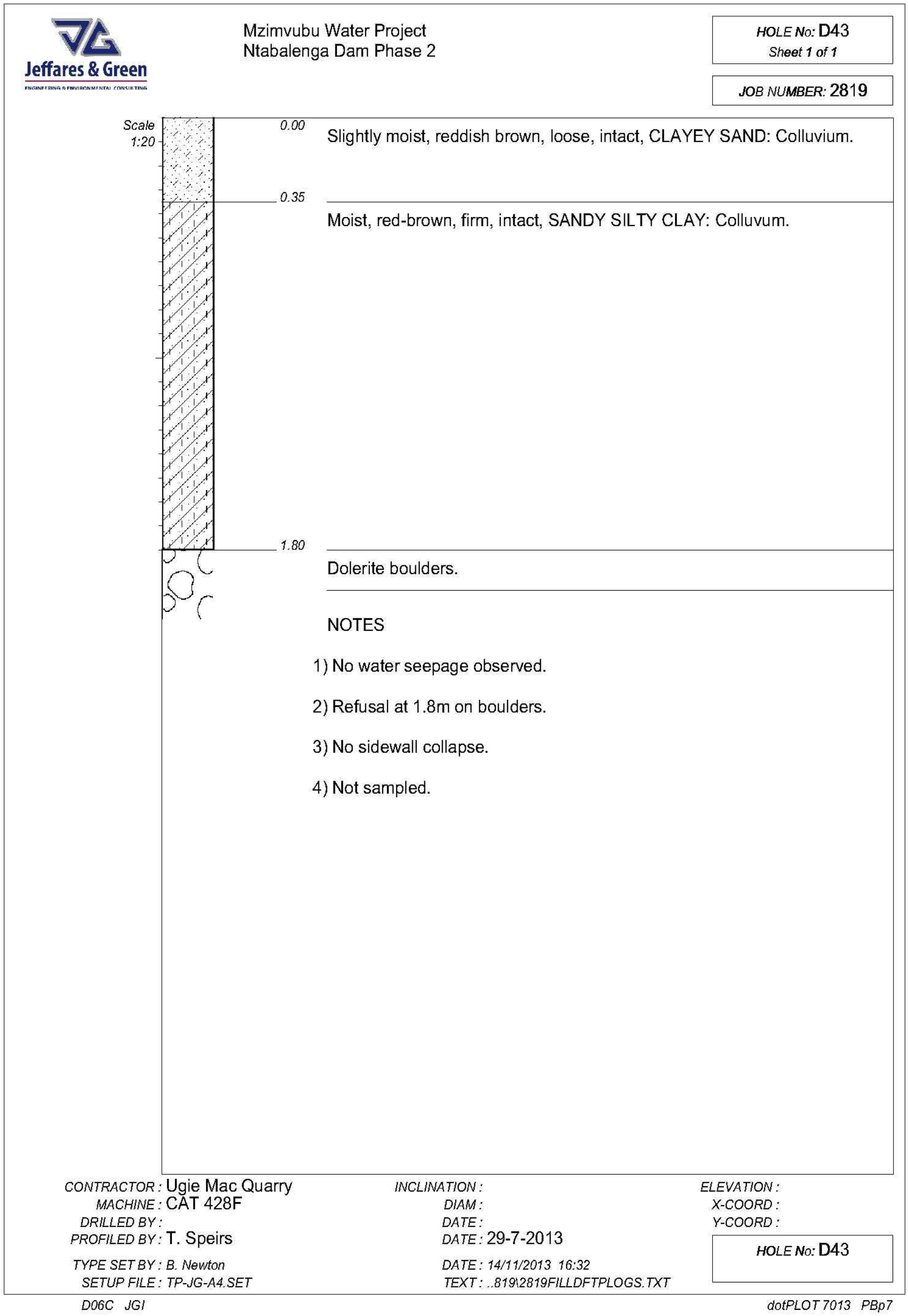
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D42

D06C JGI

dotPLOT 7013 PBp7

Fig G-8: Dam Trial Pits Hole No: D42



Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D43
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Slightly moist, reddish brown, loose, intact, CLAYEY SAND: Colluvium.
0.35	Moist, red-brown, firm, intact, SANDY SILTY CLAY: Colluvum.
1.80	Dolerite boulders.

NOTES

1) No water seepage observed.
2) Refusal at 1.8m on boulders.
3) No sidewall collapse.
4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D43

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G-9: Dam Trial Pits Hole No: D43

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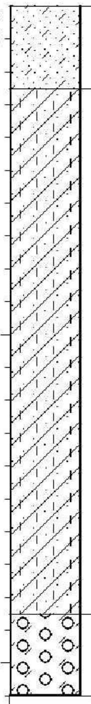
Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D44
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Slightly moist, reddish brown, loose, intact, CLAYEY SAND: Colluvium.

0.25

Moist, red-brown, firm, intact, SANDY SILTY CLAY: Colluvium.

1.85

Moist, yellowish orange blotched black and reddish brown, loose, intact, CLAYEY GRAVEL: Residual mudrock.

2.10

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D44

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

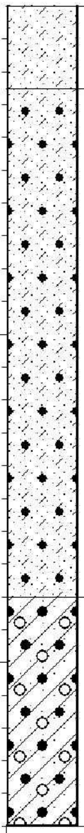
Fig G-10: Dam Trial Pits Hole No: D44

Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D45
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, reddish brown, loose, intact, CLAYEY SAND: Colluvium.
0.25	Moist, dark reddish brown speckled black, medium dense, intact, CLAYEY SAND with scattered ferricrete nodules: Colluvium.
1.80	Moist, yellowish grey speckled black, firm, slickensided, GRAVELLY SANDY CLAY with ferricrete nodules: Colluvial / Pedogenic.
2.50	

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D45

D06C JGI

dotPLOT 7013 PBp7

Fig G-11: Dam Trial Pits Hole No: D45

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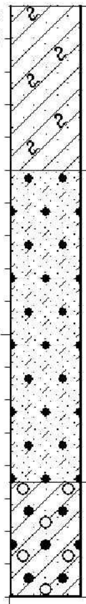
Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D46
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, black, firm, shattered, SANDY CLAY with roots: Colluvium.
0.50	Moist, dark reddish brown, medium dense, intact, CLAYEY SAND with scattered ferricrete nodules: Colluvium.
1.45	Moist, yellowish grey speckled black, firm, slickensided, GRAVELLY SANDY CLAY with ferricrete nodules: Colluvial / Pedogenic.
1.80	

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D46

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G-12: Dam Trial Pits Hole No: D46

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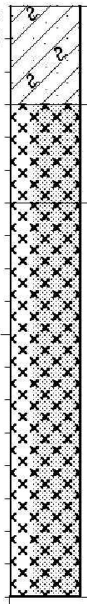
Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D47
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, black, firm, shattered, SANDY CLAY with roots: Colluvium.
0.30	Olive brown, completely weatherd, friable, very soft rock DOLERITE.
0.60	Olive brown, highly weatherd, friable / very closely jointed, very soft rock DOLERITE.
1.80	

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D47

D06C JGI *dotPLOT 7013 PBp7*

Fig G-13: Dam Trial Pits Hole No: D47

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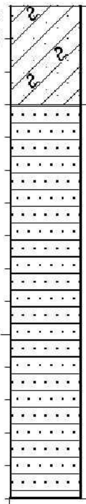
Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D48
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, black, firm, shattered, SANDY CLAY with roots: Colluvium.
0.30	Yellowish brown, completely weathered, thinly bedded, closely jointed, very soft rock, SANDSTONE.
1.50	

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D48

D06C JGI

dotPLOT 7013 PBp7

Fig G-14: Dam Trial Pits Hole No: D48

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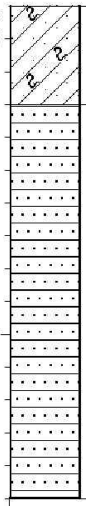
Mzimvubu Water Project
Ntabalenga Dam Phase 2

HOLE No: D49
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, black, firm, shattered, SANDY CLAY with roots: Colluvium.
0.30	Yellowish grey, highly weathered, thinly bedded, closely jointed, very soft rock, SANDSTONE.
1.50	

NOTES

1) No water seepage observed.

2) Refusal at 0.6m on sandstone.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D49

D06C JGI

dotPLOT 7013 PBp7

Fig G-15: Dam Trial Pits Hole No: D49

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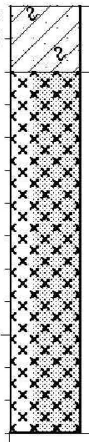
Ntabalenga Dam Phase 2

HOLE No: D50
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, black, firm, shattered, SANDY CLAY with roots: Colluvium.
0.20	Olive brown, completely weathered at top becoming highly weathered, friable / very closely jointed, very soft rock to soft rock, DOLERITE.
1.30	

NOTES

1) No water seepage observed.

2) No refusal, but difficult excavation.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 29-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: D50

D06C JGI

dotPLOT 7013 PBp7

Fig G-16: Dam Trial Pits Hole No: D50

G2:

SPILLWAY TRIAL PITS

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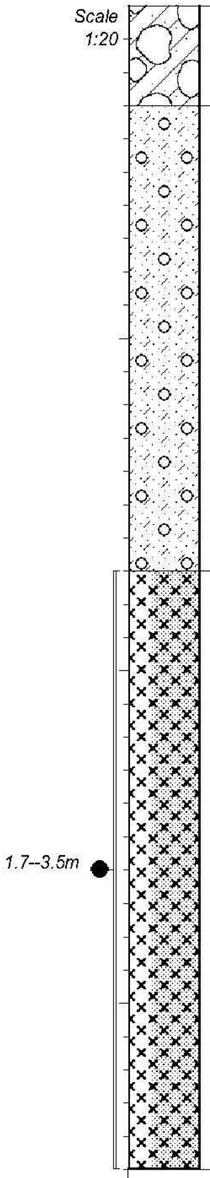
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: SSP1
Sheet 1 of 1

JOB NUMBER: 2819



0.00 Moist, blackm firm, shattered, SANDY CLAY with boulders.

0.30 Moist reddish orange, medium dense, intact, GRAVELLY CLAYEY SAND: Residual dolerite.

1.70 Orange grey-brown, highly weathered, very closely jointed / blocky, soft rock, DOLERITE.

3.50

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 1.7--3.5m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

ELEVATION :
X-COORD : 31d06'58.5" S
Y-COORD : 28d40'31.5" E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

HOLE No: SSP1

D06C JGI *dotPLOT 7013 PBp7*

Fig G-17: **Spillway Trial Pits Hole No: SP1**

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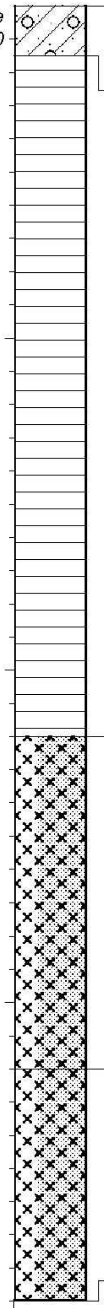
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: SSP2
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20



0.00	Slightly moist, dark brown speckled yellow, firm, shattered, SANDY GRAVELLY CLAY with mudrock fragments and dolerite boulders.
0.15	Khaki, highly weathered, thinly bedded, closely jointed, very soft rock, MUDROCK.
2.20	Olive grey blotched orange speckled black, completely weathered, friable, very soft rock, DOLERITE.
3.20	Grey, highly weathered, very closely jointed / blocky, soft rock DOLERITE.
3.90	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

ELEVATION :
X-COORD : 31d06'57.3" S
Y-COORD : 28d40'32.4" E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

HOLE No: SSP2

D06C JGI

dotPLOT 7013 PBp7

Fig G-18: **Spillway Trial Pits Hole No: SP2**

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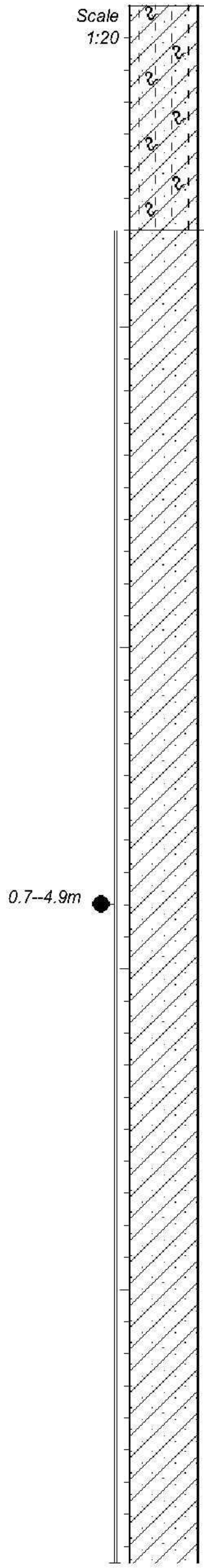
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: SSP3
Sheet 1 of 2

JOB NUMBER: 2819



0.00	Moist, dark brown, firm, intact, SILTY SANDY CLAY with numerous roots: Colluvium.
0.70	Moist, red-brown blotched orange, medium dense, intact, SANDY CLAY: Colluvium.

Fig G-19-1: Spillway Trial Pits Hole No: SP3

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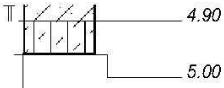
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: SSP3
Sheet 2 of 2

JOB NUMBER: 2819



Moist, pinkish grey, soft, intact, CLAYEY SILT: Residual mudrock.

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.7--4.9m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

ELEVATION :
X-COORD : 31d06'55.9" S
Y-COORD : 28d40'33.5" E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

HOLE No: SSP3

D06C JGI

dotPLOT 7013 PBp7

Fig G-19-2: Spillway Trial Pits Hole No: SP3

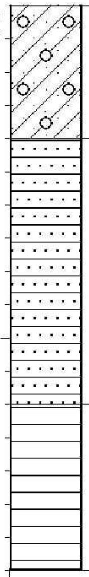
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: SP4
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, black, firm, shattered, GRAVELLY SANDY CLAY: Colluvium.
0.40	Light olive / brownish grey, medium to slightly weathered, thinly bedded, medium jointed, medium hard rock, SANDSTONE. Excavation facilitated by break out along open joints and bedding planes.
1.20	Yellowish grey-brown, highly to medium weathered, thinly bedded, closely jointed, soft rock, MUDROCK.
1.70	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013
DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

ELEVATION :
X-COORD : 31d07'12.1" S
Y-COORD : 28d40'37.5" E

HOLE No: SP4

D06C JGI

dotPLOT 7013 PBp7

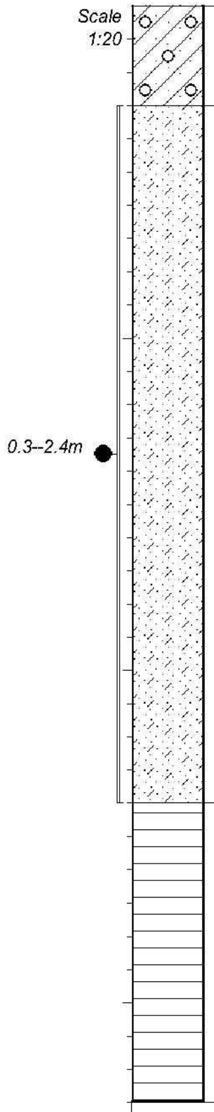
Fig G- 20: Spillway Trial Pits Hole No: SP4

Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: SP5
Sheet 1 of 1

JOB NUMBER: 2819



0.00

Slightly moist, black, firm, shattered, GRAVELLY SANDY CLAY: Colluvium.

0.30

Moist to very moist, reddish brown, loose, intact, CLAYEY SAND: Colluvium. Ferricrete nodules present lower down.

2.40

Interbedded purple, highly weathered, very thinly bedded, closely jointed, very soft to soft rock, MUDROCK and light grey, highly weathered, thinly bedded, closely to medium jointed, soft rock, silty MUDROCK.

3.30

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.3--2.4m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

ELEVATION :
X-COORD : 31d07'10.5" S
Y-COORD : 28d40'41.3" E

HOLE No: SP5

D06C JGI

dotPLOT 7013 PBp7

Fig G- 21: Spillway Trial Pits Hole No: SP5

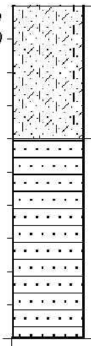
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: SP6
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, dark brown, medium dense, intact (possibly shattered at top), SILTY CLAYEY SAND: Colluvium.
0.40	Light greyish brown, stained yellow and black on joint / bedding planes, thinly bedded, closely to medium, jointed, medium hard rock SANDSTONE.
1.00	

NOTES

1) No water seepage observed.

2) Refusal at 1.0m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

ELEVATION :
X-COORD : 31d07'09.5" S
Y-COORD : 28d40'44.5" E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

HOLE No: SP6

D06C JGI

dotPLOT 7013 PBp7

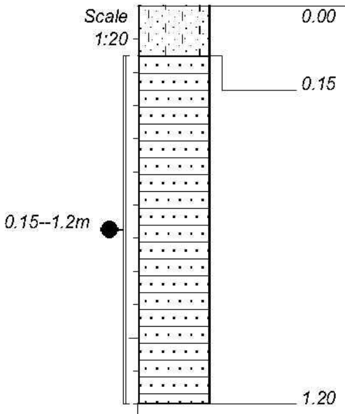
Fig G- 22: Spillway Trial Pits Hole No: SP6

Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Trial Pits

HOLE No: SP7
Sheet 1 of 1

JOB NUMBER: 2819



0.00–0.15	Slightly moist, light brown, loose, intact, slightly clayey SILTY fine SAND with gravel inclusions: Colluvium.
0.15–1.20	Light olive grey, slightly weathered, medium bedded, medium to widely jointed, medium hard rock, SANDSTONE.

NOTES

1) No water seepage observed.

2) Refusal at 1.2m.

3) Sample taken between 0.15--1.2m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

ELEVATION :
X-COORD : 31d07'07.7" S
Y-COORD : 28d40'48.0" E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:34
TEXT : ..OTPLOT\2819\2819MISC.TXT

HOLE No: SP7

D06C JGI
dotPLOT 7013 PBp7

Fig G- 23: Spillway Trial Pits Hole No: SP7

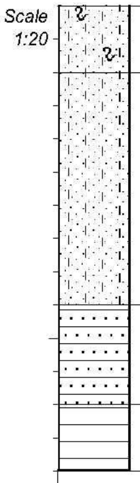
G3:

SADDLE DAM TRIAL PITS

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Saddle Dam Trial Pits

HOLE No: Saddle 1
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Sligtly moist, dark brown speckled orange, intact, medium dense, fine SILTY SAND with roots: Colluvium.
0.20	Slightly moist, light brown, medium dense, intact, slightly fissured, fine SILTY SAND: Colluvium.
0.90	Light yellowish brown, highly weathered, medium grained, blocky, very closely jointed, very thinly bedded, soft rock, SANDSTONE.
1.20	Purple grey, highly weathered, fine grained, thinly bedded, closely jointed, soft rock becoming medium hard rock, MUDROCK.
1.40	

NOTES

1) No water seepage observed.

2) No refusal, but difficult excavation.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D Excavator
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

ELEVATION :
X-COORD : 31.13166 S
Y-COORD : 28.66661 E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:35
TEXT : ..\2819\2819SADDLELOGS.TXT

HOLE No: Saddle 1

D06C JGI

dotPLOT 7013 PBp7

Fig G- 24: Saddle Dam Trial Pits Hole No: Saddle 1

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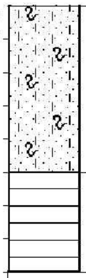
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Saddle Dam Trial Pits

HOLE No: Saddle 2
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, dark brown speckled orange, medium dense, intact, fine SILTY SAND with roots: Colluvium.
0.50	Purple grey, highly weathered, fine grained, thinly bedded, closely jointed, soft rock becoming medium hard rock, MUDROCK.
0.80	

NOTES

1) No water seepage observed.

2) No refusal, but difficult excavation.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D Excavator
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

DATE : 14/11/2013 16:35
TEXT : ..\2819\2819SADDLELOGS.TXT

ELEVATION :
X-COORD : 31.13158 S
Y-COORD : 28.66757 E

HOLE No: Saddle 2

D06C JGI

dotPLOT 7013 PBp7

Fig G- 25: Saddle Dam Trial Pits Hole No: Saddle 2

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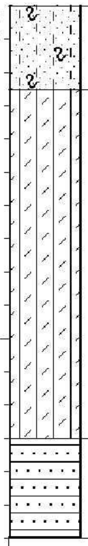
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Saddle Dam Trial Pits

HOLE No: Saddle 3
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20



0.00	Slightly moist, dark brown speckled orange, medium dense, intact, fine SILTY SAND with roots: Colluvium.
0.25	Slightly moist, brown, firm, intact, CLAYEY SILT: Colluvium.
1.30	Yellowish brown, highly weathered, medium grained, closely jointed, thinly bedded, soft becoming medium hard rock, SANDSTONE.
1.60	

NOTES

1) No water seepage observed.

2) Near refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 320D Excavator
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : Sept 2013

ELEVATION :
X-COORD : 31.13135 S
Y-COORD : 28.66885 E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:35
TEXT : ..\2819\2819SADDLELOGS.TXT

HOLE No: Saddle 3

D06C JGI

dotPLOT 7013 PBp7

Fig G- 26: Saddle Dam Trial Pits Hole No: Saddle 3

G4:

CORE BORROW PIT TRIAL PITS

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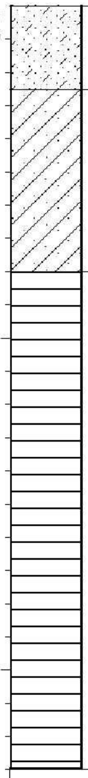
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C1
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.
0.25	Moist, reddish brown, firm, intact, SANDY CLAY: Colluvial.
0.80	Light yellowish grey, completely becoming highly weathered, friable/blocky, very soft rock, MUDROCK.
2.30	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.369' S
Y-COORD : 28d40.218' E

HOLE No: C1

D06C JGI

dotPLOT 7013 PBp7

Fig G- 27-1: Core Borrow Pit 1 - Hole No: C1

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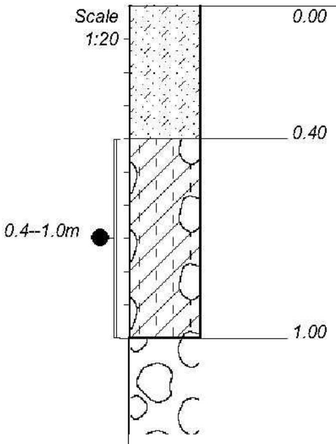
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C1A
Sheet 1 of 1

JOB NUMBER: 2819



Slightly moist to moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.

Moist, reddish brown, firm, intact, SILTY CLAY with occasional boulders: Colluvial

Boulders.

NOTES

1) No water seepage observed.

2) Refusal at 1.0m on boulders.

3) Sample taken between 0.4--1.0m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.292' S
Y-COORD : 28d40.198' E

HOLE No: C1A

D06C JGI

dotPLOT 7013 PBp7

Fig G- 27-2: Core Borrow Pit 1 - Hole No: C1A

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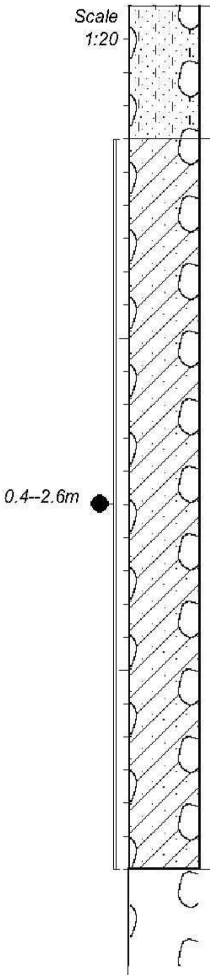
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C2
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00 Slightly moist, dark reddish brown, loose, intact, SILTY SAND with occasional boulders: Colluvial.

0.40 Moist, dark reddish brown, firm, intact, SANDY CLAY with scattered boulders: Colluvial.

2.60 Scattered Boulders.

NOTES

1) No water seepage observed.

2) Refusal at 2.6m on scattered boulders.

3) Sample taken between 0.4--2.6m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d07.243' S
Y-COORD : 28d40.200' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

HOLE No: C2

D06C JGI

dotPLOT 7013 PBp7

Fig G- 28-1: Core Borrow Pit 1 - Hole No: C2

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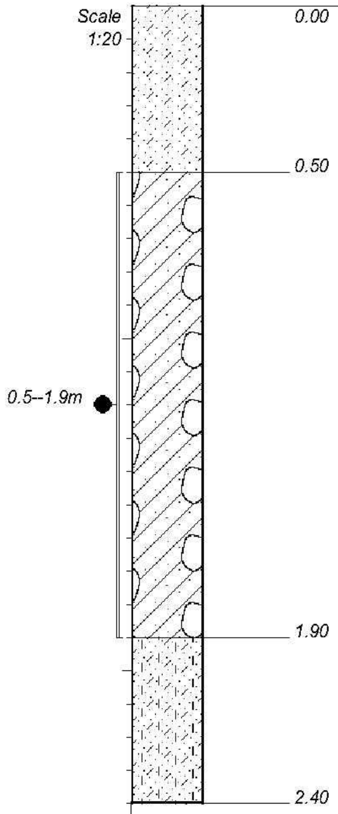
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C2A
Sheet 1 of 1

JOB NUMBER: 2819



Slightly moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.

Moist, reddish brown, firm, intact, SANDY CLAY with occasional boulders: Colluvial.

Very moist, reddish brown speckled orange, loose, intact, CLAYEY SILTY SAND: Colluvial.

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.5--1.9m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d07.239' S
Y-COORD : 28d40.180' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

HOLE No: C2A

D06C JGI

dotPLOT 7013 PBp7

Fig G- 28-2: Core Borrow Pit 1 - Hole No: C2A

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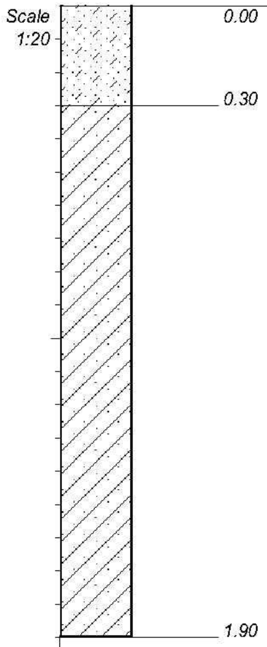
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C3
Sheet 1 of 1

JOB NUMBER: 2819



Moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.

Moist, reddish brown, firm, intact, SANDY CLAY: Colluvial.

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d07.279' S
Y-COORD : 28d40.172' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

HOLE No: C3

D06C JGI

dotPLOT 7013 PBp7

Fig G- 29: Core Borrow Pit 1 - Hole No: C3

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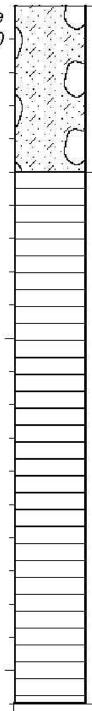
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C4
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00 Moist, dark reddish brown, loose, intact, CLAYEY SAND with scattered boulders: Colluvial.

0.50 Yellowish brown, highly weathered, blocky, very soft rock MUDROCK.

2.10

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.297' S
Y-COORD : 28d40.206' E

HOLE No: C4

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 30-1: Core Borrow Pit 1 - Hole No: C4

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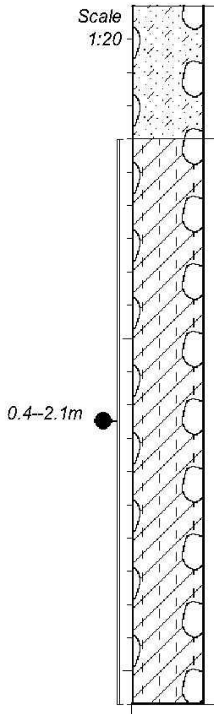
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C4A
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Slightly moist, dark reddish brown, medium dense, intact, CLAYEY SAND with scattered boulders: Colluvial.
0.40	Moist, reddish brown, firm, inact, SILTY CLAY with occasional boulders: Colluvial. At bottom speckled black with ferricrete nodules
2.10	

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.4--2.1m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.292' S
Y-COORD : 28d40.198' E

HOLE No: C4A

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 30-2: Core Borrow Pit 1 - Hole No: C4A

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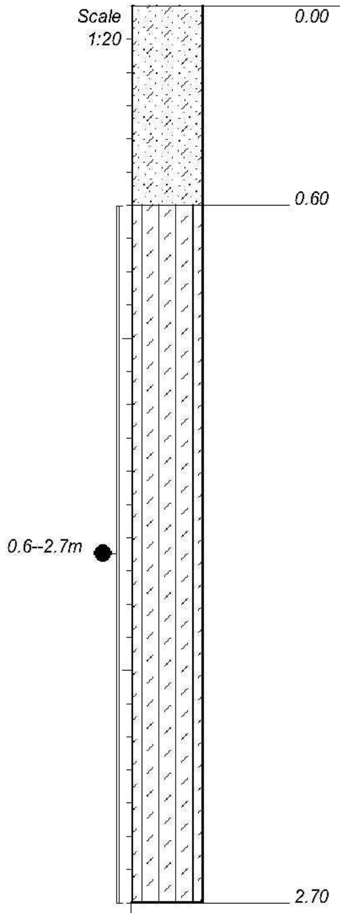
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C5
Sheet 1 of 1

JOB NUMBER: 2819



0.00 – 0.60: Moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.

0.60 – 2.70: Moist to very moist, reddish brown speckled yellow, firm, intact, CLAYEY SILT with scattered rock fragments.
At bottom numerous mudstone fragments.

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.6--2.7m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.319' S
Y-COORD : 28d40.166' E

HOLE No: C5

D06C JGI *dotPLOT 7013 PBp7*

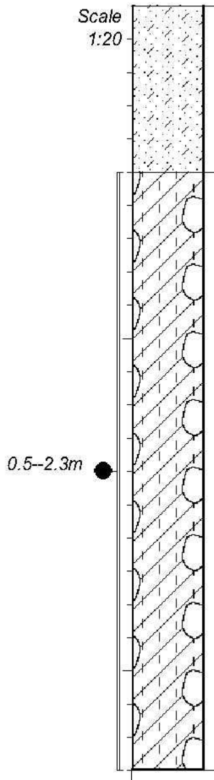
Fig G- 31: Core Borrow Pit 1 - Hole No: C5

Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C6
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Slightly moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.
0.50	Moist, reddish brown with occasional yellow and black specks, firm, intact, SILTY CLAY with occasional boulders: Colluvial.
2.30	

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.5--2.3m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.337' S
Y-COORD : 28d40.191' E

HOLE No: C6

D06C JGI

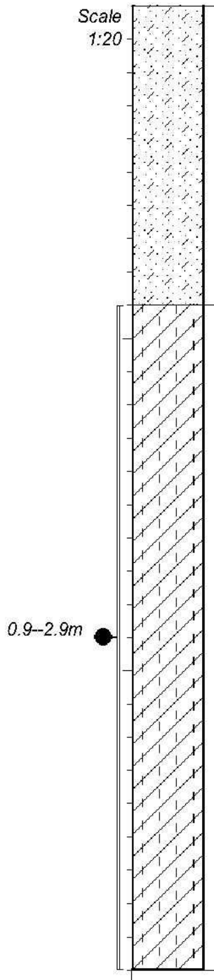
dotPLOT 7013 PBp7

Fig G- 32: Core Borrow Pit 1 - Hole No: C6

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C7
Sheet 1 of 1

JOB NUMBER: 2819



0.00 Slightly moist to moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.

0.90 Moist to very moist, reddish brown with occasional yellow and black specks, firm, intact, SILTY CLAY: Colluvial.
At bottom weathered rock fragments.

2.90

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.9--2.9m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.394' S
Y-COORD : 28d40.193' E

HOLE No: C7

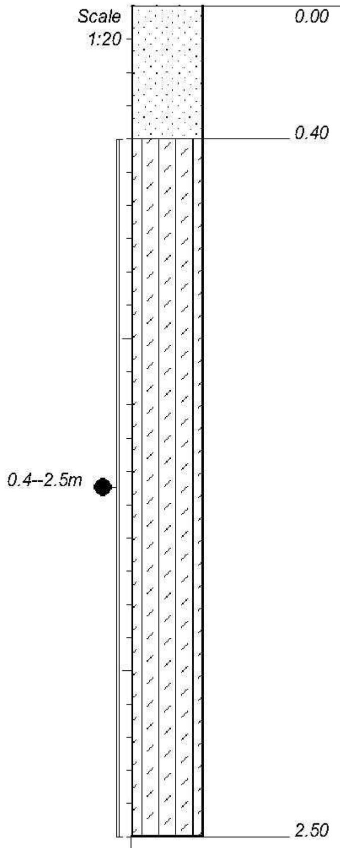
D06C JGI *dotPLOT 7013 PBp7*

Fig G- 33: Core Borrow Pit 1 - Hole No: C7

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C8
Sheet 1 of 1

JOB NUMBER: 2819



Slightly moist, dark reddish brown, loose to medium dense, slightly clayey SAND: Colluvial.

Moist to very moist, reddish brown, firm, intact, CLAYEY SILT with scattered rock fragments at 0.9m: Colluvial.

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.4--2.5m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.386' S
Y-COORD : 28d40.151' E

HOLE No: C8

D06C JGI

dotPLOT 7013 PBp7

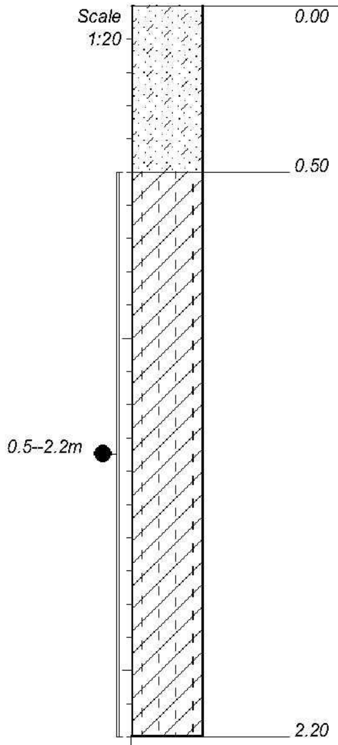
Fig G- 34: Core Borrow Pit 1 - Hole No: C8

Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C9
Sheet 1 of 1

JOB NUMBER: 2819



0.00 Slightly moist to moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.

0.50 Moist to very moist, dark brown speckled yellow, soft, intact, SILTY CLAY with scattered weathered mudrock fragments.
At bottom numerous weathered rock fragments.

2.20

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.5--2.2m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.429' S
Y-COORD : 28d40.140' E

HOLE No: C9

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 35: Core Borrow Pit 1 - Hole No: C9

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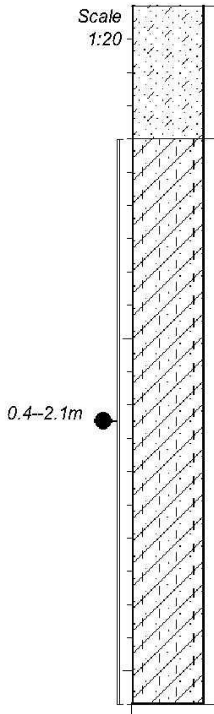
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 1

HOLE No: C10
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Slightly moist, dark reddish brown, loose to medium dense, intact, CLAYEY SAND: Colluvial.
0.40	Moist, reddish brown speckled yellow, firm, intact, SANDY SILTY CLAY: Colluvial. At bottom rock fragments.
2.10	

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.4--2.1m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.458' S
Y-COORD : 28d40.163' E

HOLE No: C10

D06C JGI

dotPLOT 7013 PBp7

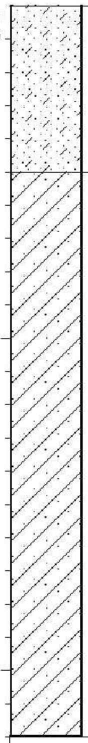
Fig G- 36: Core Borrow Pit 1 - Hole No: C10

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C11
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist to moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.
0.50	Moist, dark reddish brown to red-brown, firm, intact, SANDY CLAY with scattered weathered dolerite fragments: Colluvial. At bottom abundant weathered dolerite fragments.
2.20	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.720' S
Y-COORD : 28d39.671' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

HOLE No: C11

D06C JGI

dotPLOT 7013 PBp7

Fig G- 37: **Core Borrow Pit 2 - Hole No: C11**

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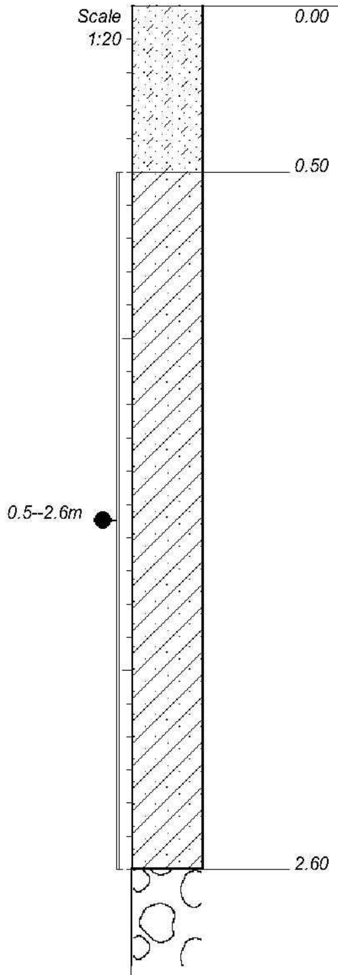
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C12
Sheet 1 of 1

JOB NUMBER: 2819



Slightly moist to moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.

Moist, dark reddish brown to red-brown, firm, intact, SANDY CLAY with scattered weathered dolerite fragments: Colluvial.
At bottom abundant weathered dolerite fragments.

Boulders.

NOTES

1) No water seepage observed.

2) Refusal on boulders.

3) Sample taken between 0.5--2.6m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.710' S
Y-COORD : 28d39.640' E

HOLE No: C12

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

D06C JGI *dotPLOT 7013 PBp7*

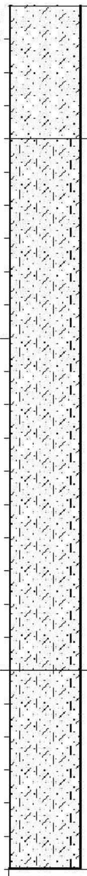
Fig G- 37: Core Borrow Pit 2 - Hole No: C12

Mzimvubu Water Project
Ntabelanga Dam Phase 2
Core Borrow Pit 2

HOLE No: C13
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.
0.40	Moist, dark brown, loose, intact, SILTY CLAYEY SAND: Coluvium.
2.00	Very moist, light reddish brown to orange brown, loose, intact, CLAYEY SILTY SAND: Colluvial.
2.60	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.745’ S
Y-COORD : 28d39.623’ E

HOLE No: C13

D06C JGI

dotPLOT 7013 PBp7

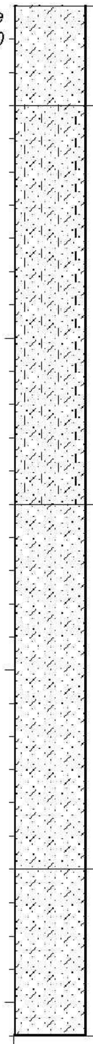
Fig G- 38: Core Borrow Pit 2 - Hole No: C13

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C14
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.
0.30	Moist, dark brown, loose, intact, SILTY CLAYEY SAND: Colluvial.
1.50	Moist, reddish brown, loose, intact, CLAYEY SAND: Coluvium.
2.60	Moist, red-brown, loose, intact, CLAYEY SAND: Colluvial.
3.10	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.755' S
Y-COORD : 28d39.632' E

HOLE No: C14

D06C JGI

dotPLOT 7013 PBp7

Fig G- 39: Core Borrow Pit 2 - Hole No: C14

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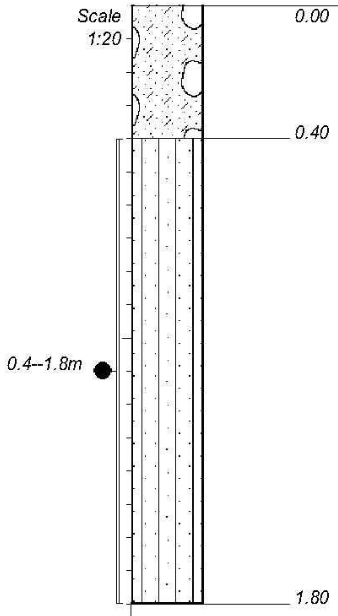
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C15
Sheet 1 of 1

JOB NUMBER: 2819



Slightly moist to moist, dark reddish brown, loose, intact, CLAYEY SAND with occasional boulders: Colluvial.

Moist, red-brown, loose to medium dense, intact, SANDY SILT with scattered rock fragments.
At bottom abud

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.4--1.8m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.758' S
Y-COORD : 28d39.667' E

HOLE No: C15

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 40: Core Borrow Pit 2 - Hole No: C15

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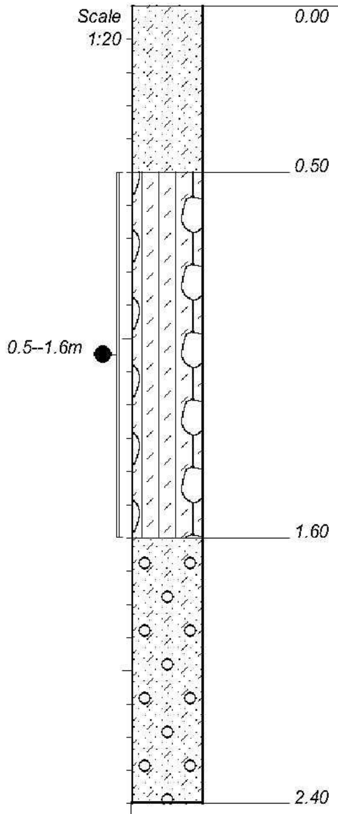
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C16
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.
0.50	Moist, reddish brown, firm, intact, CLAYEY SILT with occasional boulders: Colluvial.
1.60	Moist, reddish brown bloteched yellow, orange and black, loose, intact, GRAVELLY CLAYEY SAND: Residual.
2.40	

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.5--1.6m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.797' S
Y-COORD : 28d39.669' E

HOLE No: C16

D06C JGI

dotPLOT 7013 PBp7

Fig G- 41: Core Borrow Pit 2 - Hole No: C16

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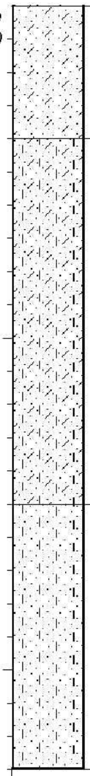
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C17
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist to moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.
0.40	Moist, dark brown, loose, intact, SILTY CLAYEY SAND: Coluvium.
1.50	Moist, light reddish brown, loose, intact, slightly clayey SILTY SAND: Colluvial.
2.30	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.814' S
Y-COORD : 28d39.648' E

HOLE No: C17

D06C JGI

dotPLOT 7013 PBp7

Fig G- 42: Core Borrow Pit 2 - Hole No: C17

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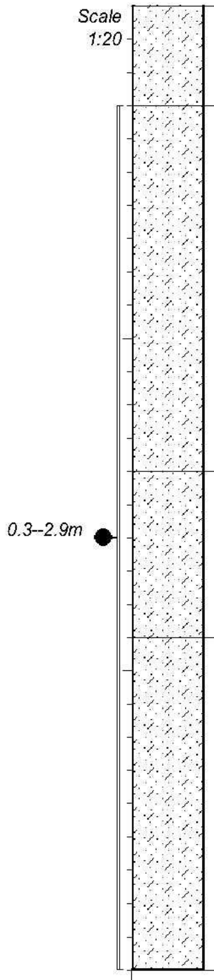
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C18
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Slightly moist, dark reddish brown, loose, intact, CLAYEY SAND: Colluvial.
0.30	Moist, dark brown, loose to medium dense, intact, CLAYEY SAND: Colluvial.
1.40	Moist, reddish brown, loose to medium dense, intact, CLAYEY SAND: Colluvial.
1.90	Moist to very moist, red-brown, loose, intact, CLAYEY SAND: Colluvial.
2.90	

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.3--2.9m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.834' S
Y-COORD : 28d39.668' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

HOLE No: C18

D06C JGI

dotPLOT 7013 PBp7

Fig G- 43: Core Borrow Pit 2 - Hole No: C18

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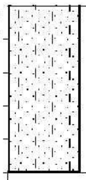
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C19
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Reddish orange SILTY fine SAND.
0.50	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.856' S
Y-COORD : 28d39.671' E

HOLE No: C19

D06C JGI

dotPLOT 7013 PBp7

Fig G- 44: Core Borrow Pit 2 - Hole No: C19

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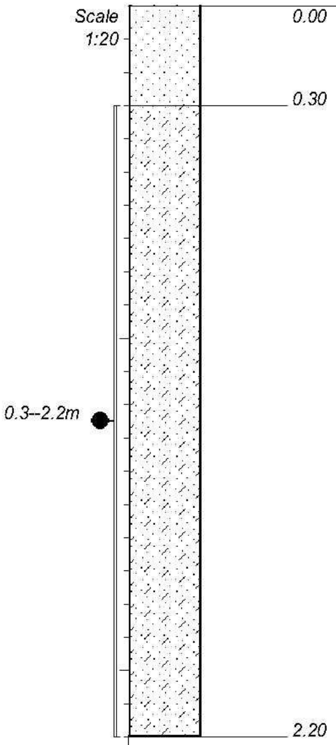
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C20
Sheet 1 of 1

JOB NUMBER: 2819



Topsoil.

Moist, red-brown, loose, intact, CLAYEY SAND: Colluvial.
At bottom residual.

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.3--2.2m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.911' S
Y-COORD : 28d39.757' E

HOLE No: C20

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 45: Core Borrow Pit 2 - Hole No: C20

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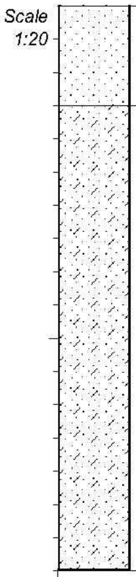
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C21
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Topsoil.
0.30	Moist, red-brown, loose, intact, CLAYEY SAND: Colluvial. At bottom numerous dolerite boulders.
1.70	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.919' S
Y-COORD : 28d39.737' E

HOLE No: C21

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 46: Core Borrow Pit 2 - Hole No: C21

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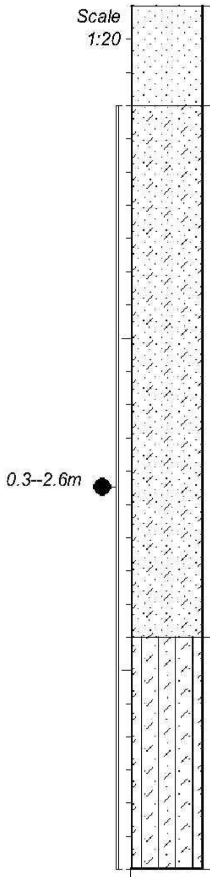
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C22
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Topsoil.
0.30	Moist, red-brown, loose, intact, CLAYEY SAND: Colluvial.
1.90	Very moist, reddish orange blotched and speckled black, soft, intact, SANDY CLAYEY SILT: Residual dolerite. Corestone at bottom.
2.60	

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.3--2.6m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.927' S
Y-COORD : 28d39.765' E

HOLE No: C22

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G- 47: Core Borrow Pit 2 - Hole No: C22

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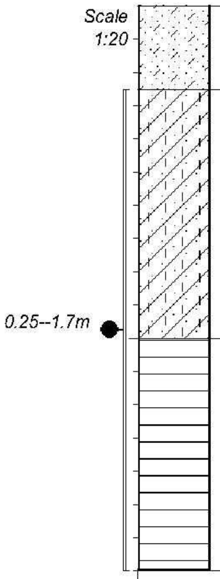
Ntabelanga Dam Phase 2
Core Borrow Pit 2

HOLE No: C23
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Slightly moist, dark reddish brown, medium dense, intact, CLAYEY SAND: Colluvial.
0.25	Moist, reddish brown, firm, intact, SANDY SILTY CLAY: Colluvial.
1.00	Light yellowish brown, completely weathered, fragmented, very soft rock, MUDROCK.
1.70	

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.25--1.7m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.938' S
Y-COORD : 28d39.803' E

HOLE No: C23

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 48: Core Borrow Pit 2 - Hole No: C23

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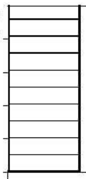
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C24
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00 Yellowish brown, completely weathered, fragmented, very soft rock, MUDROCK.

0.50

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.921’ S
Y-COORD : 28d39.827’ E

HOLE No: C24

D06C JGI

dotPLOT 7013 PBp7

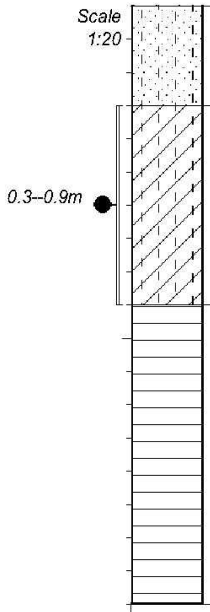
Fig G- 49: Core Borrow Pit 2 - Hole No: C24

Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C25
Sheet 1 of 1

JOB NUMBER: 2819



0.00

Slightly moist, brown, medium dense, intact, SILTY SAND: Colluvial.

0.30

Moist, reddish brown speckled orange, firm dense, intact, SILTY CLAY: Colluvial.

0.90

Yellowish grey/pink blotched orange and black, highly weathered, blocky, very soft rock, MUDROCK.

1.80

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.3--0.9m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.902' S
Y-COORD : 28d39.815' E

HOLE No: C25

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G- 50: Core Borrow Pit 2 - Hole No: C25

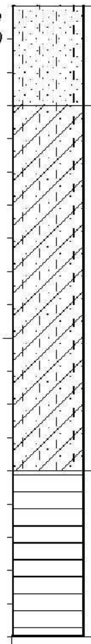
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C26
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, brown, loose to medium dense, intact, SILTY SAND: Colluvial.
0.30	Moist, reddish brown blotched orange and yellow, firm, intact, SILTY SANDY CLAY: Colluvial.
1.40	Yellowish grey/pink blotched orange and black, highly weathered, blocky, very soft rock, MUDROCK.
1.90	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.898' S
Y-COORD : 28d39.788' E

HOLE No: C26

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G- 51: Core Borrow Pit 2 - Hole No: C26

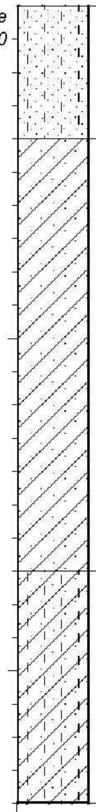
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C27
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, brown, loose, intact, SILTY SAND: Colluvial.
0.40	Moist, reddish brown, firm, intact, SANDY CLAY: Colluvial.
1.70	Moist to very moist, reddish orange blotched yellow and grey, soft, intact, SANDY SILTY CLAY: Residual mudrock.
2.40	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.888' S
Y-COORD : 28d39.737' E

HOLE No: C27

D06C JGI

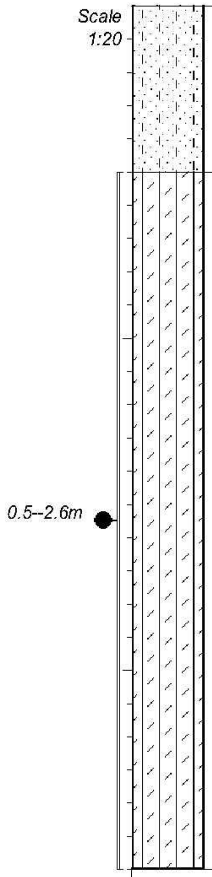
dotPLOT 7013 PBp7

Fig G- 52: Core Borrow Pit 2 - Hole No: C27

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C28
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Slightly moist, brown, loose, intact, SILTY SAND: Colluvial.
0.50	Moist, red-brown, firm, intact, CLAYEY SILT: Colluvial.
2.60	

NOTES

1) No water seepage observed.

2) No refusal.

3) Sample taken between 0.5--2.6m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.864' S
Y-COORD : 28d39.739' E

HOLE No: C28

D06C JGI

dotPLOT 7013 PBp7

Fig G- 53: Core Borrow Pit 2 - Hole No: C28

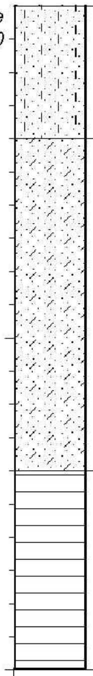
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Core Borrow Pit 2

HOLE No: C29
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, brown, loose to medium dense, intact, SILTY SAND: Colluvial.
0.40	Moist, reddish brown, medium dense, intact, CLAYEY SAND: Colluvial.
1.40	Light yellowish grey/pink blotched black, completely weathered, friable, very soft rock, MUDROCK.
2.00	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.871' S
Y-COORD : 28d39.772' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:33
TEXT : ..2819\2819CORECTPLOGS.TXT

HOLE No: C29

D06C JGI

dotPLOT 7013 PBp7

Fig G- 54: Core Borrow Pit 2 - Hole No: C29

G5:

SHELL BORROW PIT TRIAL PITS

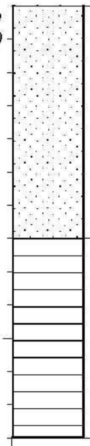
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F1
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Colluvial / Residual soil.
0.70	Purple, highly weathered, fragmented, very soft to soft rock, MUDROCK.
1.30	

NOTES

1) No water seepage observed.

2) No refusal, but difficult excavation.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.771' S
Y-COORD : 28d39.753' E

HOLE No: F1

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G- 55: Fill Borrow Pit - Hole No: F1

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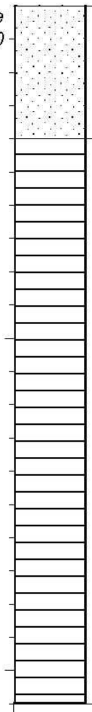
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F2
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Colluvial / Residual soil.
0.40	Light yellowish brown, highly weathered, friable / fragmented, very soft rock, SILTSTONE.
2.10	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.836' S
Y-COORD : 28d39.741' E

HOLE No: F2

D06C JGI *dotPLOT 7013 PBp7*

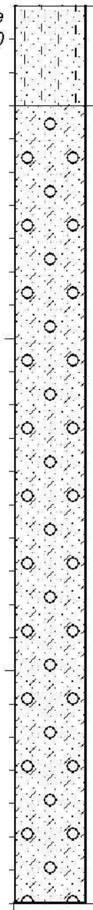
Fig G- 56: Fill Borrow Pit - Hole No: F2

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F3
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, light brown, loose, intact, SILTY SAND: Colluvial.
0.30	Moist to very moist, reddish brown speckled and blotched orange, black and grey, medium dense, intact, GRAVELLY CLAYEY SAND with scattered fericrete nodules: Colluvial.
2.70	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.771' S
Y-COORD : 28d39.800' E

HOLE No: F3

D06C JGI

dotPLOT 7013 PBp7

Fig G- 57: Fill Borrow Pit - Hole No: F3

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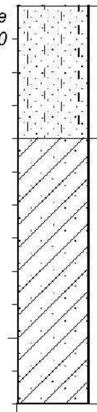
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F4
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, light brown, loose, intact, SILTY SAND: Colluvial.
0.40	Moist, grey-brown blotched orange,stiff, slickensided, SANDY CLAY with scattered shale fragments: Colluvial.
1.20	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry	*INCLINATION :*	*ELEVATION :*
MACHINE : CAT 428F	*DIAM :*	*X-COORD :* 31d06.725' S
DRILLED BY :	*DATE :*	*Y-COORD :* 28d39.800' E
PROFILED BY : T. Speirs	*DATE :* 30-7-2013	
TYPE SET BY : B. Newton	*DATE : 14/11/2013 16:32*	*HOLE No:* F4
SETUP FILE : TP-JG-A4.SET	*TEXT : ..819\2819FILLDFTPLOGS.TXT*	

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 58: Fill Borrow Pit - Hole No: F4

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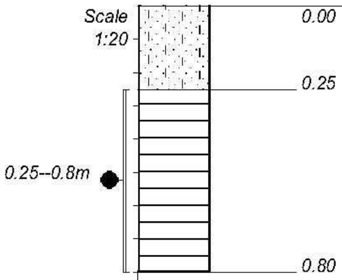
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F5
Sheet 1 of 1

JOB NUMBER: 2819



Depth	Description
0.00 – 0.25	Dry to slightly moist, light brown, loose, intact, SILTY SAND: Colluvial.
0.25 – 0.80	Purple, highly weathered, very closely jointed / fragmented, soft rock, MUDROCK.

NOTES

1) No water seepage observed.

2) No refusal, but difficult excavation.

3) Sample taken between 0.25--0.8m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.710' S
Y-COORD : 28d39.761' E

HOLE No: F5

D06C JGI

dotPLOT 7013 PBp7

Fig G- 59: Fill Borrow Pit - Hole No: F5

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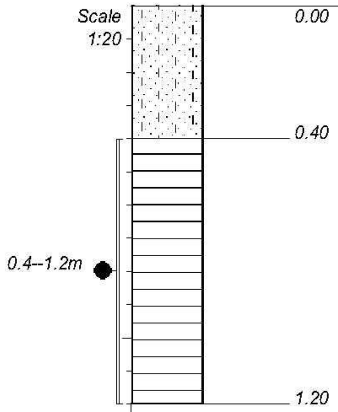
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F6
Sheet 1 of 1

JOB NUMBER: 2819



0.00 – 0.40: Dry to slightly moist, light brown, loose, intact, SILTY SAND: Colluvial.

0.40 – 1.20: Khaki / yellowish grey stained orange and black on relict joint surfaces, highly weathered, very thinly bedded, closely jointed, soft rock, MUDROCK.

NOTES

1) No water seepage observed.

2) No refusal, but difficult excavation.

3) Sample taken between 0.4--1.2m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.691' S
Y-COORD : 28d39.720' E

HOLE No: F6

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 60: Fill Borrow Pit - Hole No: F6

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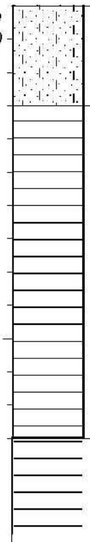
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F7
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry to slightly moist, light brown, loose, intact, SILTY SAND containing numerous pebbles and rock fragments: Colluvial.
0.30	Yellow-grey, highly weathered, thinly bedded, closely jointed, soft rock, MUDROCK.
1.30	Mudrock, becoming more indurated.

NOTES

1) No water seepage observed.

2) Refusal at 1.3m on mudrock.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.607' S
Y-COORD : 28d39.740' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F7

D06C JGI

dotPLOT 7013 PBp7

Fig G- 61: Fill Borrow Pit - Hole No: F7

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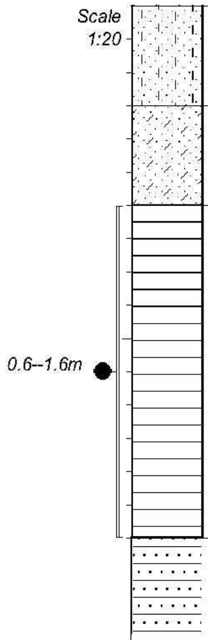
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F8
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Dry to slightly moist, light brown, loose, intact, SILTY SAND: Colluvial.
0.30	Moist, reddish brown blotched orange, medium dense, intact, CLAYEY SAND: Colluvial.
0.60	Purple, highly weathered, fragmented / disintegrated, soft rock MUDROCK.
1.60	Grey, highly weathered, thinly bedded, closely jointed, soft rock SANDSTONE.

NOTES

1) No water seepage observed.

2) Near refusal at 1.6m on mudrock.

3) Sample taken between 0.6--1.6m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.659' S
Y-COORD : 28d39.780' E

HOLE No: F8

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G- 62: Fill Borrow Pit - Hole No: F8

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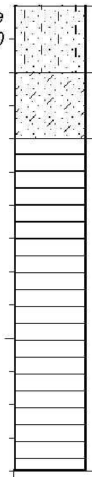
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F9
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



Depth	Description
0.00 – 0.20	Dry to slightly moist, light brown, loose, intact, SILTY SAND: Colluvial.
0.20 – 0.40	Moist, reddish brown blotched orange, medium dense, intact, CLAYEY SAND: Colluvial.
0.40 – 1.40	Purple, highly weathered, fragmented / blocky, soft rock, MUDROCK.

NOTES

1) No water seepage observed.

2) No refusal, but difficult excavation.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.701' S
Y-COORD : 28d39.833' E

HOLE No: F9

D06C JGI

dotPLOT 7013 PBp7

Fig G- 63: Fill Borrow Pit - Hole No: F9

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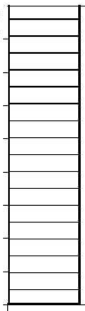
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F10
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Purple, highly weathered, thinly bedded, closely jointed, soft rock MUDROCK.

0.90

NOTES

1) No water seepage observed.

2) Difficult excavation to near refusal at 0.9m.

3) Sample taken between 0--0.9m.

4) Excavated in erosion gulley.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.721' S
Y-COORD : 28d39.868' E

HOLE No: F10

D06C JGI

dotPLOT 7013 PBp7

Fig G- 64: **Fill Borrow Pit - Hole No: F10**

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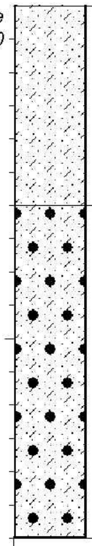
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F11
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, dark brown, loose, intact, CLAYEY SAND: Colluvial.
0.60	Moist, reddish orange blotched yellow and black, loose, intact, CLAYEY SAND with ferricrete nodules: Colluvium. At bottom residuum.
1.60	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.711' S
Y-COORD : 28d39.907' E

HOLE No: F11

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 65: Fill Borrow Pit - Hole No: F11

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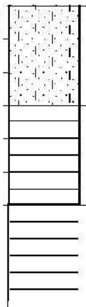
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F12
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00 Slightly moist, dark brown, loose, intact, SILTY SAND: Colluvial.

0.30 Khaki / yellowish grey, highly weathered, thinly bedded, closely jointed, soft rock, MUDROCK.

0.60 Mudrock.

NOTES

1) No water seepage observed.

2) Refusal at 0.6m on mudrock.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.685' S
Y-COORD : 28d39.861' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F12

D06C JGI

dotPLOT 7013 PBp7

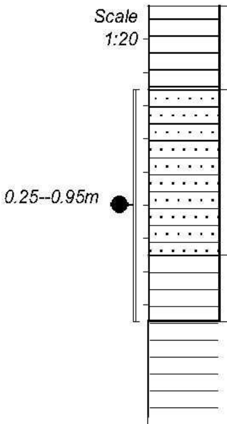
Fig G- 66: Fill Borrow Pit - Hole No: F12

Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F13
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Purple, highly weathered, very thinly bedded, closely jointed to fragmented (disintegrated on surface), soft rock, MUDROCK.
0.25	Light grey, highly to medium weathered, thinly bedded, medium jointed (blocky), soft rock, SANDSTONE.
0.75	Purple, highly weathered, thinly bedded, closely jointed, soft rock, MUDROCK.
0.95	Mudrock.

NOTES

1) No water seepage observed.

2) Refusal at 0.95m on mudrock.

3) Sample taken between 0.25--0.95m.

4) Excavated in erosion gulley.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.633' S
Y-COORD : 28d39.822' E

HOLE No: F13

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 67: Fill Borrow Pit - Hole No: F13

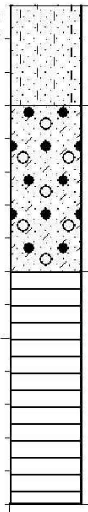
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F14
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Slightly moist, light brown, loose, intact, SILTY SAND: Colluvial.
0.30	Moist, light reddish brown blotched orange and black, loose to medium dense, intact, GRAVELLY CLAYEY SAND with ferricrete nodules: Colluvial / Pedogenic.
0.80	Purple, highly weathered, very thinly bedded, very closely jointed, very soft rock, MUDROCK.
1.50	

NOTES

1) No water seepage observed.

2) No refusal.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.595' S
Y-COORD : 28d39.836' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F14

D06C JGI

dotPLOT 7013 PBp7

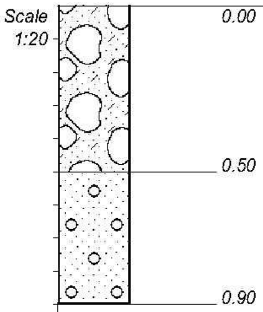
Fig G- 68: Fill Borrow Pit - Hole No: F14

Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F15
Sheet 1 of 1

JOB NUMBER: 2819



0.00 – 0.50: Dry, dark brown, loose, intact, CLAYEY SAND with numerous dolerite boulders: Colluvium.

0.50 – 0.90: Slightly moist, light yellowish brown, loose, intact, GRAVELLY SAND with numerous dolerite cobbles.

NOTES

1) No water seepage observed.

2) Refusal at 0.9m on boulder / bedrock.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.246' S
Y-COORD : 28d38.521' E

HOLE No: F15

D06C JGI

dotPLOT 7013 PBp7

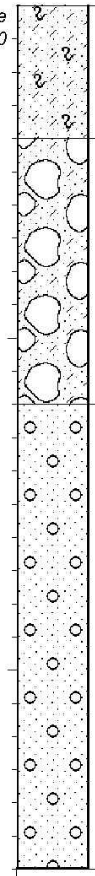
Fig G- 69: Fill Borrow Pit - Hole No: F15

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F16
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, dark reddish brown, loose, intact, CLAYEY SAND with roots: Colluvium.
0.40	Slightly moist, reddish brown, medium dense, intact, CLAYEY SAND with numerous dolerite boulders: Colluvium.
1.20	Slightly moist, yellowish brown, dense, intact, GRAVELLY SAND: Residual dolerite.
2.60	

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.246' S
Y-COORD : 28d38.521' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F16

D06C JGI

dotPLOT 7013 PBp7

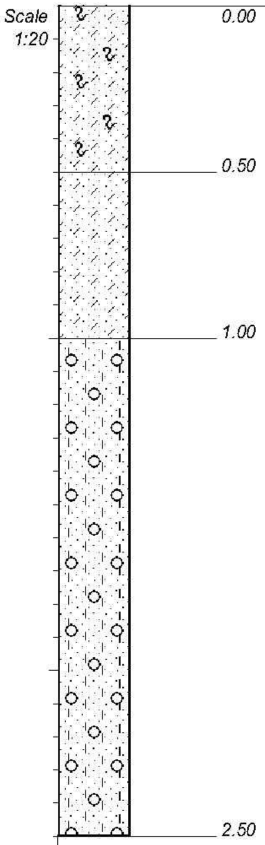
Fig G- 70: Fill Borrow Pit - Hole No: F16

Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F17
Sheet 1 of 1

JOB NUMBER: 2819



0.00 – 0.50: Dry, dark brown, loose, intact, CLAYEY SAND with numerous roots: Colluvium.

0.50 – 1.00: Slightly moist, reddish brown, loose, intact, CLAYEY SAND: Colluvium.

1.00 – 2.50: Slightly moist, yellowish olive - olive-brown, meium dense, SILTY GRAVELLY SAND: Residual. dolerite.

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.212' S
Y-COORD : 28d38.570' E

HOLE No: F17

D06C JGI

dotPLOT 7013 PBp7

Fig G- 71: Fill Borrow Pit - Hole No: F17

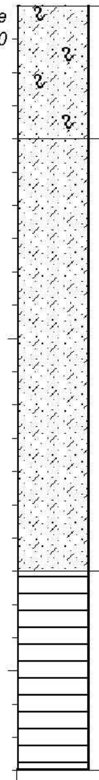
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F18
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, dark reddish brown, loose, intact, CLAYEY SAND with numerous roots: Colluvium.
0.40	Slightly moist, reddish brown blotched black, intact, CLAYEY SAND with roots at top: Colluvium.
1.70	Grey, highly weathered, closely jointed, hard rock, MUDROCK.
2.30	

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.168' S
Y-COORD : 28d38.397' E

HOLE No: F18

D06C JGI

dotPLOT 7013 PBp7

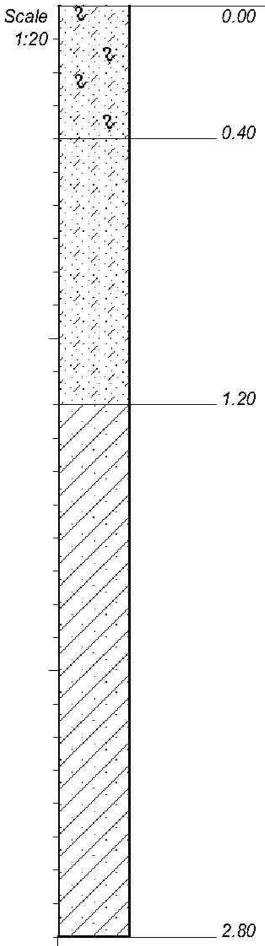
Fig G- 72: Fill Borrow Pit - Hole No: F18

Jeffares & Green
ENGINEERING & ENVIRONMENTAL CONSULTING

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F19
Sheet 1 of 1

JOB NUMBER: 2819



Depth	Description
0.00	Dry, dark brown, loose, intact, CLAYEY SAND with numerous roots: Colluvium.
0.40	Slightly moist, reddish brown, medium dense, intact, CLAYEY SAND: Colluvium.
1.20	Slightly moist, reddish brown blotched grey, firm, slickensided, SANDY CLAY: Colluvium / residuum.
2.80	

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.135' S
Y-COORD : 28d38.554' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F19

D06C JGI

dotPLOT 7013 PBp7

Fig G- 73: Fill Borrow Pit - Hole No: F19

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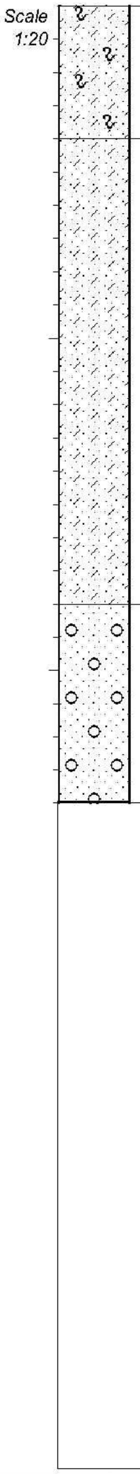
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F20
Sheet 1 of 1

JOB NUMBER: 2819



0.00

Dry, dark brown, loose, intact, CLAYEY SAND with numerous roots: Colluvium.

0.40

Moist, reddish brown, medium dense, intact, CLAYEY SAND: Colluvium.

1.80

Moist, reddish brown blotched orange speckled black, medium dense, intact, GRAVELLY SAND: Residual dolerite.

2.40

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.189' S
Y-COORD : 28d38.534' E

HOLE No: F20

D06C JGI

dotPLOT 7013 PBp7

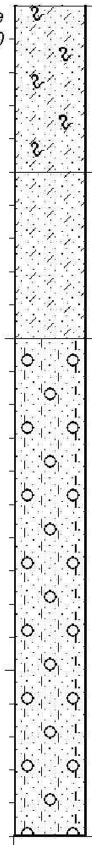
Fig G- 74: Fill Borrow Pit - Hole No: F20

Mzimvubu Water Project
Ntabelanga Dam Phase 2
Fill Borrow Pit

HOLE No: F21
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Dry, dark brown, loose, intact, CLAYEY SAND with numerous roots: Colluvium.

0.50

Slightly moist, reddish brown, loose, intact, CLAYEY SAND: Colluvium.

1.00

Slightly moist, yellowish olive-brown, medium dense, intact, SILTY GRAVELLY SAND: Residua dolerite.

2.50

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.191' S
Y-COORD : 28d38.582' E

HOLE No: F21

D06C JGI

dotPLOT 7013 PBp7

Fig G- 75: Fill Borrow Pit - Hole No: F21

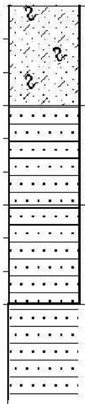
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F22
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, reddish brown, loose, intact, CLAYEY SAND: Colluvium with numerous roots.
0.30	Yellow brown, completely weathered, blocky, soft rock, SANDSTONE.
0.60	Yellowish brown, highly weathered, closely jointed, blocky, soft to medium hard rock SANDSTONE.
0.90	Sandstone, more indurated.

NOTES

1) No water seepage observed.

2) Refusal at 0.9m on sandstone.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.148' S
Y-COORD : 28d38.623' E

HOLE No: F22

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G- 76: Fill Borrow Pit - Hole No: F22

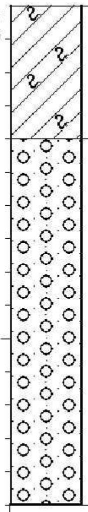
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F23
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, dark brown, loose, intact, CLAY with numerous roots: Colluvium.
0.40	Olive brown, highly weathered, friable, very soft rock, DOLERITE with corestones. Recovered as sandy gravel.
1.50	

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.141' S
Y-COORD : 28d38.650' E

HOLE No: F23

D06C JGI *dotPLOT 7013 PBp7*

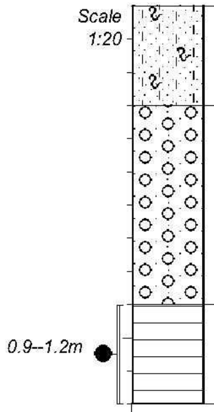
Fig G- 77: Fill Borrow Pit - Hole No: F23

Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F25
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Dry, light brown, loose, intact, SILTY SAND with numerous roots: Colluvium.
0.30	Slightly moist, light brown streaked black, dense, intact, SANDY GRAVEL: Residual mudrock.
0.90	Purple, highly weathered, thinly bedded, soft rock, MUDROCK.
1.20	

NOTES

1) No water seepage observed.

2) No refusal, but slow TLB advance.

3) No sidewall collapse.

4) Sample taken between 0.9--1.2m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.591' S
Y-COORD : 28d38.896' E

HOLE No: F25

D06C JGI

dotPLOT 7013 PBp7

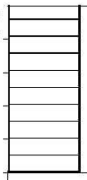
Fig G- 78: Fill Borrow Pit - Hole No: F25

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F26
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Purple / grey, highly weathered, thinly bedded, closely jointed, medium hardrock, MUDROCK.

0.50

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

5) Excavated in erosion gulley.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: F26

D06C JGI

dotPLOT 7013 PBp7

Fig G- 79: Fill Borrow Pit - Hole No: F26

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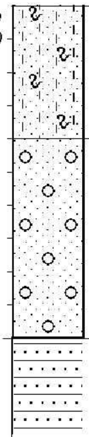
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F27
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, light brown, loose, intact, SILTY SAND with numerous roots: Colluvium.
0.40	Slightly moist, light brown blotched orange and black, GRAVELLY SAND: Residual mudrock / sandstone.
1.00	Light brown blotched orange and black, completely weathered, closely jointed, thinly bedded, very soft rock, fine silty SANDSTONE.

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: F27

D06C JGI

dotPLOT 7013 PBp7

Fig G- 80: Fill Borrow Pit - Hole No: F27

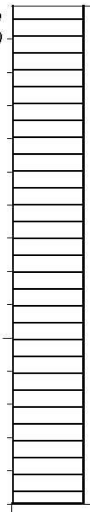
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F28
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Purple / grey, highly weathered, closely jointed, thinly bedded, very soft rock, MUDROCK.

1.50

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Sample taken between 0--1.5m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F28

D06C JGI

dotPLOT 7013 PBp7

Fig G- 81: Fill Borrow Pit - Hole No: F28

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Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F29
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00

Pinkish purple, completely to highly weathered, closely jointed, soft to medium hard rock, MUDROCK.

0.60

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Sample taken between 0--0.6m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F29

D06C JGI

dotPLOT 7013 PBp7

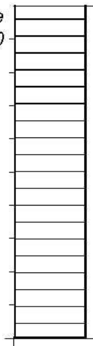
Fig G- 82: Fill Borrow Pit - Hole No: F29

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F30
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Purple grey, highly weathered, closely jointed, thinly bedded, soft rock, MUDROCK.
1.00	

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

5) Excavated in erosion gulley.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: F30

D06C JGI

dotPLOT 7013 PBp7

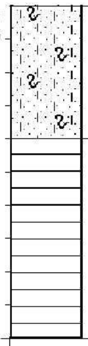
Fig G- 83: Fill Borrow Pit - Hole No: F30

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F31
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Dry, light brown, loose, intact, SILTY SAND with numerous roots: Colluvium.

0.40

Purple grey, highly weathered, closely jointed, thinly bedded, soft rock, MUDROCK.

1.00

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: F31

D06C JGI

dotPLOT 7013 PBp7

Fig G- 84: Fill Borrow Pit - Hole No: F31

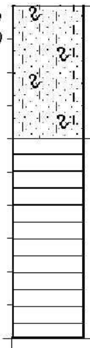
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F32
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Dry, yellowish light brown, loose, intact, SILTY SAND with numerous roots: Colluvium.

0.40

Light brown, completely weathered, very soft rock MUDROCK.

1.00

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: F32

D06C JGI

dotPLOT 7013 PBp7

Fig G- 85: Fill Borrow Pit - Hole No: F32

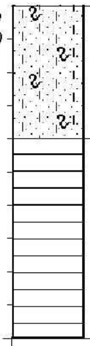
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F33
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Dry, yellowish brown, loose, intact, SILTY SAND with numerous roots: Colluvium.

0.40

Purple grey, highly weathered, closely jointed, thinly bedded, soft rock, MUDROCK.

1.00

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: F33

D06C JGI

dotPLOT 7013 PBp7

Fig G- 86: Fill Borrow Pit - Hole No: F33

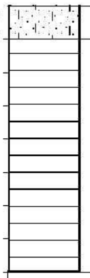
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F34
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, yellowish brown, loose, intact, SILTY SAND: Colluvium
0.10	Purple, highly weathered, thinly bedded, closely jointed, soft rock MUDROCK.
0.80	

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.542' S
Y-COORD : 28d38.289' E

HOLE No: F34

D06C JGI

dotPLOT 7013 PBp7

Fig G- 87: Fill Borrow Pit - Hole No: F34

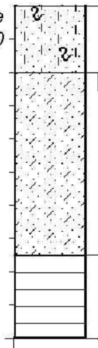
Jeffares & Green

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F35
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20



0.00	Dry, light brown, loose, intact, SILTY SAND with numerous roots: Colluvium.
0.20	Slightly moist, orange-brown, loose, intact, CLAYEY SAND: Colluvium.
0.75	Purple, highly weathered, thinly bedded, closely jointed, soft rock, MUDROCK.
1.00	

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.502' S
Y-COORD : 28d38.822' E

HOLE No: F35

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G- 88: Fill Borrow Pit - Hole No: F35

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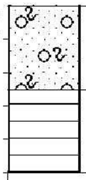
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F36
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, light brown, loose, intact, GRAVELLY SAND with numerous roots: Colluvium.
0.25	Purple, highly weathered, thinly bedded, closely jointed, soft rock, MUDROCK with interbedded sandstone.
0.50	

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.466' S
Y-COORD : 28d38.792' E

HOLE No: F36

D06C JGI
dotPLOT 7013 PBp7

Fig G- 89: Fill Borrow Pit - Hole No: F36

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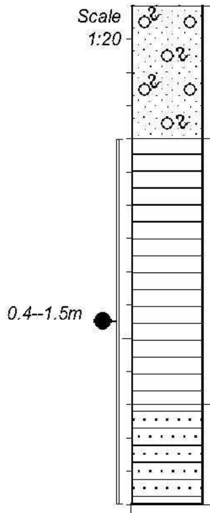
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F37
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Dry, light brown, loose, intact, GRAVELLY SAND with numerous roots: Colluvium.
0.40	Purple grey, highly weathered, thinly bedded, closely jointed, soft rock MUDROCK.
1.20	Greenish grey, highly weathered, thinly bedded, closely jointed, soft rock SANDSTONE.
1.50	

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Sample taken between 0.4--1.5m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.405' S
Y-COORD : 28d38.818' E

HOLE No: F37

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 90: Fill Borrow Pit - Hole No: F37

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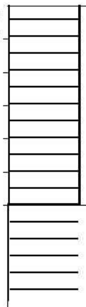
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F38
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Pinkish purple, highly weathered, closely jointed, thinly bedded, soft rock, MUDROCK.

0.60

NOTES

1) No water seepage observed.

2) Refusal at 0.6m on mudrock.

3) No sidewall collapse.

4) Not sampled.

5) Excavated in erosion gulley.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.496' S
Y-COORD : 28d38.700' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F38

D06C JGI

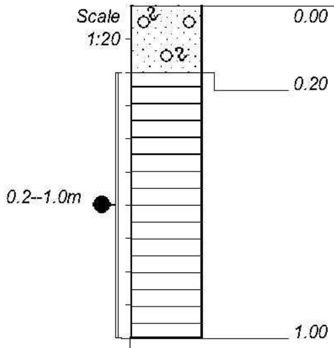
dotPLOT 7013 PBp7

Fig G- 91: Fill Borrow Pit - Hole No: F38

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F39
Sheet 1 of 1

JOB NUMBER: 2819



Dry, light brown, loose, intact, GRAVELLY SAND with numerous roots and sandstone cobbles on the surface: Colluvium.

Pinkish purple, highly weathered, closely jointed, thinly bedded, very soft to soft rock, MUDROCK interbedded with sandstone.

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Sample taken between 0.2--1.0m.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.416' S
Y-COORD : 28d38.634' E

HOLE No: F39

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G- 92: Fill Borrow Pit - Hole No: F39

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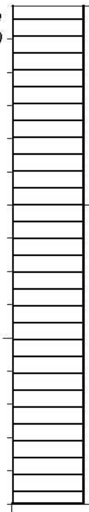
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F40
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Purple brown, medium weathered, closely jointed, thinly bedded, soft rock, MUDROCK.
0.60	Purple / pinkish, highly weathered, closely jointed, thinly bedded, very soft rock, MUDROCK. Disintegrated.
1.50	

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

5) Excavated in erosion gulley

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.354' S
Y-COORD : 28d38.669' E

HOLE No: F40

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 93: Fill Borrow Pit - Hole No: F40

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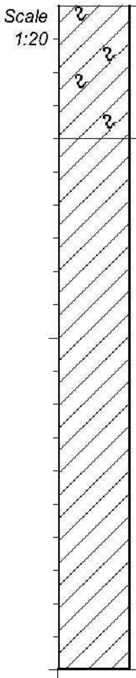
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F41
Sheet 1 of 1

JOB NUMBER: 2819



0.00 Pinkish grey, loose, intact, firm, CLAY with numerous roots: Colluvium.

0.40 Moist, dark brown, intact, firm, CLAY: Colluvium.

2.00

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013
DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.316' S
Y-COORD : 28d38.704' E

HOLE No: F41

D06C JGI *dotPLOT 7013 PBp7*

Fig G- 94: **Fill Borrow Pit - Hole No: F41**

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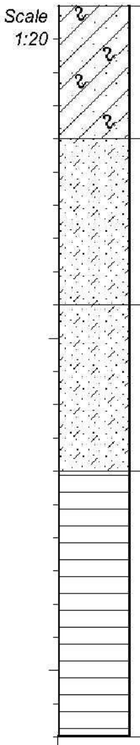
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F42
Sheet 1 of 1

JOB NUMBER: 2819



0.00
Moist, black, firm, shattered, SANDY CLAY with numerous roots: Colluvium.

0.40
Moist, reddish brown, medium dense, intact, CLAYEY SAND: Colluvium.

0.90
Moist, orange brown blotched yellow, medium dense, intact, CLAYEY SAND: Residual sandstone.

1.40
Purple, highly weathered, closely jointed, thinly bedded, very soft rock, MUDROCK.

2.20

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d06.263' S
Y-COORD : 28d38.609' E

HOLE No: F42

D06C JGI

dotPLOT 7013 PBp7

Fig G- 95: Fill Borrow Pit - Hole No: F42

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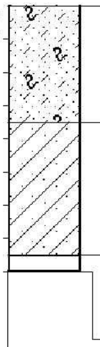
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F43
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00

Dry, grey, loose, intact, CLAYEY SAND with numerous roots: Colluvium.

0.35

Moist, grey brown, firm, shattered, SANDY CLAY: Colluvium.

0.75

Grey, highly weathered, closely jointed, thinly bedded, soft rock, MUDROCK.

0.80

NOTES

1) No water seepage observed.

2) No refusal.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: F43

D06C JGI

dotPLOT 7013 PBp7

Fig G- 96: Fill Borrow Pit - Hole No: F43

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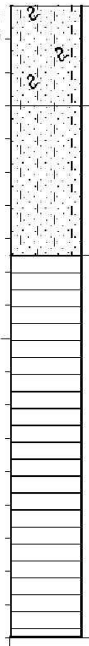
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F44
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, yellowish brown, loose, intact, SILTY SAND with roots: Colluvium.
0.30	Slighty moist, light brown streaked yellow, loose, intact, SILTY SAND: Colluvium.
0.75	Grey, highly weathered, closely jointed, thinly bedded, soft rock, MUDROCK.
1.90	

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

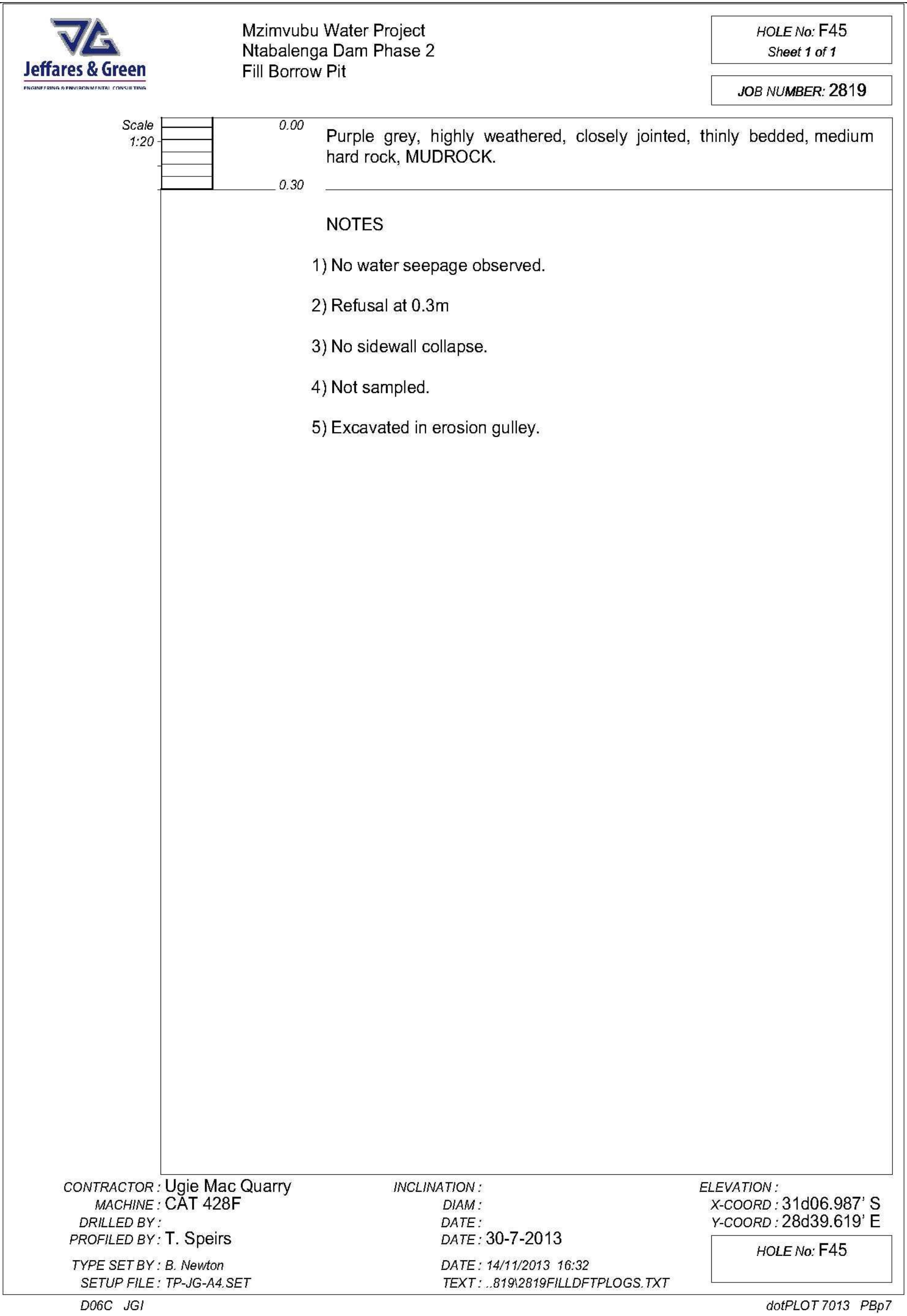
ELEVATION :
X-COORD : 31d06.979' S
Y-COORD : 28d39.497' E

HOLE No: F44

D06C JGI

dotPLOT 7013 PBp7

Fig G- 97: **Fill Borrow Pit - Hole No: F44**



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Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F45
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00 – 0.30	Purple grey, highly weathered, closely jointed, thinly bedded, medium hard rock, MUDROCK.

NOTES

1) No water seepage observed.

2) Refusal at 0.3m

3) No sidewall collapse.

4) Not sampled.

5) Excavated in erosion gulley.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d06.987' S
Y-COORD : 28d39.619' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F45

D06C JGI

dotPLOT 7013 PBp7

Fig G- 98: Fill Borrow Pit - Hole No: F46

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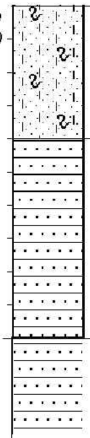
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F46
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, yellowish light brown, loose, intact, SILTY SAND with numerous roots: Colluvium.
0.40	Greenish grey, highly weathered, closley jointed, very thinly bedded, soft rock, SANDSTONE.
1.00	Sandstone.

NOTES

1) No water seepage observed.

2) Refusal at 1.0m on sandstone.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

ELEVATION :
X-COORD : 31d07.013' S
Y-COORD : 28d39.430' E

HOLE No: F46

D06C JGI

dotPLOT 7013 PBp7

Fig G- 99: Fill Borrow Pit - Hole No: F46

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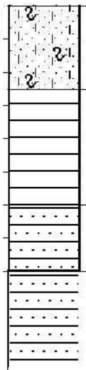
Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F47
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, yellowish light brown, loose, intact, SILTY SAND with numerous roots: Colluvium.
0.25	Purple, highly weathered, closely jointed, thinly bedded, soft rock, MUDROCK.
0.60	Greenish grey, highly weathered, closely jointed, very thinly bedded, soft rock, SANDSTONE.
0.80	Sandstone.

NOTES

1) No water seepage observed.

2) Refusal at 0.8m on sandstone.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d07.022' S
Y-COORD : 28d39.371' E

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

HOLE No: F47

D06C JGI

dotPLOT 7013 PBp7

Fig G- 100: Fill Borrow Pit - Hole No: F47

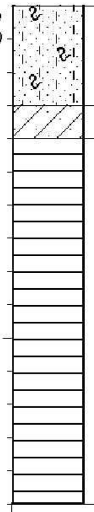
Jeffares & Green
ENGINEERING & ENVIRONMENTAL CONSULTING

Mzimvubu Water Project
Ntabalenga Dam Phase 2
Fill Borrow Pit

HOLE No: F48
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, yellowish light brown, loose, intact, SILTY SAND with numerous roots: Colluvium.
0.30	Dry, yellowish brown, firm, intact, SANDY CLAY: Colluvium.
0.40	Purple, highly weathered, closely jointed, thinly bedded, soft rock, MUDROCK.
1.50	

NOTES

1) No water seepage observed.

2) No refusal, but slow advance with TLB.

3) No sidewall collapse.

4) Not sampled.

CONTRACTOR : Ugie Mac Quarry
MACHINE : CAT 428F
DRILLED BY :
PROFILED BY : T. Speirs

INCLINATION :
DIAM :
DATE :
DATE : 30-7-2013

ELEVATION :
X-COORD : 31d07.056' S
Y-COORD : 28d39.385' E

HOLE No: F48

TYPE SET BY : B. Newton
SETUP FILE : TP-JG-A4.SET

DATE : 14/11/2013 16:32
TEXT : ..819\2819FILLDFTPLOGS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig G- 101: Fill Borrow Pit - Hole No: F48

APPENDIX H

LABORATORY TEST RESULTS

H1

UCS

CONTEST
Concrete Technology Services
P O Box 1675, Hillcrest, 3650, South Africa. Tel (031) 700 9394 (031) 700 9342
E-mail : ukhonkolo@contest.co.za

Ref: CJ13/09/935 2 October, 2013

Client: Jeffares & Green Consultants

Project: Mzimvubu Water Project - Ntabelanga Dam: Phase 2 Geotechnical Investigation

Subject: Compressive Strength Testing on Dolerite Rock Cores

Order: Mr T Speirs

LABORATORY REPORT
TESTING OF ROCK CORES

1. CLIENT

1.1 Jeffares & Green, P O Box 794, HILTON, 3201.

2. BRIEF FROM CLIENT

2.1 Contest was requested to determine the compressive strength of five dolerite rock cores received on 20.09.2013 in accordance with SANS 5865:2006.

3. SAMPLES

3.1 Five dolerite rock cores were tested on 23.09.2013.

4. INFORMATION SUPPLIED BY THE CLIENT

4.1 Site : Ntabelanga Dam (Mzimvubu Water Project)
4.2 Location : Borehole:
: N1 - (7.82 - 7.95)
: N2 - (7.75 - 7.9)
: N2 - (12.31 - 12.49)
: NL 2/6 - (1.95 - 2.25)
: NL 2/9 - (4.89 - 2.25)
4.3 Date drilled : Not given
4.4 Drilling contractor : Not given

5. CORE PREPARATION

5.1 Testing of cores were carried out by our laboratories in Westmead

5.2 The cores were measured as received; any significant details recorded and then marked up for trimming.

5.3 The cores were photographed in surface dry and wet states.

5.4 After trimming to length the cores were weighed in air and water, in order to determine the density.

5.5 Finally the cores were capped using sulphur mortar.

6. RESULTS

6.1 See appended core report and photographs.

COMMENT

Core Number N1 (7.82 – 7.95) showed the typical signs of rock decomposition which are a change in colour of the rock from a dark grey for dolorite to a brown/yellow colouration. This decomposition would have contributed significantly to the lower compressive strength measured for this core.

RJL RAW B Tech (Civil Eng)

CORE REPORT

Client	Jeffares & Green Consultants
Project	Mzimvubu Water Project - Ntabelanga Dam: Phase 2 Geotechnical Investigation
Job Number	CJ13/09/935
Date Cast	Not given
Date Tested	23.09.2013
Age, Day	Not given
Date Received	20.09.2013
Direction of Dilling	Not given
Report date	26.09.2013

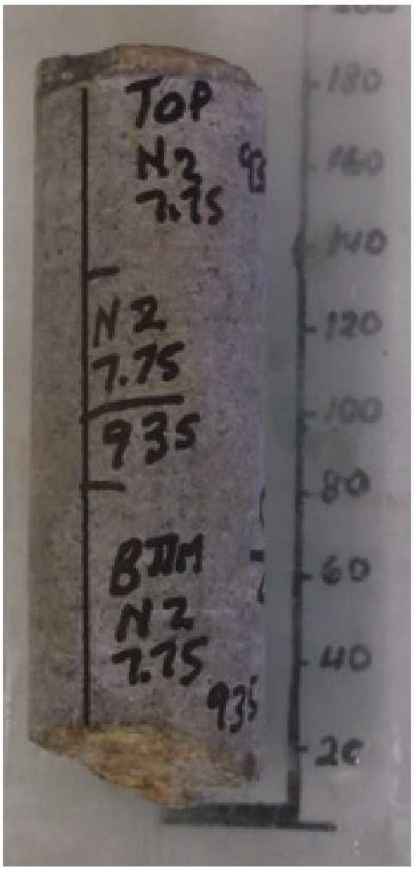
Client Reference	BOREHOLE NO - (DOLERITE ROCK CORES)				
	N1 (7.82-7.95)	**N2 (7.75-7.9)**	**N2 (12.31-12.49)**	**NL 2/6 (1.95-2.25)**	**NL 2/9 (4.89-5.09)**
DIMENSIONS					
Max length (mm)	125	155	350	300	195
Min length (mm)	120	140	295	175	175
Diameter (mm)	51.52	52.03	60.34	60.38	60.48
Trim Length (mm)	51.62	52.69	61.03	60.17	60.27
Capped length (mm)	51.40	52.67	61.04	60.07	60.19
Trim length/diameter	1.00	0.99	0.99	1.00	1.00
Cap length/diameter	1.00	0.99	0.99	1.01	1.00
REINFORCEMENT					
	Steel 1	Steel 1	Steel 1	Steel 1	Steel 1
Dist. from end (mm)	0.0	0.0	0.0	0.0	0.0
Diameter (mm)	0.0	0.0	0.0	0.0	0.0
Mass (g)	0.0	0.0	0.0	0.0	0.0
	Steel 2	Steel 2	Steel 2	Steel 2	Steel 2
Dist. from end (mm)	0.0	0.0	0.0	0.0	0.0
Diameter (mm)	0.0	0.0	0.0	0.0	0.0
Mass (g)	0.0	0.0	0.0	0.0	0.0
DENSITY					
Mass in air (g)	275	299	466	460	462
Density (kg/m3)	2894	2978	2996	2976	2981
Air Voids %	0.00	0.00	0.00	0.00	0.00
CORRECTIONS					
Length	1.00	1.00	1.00	1.00	1.00
Steel reinforcement	1.00	1.00	1.00	1.00	1.00
Air voids	1.00	1.00	1.00	1.00	1.00
LOADING					
Load at failure (kN)	97.3	354.8	390.5	375.4	584.0
Failure mode	normal	normal	normal	normal	normal
STRENGTH (MPa)					
Uncorrected Strength	46.7	166.8	136.6	131.1	203.2
Length corrected	46.7	166.8	136.6	131.1	203.2
Length/Steel corrected	46.7	166.8	136.6	131.1	203.2
Length/Voids/Steel corrected	46.7	166.8	136.6	131.1	203.2

Notes
1. Sulphur mortar capping
2. SABS Test Method 865:1994
3.Length correction is non-standard

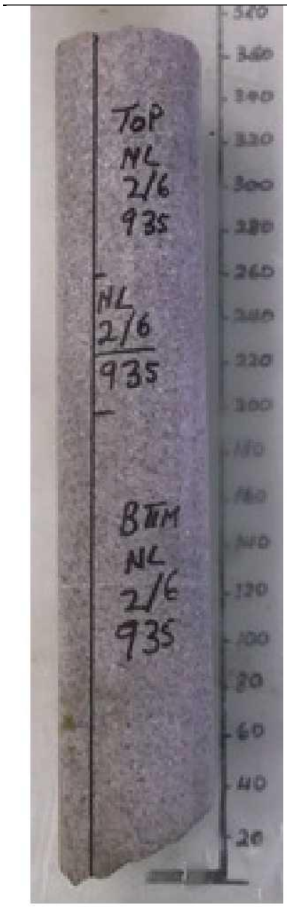
RJL RAW


TOP
N1
7.82
N1
7.82
935
N1
7.82
BTM
160
140
120
100
80
60
40
20


TOP
N1
7.82
N1
7.82
935
N1
7.82
BTM
160
140
120
100
80
60
40
20


TOP
N2
7.75
N2
7.75
935
BTM
N2
7.75
935
180
160
140
120
100
80
60
40
20


TOP
N2
7.75
7.75
935
BTM
N2
7.75
180
160
140
120
100
80
60
40
20


TOP
NL
2/6
935
NL
2/6
935
BTM
NL
2/6
935


TOP
NL
2/6
935
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2/6
935


TOP
NL
2/9
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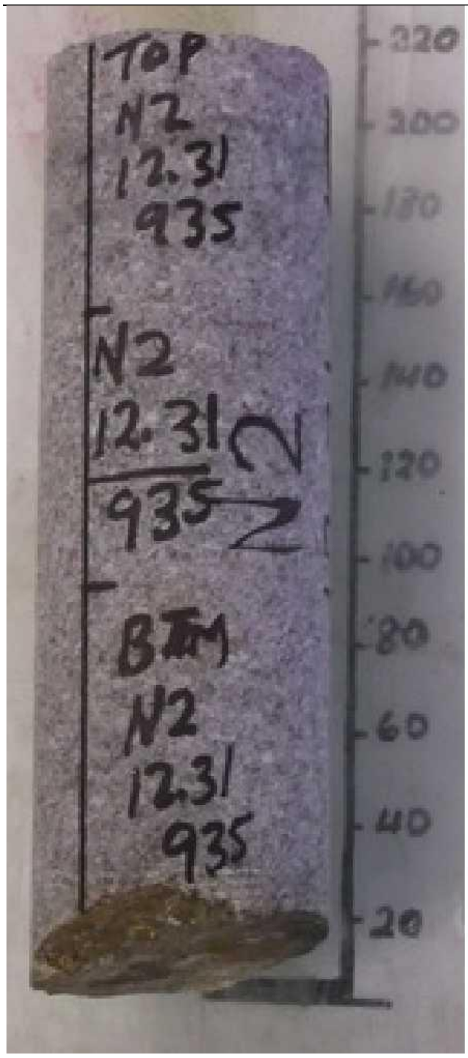
2/9
935
BTM
NL
2/9
935


TOP
N2
12.31
935
N2
12.31
935
N2
BTM
N2
12.31
935
220
200
180
160
140
120
100
80
60
40
20


N2
12.31
935
12.31
935
N2
31
935
220
200
180
160
140
120
100
80
60
40
20

H2

PETROGRAPHIC

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Natural and Agricultural Sciences

Faculty of Natural &
Agricultural Sciences
XRD & XRF Facility
Department of Geology
Pretoria 0002, South Africa

Direct Telephone: (012) 420-2722
Direct Telefax: (012) 362 5219
E-Mail: wiebke.grote@up.ac.za
http://www.up.ac.za/academic/science

CLIENT: Jeffares & Green (Pty) Ltd

DATE: 28 October 2013

SAMPLES: 5 Samples

YOUR REFERENCE: "CIVILAB SUBCONTRACT TESTING"

PROJECT: **MZIMVUBU WATER PROJECT**

ANALYSIS: Petrographic investigation of 5 dolerite core samples

Two thin sections from each core were prepared.

Summary:

Macroscopic description: Massive, fine to medium-grained dark grey intrusive igneous rock with a distinct dolerite texture.

Microscopic description:
When not stated otherwise the microscope pictures were taken with 10x magnification, field of view 1250µm wide and cross polarized illumination.
The dolerites appear holocrystalline, relatively fresh, fine to medium grained with an ophitic texture. The main constituent in the thin sections is plagioclase (feldspar) and clinopyroxene (augite). The alteration of the plagioclase to sericite and pyroxene to chlorite (or traces of hornblende and/or possible smectite) seems to be low, approximately around 10%.
The 5 samples (drill cores) are very similar.

Thin Section Description:

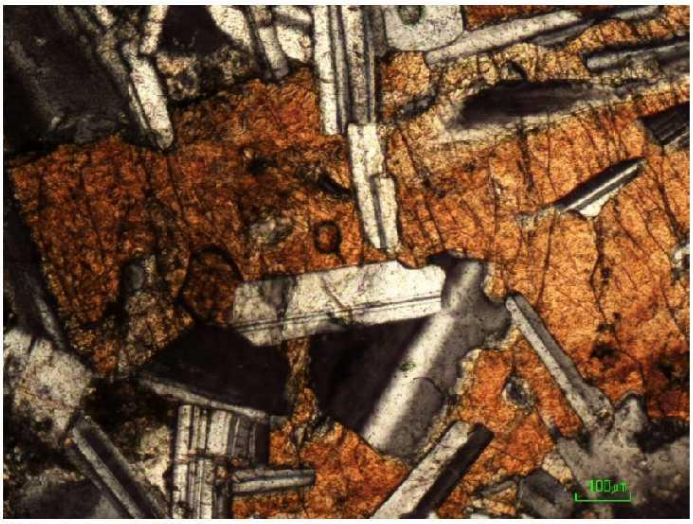
Sample name: N1_ 7.7 – 7.82

Constituents: Fine to medium grained euhedral lath-shaped plagioclase crystals (~60%) intergrown by clinopyroxene (~33%). Minor quartz (~2%) and less than 1% opaque minerals (oxides) is present. Secondary minerals (~5%) include chlorite, sericite (white mica) and traces of hornblende.

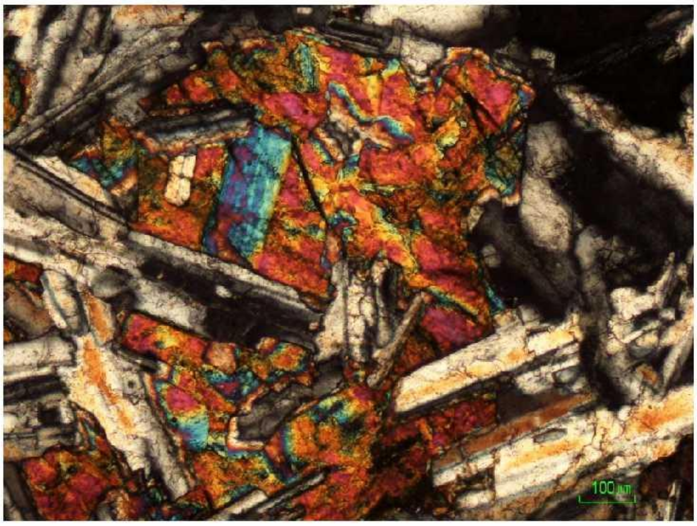
Grain size data: ≤ 500 ≥ 1000 micron

Description:

The section is dominated by generally lath-shaped medium to fine grained feldspar (plagioclase) showing albite twinning, and subhedral to anhedral clinopyroxene (augite). The laths of plagioclase are randomly orientated and the clinopyroxenes (augite) occupy a more interstitial position to the plagioclase. Some of the irregular shaped augites, exhibit a pink colour indicative of Ti-content. The pyroxenes show alteration to chlorite along cleavage and rims. Some plagioclase grains show secondary alteration to sericite. The opaque minerals (oxides) are irregular in shape. The degree of alteration is low.



N1_ 7.7 – 7.82: Larger pyroxene crystal encloses the plagioclase laths



N1_ 7.7 – 7.82: Pyroxene and plagioclase (Thin section little too thick)

Sample name: N1_ 11.84-12.2

Thin Section Description:

Constituents: Fine to medium grained euhedral lath-shaped plagioclase crystals (~55%) intergrown by clinopyroxene (~30%). Minor quartz (~3%) and about 1% opaque minerals (oxides) is present. Secondary minerals (~10%) include chlorite, sericite (white mica) and traces of hornblende and smectite (swelling clay).

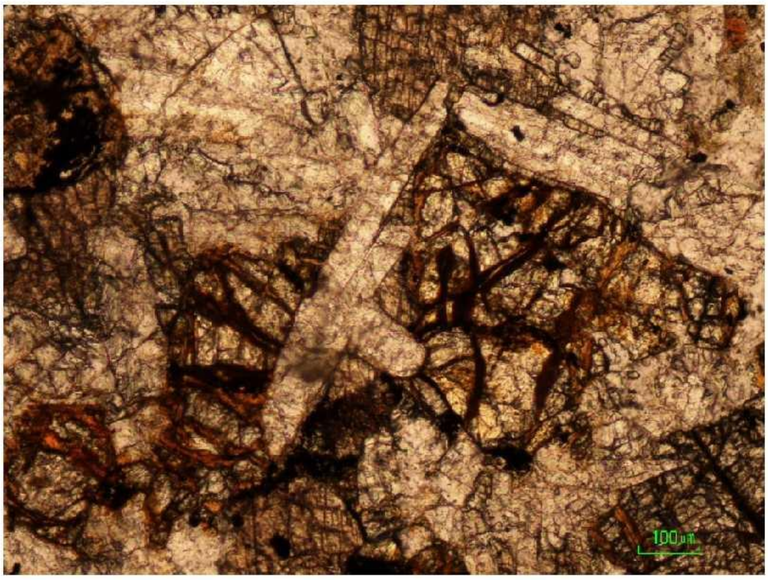
Grain size data: ≤ 500 ≥1000 micron

Description:

The section is dominated by generally lath-shaped medium to fine grained feldspar (plagioclase) showing polysynthetic twinning, and subhedral to anhedral clinopyroxene (augite). The laths of plagioclase are randomly orientated and the clinopyroxenes (augite) occupy a more interstitial position to the plagioclase. Some of the irregular augite crystals exhibit a pink colour indicative of Ti-content. The pyroxenes show alteration to chlorite and traces of hornblende along cleavage and rims. Some of the plagioclase have been replaced fine-grained white mica (sericite).The few opaques are irregular in shape. The degree of alteration is fairly low.

N1_ 11.84-12.2: Plagioclase showing polysynthetic twinnig, enclosed by clinoproxene.

N1_ 11.84-12.2: Alteration of plagioclase to sericite (white mica)



N1_ 11.84-12.2: Traces of smectite visible along cracks. (10x magnification, plane polarized light)

Sample name: N2_ 12.49-12.61

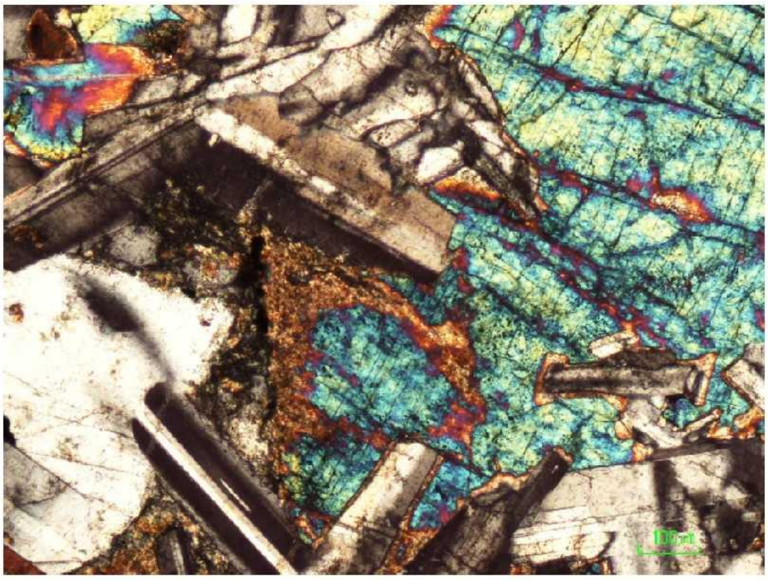
Thin Section Description:

Constituents: Fine to medium grained euhedral lath-shaped plagioclase crystals (~60%) intergrown by clinopyroxene (~26%). Minor quartz (~2%) and about 1% opaque minerals (oxides) is present. Secondary minerals (~11%) include chlorite, sericite (white mica), possibly traces of smectite (swelling clay).

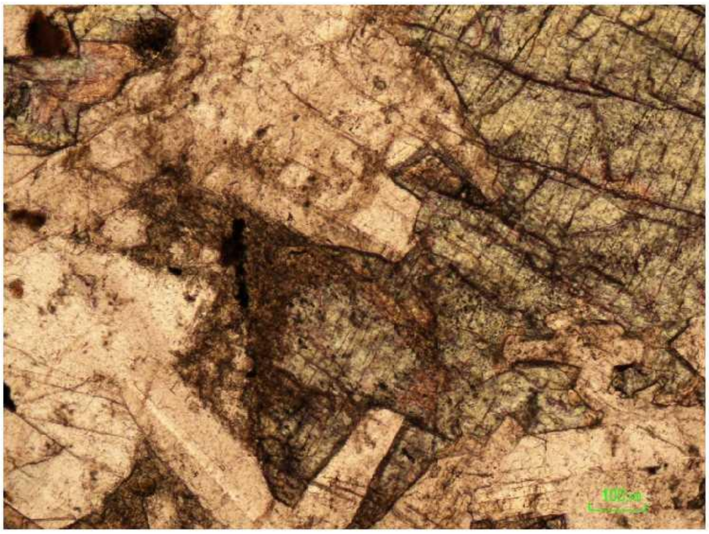
Grain size data: ≤ 500 ≥ 1000 micron

Description:

The section is dominated by generally lath-shaped medium to fine grained feldspar (plagioclase) showing albite twinning, and subhedral to anhedral clinopyroxene (augite). The laths of plagioclase are randomly orientated and the clinopyroxenes (augite) occupy a more interstitial position to the plagioclase. The pyroxenes show alteration to chlorite and possibly traces of smectite along cleavage and rims. A few plagioclase grains show partly alteration to sericite. The opaques are irregular in shape. The degree of alteration is relatively low.



N2_ 12.49-12.61: Plagioclase (showing albite or polysynthetic twinning) and Augite (showing second order interference colours, typical of clinopyroxenes). The augite crystal in the middle of the picture shows alteration on the edge.



N2_ 12.49-12.61: Same as above but under plane polarized light.
(x10 magnification, field of view 1250µm wide, plane polarized illumination)

Sample name: NL 2/6_2.25-2.47

Thin Section Description:

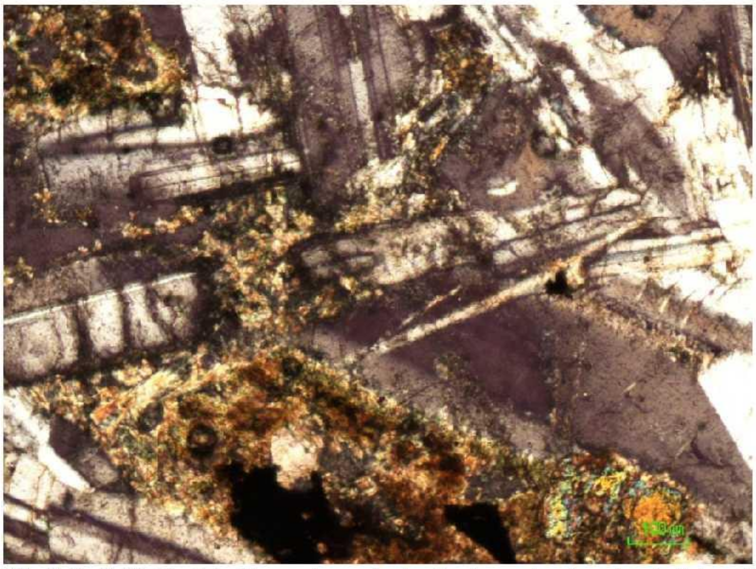
Constituents: Fine to medium grained euhedral lath-shaped plagioclase crystals (~60%) intergrown by clinopyroxene (~30%). Minor quartz (~3%) and about 1% opaque minerals (oxides) is present. Secondary minerals (~6%) include chlorite and sericite (white mica).

Grain size data: ≤ 500 ≥ 1000 micron

Description:

The section is dominated by generally lath-shaped medium to fine grained feldspar (plagioclase) showing albite twinning, and subhedral to anhedral clinopyroxene (augite). The laths of plagioclase are randomly orientated and the clinopyroxenes (augite) occupy a more interstitial position to the plagioclase. Some of the irregular augites exhibit a pink colour, indicative of Ti-content. The pyroxenes show alteration to chlorite along cleavage and rims. Some plagioclase grains show secondary alteration to sericite. The minor opaque minerals are irregular in shape. The degree of alteration is quite low.

NL 2/6_2.25-2.47: Quartz and Plagioclase



NL 2/6_2.25-2.47: Alteration of plagioclase is clearly visible. Black irregular shaped blobs are opaque minerals (oxides).

Sample name: NL 2/9 _ 4.3–4.58

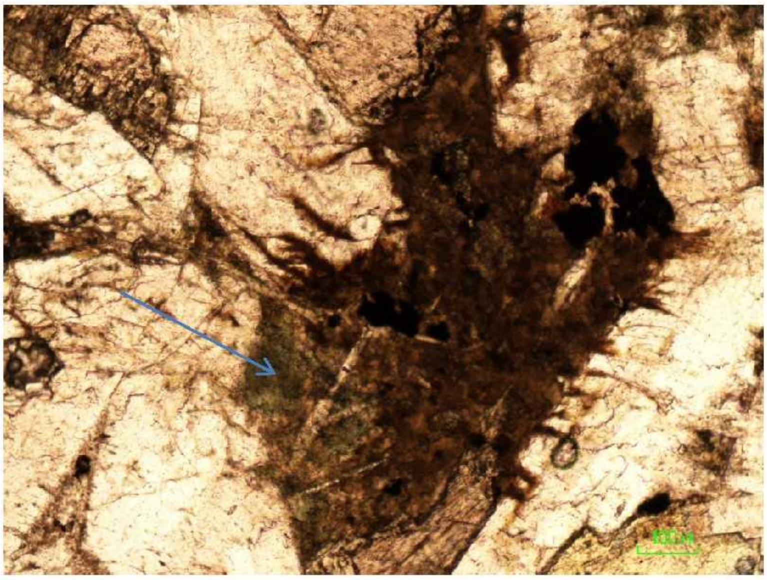
Thin Section Description:

Constituents: Fine to medium grained euhedral lath-shaped plagioclase crystals (~58%) intergrown by clinopyroxene (~30%). Minor quartz (~4%) and about 1% opaque minerals (oxides) is present. Secondary minerals (~7%) include chlorite and sericite (white mica)

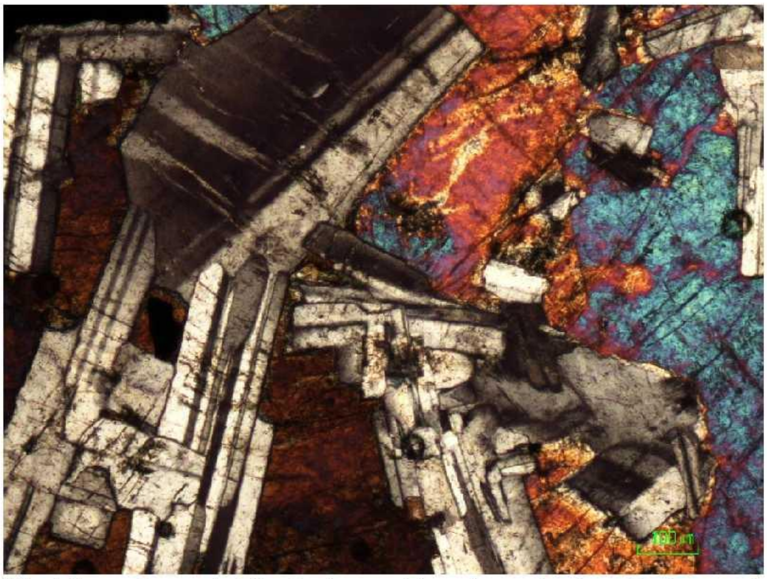
Grain size data: ≤ 500 ≥ 1000 micron

Description:

The section is dominated by generally lath-shaped medium to fine grained feldspar (plagioclase) showing albite twinning, and subhedral to anhedral clinopyroxene (augite). The laths of plagioclase are randomly orientated and the clinopyroxenes (augite) occupy a more interstitial position to the plagioclase. The pyroxenes show alteration to chlorite along cleavage and rims. Some plagioclase grains show secondary alteration to sericite. The opaques are irregular in shape. The degree of alteration is low.



NL 2/9 _ 4.3–4.58: Secondary chlorite, an alteration product, distinguishable by its green colour. (x10 magnification, field of view 1250µm wide, plane polarized illumination)



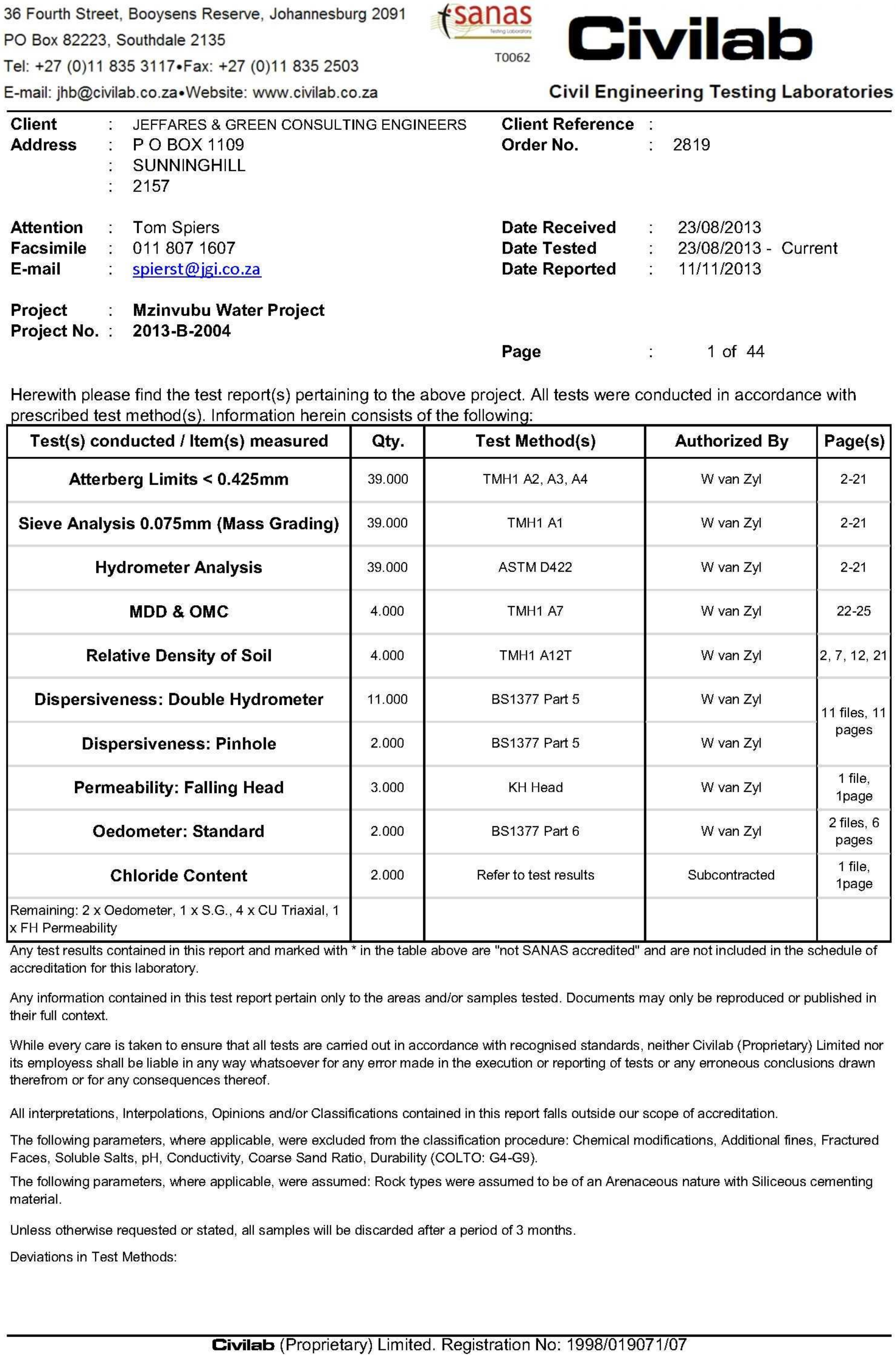
NL 2/9 _ 4.3–4.58: Plagioclase with polysynthetic twinning and augite showing interference color typical of second order.

If you have any questions, kindly contact the laboratory.

Analyst:
Wiebke Grote

H3

INDICATOR AND STANDARD PROCTOR m/d



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PO Box 82223, Southdale 2135
Tel: +27 (0)11 835 3117•Fax: +27 (0)11 835 2503
E-mail: jhb@civilab.co.za•Website: www.civilab.co.za

sanas Testing Laboratory T0062

Civilab
Civil Engineering Testing Laboratories

Client : JEFFARES & GREEN CONSULTING ENGINEERS
Address : P O BOX 1109
: SUNNINGHILL
: 2157

Client Reference :
Order No. : 2819

Attention : Tom Spiers
Facsimile : 011 807 1607
E-mail : spierst@jgi.co.za

Date Received : 23/08/2013
Date Tested : 23/08/2013 - Current
Date Reported : 11/11/2013

Project : **Mzinvubu Water Project**
Project No. : **2013-B-2004**

Page : 1 of 44

Herewith please find the test report(s) pertaining to the above project. All tests were conducted in accordance with prescribed test method(s). Information herein consists of the following:

Test(s) conducted / Item(s) measured	Qty.	Test Method(s)	Authorized By	Page(s)
Atterberg Limits < 0.425mm	39.000	TMH1 A2, A3, A4	W van Zyl	2-21
Sieve Analysis 0.075mm (Mass Grading)	39.000	TMH1 A1	W van Zyl	2-21
Hydrometer Analysis	39.000	ASTM D422	W van Zyl	2-21
MDD & OMC	4.000	TMH1 A7	W van Zyl	22-25
Relative Density of Soil	4.000	TMH1 A12T	W van Zyl	2, 7, 12, 21
Dispersiveness: Double Hydrometer	11.000	BS1377 Part 5	W van Zyl	11 files, 11 pages
Dispersiveness: Pinhole	2.000	BS1377 Part 5	W van Zyl	
Permeability: Falling Head	3.000	KH Head	W van Zyl	1 file, 1page
Oedometer: Standard	2.000	BS1377 Part 6	W van Zyl	2 files, 6 pages
Chloride Content	2.000	Refer to test results	Subcontracted	1 file, 1page
Remaining: 2 x Oedometer, 1 x S.G., 4 x CU Triaxial, 1 x FH Permeability				

Any test results contained in this report and marked with * in the table above are "not SANAS accredited" and are not included in the schedule of accreditation for this laboratory.

Any information contained in this test report pertain only to the areas and/or samples tested. Documents may only be reproduced or published in their full context.

While every care is taken to ensure that all tests are carried out in accordance with recognised standards, neither Civilab (Proprietary) Limited nor its employess shall be liable in any way whatsoever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequences thereof.

All interpretations, Interpolations, Opinions and/or Classifications contained in this report falls outside our scope of accreditation.

The following parameters, where applicable, were excluded from the classification procedure: Chemical modifications, Additional fines, Fractured Faces, Soluble Salts, pH, Conductivity, Coarse Sand Ratio, Durability (COLTO: G4-G9).

The following parameters, where applicable, were assumed: Rock types were assumed to be of an Arenaceous nature with Siliceous cementing material.

Unless otherwise requested or stated, all samples will be discarded after a period of 3 months.

Deviations in Test Methods:

Civilab (Proprietary) Limited. Registration No: 1998/019071/07

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PO Box 82223, Southdale 2135
Tel: +27 (0)11 835 3117•Fax: +27 (0)11 835 2503
E-mail: jhb@civilab.co.za•Website: www.civilab.co.za
sanas Testing Laboratory T0062
Civilab
Civil Engineering Testing Laboratories

Client	:	JEFFARES & GREEN CONSULTING ENGINEERS	Date Received:	23/08/2013
Project	:	Mzinvubu Water Project	Date Reported:	11/11/2013
Project No	:	2013-B-2004	Page No. :	2 of 44

FOUNDATION INDICATOR

Laboratory Number		1 ◆	2 ■
Field Number		C1A	C2
Client Reference			
Depth (m)		0.4-1.0	0.4-2.6
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

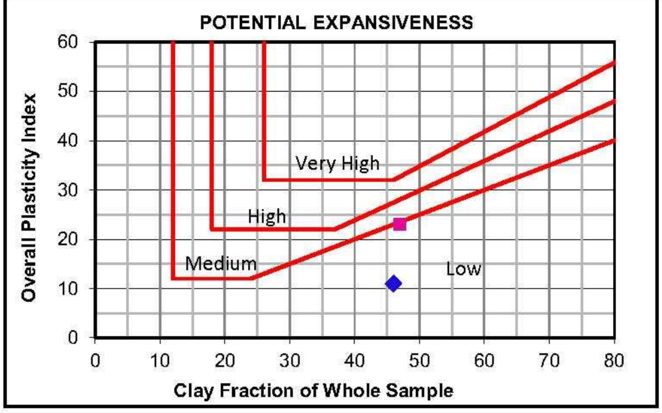
Moisture Content (%)		
Relative Density (S.G.)	2.541	

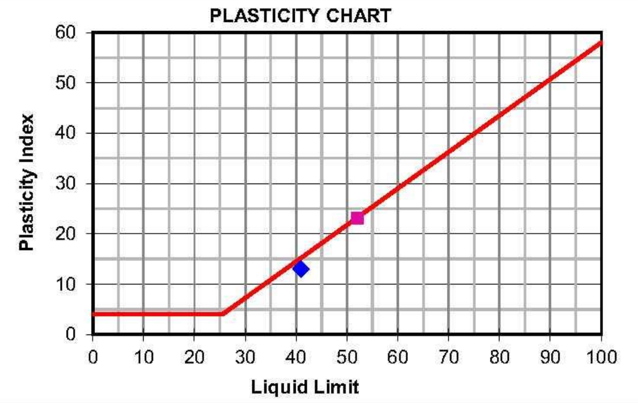
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	99	100
	4.75 mm	94	100
	2.00 mm	90	100
	0.425 mm	85	100
	0.075 mm	81	76
Grading Modulus		0.44	0.24

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	77	71
	0.040 mm	69	63
	0.020 mm	64	56
	0.006 mm	52	51
	0.002 mm	46	47
Gravel	%	10	0
Sand	%	13	29
Silt	%	31	24
Clay	%	46	47





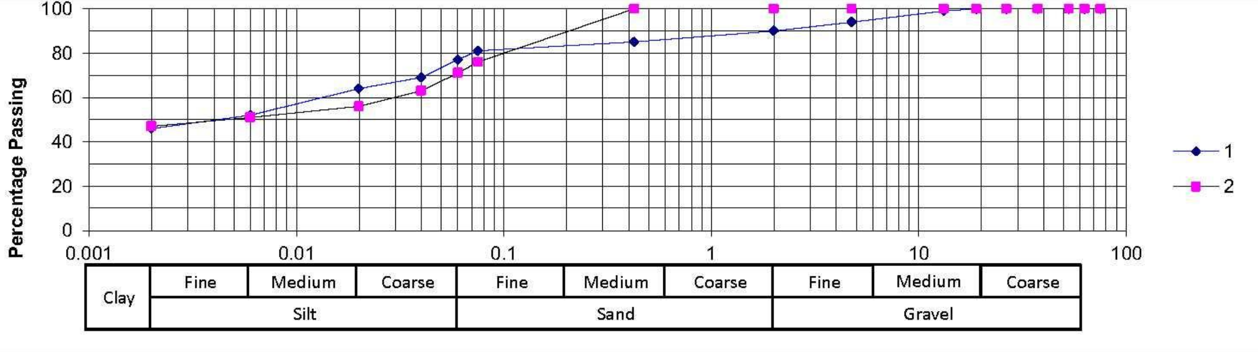
Laboratory Number		1 ◆	2 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	41	52
Plasticity Index	%	13	23
Linear Shrinkage	%	9.5	10.5
Overall PI	%	11	23

Classifications

HRB	A-7-6(11)	A-7-6(19)
Unified	ML	CH
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		3 ◆	4 ■
Field Number		C2A	C4A
Client Reference			
Depth (m)		0.5-1.9	0.4-2.1
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

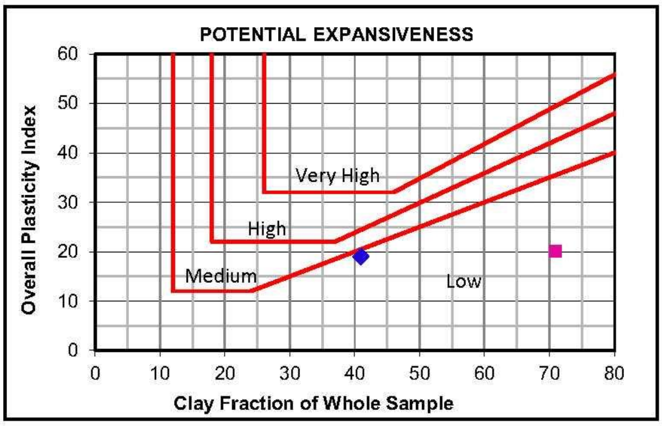
Moisture Content (%)		
Relative Density (S.G.)		

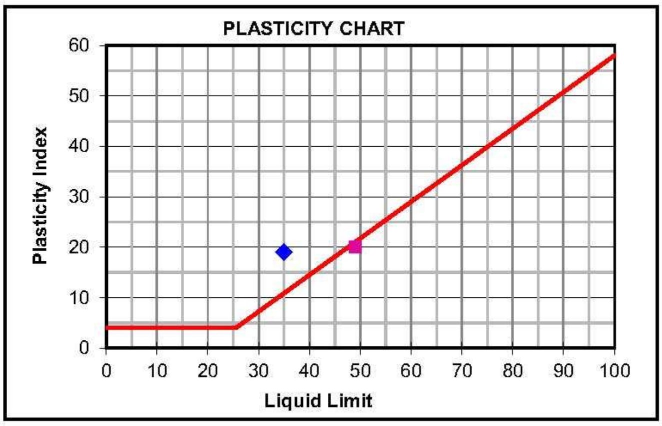
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	100	100
	2.00 mm	100	100
	0.425 mm	99	100
	0.075 mm	67	94
Grading Modulus		0.34	0.06

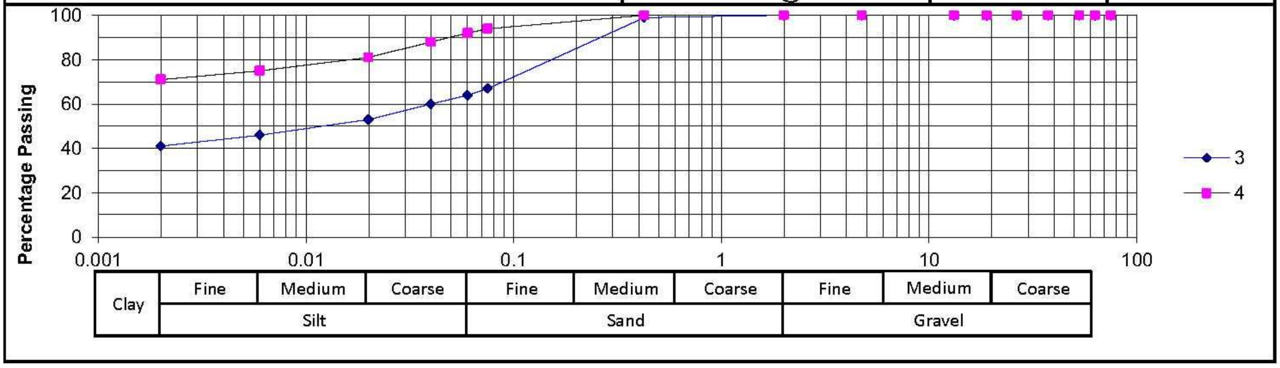
Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	64	92
	0.040 mm	60	88
	0.020 mm	53	81
	0.006 mm	46	75
	0.002 mm	41	71
Gravel	%	0	0
Sand	%	36	8
Silt	%	23	21
Clay	%	41	71





Laboratory Number		3 ◆	4 ■
Atterberg Limits - TMH1 Method A2, A3 & A4			
Liquid Limit	%	35	49
Plasticity Index	%	19	20
Linear Shrinkage	%	9.5	11.5
Overall PI	%	19	20
Classifications			
HRB		A-6(10)	A-7-6(20)
Unified		CL	ML
Weston Swell @ 1 kPa			



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FOUNDATION INDICATOR

Laboratory Number		5 ◆	6 ■
Field Number		C5	C6
Client Reference			
Depth (m)		0.6-2.7	0.5-2.3
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

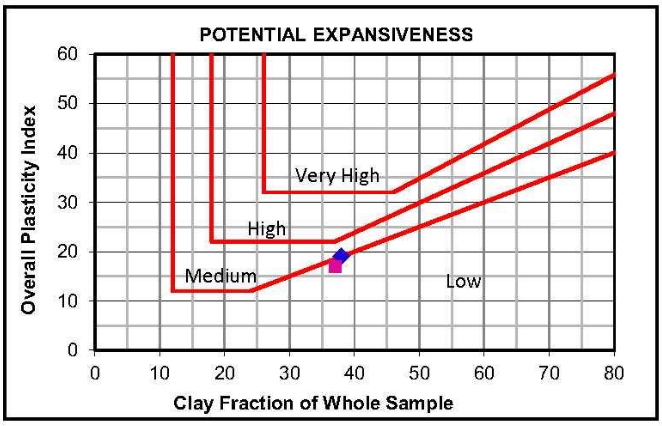
Moisture Content (%)		
Relative Density (S.G.)		

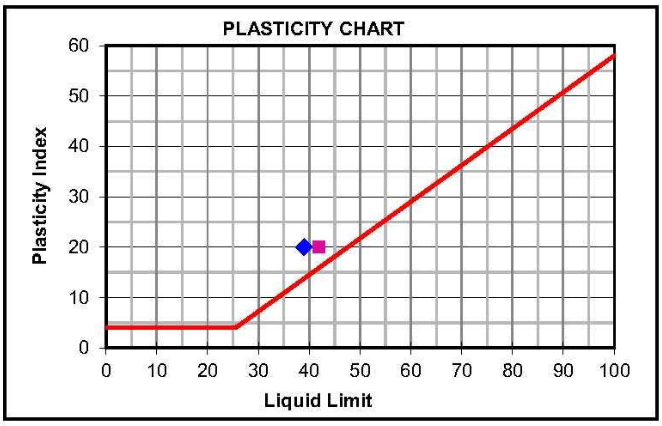
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	98	96
	2.00 mm	97	90
	0.425 mm	95	85
	0.075 mm	87	79
Grading Modulus		0.21	0.46

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	78	72
	0.040 mm	65	60
	0.020 mm	56	52
	0.006 mm	44	41
	0.002 mm	38	37
Gravel	%	3	10
Sand	%	19	18
Silt	%	40	35
Clay	%	38	37





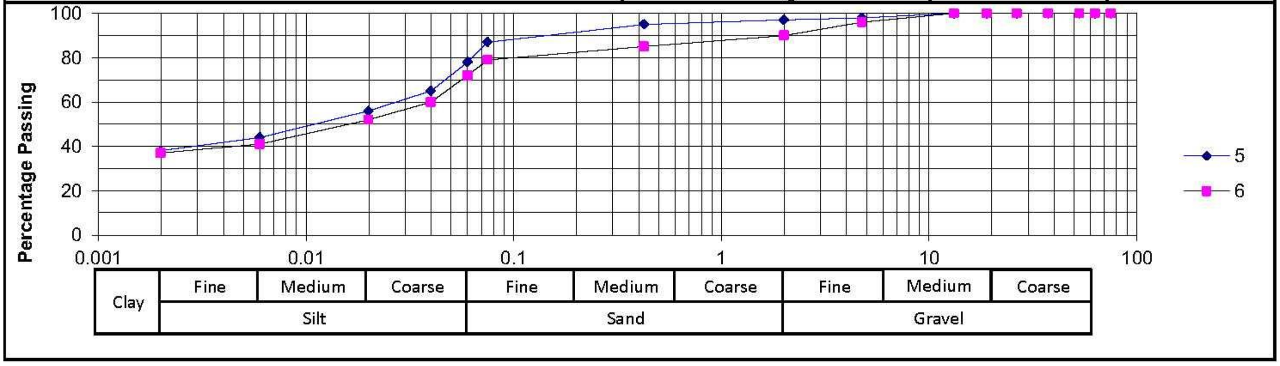
Laboratory Number		5 ◆	6 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	39	42
Plasticity Index	%	20	20
Linear Shrinkage	%	10.0	9.5
Overall PI	%	19	17

Classifications

HRB	A-6(16)	A-7-6(16)
Unified	CL	CL
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		7 ◆	8 ■
Field Number		C7	C8
Client Reference			
Depth (m)		0.9-2.9	0.4-2.5
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

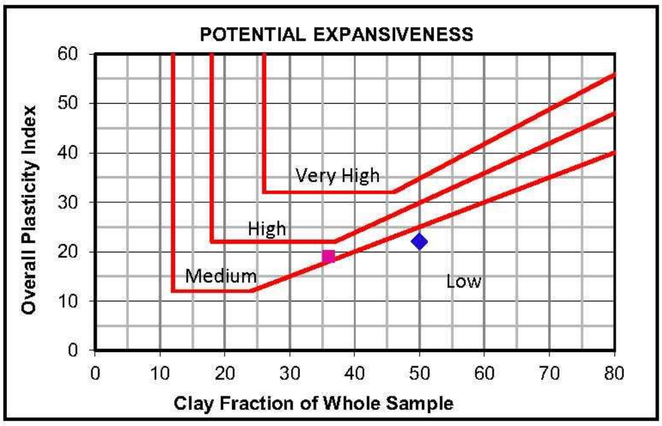
Moisture Content (%)		
Relative Density (S.G.)		

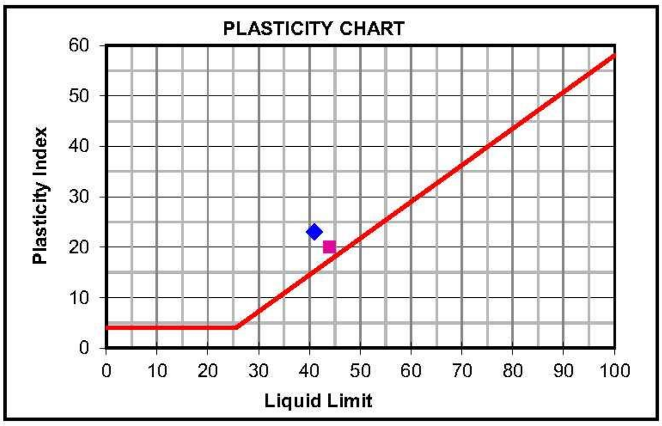
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	99	100
	2.00 mm	97	100
	0.425 mm	95	97
	0.075 mm	89	88
Grading Modulus		0.19	0.15

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	83	81
	0.040 mm	74	69
	0.020 mm	67	59
	0.006 mm	56	43
	0.002 mm	50	36
Gravel	%	3	0
Sand	%	14	19
Silt	%	33	45
Clay	%	50	36





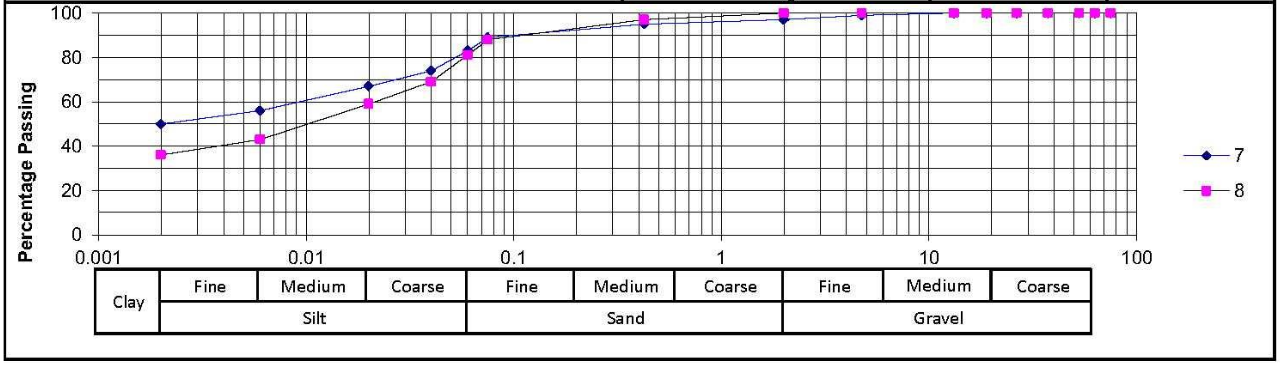
Laboratory Number		7 ◆	8 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	41	44
Plasticity Index	%	23	20
Linear Shrinkage	%	13.5	11.5
Overall PI	%	22	19

Classifications

HRB	A-7-6(20)	A-7-6(19)
Unified	CL	CL
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		9 ◆	10 ■
Field Number		C9	C10
Client Reference			
Depth (m)		0.5-2.2	0.4-2.1
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

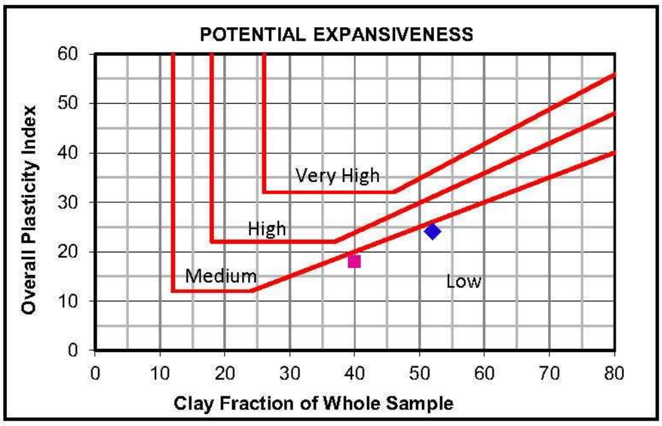
Moisture Content (%)		
Relative Density (S.G.)		

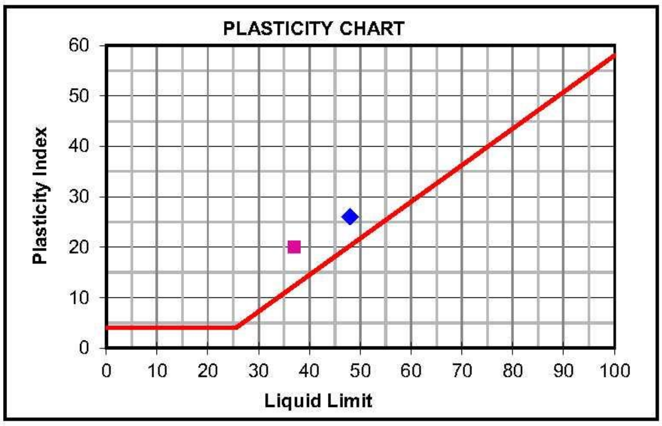
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	98	99
	2.00 mm	97	96
	0.425 mm	94	91
	0.075 mm	85	69
Grading Modulus		0.24	0.44

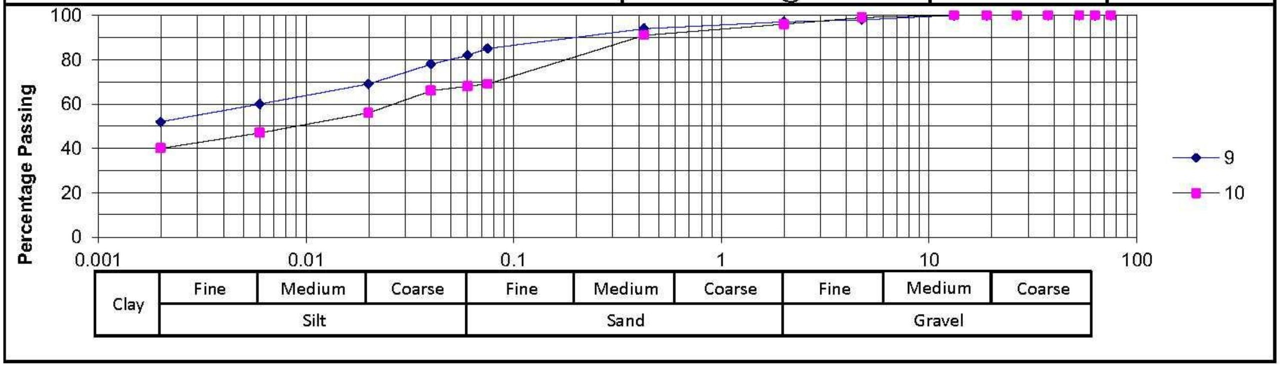
Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	82	68
	0.040 mm	78	66
	0.020 mm	69	56
	0.006 mm	60	47
	0.002 mm	52	40
Gravel	%	3	4
Sand	%	15	28
Silt	%	30	28
Clay	%	52	40





Laboratory Number		9 ◆	10 ■
Atterberg Limits - TMH1 Method A2, A3 & A4			
Liquid Limit	%	48	37
Plasticity Index	%	26	20
Linear Shrinkage	%	12.5	10.0
Overall PI	%	24	18
Classifications			
HRB		A-7-6(20)	A-6(12)
Unified		CL	CL
Weston Swell @ 1 kPa			



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FOUNDATION INDICATOR

Laboratory Number		11 ◆	12 ■
Field Number			C12
Client Reference			
Depth (m)		0.4-2.5	0.5-2.6
Position		Mix C2 + C4A + C7 + C8 + C10	
Coordinates	X		
	Y		
Description			Reddish Br. Colluvial Clayey Sand/
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

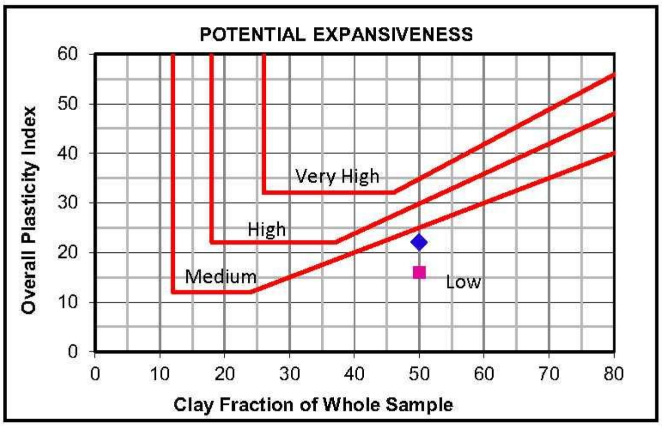
Moisture Content (%)		
Relative Density (S.G.)	2.253	

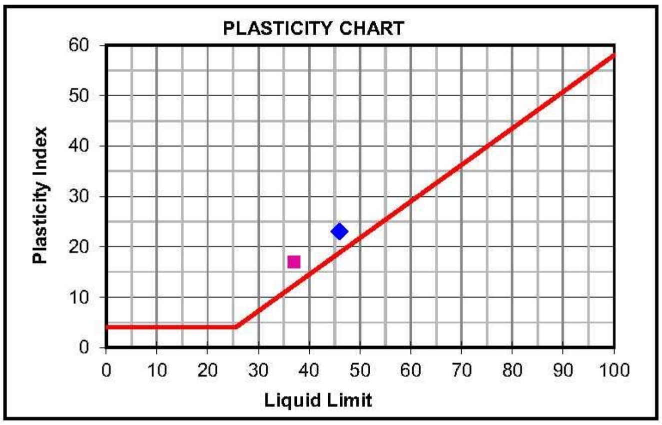
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	99	100
	2.00 mm	97	99
	0.425 mm	94	95
	0.075 mm	81	77
Grading Modulus		0.28	0.29

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	78	72
	0.040 mm	72	64
	0.020 mm	64	59
	0.006 mm	57	54
	0.002 mm	50	50
Gravel	%	3	1
Sand	%	19	27
Silt	%	28	22
Clay	%	50	50





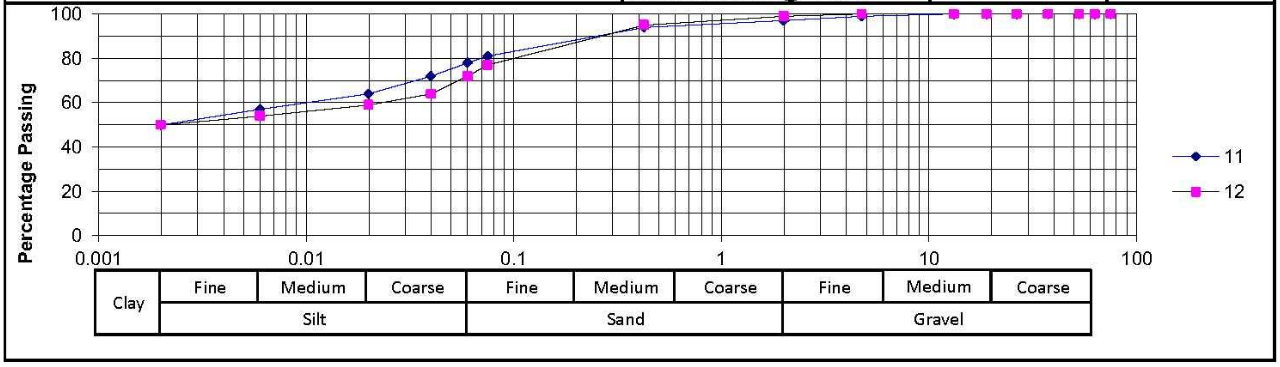
Laboratory Number		11 ◆	12 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	46	37
Plasticity Index	%	23	17
Linear Shrinkage	%	11.5	10.0
Overall PI	%	22	16

Classifications

HRB	A-7-6(19)	A-6(12)
Unified	CL	CL
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		13 ◆	14 ■
Field Number		C15	C16
Client Reference			
Depth (m)		0.4-1.8	0.5-1.6
Position			
Coordinates	X Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

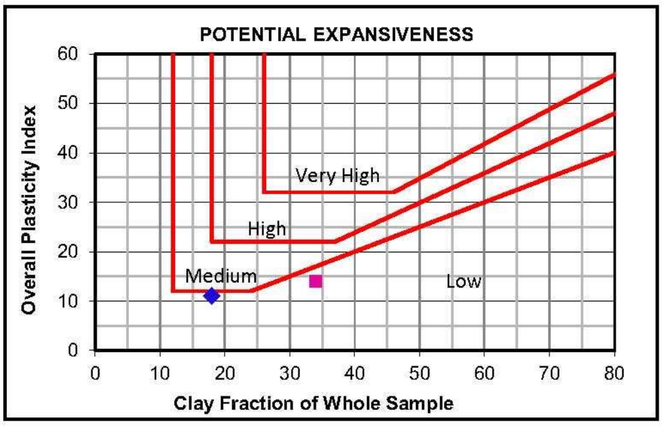
Moisture Content (%)		
Relative Density (S.G.)		

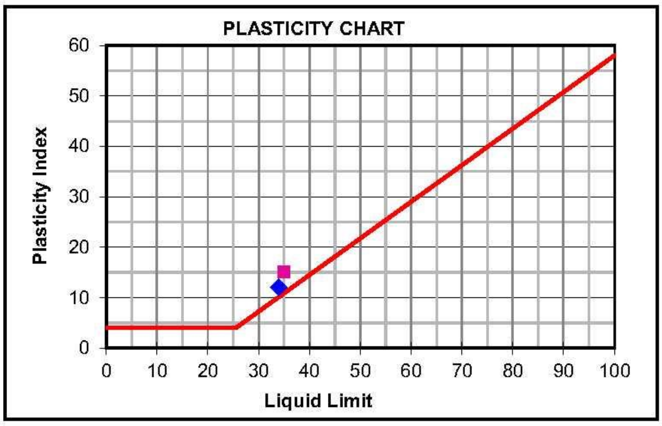
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	99	100
	4.75 mm	98	99
	2.00 mm	97	98
	0.425 mm	93	95
	0.075 mm	76	78
Grading Modulus		0.34	0.29

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	63	72
	0.040 mm	45	62
	0.020 mm	34	46
	0.006 mm	24	38
	0.002 mm	18	34
Gravel	%	3	2
Sand	%	34	26
Silt	%	45	38
Clay	%	18	34





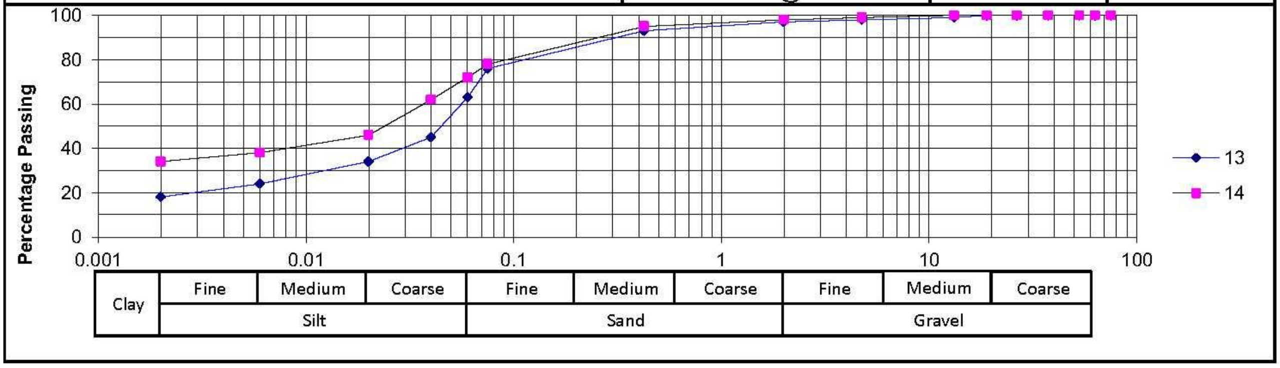
Laboratory Number		13 ◆	14 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	34	35
Plasticity Index	%	12	15
Linear Shrinkage	%	7.5	7.5
Overall PI	%	11	14

Classifications

HRB	A-6(8)	A-6(11)
Unified	CL	CL
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		15 ◆	16 ■
Field Number		C18	C20
Client Reference			
Depth (m)		0.3-2.9	0.3-2.2
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

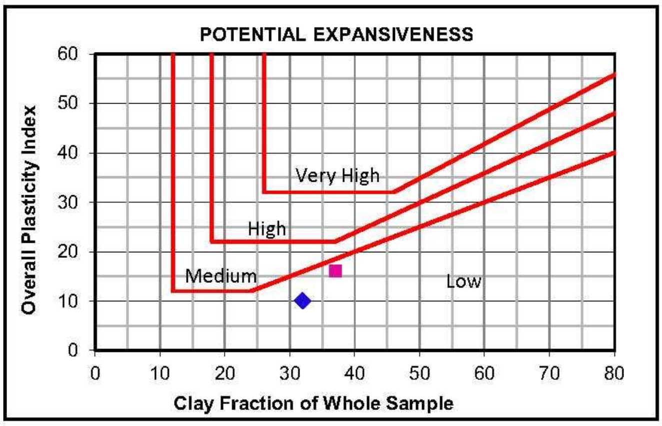
Moisture Content (%)		
Relative Density (S.G.)		

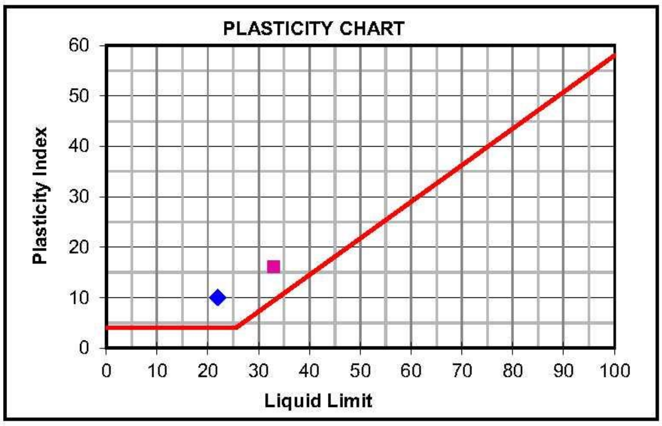
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	100	100
	2.00 mm	99	100
	0.425 mm	98	98
	0.075 mm	65	66
Grading Modulus		0.38	0.36

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	60	61
	0.040 mm	52	53
	0.020 mm	47	47
	0.006 mm	37	41
	0.002 mm	32	37
Gravel	%	1	0
Sand	%	39	39
Silt	%	28	24
Clay	%	32	37





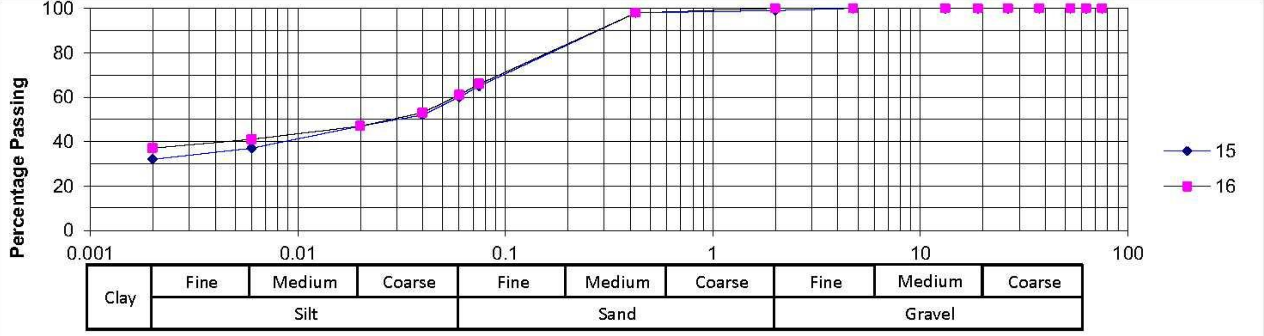
Laboratory Number		15 ◆	16 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	22	33
Plasticity Index	%	10	16
Linear Shrinkage	%	5.5	8.0
Overall PI	%	10	16

Classifications

HRB	A-4(3)	A-6(8)
Unified	CL	CL
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		17 ◆	18 ■
Field Number		C22	C23
Client Reference			
Depth (m)		0.3-2.6	0.25-1.7
Position			
Coordinates	X Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

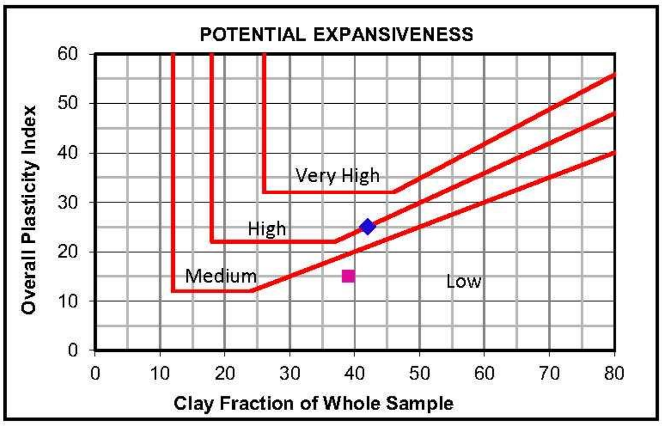
Moisture Content (%)		
Relative Density (S.G.)		

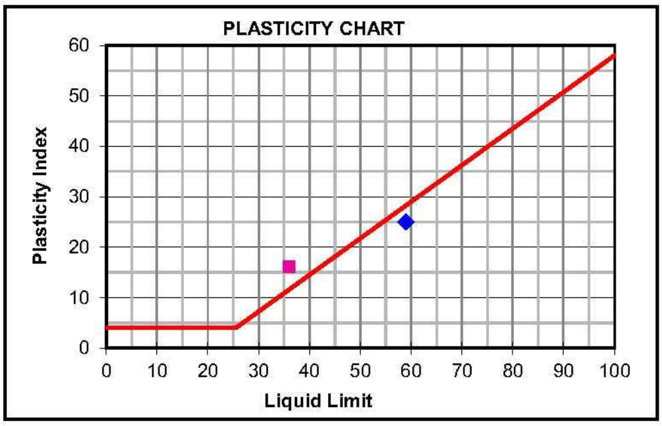
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	100	97
	2.00 mm	100	96
	0.425 mm	100	93
	0.075 mm	97	72
Grading Modulus		0.03	0.39

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	91	67
	0.040 mm	80	58
	0.020 mm	68	52
	0.006 mm	52	46
	0.002 mm	42	39
Gravel	%	0	4
Sand	%	9	29
Silt	%	49	28
Clay	%	42	39





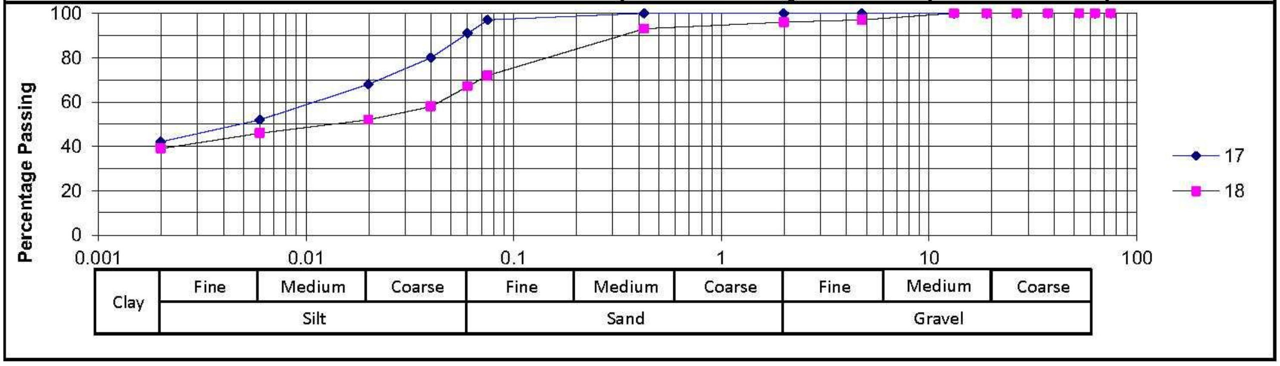
Laboratory Number		17 ◆	18 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	59	36
Plasticity Index	%	25	16
Linear Shrinkage	%	10.5	8.5
Overall PI	%	25	15

Classifications

HRB	A-7-5(20)	A-6(10)
Unified	ML	CL
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		19 ◆	20 ■
Field Number		C25	C28
Client Reference			
Depth (m)		0.3-0.9	0.5-2.6
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

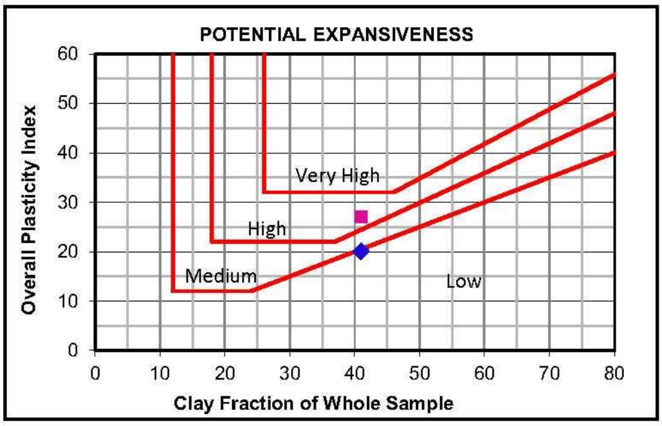
Moisture Content (%)		
Relative Density (S.G.)		

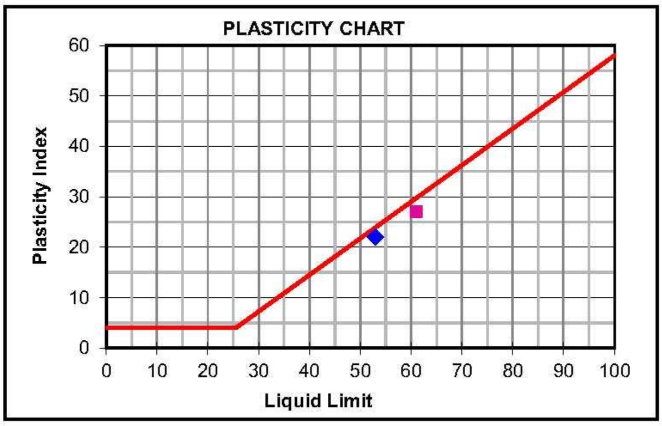
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	99	100
	2.00 mm	97	100
	0.425 mm	93	100
	0.075 mm	87	98
Grading Modulus		0.23	0.02

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	80	93
	0.040 mm	67	84
	0.020 mm	59	77
	0.006 mm	48	59
	0.002 mm	41	41
Gravel	%	3	0
Sand	%	17	7
Silt	%	39	52
Clay	%	41	41





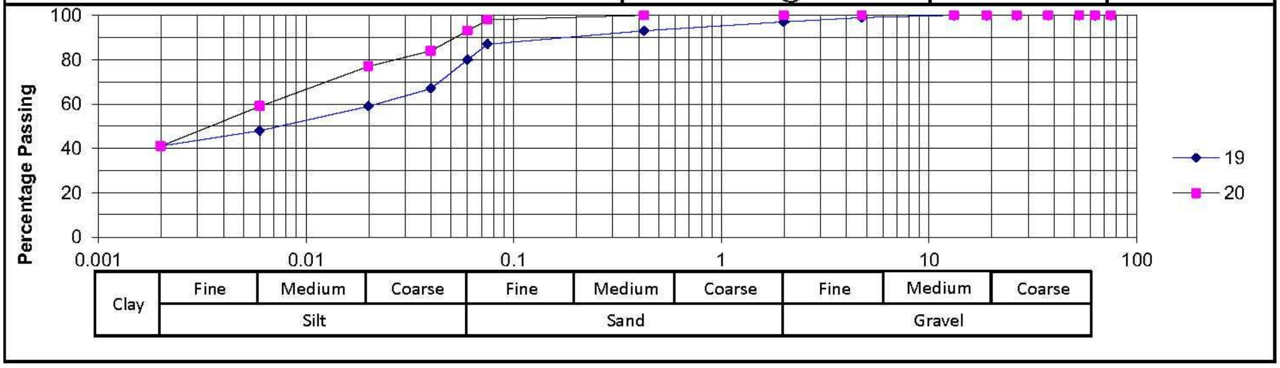
Laboratory Number		19 ◆	20 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	53	61
Plasticity Index	%	22	27
Linear Shrinkage	%	10.5	15.5
Overall PI	%	20	27

Classifications

HRB	A-7-5(20)	A-7-5(20)
Unified	ML	ML
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		21 ◆	22 ■
Field Number		C30	
Client Reference			
Depth (m)		0.5-2.1	-
Position			Mix C12 + C18 + C22 + C28 + C30
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

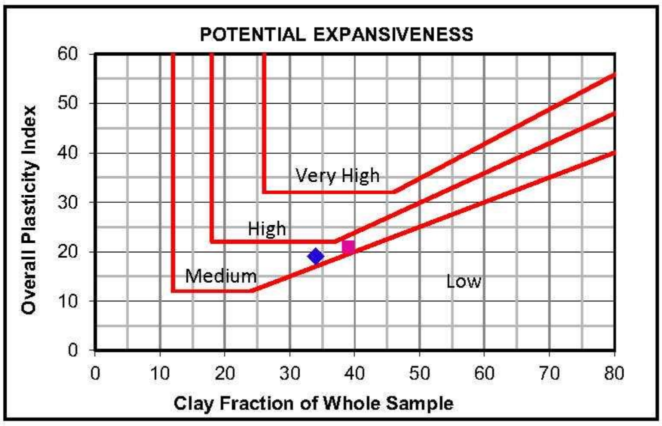
Moisture Content (%)		
Relative Density (S.G.)		2.657

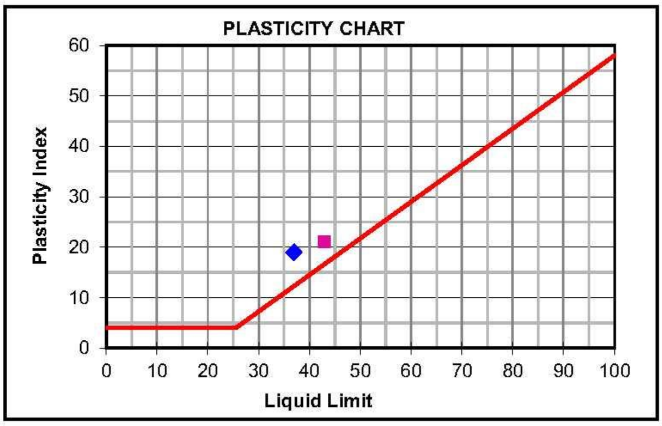
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	99	100
	2.00 mm	98	100
	0.425 mm	98	100
	0.075 mm	65	76
Grading Modulus		0.39	0.24

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	61	73
	0.040 mm	54	67
	0.020 mm	47	60
	0.006 mm	42	51
	0.002 mm	34	39
Gravel	%	2	0
Sand	%	37	27
Silt	%	27	34
Clay	%	34	39





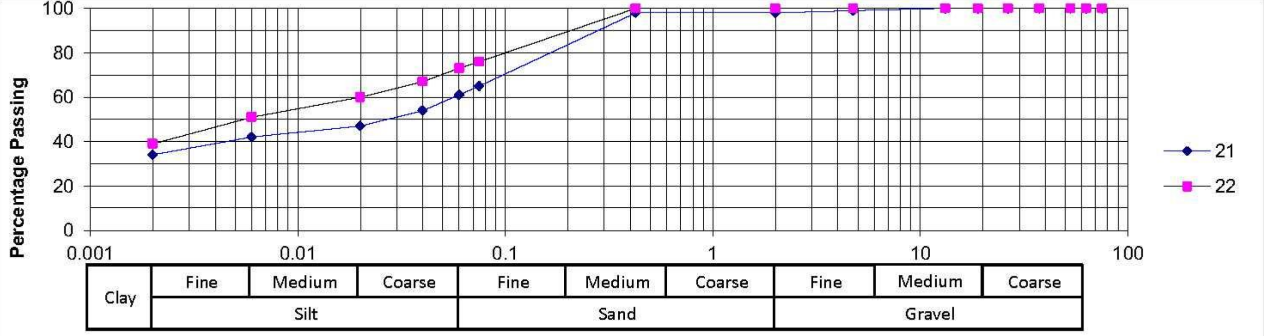
Laboratory Number		21 ◆	22 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	37	43
Plasticity Index	%	19	21
Linear Shrinkage	%	8.0	11.5
Overall PI	%	19	21

Classifications

HRB	A-6(10)	A-7-6(16)
Unified	CL	CL
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		23 ◆	24 ■
Field Number		F5	F6
Client Reference			
Depth (m)		0.25-1.20	0.4-1.2
Position			
Coordinates	X		
	Y		
Description		Weathered Mudrock/ Sandstone	
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

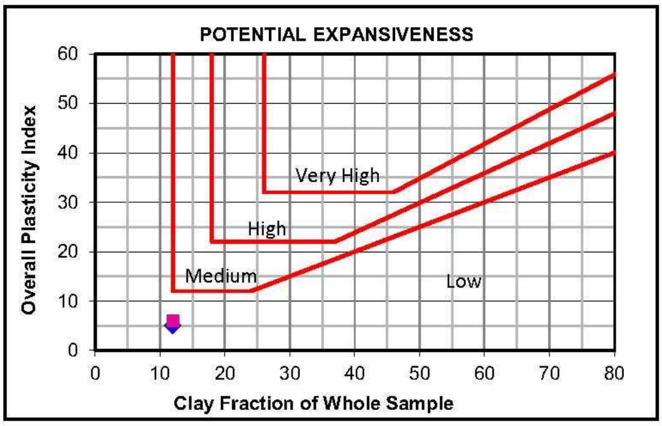
Moisture Content (%)		
Relative Density (S.G.)		

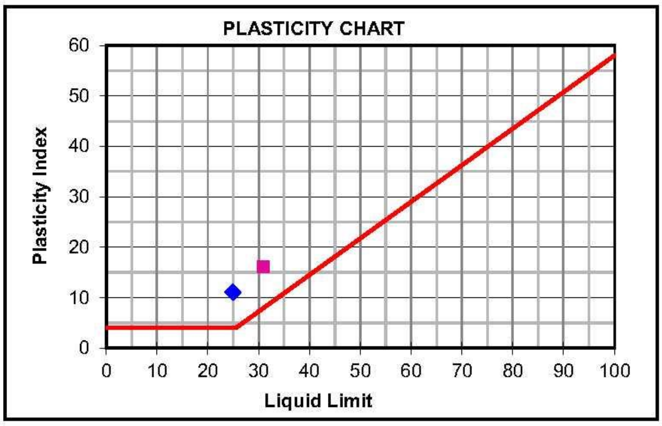
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	98
	4.75 mm	90	71
	2.00 mm	69	54
	0.425 mm	42	36
	0.075 mm	29	28
Grading Modulus		1.6	1.82

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	25	25
	0.040 mm	20	21
	0.020 mm	17	19
	0.006 mm	14	15
	0.002 mm	12	12
Gravel	%	31	46
Sand	%	44	29
Silt	%	13	13
Clay	%	12	12





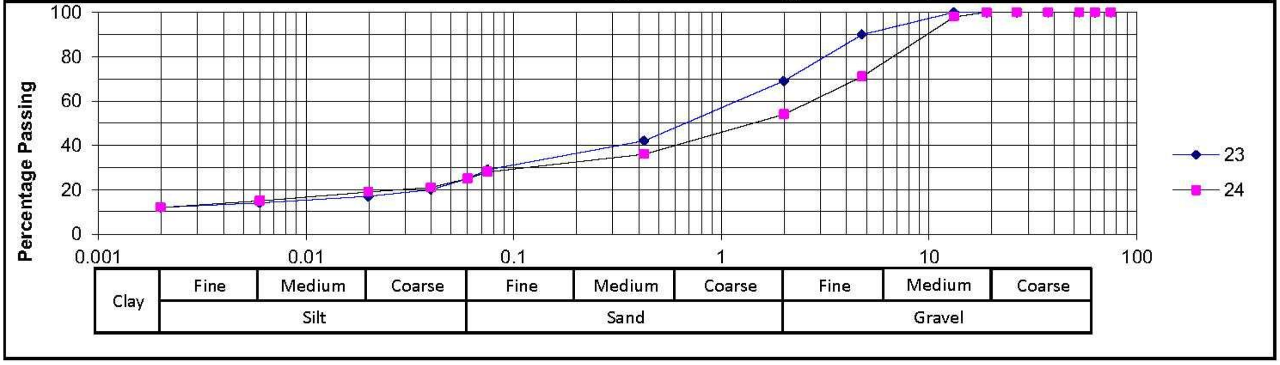
Laboratory Number		23 ◆	24 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	25	31
Plasticity Index	%	11	16
Linear Shrinkage	%	5.5	6.5
Overall PI	%	5	6

Classifications

HRB	A-2-6(0)	A-2-6(1)
Unified	SC	SC
Weston Swell @ 1 kPa		



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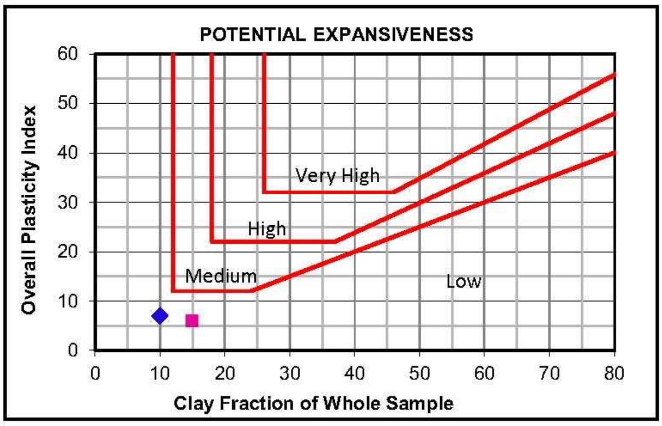
FOUNDATION INDICATOR

Laboratory Number		25 ◆	26 ■
Field Number		F8	F10
Client Reference			
Depth (m)		0.6-1.6	Channel 0.9m
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

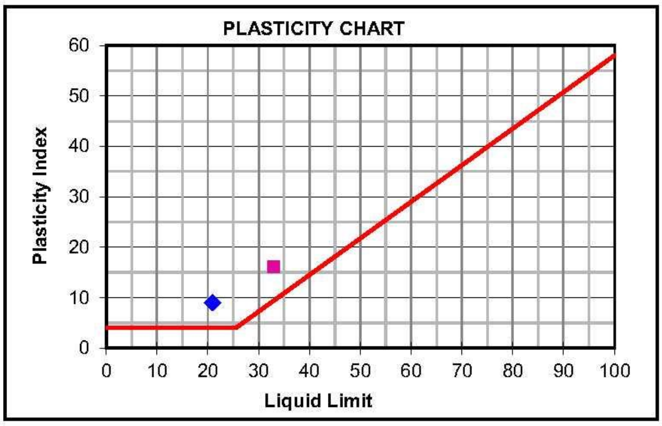


Moisture Content & Relative Density-TMH1 Metod A12T

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	97	99
	4.75 mm	87	81
	2.00 mm	84	59
	0.425 mm	80	39
	0.075 mm	31	32
Grading Modulus		1.05	1.7



Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	26	28
	0.040 mm	20	23
	0.020 mm	16	21
	0.006 mm	13	18
	0.002 mm	10	15
Gravel	%	16	41
Sand	%	58	31
Silt	%	16	13
Clay	%	10	15

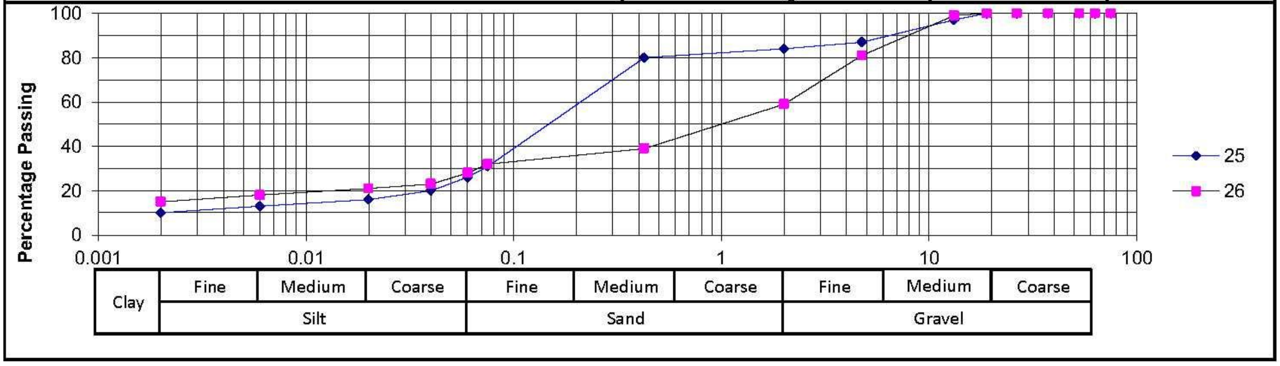
Laboratory Number		25 ◆	26 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	21	33
Plasticity Index	%	9	16
Linear Shrinkage	%	3.5	8.5
Overall PI	%	7	6

Classifications

HRB	A-2-4(0)	A-2-6(1)
Unified	SC	SC
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		27 ◆	28 ■
Field Number		F12	F13
Client Reference			
Depth (m)		0.3-0.6	0.25-0.95
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

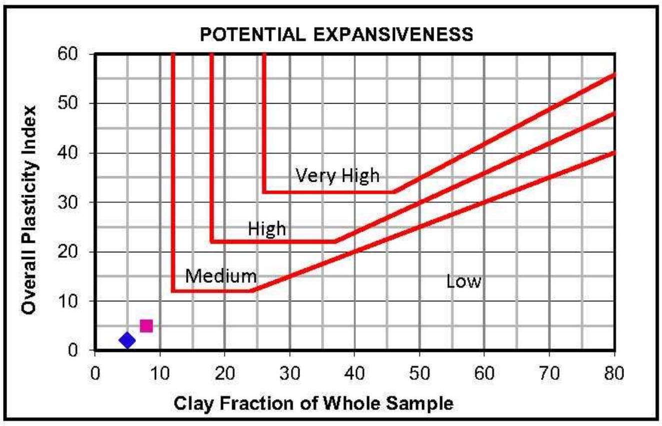
Moisture Content (%)		
Relative Density (S.G.)		

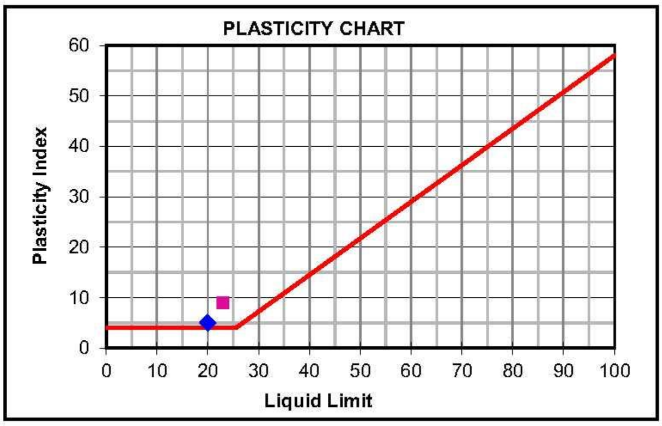
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	98
	4.75 mm	71	79
	2.00 mm	56	71
	0.425 mm	43	59
	0.075 mm	26	23
Grading Modulus		1.75	1.47

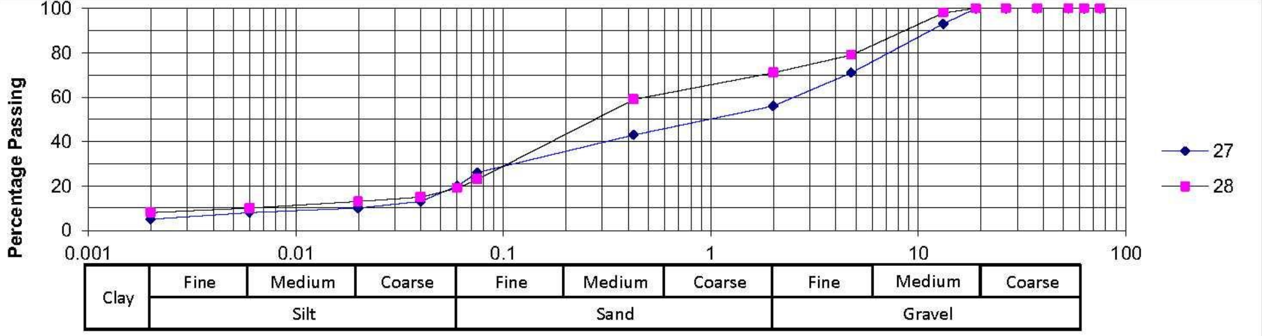
Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	20	19
	0.040 mm	13	15
	0.020 mm	10	13
	0.006 mm	8	10
	0.002 mm	5	8
Gravel	%	44	29
Sand	%	36	52
Silt	%	15	11
Clay	%	5	8





Laboratory Number		27 ◆	28 ■
Atterberg Limits - TMH1 Method A2, A3 & A4			
Liquid Limit	%	20	23
Plasticity Index	%	5	9
Linear Shrinkage	%	3.5	4.0
Overall PI	%	2	5
Classifications			
HRB		A-2-4(0)	A-2-4(0)
Unified		SC-SM	SC
Weston Swell @ 1 kPa			



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FOUNDATION INDICATOR

Laboratory Number		29 ◆	30 ■
Field Number			F25
Client Reference			
Depth (m)		-	0.9-1.2
Position		Mixed Sample F5 + F8 + F10	
Coordinates	X		
	Y		
Description			Weathered Mudrock/ Sadstone
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

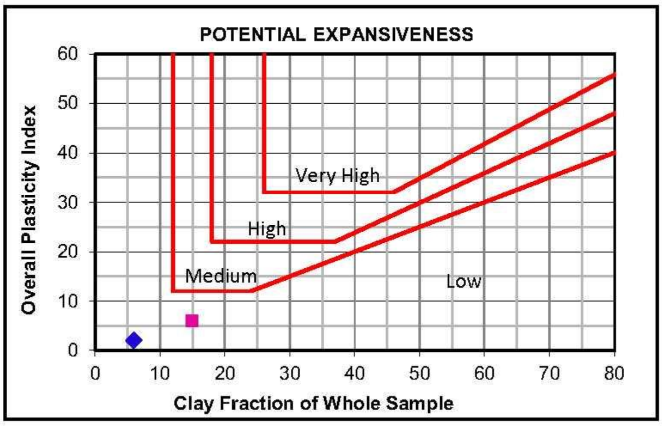
Moisture Content (%)		
Relative Density (S.G.)		

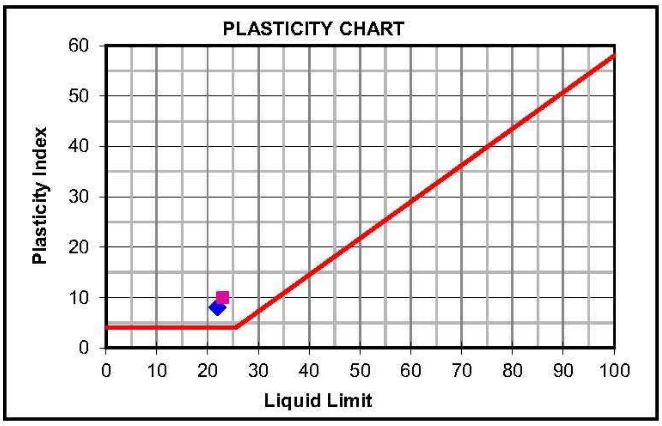
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	98	100
	63.0 mm	95	100
	53.0 mm	91	100
	37.5 mm	84	100
	26.5 mm	77	100
	19.0 mm	71	100
	13.2 mm	68	99
	4.75 mm	45	82
	2.00 mm	36	71
	0.425 mm	30	61
	0.075 mm	15	30
Grading Modulus		2.19	1.38

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	14	28
	0.040 mm	11	24
	0.020 mm	9	22
	0.006 mm	7	18
	0.002 mm	6	15
Gravel	%	64	29
Sand	%	22	43
Silt	%	8	13
Clay	%	6	15





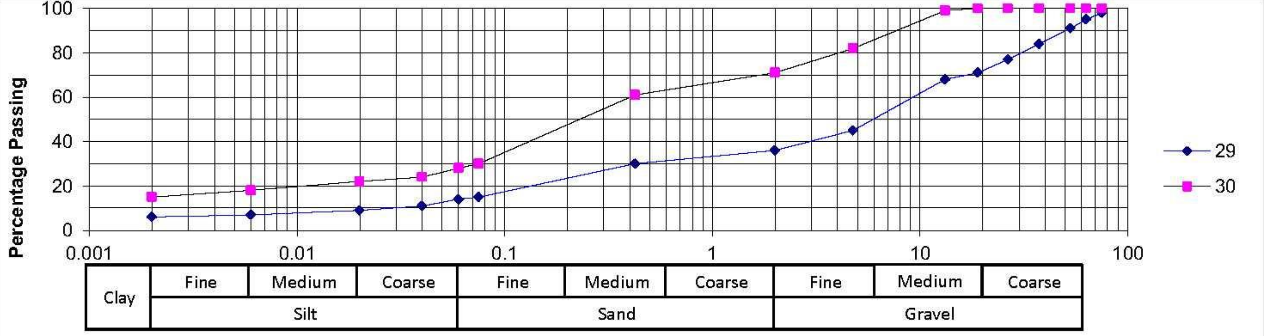
Laboratory Number		29 ◆	30 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	22	23
Plasticity Index	%	8	10
Linear Shrinkage	%	4.0	4.0
Overall PI	%	2	6

Classifications

HRB	A-2-4(0)	A-2-4(0)
Unified	GC	SC
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		31 ◆	32 ■
Field Number		F28	F29
Client Reference			
Depth (m)		0.00-1.5	0.00-0.6
Position			
Coordinates	X		
	Y		
Description			Weathered Mudrock / Sandstone
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

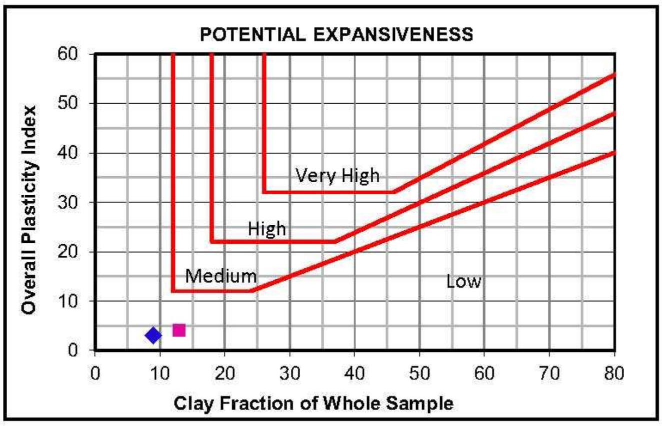
Moisture Content (%)		
Relative Density (S.G.)		

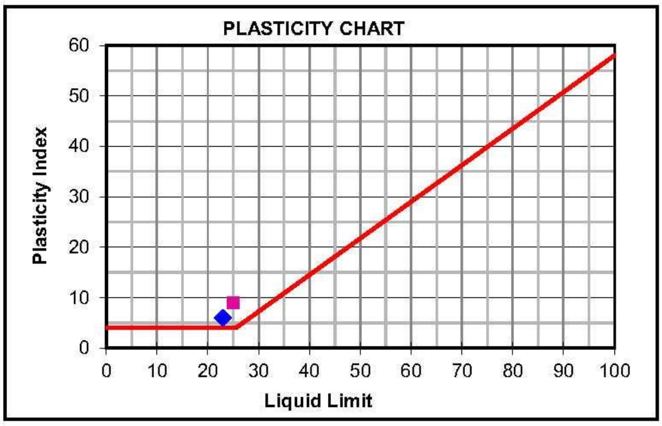
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	96	94
	2.00 mm	82	77
	0.425 mm	57	45
	0.075 mm	45	32
Grading Modulus		1.16	1.46

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	35	28
	0.040 mm	23	22
	0.020 mm	17	20
	0.006 mm	12	16
	0.002 mm	9	13
Gravel	%	18	23
Sand	%	47	49
Silt	%	26	15
Clay	%	9	13





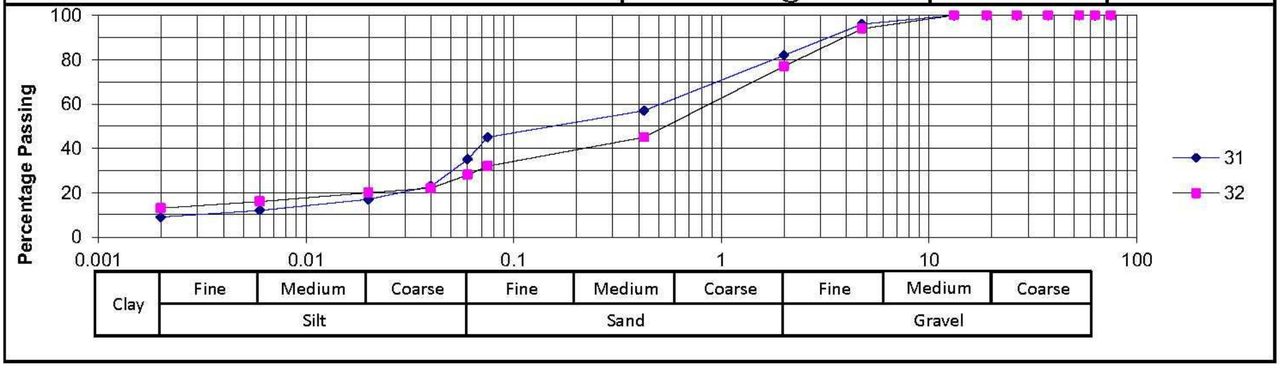
Laboratory Number		31 ◆	32 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	23	25
Plasticity Index	%	6	9
Linear Shrinkage	%	4.0	6.0
Overall PI	%	3	4

Classifications

HRB	A-4(0)	A-2-4(0)
Unified	SC-SM	SC
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		33 ◆	34 ■
Field Number		F31	F33
Client Reference			
Depth (m)		0.4-1.0	0.4-1.0
Position			
Coordinates	X		
	Y		
Description			Weathered Mudrock/ Sandstone
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

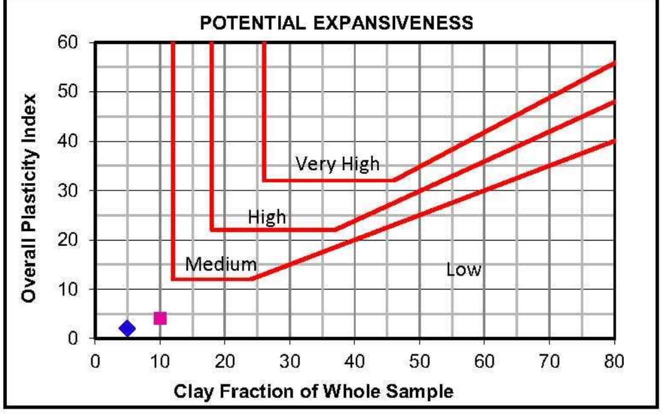
Moisture Content (%)		
Relative Density (S.G.)		

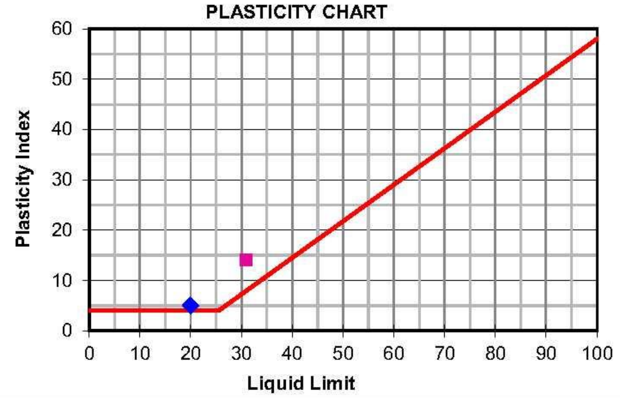
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	98	100
	4.75 mm	76	75
	2.00 mm	57	43
	0.425 mm	38	25
	0.075 mm	30	17
Grading Modulus		1.75	2.15

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	25	17
	0.040 mm	18	16
	0.020 mm	14	14
	0.006 mm	8	11
	0.002 mm	5	10
Gravel	%	43	57
Sand	%	32	26
Silt	%	20	7
Clay	%	5	10





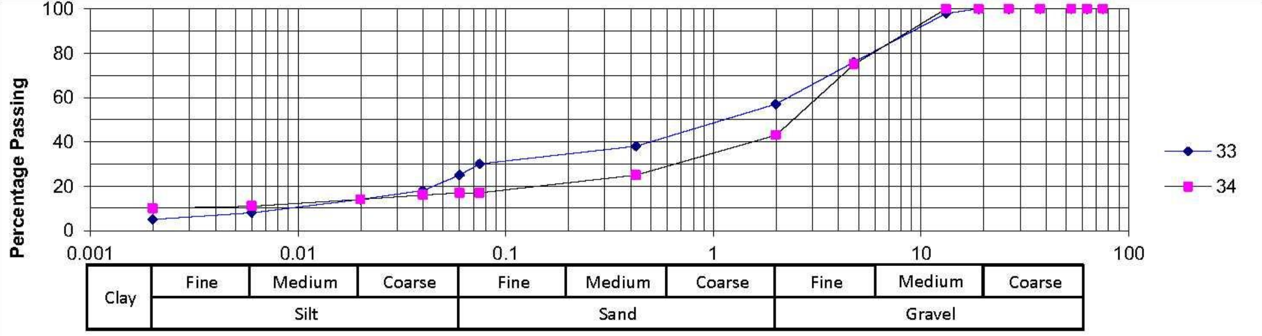
Laboratory Number		33 ◆	34 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	20	31
Plasticity Index	%	5	14
Linear Shrinkage	%	3.5	7.5
Overall PI	%	2	4

Classifications

HRB	A-2-4(0)	A-2-6(0)
Unified	SC-SM	SC
Weston Swell @ 1 kPa		



Client	:	JEFFARES & GREEN CONSULTING ENGINEERS	Date Received:		23/08/2013
Project	:	Mzinvubu Water Project	Date Reported:		11/11/2013
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FOUNDATION INDICATOR

Laboratory Number		35 ◆	36 ■
Field Number		F34	F37
Client Reference			
Depth (m)		0.1-0.8	0.0-1.5
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

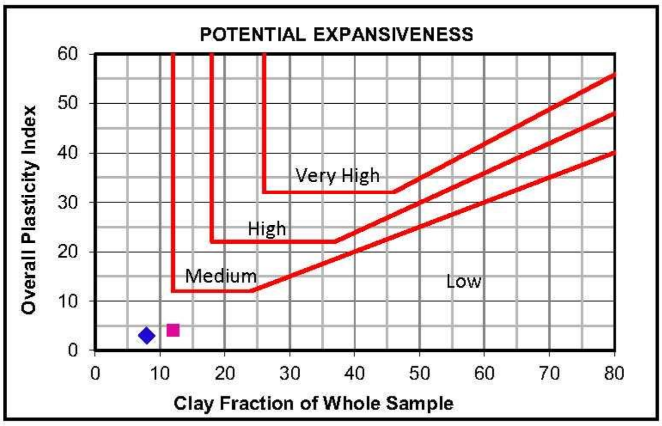
Moisture Content (%)		
Relative Density (S.G.)		

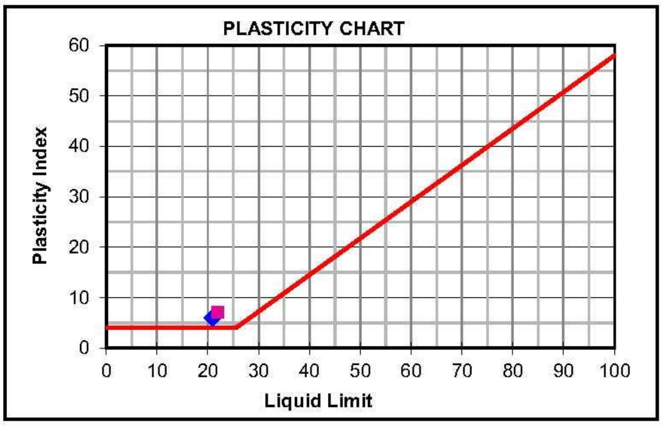
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	99
	4.75 mm	85	85
	2.00 mm	68	72
	0.425 mm	55	59
	0.075 mm	38	33
Grading Modulus		1.39	1.36

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	31	29
	0.040 mm	23	23
	0.020 mm	17	18
	0.006 mm	11	15
	0.002 mm	8	12
Gravel	%	32	28
Sand	%	37	43
Silt	%	23	17
Clay	%	8	12





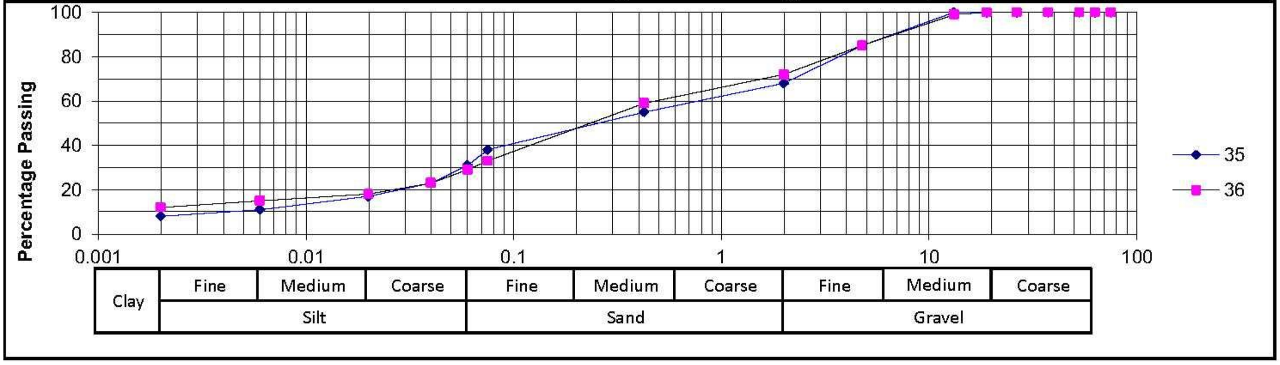
Laboratory Number		35 ◆	36 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	21	22
Plasticity Index	%	6	7
Linear Shrinkage	%	4.0	4.0
Overall PI	%	3	4

Classifications

HRB	A-4(0)	A-2-4(0)
Unified	SC-SM	SC-SM
Weston Swell @ 1 kPa		



Client	:	JEFFARES & GREEN CONSULTING ENGINEERS	Date Received:	23/08/2013
Project	:	Mzinvubu Water Project	Date Reported:	11/11/2013
Project No	:	2013-B-2004	Page No. :	20 of 44

FOUNDATION INDICATOR

Laboratory Number		37 ◆	38 ■
Field Number		F37A	F39
Client Reference			
Depth (m)		Channel	0.2-1.0
Position			
Coordinates	X Y		
Description			Weathered Mudrock/ Sandstone
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

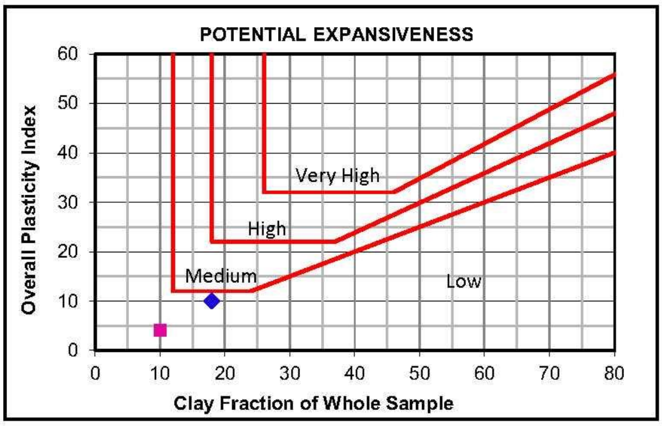
Moisture Content (%)		
Relative Density (S.G.)		

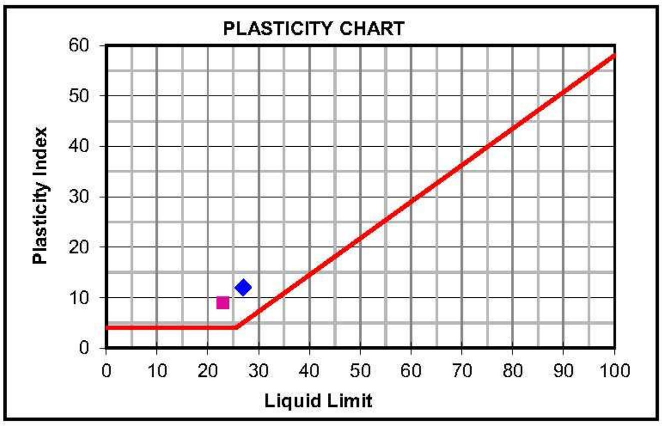
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	100	100
	4.75 mm	99	73
	2.00 mm	95	57
	0.425 mm	86	40
	0.075 mm	66	29
Grading Modulus		0.53	1.74

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	62	25
	0.040 mm	54	20
	0.020 mm	47	18
	0.006 mm	38	13
	0.002 mm	18	10
Gravel	%	5	43
Sand	%	33	32
Silt	%	44	15
Clay	%	18	10





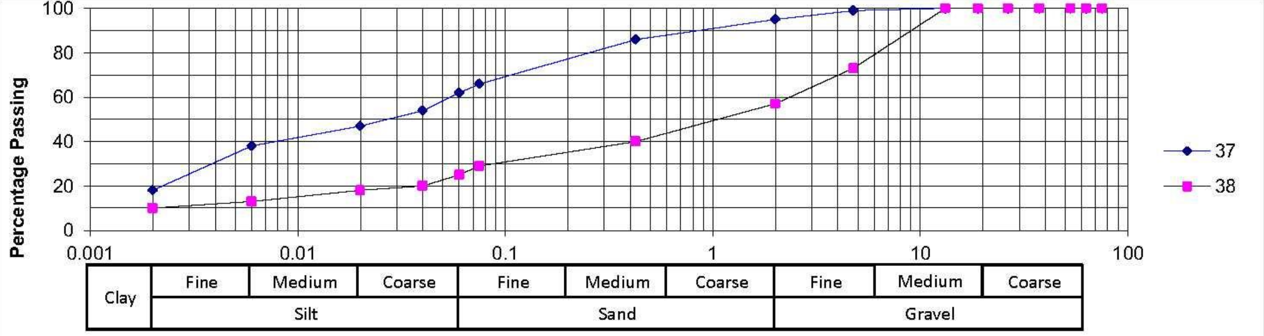
Laboratory Number		37 ◆	38 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	27	23
Plasticity Index	%	12	9
Linear Shrinkage	%	6.0	5.5
Overall PI	%	10	4

Classifications

HRB	A-6(5)	A-2-4(0)
Unified	CL	SC
Weston Swell @ 1 kPa		



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Project	:	Mzinvubu Water Project	Date Reported:	11/11/2013
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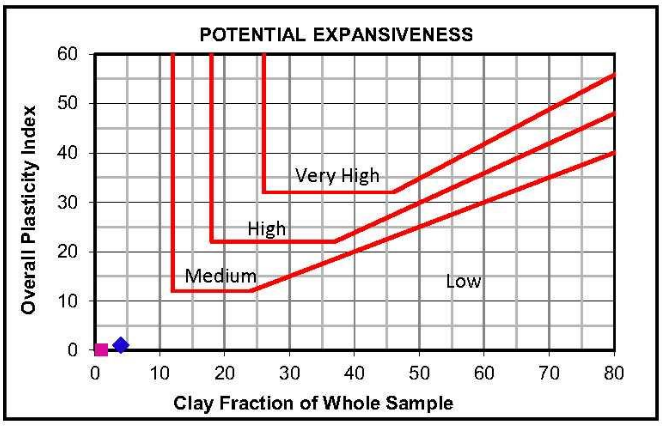
FOUNDATION INDICATOR

Laboratory Number		39 ◆	■
Field Number			
Client Reference			
Depth (m)		-	
Position		Mix F25 + F29 + F34 + F37 + F39	
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

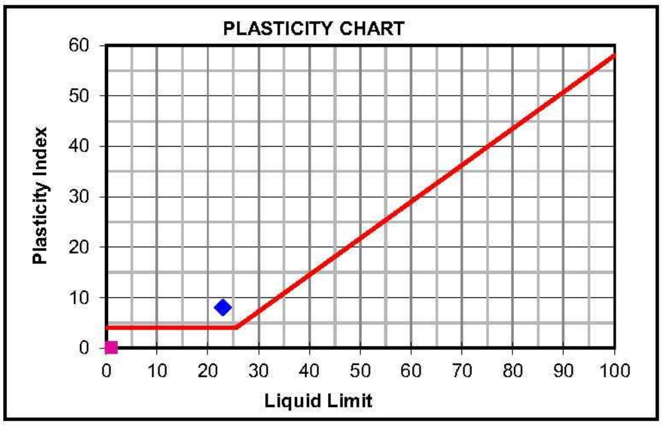


Moisture Content & Relative Density-TMH1 Metod A12T

Moisture Content (%)		
Relative Density (S.G.)	2.717	

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

Percentage Passing	75.0 mm	97	
	63.0 mm	95	
	53.0 mm	92	
	37.5 mm	87	
	26.5 mm	80	
	19.0 mm	76	
	13.2 mm	73	
	4.75 mm	44	
	2.00 mm	28	
	0.425 mm	18	
	0.075 mm	12	
Grading Modulus		2.42	



Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	11	
	0.040 mm	9	
	0.020 mm	8	
	0.006 mm	6	
	0.002 mm	4	
Gravel	%	72	
Sand	%	17	
Silt	%	7	
Clay	%	4	

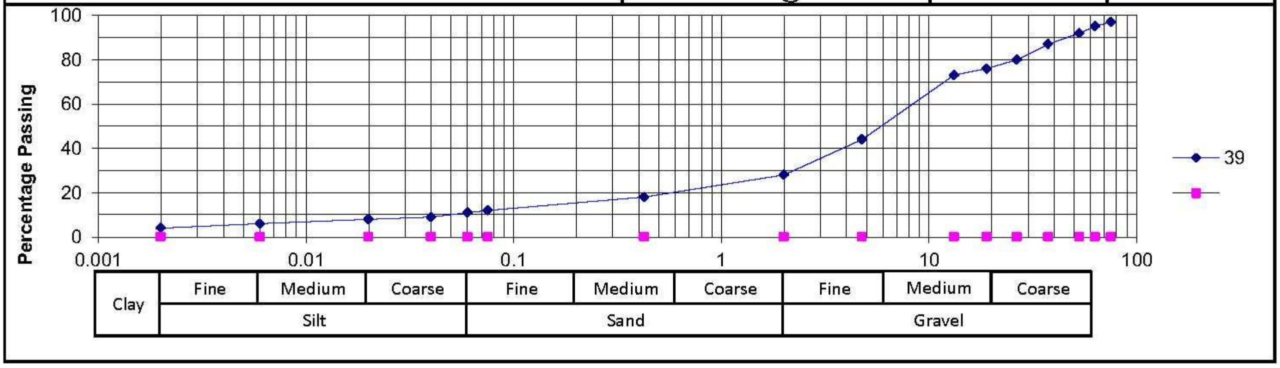
Laboratory Number		39 ◆	■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	23	
Plasticity Index	%	8	
Linear Shrinkage	%	5.5	
Overall PI	%	1	

Classifications

HRB	A-2-4(0)	
Unified	GP-GC	
Weston Swell @ 1 kPa		



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Project :	Mzinvubu Water Project	Date Reported:	11/11/2013
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MOISTURE DENSITY RELATIONSHIP

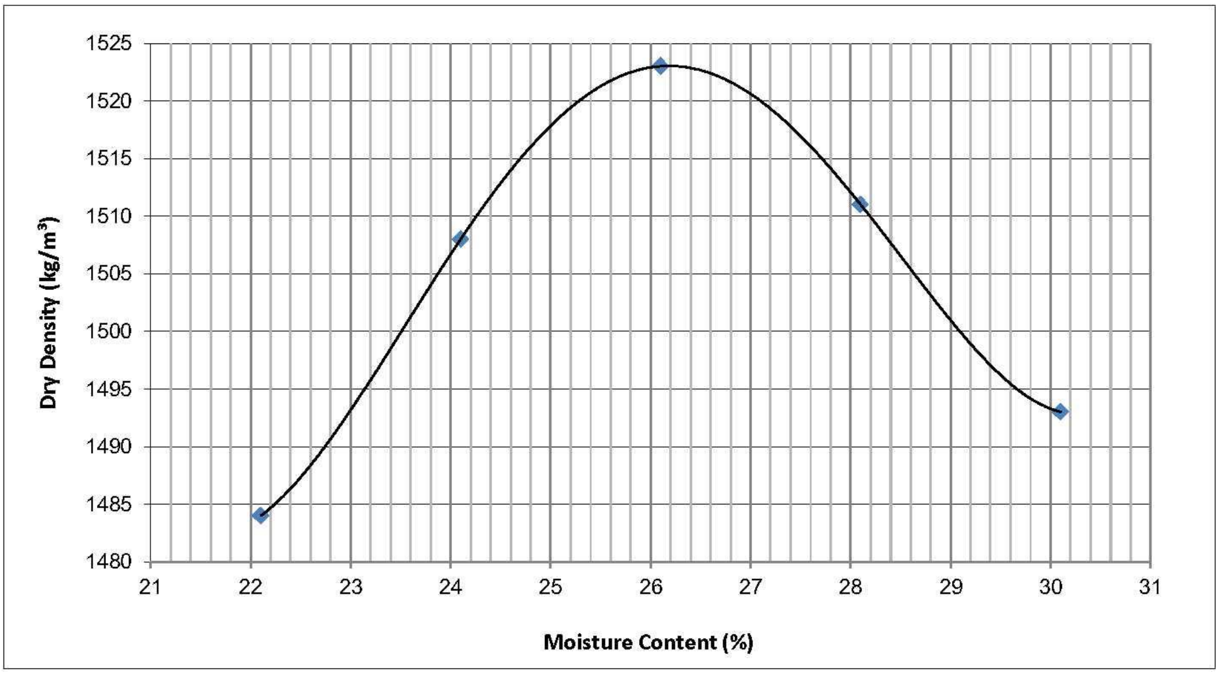
Laboratory Number		11
Field Number		Mix C2+C4A+C7+C8+C10
Client Reference		
Depth (m)		0.4-2.5
Position		
Coordinates	X	
	Y	
Description		
Additional Information		
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - TMH1 Method A7

Compactive Effort:	Standard Proctor

Dry Density	kg/m³	1484	1508	1523	1511	1493	
Moisture Content	%	22.1	24.1	26.1	28.1	30.1	

Max. Dry Density	kg/m³	1523
Optimum Moisture	%	26.2



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Project No:	2013-B-2004	Page No. :	23 of 44

MOISTURE DENSITY RELATIONSHIP

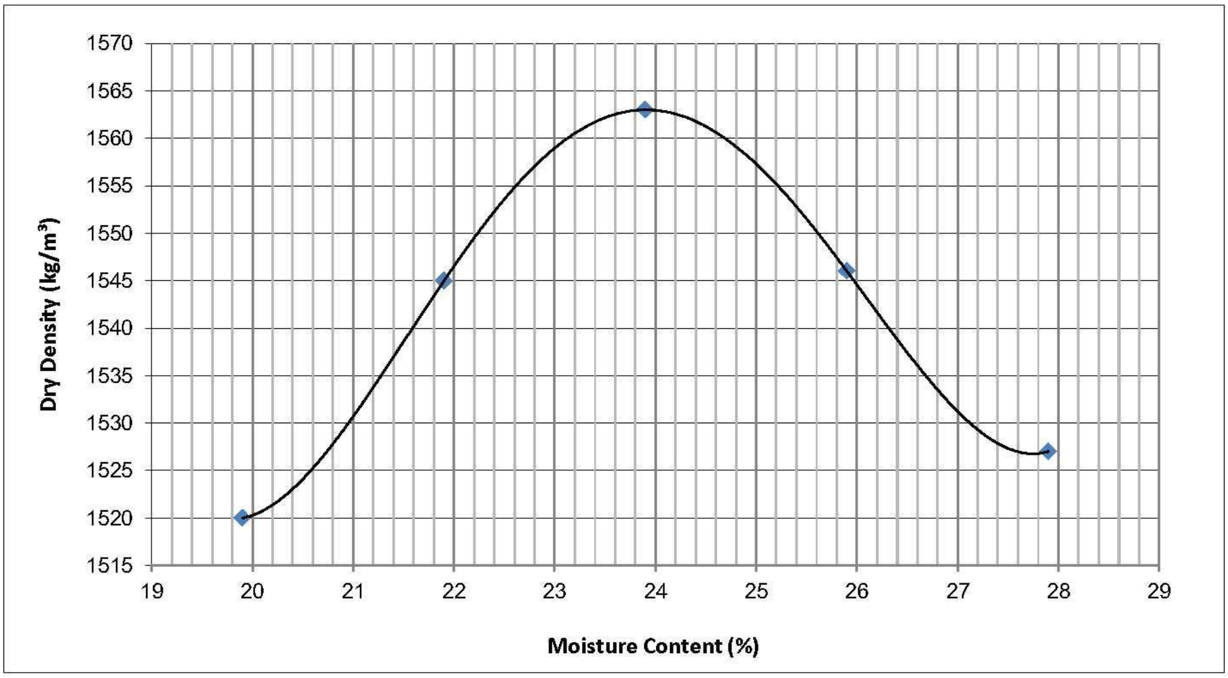
Laboratory Number		22
Field Number		Mix Sample C12+C18+C22+C28+C30
Client Reference		
Depth (m)		-
Position		
Coordinates	X	
	Y	
Description		
Additional Information		
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - TMH1 Method A7

Compactive Effort:	Standard Proctor

Dry Density	kg/m³	1520	1545	1563	1546	1527	
Moisture Content	%	19.9	21.9	23.9	25.9	27.9	

Max. Dry Density	kg/m³	1563
Optimum Moisture	%	23.9



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Project :	Mzinvubu Water Project	Date Reported:	11/11/2013
Project No:	2013-B-2004	Page No. :	24 of 44

MOISTURE DENSITY RELATIONSHIP

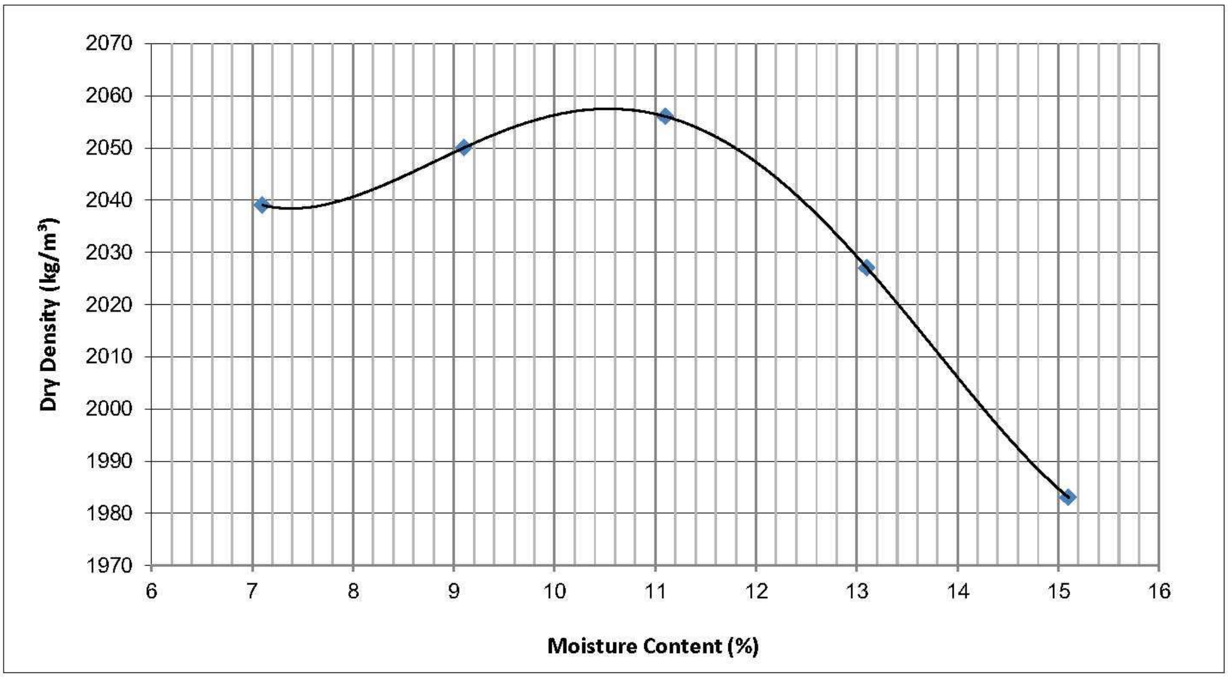
Laboratory Number		29
Field Number		Mix Sample F5+F8+F10
Client Reference		
Depth (m)		-
Position		
Coordinates	X	
	Y	
Description		
Additional Information		
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - TMH1 Method A7

Compactive Effort:	Standard Proctor

Dry Density	kg/m³	2039	2050	2056	2027	1983	
Moisture Content	%	7.1	9.1	11.1	13.1	15.1	

Max. Dry Density	kg/m³	2057
Optimum Moisture	%	10.5



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Project :	Mzinvubu Water Project	Date Reported:	11/11/2013
Project No:	2013-B-2004	Page No. :	25 of 44

MOISTURE DENSITY RELATIONSHIP

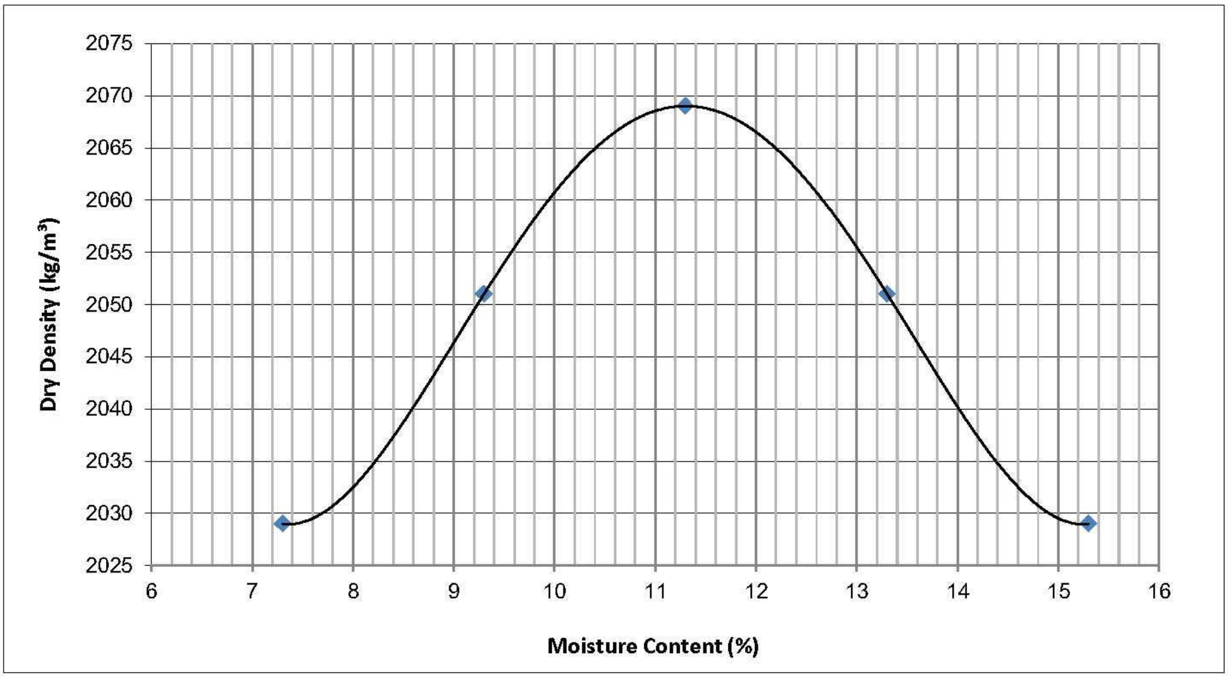
Laboratory Number		39
Field Number		Mix Sample F25+F29+F34+F37+F39
Client Reference		
Depth (m)		-
Position		
Coordinates	X	
	Y	
Description		
Additional Information		
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - TMH1 Method A7

Compactive Effort:	Standard Proctor

Dry Density	kg/m³	2029	2051	2069	2051	2029	
Moisture Content	%	7.3	9.3	11.3	13.3	15.3	

Max. Dry Density	kg/m³	2069
Optimum Moisture	%	11.3



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Client : JEFFARES & GREEN CONSULTING ENGINEERS
Address : P O BOX 1109
: SUNNINGHILL
: 2157

Client Reference :
Order No. : 2819

Attention :
Facsimile : 011 807 1607
E-mail : chettyn@jgi.co.za

Date Received : 07/10/2013
Date Tested : 07/10/2013 - 29/11/2013
Date Reported : 03/12/2013

Project : **Mzimvubu Water Project**
Project No. : **2013-B-2246**

Page : 1 of 22

Herewith please find the test report(s) pertaining to the above project. All tests were conducted in accordance with prescribed test method(s). Information herein consists of the following:

Test(s) conducted / Item(s) measured	Qty.	Test Method(s)	Authorized By	Page(s)
Atterberg Limits < 0.425mm	6.000	TMH1 A2, A3, A4	J Marques	2-4
Sieve Analysis 0.075mm (Mass Grading)	6.000	TMH1 A1	J Marques	2-4
Hydrometer Analysis	6.000	ASTM D422	J Marques	2-4
Relative Density	2.000	TMH1:A12T	J Marques	Incl. in CU
Consolidated Undrained Triaxial*	2.000	BS 1377 Part 8	J Marques	2 Files, 11 Pages
Oedometer: Standard Consolidation*	2.000	BS 1377 Part 5	J Marques	2 Files, 6 Pages
Permeability: Falling Head*	2.000	KH Head	J Marques	1 File, 1 Page

Any test results contained in this report and marked with * in the table above are "not SANAS accredited" and are not included in the schedule of accreditation for this laboratory.

Any information contained in this test report pertain only to the areas and/or samples tested. Documents may only be reproduced or published in their full context.

While every care is taken to ensure that all tests are carried out in accordance with recognised standards, neither Civilab (Proprietary) Limited nor its employess shall be liable in any way whatsoever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequences thereof.

All interpretations, Interpolations, Opinions and/or Classifications contained in this report falls outside our scope of accreditation.

The following parameters, where applicable, were excluded from the classification procedure: Chemical modifications, Additional fines, Fractured Faces, Soluble Salts, pH, Conductivity, Coarse Sand Ratio, Durability (COLTO: G4-G9).

The following parameters, where applicable, were assumed: Rock types were assumed to be of an Arenaceous nature with Siliceous cementing material.

Unless otherwise requested or stated, all samples will be discarded after a period of 3 months.

Deviations in Test Methods:

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Client	:	JEFFARES & GREEN CONSULTING ENGINEERS	Date Received:	07/10/2013
Project	:	Mzimvubu Water Project	Date Reported:	03/12/2013
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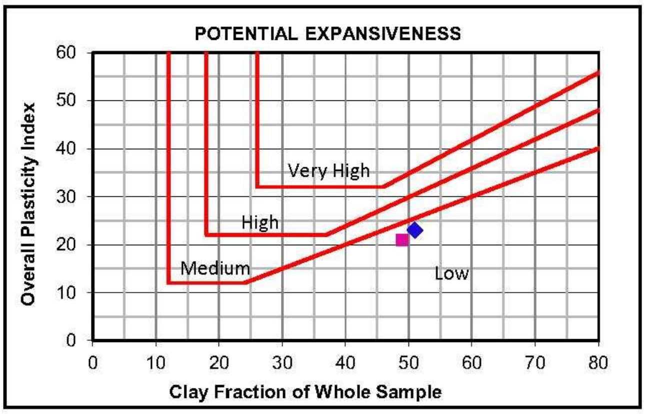
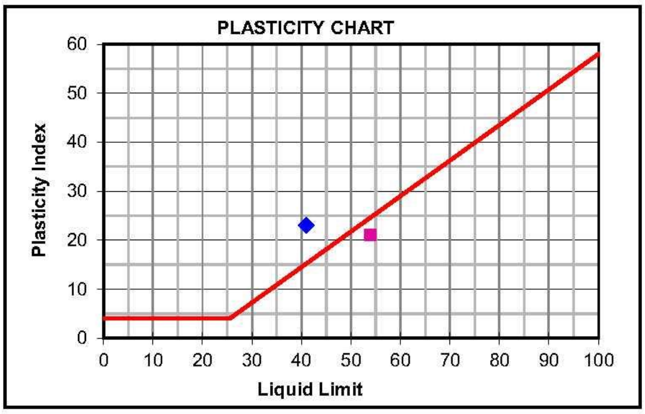
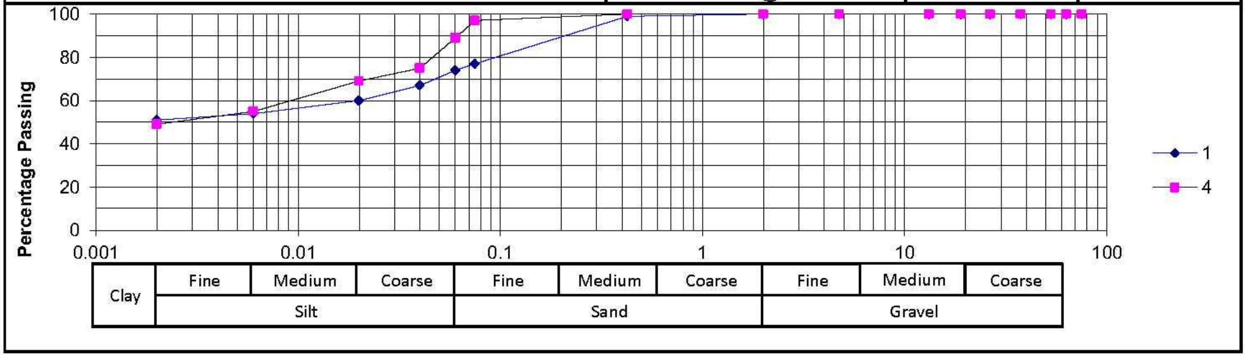
FOUNDATION INDICATOR

Laboratory Number		1 ◆	4 ■
Field Number		RF 1	LF 01
Client Reference			
Depth (m)		1.0-1.3	1.0-1.2
Position			
Coordinates	X		
	Y		
Description		Colluvial Reddish Brown	Residual Dolerite
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			
Moisture Content & Relative Density-TMH1 Metod 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	100	100
	4.75 mm	100	100
	2.00 mm	100	100
	0.425 mm	99	100
	0.075 mm	77	97
Grading Modulus		0.24	0.03
Hydrometer Analysis - ASTM Method D422			
Percentage Passing	0.060 mm	74	89
	0.040 mm	67	75
	0.020 mm	60	69
	0.006 mm	54	55
	0.002 mm	51	49
Gravel	%	0	0
Sand	%	26	11
Silt	%	23	40
Clay	%	51	49





Laboratory Number		1 ◆	4 ■
Atterberg Limits - TMH1 Method A2, A3 & A4			
Liquid Limit	%	41	54
Plasticity Index	%	23	21
Linear Shrinkage	%	10.0	11.5
Overall PI	%	23	21
Classifications			
HRB		A-7-6(17)	A-7-5(20)
Unified		CL	MH
Weston Swell @ 1 kPa			



Client	:	JEFFARES & GREEN CONSULTING ENGINEERS	Date Received:	07/10/2013
Project	:	Mzimvubu Water Project	Date Reported:	03/12/2013
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FOUNDATION INDICATOR

Laboratory Number		5 ◆	6 ■
Field Number		SSP 1	SSP 3
Client Reference			
Depth (m)		1.7-3.5	0.7-4.9
Position			
Coordinates	X		
	Y		
Description		Weathered Dolerite	
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

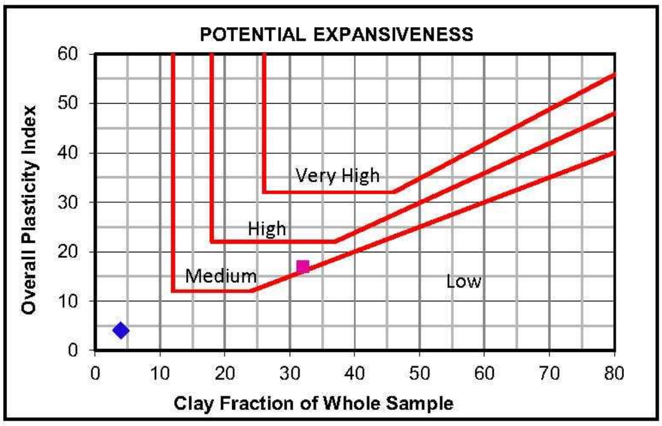
Moisture Content (%)		
Relative Density (S.G.)		

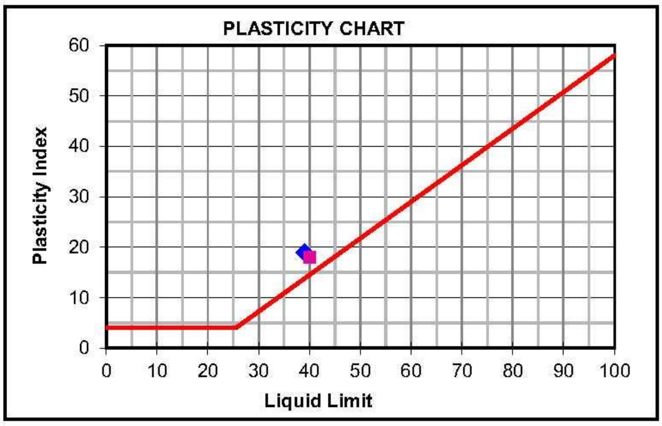
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100	100
	63.0 mm	95	100
	53.0 mm	91	100
	37.5 mm	87	100
	26.5 mm	79	100
	19.0 mm	68	100
	13.2 mm	65	100
	4.75 mm	50	99
	2.00 mm	32	99
	0.425 mm	20	97
	0.075 mm	13	84
Grading Modulus		2.35	0.2

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	11	77
	0.040 mm	8	66
	0.020 mm	6	54
	0.006 mm	5	42
	0.002 mm	4	32
Gravel	%	68	1
Sand	%	21	22
Silt	%	7	45
Clay	%	4	32





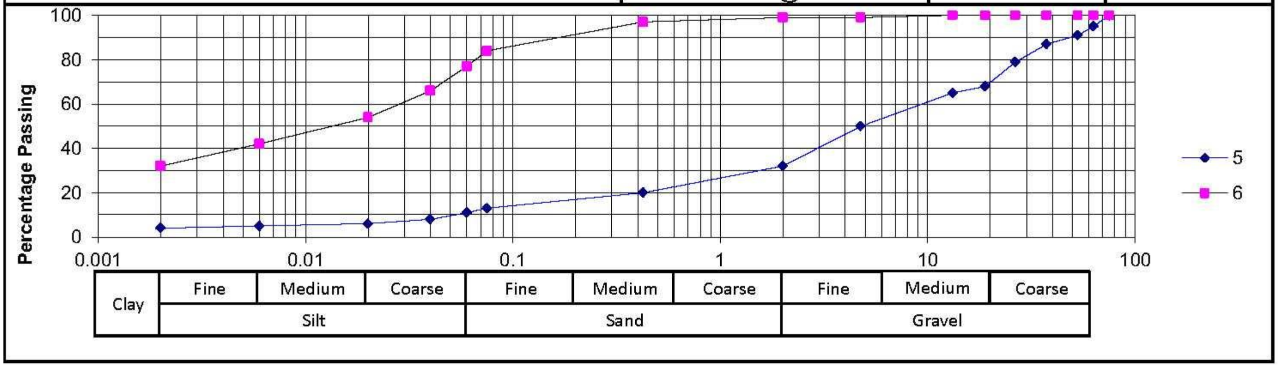
Laboratory Number		5 ◆	6 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	39	40
Plasticity Index	%	19	18
Linear Shrinkage	%	9.5	10.0
Overall PI	%	4	17

Classifications

HRB	A-2-6(0)	A-6(15)
Unified	GC	CL
Weston Swell @ 1 kPa		



Client	:	JEFFARES & GREEN CONSULTING ENGINEERS	Date Received:	07/10/2013
Project	:	Mzimvubu Water Project	Date Reported:	03/12/2013
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FOUNDATION INDICATOR

Laboratory Number		7 ◆	8 ■
Field Number		SP 5	SP 7
Client Reference			
Depth (m)		0.3-2.4	0.15-1.2
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

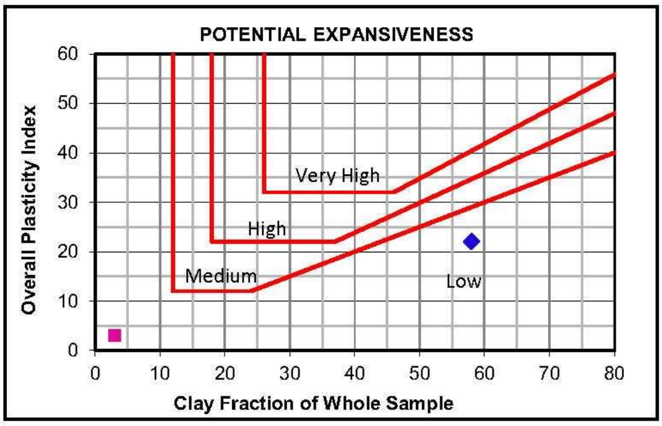
Moisture Content (%)		
Relative Density (S.G.)		

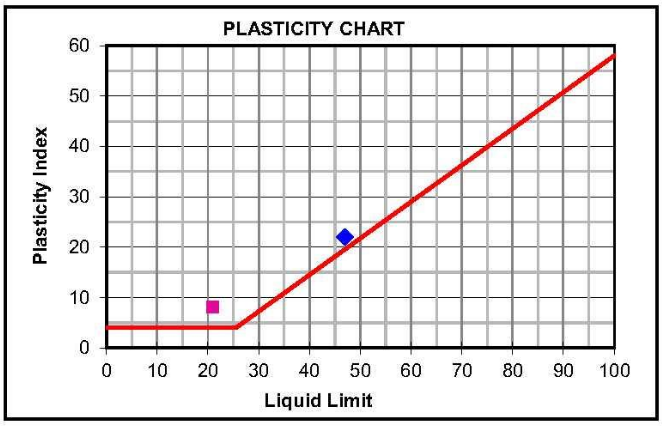
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100	100
	63.0 mm	100	94
	53.0 mm	100	84
	37.5 mm	100	75
	26.5 mm	100	67
	19.0 mm	100	57
	13.2 mm	100	56
	4.75 mm	100	44
	2.00 mm	100	40
	0.425 mm	98	35
	0.075 mm	88	11
Grading Modulus		0.14	2.14

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	84	9
	0.040 mm	77	7
	0.020 mm	70	5
	0.006 mm	64	4
	0.002 mm	58	3
Gravel	%	0	60
Sand	%	16	31
Silt	%	26	6
Clay	%	58	3





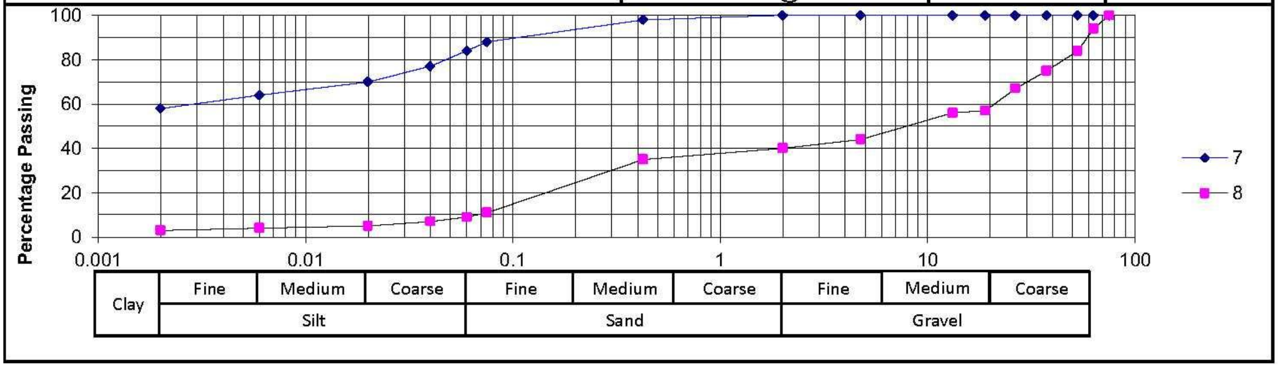
Laboratory Number		7 ◆	8 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	47	21
Plasticity Index	%	22	8
Linear Shrinkage	%	11.5	2.5
Overall PI	%	22	3

Classifications

HRB	A-7-6(20)	A-2-4(0)
Unified	CL	GP-GC
Weston Swell @ 1 kPa		



H 4:

DISPERSIVENESS

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Civill Engineering Testing Laboratories

Analyses on Potentially Dispersive Soils

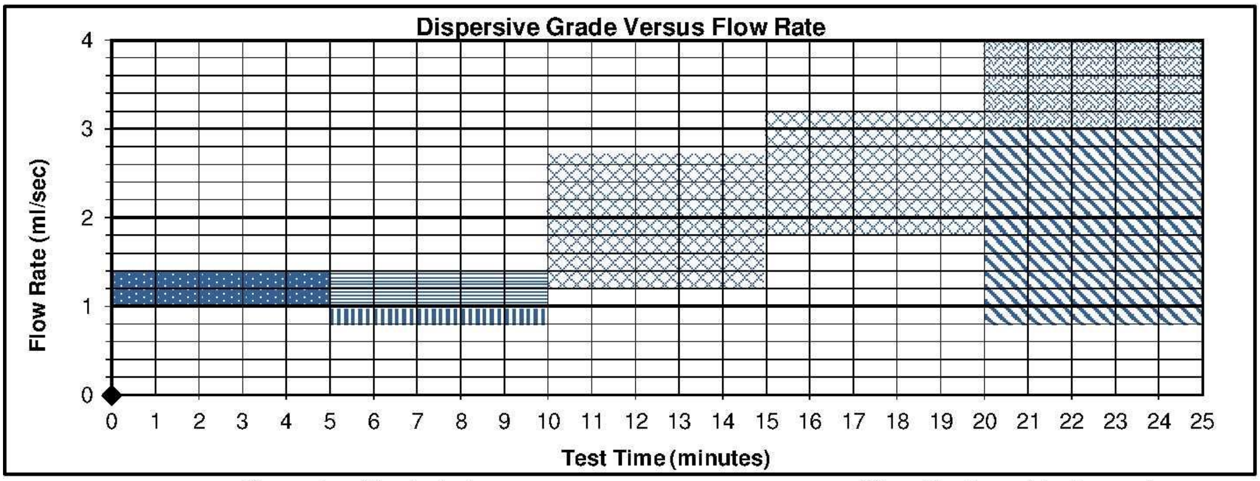
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-2
Job Number	2013-B-2004	Client/Field No.	C2
Date Received	15/10/2013	Depth (m)	0.4 - 2.6

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m³	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:		PC-Perfectly Clear					C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
▦ D1	▤ D2	▥ ND4	▨ ND3	▩ ND2	▧ ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

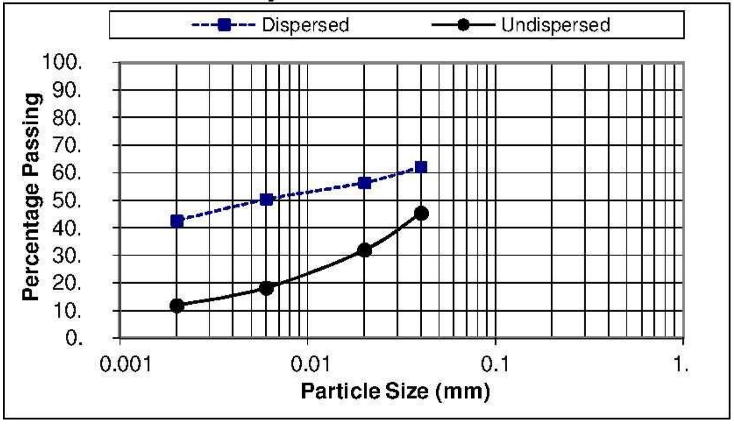
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

28 (Non-Dispersive)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

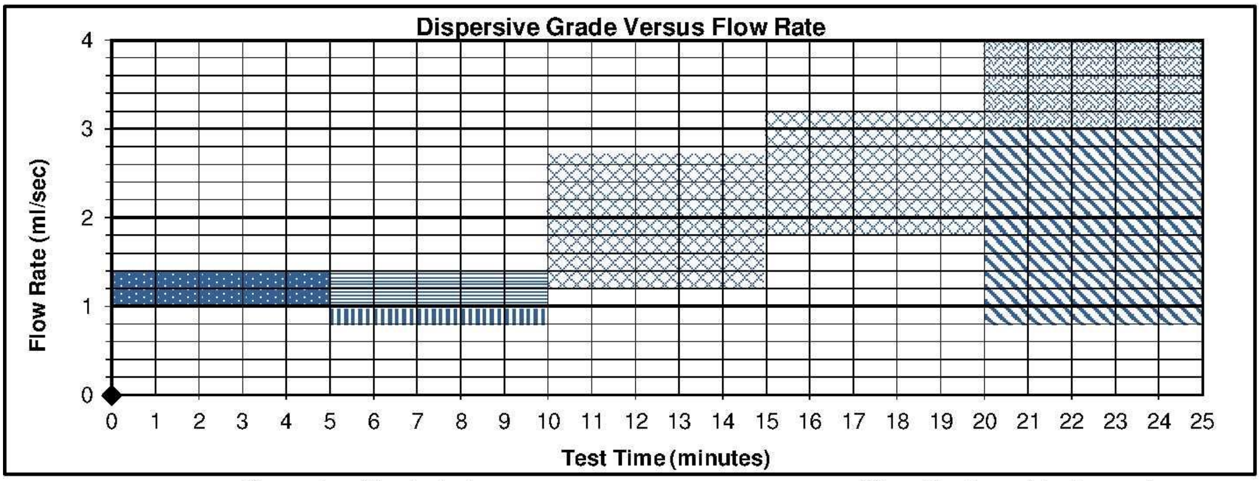
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-4
Job Number	2013-B-2004	Client/Field No.	C4A
Date Received	21/08/2013	Depth (m)	0.4 - 2.1

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:	PC-Perfectly Clear						C-Clear			SD-Slightly Dark					MD-Moderately Dark					D-Dark		VD-Very Dark		



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
▦ D1	☰ D2	▥ ND4	▩ ND3	▩ ND2	▧ ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

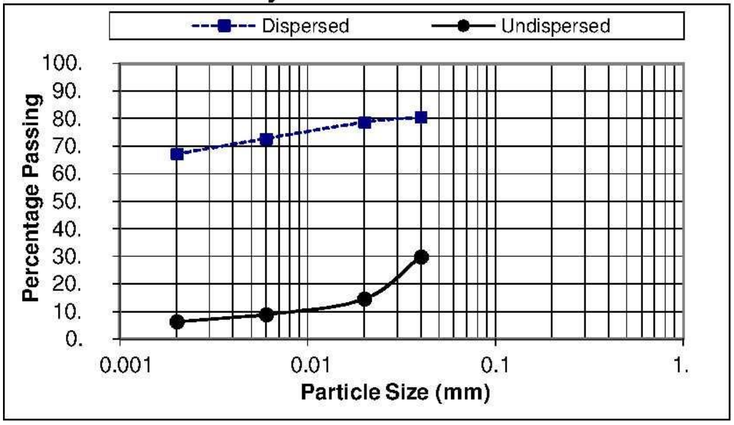
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

9 (Non-Dispersive)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

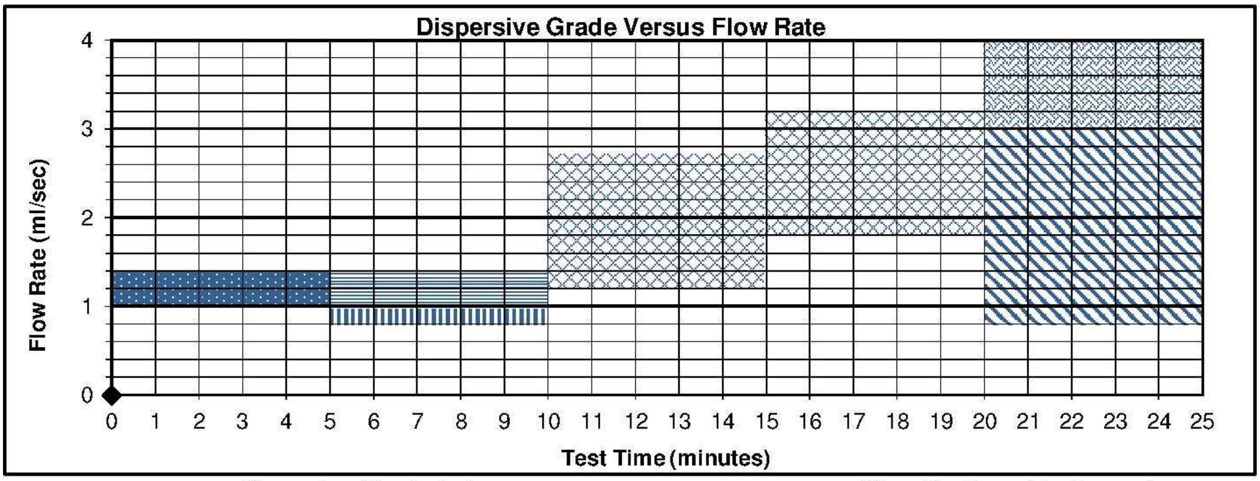
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-7
Job Number	2013-B-2004	Client/Field No.	C7
Date Received	21/08/2013	Depth (m)	0.9 - 2.9

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:	PC-Perfectly Clear						C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
▦ D1	▤ D2	▥ ND4	▨ ND3	▩ ND2	▧ ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

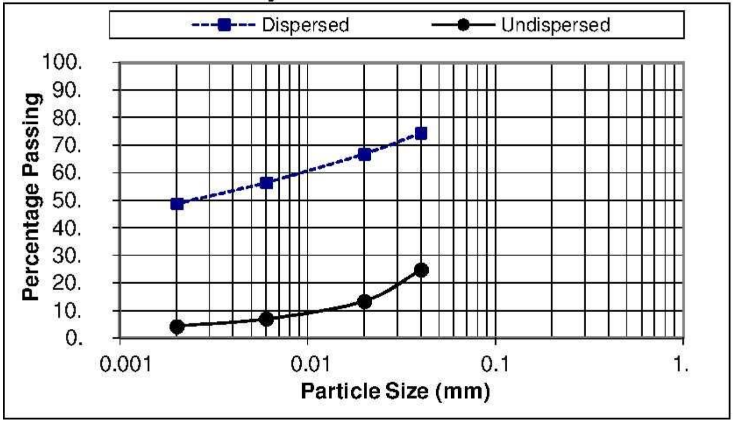
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

9 (Non-Dispersive)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

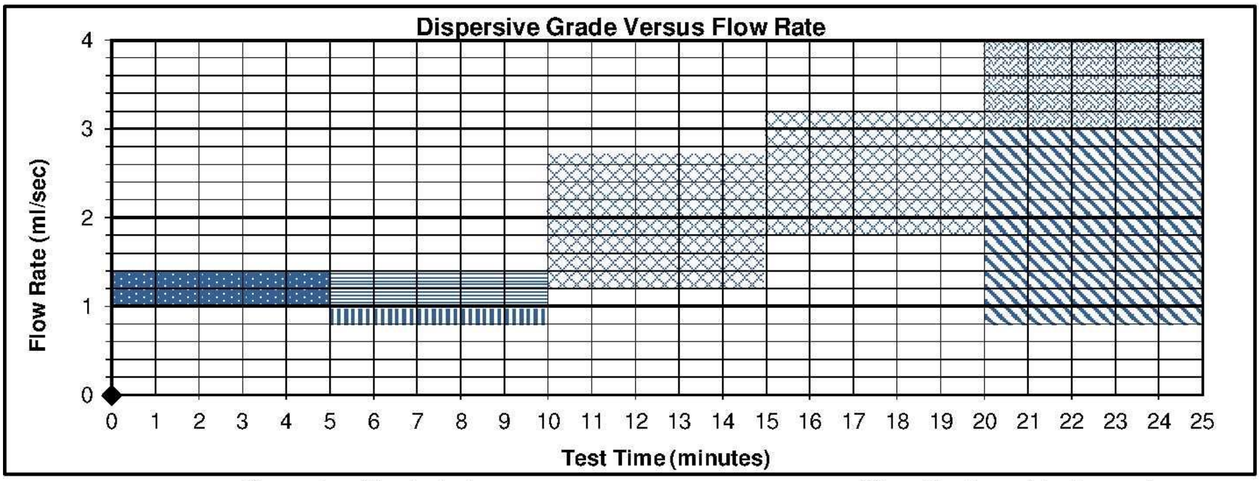
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-8
Job Number	2013-B-2004	Client/Field No.	C8
Date Received	21/08/2013	Depth (m)	0.4 - 2.5

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:	PC-Perfectly Clear						C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
▦ D1	☰ D2	▥ ND4	▨ ND3	▩ ND2	▧ ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

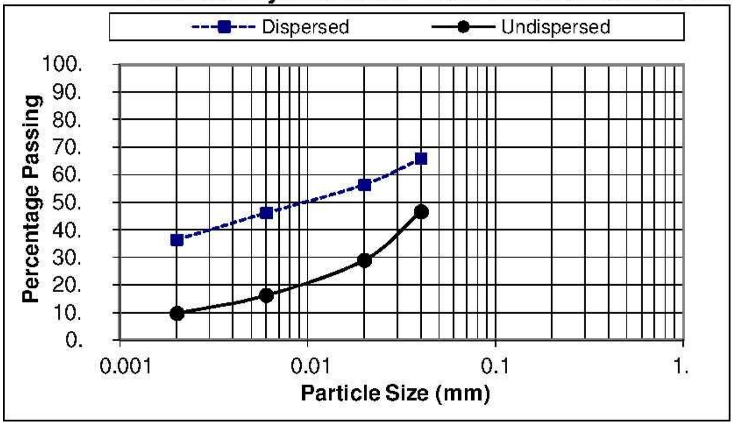
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

27 (Non-Dispersive)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

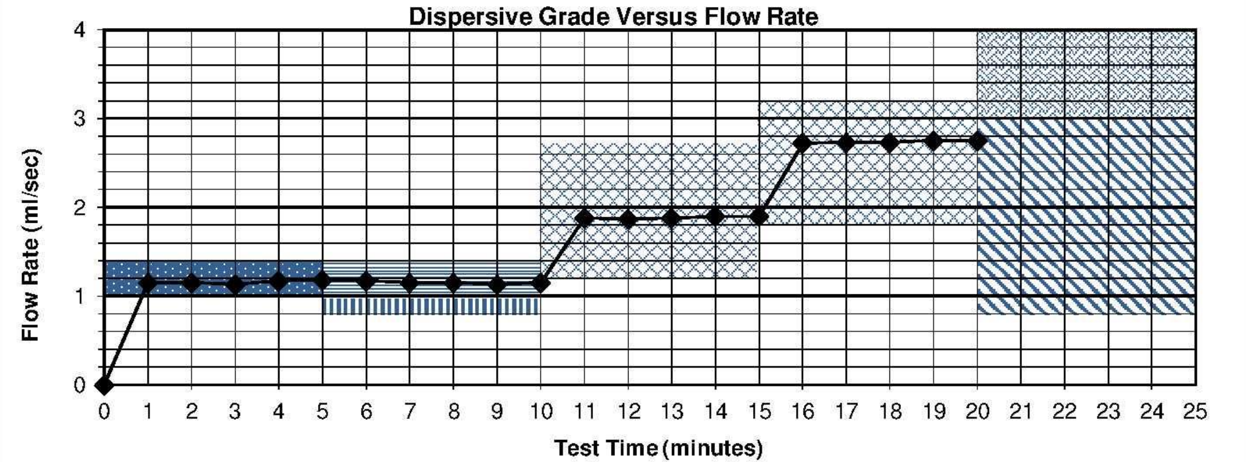
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-11
Job Number	2013-B-2004	Client/Field No.	Mix C2+C4A+C7+C8+C10
Date Received	21/08/2013	Depth (m)	0.4 - 2.5

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested		< 2.0 mm	Compacted Density	kg/m^3	Bulk	1961
Liquid Limit	%	Not tested			Dry	1556
Plastic Limit	%		Moisture Content (%)			26
Plasticity Index	%		Hole size after test (mm)			0

Head (mm)	50										180					380					860				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20					
Flow Rate (ml/sec)	1.2	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.9	1.9	1.9	1.9	1.9	2.7	2.7	2.7	2.8	2.8					
Effluent Water	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	C	C	C	C	C					
	Symbol:	PC-Perfectly Clear						C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
▦ D1	▤ D2	▥ ND4	▨ ND3	▨ ND2	▧ ND1

Classification of test sample

ND3 (Intermediate)

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

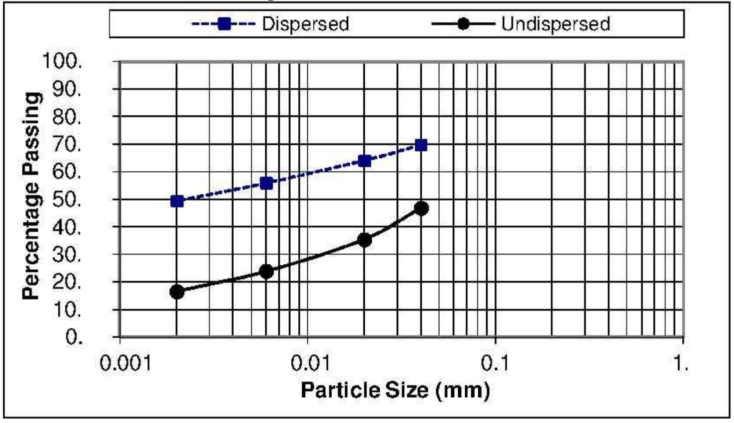
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

34 (Intermediate)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

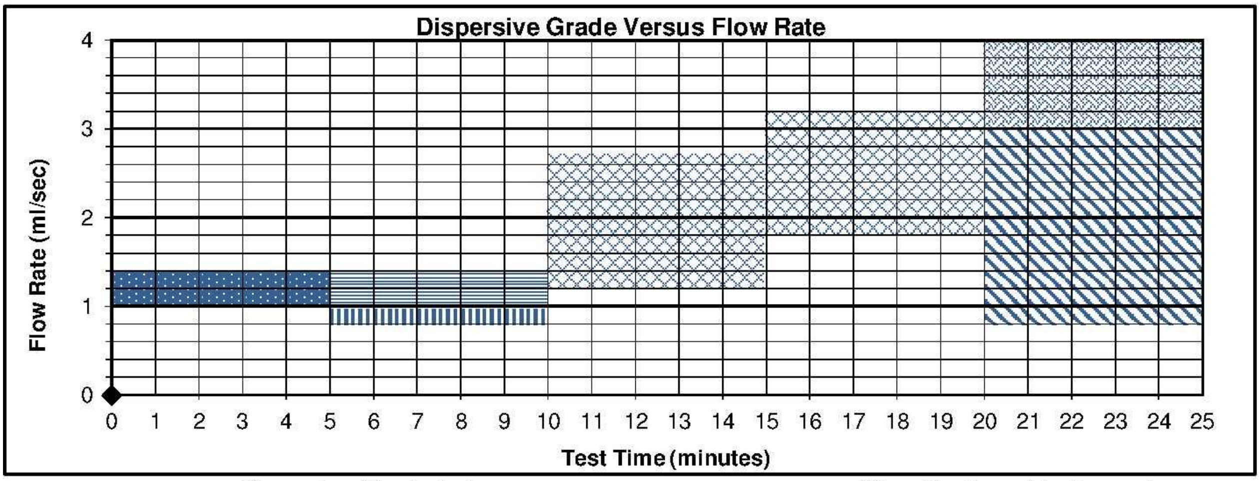
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-12
Job Number	2013-B-2004	Client/Field No.	C12
Date Received	21/08/2013	Depth (m)	0.5 - 2.6

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:	PC-Perfectly Clear					C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark			VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
▦ D1	▤ D2	▥ ND4	▩ ND3	▩ ND2	▧ ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

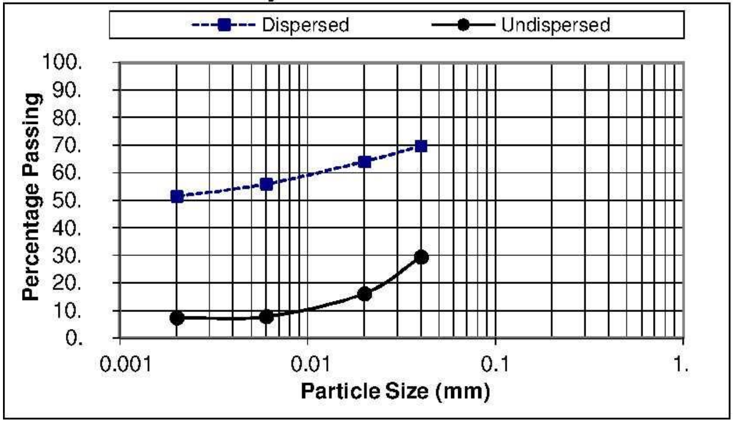
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

14 (Non-Dispersive)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

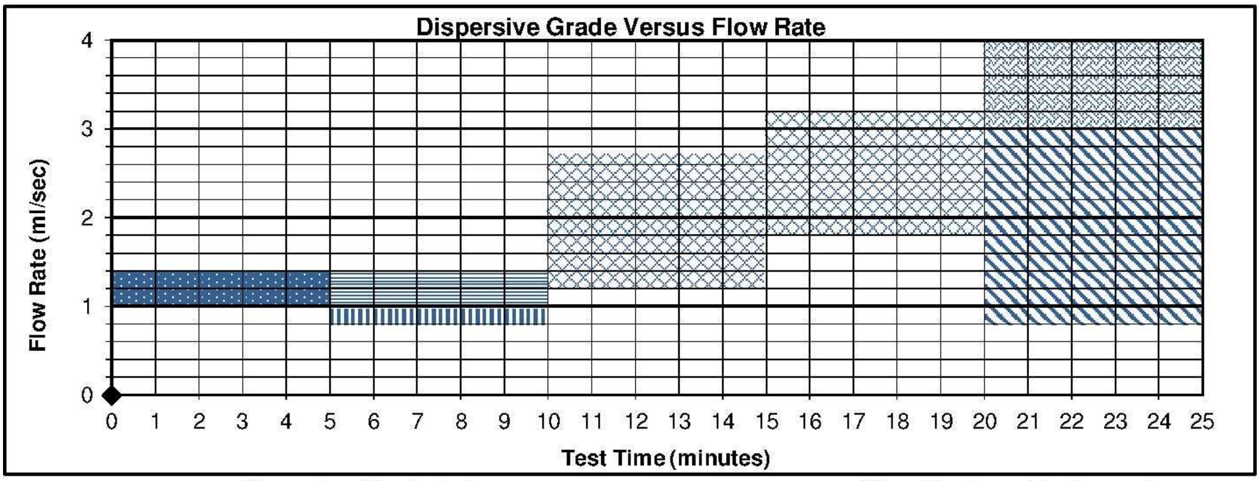
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-15
Job Number	2013-B-2004	Client/Field No.	C18
Date Received	21/08/2013	Depth (m)	0.3 - 2.9

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:		PC-Perfectly Clear					C-Clear			SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark			



Dispersive Grade Index						Classification of test sample
Dispersive		Intermediate		Non-dispersive		
▦ D1	▤ D2	▥ ND4	▩ ND3	▩ ND2	▧ ND1	**Not tested**

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

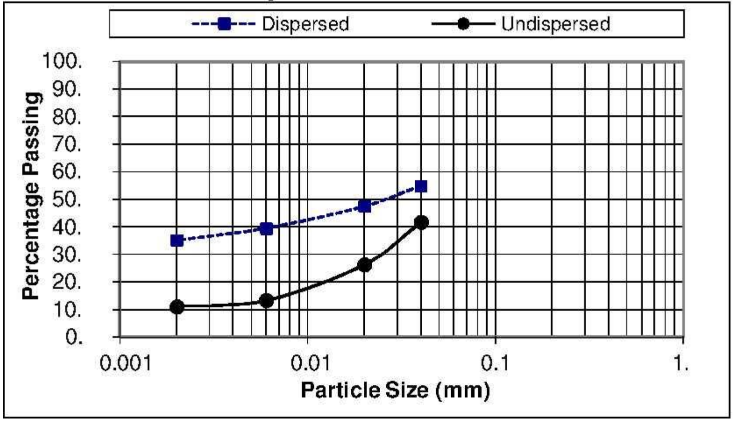
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

31 (Intermediate)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

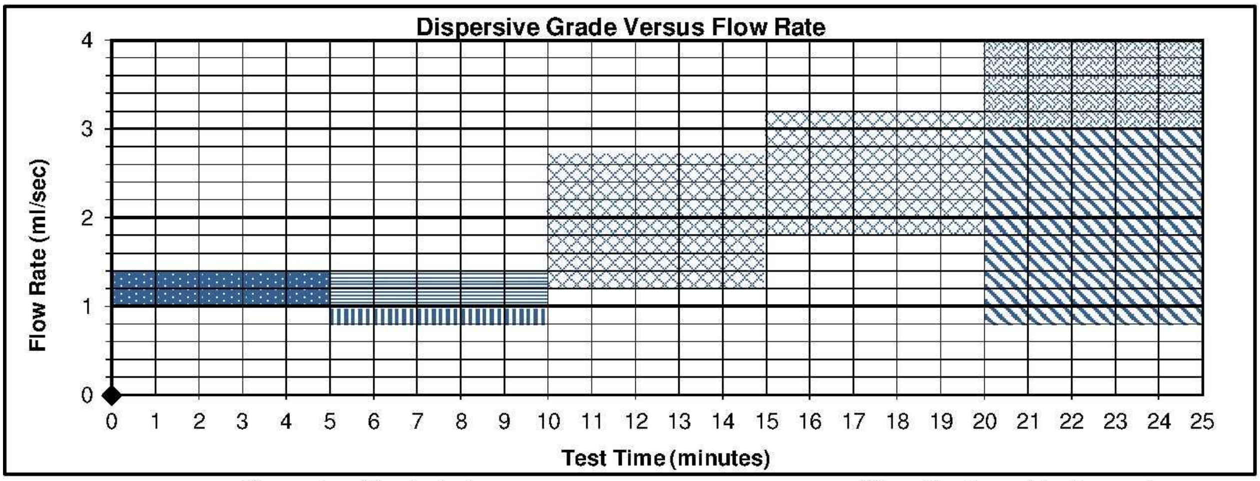
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-20
Job Number	2013-B-2004	Client/Field No.	C28
Date Received	21/08/2013	Depth (m)	0.5 - 2.6

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:	PC-Perfectly Clear						C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
▨ D1	☰ D2	▥ ND4	☒ ND3	▩ ND2	▧ ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

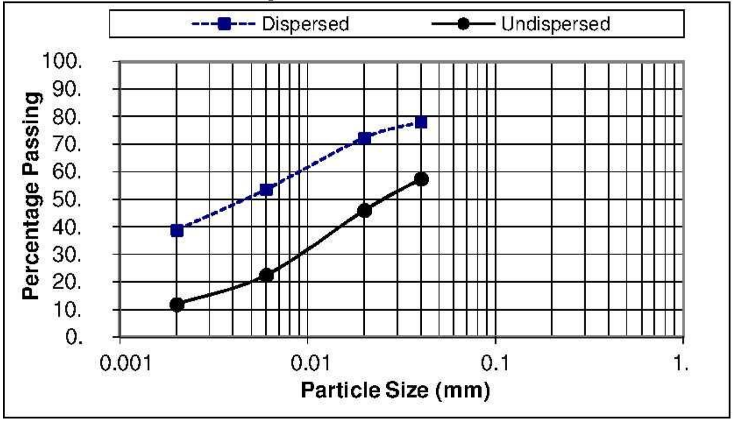
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

31 (Intermediate)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

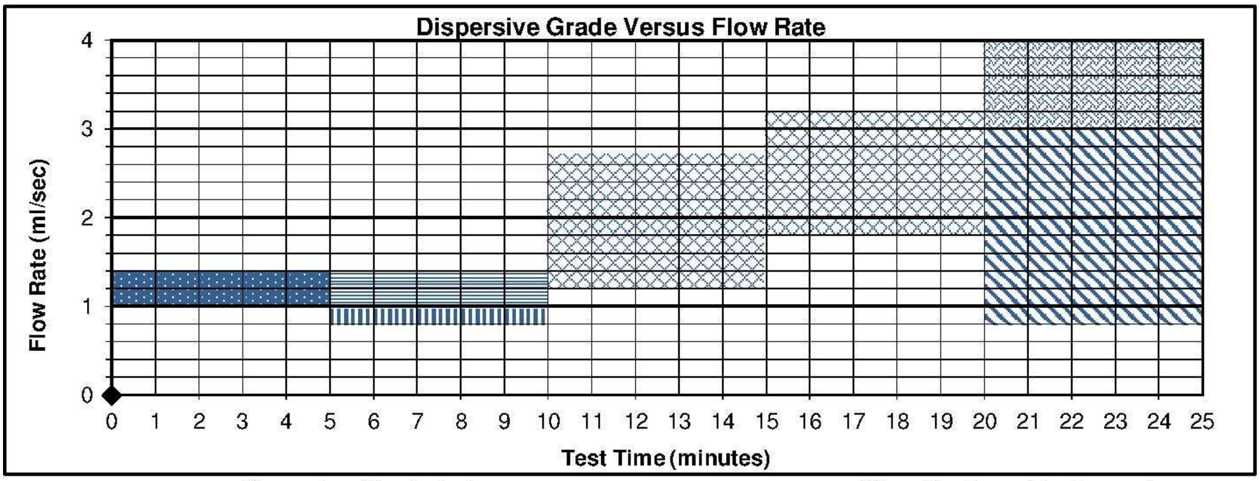
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-21
Job Number	2013-B-2004	Client/Field No.	C30
Date Received	21/08/2013	Depth (m)	0.5 - 2.1

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:		PC-Perfectly Clear					C-Clear			SD-Slightly Dark					MD-Moderately Dark					D-Dark		VD-Very Dark		



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
▦ D1	▤ D2	▥ ND4	▩ ND3	▩ ND2	▧ ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

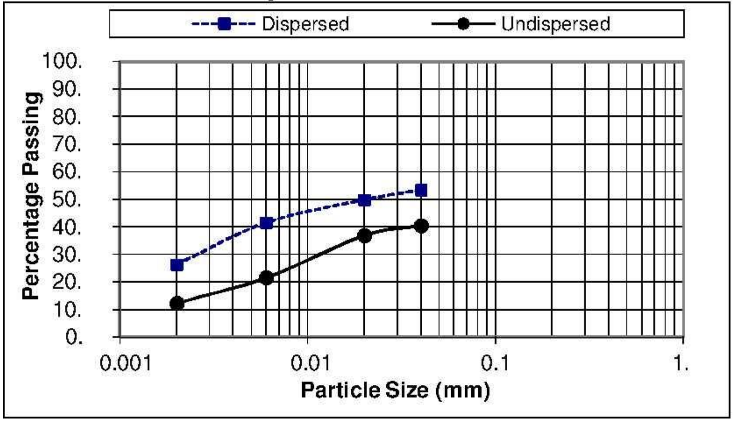
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

46 (Intermediate)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-22
Job Number	2013-B-2004	Client/Field No.	Mix C12+C18+C22+C28+C30
Date Received	21/08/2013	Depth (m)	-

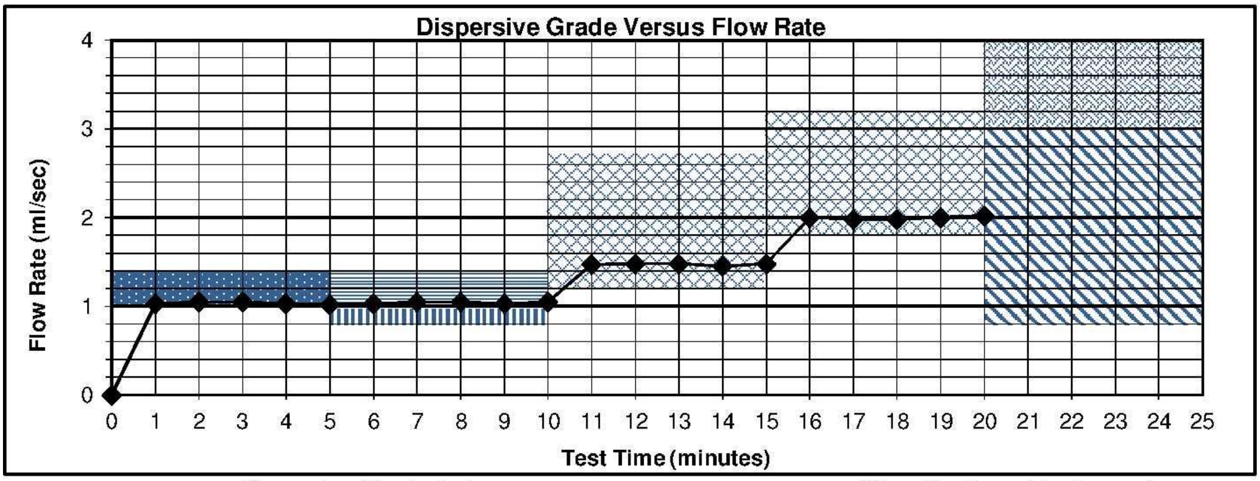
Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested		< 2.0 mm	Compacted Density	kg/m^3	Bulk	1989
Liquid Limit	%	Not tested			Dry	1608
Plastic Limit	%		Moisture Content (%)			23.7
Plasticity Index	%		Hole size after test (mm)			0

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20					
Flow Rate (ml/sec)	1.0	1.1	1.1	1.0	1.0	1.0	1.1	1.1	1.0	1.1	1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0					
Effluent Water	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	C	C	C	C					

Symbol: PC-Perfectly Clear | C-Clear | SD-Slightly Dark | MD-Moderately Dark | D-Dark | VD-Very Dark



Dispersive Grade Index					
Dispersive		Intermediate		Non-dispersive	
▨ D1	▤ D2	▥ ND4	▨ ND3	▨ ND2	▧ ND1

Classification of test sample
ND3 (Intermediate)

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

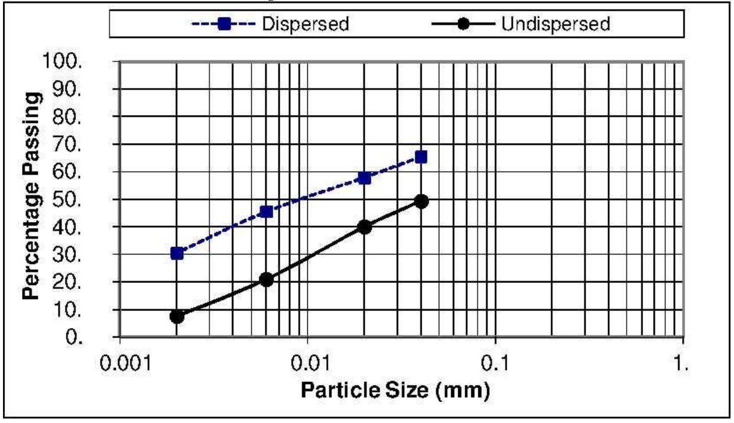
Reagent used	

Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample
Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample
25 (Non-Dispersive)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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Analyses on Potentially Dispersive Soils

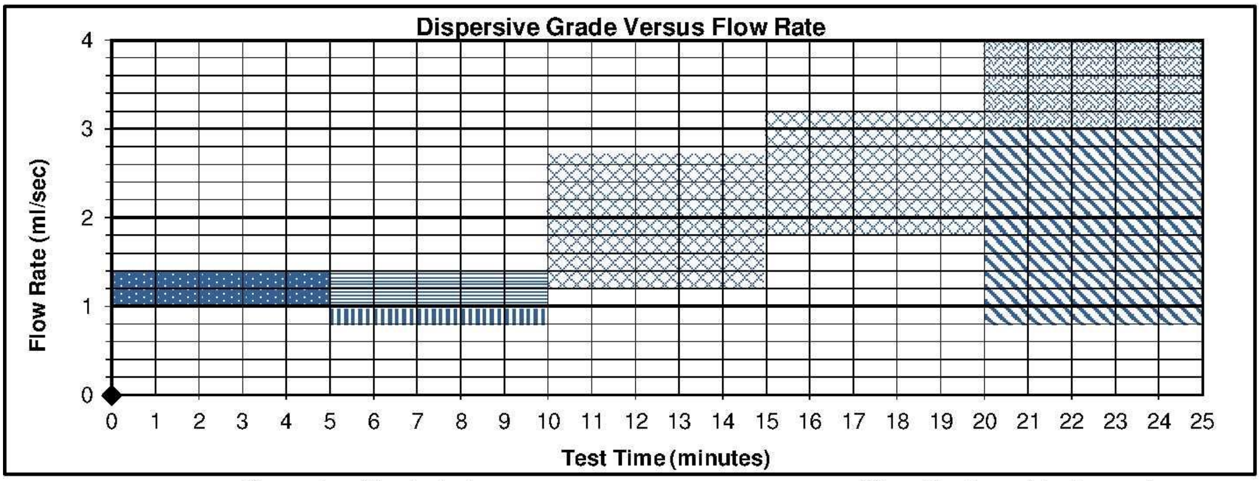
Project Name	MZIMVUBU WATER PROJECT	Lab. No.	2004-37
Job Number	2013-B-2004	Client/Field No.	F37A
Date Received	21/08/2013	Depth (m)	CHANNEL

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					380					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:		PC-Perfectly Clear					C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
▦ D1	▤ D2	▥ ND4	▨ ND3	▩ ND2	▧ ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	

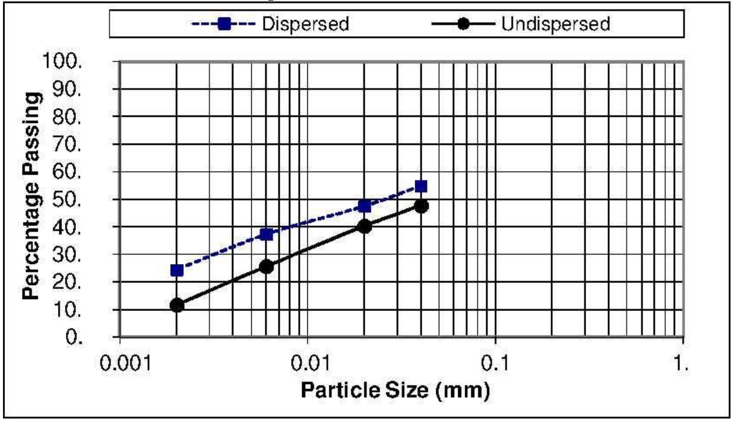
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

Not tested

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

48 (Intermediate)

Remarks: These methods may not be suited to materials where the clay content < 10% and plasticity index ≤ 4. Hydrometer tests are done in accordance with ASTM D422 and interpreted according to BS 1377: Part 5.

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H 5

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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-11
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on a remoulded sample tested saturated. Mixed C2, C4A, C7, C8, C10 in equal fractions.

Test No. 1

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100…	Differential pressure (kPa): 10.0	
Final cell pressure (kPa): 343.0	Final back pressure (kPa): 333.0	Final B parameter: 0.96	

CONSOLIDATION DATA

Effective cons. Stress (kPa): 100.0 t100 (minutes): 9 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.87	*50.1	1971.36	27.1	1457	0.8183	88	2.65 Assumed
CONSOLIDATED	100.06	49.70	1939.68	30.4	1493	0.7745	104	
FINAL (After shear)	80.01	55.57	2425.65	30.4	1493	0.7747	104	

Initial pore pressure (kPa): 442.7 Final pore pressure (kPa): 336.7 PWP dissipation (%): 100

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 1.00

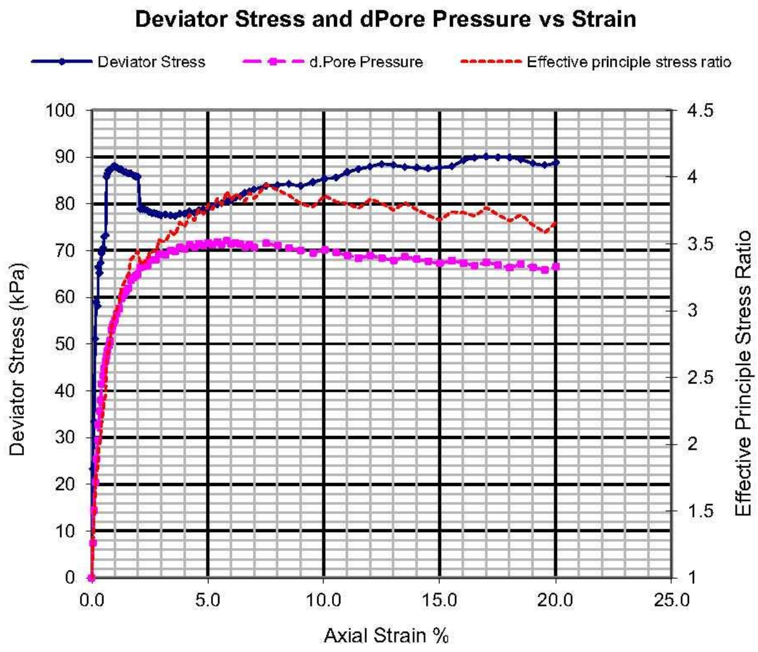
Initial pore pressure (kPa): 336.0 Initial effective stress (kPa): 100.0

Parameters at failure:

Failure Criterion: Max. Effective Principle Stress Ratio

		Principle Stresses (kPa)			
Axial strain (%):	7.52				
Deviator stress (kPa):	83.8				
Excess pore pressure (kPa):	71.5	$\sigma 1$	$\sigma 1'$	$\sigma 3$	$\sigma 3'$
Effective principle stress ratio:	3.946	183.8	112.3	100.0	28.5

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-11
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested saturated. Mixed C2, C4A, C7, C8, C10 in equal fractions.

Test No. 2

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 423.0 Final back pressure (kPa): 413.0 Final B parameter: 0.98

CONSOLIDATION DATA

Effective cons. Stress (kPa): 197.0 t100 (minutes): 4 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*101.09	*50.13	1973.72	25.3	1474	0.7978	84	2.65 Assumed
CONSOLIDATED	99.24	49.21	1901.61	21.9	1559	0.6993	83	
FINAL (After shear)	81.75	54.22	2308.65	21.9	1558	0.7005	83	

Initial pore pressure (kPa): 605.4 Final pore pressure (kPa): 415.5 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

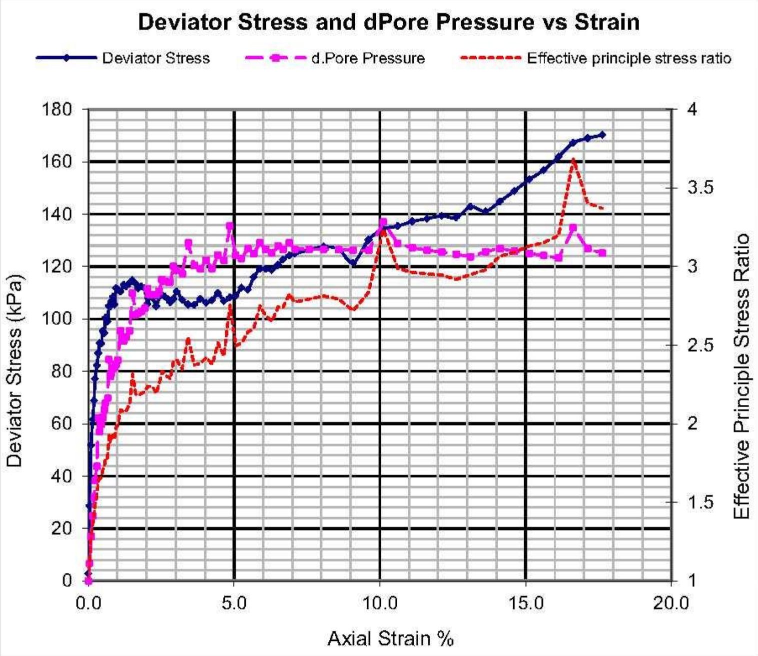
Rate of strain (%/hour): 1.25
Initial pore pressure (kPa): 420.0 Initial effective stress (kPa): 197.0

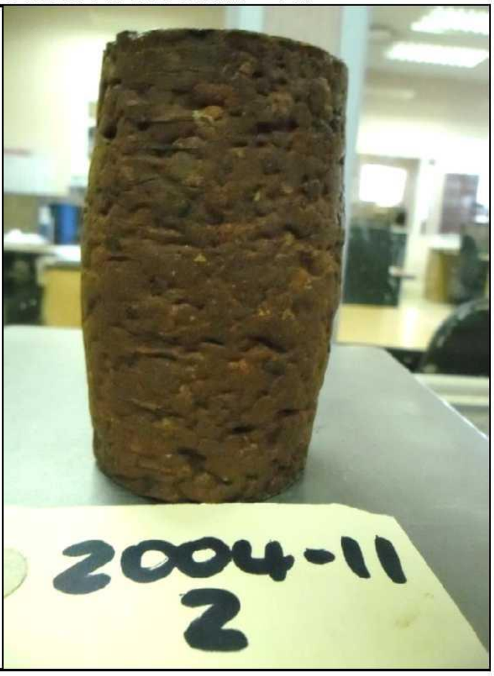
Parameters at failure:

Failure Criterion: Max. Effective Principle Stress Ratio
Axial strain (%): 16.63

		Principle Stresses (kPa)			
Deviator stress (kPa):	167.1	σ1	σ1'	σ3	σ3'
Excess pore pressure (kPa):	134.7				
Effective principle stress ratio:	3.684	364.1	229.4	197.0	62.3

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%





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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-11
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on a remoulded sample tested saturated. Mixed C2, C4A, C7, C8, C10 in equal fractions.

Test No. 3

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100... Differential pressure (kPa): 10.0
Final cell pressure (kPa): 323.0 Final back pressure (kPa): 313.0 Final B parameter: 1.00

CONSOLIDATION DATA

Effective cons. Stress (kPa): 398.7 t100 (minutes): 100 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.97	*50.14	1974.51	25.4	1472	0.8001	84	2.65 Assumed
CONSOLIDATED	97.93	48.60	1855.43	26.3	1619	0.6372	110	
FINAL (After shear)	83.72	52.57	2170.27	26.3	1615	0.6405	109	

Initial pore pressure (kPa): 704.3 Final pore pressure (kPa): 312.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

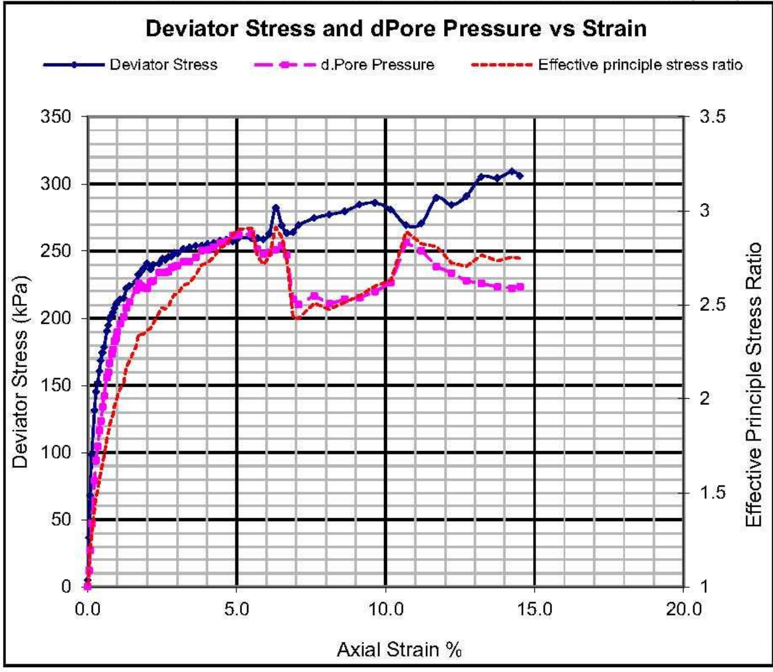
SHEAR DATA

Rate of strain (%/hour): 0.20
Initial pore pressure (kPa): 313.3 Initial effective stress (kPa): 398.7

Parameters at failure:

Failure Criterion:	Max. Effective Principle Stress Ratio				
Axial strain (%):	6.31				
Deviator stress (kPa):	282.1	Principle Stresses (kPa)			
Excess pore pressure (kPa):	251.1	$\sigma 1$	$\sigma 1'$	$\sigma 3$	$\sigma 3'$
Effective principle stress ratio:	2.912	680.7	429.6	398.7	147.5

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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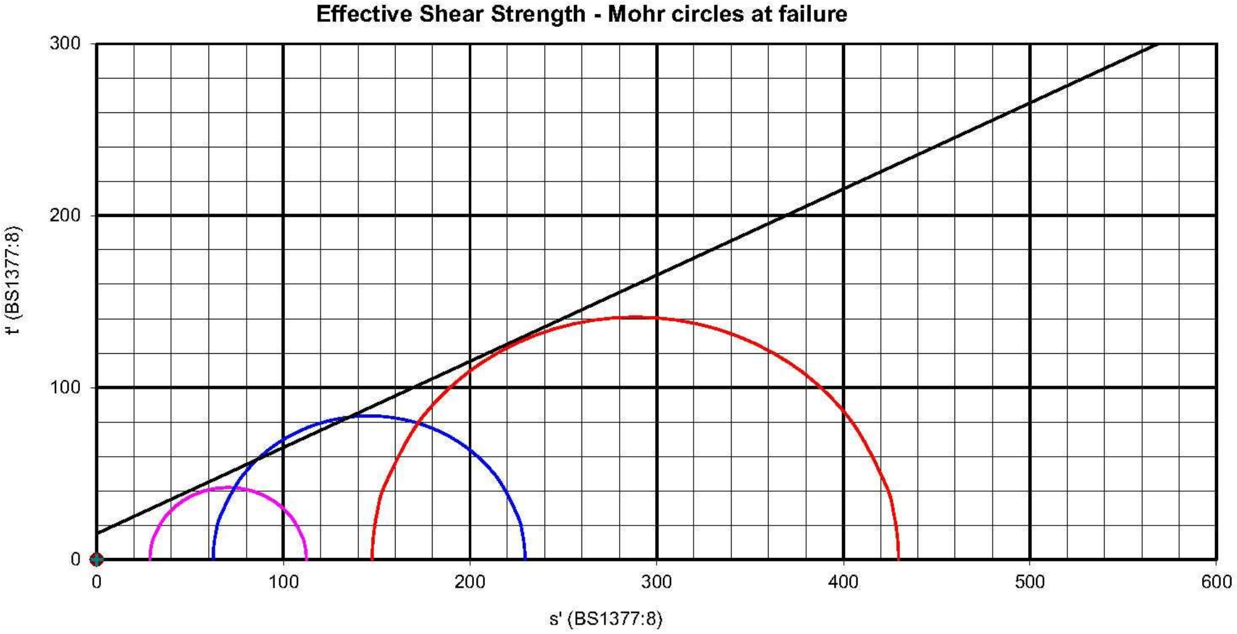
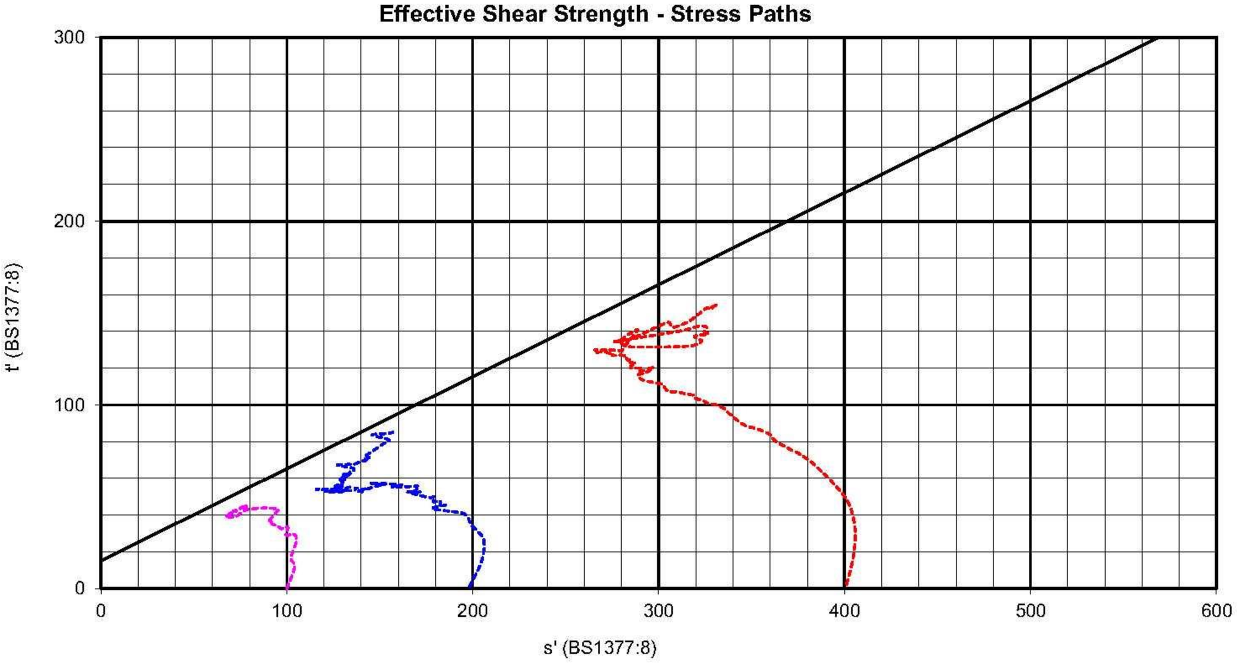
Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-11
Field Sample Reference:	Refer to Remarks	Depth (m):	-

Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	10.4	14.2
Effective	15.1	26.6





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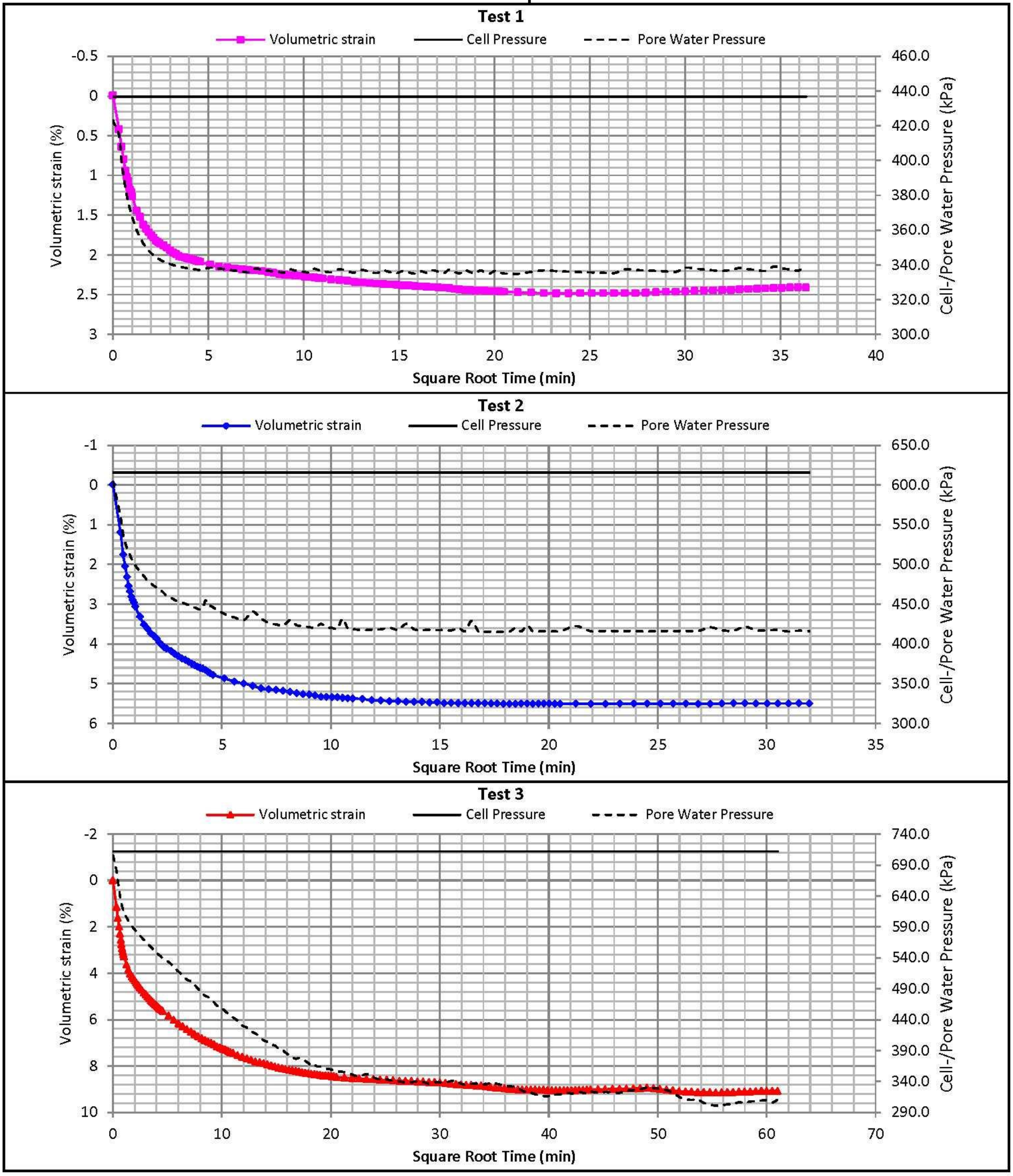
Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-11
Field Sample Reference:	Refer to Remarks	Depth (m):	-

Consolidation vs Square Root Time



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	2004-22
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested saturated. Mixed C12, C18, C22, C28, C30 in equal fractions.

SATURATION DATA

Test No. 1

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 323.0 Final back pressure (kPa): 313.0 Final B parameter: 0.99

CONSOLIDATION DATA

Effective cons. Stress (kPa): 99.2 t100 (minutes): 16 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.07	*49.96	1960.36	27.6	1470	0.8079	91	2.657 Determined
CONSOLIDATED	99.33	49.59	1931.46	31.0	1503	0.7680	107	
FINAL (After shear)	87.30	52.90	2197.68	31.0	1503	0.7682	107	

Initial pore pressure (kPa): 406.8 Final pore pressure (kPa): 317.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

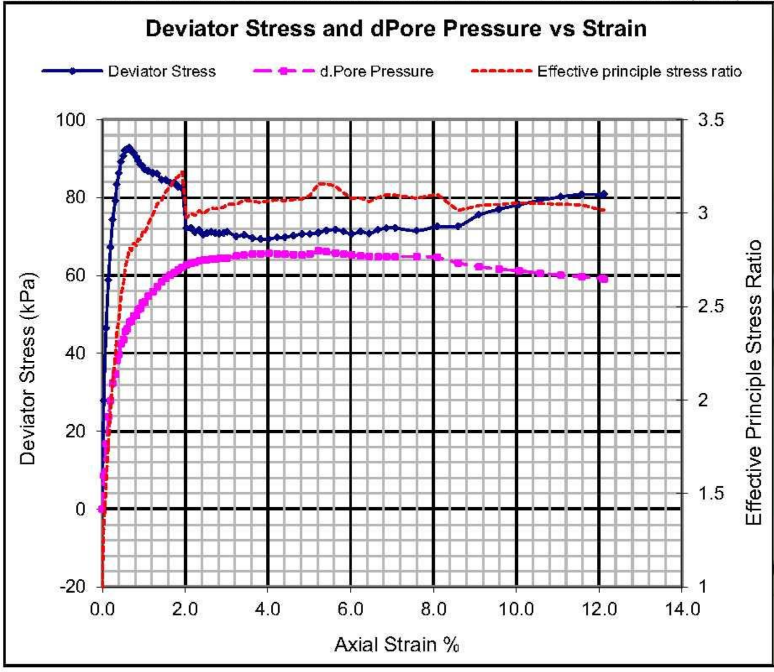
Rate of strain (%/hour): 0.25
Initial pore pressure (kPa): 322.8 Initial effective stress (kPa): 99.2

Parameters at failure:

Failure Criterion: Max. Deviator Stress

Axial strain (%):	0.65				
Deviator stress (kPa):	92.8	Principle Stresses (kPa)			
Excess pore pressure (kPa):	48.0	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	2.811	192.0	144.0	99.2	51.2

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	2004-22
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested saturated. Mixed C12, C18, C22, C28, C30 in equal fractions.

Test No. 2

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 198.5 t100 (minutes): 100 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.52	*50.01	1964.28	27.5	1464	0.8147	90	2.657 Determined
CONSOLIDATED	99.05	49.27	1906.68	29.7	1532	0.7349	107	
FINAL (After shear)	92.05	51.11	2051.57	29.7	1531	0.7356	107	

Initial pore pressure (kPa): 535.5 Final pore pressure (kPa): 346.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

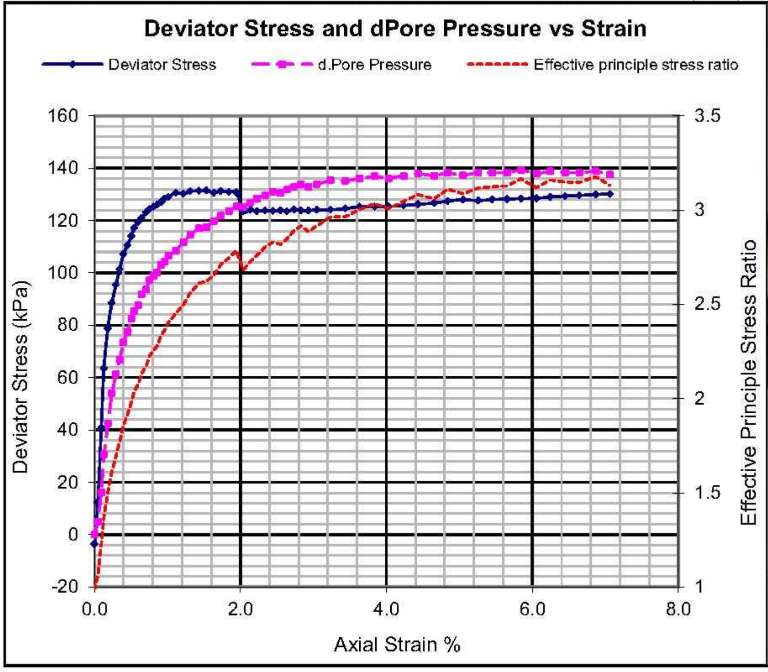
Rate of strain (%/hour): 0.33
Initial pore pressure (kPa): 348.5 Initial effective stress (kPa): 198.5

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 1.53

		Principle Stresses (kPa)			
Deviator stress (kPa):	131.4				
Excess pore pressure (kPa):	117.4	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	2.620	330.0	212.5	198.5	81.1

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	2004-22
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on a remoulded sample tested saturated. Mixed C12, C18, C22, C28, C30 in equal fractions.

Test No. 3

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 333.0 Final back pressure (kPa): 323.0 Final B parameter: 1.00

CONSOLIDATION DATA

Effective cons. Stress (kPa): 404.0 t100 (minutes): 100 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.08	*50.03	1965.85	27.3	1483	0.7921	92	2.657 Determined
CONSOLIDATED	97.77	48.86	1875.11	27.8	1593	0.6680	110	
FINAL (After shear)	88.18	51.45	2079.16	27.8	1591	0.6699	110	

Initial pore pressure (kPa): 710.4 Final pore pressure (kPa): 313.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

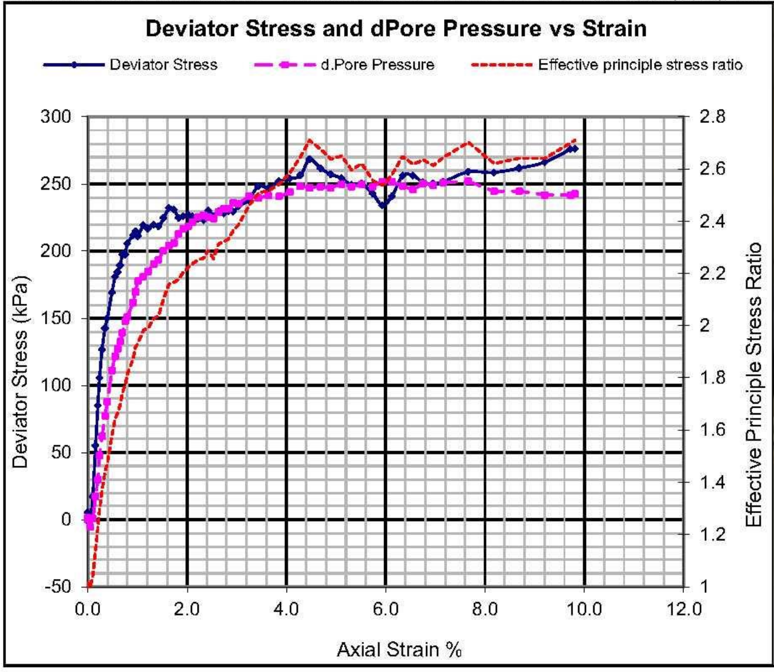
SHEAR DATA

Rate of strain (%/hour): 0.20
Initial pore pressure (kPa): 322.0 Initial effective stress (kPa): 404.0

Parameters at failure:

Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	9.81				
Deviator stress (kPa):	276.0	Principle Stresses (kPa)			
Excess pore pressure (kPa):	242.6	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	2.710	679.9	437.4	404.0	161.4

Deviator stress corrections: Membrane correction: 0 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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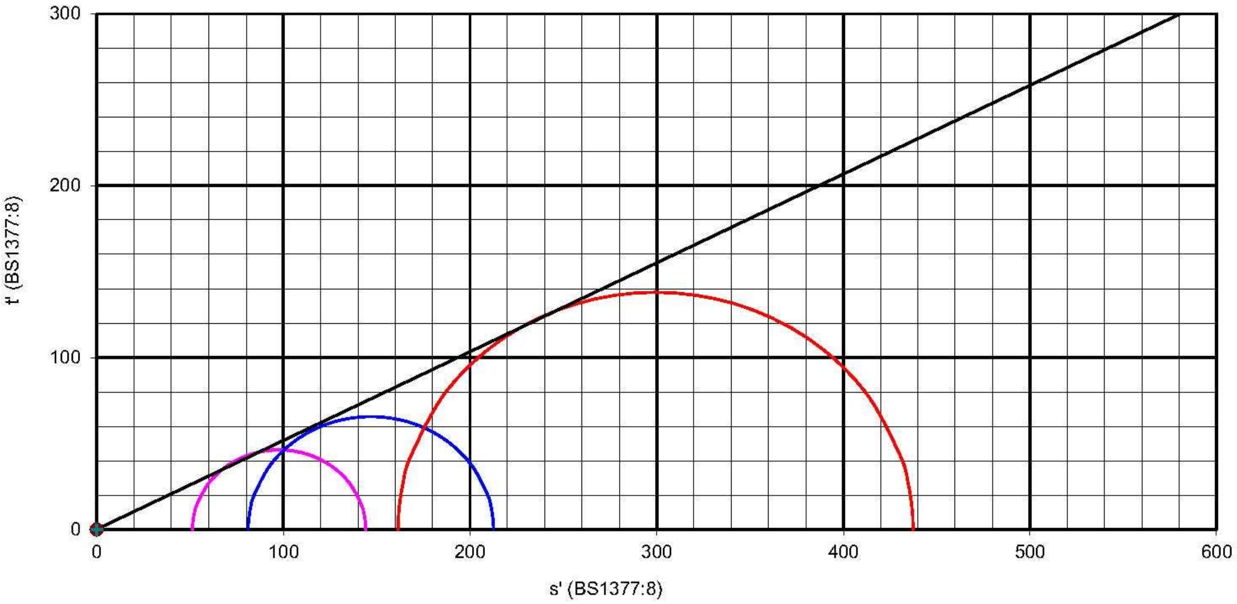
Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	2004-22
Field Sample Reference:	Refer to Remarks	Depth (m):	-

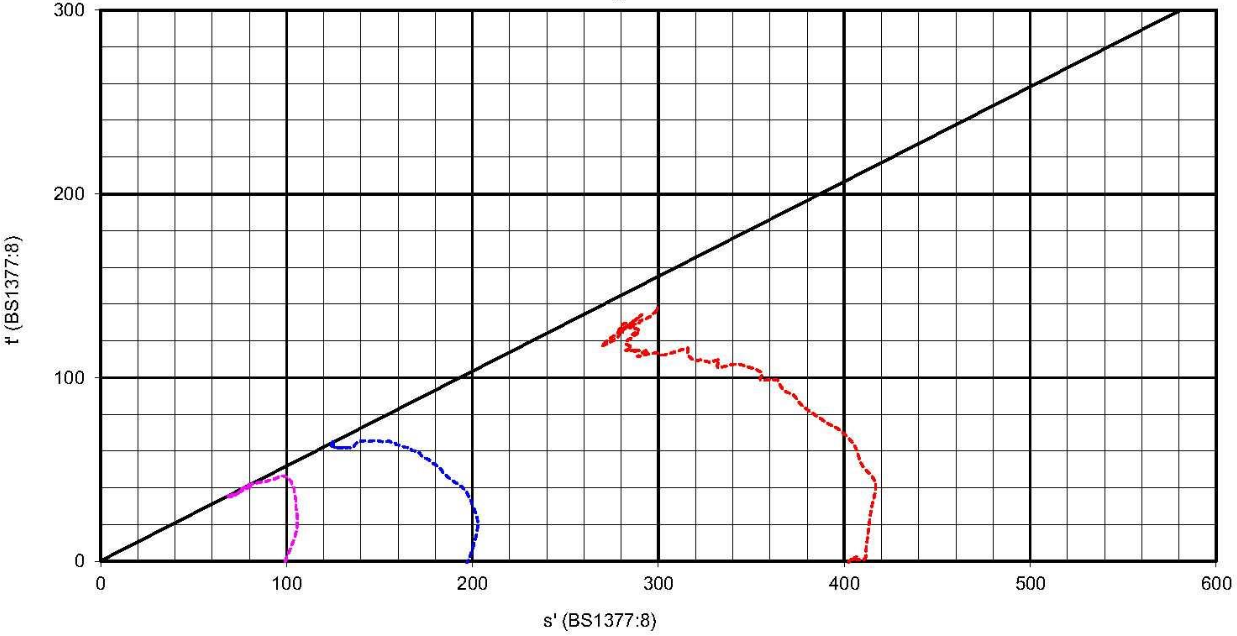
Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	8.6	13.7
Effective	0.2	27.3

Effective Shear Strength - Mohr circles at failure



Effective Shear Strength - Stress Paths



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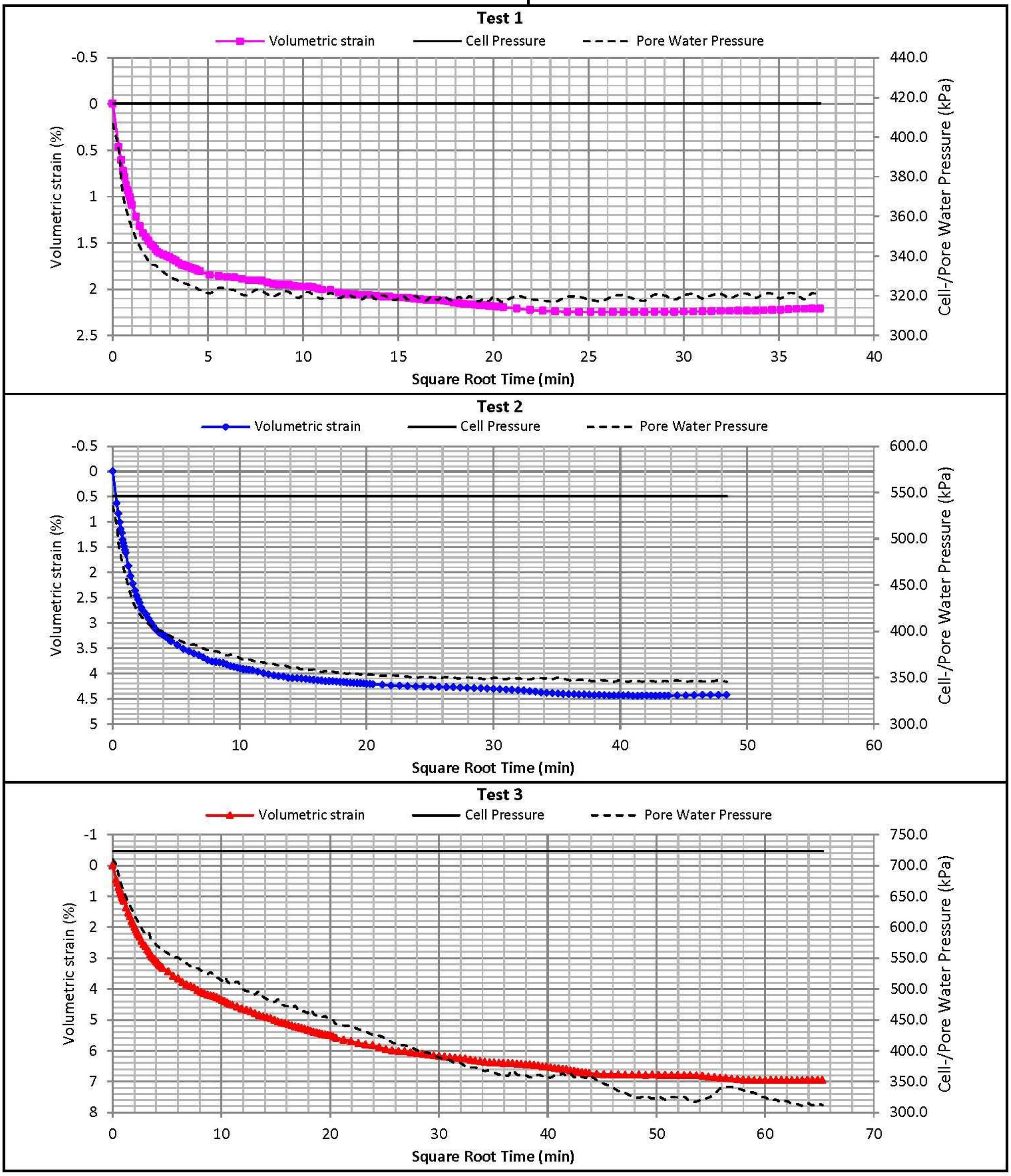
Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	2004-22
Field Sample Reference:	Refer to Remarks	Depth (m):	-

Consolidation vs Square Root Time



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-29
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on a remoulded sample tested saturated. Mixed F5, F8, F10 in equal fractions.

Test No. 1

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 0.96

CONSOLIDATION DATA

Effective cons. Stress (kPa): 101.1 t100 (minutes): 60 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.29	*50.18	1977.66	10.3	1932	0.3281	80	2.566 Determined
CONSOLIDATED	99.36	49.71	1940.91	15.4	1987	0.2911	136	
FINAL (After shear)	94.76	50.90	2035.13	15.4	1987	0.2913	136	

Initial pore pressure (kPa): 339.1 Final pore pressure (kPa): 339.6 PWP dissipation (%): No build-up
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

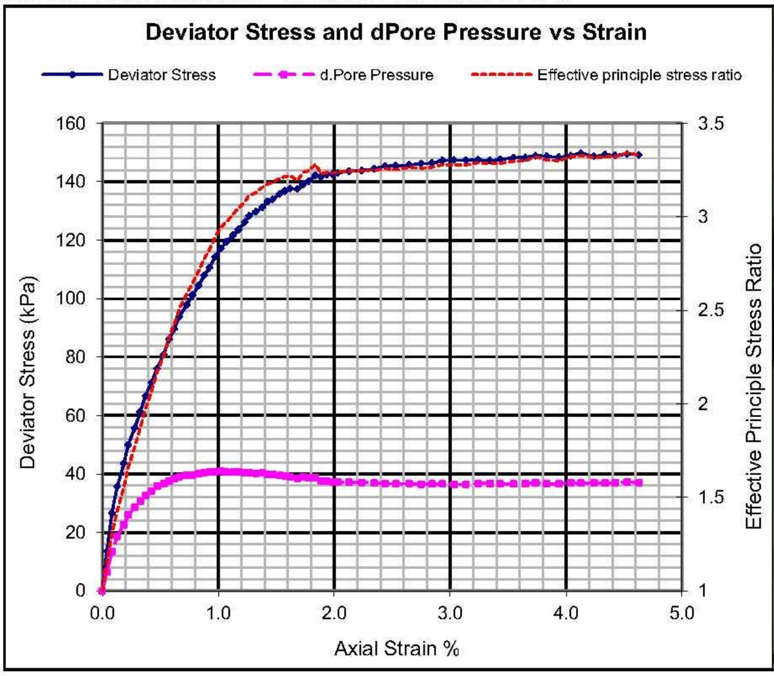
Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 336.9 Initial effective stress (kPa): 101.1

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 4.13

		Principle Stresses (kPa)			
Deviator stress (kPa):	149.7				
Excess pore pressure (kPa):	36.8	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.328	250.8	214.0	101.1	64.3

Deviator stress corrections: Membrane correction: 1.1 kPa



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-29
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested saturated. Mixed F5, F8, F10 in equal fractions.

Test No. 2

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 199.7 t100 (minutes): 60 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*99.65	*49.78	1946.25	10.7	1969	0.3035	90	2.566 Determined
CONSOLIDATED	98.53	49.22	1902.68	14.5	2037	0.2597	143	
FINAL (After shear)	94.16	50.35	1990.97	14.5	2036	0.2600	143	

Initial pore pressure (kPa): 339.6 Final pore pressure (kPa): 340.5 PWP dissipation (%): No build-up
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

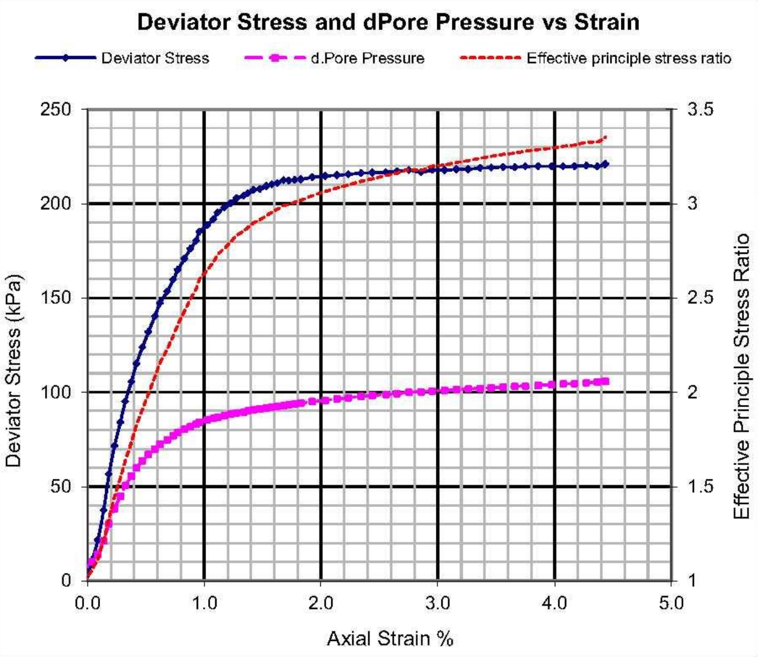
Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 340.3 Initial effective stress (kPa): 199.7

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 4.43

		Principle Stresses (kPa)			
Deviator stress (kPa):	221.0				
Excess pore pressure (kPa):	105.7	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.351	420.7	315.0	199.7	94.0

Deviator stress corrections: Membrane correction: 1.1 kPa



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-29
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on a remoulded sample tested saturated. Mixed F5, F8, F10 in equal fractions.

Test No. 3

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 399.4 t100 (minutes): 120 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.35	*50.17	1976.87	10.3	1931	0.3287	80	2.566 Determined
CONSOLIDATED	98.59	49.28	1907.50	14.0	2038	0.2588	139	
FINAL (After shear)	93.88	50.50	2003.17	14.0	2037	0.2596	139	

Initial pore pressure (kPa): 339.1 Final pore pressure (kPa): 339.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

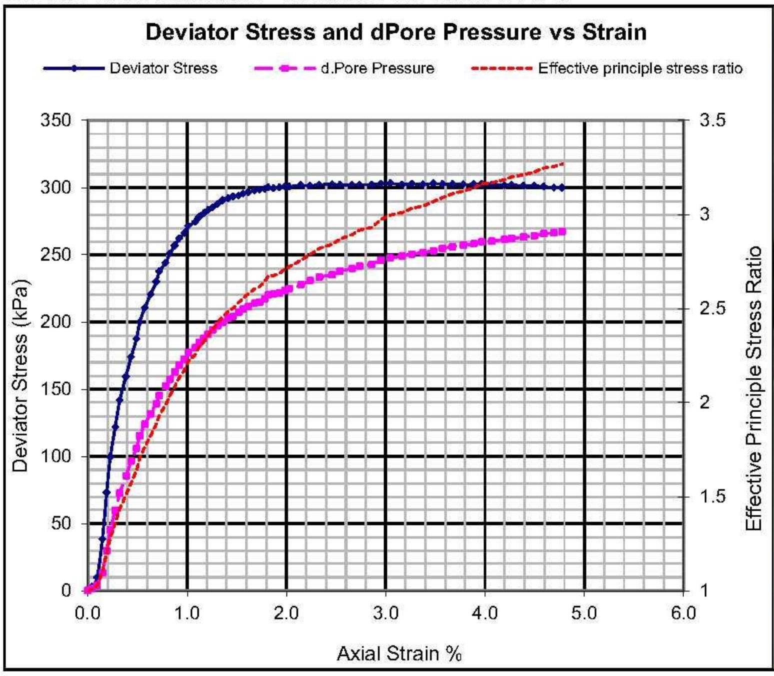
Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 338.6 Initial effective stress (kPa): 399.4

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 3.05

		Principle Stresses (kPa)			
Deviator stress (kPa):	303.0				
Excess pore pressure (kPa):	247.5	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	2.996	702.4	454.9	399.4	151.8

Deviator stress corrections: Membrane correction: 1.1 kPa



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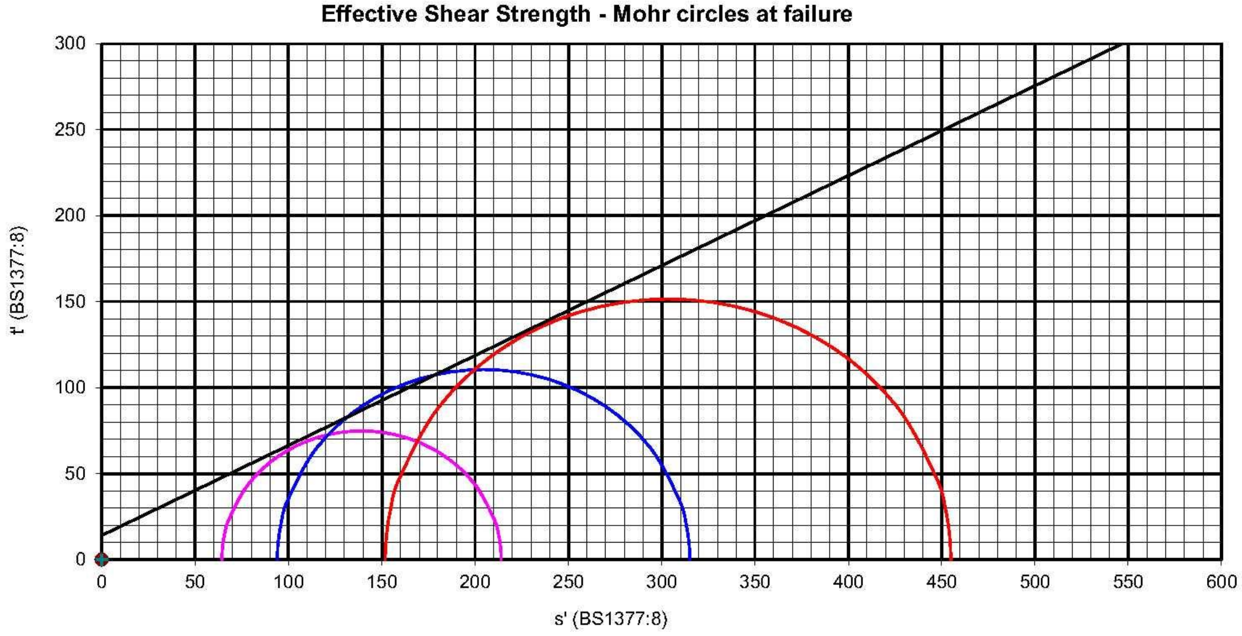
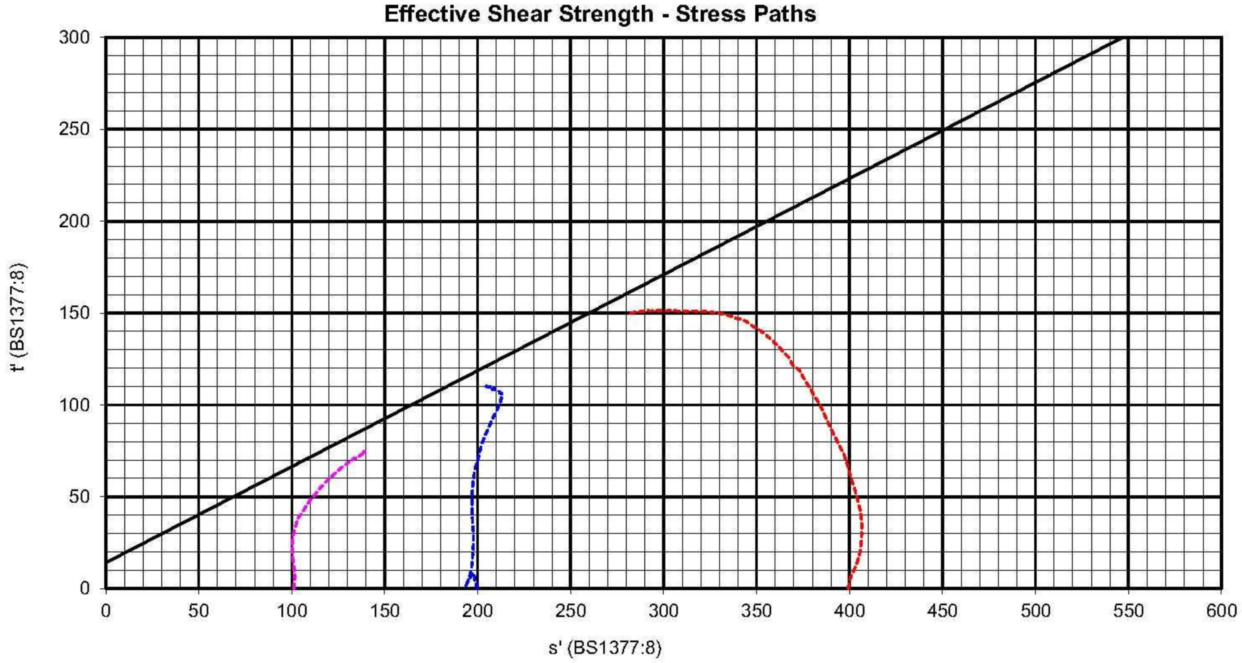
Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-29
Field Sample Reference:	Refer to Remarks	Depth (m):	-

Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	43.9	11.6
Effective	14.1	27.6





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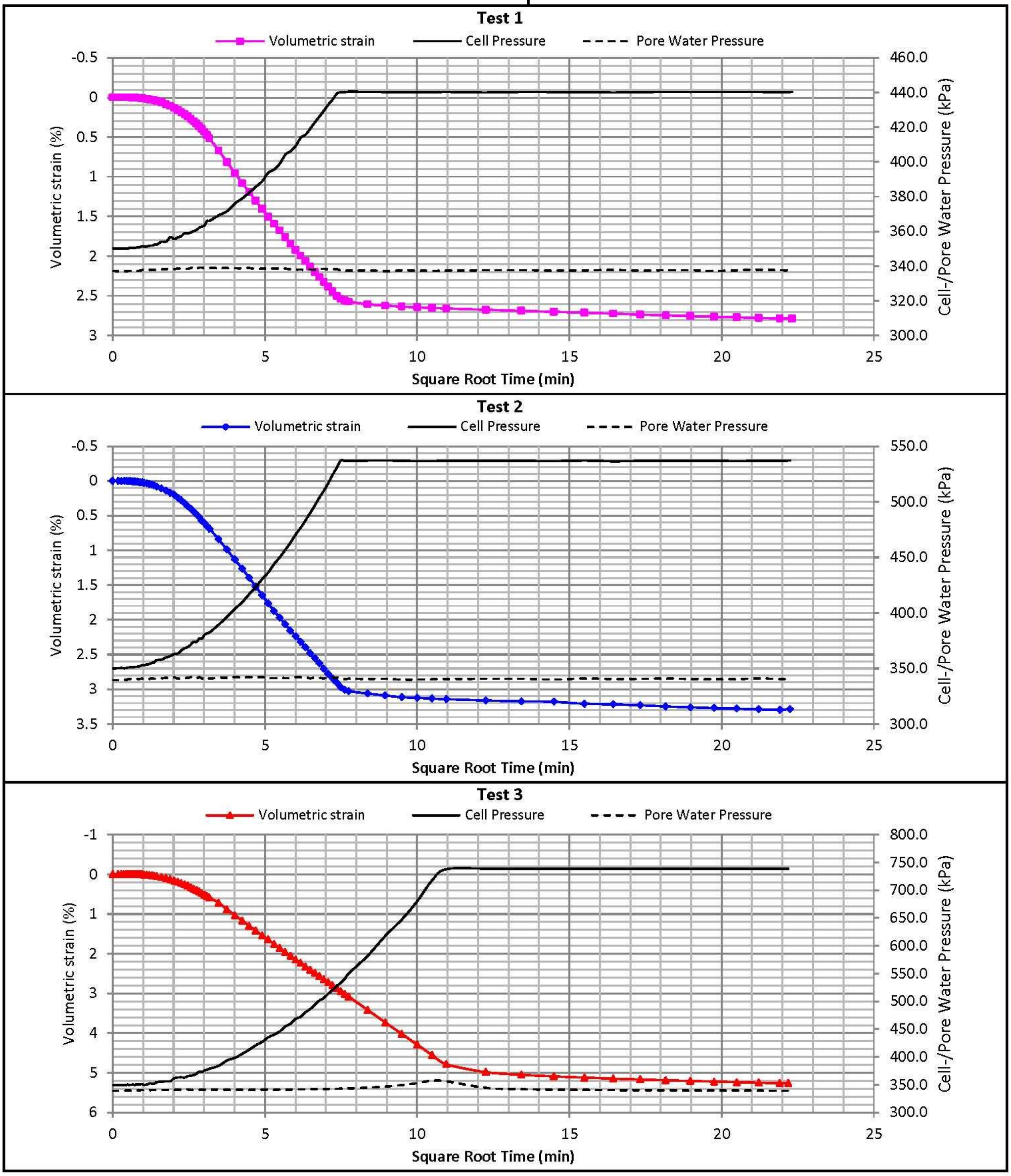
Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-29
Field Sample Reference:	Refer to Remarks	Depth (m):	-

Consolidation vs Square Root Time



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-39
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on a remoulded sample tested saturated. Mixed F25, F29, F34, F37 and F39 in equal fractions.

Test No. 1

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100…	Differential pressure (kPa):	10.0
Final cell pressure (kPa): 383.0	Final back pressure (kPa): 373.0	Final B parameter: 0.96	

CONSOLIDATION DATA

Effective cons. Stress (kPa): 96.9 t100 (minutes): 64 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.3	*50.06	1968.21	11.4	1946	0.3964	78	2.717 Determined
CONSOLIDATED	99.66	49.74	1942.95	14.1	1984	0.3695	104	
FINAL (After shear)	90.65	52.15	2135.91	14.1	1984	0.3697	104	

Initial pore pressure (kPa): 464.2 Final pore pressure (kPa): 368.0 PWP dissipation (%): 100

*: Measured dimensions; all other dimensions are calculated.

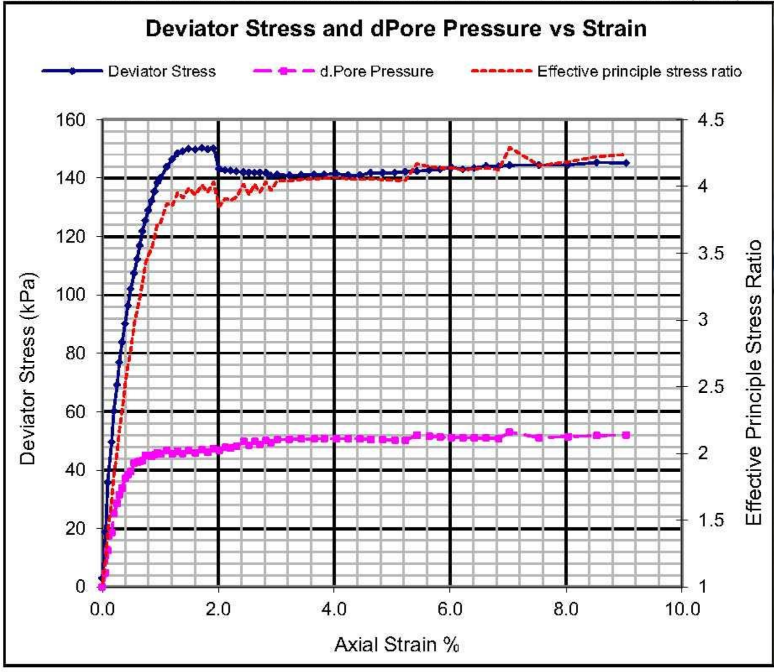
SHEAR DATA

Rate of strain (%/hour): 0.50
Initial pore pressure (kPa): 371.1 Initial effective stress (kPa): 96.9

Parameters at failure:

Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	1.72				
Deviator stress (kPa):	150.3	Principle Stresses (kPa)			
Excess pore pressure (kPa):	46.9	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	4.009	247.2	200.2	96.9	49.9

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-39
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on a remoulded sample tested saturated. Mixed F25, F29, F34, F37 and F39 in equal fractions.

SATURATION DATA

Test No. 2

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 343.0 Final back pressure (kPa): 333.0 Final B parameter: 0.96

CONSOLIDATION DATA

Effective cons. Stress (kPa): 198.1 t100 (minutes): 25 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.62	*50.01	1964.28	11.4	1943	0.3984	78	2.717 Determined
CONSOLIDATED	99.46	49.43	1918.84	13.7	2013	0.3499	107	
FINAL (After shear)	95.29	50.50	2002.72	13.7	2012	0.3503	106	

Initial pore pressure (kPa): 527.1 Final pore pressure (kPa): 339.5 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

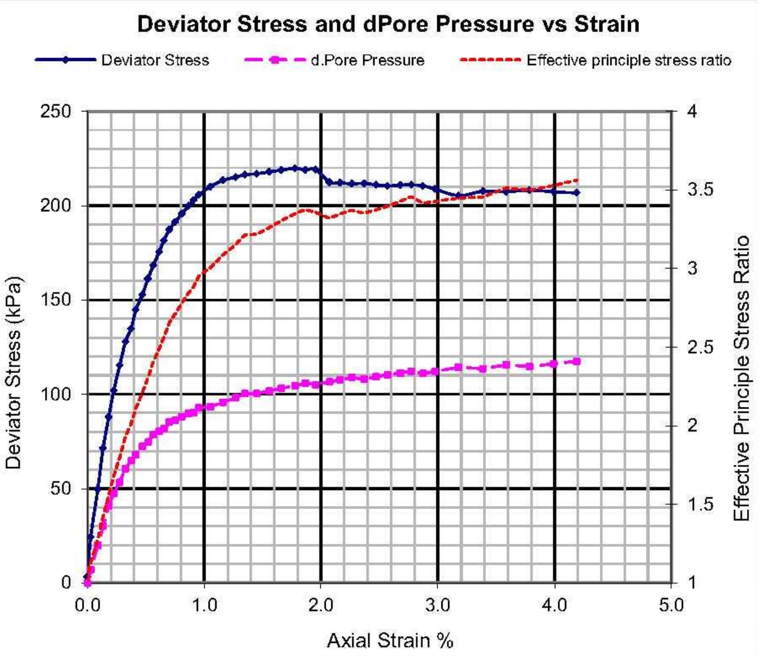
Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 340.9 Initial effective stress (kPa): 198.1

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 1.78

		Principle Stresses (kPa)			
Deviator stress (kPa):	219.7				
Excess pore pressure (kPa):	104.5	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.349	417.8	313.3	198.1	93.5

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-39
Field Sample Number:	Refer to Remarks	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on a remoulded sample tested saturated. Mixed F25, F29, F34, F37 and F39 in equal fractions.

Test No. 3

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100... Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 399.3 t100 (minutes): 120 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*99.8	*50.06	1968.21	11.7	1952	0.3920	81	2.717 Determined
CONSOLIDATED	98.33	49.32	1910.31	14.7	2042	0.3306	121	
FINAL (After shear)	91.60	51.10	2050.74	14.7	2041	0.3312	121	

Initial pore pressure (kPa): 339.5 Final pore pressure (kPa): 336.9 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

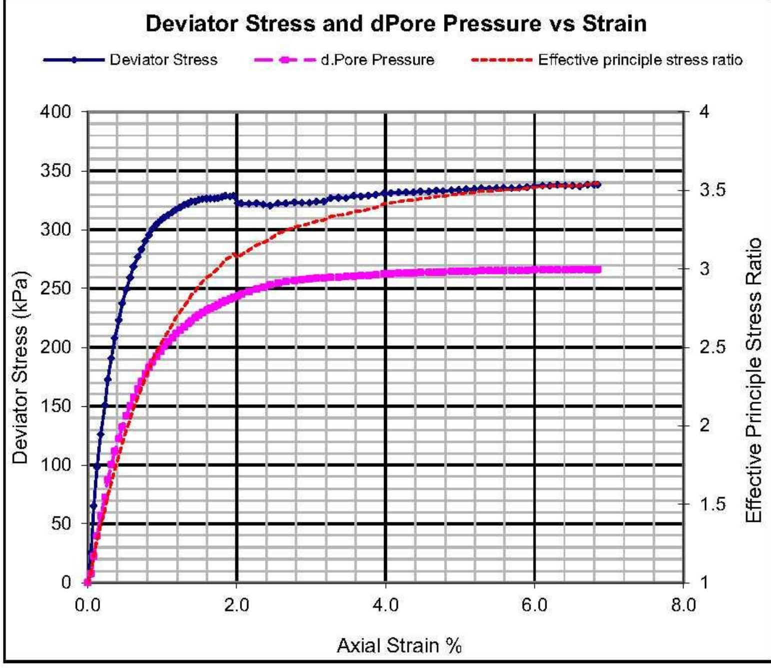
Rate of strain (%/hour): 0.28
Initial pore pressure (kPa): 335.7 Initial effective stress (kPa): 399.3

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 6.80

		Principle Stresses (kPa)			
Deviator stress (kPa):	338.2				
Excess pore pressure (kPa):	266.3	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.544	737.5	471.2	399.3	132.9

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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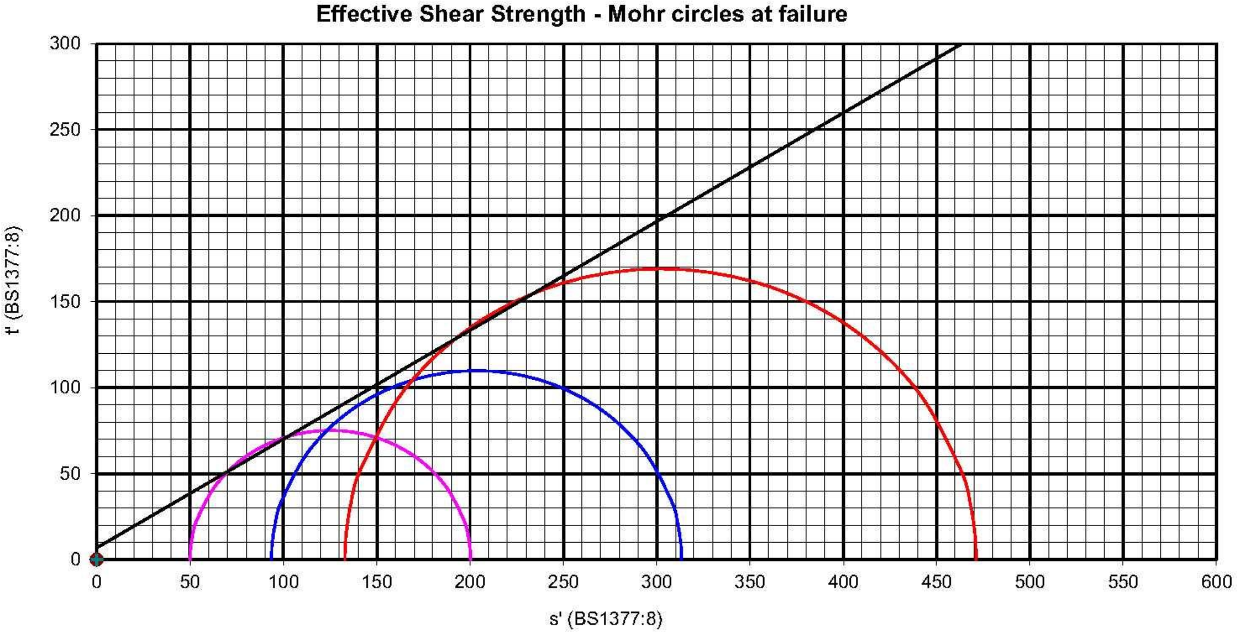
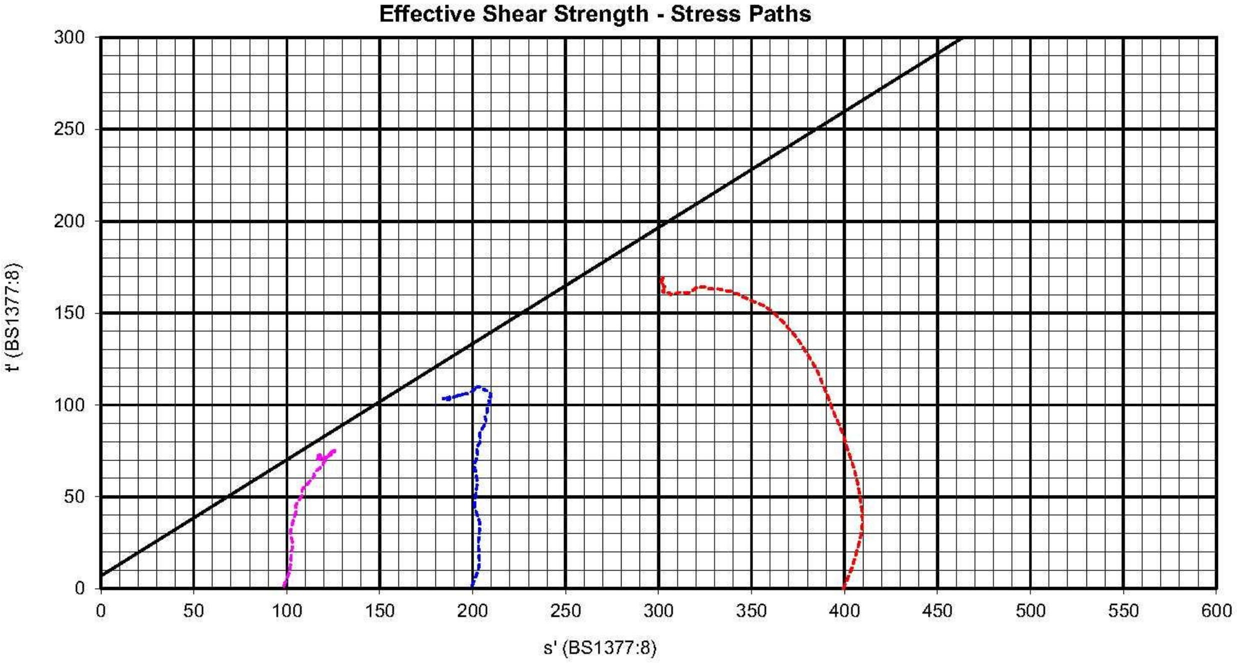
Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-39
Field Sample Reference:	Refer to Remarks	Depth (m):	-

Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	36.7	13.6
Effective	6.9	32.3

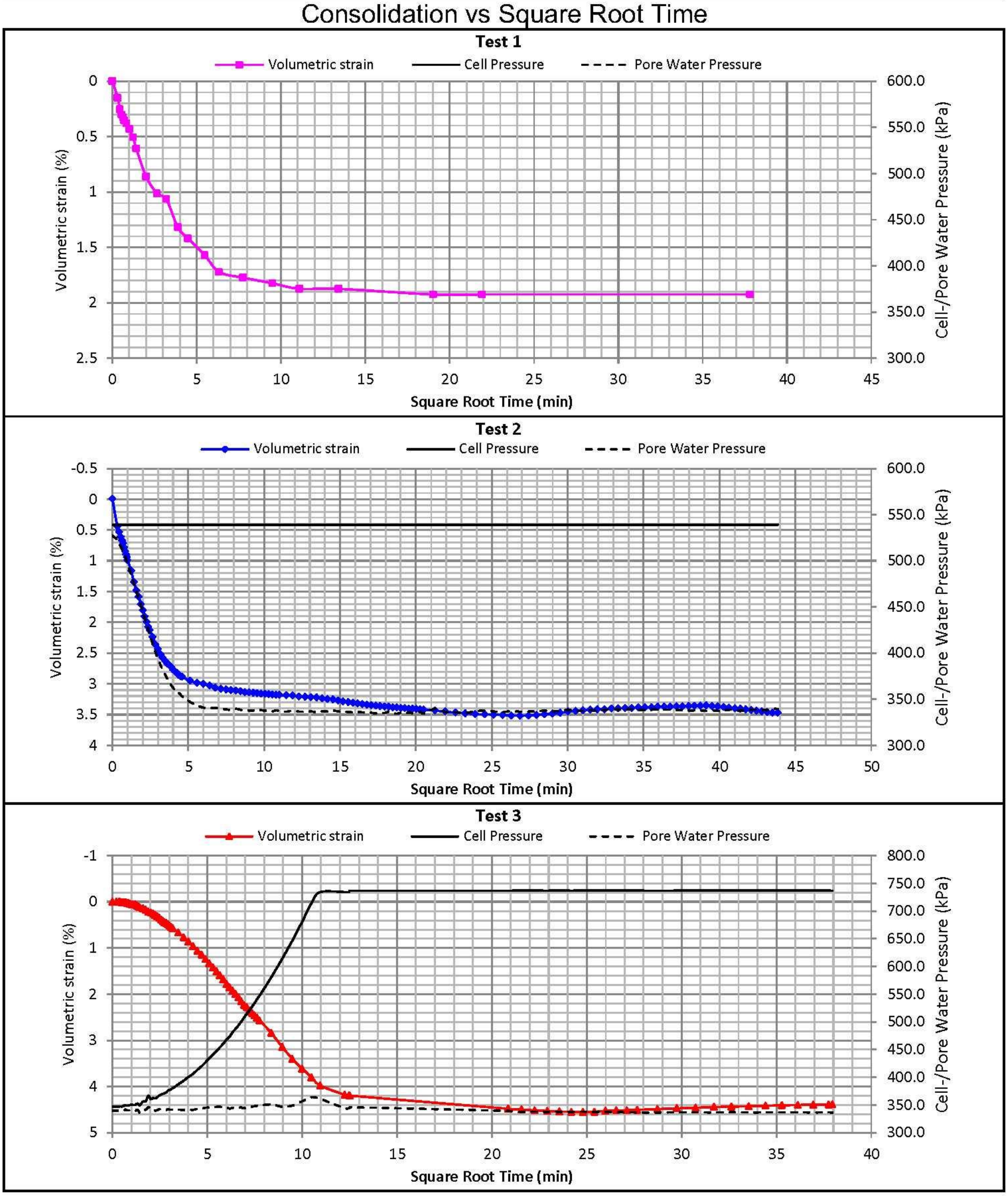




Triaxial Compression Test Results

Project:	Mzinvubu Water Project	Date Received:	2013/08/23
Job Number:	2013-B-2004	Laboratory Number:	B-2004-39
Field Sample Reference:	Refer to Remarks	Depth (m):	-

Consolidation vs Square Root Time



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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-2
Field Sample Number:	RF 1	Depth (m):	1.0 - 1.3

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 1

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 1.00

CONSOLIDATION DATA

Effective cons. Stress (kPa): 98.1 t100 (minutes): 1 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100	*50	1963.50	25.5	1433	0.8420	80	2.639 Determined
CONSOLIDATED	99.53	49.77	1945.11	30.7	1453	0.8162	99	
FINAL (After shear)	90.55	52.17	2137.95	30.7	1453	0.8162	99	

Initial pore pressure (kPa): 435.5 Final pore pressure (kPa): 347.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

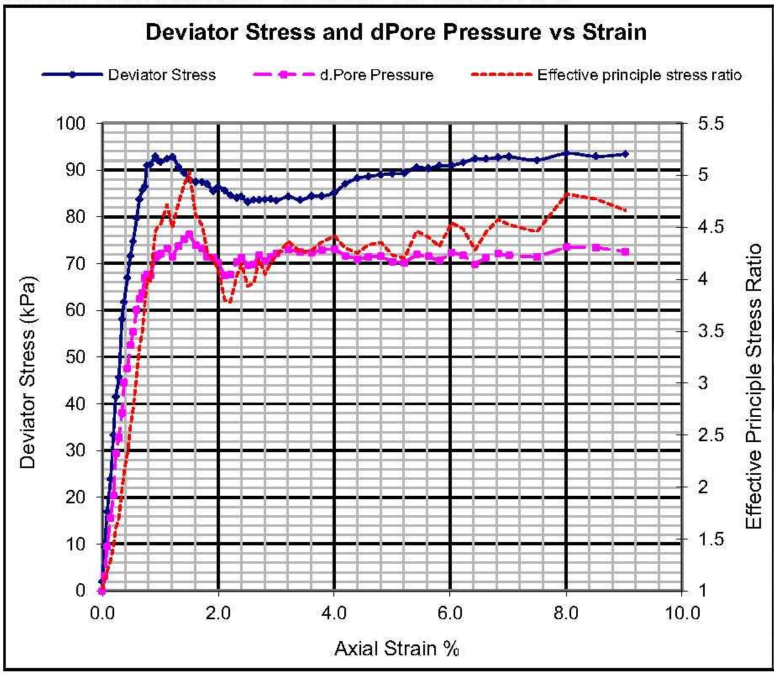
Rate of strain (%/hour): 0.40
Initial pore pressure (kPa): 348.9 Initial effective stress (kPa): 98.1

Parameters at failure:

Failure Criterion: Max. Effective Principle Stress Ratio

		Principle Stresses (kPa)			
Axial strain (%):	1.51				
Deviator stress (kPa):	88.0				
Excess pore pressure (kPa):	76.2	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	5.028	186.1	109.9	98.1	21.9

Deviator stress corrections: Membrane correction: 1.1 kPa



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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-2
Field Sample Number:	RF 1	Depth (m):	1.0 - 1.3

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 2

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 0.99

CONSOLIDATION DATA

Effective cons. Stress (kPa): 198.3 t100 (minutes): 1 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*99.84	*50.07	1969.00	21.4	1561	0.6910	82	2.639 Determined
CONSOLIDATED	98.91	49.60	1932.32	24.5	1606	0.6437	100	
FINAL (After shear)	84.89	53.54	2251.42	24.5	1605	0.6440	100	

Initial pore pressure (kPa): 535.7 Final pore pressure (kPa): 349.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

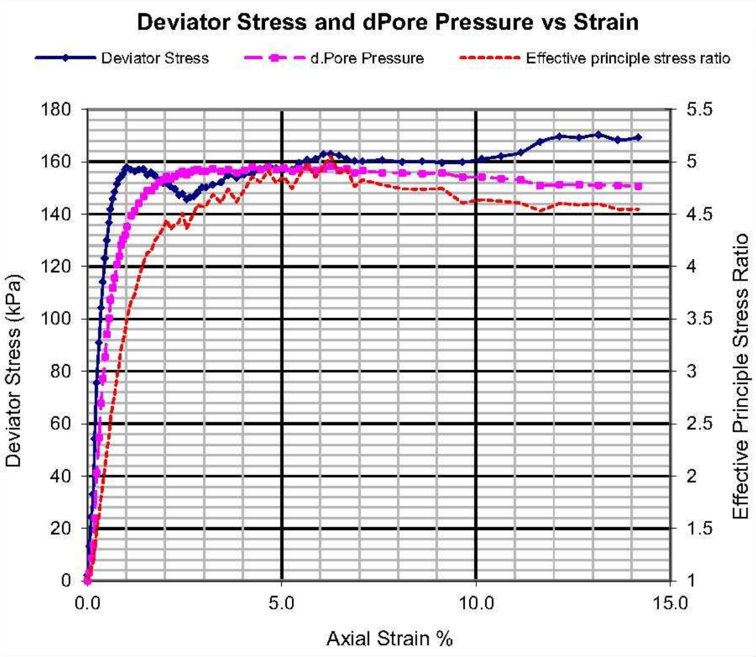
Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 350.7 Initial effective stress (kPa): 198.3

Parameters at failure:

Failure Criterion: Max. Effective Principle Stress Ratio
Axial strain (%): 6.26

		Principle Stresses (kPa)			
Deviator stress (kPa):	162.9	σ1	σ1'	σ3	σ3'
Excess pore pressure (kPa):	158.1				
Effective principle stress ratio:	5.051	361.2	203.1	198.3	40.2

Deviator stress corrections: Membrane correction: 1.1 kPa



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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-2
Field Sample Number:	RF 1	Depth (m):	1.0 - 1.3

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 3

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 398.4 t100 (minutes): 4 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*99.73	*50.14	1974.51	23.3	1422	0.8553	72	2.639 Determined
CONSOLIDATED	97.84	49.18	1899.84	26.1	1508	0.7501	92	
FINAL (After shear)	90.83	51.05	2046.52	26.1	1507	0.7514	92	

Initial pore pressure (kPa): 735.6 Final pore pressure (kPa): 355.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

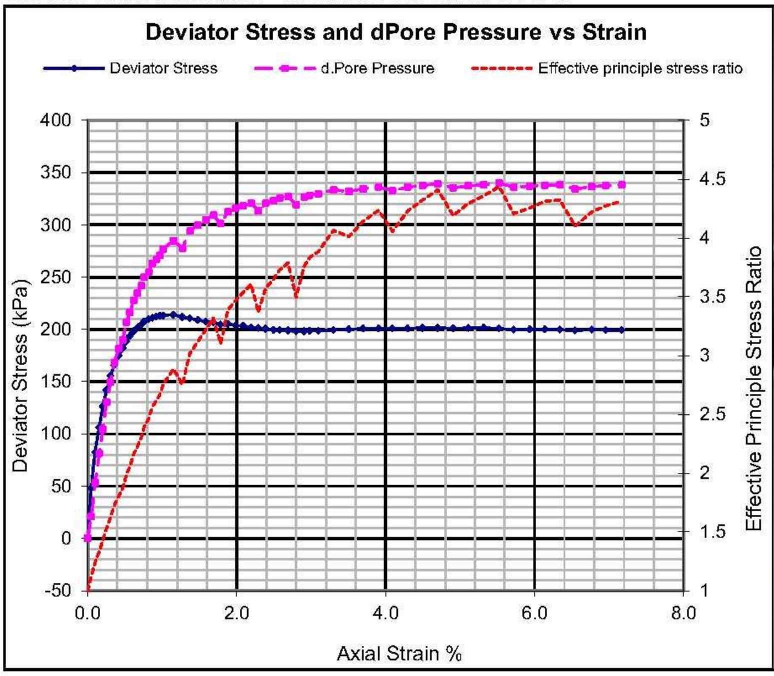
SHEAR DATA

Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 356.6 Initial effective stress (kPa): 398.4

Parameters at failure:

Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	1.15				
Deviator stress (kPa):	213.8	Principle Stresses (kPa)			
Excess pore pressure (kPa):	284.9	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	2.885	612.2	327.3	398.4	113.5

Deviator stress corrections: Membrane correction: 1.1 kPa



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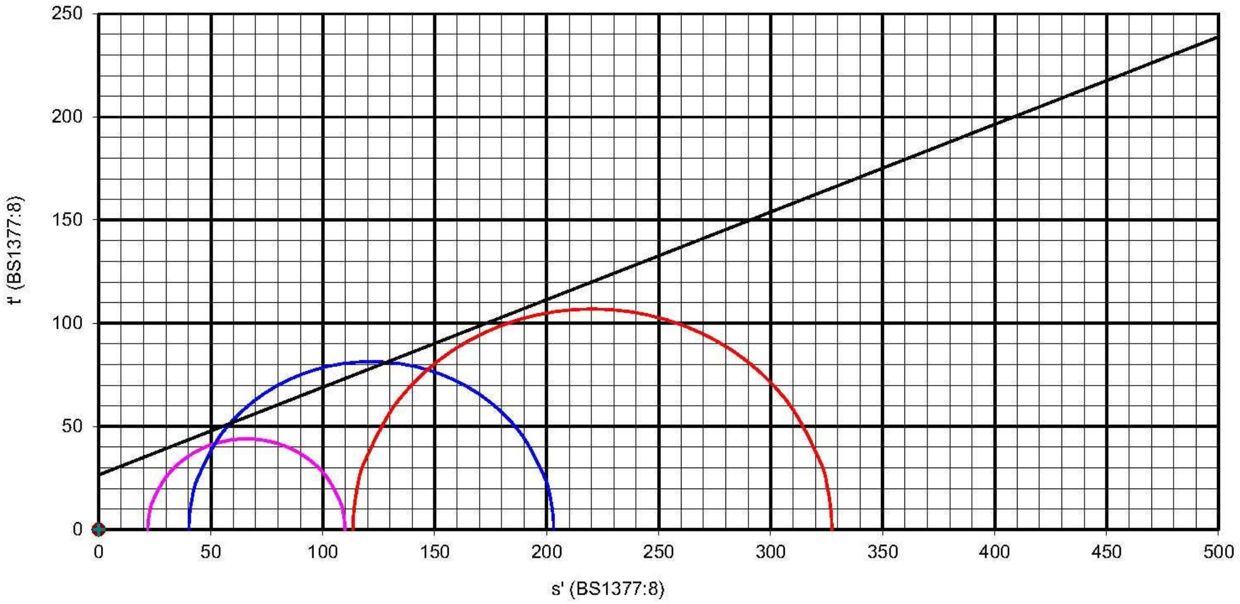
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-2
Field Sample Reference:	RF 1	Depth (m):	1.0 - 1.3

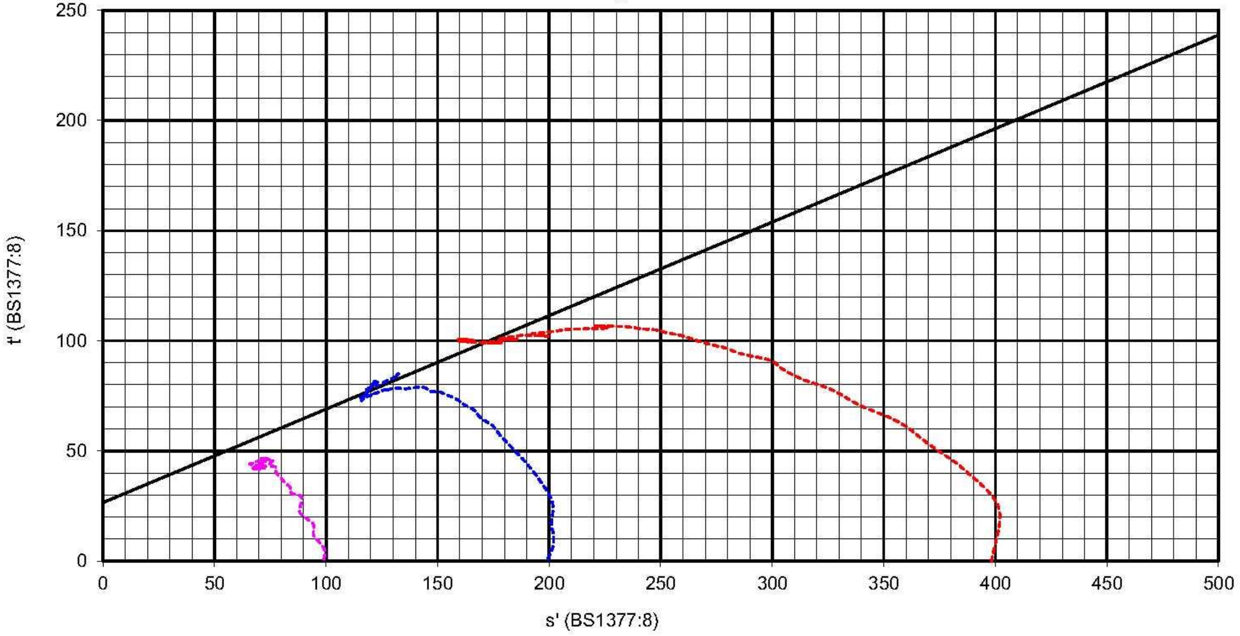
Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	26.1	9.6
Effective	26.5	23.0

Effective Shear Strength - Mohr circles at failure



Effective Shear Strength - Stress Paths



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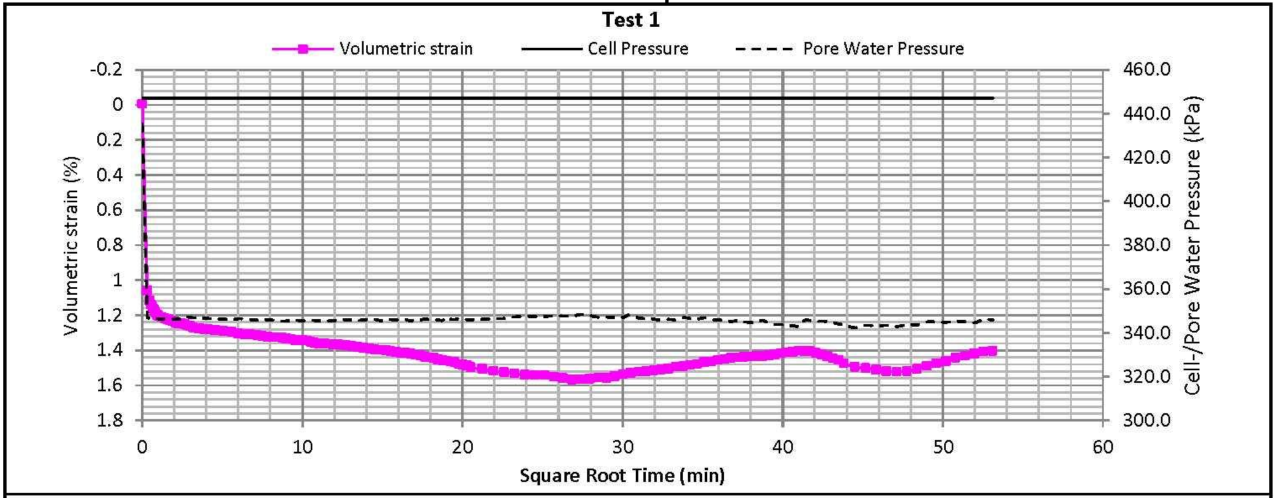
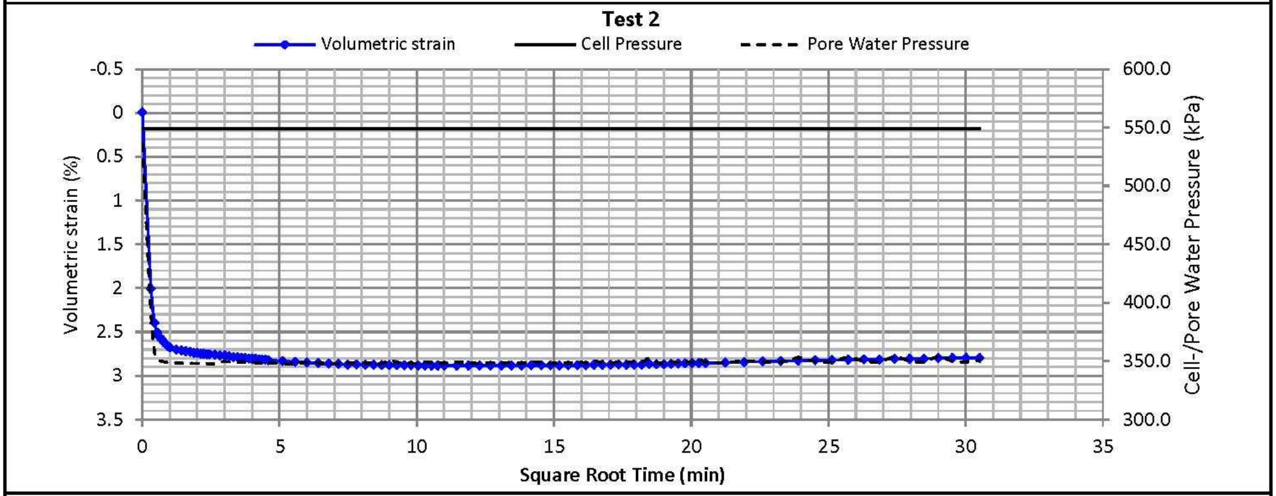
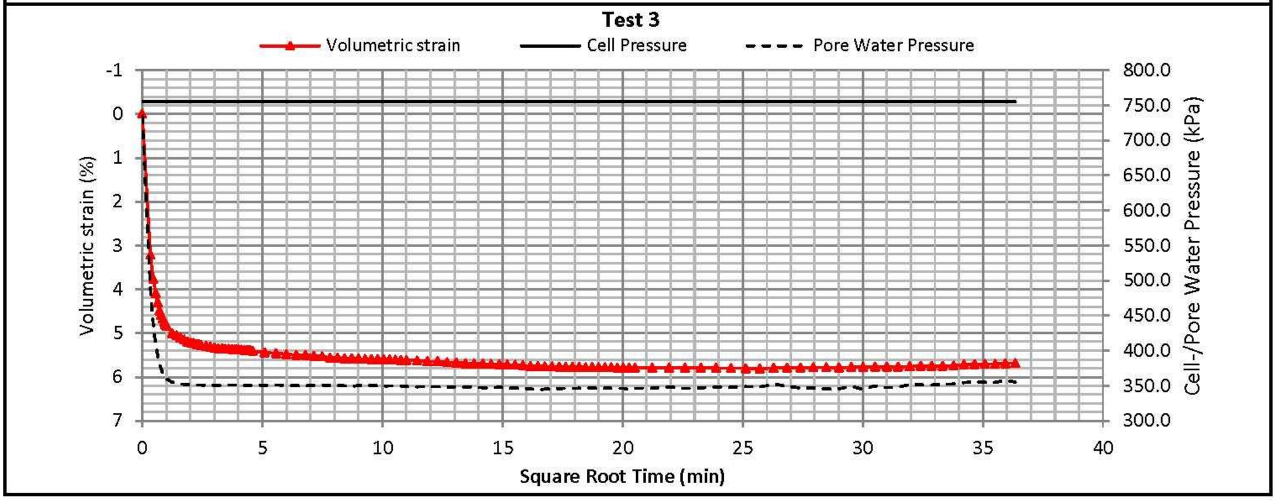
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-2
Field Sample Reference:	RF 1	Depth (m):	1.0 - 1.3

Consolidation vs Square Root Time







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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-3
Field Sample Number:	LF 1 Top	Depth (m):	1.0 - 1.2

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 1

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 100.3 t100 (minutes): 4 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*99.62	*49.99	1962.71	38.9	1118	1.2165	79	2.477 Determined
CONSOLIDATED	99.23	49.79	1947.26	52.7	1131	1.1904	110	
FINAL (After shear)	92.41	51.60	2090.83	52.7	1131	1.1904	110	

Initial pore pressure (kPa): 432.4 Final pore pressure (kPa): 346.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

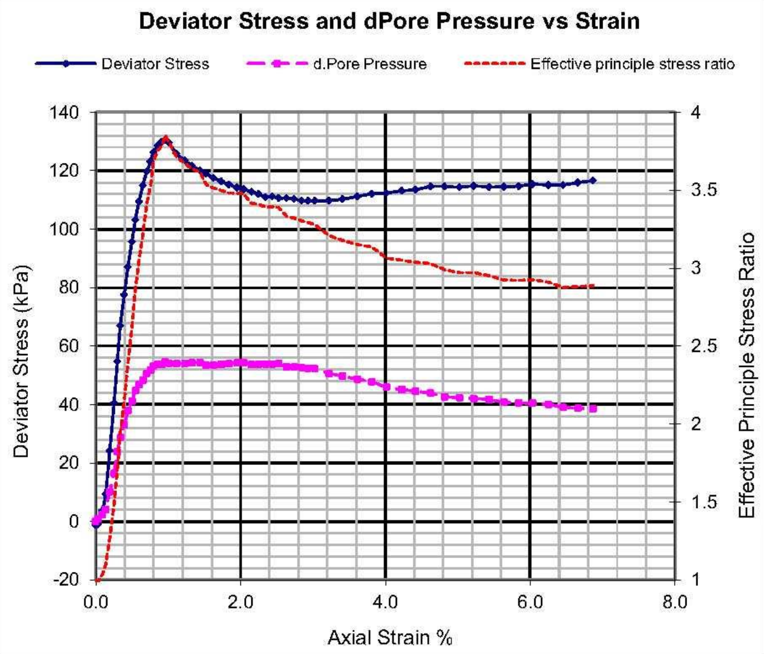
Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 345.7 Initial effective stress (kPa): 100.3

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 0.96

		Principle Stresses (kPa)			
Deviator stress (kPa):	130.4				
Excess pore pressure (kPa):	54.6	$\sigma1$	$\sigma1'$	$\sigma3$	$\sigma3'$
Effective principle stress ratio:	3.851	230.8	176.2	100.3	45.8

Deviator stress corrections: Membrane correction: 1.1 kPa



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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-3
Field Sample Number:	LF 1 Top	Depth (m):	1.0 - 1.2

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 2

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 1.00

CONSOLIDATION DATA

Effective cons. Stress (kPa): 198.1 t100 (minutes): 4 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*99.74	*49.71	1940.78	38.7	1121	1.2096	79	2.477 Determined
CONSOLIDATED	98.42	49.05	1889.27	50.5	1168	1.1216	111	
FINAL (After shear)	91.41	50.89	2033.96	50.5	1167	1.1224	111	

Initial pore pressure (kPa): 533.9 Final pore pressure (kPa): 347.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

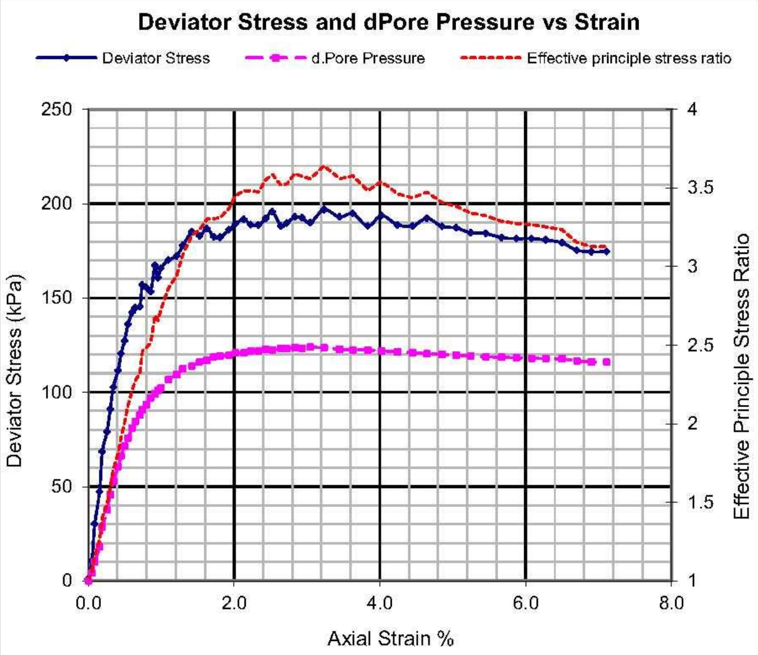
Rate of strain (%/hour): 0.50
Initial pore pressure (kPa): 347.9 Initial effective stress (kPa): 198.1

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 3.23

		Principle Stresses (kPa)			
Deviator stress (kPa):	196.7				
Excess pore pressure (kPa):	123.6	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.641	394.8	271.2	198.1	74.5

Deviator stress corrections: Membrane correction: 1.1 kPa



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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-3
Field Sample Number:	LF 1 Top	Depth (m):	1.0 - 1.2

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 3

SATURATION DATA

Saturation method: Alternating increments of cell- & back pressure
Pressure increments applied (kPa): 50,70,100,100,100… Differential pressure (kPa): 10.0
Final cell pressure (kPa): 353.0 Final back pressure (kPa): 343.0 Final B parameter: 0.96

CONSOLIDATION DATA

Effective cons. Stress (kPa): 398.6 t100 (minutes): 16 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*99.58	*50.14	1974.51	34.7	1136	1.1801	73	2.477 Determined
CONSOLIDATED	98.14	49.41	1917.55	47.1	1188	1.0858	107	
FINAL (After shear)	89.45	51.76	2103.89	47.1	1187	1.0867	107	

Initial pore pressure (kPa): 730.1 Final pore pressure (kPa): 349.5 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

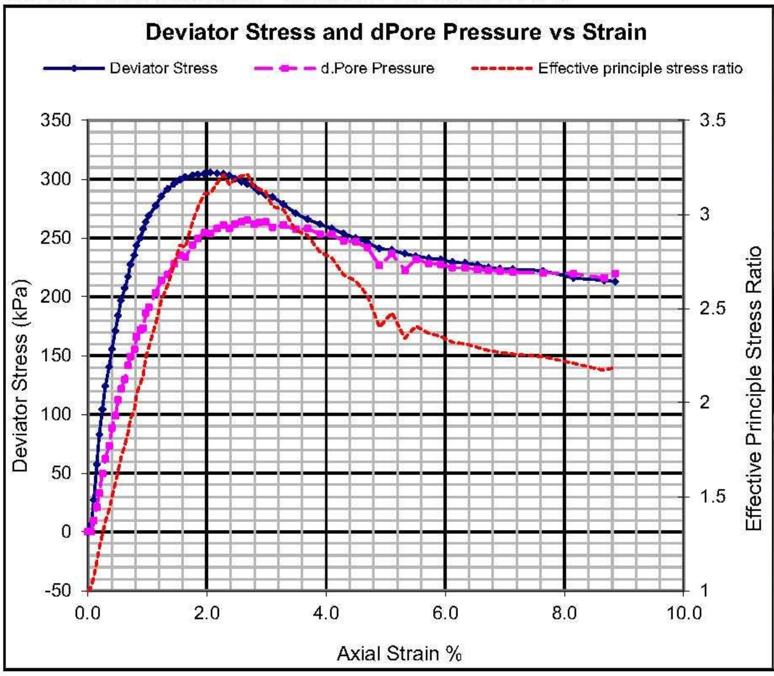
Rate of strain (%/hour): 0.35
Initial pore pressure (kPa): 349.4 Initial effective stress (kPa): 398.6

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 2.06

		Principle Stresses (kPa)			
Deviator stress (kPa):	305.6				
Excess pore pressure (kPa):	253.9	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.111	704.2	450.3	398.6	144.8

Deviator stress corrections: Membrane correction: 1.1 kPa



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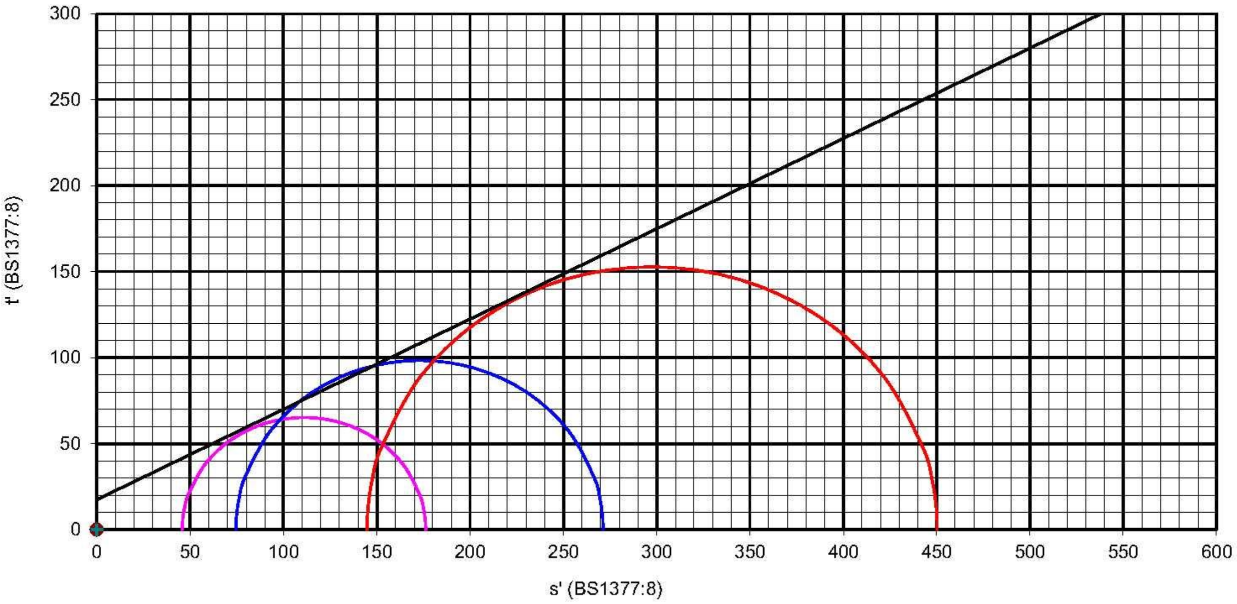
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-3
Field Sample Reference:	LF 1 Top	Depth (m):	1.0 - 1.2

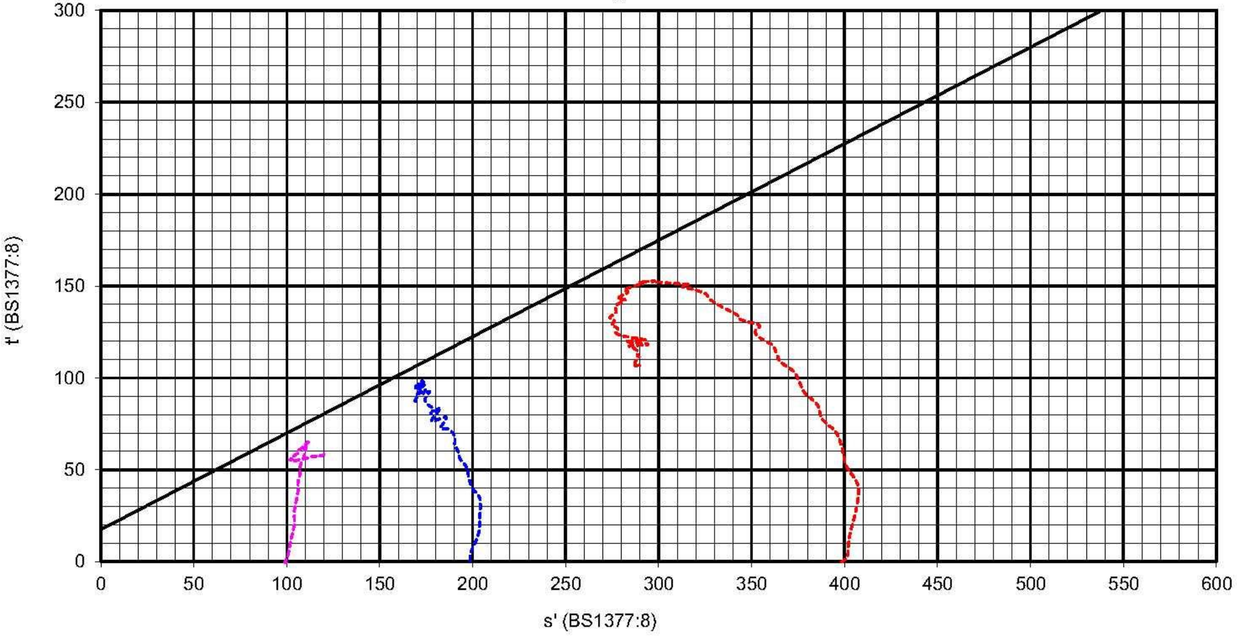
Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	30.2	13.0
Effective	17.4	27.7

Effective Shear Strength - Mohr circles at failure



Effective Shear Strength - Stress Paths



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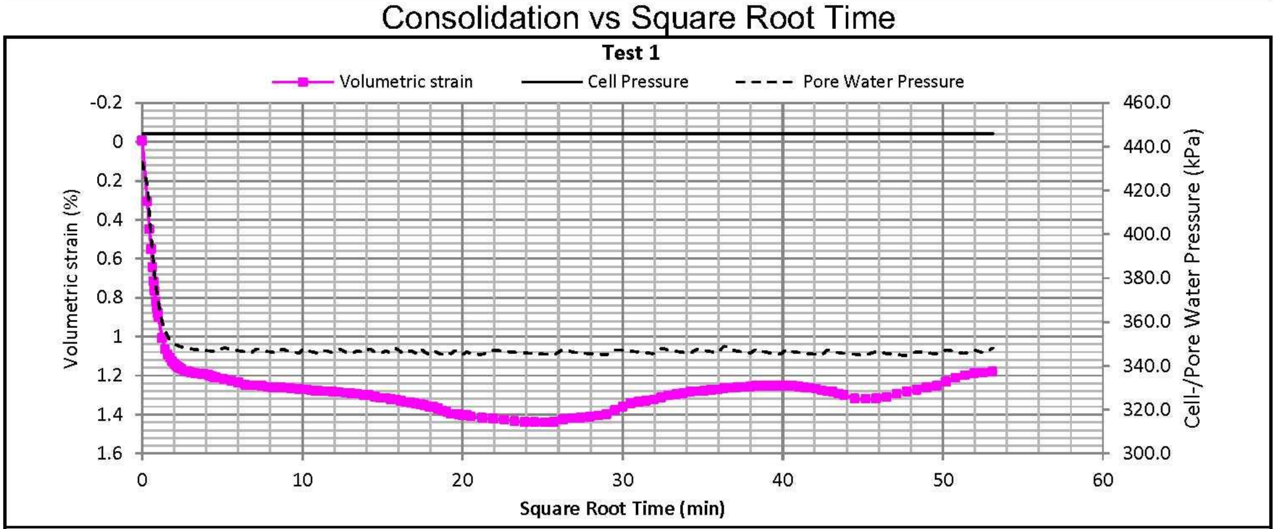
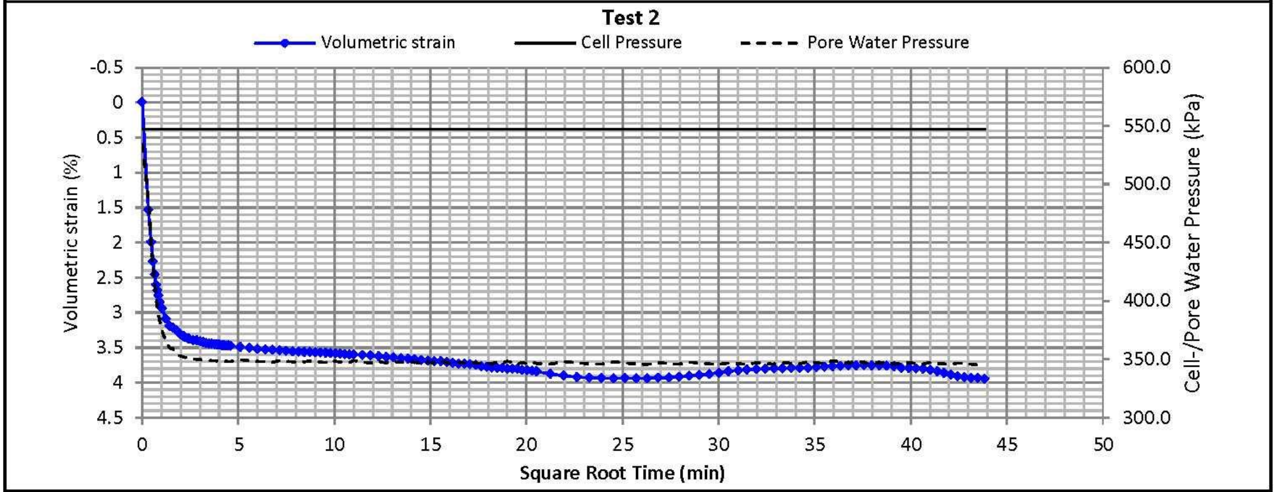
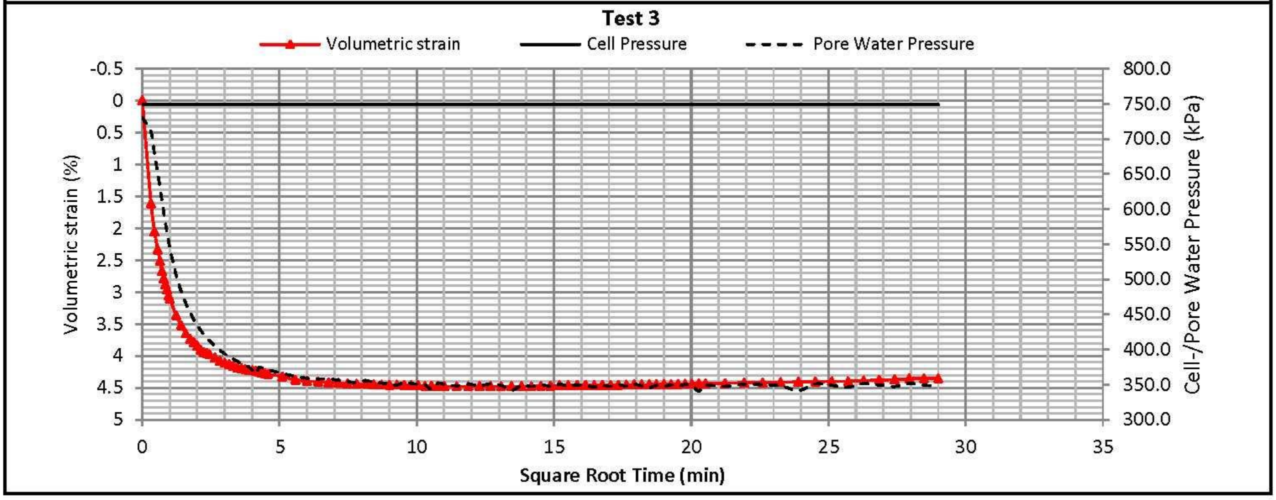
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2013/10/07
Job Number:	2013-B-2246	Laboratory Number:	B-2246-3
Field Sample Reference:	LF 1 Top	Depth (m):	1.0 - 1.2

Consolidation vs Square Root Time







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CONSOLIDATION

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Falling Head Permeability Test Results

Project:	MZIMVUBU WATER PROJECT		
Project No:	2013-B-2246	Date:	28/11/2013

Lab. Sample Reference	Field Sample Reference	Depth (m)	Moisture Contents		Dry density Kg/m^3		Coefficient of Permeability (m/s)		
							Range		Average
			Before Test (%)	After Test (%)	Initial	As tested	Minimum	Maximum	
2246-2	RF 1	1.0 - 1.3	19.3	22.4	1548	1594	1.9E-08	2.7E-08	**2.3E-08**
2246-3	LF 1 TOP	1.0 - 1.2	36.3	53.4	1016	1056	1.0E-08	2.0E-08	**1.4E-08**

Remarks: Undisturbed samples.
Saturated and tested under a load of 100kPa.
Densities reported are under a load of 100kPa.

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Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		Test 1
Project No.:	2013-B-2246	Sample No.:	2246-3A
Borehole No:	LF 1 TOP	Depth:	1.0 - 1.2
Date Received:	07/10/2013	Date Tested:	02/12/2013
Remarks:	An undisturbed sample tested soaked.		

Machine No.	5	Ring No.	16	Height (mm)	19.95	Diameter (mm)	75.95

Masses for Water Content Determination (g)

Wet Sample and Ring		Dry Sample and Ring	Ring Only	Water Content	
Before Test	After Test			Before Test	After Test
244.6	253.6	206.7	106.78	37.9%	46.9%

Pre-Determined Particle Specific Gravity	2.477

Initial Parameters

Void Ratio	1.2406	Degree of Saturation (%)	75.7	Dry Density (Kg/m3)	1106

Effect. Stress (kPa)		10	50	100	200	400	800	1600	400	100	10	0
Dial Correction (u)		0	37	68	101	170	220	321	196	112	45	0
HH:MM:SS	√Minutes					Dial Readings in Microns					Initial Dial Reading	13504
00:00:00	0.00	13504		13388		13123		11934				
00:00:06	0.32			13384		12914		11370				
00:00:12	0.45			13383		12902		11340				
00:00:18	0.55			13381		12893		11316				
00:00:24	0.63			13381		12888		11296				
00:00:30	0.71			13380		12886		11278				
00:00:42	0.84			13378		12880		11252				
00:01:00	1.00			13377		12873		11218				
00:01:30	1.22			13375		12866		11178				
00:02:00	1.41			13373		12861		11148				
00:04:00	2.00			13369		12850		11071				
00:07:00	2.65			13367		12838		10992				
00:10:00	3.16			13364		12834		10974				
00:15:00	3.87			13362		12824		10946				
00:20:00	4.47			13361		12820		10920				
00:30:00	5.48			13359		12819		10895				
00:40:00	6.32			13357		12814		10868				
01:00:00	7.75			13353		12807						
01:30:00	9.49			13350		12800		10837				
02:00:00	10.95			13349		12794		10824	11031	11374		
03:00:00	13.42			13345		12784		10807			11790	
04:00:00	15.49			13342		12778		10790				
06:00:00	18.97			13336		12769		10780				
08:00:00	21.91	13619				12764		10770				
16:00:00	30.98		13471									
24:00:00	37.95				13123	12755	11934	10745				
72:00:00	65.73			13328								
End of Primary Cons		13619	13471	13328	13123	12755	11934	10745	11031	11374	11790	
Number of Readings:		2	1	24	1	25	1	24	1	1	1	0

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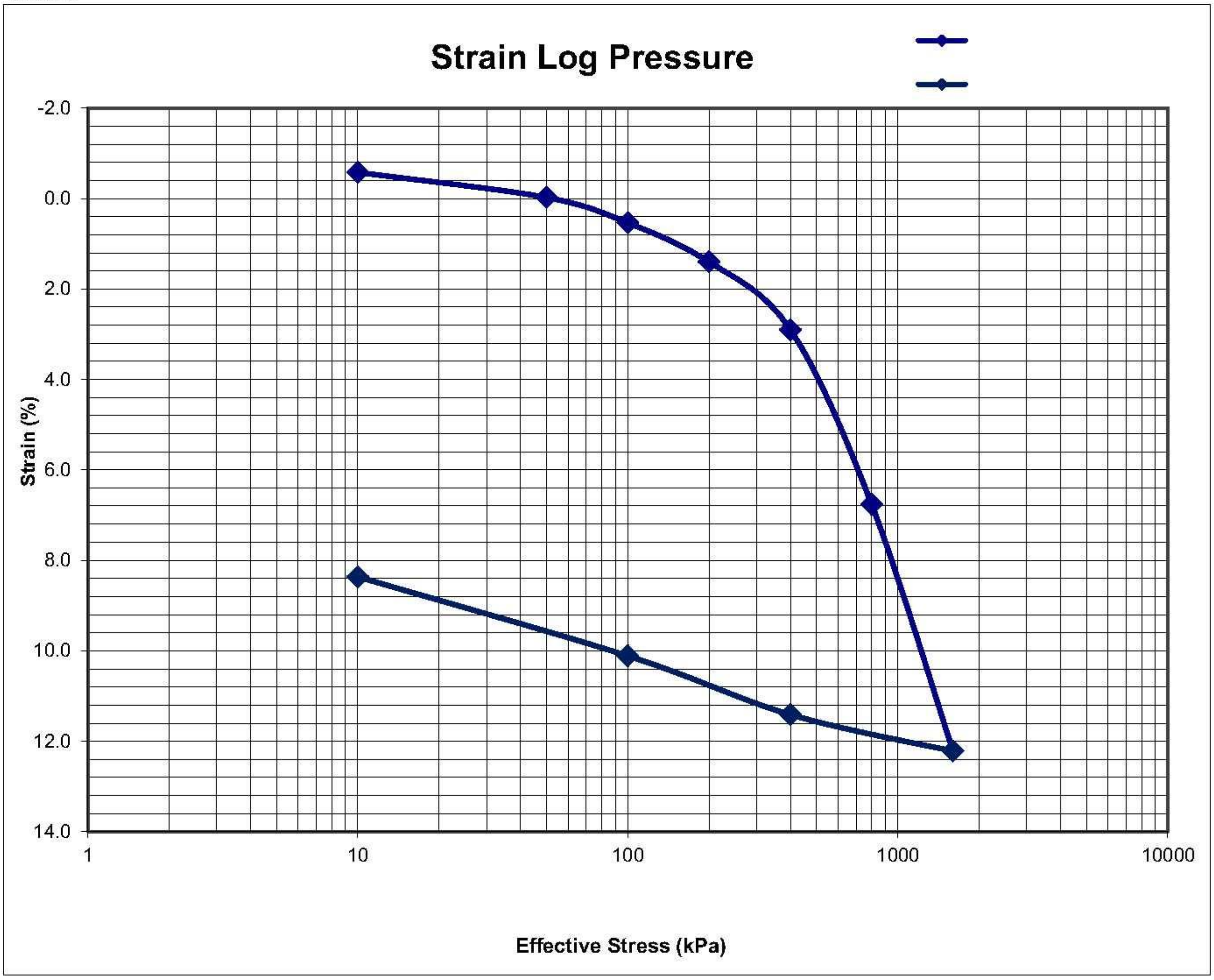
Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2246	Sample No.:	2246-3A
Borehole No:	LF 1 TOP	Depth:	1.0 - 1.2
Date Received:	07/10/2013	Date Tested:	02/12/2013

Test 1

Effect.Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.58	-0.02	0.54	1.40	2.90	6.77	12.22	11.41	10.12	8.37	
Mv (1/MPa)		0.1391	0.1123	0.0862	0.0749	0.0966	0.0682	0.0067	0.0433	0.1944	
Void Ratio	1.2535	1.241	1.2285	1.2091	1.1756	1.089	0.9668	0.9849	1.0139	1.0531	

Test 2



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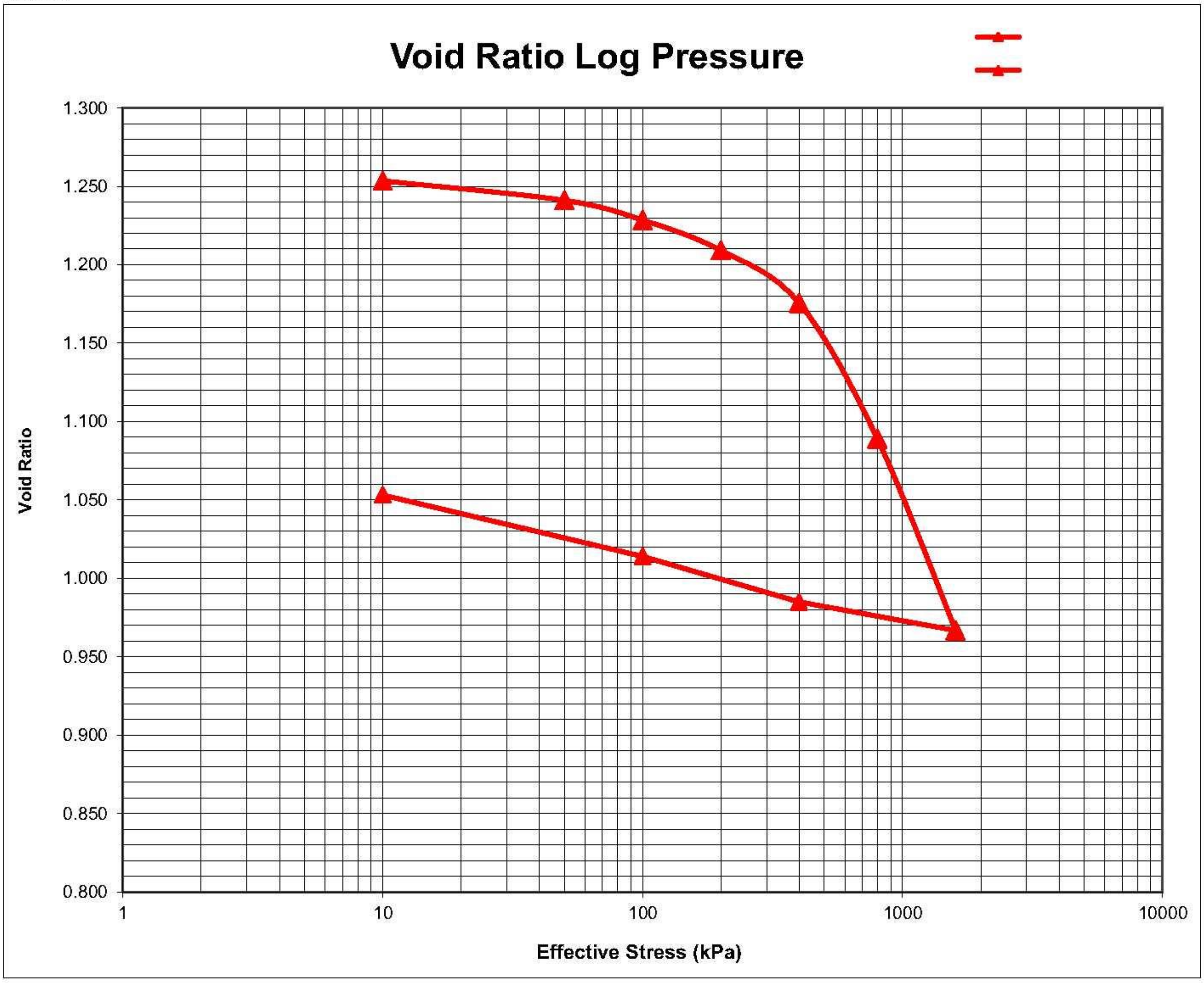
Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2246	Sample No.:	2246-3A
Borehole No:	LF 1 TOP	Depth:	1.0 - 1.2
Date Receivec	07/10/2013	Date Tested:	02/12/2013

Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.58	-0.02	0.54	1.40	2.90	6.77	12.22	11.41	10.12	8.37	
Mv (1/MPa)		0.1391	0.1123	0.0862	0.0749	0.0966	0.0682	0.0067	0.0433	0.1944	
Void Ratio	1.2535	1.241	1.2285	1.2091	1.1756	1.089	0.9668	0.9849	1.0139	1.0531	

Test 2



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Falling Head Permeability Test Results

Project:	MZINVUBU WATER PROJECT		
Project No:	2013-B-2004	Date:	17/10/2013

Lab. Sample Reference	Field Sample Reference	Depth (m)	Moisture Contents		Dry density Kg/m^3		Coefficient of Permeability (m/s)		
			Before Test (%)	After Test (%)	Initial	As tested	Range Minimum	Maximum	Average
2004-11	Mix C2+C4A+C7+C8+C10	-	35.0	32.9	1392	1469	5.1E-10	1.6E-09	**1.0E-09**
2004-22	Mix C12+C18+C22+C28+C30	-	25.7	27.6	1506	1538	7.3E-09	8.9E-09	**8.4E-09**
2004-29 *	Mix F5+F8+F10	-	10.0	14.8	1957	1990	1.5E-09	2.6E-09	**2.1E-09**
2004-39 *	Mix F25+F29+F34+F37+F39	-	11.3	12.6	1961	2020	1.9E-09	3.3E-09	**2.6E-09**

Remarks: Samples remoulded to 98% Proctor.
* = Samples remoulded to 95% Proctor.
Saturated and tested under a load of 100kPa.
Densities reported are under a load of 100kPa.

Interim results

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Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		Test 1
Project No.:	2013-B-2246	Sample No.:	2246-2A
Borehole No:	RF 1	Depth:	1.0 - 1.3
Date Received:	07/10/2013	Date Tested:	02/12/2013
Remarks:	An undisturbed sample tested soaked.		

Machine No.	6	Ring No.	26	Height (mm)	18.7	Diameter (mm)	75.6

Masses for Water Content Determination (g)

Wet Sample and Ring		Dry Sample and Ring	Ring Only	Water Content	
Before Test	After Test			Before Test	After Test
243.2	242.7	214.2	93.08	23.9%	23.5%

Pre-Determined Particle Specific Gravity	2.639

Initial Parameters

Void Ratio	0.8289	Degree of Saturation (%)	76.2	Dry Density (Kg/m3)	1443

Effect. Stress (kPa)		10	50	100	200	400	800	1600	400	100	10	0
Dial Correction (u)		0	50	82	122	189	299	417	231	117	42	0
HH:MM:SS	√Minutes	Dial Readings in Microns									Initial Dial Reading	13794
00:00:00	0.00	13794		13611		12883		11171				
00:00:06	0.32			13460		12387		10478				
00:00:12	0.45			13450		12365		10446				
00:00:18	0.55			13444		12346		10423				
00:00:24	0.63			13441		12335		10407				
00:00:30	0.71			13438		12324		10397				
00:00:40	0.82					12312						
00:00:42	0.84			13433				10376				
00:01:00	1.00			13429		12297		10356				
00:01:30	1.22			13423		12281		10338				
00:02:00	1.41			13418		12271		10324				
00:04:00	2.00			13411		12256		10296				
00:07:00	2.65			13400		12228		10273				
00:10:00	3.16			13399		12221		10264				
00:15:00	3.87			13394		12210		10254				
00:20:00	4.47			13390		12203		10246				
00:30:00	5.48			13388		12193		10237				
00:40:00	6.32			13385		12185		10227				
01:00:00	7.75			13378		12180						
01:30:00	9.49			13373		12175		10214				
02:00:00	10.95			13371		12160		10209	10458	10703		
03:00:00	13.42			13367		12148		10200			10962	
04:00:00	15.49			13362		12143		10193				
06:00:00	18.97			13355		12135		10188				
08:00:00	21.91	13791				12130		10183				
16:00:00	30.98		13611									
24:00:00	37.95				12883	12122	11171	10173				
72:00:00	65.73			13340								
End of Primary Cons		13791	13611	13340	12883	12122	11171	10173	10458	10703	10962	
Number of Readings:		2	1	24	1	25	1	24	1	1	1	0

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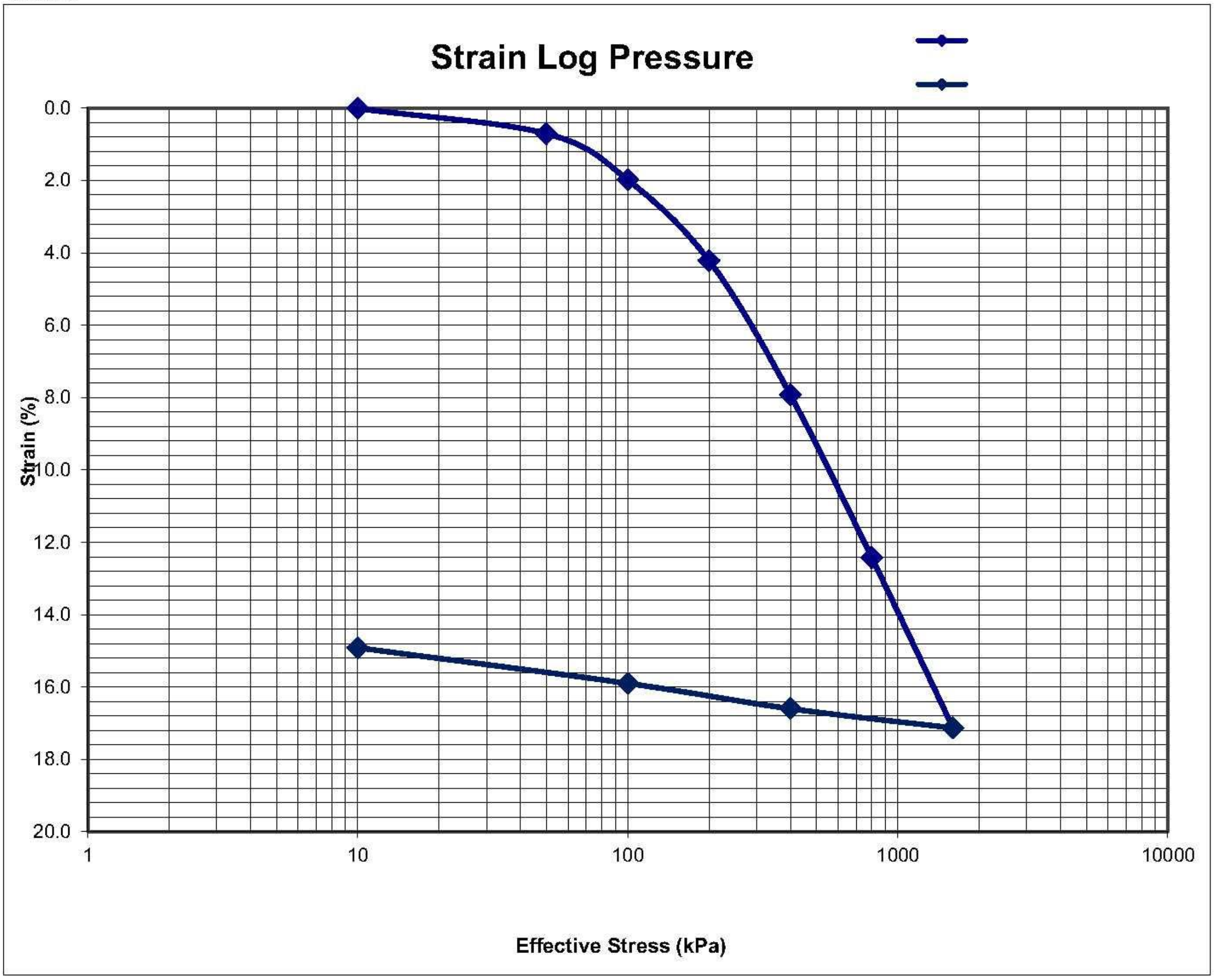
Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2246	Sample No.:	2246-2A
Borehole No:	RF 1	Depth:	1.0 - 1.3
Date Received:	07/10/2013	Date Tested:	02/12/2013

Test 1

Effect.Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	0.02	0.71	1.99	4.22	7.93	12.43	17.13	16.60	15.90	14.92	
Mv (1/MPa)		0.1738	0.2556	0.2230	0.1856	0.1124	0.0588	0.0044	0.0234	0.1093	
Void Ratio	0.8286	0.8159	0.7926	0.7518	0.6839	0.6016	0.5156	0.5253	0.5381	0.5561	

Test 2



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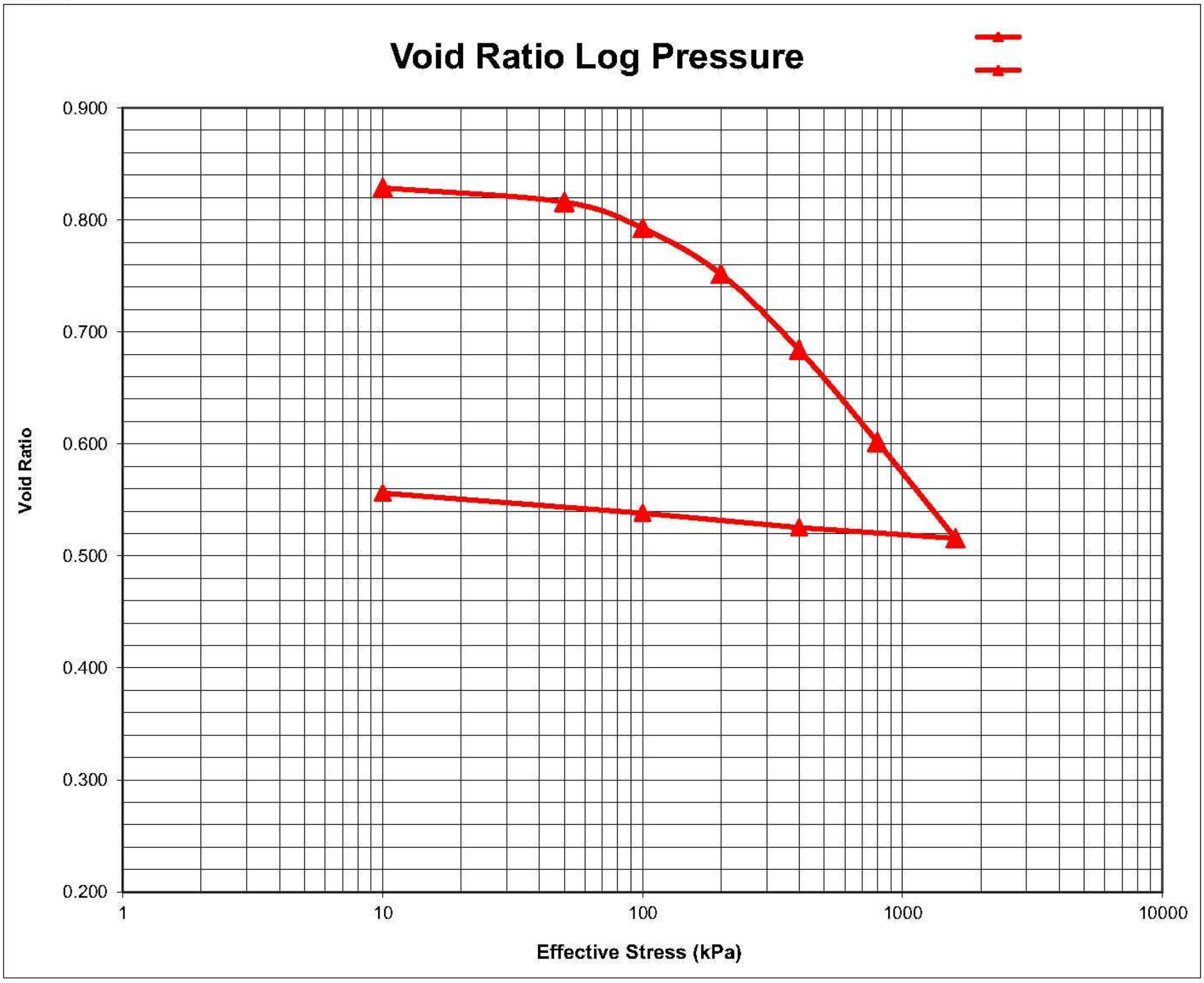
Consolidation Tests

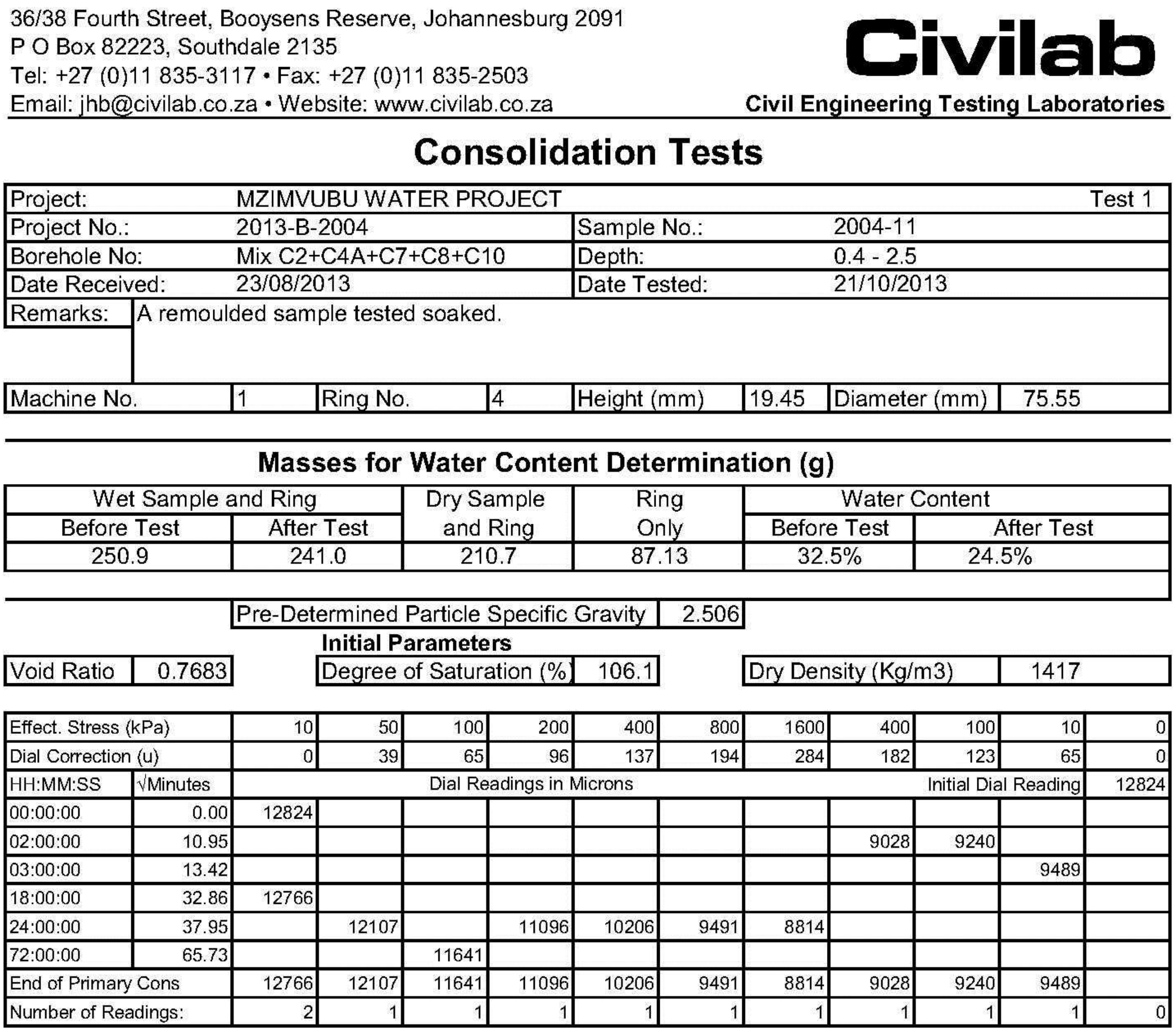
Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2246	Sample No.:	2246-2A
Borehole No:	RF 1	Depth:	1.0 - 1.3
Date Receivec	07/10/2013	Date Tested:	02/12/2013

Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	0.02	0.71	1.99	4.22	7.93	12.43	17.13	16.60	15.90	14.92	
Mv (1/MPa)		0.1738	0.2556	0.2230	0.1856	0.1124	0.0588	0.0044	0.0234	0.1093	
Void Ratio	0.8286	0.8159	0.7926	0.7518	0.6839	0.6016	0.5156	0.5253	0.5381	0.5561	

Test 2





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Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		Test 1
Project No.:	2013-B-2004	Sample No.:	2004-11
Borehole No:	Mix C2+C4A+C7+C8+C10	Depth:	0.4 - 2.5
Date Received:	23/08/2013	Date Tested:	21/10/2013
Remarks:	A remoulded sample tested soaked.		

Machine No.	1	Ring No.	4	Height (mm)	19.45	Diameter (mm)	75.55

Masses for Water Content Determination (g)

Wet Sample and Ring		Dry Sample and Ring	Ring Only	Water Content	
Before Test	After Test			Before Test	After Test
250.9	241.0	210.7	87.13	32.5%	24.5%

Pre-Determined Particle Specific Gravity: 2.506

Initial Parameters

Void Ratio	0.7683	Degree of Saturation (%)	106.1	Dry Density (Kg/m3)	1417

Effect. Stress (kPa)		10	50	100	200	400	800	1600	400	100	10	0
Dial Correction (u)		0	39	65	96	137	194	284	182	123	65	0
HH:MM:SS	√Minutes	Dial Readings in Microns								Initial Dial Reading		12824
00:00:00	0.00	12824										
02:00:00	10.95								9028	9240		
03:00:00	13.42										9489	
18:00:00	32.86	12766										
24:00:00	37.95		12107		11096	10206	9491	8814				
72:00:00	65.73			11641								
End of Primary Cons		12766	12107	11641	11096	10206	9491	8814	9028	9240	9489	
Number of Readings:		2	1	1	1	1	1	1	1	1	1	0

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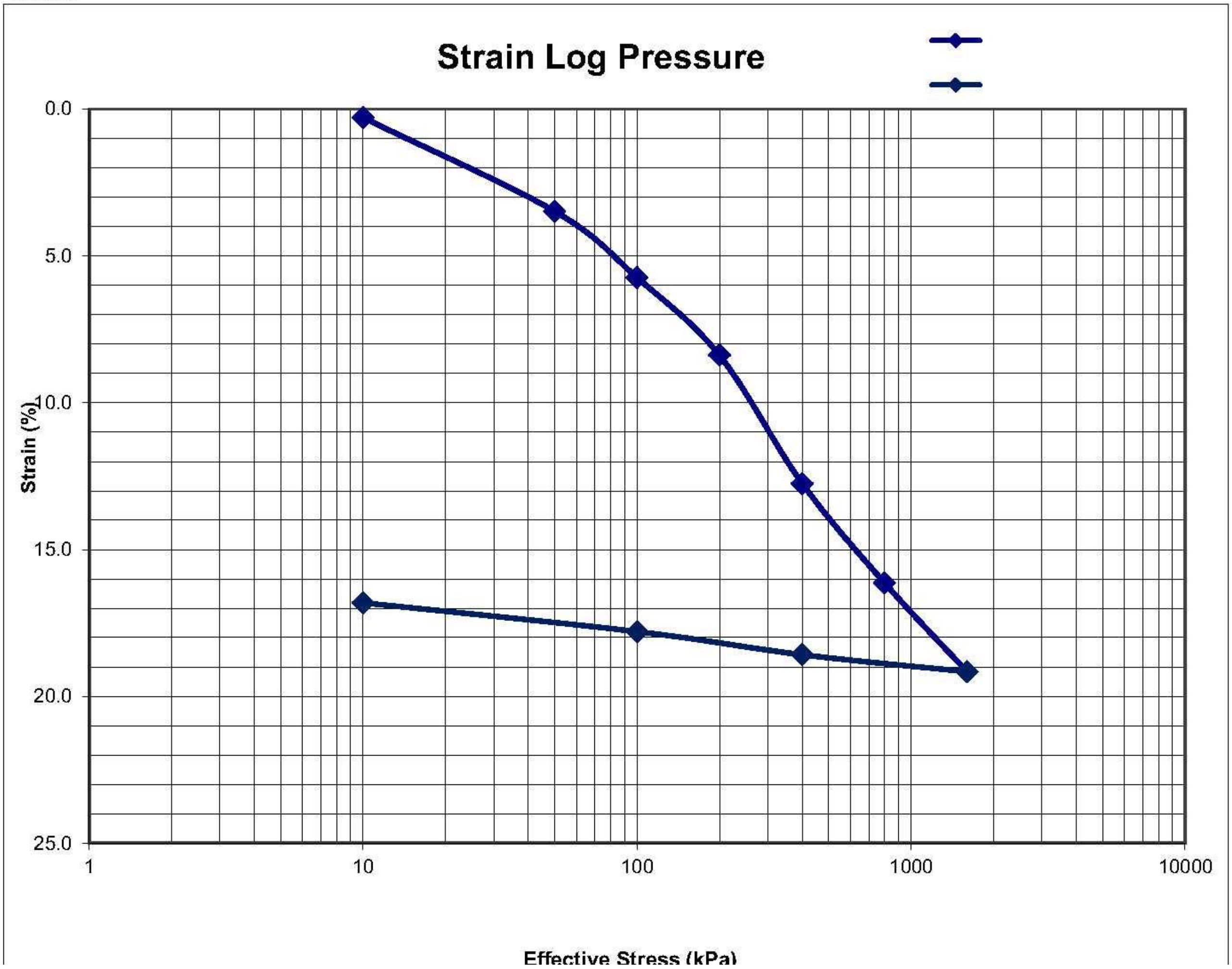
Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2004	Sample No.:	2004-11
Borehole No:	Mix C2+C4A+C7+C8+C10	Depth:	0.4 - 2.5
Date Received:	23/08/2013	Date Tested:	21/10/2013

Test 1

Effect.Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	0.30	3.49	5.75	8.39	12.76	16.14	19.16	18.58	17.79	16.81	
Mv (1/MPa)		0.7969	0.4524	0.2643	0.2183	0.0846	0.0377	0.0048	0.0262	0.1091	
Void Ratio	0.763	0.7066	0.6666	0.6199	0.5427	0.4829	0.4295	0.4397	0.4536	0.471	

Test 2



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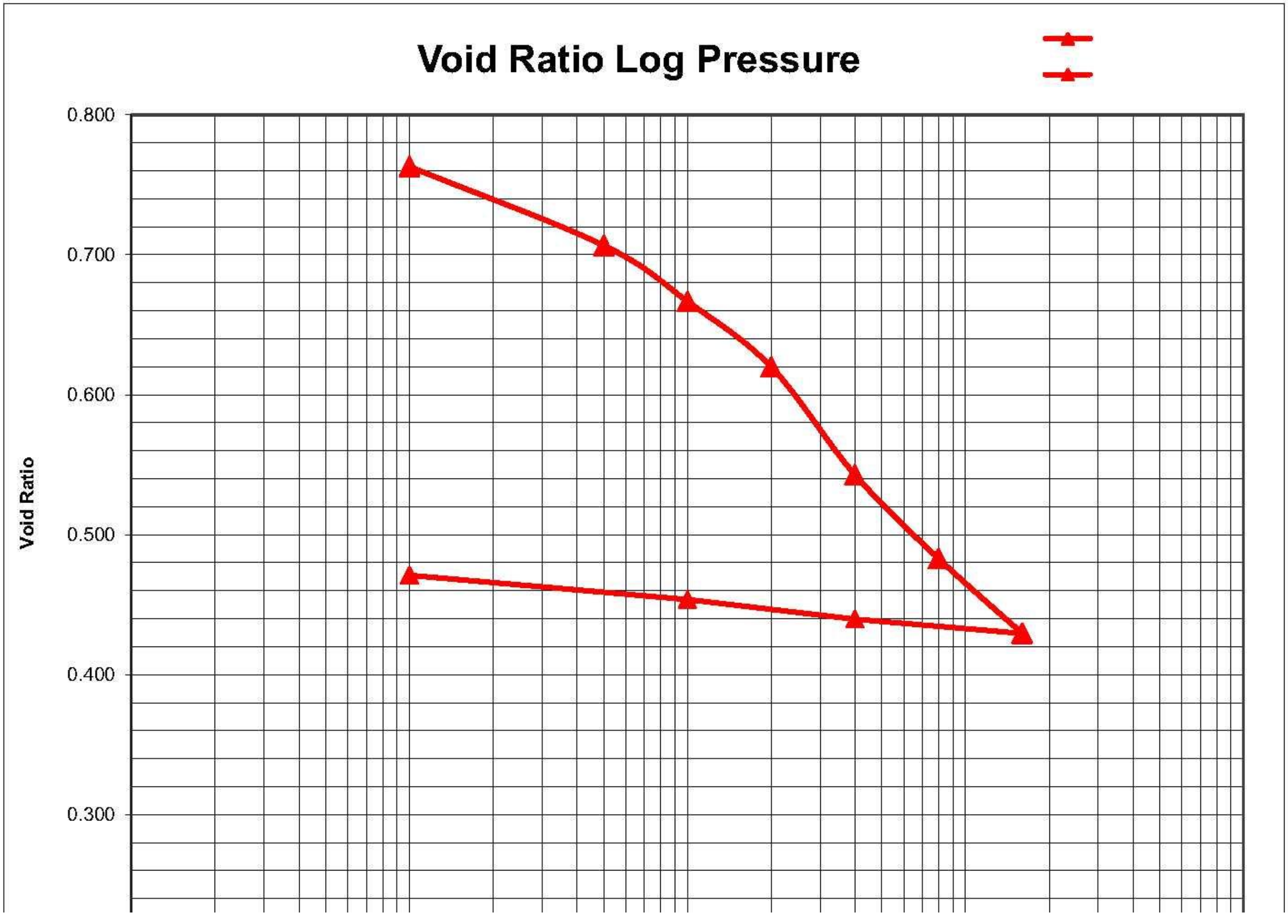
Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2004	Sample No.:	2004-11
Borehole No:	Mix C2+C4A+C7+C8+C10	Depth:	0.4 - 2.5
Date Receivec	23/08/2013	Date Tested:	21/10/2013

Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	0.30	3.49	5.75	8.39	12.76	16.14	19.16	18.58	17.79	16.81	
Mv (1/MPa)		0.7969	0.4524	0.2643	0.2183	0.0846	0.0377	0.0048	0.0262	0.1091	
Void Ratio	0.763	0.7066	0.6666	0.6199	0.5427	0.4829	0.4295	0.4397	0.4536	0.471	

Test 2



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Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		Test 1
Project No.:	2013-B-2004	Sample No.:	2004-22
Borehole No:	Mix C12+C18+C22+C28+C30	Depth:	-
Date Received:	23/08/2013	Date Tested:	21/10/2013
Remarks:	A remoulded sample tested soaked.		

Machine No.	2	Ring No.	19	Height (mm)	18.5	Diameter (mm)	76.1

Masses for Water Content Determination (g)

Wet Sample and Ring		Dry Sample and Ring	Ring Only	Water Content	
Before Test	After Test			Before Test	After Test
249.9	248.7	219.1	90.64	24.0%	23.0%

Pre-Determined Particle Specific Gravity	2.657

Initial Parameters

Void Ratio	0.7404	Degree of Saturation (%)	86.0	Dry Density (Kg/m3)	1527

Effect. Stress (kPa)		10	50	100	200	400	800	1600	400	100	10	0
Dial Correction (u)		0	56	78	112	151	208	280	226	177	117	0
HH:MM:SS	√Minutes	Dial Readings in Microns								Initial Dial Reading		11984
00:00:00	0.00	11984										
02:00:00	10.95								8332	8662		
03:00:00	13.42										9162	
18:00:00	32.86	12151										
24:00:00	37.95		11445		10687	9797	8950	8090				
72:00:00	65.73			11171								
End of Primary Cons		12151	11445	11171	10687	9797	8950	8090	8332	8662	9162	
Number of Readings:		2	1	1	1	1	1	1	1	1	1	0

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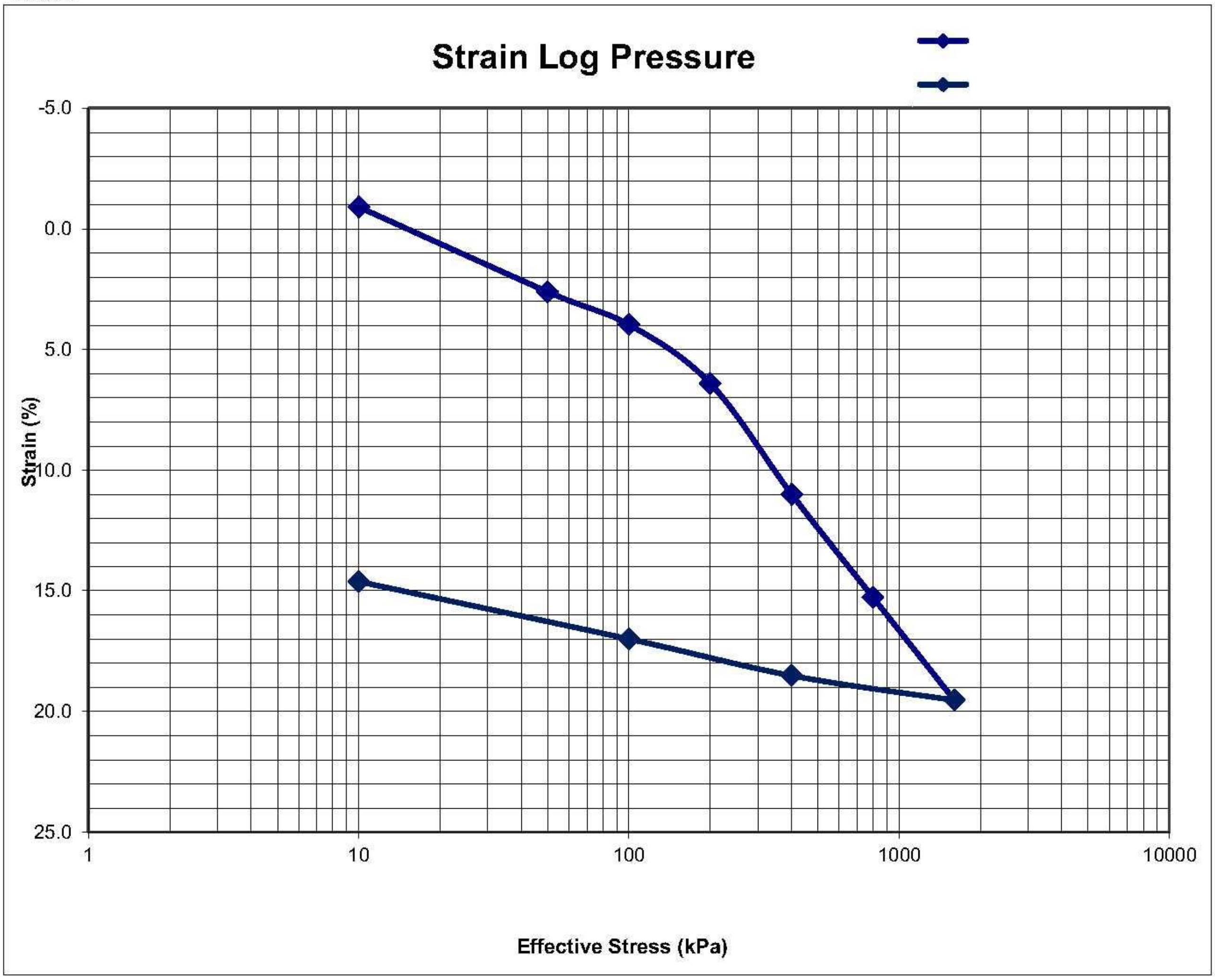
Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2004	Sample No.:	2004-22
Borehole No:	Mix C12+C18+C22+C28+C30	Depth:	-
Date Received:	23/08/2013	Date Tested:	21/10/2013

Test 1

Effect.Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.90	2.61	3.97	6.41	11.01	15.28	19.54	18.52	17.00	14.62	
Mv (1/MPa)		0.8784	0.2724	0.2432	0.2300	0.1068	0.0532	0.0085	0.0506	0.2643	
Void Ratio	0.7561	0.695	0.6713	0.6289	0.5489	0.4746	0.4004	0.4181	0.4446	0.4859	

Test 2



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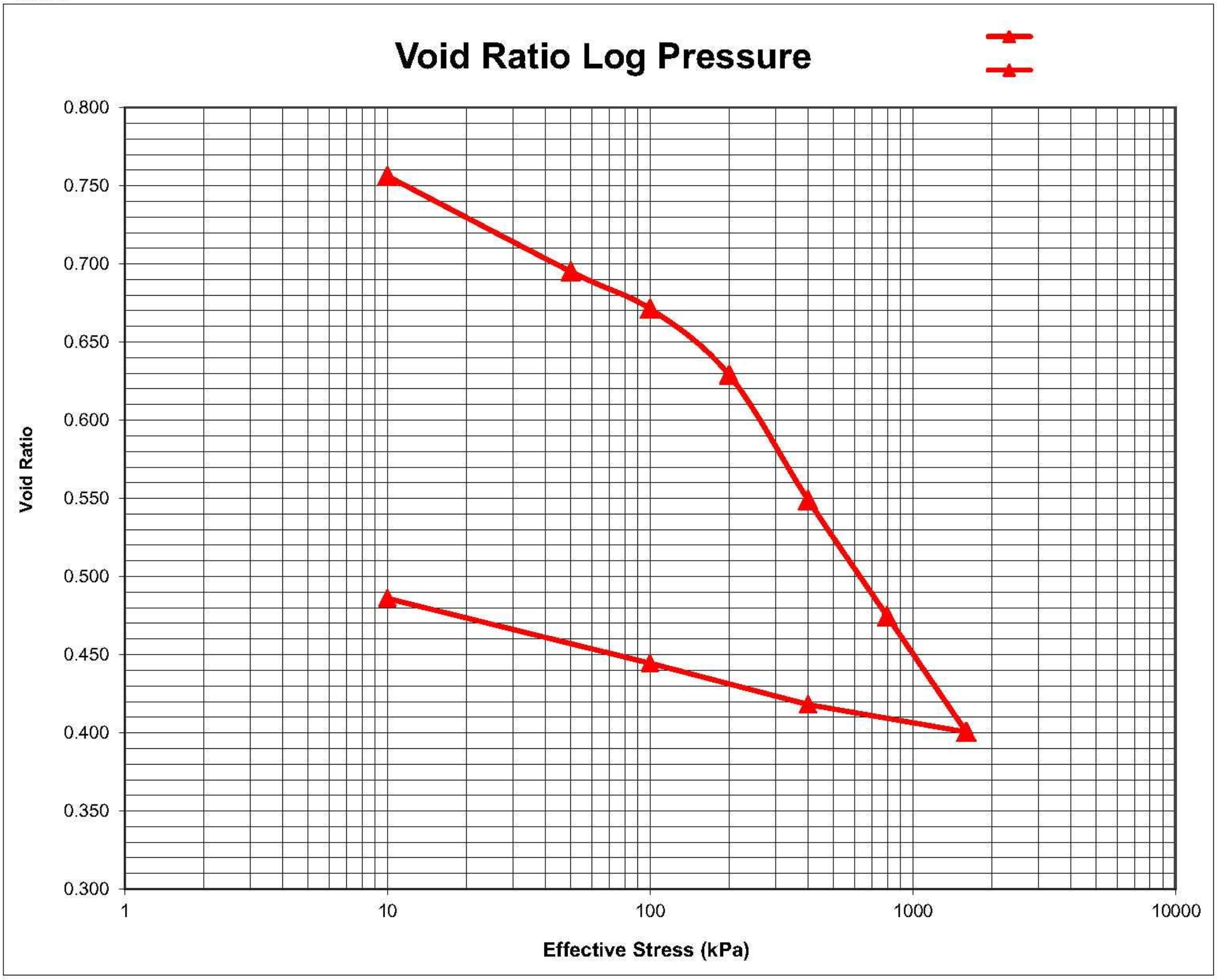
Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2004	Sample No.:	2004-22
Borehole No:	Mix C12+C18+C22+C28+C30	Depth:	-
Date Receivec	23/08/2013	Date Tested:	21/10/2013

Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.90	2.61	3.97	6.41	11.01	15.28	19.54	18.52	17.00	14.62	
Mv (1/MPa)		0.8784	0.2724	0.2432	0.2300	0.1068	0.0532	0.0085	0.0506	0.2643	
Void Ratio	0.75613	0.69498	0.67128	0.62894	0.54888	0.47456	0.40043	0.41811	0.44455	0.48594	

Test 2



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Project:	MZIMVUBU WATER PROJECT						Test 1
Project No.:	2013-B-2004			Sample No.:	2004-29		
Borehole No:	MIX F5+F8+F10			Depth:	-		
Date Received:	23/08/2013			Date Tested:	11/12/2013		
Remarks:	A remoulded sample tested soaked.						
Machine No.	12	Ring No.	19	Height (mm)	18.5	Diameter (mm)	76.1

Masses for Water Content Determination (g)

Wet Sample and Ring		Dry Sample and Ring	Ring Only	Water Content	
Before Test	After Test			Before Test	After Test
271.7	277.3	254.8	90.64	10.3%	13.7%

Pre-Determined Particle Specific Gravity 2.566

Initial Parameters

Void Ratio	0.3153	Degree of Saturation (%)	83.8	Dry Density (Kg/m3)	1951

Effect. Stress (kPa)		10	50	100	200	400	800	1600	400	100	10	0
Dial Correction (u)		0	41	67	107	141	188	257	177	112	39	0
HH:MM:SS	√Minutes	Dial Readings in Microns									Initial Dial Reading	13839
00:00:00	0.00	13839										
02:00:00	10.95								12238	12500		
03:00:00	13.42										13106	
24:00:00	37.95			13658		13124	12669	12055				
72:00:00	65.73	13877			13416							
96:00:00	75.89		13821									
End of Primary Cons		13877	13821	13658	13416	13124	12669	12055	12238	12500	13106	
Number of Readings:		2	1	1	1	1	1	1	1	1	1	0

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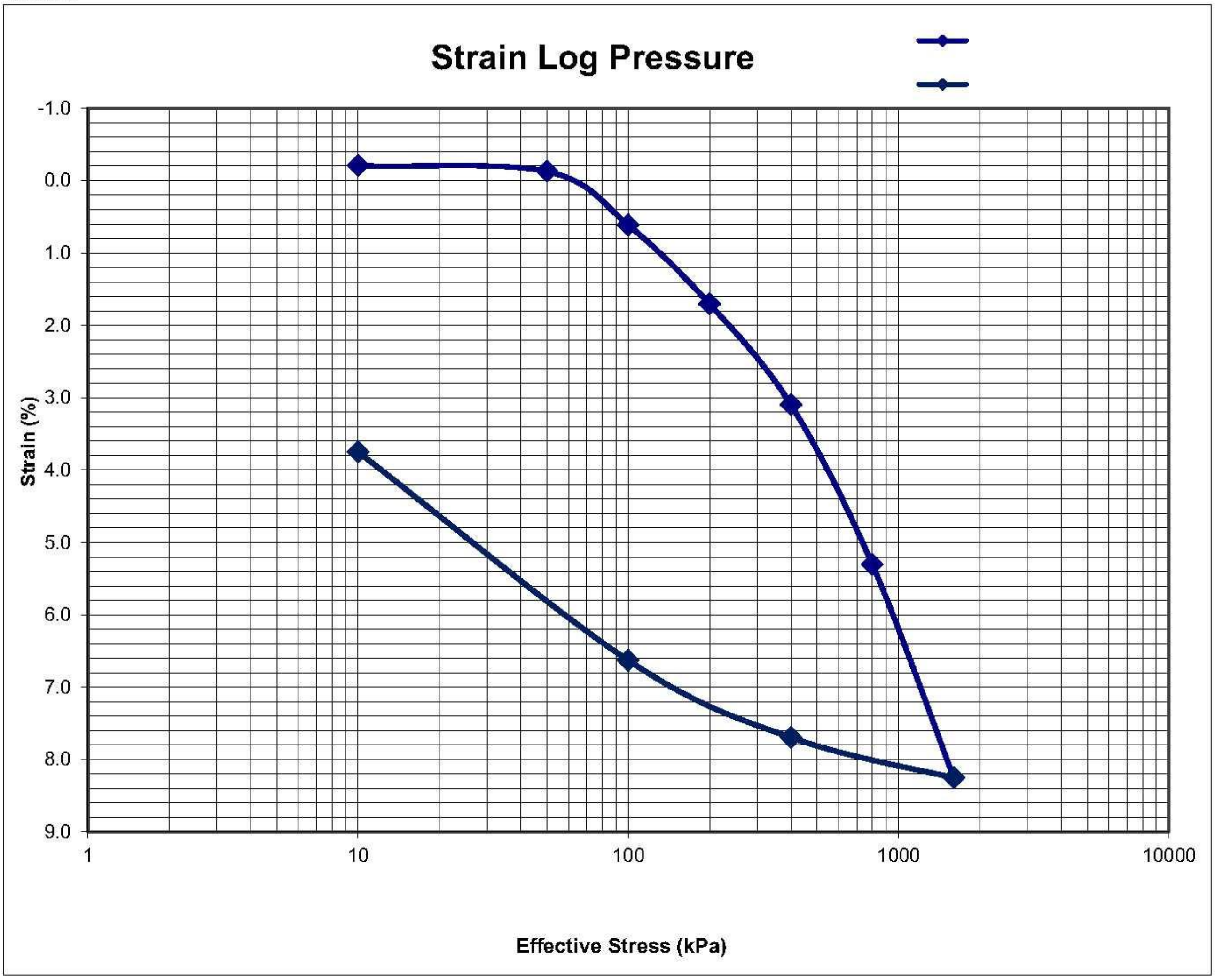
Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2004	Sample No.:	2004-29
Borehole No:	MIX F5+F8+F10	Depth:	-
Date Received:	23/08/2013	Date Tested:	11/12/2013

Test 1

Effect.Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.21	-0.12	0.62	1.71	3.10	5.31	8.25	7.70	6.63	3.75	
Mv (1/MPa)		0.0203	0.1481	0.1092	0.0697	0.0551	0.0368	0.0046	0.0355	0.3201	
Void Ratio	0.318	0.3169	0.3072	0.2928	0.2745	0.2455	0.2067	0.214	0.2281	0.2659	

Test 2



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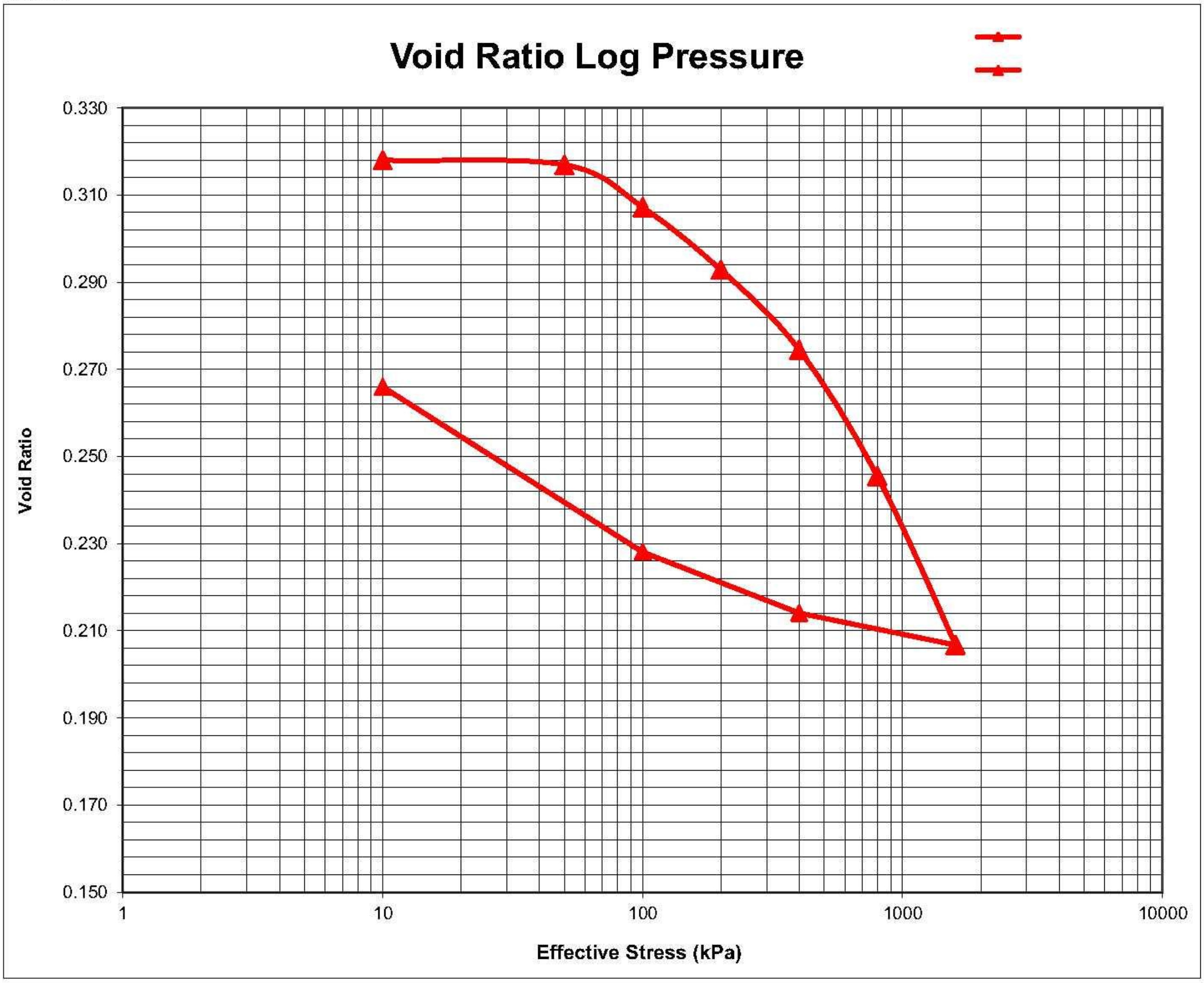
Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2004	Sample No.:	2004-29
Borehole No:	MIX F5+F8+F10	Depth:	-
Date Receivec	23/08/2013	Date Tested:	11/12/2013

Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.21	-0.12	0.62	1.71	3.10	5.31	8.25	7.70	6.63	3.75	
Mv (1/MPa)		0.0203	0.1481	0.1092	0.0697	0.0551	0.0368	0.0046	0.0355	0.3201	
Void Ratio	0.318	0.3169	0.3072	0.2928	0.2745	0.2455	0.2067	0.214	0.2281	0.2659	

Test 2



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Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		Test 1
Project No.:	2013-B-2004	Sample No.:	2004-39
Borehole No:	Mix F25+F29+F34+F37+F39	Depth:	-
Date Received:	23/08/2013	Date Tested:	21/10/2013
Remarks:	A remoulded sample tested soaked.		

Machine No.	3	Ring No.	16	Height (mm)	19.95	Diameter (mm)	75.95

Masses for Water Content Determination (g)

Wet Sample and Ring		Dry Sample and Ring	Ring Only	Water Content	
Before Test	After Test			Before Test	After Test
304.0	305.3	284.5	106.78	11.0%	11.7%

Pre-Determined Particle Specific Gravity: 2.717

Initial Parameters

Void Ratio	0.3818	Degree of Saturation (%)	78.1	Dry Density (Kg/m3)	1966

Effect. Stress (kPa)		10	50	100	200	400	800	1600	400	100	10	0
Dial Correction (u)		0	60	79	113	140	210	327	203	137	46	0
HH:MM:SS	√Minutes	Dial Readings in Microns									Initial Dial Reading	12957
00:00:00	0.00	12957										
02:00:00	10.95								11034	11281		
03:00:00	13.42										11741	
18:00:00	32.86	13040										
24:00:00	37.95		12802		12370	11990	11468	10835				
72:00:00	65.73			12616								
End of Primary Cons		13040	12802	12616	12370	11990	11468	10835	11034	11281	11741	
Number of Readings:		2	1	1	1	1	1	1	1	1	1	0

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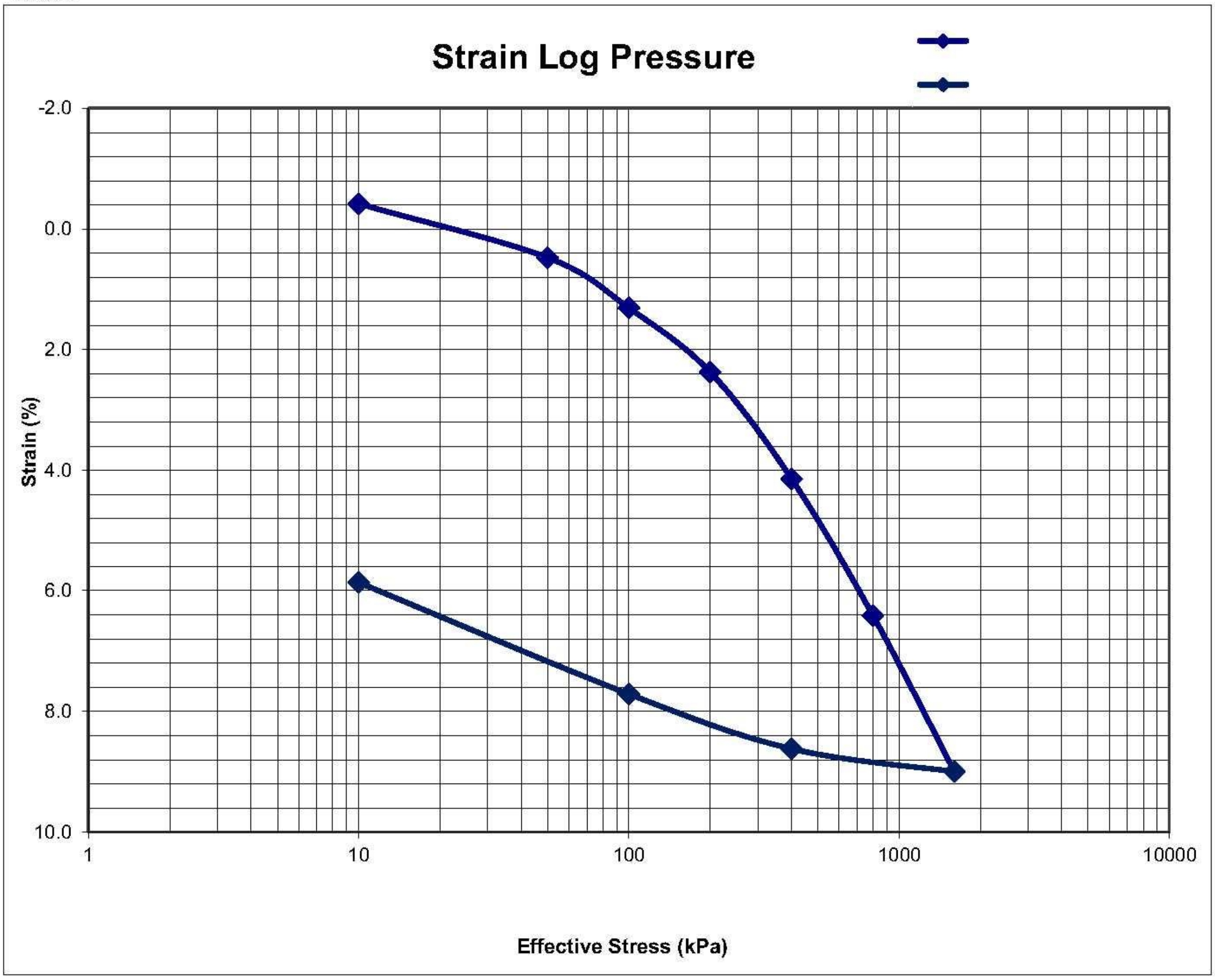
Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2004	Sample No.:	2004-39
Borehole No:	Mix F25+F29+F34+F37+F39	Depth:	-
Date Received:	23/08/2013	Date Tested:	21/10/2013

Test 1

Effect.Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.42	0.48	1.31	2.38	4.15	6.41	9.00	8.62	7.71	5.86	
Mv (1/MPa)		0.2231	0.1674	0.1063	0.0885	0.0566	0.0323	0.0031	0.0302	0.2055	
Void Ratio	0.3875	0.3752	0.3636	0.349	0.3245	0.2932	0.2575	0.2627	0.2752	0.3008	

Test 2



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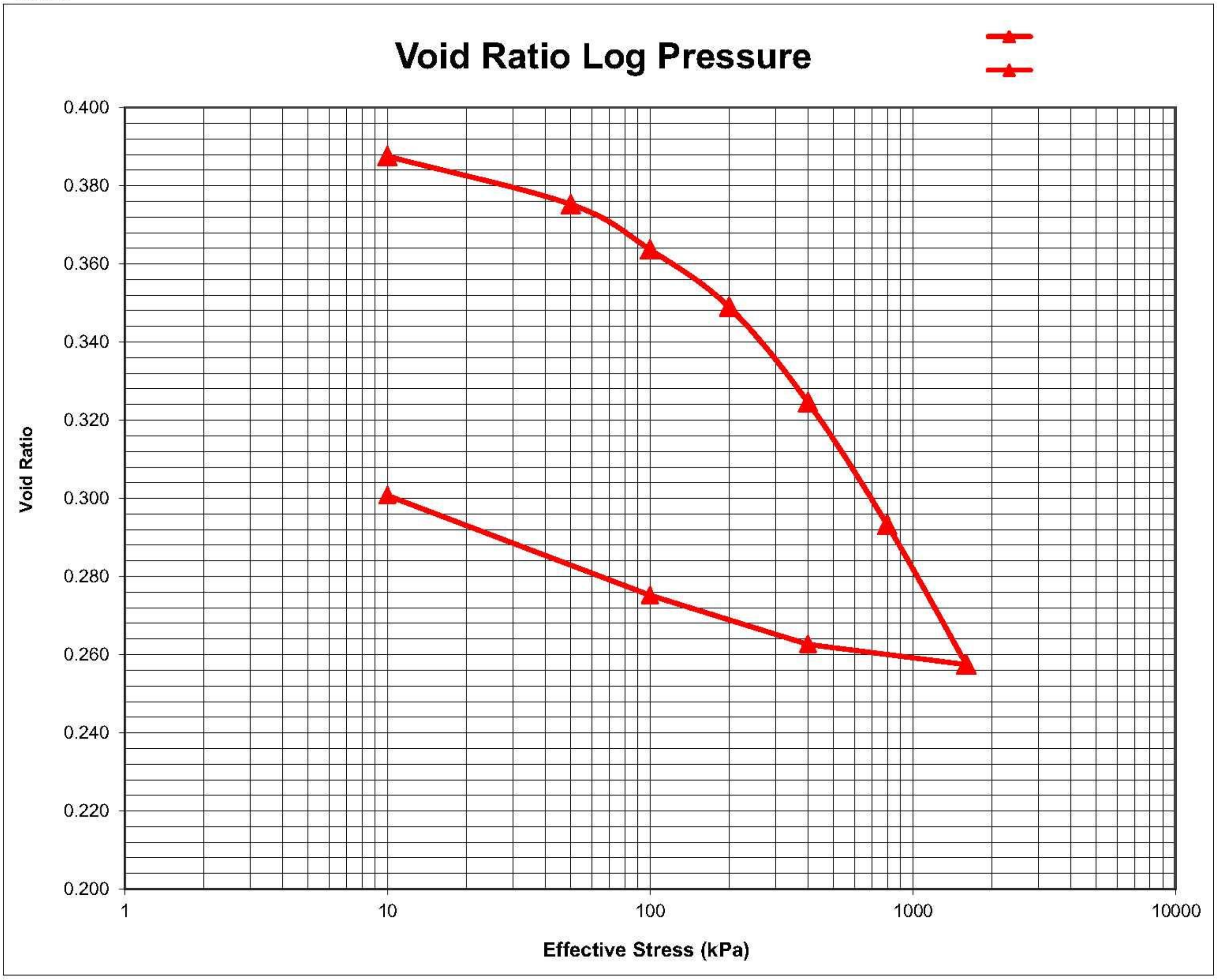
Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		
Project No.:	2013-B-2004	Sample No.:	2004-39
Borehole No:	Mix F25+F29+F34+F37+F39	Depth:	-
Date Receivec	23/08/2013	Date Tested:	21/10/2013

Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.42	0.48	1.31	2.38	4.15	6.41	9.00	8.62	7.71	5.86	
Mv (1/MPa)		0.2231	0.1674	0.1063	0.0885	0.0566	0.0323	0.0031	0.0302	0.2055	
Void Ratio	0.38754	0.37521	0.36364	0.34896	0.32451	0.2932	0.25746	0.26266	0.27519	0.30075	

Test 2



H 7

PERMIABILITY

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Falling Head Permeability Test Results

Project:	MZIMVUBU WATER PROJECT		
Project No:	2013-B-2246	Date:	28/11/2013

Lab. Sample Reference	Field Sample Reference	Depth (m)	Moisture Contents		Dry density Kg/m³		Coefficient of Permeability (m/s)		
			Before Test (%)	After Test (%)	Initial	As tested	Range Minimum	Range Maximum	Average
2246-2	RF 1	1.0 - 1.3	19.3	22.4	1548	1594	1.9E-08	2.7E-08	**2.3E-08**
2246-3	LF 1 TOP	1.0 - 1.2	36.3	53.4	1016	1056	1.0E-08	2.0E-08	**1.4E-08**

Remarks: Undisturbed samples.
Saturated and tested under a load of 100kPa.
Densities reported are under a load of 100kPa.

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Falling Head Permeability Test Results

Project:	MZINVUBU WATER PROJECT		
Project No:	2013-B-2004	Date:	17/10/2013

Lab. Sample Reference	Field Sample Reference	Depth (m)	Moisture Contents		Dry density Kg/m^3		Coefficient of Permeability (m/s)		
			Before Test (%)	After Test (%)	Initial	As tested	Range		Average
							Minimum	Maximum	
2004-11	Mix C2+C4A+C7+C8+C10	-	35.0	32.9	1392	1469	5.1E-10	1.6E-09	**1.0E-09**
2004-22	Mix C12+C18+C22+C28+C30	-	25.7	27.6	1506	1538	7.3E-09	8.9E-09	**8.4E-09**
2004-29 *	Mix F5+F8+F10	-	10.0	14.8	1957	1990	1.5E-09	2.6E-09	**2.1E-09**
2004-39 *	Mix F25+F29+F34+F37+F39	-	11.3	12.6	1961	2020	1.9E-09	3.3E-09	**2.6E-09**

Remarks:
Samples remoulded to 98% Proctor.
* = Samples remoulded to 95% Proctor.
Saturated and tested under a load of 100kPa.
Densities reported are under a load of 100kPa.

Interim results

H 8

SAND

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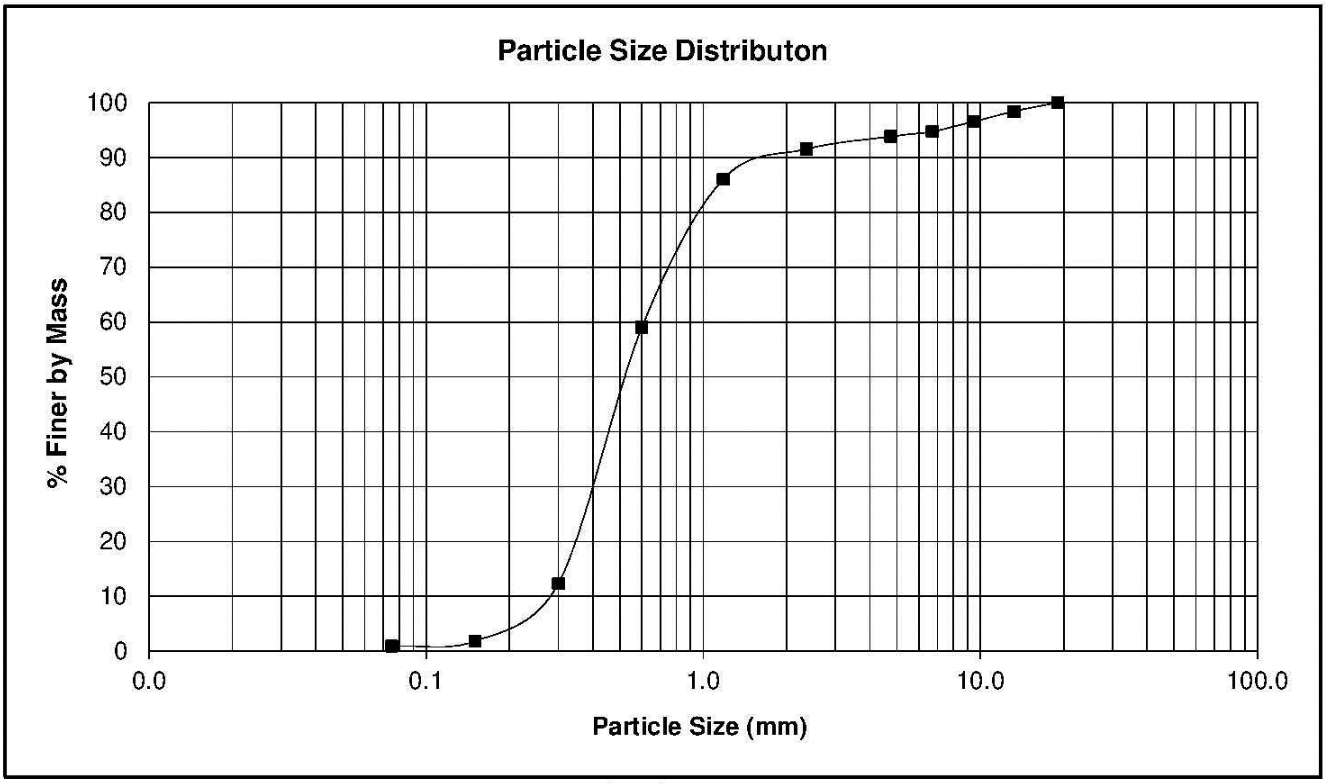
Fine Aggregate Test Results

Project	:	**MZIMVUBU WATER PROJECT**	Date	:	1 OCTOBER 2013
Project No	:	2013-B-2004	Lab Sample Reference	:	2004-40
Field Reference	:	S1	Remarks	:	-
Organic Impurities	:	N/T			

Particle Size Distribution				
Reference		Test Sample	Specification
Finer by Mass (%)	Particle Size (mm)	19 . 0	100	
		13 . 2	98	
		9 . 5	97	
		6 . 7	95	
		4 . 75	94	
		2 . 36	92	
		1 . 18	86	
		0 . 60	59	
		0 . 30	12	
		0 . 15	2	
		0 . 075	1	

Physical Properties			
Parameters		Test Sample	Specification
Fineness Modulus	%	2.55	
Dust Content		0.9	
Sand Equivalent	%	N/T	
Moisture Content	%	N/T	
Water Absorption	%	N/T	
Apparent Relative Density		N/T	
Bulk Relative Density		N/T	

N/T denotes Not Tested
N/A denotes Not Applicable



The samples were subjected to analysis according to SABS method 1083:1994.
The results reported relate only to the samples tested.
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Fine Aggregate Test Results

Project	:	**MZIMVUBU WATER PROJECT**	Date :	1 OCTOBER 2013
Project No	:	2013-B-2004	Lab Sample Reference :	2004-41
Field Reference	:	S2	Remarks :	-
Organic Impurities	:	Lighter than Reference		

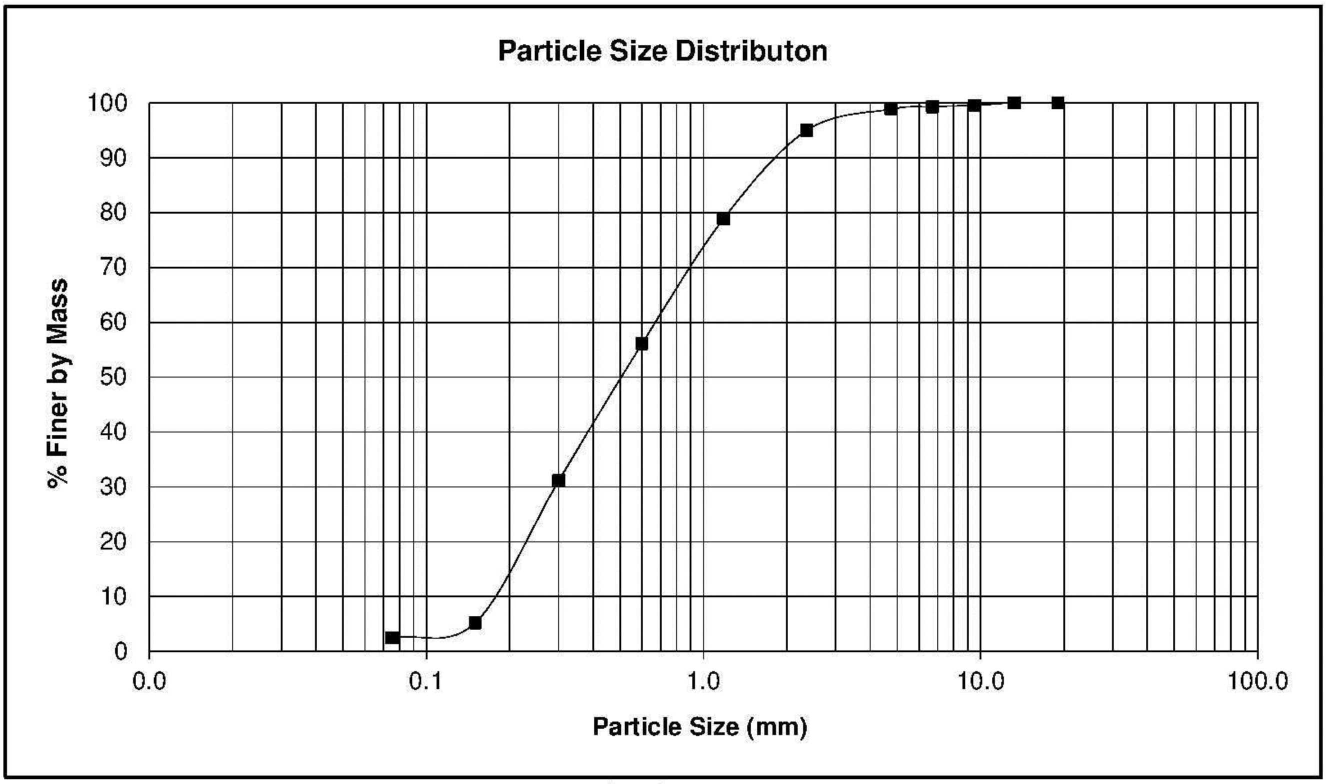
Particle Size Distribution

Reference		Test Sample	Specification
Finer by Mass (%)	Particle Size (mm)		
	19 . 0	100	
	13 . 2	100	
	9 . 5	100	
	6 . 7	99	
	4 . 75	99	
	2 . 36	95	
	1 . 18	79	
	0 . 60	56	
	0 . 30	31	
	0 . 15	5	
	0 . 075	3	

Physical Properties

Parameters		Test Sample	Specification
Fineness Modulus	%	2.35	
Dust Content		2.5	
Sand Equivalent	%	N/T	
Moisture Content	%	N/T	
Water Absorption	%	N/T	
Apparent Relative Density		N/T	
Bulk Relative Density		N/T	

N/T denotes Not Tested
N/A denotes Not Applicable



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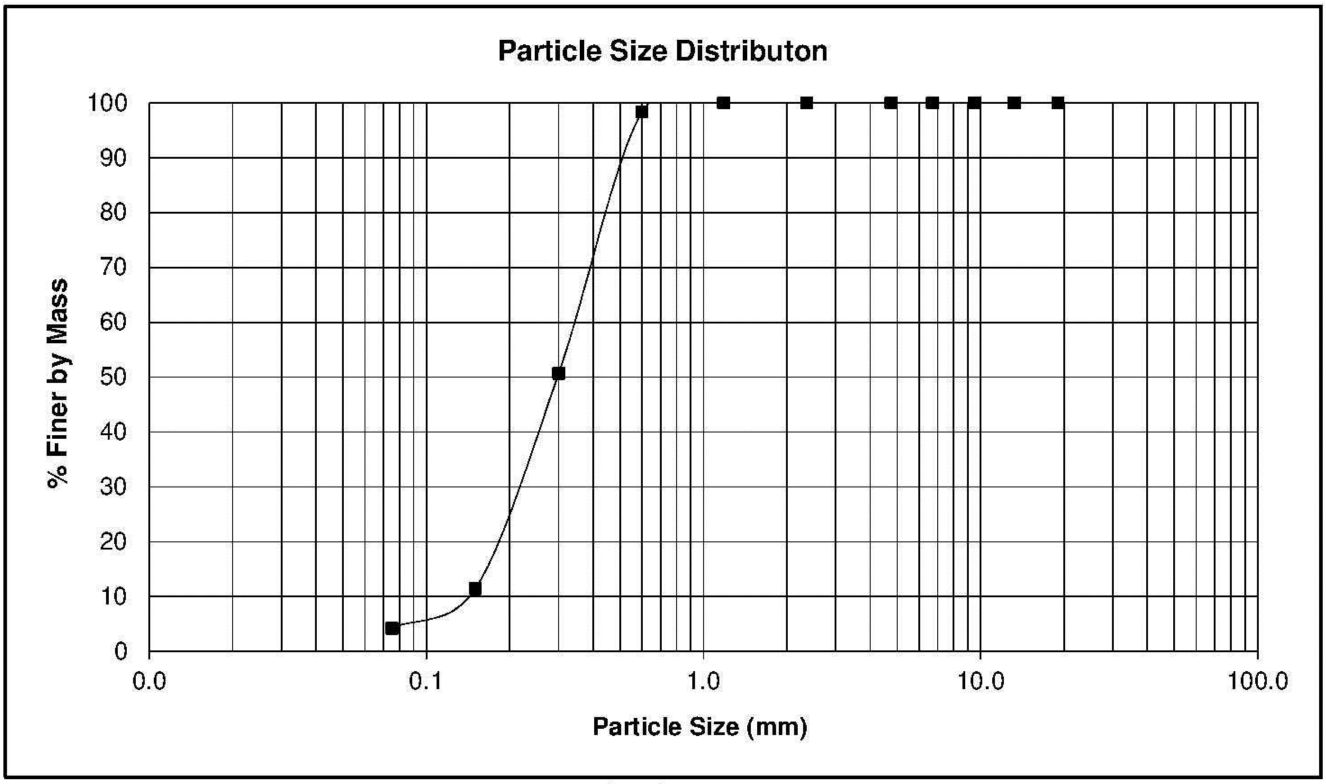
Fine Aggregate Test Results

Project	:	**MZIMVUBU WATER PROJECT**	Date	:	1 OCTOBER 2013
Project No	:	2013-B-2004	Lab Sample Reference	:	2004-42
Field Reference	:	S3	Remarks	:	-
Organic Impurities	:	N/T			

Particle Size Distribution				
Reference			Test Sample	Specification
Finer by Mass (%)	Particle Size (mm)	19 . 0	100	
		13 . 2	100	
		9 . 5	100	
		6 . 7	100	
		4 . 75	100	
		2 . 36	100	
		1 . 18	100	
		0 . 60	98	
		0 . 30	51	
		0 . 15	11	
		0 . 075	4	

Physical Properties			
Parameters		Test Sample	Specification
Fineness Modulus	%	1.39	
Dust Content		4.2	
Sand Equivalent	%	N/T	
Moisture Content	%	N/T	
Water Absorption	%	N/T	
Apparent Relative Density		N/T	
Bulk Relative Density		N/T	

N/T denotes Not Tested
N/A denotes Not Applicable



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Fine Aggregate Test Results

Project	:	**MZIMVUBU WATER PROJECT**	Date :	1 OCTOBER 2013
Project No	:	2013-B-2004	Lab Sample Reference :	2004-43
Field Reference	:	S4	Remarks :	-
Organic Impurities	:	Same as Reference		

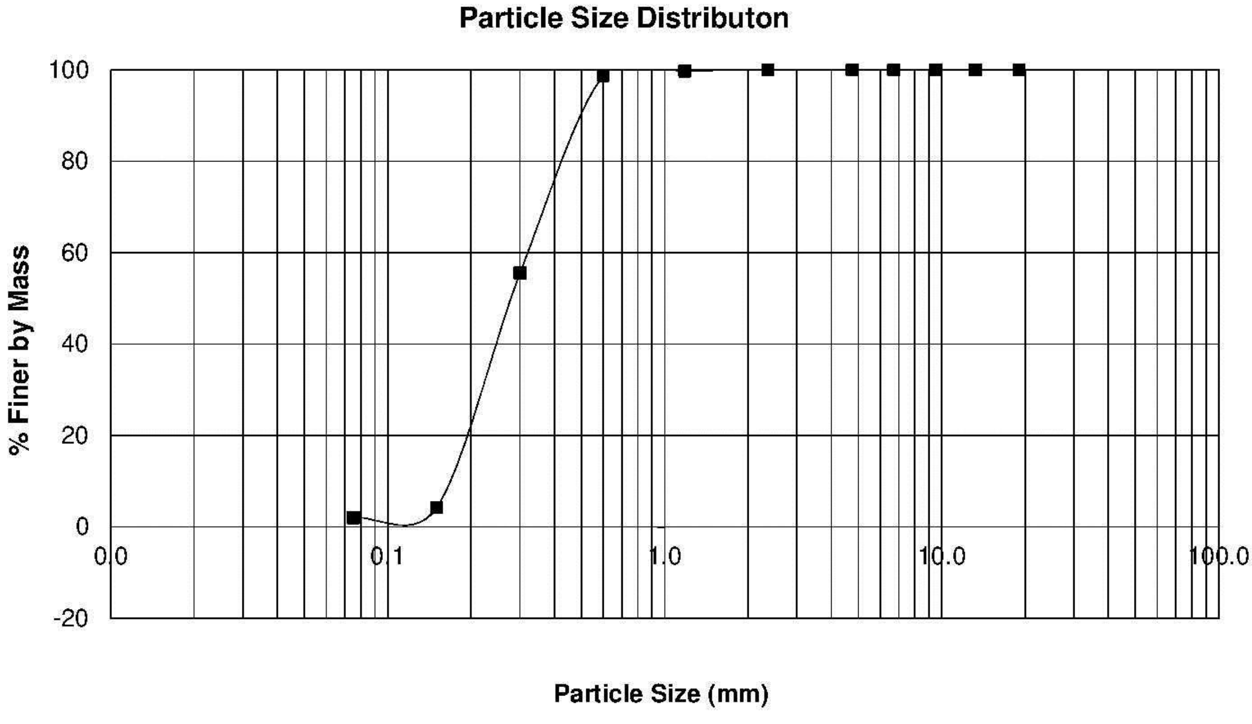
Particle Size Distribution

Reference			Test Sample	Specification
Finer by Mass (%)	Particle Size (mm)	19 . 0	100	
		13 . 2	100	
		9 . 5	100	
		6 . 7	100	
		4 . 75	100	
		2 . 36	100	
		1 . 18	100	
		0 . 60	99	
		0 . 30	56	
		0 . 15	4	
		0 . 075	2	

Physical Properties

Parameters		Test Sample	Specification
Fineness Modulus	%	1.42	
Dust Content		2.0	
Sand Equivalent	%	N/T	
Moisture Content	%	N/T	
Water Absorption	%	N/T	
Apparent Relative Density		N/T	
Bulk Relative Density		N/T	

N/T denotes Not Tested
N/A denotes Not Applicable



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Prediction of 28-day compressive strength of concrete on the third day using artificial neural networks

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Abstract

In recent decades, artificial neural networks are known as intelligent methods for modeling of behavior of physical phenomena. In this paper, implementation of an artificial neural network has been developed for prediction of compressive strength of concrete. A MISO (Multi Input Single Output) adaptive system has been introduced which can model the proposed phenomenon. The data has been collected by experimenting on concrete samples and then the neural network has been trained using these data. From among 432 specimens, 300 data sample has been used for train, 66 data sample for validation and 66 data sample for the final test of the network. The 3-day strength parameter of concrete in the introduced structure also has been used as an important index for predicting the 28-day strength of the concrete. The simulations in this paper are based on real data obtained from concrete samples which indicate the validity of the proposed tool.

Keywords: Concrete, Strength, Prediction, Artificial, Neural Networks.

1. INTRODUCTION

Different sciences are developing fast in today's world. In recent decades, man has seen increased relationship of sciences in different fields and the more relationship has led to the appearance of the more new knowledge and technology. Nowadays, one of the most important problems of man are technical and engineering problems. The complexity of the most of the problems in this field has made the experts of this field use the new mathematical and modeling methods for solving this type of problems. Intelligent systems can be used as suitable tools for identifying complex systems, due to their ability of learning and adaptation.

One of the complex problems in our world is the problem of the concrete. The main criterion for evaluating the compressive strength of concrete is the strength of the concrete on 28th day. The concrete sample is tested after 28 days and the result of this test is considered as a criterion for quality and rigidity of that concrete.

Concrete is the most widely used structural material in constructions in the world. Massive concreting in huge civil projects like dams, power plants, bridges and etc... usually is not practicable and it is necessary to be performed in several layers and the compressive strength of each layer should not be less than the specified compressive strength. Therefore one should wait 28 days to achieve 28-day strength of each layer of concrete. Thereupon if we have *n* layers of concrete we need $28 \times n$ days to complete the total project. [1]

2. CONCRETE

Concrete is the only major building material that can be delivered to the job site in a plastic state. This unique quality makes concrete desirable as a building material because it can be molded to virtually any form or shape. Concrete provides a wide latitude in surface textures and colors and can be used to construct a wide variety of structures, such as highways and streets, bridges, dams, large buildings, airport runways, irrigation structures, breakwaters, piers and docks, sidewalks, silos and farm buildings, homes, and even barges and ships.

The two major components of concrete are a cement paste and inert materials. The cement paste consists of Portland cement, water, and some air either in the form of naturally entrapped air voids or minute, intentionally entrained air bubbles. The inert materials are usually composed of fine aggregate, which is a material such as sand, and coarse aggregate, which is a material such as gravel, crushed stone, or slag.

When Portland cement is mixed with water, the compounds of the cement react to form a cementing medium. In properly mixed concrete, each particle of sand and coarse aggregate is completely surrounded and coated by this paste, and all spaces between the particles are filled with it. As the cement paste sets and hardens, it binds the aggregates into a solid mass.

Under normal conditions, concrete grows stronger as it grows older. The chemical reactions between cement and water that cause the paste to harden and bind the aggregates together require time. The reactions take place very rapidly at first and then more slowly over a long period of time. [2]

3. CEMENT

Cement is a material that has adhesive and cohesive properties enabling it to bond mineral fragments into a solid mass. Cement consists of silicates and aluminates of lime made from limestone and clay (or shale) which is ground, blended, fused in a kiln and crushed to a powder. Cement chemically combines with water (hydration) to form a hardened mass. The usual hydraulic cement is known as Portland cement because of its resemblance when hardened to Portland stone found near Dorset, England. The name was originated in a patent obtained by Joseph Aspdin of Leeds, England in 1824.

Typical Portland cements are mixtures of tricalcium silicate ($3CaO \cdot SiO2$), tricalcium aluminate ($3CaO \cdot Al2O3$), and dicalcium silicate ($2CaO \cdot SiO2$), in varying proportions, together with small amounts of magnesium and iron compounds. Gypsum is often added to slow the hardening process. [2,3]

4. WATER

The water has two roles in concrete mixture: First is the chemical composition with cement and perform cement hydration and second is to make the concrete composition fluent and workable. The water which is used to make the concrete is drink water. The impurity of water can have undesirable effect on concrete strength. [4]

5. AGGREGATES

Since aggregate usually occupies about 75% of the total volume of concrete, its properties have a definite influence on behavior of hardened concrete. Not only does the strength of the aggregate affect the strength of the concrete, its properties also greatly affect durability (resistance to deterioration under freeze-thaw cycles). Since aggregate is less expensive than cement it is logical to try to use the largest percentage feasible. Hence aggregates are usually graded by size and a proper mix has specified percentages of both fine and coarse aggregates. Fine aggregate (sand) is any material passing through a No. 4 sieve. Coarse aggregate (gravel) is any material of larger size.

Fine aggregate provides the fineness and cohesion of concrete. It is important that fine aggregate should not contain clay or any chemical pollution. Also, fine aggregate has the role of space filling between coarse aggregates. Coarse aggregate includes: fine gravel, gravel and coarse gravel

In fact coarse aggregate comprises the strongest part of the concrete. It also has reverse effect on the concrete fineness. The more coarse aggregate, the higher is the density and the lower is the fineness. [3,5]

6. COMPRESSIVE STRENGTH OF CONCRETE

The strength of concrete is controlled by the proportioning of cement, coarse and fine aggregates, water, and various admixtures. The ratio of the water to cement is the chief factor for determining concrete strength as shown in figure1. The lower the water-cement ratio, the higher is the compressive strength. A certain minimum amount of water is necessary for the proper chemical action in the hardening of concrete; extra water increases the workability (how easily the concrete will flow) but reduces strength. A measure of the workability is obtained by a slump test.

Actual strength of concrete in place in the structure is also greatly affected by quality control procedures for placement and inspection. The strength of concrete is denoted in the United States by f_c' which is the compressive strength of test cylinder 6 in. in diameter by 12 in. high measured on the 28th day after they are made. [3]

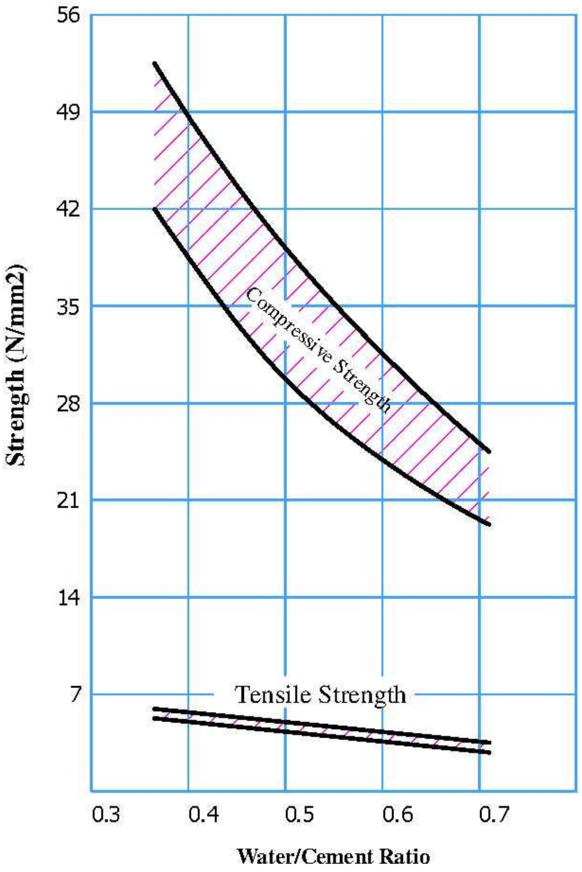

FIGURE 1: illustration of the effect of water/cement ratio in concrete strength [1]

7. CONCRETE SAMPLING

Acceptance of the concrete in the site is performed based on the results of the compressive tests of concrete samples. The concrete samples must be taken from the final consumption place.
The purpose of the concrete sampling is to prepare two specimens of concrete which their compressive tests will be performed after 28 days or in any predetermined day. To predict the 28-day compressive strength of concrete we can also have another sample to be tested earlier than 28 days. [1]

8. CONCRETE MIX DESIGN

The concrete mix design is a process of selecting the suitable ingredients of concrete and determining their most optimum proportion which would produce, as economically as possible, concrete that satisfies a certain compressive strength and desired workability. [6]
The concrete mix design is based on the principles of

- Workability
- Desired strength and durability of hardened concrete
- Conditions in site, which helps in deciding workability, strength and durability requirements

9. ADAPTIVE SYSTEMS

Adaptability, in essence, is the ability to react in sympathy with disturbances to the environment. A system that exhibits adaptability is said to be adaptive. Biological systems are adaptive systems; animals, for example, can adapt to changes in their environment through a learning process [7]. A generic adaptive system employed in engineering is shown in Figure 2. It consists of

- set of adjustable parameters (weights) within some filter structure;
- An error calculation block (the difference between the desired response and the output of the filter structure);
- A control (learning) algorithm for the adaptation of the weights.

The type of learning represented in Figure 2 is so-called supervised learning, since the learning is directed by the desired response of the system. Here, the goal is to adjust iteratively the free parameters (weights) of the adaptive system so as to minimize a prescribed cost function in some predetermined sense. [8]

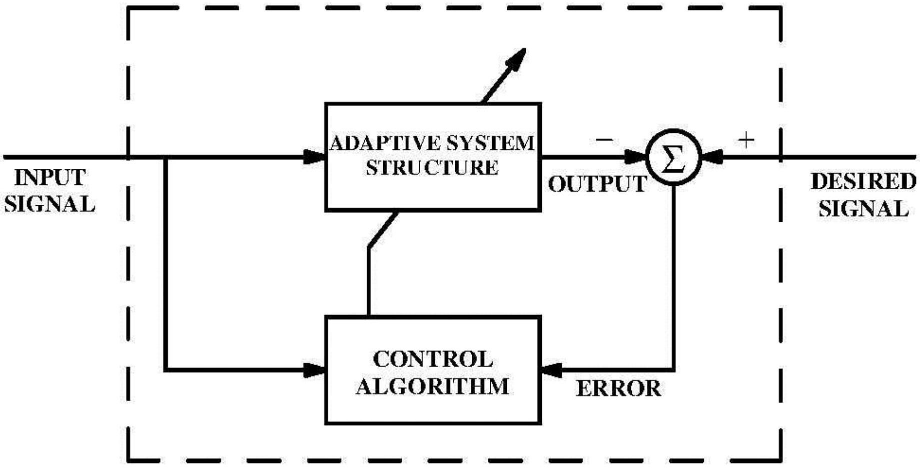

FIGURE 2: Block diagram of an adaptive system

10. ARTIFICIAL NEURAL NETWORKS

Artificial Neural Network (ANN) models have been extensively studied with the aim of achieving human-like performance, especially in the field of pattern recognition and system identification. These networks are composed of a number of nonlinear computational elements which operate in parallel and are arranged in a manner reminiscent of biological neural inter-connections.
The property that is of primary significance for a neural network is the ability of the network to learn from its environment, and to improve its performance through learning. The improvement in performance takes place over time in accordance with some prescribed measure. A neural network learns about its environment through an interactive process of adjustments applied its synaptic weights and bias levels. Ideally, the network becomes more knowledgeable about its environment after each iteration of the learning process. [7]

11. CONCRETE STRENGTH PREDICTION

To predict 28-day strength of concrete, It should identify the effective parameters of the concrete strength. The more accurately identified the parameters, the better is the result.
The studies in this paper were performed in two phases:

1. Phase one, includes the studies about the concrete and effective factors of the concrete compressive strength and also performing the experiments in the real environment and collecting data.
2. Phase two, include studies about how to use artificial neural networks to identify the presented system and to achieve accurate prediction of concrete 28-day compressive strength. [1]

12. PERFORMING EXPERIMENTS

In this study the ACI method is used to perform experiments. Experiments were performed in Aghchay dam in west Azerbaijan in IRAN. The cement used in the experiments was provided from Sofiyan cement plant and the aggregates were provided from the natural materials of the Aghchay dam site. [1]

13. COLLECTING DATA

There are lots of Parameters affect on compressive strength of concrete. But the most important parameters were collected in table 1. It is important that the range of each parameter is limited due to regarding ACI standard.

TABLE 1: Effective parameters of the compressive strength of the concrete

Row	Parameter	Unit	Range
1	Mix Design	-	A-L
2	Water/Cement Ratio	%	35.0 - 75.0
3	Density	ton/m3	2.30 - 2.60
4	Slump	mm	70 - 150
5	Air	%	1.0 - 7.0
6	Silica fumes	gr	0 - 400
7	Super-Plasticizer	kg	0.0 - 3.5
8	Age	day	3, 7, 14, 28, 42
9	Compressive Strength	kg/cm2	70.00 - 420.00

The concrete mix design is affected by these factors:
Cement, Fine aggregate, Fine gravel, gravel, coarse gravel, air

The 1st to 7th parameters are determined in the first day. There is a salient point about 8th parameter (age). As previously mentioned, the concrete age has a direct arithmetic relation with the concrete strength. The more aged the concrete the higher is the compressive strength. [1]
Here is an interesting point so that the 3-day compressive strength of concrete has a mathematical relation with the compressive strength of the same concrete in 7th, 14th, 28th and 42th day. Therefore it can be used as an important parameter for prediction of this system. In other words, the 3-day compressive strength of concrete is a very good criterion to achieve the 28-day compressive strength.
It is conceived from figure.3 that the higher the 3-day compressive strength the higher is the 28-day compressive strength of the concrete. Figure.4 shows the relationship between 3-day compressive strength and 28-day compressive strength for 4 types of concrete with variable w/c ratios, this relation is linear relatively.

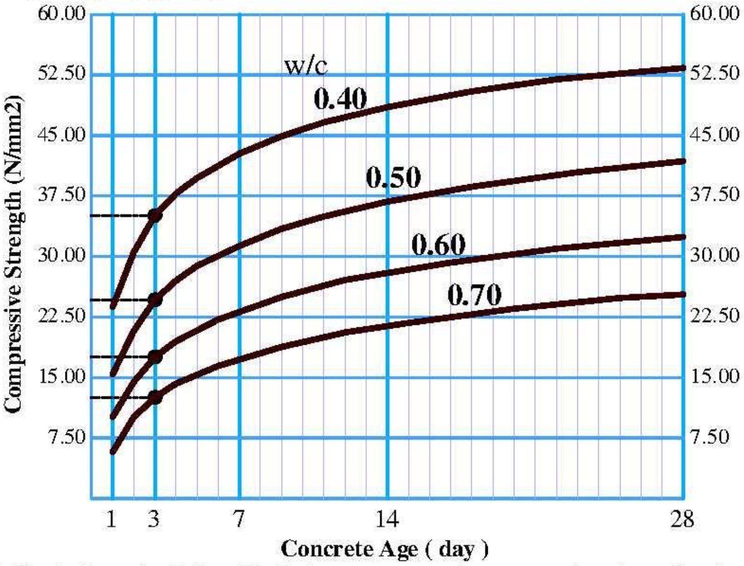

FIGURE 3: illustration of relationship between age and compressive strength of concrete [1]

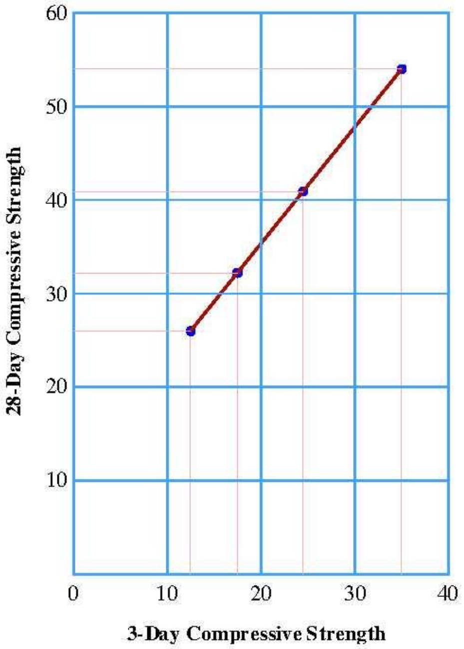

FIGURE 4: illustration of relationship between 3-day and 28-day strength of concrete [1]

14. METHODOLOGY OF CONCRETE STRENGTH NEURAL IDENTIFICATION

A methodology for concrete strength neural identification was developed. It is shown schematically in Figure 5. Three blocks can be distinguished in the scheme. Experimental results, forming a set of data on concrete, used for training and testing the neural network are an integral part of block1.

The experimental results as a set of patterns were saved in a computer file which was then used as the input data for the network in block 2. The data were divided into data for training and testing the neural network. The training patterns were randomly input into the network as following:

1. 70% of total data for training of the neural network
2. 15% of total data for validation of the neural network
3. 15% of total data for testing of the neural network,

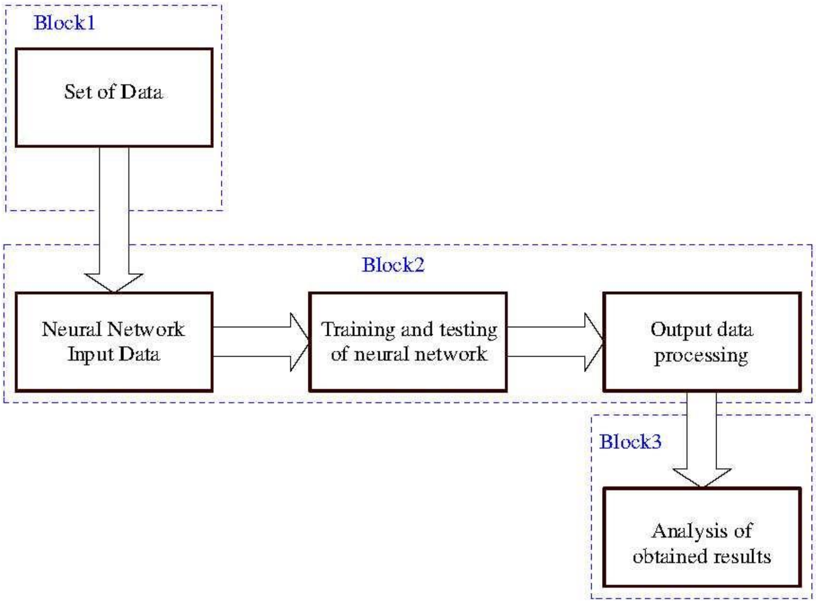

FIGURE 5: Block diagram of concrete compressive strength identification by means of neural networks [9]

If the neural network correctly mapped the training data and correctly identified the testing data, it was considered trained. The obtained results were analyzed in block 3 whose output was identified concrete compressive strength f'_c. [9]

15. FEED-FORWARD NEURAL NETWORK

The Feed-forward neural network structure for prediction of concrete compressive strength is shown in Figure 6. Feed-forward networks often have one or more hidden layers of sigmoid neurons followed by an output layer of linear neurons. Multiple layers of neurons with nonlinear transfer function allow the network to learn nonlinear and linear relationships between inputs and outputs. [10]

The process of learning with teacher in this network is executed through a back-propagation algorithm so that the network output converges to the desired output. The key distinguishing characteristic of this feed-forward neural network with the back-propagation learning algorithm is that it forms a nonlinear mapping from a set of input stimuli to a set of output using features extracted from the input patterns. The network can be designed and trained to accomplish a wide variety of nonlinear mappings, some of which are very complex. This is because the neural units in the neural network learn to respond to features found in the input. [11]

The number of input and output units is determined by dimensions of the data set whereas the number of hidden layer (M) is a free parameter which is adjusted to achieve the maximum performance. Note that, M determines the degree of freedom of the system. Therefore we expect that there was an optimum value for M. The criterion to achieve the optimum M is defined as: "The smallest M which causes minimum mse while the maximum error is small"

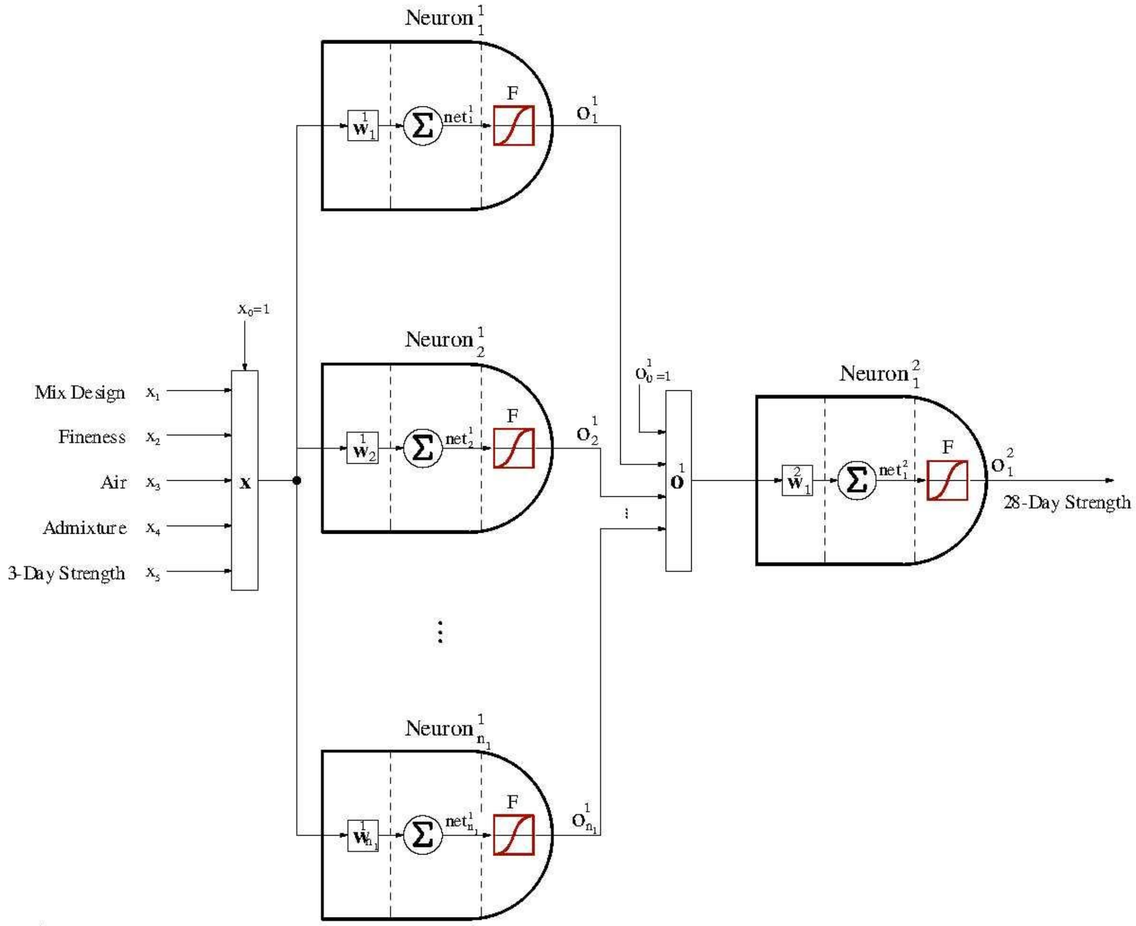

FIGURE 6: Diagram of the feed-forward neural network used for concrete compressive strength prediction

Figure.7 shows the mean squared error of the network output for validation and test data with 10 iterations for each number of hidden neurons. Figure.8 shows the maximum error between desired outputs and the network outputs with 10 iterations for each number of hidden neurons.
The optimum value in this structure is to choose *M=11* for the number of hidden neurons.
In order to backpropagage the error and update the network weights, Gradient-Descent, Quasi-Newton, Conjugate-Gradient and Levenberg-Marquardt Algorithms were used.

- Gradient Descent $W(k+1)=W(k)-\alpha_K g_k$
- Quasi Newton $W(k+1)=W(k)-H_K^{-1}g_K$
- Conjugate Gradient $W(k+1)=W(k)-g_{k+1}+\alpha_K \Delta W_K$

Where *W* is the weight matrix, *α* is the learning rate, *g* is the gradient of error and *H* is the hessian matrix of the cost function. [12]
The levenberg-marquardt algorithm is like quasi-newton but it doesn't need to calculate hessian matrix where it can be estimated as follows:

$$H = J^T J \quad , \quad \nabla E = J^T e$$

$$W(k+1) = W(k) - [H + \mu I]^{-1} . \nabla E$$

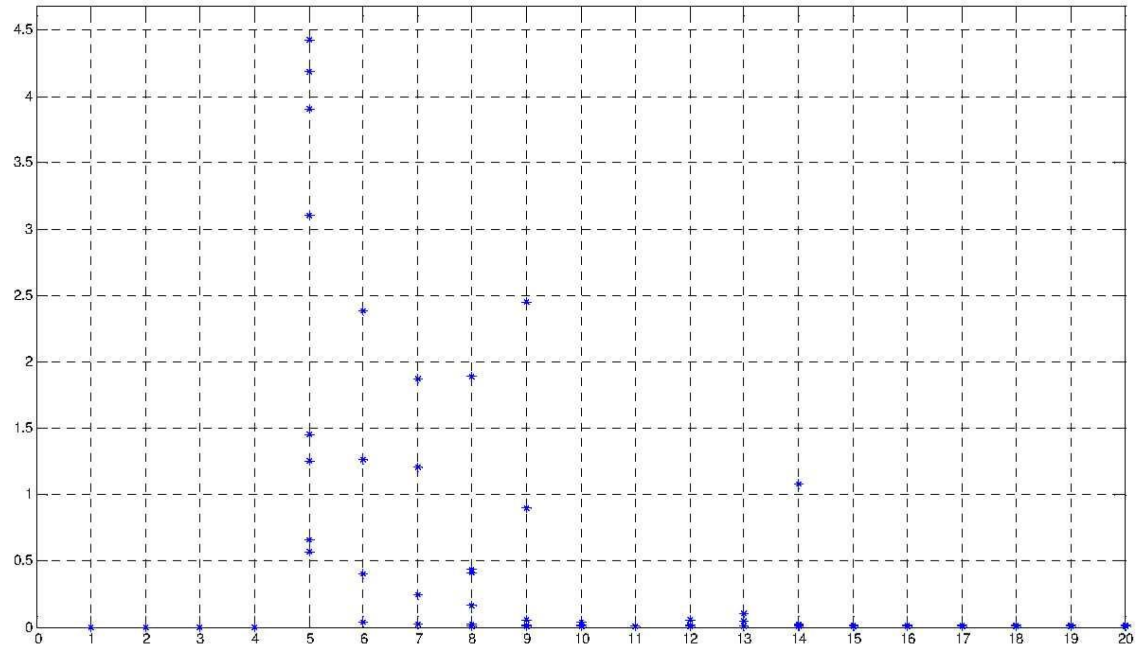

FIGURE 7: Diagram of mean squared error of the network output with 10 iterations for certain number of neurons

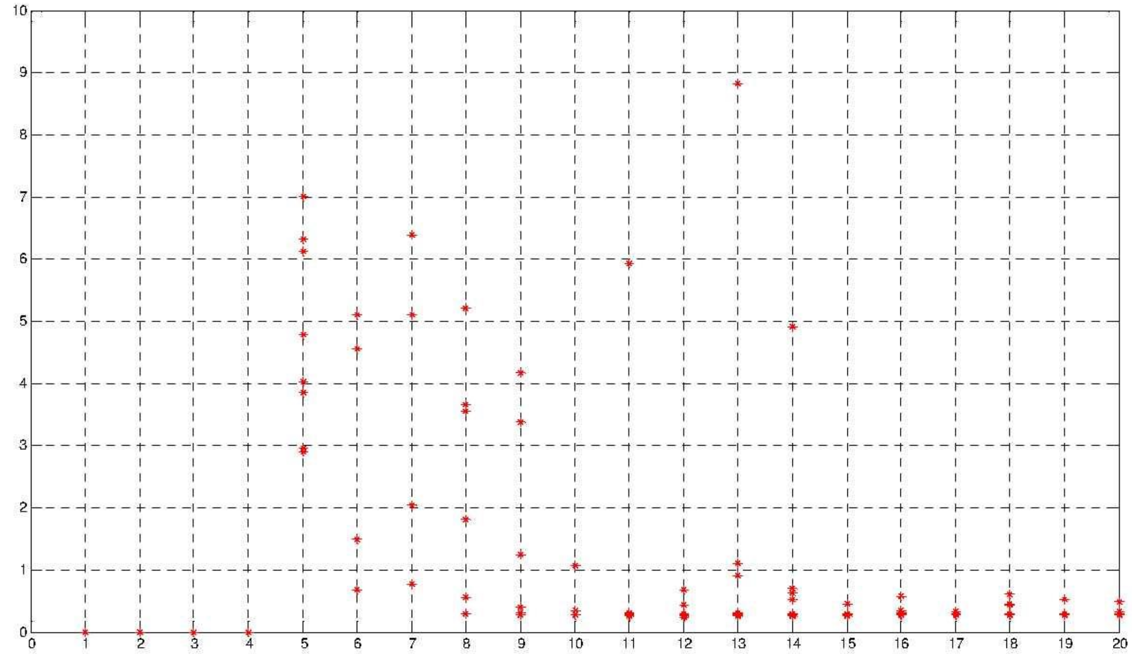

FIGURE 8: Diagram of maximum error of the network output with 10 iterations for certain number of neurons

The results of above algorithms have been collected in Table 2. Each row of the table is the result of average 40 iterations of each method. Evaluation criterion of adaptive systems was defined as following formula:

$$AveragePercentageError : APE = \frac{1}{N}\sum_{i=1}^{N}\left|\frac{e_i}{T_i}\right| *100\%$$

Where T_i is the desired output and e_i is the output error. [13]

TABLE 2: Comparison of different algorithms used for predicting the concrete compressive strength

Row	Algorithm	Accuracy on data (%)				Ave. Time
		Train	Validation	Test	Total	(second)
1	Levenberg-Marquardt	99.436	99.389	99.397	99.407	7.7
2	Polak-Ribiere Conjugate Gradient	98.861	98.836	98.866	98.854	17.3
3	Fletcher-Powell Conjugate Gradient	98.713	98.675	98.695	98.694	12.4
4	Gradient Descent	98.584	98.567	98.606	98.586	24.3
5	Quasi-Newton	98.388	98.341	98.423	98.384	89.2
		Maximum Error (kg/cm2)				epochs
1	Levenberg-Marquardt	5.830	5.056	4.437	5.108	58
2	Polak-Ribiere Conjugate Gradient	9.686	8.536	7.652	8.635	571
3	Fletcher-Powell Conjugate Gradient	10.758	9.457	8.597	9.604	368
4	Gradient Descent	11.897	10.376	9.018	10.430	1833
5	Quasi-Newton	13.825	11.539	10.691	12.018	1999

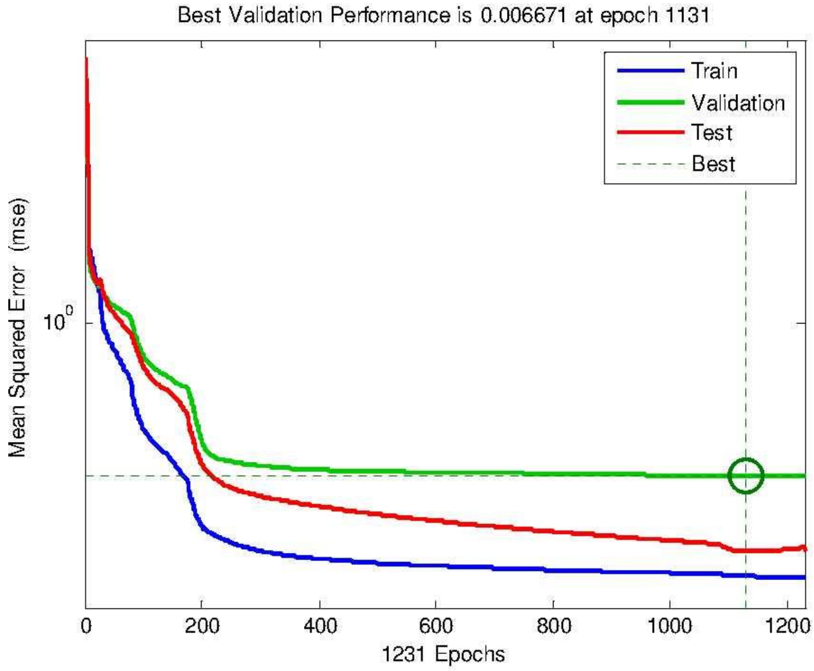

FIGURE 9: Diagram of mean squared error in the feed-forward neural network

It is conceived from table 2, that the best structure for prediction of concrete strength is the first method with levenberg-marquardt algorithm.

Figure 9 shows the mse diagram of the cost function reduction for training, validation and test data. The following results are being conceived from this figure.

1. The final mse is small and admissible
2. The test dataset error and validation dataset error are almost equal.
3. Over fitting was not happened

The diagram of figure.10 also shows the linear regression between network output and desired output for training, validation, test and total data.

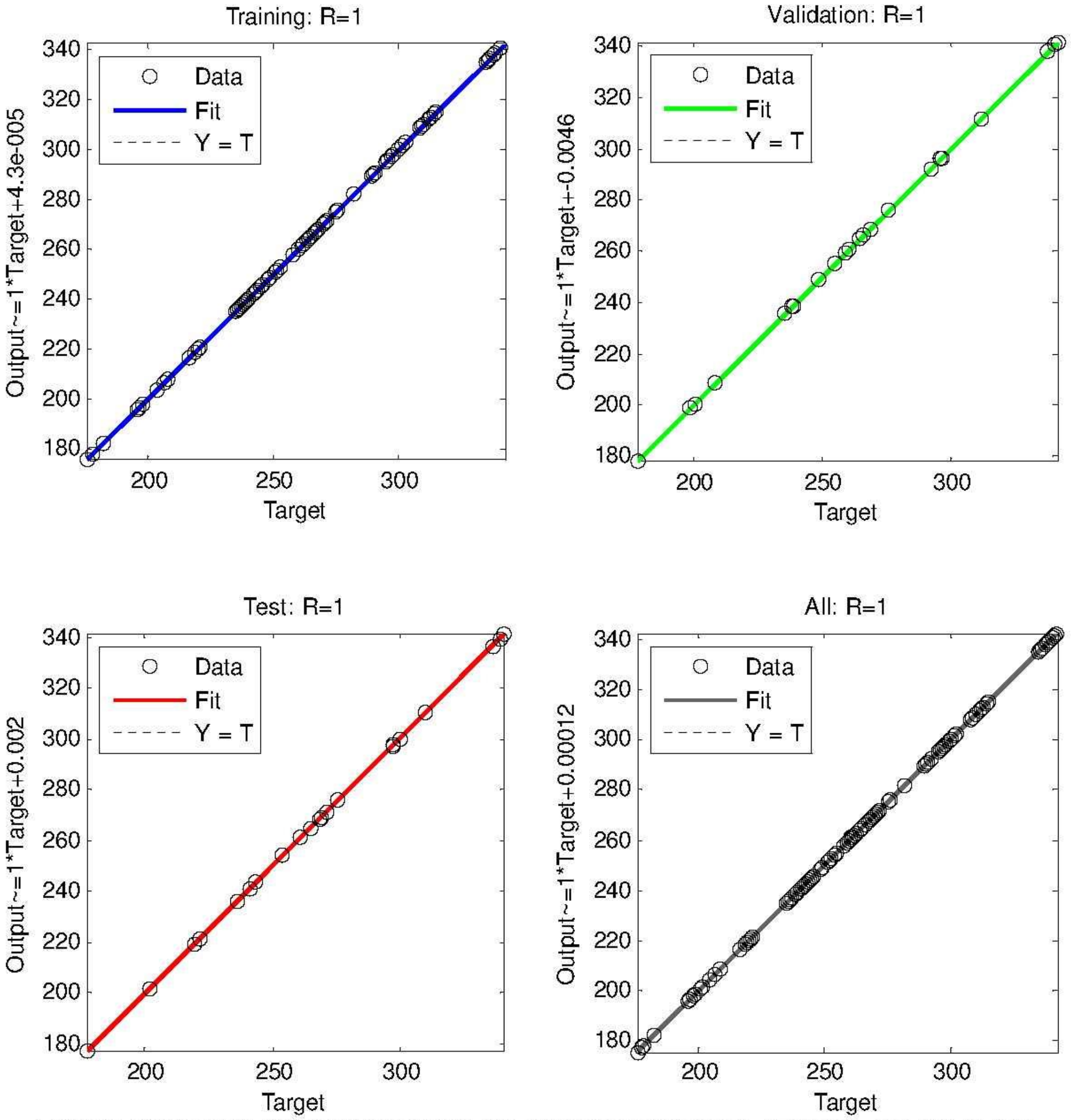

FIGURE 10: Diagram of the network output and desired output for train, validation, test and all data

16. CONCLUSION

In this paper, a practical approach has been presented for prediction of 28-day compressive strength of concrete. Basically, in all of the methods have been resented previously, the 3-day compressive strength of concrete was not considered as an important parameter.

From this point of view we can consider the proposed method as a new method in which the 3-day compressive strength parameter has been introduced as a very important index. [Ref: 13, 14, 15, 16]

The proposed technique can be used as a very useful tool for reducing the duration of the project execution in huge civil projects. For example, imagine if we have a massive concrete structure which requires 10 stages of concreting then we need at least 28×10=280 days to complete the total project regarding to standards. Therefore this project will be finished after about 1 year considering the frigid winter days which concreting is impossible.

Using the proposed tool we can have a precise prediction of the 28-day compressive strength of the concrete on the third day. Thereupon we need 3×10=30 days to complete this project and this is an important progress in order to reducing the duration of the civil projects execution.

17. REFERENCES

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Civilab
Civil Engineering Testing Laboratories

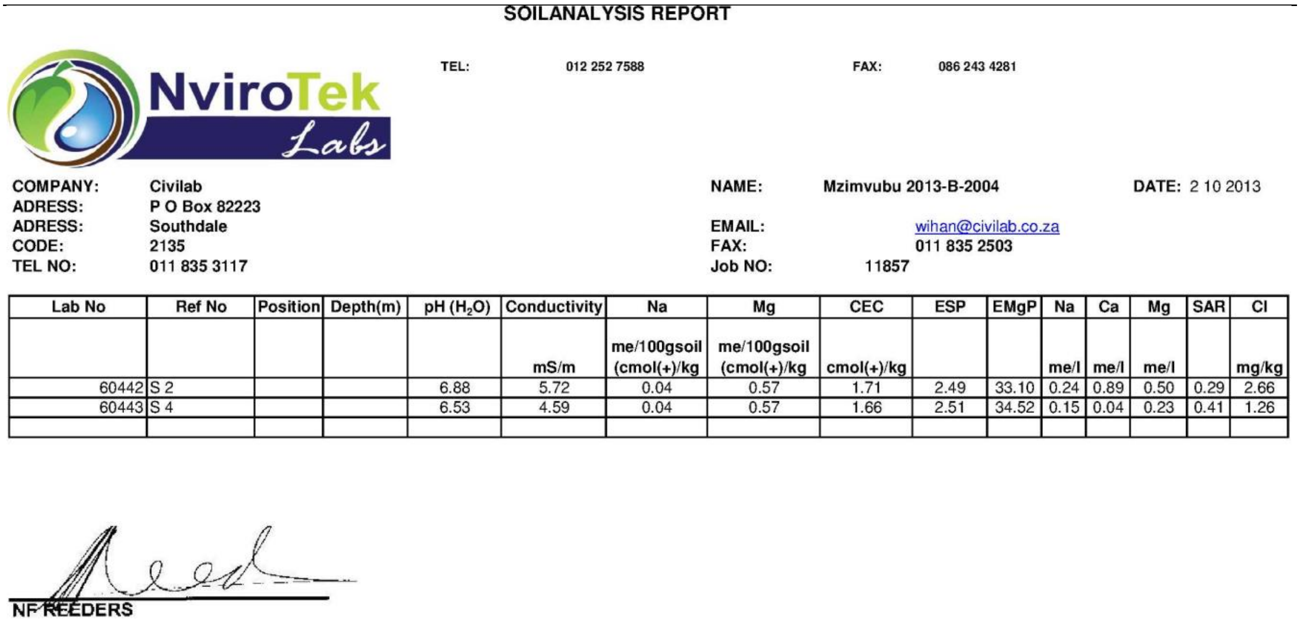
Job No : 2013-B-2004	Date : 24/01//2014
Project : MZIMVUBU	

SOLUBLE DELETERIOUS IMPURITIES

Sample No	10 day cube strength of unwashed sand (a)	18 day cube strength of washed sand	*Interpolated 10 day cube strength of washed sand (b)	a/b %
2004-41	10.1	13.5	11.9	85
2004-43	8.4	11.6	10.2	82

NOTES:
Tested according to SABS test methods 834:1994
* Data interpolated with the aid of page 570 of the International Journal of Engineering, Volume 3: Issue 6. (Submitted with test results)

solDelF2013-B-2004



SOILANALYSIS REPORT

NviroTek Labs

TEL: 012 252 7588 **FAX:** 086 243 4281

COMPANY: Civilab
ADRESS: P O Box 82223
ADRESS: Southdale
CODE: 2135
TEL NO: 011 835 3117

NAME: Mzimvubu 2013-B-2004
DATE: 2 10 2013
EMAIL: wihan@civilab.co.za
FAX: 011 835 2503
Job NO: 11857

Lab No	Ref No	Position	Depth(m)	pH (H_2O)	Conductivity	Na	Mg	CEC	ESP	EMgP	Na	Ca	Mg	SAR	Cl
					mS/m	me/100gsoil (cmol(+)/kg	me/100gsoil (cmol(+)/kg	cmol(+)/kg			me/l	me/l	me/l		mg/kg
60442	S 2			6.88	5.72	0.04	0.57	1.71	2.49	33.10	0.24	0.89	0.50	0.29	2.66
60443	S 4			6.53	4.59	0.04	0.57	1.66	2.51	34.52	0.15	0.04	0.23	0.41	1.26

NF REEDERS

H 9

WATER

CONTEST
Concrete Technology Services
P O Box 1675, Hillcrest, 3650, South Africa. Tel (031) 700 9394 (031) 700 9342
E-mail : contest@contest.co.za Web Page: www.contest.co.za

Ref: CJ13/08/739 16 August 2013
Client: Jeffares & Green
Subject: Water Testing

LABORATORY REPORT

CLIENT
Jeffares & Green, P O Box 794, HILTON, 3245

SYNOPSIS:
Physical and chemical tests on a sample of water have been provided.

BRIEF FROM CLIENT:
Contest were requested to analyse the samples for;

- Total dissolved solids
- Chloride content
- Calcium hardness as $CaCO_3$
- pH
- Sulphates (as SO_3)
- Comparative Cubes

SAMPLES:
4 5litres samples of water, referenced, Tsitsa River, by the client, were received on 07.08.2013.

TESTING:
The following test methods were used;

- Total dissolved solids - SABS Standard Method 213.
- Chloride content - Volhard method typically as described in Quantitative Analytical Chemistry by Fritz & Schenk.
- Calcium Hardness of water - SABS Standard Method 216. This does not give the total carbonates and bicarbonates, but simply the calcium hardness or equivalent calcium carbonate in mg/ℓ.
- pH - as described in the operating manual of our pH meter - a WTW inoLab pH720 meter and using Hanna buffer solutions for calibration.
- Sulphate - SABS Standard Method 212.

Ref: CJ13/08/739 16 August 2013

Client: Jeffares & Green

Subject: Water Testing

- Comparative Cubes

All tests were carried out in duplicate i.e. an A and B sample and the average values determined and reported.

RESULTS:

Chemical Testing:

	Client Sample
TDS (mg/ℓ)	105.5
Chloride (Cl^-) (mg/ℓ)	5.3
Calcium Hardness as $CaCO_3$ (mg/ℓ)	101.6
pH	7.75
Sulphate (SO_3) (mg/ℓ)	None detected

Physical Testing:

Comparative cubes:

	Control	**Sample**	**Sample as % of Control**
	MPa	MPa	%
24hr	4.6	4.5	98
5d	14.9	15.1	101
7d	16.8	17.6	105
28d	tba	tba	tba

COMMENT:

The results indicate that the water sample is suitable for concrete manufacture.

We have used the following limits based on various sources for a number of years.

	(mg/ℓ)
Total dissolved solids	2000
Chloride (as Cl^-)	500
Calcium Hardness(as $CaCO_3$)	400
pH	6 to 8

Sulphate as SO_3	1000

These values seem to be conservative based on some of the latest publications; in particular the upper range of pH seems to have been increased substantially, probably with the experience of using wash water in RMC plants.

The ninth edition of Fulton's Concrete Technology states that the mean compressive strength at **seven** days of the test specimen, prepared with the test water, shall be 90% of the mean compressive strength of the corresponding specimens prepared with distilled or deionised water.

However, the eight edition of Fulton's Concrete Technology states that the compressive strength of 'test' cubes at 28 days should be no less than 90% of the control cubes.

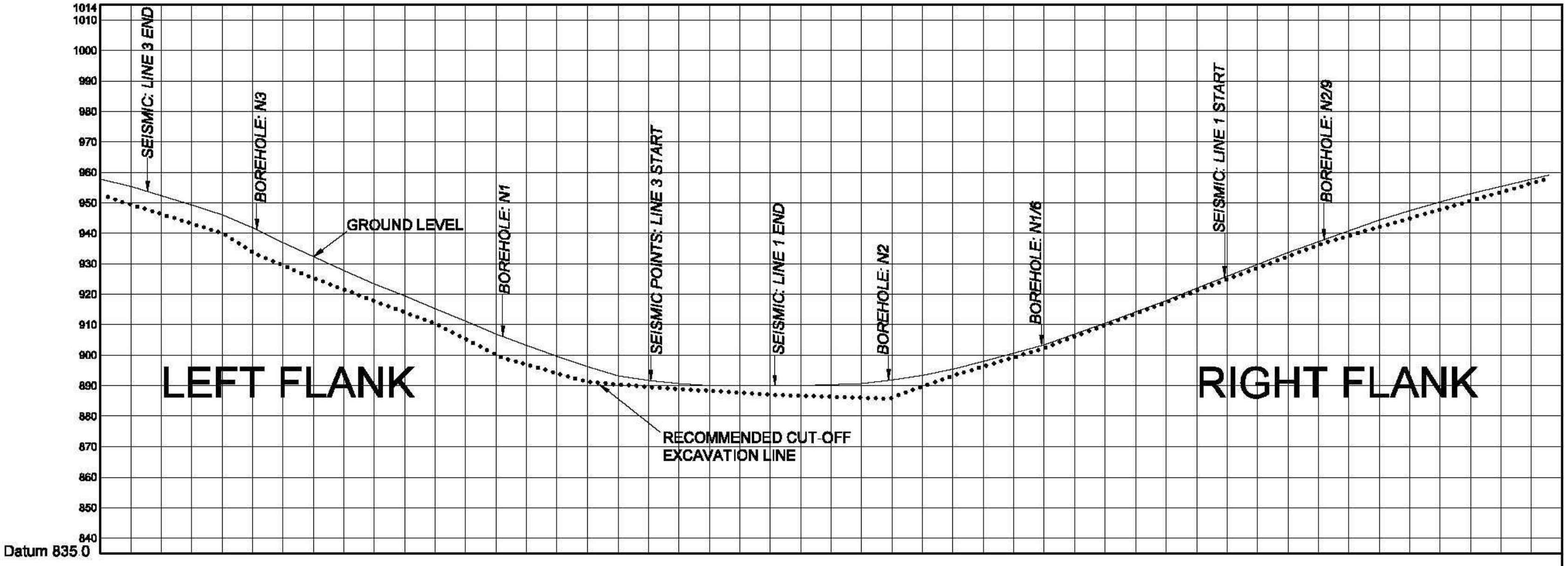
BS 3148 has suggested that if the strength is between 80 and 90%, then the water can still be used if the concrete mix proportions are adjusted.

Compressive strength of cubes at 24 hours and 5 days was carried out to determine any early age effect on the concrete strength.

R J L Raw
B Tech (Civil Eng)

APPENDIX I

LONGITUDINAL SECTION SHOWING RECOMMENDED CUT-OFF EXCAVATION



Chainage	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240
Centreline Peg Levels	957.72	955.34	952.36	949.37	946.08	941.83	936.88	932.34	927.81	923.36	919.44	915.34	911.17	906.93	903.23	899.70	896.32	893.33	891.67	890.71	890.00	890.00	890.00	890.13	890.43

Chainage	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	475.72	
Centreline Peg Levels	890.73	891.93	893.46	895.41	898.04	900.69	903.39	906.93	910.49	914.22	918.01	922.00	925.98	929.88	933.72	937.28	940.91	944.41	947.44	950.38	953.02	955.46	957.86	959.12	

PROPOSED NTABELANGA DAM
LONGITUDINAL SECTION SHOWING RECOMMENDED CUT-OFF EXCAVATION PROFILE
CHAINAGE 0 TO 475 m
LONGITUDINAL SECTION

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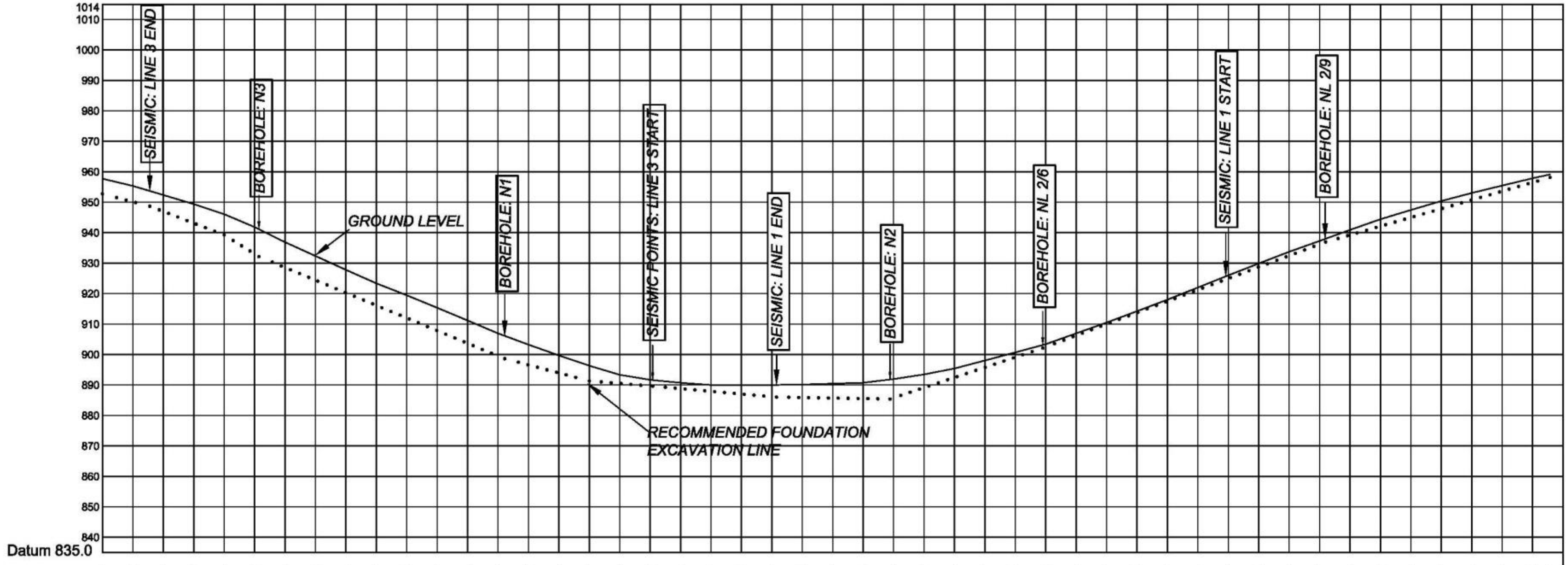
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

Jeffares & Green

SCALES
Horizontal Scale 1:2000
Vertical Scale 1:2000

Fig I-1: LS - Recommended Cut-Off Excavation Profile



Chainage	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
Centreline Peg Levels	957.72	955.34	952.36	949.37	946.08	941.83	936.88	932.34	927.81	923.36	919.44	915.34	911.17	906.93	903.23	899.70	896.32

Chainage	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330
Centreline Peg Levels	893.33	891.67	890.71	890.00	890.00	890.00	890.13	890.43	890.73	891.93	893.46	895.41	898.04	900.69	903.39	906.93	910.49

Chainage	340	350	360	370	380	390	400	410	420	430	440	450	460	470	475.72
Centreline Peg Levels	914.22	918.01	922.00	925.98	929.88	933.72	937.28	940.91	944.41	947.44	950.38	953.02	955.46	957.86	959.12

PROPOSED NTABELANGA DAM
LONGITUDINAL SECTION SHOWING RECOMMENDED FOUNDATION EXCAVATION PROFILE
FOR LINE 1
CHAINAGE 0 TO 475 m
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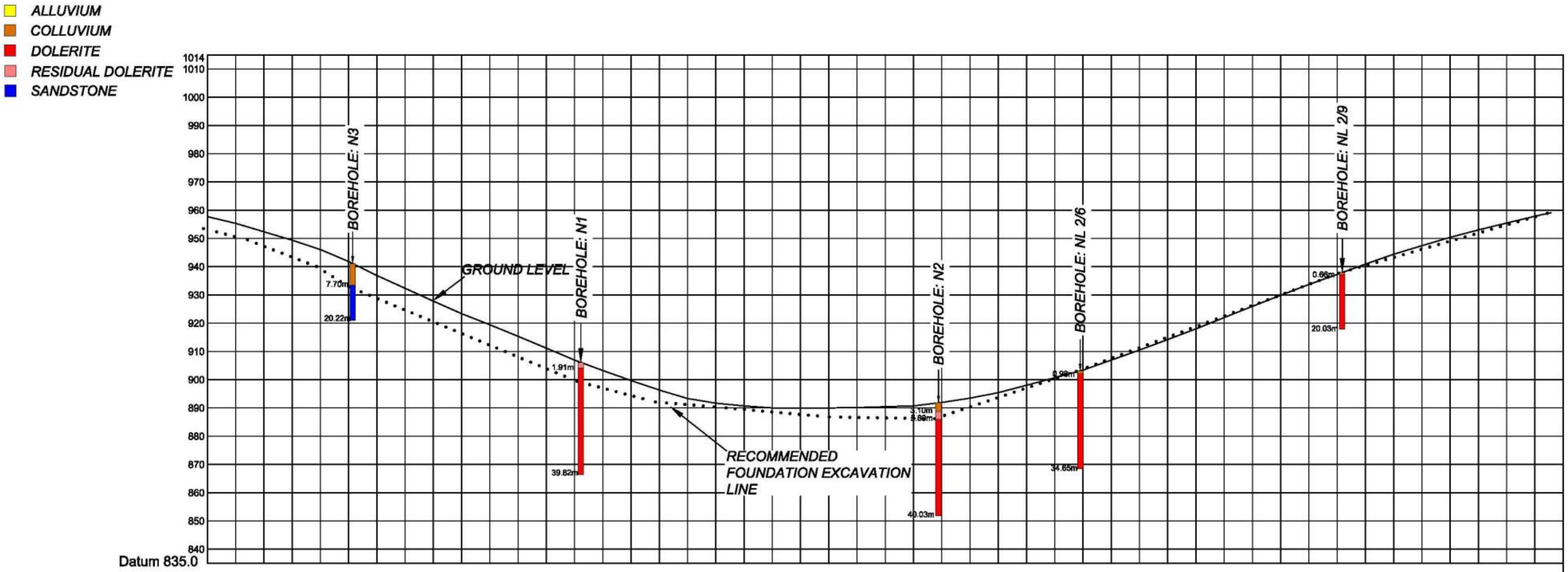
Horizontal Scale 1:2000
Vertical Scale 1:2000

Fig I-2: LS - Recommended Foundation Excavation Profile for Line 1



Chainage	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Centreline Peg Levels	957.72	955.34	952.36	949.37	946.08	941.83	936.88	932.34	927.81	923.36	919.44	915.34	911.17	906.93	903.23	899.70

Chainage	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310
Centreline Peg Levels	896.32	893.33	891.67	890.71	890.00	890.00	890.00	890.13	890.43	890.73	891.93	893.46	895.41	898.04	900.69	903.39

Chainage	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	475.72
Centreline Peg Levels	906.93	910.49	914.22	918.01	922.00	925.98	929.88	933.72	937.28	940.91	944.41	947.44	950.38	953.02	955.46	957.86	959.12

PROPOSED NTABELANGA DAM
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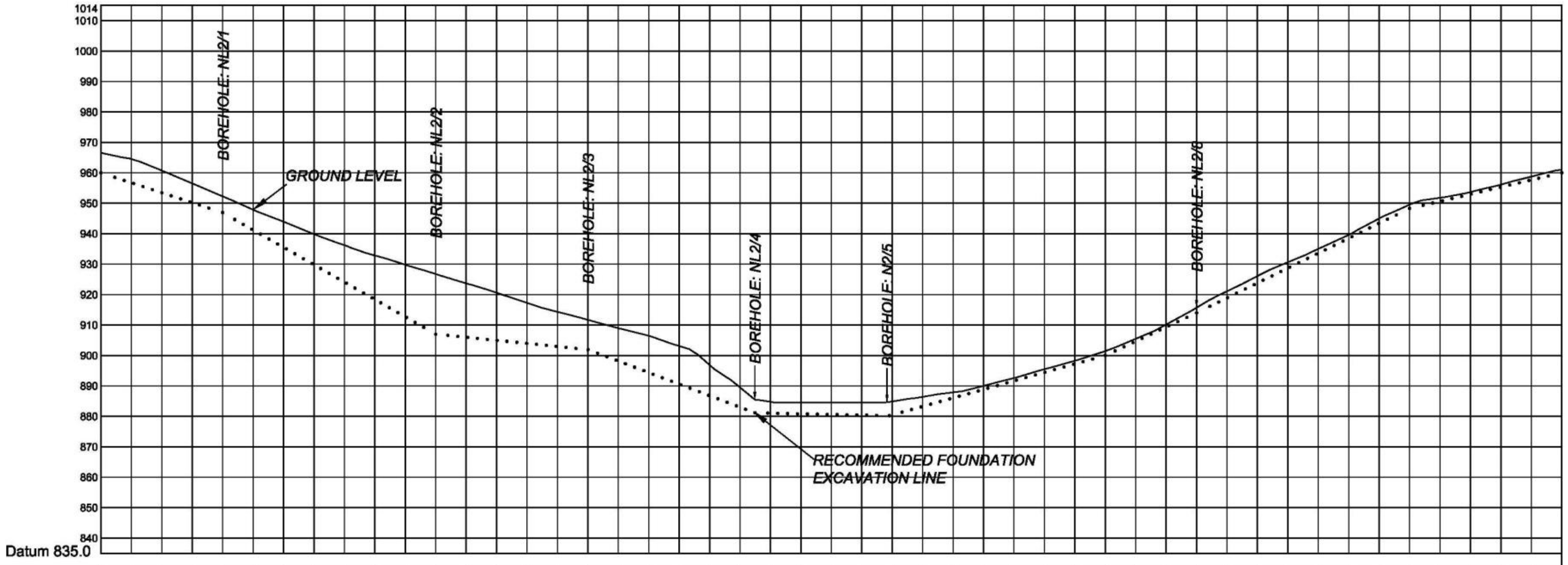
Vertical Scale 1:2000

Fig I-3: LS - Recommended Foundation Excavation Profile for Line 1



Chainage	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Centreline Peg Levels	966.57	964.53	960.75	956.52	952.27	947.88	943.97	939.85	936.23	932.85	929.79	926.74	923.69	920.63	917.27	914.33

Chainage	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310
Centreline Peg Levels	911.70	908.96	906.46	903.10	896.87	889.49	884.76	884.53	884.53	884.51	884.88	886.40	887.88	890.01	892.56	895.49

Chainage	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480
Centreline Peg Levels	898.26	901.42	905.47	910.16	915.69	921.09	926.09	930.63	935.01	939.62	945.00	949.53	951.81	953.69	956.12	958.75	961.02

PROPOSED NTABELANGA DAM
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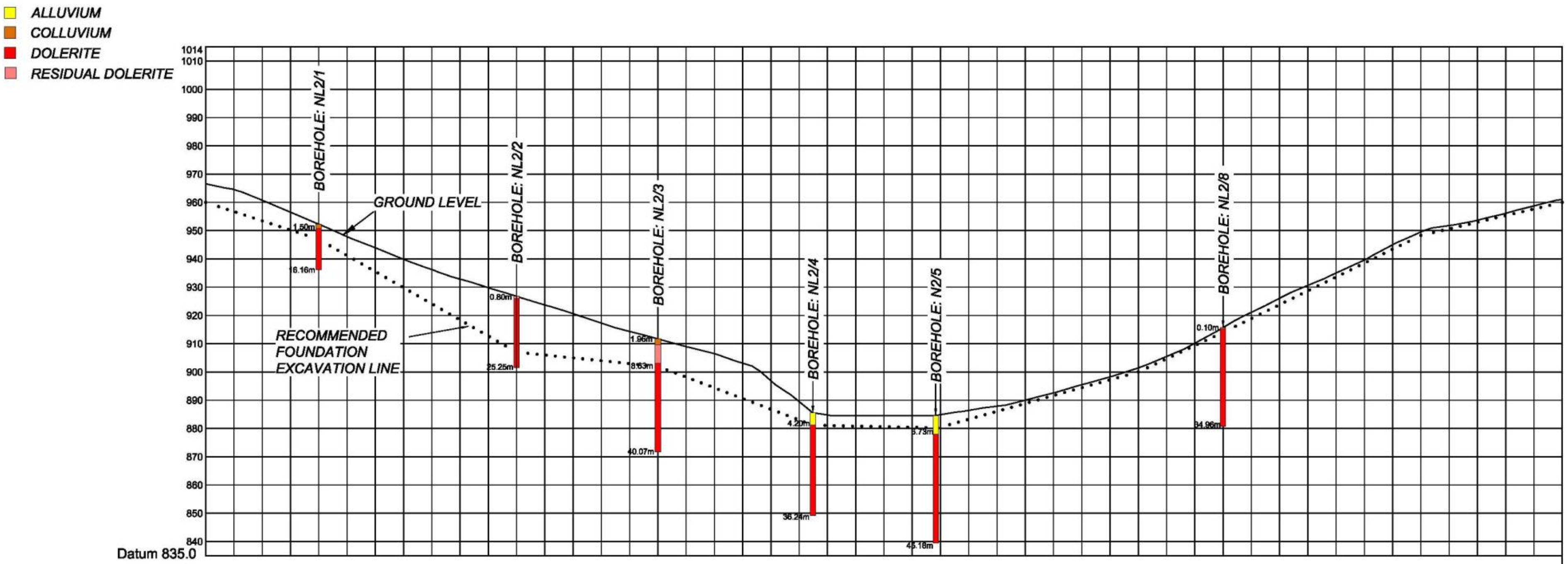
Fig I-4: LS - Recommended Foundation Excavation Profile for Line 2



Chainage	0	10	20	30	40	50	60	70	80	90	100	110	120
Centreline Peg Levels	966.57	964.53	960.75	956.52	952.27	947.88	943.97	939.85	936.23	932.85	929.79	926.74	923.69

Chainage	130	140	150	160	170	180	190	200	210	220	230	240	250
Centreline Peg Levels	920.63	917.27	914.33	911.70	908.96	906.46	903.10	896.87	889.49	884.76	884.53	884.53	884.51

Chainage	260	270	280	290	300	310	320	330	340	350	360	370	380
Centreline Peg Levels	884.88	886.40	887.88	890.01	892.56	895.49	898.26	901.42	905.47	910.16	915.69	921.09	926.09

Chainage	390	400	410	420	430	440	450	460	470	480
Centreline Peg Levels	930.63	935.01	939.62	945.00	949.53	951.81	953.69	956.12	958.75	961.02

PROPOSED NTABELANGA DAM
LONGITUDINAL SECTION SHOWING RECOMMENDED FOUNDATION EXCAVATION PROFILE
FOR LINE 2
CHAINAGE 0 TO 480 m
LONGITUDINAL SECTION

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SCALES
Horizontal Scale 1:2000
Vertical Scale 1:2000

Fig I-5: LS - Recommended Foundation Excavation Profile for Line 2