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:

LALINI DAM AND HYDROPOWER SCHEME

APPENDICES

OCTOBER 2014

LIST OF REPORTS

REPORT TITLE	DWS REPORT NUMBER
Inception Report	P WMA 12/T30/00/5212/1
Environmental Screening	P WMA 12/T30/00/5212/2
Preliminary Study	P WMA 12/T30/00/5212/3
Feasibility Study: Main Report	P WMA 12/T30/00/5212/4
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Volume 2: Book of Drawings	
FEASIBILITY STUDY: SUPPORTING REPORTS:	
Water Resources	P WMA 12/T30/00/5212/5
Water Requirements	P WMA 12/T30/00/5212/6
Reserve Determination	P WMA 12/T30/00/5212/7
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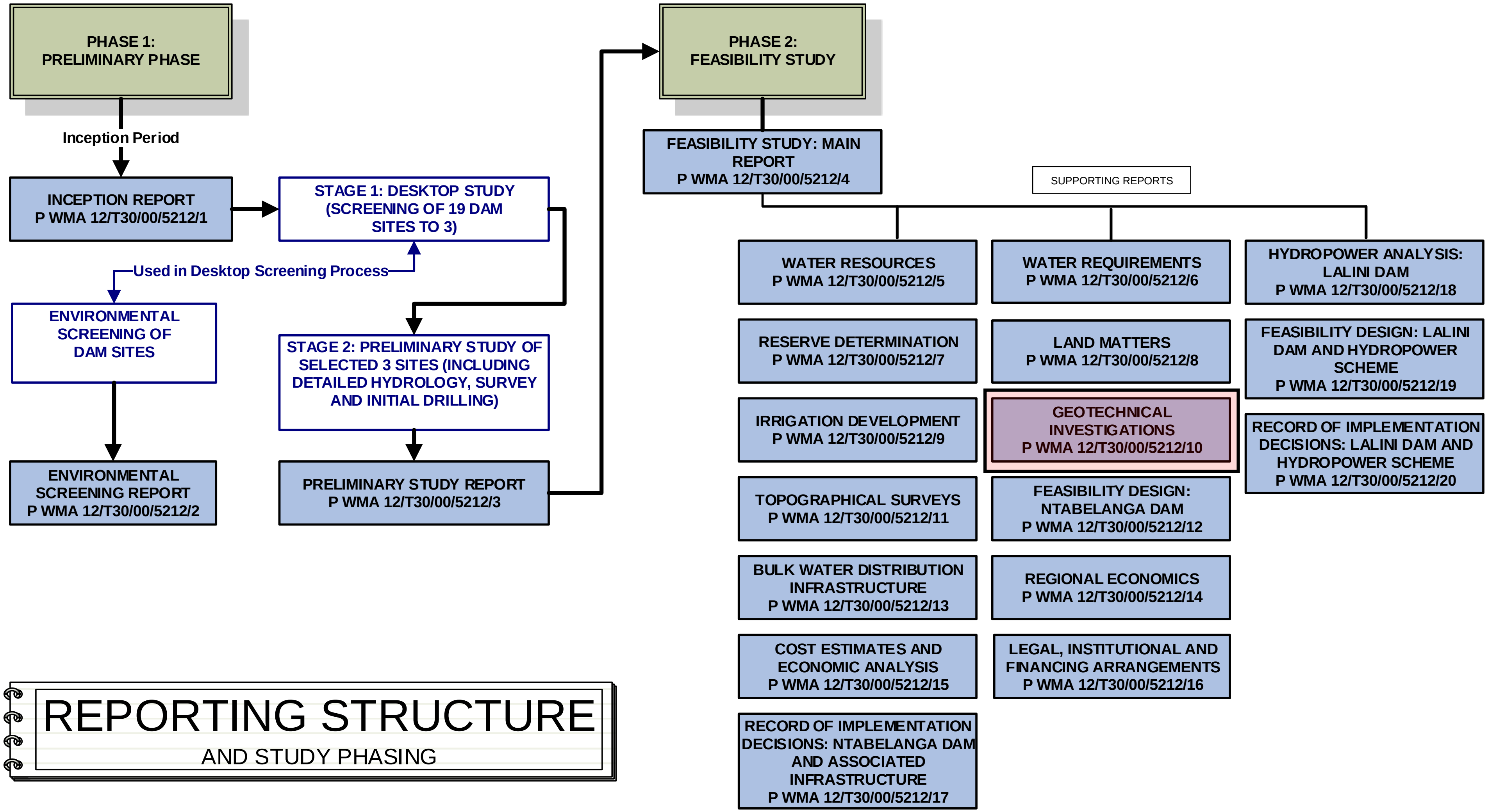
Volume 2: Estuary: Report	
Volume 3 :Estuary: Appendices	
Land Matters	P WMA 12/T30/00/5212/8
Irrigation Development	P WMA 12/T30/00/5212/9
Geotechnical Investigations	**P WMA 12/T30/00/5212/10**
Volume 1: Ntabelanga, Somabadi and Thabeng Dam Sites: Report	
Volume 2: Ntabelanga, Somabadi and Thabeng Dam Sites: Appendices	
Volume 3: Lalini Dam and Hydropower Scheme: Report	
Volume 4: Lalini Dam and Hydropower Scheme: Appendices	
Topographical Surveys	P WMA 12/T30/00/5212/11
Feasibility Design: Ntabelanga Dam	P WMA 12/T30/00/5212/12
Bulk Water Distribution Infrastructure	P WMA 12/T30/00/5212/13
Regional Economics	P WMA 12/T30/00/5212/14
Cost Estimates and Economic Analysis	P WMA 12/T30/00/5212/15
Legal, Institutional and Financing Arrangements	P WMA 12/T30/00/5212/16
Record of Implementation Decisions: Ntabelanga Dam and Associated Infrastructure	P WMA 12/T30/00/5212/17
Hydropower Analysis: Lalini Dam	P WMA 12/T30/00/5212/18
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: Lalini Dam and Hydropower Scheme: Appendices***

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

Prepared for: Directorate – Options Analysis

Prepared by: Jeffares & Green (Pty) Ltd, P O Box 794, Hilton, 3245
Tel: 033 343 6700, Fax: 033 343 6701
Contact: Mr A Pepperell
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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.

VOLUME 4

APPENDICES

APPENDIX A: SITE PLANS

APPENDIX B: DAM BOREHOLE LOGS, PHOTOPGRAPHS AND WATER PRESSURE TESTS

APPENDIX C: QUARRY BOREHOLE LOGS AND PHOTOGRAPHS

APPENDIX D: TUNNEL BOREHOLE LOGS, PHOTOGRAPHS AND WATER PRESSURE TESTS

APPENDIX E: LABORATORY TEST RESULTS

APPENDIX F: TRIAL PIT LOGS

APPENDIX A

SITE PLANS

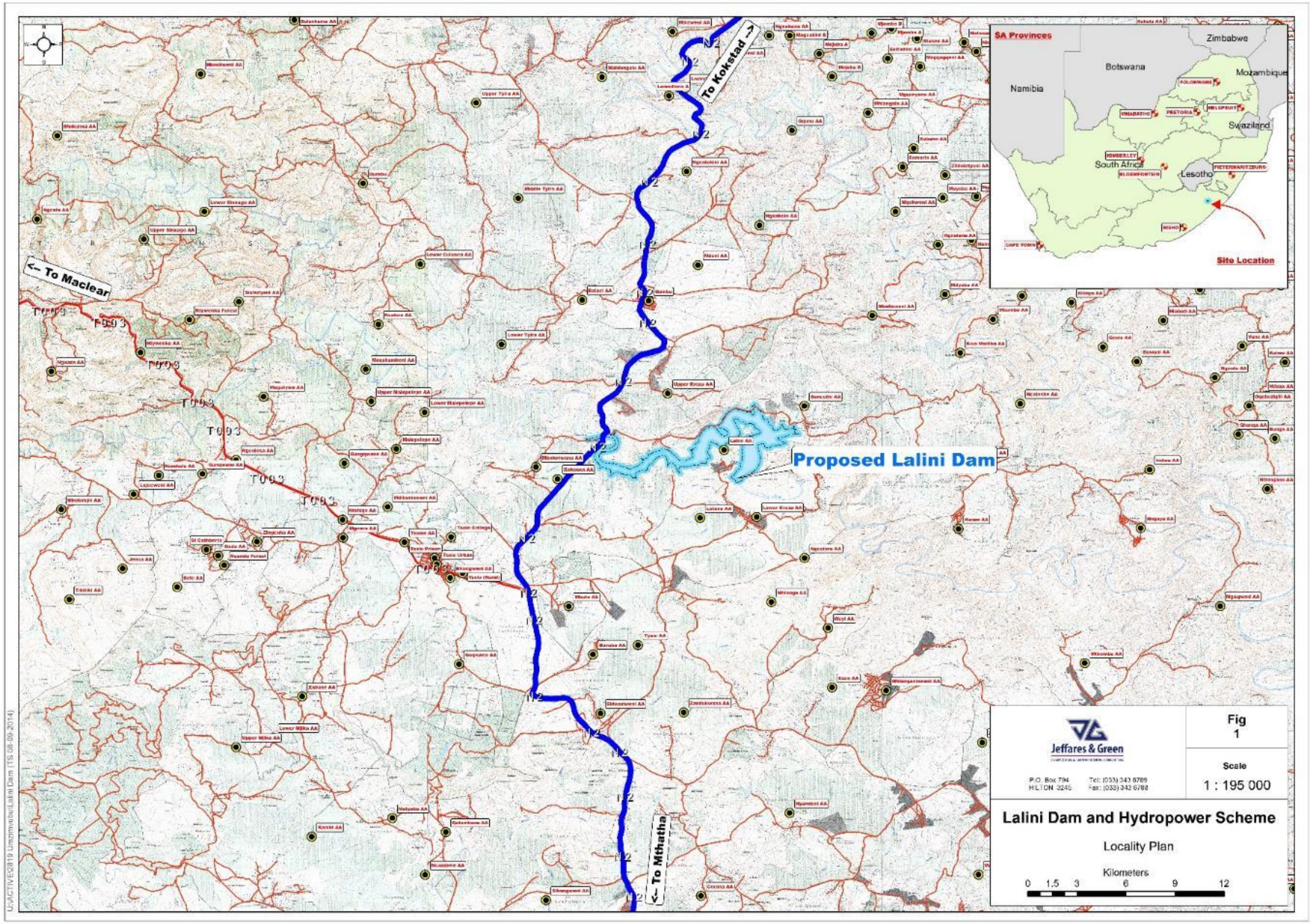


Fig A-1: Locality Plan

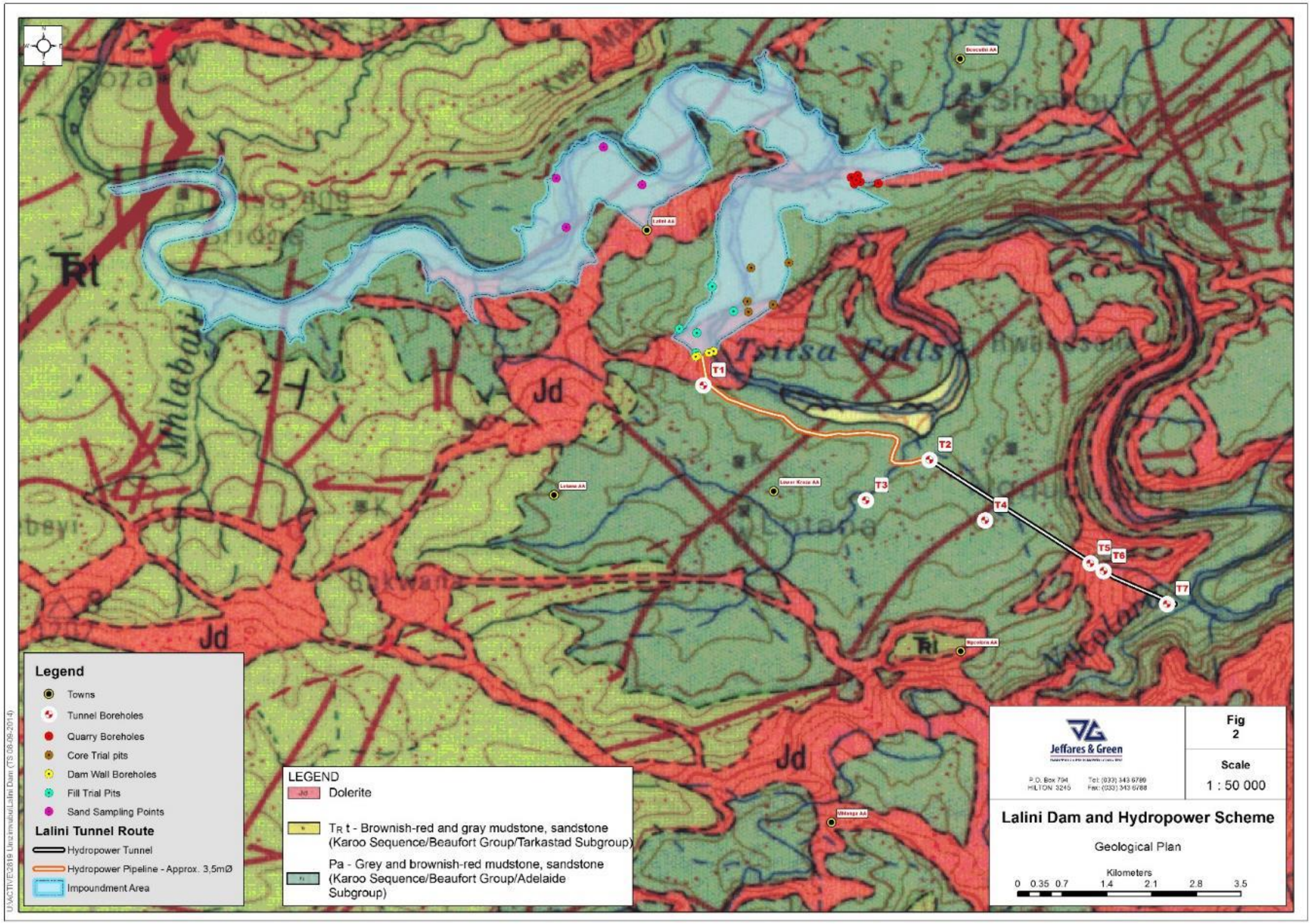
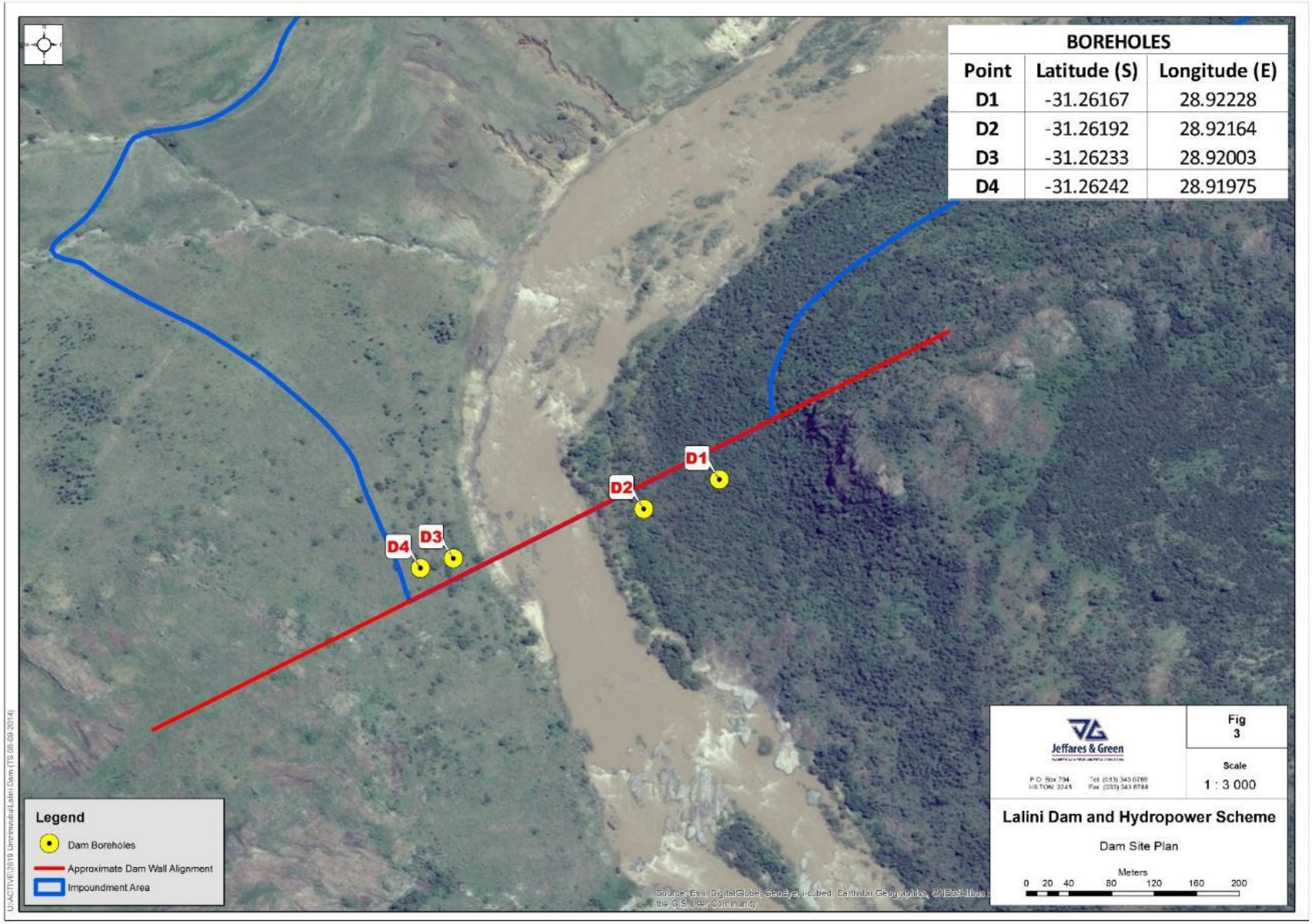


Fig A-2: Geological Plan



BOREHOLES

Point	Latitude (S)	Longitude (E)
D1	-31.26167	28.92228
D2	-31.26192	28.92164
D3	-31.26233	28.92003
D4	-31.26242	28.91975

Fig A-3: Dam Site Plan

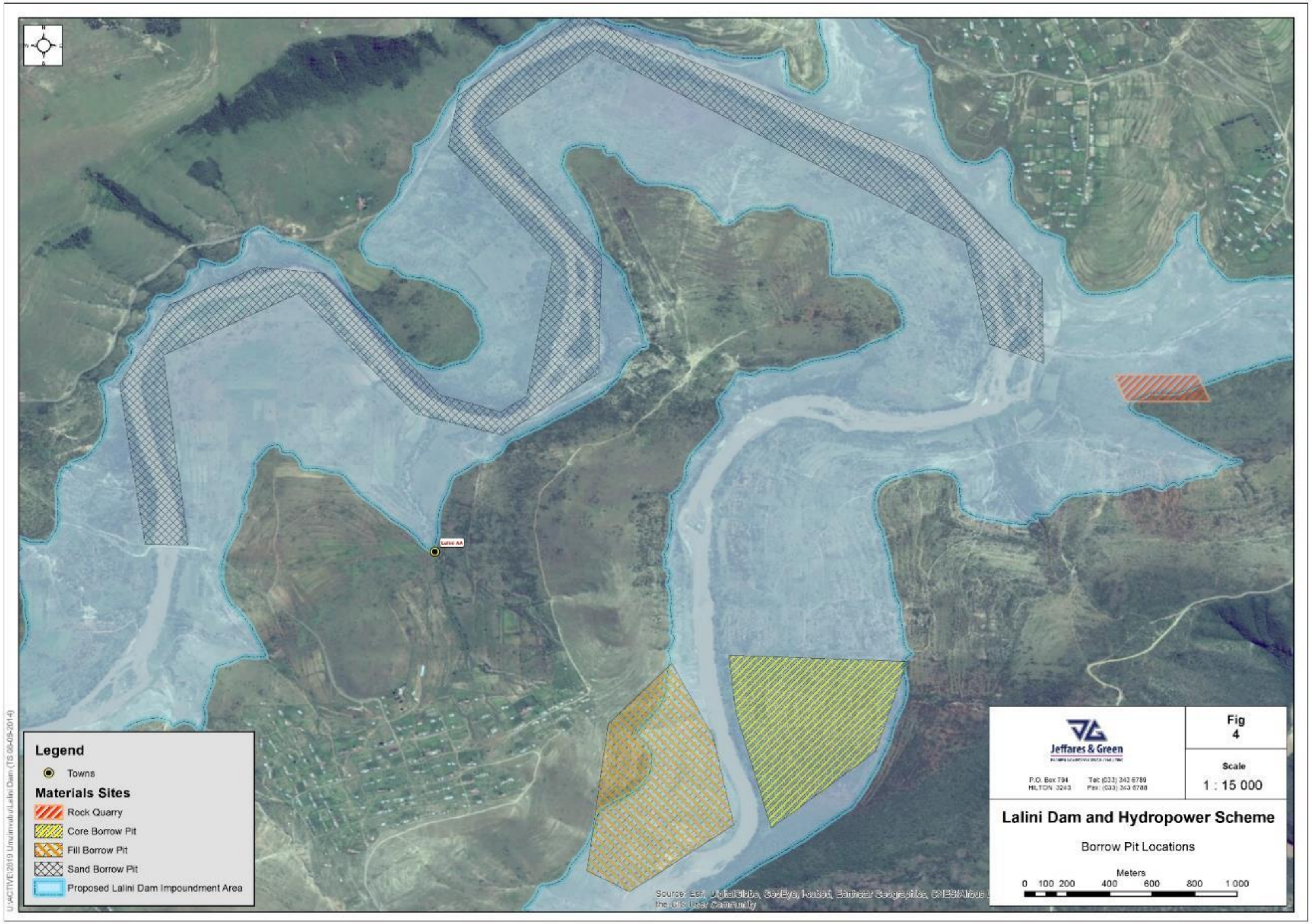


Fig A-4: Borrow Pit Locations

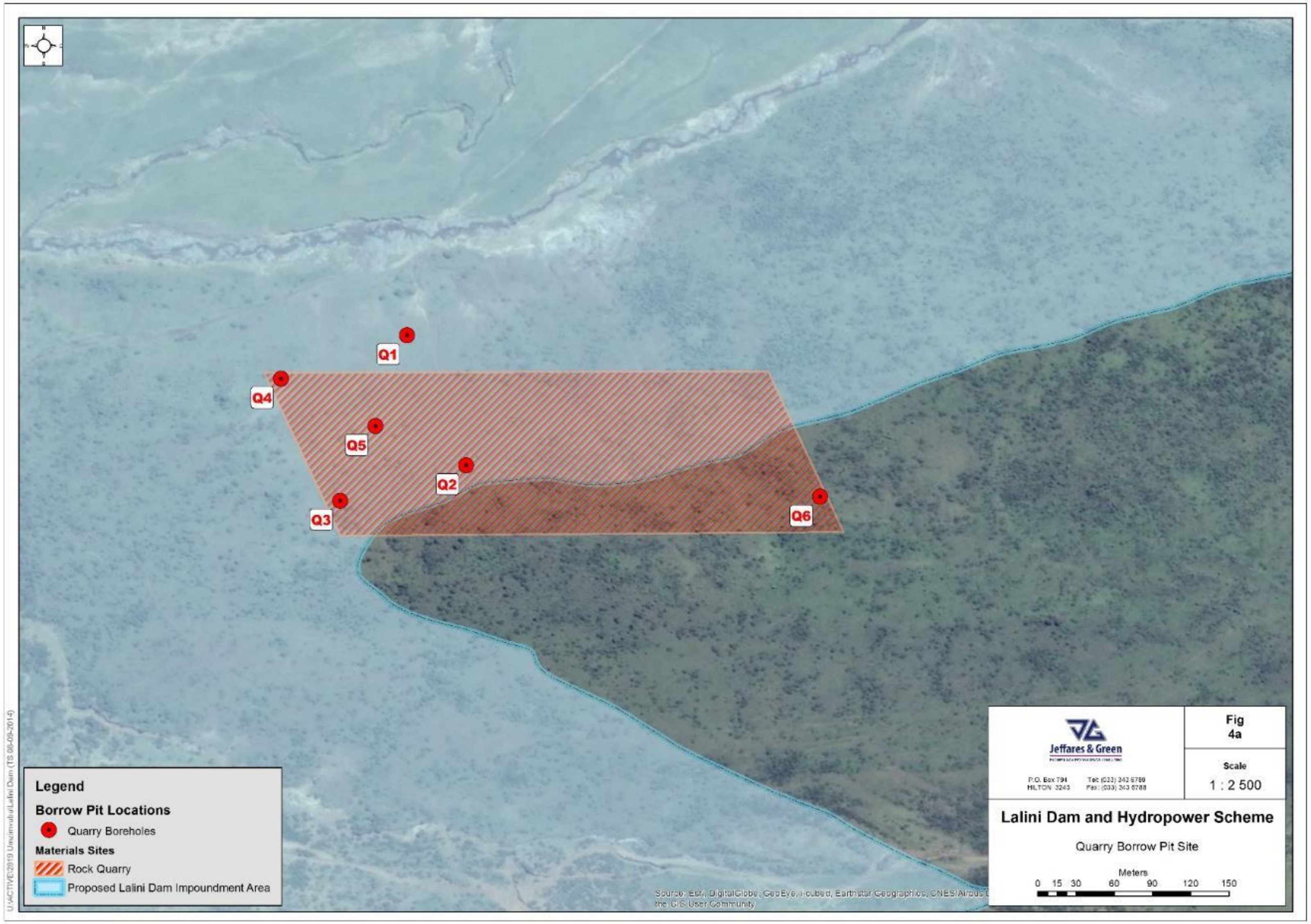


Fig A-4a: Quarry Borrow Pit Site

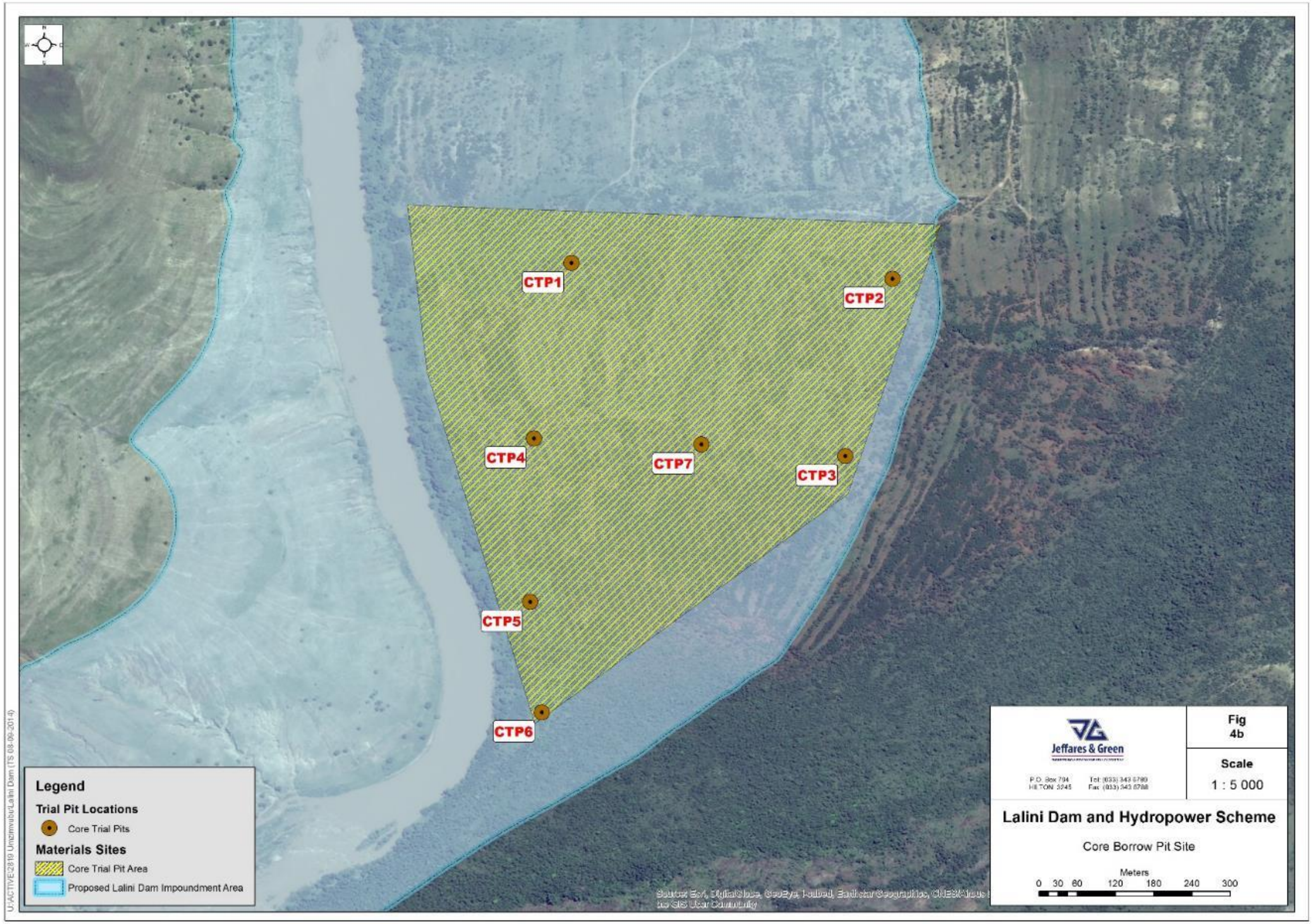


Fig A-4b: Core Borrow Pit Site

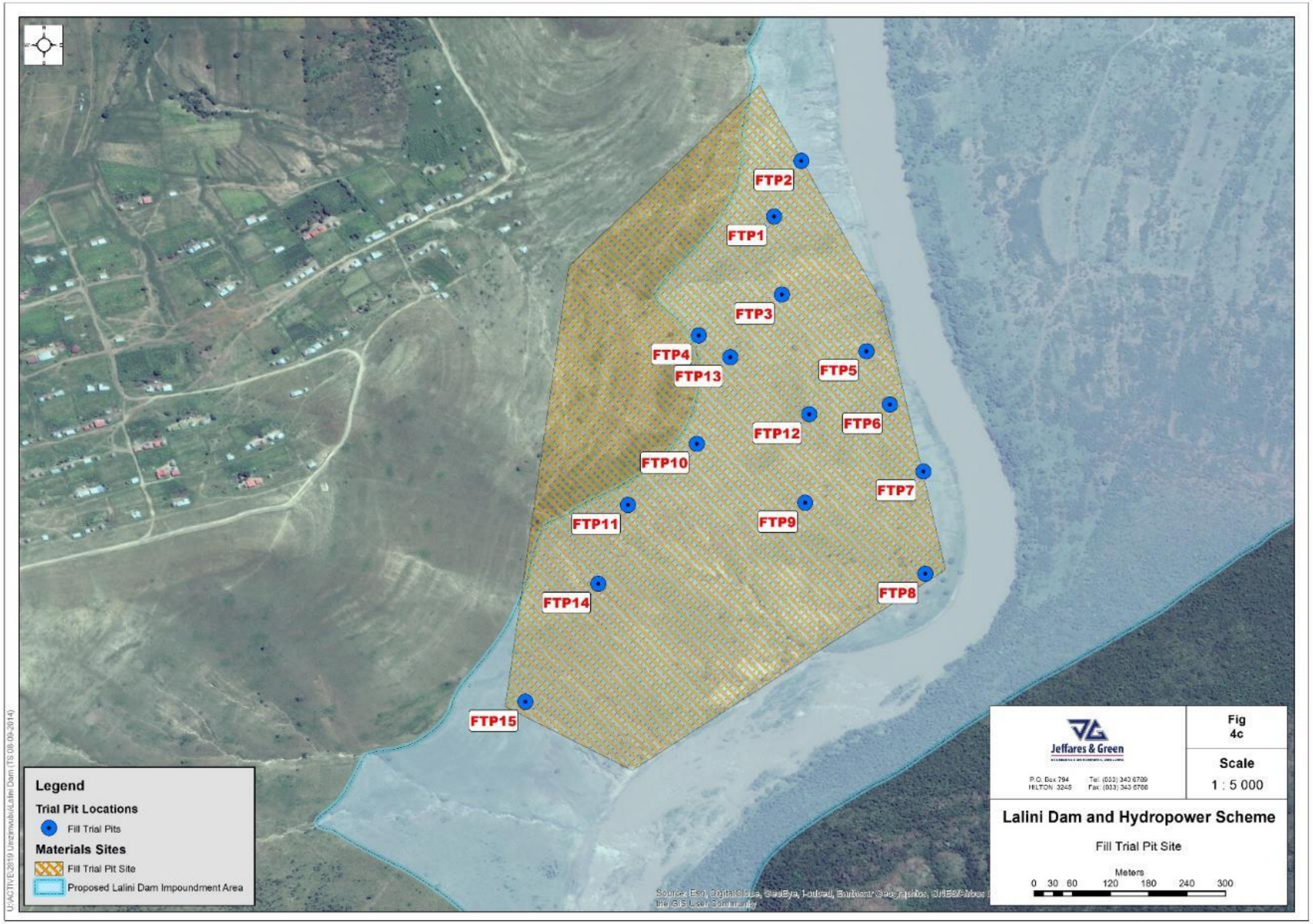


Fig A-4c: Fit Trial Pit Site

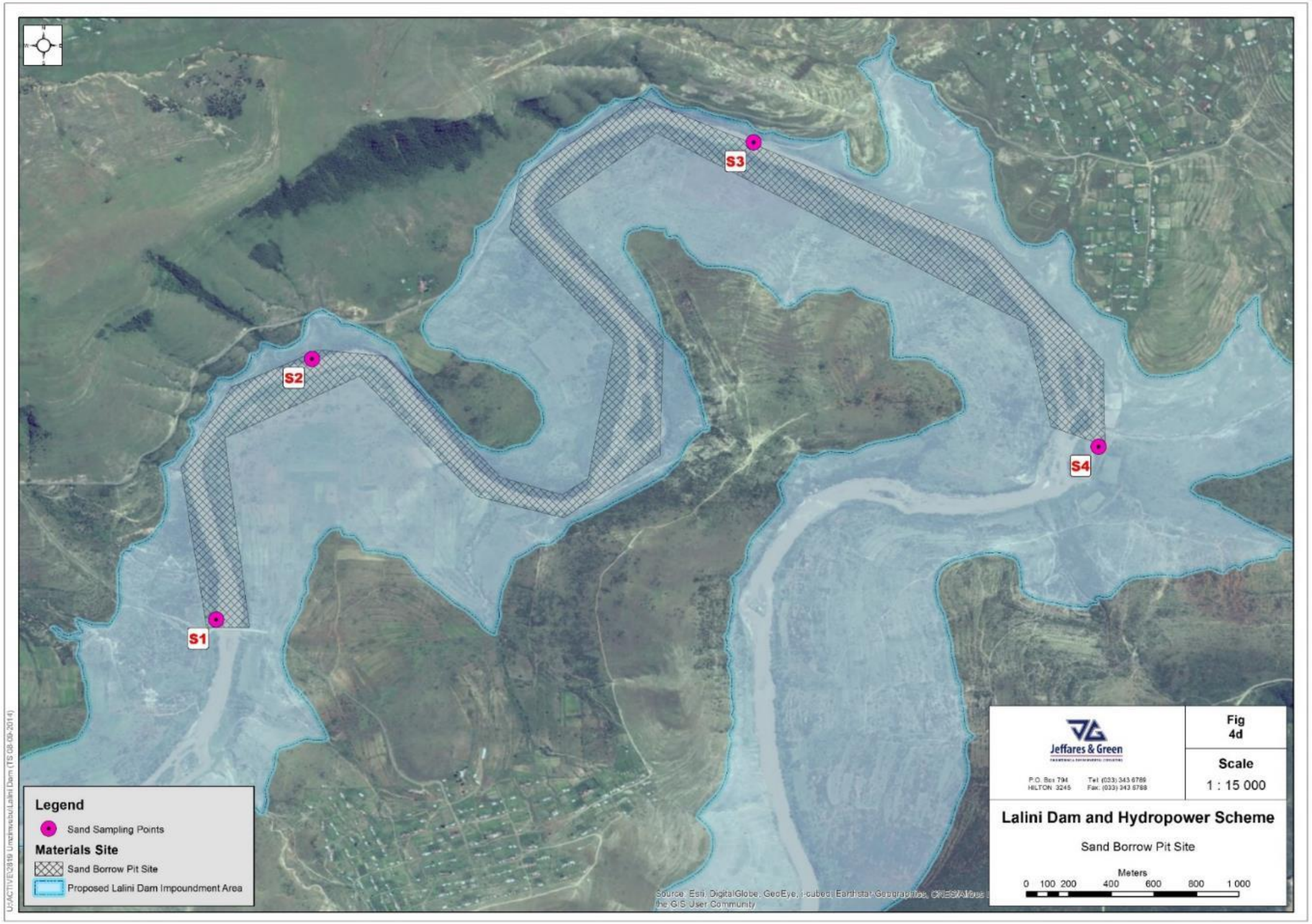


Fig A-4d: Sand Borrow Pit Site

Fig A-5: Pipeline Test Pits

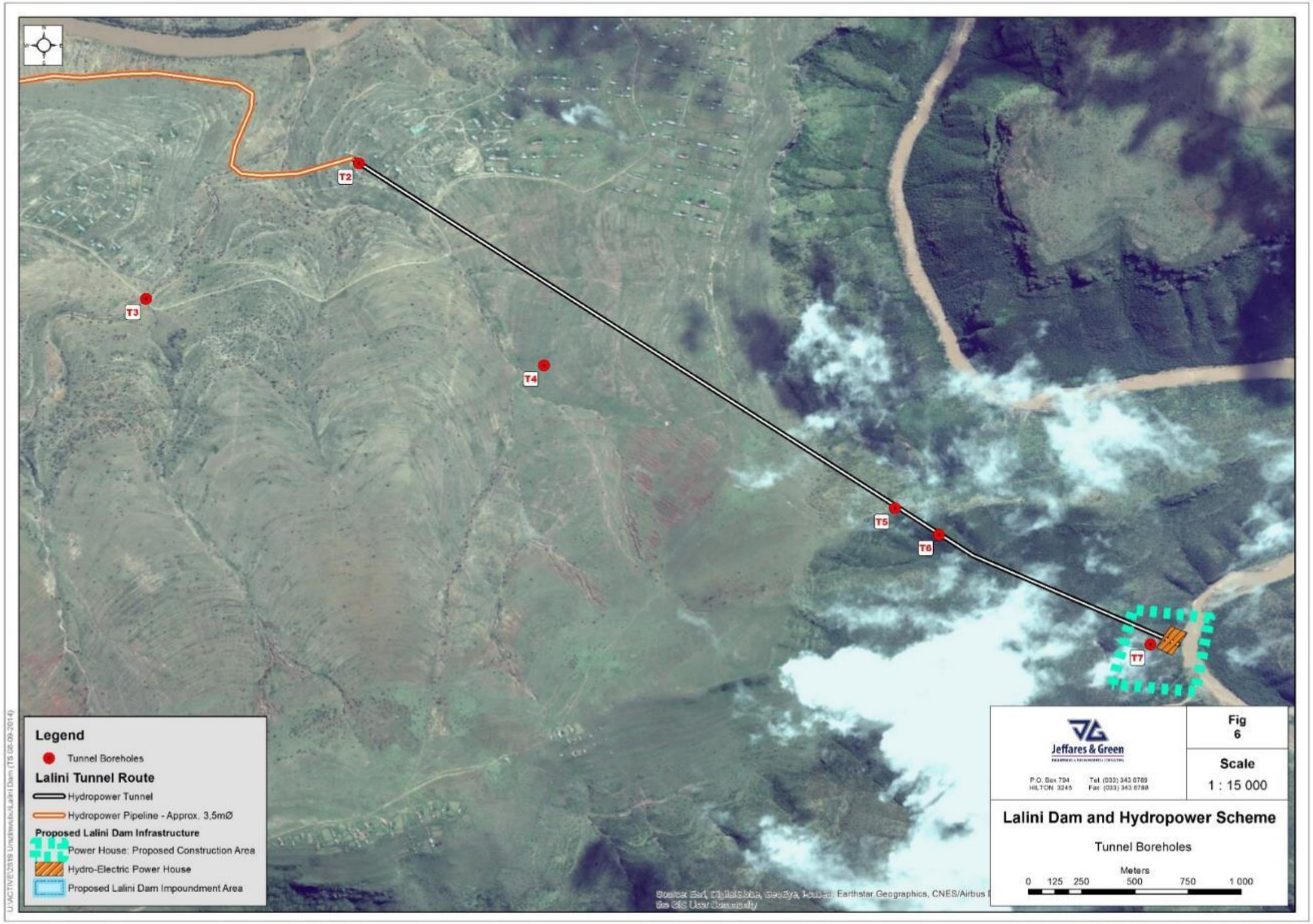
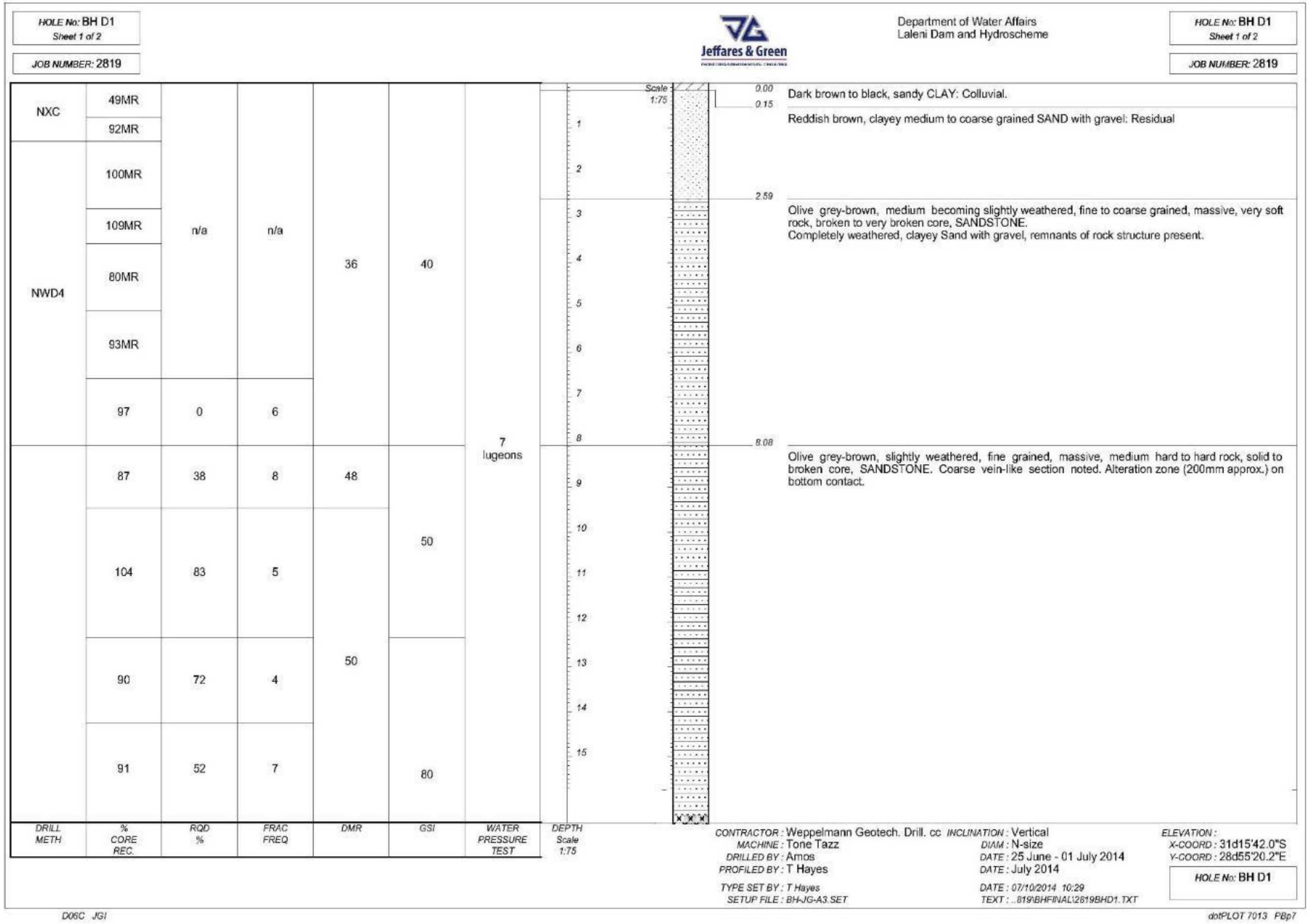


Fig A-6: Tunnel Boreholes

APPENDIX B

DAM BOREHOLE LOGS, PHOTOPGRAPHS AND WATER PRESSURE TESTS



HOLE No: BH D1
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH D1
Sheet 1 of 2

JOB NUMBER: 2819

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	49MR	n/a	n/a	36	40	7 lugeons
	92MR					
NWD4	100MR					
	109MR					
	80MR					
	93MR					
	97	0	6			
	87	38	8	48	50	
	104	83	5			
	90	72	4	50	80	
	91	52	7			

DEPTH Scale 1:75

Scale 1:75

0.00	Dark brown to black, sandy CLAY: Colluvial.
0.15	Reddish brown, clayey medium to coarse grained SAND with gravel: Residual
2.59	Olive grey-brown, medium becoming slightly weathered, fine to coarse grained, massive, very soft rock, broken to very broken core, SANDSTONE. Completely weathered, clayey Sand with gravel, remnants of rock structure present.
8.08	Olive grey-brown, slightly weathered, fine grained, massive, medium hard to hard rock, solid to broken core, SANDSTONE. Coarse vein-like section noted. Alteration zone (200mm approx.) on bottom contact.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : Tone Tazz
DRILLED BY : Amos
PROFILED BY : T Hayes

TYPE SET BY : T Hayes
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 25 June - 01 July 2014
DATE : July 2014

DATE : 07/10/2014 10:29
TEXT : ..819\BHFINAL\2819BHD1.TXT

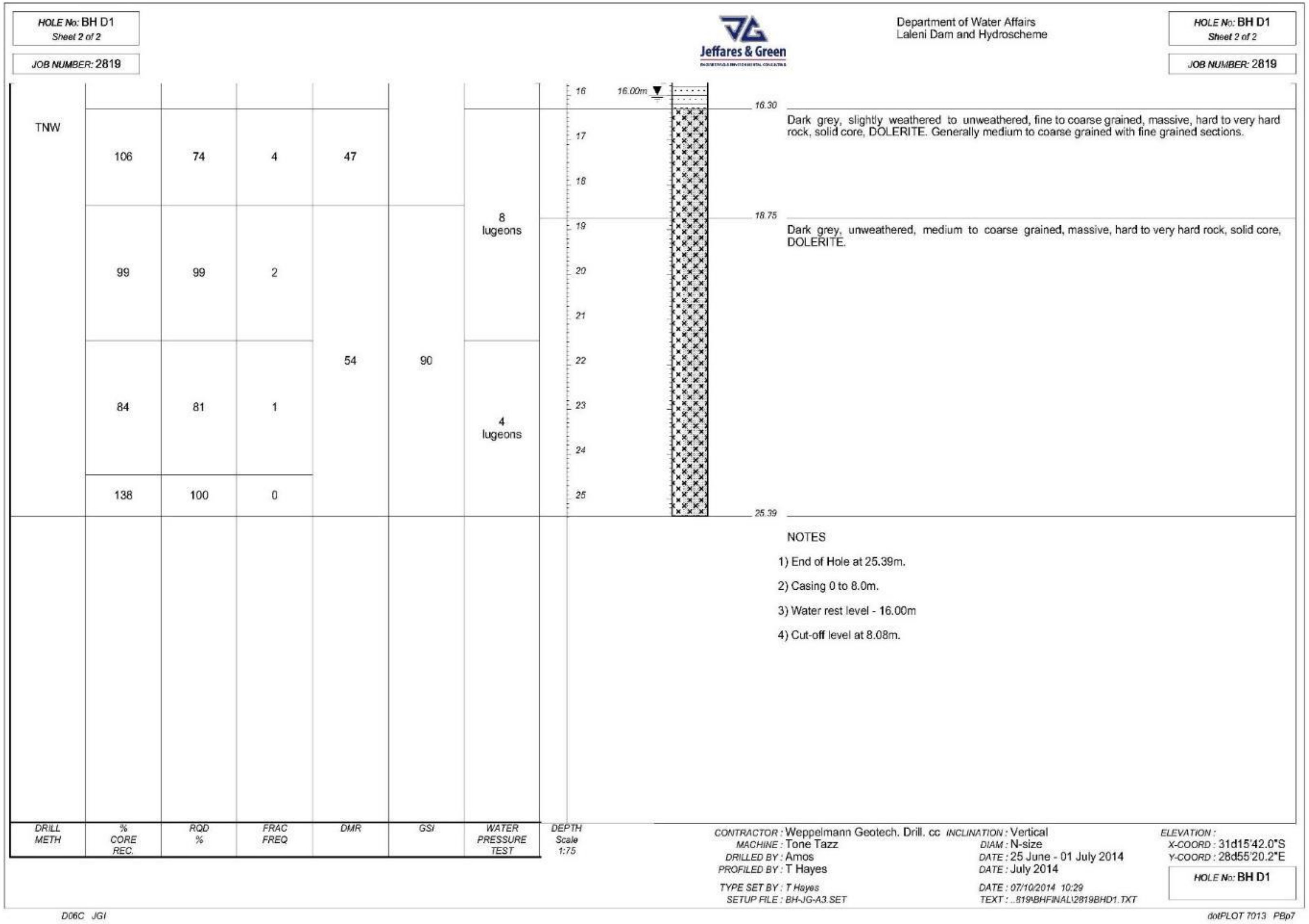
ELEVATION :
X-COORD : 31d15'42.0"S
Y-COORD : 28d55'20.2"E

HOLE No: BH D1

D06C JGI

dotPLOT 7013 PBp7

Fig B-1.1: Borehole D1 - Log



HOLE No: BH D1
Sheet 2 of 2

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
TNW	106	74	4	47		
	99	99	2	54	90	8 lugeons
	84	81	1			4 lugeons
	138	100	0			

DEPTH Scale 1:75

16.00m (water level)

16.30 Dark grey, slightly weathered to unweathered, fine to coarse grained, massive, hard to very hard rock, solid core, DOLERITE. Generally medium to coarse grained with fine grained sections.

18.75 Dark grey, unweathered, medium to coarse grained, massive, hard to very hard rock, solid core, DOLERITE.

25.39

NOTES

1) End of Hole at 25.39m.

2) Casing 0 to 8.0m.

3) Water rest level - 16.00m

4) Cut-off level at 8.08m.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : Tone Tazz
DRILLED BY : Amos
PROFILED BY : T Hayes
TYPE SET BY : T Hayes
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 25 June - 01 July 2014
DATE : July 2014
DATE : 07/10/2014 10:29
TEXT : ..819\BHFINAL\2819BHD1.TXT

ELEVATION :
X-COORD : 31d15'42.0"S
Y-COORD : 28d55'20.2"E

HOLE No: BH D1

D06C JGI

dotPLOT 7013 PBp7

Fig B-1.2: **Borehole D1 - Log**

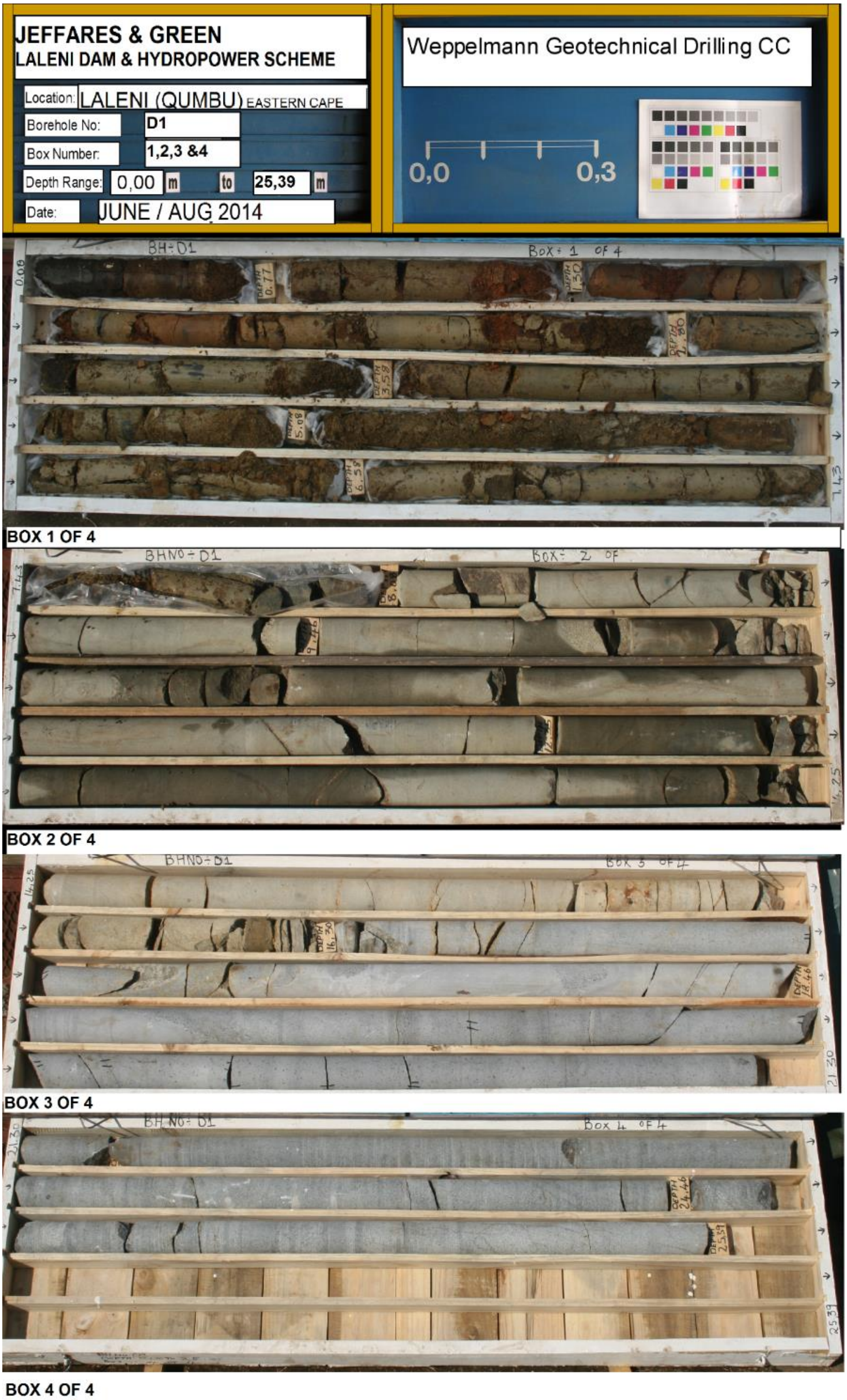
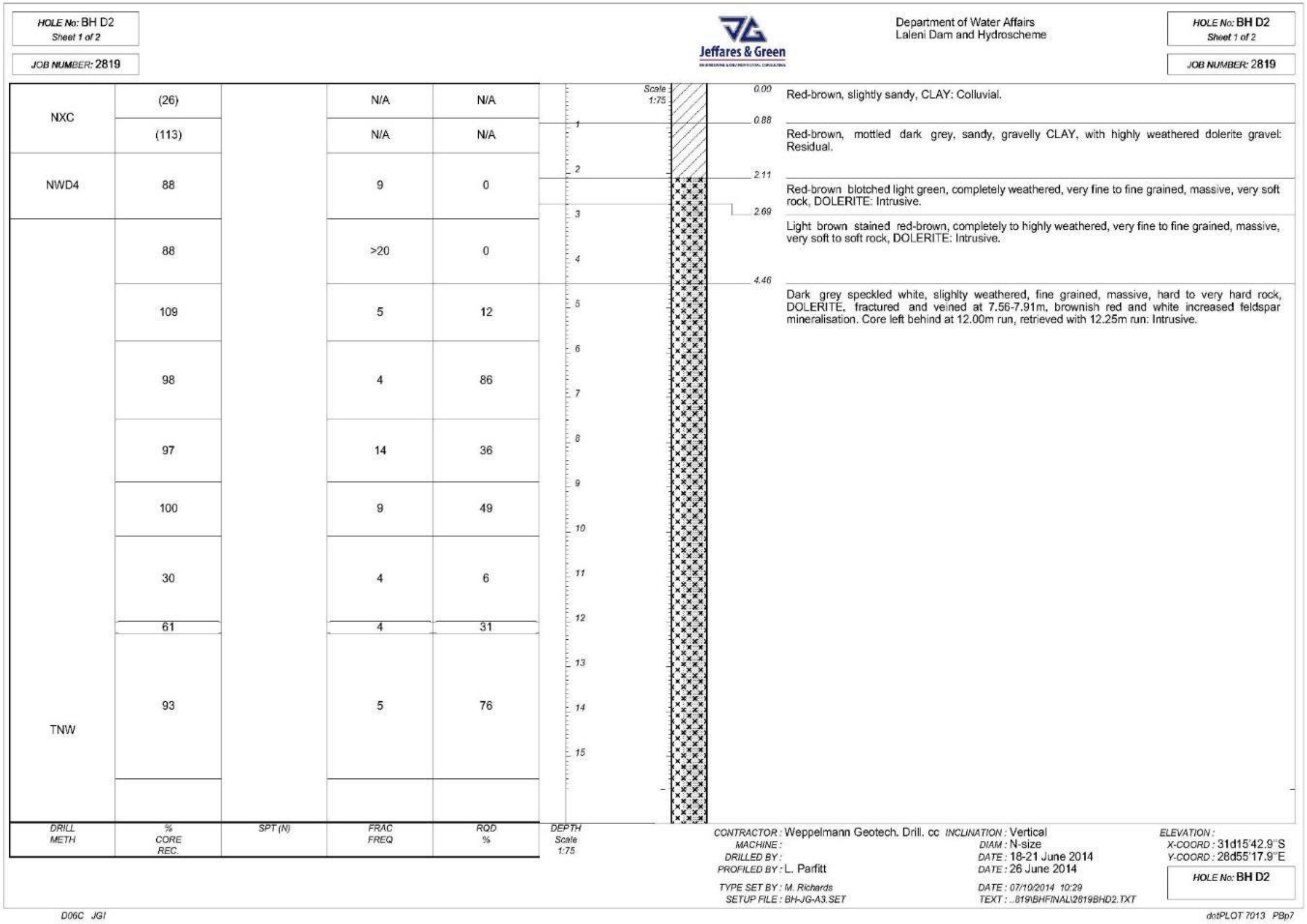


Fig B-2: **Borehole D1 – Box 1 to 4 Dry**

Guage Pressure (Bars) A	**Pressure due to Guage Height (Bars) B**	**Pressure due to water height above water table (Bars) C**	**Test Pressure (Bars) A+B+C**	**Duration (Seconds)**	**Injected Volume (l)**	**Top Level**	**Bottom Level**	**Length of hole**	**time in minutes**	**litres / metre /minute**	**Lugeon Units**
WPT 10 – 16.3m											
1.5	0	0	1.5	600	82	10	16.3	6.3	10	1.3016	9
2.6	0	0	2.6	600	120	10	16.3	6.3	10	1.9048	7
3.75	0	0	3.75	600	122.9	10	16.3	6.3	10	1.9508	5
2.6	0	0	2.6	600	125.2	10	16.3	6.3	10	1.9873	8
1.5	0	0	1.5	600	70	10	16.3	6.3	10	1.1111	7
WPT 16.3- 21.46m											
1.95	0	0	1.95	600	83.5	16.3	21.46	5.16	10	1.6182	8
3.4	0	0	3.4	600	96.4	16.3	21.46	5.16	10	1.8682	5
4.85	0	0	4.85	600	183.7	16.3	21.46	5.16	10	3.5601	7
3.4	0	0	3.4	600	154.8	16.3	21.46	5.16	10	3	9
1.95	0	0	1.95	600	90.5	16.3	21.46	5.16	10	1.7539	9
WPT 21.46 – 25.39m											
2.25	0	0	2.25	600	64.6	21.46	25.39	3.93	10	1.6438	7
3.95	0	0	3.95	600	76.3	21.46	25.39	3.93	10	1.9415	5
5.65	0	0	5.65	600	98.2	21.46	25.39	3.93	10	2.4987	4
3.95	0	0	3.95	600	73.6	21.46	25.39	3.93	10	1.8728	5
2.25	0	0	2.25	600	52.4	21.46	25.39	3.93	10	1.3333	6

Mzimvubu		Input Data	Depth from top of embankment to water table (m)	0
Borehole No	D1		Height of guage above top of embankment (m)	0

Table B-1: Water Pressure Tests – Borehole D1



HOLE No: BH D2
Sheet 1 of 2

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	SPT (N)	FRAC FREQ	RQD %
NXC	(26)		N/A	N/A
	(113)		N/A	N/A
NWD4	88		9	0
TNW	88		>20	0
	109		5	12
	98		4	86
	97		14	36
	100		9	49
	30		4	6
	61		4	31
	93		5	76

DEPTH Scale 1:75

Depth	Description
0.00	Red-brown, slightly sandy, CLAY: Colluvial.
0.88	Red-brown, mottled dark grey, sandy, gravelly CLAY, with highly weathered dolerite gravel: Residual.
2.11	Red-brown blotched light green, completely weathered, very fine to fine grained, massive, very soft rock, DOLERITE: Intrusive.
2.69	Light brown stained red-brown, completely to highly weathered, very fine to fine grained, massive, very soft to soft rock, DOLERITE: Intrusive.
4.46	Dark grey speckled white, slighlty weathered, fine grained, massive, hard to very hard rock, DOLERITE, fractured and veined at 7.56-7.91m, brownish red and white increased feldspar mineralisation. Core left behind at 12.00m run, retrieved with 12.25m run: Intrusive.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE :
DRILLED BY :
PROFILED BY : L. Parfitt
TYPE SET BY : M. Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 18-21 June 2014
DATE : 26 June 2014
DATE : 07/10/2014 10:29
TEXT : ..819\BHFINAL\2819BHD2.TXT

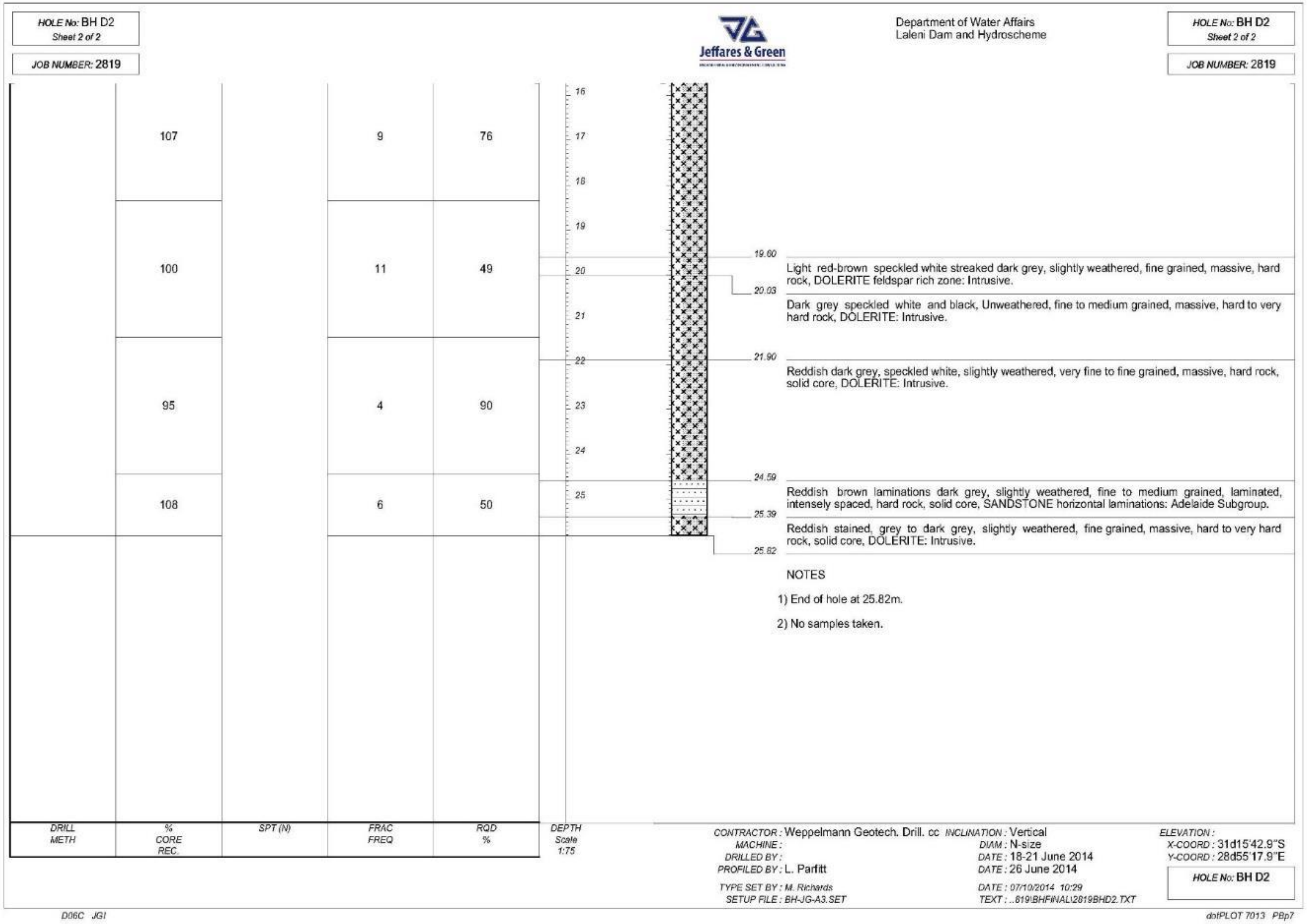
ELEVATION :
X-COORD : 31d15'42.9''S
Y-COORD : 28d55'17.9''E

HOLE No: BH D2

D06C JGI

dotPLOT 7013 PBp7

Fig B-3.1: Borehole D2 - Log



HOLE No: BH D2
Sheet 2 of 2

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	SPT (N)	FRAC FREQ	RQD %
	107		9	76
	100		11	49
	95		4	90
	108		6	50

19.60	Light red-brown speckled white streaked dark grey, slightly weathered, fine grained, massive, hard rock, DOLERITE feldspar rich zone: Intrusive.
20.03	Dark grey speckled white and black, Unweathered, fine to medium grained, massive, hard to very hard rock, DOLERITE: Intrusive.
21.90	Reddish dark grey, speckled white, slightly weathered, very fine to fine grained, massive, hard rock, solid core, DOLERITE: Intrusive.
24.59	Reddish brown laminations dark grey, slightly weathered, fine to medium grained, laminated, intensely spaced, hard rock, solid core, SANDSTONE horizontal laminations: Adelaide Subgroup.
25.39	Reddish stained, grey to dark grey, slightly weathered, fine grained, massive, hard to very hard rock, solid core, DOLERITE: Intrusive.
25.82	

NOTES

1) End of hole at 25.82m.

2) No samples taken.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE :
DRILLED BY :
PROFILED BY : L. Parfitt
TYPE SET BY : M. Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 18-21 June 2014
DATE : 26 June 2014
DATE : 07/10/2014 10:29
TEXT : ..819\BHFINAL\2819BHD2.TXT

ELEVATION :
X-COORD : 31d15'42.9"S
Y-COORD : 28d55'17.9"E

HOLE No: BH D2

Fig B-3.2: Borehole D2 - Log

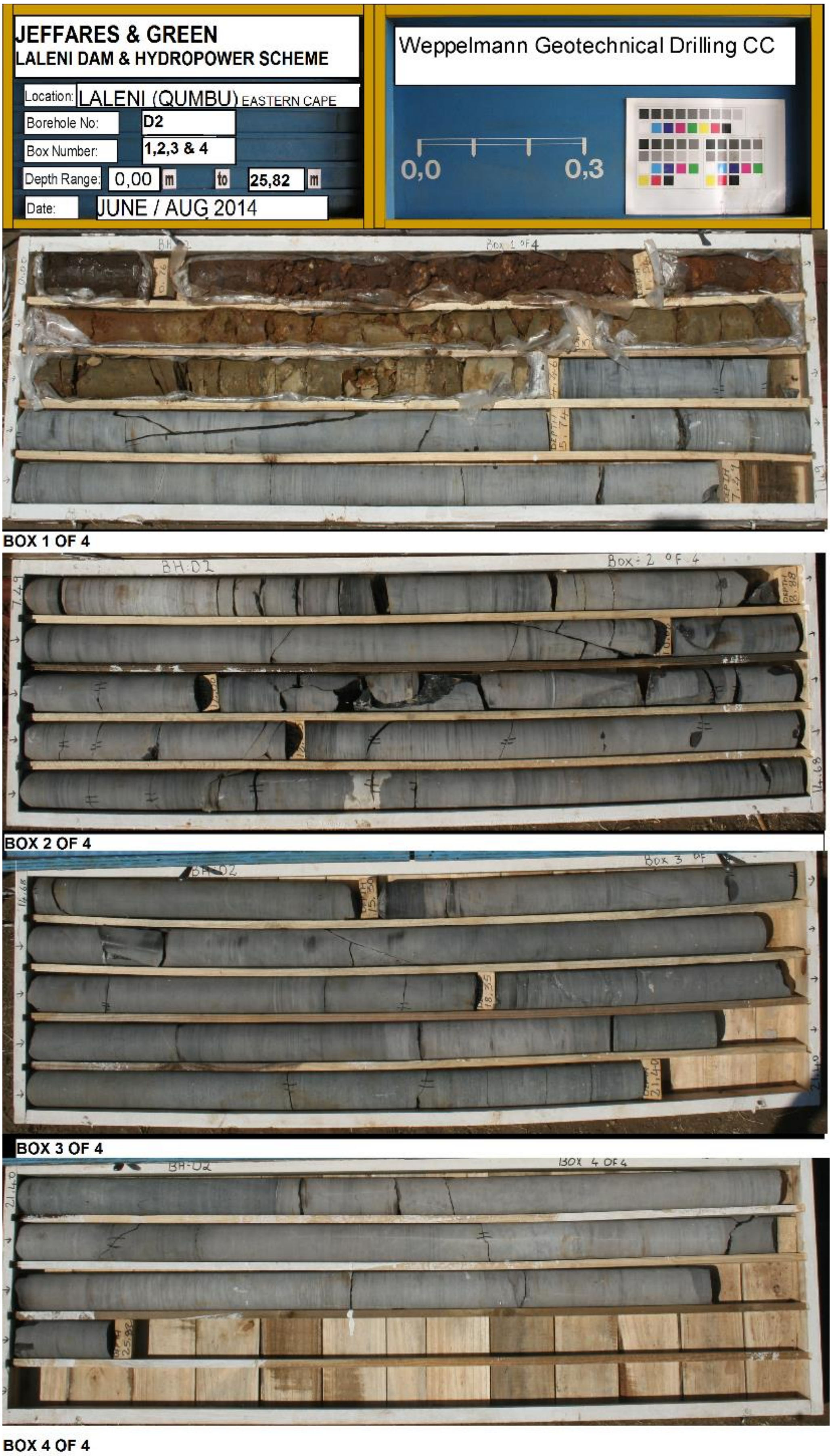
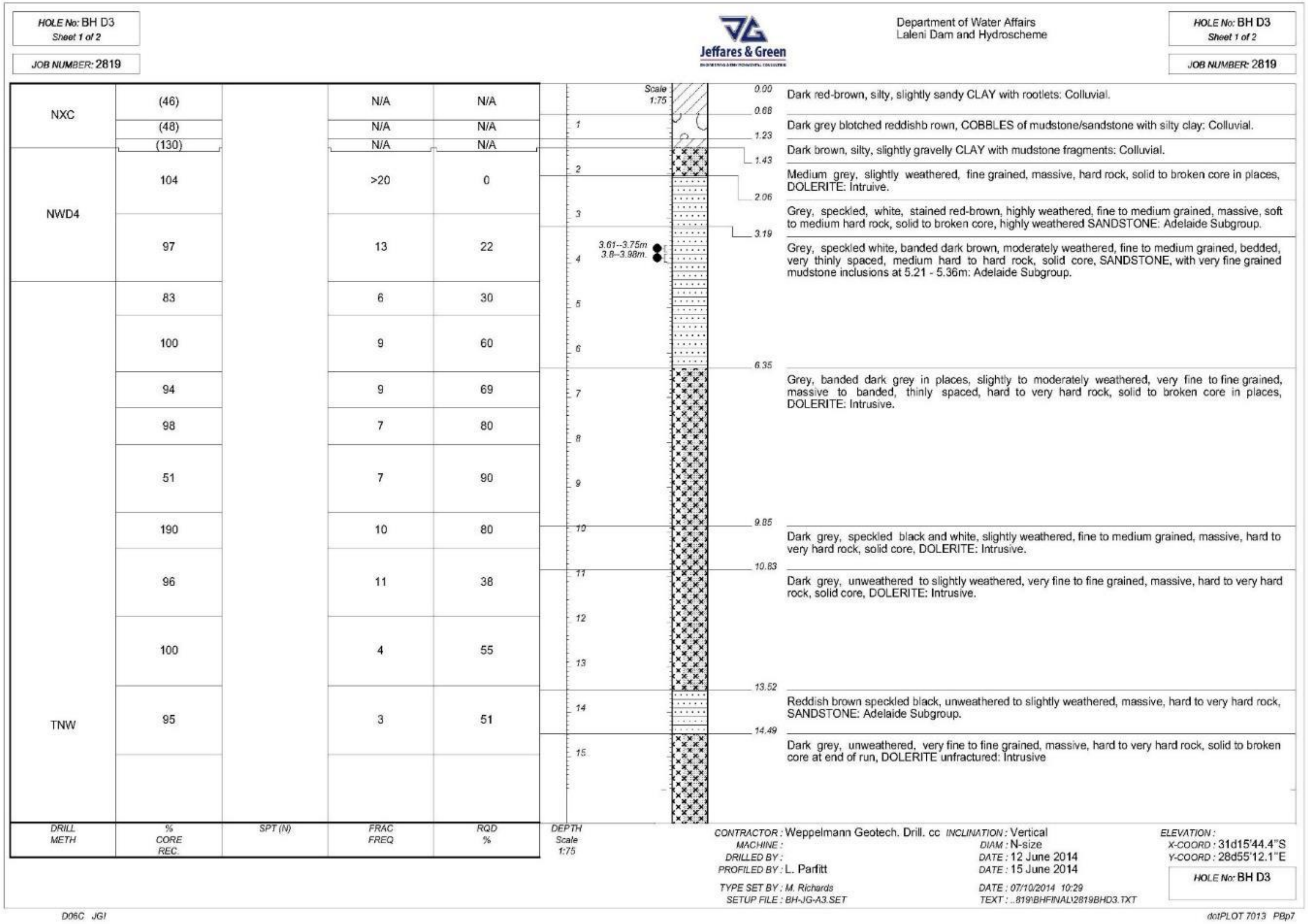


Fig B-4: **Borehole D2 – Box 1 to 4 Dry**

Guage Pressure (Bars) A	Pressure due to Guage Height (Bars) B	Pressure due to water height above water table (Bars) C	Test Pressure (Bars) A+B+C	Duration (Seconds)	Injected Volume (l)	Top Level	Bottom Level	Length of hole	time in minutes	litres / metre /minute	Lugeon Units
WPT 7.0 – 12.0m											
1.1	0	0	1.1	600	6	7	12	5	10	0.12	1
1.9	0	0	1.9	600	11	7	12	5	10	0.22	1
2	0	0	2	600	25	7	12	5	10	0.5	3
1.9	0	0	1.9	600	116.2	7	12	5	10	2.324	12
1.1	0	0	1.1	600	124.8	7	12	5	10	2.496	23
WPT 12.0- 18.35m											
1.65	0	0	1.65	600	9.1	12	18.35	6.35	10	0.1433	1
2.85	0	0	2.85	600	48.2	12	18.35	6.35	10	0.7591	3
4.05	0	0	4.05	600	42.4	12	18.35	6.35	10	0.6677	2
2.85	0	0	2.85	600	35.1	12	18.35	6.35	10	0.5528	2
1.65	0	0	1.65	600	25.6	12	18.35	6.35	10	0.4031	2
WPT 18.5 – 25.82m											
1.4	0	0	1.4	600	114.8	18.5	25.82	7.32	10	1.5683	11
	0	0	0	600		18.5	25.82	7.32	10	0	0
	0	0	0	600		18.5	25.82	7.32	10	0	0
	0	0	0	600		18.5	25.82	7.32	10	0	0
	0	0	0	600		18.5	25.82	7.32	10	0	0

Mzimvubu		Input Data	Depth from top of embankment to water table (m)	0
Borehole No	D2		Height of guage above top of embankment (m)	0

Table B-2: Water Pressure Tests – Borehole D2



HOLE No: BH D3
Sheet 1 of 2
JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	SPT (N)	FRAC FREQ	RQD %
NXC	(46)		N/A	N/A
	(48)		N/A	N/A
	(130)		N/A	N/A
NWD4	104		>20	0
	97		13	22
TNW	83		6	30
	100		9	60
	94		9	69
	98		7	80
	51		7	90
	190		10	80
	96		11	38
	100		4	55
	95		3	51

DEPTH Scale 1:75

3.61--3.75m
3.8--3.98m.

0.00	Dark red-brown, silty, slightly sandy CLAY with rootlets: Colluvial.
0.68	Dark grey blotched reddishb rown, COBBLES of mudstone/sandstone with silty clay: Colluvial.
1.23	Dark brown, silty, slightly gravelly CLAY with mudstone fragments: Colluvial.
1.43	Medium grey, slightly weathered, fine grained, massive, hard rock, solid to broken core in places, DOLERITE: Intruive.
2.06	Grey, speckled, white, stained red-brown, highly weathered, fine to medium grained, massive, soft to medium hard rock, solid to broken core, highly weathered SANDSTONE: Adelaide Subgroup.
3.19	Grey, speckled white, banded dark brown, moderately weathered, fine to medium grained, bedded, very thinly spaced, medium hard to hard rock, solid core, SANDSTONE, with very fine grained mudstone inclusions at 5.21 - 5.36m: Adelaide Subgroup.
6.35	Grey, banded dark grey in places, slightly to moderately weathered, very fine to fine grained, massive to banded, thinly spaced, hard to very hard rock, solid to broken core in places, DOLERITE: Intrusive.
9.85	Dark grey, speckled black and white, slightly weathered, fine to medium grained, massive, hard to very hard rock, solid core, DOLERITE: Intrusive.
10.83	Dark grey, unweathered to slightly weathered, very fine to fine grained, massive, hard to very hard rock, solid core, DOLERITE: Intrusive.
13.52	Reddish brown speckled black, unweathered to slightly weathered, massive, hard to very hard rock, SANDSTONE: Adelaide Subgroup.
14.49	Dark grey, unweathered, very fine to fine grained, massive, hard to very hard rock, solid to broken core at end of run, DOLERITE unfractured: Intrusive

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE :
DRILLED BY :
PROFILED BY : L. Parfitt
TYPE SET BY : M. Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 12 June 2014
DATE : 15 June 2014
DATE : 07/10/2014 10:29
TEXT : ..819\BHFINAL\2819BHD3.TXT

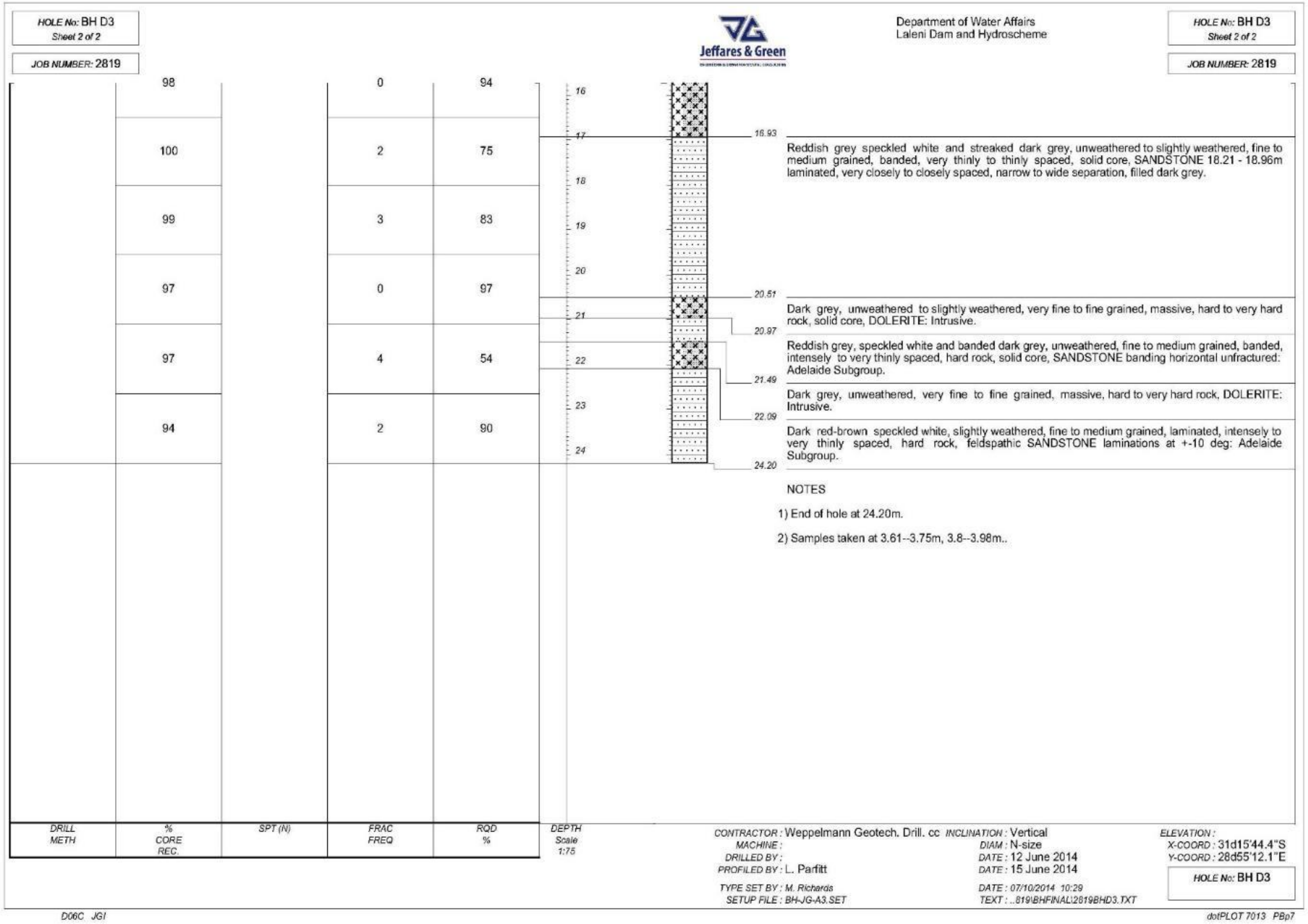
ELEVATION :
X-COORD : 31d15'44.4"S
Y-COORD : 28d55'12.1"E

HOLE No: BH D3

D06C JGI

dotPLOT 7013 PBp7

Fig B-5.1: **Borehole D3 - Log**



HOLE No: BH D3
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	SPT (N)	FRAC FREQ	RQD %
	98		0	94
	100		2	75
	99		3	83
	97		0	97
	97		4	54
	94		2	90

DEPTH Scale 1:75

16.93	Reddish grey speckled white and streaked dark grey, unweathered to slightly weathered, fine to medium grained, banded, very thinly to thinly spaced, solid core, SANDSTONE 18.21 - 18.96m laminated, very closely to closely spaced, narrow to wide separation, filled dark grey.
20.51	Dark grey, unweathered to slightly weathered, very fine to fine grained, massive, hard to very hard rock, solid core, DOLERITE: Intrusive.
20.97	Reddish grey, speckled white and banded dark grey, unweathered, fine to medium grained, banded, intensely to very thinly spaced, hard rock, solid core, SANDSTONE banding horizontal unfractured: Adelaide Subgroup.
21.49	Dark grey, unweathered, very fine to fine grained, massive, hard to very hard rock, DOLERITE: Intrusive.
22.09	Dark red-brown speckled white, slightly weathered, fine to medium grained, laminated, intensely to very thinly spaced, hard rock, feldspathic SANDSTONE laminations at +-10 deg: Adelaide Subgroup.
24.20	

NOTES

1) End of hole at 24.20m.

2) Samples taken at 3.61--3.75m, 3.8--3.98m..

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE :
DRILLED BY :
PROFILED BY : L. Parfitt

TYPE SET BY : M. Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 12 June 2014
DATE : 15 June 2014

DATE : 07/10/2014 10:29
TEXT : ..819\BHFINAL\2819BHD3.TXT

ELEVATION :
X-COORD : 31d15'44.4"S
Y-COORD : 28d55'12.1"E

HOLE No: BH D3

D06C JGI

dotPLOT 7013 PBp7

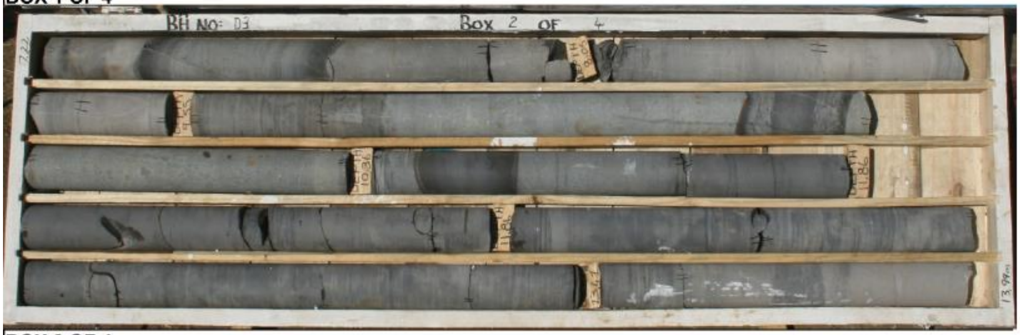
Fig B-5.2: **Borehole D3 - Log**

JEFFARES & GREEN
LALENI DAM & HYDROPOWER SCHEME

Location: LALENI (QUMBU) EASTERN CAPE
Borehole No: D3
Box Number: 1,2,3 & 4
Depth Range: 0,00 m to 24.20 m
Date: JUNE / AUG 2014

Weppelmann Geotechnical Drilling CC

BOX 1 OF 4



BOX 2 OF 4

BOX 3 OF 4

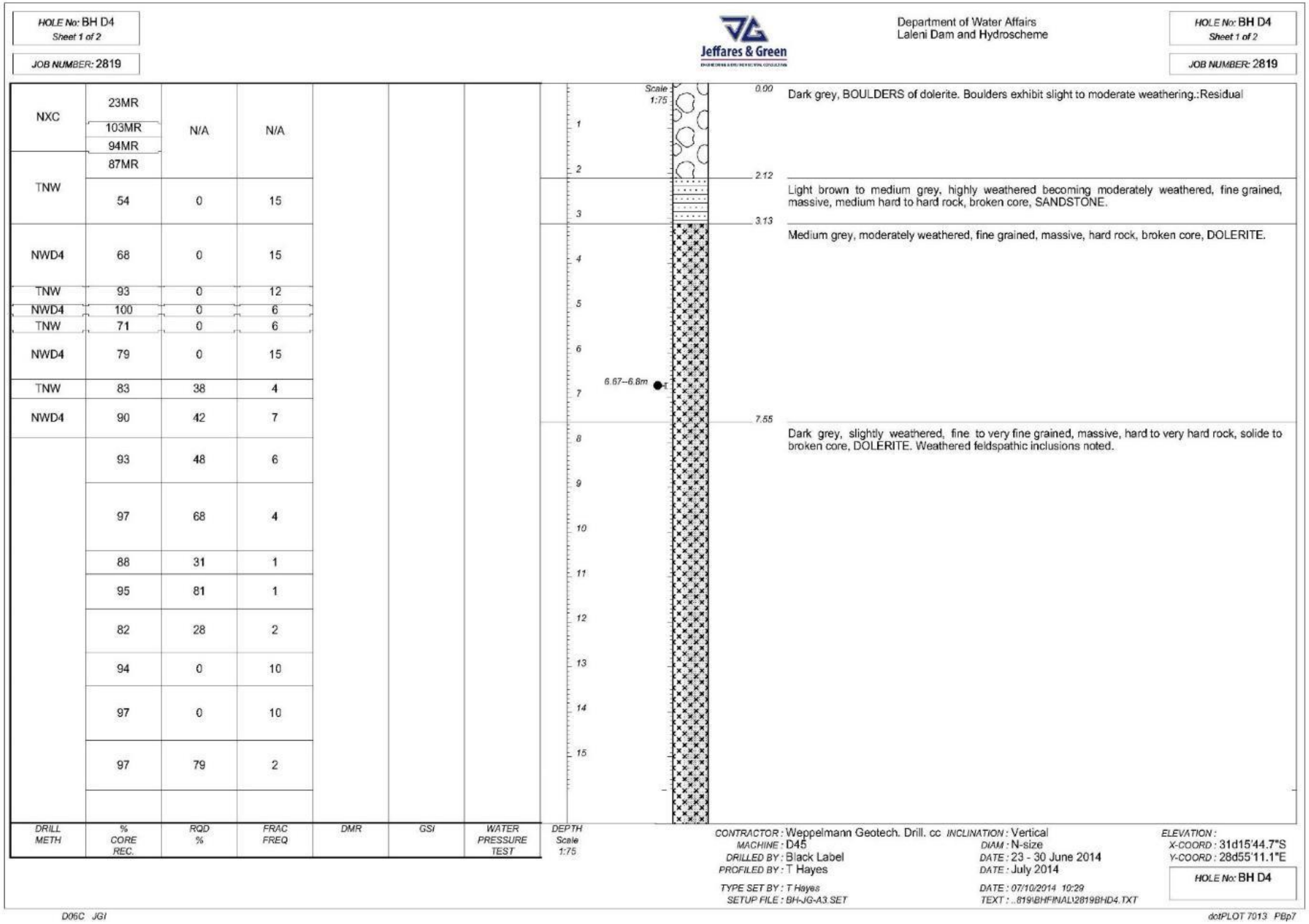
BOX 4 OF 4

Fig B-6: **Borehole D3 – Box 1 to 4 Dry**

Guage Pressure (Bars) A	Pressure due to Guage Height (Bars) B	Pressure due to water height above water table (Bars) C	Test Pressure (Bars) A+B+C	Duration (Seconds)	Injected Volume (l)	Top Level	Bottom Level	Length of hole	time in minutes	litres / metre /minute	Lugeon Units
WPT 3.5 – 7.22m											
0.3	0	0	0.3	600	62	3.5	7.22	3.72	10	1.6667	56
0.55	0	0	0.55	600	49	3.5	7.22	3.72	10	1.3172	24
0.8	0	0	0.8	600	51.5	3.5	7.22	3.72	10	1.3844	17
0.55	0	0	0.55	600	43.4	3.5	7.22	3.72	10	1.1667	21
0.3	0	0	0.3	600	34	3.5	7.22	3.72	10	0.914	30
WPT 7.5 – 13.5m											
1.2	0	0	1.2	600	90.9	7.5	13.5	6	10	1.515	13
2.15	0	0	2.15	600	92.4	7.5	13.5	6	10	1.54	7
3.05	0	0	3.05	600	83.2	7.5	13.5	6	10	1.3867	5
2.15	0	0	2.15	600	58.2	7.5	13.5	6	10	0.97	5
1.2	0	0	1.2	600	9.4	7.5	13.5	6	10	0.1567	1
WPT 13.5 – 24.2m											
2.15	0	0	2.15	600	0	13.5	24.2	10.7	10	0	0
3.8	0	0	3.8	600	88.1	13.5	24.2	10.7	10	0.8234	2
5.45	0	0	5.45	600	53.3	13.5	24.2	10.7	10	0.4981	1
3.8	0	0	3.8	600	86.7	13.5	24.2	10.7	10	0.8103	2
2.15	0	0	2.15	600	11.5	13.5	24.2	10.7	10	0.1075	0

Mzimvubu		Input Data	Depth from top of embankment to water table (m)	0
Borehole No	D3		Height of guage above top of embankment (m)	0

Table B-3: Water Pressure Tests – Borehole D3



HOLE No: BH D4
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	23MR	N/A	N/A			
	103MR					
	94MR					
TNW	87MR					
	54	0	15			
NWD4	68	0	15			
TNW	93	0	12			
NWD4	100	0	6			
TNW	71	0	6			
NWD4	79	0	15			
TNW	83	38	4			
NWD4	90	42	7			
	93	48	6			
	97	68	4			
	88	31	1			
	95	81	1			
	82	28	2			
	94	0	10			
	97	0	10			
	97	79	2			

DEPTH Scale 1:75

Depth (m)	Description
0.00	Dark grey, BOULDERS of dolerite. Boulders exhibit slight to moderate weathering.:Residual
2.12	Light brown to medium grey, highly weathered becoming moderately weathered, fine grained, massive, medium hard to hard rock, broken core, SANDSTONE.
3.13	Medium grey, moderately weathered, fine grained, massive, hard rock, broken core, DOLERITE.
7.55	Dark grey, slightly weathered, fine to very fine grained, massive, hard to very hard rock, solide to broken core, DOLERITE. Weathered feldspathic inclusions noted.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D45
DRILLED BY : Black Label
PROFILED BY : T Hayes
TYPE SET BY : T Hayes
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 23 - 30 June 2014
DATE : July 2014
DATE : 07/10/2014 10:29
TEXT : ..819\BHFINAL\2819BHD4.TXT

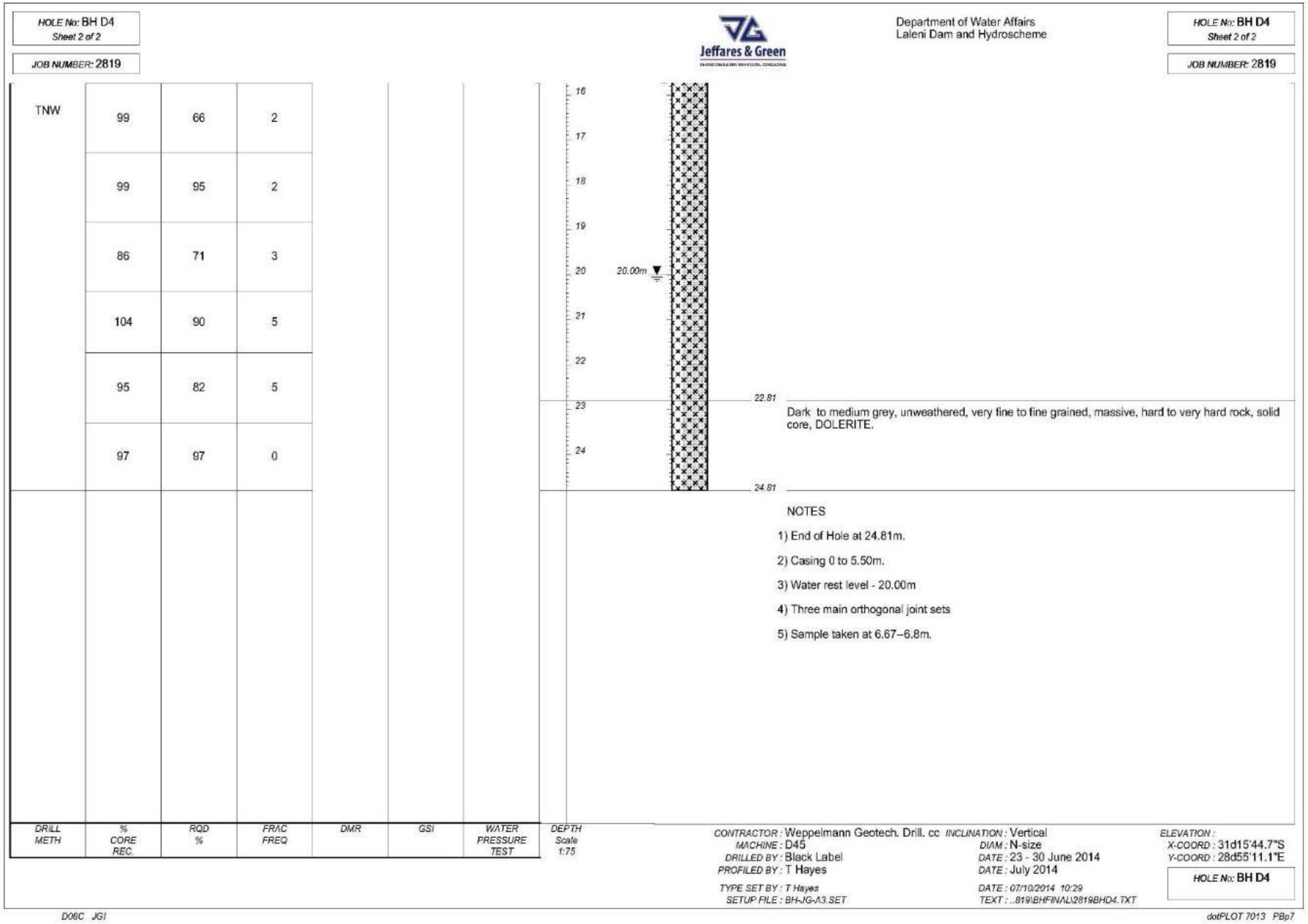
ELEVATION :
X-COORD : 31d15'44.7"S
Y-COORD : 28d55'11.1"E

HOLE No: BH D4

D06C JGI

dotPLOT 7013 PBp7

Fig B-7.1: **Borehole D4 - Log**



HOLE No: BH D4
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
TNW	99	66	2			
	99	95	2			
	86	71	3			
	104	90	5			
	95	82	5			
	97	97	0			

22.81
Dark to medium grey, unweathered, very fine to fine grained, massive, hard to very hard rock, solid core, DOLERITE.
24.81

NOTES

1) End of Hole at 24.81m.
2) Casing 0 to 5.50m.
3) Water rest level - 20.00m
4) Three main orthogonal joint sets
5) Sample taken at 6.67–6.8m.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D45
DRILLED BY : Black Label
PROFILED BY : T Hayes
TYPE SET BY : T Hayes
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 23 - 30 June 2014
DATE : July 2014
DATE : 07/10/2014 10:29
TEXT : ..819\BHFINAL\2819BHD4.TXT

ELEVATION :
X-COORD : 31d15'44.7"S
Y-COORD : 28d55'11.1"E

HOLE No: BH D4

D06C JGI

dotPLOT 7013 PBp7

Fig B-7.2: Borehole D4 - Log

Fig B-8: Borehole D4 – Box 1 to 4 Dry

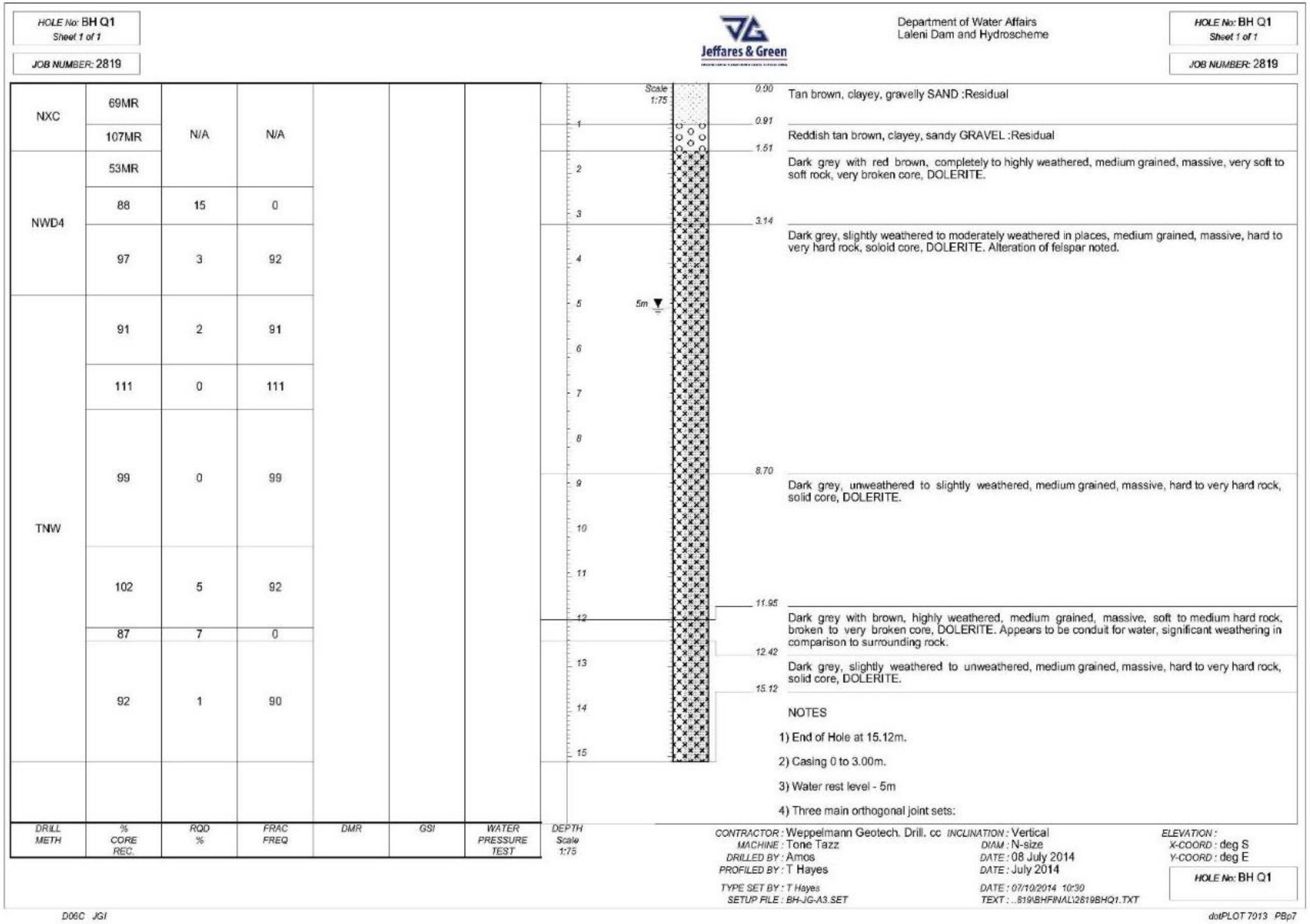
Guage Pressure (Bars) A	Pressure due to Guage Height (Bars) B	Pressure due to water height above water table (Bars) C	Test Pressure (Bars) A+B+C	Duration (Seconds)	Injected Volume (l)	Top Level	Bottom Level	Length of hole	time in minutes	litres / metre /minute	Lugeon Units
WPT 15.0 – 20.5m											
1.35	0	0	1.35	600	148.4	15	20.5	5.5	10	2.6982	20
2.4	0	0	2.4	600	169	15	20.5	5.5	10	3.0727	13
2.4	0	0	2.4	600	92.8	15	20.5	5.5	10	1.6873	7
2.4	0	0	2.4	600		15	20.5	5.5	10	0	0
1.35	0	0	1.35	600	150.7	15	20.5	5.5	10	2.74	20
WPT 20.5 – 24.81m											
1.5	0	0	1.5	600	194.5	20.5	24.81	4.31	10	4.5128	30
	0	0	0	600		20.5	24.81	4.31	10	0	0
	0	0	0	600		20.5	24.81	4.31	10	0	0
	0	0	0	600		20.5	24.81	4.31	10	0	0
	0	0	0	600		20.5	24.81	4.31	10	0	0

Mzimvubu		Input Data	Depth from top of embankment to water table (m)	0
Borehole No	D4		Height of guage above top of embankment (m)	0

Table B-4: Water Pressure Tests – Borehole D4

APPENDIX C

QUARRY BOREHOLE LOGS AND PHOTOGRAPHS



HOLE No: BH Q1
Sheet 1 of 1

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	69MR	N/A	N/A			
	107MR					
NWD4	53MR					
	88	15	0			
	97	3	92			
TNW	91	2	91			
	111	0	111			
	99	0	99			
	102	5	92			
	87	7	0			
	92	1	90			

DEPTH Scale 1:75

0.00	Tan brown, clayey, gravelly SAND :Residual
0.91	Reddish tan brown, clayey, sandy GRAVEL :Residual
1.51	Dark grey with red brown, completely to highly weathered, medium grained, massive, very soft to soft rock, very broken core, DOLERITE.
3.14	Dark grey, slightly weathered to moderately weathered in places, medium grained, massive, hard to very hard rock, soloid core, DOLERITE. Alteration of felspar noted.
8.70	Dark grey, unweathered to slightly weathered, medium grained, massive, hard to very hard rock, solid core, DOLERITE.
11.95	Dark grey with brown, highly weathered, medium grained, massive, soft to medium hard rock, broken to very broken core, DOLERITE. Appears to be conduit for water, significant weathering in comparison to surrounding rock.
12.42	Dark grey, slightly weathered to unweathered, medium grained, massive, hard to very hard rock, solid core, DOLERITE.
15.12	

NOTES

1) End of Hole at 15.12m.

2) Casing 0 to 3.00m.

3) Water rest level - 5m

4) Three main orthogonal joint sets:

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : Tone Tazz
DRILLED BY : Amos
PROFILED BY : T Hayes
TYPE SET BY : T Hayes
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 08 July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHQ1.TXT

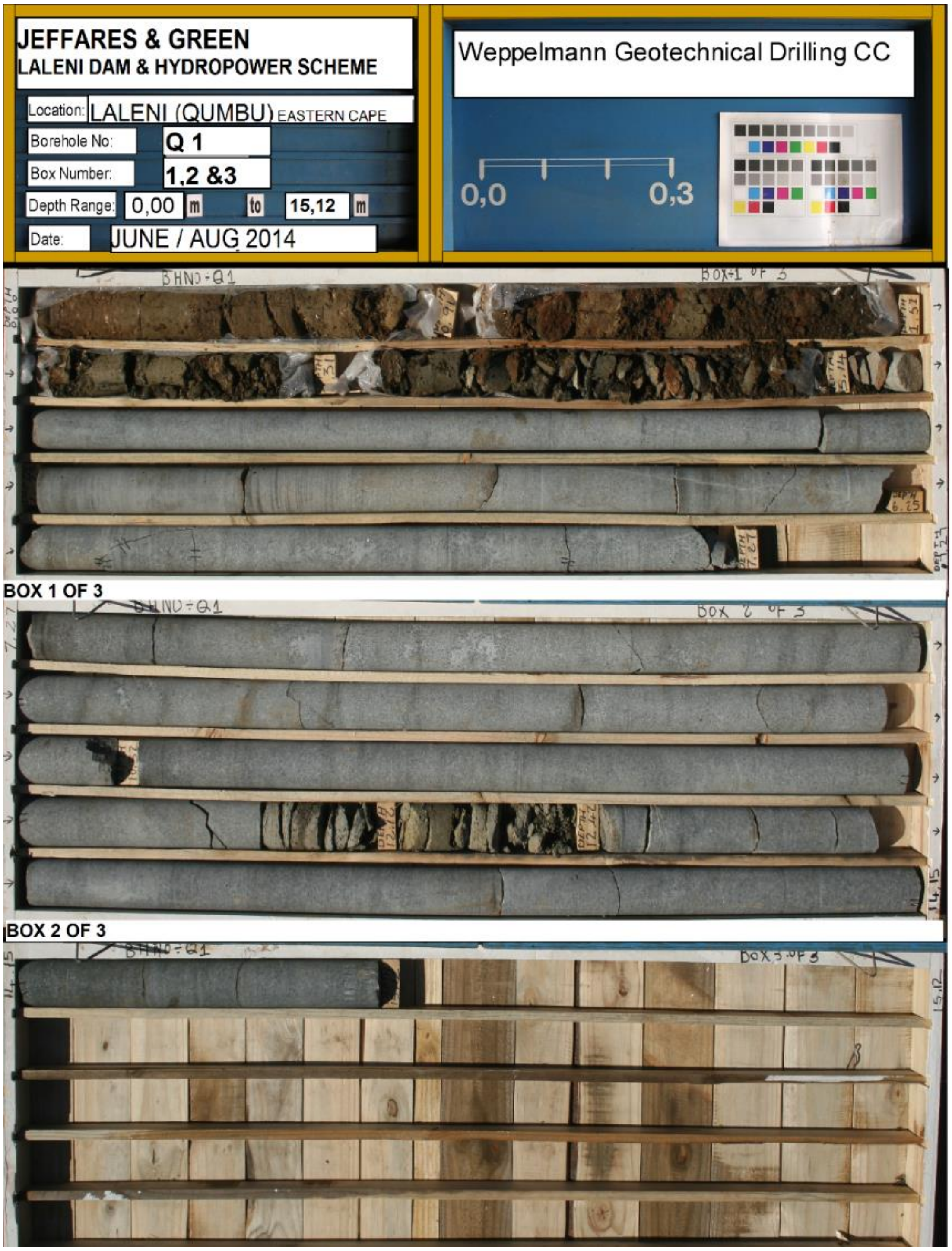
ELEVATION :
X-COORD : deg S
Y-COORD : deg E

HOLE No: BH Q1

D06C JGI

dotPLOT 7013 PBp7

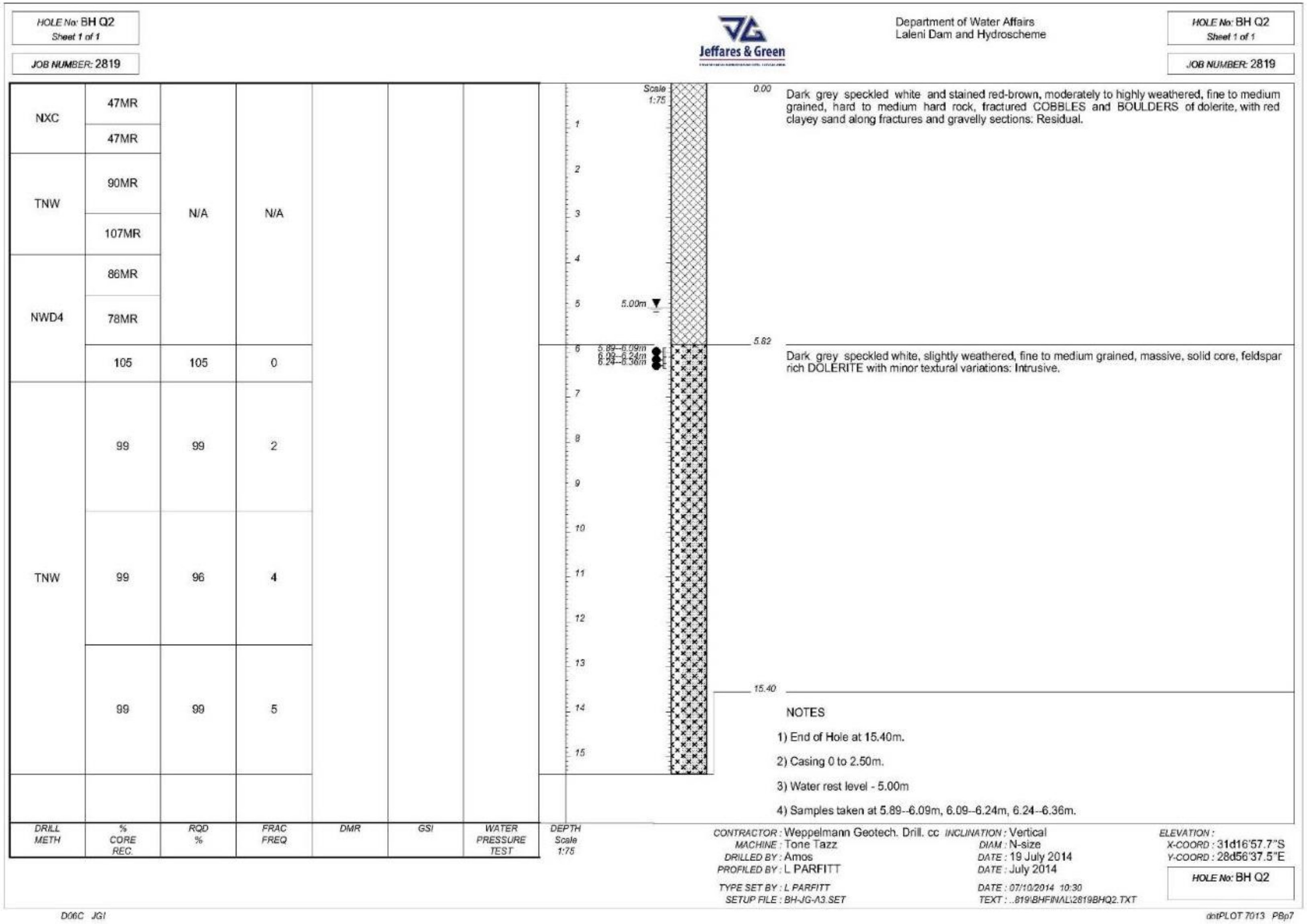
Fig C-1: **Borehole Quarry 1 - Log**



JEFFARES & GREEN
LALENI DAM & HYDROPOWER SCHEME
Location: LALENI (QUMBU) EASTERN CAPE
Borehole No: Q 1
Box Number: 1,2 &3
Depth Range: 0,00 m to 15,12 m
Date: JUNE / AUG 2014

Weppelmann Geotechnical Drilling CC

Fig C-2: Borehole Quarry 1 – Box 1 to 3 Dry



HOLE No: BH Q2
Sheet 1 of 1
JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	47MR	N/A	N/A			
	47MR					
TNW	90MR					
	107MR					
NWD4	86MR					
	78MR					
	105	105	0			
TNW	99	99	2			
	99	96	4			
	99	99	5			

DEPTH Scale 1:75

0.00 Dark grey speckled white and stained red-brown, moderately to highly weathered, fine to medium grained, hard to medium hard rock, fractured COBBLES and BOULDERS of dolerite, with red clayey sand along fractures and gravelly sections: Residual.

5.82 Dark grey speckled white, slightly weathered, fine to medium grained, massive, solid core, feldspar rich DOLERITE with minor textural variations: Intrusive.

15.40

NOTES

1) End of Hole at 15.40m.

2) Casing 0 to 2.50m.

3) Water rest level - 5.00m

4) Samples taken at 5.89--6.09m, 6.09--6.24m, 6.24--6.36m.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : Tone Tazz
DRILLED BY : Amos
PROFILED BY : L PARFITT
TYPE SET BY : L PARFITT
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 19 July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHQ2.TXT

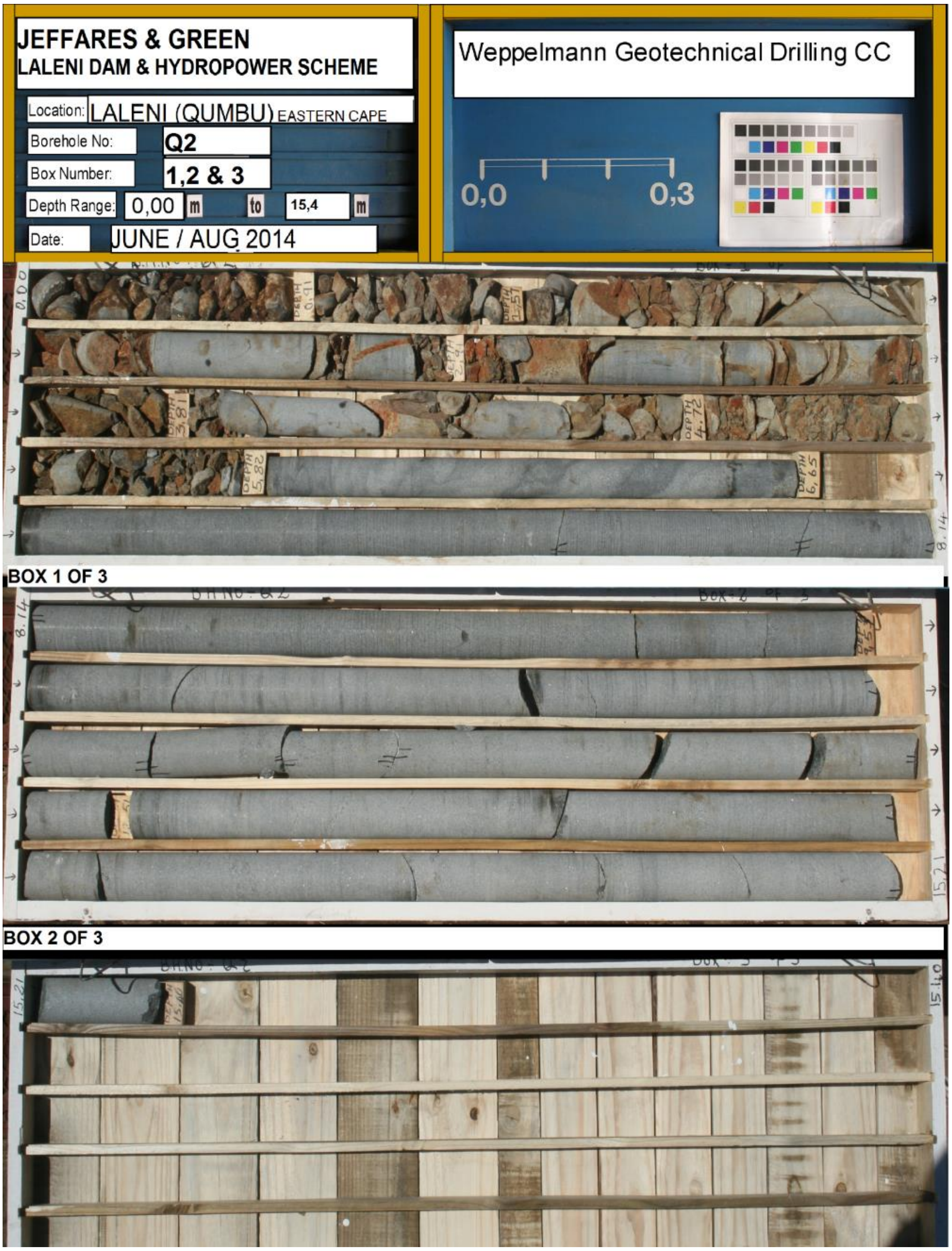
ELEVATION :
X-COORD : 31d16'57.7"S
Y-COORD : 28d56'37.5"E

HOLE No: BH Q2

D06C JGI

dotPLOT 7013 PBp7

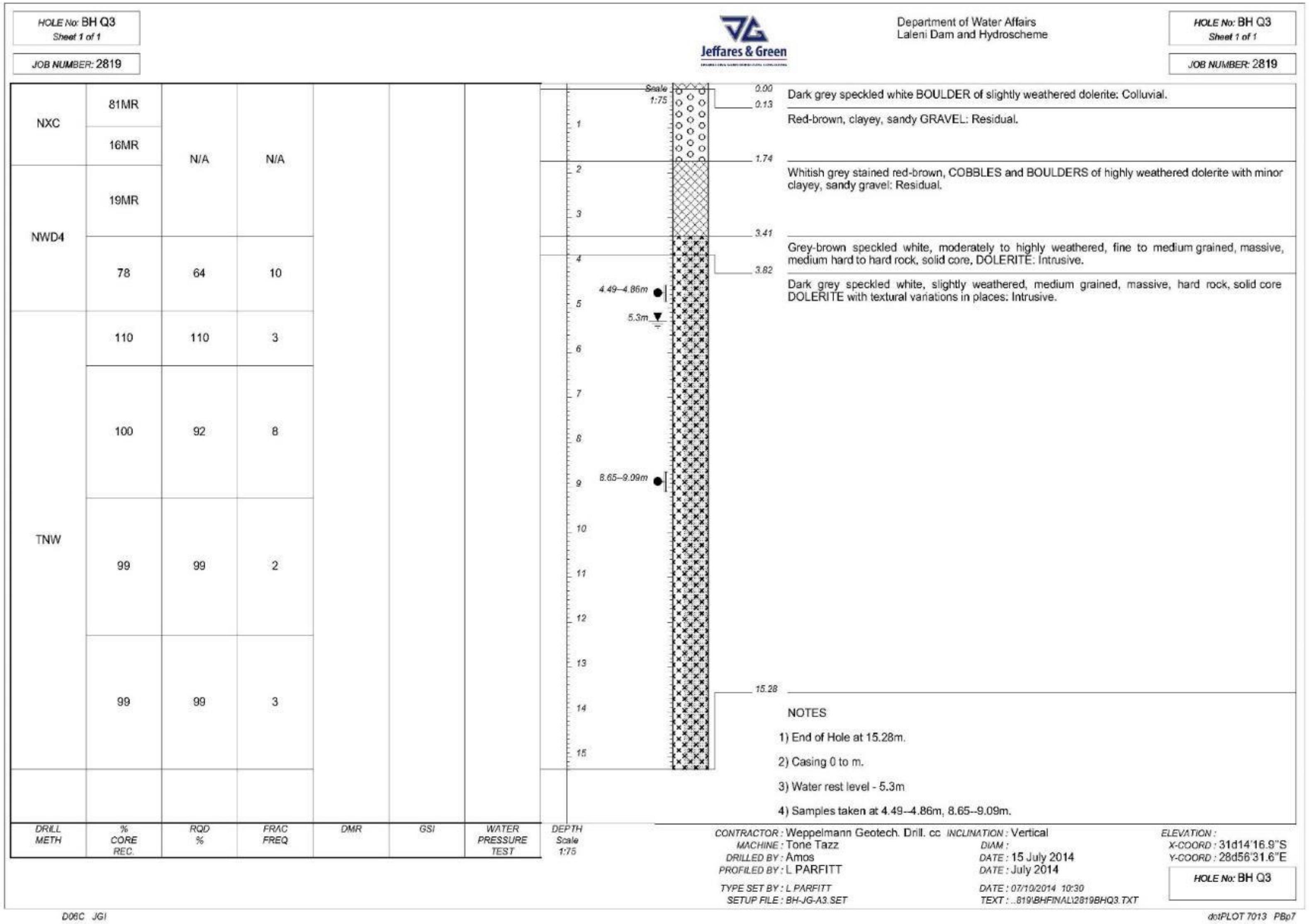
Fig C-3: **Borehole Quarry 2 - Log**



JEFFARES & GREEN
LALENI DAM & HYDROPOWER SCHEME
Location: LALENI (QUMBU) EASTERN CAPE
Borehole No: Q2
Box Number: 1,2 & 3
Depth Range: 0,00 m to 15,4 m
Date: JUNE / AUG 2014

Weppelmann Geotechnical Drilling CC

Fig C-4: Borehole Quarry 2 – Box 1 to 3 Dry



HOLE No: BH Q3
Sheet 1 of 1
JOB NUMBER: 2819

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Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH Q3
Sheet 1 of 1
JOB NUMBER: 2819

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	81MR	N/A	N/A			
	16MR					
NWD4	19MR					
	78	64	10			
TNW	110	110	3			
	100	92	8			
	99	99	2			
	99	99	3			

0.00	Dark grey speckled white BOULDER of slightly weathered dolerite: Colluvial.
0.13	Red-brown, clayey, sandy GRAVEL: Residual.
1.74	Whitish grey stained red-brown, COBBLES and BOULDERS of highly weathered dolerite with minor clayey, sandy gravel: Residual.
3.41	Grey-brown speckled white, moderately to highly weathered, fine to medium grained, massive, medium hard to hard rock, solid core, DOLERITE: Intrusive.
3.82	Dark grey speckled white, slightly weathered, medium grained, massive, hard rock, solid core DOLERITE with textural variations in places: Intrusive.
15.28	

NOTES

1) End of Hole at 15.28m.

2) Casing 0 to m.

3) Water rest level - 5.3m

4) Samples taken at 4.49--4.86m, 8.65--9.09m.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : Tone Tazz
DRILLED BY : Amos
PROFILED BY : L PARFITT
TYPE SET BY : L PARFITT
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 15 July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHQ3.TXT

ELEVATION :
X-COORD : 31d14'16.9"S
Y-COORD : 28d56'31.6"E

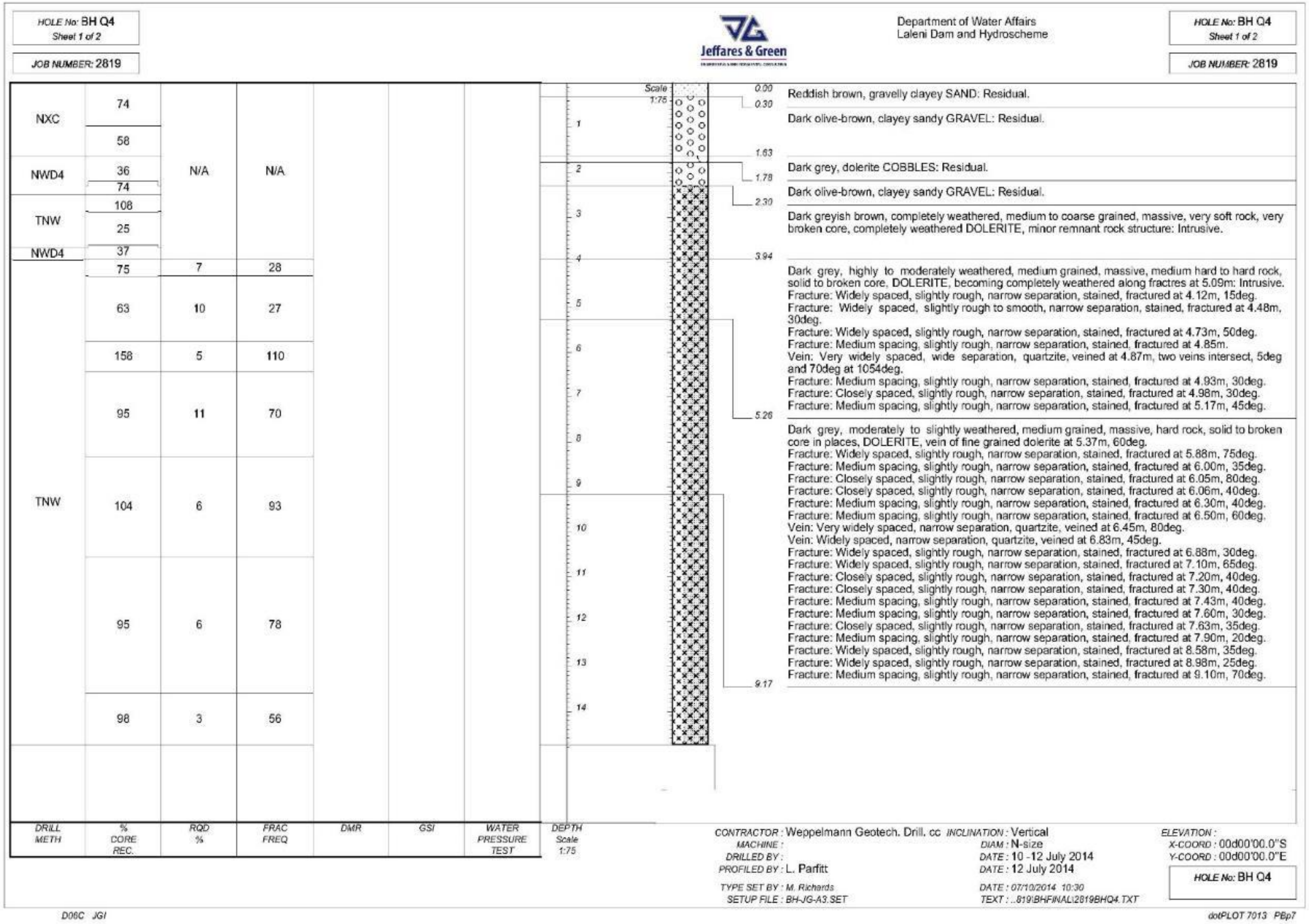
HOLE No: BH Q3

D06C JGI

dotPLOT 7013 PBp7

Fig C-5: **Borehole Quarry 3 - Log**

Fig C-6: **Borehole Quarry 3 – Box 1 to 2 Dry**



HOLE No: BH Q4
Sheet 1 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	74	N/A	N/A			
	58					
NWD4	36					
	74					
TNW	108					
	25					
NWD4	37					
TNW	75	7	28			
	63	10	27			
	158	5	110			
	95	11	70			
	104	6	93			
	95	6	78			
	98	3	56			

DEPTH Scale 1:75

0.00 – 0.30	Reddish brown, gravelly clayey SAND: Residual.
0.30 – 1.63	Dark olive-brown, clayey sandy GRAVEL: Residual.
1.63 – 1.78	Dark grey, dolerite COBBLES: Residual.
1.78 – 2.30	Dark olive-brown, clayey sandy GRAVEL: Residual.
2.30 – 3.94	Dark greyish brown, completely weathered, medium to coarse grained, massive, very soft rock, very broken core, completely weathered DOLERITE, minor remnant rock structure: Intrusive.
3.94 – 5.26	Dark grey, highly to moderately weathered, medium grained, massive, medium hard to hard rock, solid to broken core, DOLERITE, becoming completely weathered along fractres at 5.09m: Intrusive. Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 4.12m, 15deg. Fracture: Widely spaced, slightly rough to smooth, narrow separation, stained, fractured at 4.48m, 30deg. Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 4.73m, 50deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 4.85m. Vein: Very widely spaced, wide separation, quartzite, veined at 4.87m, two veins intersect, 5deg and 70deg at 1054deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 4.93m, 30deg. Fracture: Closely spaced, slightly rough, narrow separation, stained, fractured at 4.98m, 30deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 5.17m, 45deg.
5.26 – 9.17	Dark grey, moderately to slightly weathered, medium grained, massive, hard rock, solid to broken core in places, DOLERITE, vein of fine grained dolerite at 5.37m, 60deg. Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 5.88m, 75deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 6.00m, 35deg. Fracture: Closely spaced, slightly rough, narrow separation, stained, fractured at 6.05m, 80deg. Fracture: Closely spaced, slightly rough, narrow separation, stained, fractured at 6.06m, 40deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 6.30m, 40deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 6.50m, 60deg. Vein: Very widely spaced, narrow separation, quartzite, veined at 6.45m, 80deg. Vein: Widely spaced, narrow separation, quartzite, veined at 6.83m, 45deg. Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 6.88m, 30deg. Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 7.10m, 65deg. Fracture: Closely spaced, slightly rough, narrow separation, stained, fractured at 7.20m, 40deg. Fracture: Closely spaced, slightly rough, narrow separation, stained, fractured at 7.30m, 40deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 7.43m, 40deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 7.60m, 30deg. Fracture: Closely spaced, slightly rough, narrow separation, stained, fractured at 7.63m, 35deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 7.90m, 20deg. Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 8.58m, 35deg. Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 8.98m, 25deg. Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 9.10m, 70deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE :
DRILLED BY :
PROFILED BY : L. Parfitt
TYPE SET BY : M. Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 10 -12 July 2014
DATE : 12 July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHQ4.TXT

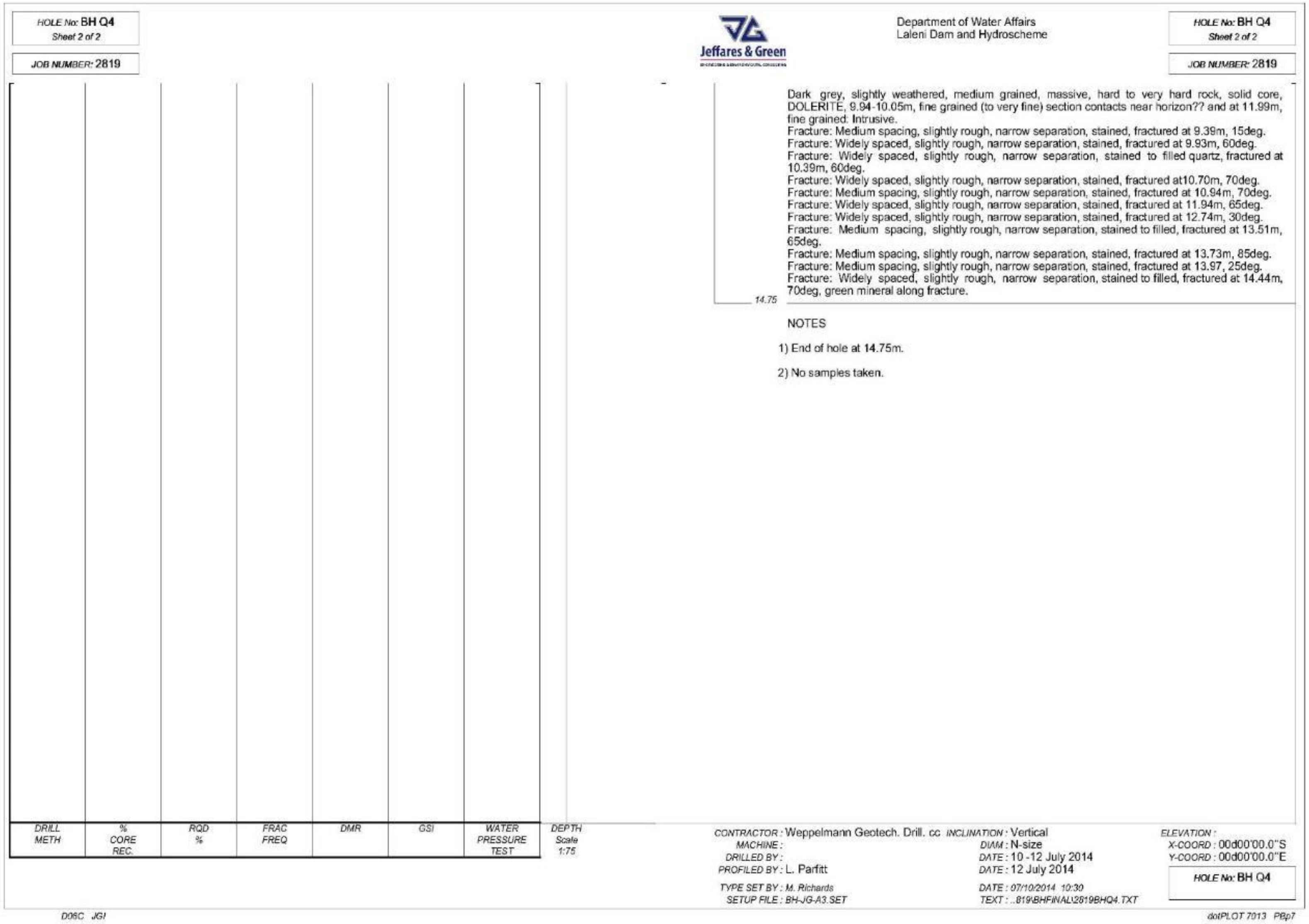
ELEVATION :
X-COORD : 00d00'00.0"S
Y-COORD : 00d00'00.0"E

HOLE No: BH Q4

D06C JGI

dotPLOT 7013 PBp7

Fig C-7-1: **Borehole Quarry 4 - Log**



HOLE No: BH Q4
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH Q4
Sheet 2 of 2

JOB NUMBER: 2819

Dark grey, slightly weathered, medium grained, massive, hard to very hard rock, solid core, DOLERITE, 9.94-10.05m, fine grained (to very fine) section contacts near horizon?? and at 11.99m, fine grained: Intrusive.
Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 9.39m, 15deg.
Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 9.93m, 60deg.
Fracture: Widely spaced, slightly rough, narrow separation, stained to filled quartz, fractured at 10.39m, 60deg.
Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at10.70m, 70deg.
Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 10.94m, 70deg.
Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 11.94m, 65deg.
Fracture: Widely spaced, slightly rough, narrow separation, stained, fractured at 12.74m, 30deg.
Fracture: Medium spacing, slightly rough, narrow separation, stained to filled, fractured at 13.51m, 65deg.
Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 13.73m, 85deg.
Fracture: Medium spacing, slightly rough, narrow separation, stained, fractured at 13.97, 25deg.
Fracture: Widely spaced, slightly rough, narrow separation, stained to filled, fractured at 14.44m, 70deg, green mineral along fracture.

14.75

NOTES

1) End of hole at 14.75m.

2) No samples taken.

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST	DEPTH Scale 1:75

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE :
DRILLED BY :
PROFILED BY : L. Parfitt
TYPE SET BY : M. Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 10 -12 July 2014
DATE : 12 July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHQ4.TXT

ELEVATION :
X-COORD : 00d00'00.0"S
Y-COORD : 00d00'00.0"E

HOLE No: BH Q4

D06C JGI

dotPLOT 7013 PBp7

Fig C-7-2: Borehole Quarry 4 - Log

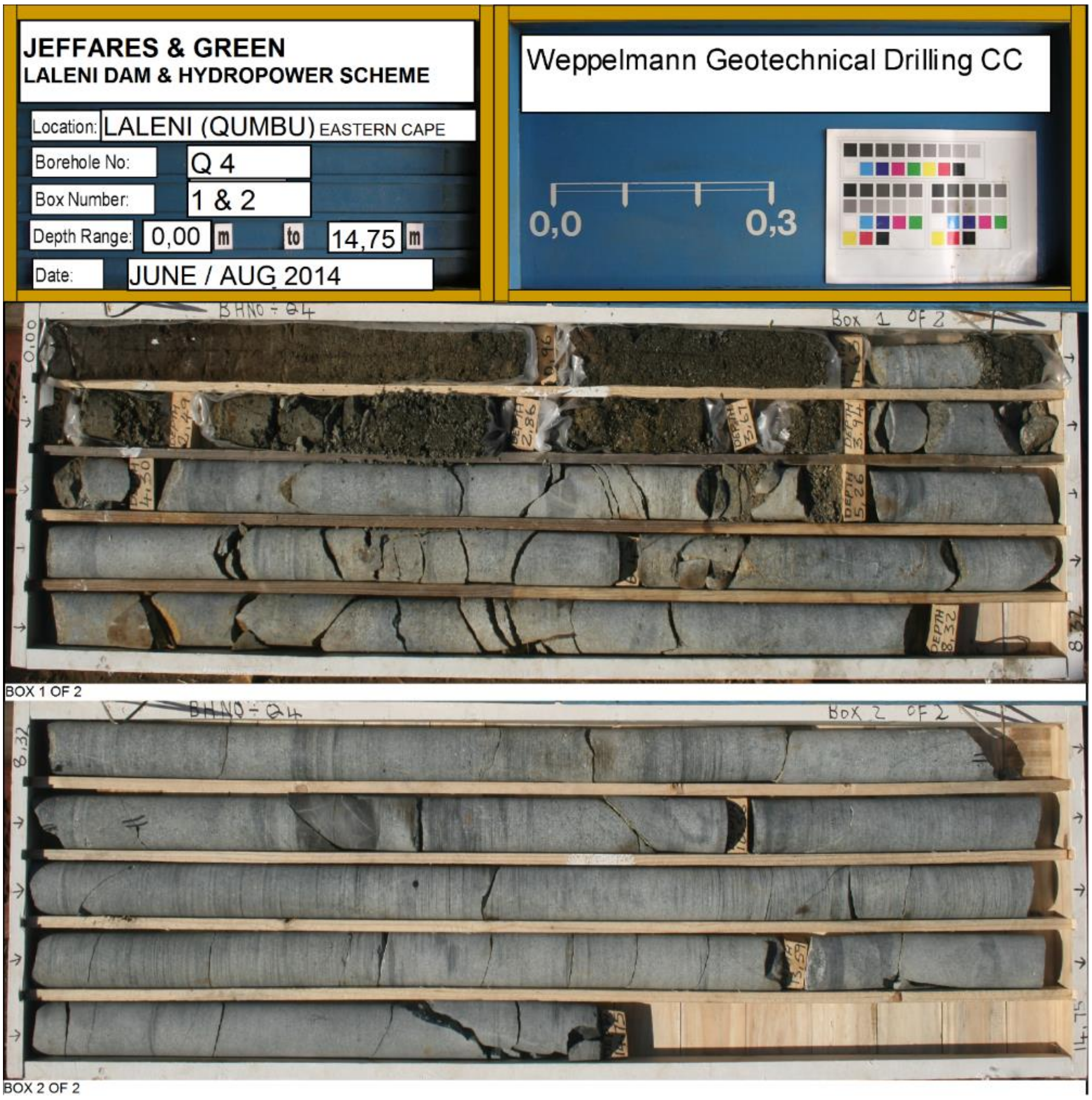
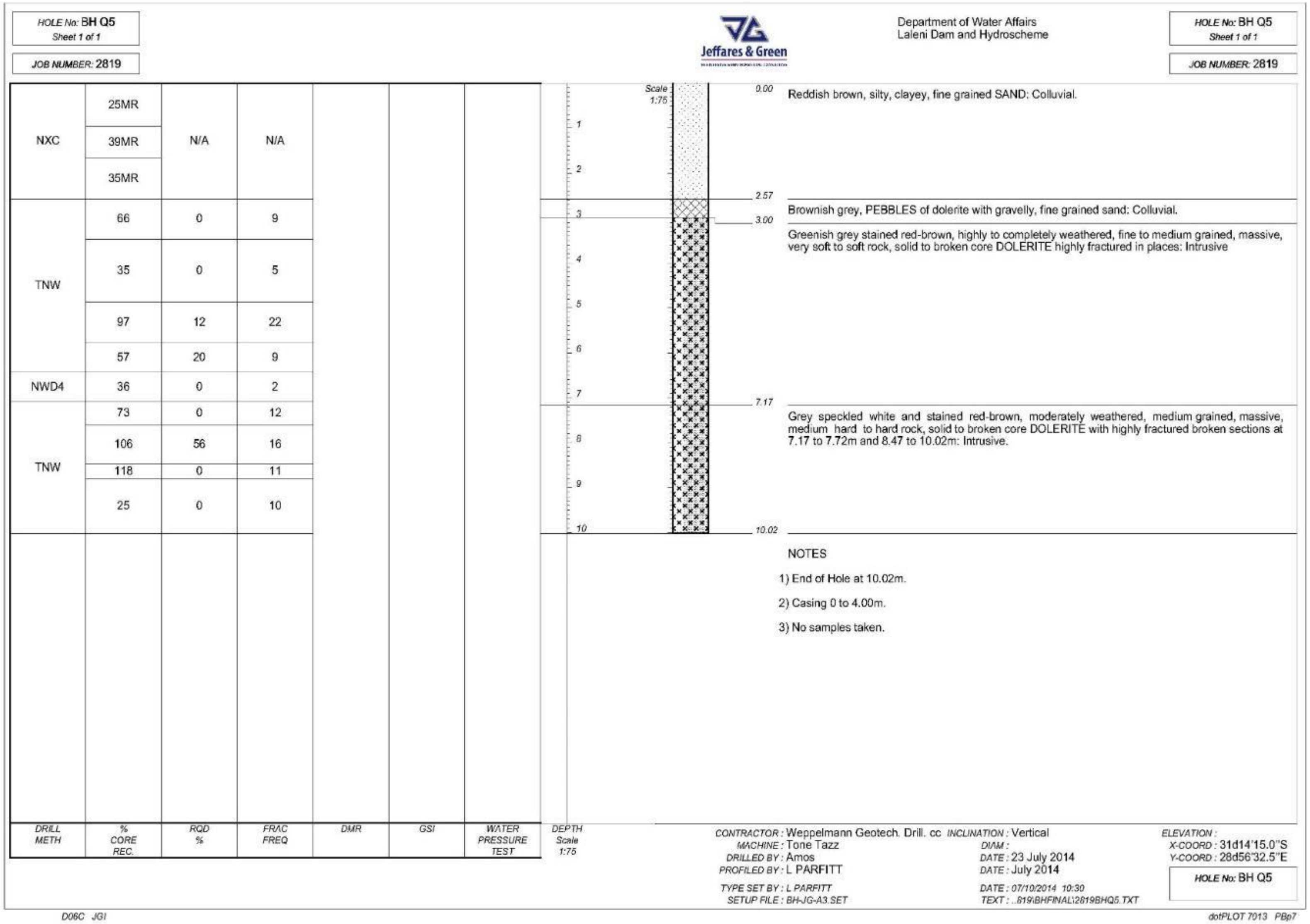


Fig C-8: Borehole Quarry 4 – Box 1 to 2 Dry



HOLE No: BH Q5
Sheet 1 of 1

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	25MR	N/A	N/A			
	39MR					
	35MR					
TNW	66	0	9			
	35	0	5			
	97	12	22			
	57	20	9			
NWD4	36	0	2			
TNW	73	0	12			
	106	56	16			
	118	0	11			
	25	0	10			

DEPTH Scale 1:75

0.00	Reddish brown, silty, clayey, fine grained SAND: Colluvial.
2.57	Brownish grey, PEBBLES of dolerite with gravelly, fine grained sand: Colluvial.
3.00	Greenish grey stained red-brown, highly to completely weathered, fine to medium grained, massive, very soft to soft rock, solid to broken core DOLERITE highly fractured in places: Intrusive
7.17	Grey speckled white and stained red-brown, moderately weathered, medium grained, massive, medium hard to hard rock, solid to broken core DOLERITE with highly fractured broken sections at 7.17 to 7.72m and 8.47 to 10.02m: Intrusive.
10.02	

NOTES

1) End of Hole at 10.02m.

2) Casing 0 to 4.00m.

3) No samples taken.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : Tone Tazz
DRILLED BY : Amos
PROFILED BY : L PARFITT
TYPE SET BY : L PARFITT
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 23 July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHQ5.TXT

ELEVATION :
X-COORD : 31d14'15.0"S
Y-COORD : 28d56'32.5"E

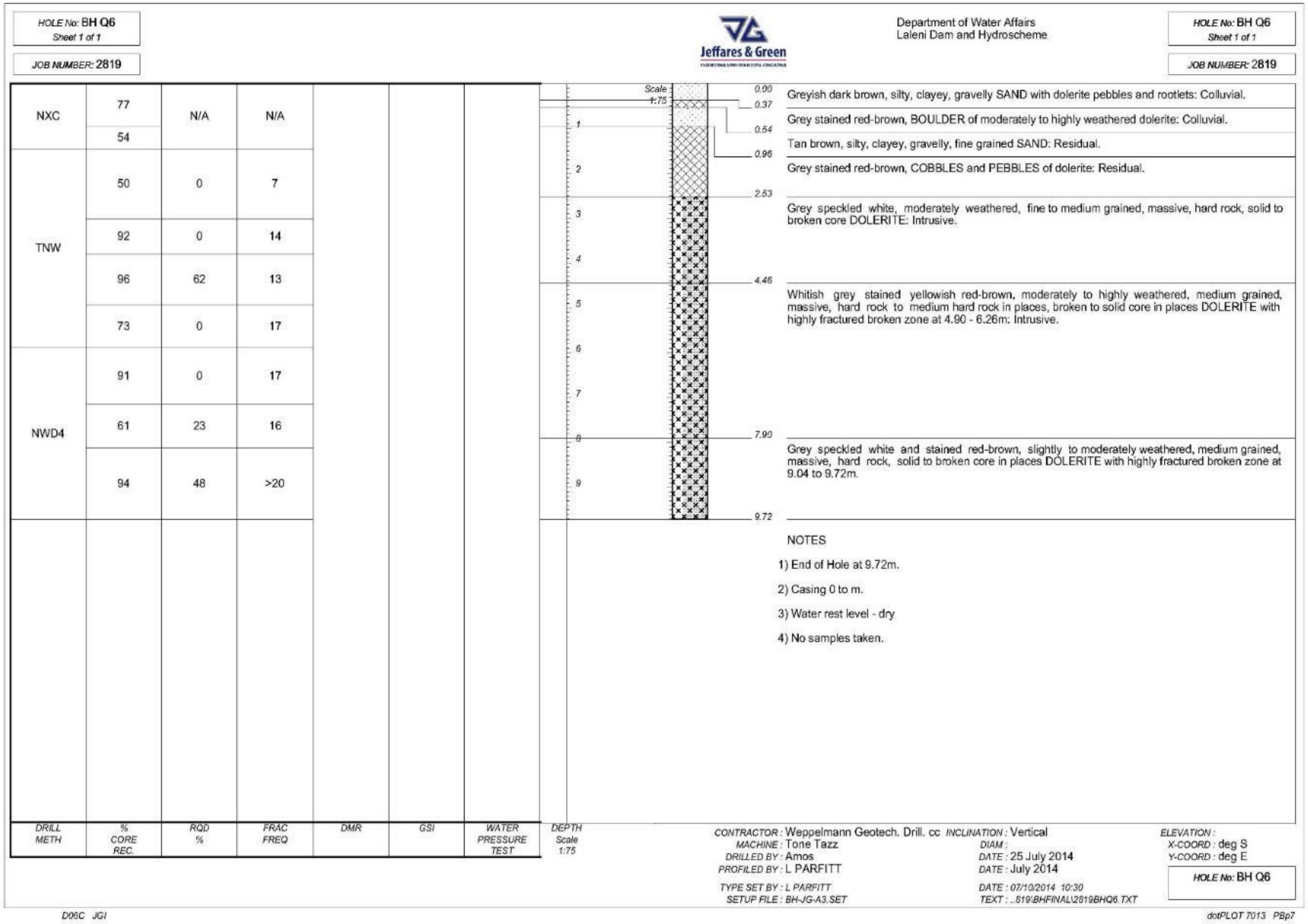
HOLE No: BH Q5

D06C JGI

dotPLOT 7013 PBp7

Fig C-8: **Borehole Quarry 5 - Log**

Fig C-9: **Borehole Quarry 5 – Box 1 Dry**



HOLE No: BH Q6
Sheet 1 of 1

JOB NUMBER: 2819

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Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	RQD %	FRAC FREQ	DMR	GSI	WATER PRESSURE TEST
NXC	77	N/A	N/A			
	54					
TNW	50	0	7			
	92	0	14			
	96	62	13			
	73	0	17			
NWD4	91	0	17			
	61	23	16			
	94	48	>20			

DEPTH Scale 1:75

0.00 – 0.37	Greyish dark brown, silty, clayey, gravelly SAND with dolerite pebbles and rootlets: Colluvial.
0.37 – 0.54	Grey stained red-brown, BOULDER of moderately to highly weathered dolerite: Colluvial.
0.54 – 0.96	Tan brown, silty, clayey, gravelly, fine grained SAND: Residual.
0.96 – 2.53	Grey stained red-brown, COBBLES and PEBBLES of dolerite: Residual.
2.53 – 4.46	Grey speckled white, moderately weathered, fine to medium grained, massive, hard rock, solid to broken core DOLERITE: Intrusive.
4.46 – 7.90	Whitish grey stained yellowish red-brown, moderately to highly weathered, medium grained, massive, hard rock to medium hard rock in places, broken to solid core in places DOLERITE with highly fractured broken zone at 4.90 - 6.26m: Intrusive.
7.90 – 9.72	Grey speckled white and stained red-brown, slightly to moderately weathered, medium grained, massive, hard rock, solid to broken core in places DOLERITE with highly fractured broken zone at 9.04 to 9.72m.

NOTES

1) End of Hole at 9.72m.

2) Casing 0 to m.

3) Water rest level - dry

4) No samples taken.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : Tone Tazz
DRILLED BY : Amos
PROFILED BY : L PARFITT
TYPE SET BY : L PARFITT
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 25 July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHQ6.TXT

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

HOLE No: BH Q6

D06C JGI

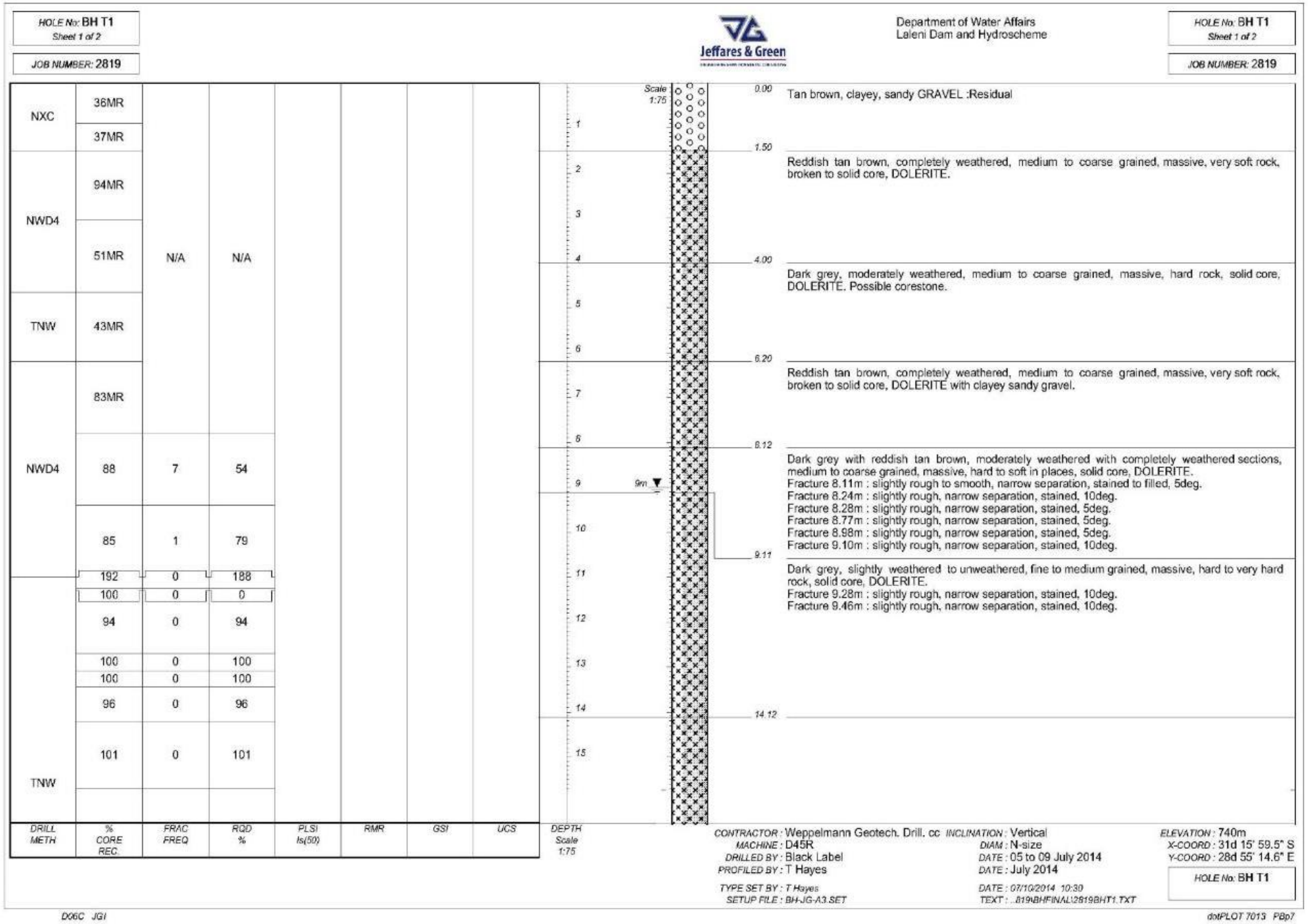
dotPLOT 7013 PBp7

Fig C-10: **Borehole Quarry 6 - Log**

Fig C-11: **Borehole Quarry 6 – Box 1 and 2 Dry**

APPENDIX D

TUNNEL BOREHOLE LOGS, PHOTOGRAPHS AND WATER PRESSURE TESTS



HOLE No: BH T1
Sheet 1 of 2

JOB NUMBER: 2819

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HOLE No: BH T1
Sheet 1 of 2

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	PLSI Is(50)	RMR	GSI	UCS
NXC	36MR	N/A	N/A				
	37MR						
NWD4	94MR						
	51MR						
TNW	43MR						
NWD4	83MR						
	88	7	54				
	85	1	79				
TNW	192	0	188				
	100	0	0				
	94	0	94				
	100	0	100				
	100	0	100				
	96	0	96				
	101	0	101				

0.00	Tan brown, clayey, sandy GRAVEL :Residual
1.50	Reddish tan brown, completely weathered, medium to coarse grained, massive, very soft rock, broken to solid core, DOLERITE.
4.00	Dark grey, moderately weathered, medium to coarse grained, massive, hard rock, solid core, DOLERITE. Possible corestone.
6.20	Reddish tan brown, completely weathered, medium to coarse grained, massive, very soft rock, broken to solid core, DOLERITE with clayey sandy gravel.
8.12	Dark grey with reddish tan brown, moderately weathered with completely weathered sections, medium to coarse grained, massive, hard to soft in places, solid core, DOLERITE. Fracture 8.11m : slightly rough to smooth, narrow separation, stained to filled, 5deg. Fracture 8.24m : slightly rough, narrow separation, stained, 10deg. Fracture 8.28m : slightly rough, narrow separation, stained, 5deg. Fracture 8.77m : slightly rough, narrow separation, stained, 5deg. Fracture 8.98m : slightly rough, narrow separation, stained, 5deg. Fracture 9.10m : slightly rough, narrow separation, stained, 10deg.
9.11	Dark grey, slightly weathered to unweathered, fine to medium grained, massive, hard to very hard rock, solid core, DOLERITE. Fracture 9.28m : slightly rough, narrow separation, stained, 10deg. Fracture 9.46m : slightly rough, narrow separation, stained, 10deg.
14.12	

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D45R
DRILLED BY : Black Label
PROFILED BY : T Hayes

INCLINATION : Vertical
DIAM : N-size
DATE : 05 to 09 July 2014
DATE : July 2014

ELEVATION : 740m
X-COORD : 31d 15' 59.5" S
Y-COORD : 28d 55' 14.6" E

HOLE No: BH T1

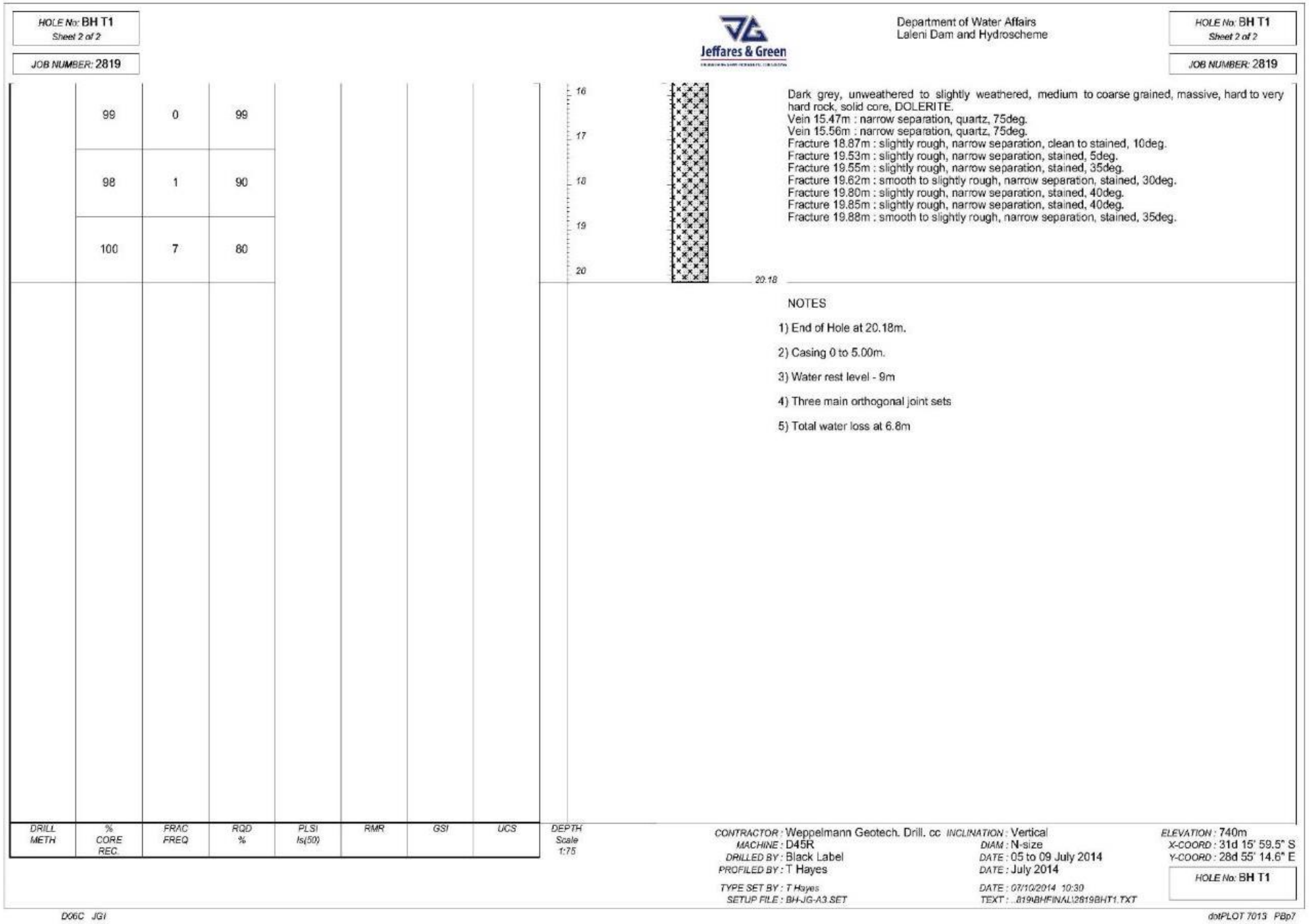
TYPE SET BY : T Hayes
SETUP FILE : BH-JG-A3.SET

DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHT1.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig D-1.1: Borehole Tunnel 1 - Log



HOLE No: BH T1
Sheet 2 of 2

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	PLSI Is(50)	RMR	GSI	UCS
	99	0	99				
	98	1	90				
	100	7	80				

Dark grey, unweathered to slightly weathered, medium to coarse grained, massive, hard to very hard rock, solid core, DOLERITE.
Vein 15.47m : narrow separation, quartz, 75deg.
Vein 15.56m : narrow separation, quartz, 75deg.
Fracture 18.87m : slightly rough, narrow separation, clean to stained, 10deg.
Fracture 19.53m : slightly rough, narrow separation, stained, 5deg.
Fracture 19.55m : slightly rough, narrow separation, stained, 35deg.
Fracture 19.62m : smooth to slightly rough, narrow separation, stained, 30deg.
Fracture 19.80m : slightly rough, narrow separation, stained, 40deg.
Fracture 19.85m : slightly rough, narrow separation, stained, 40deg.
Fracture 19.88m : smooth to slightly rough, narrow separation, stained, 35deg.

NOTES

1) End of Hole at 20.18m.

2) Casing 0 to 5.00m.

3) Water rest level - 9m

4) Three main orthogonal joint sets

5) Total water loss at 6.8m

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D45R
DRILLED BY : Black Label
PROFILED BY : T Hayes
TYPE SET BY : T Hayes
SETUP FILE : BH-JG-A3.SET

INCLINATION : Vertical
DIAM : N-size
DATE : 05 to 09 July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHT1.TXT

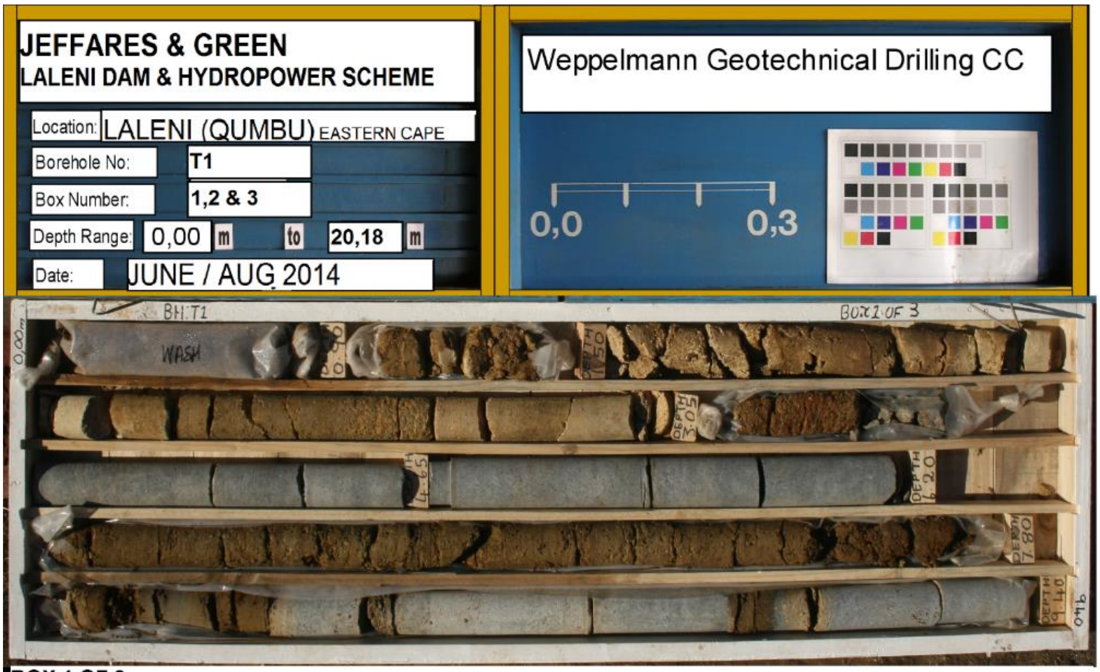
ELEVATION : 740m
X-COORD : 31d 15' 59.5" S
Y-COORD : 28d 55' 14.6" E

HOLE No: BH T1

D06C JGI

dotPLOT 7013 PBp7

Fig D-1.2: **Borehole Tunnel 1 - Log**



JEFFARES & GREEN
LALENI DAM & HYDROPOWER SCHEME
Location: LALENI (QUMBU) EASTERN CAPE
Borehole No: T1
Box Number: 1,2 & 3
Depth Range: 0,00 m to 20,18 m
Date: JUNE / AUG 2014

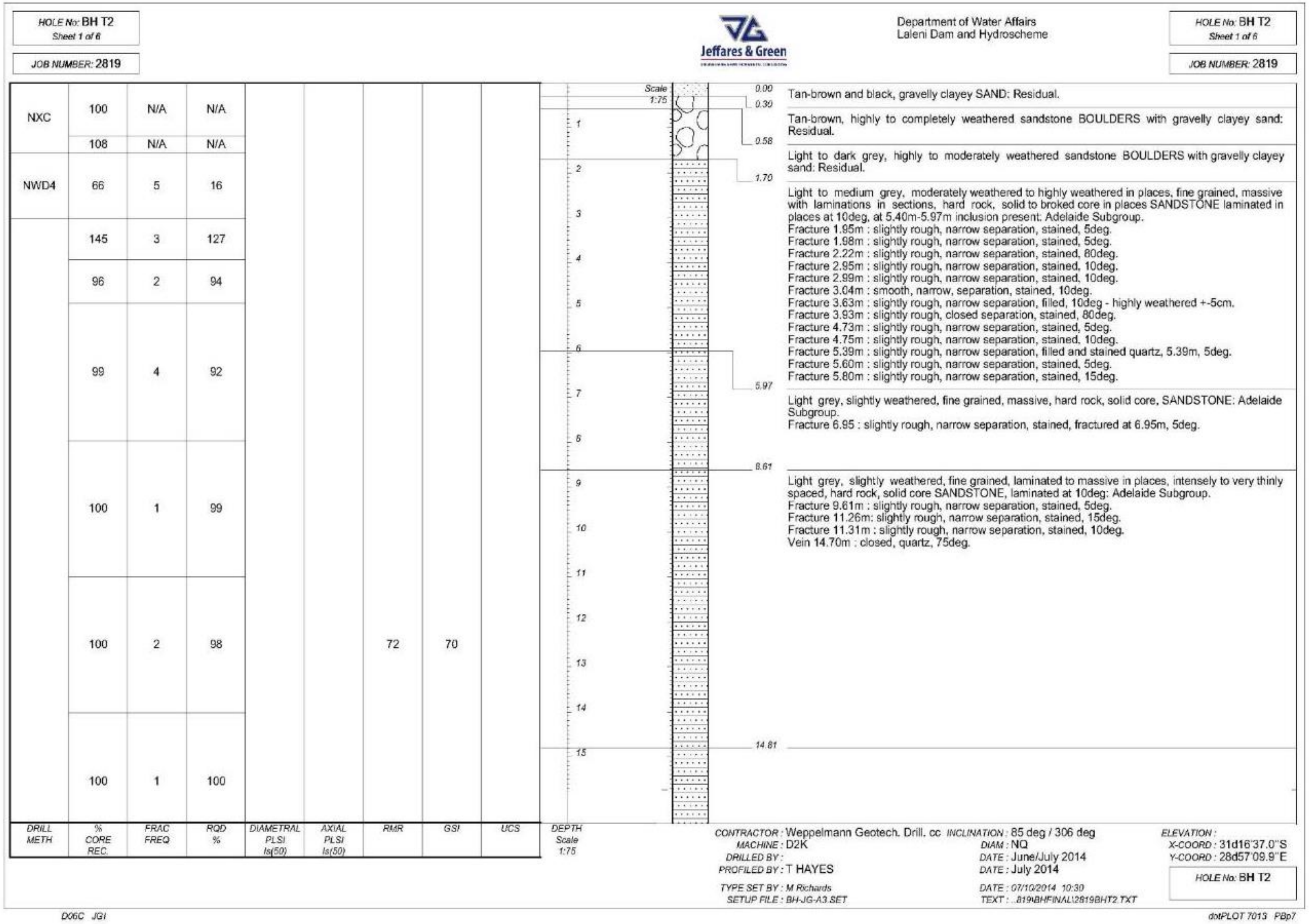
Weppelmann Geotechnical Drilling CC

BOX 1 OF 3

BOX 2 OF 3

BOX 3 OF 3

Fig D-2: Borehole Tunnel 1 – Box 1 to 3



HOLE No: BH T2
Sheet 1 of 6

JOB NUMBER: 2819

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Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T2
Sheet 1 of 6

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
NXC	100	N/A	N/A					
	108	N/A	N/A					
NWD4	66	5	16					
	145	3	127					
	96	2	94					
	99	4	92					
	100	1	99					
	100	2	98			72	70	
	100	1	100					

DEPTH Scale 1:75

0.00	Tan-brown and black, gravelly clayey SAND: Residual.
0.30	Tan-brown, highly to completely weathered sandstone BOULDERS with gravelly clayey sand: Residual.
0.58	Light to dark grey, highly to moderately weathered sandstone BOULDERS with gravelly clayey sand: Residual.
1.70	Light to medium grey, moderately weathered to highly weathered in places, fine grained, massive with laminations in sections, hard rock, solid to broked core in places SANDSTONE laminated in places at 10deg, at 5.40m-5.97m inclusion present: Adelaide Subgroup. Fracture 1.95m : slightly rough, narrow separation, stained, 5deg. Fracture 1.98m : slightly rough, narrow separation, stained, 5deg. Fracture 2.22m : slightly rough, narrow separation, stained, 80deg. Fracture 2.95m : slightly rough, narrow separation, stained, 10deg. Fracture 2.99m : slightly rough, narrow separation, stained, 10deg. Fracture 3.04m : smooth, narrow, separation, stained, 10deg. Fracture 3.63m : slightly rough, narrow separation, filled, 10deg - highly weathered +-5cm. Fracture 3.93m : slightly rough, closed separation, stained, 80deg. Fracture 4.73m : slightly rough, narrow separation, stained, 5deg. Fracture 4.75m : slightly rough, narrow separation, stained, 10deg. Fracture 5.39m : slightly rough, narrow separation, filled and stained quartz, 5.39m, 5deg. Fracture 5.60m : slightly rough, narrow separation, stained, 5deg. Fracture 5.80m : slightly rough, narrow separation, stained, 15deg.
5.97	Light grey, slightly weathered, fine grained, massive, hard rock, solid core, SANDSTONE: Adelaide Subgroup. Fracture 6.95 : slightly rough, narrow separation, stained, fractured at 6.95m, 5deg.
8.61	Light grey, slightly weathered, fine grained, laminated to massive in places, intensely to very thinly spaced, hard rock, solid core SANDSTONE, laminated at 10deg: Adelaide Subgroup. Fracture 9.61m : slightly rough, narrow separation, stained, 5deg. Fracture 11.26m: slightly rough, narrow separation, stained, 15deg. Fracture 11.31m : slightly rough, narrow separation, stained, 10deg. Vein 14.70m : closed, quartz, 75deg.
14.81	

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES
TYPE SET BY : M Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85 deg / 306 deg
DIAM : NQ
DATE : June/July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHT2.TXT

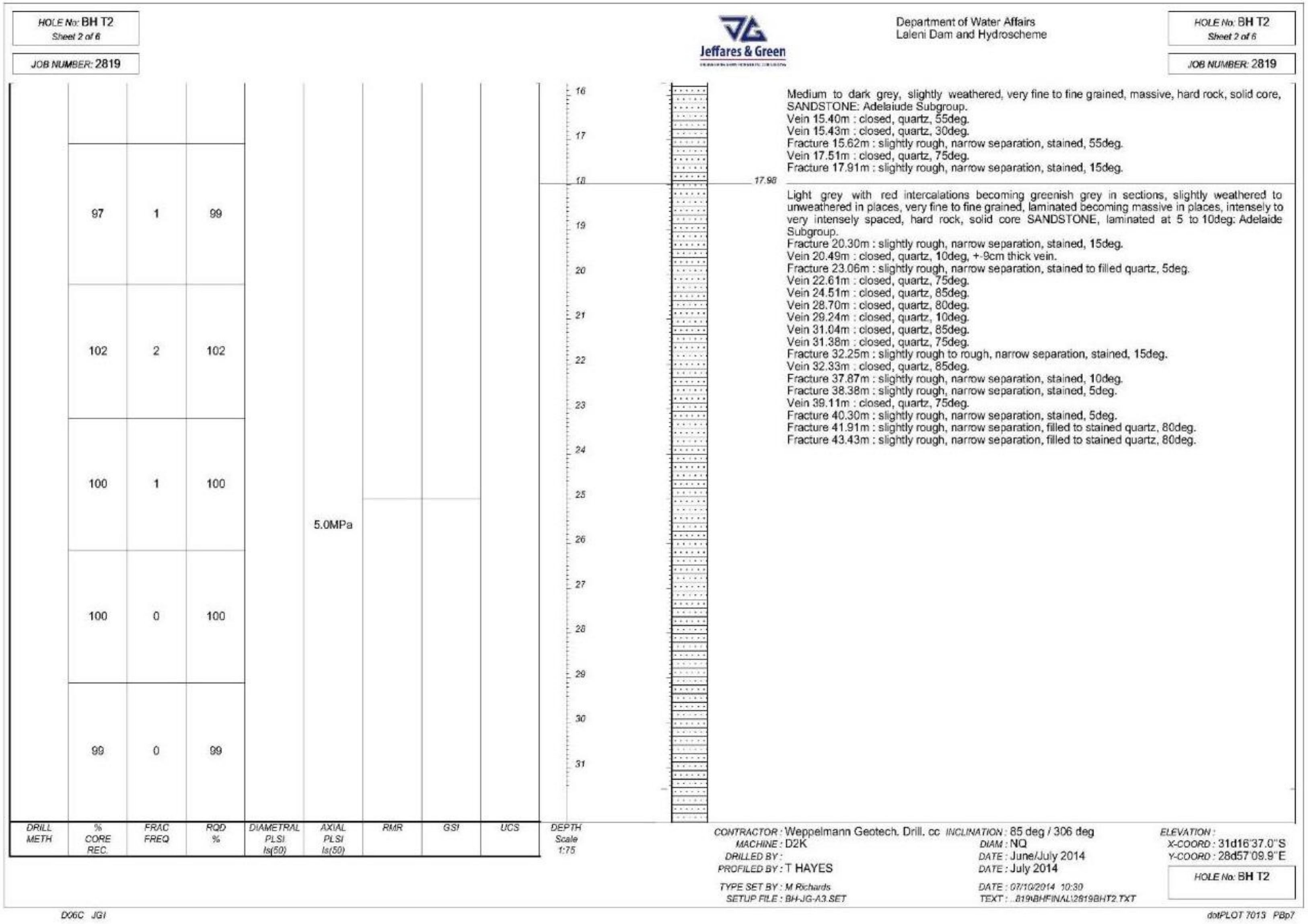
ELEVATION :
X-COORD : 31d16'37.0"S
Y-COORD : 28d57'09.9"E

HOLE No: BH T2

D06C JGI

dotPLOT 7013 PBp7

Fig D-3.1: **Borehole Tunnel 2 - Log**



HOLE No: BH T2
Sheet 2 of 6

JOB NUMBER: 2819

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Laleni Dam and Hydroscheme

HOLE No: BH T2
Sheet 2 of 6

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	97	1	99					
	102	2	102					
	100	1	100					
					5.0MPa			
	100	0	100					
	99	0	99					

Medium to dark grey, slightly weathered, very fine to fine grained, massive, hard rock, solid core, SANDSTONE: Adelaiude Subgroup.
Vein 15.40m : closed, quartz, 55deg.
Vein 15.43m : closed, quartz, 30deg.
Fracture 15.62m : slightly rough, narrow separation, stained, 55deg.
Vein 17.51m : closed, quartz, 75deg.
Fracture 17.91m : slightly rough, narrow separation, stained, 15deg.

Light grey with red intercalations becoming greenish grey in sections, slightly weathered to unweathered in places, very fine to fine grained, laminated becoming massive in places, intensely to very intensely spaced, hard rock, solid core SANDSTONE, laminated at 5 to 10deg: Adelaide Subgroup.
Fracture 20.30m : slightly rough, narrow separation, stained, 15deg.
Vein 20.49m : closed, quartz, 10deg, +-9cm thick vein.
Fracture 23.06m : slightly rough, narrow separation, stained to filled quartz, 5deg.
Vein 22.61m : closed, quartz, 75deg.
Vein 24.51m : closed, quartz, 85deg.
Vein 28.70m : closed, quartz, 80deg.
Vein 29.24m : closed, quartz, 10deg.
Vein 31.04m : closed, quartz, 85deg.
Vein 31.38m : closed, quartz, 75deg.
Fracture 32.25m : slightly rough to rough, narrow separation, stained, 15deg.
Vein 32.33m : closed, quartz, 85deg.
Fracture 37.87m : slightly rough, narrow separation, stained, 10deg.
Fracture 38.38m : slightly rough, narrow separation, stained, 5deg.
Vein 39.11m : closed, quartz, 75deg.
Fracture 40.30m : slightly rough, narrow separation, stained, 5deg.
Fracture 41.91m : slightly rough, narrow separation, filled to stained quartz, 80deg.
Fracture 43.43m : slightly rough, narrow separation, filled to stained quartz, 80deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES
TYPE SET BY : M Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85 deg / 306 deg
DIAM : NQ
DATE : June/July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHT2.TXT

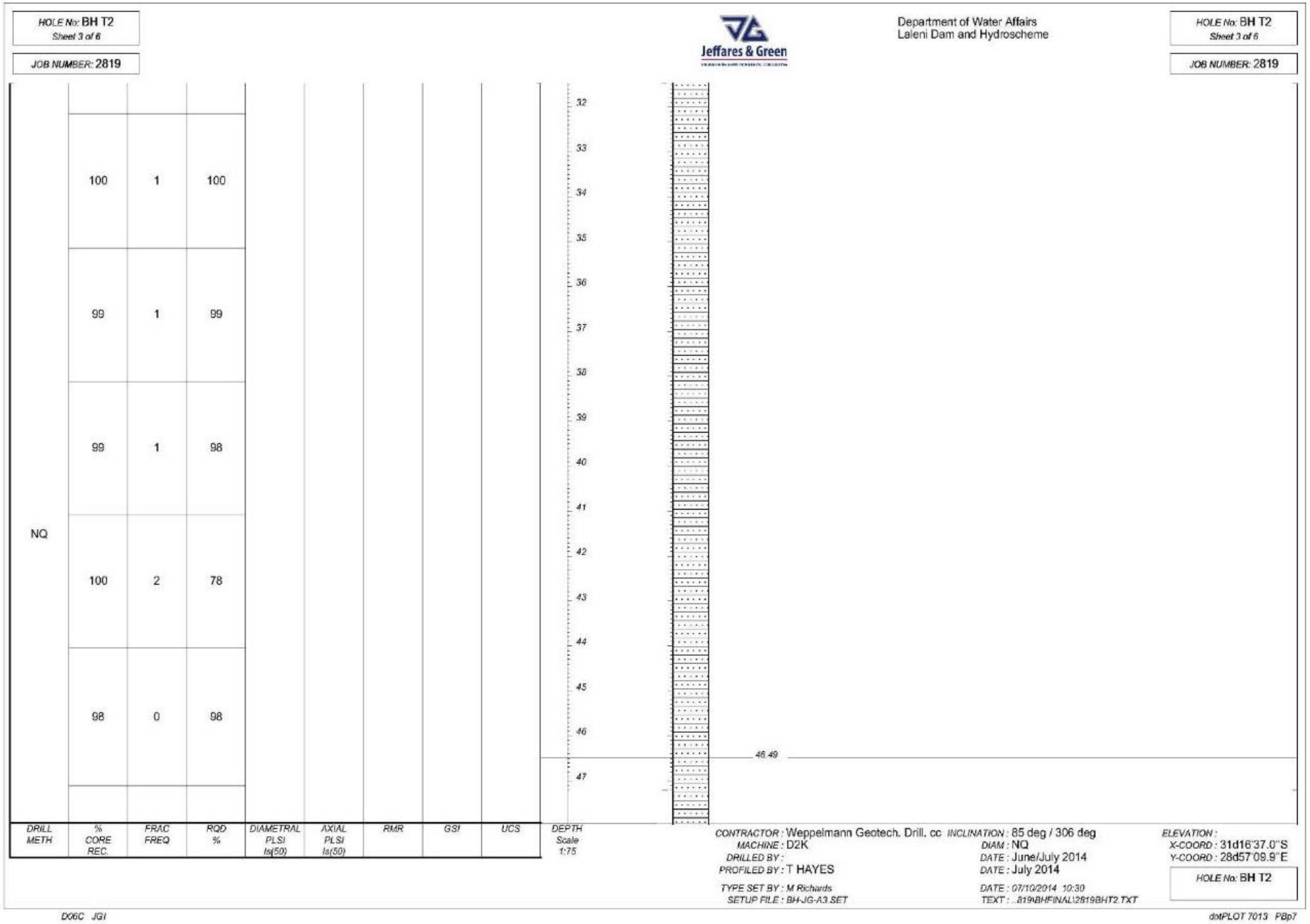
ELEVATION :
X-COORD : 31d16'37.0"S
Y-COORD : 28d57'09.9"E

HOLE No: BH T2

D06C JGI

dotPLOT 7013 PBp7

Fig D-3.2: Borehole Tunnel 2 - Log



HOLE No: BH T2
Sheet 3 of 6

JOB NUMBER: 2819

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Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
NQ	100	1	100					
	99	1	99					
	99	1	98					
	100	2	78					
	98	0	98					

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES
TYPE SET BY : M Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85 deg / 306 deg
DIAM : NQ
DATE : June/July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHT2.TXT

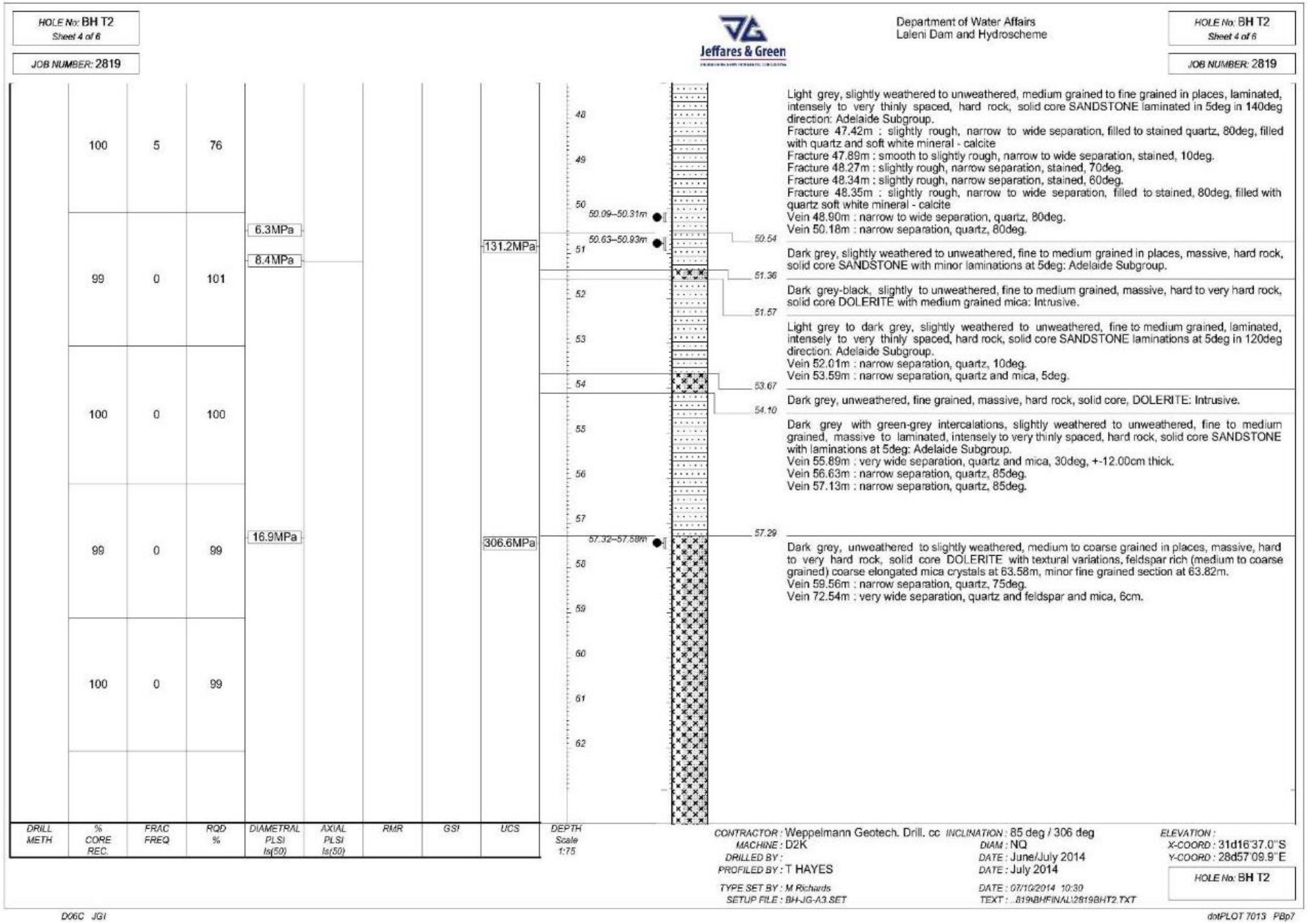
ELEVATION :
X-COORD : 31d16'37.0"S
Y-COORD : 28d57'09.9"E

HOLE No: BH T2

D06C JGI

dotPLOT 7013 PBp7

Fig D-3.3: Borehole Tunnel 2 - Log



HOLE No: BH T2
Sheet 4 of 6

JOB NUMBER: 2819

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DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	100	5	76					
	99	0	101	6.3MPa 8.4MPa				131.2MPa
	100	0	100					
	99	0	99	16.9MPa				306.6MPa
	100	0	99					

DEPTH Scale 1:75

Light grey, slightly weathered to unweathered, medium grained to fine grained in places, laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE laminated in 5deg in 140deg direction: Adelaide Subgroup.
Fracture 47.42m : slightly rough, narrow to wide separation, filled to stained quartz, 80deg, filled with quartz and soft white mineral - calcite
Fracture 47.89m : smooth to slightly rough, narrow to wide separation, stained, 10deg.
Fracture 48.27m : slightly rough, narrow separation, stained, 70deg.
Fracture 48.34m : slightly rough, narrow separation, stained, 60deg.
Fracture 48.35m : slightly rough, narrow to wide separation, filled to stained, 80deg, filled with quartz soft white mineral - calcite
Vein 48.90m : narrow to wide separation, quartz, 80deg.
Vein 50.18m : narrow separation, quartz, 80deg.

50.54

Dark grey, slightly weathered to unweathered, fine to medium grained in places, massive, hard rock, solid core SANDSTONE with minor laminations at 5deg: Adelaide Subgroup.

51.36

Dark grey-black, slightly to unweathered, fine to medium grained, massive, hard to very hard rock, solid core DOLERITE with medium grained mica: Intrusive.

51.57

Light grey to dark grey, slightly weathered to unweathered, fine to medium grained, laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE laminations at 5deg in 120deg direction: Adelaide Subgroup.
Vein 52.01m : narrow separation, quartz, 10deg.
Vein 53.59m : narrow separation, quartz and mica, 5deg.

53.67

Dark grey, unweathered, fine grained, massive, hard rock, solid core, DOLERITE: Intrusive.

54.10

Dark grey with green-grey intercalations, slightly weathered to unweathered, fine to medium grained, massive to laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE with laminations at 5deg: Adelaide Subgroup.
Vein 55.89m : very wide separation, quartz and mica, 30deg, +-12.00cm thick.
Vein 56.63m : narrow separation, quartz, 85deg.
Vein 57.13m : narrow separation, quartz, 85deg.

57.29

Dark grey, unweathered to slightly weathered, medium to coarse grained in places, massive, hard to very hard rock, solid core DOLERITE with textural variations, feldspar rich (medium to coarse grained) coarse elongated mica crystals at 63.58m, minor fine grained section at 63.82m.
Vein 59.56m : narrow separation, quartz, 75deg.
Vein 72.54m : very wide separation, quartz and feldspar and mica, 6cm.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES
TYPE SET BY : M Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85 deg / 306 deg
DIAM : NQ
DATE : June/July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHT2.TXT

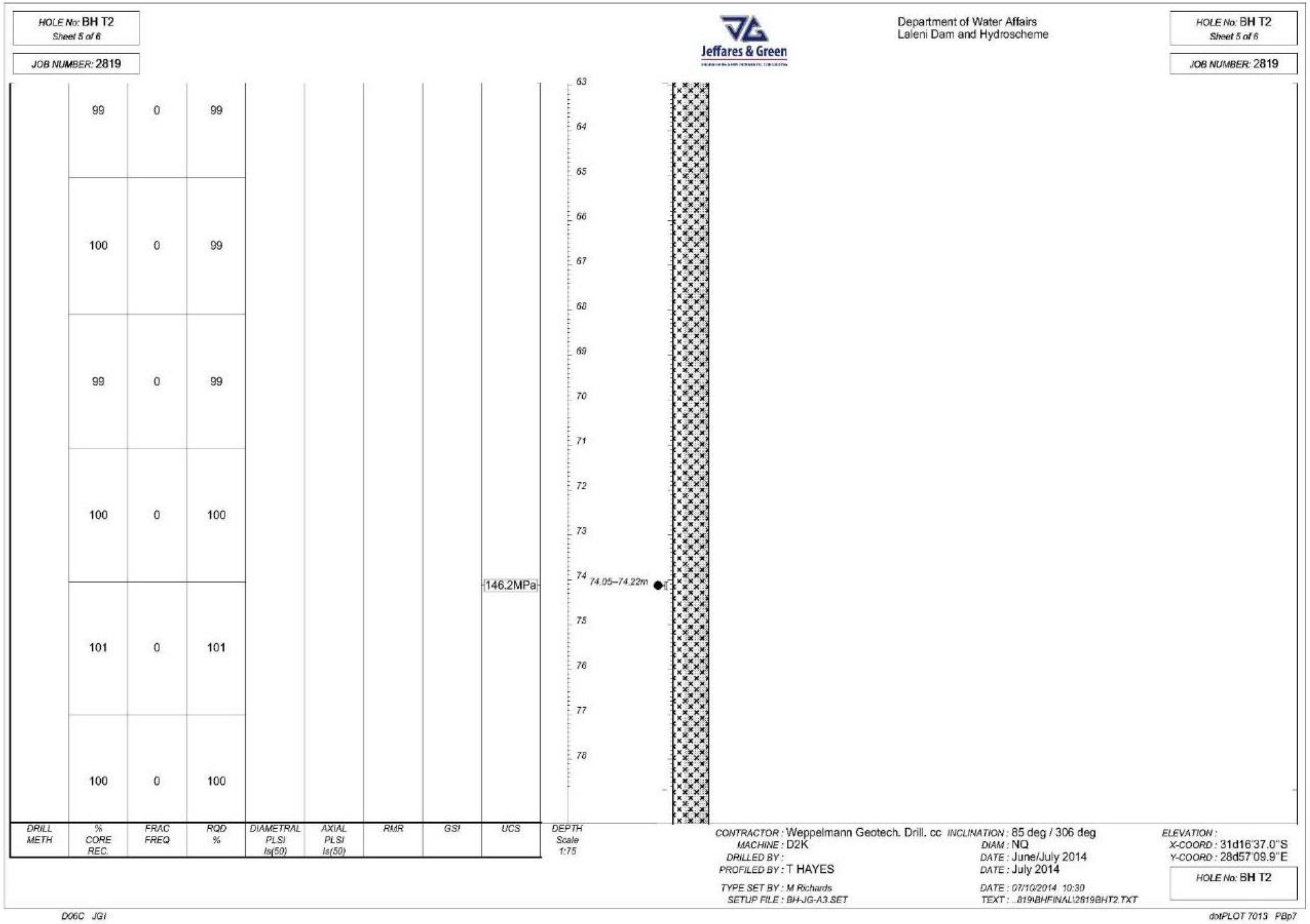
ELEVATION :
X-COORD : 31d16'37.0"S
Y-COORD : 28d57'09.9"E

HOLE No: BH T2

D06C JGI

dotPLOT 7013 PBp7

Fig D-3.4: **Borehole Tunnel 2 - Log**



HOLE No: BH T2
Sheet 5 of 6

JOB NUMBER: 2819

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Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T2
Sheet 5 of 6

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	99	0	99					
	100	0	99					
	99	0	99					
	100	0	100					
	101	0	101					146.2MPa
	100	0	100					

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES
TYPE SET BY : M Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85 deg / 306 deg
DIAM : NQ
DATE : June/July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHT2.TXT

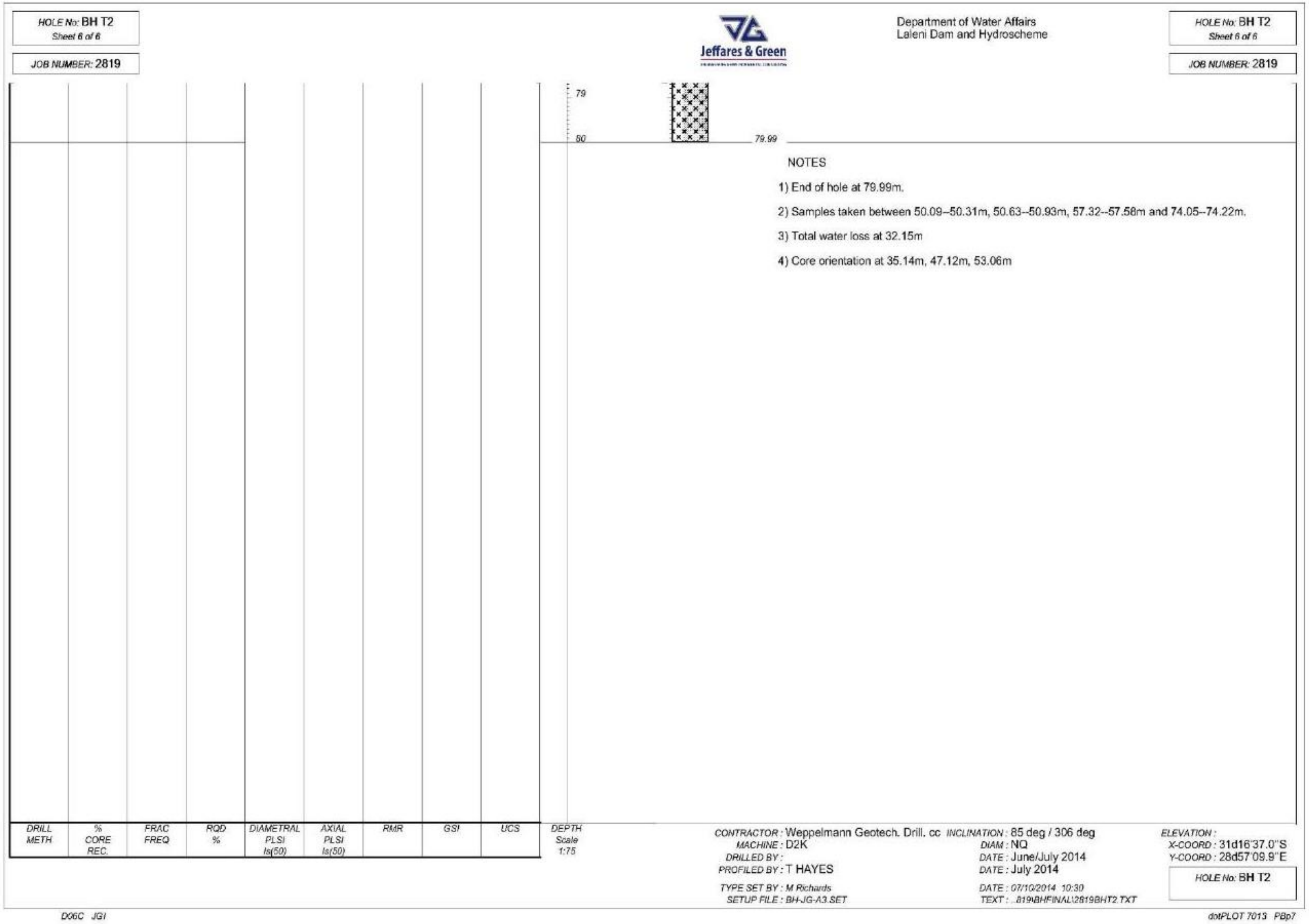
ELEVATION :
X-COORD : 31d16'37.0"S
Y-COORD : 28d57'09.9"E

HOLE No: BH T2

D06C JGI

dotPLOT 7013 PBp7

Fig D-3.5: **Borehole Tunnel 2 - Log**



HOLE No: BH T2
Sheet 6 of 6

JOB NUMBER: 2819

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HOLE No: BH T2
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JOB NUMBER: 2819

NOTES

1) End of hole at 79.99m.

2) Samples taken between 50.09--50.31m, 50.63--50.93m, 57.32--57.58m and 74.05--74.22m.

3) Total water loss at 32.15m

4) Core orientation at 35.14m, 47.12m, 53.06m

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS	DEPTH Scale 1:75

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES
TYPE SET BY : M Richards
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85 deg / 306 deg
DIAM : NQ
DATE : June/July 2014
DATE : July 2014
DATE : 07/10/2014 10:30
TEXT : ..819\BHFINAL\2819BHT2.TXT

ELEVATION :
X-COORD : 31d16'37.0"S
Y-COORD : 28d57'09.9"E

HOLE No: BH T2

D06C JGI

dotPLOT 7013 PBp7

Fig D-3.6: Borehole Tunnel 2 - Log

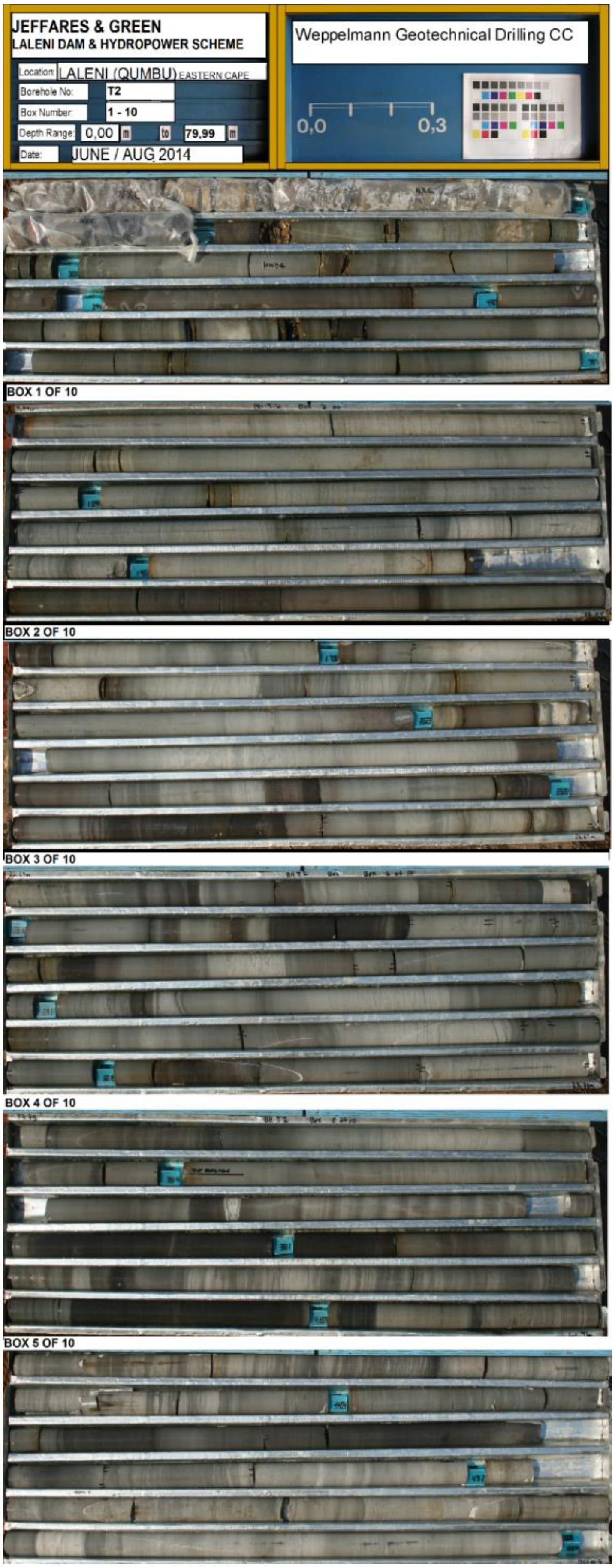


Fig D-4: **Borehole Tunnel 1 – Box 1 to 5**

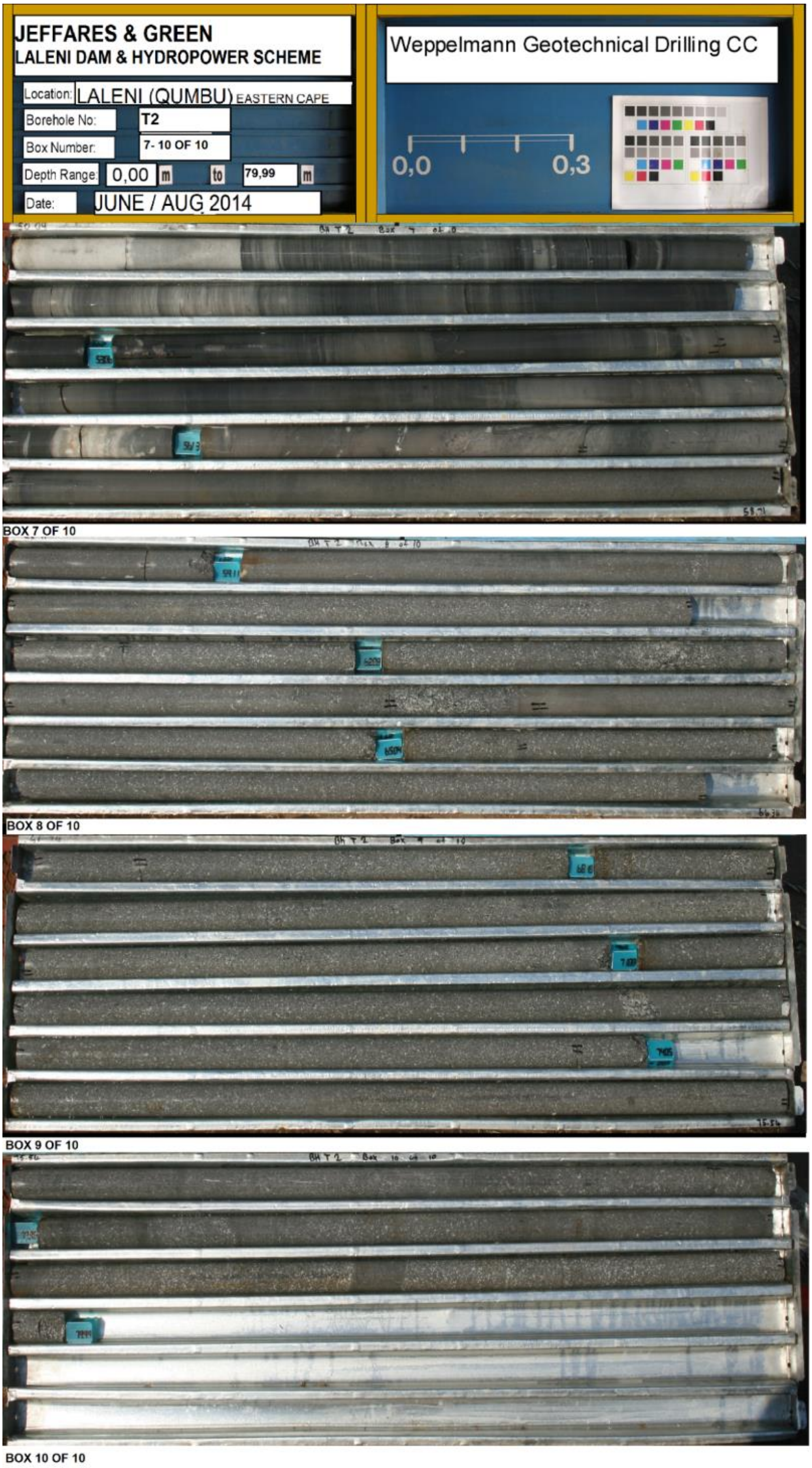
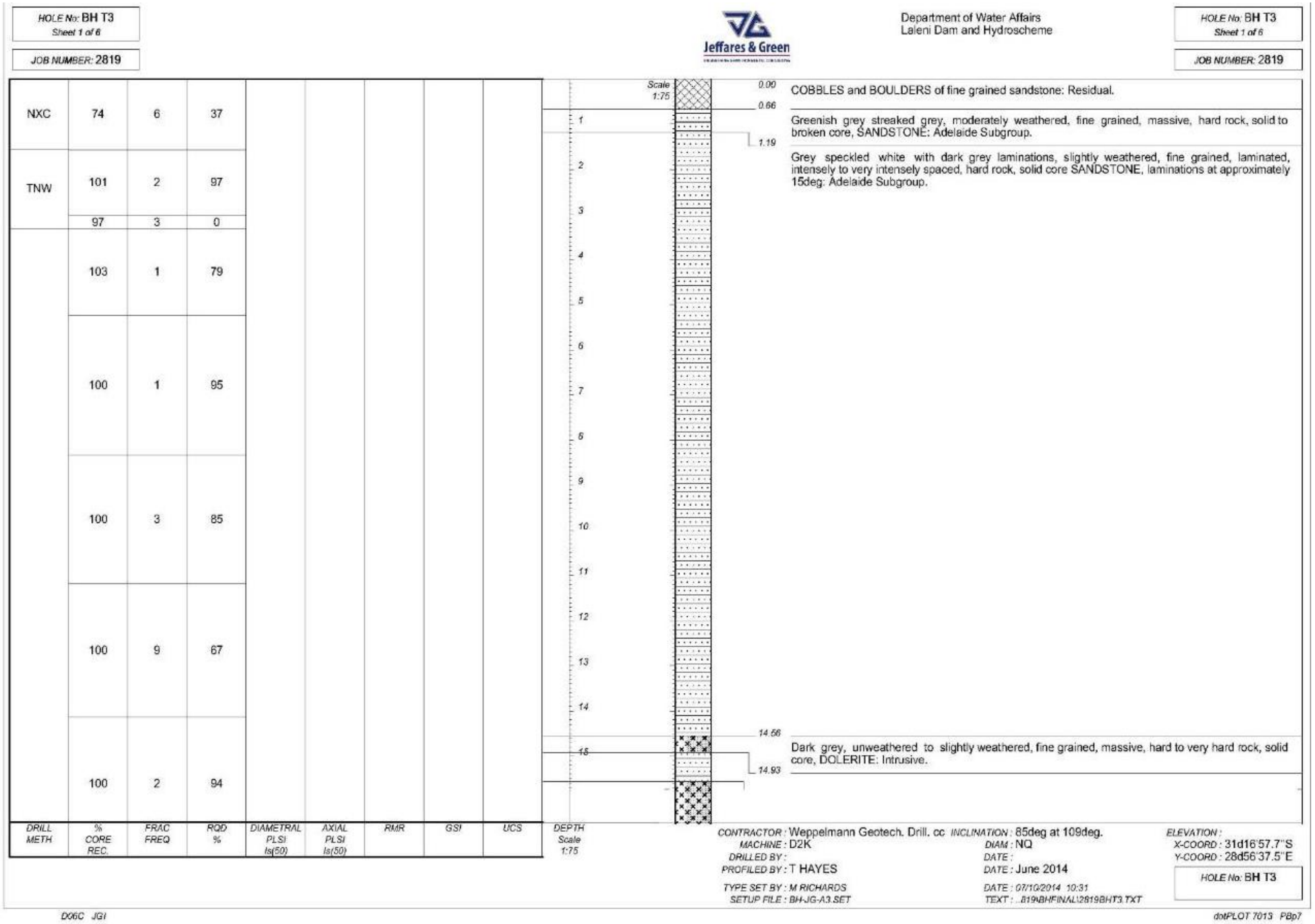


Fig D-4: **Borehole Tunnel 1 – Box 6 to 10**



HOLE No: BH T3
Sheet 1 of 6

JOB NUMBER: 2819

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Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T3
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JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
NXC	74	6	37					
TNW	101	2	97					
	97	3	0					
	103	1	79					
	100	1	95					
	100	3	85					
	100	9	67					
	100	2	94					

DEPTH Scale 1:75

0.00 – 0.66	COBBLES and BOULDERS of fine grained sandstone: Residual.
0.66 – 1.19	Greenish grey streaked grey, moderately weathered, fine grained, massive, hard rock, solid to broken core, SANDSTONE: Adelaide Subgroup.
1.19 – 14.56	Grey speckled white with dark grey laminations, slightly weathered, fine grained, laminated, intensely to very intensely spaced, hard rock, solid core SANDSTONE, laminations at approximately 15deg: Adelaide Subgroup.
14.56 – 14.93	Dark grey, unweathered to slightly weathered, fine grained, massive, hard to very hard rock, solid core, DOLERITE: Intrusive.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES

TYPE SET BY : M RICHARDS
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg.
DIAM : NQ
DATE :
DATE : June 2014

DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT3.TXT

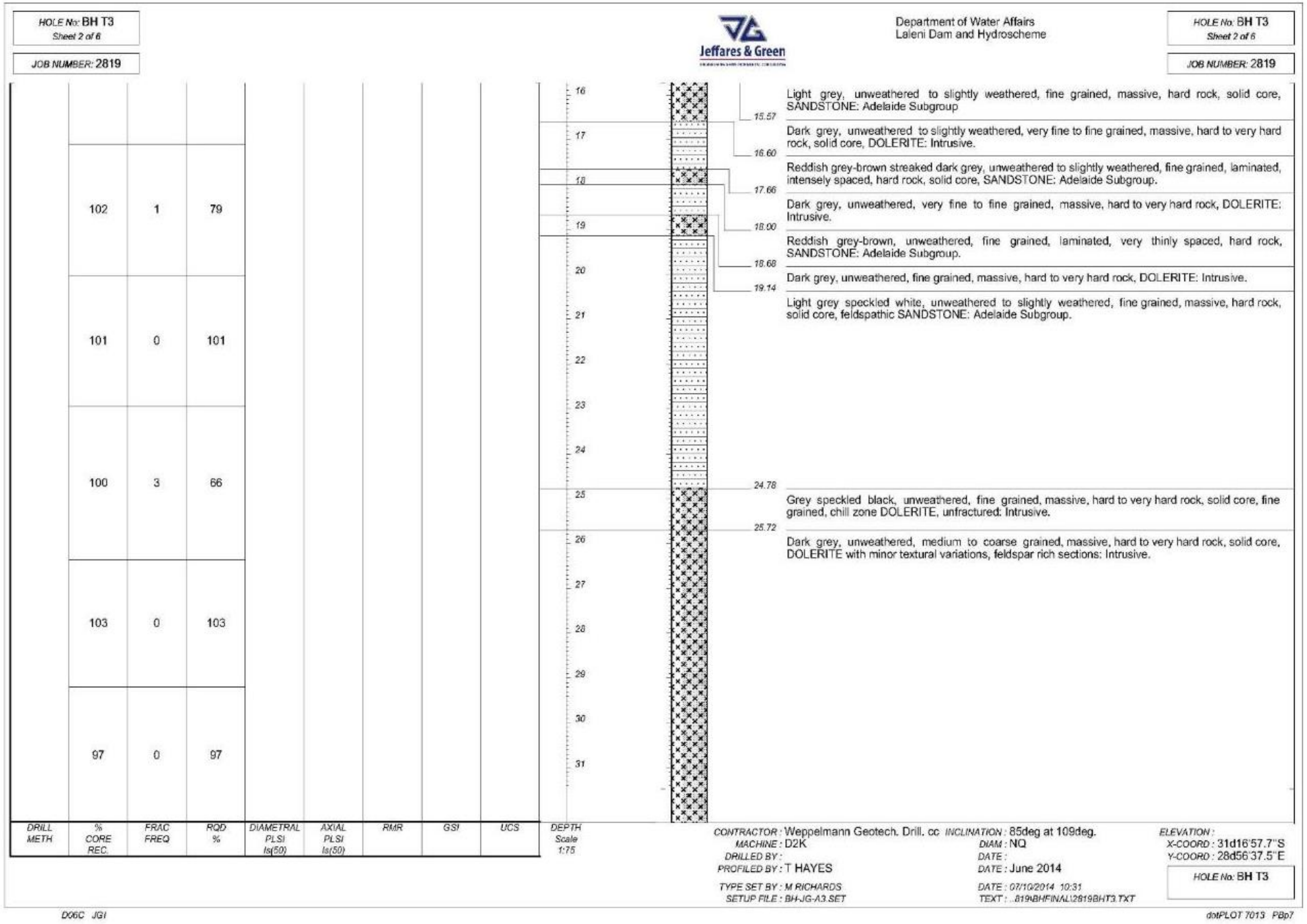
ELEVATION :
X-COORD : 31d16'57.7"S
Y-COORD : 28d56'37.5"E

HOLE No: BH T3

D06C JGI

dotPLOT 7013 PBp7

Fig D-5.1: Borehole Tunnel 3 – Log



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JOB NUMBER: 2819

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Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T3
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JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	102	1	79					
	101	0	101					
	100	3	66					
	103	0	103					
	97	0	97					

DEPTH Scale 1:75

Light grey, unweathered to slightly weathered, fine grained, massive, hard rock, solid core, SANDSTONE: Adelaide Subgroup

15.57

Dark grey, unweathered to slightly weathered, very fine to fine grained, massive, hard to very hard rock, solid core, DOLERITE: Intrusive.

16.60

Reddish grey-brown streaked dark grey, unweathered to slightly weathered, fine grained, laminated, intensely spaced, hard rock, solid core, SANDSTONE: Adelaide Subgroup.

17.66

Dark grey, unweathered, very fine to fine grained, massive, hard to very hard rock, DOLERITE: Intrusive.

18.00

Reddish grey-brown, unweathered, fine grained, laminated, very thinly spaced, hard rock, SANDSTONE: Adelaide Subgroup.

18.68

Dark grey, unweathered, fine grained, massive, hard to very hard rock, DOLERITE: Intrusive.

19.14

Light grey speckled white, unweathered to slightly weathered, fine grained, massive, hard rock, solid core, feldspathic SANDSTONE: Adelaide Subgroup.

24.78

Grey speckled black, unweathered, fine grained, massive, hard to very hard rock, solid core, fine grained, chill zone DOLERITE, unfractured: Intrusive.

25.72

Dark grey, unweathered, medium to coarse grained, massive, hard to very hard rock, solid core, DOLERITE with minor textural variations, feldspar rich sections: Intrusive.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES

TYPE SET BY : M RICHARDS
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg.
DIAM : NQ
DATE :
DATE : June 2014

DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT3.TXT

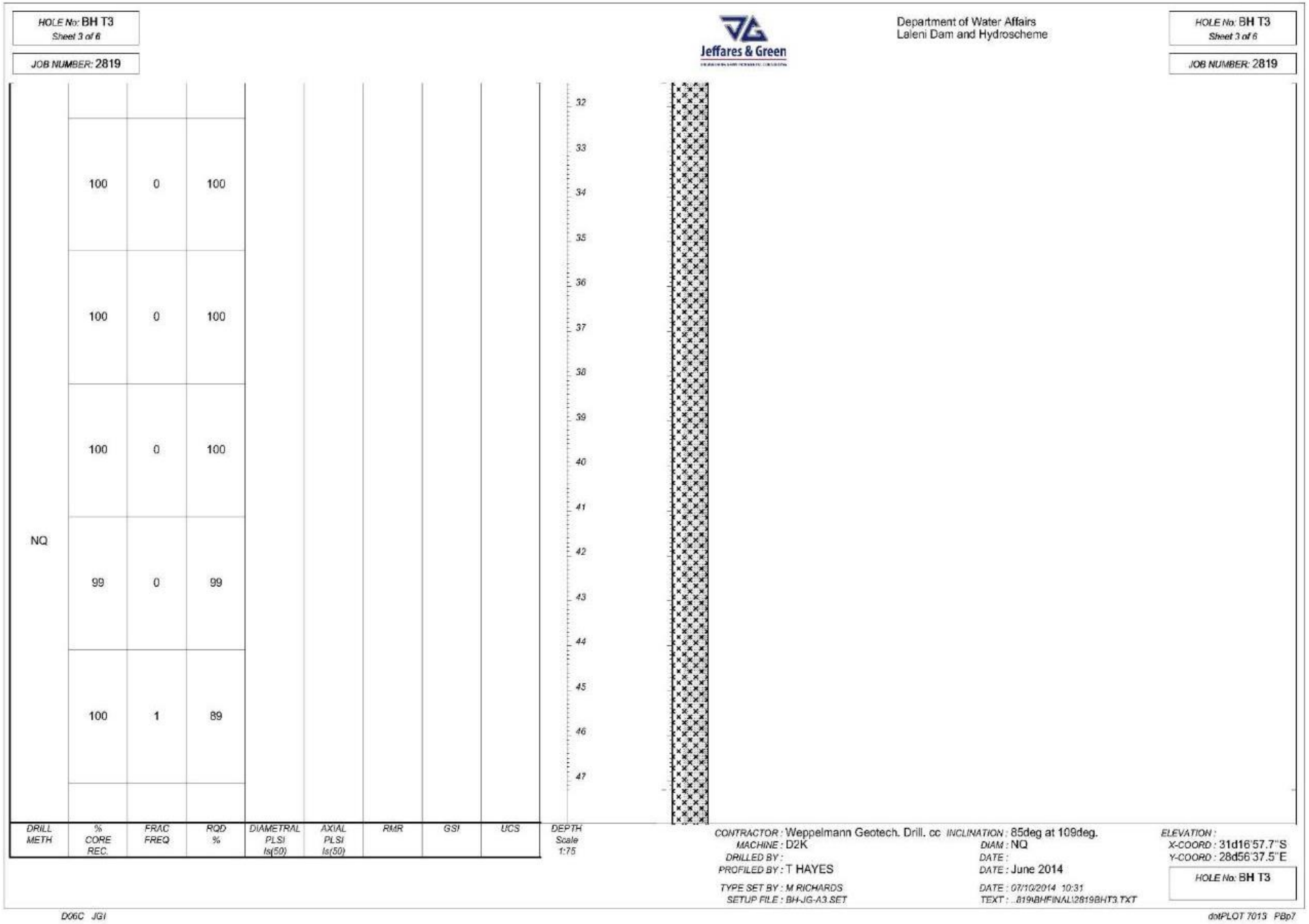
ELEVATION :
X-COORD : 31d16'57.7"S
Y-COORD : 28d56'37.5"E

HOLE No: BH T3

D06C JGI

dotPLOT 7013 PBp7

Fig D-5.2: **Borehole Tunnel 3 – Log**



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JOB NUMBER: 2819

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JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
NQ	100	0	100					
	100	0	100					
	100	0	100					
	99	0	99					
	100	1	89					

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES
TYPE SET BY : M RICHARDS
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg.
DIAM : NQ
DATE :
DATE : June 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT3.TXT

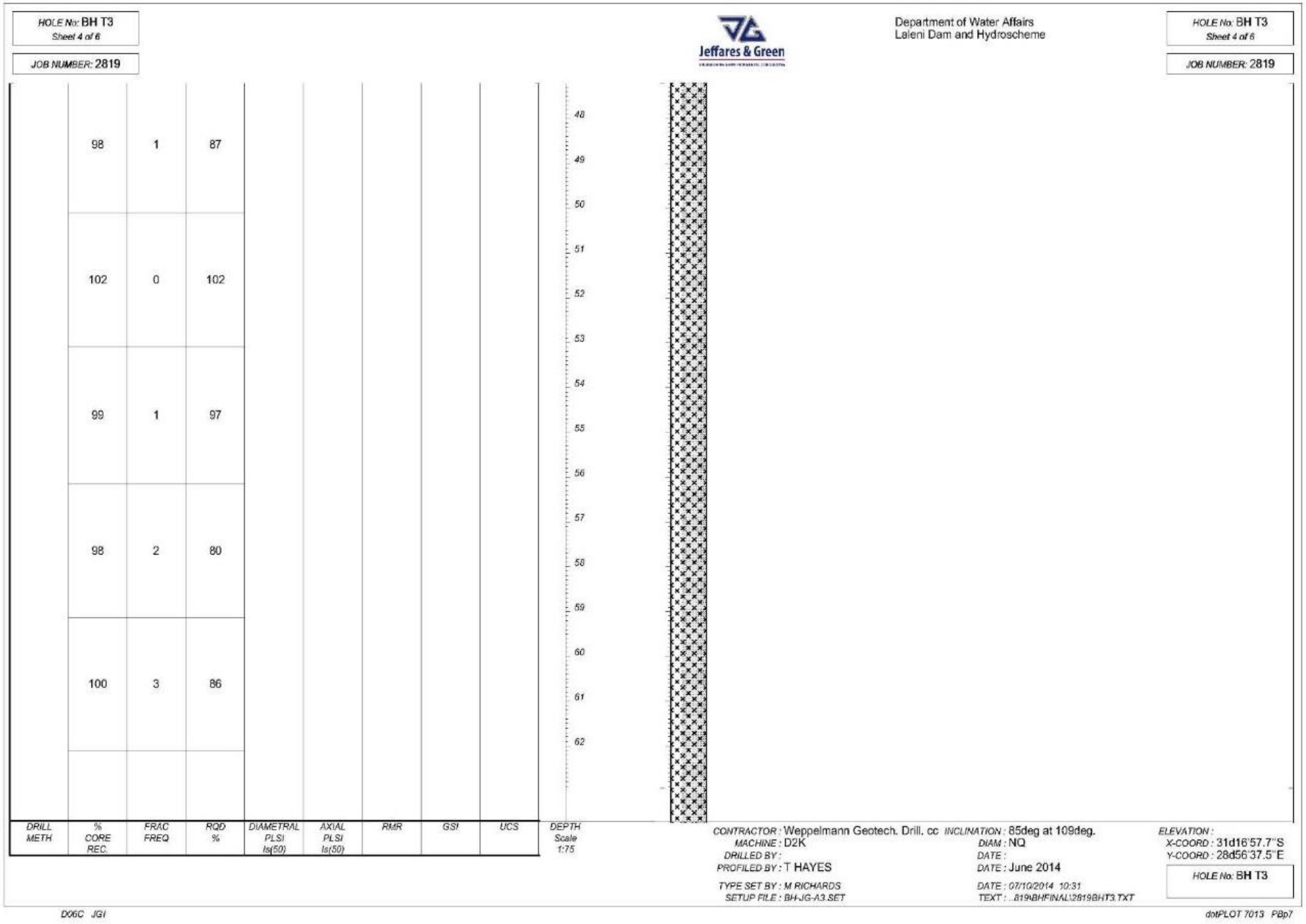
ELEVATION :
X-COORD : 31d16'57.7"S
Y-COORD : 28d56'37.5"E

HOLE No: BH T3

D06C JGI

dotPLOT 7013 PBp7

Fig D-5.3: **Borehole Tunnel 3 – Log**



HOLE No: BH T3
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JOB NUMBER: 2819

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HOLE No: BH T3
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JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	98	1	87					
	102	0	102					
	99	1	97					
	98	2	80					
	100	3	86					

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES
TYPE SET BY : M RICHARDS
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg.
DIAM : NQ
DATE :
DATE : June 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT3.TXT

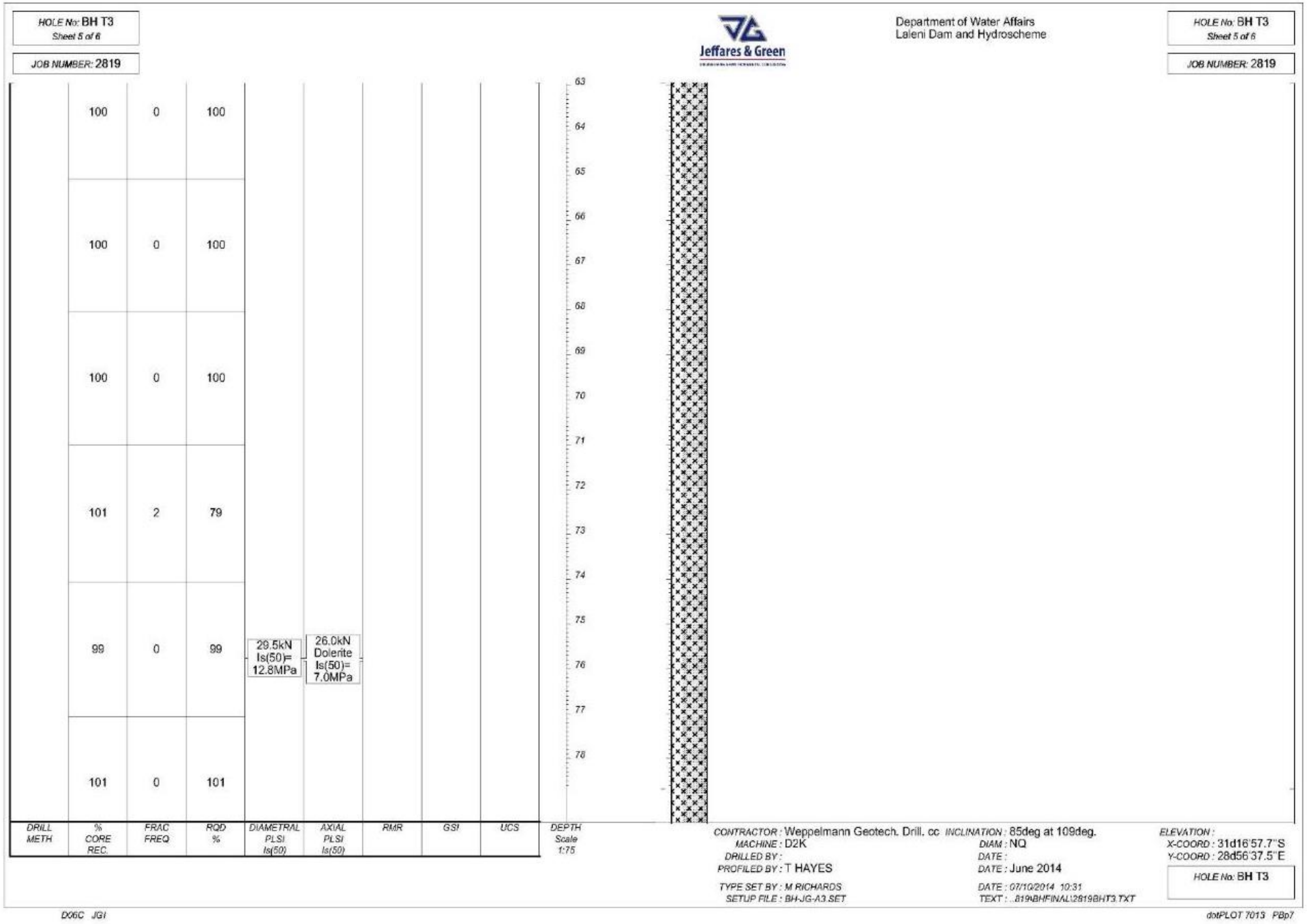
ELEVATION :
X-COORD : 31d16'57.7"S
Y-COORD : 28d56'37.5"E

HOLE No: BH T3

D06C JGI

dotPLOT 7013 PBp7

Fig D-5.4: Borehole Tunnel 3 – Log



HOLE No: BH T3
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JOB NUMBER: 2819

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DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	100	0	100					
	100	0	100					
	100	0	100					
	101	2	79					
	99	0	99	29.5kN Is(50)= 12.8MPa	26.0kN Dolerite Is(50)= 7.0MPa			
	101	0	101					

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES
TYPE SET BY : M RICHARDS
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg.
DIAM : NQ
DATE :
DATE : June 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT3.TXT

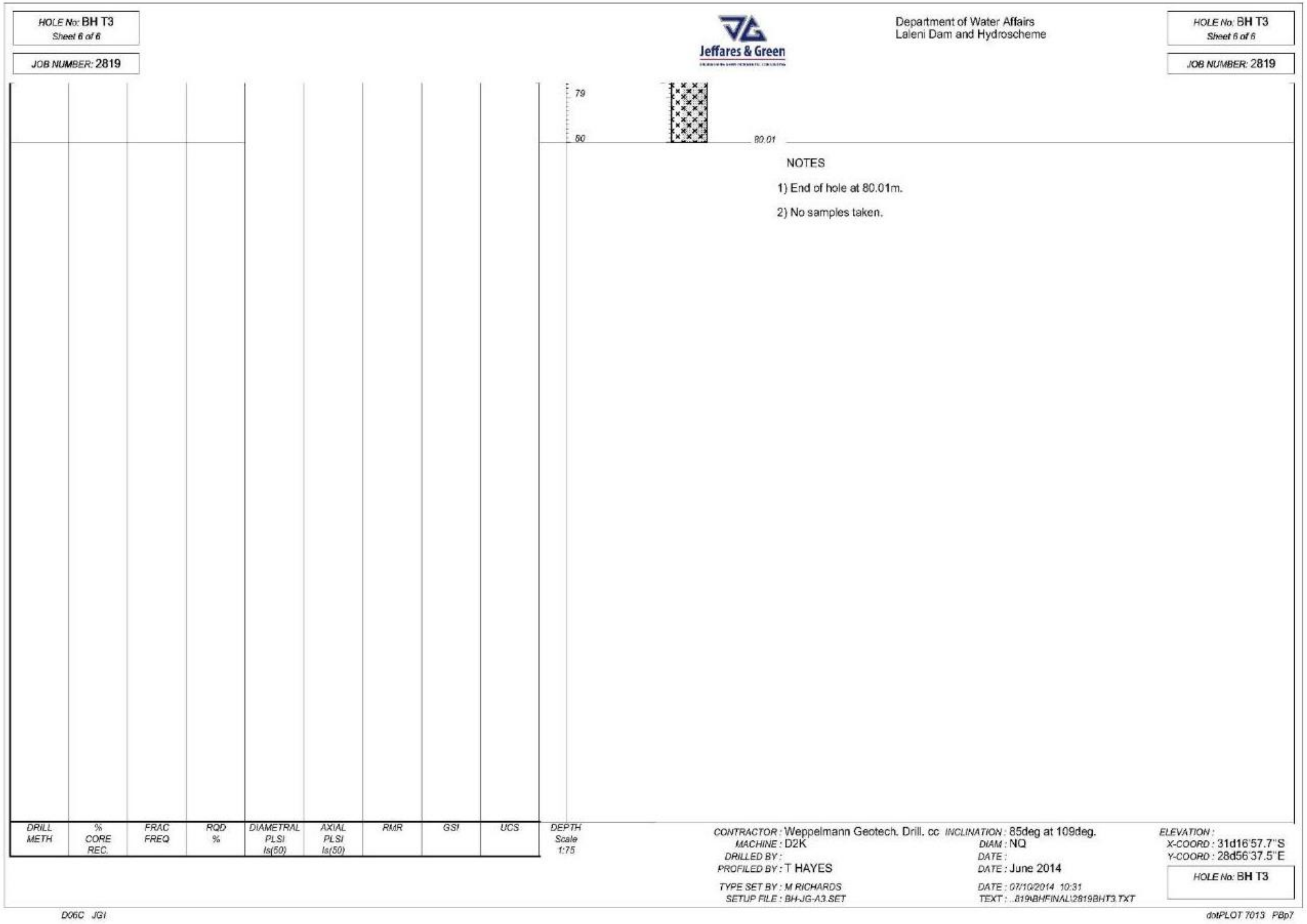
ELEVATION :
X-COORD : 31d16'57.7"S
Y-COORD : 28d56'37.5"E

HOLE No: BH T3

D06C JGI

dotPLOT 7013 PBp7

Fig D-5.5: **Borehole Tunnel 3 – Log**



HOLE No: BH T3
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JOB NUMBER: 2819

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Department of Water Affairs
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HOLE No: BH T3
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JOB NUMBER: 2819

NOTES

1) End of hole at 80.01m.

2) No samples taken.

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS	DEPTH Scale 1:75

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY :
PROFILED BY : T HAYES

TYPE SET BY : M RICHARDS
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg.
DIAM : NQ
DATE :
DATE : June 2014

DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT3.TXT

ELEVATION :
X-COORD : 31d16'57.7"S
Y-COORD : 28d56'37.5"E

HOLE No: BH T3

D06C JGI

dotPLOT 7013 PBp7

Fig D-5.6: Borehole Tunnel 3 – Log

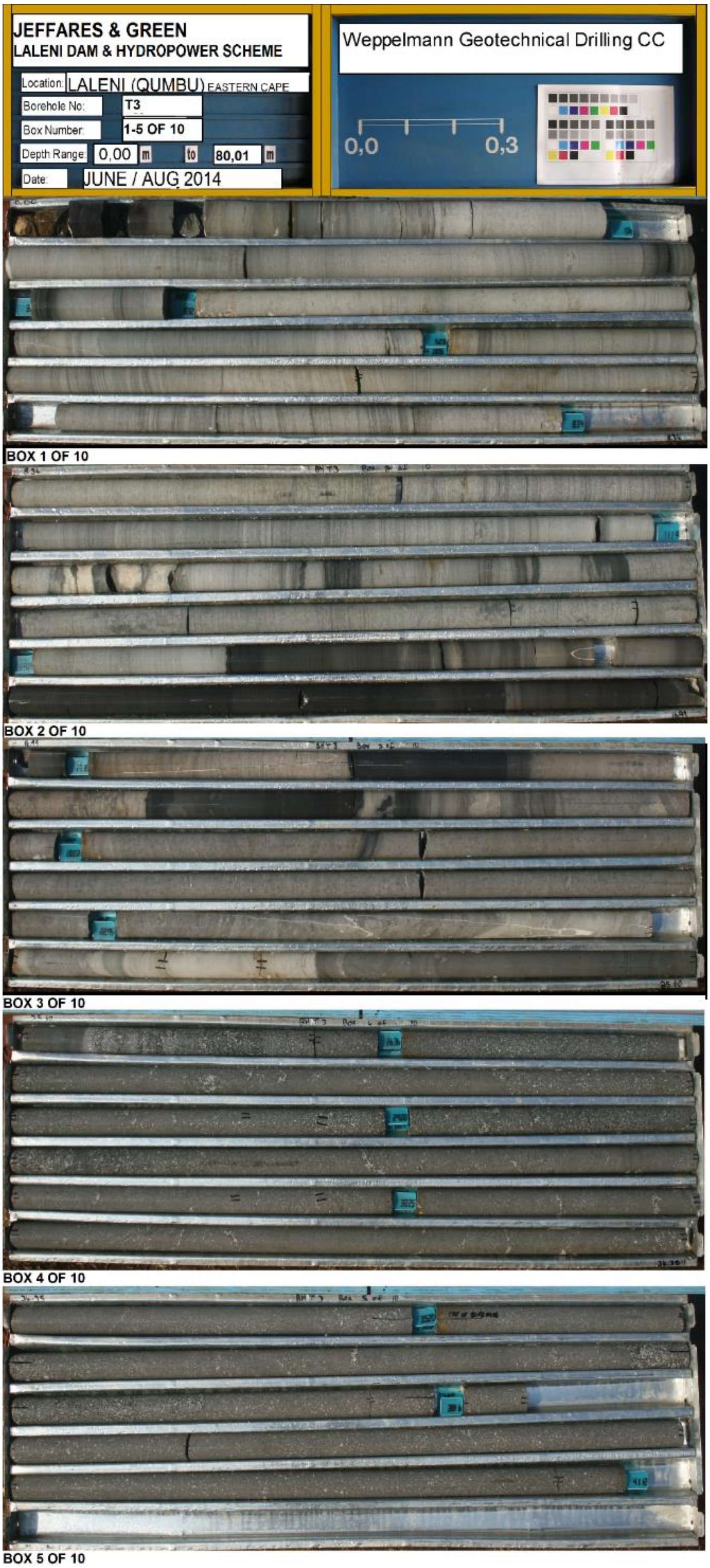


Fig D-6: **Borehole Tunnel 3 – Box 1 to 4**

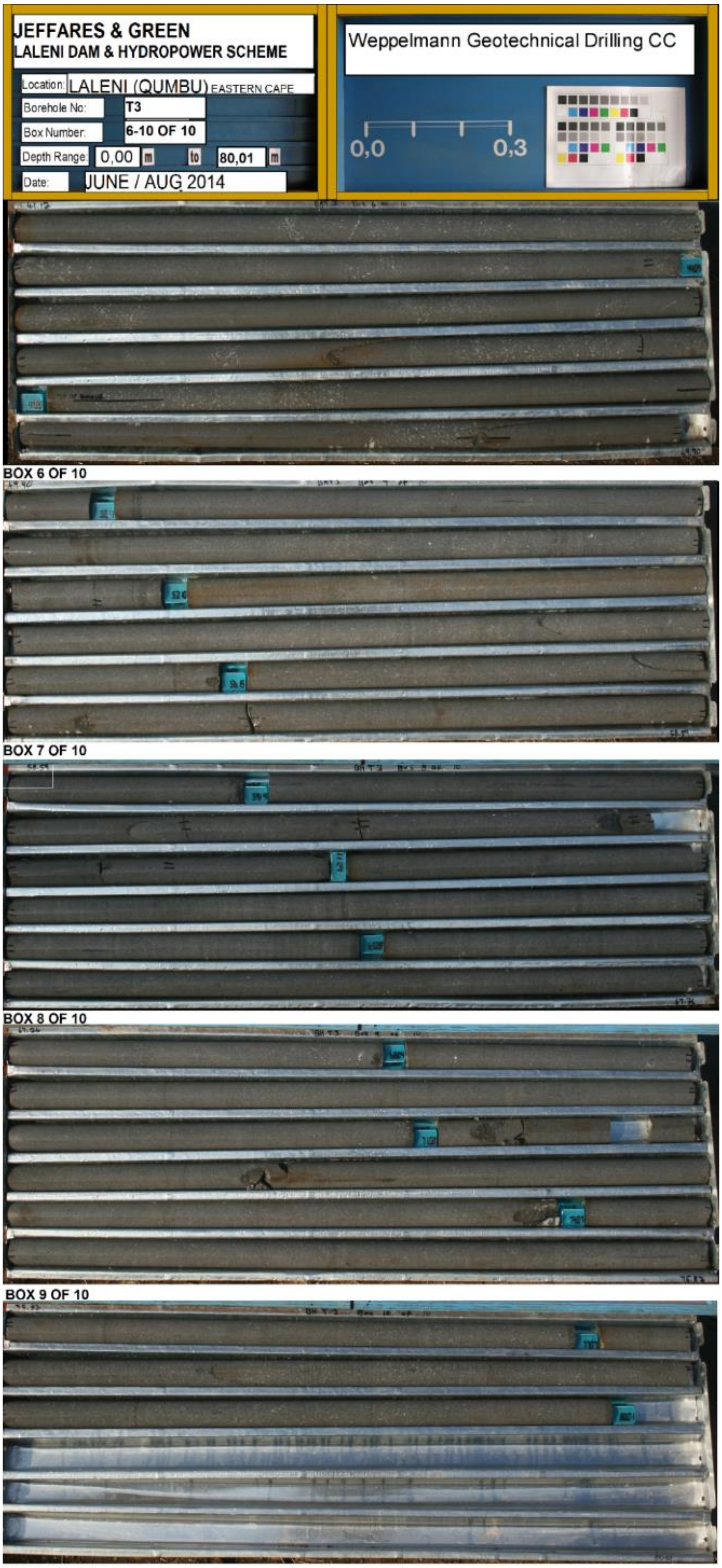
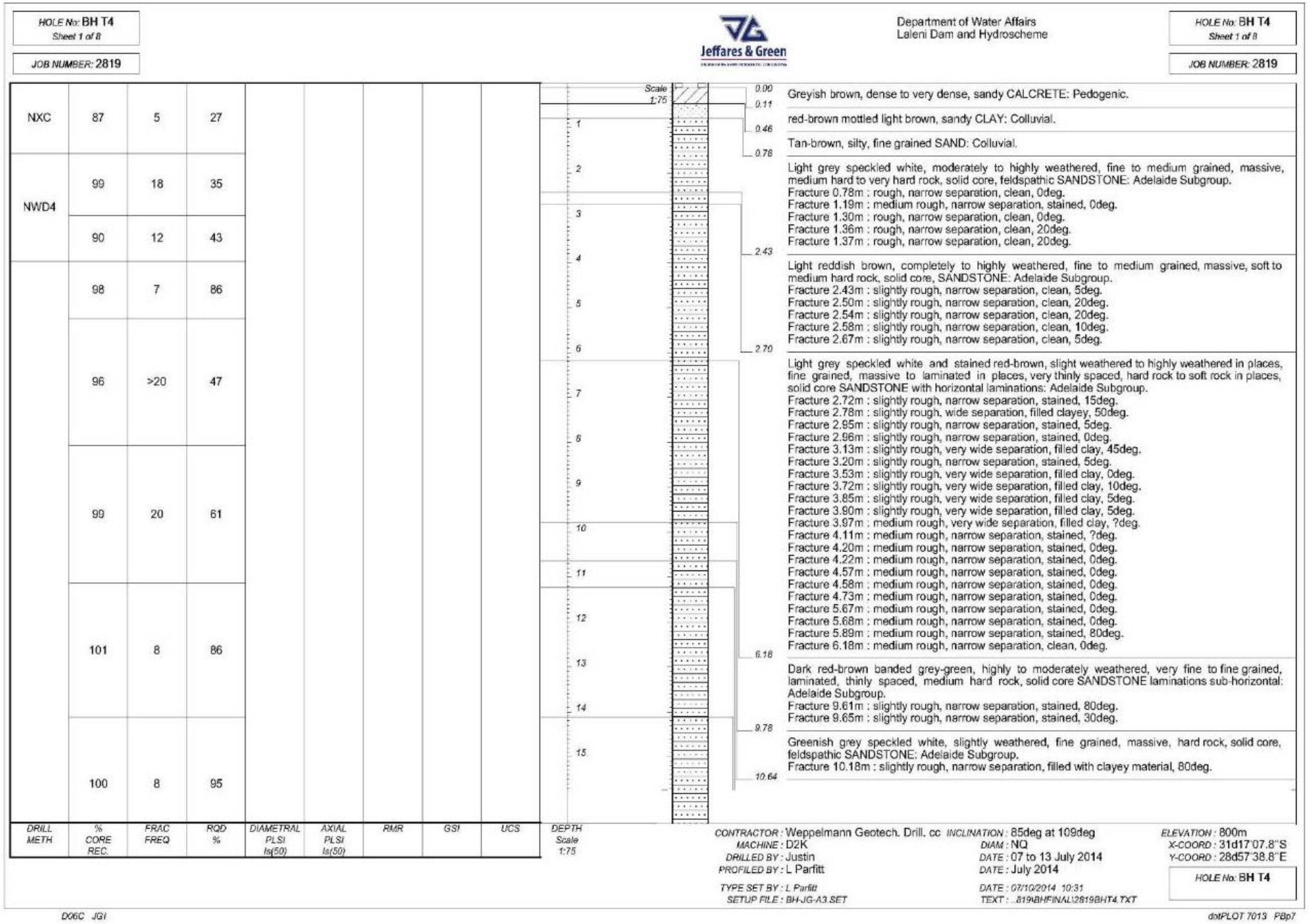


Fig D-6: **Borehole Tunnel 3 – Box 5 to 10**



HOLE No: BH T4
Sheet 1 of 8

JOB NUMBER: 2819

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Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T4
Sheet 1 of 8

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
NXC	87	5	27					
NWD4	99	18	35					
	90	12	43					
	98	7	86					
	96	>20	47					
	99	20	61					
	101	8	86					
	100	8	95					

DEPTH Scale 1:75

0.00	Greyish brown, dense to very dense, sandy CALCRETE: Pedogenic.
0.11	red-brown mottled light brown, sandy CLAY: Colluvial.
0.46	Tan-brown, silty, fine grained SAND: Colluvial.
0.78	Light grey speckled white, moderately to highly weathered, fine to medium grained, massive, medium hard to very hard rock, solid core, feldspathic SANDSTONE: Adelaide Subgroup. Fracture 0.78m : rough, narrow separation, clean, 0deg. Fracture 1.19m : medium rough, narrow separation, stained, 0deg. Fracture 1.30m : rough, narrow separation, clean, 0deg. Fracture 1.36m : rough, narrow separation, clean, 20deg. Fracture 1.37m : rough, narrow separation, clean, 20deg.
2.43	Light reddish brown, completely to highly weathered, fine to medium grained, massive, soft to medium hard rock, solid core, SANDSTONE: Adelaide Subgroup. Fracture 2.43m : slightly rough, narrow separation, clean, 5deg. Fracture 2.50m : slightly rough, narrow separation, clean, 20deg. Fracture 2.54m : slightly rough, narrow separation, clean, 20deg. Fracture 2.58m : slightly rough, narrow separation, clean, 10deg. Fracture 2.67m : slightly rough, narrow separation, clean, 5deg.
2.70	Light grey speckled white and stained red-brown, slight weathered to highly weathered in places, fine grained, massive to laminated in places, very thinly spaced, hard rock to soft rock in places, solid core SANDSTONE with horizontal laminations: Adelaide Subgroup. Fracture 2.72m : slightly rough, narrow separation, stained, 15deg. Fracture 2.78m : slightly rough, wide separation, filled clayey, 50deg. Fracture 2.95m : slightly rough, narrow separation, stained, 5deg. Fracture 2.96m : slightly rough, narrow separation, stained, 0deg. Fracture 3.13m : slightly rough, very wide separation, filled clay, 45deg. Fracture 3.20m : slightly rough, narrow separation, stained, 5deg. Fracture 3.53m : slightly rough, very wide separation, filled clay, 0deg. Fracture 3.72m : slightly rough, very wide separation, filled clay, 10deg. Fracture 3.85m : slightly rough, very wide separation, filled clay, 5deg. Fracture 3.90m : slightly rough, very wide separation, filled clay, 5deg. Fracture 3.97m : medium rough, very wide separation, filled clay, ?deg. Fracture 4.11m : medium rough, narrow separation, stained, ?deg. Fracture 4.20m : medium rough, narrow separation, stained, 0deg. Fracture 4.22m : medium rough, narrow separation, stained, 0deg. Fracture 4.57m : medium rough, narrow separation, stained, 0deg. Fracture 4.58m : medium rough, narrow separation, stained, 0deg. Fracture 4.73m : medium rough, narrow separation, stained, 0deg. Fracture 5.67m : medium rough, narrow separation, stained, 0deg. Fracture 5.68m : medium rough, narrow separation, stained, 0deg. Fracture 5.89m : medium rough, narrow separation, stained, 80deg. Fracture 6.18m : medium rough, narrow separation, clean, 0deg.
6.18	Dark red-brown banded grey-green, highly to moderately weathered, very fine to fine grained, laminated, thinly spaced, medium hard rock, solid core SANDSTONE laminations sub-horizontal: Adelaide Subgroup. Fracture 9.61m : slightly rough, narrow separation, stained, 80deg. Fracture 9.65m : slightly rough, narrow separation, stained, 30deg.
9.78	Greenish grey speckled white, slightly weathered, fine grained, massive, hard rock, solid core, feldspathic SANDSTONE: Adelaide Subgroup. Fracture 10.18m : slightly rough, narrow separation, filled with clayey material, 80deg.
10.64	

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg
DIAM : NQ
DATE : 07 to 13 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT4.TXT

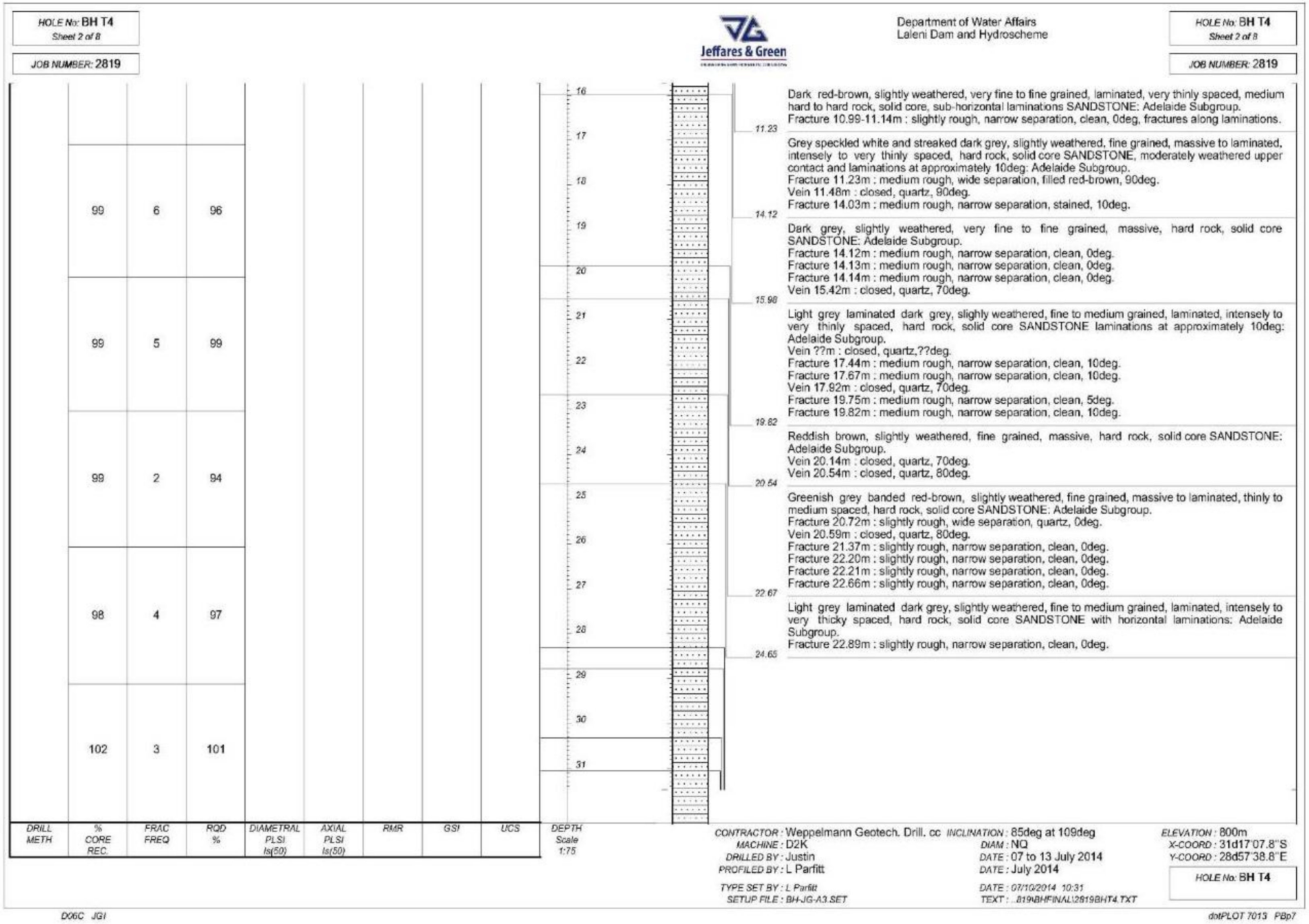
ELEVATION : 800m
X-COORD : 31d17'07.8"S
Y-COORD : 28d57'38.8"E

HOLE No: BH T4

D06C JGI

dotPLOT 7013 PBp7

Fig D-7.1: Borehole Tunnel 4 – Log



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JOB NUMBER: 2819

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HOLE No: BH T4
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JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	99	6	96					
	99	5	99					
	99	2	94					
	98	4	97					
	102	3	101					

Dark red-brown, slightly weathered, very fine to fine grained, laminated, very thinly spaced, medium hard to hard rock, solid core, sub-horizontal laminations SANDSTONE: Adelaide Subgroup.
Fracture 10.99-11.14m : slightly rough, narrow separation, clean, 0deg, fractures along laminations.

11.23

Grey speckled white and streaked dark grey, slightly weathered, fine grained, massive to laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE, moderately weathered upper contact and laminations at approximately 10deg: Adelaide Subgroup.
Fracture 11.23m : medium rough, wide separation, filled red-brown, 90deg.
Vein 11.48m : closed, quartz, 90deg.
Fracture 14.03m : medium rough, narrow separation, stained, 10deg.

14.12

Dark grey, slightly weathered, very fine to fine grained, massive, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 14.12m : medium rough, narrow separation, clean, 0deg.
Fracture 14.13m : medium rough, narrow separation, clean, 0deg.
Fracture 14.14m : medium rough, narrow separation, clean, 0deg.
Vein 15.42m : closed, quartz, 70deg.

15.98

Light grey laminated dark grey, slighly weathered, fine to medium grained, laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE laminations at approximately 10deg: Adelaide Subgroup.
Vein ??m : closed, quartz,??deg.
Fracture 17.44m : medium rough, narrow separation, clean, 10deg.
Fracture 17.67m : medium rough, narrow separation, clean, 10deg.
Vein 17.92m : closed, quartz, 70deg.
Fracture 19.75m : medium rough, narrow separation, clean, 5deg.
Fracture 19.82m : medium rough, narrow separation, clean, 10deg.

19.82

Reddish brown, slightly weathered, fine grained, massive, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Vein 20.14m : closed, quartz, 70deg.
Vein 20.54m : closed, quartz, 80deg.

20.54

Greenish grey banded red-brown, slightly weathered, fine grained, massive to laminated, thinly to medium spaced, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 20.72m : slightly rough, wide separation, quartz, 0deg.
Vein 20.59m : closed, quartz, 80deg.
Fracture 21.37m : slightly rough, narrow separation, clean, 0deg.
Fracture 22.20m : slightly rough, narrow separation, clean, 0deg.
Fracture 22.21m : slightly rough, narrow separation, clean, 0deg.
Fracture 22.66m : slightly rough, narrow separation, clean, 0deg.

22.67

Light grey laminated dark grey, slightly weathered, fine to medium grained, laminated, intensely to very thicky spaced, hard rock, solid core SANDSTONE with horizontal laminations: Adelaide Subgroup.
Fracture 22.89m : slightly rough, narrow separation, clean, 0deg.

24.65

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt

INCLINATION : 85deg at 109deg
DIAM : NQ
DATE : 07 to 13 July 2014
DATE : July 2014

ELEVATION : 800m
X-COORD : 31d17'07.8"S
Y-COORD : 28d57'38.8"E

TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

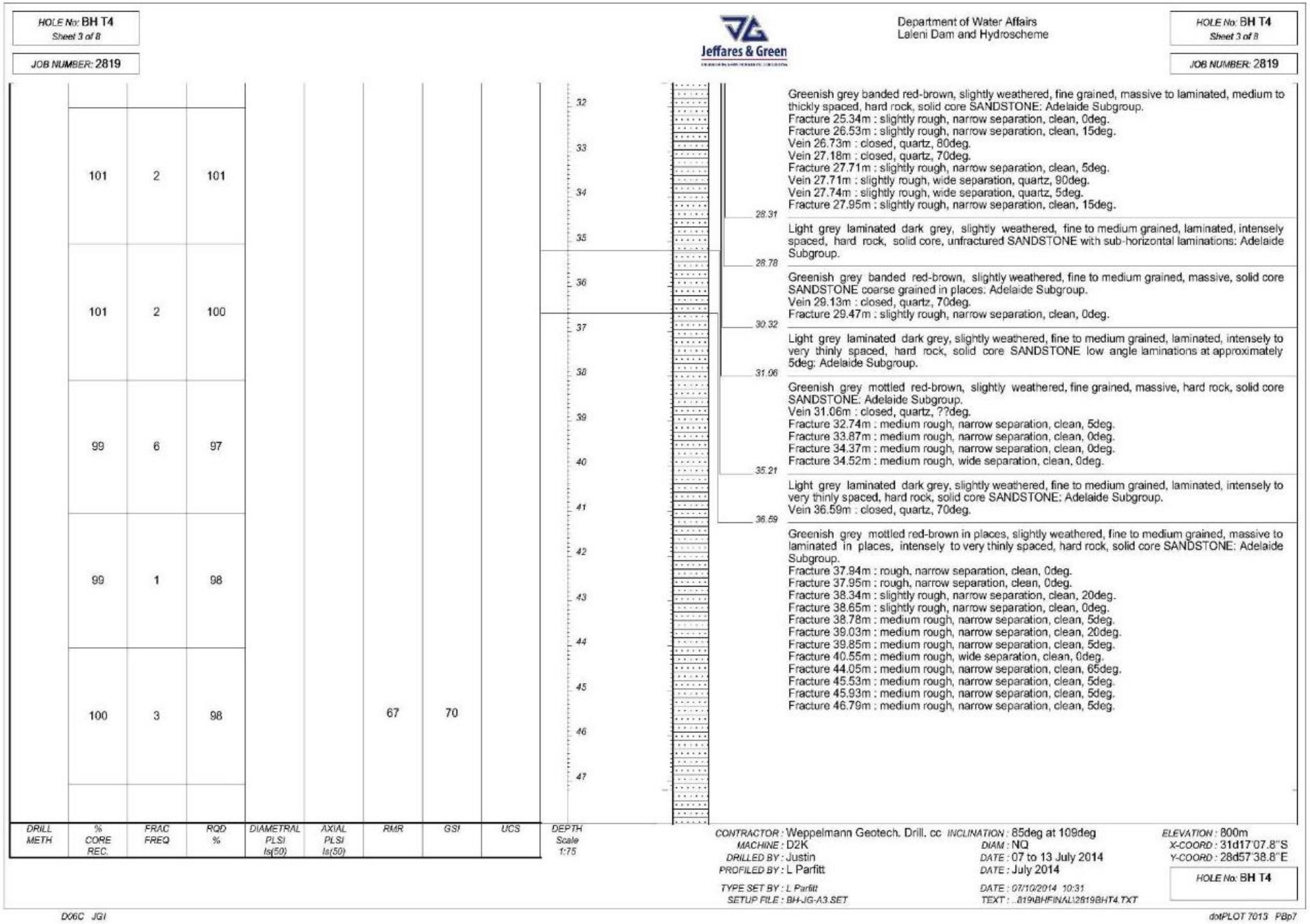
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT4.TXT

HOLE No: BH T4

D06C JGI

dotPLOT 7013 PBp7

Fig D-7.2: **Borehole Tunnel 4 – Log**



HOLE No: BH T4
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JOB NUMBER: 2819

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DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	101	2	101					
	101	2	100					
	99	6	97					
	99	1	98					
	100	3	98			67	70	

Greenish grey banded red-brown, slightly weathered, fine grained, massive to laminated, medium to thickly spaced, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 25.34m : slightly rough, narrow separation, clean, 0deg.
Fracture 26.53m : slightly rough, narrow separation, clean, 15deg.
Vein 26.73m : closed, quartz, 80deg.
Vein 27.18m : closed, quartz, 70deg.
Fracture 27.71m : slightly rough, narrow separation, clean, 5deg.
Vein 27.71m : slightly rough, wide separation, quartz, 90deg.
Vein 27.74m : slightly rough, wide separation, quartz, 5deg.
Fracture 27.95m : slightly rough, narrow separation, clean, 15deg.

28.31

Light grey laminated dark grey, slightly weathered, fine to medium grained, laminated, intensely spaced, hard rock, solid core, unfractured SANDSTONE with sub-horizontal laminations: Adelaide Subgroup.

28.78

Greenish grey banded red-brown, slightly weathered, fine to medium grained, massive, solid core SANDSTONE coarse grained in places: Adelaide Subgroup.
Vein 29.13m : closed, quartz, 70deg.
Fracture 29.47m : slightly rough, narrow separation, clean, 0deg.

30.32

Light grey laminated dark grey, slightly weathered, fine to medium grained, laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE low angle laminations at approximately 5deg: Adelaide Subgroup.

31.06

Greenish grey mottled red-brown, slightly weathered, fine grained, massive, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Vein 31.06m : closed, quartz, ??deg.
Fracture 32.74m : medium rough, narrow separation, clean, 5deg.
Fracture 33.87m : medium rough, narrow separation, clean, 0deg.
Fracture 34.37m : medium rough, narrow separation, clean, 0deg.
Fracture 34.52m : medium rough, wide separation, clean, 0deg.

35.21

Light grey laminated dark grey, slightly weathered, fine to medium grained, laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Vein 36.59m : closed, quartz, 70deg.

36.59

Greenish grey mottled red-brown in places, slightly weathered, fine to medium grained, massive to laminated in places, intensely to very thinly spaced, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 37.94m : rough, narrow separation, clean, 0deg.
Fracture 37.95m : rough, narrow separation, clean, 0deg.
Fracture 38.34m : slightly rough, narrow separation, clean, 20deg.
Fracture 38.65m : slightly rough, narrow separation, clean, 0deg.
Fracture 38.78m : medium rough, narrow separation, clean, 5deg.
Fracture 39.03m : medium rough, narrow separation, clean, 20deg.
Fracture 39.85m : medium rough, narrow separation, clean, 5deg.
Fracture 40.55m : medium rough, wide separation, clean, 0deg.
Fracture 44.05m : medium rough, narrow separation, clean, 65deg.
Fracture 45.53m : medium rough, narrow separation, clean, 5deg.
Fracture 45.93m : medium rough, narrow separation, clean, 5deg.
Fracture 46.79m : medium rough, narrow separation, clean, 5deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg
DIAM : NQ
DATE : 07 to 13 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT4.TXT

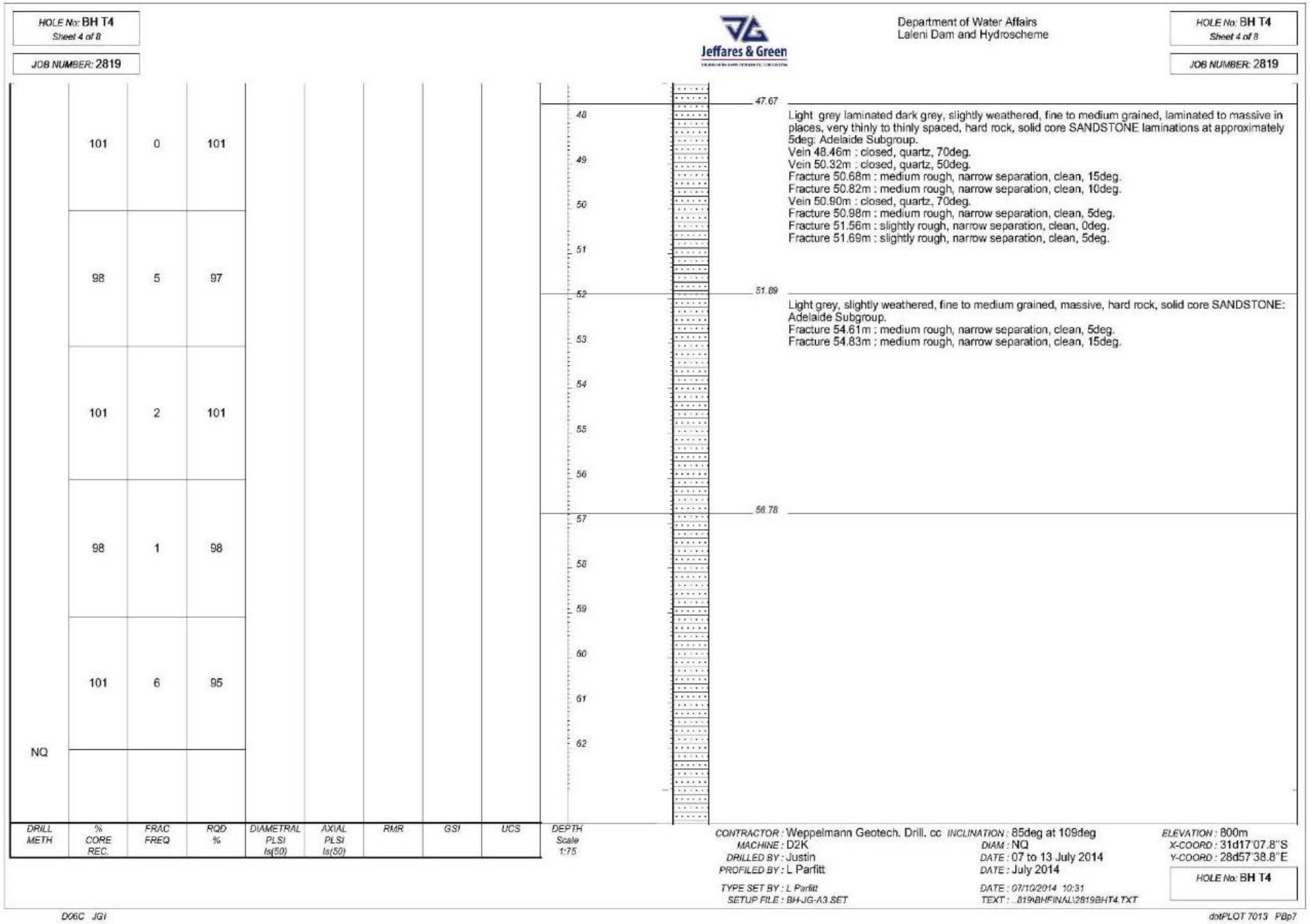
ELEVATION : 800m
X-COORD : 31d17'07.8"S
Y-COORD : 28d57'38.8"E

HOLE No: BH T4

D06C JGI

dotPLOT 7013 PBp7

Fig D-7.3: **Borehole Tunnel 4 – Log**



HOLE No: BH T4
Sheet 4 of 8

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T4
Sheet 4 of 8

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	101	0	101					
	98	5	97					
	101	2	101					
	98	1	98					
	101	6	95					
NQ								

DEPTH
Scale
1:75

47.67

Light grey laminated dark grey, slightly weathered, fine to medium grained, laminated to massive in places, very thinly to thinly spaced, hard rock, solid core SANDSTONE laminations at approximately 5deg: Adelaide Subgroup.
Vein 48.46m : closed, quartz, 70deg.
Vein 50.32m : closed, quartz, 50deg.
Fracture 50.68m : medium rough, narrow separation, clean, 15deg.
Fracture 50.82m : medium rough, narrow separation, clean, 10deg.
Vein 50.90m : closed, quartz, 70deg.
Fracture 50.98m : medium rough, narrow separation, clean, 5deg.
Fracture 51.56m : slightly rough, narrow separation, clean, 0deg.
Fracture 51.69m : slightly rough, narrow separation, clean, 5deg.

51.89

Light grey, slightly weathered, fine to medium grained, massive, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 54.61m : medium rough, narrow separation, clean, 5deg.
Fracture 54.83m : medium rough, narrow separation, clean, 15deg.

56.78

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg
DIAM : NQ
DATE : 07 to 13 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT4.TXT

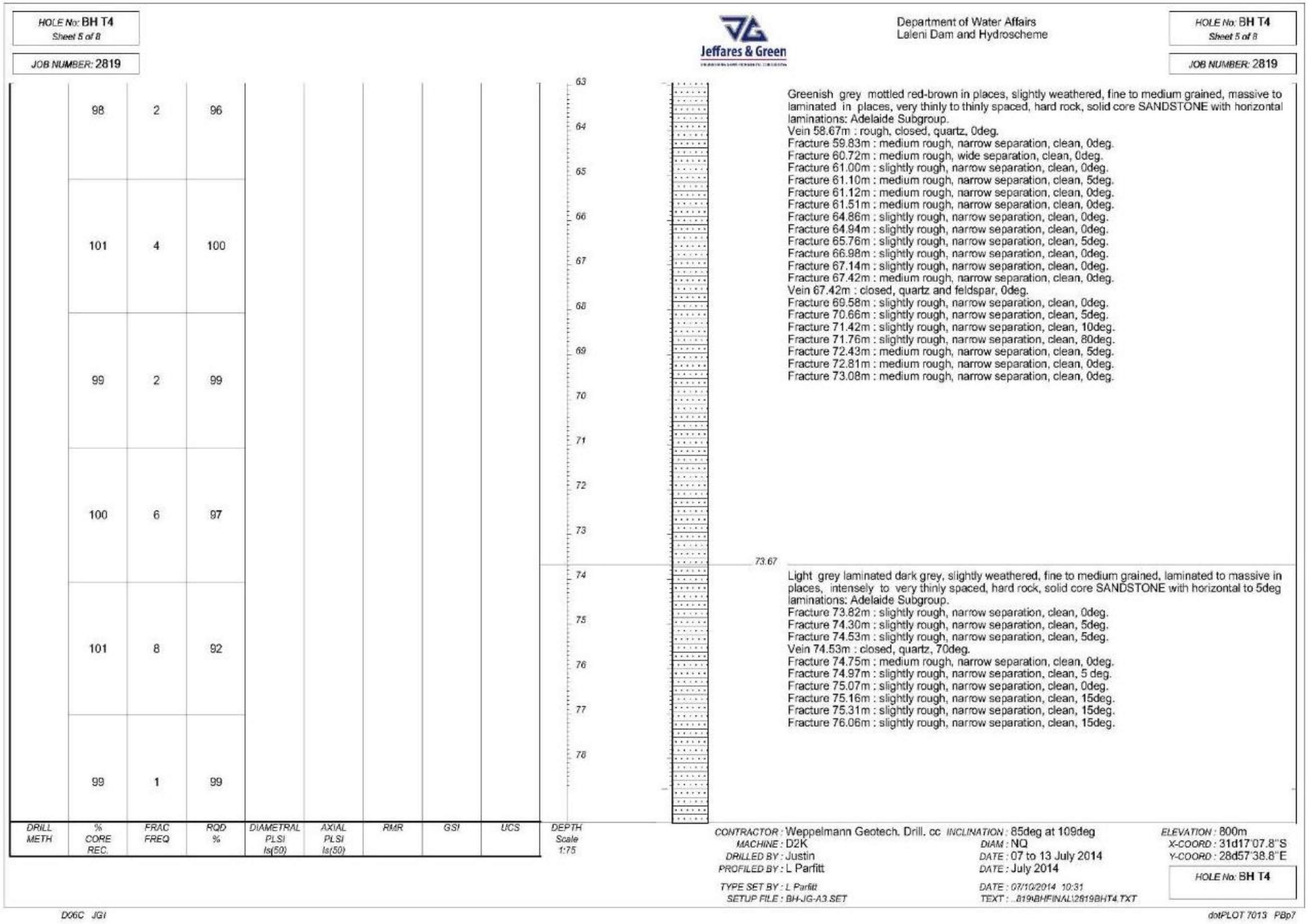
ELEVATION : 800m
X-COORD : 31d17'07.8"S
Y-COORD : 28d57'38.8"E

HOLE No: BH T4

D06C JGI

dotPLOT 7013 PBp7

Fig D-7.4: **Borehole Tunnel 4 – Log**



HOLE No: BH T4
Sheet 5 of 8

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS	DEPTH Scale 1:75
	98	2	96						
	101	4	100						
	99	2	99						
	100	6	97						
	101	8	92						
	99	1	99						

Greenish grey mottled red-brown in places, slightly weathered, fine to medium grained, massive to laminated in places, very thinly to thinly spaced, hard rock, solid core SANDSTONE with horizontal laminations: Adelaide Subgroup.
Vein 58.67m : rough, closed, quartz, 0deg.
Fracture 59.83m : medium rough, narrow separation, clean, 0deg.
Fracture 60.72m : medium rough, wide separation, clean, 0deg.
Fracture 61.00m : slightly rough, narrow separation, clean, 0deg.
Fracture 61.10m : medium rough, narrow separation, clean, 5deg.
Fracture 61.12m : medium rough, narrow separation, clean, 0deg.
Fracture 61.51m : medium rough, narrow separation, clean, 0deg.
Fracture 64.86m : slightly rough, narrow separation, clean, 0deg.
Fracture 64.94m : slightly rough, narrow separation, clean, 0deg.
Fracture 65.76m : slightly rough, narrow separation, clean, 5deg.
Fracture 66.98m : slightly rough, narrow separation, clean, 0deg.
Fracture 67.14m : slightly rough, narrow separation, clean, 0deg.
Fracture 67.42m : medium rough, narrow separation, clean, 0deg.
Vein 67.42m : closed, quartz and feldspar, 0deg.
Fracture 69.58m : slightly rough, narrow separation, clean, 0deg.
Fracture 70.66m : slightly rough, narrow separation, clean, 5deg.
Fracture 71.42m : slightly rough, narrow separation, clean, 10deg.
Fracture 71.76m : slightly rough, narrow separation, clean, 80deg.
Fracture 72.43m : medium rough, narrow separation, clean, 5deg.
Fracture 72.81m : medium rough, narrow separation, clean, 0deg.
Fracture 73.08m : medium rough, narrow separation, clean, 0deg.

73.67

Light grey laminated dark grey, slightly weathered, fine to medium grained, laminated to massive in places, intensely to very thinly spaced, hard rock, solid core SANDSTONE with horizontal to 5deg laminations: Adelaide Subgroup.
Fracture 73.82m : slightly rough, narrow separation, clean, 0deg.
Fracture 74.30m : slightly rough, narrow separation, clean, 5deg.
Fracture 74.53m : slightly rough, narrow separation, clean, 5deg.
Vein 74.53m : closed, quartz, 70deg.
Fracture 74.75m : medium rough, narrow separation, clean, 0deg.
Fracture 74.97m : slightly rough, narrow separation, clean, 5 deg.
Fracture 75.07m : slightly rough, narrow separation, clean, 0deg.
Fracture 75.16m : slightly rough, narrow separation, clean, 15deg.
Fracture 75.31m : slightly rough, narrow separation, clean, 15deg.
Fracture 76.06m : slightly rough, narrow separation, clean, 15deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg
DIAM : NQ
DATE : 07 to 13 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT4.TXT

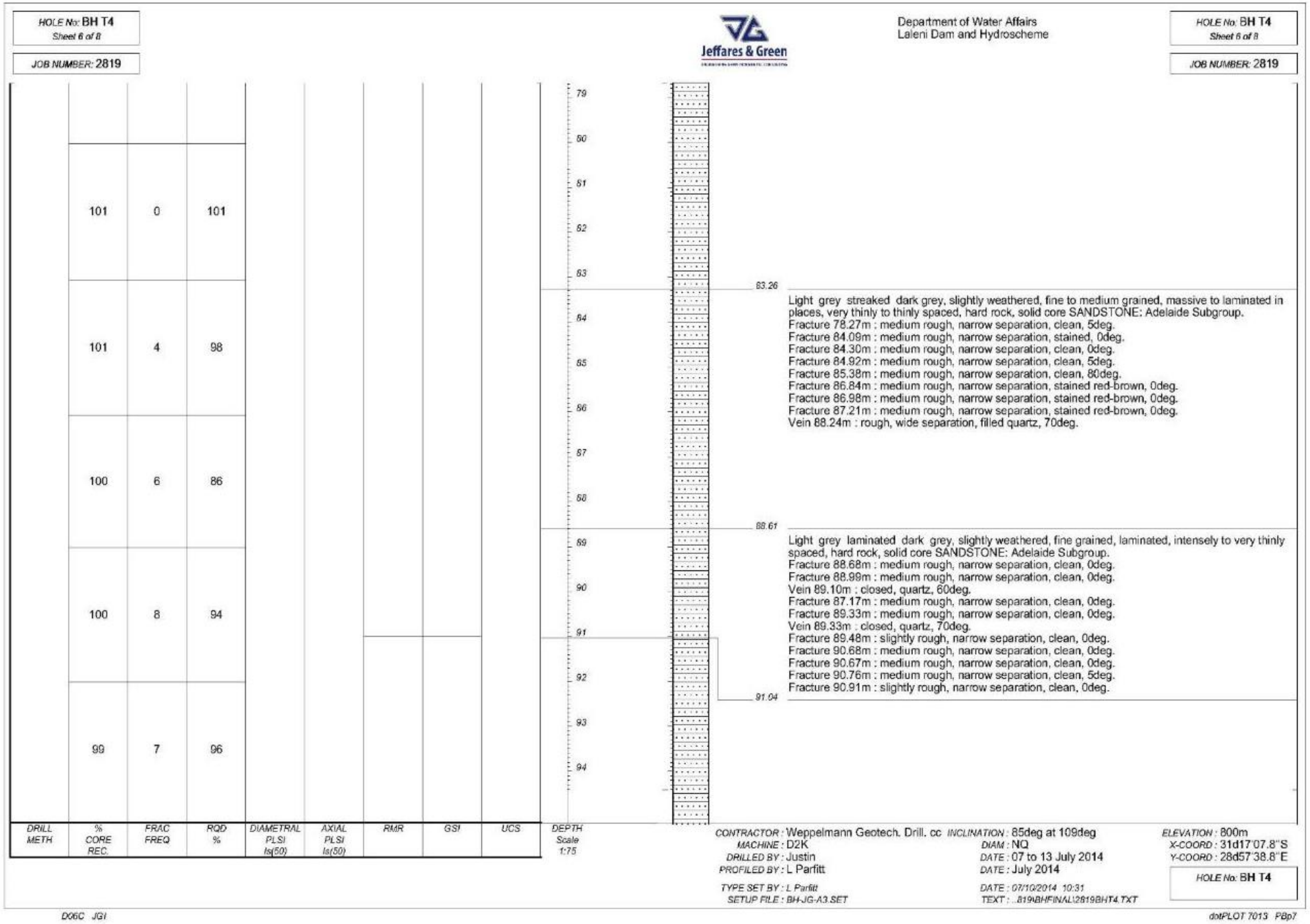
ELEVATION : 800m
X-COORD : 31d17'07.8"S
Y-COORD : 28d57'38.8"E

HOLE No: BH T4

D06C JGI

dotPLOT 7013 PBp7

Fig D-7.5: Borehole Tunnel 4 – Log



HOLE No: BH T4
Sheet 6 of 8

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	101	0	101					
	101	4	98					
	100	6	86					
	100	8	94					
	99	7	96					

DEPTH Scale 1:75

83.26

Light grey streaked dark grey, slightly weathered, fine to medium grained, massive to laminated in places, very thinly to thinly spaced, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 78.27m : medium rough, narrow separation, clean, 5deg.
Fracture 84.09m : medium rough, narrow separation, stained, 0deg.
Fracture 84.30m : medium rough, narrow separation, clean, 0deg.
Fracture 84.92m : medium rough, narrow separation, clean, 5deg.
Fracture 85.38m : medium rough, narrow separation, clean, 80deg.
Fracture 86.84m : medium rough, narrow separation, stained red-brown, 0deg.
Fracture 86.98m : medium rough, narrow separation, stained red-brown, 0deg.
Fracture 87.21m : medium rough, narrow separation, stained red-brown, 0deg.
Vein 88.24m : rough, wide separation, filled quartz, 70deg.

88.61

Light grey laminated dark grey, slightly weathered, fine grained, laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 88.68m : medium rough, narrow separation, clean, 0deg.
Fracture 88.99m : medium rough, narrow separation, clean, 0deg.
Vein 89.10m : closed, quartz, 60deg.
Fracture 87.17m : medium rough, narrow separation, clean, 0deg.
Fracture 89.33m : medium rough, narrow separation, clean, 0deg.
Vein 89.33m : closed, quartz, 70deg.
Fracture 89.48m : slightly rough, narrow separation, clean, 0deg.
Fracture 90.68m : medium rough, narrow separation, clean, 0deg.
Fracture 90.67m : medium rough, narrow separation, clean, 0deg.
Fracture 90.76m : medium rough, narrow separation, clean, 5deg.
Fracture 90.91m : slightly rough, narrow separation, clean, 0deg.

91.04

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg
DIAM : NQ
DATE : 07 to 13 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT4.TXT

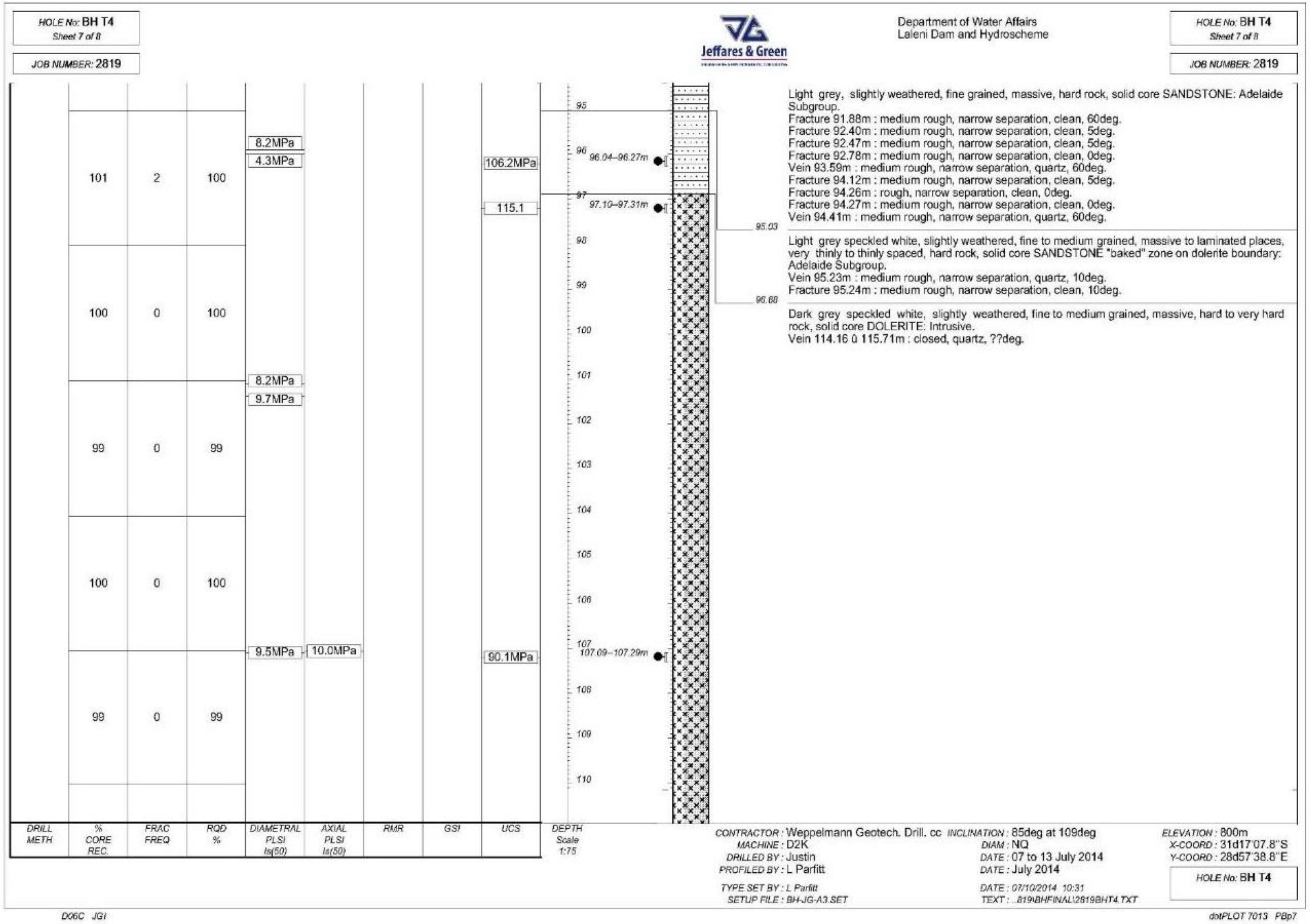
ELEVATION : 800m
X-COORD : 31d17'07.8"S
Y-COORD : 28d57'38.8"E

HOLE No: BH T4

D06C JGI

dotPLOT 7013 PBp7

Fig D-7.6: Borehole Tunnel 4 – Log



HOLE No: BH T4
Sheet 7 of 8

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	101	2	100	8.2MPa 4.3MPa				106.2MPa 115.1
	100	0	100					
	99	0	99	8.2MPa 9.7MPa				
	100	0	100					
	99	0	99	9.5MPa	10.0MPa			90.1MPa

Light grey, slightly weathered, fine grained, massive, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 91.88m : medium rough, narrow separation, clean, 60deg.
Fracture 92.40m : medium rough, narrow separation, clean, 5deg.
Fracture 92.47m : medium rough, narrow separation, clean, 5deg.
Fracture 92.78m : medium rough, narrow separation, clean, 0deg.
Vein 93.59m : medium rough, narrow separation, quartz, 60deg.
Fracture 94.12m : medium rough, narrow separation, clean, 5deg.
Fracture 94.26m : rough, narrow separation, clean, 0deg.
Fracture 94.27m : medium rough, narrow separation, clean, 0deg.
Vein 94.41m : medium rough, narrow separation, quartz, 60deg.

Light grey speckled white, slightly weathered, fine to medium grained, massive to laminated places, very thinly to thinly spaced, hard rock, solid core SANDSTONE "baked" zone on dolerite boundary: Adelaide Subgroup.
Vein 95.23m : medium rough, narrow separation, quartz, 10deg.
Fracture 95.24m : medium rough, narrow separation, clean, 10deg.

Dark grey speckled white, slightly weathered, fine to medium grained, massive, hard to very hard rock, solid core DOLERITE: Intrusive.
Vein 114.16 0 115.71m : closed, quartz, ??deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg
DIAM : NQ
DATE : 07 to 13 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT4.TXT

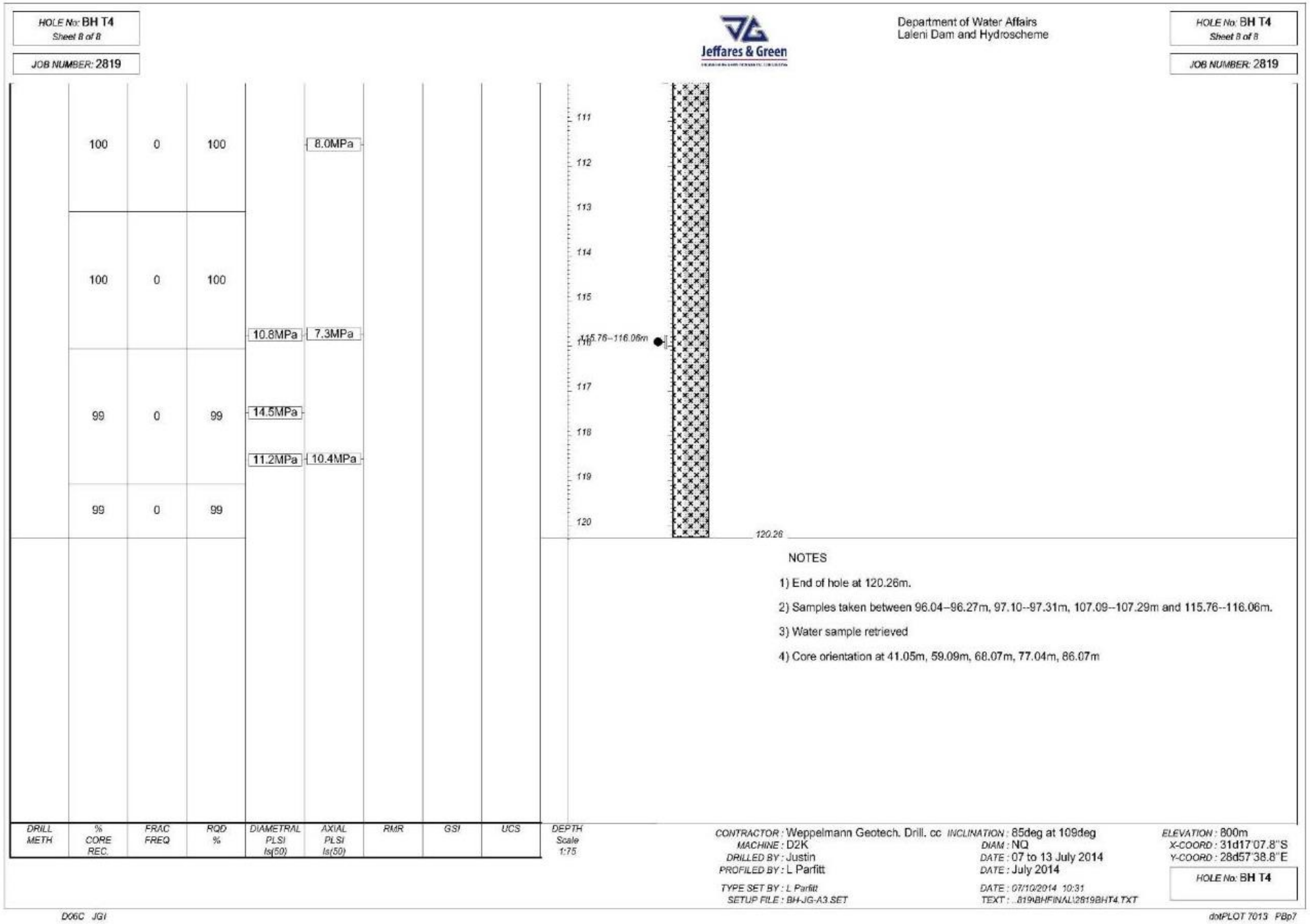
ELEVATION : 800m
X-COORD : 31d17'07.8"S
Y-COORD : 28d57'38.8"E

HOLE No: BH T4

D06C JGI

dotPLOT 7013 PBp7

Fig D-7.7: Borehole Tunnel 4 – Log



NOTES

1) End of hole at 120.26m.

2) Samples taken between 96.04--96.27m, 97.10--97.31m, 107.09--107.29m and 115.76--116.06m.

3) Water sample retrieved

4) Core orientation at 41.05m, 59.09m, 68.07m, 77.04m, 86.07m

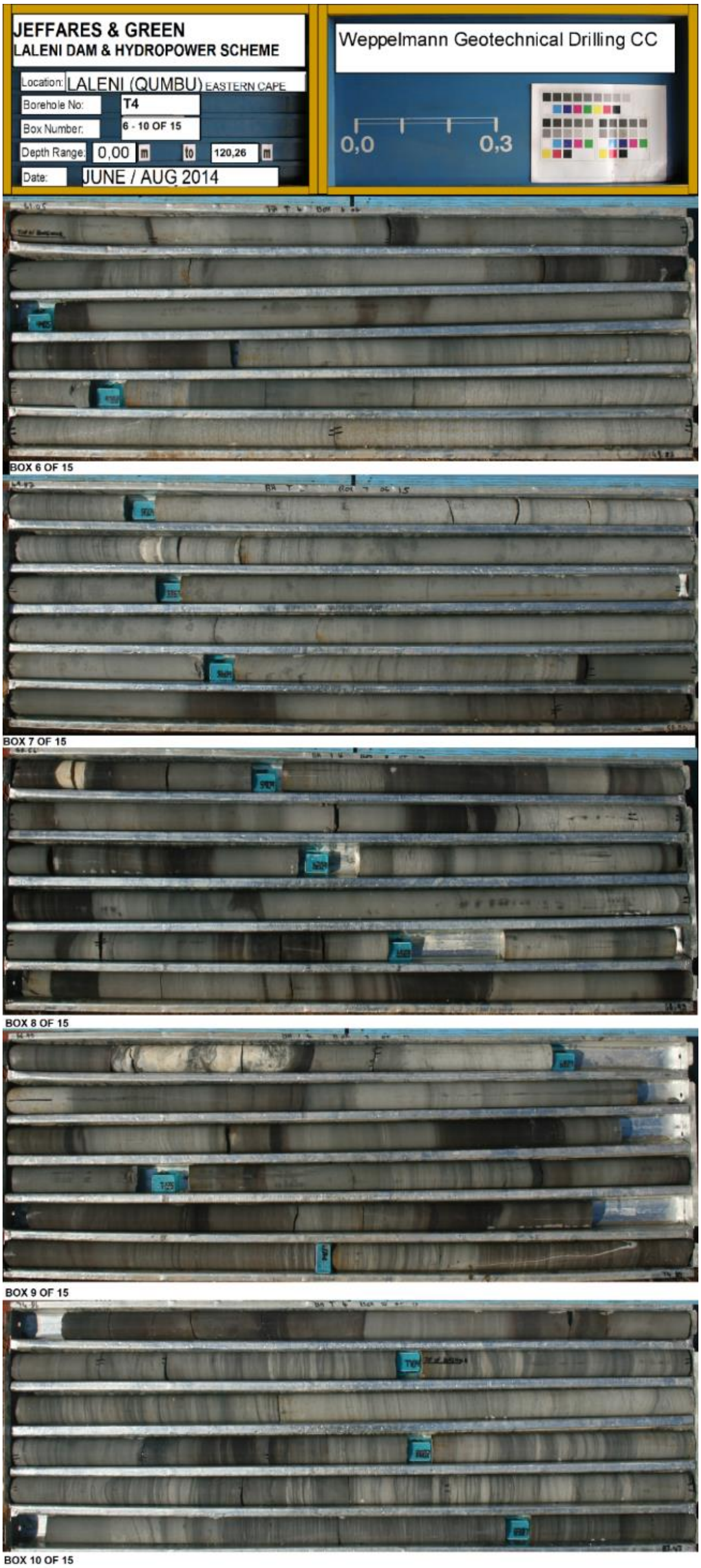
CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 109deg
DIAM : NQ
DATE : 07 to 13 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT4.TXT

ELEVATION : 800m
X-COORD : 31d17'07.8"S
Y-COORD : 28d57'38.8"E
HOLE No: BH T4

Fig D-7.1: Borehole Tunnel 4 – Log

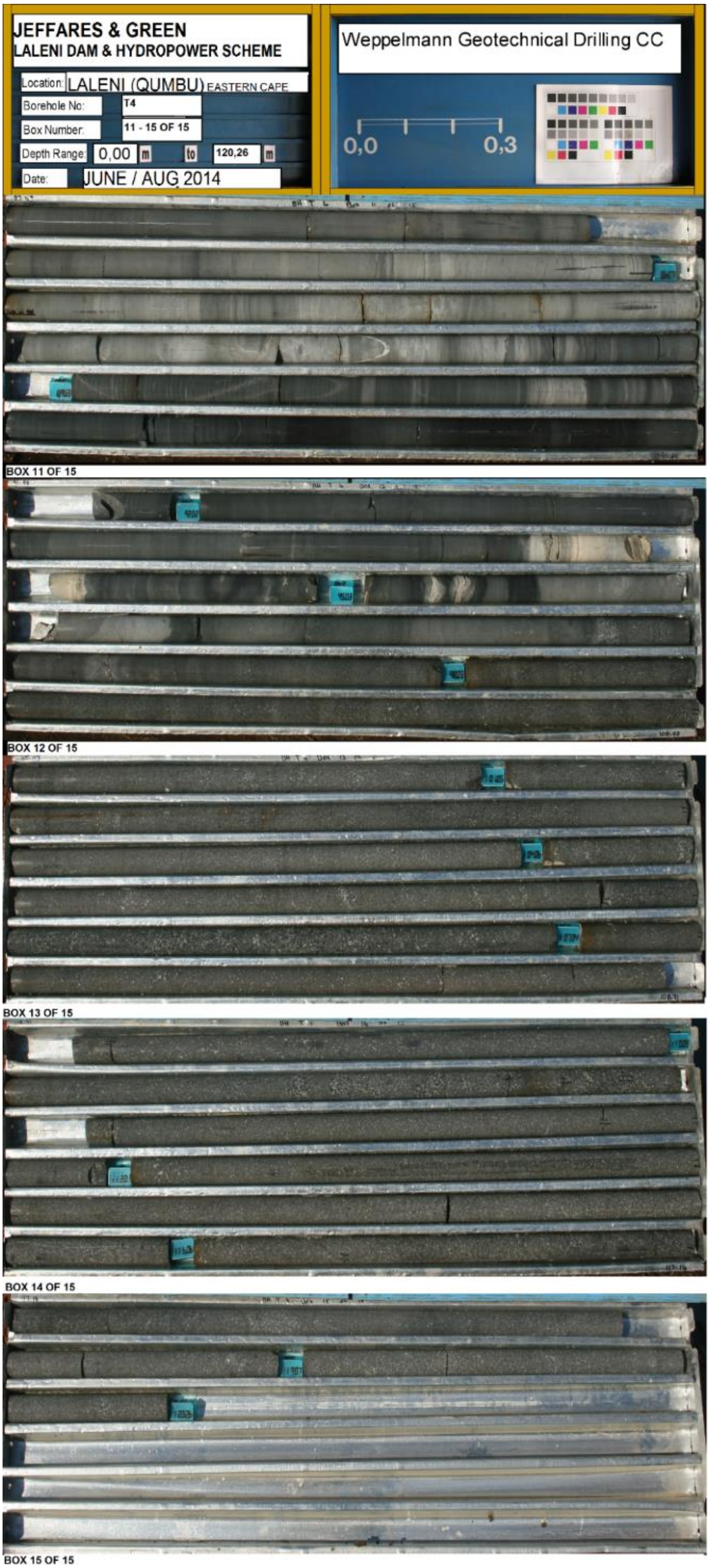
Fig D-8: **Borehole Tunnel 4 – Box 1 to 5**



JEFFARES & GREEN
LALENI DAM & HYDROPOWER SCHEME
Location: LALENI (QUMBU) EASTERN CAPE
Borehole No: T4
Box Number: 6 - 10 OF 15
Depth Range: 0,00 m to 120,26 m
Date: JUNE / AUG 2014

Weppelmann Geotechnical Drilling CC

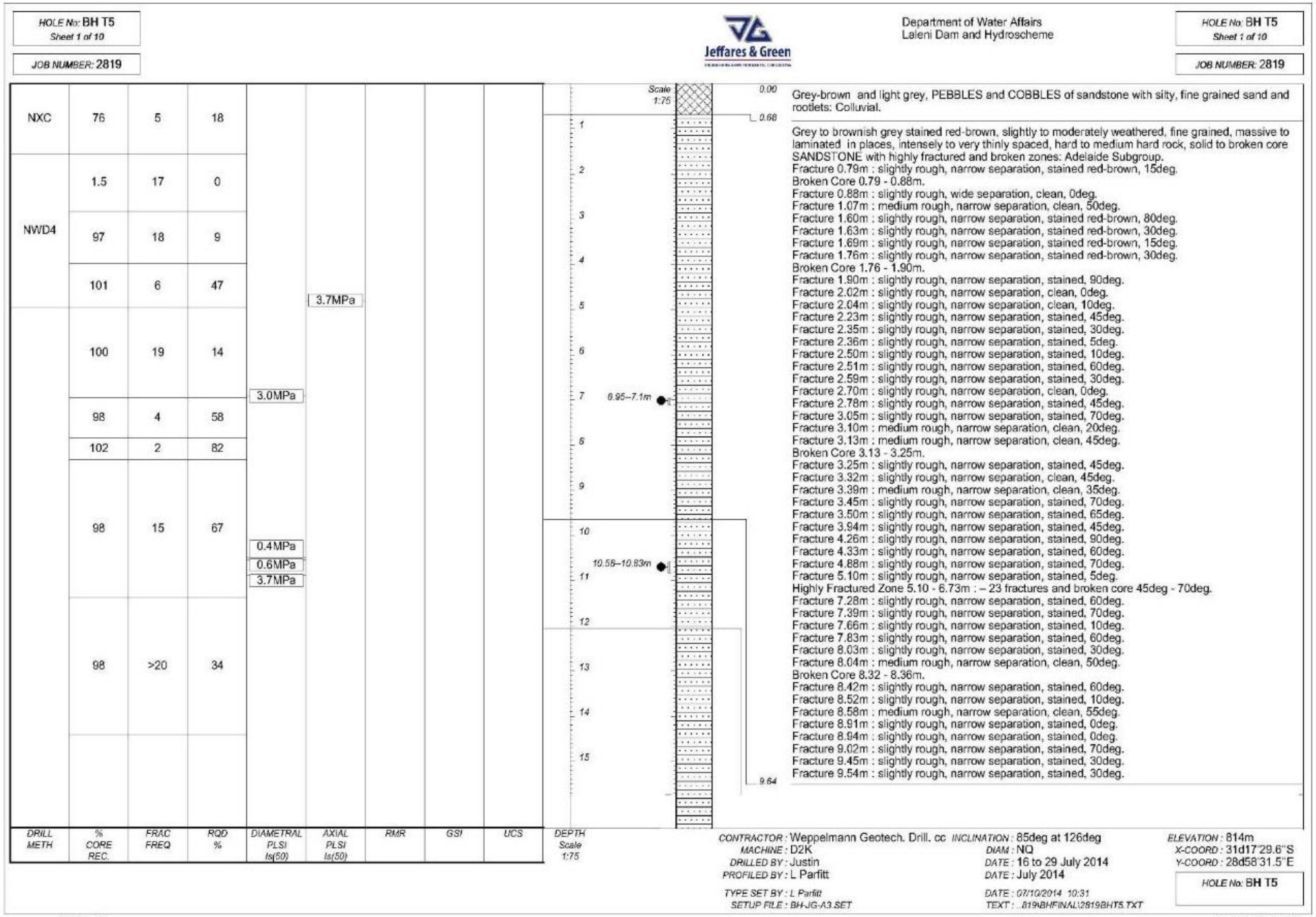
Fig D-8: **Borehole Tunnel 4 – Box 6 to 10**



JEFFARES & GREEN
LALENI DAM & HYDROPOWER SCHEME
Location: LALENI (QUMBU) EASTERN CAPE
Borehole No: T4
Box Number: 11 - 15 OF 15
Depth Range: 0,00 m to 120,26 m
Date: JUNE / AUG 2014

Weppelmann Geotechnical Drilling CC

Fig D-8: **Borehole Tunnel 4 – Box 11 to 15**



HOLE No: BH T5
Sheet 1 of 10

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
NXC	76	5	18					
NWD4	1.5	17	0					
	97	18	9					
	101	6	47		3.7MPa			
	100	19	14	3.0MPa				
	98	4	58					
	102	2	82					
	98	15	67	0.4MPa 0.6MPa 3.7MPa				
	98	>20	34					

DEPTH Scale 1:75

Grey-brown and light grey, PEBBLES and COBBLES of sandstone with silty, fine grained sand and rootlets: Colluvial.

Grey to brownish grey stained red-brown, slightly to moderately weathered, fine grained, massive to laminated in places, intensely to very thinly spaced, hard to medium hard rock, solid to broken core SANDSTONE with highly fractured and broken zones: Adelaide Subgroup.
Fracture 0.79m : slightly rough, narrow separation, stained red-brown, 15deg.
Broken Core 0.79 - 0.88m.
Fracture 0.88m : slightly rough, wide separation, clean, 0deg.
Fracture 1.07m : medium rough, narrow separation, clean, 50deg.
Fracture 1.60m : slightly rough, narrow separation, stained red-brown, 80deg.
Fracture 1.63m : slightly rough, narrow separation, stained red-brown, 30deg.
Fracture 1.69m : slightly rough, narrow separation, stained red-brown, 15deg.
Fracture 1.76m : slightly rough, narrow separation, stained red-brown, 30deg.
Broken Core 1.76 - 1.90m.
Fracture 1.90m : slightly rough, narrow separation, stained, 90deg.
Fracture 2.02m : slightly rough, narrow separation, clean, 0deg.
Fracture 2.04m : slightly rough, narrow separation, clean, 10deg.
Fracture 2.23m : slightly rough, narrow separation, stained, 45deg.
Fracture 2.35m : slightly rough, narrow separation, stained, 30deg.
Fracture 2.36m : slightly rough, narrow separation, stained, 5deg.
Fracture 2.50m : slightly rough, narrow separation, stained, 10deg.
Fracture 2.51m : slightly rough, narrow separation, stained, 60deg.
Fracture 2.59m : slightly rough, narrow separation, stained, 30deg.
Fracture 2.70m : slightly rough, narrow separation, clean, 0deg.
Fracture 2.78m : slightly rough, narrow separation, stained, 45deg.
Fracture 3.05m : slightly rough, narrow separation, stained, 70deg.
Fracture 3.10m : medium rough, narrow separation, clean, 20deg.
Fracture 3.13m : medium rough, narrow separation, clean, 45deg.
Broken Core 3.13 - 3.25m.
Fracture 3.25m : slightly rough, narrow separation, stained, 45deg.
Fracture 3.32m : slightly rough, narrow separation, clean, 45deg.
Fracture 3.39m : medium rough, narrow separation, clean, 35deg.
Fracture 3.45m : slightly rough, narrow separation, stained, 70deg.
Fracture 3.50m : slightly rough, narrow separation, stained, 65deg.
Fracture 3.94m : slightly rough, narrow separation, stained, 45deg.
Fracture 4.26m : slightly rough, narrow separation, stained, 90deg.
Fracture 4.33m : slightly rough, narrow separation, stained, 60deg.
Fracture 4.88m : slightly rough, narrow separation, stained, 70deg.
Fracture 5.10m : slightly rough, narrow separation, stained, 5deg.
Highly Fractured Zone 5.10 - 6.73m : – 23 fractures and broken core 45deg - 70deg.
Fracture 7.28m : slightly rough, narrow separation, stained, 60deg.
Fracture 7.39m : slightly rough, narrow separation, stained, 70deg.
Fracture 7.66m : slightly rough, narrow separation, stained, 10deg.
Fracture 7.83m : slightly rough, narrow separation, stained, 60deg.
Fracture 8.03m : slightly rough, narrow separation, stained, 30deg.
Fracture 8.04m : medium rough, narrow separation, clean, 50deg.
Broken Core 8.32 - 8.36m.
Fracture 8.42m : slightly rough, narrow separation, stained, 60deg.
Fracture 8.52m : slightly rough, narrow separation, stained, 10deg.
Fracture 8.58m : medium rough, narrow separation, clean, 55deg.
Fracture 8.91m : slightly rough, narrow separation, stained, 0deg.
Fracture 8.94m : slightly rough, narrow separation, stained, 0deg.
Fracture 9.02m : slightly rough, narrow separation, stained, 70deg.
Fracture 9.45m : slightly rough, narrow separation, stained, 30deg.
Fracture 9.54m : slightly rough, narrow separation, stained, 30deg.

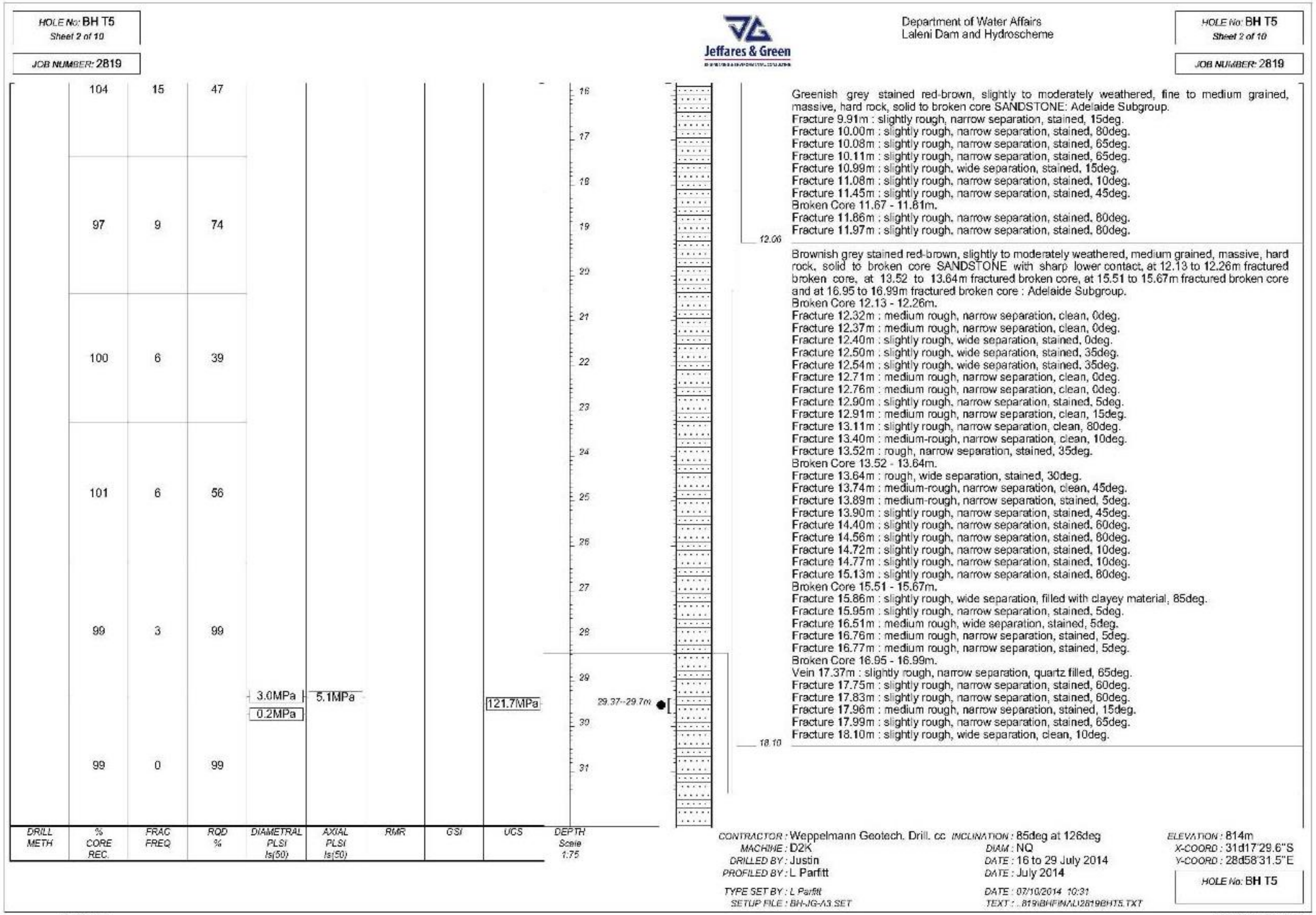
CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT

ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E

HOLE No: BH T5

Fig D-9.1: Borehole Tunnel 5 – Log



HOLE No: BH T5
Sheet 2 of 10
JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T5
Sheet 2 of 10
JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS	DEPTH Scale 1:75
	104	15	47						16 17
	97	9	74						18 19 20
	100	6	39						21 22 23
	101	6	56						24 25 26
	99	3	99						27 28
				3.0MPa 0.2MPa	5.1MPa			121.7MPa	29 30
	99	0	99						31

29.37--29.7m

Greenish grey stained red-brown, slightly to moderately weathered, fine to medium grained, massive, hard rock, solid to broken core SANDSTONE: Adelaide Subgroup.
Fracture 9.91m : slightly rough, narrow separation, stained, 15deg.
Fracture 10.00m : slightly rough, narrow separation, stained, 80deg.
Fracture 10.08m : slightly rough, narrow separation, stained, 65deg.
Fracture 10.11m : slightly rough, narrow separation, stained, 65deg.
Fracture 10.99m : slightly rough, wide separation, stained, 15deg.
Fracture 11.08m : slightly rough, narrow separation, stained, 10deg.
Fracture 11.45m : slightly rough, narrow separation, stained, 45deg.
Broken Core 11.67 - 11.81m.
Fracture 11.86m : slightly rough, narrow separation, stained, 80deg.
Fracture 11.97m : slightly rough, narrow separation, stained, 80deg.

12.06

Brownish grey stained red-brown, slightly to moderately weathered, medium grained, massive, hard rock, solid to broken core SANDSTONE with sharp lower contact, at 12.13 to 12.26m fractured broken core, at 13.52 to 13.64m fractured broken core, at 15.51 to 15.67m fractured broken core and at 16.95 to 16.99m fractured broken core : Adelaide Subgroup.
Broken Core 12.13 - 12.26m.
Fracture 12.32m : medium rough, narrow separation, clean, 0deg.
Fracture 12.37m : medium rough, narrow separation, clean, 0deg.
Fracture 12.40m : slightly rough, wide separation, stained, 0deg.
Fracture 12.50m : slightly rough, wide separation, stained, 35deg.
Fracture 12.54m : slightly rough, wide separation, stained, 35deg.
Fracture 12.71m : medium rough, narrow separation, clean, 0deg.
Fracture 12.76m : medium rough, narrow separation, clean, 0deg.
Fracture 12.90m : slightly rough, narrow separation, stained, 5deg.
Fracture 12.91m : medium rough, narrow separation, clean, 15deg.
Fracture 13.11m : slightly rough, narrow separation, clean, 80deg.
Fracture 13.40m : medium-rough, narrow separation, clean, 10deg.
Fracture 13.52m : rough, narrow separation, stained, 35deg.
Broken Core 13.52 - 13.64m.
Fracture 13.64m : rough, wide separation, stained, 30deg.
Fracture 13.74m : medium-rough, narrow separation, clean, 45deg.
Fracture 13.89m : medium-rough, narrow separation, stained, 5deg.
Fracture 13.90m : slightly rough, narrow separation, stained, 45deg.
Fracture 14.40m : slightly rough, narrow separation, stained, 60deg.
Fracture 14.56m : slightly rough, narrow separation, stained, 80deg.
Fracture 14.72m : slightly rough, narrow separation, stained, 10deg.
Fracture 14.77m : slightly rough, narrow separation, stained, 10deg.
Fracture 15.13m : slightly rough, narrow separation, stained, 80deg.
Broken Core 15.51 - 15.67m.
Fracture 15.86m : slightly rough, wide separation, filled with clayey material, 85deg.
Fracture 15.95m : slightly rough, narrow separation, stained, 5deg.
Fracture 16.51m : medium rough, wide separation, stained, 5deg.
Fracture 16.76m : medium rough, narrow separation, stained, 5deg.
Fracture 16.77m : medium rough, narrow separation, stained, 5deg.
Broken Core 16.95 - 16.99m.
Vein 17.37m : slightly rough, narrow separation, quartz filled, 65deg.
Fracture 17.75m : slightly rough, narrow separation, stained, 60deg.
Fracture 17.83m : slightly rough, narrow separation, stained, 60deg.
Fracture 17.96m : medium rough, narrow separation, stained, 15deg.
Fracture 17.99m : slightly rough, narrow separation, stained, 65deg.
Fracture 18.10m : slightly rough, wide separation, clean, 10deg.

18.10

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

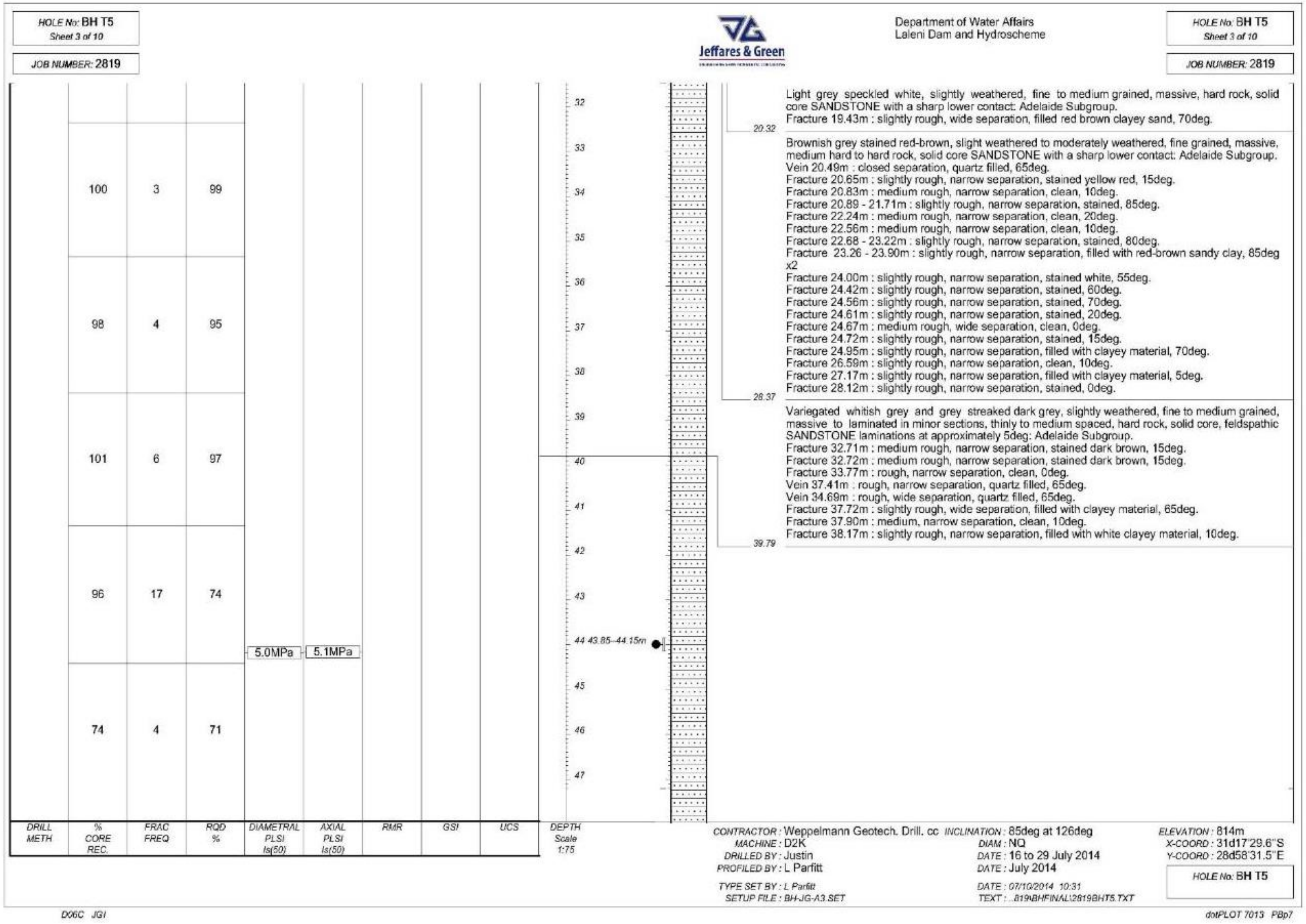
INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT

ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E
HOLE No: BH T5

D06C JGI

dotPLOT 7013 PBp7

Fig D-9.2: **Borehole Tunnel 5 – Log**



HOLE No: BH T5
Sheet 3 of 10

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	100	3	99					
	98	4	95					
	101	6	97					
	96	17	74	5.0MPa	5.1MPa			
	74	4	71					

DEPTH Scale 1:75

Light grey speckled white, slightly weathered, fine to medium grained, massive, hard rock, solid core SANDSTONE with a sharp lower contact: Adelaide Subgroup.
Fracture 19.43m : slightly rough, wide separation, filled red brown clayey sand, 70deg.

Brownish grey stained red-brown, slight weathered to moderately weathered, fine grained, massive, medium hard to hard rock, solid core SANDSTONE with a sharp lower contact: Adelaide Subgroup.
Vein 20.49m : closed separation, quartz filled, 65deg.
Fracture 20.65m : slightly rough, narrow separation, stained yellow red, 15deg.
Fracture 20.83m : medium rough, narrow separation, clean, 10deg.
Fracture 20.89 - 21.71m : slightly rough, narrow separation, stained, 85deg.
Fracture 22.24m : medium rough, narrow separation, clean, 20deg.
Fracture 22.56m : medium rough, narrow separation, clean, 10deg.
Fracture 22.68 - 23.22m : slightly rough, narrow separation, stained, 80deg.
Fracture 23.26 - 23.90m : slightly rough, narrow separation, filled with red-brown sandy clay, 85deg x2
Fracture 24.00m : slightly rough, narrow separation, stained white, 55deg.
Fracture 24.42m : slightly rough, narrow separation, stained, 60deg.
Fracture 24.56m : slightly rough, narrow separation, stained, 70deg.
Fracture 24.61m : slightly rough, narrow separation, stained, 20deg.
Fracture 24.67m : medium rough, wide separation, clean, 0deg.
Fracture 24.72m : slightly rough, narrow separation, stained, 15deg.
Fracture 24.95m : slightly rough, narrow separation, filled with clayey material, 70deg.
Fracture 26.59m : slightly rough, narrow separation, clean, 10deg.
Fracture 27.17m : slightly rough, narrow separation, filled with clayey material, 5deg.
Fracture 28.12m : slightly rough, narrow separation, stained, 0deg.

Variegated whitish grey and grey streaked dark grey, slightly weathered, fine to medium grained, massive to laminated in minor sections, thinly to medium spaced, hard rock, solid core, feldspathic SANDSTONE laminations at approximately 5deg: Adelaide Subgroup.
Fracture 32.71m : medium rough, narrow separation, stained dark brown, 15deg.
Fracture 32.72m : medium rough, narrow separation, stained dark brown, 15deg.
Fracture 33.77m : rough, narrow separation, clean, 0deg.
Vein 37.41m : rough, narrow separation, quartz filled, 65deg.
Vein 34.69m : rough, wide separation, quartz filled, 65deg.
Fracture 37.72m : slightly rough, wide separation, filled with clayey material, 65deg.
Fracture 37.90m : medium, narrow separation, clean, 10deg.
Fracture 38.17m : slightly rough, narrow separation, filled with white clayey material, 10deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT

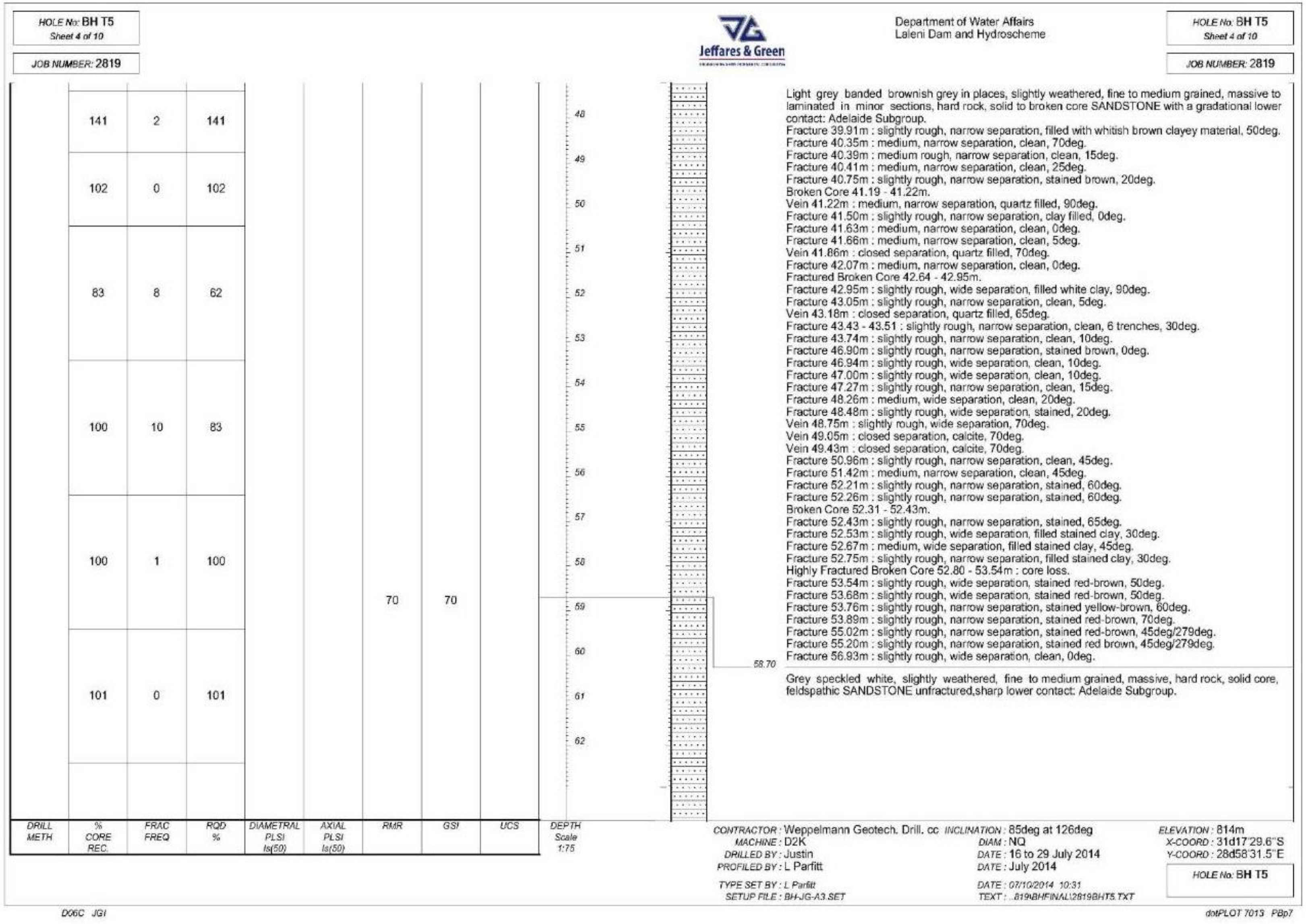
ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E

HOLE No: BH T5

D06C JGI

dotPLOT 7013 PBp7

Fig D-9.3: Borehole Tunnel 5 – Log



HOLE No: BH T5
Sheet 4 of 10

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS	DEPTH Scale 1:75
	141	2	141						
	102	0	102						
	83	8	62						
	100	10	83						
	100	1	100			70	70		
	101	0	101						

Light grey banded brownish grey in places, slightly weathered, fine to medium grained, massive to laminated in minor sections, hard rock, solid to broken core SANDSTONE with a gradational lower contact: Adelaide Subgroup.
Fracture 39.91m : slightly rough, narrow separation, filled with whitish brown clayey material, 50deg.
Fracture 40.35m : medium, narrow separation, clean, 70deg.
Fracture 40.39m : medium rough, narrow separation, clean, 15deg.
Fracture 40.41m : medium, narrow separation, clean, 25deg.
Fracture 40.75m : slightly rough, narrow separation, stained brown, 20deg.
Broken Core 41.19 - 41.22m.
Vein 41.22m : medium, narrow separation, quartz filled, 90deg.
Fracture 41.50m : slightly rough, narrow separation, clay filled, 0deg.
Fracture 41.63m : medium, narrow separation, clean, 0deg.
Fracture 41.66m : medium, narrow separation, clean, 5deg.
Vein 41.86m : closed separation, quartz filled, 70deg.
Fracture 42.07m : medium, narrow separation, clean, 0deg.
Fractured Broken Core 42.64 - 42.95m.
Fracture 42.95m : slightly rough, wide separation, filled white clay, 90deg.
Fracture 43.05m : slightly rough, narrow separation, clean, 5deg.
Vein 43.18m : closed separation, quartz filled, 65deg.
Fracture 43.43 - 43.51 : slightly rough, narrow separation, clean, 6 trenches, 30deg.
Fracture 43.74m : slightly rough, narrow separation, clean, 10deg.
Fracture 46.90m : slightly rough, narrow separation, stained brown, 0deg.
Fracture 46.94m : slightly rough, wide separation, clean, 10deg.
Fracture 47.00m : slightly rough, wide separation, clean, 10deg.
Fracture 47.27m : slightly rough, narrow separation, clean, 15deg.
Fracture 48.26m : medium, wide separation, clean, 20deg.
Fracture 48.48m : slightly rough, wide separation, stained, 20deg.
Vein 48.75m : slightly rough, wide separation, 70deg.
Vein 49.05m : closed separation, calcite, 70deg.
Vein 49.43m : closed separation, calcite, 70deg.
Fracture 50.96m : slightly rough, narrow separation, clean, 45deg.
Fracture 51.42m : medium, narrow separation, clean, 45deg.
Fracture 52.21m : slightly rough, narrow separation, stained, 60deg.
Fracture 52.26m : slightly rough, narrow separation, stained, 60deg.
Broken Core 52.31 - 52.43m.
Fracture 52.43m : slightly rough, narrow separation, stained, 65deg.
Fracture 52.53m : slightly rough, wide separation, filled stained clay, 30deg.
Fracture 52.67m : medium, wide separation, filled stained clay, 45deg.
Fracture 52.75m : slightly rough, narrow separation, filled stained clay, 30deg.
Highly Fractured Broken Core 52.80 - 53.54m : core loss.
Fracture 53.54m : slightly rough, wide separation, stained red-brown, 50deg.
Fracture 53.68m : slightly rough, wide separation, stained red-brown, 50deg.
Fracture 53.76m : slightly rough, narrow separation, stained yellow-brown, 60deg.
Fracture 53.89m : slightly rough, narrow separation, stained red-brown, 70deg.
Fracture 55.02m : slightly rough, narrow separation, stained red-brown, 45deg/279deg.
Fracture 55.20m : slightly rough, narrow separation, stained red brown, 45deg/279deg.
Fracture 56.93m : slightly rough, wide separation, clean, 0deg.

Grey speckled white, slightly weathered, fine to medium grained, massive, hard rock, solid core, feldspathic SANDSTONE unfractured,sharp lower contact: Adelaide Subgroup.

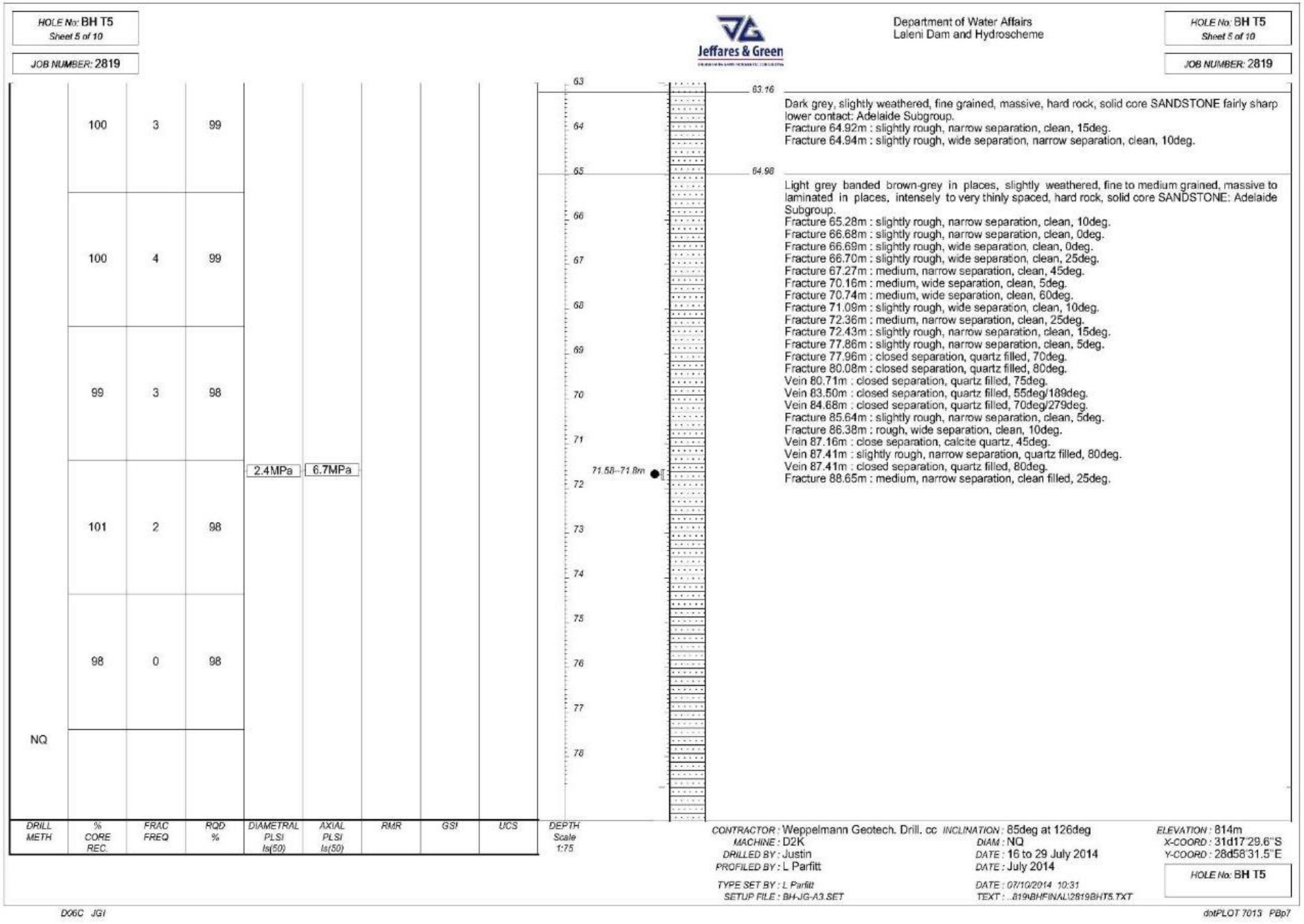
CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT

ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E

HOLE No: BH T5

Fig D-9.4: Borehole Tunnel 5 – Log



HOLE No: BH T5
Sheet 5 of 10

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS	DEPTH Scale 1:75
	100	3	99						
	100	4	99						
	99	3	98						
	101	2	98	2.4MPa	6.7MPa				71.58–71.8m
	98	0	98						
NQ									

63.16

Dark grey, slightly weathered, fine grained, massive, hard rock, solid core SANDSTONE fairly sharp lower contact: Adelaide Subgroup.
Fracture 64.92m : slightly rough, narrow separation, clean, 15deg.
Fracture 64.94m : slightly rough, wide separation, narrow separation, clean, 10deg.

64.98

Light grey banded brown-grey in places, slightly weathered, fine to medium grained, massive to laminated in places, intensely to very thinly spaced, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 65.28m : slightly rough, narrow separation, clean, 10deg.
Fracture 66.68m : slightly rough, narrow separation, clean, 0deg.
Fracture 66.69m : slightly rough, wide separation, clean, 0deg.
Fracture 66.70m : slightly rough, wide separation, clean, 25deg.
Fracture 67.27m : medium, narrow separation, clean, 45deg.
Fracture 70.16m : medium, wide separation, clean, 5deg.
Fracture 70.74m : medium, wide separation, clean, 60deg.
Fracture 71.09m : slightly rough, wide separation, clean, 10deg.
Fracture 72.36m : medium, narrow separation, clean, 25deg.
Fracture 72.43m : slightly rough, narrow separation, clean, 15deg.
Fracture 77.86m : slightly rough, narrow separation, clean, 5deg.
Fracture 77.96m : closed separation, quartz filled, 70deg.
Fracture 80.08m : closed separation, quartz filled, 80deg.
Vein 80.71m : closed separation, quartz filled, 75deg.
Vein 83.50m : closed separation, quartz filled, 55deg/189deg.
Vein 84.68m : closed separation, quartz filled, 70deg/279deg.
Fracture 85.64m : slightly rough, narrow separation, clean, 5deg.
Fracture 86.38m : rough, wide separation, clean, 10deg.
Vein 87.16m : close separation, calcite quartz, 45deg.
Vein 87.41m : slightly rough, narrow separation, quartz filled, 80deg.
Vein 87.41m : closed separation, quartz filled, 80deg.
Fracture 88.65m : medium, narrow separation, clean filled, 25deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT

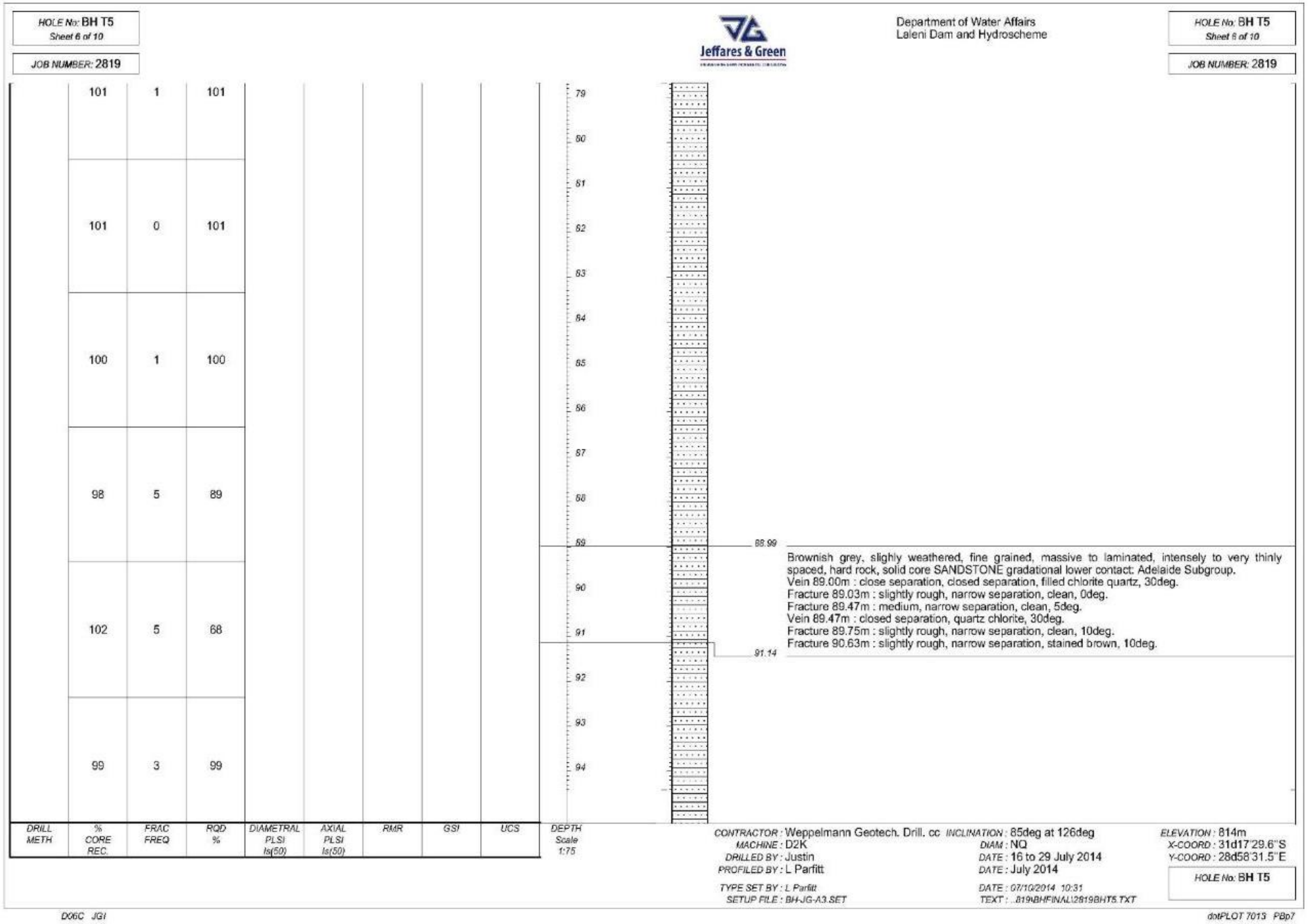
ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E

HOLE No: BH T5

D06C JGI

dotPLOT 7013 PBp7

Fig D-9.5: Borehole Tunnel 5 – Log



HOLE No: BH T5
Sheet 6 of 10
JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T5
Sheet 6 of 10
JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	101	1	101					
	101	0	101					
	100	1	100					
	98	5	89					
	102	5	68					
	99	3	99					

Brownish grey, slighly weathered, fine grained, massive to laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE gradational lower contact: Adelaide Subgroup.
Vein 89.00m : close separation, closed separation, filled chlorite quartz, 30deg.
Fracture 89.03m : slightly rough, narrow separation, clean, 0deg.
Fracture 89.47m : medium, narrow separation, clean, 5deg.
Vein 89.47m : closed separation, quartz chlorite, 30deg.
Fracture 89.75m : slightly rough, narrow separation, clean, 10deg.
Fracture 90.63m : slightly rough, narrow separation, stained brown, 10deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT

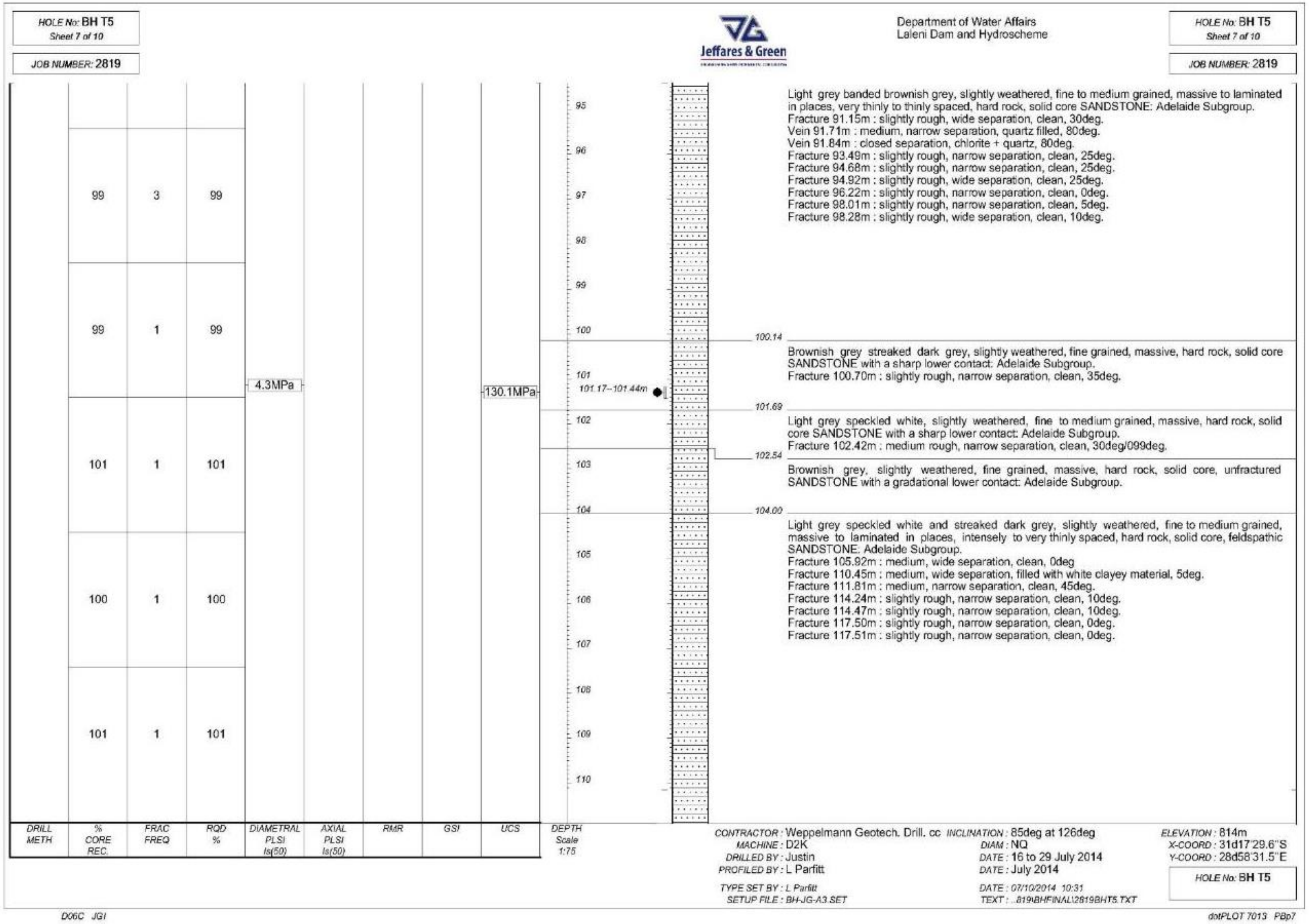
ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E

HOLE No: BH T5

D06C JGI

dotPLOT 7013 PBp7

Fig D-9.6: **Borehole Tunnel 5 – Log**



HOLE No: BH T5
Sheet 7 of 10

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	99	3	99					
	99	1	99	4.3MPa				130.1MPa
	101	1	101					
	100	1	100					
	101	1	101					

DEPTH Scale 1:75

Light grey banded brownish grey, slightly weathered, fine to medium grained, massive to laminated in places, very thinly to thinly spaced, hard rock, solid core SANDSTONE: Adelaide Subgroup.
Fracture 91.15m : slightly rough, wide separation, clean, 30deg.
Vein 91.71m : medium, narrow separation, quartz filled, 80deg.
Vein 91.84m : closed separation, chlorite + quartz, 80deg.
Fracture 93.49m : slightly rough, narrow separation, clean, 25deg.
Fracture 94.68m : slightly rough, narrow separation, clean, 25deg.
Fracture 94.92m : slightly rough, wide separation, clean, 25deg.
Fracture 96.22m : slightly rough, narrow separation, clean, 0deg.
Fracture 98.01m : slightly rough, narrow separation, clean, 5deg.
Fracture 98.28m : slightly rough, wide separation, clean, 10deg.

100.14

Brownish grey streaked dark grey, slightly weathered, fine grained, massive, hard rock, solid core SANDSTONE with a sharp lower contact: Adelaide Subgroup.
Fracture 100.70m : slightly rough, narrow separation, clean, 35deg.

101.69

Light grey speckled white, slightly weathered, fine to medium grained, massive, hard rock, solid core SANDSTONE with a sharp lower contact: Adelaide Subgroup.
Fracture 102.42m : medium rough, narrow separation, clean, 30deg/099deg.

102.54

Brownish grey, slightly weathered, fine grained, massive, hard rock, solid core, unfractured SANDSTONE with a gradational lower contact: Adelaide Subgroup.

104.00

Light grey speckled white and streaked dark grey, slightly weathered, fine to medium grained, massive to laminated in places, intensely to very thinly spaced, hard rock, solid core, feldspathic SANDSTONE: Adelaide Subgroup.
Fracture 105.92m : medium, wide separation, clean, 0deg
Fracture 110.45m : medium, wide separation, filled with white clayey material, 5deg.
Fracture 111.81m : medium, narrow separation, clean, 45deg.
Fracture 114.24m : slightly rough, narrow separation, clean, 10deg.
Fracture 114.47m : slightly rough, narrow separation, clean, 10deg.
Fracture 117.50m : slightly rough, narrow separation, clean, 0deg.
Fracture 117.51m : slightly rough, narrow separation, clean, 0deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT

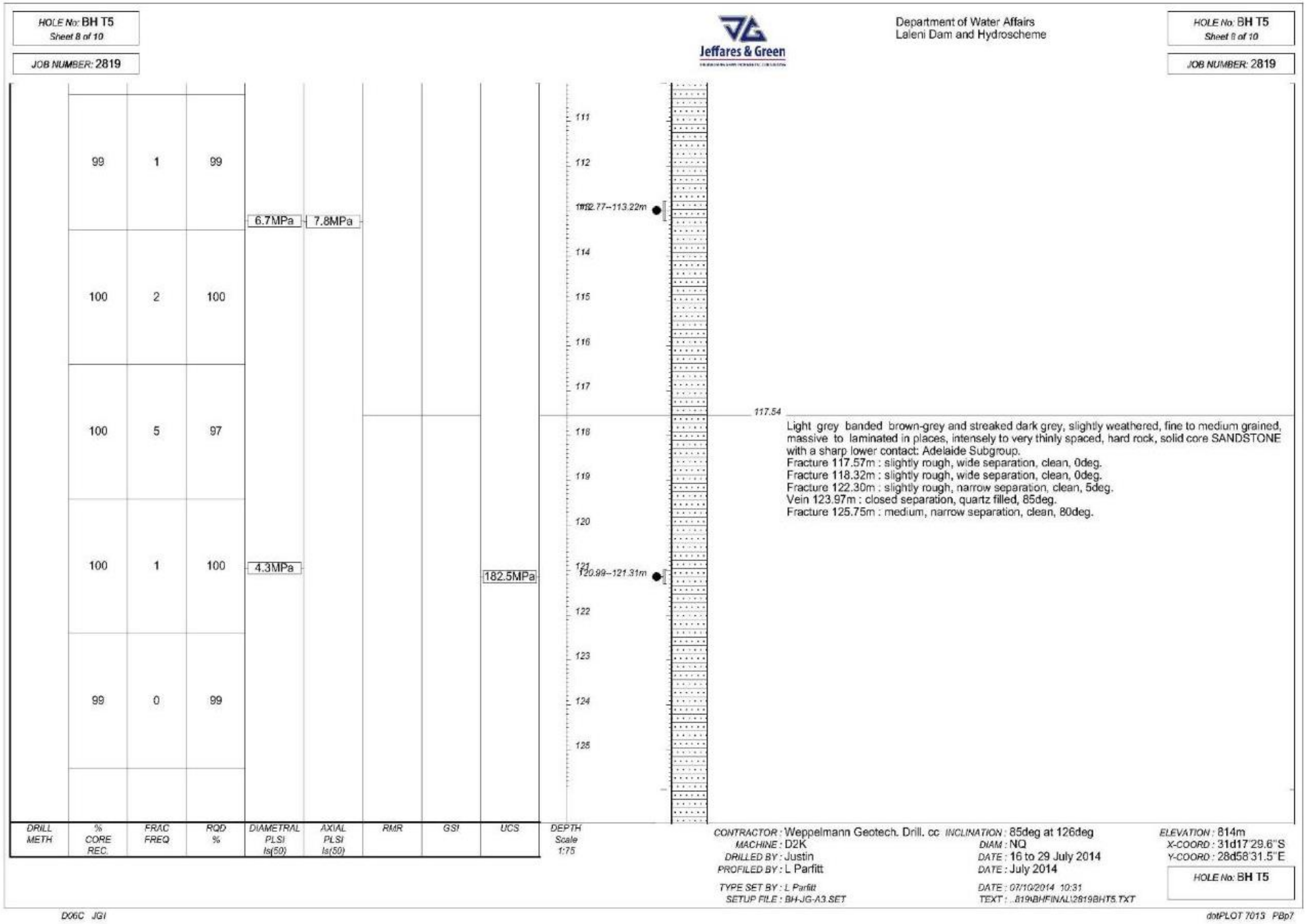
ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E

HOLE No: BH T5

D06C JGI

dotPLOT 7013 PBp7

Fig D-9.7: **Borehole Tunnel 5 – Log**



HOLE No: BH T5
Sheet 8 of 10
JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

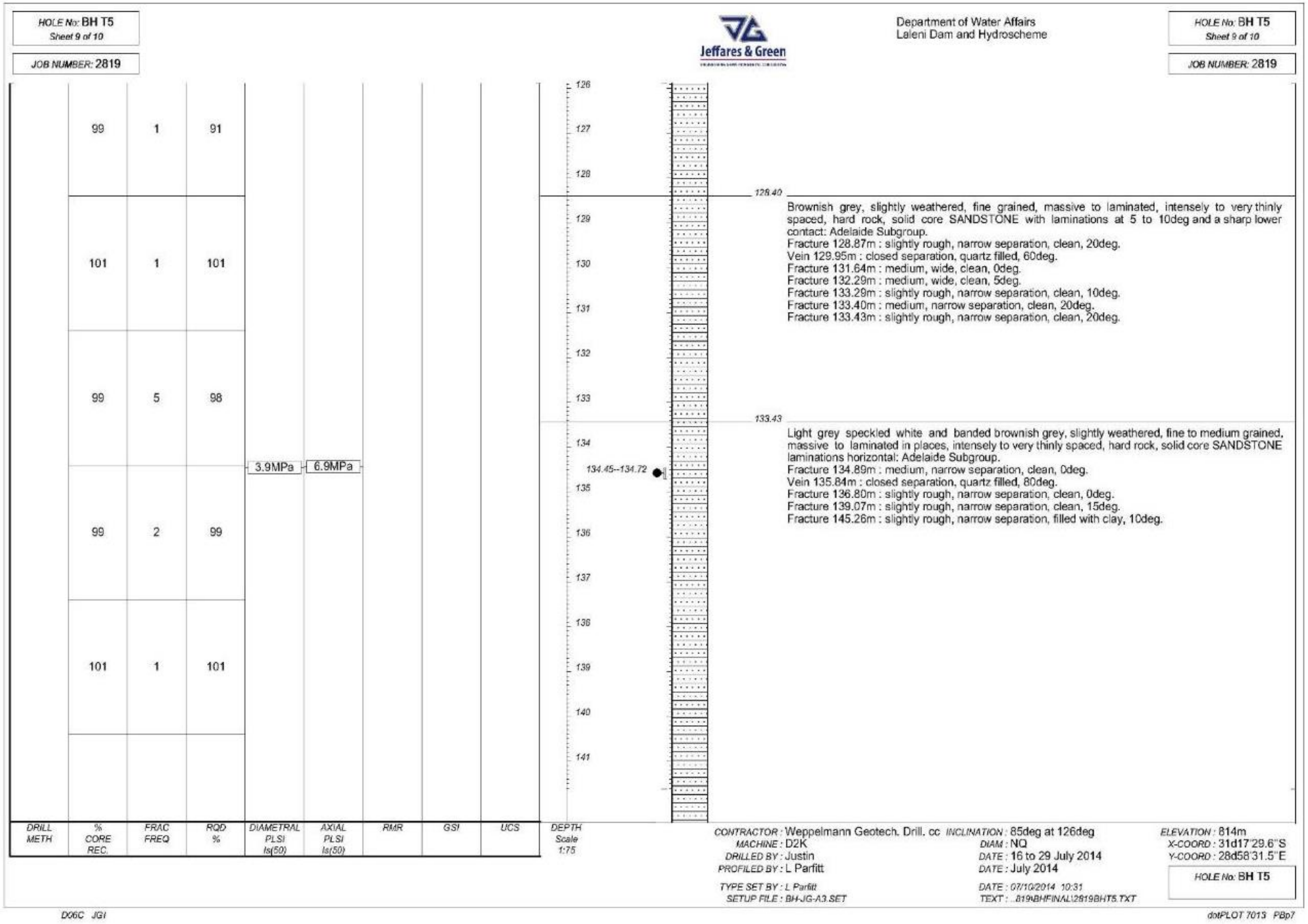
% CORE REC.	FRAC FREQ	RQD %
99	1	99
100	2	100
100	5	97
100	1	100
99	0	99

117.54

Light grey banded brown-grey and streaked dark grey, slightly weathered, fine to medium grained, massive to laminated in places, intensely to very thinly spaced, hard rock, solid core SANDSTONE with a sharp lower contact: Adelaide Subgroup.
Fracture 117.57m : slightly rough, wide separation, clean, 0deg.
Fracture 118.32m : slightly rough, wide separation, clean, 0deg.
Fracture 122.30m : slightly rough, narrow separation, clean, 5deg.
Vein 123.97m : closed separation, quartz filled, 85deg.
Fracture 125.75m : medium, narrow separation, clean, 80deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET
INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT
ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E
HOLE No: BH T5

Fig D-9.8: Borehole Tunnel 5 – Log



HOLE No: BH T5
Sheet 9 of 10

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	99	1	91					
	101	1	101					
	99	5	98					
	99	2	99	3.9MPa	6.9MPa			
	101	1	101					

DEPTH Scale 1:75

128.40

Brownish grey, slightly weathered, fine grained, massive to laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE with laminations at 5 to 10deg and a sharp lower contact: Adelaide Subgroup.
Fracture 128.87m : slightly rough, narrow separation, clean, 20deg.
Vein 129.95m : closed separation, quartz filled, 60deg.
Fracture 131.64m : medium, wide, clean, 0deg.
Fracture 132.29m : medium, wide, clean, 5deg.
Fracture 133.29m : slightly rough, narrow separation, clean, 10deg.
Fracture 133.40m : medium, narrow separation, clean, 20deg.
Fracture 133.43m : slightly rough, narrow separation, clean, 20deg.

133.43

Light grey speckled white and banded brownish grey, slightly weathered, fine to medium grained, massive to laminated in places, intensely to very thinly spaced, hard rock, solid core SANDSTONE laminations horizontal: Adelaide Subgroup.
Fracture 134.89m : medium, narrow separation, clean, 0deg.
Vein 135.84m : closed separation, quartz filled, 80deg.
Fracture 136.80m : slightly rough, narrow separation, clean, 0deg.
Fracture 139.07m : slightly rough, narrow separation, clean, 15deg.
Fracture 145.26m : slightly rough, narrow separation, filled with clay, 10deg.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT

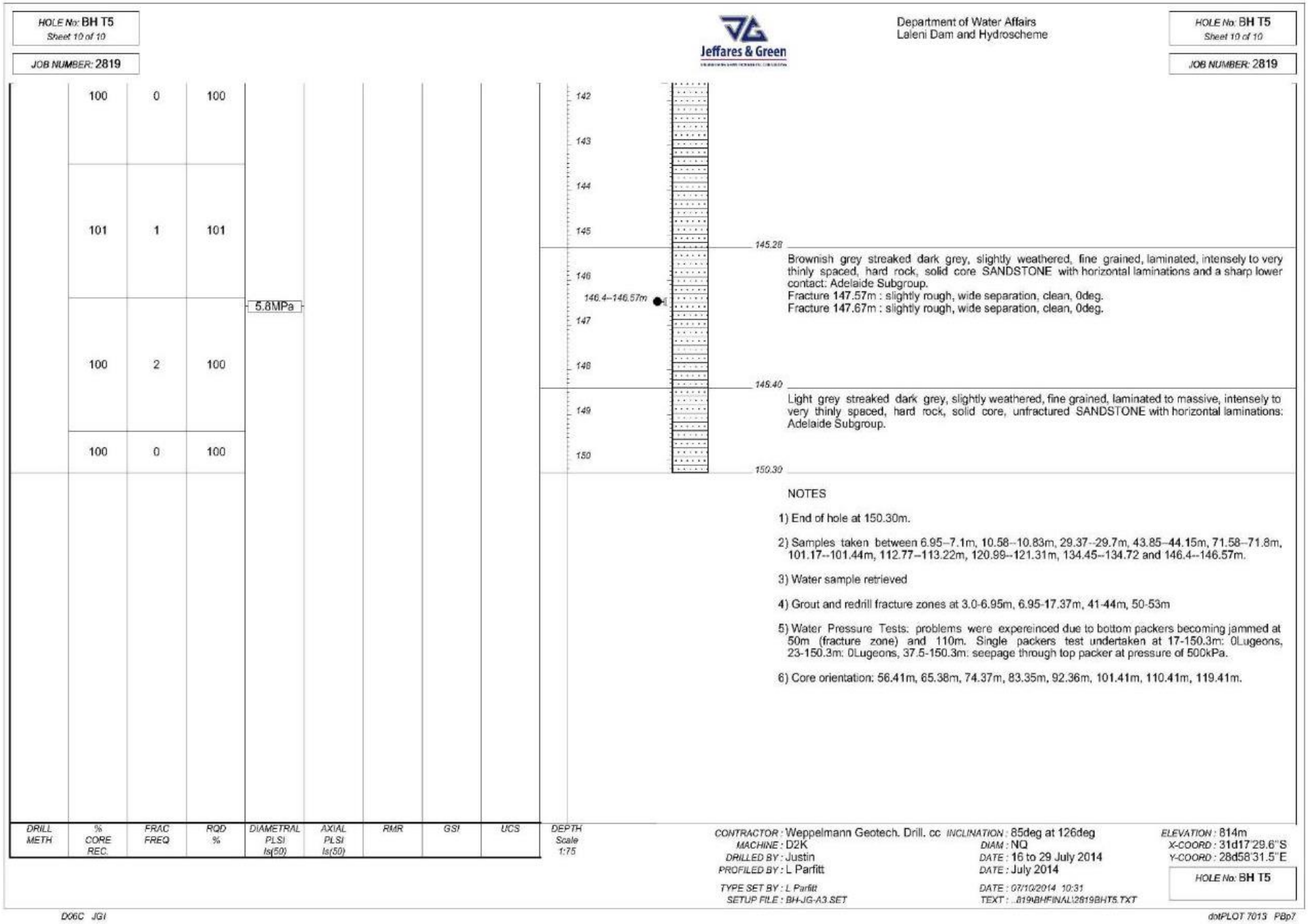
ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E

HOLE No: BH T5

D06C JGI

dotPLOT 7013 PBp7

Fig D-9.9: **Borehole Tunnel 5 – Log**



HOLE No: **BH T5**
Sheet 10 of 10

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS	DEPTH Scale 1:75
	100	0	100						142
	101	1	101						145
				5.8MPa					146.4--146.57m
	100	2	100						148
	100	0	100						150

145.28
Brownish grey streaked dark grey, slightly weathered, fine grained, laminated, intensely to very thinly spaced, hard rock, solid core SANDSTONE with horizontal laminations and a sharp lower contact: Adelaide Subgroup.
Fracture 147.57m : slightly rough, wide separation, clean, 0deg.
Fracture 147.67m : slightly rough, wide separation, clean, 0deg.

148.40
Light grey streaked dark grey, slightly weathered, fine grained, laminated to massive, intensely to very thinly spaced, hard rock, solid core, unfractured SANDSTONE with horizontal laminations: Adelaide Subgroup.

150.30

NOTES

1) End of hole at 150.30m.

2) Samples taken between 6.95–7.1m, 10.58--10.83m, 29.37--29.7m, 43.85–44.15m, 71.58–71.8m, 101.17--101.44m, 112.77–113.22m, 120.99--121.31m, 134.45--134.72 and 146.4--146.57m.

3) Water sample retrieved

4) Grout and redrill fracture zones at 3.0-6.95m, 6.95-17.37m, 41-44m, 50-53m

5) Water Pressure Tests: problems were expereinced due to bottom packers becoming jammed at 50m (fracture zone) and 110m. Single packers test undertaken at 17-150.3m: 0Lugeons, 23-150.3m: 0Lugeons, 37.5-150.3m: seepage through top packer at pressure of 500kPa.

6) Core orientation: 56.41m, 65.38m, 74.37m, 83.35m, 92.36m, 101.41m, 110.41m, 119.41m.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin
PROFILED BY : L Parfitt
TYPE SET BY : L Parfitt
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg at 126deg
DIAM : NQ
DATE : 16 to 29 July 2014
DATE : July 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT5.TXT

ELEVATION : 814m
X-COORD : 31d17'29.6"S
Y-COORD : 28d58'31.5"E

HOLE No: **BH T5**

D06C JGI

dotPLOT 7013 PBp7

Fig D-9.10: Borehole Tunnel 5 – Log

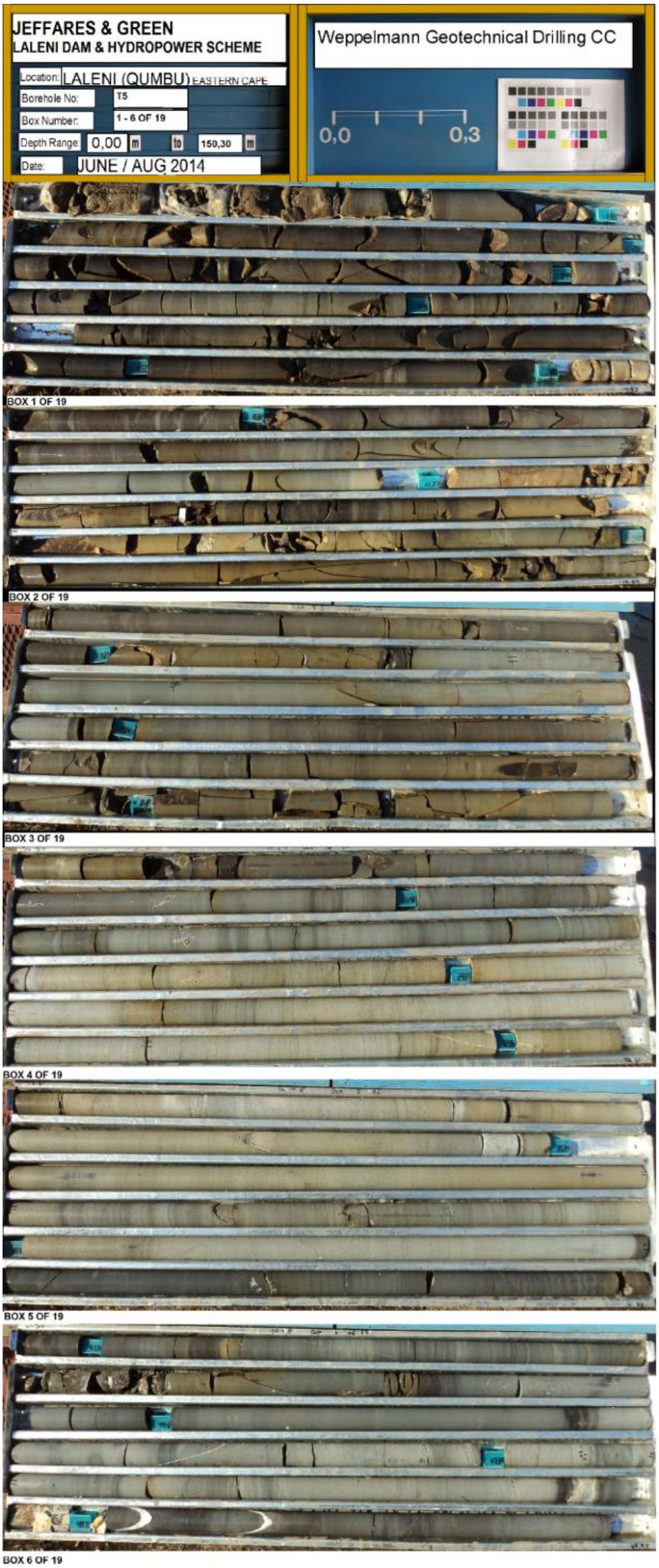


Fig D-11.1: Borehole Tunnel 5 – Box 1 to 6

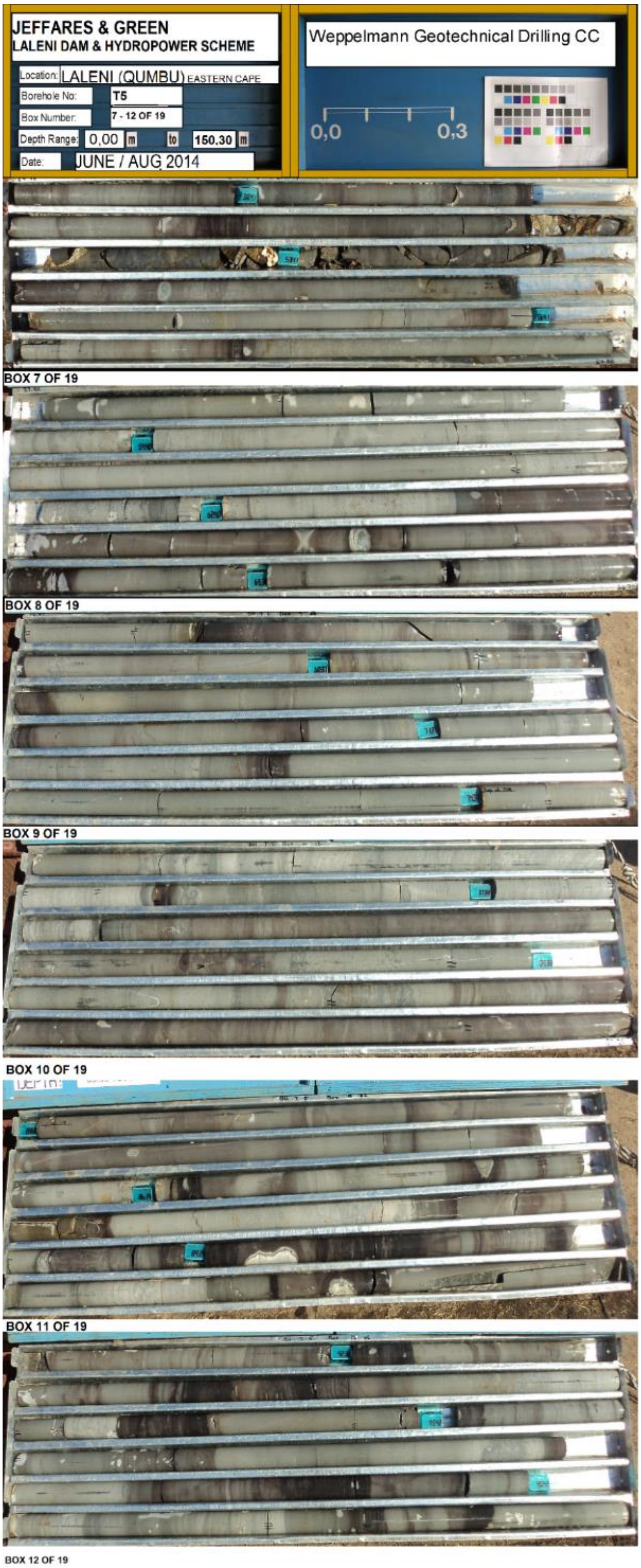
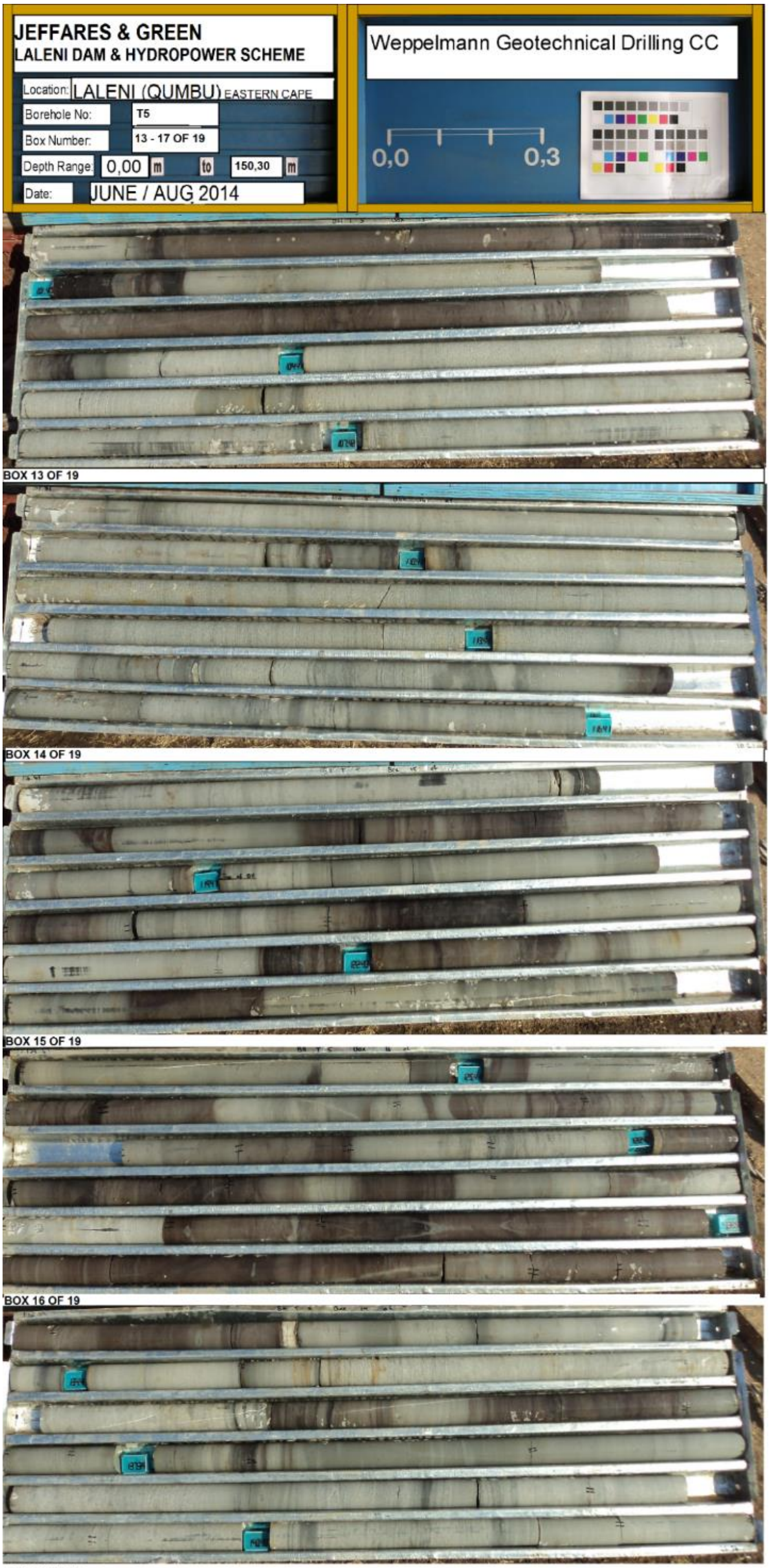


Fig D-11.2: **Borehole Tunnel 5 – Box 7 to 12**



JEFFARES & GREEN
LALENI DAM & HYDROPOWER SCHEME

Location: LALENI (QUMBU) EASTERN CAPE
Borehole No: T5
Box Number: 13 - 17 OF 19
Depth Range: 0,00 m to 150,30 m
Date: JUNE / AUG 2014

Fig D-11.3: Borehole Tunnel 5 – Box 13 to 17

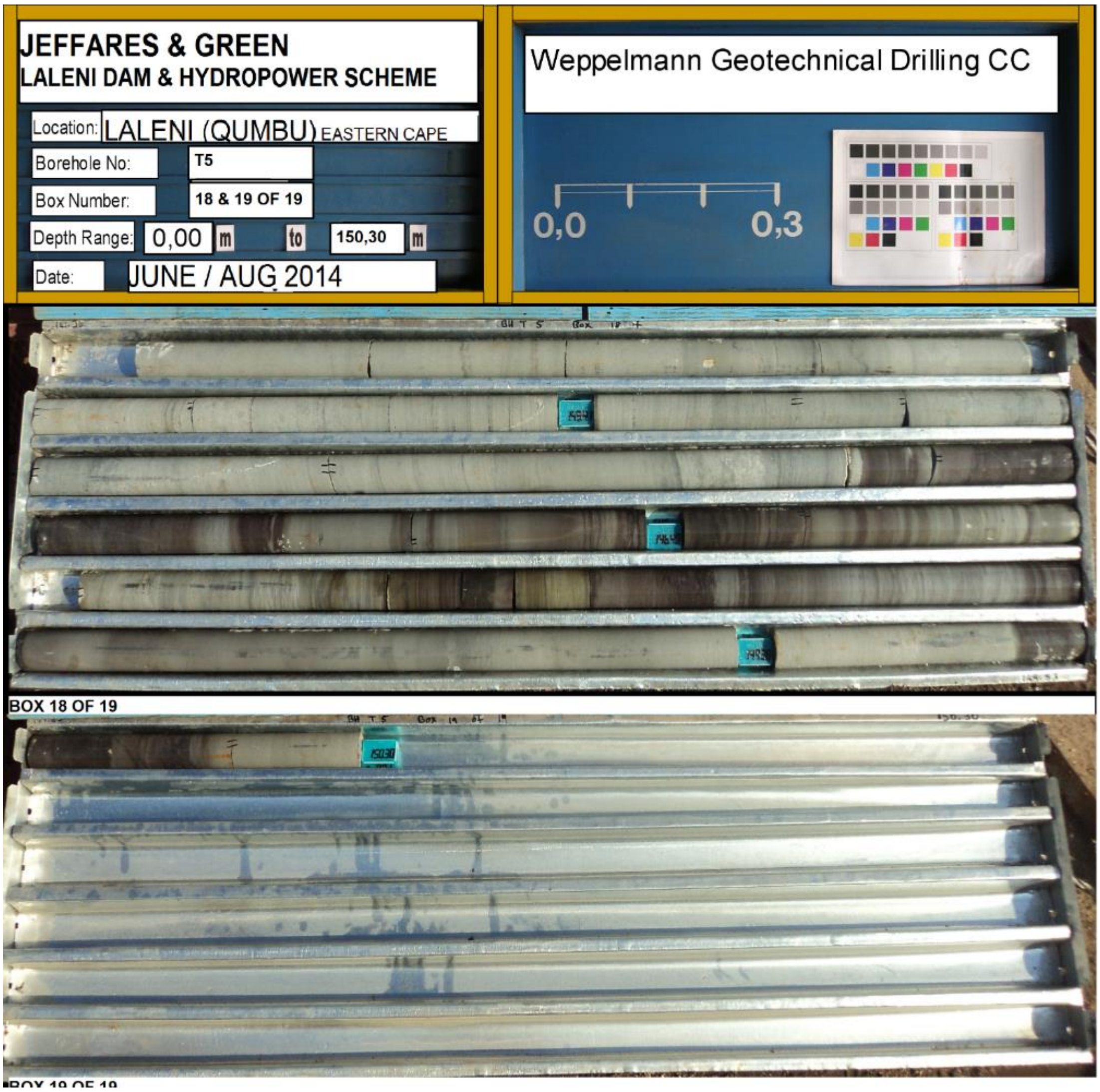
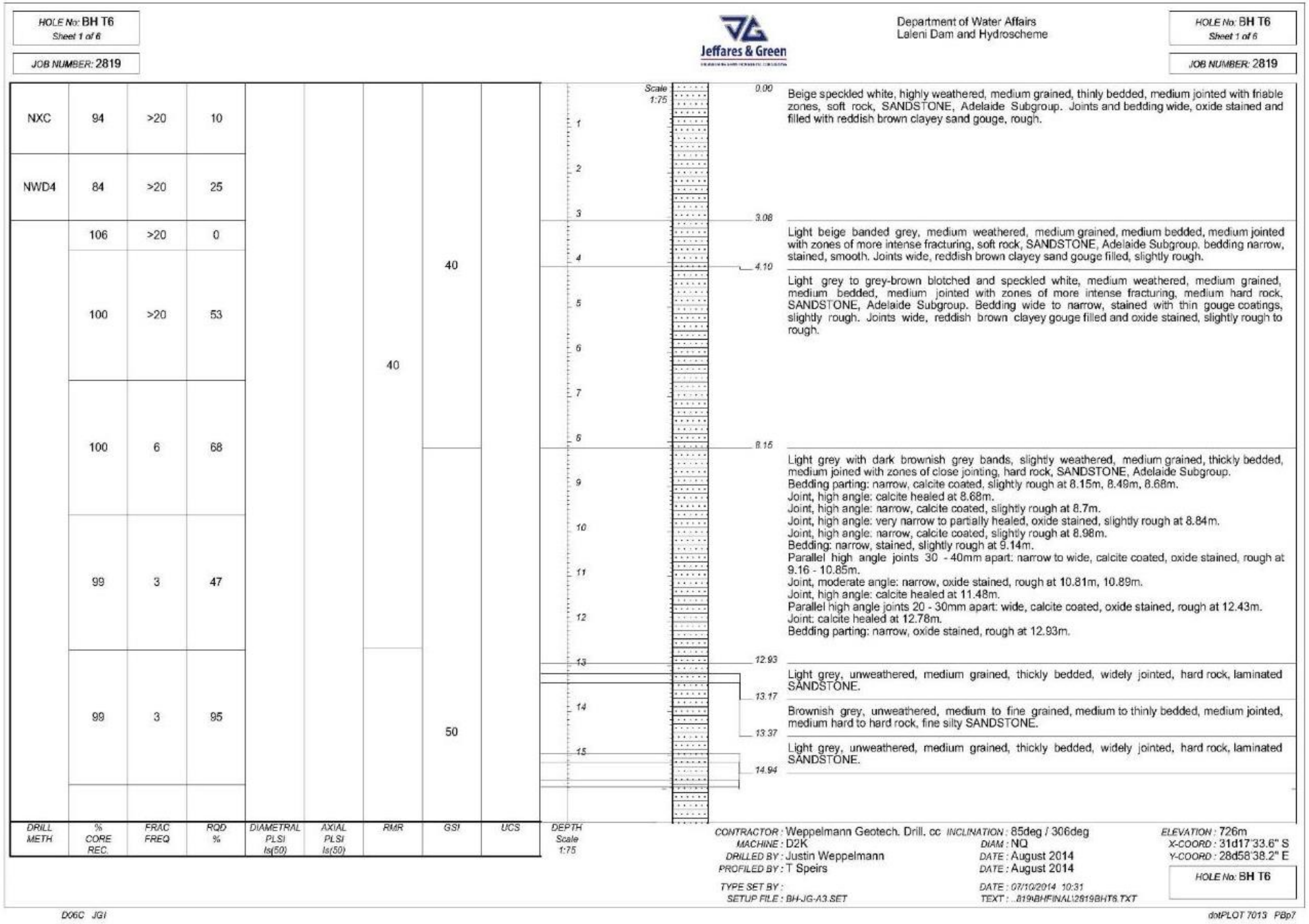


Fig D-11.4: Borehole Tunnel 5 – Box 18 to 19

Guage Pressure (Bars) A	Pressure due to Guage Height (Bars) B	Pressure due to water height above water table (Bars) C	Test Pressure (Bars) A+B+C	Duration (Seconds)	Injected Volume (l)	Top Level	Bottom Level	Length of hole	time in minutes	litres / metre /minute	Lugeon Units
WPT 17 – 150.3m											
1.55	0	0	1.55	600	103.9	17	150.3	133.3	10	0.0779	1
2.7	0	0	2.7	600	136.3	17	150.3	133.3	10	0.1023	0
3.85	0	0	3.85	600	142.4	17	150.3	133.3	10	0.1068	0
2.7	0	0	2.7	600	122.2	17	150.3	133.3	10	0.0917	0
1.33	0	0	1.33	600	110.4	17	150.3	133.3	10	0.0828	1
WPT 23 – 150.3m											
2.1	0	0	2.1	600	123.8	23	150.3	127.3	10	0.0973	0
3.65	0	0	3.65	600	181.6	23	150.3	127.3	10	0.1427	0
4	0	0	4	300	196.1	23	150.3	127.3	10	0.154	0
3.65	0	0	3.65	600	168	23	150.3	127.3	10	0.132	0
2.1	0	0	2.1	600	116.5	23	150.3	127.3	10	0.0915	0
WPT 37.5 – 150.3m											
3.4	0	0	3.4	600	141.6	37.5	150.3	112.8	10	0.1255	0
5	0	0	5	600	194	37.5	150.3	112.8	10	0.172	0
5	0	0	5	300	110	37.5	150.3	112.8	10	0.0975	0
	0	0	0			37.5	150.3	112.8	10	0	0
3.4	0	0	3.4	600	150.9	37.5	150.3	112.8	10	0.1338	0

Mzimvubu		Input Data	Depth from top of embankment to water table (m)	0
Borehole No	T5		Height of guage above top of embankment (m)	0

Table D-1: Water Pressure Tests – Borehole T5



HOLE No: BH T6
Sheet 1 of 6

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
NXC	94	>20	10			40	40	
NWD4	84	>20	25					
	106	>20	0					
	100	>20	53					
	100	6	68				50	
	99	3	47					
	99	3	95					

DEPTH Scale 1:75

0.00 Beige speckled white, highly weathered, medium grained, thinly bedded, medium jointed with friable zones, soft rock, SANDSTONE, Adelaide Subgroup. Joints and bedding wide, oxide stained and filled with reddish brown clayey sand gouge, rough.

3.06 Light beige banded grey, medium weathered, medium grained, medium bedded, medium jointed with zones of more intense fracturing, soft rock, SANDSTONE, Adelaide Subgroup. bedding narrow, stained, smooth. Joints wide, reddish brown clayey sand gouge filled, slightly rough.

4.10 Light grey to grey-brown blotched and speckled white, medium weathered, medium grained, medium bedded, medium jointed with zones of more intense fracturing, medium hard rock, SANDSTONE, Adelaide Subgroup. Bedding wide to narrow, stained with thin gouge coatings, slightly rough. Joints wide, reddish brown clayey gouge filled and oxide stained, slightly rough to rough.

8.15 Light grey with dark brownish grey bands, slightly weathered, medium grained, thickly bedded, medium joined with zones of close jointing, hard rock, SANDSTONE, Adelaide Subgroup.
Bedding parting: narrow, calcite coated, slightly rough at 8.15m, 8.49m, 8.68m.
Joint, high angle: calcite healed at 8.68m.
Joint, high angle: narrow, calcite coated, slightly rough at 8.7m.
Joint, high angle: very narrow to partially healed, oxide stained, slightly rough at 8.84m.
Joint, high angle: narrow, calcite coated, slightly rough at 8.98m.
Bedding: narrow, stained, slightly rough at 9.14m.
Parallel high angle joints 30 - 40mm apart: narrow to wide, calcite coated, oxide stained, rough at 9.16 - 10.85m.
Joint, moderate angle: narrow, oxide stained, rough at 10.81m, 10.89m.
Joint, high angle: calcite healed at 11.48m.
Parallel high angle joints 20 - 30mm apart: wide, calcite coated, oxide stained, rough at 12.43m.
Joint: calcite healed at 12.78m.
Bedding parting: narrow, oxide stained, rough at 12.93m.

12.93 Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.

13.17 Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.

13.37 Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.

14.94

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin Weppelmann
PROFILED BY : T Speirs
TYPE SET BY :
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg / 306deg
DIAM : NQ
DATE : August 2014
DATE : August 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT6.TXT

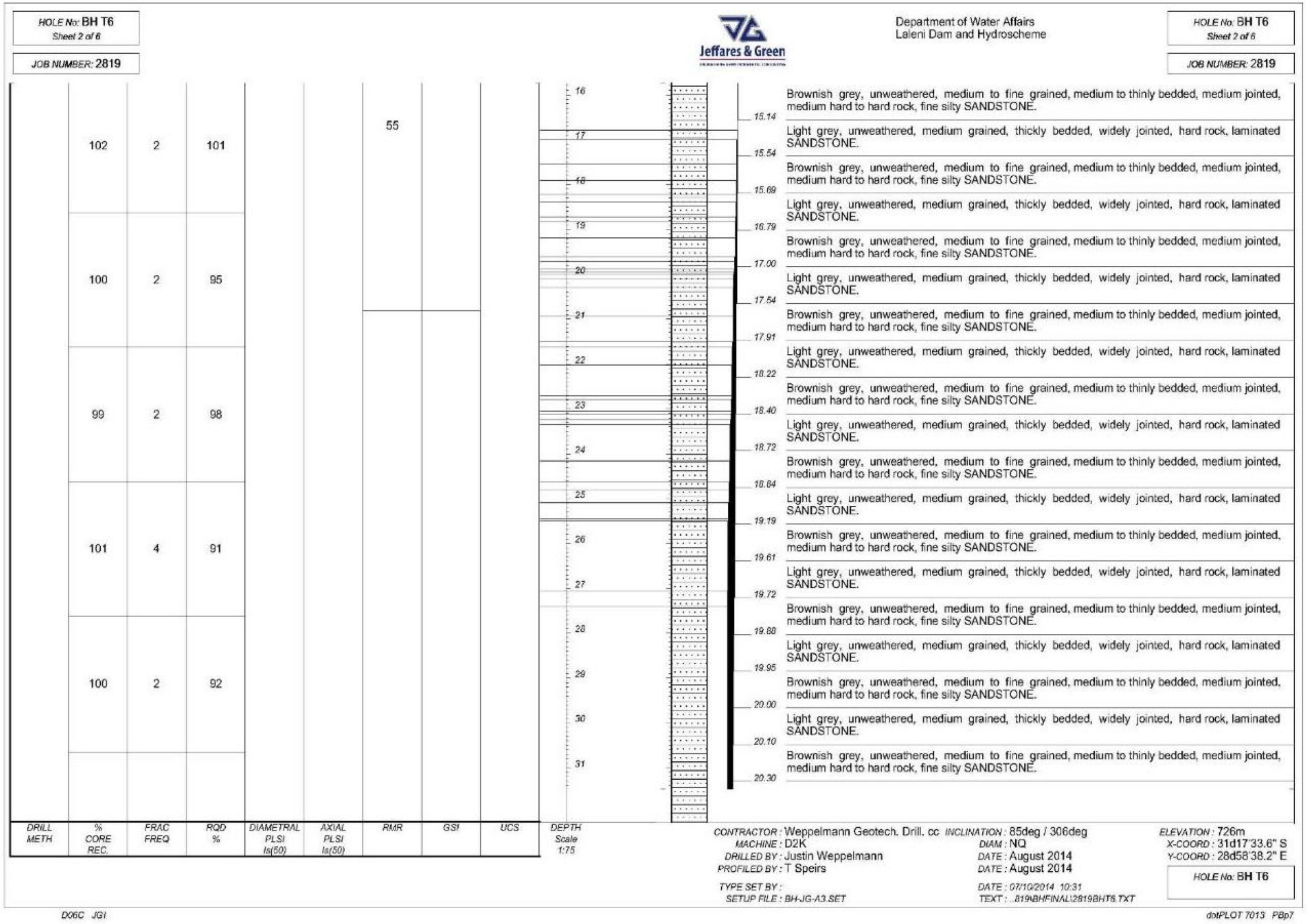
ELEVATION : 726m
X-COORD : 31d17'33.6" S
Y-COORD : 28d58'38.2" E

HOLE No: BH T6

D06C JGI

dotPLOT 7013 PBp7

Fig D-12.1: Borehole Tunnel 6 – Log



HOLE No: BH T6
Sheet 2 of 6

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T6
Sheet 2 of 6

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	102	2	101			55		
	100	2	95					
	99	2	98					
	101	4	91					
	100	2	92					

DEPTH Scale 1:75

15.14	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
15.54	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
15.69	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
16.79	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
17.00	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
17.54	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
17.91	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
18.22	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
18.40	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
18.72	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
18.84	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
19.19	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
19.61	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
19.72	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
19.88	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
19.95	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
20.00	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
20.10	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
20.30	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin Weppelmann
PROFILED BY : T Speirs
TYPE SET BY :
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg / 306deg
DIAM : NQ
DATE : August 2014
DATE : August 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT6.TXT

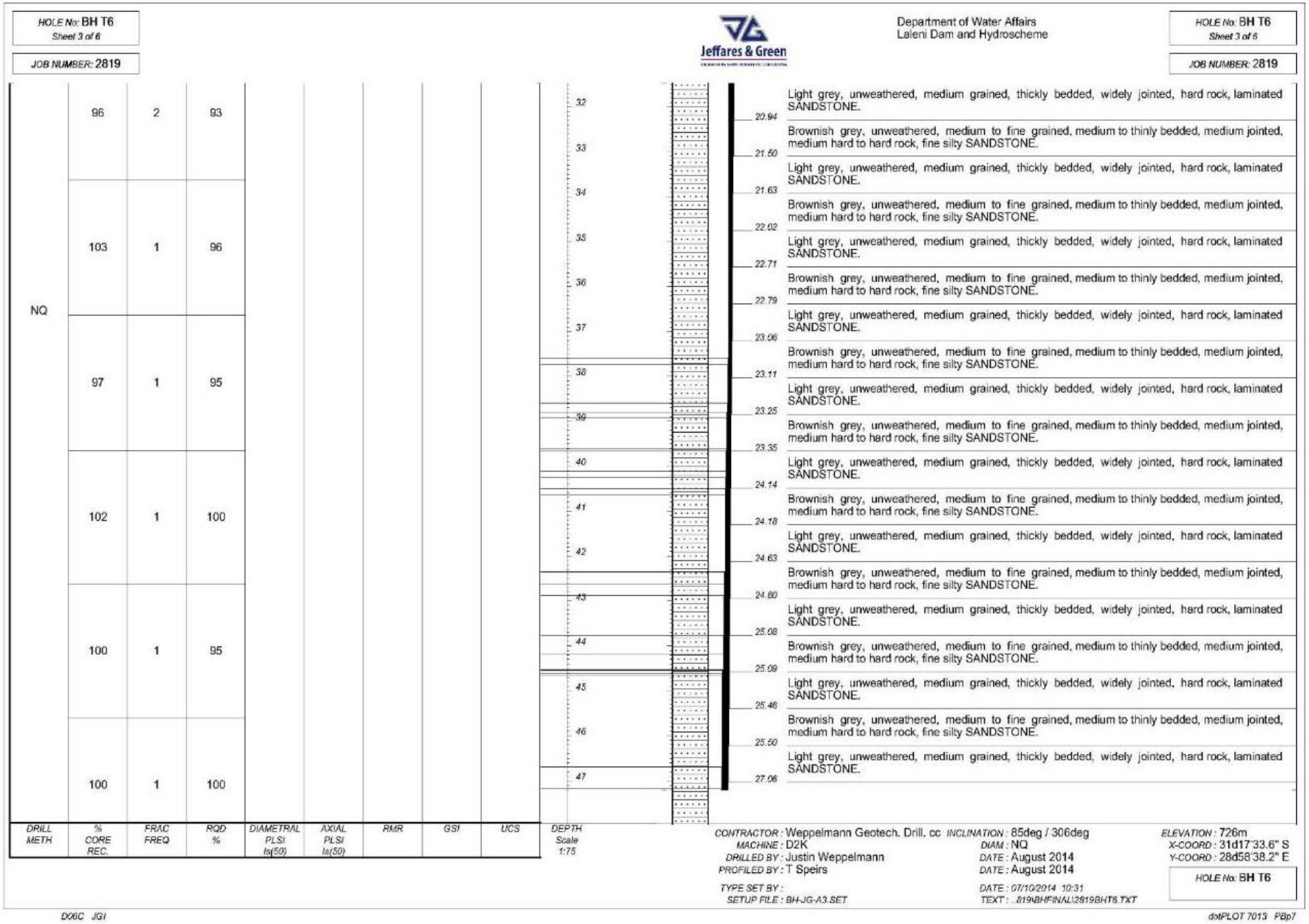
ELEVATION : 726m
X-COORD : 31d17'33.6" S
Y-COORD : 28d58'38.2" E

HOLE No: BH T6

D06C JGI

dotPLOT 7013 PBp7

Fig D-12.2: Borehole Tunnel 6 – Log



HOLE No: BH T6
Sheet 3 of 6

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T6
Sheet 3 of 6

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
NQ	96	2	93					
	103	1	96					
	97	1	95					
	102	1	100					
	100	1	95					
	100	1	100					

Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	20.94
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	21.50
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	21.63
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	22.02
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	22.71
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	22.79
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	23.06
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	23.11
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	23.25
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	23.35
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	24.14
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	24.18
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	24.63
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	24.80
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	25.08
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	25.09
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	25.46
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	25.50
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	27.06

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin Weppelmann
PROFILED BY : T Speirs
TYPE SET BY :
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg / 306deg
DIAM : NQ
DATE : August 2014
DATE : August 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT6.TXT

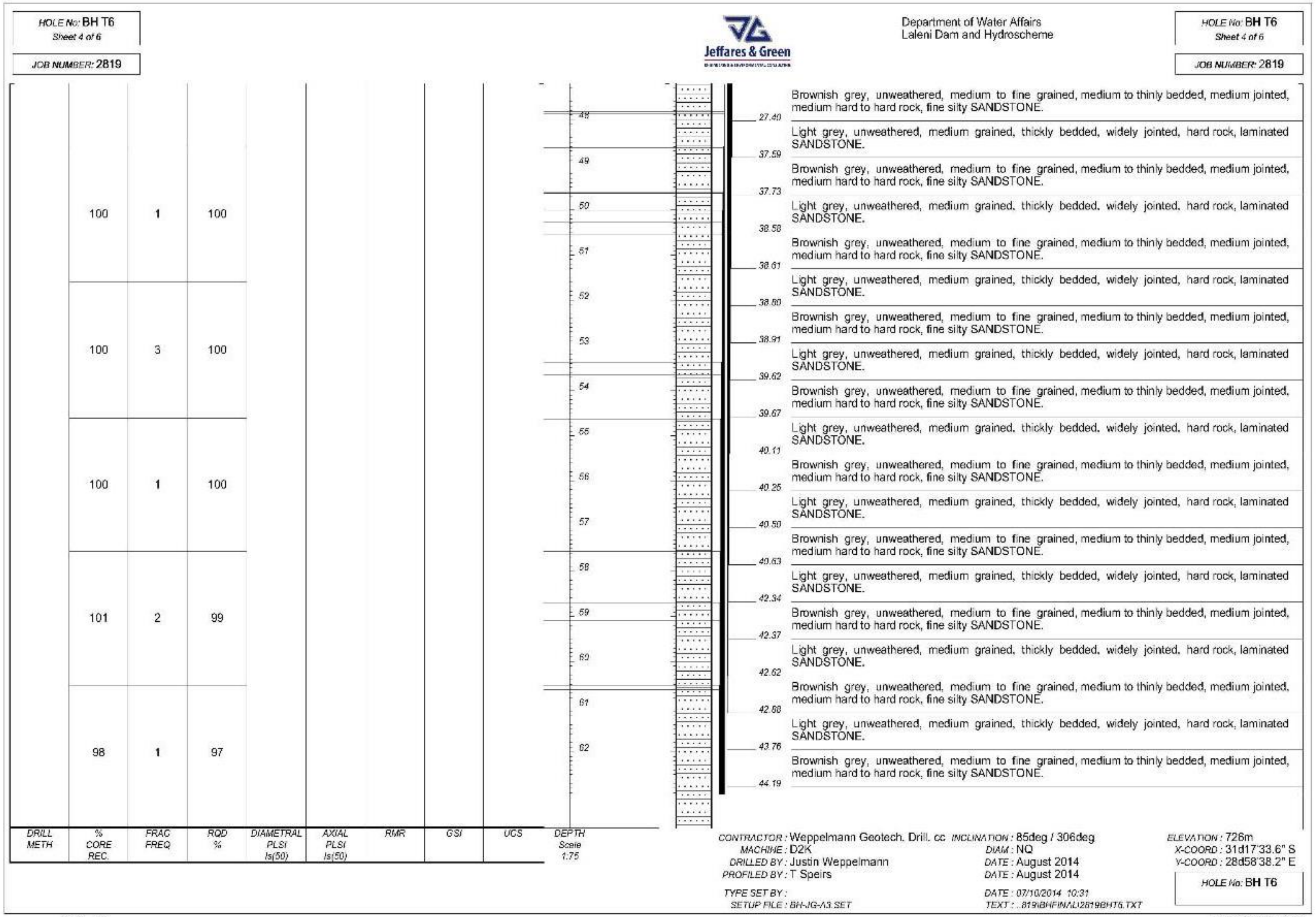
ELEVATION : 726m
X-COORD : 31d17'33.6" S
Y-COORD : 28d58'38.2" E

HOLE No: BH T6

D06C JGI

dotPLOT 7013 PBp7

Fig D-12.4: Borehole Tunnel 6 – Log



HOLE No: BH T6
Sheet 4 of 6

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS
	100	1	100					
	100	3	100					
	100	1	100					
	101	2	99					
	98	1	97					

DEPTH Scale 1:75

Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	27.40
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	37.59
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	37.73
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	38.58
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	38.61
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	38.80
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	38.91
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	39.62
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	39.67
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	40.11
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	40.25
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	40.50
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	40.63
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	42.34
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	42.37
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	42.62
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	42.88
Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.	43.76
Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.	44.19

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin Weppelmann
PROFILED BY : T Speirs
TYPE SET BY :
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg / 306deg
DIAM : NQ
DATE : August 2014
DATE : August 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT6.TXT

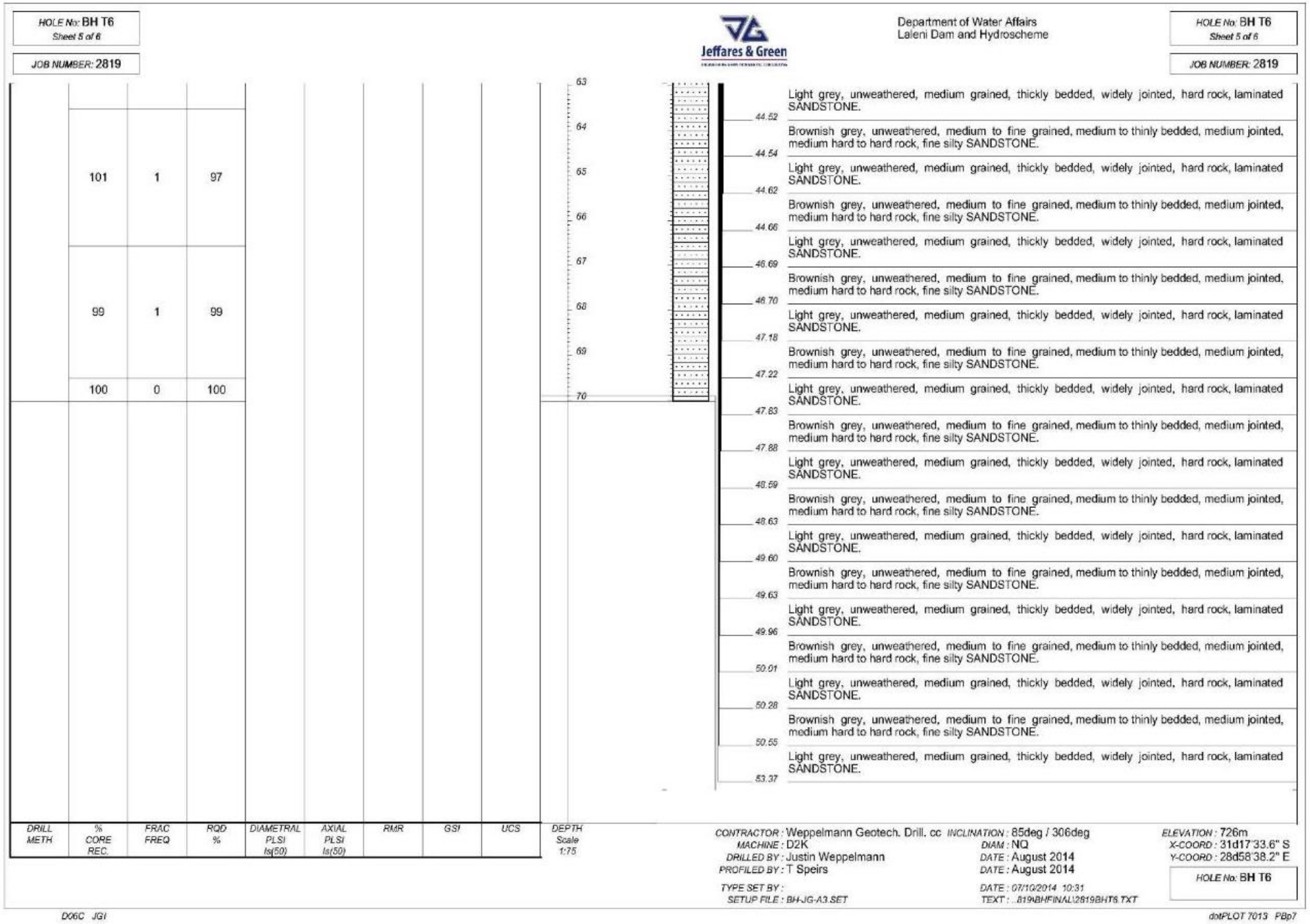
ELEVATION : 726m
X-COORD : 31d17'33.6" S
Y-COORD : 28d58'38.2" E

HOLE No: BH T6

D06C JGI

dotPLOT 7013 PBp7

Fig D-12.4: Borehole Tunnel 6 – Log



HOLE No: BH T6
Sheet 5 of 6

JOB NUMBER: 2819

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T6
Sheet 5 of 6

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS	DEPTH Scale 1:75
	101	1	97						
	99	1	99						
	100	0	100						

	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
44.52	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
44.54	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
44.62	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
44.66	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
46.69	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
46.70	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
47.18	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
47.22	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
47.83	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
47.88	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
48.59	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
48.63	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
49.60	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
49.63	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
49.96	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
50.01	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
50.28	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
50.55	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
53.37	

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin Weppelmann
PROFILED BY : T Speirs
TYPE SET BY :
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg / 306deg
DIAM : NQ
DATE : August 2014
DATE : August 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT6.TXT

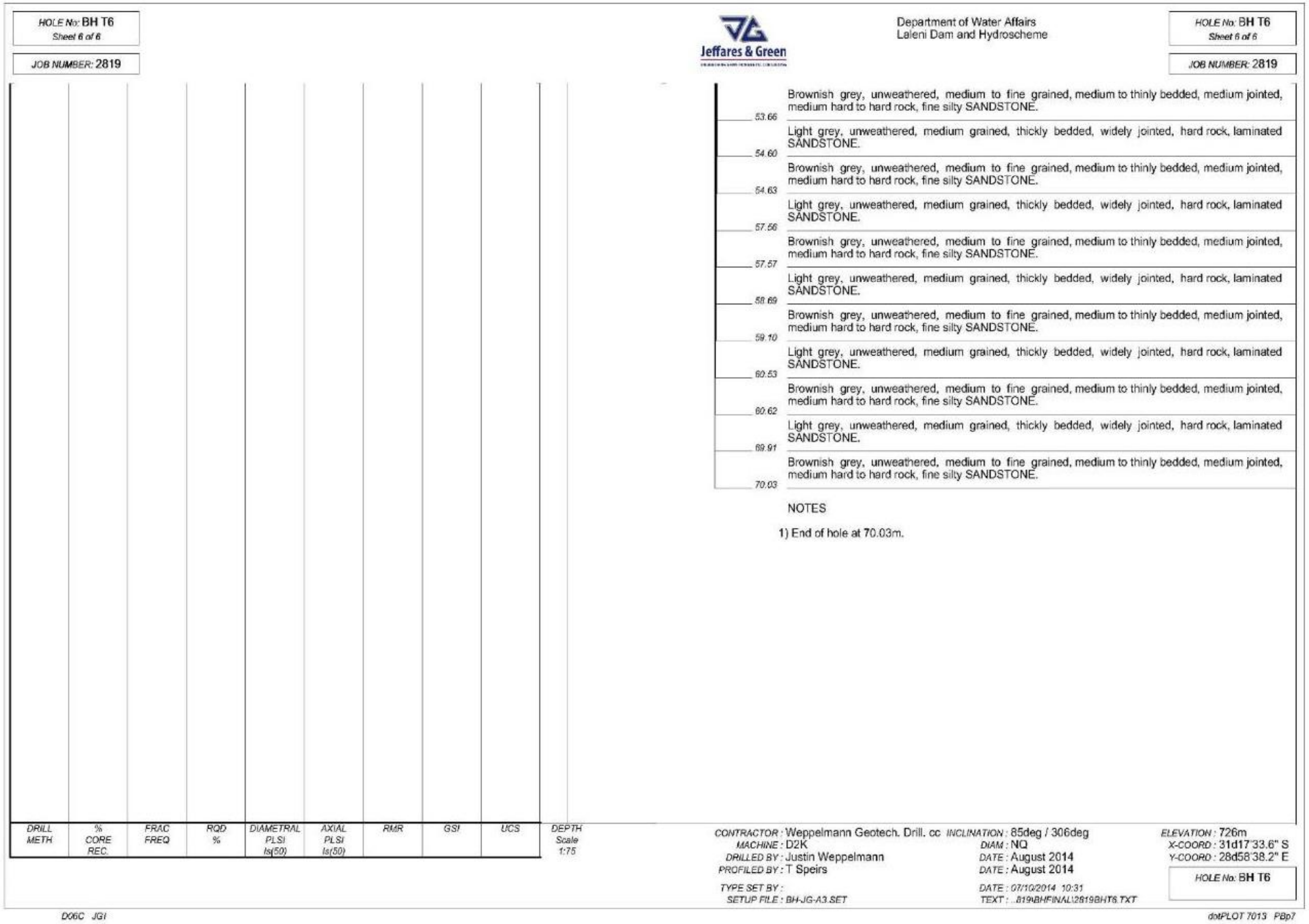
ELEVATION : 726m
X-COORD : 31d17'33.6" S
Y-COORD : 28d58'38.2" E

HOLE No: BH T6

D06C JGI

dotPLOT 7013 PBp7

Fig D-12.5: **Borehole Tunnel 6 – Log**



HOLE No: **BH T6**
Sheet 6 of 6

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: **BH T6**
Sheet 6 of 6

JOB NUMBER: 2819

Depth	Description
53.66	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
54.60	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
54.63	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
57.56	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
57.57	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
58.69	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
59.10	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
60.53	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
60.62	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.
69.91	Light grey, unweathered, medium grained, thickly bedded, widely jointed, hard rock, laminated SANDSTONE.
70.03	Brownish grey, unweathered, medium to fine grained, medium to thinly bedded, medium jointed, medium hard to hard rock, fine silty SANDSTONE.

NOTES

1) End of hole at 70.03m.

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	DIAMETRAL PLSI Is(50)	AXIAL PLSI Is(50)	RMR	GSI	UCS	DEPTH Scale 1:75

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D2K
DRILLED BY : Justin Weppelmann
PROFILED BY : T Speirs
TYPE SET BY :
SETUP FILE : BH-JG-A3.SET

INCLINATION : 85deg / 306deg
DIAM : NQ
DATE : August 2014
DATE : August 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT6.TXT

ELEVATION : 726m
X-COORD : 31d17'33.6" S
Y-COORD : 28d58'38.2" E

HOLE No: **BH T6**

D06C JGI

dotPLOT 7013 PBp7

Fig D-12.6: Borehole Tunnel 6 – Log

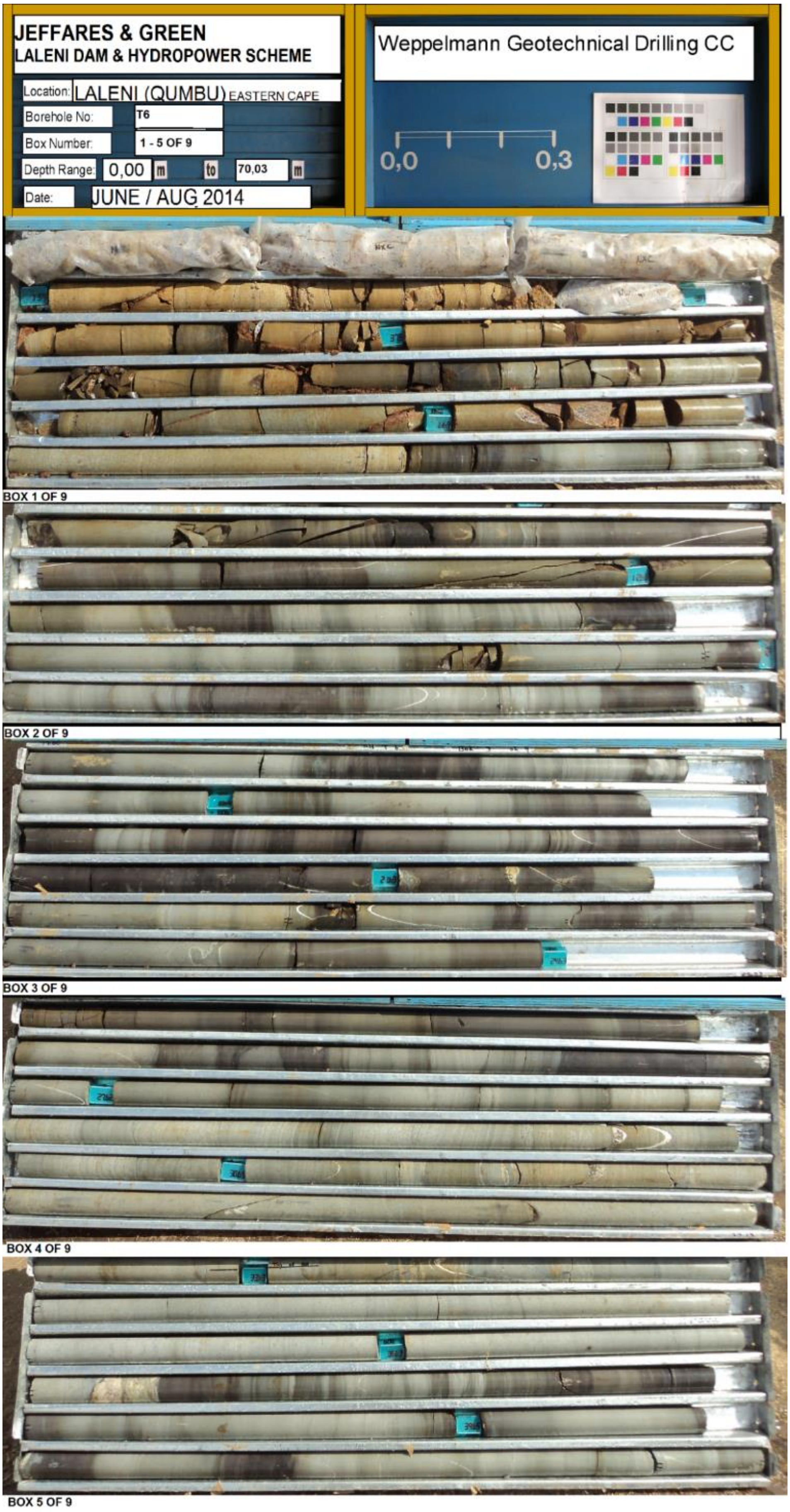


Fig D-13.1: **Borehole Tunnel 6 – Box 1 to 5**

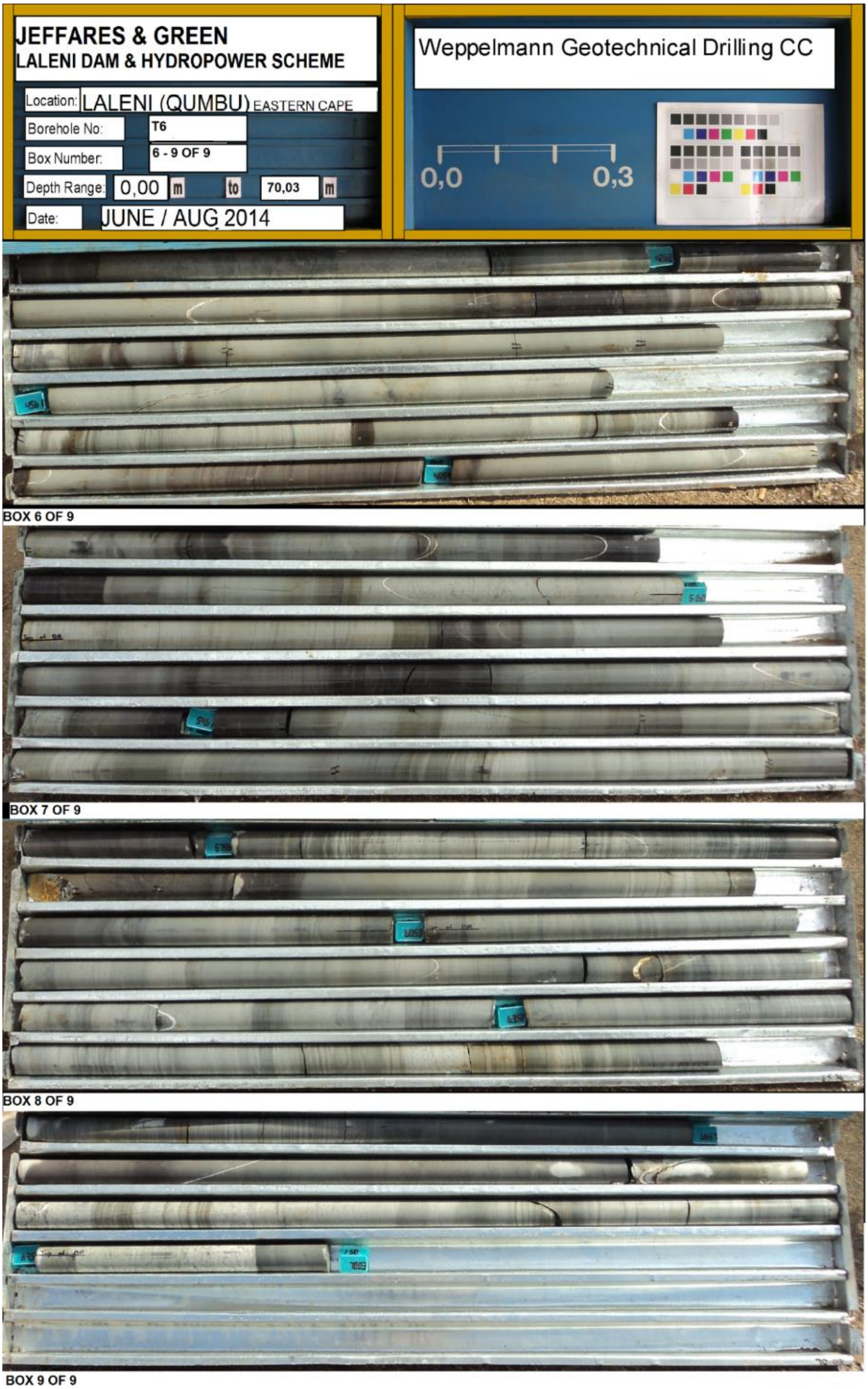
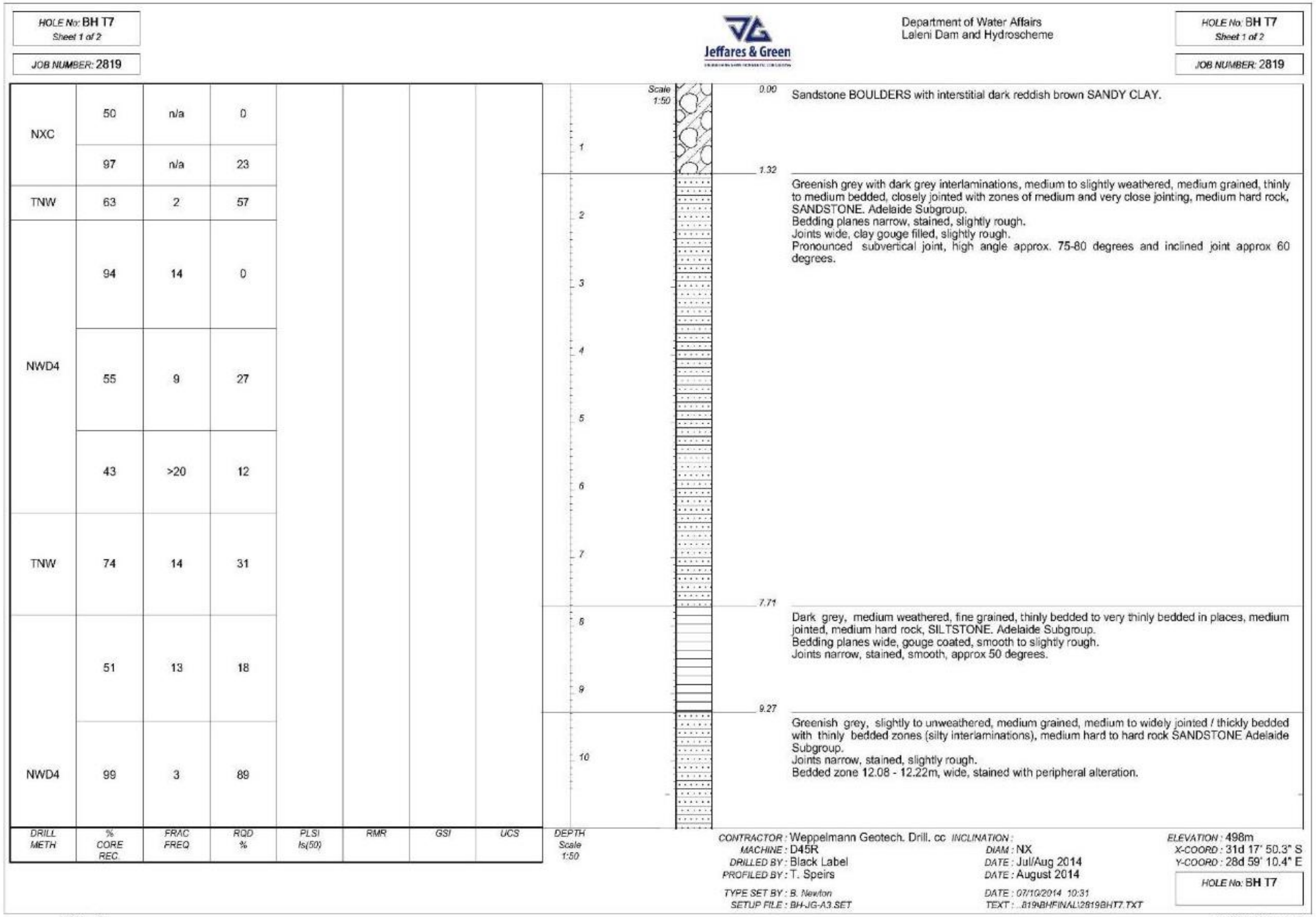


Fig D-13.2: Borehole Tunnel 6 – Box 6 to 9



HOLE No: BH T7
Sheet 1 of 2

JOB NUMBER: 2819

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Laleni Dam and Hydroscheme

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	PLSI Is(50)	RMR	GSI	UCS
NXC	50	n/a	0				
	97	n/a	23				
TNW	63	2	57				
NWD4	94	14	0				
	55	9	27				
	43	>20	12				
TNW	74	14	31				
NWD4	51	13	18				
	99	3	89				

DEPTH Scale 1:50

0.00	Sandstone BOULDERS with interstitial dark reddish brown SANDY CLAY.
1.32	Greenish grey with dark grey interlaminations, medium to slightly weathered, medium grained, thinly to medium bedded, closely jointed with zones of medium and very close jointing, medium hard rock, SANDSTONE. Adelaide Subgroup. Bedding planes narrow, stained, slightly rough. Joints wide, clay gouge filled, slightly rough. Pronounced subvertical joint, high angle approx. 75-80 degrees and inclined joint approx 60 degrees.
7.71	Dark grey, medium weathered, fine grained, thinly bedded to very thinly bedded in places, medium jointed, medium hard rock, SILTSTONE. Adelaide Subgroup. Bedding planes wide, gouge coated, smooth to slightly rough. Joints narrow, stained, smooth, approx 50 degrees.
9.27	Greenish grey, slightly to unweathered, medium grained, medium to widely jointed / thickly bedded with thinly bedded zones (silty interlaminations), medium hard to hard rock SANDSTONE Adelaide Subgroup. Joints narrow, stained, slightly rough. Bedded zone 12.08 - 12.22m, wide, stained with peripheral alteration.

CONTRACTOR : Weppelmann Geotech. Drill. cc
MACHINE : D45R
DRILLED BY : Black Label
PROFILED BY : T. Speirs
TYPE SET BY : B. Newton
SETUP FILE : BH-JG-A3.SET

INCLINATION :
DIAM : NX
DATE : Jul/Aug 2014
DATE : August 2014
DATE : 07/10/2014 10:31
TEXT : ..819\BHFINAL\2819BHT7.TXT

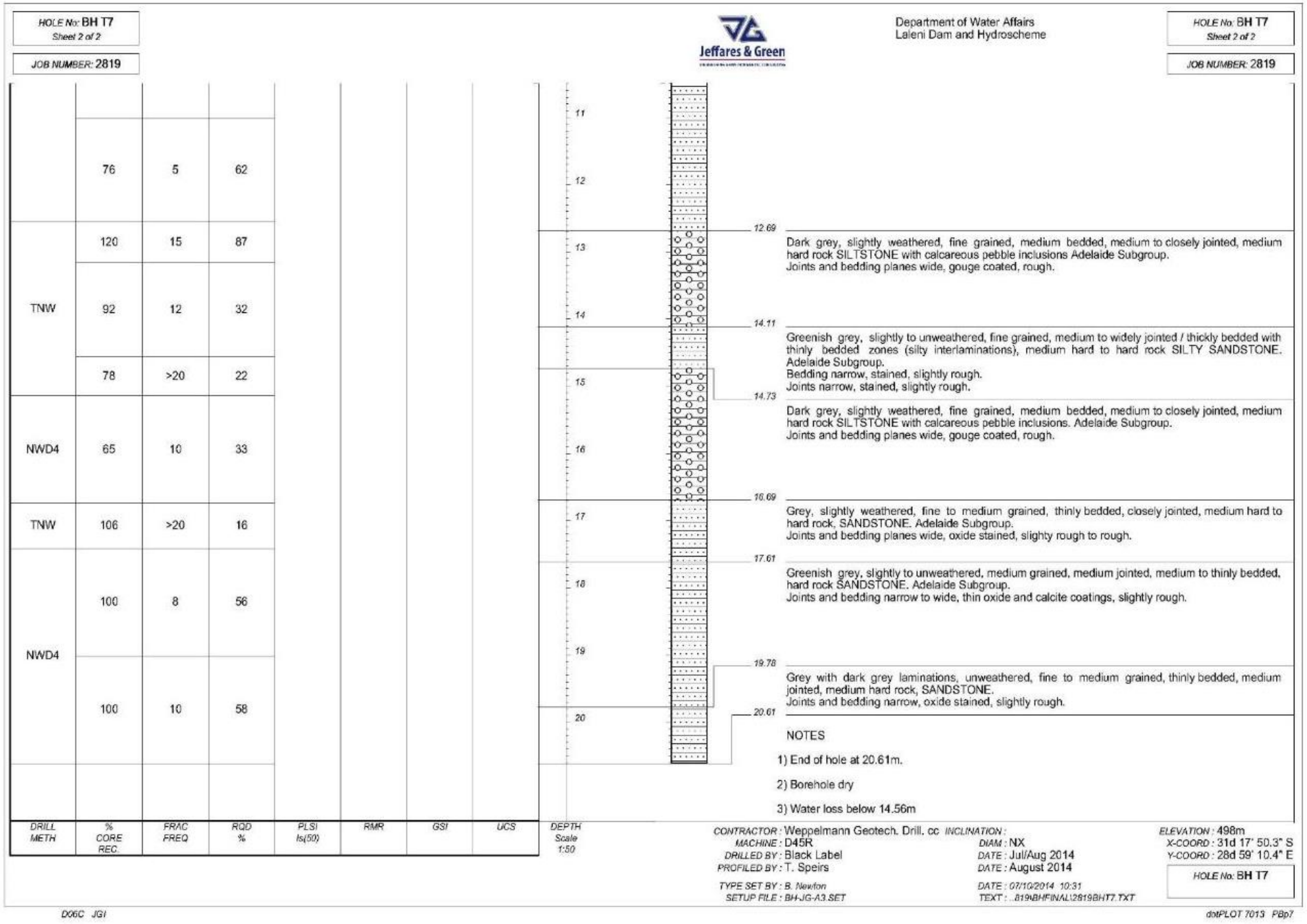
ELEVATION : 498m
X-COORD : 31d 17' 50.3" S
Y-COORD : 28d 59' 10.4" E

HOLE No: BH T7

D06C JGI

dotPLOT 7013 PBp7

Fig D-14.1: Borehole Tunnel 7 – Log



HOLE No: BH T7
Sheet 2 of 2

JOB NUMBER: 2819

Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydroscheme

HOLE No: BH T7
Sheet 2 of 2

JOB NUMBER: 2819

DRILL METH	% CORE REC.	FRAC FREQ	RQD %	PLSI Is(50)	RMR	GSI	UCS
	76	5	62				
TNW	120	15	87				
	92	12	32				
	78	>20	22				
NWD4	65	10	33				
TNW	106	>20	16				
NWD4	100	8	56				
	100	10	58				

DEPTH Scale 1:50

12.69 Dark grey, slightly weathered, fine grained, medium bedded, medium to closely jointed, medium hard rock SILTSTONE with calcareous pebble inclusions Adelaide Subgroup.
Joints and bedding planes wide, gouge coated, rough.

14.11 Greenish grey, slightly to unweathered, fine grained, medium to widely jointed / thickly bedded with thinly bedded zones (silty interlaminations), medium hard to hard rock SILTY SANDSTONE. Adelaide Subgroup.
Bedding narrow, stained, slightly rough.
Joints narrow, stained, slightly rough.

14.73 Dark grey, slightly weathered, fine grained, medium bedded, medium to closely jointed, medium hard rock SILTSTONE with calcareous pebble inclusions. Adelaide Subgroup.
Joints and bedding planes wide, gouge coated, rough.

16.69 Grey, slightly weathered, fine to medium grained, thinly bedded, closely jointed, medium hard to hard rock, SANDSTONE. Adelaide Subgroup.
Joints and bedding planes wide, oxide stained, slighty rough to rough.

17.61 Greenish grey, slightly to unweathered, medium grained, medium jointed, medium to thinly bedded, hard rock SANDSTONE. Adelaide Subgroup.
Joints and bedding narrow to wide, thin oxide and calcite coatings, slightly rough.

19.78 Grey with dark grey laminations, unweathered, fine to medium grained, thinly bedded, medium jointed, medium hard rock, SANDSTONE.
Joints and bedding narrow, oxide stained, slightly rough.

20.61

NOTES

1) End of hole at 20.61m.

2) Borehole dry

3) Water loss below 14.56m

CONTRACTOR : Weppelmann Geotech. Drill. cc
INCLINATION :
MACHINE : D45R
DIAM : NX
DRILLED BY : Black Label
DATE : Jul/Aug 2014
PROFILED BY : T. Speirs
DATE : August 2014
TYPE SET BY : B. Newton
DATE : 07/10/2014 10:31
SETUP FILE : BH-JG-A3.SET
TEXT : ..819\BHFINAL\2819BHT7.TXT

ELEVATION : 498m
X-COORD : 31d 17' 50.3" S
Y-COORD : 28d 59' 10.4" E

HOLE No: BH T7

D06C JGI

dotPLOT 7013 PBp7

Fig D-14.2: Borehole Tunnel 7 – Log

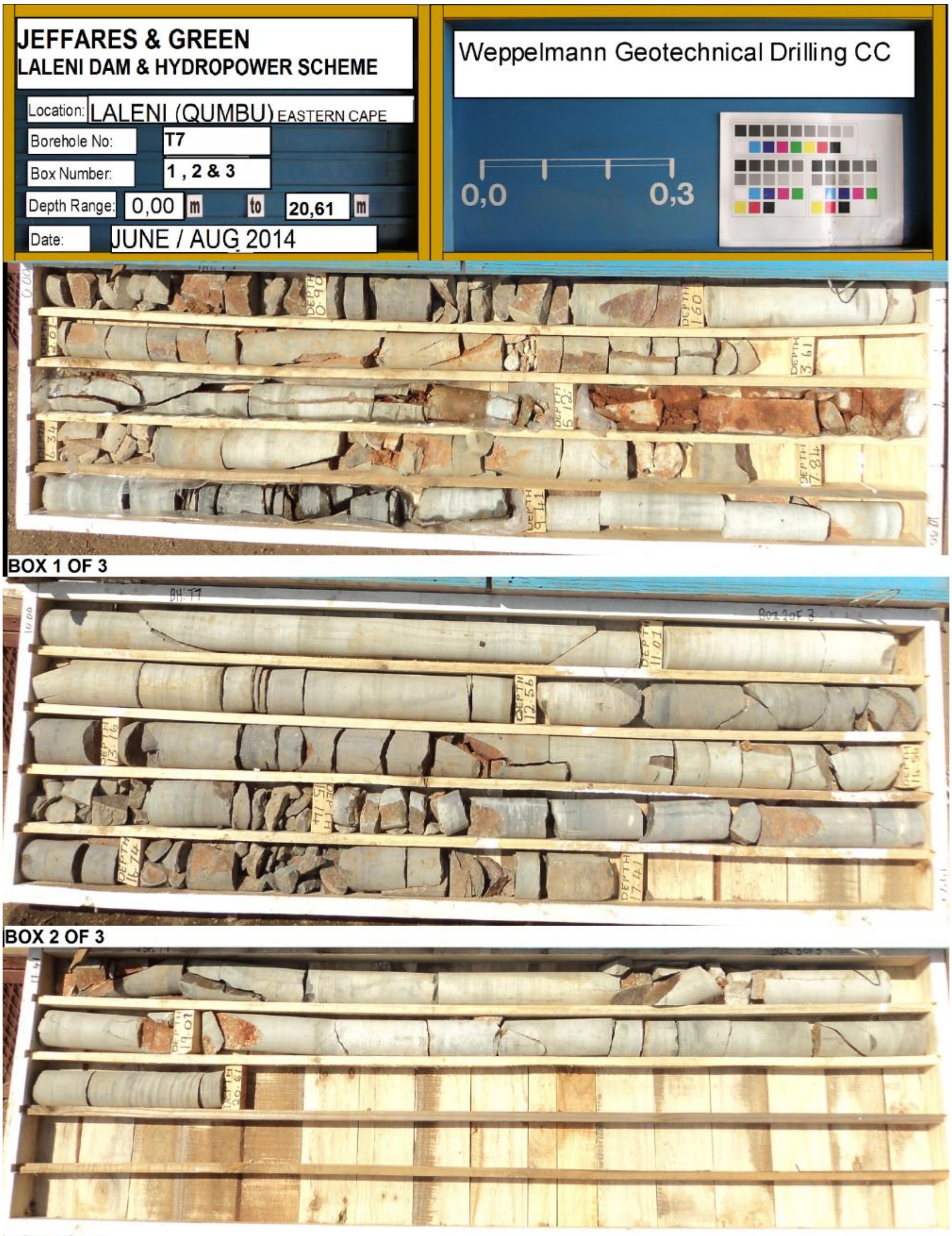


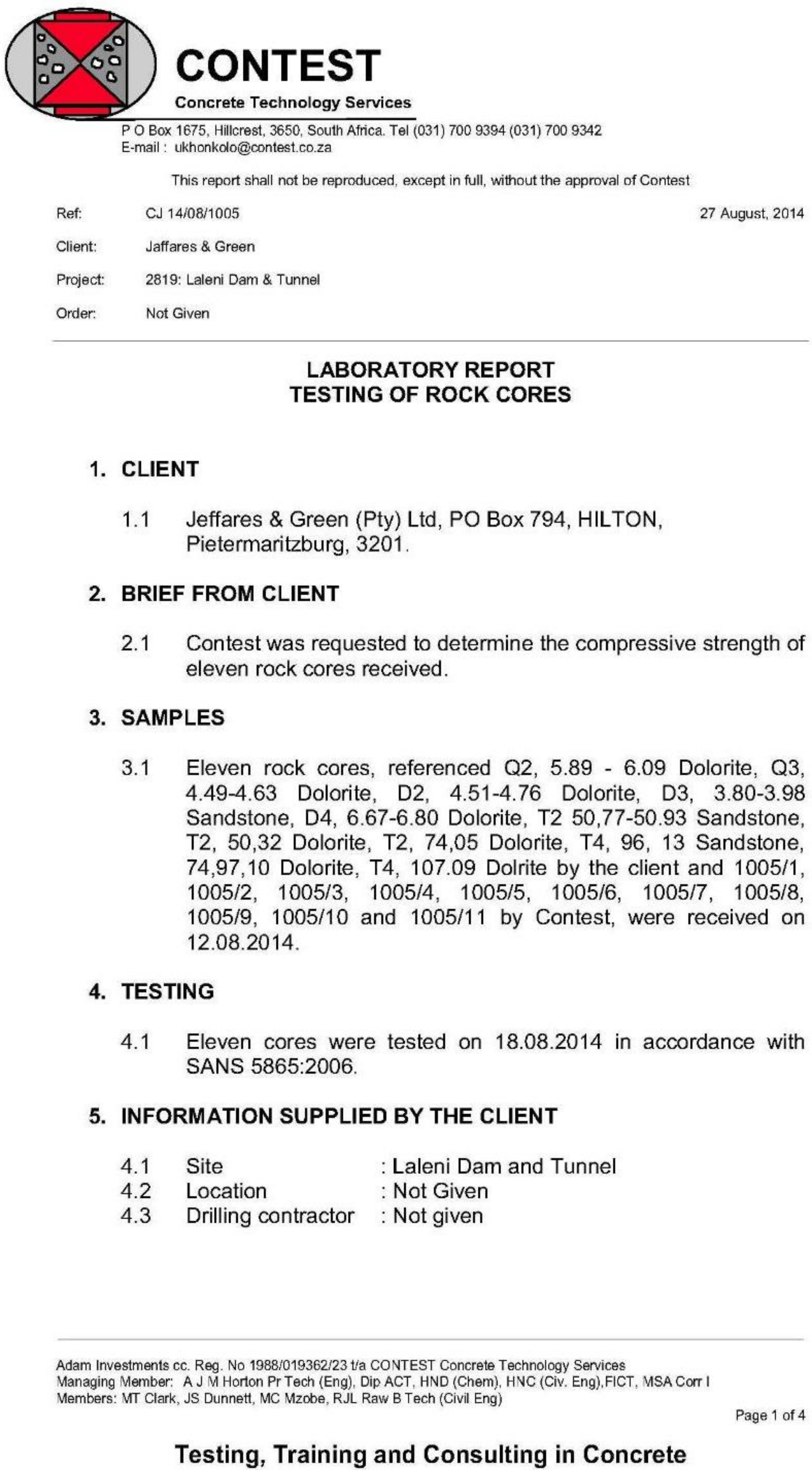
Fig D-14: **Borehole Tunnel 6 – Box 1 to 3**

APPENDIX E

LABORATORY TEST RESULTS

E1:

UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS



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: CJ 14/08/1005 27 August, 2014
Client: Jaffares & Green
Project: 2819: Laleni Dam & Tunnel
Order: Not Given

LABORATORY REPORT
TESTING OF ROCK CORES

1. CLIENT

1.1 Jeffares & Green (Pty) Ltd, PO Box 794, HILTON, Pietermaritzburg, 3201.

2. BRIEF FROM CLIENT

2.1 Contest was requested to determine the compressive strength of eleven rock cores received.

3. SAMPLES

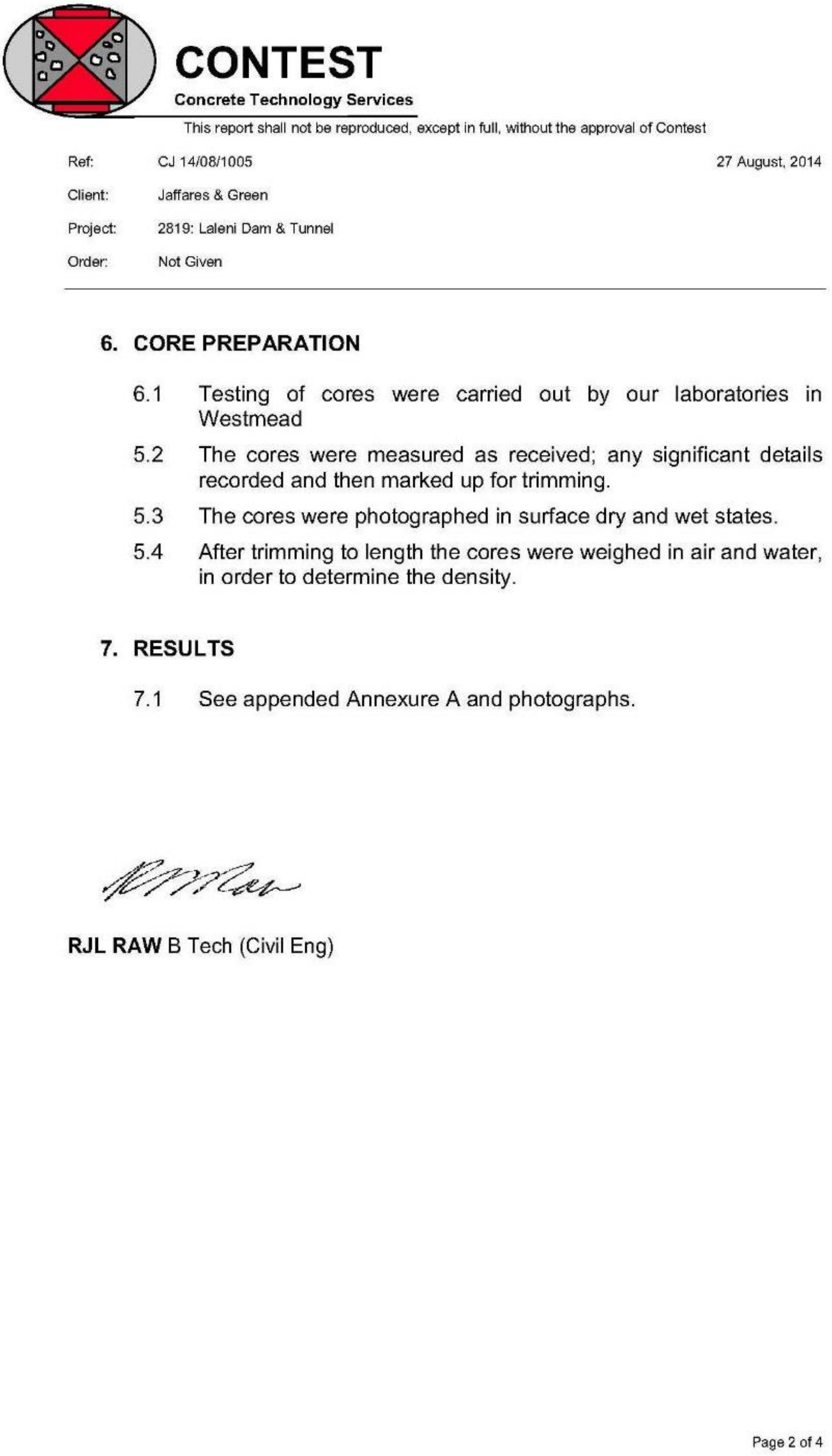
3.1 Eleven rock cores, referenced Q2, 5.89 - 6.09 Dolorite, Q3, 4.49-4.63 Dolorite, D2, 4.51-4.76 Dolorite, D3, 3.80-3.98 Sandstone, D4, 6.67-6.80 Dolorite, T2 50,77-50.93 Sandstone, T2, 50,32 Dolorite, T2, 74,05 Dolorite, T4, 96, 13 Sandstone, 74,97,10 Dolorite, T4, 107.09 Dolrite by the client and 1005/1, 1005/2, 1005/3, 1005/4, 1005/5, 1005/6, 1005/7, 1005/8, 1005/9, 1005/10 and 1005/11 by Contest, were received on 12.08.2014.

4. TESTING

4.1 Eleven cores were tested on 18.08.2014 in accordance with SANS 5865:2006.

5. INFORMATION SUPPLIED BY THE CLIENT

4.1 Site : Laleni Dam and Tunnel
4.2 Location : Not Given
4.3 Drilling contractor : Not given



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Ref: CJ 14/08/1005 — 27 August, 2014
Client: Jaffares & Green
Project: 2819: Laleni Dam & Tunnel
Order: Not Given

6. CORE PREPARATION

6.1 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.

7. RESULTS

7.1 See appended Annexure A and photographs.

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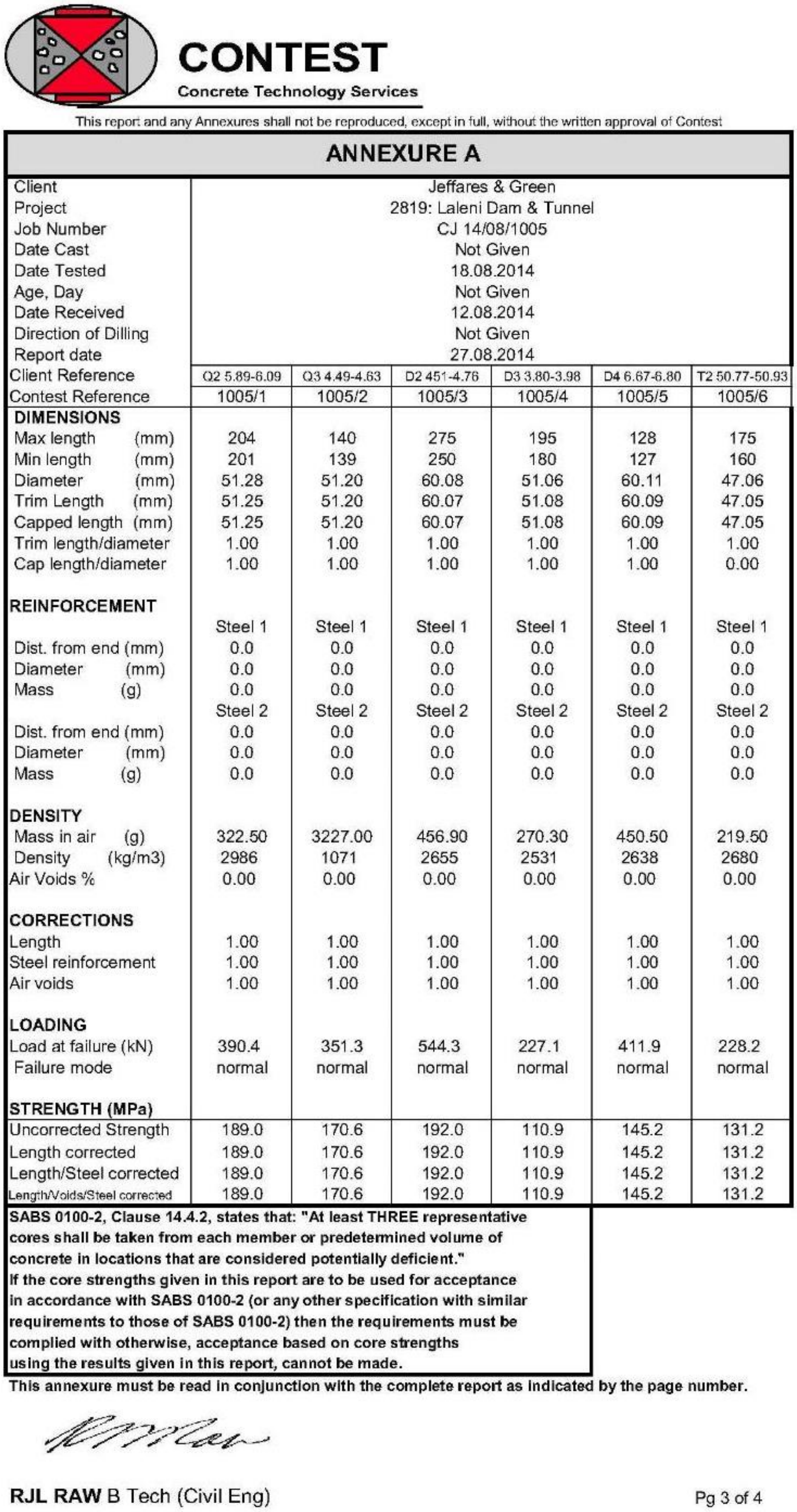

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ANNEXURE A

Client	Jeffares & Green					
Project	2819: Laleni Dam & Tunnel					
Job Number	CJ 14/08/1005					
Date Cast	Not Given					
Date Tested	18.08.2014					
Age, Day	Not Given					
Date Received	12.08.2014					
Direction of Dilling	Not Given					
Report date	27.08.2014					
Client Reference	Q2 5.89-6.09	Q3 4.49-4.63	D2 451-4.76	D3 3.80-3.98	D4 6.67-6.80	T2 50.77-50.93
Contest Reference	1005/1	1005/2	1005/3	1005/4	1005/5	1005/6
DIMENSIONS						
Max length (mm)	204	140	275	195	128	175
Min length (mm)	201	139	250	180	127	160
Diameter (mm)	51.28	51.20	60.08	51.06	60.11	47.06
Trim Length (mm)	51.25	51.20	60.07	51.08	60.09	47.05
Capped length (mm)	51.25	51.20	60.07	51.08	60.09	47.05
Trim length/diameter	1.00	1.00	1.00	1.00	1.00	1.00
Cap length/diameter	1.00	1.00	1.00	1.00	1.00	0.00
REINFORCEMENT						
	Steel 1	Steel 1	Steel 1	Steel 1	Steel 1	Steel 1
Dist. from end (mm)	0.0	0.0	0.0	0.0	0.0	0.0
Diameter (mm)	0.0	0.0	0.0	0.0	0.0	0.0
Mass (g)	0.0	0.0	0.0	0.0	0.0	0.0
	Steel 2	Steel 2	Steel 2	Steel 2	Steel 2	Steel 2
Dist. from end (mm)	0.0	0.0	0.0	0.0	0.0	0.0
Diameter (mm)	0.0	0.0	0.0	0.0	0.0	0.0
Mass (g)	0.0	0.0	0.0	0.0	0.0	0.0
DENSITY						
Mass in air (g)	322.50	3227.00	456.90	270.30	450.50	219.50
Density (kg/m3)	2986	1071	2655	2531	2638	2680
Air Voids %	0.00	0.00	0.00	0.00	0.00	0.00
CORRECTIONS						
Length	1.00	1.00	1.00	1.00	1.00	1.00
Steel reinforcement	1.00	1.00	1.00	1.00	1.00	1.00
Air voids	1.00	1.00	1.00	1.00	1.00	1.00
LOADING						
Load at failure (kN)	390.4	351.3	544.3	227.1	411.9	228.2
Failure mode	normal	normal	normal	normal	normal	normal
STRENGTH (MPa)						
Uncorrected Strength	189.0	170.6	192.0	110.9	145.2	131.2
Length corrected	189.0	170.6	192.0	110.9	145.2	131.2
Length/Steel corrected	189.0	170.6	192.0	110.9	145.2	131.2
Length/Voids/Steel corrected	189.0	170.6	192.0	110.9	145.2	131.2

SABS 0100-2, Clause 14.4.2, states that: "At least THREE representative cores shall be taken from each member or predetermined volume of concrete in locations that are considered potentially deficient." If the core strengths given in this report are to be used for acceptance in accordance with SABS 0100-2 (or any other specification with similar requirements to those of SABS 0100-2) then the requirements must be complied with otherwise, acceptance based on core strengths using the results given in this report, cannot be made.

This annexure must be read in conjunction with the complete report as indicated by the page number.

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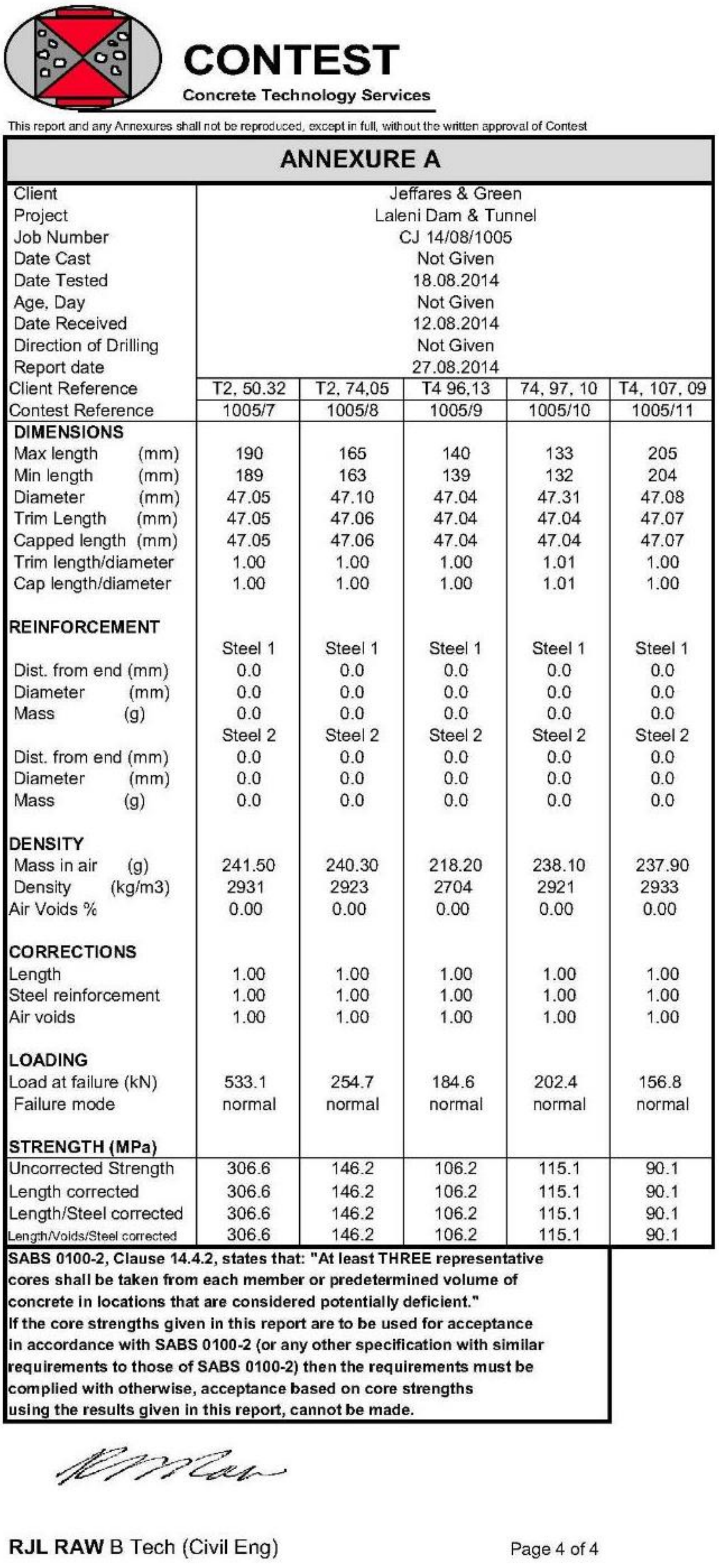
Pg 3 of 4



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ANNEXURE A

Client	Jeffares & Green
Project	Laleni Dam & Tunnel
Job Number	CJ 14/08/1005
Date Cast	Not Given
Date Tested	18.08.2014
Age, Day	Not Given
Date Received	12.08.2014
Direction of Drilling	Not Given
Report date	27.08.2014

Client Reference	T2, 50.32	T2, 74,05	T4 96,13	74, 97, 10	T4, 107, 09
Contest Reference	1005/7	1005/8	1005/9	1005/10	1005/11
DIMENSIONS					
Max length (mm)	190	165	140	133	205
Min length (mm)	189	163	139	132	204
Diameter (mm)	47.05	47.10	47.04	47.31	47.08
Trim Length (mm)	47.05	47.06	47.04	47.04	47.07
Capped length (mm)	47.05	47.06	47.04	47.04	47.07
Trim length/diameter	1.00	1.00	1.00	1.01	1.00
Cap length/diameter	1.00	1.00	1.00	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)	241.50	240.30	218.20	238.10	237.90
Density (kg/m3)	2931	2923	2704	2921	2933
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)	533.1	254.7	184.6	202.4	156.8
Failure mode	normal	normal	normal	normal	normal
STRENGTH (MPa)					
Uncorrected Strength	306.6	146.2	106.2	115.1	90.1
Length corrected	306.6	146.2	106.2	115.1	90.1
Length/Steel corrected	306.6	146.2	106.2	115.1	90.1
Length/Voids/Steel corrected	306.6	146.2	106.2	115.1	90.1

SABS 0100-2, Clause 14.4.2, states that: "At least THREE representative cores shall be taken from each member or predetermined volume of concrete in locations that are considered potentially deficient."
If the core strengths given in this report are to be used for acceptance in accordance with SABS 0100-2 (or any other specification with similar requirements to those of SABS 0100-2) then the requirements must be complied with otherwise, acceptance based on core strengths using the results given in this report, cannot be made.

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Page 4 of 4


5.89
Q2
Q2, 5.89
1005/1
Q2, 5.89
1005/1
6.09
240
220
200
180
160
140
120
100
80
60
40
20


Q2, 5.89
1005/1
Q2, 5.89
1005/1
6.09
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200
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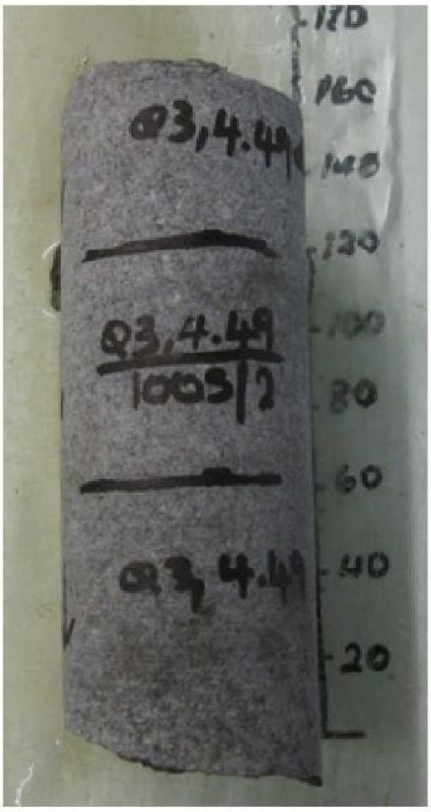
100
80
60
40
20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140
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80
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40
20


Q3, 4.49
Q3, 4.49
1005/2
Q3, 4.49
160
140
120
100
80
60
40
20


D2.4.51
1088/3
D2.4.51
1085/3
D2.4.51
1088/3
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20


320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20


3.98
D3,3E
1005
D3 3.80
1088/4
D3
3.80
220
200
180
160
140
120
100
80
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20


D3 3.80
1088/4
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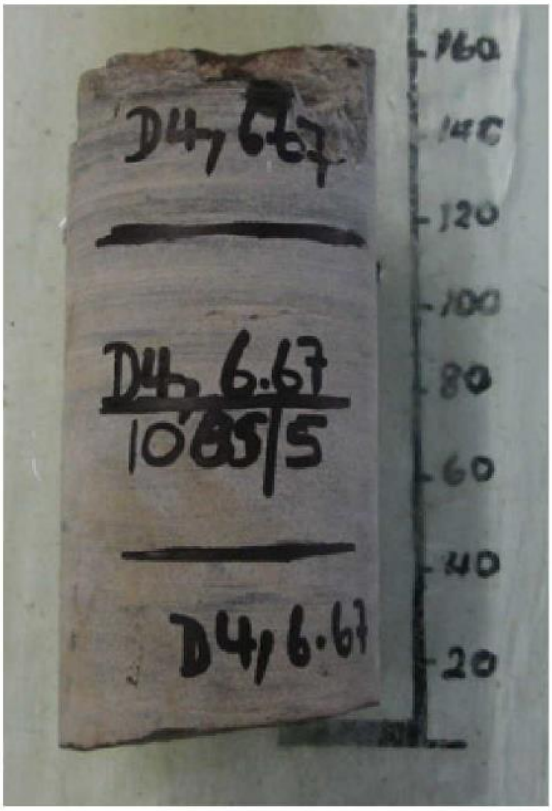
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60
40
20


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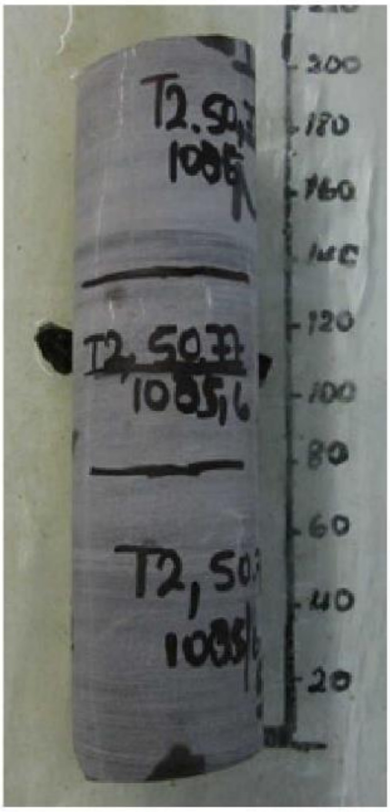
D4, 6.67
1085/5
D4, 6.67
160
140
120
100
80
60
40
20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100
80
60
40
20


T2, 50.77
1085
T2, 50.77
1085, 6
T2, 50
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100
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60
40
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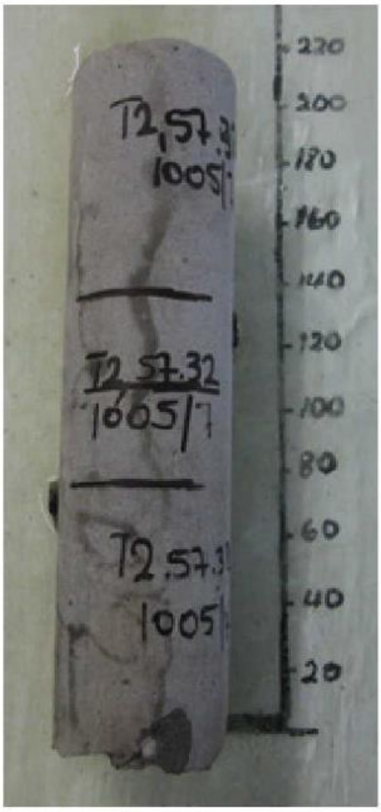
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T2 57.32
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40
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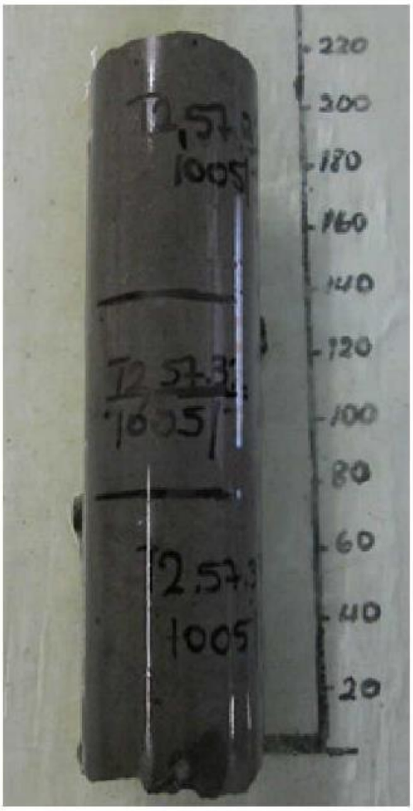
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T2 57.32
1005/
T2.57.3
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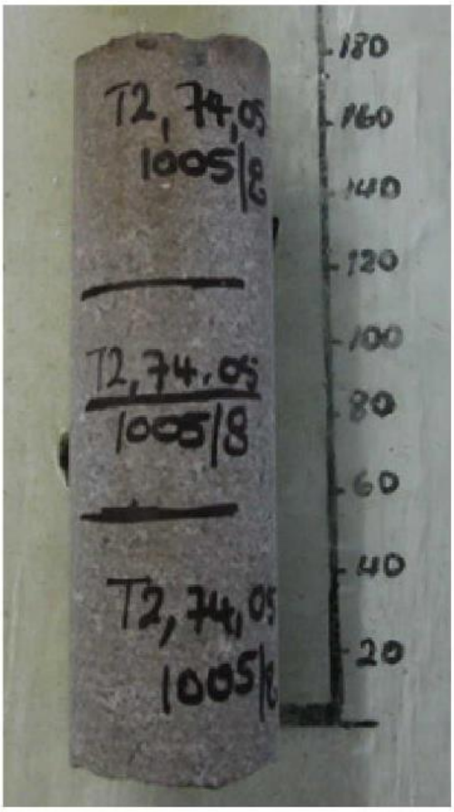
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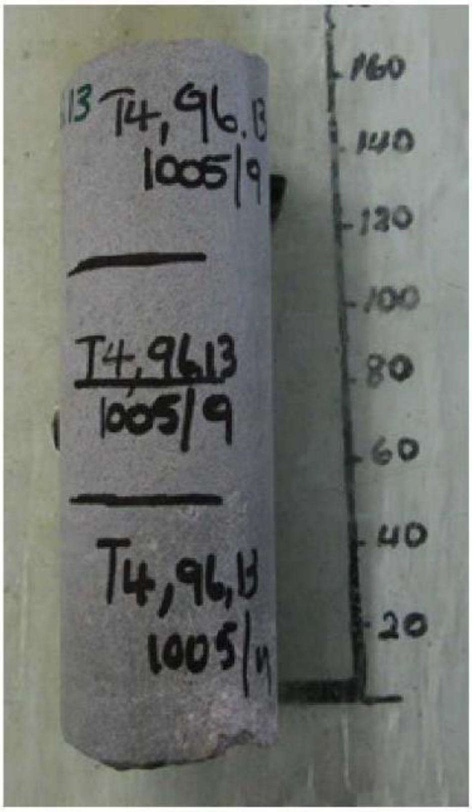
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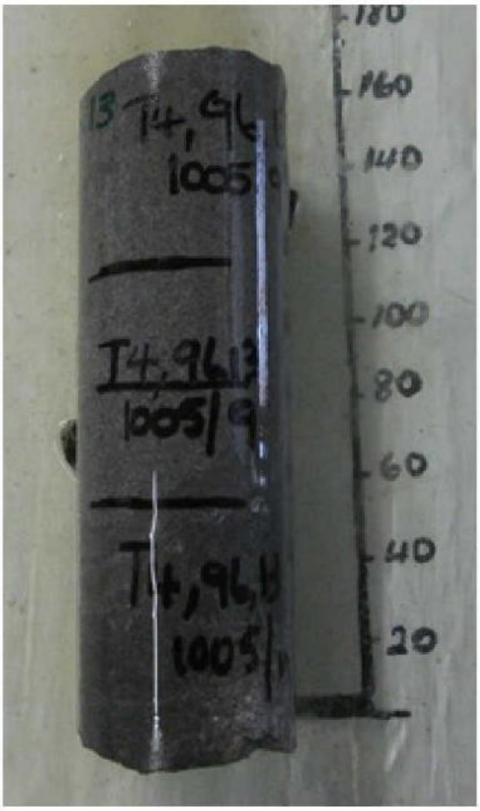
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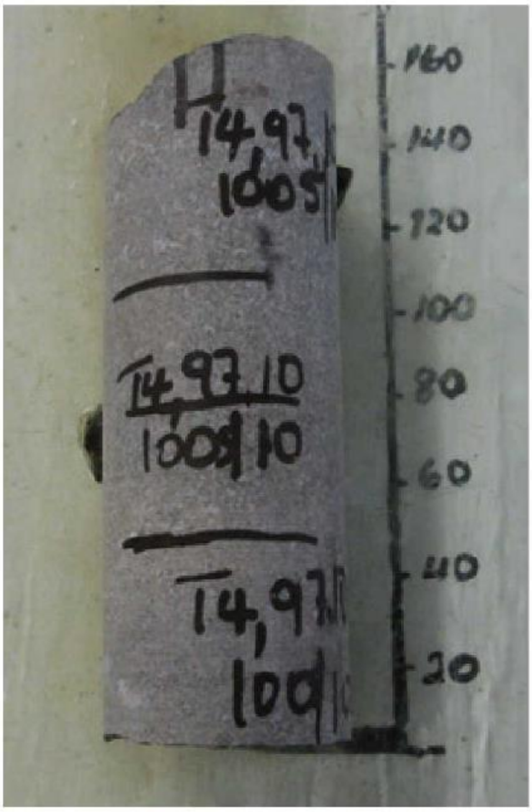
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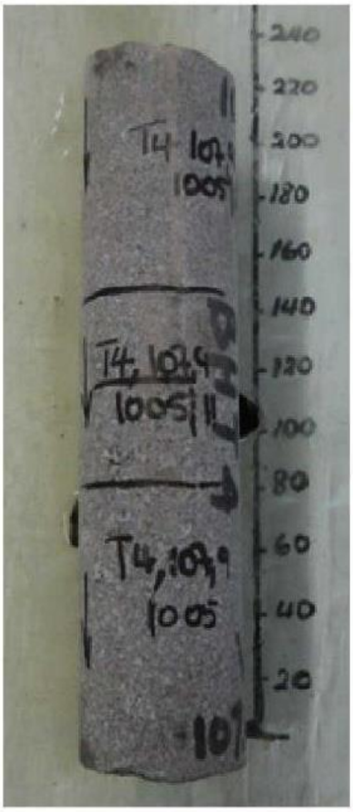
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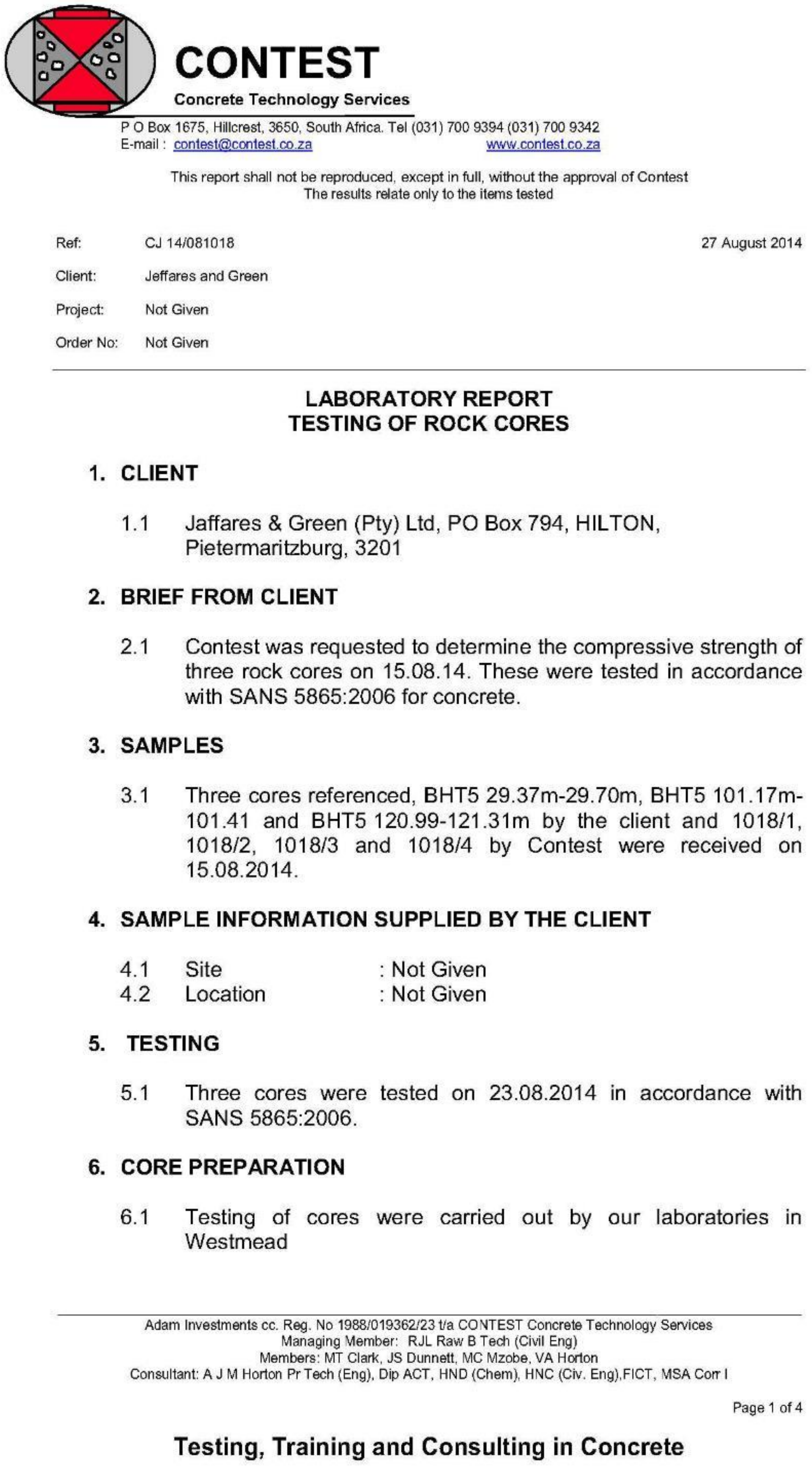


CONTEST
Concrete Technology Services
P O Box 1675, Hillcrest, 3650, South Africa. Tel (031) 700 9394 (031) 700 9342
E-mail : contest@contest.co.za www.contest.co.za

Ref: CJ 14/081018 27 August 2014
Client: Jeffares and Green
Project: Not Given
Order No: Not Given

LABORATORY REPORT
TESTING OF ROCK CORES

1. CLIENT

1.1 Jaffares & Green (Pty) Ltd, PO Box 794, HILTON, Pietermaritzburg, 3201

2. BRIEF FROM CLIENT

2.1 Contest was requested to determine the compressive strength of three rock cores on 15.08.14. These were tested in accordance with SANS 5865:2006 for concrete.

3. SAMPLES

3.1 Three cores referenced, BHT5 29.37m-29.70m, BHT5 101.17m-101.41 and BHT5 120.99-121.31m by the client and 1018/1, 1018/2, 1018/3 and 1018/4 by Contest were received on 15.08.2014.

4. SAMPLE INFORMATION SUPPLIED BY THE CLIENT

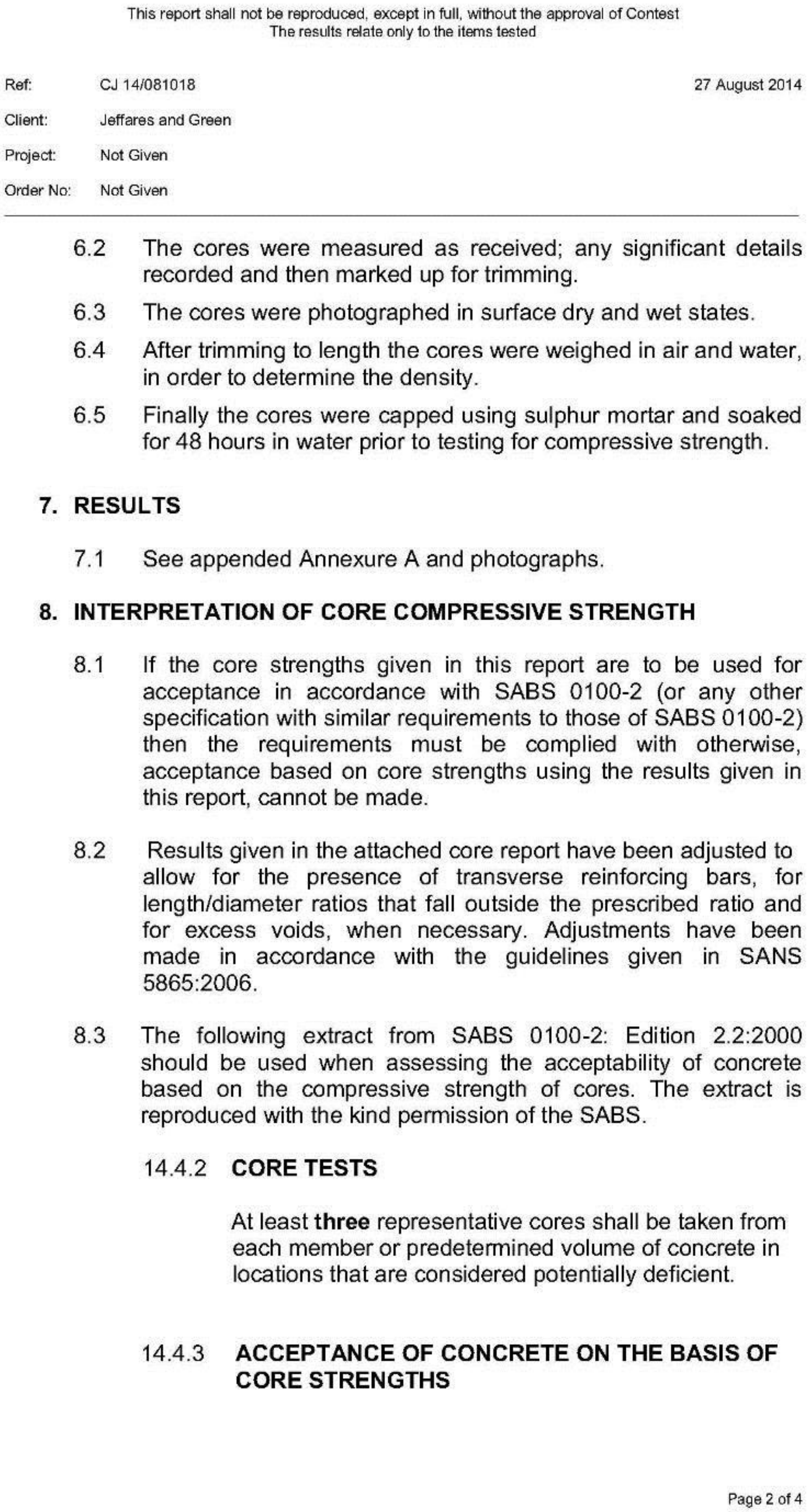
4.1 Site : Not Given
4.2 Location : Not Given

5. TESTING

5.1 Three cores were tested on 23.08.2014 in accordance with SANS 5865:2006.

6. CORE PREPARATION

6.1 Testing of cores were carried out by our laboratories in Westmead



Ref: CJ 14/081018 27 August 2014
Client: Jeffares and Green
Project: Not Given
Order No: Not Given

6.2 The cores were measured as received; any significant details recorded and then marked up for trimming.

6.3 The cores were photographed in surface dry and wet states.

6.4 After trimming to length the cores were weighed in air and water, in order to determine the density.

6.5 Finally the cores were capped using sulphur mortar and soaked for 48 hours in water prior to testing for compressive strength.

7. RESULTS

7.1 See appended Annexure A and photographs.

8. INTERPRETATION OF CORE COMPRESSIVE STRENGTH

8.1 If the core strengths given in this report are to be used for acceptance in accordance with SABS 0100-2 (or any other specification with similar requirements to those of SABS 0100-2) then the requirements must be complied with otherwise, acceptance based on core strengths using the results given in this report, cannot be made.

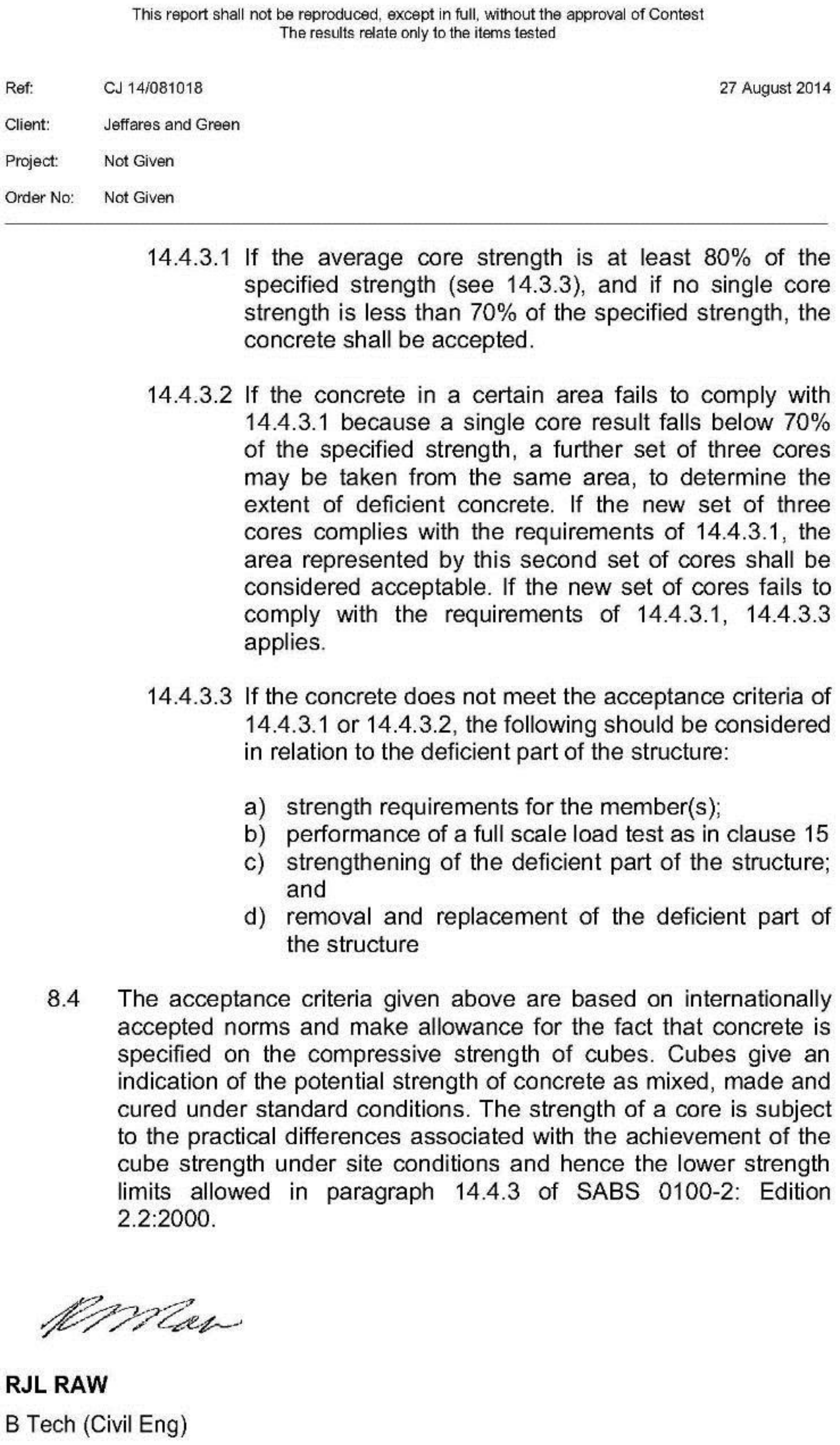
8.2 Results given in the attached core report have been adjusted to allow for the presence of transverse reinforcing bars, for length/diameter ratios that fall outside the prescribed ratio and for excess voids, when necessary. Adjustments have been made in accordance with the guidelines given in SANS 5865:2006.

8.3 The following extract from SABS 0100-2: Edition 2.2:2000 should be used when assessing the acceptability of concrete based on the compressive strength of cores. The extract is reproduced with the kind permission of the SABS.

14.4.2 CORE TESTS

At least **three** representative cores shall be taken from each member or predetermined volume of concrete in locations that are considered potentially deficient.

14.4.3 ACCEPTANCE OF CONCRETE ON THE BASIS OF CORE STRENGTHS



Ref:	CJ 14/081018	27 August 2014
Client:	Jeffares and Green	
Project:	Not Given	
Order No:	Not Given	

14.4.3.1 If the average core strength is at least 80% of the specified strength (see 14.3.3), and if no single core strength is less than 70% of the specified strength, the concrete shall be accepted.

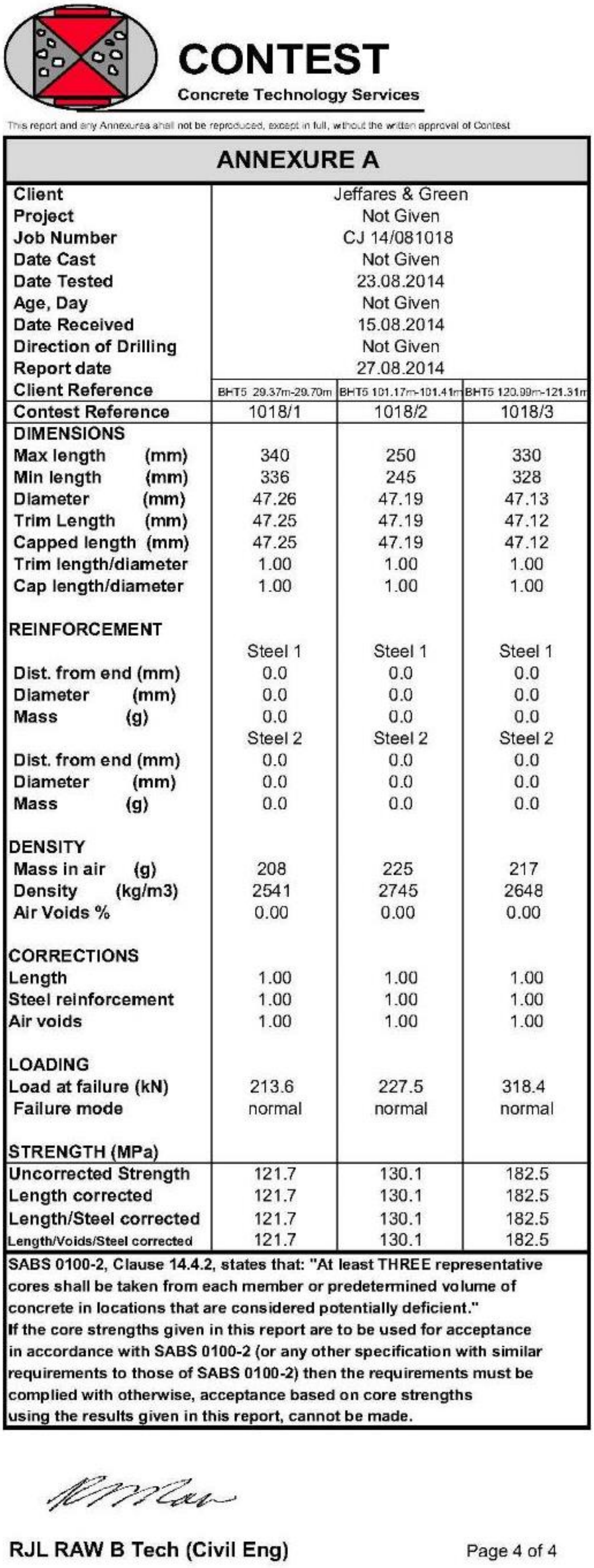
14.4.3.2 If the concrete in a certain area fails to comply with 14.4.3.1 because a single core result falls below 70% of the specified strength, a further set of three cores may be taken from the same area, to determine the extent of deficient concrete. If the new set of three cores complies with the requirements of 14.4.3.1, the area represented by this second set of cores shall be considered acceptable. If the new set of cores fails to comply with the requirements of 14.4.3.1, 14.4.3.3 applies.

14.4.3.3 If the concrete does not meet the acceptance criteria of 14.4.3.1 or 14.4.3.2, the following should be considered in relation to the deficient part of the structure:

a) strength requirements for the member(s);
b) performance of a full scale load test as in clause 15
c) strengthening of the deficient part of the structure; and
d) removal and replacement of the deficient part of the structure

8.4 The acceptance criteria given above are based on internationally accepted norms and make allowance for the fact that concrete is specified on the compressive strength of cubes. Cubes give an indication of the potential strength of concrete as mixed, made and cured under standard conditions. The strength of a core is subject to the practical differences associated with the achievement of the cube strength under site conditions and hence the lower strength limits allowed in paragraph 14.4.3 of SABS 0100-2: Edition 2.2:2000.

RJL RAW
B Tech (Civil Eng)



CONTEST
Concrete Technology Services

This report and any Annexures shall not be reproduced, except in full, without the written approval of Contest

ANNEXURE A

Client	Jeffares & Green		
Project	Not Given		
Job Number	CJ 14/081018		
Date Cast	Not Given		
Date Tested	23.08.2014		
Age, Day	Not Given		
Date Received	15.08.2014		
Direction of Drilling	Not Given		
Report date	27.08.2014		
Client Reference	BHT5 29.37m-29.70m	BHT5 101.17m-101.41m	BHT5 120.99m-121.31m
Contest Reference	1018/1	1018/2	1018/3
DIMENSIONS			
Max length (mm)	340	250	330
Min length (mm)	336	245	328
Diameter (mm)	47.26	47.19	47.13
Trim Length (mm)	47.25	47.19	47.12
Capped length (mm)	47.25	47.19	47.12
Trim length/diameter	1.00	1.00	1.00
Cap length/diameter	1.00	1.00	1.00
REINFORCEMENT			
	Steel 1	Steel 1	Steel 1
Dist. from end (mm)	0.0	0.0	0.0
Diameter (mm)	0.0	0.0	0.0
Mass (g)	0.0	0.0	0.0
	Steel 2	Steel 2	Steel 2
Dist. from end (mm)	0.0	0.0	0.0
Diameter (mm)	0.0	0.0	0.0
Mass (g)	0.0	0.0	0.0
DENSITY			
Mass in air (g)	208	225	217
Density (kg/m3)	2541	2745	2648
Air Voids %	0.00	0.00	0.00
CORRECTIONS			
Length	1.00	1.00	1.00
Steel reinforcement	1.00	1.00	1.00
Air voids	1.00	1.00	1.00
LOADING			
Load at failure (kN)	213.6	227.5	318.4
Failure mode	normal	normal	normal
STRENGTH (MPa)			
Uncorrected Strength	121.7	130.1	182.5
Length corrected	121.7	130.1	182.5
Length/Steel corrected	121.7	130.1	182.5
Length/Voids/Steel corrected	121.7	130.1	182.5

SABS 0100-2, Clause 14.4.2, states that: "At least THREE representative cores shall be taken from each member or predetermined volume of concrete in locations that are considered potentially deficient."
If the core strengths given in this report are to be used for acceptance in accordance with SABS 0100-2 (or any other specification with similar requirements to those of SABS 0100-2) then the requirements must be complied with otherwise, acceptance based on core strengths using the results given in this report, cannot be made.

RJL RAW B Tech (Civil Eng)

Page 4 of 4

E2:

PETROGRAPHIC AND X-RAY DIFFRACTION ANALYSES

UNIVERSITEIT VAN PRETORIA
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YUNIBESITHI YA PRETORIA
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E-Mail: wiebke.grote@up.ac.za
http://www.up.ac.za/academic/science

CLIENT: Jeffares & Green (Pty) Ltd

DATE: 15 September 2014

SAMPLES: 8 Samples

YOUR REFERENCE: 2819: LALENI DAM &TUNNEL

ANALYSIS: XRD and petrographic investigation of 8 core samples

TEST CONDUCTED

8 x Thin sections, 8 x XRD

After crushing and sampling with a riffle splitter, the representative samples were milled in a tungsten carbide vessel and prepared for XRD analysis using a back loading preparation method for qualitative & quantitative XRD.

The samples were analyzed using a PANalytical X'Pert Pro powder diffractometer with X'Celerator detector and variable divergence- and receiving slits with Fe filtered Co-Kα radiation. The phases were identified using X'Pert Highscore plus software.

One thin section of each sample was prepared and investigated under the microscope.

MACROSCOPIC DESCRIPTION:

Q2 6.24-6.36; T2 57.5-57.58; T4 97.23-97.31 and T4 115.97-116.06. Massive and fine grained medium grey intrusive igneous rock with a distinct dolerite/basalt texture.

D3 3.61-3.75; T2 50.63-50.77; T4 96.04-96.13 and T5 112.77-113.22. Dense, finely laminated, and very fine grained, light grey meta-sedimentary rocks (weakly metamorphosed siltstone).

MICROSCOPIC DESCRIPTION:

Thin Section Description:

Sample name: Q2 6.24-6.36

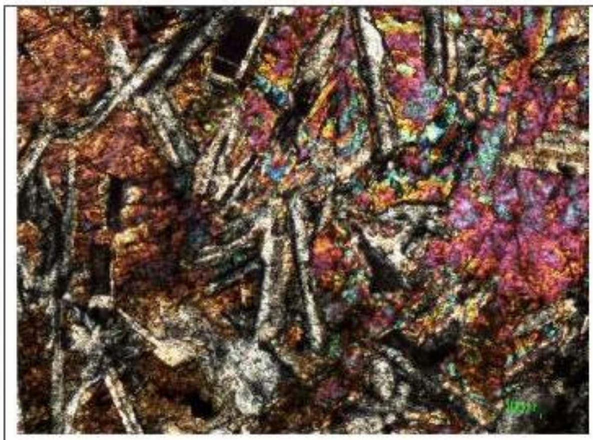
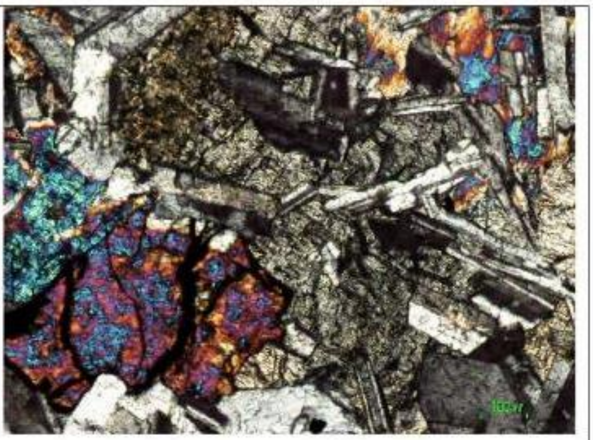
Constituents:

Fine grained euhedral lath-shaped plagioclase crystals (~56%) intergrown by clinopyroxene/diopside (~31%). Lesser quartz (~5%), muscovite (~6%) and minor hornblende (~2%) are present. Traces of opaque minerals might be present.

Description:

The section is dominated by generally lath-shaped fine grained feldspar (plagioclase) showing albite twinning, and subhedral to anhedral clinopyroxene (diopside). The laths of plagioclase are randomly orientated and the clinopyroxenes (augite) occupy a more interstitial position to the plagioclase. The degree of alteration is relatively low. Hornblende and mica (muscovite) might be alteration products.

Grain size data: 100 - 800 micron

	
Photomicrograph Q2 6.24-6.36: Cross polarized light. 10x Magnification.	Photomicrograph Q2 6.24-6.36: Cross polarized light. 10x Magnification.

Sample name: D3 3.61-3.75

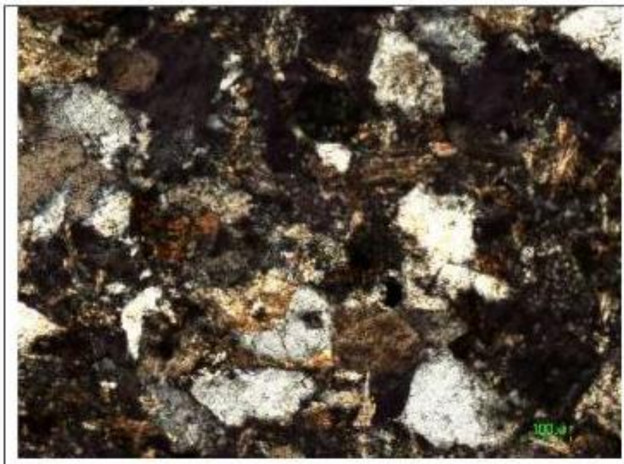
Constituents:

Fine grained quartz (~48%), plagioclase (~22%), microcline (~8%), muscovite (~7%), chlorite (~8%) and laumontite (~7%).

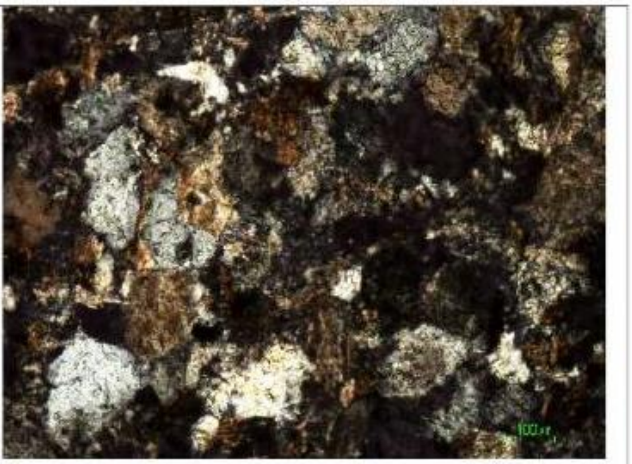
Description:

The section is dominated by angular to subrounded quartz, plagioclase and microcline embedded in a fine groundmass. The presence of the zeolite laumontite seems to be diagenetic (low grade metamorphism).

Grain Size: 100 – 500 micron



Photomicrograph **D3 3.61-3.75**: Cross polarized light. 10x Magnification.



Photomicrograph **D3 3.61-3.75**: Cross polarized light. 10x Magnification.

Sample name: T2 50.63-50.77

Constituents:

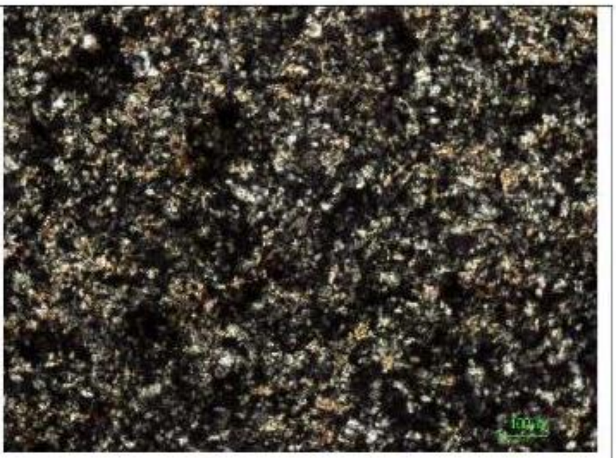
Extremely fine grained quartz (~42%), plagioclase (~19%), muscovite (~17%), microcline (~9%) chlorite (~9%) and laumontite (~4%).

Description:

The sample is extremely fine grained. Optical study is hampered by the fine grain and is difficult to distinguish between the various minerals.

Grain Size: <100 micron

Photomicrograph **T2 50.63-50.77:** Cross polarized light. 10x Magnification.



Photomicrograph **T2 50.63-50.77:** Cross polarized light. 10x Magnification.

Sample name: T2 57.5-57.58

Constituents:

Fine grained euhedral lath-shaped plagioclase crystals (~49%) intergrown by clinopyroxene/diopside (~18%) and enstatite/orthopyroxene (~13%). Lesser quartz (~7%), orthoclase (~5%), hornblende (~5%) and minor muscovite/mica (~3%) are present. Traces of opaque minerals might be present.

Description:

The section is dominated by generally lath-shaped fine grained feldspar (plagioclase) showing albite twinning, and subhedral to anhedral clinopyroxene (diopside). The laths of plagioclase are randomly orientated and the diopside occupies a more interstitial position to the plagioclase. The amphibole/hornblende and mica might be alteration products.

Grain size data: 100 - 1000 micron

Photomicrograph **T2 57.5-57.58**: Cross polarized light. 10x Magnification.

Photomicrograph **T2 57.5-57.58:** Cross polarized light. 10x Magnification.

Sample name: T4 96.04-96.13

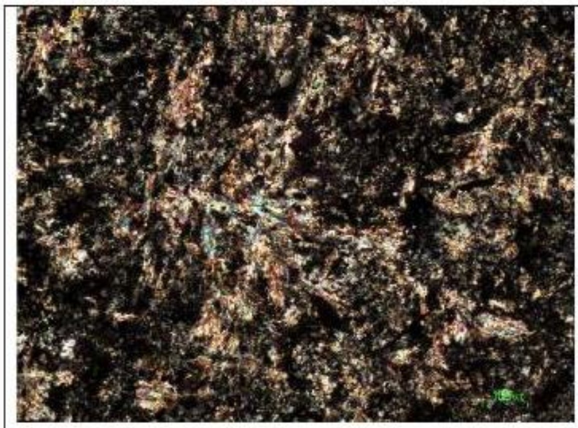
Constituents:

Very fine grained quartz (~36%), plagioclase (~19%), muscovite (~19%), microcline (~9%), chlorite (~11%) and laumontite (~5.5%)

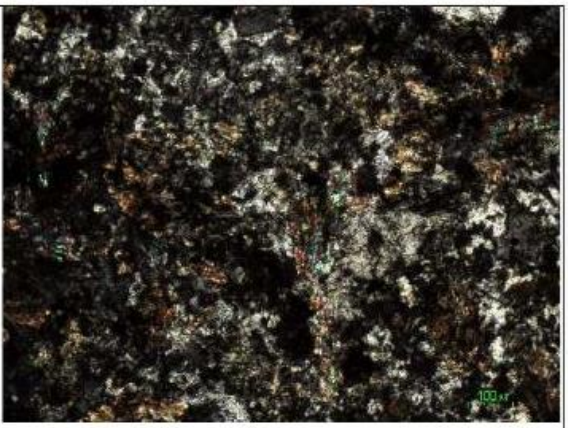
Description:

The sample is very fine grained. Optical study is hampered by the fine grain and is difficult to distinguish between the various minerals.

Grain size data: <200 micron



Photomicrograph **T4 96.04-96.13:** Cross polarized light. 10x Magnification.



Photomicrograph **T4 96.04-96.13:** Cross polarized light. 10x Magnification.

Sample name: T4 97.23 - 97.31

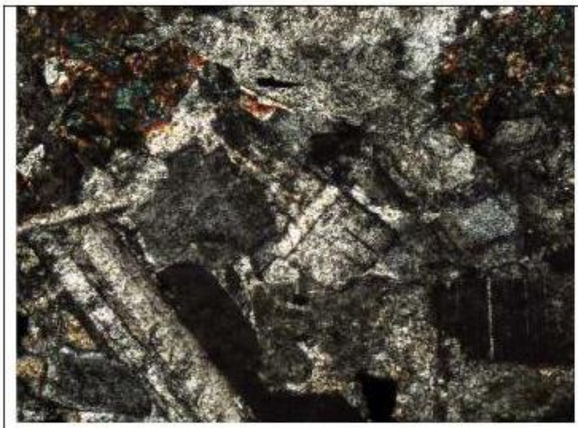
Constituents:

Fine grained euhedral lath-shaped plagioclase crystals (~33%) intergrown by clinopyroxene/diopside (~31%). Lesser orthoclase (~12%), prehnite (~13%) quartz (~6%), actinolite/amphibole (~4%) and minor epidote (~1%) are present. Traces of opaque minerals might be present.

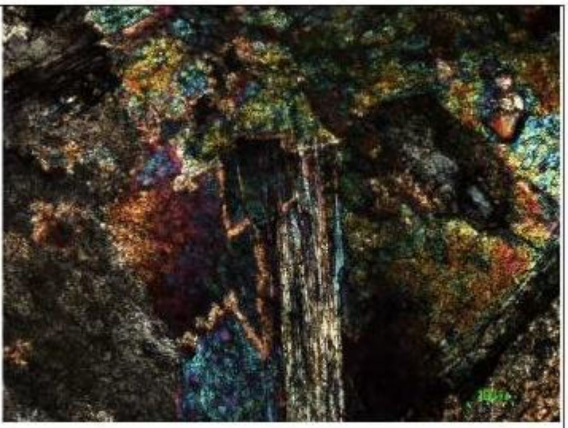
Description:

The section is dominated by generally lath-shaped fine grained feldspar (plagioclase) showing albite twinning, and subhedral to anhedral clinopyroxene (diopside). The laths of plagioclase are randomly orientated and the clinopyroxenes (diopside) occupy a more interstitial position to the plagioclase.

Grain size data: 100 - 1000 micron



Photomicrograph **T4 97.23-9.31**: Cross polarized light. 10x Magnification.



Photomicrograph **T4 97.23-9.31:** Cross polarized light. 10x Magnification.

Sample name: T4 115.97-116.06

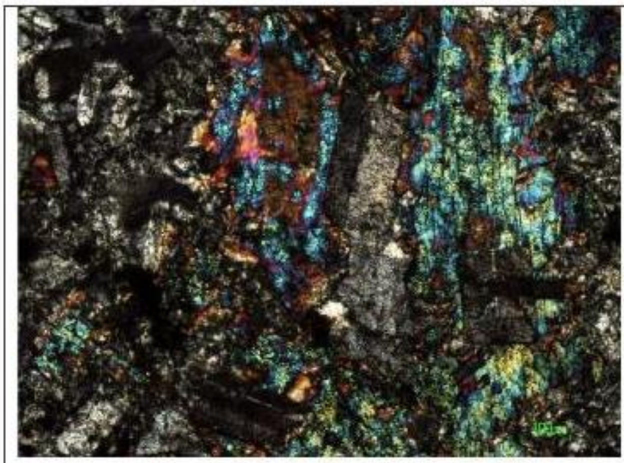
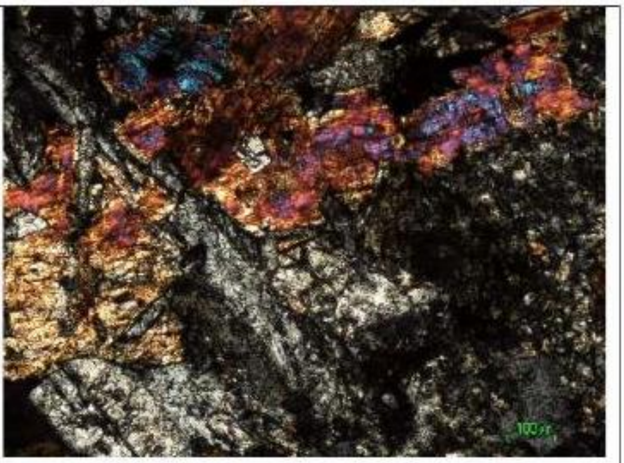
Constituents:

Fine grained euhedral lath-shaped plagioclase crystals (~51%) intergrown by clinopyroxene/diopside (~25%) and microcline (~9%). Lesser quartz (~4%), muscovite (~5%), hornblende (~4%) and about 2% opaque minerals (ilmenite) is present.

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 diopside occupy a more interstitial position to the plagioclase. The hornblende and muscovite (mica) might be alteration products. The degree of alteration is quite low.

Grain size data: 100 - 1000 micron

	
Photomicrograph **T4 115.97-116.06:** Cross polarized light. 10x Magnification.	Photomicrograph **T4 115.97-116.06:** Cross polarized light. 10x Magnification.

Sample name: T5 112.77-113.22

Constituents:

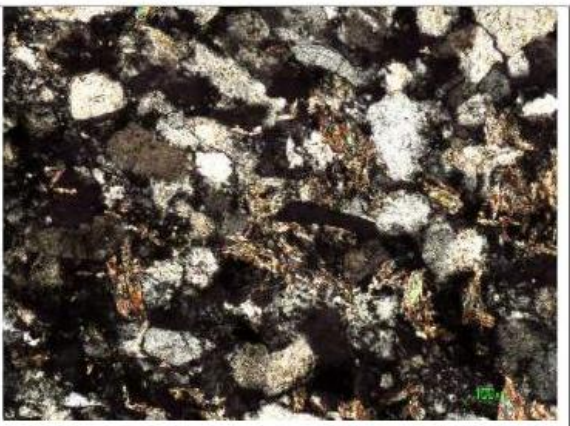
Fine grained plagioclase crystals (~40%), quartz (~38%), microcline (~9%), muscovite (~7%) and lesser chlorite (~6%).

Description:

The section is dominated by angular to subrounded quartz, plagioclase and microcline embedded in a fine groundmass. No laumontite was detected in this sample.

Grain size data: 100 – 300 micron

Photomicrograph **T5 112.77-113.22:** Cross polarized light. 10x Magnification.



Photomicrograph **T5 112.77-113.22:** Cross polarized light. 10x Magnification.

The overall bulk composition of the sample estimated by **quantitative XRD** analysis using the Rietveld method is as follows (3 σ error = standard deviation):

D3_3.61-3.75			**Q2_6.24-6.36**			**T2_50.63-50.77**		
	weight%	3 σ error		weight%	3 σ error		weight%	3 σ error
Chlorite	8.44	1.11	Diopside	31.42	0.95	Chlorite	9.4	0.87
Laumontite	6.64	1.35	Hornblende	1.84	0.9	Laumontite	3.67	1.14
Microcline	7.98	1.11	Muscovite	5.63	0.72	Microcline	9.1	0.99
Muscovite	6.92	0.81	Plagioclase	56.31	1.11	Muscovite	17.35	0.87
Plagioclase	21.66	1.14	Quartz	4.8	0.33	Plagioclase	18.95	1.21
Quartz	48.36	1.44				Quartz	41.54	1.06
T2_57,5-57.58			**T4_96.04-96.13**			**T4_97.23-97.31**		
	weight%	3 σ error		weight%	3 σ error		weight%	3 σ error
Diopside	18.22	0.9	Chlorite	11.3	1.02	Actinolite	4.25	0.54
Enstatite	12.86	0.96	Laumontite	5.49	1.04	Diopside	30.81	0.93
Hornblende	5.35	0.6	Microcline	8.92	0.99	Epidote	1.03	0.54
Muscovite	2.72	0.57	Muscovite	19.45	0.9	Orthoclase	11.9	0.9
Orthoclase	4.82	0.75	Plagioclase	19.16	1.2	Plagioclase	32.92	1.08
Plagioclase	49.03	1.02	Quartz	35.68	1.08	Prehnite	12.64	0.81
Quartz	7	0.36				Quartz	6.45	0.39
T4_115.97-116.06			**T5_112.77-113.22**					
	weight%	3 σ error		weight%	3 σ error			

Diopside	25.07	1.29	Chlorite	5.59	0.72			
Hornblende	3.92	1.05	Laumontite	0	0			
Ilmenite	1.99	0.9	Microcline	8.98	0.99			
Microcline	8.94	0.87	Muscovite	6.95	0.72			
Muscovite	4.63	0.66	Plagioclase	40.47	1.17			
Plagioclase	51.11	1.62	Quartz	38	0.96			
Quartz	4.34	0.39						

Ideal Mineral Composition:

Actinolite	Ca2(Mg,Fe)5Si8O22(OH)
Chlorite	(Mg,Fe)5Al(AlSi3O10)(OH)8
Diopside	CaMgSi2O6
Enstatite	MgSiO3
Epidote	Al2Ca2MnSi3O12 (OH)
Hornblende	Ca2(Fe,Mg)4Al(Si7Al)O22(OH,F)2
Ilmenite	FeTiO3
Laumontite	CaAl2Si4O12(H2O)2
Microcline	KAlSi3 O8
Muscovite	KAl2((OH)2AlSi3O10)
Orthoclase	KAlSi3O8
Plagioclase	(Na,Ca)(Si,Al)4O8
Prehnite	Ca2Al(AlSi3O10)(OH)2
Quartz	SiO2

EXECUTIVE SUMMARY:

- Samples Q2 6.24-6.36; T2 57.5-57.58; T4 97.23-97.31 and T4 115.97-116.06 are dolerite or basalts. No smectite (swelling clays) was detected. The prehnite in sample T4 97.23-97.31 might be secondary or a hydrothermal mineral.
- The dolerite/basalt samples appear holocrystalline, relatively fresh and fine grained with an ophitic texture and these samples seems to be fairly similar.
- Samples D3 3.61-3.75; T2 50.63-50.77; T4 96.04-96.13 and T5 112.77-113.22, vary between very fine grained to extremely fine grained. These seem to be meta-sedimentary rocks, which have undergone low grade metamorphism.

If you have any questions, kindly contact the laboratory.

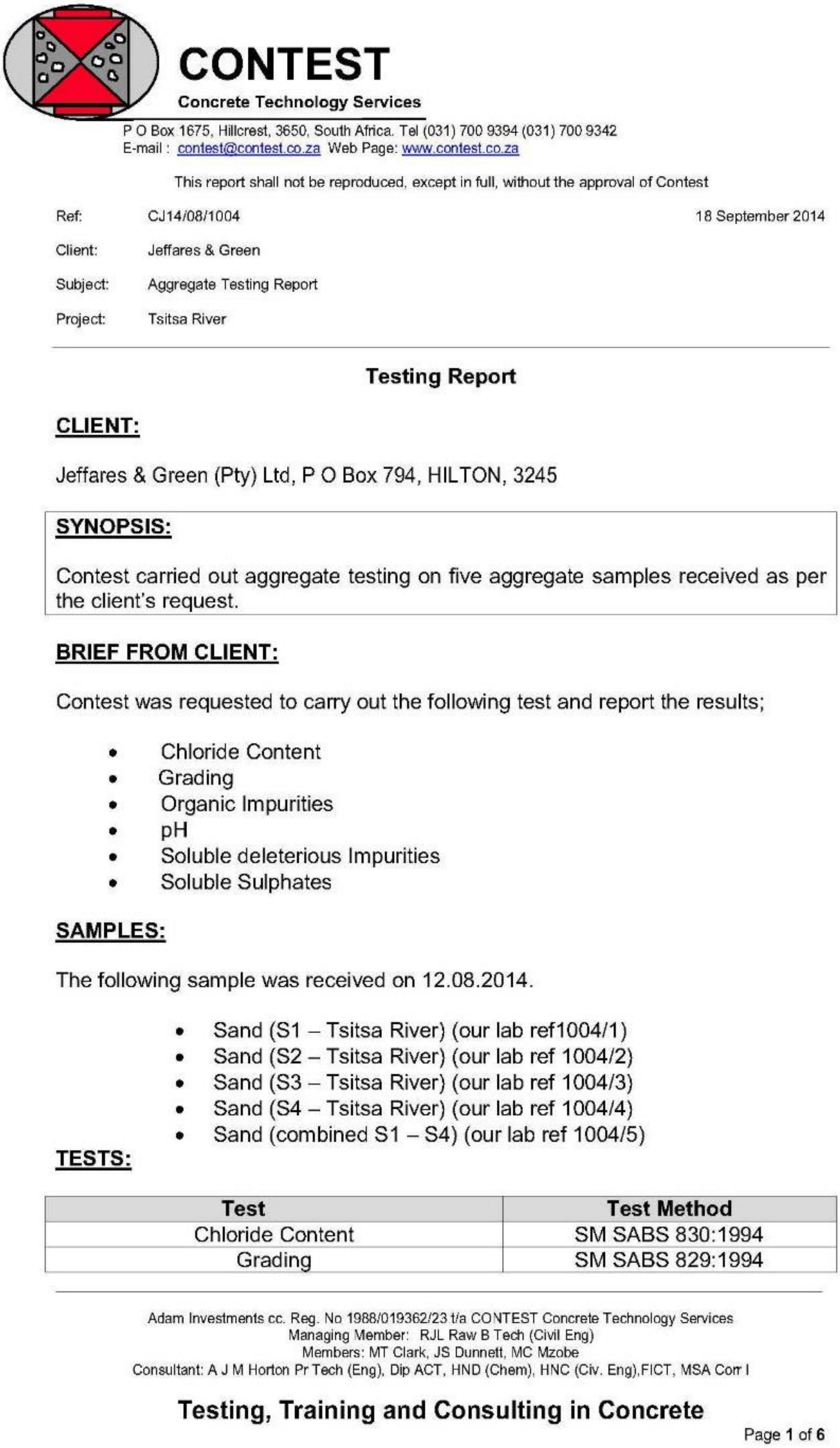
Analyst:

Grote

Wiebke Grote

E3:

SAND TEST RESULTS



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Concrete Technology Services
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E-mail : contest@contest.co.za Web Page: www.contest.co.za

Ref: CJ14/08/1004 18 September 2014

Client: Jeffares & Green

Subject: Aggregate Testing Report

Project: Tsitsa River

Testing Report

CLIENT:

Jeffares & Green (Pty) Ltd, P O Box 794, HILTON, 3245

SYNOPSIS:

Contest carried out aggregate testing on five aggregate samples received as per the client's request.

BRIEF FROM CLIENT:

Contest was requested to carry out the following test and report the results;

- Chloride Content
- Grading
- Organic Impurities
- pH
- Soluble deleterious Impurities
- Soluble Sulphates

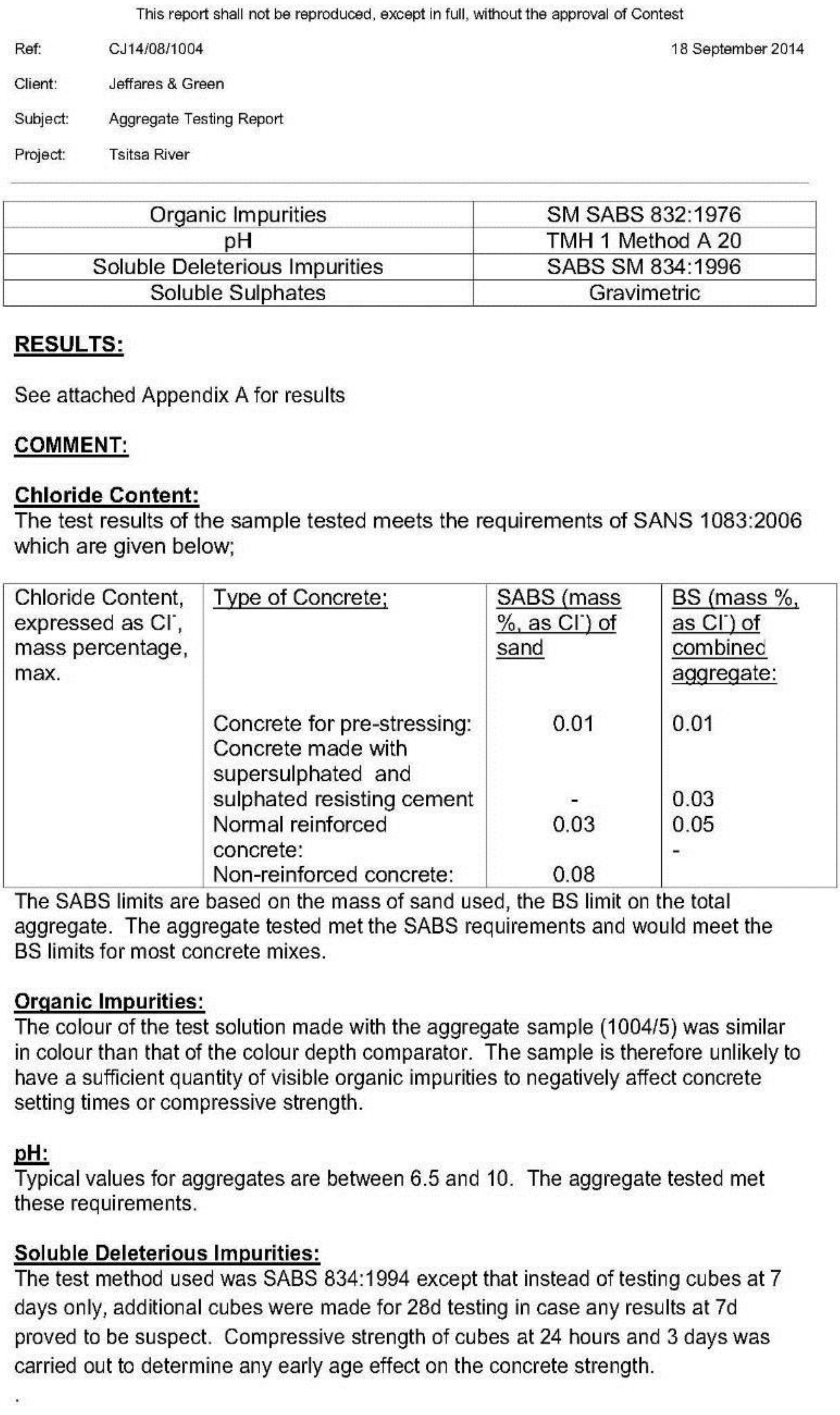
SAMPLES:

The following sample was received on 12.08.2014.

- Sand (S1 – Tsitsa River) (our lab ref1004/1)
- Sand (S2 – Tsitsa River) (our lab ref 1004/2)
- Sand (S3 – Tsitsa River) (our lab ref 1004/3)
- Sand (S4 – Tsitsa River) (our lab ref 1004/4)
- Sand (combined S1 – S4) (our lab ref 1004/5)

TESTS:

Test	Test Method
Chloride Content	SM SABS 830:1994
Grading	SM SABS 829:1994



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Ref:	CJ14/08/1004	18 September 2014
Client:	Jeffares & Green	
Subject:	Aggregate Testing Report	
Project:	Tsitsa River	

Organic Impurities	SM SABS 832:1976
pH	TMH 1 Method A 20
Soluble Deleterious Impurities	SABS SM 834:1996
Soluble Sulphates	Gravimetric

RESULTS:

See attached Appendix A for results

COMMENT:

Chloride Content:

The test results of the sample tested meets the requirements of SANS 1083:2006 which are given below;

Chloride Content, expressed as Cl^-, mass percentage, max.	Type of Concrete;	SABS (mass %, as Cl^-) of sand	BS (mass %, as Cl^-) of combined aggregate:
	Concrete for pre-stressing:	0.01	0.01
	Concrete made with supersulphated and sulphated resisting cement	-	0.03
	Normal reinforced concrete:	0.03	0.05
	Non-reinforced concrete:	0.08	-

The SABS limits are based on the mass of sand used, the BS limit on the total aggregate. The aggregate tested met the SABS requirements and would meet the BS limits for most concrete mixes.

Organic Impurities:

The colour of the test solution made with the aggregate sample (1004/5) was similar in colour than that of the colour depth comparator. The sample is therefore unlikely to have a sufficient quantity of visible organic impurities to negatively affect concrete setting times or compressive strength.

pH:

Typical values for aggregates are between 6.5 and 10. The aggregate tested met these requirements.

Soluble Deleterious Impurities:

The test method used was SABS 834:1994 except that instead of testing cubes at 7 days only, additional cubes were made for 28d testing in case any results at 7d proved to be suspect. Compressive strength of cubes at 24 hours and 3 days was carried out to determine any early age effect on the concrete strength.

.

The results relate only to the items tested

Ref:	CJ14/08/1004	18 September 2014
Client:	Jeffares & Green	
Subject:	Aggregate Testing Report	
Project:	Tsitsa River	

SABS 1083 requires that the strength developed at 7 days by the cubes made with the unwashed sand must be at least 85% of the cubes made with the washed aggregate.

The test sample met this requirement, giving a result of 97.5 %.

Soluble Sulphates:

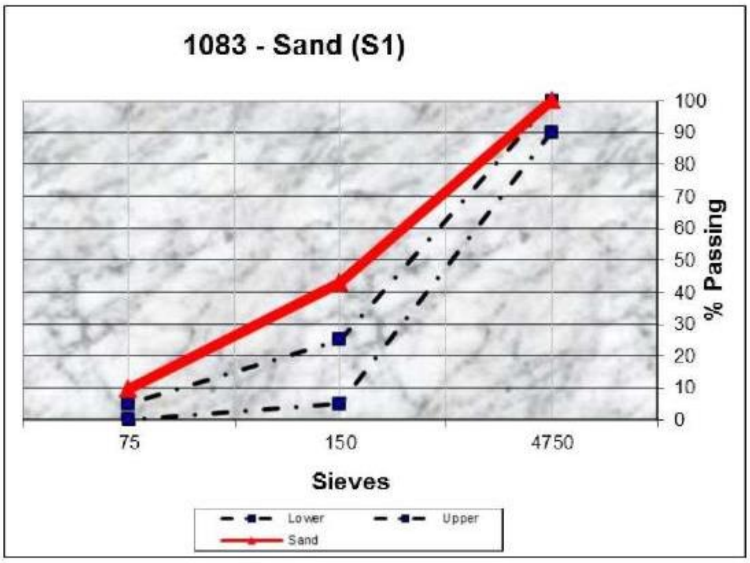
The commentary on SABS 1083:1994 states that it is difficult to define a limit to the level of sulphate or sulphide that can be regarded as tolerable in aggregate.

SABS 0100-2:1990 limits the total water-soluble sulphate content of concrete to 4% of the mass of cement.

The test results given above for the sample tested would be within this limit for most concrete mixes.

Gradings:

The sand did not meet the grading requirements for SANS 1083:2006.



Sieve Size (mm)	Cumulative % passing	
	Limits	Sample
6.7		100
4.750	90 - 100	100
2.360		100
1.180		100
0.600		100
0.300		99
0.150	5 - 25	43
0.075	0 - 5*	9.5

* 0 - 10 crushed rock

RD	0.00
LBD	0
CBD	0
FM	0.58
VOIDS	#DIV/0!

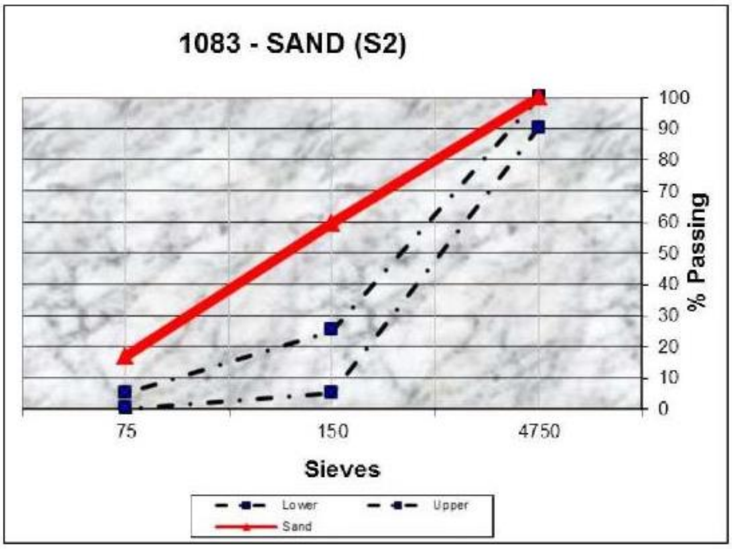
Ref: CJ14/08/1004 18 September 2014

Client: Jeffares & Green

Subject: Aggregate Testing Report

Project: Tsitsa River

The sand did not meet the grading requirements for SANS 1083:2006.

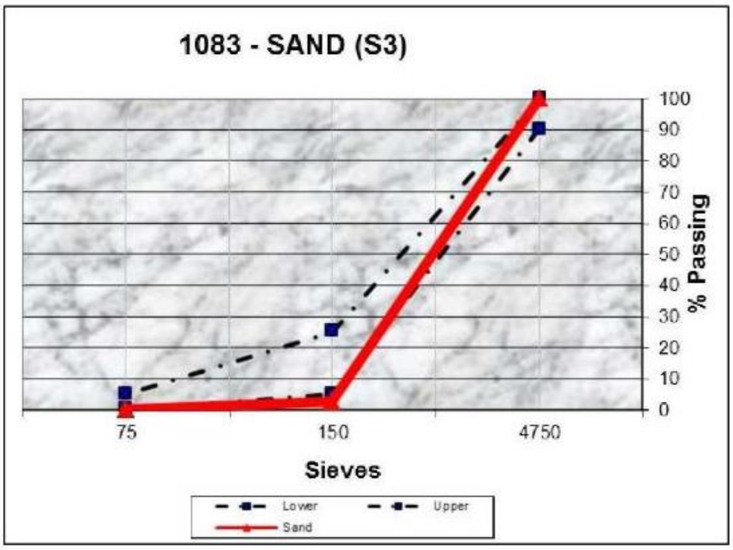


Sieve Size (mm)	Cumulative % passing	
	Limits	Sample
6.7		100
4.750	90 - 100	100
2.360		100
1.180		100
0.600		100
0.300		99
0.150	5 - 25	60
0.075	0 - 5*	16.9

* 0 - 10 crushed rock

RD	0.00
LBD	0
CBD	0
FM	0.42
VOIDS	#DIV/0!

The sand met the grading requirements for SANS 1083:2006, except for the 0.150mm sieve size.



Sieve Size (mm)	Cumulative % passing	
	Limits	Sample
6.7		100
4.750	90 - 100	100
2.360		99
1.180		97
0.600		93
0.300		69
0.150	5 - 25	3
0.075	0 - 5*	0.2

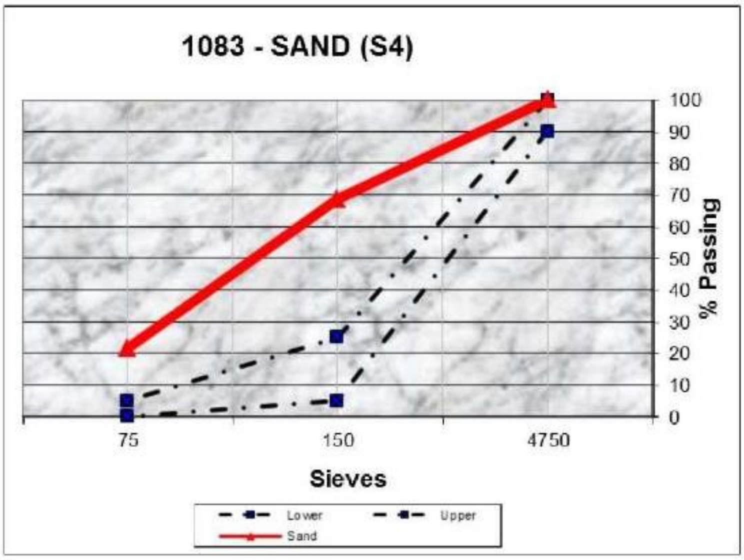
* 0 - 10 crushed rock

RD	0.00
LBD	0
CBD	0
FM	1.39
VOIDS	#DIV/0!

The results relate only to the items tested

Ref:	CJ14/08/1004	18 September 2014
Client:	Jeffares & Green	
Subject:	Aggregate Testing Report	
Project:	Tsitsa River	

The sand did not meet the grading requirements for SANS 1083:2006.

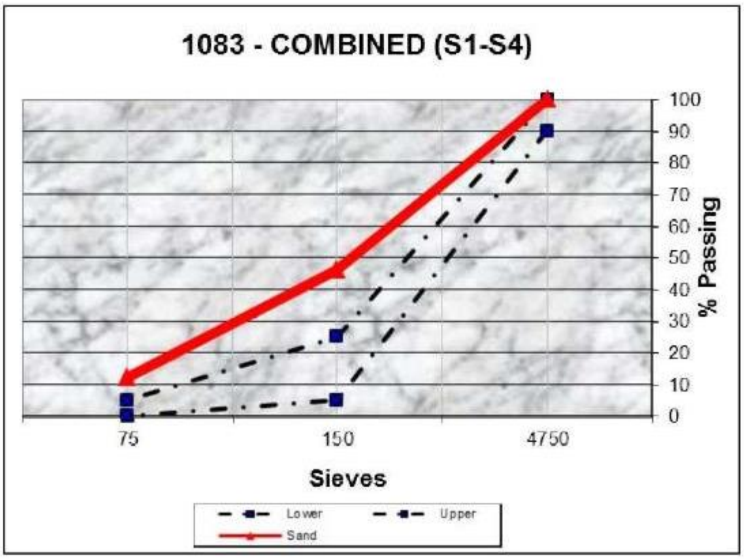


Sieve Size (mm)	Cumulative % passing	
	Limits	Sample
6.7		100
4.750	90 - 100	100
2.360		100
1.180		100
0.600		100
0.300		100
0.150	5 - 25	68
0.075	0 - 5*	21.6

* 0 - 10 crushed rock

RD	0.00
LBD	0
CBD	0
FM	0.32
VOIDS	#DIV/0!

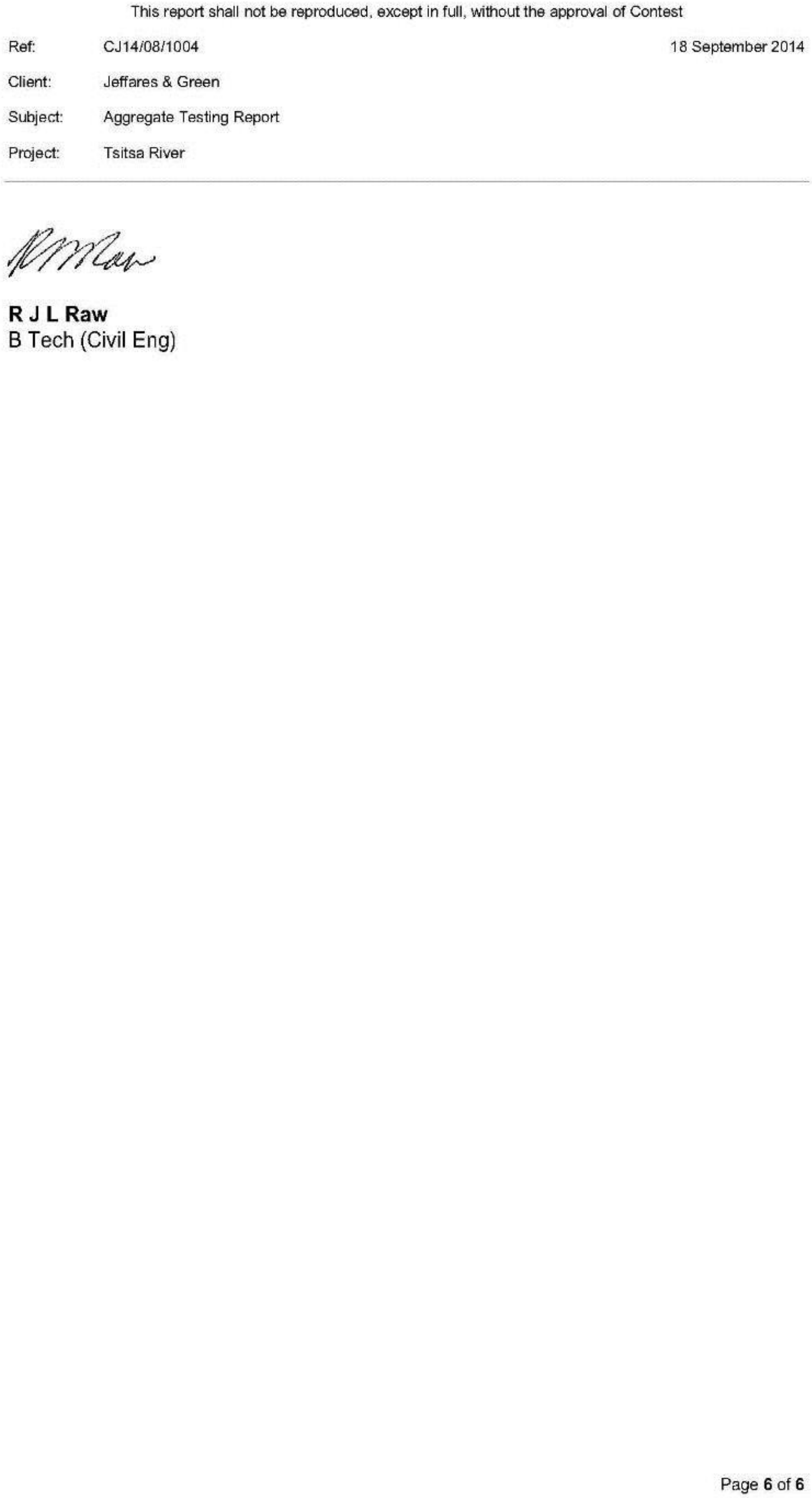
The sand did not meet the grading requirements for SANS 1083:2006.



Sieve Size (mm)	Cumulative % passing	
	Limits	Sample
6.7		100
4.750	90 - 100	100
2.360		100
1.180		99
0.600		99
0.300		93
0.150	5 - 25	46
0.075	0 - 5*	12.2

* 0 - 10 crushed rock

RD	0.00
LBD	0
CBD	0
FM	0.63
VOIDS	#DIV/0!



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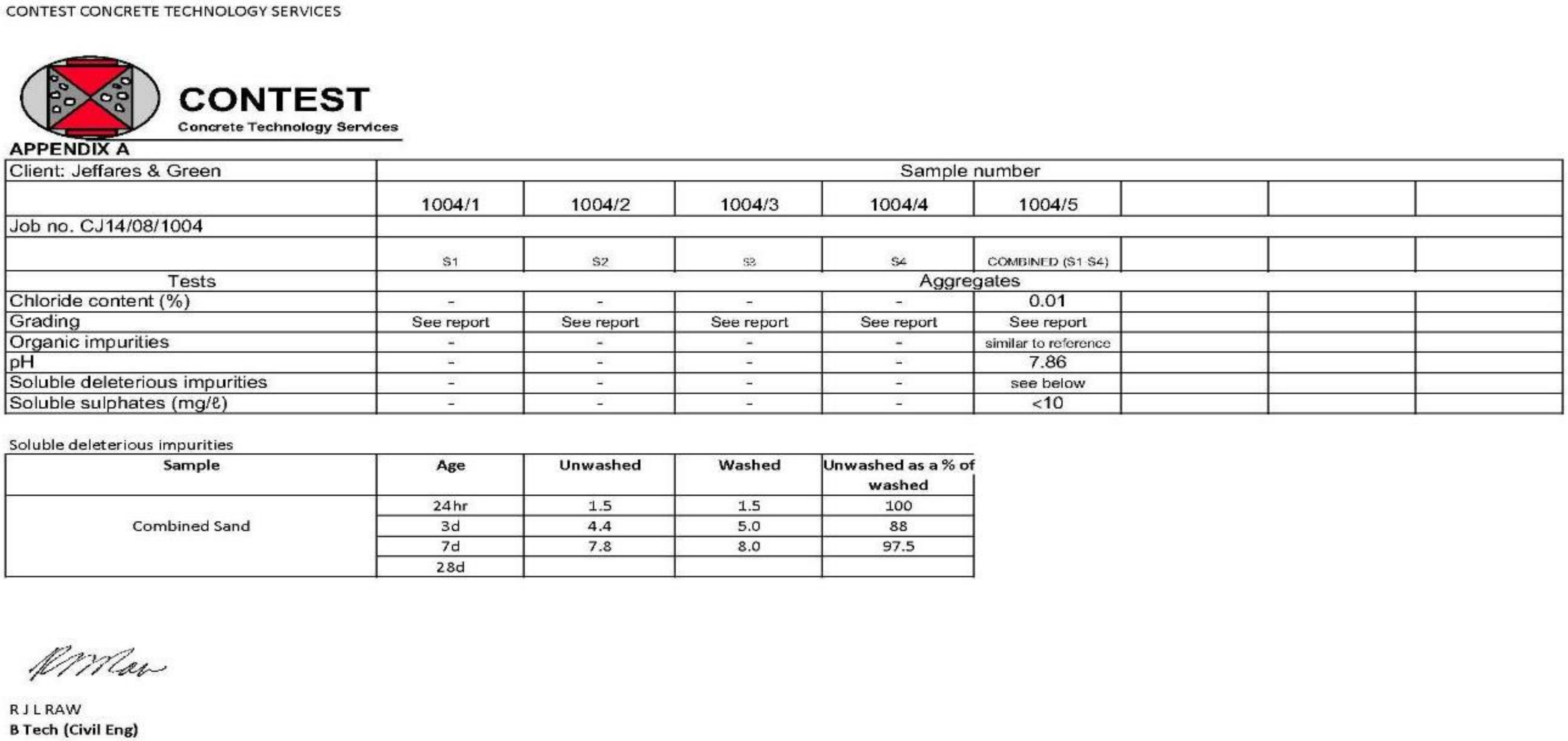
Ref:	CJ14/08/1004	18 September 2014
Client:	Jeffares & Green	
Subject:	Aggregate Testing Report	
Project:	Tsitsa River	

R J L Raw
B Tech (Civil Eng)



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APPENDIX A

Client: Jeffares & Green	Sample number							
	1004/1	1004/2	1004/3	1004/4	1004/5			
Job no. CJ14/08/1004								
	S1	S2	S3	S4	COMBINED (S1-S4)			
Tests	Aggregates							
Chloride content (%)	-	-	-	-	0.01			
Grading	See report	See report	See report	See report	See report			
Organic impurities	-	-	-	-	similar to reference			
pH	-	-	-	-	7.86			
Soluble deleterious impurities	-	-	-	-	see below			
Soluble sulphates (mg/ℓ)	-	-	-	-	<10			

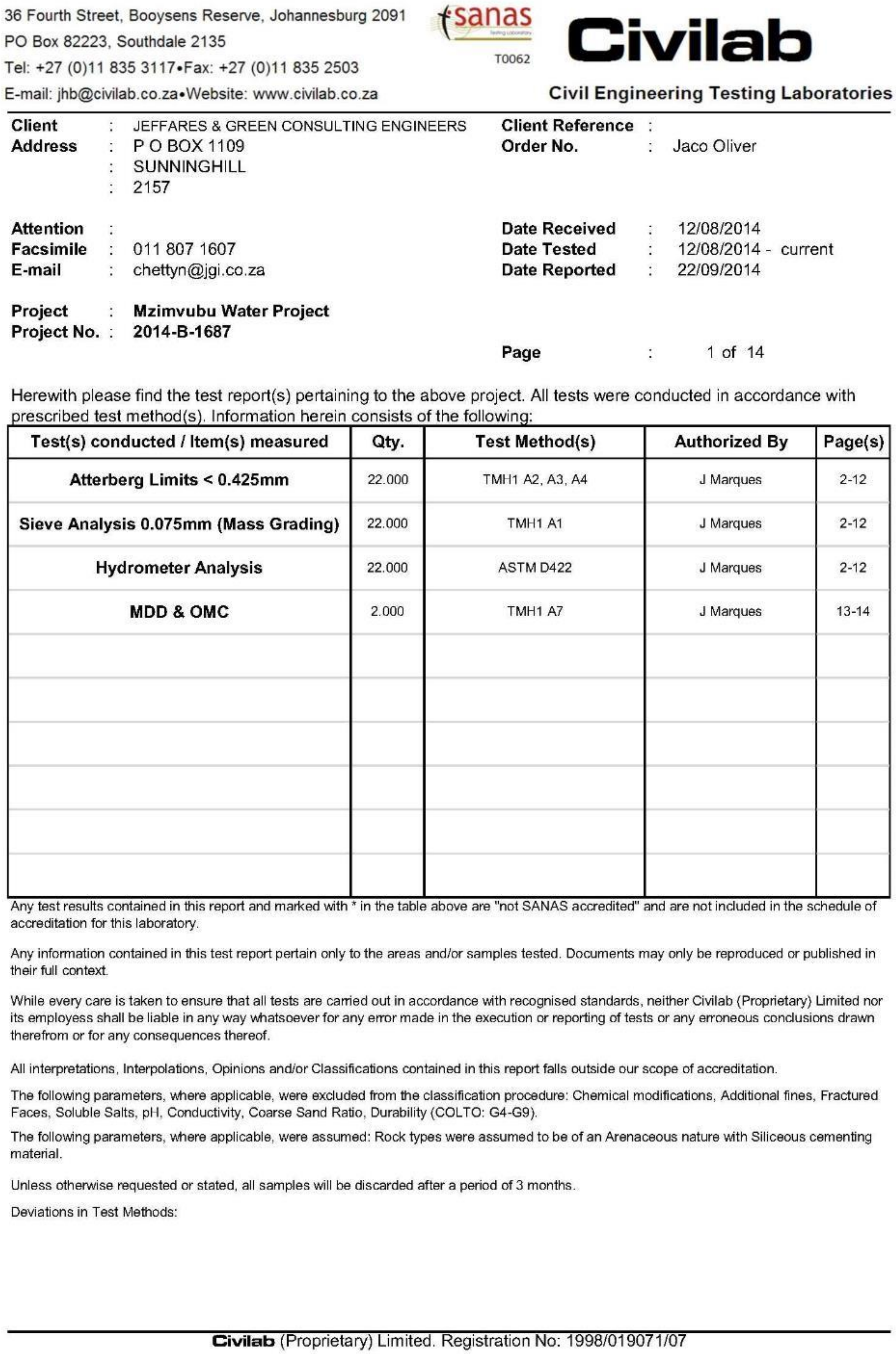
Soluble deleterious impurities

Sample	Age	Unwashed	Washed	Unwashed as a % of washed
Combined Sand	24hr	1.5	1.5	100
	3d	4.4	5.0	88
	7d	7.8	8.0	97.5
	28d			

R J L RAW
B Tech (Civil Eng)

E4:

INDICATOR AND COMPACTION TESTING – CORE AND SHELL MATERIALS



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E-mail: jhb@civilab.co.za•Website: www.civilab.co.za

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Civilab
Civil Engineering Testing Laboratories

Client : JEFFARES & GREEN CONSULTING ENGINEERS
Address : P O BOX 1109
: SUNNINGHILL
: 2157

Client Reference :
Order No. : Jaco Oliver

Attention :
Facsimile : 011 807 1607
E-mail : chettyn@jgi.co.za

Date Received : 12/08/2014
Date Tested : 12/08/2014 - current
Date Reported : 22/09/2014

Project : **Mzimvubu Water Project**
Project No. : **2014-B-1687**

Page : 1 of 14

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	22.000	TMH1 A2, A3, A4	J Marques	2-12
Sieve Analysis 0.075mm (Mass Grading)	22.000	TMH1 A1	J Marques	2-12
Hydrometer Analysis	22.000	ASTM D422	J Marques	2-12
MDD & OMC	2.000	TMH1 A7	J Marques	13-14

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:	12/08/2014
Project	:	Mzimvubu Water Project	Date Reported:	22/09/2014
Project No	:	2014-B-1687	Page No. :	2 of 14

FOUNDATION INDICATOR

Laboratory Number		1 ◆	2 ■
Field Number		CTP 1	CTP 2
Client Reference			
Depth (m)		1.1-2.4	1.0-1.9
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

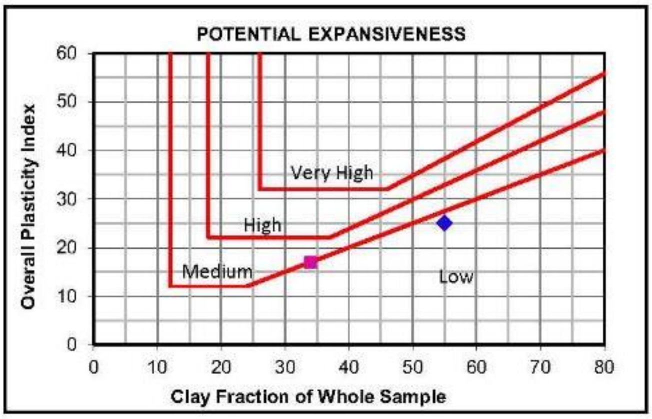
Moisture Content (%)		
Relative Density (S.G.)		

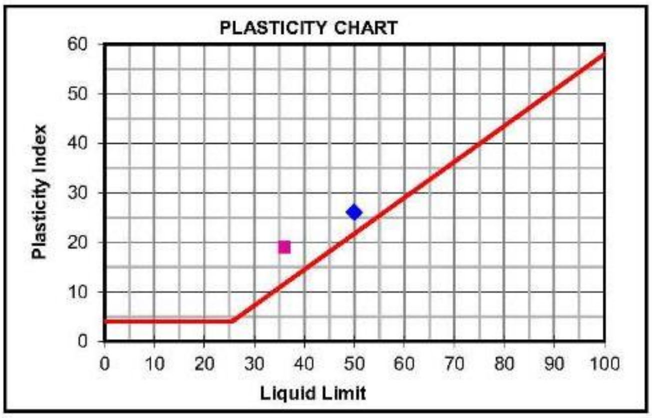
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	95
	0.425 mm	96	92
	0.075 mm	81	74
Grading Modulus		0.26	0.39

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	78	71
	0.040 mm	74	65
	0.020 mm	67	56
	0.006 mm	58	41
	0.002 mm	55	34
Gravel	%	3	5
Sand	%	19	24
Silt	%	23	37
Clay	%	55	34





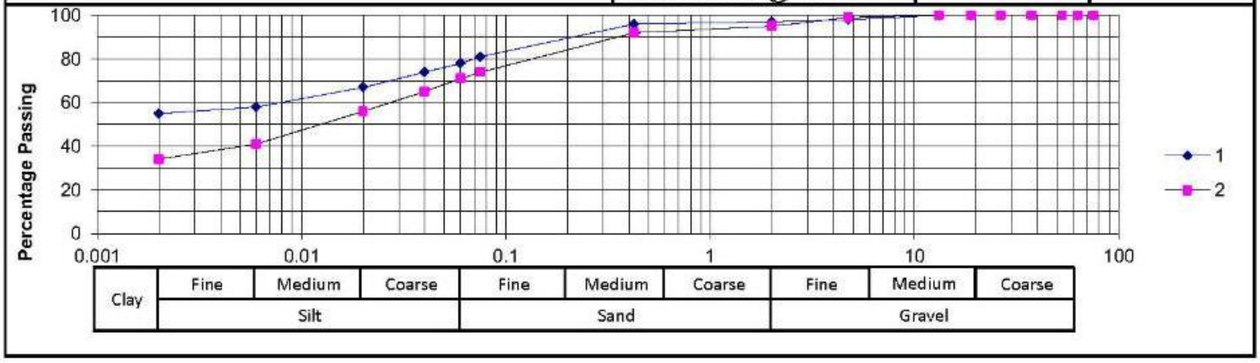
Laboratory Number		1 ◆	2 ■

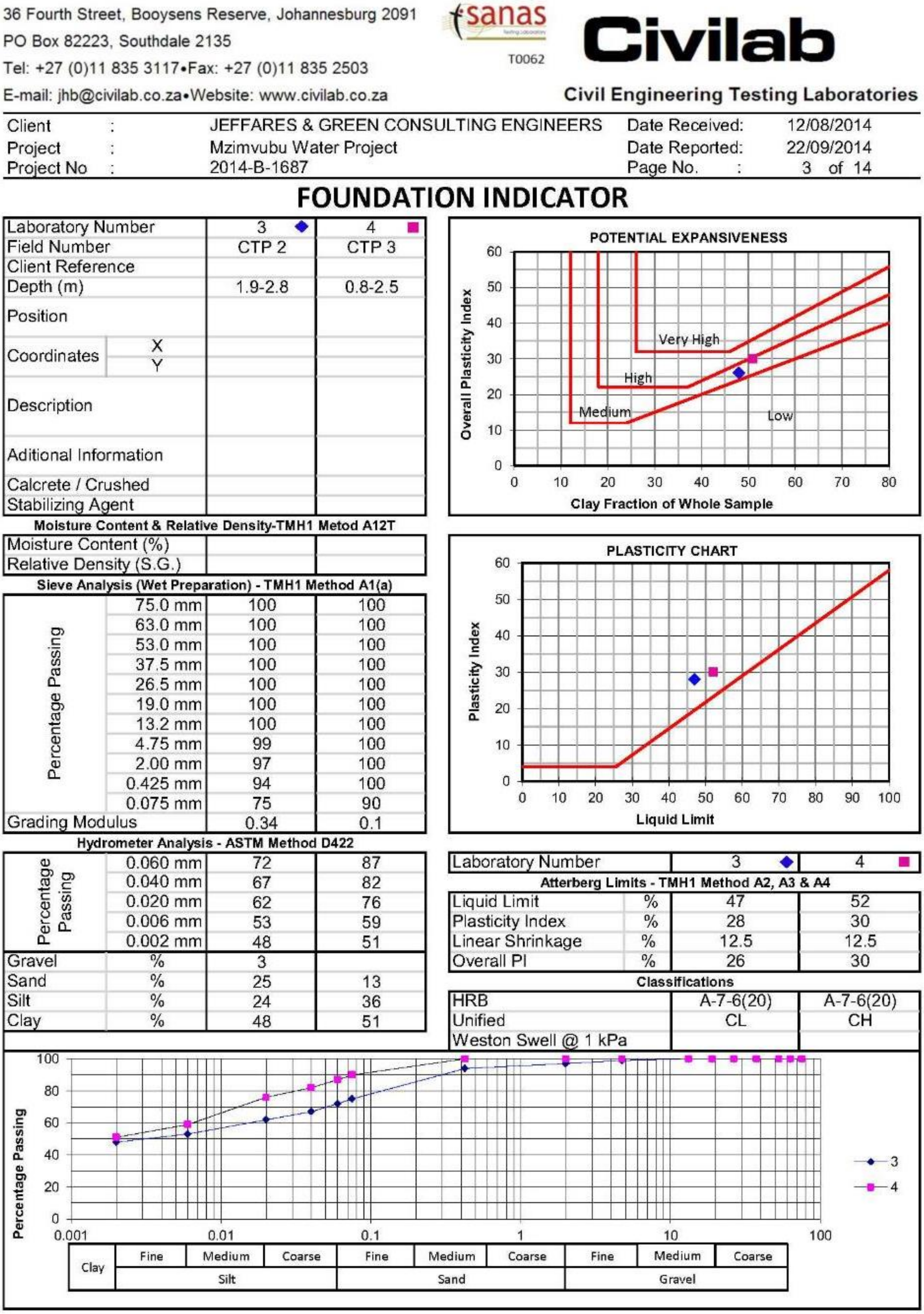
Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	50	36
Plasticity Index	%	26	19
Linear Shrinkage	%	12.0	9.5
Overall PI	%	25	17

Classifications

HRB	A-7-6(20)	A-6(12)
Unified	CH	CL
Weston Swell @ 1 kPa		





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Client	:	JEFFARES & GREEN CONSULTING ENGINEERS	Date Received:	12/08/2014
Project	:	Mzimvubu Water Project	Date Reported:	22/09/2014
Project No	:	2014-B-1687	Page No. :	3 of 14

FOUNDATION INDICATOR

Laboratory Number		3 ◆	4 ■
Field Number		CTP 2	CTP 3
Client Reference			
Depth (m)		1.9-2.8	0.8-2.5
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	94	100
	0.075 mm	75	90
Grading Modulus		0.34	0.1

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	72	87
	0.040 mm	67	82
	0.020 mm	62	76
	0.006 mm	53	59
	0.002 mm	48	51
Gravel	%	3	
Sand	%	25	13
Silt	%	24	36
Clay	%	48	51

Laboratory Number		3 ◆	4 ■
Atterberg Limits - TMH1 Method A2, A3 & A4			
Liquid Limit	%	47	52
Plasticity Index	%	28	30
Linear Shrinkage	%	12.5	12.5
Overall PI	%	26	30
Classifications			
HRB		A-7-6(20)	A-7-6(20)
Unified		CL	CH
Weston Swell @ 1 kPa			

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Client	:	JEFFARES & GREEN CONSULTING ENGINEERS	Date Received:	12/08/2014
Project	:	Mzimvubu Water Project	Date Reported:	22/09/2014
Project No	:	2014-B-1687	Page No. :	4 of 14

FOUNDATION INDICATOR

Laboratory Number		5 ◆	6 ■
Field Number		CTP 4	CTP 4
Client Reference			
Depth (m)		0.4-1.0	1.0-1.8
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

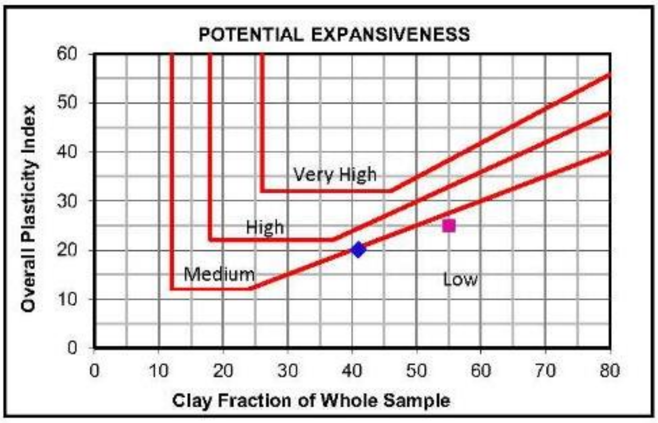
Moisture Content (%)		
Relative Density (S.G.)		

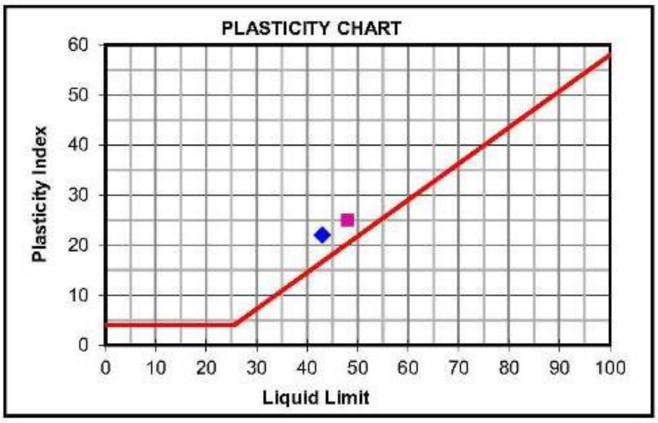
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

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	94	100
	0.425 mm	91	99
	0.075 mm	76	84
Grading Modulus		0.39	0.17

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	73	81
	0.040 mm	66	76
	0.020 mm	56	69
	0.006 mm	46	58
	0.002 mm	41	55
Gravel	%	6	
Sand	%	21	19
Silt	%	32	26
Clay	%	41	55





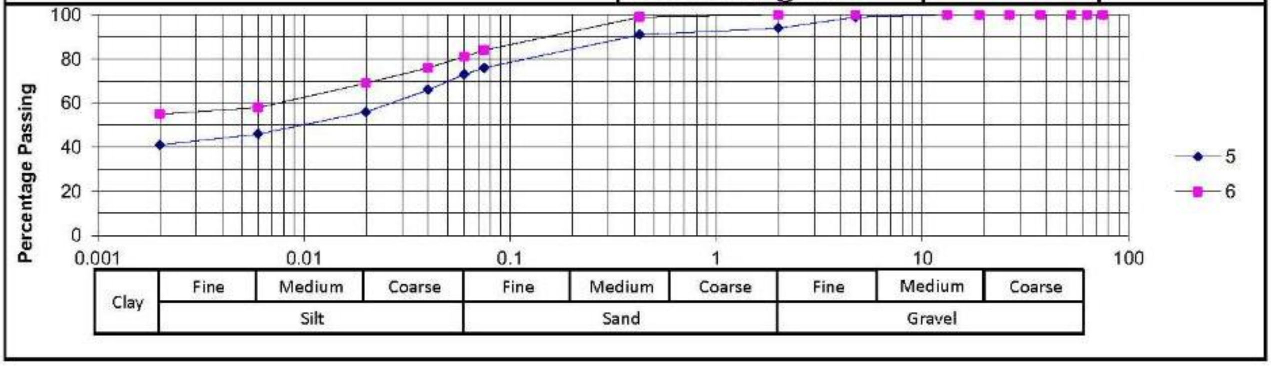
Laboratory Number		5 ◆	6 ■

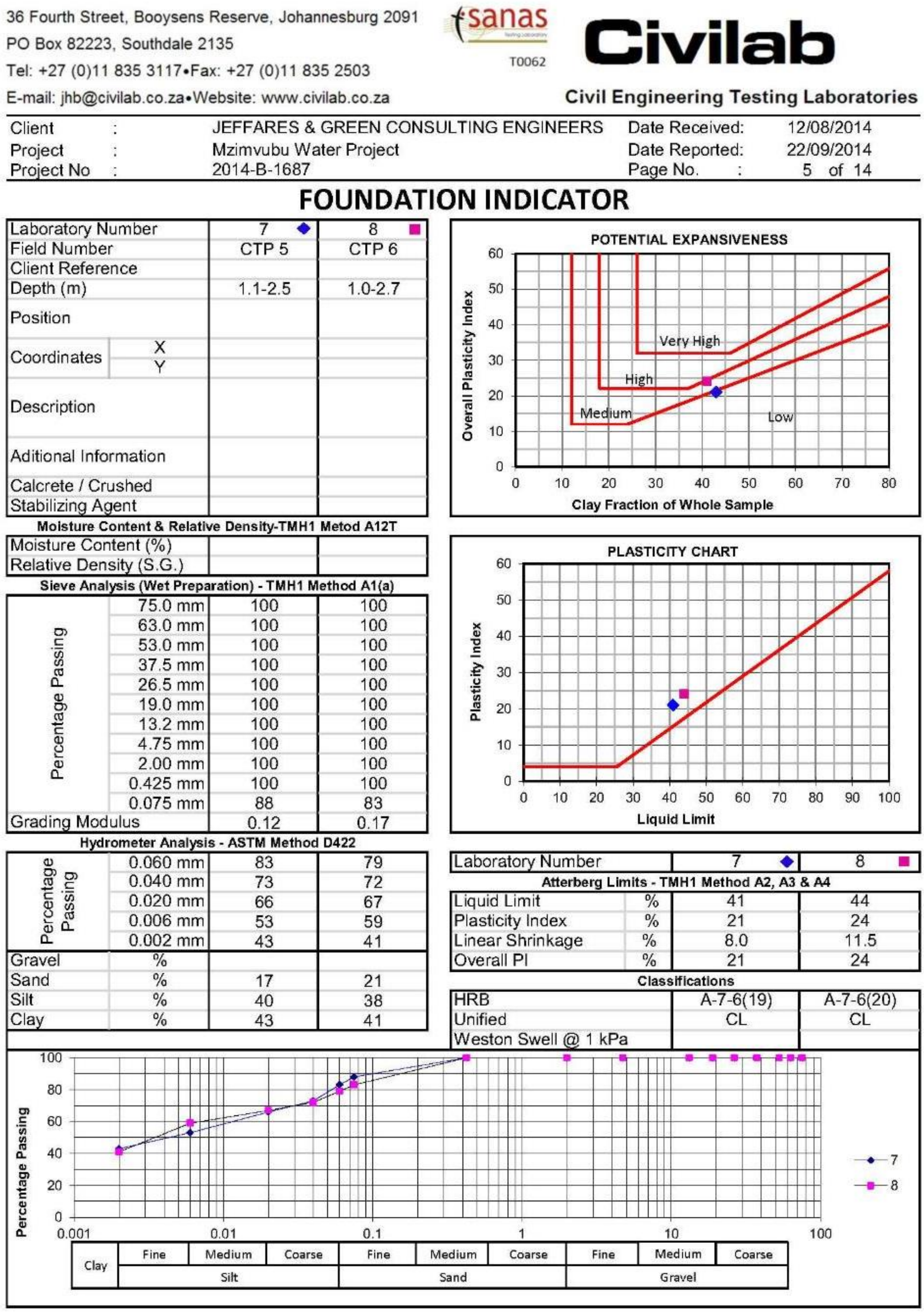
Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	43	48
Plasticity Index	%	22	25
Linear Shrinkage	%	9.5	10.5
Overall PI	%	20	25

Classifications

HRB	A-7-6(16)	A-7-6(20)
Unified	CL	CL
Weston Swell @ 1 kPa		





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Client	:	JEFFARES & GREEN CONSULTING ENGINEERS	Date Received:	12/08/2014
Project	:	Mzimvubu Water Project	Date Reported:	22/09/2014
Project No	:	2014-B-1687	Page No. :	5 of 14

FOUNDATION INDICATOR

Laboratory Number		7 ◆	8 ■
Field Number		CTP 5	CTP 6
Client Reference			
Depth (m)		1.1-2.5	1.0-2.7
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	100
	2.00 mm	100	100
	0.425 mm	100	100
	0.075 mm	88	83
Grading Modulus		0.12	0.17

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	83	79
	0.040 mm	73	72
	0.020 mm	66	67
	0.006 mm	53	59
	0.002 mm	43	41
Gravel	%		
Sand	%	17	21
Silt	%	40	38
Clay	%	43	41

Laboratory Number		7 ◆	8 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	41	44
Plasticity Index	%	21	24
Linear Shrinkage	%	8.0	11.5
Overall PI	%	21	24

Classifications

HRB	A-7-6(19)	A-7-6(20)
Unified	CL	CL
Weston Swell @ 1 kPa		

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FOUNDATION INDICATOR

Laboratory Number		9 ◆	10 ■
Field Number		CTP 7	FTP 1
Client Reference			
Depth (m)		0.7-2.5	0.2-0.7
Position			
Coordinates	X Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

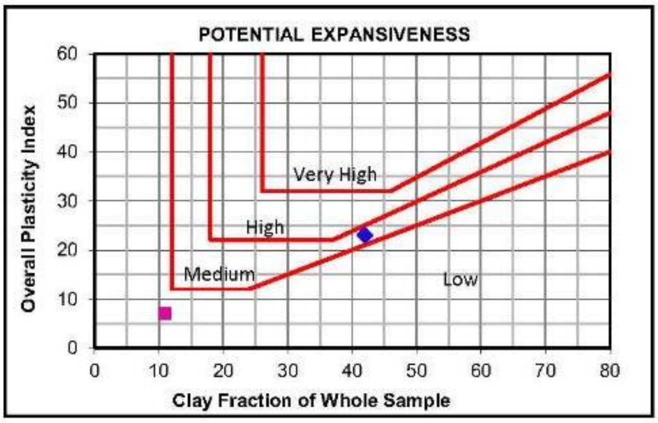
Moisture Content (%)		
Relative Density (S.G.)		

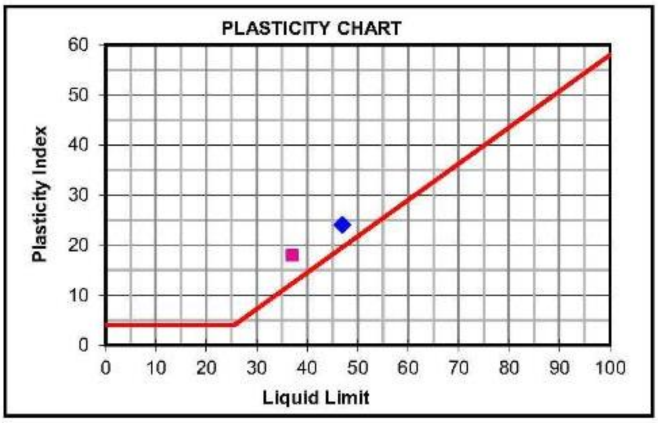
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100	100
	63.0 mm	100	100
	53.0 mm	100	100
	37.5 mm	100	92
	26.5 mm	100	81
	19.0 mm	100	69
	13.2 mm	100	66
	4.75 mm	99	54
	2.00 mm	97	45
	0.425 mm	94	38
	0.075 mm	81	30
Grading Modulus		0.28	1.87

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	77	28
	0.040 mm	70	25
	0.020 mm	63	21
	0.006 mm	55	19
	0.002 mm	42	11
Gravel	%	3	55
Sand	%	20	17
Silt	%	35	17
Clay	%	42	11





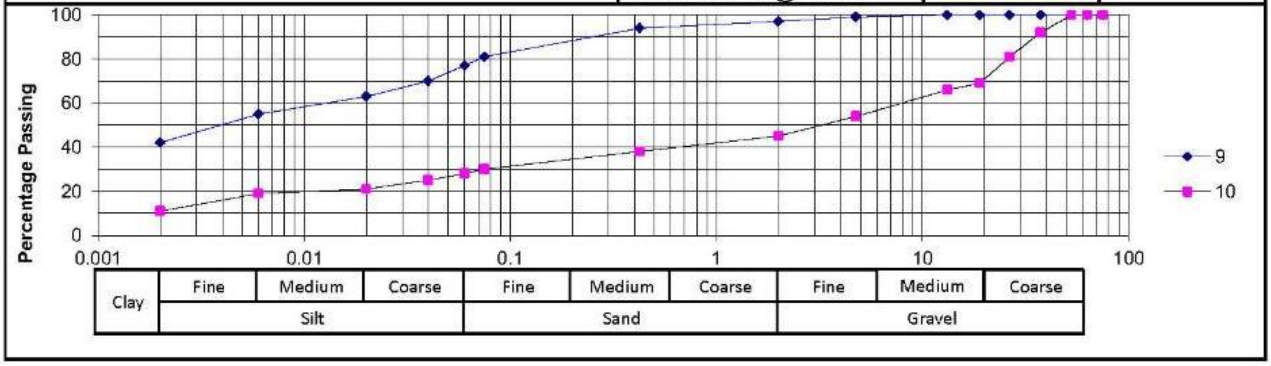
Laboratory Number		9 ◆	10 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	47	37
Plasticity Index	%	24	18
Linear Shrinkage	%	10.5	9.5
Overall PI	%	23	7

Classifications

HRB	A-7-6(20)	A-2-6(1)
Unified	CL	GC
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		11 ◆	12 ■
Field Number		FTP 3	FTP 4
Client Reference			
Depth (m)		1.0-1.6	0.2-0.9
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

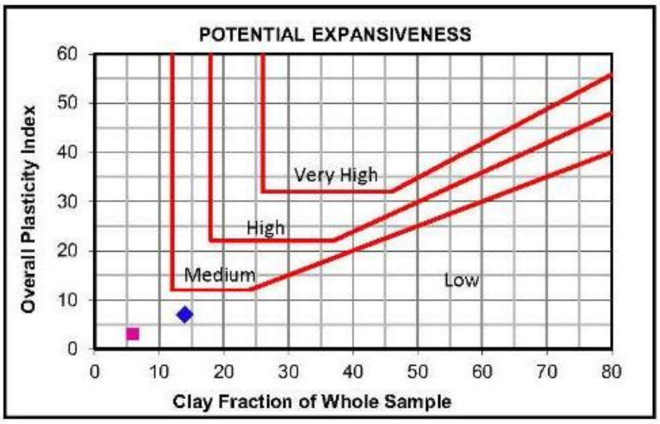
Moisture Content (%)		
Relative Density (S.G.)		

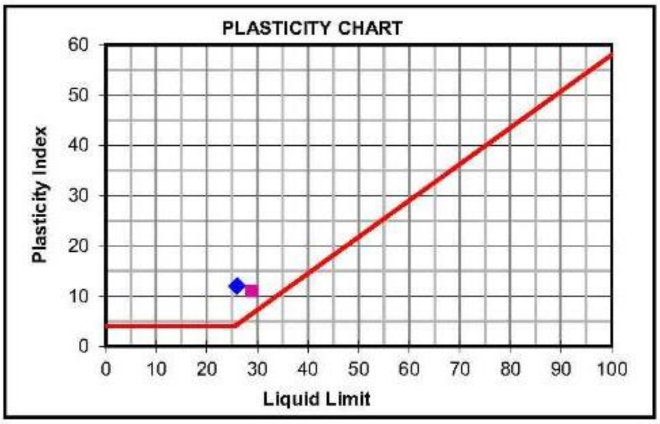
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100	100
	63.0 mm	100	94
	53.0 mm	98	90
	37.5 mm	93	81
	26.5 mm	86	67
	19.0 mm	77	54
	13.2 mm	77	51
	4.75 mm	68	38
	2.00 mm	61	33
	0.425 mm	55	30
	0.075 mm	49	16
Grading Modulus		1.35	2.21

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	41	15
	0.040 mm	30	13
	0.020 mm	26	11
	0.006 mm	20	9
	0.002 mm	14	6
Gravel	%	39	67
Sand	%	20	18
Silt	%	27	9
Clay	%	14	6





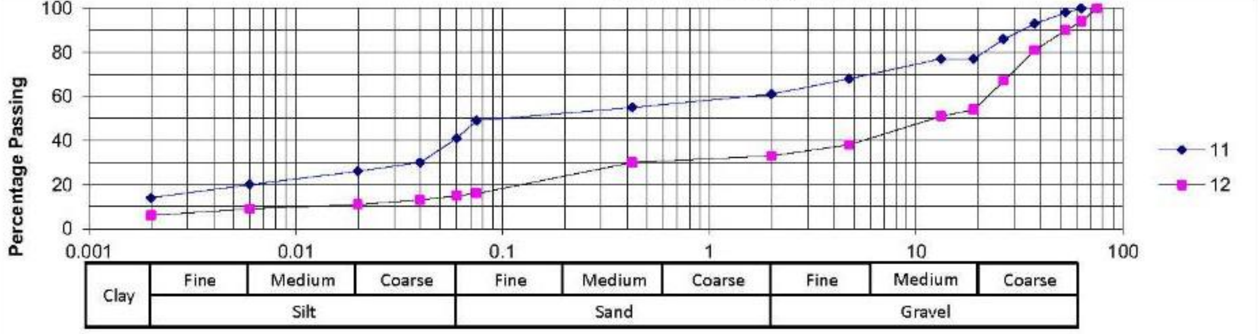
Laboratory Number		11 ◆	12 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	26	29
Plasticity Index	%	12	11
Linear Shrinkage	%	6.0	6.0
Overall PI	%	7	3

Classifications

HRB	A-6(3)	A-2-6(0)
Unified	GC	GC
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		13 ◆	14 ■
Field Number		FTP 6	FTP 7
Client Reference			
Depth (m)		1.4-1.9	0.6-0.9
Position			
Coordinates	X Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

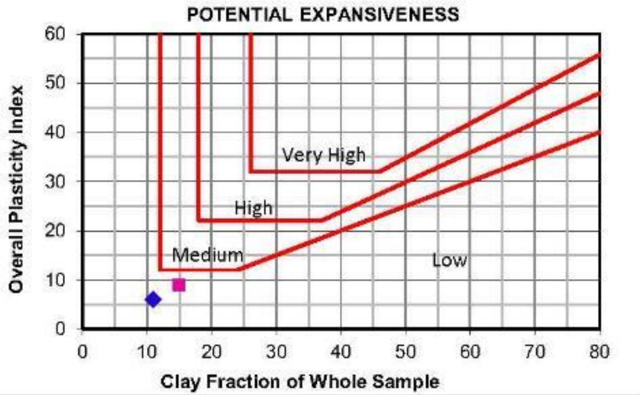
Moisture Content (%)		
Relative Density (S.G.)		

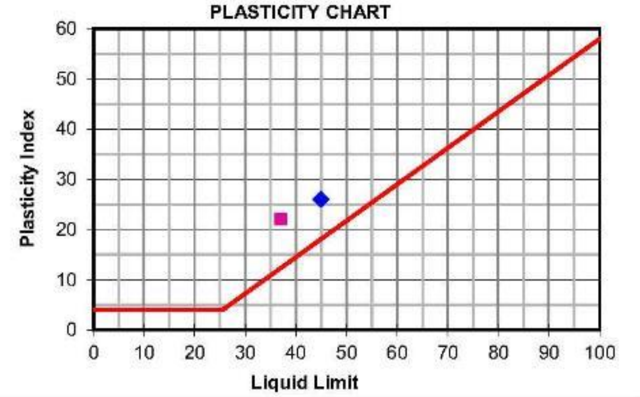
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100	100
	63.0 mm	100	100
	53.0 mm	100	96
	37.5 mm	79	90
	26.5 mm	63	74
	19.0 mm	47	63
	13.2 mm	44	60
	4.75 mm	32	49
	2.00 mm	27	44
	0.425 mm	24	41
	0.075 mm	18	27
Grading Modulus		2.31	1.88

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	18	26
	0.040 mm	17	25
	0.020 mm	14	23
	0.006 mm	13	17
	0.002 mm	11	15
Gravel	%	73	56
Sand	%	9	18
Silt	%	7	11
Clay	%	11	15





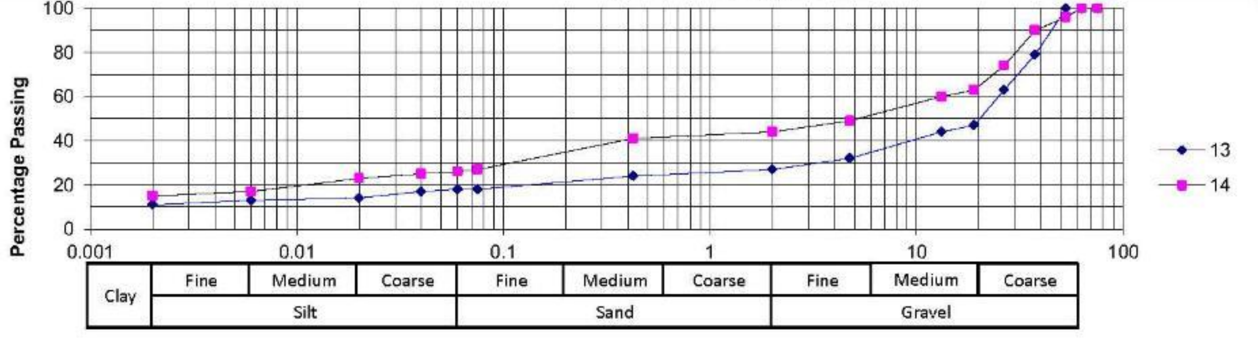
Laboratory Number		13 ◆	14 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	45	37
Plasticity Index	%	26	22
Linear Shrinkage	%	12.0	10.0
Overall PI	%	6	9

Classifications

HRB	A-2-7(0)	A-2-6(1)
Unified	GC	GC
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		15 ◆	16 ■
Field Number		FTP 9	FTP 10
Client Reference			
Depth (m)		0.4-0.6	0.2-0.6
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

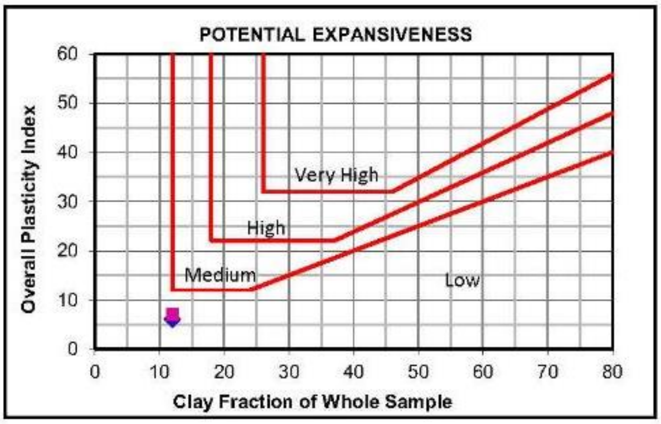
Moisture Content (%)		
Relative Density (S.G.)		

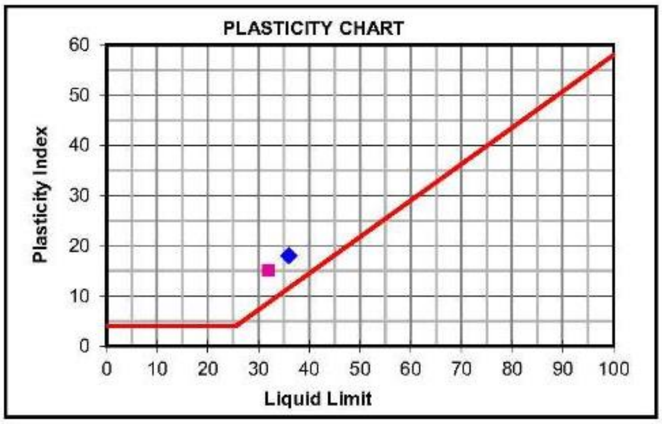
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100	100
	63.0 mm	92	100
	53.0 mm	90	100
	37.5 mm	79	86
	26.5 mm	71	76
	19.0 mm	64	65
	13.2 mm	58	62
	4.75 mm	47	53
	2.00 mm	39	49
	0.425 mm	34	46
	0.075 mm	24	26
Grading Modulus		2.03	1.79

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	23	25
	0.040 mm	21	22
	0.020 mm	18	19
	0.006 mm	17	16
	0.002 mm	12	12
Gravel	%	61	51
Sand	%	16	24
Silt	%	11	13
Clay	%	12	12





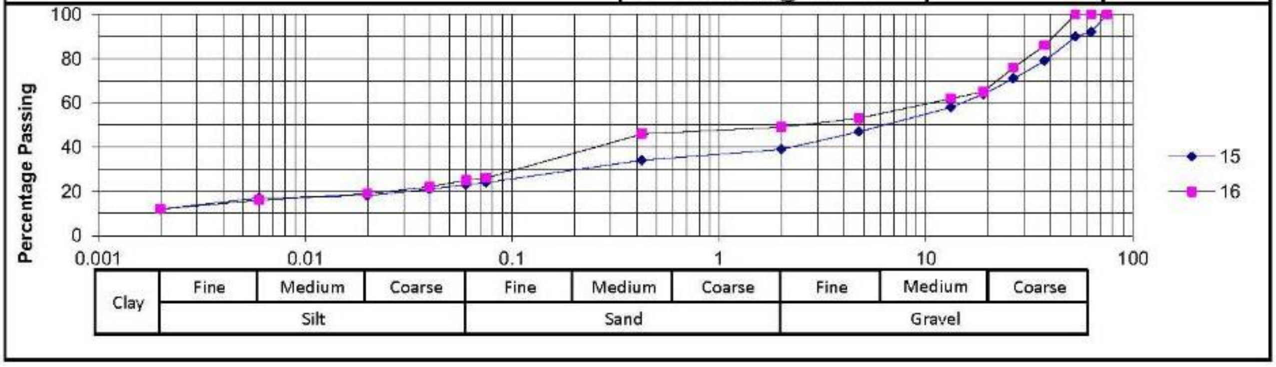
Laboratory Number		15 ◆	16 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	36	32
Plasticity Index	%	18	15
Linear Shrinkage	%	9.5	7.5
Overall PI	%	6	7

Classifications

HRB	A-2-6(1)	A-2-6(1)
Unified	GC	GC
Weston Swell @ 1 kPa		



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FOUNDATION INDICATOR

Laboratory Number		17 ◆	18 ■
Field Number		FTP 11	FTP 12
Client Reference			
Depth (m)		0.2-0.7	0.3-0.6
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

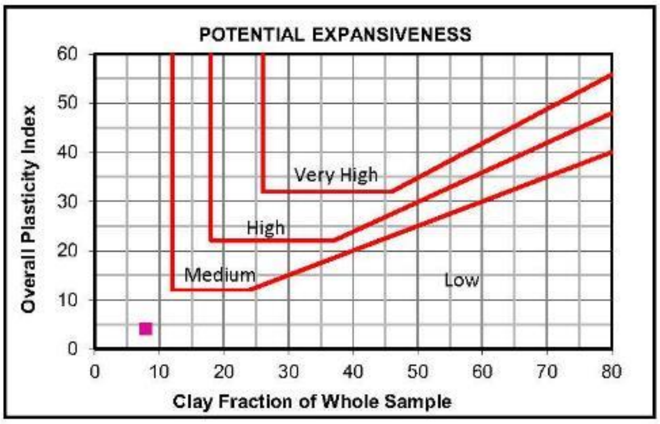
Moisture Content (%)		
Relative Density (S.G.)		

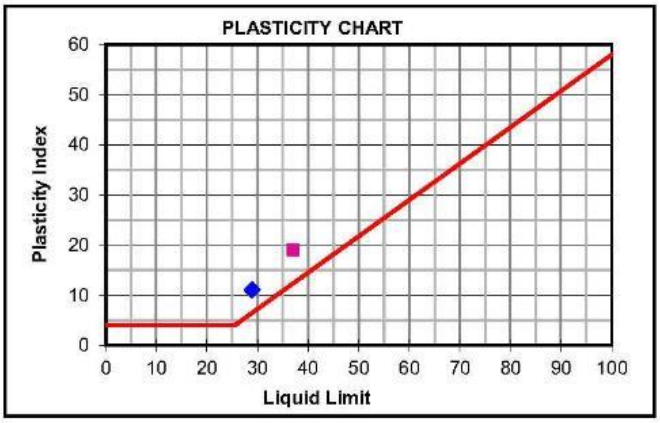
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm		100
	63.0 mm		96
	53.0 mm		90
	37.5 mm		77
	26.5 mm		64
	19.0 mm		51
	13.2 mm		50
	4.75 mm		39
	2.00 mm		29
	0.425 mm		22
	0.075 mm		17
Grading Modulus			2.32

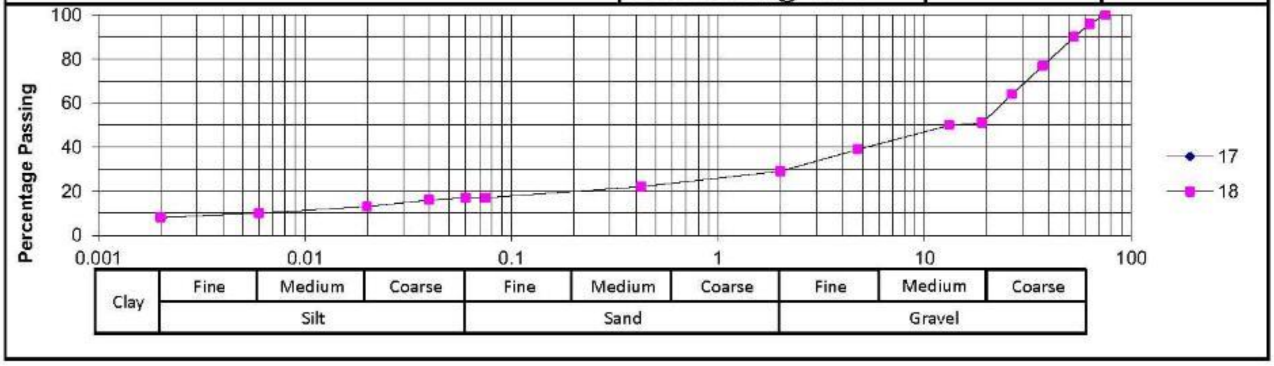
Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm		17
	0.040 mm		16
	0.020 mm		13
	0.006 mm		10
	0.002 mm		8
Gravel	%		71
Sand	%		12
Silt	%		9
Clay	%		8





Laboratory Number		17 ◆	18 ■
Atterberg Limits - TMH1 Method A2, A3 & A4			
Liquid Limit	%	29	37
Plasticity Index	%	11	19
Linear Shrinkage	%	5.5	10.0
Overall PI	%	8	4
Classifications			
HRB			A-2-6(0)
Unified			GC
Weston Swell @ 1 kPa			



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FOUNDATION INDICATOR

Laboratory Number		19 ◆	20 ■
Field Number		FTP 13	FTP 5
Client Reference			
Depth (m)		0.3-0.6	0.6-1.1
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

Moisture Content & Relative Density-TMH1 Metod A12T

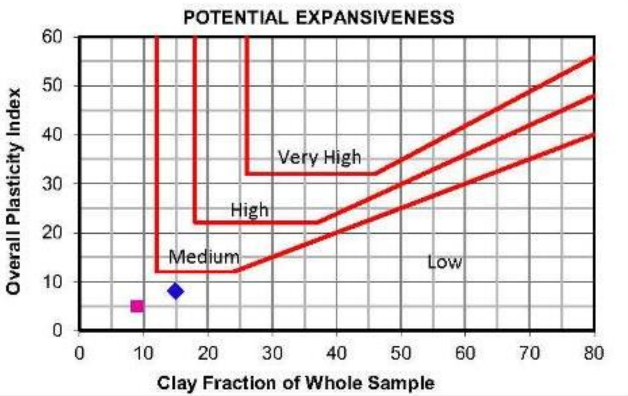
Moisture Content (%)		
Relative Density (S.G.)		

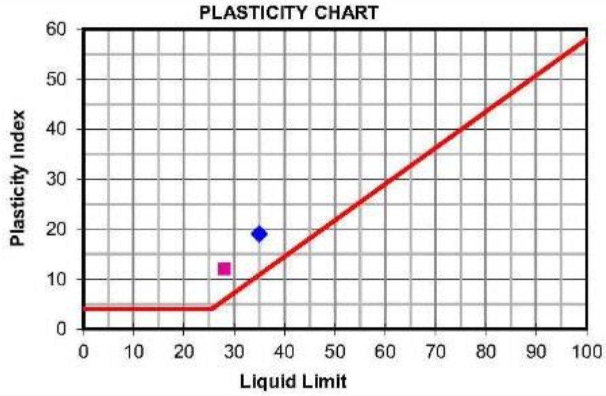
Sieve Analysis (Wet Preparation) - TMH1 Method A1(a)

Percentage Passing	75.0 mm	100	100
	63.0 mm	100	98
	53.0 mm	97	98
	37.5 mm	86	88
	26.5 mm	77	73
	19.0 mm	65	65
	13.2 mm	65	62
	4.75 mm	53	55
	2.00 mm	47	47
	0.425 mm	42	39
	0.075 mm	26	22
Grading Modulus		1.85	1.92

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	25	20
	0.040 mm	24	16
	0.020 mm	22	14
	0.006 mm	17	11
	0.002 mm	15	9
Gravel	%	53	53
Sand	%	22	27
Silt	%	10	11
Clay	%	15	9





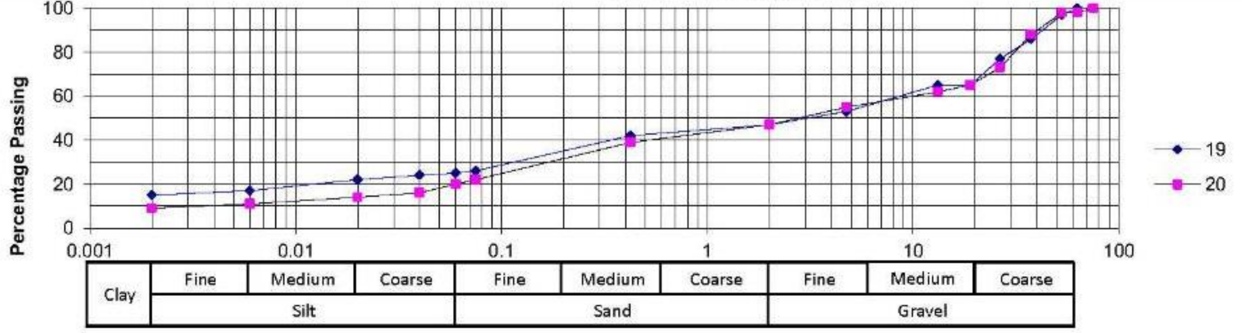
Laboratory Number		19 ◆	20 ■

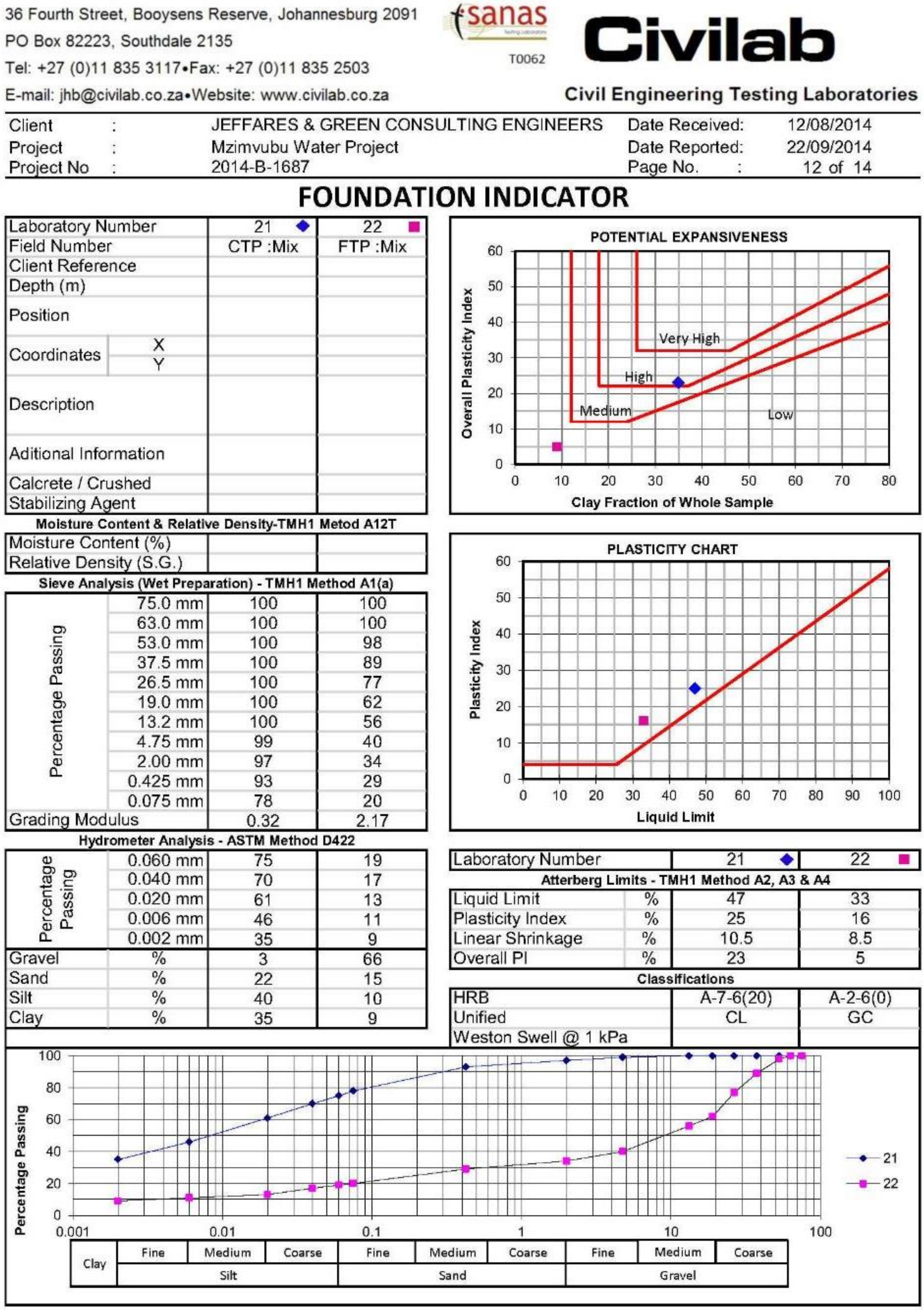
Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	35	28
Plasticity Index	%	19	12
Linear Shrinkage	%	9.5	6.5
Overall PI	%	8	5

Classifications

HRB	A-2-6(1)	A-2-6(0)
Unified	GC	GC
Weston Swell @ 1 kPa		





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FOUNDATION INDICATOR

Laboratory Number		21 ◆	22 ■
Field Number		CTP :Mix	FTP :Mix
Client Reference			
Depth (m)			
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	98
	37.5 mm	100	89
	26.5 mm	100	77
	19.0 mm	100	62
	13.2 mm	100	56
	4.75 mm	99	40
	2.00 mm	97	34
	0.425 mm	93	29
	0.075 mm	78	20
Grading Modulus		0.32	2.17

Hydrometer Analysis - ASTM Method D422

Percentage Passing	0.060 mm	75	19
	0.040 mm	70	17
	0.020 mm	61	13
	0.006 mm	46	11
	0.002 mm	35	9
Gravel	%	3	66
Sand	%	22	15
Silt	%	40	10
Clay	%	35	9

Laboratory Number		21 ◆	22 ■

Atterberg Limits - TMH1 Method A2, A3 & A4

Liquid Limit	%	47	33
Plasticity Index	%	25	16
Linear Shrinkage	%	10.5	8.5
Overall PI	%	23	5

Classifications

HRB	A-7-6(20)	A-2-6(0)
Unified	CL	GC
Weston Swell @ 1 kPa		

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MOISTURE DENSITY RELATIONSHIP

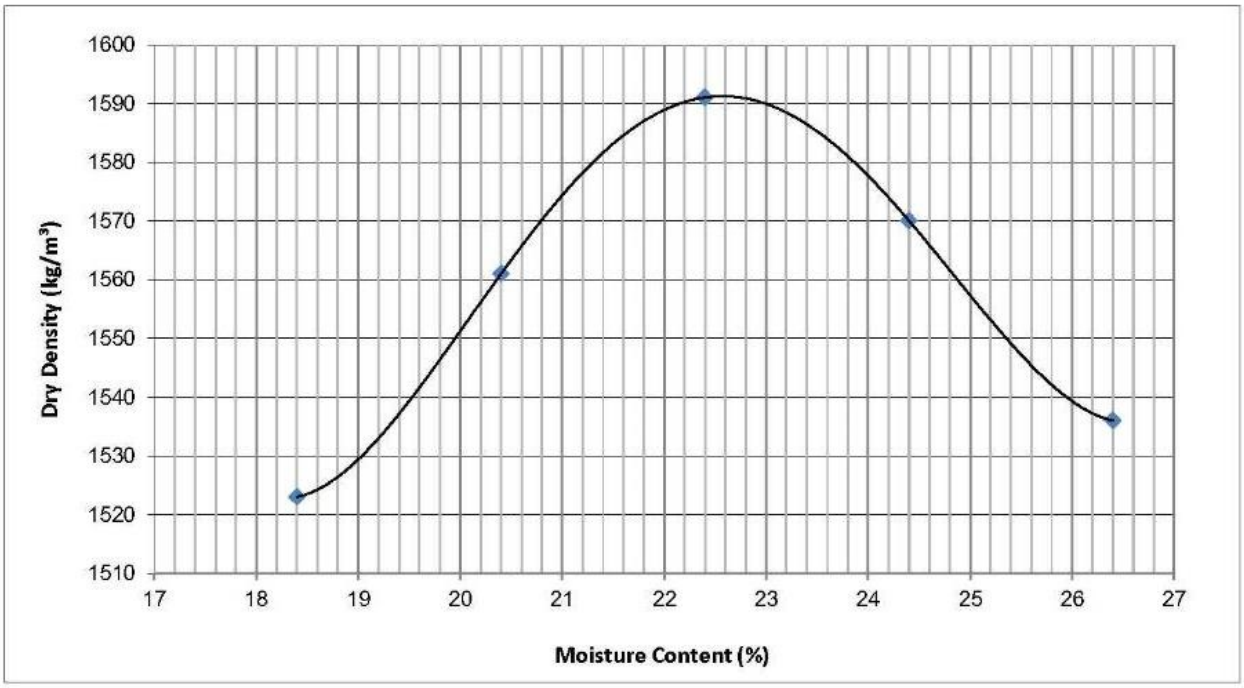
Laboratory Number		21
Field Number		CTP :Mix
Client Reference		
Depth (m)		
Position		
Coordinates	X	
	Y	
Description		
Additional Information		
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - TMH1 Method A7

Compactive Effort:	Standard Proctor

Dry Density	kg/m³	1523	1561	1591	1570	1536	
Moisture Content	%	18.4	20.4	22.4	24.4	26.4	

Max. Dry Density	kg/m³	1591
Optimum Moisture	%	22.6



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MOISTURE DENSITY RELATIONSHIP

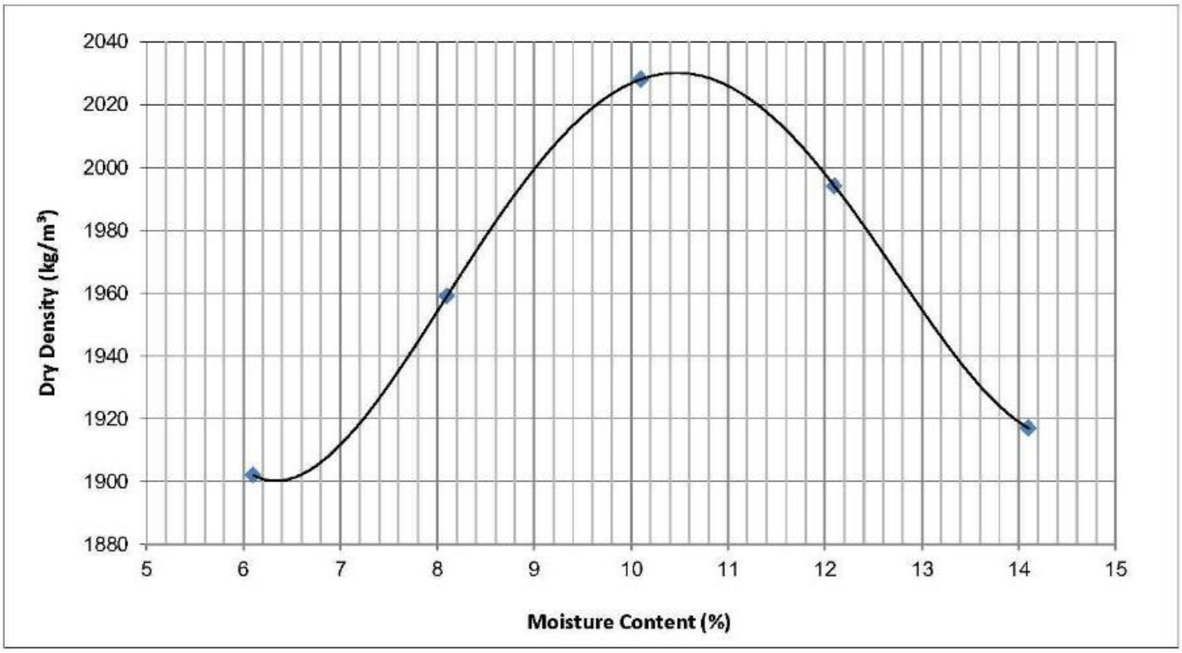
Laboratory Number		22
Field Number		FTP :Mix
Client Reference		
Depth (m)		
Position		
Coordinates	X	
	Y	
Description		
Additional Information		
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - TMH1 Method A7

Compactive Effort:	Standard Proctor

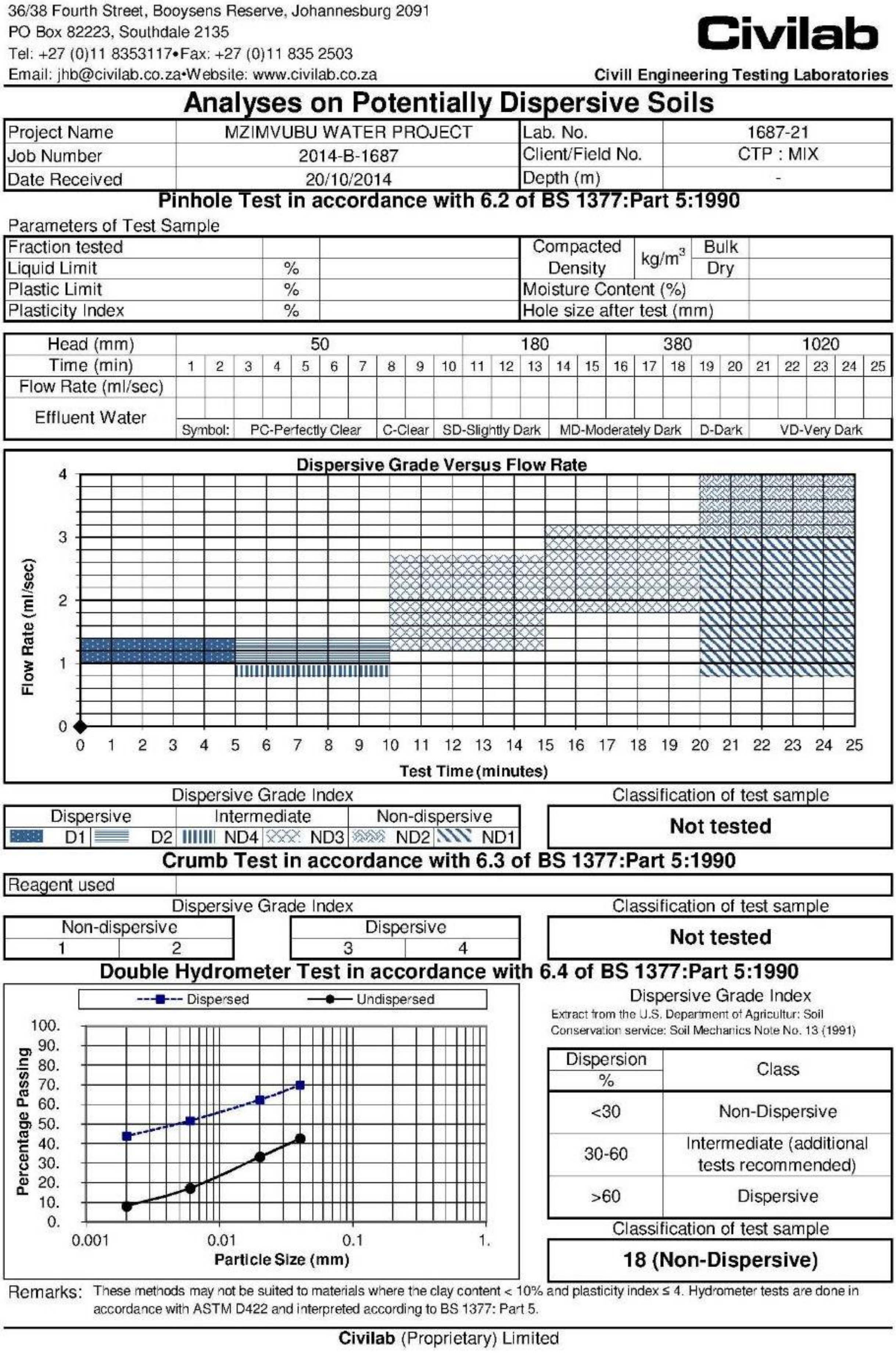
Dry Density	kg/m³	1902	1959	2028	1994	1917	
Moisture Content	%	6.1	8.1	10.1	12.1	14.1	

Max. Dry Density	kg/m³	2030
Optimum Moisture	%	10.5



E5:

GEOTECHNICAL TESTING – CORE AND SHELL MATERIALS



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Analyses on Potentially Dispersive Soils

Project Name	MZIMVUBU WATER PROJECT	Lab. No.	1687-21
Job Number	2014-B-1687	Client/Field No.	CTP : MIX
Date Received	20/10/2014	Depth (m)	-

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	19	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

18 (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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Falling Head Permeability Test Results

Project: MZIMVUBU WATER PROJECT

Project No: 2014-B-1687

Date: 21/10/2014

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	Range Maximum	Average
1687-21	CTP : MIX	-	22.0	25.2	1567	1573	2.5E-08	3.0E-08	**2.7E-08**

Remarks:
Sample remoulded to 98% Proctor.
Saturated and tested under a load of 100kPa.
Densities reported are under a load of 100kPa.

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FallingHead-2014-B-1687

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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-21
Field Sample Number:	CTP - Mix	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,8

Remarks: A Consolidated Drained teston a remoulded 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: 0.99

CONSOLIDATION DATA

Effective cons. Stress (kPa): 195.4 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)	*100.81	*50.05	1967.42	24.2	1521	0.7742	84	
CONSOLIDATED	99.15	49.22	1902.68	26.3	1600	0.6867	103	2.698 Determined
FINAL (After shear)	79.52	54.17	2304.94	24.5	1646	0.6396	103	

Initial pore pressure (kPa): 533.6 Final pore pressure (kPa): 348.9 PWP dissipation (%): 97
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

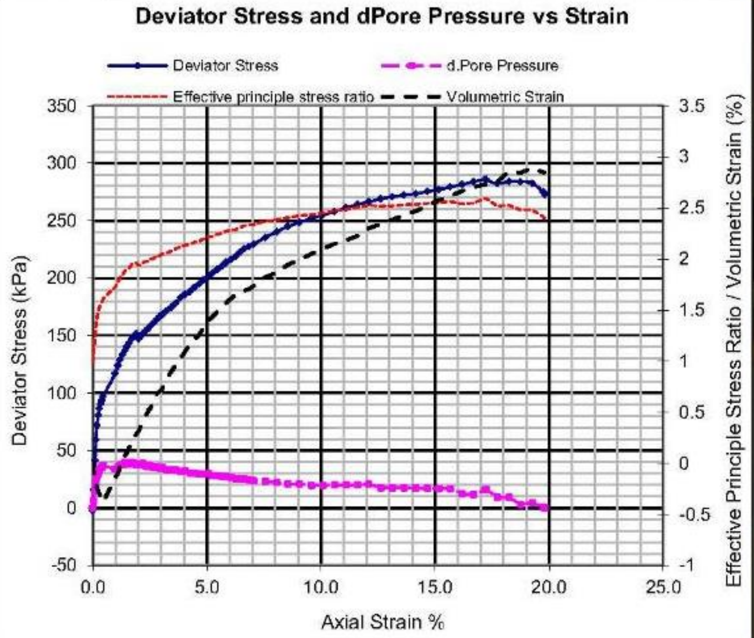
Rate of strain (%/hour): 0.50
Initial pore pressure (kPa): 347.6 Initial effective stress (kPa): 195.4

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 17.19 Volumetric strain (%): 2.73

		Principle Stresses (kPa)			
Deviator stress (kPa):	285.9				
Excess pore pressure (kPa):	15.5	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	2.590	481.3	465.8	195.4	179.8

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:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-21
Field Sample Number:	CTP - Mix	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,8

Remarks: A Consolidated Drained teston a remoulded 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): 396.7 t100 (minutes): 324 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)	*100.03	*50.03	1965.85	25.5	1519	0.7756	89	2.698 Determined
CONSOLIDATED	97.49	48.74	1865.85	26.7	1645	0.6401	113	
FINAL (After shear)	84.32	51.50	2082.96	24.6	1701	0.5859	113	

Initial pore pressure (kPa): 342.7 Final pore pressure (kPa): 345.8 PWP dissipation (%): 97
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

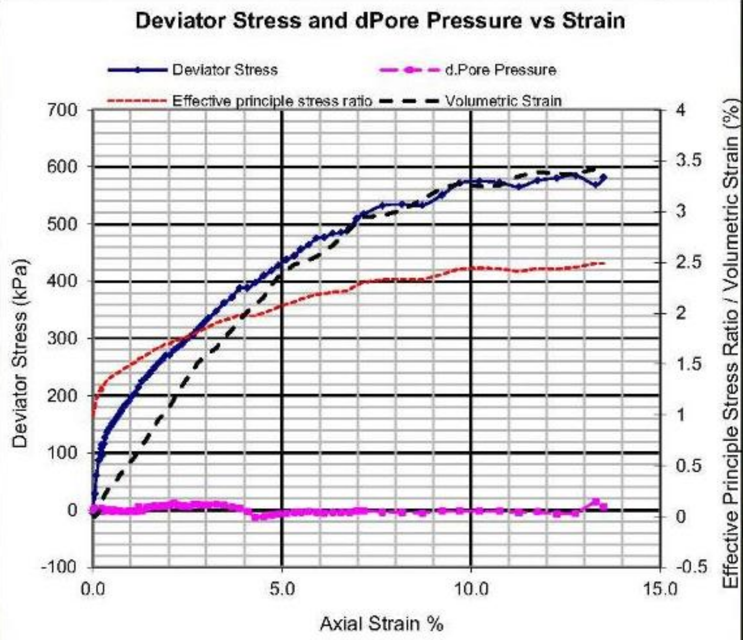
Rate of strain (%/hour): 0.09
Initial pore pressure (kPa): 346.3 Initial effective stress (kPa): 396.7

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 12.77 Volumetric strain (%): 3.37

		Principle Stresses (kPa)			
Deviator stress (kPa):	585.0	σ1	σ1'	σ3	σ3'
Excess pore pressure (kPa):	-6.0				
Effective principle stress ratio:	2.452	981.7	987.7	396.7	402.8

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:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-21
Field Sample Number:	CTP - Mix	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,8

Remarks:	A Consolidated Drained teston a remoulded 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): 802.1 t100 (minutes): 400 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)	*100.57	*50.03	1965.85	23.7	1534	0.6655	91	2.555 Determined
CONSOLIDATED	96.74	48.09	1816.28	22.5	1732	0.4754	121	
FINAL (After shear)	86.64	50.07	1969.24	20.8	1778	0.4373	122	

Initial pore pressure (kPa): 339.0 Final pore pressure (kPa): 345.0 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

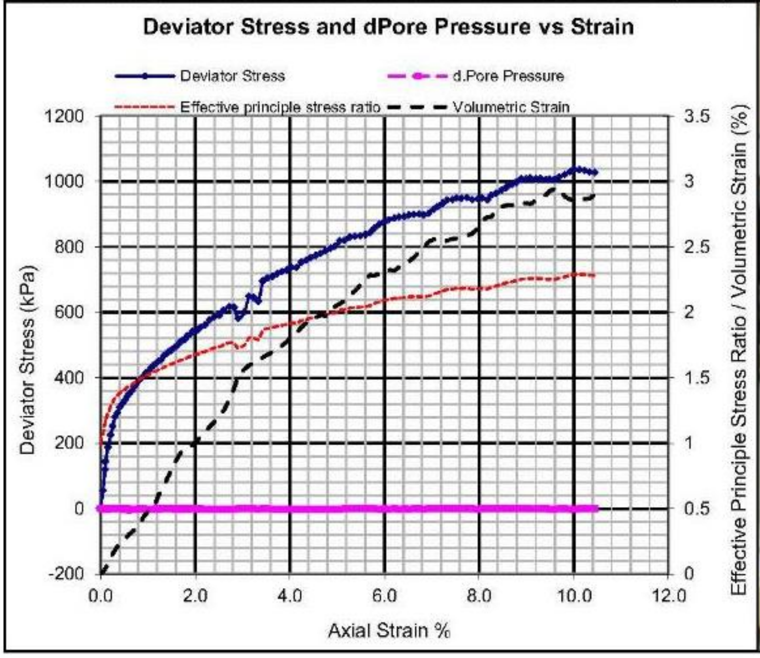
Rate of strain (%/hour): 0.05
Initial pore pressure (kPa): 338.9 Initial effective stress (kPa): 802.1

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 10.01 Volumetric strain (%): 2.85

		Principle Stresses (kPa)			
Deviator stress (kPa):	1037.7				
Excess pore pressure (kPa):	-1.1	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	2.292	1839.8	1840.9	802.1	803.2

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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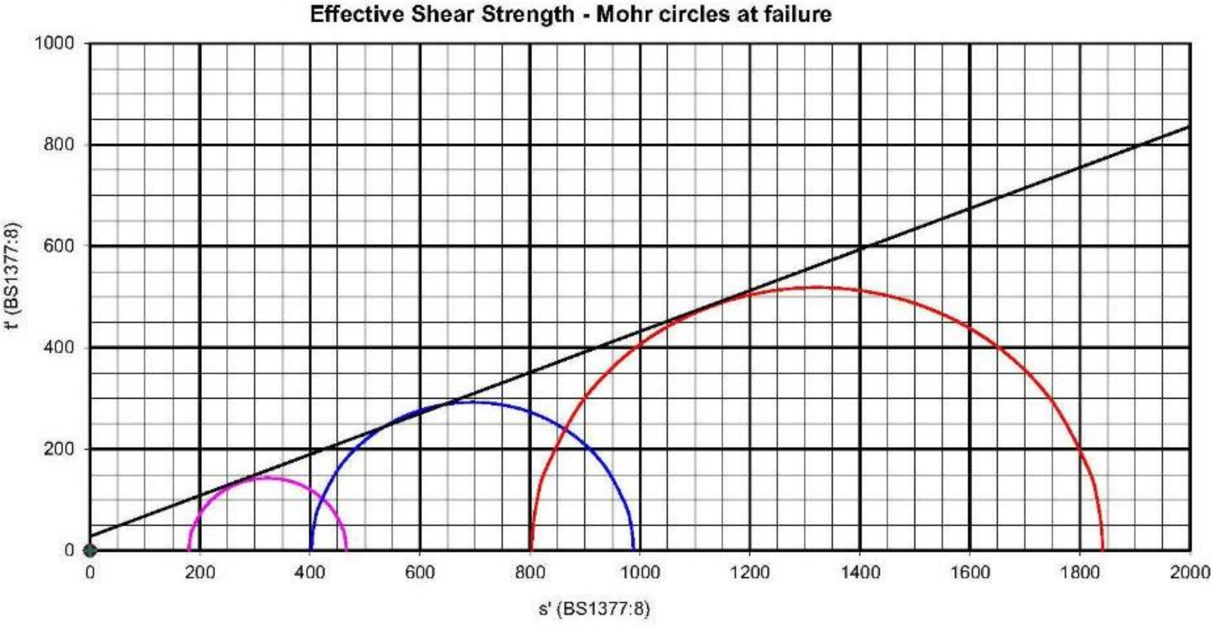
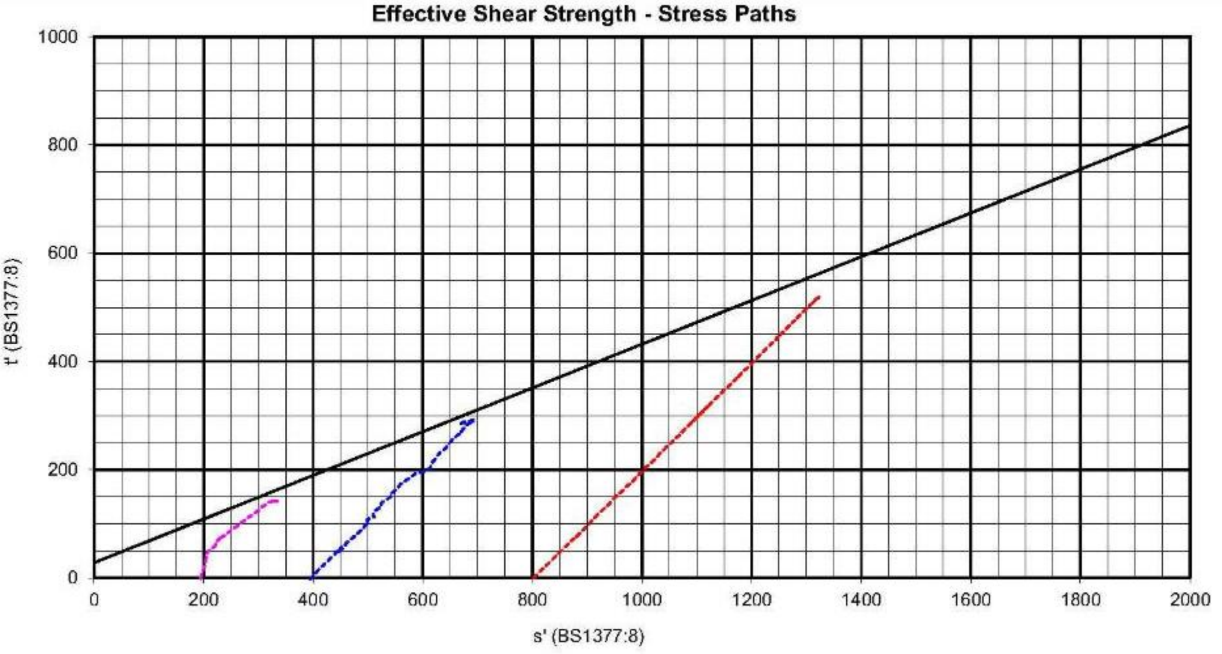
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-21
Field Sample Reference:	CTP - Mix	Depth (m):	-

Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	22.6	22.3
Effective	27.9	22.0





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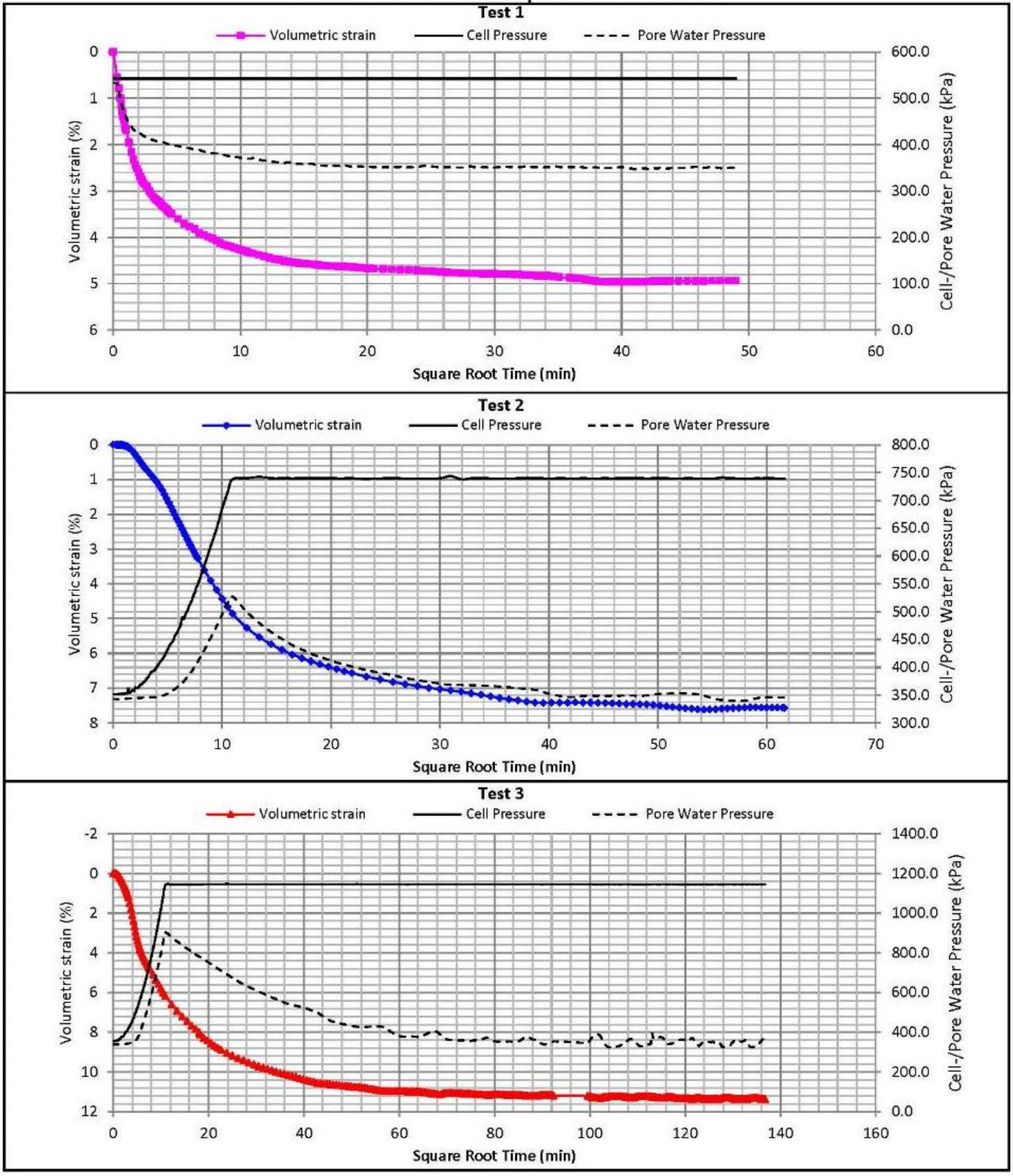
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-21
Field Sample Reference:	CTP - Mix	Depth (m):	-

Consolidation vs Square Root Time



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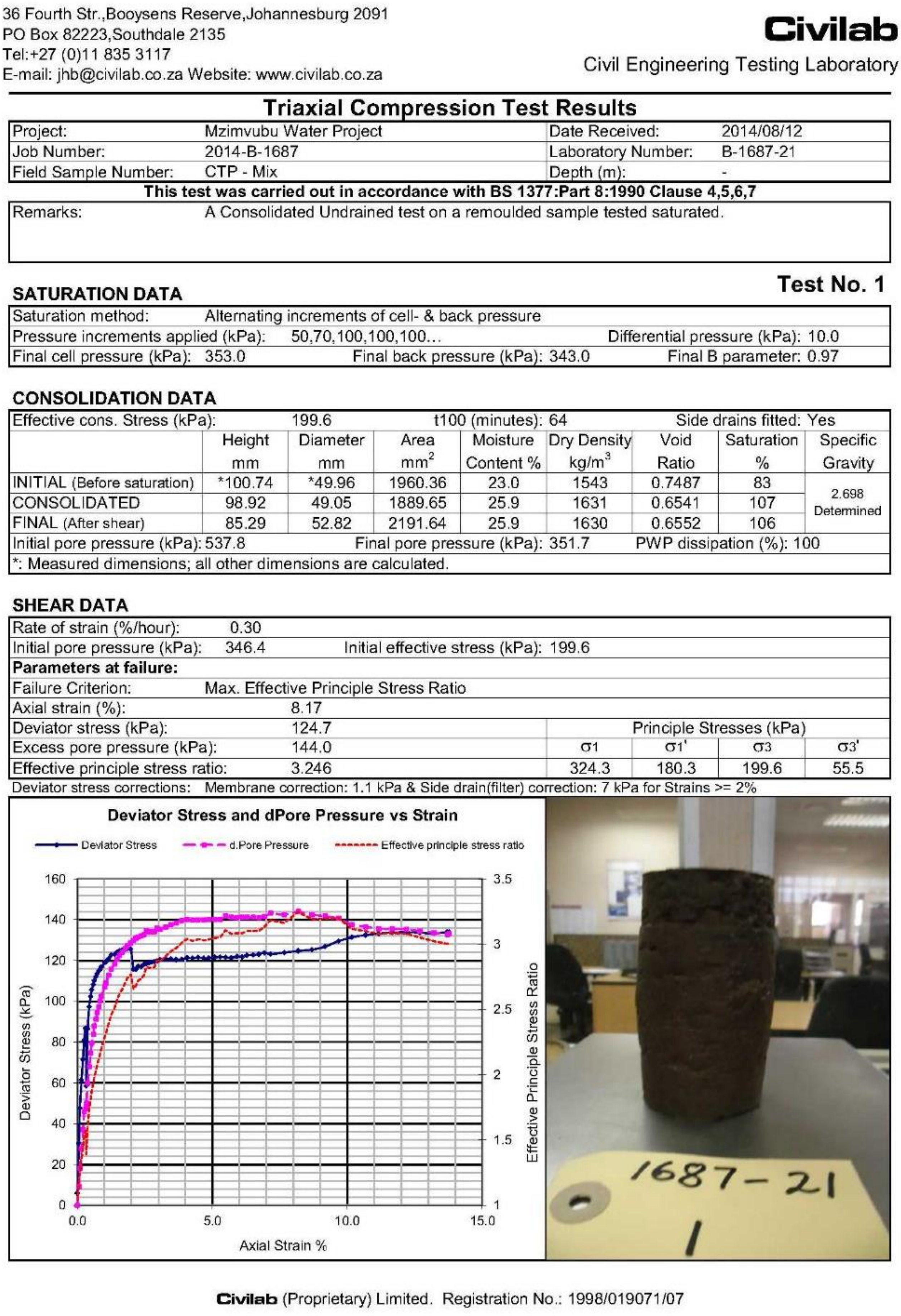

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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	B-1687-21
Field Sample Number:	CTP - Mix	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.

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): 199.6 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)	*100.74	*49.96	1960.36	23.0	1543	0.7487	83	2.698 Determined
CONSOLIDATED	98.92	49.05	1889.65	25.9	1631	0.6541	107	
FINAL (After shear)	85.29	52.82	2191.64	25.9	1630	0.6552	106	

Initial pore pressure (kPa): 537.8 Final pore pressure (kPa): 351.7 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 346.4 Initial effective stress (kPa): 199.6

Parameters at failure:

Failure Criterion: Max. Effective Principle Stress Ratio
Axial strain (%): 8.17

		Principle Stresses (kPa)			
Deviator stress (kPa):	124.7				
Excess pore pressure (kPa):	144.0	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.246	324.3	180.3	199.6	55.5

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%

Deviator Stress and dPore Pressure vs Strain

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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	B-1687-21
Field Sample Number:	CTP - Mix	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.

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): 343.0 Final back pressure (kPa): 333.0 Final B parameter: 0.99

CONSOLIDATION DATA

Effective cons. Stress (kPa): 397.1 t100 (minutes): 81 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	*50	1963.50	23.2	1550	0.7409	85	
CONSOLIDATED	97.13	48.54	1850.78	24.1	1696	0.5910	110	2.698 Determined
FINAL (After shear)	80.69	53.26	2227.83	24.1	1693	0.5939	109	

Initial pore pressure (kPa): 728.9 Final pore pressure (kPa): 343.1 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

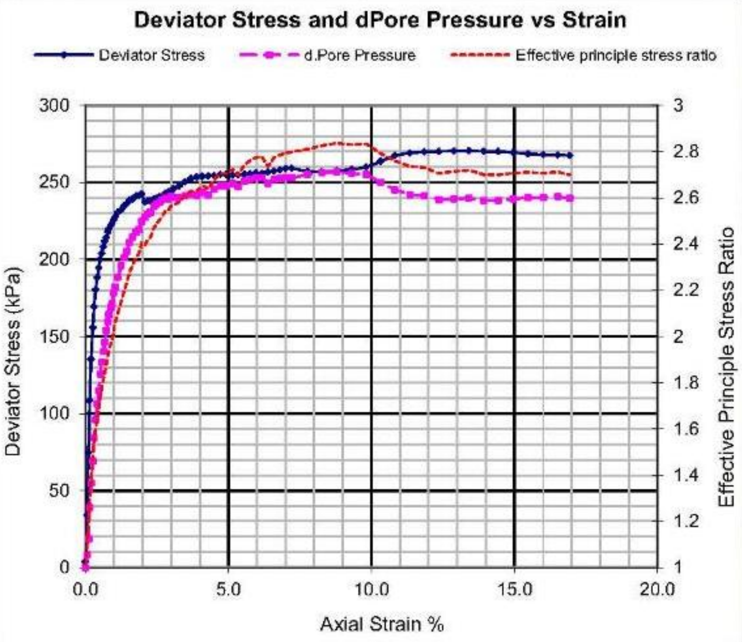
Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 341.9 Initial effective stress (kPa): 397.1

Parameters at failure:

Failure Criterion: Max. Effective Principle Stress Ratio

Axial strain (%):	8.79				
Deviator stress (kPa):	257.6	Principle Stresses (kPa)			
Excess pore pressure (kPa):	256.8	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	2.836	654.7	397.9	397.1	140.3

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:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	B-1687-21
Field Sample Number:	CTP - Mix	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.

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: 0.98

CONSOLIDATION DATA

Effective cons. Stress (kPa): 799.8 t100 (minutes): 400 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	*50	1963.50	22.9	1556	0.7335	84	2.698 Determined
CONSOLIDATED	96.20	48.06	1814.28	22.0	1757	0.5359	111	
FINAL (After shear)	86.83	50.59	2009.97	22.0	1751	0.5409	110	

Initial pore pressure (kPa): 341.7 Final pore pressure (kPa): 362.9 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

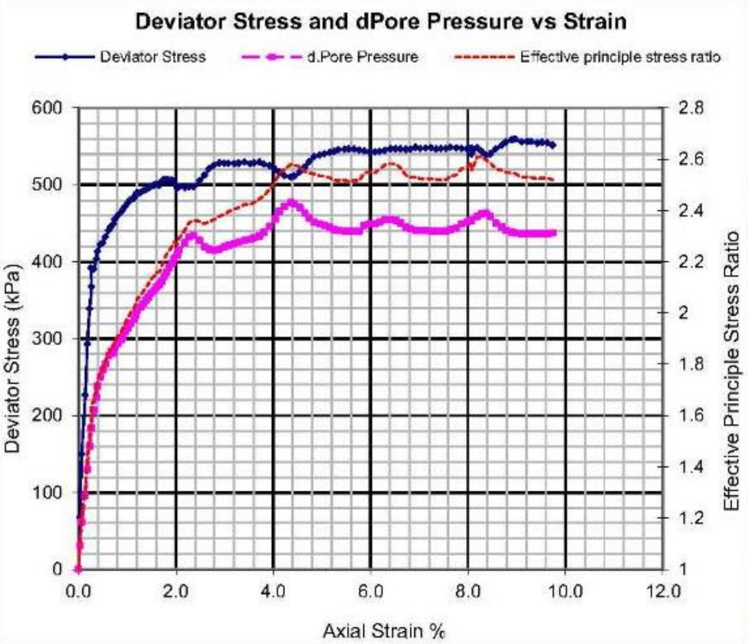
Rate of strain (%/hour): 0.08
Initial pore pressure (kPa): 342.2 Initial effective stress (kPa): 799.8

Parameters at failure:

Failure Criterion: Max. Effective Principle Stress Ratio

		Principle Stresses (kPa)			
Axial strain (%):	8.28				
Deviator stress (kPa):	543.4				
Excess pore pressure (kPa):	462.3	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	2.611	1343.2	880.9	799.8	337.4

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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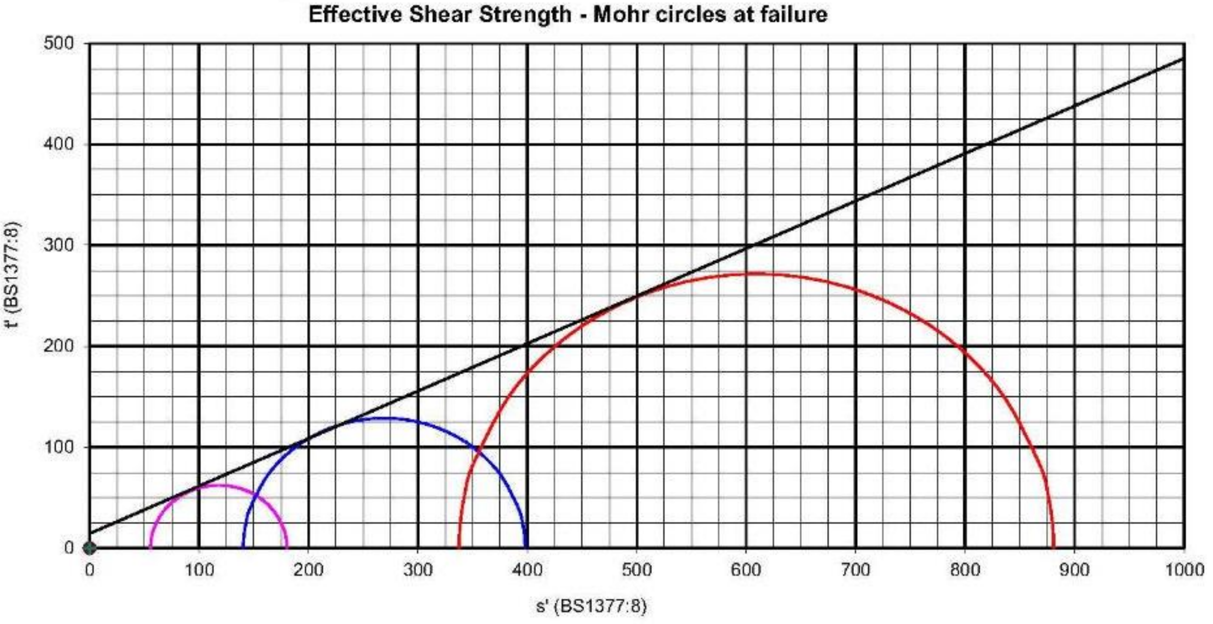
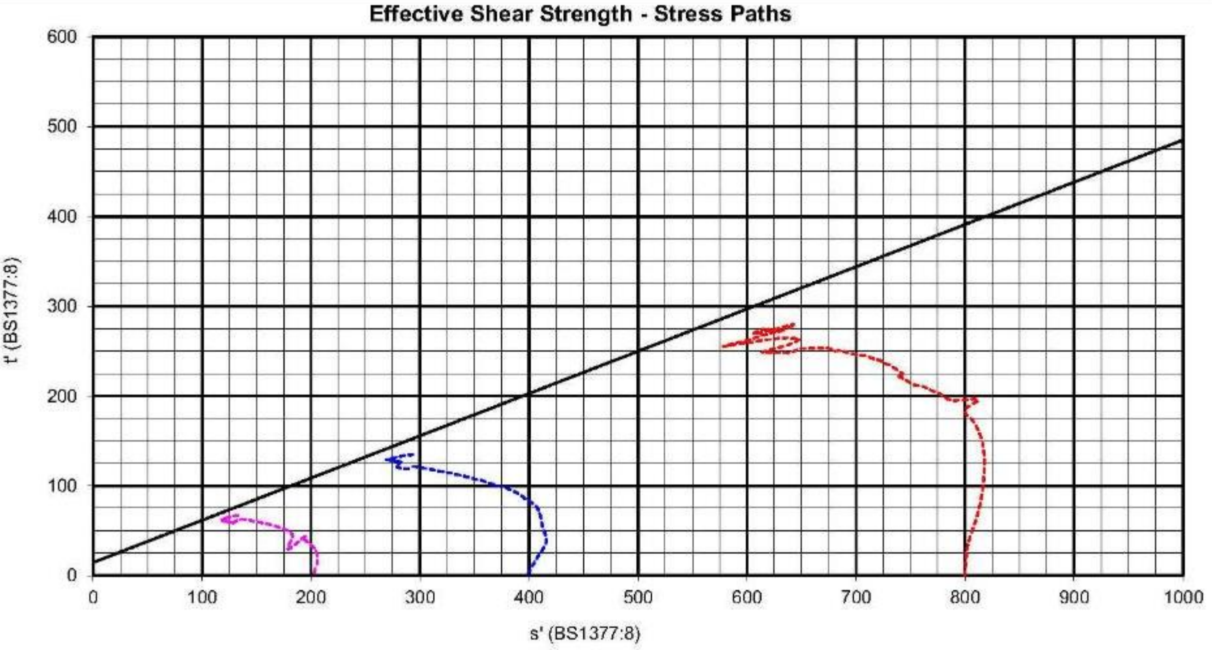
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	B-1687-21
Field Sample Reference:	CTP - Mix	Depth (m):	-

Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	0.0	14.6
Effective	14.5	25.2





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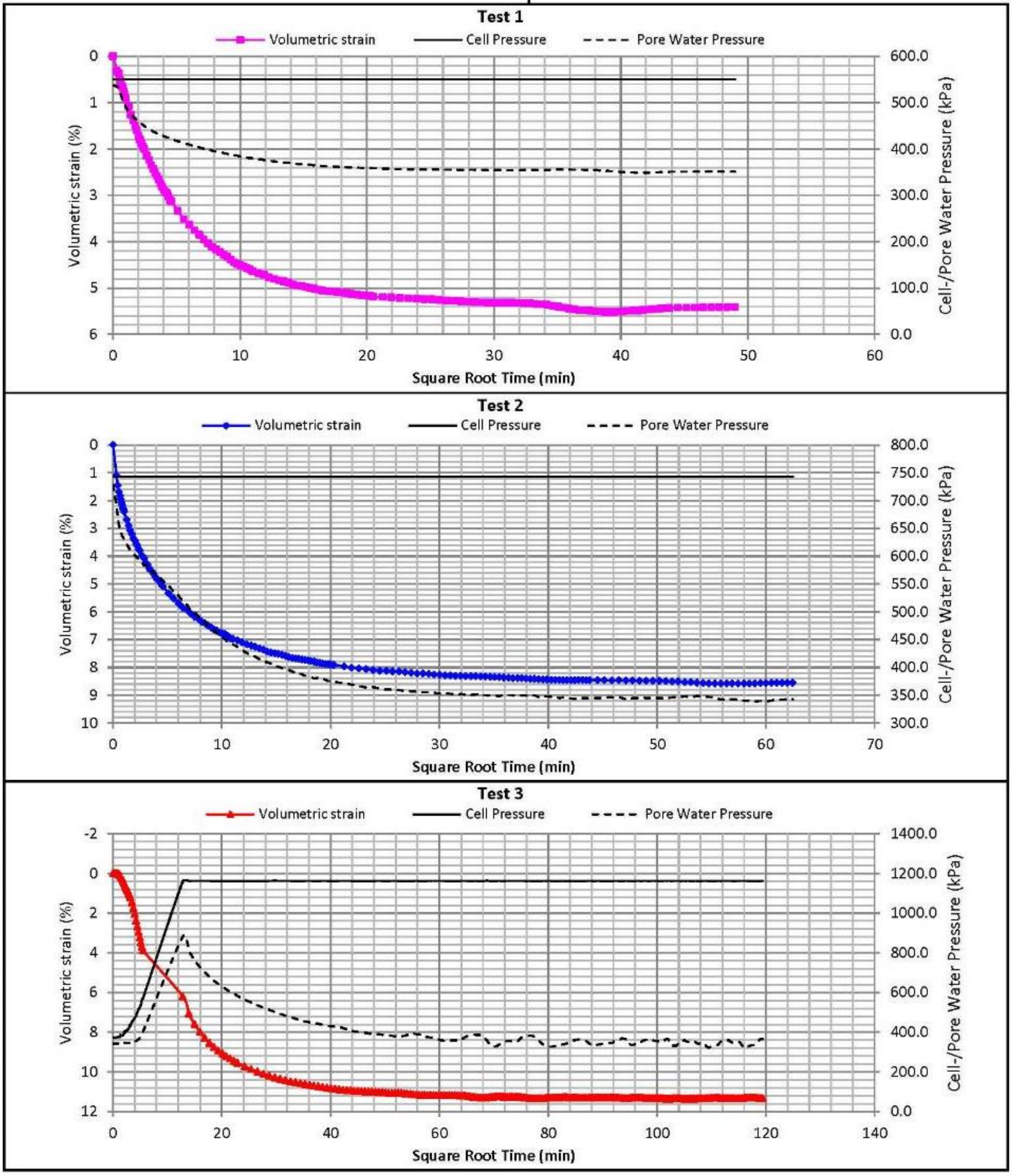
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	B-1687-21
Field Sample Reference:	CTP - Mix	Depth (m):	-

Consolidation vs Square Root Time



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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Number:	FTP - Mix	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,8

Remarks:	A Consolidated Drained teston a remoulded 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:	0.98

CONSOLIDATION DATA

Effective cons. Stress (kPa): 199.6 t100 (minutes): 1 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)	*103.98	*50.11	1972.14	10.0	1909	0.4324	63	
CONSOLIDATED	102.37	49.33	1911.19	15.7	2001	0.3660	117	2.734 Determined
FINAL (After shear)	85.47	53.52	2249.30	14.8	2036	0.3428	118	

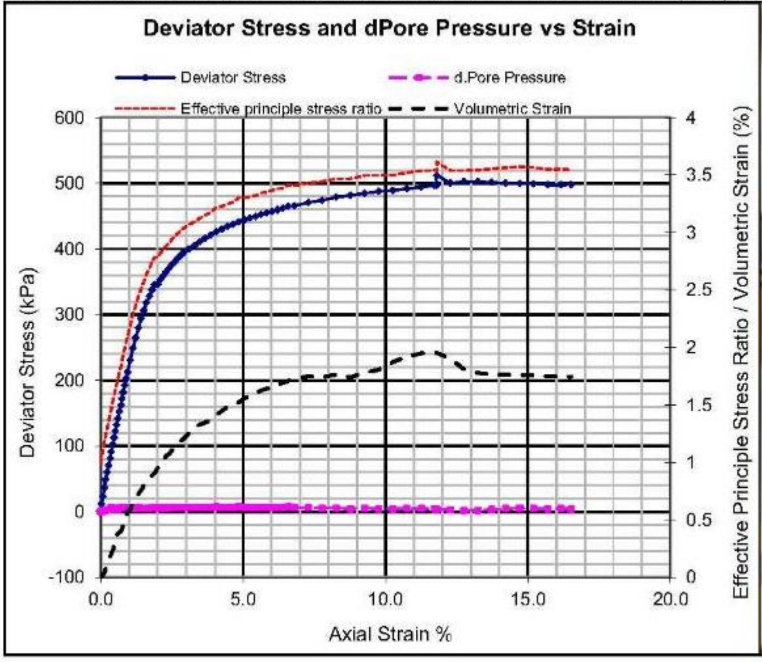
Initial pore pressure (kPa): 539.2 Final pore pressure (kPa): 343.4 PWP dissipation (%): 100

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	0.50				
Initial pore pressure (kPa):	341.4	Initial effective stress (kPa): 199.6			
Parameters at failure:					
Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	11.80	Volumetric strain (%): 1.95			
Deviator stress (kPa):	511.4	Principle Stresses (kPa)			
Excess pore pressure (kPa):	3.8	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.611	711.1	707.3	199.6	195.9

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:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Number:	FTP - Mix	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,8

Remarks:	A Consolidated Drained teston a remoulded sample tested saturated.

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): 353.0	Final back pressure (kPa): 343.0	Final B parameter:	0.96

CONSOLIDATION DATA

Effective cons. Stress (kPa):	400.4	t100 (minutes):	121		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)	*104.49	*50.36	1991.87	10.2	1880	0.4542	62	2.734 Determined
CONSOLIDATED	102.63	49.45	1920.87	14.8	1986	0.3764	108	
FINAL (After shear)	87.50	53.44	2243.10	14.6	1994	0.3713	107	

Initial pore pressure (kPa): 339.8 Final pore pressure (kPa): 339.6 PWP dissipation (%): 104

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

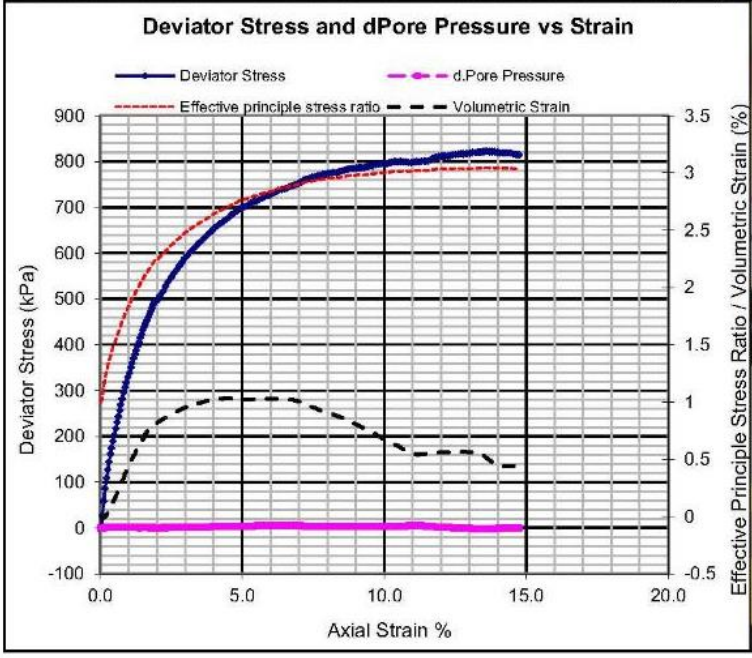
Rate of strain (%/hour): 0.21
Initial pore pressure (kPa): 337.6 Initial effective stress (kPa): 400.4

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 13.60 Volumetric strain (%): 0.51

		Principle Stresses (kPa)			
Deviator stress (kPa):	822.4	σ1	σ1'	σ3	σ3'
Excess pore pressure (kPa):	-1.3				
Effective principle stress ratio:	3.047	1222.8	1224.1	400.4	401.7

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:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Number:	FTP - Mix	Depth (m):	-

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,8

Remarks: A Consolidated Drained teston a remoulded 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): 800.2 t100 (minutes): 121 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)	*104.82	*50.1	1971.36	10.0	1898	0.4408	62	2.734 Determined
CONSOLIDATED	102.14	48.80	1870.44	14.3	2055	0.3302	118	
FINAL (After shear)	88.72	51.56	2088.11	12.8	2117	0.2917	120	

Initial pore pressure (kPa): 337.4 Final pore pressure (kPa): 337.9 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

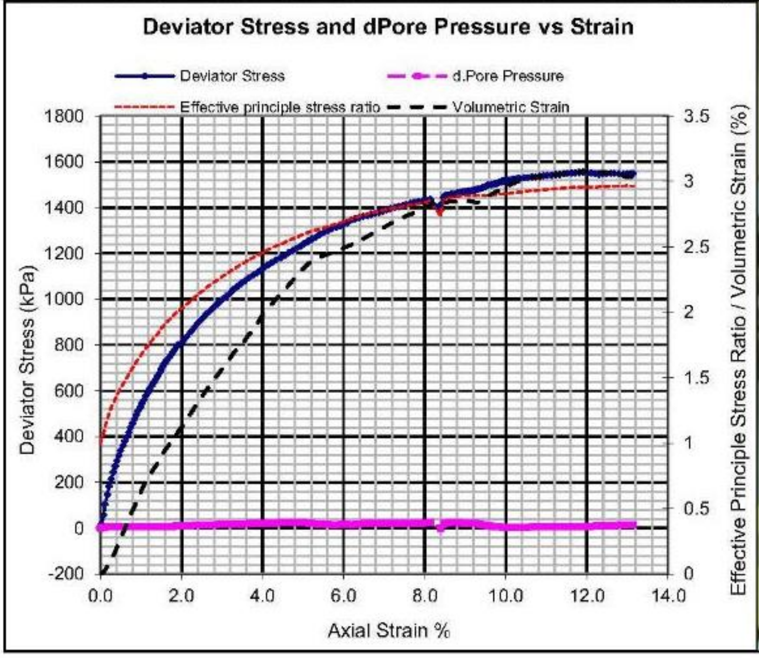
Rate of strain (%/hour): 0.18
Initial pore pressure (kPa): 336.8 Initial effective stress (kPa): 800.2

Parameters at failure:

Failure Criterion: Max. Deviator Stress
Axial strain (%): 11.90 Volumetric strain (%): 3.08

		Principle Stresses (kPa)			
Deviator stress (kPa):	1554.2	σ1	σ1'	σ3	σ3'
Excess pore pressure (kPa):	6.2				
Effective principle stress ratio:	2.957	2354.4	2348.2	800.2	794.0

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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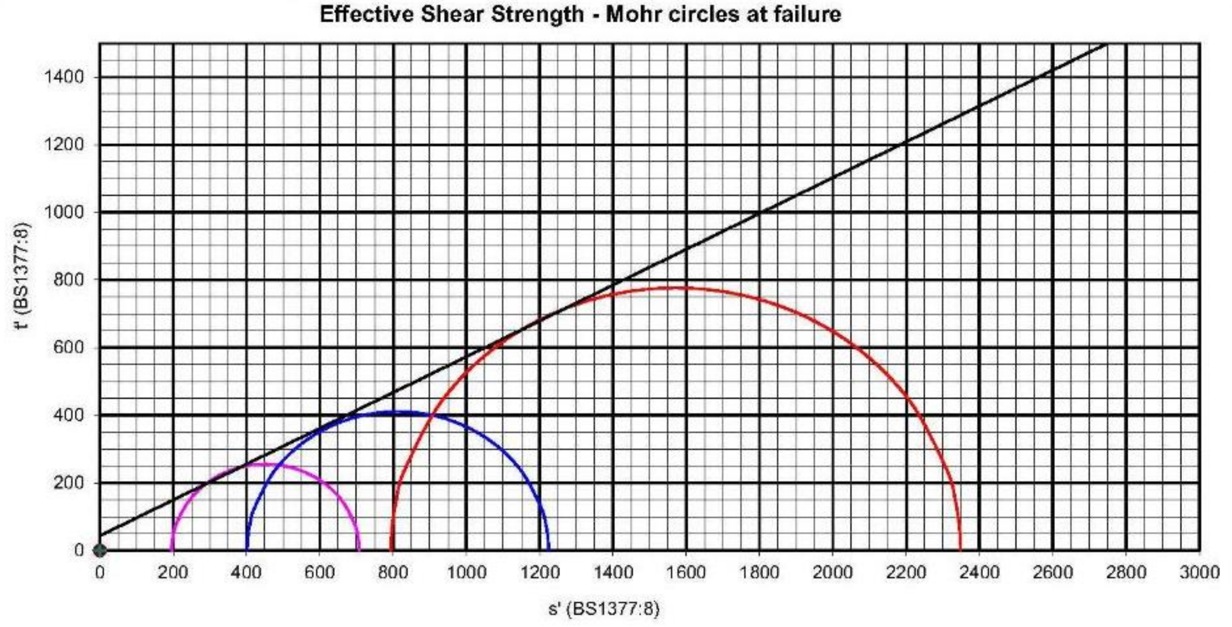
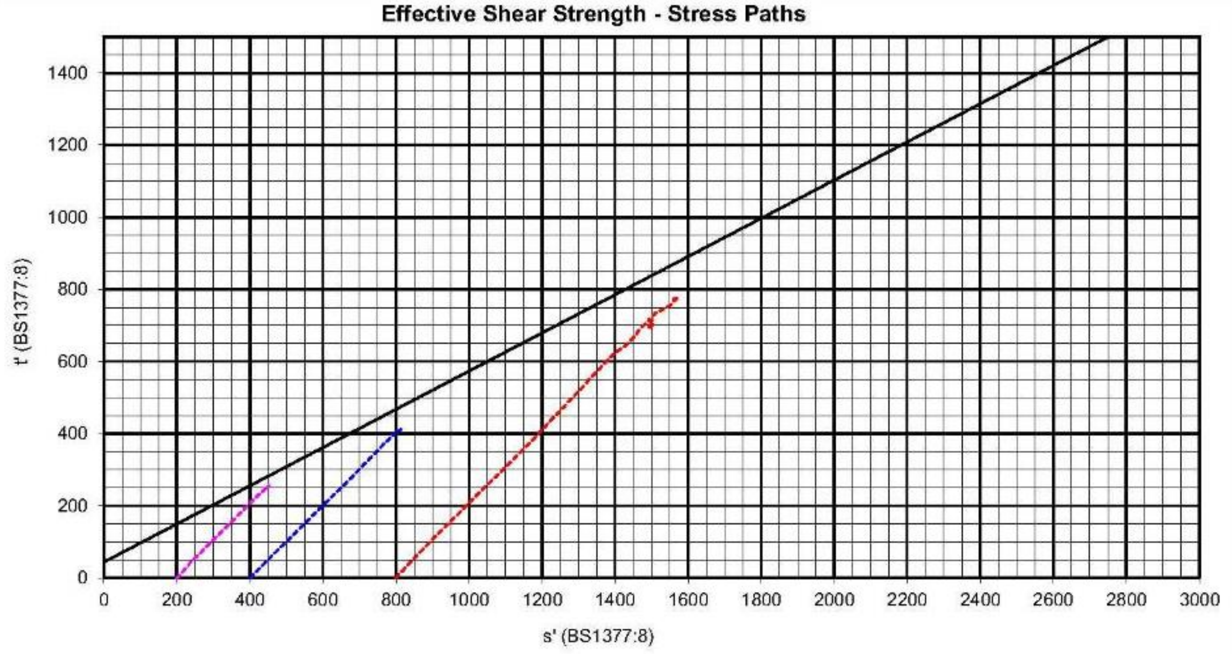
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Reference:	FTP - Mix	Depth (m):	-

Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	43.8	27.8
Effective	43.8	27.9





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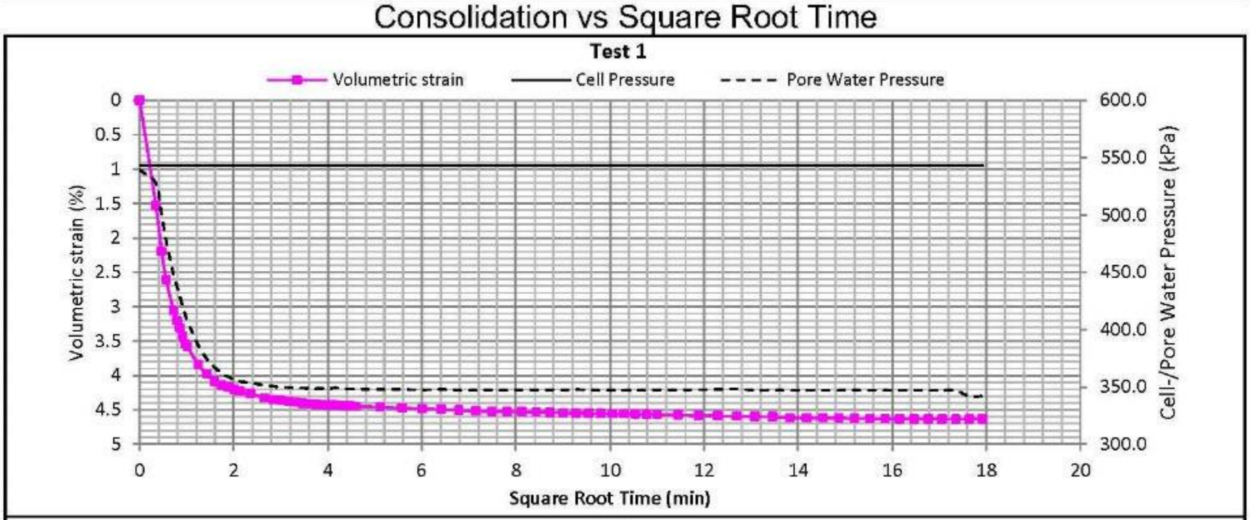
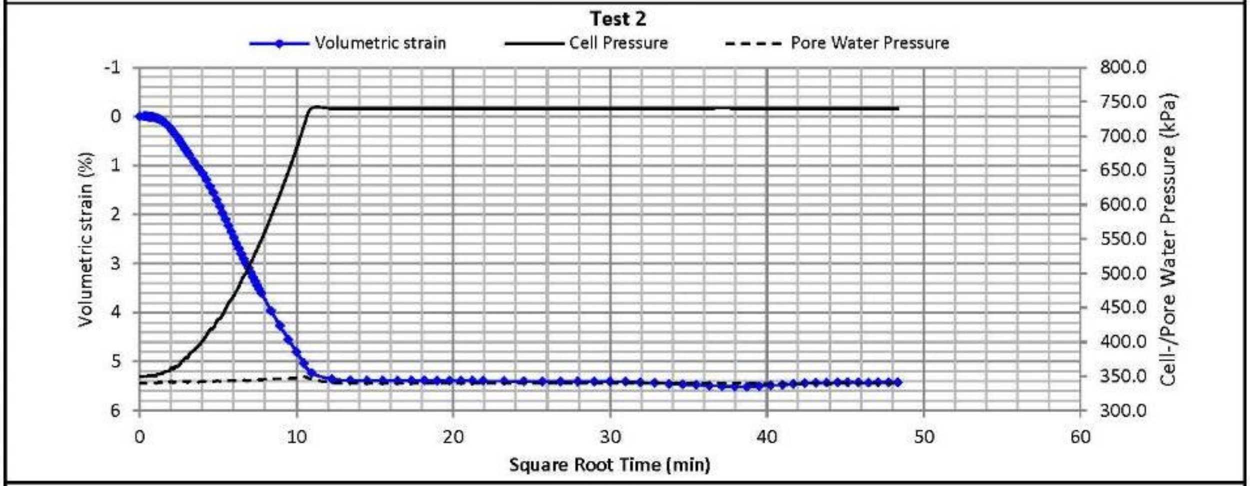
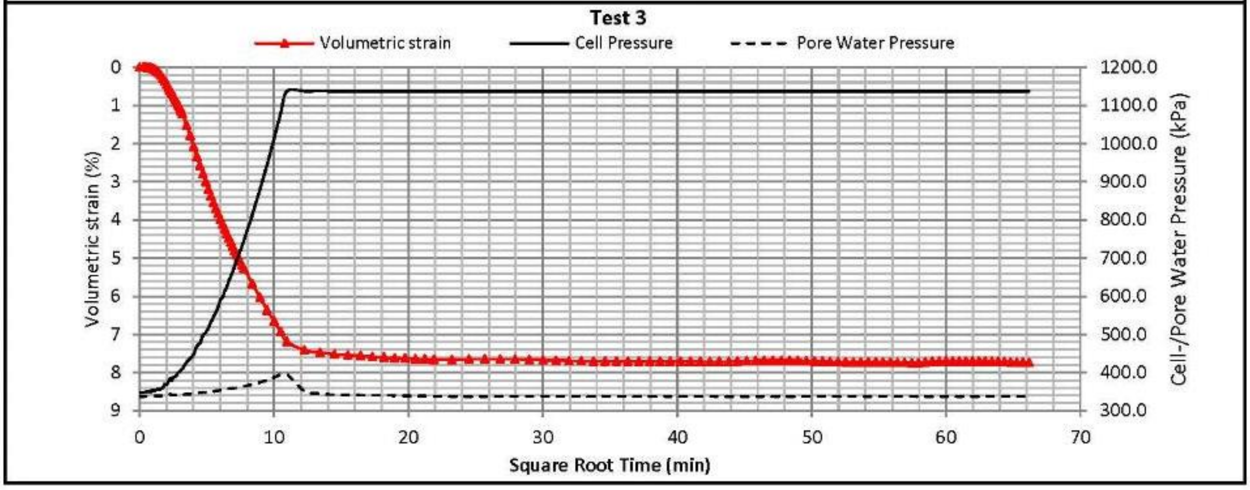
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Reference:	FTP - Mix	Depth (m):	-

Consolidation vs Square Root Time







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Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Number:	FTP - Mix	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.

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): 393.0 Final back pressure (kPa): 383.0 Final B parameter: 1.00

CONSOLIDATION DATA

Effective cons. Stress (kPa): 199.8 t100 (minutes): 1 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)	*105.19	*50.65	2014.88	10.0	1849	0.4786	57	2.734 Determined
CONSOLIDATED	104.13	50.14	1974.32	15.7	1907	0.4339	99	
FINAL (After shear)	87.67	54.64	2345.09	15.7	1906	0.4342	99	

Initial pore pressure (kPa): 573.7 Final pore pressure (kPa): 387.4 PWP dissipation (%): 100
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

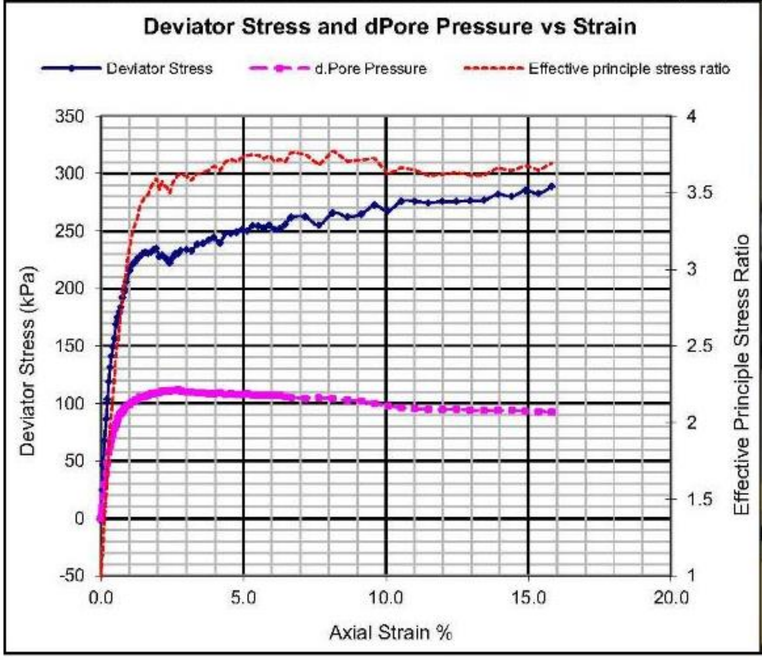
Rate of strain (%/hour): 0.30
Initial pore pressure (kPa): 386.2 Initial effective stress (kPa): 199.8

Parameters at failure:

Failure Criterion: Max. Effective Principle Stress Ratio

		Principle Stresses (kPa)			
Axial strain (%):	8.15				
Deviator stress (kPa):	265.9				
Excess pore pressure (kPa):	104.0	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.774	465.7	361.7	199.8	95.9

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:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Number:	FTP - Mix	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.

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): 333.0	Final back pressure (kPa): 323.0	Final B parameter: 0.96	

CONSOLIDATION DATA

Effective cons. Stress (kPa): 406.5 t100 (minutes): 0 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)	*104.42	*50.62	2012.49	10.0	1867	0.4645	59	2.734 Determined
CONSOLIDATED	102.88	49.87	1953.12	13.9	1953	0.3997	95	
FINAL (After shear)	83.59	55.32	2403.96	13.9	1952	0.4004	95	

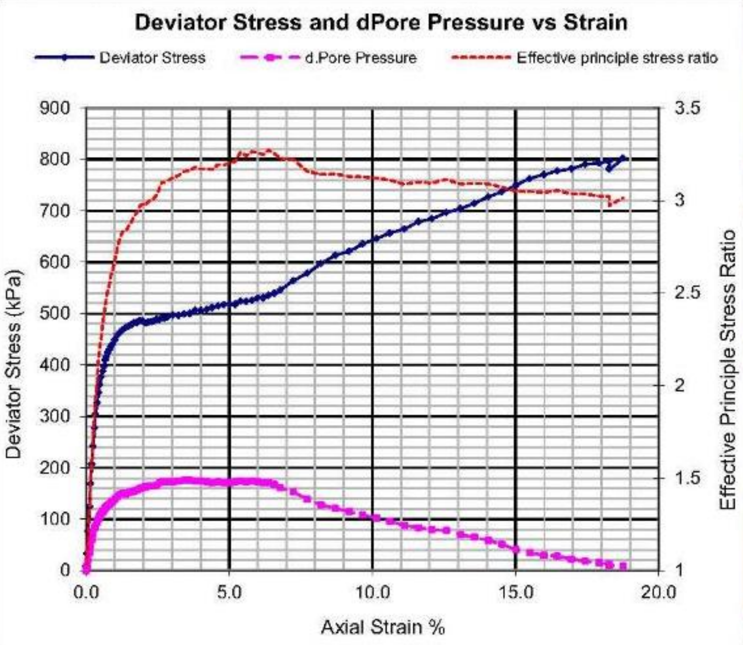
Initial pore pressure (kPa): 704.8 Final pore pressure (kPa): 322.2 PWP dissipation (%): 100

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	0.50				
Initial pore pressure (kPa):	319.5	Initial effective stress (kPa): 406.5			
Parameters at failure:					
Failure Criterion:	Max. Effective Principle Stress Ratio				
Axial strain (%):	6.37				
Deviator stress (kPa):	535.1	Principle Stresses (kPa)			
Excess pore pressure (kPa):	170.9	σ1	σ1'	σ3	σ3'
Effective principle stress ratio:	3.271	941.6	770.7	406.5	235.6

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:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Number:	FTP - Mix	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.

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: 0.98

CONSOLIDATION DATA

Effective cons. Stress (kPa): 799.7 t100 (minutes): 169 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)	*105.72	*50.84	2030.02	9.8	1831	0.4934	55	2.734 Determined
CONSOLIDATED	104.13	50.07	1968.78	13.8	1918	0.4258	89	
FINAL (After shear)	86.01	55.09	2383.39	13.8	1917	0.4265	88	

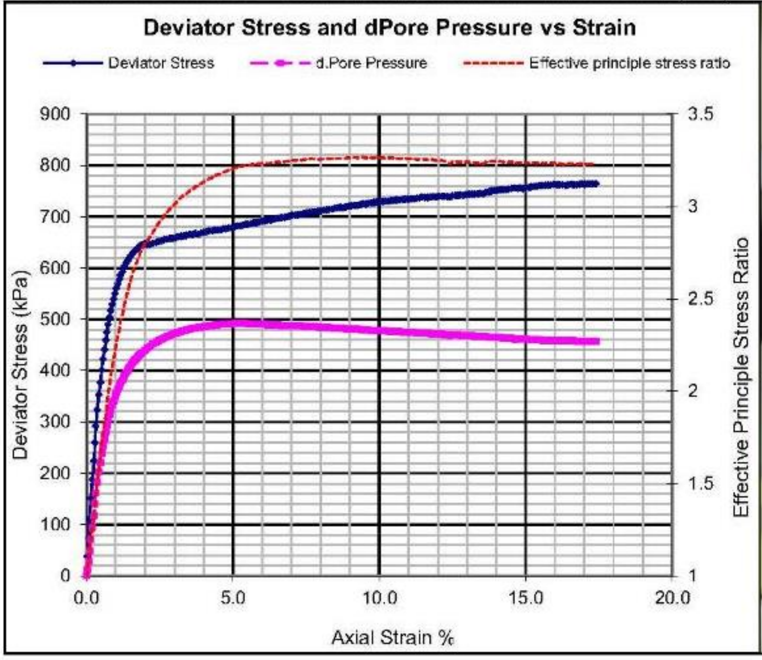
Initial pore pressure (kPa): 341.8 Final pore pressure (kPa): 342.4 PWP dissipation (%): 99
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 0.79
Initial pore pressure (kPa): 341.3 Initial effective stress (kPa): 799.7
Parameters at failure:
Failure Criterion: Max. Effective Principle Stress Ratio

Axial strain (%):	9.44				
Deviator stress (kPa):	725.4	Principle Stresses (kPa)			
Excess pore pressure (kPa):	479.8	$\sigma 1$	$\sigma 1'$	$\sigma 3$	$\sigma 3'$
Effective principle stress ratio:	3.267	1525.1	1045.3	799.7	319.9

Deviator stress corrections: Membrane correction: 2.2 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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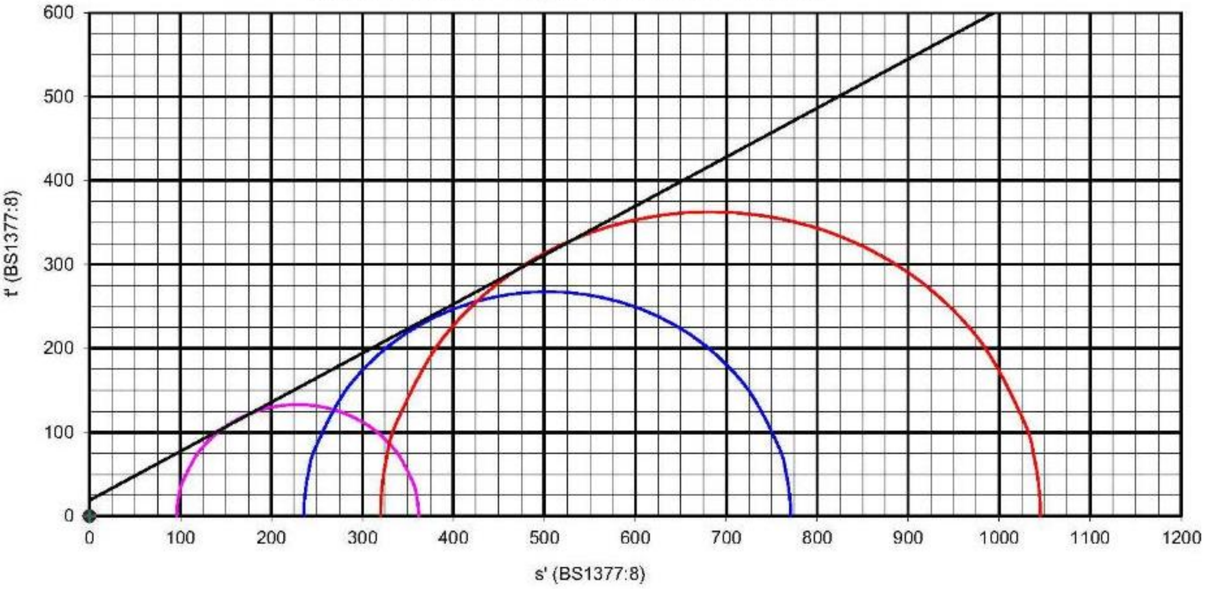
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Reference:	FTP - Mix	Depth (m):	-

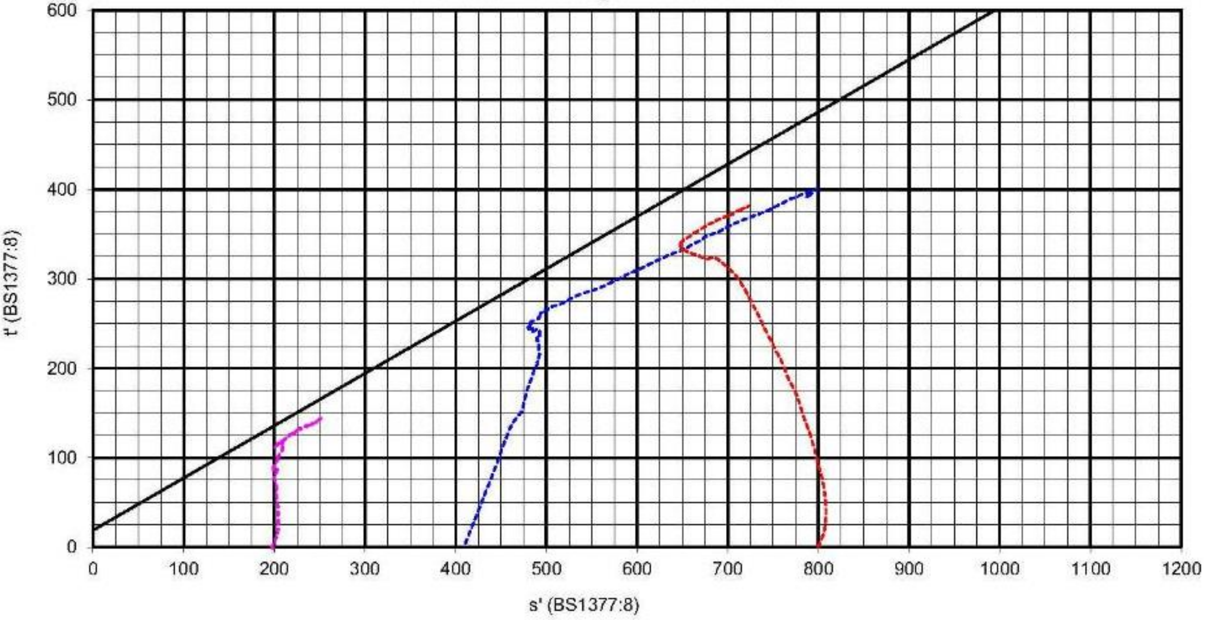
Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	60.5	15.7
Effective	18.9	30.3

Effective Shear Strength - Mohr circles at failure



Effective Shear Strength - Stress Paths



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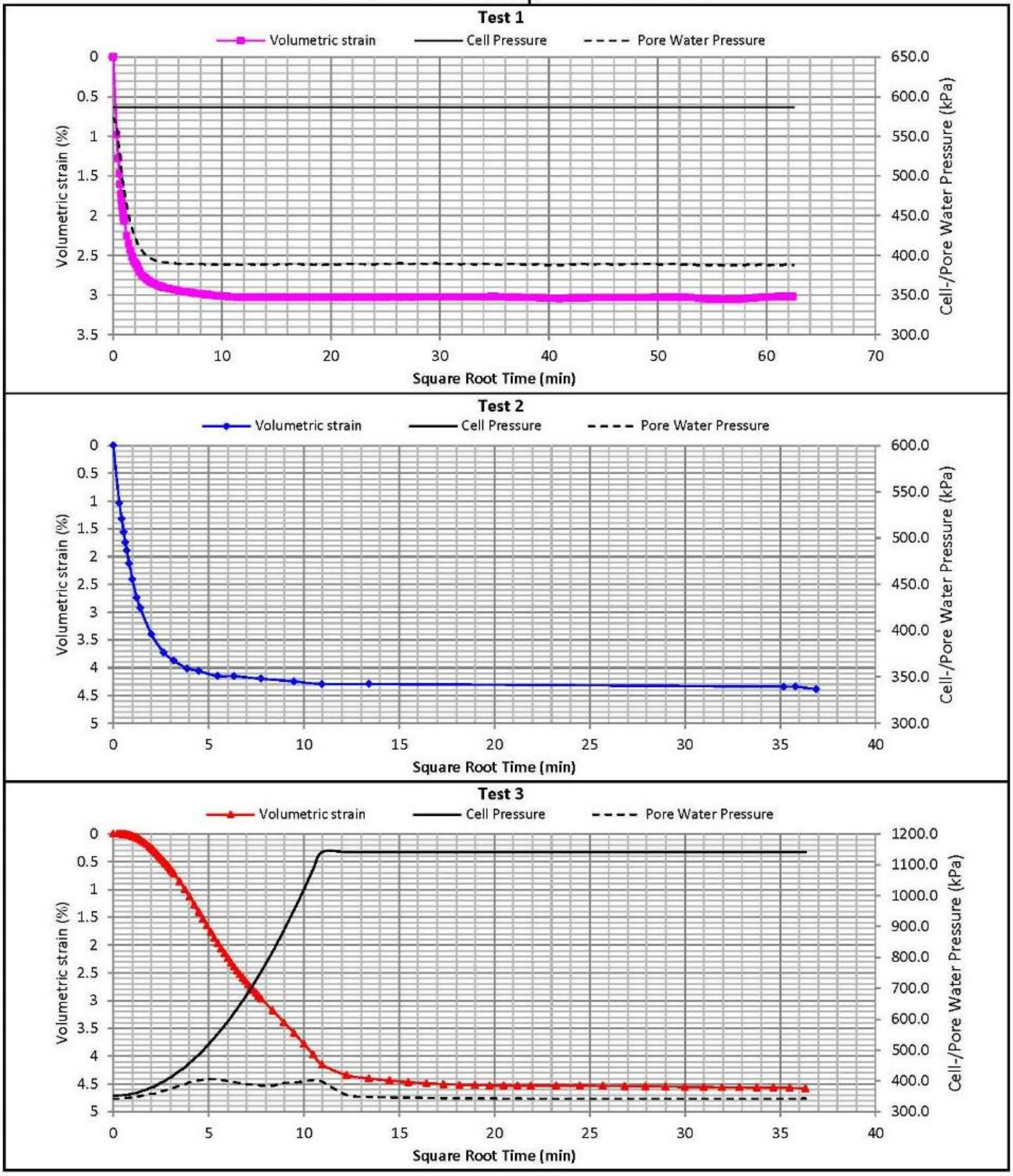
Triaxial Compression Test Results

Project:	Mzimvubu Water Project	Date Received:	2014/08/12
Job Number:	2014-B-1687	Laboratory Number:	1687-22
Field Sample Reference:	FTP - Mix	Depth (m):	-

Consolidation vs Square Root Time



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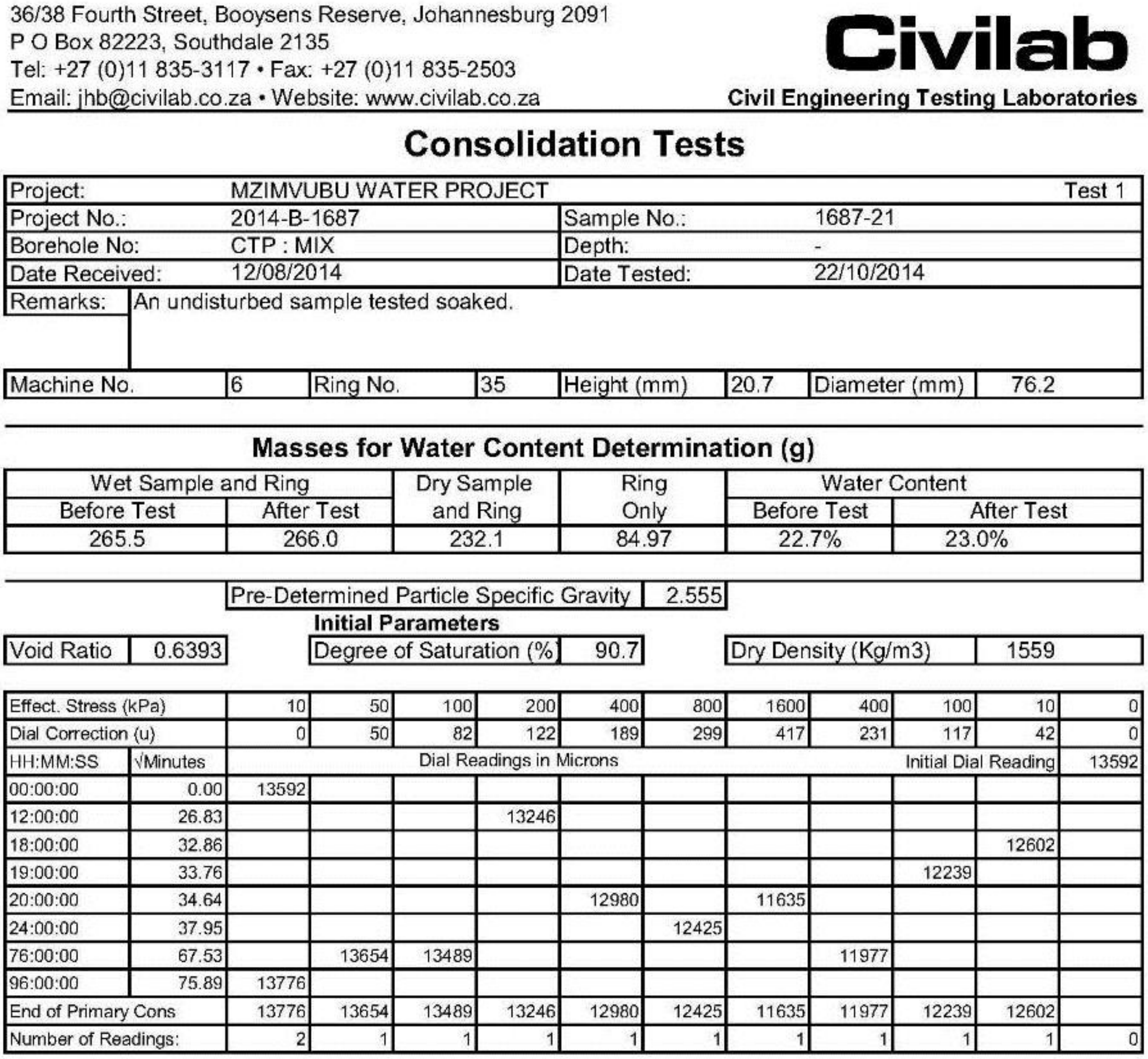

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Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		Test 1
Project No.:	2014-B-1687	Sample No.:	1687-21
Borehole No:	CTP : MIX	Depth:	-
Date Received:	12/08/2014	Date Tested:	22/10/2014
Remarks:	An undisturbed sample tested soaked.		

Machine No.	6	Ring No.	35	Height (mm)	20.7	Diameter (mm)	76.2

Masses for Water Content Determination (g)

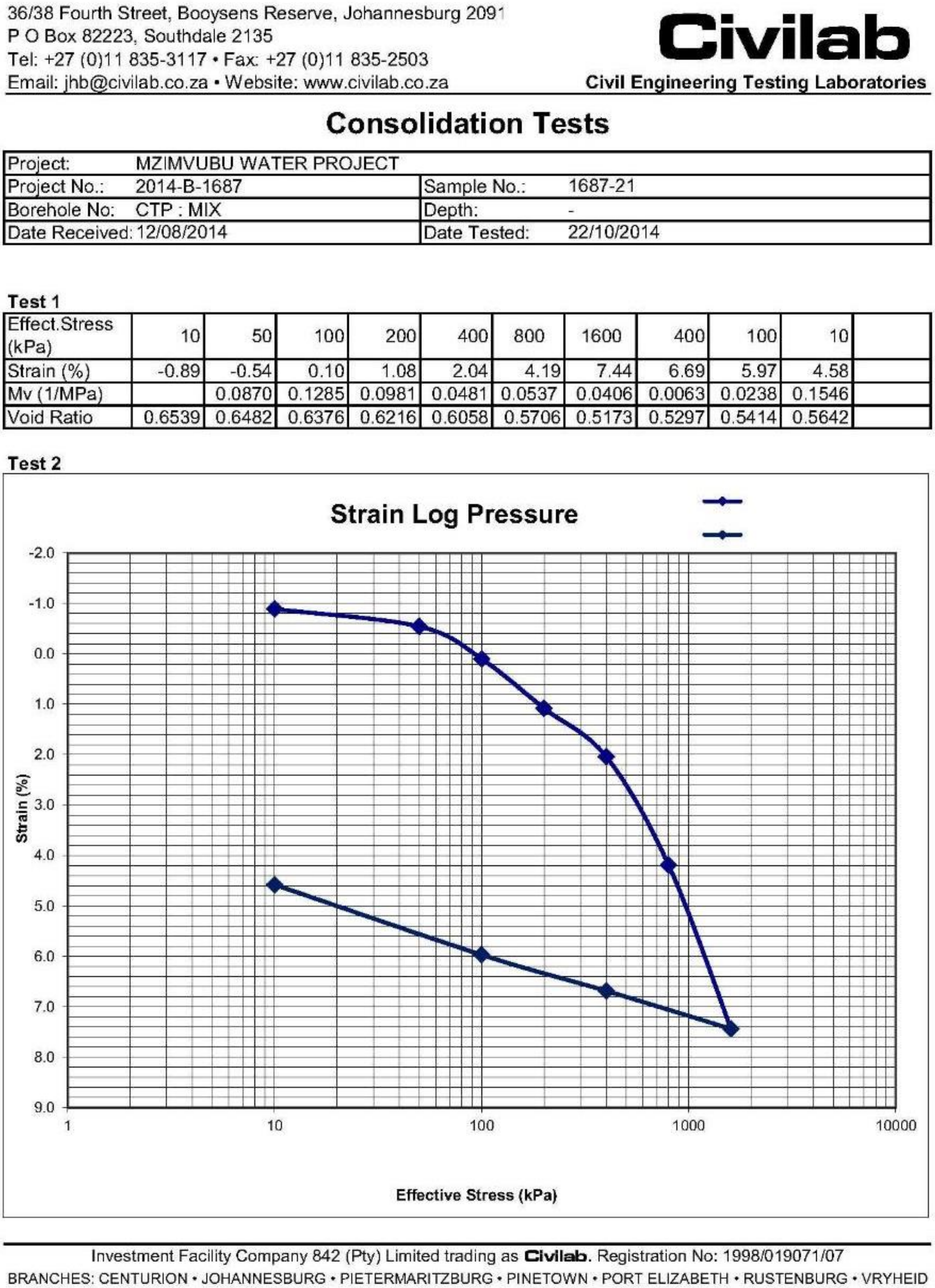
Wet Sample and Ring		Dry Sample and Ring	Ring Only	Water Content	
Before Test	After Test			Before Test	After Test
265.5	266.0	232.1	84.97	22.7%	23.0%

Pre-Determined Particle Specific Gravity 2.555

Initial Parameters

Void Ratio	0.6393	Degree of Saturation (%)	90.7	Dry Density (Kg/m3)	1559

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		13592
00:00:00	0.00	13592										
12:00:00	26.83				13246							
18:00:00	32.86										12602	
19:00:00	33.76									12239		
20:00:00	34.64					12980		11635				
24:00:00	37.95						12425					
76:00:00	67.53		13654	13489					11977			
96:00:00	75.89	13776										
End of Primary Cons		13776	13654	13489	13246	12980	12425	11635	11977	12239	12602	
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.:	2014-B-1687	Sample No.:	1687-21
Borehole No:	CTP : MIX	Depth:	-
Date Received:	12/08/2014	Date Tested:	22/10/2014

Test 1

Effect.Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.89	-0.54	0.10	1.08	2.04	4.19	7.44	6.69	5.97	4.58	
Mv (1/MPa)		0.0870	0.1285	0.0981	0.0481	0.0537	0.0406	0.0063	0.0238	0.1546	
Void Ratio	0.6539	0.6482	0.6376	0.6216	0.6058	0.5706	0.5173	0.5297	0.5414	0.5642	

Test 2

Strain Log Pressure

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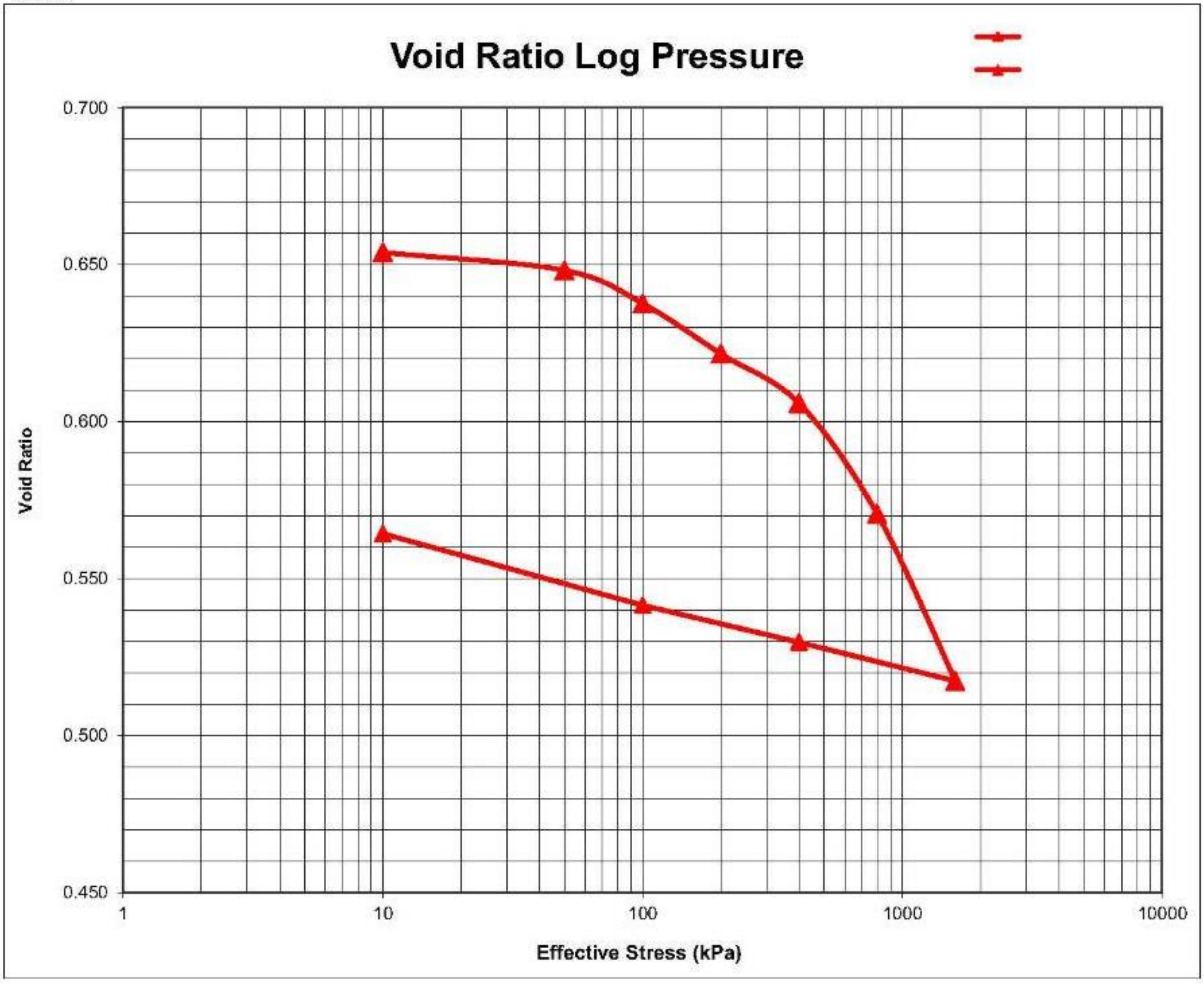
Consolidation Tests

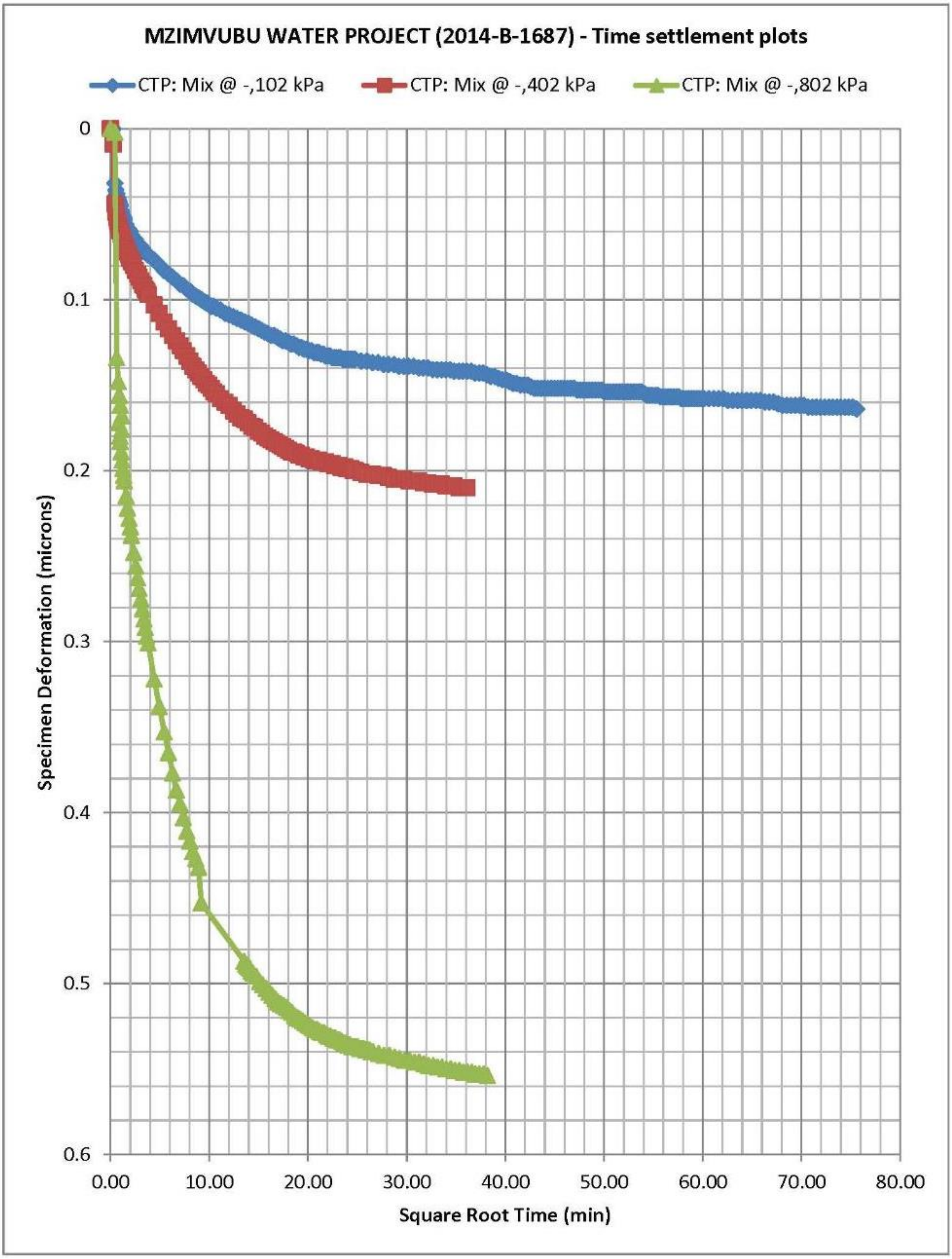
Project:	MZIMVUBU WATER PROJECT		
Project No.:	2014-B-1687	Sample No.:	1687-21
Borehole No:	CTP : MIX	Depth:	-
Date Receivec	12/08/2014	Date Tested:	22/10/2014

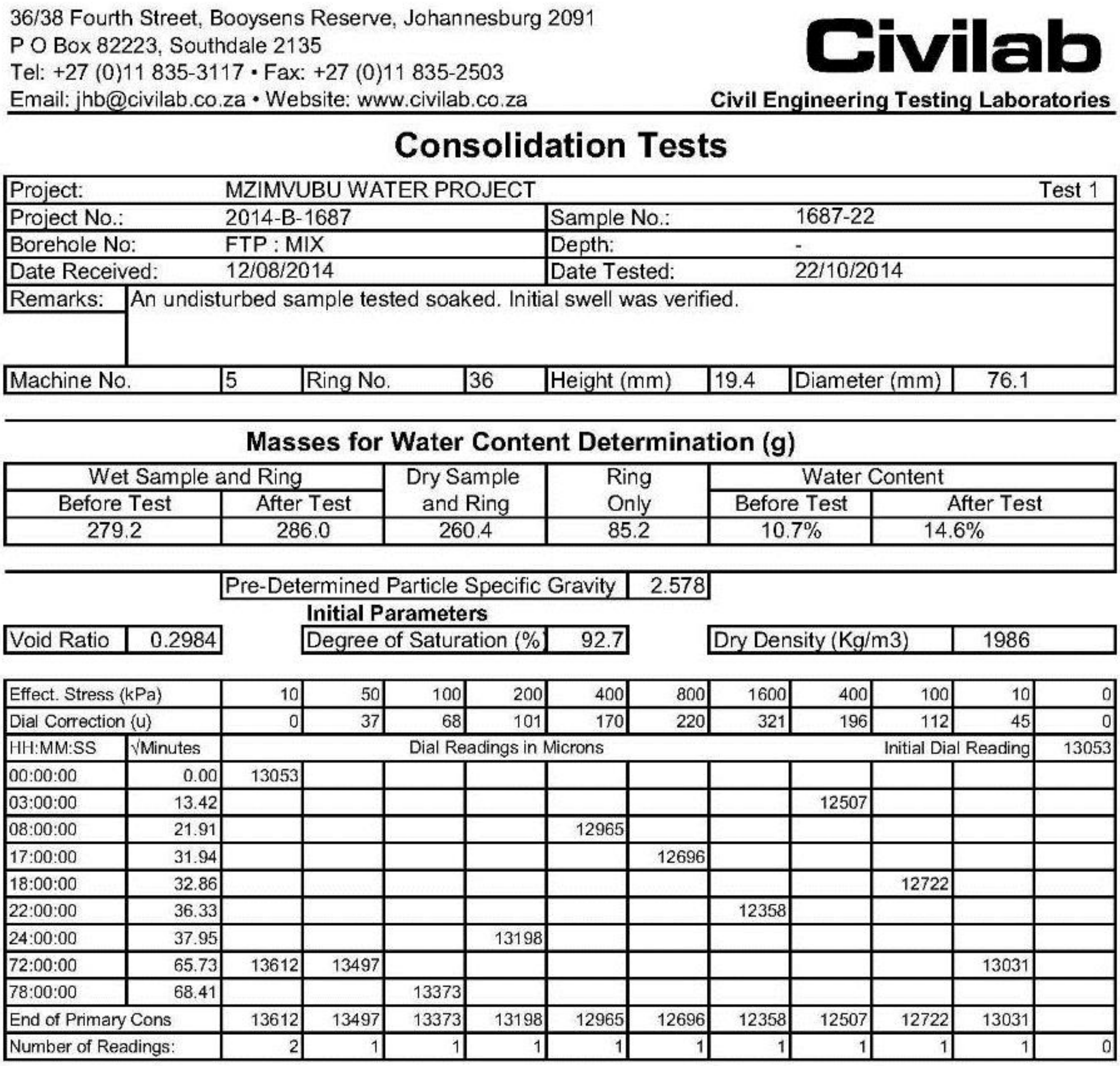
Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-0.89	-0.54	0.10	1.08	2.04	4.19	7.44	6.69	5.97	4.58	
Mv (1/MPa)		0.0870	0.1285	0.0981	0.0481	0.0537	0.0406	0.0063	0.0238	0.1546	
Void Ratio	0.6539	0.6482	0.6376	0.6216	0.6058	0.5706	0.5173	0.5297	0.5414	0.5642	

Test 2




MZIMVUBU WATER PROJECT (2014-B-1687) - Time settlement plots
CTP: Mix @ -,102 kPa
CTP: Mix @ -,402 kPa
CTP: Mix @ -,802 kPa
Specimen Deformation (microns)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Square Root Time (min)



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Email: jhb@civilab.co.za • Website: www.civilab.co.za

Civilab
Civil Engineering Testing Laboratories

Consolidation Tests

Project:	MZIMVUBU WATER PROJECT						Test 1
Project No.:	2014-B-1687			Sample No.:	1687-22		
Borehole No:	FTP : MIX			Depth:	-		
Date Received:	12/08/2014			Date Tested:	22/10/2014		
Remarks:	An undisturbed sample tested soaked. Initial swell was verified.						
Machine No.	5	Ring No.	36	Height (mm)	19.4	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
279.2	286.0	260.4	85.2	10.7%	14.6%

Pre-Determined Particle Specific Gravity 2.578

Initial Parameters

Void Ratio	0.2984	Degree of Saturation (%)	92.7	Dry Density (Kg/m3)	1986

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		13053
00:00:00	0.00	13053										
03:00:00	13.42								12507			
08:00:00	21.91					12965						
17:00:00	31.94						12696					
18:00:00	32.86									12722		
22:00:00	36.33							12358				
24:00:00	37.95				13198							
72:00:00	65.73	13612	13497								13031	
78:00:00	68.41			13373								
End of Primary Cons		13612	13497	13373	13198	12965	12696	12358	12507	12722	13031	
Number of Readings:		2	1	1	1	1	1	1	1	1	1	0

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Civilab
Civil Engineering Testing Laboratories

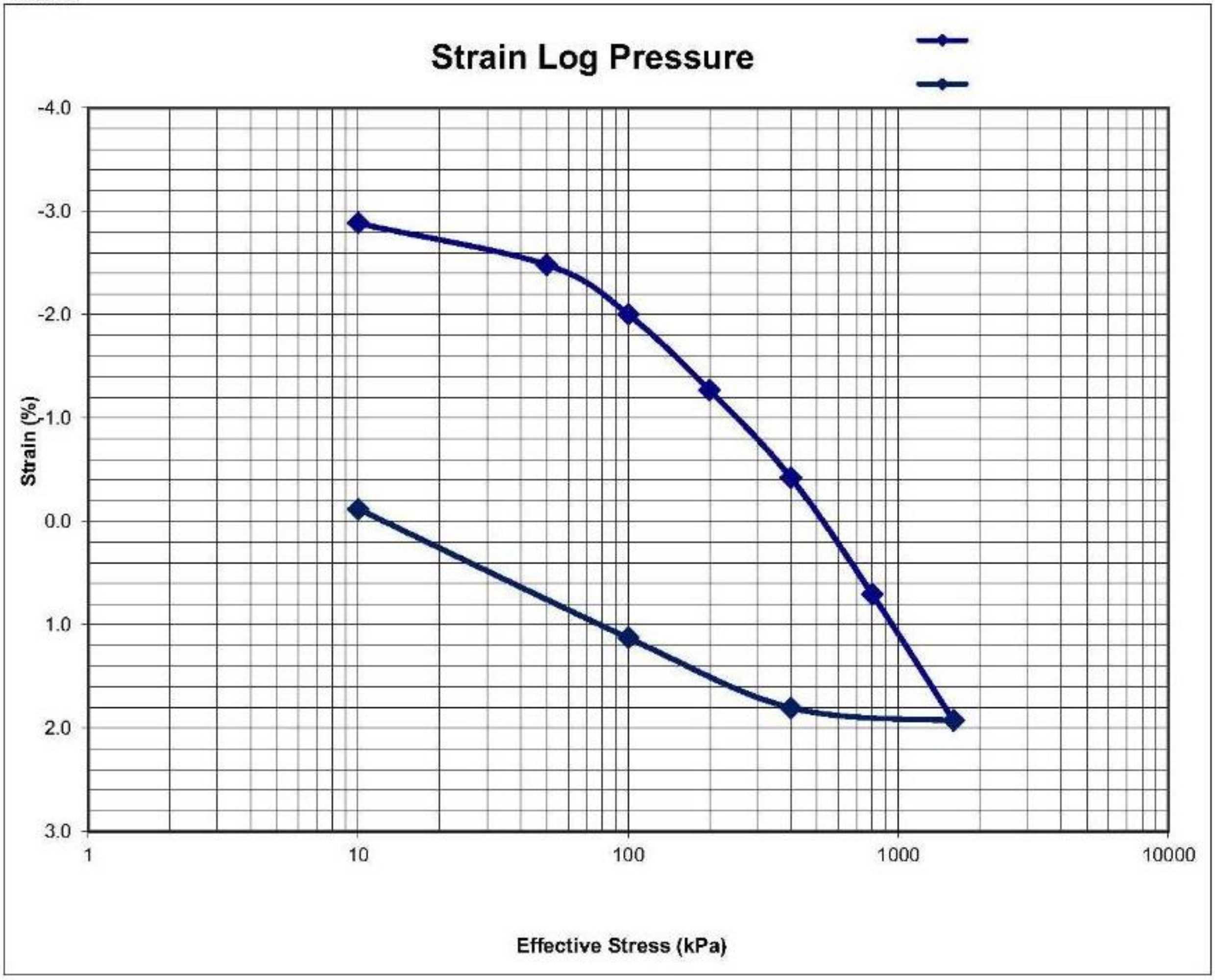
Consolidation Tests

Project:	MZIMVUBU WATER PROJECT		
Project No.:	2014-B-1687	Sample No.:	1687-22
Borehole No:	FTP : MIX	Depth:	-
Date Received:	12/08/2014	Date Tested:	22/10/2014

Test 1

Effect.Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-2.88	-2.48	-2.00	-1.27	-0.42	0.71	1.93	1.80	1.13	-0.12	
Mv (1/MPa)		0.1005	0.0959	0.0732	0.0423	0.0282	0.0153	0.0010	0.0225	0.1386	
Void Ratio	0.3358	0.3306	0.3244	0.3149	0.3039	0.2892	0.2734	0.275	0.2837	0.2999	

Test 2



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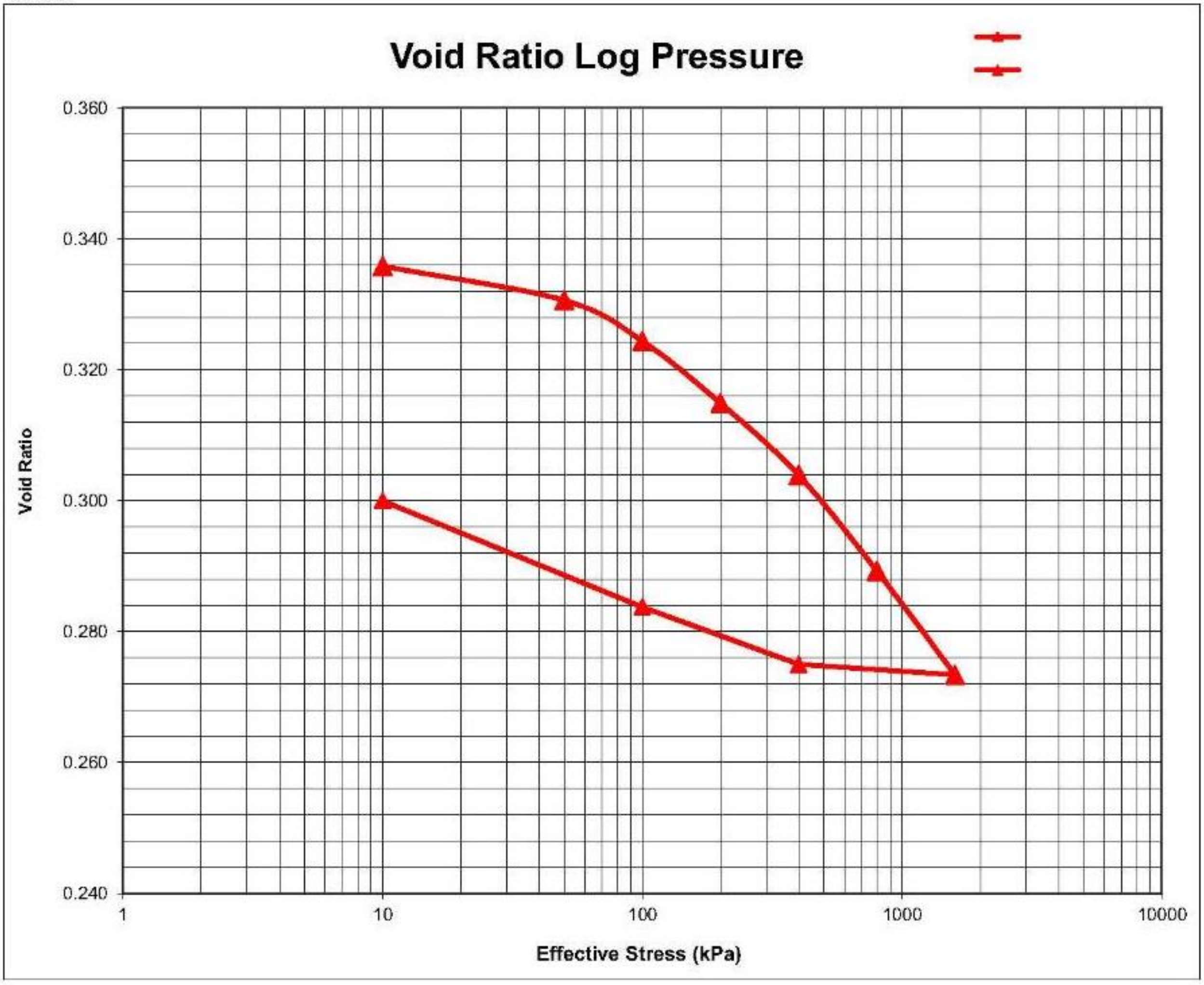
Consolidation Tests

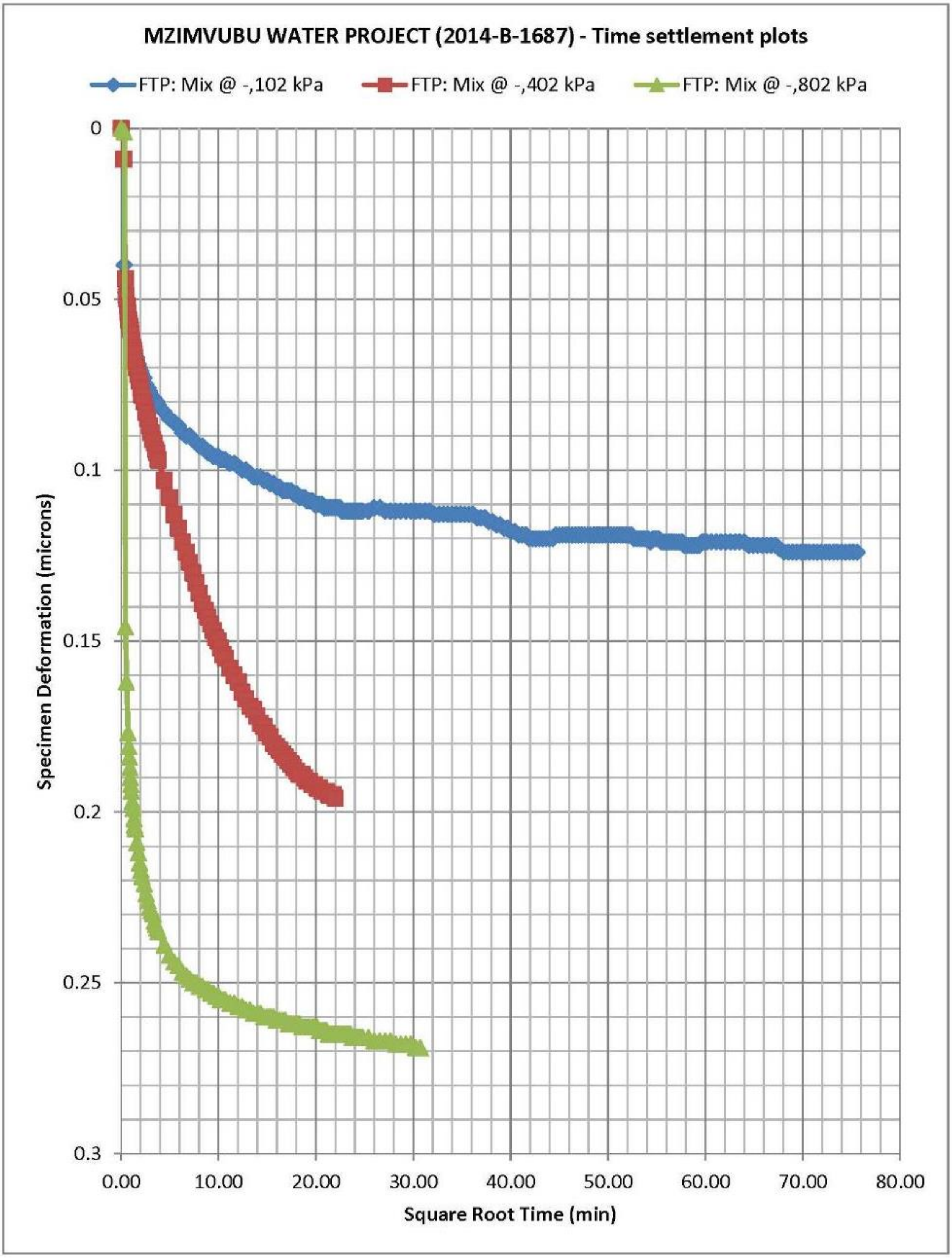
Project:	MZIMVUBU WATER PROJECT		
Project No.:	2014-B-1687	Sample No.:	1687-22
Borehole No:	FTP : MIX	Depth:	-
Date Receivec	12/08/2014	Date Tested:	22/10/2014

Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10	
Strain (%)	-2.88	-2.48	-2.00	-1.27	-0.42	0.71	1.93	1.80	1.13	-0.12	
Mv (1/MPa)		0.1005	0.0959	0.0732	0.0423	0.0282	0.0153	0.0010	0.0225	0.1386	
Void Ratio	0.3358	0.3306	0.3244	0.3149	0.3039	0.2892	0.2734	0.275	0.2837	0.2999	

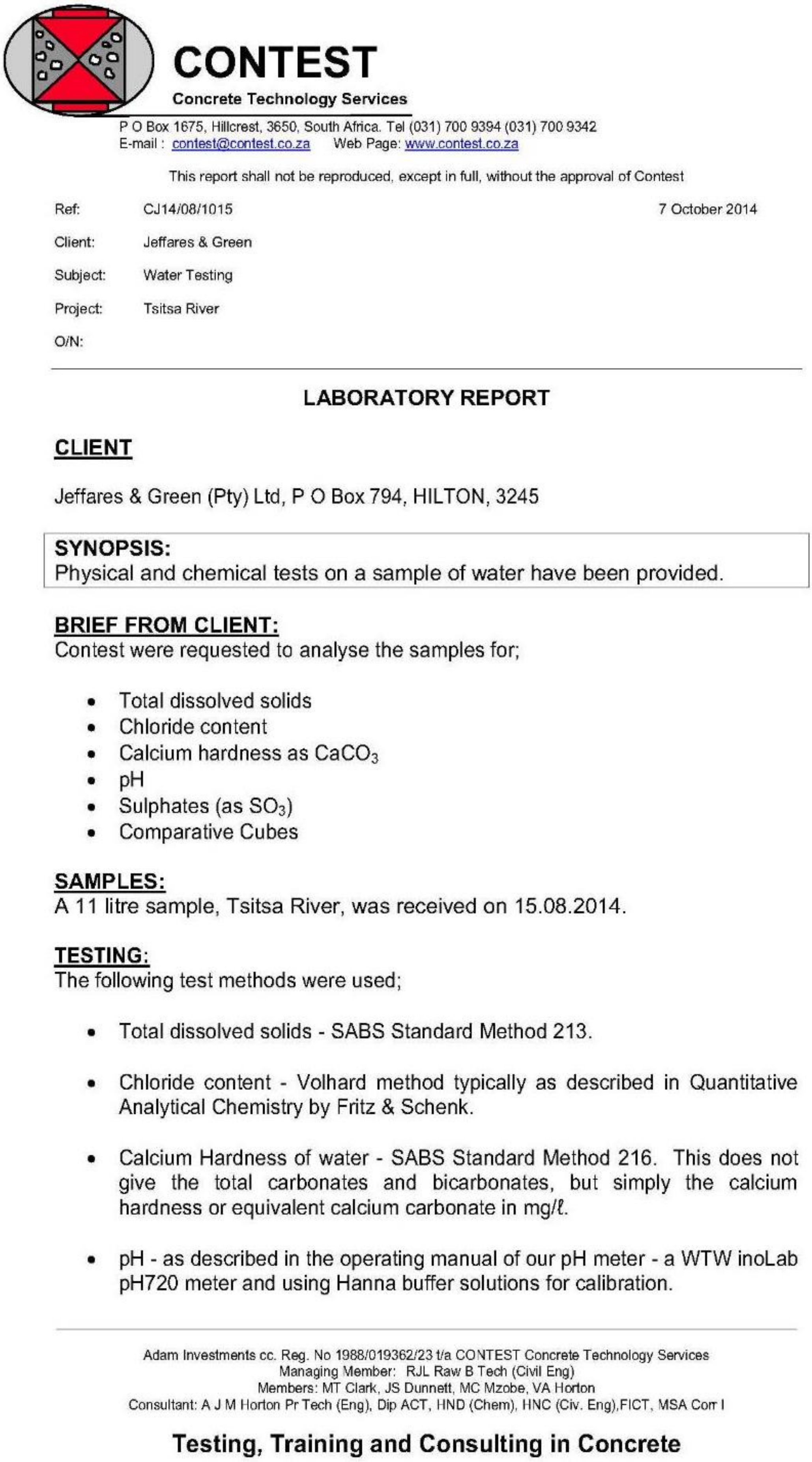
Test 2




MZIMVUBU WATER PROJECT (2014-B-1687) - Time settlement plots
FTP: Mix @ -,102 kPa
FTP: Mix @ -,402 kPa
FTP: Mix @ -,802 kPa
Specimen Deformation (microns)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Square Root Time (min)

E6:

WATER TEST RESULTS



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Concrete Technology Services
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E-mail : contest@contest.co.za Web Page: www.contest.co.za

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Ref: CJ14/08/1015 7 October 2014
Client: Jeffares & Green
Subject: Water Testing
Project: Tsitsa River
O/N:

LABORATORY REPORT

CLIENT

Jeffares & Green (Pty) Ltd, 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:

A 11 litre sample, Tsitsa River, was received on 15.08.2014.

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.

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Managing Member: RJL Raw B Tech (Civil Eng)
Members: MT Clark, JS Dunnett, MC Mzobe, VA Horton
Consultant: A J M Horton Pr Tech (Eng), Dip ACT, HND (Chem), HNC (Civ. Eng),FICT, MSA Corr I

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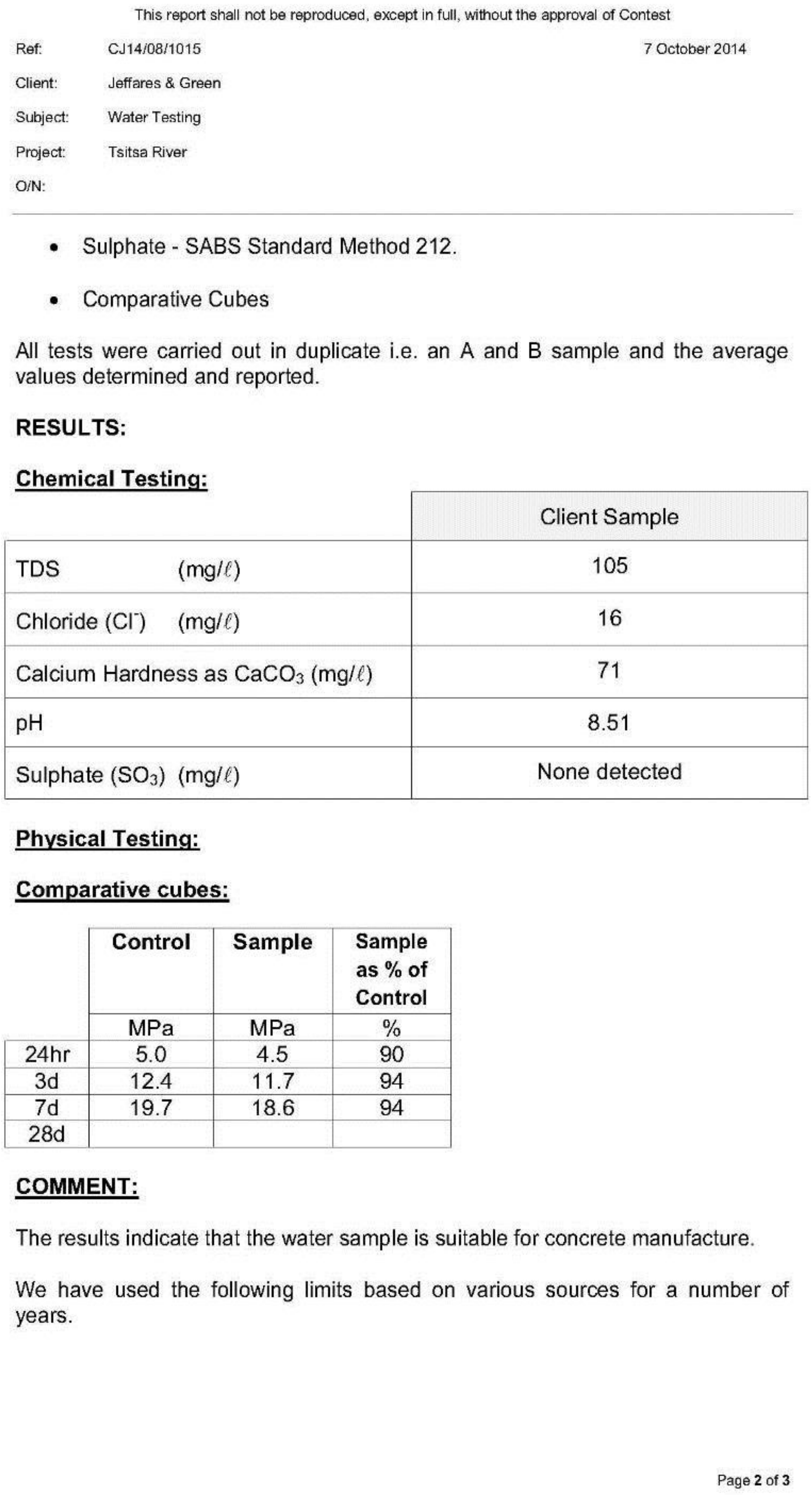


Ref: CJ14/08/1015 7 October 2014
Client: Jeffares & Green
Subject: Water Testing
Project: Tsitsa River
O/N:

- Sulphate - SABS Standard Method 212.
- 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
Chloride (Cl^-) (mg/ℓ)	16
Calcium Hardness as $CaCO_3$ (mg/ℓ)	71
pH	8.51
Sulphate (SO_3) (mg/ℓ)	None detected

Physical Testing:

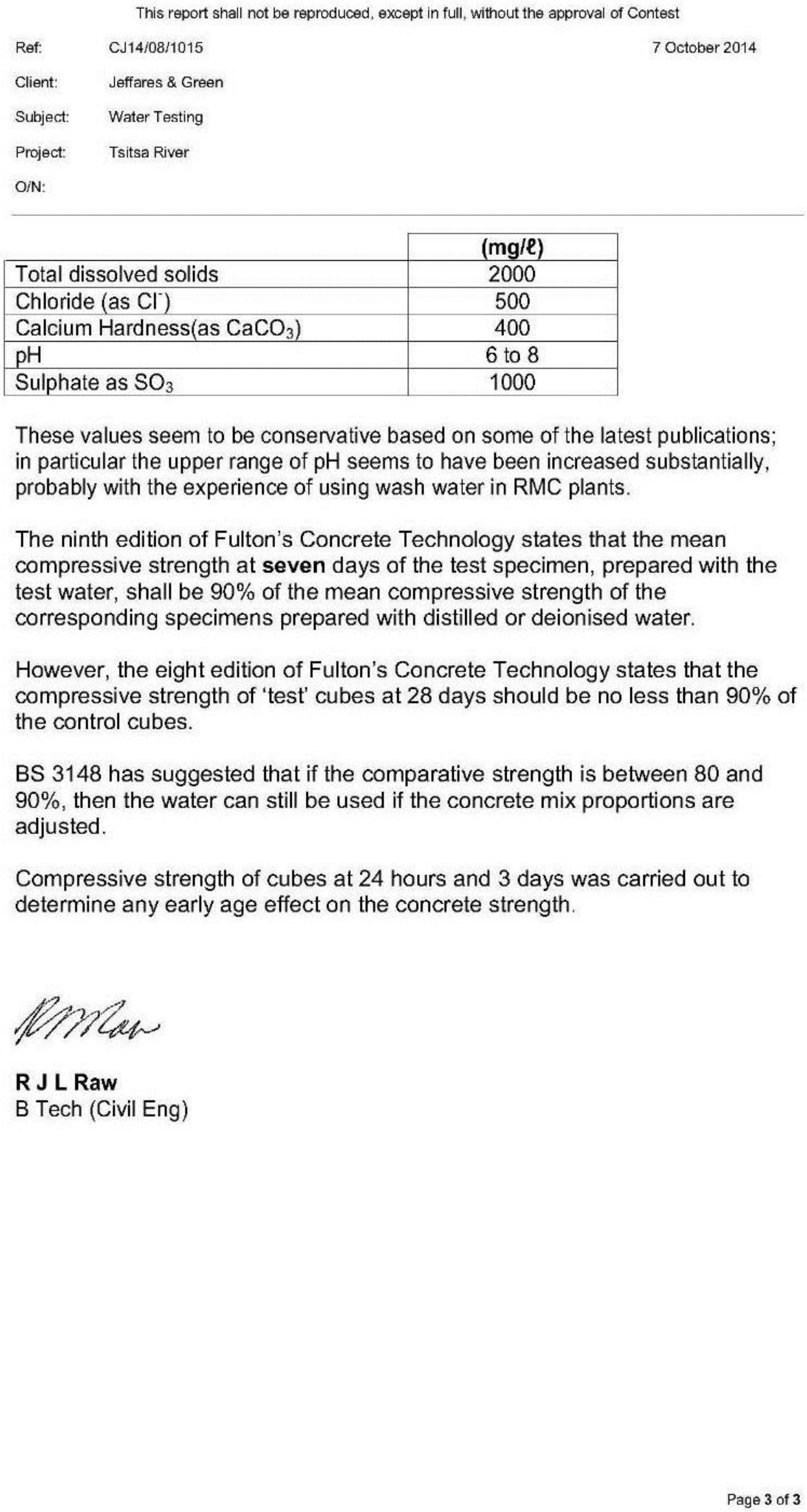
Comparative cubes:

	Control	**Sample**	**Sample as % of Control**
	MPa	MPa	%
24hr	5.0	4.5	90
3d	12.4	11.7	94
7d	19.7	18.6	94
28d			

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.



Ref:	CJ14/08/1015	7 October 2014
Client:	Jeffares & Green	
Subject:	Water Testing	
Project:	Tsitsa River	
O/N:		

	(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.

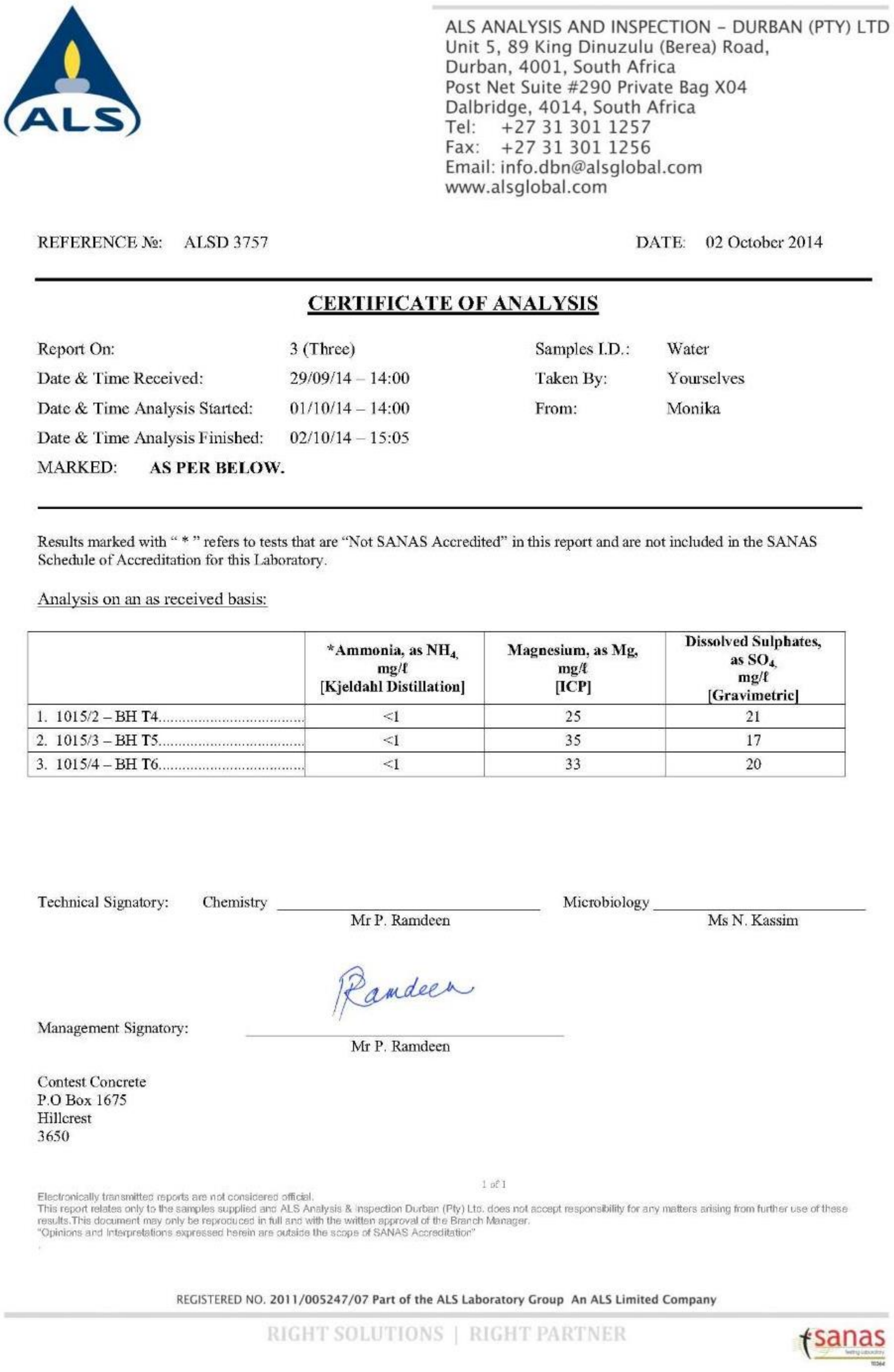
The ninth edition of Fulton's Concrete Technology states that the mean compressive strength at **seven** days of the test specimen, prepared with the test water, shall be 90% of the mean compressive strength of the corresponding specimens prepared with distilled or deionised water.

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 comparative 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 3 days was carried out to determine any early age effect on the concrete strength.

R J L Raw
B Tech (Civil Eng)



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Tel: +27 31 301 1257
Fax: +27 31 301 1256
Email: info.dbn@alsglobal.com
www.alsglobal.com

REFERENCE №: ALSD 3757

DATE: 02 October 2014

CERTIFICATE OF ANALYSIS

Report On: 3 (Three)
Date & Time Received: 29/09/14 – 14:00
Date & Time Analysis Started: 01/10/14 – 14:00
Date & Time Analysis Finished: 02/10/14 – 15:05
MARKED: **AS PER BELOW.**

Samples I.D.: Water
Taken By: Yourselves
From: Monika

Results marked with " * " refers to tests that are "Not SANAS Accredited" in this report and are not included in the SANAS Schedule of Accreditation for this Laboratory.

Analysis on an as received basis:

	***Ammonia, as NH_4 mg/ℓ [Kjeldahl Distillation]**	**Magnesium, as Mg, mg/ℓ [ICP]**	**Dissolved Sulphates, as SO_4 mg/ℓ [Gravimetric]**
1. 1015/2 – BH T4....................................	<1	25	21
2. 1015/3 – BH T5....................................	<1	35	17
3. 1015/4 – BH T6....................................	<1	33	20

Technical Signatory: Chemistry ______________________ Microbiology ______________________
Mr P. Ramdeen Ms N. Kassim

Ramdeen

Management Signatory: ______________________
Mr P. Ramdeen

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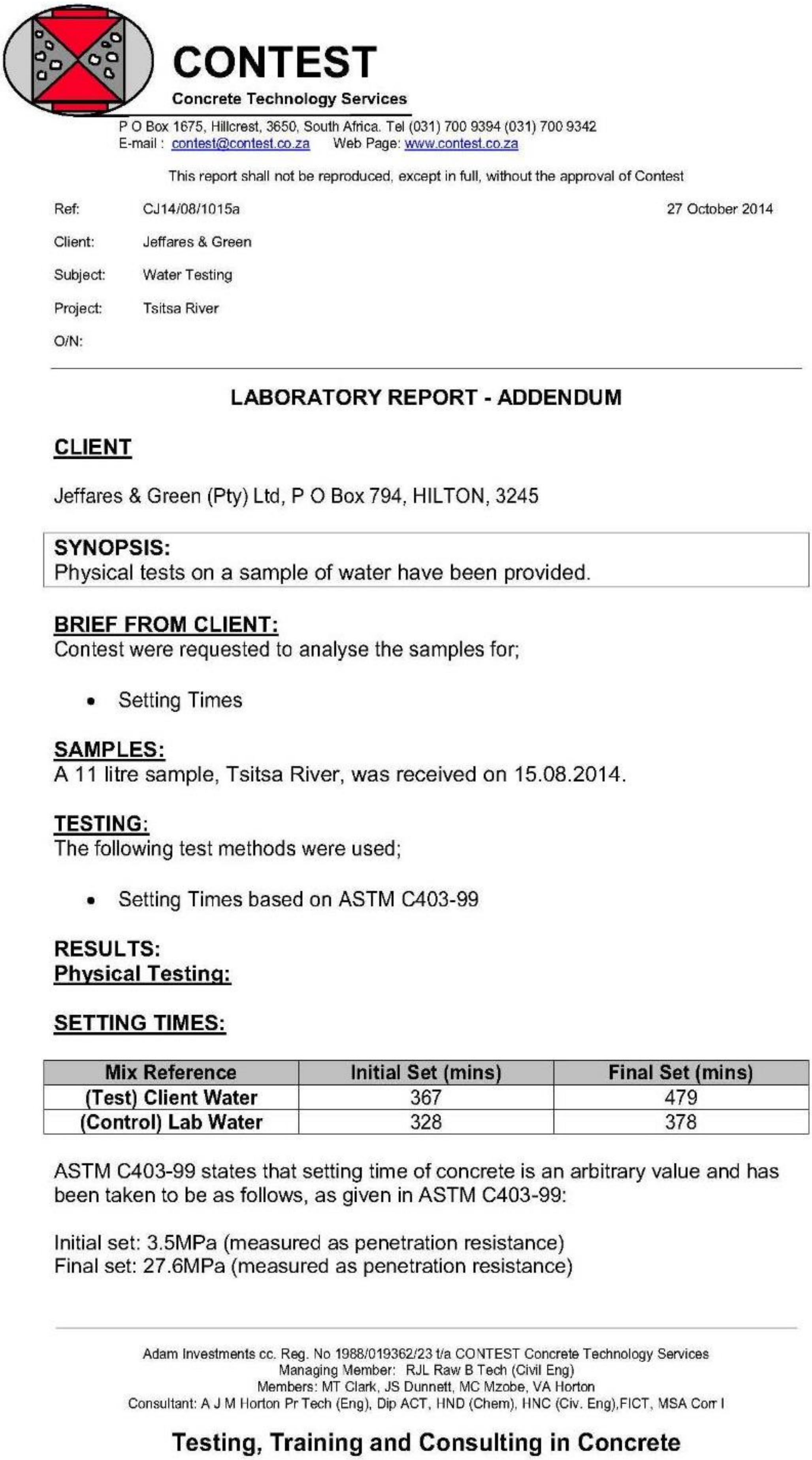

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Ref: CJ14/08/1015a 27 October 2014
Client: Jeffares & Green
Subject: Water Testing
Project: Tsitsa River
O/N:

LABORATORY REPORT - ADDENDUM

CLIENT

Jeffares & Green (Pty) Ltd, P O Box 794, HILTON, 3245

SYNOPSIS:
Physical tests on a sample of water have been provided.

BRIEF FROM CLIENT:

Contest were requested to analyse the samples for;

- Setting Times

SAMPLES:

A 11 litre sample, Tsitsa River, was received on 15.08.2014.

TESTING:

The following test methods were used;

- Setting Times based on ASTM C403-99

RESULTS:

Physical Testing:

SETTING TIMES:

Mix Reference	Initial Set (mins)	Final Set (mins)
(Test) Client Water	367	479
(Control) Lab Water	328	378

ASTM C403-99 states that setting time of concrete is an arbitrary value and has been taken to be as follows, as given in ASTM C403-99:

Initial set: 3.5MPa (measured as penetration resistance)
Final set: 27.6MPa (measured as penetration resistance)

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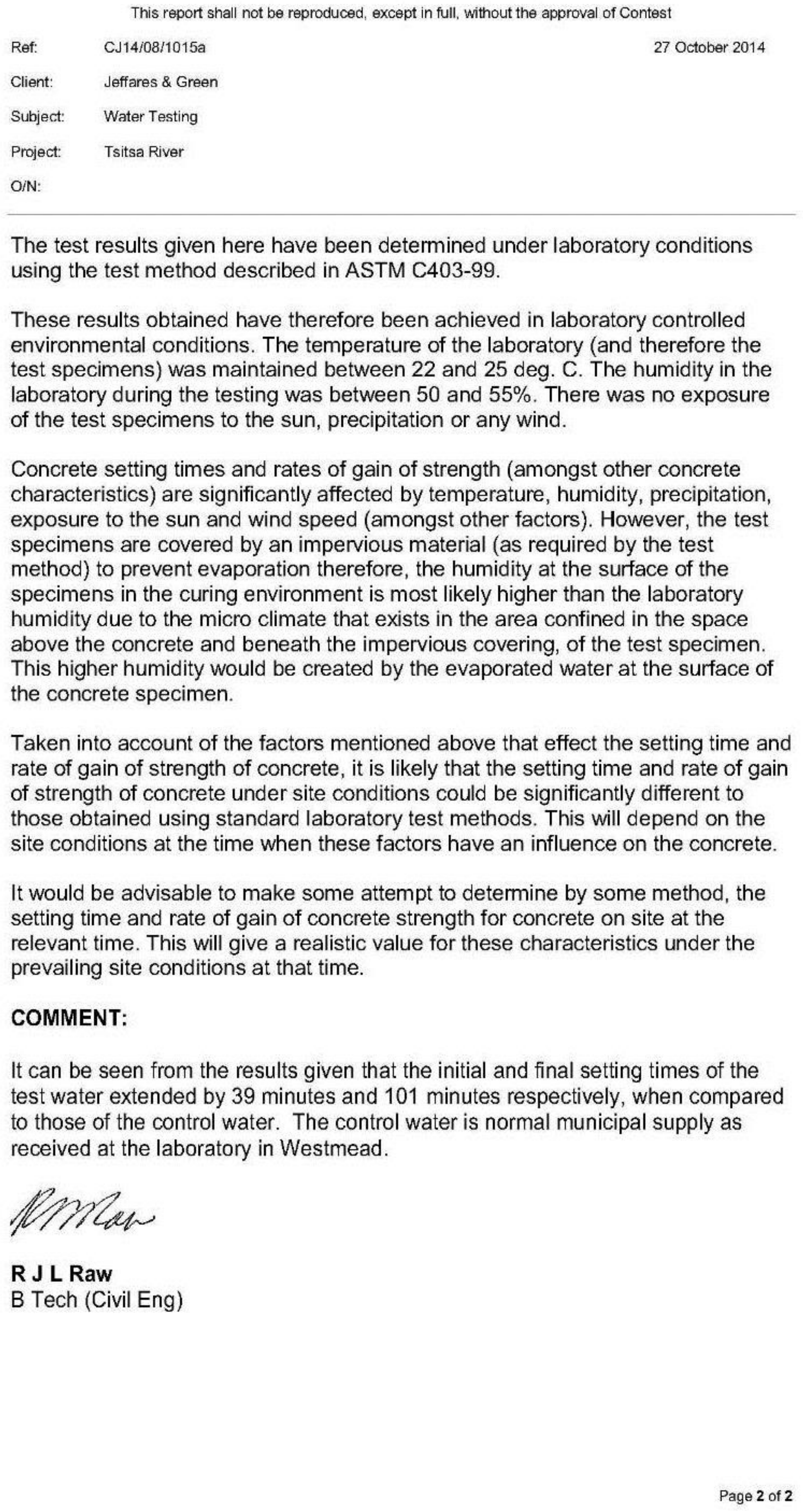

Ref:	CJ14/08/1015a	27 October 2014
Client:	Jeffares & Green	
Subject:	Water Testing	
Project:	Tsitsa River	
O/N:		

The test results given here have been determined under laboratory conditions using the test method described in ASTM C403-99.

These results obtained have therefore been achieved in laboratory controlled environmental conditions. The temperature of the laboratory (and therefore the test specimens) was maintained between 22 and 25 deg. C. The humidity in the laboratory during the testing was between 50 and 55%. There was no exposure of the test specimens to the sun, precipitation or any wind.

Concrete setting times and rates of gain of strength (amongst other concrete characteristics) are significantly affected by temperature, humidity, precipitation, exposure to the sun and wind speed (amongst other factors). However, the test specimens are covered by an impervious material (as required by the test method) to prevent evaporation therefore, the humidity at the surface of the specimens in the curing environment is most likely higher than the laboratory humidity due to the micro climate that exists in the area confined in the space above the concrete and beneath the impervious covering, of the test specimen. This higher humidity would be created by the evaporated water at the surface of the concrete specimen.

Taken into account of the factors mentioned above that effect the setting time and rate of gain of strength of concrete, it is likely that the setting time and rate of gain of strength of concrete under site conditions could be significantly different to those obtained using standard laboratory test methods. This will depend on the site conditions at the time when these factors have an influence on the concrete.

It would be advisable to make some attempt to determine by some method, the setting time and rate of gain of concrete strength for concrete on site at the relevant time. This will give a realistic value for these characteristics under the prevailing site conditions at that time.

COMMENT:

It can be seen from the results given that the initial and final setting times of the test water extended by 39 minutes and 101 minutes respectively, when compared to those of the control water. The control water is normal municipal supply as received at the laboratory in Westmead.

R J L Raw
B Tech (Civil Eng)

Page **2** of **2**

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Ref: CJ14/08/1015 6 October 2014

Client: Jeffares & Green

Subject: Basson Index

Project: Laleni Dam & Tunnel

Water Analysis – Basson Index

Four bore hole water samples received on 15.08.2014 were analysed, as requested, to determine the Basson Index.

The results of the chemical analyses may be found appended. (The ammonium ion, magnesium and sulphate contents were determined by ALS).

The following indices were calculated as set out in the PCI publication "Deterioration of Concrete in aggressive waters – measuring aggressiveness and taking counter measures" and the subsequent addendum.

Reference	B/H T4	B/H T5	B/H T6
Leaching Corrosion sub index LSCI	305	224	252
Spalling Corrosion sub index SCSI	7	9	9
Aggressiveness Index LSCI + SCSI	312	233	261

The table of recommendations from the publication has been provided below;

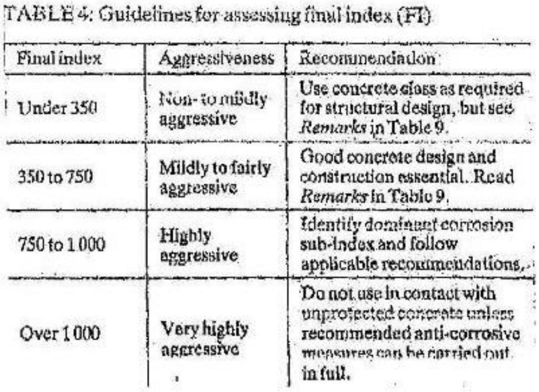

TABLE 4: Guidelines for assessing final index (FI)

Final index	Aggressiveness	Recommendation
Under 350	Non- to mildly aggressive	Use concrete class as required for structural design, but see *Remarks* in Table 9.
350 to 750	Mildly to fairly aggressive	Good concrete design and construction essential. Read *Remarks* in Table 9.
750 to 1 000	Highly aggressive	Identify dominant corrosion sub-index and follow applicable recommendations.
Over 1 000	Very highly aggressive	Do not use in contact with unprotected concrete unless recommended anti-corrosive measures can be carried out in full.

No optional corrections have been applied as there are essentially environmental factors and must be provided by yourselves.

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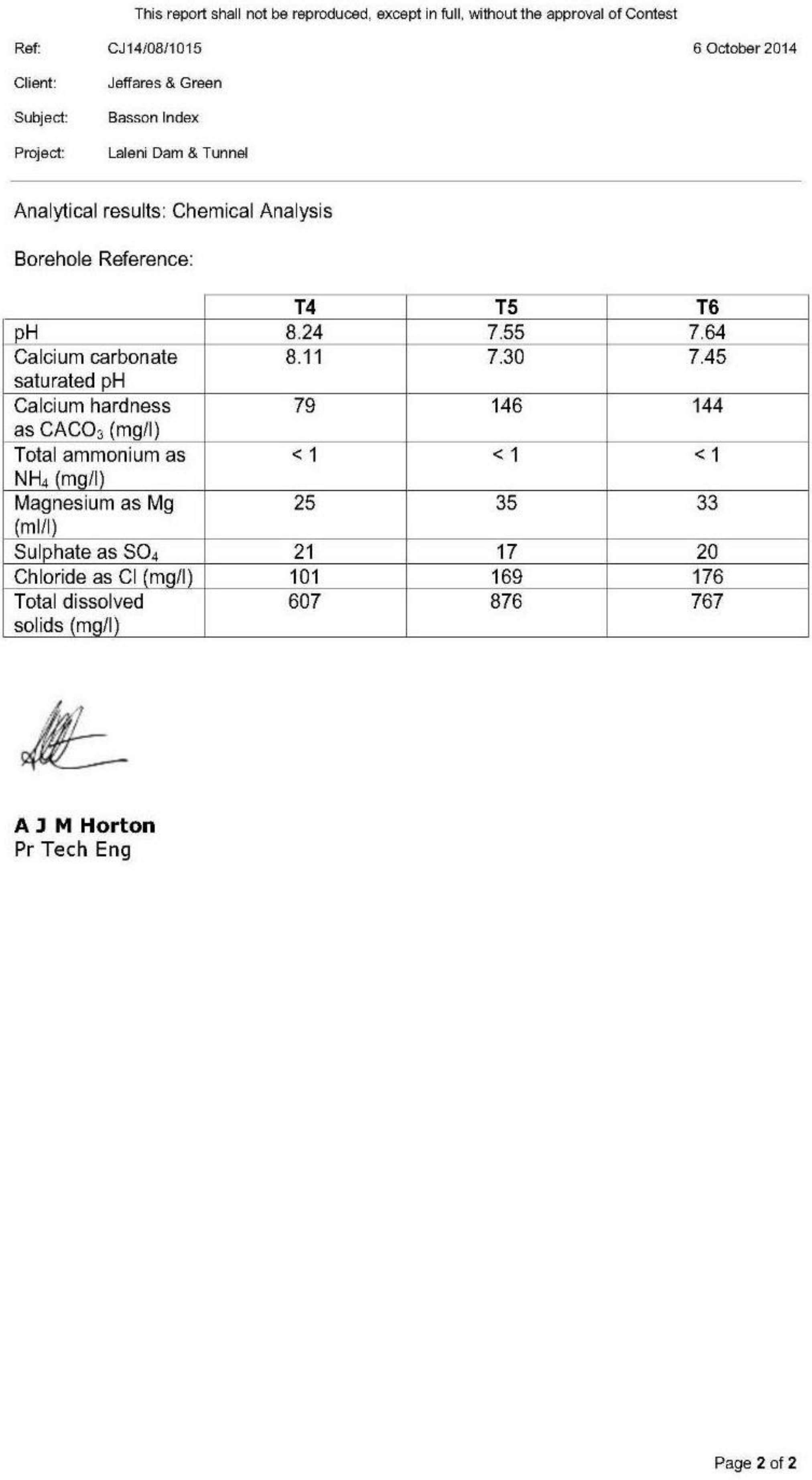


Ref: CJ14/08/1015 6 October 2014

Client: Jeffares & Green

Subject: Basson Index

Project: Laleni Dam & Tunnel

Analytical results: Chemical Analysis

Borehole Reference:

	T4	T5	T6
pH	8.24	7.55	7.64
Calcium carbonate saturated pH	8.11	7.30	7.45
Calcium hardness as $CACO_3$ (mg/l)	79	146	144
Total ammonium as NH_4 (mg/l)	< 1	< 1	< 1
Magnesium as Mg (ml/l)	25	35	33
Sulphate as SO_4	21	17	20
Chloride as Cl (mg/l)	101	169	176
Total dissolved solids (mg/l)	607	876	767

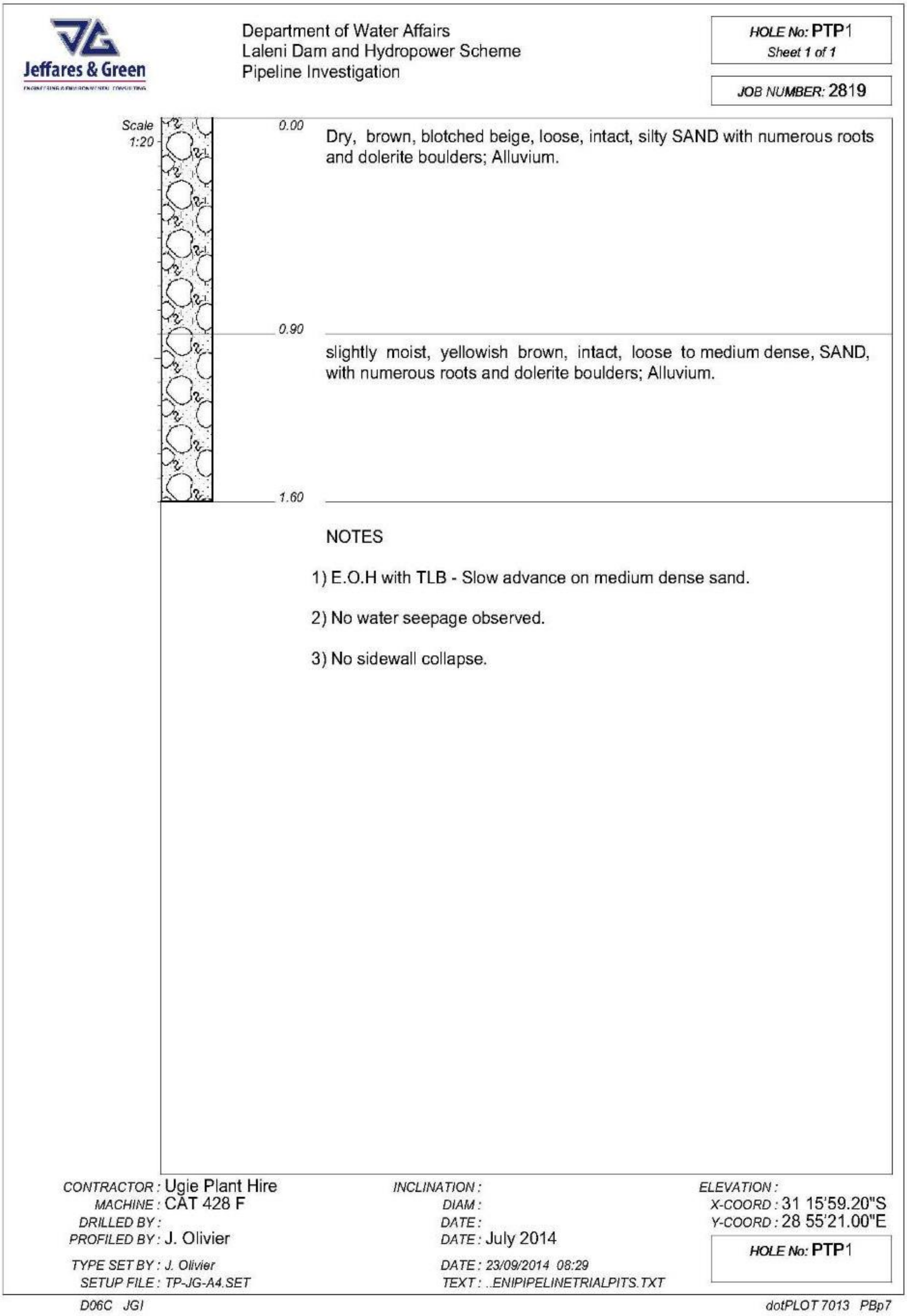
A J M Horton
Pr Tech Eng

APPENDIX F

TRIAL PIT LOGS

F1:

PIPELINE TRIAL PIT LOGS



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP1
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Dry, brown, blotched beige, loose, intact, silty SAND with numerous roots and dolerite boulders; Alluvium.
0.90	slightly moist, yellowish brown, intact, loose to medium dense, SAND, with numerous roots and dolerite boulders; Alluvium.
1.60	

NOTES

1) E.O.H with TLB - Slow advance on medium dense sand.

2) No water seepage observed.

3) No sidewall collapse.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

INCLINATION :
DIAM :
DATE :
DATE : July 2014

ELEVATION :
X-COORD : 31 15'59.20"S
Y-COORD : 28 55'21.00"E

HOLE No: PTP1

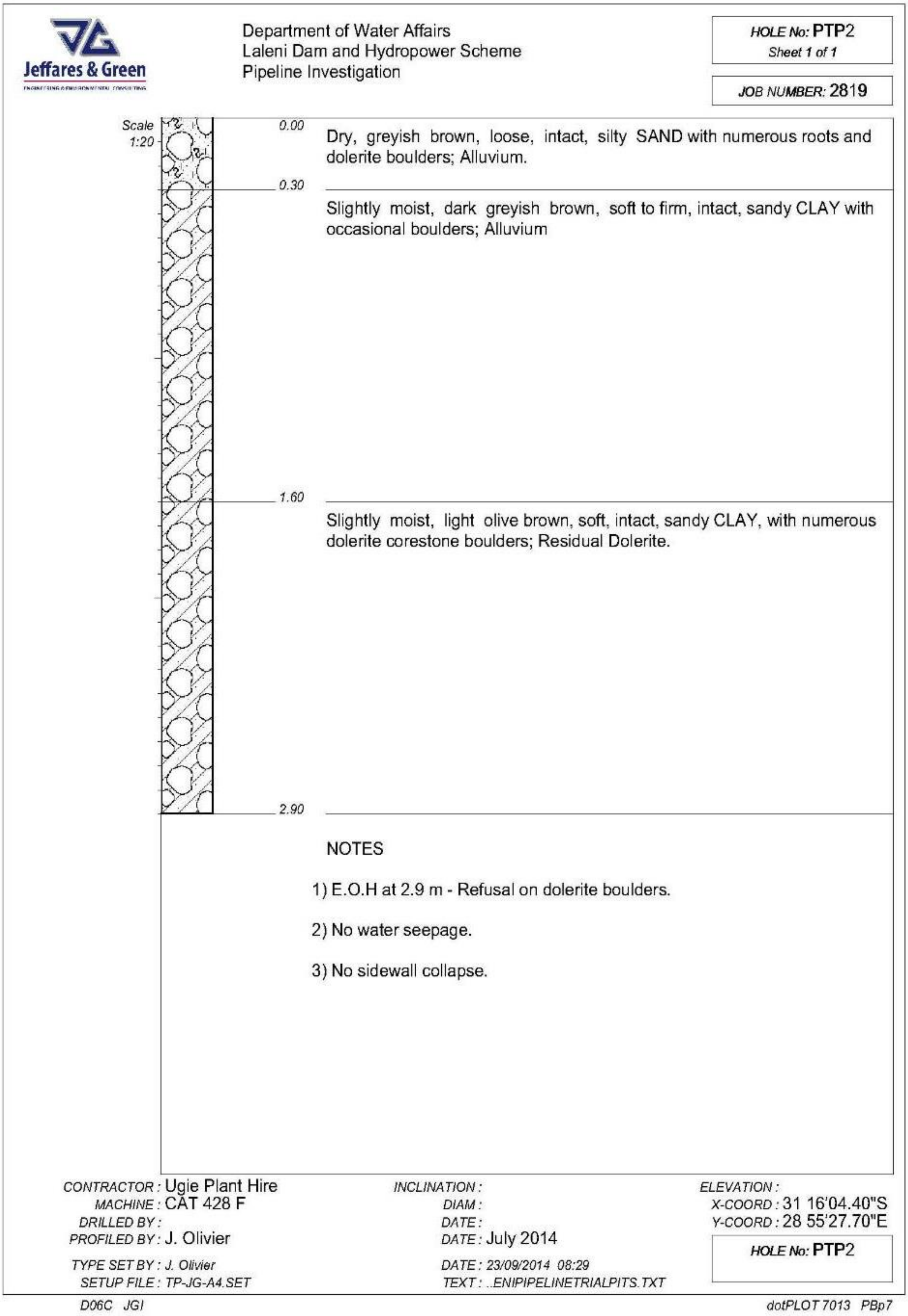
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.1: Pipeline Trial Pit 1



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP2
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Dry, greyish brown, loose, intact, silty SAND with numerous roots and dolerite boulders; Alluvium.
0.30	Slightly moist, dark greyish brown, soft to firm, intact, sandy CLAY with occasional boulders; Alluvium
1.60	Slightly moist, light olive brown, soft, intact, sandy CLAY, with numerous dolerite corestone boulders; Residual Dolerite.
2.90	

NOTES

1) E.O.H at 2.9 m - Refusal on dolerite boulders.

2) No water seepage.

3) No sidewall collapse.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

INCLINATION :
DIAM :
DATE :
DATE : July 2014

ELEVATION :
X-COORD : 31 16'04.40"S
Y-COORD : 28 55'27.70"E

HOLE No: PTP2

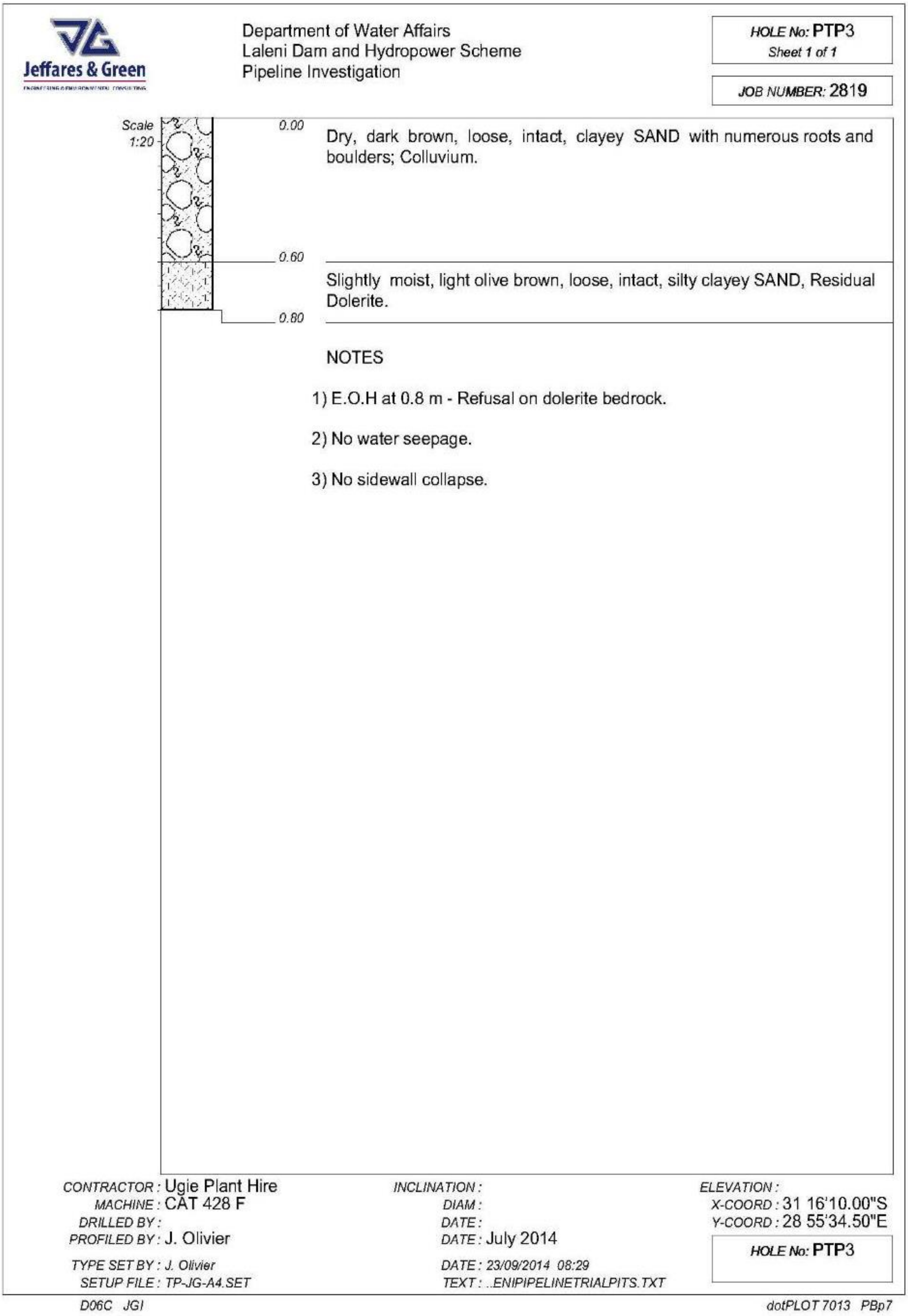
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.2: Pipeline Trial Pit 2



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP3
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

0.00	Dry, dark brown, loose, intact, clayey SAND with numerous roots and boulders; Colluvium.
0.60	Slightly moist, light olive brown, loose, intact, silty clayey SAND, Residual Dolerite.
0.80	

NOTES

1) E.O.H at 0.8 m - Refusal on dolerite bedrock.

2) No water seepage.

3) No sidewall collapse.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

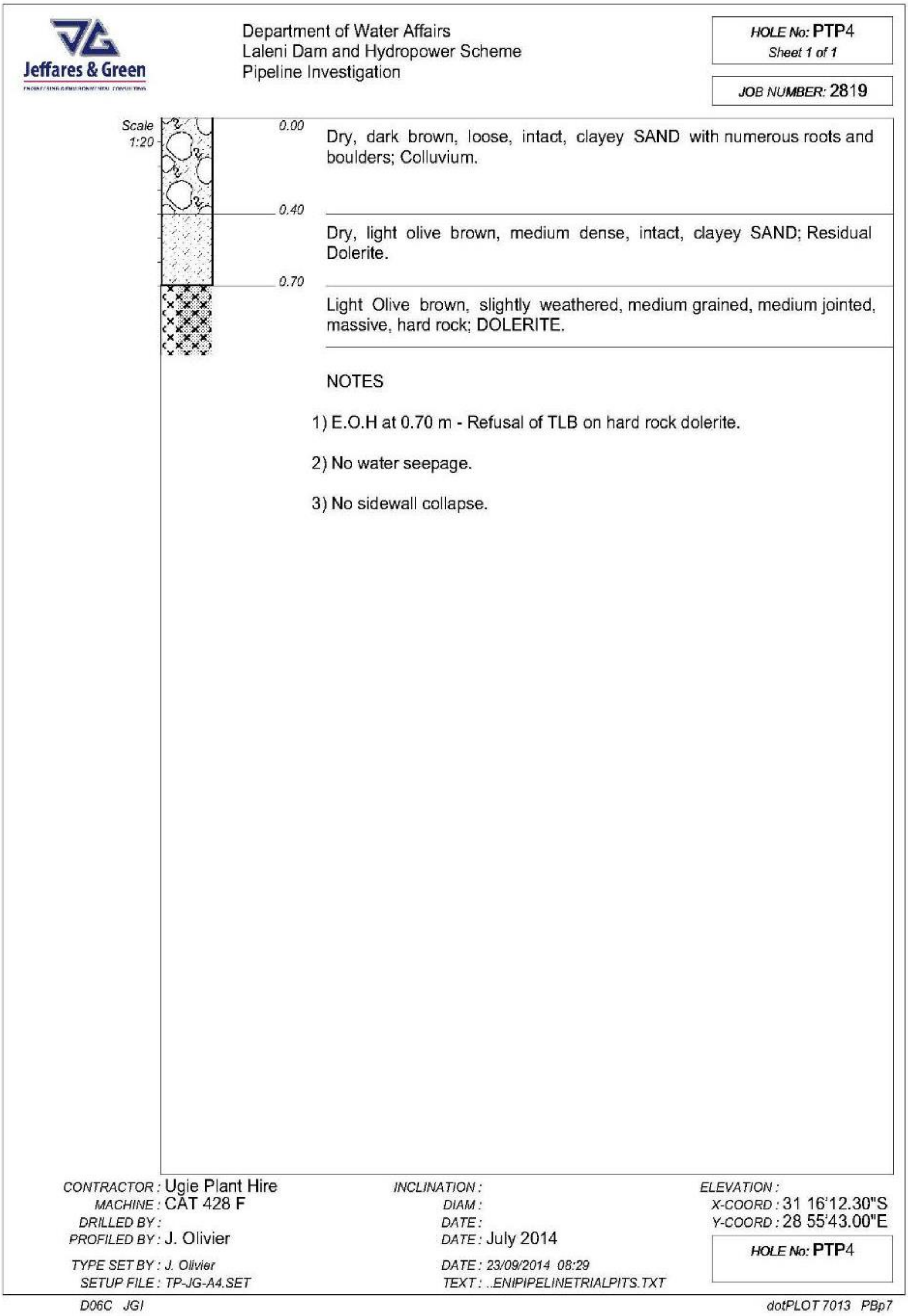
ELEVATION :
X-COORD : 31 16'10.00"S
Y-COORD : 28 55'34.50"E

HOLE No: PTP3

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.3: Pipeline Trial Pit 3



Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP4
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

0.00	Dry, dark brown, loose, intact, clayey SAND with numerous roots and boulders; Colluvium.
0.40	Dry, light olive brown, medium dense, intact, clayey SAND; Residual Dolerite.
0.70	Light Olive brown, slightly weathered, medium grained, medium jointed, massive, hard rock; DOLERITE.

NOTES

1) E.O.H at 0.70 m - Refusal of TLB on hard rock dolerite.

2) No water seepage.

3) No sidewall collapse.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014
DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

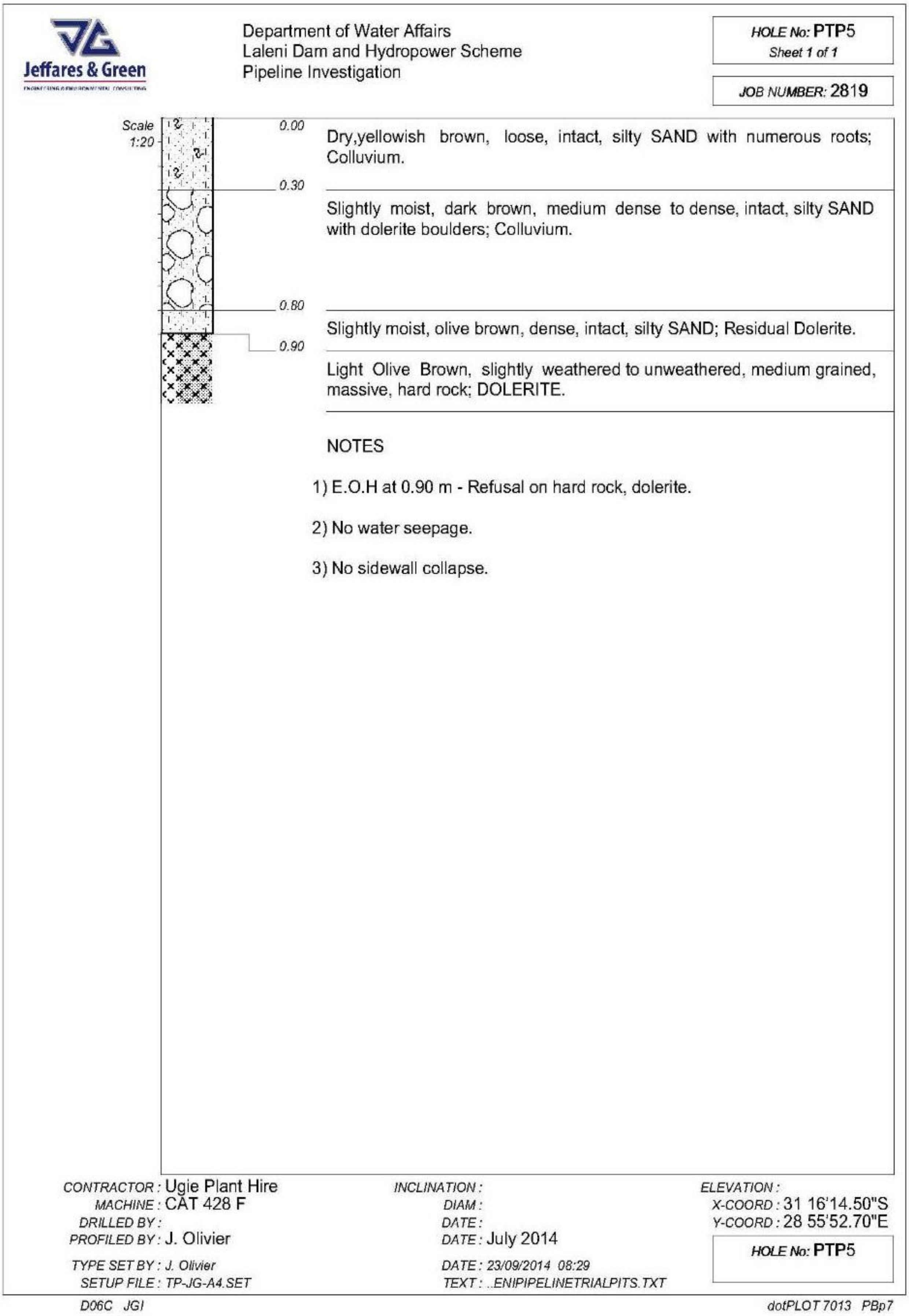
ELEVATION :
X-COORD : 31 16'12.30"S
Y-COORD : 28 55'43.00"E

HOLE No: PTP4

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.4: Pipeline Trial Pit 4



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP5
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Dry,yellowish brown, loose, intact, silty SAND with numerous roots; Colluvium.
0.30	Slightly moist, dark brown, medium dense to dense, intact, silty SAND with dolerite boulders; Colluvium.
0.80	Slightly moist, olive brown, dense, intact, silty SAND; Residual Dolerite.
0.90	Light Olive Brown, slightly weathered to unweathered, medium grained, massive, hard rock; DOLERITE.

NOTES

1) E.O.H at 0.90 m - Refusal on hard rock, dolerite.

2) No water seepage.

3) No sidewall collapse.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

INCLINATION :
DIAM :
DATE :
DATE : July 2014

ELEVATION :
X-COORD : 31 16'14.50"S
Y-COORD : 28 55'52.70"E

HOLE No: PTP5

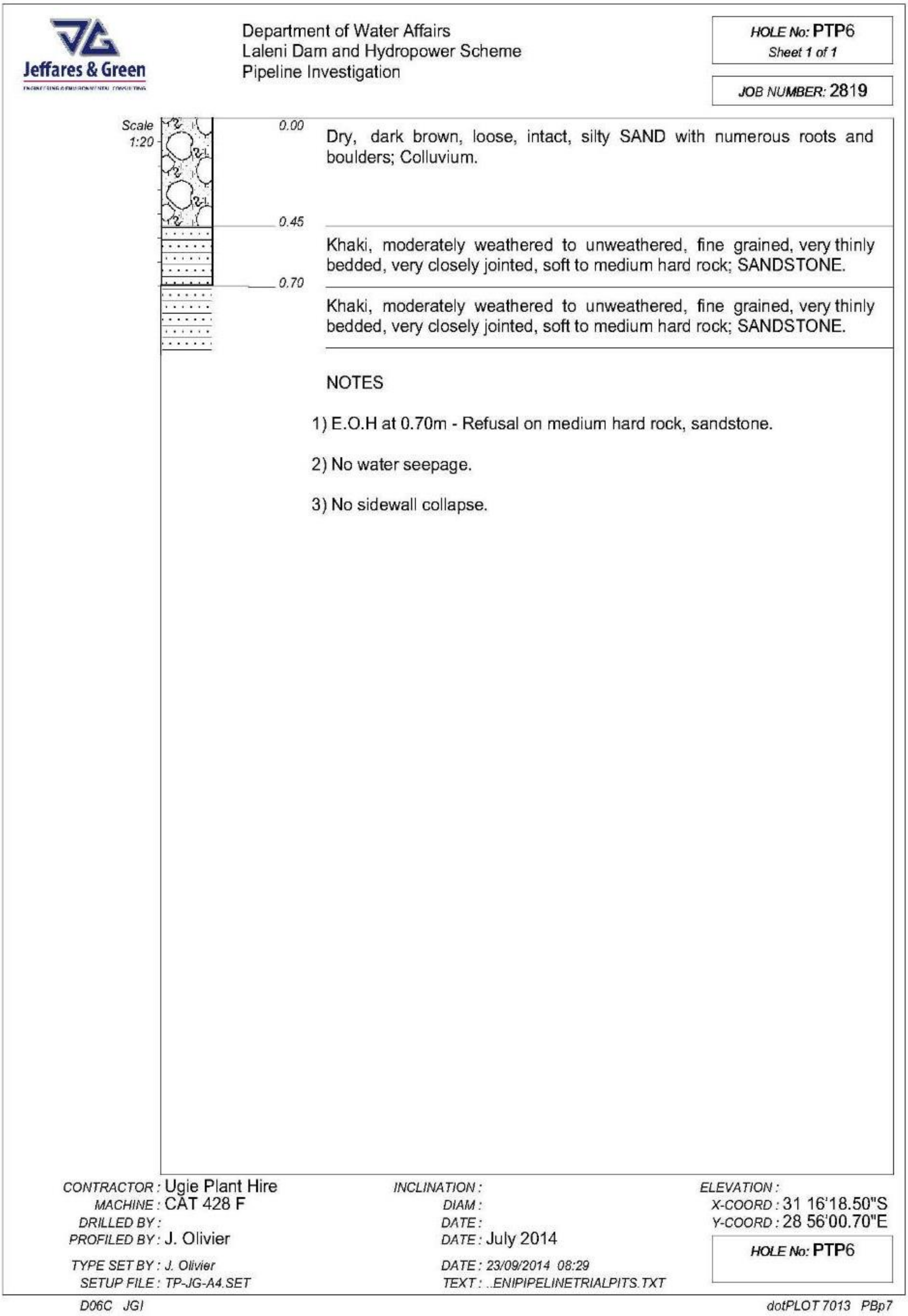
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.5: Pipeline Trial Pit 5



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP6
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

Depth	Description
0.00	Dry, dark brown, loose, intact, silty SAND with numerous roots and boulders; Colluvium.
0.45	Khaki, moderately weathered to unweathered, fine grained, very thinly bedded, very closely jointed, soft to medium hard rock; SANDSTONE.
0.70	Khaki, moderately weathered to unweathered, fine grained, very thinly bedded, very closely jointed, soft to medium hard rock; SANDSTONE.

NOTES

1) E.O.H at 0.70m - Refusal on medium hard rock, sandstone.

2) No water seepage.

3) No sidewall collapse.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

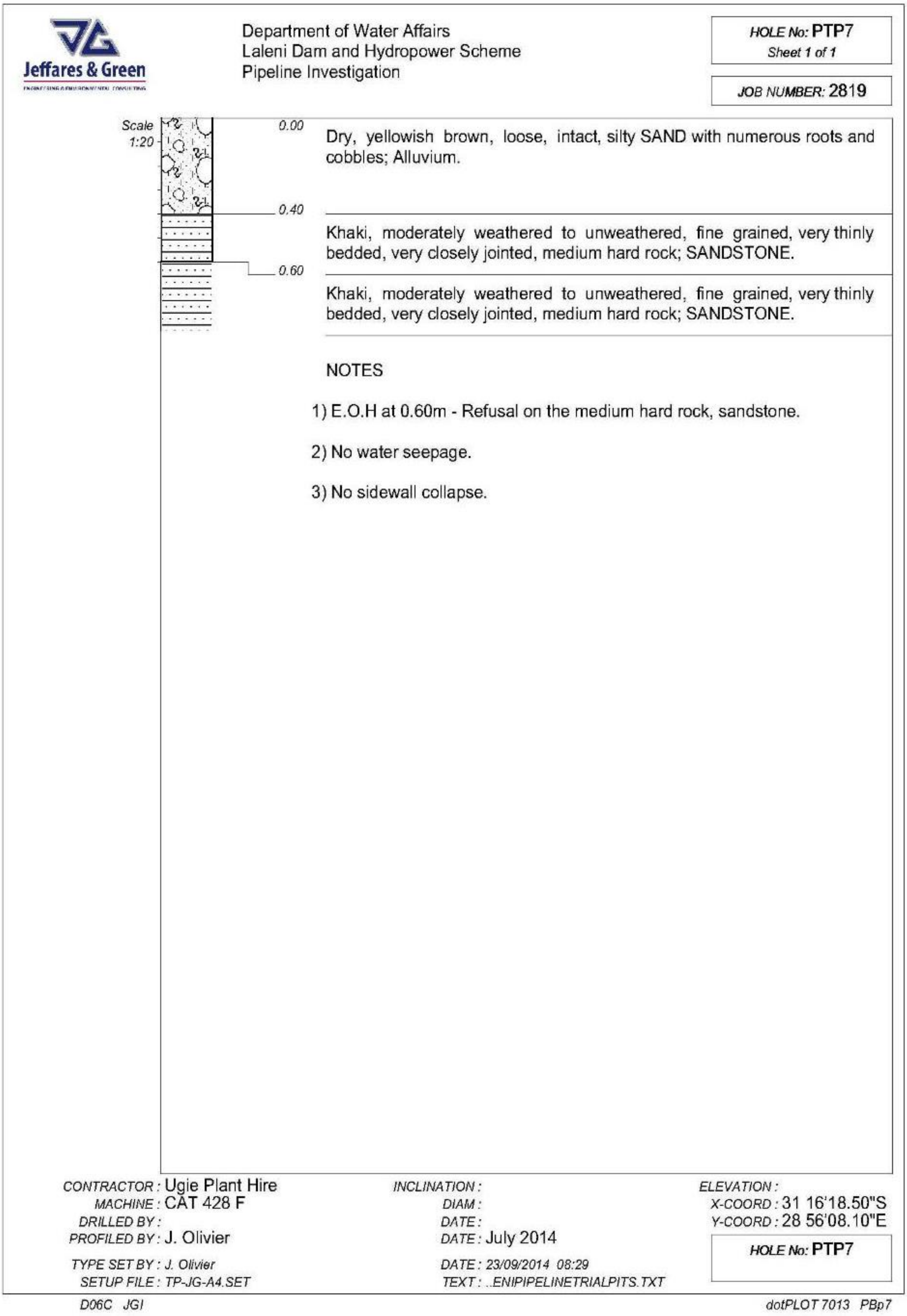
ELEVATION :
X-COORD : 31 16'18.50"S
Y-COORD : 28 56'00.70"E

HOLE No: PTP6

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.6: Pipeline Trial Pit 6



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP7
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Dry, yellowish brown, loose, intact, silty SAND with numerous roots and cobbles; Alluvium.
0.40	Khaki, moderately weathered to unweathered, fine grained, very thinly bedded, very closely jointed, medium hard rock; SANDSTONE.
0.60	Khaki, moderately weathered to unweathered, fine grained, very thinly bedded, very closely jointed, medium hard rock; SANDSTONE.

NOTES

1) E.O.H at 0.60m - Refusal on the medium hard rock, sandstone.

2) No water seepage.

3) No sidewall collapse.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

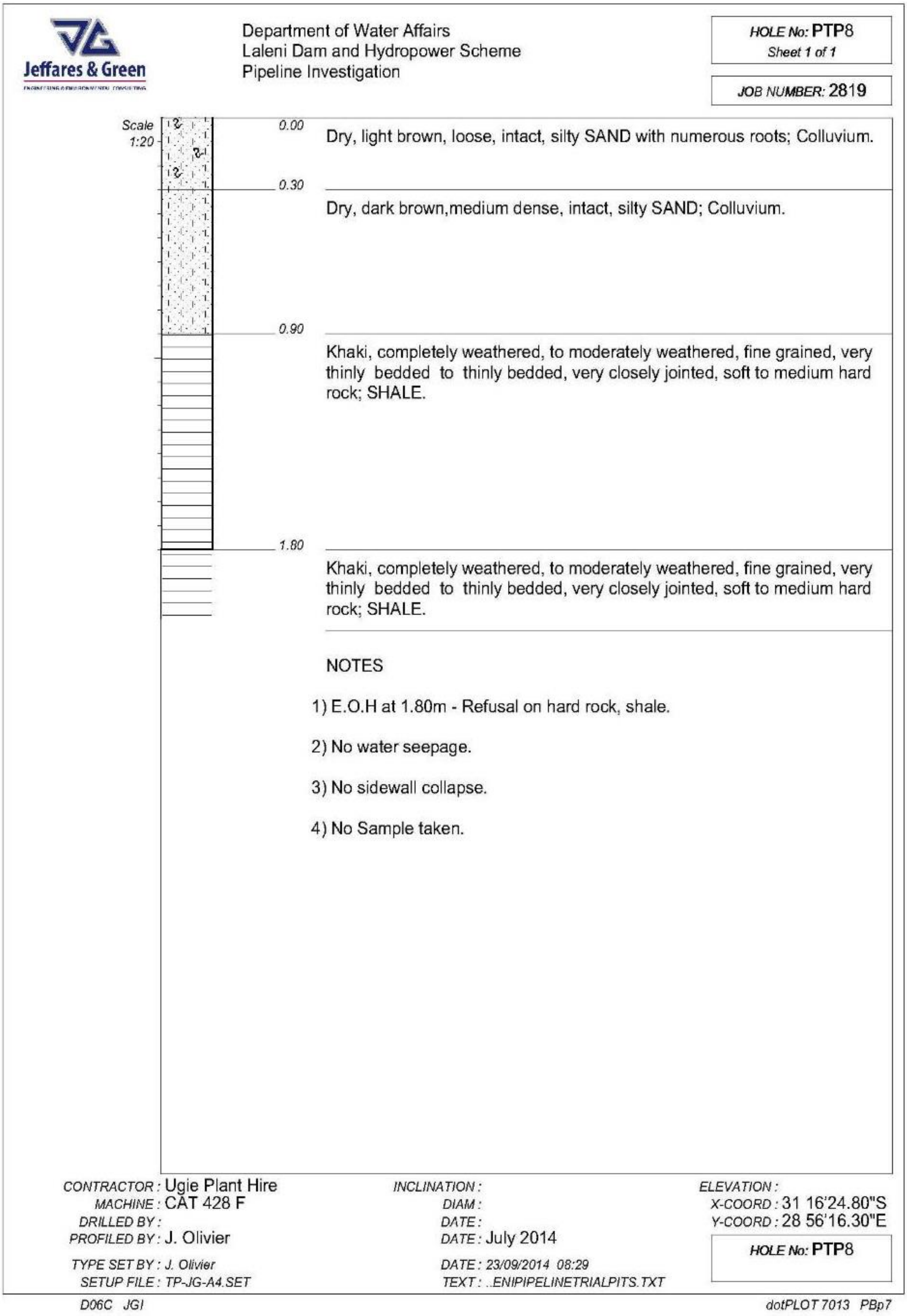
ELEVATION :
X-COORD : 31 16'18.50"S
Y-COORD : 28 56'08.10"E

HOLE No: PTP7

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.7: Pipeline Trial Pit 7



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Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP8
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Dry, light brown, loose, intact, silty SAND with numerous roots; Colluvium.
0.30	Dry, dark brown,medium dense, intact, silty SAND; Colluvium.
0.90	Khaki, completely weathered, to moderately weathered, fine grained, very thinly bedded to thinly bedded, very closely jointed, soft to medium hard rock; SHALE.
1.80	Khaki, completely weathered, to moderately weathered, fine grained, very thinly bedded to thinly bedded, very closely jointed, soft to medium hard rock; SHALE.

NOTES

1) E.O.H at 1.80m - Refusal on hard rock, shale.

2) No water seepage.

3) No sidewall collapse.

4) No Sample taken.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

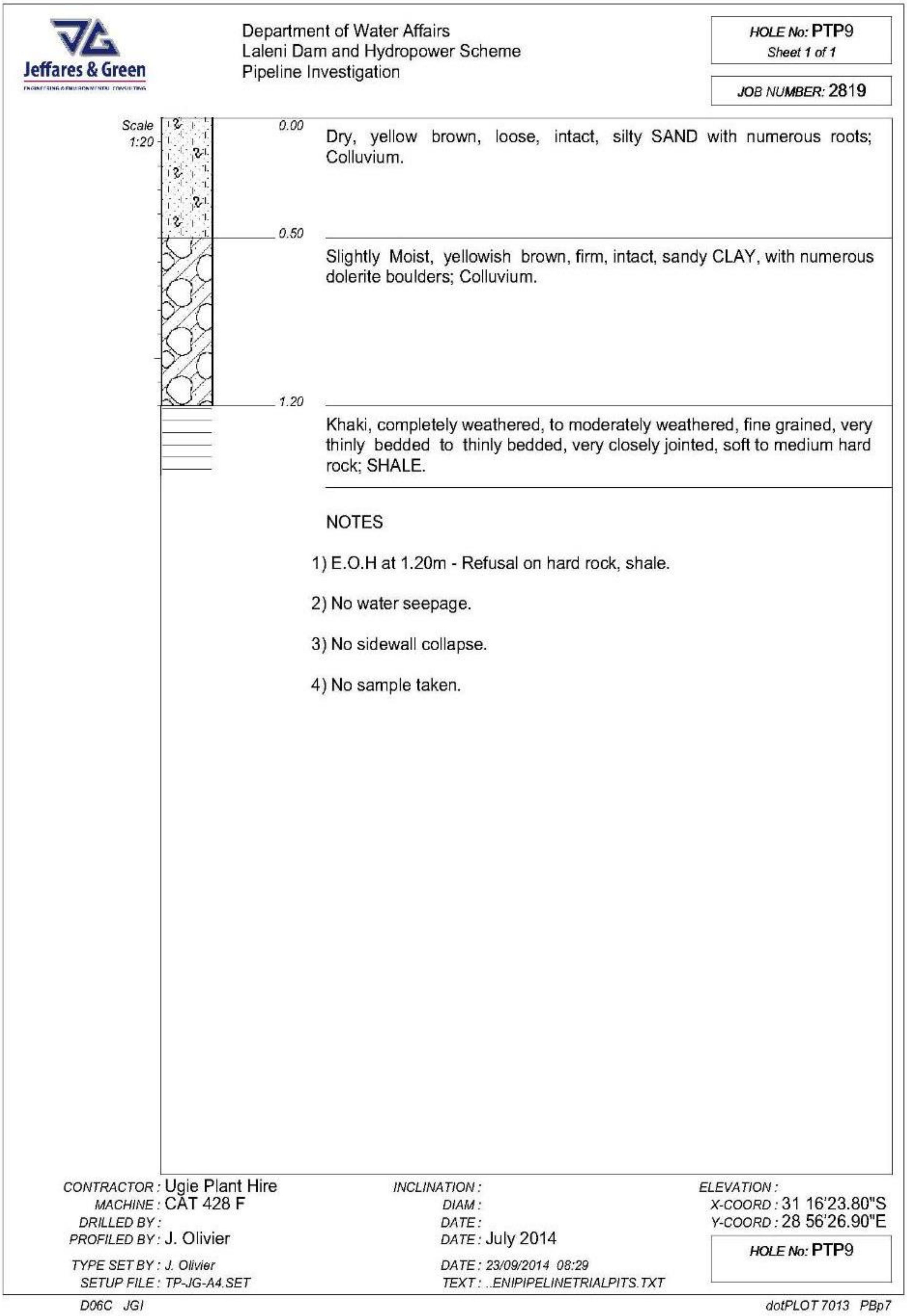
ELEVATION :
X-COORD : 31 16'24.80"S
Y-COORD : 28 56'16.30"E

HOLE No: PTP8

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.8: Pipeline Trial Pit 8



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP9
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

Depth	Description
0.00	Dry, yellow brown, loose, intact, silty SAND with numerous roots; Colluvium.
0.50	Slightly Moist, yellowish brown, firm, intact, sandy CLAY, with numerous dolerite boulders; Colluvium.
1.20	Khaki, completely weathered, to moderately weathered, fine grained, very thinly bedded to thinly bedded, very closely jointed, soft to medium hard rock; SHALE.

NOTES

1) E.O.H at 1.20m - Refusal on hard rock, shale.

2) No water seepage.

3) No sidewall collapse.

4) No sample taken.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

INCLINATION :
DIAM :
DATE :
DATE : July 2014

ELEVATION :
X-COORD : 31 16'23.80"S
Y-COORD : 28 56'26.90"E

HOLE No: PTP9

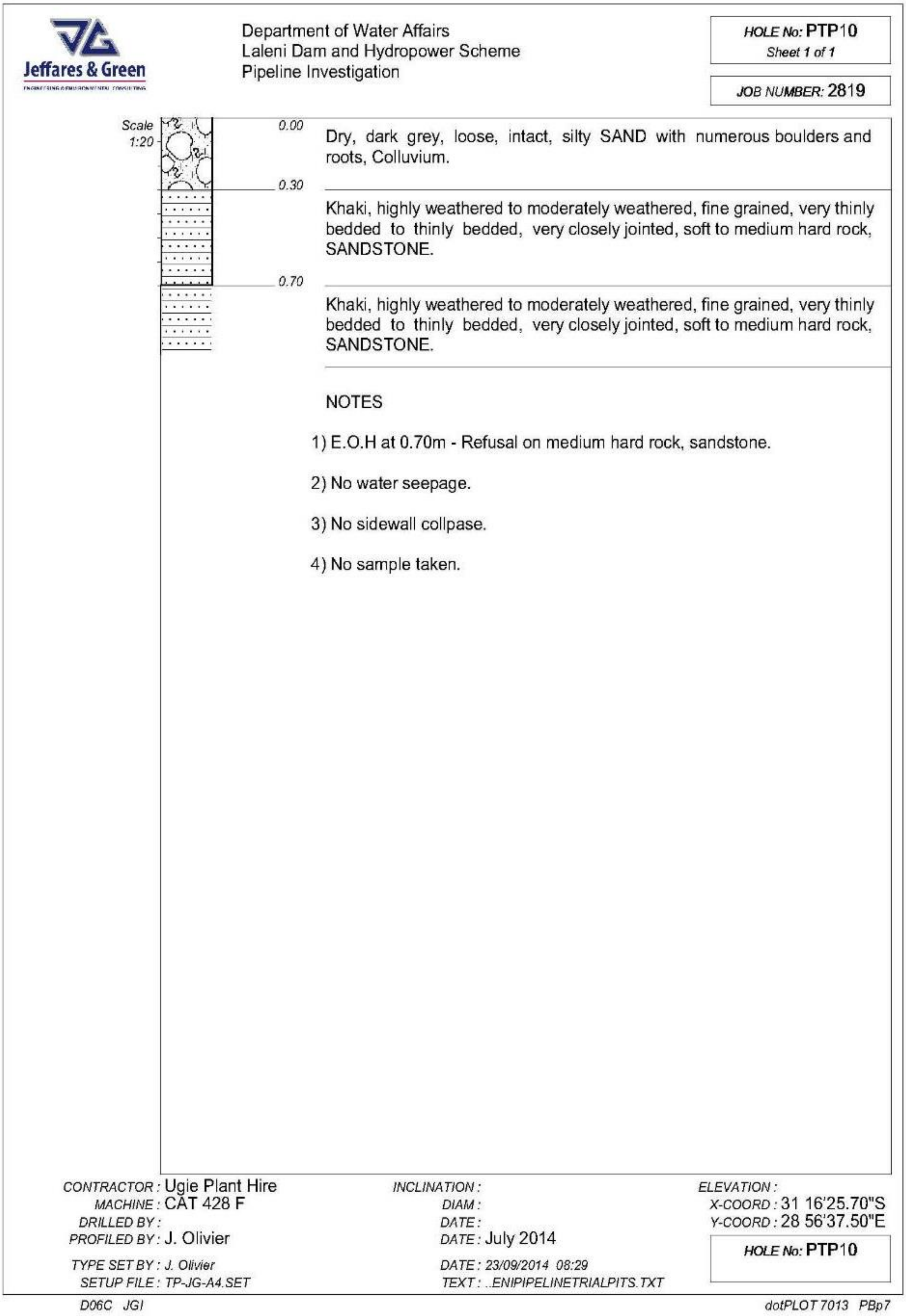
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.9: Pipeline Trial Pit 9



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP10
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Dry, dark grey, loose, intact, silty SAND with numerous boulders and roots, Colluvium.
0.30	Khaki, highly weathered to moderately weathered, fine grained, very thinly bedded to thinly bedded, very closely jointed, soft to medium hard rock, SANDSTONE.
0.70	Khaki, highly weathered to moderately weathered, fine grained, very thinly bedded to thinly bedded, very closely jointed, soft to medium hard rock, SANDSTONE.

NOTES

1) E.O.H at 0.70m - Refusal on medium hard rock, sandstone.

2) No water seepage.

3) No sidewall collpase.

4) No sample taken.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

INCLINATION :
DIAM :
DATE :
DATE : July 2014

ELEVATION :
X-COORD : 31 16'25.70"S
Y-COORD : 28 56'37.50"E

HOLE No: PTP10

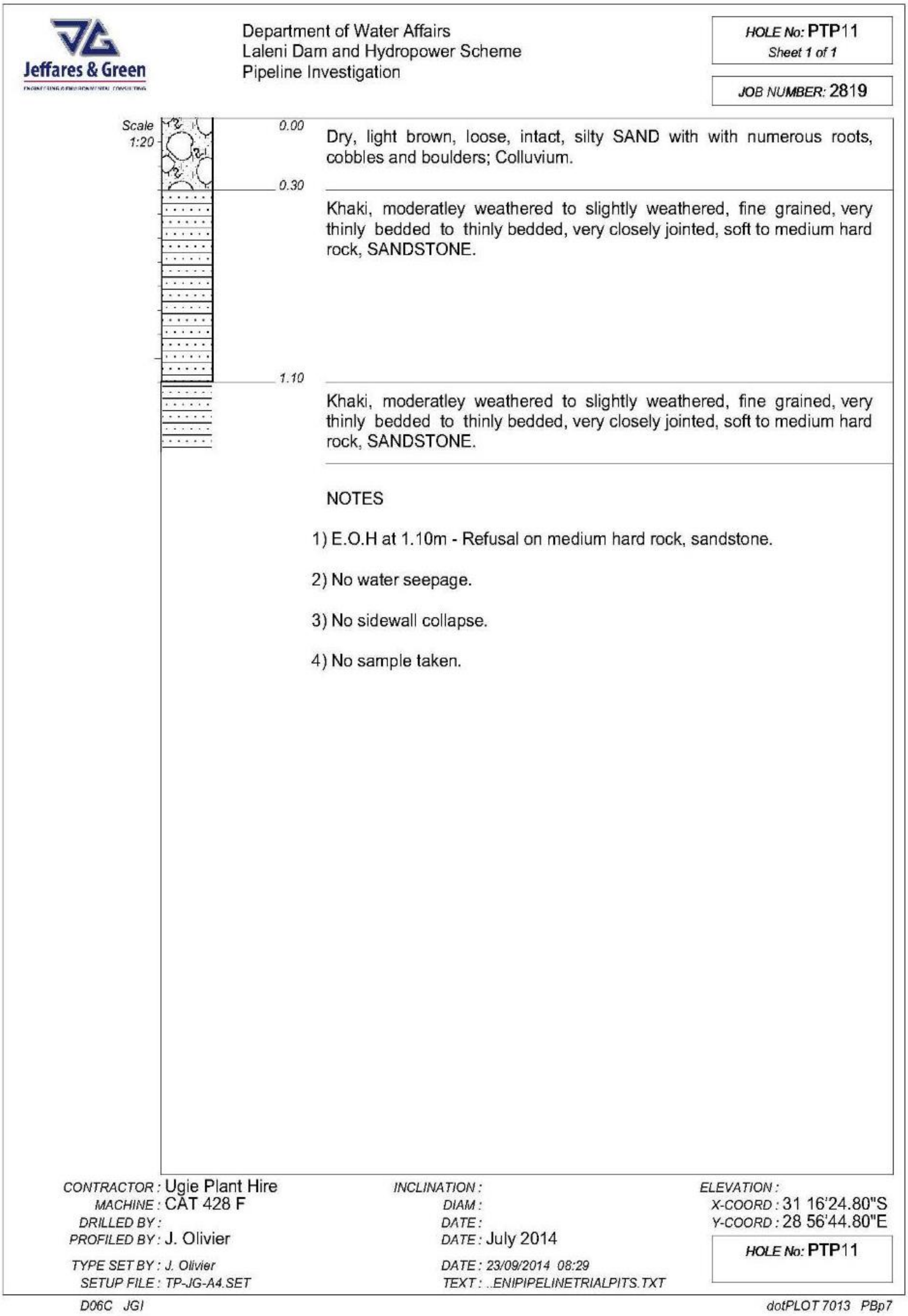
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

DATE : 23/09/2014 08:29
TEXT : ..ENIPIPELINETRIALPITS.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.10: Pipeline Trial Pit 10



Department of Water Affairs
Laleni Dam and Hydropower Scheme
Pipeline Investigation

HOLE No: PTP11
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

0.00	Dry, light brown, loose, intact, silty SAND with with numerous roots, cobbles and boulders; Colluvium.
0.30	Khaki, moderatley weathered to slightly weathered, fine grained, very thinly bedded to thinly bedded, very closely jointed, soft to medium hard rock, SANDSTONE.
1.10	Khaki, moderatley weathered to slightly weathered, fine grained, very thinly bedded to thinly bedded, very closely jointed, soft to medium hard rock, SANDSTONE.

NOTES

1) E.O.H at 1.10m - Refusal on medium hard rock, sandstone.

2) No water seepage.

3) No sidewall collapse.

4) No sample taken.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:29
TEXT : ..EN\PIPELINETRIALPITS.TXT

ELEVATION :
X-COORD : 31 16'24.80"S
Y-COORD : 28 56'44.80"E

HOLE No: PTP11

D06C JGI

dotPLOT 7013 PBp7

Fig F-1.11: Pipeline Trial Pit 11

F2:

CORE BORROW PIT TRIAL PIT LOGS

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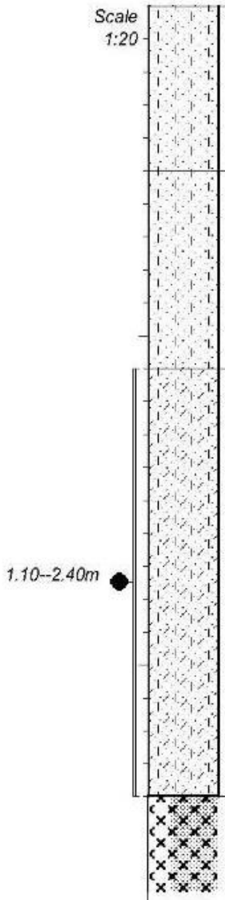
Laleni Dam and Hydropower Scheme
Core Borrow Pit Investigation

HOLE No: CTP1
Sheet 1 of 1

JOB NUMBER: 2819



0.00	Slightly moist, reddish brown, loose, intact, silty SAND with abundant roots. Alluvium.
0.50	Slightly moist, dark reddish brown, dense, intact, silty SAND. Alluvium.
1.10	Slightly moist, orange brown, dense, intact, clayey silty SAND, Residual Dolerite.
2.40	Grey, blotched orange, completely weathered to moderately weathered, medium grained, massive, medium hard rock to hard rock, DOLERITE.

NOTES

1) E.O.H at 2.40m - Refusal at medium hard rock dolerite.

2) No water seepage observed.

3) No sidewall collapse.

4) Disturbed sample taken between 1.10--2.40m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014
DATE : 23/09/2014 08:27
TEXT : ..9LALENICOREBORROWPIT.TXT

ELEVATION :
X-COORD : 31 14'59.30"S
Y-COORD : 28 55'39.40"E

HOLE No: CTP1

D06C JGI

dotPLOT 7013 PBp7

Fig F-2.1: Core Borrow Pit 1

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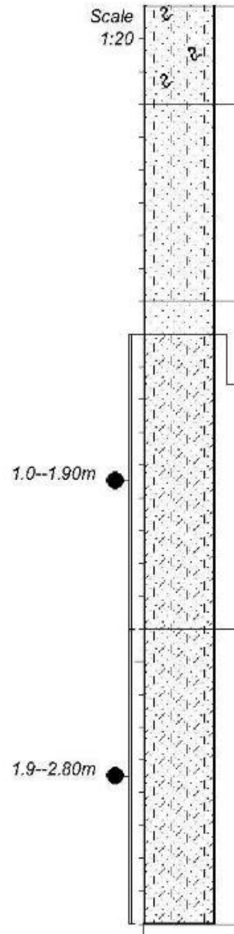
Department of Water Affairs
Laleni Dam and Hydropower Scheme
Core Borrow Pit Investigation

HOLE No: CTP2
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, dark brown, loose, intact, silty SAND with numerous roots. Colluvium.
0.30	Slightly moist, dark brown, loose to medium dense, intact, silty SAND, Colluvium.
0.90	Slightly moist, lightly grey, medium dense, intact, gravelly SAND, Pebble marker.
1.00	Slightly moist, Reddish Brown, medium dense to dense, intact, clayey silty SAND, Residual Dolerite.
1.90	Slightly moist, light olive brown, dense, intact, clayey silty SAND, Residual Dolerite.
2.80	

NOTES

1) E.O.H at 2.80m - Slow advance on residual dolerite.

2) No water seepage.

3) No sidewall collapse.

4) Disturbed sample taken at 1.0--1.90m.

5) Disturbed sample taken at 1.9--2.80m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

INCLINATION :
DIAM :
DATE :
DATE : July 2014

ELEVATION :
X-COORD : 31 15'00.10"S
Y-COORD : 28 55'55.70"E

HOLE No: CTP2

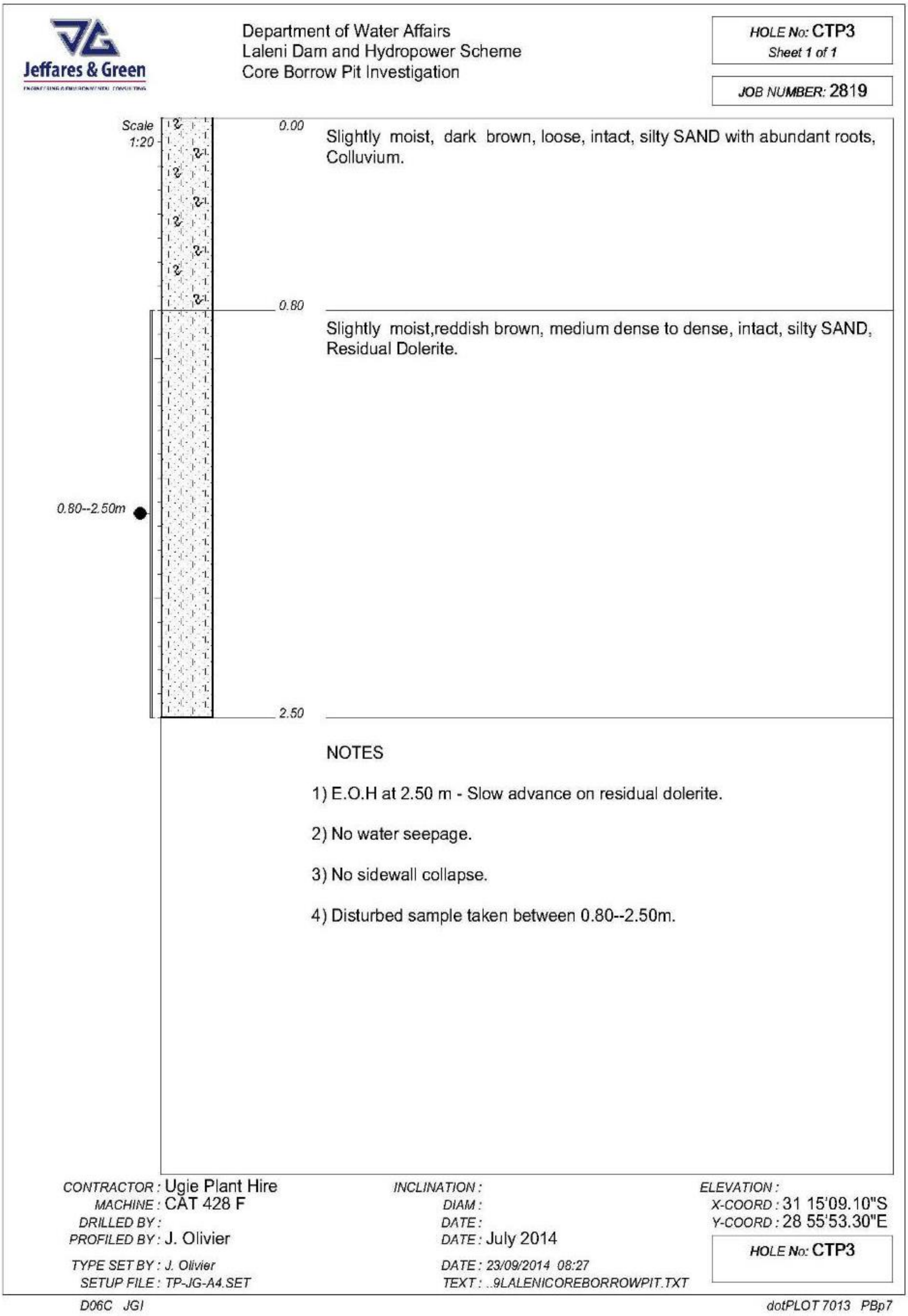
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

DATE : 23/09/2014 08:27
TEXT : ..9LALENICOREBORROWPIT.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig F-2.2: **Core Borrow Pit 2**



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Laleni Dam and Hydropower Scheme
Core Borrow Pit Investigation

HOLE No: CTP3
Sheet 1 of 1

JOB NUMBER: 2819

0.00 Slightly moist, dark brown, loose, intact, silty SAND with abundant roots, Colluvium.

0.80 Slightly moist,reddish brown, medium dense to dense, intact, silty SAND, Residual Dolerite.

2.50

NOTES

1) E.O.H at 2.50 m - Slow advance on residual dolerite.

2) No water seepage.

3) No sidewall collapse.

4) Disturbed sample taken between 0.80--2.50m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

INCLINATION :
DIAM :
DATE :
DATE : July 2014

ELEVATION :
X-COORD : 31 15'09.10"S
Y-COORD : 28 55'53.30"E

HOLE No: CTP3

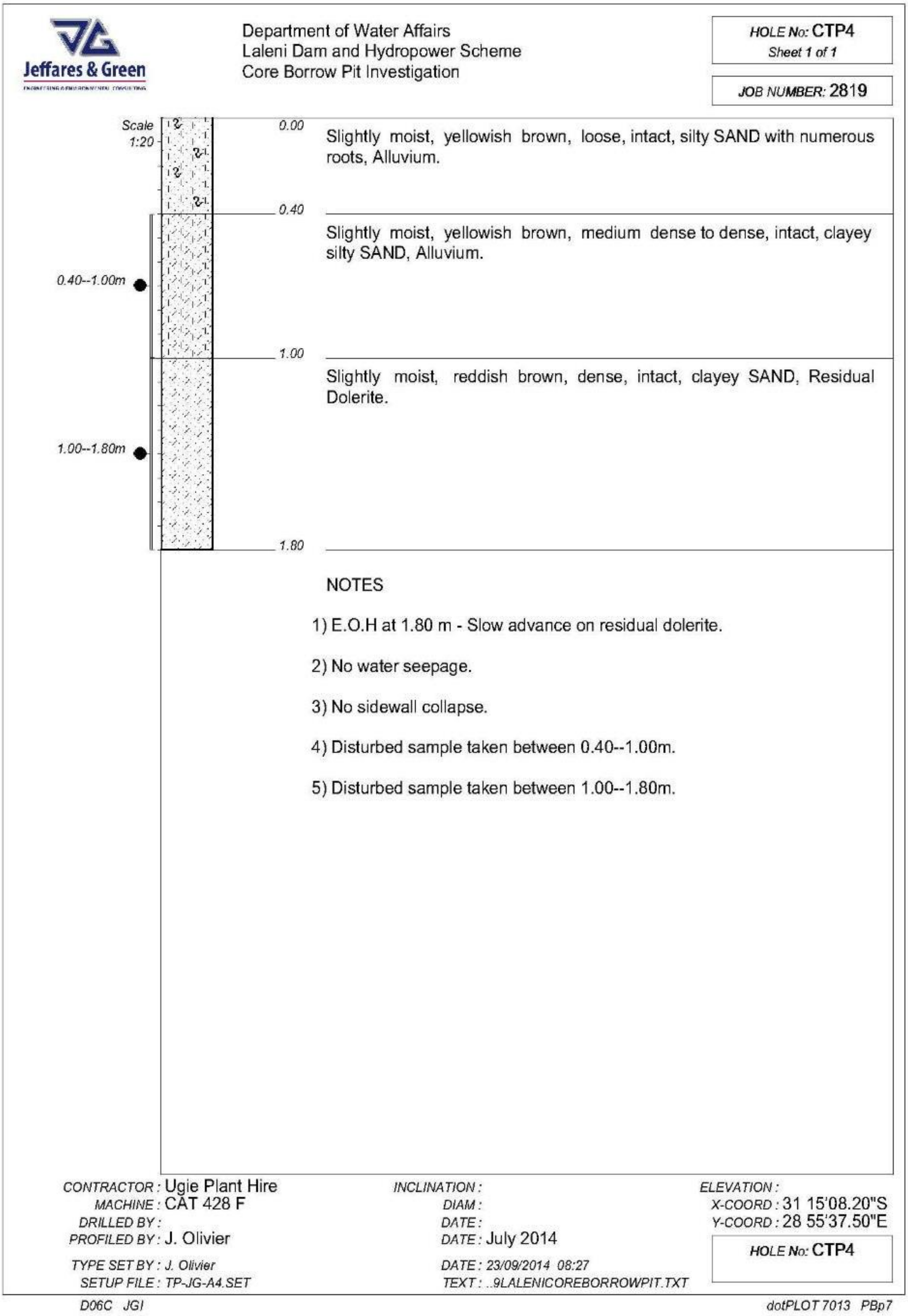
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

DATE : 23/09/2014 08:27
TEXT : ..9LALENICOREBORROWPIT.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig F-2.3: Core Borrow Pit 3



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Core Borrow Pit Investigation

HOLE No: CTP4
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

Depth	Description
0.00	Slightly moist, yellowish brown, loose, intact, silty SAND with numerous roots, Alluvium.
0.40	Slightly moist, yellowish brown, medium dense to dense, intact, clayey silty SAND, Alluvium.
1.00	Slightly moist, reddish brown, dense, intact, clayey SAND, Residual Dolerite.
1.80	

0.40--1.00m ●

1.00--1.80m ●

NOTES

1) E.O.H at 1.80 m - Slow advance on residual dolerite.

2) No water seepage.

3) No sidewall collapse.

4) Disturbed sample taken between 0.40--1.00m.

5) Disturbed sample taken between 1.00--1.80m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:27
TEXT : ..9LALENICOREBORROWPIT.TXT

ELEVATION :
X-COORD : 31 15'08.20"S
Y-COORD : 28 55'37.50"E

HOLE No: CTP4

D06C JGI

dotPLOT 7013 PBp7

Fig F-2.4: Core Borrow Pit 4

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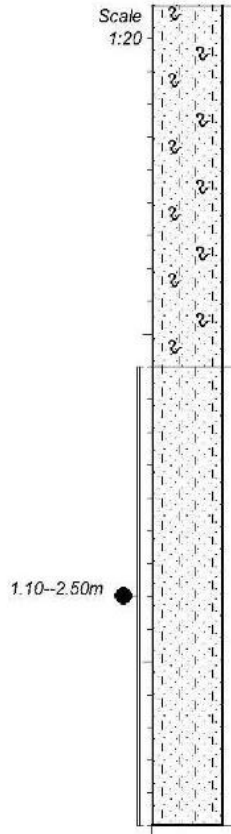
Laleni Dam and Hydropower Scheme
Core Borrow Pit Investigation

HOLE No: **CTP5**
Sheet 1 of 1

JOB NUMBER: **2819**



0.00	Dry,dark brown, loose, intact, silty SAND with abundant roots, Alluvium.
1.10	Slightly moist, reddish brown, medium dense to dense, intact, silty SAND, Residual Dolerite.
2.50	

NOTES

1) E.O.H at 2.50m - Slow advance of TLB on residual dolerite.

2) No water seepage.

3) No sidewall collapse.

4) Disturbed sample taken between 1.10--2.50m

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:27
TEXT : ..9LALENICOREBORROWPIT.TXT

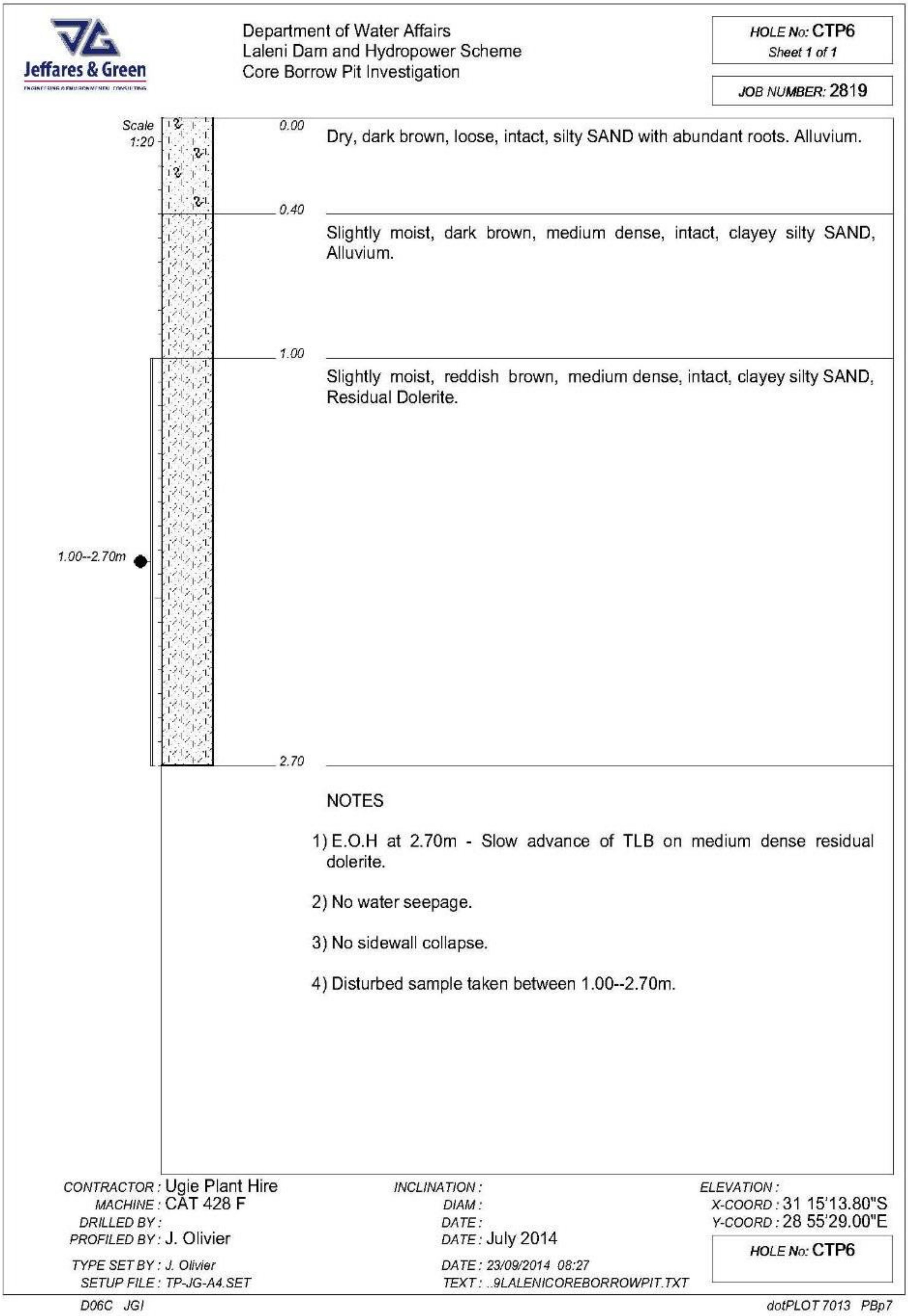
ELEVATION :
X-COORD : 31 15'16.50"S
Y-COORD : 28 55'37.50"E

HOLE No: **CTP5**

D06C JGI

dotPLOT 7013 PBp7

Fig F-2.5: Core Borrow Pit 5



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Core Borrow Pit Investigation

HOLE No: CTP6
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

Depth (m)	Description
0.00 – 0.40	Dry, dark brown, loose, intact, silty SAND with abundant roots. Alluvium.
0.40 – 1.00	Slightly moist, dark brown, medium dense, intact, clayey silty SAND, Alluvium.
1.00 – 2.70	Slightly moist, reddish brown, medium dense, intact, clayey silty SAND, Residual Dolerite.

1.00--2.70m

NOTES

1) E.O.H at 2.70m - Slow advance of TLB on medium dense residual dolerite.

2) No water seepage.

3) No sidewall collapse.

4) Disturbed sample taken between 1.00--2.70m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014
DATE : 23/09/2014 08:27
TEXT : ..9LALENICOREBORROWPIT.TXT

ELEVATION :
X-COORD : 31 15'13.80"S
Y-COORD : 28 55'29.00"E

HOLE No: CTP6

D06C JGI

dotPLOT 7013 PBp7

Fig F-2.6: Core Borrow Pit 6

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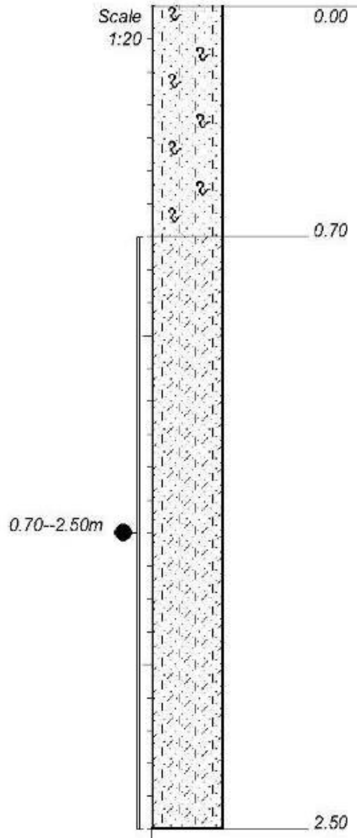
Laleni Dam and Hydropower Scheme
Core Borrow Pit Investigation

HOLE No: CTP7
Sheet 1 of 1

JOB NUMBER: 2819



Dry, light brown, loose, intact, silty SAND with numerous roots. Colluvium.

Slightly moist, reddish brown, medium dense to dense, intact, clayey silty SAND, Reidual Dolerite.

NOTES

1) E.O.H at 2.50m - Slow advance on the dense residual dolerite.

2) No water seepage.

3) No sidewall collapse.

4) Sample taken between 0.70--2.50m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014
DATE : 23/09/2014 08:27
TEXT : ..9LALENICOREBORROWPIT.TXT

ELEVATION :
X-COORD : 31 15'08.50"S
Y-COORD : 28 55'46.00"E

HOLE No: CTP7

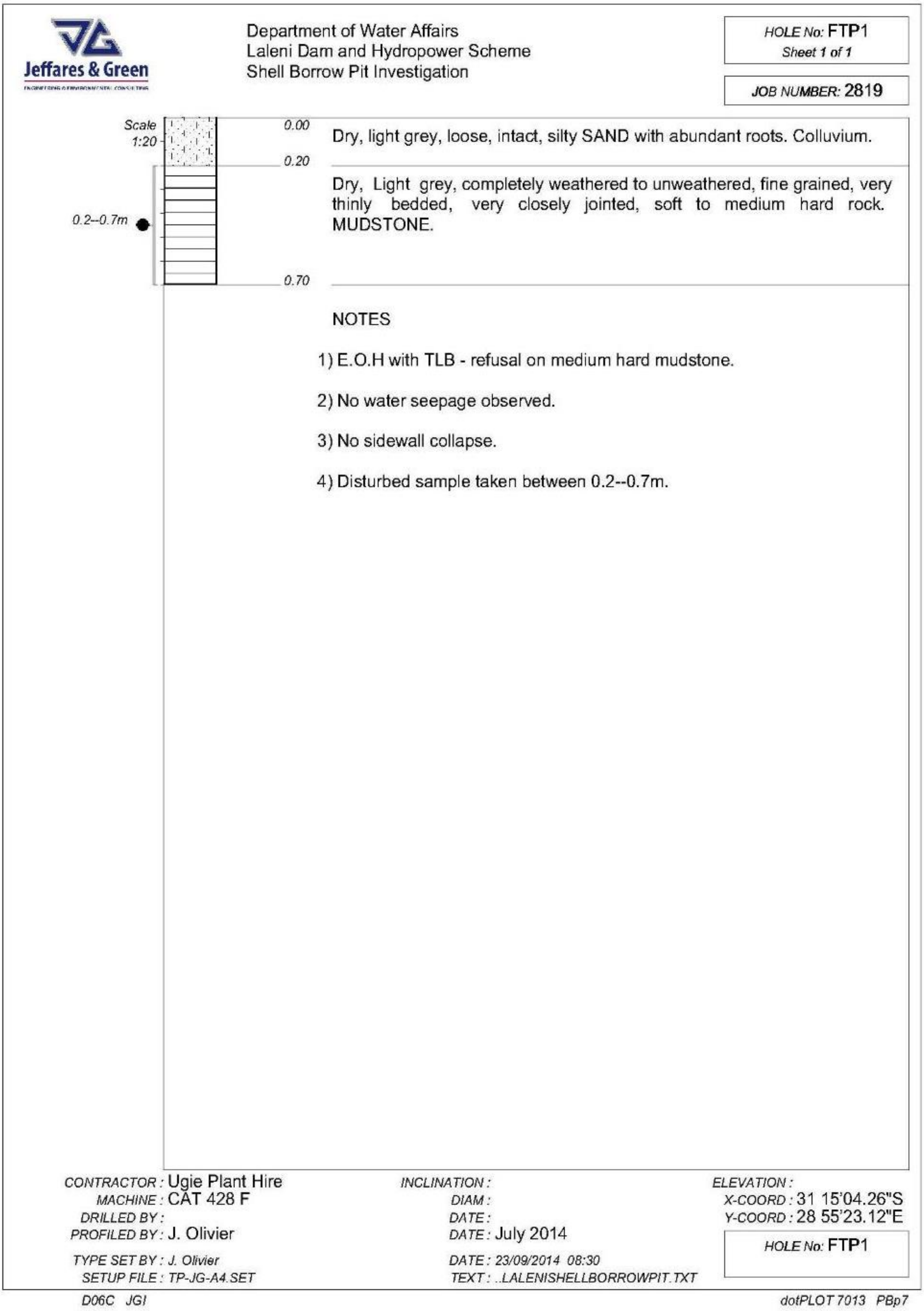
D06C JGI

dotPLOT 7013 PBp7

Fig F-2.7: Core Borrow Pit 7

F3:

SHELL BORROW PIT LOGS



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP1
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

0.00

Dry, light grey, loose, intact, silty SAND with abundant roots. Colluvium.

0.20

Dry, Light grey, completely weathered to unweathered, fine grained, very thinly bedded, very closely jointed, soft to medium hard rock. MUDSTONE.

0.2--0.7m ●

0.70

NOTES

1) E.O.H with TLB - refusal on medium hard mudstone.

2) No water seepage observed.

3) No sidewall collapse.

4) Disturbed sample taken between 0.2--0.7m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

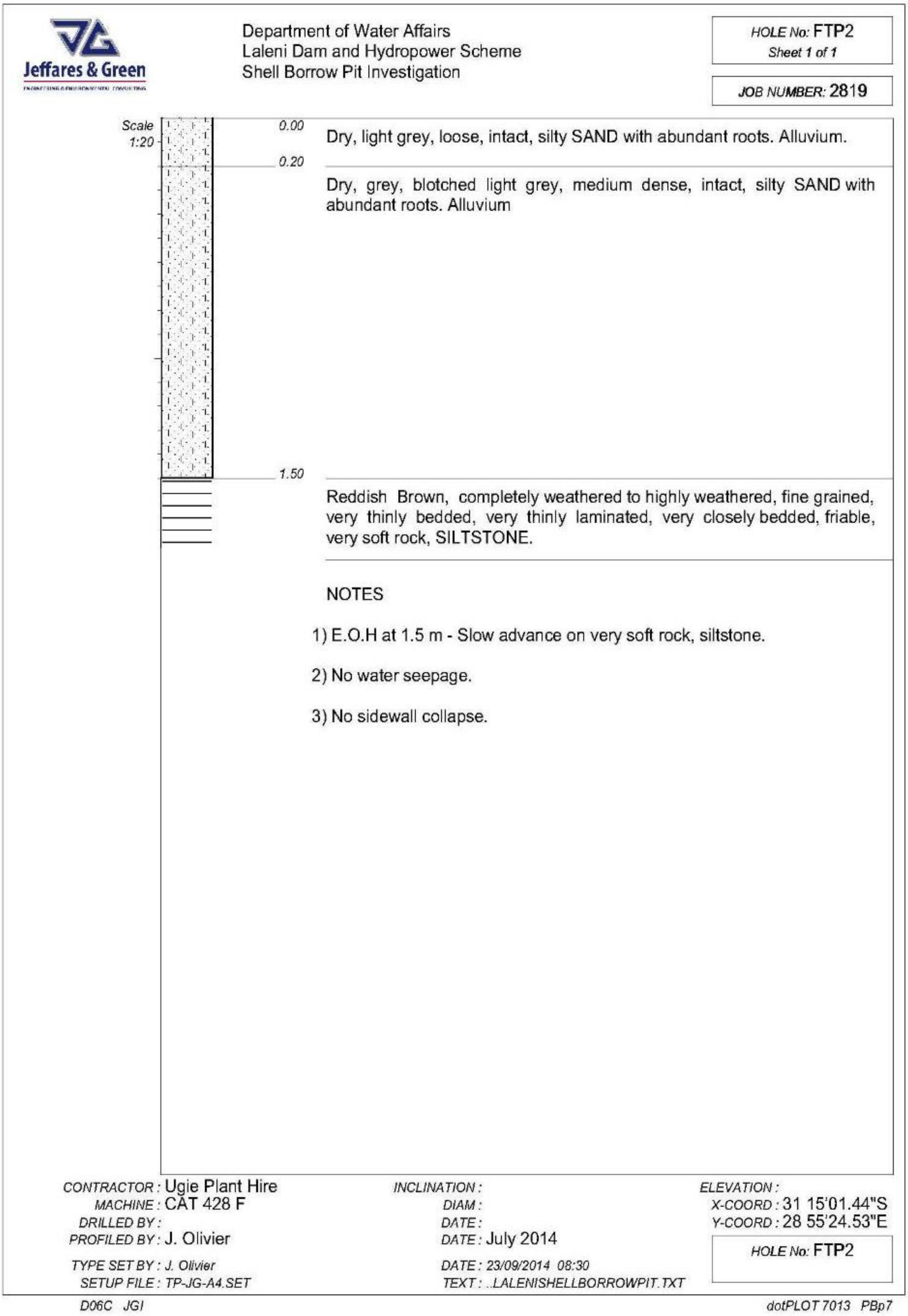
ELEVATION :
X-COORD : 31 15'04.26"S
Y-COORD : 28 55'23.12"E

HOLE No: FTP1

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.1: Shell Borrow Pit 1



Jeffares & Green

Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP2
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Dry, light grey, loose, intact, silty SAND with abundant roots. Alluvium.
0.20	Dry, grey, blotched light grey, medium dense, intact, silty SAND with abundant roots. Alluvium
1.50	Reddish Brown, completely weathered to highly weathered, fine grained, very thinly bedded, very thinly laminated, very closely bedded, friable, very soft rock, SILTSTONE.

NOTES

1) E.O.H at 1.5 m - Slow advance on very soft rock, siltstone.

2) No water seepage.

3) No sidewall collapse.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

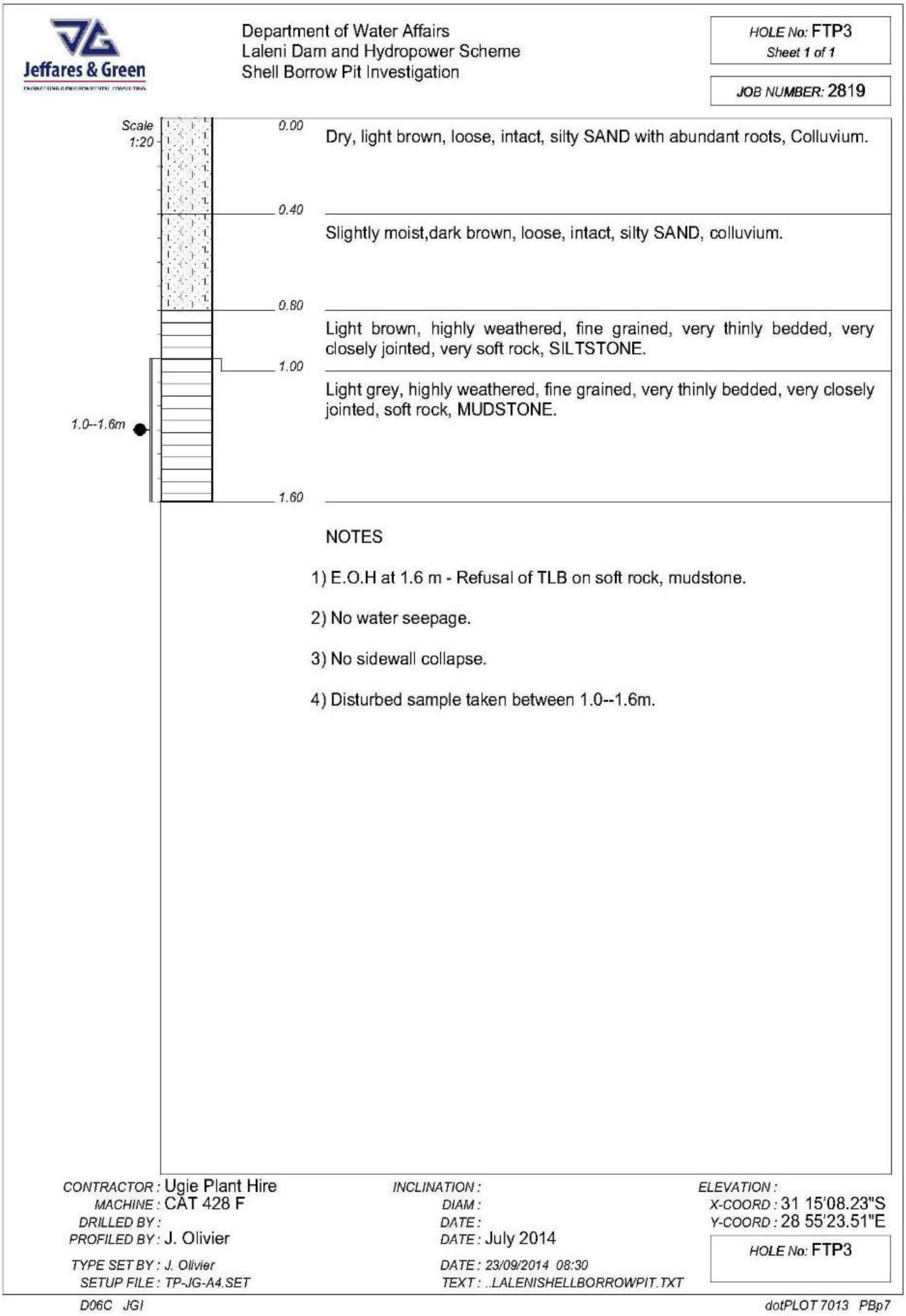
ELEVATION :
X-COORD : 31 15'01.44"S
Y-COORD : 28 55'24.53"E

HOLE No: FTP2

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.2: Shell Borrow Pit 2



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP3
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

0.00	Dry, light brown, loose, intact, silty SAND with abundant roots, Colluvium.
0.40	Slightly moist,dark brown, loose, intact, silty SAND, colluvium.
0.80	Light brown, highly weathered, fine grained, very thinly bedded, very closely jointed, very soft rock, SILTSTONE.
1.00	Light grey, highly weathered, fine grained, very thinly bedded, very closely jointed, soft rock, MUDSTONE.
1.60	

1.0--1.6m ●

NOTES

1) E.O.H at 1.6 m - Refusal of TLB on soft rock, mudstone.

2) No water seepage.

3) No sidewall collapse.

4) Disturbed sample taken between 1.0--1.6m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

INCLINATION :
DIAM :
DATE :
DATE : July 2014

ELEVATION :
X-COORD : 31 15'08.23"S
Y-COORD : 28 55'23.51"E

HOLE No: FTP3

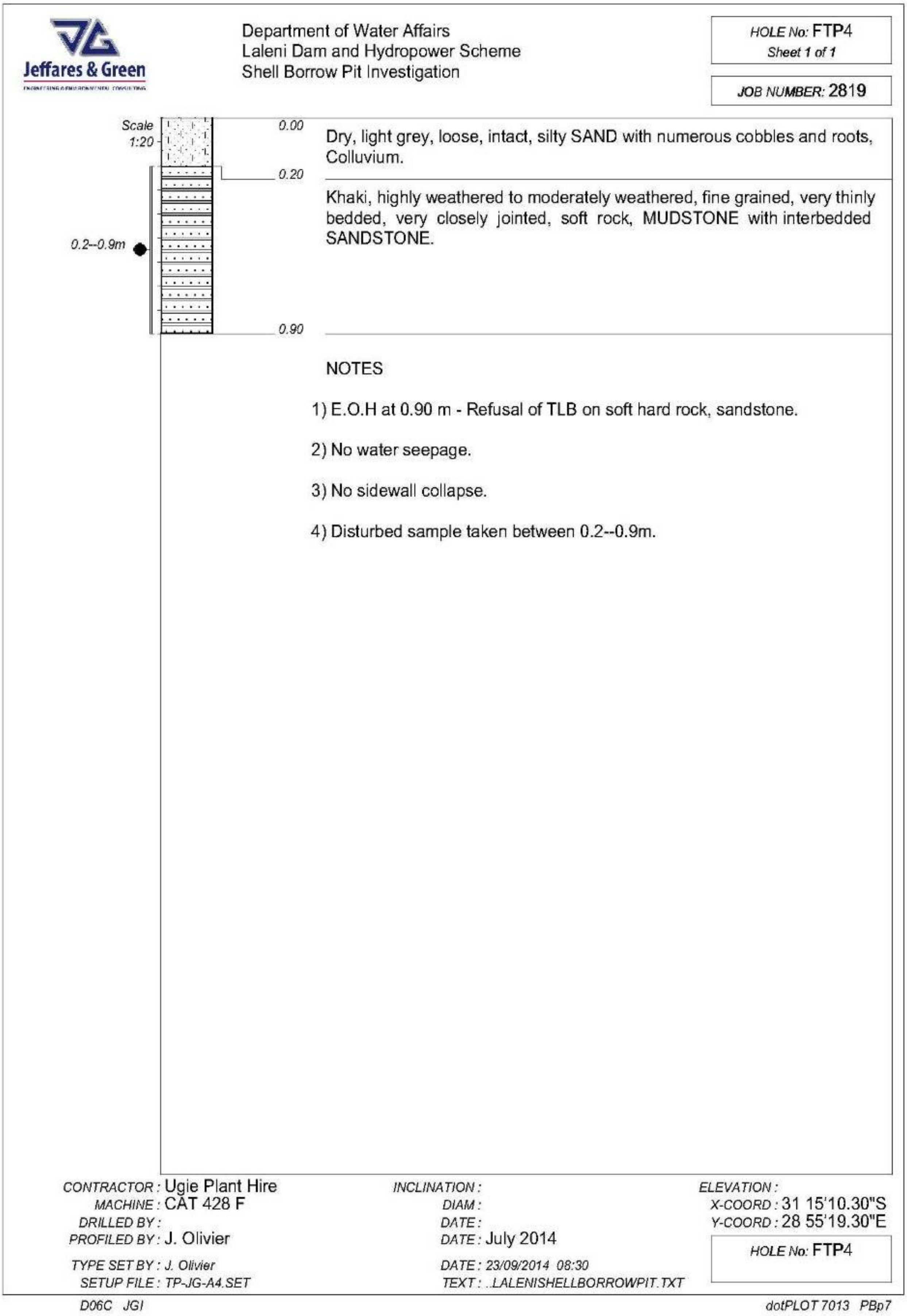
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.3: Shell Borrow Pit 3



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP4
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00

Dry, light grey, loose, intact, silty SAND with numerous cobbles and roots, Colluvium.

0.20

Khaki, highly weathered to moderately weathered, fine grained, very thinly bedded, very closely jointed, soft rock, MUDSTONE with interbedded SANDSTONE.

0.2--0.9m

0.90

NOTES

1) E.O.H at 0.90 m - Refusal of TLB on soft hard rock, sandstone.

2) No water seepage.

3) No sidewall collapse.

4) Disturbed sample taken between 0.2--0.9m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014
DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

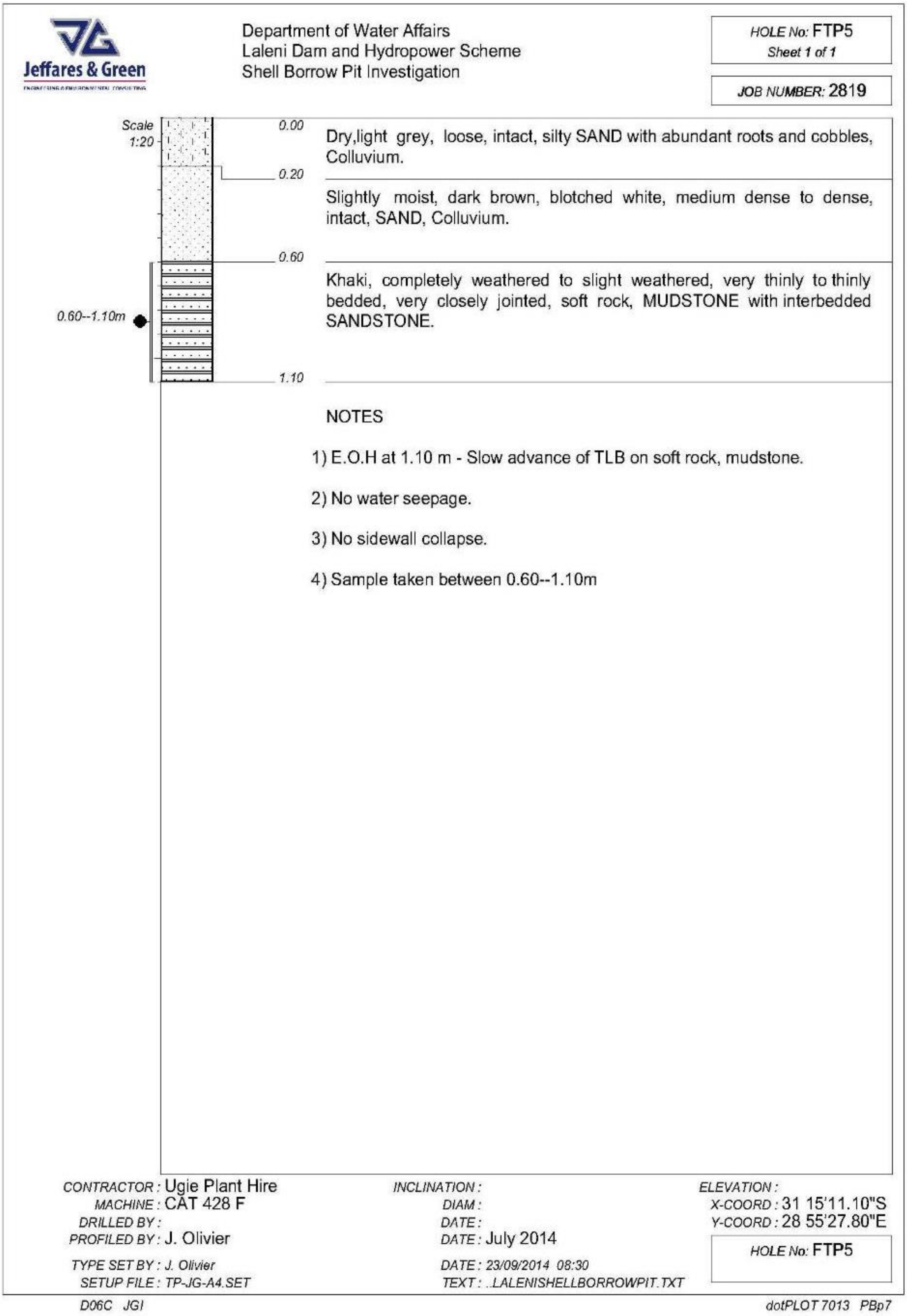
ELEVATION :
X-COORD : 31 15'10.30"S
Y-COORD : 28 55'19.30"E

HOLE No: FTP4

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.4: Shell Borrow Pit 4



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP5
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Dry,light grey, loose, intact, silty SAND with abundant roots and cobbles, Colluvium.
0.20	Slightly moist, dark brown, blotched white, medium dense to dense, intact, SAND, Colluvium.
0.60	Khaki, completely weathered to slight weathered, very thinly to thinly bedded, very closely jointed, soft rock, MUDSTONE with interbedded SANDSTONE.
1.10	

NOTES

1) E.O.H at 1.10 m - Slow advance of TLB on soft rock, mudstone.

2) No water seepage.

3) No sidewall collapse.

4) Sample taken between 0.60--1.10m

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

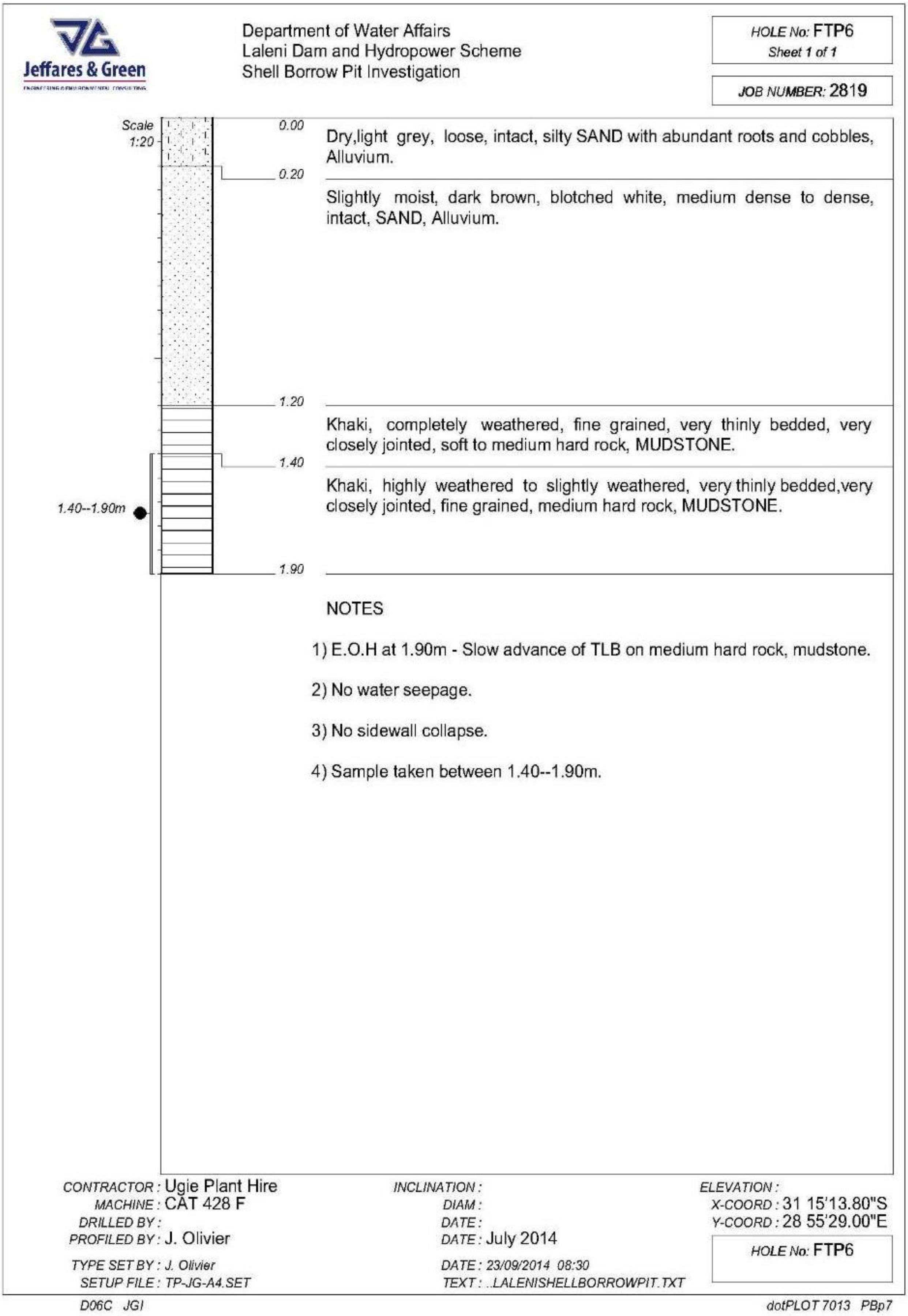
ELEVATION :
X-COORD : 31 15'11.10"S
Y-COORD : 28 55'27.80"E

HOLE No: FTP5

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.5: Shell Borrow Pit 5



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP6
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

Depth	Description
0.00 – 0.20	Dry,light grey, loose, intact, silty SAND with abundant roots and cobbles, Alluvium.
0.20 – 1.20	Slightly moist, dark brown, blotched white, medium dense to dense, intact, SAND, Alluvium.
1.20 – 1.40	Khaki, completely weathered, fine grained, very thinly bedded, very closely jointed, soft to medium hard rock, MUDSTONE.
1.40 – 1.90	Khaki, highly weathered to slightly weathered, very thinly bedded,very closely jointed, fine grained, medium hard rock, MUDSTONE.

1.40--1.90m ●

NOTES

1) E.O.H at 1.90m - Slow advance of TLB on medium hard rock, mudstone.

2) No water seepage.

3) No sidewall collapse.

4) Sample taken between 1.40--1.90m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

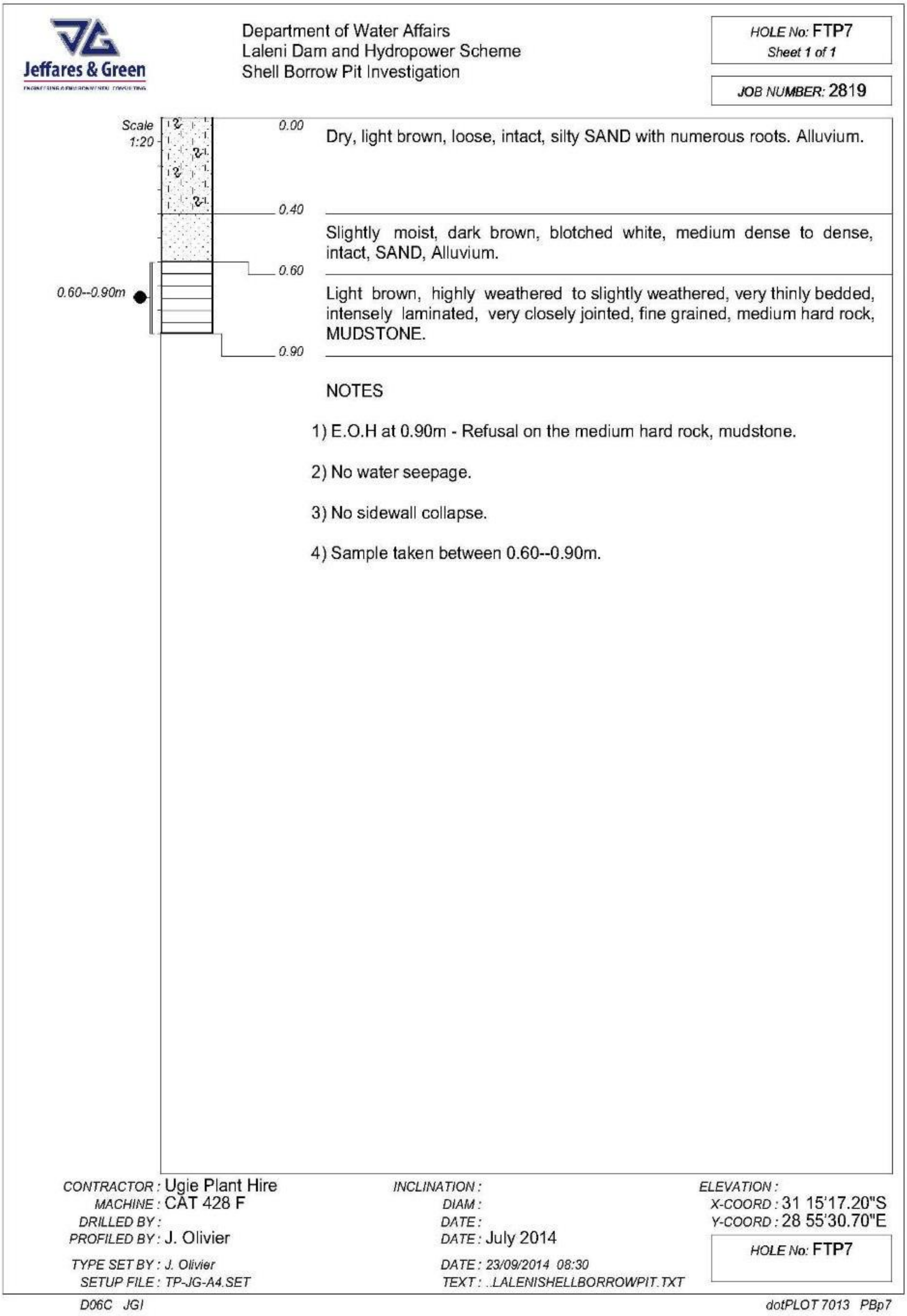
ELEVATION :
X-COORD : 31 15'13.80"S
Y-COORD : 28 55'29.00"E

HOLE No: FTP6

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.6: Shell Borrow Pit 6



Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP7
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

Depth (m)	Description
0.00–0.40	Dry, light brown, loose, intact, silty SAND with numerous roots. Alluvium.
0.40–0.60	Slightly moist, dark brown, blotched white, medium dense to dense, intact, SAND, Alluvium.
0.60–0.90	Light brown, highly weathered to slightly weathered, very thinly bedded, intensely laminated, very closely jointed, fine grained, medium hard rock, MUDSTONE.

0.60--0.90m ●

NOTES

1) E.O.H at 0.90m - Refusal on the medium hard rock, mudstone.

2) No water seepage.

3) No sidewall collapse.

4) Sample taken between 0.60--0.90m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

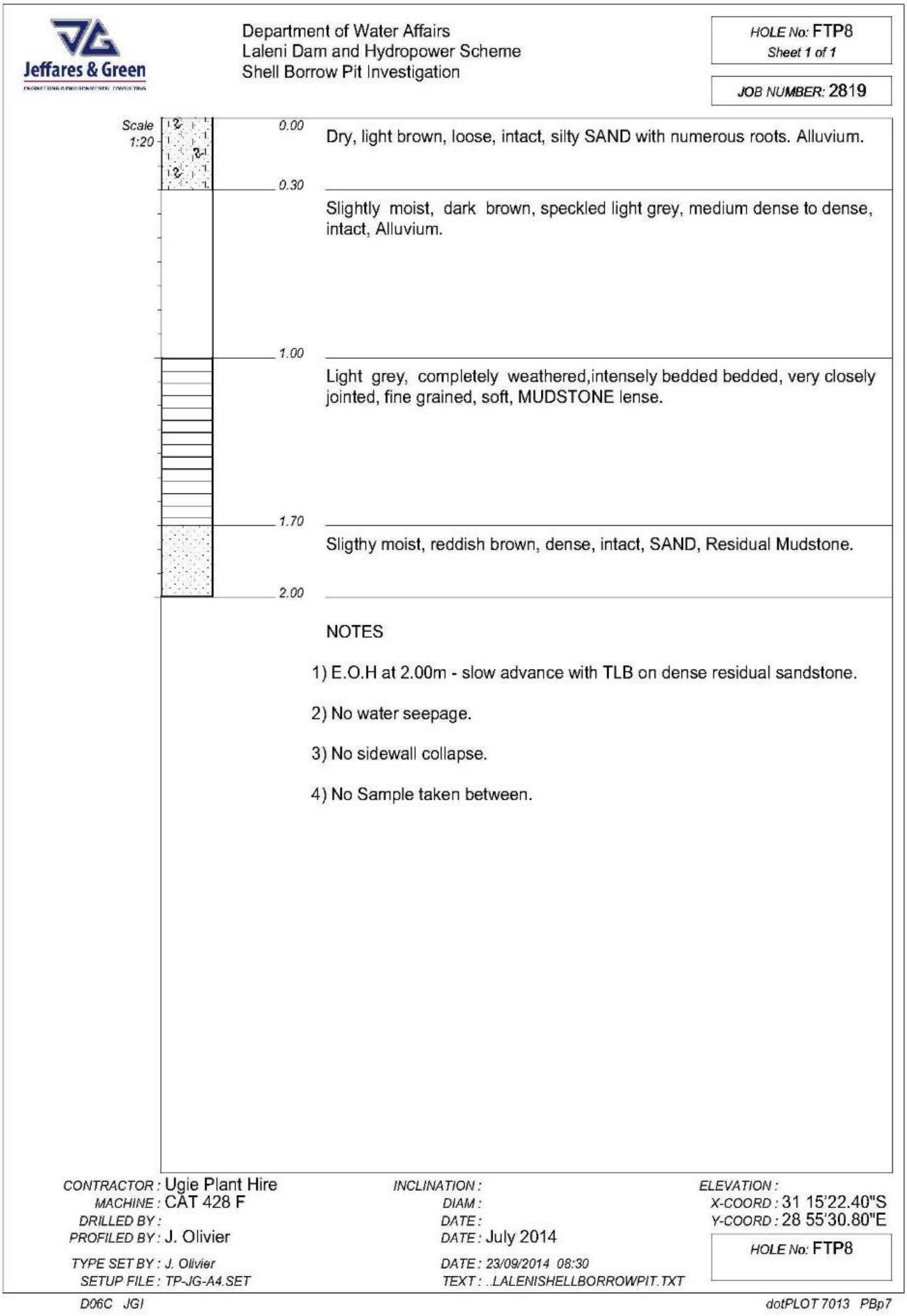
ELEVATION :
X-COORD : 31 15'17.20"S
Y-COORD : 28 55'30.70"E

HOLE No: FTP7

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.7: Shell Borrow Pit 7



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP8
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00	Dry, light brown, loose, intact, silty SAND with numerous roots. Alluvium.
0.30	Slightly moist, dark brown, speckled light grey, medium dense to dense, intact, Alluvium.
1.00	Light grey, completely weathered,intensely bedded bedded, very closely jointed, fine grained, soft, MUDSTONE lense.
1.70	Sligthy moist, reddish brown, dense, intact, SAND, Residual Mudstone.
2.00	

NOTES

1) E.O.H at 2.00m - slow advance with TLB on dense residual sandstone.

2) No water seepage.

3) No sidewall collapse.

4) No Sample taken between.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

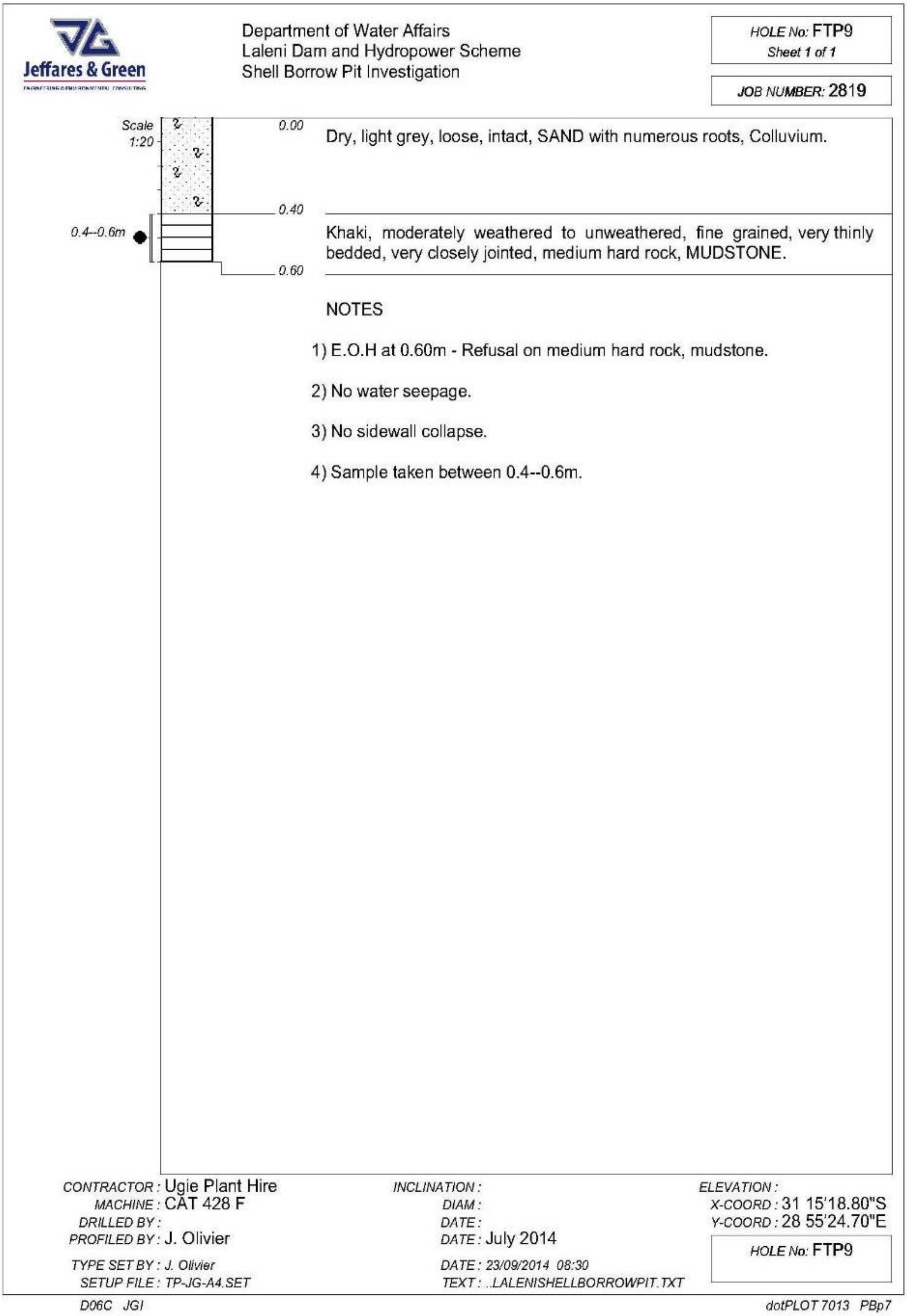
ELEVATION :
X-COORD : 31 15'22.40"S
Y-COORD : 28 55'30.80"E

HOLE No: FTP8

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.8: Shell Borrow Pit 8



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP9
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

Depth	Description
0.00	Dry, light grey, loose, intact, SAND with numerous roots, Colluvium.
0.40	Khaki, moderately weathered to unweathered, fine grained, very thinly bedded, very closely jointed, medium hard rock, MUDSTONE.
0.60	

0.4--0.6m ●

NOTES

1) E.O.H at 0.60m - Refusal on medium hard rock, mudstone.

2) No water seepage.

3) No sidewall collapse.

4) Sample taken between 0.4--0.6m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014
DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

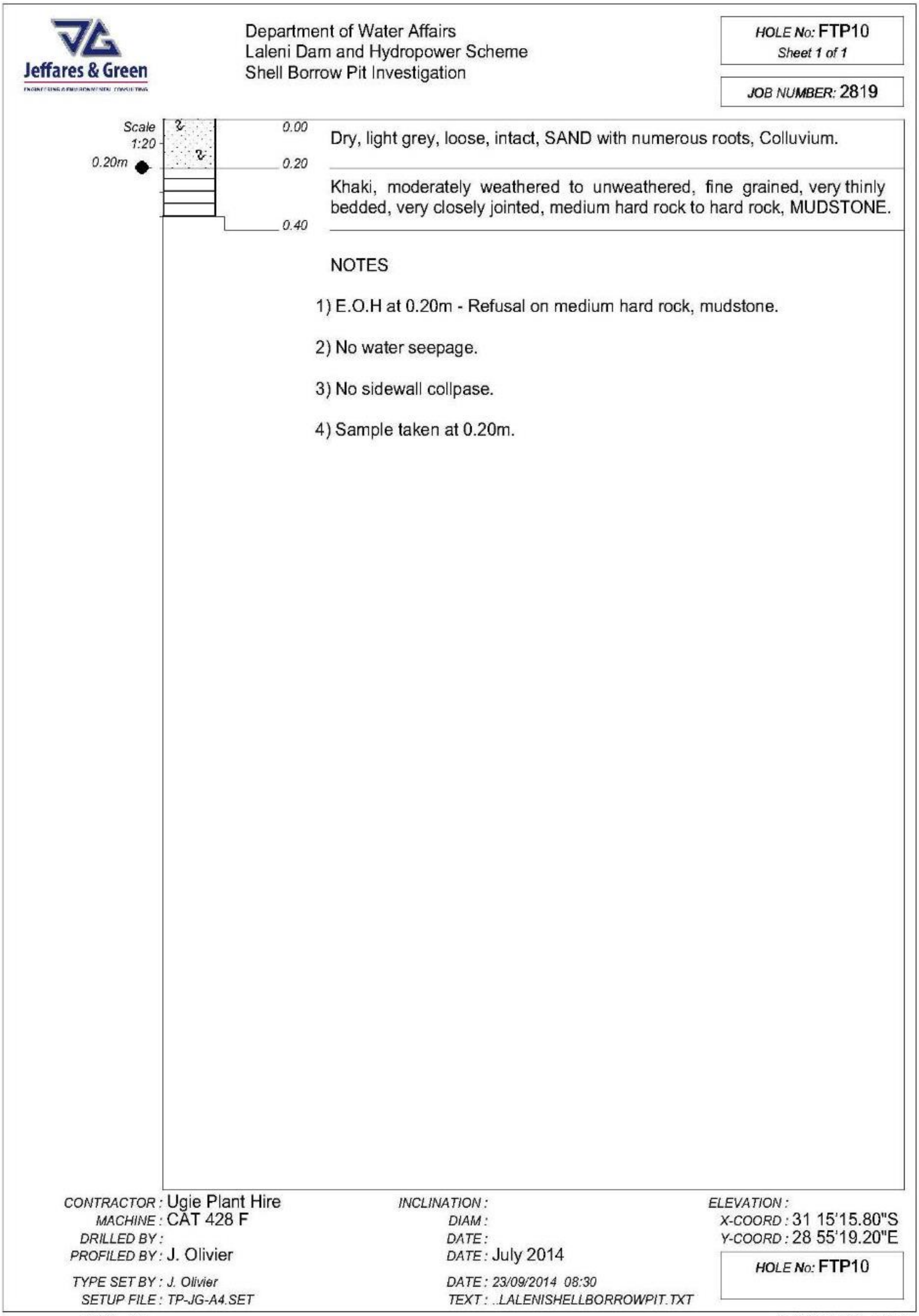
ELEVATION :
X-COORD : 31 15'18.80"S
Y-COORD : 28 55'24.70"E

HOLE No: FTP9

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.9: Shell Borrow Pit 9



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP10
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

0.20m ●

0.00	Dry, light grey, loose, intact, SAND with numerous roots, Colluvium.
0.20	Khaki, moderately weathered to unweathered, fine grained, very thinly bedded, very closely jointed, medium hard rock to hard rock, MUDSTONE.
0.40	

NOTES

1) E.O.H at 0.20m - Refusal on medium hard rock, mudstone.

2) No water seepage.

3) No sidewall collpase.

4) Sample taken at 0.20m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

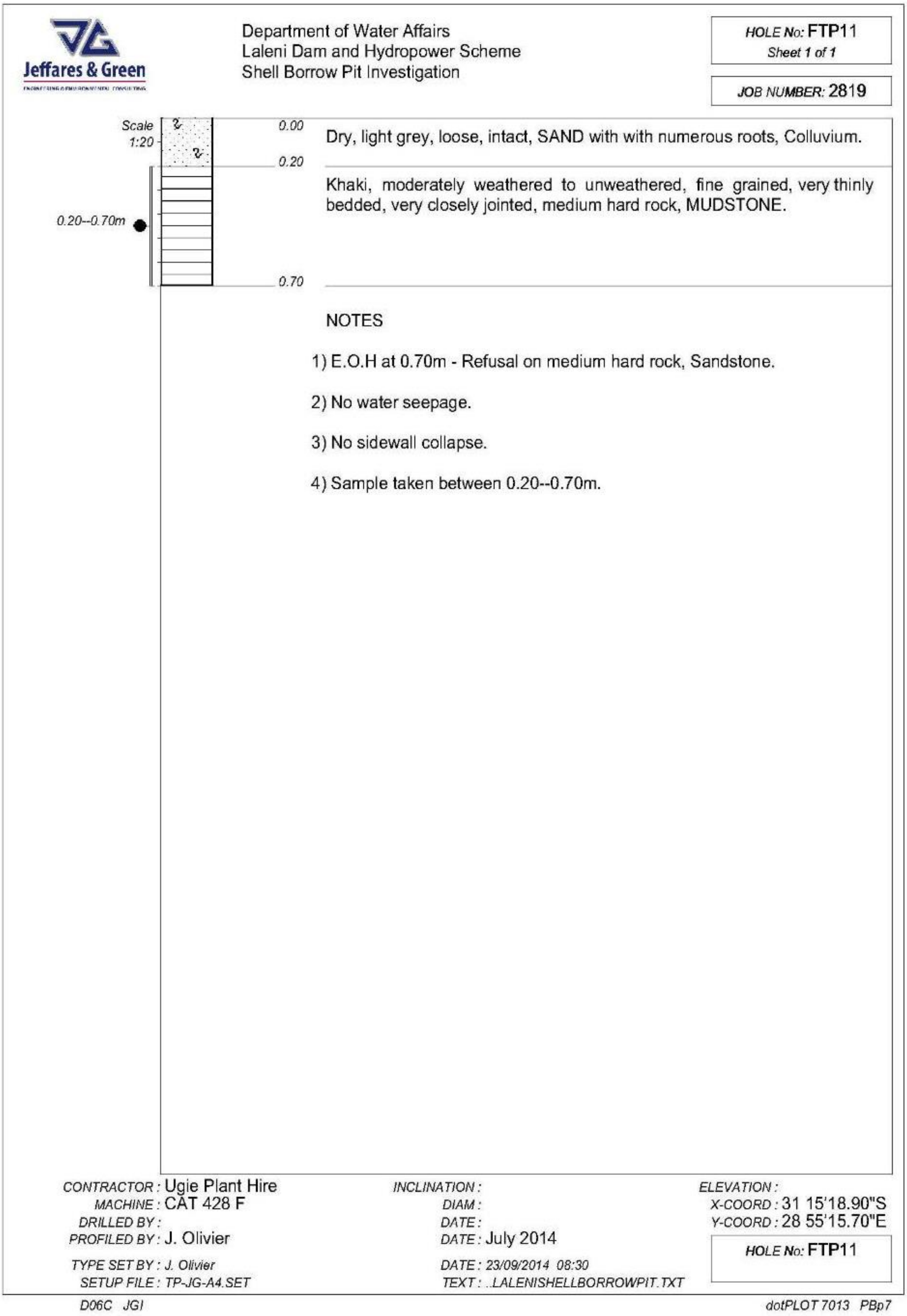
ELEVATION :
X-COORD : 31 15'15.80"S
Y-COORD : 28 55'19.20"E

HOLE No: FTP10

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.10: Shell Borrow Pit 10



Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP11
Sheet 1 of 1

JOB NUMBER: 2819

Scale 1:20

Sample	Depth (m)	Description
	0.00–0.20	Dry, light grey, loose, intact, SAND with with numerous roots, Colluvium.
0.20--0.70m ●	0.20–0.70	Khaki, moderately weathered to unweathered, fine grained, very thinly bedded, very closely jointed, medium hard rock, MUDSTONE.

NOTES

1) E.O.H at 0.70m - Refusal on medium hard rock, Sandstone.

2) No water seepage.

3) No sidewall collapse.

4) Sample taken between 0.20--0.70m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014
DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

ELEVATION :
X-COORD : 31 15'18.90"S
Y-COORD : 28 55'15.70"E

HOLE No: FTP11

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.11: Shell Borrow Pit 11

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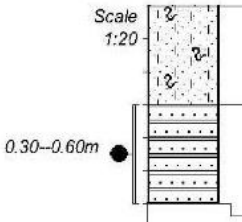
Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP12
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20



0.00	Dry, light olive brown, loose, intact, silty SAND with numerous roots. Colluvium.
0.30	Khaki, slightly weathered to moderately weathered, fine grained, very thinly bedded, very closely jointed, mediumhard rock, MUDSTONE with interbedded SANDSTONE.
0.60	

NOTES

1) E.O.H at 0.60m - Refusal on medium hard rock, Sandstone.
2) No water seepage.
3) No sidewall collapse.
4) Sample taken between 0.30--0.60m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

ELEVATION :
X-COORD : 31 15'14.30"S
Y-COORD : 28 55'24.90"E

HOLE No: FTP12

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.12: Shell Borrow Pit 12

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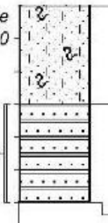
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: **FTP13**
Sheet 1 of 1

JOB NUMBER: **2819**

Scale 1:20



0.30--0.60m ●

0.00

Dry, greyish brown, loose, intact, silty SAND with numerous roots, Colluvium.

0.30

Khaki, moderately weathered, fine grained, very thinly bedded, very closely jointed, medium hard to hard rock, MUDSTONE with interbedded SANDSTONE.

0.60

NOTES

1) E.O.H at 0.6m - Refusal on hard rock sandstone.

2) No water seepage.

3) No sidewall collapse

4) Sample taken between 0.30--0.60m.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

ELEVATION :
X-COORD : 31 15'11.40"S
Y-COORD : 28 55'20.90"E

HOLE No: **FTP13**

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.13: Shell Borrow Pit 13

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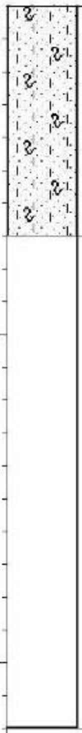
Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: **FTP14**
Sheet 1 of 1

JOB NUMBER: **2819**

Scale
1:20



0.00 Dry, dark grey, loose, intact, silty SAND with numerous roots, Colluvium.

0.70 Slightly moist, dark brown, blotched light grey, medium dense to dense, Colluvium.

2.20

NOTES

1) E.O.H at 2.20m - No refusal.

2) No water seepage.

3) No sidewall collapse.

4) No sample taken between.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier

TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014

DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

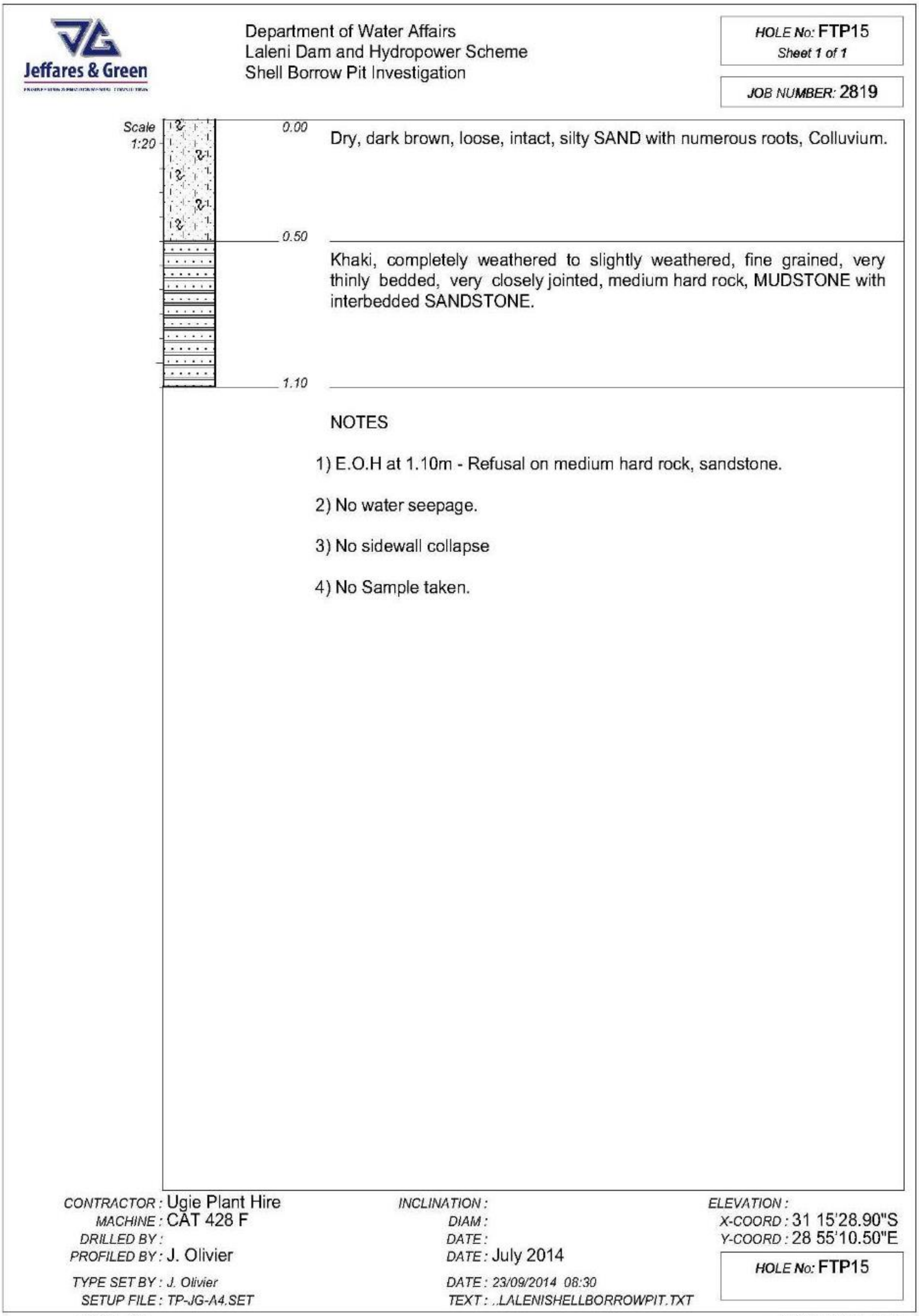
ELEVATION :
X-COORD : 31 15'22.90"S
Y-COORD : 28 55'14.20"E

HOLE No: **FTP14**

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.14: Shell Borrow Pit 14



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Department of Water Affairs
Laleni Dam and Hydropower Scheme
Shell Borrow Pit Investigation

HOLE No: FTP15
Sheet 1 of 1

JOB NUMBER: 2819

Scale
1:20

0.00 Dry, dark brown, loose, intact, silty SAND with numerous roots, Colluvium.

0.50 Khaki, completely weathered to slightly weathered, fine grained, very thinly bedded, very closely jointed, medium hard rock, MUDSTONE with interbedded SANDSTONE.

1.10

NOTES

1) E.O.H at 1.10m - Refusal on medium hard rock, sandstone.

2) No water seepage.

3) No sidewall collapse

4) No Sample taken.

CONTRACTOR : Ugie Plant Hire
MACHINE : CAT 428 F
DRILLED BY :
PROFILED BY : J. Olivier
TYPE SET BY : J. Olivier
SETUP FILE : TP-JG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : July 2014
DATE : 23/09/2014 08:30
TEXT : ..LALENISHELLBORROWPIT.TXT

ELEVATION :
X-COORD : 31 15'28.90"S
Y-COORD : 28 55'10.50"E

HOLE No: FTP15

D06C JGI

dotPLOT 7013 PBp7

Fig F-3.15: Shell Borrow Pit 15