



Waterloo Station

Geotechnical Factual Report

Prepared for

Greater Wellington Regional Council

Prepared by

Tonkin & Taylor Ltd

Date

October 2025

Job Number

1098196.1000 v1



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sustain a better world**

www.tonkintaylor.co.nz

Document control

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1 Introduction

Tonkin & Taylor (T+T) was engaged by Greater Wellington Regional Council to carry out geotechnical investigations at Waterloo Station, Lower Hutt, in accordance with our contract (T+T Ref. 1098196.1000).

The purpose of the investigation was to inform geotechnical conditions for the proposed re-development of Waterloo station which is to include a new station building, pedestrian bridge and platforms. It was also to inform geotechnical conditions for the existing subway.

This factual report collates geotechnical data from investigations carried out at the site. Available historical geotechnical data immediately adjacent the site from the neighbouring Waterloo Water Treatment Plant is also included for information.

Depths reported are measured from ground surface level current at the time of the investigation, unless indicated otherwise. Elevations in this report are in NZVD2016 Datum.

2 Geotechnical investigations

Investigation data is attached as set out below. Approximate investigation locations are presented on Figure A1 in Appendix A.

- Appendix A Figures
- Appendix B Machine boreholes
- Appendix C Cone Penetration Tests
- Appendix D Laboratory Testing
- Appendix E Groundwater monitoring

2.1 Previous Waterloo Water Treatment Plant Investigations

Investigations were carried out by Morrison, Cooper & Partners in 1977, Opus in 2016, WSP in 2020 for the Water Treatment Plant as set out below. Only selected data for investigations immediately adjacent the Waterloo Station site are included in this report and appendices. Refer WSP's Factual Report¹ for further details. Where investigation ground levels were originally reported in Wellington 1953 datum, 0.38m has been subtracted to convert to NZVD2016 datum levels.

Morrison, Cooper & Partners, 1977:

- 8 No. boreholes (Boring 1 to Boring 8 included).

Opus, 2016:

- 3 No. boreholes with SPT testing (BH1 to BH3 included).
- 5 No. cone penetration tests (only CPT9 included).
- One groundwater monitoring standpipe installed in borehole BH3. Groundwater level was measured on 7 occasions between September 2020 and March 2021.

WSP, 2020:

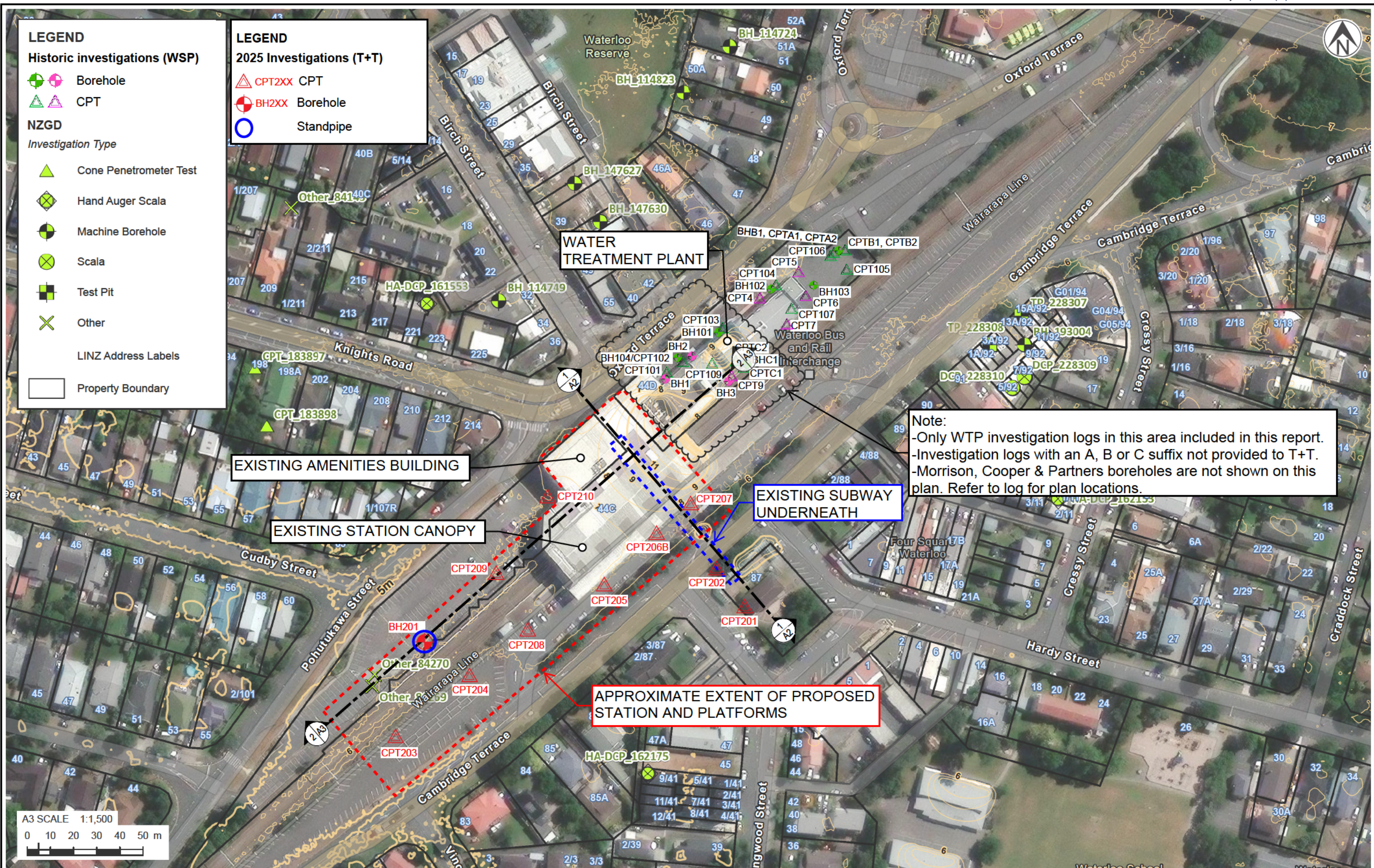
- Geophysical (MASW) survey (excluded).
- 4 No. boreholes with SPT testing (only BH101 and BH104 included in this report).
- 8 No. cone penetration tests (only CPT101, CPT102, CPT103, CPT109 included).
- Laboratory testing from BH101 and BH104:

¹ WSP (17 May 2021) Report for Wellington Water "Waterloo WTP Ground Improvement, Geotechnical Site Investigations Factual Report". WSP Ref. 3-WW019.11.

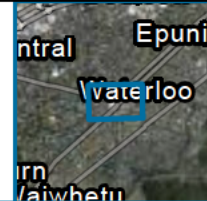
s7(2)(a)

Appendix A Figures

- Figure A1: Site Investigation Plan

**NOTES:**

CRS: NZGD 2000 New Zealand Transverse Mercator Credits: Tonkin & Taylor Group, Esri Community Maps Contributors, LINZ, Stats NZ, Esri, TomTom, Garmin, Foursquare, MET/NASA, USGS, Earthstar Geographics, Maxar, LINZ, Stats NZ, Esri, TomTom, Garmin, Foursquare, MET/NASA, USGS



LOCATION PLAN

PROJECT No. 1098196

DESIGNED
DRAWN
CHECKEDBHR
-WEB-FEB.25
FEB.25

APPROVED

DATE

CLIENT GREATER WELLINGTON REGIONAL COUNCIL

PROJECT WATERLOO STATION

TITLE SITE INVESTIGATION PLAN

SCALE (A3) 1:1,500

FIG No. FIGURE A1.

REV 0

Appendix B Machine boreholes

- Table B1: Summary of borehole investigations
- Borehole logs

Table B1: Summary of boreholes

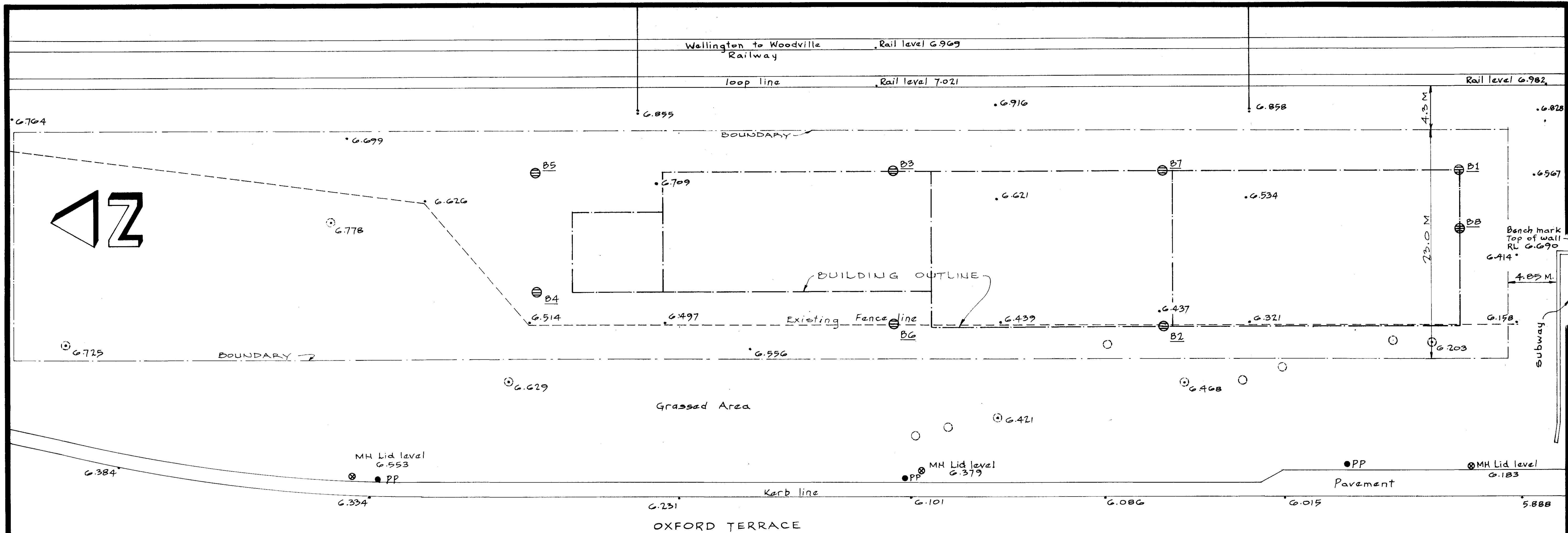
ID	Date	Ground surface level, RL (m)	Drill method	Pre-drill depth (m)	Total depth (m)	In-situ testing	Termination reason
Boring 1 ⁽¹⁾	1977	-	-	-	11.00	-	-
Boring 2 ⁽¹⁾	1977	-	-	-	15.00	-	-
Boring 3 ⁽¹⁾	1977	-	-	-	11.00	-	-
Boring 4 ⁽¹⁾	1977	-	-	-	13.00	-	-
Boring 5 ⁽¹⁾	1977	-	-	-	5.00	-	-
Boring 6 ⁽¹⁾	1977	-	-	-	5.00	-	-
Boring 7 ⁽¹⁾	1977	-	-	-	5.00	-	-
Boring 8 ⁽¹⁾	1977	-	-	-	5.00	-	-
BH1 ⁽²⁾	19 to 20/10/2016	6	HQ coring + Wash drilling	2.5	11.95	SPT	-
BH2 ⁽²⁾	21/10/2016	6	Wash drilling	2.5	7.95	SPT	-
BH3 ⁽²⁾	25/10/2016	6	HQ coring + Wash drilling	3.0	12.45	SPT	-
BH101 ⁽³⁾	1 to 2/10/2020	6.31	Sonic	1.5	13.00	SPT	Target depth
BH104 ⁽³⁾	3 to 7/10/2020	6.17	Sonic	2.5	21.30	SPT	Target depth
BH201 ⁽⁴⁾	18 to 19/8/2025	6	Sonic	1.5	9.95	SPT	Target depth

Note 1) Consultant: Morrison, Cooper & Partners.

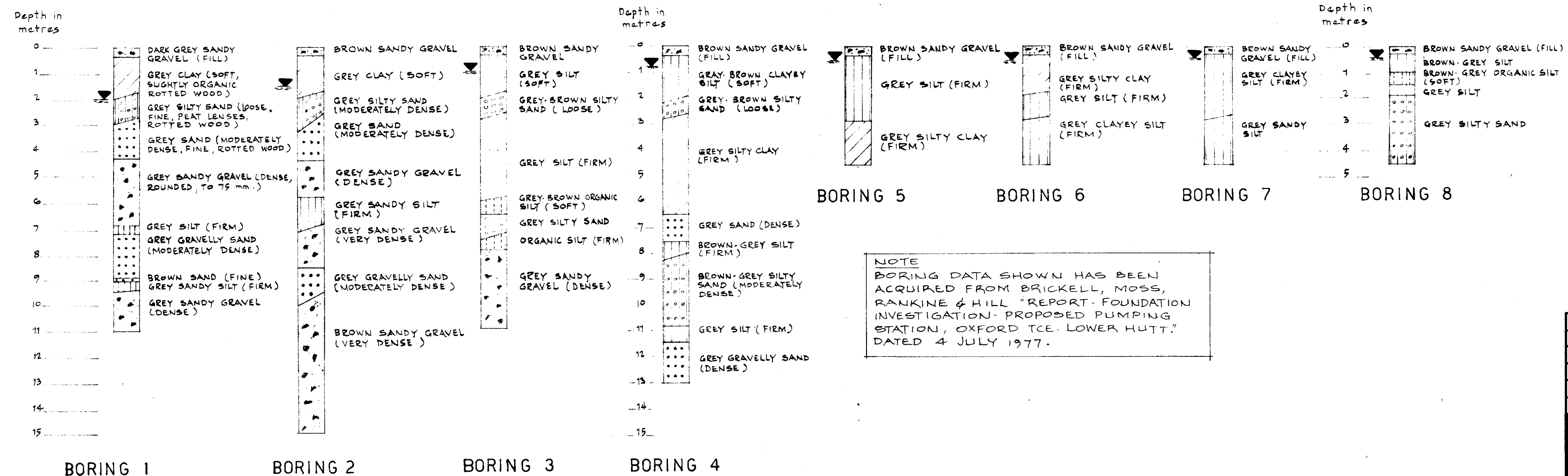
Note 2) Consultant: Opus. Contractor: Griffiths Drilling.

Note 3) Consultant: WSP. Contractor: Griffiths Drilling.

Note 4) Consultant: Tonkin + Taylor. Contractor: Webster Drilling & Exploration.



- ### Legend
- ⊗ MH - Manhole
 - PP - Power Pole
 - - Shrub
 - 0.460 - Reduced level (RL) metres Related to LHCC datum
 - ⊕ B7 - Boring holes
 - ⚡ - Ground water level



NOTE
BORING DATA SHOWN HAS BEEN
ACQUIRED FROM BRICKELL, MOSS,
RANKINE & HILL "REPORT- FOUNDATION
INVESTIGATION- PROPOSED PUMPING
STATION, OXFORD TCE. LOWER HUTT."
DATED 4 JULY 1977.



WELLINGTON REGIONAL
WATER BOARD

R. G. BISHOP
CHIEF ENGINEER

NO	BY	VO	AMENDMENT		DATE

WELLINGTON REGIONAL WATER BOARD
WATERLOO PUMPING STATION

SITE SURVEY

**MORRISON, COOPER
& PARTNERS**

**Consulting Engineers and Architects
Wellington-Invercargill**

SCALES : 200, 1:100	DRAWN RAL
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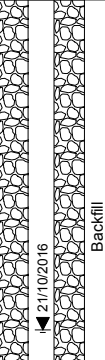
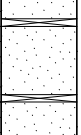
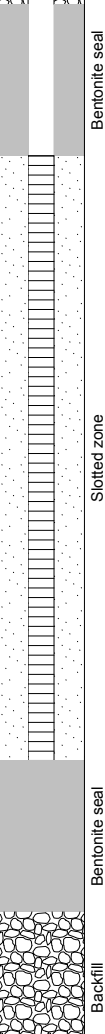
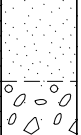
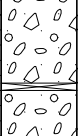
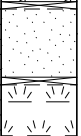
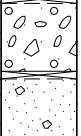
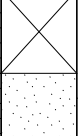
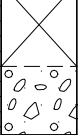
DATE FEB. 1978	APPROVED <i>[Signature]</i>
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DRAWING NUMBER	AMENDMENT
67073/A3	

BS 77/3

Project: Waterloo Water Treatment Plant
Client: Wellington Water
Project No.: 3-WW016.00
Location: SW corner, near train station entrance
 Waterloo, Lower Hutt, Wellington

Coordinates: 1761046 E 5435759 N
Ref. Grid: NZTM
R.L.: 6 m
Datum: MSL (NZ Geoid 2009)
Depth: 11.95 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING			NOTES / OTHER TESTS	INSTALLATION DETAILS
					SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING	BASE OF HOLE & WATER LEVEL		
Fill	Vacuum excavation. FILL comprised of sandy GRAVEL, tightly packed.		1				VE	0					
			2										
Marine and Alluvial Deposits	SAND; dark grey, loose, moist.		3		4	2// 0/1/1/2	SPT	56				2.50m - Corase sand, minor white grains.	
			4		7	1// 1/2/2/2	SPT	82				3.00m - Large wood fragments.	
	Becomes medium dense.		5		12	3// 3/2/3/4	SPT	78				3.50m - No wood fragments. Lab: PSD	
			6		19	3// 2/3/6/8	SPT	84				4.00m - Some wood fragments.	
	Approximate contact. Sandy GRAVEL; dark grey, medium dense to dense, moist.		7		30	10// 9/6/8/7	SPT	67				4.50m - Gravel is subrounded, fine to 4 cm. Wood fragments.	
	Becomes more sandy, medium dense. Possible sand heave in sample.		8		20	4// 3/4/5/8	SPT	100				5.00m - Subrounded gravel fragment, 4 cm.	
	Possible sand heave in sample.		9		17	4// 5/5/4/3	SPT	67				5.50m - Well rounded gravel, minor wood fragments. Lab: PSD	
	Upper 0.14 m of SPT sample is fine gravel wash. Lower 0.15 m: SAND with minor gravel; dark grey, loose, moist. Minor zones of brown, organic peat.		10		4	6// 2/0/1/1	SPT	56				6.00m - Coarse sand. Abundant wood fragments. Fine gravel, subangular to subrounded, mostly <0.5 cm.	
	Sandy SILT with some clay; dark brown, very soft, high plasticity. Interbedded with lesser beds (5 cm) of SAND with minor gravel; dark grey.		11		3	3// 0/1/0/2	SPT					6.50m - Sand is coarse. Very fine gravel.	
	Sandy GRAVEL with minor silt; dark grey, medium dense, moist.		12		31	8// 8/8/8/7	SPT					7.00m - Gravel is mostly fine, up to 2 cm, rounded.	
	Becomes gravelly SAND; dark grey, medium dense, moist, interbedded with SAND.		13		14	10// 4/3/3/4	SPT	62				7.50m - Coarse sand, gravel is mostly fine, <0.5 cm, up to 3 cm, subrounded to aubangular. Lab: PSD	
			14				WD	0					
	Becomes sand with minor gravel and trace silt; dark grey, medium dense, moist.		15		16	6// 4/4/4/4	SPT	74				8.50m - Coarse sand. Gravel is fine to 1 cm, subrounded.	
			16				WD	0					
	Sandy GRAVEL; dark grey-brown, dense, moist. Minor iron staining throughout.		17		37	18// 10/9/9/9	SPT	67				9.50m - Gravel is brown, highly weathered, fine to 3 cm. Subrounded, some subangular fragments. Coarse sand.	
			18										

Notes:

Started: 19/10/2016
Drilling Co.: Griffiths Drilling
Logged by: S7(2)(a)

Finished: 20/10/2016
Drilling Rig: PLG Fraste
Checked by: S7(2)(a)



Project: Waterloo Water Treatment Plant
 Client: Wellington Water
 Project No.: 3-WW016.00
 Location: SW corner, near train station entrance
 Waterloo, Lower Hutt, Wellington

Coordinates: 1761046 E 5435759 N
 Ref. Grid: NZTM
 R.L.: 6 m
 Datum: MSL (NZ Geoid 2009)
 Depth: 11.95 m
 Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING			NOTES / OTHER TESTS	INSTALLATION DETAILS
					SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING	BASE OF HOLE & WATER LEVEL		
Marine Deposits	Sandy GRAVEL; dark grey-brown, dense, moist. Minor iron staining throughout.	11		41	14// 11/8/10/12	WD	0	Wash boring			10.50m - Gravel is mostly fine, angular fragments. Well rounded, up to 2 cm.		
						SPT	67						
						WD	0						
				43	16// 9/11/11/12	SPT	67						
	END OF BOREHOLE AT 11.95m	-6	12										
			13										
		-8	14										
			15										
		-10	16										
			17										
		-12	18										
			19										
		-14											

Notes:

Started: 19/10/2016

Finished: 20/10/2016

Drilling Co.: Griffiths Drilling

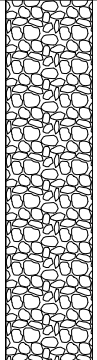
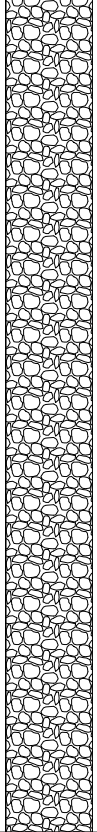
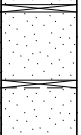
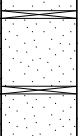
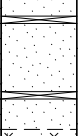
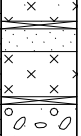
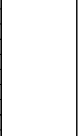
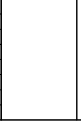
Drilling Rig: PLG Fraste

Logged by: s7(2)(a)

Checked by: s7(2)(a)

Project: Waterloo Water Treatment Plant
Client: Wellington Water
Project No.: 3-WW016.00
Location: W side, centre of building
 Waterloo, Lower Hutt, Wellington

Coordinates: 1761072 E 5435780 N
Ref. Grid: NZTM
R.L.: 6 m
Datum: MSL (NZ Geoid 2009)
Depth: 7.95 m
Inclination: Vertical

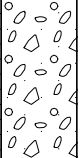
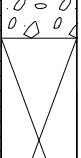
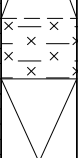
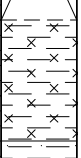
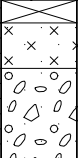
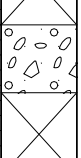
GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING			NOTES / OTHER TESTS	INSTALLATION DETAILS
					SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING	BASE OF HOLE & WATER LEVEL		
Fill	Vacuum excavation. FILL comprised of sandy GRAVEL, tightly packed.		1				VE	0					
			2										
Marine and Alluvial Deposits	Sandy GRAVEL; brown, loose, moist. Low SPT value likely due to disturbance from vacuum excavation and wash drilling.		3		9	3// 3/2/1/3	SPT	22				2.50m - Medium sand. Gravel is fine to 2 cm, subangular, some rounded.	
	Approximate contact. SAND with minor gravel; dark grey, medium dense, moist.		4		12	4// 2/2/4/4	SPT	82				3.00m - Coarse sand. Trace zones of iron staining. Gravel is fine to 0.5 cm, rounded.	
	SAND with minor to trace gravel, loose.		5		8	8// 2/1/3/2	SPT	73				3.50m - Trace wood fragments. Coarse sand. Gravel is <0.5 cm subangular.	
	Becomes SAND; dark grey, loose, moist.		6		8	4// 2/2/2/2	SPT	69				4.00m - Coarse sand. Abundant wood fragments.	
			7		13	6// 3/4/3/3	SPT	71				4.50m - Trace wood fragments.	
	Minor gravel throughout.		8		15	3// 3/4/4/4	SPT	60				5.00m - More abundant wood fragments. Gravel is fine to 3 cm. Well rounded.	
	Some gravel throughout.		9		20	3// 4/4/5/7	SPT	60					
			10		8	3// 1/1/3/3	SPT	60				6.20m - Abundant wood and organic material throughout.	
	Becomes SAND; dark grey, loose, moist interbedded with SILT; dark brown, soft.		11		3	4// 1/0/1/1	SPT	87				6.65m - Some organic fragments throughout.	
	Becomes SAND; dark grey, loose, moist.		12		24	10// 6/5/5/8	SPT	80				7.00m - Coarse sand. Gravel is fine to 3 cm. Well rounded.	
	SILT; dark brown, very soft, moist, high plasticity.		13		31	9// 5/5/9/12	SPT	71				7.50m - Gravel is fine to 3 cm, well rounded.	
	Sandy GRAVEL; grey, medium dense, moist, minor silty zones; light grey-brown, no plasticity.		14										
	Becomes dark grey, dense.		15										
	END OF BOREHOLE AT 7.95m		16								SWL 2.50m 22/10		

Notes:

Started: 21/10/2016
Finished: 21/10/2016
Drilling Co.: Griffiths Drilling
Drilling Rig: PLG Fraste
Logged by: S7(2)(a)
Checked by: S7(2)(a)

Project: Waterloo Water Treatment Plant
Client: Wellington Water
Project No.: 3-WW016.00
Location: SE corner
 Waterloo, Lower Hutt, Wellington

Coordinates: 1761085 E 5435761 N
Ref. Grid: NZTM **Depth:** 12.45 m
R.L.: 6 m **Inclination:** Vertical
Datum: MSL (NZ Geoid 2009)

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING		NOTES / OTHER TESTS	INSTALLATION DETAILS
					SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING		
Fill	Vacuum excavation. FILL comprised of sandy GRAVEL, tightly packed.		1				VE	0				
	Sandy GRAVEL; grey, medium dense, moist.		2				HQ	10	HWT		3.00m - Coarse sand. Gravel is >3 cm, subangular to subrounded.	
Marine and Alluvial Deposits	Clayey SILT with minor gravel; blue-grey, very soft, high plasticity.		3				HQ	27				
	Silty CLAY with minor gravels; dark brown, firm, moist, high plasticity. Mottled blue-grey silty zones.		4				HQ	90			6.00m - Very sticky. Gravel is fine, angular to subangular.	
	Silty SAND; blue grey and brown, loose to medium dense, moist.		5				HQ	0			6.80m - Minor organic/wood fragments.	
	Clayey GRAVEL; blue grey, loose to medium dense, moist to wet, low plasticity. Material too wet to roll.		6				SPT	89			7.50m - Gravel is fine to 2 cm, subangular to rounded.	
	Sandy SILT with minor gravel; dark grey and brown, soft to firm, moist.		7				HQ	0			8.00m - Gravel is medium, well rounded.	
	Sandy GRAVEL; grey, medium dense to dense.		8				SPT	100			9.00m - Fine gravel.	
	Becomes loose.		9				HQ	0				

Notes:
 Borehole drilled over CPT hole to ~ 8 m.

Started: 25/10/2016
Drilling Co.: Griffiths Drilling
Logged by: s7(2)(a)

Finished: 25/10/2016
Drilling Rig: PLG Fraste
Checked by: s7(2)(a)

Project: Waterloo Water Treatment Plant
Client: Wellington Water
Project No.: 3-WW016.00
Location: SE corner
 Waterloo, Lower Hutt, Wellington

Coordinates: 1761085 E 5435761 N
Ref. Grid: NZTM
R.L.: 6 m
Datum: MSL (NZ Geoid 2009)
Depth: 12.45 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING			NOTES / OTHER TESTS	INSTALLATION DETAILS	
					SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING	BASE OF HOLE & WATER LEVEL		Bentonite seal	Slotted zone
Marine and Alluvial Deposits	Becomes medium dense.				26	5// 5/9/5/7	SPT	75	HQ Size, Triple Tube, Wireline Rotary Coring			11.00m - Gravel becomes more coarse, subangular. Wood fragments throughout. Medium sand. 12.00m - Gravel is coarse, angular to subangular.		
	Silty SAND with some gravel; grey, dense to very dense.	11		49	38// 15/12/10/12	SPT	89	HQ		0				
						HQ	0							
		Silty CLAY with some gravel; grey, stiff to very stiff.	-6		30	6// 7/6/8/9	SPT	89						
	END OF BOREHOLE AT 12.45m												SWL 2.50m 26/10	
			13											
			-8											
			14											
			15											
			-10											
			16											
			17											
			-12											
			18											
			19											
			-14											

Notes:
 Borehole drilled over CPT hole to ~ 8 m.

Started: 25/10/2016
Drilling Co.: Griffiths Drilling
Logged by: s7(2)(a)

Finished: 25/10/2016
Drilling Rig: PLG Fraste
Checked by: s7(2)(a)

Project: Waterloo WTP
 Client: Wellington Water Ltd.
 Project No.: 3-WW019.11
 Location: Lower Hutt, New Zealand

Coordinates: 1761083 E 5435782 N
 Ref. Grid: NZTM
 R.L.: Approx. 6.69 m
 Datum: Wellington 1953
 Depth: 13 m
 Inclination: Vertical

GEOLOGY	CPT103 END RESISTANCE (MPa)	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING		NOTES / OTHER TESTS	INSTALLATION DETAILS
						SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING		
Fill		Vacuum excavation, no core recovery.		6				VE					
		Sandy GRAVEL with some silt, orange, loose, wet.		1									
Taita Alluvium		Lost core.		2		8	1// 1/3/2/2	SPT	100				
		D&M, disturbed sample not observed.		3		6	4// 2/1/2/1	SPT	33				
		Clayey SILT, grey, moist, very soft, high plasticity.		4				Sonic	30				
		Brown streaks.		3				D&M	98				
		With trace gravel from backfill used for vacuum excavation.		4				Sonic	100				
				4				D&M	98				
				2				Sonic	100				
				5				D&M	99				
				5				Sonic	100				
				6				D&M	98				
				6				Sonic	100				
				0				D&M	100				
Petone Marine Beds		Silty SAND, dark grey, very loose, moist, wood fragments.		7									
		Sandy SILT, greyish brown, moist, stiff, nonplastic, organics.		8		3	3// 1/0/1/1	SPT	100				
		Silty SAND, greyish brown, moist, loose, organics.		8									
				6				SPT	100				
				9									
		Sandy GRAVEL, bluish grey, medium dense to dense, moist.		9		37	7// 9/10/9/9	SPT	75				

Notes:

- SPT hammer energy ratio 87%
- SPT hammer standard deviation 2.9%
- GWRC Consent No. WGN200182
- GWRC Borehole No. BQ32/0481
- D&M: Dames and Moore Sampling
- Adjacent to CPT103. CPT undertaken by Griffiths.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Started: 1/10/2020 Finished: 2/10/2020
 Drilling Co.: Griffiths Drilling Ltd. Drilling Rig: Fraste XL Duo Sonic
 Logged by: s7(2)(a) Checked by: s7(2)(a)

Project: Waterloo WTP
 Client: Wellington Water Ltd.
 Project No.: 3-WW019.11
 Location: Lower Hutt, New Zealand

Coordinates: 1761083 E 5435782 N
 Ref. Grid: NZTM
 R.L.: Approx. 6.69 m
 Datum: Wellington 1953
 Depth: 13 m
 Inclination: Vertical

GEOLOGY	CPT103 END RESISTANCE (MPa)	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING		NOTES / OTHER TESTS	INSTALLATION DETAILS
						SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING		
Waioheta Gravels	0 10 20 30	Sandy GRAVEL, bluish grey, medium dense to dense, moist. (continued)		4		25	4// 6/5/7/7	SPT	85	Sonic core drilling		11.00-13.00m - Gravel is coarse, moderately to highly weathered, subangular.	
		Sandy GRAVEL, brown, very dense, wet.		11		50+	6// 6/13/17/14 for 30mm	SPT	100				
		END OF BOREHOLE AT 13m - Target Depth Reached		13				Sonic 100					
				14									
				15									
				16									
				17									
				18									
				19									

Notes:

- SPT hammer energy ratio 87%
- SPT hammer standard deviation 2.9%
- GWRC Consent No. WGN200182
- GWRC Borehole No. BQ32/0481
- D&M: Dames and Moore Sampling
- Adjacent to CPT103. CPT undertaken by Griffiths.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Started: 1/10/2020
 Finished: 2/10/2020
 Drilling Co.: Griffiths Drilling Ltd.
 Drilling Rig: Fraste XL Duo Sonic
 Logged by: s7(2)(a)
 Checked by: s7(2)(a)

Project: Waterloo WTP
 Client: Wellington Water Ltd.
 Project No.: 3-WW019.11
 Location: Lower Hutt, New Zealand

Coordinates: 1761083 E 5435782 N
 Ref. Grid: NZTM
 R.L.: Approx. 6.69 m
 Datum: Wellington 1953
 Depth: 13 m
 Inclination: Vertical

PHOTOGRAPHS



Photo BH101.1
Box 1



Photo BH101.2
Box 2

Notes:

1. SPT hammer energy ratio 87%
2. SPT hammer standard deviation 2.9%
3. GWRC Consent No. WGN200182
4. GWRC Borehole No. BQ32/0481
5. D&M: Dames and Moore Sampling
6. Adjacent to CPT103. CPT undertaken by Griffiths.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Started: 1/10/2020
 Drilling Co.: Griffiths Drilling Ltd.
 Logged by: S7(2)(a)
 Finished: 2/10/2020
 Drilling Rig: Fraste XL Duo Sonic
 Checked by: S7(2)(a)

Project: Waterloo WTP
Client: Wellington Water Ltd.
Project No.: 3-WW019.11
Location: Lower Hutt, New Zealand

Coordinates: 1761083 E 5435782 N
Ref. Grid: NZTM
R.L.: Approx. 6.69 m
Datum: Wellington 1953
Depth: 13 m
Inclination: Vertical

PHOTOGRAPHS



Photo BH101.3
Box 3

Notes:

1. SPT hammer energy ratio 87%
2. SPT hammer standard deviation 2.9%
3. GWRC Consent No. WGN200182
4. GWRC Borehole No. BQ32/0481
5. D&M: Dames and Moore Sampling
6. Adjacent to CPT103. CPT undertaken by Griffiths.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Started: 1/10/2020
Finished: 2/10/2020
Drilling Co.: Griffiths Drilling Ltd.
Drilling Rig: Fraste XL Duo Sonic
Logged by: s7(2)(a)
Checked by: s7(2)(a)

Project: Waterloo WTP
 Client: Wellington Water Ltd.
 Project No.: 3-WW019.11
 Location: Lower Hutt, New Zealand

Coordinates: 1761064 E 5435769 N
 Ref. Grid: NZTM
 R.L.: Approx. 6.55 m
 Datum: Wellington 1953
 Depth: 21.3 m
 Inclination: Vertical

GEOLOGY	CPT101 END RESISTANCE (MPa)	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING		NOTES / OTHER TESTS	INSTALLATION DETAILS
						SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING		
Taia Alluvium	0	Vacuum Excavation.	6	1				VE	0				Flush toby.
	10		1	2									50mm PVC.
	20	Core loss.	4	3				Sonic	0				
	30	SAND with some silt, dark grey, loose to medium dense, moist to wet, wood fragments.		4		9	3// 1/3/2/3	SPT	100				
		No silt.		5				Sonic	100				
		Gravelly SAND, dark grey, moist, loose to medium dense, wood fragments.		6		21	4// 4/5/7/5	SPT	100				
				7				Sonic	100				
		SAND, dark grey, loose, moist, wood fragments.		8		9	5// 3/2/2/2	SPT	100				
		Clayey SILT, brownish grey, stiff, moist, moderate plasticity, wood fragments and organic material.		9				Sonic	100				
		Sandy GRAVEL, dark grey, medium dense, wet.		10		21	7// 5/6/5/5	SPT	100				
Petone Marine Beds		Silty SAND, dark grey, medium dense, wet to saturated, wood fragments.		11		12	5// 3/3/2/4	SPT	100				
				12				Sonic	100				
				13				Sonic	100				
				14		14	1// 1/3/4/6	SPT	85				

Notes:

- Vacuum excavation to 2.5m due to proximity of services.
- SPT hammer energy ratio 87%
- SPT hammer standard deviation 2.9%
- GWRC Consent No. WGN200182
- GWRC Borehole No. BQ32/0484
- Coordinates and elevation are approximate.
- Adjacent to CPT101.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Started: 3/09/2020 Finished: 7/09/2020
 Drilling Co.: Griffiths Drilling Ltd. Drilling Rig: Fraste XL Duo Sonic
 Logged by: s7(2)(a) Checked by: s7(2)(a)

Project: Waterloo WTP
 Client: Wellington Water Ltd.
 Project No.: 3-WW019.11
 Location: Lower Hutt, New Zealand

Coordinates: 1761064 E 5435769 N
 Ref. Grid: NZTM
 R.L.: Approx. 6.55 m
 Datum: Wellington 1953
 Depth: 21.3 m
 Inclination: Vertical

GEOLOGY	CPT101 END RESISTANCE (MPa)	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING		NOTES / OTHER TESTS	INSTALLATION DETAILS
						SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING		
Waioheta Gravels	0	Silty SAND, dark grey, medium dense, wet to saturated, wood fragments. (continued)				19	10// 4/2/4/9	SPT	100				
	10	Sandy GRAVEL with traces of silt, brown with some grey streaks, medium to very dense, wet.	-4					Sonic	100				
	20			11		50+	17// 15/10/12/13	SPT	80				
	30			12		50+	12// 13/12/14/11	SPT					
		With some orange streaks.	-6					Sonic	100			SWL 2.50m 4/09 SWL 0.00m 3/09	
				13		50+	50	SPT	100				
				14				Sonic	100				
		With some cobbles.	-8			50+	19// 13/13/14/10	SPT	75				
				15		50+	13// 16/12/22	SPT	100				
				16		50+	50	SPT	100				
				17		50+	12// 22/28	SPT	77				
		SAND with some gravel, brown, moist to wet, loose to very dense.						Sonic	100				
		Silty SAND with some clay, brown, loose, moist, non plastic.	-12			4	2// 1/1/1/1	SPT	100				
		Sandy GRAVEL with traces of silt, brown with some grey streaks, medium dense, wet.						Sonic	100				
		Wet to saturated.		19		50+	35// 35/15	SPT	100				
								Sonic	100				

Notes:

- Vacuum excavation to 2.5m due to proximity of services.
- SPT hammer energy ratio 87%
- SPT hammer standard deviation 2.9%
- GWRC Consent No. WGN200182
- GWRC Borehole No. BQ32/0484
- Coordinates and elevation are approximate.
- Adjacent to CPT101.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Started: 3/09/2020 Finished: 7/09/2020
 Drilling Co.: Griffiths Drilling Ltd. Drilling Rig: Fraste XL Duo Sonic
 Logged by: s7(2)(a) Checked by: s7(2)(a)

Project: Waterloo WTP
 Client: Wellington Water Ltd.
 Project No.: 3-WW019.11
 Location: Lower Hutt, New Zealand

Coordinates: 1761064 E 5435769 N
 Ref. Grid: NZTM
 R.L.: Approx. 6.55 m
 Datum: Wellington 1953
 Depth: 21.3 m
 Inclination: Vertical

GEOLOGY	CPT101 END RESISTANCE (MPa)	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS		CORE		DRILLING		NOTES / OTHER TESTS	INSTALLATION DETAILS
						SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	CORE TYPE	TOTAL CORE RECOVERY (%)	DRILLING METHOD	CASING		
Waioheta Gravels	0	Sandy GRAVEL with traces of silt, brown with some grey streaks, medium dense, wet. (continued) With some silt and clay.				50+	27// 14/15/14/7	SPT	100	Sonic core drilling			
	10			-14									
	20			21				Sonic	100				
	30	END OF BOREHOLE AT 21.3m - Target Depth Reached						SPT	100				
				22									
				-16									
				23									
				24									
				-18									
				25									
				26									
				-20									
				27									
				28									
				-22									
				29									

Notes:

- Vacuum excavation to 2.5m due to proximity of services.
- SPT hammer energy ratio 87%
- SPT hammer standard deviation 2.9%
- GWRC Consent No. WGN200182
- GWRC Borehole No. BQ32/0484
- Coordinates and elevation are approximate.
- Adjacent to CPT101.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Started: 3/09/2020 Finished: 7/09/2020
 Drilling Co.: Griffiths Drilling Ltd. Drilling Rig: Fraste XL Duo Sonic
 Logged by: s7(2)(a) Checked by: s7(2)(a)

Project: Waterloo WTP
 Client: Wellington Water Ltd.
 Project No.: 3-WW019.11
 Location: Lower Hutt, New Zealand

Coordinates: 1761064 E 5435769 N
 Ref. Grid: NZTM
 R.L.: Approx. 6.55 m
 Datum: Wellington 1953
 Depth: 21.3 m
 Inclination: Vertical

PHOTOGRAPHS



Photo BH104.1
Box 1



Photo BH104.2
Box 2

Notes:

1. Vacuum excavation to 2.5m due to proximity of services.
2. SPT hammer energy ratio 87%
3. SPT hammer standard deviation 2.9%
4. GWRC Consent No. WGN200182
5. GWRC Borehole No. BQ32/0484
6. Coordinates and elevation are approximate.
7. Adjacent to CPT101.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Started: 3/09/2020
 Finished: 7/09/2020
 Drilling Co.: Griffiths Drilling Ltd.
 Drilling Rig: Fraste XL Duo Sonic
 Logged by: s7(2)(a)
 Checked by: s7(2)(a)

Project: Waterloo WTP
 Client: Wellington Water Ltd.
 Project No.: 3-WW019.11
 Location: Lower Hutt, New Zealand

Coordinates: 1761064 E 5435769 N
 Ref. Grid: NZTM
 R.L.: Approx. 6.55 m
 Datum: Wellington 1953
 Depth: 21.3 m
 Inclination: Vertical

PHOTOGRAPHS



Photo BH104.3
Box 3



Photo BH104.4
Box 4

Notes:

1. Vacuum excavation to 2.5m due to proximity of services.
2. SPT hammer energy ratio 87%
3. SPT hammer standard deviation 2.9%
4. GWRC Consent No. WGN200182
5. GWRC Borehole No. BQ32/0484
6. Coordinates and elevation are approximate.
7. Adjacent to CPT101.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Started: 3/09/2020
 Finished: 7/09/2020
 Drilling Co.: Griffiths Drilling Ltd.
 Drilling Rig: Fraste XL Duo Sonic
 Logged by: S7(2)(a)
 Checked by: S7(2)(a)

Project: Waterloo WTP
 Client: Wellington Water Ltd.
 Project No.: 3-WW019.11
 Location: Lower Hutt, New Zealand

Coordinates: 1761064 E 5435769 N
 Ref. Grid: NZTM
 R.L.: Approx. 6.55 m
 Datum: Wellington 1953
 Depth: 21.3 m
 Inclination: Vertical

PHOTOGRAPHS



Photo BH104.5
Box 5



Photo BH104.6
Box 6

Notes:

1. Vacuum excavation to 2.5m due to proximity of services.
2. SPT hammer energy ratio 87%
3. SPT hammer standard deviation 2.9%
4. GWRC Consent No. WGN200182
5. GWRC Borehole No. BQ32/0484
6. Coordinates and elevation are approximate.
7. Adjacent to CPT101.

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Started: 3/09/2020
 Finished: 7/09/2020
 Drilling Co.: Griffiths Drilling Ltd.
 Drilling Rig: Fraste XL Duo Sonic
 Logged by: s7(2)(a)
 Checked by: s7(2)(a)

BOREHOLE LOG

BOREHOLE No.:

BH201

SHEET: 1 OF 2

DRILLED BY: **67(2)(a)**

LOGGED BY: **67(2)(a)**

CHECKED: NCP

START DATE: 18/08/2025

FINISH DATE: 19/08/2025

CONTRACTOR: Webster Drilling

PROJECT: Waterloo Train Station

JOB No.: 1098196.1000.01

LOCATION: Waterloo

CO-ORDINATES: 5435650 mN
(NZTM2000) 1760959 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 6m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Google earth

GEOLOGICAL UNIT	MATERIAL DESCRIPTION		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level / Fluid Loss (%)	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations				
Fill	0.00m: Unweathered, dark grey, ASPHALT. Very strong.																	
	0.07m: Sandy fine to medium GRAVEL; grey. "Dense", moist, well graded. Gravel, angular, slightly weathered, strong; sand, fine to coarse. Shell and brick fragments observed.																	
?	0.20m: Cobbly fine to coarse GRAVEL, some sand, trace silt; brownish grey. "Dense", moist, well graded. Gravel, slightly weathered, strong; cobbles, sub-angular to angular, slightly weathered, strong; sand, fine to coarse.																	
	1.00m: NO RECOVERY - HVAC. Could not evaluate material.																	
Melting Peat	1.40m: SILT, some clay, trace sand; grey. Soft, moist, low plasticity. Sand, fine.																	
	1.55m: Sandy SILT, some clay; grey mottled brown. Firm, moist, low plasticity. Sand, fine.																	
	1.75m: Fine to coarse SAND, some silt; grey mottled brown. Very loose to loose, wet, well graded.																	
	2.25m: SILT, minor sand, trace clay; greyish brown. Stiff, moist, low plasticity. Sand, fine.																	
	2.50m: Fine to coarse SAND, some silt; grey mottled brown. Very loose to loose, wet, well graded.																	
	2.60m: Clayey SILT, minor organics; brown. Very soft, moist, high plasticity. Organics, wood fragments (partially decomposed).																	
	3.60m: Fine to coarse SAND, minor silt, trace organics; grey. Medium dense, moist.																	
	3.95m: Sandy fine to coarse GRAVEL; bluish grey. Dense, moist, well graded. Gravel, rounded to sub-angular, slightly weathered, strong, greywacke; sand, fine to coarse.																	
Taita Alluvium	4.10m: Fine to coarse GRAVEL, some sand; bluish grey. Dense, moist, well graded. Gravel, rounded to sub-angular, slightly weathered, strong, greywacke.																	
	5.00 - 5.45m: Very Dense																	
	6.00 - 6.45m: Medium Dense																	
	6.60m: CORE LOSS. Suspect fine pushed out at bottom of run.																	
	7.00m: Fine to coarse SAND, some gravel; dark grey. Medium dense, moist, well graded. Gravel, fine to medium, rounded to sub-rounded, slightly weathered, strong, greywacke.																	
	7.40m: Sandy fine to coarse GRAVEL; bluish grey. Dense, moist, well graded. Gravel, rounded to sub-angular, slightly weathered, strong, greywacke; sand, fine to coarse.																	
	9.80m: CORE LOSS. Suspect material dropped out																	
	9.95m: END OF BOREHOLE. Target depth.																	

COMMENTS: 1) SPT hammer efficiency#: WDESPT#8 84.5% ETR.

Hole Depth
9.95m

Scale 1:50

Rev.: A

CORE PHOTOS

PROJECT: Waterloo Train Station		LOCATION: Waterloo	JOB No.: 1098196.1000.01
CO-ORDINATES: (NZTM2000)	5435650 mN 1760959 mE	DRILL TYPE: WD-SD100 Heliport SONIC	HOLE STARTED: 18/08/2025
R.L.:	6m	METHOD: Sonic core drilling	HOLE FINISHED: 19/08/2025
DATUM:	NZVD2016	LOGGED BY: S7(2)(a)	CHECKED: NCP

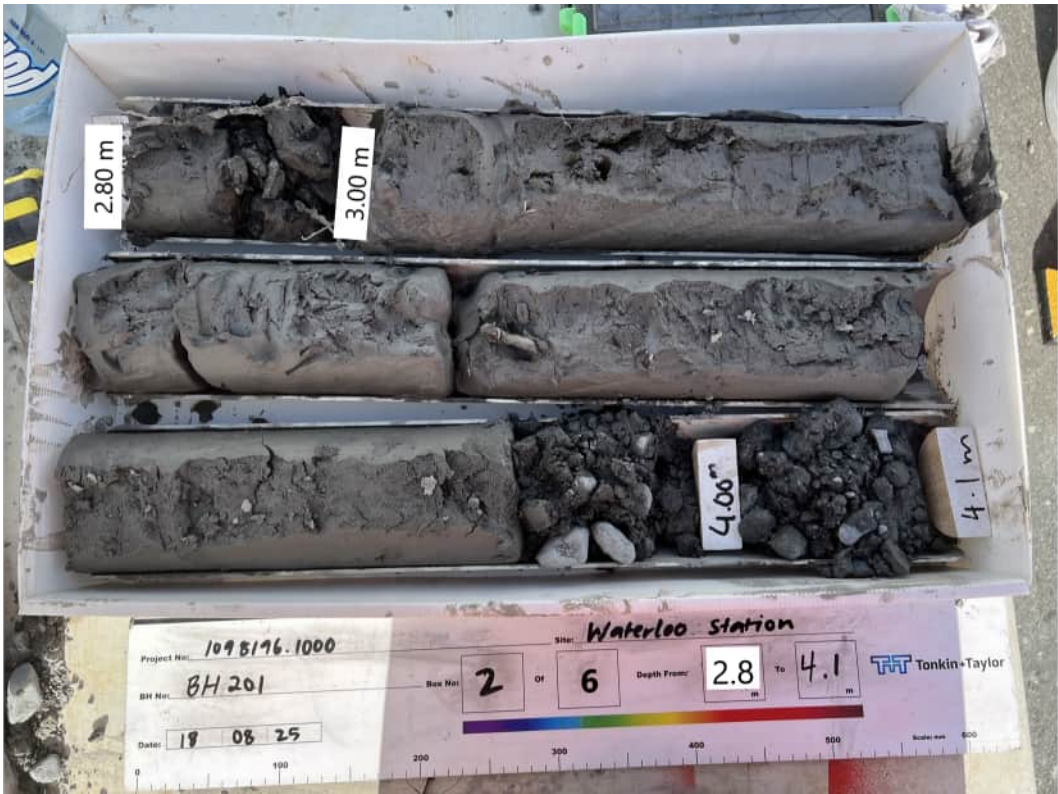


0.00-1.50m: HVAC



1.40-2.80m

PROJECT: Waterloo Train Station		LOCATION: Waterloo	JOB No.: 1098196.1000.01
CO-ORDINATES: (NZTM2000)	5435650 mN 1760959 mE	DRILL TYPE: WD-SD100 Heliport SONIC	HOLE STARTED: 18/08/2025
R.L.:	6m	METHOD: Sonic core drilling	HOLE FINISHED: 19/08/2025
DATUM:	NZVD2016		DRILLED BY: Webster Drilling
			LOGGED BY: S7(2)(a) CHECKED: NCP

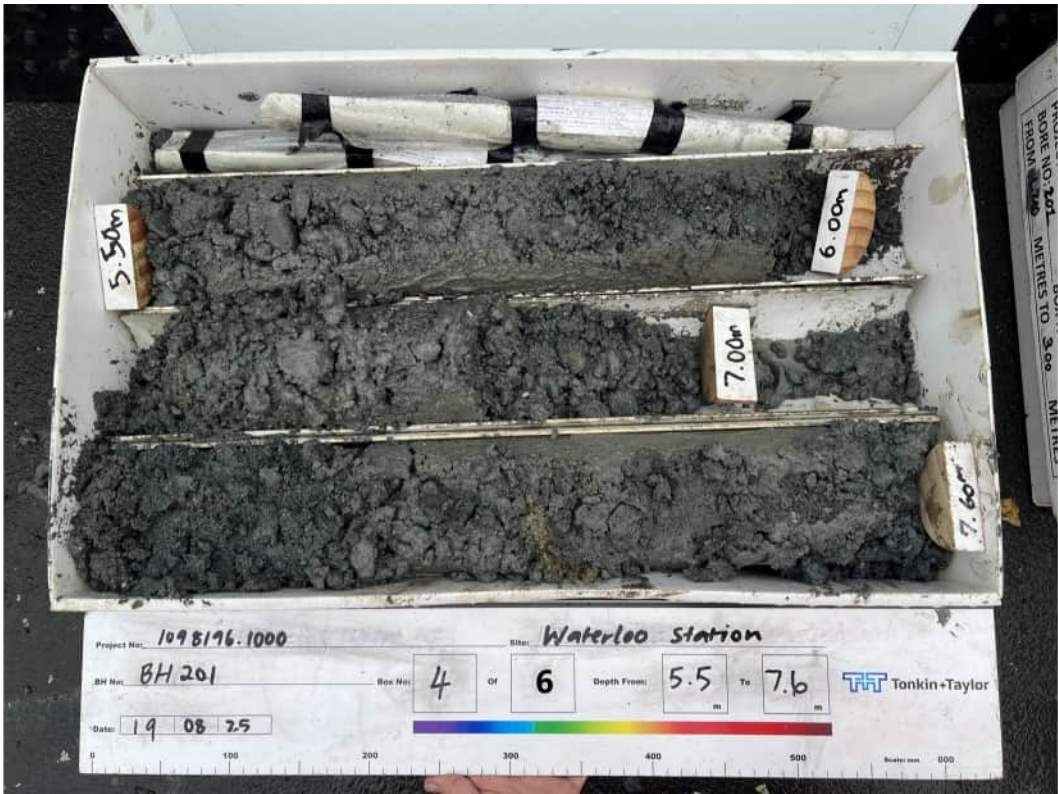


2.80-4.10m



4.10-5.50m

PROJECT: Waterloo Train Station		LOCATION: Waterloo	JOB No.: 1098196.1000.01
CO-ORDINATES: (NZTM2000)	5435650 mN 1760959 mE	DRILL TYPE: WD-SD100 Heliport SONIC	HOLE STARTED: 18/08/2025
R.L.:	6m	METHOD: Sonic core drilling	HOLE FINISHED: 19/08/2025
DATUM:	NZVD2016		DRILLED BY: Webster Drilling
			LOGGED BY: S7(2)(a) CHECKED: NCP



5.50-7.60m



7.60-9.00m

PROJECT: Waterloo Train Station		LOCATION: Waterloo	JOB No.: 1098196.1000.01
CO-ORDINATES: (NZTM2000)	5435650 mN 1760959 mE	DRILL TYPE: WD-SD100 Heliport SONIC	HOLE STARTED: 18/08/2025
R.L.:	6m	METHOD: Sonic core drilling	HOLE FINISHED: 19/08/2025
DATUM:	NZVD2016		DRILLED BY: Webster Drilling
			LOGGED BY: S7(2)(a) CHECKED: NCP



9.00-9.50m

Depth	SPTs	N
2 m		4
3 m		0
4 m		43
5 m		>50
6 m		26

2.00-6.00m

PROJECT: Waterloo Train Station		LOCATION: Waterloo	JOB No.: 1098196.1000.01
CO-ORDINATES: (NZTM2000)	5435650 mN 1760959 mE	DRILL TYPE: WD-SD100 Heliport SONIC	HOLE STARTED: 18/08/2025
R.L.:	6m	METHOD: Sonic core drilling	HOLE FINISHED: 19/08/2025
DATUM:	NZVD2016		DRILLED BY: Webster Drilling
			LOGGED BY: S7(2)(a) CHECKED: NCP

<u>Depth</u>	<u>SPTs</u>	<u>N</u>
7 m		26
8 m		>50
9 m		>50
9.5 m		44

6.00-9.50m

Appendix C Cone Penetration Tests

- Table C1: Summary of CPT investigations
- CPT logs

Table C1: Summary of CPTs

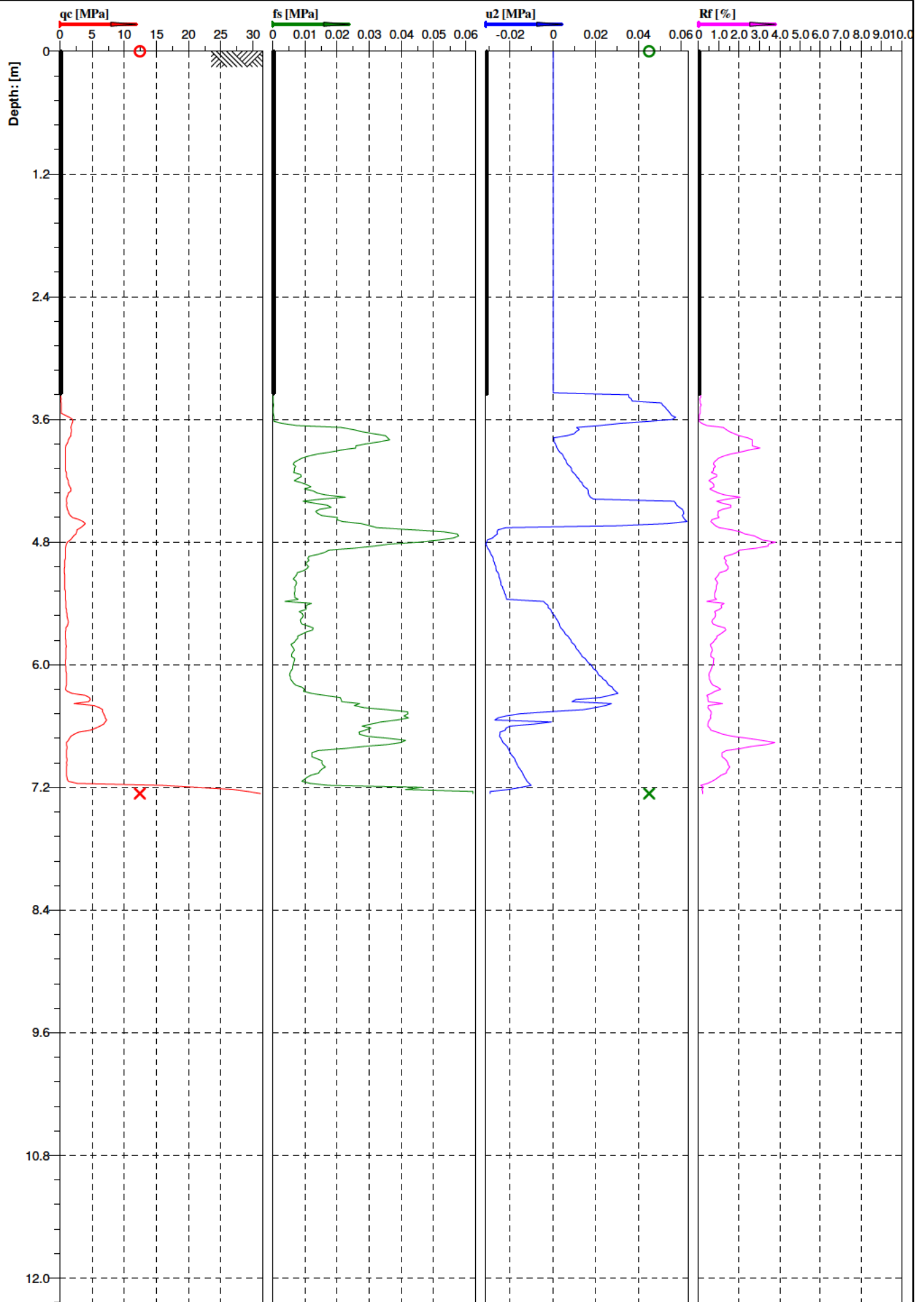
ID	Date	Ground surface level, RL (m)	Pre-drill depth (m)	Total depth (m)	Termination reason
CPT9 ⁽¹⁾	19/10/2016	-	3.36	7.26	Refusal
CPT101 ⁽²⁾	6/10/2020	6.19	1.5	8.41	Target depth
CPT102 ⁽²⁾	14/9/2020	6.21	1.5	7.54	Refusal
CPT103 ⁽²⁾	14/9/2020	6.31	1.5	8.99	Refusal
CPT109 ⁽³⁾	15/9/2020	3.92	-	5.09	Refusal
CPT201 ⁽⁴⁾	20/8/2025	6	1.5	10.00	Target depth
CPT202 ⁽⁴⁾	20/8/2025	6	1.5	10.00	Target depth
CPT203 ⁽⁴⁾	22/8/2025	6	1.5	5.75	Refusal
CPT204 ⁽⁴⁾	22/8/2025	6	1.5	10.00	Target depth
CPT205 ⁽⁴⁾	20/8/2025	7	1.5	10.00	Target depth
CPT206B ⁽⁴⁾	22/8/2025	7	1.7	6.50	Refusal
CPT207 ⁽⁴⁾	21/8/2025	7	1.5	10.00	Target depth
CPT208 ⁽⁴⁾	22/8/2025	6	1.5	10.00	Target depth
CPT209 ⁽⁴⁾	19/8/2025	6	1.5	10.00	Target depth
CPT210 ⁽⁴⁾	13/8/2025	6	1.5	10.00	Target depth

Note 1) Consultant: Opus. Contractor: Griffiths Drilling.

Note 2) Consultant: WSP. Contractor: Griffiths Drilling.

Note 3) Consultant: WSP. Contractor: Ground Investigation.

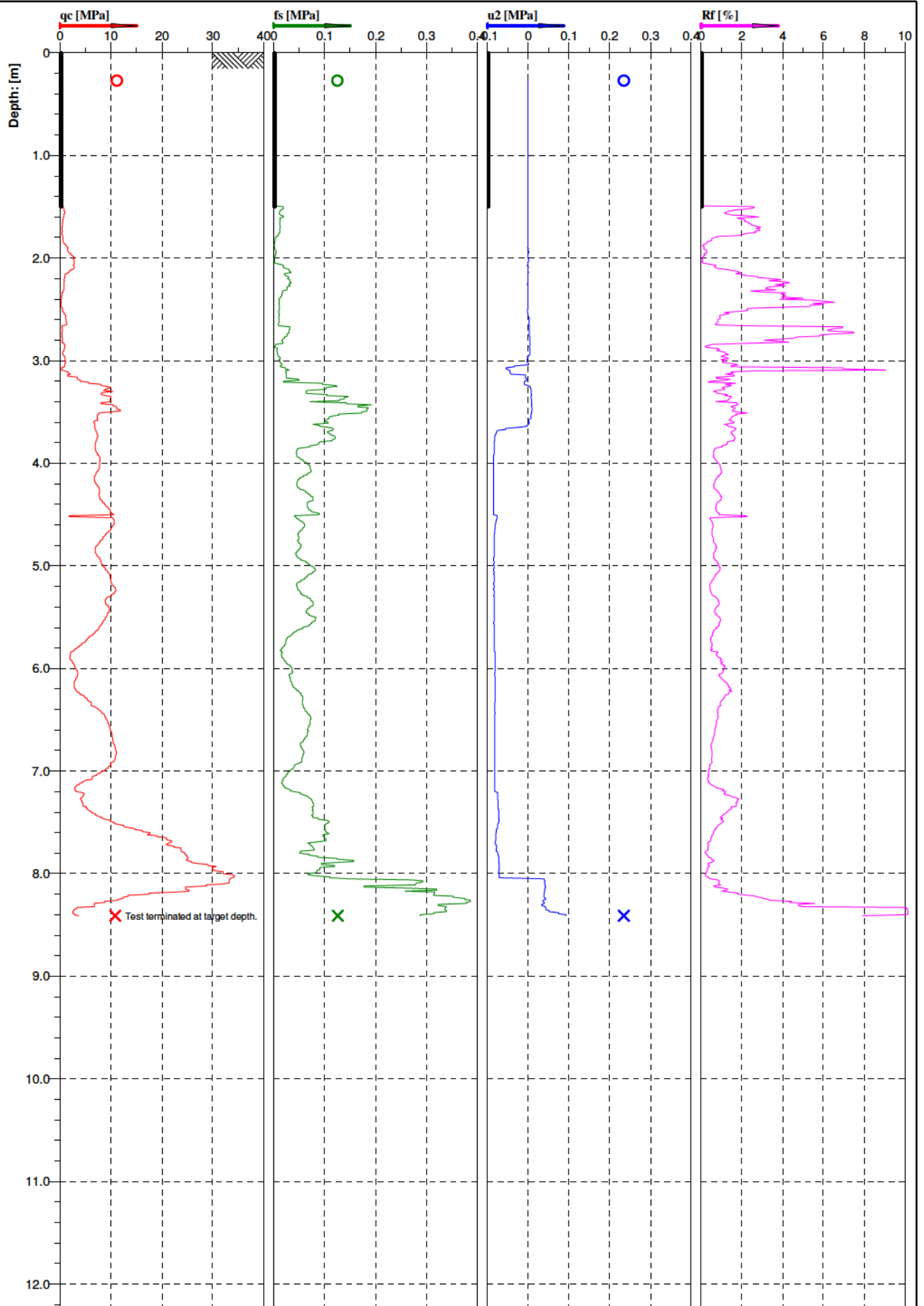
Note 4) Consultant: Tonkin + Taylor. Contractor: Webster Drilling & Exploration using Pagani tracked rig (ballasted 15T). Cone area (10 cm²). Cone tip net area ratio = 0.78.



Cone No: 4616
Tip area [cm²]: 10
Sleeve area [cm²]: 150



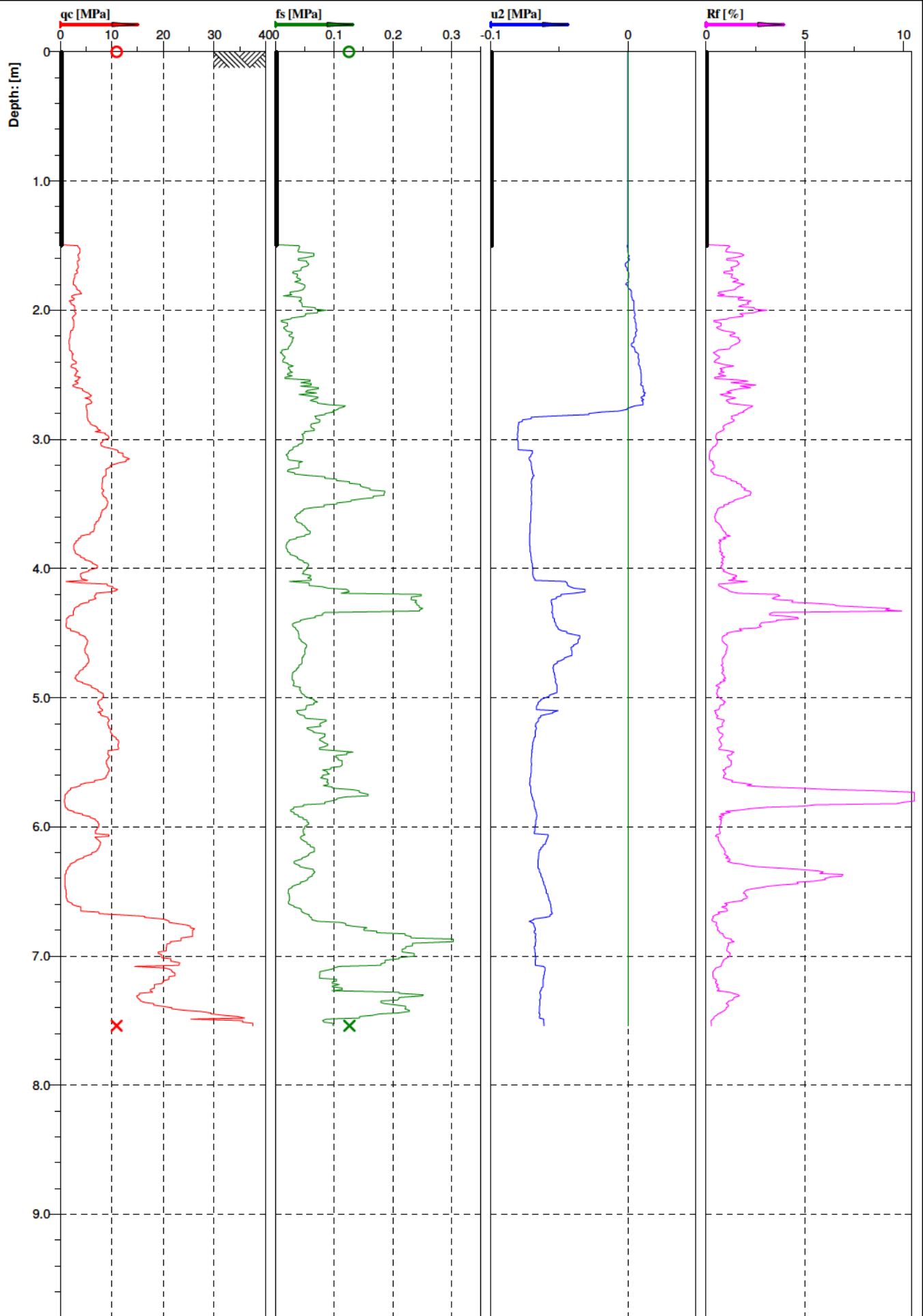
Location:	Waterloo WTP	Position:	S41°12.810', E174°55.295'	Ground level:	0.00	Test No.:	CPT9
Project ID:	9	Client:	Opus	Date:	19/10/2016	Scale:	1 : 50
Project:	WATERLOO			Page:	1/1	Fig.:	
Qc Refusal				File:	cpt9.cpt		



Cone No: 5336
Tip area [cm²]: 10
Sleeve area [cm²]: 150



Location: 44D Oxford Terrace, Lower Hutt	Position:	Ground level: 0.00	Test No.: 1
Project ID: CPT101	Client: WSP	Date: 6/10/2020	Scale: 1 : 50
Project: Waterloo WTP		Page: 1/1	Fig.:
~1.5m Hydrovacced, ~1.25m Backfilled. NB: fs graph max-value (0.4 MPa) increased compared to other Waterloo CTP graphs (0.35 MPa).		File: Waterloo CPT101.1.cpd	



Cone No: 5336
Tip area [cm²]: 10
Sleeve area [cm²]: 150



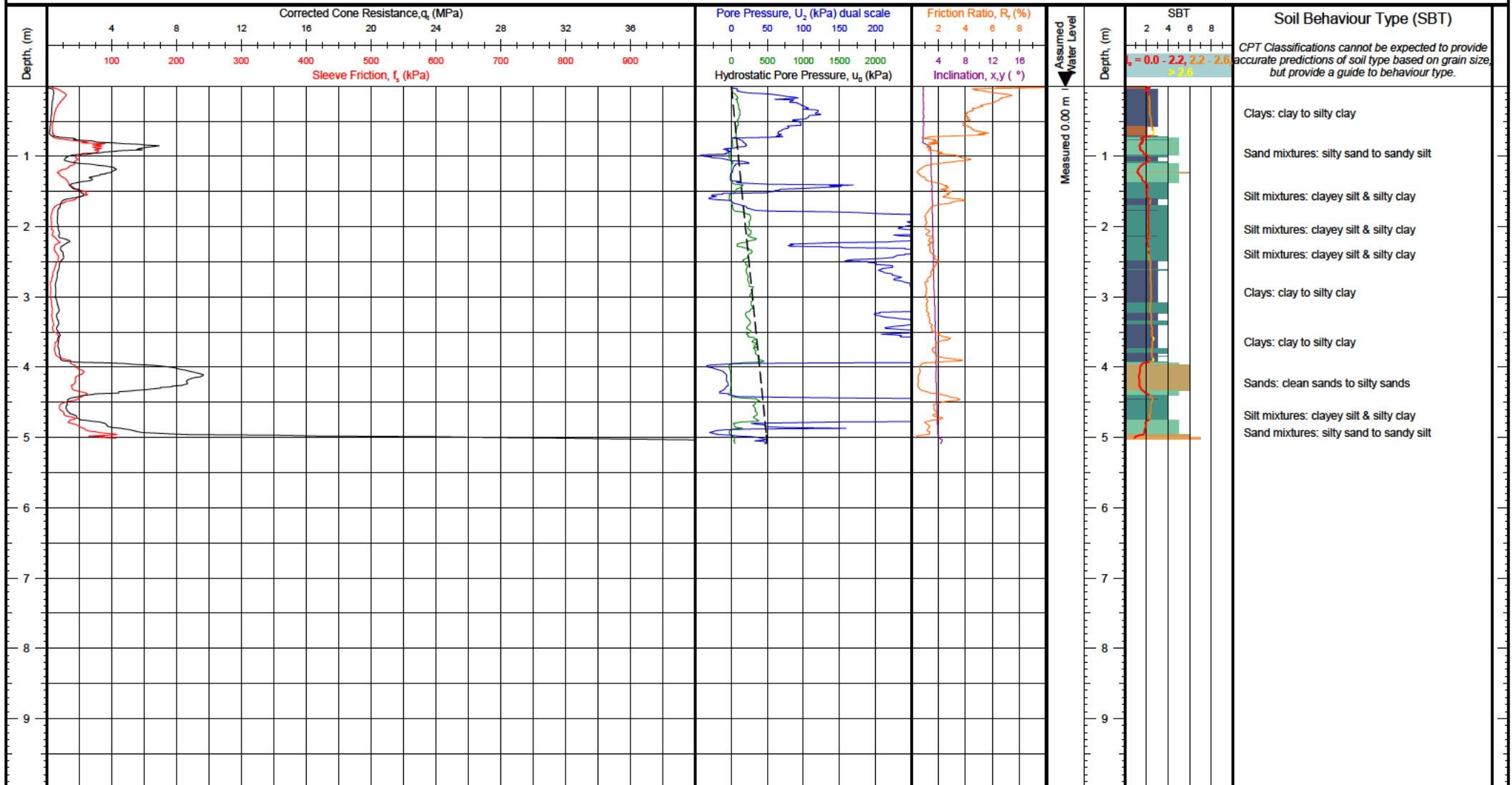
Location: 44D Oxford Terrace, Lower Hut	Position:	Ground level: 0.00	Test No.: 1
Project ID: CPT102	Client: WSP	Date: 14/09/2020	Scale: 1 : 40
Project: Waterloo WTP		Page: 1/1	Fig.:
~1.5m Hydrovacted, ~1.25m Backfilled		File: WTP CPT3.1(102).cpd	



u2

Location: 44D Oxford Terrace, Lower Hutt	Position:	Ground level: 0.00	Test No.: 1
Project ID: CPT103	Client: WSP	Date: 14/09/2020	Scale: 1 : 40
Project: Waterloo WTP		Page: 1/1	Fig.:
~1.5m Hydrovaccd & Backfilled		File:	WTP CPT2.1(103).cpd

CONE PENETRATION TEST (CPT) LOG



Client: Griffiths Drilling
 Project: Waterloo Water Treatment Plant
 Location: 44D Oxford Terrace, Lower Hutt, Wellington
 Engineer: S7(2)(a)
 Contractor: Ground Investigation Ltd.

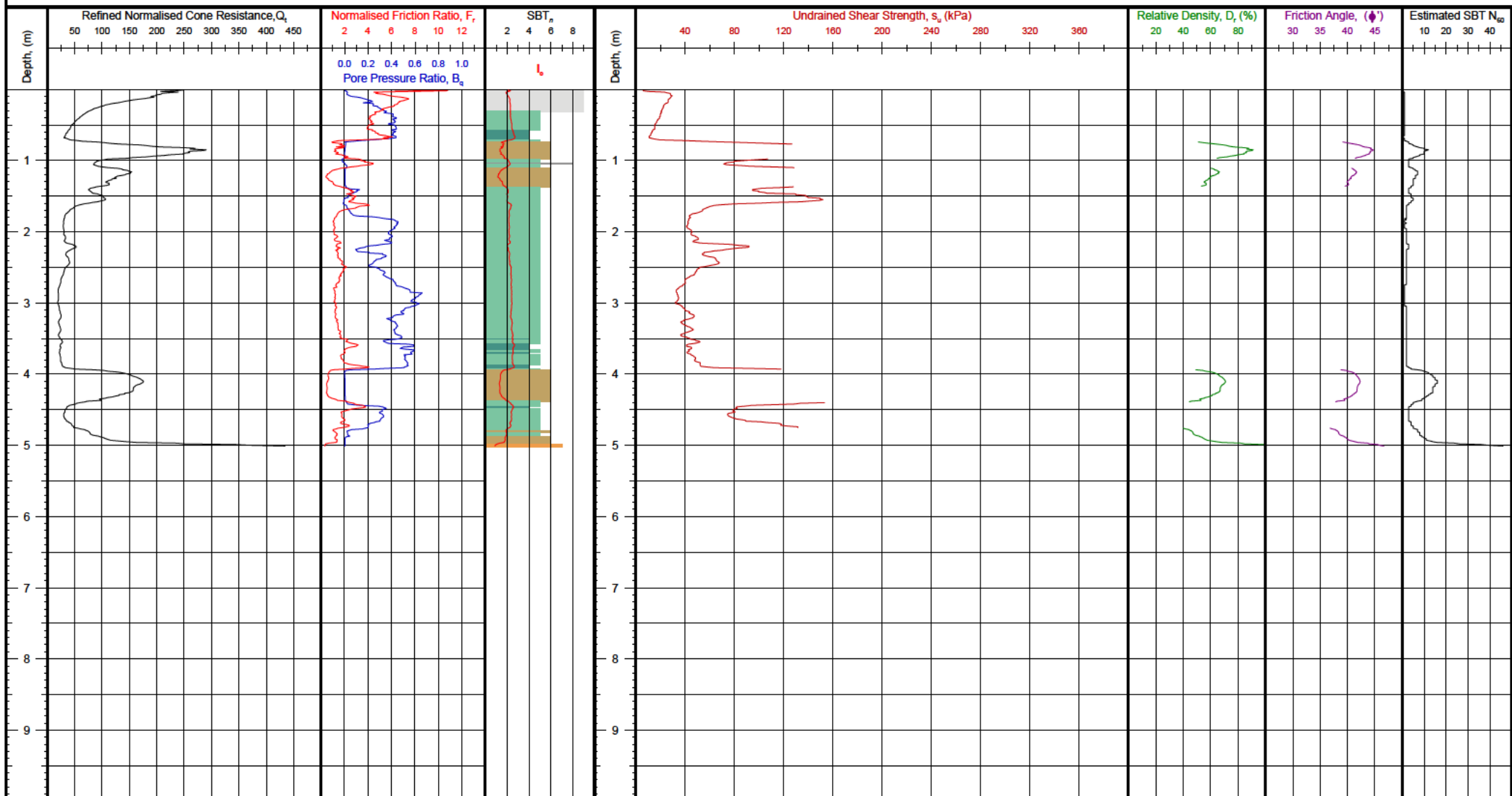
Operator: S7(2)(a)
 Cone Ref: MKJ540
 Cone Type: 10cm² Compression
 Area Ratio: 0.8
 Filter Type: u_2

NZTM 2000 N, E (m): 5435789.85, 1761097.68
 WGS84 (deg): -41.213246, 174.921673
 Location Method: Handheld GPS
 Surveyor:
 Termination Reason: Limit of reaction force

Elevation (m): Unknown
 Date of Test: 15/09/2020
 Depth (m): 5.09
 Pre Drill (m): N/A

Client Job Ref:
 Test Number: **CPT-109**
 G.I. Job Ref: 200454

Comments:



Client: Griffiths Drilling
Project: Waterloo Water Treatment Plant
Location: 44D Oxford Terrace, Lower Hutt, Wellington
Engineer: S7(2)(a)
Contractor: Ground Investigation Ltd.

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Job Ref:

Test Number: CPT-109

G.I. Job Ref: 200454

Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 20/08/2025 12:02:48 pm	
Site: Waterloo Station - Test: CPT201	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: s7(2)(a)@websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT201

Location: CPT201

Date: 20/08/2025 12:02:48 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

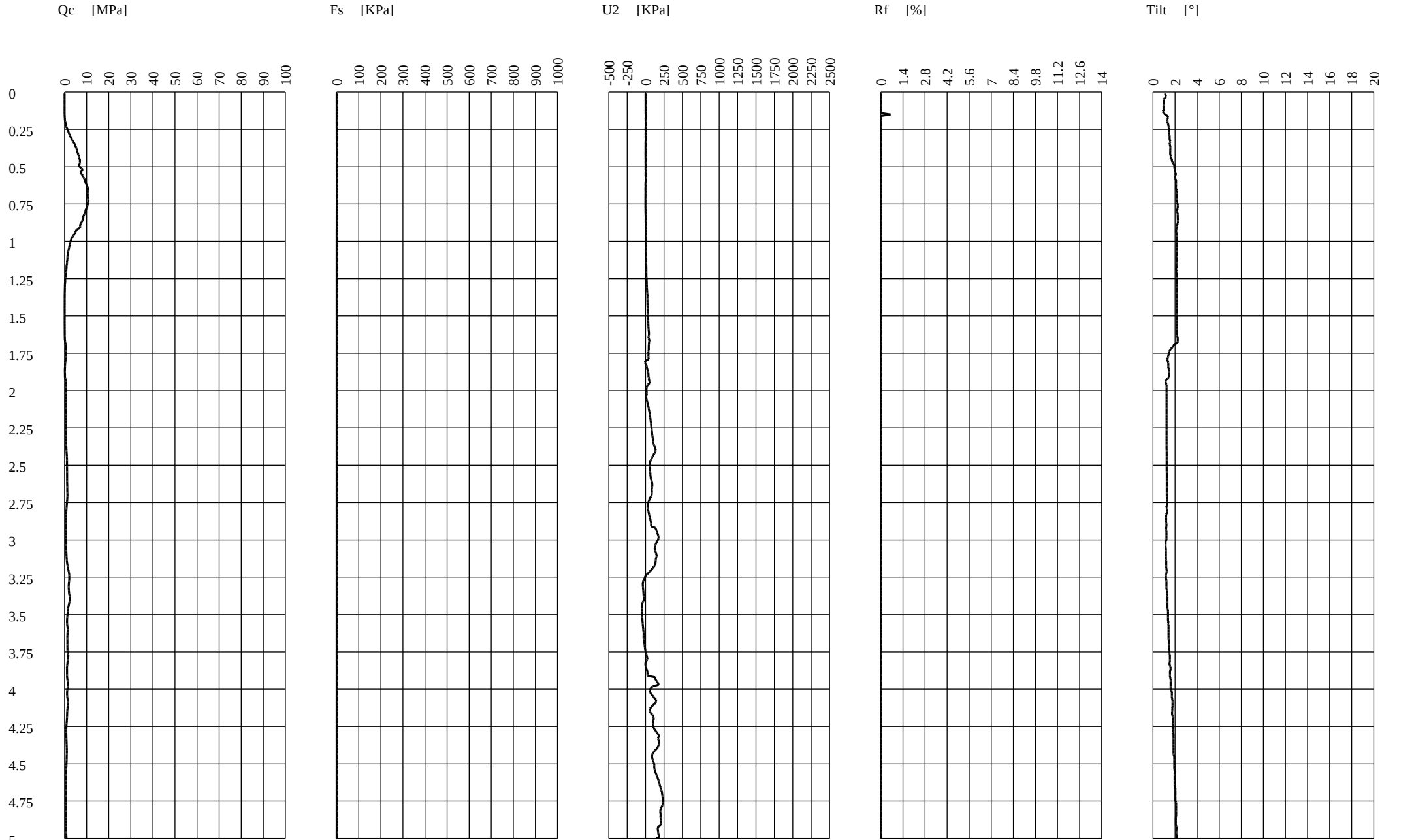
Latitude: -41.214404

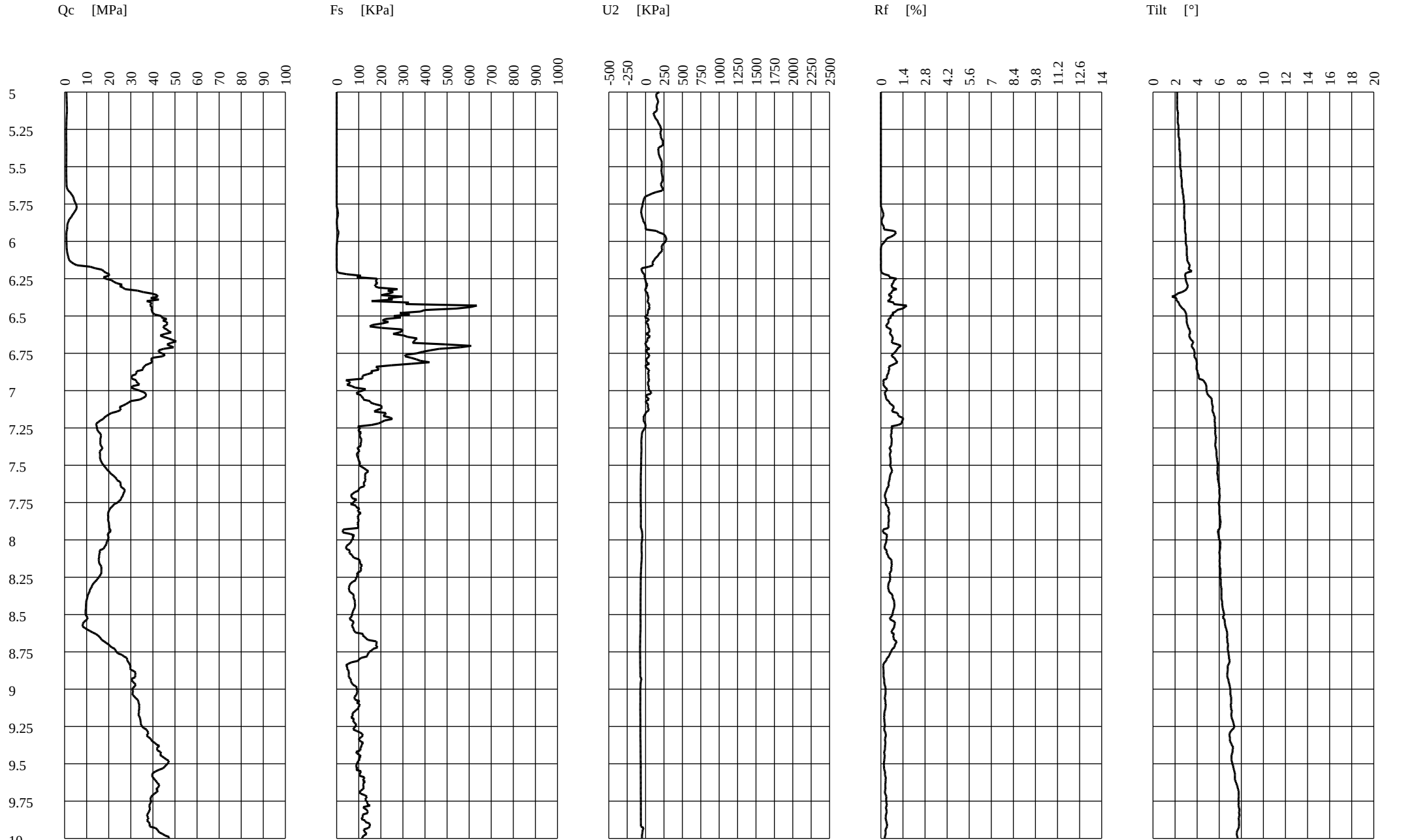
Longitude: 174.921722

Operator: s7(2)(a)

Comments: Jet Vac to 1.5m

Probe code: Mks680





Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 20/08/2025 12:02:51 pm	
Site: Waterloo Station - Test: CPT202	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: s7(2)(a)@websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT202

Location: CPT202

Date: 20/08/2025 12:02:51 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

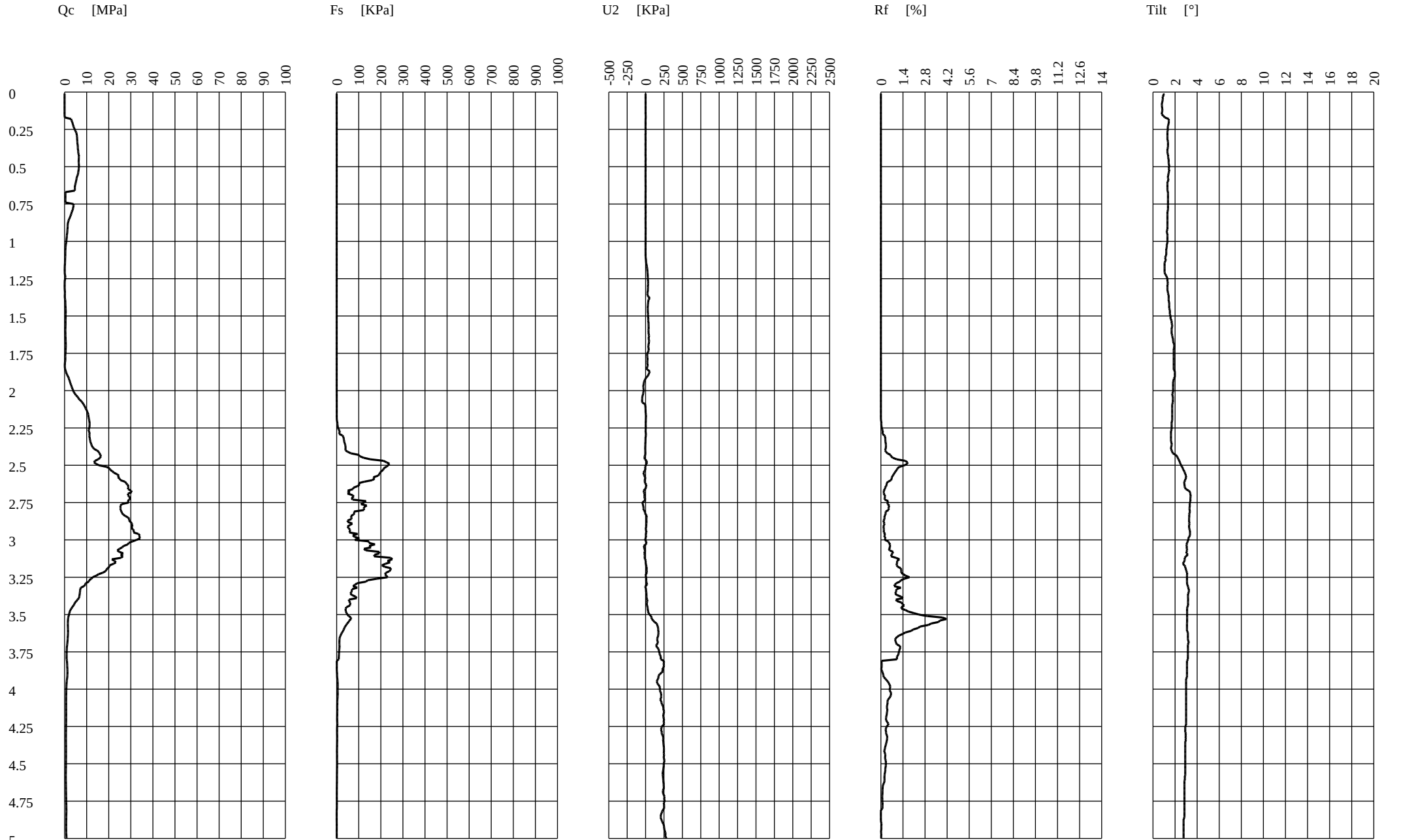
Latitude: -41.214282

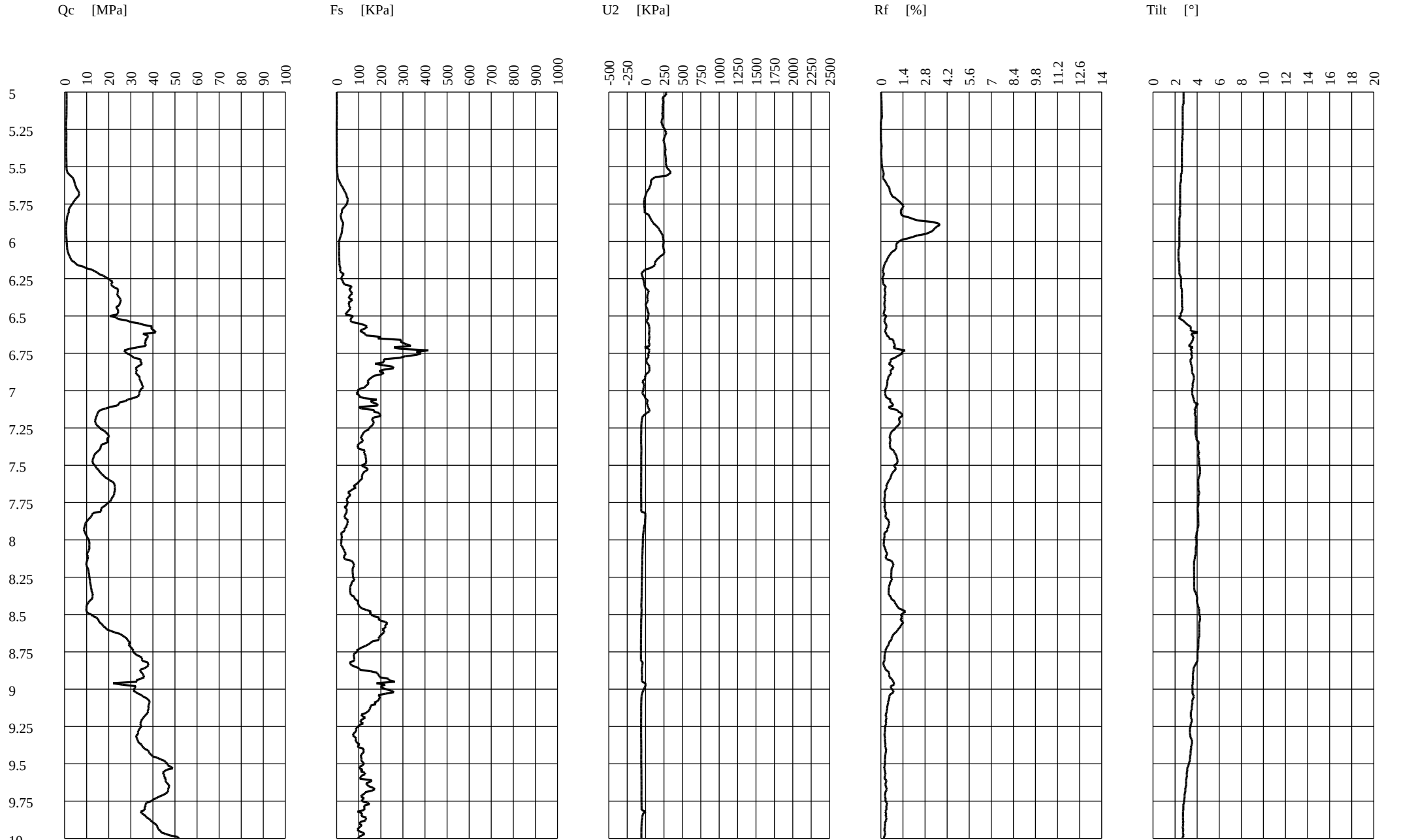
Longitude: 174.921484

Operator: s7(2)(a)

Comments: Jet Vac 1.5m

Probe code: Mks680





Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 22/08/2025 12:14:24 pm	
Site: Waterloo Station - Test: CPT203	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: h57(2)(a)websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT203

Location: CPT203

Date: 22/08/2025 12:14:24 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

Latitude: -41.214906

Longitude: 174.919885

Operator: s7(2)(a)

Comments: Jet Vac to 1.5m

Probe code: Mks680



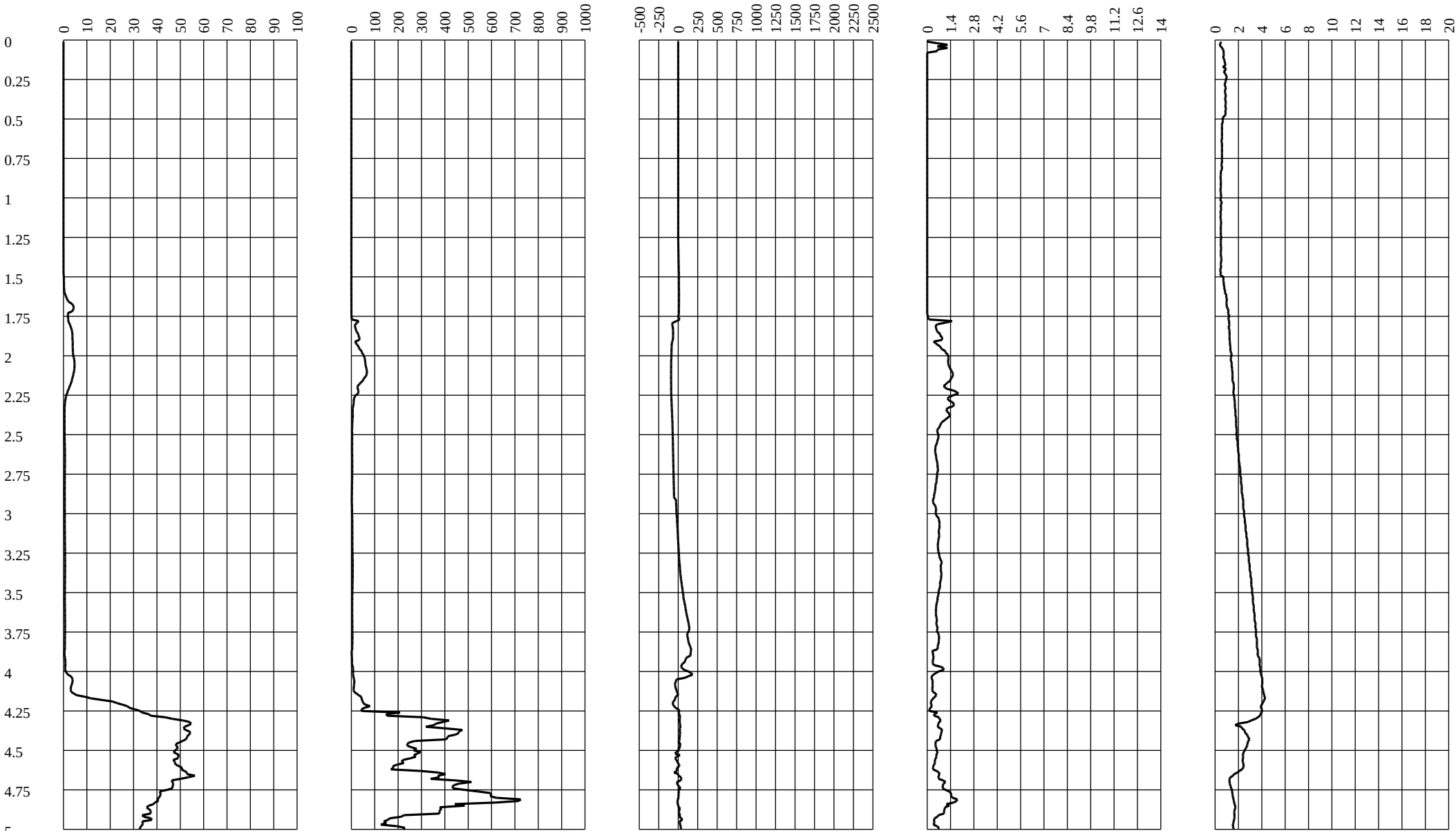
Qc [MPa]

Fs [KPa]

U2 [KPa]

Rf [%]

Tilt [°]





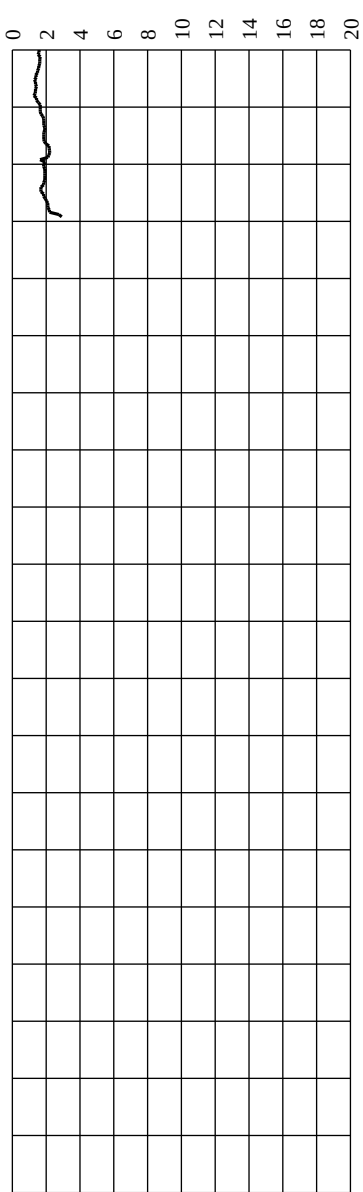
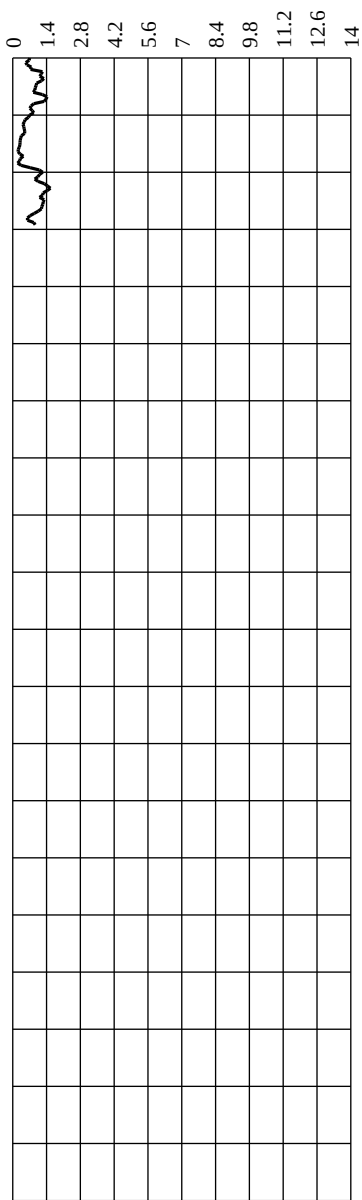
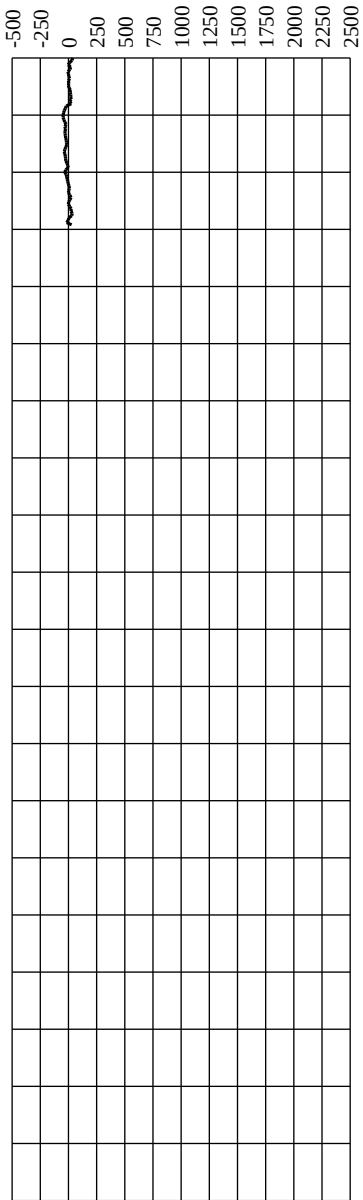
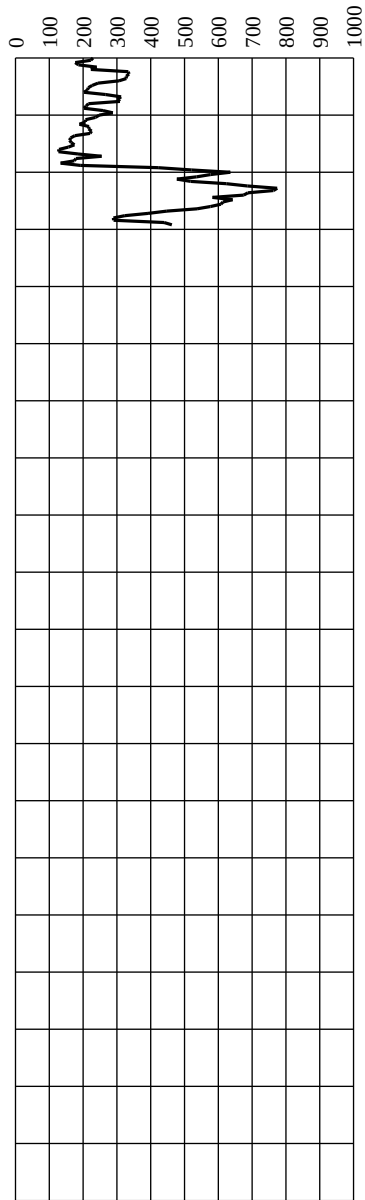
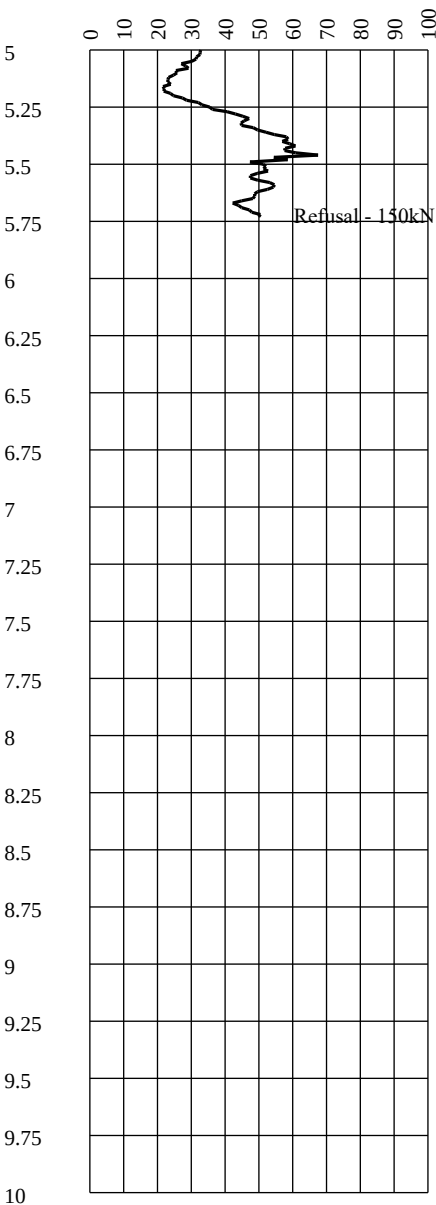
Qc [MPa]

Fs [KPa]

U2 [KPa]

Rf [%]

Tilt [°]



Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 22/08/2025 12:03:44 pm	
Site: Waterloo Station - Test: CPT204	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: s7(2)(a)@websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT204

Location: CPT204

Date: 22/08/2025 12:03:44 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

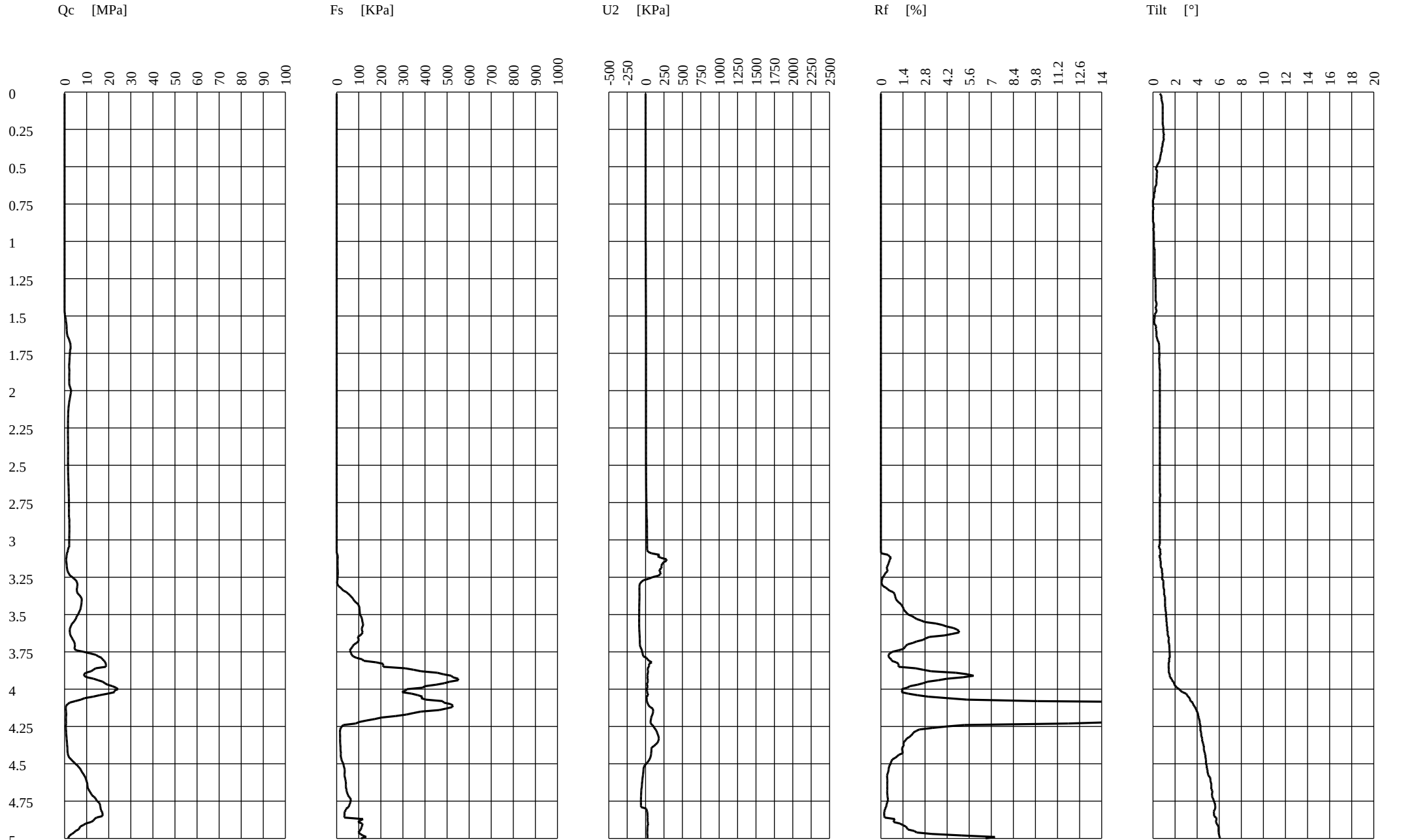
Latitude: -41.214610

Longitude: 174.920303

Operator: s7(2)(a)

Comments: Jet Vac to 1.5m

Probe code: Mks680



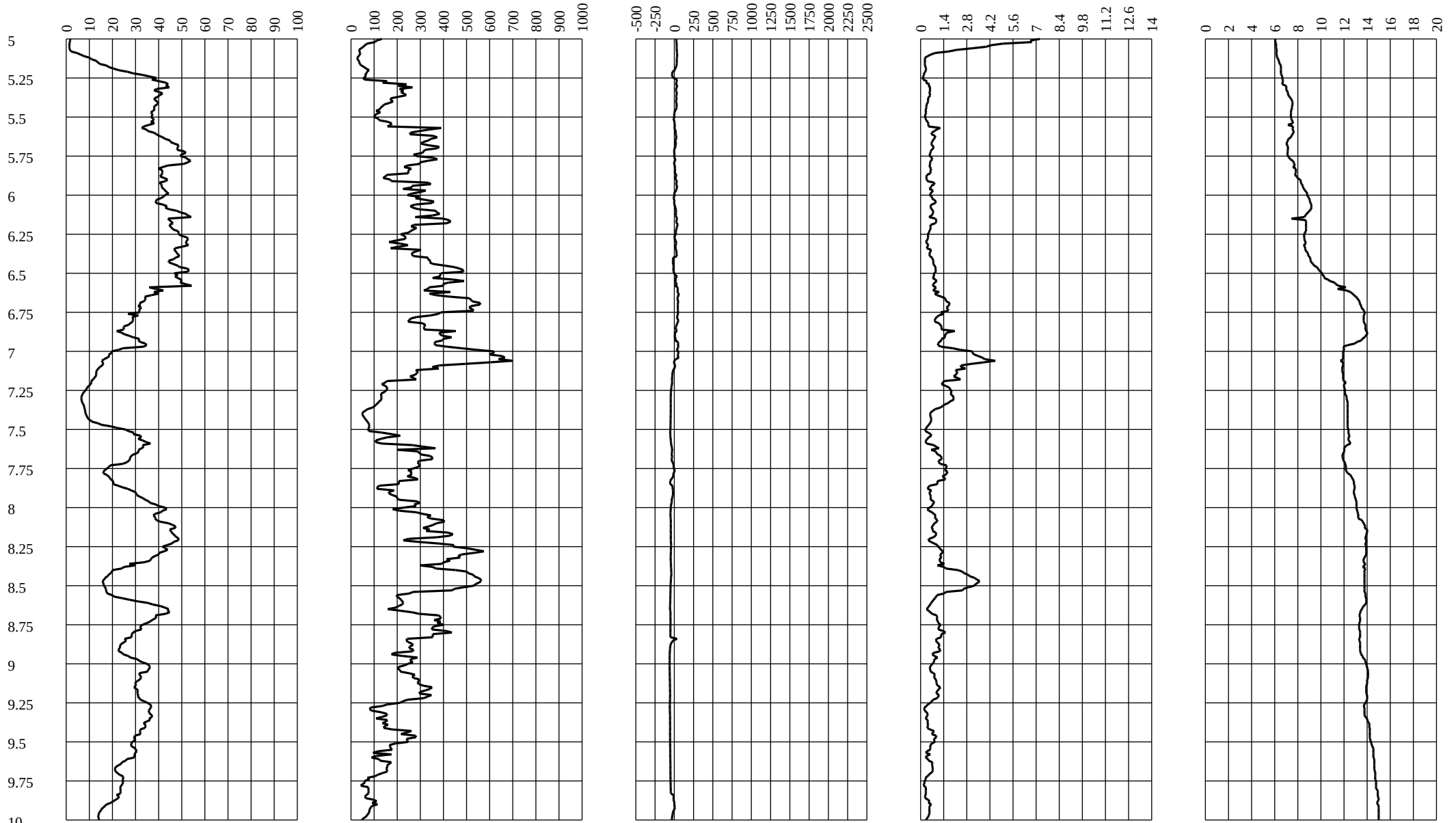
Qc [MPa]

Fs [KPa]

U2 [KPa]

Rf [%]

Tilt [°]



Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 20/08/2025 12:20:26 pm	
Site: Waterloo Station - Test: CPT205	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: s7(2)(a)@websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT205

Location: CPT205

Date: 20/08/2025 12:20:26 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

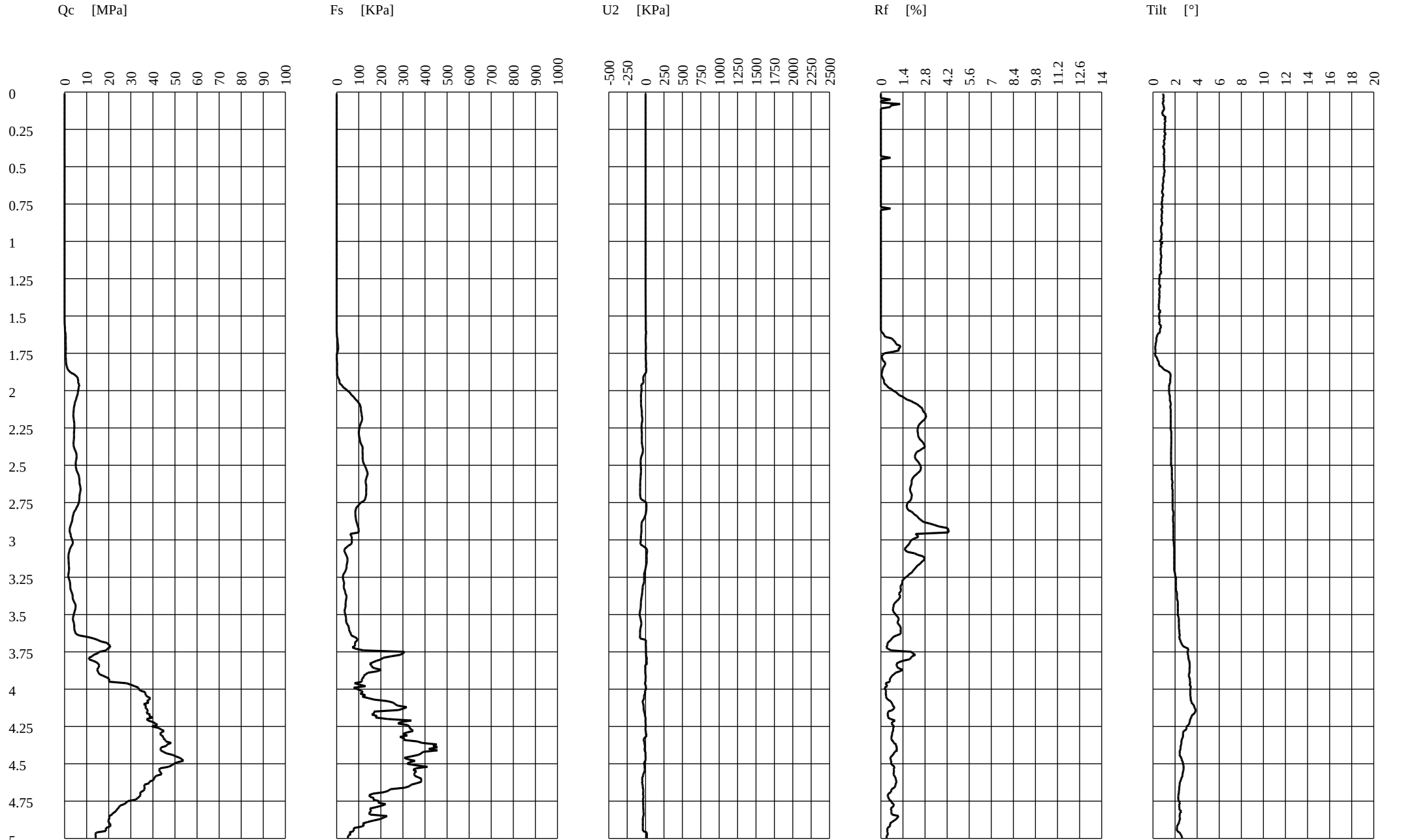
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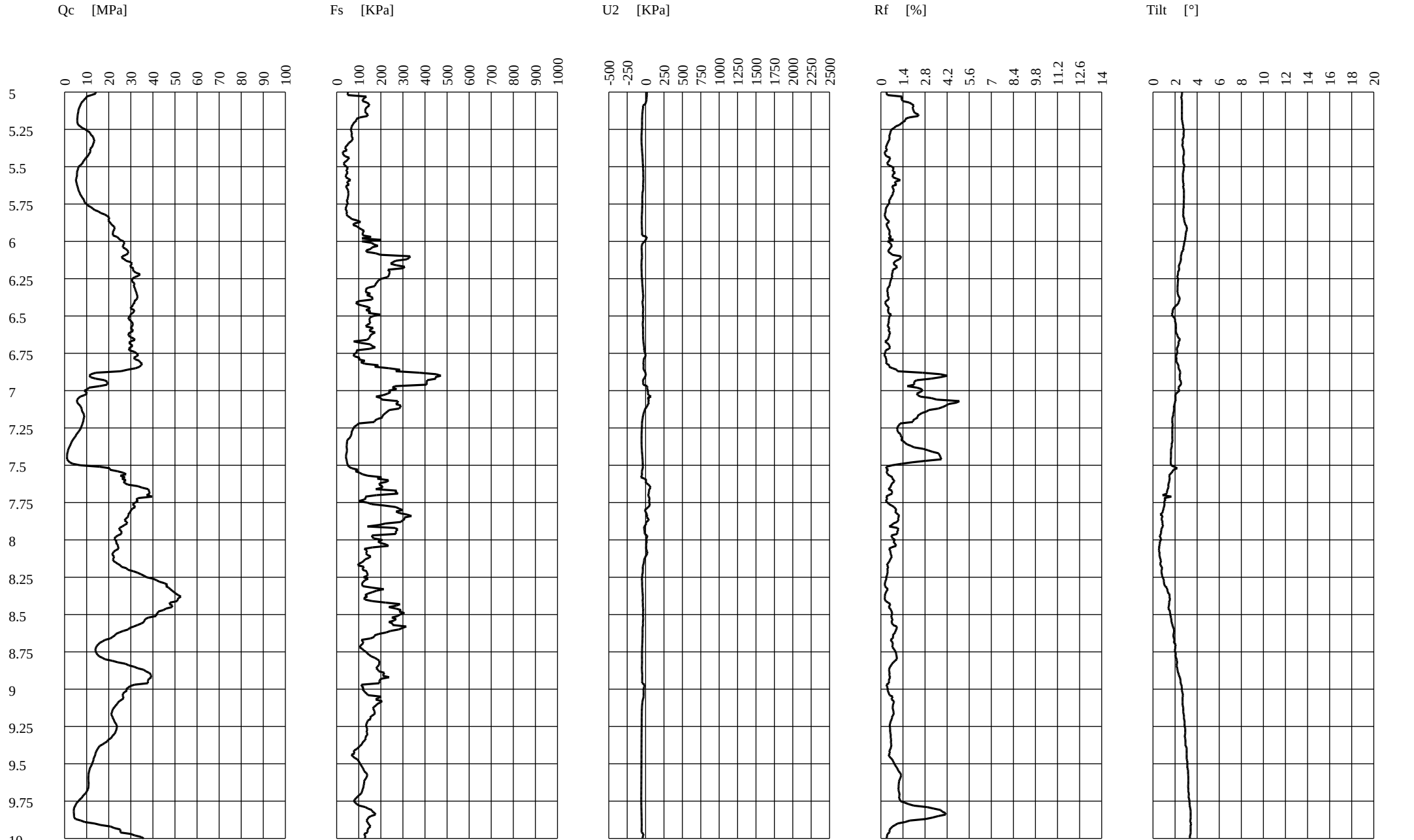
Longitude: 174.920917

Operator:

Comments: Jet Vac to 1.5m

Probe code: Mks680





Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 21/08/2025 12:17:08 pm	
Site: Waterloo Station - Test: CPT206B	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: s7(2)(a)@websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT206B

Location: CPT206B

Date: 21/08/2025 12:17:08 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

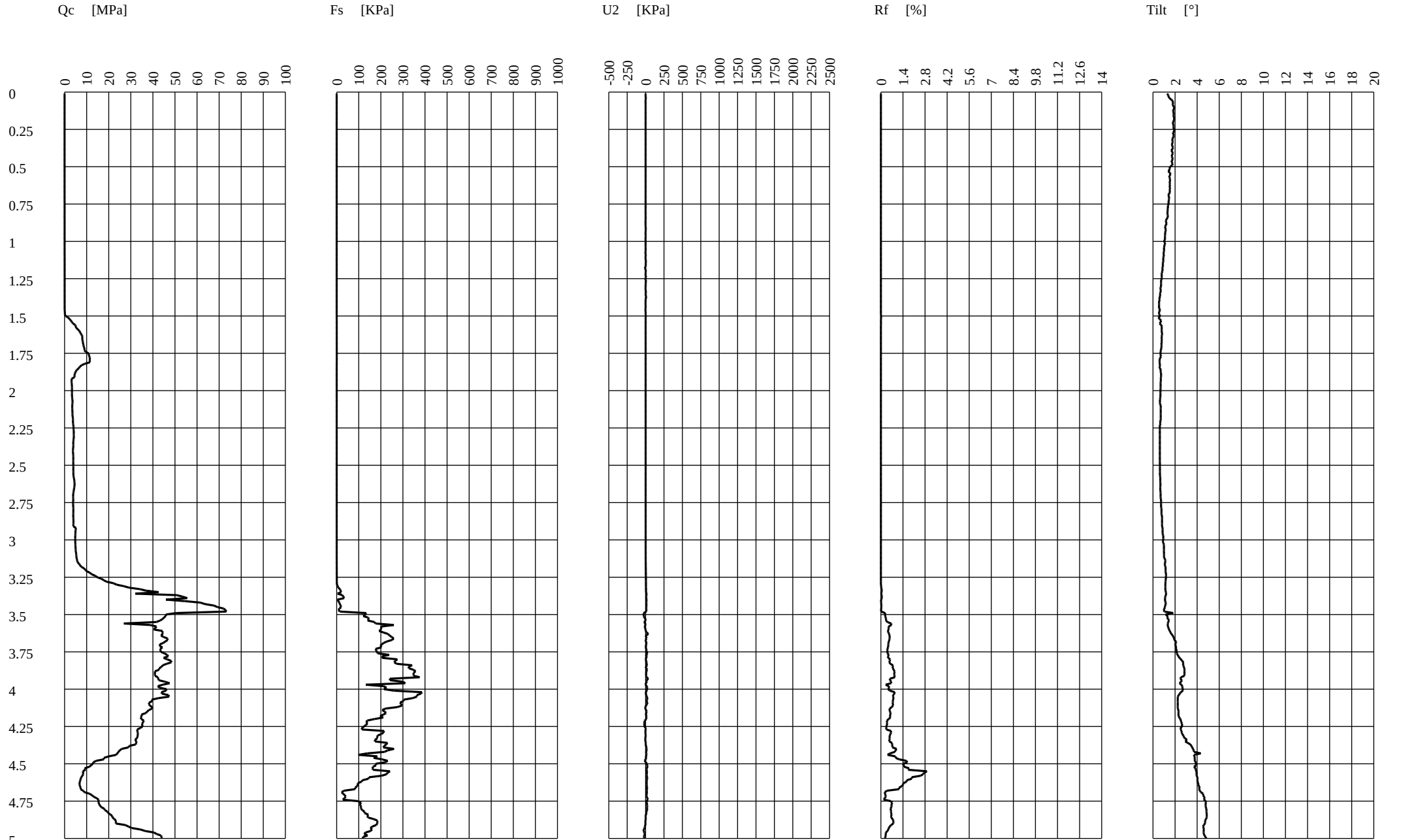
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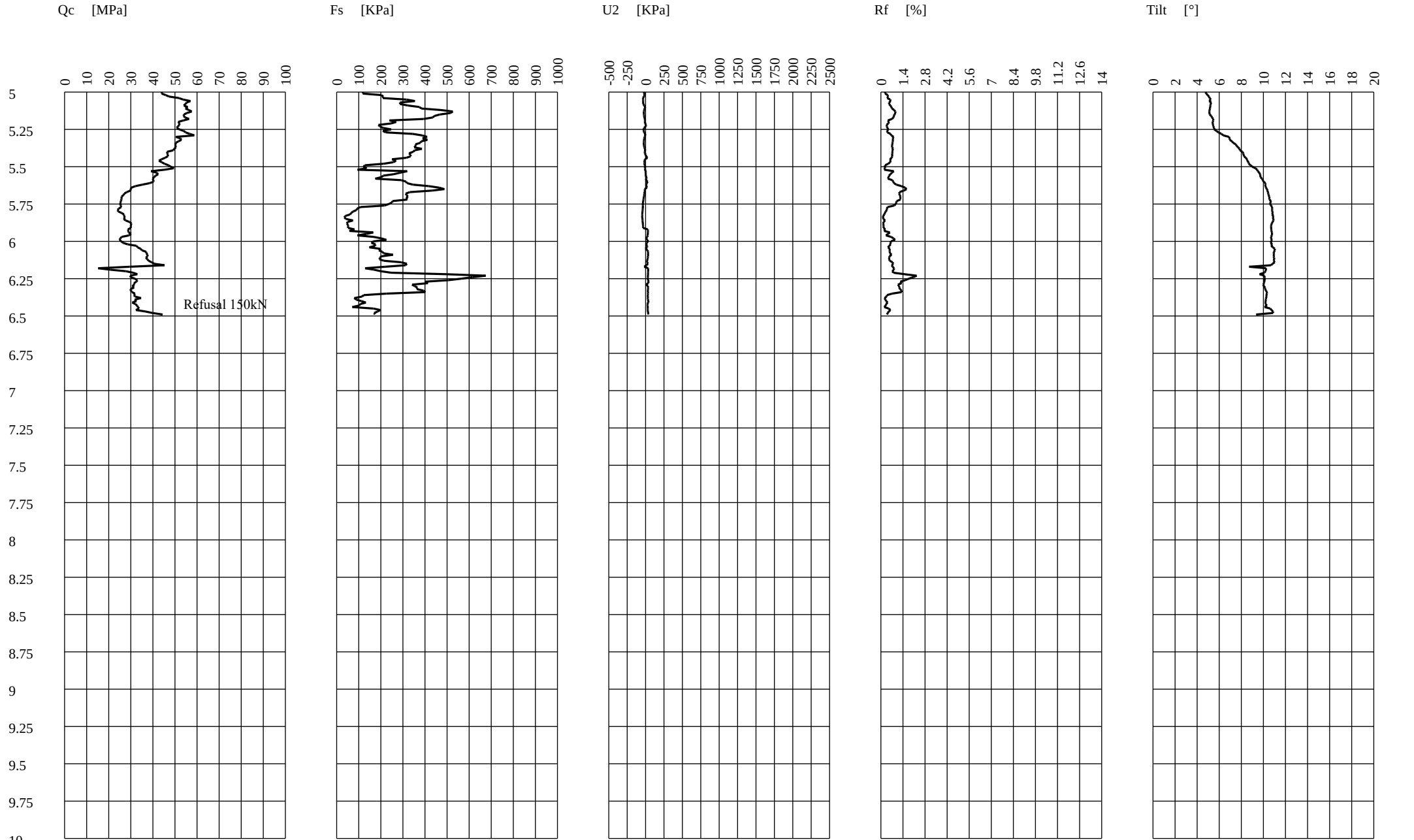
Longitude: 174.921474

Operator: s7(2)(a)

Comments: Jet Vac to 1.5m

Probe code: Mks680





Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 21/08/2025 12:33:53 pm	
Site: Waterloo Station - Test: CPT207	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: s7(2)(a)@websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT207

Location: CPT207

Date: 21/08/2025 12:33:53 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

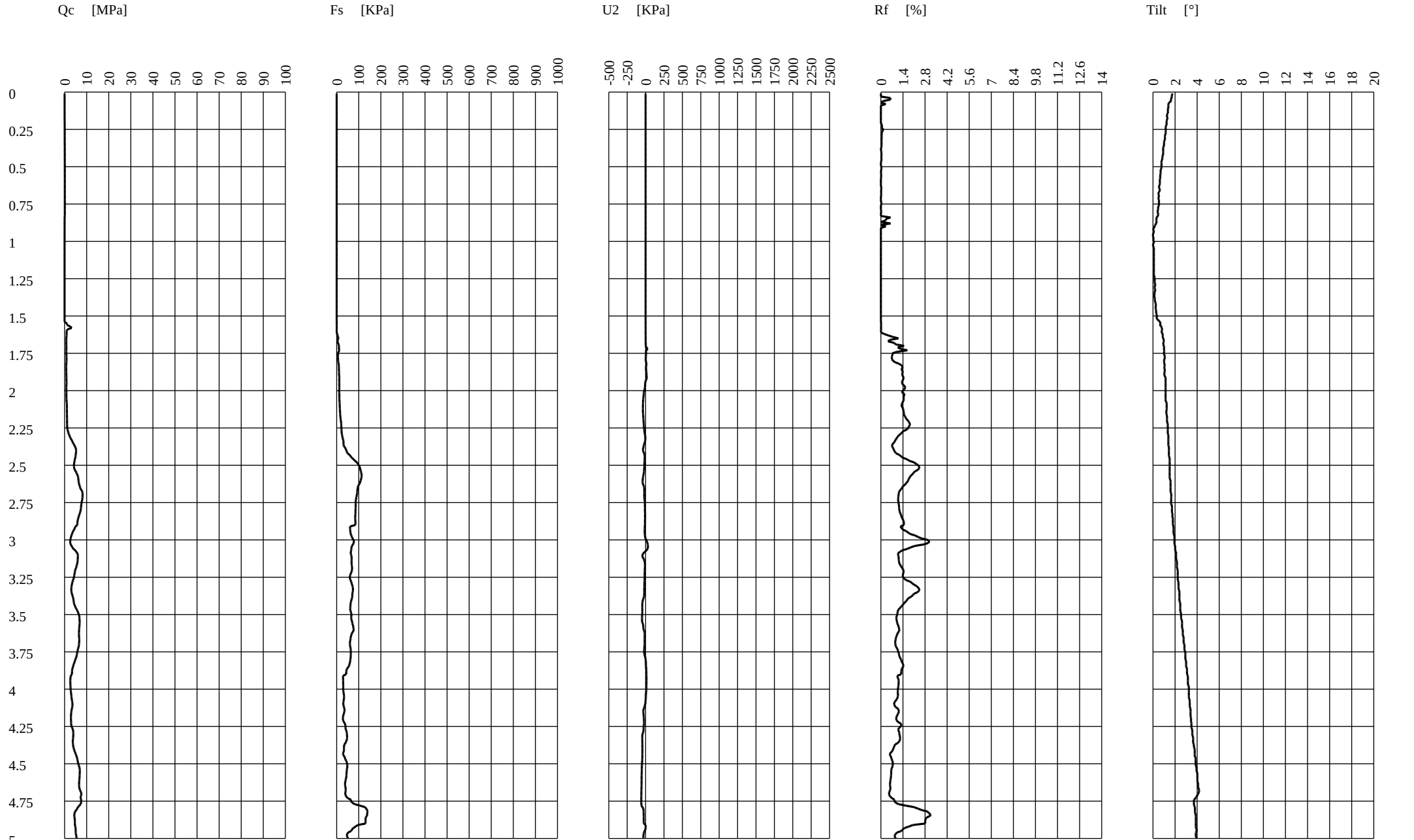
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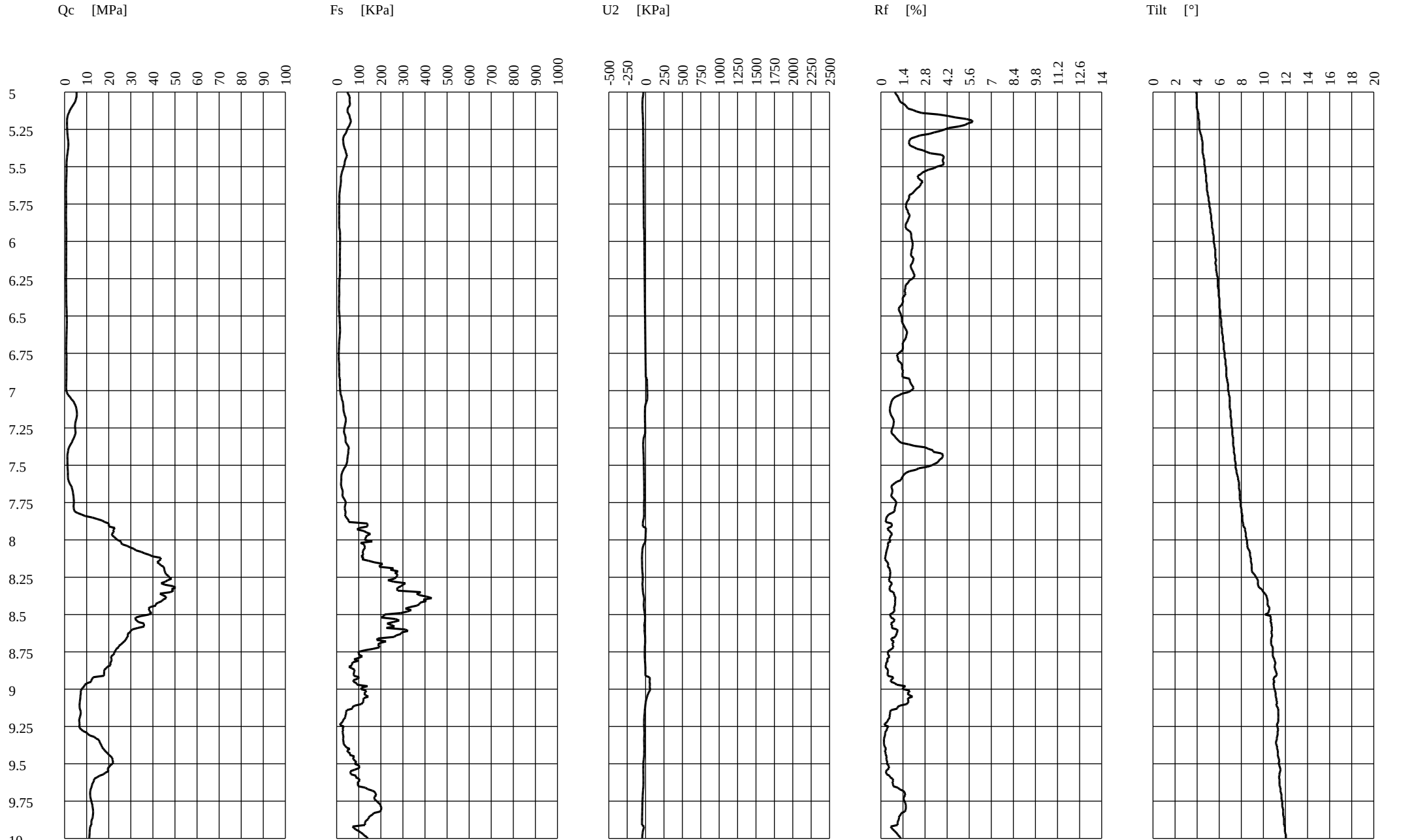
Longitude: 174.921443

Operator: s7(2)(a) Comments:

Jet Vac & to 1.5m Probe code:

Mks680





Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 1/01/2006 12:00:21 pm	
Site: Waterloo Station - Test: CPT208	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: s7(2)(a)@websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT208

Location: CPT208

Date: 1/01/2006 12:00:21 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

Latitude: -41.214440

Longitude: 174.920669

Operator: s7(2)(a)

Comments: Jet Vac to 1.5m

Probe code: Mks680

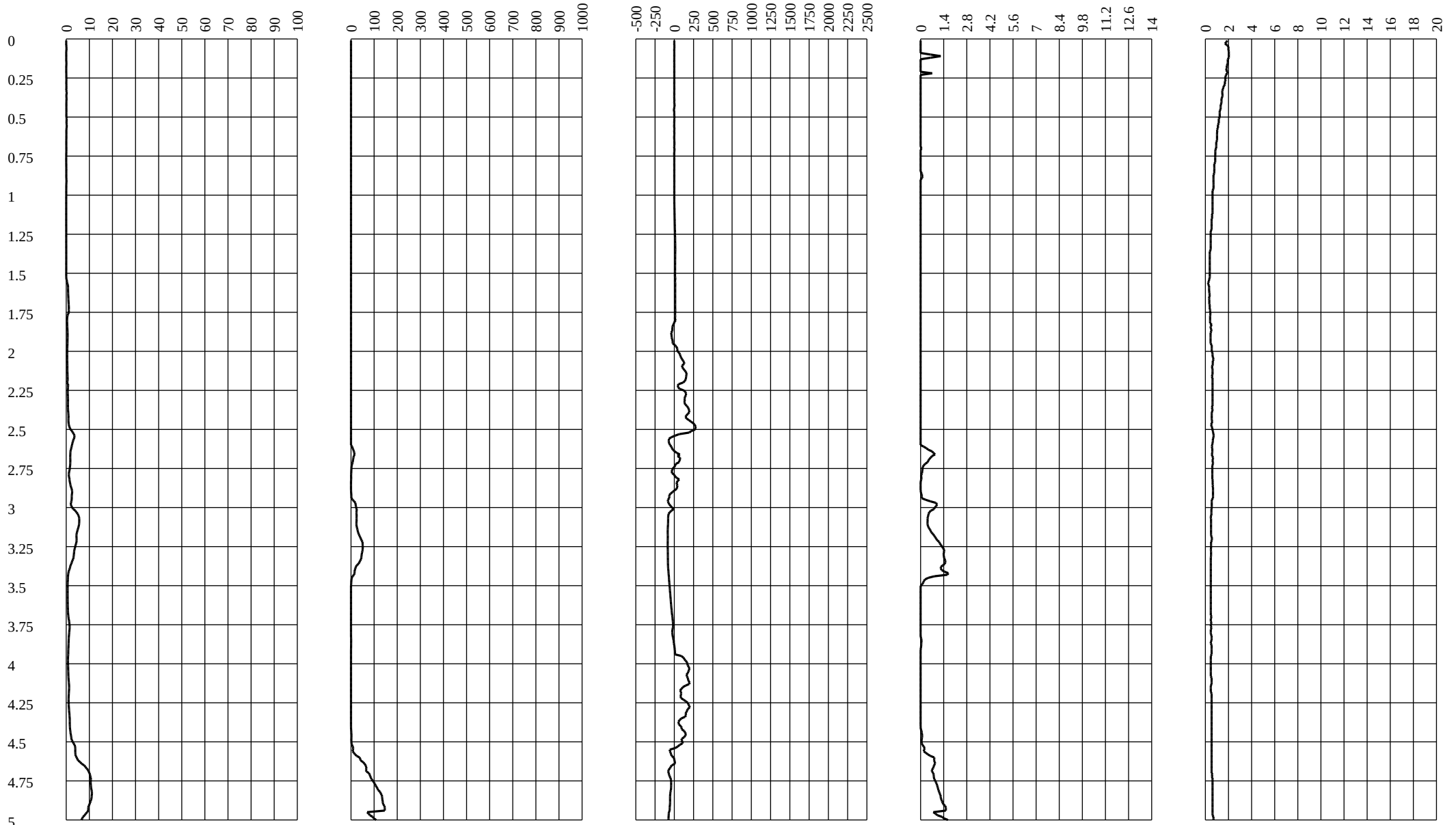
Qc [MPa]

Fs [KPa]

U2 [KPa]

Rf [%]

Tilt [°]



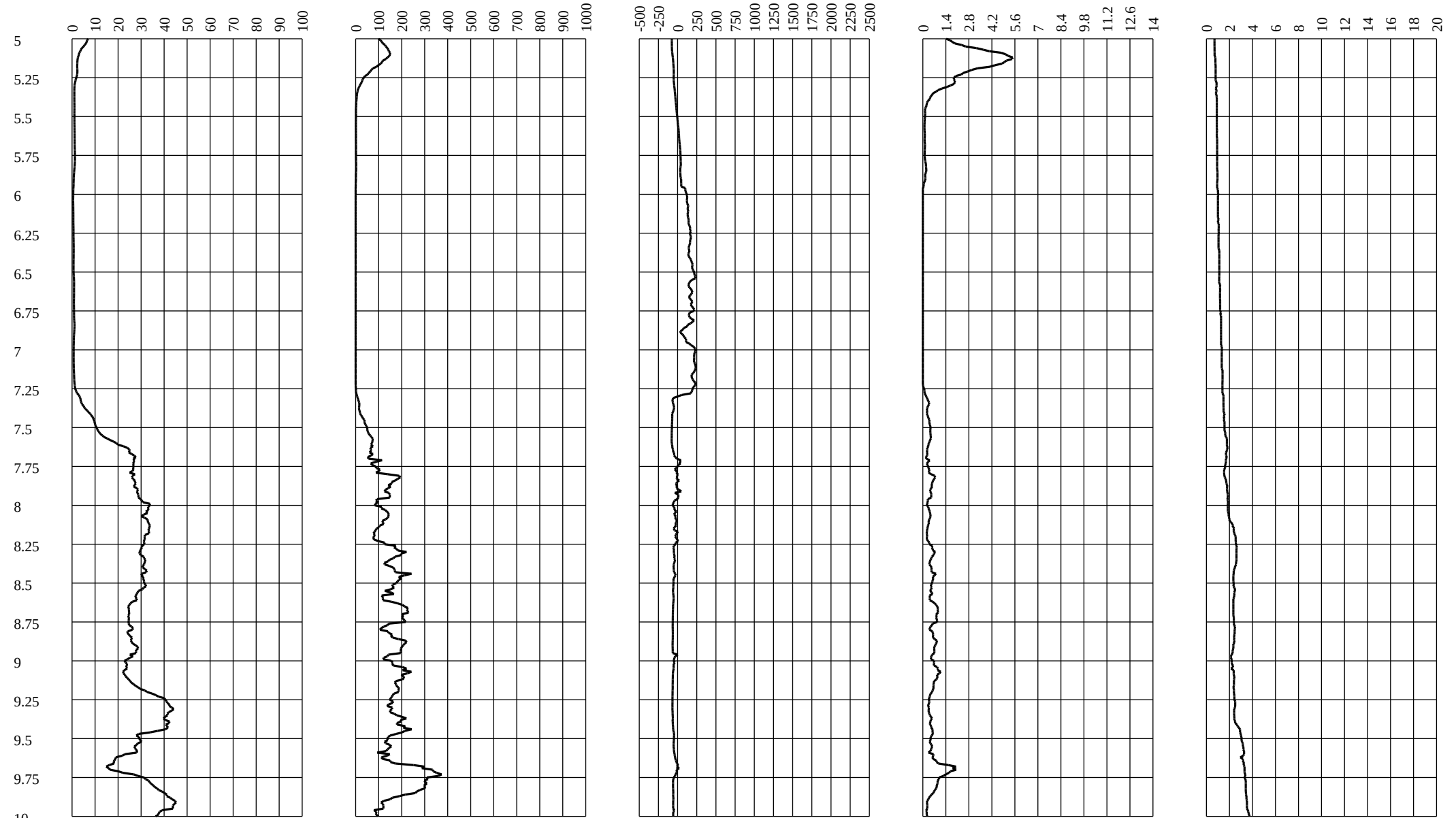
Qc [MPa]

Fs [KPa]

U2 [KPa]

Rf [%]

Tilt [°]



Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 19/08/2025 12:02:00 pm	
Site: Waterloo Station - Test: CPT209	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: s7(2)(a)@websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT209

Location: CPT209

Date: 19/08/2025 12:02:00 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

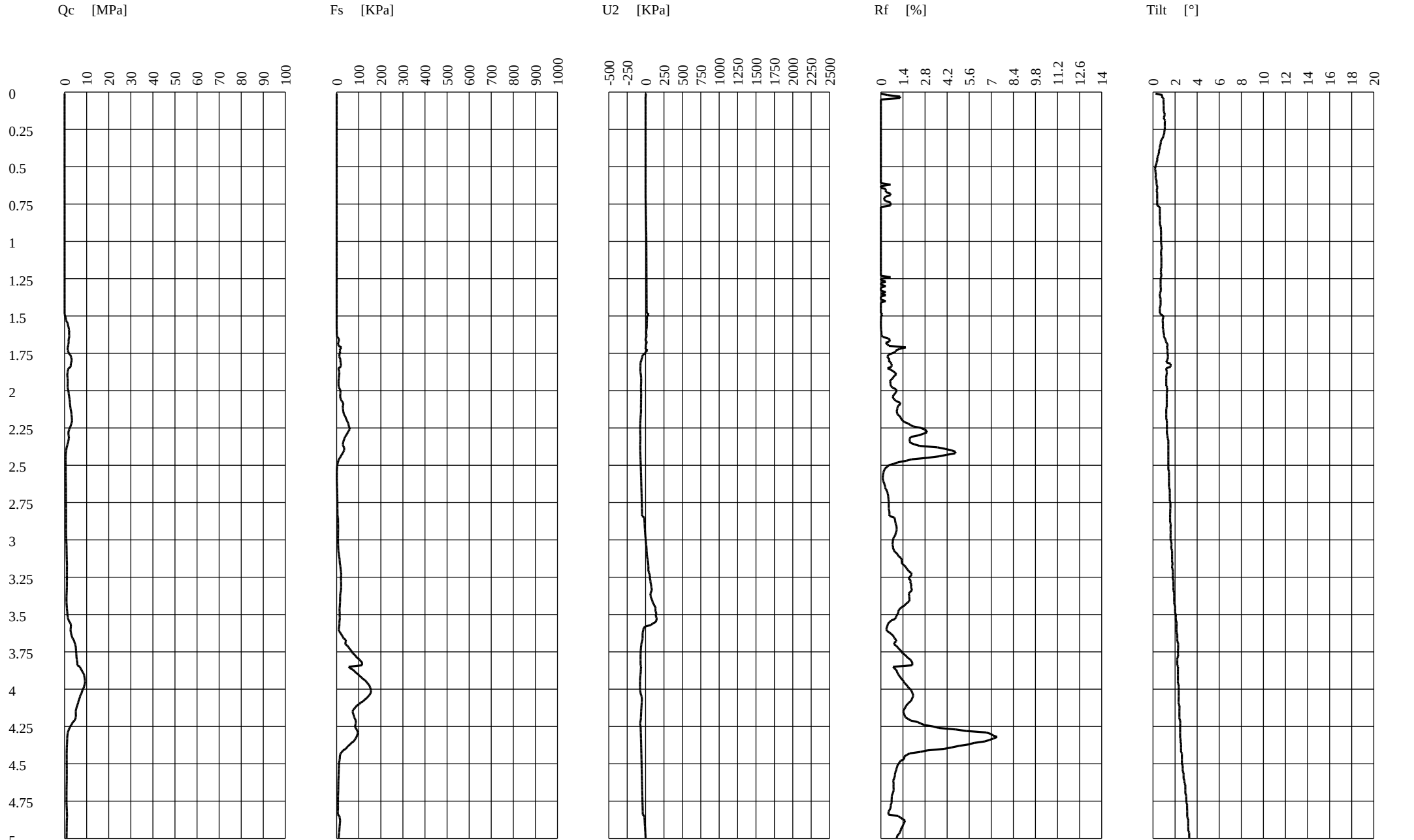
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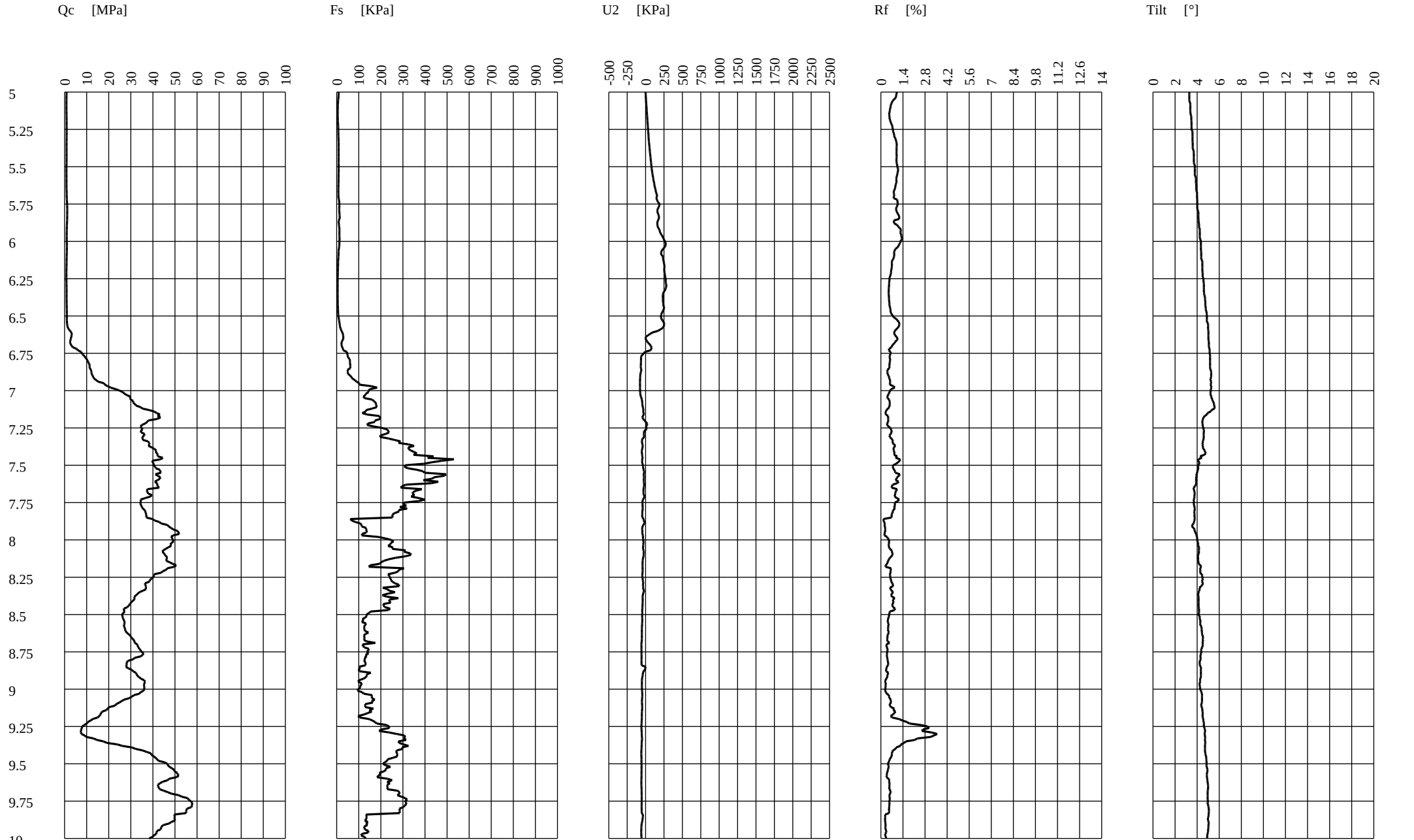
Longitude: 174.920433

Operator: s7(2)(a)

Comments: Jet Vac to 1.5m

Probe code: Mks680





Webster Drilling & Exploration Ltd	
Cone Penetration Test (CPTU) - Date: 13/08/2025 12:13:39 pm	
Site: Waterloo Station - Test: CPT210	

Company information

Name: Webster Drilling & Exploration Ltd

Address: 10 Raiha Street

Zip code: 5024

City: Porirua

P.IVA:

E-Mail: s7(2)(a)@websterdrilling.com

Phone number: 042375264

Fax number:

Site information

Name: Waterloo Station

Date: 27/08/2025

Commissioner: Tonkin & Taylor

Locality: Wellington

Test information

Name: CPT210

Location: CPT210

Date: 13/08/2025 12:13:39 pm

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 0

Ground level [cm]: 0

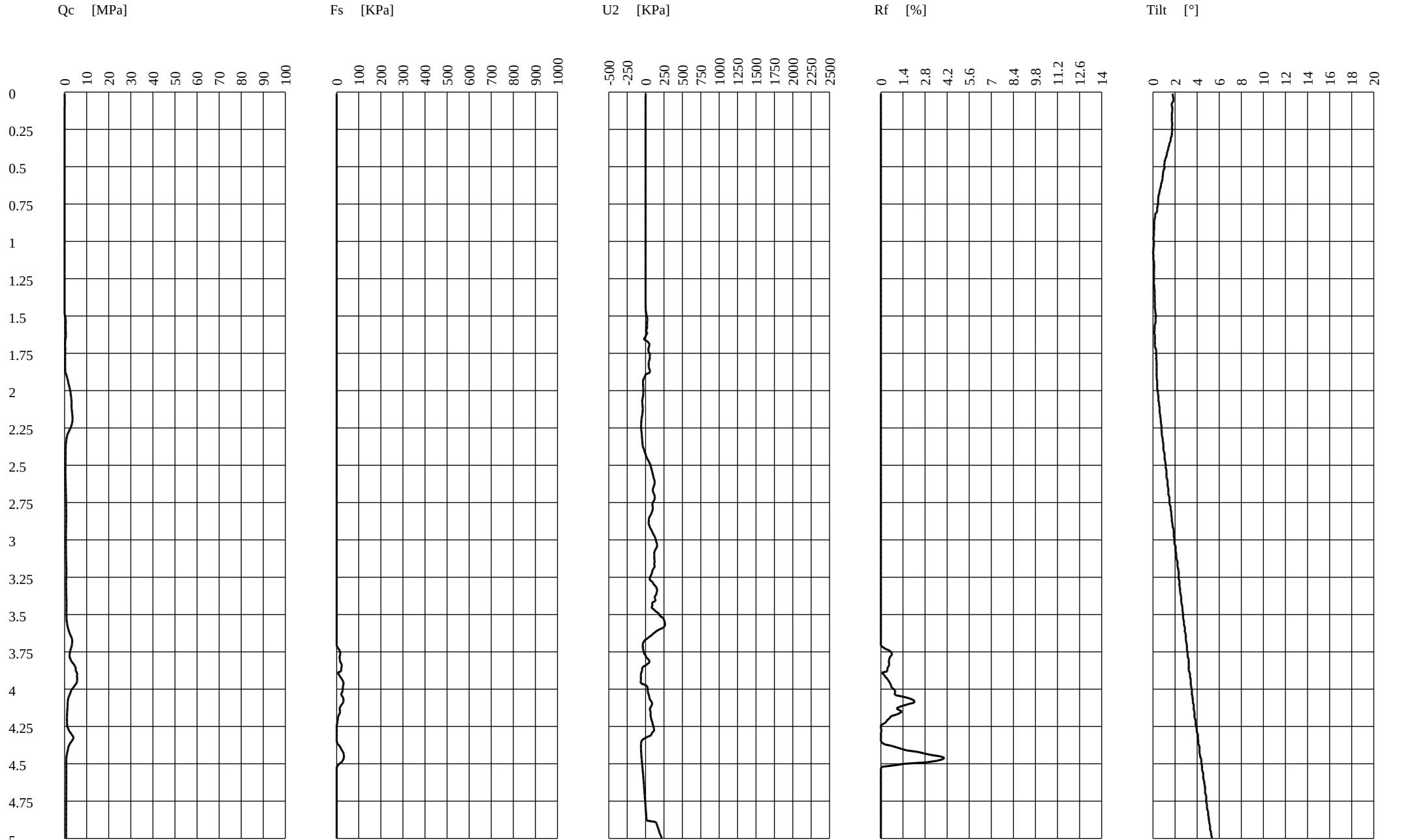
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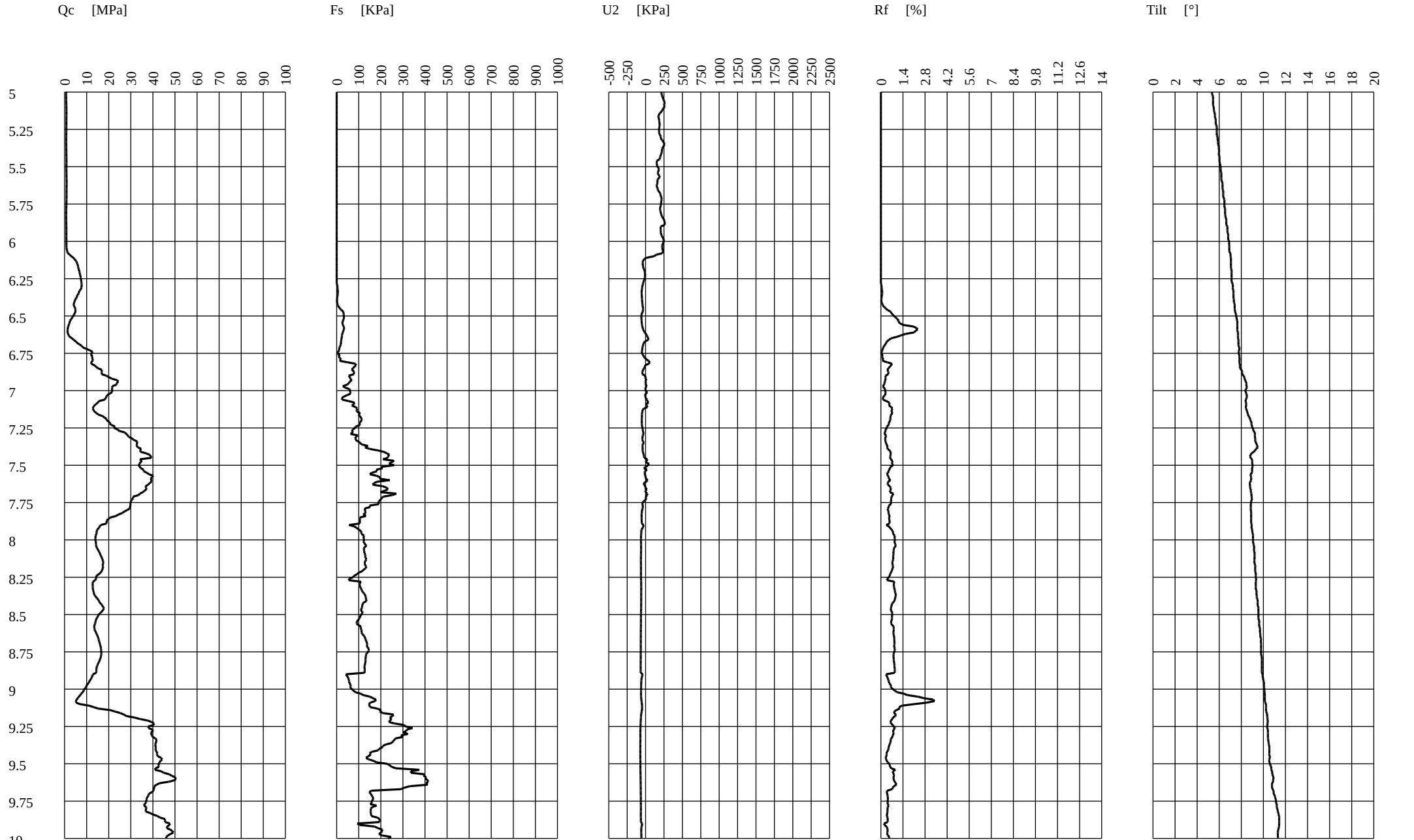
Longitude: 174.920602

Operator: s7(2)(a)

Comments: Jet Vac to 1.5m

Probe code: Mks680





Appendix D Laboratory tests

- Table D1: Summary of cyclic triaxial test results
- Table D2: Summary of particle size distribution test results
- Table D3: Summary of Atterberg limits test results
- Laboratory Test Reports

Table E1: Summary of cyclic triaxial test results

Borehole	Depth (m)	Initial unit weight (kN/m ³)	Effective consolidation pressure (kPa)	Initial water content (%)	Final water content (%)	Target CSR	Cyclic axial stress at CSR (kPa)	No. of cycles to 5% DA axial strain	No. of cycles to $U_{cyc} / \sigma'_{30} = 0.95$
BH101	3.0 to 3.45	19.1	50	27.5	26.8	0.67	67	2 ⁽¹⁾	NA
BH101	3.0 to 3.45	19.2	50	25.2	23.9	0.37	37	20 ⁽²⁾	NA
BH101	3.65 to 4.1	19.7	55	23	22.8	0.47	51.7	9 ⁽³⁾	6
BH101	3.65 to 4.1	19.7	55	24.3	23.4	0.26	28.6	NA	NA

Note 1) After liquefaction was observed ($\epsilon_{DA} = 5\%$), the specimen was subjected to strain-controlled monotonic load to about 5% axial strain at rate of 0.01 mm/sec.

Note 2) The specimen reached 5% double amplitude axial stain after 20 cycles of loading. The cyclic test was terminated after 30 cycles of loading. After cyclic test, the specimen was subjected to strain-controlled monotonic load to failure (i.e. large deformation) at rate of 0.01 mm/sec.

Note 3) The specimen reached 5% double amplitude axial stain after 9 cycles of loading. The cyclic test was terminated after about 12 cycles of loading. After the cyclic test, the specimen was subjected to strain-controlled monotonic load to failure (i.e., large deformation) at a rate of 0.01 mm/sec. In order to overcome the problem of different starting points for post-cyclic monotonic loading, the initial height of the specimen before cyclic loading was considered as the basis for calculating the axial strain for data processing; i.e., zero (0%) axial strain correlated with the initial height of the specimen before cyclic loading; a negative axial strain as a starting point had the post-cyclic monotonic loading start when the specimen was in extension condition.

Note 4) The cyclic test was performed for about 21 cycles. After the cyclic test, the specimen was subjected to strain-controlled monotonic load to failure (i.e., large deformation) at a rate of 0.01 mm/sec. This was done to understand residual strength following dynamic loading but without triggering cyclic softening.

Table E2: Summary of particle size distribution test results

Borehole	Depth (m)	Sample description	Water content (%)	Cobbles (>63mm)	Gravel (2mm to 63mm)	Sand (63micron to 2mm)	Fines (<75micron)	Fines (<63micron)
BH104	8.5 to 9.0	Sand	23.5	-	14	70	18	16
BH101	3.0 to 3.45	Clayey SILT with minor sand	23.9	0	0	6	95	94
BH101	3.0 to 3.45	Clayey SILT with minor sand	19.9	0	0	9	94	91
BH101	3.0 to 3.45A	Clayey SILT with trace sand	20.3	0	0	8	95	92
BH101	3.65 to 4.1B	Clayey SILT with minor sand	22.6	0	0	10	93	90
BH101	7.5 to 8.0	Sandy SILT	38	0	0	34	71	66

Table E3: Summary of Atterberg limits testing results ⁽¹⁾

Borehole	Depth (m)	Sample description	Soil fraction tested	Liquid Limit	Plastic Limit	Plasticity Index
BH101	3.0 to 3.45 (A)	Clayey SILT, minor sand	-425micron	29	19	10
BH101	3.0 to 3.45 (B)	Clayey SILT, minor sand	-425micron	24	18	6
BH101	3.65 to 4.1 (A)	Clayey SILT, trace sand	-425micron	24	18	6
BH101	3.65 to 4.1 (B)	Clayey SILT, minor sand	-425micron	26	20	6

Note 1) Testing not accredited due to samples being oven dried prior to testing. Water content not included in report due to rewetting of samples.

Cyclic triaxial test for WSP OPUS**(Waterloo WTP Project)****Test 1 (BH-101, 3.0 - 3.45 m)**

Auckland UniServices Limited

70 Symonds St, Auckland 1142

Sample: BH-101, 3.0 - 3.45m	Depth (m): 3.0 – 3.45m	Formation: -
Test start: 19 August 2019	Test end: 22 August 2019	Initial mass (gr): 729.2
Initial length (mm): 126	Initial diameter (mm): 61.4	Initial unit weight (kN/m ³): 19.1
Effective consolidation pressure (kPa): 50		Consolidation volume change (ml): 7.5
Initial water content (%): 27.5		Final water content (%): 26.8
Target CSR: 0.67		Cyclic axial stress at CSR (kPa): 67
Number of cycles to 5% DA axial strain: 2		Number of cycles to $U_{cyc} / \sigma'_{30} = 0.95$: NA
Test performed by: s7(2)(a)		Apparatus: Geomechanics lab MTS810
Comments: After saturation and consolidation stages, the specimen was subjected to stress-controlled cyclic loading with frequency of 0.1 Hz. After liquefaction was observed ($\varepsilon_{DA} = 5\%$), the specimen was subjected to strain-controlled monotonic load to about 5% axial strain at rate of 0.01 mm/sec. <u>Minor Incident:</u> During the consolidation stage, the data acquisition system did not save the data for unknown reasons; hence, in this report, a snapshot of the volume change versus time plot is taken from the data acquisition software (as illustrated in Figure 4).		

Photos:

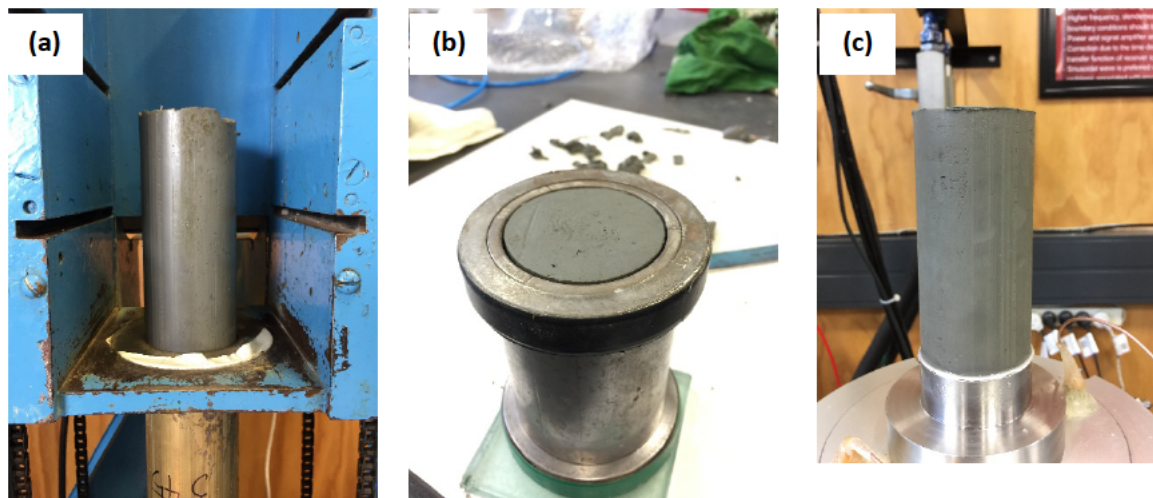


Figure 1: Specimen preparation for the triaxial test: (a) extruding the soil sample using a hydraulic jack; (b) trimming the specimen end inside the mould; (c) set up of specimen in the triaxial cell.

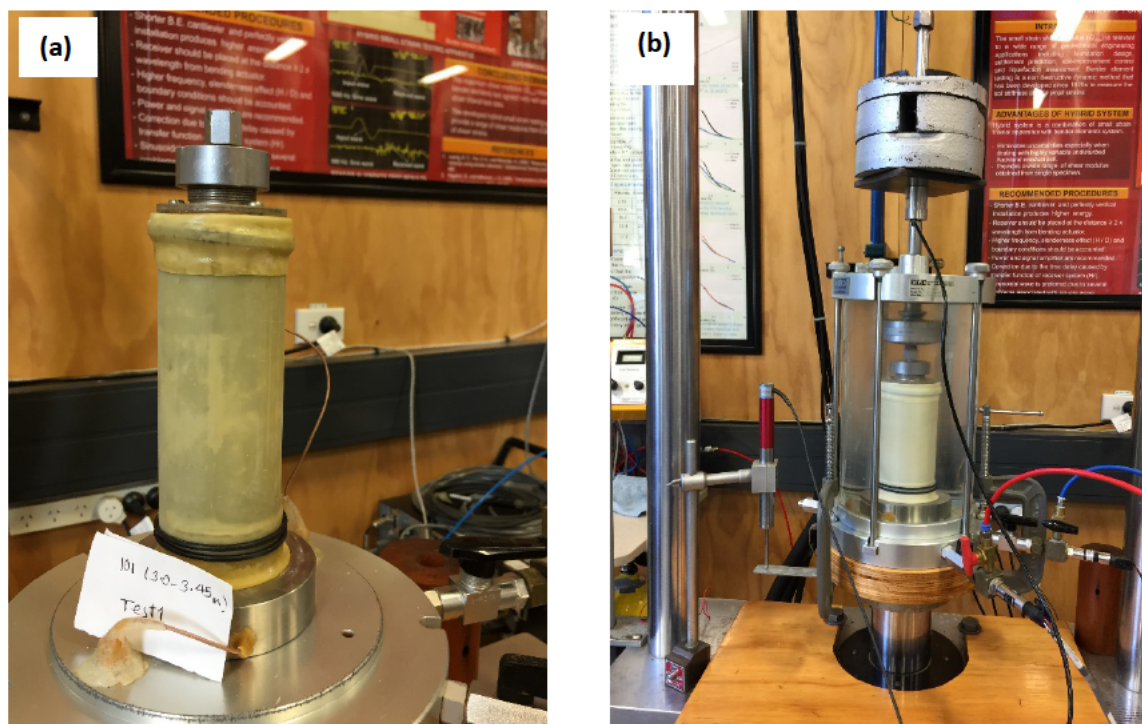


Figure 2: (a) Specimen enclosed with rubber membrane secured to the top cap and pedestal with O-rings; (b) filling the triaxial cell with water.



Figure 3: Condition of the specimen: (a) after undrained cyclic loading and before post-monotonic loading; (b) after post-monotonic loading; (c) after post-monotonic loading without the membrane.

Consolidation stage:

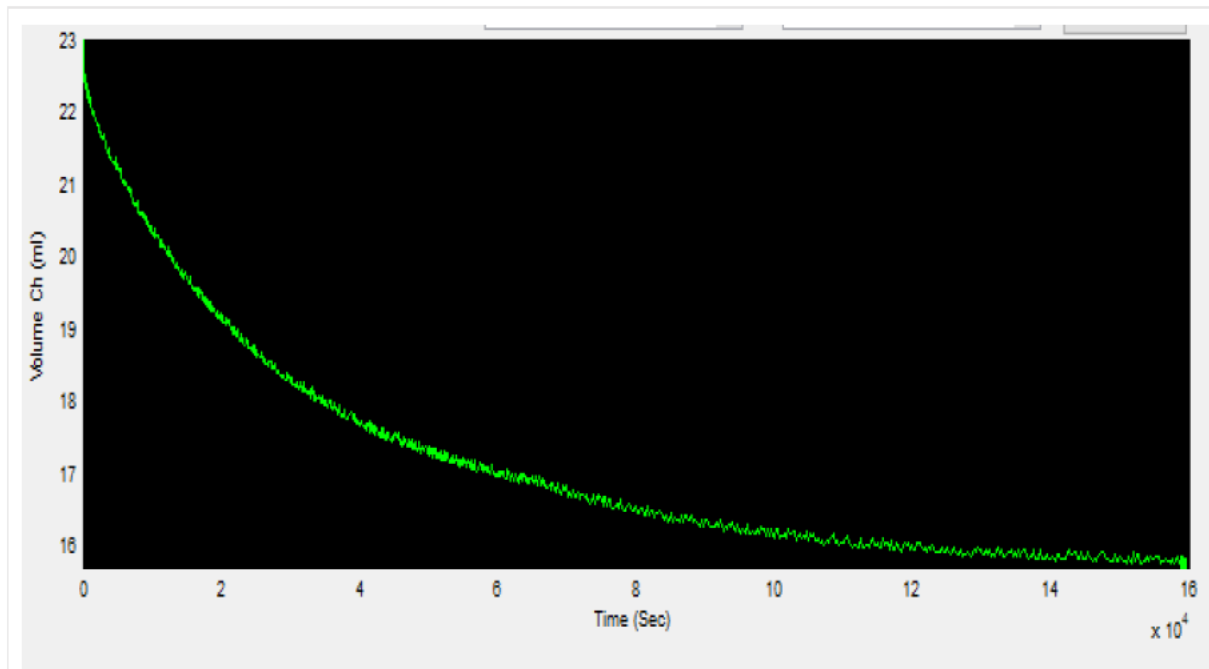


Figure 4: Consolidation volume change vs time.

Cyclic shear stage:

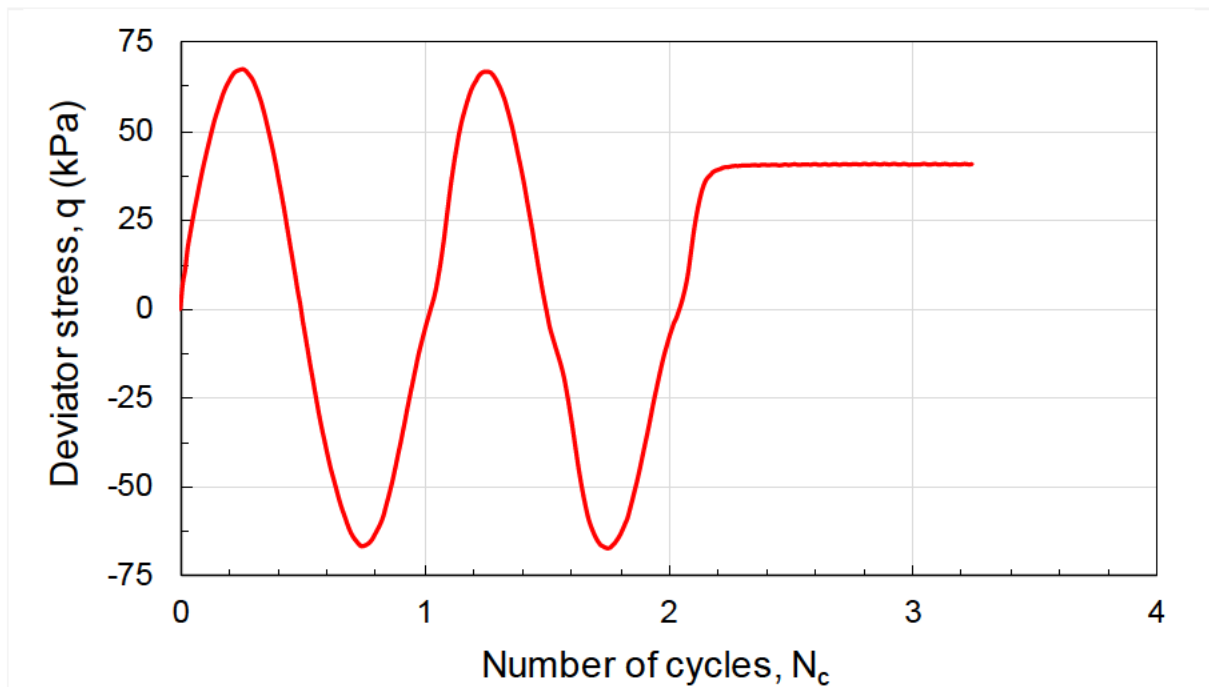


Figure 5: Deviator stress vs number of cycles

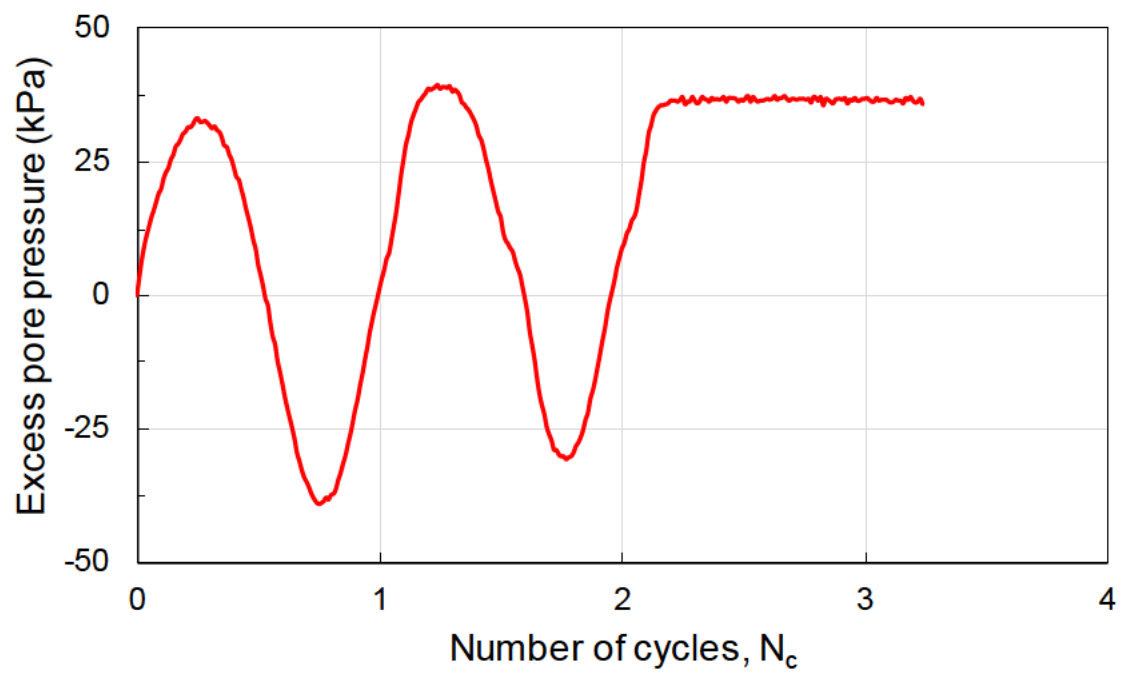


Figure 6: Excess pore water pressure vs number of cycles

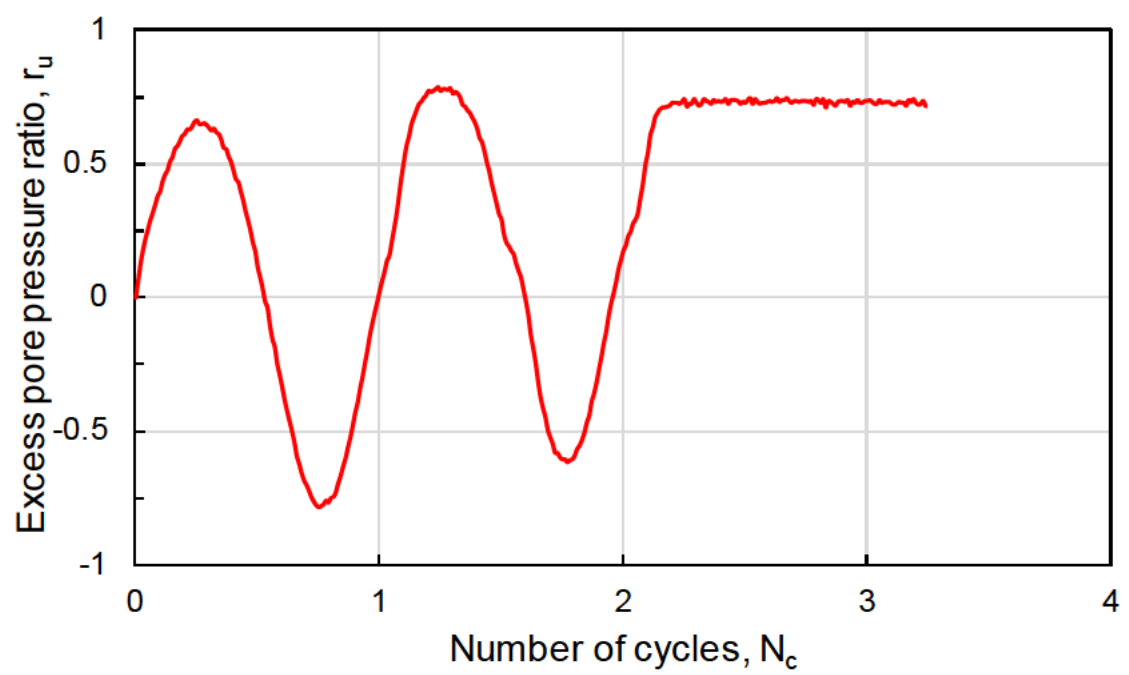


Figure 7: Excess pore water pressure ratio vs number of cycles

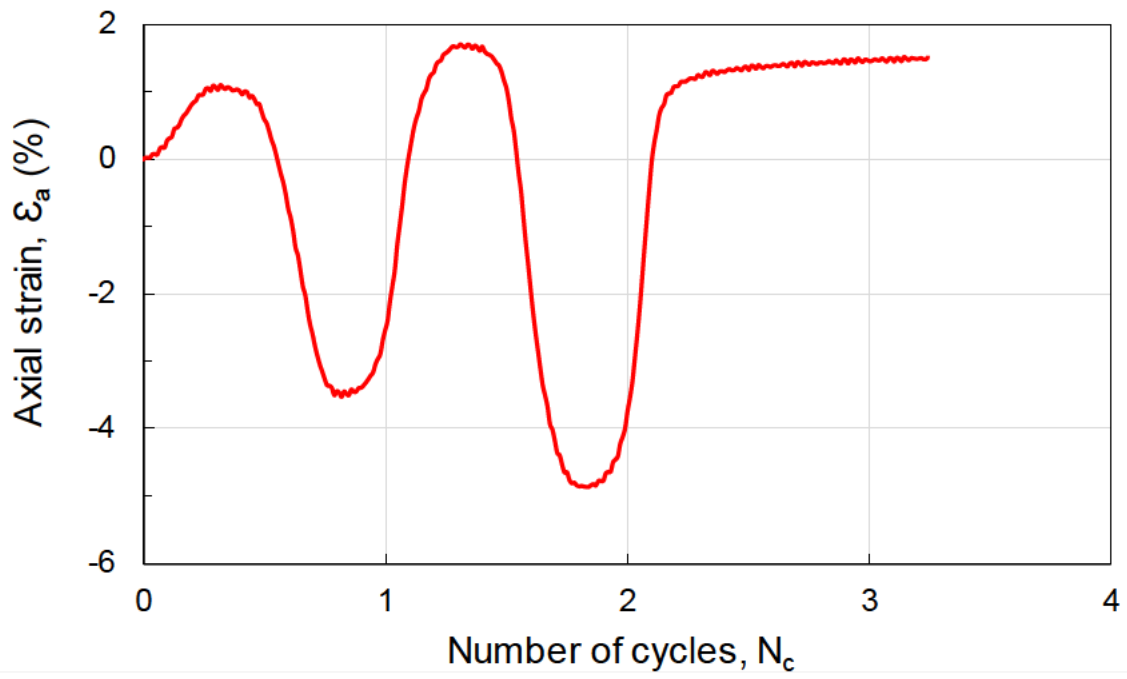


Figure 8: Axial strain vs number of cycles

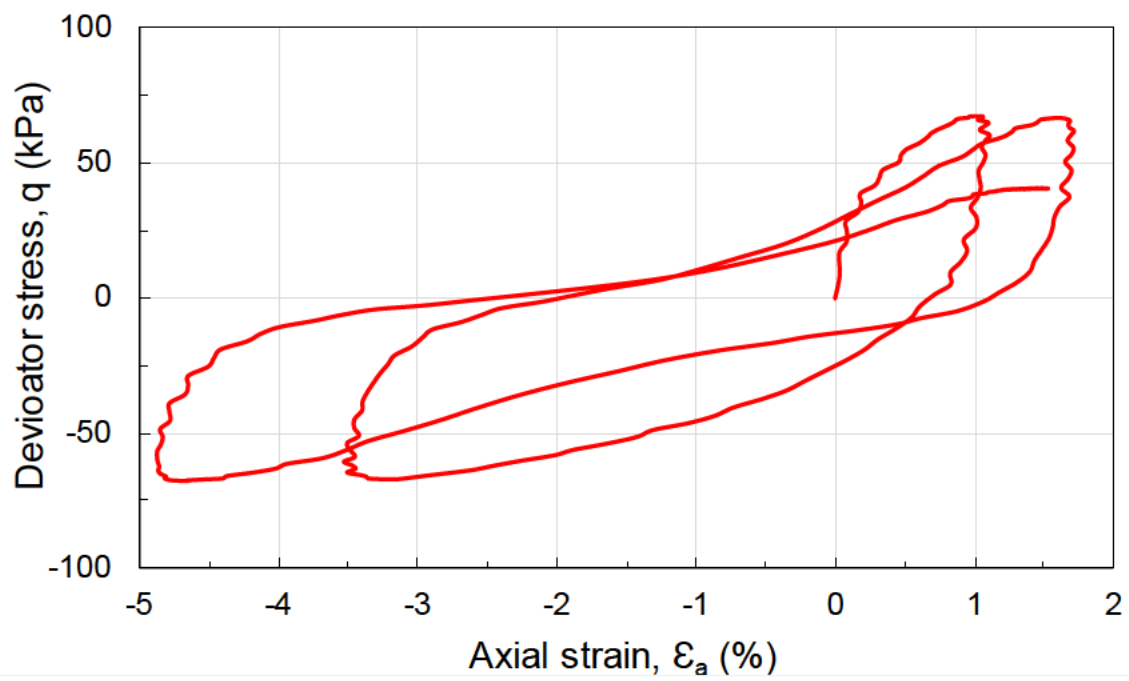


Figure 9: Deviator stress vs axial strain

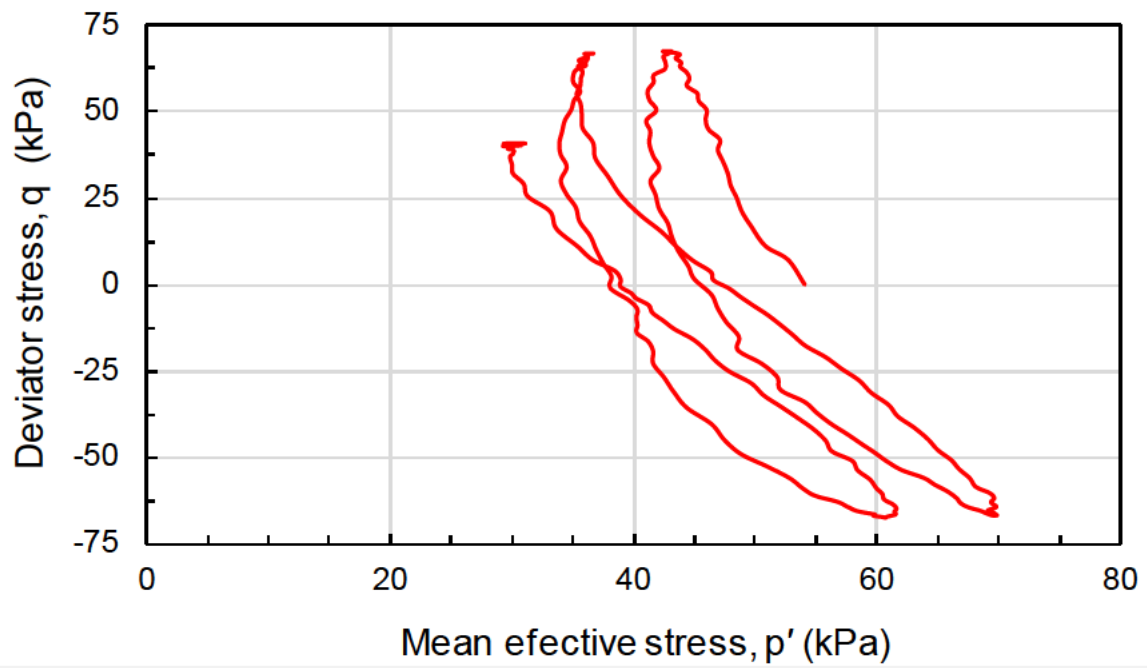


Figure 10: Deviator stress vs mean effective stress

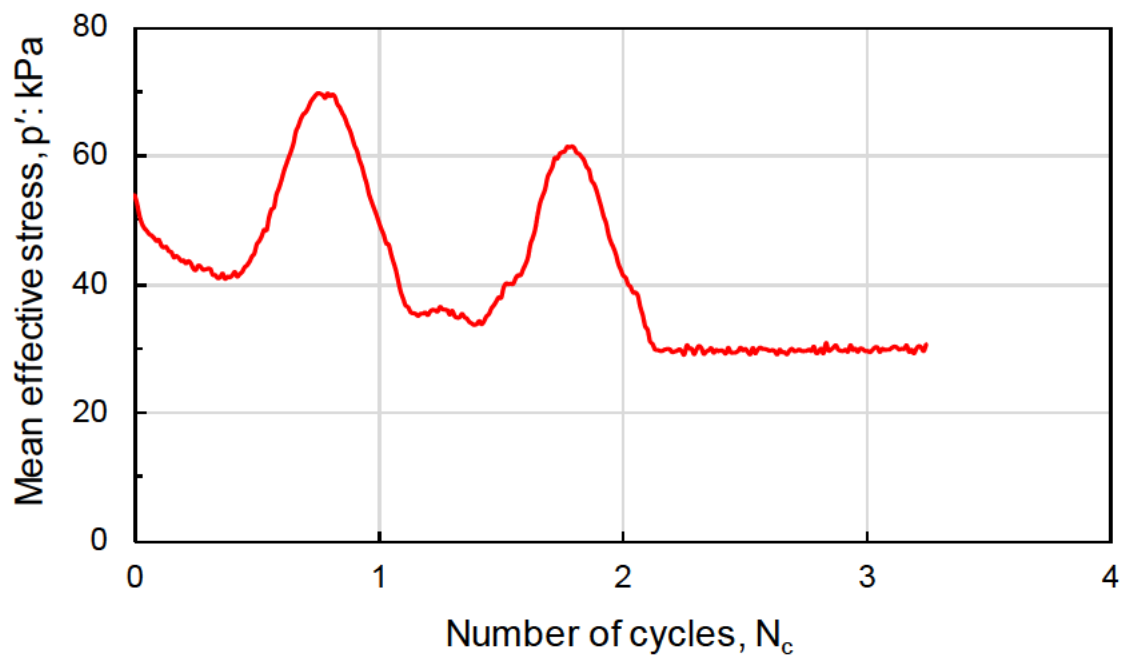


Figure 11: Mean effective stress vs number of cycles.

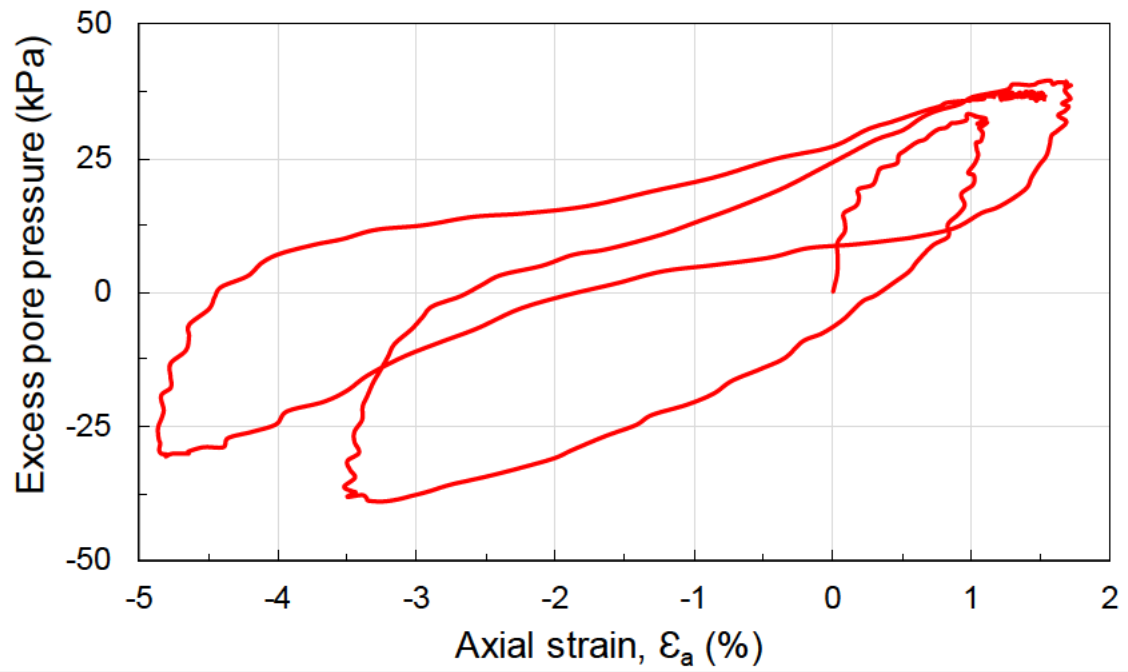


Figure 12: Excess pore water pressure vs axial strain

Post-cyclic monotonic shear stage:

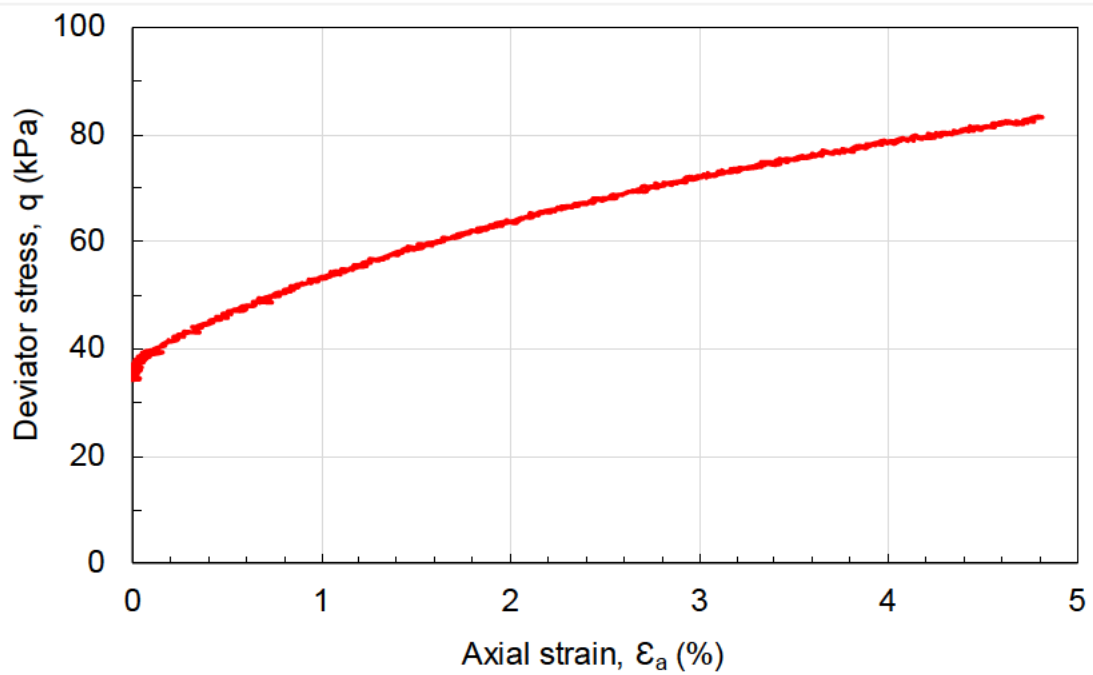


Figure 13: Deviator stress vs axial strain

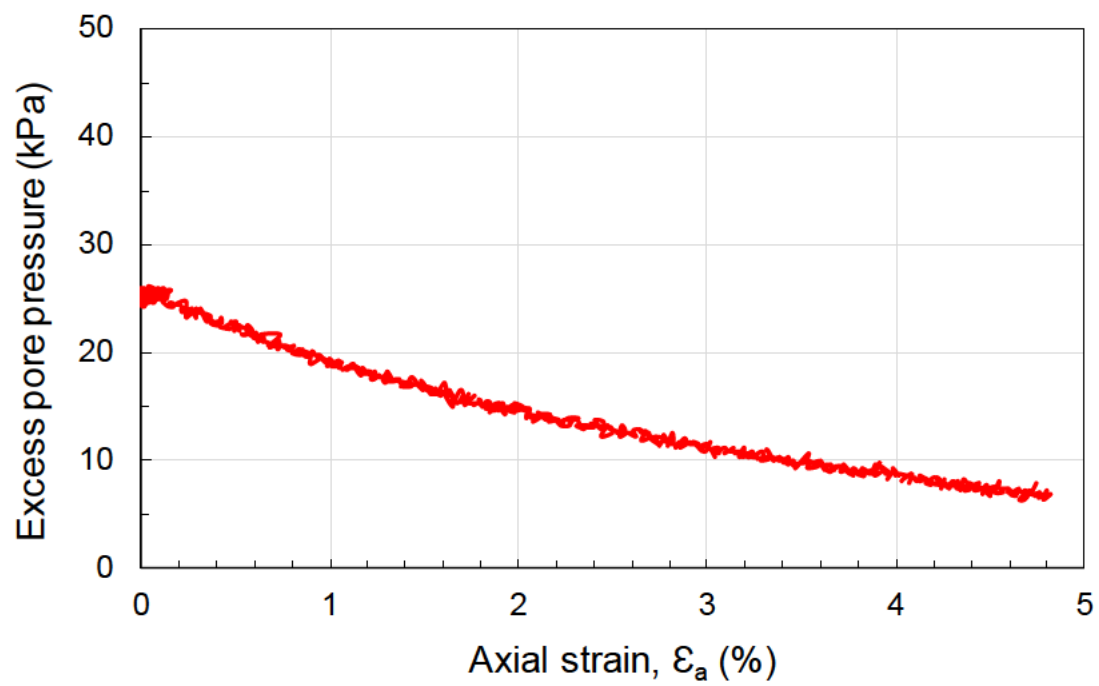


Figure 14: Excess pore water pressure vs axial strain

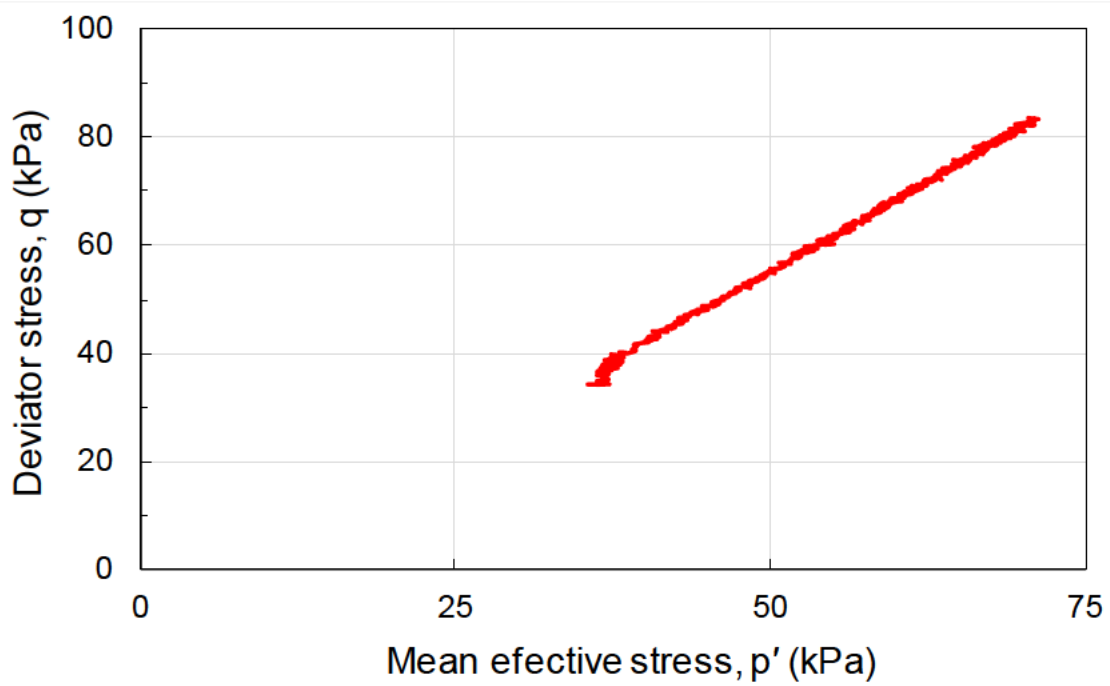


Figure 15: Post-cyclic stress path

Cyclic triaxial test for WSP OPUS**(Waterloo WTP Project)****Test 2 (BH-101, 3.0 - 3.45 m)**

Auckland UniServices Limited

70 Symonds St, Auckland 1142

Sample: BH-101, 3.0 - 3.45m	Depth (m): 3.0 - 3.45m	Formation: -
Test start: 22 October 2020	Test end: 27 October 2020	Initial mass (gr): 729.14
Initial length (mm): 126	Initial diameter (mm): 61.5	Initial unit weight (kN/m ³): 19.2
Effective consolidation pressure (kPa): 50		Consolidation volume change (ml): 7.3
Initial water content (%): 25.2		Final water content (%): 23.9
Target CSR: 0.37		Cyclic axial stress at CSR (kPa): 37
Number of cycles to 5% DA axial strain: 20		Number of cycles to $U_{cyc} / \sigma'_{30} = 0.95$: NA
Test performed by: s7(2)(a)		Apparatus: Geomechanics lab MTS810
Comments: After saturation and consolidation stages, the specimen was subjected to stress-controlled cyclic loading with frequency of 0.1 Hz. The specimen reached 5% double amplitude axial stain after 20 cycles of loading. The cyclic test was terminated after 30 cycles of loading. After cyclic test, the specimen was subjected to strain-controlled monotonic load to failure (i.e. large deformation) at rate of 0.01 mm/sec.		

Photos:

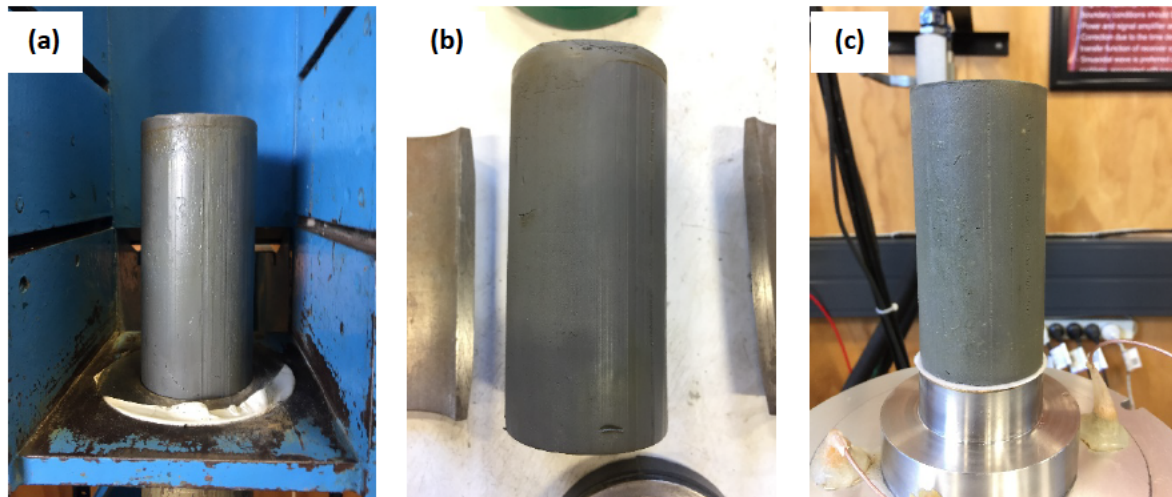


Figure 1: Specimen preparation for the triaxial test: (a) extruding the soil sample using a hydraulic jack; (b) trimming the specimen end inside the mould; (c) set up of specimen in the triaxial cell

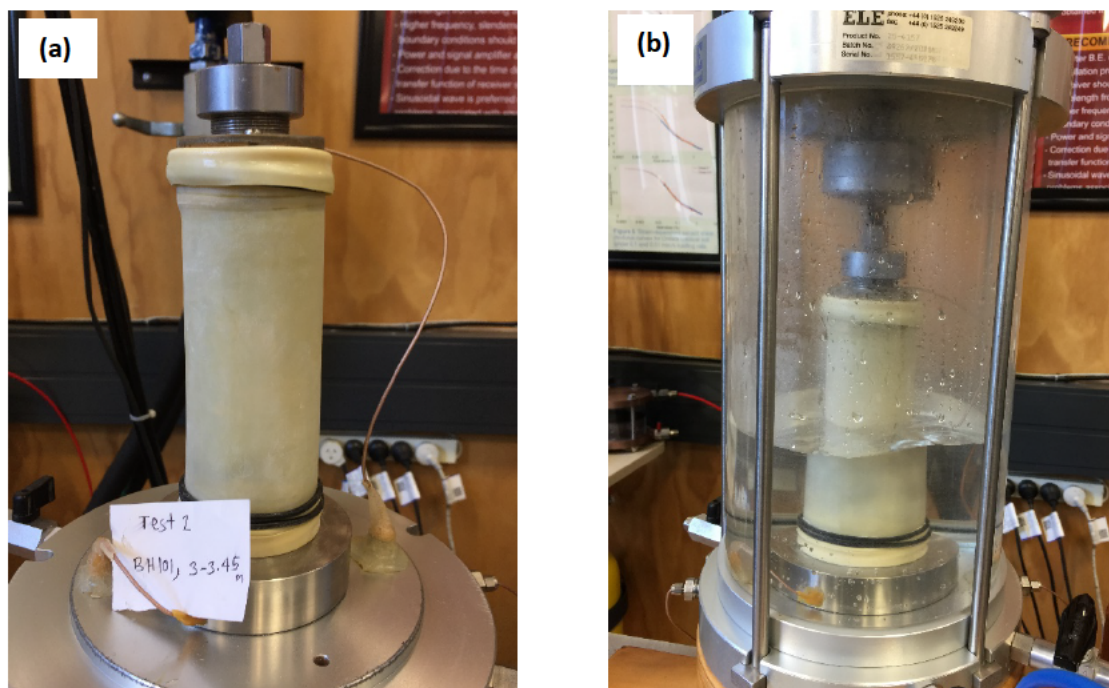


Figure 2: (a) Specimen enclosed with rubber membrane secured to the top cap and pedestal with O-rings; (b) filling the triaxial cell with water.

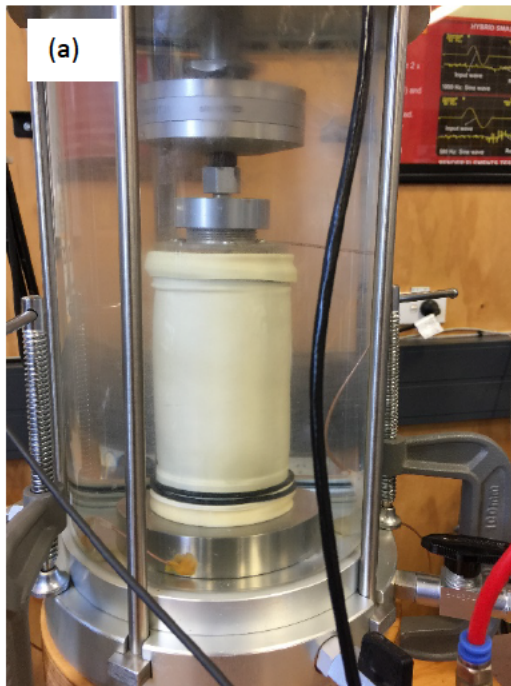


Figure 3: Condition of the specimen (a) after undrained cyclic loading and before post-monotonic loading; (b) after post-monotonic loading; (c) after post-monotonic loading without the membrane.

Consolidation stage:

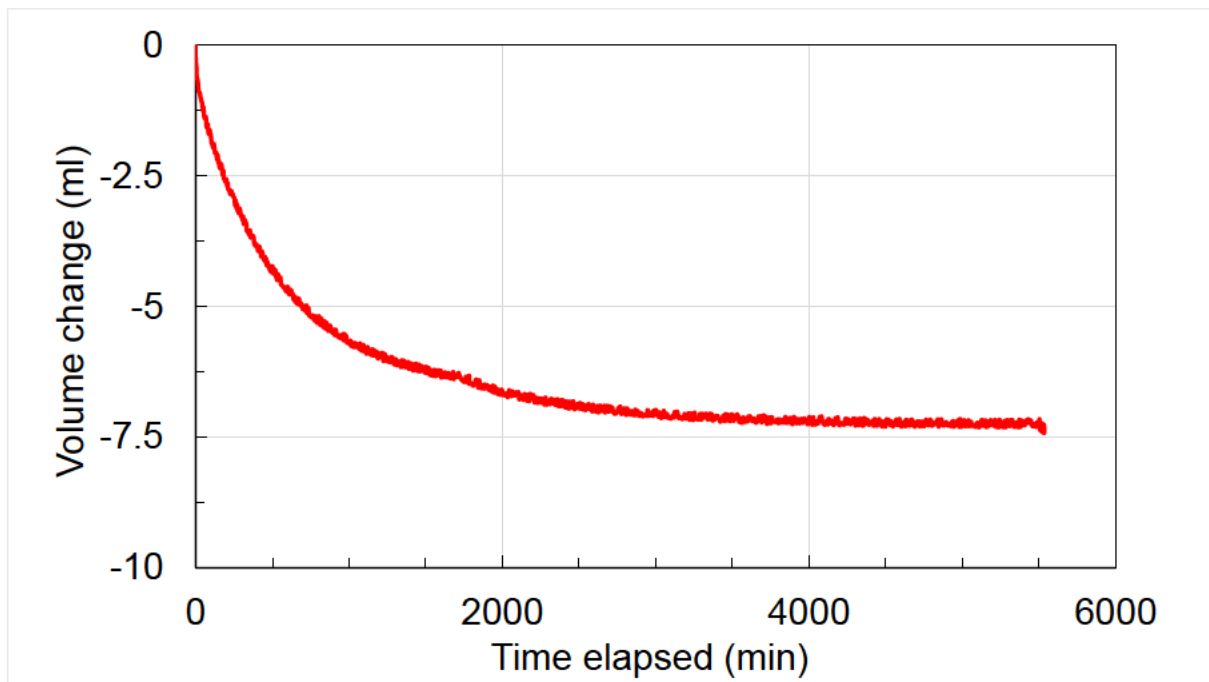


Figure 4: Consolidation volume change vs time.

Cyclic shear stage:

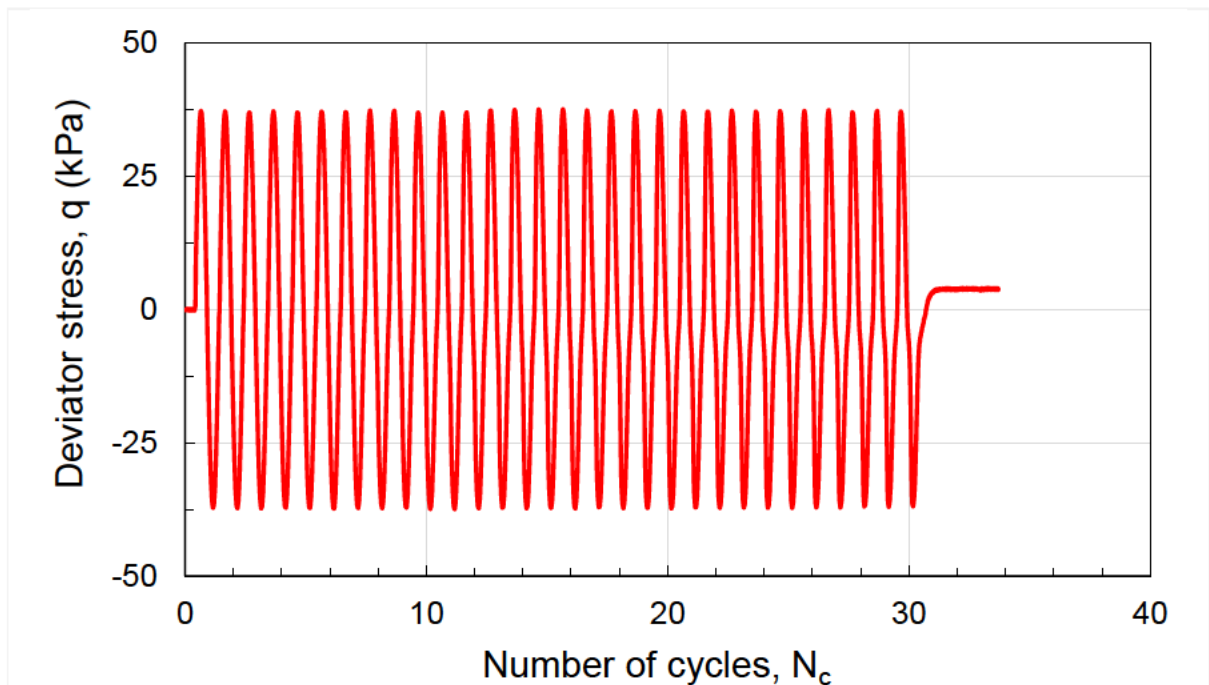


Figure 5: Deviator stress vs number of cycles

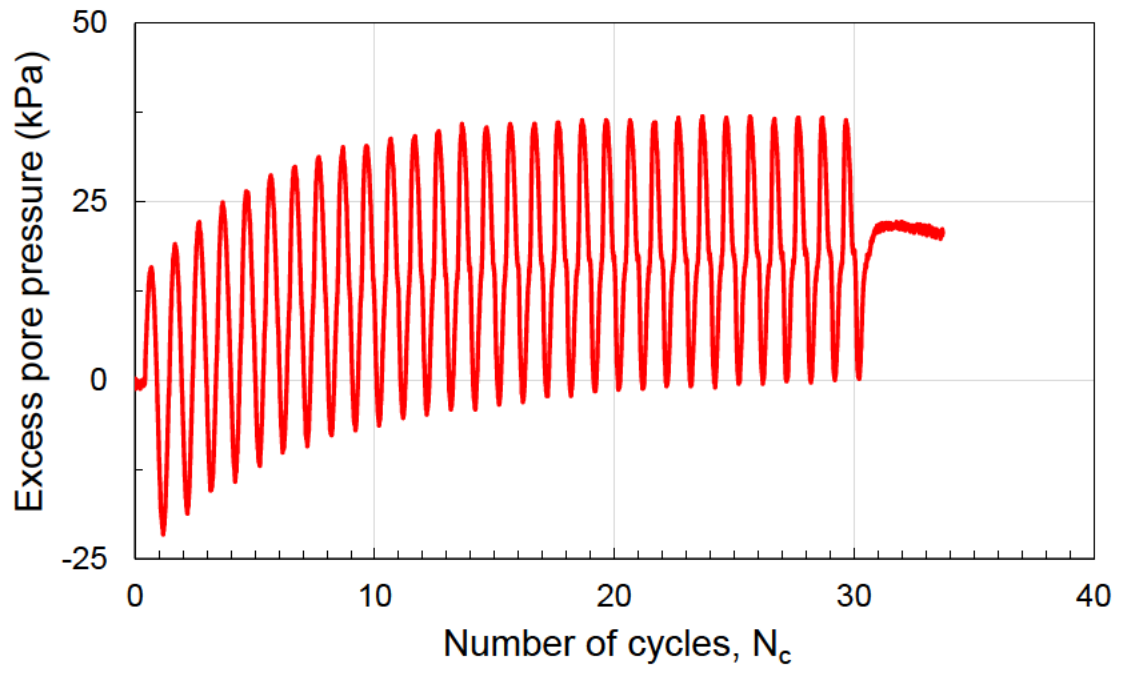


Figure 6: Excess pore water pressure vs number of cycles

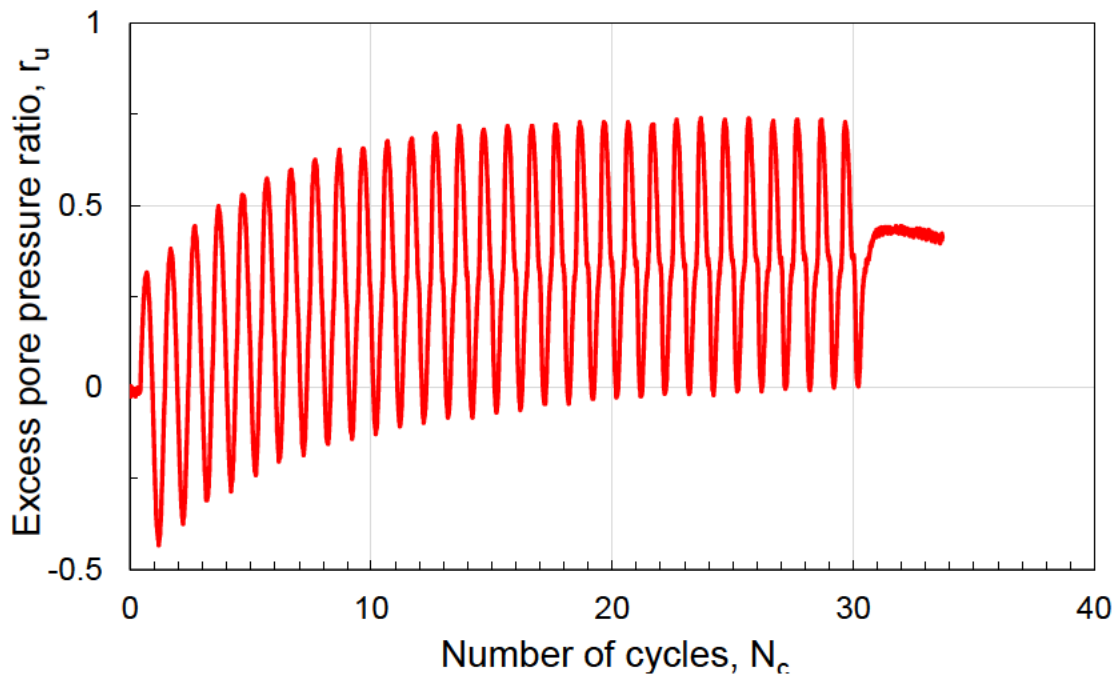


Figure 7: Excess pore water pressure ratio vs number of cycles

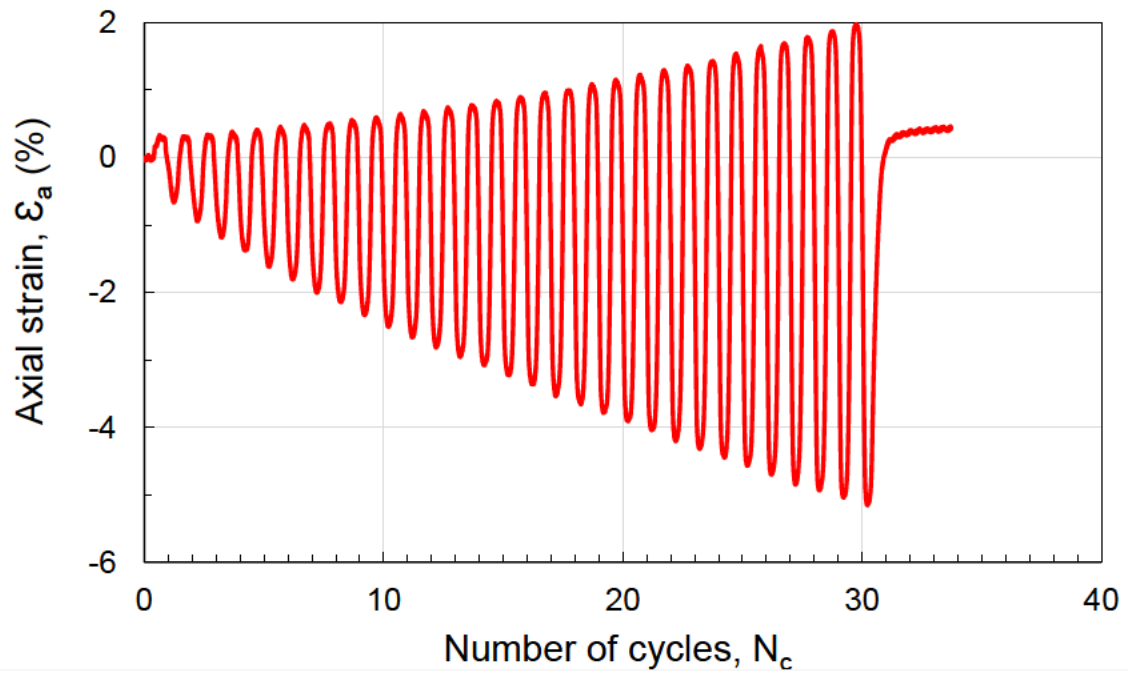


Figure 8: Axial strain vs number of cycles

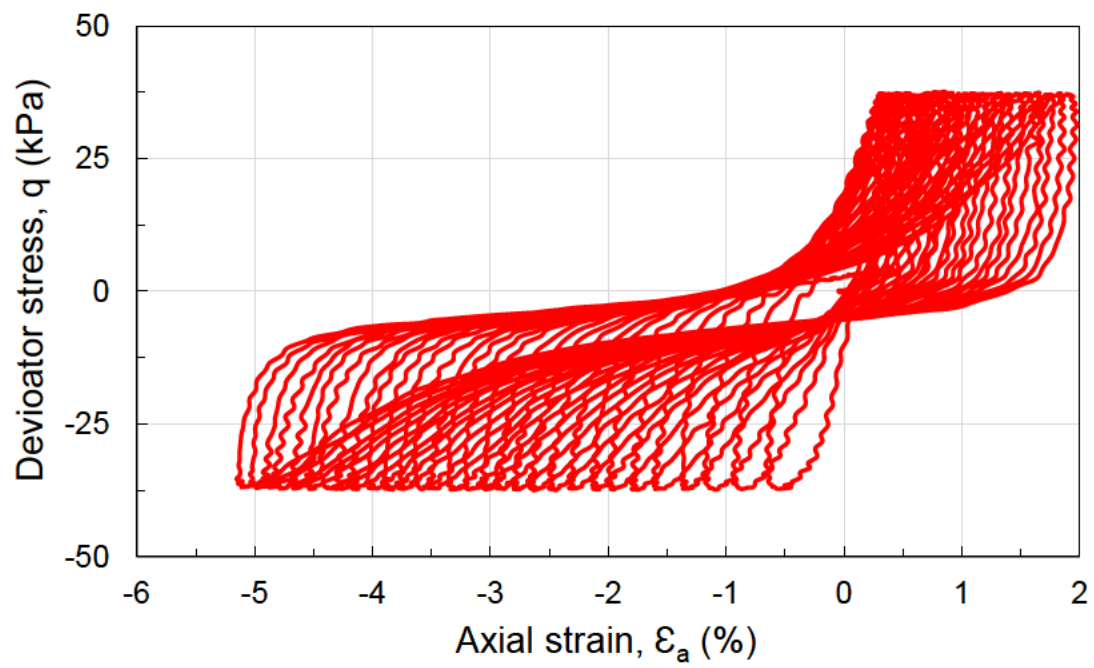


Figure 9: Deviator stress vs axial strain

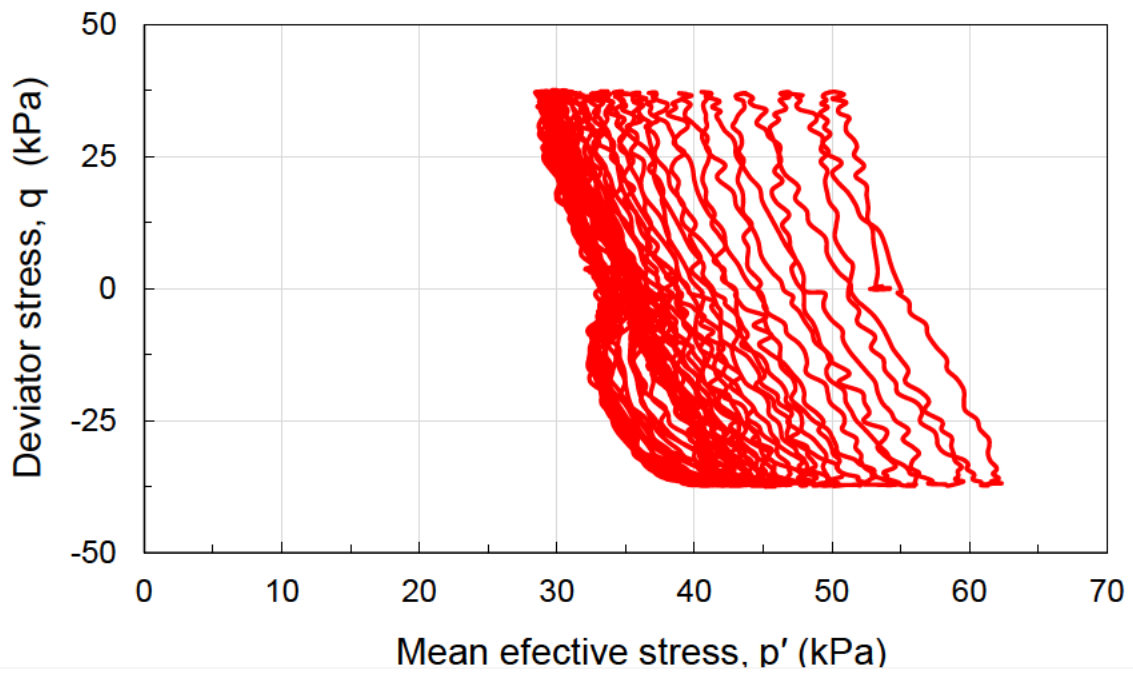


Figure 10: Deviator stress vs mean effective stress

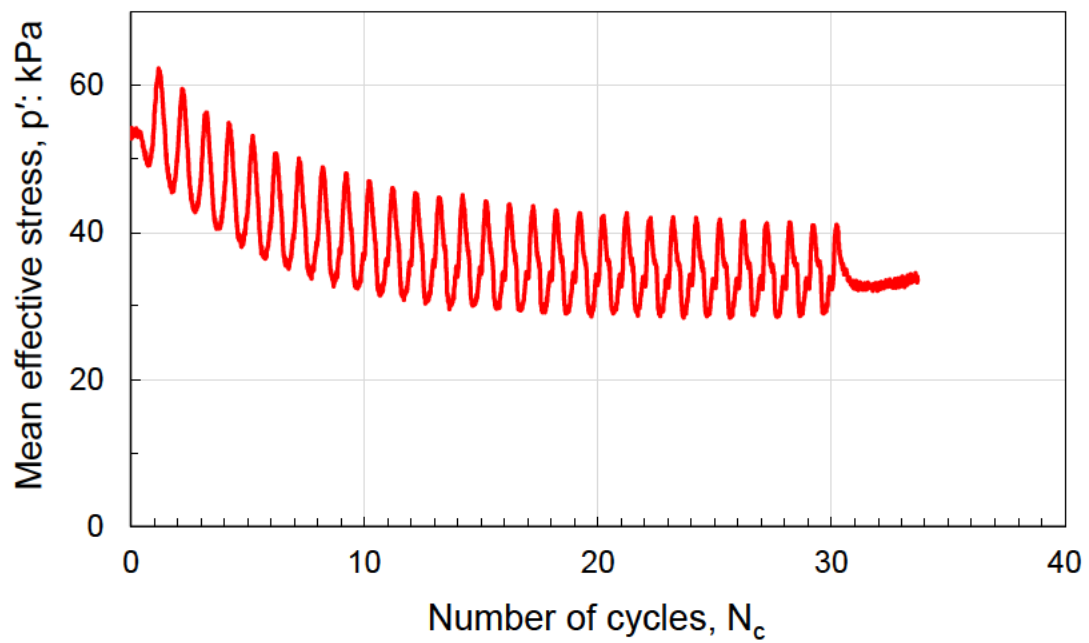


Figure 11: Mean effective stress vs number of cycles.

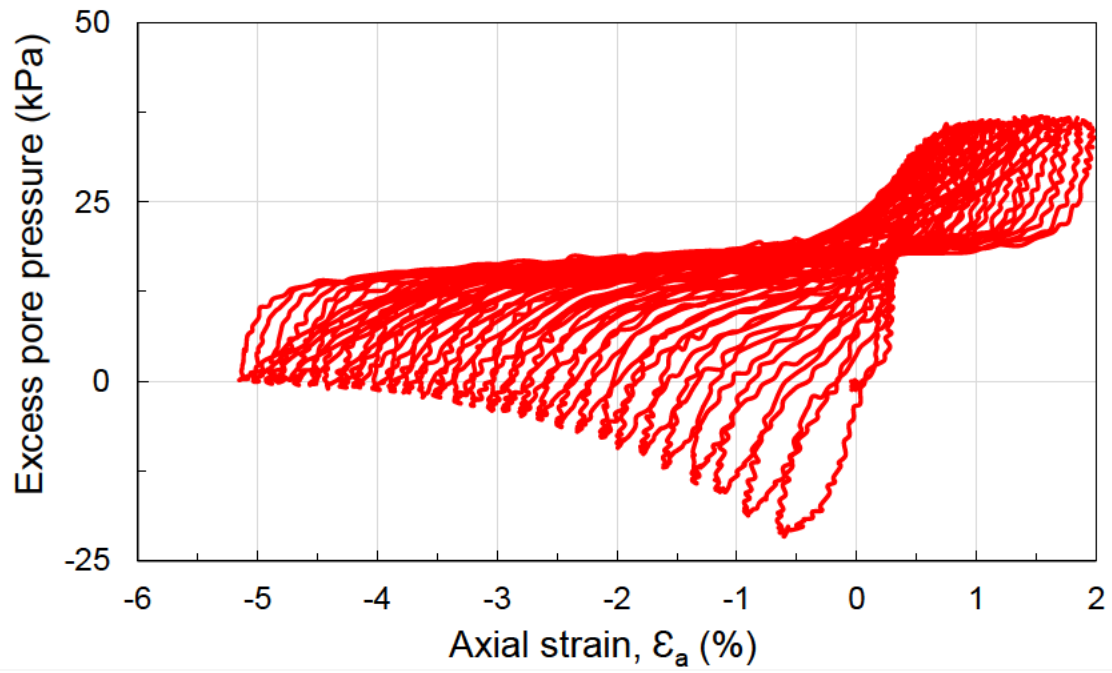


Figure 12: Excess pore water pressure vs axial strain

Post-cyclic monotonic shear stage:

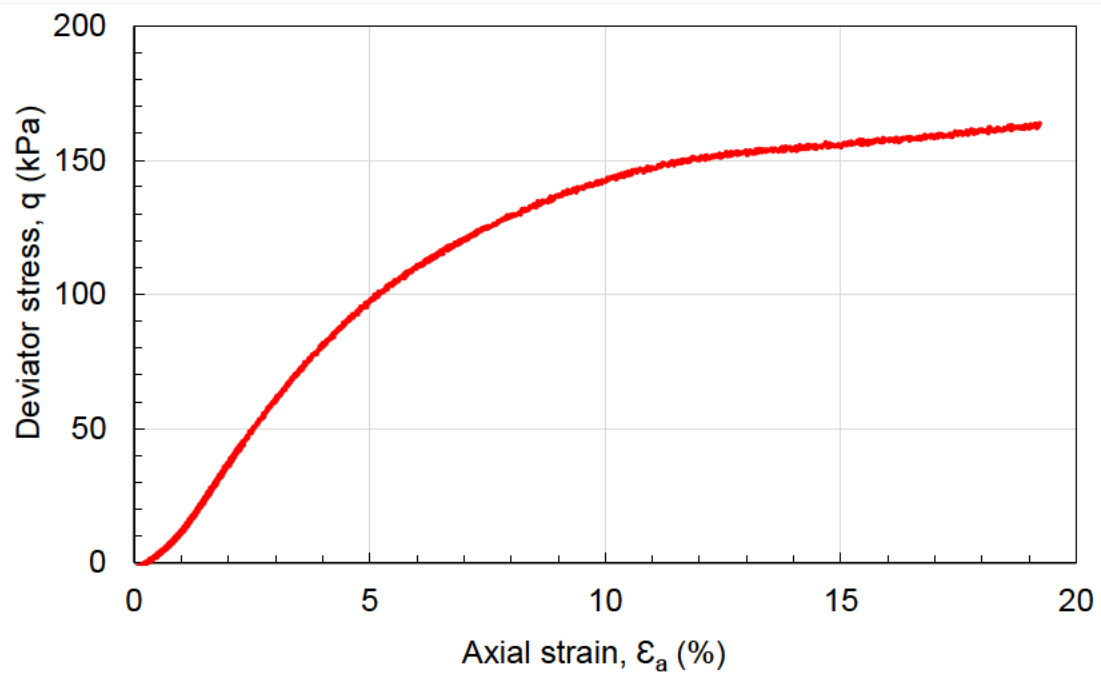


Figure 13: Deviator stress vs axial strain

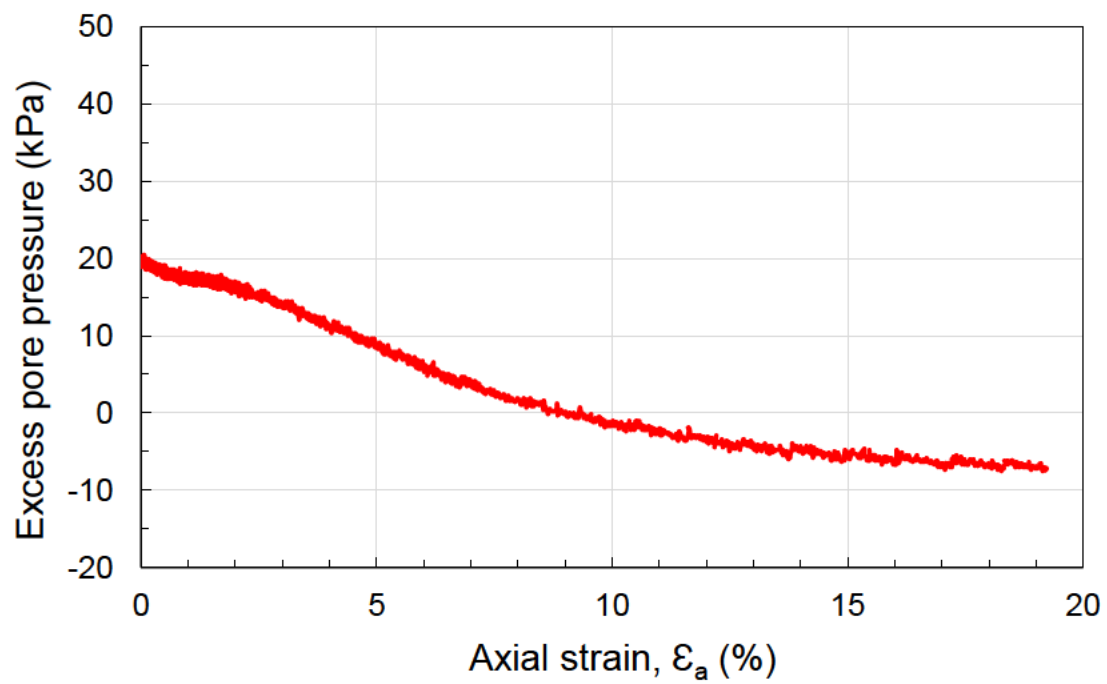


Figure 14: Excess pore water pressure vs axial strain

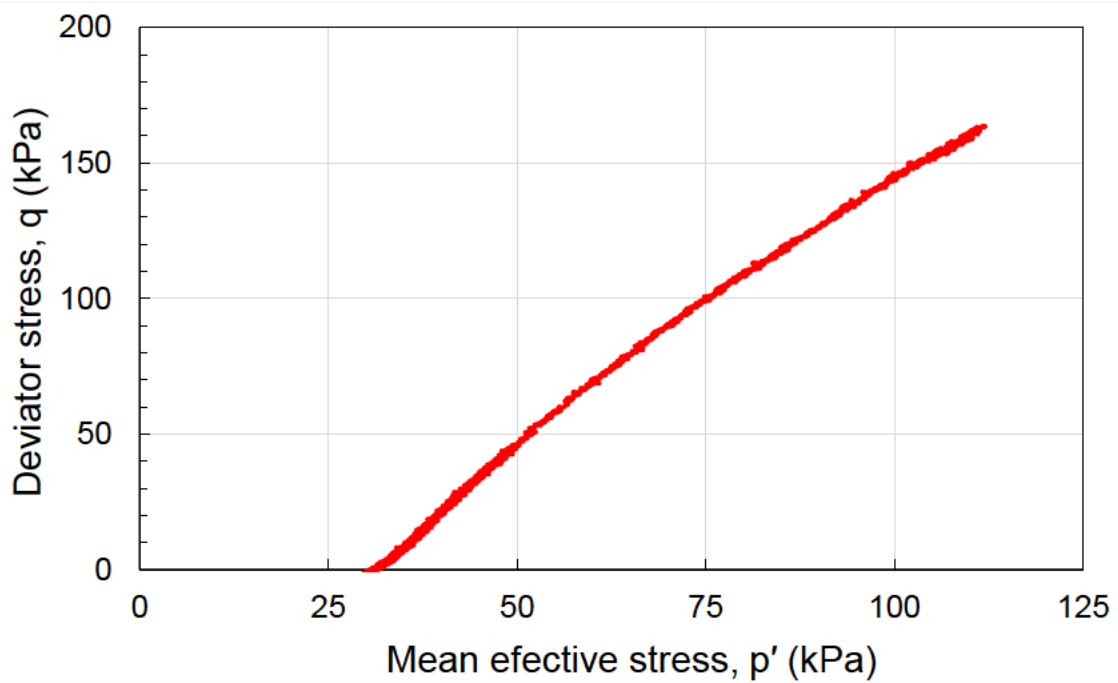


Figure 15: Post-cyclic stress path

Cyclic triaxial test for WSP OPUS**(Waterloo WTP Project)****Test 3 (BH-101, 3.65 - 4.1 m)**

Auckland UniServices Limited

70 Symonds St, Auckland 1142

Sample: BH-101, 3.65 - 4.1m	Depth (m): 3.65 - 4.1m	Formation: -
Test start: 27 October 2020	Test end: 30 October 2020	Initial mass (gr): 749.3
Initial length (mm): 126	Initial diameter (mm): 61.5	Initial unit weight (kN/m ³): 19.7
Effective consolidation pressure (kPa): 55		Consolidation volume change (ml): 2.4
Initial water content (%): 23		Final water content (%): 22.8
Target CSR: 0.47		Cyclic axial stress at CSR (kPa): 51.7
Number of cycles to 5% DA axial strain: 9		Number of cycles to $U_{cyc} / \sigma'_{30} = 0.95$: 6
Test performed by: s7(2)(a)		Apparatus: Geomechanics lab MTS810
Comments: After saturation and consolidation stages, the specimen was subjected to stress-controlled cyclic loading with a frequency of 0.1 Hz. The specimen reached 5% double amplitude axial stain after 9 cycles of loading. The cyclic test was terminated after about 12 cycles of loading. After the cyclic test, the specimen was subjected to strain-controlled monotonic load to failure (i.e., large deformation) at a rate of 0.01 mm/sec. In order to overcome the problem of different starting points for post-cyclic monotonic loading, the initial height of the specimen before cyclic loading was considered as the basis for calculating the axial strain for data processing; i.e., zero (0%) axial strain correlated with the initial height of the specimen before cyclic loading; a negative axial strain as a starting point had the post-cyclic monotonic loading start when the specimen was in extension condition.		

Photos:

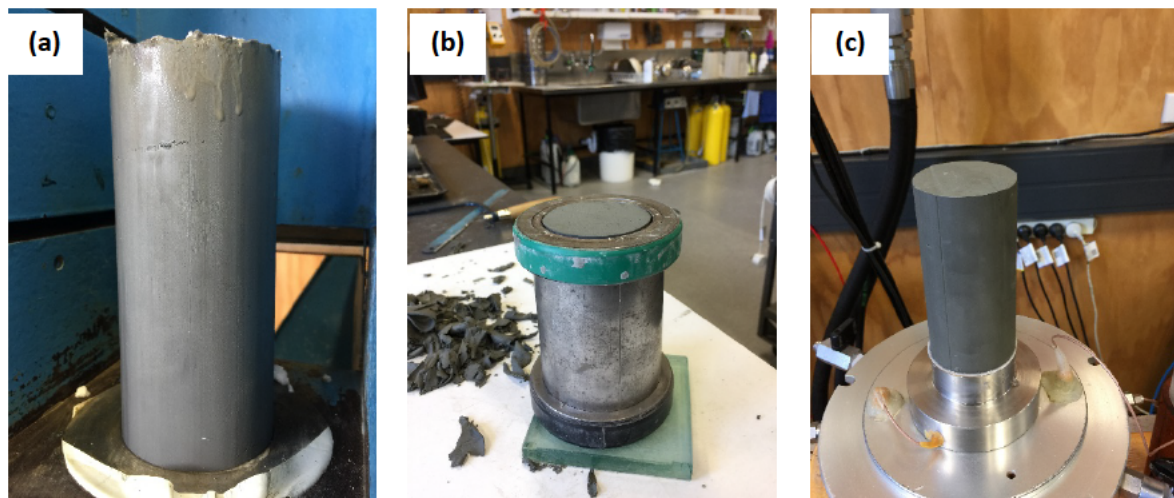


Figure 1: Specimen preparation for the triaxial test: (a) extruding the soil sample using a hydraulic jack; (b) trimming the specimen end inside the mould; (c) set up of specimen in the triaxial cell

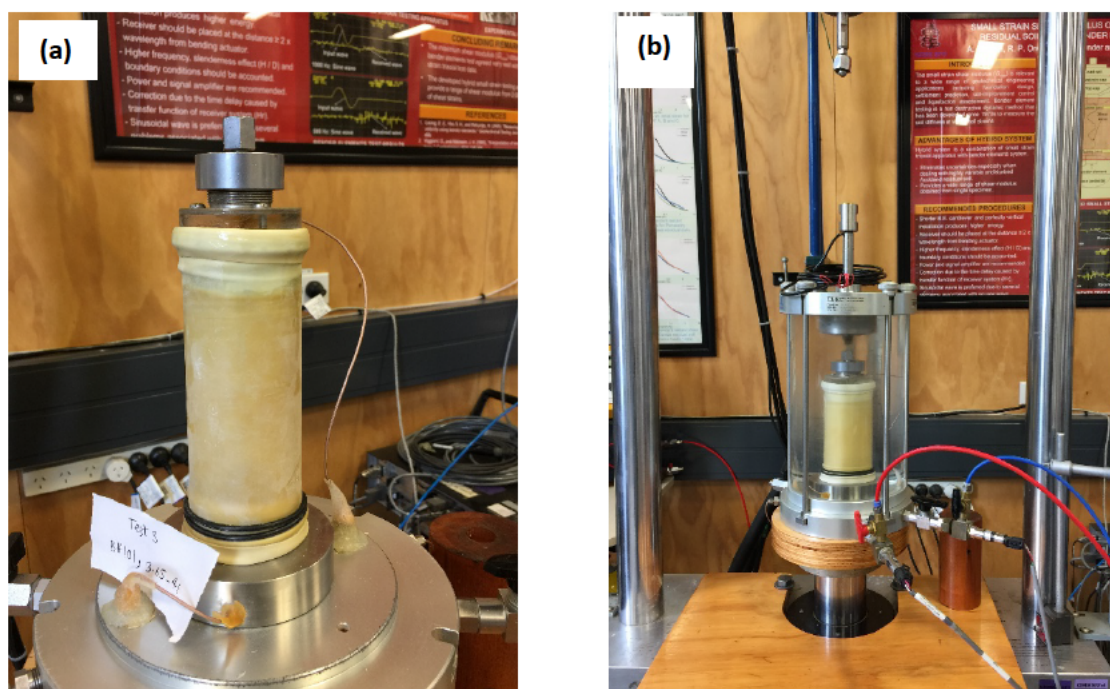


Figure 2: (a) Specimen enclosed with a rubber membrane secured to the top cap and pedestal with O-rings; (b) filling the triaxial cell with water.



Figure 3: Condition of the specimen: (a) after undrained cyclic loading and before post-monotonic loading; (b) after post-monotonic loading; (c) after post-monotonic loading without the membrane.

Consolidation stage:

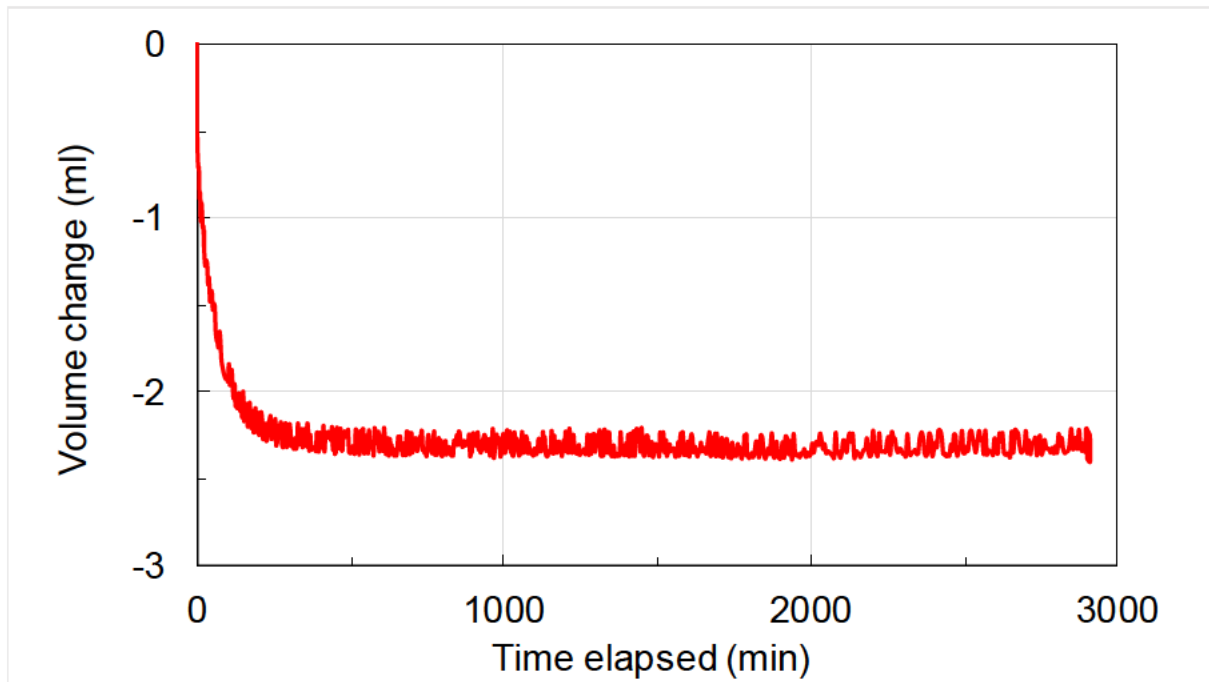


Figure 4: Consolidation volume change vs time.

Cyclic shear stage:

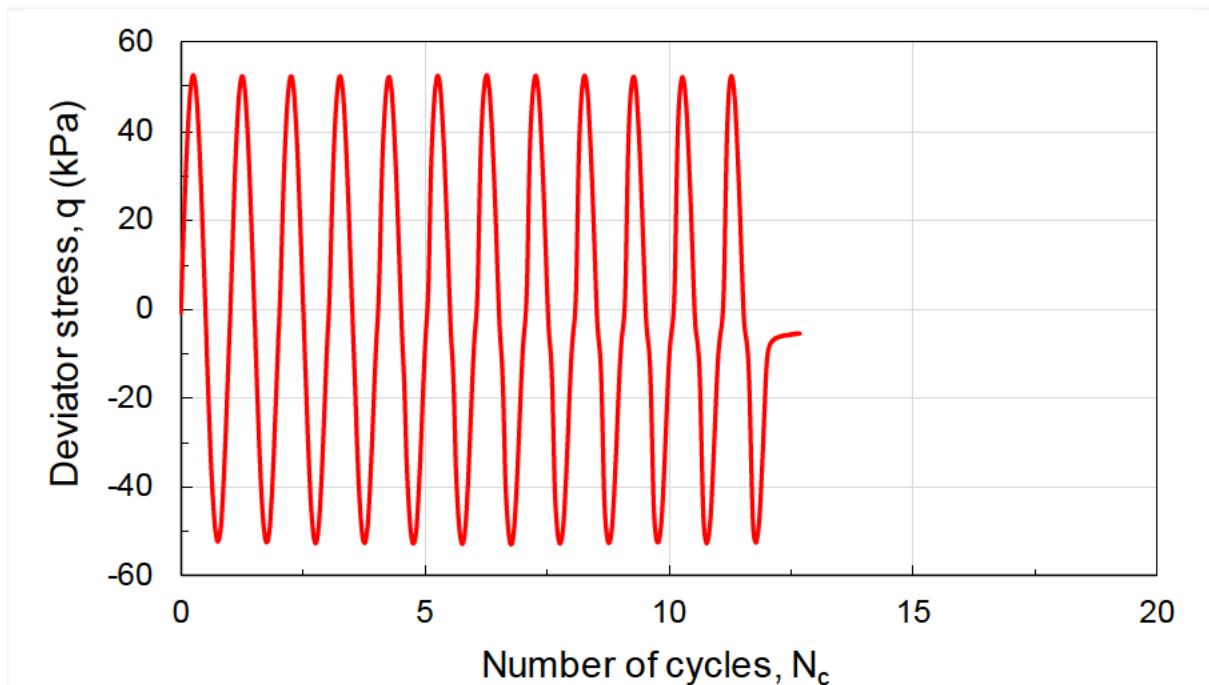


Figure 5: Deviator stress vs number of cycles

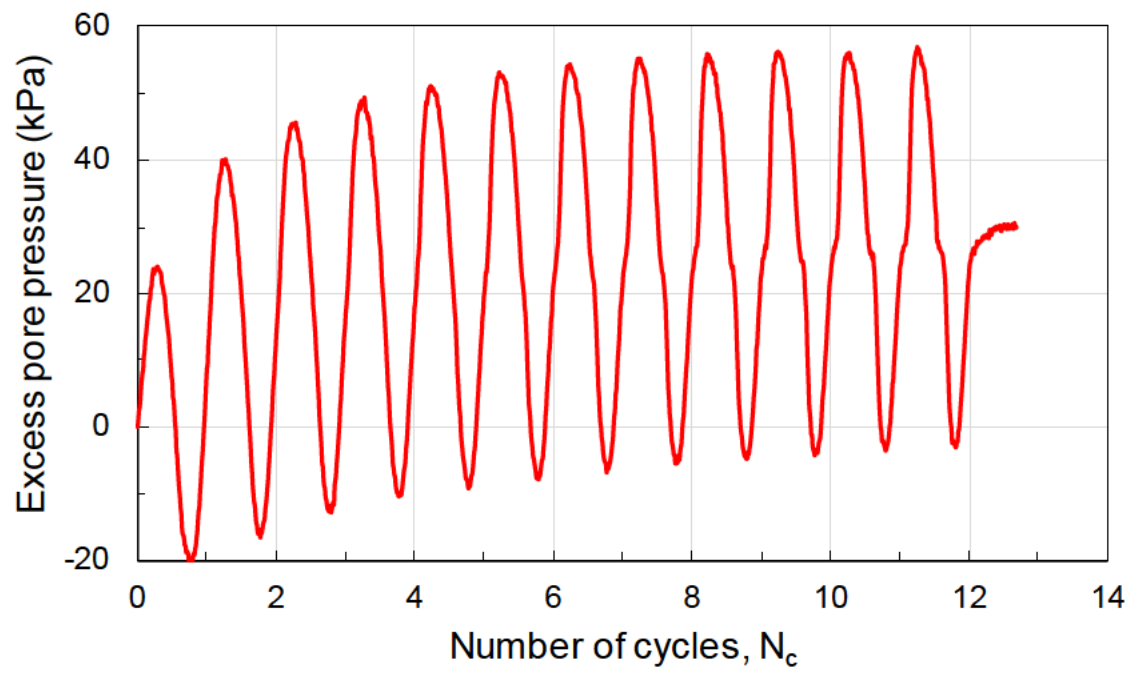


Figure 6: Excess pore water pressure vs number of cycles

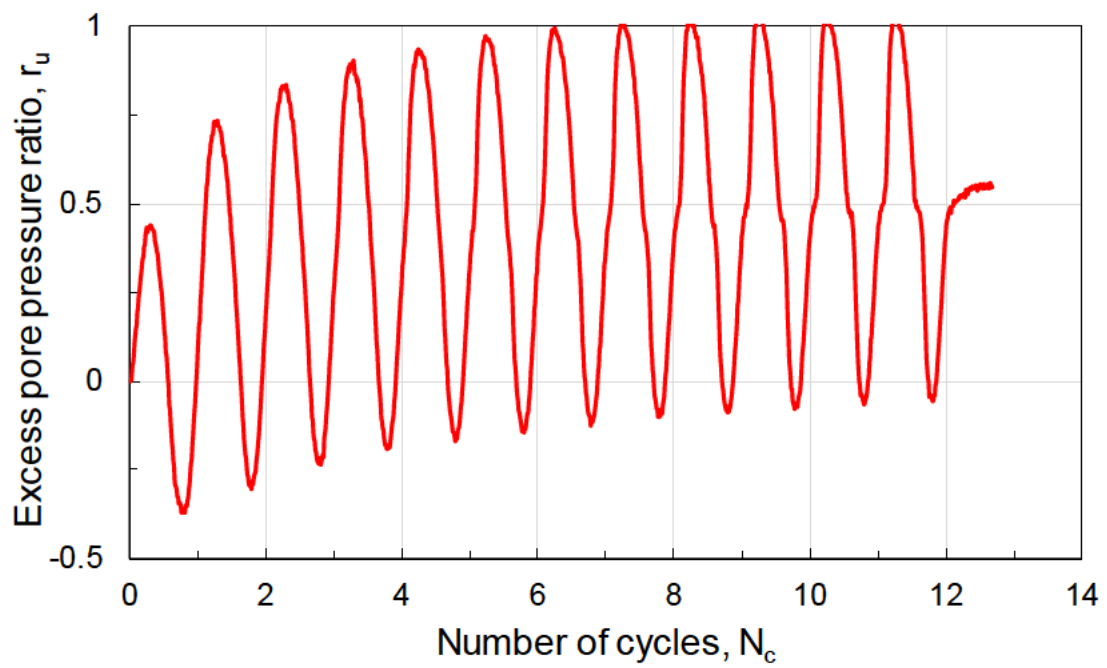


Figure 7: Excess pore water pressure ratio vs number of cycles

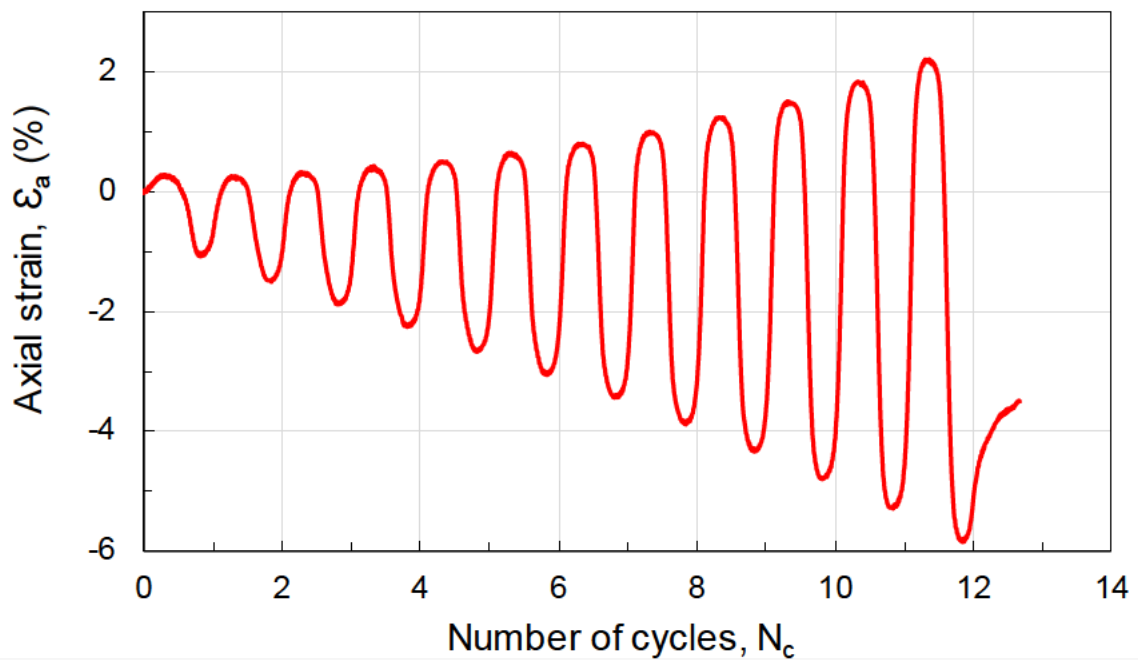


Figure 8: Axial strain vs number of cycles

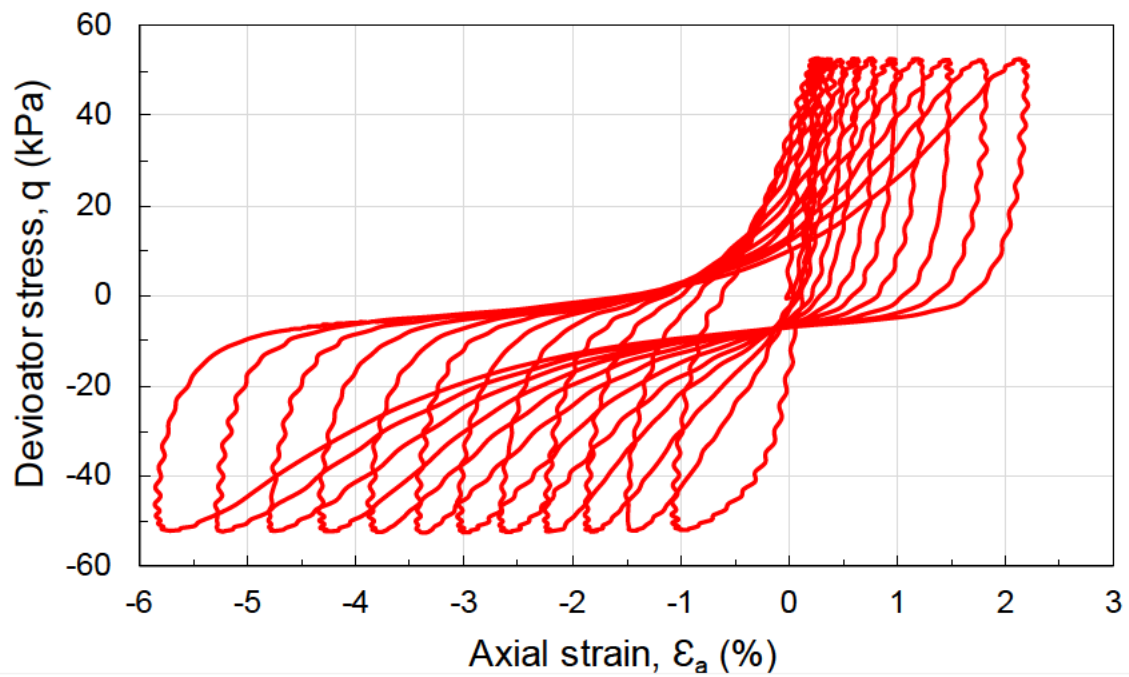


Figure 9: Deviator stress vs axial strain

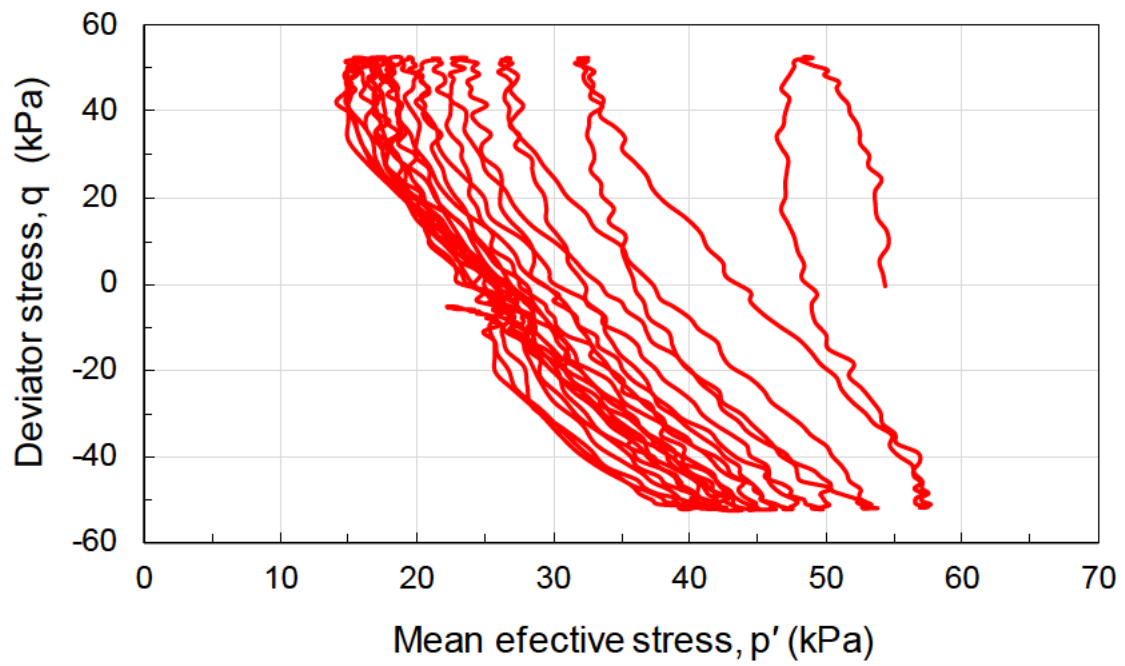


Figure 10: Deviator stress vs mean effective stress

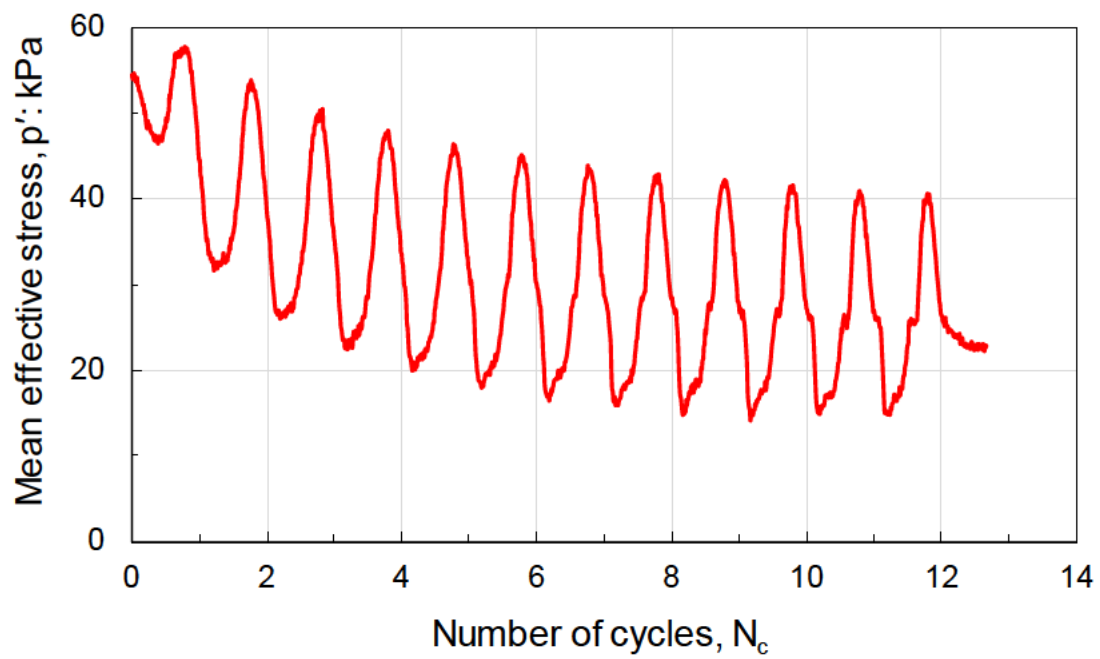


Figure 11: Mean effective stress vs number of cycles.

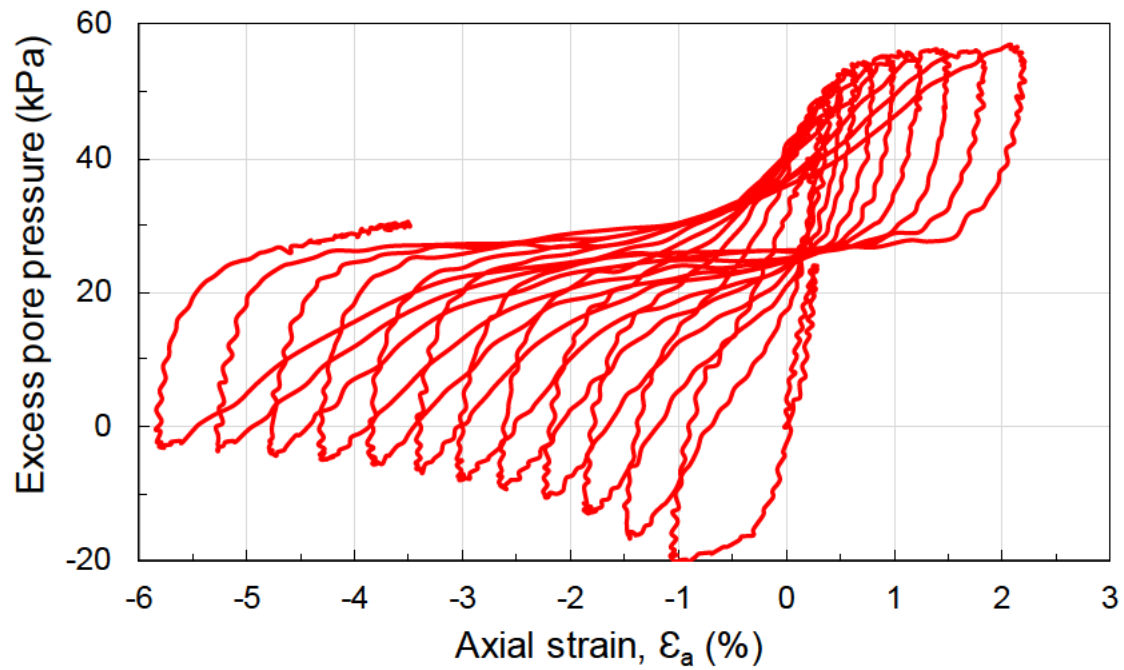


Figure 12: Excess pore water pressure vs axial strain

Post-cyclic monotonic shear stage:

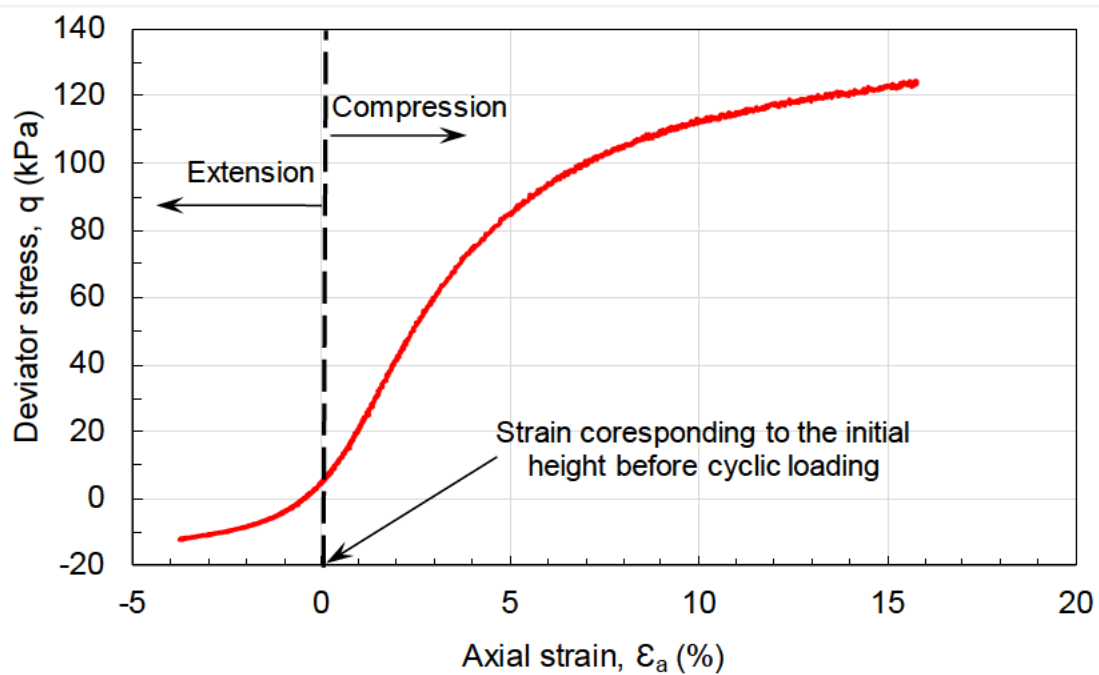


Figure 13: Deviator stress vs axial strain

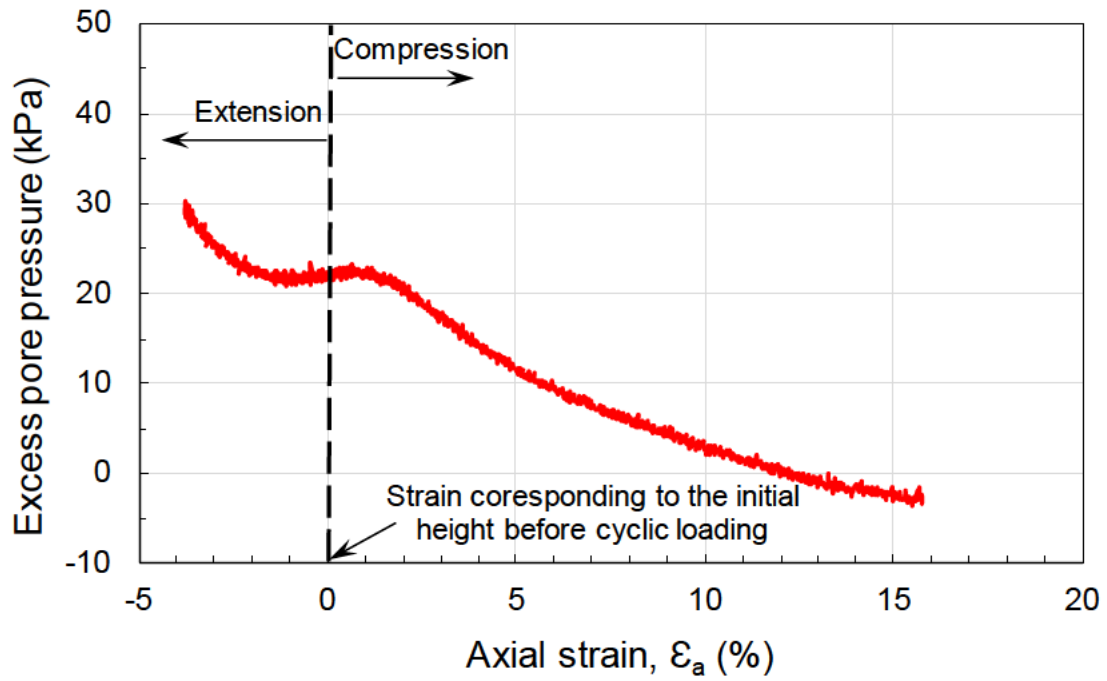


Figure 14: Excess pore water pressure vs axial strain

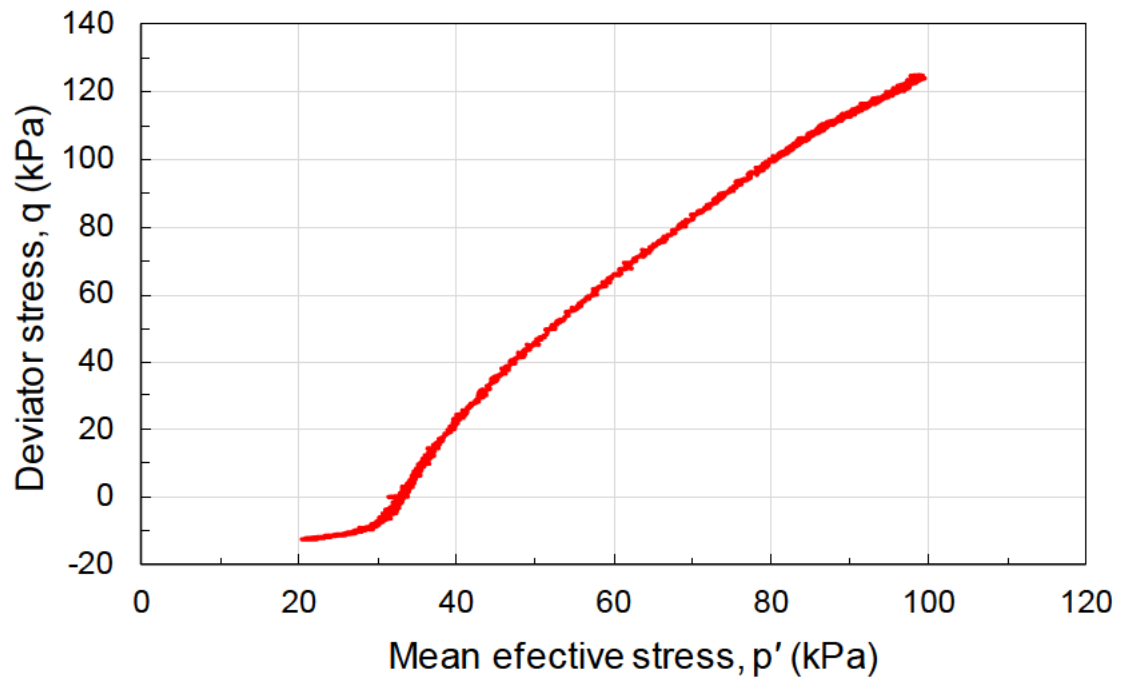


Figure 15: Post-cyclic stress path

Cyclic triaxial test for WSP OPUS**(Waterloo WTP Project)****Test 4 (BH-101, 3.65 - 4.1 m)**

Auckland UniServices Limited

70 Symonds St, Auckland 1142

Sample: BH-101, 3.65 - 4.1m	Depth (m): 3.65 - 4.1m	Formation: -
Test start: 11 November 2020	Test end: 13 November 2020	Initial mass (gr): 749
Initial length (mm): 126	Initial diameter (mm): 61.5	Initial unit weight (kN/m ³): 19.7
Effective consolidation pressure (kPa): 55		Consolidation volume change (ml): 3
Initial water content (%): 24.3		Final water content (%): 23.4
Target CSR: 0.26		Cyclic axial stress at CSR (kPa): 28.6
Number of cycles to 5% DA axial strain: NA		Number of cycles to $U_{cyc} / \sigma'_{30} = 0.95$: NA
Test performed by: s7(2)(a)		Apparatus: Geomechanics lab MTS810
Comments: After saturation and consolidation stages, the specimen was subjected to stress-controlled cyclic loading with a frequency of 0.1 Hz. The cyclic test was performed for about 21 cycles. After the cyclic test, the specimen was subjected to strain-controlled monotonic load to failure (i.e., large deformation) at a rate of 0.01 mm/sec.		

Photos:

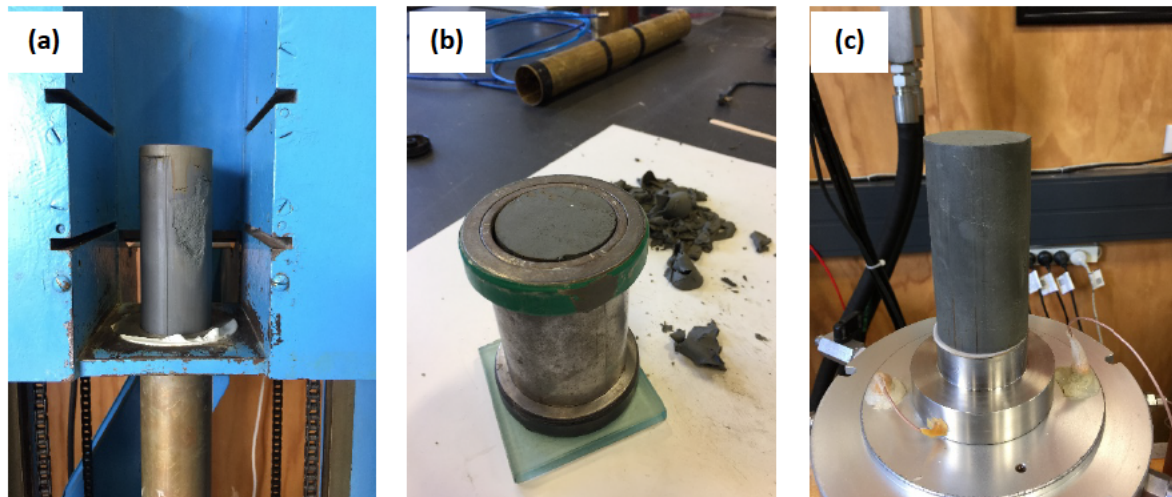


Figure 1: Specimen preparation for the triaxial test: (a) extruding the soil sample using a hydraulic jack; (b) trimming the specimen end inside the mould; (c) set up of specimen in the triaxial cell

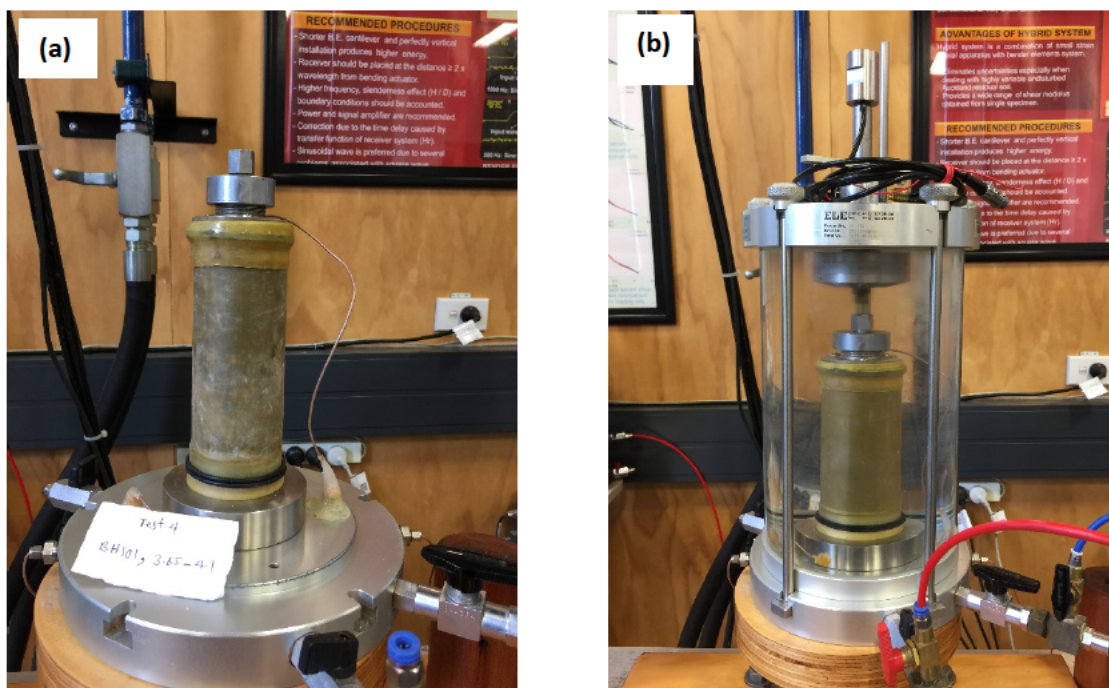


Figure 2: (a) Specimen enclosed with rubber membrane secured to the top cap and pedestal with O-rings; (b) filling the triaxial cell with water.

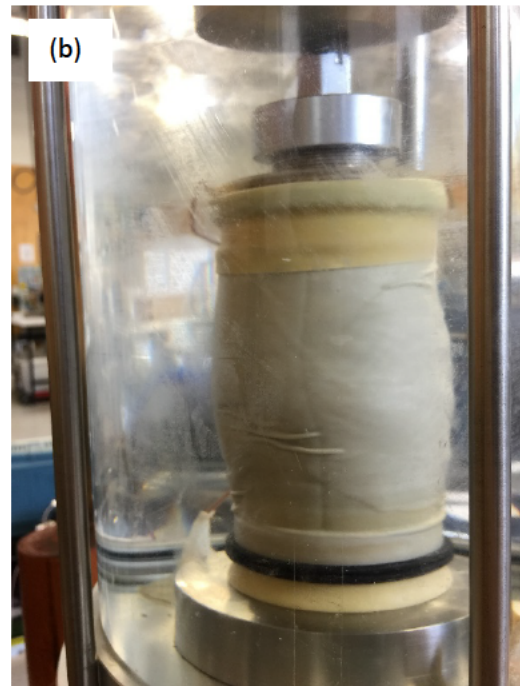


Figure 3: Condition of the specimen (a) after undrained cyclic loading and before post-monotonic loading; (b) after post-monotonic loading; (c) after post-monotonic loading without the membrane.

Consolidation stage:

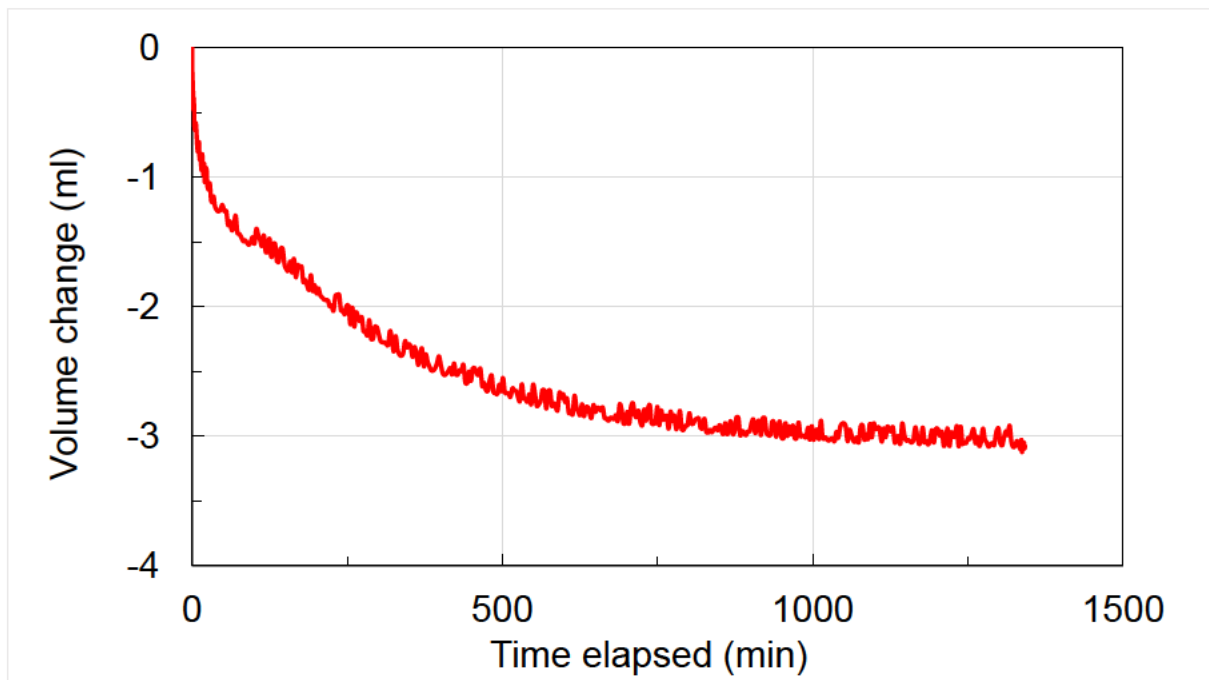


Figure 4: Consolidation volume change vs time.

Cyclic shear stage:

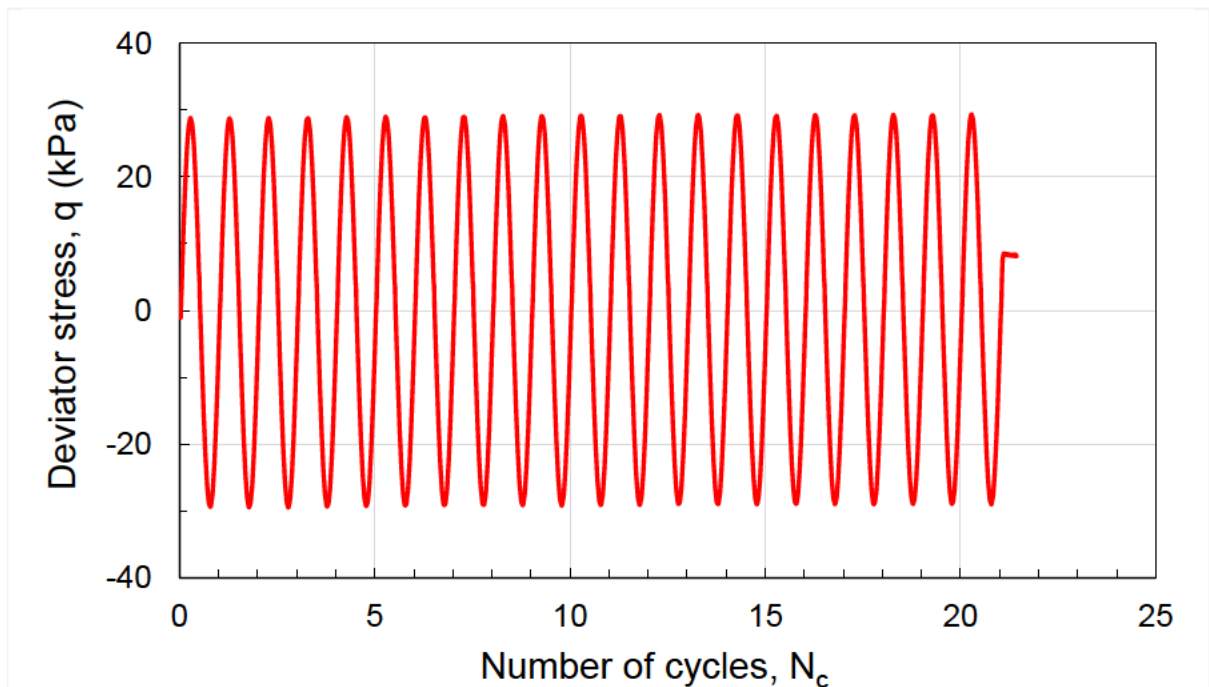


Figure 5: Deviator stress vs number of cycles

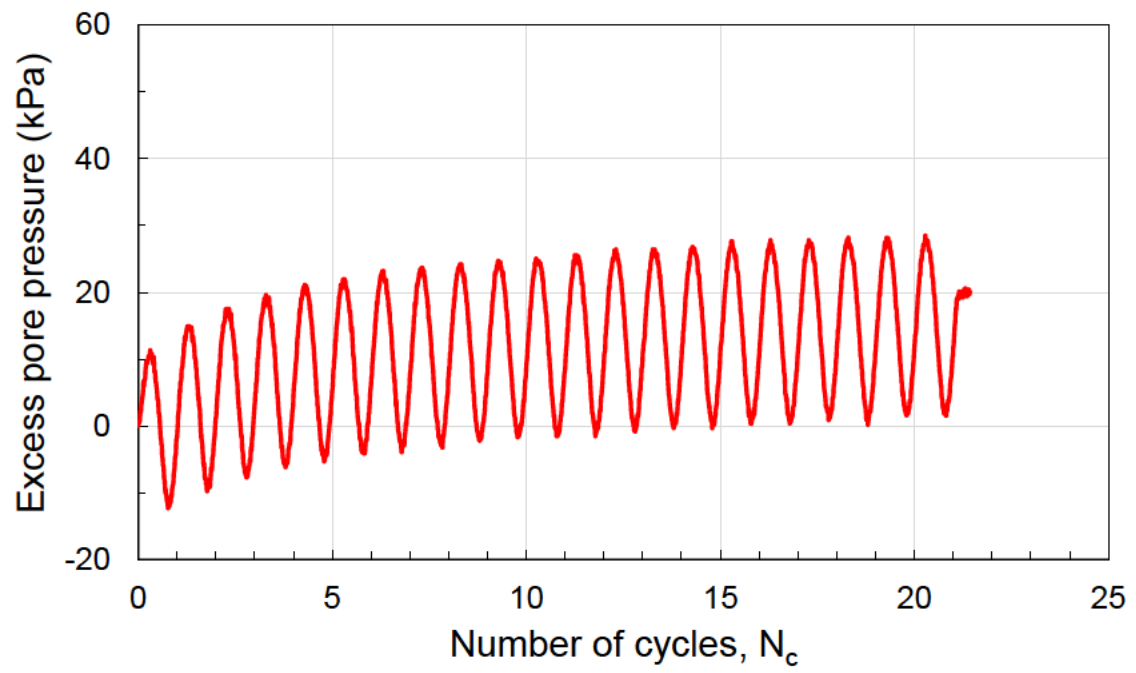


Figure 6: Excess pore water pressure vs number of cycles

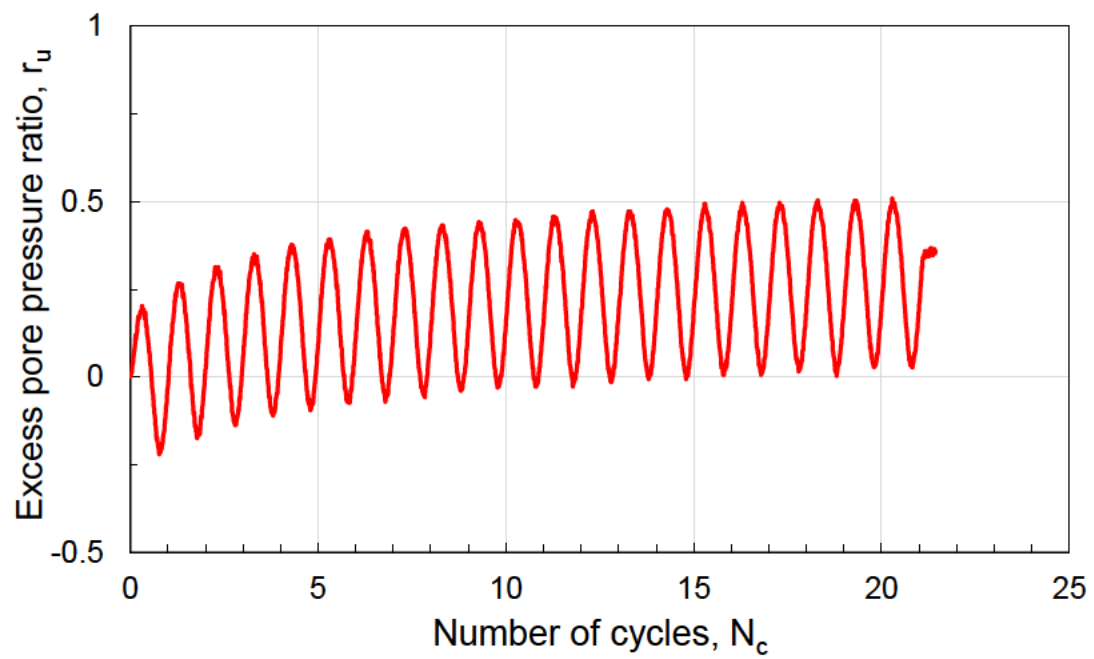


Figure 7: Excess pore water pressure ratio vs number of cycles

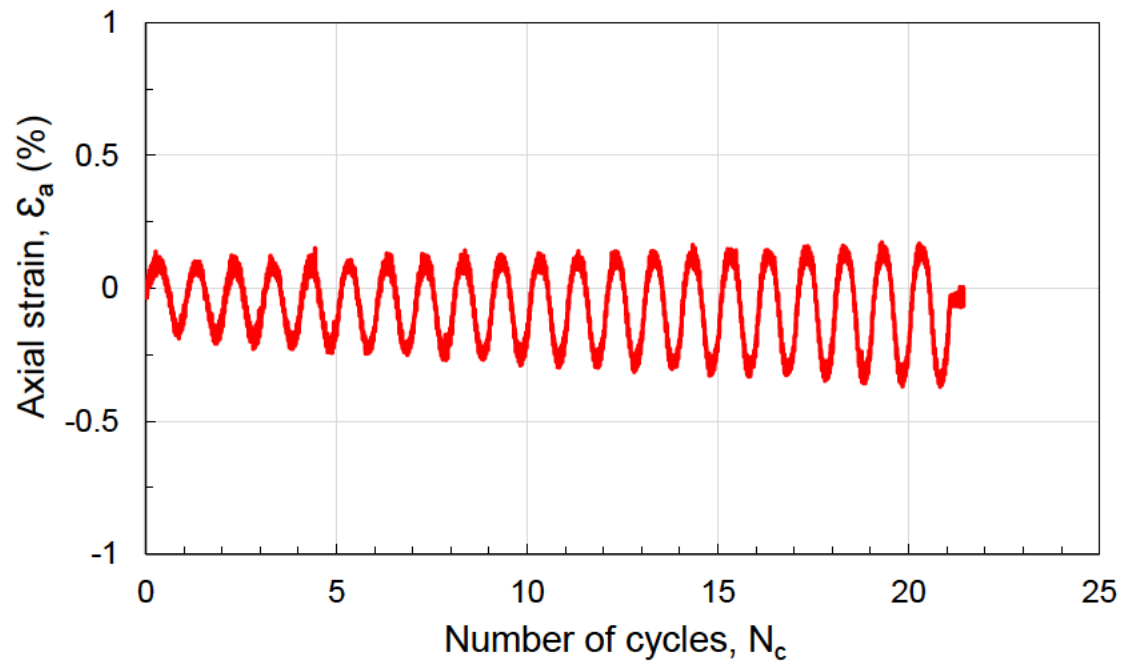


Figure 8: Axial strain vs number of cycles

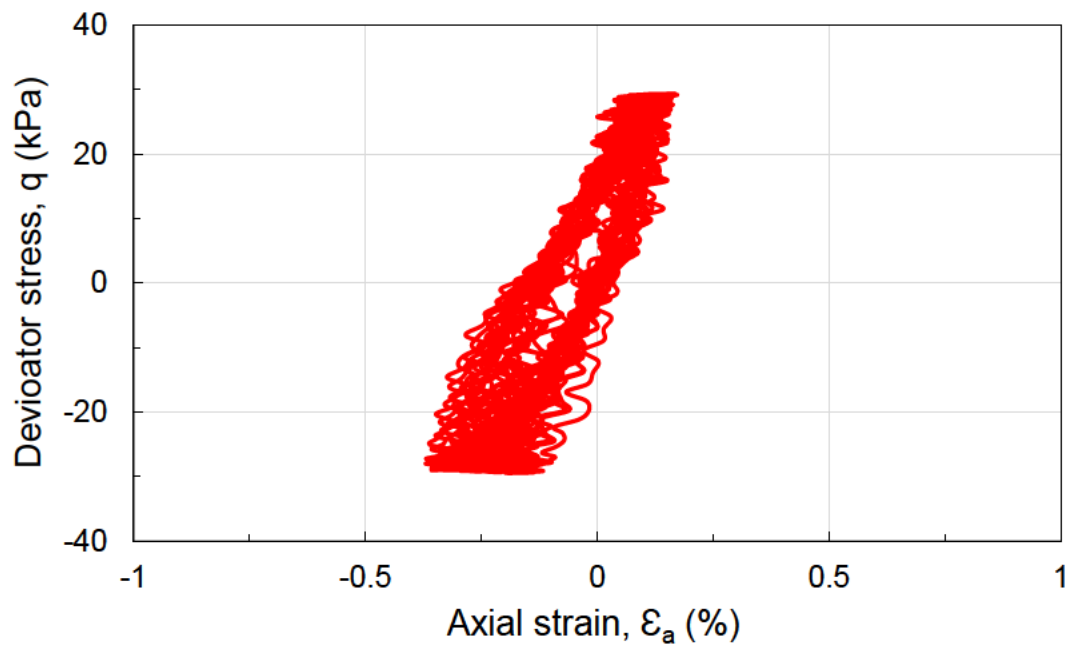


Figure 9: Deviator stress vs axial strain

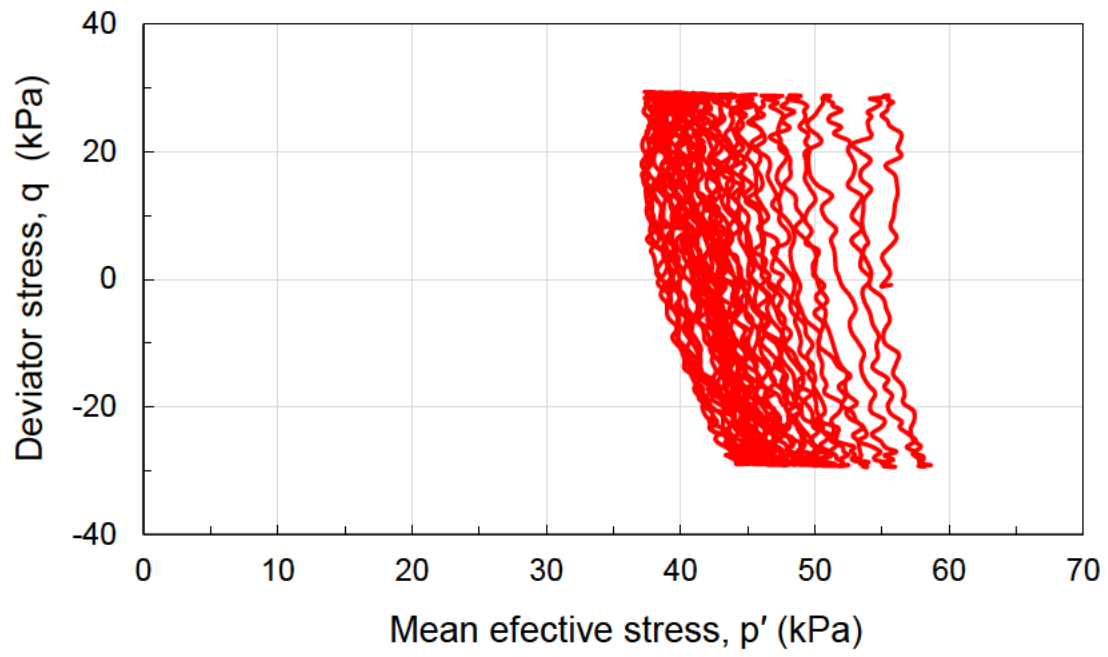


Figure 10: Deviator stress vs mean effective stress

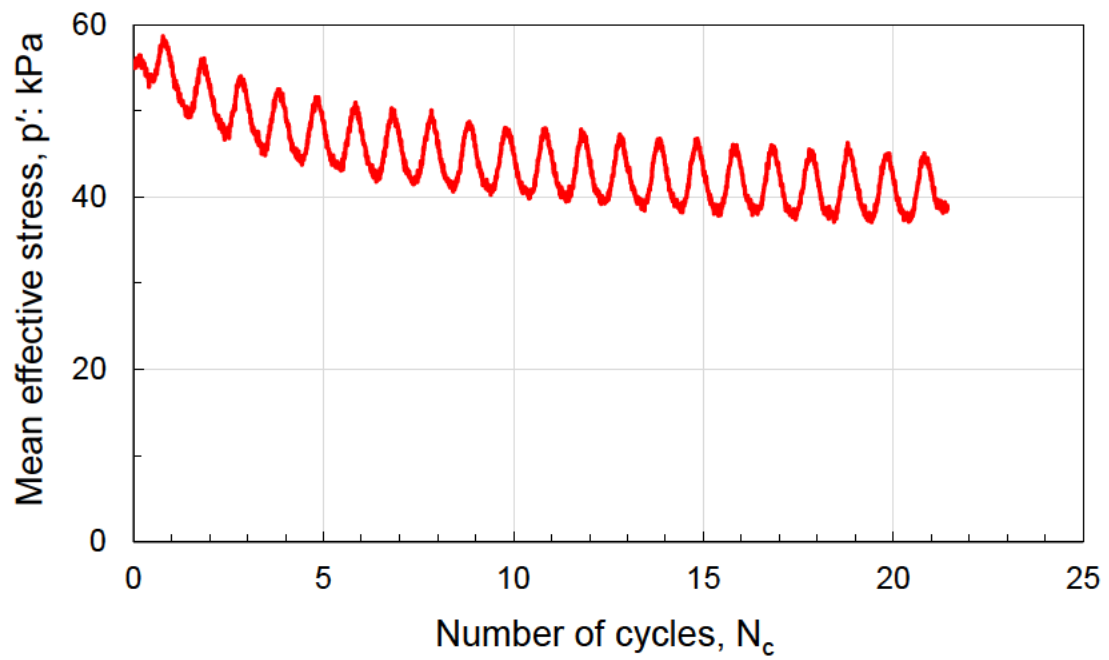


Figure 11: Mean effective stress vs number of cycles.

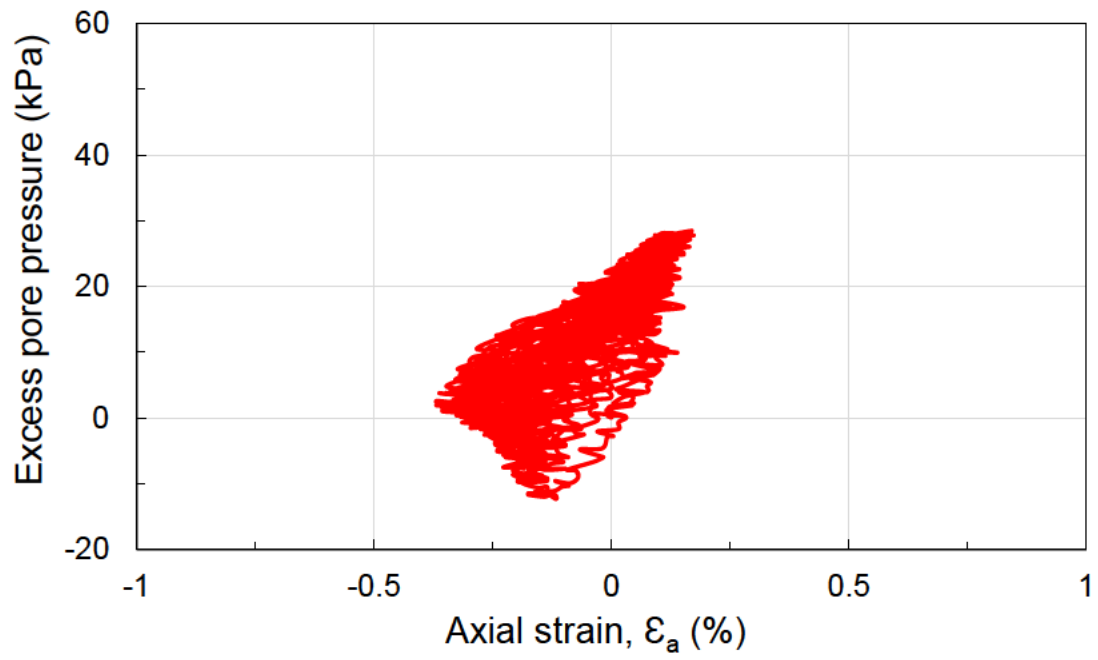


Figure 12: Excess pore water pressure vs axial strain

Post-cyclic monotonic shear stage:

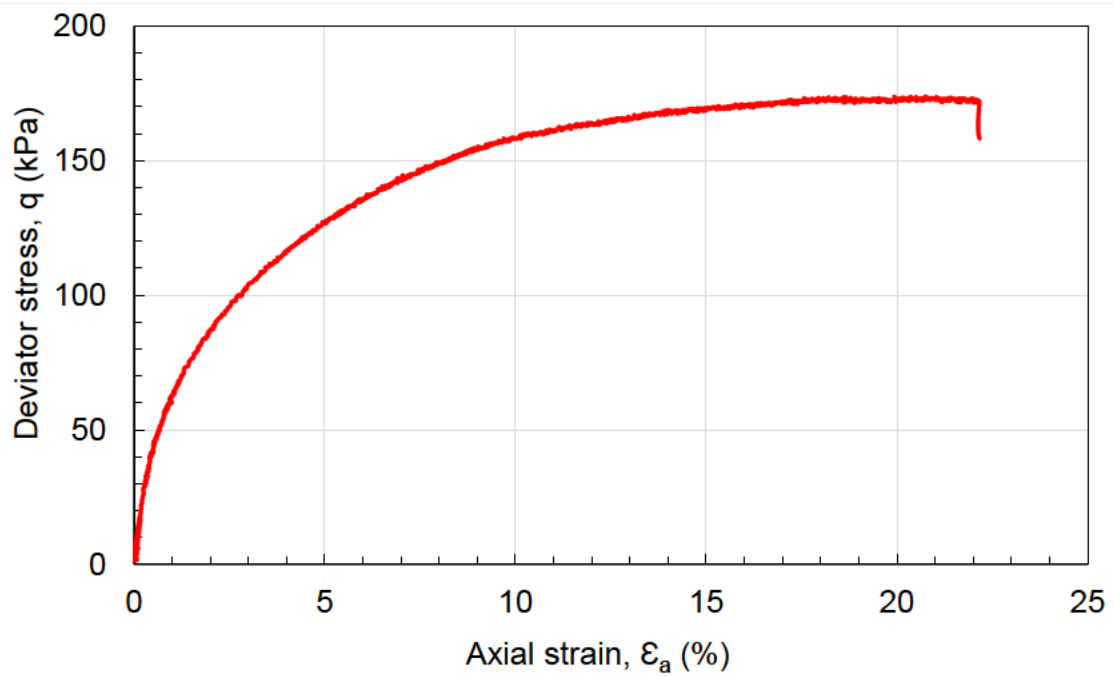


Figure 13: Deviator stress vs axial strain

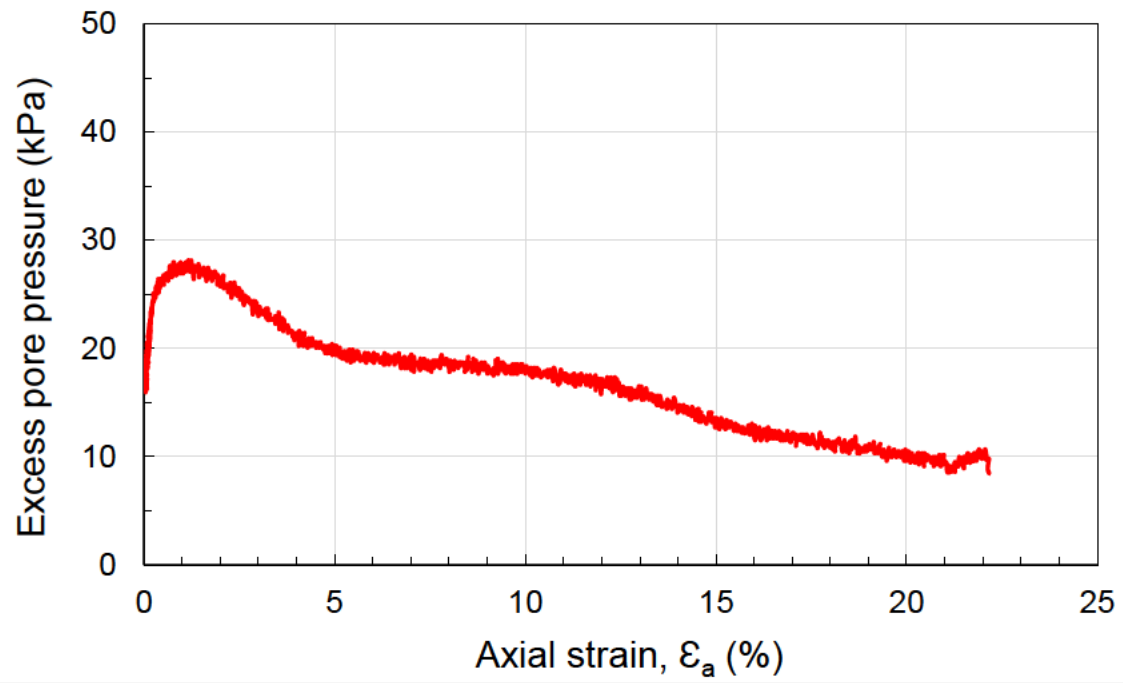


Figure 14: Excess pore water pressure vs axial strain

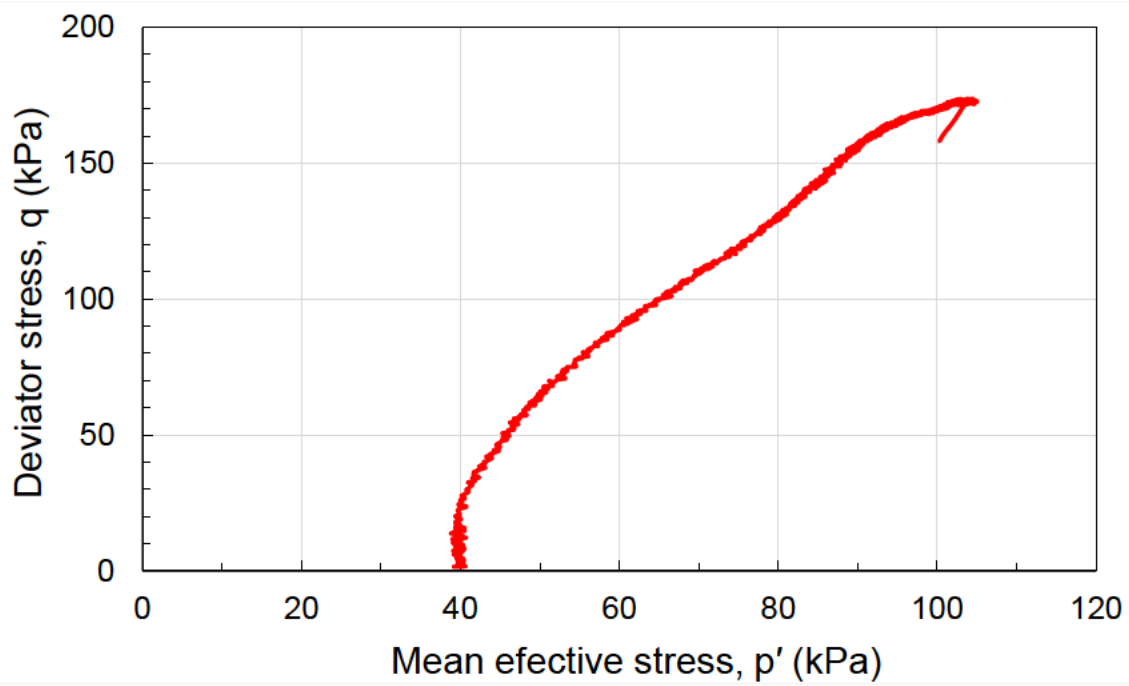


Figure 15: Post-cyclic stress path

PARTICLE SIZE ANALYSIS TEST REPORT

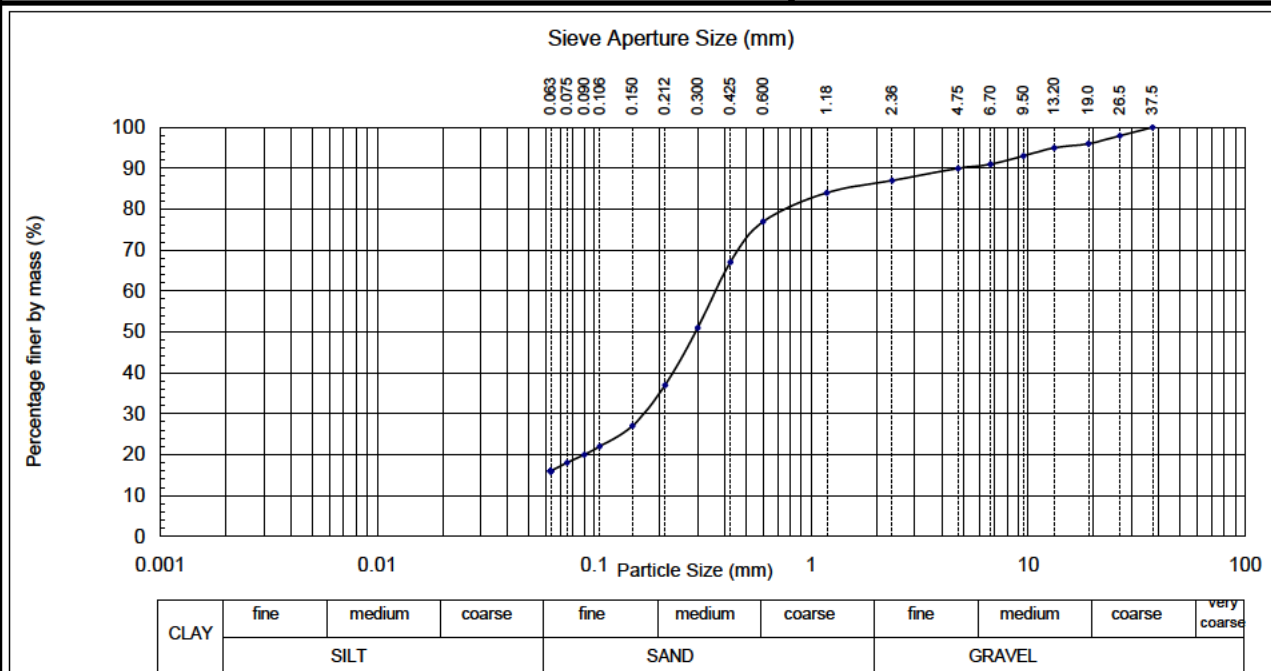


Project: **Waterloo WTP Ground Improvement 3-WW019.11**
 Location: **Waterloo Water Treatment Plant, Oxford Tce, LH**
 Client: **Wellington Water**
 Contractor: **Griffiths Drilling Limited**
 Sampled by: **s7(2)(a)**
 Date sampled: **3.9.20**
 Sampling method: **Sonic core drilling**
 Sample source: **BH104 8.5-9.0m**
 Sample description: **SAND:**
 Sample condition: **As received**
 Solid density (fines) **n/a** t/m³ **Assumed**
 Water content as rec'd **23.5** % **whole**

Report No: **522900/1406**
 Sample No: **2-20/299**
 Client Ref: **3-WW019.11**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
37.5	100	4.75	90	0.212	37				
26.5	98	2.36	87	0.150	27				
19.0	96	1.18	84	0.106	22				
13.20	95	0.600	77	0.090	20				
9.50	93	0.425	67	0.075	18				
6.70	91	0.300	51	0.063	16				

Percent passing finest sieve obtained by difference



Test Methods (where used)	Notes
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Air dried
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212, 0.106, 0.090mm
	Project / sample details supplied by client

Date Tested: **10-23.11.20**
 Date Reported: **24.11.20**

Testing only is covered by IANZ Accreditation
 This report may only be reproduced in full

IANZ Approved Signatory
 Designation *Technical Officer*
 Date:

s7(2)(a)
 24.11.20



All tests reported herein
 have been performed in
 accordance with the
 laboratory's scope of
 accreditation

PLASTICITY INDEX FOR SOILS
TEST REPORT



Project : Waterloo Water Treatment Plant - Ground Improvement
Location : Lower Hutt, Wellington
Client : Wellington Water Limited c/o WSP
Contractor : -
Sampled by : WSP
Date sampled : October 2020
Date received : 6/11/2020
Sampling method : Bag Sample
Sample condition : As received

Project No : 3-WW019.11
Lab Ref No : HA6768/I-4_PI
Client Ref No :

Test Results

Sample Lab Ref No :	HA6768_1_PI	HA6768_2_PI	HA6768_3_PI	HA6768_4_PI
Sample Location ID :	BH101	BH101	BH101	BH101
Sample Depth (m) :	3.0-3.45(A)	3.0-3.45(B)	3.65-4.1(A)	3.65-4.1(B)
Soil Fraction Tested :	-425µm	-425µm	-425µm	-425µm
Liquid Limit :	29	24	24	26
Plastic Limit :	19	18	18	20
Plasticity Index :	10	6	6	6

Sample Description : HA6768_1_PI Clayey SILT, minor sand
HA6768_2_PI Clayey SILT, minor sand
HA6768_3_PI Clayey SILT, trace sand
HA6768_4_PI Clayey SILT, minor sand

Test Methods	Notes
Water Content NZS 4402 : 1986, Test 2.1	Soil fraction tested as shown.
Liquid Limit NZS 4402 : 1986, Test 2.2	1. Testing not accredited due to samples being oven dried prior to testing
Plastic Limit NZS 4402 : 1986, Test 2.3	2. W/C not included in report due to rewetting of samples
Plasticity Index NZS 4402 : 1986, Test 2.4	

Date tested : 18/01/21

Date reported : 04/02/21

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without written approval by Client

Approved

s7(2)(a)

Designation :

Date : 04/02/21

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)

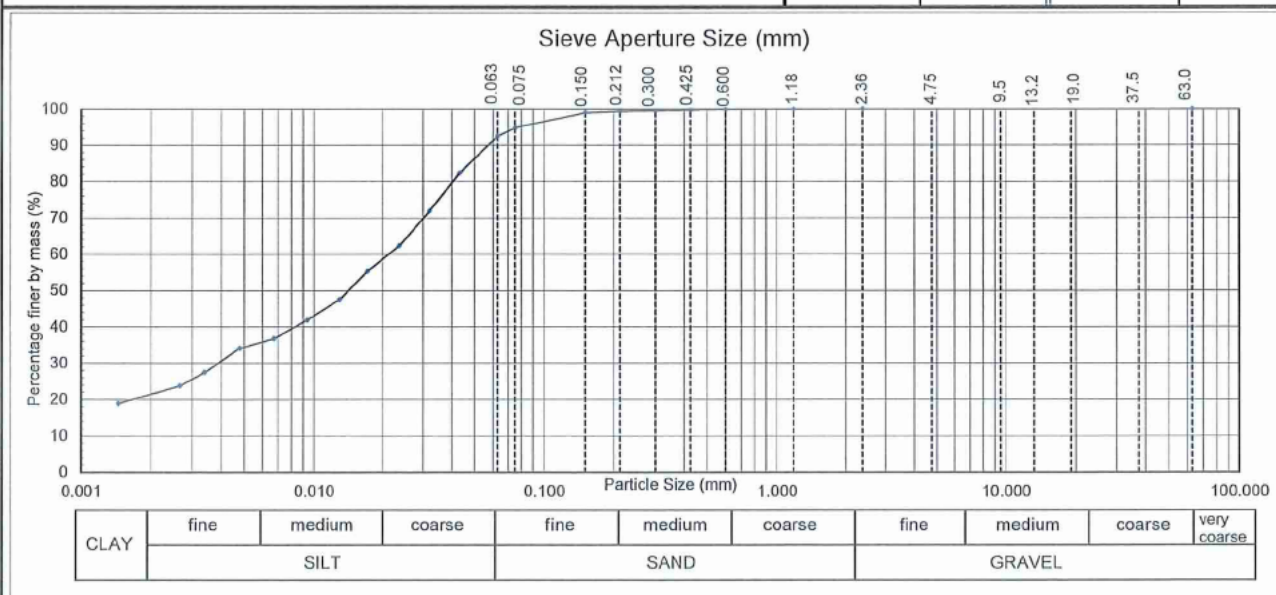
TEST REPORT



Project : Waterloo WTP Ground Improvements
 Location : Lower Hutt, Wellington
 Client : Wellington Water Limited c/o WSP
 Client/Sample Ref : 101_3-3.45A
 Contractor : -
 Borehole No: BH101 Depth: 3.0-3.45 metres
 Sampled by : WSP
 Date received : 06/11/20
 Sampling method : Bag Sample
 Sample condition : As received
 Sample description : Clayey SILT with minor sand
 Solid Particle Density (t/m³): 2.70 Assumed
 Water Content (as received): 23.9 %

Project No: 3-VW019.11
 Lab Ref No: HA6768/1_Hydro
 Client Ref:

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	--	0.300	99	0.0431	82	0.0067	37
37.5	--	2.36	100	0.212	99	0.0320	72	0.0048	34
19.0	--	1.18	100	0.150	99	0.0235	62	0.0034	27
13.2	--	0.600	100	0.075	95	0.0172	55	0.0026	24
9.5	--	0.425	100	0.063	93	0.0129	48	0.0014	19
Note: "--" denotes sieve not used and/or hydrometer analysis not tested						0.0093	42		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 8.0 (Whatmans Full Range pH Indicator paper) All information supplied by Client Re wet sample. Sample cannot be IANZ accredited

Date Tested: 19/01/21 This report may only be reproduced in full

Date Reported: 04/02/21

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Designation : Senior Civil Engineering Technician

Date : 04/02/21

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)

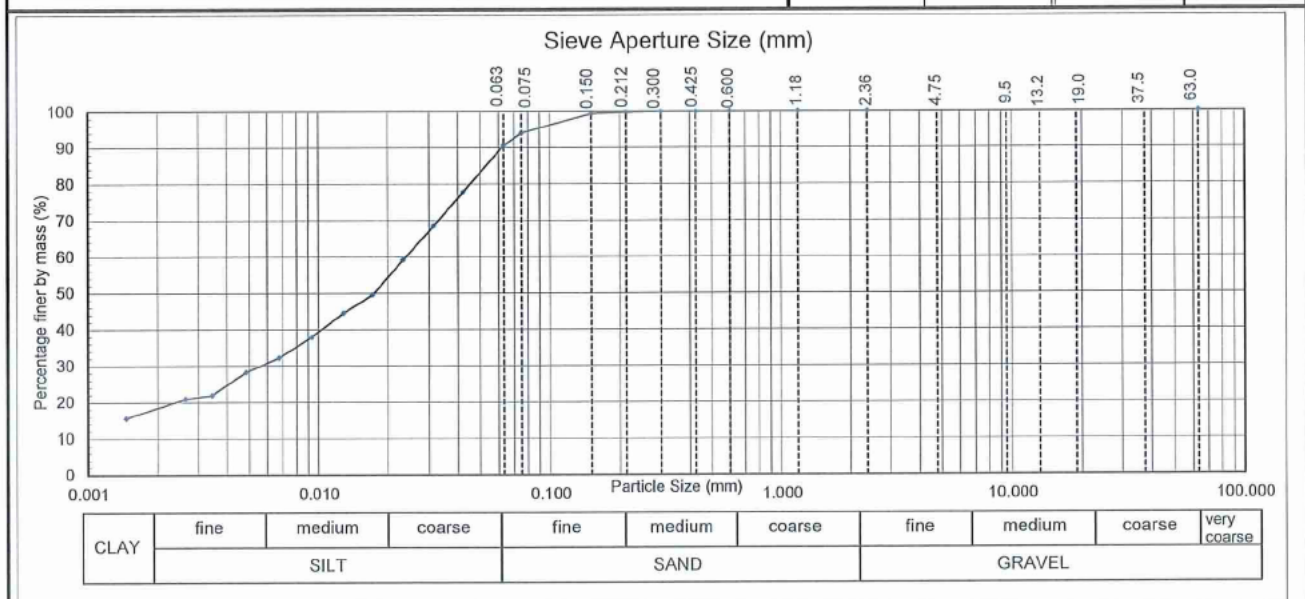
TEST REPORT



Project : Waterloo WTP Ground Improvements
 Location : Lower Hutt, Wellington
 Client : Wellington Water Limited c/o WSP
 Client/Sample Ref : 101_3-3.45B
 Contractor : -
 Borehole No: BH101 Depth: 3.0-3.45 metres
 Sampled by : WSP
 Date received : 06/11/20
 Sampling method : Bag Sample
 Sample condition : As received
 Sample description : Clayey SILT with minor sand
 Solid Particle Density (t/m^3): 2.70 Assumed
 Water Content (as received): 19.9 %

Project No: 3-WW019.11
 Lab Ref No: HA6768/2_Hydro
 Client Ref:

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	--	0.300	100	0.0422	78	0.0067	32
37.5	--	2.36	100	0.212	100	0.0314	68	0.0048	28
19.0	--	1.18	100	0.150	99	0.0232	59	0.0034	22
13.2	--	0.600	100	0.075	94	0.0172	50	0.0026	21
9.5	--	0.425	100	0.063	91	0.0128	45	0.0015	16
Note: "--" denotes sieve not used and/or hydrometer analysis not tested						0.0093	38		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 8.0 (Whatmans Full Range pH Indicator paper) All information supplied by Client Re wet sample. Sample cannot be IANZ accredited

Date Tested: 19/01/21 This report may only be reproduced in full

Date Reported: 04/02/21 **s7(2)(a)**

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 Designation : Senior Civil Engineering Technician
 Date : 04/02/21

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)

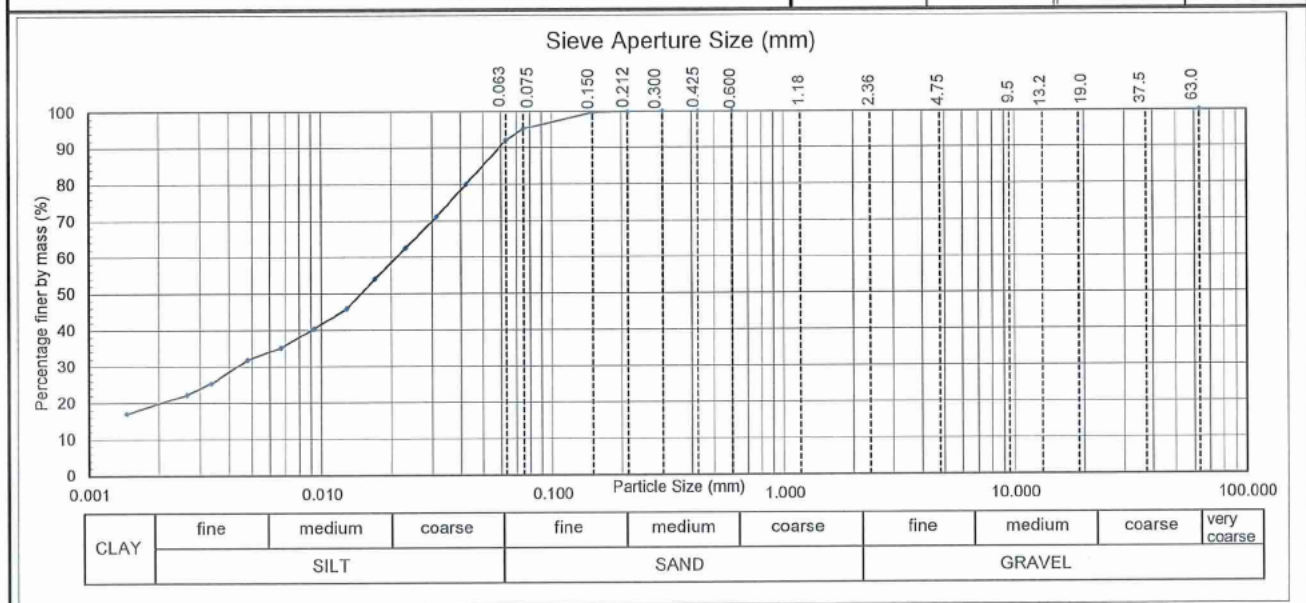
TEST REPORT



Project : Waterloo WTP Ground Improvements
 Location : Lower Hutt, Wellington
 Client : Wellington Water Limited c/o WSP
 Client/Sample Ref : 101_3.65-4.1A
 Contractor : -
 Borehole No: BH101 Depth: 3.65-4.1 metres
 Sampled by : WSP
 Date received : 06/11/20
 Sampling method : Bag Sample
 Sample condition : As received
 Sample description : Clayey SILT with trace sand
 Solid Particle Density (t/m³): 2.70 Assumed
 Water Content (as received): 20.3 %

Project No: 3-WW019.11
 Lab Ref No: HA6768/3_Hydro
 Client Ref:

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	--	0.300	100	0.0421	80	0.0067	35
37.5	--	2.36	--	0.212	100	0.0312	71	0.0048	32
19.0	--	1.18	--	0.150	100	0.0230	63	0.0033	25
13.2	--	0.600	100	0.075	95	0.0169	54	0.0026	22
9.5	--	0.425	100	0.063	92	0.0128	46	0.0014	17
Note: "--" denotes sieve not used and/or hydrometer analysis not tested						0.0092	40		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 8.0 (Whatmans Full Range pH Indicator paper) All information supplied by Client Re wet sample. Sample cannot be IANZ accredited.

Date Tested: 19/01/21 This report may only be reproduced in full

Date Reported: 04/02/21

s7(2)(a)

Approved

Designation : Senior Civil Engineering Technician

Date : 04/02/21

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)

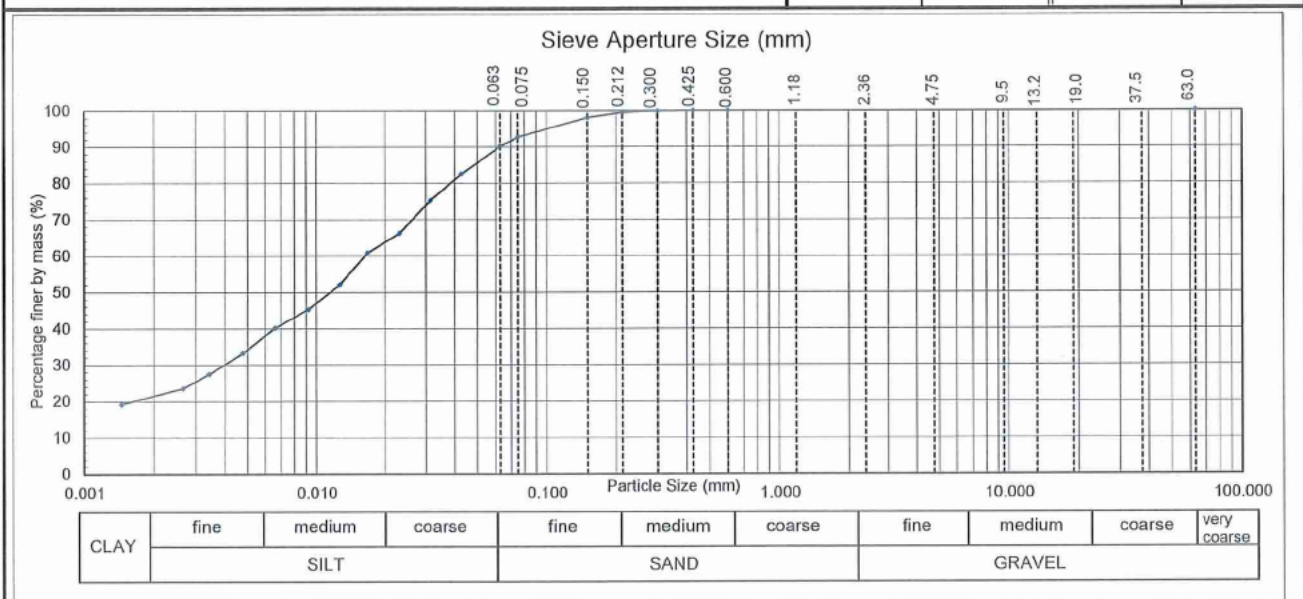
TEST REPORT



Project : Waterloo WTP Ground Improvements
 Location : Lower Hutt, Wellington
 Client : Wellington Water Limited c/o WSP
 Client/Sample Ref : 101_3.65-4.1B
 Contractor : -
 Borehole No: BH101 Depth: 3.65-4.1 metres
 Sampled by : WSP
 Date received : 06/11/20
 Sampling method : Bag Sample
 Sample condition : As received
 Sample description : Clayey SILT with minor sand
 Solid Particle Density (t/m^3): 2.70 Assumed
 Water Content (as Tested): 22.6 %

Project No: 3-WW019.11
 Lab Ref No: HA6768/4_Hydro
 Client Ref:

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	--	0.300	100	0.0427	83	0.0066	40
37.5	--	2.36	--	0.212	99	0.0313	75	0.0048	33
19.0	--	1.18	--	0.150	98	0.0231	66	0.0034	28
13.2	--	0.600	100	0.075	93	0.0167	61	0.0026	24
9.5	--	0.425	100	0.063	90	0.0125	52	0.0014	19
Note: "--" denotes sieve not used and/or hydrometer analysis not tested						0.0092	45		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 8.0 (Whatmans Full Range pH Indicator paper) All information supplied by Client Re Wet sample. Sample cannot be IANZ accredited

Date Tested: 19/01/21 This report may only be reproduced in full

Date Reported: 04/02/21 **s7(2)(a)**

Approved
 Designation : Senior Civil Engineering Technician
 Date : 04/02/21

PARTICLE SIZE ANALYSIS TEST REPORT

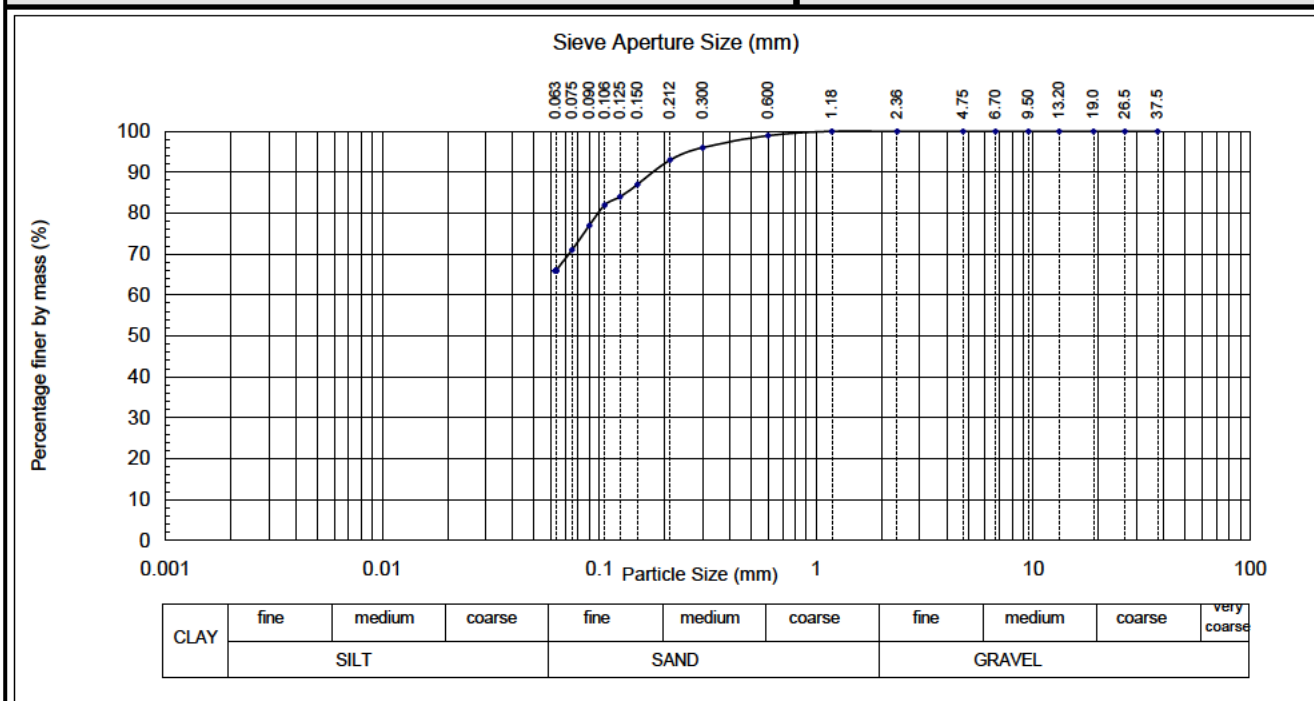


Project: **Waterloo WTP Ground Improvement 3-WW019.11**
 Location: **Waterloo Water Treatment Plant, Oxford Tce, LH**
 Client: **Wellington Water**
 Contractor: **Griffiths Drilling Limited**
 Sampled by: **s7(2)(a)**
 Date sampled: **2.10.20**
 Sampling method: **Sonic core drilling**
 Sample source: **BH101 7.5-8.0m**
 Sample description: **Sandy SILT:**
 Sample condition: **As received**
 Solid density (fines) **n/a** **t/m³** **Assumed**
 Water content as rec'd **38.0** **%** **whole**

Report No: **522900/1406**
 Sample No: **2-20/294**
 Client Ref: **3-WW019.11**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
37.5	100	4.75	100	0.150	87				
26.5	100	2.36	100	0.125	84				
19.0	100	1.18	100	0.106	82				
13.20	100	0.600	99	0.090	77				
9.50	100	0.300	96	0.075	71				
6.70	100	0.212	93	0.063	66				

Percent passing finest sieve obtained by difference



Test Methods (where used)	Notes
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Air dried
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212, 0.125, 0.106, 0.090mm
	Project / sample details supplied by client

Date Tested: **10-23.11.20**
 Date Reported: **24.11.20**

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IANZ Approved Signatory
 Designation *Technical Officer*
 Date: **24.11.20**

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PARTICLE SIZE ANALYSIS TEST REPORT

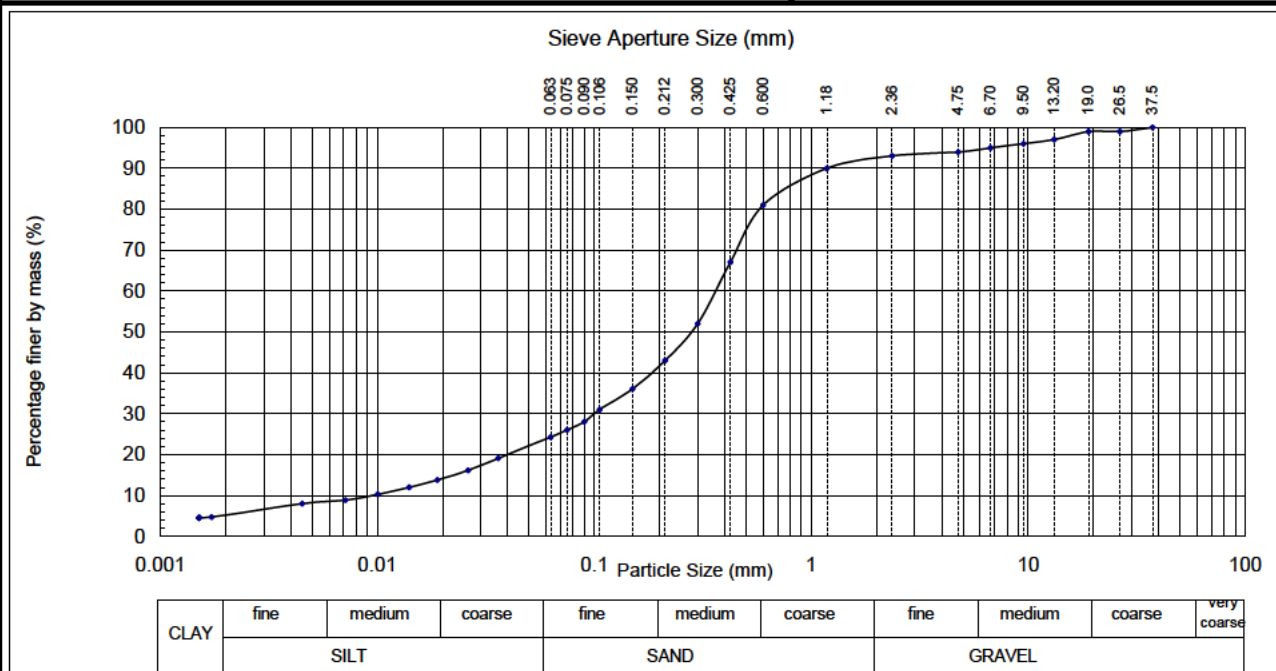


Project: **Waterloo WTP Ground Improvement 3-WW019.11**
 Location: **Waterloo Water Treatment Plant, Oxford Tce, LH**
 Client: **Wellington Water**
 Contractor: **Griffiths Drilling Limited**
 Sampled by: **s7(2)(a)**
 Date sampled: **3.9.20**
 Sampling method: **Sonic core drilling**
 Sample source: **BH104 3.5-4.0m**
 Sample description: **Silty SAND:**
 Sample condition: **As received**
 Solid density (fines) **2.70 t/m³** Assumed
 Water content as rec'd **17.8 %** whole

Report No: **522900/1406**
 Sample No: **2-20/297**
 Client Ref: **3-WW019.11**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
37.5	100	4.75	94	0.212	43	0.0361	19	0.0045	8
26.5	99	2.36	93	0.150	36	0.0262	16	0.0017	5
19.0	99	1.18	90	0.106	31	0.0189	14	0.0015	5
13.20	97	0.600	81	0.090	28	0.0140	12		
9.50	96	0.425	67	0.075	26	0.0101	10		
6.70	95	0.300	52	0.063	24	0.0071	9		

Percent passing finest sieve obtained by difference



Test Methods (where used)	Notes
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Air dried
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212, 0.106, 0.090mm
	Project / sample details supplied by client

Date Tested: **10-23.11.20**
 Date Reported: **24.11.20**

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PARTICLE SIZE ANALYSIS TEST REPORT

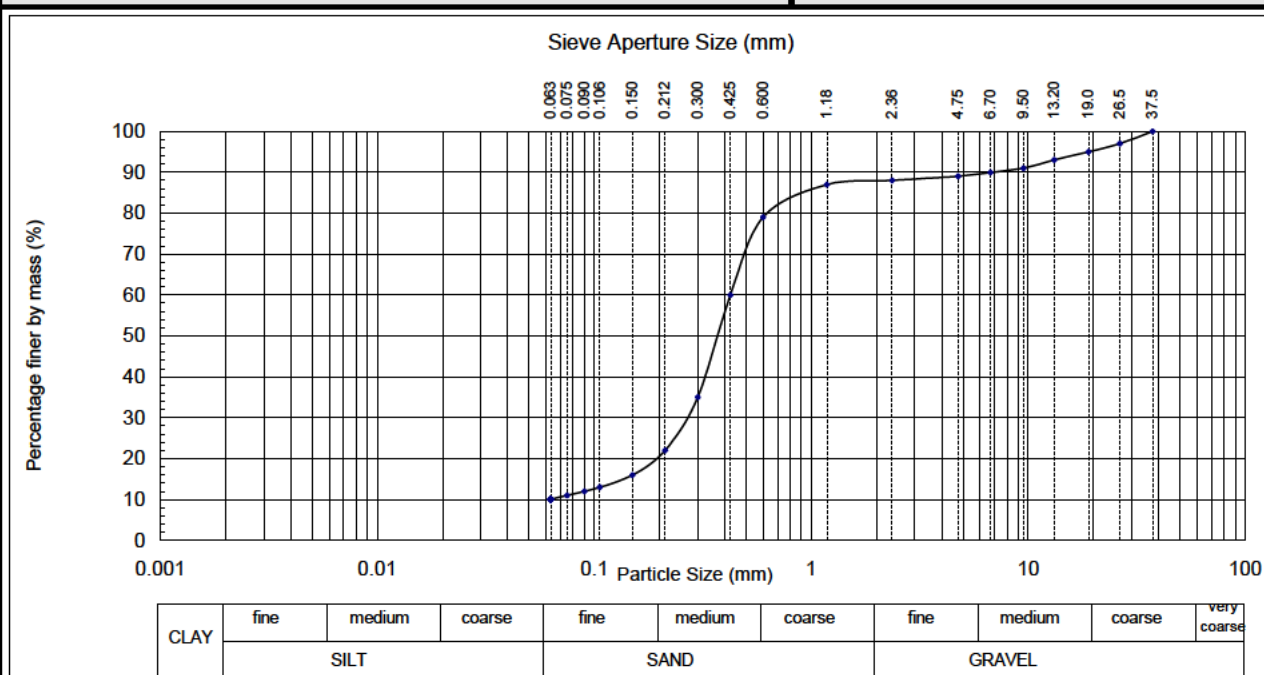


Project: **Waterloo WTP Ground Improvement 3-WW019.11**
 Location: **Waterloo Water Treatment Plant, Oxford Tce, LH**
 Client: **Wellington Water**
 Contractor: **Griffiths Drilling Limited**
 Sampled by: **s7(2)(a)**
 Date sampled: **3.9.20**
 Sampling method: **Sonic core drilling**
 Sample source: **BH104 5.5-6.0m**
 Sample description: **SAND:**
 Sample condition: **As received**
 Solid density (fines) **n/a** t/m³ **Assumed**
 Water content as rec'd **28.7** % **whole**

Report No: **522900/1406**
 Sample No: **2-20/298**
 Client Ref: **3-WW019.11**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
37.5	100	4.75	89	0.212	22				
26.5	97	2.36	88	0.150	16				
19.0	95	1.18	87	0.106	13				
13.20	93	0.600	79	0.090	12				
9.50	91	0.425	60	0.075	11				
6.70	90	0.300	35	0.063	10				

Percent passing finest sieve obtained by difference



Test Methods (where used)	Notes
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Air dried
Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	Uncalibrated sieve sizes 0.212, 0.106, 0.090mm
	Project / sample details supplied by client

Date Tested: **10-23.11.20**
 Date Reported: **24.11.20**

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 Designation *Technical Officer*
 Date:

s7(2)(a)
24.11.20



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Appendix E Groundwater monitoring

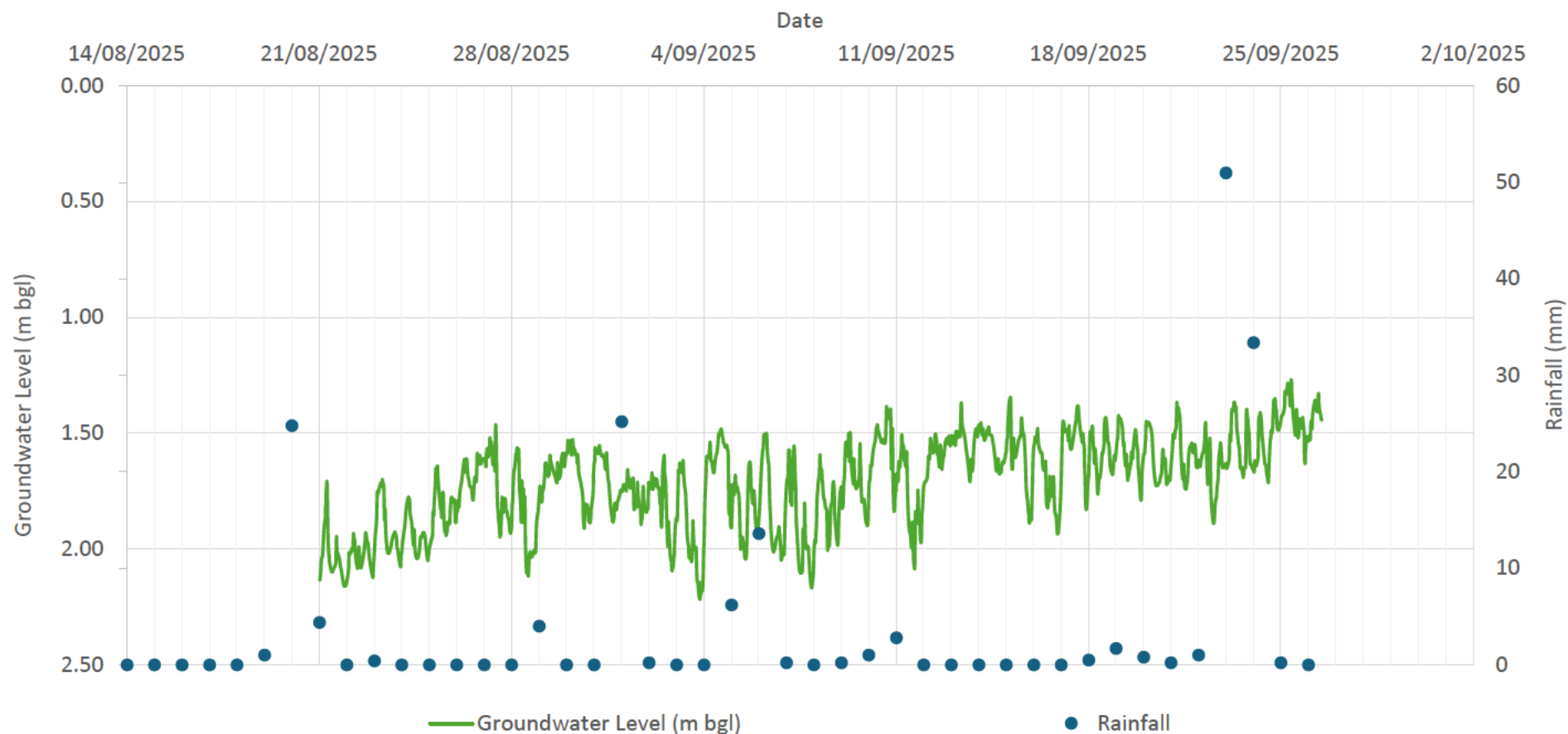
- Table E1: Summary of groundwater level measurements during drilling
- Table E2: Summary of standpipe piezometers and groundwater level measurements
- Figures E1 and E2: BH201 Continuous groundwater monitoring data

Table E1: Summary of groundwater level measurements during drilling

ID	Ground level, RL (m)	Date / Time	Groundwater level measurements	
			Depth (m)	Elevation, RL (m)
BH3	6	26/10/2016	2.5 (base of hole at 12.45m)	3.5
BH101	6.31	2/10/2020	1.7 (base of hole at 4.75m)	4.61
BH104	6.17	3/9/2020	0.0 (base of hole at 12m)	6.17
		4/9/2020	2.5 (base of hole at 12m)	3.67
		7/9/2020	2.3 (base of hole at 21.3m)	3.87
BH201	6	18/8/2025 4pm	2.1	3.9
		19/8/2025 8am	2.0	4.0
CPT201	6	20/8/2025 7pm	1.40 (before CPT)	4.6
		20/8/2025 9pm	Hole collapse – no reading (after CPT)	-
CPT202	6	20/8/2025 10pm	1.25 (after CPT)	4.75
CPT203	6	22/8/2025 7pm	1.25 (before CPT)	4.75
		22/8/2025 8pm	0.93 (after CPT)	5.07
CPT204	6	22/8/2025 7pm	Hole collapse - no reading (after CPT)	-
CPT205	7	21/8/2025 2am	2.0 (before CPT)	5.0
		21/8/2025 3am	Hole collapse - no reading (after CPT)	-
CPT206B	7	22/8/2025 2am	Hole collapse - no reading (after CPT)	-
CPT207	7	22/8/2025 4am	Hole collapse @ 2.5m, no water encountered (after CPT)	-
CPT208	6	21/8/2025 11pm	Hole collapse - no reading (after CPT)	-
CPT209	6	19/8/2025	1.6	4.4
CPT210	6	19/8/2025	1.6	4.4

Table E2: Summary of standpipes and groundwater level measurements

ID	Ground level, RL (m)	Screened RL (m)	Slotted unit	Date of measurements	Groundwater level measurements	
					Depth (m)	Elevation, RL (m)
BH3	6	-2 to -6	Marine and Alluvial Deposits	4/9/2020	1.9	4.10
				9/9/2020	1.6	4.40
				16/9/2020	1.5	4.50
				30/9/2020	1	5.00
				9/10/2020	1.27	4.73
				23/2/2021	2.45	3.55
				15/3/2021	5.5	0.50
BH101	6.31	-5.81 to -4.81	Waiwhetu Gravels	9/10/2020	1.95	4.36
				23/2/2021	3.05	3.26
BH104	6.17	-1.45 to +2.55	Taita Alluvium	9/9/2020	2.1	4.07
				16/9/2020	1.91	4.26
				30/9/2020	1.6	4.57
				9/10/2020	1.82	4.35
				23/2/2021	2.8	3.37
				15/3/2021	2.7	3.47
BH201	6	+0.2 to +5	Melling Peat / Taita Alluvium	21/8/2025 12am 21/8/2025 to 26/9/25	2.15 Refer Figure E1 High: 1.27 Low: 2.22 Average: 1.71	3.85 Refer Figure E2 High: 4.73 Low: 3.78 Average: 4.29

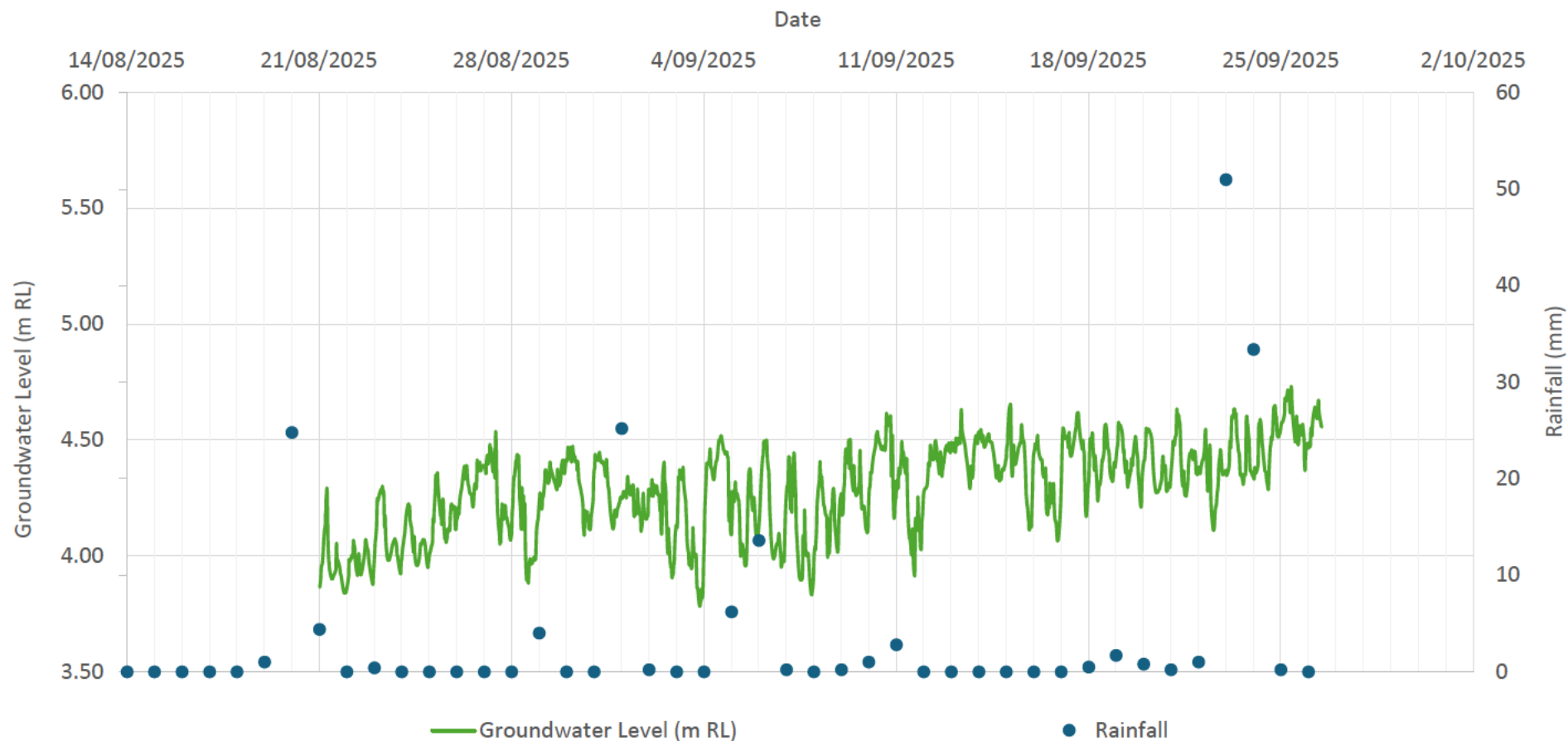


Rainfall data obtained from GWRC website, Hut River at Birch Lane Site.

Figure E1

Calc by: BHR
 Date: 6/10/2025

Waterloo Station Groundwater Level Monitoring (BH201)



Rainfall data obtained from GWRC website, Hut River at Birch Lane Site. Groundwater levels based on an approximate ground level of 6m RL.

Figure E2

Calc by: BHR
 Date: 6/10/2025

Waterloo Station Groundwater Level Monitoring (BH201)

