Kukas Brothers

Proposed Forster Civic Precinct Project
Cnr Lake, West and Middle Street, Forster

Geotechnical Assessment

Report No. RGS01471.1-AB

31 January 2016

REGIONAL
GEOTECHNICAL SOLUTIONS

Manning-Great Lakes

Port Macquarie

Coffs Harbour

RGS01471.1-AB

31 January 2016

Kukas Brothers
PO Box 205
FORSTER NSW 2290

Attention: Mal Kukas

Dear Mal,

RE: Proposed Forster Civic Precinct Project
Cnr Lake, West and Middle Street, Forster

Geotechnical Assessment

As requested, Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical assessment for the proposed Forster Civic Precinct Project at the corner of Lake, West and Middle Street, Forster.

Surface and subsurface conditions at the site as well as comments and recommendations on foundation conditions, earthworks and design parameters for foundation designs are presented in the attached report.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

For and on behalf of

Regional Geotechnical Solutions Pty Ltd

Steve Morton

Principal Engineer

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1 INTRODUCTION

As requested, Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical assessment of the proposed Forster Civic Precinct Project at the corner of Lake, West and Middle Streets, Forster.

It is understood that the proposed development comprises:

- Council Works - Library and Civic Centre;
- Evermore Retirement Village - 138 Retirement units and common areas;
- Retail precinct - small shopping centre, restaurants, cinema, retail and
- Hotel - Hotel units, serviced apartments, restaurant, lounge child care and gym.

The proposed development will comprise up to eleven stories plus up to two basement levels and will be constructed in various stages. Excavations would therefore be anticipated to be around 6 to 7m depth.

The purpose of the work described herein was to address:

- Foundation design parameters for shallow and piled foundations as appropriate;
- Earth retention parameters for the design of basement earth retention systems at the site;
- Assessment of geotechnical conditions affecting pile construction or installation;
- Potential for ground heave and damage to adjacent structures or neighbouring piles;
- Presence of acid sulfate soils at the site and the need for an acid sulfate soil management plan;
- Assessment of site conditions on pile and concrete durability, (sulphates, chlorides, pH in soil and water);
- Groundwater level, dewatering requirements and possible effect on surrounding buildings;
- Short and long term design parameters for the basement shoring design;
- Recommendations on acceptable temporary and permanent batter slopes;
- Earthquake site factor (to AS1170.4) and liquefaction potential;
- Any other comments relevant to design and construction as may be revealed by the investigation and testing.

2 FIELD WORK

Field work for the assessment was undertaken on 16 January 2017 and was based on the supplied drawings. Fieldwork included:

- Observation of site and surrounding features relevant to the geotechnical conditions of the site;
- Logging and sampling of six boreholes using Toyota 4WD mounted drilling rig;

- Six Cone Penetration Tests (CPT) within the development footprint; and
- Four in-situ falling head permeability tests.

Engineering logs of the boreholes, CPT results, and infiltration test results are presented in Appendix A. The locations of the boreholes, infiltration tests and CPT are shown on Figure 1. They were obtained on site by measurement relative to existing site features.

3 LABORATORY TESTING

Samples retrieved during field work were returned to a NATA registered laboratory for testing which included the following:

- Soil Aggressivity testing on two samples; and
- ASS Screening tests on eight samples and One Chromium Reducible Sulfur analysis to detect oxidisable sulphur and acid generating potential.

4 SITE CONDITIONS

4.1 Surface Conditions

The site is situated in flat to gently undulating topography associated with a broad, wind-blown sand plain on the eastern side of Wallis Lake.

Surface slopes across the site are generally flat to 1^0, increasing towards the south west corner up to 3 to 5^0 toward south at the southern boundary of the site.

An image of the site taken from the NSW Department of Property Information website is reproduced below.

Approximate extent of site in red.

The site is bound by residential houses to the east and south east, Lake Street to north, West Street to the west and Middle Street to the south. Currently the site is vacant except for some paved areas on the north-western portion of the site. Several large trees were present across the site. Previously the site was occupied by a school and associated buildings such as toilet blocks. A small house was observed approximately in the middle of the site.

Drainage of the site would be via a combination of overland flow and surface infiltration.

A selection of images of the site is presented below.

Looking northeast toward Lake Street from middle of site.

Looking northwest toward Lake Street from eastern part of site.

Looking south from eastern part of site.

Looking west toward West Street showing paved areas.

Looing north from south west corner of site near Middle Street

Looking south east from western portion of site showing abandoned toilet facilites

4.2 Subsurface Conditions

The Forster 1:100000 Quaternary Geology map indicates that the site is situated in an area underlain by Pleistocene backbarrier flats which comprise marine sand, indurated sand, silt, clay, gravel, organic mud and peat.

The investigations encountered a deep sand profile. The profile encountered within the boreholes and CPTs undertaken for this investigation is summarised in Table 1 and Figure 2.

Table 1: Summary of Subsurface Materials

Material Unit	Material Name	Material Description	Depth to Base of Material Layer (m)					
			CPT1 BH3, BH6	CPT2 BH5	CPT3 BH4	CPT4 BH2	CPT5	CPT6 BH1
1	TOPSOIL	SAND, fine to medium, grey with organic fines, Sandy Gravel up to 0.15m encountered at BH3	0.3	0.1	0.25	0.1	0.1	0.1
2a	Aeolian Sand (MD)	SAND, fine to medium, white	2.8, 12.3	2.6	3.65, 11.75	2.25, 11.85	2.5, 11.48	1.6, 10.0
2b	Aeolian Sand – with Indurated layers (D - VD)	SAND, fine to medium, white with at the bottom up to 800mm of medium dense sand. Interlayered thin medium dense bands and indurated sands encountered.	9.23, 14.5	*≥ 4.65**	9.84**, 13.62	9.6, 14.3	8.45, 13.87	7.5, 12.04
2c	Aeolian Sand (VL -L)	Silty SAND/Sandy Silt, fine to medium sand with thin very stiff layer of clay soil	10.7, 14.6		10.47, 13.65	10.01, 14.34	9.45, 13.89	8.01, 12.05
3	Alluvial Clay	CLAY/Silty CLAY, stiff to very stiff clay	*≥ 15.4*		*≥ 15.45*	*≥ 15.5*	*≥ 18.2*	*≥15.0*

Table Notes: ≥ *Base of material layer not encountered*
* *Refusal on indurated sand layer*
** *Within 3.65 to 9.84m for CPT3 thin layer of Loose to Very Loose sand(5.2-5.5), Stiff to Very Stiff Clay (5.5-5.65) and Loose Sand (5.65-5.7) encountered.*

Groundwater was encountered in all test locations at depths summarised in Table 2. Groundwater levels do fluctuate as a result of climatic variations such as prolonged rainfall or extended periods of low rainfall etc.

Table 2: Summary of Groundwater Depths (m) Below Existing Surface

CPT1 BH3, BH6	CPT2 BH5	CPT3 BH4	CPT4 BH2	CPT5	CPT6 BH1
4.0	4.0	3.0	4.0	3.8	3.4

It should be noted that fluctuations in groundwater levels can occur as a result of seasonal variations, temperature, rainfall and other similar factors, the influence of which may not have been apparent at the time of the assessment.

5 PROPOSED DEVELOPMENT AND GEOTECHNICAL CONSTRAINTS

The proposed development will I involve several stages that include up to 6m of excavation in the south west corner and up to 3m excavation over the rest of the site. Groundwater was encountered at depths of between 3.4 and 4.0 below current site level.

Pending review of the design loads, structures could be supported by raft foundations on Unit 2b or piles founded within the Unit 3 stiff to very stiff clay.

During excavations for a basement level groundwater inflows are likely to occur and a dewatering management plan is likely to be required.

6 EXCAVATION CONDITIONS AND DEWATERING

Excavation depths are currently not known, however, it is understood that single and double basement developments are proposed and these are likely to require excavations of up to 3m and 6m respectively. Excavation to these depths will encounter sands and will be achievable with conventional hydraulic excavators or backhoes, pending appropriate dewatering of the excavation area. Slow digging may be encountered in very dense sand horizons at depth, depending on the depth and width of excavation.

Estimated excavation depths are shown relative to groundwater levels and soil profiles encountered, on Figure 2. As shown by Figure 2, single basement excavations may not encounter the permanent groundwater table over much of the site, however, there may be localised inflows from perched water tables within the upper 3m, as perched water tables on lenses of indurated sand within the upper 3m of the profile are common in the area.

Excavations below 3m depth will encounter groundwater, and dewatering will be required. Management of construction dewatering will be necessary to manage the risk of damage to adjacent properties due to dewatering induced settlement. It is recommended that recharge and partial cutoff measures be employed during dewatering for excavation to reduce off-site drawdown impacts.

Partial cut-off measures could involve the use of sheet piles or similar, founded within the Unit 2a or Unit 2b sand materials. The excavation area could then be dewatered using a series of spear points inside the perimeter of the wall, together with a line of groundwater injection bores outside the partial cutoff wall to maintain groundwater levels beneath surrounding structures, which would limit groundwater drawdown outside the excavation and thereby reduce the risks of settlement due to lowering of the groundwater table.

Driving of sheet piles may result in settlement of the loose sands and could result in vibration and/or settlement impacts on the adjacent buildings. Alternatively, cut-off walls could be constructed using secant pilling. Secant piling would result in significantly lower ground vibration impacts and could potentially be used for the basement walls subject to suitability from a structural and architectural perspective.

Prior to dewatering, detailed design of the dewatering system would need to be carried out by a dewatering specialist, and would also need to take into account potential impacts on nearby registered water bores.

7 EARTH RETENTION & BATTERED SLOPES

Where space permits, temporary batter slopes can be constructed in sand materials above the groundwater level at 1.5H:1V. Excavations below the water table will require dewatering and/or shoring using continuous steel shoring (eg. Sheet piles) or other temporary casing due to the potential for collapse of waterlogged sands into the excavation.

Temporary or permanent retaining walls at the site can be designed based on the following parameters:

- Bulk unit weight, ɣ = 20 kN/m^3
- Effective Friction Angle, Ø' = 29°
- Effective Cohesion, c' = 0 kPa
- Active Earth Pressure Coefficient, Ka = 0.45
- Passive Earth Pressure Coefficient, Kp = 2.20
- At Rest Earth Pressure Coefficient, Ko = 0.75

Design of the walls must take into account any surcharge from loadings behind the wall. Drainage measures as described above, if properly maintained, should reduce pore pressures at the back of the wall to zero, however, pore pressures may still be generated at other points behind the wall. The design should incorporate an allowance for such pressures and a fluctuating groundwater table.

8 INFILTRATION RATES

Infiltration testing was undertaken in four locations during the investigation and a summary of the results is presented in Table 3 below.

Table 3: Summary of Infiltration Test Results

Test Location#	Measured Infiltration Rate (m/s)
IT1 below 0.5m from existing ground	6.78×10^{-4}
IT2 below 0.65m from existing ground	1.02×10^{-2}
IT3 below 0.7m from existing ground	1.03×10^{-2}
IT4 below 0.5m from existing ground	1.48×10^{-3}

The site is underlain by about 0.2m of topsoil overlying aeolian sand. For sand below topsoil and up to 0.6m depth an infiltration rate of 1×10^{-4}m/s can be adopted, and below 0.6m from the existing surface an infiltration rate of about 1.02×10^{-2}m/s is appropriate for the aeolian sands.

9 SOIL AGGRESSIVITY

Two samples were submitted to a NATA accredited laboratory for chemical analysis. The results are presented in Appendix B.

In accordance with the aggressivity and exposure classifications provided in AS2159-2009 the soil would be considered non-aggressive to steel and mildly aggressive for concrete.

10 ACID SULFATE SOILS

Sampling and analysis for the presence of Acid Sulfate Soils (ASS) has been undertaken in areas where excavations are expected to occur. Reference to the Forster 1:25,000 Acid Sulfate Soil Risk Map indicates the site is situated within an area with no known occurrence of ASS.

Eight samples of Aeolian soils obtained were screened for the presence of actual or potential ASS using methods 21Af and 21Bf of the ASSMAC Acid Sulfate Soils Manual. The test results are attached in Appendix B and are summarised in Table 4.

Table 4. Summary of ASS Screening Test results

Borehole #	Soil Type	Depth (m)		$pH_{(F)}$	$pH_{(Fox)}$
		From	To		
BH1	SAND	2.4	2.6	6.94	5.46
BH1	SAND	3.5	3.6	6.73	5.30
BH2	SAND	0.5	0.6	7.10	5.38
BH2	SAND	3.7	3.8	5.05	3.95
BH4	SAND	0.8	1.0	5.75	4.88
BH4	SAND	3.7	3.9	6.12	5.20
BH5	SAND	1.4	1.5	6.15	5.13
BH6	SAND	4.0	4.1	6.51	5.21

In the ASS Screening test, pH <4 is an indicator of Actual ASS and pH_{FOX} values of less than 3 and a pH change of greater than 2 can be an indicator of Potential ASS. Based on the results, the soils encountered are not actual or potential acid sulfate soil.

To provide a more comprehensive assessment, one sample was submitted for Chromium Reducible Sulphur (CRS) analysis. A summary of the test results is presented in Table 5.

Table 5: Summary of CRS Analysis

Borehole	Depth (m)	Texture	Acid Trail (mol H+/tonne)		Sulfur Trail (% S Oxidisable)	
			TAA	Action Criteria	S_{cr}	Action Criteria
BH2	3.7 – 3.8	Coarse	67	18	0.007	0.03

The sample tested during the current investigation recorded Titratable Actual Acidity (TAA) concentrations that exceed the adopted action criteria, thus indicating that there is actual acidity.

CRS (Scr) results were below the adopted action criteria which indicates that the sample is not Potential ASS. Based on the results, the soils encountered within the assessment are acidic in nature but are not considered to be Acid Sulfate Soils due to the absence of oxidisable sulfur. As such, an Acid Sulfate Soil Management Plan will not be required. However, it would be prudent to apply lime at a rate of 6kg/tonne (dry weight) to excavation spoil that is to be re-used, to neutralise the acid present in the site soils. It is recommended that good quality agricultural lime be used and thoroughly mixed through before re-use.

11 FOUNDATIONS

11.1 Foundation Options

Based on the subsurface conditions encountered at the site, there are several options for support of proposed structures. These options include:

- Stiffened raft footings in the medium dense to dense sand in the upper profile, designed to accommodate total and differential settlements; or
- Friction piles founded within the medium dense to very dense sands

11.2 Stiffened Raft Footings

The building could be founded on a stiffened raft slab specifically designed to accommodate the expected settlements. For a stiffened raft slab founded on the existing sands in the upper profile an allowable bearing pressure of 200kPa could be adopted. For the assessment of settlements over the effective depth of influence for the slab, the elastic values for vertical response provided in Table 6 may be adopted.

11.3 Piled Foundations

Taking into account the close proximity of buildings to the site and the presence of deep sands, driven piles should not be adopted due to the likelihood of vibration induced damage. Grout injected piles (CFA or similar) will provide an appropriate alternative. Geotechnical design parameters for pile foundations have been provided in Table 6.

The distribution of the nominated soil types within the profile is summarised in Figure 2. End bearing piles founded in sands should be designed such that the base of the pile is not within four pile diameters of any underlying loose sand layer, or clay layer. Founding less than six diameters from the base of the dense or very dense sand layer will result in lower pile capacities than those shown, due to the influence of the underlying layer. Therefore, as a guide, 600mm diameter piles designed for end bearing should be founded either:

- In the dense sand above RL -6.5m (4 pile diameters above the underlying loose sand zone); or
- In the medium dense to very dense sand between RL -10m and -11.5m (4 pile diameters above the underlying clay.

Alternatively, deeper piles can be utilised to take advantage of the available skin friction provided the end bearing is restricted to the values nominated in Table 6 for the underlying clay.

Table 6: Ultimate Design Parameters for Non-Displacement Piles

Material Unit	Material Name	Ultimate End Bearing Capacity, fb	Ultimate Shaft Adhesion-Compression, fms*	Effective Vertical Young's Modulus, E'v	Effective Horizontal Young's Modulus, E'h
2a	Aeolian Sand (MD)	3000 kPa	35 kPa	20 MPa	15 MPa
2b	Aeolian Sand (D - VD)	6000 kPa	40 kPa	30 MPa	20 MPa
2c	Aeolian Sand (VL -L)	--	20 kPa	15 MPa	12 MPa
3a	Alluvial Clay (St-Vst)	450 kPa	50 kPa	20 MPa	12 MPa

Notes: * For piles designed to resist uplift forces, it is recommended that the ultimate skin friction values given above be reduced by 50%

For pile design in accordance with AS2159-2009, 'Piling-Design and installation', the ultimate geotechnical strength (Rd,ug) can be calculated using the shaft capacity and ultimate end bearing capacity values provided in Table 6. Calculation of the design geotechnical strength (Rd,g) requires an assessment of the geotechnical strength reduction factor (Φg), which is based on a series of project specific variables. In assessing a suitable geotechnical strength reduction factor for this project, the following assumptions have been made:

- Design of piles and pile groups will be undertaken in accordance with the recommendations presented in this report;
- Limited geotechnical involvement will occur during pile installation;
- Some performance monitoring of the supported structure during or after construction; and
- The foundations will be designed by a designer of at least moderate experience in similar geotechnical profiles and pile design;
- Well established pile design methods will be adopted.

Based on the above and in accordance with AS2159-2009, a risk rating of 1.97 is estimated. Therefore, assuming the pile configuration will have low redundancy a Geotechnical Strength Reduction Factor of Φg=0.56 would be appropriate for the site if no static load testing is undertaken. This could be increased to Φg=0.71 if a proportion of the piles are dynamically tested or Φg=0.75 if a proportion of the piles are statically tested. In the event that any of the assumptions outlined above are not correct, the Geotechnical Strength Reduction Factor may change and further advice should be sought. Calculation sheets for assessment of the Geotechnical Reduction Factor are presented in Appendix C.

12 EARTHQUAKE SITE FACTOR

Based on the Australian Standard AS1170.4 – 2007 'Structural Design Actions Part 4: Earthquake Actions in Australia' the standard nominates earthquake factors based on Subsoil Class and specific locations within Australia. Based on the ground conditions encountered and the location of the site in Forster, design for earthquake effects can be undertaken for a Subsoil Class (De) Deep Soil Site and a site Hazard Factor (Z) of 0.08

13 LIMITATIONS

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points. If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

For and on behalf of

Regional Geotechnical Solutions Pty Ltd

Steve Morton

Principal Engineer

Figure

Proposed development Stage 2 with single basement

Proposed development Stage 1 with single basement

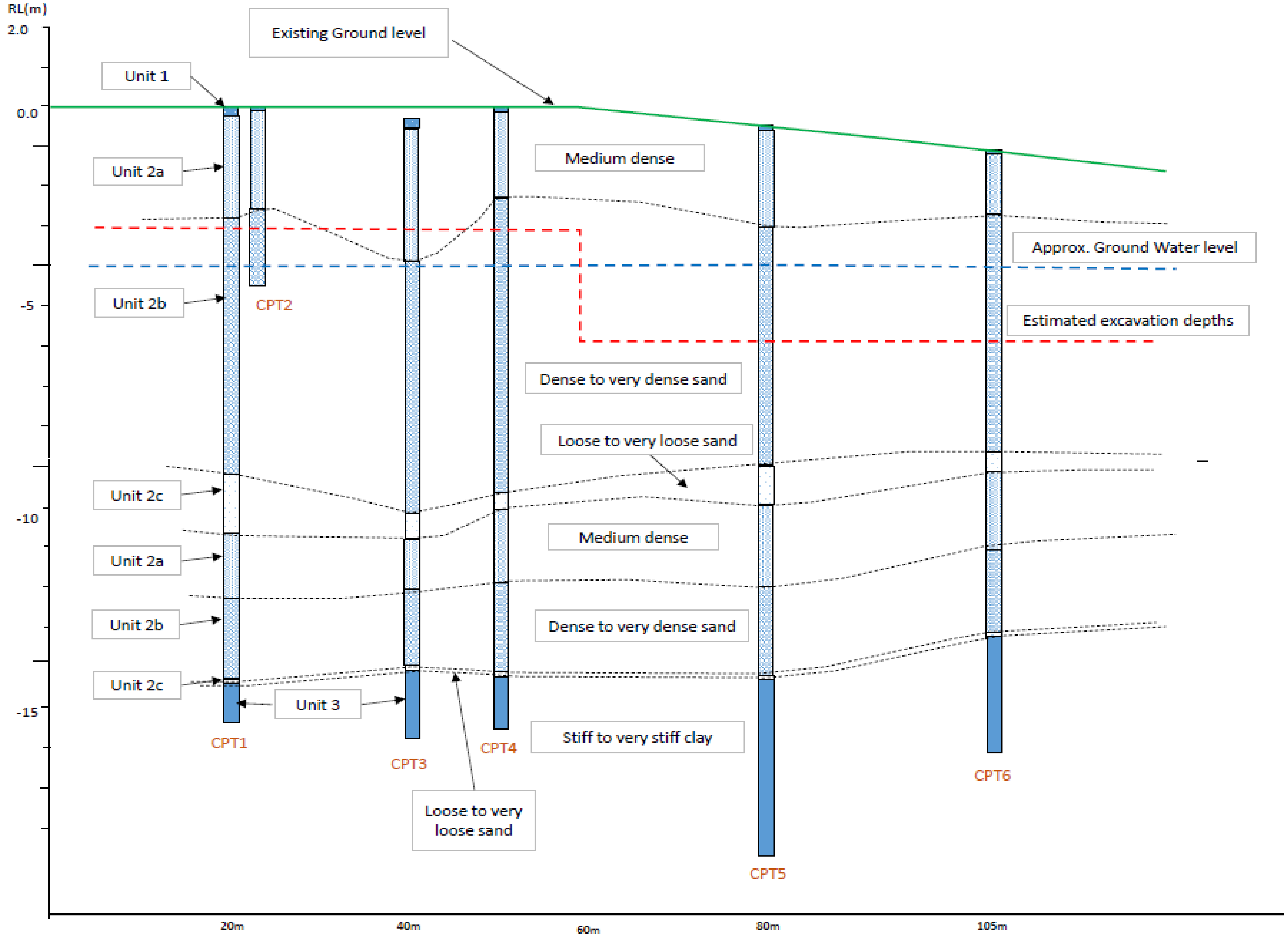
Proposed development Stage 4 with double basement

Legend

- Borehole Location
- CPT Location
- ● Infiltration Test Location

REGIONAL
GEOTECHNICAL SOLUTIONS

Client	Kukas Brothers	Job No.	RGS01471.1
Project:	Forster Civic Precinct Project	Drawn By:	CN
	Cnr Lake, West and Middle Street, Forster	Date:	30-Jan-17
Title:	Investigation Location Plan	Drawing No.	**Figure 1**



REGIONAL
GEOTECHNICAL SOLUTIONS

Client	Kukas Brothers	Job No.	RGS01471.1
Project:	Forster Civic Precinct Project	Drawn By:	CN
	Cnr Lake, West and Middle Street, Forster	Date:	30-Jan-17
Title:	Cross Section	Drawing No.	**Figure 2**

Appendix A

Results of Field Investigations

FALLING HEAD INFILTRATION TEST - CASED HOLE

CLIENT:	Kukas Brothers	**Job No.:**	RGS0471.1
PROJECT:	Proposed Forster Civic Precint Project	**Date:**	16-Jan-17
LOCATION:	Refer to Figure	**By:**	CN

Test number:	IT1	Test Location:	Refer to Figure 1
Hole radius (m):	0.042	Surface RL:	Not measured
Hole depth(m):	0.50	Casing stickup(m):	1.30
Depth to water table (m):		Water table RL(m)	Unknown

Reading	Time elapsed (min)	Depth to water (m)	Height of water (m)
1	0	0.000	1.80
2	0.25	0.015	1.79
3	0.5	0.025	1.78
4	0.75	0.040	1.76
5	1	0.063	1.74
6	1.5	0.090	1.71
7	2	0.117	1.68
8	2.5	0.141	1.66
9	3	0.165	1.64
10	3.5	0.187	1.61
11	4	0.208	1.59
12	4.5	0.226	1.57
13	5	0.245	1.56
14	5.5	0.262	1.54
15	6	0.281	1.52
16	6.5	0.300	1.50
17	7	0.316	1.48
18	7.5	0.332	1.47
19	8	0.348	1.45
20	8.5	0.363	1.44
21	9	0.379	1.42
22	9.5	0.394	1.41
23	10	0.408	1.39

Calculations

Constant loss time period:

Reading 1:	7	Time 1:	2	Height 1:	1.683
Reading 2:	16	Time 2:	6.5	Height 2:	1.500

Total time (min): 4.50

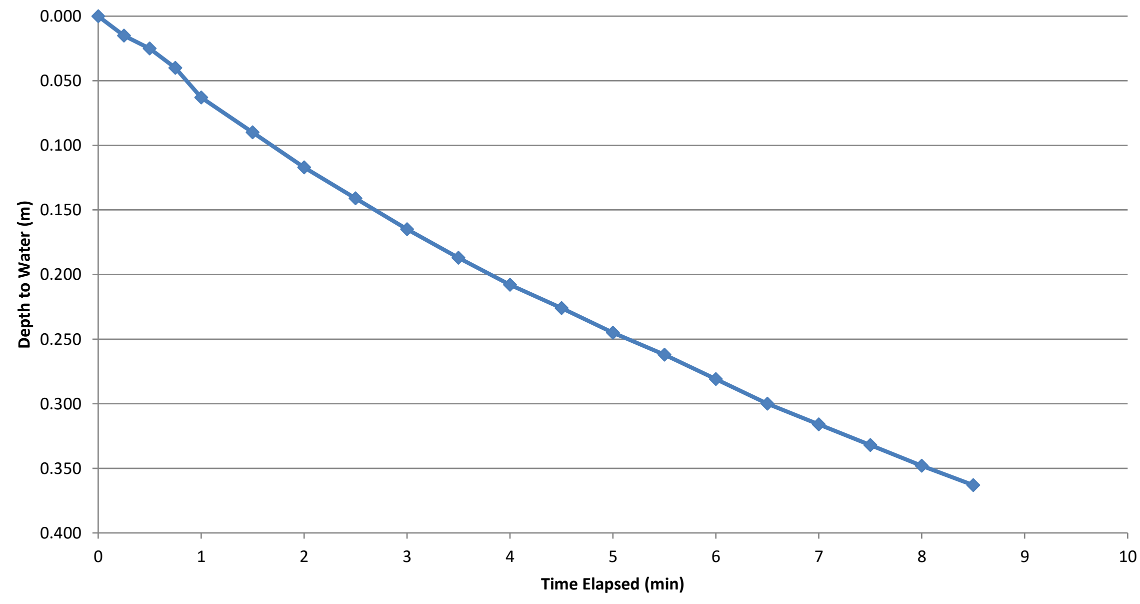
Total head loss (m): -0.183

In situ Permeability:

$$K = \frac{(Height\ 2 - Height\ 1)}{(Time\ 2 - Time1)}$$

K= 6.78E-04 m/sec

(x 10m/sec)



FALLING HEAD INFILTRATION TEST - CASED HOLE

CLIENT:	Kukas Brothers	**Job No.:**	RGS0471.1
PROJECT:	Proposed Forster Civic Precint Project	**Date:**	16-Jan-17
LOCATION:	Refer to Figure	**By:**	CN

Test number:	IT2	Test Location:	Refer to Figure 1
Hole radius (m):	0.042	Surface RL:	Not measured
Hole depth(m):	0.65	Casing stickup(m):	1.30
Depth to water table (m):		Water table RL(m)	Unknown

Reading	Time elapsed (min)	Depth to water (m)	Height of water (m)
1	0	0.000	1.95
2	0.25	0.221	1.73
3	0.5	0.420	1.53
4	0.75	0.620	1.33
5	1	0.770	1.18
6	1.5	1.030	0.92
7	2	1.370	0.58
8	2.5		
9	3		
10	3.5		
11	4		
12	4.5		
13	5		
14	5.5		
15	6		
16	6.5		
17	7		
18	7.5		
19	8		
20	8.5		
21	9		
22	9.5		
23	10		

Calculations

Constant loss time period:

Reading 1:	3	Time 1:	0.5	Height 1:	1.530
Reading 2:	6	Time 2:	1.5	Height 2:	0.920

Total time (min): 1.00

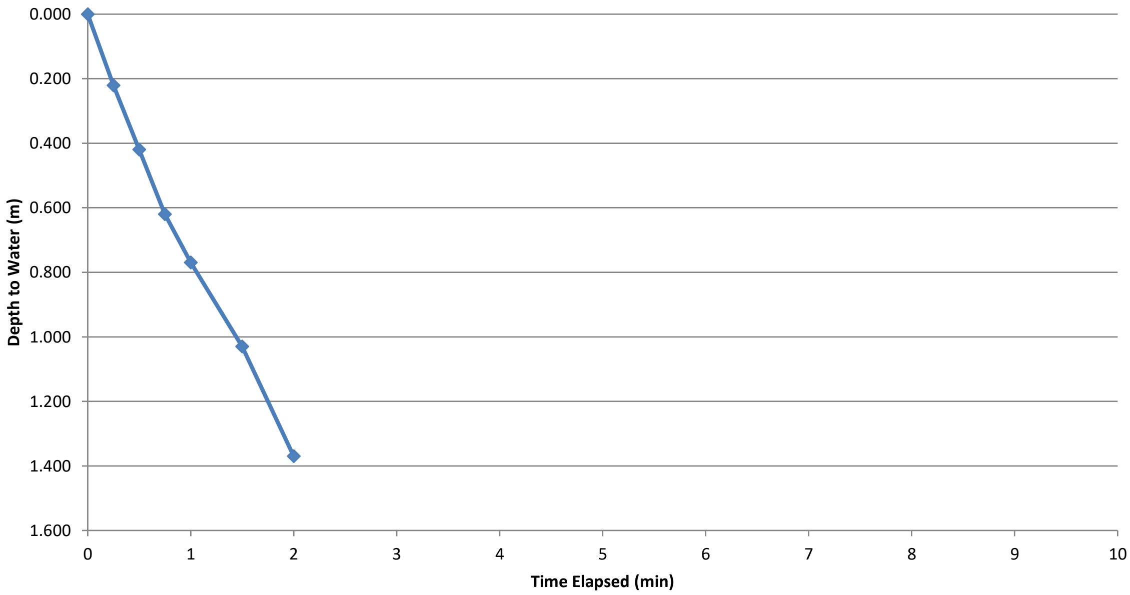
Total head loss (m): -0.610

In situ Permeability:

$$K = \frac{(Height\ 2 - Height\ 1)}{(Time\ 2 - Time1)}$$

K= 1.02E-02 m/sec

(x 10m/sec)



FALLING HEAD INFILTRATION TEST - CASED HOLE

CLIENT: Kukas Brothers
PROJECT: Proposed Forster Civic Precint Project
LOCATION: Refer to Figure

Job No.: RGS0471.1
Date: 16-Jan-17
By: CN

Test number:	IT3	Test Location:	Refer to Figure 1
Hole radius (m):	0.042	Surface RL:	Not measured
Hole depth(m):	0.70	Casing stickup(m):	1.30
Depth to water table (m):		Water table RL(m)	Unknown

Reading	Time elapsed (min)	Depth to water (m)	Height of water (m)
1	0	0.000	2.00
2	0.25	0.240	1.76
3	0.5	0.460	1.54
4	0.75	0.620	1.38
5	1	0.810	1.19
6	1.5	1.080	0.92
7	2	1.340	0.66
8	2.5		
9	3		
10	3.5		
11	4		
12	4.5		
13	5		
14	5.5		
15	6		
16	6.5		
17	7		
18	7.5		
19	8		
20	8.5		
21	9		
22	9.5		
23	10		

Calculations

Constant loss time period:

Reading 1:	3	Time 1:	0.5	Height 1:	1.540
Reading 2:	6	Time 2:	1.5	Height 2:	0.920

Total time (min): 1.00

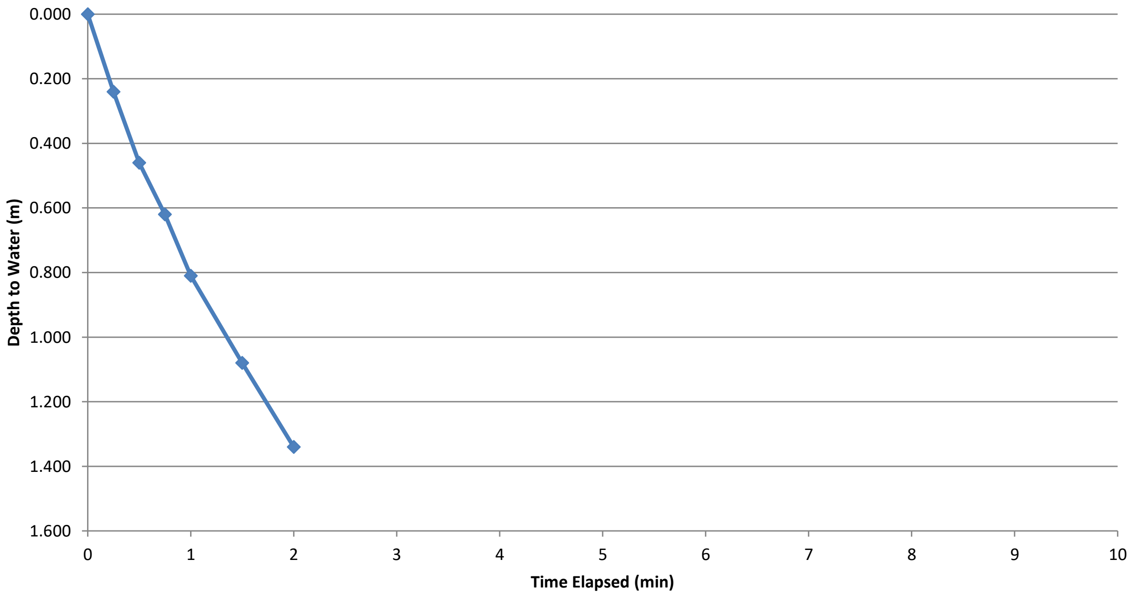
Total head loss (m): -0.620

In situ Permeability:

$$K = \frac{(Height\ 2 - Height\ 1)}{(Time\ 2 - Time1)}$$

K= 1.03E-02 m/sec

(x 10m/sec)



FALLING HEAD INFILTRATION TEST - CASED HOLE

CLIENT:	Kukas Brothers	**Job No.:**	RGS0471.1
PROJECT:	Proposed Forster Civic Precint Project	**Date:**	16-Jan-17
LOCATION:	Refer to Figure	**By:**	CN

Test number:	IT1	Test Location:	Refer to Figure 1
Hole radius (m):	0.042	Surface RL:	Not measured
Hole depth(m):	0.50	Casing stickup(m):	1.30
Depth to water table (m):		Water table RL(m)	Unknown

Reading	Time elapsed (min)	Depth to water (m)	Height of water (m)
1	0	0.000	1.80
2	0.25	0.035	1.77
3	0.5	0.077	1.72
4	0.75	0.110	1.69
5	1	0.150	1.65
6	1.5	0.215	1.59
7	2	0.280	1.52
8	2.5	0.342	1.46
9	3	0.400	1.40
10	3.5	0.458	1.34
11	4	0.510	1.29
12	4.5	0.560	1.24
13	5	0.608	1.19
14	5.5	0.655	1.15
15	6	0.700	1.10
16	6.5	0.745	1.06
17	7	0.786	1.01
18	7.5	0.826	0.97
19	8	0.865	0.94
20	8.5	0.902	0.90
21	9	0.940	0.86
22	9.5	0.975	0.83
23	10	1.008	0.79

Calculations

Constant loss time period:

Reading 1:	10	Time 1:	3.5	Height 1:	1.342
Reading 2:	20	Time 2:	8.5	Height 2:	0.898

Total time (min): 5.00

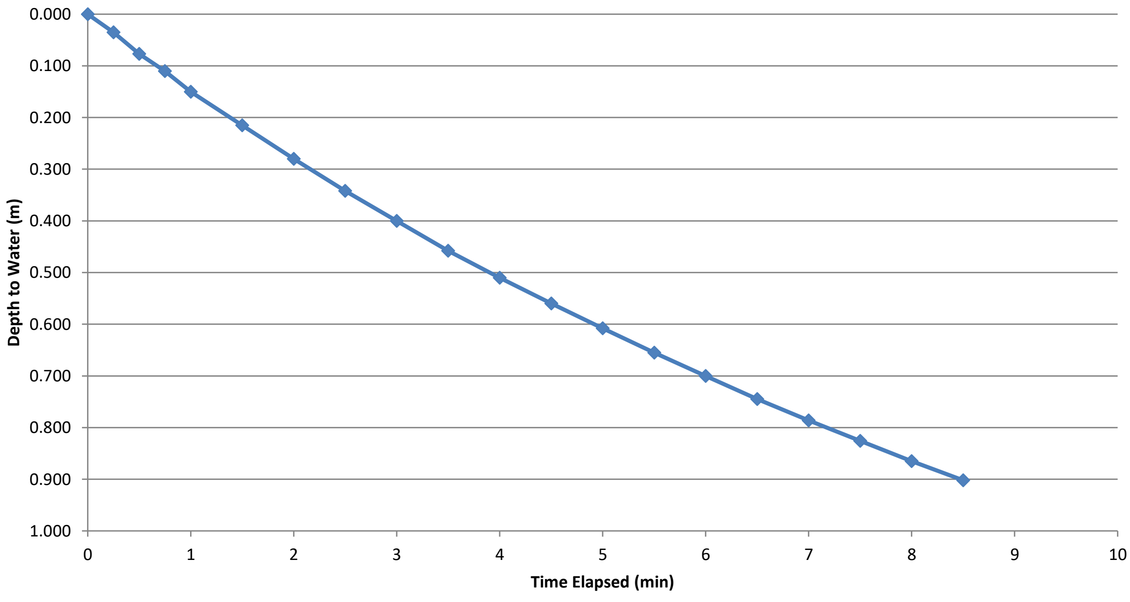
Total head loss (m): -0.444

In situ Permeability:

$$K = \frac{(Height\ 2 - Height\ 1)}{(Time\ 2 - Time1)}$$

K= 1.48E-03 m/sec

(x 10m/sec)



ENGINEERING LOG - BOREHOLE

CLIENT:	Kukas Brothers	**BOREHOLE NO:**	**BH1**
PROJECT NAME:	Forster Civic Precinct Project	**PAGE:**	1 of 1
SITE LOCATION:	Cnr Lake, West and Middle Street, Forster	**JOB NO:**	RGS01471.1
TEST LOCATION:	See figure 1	**LOGGED BY:**	CN
		DATE:	16/1/16

DRILL TYPE: Toyota 4WD Mounted Drill Rig **EASTING:** 454181 m **SURFACE RL:**

BOREHOLE DIAMETER: 100 mm **INCLINATION:** 90° **NORTHING:** 6439115 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information				Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC					SP	0.10m **TOPSOIL:** SAND, fine to medium grained, grey, white	M				TOPSOIL
					SP	**SAND:** Fine to medium grained, grey, white					AEOLIAN
		0.50m 0.60m D		0.5							
						0.70m					
					SP	**SAND:** Fine to medium grained, white					
		1.00m D 1.20m		1.0							
		1.50m D 1.70m		1.5							
		2.00m 2.10m D		2.0							
		2.40m D 2.60m		2.5							
				3.0							
	▶	3.50m 3.60m D		3.5			W				
				4.0		4.00m					
						Hole Terminated at 4.00 m					
				4.5							

LEGEND:

Water

▼ Water Level (Date and time shown)

▶ Water Inflow

◀ Water Outflow

Strata Changes

— — Gradational or transitional strata

—— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: **BH2**
CLIENT: Kukas Brothers
PAGE: 1 of 1
PROJECT NAME: Forster Civic Precinct Project
JOB NO: RGS01471.1
SITE LOCATION: Cnr Lake, West and Middle Street, Forster
LOGGED BY: CN
TEST LOCATION: See figure 1
DATE: 16/1/16

DRILL TYPE: Toyota 4WD Mounted Drill Rig
EASTING: 454204 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6439159 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC	Not Encountered			0.05m			**TOPSOIL:** SAND, fine to medium grained, grey	M				TOPSOIL
				0.25m		SP	**SAND:** Fine to medium grained, brown, grey					AEOLIAN
		0.50m 0.60m D		0.5 0.80m		SP	**SAND:** Fine to medium grained, grey, white					
		1.50m 1.60m D 2.90m 3.00m D		1.0 1.5 2.0 2.5 3.0 3.5 3.50m		SP	**SAND:** Fine to medium grained, white					
		3.70m 3.80m D		3.80m		SP	**SAND:** Fine to medium grained, dark brown, grey					INDURATED SAND
				4.0 4.5			Hole Terminated at 3.80 m					

LEGEND:

Water

Water Level (Date and time shown)
Water Inflow
Water Outflow

Strata Changes

— — Gradational or transitional strata
—— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

CLIENT:	Kukas Brothers	**BOREHOLE NO:**	**BH3**
		PAGE:	1 of 1
PROJECT NAME:	Forster Civic Precinct Project	**JOB NO:**	RGS01471.1
SITE LOCATION:	Cnr Lake, West and Middle Street, Forster	**LOGGED BY:**	CN
TEST LOCATION:	See figure 1	**DATE:**	16/1/16

DRILL TYPE:	Toyota 4WD Mounted Drill Rig	**EASTING:**	454191 m	**SURFACE RL:**	
BOREHOLE DIAMETER:	100 mm **INCLINATION:** 90°	**NORTHING:**	6439193 m	**DATUM:**	AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC	Not Encountered					SP	**FILL:** Sandy GRAVEL, fine to medium grained, fine to coarse grained Sand	D				FILL
				0.15m		SP	**SAND:** Fine to medium grained, grey, dark brown	M				AEOLIAN
				0.20m		SP	**SAND:** Fine to medium grained, white					
		0.50m		0.5								
		0.60m D										
				1.0								
				1.5								
		1.80m D 2.00m					Becoming white, pale brown					
				2.0								
				2.5								
		2.80m D 3.00m		3.0			3.00m					
							Hole Terminated at 3.00 m					
				3.5								
				4.0								
				4.5								

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

CLIENT:	Kukas Brothers	**BOREHOLE NO:**	**BH4**
PROJECT NAME:	Forster Civic Precinct Project	**PAGE:**	1 of 1
SITE LOCATION:	Cnr Lake, West and Middle Street, Forster	**JOB NO:**	RGS01471.1
TEST LOCATION:	See figure 1	**LOGGED BY:**	CN
		DATE:	16/1/16

DRILL TYPE:	Toyota 4WD Mounted Drill Rig	**EASTING:**	454245 m	**SURFACE RL:**	
BOREHOLE DIAMETER:	100 mm **INCLINATION:** 90°	**NORTHING:**	6439173 m	**DATUM:**	AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC						SP	0.10m **TOPSOIL:** SAND, fine grained, grey, brown	M				TOPSOIL
				0.5		SP	**SAND:** Fine to medium grained, grey					AEOLIAN
		0.80m D 1.00m		1.0		SP	0.60m **SAND:** Fine to medium grained, white					
				1.5								
		1.80m D 2.00m		2.0								
				2.5								
				3.0								
	▽			3.5				W				
		3.70m D 3.90m		4.0								
				4.5			4.50m					
							Hole Terminated at 4.50 m					

LEGEND:

Water

- ▼ Water Level (Date and time shown)
- ▶ Water Inflow
- ◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

CLIENT:	Kukas Brothers	**BOREHOLE NO:**	**BH5**
PROJECT NAME:	Forster Civic Precinct Project	**PAGE:**	1 of 1
SITE LOCATION:	Cnr Lake, West and Middle Street, Forster	**JOB NO:**	RGS01471.1
TEST LOCATION:	See figure 1	**LOGGED BY:**	CN
		DATE:	16/1/16

DRILL TYPE:	Toyota 4WD Mounted Drill Rig			**EASTING:**	454273 m	**SURFACE RL:**	
BOREHOLE DIAMETER:	100 mm	**INCLINATION:**	90°	**NORTHING:**	6439188 m	**DATUM:**	AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC	Not Encountered					SP	0.10m **TOPSOIL:** SAND, fine to medium grained, brown	M				TOPSOIL
		0.40m 0.50m D		0.5		SP	**SAND:** Fine to medium grained, grey, white 0.70m					AEOLIAN
		1.40m 1.50m D 2.80m D 3.00m		1.0 1.5 2.0 2.5 3.0		SP	**SAND:** Fine to medium grained, white 3.00m					
				3.5 4.0 4.5			Hole Terminated at 3.00 m					

LEGEND:

Water

▼ Water Level (Date and time shown)

►— Water Inflow

—◄ Water Outflow

Strata Changes

— — Gradational or transitional strata

—— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

CLIENT:	Kukas Brothers	**BOREHOLE NO:**	**BH6**
PROJECT NAME:	Forster Civic Precinct Project	**PAGE:**	1 of 1
SITE LOCATION:	Cnr Lake, West and Middle Street, Forster	**JOB NO:**	RGS01471.1
TEST LOCATION:	See figure 1	**LOGGED BY:**	CN
		DATE:	16/1/16

DRILL TYPE: Toyota 4WD Mounted Drill Rig
EASTING: 454181 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6439193 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC	Not Encountered					SP	0.10m **TOPSOIL:** SAND, fine to medium grained, brown, grey	M				TOPSOIL
				0.5		SP	**SAND:** Fine to medium grained, grey, white 0.70m					AEOLIAN
		4.00m 4.10m D		1.0 1.5 2.0 2.5 3.0 3.5 4.0		SP	**SAND:** Fine to medium grained, white 4.10m					
				4.5			Hole Terminated at 4.10 m					

LEGEND:

Water

- Water Level (Date and time shown)
- ▶— Water Inflow
- —◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

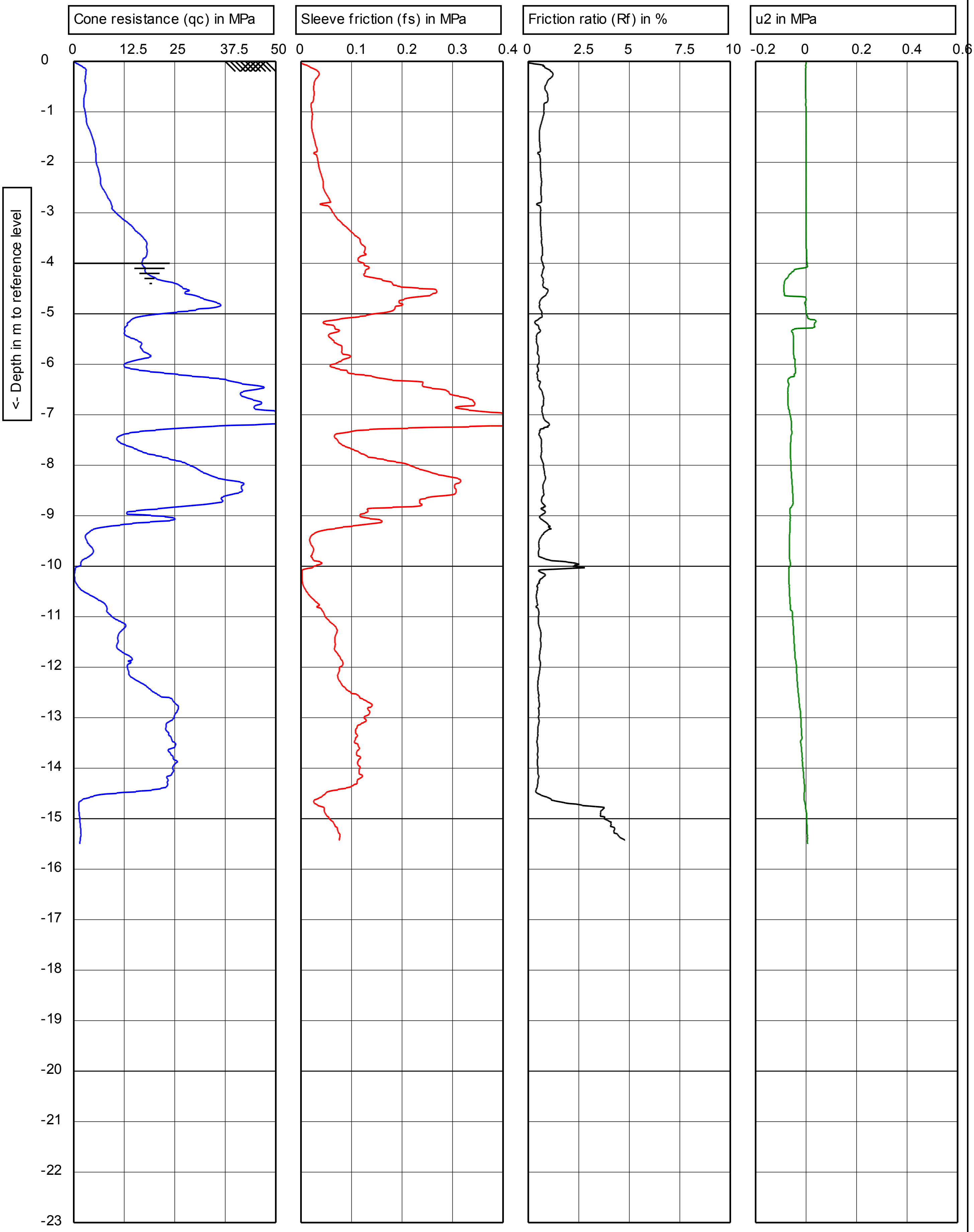
Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1

G.L. 0

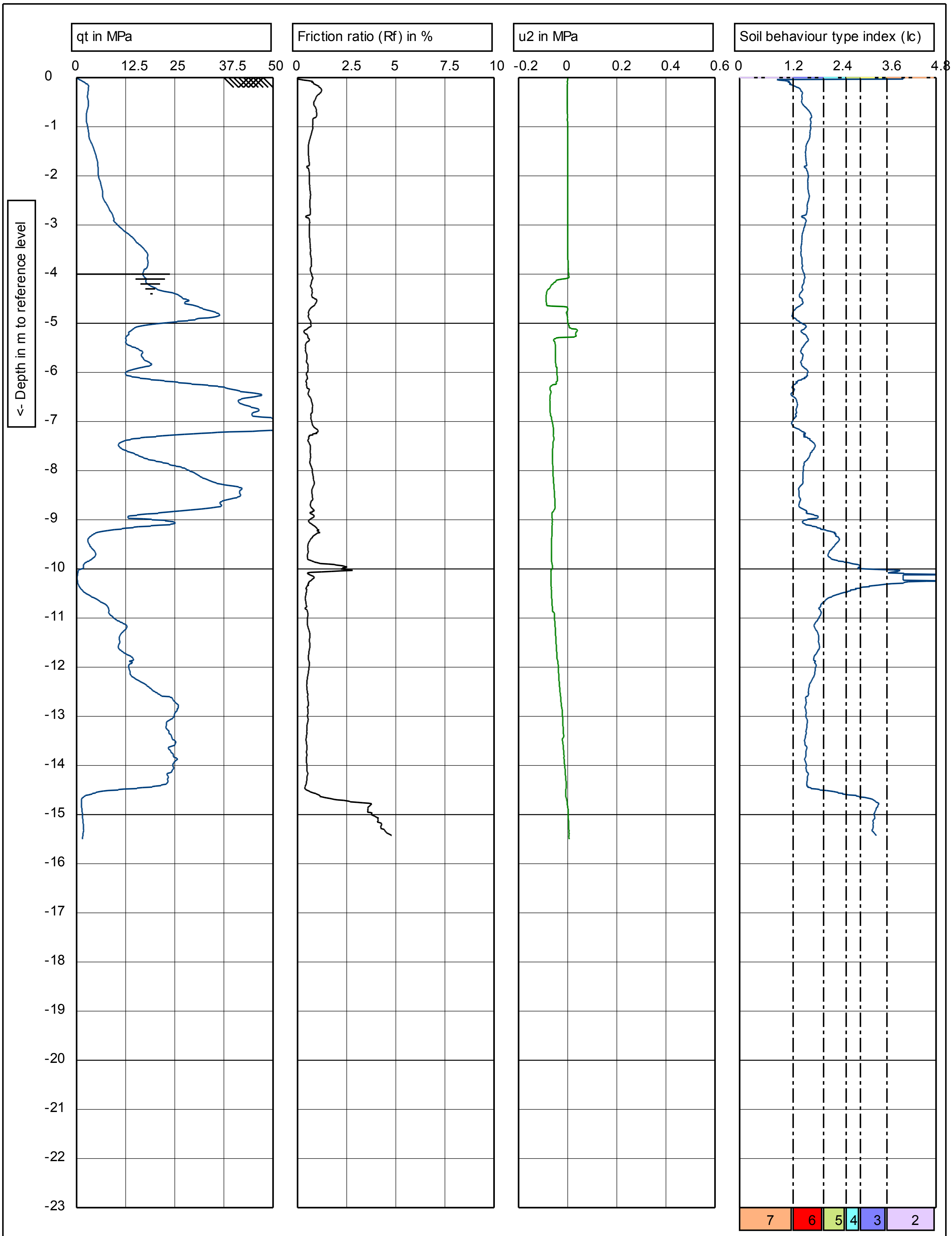
W.L.: **-4**

Project: **Geotechnical Investigation**
Location: **Cnr Middle & West St, Foster**
Position: **454188, 6439201 UTM Zone 56H**

Predrill : **0 m Predrilled**
Date: **1/16/2017**
Cone no.: **C10CFIIP.E38**
Project no.: **RGS01471.1**
CPT no.: **CPT-1**

1/3

1.40



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1

G.L. 0

W.L.: **-4**

Project: **Geotechnical Investigation**

Location: **Cnr Middle & West St, Foster**

Position: **454188, 6439201 UTM Zone 56H**

Predrill : **0 m Predrilled**

Date: **1/16/2017**

Cone no.: **C10CFIIP.E38**

Project no.: **RGS01471.1**

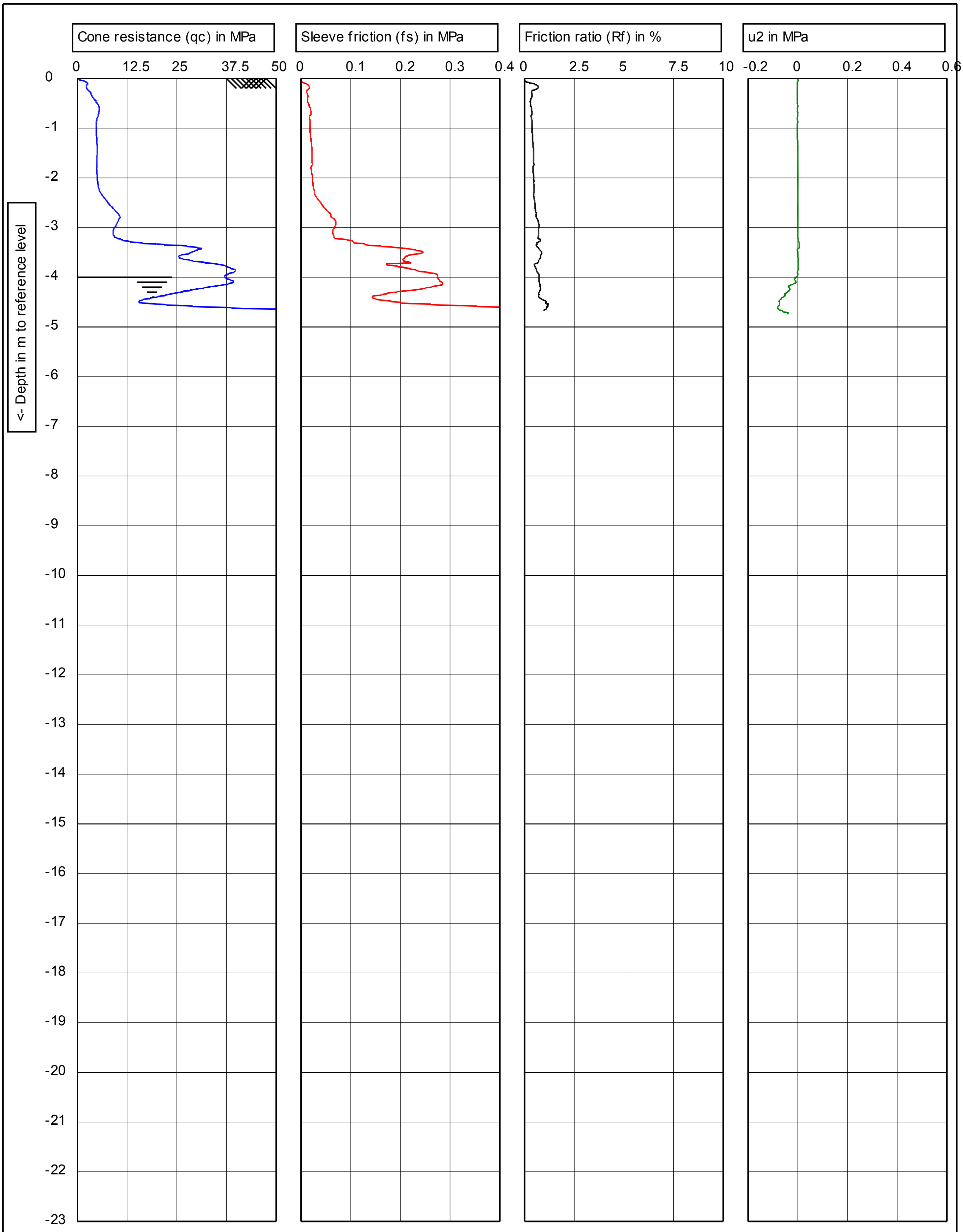
CPT no.: **CPT-1** **2/3**

1.40

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

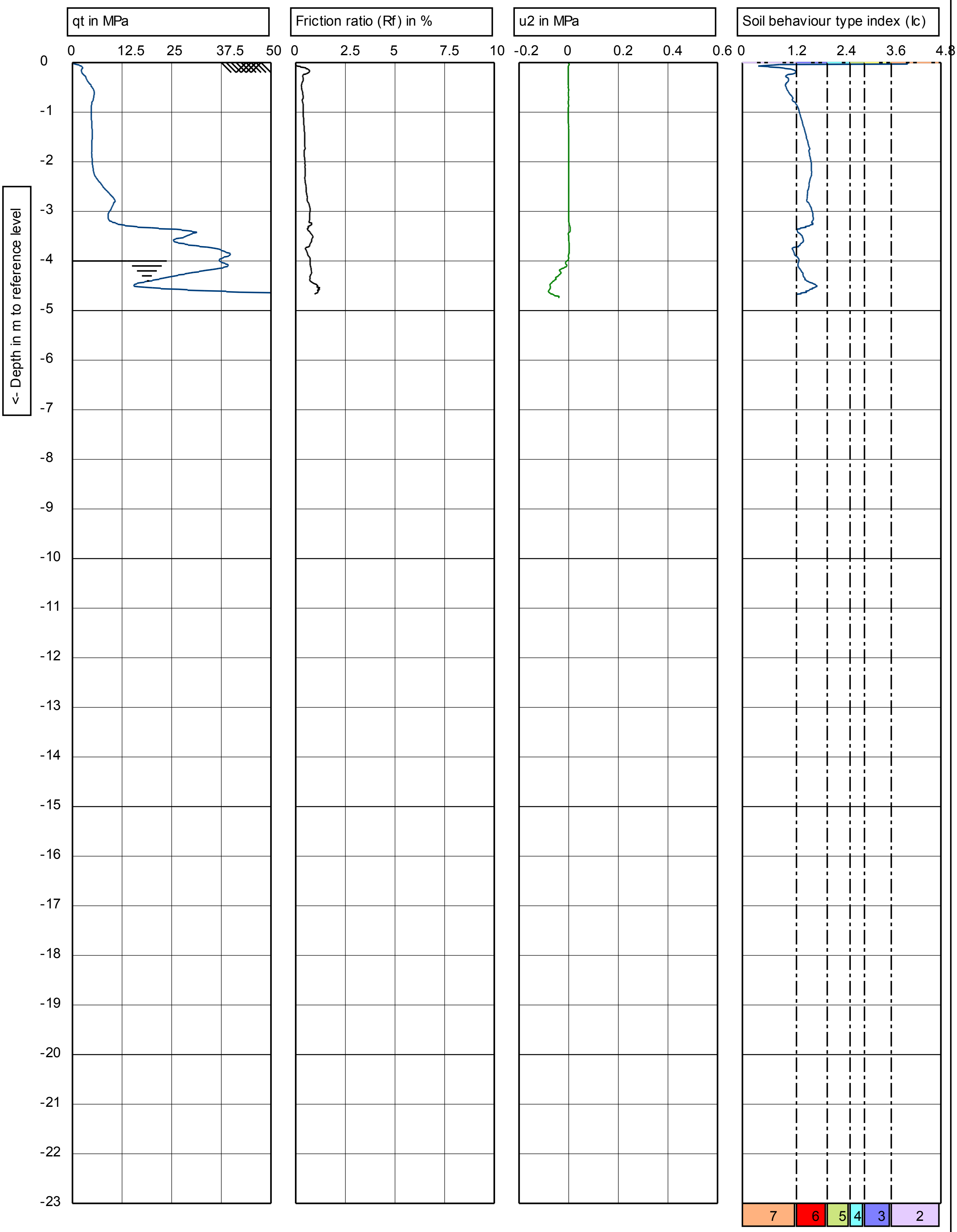
NEWSYD GEOTECHNICAL TESTING Ph:0408292638	u2 150 cm² 10 cm²	Test according NEN 5140 class 1		Predrill :	**0 m Predrilled**
		G.L. 0	W.L.: **-4**	Date:	**1/16/2017**
		Project: **Geotechnical Investigation**		Cone no.:	**C10CFIIP.E38**
		Location: **Cnr Middle & West St, Foster**		Project no.:	**RGS01471.1**
		Position: **454188, 6439201 UTM Zone 56H**		CPT no.:	**CPT-1** 3/3

1.40



NEWSYD GEOTECHNICAL TESTING Ph:0408292638	u2 150 cm² 10 cm²	Test according NEN 5140 class 1	Predrill :	**0 m Predrilled**
		G.L. 0 W.L.: **-4**	Date:	**1/16/2017**
	Project:	**Geotechnical Investigation**	Cone no.:	**C10CFIIP.E38**
	Location:	**Cnr Middle & West St, Foster**	Project no.:	**RGS01471.1**
	Position:	**454259, 6439192 UTM Zone 56H**	CPT no.:	**CPT-2** **1/3**

1.40



NEWSYD GEOTECHNICAL TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1
G.L. 0
W.L.: **-4**

Predrill : **0 m Predrilled**
Date: **1/16/2017**
Cone no.: **C10CFIIP.E38**
Project no.: **RGS01471.1**
CPT no.: **CPT-2** **2/3**

Project: **Geotechnical Investigation**
Location: **Cnr Middle & West St, Foster**
Position: **454259, 6439192 UTM Zone 56H**

1.40

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

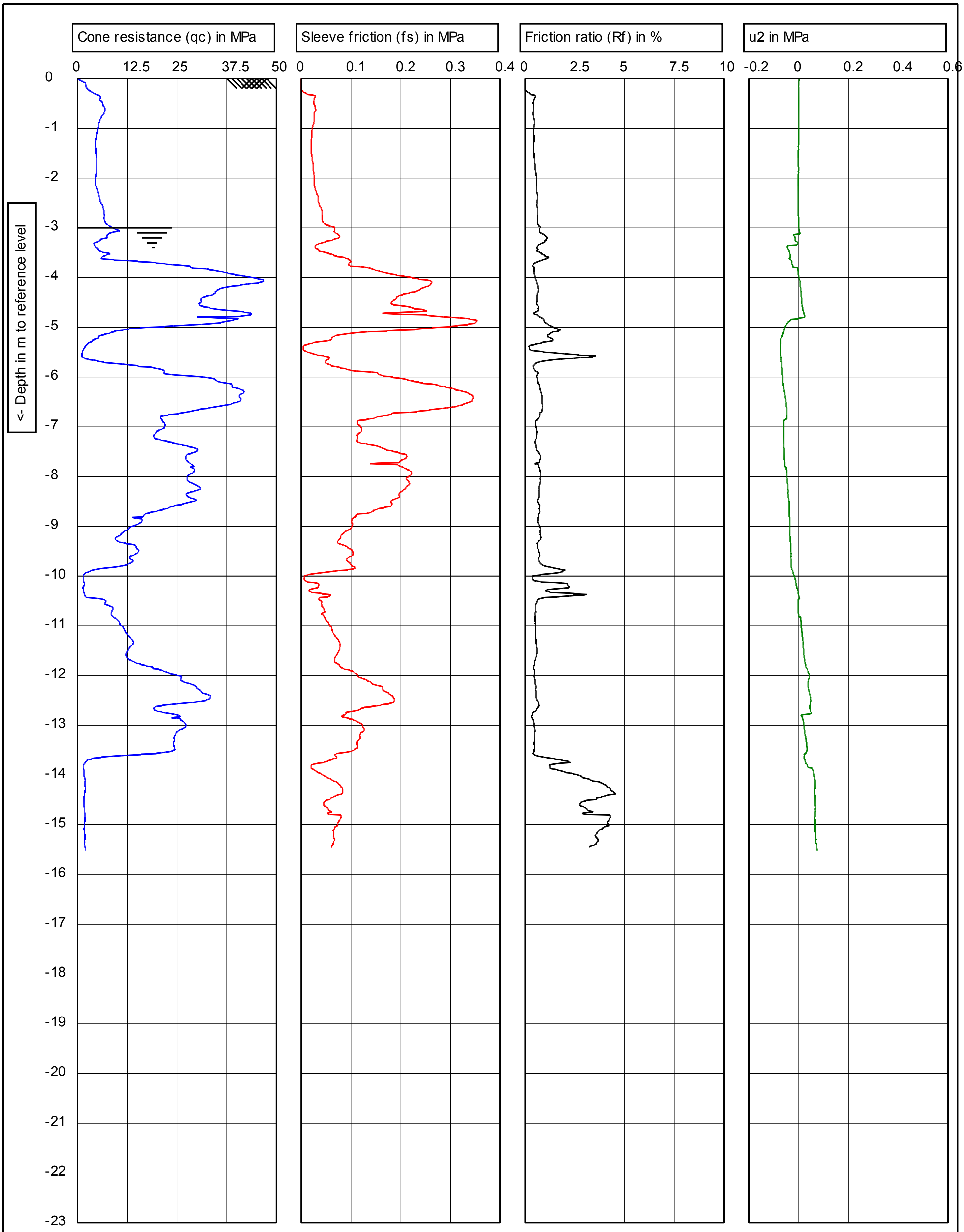
Test according NEN 5140 class 1

G.L. 0
W.L.: **-4**

Project: **Geotechnical Investigation**
Location: **Cnr Middle & West St, Foster**
Position: **454259, 6439192 UTM Zone 56H**

Predrill : **0 m Predrilled**
Date: **1/16/2017**
Cone no.: **C10CFIIP.E38**
Project no.: **RGS01471.1**
CPT no.: **CPT-2**
3/3

1.40



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

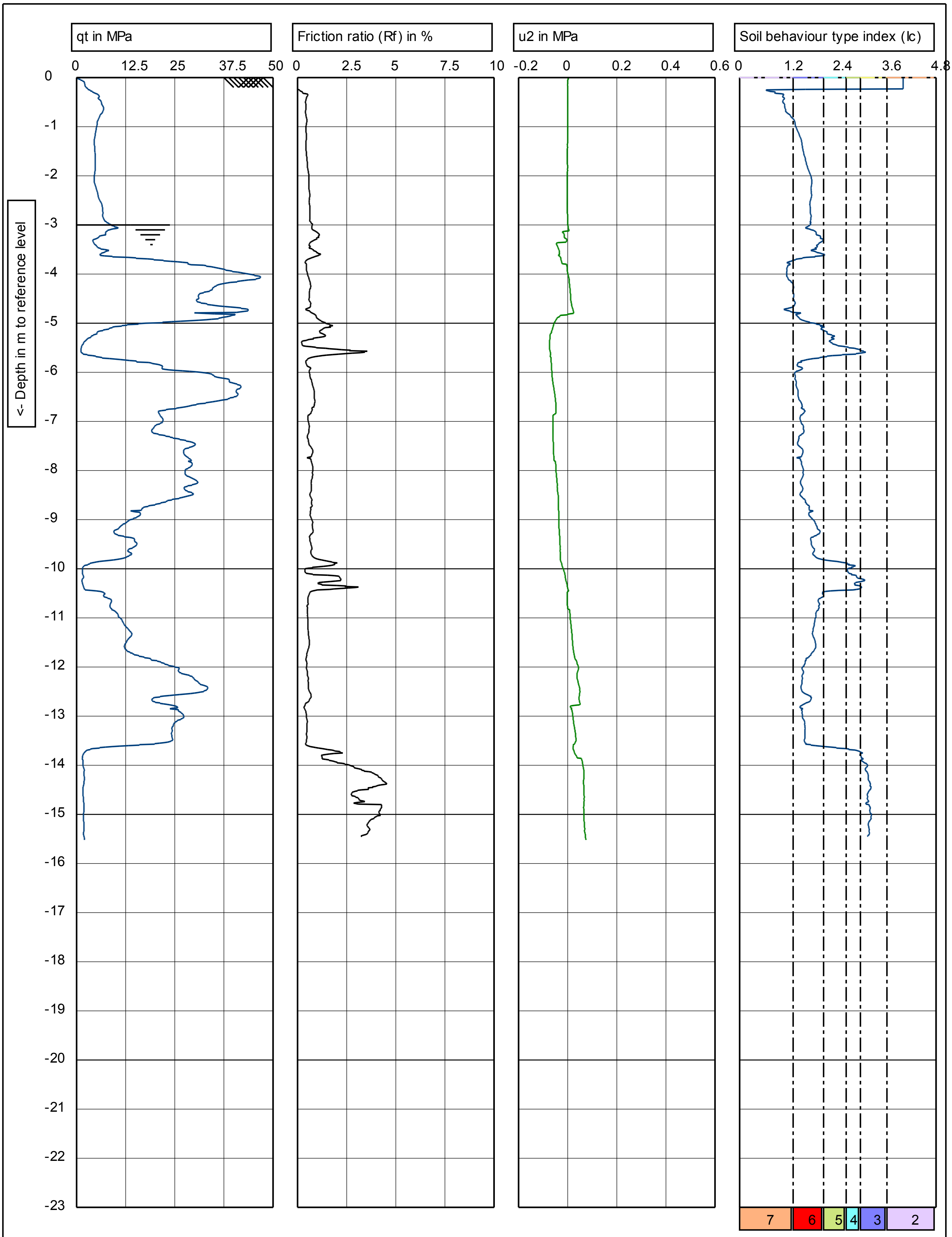
Test according NEN 5140 class 1

G.L. 0
W.L.: **-3**

Project: **Geotechnical Investigation**
Location: **Cnr Middle & West St, Foster**
Position: **454267, 6439164 UTM Zone 56H**

Predrill :	**0 m Predrilled**
Date:	**1/16/2017**
Cone no.:	**C10CFIIP.E38**
Project no.:	**RGS01471.1**
CPT no.:	**CPT-3** **1/3**

1.40



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1

G.L. 0

W.L.: **-3**

Project: **Geotechnical Investigation**

Location: **Cnr Middle & West St, Foster**

Position: **454267, 6439164 UTM Zone 56H**

Predrill : **0 m Predrilled**

Date: **1/16/2017**

Cone no.: **C10CFIIP.E38**

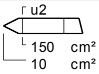
Project no.: **RGS01471.1**

CPT no.: **CPT-3** **2/3**

1.40

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638



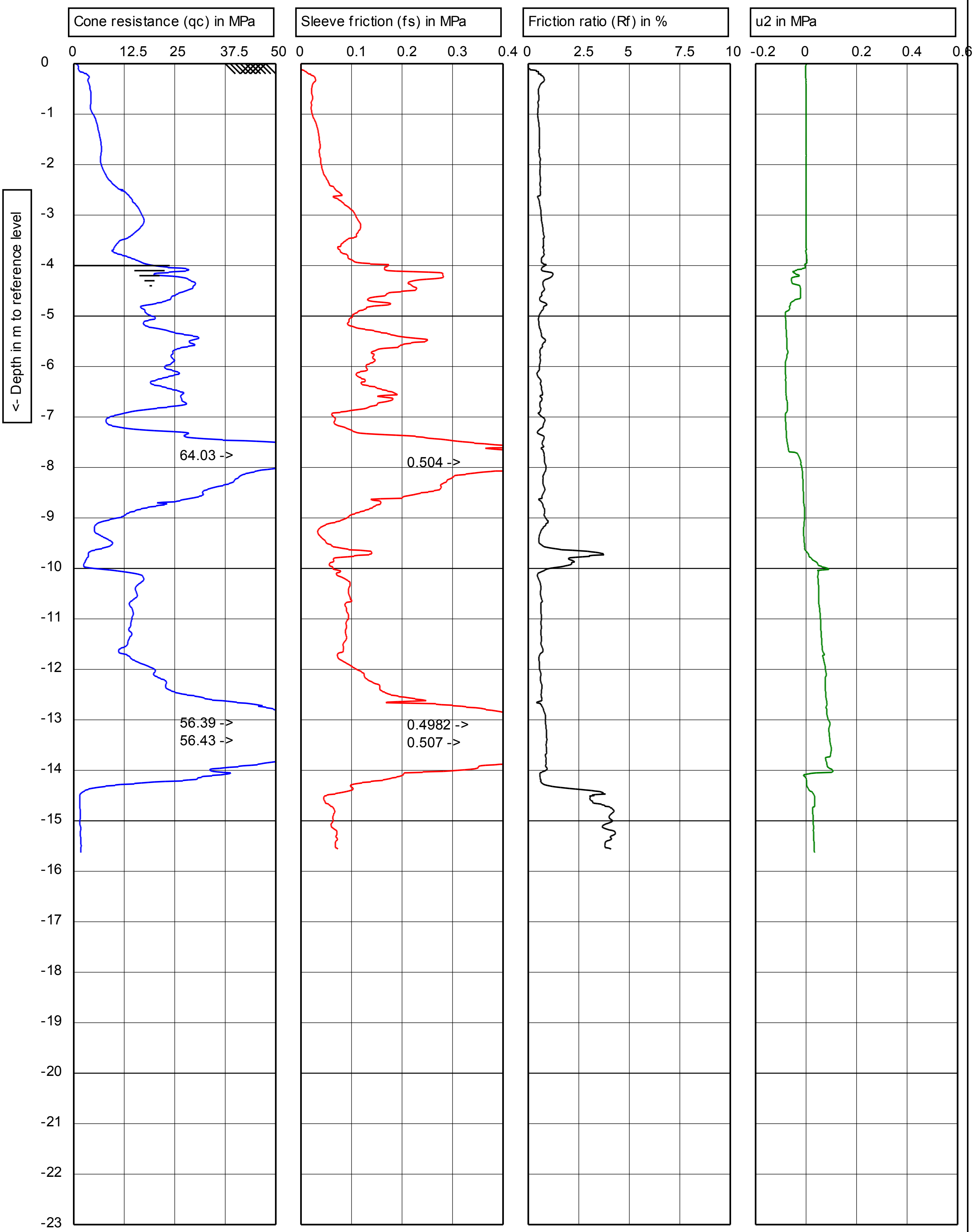
Test according NEN 5140 class 1

G.L. 0
W.L.: **-3**

Project: **Geotechnical Investigation**
Location: **Cnr Middle & West St, Foster**
Position: **454267, 6439164 UTM Zone 56H**

Predrill : **0 m Predrilled**
Date: **1/16/2017**
Cone no.: **C10CFIIP.E38**
Project no.: **RGS01471.1**
CPT no.: **CPT-3**
3/3

1.40



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1

G.L. 0

W.L.: **-4**

Predrill : **0 m Predrilled**

Date: **1/16/2017**

Cone no.: **C10CFIIP.E38**

Project no.: **RGS01471.1**

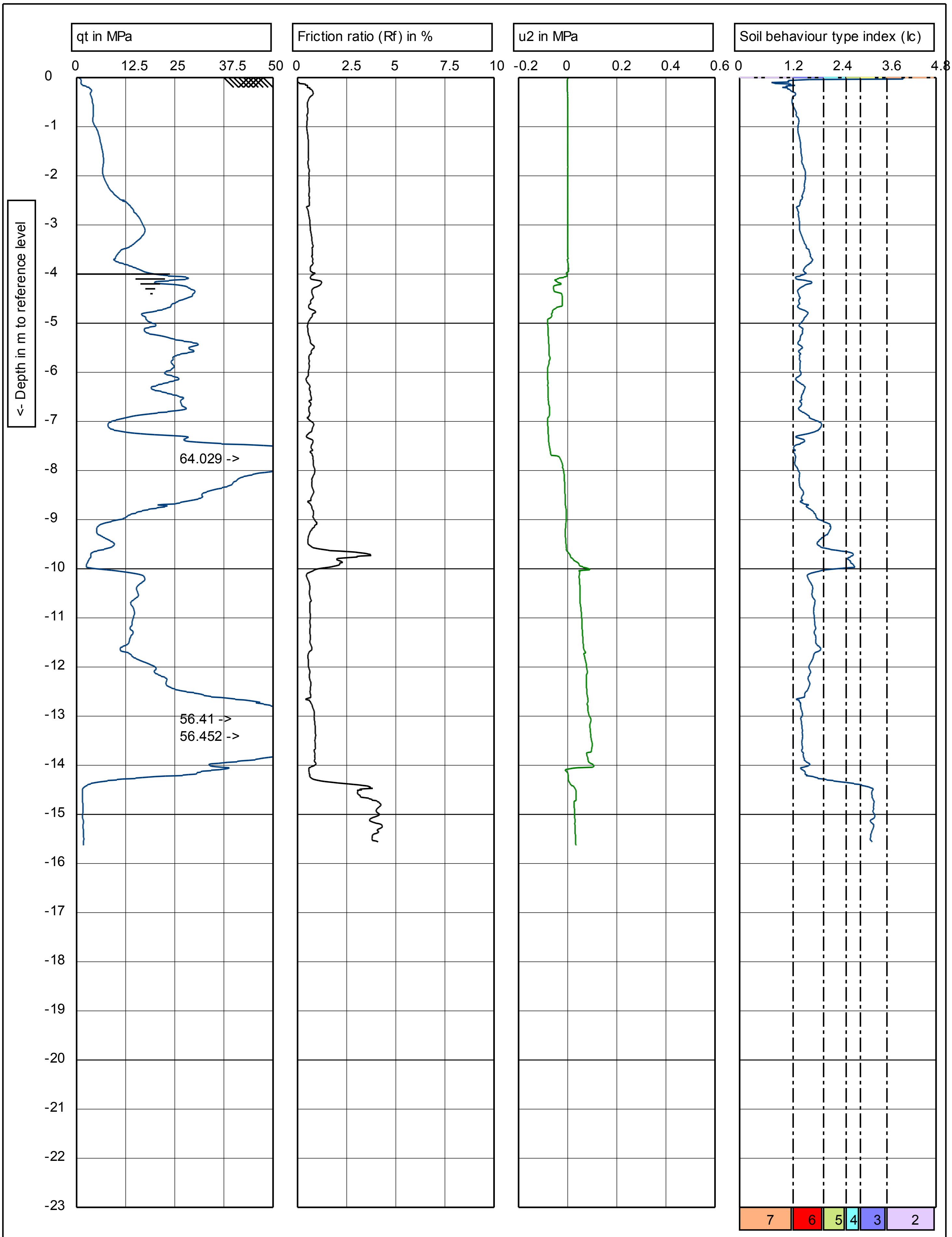
CPT no.: **CPT-4** **1/3**

Project: **Geotechnical Investigation**

Location: **Cnr Middle & West St, Foster**

Position: **454201, 6439168 UTM Zone 56H**

1:40



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1

G.L. 0

W.L.: **-4**

Project: **Geotechnical Investigation**

Location: **Cnr Middle & West St, Foster**

Position: **454201, 6439168 UTM Zone 56H**

Predrill : **0 m Predrilled**

Date: **1/16/2017**

Cone no.: **C10CFIIP.E38**

Project no.: **RGS01471.1**

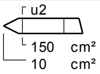
CPT no.: **CPT-4** **2/3**

1.40

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

1.40



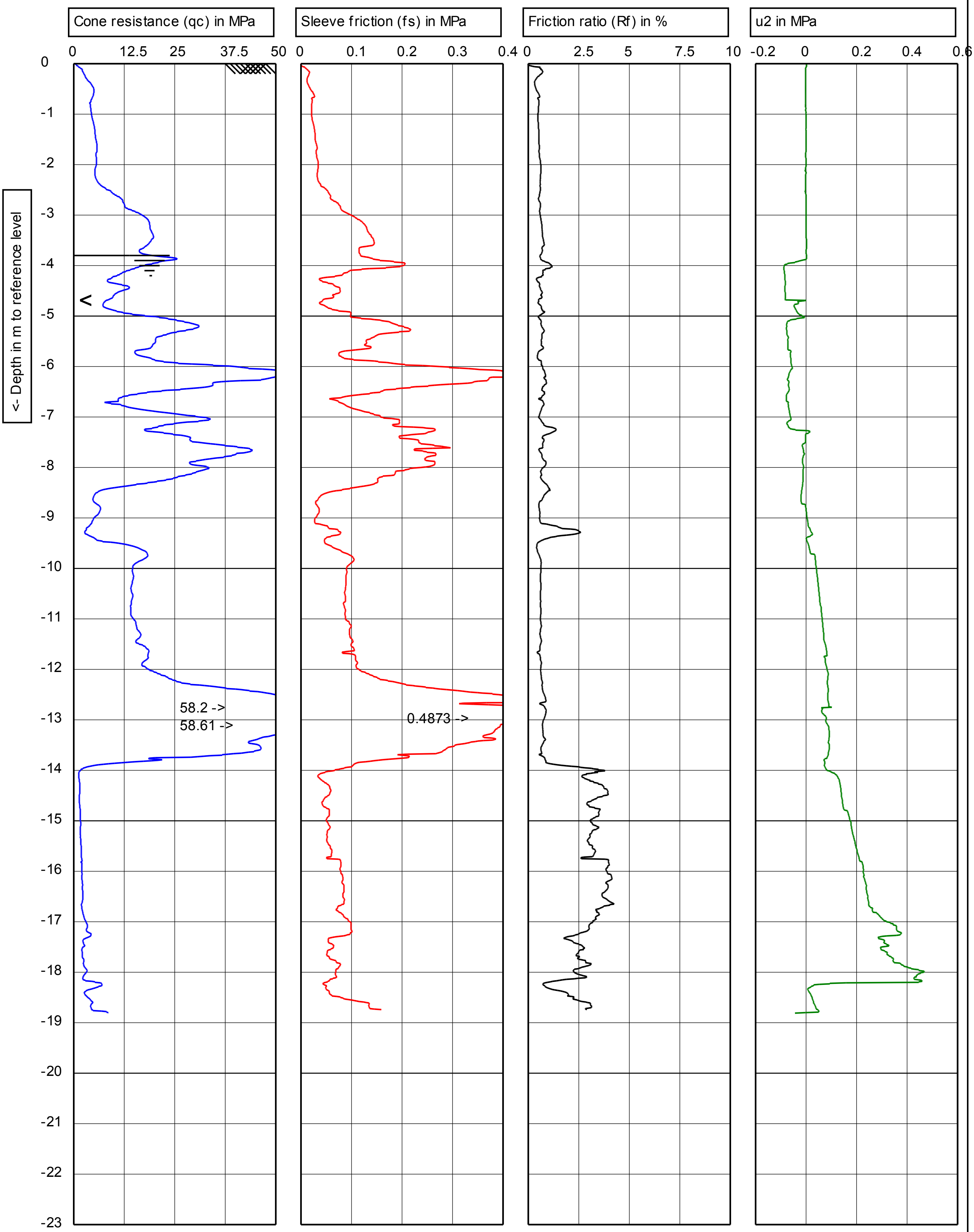
Test according NEN 5140 class 1

G.L. 0

W.L.: **-4**

Project: **Geotechnical Investigation**
Location: **Cnr Middle & West St, Foster**
Position: **454201, 6439168 UTM Zone 56H**

Predrill : **0 m Predrilled**
Date: **1/16/2017**
Cone no.: **C10CFIIP.E38**
Project no.: **RGS01471.1**
CPT no.: **CPT-4** **3/3**



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1

G.L. 0

W.L.: **-3.8**

Predrill : **0 m Predrilled**

Date: **1/16/2017**

Cone no.: **C10CFIIP.E38**

Project no.: **RGS01471.1**

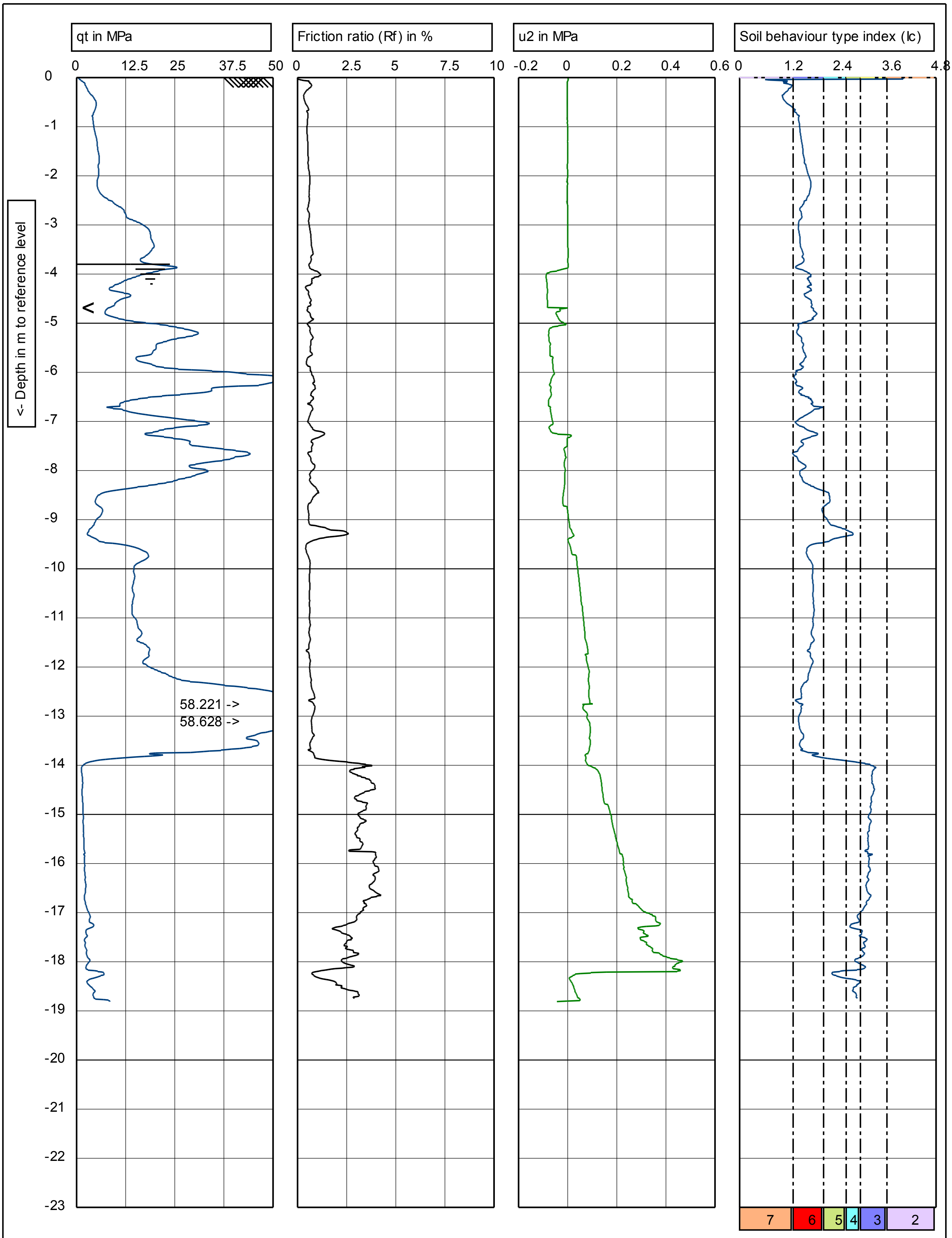
CPT no.: **CPT-05** 1/3

Project: **Geotechnical Investigation**

Location: **Cnr Middle & West St, Foster**

Position: **454176, 6439143 UTM Zone 56H**

1.40



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1

G.L. 0

W.L.: **-3.8**

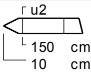
Project: **Geotechnical Investigation**
Location: **Cnr Middle & West St, Foster**
Position: **454176, 6439143 UTM Zone 56H**

Predrill : **0 m Predrilled**
Date: **1/16/2017**
Cone no.: **C10CFIIP.E38**
Project no.: **RGS01471.1**
CPT no.: **CPT-05** **2/3**

1.40

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

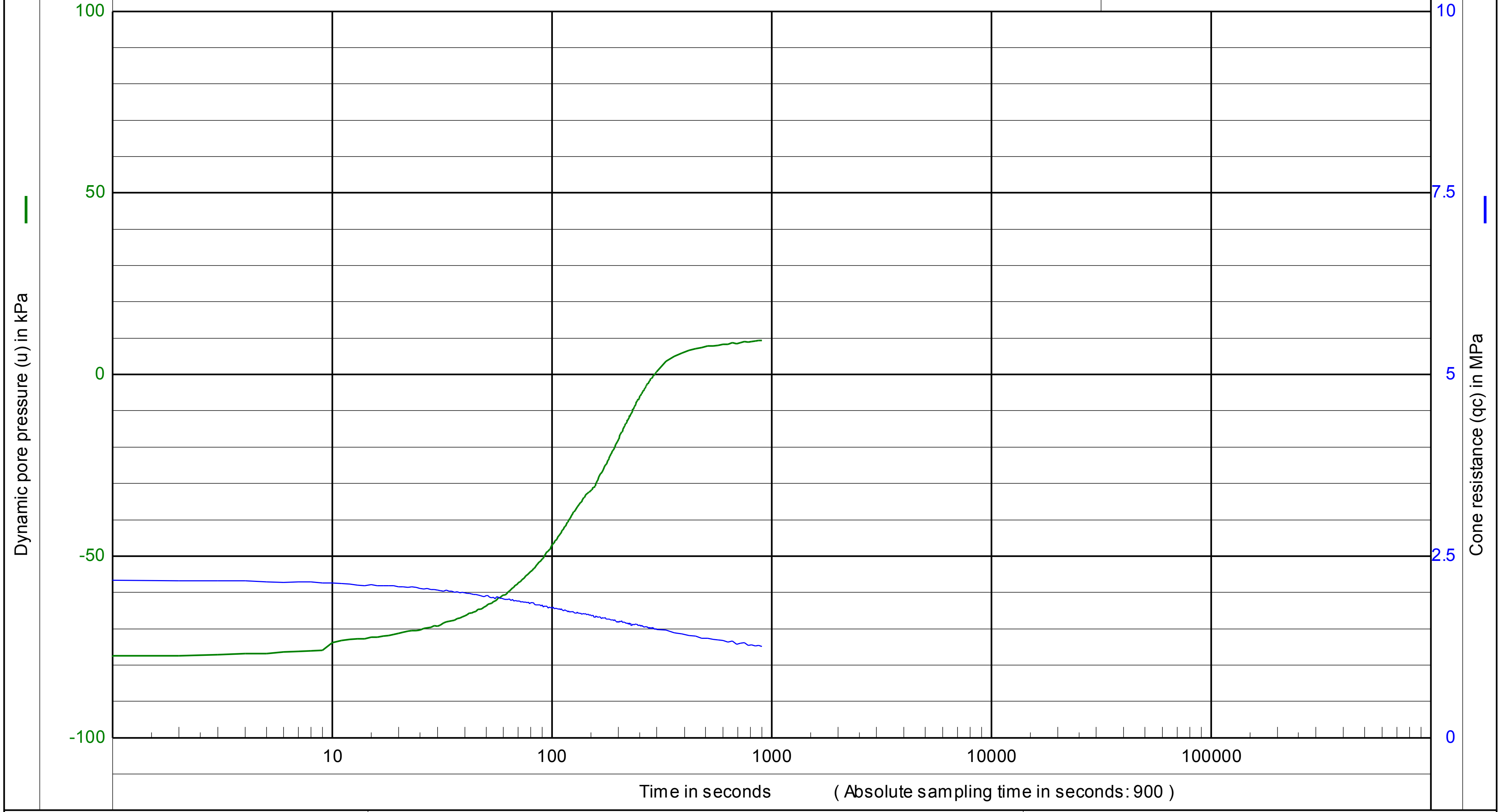


Test according NEN 5140 class 1		Predrill :	**0 m Predrilled**
G.L. 0	W.L.: **-3.8**	Date:	**1/16/2017**
Project:	**Geotechnical Investigation**	Cone no.:	**C10CFIIP.E38**
Location:	**Cnr Middle & West St, Foster**	Project no.:	**RGS01471.1**
Position:	**454176, 6439143 UTM Zone 56H**	CPT no.:	**CPT-05** 3/3

1.40

Test number 1

Ubegin	:	-0.078 MPa
Uo	:	0.009 MPa



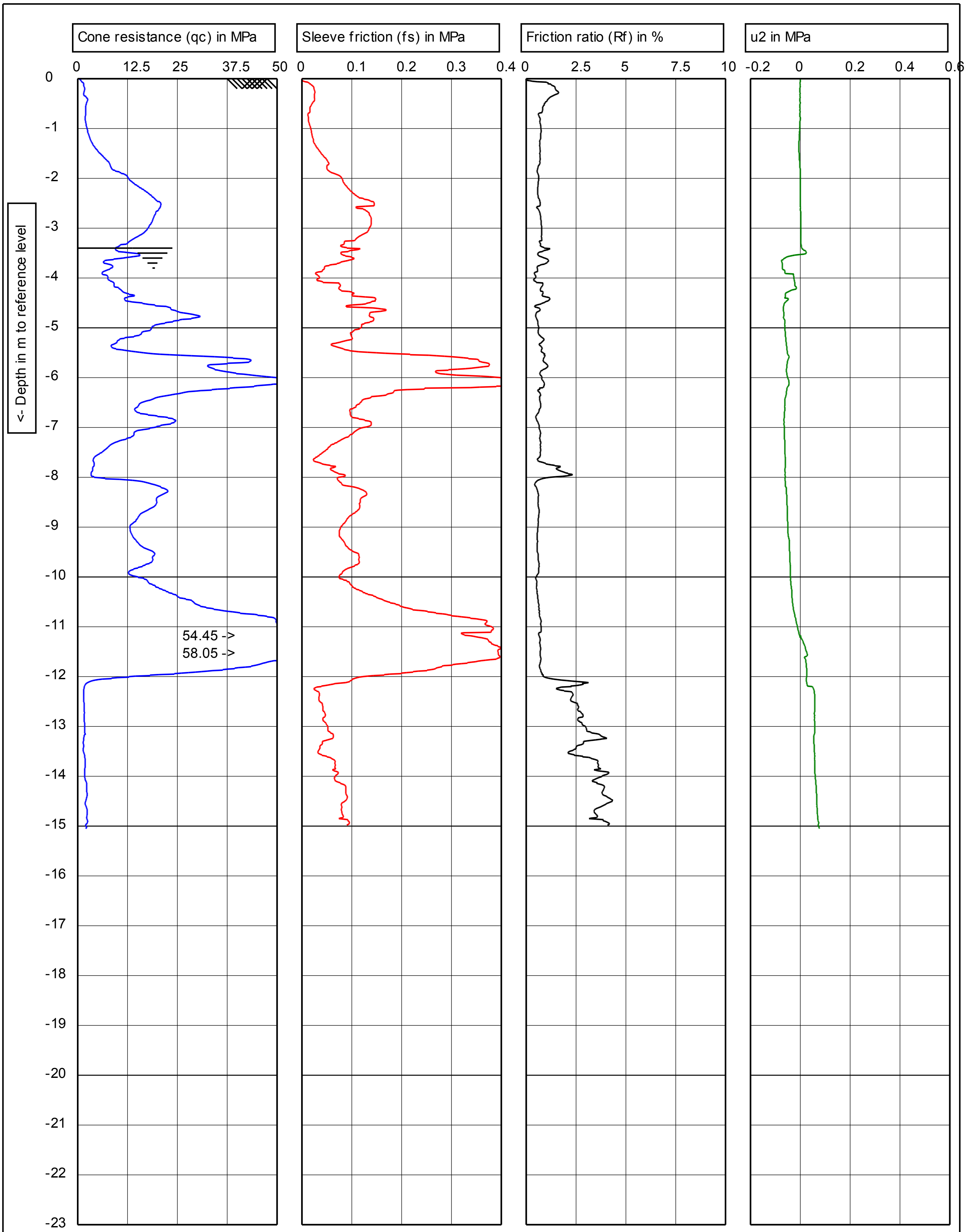
NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

Test according NEN 5140 class 1

Project : Geotechnical Investigation

Location : Cnr Middle & West St, Foster

Date	:	1/16/2017	
Project no.	:	RGS01471.1	
CPT no.	:	CPT-05	
Test depth	:	4.68	[m] - G.L.
Water level	:	-3.8	[m] - G.L.



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1

G.L. 0

W.L.: **-3.4**

Predrill : **0 m Predrilled**

Date: **1/16/2017**

Project: **Geotechnical Investigation**

Location: **Cnr Middle & West St, Foster**

Position: **454195, 6439111 UTM Zone 56H**

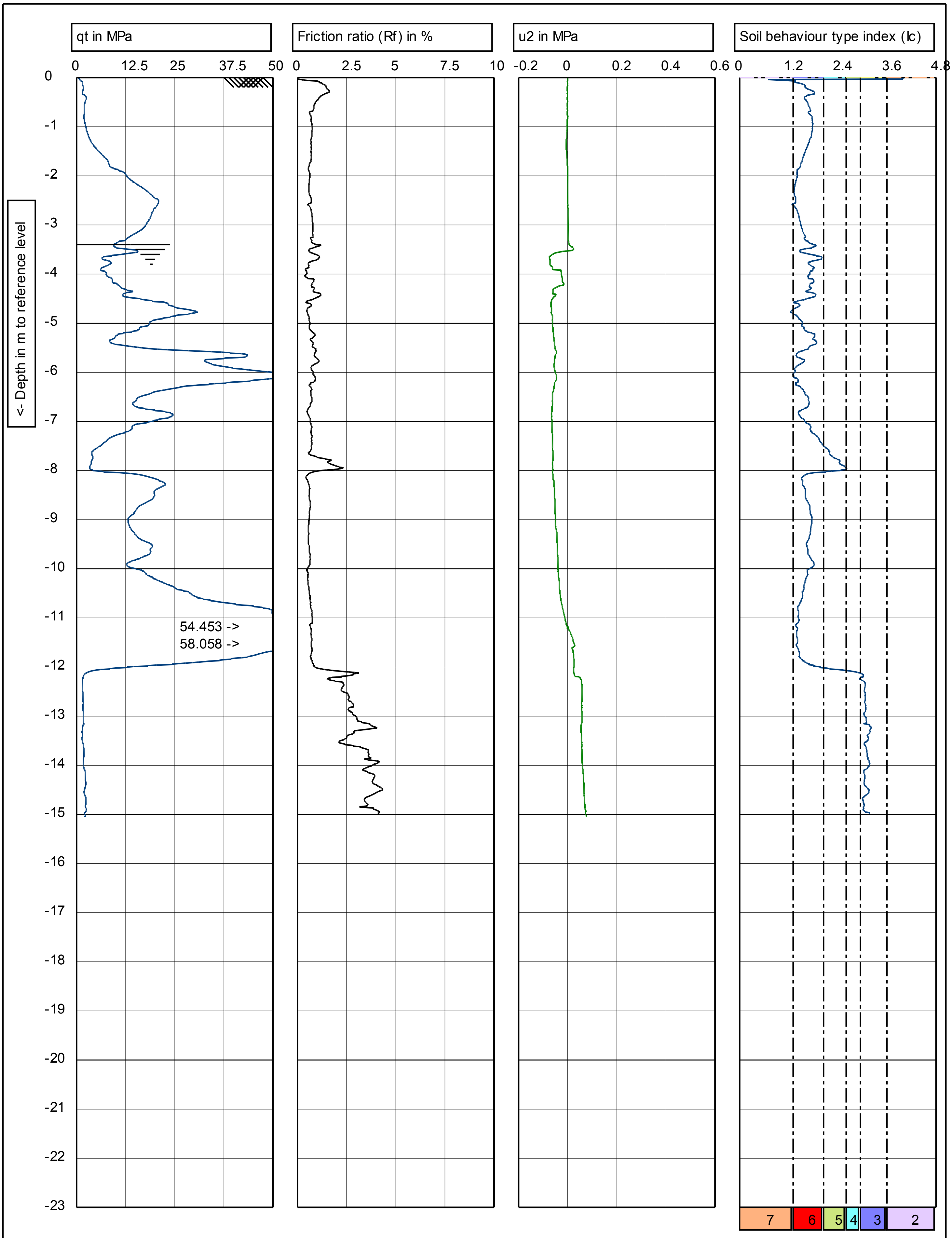
Cone no.: **C10CFIIP.E38**

Project no.: **RGS01471.1**

CPT no.: **CPT-06**

1/3

1.40



NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638

u2
150 cm²
10 cm²

Test according NEN 5140 class 1

G.L. 0

W.L.: **-3.4**

Predrill : **0 m Predrilled**

Date: **1/16/2017**

Project: **Geotechnical Investigation**

Location: **Cnr Middle & West St, Foster**

Position: **454195, 6439111 UTM Zone 56H**

Cone no.: **C10CFIIP.E38**

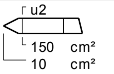
Project no.: **RGS01471.1**

CPT no.: **CPT-06** **2/3**

1.40

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD
GEOTECHNICAL
TESTING
Ph:0408292638



Test according NEN 5140 class 1

G.L. 0
W.L.: **-3.4**

Project: **Geotechnical Investigation**
Location: **Cnr Middle & West St, Foster**
Position: **454195, 6439111 UTM Zone 56H**

Predrill :	**0 m Predrilled**
Date:	**1/16/2017**
Cone no.:	**C10CFIIP.E38**
Project no.:	**RGS01471.1**
CPT no.:	**CPT-06** **3/3**

1.40

Appendix B

Laboratory Test Results

RESULTS OF ACID SULFATE SOIL ANALYSIS

8 samples supplied by Regional Geotechnical Solutions Pty Ltd on 18th January, 2017 - Lab. Job No. F6122
Analysis requested by Champak Nag. **Your Project: RGS01471.1**

(44 Bent Street WINGHAM NSW 2429)

Sample Site	EAL lab code	TEXTURE (note 7)	MOISTURE CONTENT		FIELD/ LAB PEROXIDE SCREENING TECHNIQUE			
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	Initial pH_F water	pH_{FOX} peroxide	pH change	Reaction
Method Info.		**	**					
BH1 2.4-2.6	*F6122/1*	Coarse	4.0	0.04	6.94	5.46	-1.48	Low
BH1 3.5-3.6	*F6122/2*	Coarse	10.7	0.12	6.73	5.30	-1.43	Low
BH2 0.5-0.6	*F6122/3*	Coarse	3.8	0.04	7.10	5.38	-1.72	Low
BH2 3.7-3.8	*F6122/4*	Coarse	10.7	0.12	5.05	3.95	-1.10	Low
BH4 0.8-1.0	*F6122/5*	Coarse	1.6	0.02	5.75	4.88	-0.87	Low
BH4 3.7-3.9	*F6122/6*	Coarse	14.7	0.17	6.12	5.20	-0.92	Low
BH5 1.4-1.5	*F6122/7*	Coarse	2.5	0.03	6.15	5.13	-1.02	Low
BH6 4.0-4.1	*F6122/8*	Coarse	10.6	0.12	6.51	5.21	-1.30	Low

NOTE:
1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)
2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & sulfate) and 'Chromium Reducible Sulfur' technique (Scr - Method 22B)
3 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines.*** QLD DNRME.
4 - Bulk Density is required for liming rate calculations per soil volume. Lab. Bulk Density is no longer applicable - field bulk density rings can be used and dried/ weighed in the laboratory.
5 - **ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Scrs or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF (with FF currently defaulted to 1.5)**
6 - The neutralising requirement, lime calculation, includes a 1.5 safety margin for acid neutralisation (an increased safety factor may be required in some cases)
7 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
8 - .. denotes not requested or required. '0' is used for ANC and Snag calcs if TAA pH <6.5 or >4.5
9 - SCREENING, CRS, TAA and ANC are NATA accredited but other SPOCAS segments are currently not NATA accredited
10- Results at or below detection limits are replaced with '0' for calculation purposes.
11 - **Projects that disturb >1000 tonnes of soil, the ≥0.03% S classification guideline would apply (refer to acid sulfate management guidelines).**
12 - Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
13 ** denotes these test procedure or calculation are as yet not NATA accredited but quality control data is available

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Accreditation No. 14960.
Accredited for compliance
with ISO/IEC 17025.

(Classification of potential acid sulfate material if: coarse Scr≥0.03%S or 19mole H^+/t; medium Scr≥0.06%S or 37mole H^+/t; fine Scr≥0.1%S or 62mole H^+/t) - as per QUASSIT Guidelines

checked: ....
Graham Lancaster
Laboratory Manager

RESULTS OF ACID SULFATE SOIL ANALYSIS

8 samples supplied by Regional Geotechnical Solutions Pty Ltd on 18th January, 2017 - Lab. Job No. F6122

Analysis requested by Champak Nag. **Your Project: RGS01471.1**

(44 Bent Street WINGHAM NSW 2429)

Required if pH_{KCL} <4.5

Sample Site	EAL lab code	TEXTURE (note 7)	MOISTURE CONTENT		FIELD/ LAB PEROXIDE SCREENING TECHNIQUE				TITRATABLE ACTUAL ACIDITY (TAA)	(To pH 6.5)	REDUCED INORGANIC SULFUR (% chromium reducible S)		RETAINED ACIDITY (HCL extract) (as $\%S_{HCL}$ - $\%S_{kcl}$)	S_{NAS}	NET ACIDITY Chromium Suite mole H^+/tonne	LIME CALCULATION Chromium Suite kg $CaCO_3$/tonne DW
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	Initial pH_F water	pH_{FOX} peroxide	pH change	Reaction	pH_{KCl}	(mole H^+/tonne)	(%Scr)	(mole H^+/tonne)	($\%S_{NAS}$)	(mole H^+/tonne)	(based on %Scrs)	(includes 1.5 safety Factor when liming rate is $^+$ve)
Method Info.		**	**						*(ACTUAL ACIDITY-Method 23)*		*(POTENTIAL ACIDITY-Method 22B)*		*(RETAINED ACIDITY)*		*** & note 5*	*** & note 4 and 6*
BH1 2.4-2.6	*F6122/1*	Coarse	4.0	0.04	6.94	5.46	-1.48	Low	..	..	..	..	..	..	..	..
BH1 3.5-3.6	*F6122/2*	Coarse	10.7	0.12	6.73	5.30	-1.43	Low	..	..	..	..	..	..	..	..
BH2 0.5-0.6	*F6122/3*	Coarse	3.8	0.04	7.10	5.38	-1.72	Low	..	..	..	..	..	..	..	..
BH2 3.7-3.8	*F6122/4*	Coarse	10.7	0.12	5.05	3.95	-1.10	Low	4.40	67	0.007	4	0.007	3	74	6
BH4 0.8-1.0	*F6122/5*	Coarse	1.6	0.02	5.75	4.88	-0.87	Low	..	..	..	..	..	..	..	..
BH4 3.7-3.9	*F6122/6*	Coarse	14.7	0.17	6.12	5.20	-0.92	Low	..	..	..	..	..	..	..	..
BH5 1.4-1.5	*F6122/7*	Coarse	2.5	0.03	6.15	5.13	-1.02	Low	..	..	..	..	..	..	..	..
BH6 4.0-4.1	*F6122/8*	Coarse	10.6	0.12	6.51	5.21	-1.30	Low	..	..	..	..	..	..	..	..

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)

2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & sulfate) and 'Chromium Reducible Sulfur' technique (Scr - Method 22B)

3 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines.*** QLD DNRME.

4 - Bulk Density is required for liming rate calculations per soil volume. Lab. Bulk Density is no longer applicable - field bulk density rings can be used and dried/ weighed in the laboratory.

5 - **ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Scrs or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF (with FF currently defaulted to 1.5)**

6 - The neutralising requirement, lime calculation, includes a 1.5 safety margin for acid neutralisation (an increased safety factor may be required in some cases)

7 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays

8 - .. denotes not requested or required. '0' is used for ANC and Snag calcs if TAA pH <6.5 or >4.5

9 - SCREENING, CRS, TAA and ANC are NATA accredited but other SPOCAS segments are currently not NATA accredited

10- Results at or below detection limits are replaced with '0' for calculation purposes.

11 - Projects that disturb >1000 tonnes of soil, the ≥0.03% S classification guideline would apply (refer to acid sulfate management guidelines).

12 - Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.

13 ** denotes these test procedure or calculation are as yet not NATA accredited but quality control data is available

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with ISO/IEC 17025.

(Classification of potential acid sulfate material if: coarse Scr≥0.03%S or 19mole H^+/t; medium Scr≥0.06%S or 37mole H^+/t; fine Scr≥0.1%S or 62mole H^+/t) - as per QUASSIT Guidelines

checked: ....
Graham Lancaster
Laboratory Manager

RESULTS OF SOIL ANALYSIS (Page 1 of 1)

2 samples supplied by Regional Geotechnical Solutions Pty Ltd on 18th January, 2017 - Lab Job No. F6123
Analysis requested by Champak nag. - **Your Project: RGS01471.1**
(44 Bent Street WINGHAM NSW 2429)

	Method	Sample 1 BH3 2.8-3.0m	Sample 2 BH5 2.8-3.0m
	EAL job No.	*F6123/1*	*F6123/2*
Moisture (%)	*inhouse*	4	5
Texture	*See note 2 below.*	Coarse	Coarse
Soil pH (1:5 water)	Rayment and Lyons 4A1	5.93	6.08
Soil Conductivity (1:5 water dS/m)	Rayment and Lyons 4B1	0.017	0.010
Soil Resistivity (ohm.mm)	** Calculation	588,235	1,000,000
Chloride (mg/kg)	** Water Extract- Rayment and Lyons 5A2b	<10	<10
Chloride **(as %)**	** Calculation	<0.001	<0.001
Sulfate (mg/kg)	** Water Extract-Apha 3120 ICPOES	11	8
Sulfate **(as % SO_3)**	** Calculation	0.001	0.001
Chloride / Sulfate Ratio	** calculation	NA	NA

Notes:
1. ppm = mg/Kg dried soil
2. For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
3. All results as dry weight DW - soils were dried at 60oC for 48hrs prior to crushing and analysis.
4. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
5. Methods from Rayment and Lyons. Soil Chemical Methods - Australasia
6. Based on Australian Standard AS: 159-1995
7 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). *Acid Sulfate Soils Laboratory Methods Guidelines*. QLD DNRME.
8. ** denotes these test procedure or calculation are as yet not NATA accredited but quality control data is available

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Accredited for compliance
with ISO/IEC 17025.

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: ....
Graham Lancaster
Laboratory Manager

Appendix C

Determination of the Geotechnical Strength Reduction Factor

Determination of the Geotechnical Strength Reduction Factor, Φ_g

AS2159-2009, Section 4.3.1

Job Number:	RGS01471.1
Client:	Kukas Brothers
Project:	Proposed Development
Site Location:	Cnr Lake, West and Middle Street, Forster

Pile Testing?	No
Φ_{tf}	
Static/Rapid or Dynamic Load Testing?	
K	
P	

Weighting Factors & Individual Risk Ratings for Risk Factors (Table 4.3.2(A))

	Individual Risk Rating (IRR)		
Risk Factor	**Weighting Factor, w_i**	**Risk weighting (VL=1, M=3 or VH=5)**	**Risk Rating**
Site			
Geological Complexity	2	3	6
Extent of Investigation	2	2	4
Amount/Quality of data	2	2	4
Design			
Experience in similar	1	2	2
Method assessment geotech parameters	2	2	4
Design Method	1	2	2
Method of utilizing results	2	2	4
Installation			
Level of Construction Control	2	2	4
Level of Performance monitoring	0.5	3	1.5

ARR	2.17
Redundancy in System	Low

	Low	High
Basic Geotechnical Reduction Factor, Φ_{gb}	0.56	0.64

Adopted Φ_{gb}	**0.56**
Geotechnical Strength Reduction Factor, Φ_g	**0.56**

Determination of the Geotechnical Strength Reduction Factor, Φ_g

AS2159-2009, Section 4.3.1

Job Number:	RGS01471.1
Client:	Kukas Brothers
Project:	Proposed Development
Site Location:	Cnr Lake, West and Middle Street, Forster

Pile Testing?	Yes
Φ_{tf}	0.9
Static/Rapid or Dynamic Load Testing?	Static
K	0.5
P	2

Weighting Factors & Individual Risk Ratings for Risk Factors (Table 4.3.2(A))

Risk Factor	Individual Risk Rating (IRR)		
	Weighting Factor, w_i	Risk weighting (VL=1, M=3 or VH=5)	Risk Rating
Site			
Geological Complexity	2	3	6
Extent of Investigation	2	2	4
Amount/Quality of data	2	2	4
Design			
Experience in similar	1	2	2
Method assessment geotech parameters	2	2	4
Design Method	1	2	2
Method of utilizing results	2	2	4
Installation			
Level of Construction Control	2	2	4
Level of Performance monitoring	0.5	3	1.5

ARR	2.17
Redundancy in System	Low

	Low	High
Basic Geotechnical Reduction Factor, Φ_{gb}	0.56	0.64

Adopted Φ_{gb}	**0.56**
Geotechnical Strength Reduction Factor, Φ_g	**0.73**