23 April 2021

TITANIUM BUSINESS PARK
RAYNES ROAD, HAMILTON

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

Titanium Park Limited

HAM2020-0020AB Rev.0

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Date	Revision	Comments
16 April 2021	A	Initial draft for internal review
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	Name	Signature	Position
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EXECUTIVE SUMMARY

This report presents the results of geotechnical investigations and a geohazards assessment of a proposed Titanium Park Northern Precinct land development located to the south of Raynes Road, Hamilton.

The majority of the 100ha site is situated on a near level terrace at RL 49 to 52m underlain by Hinuera Formation alluvium. Two low hills up to RL 62.5m are present in the eastern part of the site that are underlain by older volcanic ash and silts/clays of the Walton Subgroup.

The masterplan for the site depicts the development of industrial and commercial lots with associated roading, green spaces and stormwater attenuation basins.

We consider that the site is suitable for the proposed level of development subject to our geohazards assessment and geotechnical recommendations summarised as follows:

- Liquefaction induced vertical settlements in the ULS earthquake scenario are expected to be of the order of 26mm or less. Accordingly, the liquefaction risk is considered to be low for the development. Seismic slope stability analyses for the stormwater basins is recommended at detailed design stage to demonstrate compliance with the project design criteria.
- For the low hill remaining following proposed earthworks, due to the low slope gradients the slope stability risk is considered to be negligible.
- On account of the depth to liquefaction being greater than 6m along with the thin and discrete distribution of liquefied layers, the risk of lateral spreading into the proposed approximately 3m deep stormwater soakage basins is considered to be very low.
- For large commercial / industrial buildings, preliminary estimates of static settlements for strip pad footings are expected to be of the order of up to 10 to 100mm. For widespread foundation loads of 35kPa, static settlements of 40 to 265mm are estimated. The upper bound values are considered to be overestimates as the CPT Qc values within the upper Walton Subgroup – Puketoka Formation soils underestimate soil strength and stiffness due to the sensitivity of these soils to disturbance. Typically shallow foundation types are considered feasible subject to further assessment.
- For particularly heavy building loads, ground improvement may be required to mitigate excessive settlement. Appropriate options include:
    - shallow undercut and replacement of any low-strength near surface soils;
    - temporary surcharge (pre-load) fill embankment construction above design finished level to over-consolidate the compressible soils
    - compensated foundation design using lightweight geofoam to keep pressures below pre-consolidation pressures within compressible soils;
    - deeper ground improvement beneath the building footprint to transfer loads from the structure to more competent underlying soils at depth.
- The southern hill is expected to be lowered to the surrounding terrace level with filling expected in lower parts of the site in order to form level building platforms. Cut soils are generally expected to be suitable for reuse as fill subject to conditioning including moisture control and blending.
- A preliminary geotechnical ultimate bearing pressure of 300 kPa should be available for foundations in most areas. However reduced bearing pressures may be required where Puketoka Formation silt/clay is near finished levels. Improvement of near surface soil bearing capacity could be achieved with conventional compaction equipment.
- Trench collapse may pose problems where excavations are in loose soils or extend below the water table. Temporary dewatering and trench support or battering may be required.
- Hinuera Formation sands are considered suitable road subgrade materials. If loose sands are exposed, proof rolling is typically effective to increase CBR values. Hinuera Formation silts and Walton Subgroup silts and clays may require undercutting and replacement with a subgrade improvement layer.

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1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by Titanium Park Ltd to provide an update to the preliminary geotechnical investigation report prepared by Coffey Geotechnics (NZ) Ltd in 2011 of a site located at Raynes Road, Hamilton, which is being considered for the construction of the Titanium Business Park industrial and commercial subdivision.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal referenced HAM2020-0020AA Rev.0 dated 11 March 2020.

This report is to support a Private Plan Change (PPC) application to Hamilton City Council and provides the basis for the Statement of Professional Opinion in Section 9***.***

1.2 Scope of Work

As detailed in our services proposal, the agreed scope of work to be conducted by CMW was defined as follows:

- Review of Harrison Grierson Consultants Masterplan documentation.
- Review of existing geotechnical information for the site (Coffey Geotechnics Preliminary Geotechnical Investigation Report)[1].
- Re-assessment of liquefaction risk in accordance with the MBIE / NZGS earthquake geotechnical engineering practice notes released in 2016.
- Confirmation of previous recommendations for future building foundation suitability and bearing capacity, static settlement and soakage assessments, and earthworks recommendations.
- Comment on the land suitability for commercial / industrial land development as presented on the current Masterplan.
- Provision of a preliminary geotechnical report to support the PPC in accordance with current standards and engineering guidelines.

2 SITE DESCRIPTION

2.1 Site Location

The site now referred to as Titanium Park Northern Precinct comprises an area of approximately 100ha and is located south of the Raynes Road and Narrows Road intersection and to the east of Middle Road as shown on ***Figure 1*** below.

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[1] “Preliminary Geotechnical Investigation Report on Proposed Montgomerie Block Industrial Land Development at Raynes Toad, Hamilton” Coffey Report ref GENZ17003AAd dated 9 November 2011

Figure 1: Site Location Plan (Open Street Map)

2.2 Landform

The current general landform, together with associated features located within and adjacent to the site is presented on the attached Coffey Geotechnics Site Plan (***Appendix A***). The site has not changed in the 10 year period since the Coffey report was prepared.

The majority of the site is near level with a gentle grade towards the north and west. Two low hills are located in the central-eastern and south-eastern portions. Existing ground levels for the majority of the site range from RL49m (Moturiki Vertical Datum) in the west to RL52.5m at the southern boundary.

The hills rise up to RL62.5m. A dairy effluent storage pond is located on top of the southern hill that has had the crest cut down in the past to form a level surface at approximate RL62.

A series of open drains flow from east to west across the property as shown on the attached Site Plan, that flow through several culverts beneath the roads bordering the site.

The site is bound to the north by Raynes Road, to the west by Narrows Road and Middle Road and to the south and east by airport airside land. An existing dwelling and farm buildings are present.

Historical aerial photographs[2] show that the land has been farmed since prior to 1943 with little change since then.

3 PROPOSED DEVELOPMENT

The current development proposal, as shown on the Illustrative Masterplan provided by Harrison Grierson and provided in ***Appendix B***, is to create multiple industrial and commercial lots of varying sizes with associated access roads connecting to future roads in the north, south and west. This is consistent with the land development proposed at the time of the Coffey site investigation and report preparation.

At the time of writing this report the project was still in planning and preliminary urban design phase and no earthworks or engineering design drawings have yet been developed.

We have prepared this report on the basis that a future development will mostly comprise minor cuts and fills to form a near level site supporting commercial and industrial buildings with shallow strip and pad foundations and widespread floor loads of up to 35kPa. As indicated on the Masterplan is assumed that the southern hill will be cut down to near the surrounding ground level while the northern hill will largely remain.

A large stormwater attenuation basin is depicted along the western boundary, plus smaller stormwater swales in the northwest, north and centre of the site.

4 INVESTIGATION SCOPE

4.1 Desktop Study

CMW undertook a desktop study including review of geology maps, aerial photos, previous reports and information on the NZ Geotechnical Database.

4.2 Previous Field Investigation

The Coffey Geotechnics field investigation was carried out during August 2011 and comprised:

- A walkover survey by senior engineering geologist of the site;
- Five machine boreholes, denoted MH01 and MH05, drilled using HQ3 coring techniques to depths of up to 30m to determine the deeper ground model for the site and below the likely cut level in the hill area. Standard Penetration Tests (SPT‘s) were undertaken at regular intervals and Vane Shear Strength VSS tests where applicable in fine-grained soils. Standpipe piezometers were installed in MH01 to MH04 and subsequently monitored;
- Fourteen Cone Penetrometer Tests (CPTu), denoted CPT1 to CPT14, were pushed to depths of up to 31m to help define the ground model through the zone of influence of future building foundations and to provide preliminary indication of foundation requirements. Results of the CPT’s are presented as traces of tip resistance (qc), friction resistance (fs) and friction ratio;
- Five hand auger boreholes, denoted HA01 to HA05, were drilled using a 100mm diameter auger to target depths of between 1.2 and 5.2m below existing ground levels to visually observe the near surface soil profile and to facilitate in-situ permeability testing;
- Dynamic cone (Scala) penetrometer (DCP) tests were carried out within each hand auger borehole to depths of up to 4.4m to provide soil density profiles for use as a comparison with the CPT data, and to provide a subgrade CBR value for pavement design purposes;
- In-situ falling head permeability tests were carried out in hand auger boreholes;

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[2] Retrolens website, Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0

- Groundwater monitoring was undertaken at completion of machine borehole drilling and during further visits to the site 8 and 20 days following the initial fieldwork, to monitor the groundwater levels in the boreholes.

Copies of Coffey's engineering logs of the boreholes, the CPT traces and soakage results are provided in ***Appendix C***;

The approximate locations of the respective boreholes and CPTs referred to above are shown on the Coffey Site Plan (Figure 01) in ***Appendix A***.

5 GROUND MODEL

5.1 Published Geology

The published geological map[3] for the area indicates the majority of the site is underlain by Late Pleistocene aged river deposits comprising cross-bedded pumice sand, silt and gravel with interbedded peat of the Hinuera Formation as illustrated in Figure 2 below.

The low hills are shown to be underlain by older volcanic silts and clays of the Walton Subgroup derived from insitu and fluvially reworked and weathered non-welded distal ignimbrites that are mantled with weathered volcanic ash.

The geologically older Walton Subgroup represents an older (1.2 million year old) landform that is present below the younger Hinuera Formation deposits.

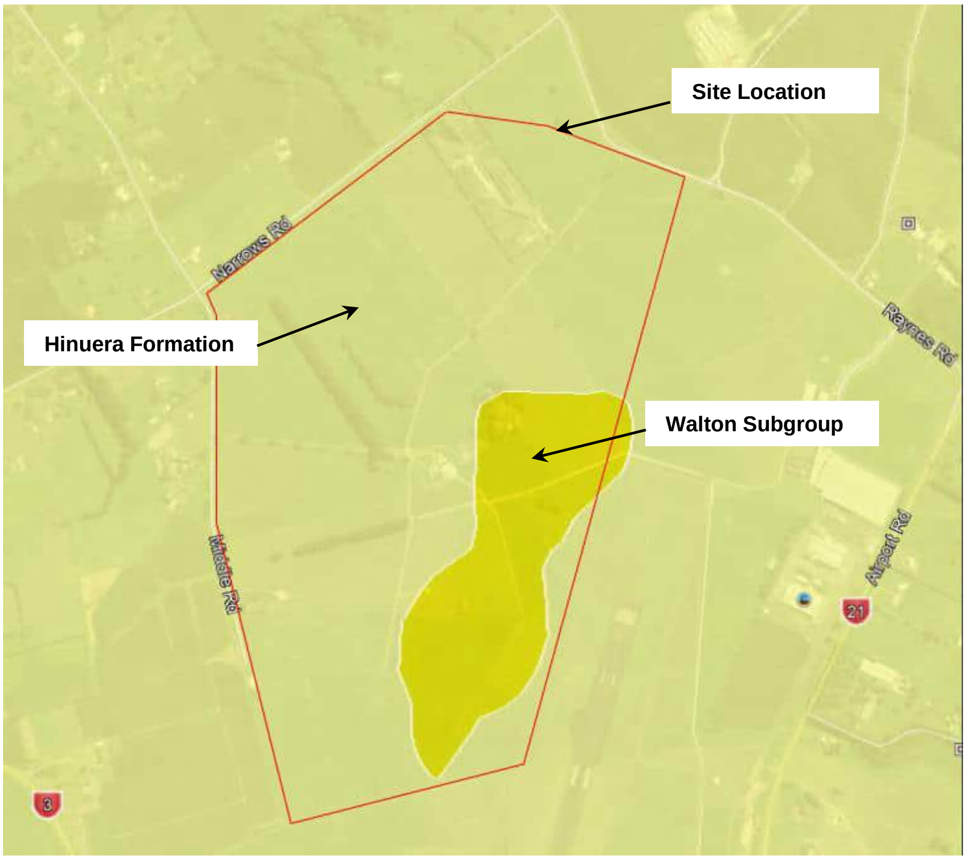

Figure 2: Regional Geology (QMap)

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[3] Waikato 1:250,000 Geological Map, No 4, Institute of Geological and Nuclear Sciences Limited, 2005.

Based on the known history of the site, some superficial depths of fill are anticipated as a result of farming activities.

5.2 Stratigraphic Units

The ground conditions encountered and inferred from the investigation are considered to be generally consistent with the published geology for the area and can be generalised according to the following subsurface sequences.

The distribution of the various units encountered is presented in the appended Cross-sections A-A and B-B (Coffey Figures 2 to 6) in ***Appendix A.***

5.2.1 Topsoil / Fill

Topsoil was encountered in all boreholes with thicknesses of 0.1 to 0.3m.

5.2.2 Hinuera Formation

Hinuera Formation deposits were encountered on the terrace surrounding the low hills and underly the greatest portion of the development area. The soils typically consist of very loose to dense silty sands (typically loose to dense) with interbedded firm to stiff alluvial clayey or sandy silts, silty clays and minor organic silts and clays.

Relatively thick uniform layers of loose to medium dense sand are present between 3.5 to 16 and 17.7 to 27.55 metres depth in machine boreholes 01, 02 and 03 respectively.

Due to the interbedded nature of the Hinuera Formation soils SPT N values obtained in these layers are variable. The lower values of between 0 and 7 were recorded within fine-grained clayey silt and silty clayey deposits. N values of between 2 and 50 were obtained within the sandy soils and generally increased with depth.

Peak shear vane values ranging between 30 and greater than 130kPa were also recorded in several fine grained silt and clay layers with readings also increasing with depth.

The typical soil profiles on the CPT traces are similar to the soil profiles recorded in machine boreholes 01 to 03 where interbedded layers of sand, silty sands and clayey silts and silty clays were encountered.

In general, these layers comprise firm to stiff silts or clays and medium dense sands, however CPT qc values as low as 0.2 MPa (interpreted as very soft) were recorded within the silt horizons and up to more than 20 MPa (very dense) within the sands.

Thick layers of medium dense to dense sandy layers are also present in the soil profile.

5.2.3 Walton Subgroup – Volcanic Ashes

Weathered volcanic ashes comprising the Hamilton Ash and older tephra’s were encountered below the Hinuera Formation and also form a mantle over the low hills. These soils consist of firm to very stiff silty clays.

N values ranging between 2 and 11 were recorded within fine-grained silty clays. Peak shear vane values recorded in the volcanic ashes were between 60 to 120kPa. CPT Qc values were reasonably broad between 0.5 and 8.0MPa.

5.2.4 Walton Subgroup – Puketoka Formation Silt and Clay

Variable strength (soft to stiff) sensitive silts and clays and silty fine sands were encountered in all CPT’s below the volcanic ash layers to depths of between 10.5 and 29.0 metres. CPT Qc values ranged from 0.4 to 2.8 MPa, averaging approximately 1.0 MPa. N values of 0 to 22 were obtained within the fine grained silts and clays. It is important to note that CPT’s and SPT’s both underestimate soil strengths in Puketoka Formation soils due to the presence of Halloysite clays that are sensitive to disturbance.

Where recorded, peak shear vane values were between 15 and 200kPa.

5.2.5 Walton Subgroup – Puketoka Formation Sands

Beneath the fine-grained Puketoka Formation. soils, typically medium dense to very dense silty sands are present with minor layers of hard sandy silts. CPT Qc values of up to more than 20 MPa. N values of 7 to 44 were obtained within these typically sandy soils. Refusal of the CPT probe occurred within these materials in all test locations at depths of 18.0 to 31.1 metres.

5.2.6 Summary

The distribution of these units is illustrated on the appended Coffey Geological Sections A-A and B-B (Figures 02 to 05 inclusive) and is summarised below in Table 1.

Table 1: Summary of Strata Encountered

Unit	**Top of Unit (mbgl)**		**Thickness (m)****	
	Min	**Max**	**Min**	**Max**
Topsoil	0.0	0.0	0.1	0.3
Hinuera Fm. – very loose to dense silty sands or gravels and firm to stiff alluvial clayey or sandy silts, silty clays or organic silts and clays	0.1	0.3	0.0	18.0
Walton SG. - Volcanic Ashes – firm to very stiff silty clays	0.1	18.5	0.0	8.5
Walton SG. - Puketoka Fm. – firm to very stiff silty clays	5.5	20.0	7.0	17.0
Walton SG. - Puketoka Fm. – medium dense to very dense silty sands	11.5	27.0	-	-
Notes: **Thickness only recorded were base of strata has been confirmed.				

5.3 Groundwater

During the 2011 investigation, which was carried out in late winter (August and September 2011), groundwater was encountered within the CPTs and boreholes at variable depths.

Hand auger boreholes S1 to S3 were drilled in the northern and western portion of the site respectively where groundwater was recorded between 0.85 and 1.2 metres below ground level respectively.

Hand augers S4 and S5 were drilled at the southern end of the property where the ground level is up to 2.5 metres higher. Groundwater here was recorded in S4 at 3.55 metres depth and was not observed in hand auger S5.

On Table 2 we present the results of groundwater monitoring undertaken in the piezometers installed following the investigation:

Table 2: Groundwater Monitoring Data

Standpipe	Screen Depth (mbgl)	Screened Formation	26 August 2011		7 September 2011	
			Depth (mbgl)	Elevation (m RL)	Depth (mbgl)	Elevation (m RL)
P1 MH01 (shallow)	1 to 3	Hinuera Fm.	0.7	49.5	1.2	49.0
P2 MH01 (deep)	6 to 12	Hinuera Fm.	5.0	45.2	5.4	44.8
P3 MH02 (shallow)	1 to 3	Hinuera Fm.	1.1	48.5	1.4	48.2
P4 MH02 (deep)	6 to 12	Hinuera Fm.	3.2	46.3	3.7	45.9
P5 MH03 (shallow)	1 to 6	Hinuera Fm.	2.4	49.4	2.7	49.1
P6 MH03 (deep)	18 to 24	Walton SG.	6.6	53.6	7.2	52.9
P7 MH04 (deep)	6 to 18	Walton SG.	9.2	52.5	9.7	52.0

Note: mbgl = metres below ground level
Vertical Datum = Moturiki 1953

Historical information provided by the owner indicates that a network of subsoil drains has been installed across the property and extending to the north-east of the development area in order to lower the high groundwater table that was known to cause surface flooding in the lower lying paddocks.

This was confirmed by a Google Earth aerial photo taken on 17 January 2006 that shows the layout of the existing shallow subsoil drainage system.

The approximate layout of these drains within the site is shown on the attached Existing Drainage Network drawing (Figure 07).

Anecdotal information suggests that the construction of the subsoil drains typically consists of 1 metre deep trenches with a buried perforated drain coil pipe with filter cloth sock. The nature of the backfill material is unknown. This drainage system is reported to have been successful with decreased surface flooding following heavy rainfall events since installation.

Seasonal fluctuation in groundwater levels is expected. Due to the short groundwater monitoring duration the magnitude of this variation is uncertain. However from our experience in the area this may be in the order of 1m or more.

5.4 Soakage Test Results

Falling head soakage (percolation) tests were carried out by Coffey within the hand auger borehole locations by lining the 100 mm diameter boreholes with perforated PVC pipe, filling the holes with water and monitoring the rate of water level fall over time.

The test results were used to calculate soil hydraulic conductivity in accordance with the analysis method of Hvorslev[4] and the inverted auger test method of van Beers[5].

Analysis using the Hvorslev method considers soakage from both the base and sides of the test hole with no overlying restrictive layer.

Results of Coffey analyses are presented in Table 3. The Hvorslev method assumes horizontal flow and is relevant to flow below the water table, and the Inverse Auger Hole method assumes vertical flow and is relevant to testing above the water table (with the ground wetted-up prior to measurement).

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[4] Hvorslev, M.J. (1951), Time Lag and Soil Permeability in Ground Water Observations. U.S. Army Corps of Engineers Waterway Experimentation Station, Bulletin 36

[5] van Beers, W.F.J. (1983), The Auger Hole Method: A Field Measurement of the Hydraulic Conductivity of Soil Below the Water Table, International Institute for Land Reclamation and Improvement, ILRI Wageningen, The Netherlands

Based on the data results, the tests at locations S4 and S5 are expected to have been performed above the water table (the Inverse Auger Hole method is therefore relevant), while tests at locations S1, S2 and S3 straddled the water table and Hvorslev analysis is expected be more relevant at these locations.

Table 3: Soakage Test Results

Test Location	Hvorslev Method K (m/sec)	Inverted Auger Method K (m/sec)
S1	***1.2×10^{-6}***	3.4×10^{-5}
S2	***2.2×10^{-5}***	7.6×10^{-5}
S3	***3.5×10^{-6}***	3.6×10^{-6}
S4	9.6×10^{-7}	***7.7×10^{-5}***
S5	6.4×10^{-7}	***1.1×10^{-5}***
Note: More appropriate analysis method in bold & italics for each test location		

6 GEOHAZARDS ASSESSMENT

6.1 Seismicity

Practice in assessing seismic risk has changed since 2011 and the review below therefore supersedes that in the earlier Coffey report.

A seismic assessment has been carried out in general accordance with NZGS guidance[6] to calculate the peak horizontal ground acceleration or PGA (a_{max}) as follows:

$$a_{max} = C_{0,1000}\frac{R}{1.3} x\ f\ x\ g$$

Where: $C_{0,1000}$ = unweighted PGA coefficient (refer Section 7.1 for subsoil class)

R = return period factor given in NZS1170.5, Table 3.5 (refer Section 7.1 for importance level)

f = site response factor subject to subsoil class (refer Section 7.1 for subsoil class)

g = acceleration due to gravity

The ULS PGA was calculated based on a 50-year design life in accordance with the New Zealand Building Code[7] and importance level (IL) 2 structures. The PGA for the serviceability limit state (SLS) and ultimate limit state (ULS) earthquake scenarios is as follows:

Table 4: Design Peak Ground Acceleration (PGA) for Various Limit States

Limit State	AEP	R	PGA(g)	$\text{Magnitude}_{\text{eff}}$
SLS	1/25	0.25	0.06	5.9
ULS	1/500	1.0	0.22	5.9
Note: SLS = serviceability limit state; ULS = ultimate limit state; AEP = annual exceedance probability				

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[6] NZ Geotechnical Society publication “Earthquake geotechnical engineering practice, Module 1: Overview of the standards”, (March 2016)

[7] Ministry of Business, Innovation and Employment (1992) NZ Building Code Handbook, Third Edition, Amendment 13 (effective from 14 February 2014)

6.2 Fault Rupture

The nearest known active fault recorded in the GNS Active Faults Database[8] is the Kerepehi Fault approximately 38km to the east of the site. The risk of fault rupture affecting the site is therefore considered low.

6.3 Liquefaction

6.3.1 General

Soil liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading that exceed the effective stress of the soil. In loose soils, some dilation can occur during this process, which can lead to individual soil grains moving into suspension. Following the onset of liquefaction, the shear strength and stiffness of the liquefied soil is effectively lost causing excessive differential settlement of the ground surface, bearing capacity failure and collapse of structures and low-angle lateral spreading of slopes in liquefiable soils.

In accordance with NZGS guidance[9] the liquefaction susceptibility of the soils at this site has been considered with respect to geological age, soil fabric and soil consistency / density.

6.3.2 Geological Age

The vast majority of case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills[10][11]. Pleistocene aged alluvium (>12,000 years) is considered to have a very low to low risk of liquefaction[11.]

Hinuera Formation deposits are of mid to late Pleistocene geological age. The Walton Subgroup soils forming the low hills and underling the Hinuera Formation deposits are defined as being of later to early Pleistocene geological age. These deposits are therefore significantly older than what case history data would suggest as being susceptible to liquefaction.

Notwithstanding this, age alone is often debated as being of insufficient evidence to discount liquefaction potential due to its qualitative nature. Consideration can therefore be given to applying an ageing factor (K_{DR}) to site specific liquefaction analyses in accordance with methods described in Saftner et al[12] based on the following relationship (where t = time (years)):

$$K_{DR}=0.189\cdot\log(t)+0.878$$

The calculated aging factor for the Hinuera Formation is 1.65.

For Walton Subgroup the calculated aging factor is 1.85.

The method described by Saftner is based on Hayati and Andrus [13] but is updated following further studies and field trials. The basis for applying ageing factors to CPT-based liquefaction assessments is multi-faceted and discussed as follows:

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[8] https://data.gns.cri.nz/

[9] Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards", (May 2016)

[10] Seed, H.B. and Idriss, I.M. (1971) *A simplified procedure for evaluating soil liquefaction potential*, Earthquake Engineering Research Centre, Report No. EERC 70-9, University of California

[11] Youd, T.L. and Perkins, D.M. (1978) Mapping liquefaction-induced ground failure potential, *Journal of the Geotechnical Engineering Division,* ASCE, Vol. 104, No. GT4, Proc Paper 13659, p. 433-446

[12] Saftner, D.A.; Green, R.A.; Hryciw, R.D. (2015). Use of explosives to investigate liquefaction resistance of aged sand deposits, *Engineering Geology*, Vol 199, p.140-147.

[13] Hayati H, Andrus RD. (2009) Updated liquefaction resistance correction factors for aged sands Journal of Geotechnical and Geoenvironmental Engineering. 135: 1683-1692.

- MBIE Module 3 states that liquefaction susceptibility of soils should be assessed with respect to geological criteria (age) and compositional criteria (soil fabric and consistency/density). The geological criteria for liquefaction susceptibility is outlined in Section 5.2.1 and states "The age of the deposit is an important factor to consider when assessing liquefaction susceptibility". However, it also notes that ageing effects can be difficult to quantify. Overall, the MBIE Module 3 guidance is inconclusive around applying ageing factors and therefore CMW assessments do not rely on age alone to discount liquefaction. Geological age and compositional criteria are considered in conjunction when assessing liquefaction, as well as consideration of the geomorphology and topography of the area.
- Nearly all case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills (Seed & Idriss, 1971 and MBIE Module 3). Pleistocene aged alluvium (>12,000 years) is considered to have a very low to low risk of liquefaction (Youd & Perkins, 1978). Hinuera Formation deposits which underlie the site are Late Pleistocene alluvial deposits, with a geological age of 60 to 17 thousand years.

6.3.3 Soil Fabric

Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. Based on more recent case histories, there is general agreement that sands, non-plastic silts, gravels and their mixtures form soils that are susceptible to liquefaction. Clays, although they may significantly soften under cyclic loading, do not exhibit liquefaction features, and therefore are not considered liquefiable. NZGS guidance[5] sets out the plasticity index (PI) criteria for liquefaction susceptibility as follows:

PI < 7: Susceptible to Liquefaction

7 ≤ PI ≥ 12: Potentially Susceptible to Liquefaction

PI ≥ 12: Not Susceptible to Liquefaction

The fines content of the sands beneath the site also has a significant impact on their liquefaction susceptibility.

Specific soil grading / plasticity index laboratory testing has not been undertaken to date. Further testing may be of value at building design stage if CPT based liquefaction assessment results are problematic and refinement of susceptibility is warranted.

6.3.4 Specific Analyses

Specific liquefaction analyses were based on the Boulanger and Idriss (2014) methods using the software package CLiq by comparing the cyclic stress ratio (CSR), being a function of the earthquake magnitude for the design return period event, to the cyclic resistance ratio (CRR), being a function of the CPT cone resistance (qc) and friction ratio.

Ageing of the soils was applied to the CLiq models based on the ages specified in Section 6.3.2 above.

Results are presented in ***Appendix D*** and are summarised on Table 5 below:

Table 3: Liquefaction Analyses Results (Current Ground Profile)

CPT No.	ULS Settlement (mm)	Depth to Liquefied Layer (m) *	Liquefaction Comments
1	19	9.0	Several layers between 0.5 and 0.7m thick
2	7	8.4	Thin discrete layers from 0.2 to 0.4m thick
3	6	11.6	Single layer 0.3 to 0.4m thick
4	6	7.1	Thin discrete layers 0.2m thick
5	9	10.8	Single layer 0.4m thick
6	11	6.5	Thin discrete layers from 0.2 to 0.5m thick
7	4	NA	No significant liquefiable layers
8	5	7.3	Single layer 0.2 to 0.3m thick
9	7	7.4	Thin discrete layers from 0.2 to 0.3m thick
10	26	6.1	Thin discrete layers up to 0.5m thick. Suspect WSG from 10m ruling out deeper liquefaction
11	9	7.5	Thin discrete layers from 0.2 to 0.4m thick
12	0	NA	No significant liquefiable layers. WSG soils
13	7	8.5	Thin discrete layers from 0.2 to 0.4m thick
14	0	NA	No significant liquefiable layers

Note: * liquefied layer considered if greater than 200mm thick
Settlements and depths are based on current ground profile with no fill surcharge applied.
NA = Not Applicable, WSG = Walton Subgroup Soils

No liquefaction is predicted under the SLS earthquake event.

6.4 Cyclic Softening

Although the fine-grained Hinuera Formation soils, are not considered liquefiable due to their high plasticity, they may still be susceptible to some strength loss, referred to as cyclic softening, during the ULS seismic event.

Cyclic softening analyses of those soils was carried out in accordance with Boulanger[14] and Idriss[15]. This correlates earthquake magnitude to the estimated number of equivalent stress cycles (Figure 3 below) and then correlates number of cycles to a cyclic shear strength ratio (Figure 4 below).

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[14] Boulanger, R.W. and Idriss. I. M. (2007) Evaluation of Cyclic Softening in Silts and Clays, Journal of Geotechnical and Environmental Engineering, Vol 133, Issue 6.

[15] Idriss, I. M. and Boulanger, R. W. (2008) Soil Liquefaction During Earthquakes. Monograph 12, Earthquake Engineering Research Institute.

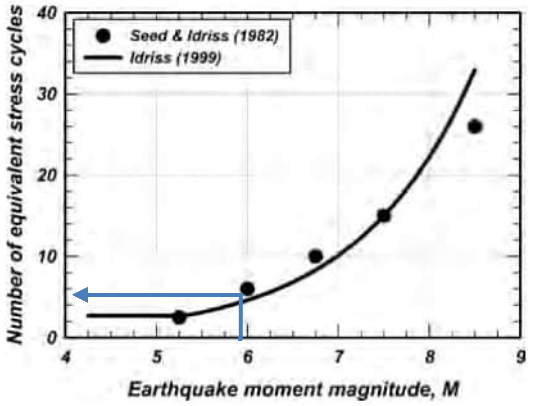

Figure 3: Relationship between earthquake magnitude and mean number of uniform stress cycles

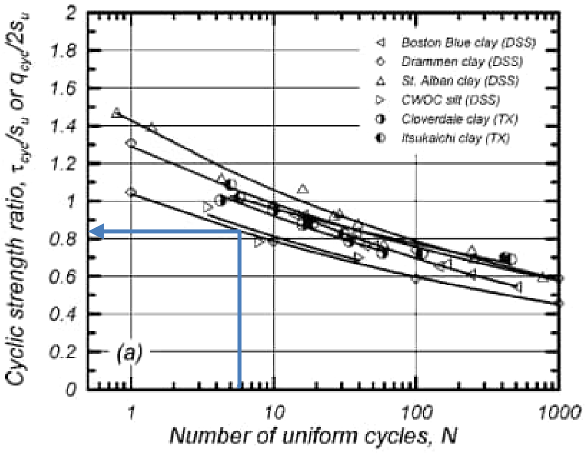

Figure 4: Relationship between cyclic strength ratio and number of uniform stress cycles

Based on the above assessment, 6 stress cycles are estimated during the ULS M5.9 earthquake resulting in an estimated cyclic shear strength of no more than 85% of the peak shear strength. Reduced peak shear strengths should be considered if any slope stability analyses are required e.g. for soakage basin detailed design.

6.5 Lateral Spread

Following the onset of liquefaction, the liquefied soils behave as a very weak undrained material, which can give rise to lateral spreading where a free face is present within the vicinity of the site.

Literature suggests that lateral spreading may occur if laterally persistent liquefied layers are present within a depth of 2 times the free face height. In this case, assuming a 3m deep soakage basin liquefaction above a depth of 6m may result in lateral spreading.

On account of the depth to liquefaction being greater than 6m along with the thin and discrete distribution of liquefied layers, the risk of lateral spreading into the proposed stormwater soakage basins in considered to be very low.

6.6 Soakage Basin Batters and Slope Stability

Detailed slope stability analyses are not warranted for the soakage basin at this early stage of the proposed development. Preliminary design recommendations are provided in Section 7.3 below.

For the hill remaining following proposed earthworks, due to the low slope gradients the slope stability risk is considered to be negligible.

6.7 Erosion

The predominantly sandy and silty nature of the natural soils, which will also generally be used as engineered fill, means that there is a risk of erosion if appropriate controls are not in place.

However, considering the relatively flat finished landform there will be a low risk of erosion across the site as a whole.

6.8 Load Induced Settlement

Although no earthworks plans are available at the time of this report preparation, it is anticipated that only minor fill placement will be undertaken of the order 1m thick across the lower lying portions of the site.

Proposed fill and future building loads may induce settlements within the underlying subsoils.

As the Hinuera Formation soils are sand dominated with lenses of fine grained silt, clay and localised organic silt and clay layers, load induced settlement is anticipated to be largely immediate.

Static settlements were calculated from selected representative CPT data to simulate widespread floor loads of 35kPa, and for shallow strip and pad foundations of dimensions 0.4 x 0.4 metres and 1.5 x 1.5 metres respectively with an applied working load of 100kPa.

The calculations were carried out adopting correlations with soil modulus from CPT data following the different methods of Schmertmann and Burland & Burbridge (carried out by Coffey) and re-assessed for comparison by CMW using the software package CPeT-IT.

Estimated static settlements are presented in Table 6 below:

Table 6: Estimated Fill Induced Static Settlements (mm)

CPT No	Method	0.4 x 0.4m strip footing with 100 kPa applied load	1.5 x 1.5m pad footing with 100 kPa applied load	35kPa widespread load *
3	Schmertmann	10	20	125
3	Burland & Burbridge	35	35	155
3	CPeT-IT	25	30	60
4	Schmertmann	15	50	55
4	Burland & Burbridge	50	70	75
4	CPeT-IT	35	40	265
6	Schmertmann	5	20	100
6	Burland & Burbridge	20	30	50
6	CPeT-IT	45	50	120
8	Schmertmann	10	80	130
8	Burland & Burbridge	25	60	135
8	CPeT-IT	85	100	205
10	Schmertmann	10	30	100
10	Burland & Burbridge	30	35	140
10	CPeT-IT	30	35	85
11	Schmertmann	5	10	40

Table 6: Estimated Fill Induced Static Settlements (mm)

CPT No	Method	0.4 x 0.4m strip footing with 100 kPa applied load	1.5 x 1.5m pad footing with 100 kPa applied load	35kPa widespread load *
11	Burland & Burbridge	10	15	35
11	CPeT-IT	35	40	65

Notes: * Total load represents nominal 5 kPa dead load and 30 kPa live load

Data from CPT 12 located on the southern low hill was not analysed as this location is proposed to be cut down in the order of 10m resulting in a large load compensation at finished subgrade levels.

Fill loads have not been considered in the settlement estimates as due to the primarily sandy nature of the Hinuera Formation soils beneath where fill will be placed. Associated settlements are anticipated to be immediate and largely resolved during earthworks construction.

These preliminary results show that settlement magnitudes for shallow pad and strip footings range from 5 to 100mm, where stress increases are primarily within the near surface deposits.

For widespread floor loads, settlement magnitudes are calculated to range from 35 to 265mm, where the theoretical pad width was adjusted to determine the greatest associated magnitude of settlement at each selected CPT location.

Load induced settlement estimates, in particular the widespread load values in Table 6 are considered to be very conservative. This is on the basis that the CPT Qc values within the upper Walton Subgroup – Puketoka Formation soils underestimate soil strength and stiffness due to the sensitivity of these soils to disturbance.

6.9 Sensitive Soils

The Walton Subgroup – Puketoka Formation silts and clays that are expected to be exposed following cutting down of the low hill area at / or immediately below design subgrade level typically contains very high moisture contents, sometimes approaching the soil liquid limit. They are highly sensitive resulting in significant strength loss upon remoulding.

Those characteristics may make the Puketoka Formation silty and clay soils particularly challenging to earthwork requiring specific consideration of plant types, vehicle movements and cut to fill methodologies. Further recommendations are provided in Section 7.5 below.

The majority of silt and clay soils present are sensitive to remoulding and moisture ingress resulting in a loss of strength. Care will be required to avoid over-working and trafficking of these materials during building, and to protect them from moisture ingress.

6.10 Expansive Soils

National standards exclude from the definition of ‘good ground’, soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content.

This shrinking and swelling results in vertical surface ground movement which can cause significant cracking of floor slabs and walls. There have been instances of concrete floors and/ or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking requiring extensive repairs or re-building once the soil moisture contents have returned to higher levels.

Whilst no laboratory testing has been undertaken for this site, from our experience the Walton Subgroup clay soils may be expected to have liquid limits above 50% indicating potentially expansive soils.

Hinuera Formation soils and Walton Subgroup silts and sands are not considered expansive.

The November 2019 update to the NZ Building Code, B1/AS1, includes significant detail on the assessment of expansive soil class and associated foundation design which may be relevant where clay soils are present.

With reference to published literature (Lowe & Percival, 1993[16], Lowe et al., 2001[17]) the Waikato region clay soils of the Walton Subgroup (the dominant surficial soil type at Lockerbie) have the potential to contain Halloysite, Kaolinite and some Allophane clay mineralogy's.

Upon exposure to air during periods of dry weather, these clay minerals can undergo non-recoverable shrinkage i.e., the volume of the soil is permanently decreased. In this case significant surface cracking can occur. This behaviour is unique to Halloysite dominant clays and therefore differs from Smectite / Montmorillonite (swelling/shrinking) dominated clays, on which AS2870 is based. Specific testing for expansive soils has not been carried out for this site and our advice is based on research in the greater Waikato region.

7 GEOTECHNICAL RECOMMENDATIONS

7.1 Seismic Site Subsoil Category

The geological units encountered beneath the development area comprise soil strength materials, which with respect to the seismic site subsoil category defined in Section 3.1.3 of NZS1170.5, is defined as having a UCS < 1MPa therefore a seismic site subsoil class of D (deep or soft soil) is considered appropriate.

It is anticipated that future buildings will be considered Importance Level IL2 structures with respect to NZS1170.

7.2 Liquefaction / Lateral Spread Mitigation

With reference to the liquefaction, cyclic softening, and lateral spread assessment in Sections 6.3 to 6.5 above, these geohazards are not anticipated to be significant constraints for the proposed development with respect to the defined design criteria.

Following installation of a series of subsoil drain the

Avoidance of stormwater soakage basin excavations deeper than 3m is recommended to reduce the risk of lateral spreading during ULS earthquake conditions.

However seismic slope stability analyses for the stormwater basins is recommended at detailed design stage to demonstrate compliance with design criteria above.

7.3 Soakage Basin Batter Stability

Based on our experience within similar soils as present at the site, a preliminary internal batter gradient of 1v:3h should be suitable assuming loose to medium dense sands.

Further slope stability analyses should be undertaken at the time of detailed design including assessment of soil types, variation of water levels, potential for scour/erosion and any surcharge loading.

A building restriction setback from the basins is expected and should be defined at the detailed design stage.

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[16] Lowe, D.J. & Percival, H. J. 1993. Clay Mineralogy of Tephras and Associated Paleosols and Soils, and Hydrothermal Deposits, North Island. 10th International Clay Conference, Adelaide.

[17] Lowe, D.J. et al, 2001. Ages on Weathered Plio-Pleistocene Tephra Sequences, Western North Island, New Zealand. Le Dossiers de l'Archeo-Logis 1, 45-60.

7.4 Static Settlement Management

7.4.1 General

Buildings should be designed to tolerate differential settlements of up to 1 in 240 (approximately 25mm over a 6 metre length of building) as required by the New Zealand Building Code.

Load induced settlement estimates stated in Section 6.8 are considered to be very conservative on the basis that the CPT Qc values within the upper Walton Subgroup – Puketoka Formation soils underestimate soil strength and stiffness due to the sensitivity of these soils to disturbance.

Typically shallow foundation types are considered feasible for lightweight industrial and commercial buildings subject to further geotechnical assessment at Building Consent stage.

Consideration should be given to positioning buildings to avoid spanning over the cut down hills and surrounding terrace where the risk of differential settlement issues is greatest.

Due to the inherent variability of the natural subsoils, foundation improvement works may be required. For any deeper or larger foundation dimensions, changes in stress conditions to the underlying variable strength natural subsoils are likely to result in increased settlements to those indicated in Section 6.8 above.

7.4.2 Ground Improvement Options

If particularly heavy building dead and live load combinations are proposed and specific geotechnical investigation and analysis indicates that settlement magnitudes are unacceptable then to minimise post construction static ground settlements, a range of options may be considered, including the following:

- Nominal 0.5 to 1m undercut of any low-strength near surface soils (such as sensitive silt/clay of the Puketoka Formation or Hinuera Formation silts or loose sands) and replacement with engineered fill (reused or imported sand, or hardfill), possibly with geogrid layers and possibly with stiffened raft foundations;
- Construction of a temporary surcharge or pre-load fill embankment above design finished level, to over-consolidate the compressible soils and minimise post construction embankment settlements;
- Compensated foundation design using lightweight geofoam, such as EPS-block materials to keep pressures below pre-consolidation pressures within compressible soils thereby reducing consolidation settlements;
- Undertake deeper ground improvement beneath the building footprint, such as stone columns, soil mixed columns, CFA piles, Rammed Aggregate Piers (RAP's) or similar rigid inclusions to transfer loads from the structure to more competent underlying soils at depth.

The Masterplan indicates that buildings may span from cut Walton Subgroup soils onto Hinuera Formation with or without earthfill, where post-construction differential settlements may occur. It is expected that geotechnical designers should give consideration to this differential settlement potential and also consider positioning buildings entirely on cuts or fills.

7.5 Earthworks

7.5.1 General

All earthwork activities should be carried out in general accordance with the requirements of NZS 4431[18] and the general requirements of the Waikato Regional Infrastructure Technical Specifications (RITS) under the guidance of a Chartered Professional Geotechnical Engineer.

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[18] Standards New Zealand (1989) Code of practice for earth fill for residential development, incorporating Amendment No. 1, NZS 4431:1989, NZ Standard

7.5.2 Subgrade Preparation

Preparation of the natural soil subgrade beneath proposed fill areas should comprise stripping of all vegetation, topsoil, any pre-existing fill materials or weak surficial alluvium. The subgrade should then be scarified and moisture conditioned where necessary and then proof rolled to verify the subgrade stiffness and consistency.

Where any particularly weak materials are encountered that weave excessively during the proof rolling process, they should be undercut and removed prior to placing engineered fill.

For all existing farm drains, allowance should be made for excavating out all organic materials, cleaning out of all accumulated sediment, placement of drainage materials and bulk engineered fill above.

7.5.3 Subsoil Drainage

A network of subsoil drains will need to be installed across the site that will supersede the existing farm subsoil drains and manage near surface groundwater levels over the winter months.

The Coffey Existing Subsoil Drainage Plan drawing Figure 07 (in ***Appendix A***) depicts the indicative existing farm subsoil drain layout. At this early stage of the development it is recommended that the new subsoil drain network cover this area with a nominal 30m spacing. The drain layout should be designed to discharge into the proposed stormwater basins.

Subsoil drains are anticipated to comprise a nominal 2m to 3m deep excavated trench with perforated draincoil, drainage aggregate and fully wrapped in a non-woven geotextile fabric. The geotextile wrapped drainage aggregate should be approximately 1m thick. The upper trench backfill should be compacted to engineer certifiable standard.

The function of subsoil drains and their outlets into proposed stormwater soakage basins will be protected using restrictions applied in the Geotechnical Completion Report. These may also include foundation piling requirements to prevent conflict with the drains.

7.5.4 Compaction

Earthfill must be placed, spread and compacted in controlled lifts under the direction of a geotechnical engineer. The fill is expected to comprise cohesive clay and silt, free of any organic.

All earthfill must be placed to ensure adequate knitting of successive fill lifts by ripping any natural subgrade or fill surfaces that have become dry prior to placing the following fill lift.

The volcanic ash sourced cut material should be suitable for reuse as Engineer Certified Fill with minimal conditioning during dry summer construction period.

The deeper Puketoka Formation silt and clay is highly sensitive to strength loss upon remoulding and carefully developed earthworks methodologies and practices are required to successfully earthwork these soils. From our experience these soils can be suitably dried and blended with volcanic ash soils during dry summer months. The success of this is highly dependent on slow and well executed compaction methodologies. Selection of earthworks contractors experienced in dealing with these soils is strongly recommended.

7.5.5 Compaction Factor

Comparison of in-situ dry densities to maximum dry densities within the likely onsite cut materials comprising Walton Subgroup clays and silts, together with data derived from other sites, suggests that an average compaction factor of approximately 1.3 to 1.5 should be appropriate for those materials.

7.5.6 Quality Control

The source and / or type of material used for engineered fill will dictate the type of quality control testing undertaken.

It is expected that the onsite cut will comprise clays and silts to be used as structural earth filling. In this case test criteria using vane shear strength and air voids should be used. A representative suite of compaction curves with solid density and moisture content tests are recommended to confirm a project specific compaction specification.

For any imported granular (sand and gravel) fill materials, testing following compaction should be principally in terms of the maximum dry density within the appropriate water content range, which may be calibrated with a dynamic cone (Scala) penetrometer test that is then used as the primary testing measure. Where the source or quality of fill changes, re-calibration will be required.

The source of the fill should be discussed with and approved by the project geotechnical engineer to verify its appropriateness and quality control testing requirements.

7.6 Civil Works

7.6.1 Road Subgrades

The development masterplan indicates subdivision roading which will be constructed in primarily cut areas or where thin structural earthfill has been placed.

The Walton Subgroup clay and silt soils, Hinuera silts, particularly the Puketoka Formation clays and silts, are sensitive to disturbance and degrade rapidly with trafficking. Where traffic can be left off these materials, they are moisture conditioned, recompacted at optimum moisture contents and located at least 1m above the peak winter water table, there could be some opportunity to use them as a pavement subgrade material for minor roads. However, this is not considered practical for main collector-type roads and allowance should therefore be made to undercut these materials and replace with a subgrade improvement layer (SIL).

The thickness of the SIL should be determined by the pavement designer although a nominal thickness of 1m is envisaged to adequately dissipate traffic loads within the Puketoka Formation soils. From our experience a 1m thick sand SIL overlying high strength geotextile and geogrid may be appropriate. Specific consideration to construction methodologies, such as the use of long reach excavators, progressive excavation and SIL placement, along with use of geotextiles, etc, will also be required to avoid trafficking over sensitive clay/silt subgrades.

It is envisioned that well-graded clean sand excavated during proposed stormwater basin construction would be suitable for use as SIL material.

Medium dense to dense Hinuera Formation sandy soils are generally suitable as road subgrade materials. Where loose Hinuera Formation sands are present at subgrade levels these may be conditioned by proof rolling to achieve suitable subgrade strengths.

7.6.2 Service Trenches

All of the materials to be exposed during the excavation of service trenches should be readily removed using an excavator.

Trench collapse is expected to pose problems in areas where groundwater is encountered, particular over winter months.

Installation of the proposed subsoil drainage network prior to service trenching is recommended. However for service lines deeper than the subsoil drains these should be installed first and are expected to require temporary construction dewatering in the form of regularly spaced sump pumps or well point dewatering spears.

Potential for dewatering induced settlements should be considered during detailed subdivision design and impact on adjacent roading and existing structures assessed.

It is anticipated that all trench backfill will be placed and compacted in accordance with RITS requirements.

7.6.3 Stormwater Soakage

The Hinuera Formation sandy soils at this site are considered suitable to provide a seepage function for the design of stormwater attenuation and soakage basins. The soakage test results indicate a range in K value of 1.2x10-6 m/sec to 7.7x10-5 m/sec.

Detailed soakage design is being undertaken by others. We recommend the design consider depth to groundwater table, potential for blinding of the base due to progressive fines build up, secondary overland flow paths and downstream effects.

There is a lot of variability in the soakage test results, and for preliminary design purposes conservatively using the lower value may be more appropriate than adopting an average. As such, further soakage testing in the location of the proposed soakage basins should provide greater confidence.

It is important to note that soil permeability rates in the clayey and silty soils forming the low hills will be low and soakage in these soils is not recommended.

8 FOUNDATIONS

At the completion of earthworks, a Geotechnical Completion Report (GCR) will be prepared. The GCR will advise on anticipated foundation design parameters and any restrictions that require further engineering investigation and/ or design on individual lots to address any remaining natural hazards as described in Section 71(3) of the Building Act i.e., erosion, falling debris, subsidence, slippage, and inundation.

Restrictions that are expected to be applied in the GCR to protect the future buildings from natural hazards associated with static settlement and liquefaction, batters and drainage are outlined in the respective sections in this report.

On this site our provisional expectation is that, provided earthworks are completed in accordance with the standards and recommendations described herein, the following will apply:

- A preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas, subject to the short axis of those footings measuring no greater than 1.5m in plan.

  There may be areas where localised variations in shear strength within the natural cut ground occur, particularly where Puketoka Formation soils are exposed and where the depth of cut varies across the building platforms. Further confirmation of available bearing pressures will be addressed at the time of post earthworks soil testing.
- On the basis of soil descriptions and our experience, we have assessed the preliminary AS2870 Site Class for building platforms within the Walton Subgroup soils to be M (moderate). These recommendations should be subject to further review by a suitably qualified geotechnical engineer for specific building foundations.
- Hinuera Formation soils are considered to be Site Class A.
- As required by section B1/VM4[19] of the New Zealand Building Code Handbook, a strength reduction factor of 0.5 and 0.8 must be applied to all recommended geotechnical ultimate soil capacities in conjunction with their use in factored design load cases for static and earthquake overload conditions respectively.

9 STATEMENT OF PROFESSIONAL OPINION

Based on the results of previous geotechnical investigations at the site and subject to the preliminary recommendations stated above, we consider that the site is suitable for the proposed level of development. The proposed private plan change from industrial to mixed residential, commercial and recreational land use is considered to be appropriate from a geotechnical perspective.

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[19] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/VM4, Amendment 19

10 FURTHER WORK

Further geotechnical field investigation and design will be required to suitably mitigate the geotechnical risks identified in Section 6 above.

Our recommendations for further work are as follows:

- Hand auger boreholes with associated soakage testing in the locations of the proposed stormwater basins to provide in-situ soil permeability values for soakage design;
- Subsoil drainage design including drain layout and construction detailing;
- Further slope stability analyses should be undertaken at the time of detailed design of the stormwater basins including assessment of soil types, variation of water levels, potential for scour/erosion and any surcharge loading. A building restriction setback from the basins should be confirmed at this time;
- Earthworks material suitability assessment including sampling, laboratory testing and preparation of an project specific earthworks compaction control specification;
- Section 106 of the Resource Management Act[20] (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land or structures (consequence). This is a requirement at Resource Consent application stage.
- Presentation of the above work in a Geotechnical Design Report suitable to support a Resource Consent application and / or detailed design as appropriate.

Proposed buildings should be subject to specific geotechnical site investigation, analyses and reporting at the time of Building Consent application.

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[20] Resource Management Act (1991), as at 29 October 2019

USE OF THIS REPORT

Site subsurface conditions cause more construction problems than any other factor and therefore are generally the largest technical risk to a project. These notes have been prepared to help you understand the limitations of your geotechnical report.

Your geotechnical report is based on project specific criteria

Your geotechnical report has been developed on the basis of our understanding of your project specific requirements and applies only to the site area investigated. Project requirements could include the general nature of the project; its size and configuration; the location of any structures on or around the site; and the presence of underground utilities. If there are any subsequent changes to your project you should seek geotechnical advice as to how such changes affect your report's recommendations. Your geotechnical report should not be applied to a different project given the inherent differences between projects and sites.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface investigation, the conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation of factual data

Site investigations identify actual subsurface conditions at points where samples are taken. Additional geotechnical information (e.g. literature and external data source review, laboratory testing on samples, etc) are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can exactly predict what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

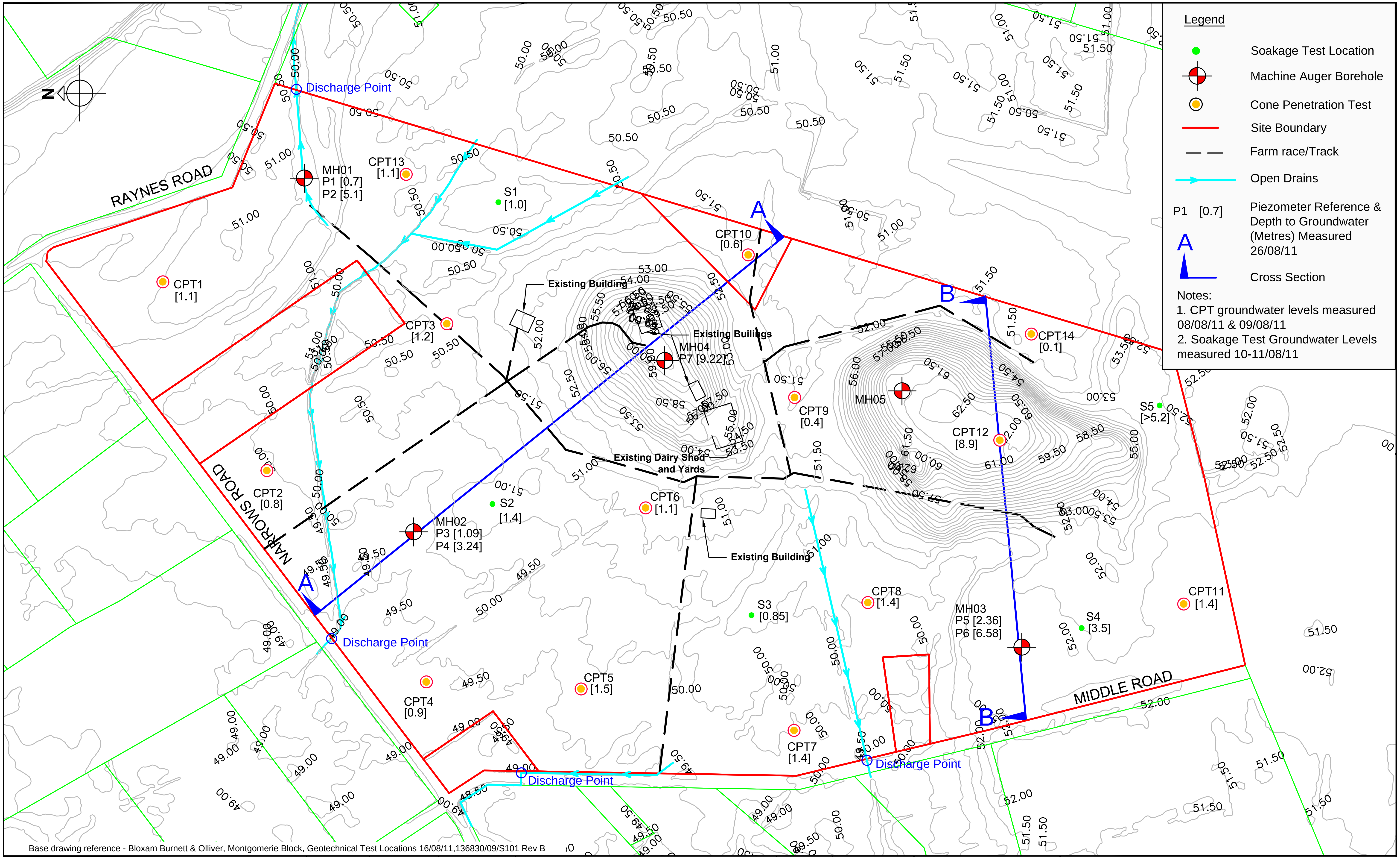
Your report's recommendations require confirmation during construction

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site. A geotechnical designer, who is fully familiar with the background information, is able to assess whether the report's recommendations are valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. Read all geotechnical documents closely and do not hesitate to ask any questions you may have. To help avoid misinterpretations, retain the assistance of geotechnical professionals familiar with the contents of the geotechnical report to work with other project design professionals who need to take account of the contents of the report. Have the report implications explained to design professionals who need to take account of them, and then have the design plans and specifications produced reviewed by a competent Geotechnical Engineer.

Appendix A: Coffey Geotechnics Figures 01 to 07



Legend

● Soakage Test Location

⊕ Machine Auger Borehole

● Cone Penetration Test

— Site Boundary

— — Farm race/Track

→ Open Drains

P1 [0.7] Piezometer Reference & Depth to Groundwater (Metres) Measured 26/08/11

A Cross Section

Notes:
1. CPT groundwater levels measured 08/08/11 & 09/08/11
2. Soakage Test Groundwater Levels measured 10-11/08/11

Base drawing reference - Bloxam Burnett & Olliver, Montgomerie Block, Geotechnical Test Locations 16/08/11,136830/09/S101 Rev B

revision	description	drawn	approved	date

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Horizontal Scale (metres)

0 50.0 100.0 200.0 300.0
Vertical Scale (metres)

drawn	PD/TM
approved	KL
date	12/09/2011
scale	1:5000
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

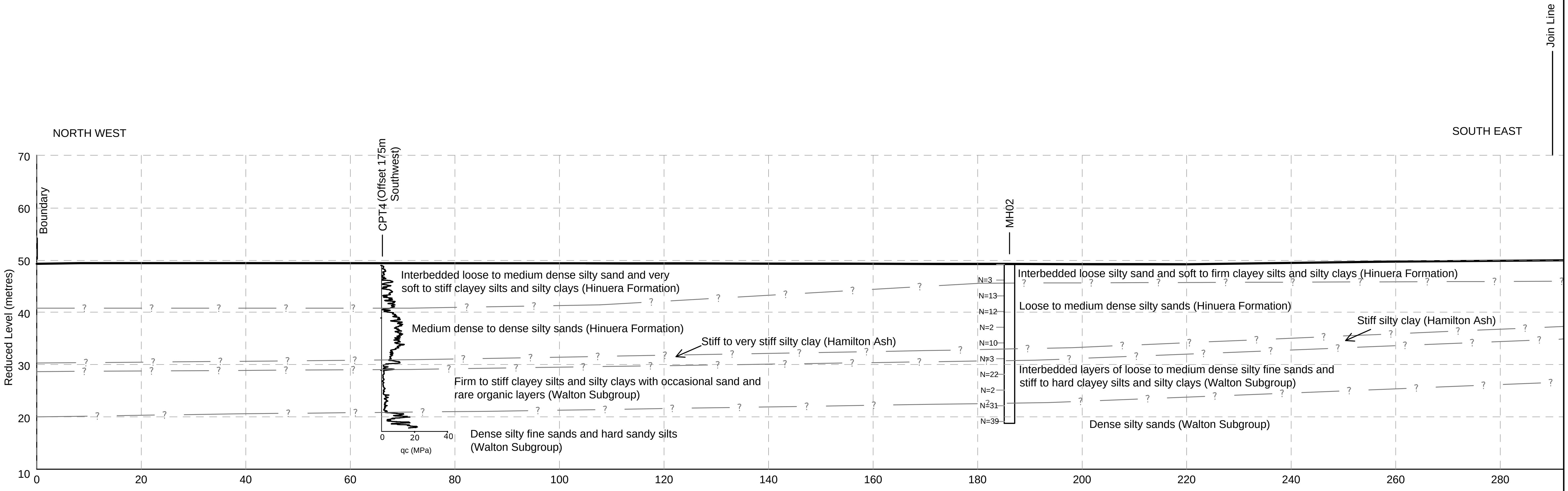
client: **BLOXAM BURNETT AND OLLIVER LIMITED**

project: **MONTGOMERIE BLOCK, RAYNES ROAD, HAMILTON**

title: **SITE PLAN**

project no: **GENZHAMI17003AA** figure no: **01**

28/09/2011\AUCKFS02\DATA$\GENZ\20 HAMI PROJECTS\17003AA MONTGOMERIE BLOCK\DRAWINGS\CGL DRAWINGS\WORKING\17003 SP XS.DWG



CROSS SECTION A-A (1)

Notes

1. Geological boundaries, where shown, have been drawn between known data points to assist in the geological interpretation and should not be considered to represent actual boundaries which may vary from these lines

revision	description	drawn	approved	date

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Horizontal Scale (metres)
0 15.0 30.0 45.0
Vertical Scale (metres)

drawn	**PD/TM**
approved	**KL**
date	**12/09/2011**
scale	**1:750**
original size	**A3**

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client:	**BLOXAM BURNETT AND OLLIVER LIMITED**
project:	**MONTGOMERIE BLOCK, RAYNES ROAD, HAMILTON**
title:	**CROSS SECTION A-A (1)**
project no:	**GENZHAMI17003AA**
figure no:	**02**

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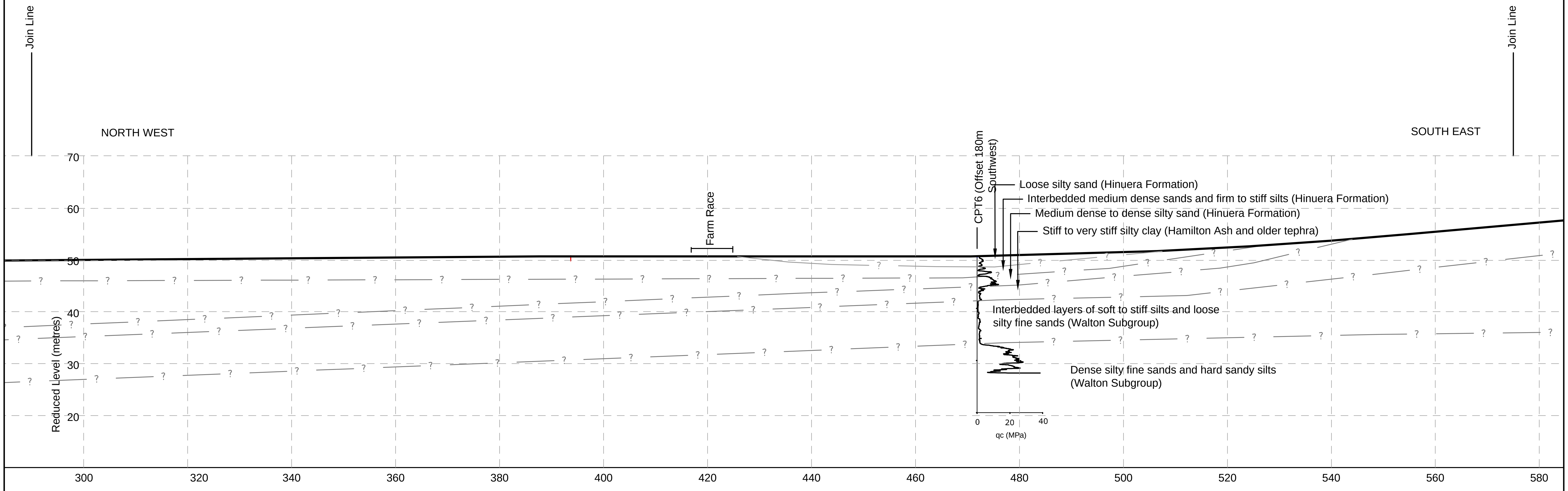

CROSS SECTION A-A (2)

Notes

1. Geological boundaries, where shown, have been drawn between known data points to assist in the geological interpretation and should not be considered to represent actual boundaries which may vary from these lines

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Horizontal Scale (metres)

0 15.0 30.0 45.0

Vertical Scale (metres)

drawn	PD/TM
approved	KL
date	12/09/2011
scale	1:750
original size	A3

coffey geotechnics

SPECIALISTS MANAGING THE EARTH

client: **BLOXAM BURNETT AND OLLIVER LIMITED**

project: **MONTGOMERIE BLOCK,**
RAYNES ROAD, HAMILTON

title: **CROSS SECTION A-A (2)**

project no: **GENZHAMI17003AA** figure no: **03**

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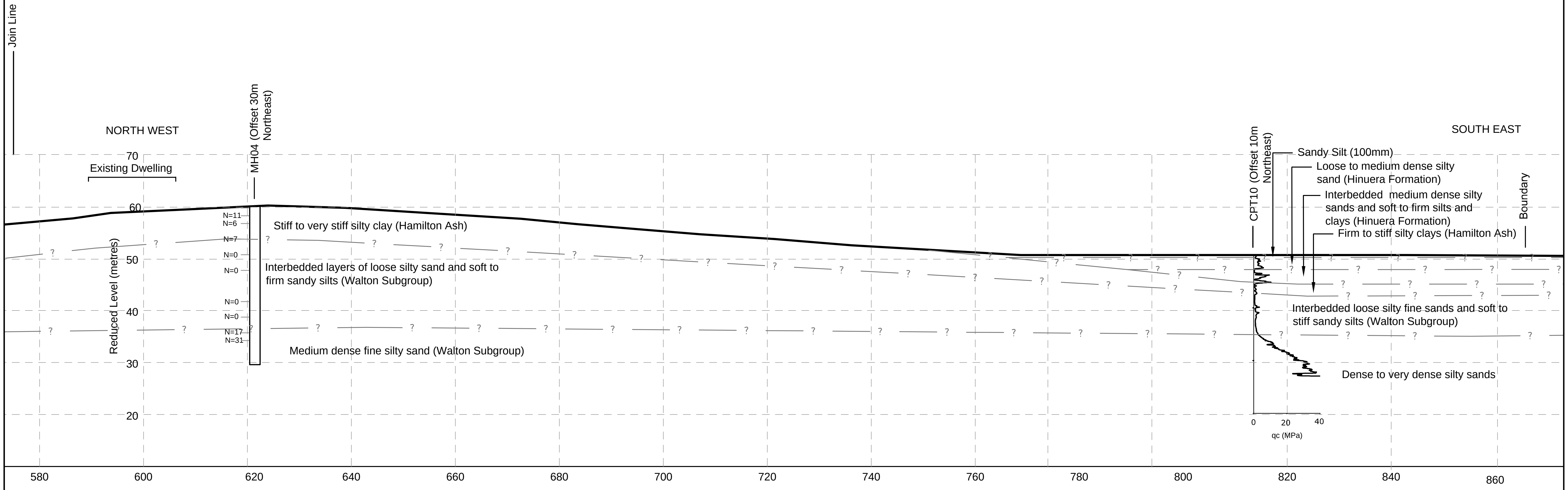

CROSS SECTION A-A (3)

Notes

1. Geological boundaries, where shown, have been drawn between known data points to assist in the geological interpretation and should not be considered to represent actual boundaries which may vary from these lines

revision	description	drawn	approved	date

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Horizontal Scale (metres)
0 15.0 30.0 45.0
Vertical Scale (metres)

drawn	**PD/TM**
approved	**KL**
date	**12/09/2011**
scale	**1:750**
original size	**A3**

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

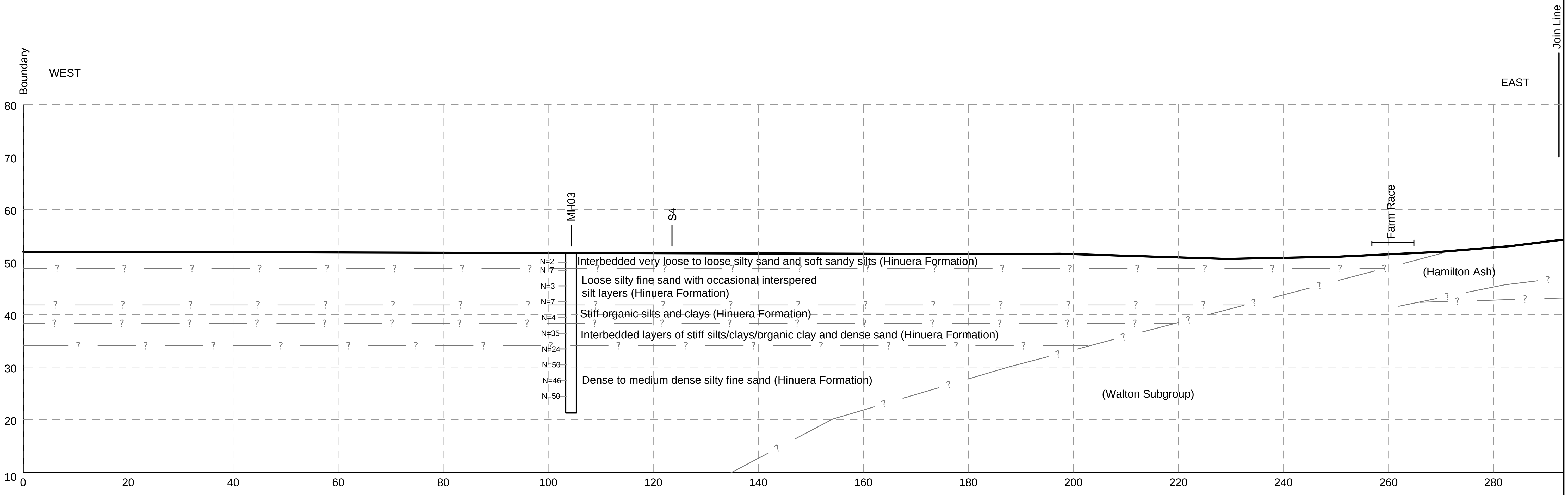
client: **BLOXAM BURNETT AND OLLIVER LIMITED**

project: **MONTGOMERIE BLOCK, RAYNES ROAD, HAMILTON**

title: **CROSS SECTION A-A (3)**

project no: **GENZHAMI17003AA** figure no: **04**

12/09/2011C:\USERS\TYLER_MANDERSON\DESKTOP\HAMI_TAUC PROECTS\TYLER\17003 MONTGOMERIE\17003 SP XS.DWG



CROSS SECTION B-B (1)

Notes

1. Geological boundaries, where shown, have been drawn between known data points to assist in the geological interpretation and should not be considered to represent actual boundaries which may vary from these lines

revision	description	drawn	approved	date

0 15.0 30.0 45.0

Horizontal Scale (metres)

0 15.0 30.0 45.0

Vertical Scale (metres)

drawn	**PD/TM**
approved	**KL**
date	**12/09/2011**
scale	**1:750**
original size	**A3**

coffey geotechnics

SPECIALISTS MANAGING THE EARTH

client: **BLOXAM BURNETT AND OLLIVER LIMITED**

project: **MONTGOMERIE BLOCK,**
RAYNES ROAD, HAMILTON

title: **CROSS SECTION B-B (1)**

project no: **GENZHAMI17003AA** figure no: **05**

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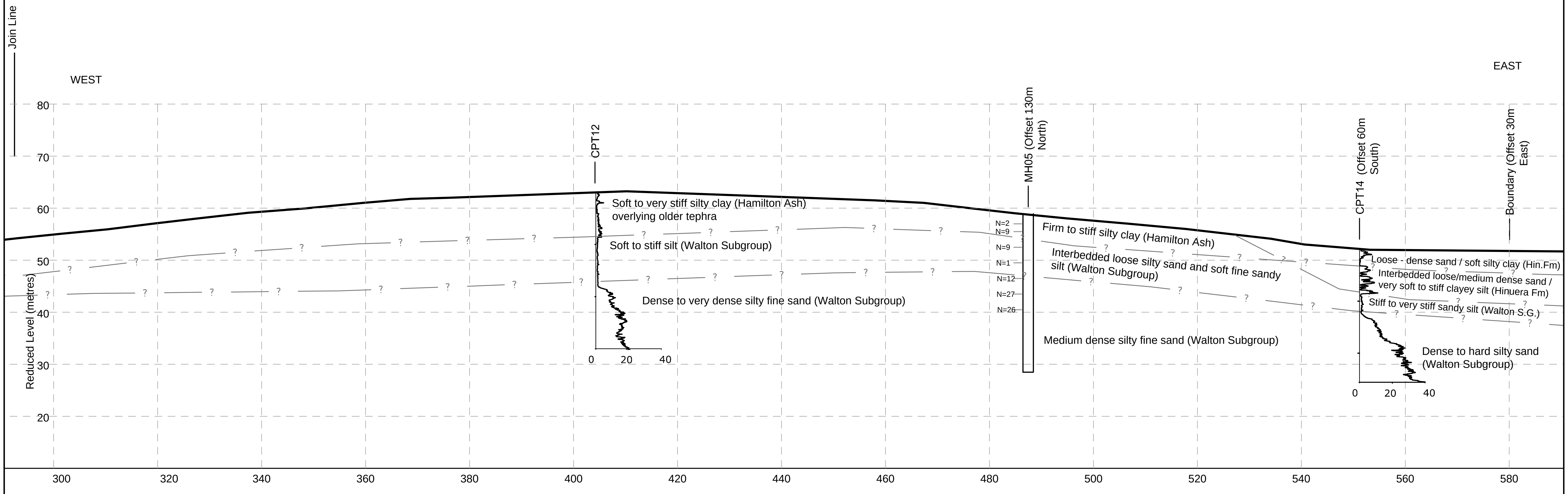

CROSS SECTION B-B (2)

Notes

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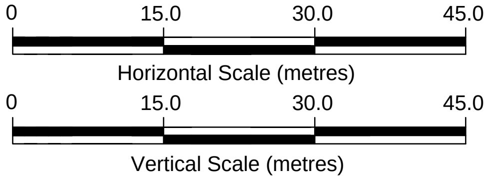


drawn	PD/TM
approved	KL
date	12/09/2011
scale	1:750
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

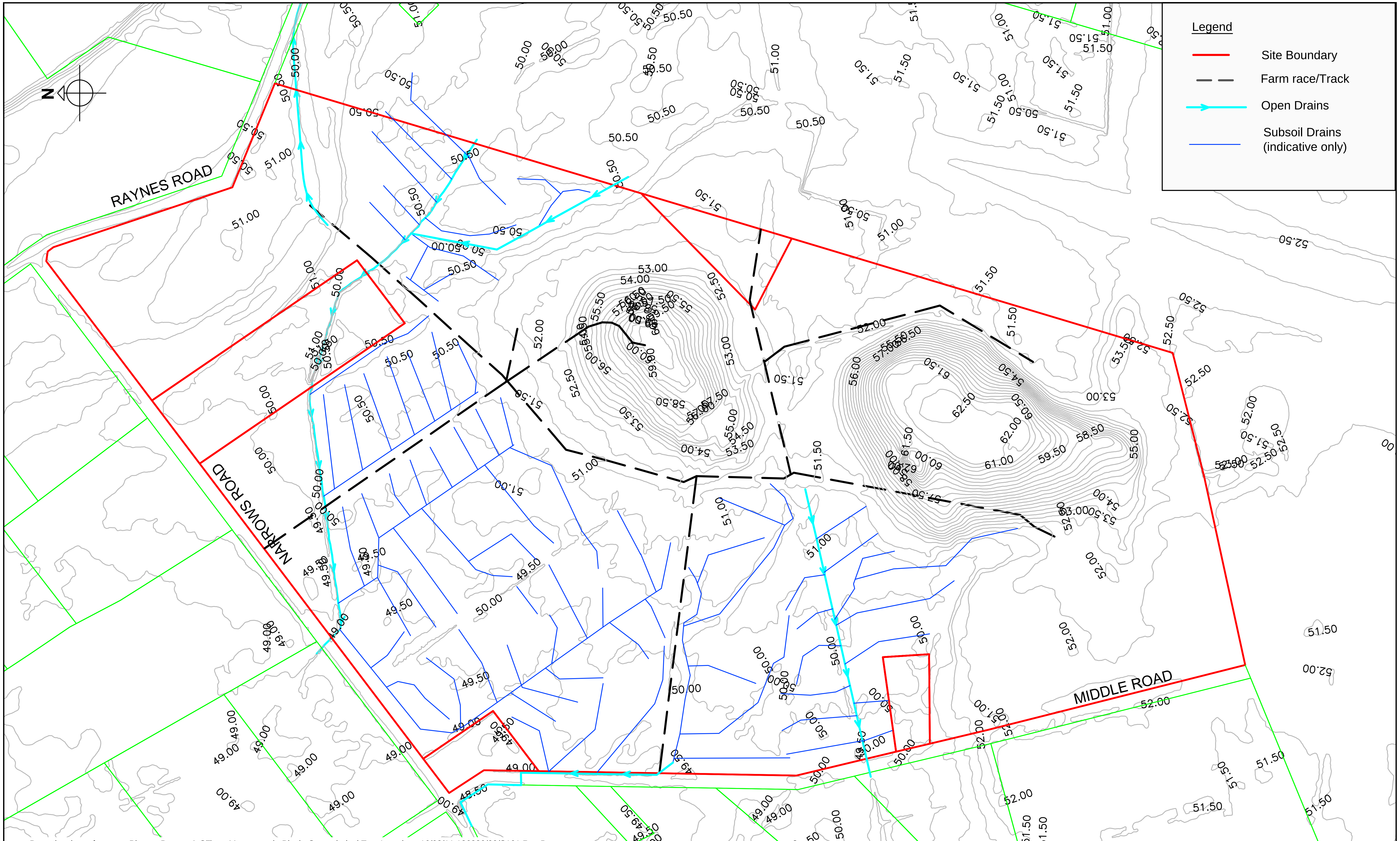
client: **BLOXAM BURNETT AND OLLIVER LIMITED**

project: **MONTGOMERIE BLOCK, RAYNES ROAD, HAMILTON**

title: **CROSS SECTION B-B (2)**

project no: **GENZHAMI17003AA** figure no: **06**

28/09/2011Z:\20 HAMI PROJECTS\17003AA MONTGOMERIE BLOCK\DRAWINGS\CGL DRAWINGS\WORKING\17003 SP XS.DWG



Base drawing reference - Bloxam Burnett & Olliver, Montgomerie Block, Geotechnical Test Locations 16/08/11,136830/09/S101 Rev B

revision	description	drawn	approved	date

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Horizontal Scale (metres)

0 50.0 100.0 200.0 300.0
Vertical Scale (metres)

drawn	PD/TM
approved	KL
date	05/10/2011
scale	1:5000
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client: **BLOXAM BURNETT AND OLLIVER LIMITED**

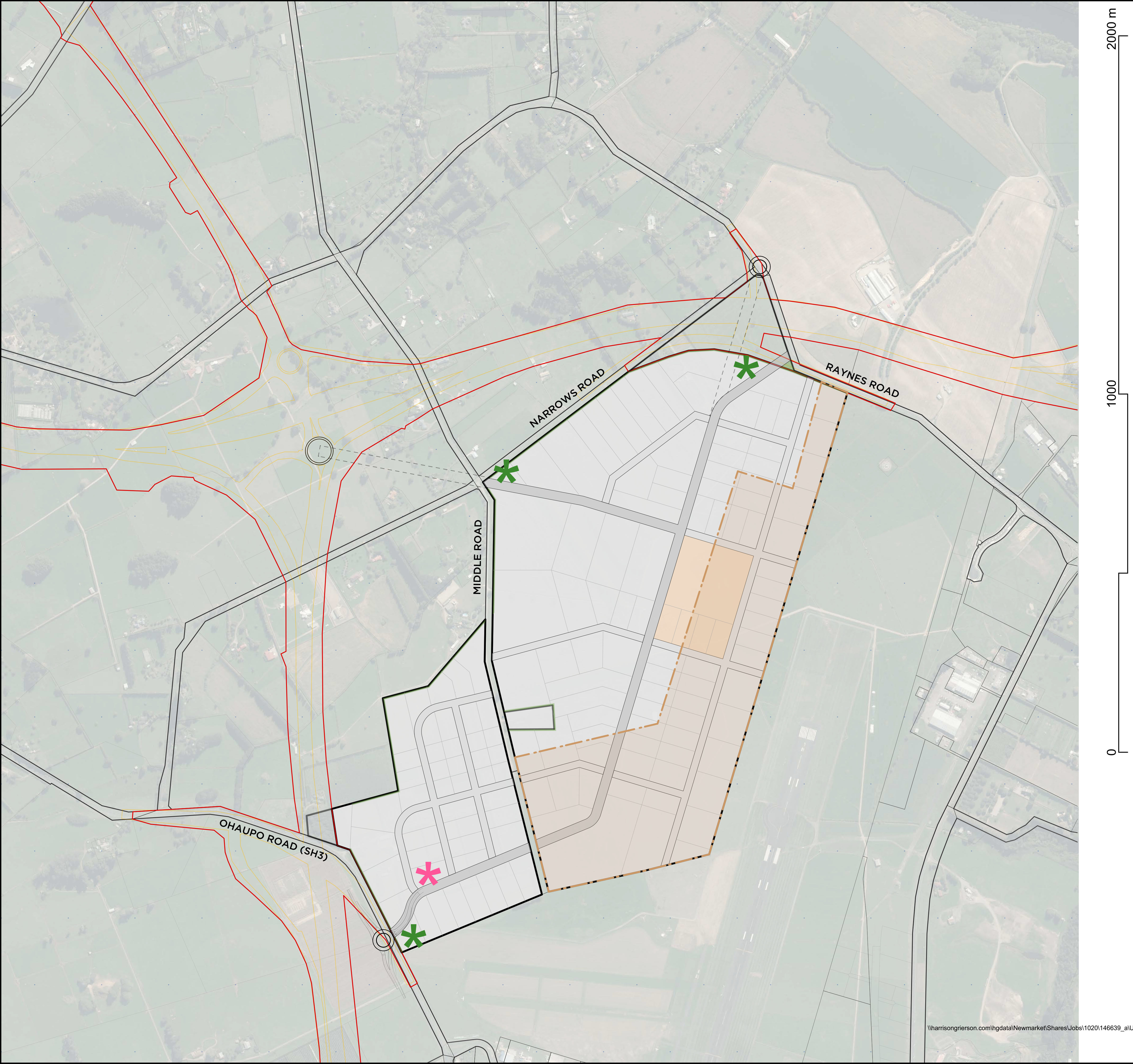
project: **MONTGOMERIE BLOCK, RAYNES ROAD, HAMILTON**

title: **EXISTING SUBSOIL DRAINAGE PLAN**

project no: **GENZHAMI17003AA** figure no: **07**

28/09/2011G:\GENZ\20 HAMI PROJECTS\17003AA MONTGOMERIE BLOCK\DRAWINGS\CGL DRAWINGS\WORKING\17003 SP XS.DWG

Appendix B: HGCL Illustrative Masterplan



Integrated Masterplan Concept

KEY

- 🟧 Hub
- ⬚ Indicative Future Road Connections to Southern Links
- 🟥 Southern Links Designation Extent
- ▬ Landscape Buffer
- ✱ Indicative Landscape Feature
- ✱ Indicative Retail Area
- ⬚ Operative Airport Business Zone Extent Land area extent - approx. 41ha

NOTE: Lot layout is indicative only and for illustrative purposes. Further development is anticipated following experts review and additional information from others.

HARRISON GRIERSON

NORTHERN PRECINCT

Project:	1020-146639-01
Date:	20/04/2022
Dwg No:	146639-122
Status:	for information
Scale:	1:10000
Revision:	D

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\\harrisongrierson.com\hgdata\Newmarket\Shares\Jobs\1020\146639_a\UD\06_Vectorworks & Cad\VECTORWORKS\146639_Titanium Park-Urban Design Masterplan-v7 (Lastest version).vwx

Appendix C: Coffey Field Investigation Results

Soil Description Explanation Sheet (1 of 2)

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are broadly described in accordance with the Unified Soil Classification System (UCS) as shown in the table on Sheet 2. However, there are some departures from this and reference should be made to the New Zealand Geotechnical Society 'Field Description of Soil and Rock' 2005 for clarification.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		60 mm to 200 mm
Gravel	coarse	20 mm to 60 mm
	medium	6 mm to 20 mm
	fine	2 mm to 6 mm
Sand	coarse	600 µm to 2 mm
	medium	200 µm to 600 µm
	fine	60 µm to 200 µm

MOISTURE CONDITION

Dry	Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.
Moist	Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet	As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	Easily exudes between fingers when squeezed.
Soft	12 - 25	Easily indented by fingers.
Firm	25 - 50	Indented by strong finger pressure & can be indented by thumb pressure.
Stiff	50 - 100	Cannot be indented by thumb pressure.
Very Stiff	100 - 200	Can be indented by thumb nail.
Hard	200 - 500	Difficult to indent by thumb nail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)	SPT N-value (Blows / 300mm)
Very loose	Less than 15	Less than 4
Loose	15 - 35	4 - 10
Medium Dense	35 - 65	10 - 30
Dense	65 - 85	30 - 50
Very Dense	Greater than 85	Greater than 50

MINOR COMPONENTS

FRACTION	TERM	% OF SOIL MASS	EXAMPLE
Major	(...) [UPPER CASE]	≥ 50 [major constituent]	GRAVEL
Subordinate	(...)y [lower case]	20 - 50	Sandy
Minor	with some... with minor...	12 - 20 5 - 12	with some sand with minor sand
	with trace of (or slightly) ...	< 5	with trace of sand (slightly sandy)

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS	
Extremely weathered material	Structure and fabric of parent rock visible.
Residual soil	Structure and fabric of parent rock not visible.

TRANSPORTED SOILS	
Aeolian soil	Deposited by wind.
Alluvial soil	Deposited by streams and rivers.
Colluvial soil	Deposited on slopes (transported downslope by gravity).
Fill	Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.
Lacustrine soil	Deposited by lakes.
Marine soil	Deposited in ocean basins, bays, beaches and estuaries.

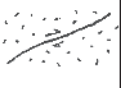
Soil Description Explanation Sheet (2 of 2)

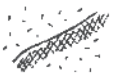
SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

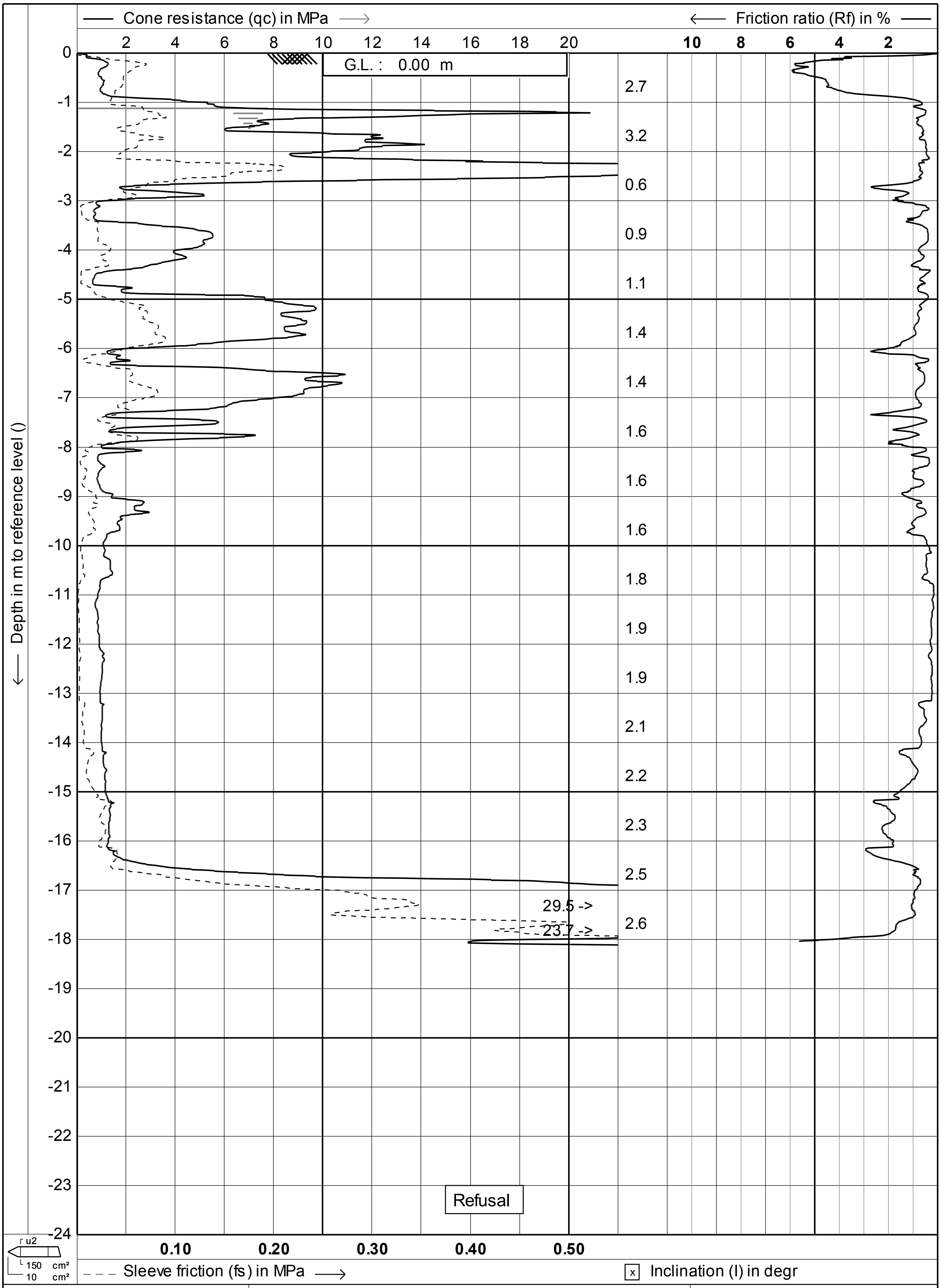
FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)							USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 60 mm is larger than 0.06 mm	(A 0.06 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 60 mm is smaller than 0.05 mm				IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.				
				DRY STRENGTH	**DILATANCY**	**TOUGHNESS**		
		SILTS & CLAYS Liquid limit less than 50		None to Low	Quick to slow	None	ML	SILT
				Medium to High	None	Medium	CL	CLAY
				Low to medium	Slow to very slow	Low	OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50		Low to medium	Slow to very slow	Low to medium	MH	SILT
				High	None	High	CH	CLAY
				Medium to High	None	Low to medium	OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS				Readily identified by colour, odour, spongy feel and frequently by fibrous texture.			Pt	PEAT

- Low plasticity – Liquid Limit W_L less than 35%.
- Medium plasticity – W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter.	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	



CPTask V1.26

Perry DRILLING GEO PROBE
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

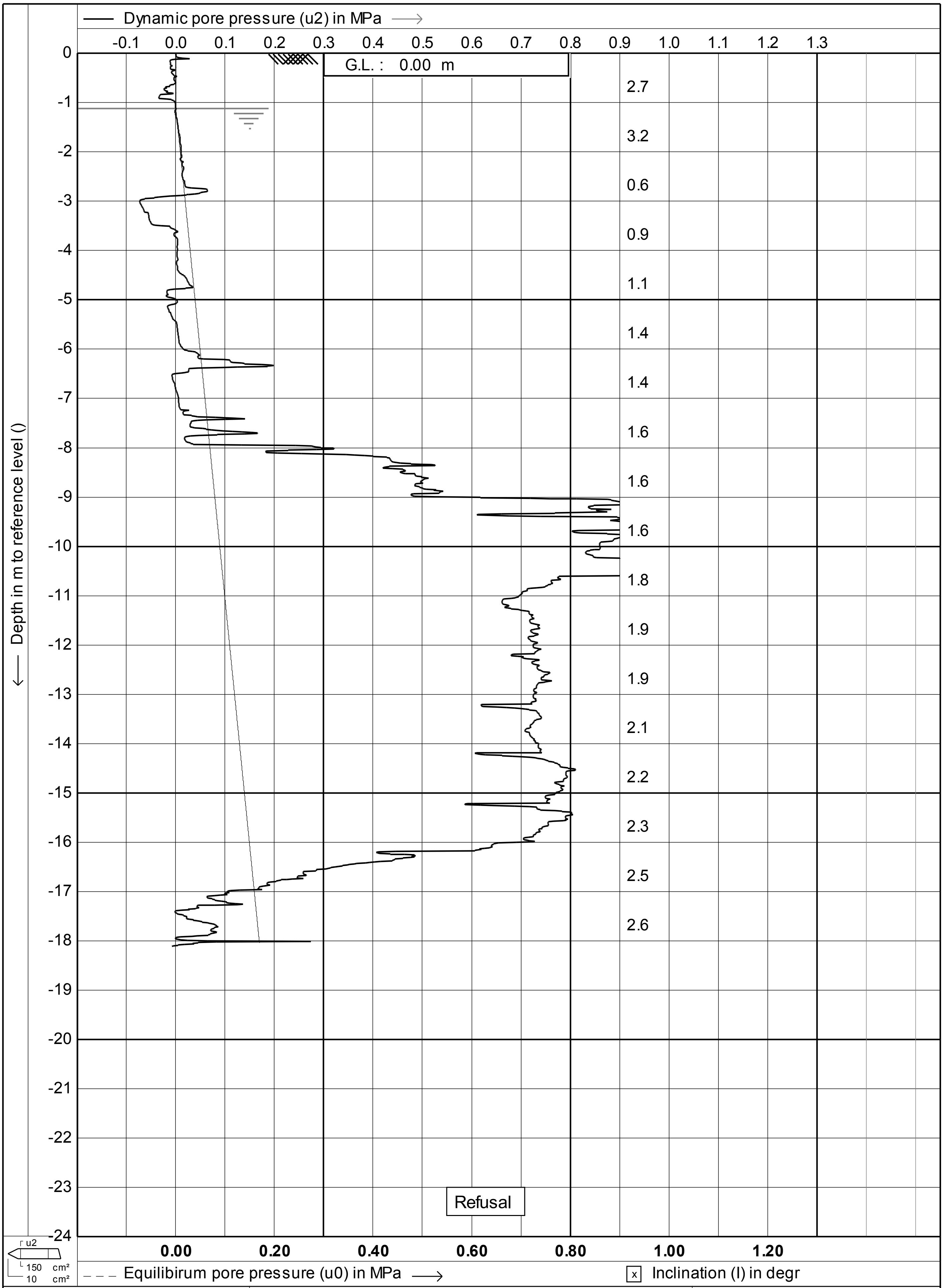
Date : **8-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **1**

1/14



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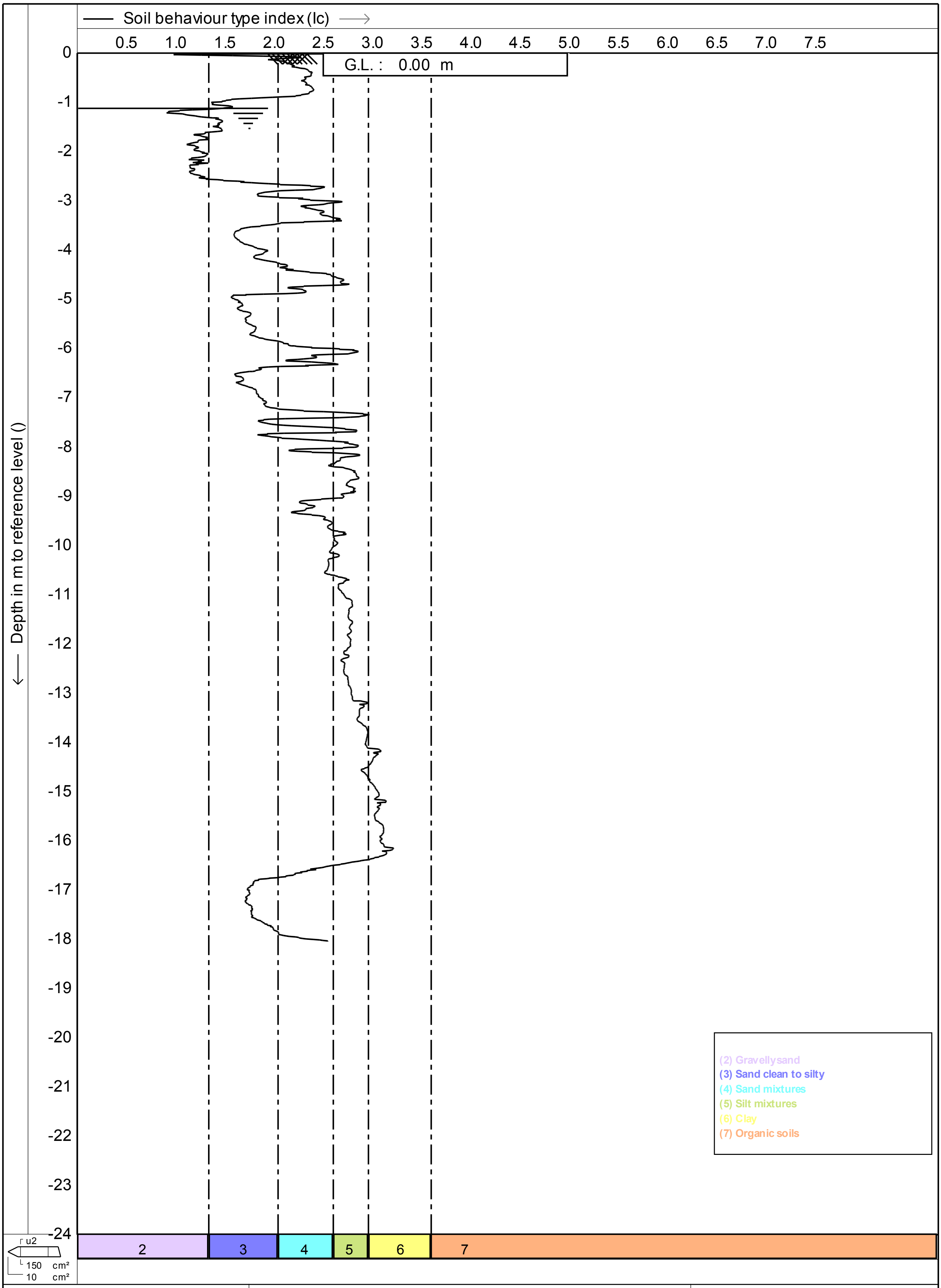
CPTask V1.26



CPTask V1.26

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Project no. :	**02CGL7**
CPT no.	: **1**

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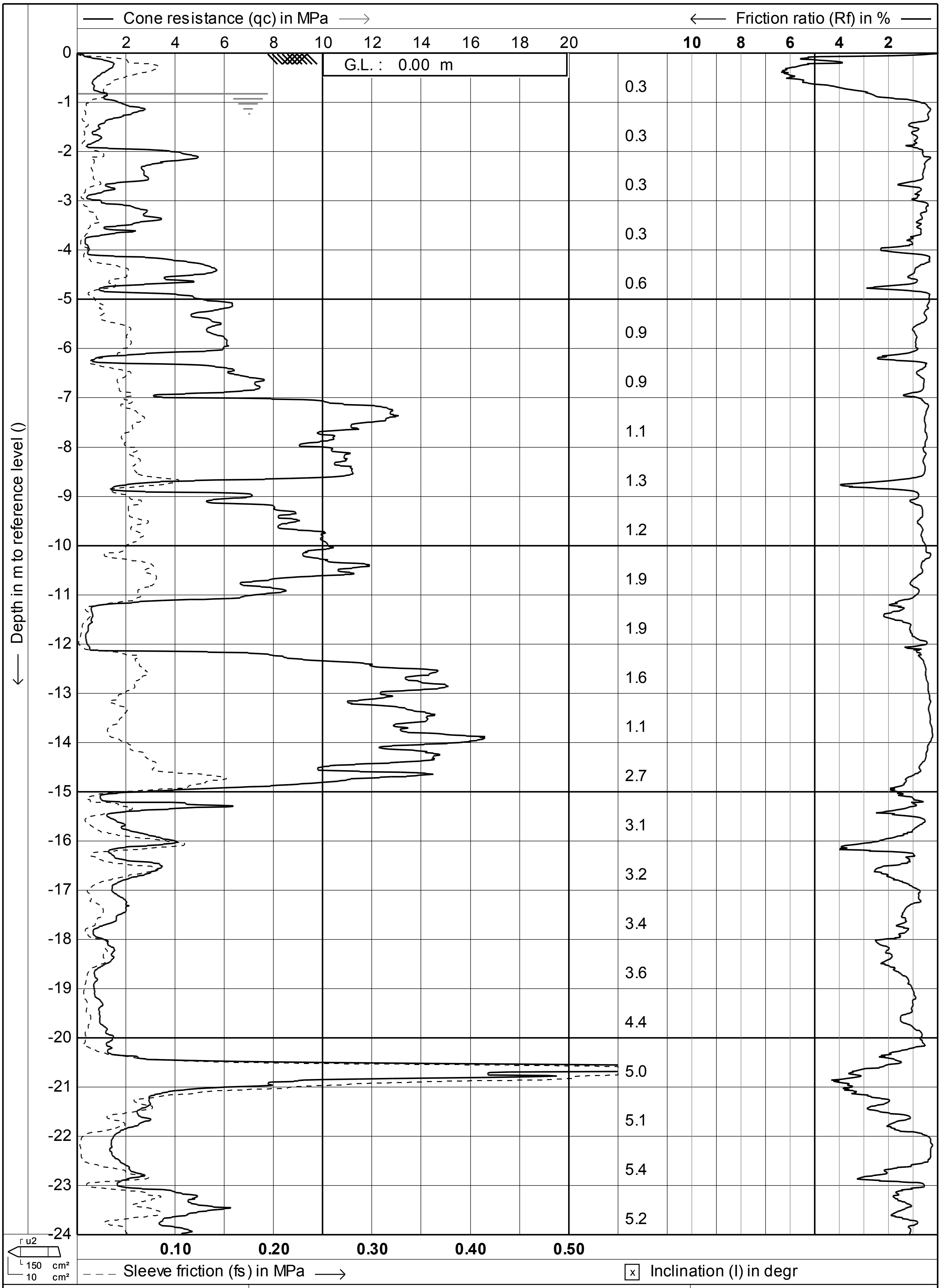

CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

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Location: **Middle Road - Hamilton**

Date : **8-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **2**

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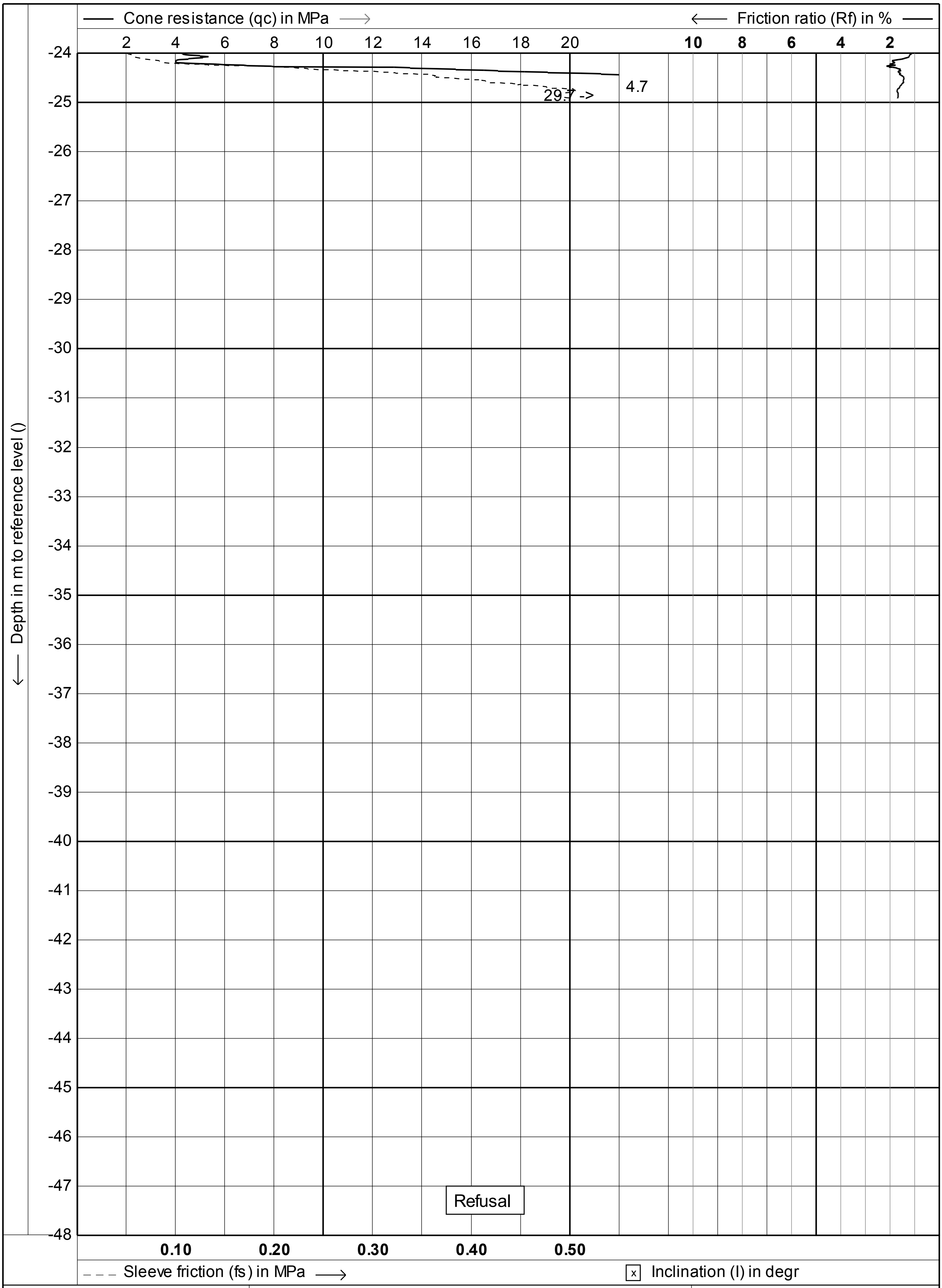

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **8-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **2**

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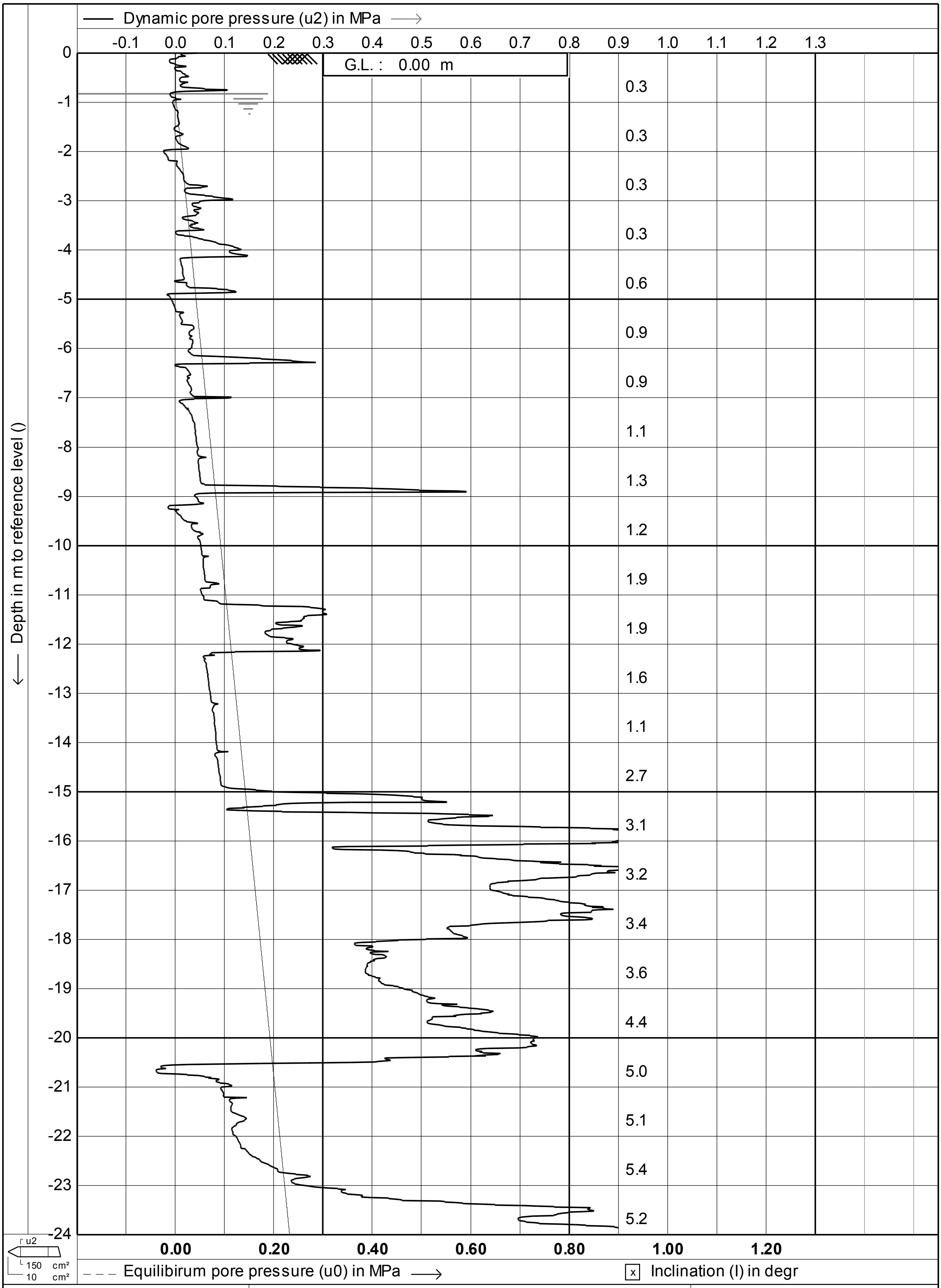
CPTask V1.26



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Location: **Middle Road - Hamilton**

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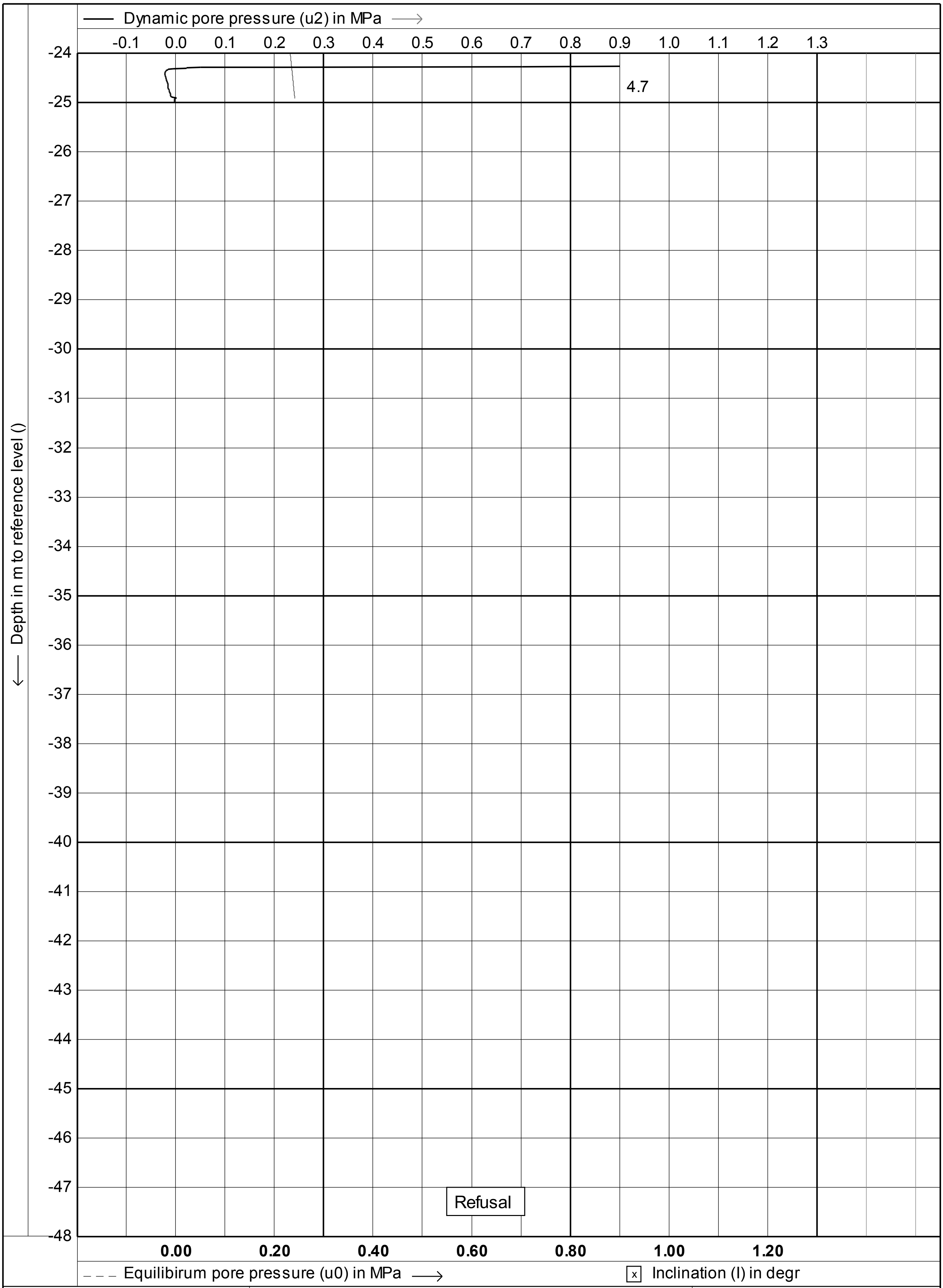

Perry DRILLING GEO PROBE
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **8-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **2**

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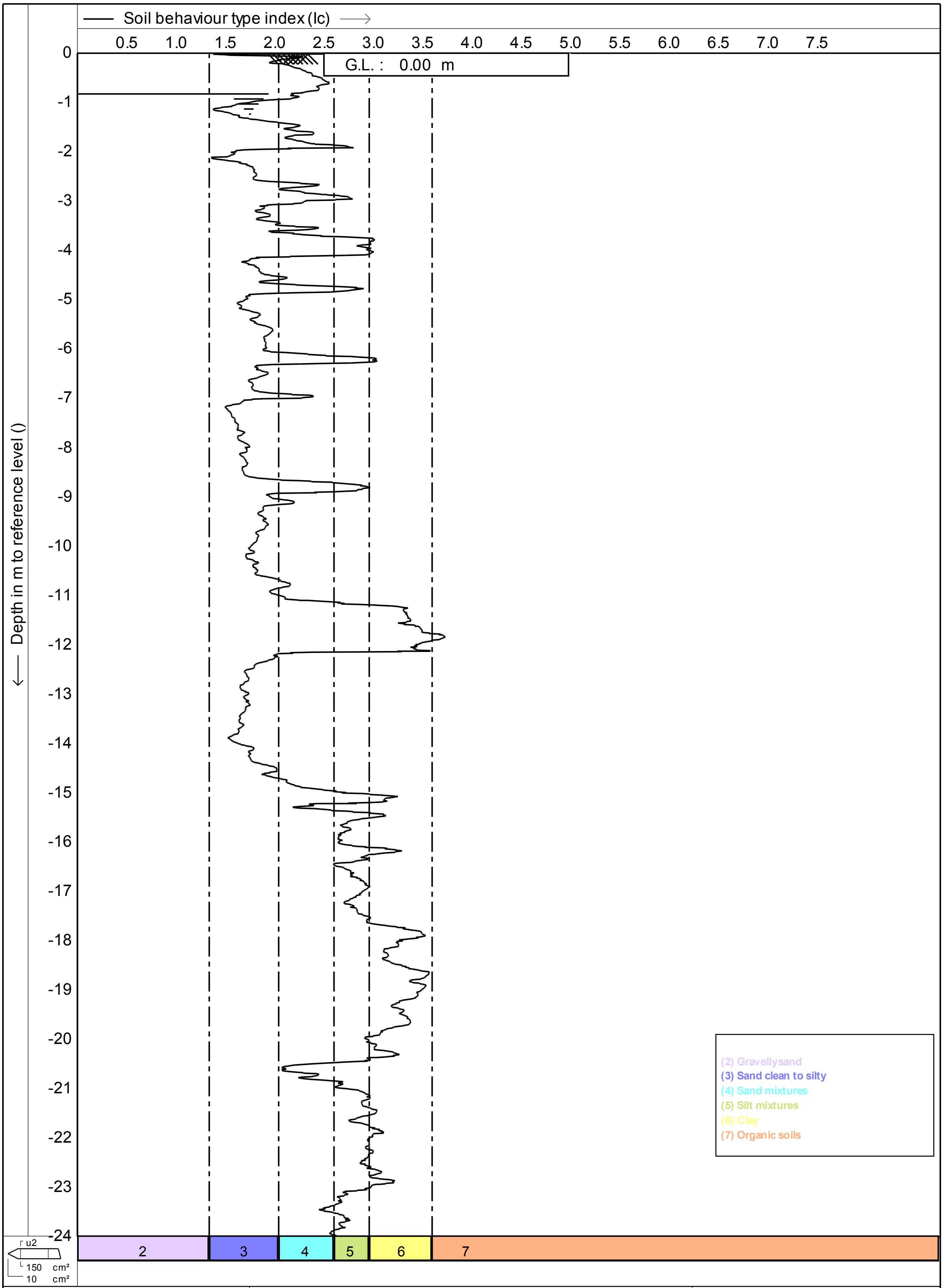
CPTask V1.26



CPTask V1.26

Perry DRILLING GEO PROBE Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

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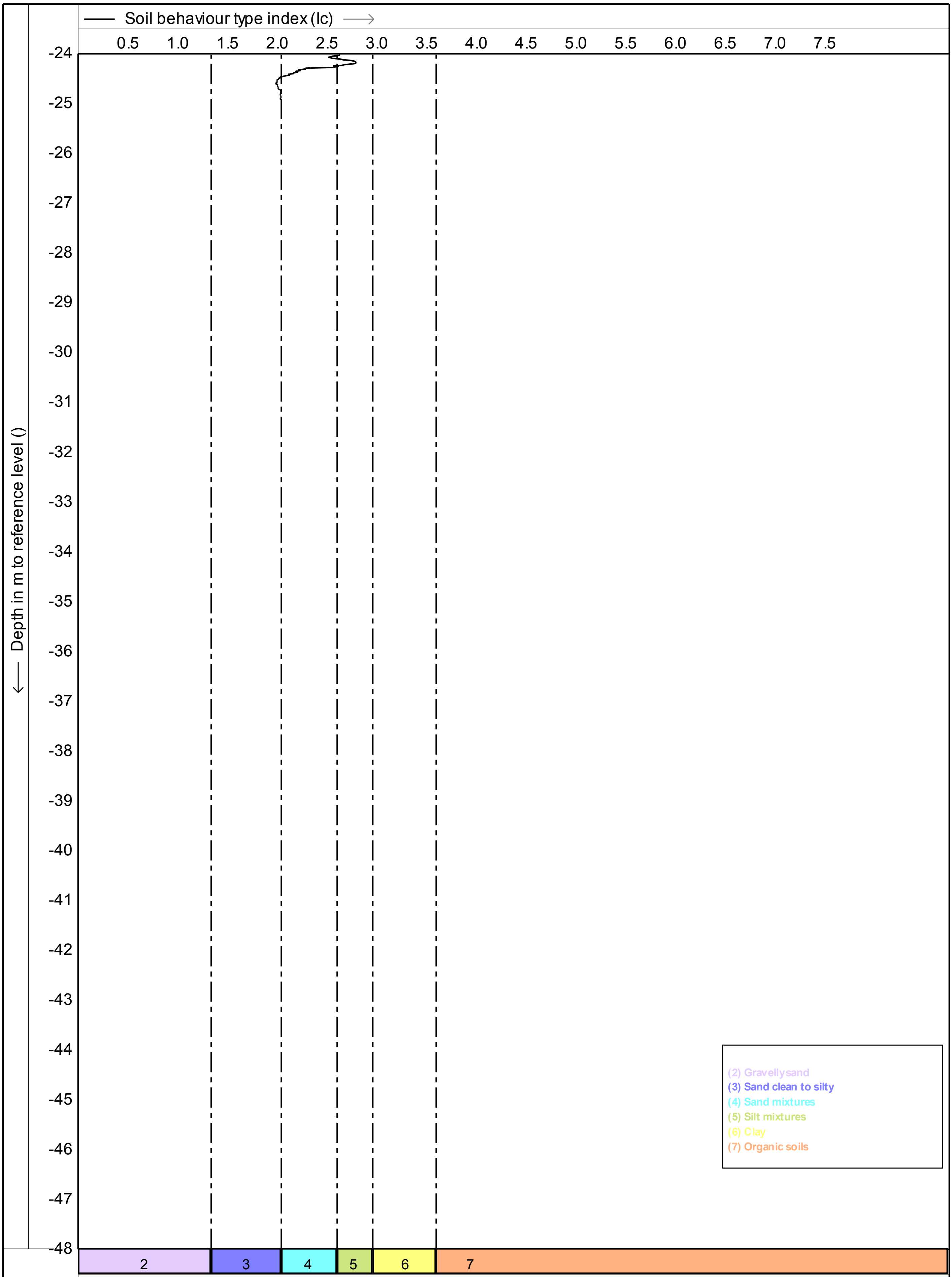

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **8-8-2011**

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Project no. : **02CGL7**

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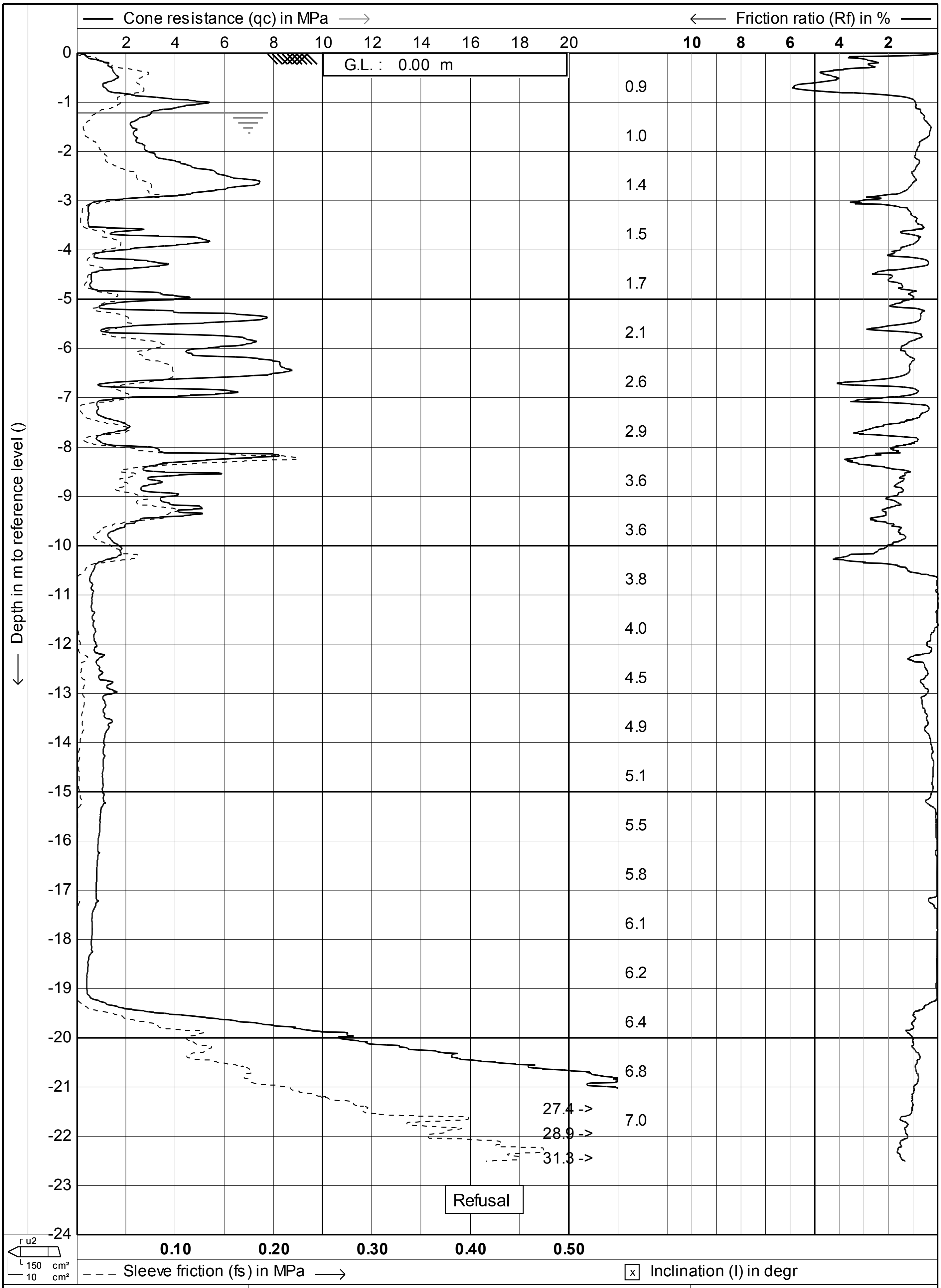

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Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

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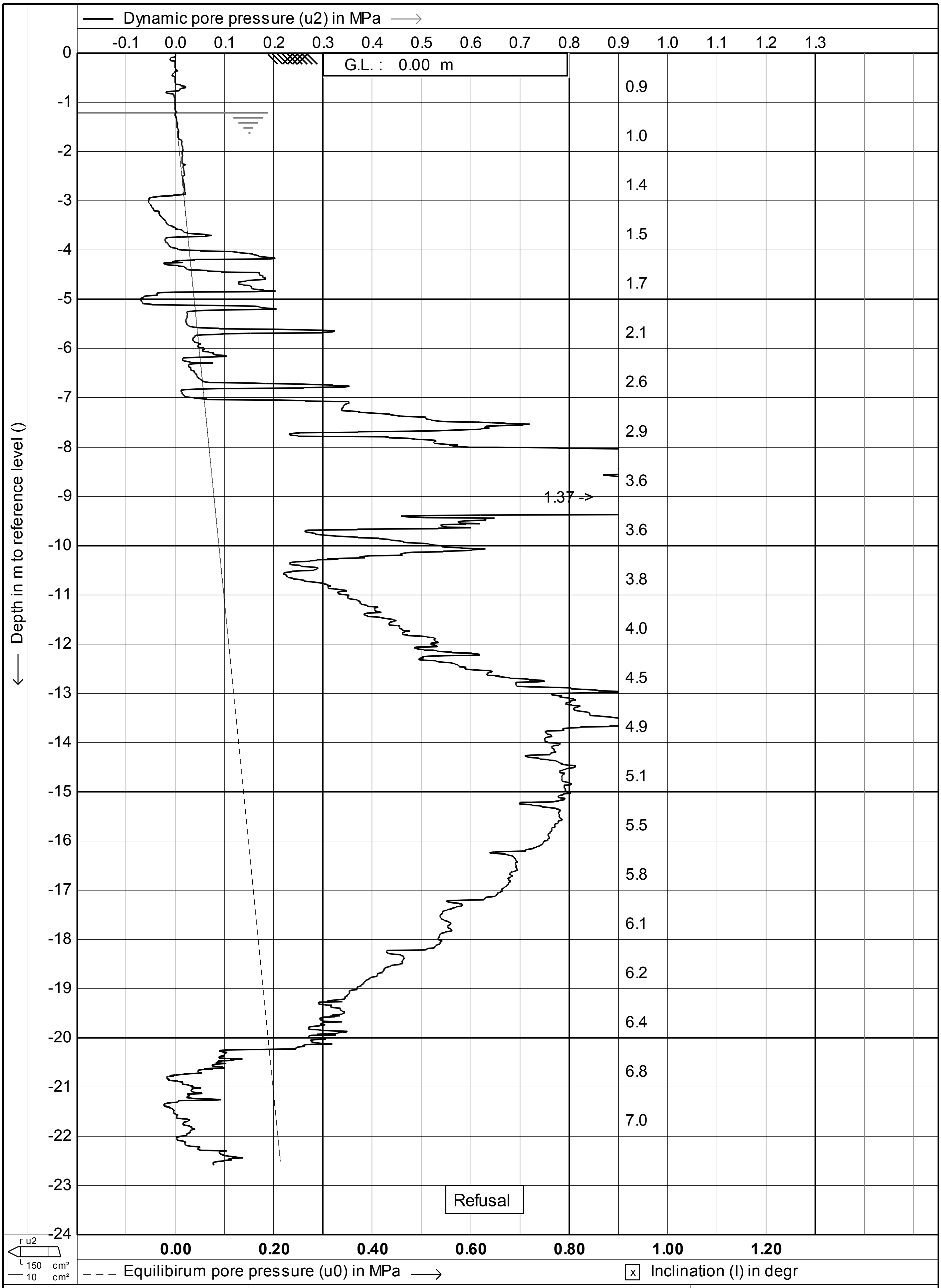

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Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

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Project no. : **02CGL7**

CPT no. : **3**

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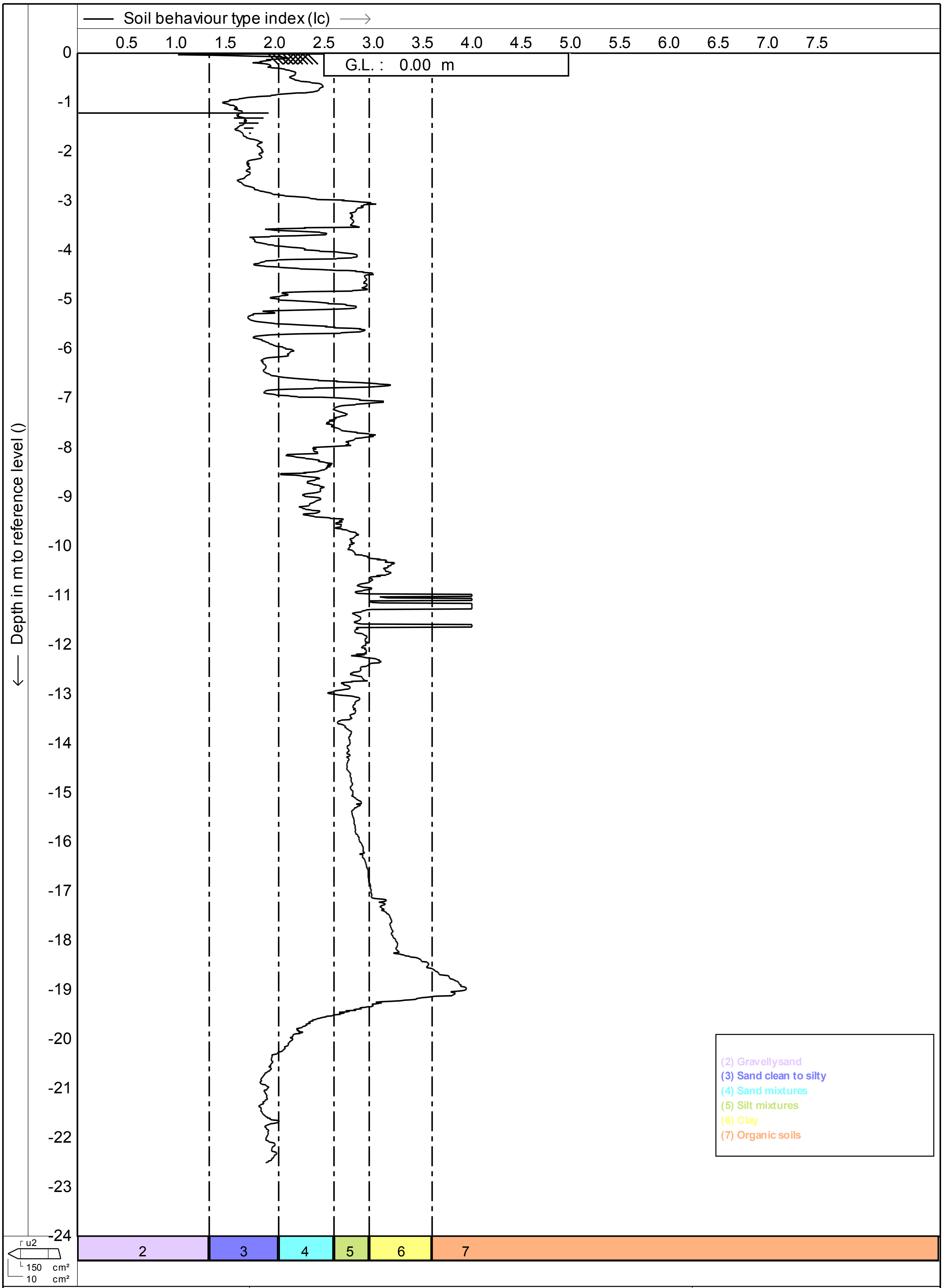

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Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

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Project no. : **02CGL7**

CPT no. : **3**

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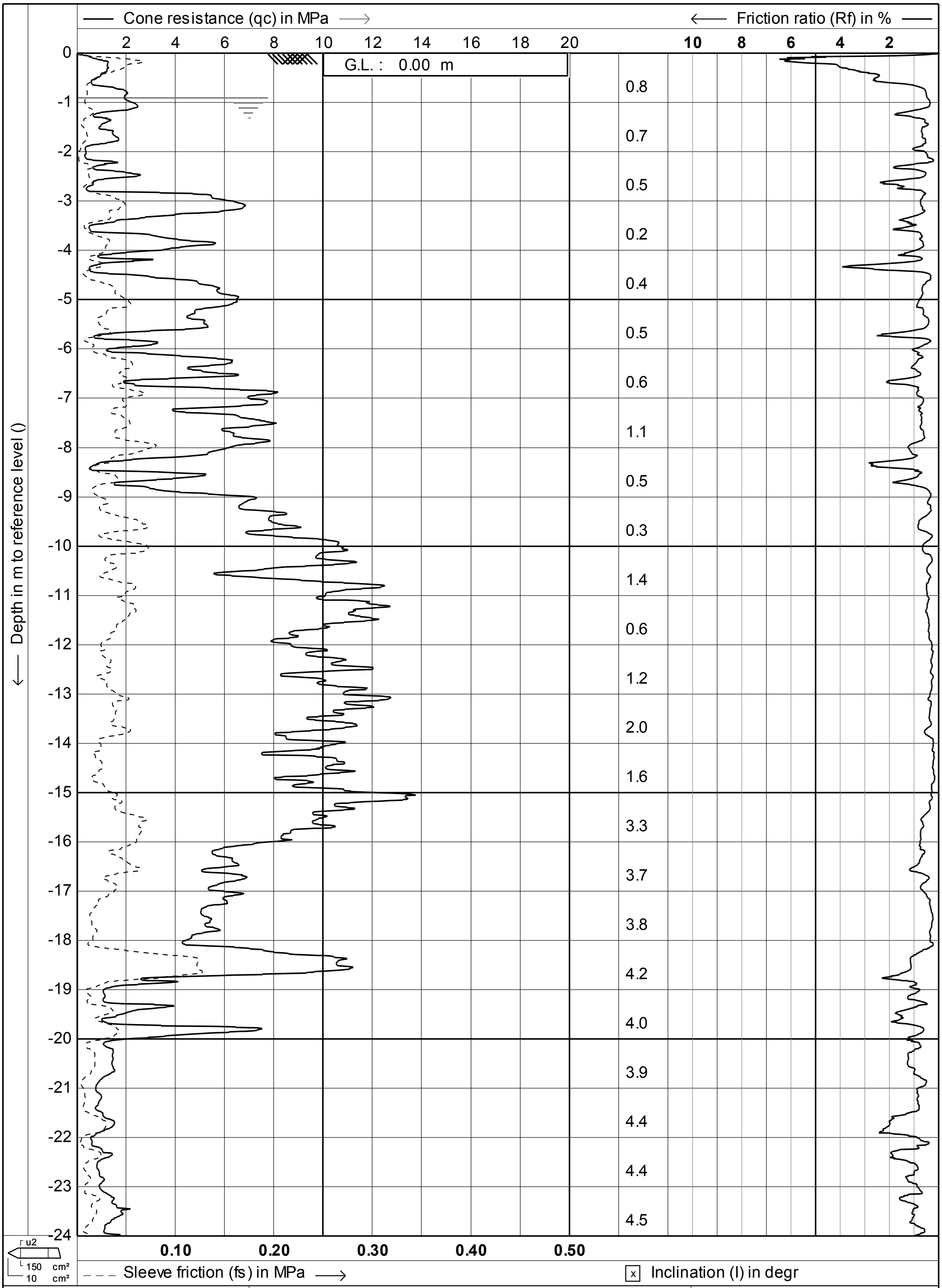

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Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **8-8-2011**
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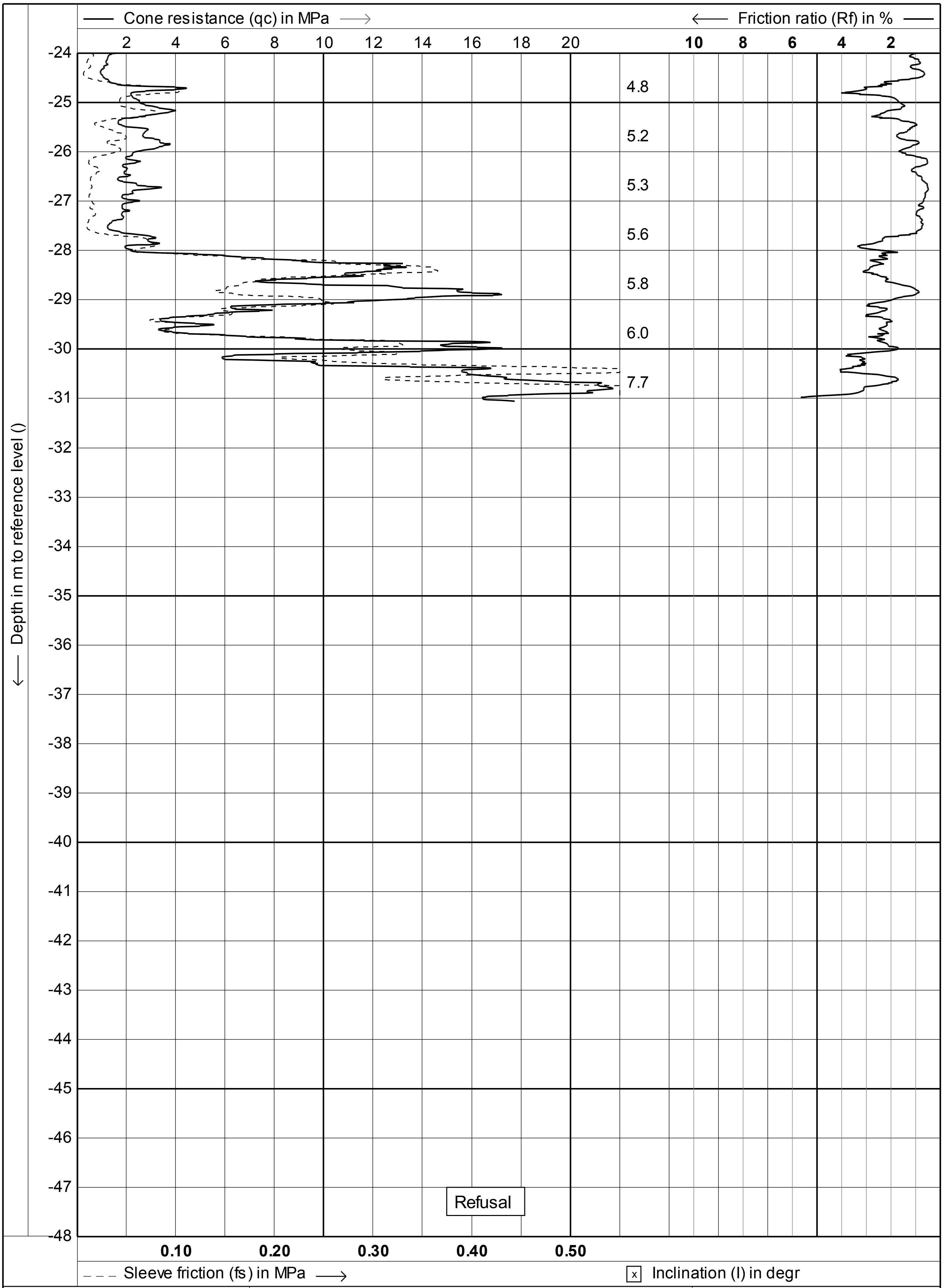
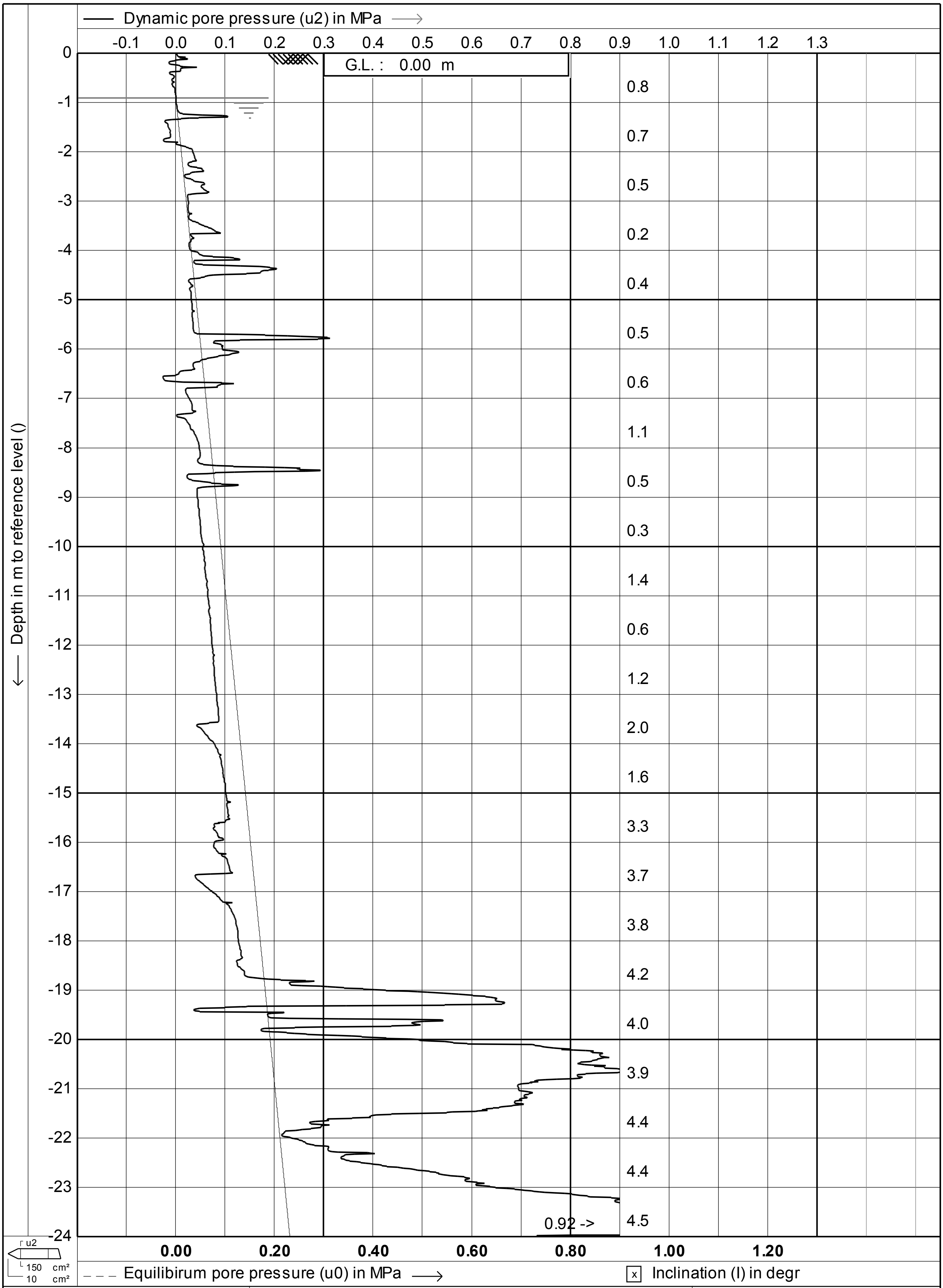
Project no. : **02CGL7**
CPT no. : **4** **1/28**

CPTask V1.26



CPTask V1.26

Perry Drilling GEO PROBE Ground Drilling and Environmental Specialists	Test according A.S.T.M. Standard D 5778-07	Date : **8-8-2011** Cone no. : **C10CFIIP.F57**
	Project : **Montgomerie Block - Hamilton Airport**	Project no. : **02CGL7**
	Location: **Middle Road - Hamilton**	CPT no. : **4** **2/28**



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

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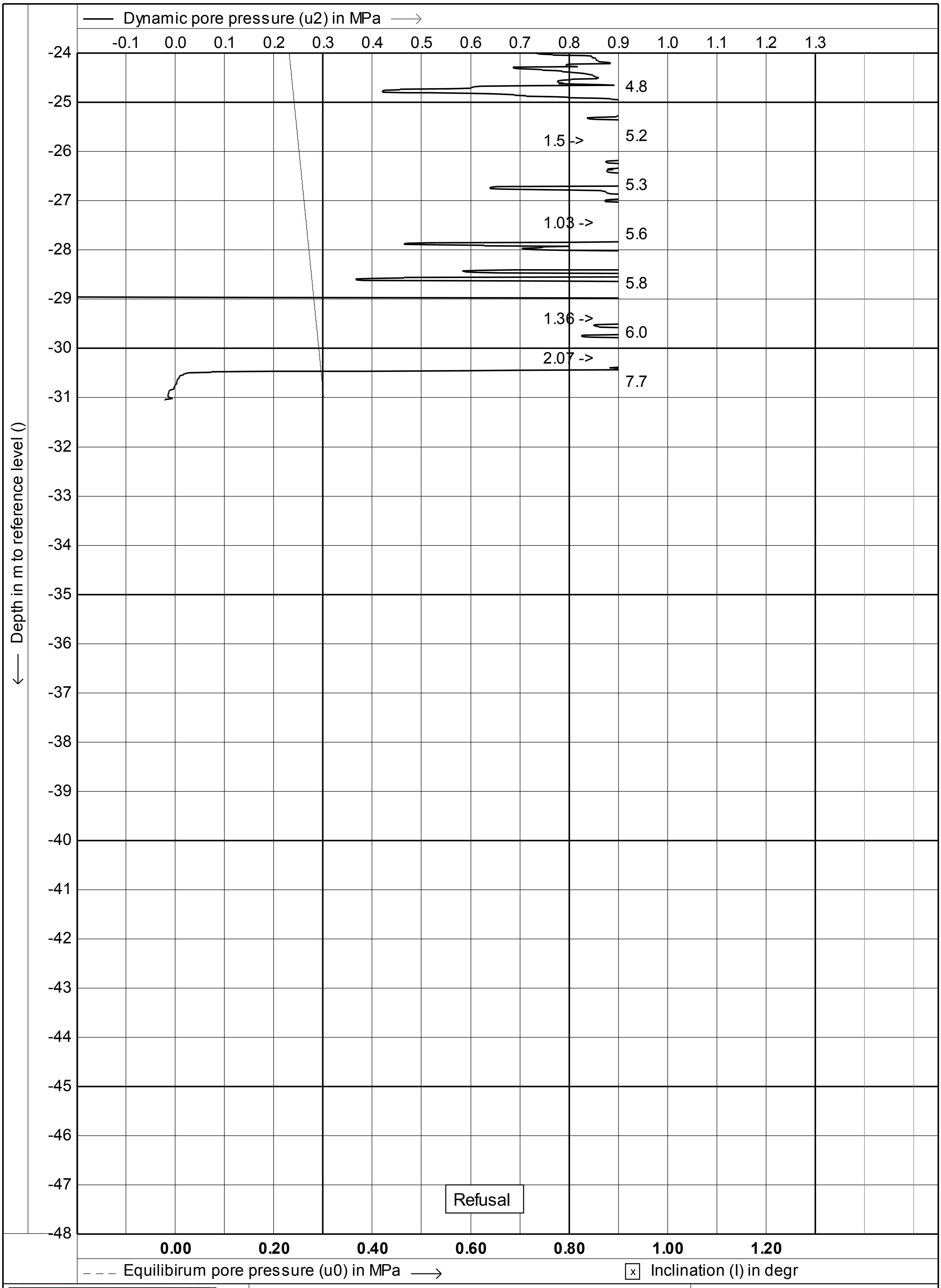
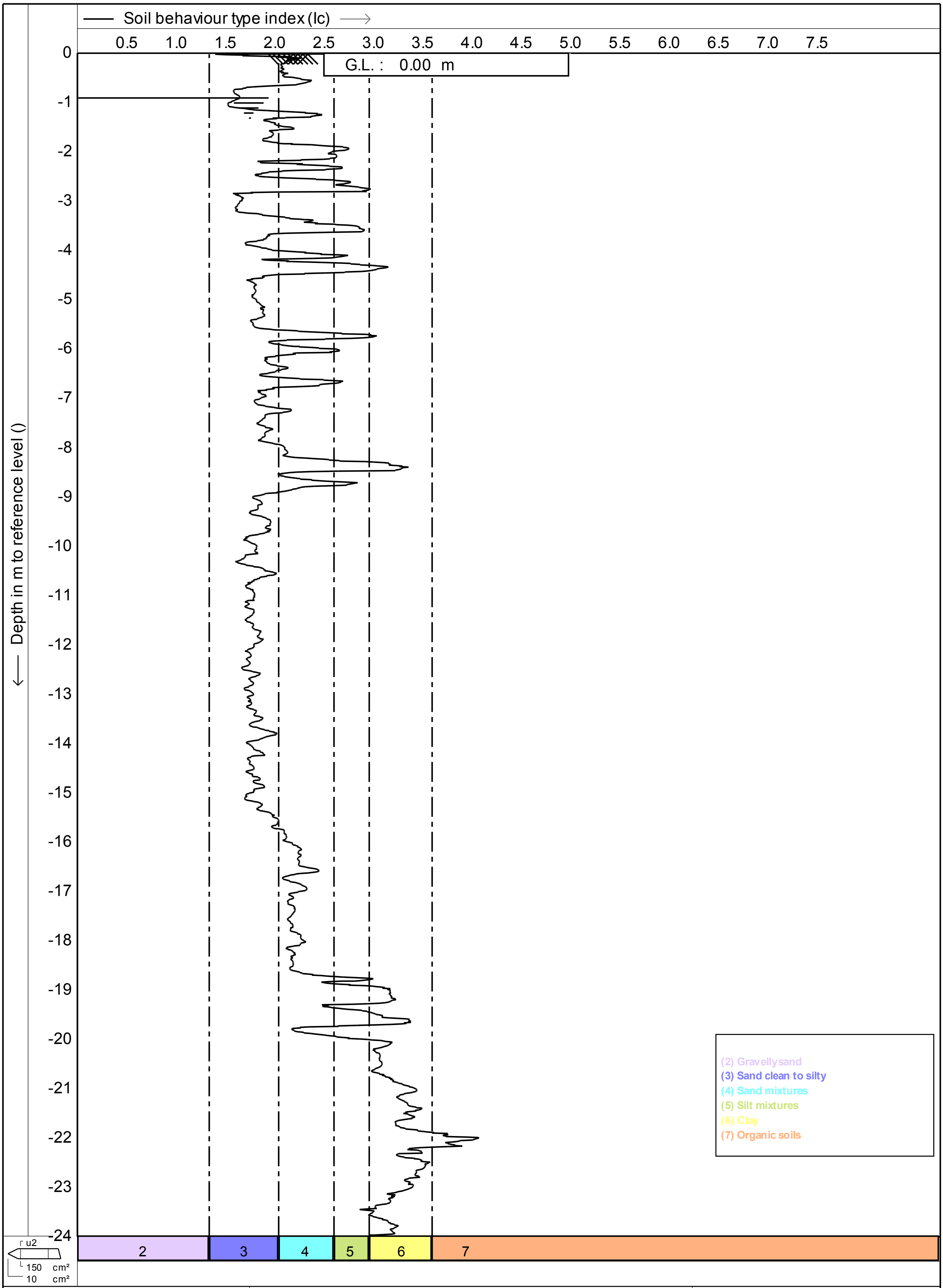


CPTask V1.26

Test according A.S.T.M. Standard D 5778-07	Date : **8-8-2011**
Project : **Montgomerie Block - Hamilton Airport**	Cone no. : **C10CFIIP.F57**
	Project no. : **02CGL7**
Location: **Middle Road - Hamilton**	CPT no. : **4** **4/28**



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07	Date	: **8-8-2011**
Project : **Montgomerie Block - Hamilton Airport**	Cone no.	: **C10CFIIP.F57**
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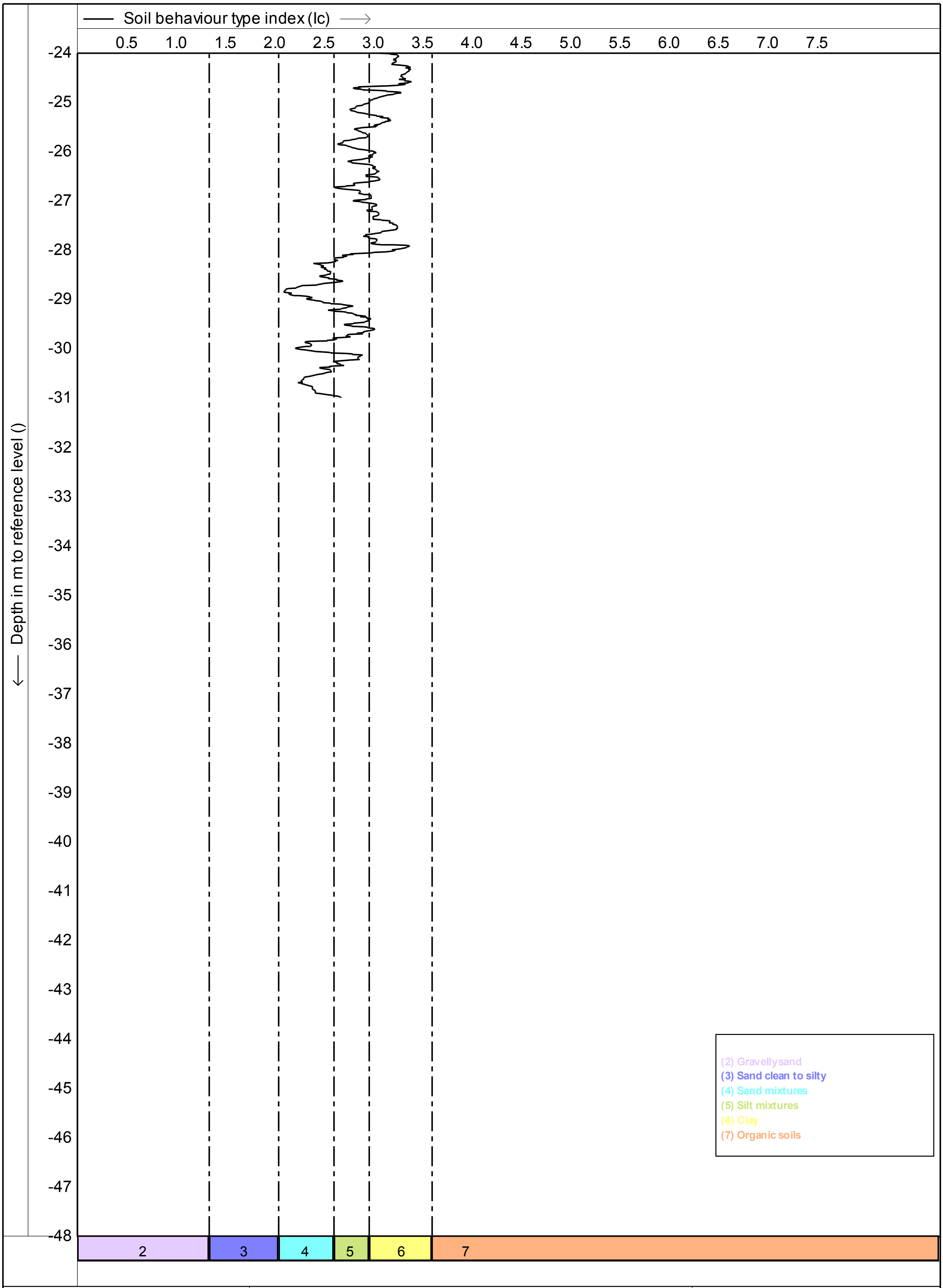
Location: **Middle Road - Hamilton**	CPT no.	: **4** **17/28**



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **8-8-2011**

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Project no. : **02CGL7**

CPT no. : **4**

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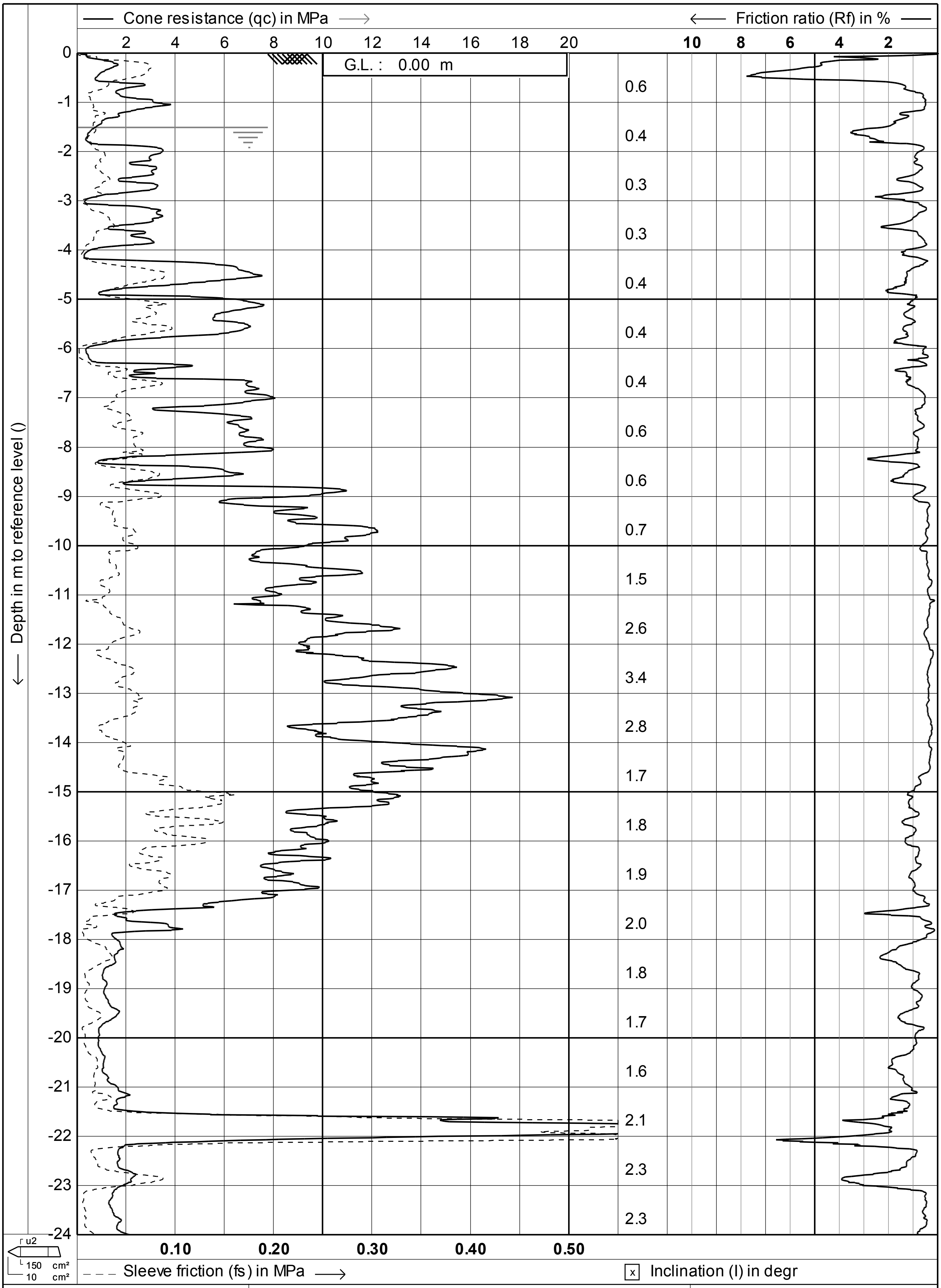
CPTask V1.26



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

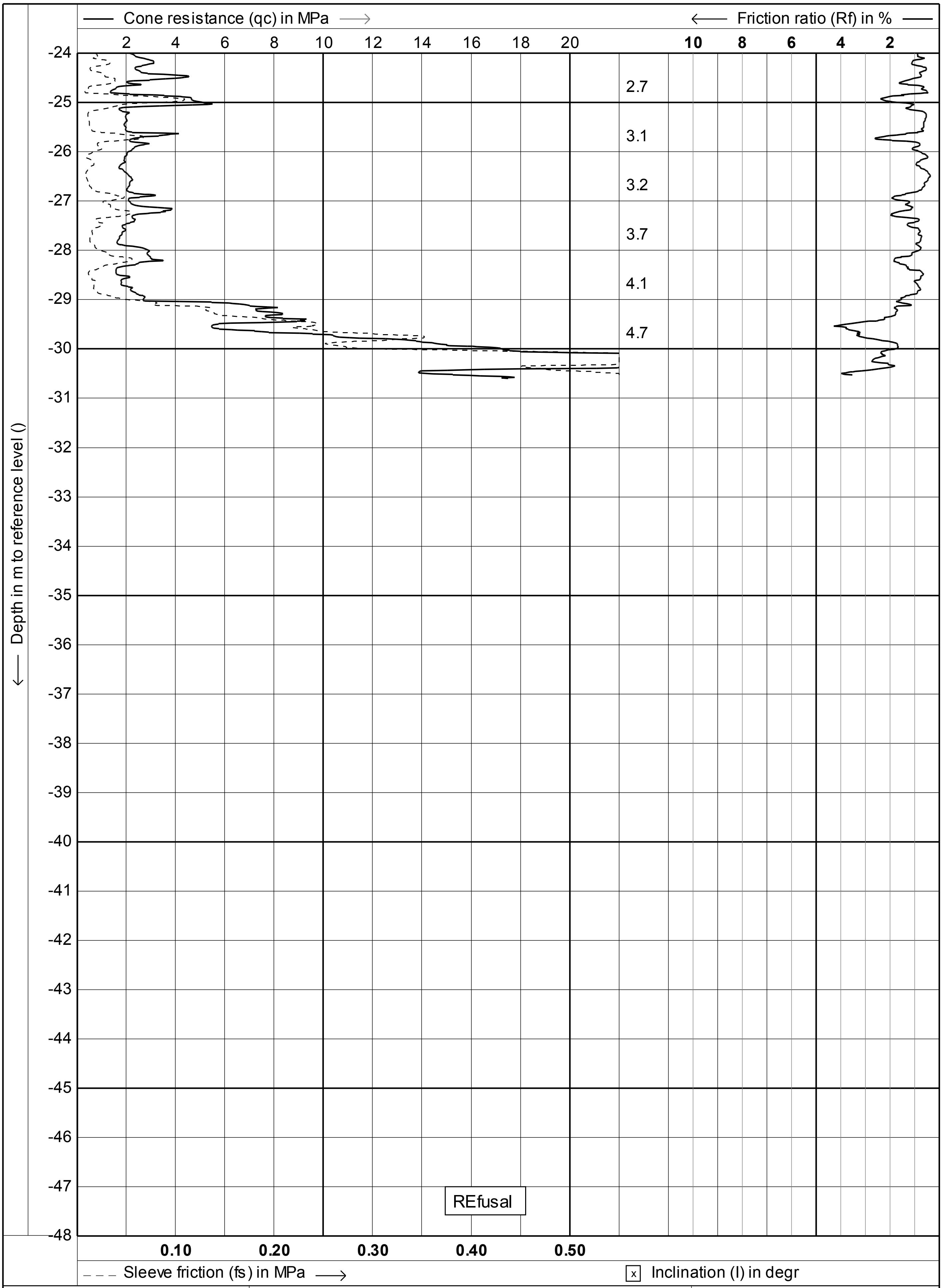
Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **5**

1/28



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **5**

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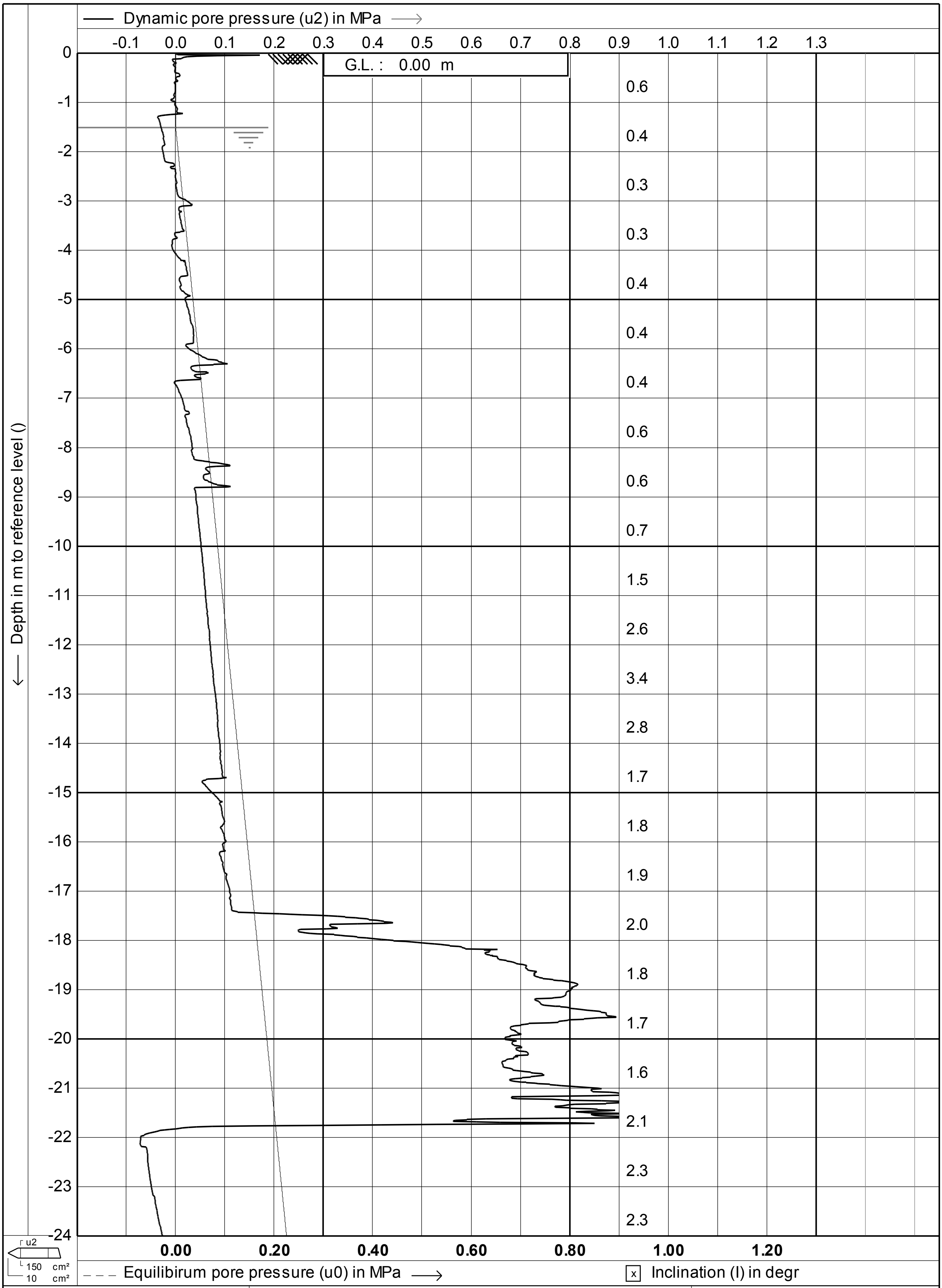

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **5**

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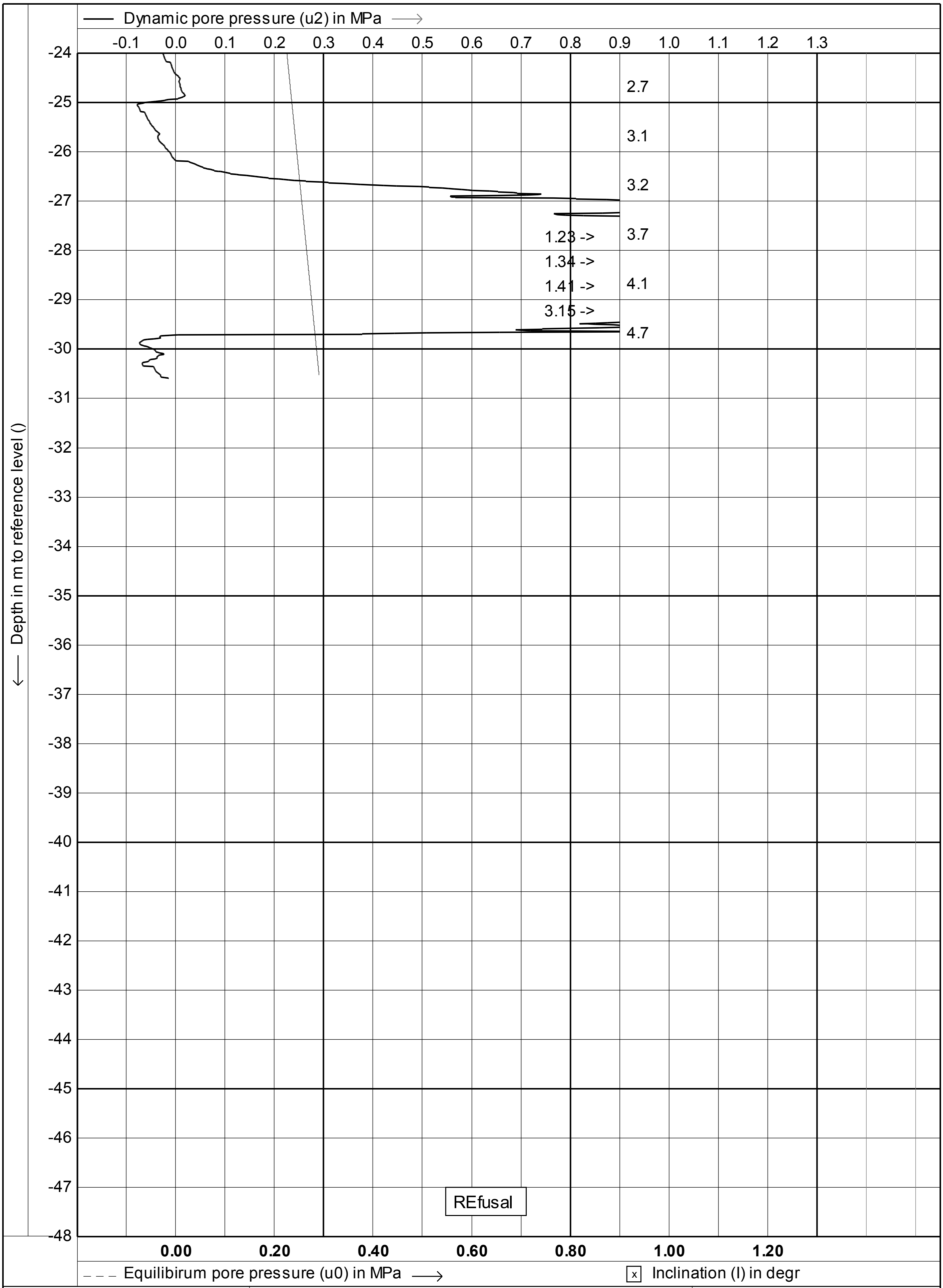
CPTask V1.26



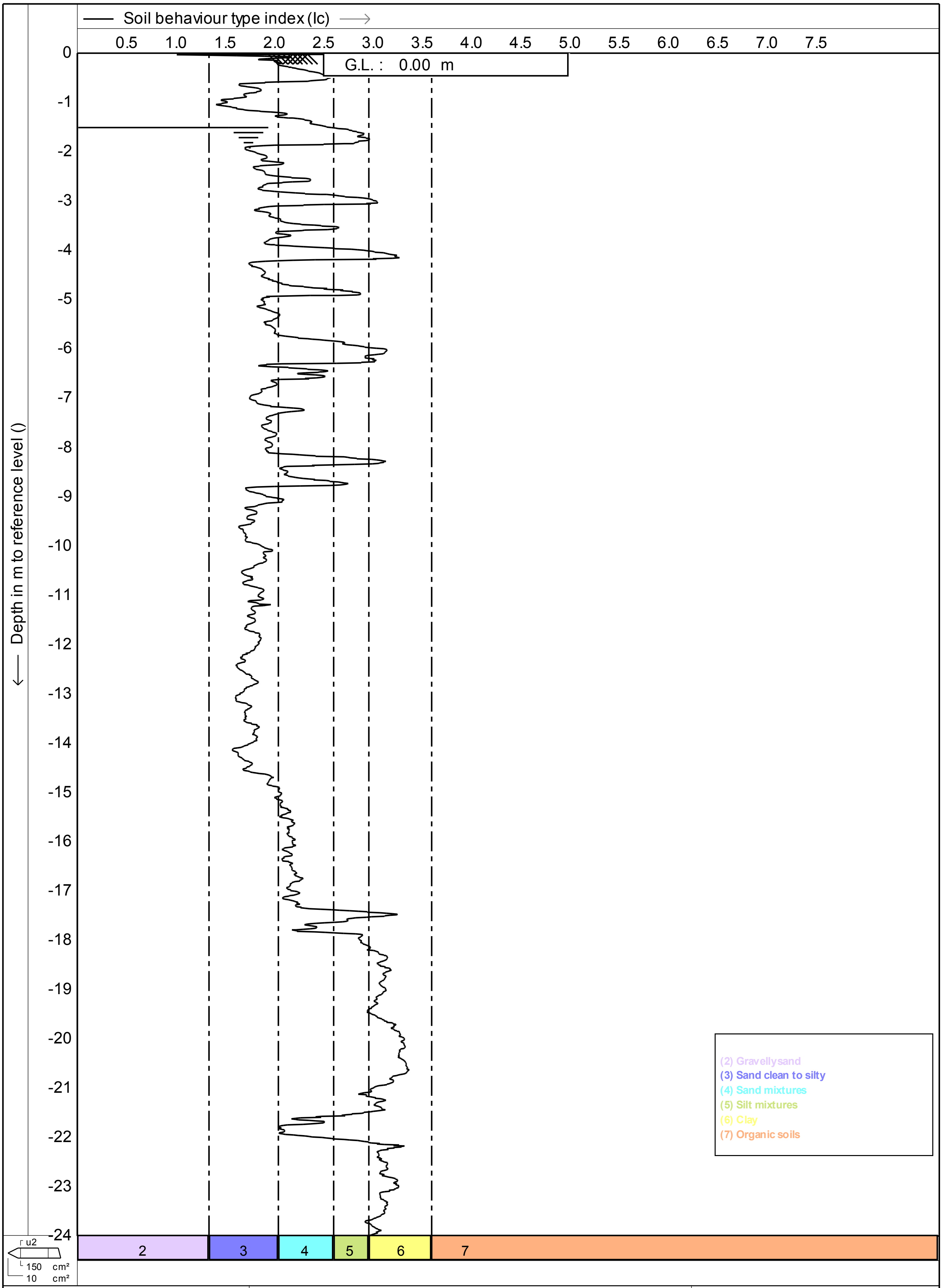
Perry Drilling
GEO PROBE
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **5**



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **5**

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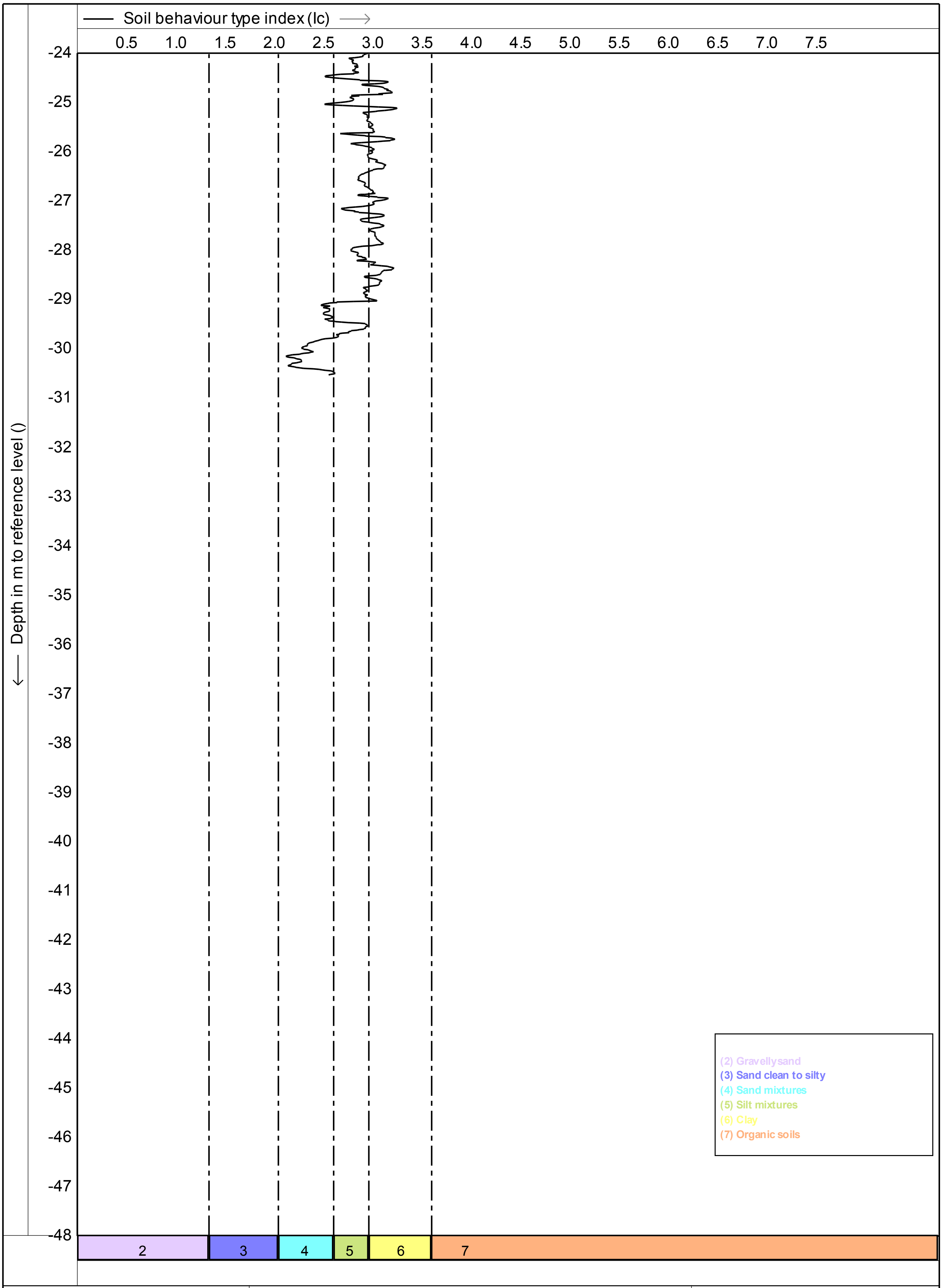
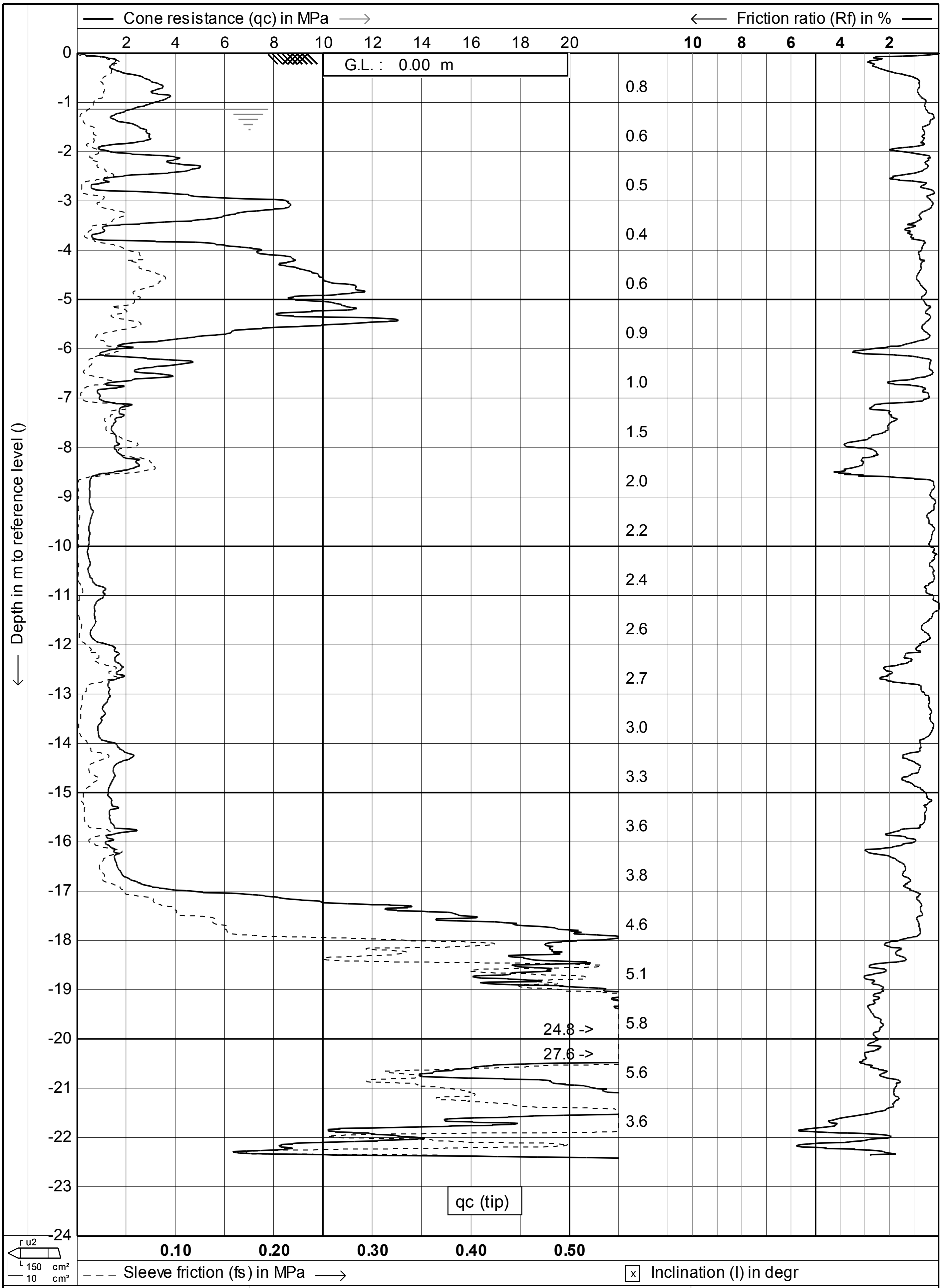
CPTask V1.26



Test according A.S.T.M. Standard D 5778-07		Date	: **9-8-2011**
Project :	**Montgomerie Block - Hamilton Airport**	Cone no.	: **C10CFIIP.F57**
		Project no. :	**02CGL7**
Location:	**Middle Road - Hamilton**	CPT no.	: **5** **18/28**

CPTask V1.26



CPTask V1.26

Perry Drilling GEO PROBE Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **6**

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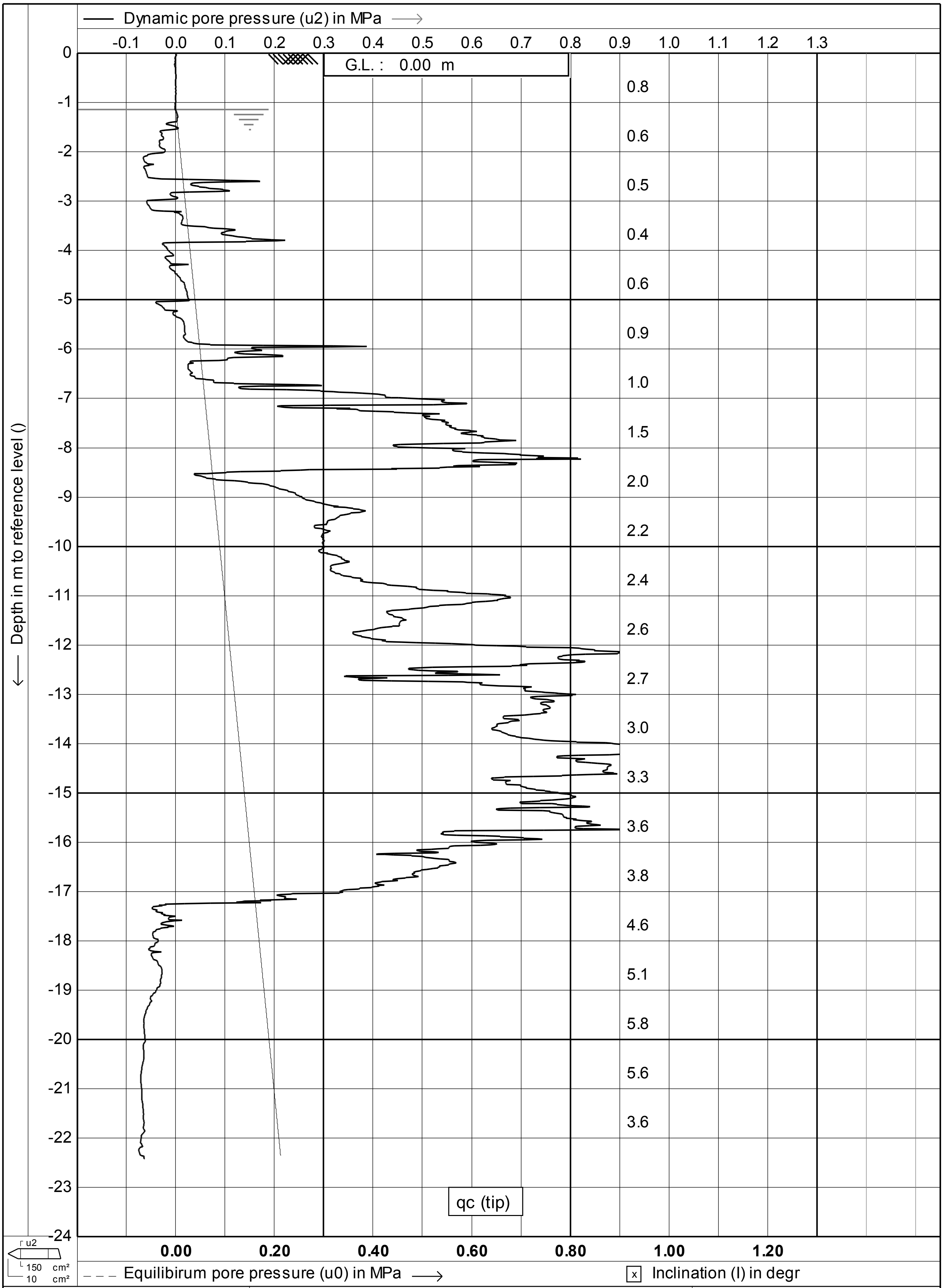

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **6**

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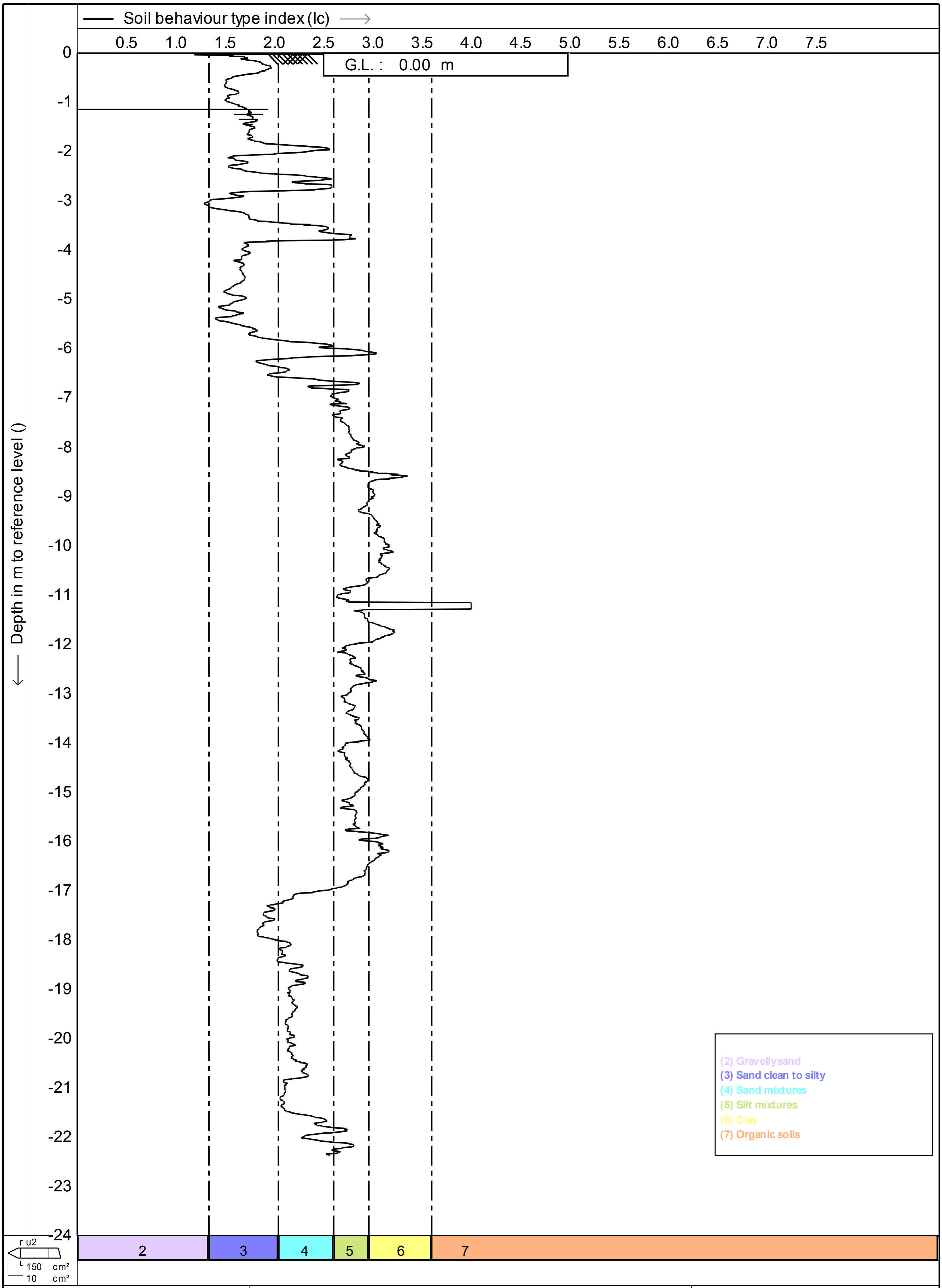
CPTask V1.26



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **6**

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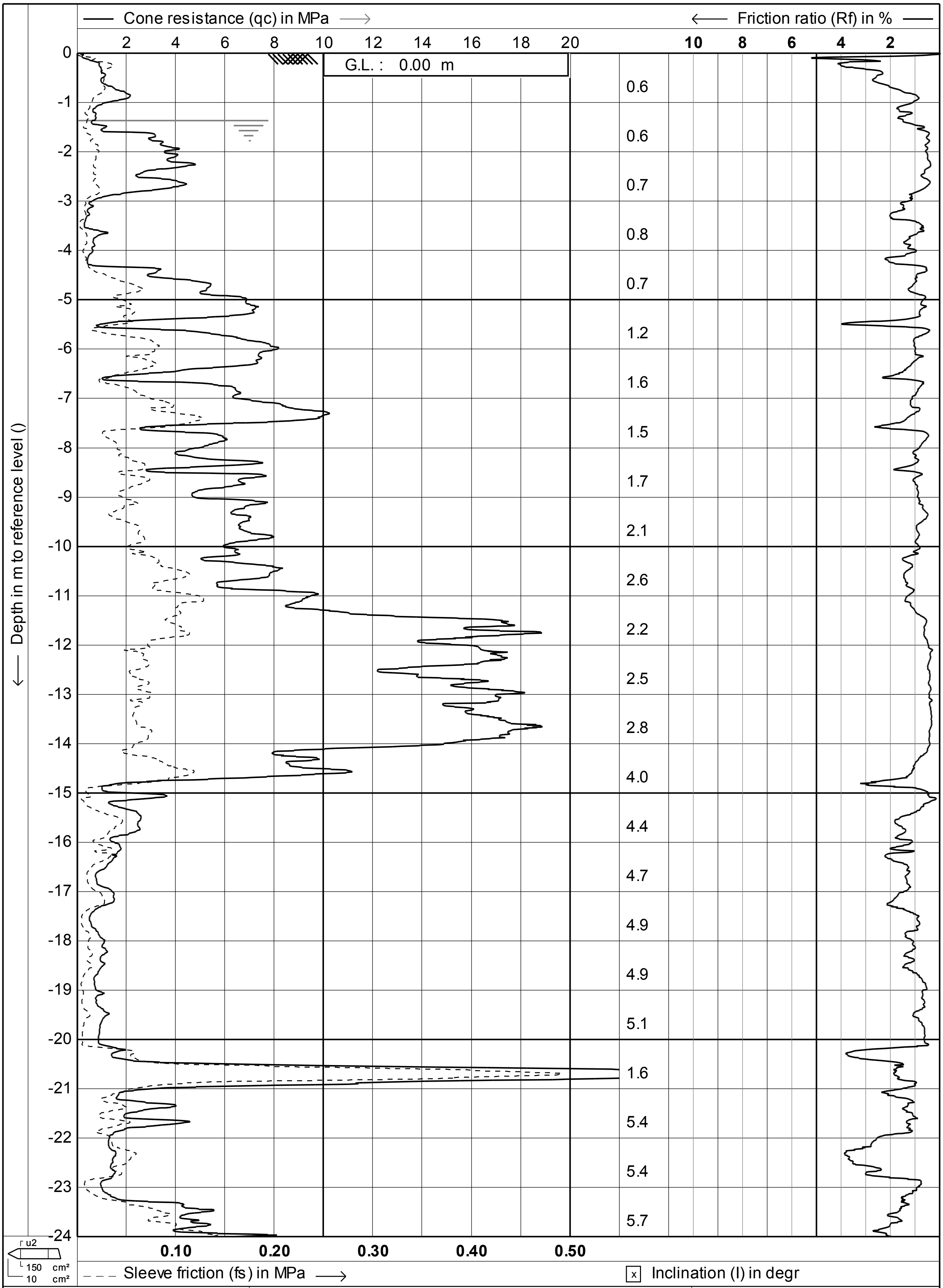
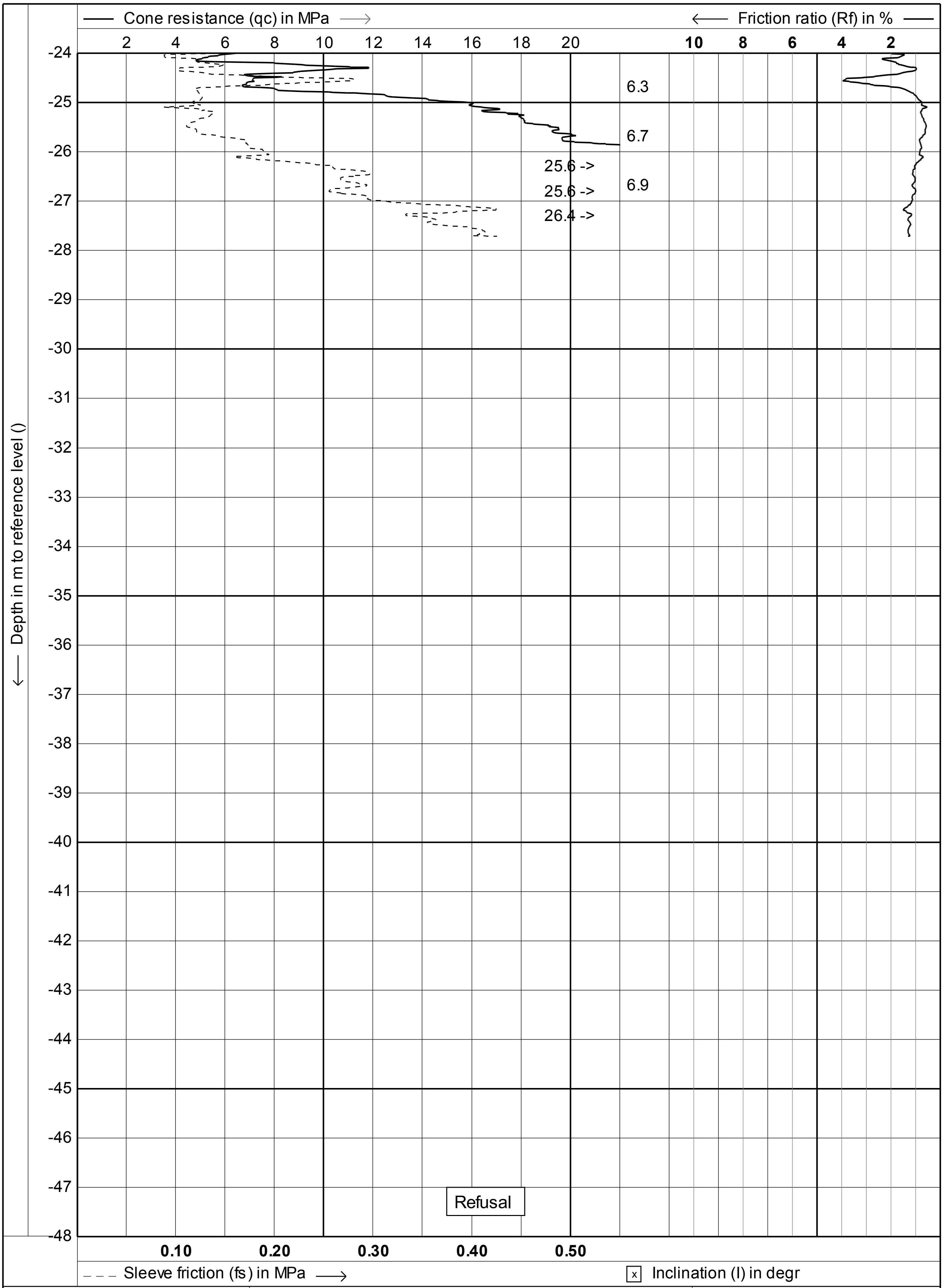


Perry Drilling
GEO PROBE
Ground Drilling and Environmental Specialists

CPTask V1.26

Test according A.S.T.M. Standard D 5778-07	Date : **9-8-2011**
Project : **Montgomerie Block - Hamilton Airport**	Cone no. : **C10CFIIP.F57**
	Project no. : **02CGL7**
Location: **Middle Road - Hamilton**	CPT no. : **7** **1/28**



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **7**

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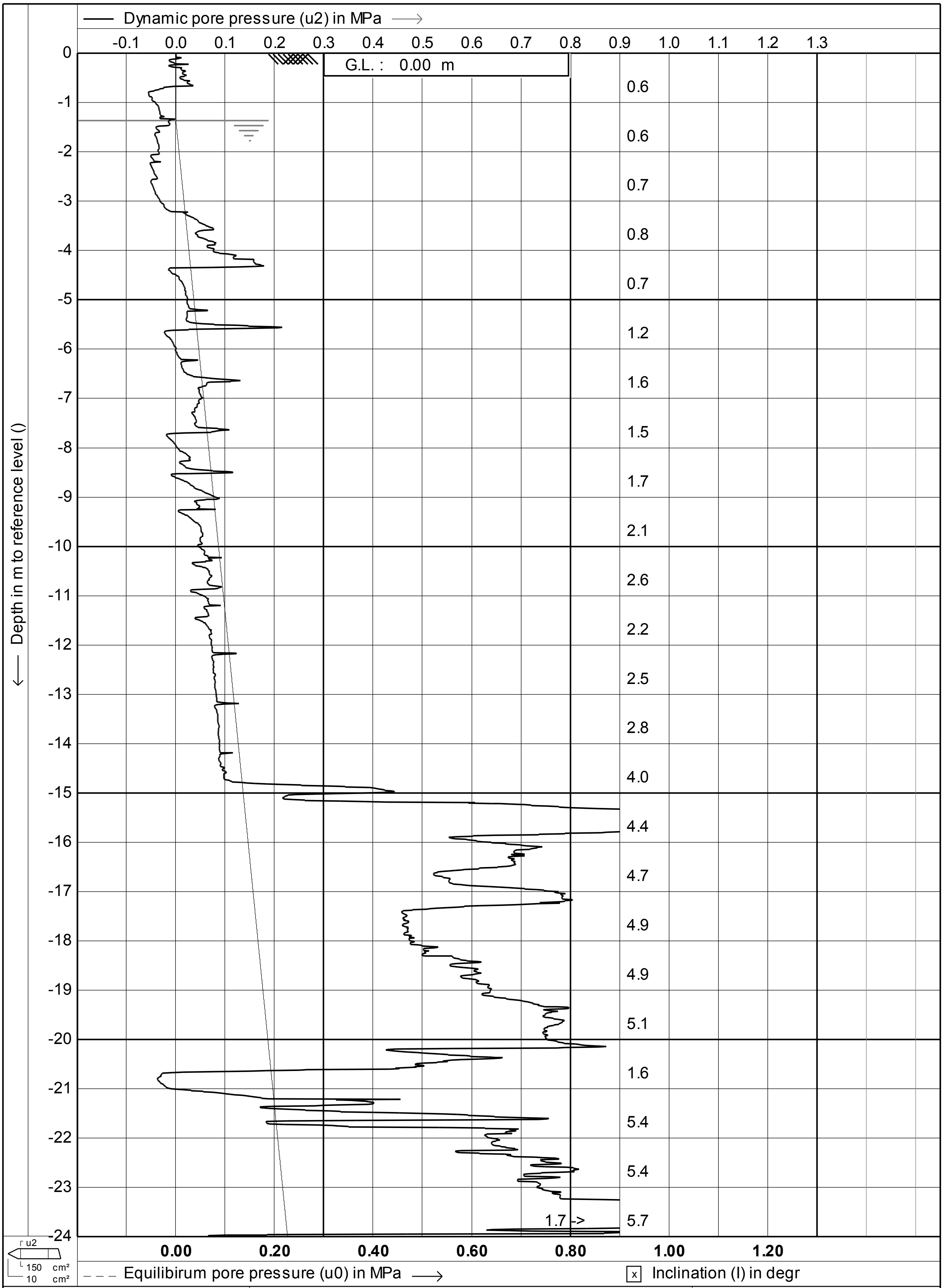
CPTask V1.26



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **7**

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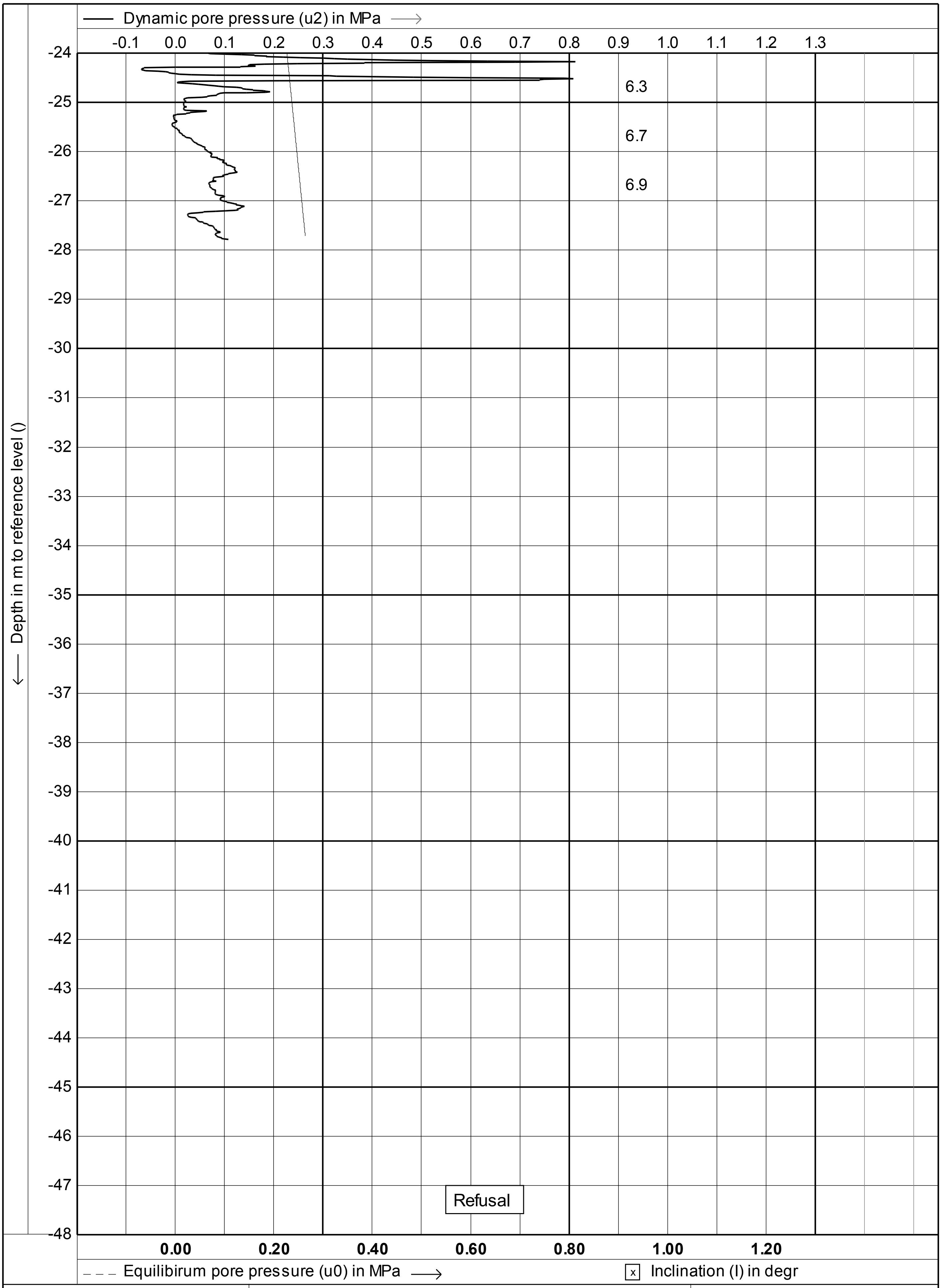
CPTask V1.26



Perry DRILLING GEO PROBE
Ground Drilling and Environmental Specialists

CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **7**

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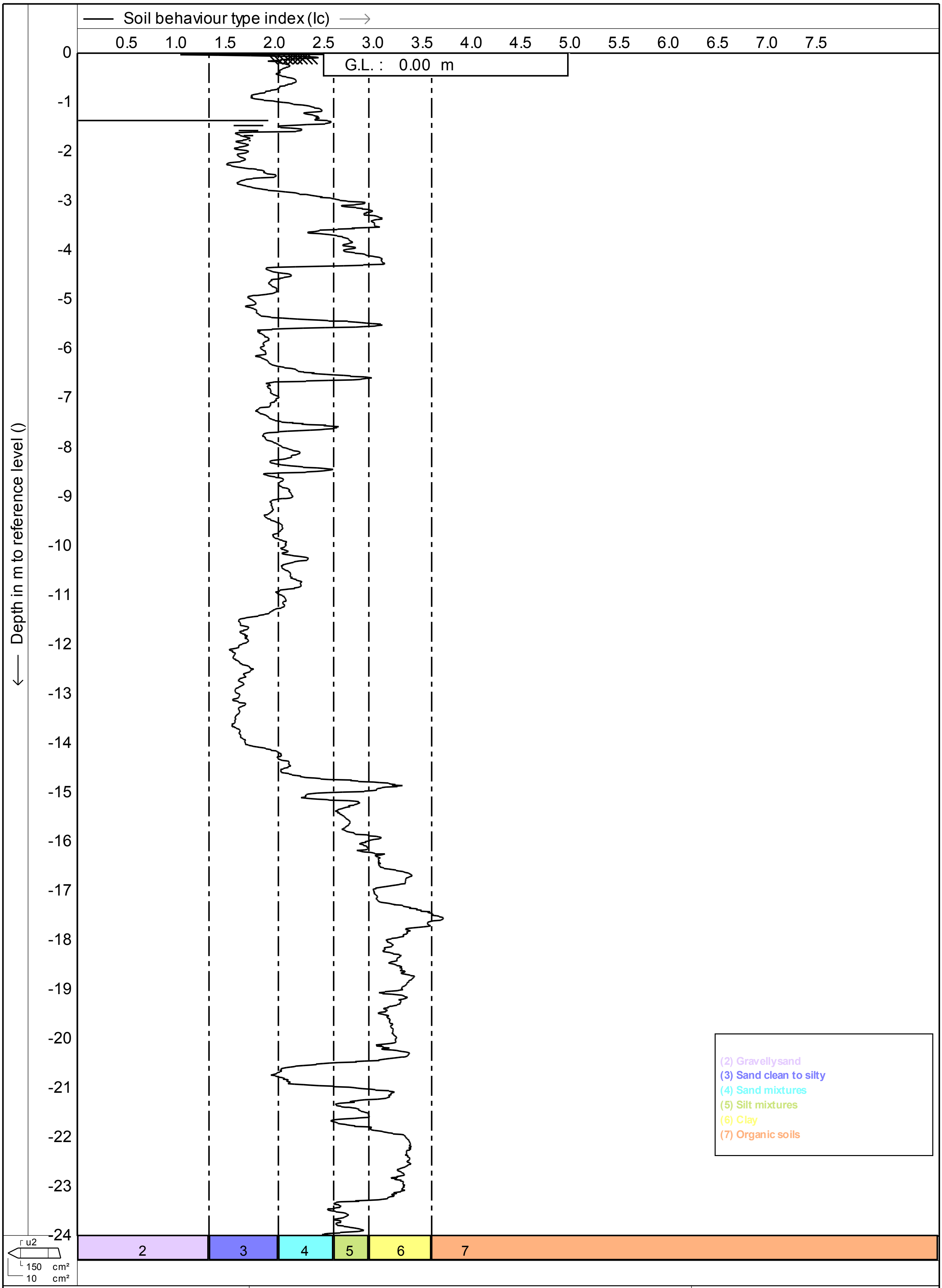

CPTask V1.26

Perry DRILLING GEO PROBE Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **7**

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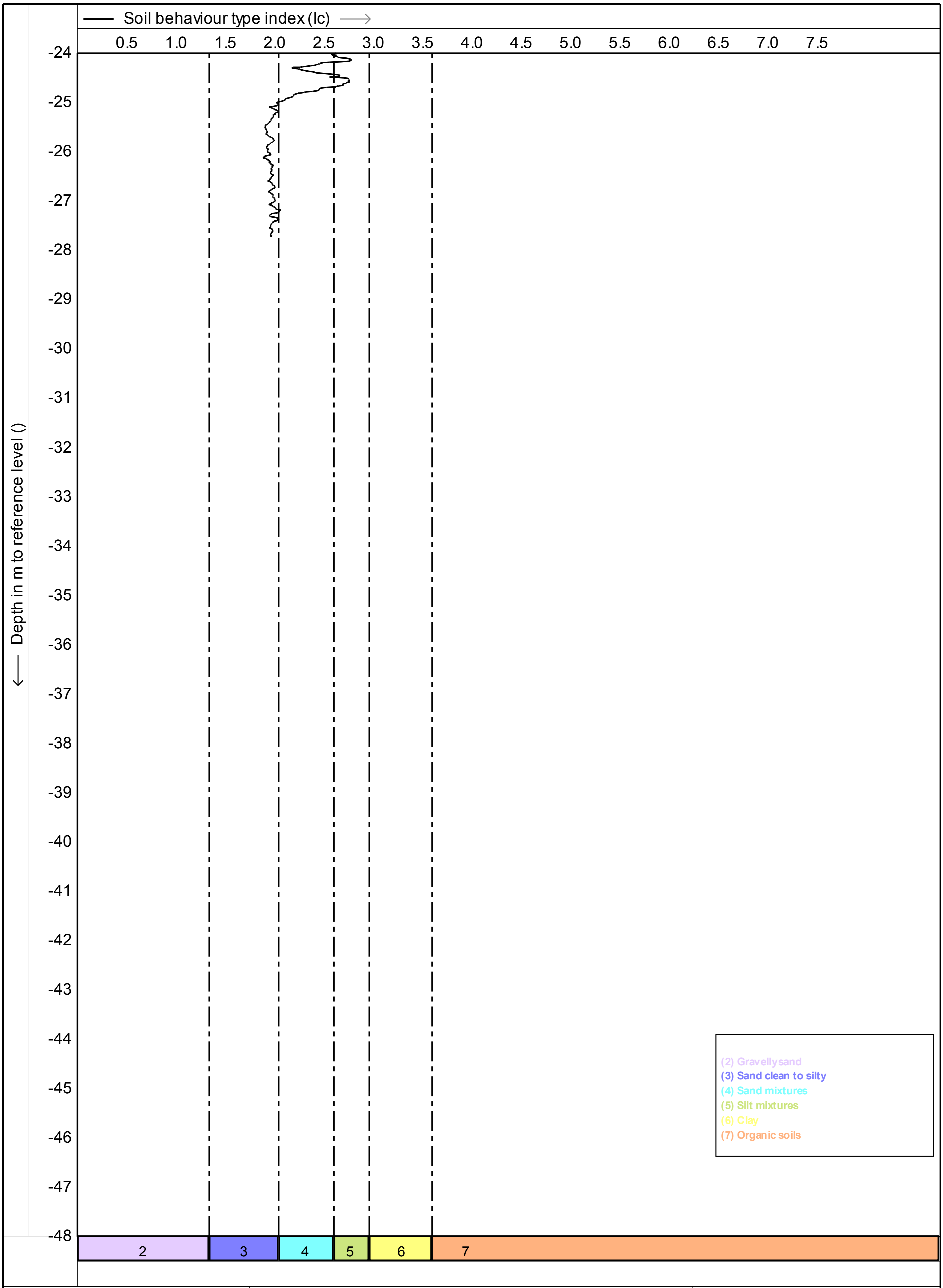


Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

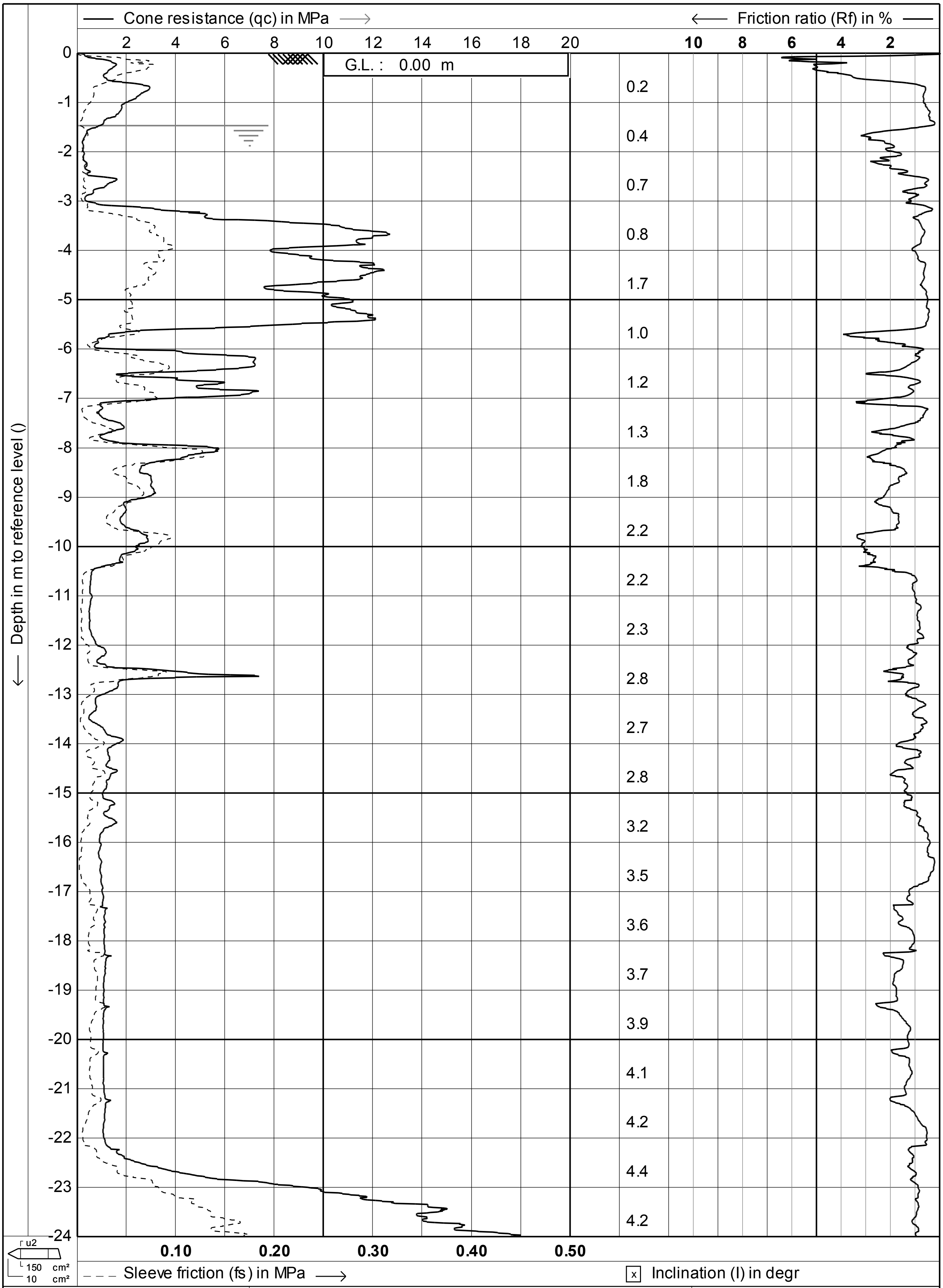
Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **7**

CPTask V1.26



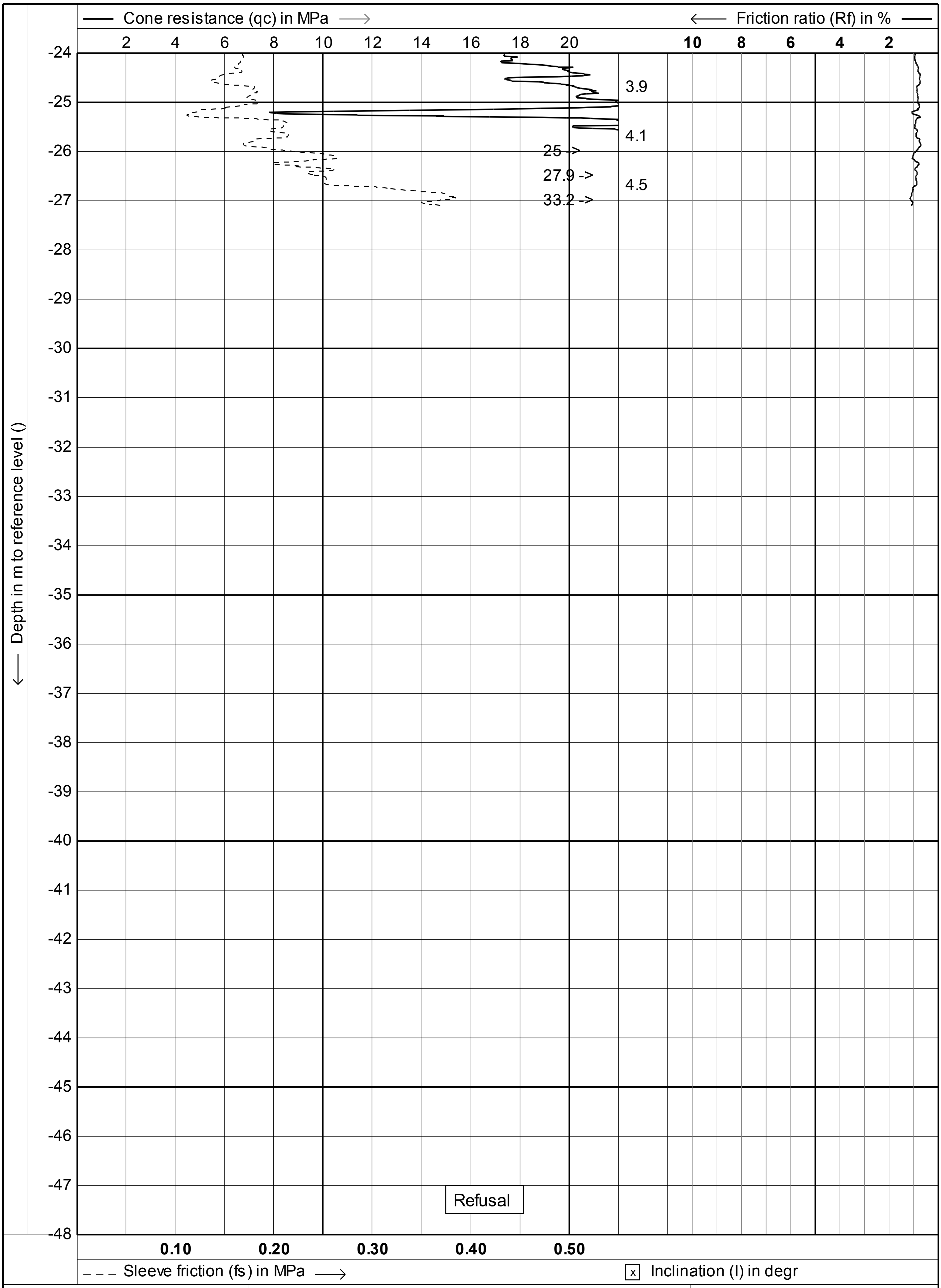
Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date	: **9-8-2011**
Cone no.	: **C10CFIIP.F57**
Project no.	: **02CGL7**
CPT no.	: **8**

1/28



Perry Drilling
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Ground Drilling and Environmental Specialists

CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **8**

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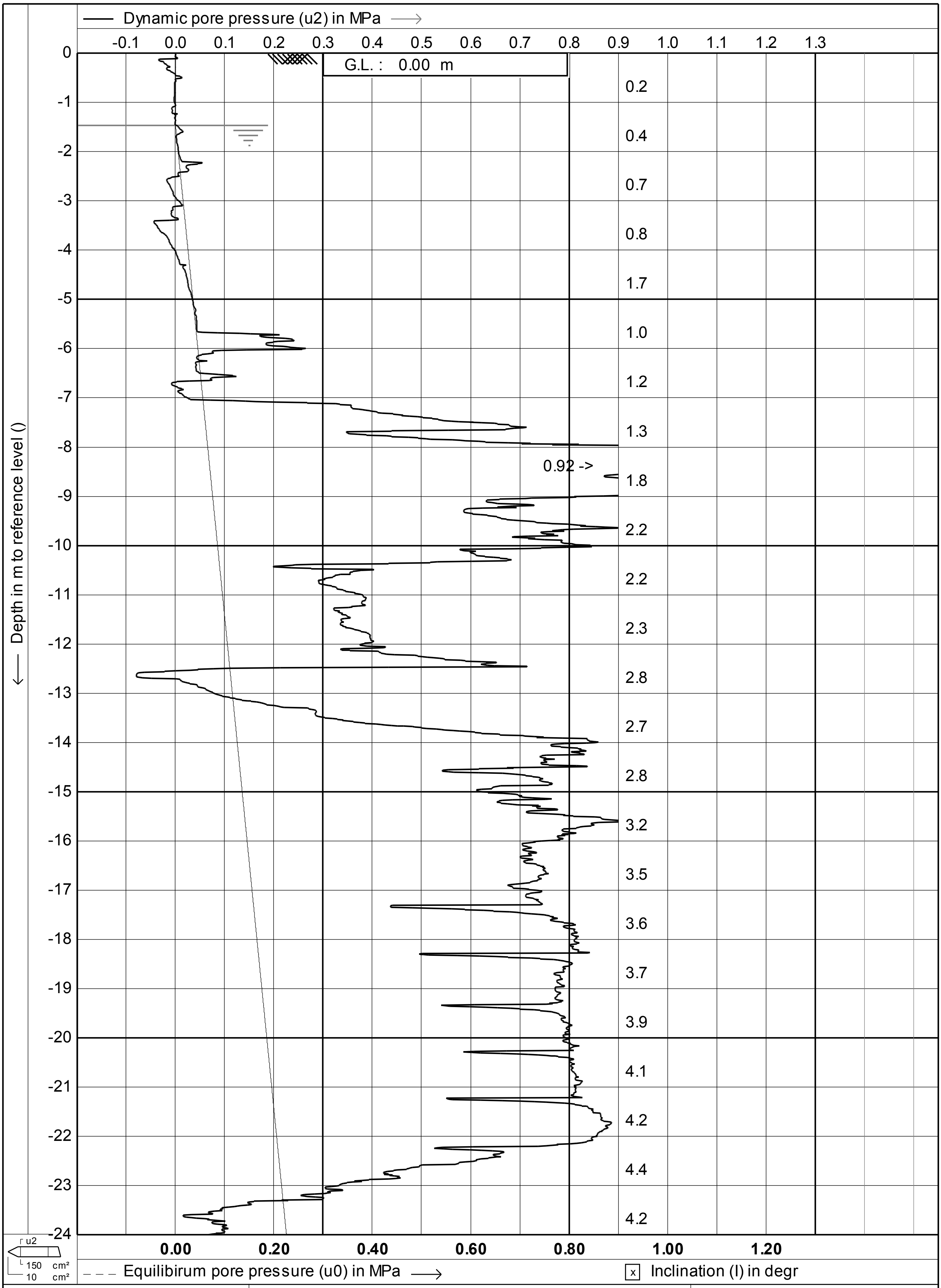

CPTask V1.26

Perry Drilling
GEO PROBE
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

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Cone no. : **C10CFIIP.F57**
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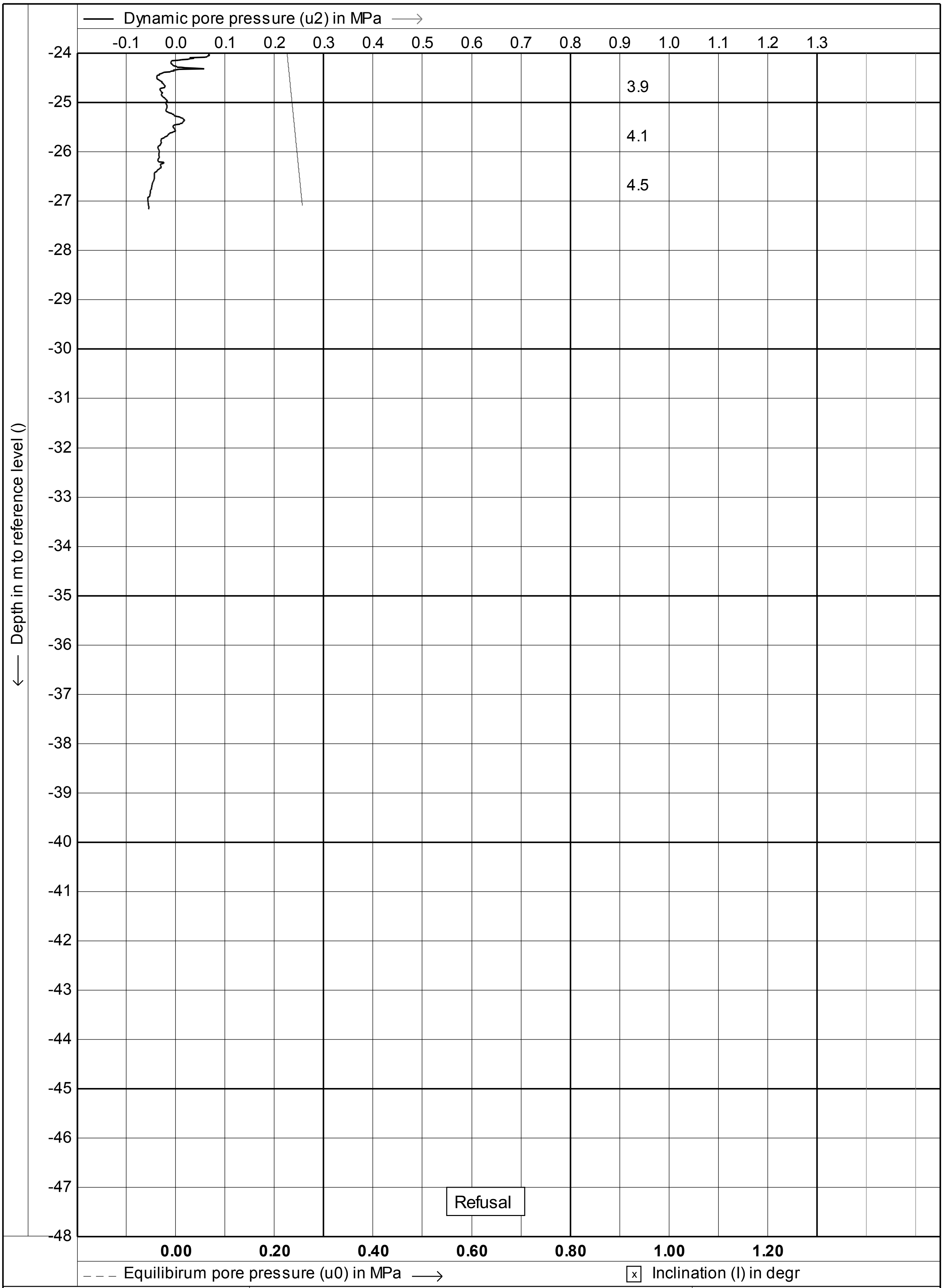
CPT no. : **8**



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **8**

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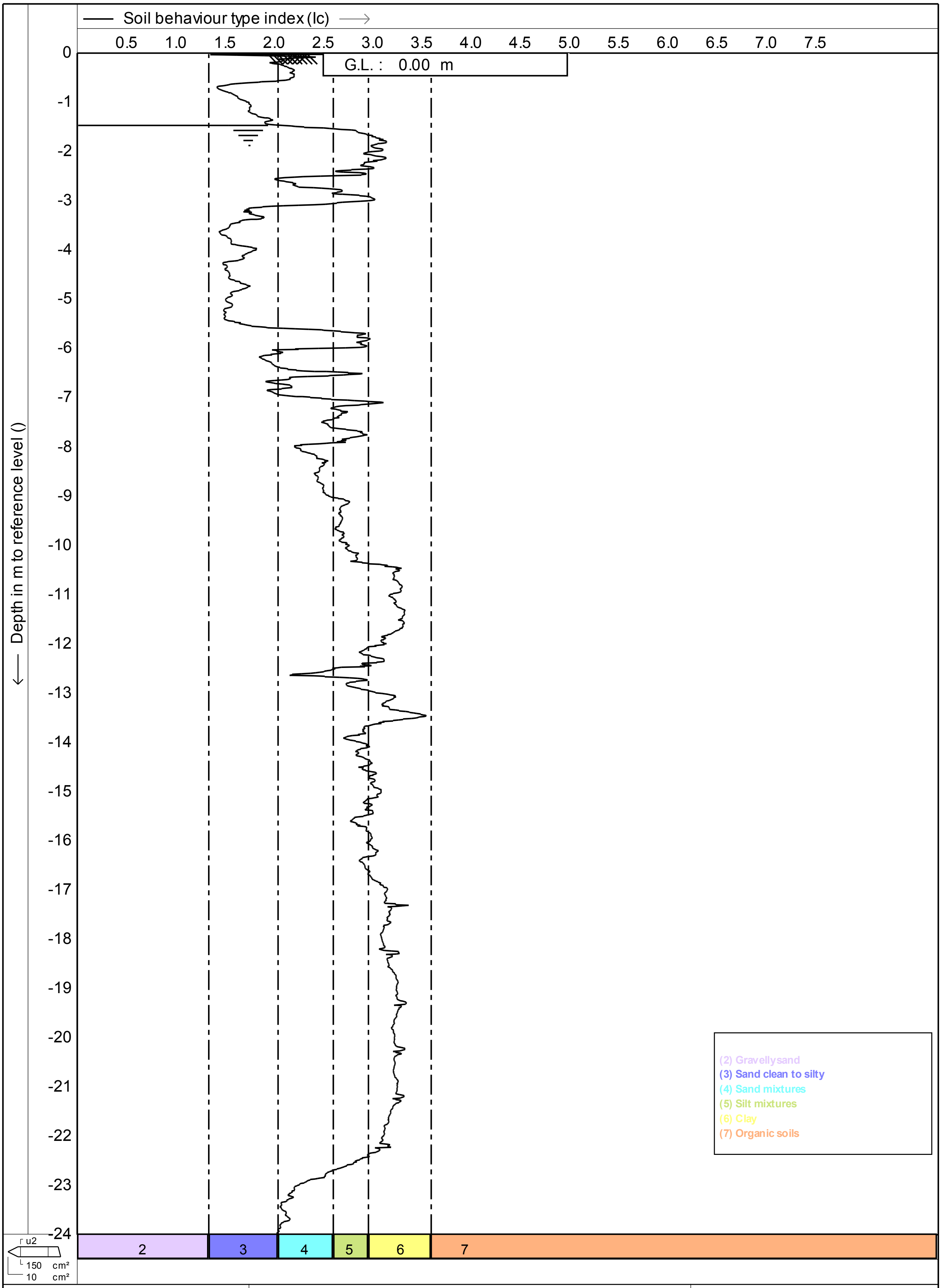

CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **8**

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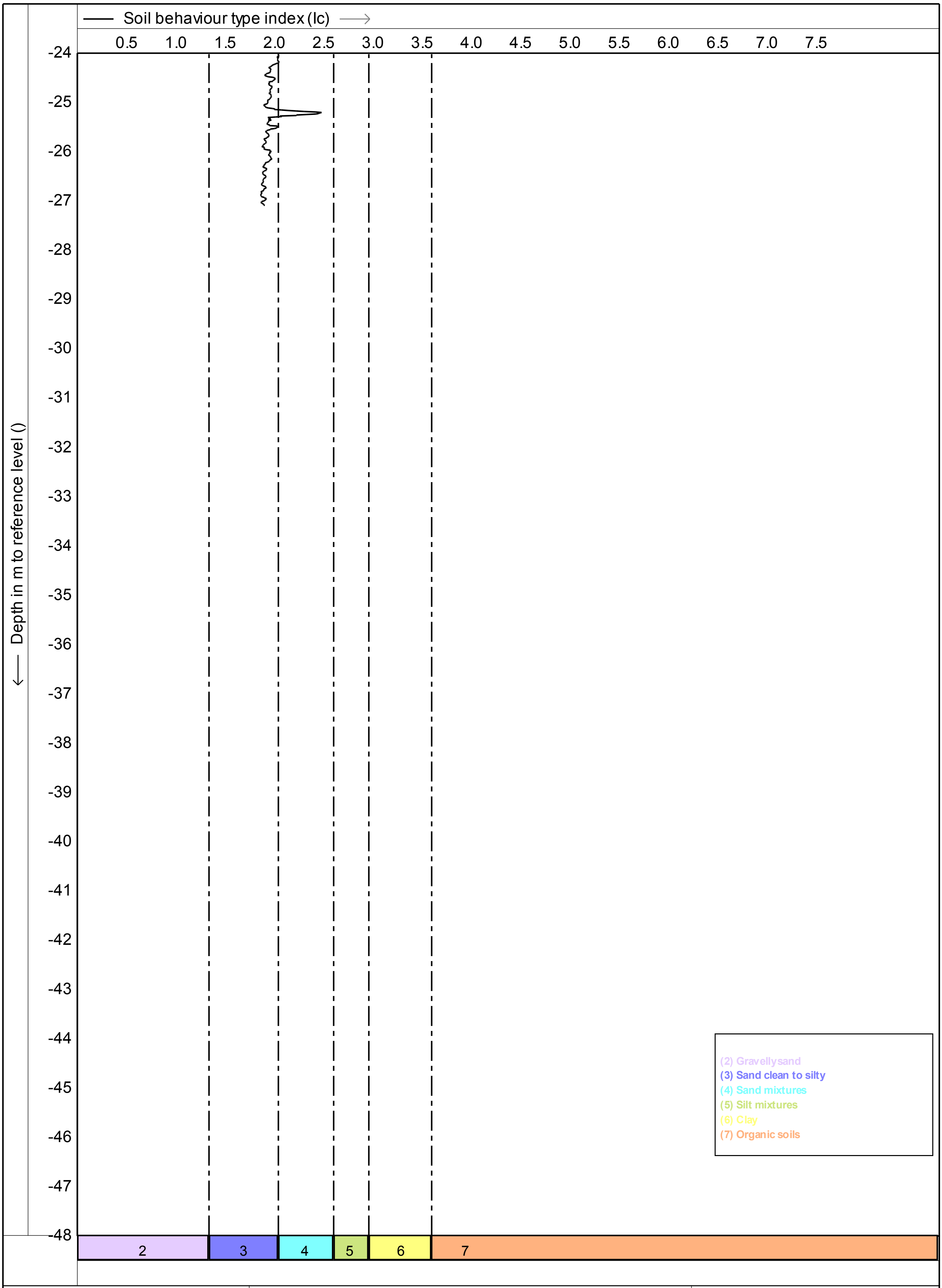


CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

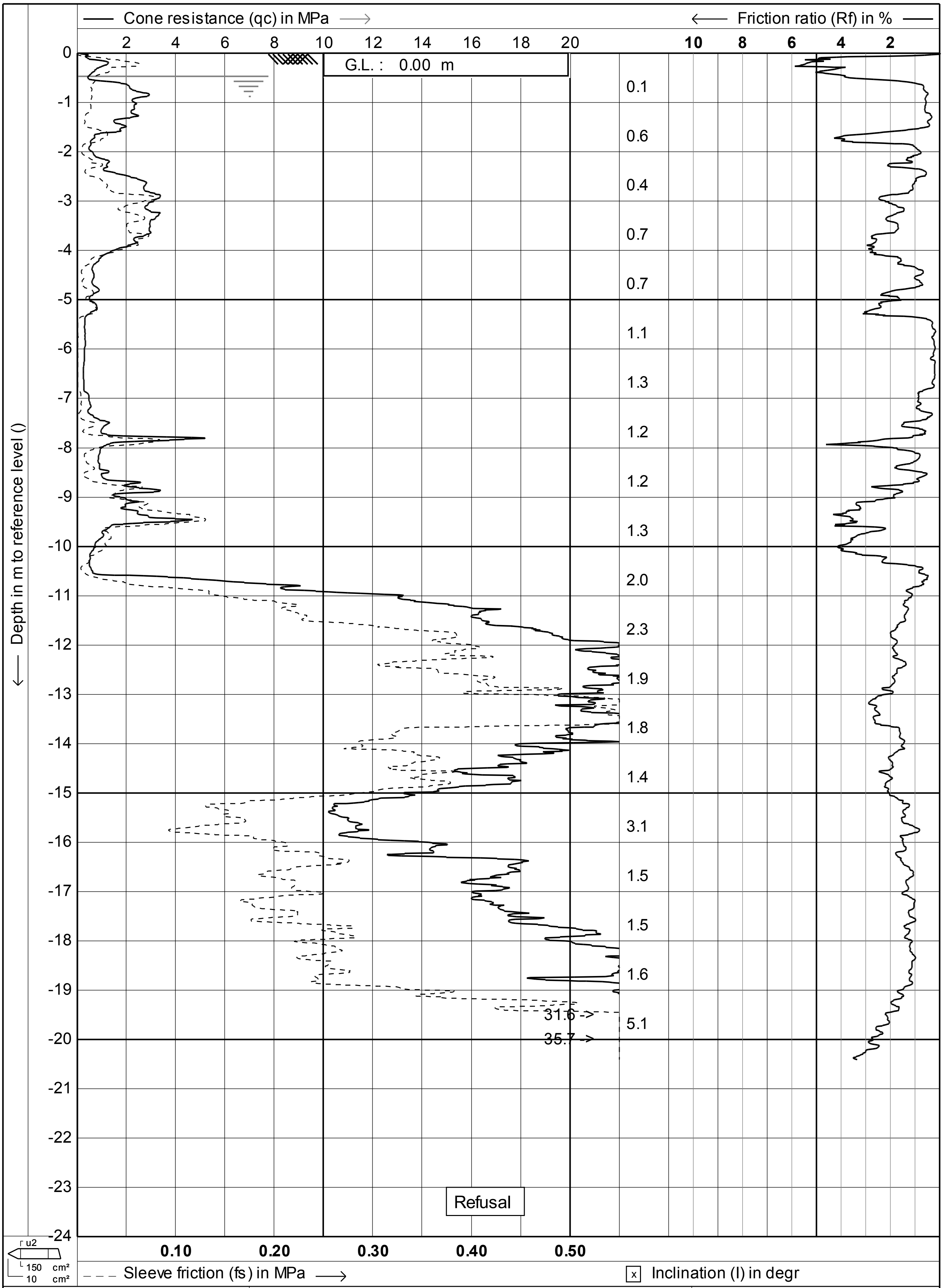
Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

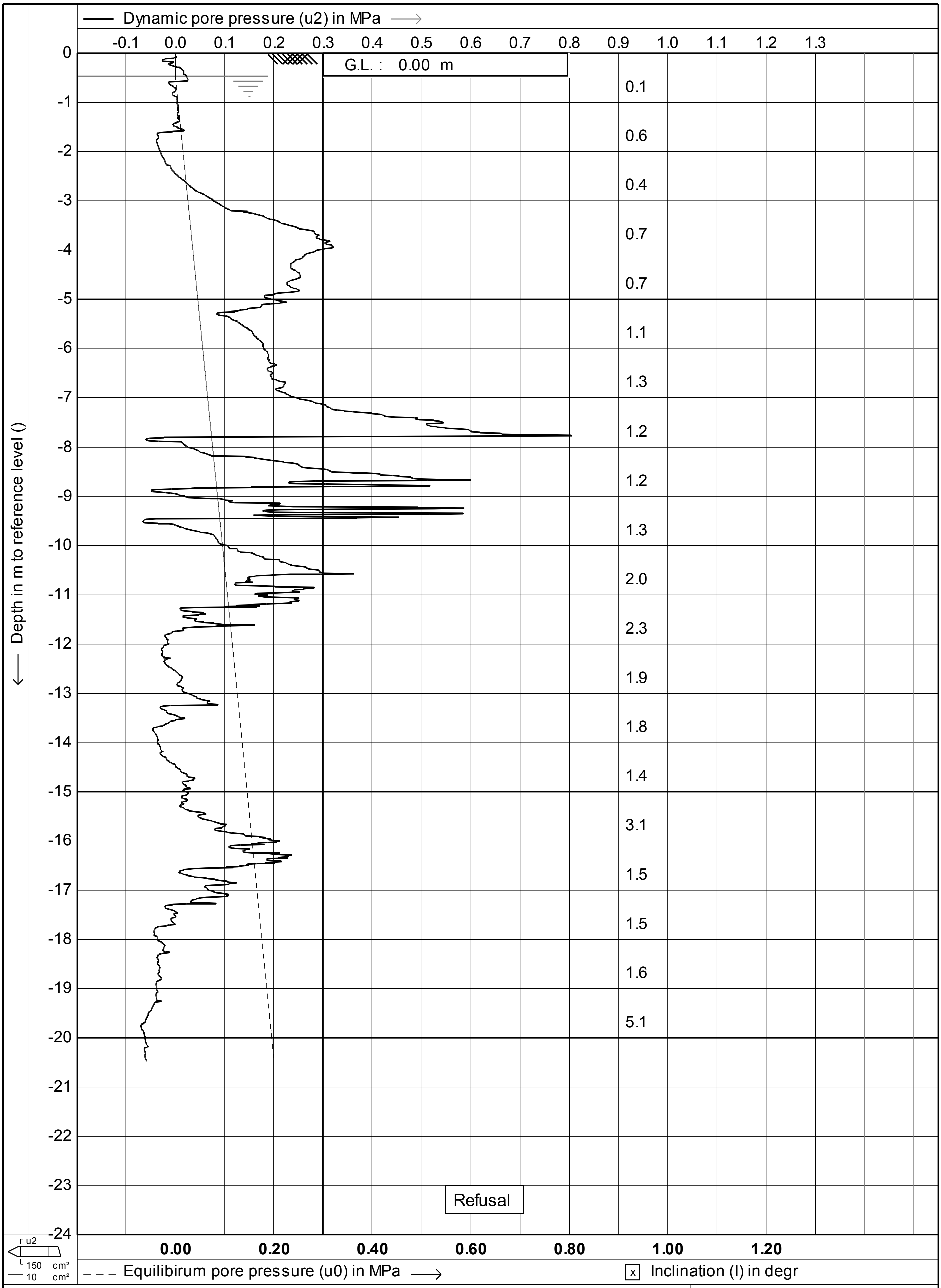
Project no. : **02CGL7**

CPT no. : **8**



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07	Date : **9-8-2011**
	Cone no. : **C10CFIIP.F57**
Project : **Montgomerie Block - Hamilton Airport**	Project no. : **02CGL7**
Location: **Middle Road - Hamilton**	CPT no. : **9** **1/14**



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **9**

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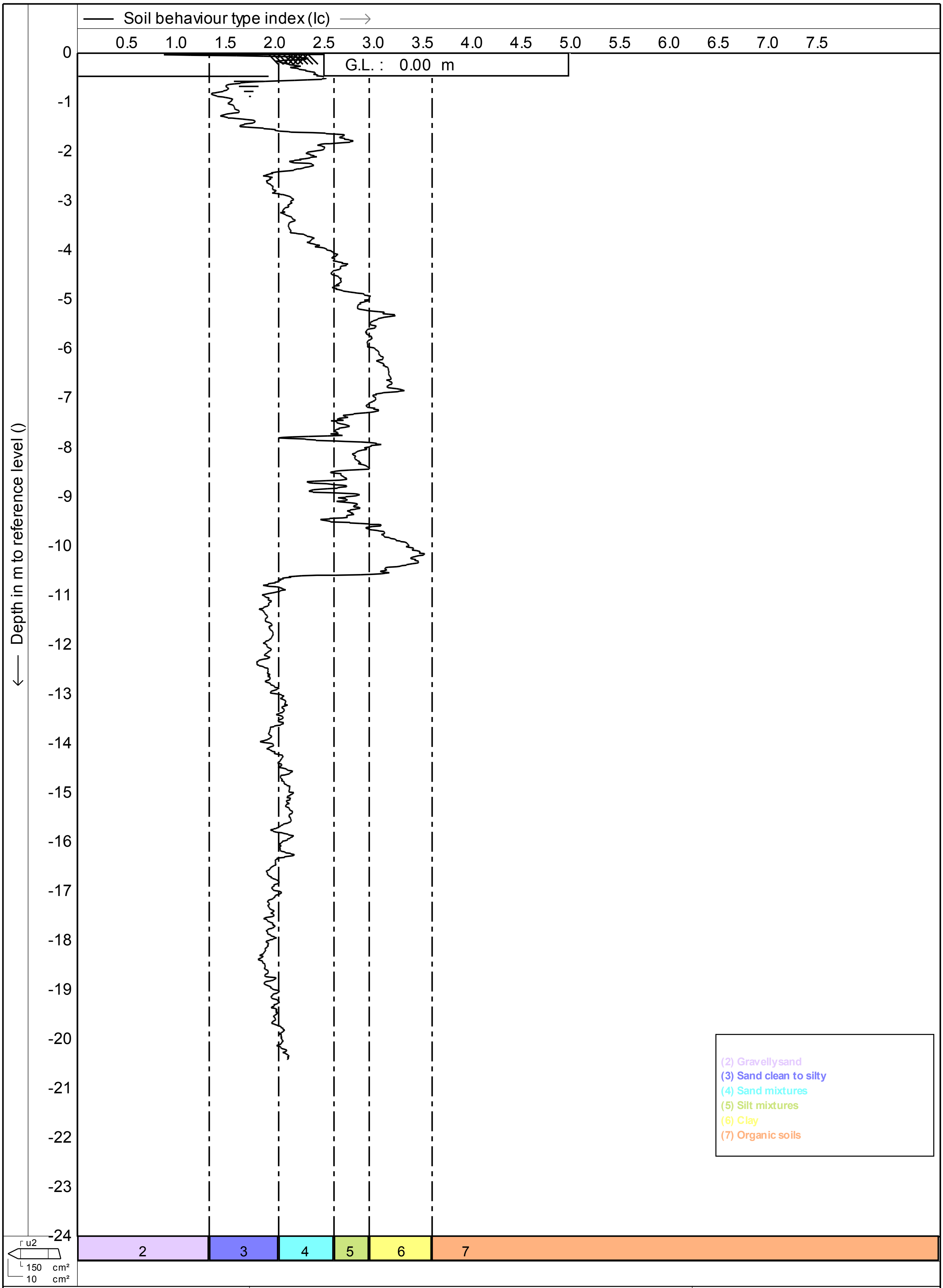
CPTask V1.26



CPTask V1.26

Perry DRILLING GEO PROBE

Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **9**

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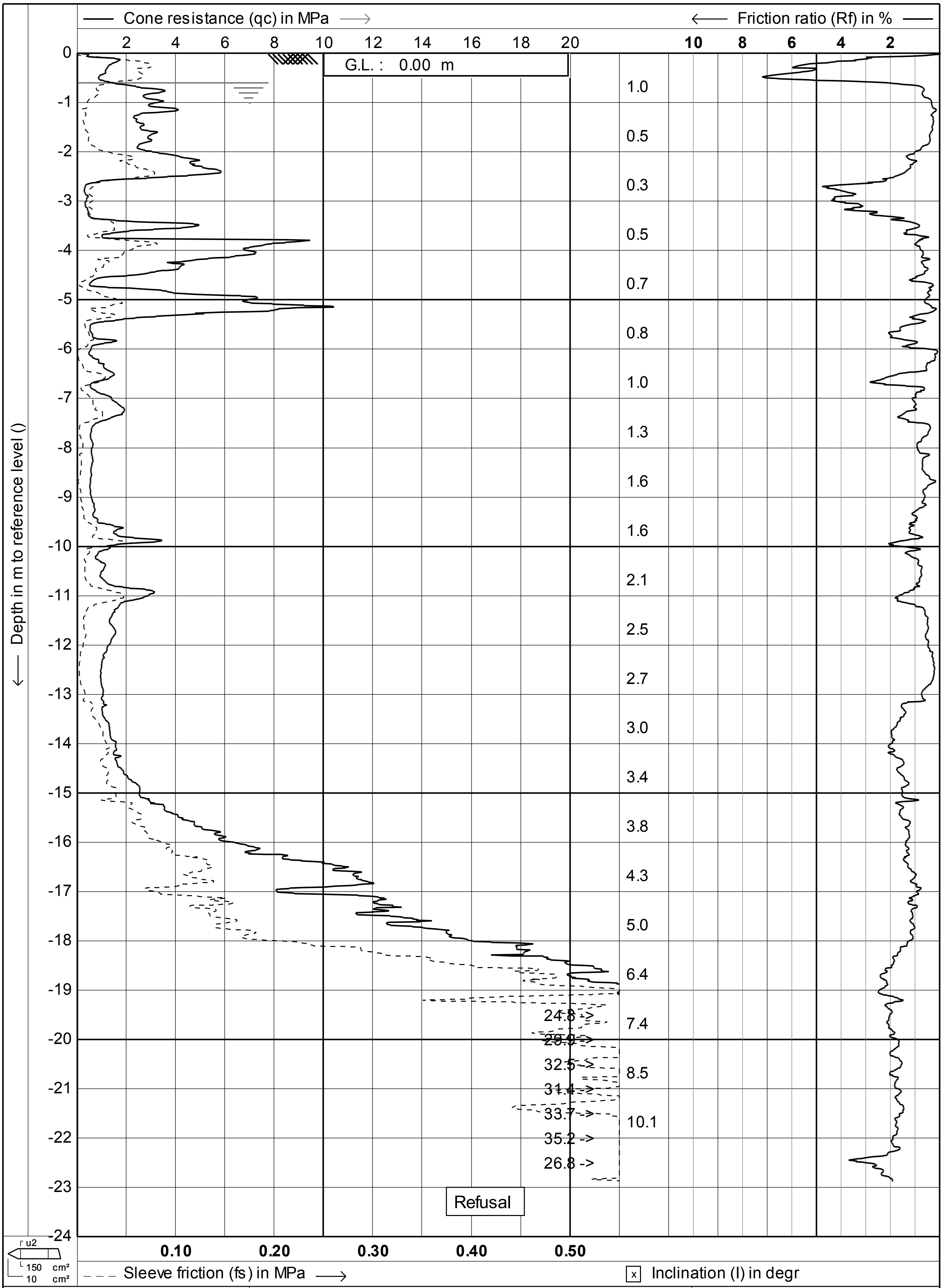


CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

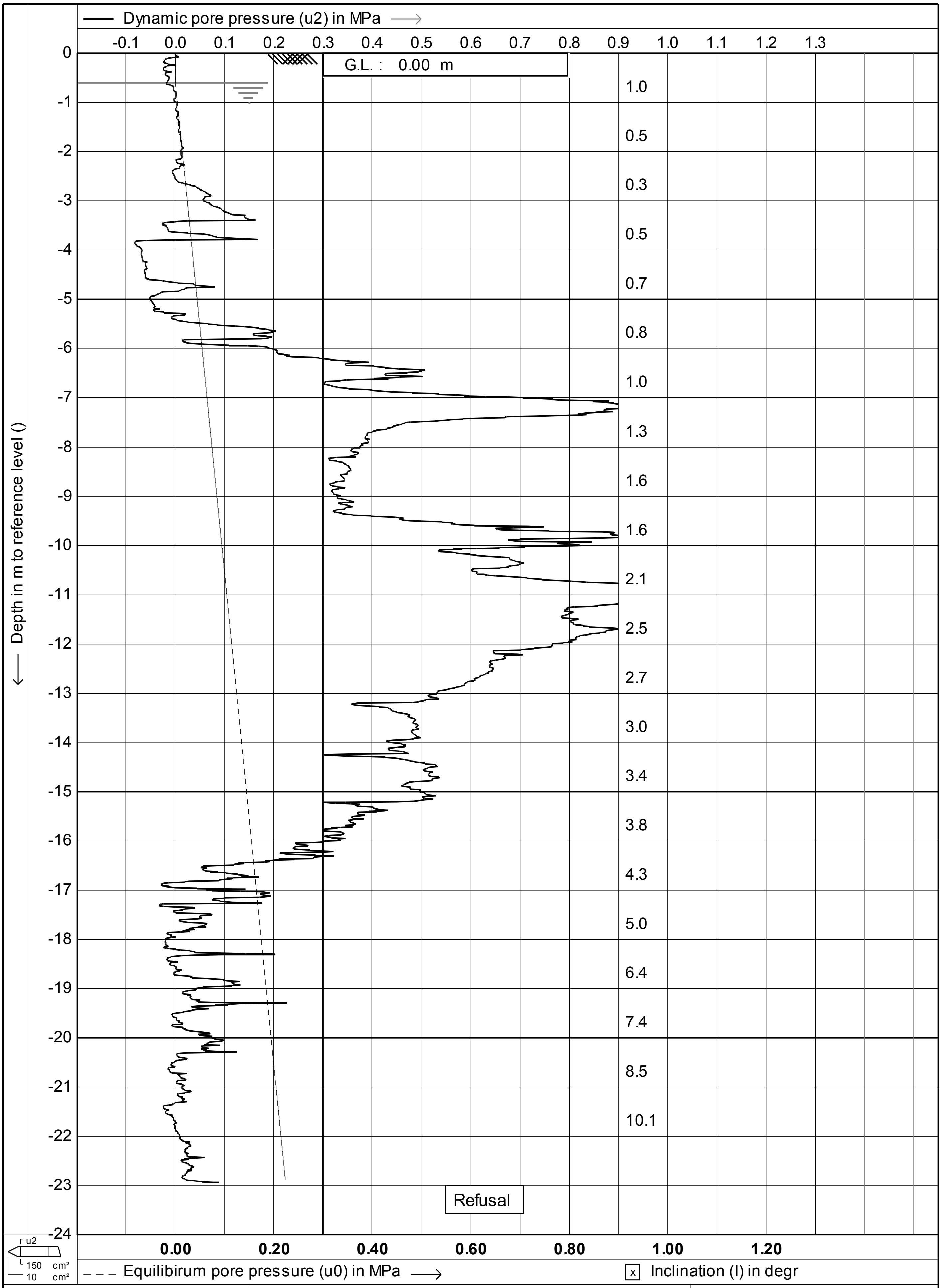
Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **10** **1/14**



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **10**

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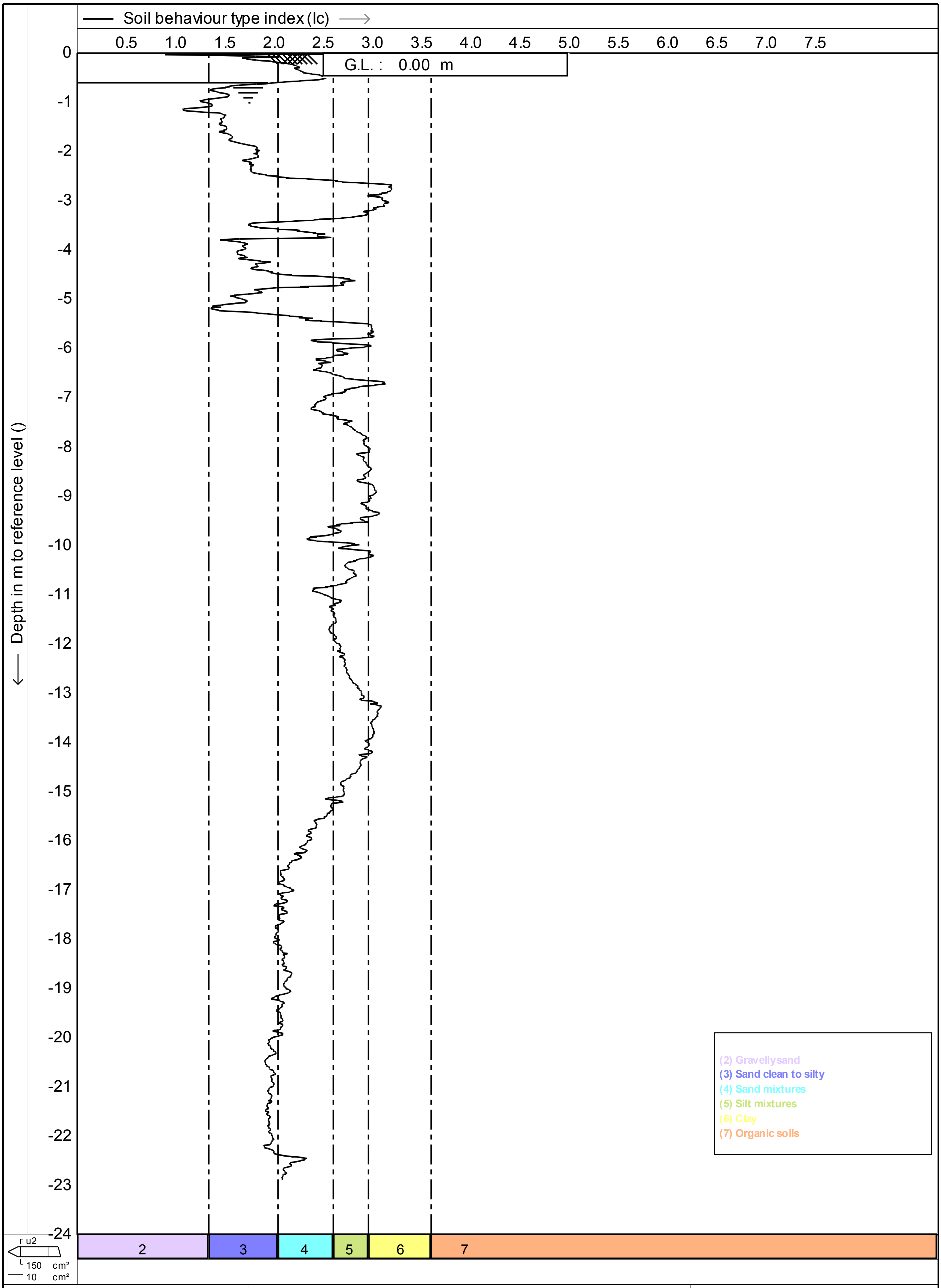


CPTask V1.26

Perry DRILLING GEO PROBE Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

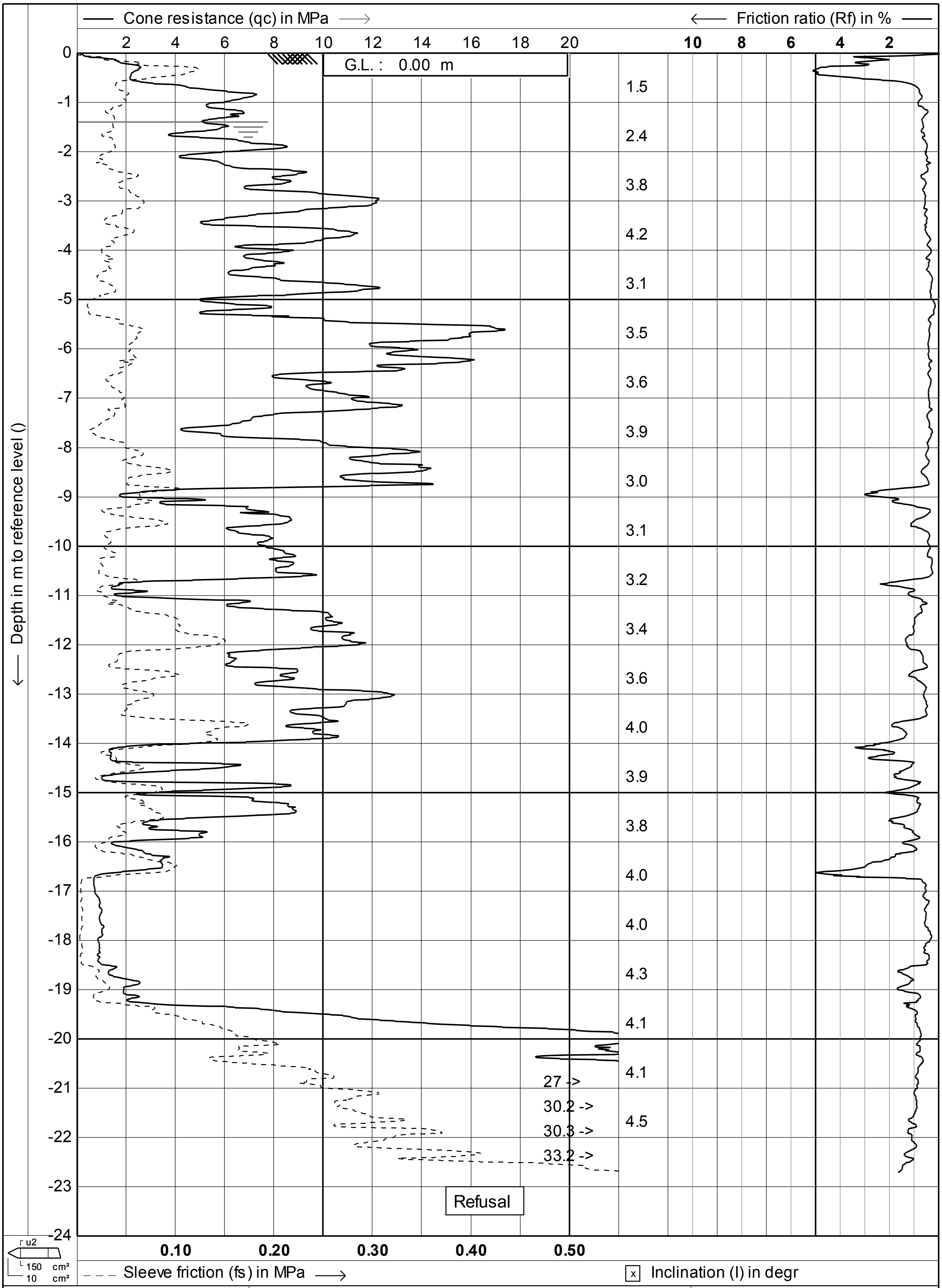
Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **10**

9/14



CPTask V1.26

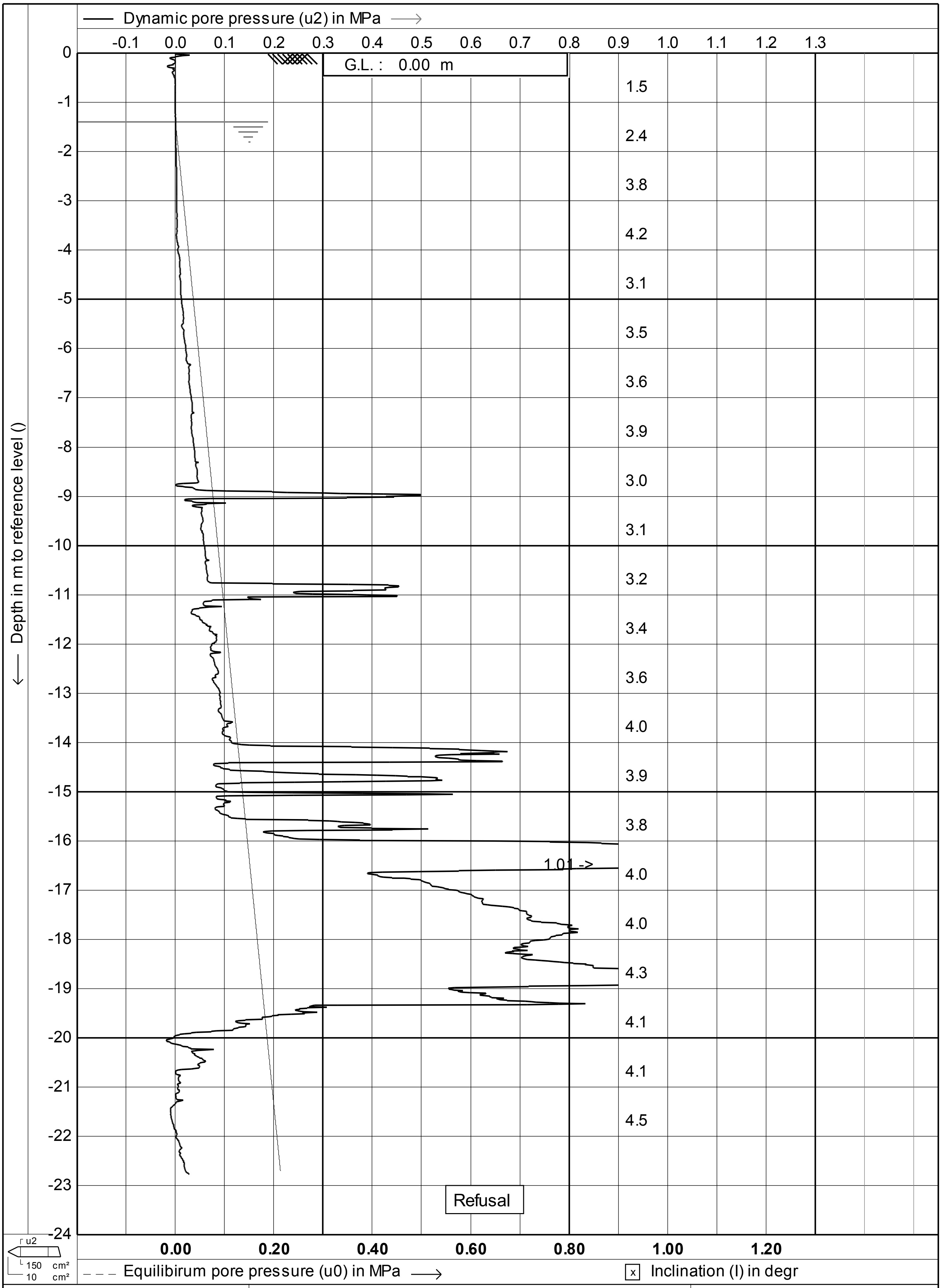
Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **11**

1/14



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **11**

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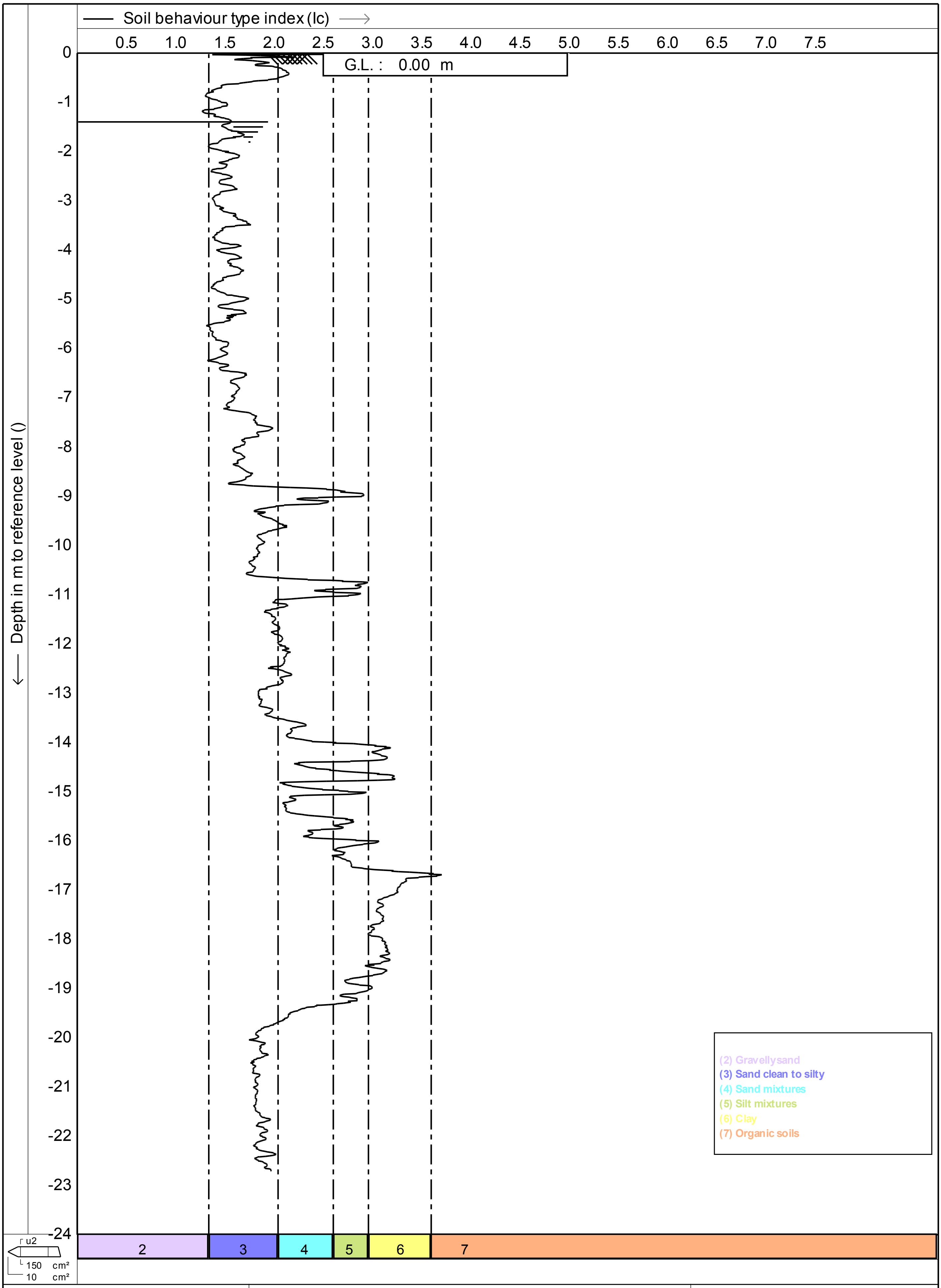

CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **11**

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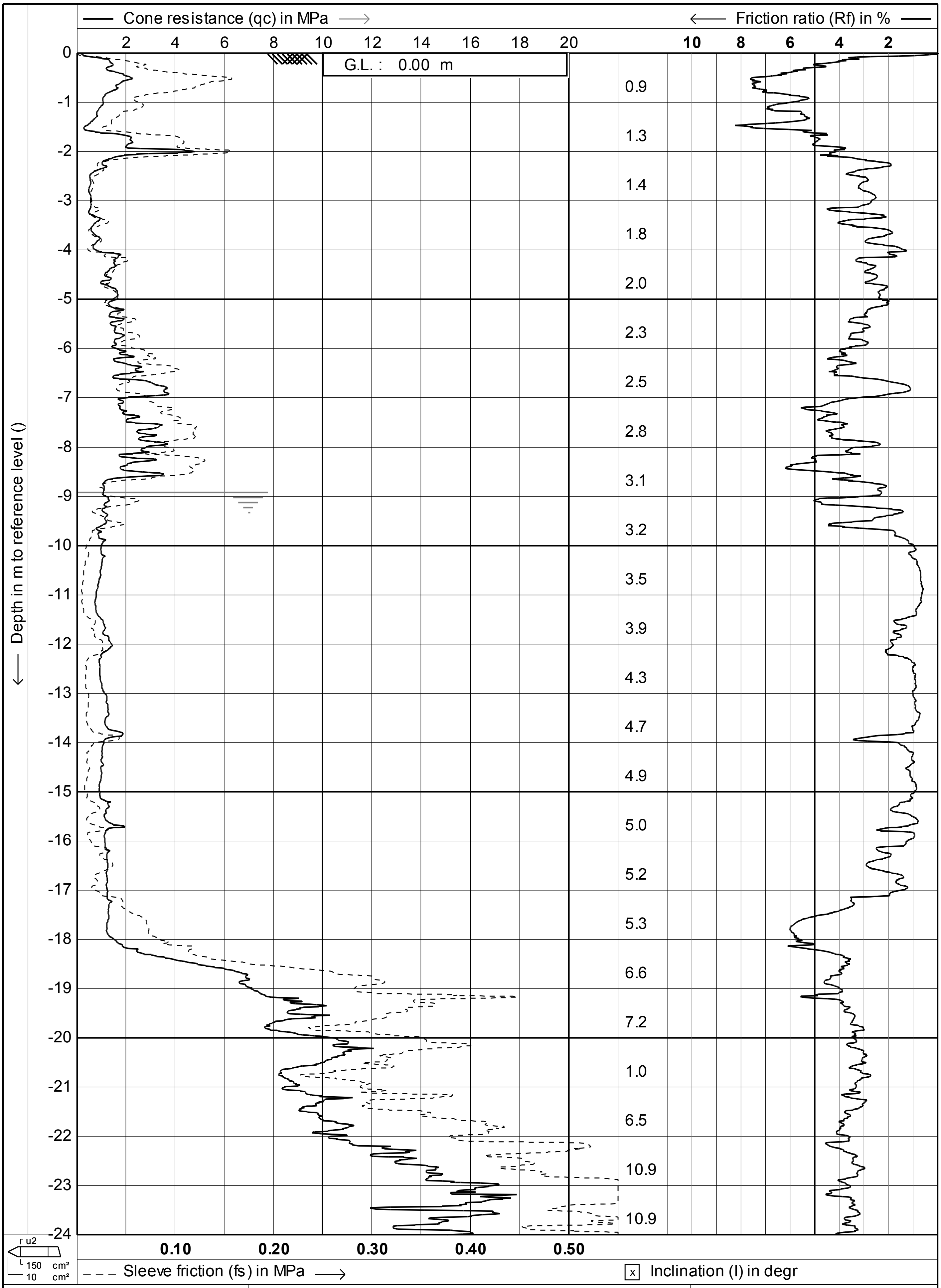

Perry DRILLING GEO PROBE Ground Drilling and Environmental Specialists

CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **12**

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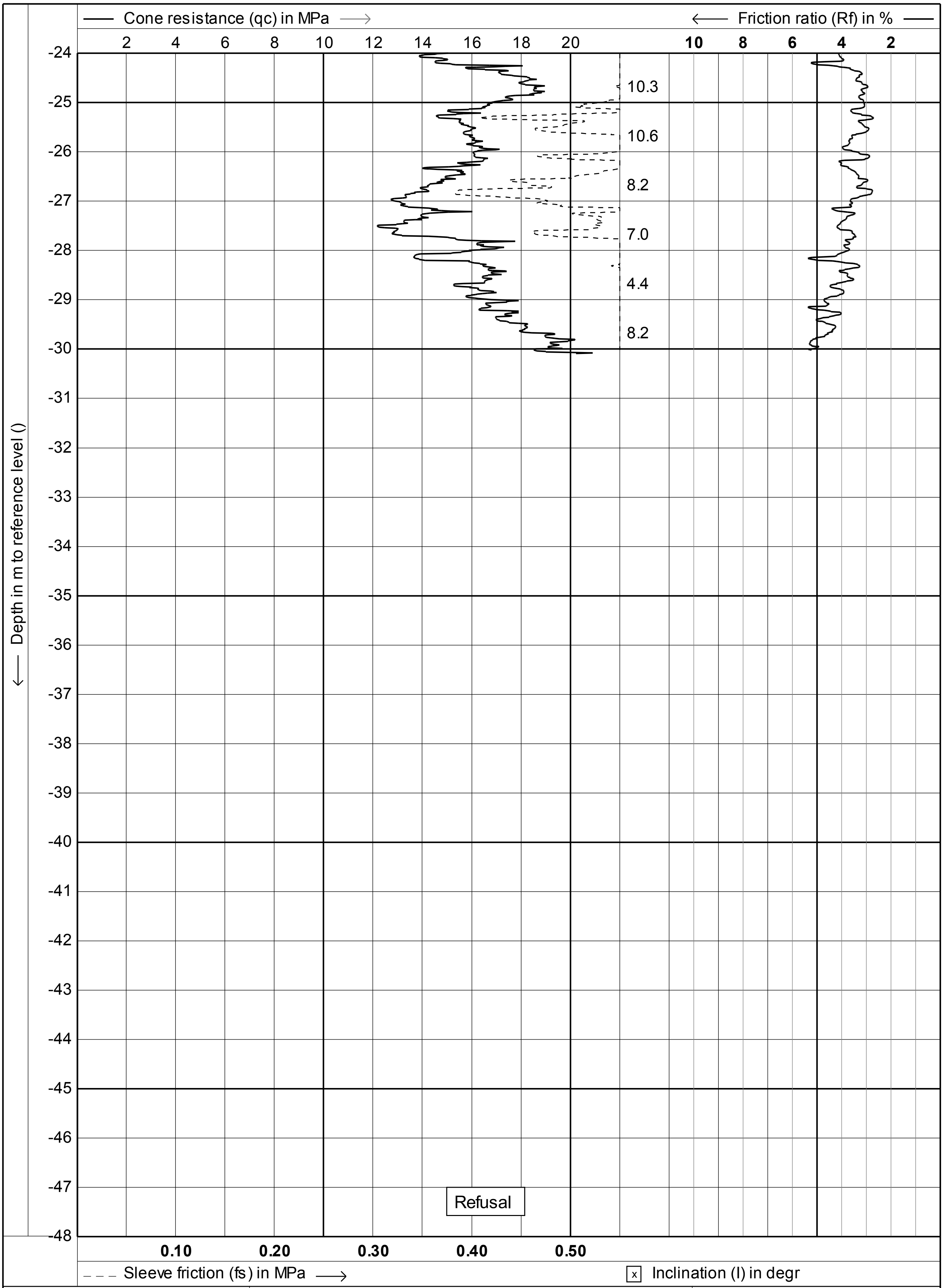

CPTask V1.26

Perry DRILLING GEO PROBE
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **12**

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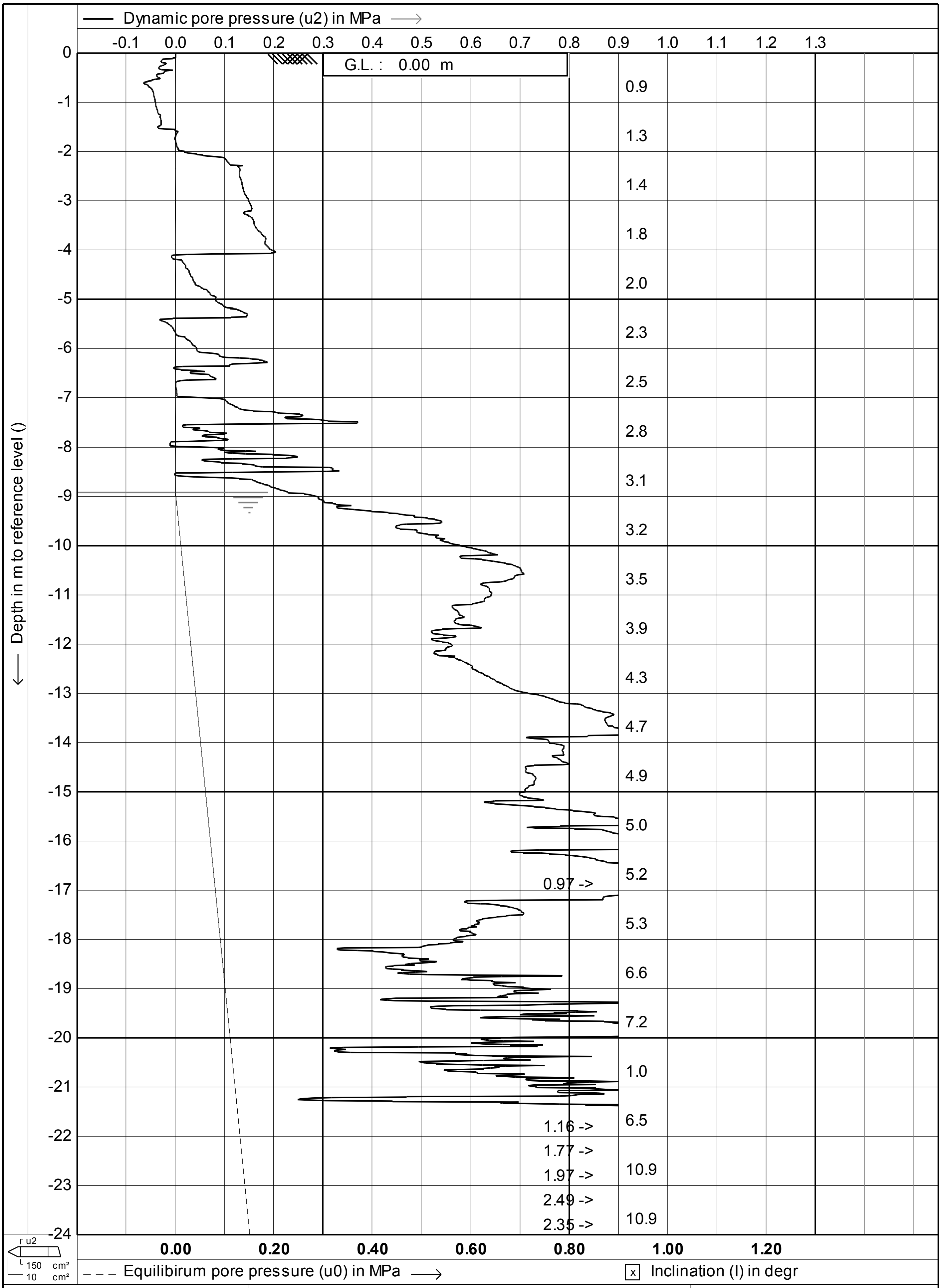

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **12**

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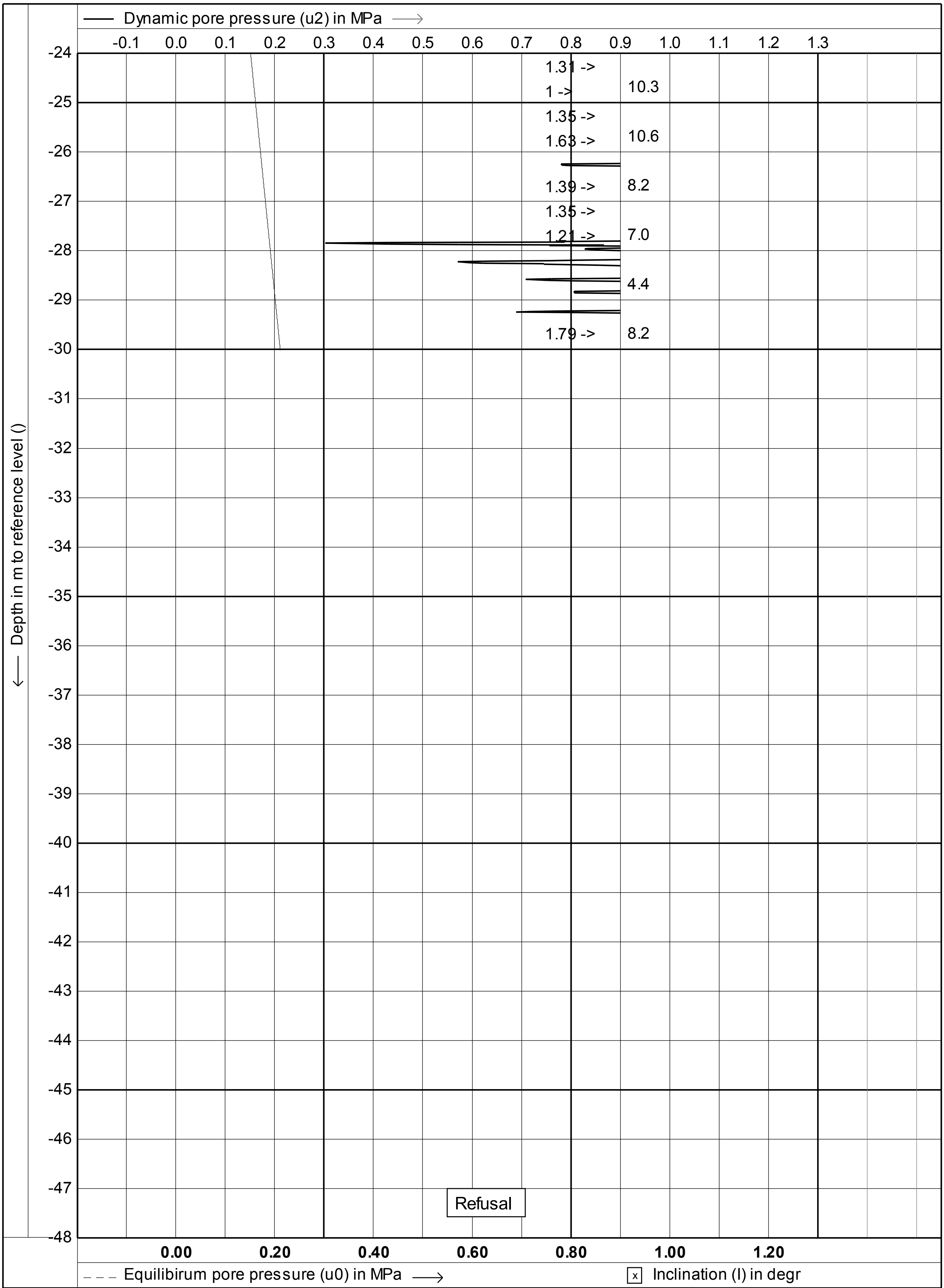
CPTask V1.26



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **12**

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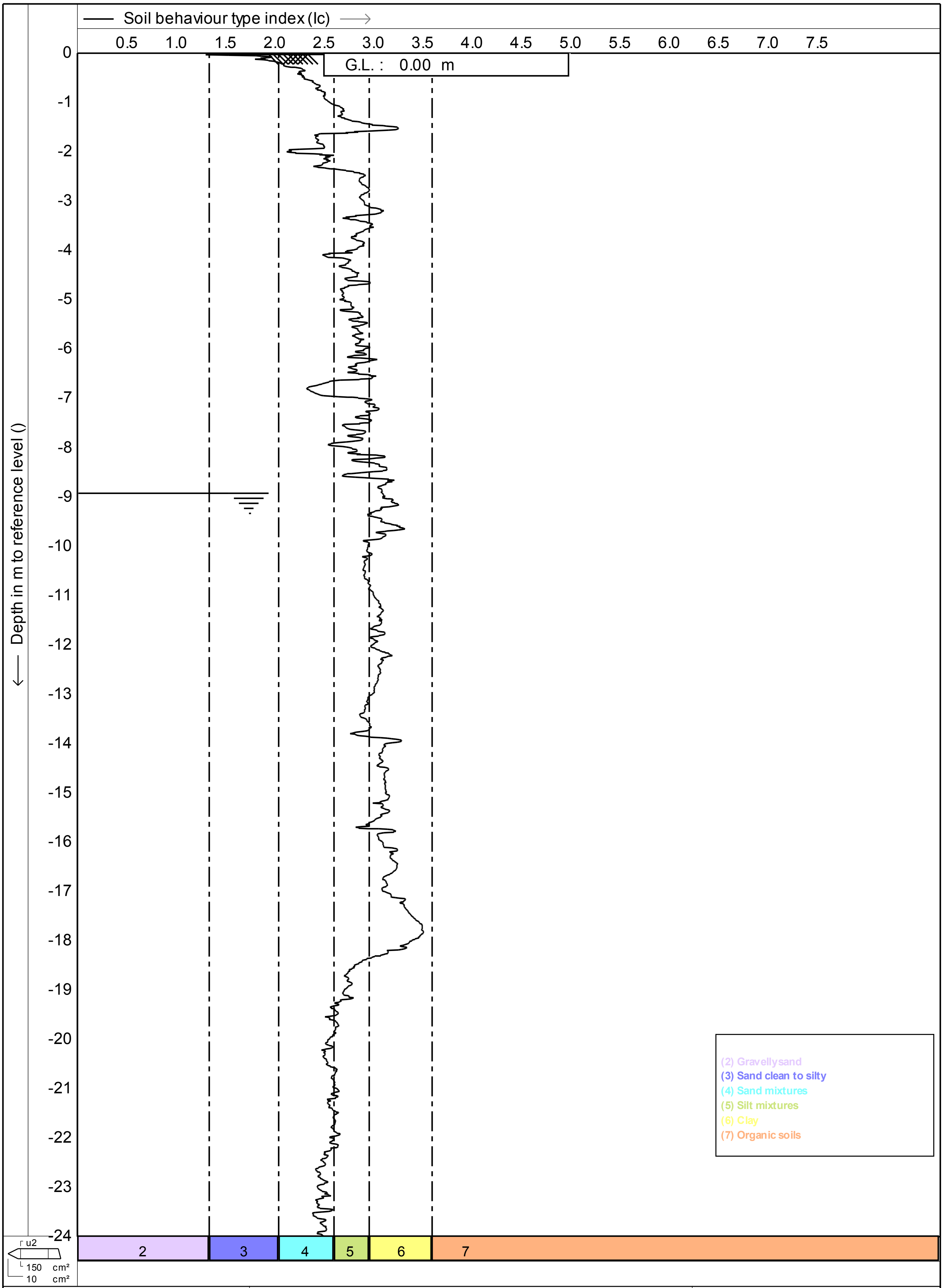

CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **12**

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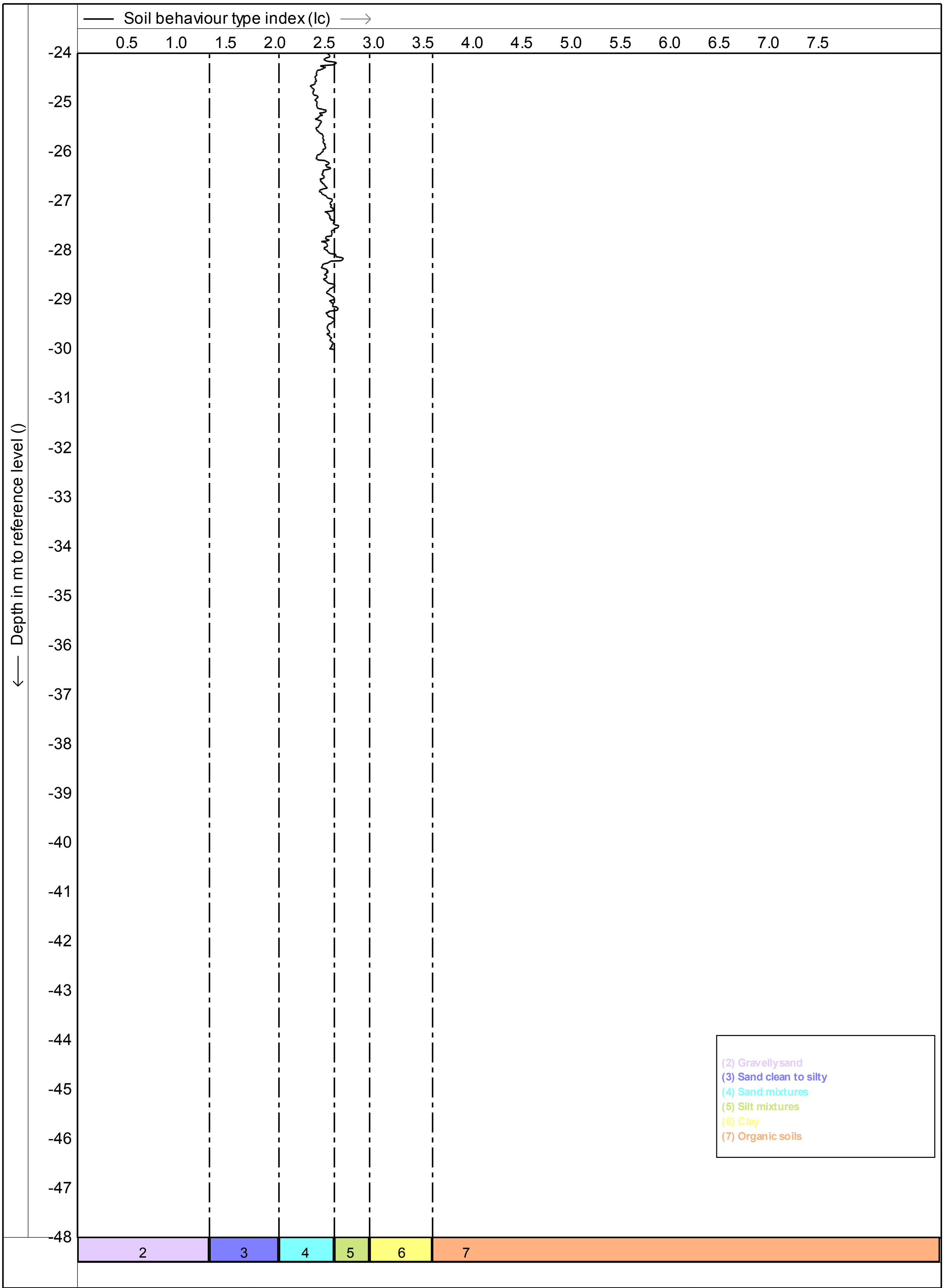
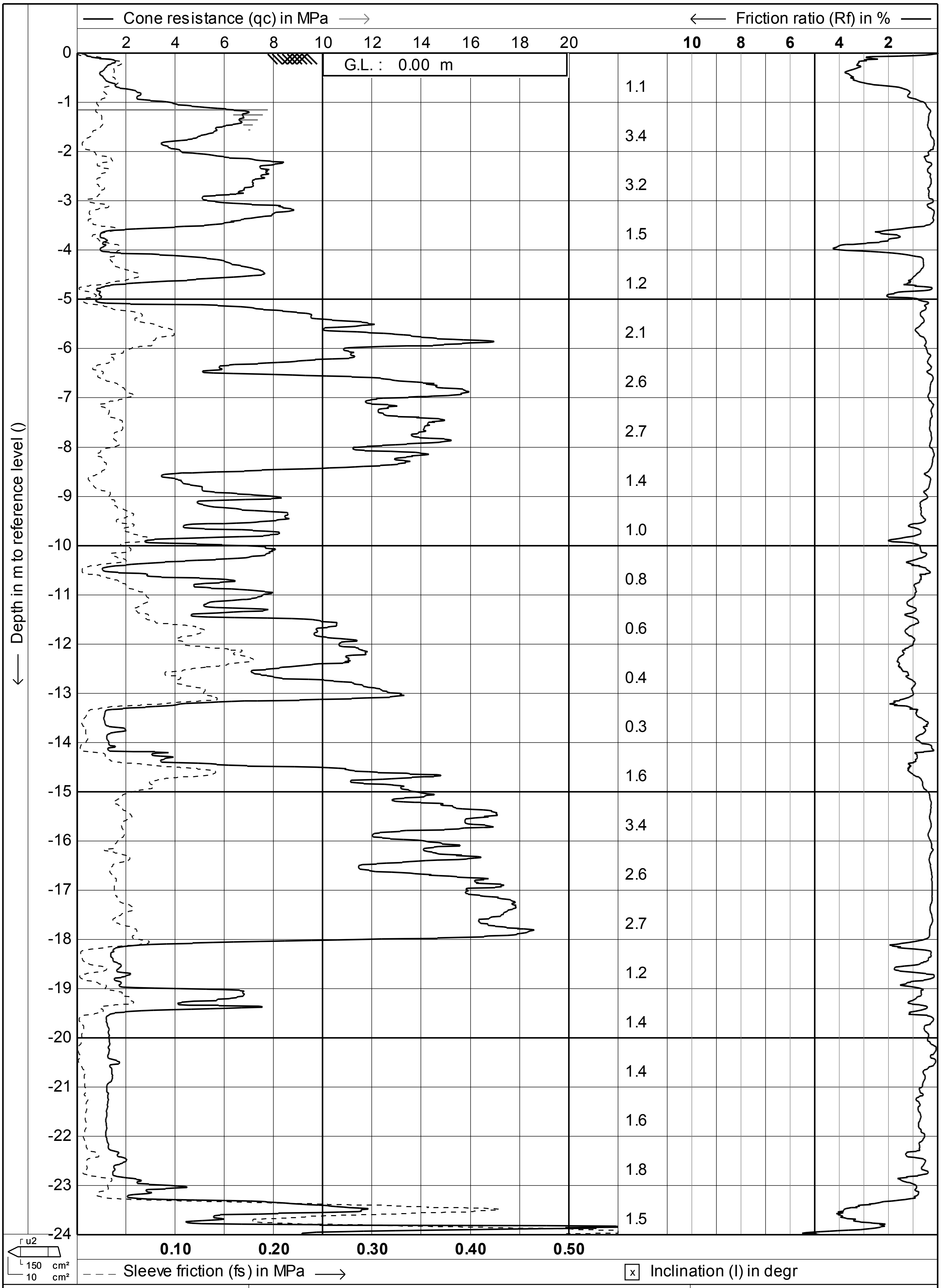


CPTask V1.26

Perry Drilling Geo Probe Ground Drilling and Environmental Specialists	Test according A.S.T.M. Standard D 5778-07	Date : **9-8-2011**
		Cone no. : **C10CFIIP.F57**
	Project : **Montgomerie Block - Hamilton Airport**	Project no. : **02CGL7**
	Location: **Middle Road - Hamilton**	CPT no. : **12** — **18/28**



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **8-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **13**

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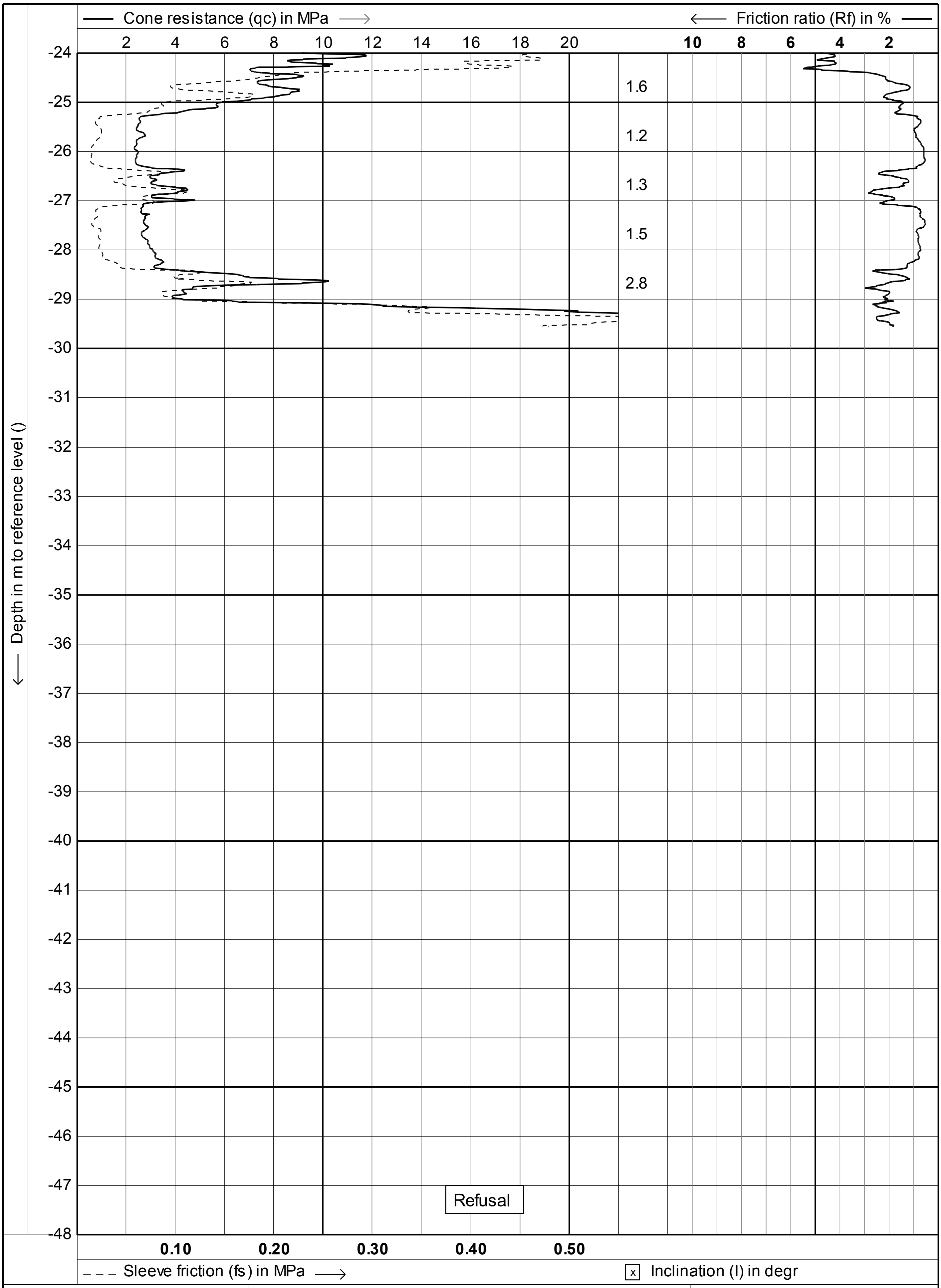

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

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Date : **8-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **13**

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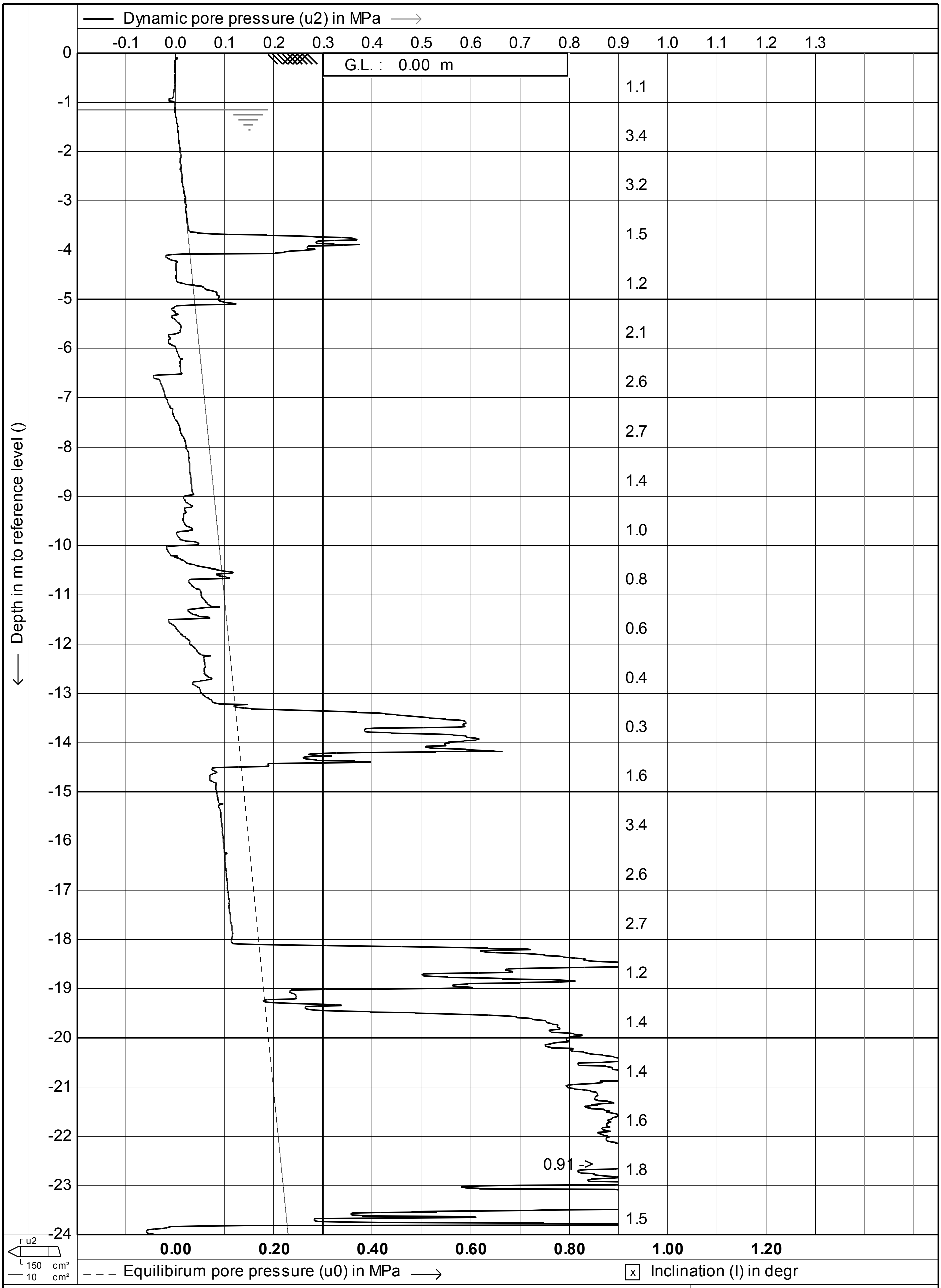
CPTask V1.26



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

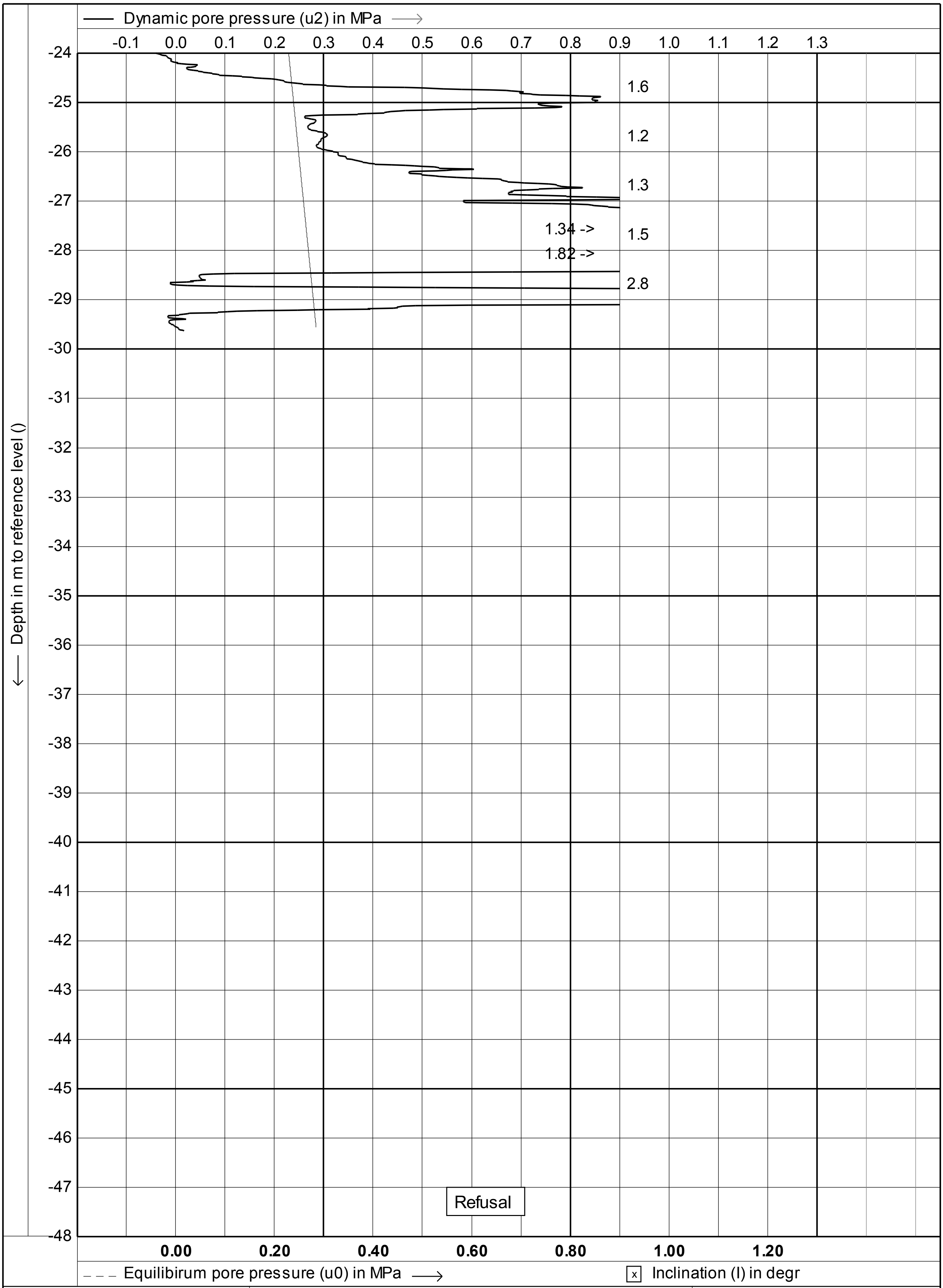
Date : **8-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

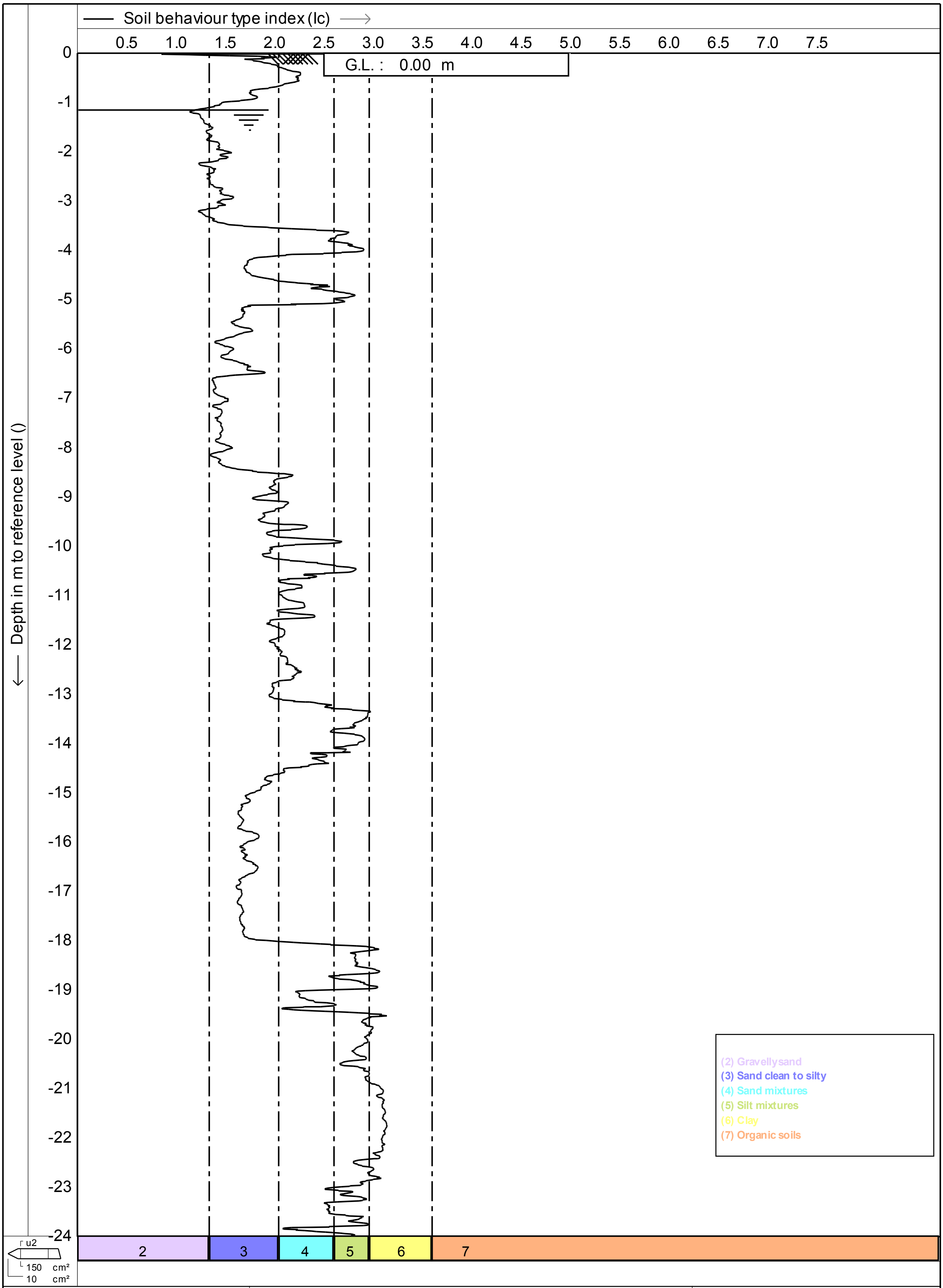
CPT no. : **13**

3/28



CPTask V1.26

Test according A.S.T.M. Standard D 5778-07	Date	: **8-8-2011**
Project : **Montgomerie Block - Hamilton Airport**	Cone no.	: **C10CFIIP.F57**
	Project no.	: **02CGL7**
Location: **Middle Road - Hamilton**	CPT no.	: **13** **4/28**



CPTask V1.26

Perry DRILLING GEO PROBE
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

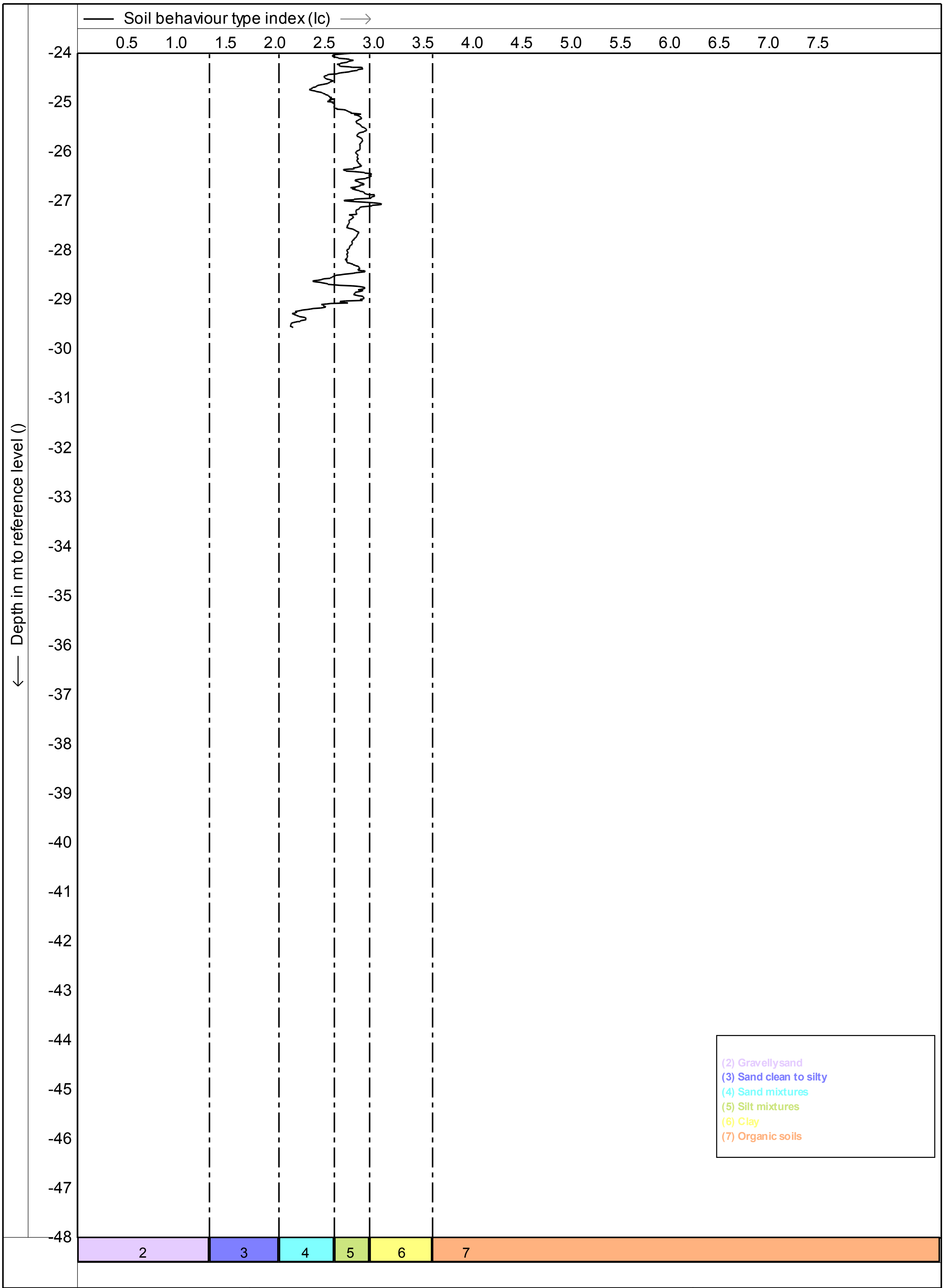
Date : **8-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **13**

17/28

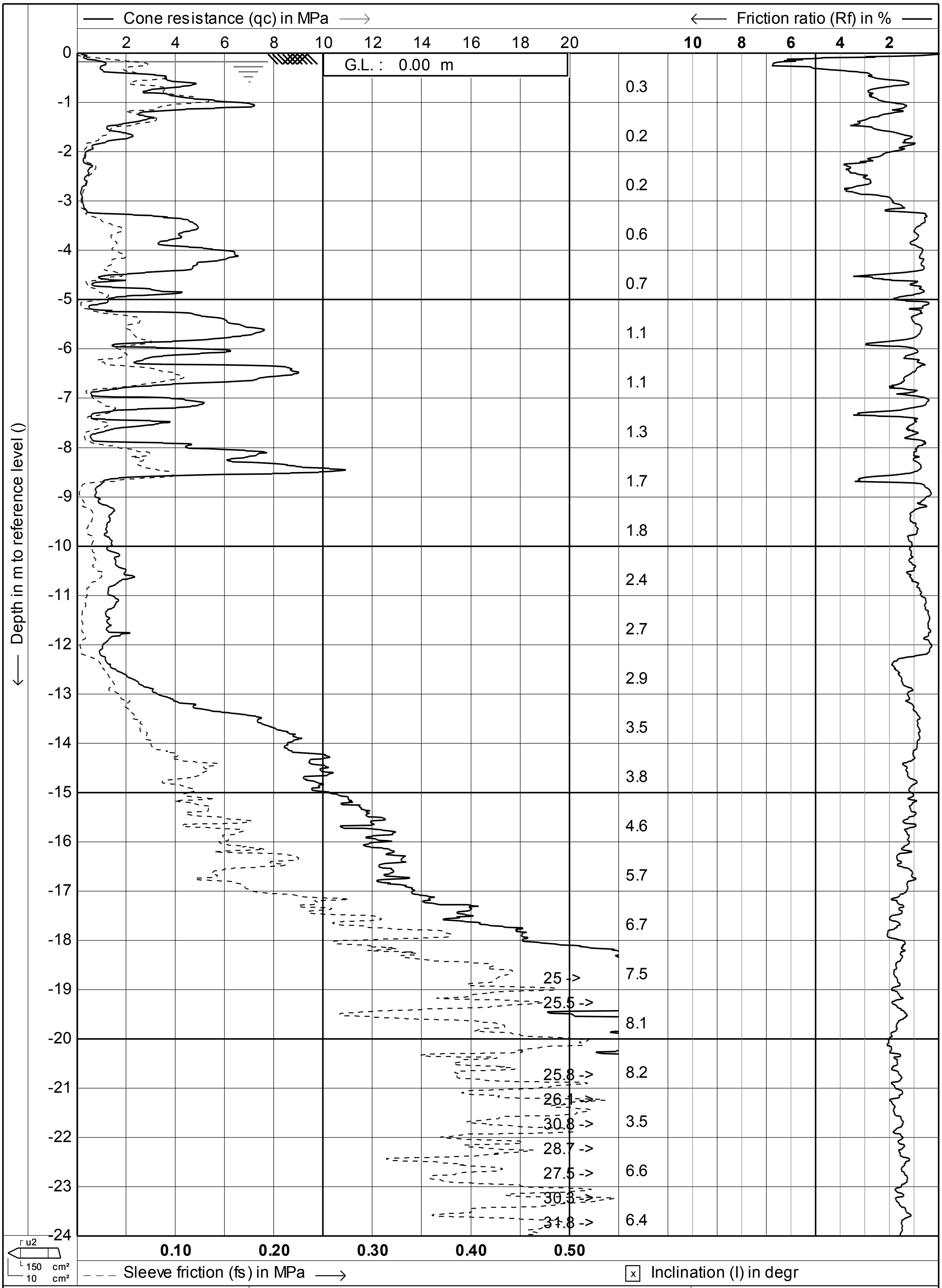


Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **8-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **13**



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

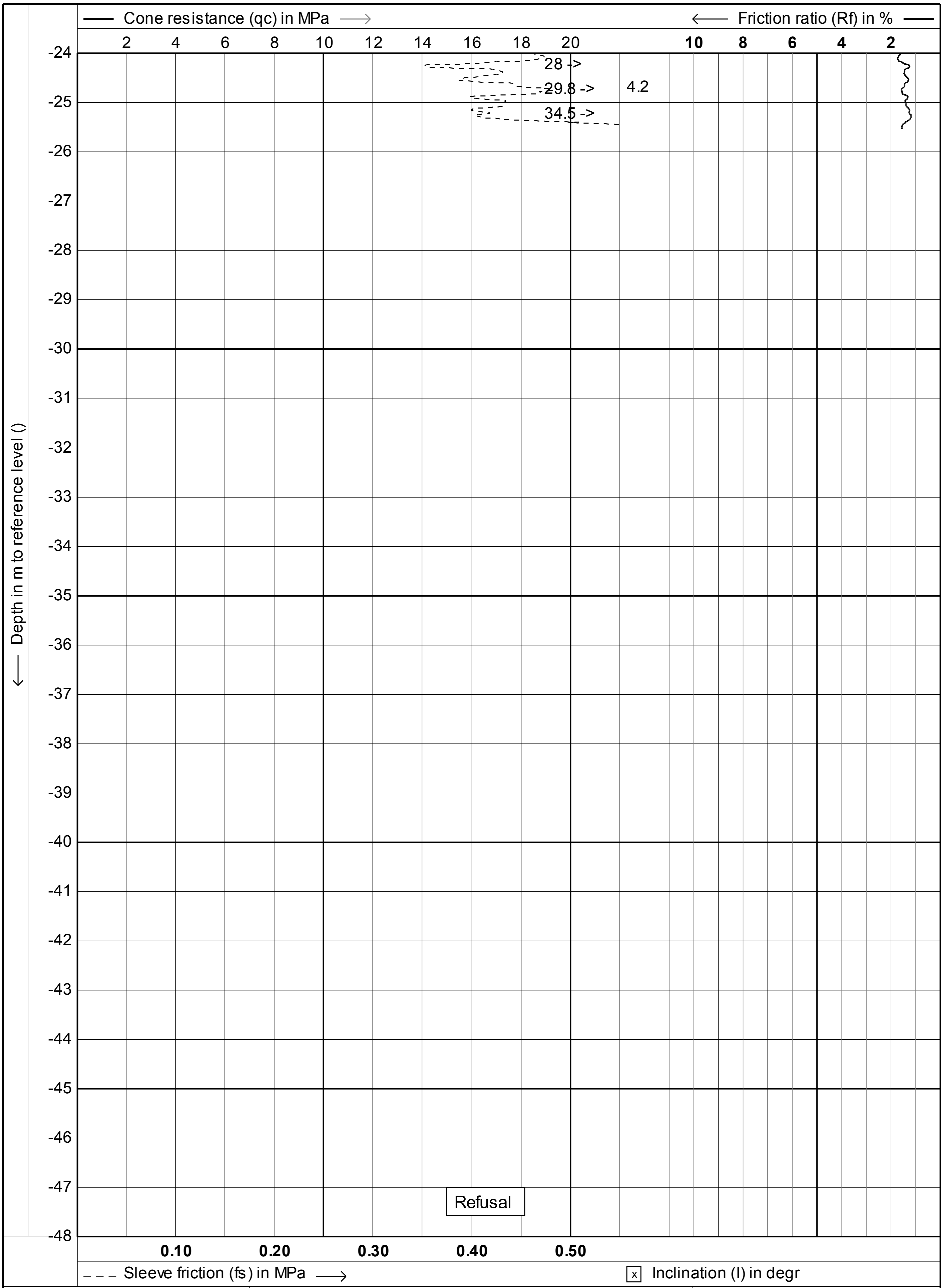
Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **14**

1/28



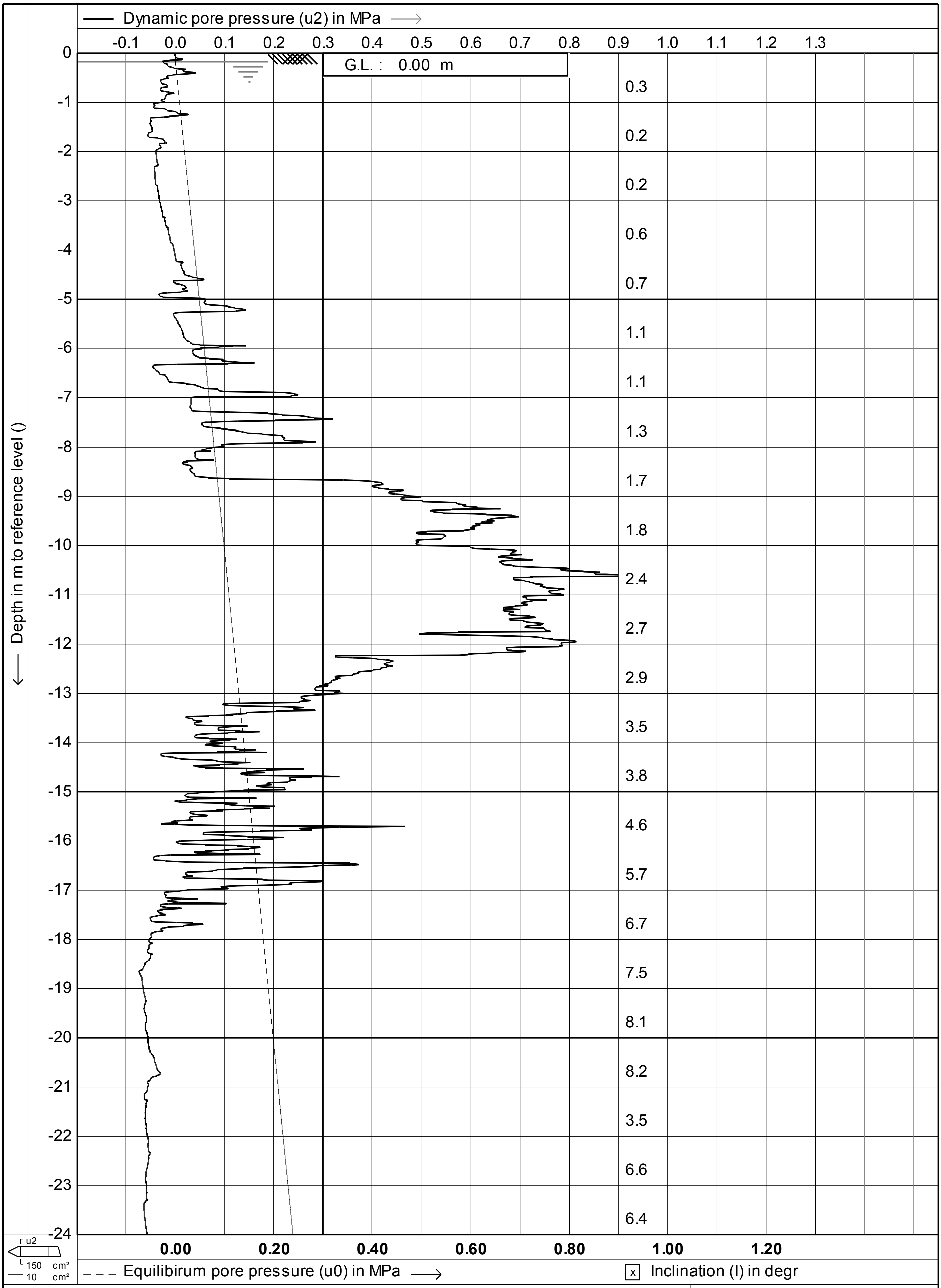
CPTask V1.26

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**
Cone no. : **C10CFIIP.F57**
Project no. : **02CGL7**
CPT no. : **14**
2/28



Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

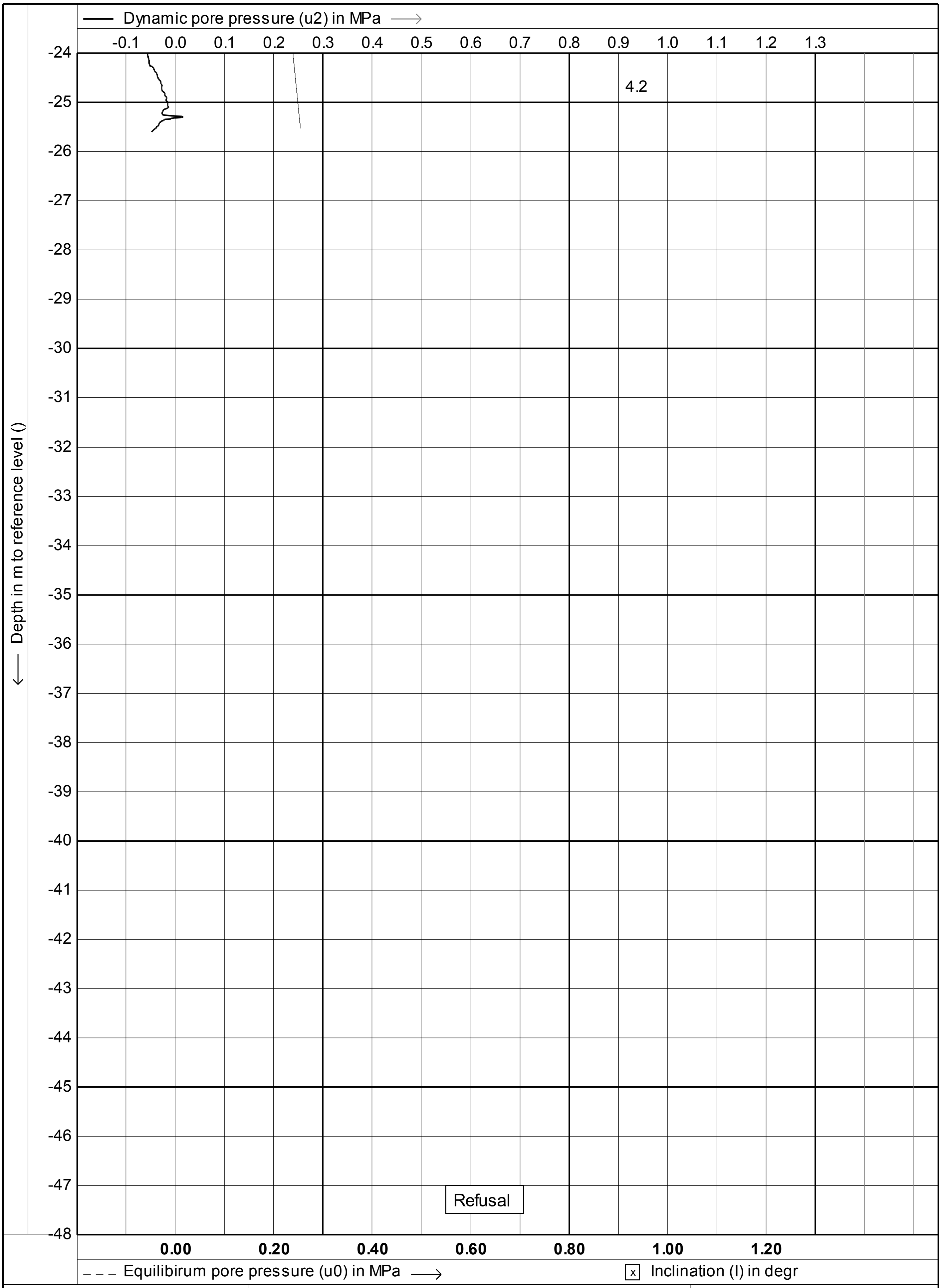
Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **14**

3/28

CPTask V1.26



CPTask V1.26

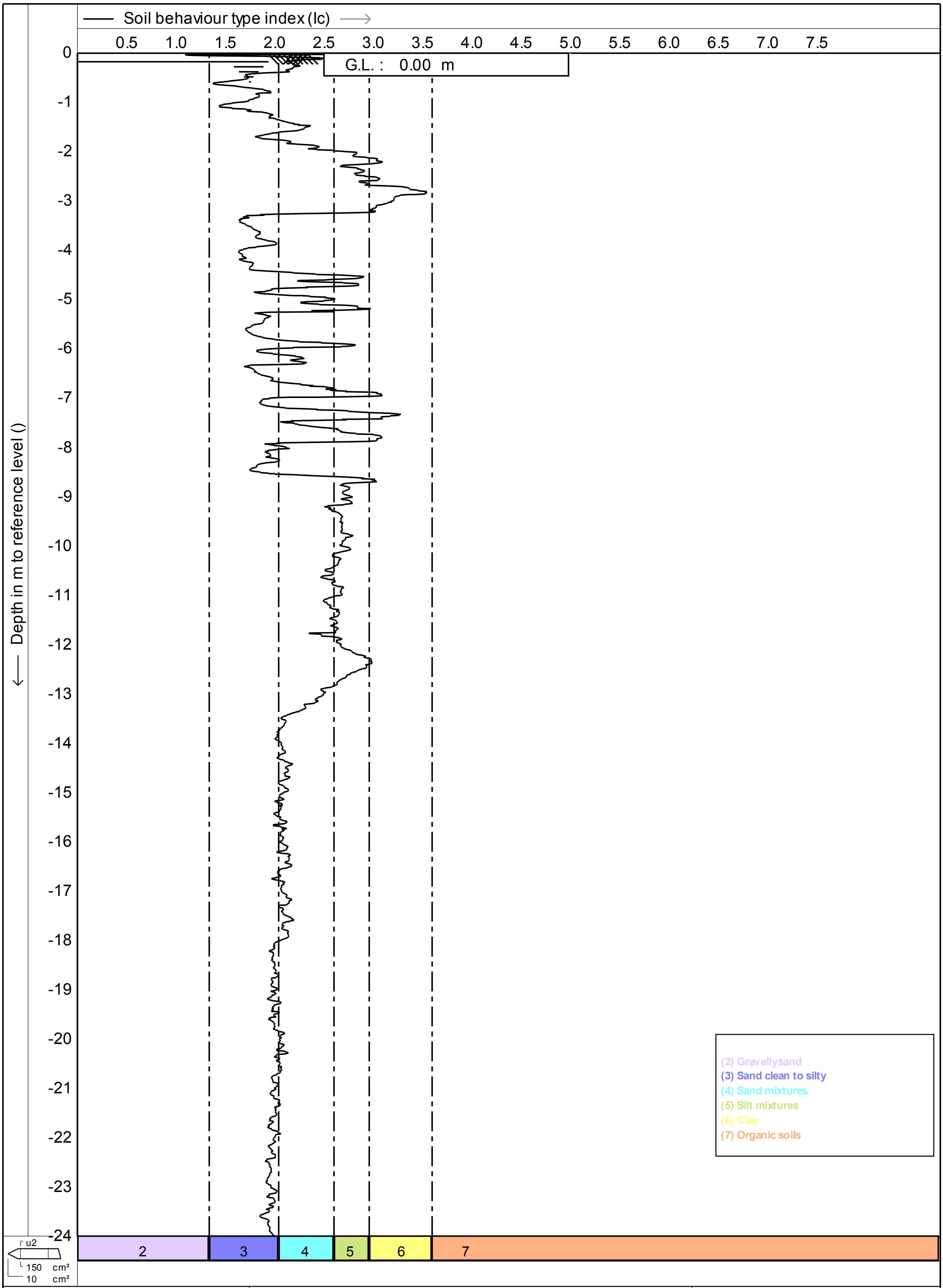
Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date	: **9-8-2011**
Cone no.	: **C10CFIIP.F57**
Project no.	: **02CGL7**
CPT no.	: **14**

4/28



CPTask V1.26

Perry DRILLING GEO PROBE
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

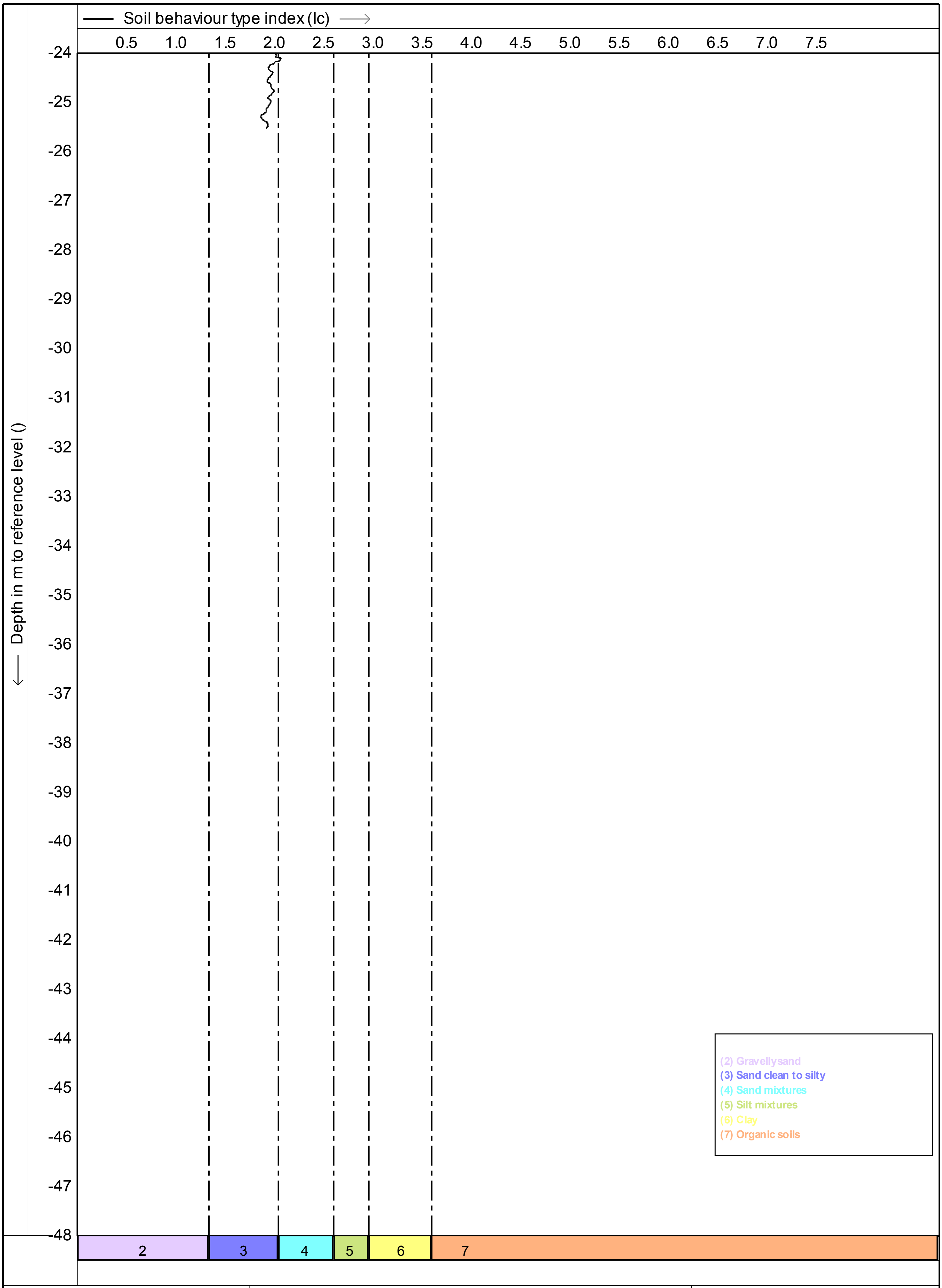
Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **14**

17/28



Perry DRILLING GEO PROBE
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Montgomerie Block - Hamilton Airport**

Location: **Middle Road - Hamilton**

Date : **9-8-2011**

Cone no. : **C10CFIIP.F57**

Project no. : **02CGL7**

CPT no. : **14**

coffey geotechnics

Engineering Log - Hand Auger

Hand Auger No. **S1**
Sheet 1 of 1
Project No: **GENZHAMI17003AA**

Client: **Bloxam Burnett & Olliver Limited**
Principal:
Project: **Montgomerie Block, Raynes Road, Hamilton**
Hand Auger location: **Refer to Site Plan**

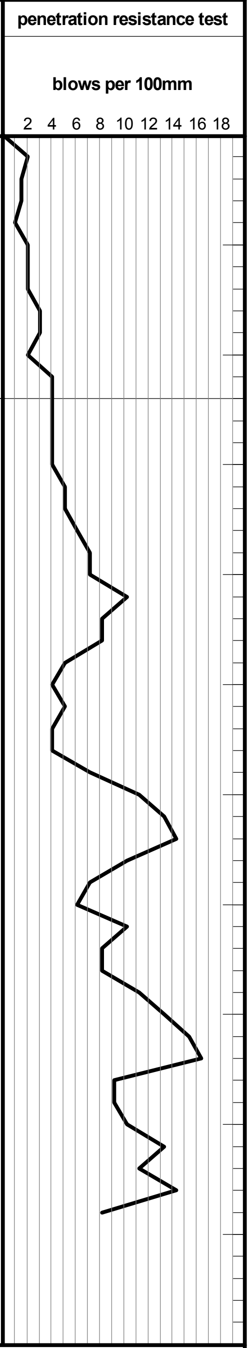
Date started: **10.8.2011**
Date completed: **10.8.2011**
Logged by: **TM**
Checked by: **KAL**

Dynamic penetrometer type: scala
Hole diameter: 100mm mm
Easting: 450264.23 m
Northing: 692137.2 m
Slope: -90°
Bearing:
R.L. Surface: 50.41 m
Datum: Moturiki Vertical 1953
Vane No: 4216 iiivi

drilling information | **material substance**

stratigraphy	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components, additional information.	moisture condition	consistency/ density index	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175
Hinuera Formation						OL	TOPSOIL; dark brown.	D	L	
						SM	Slightly silty fine SAND; light brown, poorly graded.			
			50.0	0.5		SP	Fine to coarse SAND; light brown, mottled orange, well graded.	M		
	▼		49.5	1.0					MD	
	10/08/11					SP	Fine to medium SAND; grey, well graded, pumicious.	S		
			49.0	1.5			- EOB @ 1.2m due to borehole collapse. Borehole S1 terminated at 1.2 metres.			
			48.5	2.0						
			48.0	2.5						
			47.5	3.0						
			47.0	3.5						
			46.5	4.0						
			46.0	4.5						
			45.5	5.0						
			45.0	5.5						

penetration resistance test



HAND AUGER SCALA 160811 S1 TO S5 BOREHOLES.GPJ COFFEY.GDT 13.9.11

classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

vane shear (kPa)
● remoulded
× peak
>>× peak greater than 200kPa
UTP unable to penetrate

water
▼ 10/1/98 water level on date shown
► water inflow
◄ water outflow

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft	VL	very loose
S	soft	L	loose
F	firm	MD	medium dense
St	stiff	D	dense
VSt	very stiff	VD	very dense
H	hard		

Form GEO 5.2 Rev.6

coffey geotechnics

Engineering Log - Hand Auger

Hand Auger No.	**S2**
Sheet	1 of 1
Project No:	***GENZHAMI17003AA***
Client:	***Bloxam Burnett & Olliver Limited***
Date started:	***10.8.2011***
Principal:	
Date completed:	***10.8.2011***
Project:	***Montgomerie Block, Raynes Road, Hamilton***
Logged by:	***TM***
Hand Auger location:	***Refer to Site Plan***
Checked by:	***KAL***

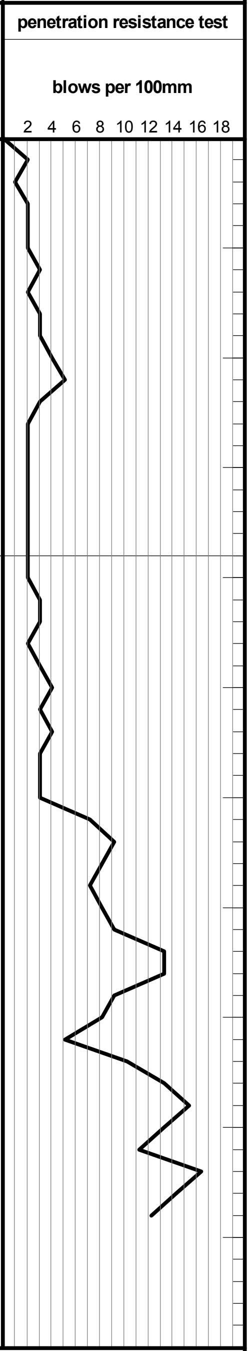
Dynamic penetrometer type: scala
Easting: 449830.94 m
Slope: -90°
R.L. Surface: 50.63 m
Vane No: 4216 iiivi

Hole diameter: 100mm mm
Northing: 692145.74 m
Bearing:
Datum: Moturiki Vertical 1953

drilling information | **material substance**

stratigraphy	water	notes samples, tests, etc	RL	depth metres	classification symbol	material Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components, additional information.	moisture condition	consistency/ density index	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175
Hinuera Formation			50.5		OL	TOPSOIL; dark brown.	M	L	
					SP	Fine to medium SAND; light orange brown, well graded, slight clumping of soil			
			50.0	0.5					
				1.0				MD	
	▼ 10/08/11		49.5					L	
				1.5	SP	Fine to medium SAND; grey, well graded, pumiceous.	S		
			49.0						
			48.5	2.0		- EOB @ 1.9m due to borehole collapse. Borehole S2 terminated at 1.9 metres.			
			48.0	2.5					
			47.5	3.0					
			47.0	3.5					
			46.5	4.0					
			46.0	4.5					
			45.5	5.0					
				5.5					

penetration resistance test



classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

vane shear (kPa)

●	remoulded
×	peak
>>×	peak greater than 200kPa
UTP	unable to penetrate

water

▼	10/1/98 water level on date shown
►	water inflow
◄	water outflow

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft	VL	very loose
S	soft	L	loose
F	firm	MD	medium dense
St	stiff	D	dense
VSt	very stiff	VD	very dense
H	hard		

coffey geotechnics

Engineering Log - Hand Auger

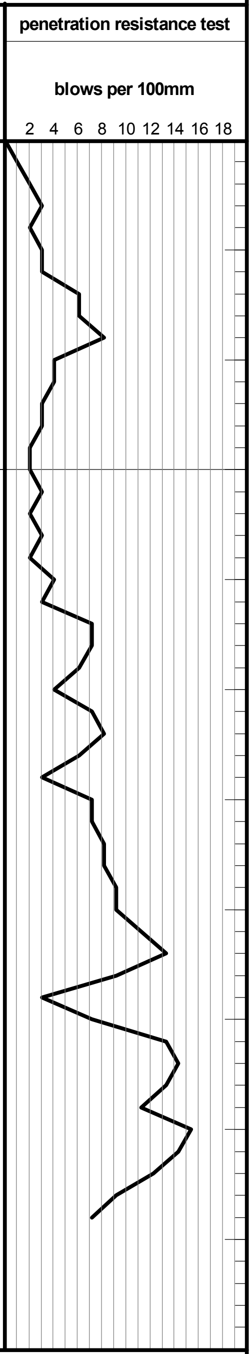
Hand Auger No.	***S3***
Sheet	1 of 1
Project No:	***GENZHAMI17003AA***
Client:	***Bloxam Burnett & Olliver Limited***
Principal:	
Project:	***Montgomerie Block, Raynes Road, Hamilton***
Hand Auger location:	***Refer to Site Plan***
Date started:	***10.8.2011***
Date completed:	***11.8.2011***
Logged by:	***TM***
Checked by:	***KAL***

Dynamic penetrometer type: scala | Easting: 449671.49 m | Slope: -90° | R.L. Surface: 50.49 m | Vane No: 4216 iiivi

Hole diameter: 100mm mm | Northing: 691773.71 m | Bearing: | Datum: Moturiki Vertical 1953

drilling information | **material substance**

stratigraphy	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	**material** Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components, additional information.	moisture condition	consistency/ density index	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175
Hinuera Formation						OL	TOPSOIL; dark brown.	M	L	
						SW	Fine SAND; orange brown, poorly graded.			
			50.0	0.5					MD	
						SP	Fine to medium SAND; grey, well graded, pumiceous.			
	▼ 10/08/11							S		
			49.5	1.0						
									L	
			49.0	1.5		SM	Silty fine SAND; grey, poorly graded.			
							- EOB @ 1.5m due to borehole collapse. Borehole S3 terminated at 1.5 metres.			
			48.5	2.0						
			48.0	2.5						
			47.5	3.0						
			47.0	3.5						
			46.5	4.0						
			46.0	4.5						
			45.5	5.0						
			45.0	5.5						



classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

vane shear (kPa)
- ● remoulded
- × peak
- >>× peak greater than 200kPa
- UTP unable to penetrate

water
- ▼ 10/1/98 water level on date shown
- ► water inflow
- ◄ water outflow

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft	VL	very loose
S	soft	L	loose
F	firm	MD	medium dense
St	stiff	D	dense
VSt	very stiff	VD	very dense
H	hard		

coffey geotechnics

Engineering Log - Hand Auger

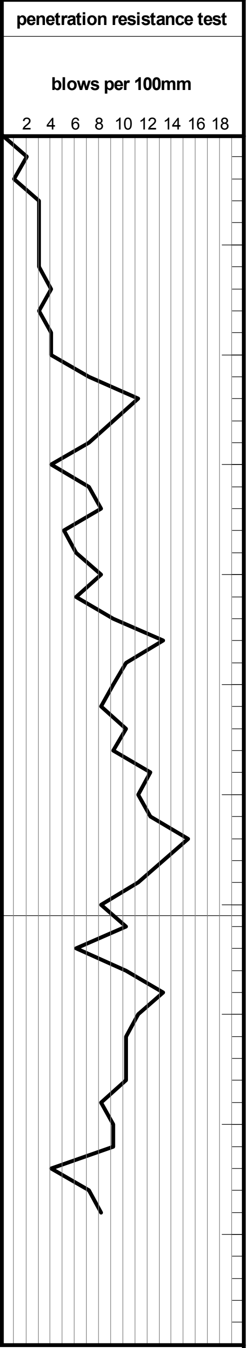
Hand Auger No.	**S4**
Sheet	1 of 1
Project No:	**GENZHAMI17003AA**
Client:	**Bloxam Burnett & Olliver Limited**
Principal:	
Project:	**Montgomerie Block, Raynes Road, Hamilton**
Hand Auger location:	**Refer to Site Plan**
Date started:	**10.8.2011**
Date completed:	**11.8.2011**
Logged by:	**TM**
Checked by:	**KAL**

Dynamic penetrometer type: scala
Easting: 449652.98 m
Slope: -90°
R.L. Surface: 52.03 m
Vane No: 4216 iiivi
Hole diameter: 100mm mm
Northing: 691299.5 m
Bearing:
Datum: Moturiki Vertical 1953

drilling information | **material substance**

stratigraphy	water	notes samples, tests, etc	RL	depth metres	classification symbol	material: Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components, additional information.	moisture condition	consistency/ density index
Hinuera Formation				0.0	OL	TOPSOIL; dark brown.	M	L
					SM	Silty medium SAND; orange brown, poorly graded, minor medium gravel.		MD
			51.5	0.5				
					SP	Medium to coarse gravelly SAND; orange brown, well graded, gravel fine to medium.		
			51.0	1.0				D
			50.5	1.5				MD
			50.0	2.0				D
			49.5	2.5		- becoming grey well graded sand lense		
			49.0	3.0				
	▼ 10/08/11		48.5	3.5			S	
						- EOB @ 3.55m due to borehole collapse. Borehole S4 terminated at 3.55 metres.		
			48.0	4.0				
			47.5	4.5				
			47.0	5.0				
				5.5				

vane shear (remoulded /peak) kPa: 25 50 75 100 125 150 175



classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

vane shear (kPa)
● remoulded
× peak
>>× peak greater than 200kPa
UTP unable to penetrate

water
▼ 10/1/98 water level on date shown
► water inflow
◄ water outflow

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft	VL	very loose
S	soft	L	loose
F	firm	MD	medium dense
St	stiff	D	dense
VSt	very stiff	VD	very dense
H	hard		

coffey geotechnics

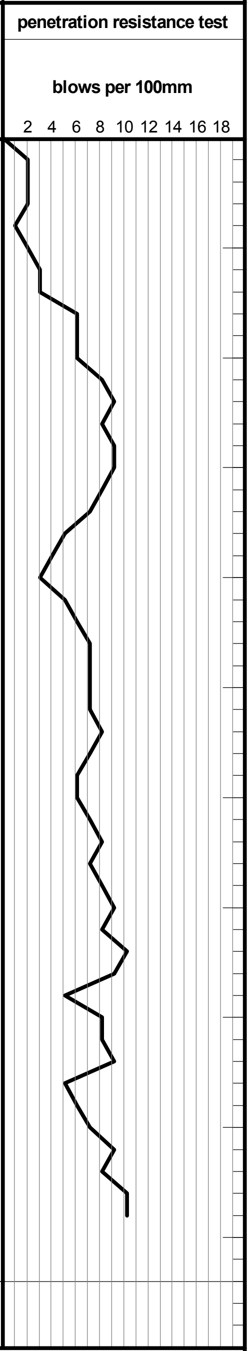
Engineering Log - Hand Auger

Hand Auger No.	**S5**
Sheet	1 of 1
Project No:	**GENZHAMI17003AA**
Client:	**Bloxam Burnett & Olliver Limited**
Principal:	
Project:	**Montgomerie Block, Raynes Road, Hamilton**
Hand Auger location:	**Refer to Site Plan**
Date started:	**10.8.2011**
Date completed:	**11.8.2011**
Logged by:	**TM**
Checked by:	**KAL**

Dynamic penetrometer type: scala	Easting: 449972.62 m	Slope: -90°	R.L. Surface: 52.57 m	Vane No: 4216 iiivi
Hole diameter: 100mm mm	Northing: 691187.45 m	Bearing:	Datum: Moturiki Vertical 1953	

drilling information | **material substance**

stratigraphy	water	notes samples, tests, etc	RL	depth metres	classification symbol	material: Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components, additional information.	moisture condition	consistency/ density index	vane shear (remoulded /peak) kPa
Hinura Formation	Groundwater not encountered		52.5		OL	TOPSOIL; dark brown.	M	L	
				0.5	SM	Silty medium SAND; orange brown, poorly graded, minor medium gravel.		MD	
			52.0 51.5 51.0 50.5 50.0	1.0 1.5 2.0 2.5	SP	Fine to medium SAND; brown, well graded, minor fine to medium gravel.		D MD	
			49.5 49.0 48.5 48.0	3.0 3.5 4.0 4.5	SP	Fine to medium SAND; greyish brown, well graded, trace fine to coarse gravel. - Alternating between greyish brown and brown.		D MD	
			47.5	5.0	SP	Medium to coarse gavelly SAND; orange brown, well graded, gravel fine to medium.		D	
				5.5		- EOB @ 5.2m due to borehole collapse. Borehole S5 terminated at 5.2 metres.			



classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

vane shear (kPa)

●	remoulded
×	peak
>>×	peak greater than 200kPa
UTP	unable to penetrate

water

▼	10/1/98 water level on date shown
►	water inflow
◄	water outflow

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft	VL	very loose
S	soft	L	loose
F	firm	MD	medium dense
St	stiff	D	dense
VSt	very stiff	VD	very dense
H	hard		

coffey geotechnics

Engineering Log - Machine Borehole

Client:	**Bloxam Burnett & Olliver Limited**	Machine Borehole No.	**MH01**
Principal:		Sheet	1 of 3
Project:	**Montgomerie Block, Raynes Road, Hamilton**	Project No:	**GENZHAMI17003AA**
Machine Borehole Location:	**Refer to site plan**	Date started:	**16.8.2011**
		Date completed:	**16.8.2011**
		Logged by:	**NO**
		Checked by:	**KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted | Easting: 450298.81 m | Slope: -90° | R.L. Surface: 50.20 m | Vane No: 4216/iiivi

Hole diameter: 90 mm | Drilling fluid: Biovis/Water | Northing: 692416.11 m | Bearing: | Datum: Moturiki Vertical 1953

drilling information

stratigraphy: Hinuera Formation

method: TT-HQC

support: N

water:
- ▼ 26/8/11 (P1)
- ▼ 26/8/11 (P2)

notes samples, tests, etc:
- SPT 9,8,5 N*=13
- SPT 2,3,1 N*=4
- SPT 8,9,11 N*=20
- SPT 2,9,10 N*=19

well details: P1 Response Zone; P2 Response Zone

RL: 50, 49, 48, 47, 46, 45, 44, 43, 42, 41

depth metres: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

material substance

classification symbol	material Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index
	TOPSOIL		MD
ML	Sandy SILT, fine; yellowish brown, no-plasticity.		
GW	GRAVEL; fine to coarse, loosely packed, well graded, sub-angular to sub-rounded, minor fine to coarse sand.		
ML	Sandy SILT, fine; olive grey, no-plasticity, pumiceous.		S to F
CL	Silty CLAY; olive grey, low plasticity with trace organic staining, trace fibrous, organic bands.		
SP	Silty fine SAND; olive grey, poorly graded, pumiceous - with trace fine sandy, organic, SILT layers and trace rootlets.		MD
SM	Fine to medium SAND; some silt, olive grey, loosely packed, well graded, some fine pumice gravels.		
SP	Fine to medium SAND; minor silt, grey, loosely packed, poorly graded, some fine pumice gravels.		
SP	Fine to coarse SAND; minor silt, grey, loosely packed, well graded, fine to medium gravels, with fine sand lenses.		

weathering | alteration | estimated strength: EW VW W MS S VS ES | vane shear (remoulded /peak) kPa: 25 50 75 100 125 150 175

rock mass defects

recovery %: 80, 56, 100, 63, 100, 56, 78

RQD %

defect description: number, type, orientation, shape, roughness, aperture, infill description (refer to defect description explanation sheet) — particular / general

method
- AD auger drilling
- OB open barrel
- TT triple tube
- W washbore

support
- N nil
- C casing

vane shear (kPa)
- ● remoulded
- × peak
- >>× peak greater than 200kPa
- UTP unable to penetrate

classification symbols and soil description

based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N*	SPT - sample recovered
Nc	SPT with solid cone
Bs	bulk sample
E	environmental sample

water
- ▼ 10/1/98 water level on date shown
- ► water inflow
- ◁ partial drill fluid loss
- ◄ complete drill fluid loss

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

weathering

UW	unweathered
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
CW	completely weathered
RS	residual soil

rock mass strength

EW	extremely weak
VW	very weak
W	weak
MS	moderately strong
S	strong
VS	very strong
ES	extremely strong

coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No. **MH01**

Sheet 2 of 3

Project No: **GENZHAMI17003AA**

Client: **Bloxam Burnett & Olliver Limited**

Principal:

Project: **Montgomerie Block, Raynes Road, Hamilton**

Machine Borehole Location: **Refer to site plan**

Date started: **16.8.2011**

Date completed: **16.8.2011**

Logged by: **NO**

Checked by: **KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted

Easting: 450298.81 m

Slope: -90°

R.L. Surface: 50.20 m

Vane No: 4216/iiivi

Hole diameter: 90 mm

Drilling fluid: Biovis/Water

Northing: 692416.11 m

Bearing:

Datum: Moturiki Vertical 1953

drilling information / material substance

stratigraphy	method	notes samples, tests, etc	well details	RL	depth metres	classification symbol	material	consistency/density index
Hinuera Formation	TT-HQN		P2 Response Zone	40	10.0	SP (cont)	Fine to coarse SAND; minor silt, grey, loosely packed, well graded, fine to medium gravels, with fine sand lenses. *(continued)*	MD
				39	11.25	ML	Sandy SILT, trace fine sand; olive brown, no-plasticity, sensitive, trace organic staining.	VSt
		SPT 0,2,0 N*=2		38	12			
		S1 (U60)						
		Vane Shear drilling disturbed		37	13			
				36	14	ML	SILT; trace fine sand, olive grey, no-plasticity.	F
		SPT 0,0,1 N*=1		35	15	ML	SILT; some fine sand, light olive grey, no-plasticity, micaceous.	F
		Vane Shear drilling disturbed		34	15.75	ML	SILT; light olive grey, low plasticity, sensitive. - with fine to medium sandy, poorly graded, silt lenses.	
				33	17	OL	Organic SILT; dark brown, homogenous, low plasticity, minor fibrous rootlets. - becoming brown, minor organic staining, trace rootlets.	
		SPT 0,0,0 N*=0		32	18			
Walton Subgroup				31	18.5	SM	Silty fine SAND; olive grey, moderately graded, pumiceous, minor fine pumice gravel. - fine to medium pumice gravel	D
					20			

moisture condition | weathering alteration | estimated strength EW VW W MS S VS ES | vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175

rock mass defects

recovery %	RQD %
78	
63	
60	
73	
100	
70	
100	
40	

defect description: number, type, orientation, shape, roughness, aperture, infill description (refer to defect description explanation sheet) particular general

method
AD auger drilling
OB open barrel
TT triple tube
W washbore

support
N nil
C casing

vane shear (kPa)
● remoulded
× peak
>>× peak greater than 200kPa
UTP unable to penetrate

classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N* SPT - sample recovered
Nc SPT with solid cone
Bs bulk sample
E environmental sample

water
▼ 10/1/98 water level on date shown
► water inflow
◁ partial drill fluid loss
◄ complete drill fluid loss

moisture
D dry
M moist
W wet
S saturated

consistency/ density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
VL very loose
L loose
MD medium dense
D dense
VD very dense

weathering
UW unweathered
SW slightly weathered
MW moderately weathered
HW highly weathered
CW completely weathered
RS residual soil

rock mass strength
EW extremely weak
VW very weak
W weak
MS moderately strong
S strong
VS very strong
ES extremely strong

coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No.	**MH01**
Sheet	3 of 3
Project No:	**GENZHAMI17003AA**
Client:	**Bloxam Burnett & Olliver Limited**
Principal:	
Project:	**Montgomerie Block, Raynes Road, Hamilton**
Machine Borehole Location:	**Refer to site plan**
Date started:	**16.8.2011**
Date completed:	**16.8.2011**
Logged by:	**NO**
Checked by:	**KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted
Easting: 450298.81 m
Slope: -90°
R.L. Surface: 50.20 m
Vane No: 4216/iiivi

Hole diameter: 90 mm
Drilling fluid: Biovis/Water
Northing: 692416.11 m
Bearing:
Datum: Moturiki Vertical 1953

drilling information								material substance									rock mass defects		
stratigraphy	method	support	water	**notes** samples, tests, etc	well details	RL	depth metres	graphic log core recovery	classification symbol	**material** Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index	weathering alteration	estimated strength EW VW W MS S VS ES	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175	recovery %	RQD %	**defect description** number, type, orientation, shape, roughness, aperture, infill description (refer to defect description explanation sheet) particular general
Walton Subgroup	TT-HQN					30			SM (*cont*)	Silty fine SAND; olive grey, moderately graded, pumiceous, minor fine pumice gravel. *(continued)*		D				40		
				SPT 13,21,23 N*=44		29	21		SM	Silty fine SAND; light olive grey, tightly packed, poorly graded, pumiceous, minor fine gravel.						73		
						28	22		SP	Coarse SAND; trace silt; olive/black, fine angular pumice gravel.								
									ML	SILT; trace fine sand, olive/grey (mottled), low plasticity, sensitive, iron stained.		St			● ×			
						27	23									100		
				SPT 3,5,8 N*=13		26	24		SM	Silty fine SAND; white, poorly graded, pumiceous.		MD				100		
										MH01 terminated at 24.45 metres.								
						25	25											
						24	26											
						23	27											
						22	28											
						21	29											
							30											

method

AD	auger drilling
OB	open barrel
TT	triple tube
W	washbore

support

N	nil
C	casing

vane shear (kPa)

●	remoulded
×	peak
>>×	peak greater than 200kPa
UTP	unable to penetrate

classification symbols and soil description

based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N*	SPT - sample recovered
Nc	SPT with solid cone
Bs	bulk sample
E	environmental sample

water

▼	10/1/98 water level on date shown
►	water inflow
◁	partial drill fluid loss
◀	complete drill fluid loss

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

weathering

UW	unweathered
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
CW	completely weathered
RS	residual soil

rock mass strength

EW	extremely weak
VW	very weak
W	weak
MS	moderately strong
S	strong
VS	very strong
ES	extremely strong

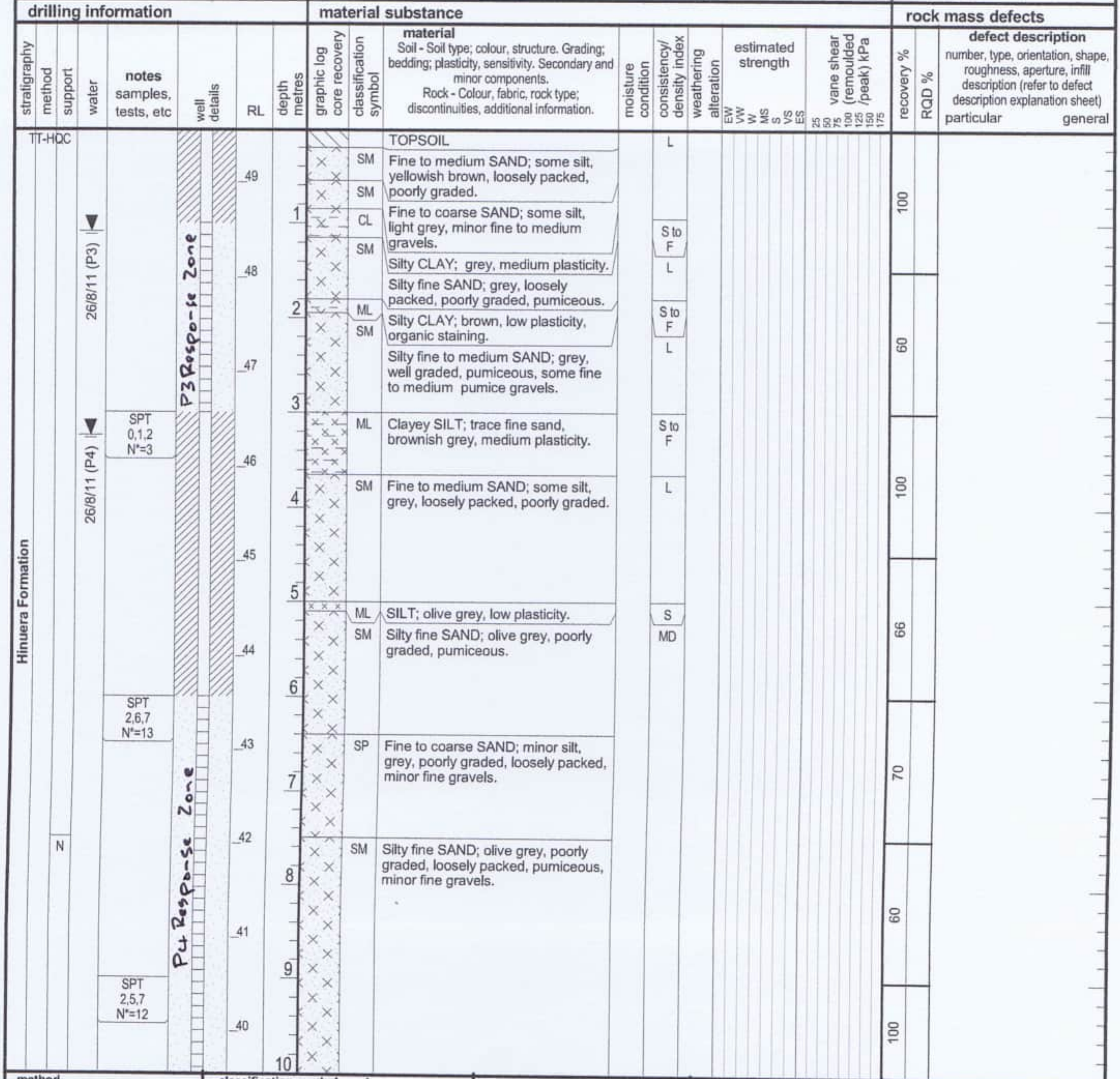
coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No. **MH02**

Sheet 1 of 4
Project No: **GENZHAMI17003AA**
Client: **Bloxam Burnett & Olliver Limited**
Date started: **15.8.2011**
Principal:
Date completed: **15.8.2011**
Project: **Montgomerie Block, Raynes Road, Hamilton**
Logged by: **NO**
Machine Borehole Location: **Refer to plan**
Checked by: **KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted
Easting: 449791.06 m
Slope: -90°
R.L. Surface: 49.57 m
Vane No: 4216/iiivi
Hole diameter: 90 mm
Drilling fluid: Biovis/Water
Northing: 692258.98 m
Bearing:
Datum: Moturiki Vertical 1953



classification symbol	material	consistency/ density index
	TOPSOIL	L
SM SM	Fine to medium SAND; some silt, yellowish brown, loosely packed, poorly graded.	
CL SM	Fine to coarse SAND; some silt, light grey, minor fine to medium gravels.	
	Silty CLAY; grey, medium plasticity.	S to F
	Silty fine SAND; grey, loosely packed, poorly graded, pumiceous.	L
ML SM	Silty CLAY; brown, low plasticity, organic staining.	S to F
	Silty fine to medium SAND; grey, well graded, pumiceous, some fine to medium pumice gravels.	L
ML	Clayey SILT; trace fine sand, brownish grey, medium plasticity.	S to F
SM	Fine to medium SAND; some silt, grey, loosely packed, poorly graded.	L
ML	SILT; olive grey, low plasticity.	S
SM	Silty fine SAND; olive grey, poorly graded, pumiceous.	MD
SP	Fine to coarse SAND; minor silt, grey, poorly graded, loosely packed, minor fine gravels.	
SM	Silty fine SAND; olive grey, poorly graded, loosely packed, pumiceous, minor fine gravels.	

Notes, samples, tests:

SPT 0,1,2 N*=3

SPT 2,6,7 N*=13

SPT 2,5,7 N*=12

Recovery %: 100, 60, 100, 66, 70, 60, 100

method		classification symbols and soil description		water		consistency/ density index		weathering	
AD	auger drilling	based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005		▼	10/1/98 water level on date shown	VS	very soft	UW	unweathered
OB	open barrel			►	water inflow	S	soft	SW	slightly weathered
TT	triple tube	**notes, samples, tests**		◁	partial drill fluid loss	F	firm	MW	moderately weathered
W	washbore	U_{50}	undisturbed sample 50mm diameter	◀	complete drill fluid loss	St	stiff	HW	highly weathered
support		U_{63}	undisturbed sample 63mm diameter			VSt	very stiff	CW	completely weathered
N	nil	D	disturbed sample	**moisture**		H	hard	RS	residual soil
C	casing	N*	SPT - sample recovered	D	dry	VL	very loose	**rock mass strength**	
vane shear (kPa)		Nc	SPT with solid cone	M	moist	L	loose	EW	extremely weak
●	remoulded	Bs	bulk sample	W	wet	MD	medium dense	VW	very weak
×	peak	E	environmental sample	S	saturated	D	dense	W	weak
>>×	peak greater than 200kPa					VD	very dense	MS	moderately strong
UTP	unable to penetrate							S	strong
								VS	very strong
								ES	extremely strong

coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No. **MH02**
Sheet 2 of 4
Project No: **GENZHAMI17003AA**
Date started: **15.8.2011**
Date completed: **15.8.2011**
Logged by: **NO**
Checked by: **KAL**

Client: **Bloxam Burnett & Olliver Limited**
Principal:
Project: **Montgomerie Block, Raynes Road, Hamilton**
Machine Borehole Location: **Refer to plan**

Drill model & mounting: Edson (Mark 2), Marooka Mounted
Easting: 449791.06 m
Slope: -90°
R.L. Surface: 49.57 m
Vane No: 4216/iiivi
Hole diameter: 90 mm
Drilling fluid: Biovis/Water
Northing: 692258.98 m
Bearing:
Datum: Moturiki Vertical 1953

stratigraphy	method	notes samples, tests, etc	well details	RL	depth metres	classification symbol	material description	consistency/ density index	vane shear (remoulded /peak) kPa	recovery %
Hinuera Formation	TT-HQN		P4 Response Zone			SM (cont)		MD		100
				39		ML	SILT; olive brown, low plasticity, minor organic staining.	St		100
				38	11	SM	Silty fine SAND; olive grey, poorly graded, loosely packed, pumiceous.	L		
		SPT 1,1,1 N*=2		37	12					76
		S1 (U60)			13					
				36		SM	Fine to medium SAND; some silt, olive grey, poorly graded, loosely packed, iron stained.			100
				35	14	SM	Silty fine SAND; light grey, poorly graded, loosely packed, pumiceous.			
		SPT 2,4,6 N*=10		34	15					90
Hamilton Ash				33	16	CL	Silty CLAY; dark olive brown, medium plasticity, moderately sensitive, organic staining.	St	● ×	
				32	17	CL	Silty CLAY; light yellowish brown, medium plasticity, sensitive.			100
		SPT 0,1,2 N*=3			18				● ×	
Walton Subgroup		S1 (U60)		31		CL	Silty CLAY; white with orange flecks, medium plasticity, sensitive.			100
				30	19	SM	Silty fine SAND; white, poorly graded, loosely packed, pumiceous.	L	● ×	63
					20					

method
AD auger drilling
OB open barrel
TT triple tube
W washbore

support
N nil
C casing

vane shear (kPa)
● remoulded
× peak
>>× peak greater than 200kPa
UTP unable to penetrate

classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N* SPT - sample recovered
Nc SPT with solid cone
Bs bulk sample
E environmental sample

water
▼ 10/1/98 water level on date shown
► water inflow
◁ partial drill fluid loss
◄ complete drill fluid loss

moisture
D dry
M moist
W wet
S saturated

consistency/ density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
VL very loose
L loose
MD medium dense
D dense
VD very dense

weathering
UW unweathered
SW slightly weathered
MW moderately weathered
HW highly weathered
CW completely weathered
RS residual soil

rock mass strength
EW extremely weak
VW very weak
W weak
MS moderately strong
S strong
VS very strong
ES extremely strong

coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No. **MH02**
Sheet 3 of 4
Project No: **GENZHAMI17003AA**

Client:	**Bloxam Burnett & Olliver Limited**	Date started:	**15.8.2011**
Principal:		Date completed:	**15.8.2011**
Project:	**Montgomerie Block, Raynes Road, Hamilton**	Logged by:	**NO**
Machine Borehole Location:	**Refer to plan**	Checked by:	**KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted — Easting: 449791.06 m — Slope: -90° — R.L. Surface: 49.57 m — Vane No: 4216/iiivi

Hole diameter: 90 mm — Drilling fluid: Biovis/Water — Northing: 692258.98 m — Bearing: — Datum: Moturiki Vertical 1953

stratigraphy	method	notes samples, tests, etc	RL	depth metres	classification symbol	material	consistency/ density index	recovery %
Walton Subgroup	TT-HQN		29		SM *(cont)*	Silty fine SAND; white, poorly graded, loosely packed, pumiceous. *(continued)*	L	63
		SPT 8,11,11 N*=22	28	21	ML	Sandy SILT, fine sand; brown, low plasticity, extra sensitive, minor organic inclusions, pumiceous.	VSt	100
				22	SM	Silty fine SAND; white, poorly graded, tightly packed, pumiceous.	MD	
			27	23	SM OL	Silty fine SAND; olive grey, poorly graded, tightly packed, pumiceous. Organic clayey SILT; black, low plasticity, amorphous.	St	56
		SPT 1,1,1 N*=2	26 25 24	24 25 26	SM CL	Silty fine SAND; olive grey, poorly graded, minor fine gravels, pumiceous. Silty CLAY; light grey, low plasticity, sensitive, trace rootlets. - with interbedded fine sandy pumiceous lenses.	St H	100 100
		SPT 6,15,16 N*=31	23	27	SM	Silty fine SAND; pale grey, poorly graded, pumiceous, with olive grey silt lenses.	D	
			22	28	SP	Fine to coarse SAND; grey, well graded, tightly packed, some fine pumice/rhyolite gravels.		100
			21 20	29 30	SM	Silty fine SAND; grey, poorly graded, tightly packed, pumiceous. - interbedded fine to medium sand lenses.		100

method
AD auger drilling
OB open barrel
TT triple tube
W washbore

support
N nil
C casing

vane shear (kPa)
● remoulded
× peak
>>× peak greater than 200kPa
UTP unable to penetrate

classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N* SPT - sample recovered
Nc SPT with solid cone
Bs bulk sample
E environmental sample

water
▼ 10/1/98 water level on date shown
► water inflow
◁ partial drill fluid loss
◄ complete drill fluid loss

moisture
D dry
M moist
W wet
S saturated

consistency/ density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
VL very loose
L loose
MD medium dense
D dense
VD very dense

weathering
UW unweathered
SW slightly weathered
MW moderately weathered
HW highly weathered
CW completely weathered
RS residual soil

rock mass strength
EW extremely weak
VW very weak
W weak
MS moderately strong
S strong
VS very strong
ES extremely strong

coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No. **MH02**

Sheet	4 of 4
Project No:	**GENZHAMI17003AA**
Client:	**Bloxam Burnett & Olliver Limited**
Principal:	
Project:	**Montgomerie Block, Raynes Road, Hamilton**
Machine Borehole Location:	**Refer to plan**
Date started:	**15.8.2011**
Date completed:	**15.8.2011**
Logged by:	**NO**
Checked by:	**KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted
Easting: 449791.06 m
Slope: -90°
R.L. Surface: 49.57 m
Vane No: 4216/iiivi

Hole diameter: 90 mm
Drilling fluid: Biovis/Water
Northing: 692258.98 m
Bearing:
Datum: Moturiki Vertical 1953

drilling information								material substance									rock mass defects		
stratigraphy	method	support	water	**notes** samples, tests, etc	well details	RL	depth metres	graphic log core recovery	classification symbol	**material** Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index	weathering alteration	estimated strength EW VW W MS S VS ES	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175	recovery %	RQD %	**defect description** number, type, orientation, shape, roughness, aperture, infill description (refer to defect description explanation sheet) particular	general
	TT-HQN			SPT 16,17,22 N*=39					SM (cont)	Silty fine SAND; grey, poorly graded, tightly packed, pumiceous. *(continued)*		D				100			
						19				MH02 terminated at 30.45 metres.									
							31												
						18													
							32												
						17													
							33												
						16													
							34												
						15													
							35												
						14													
							36												
						13													
							37												
						12													
							38												
						11													
							39												
						10													
							40												

method

AD	auger drilling
OB	open barrel
TT	triple tube
W	washbore

support

N	nil
C	casing

vane shear (kPa)

●	remoulded
×	peak
>>×	peak greater than 200kPa
UTP	unable to penetrate

classification symbols and soil description

based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N*	SPT - sample recovered
Nc	SPT with solid cone
Bs	bulk sample
E	environmental sample

water

▼	10/1/98 water level on date shown
►	water inflow
◁	partial drill fluid loss
◀	complete drill fluid loss

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

weathering

UW	unweathered
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
CW	completely weathered
RS	residual soil

rock mass strength

EW	extremely weak
VW	very weak
W	weak
MS	moderately strong
S	strong
VS	very strong
ES	extremely strong

coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No.	*MH03*
Sheet	1 of 3
Project No:	*GENZHAMI17003AA*
Client:	***Bloxam Burnett & Olliver Limited***
Principal:	
Project:	***Montgomerie Block, Raynes Road, Hamilton***
Machine Borehole Location:	***Refer to plan***
Date started:	***17.8.2011***
Date completed:	***17.8.2011***
Logged by:	***NO***
Checked by:	***KAL***

Drill model & mounting: Edson (Mark 2), Marooka Mounted
Easting: 450037.03 m
Slope: -90°
R.L. Surface: 51.78 m
Vane No: 4216/iiivi

Hole diameter: 90 mm
Drilling fluid: Biovis/Water
Northing: 691898.22 m
Bearing:
Datum: Moturiki Vertical 1953

drilling information | **material substance** | **rock mass defects**

stratigraphy	method	support	water	notes samples, tests, etc	well details	RL	depth metres	graphic log core recovery	classification symbol	material Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index	weathering alteration	estimated strength EW VW W MS S VS ES	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175	recovery %	RQD %	defect description number, type, orientation, shape, roughness, aperture, infill description (refer to defect explanation sheet) particular general
Hinuera Formation	TT-HQC									TOPSOIL								
									SM	Fine to medium SAND; minor silt, yellowish brown, well graded, loosely packed, some fine rhyolite gravel.		VL to L						
						51	1		SM	Fine to coarse SAND; minor silt, grey, well graded, loosely packed, some fine to medium rhyolite gravel.						73		
				SPT 1,1,1 N*=2	PS Response Zone	50	2											
			26/8/11 (P5)						ML	Sandy SILT, fine; brown, no-plasticity, pumiceous.		S				100		
				SPT 2,3,4 N*=7		49	3		SM	Silty fine SAND; light grey, poorly graded, loosely packed, pumiceous. - with interbedded fine pumiceous silt/gravel lenses and fine to coarse gravelly lenses		L				100		
						48	4											
						47	5									60		
		N		SPT 1,1,2 N*=3		46	6											
			26/8/11 (P6)						ML	SILT; pale grey, medium plasticity.		F						
						45	7		ML	SILT; trace fine sand, pale grey, low plasticity, pumiceous.						86		
									SM	Silty fine SAND; grey, poorly graded, loosely packed, pumiceous. - with some pumice gravels		L						
						44	8									80		
						43	9											
				SPT 1,3,4 N*=7					ML	SILT; trace fine sand, grey, low plasticity, pumiceous.		St				100		
						42	10		ML	SILT; greyish brown, low plasticity,								

method

AD	auger drilling
OB	open barrel
TT	triple tube
W	washbore

support

N	nil
C	casing

vane shear (kPa)

●	remoulded
×	peak
>>×	peak greater than 200kPa
UTP	unable to penetrate

classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N*	SPT - sample recovered
Nc	SPT with solid cone
Bs	bulk sample
E	environmental sample

water

▼	10/1/98 water level on date shown
►	water inflow
◁	partial drill fluid loss
◀	complete drill fluid loss

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

weathering

UW	unweathered
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
CW	completely weathered
RS	residual soil

rock mass strength

EW	extremely weak
VW	very weak
W	weak
MS	moderately strong
S	strong
VS	very strong
ES	extremely strong

coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No. **MH03**

Sheet 2 of 3
Project No: **GENZHAMI17003AA**
Date started: **17.8.2011**
Date completed: **17.8.2011**
Logged by: **NO**
Checked by: **KAL**

Client: **Bloxam Burnett & Olliver Limited**
Principal:
Project: **Montgomerie Block, Raynes Road, Hamilton**
Machine Borehole Location: **Refer to plan**

Drill model & mounting: Edson (Mark 2), Marooka Mounted
Easting: 450037.03 m
Slope: -90°
R.L. Surface: 51.78 m
Vane No: 4216/iiivi
Hole diameter: 90 mm
Drilling fluid: Biovis/Water
Northing: 691898.22 m
Bearing:
Datum: Moturiki Vertical 1953

drilling information / material substance / rock mass defects

Stratigraphy: Hinuera Formation
Method/support: TT-HQN
Well details: Pb Response Zone (18.0–20.0 m)

depth metres	RL	notes samples, tests, etc	classification symbol	material: Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index	vane shear (remoulded /peak) kPa	recovery %
10.0			OH (cont)	minor organic. Organic silty CLAY; dark brown, homogenous, medium plasticity, sensitive, amorphous, organic inclusions. *(continued)*		St		100
10.5						St	● ×	
10.8	41							100
11								
11.8	40							
12		SPT 0,2,2 N*=4					● ×	80
12.8	39							
13								
13.5			ML	SILT; light bluish grey, medium plasticity.			● ×	76
13.8	38							
14								
14.8	37							
15		SPT 40,27,8 N*=35 S1 (U60)	SM	Silty fine SAND; grey, poorly graded, tightly packed, pumiceous.		D		100
15.8	36							
16								
16.4			OH	Organic silty CLAY; dark brown, homogenous, medium plasticity, amorphous, organic inclusions.		St		100
16.8	35							
17			CL	Silty CLAY; trace fine sand, olive grey, medium plasticity, micaceous.				
17.8	34							
18		SPT 10,10,14 N*=24	SM	Fine silty SAND; olive grey, poorly graded, tightly packed, major fine to coarse pumice gravels, pumiceous.		MD		100
18.8	33							
19								
19.8	32							100
20								

estimated strength: EW VW W MS S VS ES
vane shear scale: 25 50 75 100 125 150 175

rock mass defects — defect description: number, type, orientation, shape, roughness, aperture, infill description (refer to defect description explanation sheet) particular general

method
AD auger drilling
OB open barrel
TT triple tube
W washbore

support
N nil
C casing

vane shear (kPa)
● remoulded
× peak
>>× peak greater than 200kPa
UTP unable to penetrate

classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N* SPT - sample recovered
Nc SPT with solid cone
Bs bulk sample
E environmental sample

water
10/1/98 water level on date shown
water inflow
partial drill fluid loss
complete drill fluid loss

moisture
D dry
M moist
W wet
S saturated

consistency/ density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
VL very loose
L loose
MD medium dense
D dense
VD very dense

weathering
UW unweathered
SW slightly weathered
MW moderately weathered
HW highly weathered
CW completely weathered
RS residual soil

rock mass strength
EW extremely weak
VW very weak
W weak
MS moderately strong
S strong
VS very strong
ES extremely strong

coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No.	***MH03***
Sheet	3 of 3
Project No:	***GENZHAMI17003AA***
Date started:	***17.8.2011***
Date completed:	***17.8.2011***
Logged by:	***NO***
Checked by:	***KAL***

Client:	***Bloxam Burnett & Olliver Limited***
Principal:	
Project:	***Montgomerie Block, Raynes Road, Hamilton***
Machine Borehole Location:	***Refer to plan***

Drill model & mounting: Edson (Mark 2), Marooka Mounted
Easting: 450037.03 m
Slope: -90°
R.L. Surface: 51.78 m
Vane No: 4216/iiivi
Hole diameter: 90 mm
Drilling fluid: Biovis/Water
Northing: 691898.22 m
Bearing:
Datum: Moturiki Vertical 1953

drilling information | **material substance** | **rock mass defects**

stratigraphy	method	support	water	notes samples, tests, etc	well details	RL	depth metres	graphic log core recovery	classification symbol	material Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index	weathering alteration	estimated strength EW VW W MS S VS ES	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175	recovery %	RQD %	defect description number, type, orientation, shape, roughness, aperture, infill description (refer to defect description explanation sheet) particular general
Hinuera Formation	TT-HQ	N			P6 Response Zone	31	21		SM *(cont)*	Fine silty SAND; olive grey, poorly graded, tightly packed, major fine to coarse pumice gravels, pumiceous. *(continued)*		MD				100		
				SPT 17,22,28 N*=50		30	22					D				100		
						29	23									100		
				SPT 15,20,26 N*=46		28	24									100		
						27	25									100		
						26	26									100		
				SPT 18,30,20 N*=50		25	27									100		
						24	28			MH03 terminated at 27.45 metres.								
						23	29											
						22	30											

method
AD auger drilling
OB open barrel
TT triple tube
W washbore

support
N nil
C casing

vane shear (kPa)
● remoulded
× peak
>>× peak greater than 200kPa
UTP unable to penetrate

classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N* SPT - sample recovered
Nc SPT with solid cone
Bs bulk sample
E environmental sample

water
▼ 10/1/98 water level on date shown
► water inflow
◁ partial drill fluid loss
◀ complete drill fluid loss

moisture
D dry
M moist
W wet
S saturated

consistency/ density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
VL very loose
L loose
MD medium dense
D dense
VD very dense

weathering
UW unweathered
SW slightly weathered
MW moderately weathered
HW highly weathered
CW completely weathered
RS residual soil

rock mass strength
EW extremely weak
VW very weak
W weak
MS moderately strong
S strong
VS very strong
ES extremely strong

coffey geotechnics

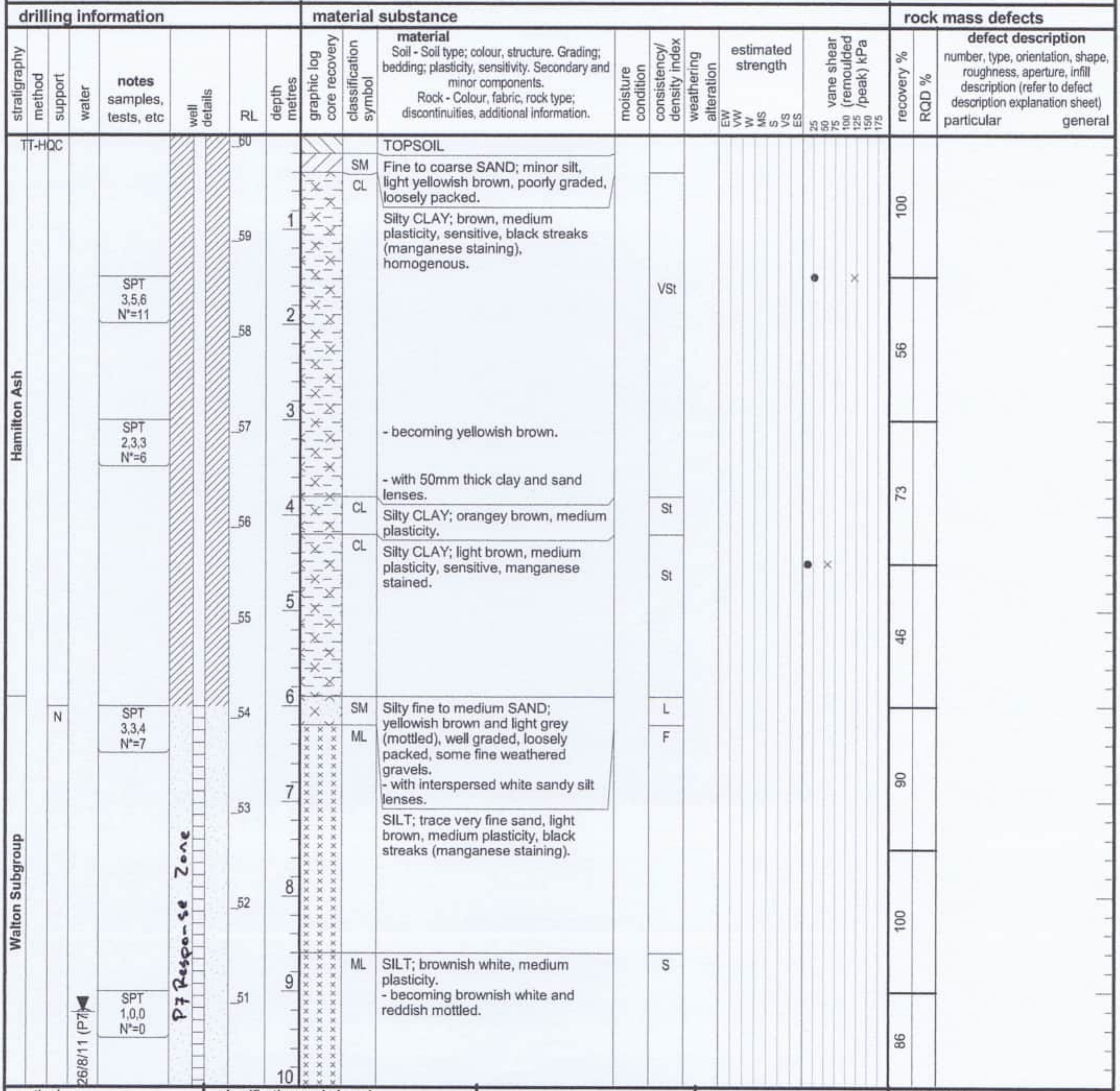
Machine Borehole No. **MH04**

Engineering Log - Machine Borehole

Client:	**Bloxam Burnett & Olliver Limited**	Sheet	1 of 3
		Project No:	**GENZHAMI17003AA**
Principal:		Date started:	**18.8.2011**
		Date completed:	**18.8.2011**
Project:	**Montgomerie Block, Raynes Road, Hamilton**	Logged by:	**NO**
Machine Borehole Location:	**Refer to plan**	Checked by:	**KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted | Easting: 449993.41 m | Slope: -90° | R.L. Surface: 60.13 m | Vane No: 4216/iiivi

Hole diameter: 90 mm | Drilling fluid: Biovis/Water | Northing: 691557.43 m | Bearing: | Datum: Moturiki Vertical 1953



drilling information | **material substance** | **rock mass defects**

material Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.

defect description number, type, orientation, shape, roughness, aperture, infill description (refer to defect explanation sheet)

Method: TT-HQC

stratigraphy	classification symbol	material	consistency/ density index
Hamilton Ash		TOPSOIL	
	SM	Fine to coarse SAND; minor silt, light yellowish brown, poorly graded, loosely packed.	
	CL	Silty CLAY; brown, medium plasticity, sensitive, black streaks (manganese staining), homogenous. - becoming yellowish brown. - with 50mm thick clay and sand lenses.	VSt
	CL	Silty CLAY; orangey brown, medium plasticity.	St
	CL	Silty CLAY; light brown, medium plasticity, sensitive, manganese stained.	St
Walton Subgroup	SM	Silty fine to medium SAND; yellowish brown and light grey (mottled), well graded, loosely packed, some fine weathered gravels. - with interspersed white sandy silt lenses.	L
	ML	SILT; trace very fine sand, light brown, medium plasticity, black streaks (manganese staining).	F
	ML	SILT; brownish white, medium plasticity. - becoming brownish white and reddish mottled.	S

RL	depth metres
60	
59	1
58	2
57	3
56	4
55	5
54	6
53	7
52	8
51	9
	10

Notes, samples, tests:
SPT 3,5,6 N*=11
SPT 2,3,3 N*=6
SPT 3,3,4 N*=7
SPT 1,0,0 N*=0

Support: N

Water: 26/8/11 (P7)

P7 Response Zone

Recovery %: 100, 56, 73, 46, 90, 100, 86

method		classification symbols and soil description		water		consistency/ density index		weathering	
AD	auger drilling	based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005		▼	10/1/98 water level on date shown	VS	very soft	UW	unweathered
OB	open barrel			►	water inflow	S	soft	SW	slightly weathered
TT	triple tube			◁	partial drill fluid loss	F	firm	MW	moderately weathered
W	washbore			◀	complete drill fluid loss	St	stiff	HW	highly weathered
support		**notes, samples, tests**				VSt	very stiff	CW	completely weathered
N	nil	U_{50}	undisturbed sample 50mm diameter			H	hard	RS	residual soil
C	casing	U_{63}	undisturbed sample 63mm diameter			VL	very loose	**rock mass strength**	
vane shear (kPa)		D	disturbed sample	**moisture**		L	loose	EW	extremely weak
●	remoulded	N*	SPT - sample recovered	D	dry	MD	medium dense	VW	very weak
×	peak	Nc	SPT with solid cone	M	moist	D	dense	W	weak
>>×	peak greater than 200kPa	Bs	bulk sample	W	wet	VD	very dense	MS	moderately strong
UTP	unable to penetrate	E	environmental sample	S	saturated			S	strong
								VS	very strong
								ES	extremely strong

PIEZOMETER - MACHINE 17003AA MONTGOMERIE FARM BORELOGS.GPJ COFFEY.GDT 7.11.11

Form GEO 5.3 Rev.6

Engineering Log - Machine Borehole

Machine Borehole No.	**MH04**
Sheet	2 of 3
Project No:	**GENZHAMI17003AA**
Date started:	**18.8.2011**
Date completed:	**18.8.2011**
Logged by:	**NO**
Checked by:	**KAL**

Client: **Bloxam Burnett & Olliver Limited**

Principal:

Project: **Montgomerie Block, Raynes Road, Hamilton**

Machine Borehole Location: **Refer to plan**

Drill model & mounting: Edson (Mark 2), Marooka Mounted	Easting: 449993.41 m	Slope: -90°	R.L. Surface: 60.13 m	Vane No: 4216/iiivi
Hole diameter: 90 mm Drilling fluid: Biovis/Water	Northing: 691557.43 m	Bearing:	Datum: Moturiki Vertical 1953	

drilling information / material substance

stratigraphy	method	depth metres	RL	notes samples, tests, etc	well details	classification symbol	material	consistency/ density index
Walton Subgroup	TT-HQN	10.1 – 12.1	50 – 48			ML (cont)	SILT; brownish white, medium plasticity. - becoming brownish white and reddish mottled. *(continued)*	S
		12.1 – 16.6	48 – 43.5	SPT 0,0,0 N*=0 - equip failure (no SPT)	P7 Response Zone	ML	SILT; white, low plasticity, sensitive with fine sandy silt and thin interspersed fine to medium pumiceous sand lenses.	F
		16.6 – 20	43.5 – 40.1	SPT 0,0,0 N*=0		ML	Sandy SILT, fine; pale greyish brown, low plasticity, sensitive, minor weathered pumice gravels, trace mica.	F

vane shear (remoulded /peak) kPa: ● × (about 13.6 m); ● × (about 19.6 m)

rock mass defects

recovery %: 86, 100, 100, 100, 80, 100, 100, 100

method		classification symbols and soil description		water		consistency/ density index		weathering	
AD	auger drilling	based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005		▼	10/1/98 water level on date shown	VS	very soft	UW	unweathered
OB	open barrel			►	water inflow	S	soft	SW	slightly weathered
TT	triple tube	**notes, samples, tests**		◁	partial drill fluid loss	F	firm	MW	moderately weathered
W	washbore	U_{50}	undisturbed sample 50mm diameter	◀	complete drill fluid loss	St	stiff	HW	highly weathered
support		U_{63}	undisturbed sample 63mm diameter			VSt	very stiff	CW	completely weathered
N	nil	D	disturbed sample	**moisture**		H	hard	RS	residual soil
C	casing	N*	SPT - sample recovered	D	dry	VL	very loose	**rock mass strength**	
vane shear (kPa)		Nc	SPT with solid cone	M	moist	L	loose	EW	extremely weak
●	remoulded	Bs	bulk sample	W	wet	MD	medium dense	VW	very weak
×	peak	E	environmental sample	S	saturated	D	dense	W	weak
>>×	peak greater than 200kPa					VD	very dense	MS	moderately strong
UTP	unable to penetrate							S	strong
								VS	very strong
								ES	extremely strong

coffey geotechnics

Machine Borehole No. **MH04**

Engineering Log - Machine Borehole

Sheet 3 of 3
Project No: **GENZHAMI17003AA**

Client: **Bloxam Burnett & Olliver Limited**
Principal:
Project: **Montgomerie Block, Raynes Road, Hamilton**
Machine Borehole Location: **Refer to plan**

Date started: **18.8.2011**
Date completed: **18.8.2011**
Logged by: **NO**
Checked by: **KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted
Easting: 449993.41 m
Slope: -90°
R.L. Surface: 60.13 m
Vane No: 4216/iiivi
Hole diameter: 90 mm
Drilling fluid: Biovis/Water
Northing: 691557.43 m
Bearing:
Datum: Moturiki Vertical 1953

drilling information								material substance								rock mass defects		
stratigraphy	method	support	water	notes samples, tests, etc	well details	RL	depth metres	graphic log core recovery	classification symbol	material Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index	weathering alteration	estimated strength EW VW W MS S VS ES	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175	recovery %	RQD %	defect description number, type, orientation, shape, roughness, aperture, infill description (refer to defect description explanation sheet) particular general
Walton Subgroup	TT-HQN					40			ML (cont)	Sandy SILT, fine; pale greyish brown, low plasticity, sensitive, minor weathered pumice gravels, trace mica. *(continued)*		F				100		
				SPT 0,0,0 N*=0		39	21					S			●×	100		
				S1 (U60)		38	22											
						37	23									100		
									ML	Fine silty SAND; pale brown, poorly graded, tightly packed, some fine to medium highly weathered pumice gravel.		MD						
				SPT 4,7,10 N*=17		36	24											
						35	25									93		
				SPT 9,15,16 N*=31												100		
						34	26			MH04 terminated at 25.95 metres.								
						33	27											
						32	28											
						31	29											
							30											

method
AD auger drilling
OB open barrel
TT triple tube
W washbore

support
N nil
C casing

vane shear (kPa)
● remoulded
× peak
>>× peak greater than 200kPa
UTP unable to penetrate

classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N* SPT - sample recovered
Nc SPT with solid cone
Bs bulk sample
E environmental sample

water
▼ 10/1/98 water level on date shown
► water inflow
◁ partial drill fluid loss
◀ complete drill fluid loss

moisture
D dry
M moist
W wet
S saturated

consistency/ density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
VL very loose
L loose
MD medium dense
D dense
VD very dense

weathering
UW unweathered
SW slightly weathered
MW moderately weathered
HW highly weathered
CW completely weathered
RS residual soil

rock mass strength
EW extremely weak
VW very weak
W weak
MS moderately strong
S strong
VS very strong
ES extremely strong

PIEZOMETER - MACHINE 17003AA MONTGOMERIE FARM BORELOGS.GPJ COFFEY.GDT 7.11.11

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Engineering Log - Machine Borehole

Machine Borehole No. **MH05**
Sheet 1 of 3
Project No: **GENZHAMI17003AA**

Client: **Bloxam Burnett & Olliver Limited**
Principal:
Project: **Montgomerie Block, Raynes Road, Hamilton**
Machine Borehole Location: **Refer to plan**

Date started: **17.8.2011**
Date completed: **17.8.2011**
Logged by: **NO**
Checked by: **KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted
Easting: 449625.59 m
Slope: -90°
R.L. Surface: 61.68 m
Vane No: 4216/iiivi
Hole diameter: 90 mm
Drilling fluid: Biovis/Water
Northing: 691385.55 m
Bearing:
Datum: Moturiki Vertical 1953

drilling information								material substance								rock mass defects		
stratigraphy	method	support	water	notes samples, tests, etc	well details	RL	depth metres	classification symbol	material Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index	weathering alteration	estimated strength EW VW W MS S VS ES	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175	recovery %	RQD %	defect description number, type, orientation, shape, roughness, aperture, infill description (refer to defect description explanation sheet) particular	general
Hamilton Ash	TT-HQC								TOPSOIL						90			
						61	1	CL	Silty CLAY; yellowish brown, medium plasticity.		F							
								CL CL	Silty CLAY; yellowish brown/light brown (mottled), medium plasticity, some mica.									
				SPT 0,1,1 N*=2		60	2		Silty CLAY; brown, medium plasticity.						93			
						59	3		- becoming yellowish brown									
				SPT 2,4,5 N*=9		58	4	CL	Silty CLAY; pale pinkish brown mottled yellowish brown, medium plasticity.						80			
								ML	SILT, fine to medium sandy; reddish brown/light yellowish brown (mottled), low plasticity.									
Walton Subgroup			17/8/11 ▼			57 56	5 6	SM	Silty fine to medium SAND; yellowish white mottled pinkish brown, loosely packed, poorly graded, with some manganese nodules.		L				80			
		N		SPT 5,4,5 N*=9		55	7								93			
						54		CL-ML	SILT; white, flecked pink, medium plasticity.		S				73			
						53	8 9	ML	Sandy SILT, fine; light grey, no-plasticity.		S							
				SPT 0,1,0 N*=1		52		ML	SILT; trace fine sand, light brownish white, no-plasticity.		S				83			
							10	ML			S							

method

AD	auger drilling
OB	open barrel
TT	triple tube
W	washbore

support

N	nil
C	casing

vane shear (kPa)

●	remoulded
×	peak
>>×	peak greater than 200kPa
UTP	unable to penetrate

classification symbols and soil description
based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N*	SPT - sample recovered
Nc	SPT with solid cone
Bs	bulk sample
E	environmental sample

water

▼	10/1/98 water level on date shown
►	water inflow
◁	partial drill fluid loss
◀	complete drill fluid loss

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

weathering

UW	unweathered
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
CW	completely weathered
RS	residual soil

rock mass strength

EW	extremely weak
VW	very weak
W	weak
MS	moderately strong
S	strong
VS	very strong
ES	extremely strong

coffey geotechnics

Engineering Log - Machine Borehole

Machine Borehole No. ***MH05***

Sheet	2 of 3
Project No:	***GENZHAMI17003AA***
Client:	***Bloxam Burnett & Olliver Limited***
Date started:	***17.8.2011***
Principal:	
Date completed:	***17.8.2011***
Project:	***Montgomerie Block, Raynes Road, Hamilton***
Logged by:	***NO***
Machine Borehole Location:	***Refer to plan***
Checked by:	***KAL***

Drill model & mounting: Edson (Mark 2), Marooka Mounted	Easting: 449625.59 m	Slope: -90°	R.L. Surface: 61.68 m	Vane No: 4216/iiivi
Hole diameter: 90 mm	Drilling fluid: Biovis/Water	Northing: 691385.55 m	Bearing:	Datum: Moturiki Vertical 1953

drilling information								material substance								rock mass defects		
stratigraphy	method	support	water	notes samples, tests, etc	well details	RL	depth metres	graphic log core recovery	classification symbol	material Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index	weathering alteration	estimated strength EW VW W MS S VS ES	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175	recovery %	RQD %	defect description number, type, orientation, shape, roughness, aperture, infill description (refer to defect explanation sheet) particular general
Walton Subgroup	TT	HQN							ML (cont)	Sandy SILT, fine; light olive grey, low plasticity, pumiceous. *(continued)* - becoming light brownish white with some highly weathered fine pumice gravel.		S				83		
						51												
							11											
									SM	Silty fine SAND; light grey, poorly graded, tightly packed, with highly weathered fine to coarse pumice gravel.		MD				93		
						50												
							12											
				SPT 4,5,7 N*=12												100		
						49												
							13											
						48												
							14									100		
						47												
				SPT 9,12,15 N*=27			15											
						46										100		
							16											
						45												
							17									100		
						44												
				SPT 6,11,15 N*=26			18											
						43										100		
							19											
						42										100		
							20											

method

AD	auger drilling
OB	open barrel
TT	triple tube
W	washbore

support

N	nil
C	casing

vane shear (kPa)

●	remoulded
×	peak
>>×	peak greater than 200kPa
UTP	unable to penetrate

classification symbols and soil description

based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N*	SPT - sample recovered
Nc	SPT with solid cone
Bs	bulk sample
E	environmental sample

water

▼	10/1/98 water level on date shown
►	water inflow
◁	partial drill fluid loss
◀	complete drill fluid loss

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

weathering

UW	unweathered
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
CW	completely weathered
RS	residual soil

rock mass strength

EW	extremely weak
VW	very weak
W	weak
MS	moderately strong
S	strong
VS	very strong
ES	extremely strong

Engineering Log - Machine Borehole

Machine Borehole No. **MH05**

Sheet	3 of 3
Project No:	**GENZHAMI17003AA**
Client:	**Bloxam Burnett & Olliver Limited**
Date started:	**17.8.2011**
Principal:	
Date completed:	**17.8.2011**
Project:	**Montgomerie Block, Raynes Road, Hamilton**
Logged by:	**NO**
Machine Borehole Location:	**Refer to plan**
Checked by:	**KAL**

Drill model & mounting: Edson (Mark 2), Marooka Mounted — Easting: 449625.59 m — Slope: -90° — R.L. Surface: 61.68 m — Vane No: 4216/iiivi

Hole diameter: 90 mm — Drilling fluid: Biovis/Water — Northing: 691385.55 m — Bearing: — Datum: Moturiki Vertical 1953

drilling information								material substance									rock mass defects			
stratigraphy	method	support	water	notes samples, tests, etc	well details	RL	depth metres	graphic log core recovery	classification symbol	material Soil - Soil type; colour, structure. Grading; bedding; plasticity, sensitivity. Secondary and minor components. Rock - Colour, fabric, rock type; discontinuities, additional information.	moisture condition	consistency/ density index	weathering	alteration	estimated strength EW VW W MS S VS ES	vane shear (remoulded /peak) kPa 25 50 75 100 125 150 175	recovery %	RQD %	defect description number, type, orientation, shape, roughness, aperture, infill description (refer to defect description explanation sheet) particular	general
	TT-HQN					41	21	× × × × × ×	SM *(cont)*	Silty fine SAND; light grey, poorly graded, tightly packed, with highly weathered fine to coarse pumice gravel. *(continued)*		MD					100			
						40	22			MH05 terminated at 21 metres.										
						39	23													
						38	24													
						37	25													
						36	26													
						35	27													
						34	28													
						33	29													
						32	30													

method

AD	auger drilling
OB	open barrel
TT	triple tube
W	washbore

support

N	nil
C	casing

vane shear (kPa)

●	remoulded
×	peak
>>×	peak greater than 200kPa
UTP	unable to penetrate

classification symbols and soil description

based on Field Description of Soil and Rock, New Zealand Geotechnical Society Inc 2005

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N*	SPT - sample recovered
Nc	SPT with solid cone
Bs	bulk sample
E	environmental sample

water

▼	10/1/98 water level on date shown
►	water inflow
◁	partial drill fluid loss
◀	complete drill fluid loss

moisture

D	dry
M	moist
W	wet
S	saturated

consistency/ density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

weathering

UW	unweathered
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
CW	completely weathered
RS	residual soil

rock mass strength

EW	extremely weak
VW	very weak
W	weak
MS	moderately strong
S	strong
VS	very strong
ES	extremely strong

CLIENT: BBO Ltd
LOCATION: Montgomerie Block

JOB NUMBER: GENZHAMI17003AA
DATE: 31-Oct-11

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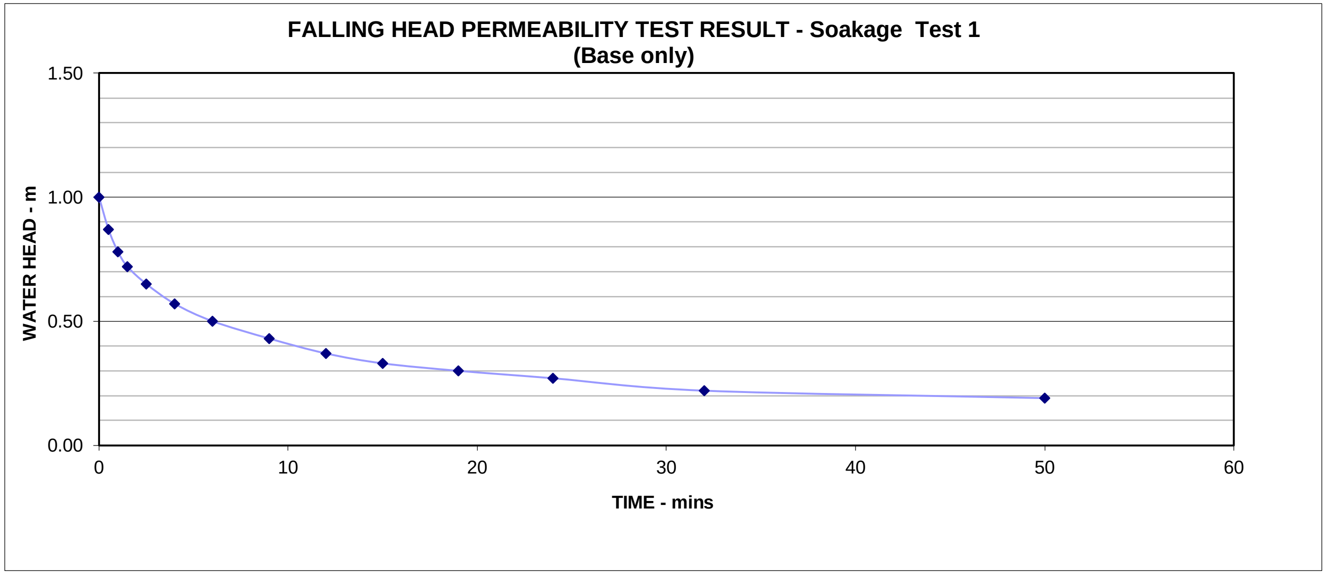

FALLING HEAD PERMEABILITY TEST RESULT - Soakage Test 1
(Base only)

STRATIGRAPHIC LOG

Refer to S1

E.O.B @ 1.2 metres

HVORSLEV CASE C:
Soakage out base of test hole only with no overlying restrictive layer:

$$\text{Hydraulic conductivity (k)} = \frac{\text{PI . D}}{11 . (t2 - t1)} \text{ x ln } \frac{H1}{H2}$$

where
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

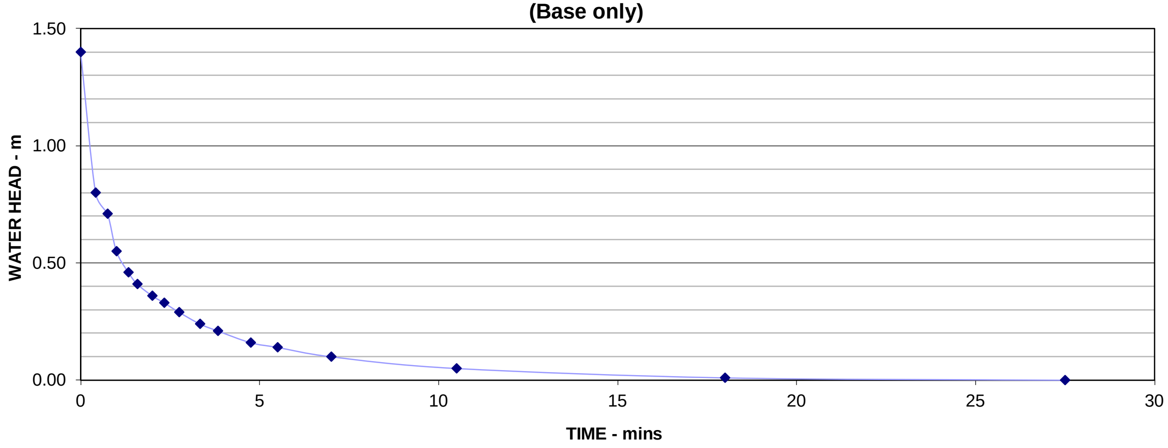
Standing groundwater level before test (metres): 1 m

Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	1.00		
0.50	30	0.13	0.87	0.14	1.33E-04
1.00	30	0.22	0.78	0.11	1.04E-04
1.50	30	0.28	0.72	0.08	7.62E-05
2.50	60	0.35	0.65	0.10	4.87E-05
4.00	90	0.43	0.57	0.13	4.17E-05
6.00	120	0.50	0.50	0.13	3.12E-05
9.00	180	0.57	0.43	0.15	2.39E-05
12.00	180	0.63	0.37	0.15	2.38E-05
15.00	180	0.67	0.33	0.11	1.82E-05
19.00	240	0.70	0.30	0.10	1.13E-05
24.00	300	0.73	0.27	0.11	1.00E-05
32.00	480	0.78	0.22	0.20	1.22E-05
50.00	1080	0.81	0.19	0.15	3.88E-06

CLIENT: BBO Ltd
LOCATION: Montgomerie Block

JOB NUMBER: GENZHAMI17003AA
DATE: 31-Oct-11

FALLING HEAD PERMEABILITY TEST RESULT - Soakage Test 2
(Base only)



STRATIGRAPHIC LOG

Refer to S2

E.O.B @ 1.9 metres

HVORSLEV CASE C:
Soakage out base of test hole only with no overlying restrictive layer:

Hydraulic conductivity (k) = $\frac{PI\ .\ D}{11\ .\ (t2 - t1)}$ x ln $\frac{H1}{H2}$

where
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

Standing groundwater level before test (metres): 1.4 m

Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	1.40		
0.42	25	0.60	0.80	0.56	6.39E-04
0.75	20	0.69	0.71	0.12	1.70E-04
1.00	15	0.85	0.55	0.26	4.86E-04
1.33	20	0.94	0.46	0.18	2.55E-04
1.58	15	0.99	0.41	0.12	2.19E-04
2.00	25	1.04	0.36	0.13	1.49E-04
2.33	20	1.07	0.33	0.09	1.24E-04
2.75	25	1.11	0.29	0.13	1.48E-04
3.33	35	1.16	0.24	0.19	1.54E-04
3.83	30	1.19	0.21	0.13	1.27E-04
4.75	55	1.24	0.16	0.27	1.41E-04
5.50	45	1.26	0.14	0.13	8.47E-05
7.00	90	1.30	0.10	0.34	1.07E-04
10.50	210	1.35	0.05	0.69	9.43E-05
18.00	450	1.39	0.01	1.61	1.02E-04
27.50	570	1.40	0.00	#DIV/0!	#DIV/0!

CLIENT: BBO Ltd
LOCATION: Montgomerie Block

JOB NUMBER: GENZHAMI17003AA
DATE: 31-Oct-11

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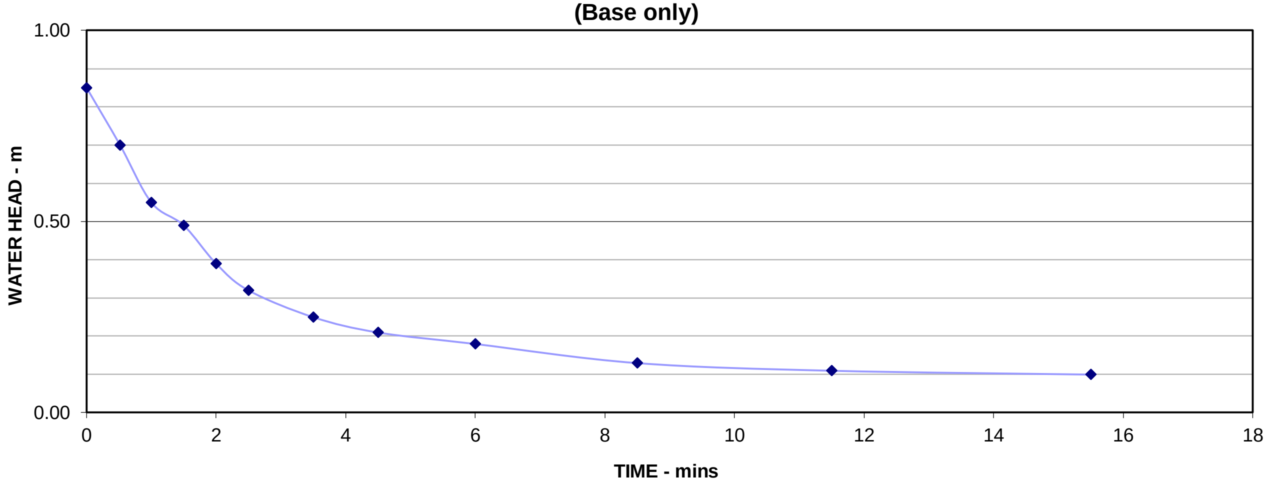
FALLING HEAD PERMEABILITY TEST RESULT - Soakage Test 3
(Base only)



STRATIGRAPHIC LOG

Refer to S3

E.O.B @ 1.5 metres

HVORSLEV CASE C:
Soakage out base of test hole only with no overlying restrictive layer:

Hydraulic conductivity (k) $= \dfrac{PI\ .\ D}{11\ .\ (t2 - t1)} \times \ln \dfrac{H1}{H2}$

where
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

Standing groundwater level before test (metres): 0.85 m

Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	0.85		
0.52	31	0.15	0.70	0.19	1.79E-04
1.00	29	0.30	0.55	0.24	2.38E-04
1.50	30	0.36	0.49	0.12	1.10E-04
2.00	30	0.46	0.39	0.23	2.17E-04
2.50	30	0.53	0.32	0.20	1.88E-04
3.50	60	0.60	0.25	0.25	1.18E-04
4.50	60	0.64	0.21	0.17	8.30E-05
6.00	90	0.67	0.18	0.15	4.89E-05
8.50	150	0.72	0.13	0.33	6.20E-05
11.50	180	0.74	0.11	0.17	2.65E-05
15.50	240	0.75	0.10	0.10	1.13E-05

CLIENT: BBO Ltd
LOCATION: Montgomerie Block

JOB NUMBER: GENZHAMI17003AA
DATE: 31-Oct-11

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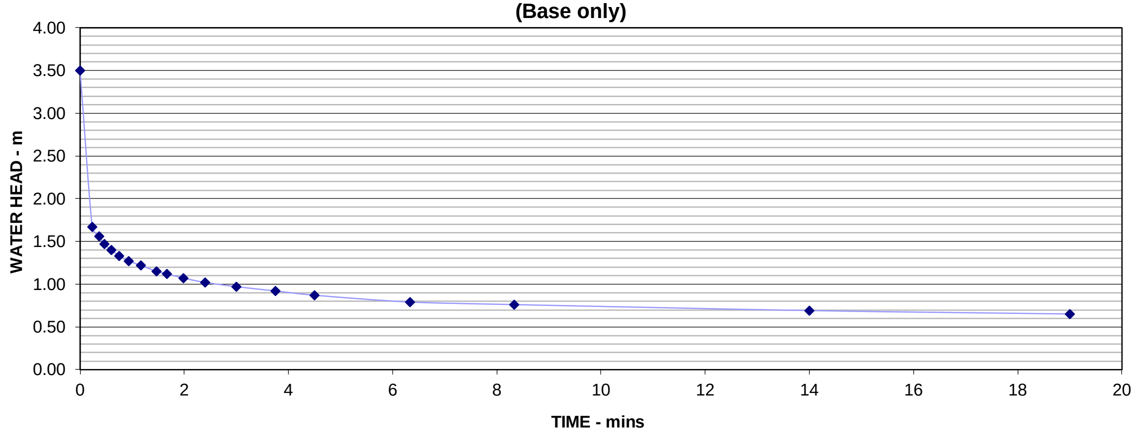
FALLING HEAD PERMEABILITY TEST RESULT - Soakage Test 4
(Base only)



STRATIGRAPHIC LOG

Refer to S4

E.O.B @ 3.55 metres

HVORSLEV CASE C:
Soakage out base of test hole only with no overlying restrictive layer:

$$\text{Hydraulic conductivity (k)} = \frac{PI\ .\ D}{11\ .\ (t2 - t1)} \times \ln \frac{H1}{H2}$$

where
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

Standing groundwater level before test (metres): 3.5 m

Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	3.50		
0.23	14	1.83	1.67	0.74	1.51E-03
0.37	8	1.94	1.56	0.07	2.43E-04
0.47	6	2.03	1.47	0.06	2.83E-04
0.60	8	2.10	1.40	0.05	1.74E-04
0.75	9	2.17	1.33	0.05	1.63E-04
0.93	11	2.23	1.27	0.05	1.20E-04
1.17	14	2.28	1.22	0.04	8.19E-05
1.47	18	2.35	1.15	0.06	9.38E-05
1.67	12	2.38	1.12	0.03	6.29E-05
1.98	19	2.43	1.07	0.05	6.86E-05
2.40	25	2.48	1.02	0.05	5.47E-05
3.00	36	2.53	0.97	0.05	3.99E-05
3.75	45	2.58	0.92	0.05	3.36E-05
4.50	45	2.63	0.87	0.06	3.55E-05
6.33	110	2.71	0.79	0.10	2.50E-05
8.33	120	2.74	0.76	0.04	9.21E-06
14	340	2.81	0.69	0.10	8.12E-06
19	300	2.85	0.65	0.06	5.69E-06

CLIENT: BBO Ltd
LOCATION: Montgomerie Block

JOB NUMBER: GENZHAMI17003AA
DATE: 31-Oct-11

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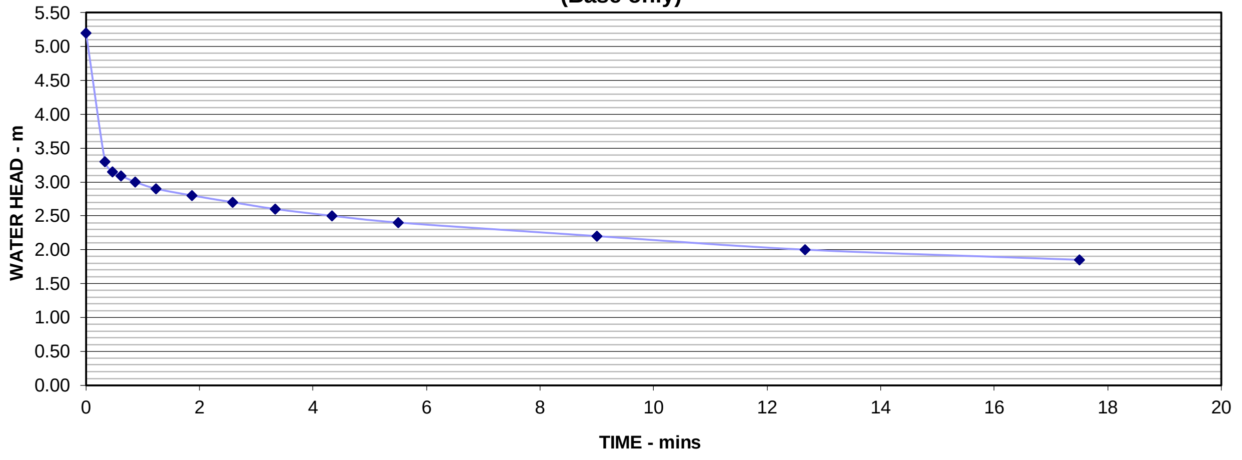
FALLING HEAD PERMEABILITY TEST RESULT - Soakage Test 5
(Base only)



STRATIGRAPHIC LOG

Refer to S5

E.O.B @ 5.2 metres

HVORSLEV CASE C:
Soakage out base of test hole only with no overlying restrictive layer:

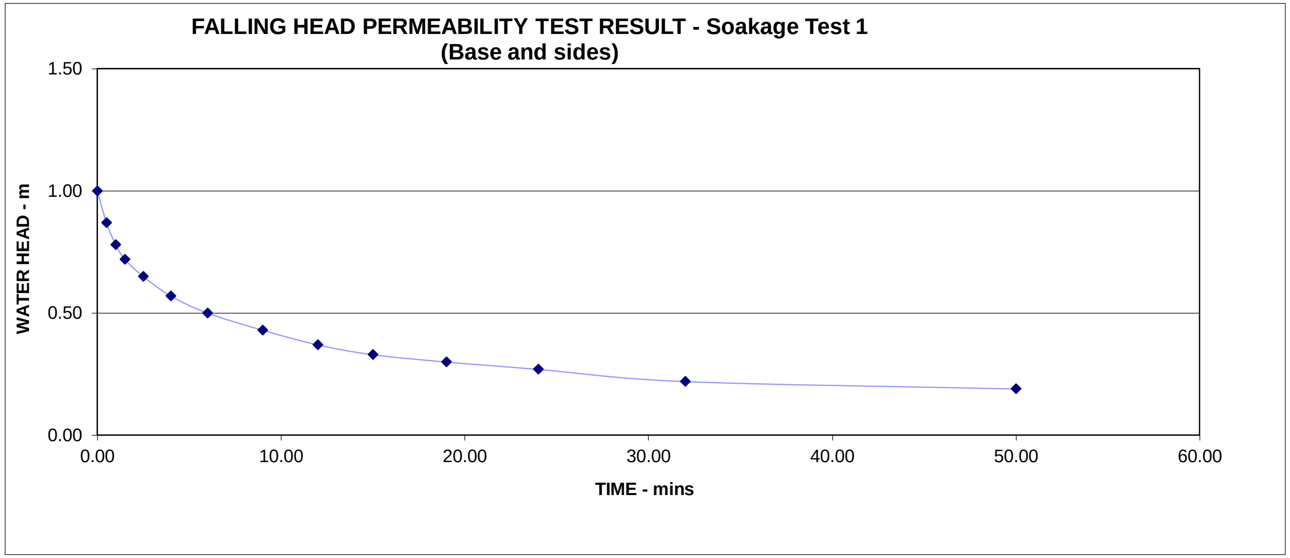
$$\text{Hydraulic conductivity (k)} = \frac{\text{PI . D}}{\text{11 . (t2 - t1)}} \text{ x ln } \frac{\text{H1}}{\text{H2}}$$

where
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

Standing groundwater level before test (metres): 5.2 m

Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	5.20		
0.33	20	1.90	3.30	0.45	6.49E-04
0.47	8	2.05	3.15	0.05	1.66E-04
0.62	9	2.11	3.09	0.02	6.10E-05
0.87	15	2.20	3.00	0.03	5.63E-05
1.23	22	2.30	2.90	0.03	4.40E-05
1.87	38	2.40	2.80	0.04	2.64E-05
2.58	43	2.50	2.70	0.04	2.42E-05
3.33	45	2.60	2.60	0.04	2.40E-05
4.33	60	2.70	2.50	0.04	1.87E-05
5.50	70	2.80	2.40	0.04	1.67E-05
9.00	210	3	2.20	0.09	1.18E-05
12.67	220	3.2	2.00	0.10	1.24E-05
17.50	290	3.35	1.85	0.08	7.68E-06

CLIENT:	BBO Ltd
LOCATION:	Montgomerie Block
JOB NUMBER:	GENZHAMI17003AA
DATE:	31-Oct-11



FALLING HEAD PERMEABILITY TEST RESULT - Soakage Test 1 (Base and sides)

STRATIGRAPHIC LOG

Refer to S1

E.O.B @ 1.2 metres

HVORSLEV CASE G:
Soakage out base and sides of test hole with no overlying restrictive layer:

$$\text{Hydraulic conductivity (k)} = \frac{d^2 \times \ln(2.m.L/D)}{8.L.(t2 - t1)} \times \ln \frac{H1}{H2}$$

where

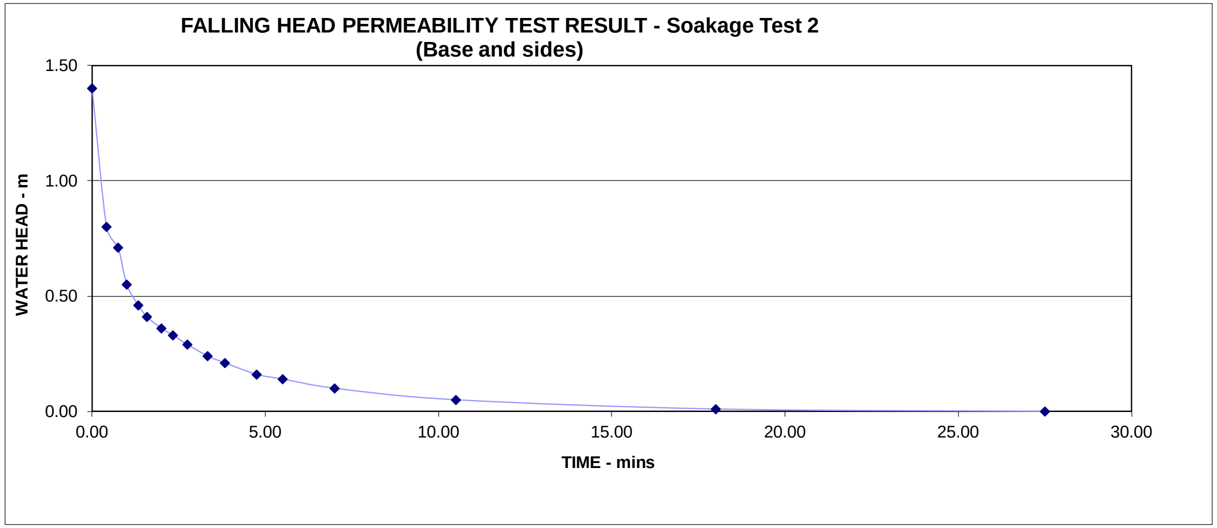
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

Standing groundwater level before test (metres): 1 m

Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	Average L (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	1.00			
0.50	30	0.13	0.87	0.94	0.14	1.82E-05
1.00	30	0.22	0.78	0.83	0.11	1.55E-05
1.50	30	0.28	0.72	0.75	0.08	1.20E-05
2.50	60	0.35	0.65	0.69	0.10	8.14E-06
4.00	90	0.43	0.57	0.61	0.13	7.48E-06
6.00	120	0.50	0.50	0.54	0.13	6.05E-06
9.00	180	0.57	0.43	0.47	0.15	5.02E-06
12.00	180	0.63	0.37	0.40	0.15	5.43E-06
15.00	180	0.67	0.33	0.35	0.11	4.42E-06
19.00	240	0.70	0.30	0.32	0.10	2.90E-06
24.00	300	0.73	0.27	0.29	0.11	2.68E-06
32.00	480	0.78	0.22	0.25	0.20	3.46E-06
50.00	1080	0.81	0.19	0.21	0.15	1.17E-06

CLIENT: BBO Ltd
LOCATION: Montgomerie Block

JOB NUMBER: GENZHAMI17003AA
DATE: 31-Oct-11



FALLING HEAD PERMEABILITY TEST RESULT - Soakage Test 2 (Base and sides)

STRATIGRAPHIC LOG

Refer to S2

E.O.B @ 1.9 metres

HVORSLEV CASE G:
Soakage out base and sides of test hole with no overlying restrictive layer:

$$\text{Hydraulic conductivity (k)} = \frac{d^2 \times \ln(2.m.L/D)}{8.L.(t2 - t1)} \times \ln \frac{H1}{H2}$$

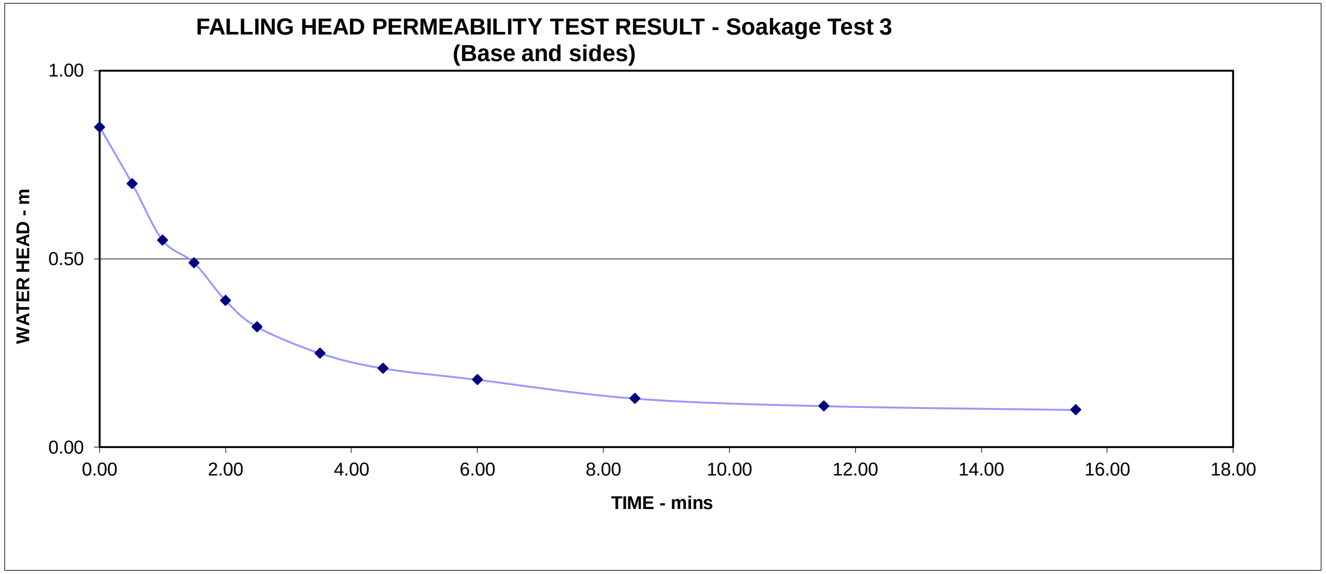
where
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

Standing groundwater level before test (metres): 1.4 m

Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	Average L (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	1.40			
0.42	25	0.60	0.80	1.10	0.56	7.86E-05
0.75	20	0.69	0.71	0.76	0.12	2.68E-05
1.00	15	0.85	0.55	0.63	0.26	8.56E-05
1.33	20	0.94	0.46	0.51	0.18	5.11E-05
1.58	15	0.99	0.41	0.44	0.12	4.77E-05
2.00	25	1.04	0.36	0.39	0.13	3.45E-05
2.33	20	1.07	0.33	0.35	0.09	3.04E-05
2.75	25	1.11	0.29	0.31	0.13	3.80E-05
3.33	35	1.16	0.24	0.27	0.19	4.25E-05
3.83	30	1.19	0.21	0.23	0.13	3.72E-05
4.75	55	1.24	0.16	0.19	0.27	4.37E-05
5.50	45	1.26	0.14	0.15	0.13	2.72E-05
7.00	90	1.3	0.10	0.12	0.34	3.41E-05
10.5	210	1.35	0.05	0.07	0.69	2.23E-05
18	450	1.39	0.01	0.03	1.61	-7.61E-05
27.5	570	1.4	0.00	0.01	#DIV/0!	#DIV/0!

CLIENT: BBO Ltd
LOCATION: Montgomerie Block

JOB NUMBER: GENZHAMI17003AA
DATE: 31-Oct-11


FALLING HEAD PERMEABILITY TEST RESULT - Soakage Test 3
(Base and sides)

STRATIGRAPHIC LOG

Refer to S3

E.O.B @ 1.5 metres

HVORSLEV CASE G:
Soakage out base and sides of test hole with no overlying restrictive layer:

$$\text{Hydraulic conductivity (k)} = \frac{d^2 \times \ln(2.m.L/D)}{8.L.(t2 - t1)} \times \ln \frac{H1}{H2}$$

where
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

Standing groundwater level before test (metres): 0.85 m

Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	Average L (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	0.85			
0.52	31	0.15	0.70	0.78	0.19	2.77E-05
1.00	29	0.30	0.55	0.63	0.24	4.20E-05
1.50	30	0.36	0.49	0.52	0.12	2.17E-05
2.00	30	0.46	0.39	0.44	0.23	4.70E-05
2.50	30	0.53	0.32	0.36	0.20	4.55E-05
3.50	60	0.60	0.25	0.29	0.25	3.14E-05
4.50	60	0.64	0.21	0.23	0.17	2.41E-05
6.00	90	0.67	0.18	0.20	0.15	1.49E-05
8.50	150	0.72	0.13	0.16	0.33	1.98E-05
11.50	180	0.74	0.11	0.12	0.17	8.46E-06
15.50	240	0.75	0.10	0.11	0.10	3.51E-06

CLIENT: BBO Ltd
LOCATION: Montgomerie Block

JOB NUMBER: GENZHAMI17003AA
DATE: 31-Oct-11

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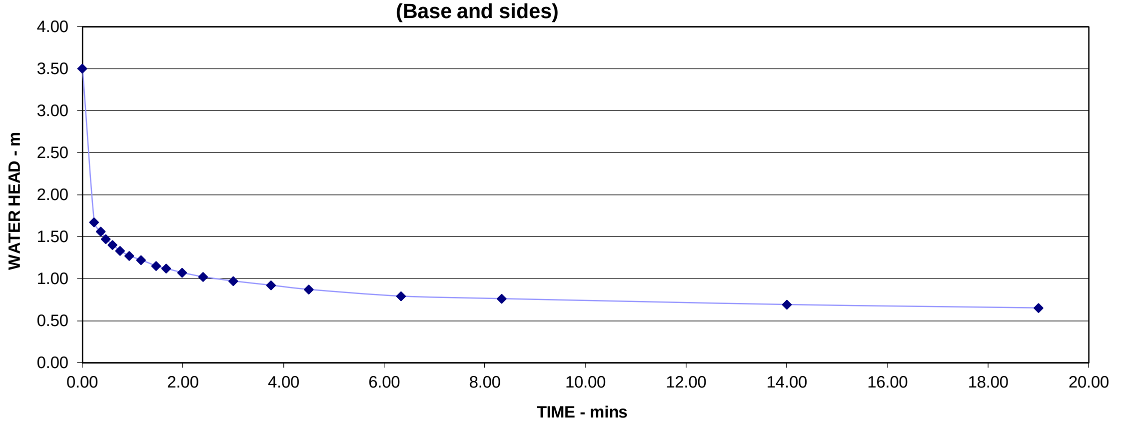
FALLING HEAD PERMEABILITY TEST RESULT - Soakage Test 4 (Base and sides)



STRATIGRAPHIC LOG

Refer to S4

E.O.B @ 3.55 metres

HVORSLEV CASE G:
Soakage out base and sides of test hole with no overlying restrictive layer:

Hydraulic conductivity (k) $= \frac{d^2 \times \ln(2.m.L/D)}{8.L.(t2 - t1)} \times \ln \frac{H1}{H2}$

where
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

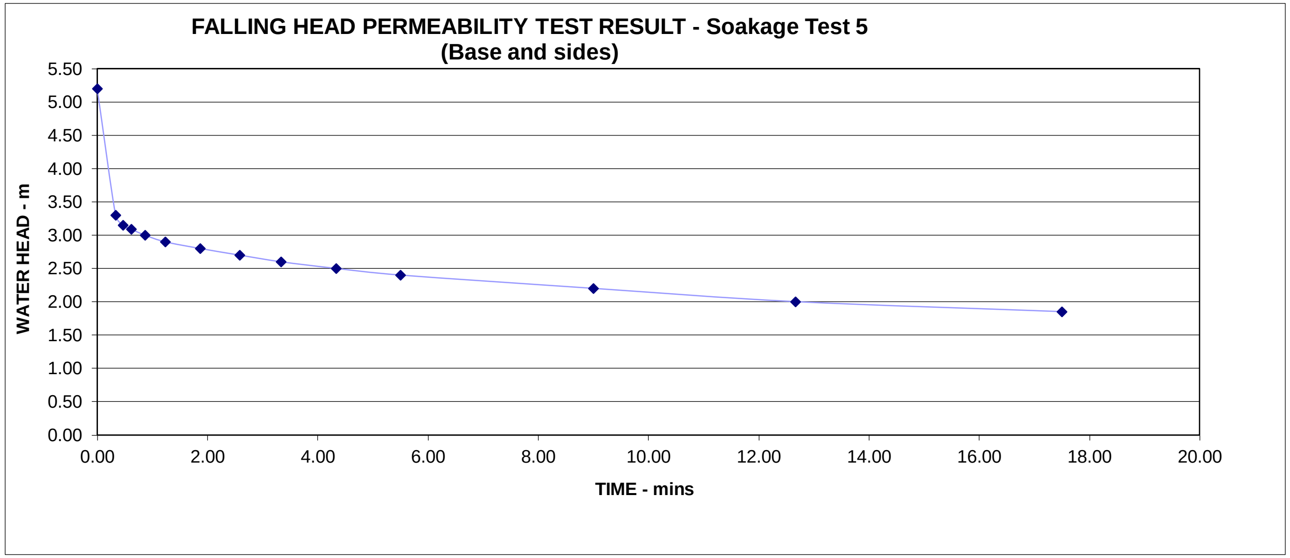
Standing groundwater level before test (metres): 3.5 m

Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	Average L (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	3.50			
0.23	14	1.83	1.67	2.59	0.74	1.01E-04
0.37	8	1.94	1.56	1.62	0.07	2.29E-05
0.47	6	2.03	1.47	1.52	0.06	2.79E-05
0.60	8	2.10	1.40	1.44	0.05	1.78E-05
0.75	9	2.17	1.33	1.37	0.05	1.73E-05
0.93	11	2.23	1.27	1.30	0.05	1.31E-05
1.17	14	2.28	1.22	1.25	0.04	9.26E-06
1.47	18	2.35	1.15	1.19	0.06	1.10E-05
1.67	12	2.38	1.12	1.14	0.03	7.57E-06
1.98	19	2.43	1.07	1.10	0.05	8.47E-06
2.40	25	2.48	1.02	1.05	0.05	6.96E-06
3.00	36	2.53	0.97	1.00	0.05	5.25E-06
3.75	45	2.58	0.92	0.95	0.05	4.57E-06
4.50	45	2.63	0.87	0.90	0.06	5.00E-06
6.33	110	2.71	0.79	0.83	0.10	3.71E-06
8.33	120	2.74	0.76	0.78	0.04	1.43E-06
14.00	340	2.81	0.69	0.73	0.10	1.31E-06
19.00	300	2.85	0.65	0.67	0.06	9.64E-07

CLIENT: BBO Ltd
LOCATION: Montgomerie Block

JOB NUMBER: GENZHAMI17003AA
DATE: 31-Oct-11

coffey geotechnics



STRATIGRAPHIC LOG

Refer to S5

E.O.B @ 5.2 metres

HVORSLEV CASE G:
Soakage out base and sides of test hole with no overlying restrictive layer:

$$\text{Hydraulic conductivity (k)} = \frac{d^2 \times \ln(2.m.L/D)}{8.L.(t2 - t1)} \times \ln \frac{H1}{H2}$$

where
d = D = test hole diameter (m) = 0.100 m
m = transformation ratio = 1
L = average soakage length (m)
t = time (secs)
H1 = piezometric head for t = t1
H2 = piezometric head for t = t2

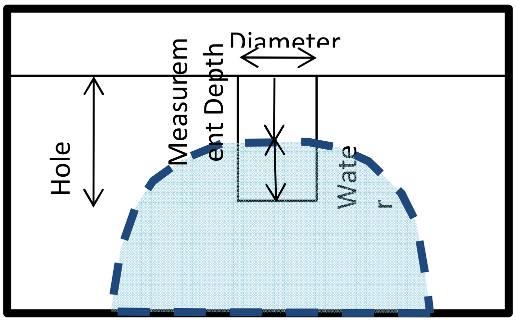
Standing groundwater level before test (metres): 5.2 m

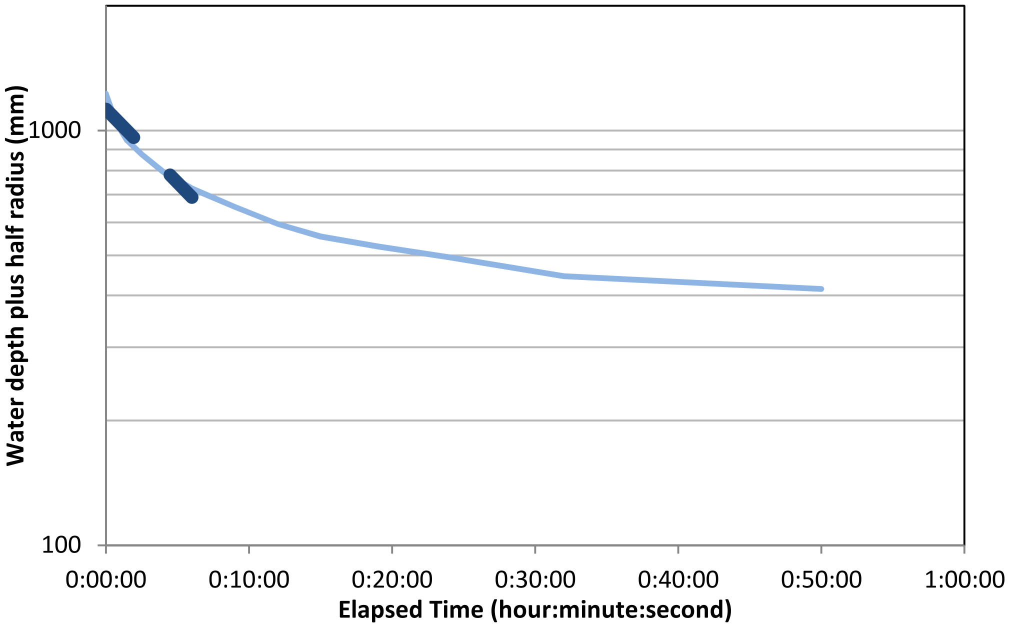
Elapsed Time (mins)	t2 - t1 (secs)	Water level from top of hole (m)	Piezometric Head H (m)	Average L (m)	ln (H1/H2)	Hydraulic Conductivity k (m/sec)
0.00	0	0.00	5.20			
0.33	20	1.90	3.30	4.25	0.45	2.97E-05
0.47	8	2.05	3.15	3.23	0.05	9.39E-06
0.62	9	2.11	3.09	3.12	0.02	3.54E-06
0.87	15	2.20	3.00	3.05	0.03	3.32E-06
1.23	22	2.30	2.90	2.95	0.03	2.66E-06
1.87	38	2.40	2.80	2.85	0.04	1.64E-06
2.58	43	2.50	2.70	2.75	0.04	1.54E-06
3.33	45	2.60	2.60	2.65	0.04	1.57E-06
4.33	60	2.70	2.50	2.55	0.04	1.26E-06
5.50	70	2.80	2.40	2.45	0.04	1.16E-06
9.00	210	3	2.20	2.30	0.09	8.62E-07
12.67	220	3.2	2.00	2.10	0.10	9.64E-07
17.50	290	3.35	1.85	1.93	0.08	6.37E-07

HOLE DIMENSIONS	
Diameter (mm)	100
Depth (mm)	1200

MEASUREMENTS	
Time (hr:min:sec)	Depth (mm)
0:00:00	0
0:00:30	130
0:01:00	220
0:01:30	280
0:02:30	350
0:04:00	430
0:06:00	500
0:09:00	570
0:12:00	630
0:15:00	670
0:19:00	700
0:24:00	730
0:32:00	780
0:50:00	810

INVERTED AUGER TEST





Match interval	
Initial time	0:00:00
Final time	0:06:00

Intepreted Permeability
3.4E-05 m/s
2.9E+00 m/d

Note: Method described by: RJ Oosterbaan and HJ Nijland in *Determining the saturated hydraulic conductivity. In Chapter 12 of Drainage Principals and Applications ILRI Publication 16 2nd Edition 1994*

drawn	BR
approved	RJB
date	12-Sep-2011
scale	AS SHOWN
original size	A4

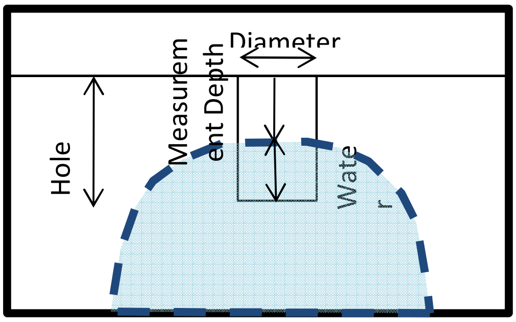
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

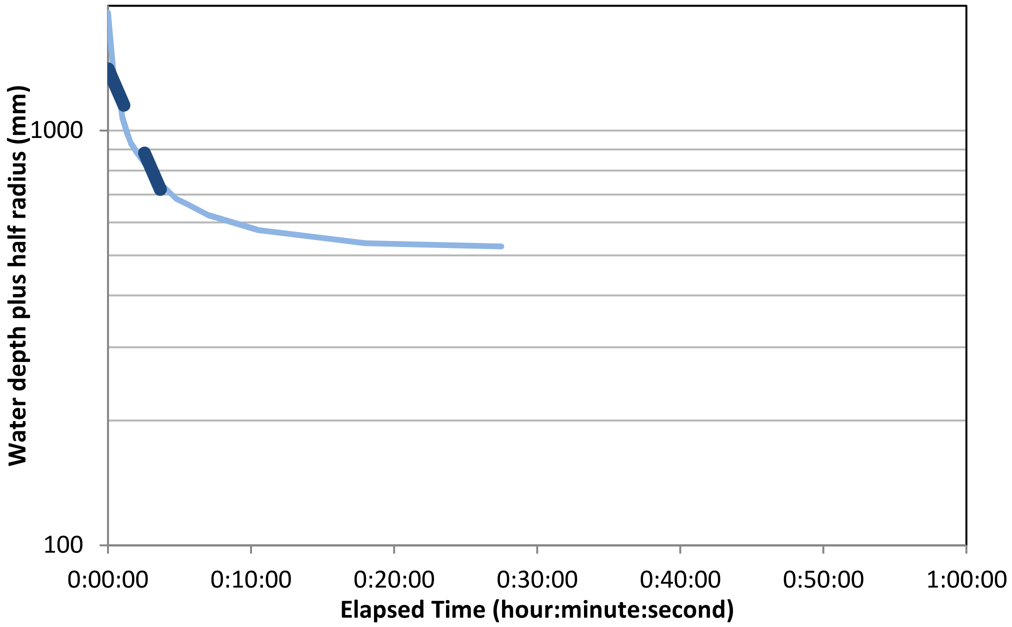
client:	**BBO Limited**		
project:	**Montgomerie Block** **Raynes Road, Hamilton**		
title:	**Permeability Test Result - S1**		
project no:	**GENZHAMI17003AA**	figure no:	**FIGURE**

HOLE DIMENSIONS	
Diameter (mm)	100
Depth (mm)	1900

INVERTED AUGER TEST

MEASUREMENTS	
Time (hr:min:sec)	Depth (mm)
0:00:00	0
0:00:25	600
0:00:45	690
0:01:00	850
0:01:20	940
0:01:35	990
0:02:00	1040
0:02:20	1070
0:02:45	1110
0:03:20	1160
0:03:50	1190
0:04:45	1240
0:05:30	1260
0:07:00	1300
0:10:30	1350
0:18:00	1390
0:27:30	1400





Match interval	
Initial time	0:00:00
Final time	0:04:45

Intepreted Permeability

7.6E-05 m/s

6.6E+00 m/d

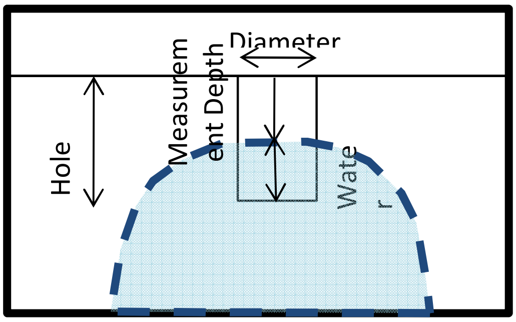
Note: Method described by: RJ Oosterbaan and HJ Nijland in *Determining the saturated hydraulic conductivity. In Chapter 12 of Drainage Principals and Applications ILRI Publication 16 2nd Edition 1994*

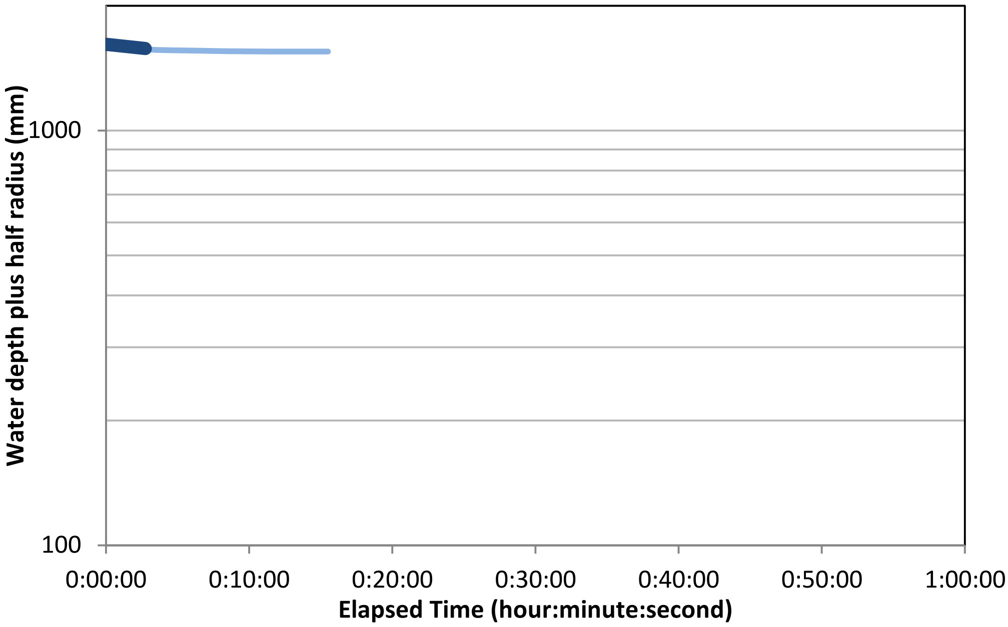
drawn	BR	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BBO Limited	
approved	RJB		project:	Montgomerie Block Raynes Road, Hamilton	
date	12-Sep-2011				
scale	AS SHOWN		title:	Permeability Test Result - S2	
original size	A4		project no:	GENZHAMI17003AA	figure no: FIGURE

INVERTED AUGER TEST

HOLE DIMENSIONS	
Diameter (mm)	100
Depth (mm)	1600

MEASUREMENTS	
Time (hr:min:sec)	Depth (mm)
0:00:00	0
0:00:31	15
0:01:00	30
0:01:30	36
0:02:00	46
0:02:30	53
0:03:30	60
0:04:30	64
0:06:00	67
0:08:30	72
0:11:30	74
0:15:30	75





Match interval	
Initial time	0:00:00
Final time	0:04:30

Intepreted Permeability

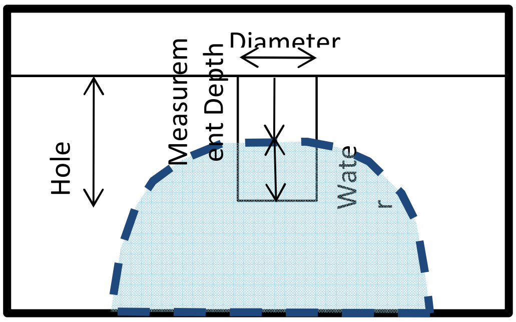
3.6E-06 m/s
3.1E-01 m/d

Note: Method described by: RJ Oosterbaan and HJ Nijland in *Determining the saturated hydraulic conductivity. In Chapter 12 of Drainage Principals and Applications ILRI Publication 16 2nd Edition 1994*

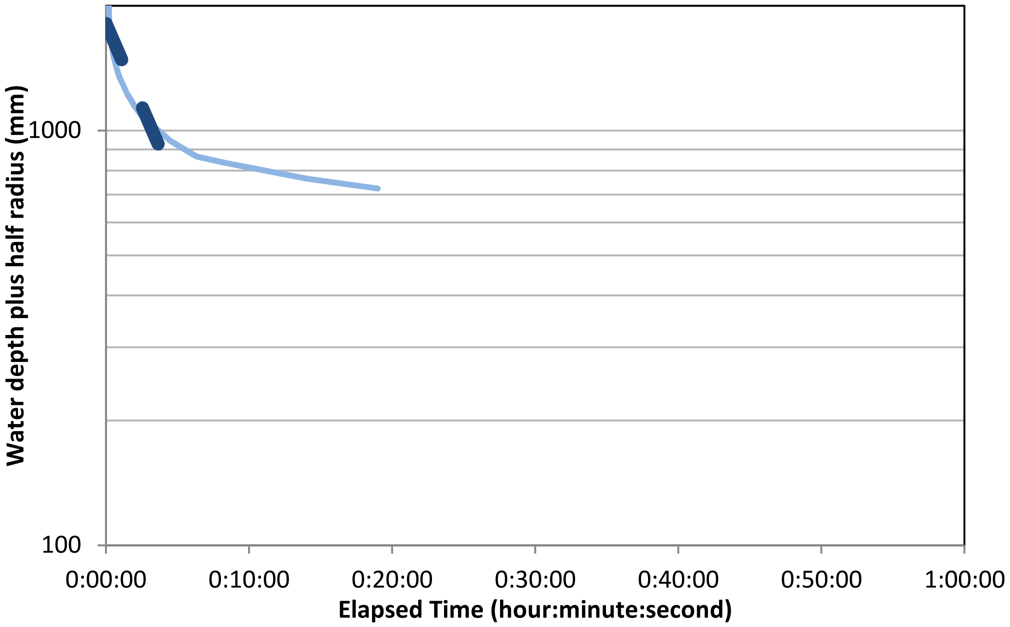
drawn	BR	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BBO Limited	
approved	RJB		project:	Montgomerie Block Raynes Road, Hamilton	
date	12-Sep-2011				
scale	AS SHOWN		title:	Permeability Test Result - S3	
original size	A4		project no:	GENZHAMI17003AA	figure no: FIGURE

HOLE DIMENSIONS	
Diameter (mm)	100
Depth (mm)	3550

INVERTED AUGER TEST



MEASUREMENTS	
Time (hr:min:sec)	Depth (mm)
0:00:00	0
0:00:14	1830
0:00:22	1940
0:00:28	2030
0:00:36	2100
0:00:45	2170
0:00:56	2230
0:01:10	2280
0:01:28	2350
0:01:40	2380
0:01:59	2430
0:02:24	2480
0:03:00	2530
0:03:45	2580
0:04:30	2630
0:06:20	2710
0:08:20	2740
0:14:00	2810
0:19:00	2850



Match interval	
Initial time	0:00:00
Final time	0:04:30

Intepreted Permeability
7.7E-05 m/s
6.6E+00 m/d

Note: Method described by: RJ Oosterbaan and HJ Nijland in *Determining the saturated hydraulic conductivity. In Chapter 12 of Drainage Principals and Applications ILRI Publication 16 2nd Edition 1994*

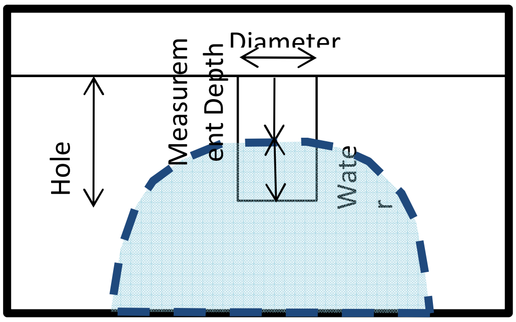
drawn	BR	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BBO Limited	
approved	RJB		project:	Montgomerie Block Raynes Road, Hamilton	
date	12-Sep-2011				
scale	AS SHOWN		title:	Permeability Test Result - S4	
original size	A4		project no:	GENZHAMI17003AA	figure no: FIGURE

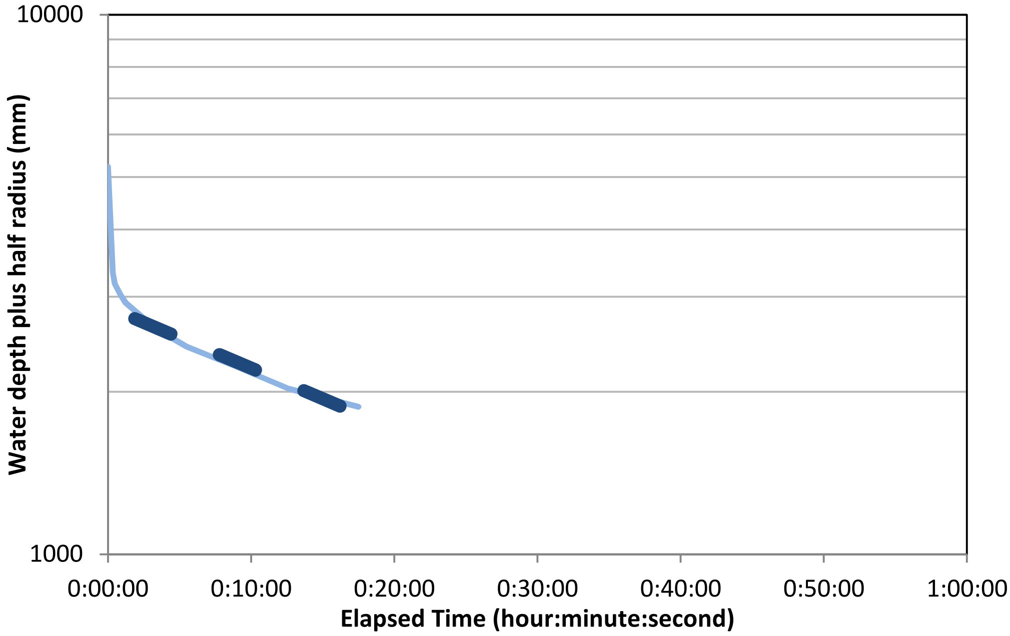
G:\17003AA MONTGOMERIE BLOCK\LAB & FIELD TESTING\FIELD TEST RESULTS\[Inverted Auger Test Rev2 - S-series Tests 130911.xlsx]S5

HOLE DIMENSIONS	
Diameter (mm)	100
Depth (mm)	5200

MEASUREMENTS	
Time (hr:min:sec)	Depth (mm)
0:00:00	0
0:00:20	1900
0:00:28	2050
0:00:37	2110
0:00:52	2200
0:01:14	2300
0:01:52	2400
0:02:35	2500
0:03:20	2600
0:04:20	2700
0:05:30	2800
0:09:00	3000
0:12:40	3200
0:17:30	3350

INVERTED AUGER TEST





Match interval	
Initial time	0:01:52
Final time	0:17:30

Intepreted Permeability
1.1E-05 m/s
9.3E-01 m/d

Note: Method described by: RJ Oosterbaan and HJ Nijland in *Determining the saturated hydraulic conductivity. In Chapter 12 of Drainage Principals and Applications ILRI Publication 16 2nd Edition 1994*

drawn	BR	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BBO Limited	
approved	RJB		project:	Montgomerie Block Raynes Road, Hamilton	
date	12-Sep-2011				
scale	AS SHOWN		title:	Permeability Test Result - S5	
original size	A4		project no:	GENZHAMI17003AA	figure no: FIGURE

Appendix 2

Stormwater Soakage Calculations

CLIENT:	BLOXAM BURNETT AND OLLIVER LIMITED	**JOB NUMBER:**	GENZHAMI17003AA
LOCATION:	MONTGOMERIE BLOCK, RAYNES ROAD, HAMILTON	**DATE:**	7-Nov-2011

STORMWATER MANAGEMENT PLAN

10 YEAR RETURN PERIOD DESIGN REQUIREMENT

LOT CATCHMENT AREA:

Lot Area (m^2)	100% Imperviousness (m^2)	Runoff Coefficient (C)
30,000	30,000	0.9

DRAINAGE AGGREGATE FILLED SOAKAGE TRENCH

Average Trench Width:	3.0	m	Exposed Soil Depth:	1.5	m (excludes 0.5 m deep capping)
Backfill void ratio:	0.35		Average Water Head (H):	0.4	m
Average Trench Depth:	2.0	m	Hydraulic Conductivity (k)	2.3E-06	m/sec
			Trench Soakage Capacity:	3.1E-02	m^2/hr

SOAKAGE TRENCH DESIGN:

	10 Yr ARI RF	50 Yr ARI RF	Rational Formula Runoff			2	m Deep Trench
Duration (hrs)	Depth (D) (mm)	Depth (D) (mm)	Q = CDA (m^3)	Q = CIA (l/sec)	Trench Capacity (m^3/m length)	Required Trench Length (10 Yr) (m)	50 Yr excess (m^3)
0.167	18.0	23.0	486	808.4	2.11	230.9	-1511
0.33	27.0	35.0	729	613.6	2.11	345.4	-1192
0.5	33.0	45.0	891	495.0	2.12	421.2	-927
1	45.0	61.0	1215	337.5	2.13	570.1	-511
2	54.0	73.0	1458	202.5	2.16	674.2	-219
6	72.0	95.0	1944	90.0	2.29	849.8	249
12	91.0	120.0	2457	56.9	2.48	992.7	734
24	112.0	149.0	3024	35.0	2.85	**1061.1**	1137
48	135.0	180.0	3645	21.1	3.60	1012.5	**1215**
72	142.0	190.0	3834	14.8	4.35	881.4	726

MODULAR SOAKAGE TRENCH

Average Trench Width:	3.0	m	Exposed Soil Depth:	1.5	m (excludes 0.5 m deep capping)
Backfill void ratio:	0.95		Average Water Head (H):	0.4	m
Average Trench Depth:	2.0	m	Hydraulic Conductivity (k)	2.3E-06	m/sec
			Trench Soakage Capacity:	3.1E-02	m^2/hr

SOAKAGE TRENCH DESIGN:

	10 Yr ARI RF	50 Yr ARI RF	Rational Formula Runoff			2	m Deep Trench
Duration (hrs)	Depth (D) (mm)	Depth (D) (mm)	Q = CDA (m^3)	Q = CIA (l/sec)	Trench Capacity (m^3/m length)	Required Trench Length (10 Yr) (m)	50 Yr excess (m^3)
0.167	18.0	23.0	486	808.4	5.71	85.2	-2267
0.33	27.0	35.0	729	613.6	5.71	127.7	-1946
0.5	33.0	45.0	891	495.0	5.72	155.9	-1679
1	45.0	61.0	1215	337.5	5.73	212.0	-1254
2	54.0	73.0	1458	202.5	5.76	253.0	-946
6	72.0	95.0	1944	90.0	5.89	330.2	-416
12	91.0	120.0	2457	56.9	6.08	404.4	165
24	112.0	149.0	3024	35.0	6.45	468.8	758
48	135.0	180.0	3645	21.1	7.20	**506.3**	**1215**
72	142.0	190.0	3834	14.8	7.95	482.3	1105

Appendix 3

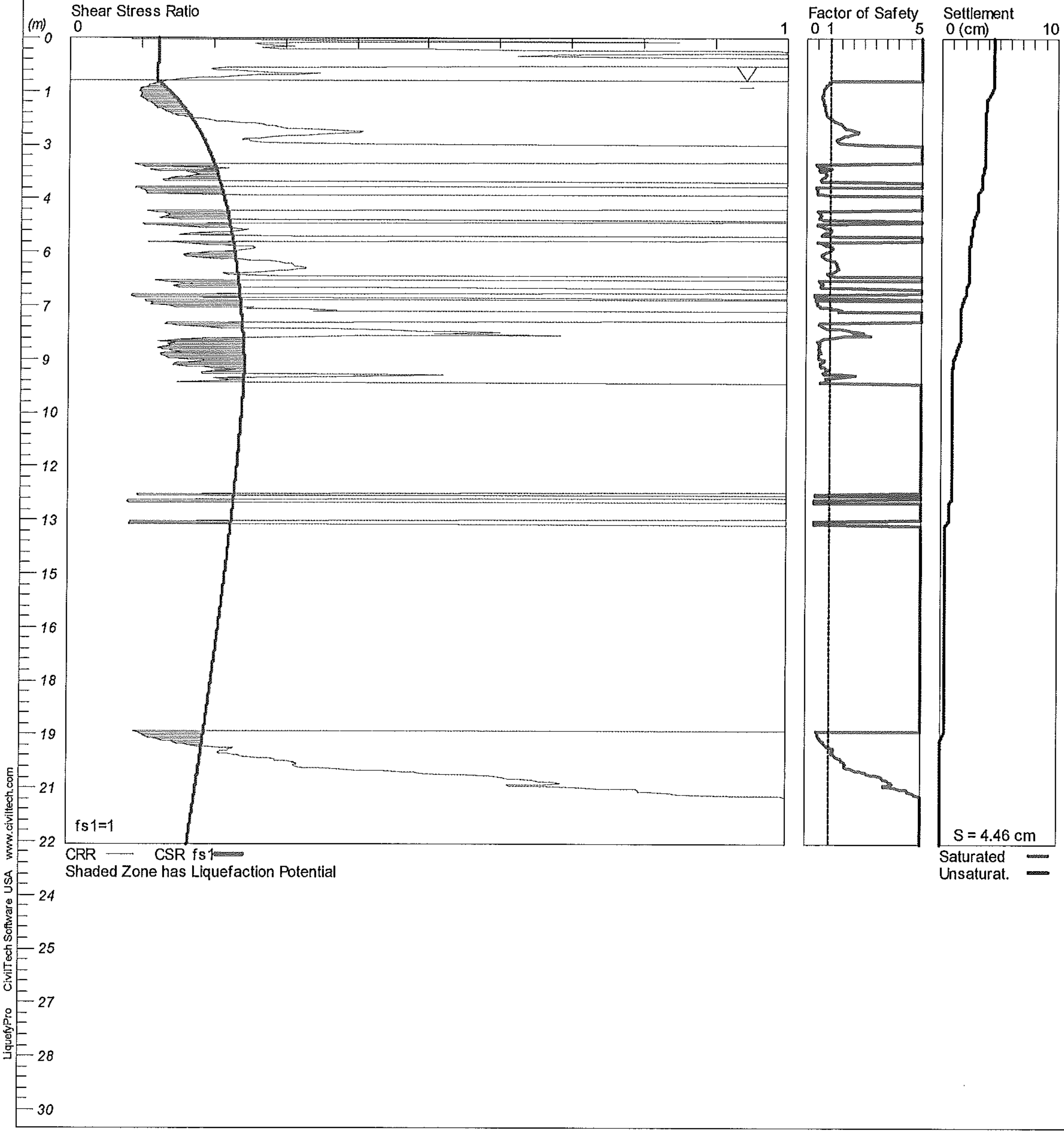
Liquefaction Analysis Results

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT03   Water Depth=1.19 m

Magnitude=7.5
Acceleration=.19g



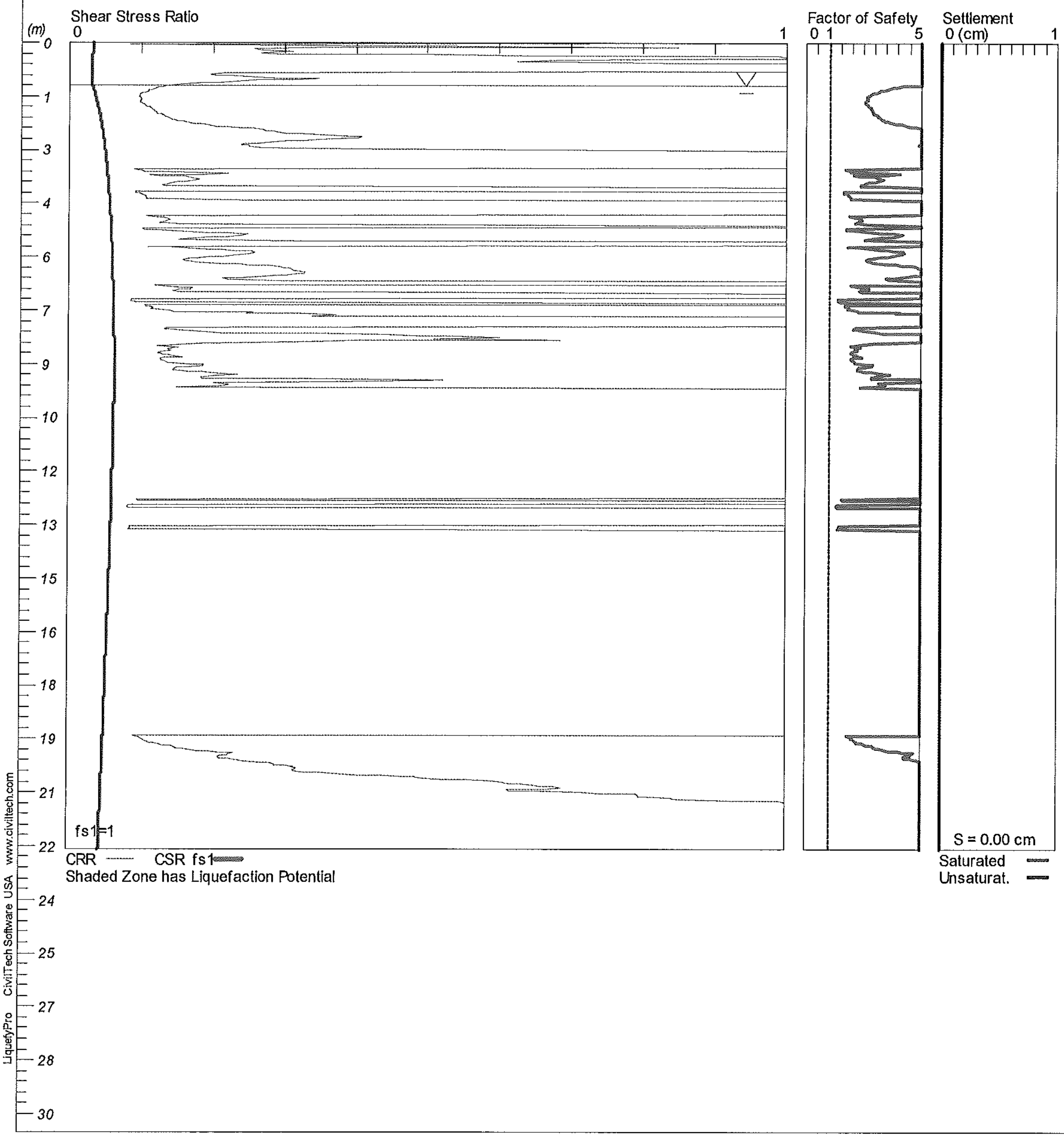
CivilTech Corporation   **Coffey Geotechnics (NZ) Limited**   **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT03   Water Depth=1.19 m

Magnitude=7.5
Acceleration=.05g



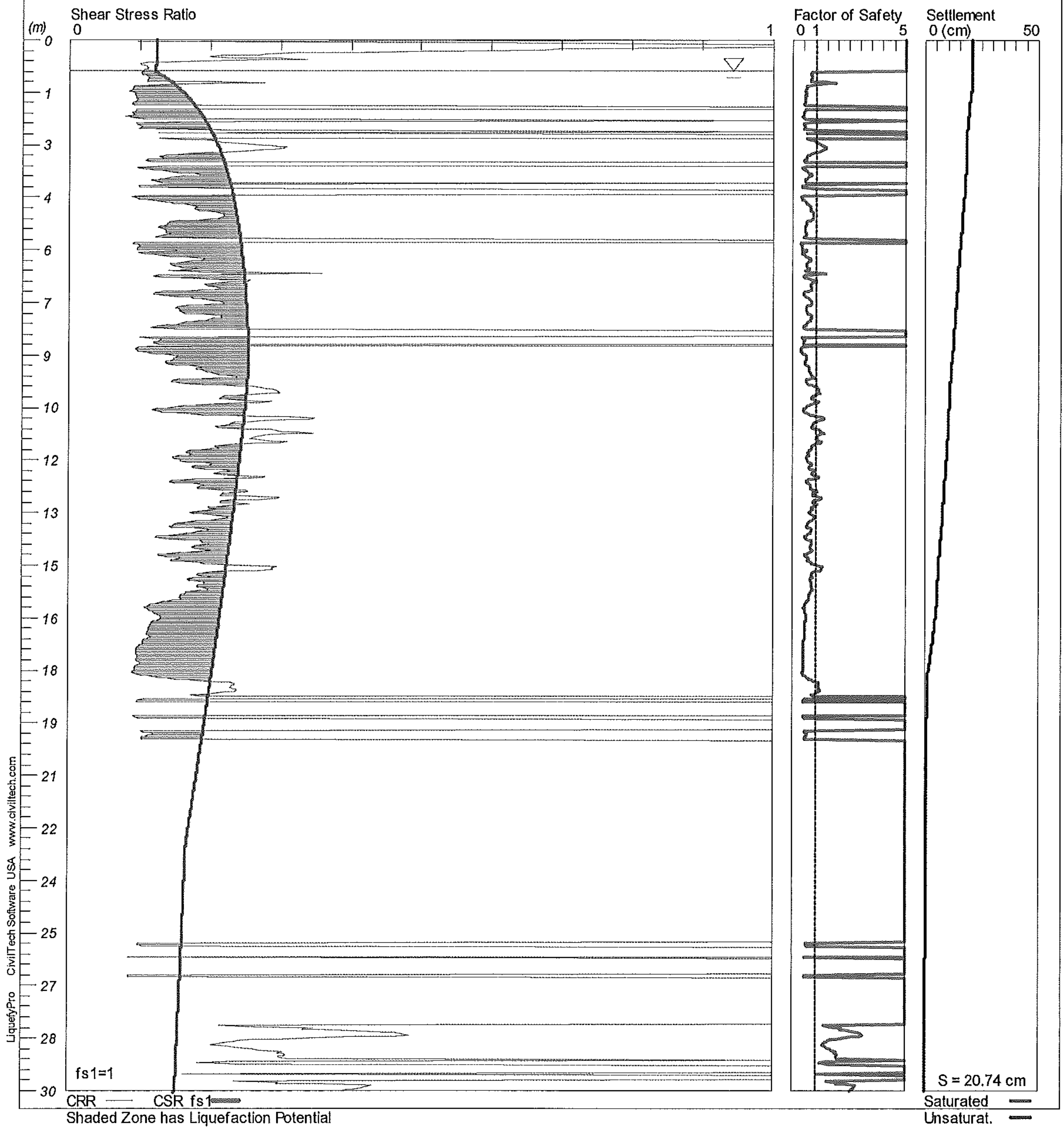
CivilTech Corporation   **Coffey Geotechnics (NZ) Limited**   **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT04   Water Depth=.89 m

Magnitude=7.5
Acceleration=.19g



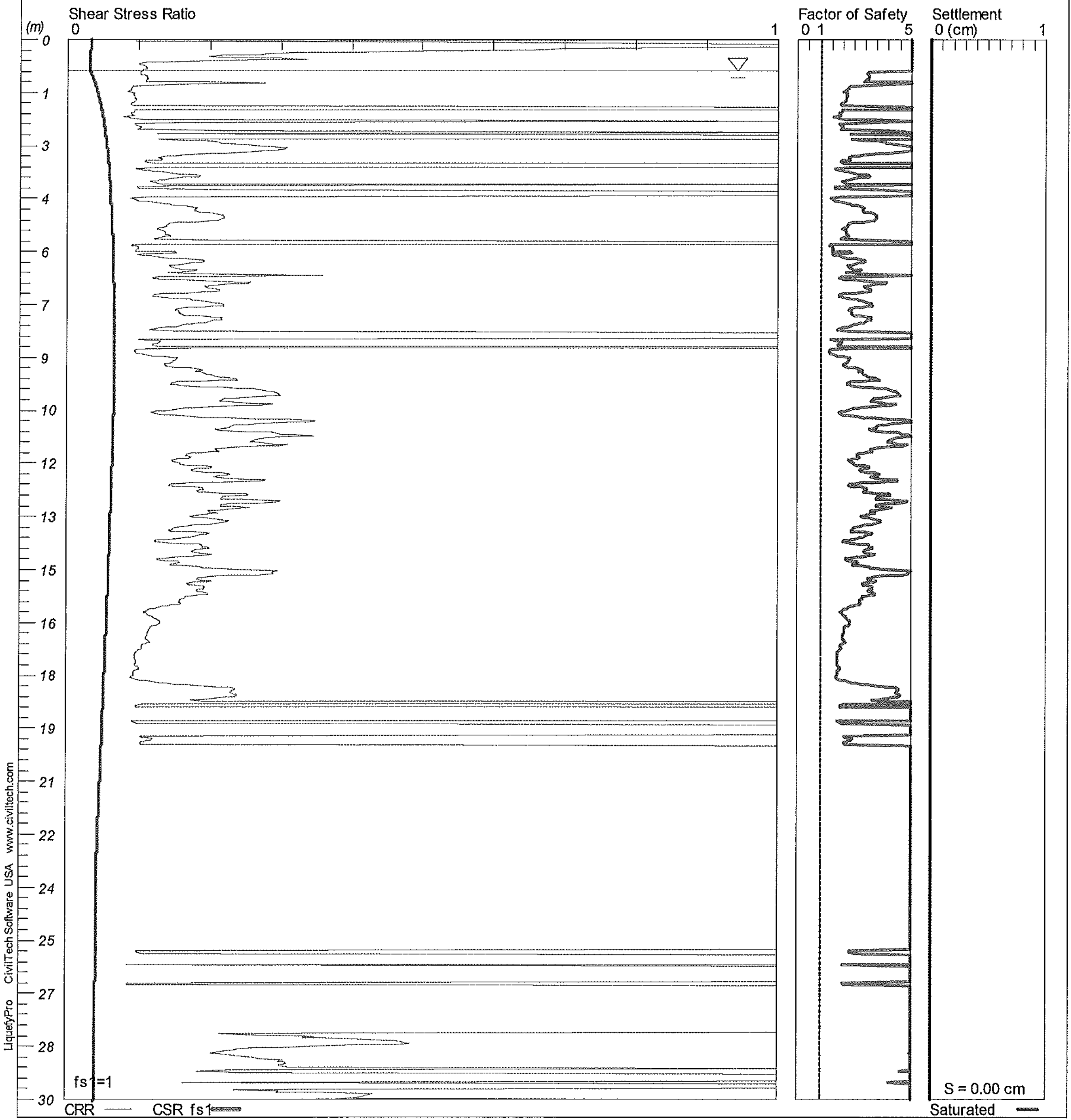
CivilTech Corporation   **Coffey Geotechnics (NZ) Limited**   **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT04   Water Depth=.89 m

Magnitude=7.5
Acceleration=.05g



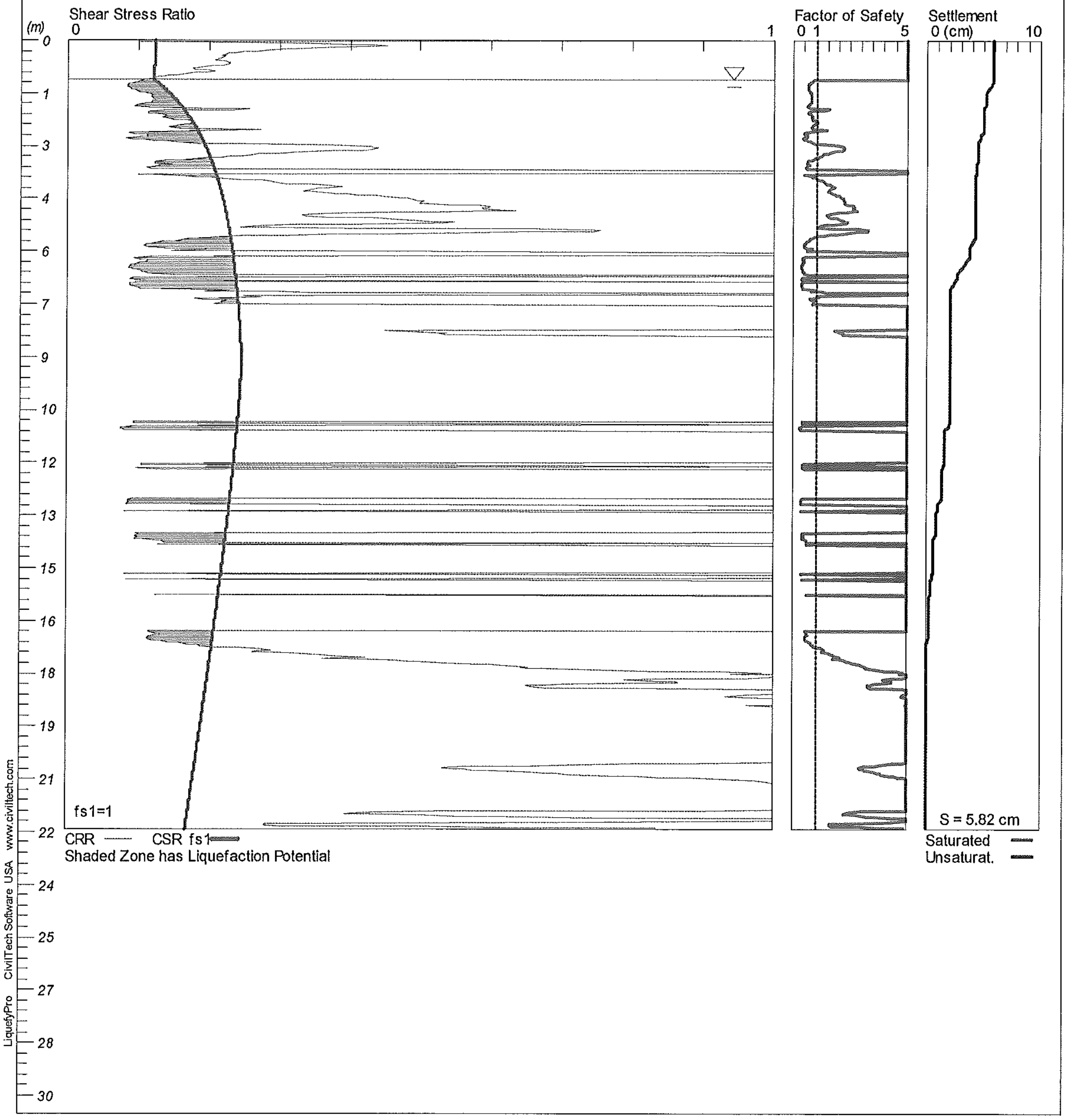
CivilTech Corporation   **Coffey Geotechnics (NZ) Limited**   **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT06 Water Depth=1.12 m

Magnitude=7.5
Acceleration=0.19g



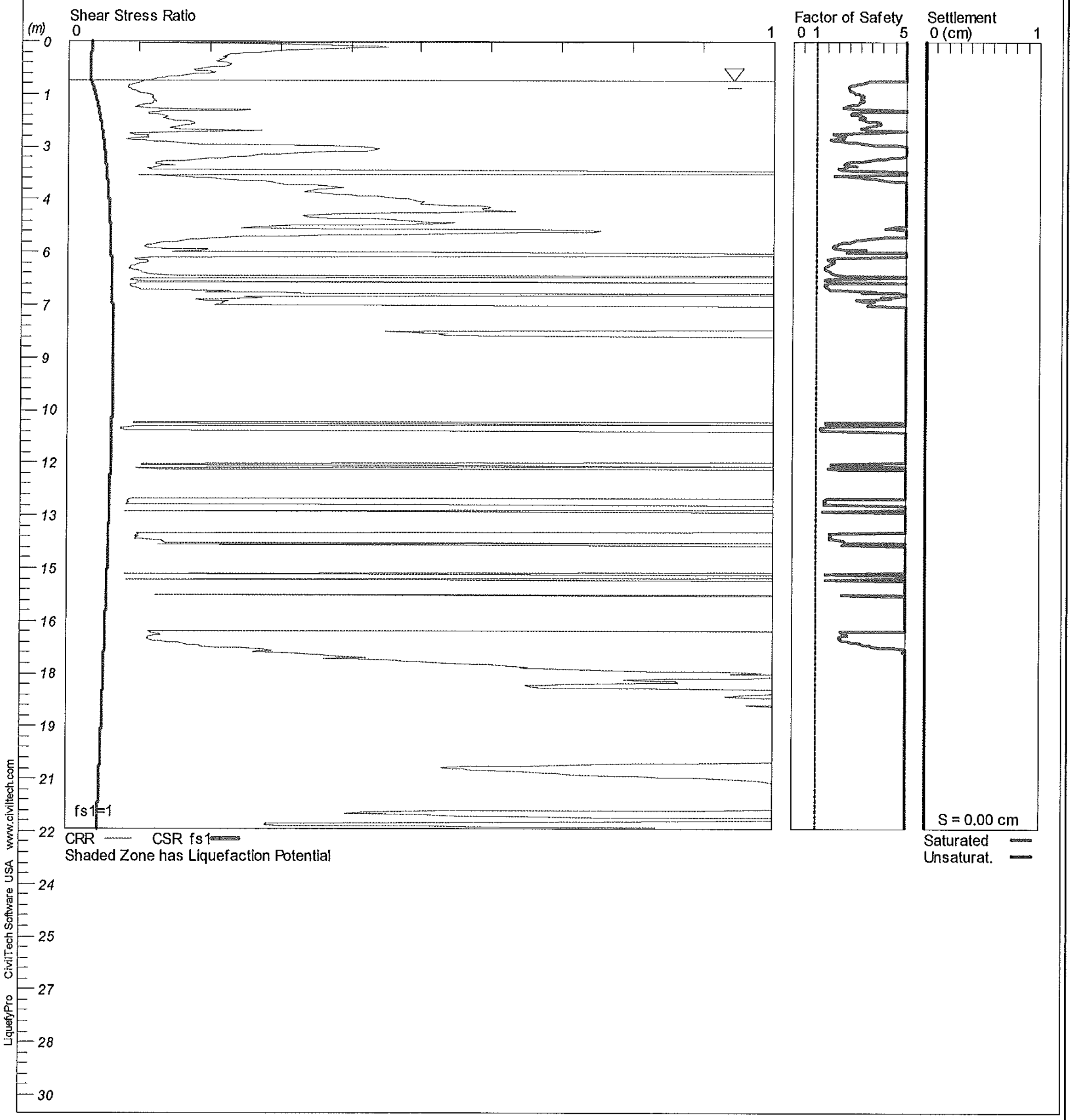
CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT06 Water Depth=1.12 m

Magnitude=7.5
Acceleration=0.05g

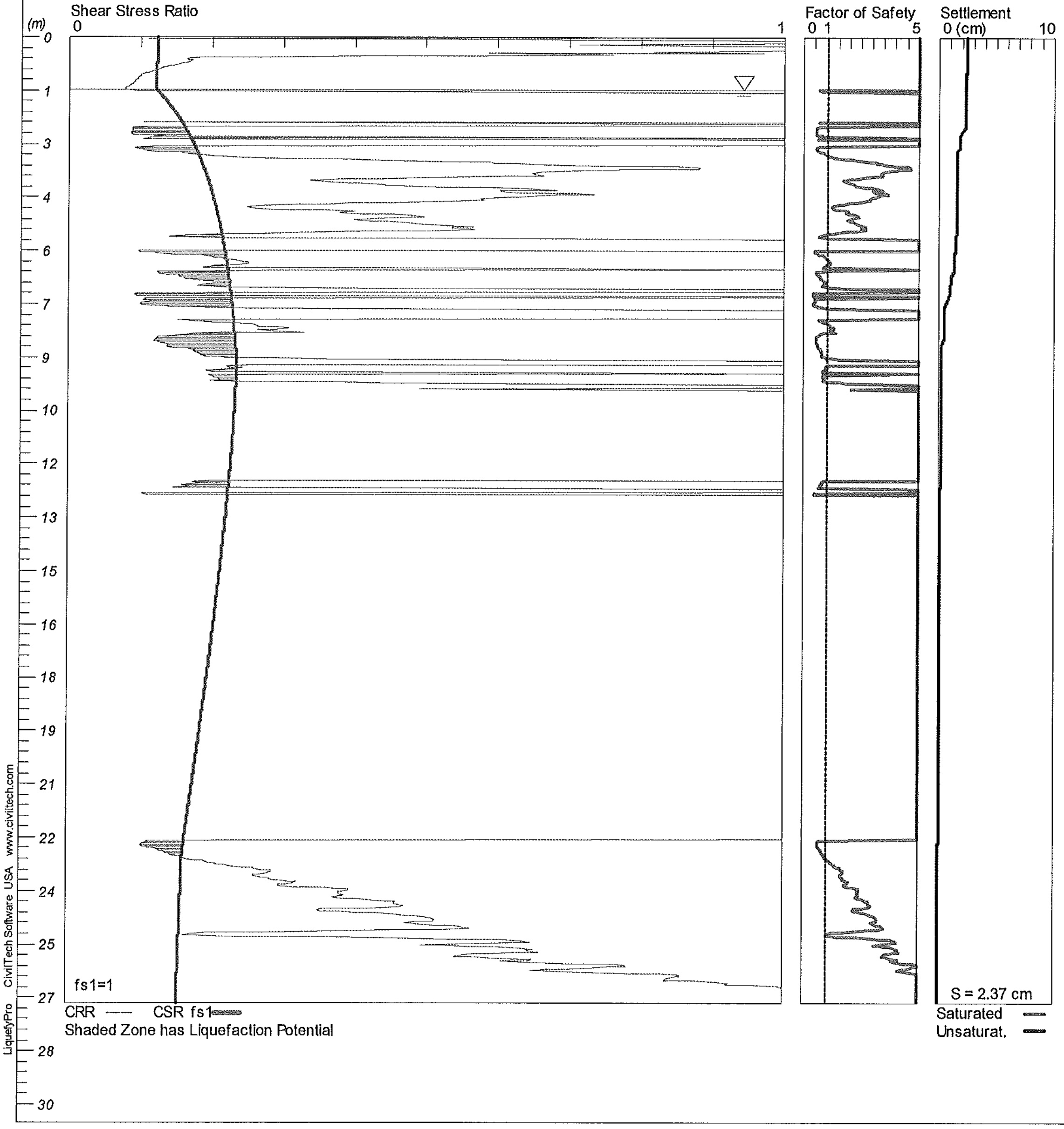


CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT08 Water Depth=1.45 m *Magnitude=7.5*
Acceleration=0.19g

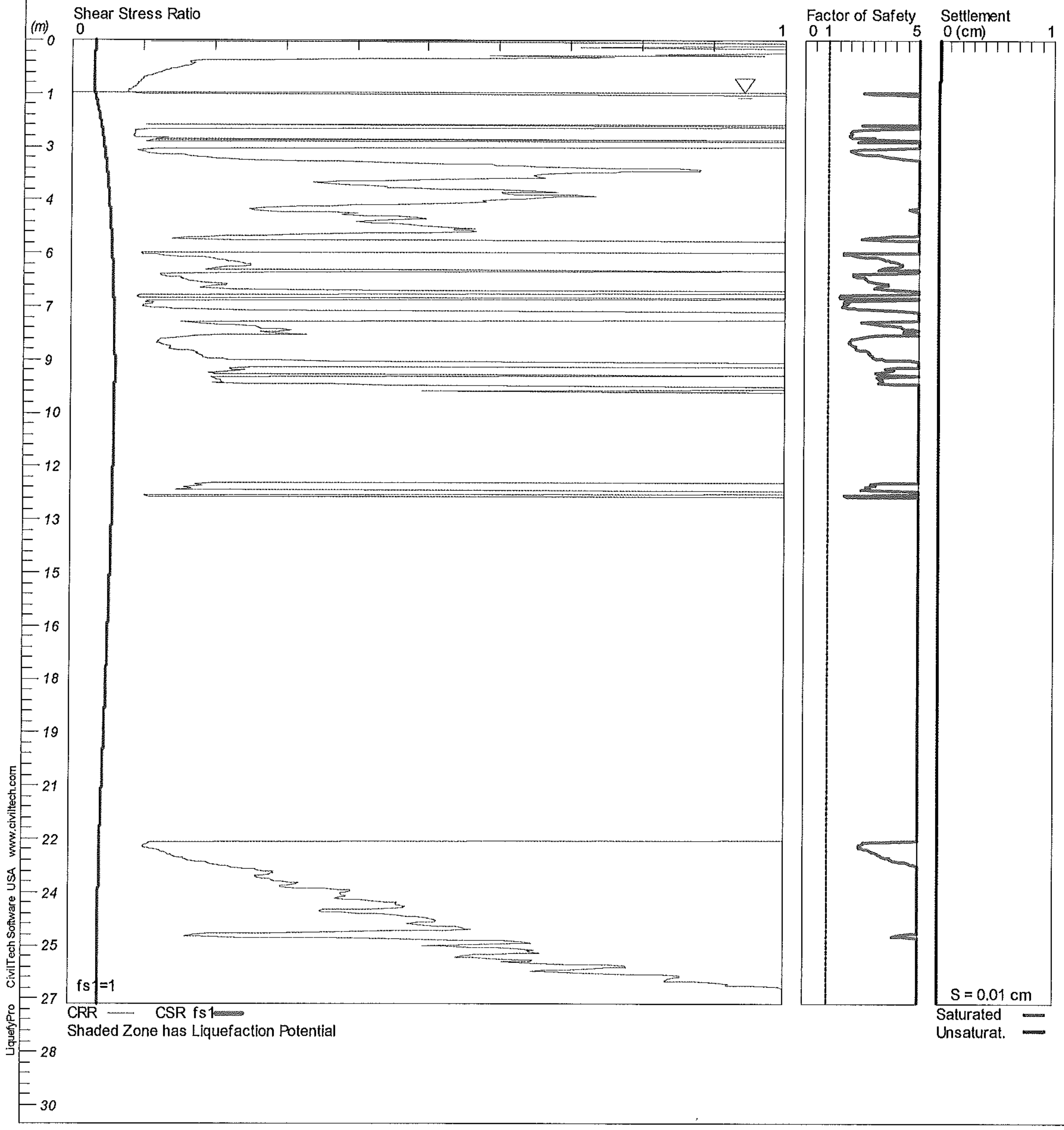


LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT08 Water Depth=1.45 m

Magnitude=7.5
Acceleration=0.05g



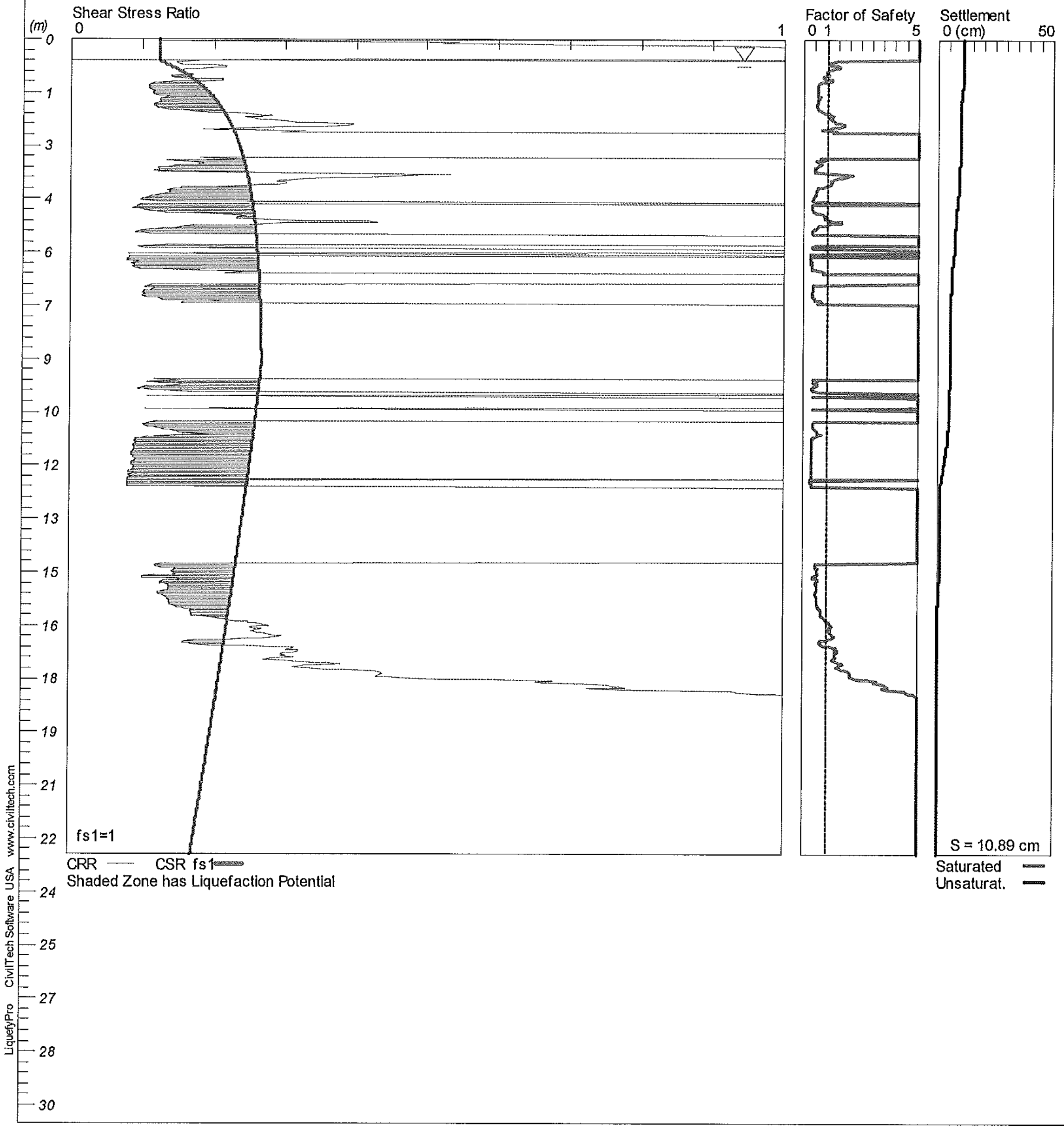
CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT10   Water Depth=.58 m

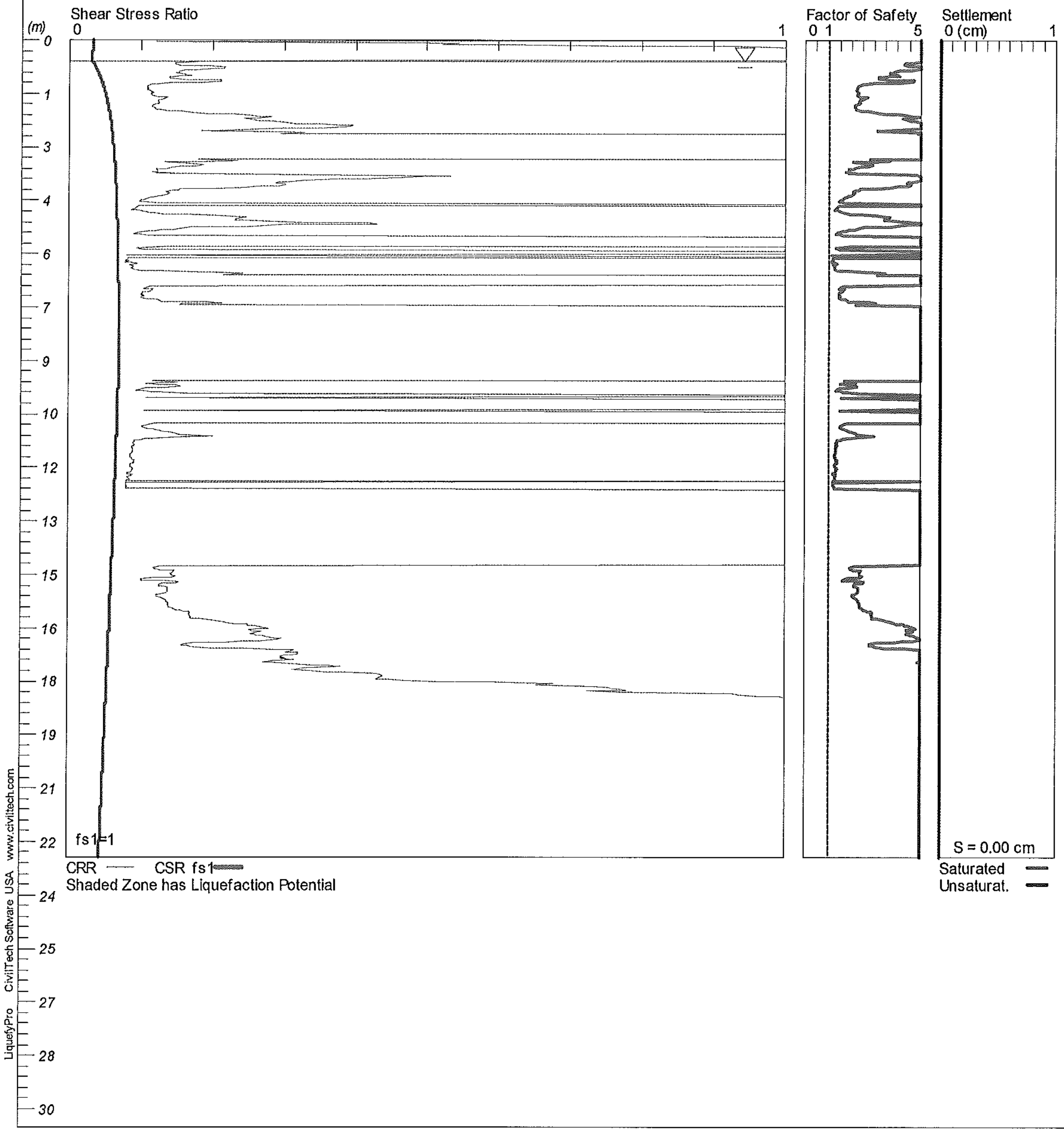
Magnitude=7.5
Acceleration=.19g



LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT10 Water Depth=.58 m | *Magnitude=7.5*
Acceleration=.05g

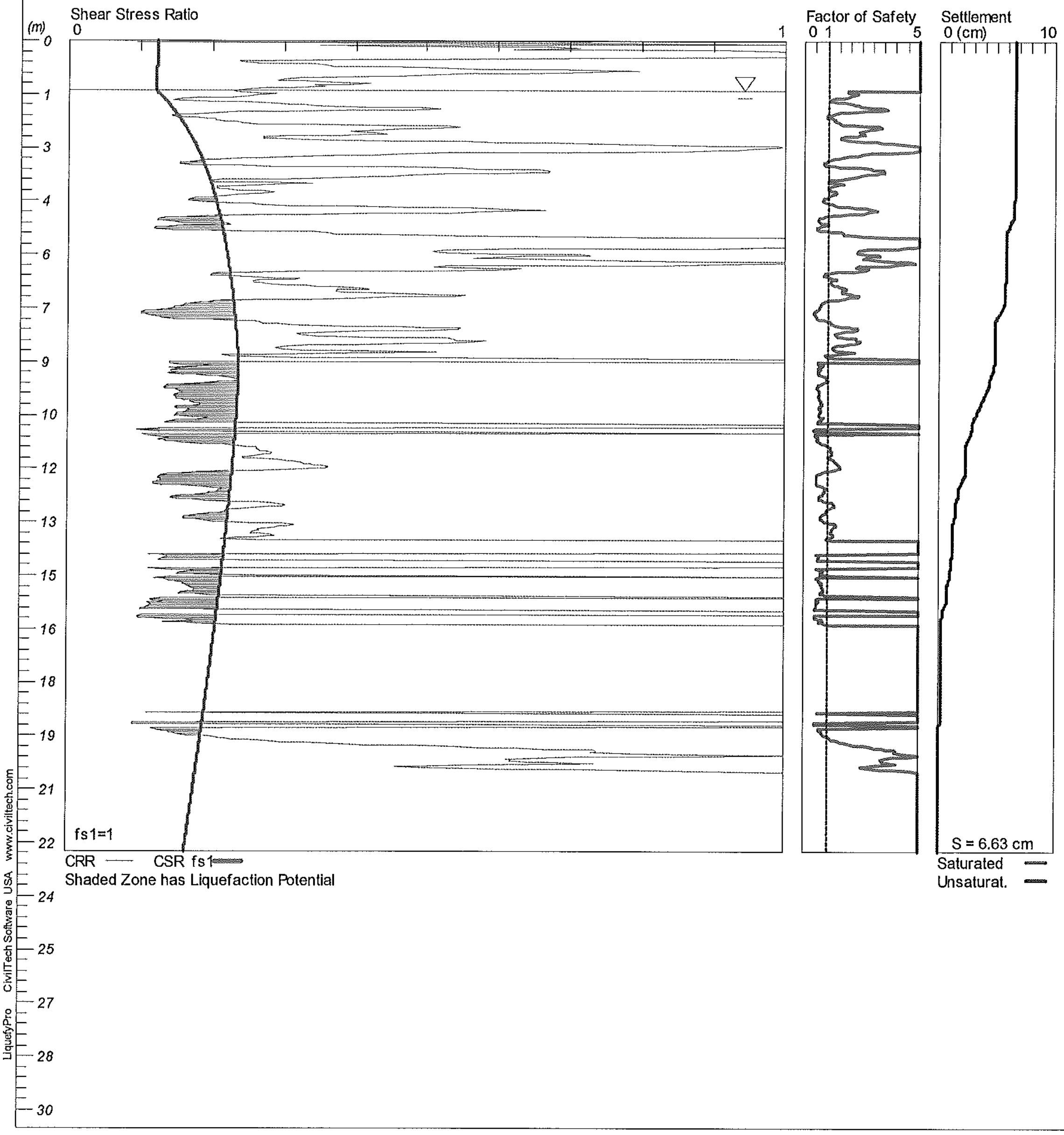


LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT11 Water Depth=1.38 m

Magnitude=7.5
Acceleration=0.19g



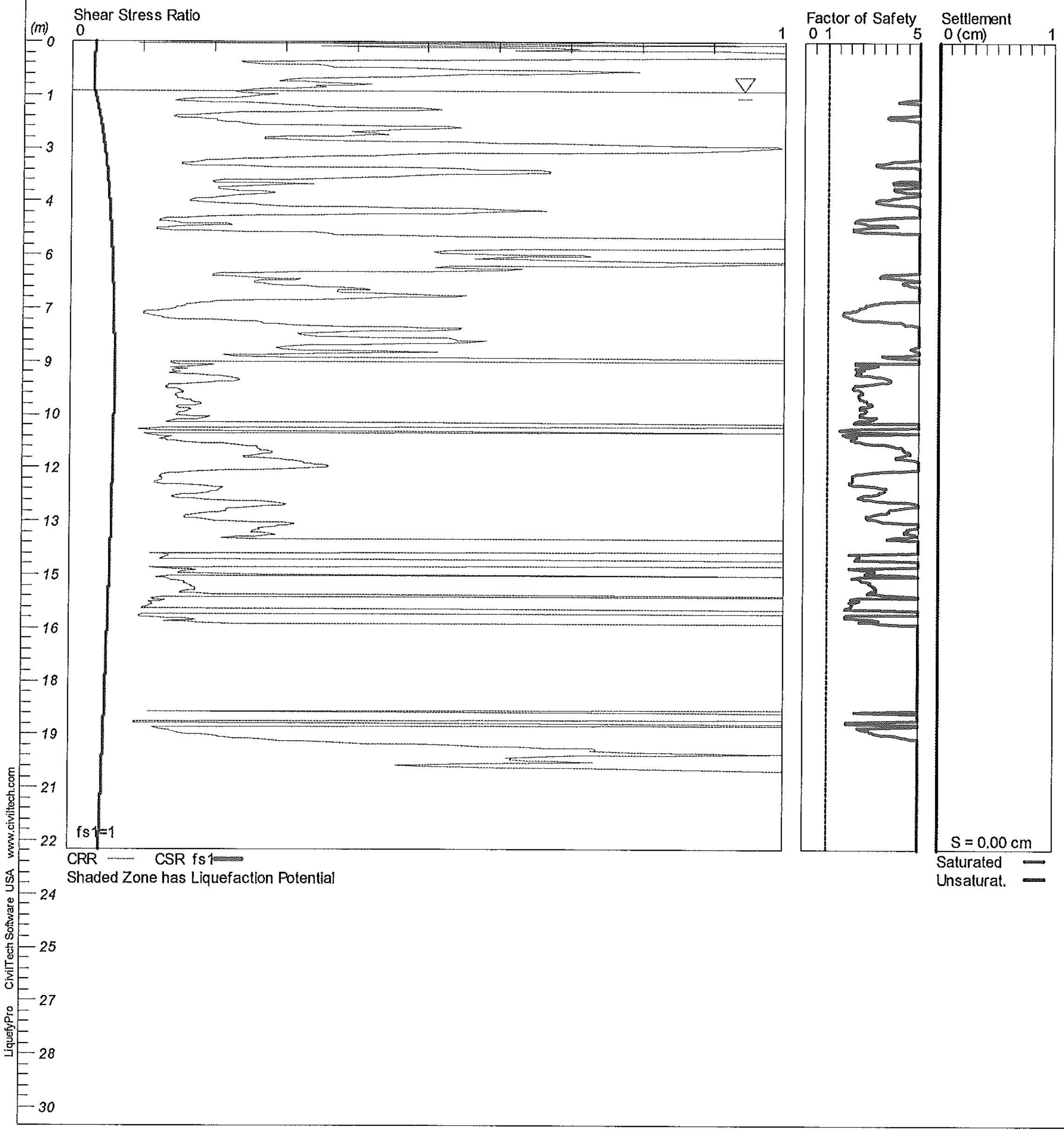
CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT11 Water Depth=1.38 m

Magnitude=7.5
Acceleration=0.05g



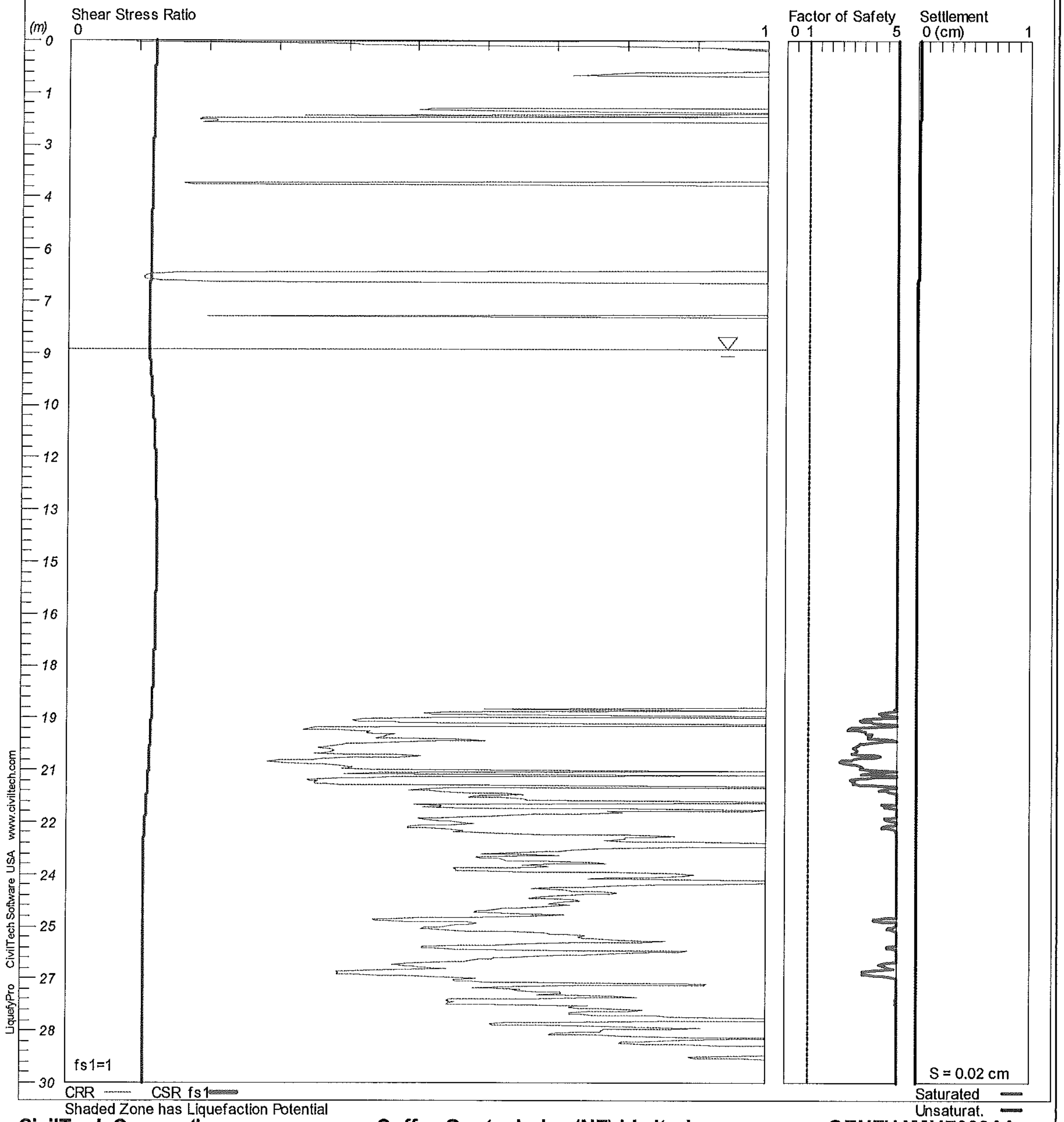
CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT12   Water Depth=8.9 m

Magnitude=7.5
Acceleration=0.19g



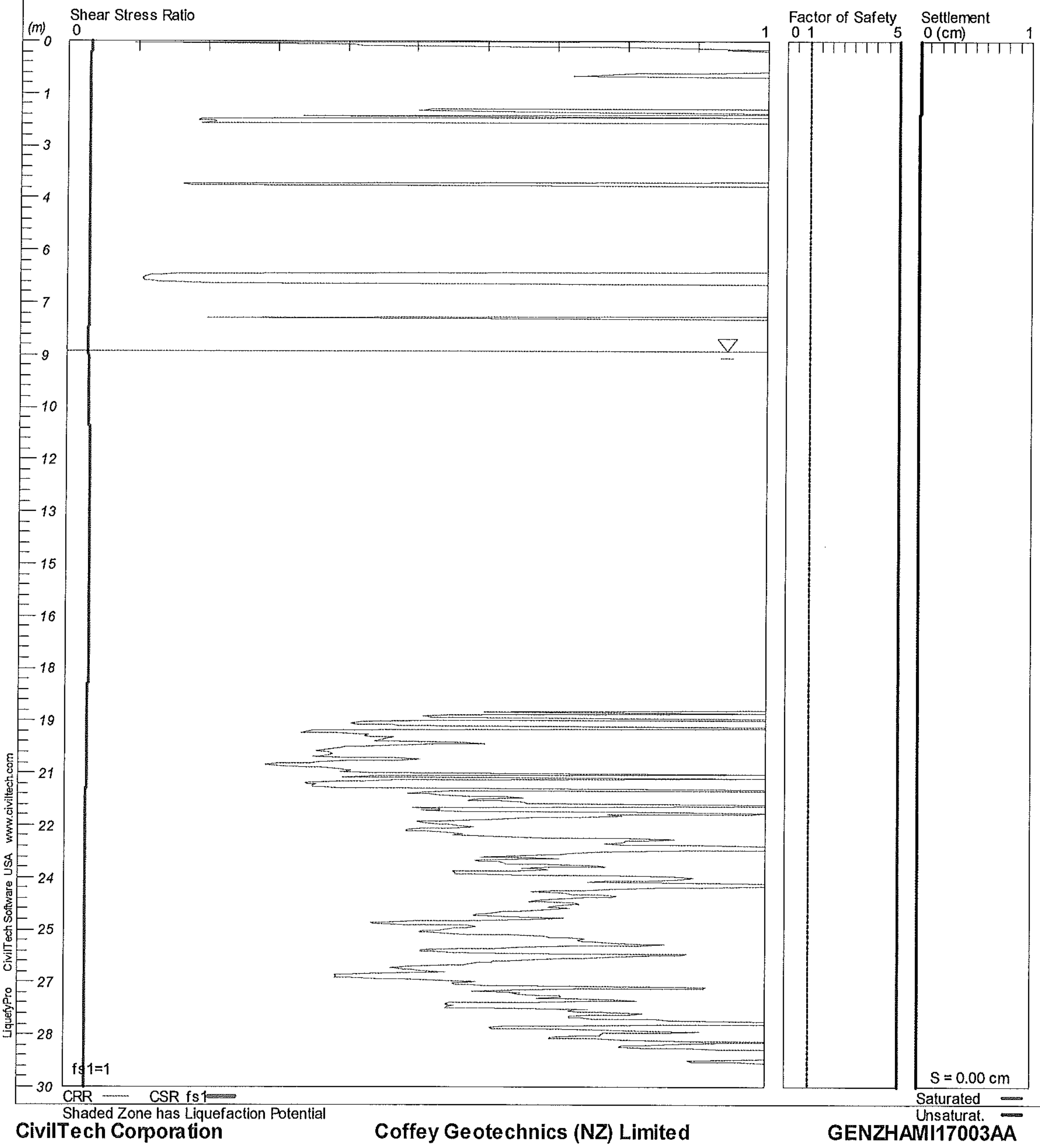
CivilTech Corporation   **Coffey Geotechnics (NZ) Limited**   **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT12 Water Depth=8.9 m *Magnitude=7.5*

Acceleration=0.05g



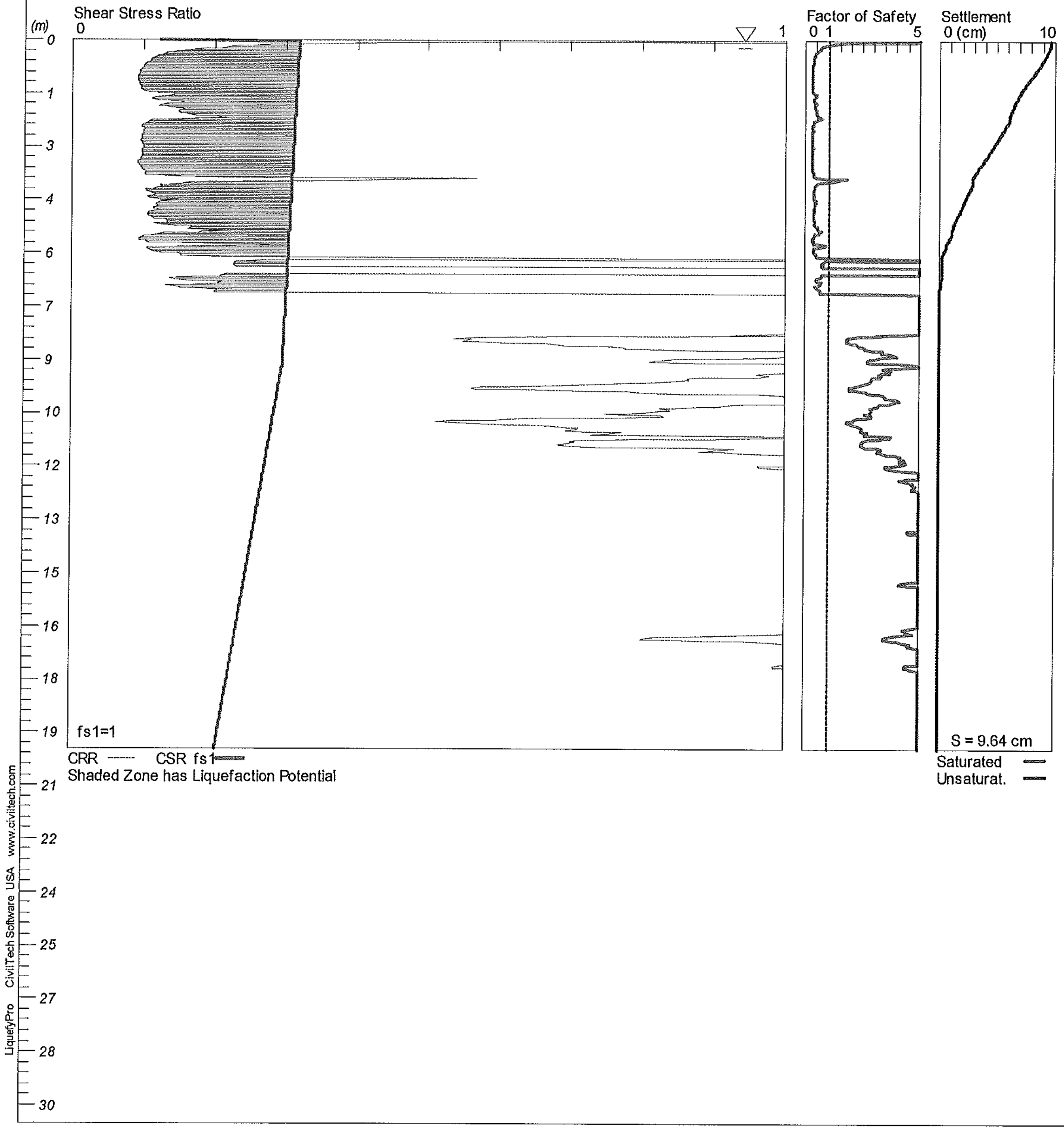
CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT12 Water Depth=0 m

Magnitude=7.5
Acceleration=.19g



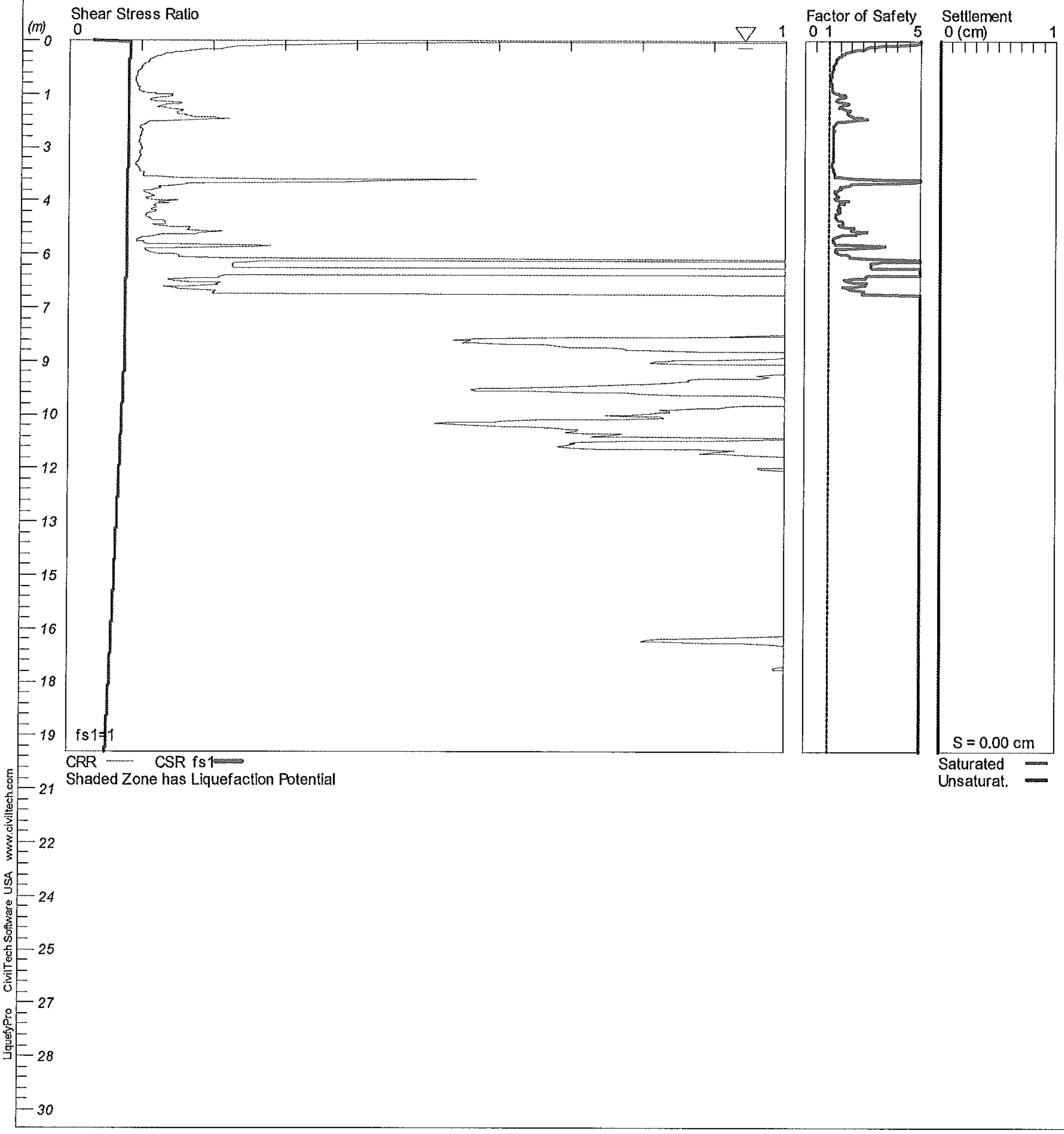
CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT12 Water Depth=0 m ***Magnitude=7.5***

Acceleration=.05g



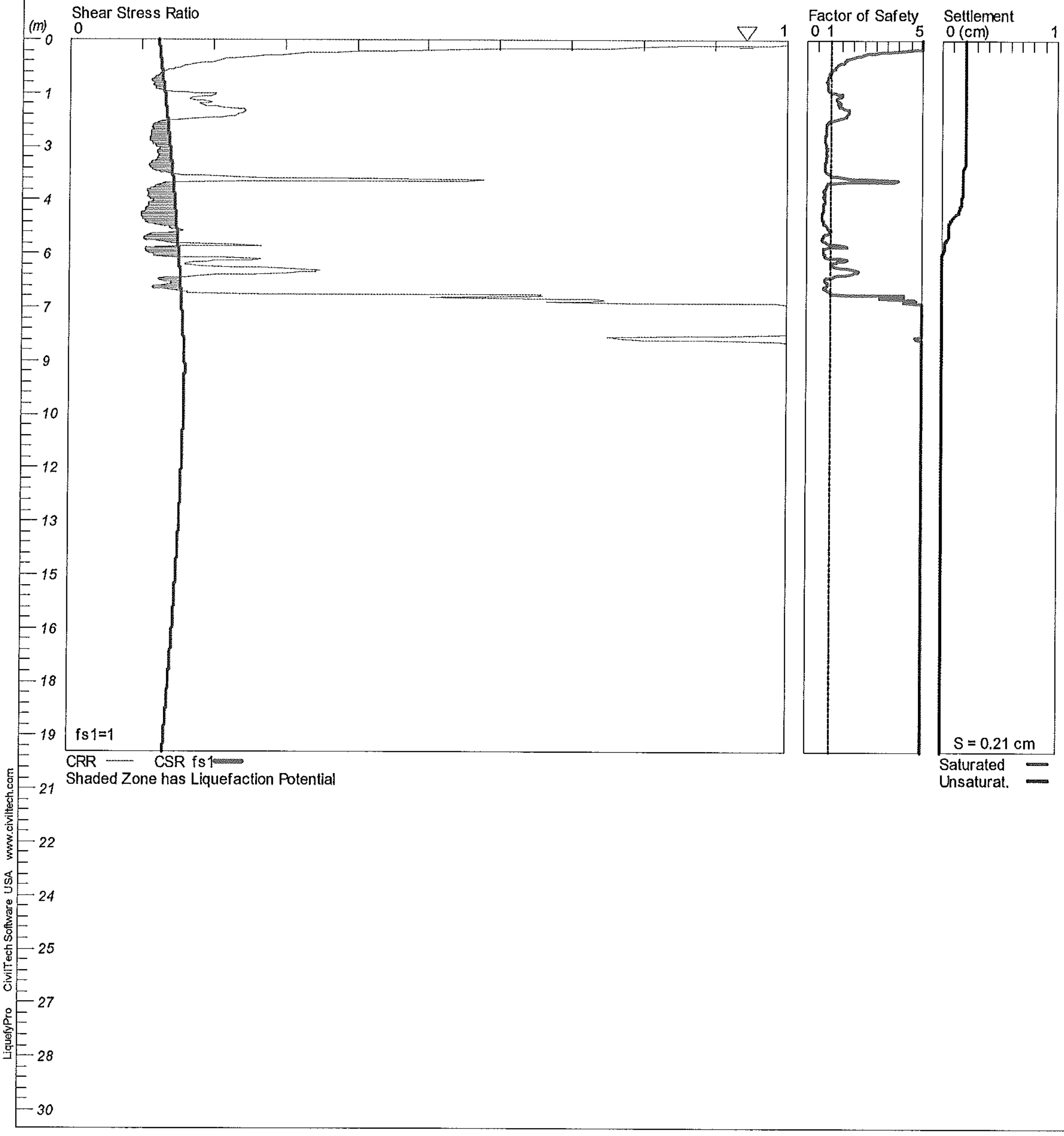
CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT12 Water Depth=0 m *Magnitude=7.5*

Ground Improvement of Fill=10 m *Acceleration=.19g*



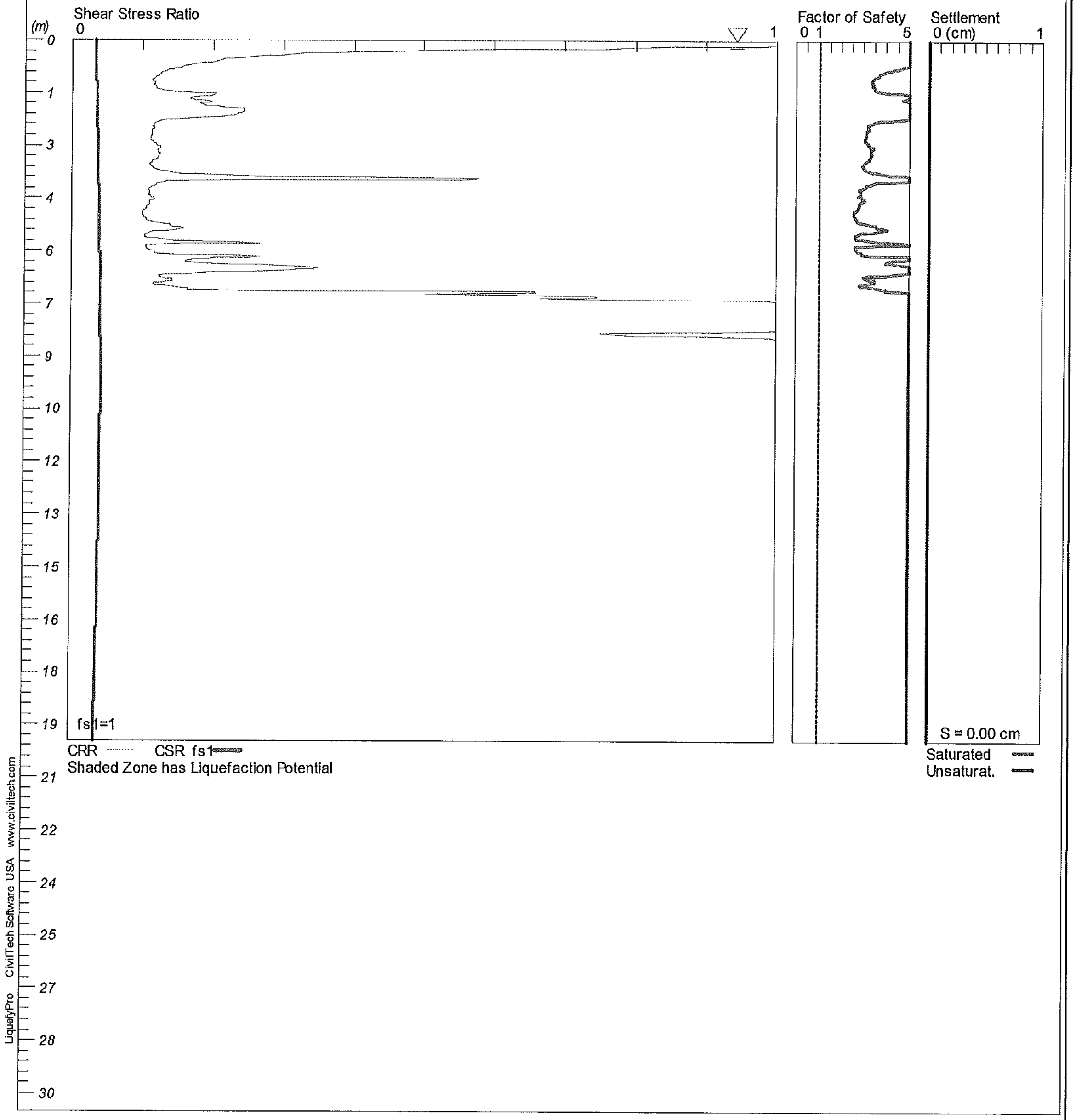
CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

LIQUEFACTION ANALYSIS

Montgomerie Block, Raynes Road, Hamilton

Hole No.=CPT12 Water Depth=0 m *Magnitude=7.5*

Ground Improvement of Fill=10 m *Acceleration=.05g*



CivilTech Corporation **Coffey Geotechnics (NZ) Limited** **GENZHAMI17003AA**

Appendix D: Liquefaction Analysis Results

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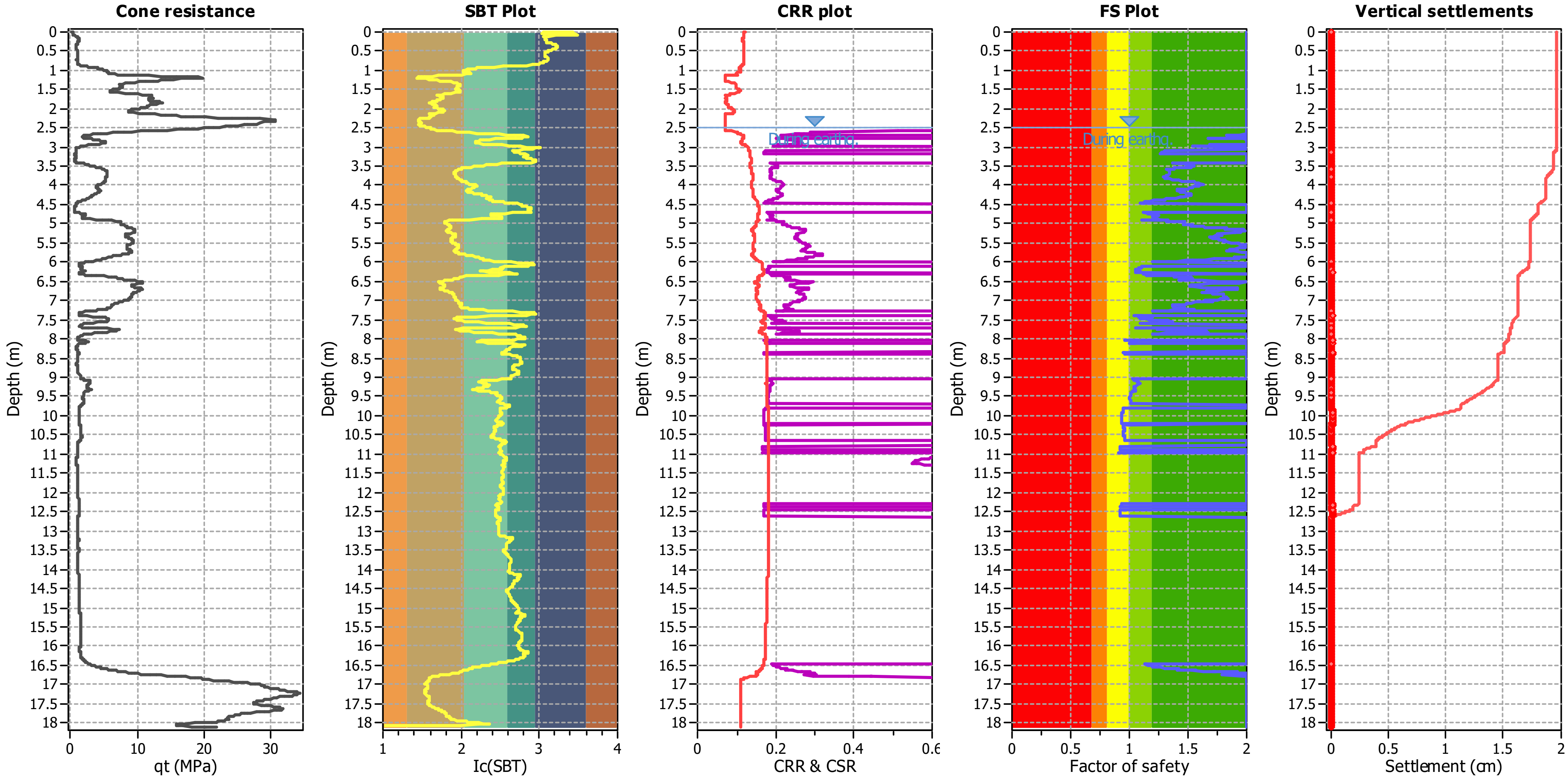
Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

CPT: CPT-01
Total depth: 18.11 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.90
Peak ground acceleration: 0.22

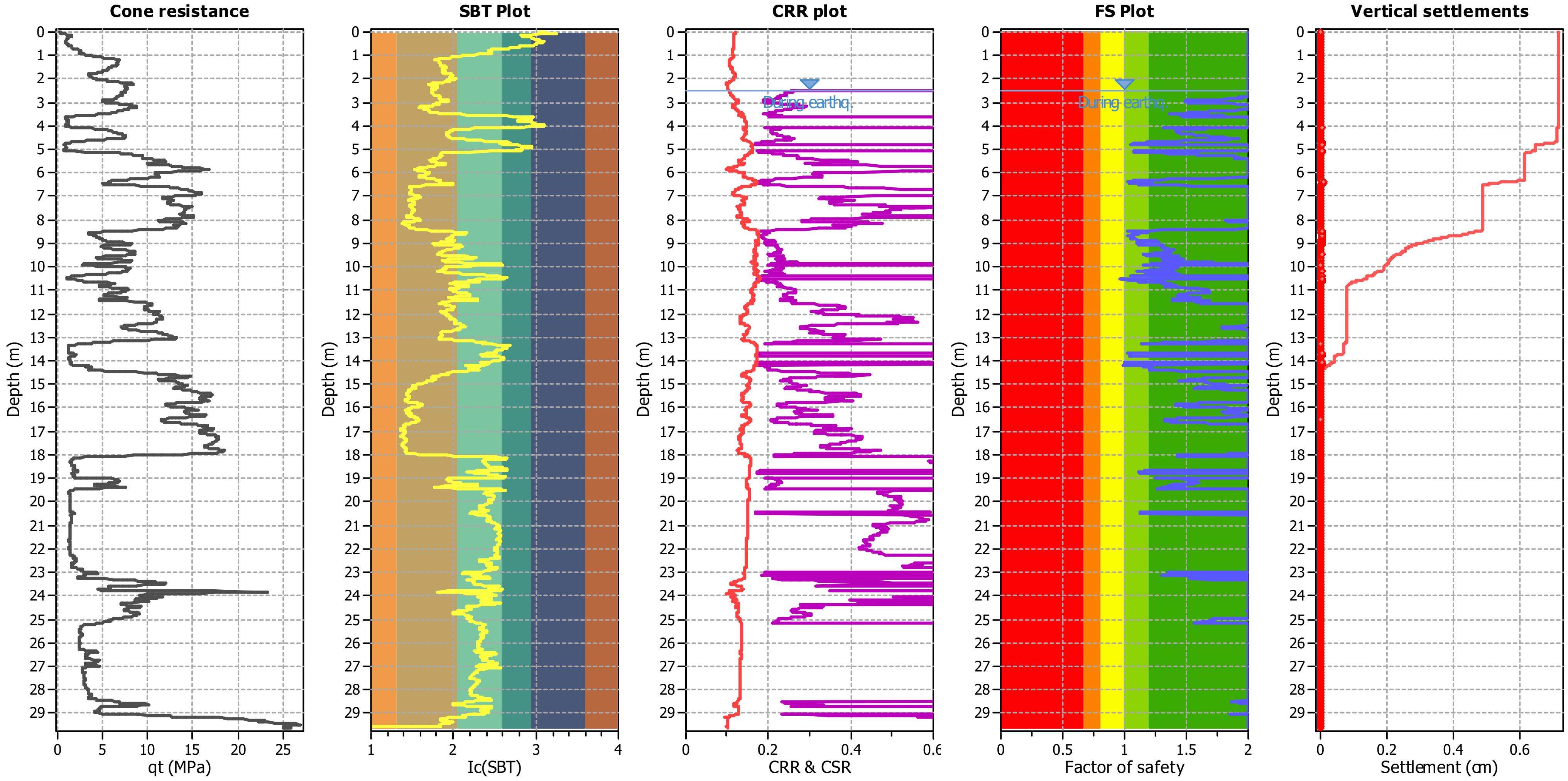
G.W.T. (in-situ): 2.50 m
G.W.T. (earthq.): 2.50 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT

Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

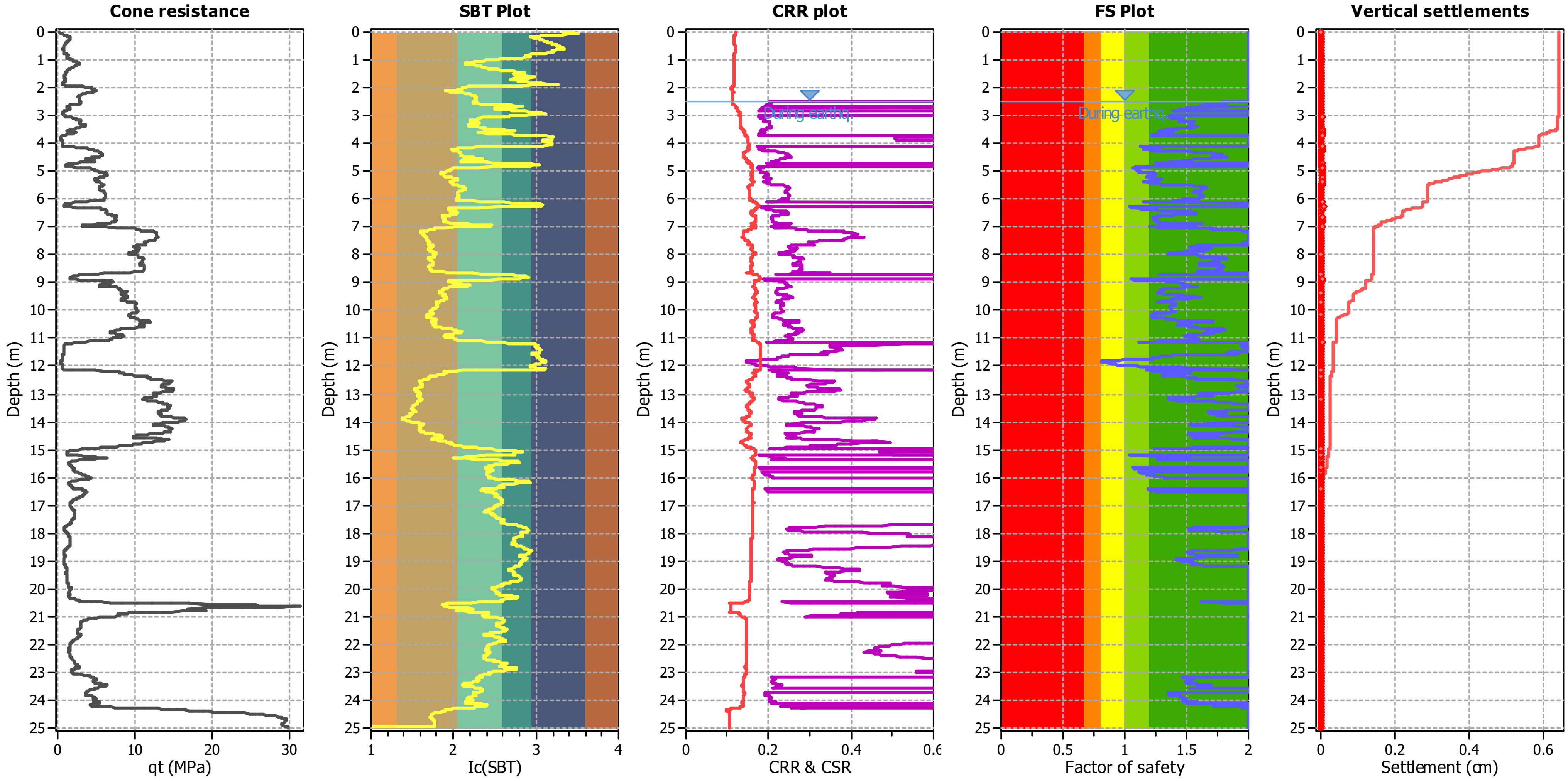
CPT: CPT-02
Total depth: 29.63 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

CPT: CPT-03
Total depth: 24.99 m



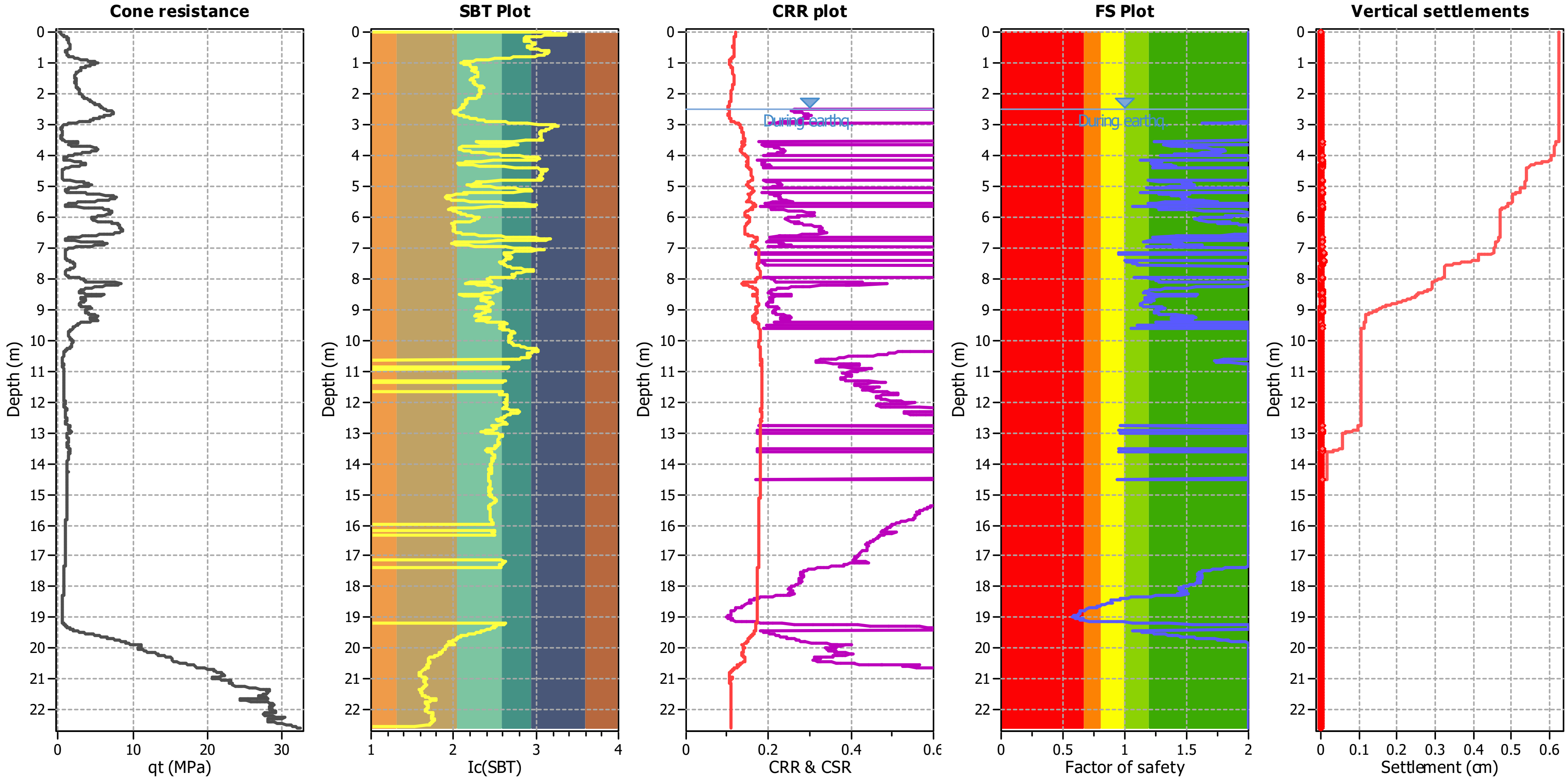
Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **Titanium Park Northern Precinct**

Location: **Raynes Road, Hamilton**

CPT: CPT-04

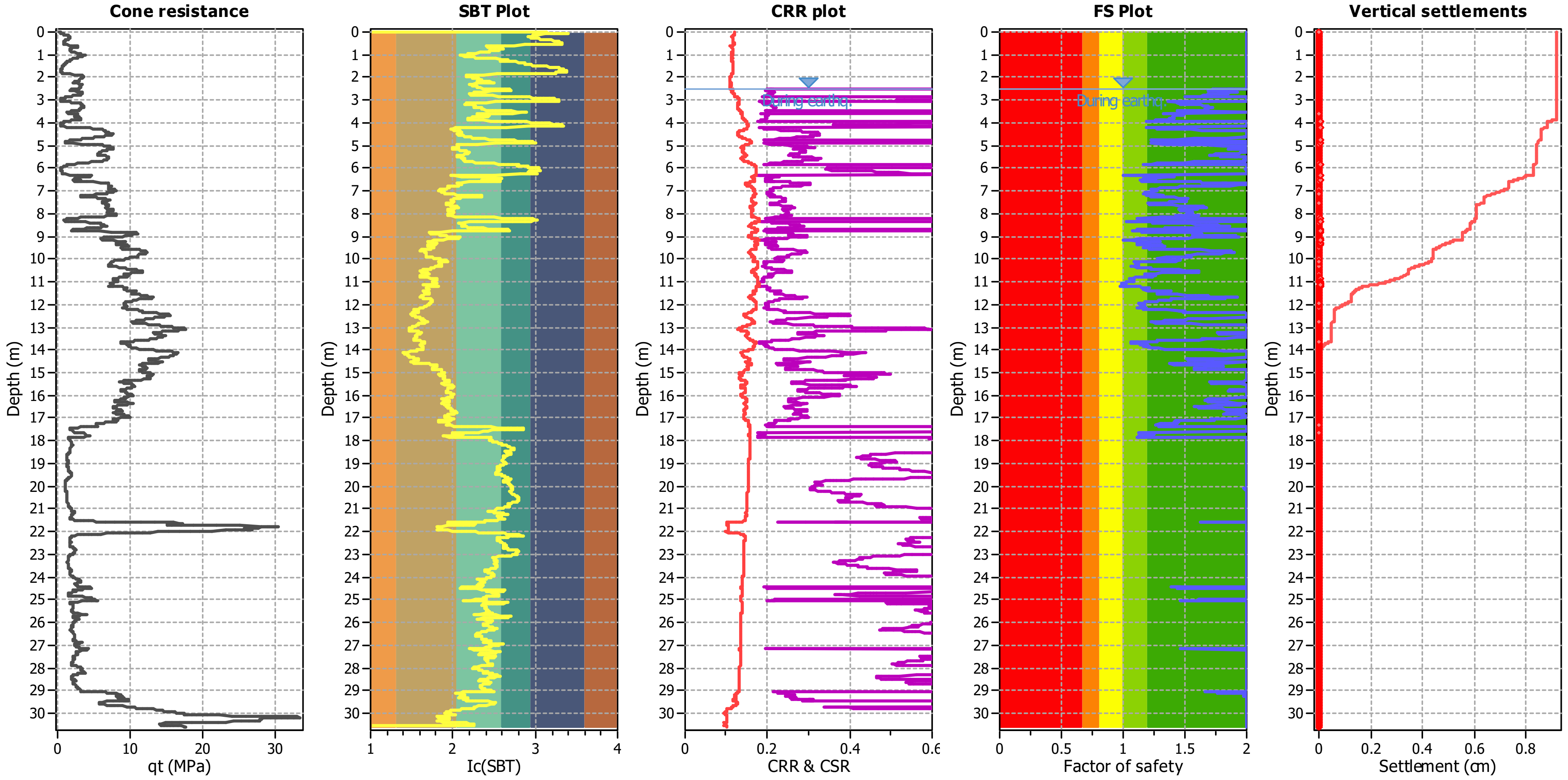
Total depth: 22.58 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

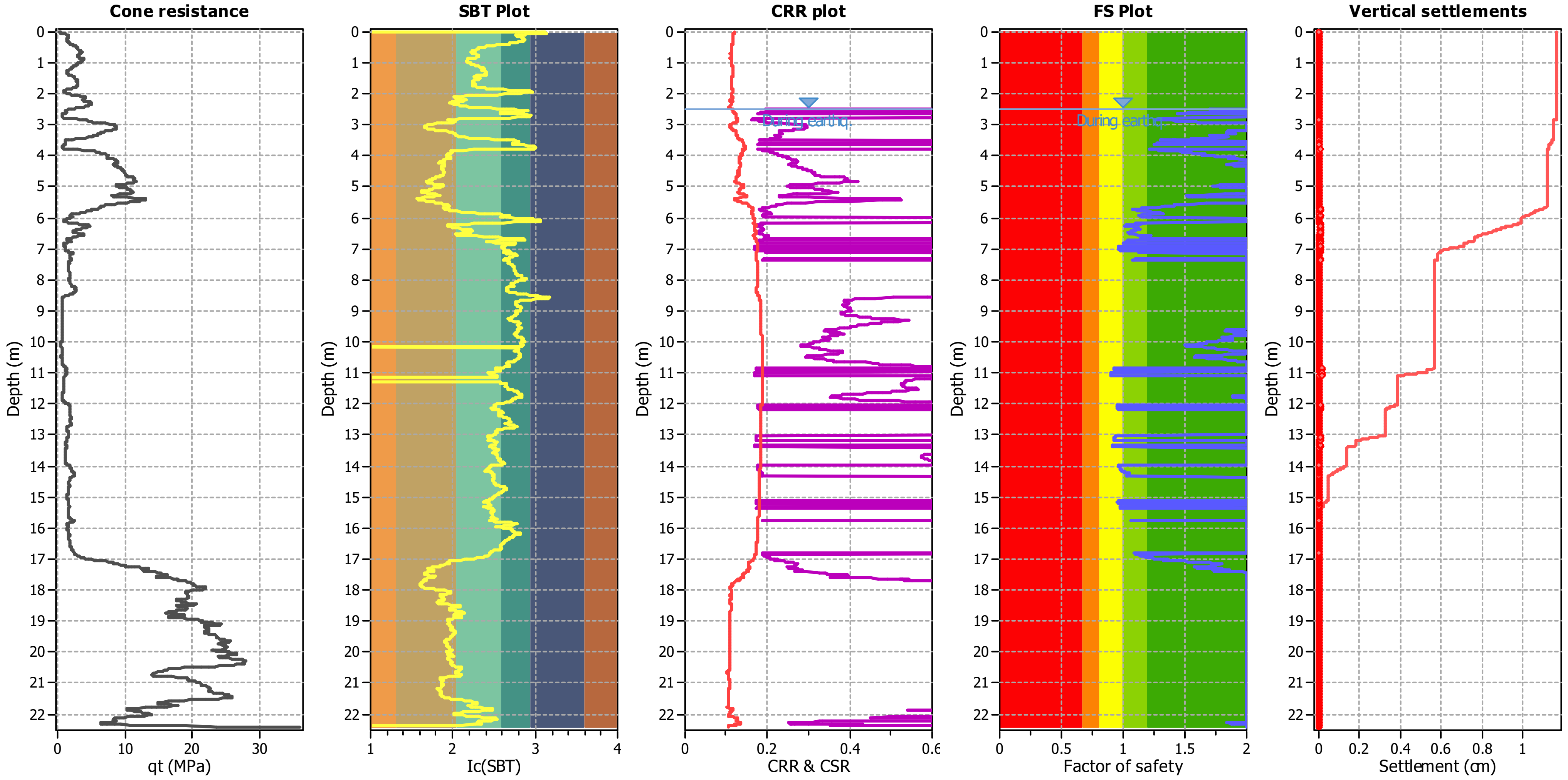
CPT: CPT-05
Total depth: 30.60 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

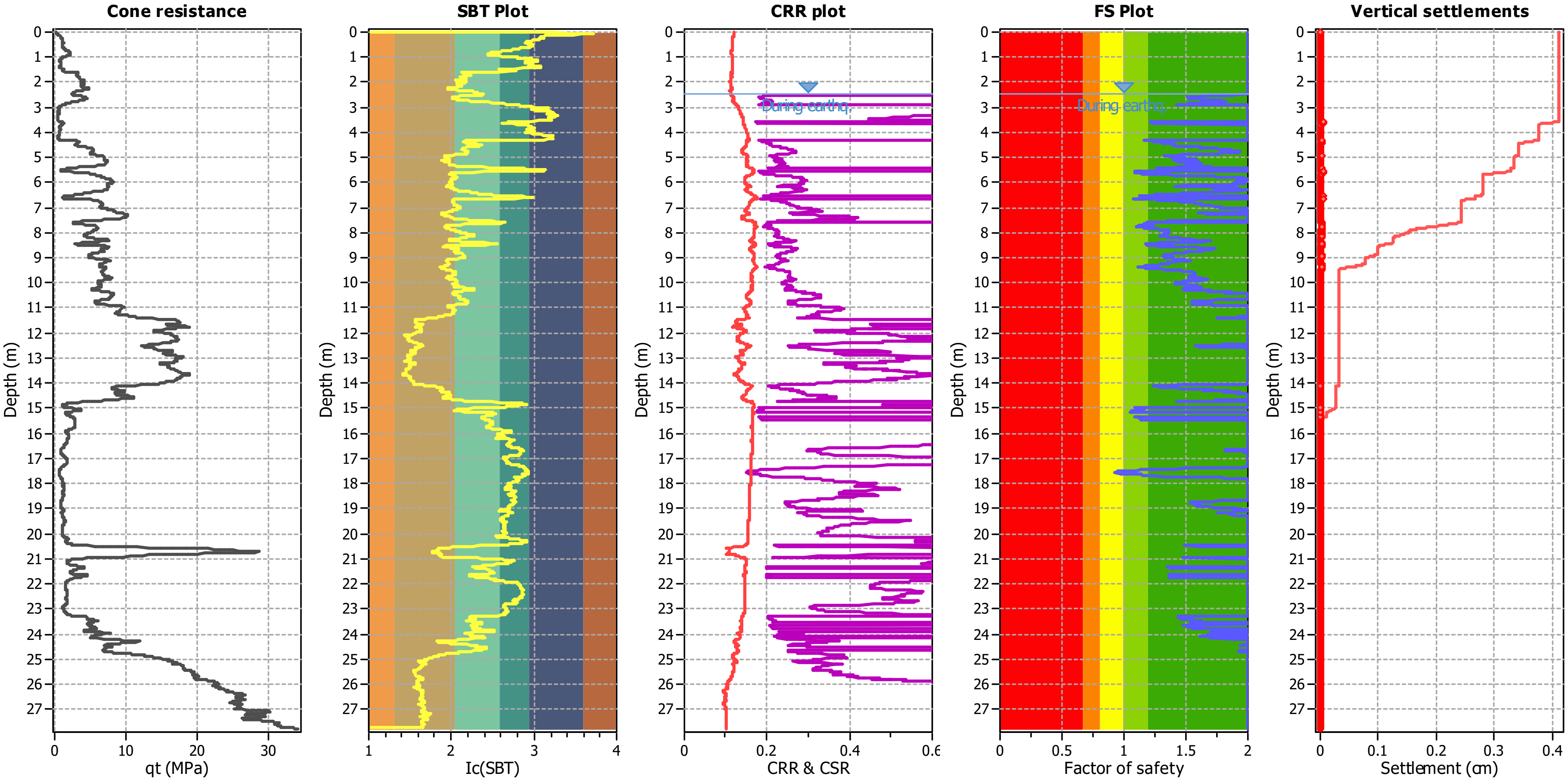
CPT: CPT-06
Total depth: 22.42 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

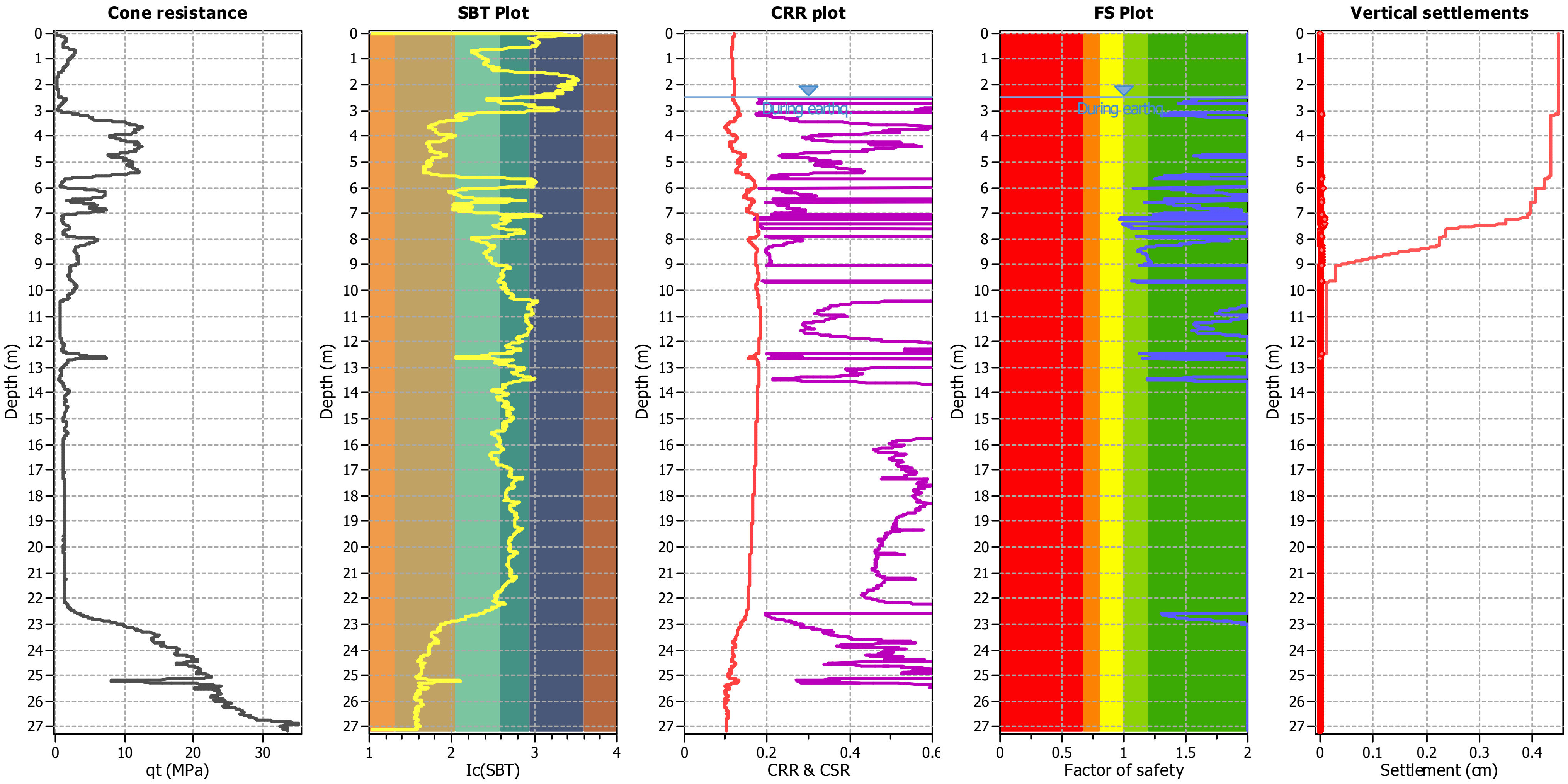
CPT: CPT-07
Total depth: 27.78 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

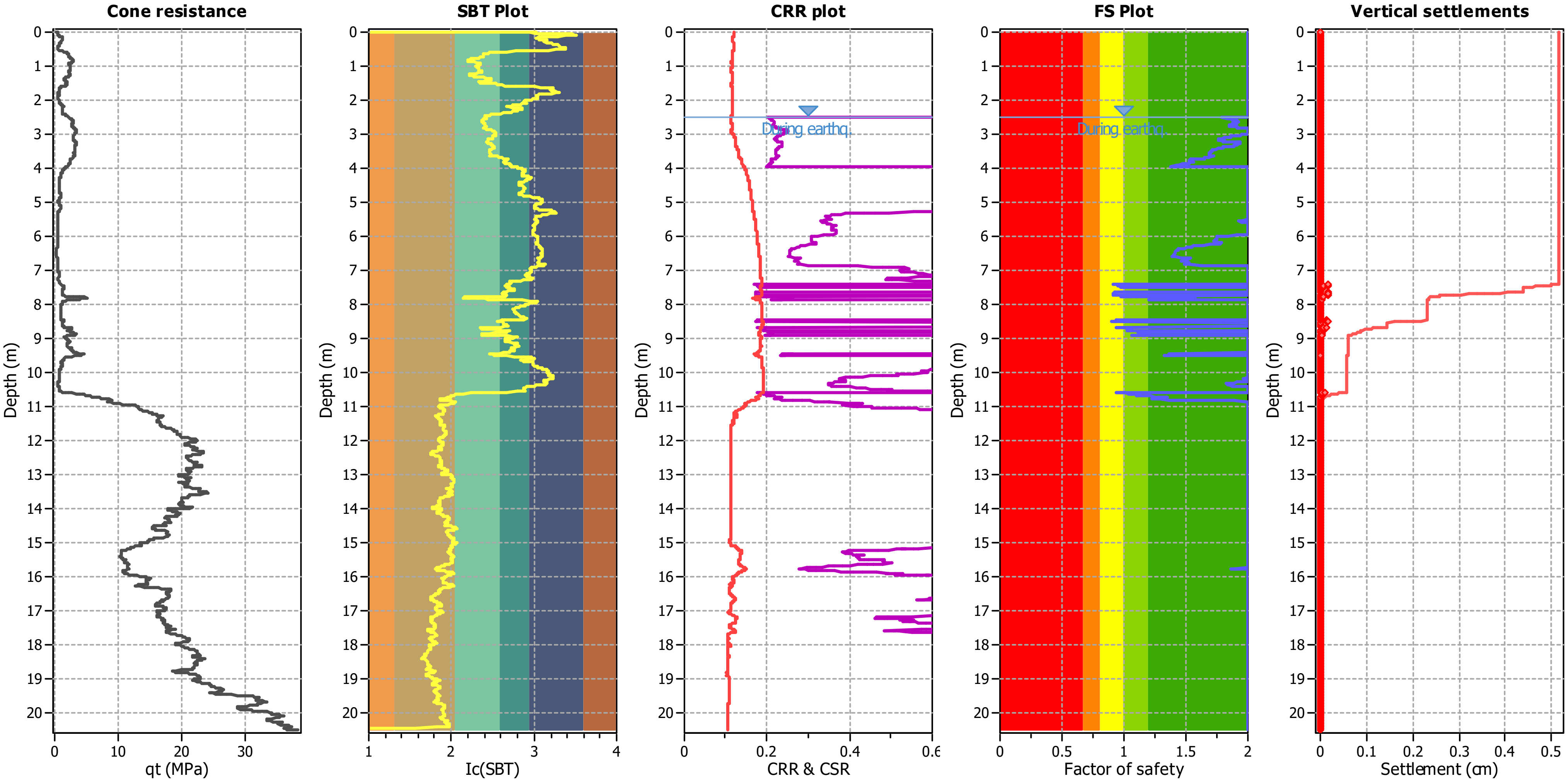
CPT: CPT-08
Total depth: 27.16 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

CPT: CPT-09
Total depth: 20.48 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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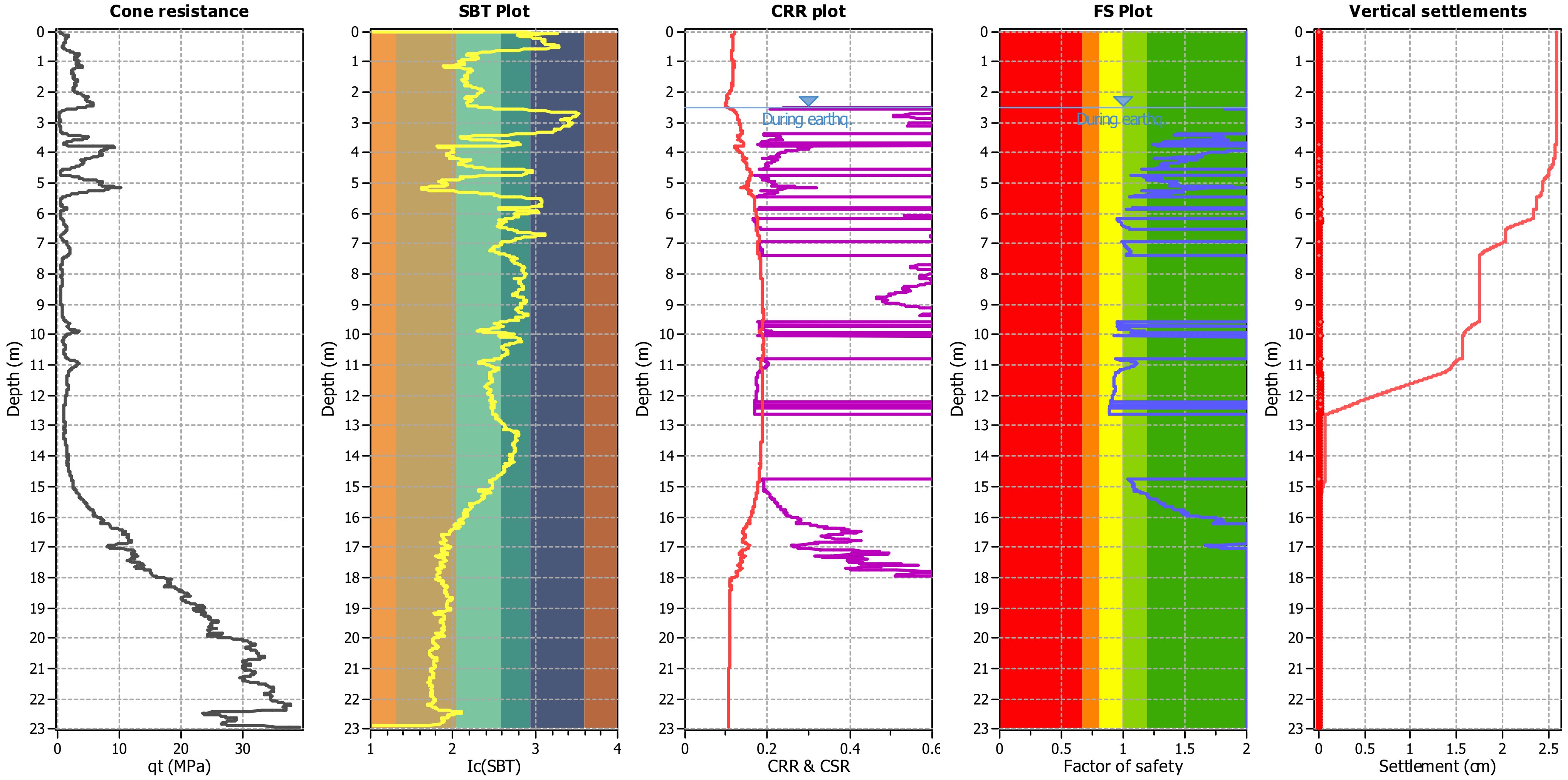
Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

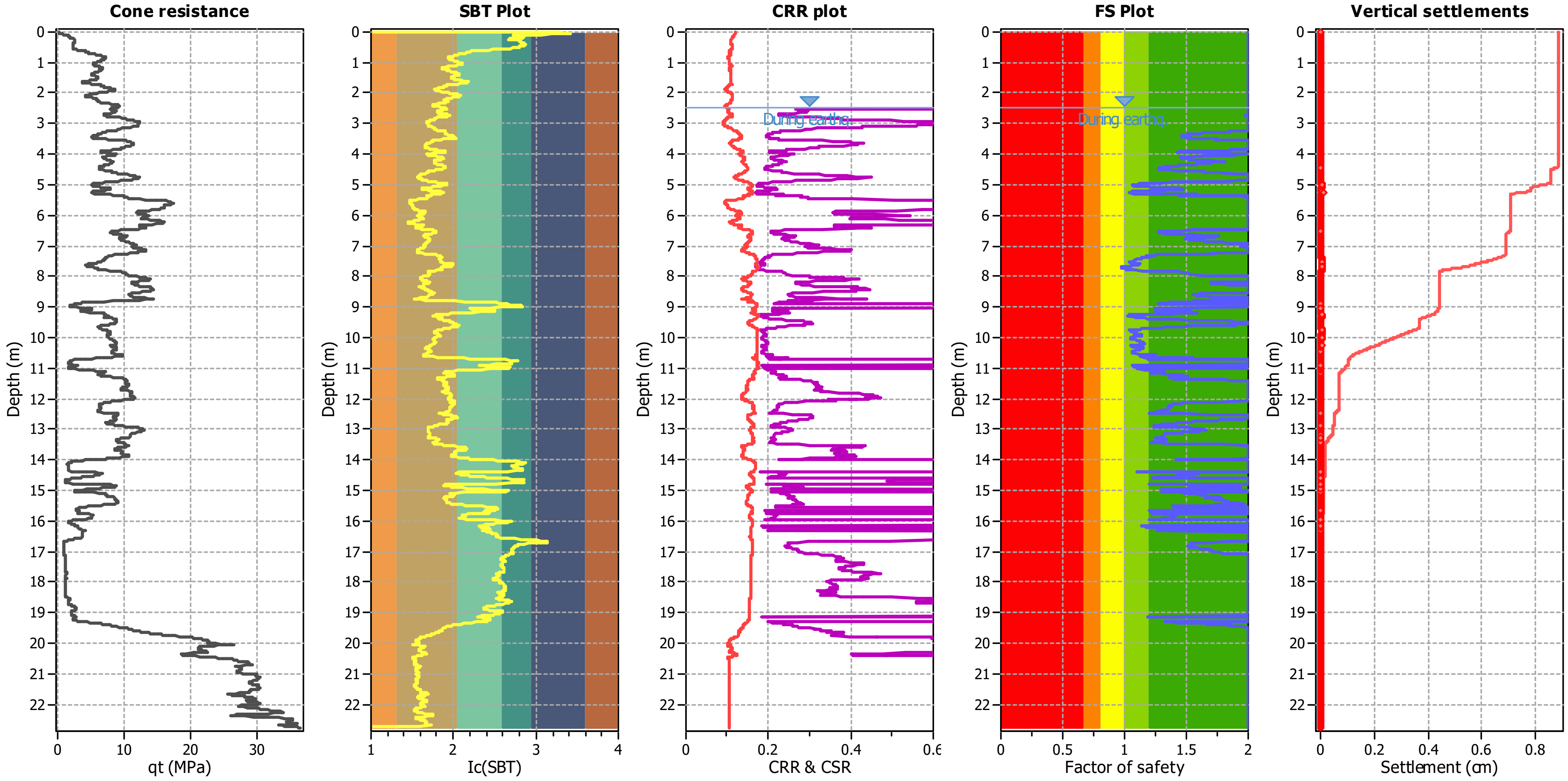
CPT: CPT-10
Total depth: 22.94 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

CPT: CPT-11
Total depth: 22.77 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

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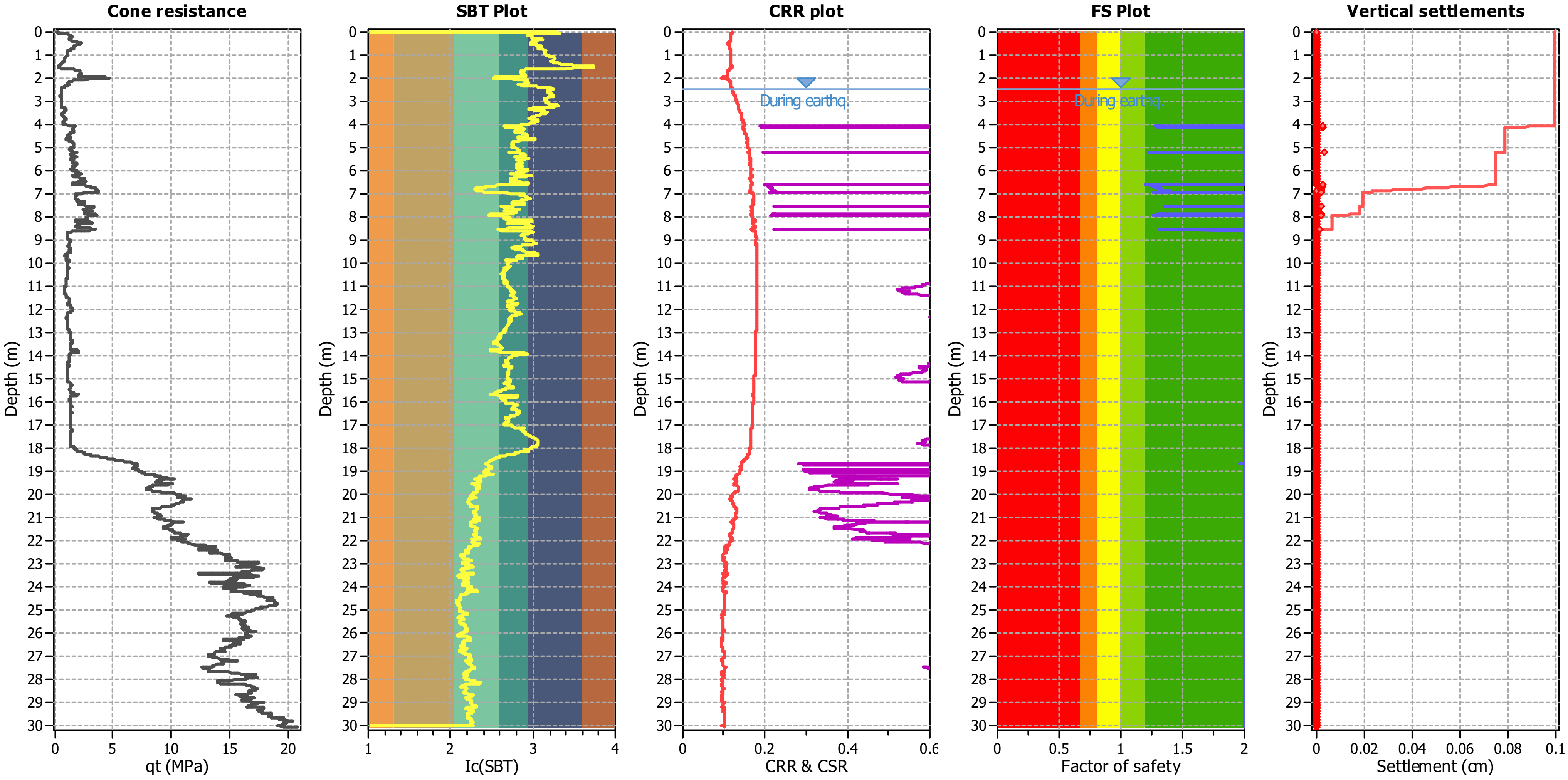
Project: **Titanium Park Northern Precinct**

Location: **Raynes Road, Hamilton**

CPT: CPT-12

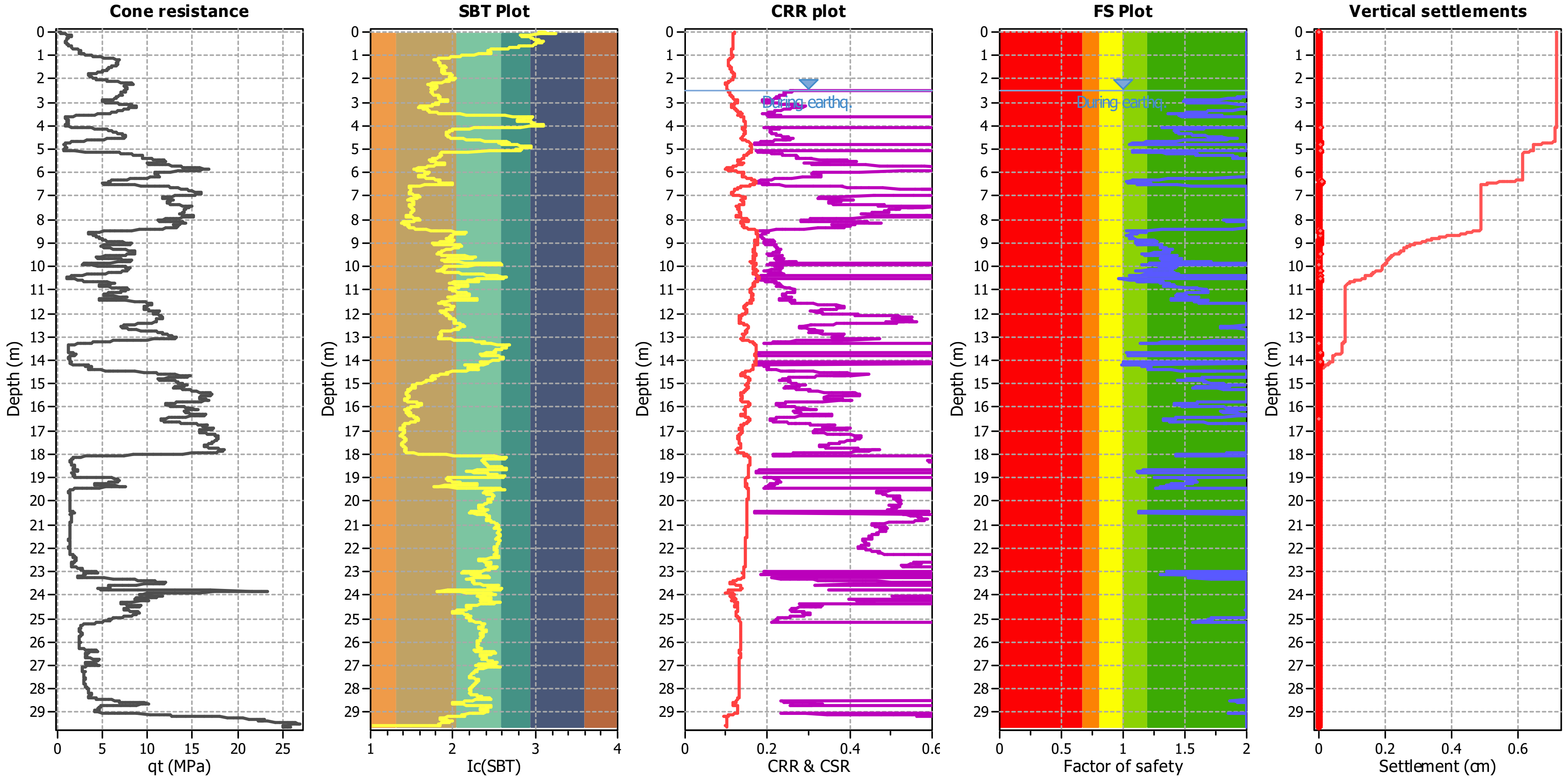
Total depth: 30.09 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

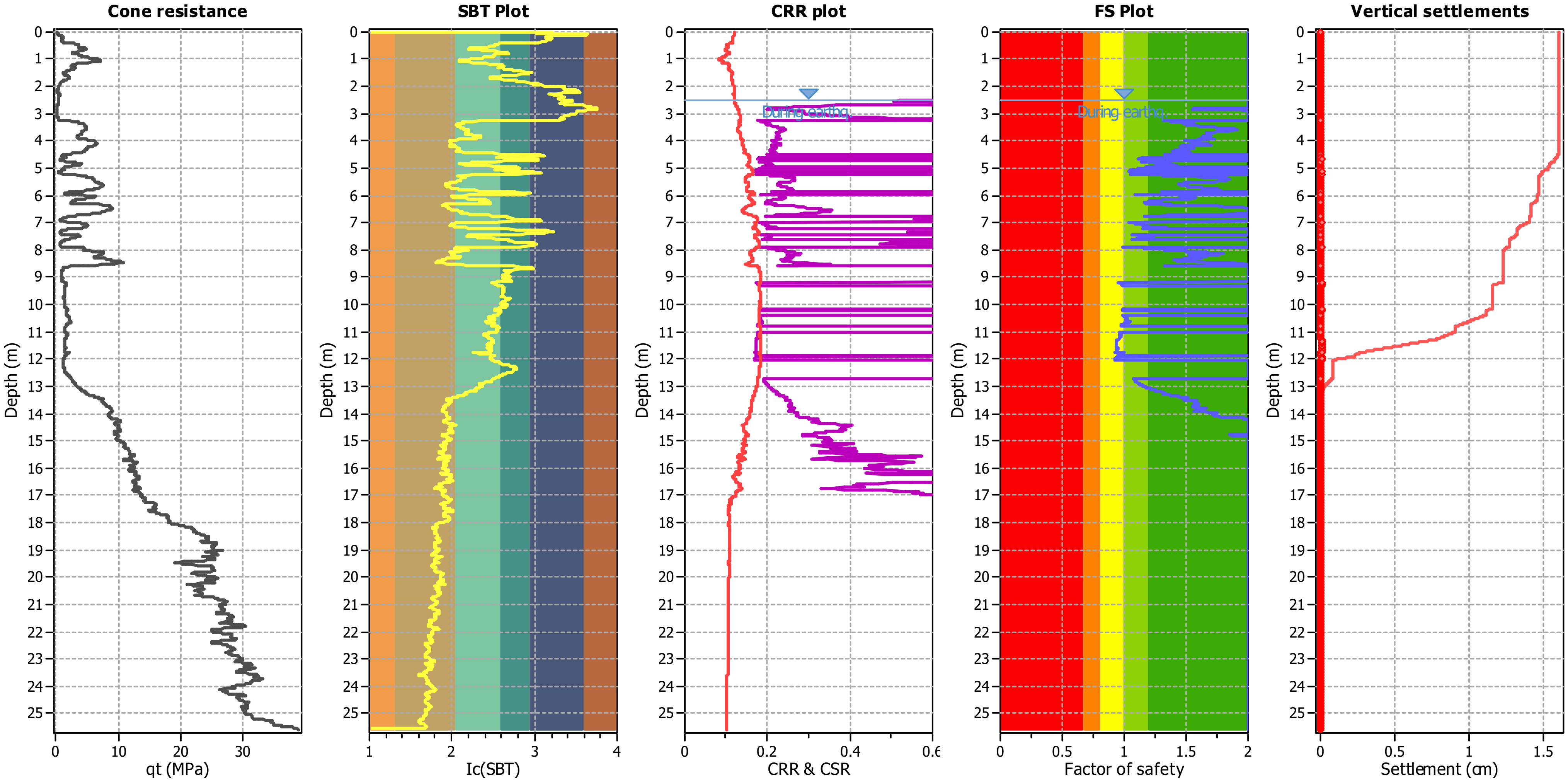
CPT: CPT-13
Total depth: 29.63 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **Titanium Park Northern Precinct**
Location: **Raynes Road, Hamilton**

CPT: CPT-14
Total depth: 25.60 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.22	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project title : Titanium Park Northern Precinct

Location : Raynes Road, Hamilton

Overall vertical settlements report