

**PROPOSED EXTENSIONS TO LAKE
MACQUARIE YACHT CLUB,
BELMONT**

EJE Architecture Pty Ltd

GEOTWARA20706AA-AF
4 June 2009

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EJE Architecture Pty Ltd
412 King Street
NEWCASTLE NSW 2300

Attention: Peter Johnson

Dear Peter

**RE: PROPOSED EXTENSIONS TO CAR PARK AND NEW CLUBHOUSE
LAKE MACQUARIE YACHT CLUB
GEOTECHNICAL ASSESSMENT**

Please find enclosed our report on the above project.

If you have any questions regarding this matter, please do not hesitate to contact Robert Pearce or the undersigned.

For and on behalf of Coffey Geotechnics Pty Ltd



Arthur Love

Principal Geotechnical Engineer

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1 INTRODUCTION

This report presents the results of a geotechnical assessment carried out by Coffey Geotechnics Pty Ltd (Coffey) for a proposed extension to the existing Lake Macquarie Yacht Club (LMYC) car park area and a proposed new clubhouse or refurbishment of the existing clubhouse.

The work was commissioned by Peter Johnson of EJE Architecture in an email dated 27 November 2008.

The proposed development is understood to involve extension of the existing car park area over the existing rock ballast walls to both the north and south by construction of new pile supported concrete edge beams and construction of suspended concrete slabs or similar. A new clubhouse or refurbishment of the existing clubhouse is also proposed.

The scope of work for the geotechnical assessment included providing recommendations on:

- Pavement design and construction;
- Alternative footing types and founding depths, including recommendations as to allowable bearing pressure and probable settlements;
- Acid sulfate soil conditions and requirements for an acid sulfate soil management plan;
- Groundwater issues;
- Potential mine subsidence constraints.

A plan of the proposed development (ref: EJE Architecture Project No. 4000, Drawing No. A02, dated 9 January 2009) and survey plan of the site (ref: Harper Somers O'Sullivan Job Ref: 25536, dated 18 November 2008) was provided by the client.

2 FIELD WORK

Field work was carried out on 14 January 2009 and consisted of:

- Cone Penetrometer Testing (CPT) at six locations (CPT-01 to CPT-06) using a truck mounted rig to a maximum depth of 7.8m;
- Hand augering six boreholes to a maximum depth of 1.0m below lake bed level. Disturbed samples of representative materials were taken for subsequent laboratory testing;
- Dynamic Cone Penetrometer (DCP) testing adjacent to borehole locations and at an additional six locations to a maximum depth of 2.85m below lake bed level;
- Observation and mapping of relevant site features.

All field work was carried out in the full time presence of an Engineering Geologist from Coffey who located the CPT and borehole locations, carried out the sampling and testing and produced field logs for the boreholes.

CPT results and engineering logs of the boreholes are presented in Appendix A, together with explanation sheets defining the terms and symbols used in their preparation. Results of DCP testing are also included in Appendix A. CPT and borehole locations were located by tape measurements relative to existing site features. Approximate CPT and borehole locations are shown on Figure 1.

3 SITE CONDITIONS

3.1 Surface Conditions

The site is located near the eastern shoreline of Lake Macquarie, off the end of Ada Street, Belmont. The site has been formed by filling into Lake Macquarie and is about 1.0m above lake water level. The site is accessed via a short bridge. The existing car park and boat storage area is roughly rectangular in shape and is about 35m wide by about 100m long with its long axis orientated in roughly an east / west direction. The existing clubhouse and adjoining courtyard area is located at the western end of the car park area and occupies an area of about 45m by 25m. The existing clubhouse is thought to be largely supported on timber piles above the lake.

Topographically the site is located near the base of a prominent hill formation and the eastern shoreline of Lake Macquarie.

The existing car park is flat to slightly sloping and is asphalt surfaced. Rock boulders have been placed around the majority of the perimeter of this area. The existing clubhouse comprises a one and two storey clad and tile roof building. The area immediately to the north of the clubhouse comprises a partially covered, relatively flat paved and grassed courtyard area.

Timber pile supported decking is located around the three sides of the clubhouse and courtyard area bordering the lake.

3.2 Subsurface Conditions

Reference to the 1:100,000 scale Newcastle Coalfield Regional Geology Series Sheet 9231 indicates the site is underlain by Quaternary aged sand deposits near the base of a hill formation underlain by the Moon Island Beach Subgroup of the Newcastle Coal Measures comprising conglomerate, sandstone, siltstone, tuff and coal.

The subsurface profiles encountered at borehole locations are presented on the appended engineering logs and have been divided into geotechnical units as summarised in Table 1.

TABLE 1 – SUMMARY OF GEOTECHNICAL UNITS AND SOIL TYPES ENCOUNTERED AT BOREHOLE LOCATIONS

GEOTECHNICAL UNIT	MATERIAL TYPE	DESCRIPTION
UNIT 2A	ORGANIC	Organic SILT and PEAT, dark grey, organic odour.
UNIT 2B	ALLUVIAL / ESTUARINE SAND	SAND, fine to medium grained, very loose to loose and wet.
UNIT 3	RESIDUAL	CLAY, of high plasticity, very stiff consistency, grey, light grey and blue, blocky structure.

Table 2 provides a summary of the distribution of the above geotechnical units at each borehole location.

TABLE 2 – SUMMARY OF DISTRIBUTION OF GEOTECHNICAL UNITS AT BOREHOLE LOCATIONS

LOCATION	UNIT 2A	UNIT 2B	UNIT 3
	DEPTH ENCOUNTERED BELOW LAKE BED LEVEL (m)		
HA1	0.00 – 0.30	-	0.30 – 0.60
HA2	0.00 – 0.10	0.10 - >0.70	-
HA3	-	0.00 - >0.50	-
HA4	0.00 – 0.10	-	0.10 – 0.40
HA5	-	0.00 - >0.90	-
HA6	0.00 – 0.10	0.00 - >1.00	-

Water depth varied from between 0.2m to 1.2m at borehole locations during the field investigation.

DCP testing carried out at borehole locations and an additional six locations around the perimeter of the existing clubhouse indicates sands are typically very loose to loose to depths of between 0.30m below lake bed level at the eastern end of the existing car park area to the limit of testing at depths of up to 2.85m below lake bed level at the western end of the car park area. DCP refusal was encountered at about 0.90m depth below lake bed level at the eastern end of the existing car park area, probably on weathered rock.

CPT values indicate a subsurface profile comprising interbedded predominately Sand, Silty Sand and Sandy Silt, overlying predominately Clay with thin Sand, Silty Sand and Sandy Silt bands, except at CPT-04, overlying weathered rock causing CPT refusal at some locations.

Table 3 provides a summary of inferred geotechnical units encountered at each CPT location.

TABLE 3 – SUMMARY OF DISTRIBUTION OF INFERRED GEOTECHNICAL UNITS AT CPT LOCATIONS

INFERRED GEOTECHNICAL UNIT	UNIT 1	UNIT 2B	UNIT 2C	UNIT 4
MATERIAL	FILL*	ALLUVIAL SAND (interbedded predominately Sand, Silty Sand and Sandy Silt), of variable density ranging from very loose to very dense	ALLUVIAL CLAY, of stiff to hard consistency, with thin interbedded Sand, Silty Sand and Sandy Silt bands	WEATHERED ROCK, causing CPT refusal
LOCATION	DEPTH ENCOUNTERED BELOW EXISTING GROUND SURFACE LEVEL (m)			
CPT-01	0.00 – 0.90	0.90 – 2.40	2.40 – 5.90	5.90 (R)
CPT-02	0.00 – 0.90	0.90 – 2.20	2.20 – 5.80	5.80 (R)
CPT-03	0.00 – 1.10	1.10 – 2.70	2.70 – 6.70	6.70 (R)
CPT-04	0.00 – 1.00	1.00 – 7.20	-	7.20 (R)
CPT-05	0.00 – 0.50	0.50 – 5.40	5.40 - >6.90	-
CPT-06	0.00 – 1.80?	1.80? – 4.60	4.60 – 7.80?	7.80?
NOTES: * - Fill depths assumed base on interpretation of CPT results and site observations; (R) - CPT refusal encountered.				

4 DISCUSSIONS AND RECOMMENDATIONS

4.1 General

Based on a plan of the proposed development, construction of a pile supported concrete edge beam and suspended concrete slabs or similar over the existing rock ballast walls along the northern and southern edges of the existing car park area will widen the existing car park by less than typically 3m and 5m respectively, except at the south western corner where it will create a finished surface that is up to about 10m wider than the existing.

Details of the proposed new clubhouse are not known at this stage, however based on a plan of the proposed development it is understood it will be located over roughly the same building footprint as the existing clubhouse. Soils beneath lake bed level within the existing and proposed new clubhouse building footprint are expected to comprise Unit 2 alluvium, comprising variable density sands overlying stiff to hard clays, to greater than 7m depth below existing car park level. Therefore, it is recommended that the proposed new clubhouse be supported on pile foundations founded into weathered rock beneath any Unit 1 fill and variable density Unit 2 alluvium.

4.2 Pavement Design

4.2.1 Design Traffic Loading

A design traffic loading of 7×10^4 ESAs has been adopted for areas of the existing car park that might require reconstruction, assuming a 'Local Road – Access Place or Cul-de-sac' street type in accordance with Lake Macquarie City Council guidelines.

4.2.2 Design CBR

A design subgrade CBR value of 10% has been adopted for the existing car park area assuming existing embankment fill materials comprise clean sand or similar.

4.2.3 Flexible Pavement Design

A flexible pavement thickness design for proposed car park reconstruction areas has been prepared with reference to APRG Report No. 21.

The recommended material, construction specification and pavement make-up is presented on the attached Pavement Thickness Design Summary (PTDS) sheet.

It is recommended that each construction length be boxed out to the minimum subgrade level required and the exposed subgrade assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.

4.2.4 Drainage

The enclosed pavement design assumes the provision of adequate surface and subsurface drainage of the pavement and adjacent areas. Subsoil drains are not considered to be necessary provided existing embankment fill materials comprise clean sand or similar.

4.3 Foundations

Suitable pile options include grout injected piles, 'Atlas' screw piles or driven piles. Large heavily driven piles should consider the potential effect of vibration on existing structures. Conventional bored piles are not recommended due to the potential for collapse of the wet sands.

Piles founded into Unit 3 weathered rock may be designed for the Geotechnical Strength parameters provided in Table 4.

TABLE 4 –DESIGN GEOTECHNICAL STRENGTH PARAMETERS

FOUNDING MATERIAL	ULTIMATE END BEARING PRESSURE ^{1,3} (kPa)	SERVICEABILITY END BEARING PRESSURE ^{2,3} (kPa)	ULTIMATE SHAFT ADHESION ³ (kPa)
Unit 3 (weathered rock)	2100	700	70
NOTES: 1. <i>Ultimate values occur at large settlements (>5% of pile diameter);</i> 2. <i>End bearing pressure to cause settlement of <1% of pile diameter;</i> 3. <i>Parameter applicable for bored piles with a minimum socket length equal to the pile diameter.</i>			

The above parameters may be able to be upgraded subject to further geotechnical investigation comprising cored boreholes. A geotechnical reduction factor of 0.45 should be applied to ultimate capacities to obtain limit state design parameters.

The capacity of piles driven to a refusal set may be evaluated by the Hiley pile driving formulae once the pile capacity and hammer size and type are known. Depth to the required set will be dependant on required capacity and size of piles and would be best evaluated by driving test piles.

4.4 Acid Sulfate Soils (ASS) Assessment

4.4.1 Background Information

Acid Sulfate Soils (ASS), are soils which contain significant concentrations of pyrite which, in the present of sufficient moisture, oxidises when exposed to oxygen, resulting in the generation of sulphuric acid.

Unoxidised pyritic soils are referred to as potential ASS. When the soils are exposed, the oxidation of pyrite occurs and sulphuric acids are generated, the soils are said to be actual ASS.

Pyritic soils typically form as waterlogged, saline sediments rich in iron and sulphate. Typically, the environments for the formation of these soils include tidal flats, salt marshes and mangrove swamps below about RL 5m AHD. They can also form as bottom sediments in coastal rivers and creeks.

Pyritic soils of concern on low lying NSW and coastal lands have mostly formed in the Holocene period, (ie: 10, 000 years ago) predominantly in the 7,000 years since the last rise in sea level. It is generally considered that pyritic soils which formed prior to the Holocene period (ie: >10,000 years ago) would already have oxidised and leached during periods of low sea level during ice ages, which exposed pyritic coastal sediments to oxygen.

4.4.2 Significance of ASS

Disturbance or poorly managed development and use of acid sulphate soils can generate significant amounts of sulfuric acid, which can lower soil and water pH to extreme levels (generally <4) and produce acid salts, resulting in high salinity.

The low pH, high salinity soils can reduce or altogether preclude vegetation growth and can produce aggressive soil conditions which may be detrimental to concrete and steel components of structures, foundations, pipelines and other engineering works.

Generation of the acid conditions often releases aluminium, iron and other naturally occurring elements from the otherwise stable soil matrices. High concentrations of some such elements, coupled with low pH and alterations to salinity can be detrimental to aquatic life. In severe cases, affected waters can have a detrimental effect on aquatic ecosystems.

4.4.3 Acid Sulfate Soils Risk Map

Reference to the Acid Sulfate Soils Risk Map for Swansea 9231N4 indicates that the site is located in an area where there is a high probability of occurrence of acid sulfate soil materials below lake water level. Figure 2 shows the relevant part of this map and the location of the site.

4.4.4 Laboratory Testing

Samples obtained during the field investigation were screened for the presence of actual and potential acid sulfate soils using methods 21Af and 21Bf of the 1998 ASSMAC Guidelines.

The results of screening tests are presented in Appendix B and are summarised below:

- pH values in 1:5 soil to distilled water mix ranged from 6.49 to 8.31. A pH of <4 in this test can indicate the presence of actual ASS;
- pH values of soil in 30% H₂O₂ were between 1.45 to 4.97. A pH of <3 in this test can indicate the presence of potential ASS;
- A maximum pH change of 6.86 after oxidation with H₂O₂ was recorded. Significant pH changes (>2) after oxidation with H₂O₂ can indicate potential ASS. pH changes >2 were recorded in all of the samples tested;
- Slight to moderate effervescence was observed during oxidation with H₂O₂ in all samples tested. Vigorous effervescent reactions with oxidation in H₂O₂ can indicate potential ASS;
- No odour was released upon oxidation with H₂O₂ in all samples tested. A sulphurous odour is often associated with oxidising potential ASS;
- A maximum temperature of 26.7°C was recorded for all H₂O₂ oxidation screening tests. Generally the oxidation of significant quantities of pyrite in this test will generate temperatures to >60°C.

4.4.5 Laboratory Analysis

Based on the results of screening tests, selected samples were sent in an ice filled esky to a NATA registered chemical laboratory under chain of custody conditions for SCR technique analysis.

Laboratory test results for samples sent for SCR technique analysis are summarised in Table 5.

TABLE 5 – SUMMARY OF ASS TEST RESULTS

LOCATION	SAMPLE DEPTH (m)	SCREENING TEST RESULT		S _{CR} (%)	NET ACIDITY (mol H ⁺ / tonne)	LIMING RATE (kg / tonne)
		pH _F	pH _{FOX}			
HA1	0.00 – 0.30	6.49	2.00	0.832	358	27
HA2	0.10 – 0.30	7.51	2.57	0.152	-434	-33
HA5	0.60 – 0.70	8.06	4.12	0.130	-128	-10
HA6	0.60 – 0.70	8.31	1.45	0.396	167	13
ASSMAC Action Criteria	-	-	-	0.1* 0.03**	62* 18**	-
Levels of Concern for Screening Test	-	4	3	-	-	-
NOTES: * - Action criteria shown are those for fine textured soils (ie clays) and management of excavations involving disturbance of less than 1000 tonnes of soil. ** - Action criteria shown are those for coarse textured soils (ie sands) and management of excavations involving disturbance of more than 1000 tonnes of soil. S_{CR} – Percentage of chromium reducible sulfur						

4.4.6 Interpretations of Results

Results of screening tests indicate that none of the 12 samples tested are actual ASS. Results of SCR technique analysis indicate the percentage of chromium reducible sulphur in all of the samples tested and net acidity in two of the four samples tested exceed the ASSMAC action criteria and are therefore considered potential ASS. Works involving disturbance of soils that exceed these action criteria must prepare an Acid Sulfate Soils Management Plan.

A negative net acidity measured in two of the four samples tested indicates these samples had sufficient in situ neutralising capacity, probably in the form of shell matter, to neutralise the potential acidity.

4.4.7 Recommendation

Despite ASS being present in bottom sediments below lake water level, the risk of these soils being exposed to oxygen and hence generating sulphuric acid and causing harm to the environment is considered very low given the likely construction methodology (filling and driven piles).

Therefore it is assessed that an ASS Management Plan for construction works that involve no excavation of sediments from the lake bed, as is likely, is not required. If sediments are to be excavated from the lake bed and exposed to oxygen, an ASS Management Plan for construction activities will be required.

4.5 Groundwater Issues

The site is located within Lake Macquarie. It is understood that no temporary or permanent excavations below lake water level are proposed as part of the development. Piles, which are likely to be either driven or screwed, will extend below lake water level, but will not involve any excavation. Therefore it is considered unlikely that the proposed development will have any impact on groundwater levels or quality beneath the site.

4.6 Potential Mine Subsidence Constraints

The site is not located within a designated Mine Subsidence District and as such the MSB is not a referral authority for proposed development.

No mining has been carried out beneath the site so there are no restrictions on the development due to mine subsidence. The nearest mining is located about 500m to the north east of the site.

5 CONSTRUCTION RISK

The extent of the testing associated with this assessment is limited to discrete borehole and CPT locations. Subsurface conditions away from such locations may be different to those observed during testing and used as the basis of the recommendations contained in this report. If subsurface conditions encountered during excavation differ from those given in this report further advice should be sought without delay.

For and on behalf of Coffey Geotechnics Pty Ltd



Arthur Love

Principal Geotechnical Engineer

pavement thickness design summary

client :	EJE ARCHITECTURE PTY LTD	job no :	GEOTWARA20706AA
principal :		laboratory :	NEWCASTLE
project:	PROPOSED EXTENSIONS TO CAR PARK	report date :	14/05/2008
location :	LAKE MACQUARIE YACHT CLUB	designed by :	RJP
council :	LAKE MACQUARIE CITY COUNCIL	checked by :	

road name or type:	CAR PARK			
chainage interval: (m)				
design traffic loading: (ESA)	7 x 10 ⁴			
wearing course thickness: (mm)	30			
basecourse thickness: (mm)	100			
sub-base thickness: (mm)	50			
select thickness: (mm)				
total thickness: (mm)	250			
CBR used for design: (%)	10			

design traffic loading:

Design traffic loading is the number of equivalent standard axles (ESA) in the design lane during the design period. For definitions, refer Appendix 1.1 "Pavement Design" AUSTROADS. Refer covering letter/report.

material quality:

wearing course:	Conforming to council requirements
basecourse:	Conforming to ARRB Special Report No 41
sub-base:	Conforming to ARRB Special Report No 41
select:	

Note: Recommended materials types may vary from those of job specification or statutory authority. Refer covering letter/report.

compaction requirements:

wearing course :	Conforming to council requirements
basecourse :	98% MODIFIED
sub-base :	95% MODIFIED
select :	
subgrade :	80% DENSITY INDEX
fill below:	70% DENSITY INDEX

Modified: Minimum required dry density ratio, AS1289 5.4.1-2007, calculated using field dry density determined by AS1289 5.3.1-2004 or equivalent and the maximum dry density obtained using AS1289 5.2.1-2003 or equivalent.

Standard: As above, but maximum dry density obtained using AS1289 5.1.1-2003 or equivalent.

Density Index: Minimum required Density Index AS1289 5.6.1-1998, calculated using field dry density determined by AS1289 5.3.1-2004 or equivalent and laboratory values of maximum and minimum density obtained by AS1289 5.5.1-1998 or equivalent.

Note : Recommendations for compaction may vary from those of job specification or statutory authority. Refer covering letter/report.

Drainage:

The design assumes the provision of adequate surface and subsurface drainage of the pavement and adjacent areas. Refer covering letter/report.

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

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 exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing 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 reveal 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. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

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 and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

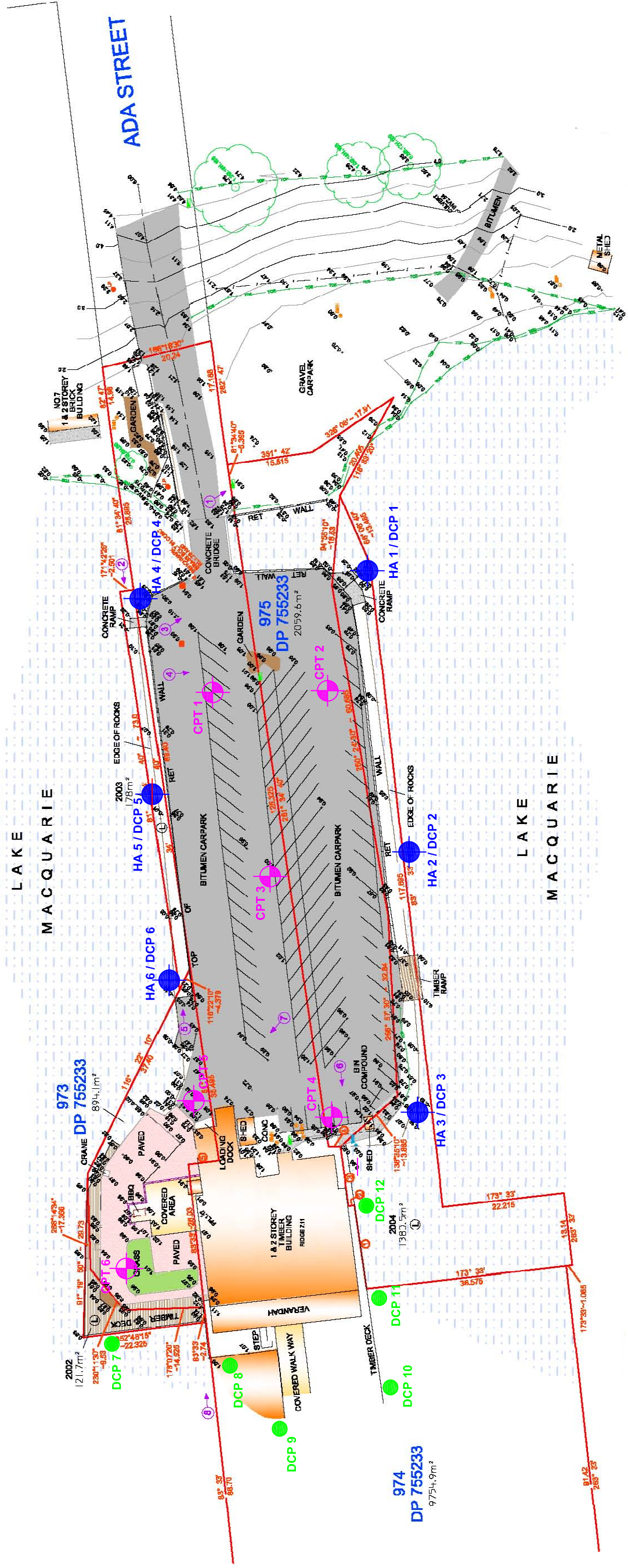
Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

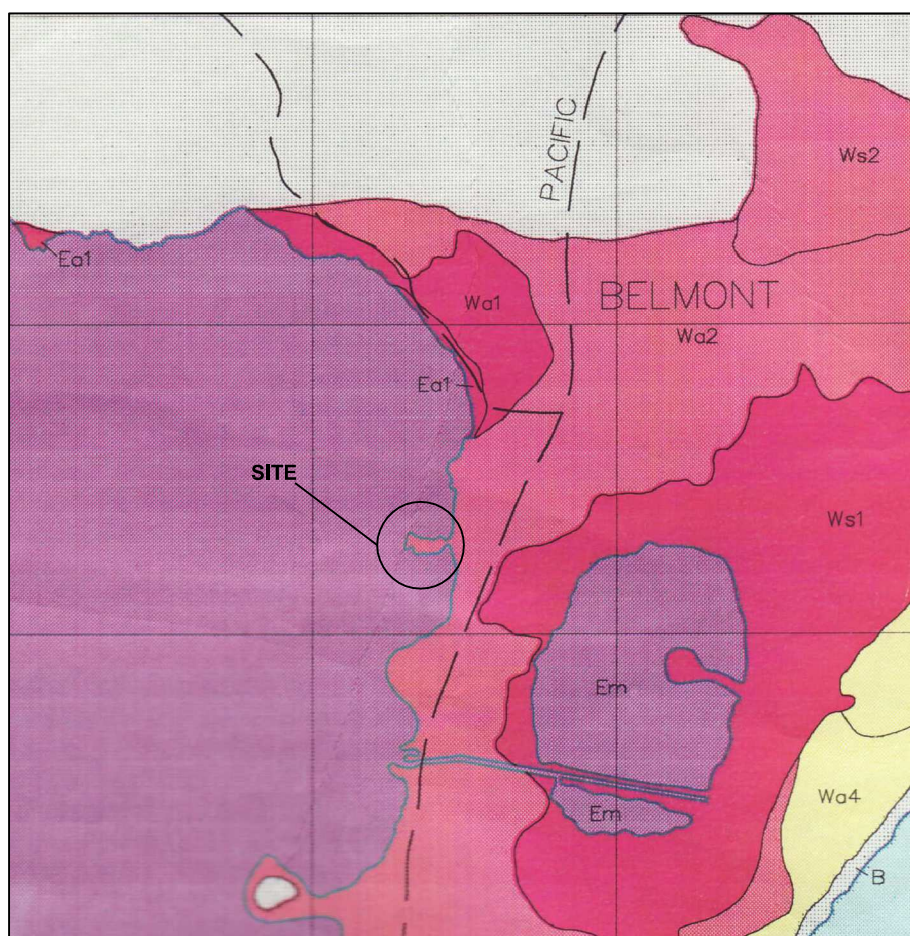
Figures



LEGEND

- 
- APPROXIMATE DCP TEST LOCATION
- APPROXIMATE CPT LOCATION
- APPROXIMATE HAND AUGER AND DCP TEST LOCATION

revision	description	drawn	approved	date	<
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PART KEY

Map Class Description	Depth to Acid Sulphate Soil Materials	
HIGH PROBABILITY High probability of occurrence of acid sulphate soil materials within the soil profile. The environment of deposition has been suitable for the formation of acid sulphate soil materials. Acid sulphate soil materials are widespread or sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.
		At or near the ground surface.
		Within 1 metre of the ground surface.
		Between 1 and 3 metres below the ground surface.
		Greater than 3 metres below the ground surface.*
LOW PROBABILITY Low probability of occurrence of acid sulphate soil materials within the soil profile. The environment of deposition has generally not been suitable for the formation of acid sulphate soil materials. Soil materials are often Pleistocene in age. Acid sulphate soil materials, if present, are sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.
		At or near the ground surface.
		Within 1 metre of the ground surface.
		Between 1 and 3 metres below the ground surface.
		Greater than 3 metres below the ground surface.*
NO KNOWN OCCURRENCE Acid sulphate soils are not known or expected to occur in these environments.		No known occurrences of acid sulphate soil materials.

PART MAP COPIED FROM SOIL CONSERVATION SERVICE OF NSW ACID SULPHATE SOIL RISK MAP FOR SWANSEA 9231N4

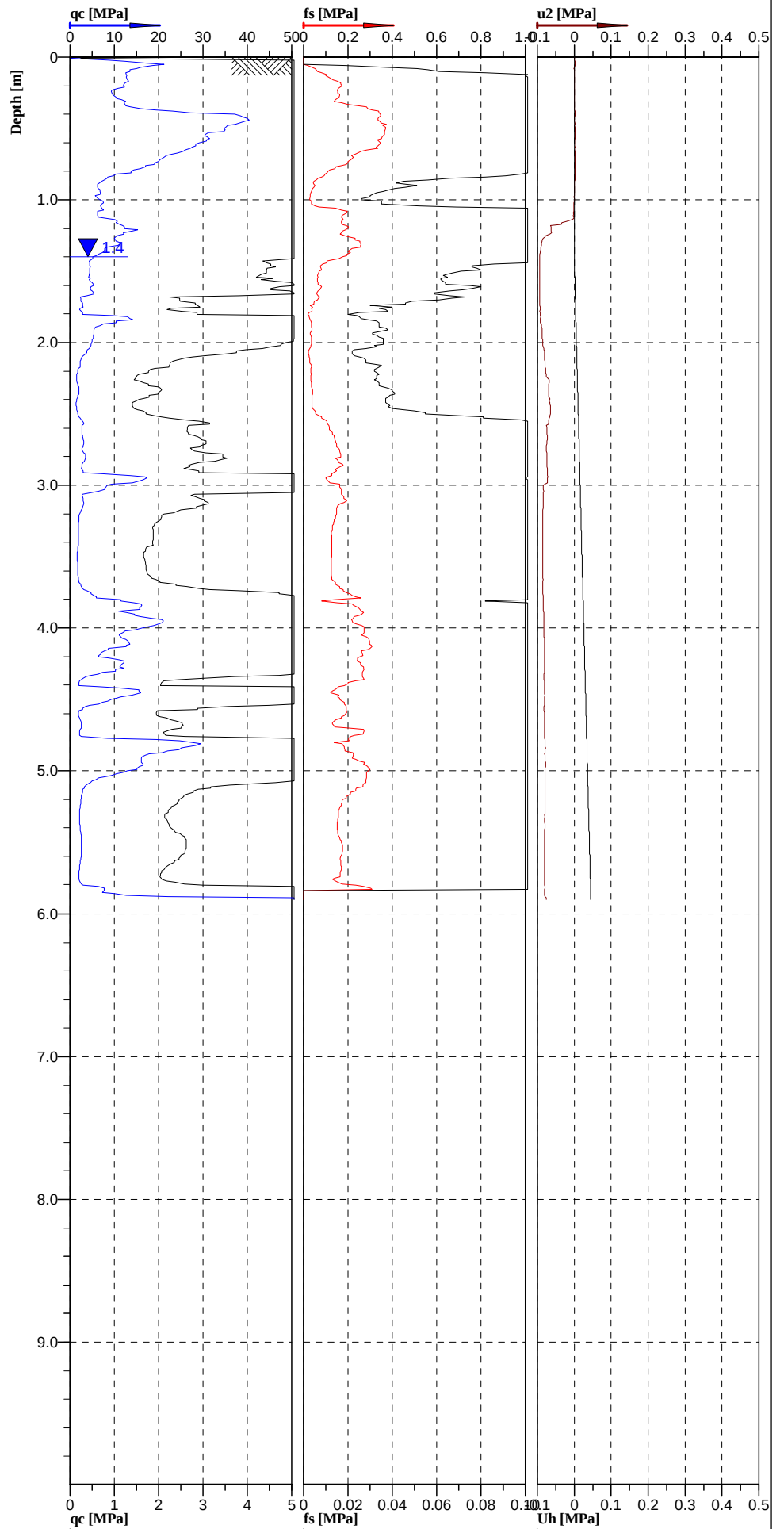
drawn	NLS	 SPECIALISTS MANAGING THE EARTH	client:	EJE ARCHITECTURE PTY LTD	
approved	RJP		project:	LAKE MACQUARIE YACHT CLUB PROPOSED EXTENSIONS TO CAR PARK AND NEW CLUBHOUSE GEOTECHNICAL ASSESSMENT	
date	02-06-09		title:	PART ACID SULPHATE SOIL RISK MAP FOR SWANSEA	
scale	1:25000		project no:	GEOTWARA20706AA	figure no: FIGURE 2
original size	A4				

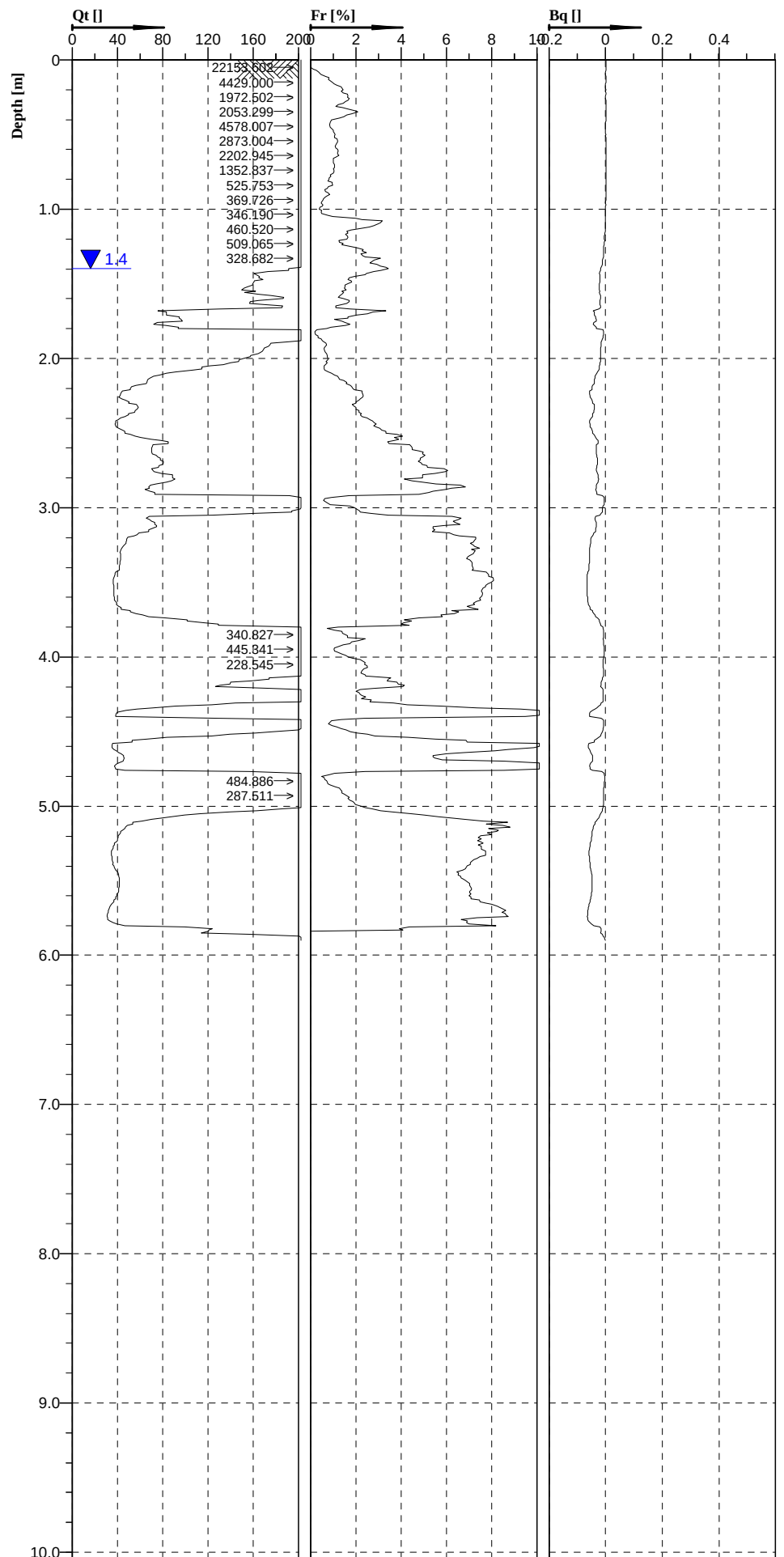
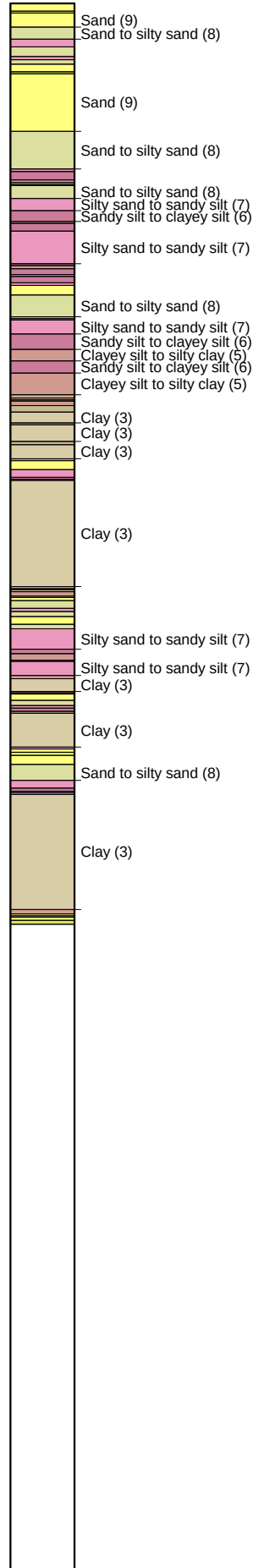
Appendix A

Results of Field Investigations

**Classification by
Robertson 1986**

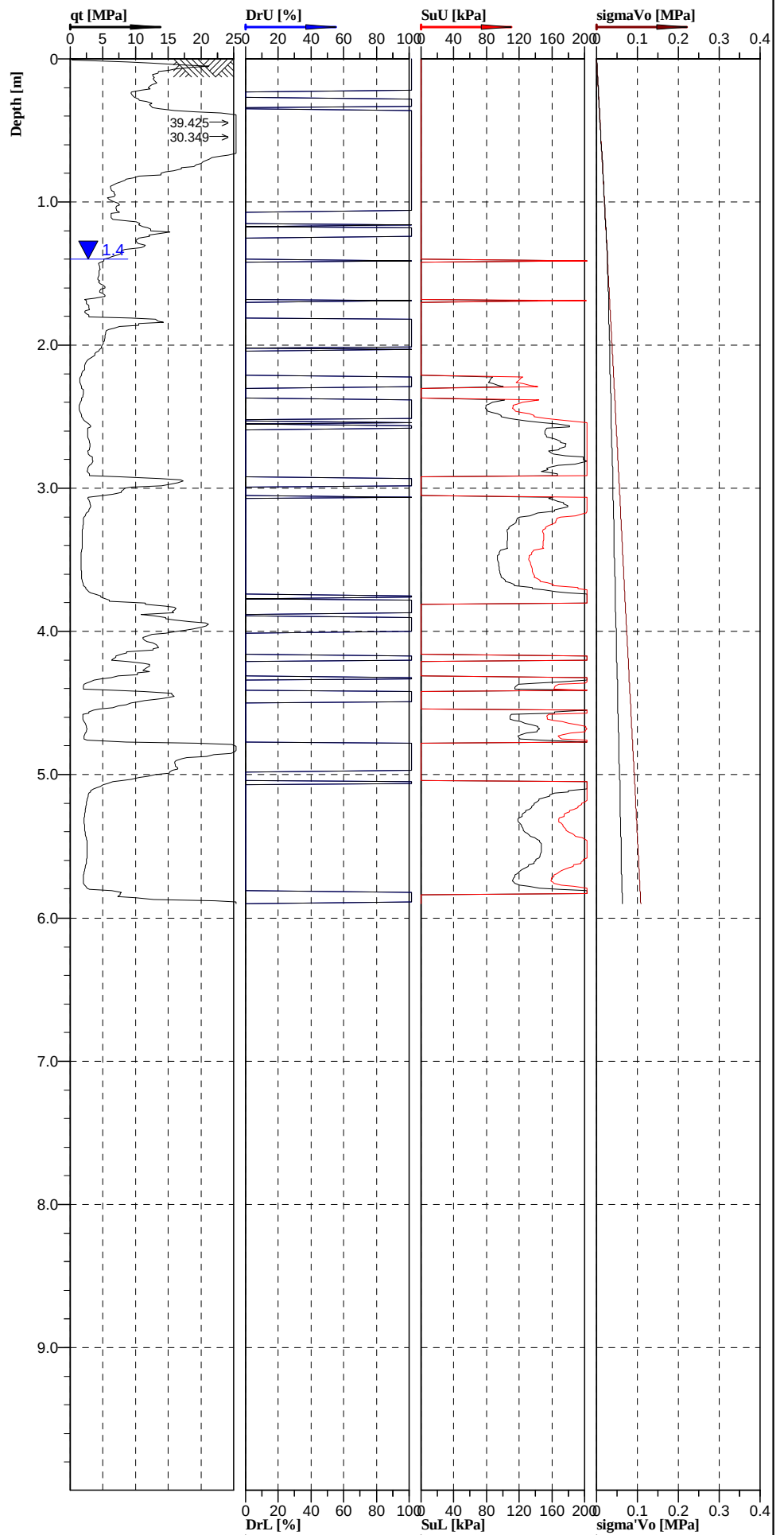
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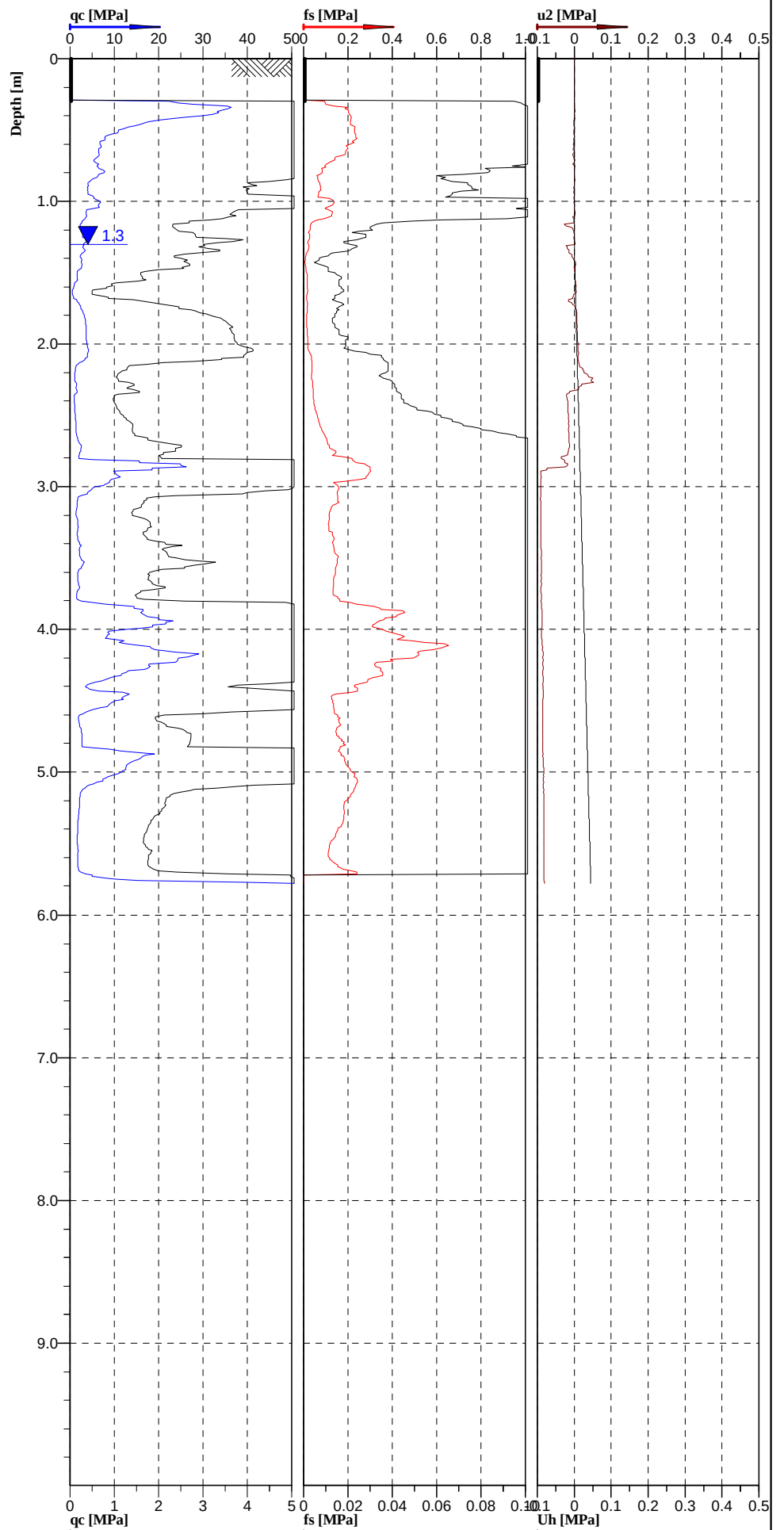
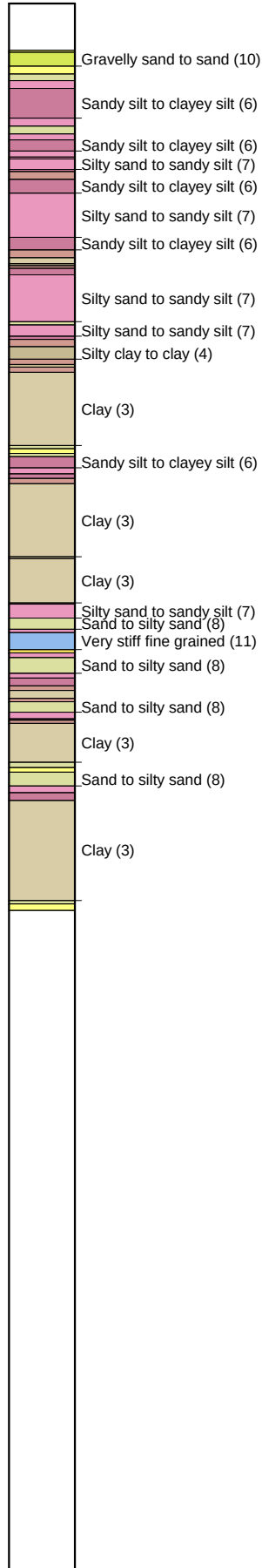


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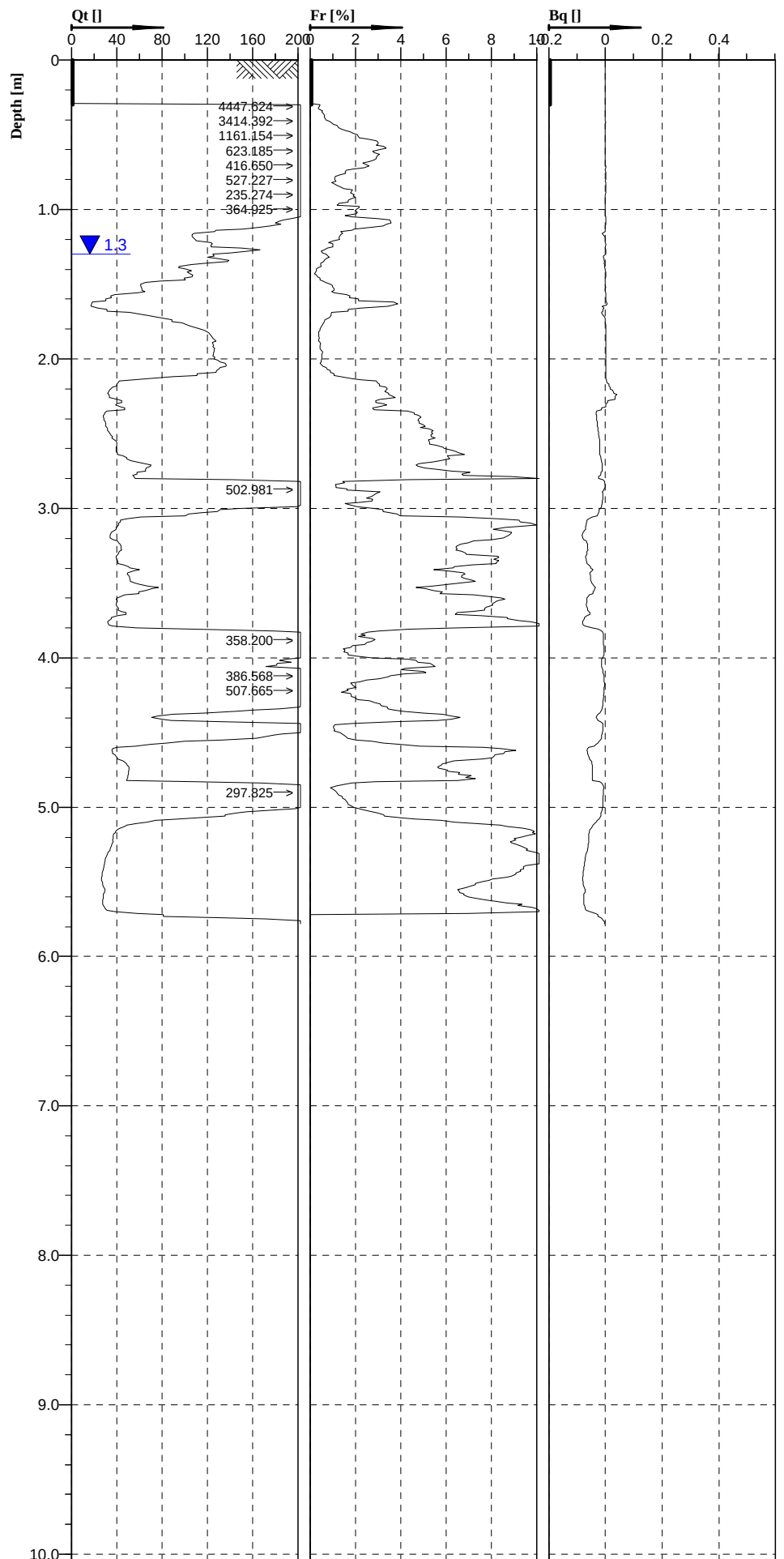
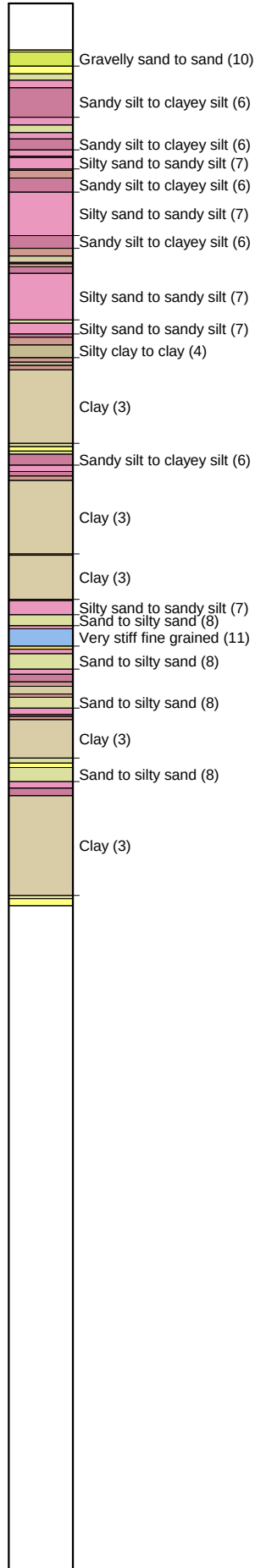
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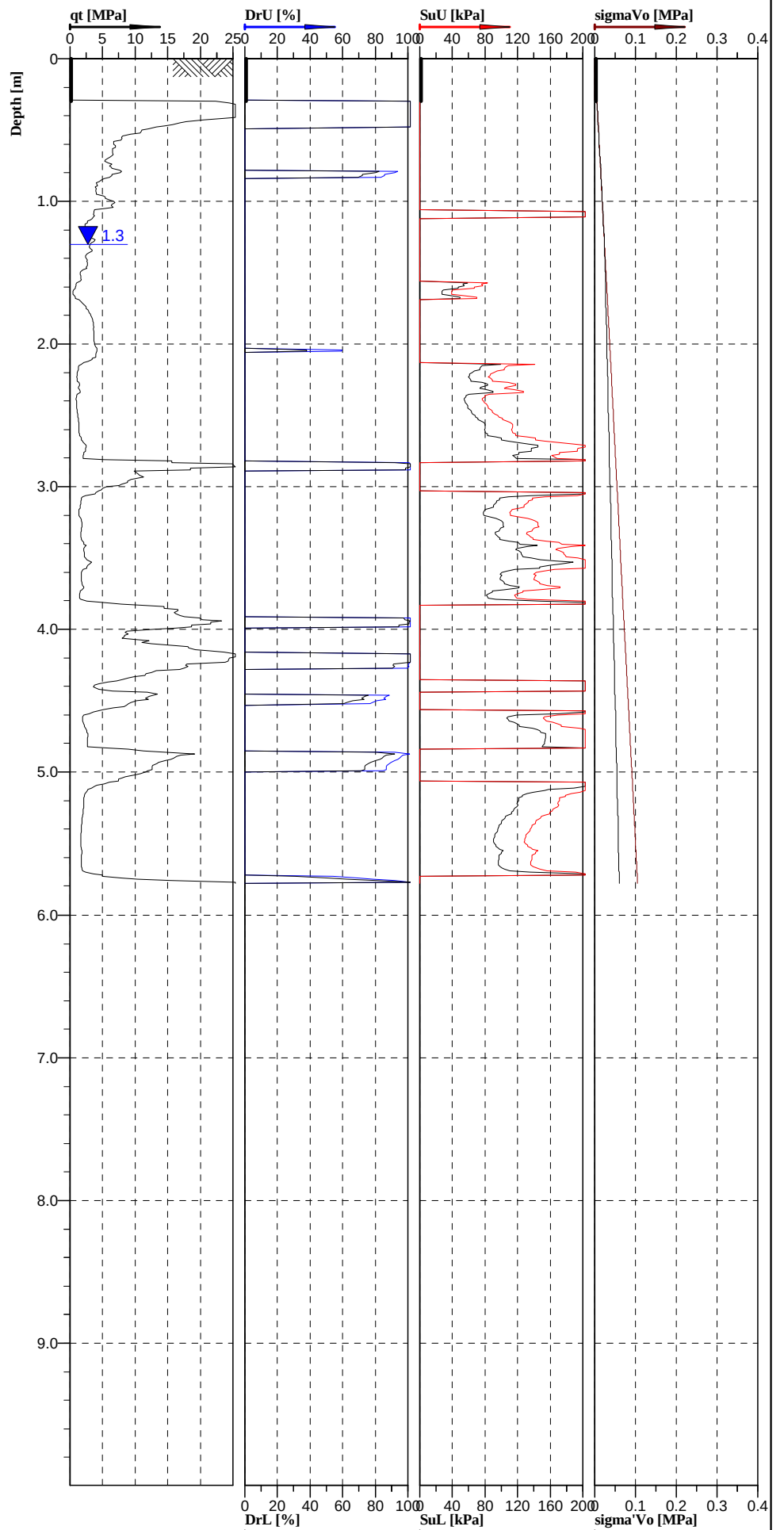
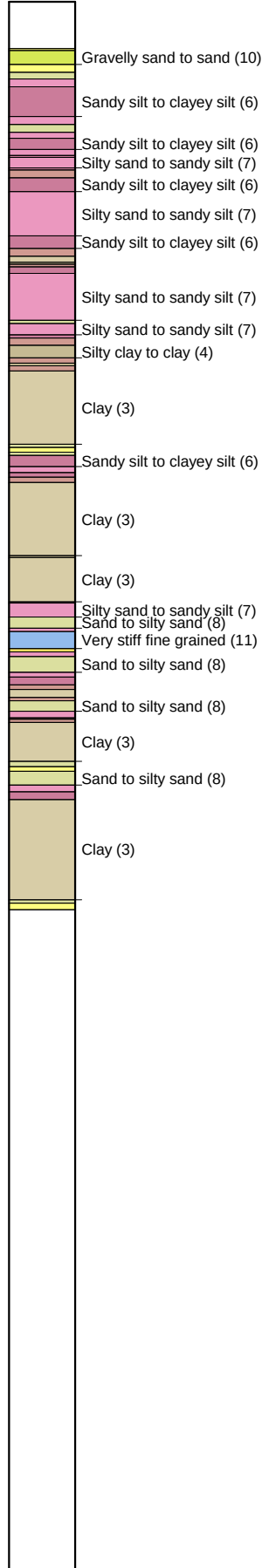
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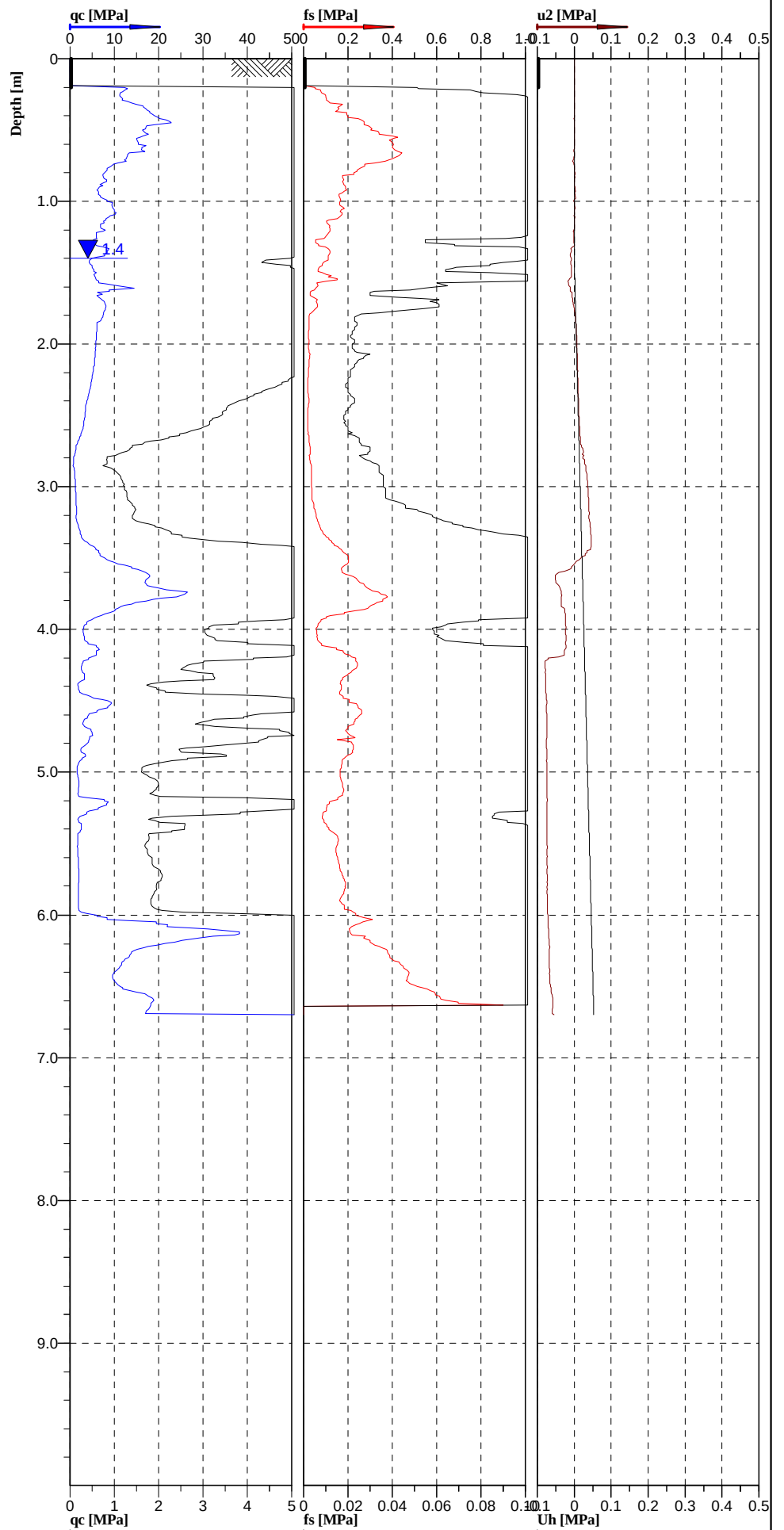
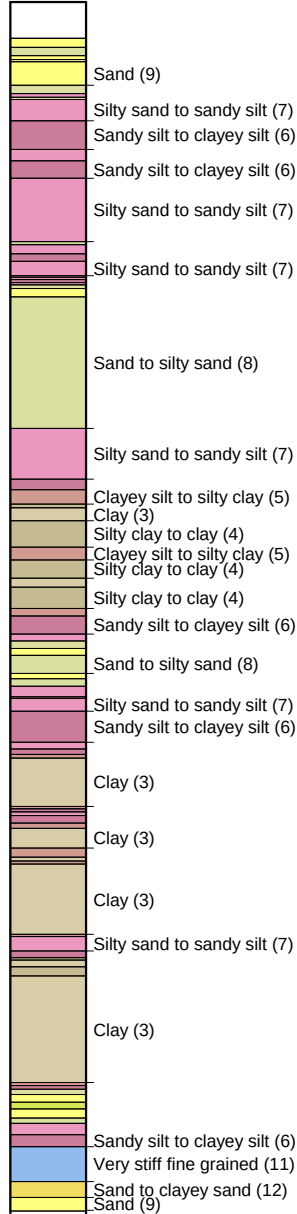
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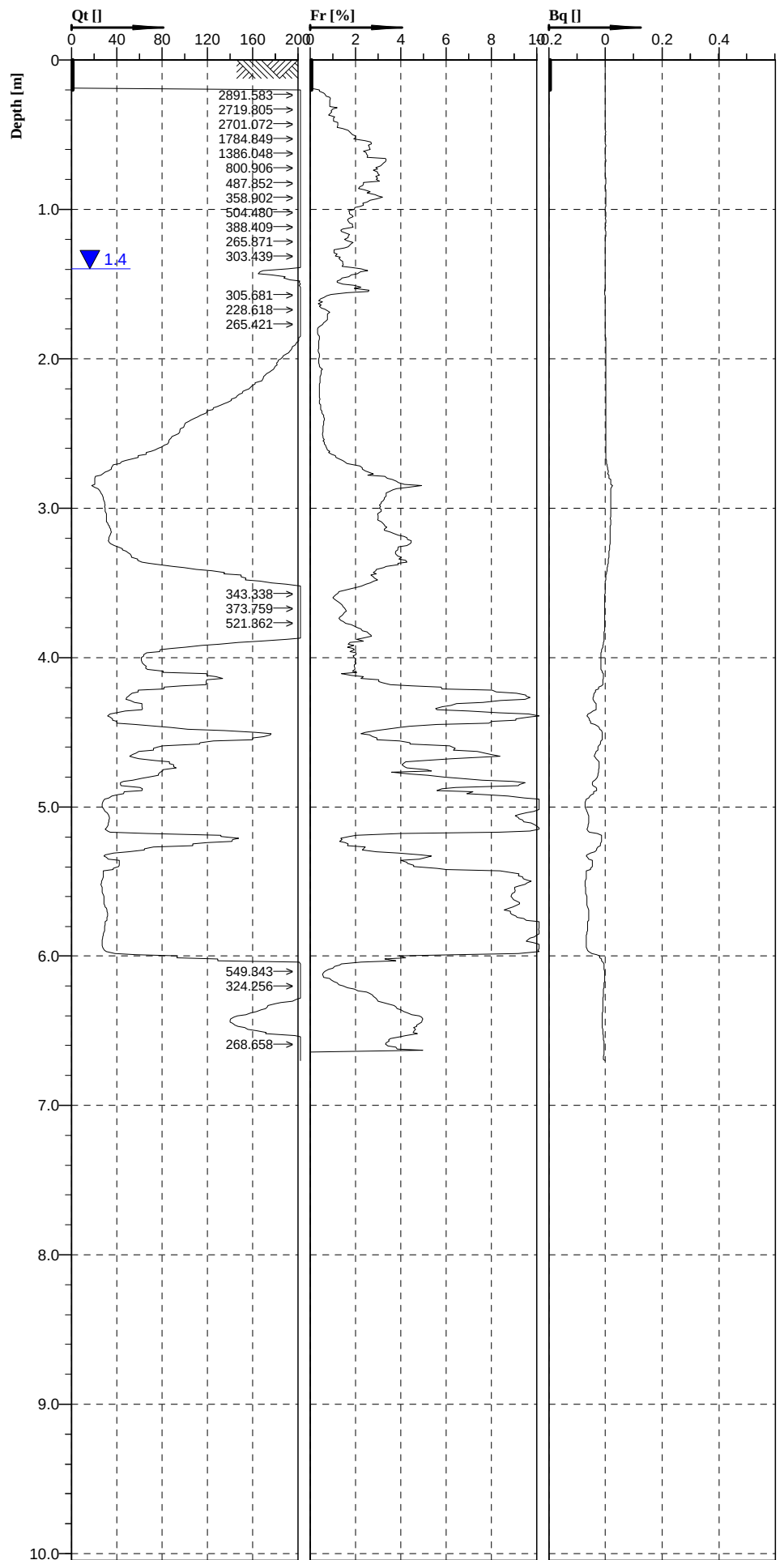
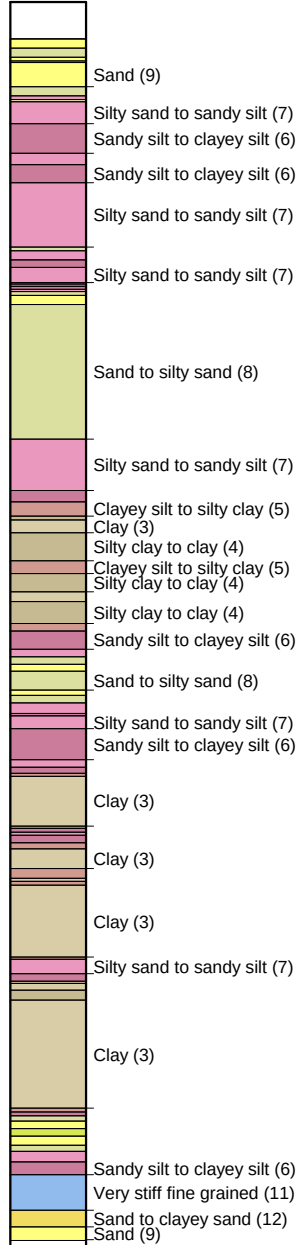
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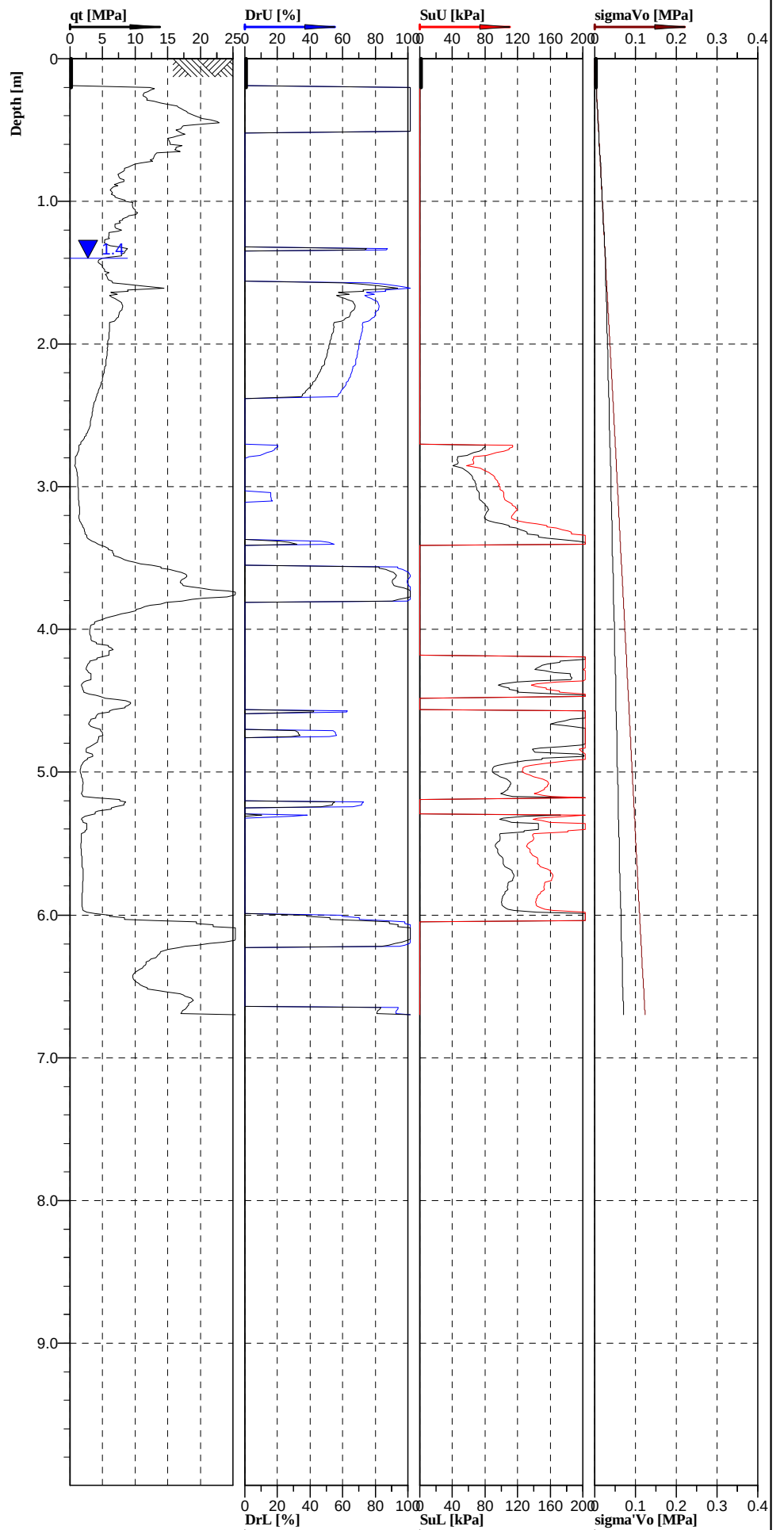
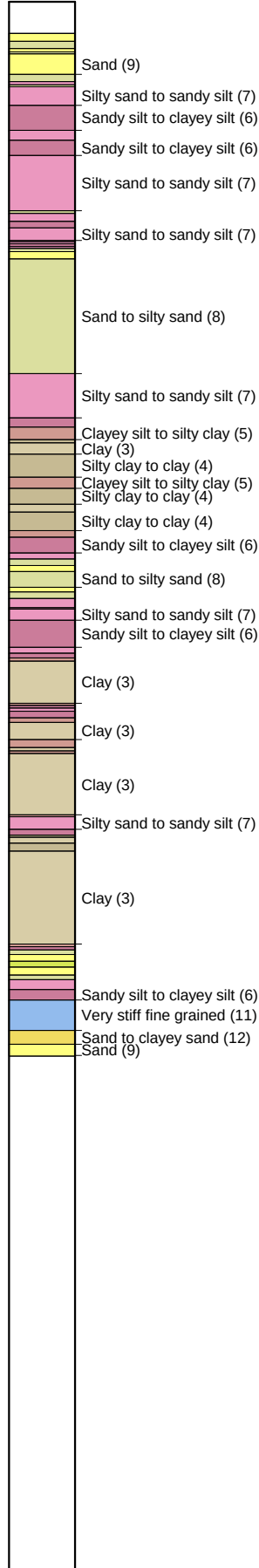
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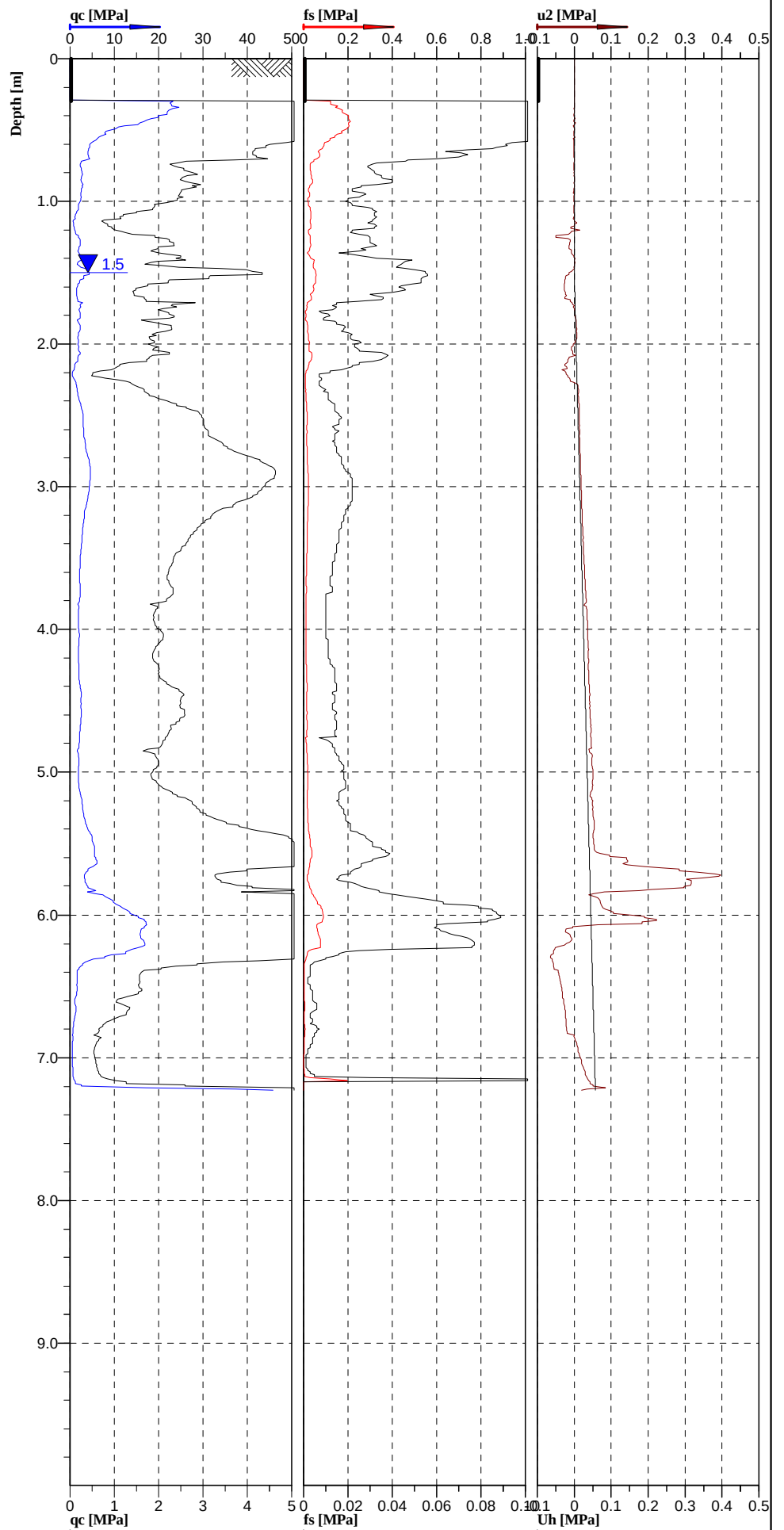
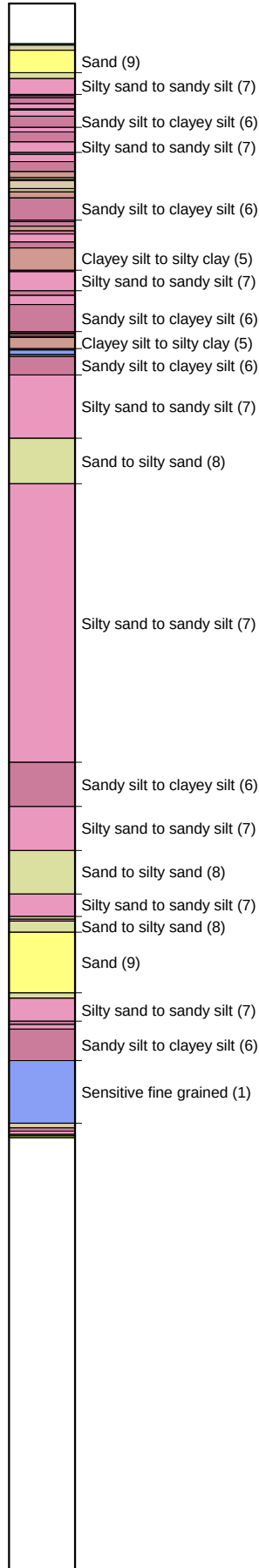
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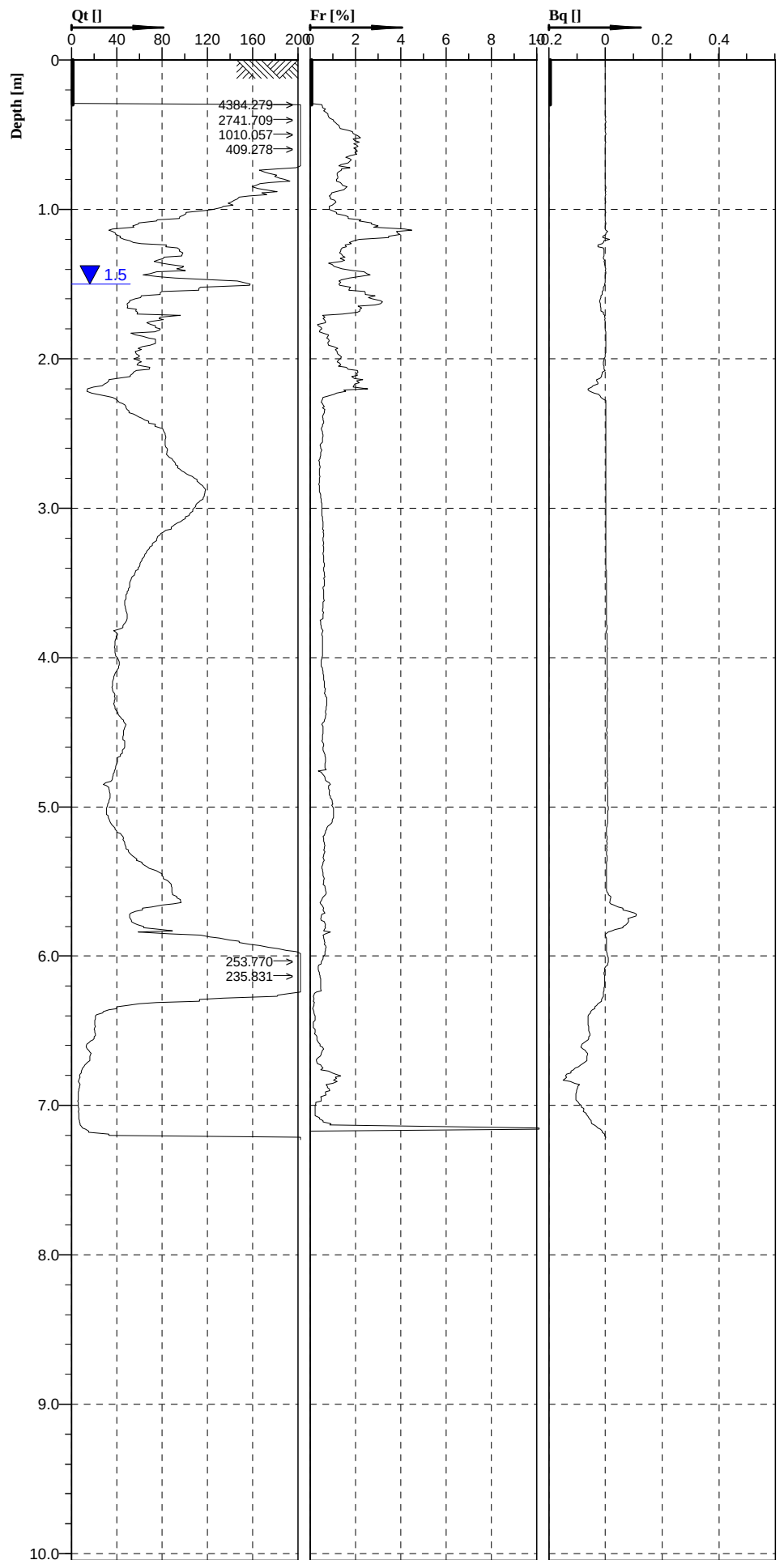
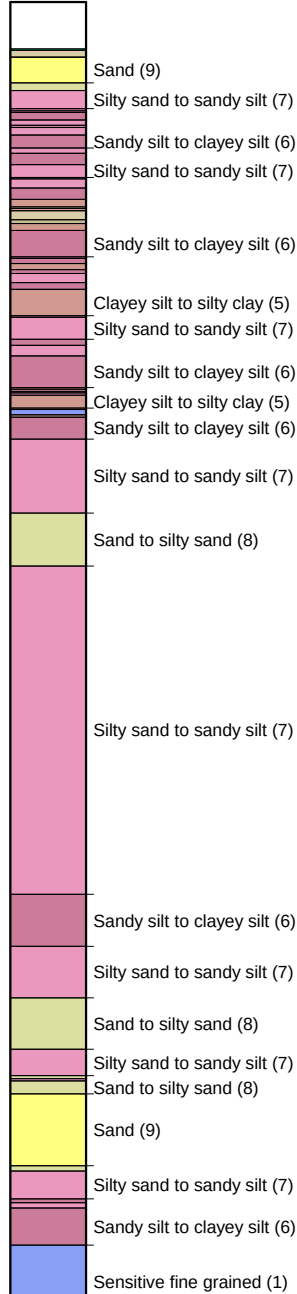
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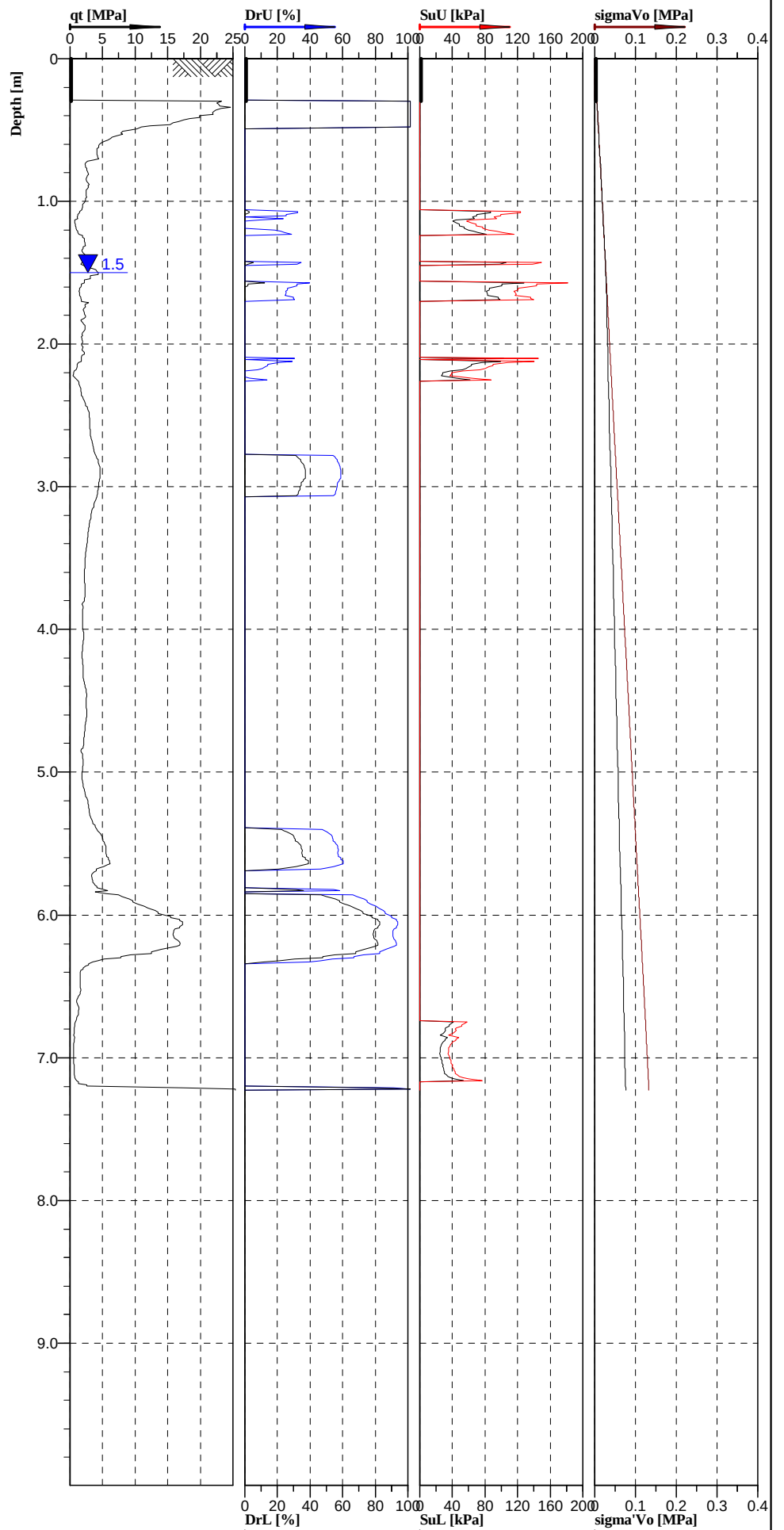
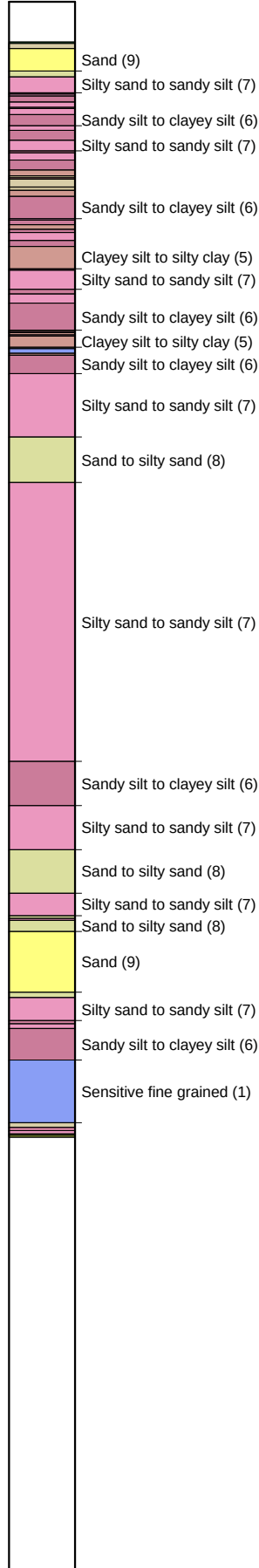
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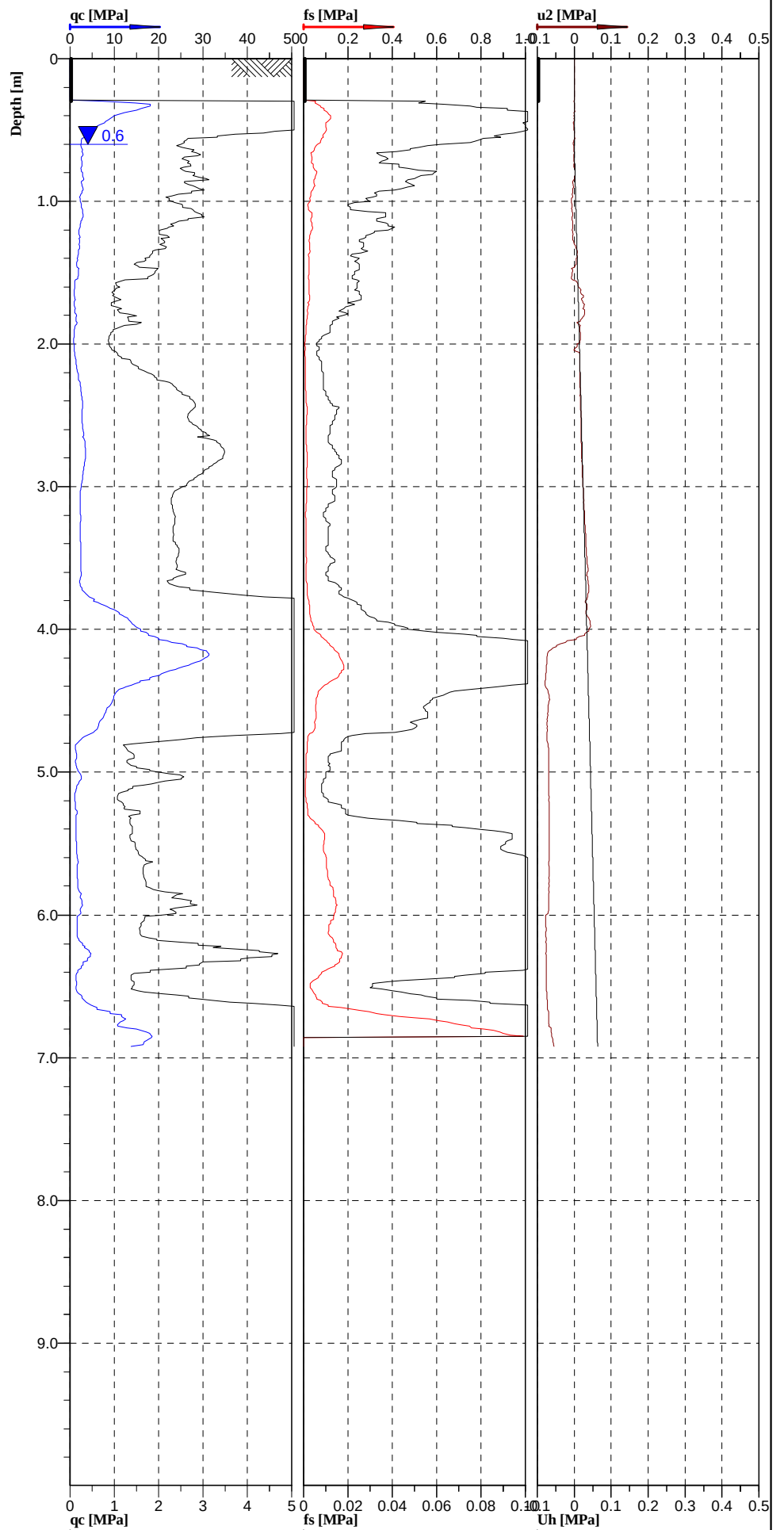
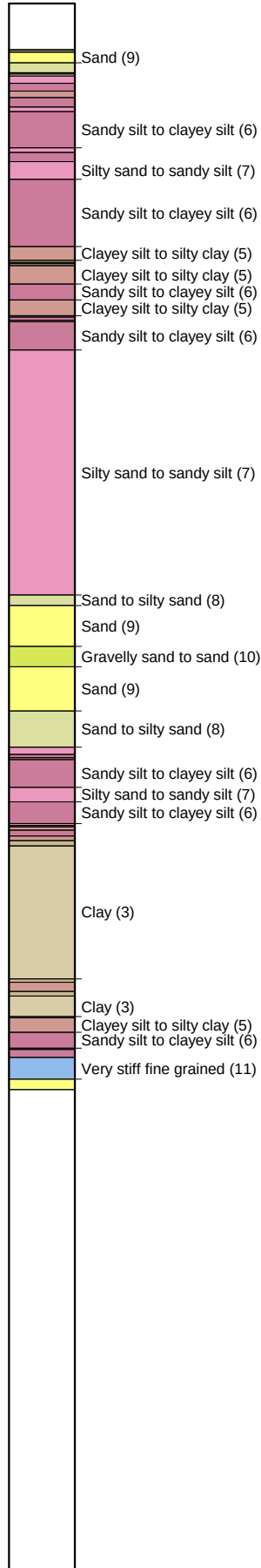
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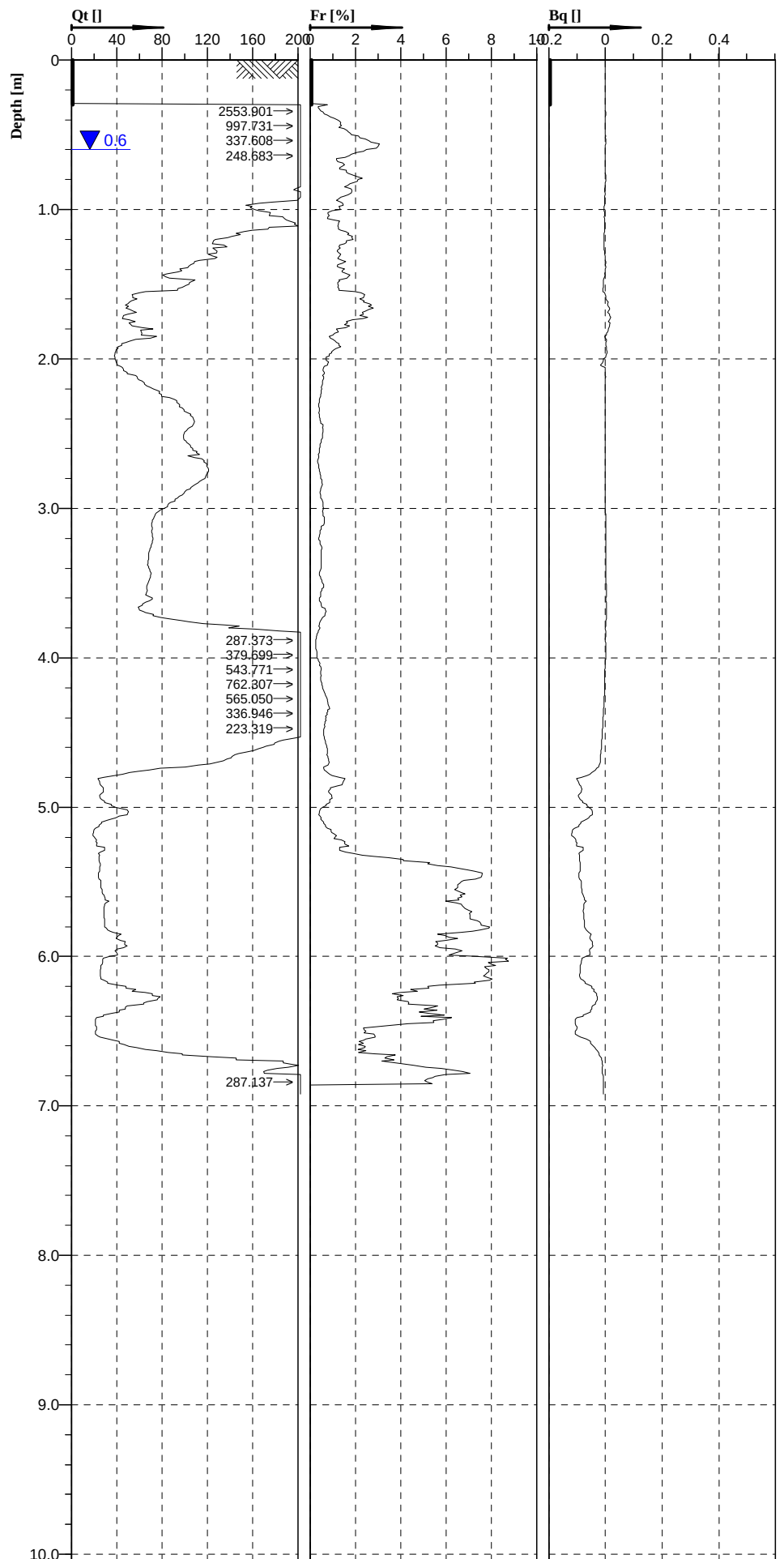
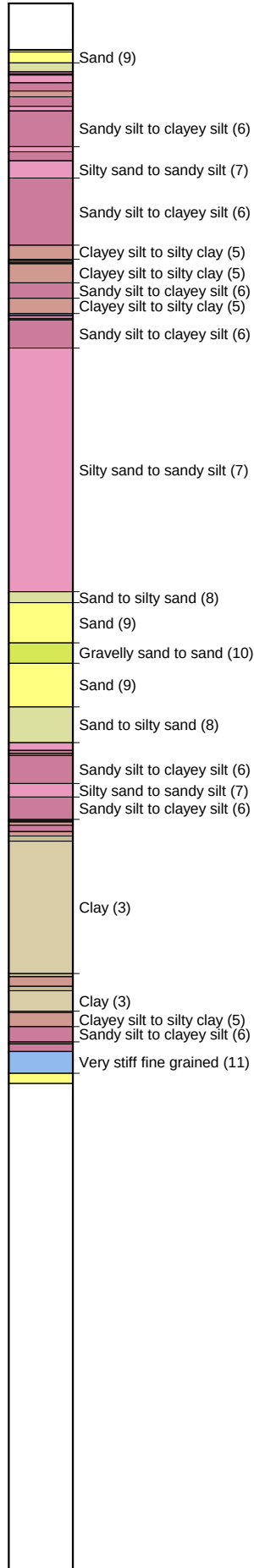
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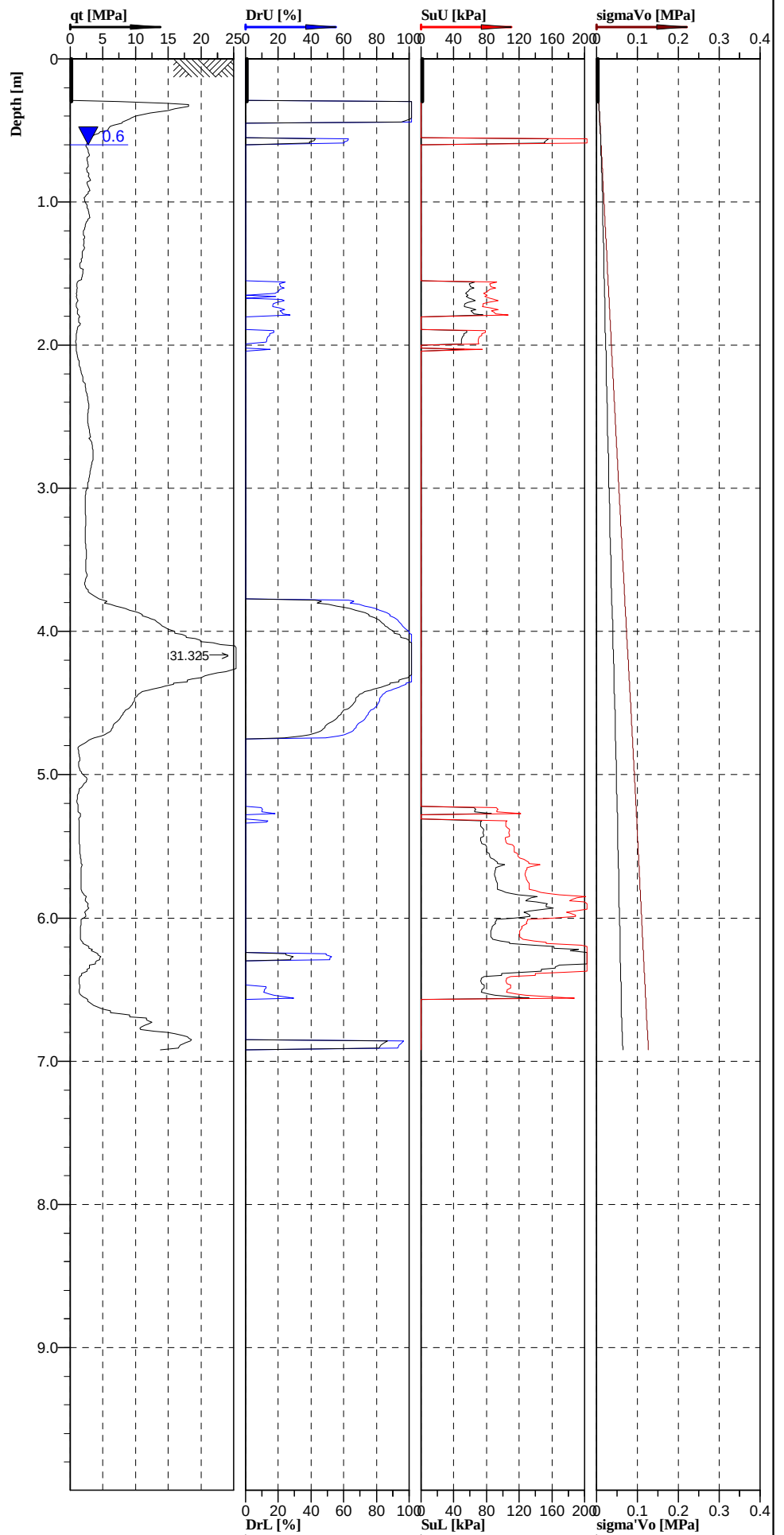
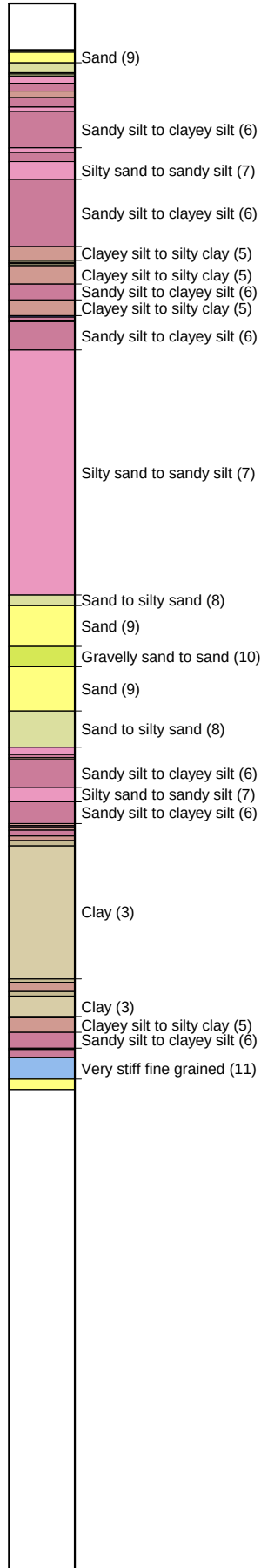
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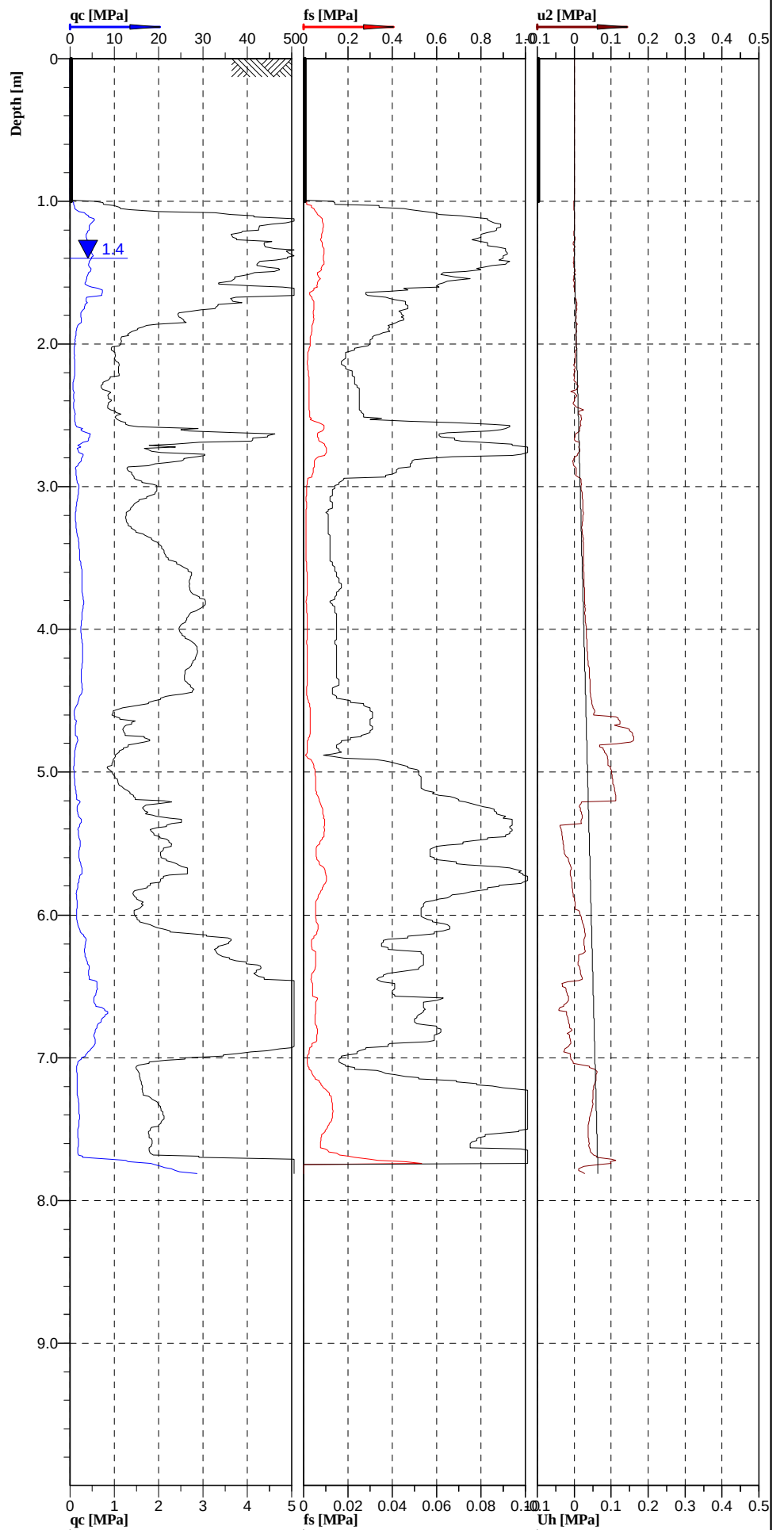
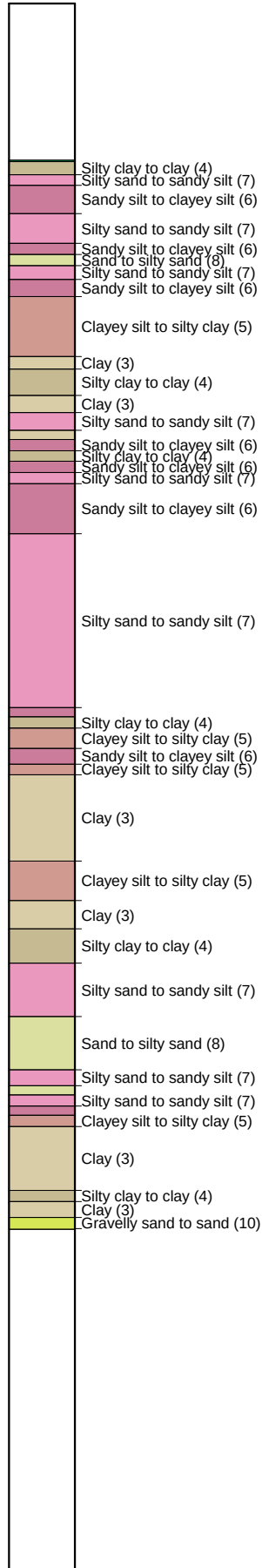
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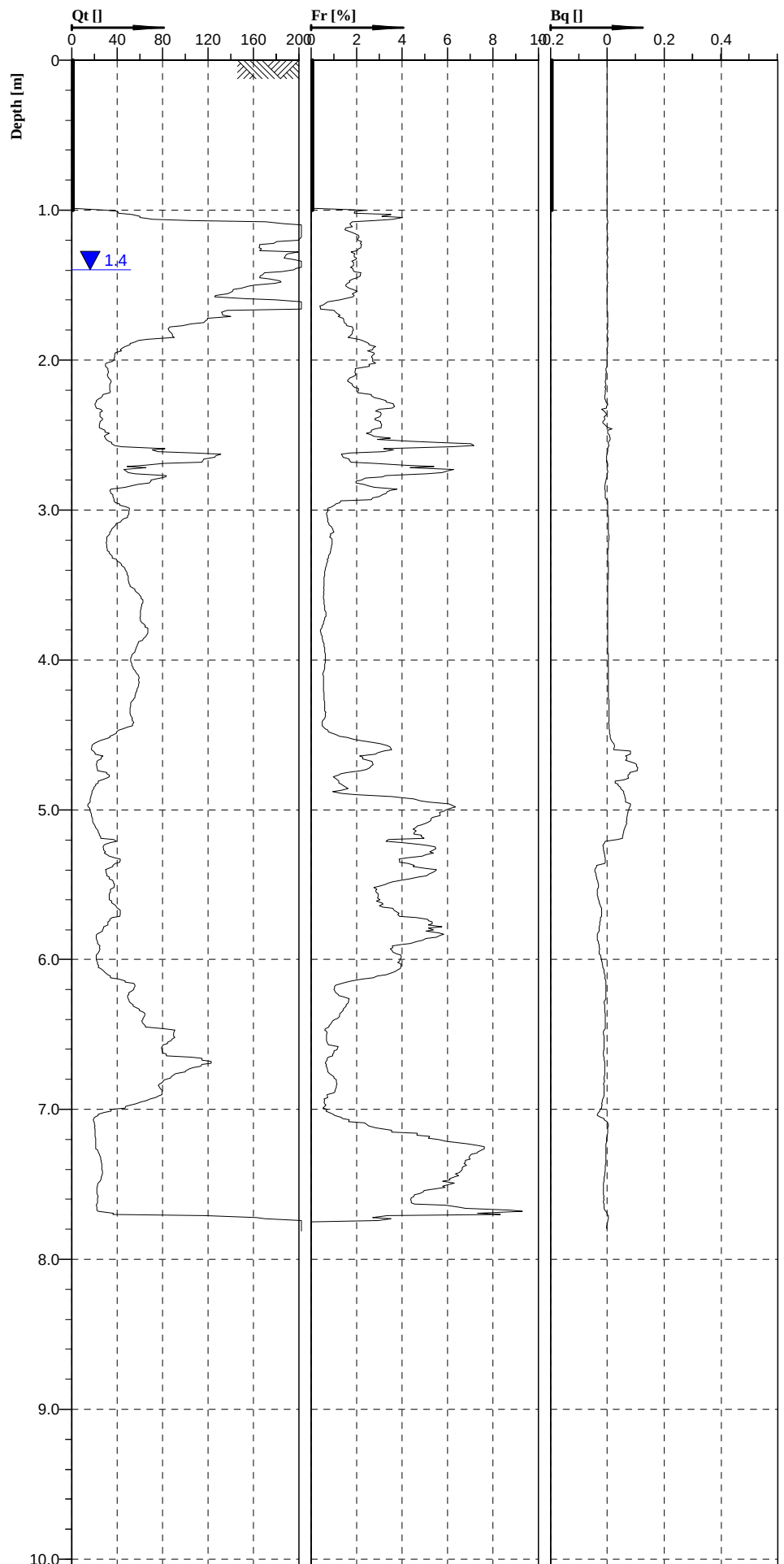
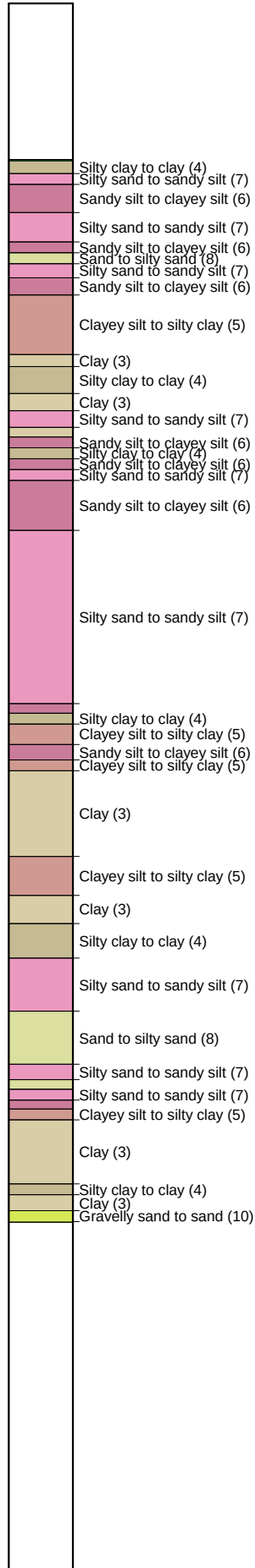
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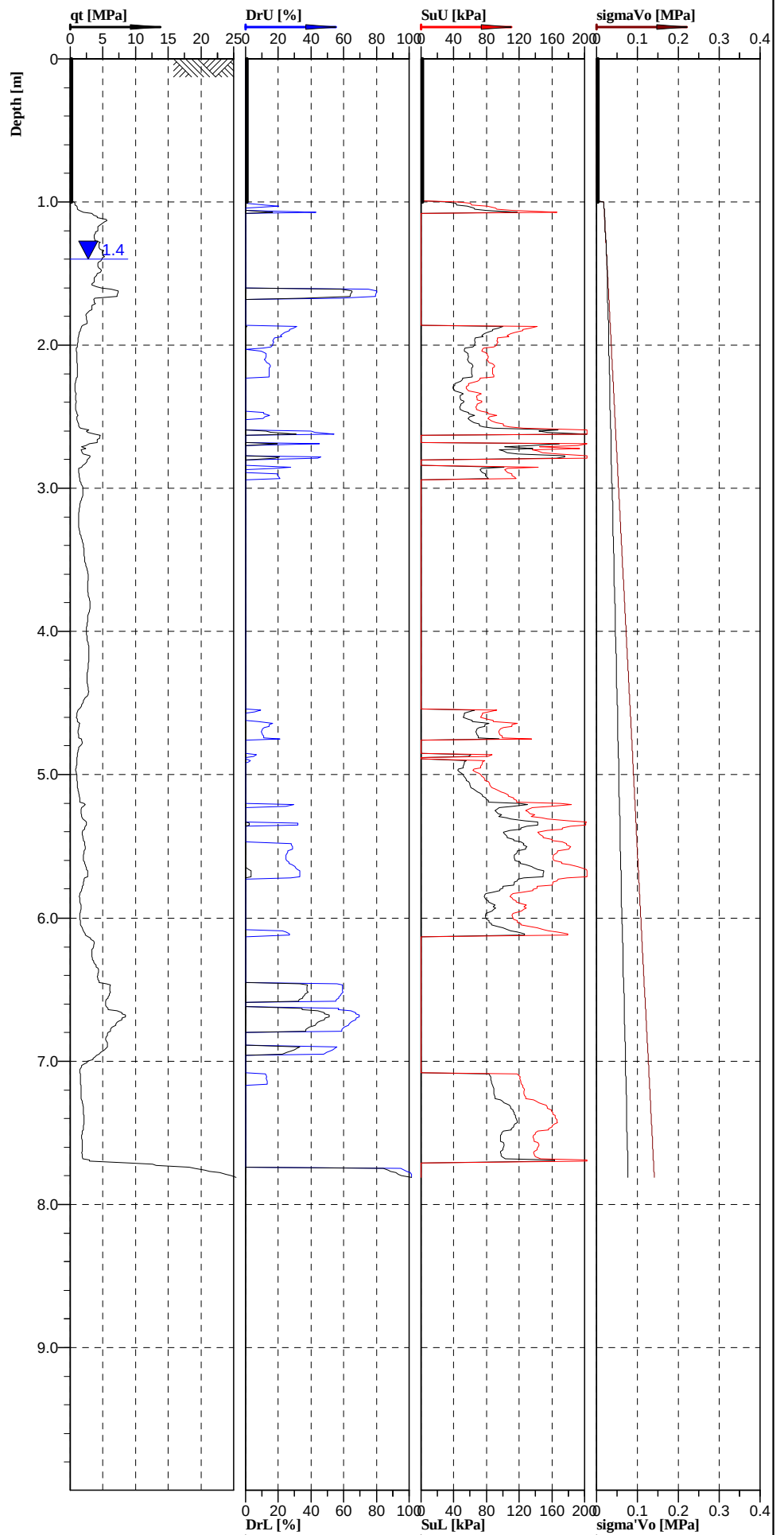
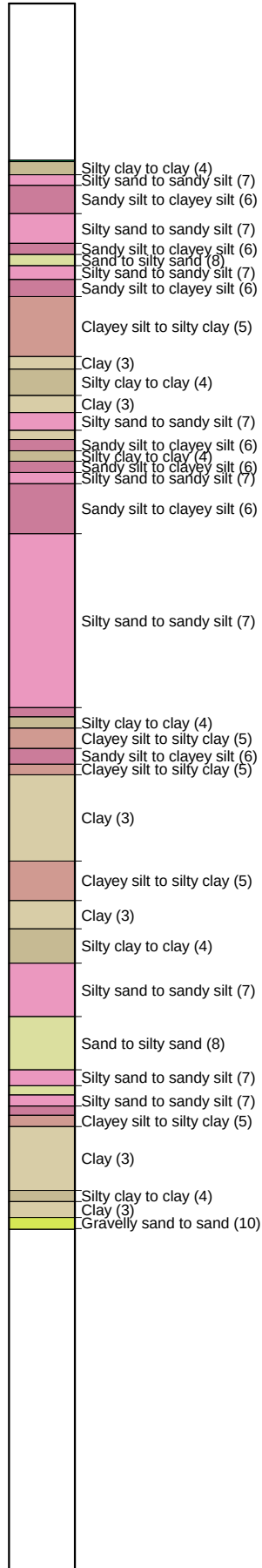
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Classification by
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Classification by
Robertson 1986



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 described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μ m to 2.36 mm
	medium	200 μ m to 600 μ m
	fine	75 μ m to 200 μ m

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	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

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.

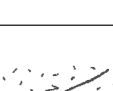
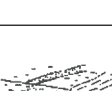
Soil Description Explanation Sheet (2 of 2)

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 63 mm is larger than 0.075 mm	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 63 mm is smaller than 0.075 mm	SILTS & CLAYS Liquid limit less than 50	IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.				
		DRY STRENGTH	DILATANCY	TOUGHNESS		
		None to Low	Quick to slow	None	ML	SILT
		Medium to High	None	Medium	CL	CLAY
	SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low	OL	ORGANIC SILT
		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%.						

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

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM	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.		SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
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.		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	
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.		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.	
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.		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.	

Rock Description Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance In engineering terms rock substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.

Defect Discontinuity or break in the continuity of a substance or substances.

Mass Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME Simple rock names are used rather than precise geological classification.

PARTICLE SIZE Grain size terms for sandstone are:
Coarse grained Mainly 0.6mm to 2mm
Medium grained Mainly 0.2mm to 0.6mm
Fine grained Mainly 0.06mm (just visible) to 0.2mm

FABRIC Terms for layering of penetrative fabric (eg. bedding, cleavage etc.) are:

Massive No layering or penetrative fabric.

Indistinct Layering or fabric just visible. Little effect on properties.

Distinct Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	Definition
Residual Soil	RS	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Material	XW	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	HW	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	MW	The whole of the rock substance is discoloured, usually by iron staining or bleaching, to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	SW	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	FR	Rock substance unaffected by weathering.

Notes on Weathering:

- AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
- Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

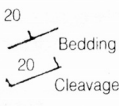
ROCK SUBSTANCE STRENGTH TERMS

Term	Abbreviation	Point Load Index, I_{s50} (MPa)	Field Guide
Very Low	VL	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
Low	L	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	H	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	VH	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	EH	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

Notes on Rock Substance Strength:

- In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
- The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
- The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index (I_{s50}). The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES		Diagram	Map Symbol	Graphic Log (Note 1)	DEFECT SHAPE	TERMS
Term	Definition				Planar	The defect does not vary in orientation
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.				Curved	The defect has a gradual change in orientation
Joint	A surface or crack across which the rock has little or no tensile strength, but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.				Undulating	The defect has a wavy surface
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.				Stepped	The defect has one or more well defined steps
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.				Irregular	The defect has many sharp changes of orientation
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.				ROUGHNESS TERMS	
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.				Slickensided	Grooved or striated surface, usually polished
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formed by weathering of the rock substance in place.				Polished	Shiny smooth surface
					Smooth	Smooth to touch. Few or no surface irregularities
					Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
					Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.
					COATING TERMS	
					Clean	No visible coating
					Stained	No visible coating but surfaces are discoloured
					Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
					Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.
					BLOCK SHAPE TERMS	
					Blocky	Approximately equidimensional
					Tabular	Thickness much less than length or width
					Columnar	Height much greater than cross section

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

Engineering Log - Borehole

Client: **EJE ARCHITECTURE**

Principal: **LAKE MACQUARIE YACHT CLUB**

Project: **EXTENSIONS TO CAR PARK AREA AND NEW CLUB HOUSE**

Borehole Location: **REFER TO FIGURE 1**

Borehole No. **HA 1**

Sheet **1 of 1**

Project No: **GEOTWARA20706AA**

Date started: **14.1.2009**

Date completed: **14.1.2009**

Logged by: **CW/RJP**

Checked by: **///**

drill model and mounting:		Hand Auger		Easting:		slope: -90°		R.L. Surface:		Not Measured			
hole diameter:		100 mm		Northing		bearing:		datum:					
drilling information						material substance							
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/density index	pocket penetrometer kPa	structure and additional observations	
HA	1 2 3	N					OL	Organic SILT: dark grey, organic odour.	W	VS		ALLOVIAL / ESTUARINE	
		None Observed		D									
				D	0.5		CH	CLAY: high plasticity, white, blue, grey. Friable, blocky structure.	M>Wp	VSt		RESIDUAL - Organic odour	
					1.0								
					1.5			BH HA 1 terminated at 0.6m due to practical refusal. NOTE: 0.5m water depth, 4.5m from toe of car park ramp. Borehole HA 1 terminated at 0.6m					
method AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube B blank bit V V bit T TC bit *bit shown by suffix e.g. ADT				support M mud N nil C casing penetration 1 2 3 4  no resistance ranging to refusal water  10/1/98 water level on date shown  water inflow  water outflow		notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone V vane shear (kPa) P pressuremeter Bs bulk sample E environmental sample R refusal				classification symbols and soil description based on unified classification system moisture D dry M moist W wet Wp plastic limit W _L liquid limit		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense	

Borehole Location: **REFER TO FIGURE 1**

Form GEO 5.3 Issue 3 Rev.2

Engineering Log - Borehole

Client: **EJE ARCHITECTURE**

Principal: **LAKE MACQUARIE YACHT CLUB**

Project: **EXTENSIONS TO CAR PARK AREA AND NEW CLUB HOUSE**

Borehole Location: **REFER TO FIGURE 1**

Borehole No. **HA 3**

Sheet **1 of 1**

Project No: **GEOTWARA20706AA**

Date started: **14.1.2009**

Date completed: **14.1.2009**

Logged by: **CW/RJP**

Checked by: **///**

drill model and mounting: Hand Auger		Easting:		slope: -90°		R.L. Surface: Not Measured													
hole diameter: 100 mm		Northing		bearing:		datum:													
drilling information				material substance															
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol												
1	2	3																	
HA		N		D	0.5		SP												
			None Observed																
					1.0														
					1.5														
				SAND: fine to medium grained, light grey-grey. BH HA 3 terminated at 0.5m due to collapsing sands. NOTE: 1.2m water depth, 5m from toe. Borehole HA 3 terminated at 0.5m															
				ALLUVIAL / ESTUARINE															
method AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube B blank bit V V bit T TC bit *bit shown by suffix e.g. ADT				support M mud C casing penetration 1 2 3 4 no resistance ranging to refusal water 10/1/98 water level on date shown water inflow water outflow				notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone V vane shear (kPa) P pressuremeter Bs bulk sample E environmental sample R refusal				classification symbols and soil description based on unified classification system moisture D dry M moist W wet Wp plastic limit W _L liquid limit				consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense			

Engineering Log - Borehole

Client: **EJE ARCHITECTURE**

Principal: **LAKE MACQUARIE YACHT CLUB**

Project: **EXTENSIONS TO CAR PARK AREA AND NEW CLUB HOUSE**

Borehole Location: **REFER TO FIGURE 1**

Borehole No. **HA 4**

Sheet **1 of 1**

Project No: **GEOTWARA20706AA**

Date started: **14.1.2009**

Date completed: **14.1.2009**

Logged by: **CW/RJP**

Checked by: **/**

drill model and mounting: Hand Auger		Easting:		slope: -90°		R.L. Surface: Not Measured	
hole diameter: 100 mm		Northing		bearing:		datum:	
drilling information				material substance			
method	penetration 1 2 3	support water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.
HA		N	D			OL	Organic SILT: dark grey.
		None Observed				CH	CLAY: high plasticity fines, grey-light grey, trace of claystone gravel throughout.
			D				
				0.5			BH HA 4 terminated at 0.4m due to practical refusal.
				1.0			NOTE: 0.4m water depth, 5m from toe. Borehole HA 4 terminated at 0.4m
				1.5			
method				support		notes, samples, tests	
AS auger screwing*				M mud N nil		U ₅₀ undisturbed sample 50mm diameter	
AD auger drilling*				C casing		U ₆₃ undisturbed sample 63mm diameter	
RR roller/tricone				penetration 1 2 3 4		D disturbed sample	
W washbore				no resistance ranging to refusal		N* standard penetration test (SPT)	
CT cable tool				water		Nc SPT - sample recovered	
HA hand auger				10/1/98 water level on date shown		V vane shear (kPa)	
DT diatube				water inflow		P pressuremeter	
B blank bit				water outflow		Bs bulk sample	
V V bit						E environmental sample	
T TC bit						R refusal	
*bit shown by suffix e.g. ADT							
				classification symbols and soil description based on unified classification system		consistency/density index	
				moisture		VS very soft	
				D dry		S soft	
				M moist		F firm	
				W wet		St stiff	
				Wp plastic limit		VSt very stiff	
				WL liquid limit		H hard	
						Fb friable	
						VL very loose	
						L loose	
						MD medium dense	
						D dense	
						VD very dense	

Engineering Log - Borehole

Client: **EJE ARCHITECTURE**

Principal: **LAKE MACQUARIE YACHT CLUB**

Project: **EXTENSIONS TO CAR PARK AREA AND NEW CLUB HOUSE**

Borehole Location: **REFER TO FIGURE 1**

Borehole No. **HA 5**

Sheet **1 of 1**

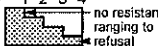
Project No: **GEOTWARA20706AA**

Date started: **14.1.2009**

Date completed: **14.1.2009**

Logged by: **CW/RJP**

Checked by: 

drill model and mounting:		Hand Auger		Easting:		slope: -90°		R.L. Surface:		Not Measured			
hole diameter:		100 mm		Northing		bearing:		datum:					
drilling information						material substance							
method	penetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations
HA	1 2 3	N						SP	SAND: fine to medium grained, dark grey-grey. Trace of clay, grey-light grey, organic odour.	W	VL	100 200 300 400	ALLUVIAL / ESTUARINE
			None Observed	D		0.5							
				D									
						1.0			BH HA 9 terminated at 0.9m due to collapsing sands.				
									NOTE: 0.2m water depth, 2m from toe. Borehole HA 5 terminated at 0.9m				
						1.5							
method				support		notes, samples, tests				classification symbols and soil description based on unified classification system		consistency/density Index	
AS auger screwing*				M mud		U ₅₀ undisturbed sample 50mm diameter				moisture D dry M moist W wet W _p plastic limit W _L liquid limit		VS very soft	
AD auger drilling*				C casing		U ₆₃ undisturbed sample 63mm diameter						S soft	
RR roller/tricone				penetration		D disturbed sample						F firm	
W washbore				1 2 3 4		N standard penetration test (SPT)						St stiff	
CT cable tool				no resistance ranging to refusal		N* SPT - sample recovered						VS _t very stiff	
HA hand auger						Nc SPT with solid cone						H hard	
DT diatube				water		V vane shear (kPa)						Fb friable	
B blank bit				10/1/98 water level on date shown		P pressuremeter						VL very loose	
V V bit						Bs bulk sample						L loose	
T TC bit						E environmental sample						MD medium dense	
*bit shown by suffix e.g. ADT						R refusal						D dense	
												VD very dense	

Engineering Log - Borehole

Client: **EJE ARCHITECTURE**

Principal: **LAKE MACQUARIE YACHT CLUB**

Project: **EXTENSIONS TO CAR PARK AREA AND NEW CLUB HOUSE**

Borehole Location: **REFER TO FIGURE 1**

Borehole No. **HA 6**

Sheet **1 of 1**

Project No: **GEOTWARA20706AA**

Date started: **14.1.2009**

Date completed: **14.1.2009**

Logged by: **CW/RJP**

Checked by: 

drill model and mounting: Hand Auger		Easting:		slope: -90°		R.L. Surface: Not Measured	
hole diameter: 100 mm		Northing		bearing:		datum:	
drilling information				material substance			
method	penetration	support	water	notes samples, tests, etc	depth metres	classification symbol	material
HA	1 2 3	N		D		ML	Sandy SILT: fine to medium grained-fine grained, grey-dark grey.
						SP	SAND: fine to medium grained, dark grey-grey, trace of clay, organic odour.
				D	0.5		Becoming light grey with thin clay lenses.
				D	1.0		
					1.5		BH HA 5 terminat at 1m due to collapsing of sands.
				NOTE: 0.7m water depth, 3m from toe. Borehole HA 6 terminated at 1m			
method				support		notes, samples, tests	
AS auger screwing*				M mud N nil		U ₅₀ undisturbed sample 50mm diameter	
AD auger drilling*				C casing		U ₆₃ undisturbed sample 63mm diameter	
RR roller/tricone				penetration 1 2 3 4		D disturbed sample	
W washbore						N standard penetration test (SPT)	
CT cable tool						N* SPT - sample recovered	
HA hand auger						Nc SPT with solid cone	
DT diatube						V vane shear (kPa)	
B blank bit						P pressuremeter	
V V bit						Bs bulk sample	
T TC bit						E environmental sample	
*bit shown by suffix e.g. ADT						R refusal	
				water		classification symbols and soil description based on unified classification system	
				no resistance ranging to refusal		moisture	
				10/1/98 water level on date shown		D dry	
				water inflow		M moist	
				water outflow		W wet	
						Wp plastic limit	
						WL liquid limit	
						VS very soft	
						S soft	
						F firm	
						St stiff	
						VSt very stiff	
						H hard	
						Fb friable	
						VL very loose	
						L loose	
						MD medium dense	
						D dense	
						VD very dense	

Dynamic Cone Penetrometer Test Results

Issue No.: 1

Client: EJE ARCHITECTURE

Principal:

Job No.: GEOTWARA20706AA

Project: LAKE MACQUARIE YACHT CLUB, EXTENSIONS TO CAR PARKING AREA AND NEW CLUB HOUSE

Location: ADA STREET, BELMONT

Sample Details

Test procedure:		Test date: 14/01/2009						Readings recorded in blows per 150mm		Test location/Remarks
Depth below surface	Test Numbers									
	DCP1	DCP2	DCP3	DCP4	DCP5	DCP6				
150	0	0	0	0	0	0			DCP1 0.5m water depth	
300	0	0	0	2	0	0				
450	2	0	0	5	0	0			DCP2 0.4m water depth	
600	5	1	0	5	0	0				
750	8	2	0	13	0	0			DCP3 1.2m water depth	
900	12	2	1	25/130mm	1	0				
1050	15/30mm	2	0		1	0			DCP4 0.4m water depth	
1200		1	0		3	2				
1350		1	0		6	2			DCP5 0.2m water depth	
1500		2	0		10	3				
1650		2	1		16	4			DCP6 0.7m water depth	
1800		20	0			9				
1950			0			9				
2100			1			15				
2250			3							
2400			3							
2550			2							
2700			2							
2850			3							
3000										
3150										
3300										
3450										
3600										
3750										
3900										
4050										
4200										
4350										
4500										
4650										
4800										
4950										
5100										
5250										

Remarks	General Information
	AS 1289 6.3.2 ☐ Drop height 510mm ± 5 ☒ Cone tip ☐ Blunt tip AS 1289 6.3.3 ☐ Drop height 600mm ± 5

Dynamic Cone Penetrometer Test Results

Issue No.: 1

Client: EJE ARCHITECTURE

Principal:

Job No.: GEOTWARA20706AA

Project: LAKE MACQUARIE YACHT CLUB, EXTENSIONS TO CAR PARKING AREA AND NEW CLUB HOUSE

Location: ADA STREET, BELMONT

Sample Details

Test procedure:		Test date: 14/01/2009						Readings recorded in blows per 150mm		Test location/Remarks
Depth below surface	Test Numbers									
	DCP7	DCP8	DCP9	DCP10	DCP11	DCP12				
150	2	0	0	1	0	0			* = ran out of rods	
300	3	0	0	0	0	0				
450	1	7	0	0	0	0				
600	1	1	0	0	0	0				
750	0	0	0	0	1	0				
900	0	0	2	0	2	0				
1050	1	1	1	0	1	1				
1200	2	1	3	0	0	0				
1350	4	1	3	1	1	0				
1500		1	1	0	0	2				
1650		2	2	0	1	1				
1800		2	2	0	0	0				
1950		3	2	1	1	1				
2100		2	2	0	1	0				
2250		2	1	1	1	2				
2400		2	2	1	3*	3				
2550		2		2		2				
2700		3		2		2				
2850		4								
3000										
3150										
3300										
3450										
3600										
3750										
3900										
4050										
4200										
4350										
4500										
4650										
4800										
4950										
5100										
5250										

Remarks

General Information

AS 1289 6.3.2

☐ Drop height 510mm ± 5

☒ Cone tip

☐ Blunt tip

AS 1289 6.3.3

☐ Drop height 600mm ± 5

Appendix B

Results of Laboratory Testing

acid sulfate soil screening test

client:	COFFEY GEOTECHNICS PTY LTD										date:	19/01/09	
principal:	EJE ARCHITECTURE										test location:	Warabrook	
project:	GEOTWARA20706AA – LMYC Extensions										tested by:	GREG E	
location:	Lake Macquarie Yacht Club, Belmont										checked by:		
date samples recovered:		14/01/09		pH meter used/serial	HORIBA-D24		date of calibration:		19/01/09				
hydrogen peroxide pH prior to use:		4.6		hydrogen peroxide temperature prior to use:								21.0°C	

sample location	depth (m)	RL (mAHD)	soil description	pH _F in 1:5 distilled water	pH _{Fox} (oxidation in 30% hydrogen peroxide)					Additional comments		
					time (mins)	pH _{FOX}	temp (°C)	Effervescence (see note below)	Odour		Colour change during reaction	pH Change (ie pH _F -pH _{Fox})
HA 1	0.0 – 0.3		SILT	6.49	20	2.00	24.7	b	Nil	Grey / Black - Brown	4.49	Froth
HA 1	0.3 – 0.6		CLAY	7.60	20	4.97	24.1	b	Nil	Nil	2.63	
HA 2	0.1 – 0.3		SAND	7.51	20	2.57	24.8	b	Nil	Grey / Black - Brown	4.94	Froth
HA 2	0.5 – 0.7		SAND	7.66	20	3.86	2.7	b	Nil	Grey / Black - Brown	3.80	Froth
HA 3	0.0 – 0.3		SILT	7.27	20	3.79	23.5	b	Nil	Grey / Black - Brown	3.48	Froth
HA 4	0.0 – 0.1		SILT	7.71	20	2.33	24.0	b	Nil	Grey / Black - Brown	5.38	Froth
HA 4	0.2 – 0.3		SAND	7.01	20	4.60	24.8	b	Nil	Grey / Black - Brown	2.41	Froth
HA 5	0.6 – 0.7		SAND	8.06	20	4.12	26.7	b	Nil	Grey / Black - Brown	3.94	Froth
HA 5	0.2 – 0.3			7.52	20	1.95	25.5	b	Nil	Grey / Black - Brown	5.57	Froth
HA 6	0.0 – 0.1		SILT	7.10	20	3.16	24.8	b	Nil	Grey / Black - Brown	3.94	Froth
HA 6	0.2 – 0.3		SILT	7.89	20	2.10	22.7	b	Nil	Grey / Black - Brown	5.79	Froth

NOTES:

1. Observed Reaction: a. No visible effervescence b. Slight to moderate effervescence c. Vigorous effervescent reaction

2. Strong Odour:

acid sulfate soil screening test

client:	COFFEY GEOTECHNICS PTY LTD						date:	19/01/09				
principal:	EJE ARCHITECTURE						test location:	Warabrook				
project:	GEOTWARA20706AA – LMYC Extensions						tested by:	GREG E				
location:	Lake Macquarie Yacht Club, Belmont						checked by:					
date samples recovered:		14/01/09		pH meter used/serial	HORIBA-D24		date of calibration:		19/01/09			
hydrogen peroxide pH prior to use:		4.6		hydrogen peroxide temperature prior to use: 21.0°C								
sample location	depth (m)	RL (mAHD)	soil description	p _{Hf} pH in 1:5 distilled water	p _{Hfox} (oxidation in 30% hydrogen peroxide)					Additional comments		
					time (mins)	pH _{Fox}	temp (°C)	Effervescence (see note below)	Odour		Colour change during reaction	pH Change (ie p _{Hf} -p _{Hfox})
HA 6	0.6 – 0.7		SILT	8.31	20	1.45	26.7	b	Nil	Grey / Black - Brown	6.86	Froth
NOTES:												
1. Observed Reaction:												
2. Strong Odour:												
a. No visible effervescence b. Slight to moderate effervescence c. Vigorous effervescent reaction												

RESULTS OF ACID SULFATE SOIL ANALYSIS (Page 1 of 1)

4 samples supplied by Coffey- Warabrook on 21st January, 2009 - Lab. Job No. A1788
Analysis requested by Caell Waikari. - Your Project: GEOTWARA20706AA

Sample Site	Depth (m)	EAL lab code	Texture (note 6)	Moisture Content (% moisture)	TAA pH _{ka}	Titrateable Actual Acidity (TAA) mole H ⁺ /tonne (to pH 6.5)	Reduced Inorganic Sulfur (% chromium reducible S) (%Scr) (note 2)	Reduced Inorganic Sulfur (Scr) mole H ⁺ /tonne	% ANC _{gr} %CaCO ₃	a-ANC _{gr} mole H ⁺ /tonne	NET ACIDITY Chromium Suite mole H ⁺ /tonne (based on %Scr)	LIME CALCULATION Chromium Suite kg CaCO ₃ /tonne DW (includes 1.5 safety Factor)
<i>Method No.</i>					23A	23F	22B	a- 22B	19A2	a-19A2	note 5	note 4 and 6
HA 1	0.0-0.3	A1788/1	Fine	75.4	6.83	0	0.832	519	1.21	242	358	27
HA 2	0.1-0.3	A1788/2	Coarse	22.8	8.49	0	0.152	95	3.97	793	-434	-33
HA 5	0.6-0.7	A1788/3	Coarse	24.1	8.62	0	0.130	81	1.57	314	-128	-10
HA 6	0.6-0.7	A1788/4	Coarse	25.0	8.34	0	0.396	247	0.60	120	167	13

NOTE:

- All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)
- Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & sulfate) and 'Chromium Reducible Sulfur' technique (Scr - Method 22B)
- Methods from Aherm, CR, McElnea AE, Sullivan LA (2004). *Acid Sulfate Soils Laboratory Methods Guidelines*. QLD DNRME.
- Bulk Density is required for limiting rate calculations per soil volume. Lab. Bulk Density is no longer applicable - field bulk density rings can be used and dried/ weighed in the laboratory.
- ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Sors or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF (with FF currently defaulted to 1.5)
- The neutralising requirement. Lime calculation, includes a 1.5 safety margin for acid neutralisation (an increased safety factor may be required in some cases)
- For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
- ... denotes not requested or required
- SCREENING, CRS, TAA and ANC are NATA certified but other SPOCAS segments are currently not NATA certification
- Results at or below detection limits are replaced with '0' for calculation purposes.
- Projects that disturb >1000 tonnes of soil, the ≥0.03% S classification guideline would apply (refer to acid sulfate management guidelines).

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



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