Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Preliminary Geotechnical Investigation

Proposed Train Support Facility
Woodlands Close, Hexham

Prepared for
QR National

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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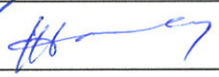
Reviewer		12 November 2012

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Executive Summary

A preliminary geotechnical investigation has been carried out at the proposed Train Support Facility at Hexham. The investigation was undertaken at the request of QR National to provide geotechnical advice for the preliminary civil/structural design. The proposed development includes construction of a train support facility along the eastern boundary of the site.

The field investigation included test bores and cone penetration tests (CPT). Samples were collected for geotechnical and geo-chemical testing purposes.

The stratigraphy is characterised by filling mainly located over the southern parts of the site. The filling was typically less than 2 m thick and was associated with a former coal preparation plant and Hexham-Minmi Railway. The underlying natural soils include soft clay which is typically 15 m to 17 m thick but up to 25 m thick at the southern end of the site. The soft clay is underlain by sand with occasional gravel, usually loose to medium dense, becoming dense with depth. Clay (possibly residual in origin) was encountered beneath the sand. Based on previous investigations, the clay graded into weathered bedrock at depths in the range of 25 m to 33 m below the current site levels.

The regional groundwater level is typically shallow relative to the natural ground surface. The data indicate that ground water levels are typically around 0 m to about 2 m below ground level. The frequent irrigation of the northern part of the site, combined with the flooding in June 2007, could also have caused perched water levels within the fill and sometimes at the ground surface, above the regional water table level.

Geotechnical analysis indicated that the site is suitable for the proposed rail development provided that ground treatment is carried out to reduce post-construction settlements. The report presents several options for ground treatment but it is considered that preloading or deep soil mixing would be a suitable technique for the rail embankments, and piles would be appropriate for the support of building structures which are sensitive to settlement. The ground improvement method should be monitored by geotechnical instrumentation to measure and verify performance.

The report presents several pavement thickness options taking into consideration the poor trafficability across the northern low lying parts of the site and provides guidance on site preparation measures and bridging over the soft/wet low lying areas.

The report recommended further contamination assessment. Investigation has since been undertaken and results are in Report on Preliminary Contamination Assessment, 39798.06, September 2012.

Based on laboratory testing of the natural soils, potential acid sulphate soils were confirmed to be present. An ASSMP was prepared for the proposed development and presented in Report 39798.08-1, September 2012.

An investigation of the Tarro interchange was undertaken by DP in 2007/2008. The current alignment has changed since preparation of the original report. A copy of the revised 2008 report is presented in Appendix G.

Report on Preliminary Geotechnical Investigation
Proposed Train Support Facility
Woodlands Close, Hexham

1. Introduction

This report presents the results of a preliminary geotechnical investigation for a proposed train support facility (TSF) at Woodlands Close, Hexham. The report was prepared at the request of QR National and in consultation with ADW Johnson, GHD and Engenicom.

It is understood that the proposed development includes the construction of a train support facility, located adjacent to the Great Northern Railway Line, west of the Pacific Highway at Hexham.

A geotechnical investigation was required to provide the following information:

- Subsurface conditions, including depth to groundwater;
- Subgrade conditions along the proposed road alignment for the railway siding and the proposed access road;
- Pavement thickness design for the access road;
- Excavation conditions within the areas of proposed cut;
- Suitable footing types and geotechnical design parameters for the proposed locomotive provisioning shed, multi-cell stormwater culvert and embankments;
- Settlement estimates;
- Safe batter slopes for the proposed cuts and fills;
- Construction techniques and site preparation procedures;
- Drainage measures;
- Assessment of soil contamination and acid sulphate soil potential.

The investigation consisted of test bores and cone penetration tests (CPTs), in situ soil sampling and strength testing and laboratory and engineering analysis. The results are presented in the report, together with preliminary geotechnical advice on design and construction.

An additional investigation for the upgrade of the Tarro Interchange and the existing Woodland Close was completed by Douglas Partners in 2007/2008. The results from that investigation are presented in Appendix G. The current report, however, has been modified to reflect the current proposed development.

For the purpose of the investigation, the client supplied a concept plan of the site, overlaid on an aerial photograph, Ref MASTER_SENDOUT_C.dwg. QR National Limited also supplied co-ordinates for test locations.

This report supersedes Douglas Partners Pty Ltd (DP) previous preliminary geotechnical investigation report prepared for Queensland Rail (QR) in May 2011 (Project 39798.08 Rev 4) – Ref 1. The borehole logs, CPTs and laboratory testing from that investigation are attached.

The positions of the bores and CPTs were based on the development layout that was proposed in 2007.

2. Site Description

The site description is based on observations of the site in July 2007, during a walk-over survey by a geotechnical engineer from DP. A follow-up inspection of the site was undertaken by DP in March 2011.

The site is located at the southern end of Woodlands Close, Hexham and is bounded to the east by the Great Northern Railway which runs north-south parallel to the New England Highway and the Hunter River which is situated further to the east.

The proposed TSF development area is generally limited to a corridor about 150 m wide adjacent to the Great Northern Railway, due to the linear nature of the development. The ARTC Hexham Relief Roads Project which comprised five new train line (tracks) is located between the proposed TSF and the Great Northern Railway. The development generally only occupies a relatively narrow strip along the eastern side of the overall site, as shown on the Worley Parsons general arrangement figures in Appendix A.

The site can be divided into two distinctly different sections. The southern section has been heavily disturbed, with the site raised by filling. The northern part of the site is mostly low lying grazing land with only very localised areas of filling having been placed, associated with narrow access roads.

Each section of the site is described below.

Southern Side (Ch 174.170 km to Ch 175.800 km)

The southern part of the site contains the remains of former coal handling facilities, tailings ponds (mainly to the west) and part of the disused Hexham-Minmi Railway. The rail line is listed under the Newcastle LEP 2002 as a State significant item of heritage significance. A former rail loop was present on the southern part of the site which appears to have been connected onto the Great Northern Railway at approximately Ch 174.200 km.

An unsealed access road is situated along the eastern boundary of the site, immediately adjacent to the Great Northern Railway. The access road was used to gain access to Lot 312 DP 583724 further to the south. The access road was constructed in 1999.

Site levels have been modified by the placement of filling generally associated with the former coal handling plant facilities with site levels varying from RL 0.4 AHD to RL 3.7 AHD.

Filling was evident in the central and eastern portions of the site. Surface observations indicated that coal washery reject was the predominant filling type (refer Figure 1).

Figure 1: Filling stockpiles in the eastern portion of the site

Remnants of the previous coal handling facilities are present at the southern part of the site and include:

- A former storage tank was located in the central portion of the site near CPT TP15. Some minor surface staining was observed in the vicinity of the tank (refer Figure 2);
- Other stockpiles of filling observed onsite comprised terracotta roof tiles (refer Figure 3), fibro (possibly containing asbestos – Figure 4) and other deleterious material such as concrete, bricks and timber (Figure 5);
- Concrete slabs and piers, relating to the former building and conveyors, were observed across the southern parts of the site.

Figure 2: Storage tank observed in the central/eastern portion of the site

Figure 3: Scattered stockpile of terracotta roof tiles

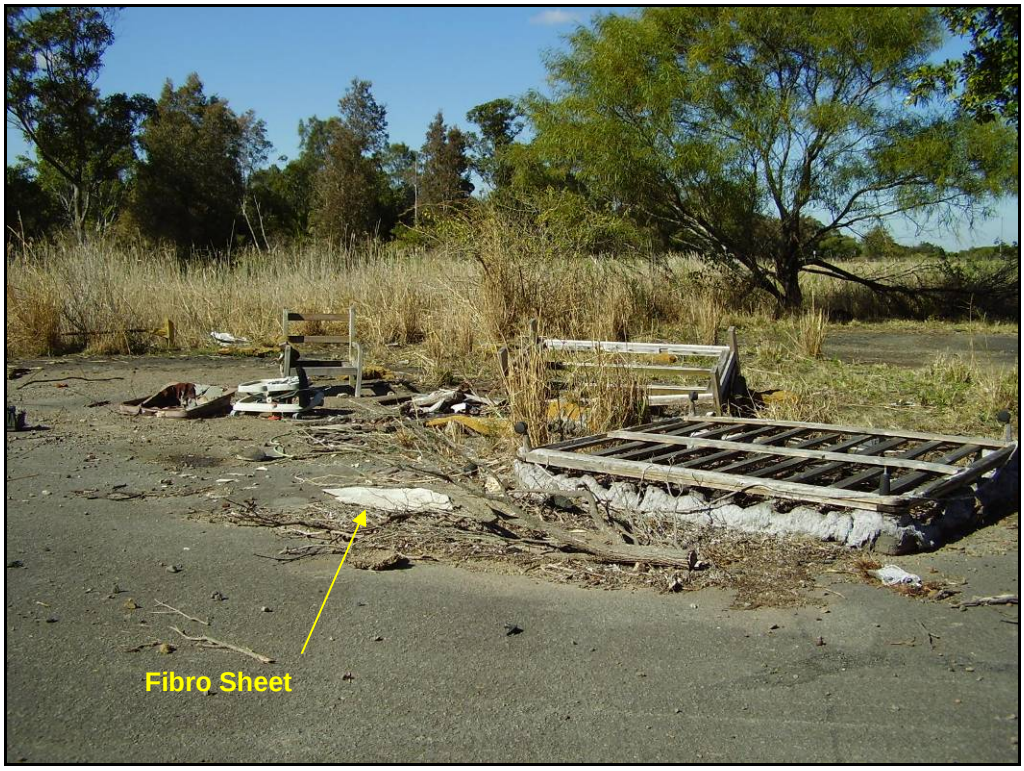

Figure 4: Scattered filling over a paved area in the central part of the site

Figure 5: Scattered stockpile of timber, tyres and 44 gallon drums

Site vegetation comprised grass, reeds (low lying parts) together with scattered trees. Some parts of the site are more densely vegetated such as the northern parts of the area.

Several drains and low lying areas are situated throughout the southern part of the site including a pond containing reeds between test locations Bore TP27 and Bore TP28 and adjacent to CPT 12.

A series of former tailings pond is located generally west of the proposed development layout. The tailings pond had been filled with coal fines and coal reject forming an elevated platform (stockpile) approximately 6 m (RL 8 AHD) above the surrounding site. At the time of the investigation, the stockpile was spray irrigated with treated effluent and was surfaced with grass. The overall dimensions of the tailings pond is about 0.5 km (east west) and up to 1.3 km long (north-south).

Northern Side (Ch 175.800 km to Ch 177.200 km)

The northern part of the site is generally located between the former Hexham-Mimi railway and the Tarro interchange along the New England Highway.

The northern 'Dairy Farmers' site is generally low lying with dense grass cover and scattered trees. The site levels typically range from RL 0.5 AHD to RL 1.5 AHD.

The site is accessed via a gravel access road which forms an extension to Woodlands Drive.

Surface water was ponding at the time of field investigations in July to September 2007 and was generally 0.1 m to 0.4 m in depth. The water was observed over the central low-lying areas of the site (ie CPT 2 to 10) and Bore TP35. The area was not accessible to standard vehicles and a specialised light weight "all terrain" vehicle was required to gain access to this section of the site (refer Figure 6).

Figure 6: General site figure showing low lying areas

Effluent treatment dams are situated within the grazing area to the west of the site. It is understood that effluent is treated to a secondary level and then spray irrigated on areas generally to the west of the site.

One major drain is situated at the northern part of the site. The drain flows from west to east via an unlined grassed channel which appears to have been excavated below former ground levels. The drain passes beneath the rail embankment at Ch 177.060 km via a concrete culvert (refer Figure 7). Water was ponding in the base of the drain.

Figure 7: Culvert beneath existing track at Ch 177.060 km

The western part of the site between Woodlands Close and the Tarro interchange where the access road is proposed comprises flat grassed paddocks (refer Figure 8).

The Chichester Pipeline passes through the site together with overhead power lines and drainage channels.

Figure 8: Western part of the site

3. Data Review

3.1 General

The data review had two main components: published information and in-house information from Douglas Partners files on previous investigations. The published information includes geological maps, soil landscape maps, acid sulphate risk maps and historical aerial photographs. These are described on Section 3.2 below.

The in-house information comprises data from several previous investigations both within the subject site and on adjacent or nearby sites, dating from 1959 to 2004. A summary of the data is presented in Appendix A and it is described in Section 3.3.

3.2 Published Data

3.2.1 Geological Map

The 1:100,000 scale Newcastle Coalfield Regional Geology map (Sheet 9321), published by the Department of Mineral Resources, indicates that the site is underlain by Quaternary Alluvium. The alluvium typically comprises unconsolidated sediments deposited in a fluvial or estuarine environment, and includes gravel, sand, silt and clay.

3.2.2 Landscape Map

The soil landscape map for Newcastle (Sheet 9232), published by the Soil Conservation Service, shows that the majority of the southern part of the site is categorised as “disturbed terrain”, being extensively disturbed by human activity. The soils and hence the potential limitations are highly variable, and may include foundation hazard, unconsolidated low wet bearing strength materials, potential acid sulphate soils, impermeable soils, poor drainage, erosion hazard, very low fertility.

The northern part of the site is shown to be part of the Millers Forest landscape, described as comprising extensive alluvial flood plain / delta on recent sediments with elevation below 3 m to 6 m AHD. Limitations, as listed, include flood hazard, permanently high water table, seasonal water-logging, foundation hazard. This landscape would also be expected to underlie the disturbed terrain of the remainder of the site.

3.2.3 Acid Sulphate Soil Risk Map

The Acid Sulphate Soil Risk Map for Beresfield (Sheet 9232 N3), published by the Department of Land and Water Conservation, indicates that the entire site has a high probability of acid sulphate soils within one metre of the (natural) ground surface. There would be an environmental risk if acid sulphate materials were disturbed without appropriate management procedures in place.

3.2.4 Aerial Photographs

The following historical aerial photos were reviewed for the assessment:

Table 1: Aerial Photo Review

Year	Approximate Scale	Black and White/Colour
1954	1: 30,000	B & W
1966	1: 30,000	B & W
1975	1:40,000	B & W
1986	1:4,000	B & W
2004	1:10,000	Colour

These are listed below with relevant comments on the site condition.

1954 Aerial Photograph

- The Hexham-Minmi Railway runs parallel and to the west of the Main Northern railway along the southern part of the site before heading west about midway along the site (south of Dairy Farmers boundary);
- The Pacific Highway and Great Northern Railway are present east of the site;
- The rail line / road following the Hexham-Minmi railway appears to have been recently constructed;
- Water appears to be ponding in the area of the Dairy Farmers property (eastern part) with pastures / crops to the west.

1966 Aerial Photograph

- Buildings (coal preparation plant) situated at the southern part of the site between Great Northern Railway and Hexham Minmi railway at about Ch 174.65 km to 174.850 km;
- Rail crossing on southern part of the site at about Ch 175.450 km.

1975 Aerial Photograph

- Coal Preparation Plant buildings, stockpiles, tailings ponds, conveyors and the rail loop are present on the southern half of the site.

1986 OrthoPhotomap

- Coal Preparation Plant buildings, stockpiles, tailings ponds, conveyors and the rail loop are present, and in operation;
- Rail carriages appear to be present on the rail loop, the rail lines / sidings adjacent to the Hexham Minmi railway;
- Buildings were observed north of the Hexham Minmi Rail line;
- Several trucks were present across the site;
- Gravel access tracks were constructed within the Dairy Farmers (northern) part of the site.

2004 Aerial Photograph

- Operations associated with the Coal Preparation Plant have ceased;
- Buildings and other structures associated with the Coal Preparation Plant have been demolished and trees now growing over rail line;
- The stockpile and tailings ponds to the west of the Coal Preparation Plant are vegetated with grass;
- The Dairy Farmers Treatment ponds/plant is present.

It is noted that the review of aerial photos was limited by the relatively small scale and poor resolutions.

3.3 Data from Previous DP Investigations

The archive search revealed a number of relevant previous investigations by DP (and its predecessors). Some of these were carried out within the subject site, and the others were on adjacent or nearby sites. These assist in building a geotechnical model of the site. The reports are listed in Table 2 in chronological order, identified by a letter prefix, and the sites associated with these projects are shown on Drawing 1-1, Appendix H.

A brief summary of each report, including the work done and predominant findings is contained in Appendix A.

Table 2: Previous Investigations Undertaken on the Site and Surrounding Area by DP

Reference Prefix**	Project Number	Date	Report Title	Field Tests
A	00083	February 1959	Subsoil Investigation, Hexham	3 Bores (location uncertain)
B	02961	March 1971	Foundation Investigation, Ironbark Colliery, Hexham	13 Bores
C	03389	March 1972	Foundation Conditions, Proposed Coal Preparation Plant Hexham	4 Bores
D	06109	June 1978	Foundation Conditions Proposed Road and Rail Interchange Station, Hexham	5 Bores, 2 CPTs
E	16781	August 1993	Geotechnical Investigation, Proposed Depot Redevelopment, Australian Co-Operative Foods Ltd, New England Highway Hexham	4 Bores, 3 CPTs
F	17163, 17163A	August 1995	Geotechnical Investigation and Building Preload, Proposed Service Station Redevelopment, Pacific Highway Hexham	8 Wells*
G	18419, 18419A, 18419B	November 1995	Geotechnical and Acid Sulphate Soil Investigation, Proposed Effluent Ponds, ACF, New England Highway Hexham	6 Test Pits
H	18419C	November 1995	Geotechnical And Acid Sulphate Soil Investigation, Proposed Effluent Ponds, ACF, New England Highway Hexham	2 Bores
I	18457	February 1996	Geotechnical Investigation, Proposed Industrial Development, Lots 1 and 2 Old Maitland Road Hexham	3 CPTs
J	18603	November 1996	Geotechnical Investigation, Proposed Extensions to Club and Car park, Hexham Bowling Club, Hexham	6 Bores, 2 CPTs
K	18891	September 1998	Geotechnical Investigation, Proposed Access Road Hexham	12 Test Pits
L	18891A	January 1999	Geotechnical Investigation, Power Poles, Access Road and Smithy's Crossing, Hexham	5 Bores
M	18944, 18944A, 18944B	February 1999 to November 2000	Groundwater Monitoring, Dairy Farmers, 189 Maitland Road Hexham	10 Wells*
N	31773	July 2003	Geotechnical Investigation, Augmentation Of Hexham Bowling Club Wastewater Facilities, Hexham Bowling Club Hexham	2 Bores
O	39033	September 2004	Geotechnical Investigation, Proposed Weighbridge, Sparke Street Hexham	3 Test Pits, 1 CPT
P	39052	September 2004	Preliminary Site Assessment, Maitland Road, Hexham	Desktop review of geotechnical and geo-environmental data
Q	39159	June 2005	Report on Water Balance Assessment for Disposal of Treated Waste Water	NA
R	39798	October 2007	Preliminary Geotechnical Investigation, Proposed Maintenance Facility, Woodlands Close, Hexham	15 CPTs, 12 Bores, 11 hand augers
S	39798.01	March 2008	Geotechnical Assessment Proposed Rail Siding, Hexham	Desktop review of geotechnical data
T	39798.05	February 2012	Groundwater Assessment, Proposed Hexham Redevelopment, Maitland Road and Woodlands Close, Hexham	12 Wells*

Notes to Table 2:
* Wells – Groundwater monitoring wells
** - Refer Drawing 1-1 Appendix H for reference Prefix location
CPT – Cone Penetration Test
NA – Not Applicable

It should be noted that the locations of the tests are quite approximate in most cases, particularly for the older investigations where site plans are unclear or open to interpretation.

4. Field Work

4.1 Methods

General

The field work for the 2007 study was undertaken in the period 30 July 2007 to 19 September 2007, and comprised bores, hand auger bores, cone penetration tests (CPT / CPTu). The field work methods and results for the investigation of the upgrade of the Tarro Interchange is presented in Appendix G.

The bores and CPT locations were generally set out at pegged locations nominated by QR with consideration given to potential access issues at a number of locations. The numbering system at test locations was based on QR numbering system, except that Bores 2 to 12 were renamed CPT 2 to 12 to account for the type of testing that was undertaken. CPTs were also undertaken at locations proposed as test pit locations TP13, TP15, TP17 and TP19. The bores and CPTs were positioned for the development layout that was proposed in 2007.

Bore 1 was not undertaken as this test was located within the ARTC corridor and it was agreed by QR that the test could be deleted from the scope of work.

Test 20 was also not undertaken as this test was situated within swampy ground and testing could not be undertaken due to access constraints.

The tests were located to ISG co-ordinates and AHD datum. The test locations are presented on Drawing 1-2 in Appendix H. The recorded test co-ordinates and levels are shown on the respective CPT charts and borehole logs.

Cone Penetration Testing

A total of 15 cone penetration tests were carried out comprising six standard cone penetration tests and nine piezocone tests. The standard tests are numbered CPT 11 and 12, TP13, 15, 17 and 19 (standard cones) and CPT 2 to 9 (piezocones).

The standard tests were carried out using a custom-built, truck-mounted CPT rig, with centrally located hydraulic rams. The piezocones were carried out with an ‘all terrain’ CPT rig capable of accessing the soft / wet areas of the site (refer Figure 9 below). The cones were advanced at a constant rate of approximately 20 mm / second and a digital data acquisition system recorded cone tip resistance, friction sleeve resistance, dynamic pore pressure (only in piezocone), inclination from vertical and encoded depth at measurement intervals of 20 mm.

Figure 9: CPTu testing within low lying parts of the site using "all terrain" rig (2007)

The tests were generally carried out to depths ranging between 20 m and 32.9 m. The piezocone tests were limited to depths of 17 m to 27 m as the rig was lighter in weight and refusal was encountered generally within the medium dense sands.

Test Bores

4WD-Mounted Bores

A total of 12 bores (Bores 14, 16, 18, 21, 25, 27 to 30, 34, 36 and 37) were drilled across the site. The bores were drilled to depths ranging from 4 m to 4.95 m.

The bores were drilled using a 4WD mounted rotary drilling rig equipped with solid flight augers.

Sampling and testing included standard penetration testing (SPT) at depth intervals of about 1.5 m.

Hand Augers

A total of 11 hand-augered test bores (Bores TP22 to 24, 26, 31 to 33, 35, 38 to 40) were drilled in areas where the drilling rig could not gain access due to wet and boggy conditions. It should be noted that the field work was undertaken following a period of unusually high rainfall and part of the site had become flooded.

The bores were drilled to depths ranging between 1.1 m and 2.5 m depth.

The subsurface profile in each bore was logged by a geotechnical engineer or environmental scientist from DP who also collected samples for subsequent laboratory testing and identification purposes.

The bores and hand augers were augmented by dynamic penetrometer testing at each location together with pocket penetrometer tests at selected depths and locations.

Samples for environmental purposes were generally collected from the near surface, and at regular depth intervals or changes in strata within each bore. Soil samples were collected directly from the solid flight augers using stainless steel sampling equipment. Augers were screwed into the ground at discrete depths and retracted without rotation to minimise sample disturbance. Care was taken to remove any extraneous material deposited on the outer auger flights as the auger was withdrawn from the borehole.

Disturbed samples of the underlying natural soils were also collected for the purpose of acid sulphate screening tests. The samples were double wrapped in plastic and stored in an iced cooler for transport to DP's Newcastle laboratory for testing.

All environmental sampling data was recorded on DP chain of custody sheets, and the general sampling procedure comprised:

- Decontamination of all sampling equipment using a 3% solution of phosphate free detergent (Decon 90) and tap water prior to collecting each sample;
- The use of disposable gloves for each sampling event;
- Transfer of samples into laboratory-prepared glass jars, and capping immediately;
- Collection of 10% replicate samples for QA/QC purposes;
- Collection of replicate soil samples in zip-lock plastic bags at each depth for PID screening;
- Labelling of sample containers with individual and unique identification, including project number, sample location and sample depth;
- Placement of the sample jars and replicate sample bags into a cooled, insulated and sealed container for transport to the laboratory;
- Use of chain of custody (C-O-C) documentation ensuring that sample tracking and custody could be cross-checked at any point in the transfer of samples from the field to the laboratory. Copies of completed forms are contained in Appendix D.

Replicate samples for each sample were screened for the presence of volatile organic compounds (VOC's), using a Microtip HL-2000 Photo-ionisation detector (PID) with a 10.6 eV lamp, calibrated to 100 ppm Isobutylene. The PID is capable of detecting over 300 VOC's.

Samples for contamination testing were selected for analysis from filling material at bore locations which were nominated by QR.

4.2 Results

The subsurface conditions encountered in the testing undertaken in 2007 are presented in detail in the attached test bore logs and CPT charts in Appendix A. The CPT charts show the measured parameters, together with an inferred strata description, based on published correlations. The charts and report sheets should be read in conjunction with the accompanying notes preceding them, which explain the descriptive terms and classification methods used in the logs.

The following is a summary of the subsurface conditions encountered in the bores / CPT together with previous investigations undertaken in the vicinity of the site:

Table 3: Summary of Subsurface Profile

Stratum	Description
FILL	Predominantly comprising coarse coal reject (chitter), and intermixed with sand and clays where spread elsewhere particularly on the southern half of the site in the area of a former Coal Handling Preparation Plant. Over the southern half of the site the fill depth is typically 0.5 m to 1.5 m depth, but up to about 2 m.
CLAY (alluvial)	Soft to firm silty clays / clays and clayey silts are present beneath the fill at all CPT test locations. The clay layer is typically 15 m to 17 m thick but up to 25m thick at the southern end of the site. It is this layer which presents issues of poor bearing capacity for footings and pavements, as well as potential long term settlements under load due to its compressibility. The clay profile is interbedded by silty sand / clayey sand, particularly in the upper profile of the unit.
SAND	Sand, clayey sand or silty sand, with occasional gravel, usually loose to medium dense, becoming dense with depth. The thickness and distribution of this layer is quite variable and it is not present at all locations.
CLAY (residual)	The deeper clays are generally stiff to very stiff sandy clay, grading to hard clays and weathered rock although weathered rock was not encountered during the current investigation.
BEDROCK	Sandstone, siltstone, shale and coal were encountered in previous bores that were taken to rock. The depth to rock varies considerably, from about 25 m (below natural surface) in the south-eastern area (former colliery facilities) to 33 m near the former rail loop, west of the southern end of the site. More generally, it appears that the depth to rock is round 30 m to 35 m over most of the site, probably increasing to the west towards Hexham Swamp.

A geological section along the rail line is provided in Drawing 1-3, Appendix H.

The regional groundwater level is typically shallow relative to the natural ground surface. The data indicates that ground water levels are typically around 0 m to about 2 m below ground level. The frequent irrigation of the northern part of the site, combined with the flooding in June 2007 could also have caused perched water levels within the fill and sometimes at the ground surface, above the regional water table level.

Due to the above features, and with climatic variations, water levels within the site will be transient and also vary across the site. Further discussions on groundwater is presented in Douglas Partners report Ref 13.

4.3 Contaminant Observations

Fill materials generally comprised coal reject materials with no visual or olfactory evidence of contamination (ie no staining or odour).

The following observations of potential contamination were observed during the walkover and subsurface investigation:

- Presence of building materials (rubble) within filling (possible asbestos) in the southern part of the site (former coal preparation plant);
- Presence of fuel storage area (Figure 2) with some minor staining of adjacent ground surface;
- Presence of coal chitter and filling covering generally the southern parts (Figures 4 and 5) of the site;
- Scattered stockpiles of rubbish including fuel drums generally adjacent to access tracks;
- The results of PID Screening on soil samples are shown on some borehole logs in Appendix B and generally suggest the absence of gross volatile hydro-carbon impact;
- Groundwater was observed in the boreholes; observation of the water suggested the absence of visual or olfactory contamination (ie visible staining and odour). It is noted that groundwater was not sampled or analysed to confirm chemical condition.

Further discussions on contamination observations and results are presented in Ref 12.

5. Laboratory Results

5.1 Geotechnical Testing

Samples of expected subgrade material were submitted to the DP Newcastle laboratory for California bearing ratio (CBR), standard compaction, Atterberg limits and linear shrinkage testing. Detailed results are attached (Appendix C) and are summarised in Table 4.

Table 4: Results of Laboratory Testing

Test Location	Depth (m)	Description	FMC (%)	MDD (t/m^3)	OMC (%)	CBR (%)	LL (%)	PL (%)	PI (%)	LS (%)
TP16	2.3	Silty Clay – dark brown	41.9	-	-	-	56	25	31	14.0
TP18	0.0-1.0	Coal Reject (chitter)	11.7	1.58	13.5	9	-	-	-	-
TP21	1.5-1.95	Silty Clay – brown	41.1	-	-	-	44	23	21	12
TP27	1.0-1.5	Gravelly clay – dark grey (chitter)	20.7	1.48	15.0	14	-	-	-	-
TP34	0.7-1.0	Silty Clay – dark grey / brown	51.4	1.32	34.5	1.0	-	-	-	-
TP36	0.1-1.0	Sandy Clay – dark brown	28.5	1.50	25.5	2.0	-	-	-	-
TP37	3.9	Sandy Silt – grey black	37.0	-	-	-	-	-	NP	-

Notes to Table 4:
FMC – Field Moisture Content
OMC – Optimum Moisture Content
LL – Liquid Limit
PI – Plasticity Index
NP – Non-Plastic
MDD – Maximum Dry Density
CBR – California Bearing Ratio
PL – Plastic Limit
LS – Linear Shrinkage

5.2 Chemical Testing

5.2.1 Analytical Programme

Laboratory testing was undertaken by SGS Pty Limited, a National Association of Testing Authorities, Australia (NATA) registered laboratory. Analytical methods used are shown on the laboratory sheets in Appendix D.

Five samples of filling were selected to provide a preliminary assessment of fill materials. QR specified the laboratory testing schedule. The samples were analysed for pH, sulphate and phosphorus as well as the following potential contaminants:

- Total Recoverable Hydrocarbons (TRH);
- Polycyclic Aromatic Hydrocarbons (PAH);
- Organochlorine Pesticides (OCP);
- Organophosphorus Pesticides (OPP);

- Polychlorinated Biphenyls (PCB);
- Benzene, Toluene, Ethyl Benzene, Xylene (BTEX);
- Metals: Arsenic (As); Cadmium (Cd); Chromium (Cr); Copper (Cu); Lead (Pb); Mercury (Hg); Nickel (Ni); Zinc (Zn).

Quality Control/Quality Assurance (QA/QC) testing comprised one soil replicate (sample D1), the results of which are detailed in Appendix D.

5.2.2 Analytical Results

The results of chemical analysis of soil samples are presented in the laboratory report sheets (Appendix D), and are summarised in Tables 5, 6 and 7 below.

Table 5: Laboratory Results for Metals in Soil

Test	Depth (m)	PID (ppm)	Metal							
			As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
TP14	0.8	<1	<3	<0.1	2.1	5.9	15	<0.05	3.5	24
TP18	1.0	<1	20	0.3	2.2	17	16	0.13	3.5	33
TP28	0.1	<1	7	0.3	8.0	18	20	0.06	13	140
D1	-	<1	4	0.1	14.0	11	9	0.05	13	36
TP28	1.0	<1	<3	<0.1	3.5	5.0	5	<0.05	3.8	110
TP29	0.4	<1	<3	0.2	4.0	6.7	23	<0.05	8	81
Laboratory PQL			3	0.1	0.3	0.5	1	0.05	0.5	0.3
NSW EPA - NEHF F [1] (Ref 5)			500	100	500	5000	1500	75	3000	35000
NSW EPA –General Solid Waste Guidelines – CT1 (Ref 7)			100	20	100	NC	100	4	40	NC
NSW EPA – Restricted Solid Waste Guidelines – CT2 (Ref 7)			400	80	400	NC	400	16	160	NC

Notes to Table 5:
All results in mg/kg on a dry weight basis
NC - No Criteria
CT - Concentration Threshold
D1 - Replicate of TP 28/0.1 m
PQL - Practical Quantification Limits
1 - Health Based Criteria for Commercial / Industrial Land Use
PID - Photoionisation Detector

Table 6: Laboratory Results for TRH and BTEX in Soil

Pit	Depth (m)	PID (ppm)	TRH				BTEX			
			C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	Benzene	Toluene	Ethyl Benzene	Xylene
TP14	0.8	<1	<20	<20	<50	<50	<0.50	<0.50	<0.50	<1.5
TP18	1.0	<1	<20	<20	100	<50	<0.50	<0.50	<0.50	<1.5
TP28	0.1	<1	<20	23	290	170	<0.50	<0.50	<0.50	<1.5
D1		<1	<20	<20	250	170	<0.50	<0.50	<0.50	<1.5
TP28	1.0	<1	<20	<20	<50	<50	<0.50	<0.50	<0.50	<1.5
TP29	0.4	<1	<20	110	**2600**	**1900**	<0.50	<0.50	<0.50	<1.5
Laboratory PQL			20	20	50	50	0.5	0.5	0.5	1.5
NSW EPA Criteria for Service Station Sites [2] (Ref 6)			65	1000 total			1	1.4 [1]	3.1 [1]	14 [1]
NSW EPA – General Solid Waste Guidelines - CT1 (Ref 7)			650 SCC1	10000 total SCC1			10	288	600	1000
NSW EPA - Restricted Solid Waste Guidelines - CT2 (Ref 7)			650 SCC2	40000 total SCC2			40	1152	2400	4000

Notes to Table 6:

All results in mg/kg on a dry weight basis

PQL - Practical Quantification Limits

1 - Human Health Based Protection Level

2 - Threshold Concentration for Sensitive Land Use

SCC - Specific Contaminant Concentration

CT - Concentration Threshold

PID - Photoionisation Detector

D1 - Replicate of Pit 28/0.1 m

Bold results exceed “Threshold Concentrations for Sensitive Land Use”

Table 7: Laboratory Results for OCP, PCB and PAH in Soil

Pit	Depth (m)	PID (ppm)	Total PAHs	Benzo(a) Pyrene	Total OCPs	Aldrin + Dieldrin	PCBs
TP14	0.8	<1	0.57	0.07	<0.1	<0.1	<0.90
TP18	1.0	<1	0.86	0.06	<0.1	<0.1	<0.90
TP28	0.1	<1	1.69	0.09	<0.1	<0.1	<0.90
D1		<1	1.68	0.08	<0.1	<0.1	<0.90
TP28	1.0	<1	0.1	<0.05	<0.1	<0.1	<0.90
TP29	0.4	<1	13.92	0.62	<0.1	<0.1	<0.90
Laboratory PQL			0.05	0.05	0.1	0.1	0.9
NSW EPA - NEHF F [1] (Ref 5)			100	5	NC	50	50
NSW EPA - General Solid Waste Guidelines - CT1 (Ref 7)			200 SCC1	0.8	NC	NC	50 SCC1
NSW EPA - Restricted Solid Waste Guidelines - CT2 (Ref 7)			800 SCC2	3.2	NC	NC	50 SCC2

Notes to Table 7:
All results in mg/kg on a dry weight basis
PQL - Practical Quantification Limits
NC - No Criteria
PID - Photoionisation Detector
1 - Health Based Criteria for Various Land Uses
SCC - Specific Contaminant Concentration
CT - Concentration Threshold
Total PAH - Sum of positive PAH species
D1 - Replicate of Pit 28/0.1 m

The results of the preliminary assessment of contamination are discussed in Section 8 of this report.

5.3 Acid Sulphate Soil Testing

A total of 55 acid sulphate screening tests were undertaken on selected soil samples. The testing was undertaken in accordance with the ASSMAC “Acid Sulphate Soils Manual” (Ref 3). The soil samples were tested at the DP laboratory for pH in water (H_2O), and pH following oxidation with hydrogen peroxide (H_2O_2), using a calibrated pH meter. Samples were selected to test the acid forming potential of each material encountered that will potentially be disturbed by the excavation works. The results of the screening tests are presented in Table 8 below.

Table 8: Acid Sulphate Soil Screening Tests

Bore / Test Pit	Sample Depth [a] (m)	Sample RL (m AHD)	Sample Description	Screening Test Results			
				pH			Strength of Reaction [b]
				pH_F	pH_{FOX}	pH_F - pH_{FOX}	
14	2.4	-0.9	Silty Sand – grey	7.2	2.6	4.6	3FH
14	2.9	-1.4	Silty Sand – grey	7.4	5.2	2.2	1
16	2.3	0.0	Silty Clay – grey / brown	7.3	6.1	1.2	1-2
16	2.8	-0.5	Sandy Silty Clay - grey	7.6	6.5	1.1	1
16	3.0 - 3.45	-0.7 to -1.1	Sandy Silty Clay - grey	7.6	2.3	5.3	1-2
21	0.5 - 0.95	0.6 to 1.0	Silty Clay – grey brown	7.4	6.2	1.2	1-2
21	1.5 - 1.95	0.0 to -0.4	Silty Clay – grey brown	7.6	6.9	0.7	1
21	2.4	-0.9	Sandy Silt – grey	7.5	6.9	0.6	1
21	3.0 - 3.45	-1.5 to -1.9	Clayey Sand - grey	7.6	6.2	1.4	1
22	0.4	0.3	Silty Clay – grey	6.8	5.9	0.9	1H
22	0.9	-0.2	Silty Clay – grey	6.8	6.7	0.1	1H
22	1.4	-0.7	Clayey Silty Sand – grey mottled orange	7.0	6.8	0.2	1
22	1.7	-1.0	Clayey Silty Sand – grey mottled orange	7.1	6.9	0.2	1
22	2.4	-1.7	Clayey Silty Sand – grey mottled orange	7.1	6.9	0.2	1
23	0.7	0.4	Silty Clay – grey	7.4	6.6	0.8	1H
23	0.9	0.2	Silty Clay – grey	7.2	6.6	0.6	1H
23	1.2	-0.1	Clayey Silty Sand – grey	7.1	7.0	0.1	1H
24	0.4	3.1	Silty Clay – grey brown	7.3	6.0	1.3	1
24	0.7	2.8	Silty Sand – grey	6.7	6.3	0.4	1
24	0.9	2.6	Silty Sand – grey	6.7	6.2	0.5	1
24	1.6	1.8	Silty Sand – grey	6.5	5.5	1.0	1
Guideline			Sands to Loamy Sands	<4[c]	<3.5[d]	>1[d]	-
			Sandy Loams to Light Clays				
			Medium to Heavy Clays and Silty Clays				

Table 8: Acid Sulphate Soil Screening Tests (continued)

Bore / Test Pit	Sample Depth [a] (m)	Sample RL (m AHD)	Sample Description	Screening Test Results			
				pH			Strength of Reaction [b]
				pH_F	pH_{FOX}	pH_F - pH_{FOX}	
25	0.8 - 0.95	0.4 to 0.5	Silty Sand – grey	8.4	7.2	1.2	1
25	1.4	-0.1	Silty Sand - brown	8.0	7.5	0.5	1
25	1.5 - 1.95	-0.2 to -0.6	Silty Sand - brown	8.0	6.4	1.6	1
25	2.4	-1.1	Silty Sand – brown (shells)	8.5	6.9	1.6	1-2
25	3.9	-2.6	Silty Sand - brown	8.3	6.3	2.0	1-2
27	1.5 - 1.95	0.3 to -0.2	Silty Clay – grey	8.1	5.5	2.6	1
27	2.4	-0.6	Clayey Silty Sand - grey	8.1	6.3	1.7	1
27	2.9	-1.1	Clayey Silty Sand - grey	8.0	6.0	2.0	1-2
27	3.0 - 3.45	-1.2 to -1.7	Clayey Silty Sand - grey	8.2	7.2	1.0	1-2
28	3.3	-0.3	Silty Clay – grey	7.8	3.9	3.9	1-2
28	4.5 - 4.95	-1.5 to -1.9	Sandy Silt – grey	7.6	5.6	2.0	1-2
30	0.4	1.4	Sandy Clay - brown	5.9	4.4	1.5	2
30	0.5 - 0.95	0.8 to 1.3	Sandy Clay - brown	6.3	6.3	0.0	1-2
30	1.4	0.4	Clay – grey	7.2	6.6	0.6	1-2
30	1.5 - 1.95	0.3 to -0.2	Clay – grey	7.1	6.5	0.6	1
30	2.4	-0.6	Silty Sand – grey mottled orange	7.0	6.6	0.4	1
30	3.0 - 3.45	-1.2 to -1.7	Clayey Silt – grey (shells)	7.7	2.4	5.3	1-2
30	4.5 - 4.95	-2.7 to -3.2	Clayey Silt – grey (shells)	7.5	2.6	4.9	4HF
31	1.3	0.0	Silty Clay – grey mottled orange	7.4	6.1	1.3	1H
31	1.5	-0.2	Silty Clay – grey mottled orange	7.0	6.9	0.1	1H
31	1.8	-0.5	Silty Clay – grey mottled orange	7.7	7.6	0.1	1H
Guideline			Sands to Loamy Sands	<4[c]	<3.5[d]	>1[d]	-
			Sandy Loams to Light Clays				
			Medium to Heavy Clays and Silty Clays				

Table 8: Acid Sulphate Soil Screening Tests (continued)

Bore / Test Pit	Sample Depth [a] (m)	Sample RL (m AHD)	Sample Description	Screening Test Results			
				pH			Strength of Reaction [b]
				pH_F	pH_{FOX}	pH_F - pH_{FOX}	
34	1.3	-0.7	Silty clay - grey	7.2	6.4	0.8	1
34	1.4 - 1.95	-0.8 to -1.35	Silty clay - grey	7.1	6.5	0.6	1
34	2.4	-1.8	Silty clay - grey	7.0	6.1	0.9	1
34	3.0 - 3.45	-2.4 to -2.8	Silty clay - grey	7.2	4.5	2.7	1
36	0.4	0.8	Silty sand - brown	6.9	5.4	1.5	1-2
36	0.5 - 0.95	0.3 to 0.7	Sandy clay - brown	7.6	7.6	0.0	1
36	1.4	-0.2	Sand - brown	8.0	7.8	0.2	1
36	1.5 - 1.95	-0.3 to -0.7	Sand - brown	8.1	7.8	0.3	1
36	2.5	-1.3	Silty sand - grey	8.1	6.6	1.5	1
36	3.0 - 3.45	-1.8 to -2.2	Silty sand - grey	8.1	4.8	3.3	1-2
36	4.0	-2.8	Silty sand - grey	8.2	6.8	1.4	1-2
37	1.4	-0.1	Clay - grey	7.3	5.2	2.1	1
37	2.4	-1.1	Clayey silt - grey	7.3	2.9	4.4	1
Guideline			Sands to loamy sands	<4[c]	<3.5[d]	>1[d]	-
			Sandy loams to light clays				
			Medium to heavy clays and silty clays				

Notes to Table 8:

a Depth below ground surface

b Strength of Reaction

- 1 denotes no or slight reaction
- 2 denotes moderate reaction
- 3 denotes high reaction
- 4 denotes very vigorous reaction
- F denotes bubbling/frothy reaction indicative of organics
- H denotes heat generated

c For actual acid sulphate soils (ASS)

d Indicative value only for Potential Acid Sulphate Soils (PASS)

Shaded results indicate potential for acid generation upon oxidation (ie PASS)

pH_F - Soil pH Test (1:5 soil:distilled water)

pH_{FOX} - Soil Peroxide pH Test (1:4 soil:distilled water following oxidation of soil with 30% hydrogen peroxide (H_20_2))

Based on the above screening results, three samples were selected and submitted to ALS Environmental Pty Ltd for detailed laboratory testing as follows:

- Total potential acidity (TPA);
- Total actual acidity (TAA);
- Chromium reducible sulphur (S_{cr}).

The results of the acid sulphate soil testing are presented in Appendix D and are summarised in Table 9 below.

Table 9: Acid Sulphate Soil – Detailed Laboratory Testing

Bore / Test Pit	Sample Depth [a] (m)	Sample RL (m AHD)	Sample Description	Laboratory Results			
				pH_{KCL}	Scr %S	TAA (mole H+/t)	TPA (mole H+/t)
14	2.4	-0.9	Silty Sand - grey	5.6	0.65	6	359
16	3.0 - 3.45	-0.7 to -1.1	Sandy Silty Clay - grey	6.8	0.08	<2	388
27	1.5 - 1.95	0.3 to -0.2	Silty Clay - grey	5.5	<0.02	21	184
28	3.3	-0.3	Silty Clay - grey	5.9	<0.02	4	<2
30	0.4	1.4	Sandy Clay - brown	5.4	0.04	16	230
Guideline			Sands to Loamy Sands	-	0.03	18	18
			Sandy Loams to Light Clays		0.06[b]/0.03[c]	36[b]/18[c]	36[b]/18[c]
			Medium to Heavy Clays and Silty Clays		0.1[b]/0.03[c]	62[b]/18[c]	62[b]/18[c]

Notes to Table 9:
a – depth below ground surface
b – ASSMAC Action Criteria for disturbance of 1-1000 tonnes of material
c – ASSMAC Action Criteria for disturbance of more than 1000 tonnes of material
Shaded results indicate an exceedence of ASSMAC action criteria for 1-1000 tonnes of ASS soil (Ref 3)

The results of the acid sulphate testing are discussed in Section 9 of this report.

6. Proposed Development

It is understood that the proposed development includes the construction of a rolling stock maintenance facility, located adjacent to the Great Northern Railway Line. The proposed development will include the following aspects:

Stage 1:

- Construction of a connection to the Tarro Interchange and main vehicle access road to the site;
- Construction of earthworks, drainage, circulating roadwork and the construction of one provisioning track, a train examination road, two cut out roads and two wagon maintenance roads;
- Filling and grading of the TSF area (approximately 380,000 m³ of suitable fill to be imported) so that site levels can match the adjoining rail network;
- Associated signalling and connections to the down coal road on the Great Northern Line;
- Construction of a Provisioning Facility;
- 2 x Provisioning roads and UTM road;
- 2 x Wagon Maintenance roads;
- Wagon storage road;
- Construction of a Wagon Maintenance Building;
- 1 x Wagon storage road;
- Fuel storage area to initially accommodate 2 x 100,000 litre tanks and to be constructed in such a manner as to allow for future expansion of up to 4 x 100,000 litre tanks of diesel fuel.

Stage 2:

- Locomotive Maintenance Building;
- Locomotive Wash Building;
- Locomotive Turntable;
- Locomotive Maintenance roads.

The proposed TSF development is shown in Worley Parsons Proposed Arrangement Figure 2 in Appendix H.

Filling

The majority of filling is proposed to be along the rail formation with the depth of filling in the range 0.2 m to 0.4 m on the southern parts of the site where the site is already filled and from 1.4 m to 1.8 m on the northern parts of the site, where the site is at low lying natural grades.

Localised areas of filling are also proposed as follows:

- 0.3 m high access road on northern parts of site;
- 0.3 m perimeter road around overall southern site, mostly on existing filled areas;
- 0.5 m high temporary construction compound on northern low lying part of site.

Approximate areas of proposed filling are shown on the GHD Areas of Disturbance – Fill plan in Appendix H.

Excavations

Excavations on site are proposed to comprise the following:

- Proposed Basins 1 to 3, with cut ranging from 0.1 m for Basins 1 and 2 on the northern part of the site which are expected to be through natural clay soils to 2.6 m for the Basin 3 at the southern part of the site, which is expected to be mostly through existing filling;
- Proposed cess drains leading to the various basins with depths of cut ranging from 1.6 m though existing filling on the southern site to 1.0 m or less on the northern site;
- Site preparation for proposed access roads and associated culverts with depths of cut typically 0.3 m or less and in places up to 1.5 m;
- Temporary trench excavations for buried services, to depths of up to about 0.8 m.

Approximate areas of proposed cut (excavations) are shown on the GHD Area of Disturbance – Cut plan in Appendix H.

Preliminary column loads provided by the client indicate that the main portal frame structures will be in the range of 40 to 50 tonne and between 20 and 40 tonne for the service platform. It has been assumed that these loads are working loads.

Based on information provided by ADW Johnson, it is understood that about 13 freight trains will be refuelled each day which will require three B-double tankers to service the facility each day. It is further understood that other delivery trucks will service the facility but on an infrequent basis.

It is expected that a multi cell culvert will be required at the northern end of the project to connect into the existing culvert which runs beneath the Great Northern Railway.

7. Geotechnical Assessment

7.1 Summary of Geotechnical Factors

A number of geotechnical factors require consideration as listed below:

- Consolidation settlement in areas of soft clay, due to imported fill, structural loads and dewatering; this is discussed in Section 7.2;
- Acid Sulphate Soil:
  - There is a high probability that the site is underlain by potential acid sulphate soil. Disturbance of those soils, therefore, will require the implementation of a management plan;
  - This matter is discussed further in Section 9.
- Some of the existing granular filling at the site could be used as a bridging layer for the support of pavements such as access roads but may need to be removed and replaced with engineered fill for areas beneath buildings and proposed rail lines;

- Excavation and disturbance of existing coal fines and coal chitter would need to consider the risks associated with spontaneous combustion. These risks have not been assessed as part of the preliminary investigation;
- Ground improvement methods for areas where structures and services will be affected by settlement.

Notwithstanding the above, the southern part of the site has successfully been used as a rail facility for loading coal and the adjacent Great Northern Railway confirms the development at this site is feasible from a geotechnical perspective.

7.2 Ground Conditions

Soft soils are present beneath the fill over most of the site, as described in the Section 4.2, typically comprising soft to firm alluvial silty clay, sometimes described as organic. These soils have low permeability and are highly compressible, leading to long-term consolidation when subject to load.

Based on the field and laboratory tests conducted during previous investigations within the site, the typical range of engineering parameters for the soft silty clays is shown in Table 10.

Table 10: Typical Engineering Properties of the Soft to Firm Alluvial Silty Clay

Parameter	Symbol	Unit	Range	Typical Value
Moisture Content	W	%	41.2 – 75.0	60
Unit Weight	γ_b	kN/m^3	15.5 – 18.9	17
Undrained Shear Strength	c_u	kPa	5– 50	25
Drained Shear Strength	c'	kPa	5 – 6	5
Drained Friction Angle	ϕ'	°	30 – 31	30
Coefficient of Consolidation	c_v	m^2/yr	0.2 – 2.0	0.8
Coefficient of Volume Change	m_v	m^2/MN	0.22 – 2.40	1.0
Coefficient of Creep	c_α	-	0.005 – 0.040	0.020*
Coefficient of Permeability	k_v	m/s	2 x10^{-9} - <1 x10^{-10}	5 x 10^{-9}

Notes to Table 10:

* could differ widely

Long-term settlements would be expected for heavily loaded slabs, or any area where new fill is placed, thereby increasing the load on the soil. The magnitude of the settlement will depend on the load, the dimensions of the loaded area and the thickness of the compressible clay layer. As a guide, the settlement induced by placing 1 m of compacted fill (about 20 kPa) over an area with 16 m of soft to firm clay beneath would be in the order of 500 mm (primary settlement plus creep), taking many years to occur. This settlement depends on the preconsolidation pressure (load history) and also the staging of construction.

The time for the settlement of clay layers to occur can be difficult to predict, and will vary with the thickness of the clay, the coefficient of consolidation and whether there are any intermediate drainage layers (eg sandy layers). The theoretical time for 95% primary consolidation to occur is shown in Figure 10 plotted against clay thickness and the c_v values given in Table 10.

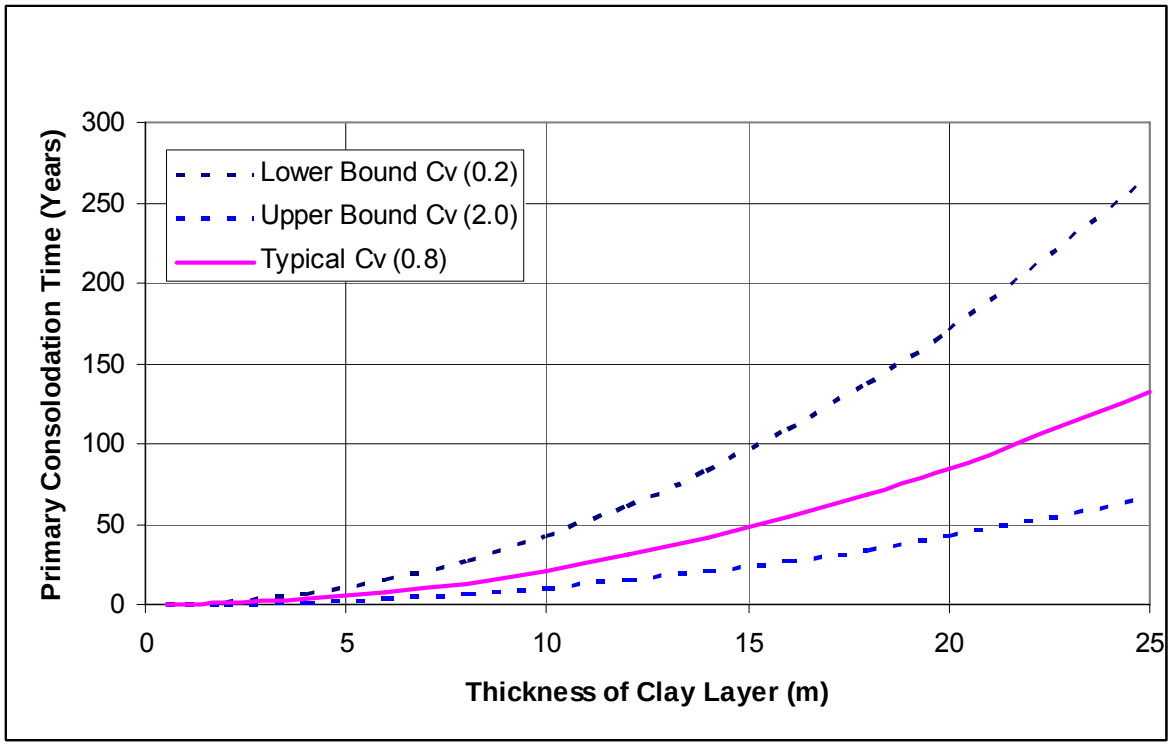

Figure 10: Primary Consolidation

It may be seen that the time for primary consolidation of a 15 m layer would be expected to take somewhere between 24 and 95 years, and probably around 50 years, in the absence of any intervening drainage layers.

The above is supported by monitoring undertaken by the RTA (Ref 9) for the Hexham bridge approach ramps (east of the site). The monitoring recorded settlements in the order of about 700 mm under a 65 kPa embankment load. Additional post construction settlements, also observed at the approaches, are probably associated with secondary (creep) settlements. The original estimated consolidation time was 15 years, which was reduced to about 1.5 years by using wick drains to accelerate consolidation. The thickness of the soft to firm clays at the Hexham bridge site were typically less than those at the QR site.

7.3 Foundation Conditions

7.3.1 Buildings

Due to the relatively low strength of the soft to firm clays, the use of high level foundations would not generally be feasible for any heavily loaded structure, particularly where the structure is sensitive to settlement.

The site is classified as Class P in accordance with AS 2870-2011 (Ref 10) due to the presence of the soft to firm clays and the associated long term total and differential settlements. Footings, therefore, will need to be designed in accordance with engineering principles.

Based on the results of the testing, it is considered that the applied bearing pressure beneath pad footings, strip footings or raft edge beams should not exceed 40 kPa and the width of pad and strip footings should not exceed 1 m and 0.5 m respectively. The actual bearing capacity would be a function of the strength of the natural clays, thickness of filling over the clay and dimensions of the footing and therefore should be confirmed during detailed design. Furthermore, as the ground conditions generally decrease with depth, footings should be founded as shallow as practicable. Notwithstanding the above, footings as designed above are expected to undergo settlements in the range of 20 mm to 50 mm in addition to settlement associated with any filling placed over the site (refer Section 7.2 above).

Heavily loaded structures, or settlement – sensitive structures, will need to be founded on piled foundations, with the foundations taken to the underlying sand or bedrock. Further comments on piles are presented in Section 7.6.

As an alternative to piled structures, ground improvement could be considered to improve the shear strength of the underlying clay with the aim of increasing the bearing capacity of the upper soil profile and reduce the magnitude of total and differential settlements. Further comments on ground improvement are presented in Section 7.4

7.3.2 Rail Embankment

Due to the presence of soft clay at the site, it is recommended that a slope stability assessment and analysis is undertaken once embankment heights and train loads are finalised. A preliminary geotechnical assessment on the expected track settlement for an unimproved site and slope stability of the rail embankment is presented in Appendix F. The results of the analysis was based on the elevation of the previous development and therefore should be confirmed during detailed design.

Ground improvement may be required to increase the shear strength of the underlying clays and thereby increase the factor of safety against failure.

Based on previous assessments at the site, a preliminary batter slope of 1V:3H should be adopted until more rigorous analysis is undertaken.

7.4 Ground Improvement Options

A number of possible ground improvement options may be considered, including:

- Preloading: this involves applying a load to the foundation which is equal to or greater than the final loads after construction. The load is usually applied in the form of additional fill material which is later removed. This method is one of the most straightforward and effective ground improvement techniques, but can require significant time. The proximity of the existing rail infrastructure and existing major services should be considered with preloading as preloading can induce settlements beyond the footprint of the surcharge and such settlements would need to be assessed and managed;
- Wick drains: carried out in conjunction with preloading in order to accelerate the consolidation process by providing a shorter drainage path for the expulsion of water. This method has been used with success for the approaches to the Hexham Bridge;
- Deep Soil Mixing: columns are formed by mixing lime and / or cement with the soft clay to form a column of treated soil. They reduce the plasticity and compressibility of the soil. Typical column diameters are 0.5 m to 0.8 m, spaced at 1.5 m to 2.5 m centres. The thickness of the clay may preclude full penetration of the clay but partial penetration would improve the shear strength of the upper clay stratum and provide increased shear resistance to improve stability of embankments and provide higher bearing capacities for shallow footings. This method has also been used with success for limiting differential settlements beneath embankments and light weight buildings;
- Vacuum consolidation involves extraction of pore water under vacuum, thereby causing consolidation without the need for any surcharge loading. It thereby replicates the effect of preloading without the need to bring in (and subsequently remove) large quantities of fill. A closely spaced series of vertical drains and pumps is installed. A limitation is that the maximum pressure that can be generated is around 80 kPa (limited by atmospheric pressure). Some surcharge fill may still be required depending on the final embankment height and loads applied. The surcharge would be applied simultaneously to the vacuum. The proximity of existing services and rail infrastructure may preclude this ground improvement option;
- Stone columns: this involves the installation of many stone piers to a stable stratum (such as the lower sand), which then support the ‘earth raft’ of compacted sand which forms the immediate foundation for the development; also known as ‘vibro – replacement’. The columns are typically 0.8 m to 1.2 m in diameter, spaced on a 1.5 m to 3 m grid. The thickness of the clay however, may preclude this method.

It should be noted that the above techniques do not eliminate post-construction settlement: they merely aim to reduce settlement to manageable/tolerable levels.

7.5 Preload

7.5.1 Preload Times

It is considered that preloading would be a suitable technique for this site taking into account existing services and infrastructure, however it should be recognised that in the areas of thick soft clay, the preload times will be excessive unless additional measures are taken such as the installation of wick drains (discussed further below). The preload should aim to achieve 90% primary consolidation, and the time for this to occur is related to the soft clay thickness and the coefficient of consolidation (c_v).

Areas where the very soft to soft clay is the maximum of about 15 m thickness would require preload times of up to about 25 to 50 years.

Vertical Wick drains installed at optimum spacing of probably about 1.5 m to 2 m would reduce the preload time for the thickest clay to about 1.5 years based on the RTA experience at the Hexham Bridge (Ref 9).

Further subsurface investigations and detailed analysis would be required to delineate the areal extent, strength and thickness of the soft clays in order to optimise the construction preloading times and spacing of wick drains.

7.5.2 Preload Design

Preliminary comments are presented on the use of sand as a preload material, but the use of on-site filling such as chitter could be utilised subject to further assessment.

The preload should cover areas where strength gain is required for stability/bearing capacity and long term settlements are needed to be reduced to acceptable levels. Such areas may include building areas, rail embankments, roads and services.

The height of preload required depends on the final loads, on the density of the preload material and on slope stability considerations. For example an embankment of 2 m may require a preload height of 4 m; that is 2 m height of sand fill placed temporarily above the general site finished level and removed after 90% primary consolidation is complete.

The stability of the preload mound at the edges of the fill embankment will require assessment and design to ensure batter slope stability. It is commonly found in the Hunter River estuary areas that batter slopes of 1V:3H are suitable for the general fill (or stability berm at the toe of the preload mound) and 1V:1.5H for the preload fill.

7.5.3 Preload Construction and Monitoring

The magnitude and rates of settlement are estimated from the results of geotechnical investigation and analysis. Preliminary estimates are included in this report on the basis of a few tests only.

Even after more detailed investigation and design, the preload performance must be monitored by geotechnical instrumentation and survey.

The instruments normally include settlement monitoring plates to measure surface settlement, inclinometers to measure lateral deflections, and piezometers to measure pore water response in the soft clay. Survey of the settlement monitoring plates and the preload mound height and location would be carried out by project surveyors.

The results of monitoring should be compared with settlement predictions so that the soil settlement model can be refined, and predictions updated, as the preload consolidation proceeds on the site.

7.6 Piles

Heavily loaded structures, or settlement–sensitive structures, which include overhead cranes, could be supported on separate piled foundations.

Preliminary column loads provided by the client indicate that the main portal fame will be in the range of 40 tonne to 50 tonne (about 400 kN to 500 kN) and between 20 tonne and 40 tonne (about 200 kN to 400 kN) for the service platform. The loads are assumed to be working loads.

Various pile types have been considered for this project and are discussed below.

Driven piles such as timber, concrete or steel will require splicing to achieve a suitable founding stratum which is typically encountered at depths of 17 m to 23 m. Noise and the potential for vibration should be also be considered with these piles types.

G-piles could also be used at the site which would minimise noise and vibration. The G-pile is a concrete precast pile which is pushed into the ground until the pile achieves a particular load capacity. The piles are easily spliced together until a suitable founding stratum is encountered.

Steel screw piles are not considered suitable due to the applied loads and the depth to a suitable founding stratum as these piles only gain load capacity from end bearing and therefore rely solely on a suitable end bearing stratum.

Uncased bored piles are not considered suitable as bore hole collapse would be expected upon withdrawal of the augers within the saturated alluvial sands that underlie the site.

Screw cast concrete piles were considered but the depth to a suitable founding stratum is expected to be beyond the reach of such piling equipment.

Continuous flight auger (CFA or grout injected) piles could be used provided the depth of reach of such piling equipment is suited for this site. The disadvantage with these pile types is that the capacity cannot be estimated during augering and accordingly additional CPT would be required to assess the variability in ground conditions across the site. Furthermore, spoil is generated from piling activities which could expose potential acid sulphate soils. In this regard the layout of the proposed developed has changed since the previous investigation in 2007 and additional investigation is recommended at proposed building locations.

Pile capacity plots are provided in Appendix E for single 350 mm square concrete driven pile and 0.25 m diameter timber pile, in vertical down-thrust. The pile capacities have been estimated based on the profile at CPT 4 and CPT 11 which are considered typical of the tests that were undertaken.

These plots suggest that a Geotechnical Strength (R_{dg}) in the order of 270 kN to 600 kN (working load of 200 kN to 440 kN) could be gained within the sand layer encountered at depths in the range of about 18 m to 24 m for both driven timber and concrete piles. Higher capacities may be achieved if the piles are driven further but additional deeper investigations would be required to confirm the deeper stratum.

The ground around pile – supported structures would continue to consolidate over the years and the design of services and pavements would need to take this into account.

A suitably designed bridging layer would be required over the existing soils to enable access for piling rigs and construction equipment, particularly in the northern parts of the site.

7.7 Pavements

7.7.1 Subgrade Conditions

Based on the subsurface conditions encountered at the test locations, the subgrade conditions across the site are expected to comprise silty clay or filling (generally southern parts of the site). Coal tailings which are very soft / soft inconsistency could also be encountered on the western parts of the site (ie west of CPT 12).

The success of the earthworks and site preparation will depend on the experience of the contractor, on the equipment, techniques and materials used, and on the prevailing weather conditions. In this regard, it is suggested that a field trial pavement be undertaken at the commencement of earthworks to address and revise the subgrade preparation measures presented below.

Laboratory testing on clay subgrade indicated a CBR (4 day soaked) of 1.0% and 2.0% with field moisture contents of up to 15.9% above optimum moisture content. This is consistent with previous investigations undertaken in the Hexham area.

The dynamic penetrometer results suggest that a crust is present over the site which is generally about 0.5 m to 1 m thick. The subgrade significantly reduces in strength below this level. It is recommended (where possible) that pavements are constructed with minimal excavation into the surface crust to avoid exposing the underlying soft and wet soils.

The low strength of the soils is expected to require a bridging material to enable compaction of pavement layers. The thickness of the bridging material will depend on the location of the pavement, weather conditions at the time of construction, the type of bridging material to be used and the earthworks contractor's experience.

Based on the results of field work together with previous laboratory testing, a CBR value of 1% was adopted for the on-site clay soils for pavement design purposes. Where existing pavements are present and trafficability is reasonable, a bridging layer may not be required.

7.7.2 Traffic Loading

It is understood that three B-double tanker trucks will service the facility each day together with other delivery trucks on an infrequent basis. As provided by GHD, the estimated traffic design load adopted for preliminary design for the access road is 5 x 10^5 ESA (based on anticipated traffic loading) or 1 x 10^7 ESA (based on industrial road classification). The design for both loading scenarios is provided below. The pavement thickness design is preliminary and subject to detailed design. The design should be reviewed if more detailed traffic information becomes available and/or concentrated wheel loads such as those imposed by forklifts are proposed.

7.7.3 Pavement Thickness

Two pavement options have been considered for the proposed road which include the following:

- Option 1 - Unbound granular pavement;
- Option 2 – Bound pavement.

These options are for vehicular movements along the alignment with the exception of drains and creek crossings.

A third option has also been presented for the construction of temporary access roads that do not require sealing.

Options 1 and 2: Bound or Unbound Pavement

The poor strength of the natural clay may result in construction problems associated with compaction of the overlying pavement material and poor trafficability over the site.

For the reasons provided above, it is suggested that a geofabric be placed over the surface in some areas followed by a select subgrade to provide a working platform. The thickness of the select material would depend on moisture conditions at the time of construction. The use of a 300 mm to 500 mm select material would improve constructability of the pavement. A thicker layer would be required if the upper crust is removed. The required thickness of the select layer will depend also on the properties of the material. It may be necessary to use sand as a select subgrade particularly in areas where water is ponding to improve drainage of the base material. The use of an open ballast material could also be considered but would require a geofabric separator to reduce migration of fines into the ballast. Alternatively, self-cementing material would be preferred to bridge the underlying softer ground.

The following pavement thickness designs have been based on Austroads (Ref 11). It should be noted that the pavement provided below could be locally thicker in poorer subgrade areas.

Table 11: Preliminary Pavement Thickness Design: (Options 1 and 2) – 5 x 10^5 ESA

Pavement Layer	Thickness (mm) CBR = 1% (clay)	
	Unbound (Option 1)	Bound (Option 2)
Asphalt and Primer Seal	40	40
Basecourse / Subbase	580	340
Select Subgrade	300 - 500	300 - 500
Total	**620 plus select**	**380 plus select**

Table 12: Preliminary Pavement Thickness Design: (Options 1 and 2) – 1 x 10^7 ESA

Pavement Layer	Thickness (mm) CBR = 1% (clay)	
	Unbound (Option 1)	Bound (Option 2)
Asphalt and Primer Seal	40	100
Basecourse / Subbase	800	360
Select Subgrade	300 – 500	300 – 500
Total	**840 plus select**	**550 plus select**

Option 3: Recycled Truck Tyres

An alternative system for the use as a temporary access road involves the use of recycled truck tyres (Ecocflex), which are laid over a geofabric layer placed directly on the existing ground surface. The tyres are then filled with granular material. A second layer of tyres can be placed if necessary. This system is a recent innovation and there is little data available on the performance of such systems and no formal design method has been developed for this system. Douglas Partners experience with this system for a temporary access road, however, suggests such systems have performed well in similar situations.

7.7.4 Subgrade Preparation

Based on the results of the investigation, soft to firm or wet clay soils are expected for the majority of the alignment.

Preparation of the natural subgrade should include the following:

- Remove large vegetation (trees and shrubs) or deleterious materials. The grass could be retained for temporary roads;
- Rubber tyre vehicles should not travel on the exposed subgrade;
- Due to the high moisture condition of the subgrade soils, it will be necessary to place the select layer (Options 1 and 2) immediately over the subgrade (ie without compaction of the subgrade). The thickness of the select subgrade should be confirmed by geotechnical inspection and dynamic penetrometer testing but is expected to range between 300 mm and about 500 mm. A suitable bridging material, would comprise sand, crushed recycled concrete (if suitable), ballast or similar (CBR≥15%, PI≤5%). Where open graded material is used as a bridging layer or as a pavement, a geotextile should be used over the bridging layer, to prevent subsequent filling from migrating into the rock fill voids. Compaction of the bridging layer should involve surface rolling (about 6 to 8 passes) initially with a tracked excavator and possibly with a medium size roller of non-vibration mode;
- If heaving occurs, leave the select subgrade for one or two days to allow pore pressures to dissipate or increase the layer thickness;
- For Option 3, place the geofabric over the surface following removal of trees, grass and shrubs followed by the truck tyre system;
- Place and spread granular fill from the layer of existing fill in such a manner that the need to traffic the exposed surface of the weak material is avoided. Compaction of the pavement should involve surface rolling (about 6 to 8 passes) with a roller of at least 8 tonnes capacity operating in non-vibration mode.

Geotechnical inspections and testing should be undertaken by DP during construction to confirm the above requirements. Additional assessment is required to confirm the properties and site preparation measures associated with the coal tailings stockpile in the area west of CPT12.

7.8 Drains

There are numerous drains along the alignment, many of which will require crossing. The majority of these drains are expected to encounter very soft clay to below the drain invert level. Additional testing would be required to establish the depth of soft clay.

For drains containing significant thicknesses of very soft soil it is expected that any filling material placed in these drains will displace and sink into the very soft clay. This displacement can be reduced by the placement of a geo-fabric material in conjunction with coarse cobble filling, however the depth and extent of clay displacement is difficult to predict. In addition, the displacement of the softer clay would also depend on the thickness of the filling and placement methods. It is suggested that a trial be undertaken to assess whether it will be feasible to use a fill bridging layer, as discussed above, to found the culverts and overlying pavement.

7.9 Proposed Excavations

It is understood that excavations are proposed for the site for a possible underfloor, detention basins and service trenches. Subsurface conditions are expected to comprise filling, firm to stiff clays overlying saturated silty sands and soft to firm clays.

Based on the results of the investigation potentially collapsing conditions are expected where excavation is proposed through soft to firm clays and saturated silty sand / sand. These soil conditions were encountered at the majority of test locations beneath the filling and upper 'crust' of the natural soil.

Groundwater was encountered at or near the surface and accordingly groundwater seepage is also expected in proposed excavations.

Temporary excavations (less than about 1 m below natural ground levels) could be undertaken provided the excavation is battered at 1H:1V and groundwater is managed. If saturated sands or granular fill are encountered during excavation, the batter will need to be reduced to at least 2.5H:1V or potentially flatter.

There is a risk that base heave and accompanying large settlements of the ground surface could occur where excavations are proposed through the soft clay. Preliminary calculations indicate that, for excavations of about 3 m with no surcharge load, the factor of safety against base heave is about unity and less if surcharge pressure (such as excavator or spoil) is applied to the adjacent ground surface.

Based on the above, if it is essential to have equipment at the surface which applies surcharge pressure or if excavations are required to be greater than say 2.5 m depth (without surcharge), the excavation will need to be supported by sheet piling, braced internally as the excavation proceeds. The sheet piling will need to be driven to a sufficient depth below the excavation base to ensure stability and prevent base heave.

Due to the variability of the depth and strength of the soft clay at the site, it is recommended that detailed geotechnical analysis is undertaken to refine the requirements at the site specific locations following completion of detailed design and confirmation of construction methods.

Excavation into the soft clays or saturated silty sand/sand will probably require granular bedding material, such as ballast, slag or rock spalls at the base of the excavation, to assist with construction.

Based on the shallow groundwater levels at site it is anticipated that most excavations will intersect groundwater. Temporary dewatering may be required to allow construction activities, especially for the access road, culvert and buried service excavations. For the proposed cess drains and detention ponds it may be possible to excavate these without dewatering.

Excavations on the southern parts of the site will be predominantly through existing filling which is typically granular and can be expected to be relatively permeable. Dewatering is likely to be achieved by a combination of sump and pump methods for localised excavations with the possibility of spear point dewatering in some areas.

On the northern parts of the site excavations will be through the natural clay soils, which are generally of low permeability with the exception of local sandy or silty layers. Sump and pump dewatering is expected to be used and due to the low permeability of these soils flow rates are expected to be relatively low if they are not under surface water.

The detailed design should consider the subsurface conditions for excavation and dewatering requirements.

8. Contamination Assessment

8.1 Assessment Criteria

Selected existing fill materials encountered during the geotechnical assessment were assessed for potential contamination. The results of the chemical analyses were compared to the following NSW EPA recommended guidelines:

- NSW EPA (1994). Contaminated Sites – Guidelines for Assessing Service Station Sites, December 1994, (Ref 6);
- NSW DECCW, "Waste Classification Guidelines, Part 1: Classifying Waste," December 2009 (Ref 7);
- NSW EPA, Guidelines for the NSW Site Auditor Scheme, (2nd Edition) April 2006. (Ref 5).

The NSW EPA Guidelines for Assessing Service Station Sites (Ref 6) were used to assess total recoverable hydrocarbons (TRH) and BTEX contamination across the site. The criteria used are threshold concentrations for sensitive land use.

The NSW EPA Guidelines for the Site Auditor Scheme (Ref 5) contain National Environmental Health Forum (NEHF) health-based investigation levels for various beneficial use scenarios including: low density residential (A), medium/high density residential (D), recreational (E) and commercial/industrial (F). These criteria are applicable where aesthetic and ecological concerns are not an issue. The criteria for commercial/industrial land use (NEHF F) are considered appropriate for assessing contamination within soil over the site due to the proposed industrial development.

Classification of fill materials were conducted with reference to the NSW DECCW, "Waste Classification Guidelines, Part 1: Classifying Waste," December 2009 (Ref 7).

8.2 Assessment of Contamination

The results of chemical analysis on the two fill samples indicated the following:

- Soil chemical analysis results were generally within the health based criteria for commercial/industrial land use (ie NEHF F), and NSW EPA sensitive land use criteria for TRH and BTEX with the exception of elevated TRH detected in TP29/0.4 m;
- The samples tested are classified 'General Solid Waste', with respect to potential chemical contaminants.

If the fibro sheeting observed at the site (Figure 4) is found to contain bonded asbestos, testing of the soil matrix for asbestos is required, in order to confirm waste classification. Asbestos materials or asbestos impacted materials are classified as 'Special Waste' in accordance with Ref 7.

Dumped fill materials observed within the site are likely to be variable, and may contain further bonded asbestos (fibro) materials. Additional investigation is recommended to confirm the condition of fill materials with respect to potential chemical contamination and the potential for bonded asbestos fragments.

Investigation, remediation and validation of fill materials with respect to asbestos waste should be conducted by a qualified asbestos consultant.

Due to the presence and variability of extensive fill materials within the site, this assessment cannot be considered to be exhaustive and as such there may be areas within the site that have not been identified that may require remediation. Further detailed investigation should be carried out as the development proceeds. In this regard based on site observations and preliminary site history, the areas comprising potential contamination could include:

- Former above ground fuel storage tanks (ASTs) and bowsers (hydrocarbons);
- Truck wash bay (hydrocarbons);
- Railway lines: rail loop, rail line north of site, internal rail line 100m from east boundary running north-south (1986 orthophoto), and associated buildings on the northern boundary (servicing of locomotives) (herbicides, pesticides, heavy metals, hydrocarbons, asbestos);
- Ash from steam locomotives may have been deposited on site (metals, hydrocarbons);
- Fill materials of unknown origin – topsoil capping material and building rubble deposited across the site (metals, hydrocarbons, asbestos). Potential for further illegal dumping activities;
- Irrigation of treated effluent across northern half of site from Dairy Farmers (biological contaminants, nutrients, hydrocarbons etc);
- Acid drainage from former coal stockpiles (Acidic run-off, heavy metals);
- Leached salts from coal fine stockpiles (salinity in surface water and groundwater).

The additional assessment should include the following:

- Additional subsurface investigation, soil sampling and laboratory testing to assess potential soil contamination across the site;
- Installation of groundwater wells within the site, sampling and analysis.

If remedial works are required on the basis of further investigations, they should be conducted in accordance with an appropriate remediation action plan (RAP) with reference to relevant NSW EPA guidelines and regulatory requirements.

Please note, further details of contamination analysis and testing can be found within DP Report titled "Preliminary Contamination Assessment, Proposed Train Support Facility, Maitland Road and Woodlands Close, Hexham", Project 39798.06, September 2012 (Ref 12)

9. Acid Sulphate Soil Assessment

The ASSMAC guidelines suggest that a soil pH<4 in water is an indicator of actual acid sulphate soils. The results of screening tests therefore suggest the absence of actual acid sulphate soils at the locations and depths tested.

The ASSMAC guidelines also suggest that indicators of potential acid sulphate soils (PASS) include the following:

- Soil pH <3.5 in H_2O_2 (ie. pH_{FOX});
- Drop of 1 pH unit or more between pH_F and pH_{FOX}.

A total of 29 of the samples tested exhibited a pH drop of greater than one pH unit and of these, five samples also exhibited a soil pH following oxidation below 3.5.

It is noted that the above test method is a qualitative method only and gives an indication of the intensity of total acidification (pH). The ASSMAC guidelines indicate that peroxide may also oxidise organic matter (in addition to pyrite) to produce acids which are unlikely to form under natural conditions, thus giving falsely high indication of acid sulphate potential.

Detailed (laboratory) testing was undertaken to more accurately determine the presence or absence of acid sulphate soil forming conditions at the site. The results of detailed analysis confirmed that there are potential acid sulphate soil conditions on the site.
The result of the chromium reducible sulphur testing and / or TPA testing for samples 14/2.4 m, 16/3.0-3.45 m, 27/1.5-1.95 and 30/0.4 m was above the ASSMAC action criteria for disturbance of soils (regardless of volume excavated) above and below. This means that an Acid Sulphate Soil Management Plan (ASSMP) will be required for any activities which are likely to disturb PASS (ie excavations which expose the natural clay / sand or when dewatering is required).

The ASSMP is presented in Report 39798.08-1, September 2012.

10. References

1. Douglas Partners Pty Ltd, “Report on Preliminary Geotechnical Investigation, Proposed Maintenance Facility, Woodlands Close, Hexham”, Project 39798 (Rev A), August 2008.
2. AS 2159-2009, “Piling Design and Installation”, Standards Australia.
3. ASSMAC Acid Sulfate Soil Manual”, New South Wales Acid Sulfate Soil Management Advisory Committee, August 1998.
4. NSW EPA Contaminated Sites. “Guidelines for Consultants Reporting on Contaminated Sites”, September 2000.
5. NSW EPA Contaminated Sites. “Guidelines for NSW Site Auditor Scheme”, (2nd Edition) April 2006.
6. NSW EPA Contaminated Sites, “Guidelines for Assessing Service Station Sites”, December 1994.

7. NSW DECCW, "Waste Classification Guidelines, Part 1: Classifying Waste", December 2009.
8. NSW EPA Contaminated Sites, "Sampling Design Guidelines", 1995.
9. Coleman, R.A (1986) "Hexham embankment, Case study, Wick drains, Predictions".
10. Australian Standard AS 2870-2011 "Residential Slabs and Footings", Standards Australia.
11. Austroads 2012, "Guide to Pavement Technology Part 2: Pavement Structural Design", Austroads Publication No AGPT02-12.
12. Douglas Partners Pty Ltd, "Preliminary Contamination Assessment, Proposed Train Support Facility, Maitland Road and Woodlands Close, Hexham", Project 39798.06, September 2012.
13. Douglas Partners Pty Ltd, "Report on Groundwater Assessment, Proposed Hexham Redevelopment, Maitland Road and Woodlands Close, Hexham, Project 39798.05, February 2012.

11. Limitations

DP has prepared this report for a project at Woodlands Close, Hexham in accordance with DP's Proposal No P7771 dated 16 March 2007 and subsequent proposal NCL120293 dated 29 June 2012 and acceptance received by QR National. The report is provided for the exclusive use of QR National for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

It is noted that this report does not represent a preliminary contamination assessment in accordance with NSW EPA guidelines (Ref 4).

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

Douglas Partners Pty Ltd

Appendix A

Summary of Previous Douglas Partners Reports

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39798.08 – Preliminary Geotechnical Investigation, Hexham
Summary of DP Projects

3389
Foundation Conditions Proposed Coal Preparation Plant
Hexham, May 1972

Client: J&A Brown, Abermain and Seaham Collieries Ltd

Purpose: Assessment of foundation conditions for proposed coal preparation plant.

Comments:
Four bores were drilled to between 24 m to 31 m depth. Insitu vane shear tests were carried out in soft clays in Bores 2 and 4. Rock coring was undertaken in Bores 1 and 2.

Subsurface conditions generally comprised filling (loose coal wash and soft to firm clays) up to maximum depth of 6 m underlain by soft to firm silty clays and shells to 12 m to 18 m depth; silty and sandy clays and silty sands with occasional gravel (medium dense in Bores 1 and 2, very loose to loose becoming medium dense from 22.5 m to 23m in Bores 3 and 4). Bores 1 and 2 were underlain by very stiff silty and shaley clays from 29 m depth, and soft shales from 29.5/33 m underlain by medium hard shale.

Groundwater was encountered in all bores between 0.5 m to 3.6 m depth during the investigation.

Undrained shear strength tests were performed on nine soft to firm clay samples from Bores 2 to 4. Triaxial testing was performed on two samples from Bore 2, and indicate an angle of shear resistance of 30^o to 31^o, and cohesion intercepts of 110 and 115 bs/ft^2.

Odometer testing of two samples from Bore 4 indicate the clays to be of high compressibility.

Permeability tests (in a triaxial cell) were conducted on three samples from Bore 2 (silty clay at 2.1 m and 4.5 m, and silty sand at 3.3 m). Results indicate very low clay permeability (10^{-7} to 10^{-8} cm/s) and relatively low permeability for sand (2.4 x 10^{-5} cm/s).

6109
Foundation Conditions
Proposed Road and Rail Interchange Station
Hexham, June 1978

Client: CMPS Consulting Engineers for RW Miller and Co

Purpose: Investigation for proposed road and rail interchange station.

Comments:
Five bores (including two CPTs) were drilled to between 3 m and 26.5 m depth. Subsurface conditions generally comprised alluvial soils (generally soft organic silty clays with some shells) to about 25 m depth underlain by coal and shale.

Laboratory shear strength testing of clays indicate an undrained cohesion of 19 kPa to 25 kPa. Odometer testing was performed on four clay samples and indicated the clays to be highly compressible.

16781
Geotechnical Investigation
Proposed Depot Redevelopment, Australian Co-Operative Foods Ltd
New England Highway, Hexham, August 1993

Client: Meinhardt (NSW) Pty Ltd

Purpose: Proposed redevelopment (new buildings). Estimate settlements for proposed high level footings, estimate pile capacities for proposed deep footings, comment on site preparation and general construction practice.

Comments:
High Level Footings: Lightly loaded structures may be supported on high level footings such as raft slabs, pad footings or strip footings, provided the estimated settlements (given in Table 1, 16781) are acceptable. As ground conditions generally decrease in strength with depth, footings should be founded as shallow as practicable (about 300 mm below finished surface level). The applied bearing pressure beneath pad footings, strip footings or raft slab edge beams should not exceed 50 kPa. Overall distributed raft slab loads should not exceed 25 kPa. Width of pad and strip footings should not exceed 1.0 m and 0.5 m respectively. Edge to edge distance between footings should be at least 3 m.

Deep Footings: Heavily loaded structures (such as silos) should be supported on piled foundations. Piles should be founded in the very dense sand encountered between approx. 8.7 m to 10.3 m depth. Refer to table below for estimated pile capacities.

Table: Estimated Pile Capacities

Pile Type	Approx Founding Depth (m)	Allowable Load (kN)
Driven Timber (300 mm toe)	10 - 12	500 – 700
	13 - 15	800 – 900
Driven Steel Tube 450 mm diameter (closed end or soil plug)	10 - 12	1000 – 1200
Grout Injected	11 - 13	350 – 400
500 mm diameter	11 - 13	650 – 700
600 mm diameter		

Site Preparation: For structures on shallow footings, remove 1m of soil and replace with granular filling such as sand or granulated slag compacted to 75% density index or 100% Standard dry density ratio. Note groundwater flow may be expected where excavating to over 0.5 m depth. Hence ground improvement may require dewatering etc.

17163 and 17163A
Geotechnical Investigation and Building Preload
Proposed Service Station Redevelopment
Pacific Highway, Hexham, August 1995

Client: Shell Company of Australia Ltd

Purpose: Provide footing design parameters, settlement estimation, subgrade evaluation and pavement thickness design, soil chemical aggressiveness, and comment on slope instability and mine subsidence for proposed new service station building and pavements. Settlement monitoring of preload beneath proposed building area.

Comments:
8 bores drilled to 5.5 m/8.5 m depth, and wells installed (see 17163/1 below). Ground conditions generally comprised fill to 0.5 m/1.25 m underlain by soft to firm silty clay to 1.4 m/2.0 m, very loose clayey sand to 5.5+/6.0, and very soft to soft silty clay to >8.5 m depth. Groundwater was observed in wells between 0.25 m to 0.95 m AHD on 25/7/95.

CBR of sandy gravel filling (coal refuse) was 35%. Total settlement for a 'L' shaped 450 m^2 raft slab with overall site surcharge load of 12 kPa, uniformly distributed building load of 5 kPa to 13 kPa, total load in building area (including fill under slab) of 10 kPa to 17.6 kPa, and internal and edge beam width of 0.4 m – average spacing of 4 m was estimated to be 80 mm to 130 mm.

17163A – The building area was preloaded with 1.5 m select granular material. Monitoring recorded 56 mm to 82 mm settlement after 45 days under load (primary consolidation was still in progress when preload was removed). Following preload, new settlement estimates were 20 mm to 50 mm.

17163/1
Preliminary Contamination Assessment
Proposed Service Station Redevelopment
Pacific Highway, Hexham, August 1995

Client: Shell Company of Australia Ltd

Purpose: Investigate existing contamination onsite resulting from ongoing use as a service station.

Comments:
8 wells installed to 5.5 m/8.5 m depth. Ground conditions generally comprised fill to 0.5 m/1.25 m underlain by soft to firm silty clay to 1.4 m/2.0 m, very loose clayey sand to 5.5+/6.0, and very soft to soft silty clay to >8.5 m depth. Groundwater was observed in wells between 0.25 m to 0.95 m AHD on 25/7/95. Local groundwater contours indicate general north-easterly flow toward the Hunter River at a gradient of 0.7%.

Elevated PID in soil was observed in Well 2 at 0.5 and 2.0m depth (465 ppm and 148 ppm respectively). Elevated PID in groundwater observed in Bores 2, 3 and 6 (230 ppm to 2500 ppm). No floating product detected with oil-water interface meter.

No chemical testing of soil conducted. Results of chemical testing of groundwater indicated Wells 2 and 3 exceed “EPA Service Station Sites” for BTEX (maximum benzene was 32 mg/L and xylenes 18 mg/L). Wells 4, 6, 7, 8 exceed “EPA Service Station Sites” for lead (0.05 mg/L to 0.08 mg/L).

18419, 18419A, 18419B
Geotechnical and Acid Sulphate soil Investigation
Proposed Effluent Ponds
ACF, New England Highway, Hexham, November 1995

Client: Meinhardt (NSW) Pty Ltd

Purpose: Geotechnical and acid sulphate soil investigation for two proposed effluent ponds.

Comments:
Subsurface conditions generally comprised filling to 0.3 m/0.75 m underlain by firm to stiff clay to 1.1 m/1.3 m, soft to firm/loose sandy clay/clayey sand to 2.3 m/2.6 m, loose/soft clayey sand to 3.1 m/3.5 m, and very soft clay and shells to termination at 3.6m /4.2 m. Groundwater seepage was observed between 1.1 m and 3.8 m depth in the test pits. Testing of silty clays between 0.3 m/1.3 m indicated a field moisture content between 24% to 41%, Plasticity Index of 56% to 58% and Emerson Class Number 5.

Acid sulphate soil laboratory testing of two soil samples at 0.5 m and 1.0 m depth indicated a Total Actual Acidity of 0 mol/kg, and a maximum Total Potential Acidity of 0.03 mol/kg, which indicates low acid sulphate potential.

18457
Geotechnical Investigation, Proposed Industrial Development
Lots 1 and 2, Old Maitland Road, Hexham, February 1996

Client: Stephen H Savage, Consulting Engineer

Purpose: Estimation of settlements, consolidation rates, site improvement options and footing / pile design parameters for a proposed steel clad portal frame workshop, brick veneer office and amenities and 2.1 m to 2.4 m fill pad (with retaining walls).

Comments:
Two CPTs to 15 m depth and pore pressure dissipation tests in clay strata were conducted on the site. Soil profile comprised fill to about 1 m, interbedded firm clays and loose sand to about 4.5 m, soft to firm silty clay to 17.7 m/18.1 m, underlain by very stiff clay and medium dense sand to >22 m. Groundwater was observed from 1-1.5 m. Settlement estimates for a 45 kPa to 60 kPa load ranged between 240 mm to 365 mm.

For comparison it was noted that at the Hexham bridge approach embankment settlements of 530 mm to 615 mm were recorded under an applied load of 65 kPa. The soil profile included an 11-16 m thick layer of very soft silty clay. Laboratory testing of samples from the Hexham bridge approach indicated an average c_v of 0.5 m^2/yr for very soft silty clay (range of 0.1 m^2/yr to 2.5 m^2/yr). (Ref: Coleman RA (1985) “Hexham Embankment Case Study, Wick Drains, Predictions”).

18603
Geotechnical Investigation
Proposed Extensions to Club and Carpark
Hexham Bowling Club, Hexham, November 1996

Client: Michael Fitzgerald Consulting Engineers Pty Ltd

Purpose: Geotechnical investigation for a proposed one to two storey building extension and pavements.

Comments:
The investigation comprised two CPTs including dissipation testing to 20 m, and six test bores to 1.2 m to 1.9 m depth. Soil profiles comprised filling to 0.5 m/1.3 m depth, soft to firm silty clay to 15.0 m/15.6 m, medium dense sand with interbedded sandy clay to 18.3 m, underlain by firm to stiff silty clay becoming sandier with depth to >20 m. Groundwater was observed from 0.9 m depth during the investigation. Refer to report for settlement estimates and coefficients of consolidation.

18891
Geotechnical Investigation, Proposed Access Road
Hexham, September 1998

Client: GHD Pty Ltd

Purpose: Assess subsurface conditions and provide pavement thickness design and subgrade preparation measures for a proposed 3 km long access road alongside the main northern railway line.

Comments:
Subsurface conditions generally comprised filling to 0.7 m/1.0 m depth, (sand in some locations 0.2 m/0.3 m thick), clay generally firm to stiff (soft in TP5) with shear strength generally decreasing with depth. Groundwater seepage was observed at most locations between 0.5 m to 1.0m depth.

18891A
Geotechnical Investigation, Power Poles
Access Road Smithy's Crossing, Hexham, January 1999

Client: GHD Pty Ltd

Purpose: Assess subsurface conditions and provide comments on lateral stability of existing and proposed power poles adjacent to the Great Northern railway line at Hexham.

Comments:
Subsurface conditions generally comprised fill (railway ballast) to 0.2 m/0.6 m underlain by generally firm silty clay (very soft in Bore 2) to 1.2m depth becoming sandy and very soft from 1.2 m/1.4 m depth. Bore 5 encountered filling to 1.7 m. Groundwater was observed between 0.55 m and 1.0 m depth during the investigation.

18944, 18944A, 18944B
Groundwater Monitoring, Dairy Farmers, 189 Maitland Road, Hexham, February 1999 to November 2000

Client: Dairy Farmers

Purpose: Installation of 10 groundwater monitoring wells and subsequent groundwater monitoring to assess potential groundwater impacts resulting from operation of a liquid waste disposal system utilising spray irrigation (under EPA licence).

Comments:
The bores generally comprised topsoil or fill to 0.2 m/0.5 m, underlain by silty clays to 0.5 m/2.8 m, underlain by sandy clays to termination between 2.8 m/4.3 m. Clayey sand layers were encountered in Bores 5, 8 and 10.

Groundwater levels ranged between 0.36 m to 1.26 m AHD on 9/04/99, 0.12 m to 0.96 m AHD on 28/9/99, and –0.43 m to 1.49 m AHD on 4/10/00. Groundwater contours generally indicate groundwater associated with the factory complex (east of the railway) generally flows east toward the Hunter River with a hydraulic gradient of 0.015 to 0.017. Groundwater associated with effluent irrigation areas west of the railway line generally flow north and north-west toward the tidal drain, with a relatively flat hydraulic gradient (0/0005-0.003). Note groundwater levels were measured following an above average period of rainfall.

Results from installation of piezometric data loggers in wells 3, 6 and 9 suggest minimal tidal influence on groundwater from the Hunter River.

Rising Head (Slug) tests in wells 3, 5, 7 and 10 estimated hydraulic conductivities of sandy clays / clayey sands to be between 2 x 10^{-6} m/s and 7 x 10^{-6} m/s. Assuming an aquifer porosity of 0.4, the groundwater seepage velocity beneath the factory complex was estimated to be 4m to 5 m/year towards the Hunter River. West of the railway line, groundwater seepage flows were estimated to be 0.5 m to 2 m/year north toward the tidal drain.

Groundwater Quality: EC testing indicates very high to extremely high salinity. Elevated concentrations of faecal coliforms (FC) and TKN were encountered in wells 3, 9 and 10 (and well 7 for TKN). Comparison of GC in irrigation effluent and the groundwater concentrations indicate significant dilution and attenuation has occurred.

31773
Geotechnical Investigation
Augmentation of Hexham Bowling Club Wastewater Facilities
Hexham Bowling Club, Hexham

Client: Hunter Water Australia

Purpose: Geotechnical and acid sulphate soil investigation for the upgrade of an onsite wastewater facility within club grounds.

Comments:
Investigation comprised drilling of two bores to 7.3 m depth. Subsurface conditions comprised filling to 0.4 m/1.0 m, underlain by very soft to firm (typically soft) clay / sandy clay to >5.0 m. Groundwater was encountered between 0.8 m to 1.2 m during the investigation, and from 1.85 m within piezometer B101 on 11/7/03 (3 days after drilling).

Acid sulphate soil screening, TPA and chromium reducible sulphur testing indicate the presence of Potential Acid Sulphate Soils below 2.8 m depth.

39033
Geotechnical Investigation, Proposed Weighbridge
Sparke Street, Hexham, September 2004

Client: Ridge Group

Purpose: Comment on suitable footing types and expected settlements for a proposed weighbridge.

Comments:
Ground conditions comprised filling to about 2.2 m to 2.5m underlain by compressible clays with medium dense to dense sand from about 12.4 m depth. Groundwater was observed from about 1 m during the investigation.

Expected settlement estimates are based on a working load of 550 kN and placement of 0.5 m of additional filling. Pad footings: for 3 strip footings 3.5 m by 1 m, total settlements are in the order 35 mm to 50 mm. Stiffened raft: of dimensions 3.5 m by 25 m, estimated total settlement is 20 mm to 30 mm.

Site preparation for shallow footings include replacing existing filling to 0.5m below existing ground level, before placing additional bridging material up to 0.5m (total bridging layer of 1.0 m).

Piled footings founded on medium dense to dense sand encountered from about 13 m depth may be necessary if the expected settlements of the proposed structure exceed acceptable limits.

Appendix B

About This Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Cone Penetration Tests
Cone Penetration Test Charts (CPT2 to 12, TP13, TP15, TP17 and TP19)
Borehole Logs (TP14, TP16, TP18, TP21, TP22 to TP40)
Results of Dynamic Penetrometer Tests

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Symbols & Abbreviations

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Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base


Concrete


Filling

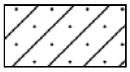
Soils


Topsoil

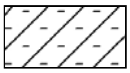

Peat


Clay

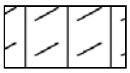

Silty clay

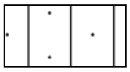

Sandy clay

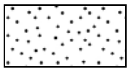

Gravelly clay

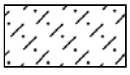

Shaly clay

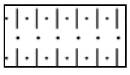

Silt


Clayey silt


Sandy silt

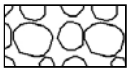

Sand

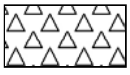

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

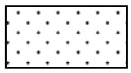

Talus

Sedimentary Rocks

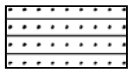

Boulder conglomerate

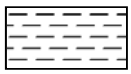

Conglomerate


Conglomeratic sandstone

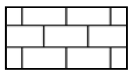

Sandstone


Siltstone


Laminite

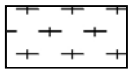

Mudstone, claystone, shale

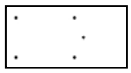

Coal


Limestone

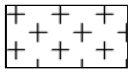
Metamorphic Rocks

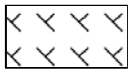

Slate, phyllite, schist

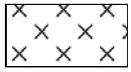

Gneiss

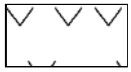

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Cone Penetration Tests

Douglas Partners

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

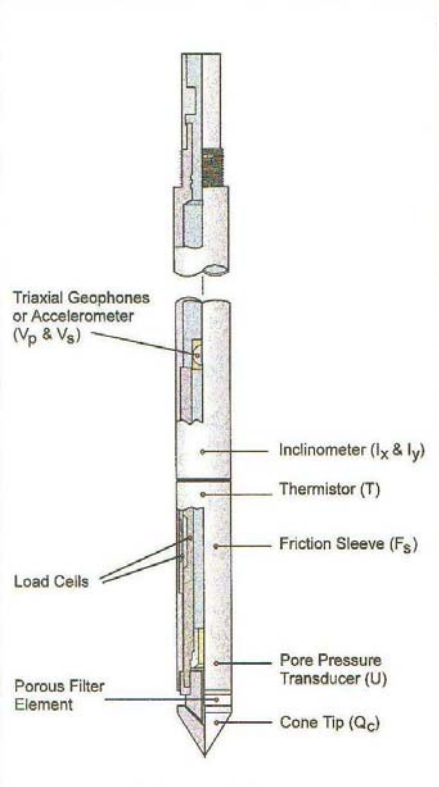


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

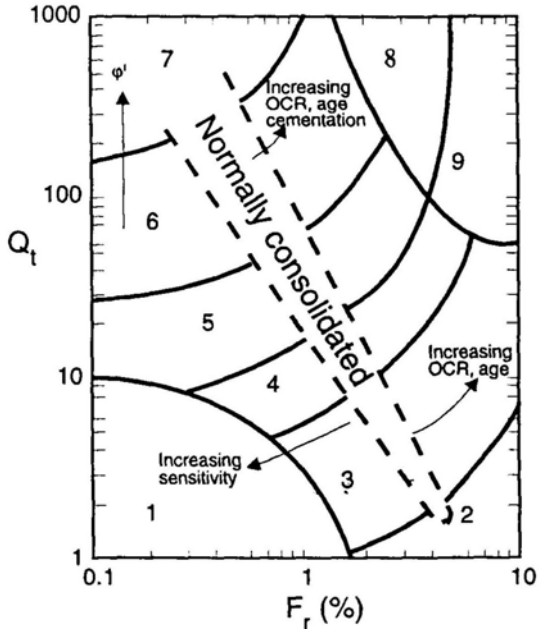


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

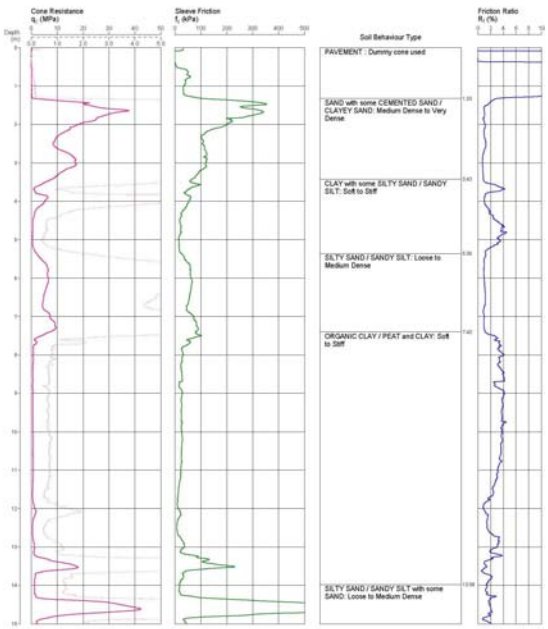


Figure 4: Sample Cone Plot

CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

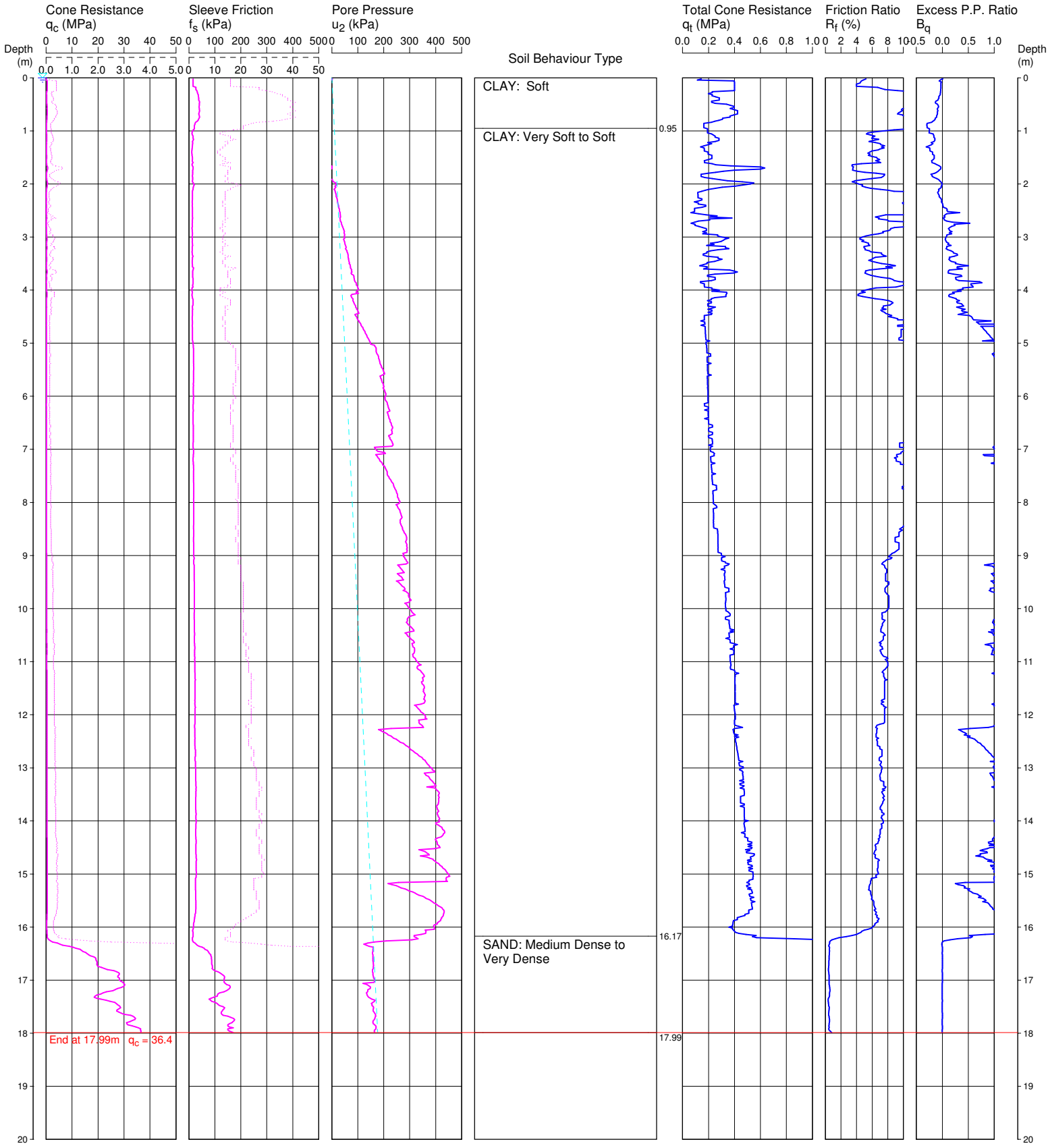
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 2

DATE 17/08/2007

SURFACE RL: 0.69 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E 363744 N 1366402

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT02.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

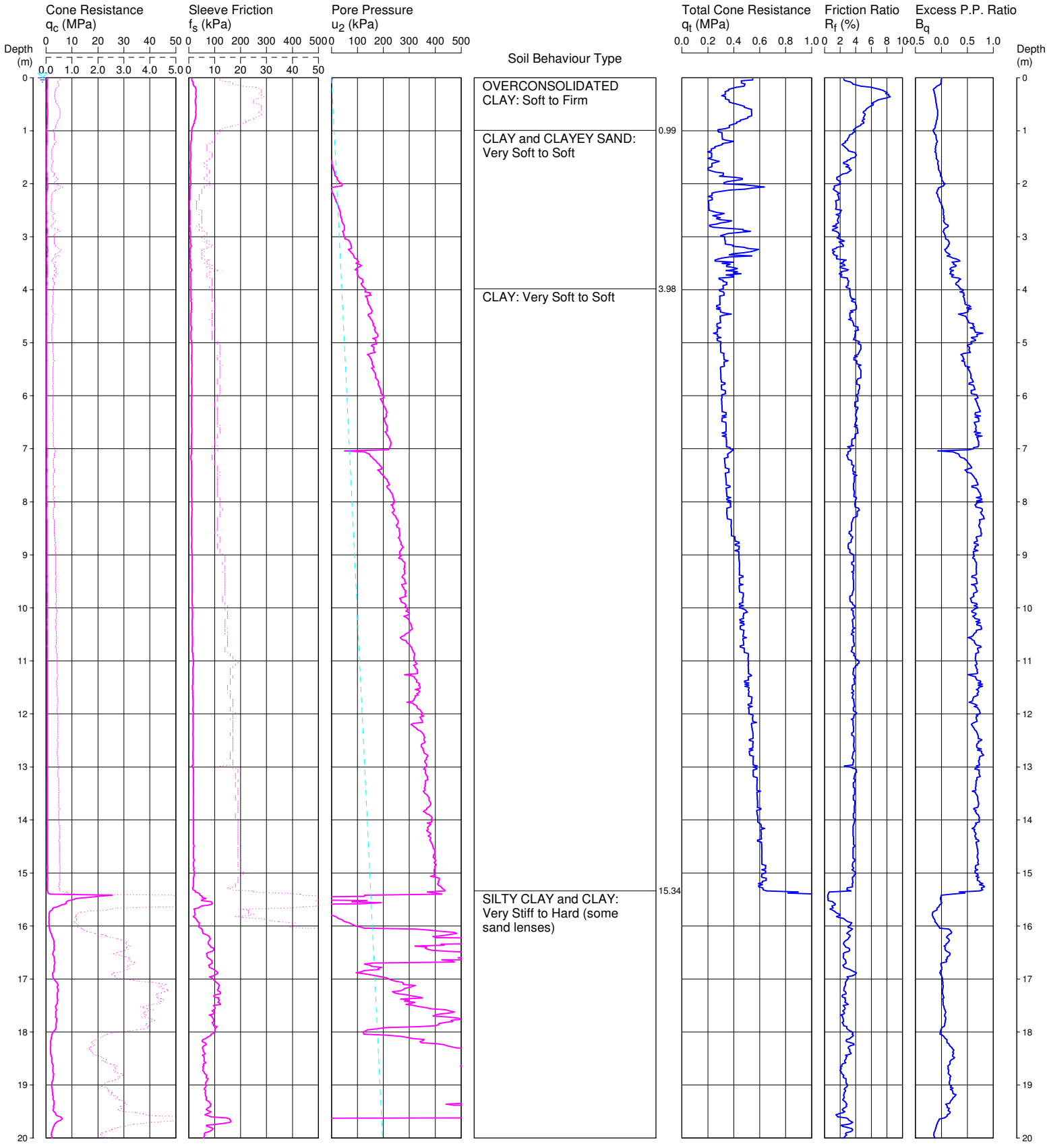
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 3

DATE 20/08/2007

SURFACE RL: 0.68 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E:363762 N:1366349

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT03.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

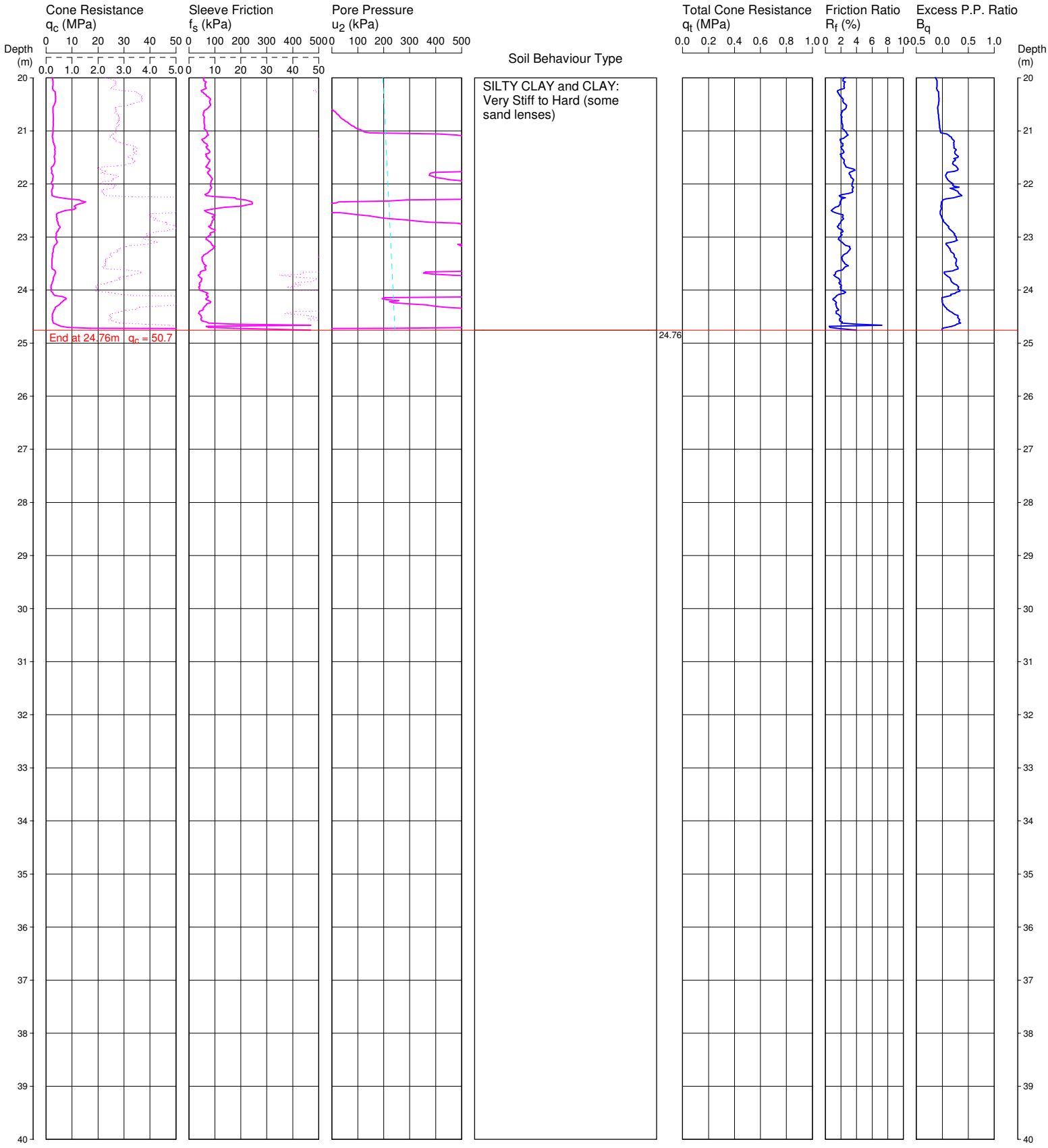
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 3

DATE 20/08/2007

SURFACE RL: 0.68 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E:363762 N:1366349

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT03.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

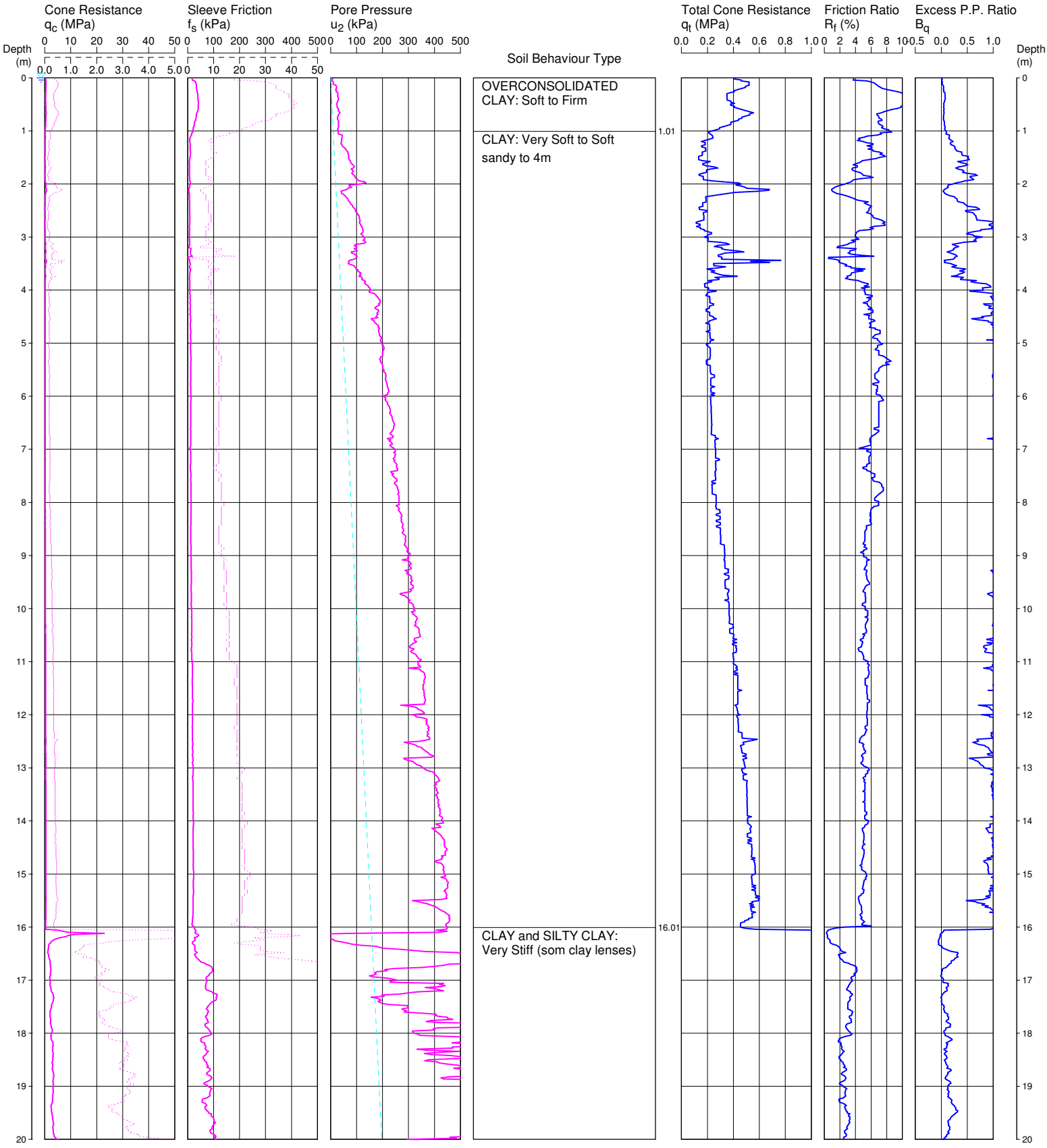
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 4

DATE 20/08/2007

SURFACE RL: 0.73 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E: 363750 N: 1366338

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT04.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

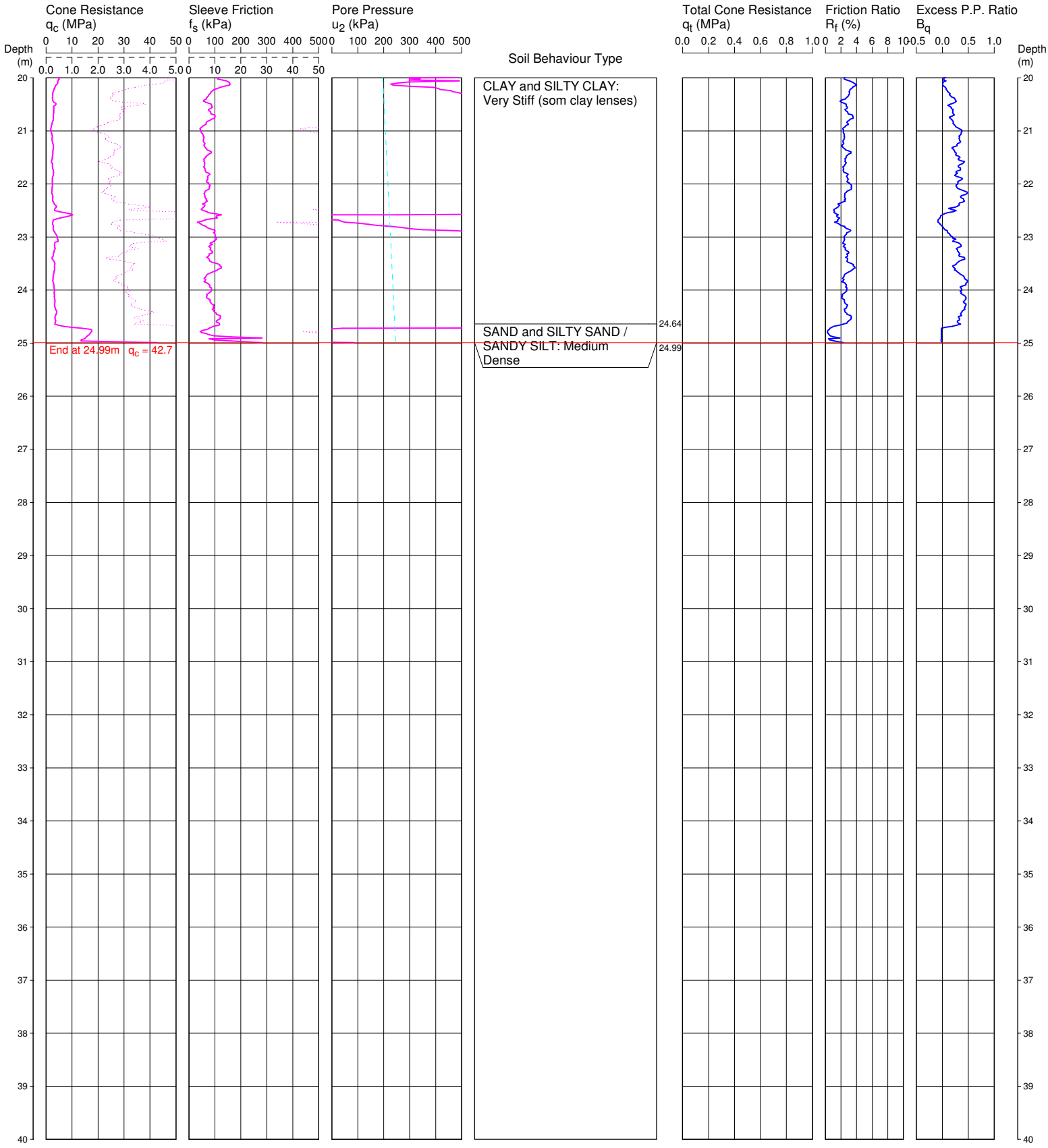
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 4

DATE 20/08/2007

SURFACE RL: 0.73 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E: 363750 N: 1366338

Date
Plotted
Checked

File: P:\39798\Field\CP5 files\CPT04.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

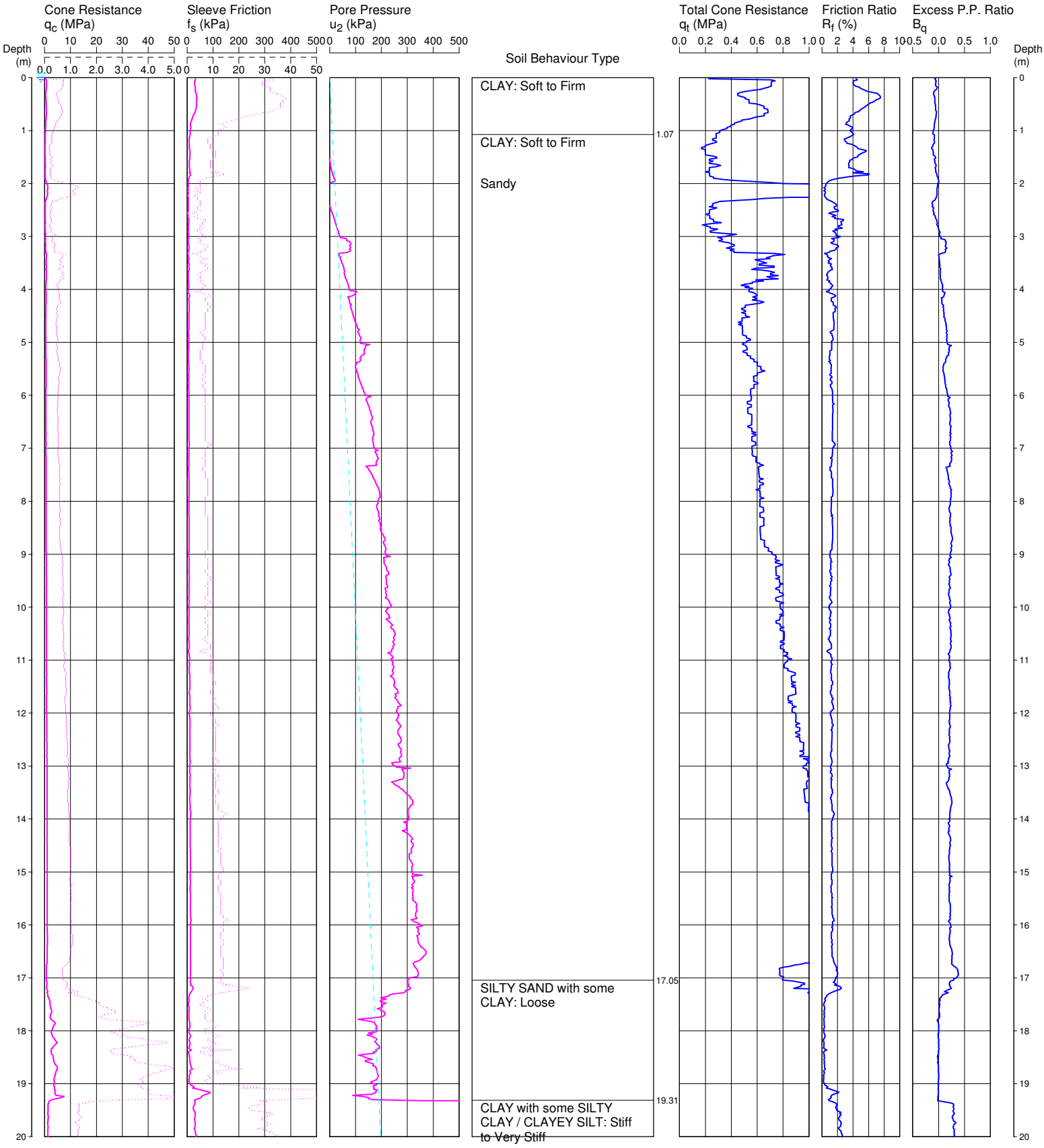
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 5

DATE 16/08/2007

SURFACE RL: 0.72 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E: 363764 N:1366303

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT05.CP5
Cone ID: ISG **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

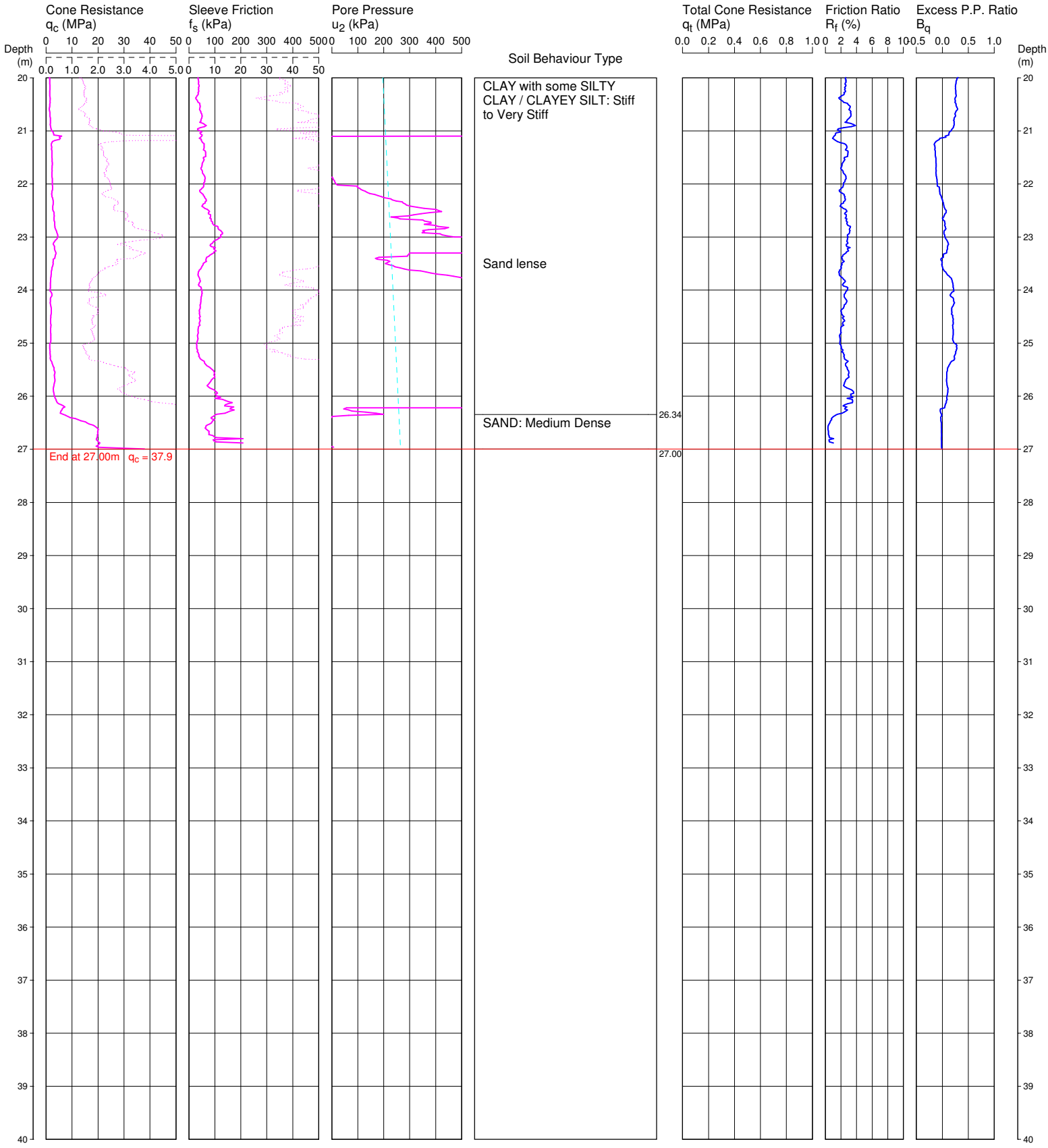
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 5

DATE 16/08/2007

SURFACE RL: 0.72 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E: 363764 N:1366303

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT05.CP5
Cone ID: ISG **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

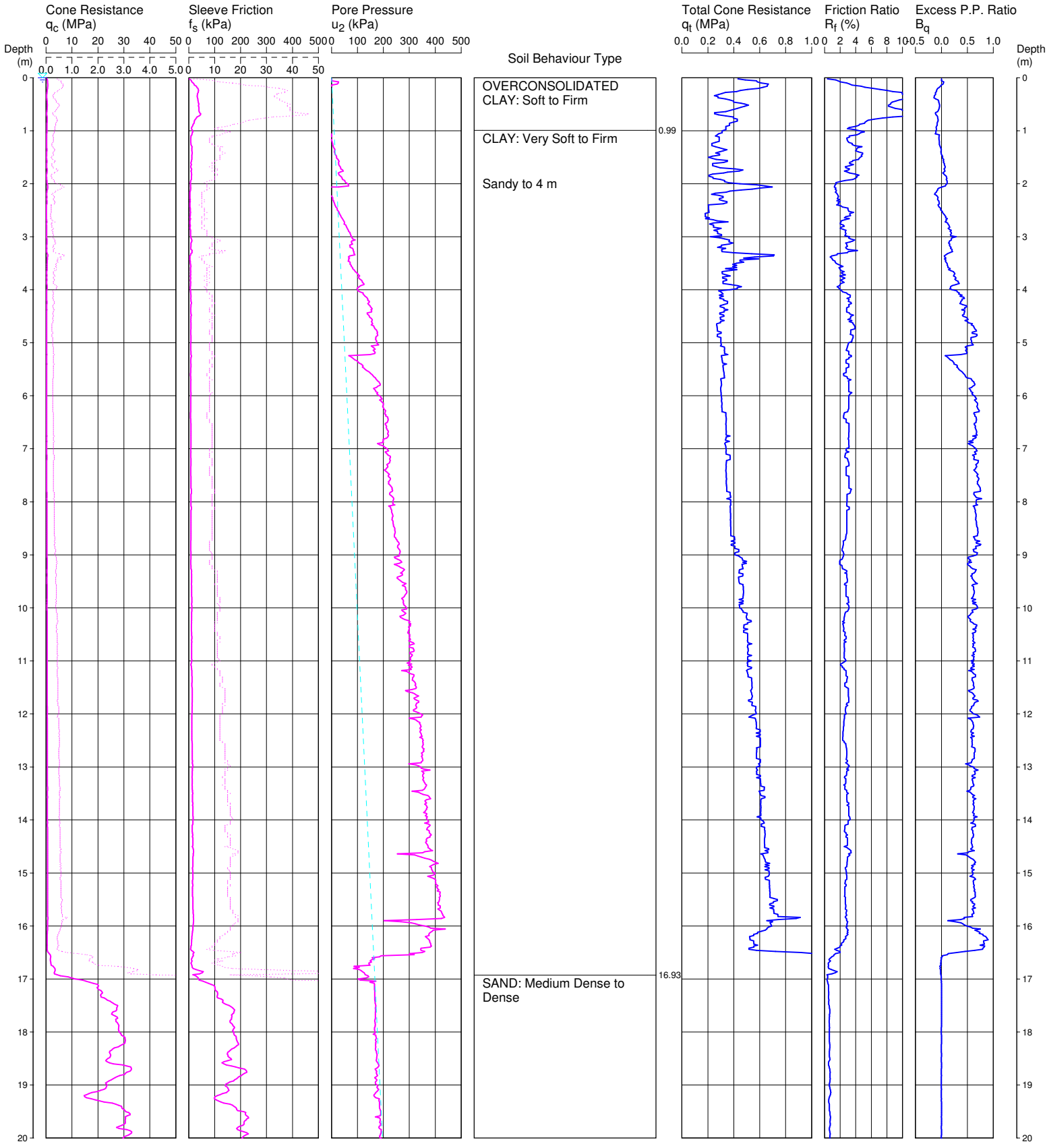
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 6

DATE 17/08/2007

SURFACE RL: 0.72



REMARKS: DEPTH TO WATER AT SURFACE
E:363701 N: 1366426

Date
Plotted
Checked

File: P:\39798\Field\CP5 files\CPT06.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

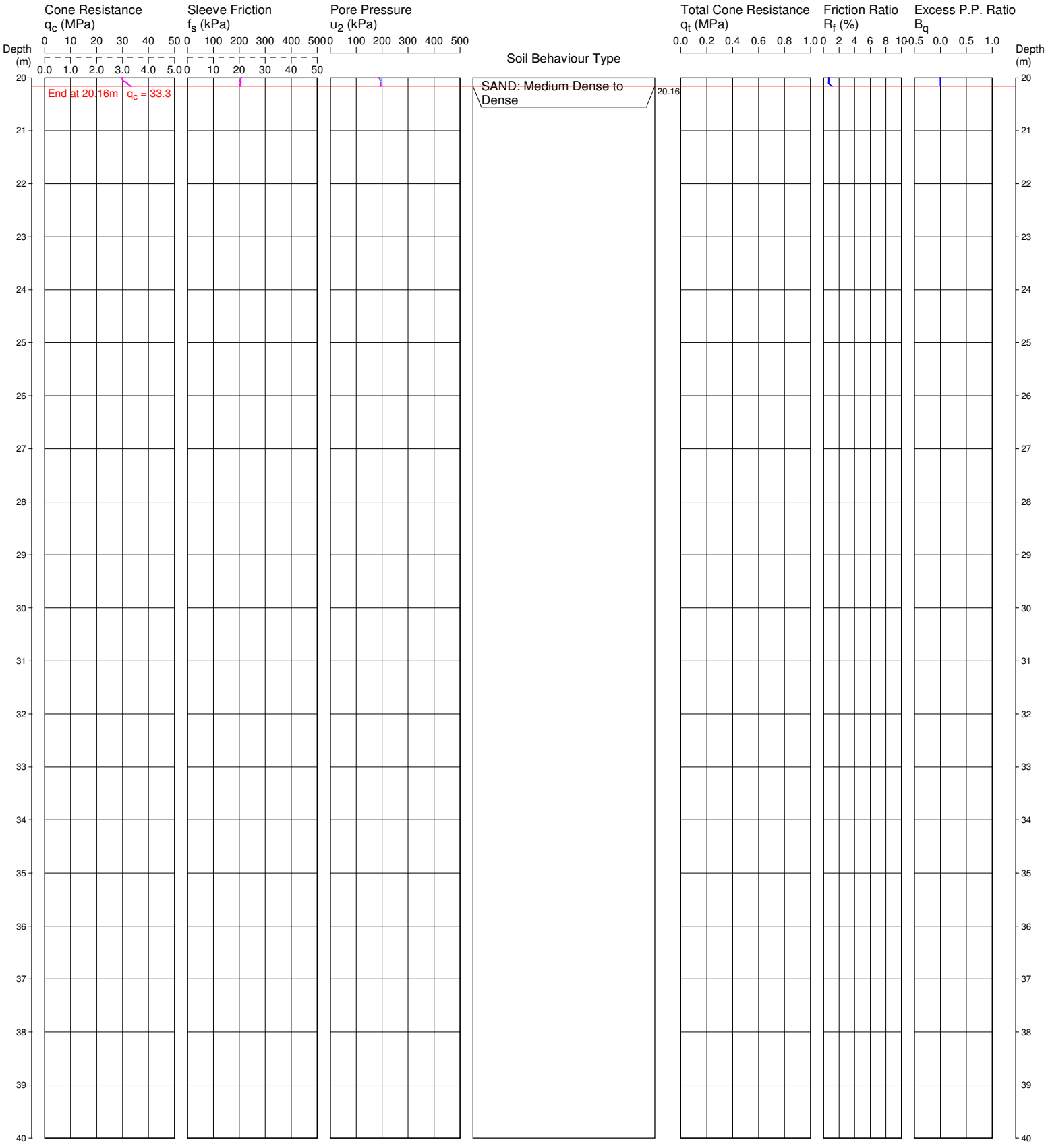
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 6

DATE 17/08/2007

SURFACE RL: 0.72



REMARKS: DEPTH TO WATER AT SURFACE
E:363701 N: 1366426

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT06.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

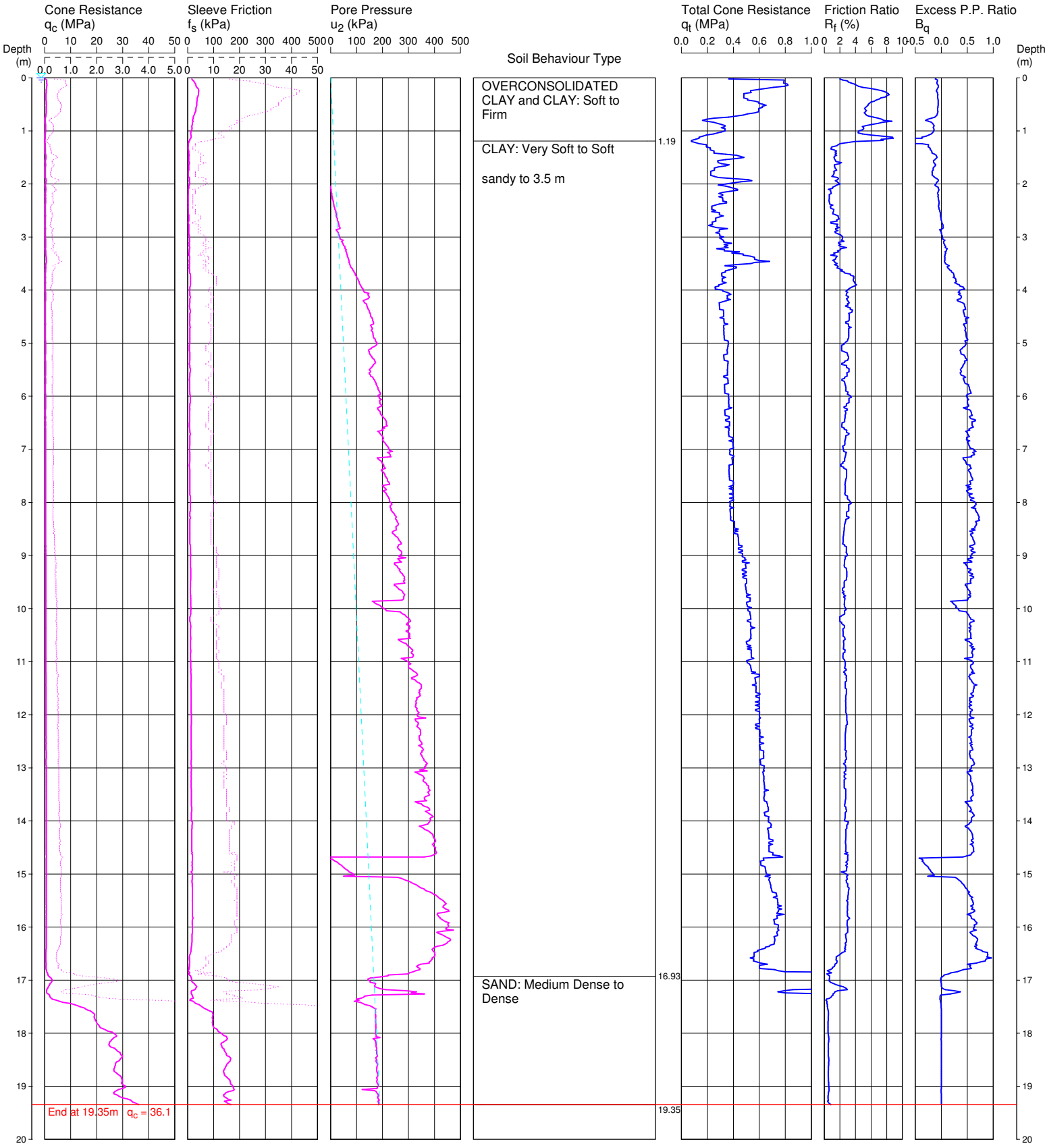
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 7

DATE 17/08/2007

SURFACE RL: 0.58 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E: 363710 N:1366392

Date
Plotted
Checked

File: P:\39798\Field\CP5 files\CPT07.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

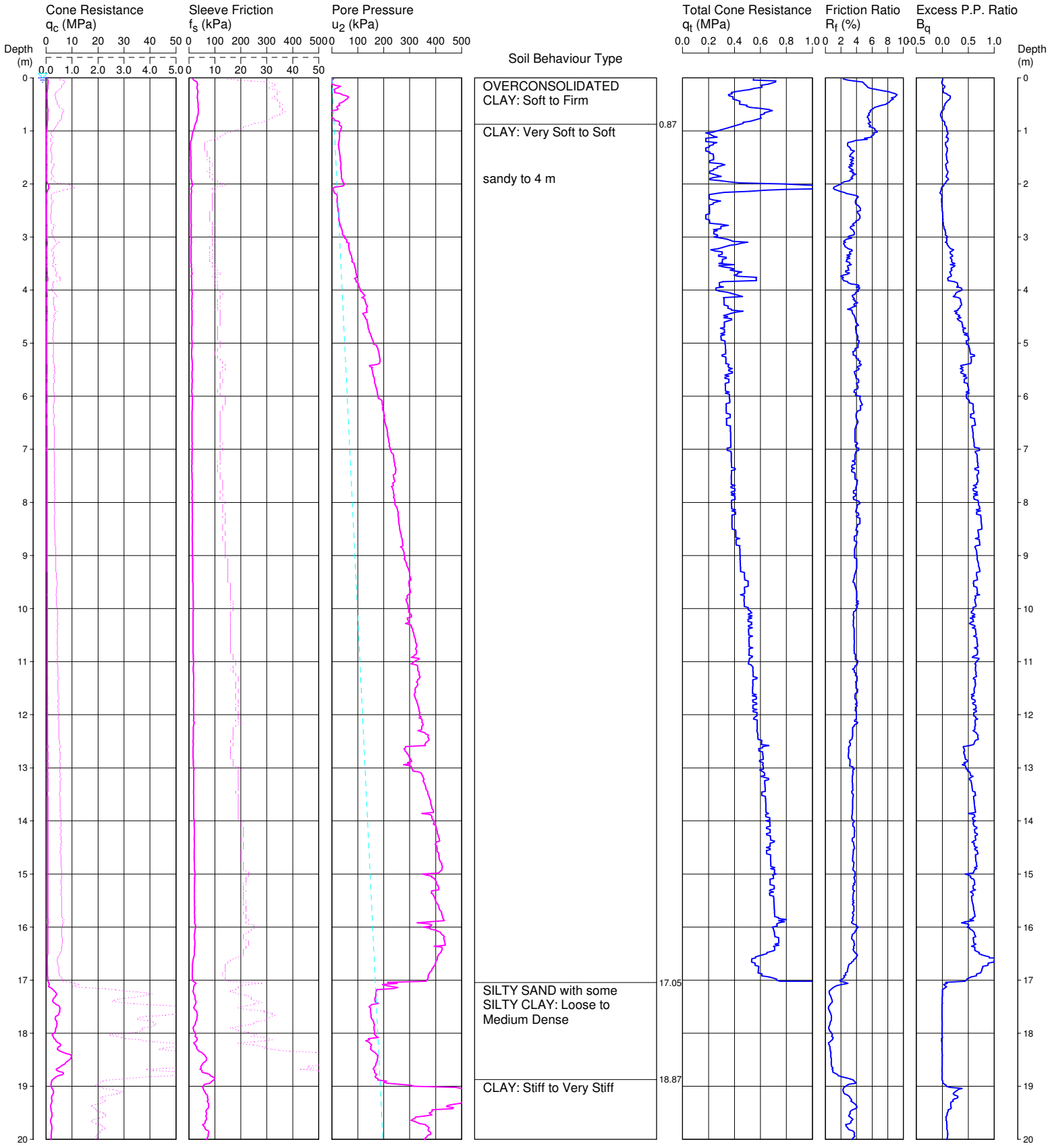
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 8

DATE 20/08/2007

SURFACE RL: 0.67 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E:363727 N:1366340

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT08.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

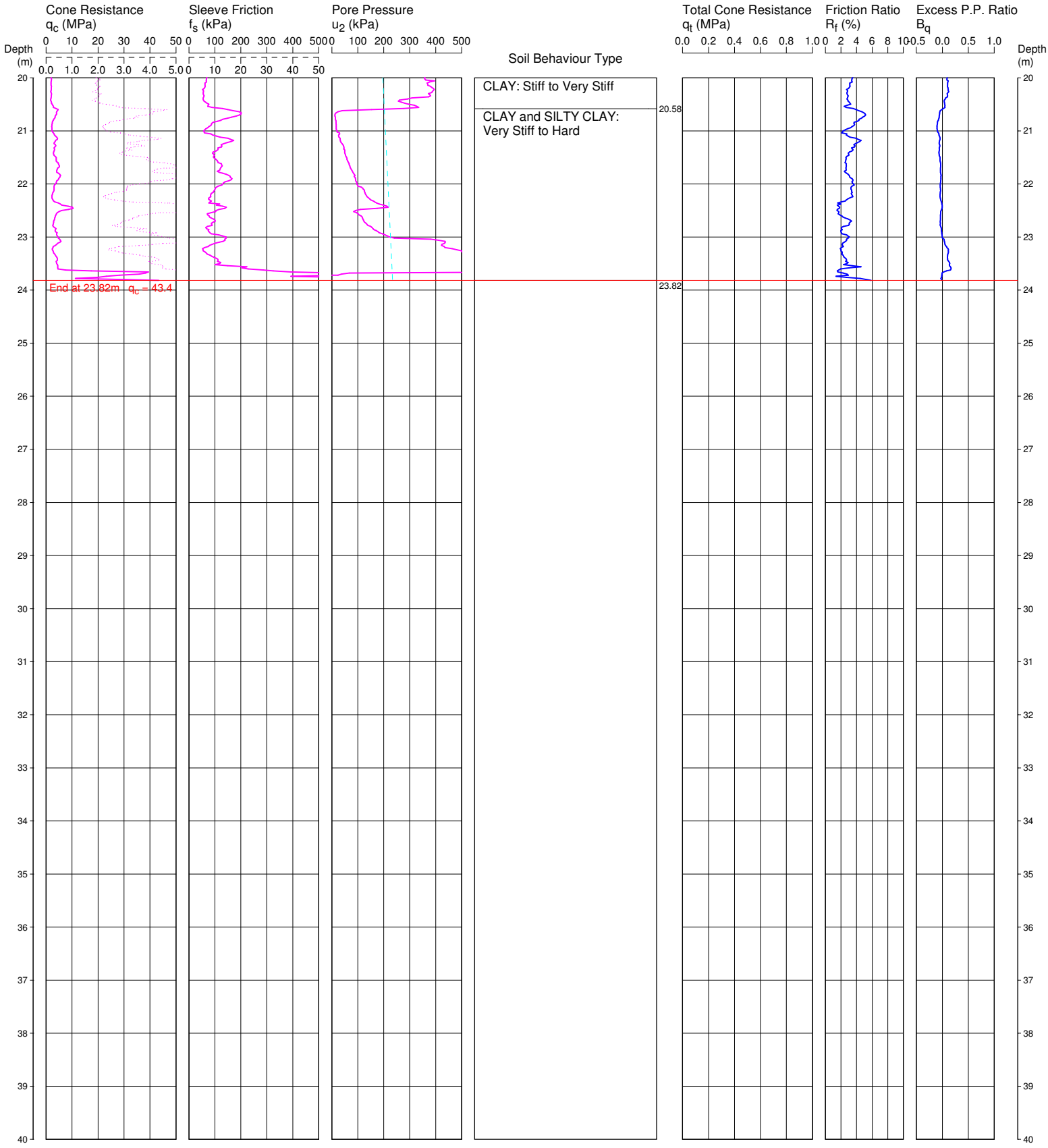
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 8

DATE 20/08/2007

SURFACE RL: 0.67 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E:363727 N:1366340

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT08.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

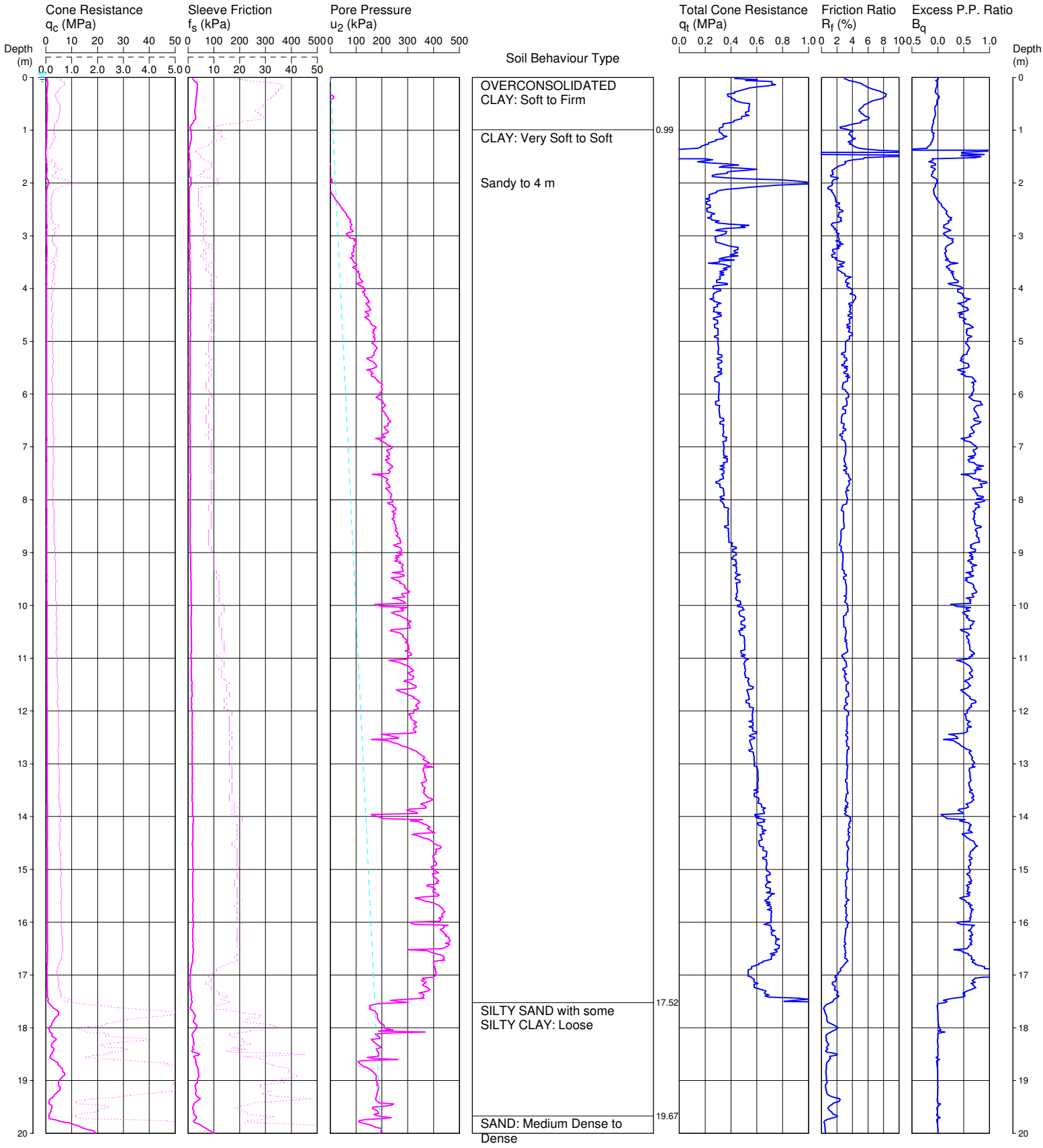
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 9

DATE 17/08/2007

SURFACE RL: 0.56 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E: 363682 N:1366378

Date Plotted Checked

File: P:\39798\Field\CP5 files\CPT09.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

LOCATION: WOODLANDS CLOSE, HEXHAM

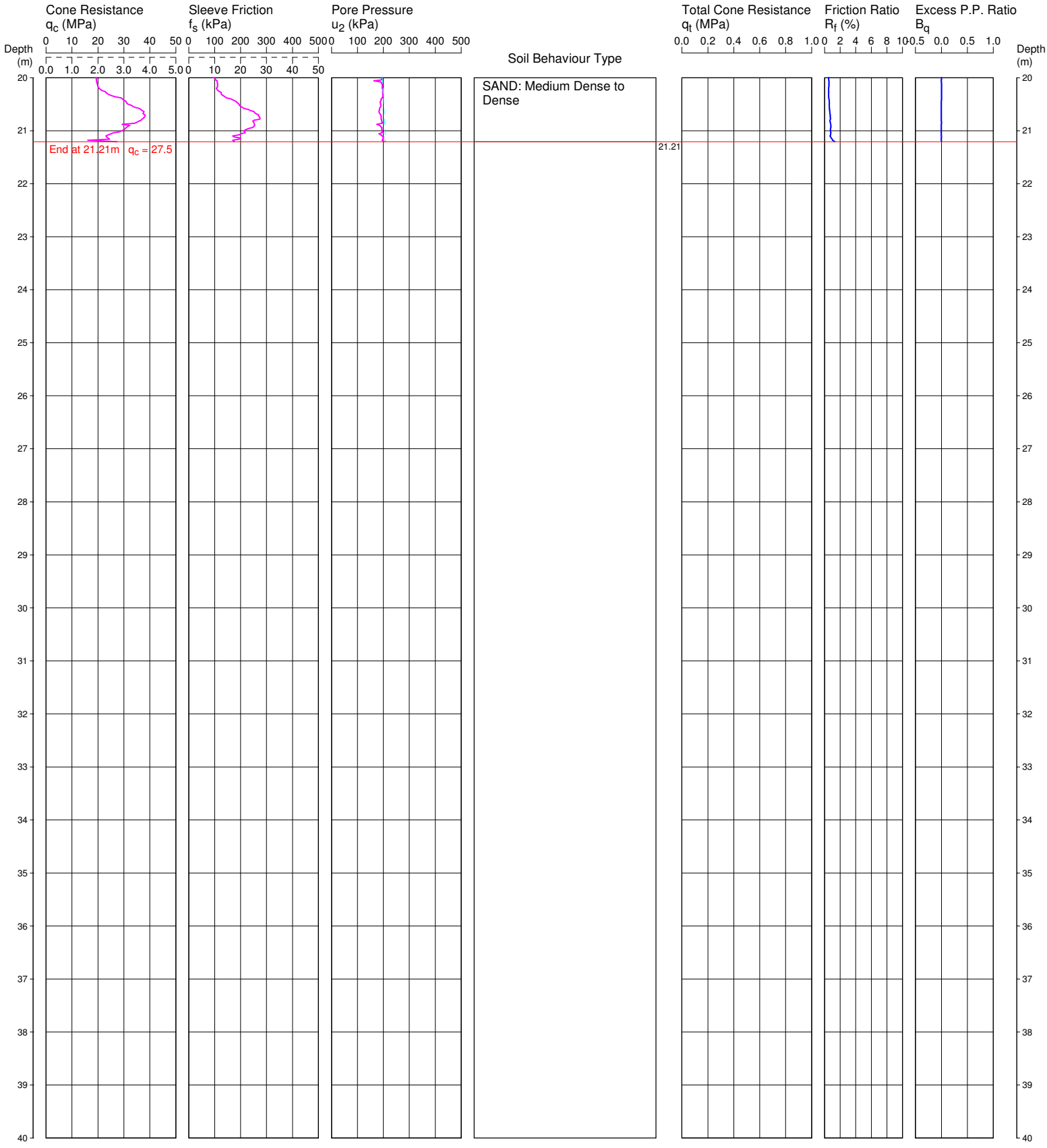
PROJECT No: 39798

CPT 9

Page 2 of 2

DATE 17/08/2007

SURFACE RL: 0.56 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E: 363682 N:1366378

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT09.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

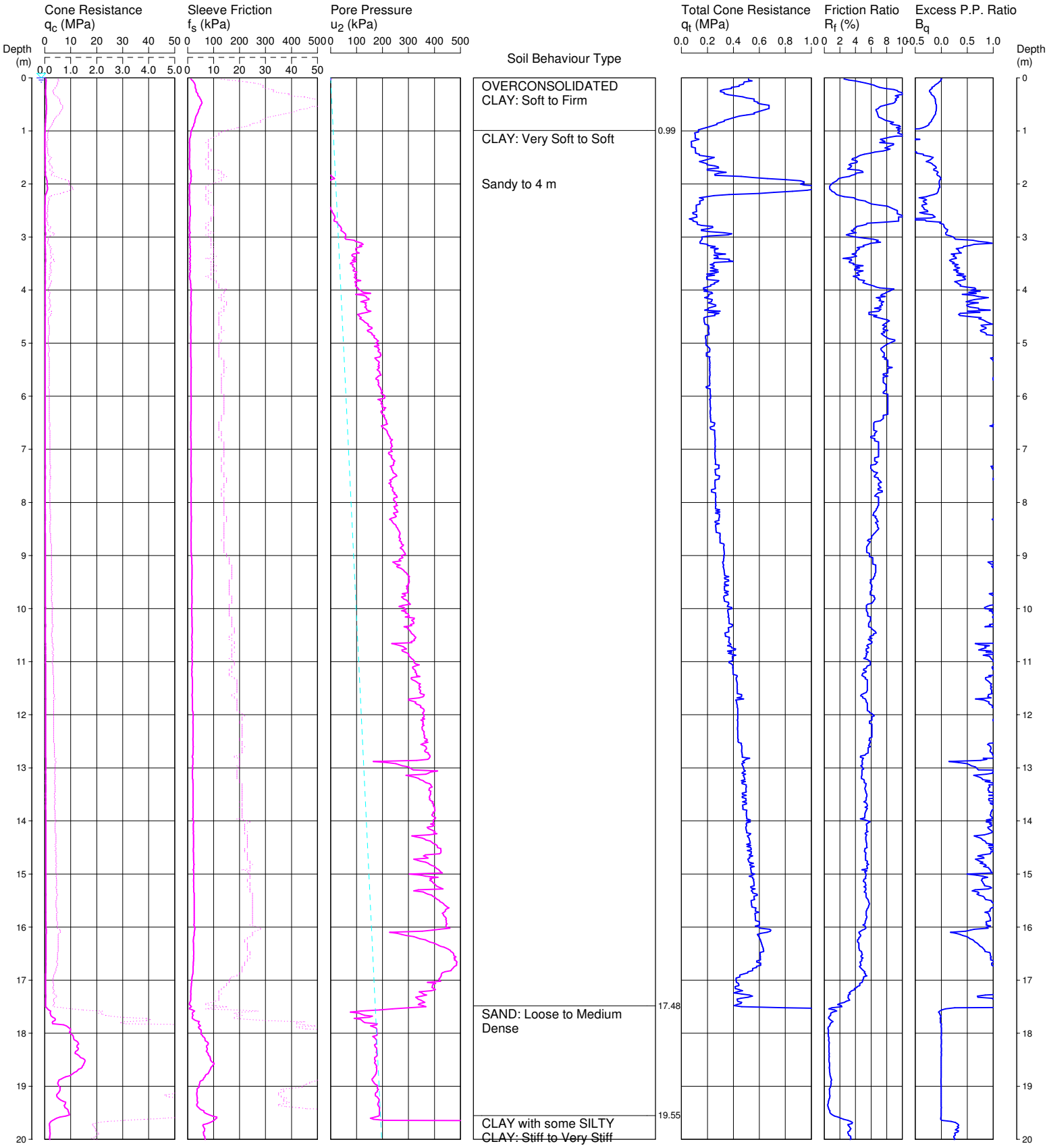
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 10

DATE 16/08/2007

SURFACE RL: 0.67 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E:363709 N1366314

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT10.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

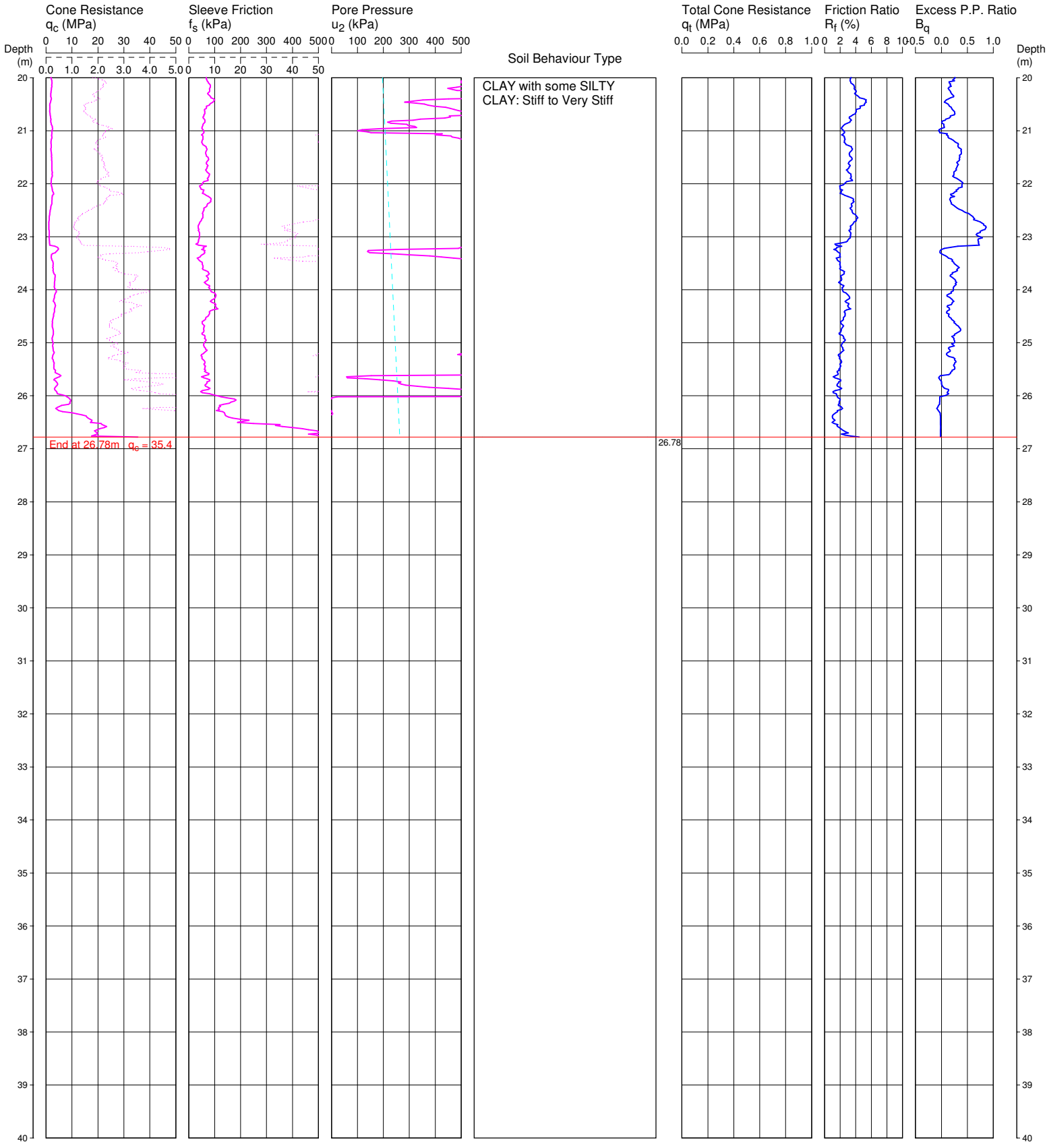
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 10

DATE 16/08/2007

SURFACE RL: 0.67 AHD



REMARKS: DEPTH TO WATER AT SURFACE
E:363709 N1366314

Date
Plotted
Checked

File: P:\39798\Field\CP5 files\CPT10.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

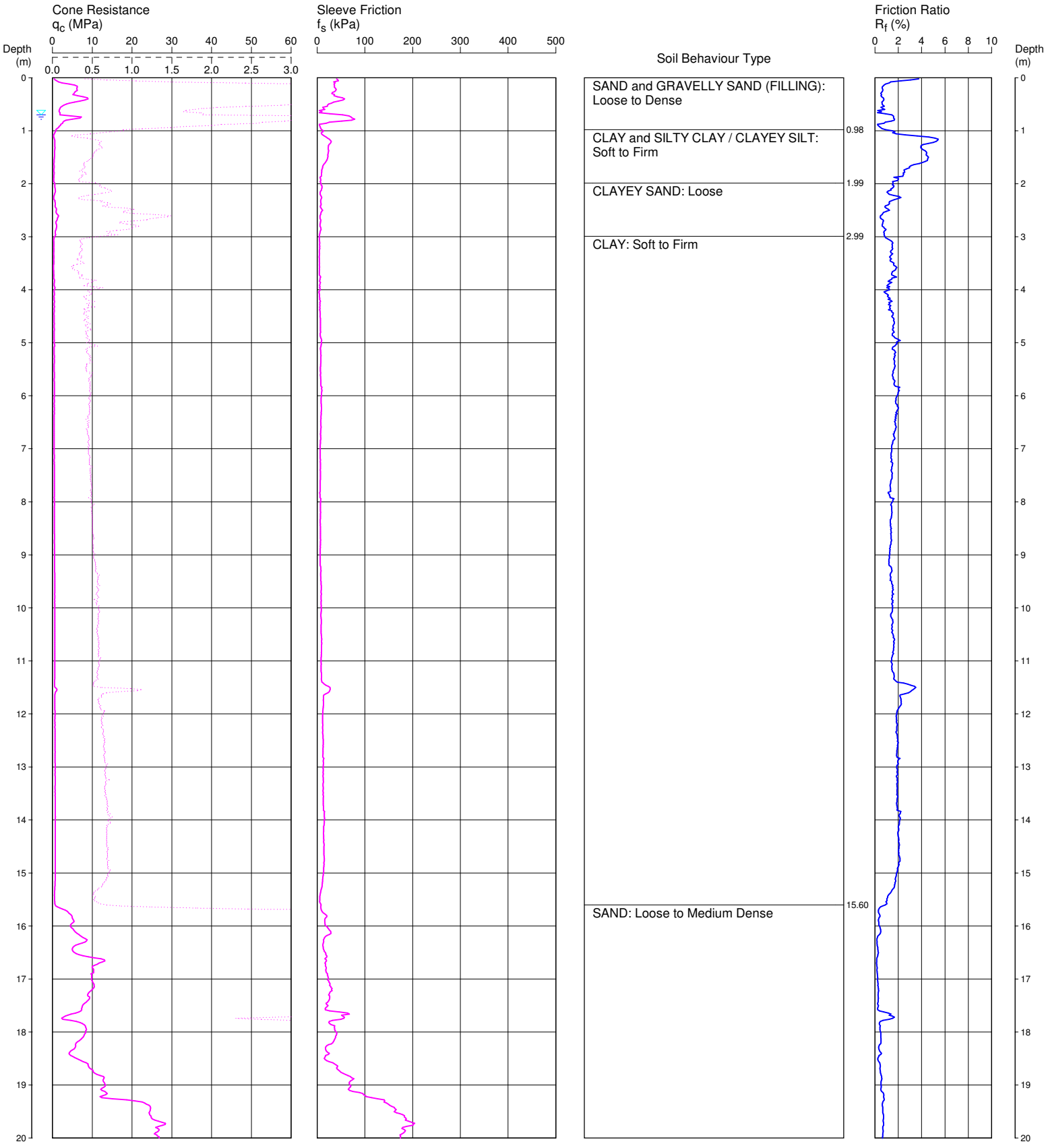
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 11

DATE 30/07/2007

SURFACE RL: 1.53 AHD



REMARKS: DEPTH TO WATER NOT MEASURED - WATER LEVEL ASSUMED
E:363726 N:1366266 (approx)

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT11.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

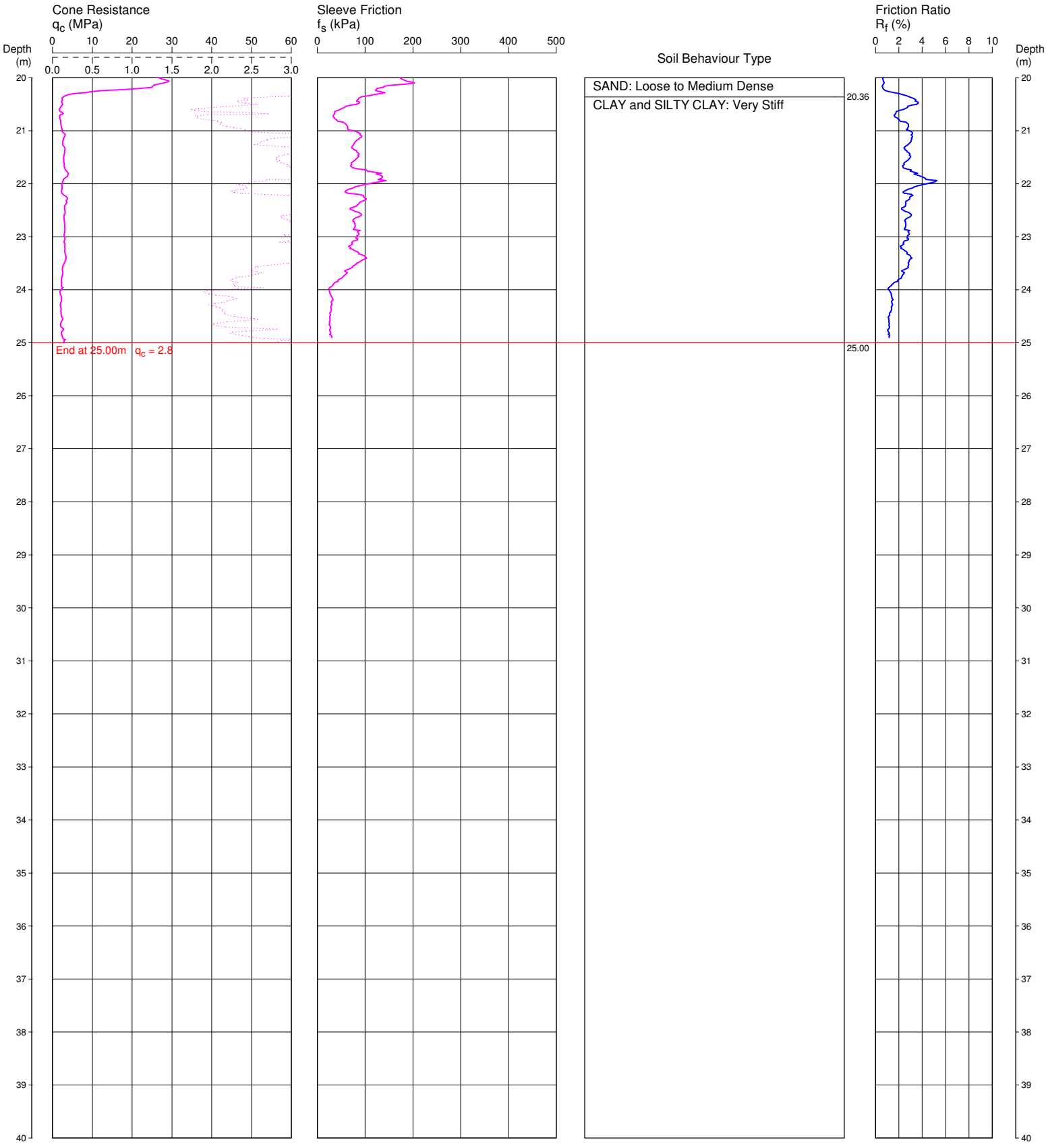
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 11

DATE 30/07/2007

SURFACE RL: 1.53 AHD



REMARKS: DEPTH TO WATER NOT MEASURED - WATER LEVEL ASSUMED
E:363726 N:1366266 (approx)

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT11.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

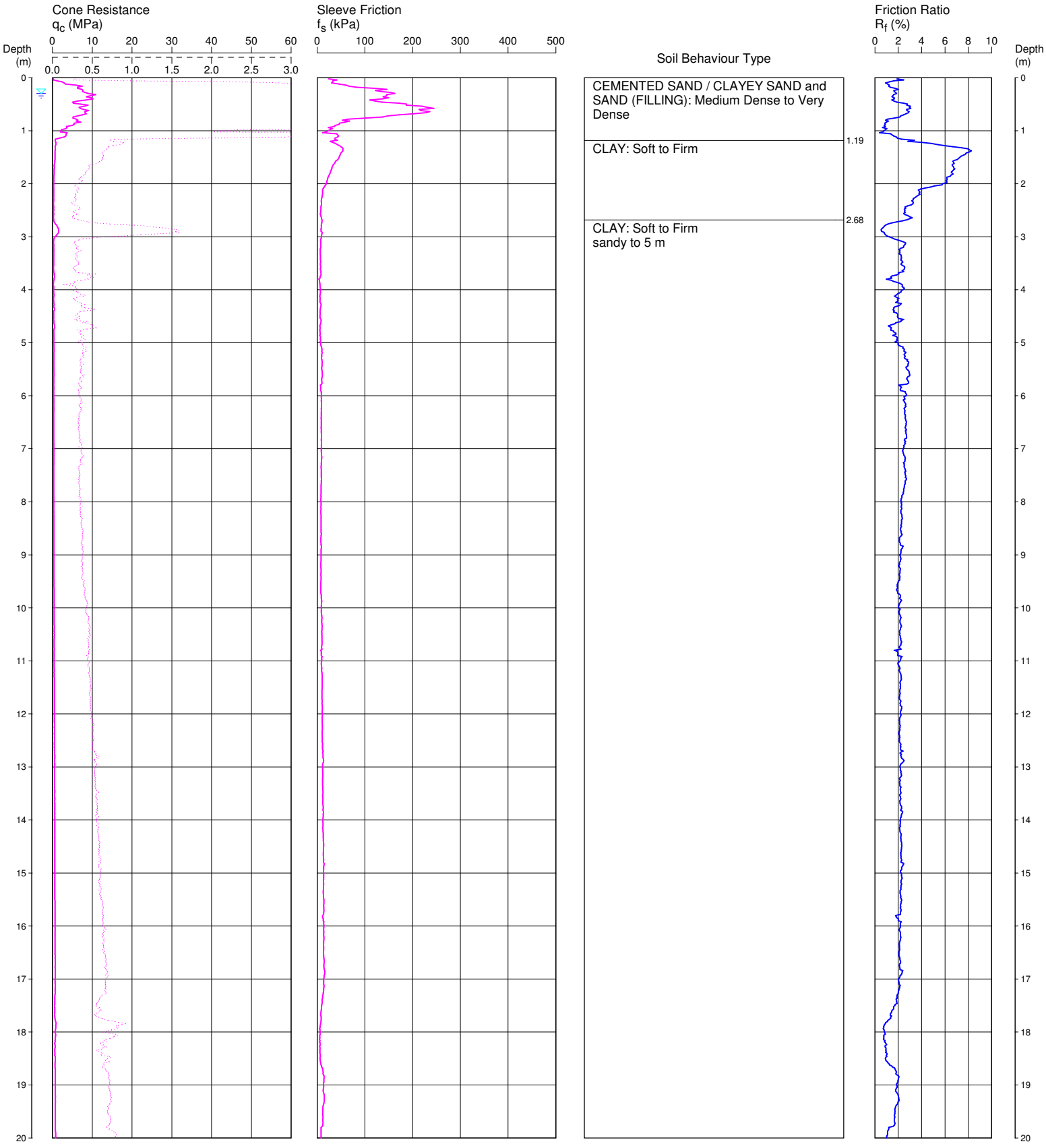
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 12

DATE 30/07/2007

SURFACE RL: 1.3 AHD



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST :0.3 m
E:363819 N:1366055 (approx)

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT12.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

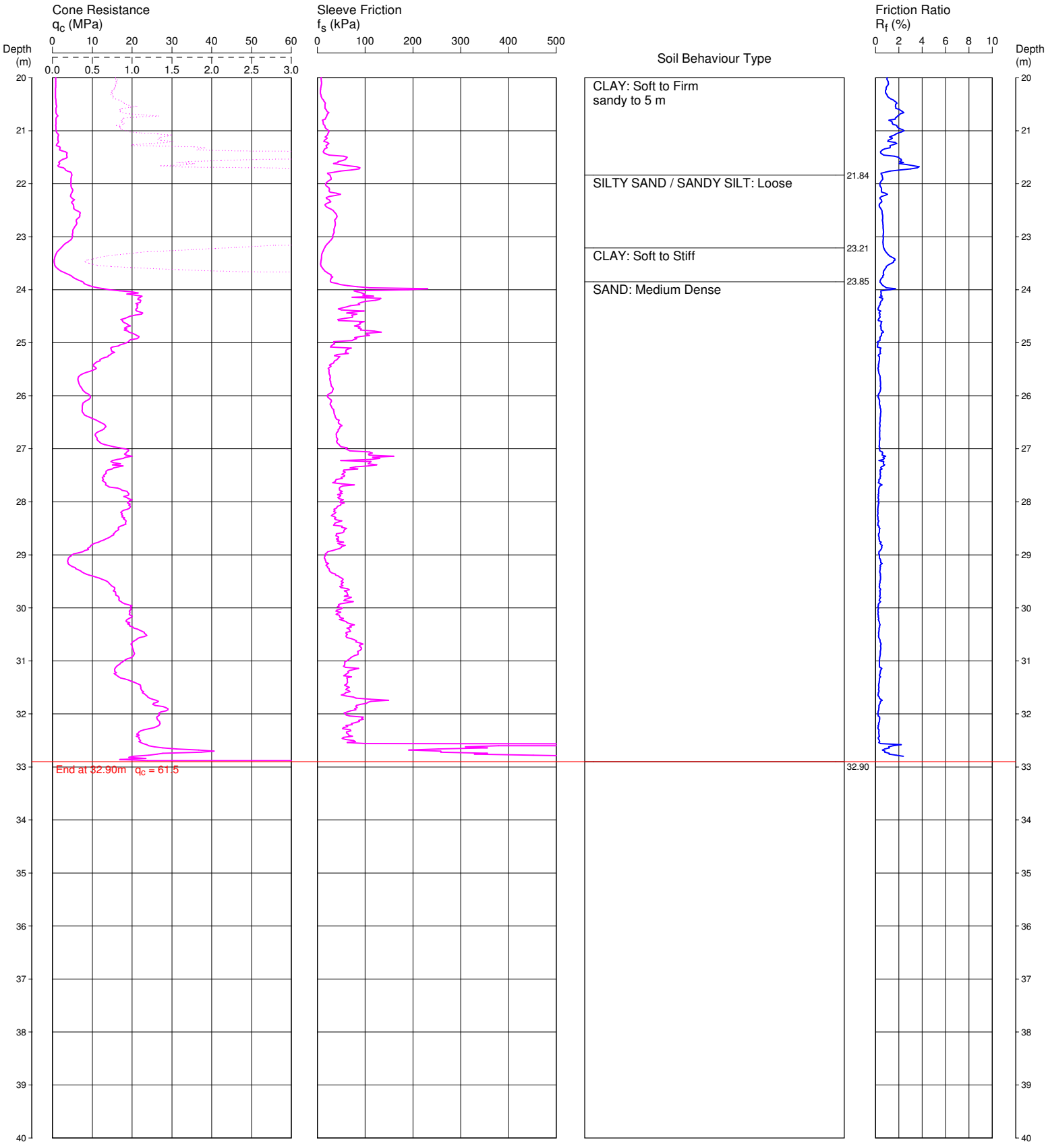
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT 12

DATE 30/07/2007

SURFACE RL: 1.3 AHD



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST :0.3 m
E:363819 N:1366055 (approx)

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\CPT12.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PRELIMINARY GEOTECHNICAL INVESTIGATION

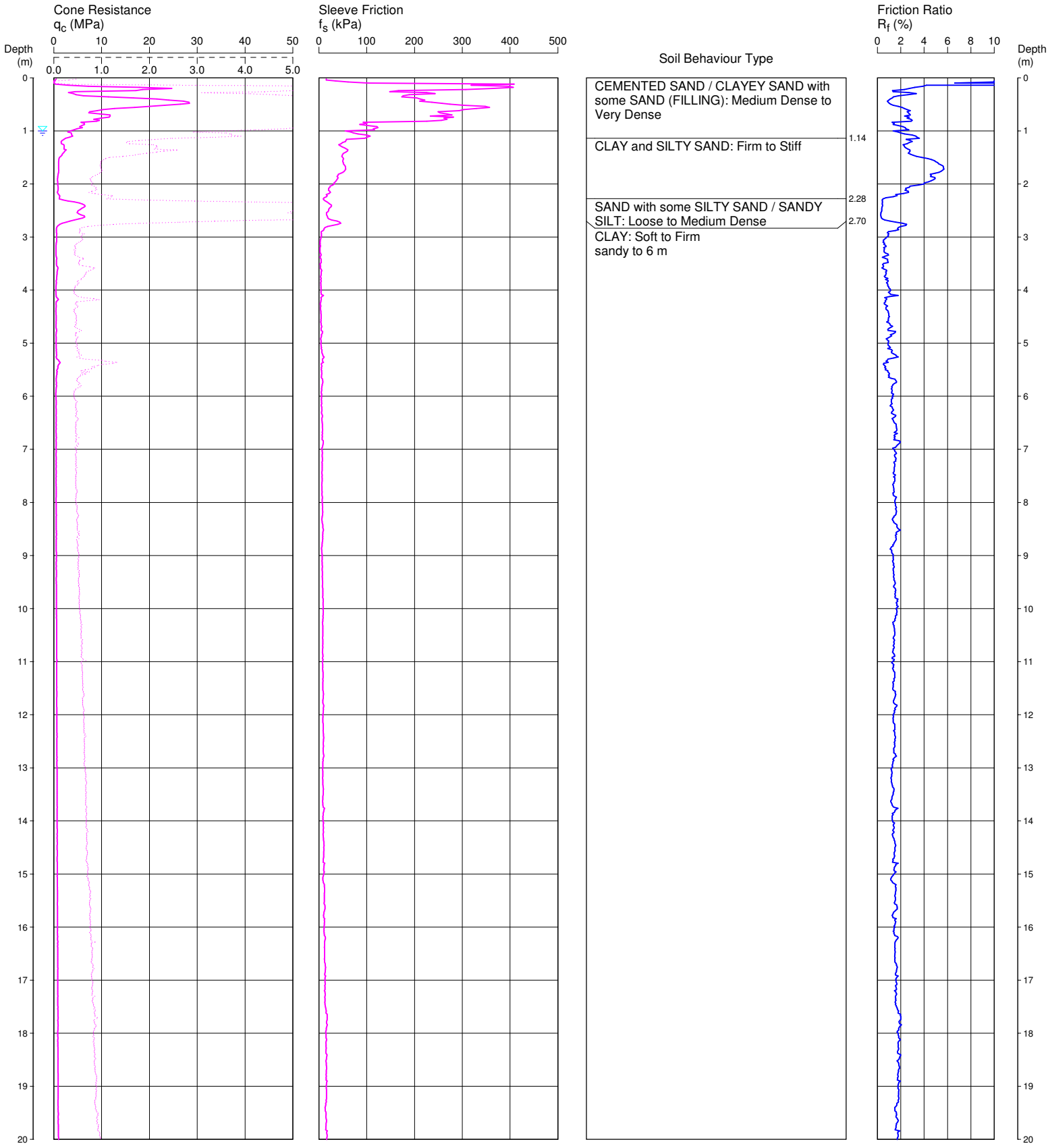
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT TP13

DATE 30/07/2007

SURFACE RL: 1.89 AHD



REMARKS: HOLE COLLAPSE AT SURFACE (WATER LEVEL ASSUMED)
DUMMY CONED USED FROM SURFACE TO 0.6mE:364405 N:1364670 (approx)

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\TP13.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PRELIMINARY GEOTECHNICAL INVESTIGATION

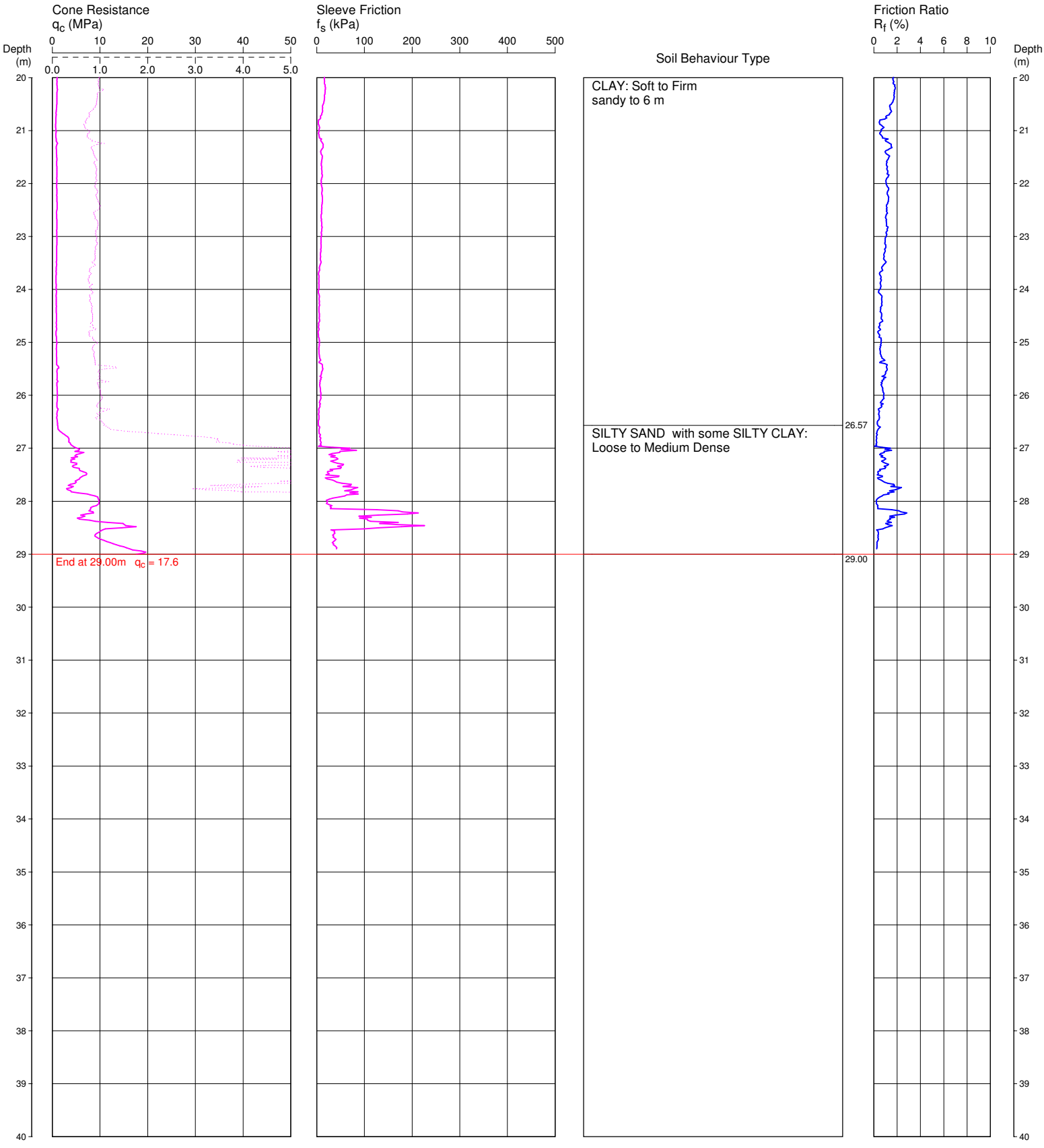
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT TP13

DATE 30/07/2007

SURFACE RL: 1.89 AHD



REMARKS: HOLE COLLAPSE AT SURFACE (WATER LEVEL ASSUMED)
DUMMY CONED USED FROM SURFACE TO 0.6mE:364405 N:1364670 (approx)

Date
Plotted
Checked

File: P:\39798\Field\CP5 files\TP13.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

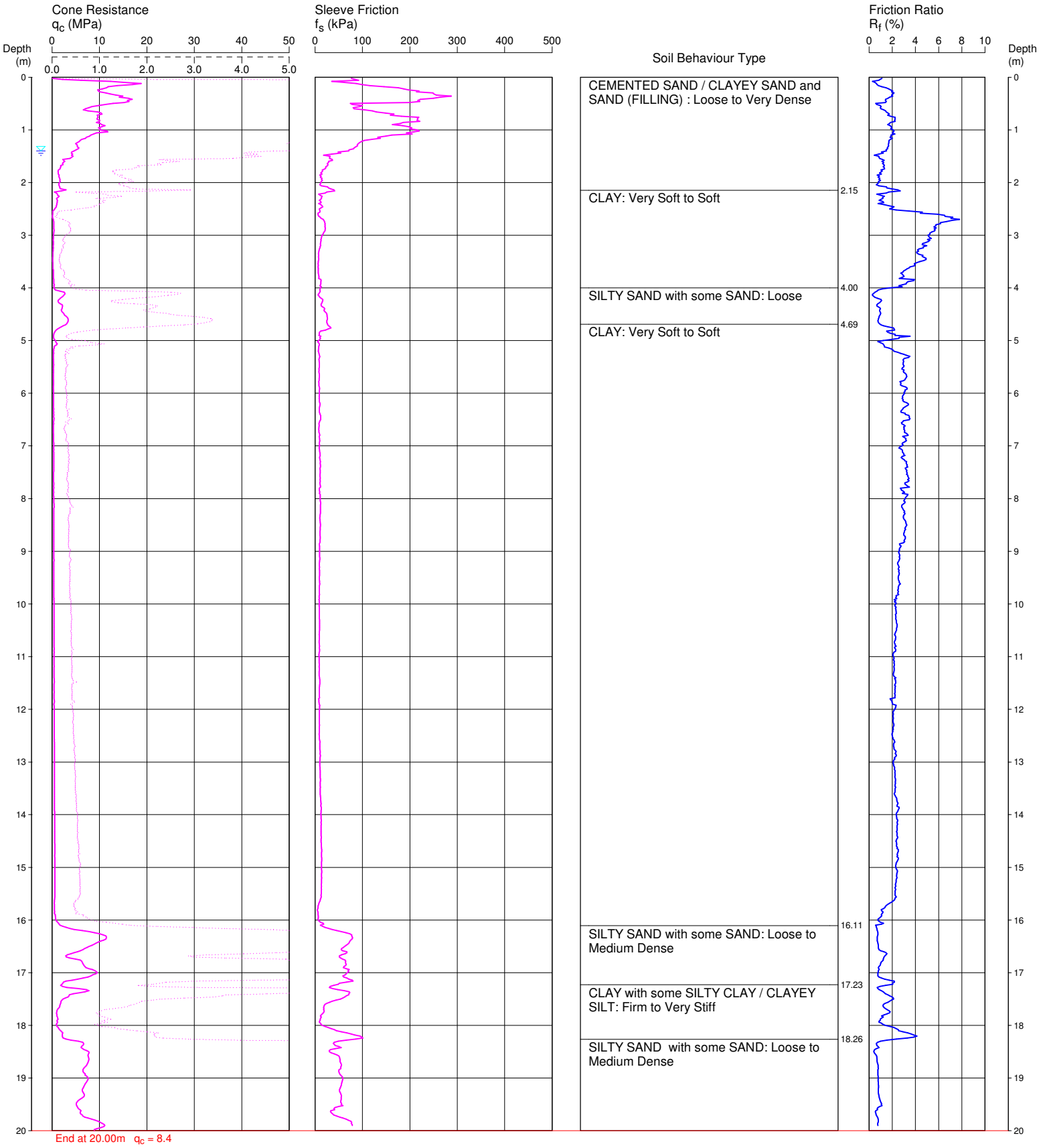
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT TP15

DATE 30/07/2007

SURFACE RL: 2.64 AHD



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 1.4 m
E: 364228 N:1365028

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\TP15.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

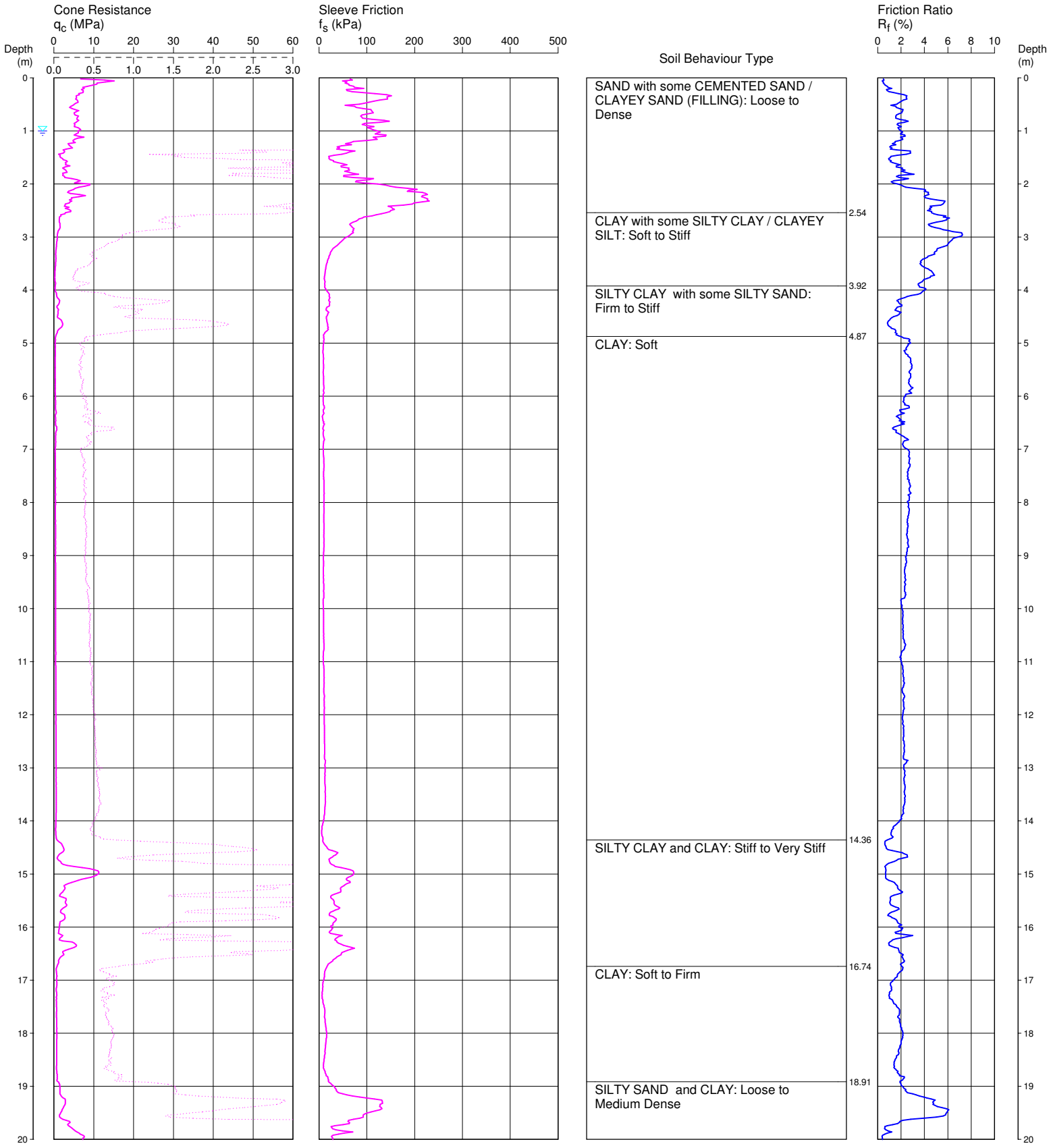
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT TP17

DATE 30/07/2007

SURFACE RL: 2.59 AHD



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 1.0 m
E:3647094 N:1365405

Date	
Plotted	
Checked	

File: P:\39798\Field\CP5 files\TP17.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

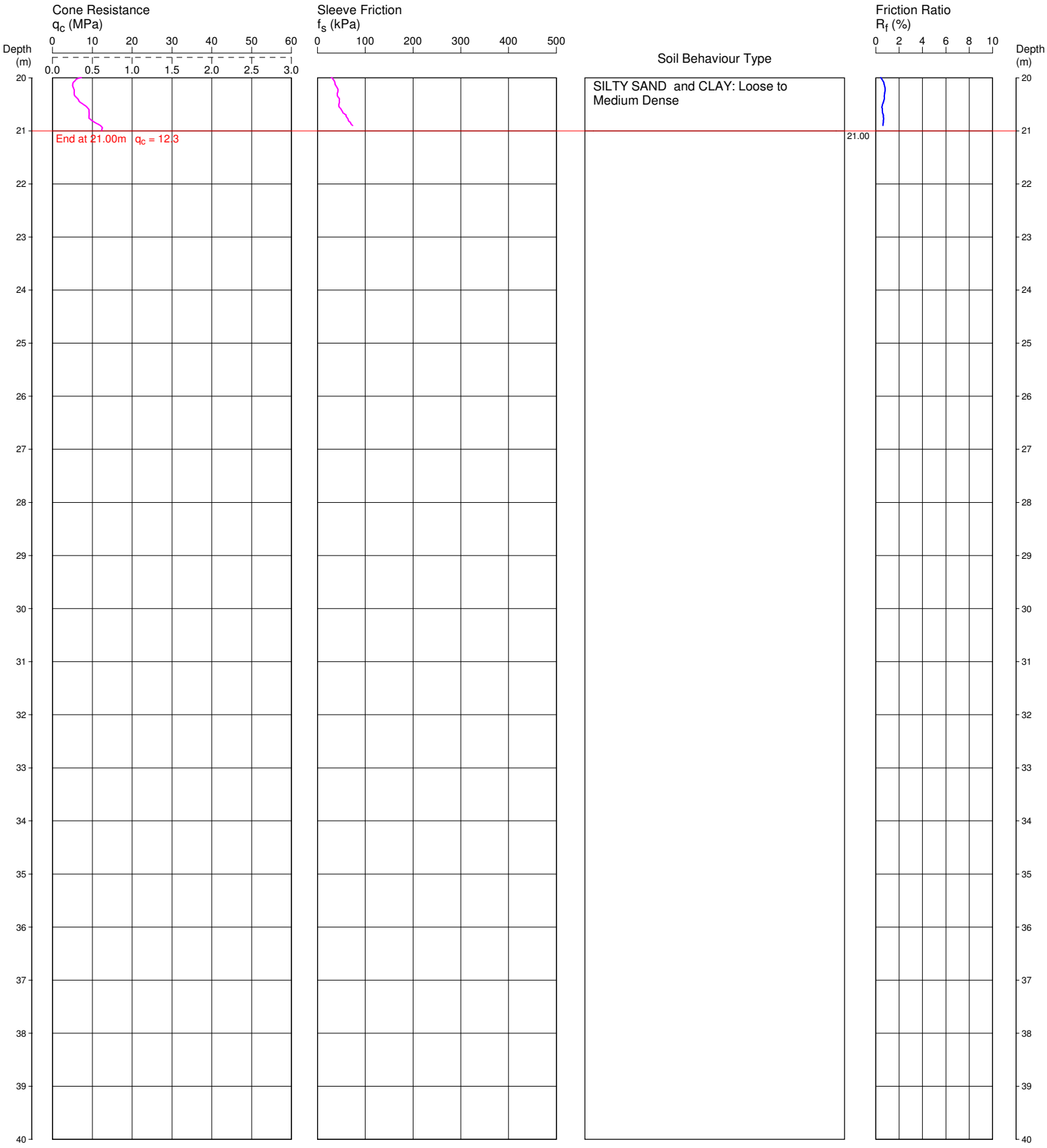
LOCATION: WOODLANDS CLOSE, HEXHAM

PROJECT No: 39798

CPT TP17

DATE 30/07/2007

SURFACE RL: 2.59 AHD



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 1.0 m
E:3647094 N:1365405

Date
Plotted
Checked

File: P:\39798\Field\CP5 files\TP17.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: PROPOSED MAINTENANCE FACILITY

LOCATION: WOODLANDS CLOSE, HEXHAM

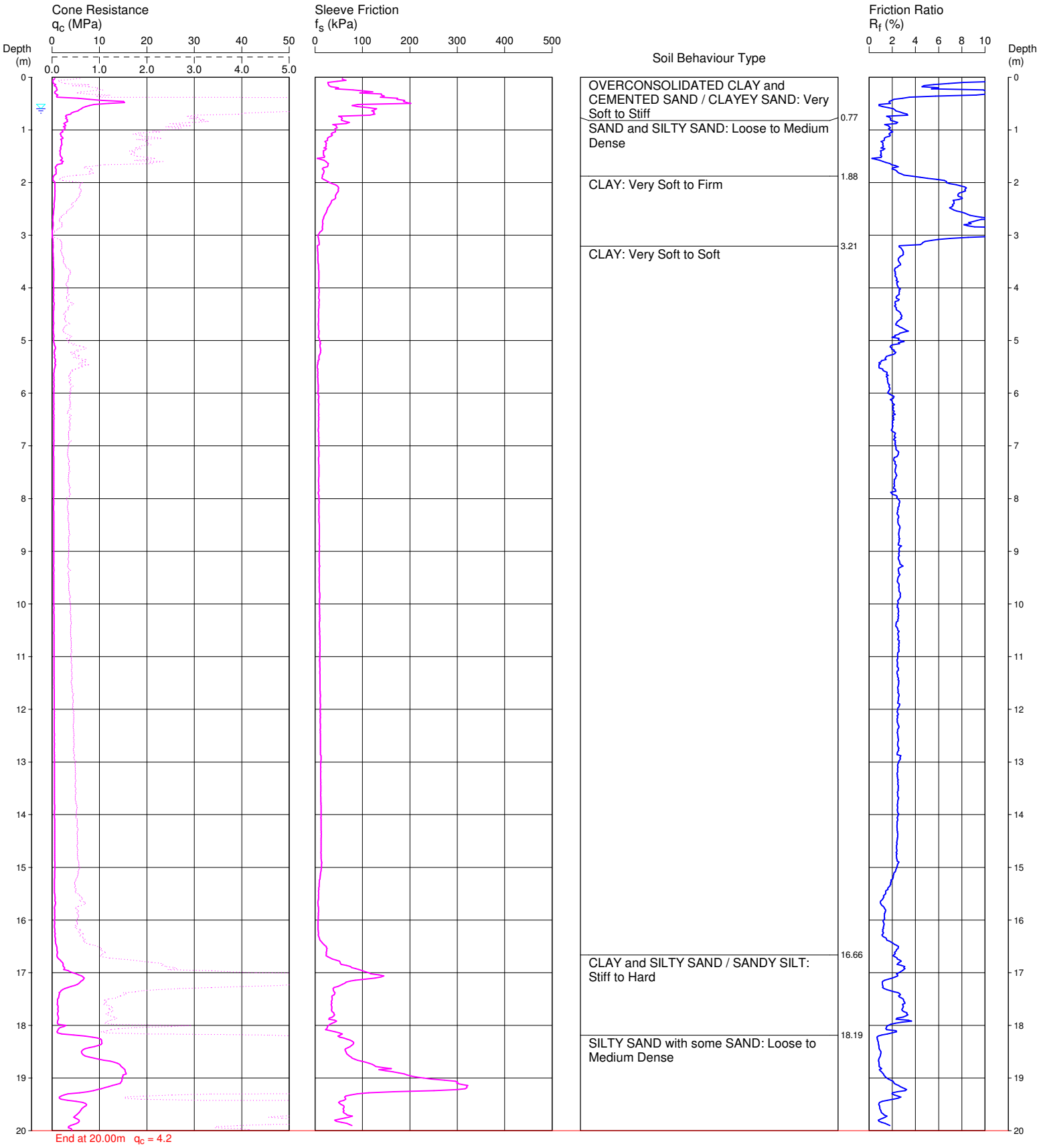
PROJECT No: 39798

CPT TP19

Page 1 of 1

DATE 30/07/2007

SURFACE RL: 1.5



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 0.6 m
SURFACE LEVEL ASSUMED 364027 N:1365782 (approx)

Date
Plotted
Checked

File: P:\39798\Field\CP5 files\TP19.CP5
Cone ID: 400 **Type:** 2 Standard

ConePlot Version 5.8.1

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 1.53 AHD
EASTING: 364313
NORTHING: 1364847
DIP/AZIMUTH: 90°/--

BORE No: TP14
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	FILLING: Dark grey/black gravelly sand (coal reject) some silt, damp		A,PID	0.1		< 1 ppm		
				B,PID			< 1 ppm		
	0.4	FILLING: Orange, fine to medium grained gravelly fine to coarse grained sand (roadbase), humid			0.5				
	0.6	FILLING: Dark grey/brown, fine gravelly clay, M>Wp		A, PID	0.8		< 1 ppm		
	1.3	SILTY CLAY: Soft to firm, grey silty clay, M>Wp		A	1.3				
					1.5				
		From 1.7m depth, sandy clay		S			1,1,3 N = 4		
	2.0	SILTY SAND: Very soft, grey silty fine grained sand, saturated		pp	1.95		120-150kPa		
				A	2.4				
		From 2.9m depth, sandy silt, some shells		A	2.9				
					3.0				
				S			0,0,1 N = 1 under hammer 300mm		
					3.45				
					4.0				
				S			0,0,1 N = 1 under hammer 300mm		
					4.45				
	4.95	Bore discontinued at 4.95m, limit of investigation							

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.1m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED	
Initials:	
Date:	

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 2.34 AHD
EASTING: 364160
NORTHING: 1365216
DIP/AZIMUTH: 90°/--

BORE No: TP16
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILLING: Dark grey/black gravelly sand (coal reject), with some silt, moist		A, PID	0.4		<1 ppm		
					0.5				
		From 0.7m depth, saturated		S			1,2,1 N = 3	▼	
					0.95				
				A, PID	1.4		<1ppm		
					1.5				
				S			3,2,2 N = 4		
					1.95				
	2.0	SILTY CLAY: Firm, grey/brown silty clay, M>Wp		A,pp	2.3		700-100kPa		
	2.7	SANDY SILTY CLAY: Very soft, grey, fine grained sandy silty clay, some clay, saturated		A	2.8				
					3.0				
				S			sunk 300mm under hammer then 1 blow, N=1		
					3.45				
		From 3.7m depth, with some shells							
	4.95	Bore discontinued at 4.95m, limit of investigation							

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.7m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 2.21 AHD
EASTING: 364027
NORTHING: 1365593
DIP/AZIMUTH: 90°/--

BORE No: TP18
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
									5 10 15 20
		FILLING: Dark grey/black, fine to medium gravelly fine to coarse grained (coal reject), some silt, humid			0.0				
				B A,PID	0.5		<1ppm		
				A,PID	1.0		<1ppm		
					1.5				
				S			3,4,3 N = 7		
					1.95			▼	
				A.PID	2.5		<1 ppm		
		Some cobbles from 2.6m depth							
	2.8	SILTY CLAY: Stiff, grey silty clay, M>Wp							
				pp	3.0		130-150kPa		
							2,2,2 N = 4		
		From 3.3m depth, sandy clay, firm							
				pp	3.45		70-90kPa		
	4.1	SANDY SILT: Very soft to soft, fine grained sandy silt, saturated							
					4.5				
				S			0,0,1 N = 1		
	4.95	Bore discontinued at 4.95m, limit of investigation			4.95				

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 2.2m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 1.51 AHD
EASTING: 363827
NORTHING: 1366158
DIP/AZIMUTH: 90°/--

BORE No: TP21
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.3	FILLING: Dark grey/brown, fine to medium gravelly fine to coarse grained sand, some silt, moist to wet							
		SILTY CLAY: Firm, grey/brown silty clay, M>Wp			0.5			▼	
				S			1,2,4 N = 6		
				pp, PID	0.95		90-120kPa , <1ppm		
		From 1.2m depth, mottled orange		A,pp,PID	1.1		100-120kPa,1ppm		
		From 1.5m depth, very soft to soft, with some sand			1.5				
				S			1,1,1 N = 2		
				pp	1.95		60-100kPa		
	2.1	SANDY SILT: (Very soft), grey fine grained sandy silt with some clay, saturated		A	2.4				
	2.8	CLAYEY SAND: Very soft, grey, fine grained clayey sand with some silt and shell, saturated			3.0				
				S			1,0,0 N = 0		
					3.45				
	3.6	SILT: Very soft, grey silt, some fine grained sand, clay and shells, saturated							
					4.5				
	4.95	Bore discontinued at 4.95m, limit of investigation			4.95				

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.5m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 0.72 AHD
EASTING: 363700
NORTHING: 1366538
DIP/AZIMUTH: 90°/--

BORE No: TP22
PROJECT No: 39798
DATE: 22 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
0	0.2	CLAYEY SILT - Grey-brown clayey silt, some organics, M>Wp							
		SILTY CLAY - Firm, grey silty clay, M>Wp		A,pp	0.4		50-80 kPa		
-1	1.2	CLAYEY SILTY SAND - Grey mottled orange silty sand, saturated			0.9				
	2.5	Bore discontinued at 2.5m, collapse			1.4				
-2					1.7				
-3					2.4				
-4									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools
DRILLER: Musgrove
LOGGED: Rice
CASING: Uncased

TYPE OF BORING: 90mm hand auger

WATER OBSERVATIONS: Water at surface 50mm

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED	
Initials:	
Date:	

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 1.07 AHD
EASTING: 363644
NORTHING: 1366730
DIP/AZIMUTH: 90°/--

BORE No: TP23
PROJECT No: 39798
DATE: 22 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
1	0.1	FILLING - Generally comprising fine to coarse sandy fine to medium gravel with some dark grey-black coal reject, saturated						
		SILTY CLAY - Grey silty (firm) clay, some organics, M>>Wp		pp	0.5		50-90 kPa	
				A	0.7			
		from 0.8m, grey mottled orange with some fine grained sand		A	0.9			
0	1							
	1.1	CLAYEY SILTY SAND - Grey clayey silty sand with some clay, saturated, trace organics		A	1.2			
-1	2							
	2.0	Bore discontinued at 2.0m, collapse						
-2	3							
-3	4							
	5							

Dynamic Penetrometer Test (blows per 150mm)
5 10 15 20

RIG: Hand Tools **DRILLER:** Musgrove **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: 90mm hand auger

WATER OBSERVATIONS: Free groundwater at surface ~150mm

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 3.48 AHD
EASTING: 363582
NORTHING: 1366920
DIP/AZIMUTH: 90°/--

BORE No: TP24
PROJECT No: 39798
DATE: 22 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		SILTY CLAY - Firm, grey-brown silty clay, some organics, M>>Wp		A	0.4				
	0.6	SILTY SAND - Grey (firm), mottled orange silty sand with some clay, saturated		A	0.7				
				A	0.9				
				A	1.6				
	2.0	Bore discontinued at 2.0m, collapse							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** Musgrove **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: 90mm hand auger

WATER OBSERVATIONS: Free groundwater at surface

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 1.33 AHD
EASTING: 363505
NORTHING: 1367105
DIP/AZIMUTH: 90°/--

BORE No: TP25
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	SILTY SAND: Brown, fine grained silty sand, moist			0.0				
		SANDY CLAY: Firm, brown, fine grained sandy clay, M>Wp		B	0.5				
				S			1,3,2 N = 5	▼	
	0.8	SILTY SAND: Loose, brown, fine grained silty sand some clay, saturated			0.95				
					1.0				
				A	1.14				
					1.5				
				S			2,3,5 N = 8		
					1.95				
		From 2.3m depth, very loose with shell fragments between 2.4m to 2.5m		A	2.4				
					3.0				
				S			under hammer		
					3.45				
				A	3.9				
	4.0	Bore discontinued at 4.0m, limit of investigation							

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.8m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED	
Initials:	
Date:	

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Woodland Close

SURFACE LEVEL: 1.42 AHD
EASTING: 363424
NORTHING: 1367277
DIP/AZIMUTH: 90°/--

BORE No: TP26
PROJECT No: 39798
DATE: 19 Sep 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.4	FILLING - Grey clayey gravelly sand filling, dry to moist (gravel containing slog)							
	0.7	FILLING - Brown clayey gravelly sand (ash), moist							
	1.3	FILLING - Stiff grey mottled orange brown clay filling, some silt, M>Wp from 1.0 m moisture content increasing with strength							
	1.5	FILLING - Stiff orange brown gravelly clay filling							
		Bore discontinued at 1.5m, due to potential service							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** McFarlane **LOGGED:** McFarlane **CASING:** Uncased

TYPE OF BORING: 90 mm diameter hand auger

WATER OBSERVATIONS: No Free Ground Water Observed

REMARKS: Adjacent to access load, 10m south of peg

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 1.77 AHD
EASTING: 364225
NORTHING: 1364963
DIP/AZIMUTH: 90°/--

BORE No: TP27
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	FILLING: Dark grey/black, fine gravelly fine to coarse sand (coal reject) some silt, humid		A,PID	0.4		<1ppm 6,bounce,ref		
				S	0.5		refusal		
	1.0				1.0				
				B A,PID	1.3		<1 ppm	▼	
	1.5	SILTY CLAY: Soft to firm, grey silt clay, M>Wp			1.5				
				S			1,1,2 N = 3		
				pp	1.95		100-150kPa		
	2.1	CLAYEY SILTY SAND: Very soft, grey, fine grained clayey silty sand, saturated		A	2.4				
		decreasing clay from 2.5m depth		A	2.9				
	3.0				3.0				
				S			0,0,1 N = 1 hammer under pressure		
					3.45				
					4.5				
				S			0,0,1 N = 1		
	4.95	Bore discontinued at 4.95m, limit of investigation			4.95				

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.3m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 3.05 AHD
EASTING: 364053
NORTHING: 1365366
DIP/AZIMUTH: 90°/--

BORE No: TP28
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
3		FILLING: Dark grey/black, fine to medium gravelly fine to coarse grained sand (coal reject), humid		A,PID	0.1		<1ppm		
	0.3	FILLING: Orange, fine gravelly, fine to coarse sand (roadbase)							
	0.5	FILLING: Dark grey, fine to medium grained sand, some site, moist							
2	1			A,PID	1.0		<1ppm		1
	1.3	FILLING: Grey/brown, fine to medium gravelly clay, M>Wp							
				A,PID	1.5		<1ppm	▼	
				S			7,7,9 N = 16		
1	2				1.95				2
				A,PID	2.5		<1ppm		
	2.7	SILTY CLAY: Firm to stiff, grey silty clay, M>Wp							
0	3				3.0				3
				S			3,7/100,ref refusal bouncing on backfill		
					3.25				
				pp	3.3		120-140kPa		
	3.8	SANDY SILT: Very soft to soft grey, fine grained sandy silt, saturated							
-1	4								4
					4.5				
				S					
-2	4.95	Bore discontinued at 4.95m, limit of investigation			4.95				5
	5								

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.5m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED	
Initials:	
Date:	

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 3.76 AHD
EASTING: 363920
NORTHING: 1365716
DIP/AZIMUTH: 90°/--

BORE No: TP29
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILLING: Brown silty fine to coarse sand with some low to medium dark grey/black gravelly sand (coal reject), humid		A,PID	0.4		<1ppm		
	0.8	FILLING: Dark grey/black, fine to medium gravelly fine to coarse sand (coal reject), moist		A,PID	0.9		<1ppm		
				A,PID	1.4		<1ppm		
					1.5				
				S			2,2,3 N = 5		
					1.95				
				A,PID	2.4		<1ppm	▼	
				A,PID	2.9		<1ppm		
					3.0				
				S			1,1,2 N = 3		
					3.45				
	4.2	SILTY CLAY: Firm, grey silty clay, M>Wp							
		From 4.5m depth, firm/stiff		pp	4.5		110-140kPa		
				S			1,2,3 N = 5		
	4.95	From 4.9m depth, firm		pp	4.9		70-90kPa		
		Bore discontinued at 4.95m, limit of investigation			4.95				

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 2.3m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 1.76 AHD
EASTING: 363764
NORTHING: 1366115
DIP/AZIMUTH: 90°/--

BORE No: TP30
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	SILTY SAND: Brown, fine to medium grained silty sand, damp to moist							
		SANDY CLAY: Firm, brown fine grained sandy clay some silt, M>Wp		A	0.4				
					0.5				
				S			2,2,3 N = 5		
					0.95				
	1.1	CLAY: Very soft to soft, grey clay, M>Wp							
				A,pp	1.4		<50-70kPa		
					1.5				
	1.6	SILTY SAND: Very loose, grey mottled orange silty fine grained sand, saturated		S			weight of hammer	▼	
					1.95				
	2.3								
		CLAYEY SILT: Very soft grey clayey silt, some fine grained sand and abundant shells, saturated		A	2.4				
					3.0				
				S			weight of hammer		
					3.45				
					4.5				
				S			weight of hammer		
	4.95				4.95				
		Bore discontinued at 4.95m, limit of investigation							

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.7m

REMARKS: 10m west of pegged location

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 1.30 AHD
EASTING: 363743
NORTHING: 1366178
DIP/AZIMUTH: 90°/--

BORE No: TP31
PROJECT No: 39798
DATE: 22 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
1		FILLING - Generally comprising dark grey-black fine to coarse sandy fine to medium gravel (coal reject), wet to saturated						▼	
0	1.0	SILTY CLAY - (Firm to stiff), grey mottled orange silty clay, M>>Wp		A	1.3				1
		from 1.5m, stiff		A,pp	1.5		100-160 kPa		
				A	1.8				
-1	1.9	Bore discontinued at 1.9m, limit of investigation							2
-2	2								3
-3	3								4
	4								5
	5								

RIG: Hand Tools **DRILLER:** Musgrove **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: 90mm hand auger

WATER OBSERVATIONS: Free groundwater at 0.4m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 0.66 AHD
EASTING: 363604
NORTHING: 1366467
DIP/AZIMUTH: 90°/--

BORE No: TP32
PROJECT No: 39798
DATE: 22 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
0	0.4	CLAYEY SILT - Grey-brown clayey silt, some organics, M>Wp, saturated						▼	
	1	SILTY CLAY - Firm to stiff, grey silty clay, M>Wp		A,pp	0.5		110-140 kPa		
	1.3	SILTY SAND - Grey mottled orange silty sand, saturated							
-1	1.4	Bore discontinued at 1.4m, due to hole collapse							
-2	2								
-3	3								
-4	4								
	5								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** Musgrove **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: 90mm hand auger

WATER OBSERVATIONS: Free groundwater at surface ~150mm

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 0.54 AHD
EASTING: 363666
NORTHING: 1366490
DIP/AZIMUTH: 90°/--

BORE No: TP33
PROJECT No: 39798
DATE: 22 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
0	0.3	CLAYEY SILT - Grey-brown clayey silt, some organics, M>Wp, saturated							
		SILTY CLAY - Firm to stiff, grey silty clay, M>Wp		A,pp	0.5		90-130 kPa		
1	1.0	SILTY SAND - Grey mottled orange silty sand, saturated							
	1.1	Bore discontinued at 1.1m, due to hole collapse							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** Musgrove **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: 90mm hand auger

WATER OBSERVATIONS: Free groundwater at surface ~200mm

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: --
EASTING: 363632
NORTHING: 1366677
DIP/AZIMUTH: 90°/--

BORE No: TP34
PROJECT No: 39798
DATE: 06 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILLING: Grey/orange, fine to coarse gravelly fine to coarse grained sand (roadbase, humid							
	0.7	CLAY: Fimr to soft, grey clay, M>Wp		B	0.7				
1				pp	1.0		100-150kPa		1
	1.1	SILTY CLAY: Very soft, grey silty clay, saturated		A,pp	1.3		<50-70kPa		
					1.5				
				S			weight of hammer		
2					1.95				2
				A	2.4				
3					3.0				3
				S			weight of hammer		
					3.45				
4	4.0	CLAYEY SILT: Very soft grey clayey silt, abundant shells, saturated							4
					4.5				
				S			weight of hammer		
5	4.95	Bore discontinued at 4.95m, limit of investigation			4.95				5

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.5m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Woodland Close

SURFACE LEVEL: 1.07 AHD
EASTING: 363538
NORTHING: 1366848
DIP/AZIMUTH: 90°/--

BORE No: TP35
PROJECT No: 39798
DATE: 19 Sep 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
1	0.3	TOPSOIL - Dark grey silty clay topsoil, some rootlets, moist							
	0.5	CLAYEY SILT - Firm to stiff brown mottled orange brown clayey sit, some fine sand							
	0.9	CLAYEY SAND - Firm to stiff light grey mottled orange brown clayey sand						▼	
0	1	SAND - Loose to medium dense light grey mottled orange brown sand, some clay, saturated							1
	1.2	SANDY CLAY - Firm light grey mottled orange brown sandy clay, M>Wp							
	1.3	CLAYEY SAND - Light grey mottled orange brown clayey sand, saturated							
	1.9	Bore discontinued at 1.9m							
-1	2								2
-2	3								3
-3	4								4

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** McFarlane **LOGGED:** McFarlane **CASING:** Uncased

TYPE OF BORING: 90 mm diameter hand auger

WATER OBSERVATIONS: Free Ground Water Observed at 0.8 m depth

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 1.22 AHD
EASTING: 363507
NORTHING: 1367026
DIP/AZIMUTH: 90°/--

BORE No: TP36
PROJECT No: 39798
DATE: 07 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	SILTY SAND: Brown, fine grained silty sand, moist			0.1				
		SANDY CLAY: Stiff, brown, fine grained sandy clay, M>Wp			0.3				
				S			3,4,4		
				B			N = 8		
				pp	0.95		130-150kPa		
	1.2				1.0			▼	
		SAND: Very loose to loose, brown sand with abundant shells, some clay, saturated		A	1.4				
					1.5				
				S					
					1.95				
	2.2	SILTY SAND: Very loose to loose, grey silty sand, abandant shells, saturated		A	2.5				
					3.0				
				S			under hammer		
					3.45				
		with some clay from 3.5m depth							
	4.0	Bore discontinued at 4.0m, limit of investigation		A	4.0				

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.2m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Off Woodlands Close, Hexham

SURFACE LEVEL: 1.29 AHD
EASTING: 363449
NORTHING: 1367181
DIP/AZIMUTH: 90°/--

BORE No: TP37
PROJECT No: 39798
DATE: 07 Aug 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	FILLING: Intermixed dark grey black gravelly, fine to coarse sand (coal reject) and brown, fine to medium grained silty sand, humid		A,PID	0.4		<1ppm		
					0.5				
				S			3,5,3 N = 8		
					0.95				
	1.1	CLAY: Very soft to firm, grey clay, some silt, M>Wp						▼	
				A	1.4				
	1.5	CLAYEY SILT: Very soft, grey clayey silt, some fine grained sand, abundant shells, saturated		A,pp	1.5		70-90kPa		
				S			0,0,1 N = 1		
					1.95				
				A	2.4				
					3.0				
				A					
					3.45				
					3.9				
	4.0	Bore discontinued at 4.0m, limit of investigation							

RIG: 4WD Mounted Drill Rig **DRILLER:** Atkins (Foody) **LOGGED:** Rice **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.1m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Woodland Close

SURFACE LEVEL: 0.21 AHD
EASTING: 363347
NORTHING: 1367365
DIP/AZIMUTH: 90°/--

BORE No: TP38
PROJECT No: 39798
DATE: 19 Sep 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
0	0.15	CLAYEY SILT - Firm brown grey clayey silt, some organics, M>Wp							
		CLAY - Firm to stiff grey mottled orange brown clay		A	0.25			▼	
		from 0.6 m soft to firm grey mottled orange brown							
		from 0.7 m soft		A	0.9				
-1	1								1
				A	1.3				
	2.0	Bore discontinued at 2.0m							
-2	2								2
-3	3								3
-4	4								4

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** McFarlane **LOGGED:** McFarlane **CASING:** Uncased

TYPE OF BORING: 90 mm diameter hand auger

WATER OBSERVATIONS: Sepage from 0.6 m

REMARKS: Adjacant to Drain (0.5 m higher than water)

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Woodland Close

SURFACE LEVEL: 0.87 AHD
EASTING: 362895
NORTHING: 1367574
DIP/AZIMUTH: 90°/--

BORE No: TP39
PROJECT No: 39798
DATE: 19 Sep 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
0	0.15	TOPSOIL - Dark grey silty clay, topsoil, some rootlets, moist							
		CLAY - Stiff light grey mottled orange brown clay M>Wp							
	0.5	CLAYEY SAND - Stiff brown mottled orange brown clayey soil, moist						▼	
-1	1.5	SANDY CLAY - Soft grey mottled orange brown sandy clay, M>>Wp							
	1.8	SILTY CLAY - Soft grey silty clay, some sand M>>Wp							
-2	2.0	Bore discontinued at 2.0m							
-3									
-4									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** McFarlane **LOGGED:** McFarlane **CASING:** Uncased

TYPE OF BORING: 90 mm diameter hand auger

WATER OBSERVATIONS: Free Ground Water Observed at 0.8 m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Proposed Maintenance Facility
LOCATION: Woodland Close

SURFACE LEVEL: 0.76 AHD
EASTING: 362517
NORTHING: 1367641
DIP/AZIMUTH: 90°/--

BORE No: TP40
PROJECT No: 39798
DATE: 19 Sep 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
0	0.1	TOPSOIL - Dark grey clay with sone silt and rootlets, moist							
		CLAY - Stiff dark grey clay, some silt< M>Wp from 1.2 m with some shells / shell fragments							
		from 0.4 m light grey mottled orange brown						▼	
		from 0.6 m sand content increasing, becoming firm							
	0.7	SANDY SILTY CLAY - Firm to stiff grey sandy silty clay, M>Wp							
-1		from 1.5 m abundant shells							
-2	2.0	Bore discontinued at 2.0m							
-3									
-4									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** McFarlane **LOGGED:** McFarlane **CASING:** Uncased

TYPE OF BORING: 90 mm diameter hand auger

WATER OBSERVATIONS: Free Ground Water Observed at 0.5 m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

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Initials:
Date:

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RESULTS OF DYNAMIC PENETROMETER TESTS

CLIENT	Queensland Rail	DATE	6.8.07– 19.09.07
PROJECT	Proposed Maintenance Facility	PROJECT NO	39798
LOCATION	Off Woodlands Close, Hexham	PAGE NO	Page 1 of 3

TEST LOCATIONS	TP14	TP16	TP18	TP21	TP22	TP23	TP24	TP25	TP26	TP27
RL OF TEST	1.53	2.34	2.21	1.51	0.72	1.07	3.48	1.33	1.42	1.77
DEPTH m	**PENETRATION RESISTANCE** BLOWS/150mm									
0.00 - 0.15	15	7	3	3	0	1	0	3	-	7
0.15 - 0.30	12	bouncing	3	5	2	1	2	5	-	8
0.30 - 0.45	20		3	3	1	2	3	4	10	13
0.45 - 0.60	ref		19	3	3	3	2	3	6	7
0.60 - 0.75			20/100	4	2	3	4	3	4	8
0.75 - 0.90			ref	6	2	8	5	4	4	20
0.90 - 1.05				4	7	6	5	4	4	ref
1.05 - 1.20					9		5			
1.20 - 1.35					9					
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										

TEST METHOD AS 1289.6.3.2, CONE PENETROMETER ☑
AS 1289.6.3.3, FLAT END PENETROMETER ☐

TESTED BY: BRR/SAM
CHECKED BY:

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RESULTS OF DYNAMIC PENETROMETER TESTS

CLIENT	Queensland Rail	DATE	6.8.07 – 19.09.07
PROJECT	Proposed Maintenance Facility	PROJECT NO	39798
LOCATION	Off Woodlands Close, Hexham	PAGE NO	Page 2 of 3

TEST LOCATIONS	TP28	TP29	TP30	TP31	TP32	TP33	TP34	TP35	TP36	TP37
RL OF TEST	3.05	3.76	1.76	1.3	0.66	0.54	-	1.07	1.22	1.29
DEPTH m	**PENETRATION RESISTANCE** BLOWS/150mm									
0.00 - 0.15	12	8	3	3	1	1	3	1	3	10
0.15 - 0.30	11	9	3	9	1	2	3	1	4	10
0.30 - 0.45	9	20	2	8	2	2	3	3	3	10
0.45 - 0.60	8	ref	3	9	2	2	2	4	3	10
0.60 - 0.75	9		4	12	3	3	5	6	4	10
0.75 - 0.90	11		6	4	4	3	5	10	2	8
0.90 - 1.05	9		7	4			5	5	6	4
1.05 - 1.20	8			4			6	4	9	3
1.20 - 1.35										
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										

TEST METHOD AS 1289.6.3.2, CONE PENETROMETER ☑
AS 1289.6.3.3, FLAT END PENETROMETER ☐

TESTED BY: BRR/SAM
CHECKED BY:

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RESULTS OF DYNAMIC PENETROMETER TESTS

CLIENT	Queensland Rail	DATE	6.8.07 – 19.09.07
PROJECT	Proposed Maintenance Facility	PROJECT NO	39798
LOCATION	Off Woodlands Close, Hexham	PAGE NO	Page 3 of 3

TEST LOCATIONS	TP38	TP39	TP40							
RL OF TEST	0.21	0.87	0.76							
DEPTH m	**PENETRATION RESISTANCE** BLOWS/150mm									
0.00 - 0.15	2	1	2							
0.15 - 0.30	1	3	1							
0.30 - 0.45	1	5	2							
0.45 - 0.60	1	8	4							
0.60 - 0.75	2	9	5							
0.75 - 0.90	1	10	8							
0.90 - 1.05	1	9	8							
1.05 - 1.20		7	8							
1.20 - 1.35										
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										

TEST METHOD AS 1289.6.3.2, CONE PENETROMETER ☑
AS 1289.6.3.3, FLAT END PENETROMETER ☐

TESTED BY: BRR/SAM
CHECKED BY:

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Appendix C

Geotechnical Laboratory Test Results

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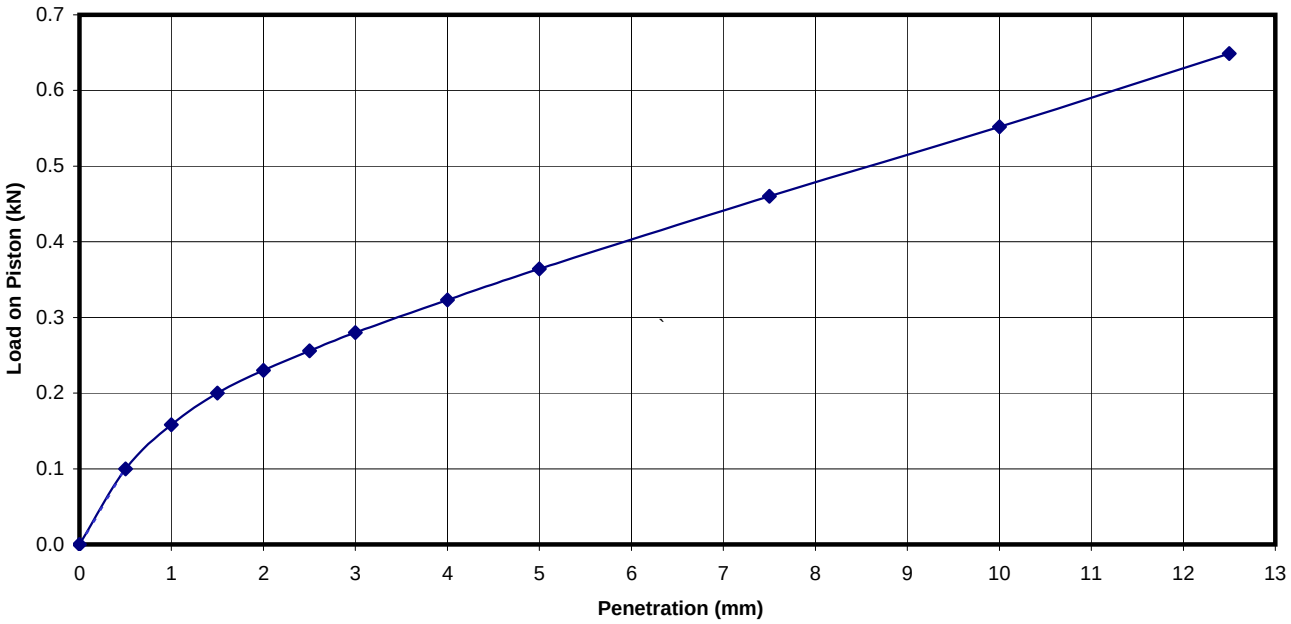
RESULT OF CALIFORNIA BEARING RATIO TEST

Client :	Queensland Rail	**Project No. :**	39798
		Report No. :	N07-179g
Project :	Preliminary Geotechnical Investigation	**Report Date :**	12/09/2007
		Date Sampled :	6/08/2007
Location :	Woodlands Close, Hexham	**Date of Test:**	8/09/2007
Test Location :	TP 36		
Depth / Layer :	0.1-1.0m	**Page:**	1 of 1



Description: Sandy CLAY - Dark brown

Test Method(s): AS 1289.6.1.1-1998, AS 1289.2.1.1-2005

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001 **Percentage > 19mm:** 0.0%

LEVEL OF COMPACTION: 100% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 2.0%
MOISTURE RATIO: 100% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		25.4	1.49
After soaking		27.7	1.46
After test	Top 30mm of sample	32.6	-
	Remainder of sample	26.8	-
Field values		28.5	-
Standard Compaction		25.5	1.50

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**2.0**
	5.0 mm	**2.0**

NATA Accredited Laboratory Number: 828
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Approved Signatory:

Tested:	MG
Checked:	DM

Dave Millard
Laboratory Manager

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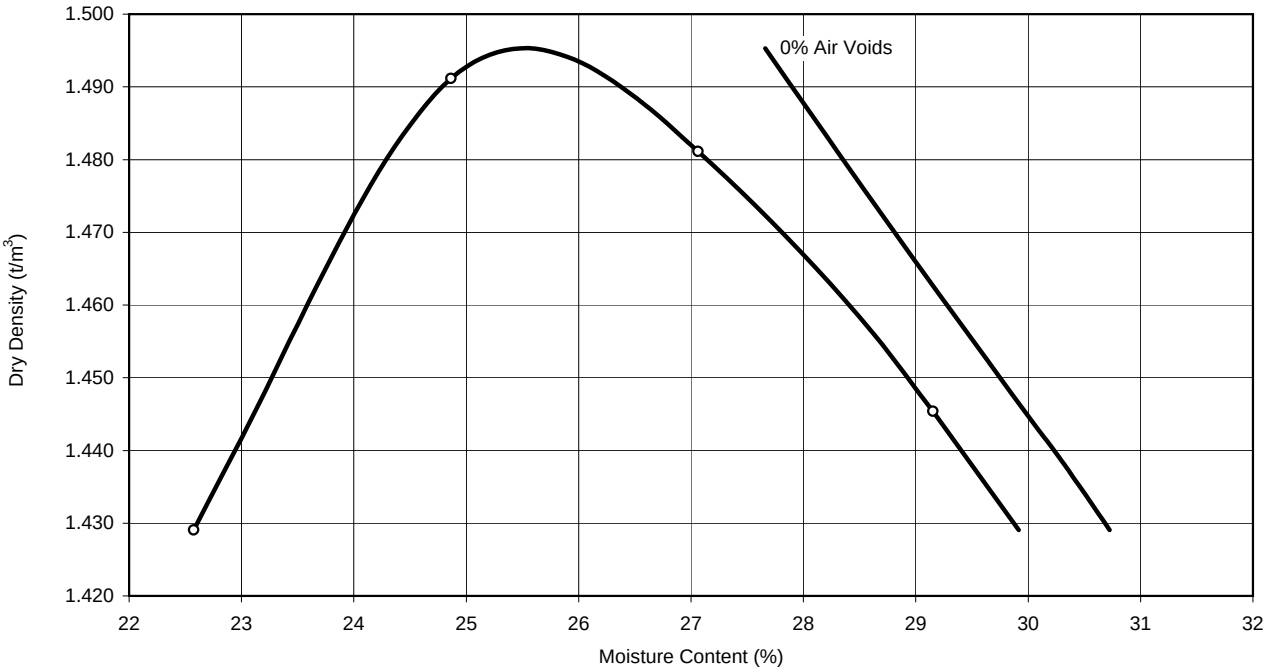
RESULTS OF COMPACTION TEST

Client :	Queensland Rail	**Project No. :**	39798
		Report No. :	N07-179f
Project :	Preliminary Geotechnical Investigation	**Report Date :**	12/09/2007
Location :	Woodlands Close, Hexham	**Date of Test:**	28/08/2007
		Page:	1 of 1



Sample Details **Location:** TP 36
Depth: 0.1-1.0m

Particles > 19mm: 0%

Description: Sandy CLAY - Dark brown

Maximum Dry Density:	**1.50 t/m^3**
Optimum Moisture Content:	**25.5 %**

Remarks:

Test Methods: AS 1289.5.1.1-2003 (STD), AS 1289.2.1.1-2005

Sampling Methods: AS 1289.1.1.1-1998, AS1289.1.2.1-2001

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Approved Signatory:

Tested:	BB
Checked:	DM

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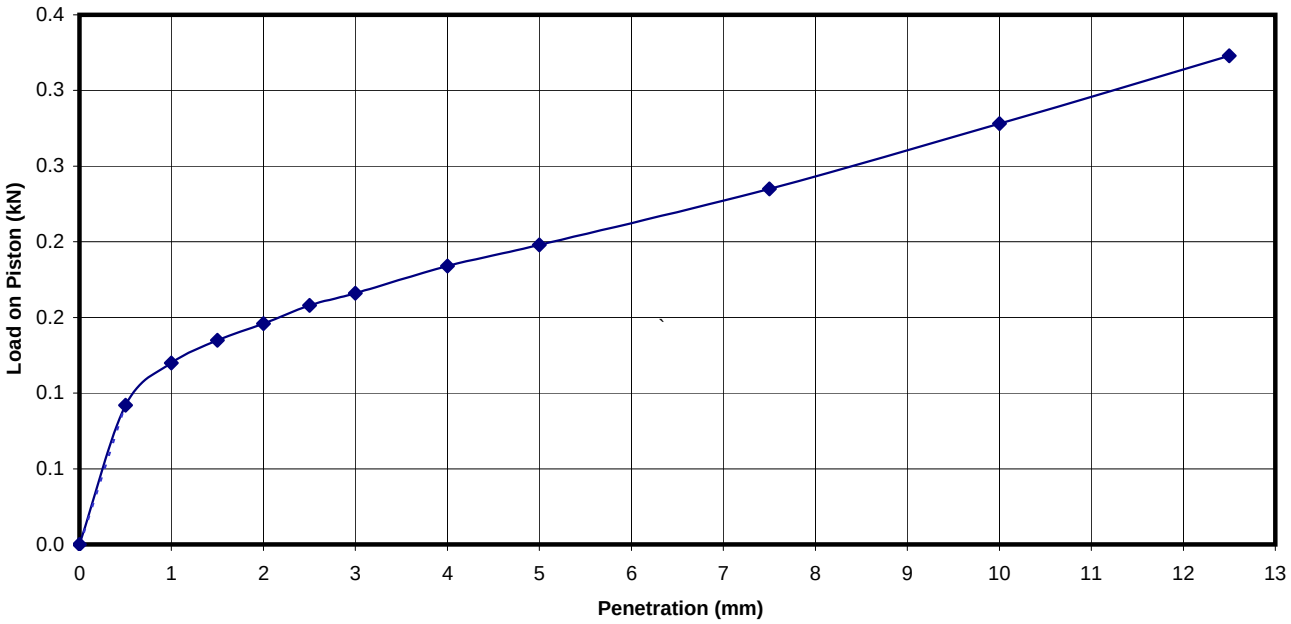
RESULT OF CALIFORNIA BEARING RATIO TEST

Client :	Queensland Rail	**Project No. :**	39798
		Report No. :	N07-179e
Project :	Preliminary Geotechnical Investigation	**Report Date :**	12/09/2007
		Date Sampled :	6/08/2007
Location :	Woodlands Close, Hexham	**Date of Test:**	8/09/2007
Test Location :	TP 34		
Depth / Layer :	0.7-1.0m	**Page:**	1 of 1



Description: Silty CLAY - Dark grey/brown

Test Method(s): AS 1289.6.1.1-1998, AS 1289.2.1.1-2005

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001 **Percentage > 19mm:** 0.0%

LEVEL OF COMPACTION: 100% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 4.0%
MOISTURE RATIO: 99% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		34.2	1.32
After soaking		39.5	1.27
After test	Top 30mm of sample	48.4	-
	Remainder of sample	35.1	-
Field values		51.4	-
Standard Compaction		34.5	1.32

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**1.0**
	5.0 mm	**1.0**

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Approved Signatory:

Tested:	MG
Checked:	DM

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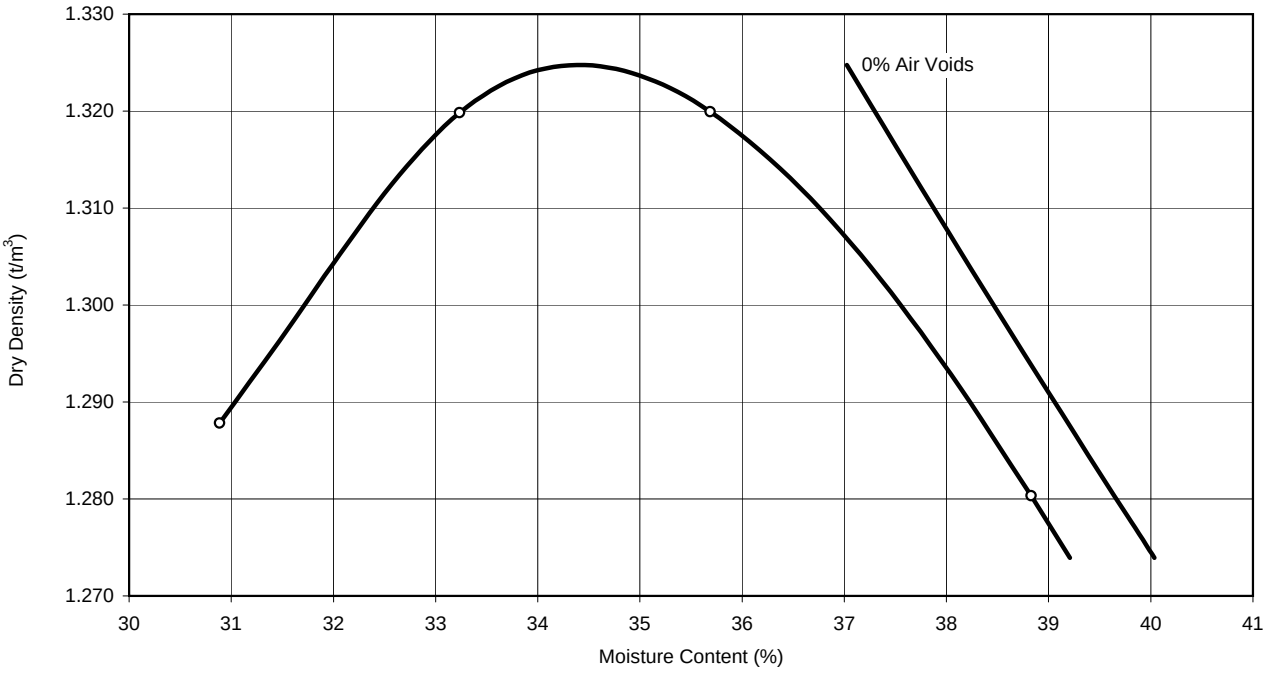
RESULTS OF COMPACTION TEST

Client :	Queensland Rail	**Project No. :**	39798
		Report No. :	N07-179d
Project :	Preliminary Geotechnical Investigation	**Report Date :**	12/09/2007
Location :	Woodlands Close, Hexham	**Date of Test:**	28/08/2007
		Page:	1 of 1



Sample Details **Location:** TP 34
Depth: 0.7-1.0m

Particles > 19mm: 0%

Description: Silty CLAY - Dark grey/brown

Maximum Dry Density:	**1.32 t/m^3**
Optimum Moisture Content:	**34.5 %**

Remarks:

Test Methods: AS 1289.5.1.1-2003 (STD), AS 1289.2.1.1-2005

Sampling Methods: AS 1289.1.1.1-1998, AS1289.1.2.1-2001

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Approved Signatory:

Tested:	BB
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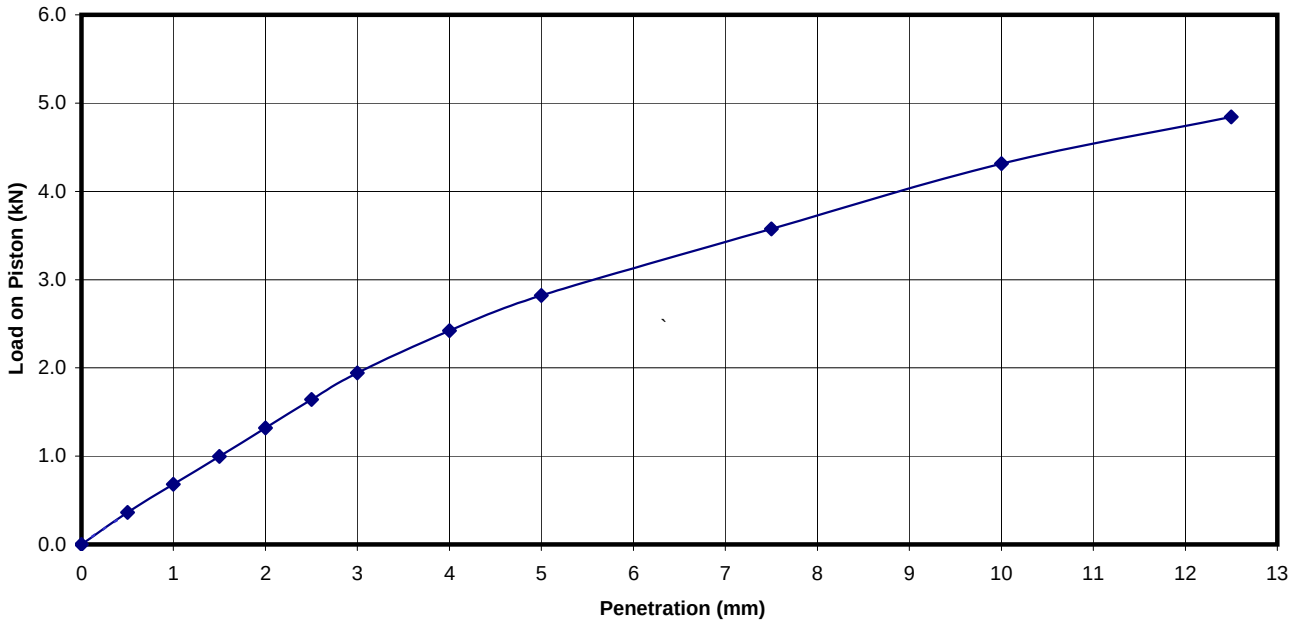
RESULT OF CALIFORNIA BEARING RATIO TEST

Client :	Queensland Rail	**Project No. :**	39798
		Report No. :	N07-179c
Project :	Preliminary Geotechnical Investigation	**Report Date :**	12/09/2007
		Date Sampled :	6/08/2007
Location :	Woodlands Close, Hexham	**Date of Test:**	8/09/2007
Test Location :	TP 27		
Depth / Layer :	1.0-1.5m	**Page:**	1 of 1



Description: Gravelly CLAY - Dark grey (Coal Chitter)

Test Method(s): AS 1289.6.1.1-1998, AS 1289.2.1.1-2005

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001 **Percentage > 19mm:** 0.0%

LEVEL OF COMPACTION: 100% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** -0.1%
MOISTURE RATIO: 99% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		14.8	1.48
After soaking		16.1	1.48
After test	Top 30mm of sample	17.9	-
	Remainder of sample	15.1	-
Field values		20.7	-
Standard Compaction		15.0	1.48

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**12**
	5.0 mm	**14**

NATA Accredited Laboratory Number: 828
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Approved Signatory:

Tested:	MG
Checked:	DM

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Laboratory Manager

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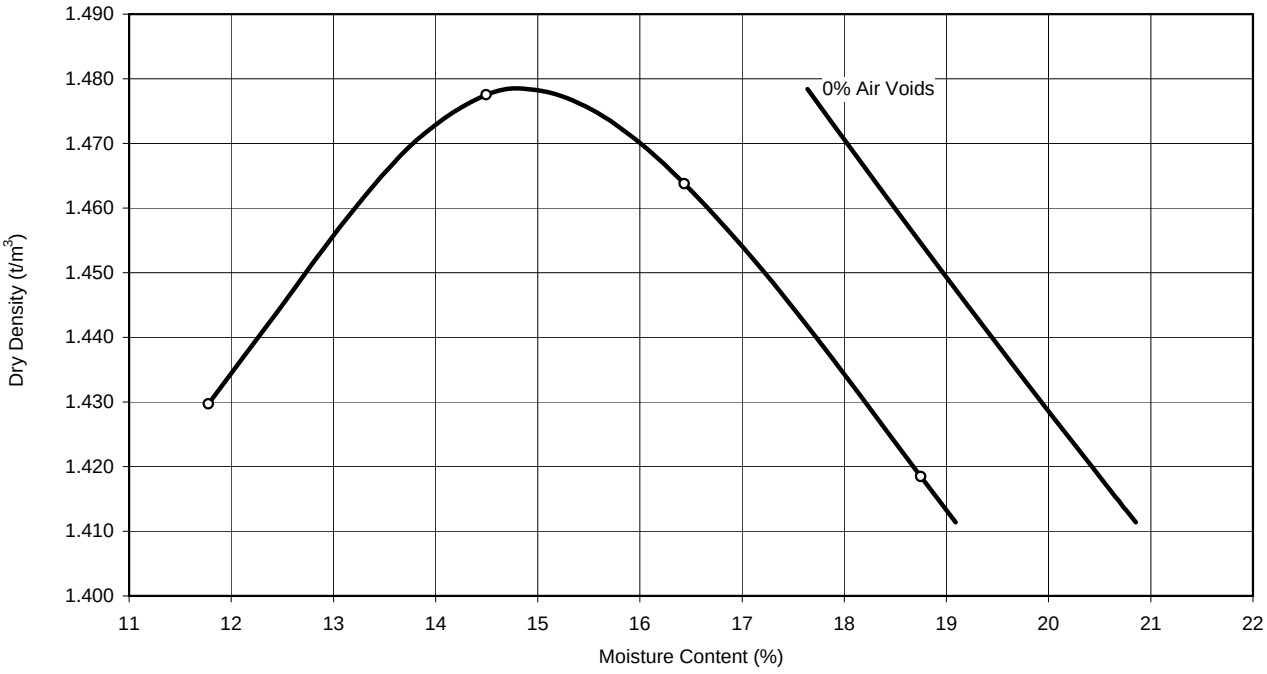
RESULTS OF COMPACTION TEST

Client :	Queensland Rail	**Project No. :**	39798
		Report No. :	N07-179b
Project :	Preliminary Geotechnical Investigation	**Report Date :**	12/09/2007
Location :	Woodlands Close, Hexham	**Date of Test:**	30/08/2007
		Page:	1 of 1



Sample Details **Location:** TP 27
Depth: 1.0-1.5m

Particles > 19mm: 15%

Description: Gravelly CLAY - Dark grey (Coal Chitter)

Maximum Dry Density:	**1.48 t/m^3**
Optimum Moisture Content:	**15.0 %**

Remarks:

Test Methods: AS 1289.5.1.1-2003 (STD), AS 1289.2.1.1-2005

Sampling Methods: AS 1289.1.1.1-1998, AS1289.1.2.1-2001

NATA Accredited Laboratory Number: 828
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Approved Signatory:

Tested:	BB
Checked:	DM

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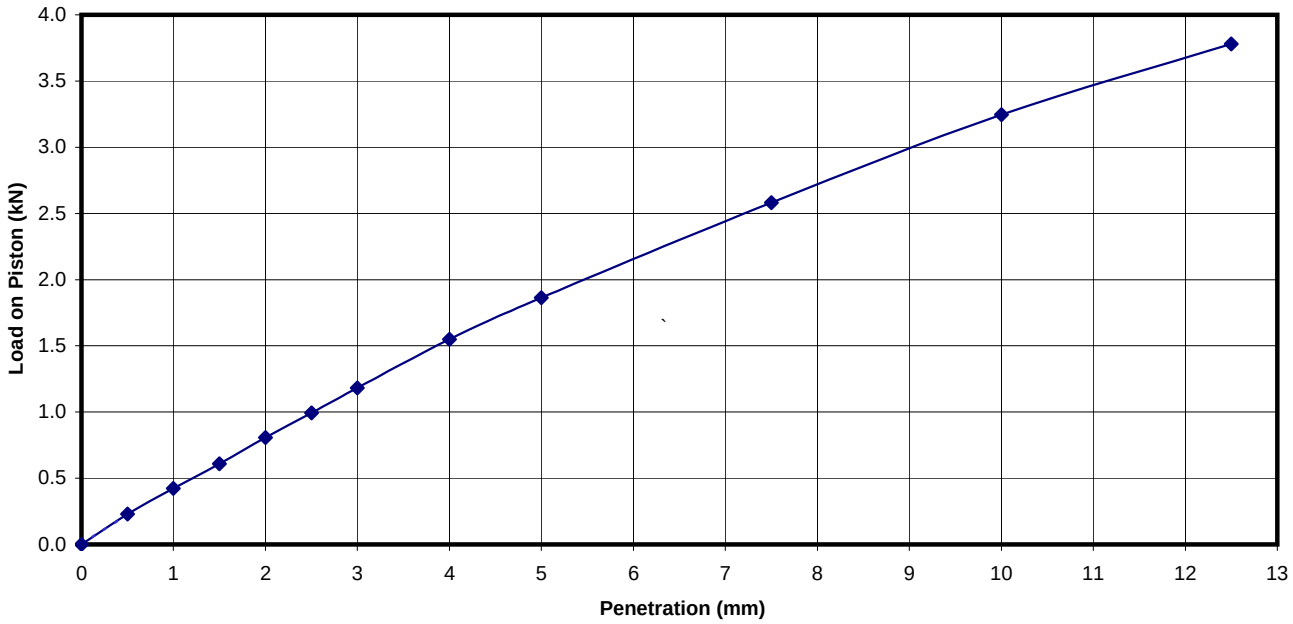
RESULT OF CALIFORNIA BEARING RATIO TEST

Client :	Queensland Rail	**Project No. :**	39798
		Report No. :	N07-179a
Project :	Preliminary Geotechnical Investigation	**Report Date :**	12/09/2007
		Date Sampled :	6/08/2007
Location :	Woodlands Close, Hexham	**Date of Test:**	8/09/2007
Test Location :	TP 18		
Depth / Layer :	0.0-1.0m	**Page:**	1 of 1



Description: Coal Rejects

Test Method(s): AS 1289.6.1.1-1998, AS 1289.2.1.1-2005

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001 **Percentage > 19mm:** 0.0%

LEVEL OF COMPACTION: 100% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** -0.1%
MOISTURE RATIO: 99% of STD OMC **SOAKING PERIOD:** 4 days

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		13.4	1.58
After soaking		14.8	1.58
After test	Top 30mm of sample	16.3	-
	Remainder of sample	14.6	-
Field values		11.7	-
Standard Compaction		13.5	1.58

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**8**
	5.0 mm	**9**

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	MG
Checked:	DM

Dave Millard
Laboratory Manager

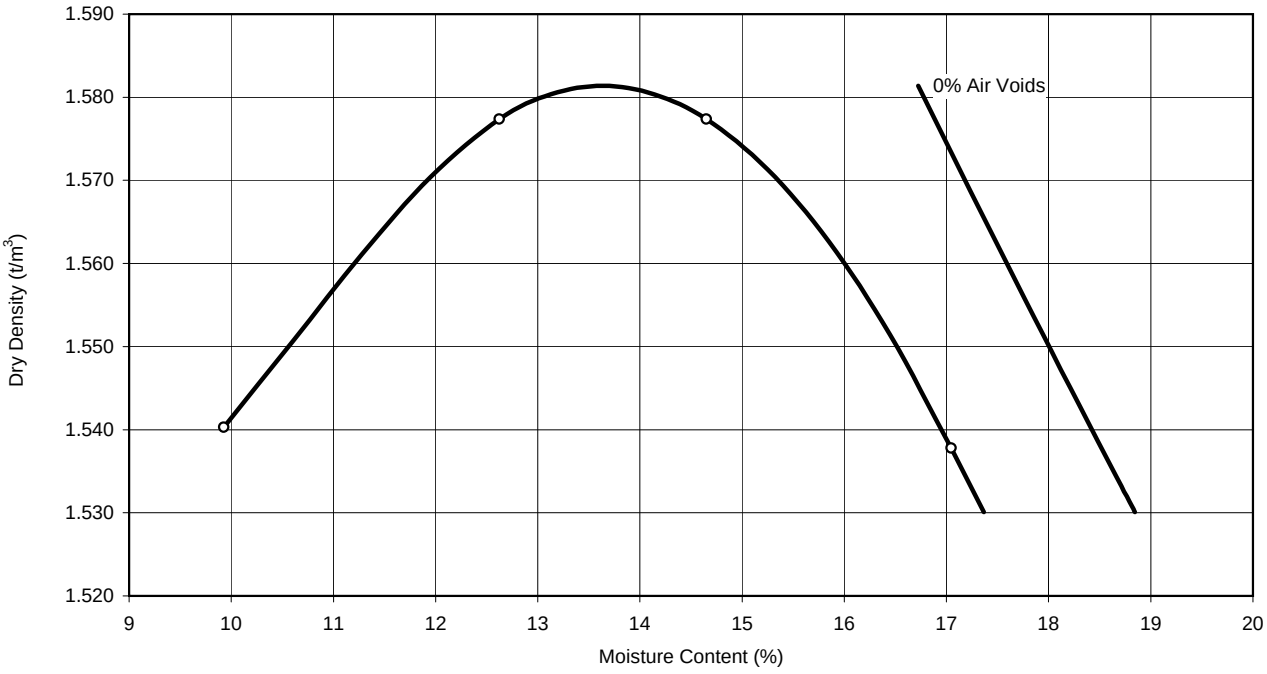
Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304
Phone (02) 4960 9600
Fax: (02) 4960 9601
newcastle@douglaspartners.com.au

RESULTS OF COMPACTION TEST

Client :	Queensland Rail	**Project No. :**	39798
		Report No. :	N07-179
Project :	Preliminary Geotechnical Investigation	**Report Date :**	12/09/2007
Location :	Woodlands Close, Hexham	**Date of Test:**	27/08/2007
		Page:	1 of 1



Sample Details **Location:** TP 18
Depth: 0.0-1.0m

Particles > 19mm: 0%

Description: Coal Rejects

Maximum Dry Density:	**1.58 t/m^3**
Optimum Moisture Content:	**13.5 %**

Remarks:

Test Methods: AS 1289.5.1.1-2003 (STD), AS 1289.2.1.1-2005

Sampling Methods: AS 1289.1.1.1-1998, AS1289.1.2.1-2001

NATA Accredited Laboratory Number: 828
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Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	BB
Checked:	DM

Dave Millard
Laboratory Manager

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Phone (02) 4960 9600
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newcastle@douglaspartners.com.au

RESULTS OF MOISTURE CONTENT, PLASTICITY AND LINEAR SHRINKAGE TESTS

Client: **Queensland Rail**

Project: Preliminary Geotechnical Investigation

Location: Woodlands Close, Hexham

Project No: 39798
Report No: N07-179h
Report Date: 12/9/2007

Date Sampled: 6/8/2007
Date of Test: 6/9/2007
Page: 1 of 1

TEST LOCATION	DEPTH (m)	DESCRIPTION	CODE	W_F %	W_L %	W_P %	PI %	*LS %
TP 16	2.3	Silty CLAY - Dark brown	2,5	41.9	56	25	31	14.0 (CU)
TP 21	1.5-1.95	Silty CLAY - Brown	2,5	41.1	44	23	21	12.0
TP 37	3.9	Sandy SILT - Grey black	2,5	37.0	-	-	N/P	-

Legend:
W_F Field Moisture Content
W_L Liquid limit
W_P Plastic limit
PI Plasticity index
LS Linear shrinkage from liquid limit condition (Mould length 125mm)

Test Methods:
Moisture Content: AS 1289 2.1.1 - 2005
Liquid Limit: AS 1289 3.1.2 - 1995
Plastic Limit: AS 1289 3.2.1 - 1995
Plasticity Index: AS 1289 3.3.1 - 1995
Linear Shrinkage: AS 1289 3.4.1 - 1995

Code
Sample history for plasticity tests
1. Air dried
2. Low temperature (<50ºC) oven dried
3. Oven (105ºC) dried
4. Unknown

Method of preparation for plasticity tests
5. Dry sieved
6. Wet sieved
7. Natural

*Specify if sample crumbled CR or curled CU

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Remarks:

Approved Signatory:

Tested: LB
Checked: DM

D Millard
Laboratory Manager

NATA Accredited Laboratory Number: 828

This Document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025

Appendix D

Analytical Laboratory Test Results
Chain of Custody Forms
Quality Assurance / Quality Control

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CHAIN OF CUSTODY DESPATCH SHEET

Project Name: Hexham Preliminary Geotechnical Investigation
Project No: 39798 DP Order No: 67344
DP Contact Person: S McFarlane
Prior Storage: esky / fridge / shelved (circle) ... Freezer

To: ALS PTY LTD
5 Rosegum Close
Warabrook NSW 2304
Ph: (02) 4968 9433
Attn: Ken Reid

	Sample ID	Date Sampled	Sample Type S-soil W-water	Lab ID	Analytes: TPA	TAA	Scr											TCLP	Notes
1	14/2-4	6.08.07	S		✓	✓	✓												
2	16/3.0-3.45	6.08.07	S		↓	↓	↓												
3	27/1.5-1.95	6.08.07	S																
4	28/3.3	6.08.07	S																
5	30/0.4	6.08.07	S																
PQL (S)			mg/kg																
PQL (W)			mg/L																

Environmental Division
Brisbane
Work Order
EB0709130

Telephone : +61-7-3243 7222

PQL = practical quantitation limit *As per Laboratory Method (Detection Limit)
# - Metals to Analyse (Please circle): As Cd Cr Cu Pb Zn Hg Ni Other
Date relinquished: 14.08.07
Total number of samples in container: 5
Results required by:
TAT (Circle): (Standard) 72 hr 48hr 24hr

SAMPLES RECEIVED
Please sign and date to acknowledge receipt of samples and return by fax
Signature: PETER DONAGHY ALS NEWCASTLE
Date: 15/8/07 Lab Ref:

Send results to:
Douglas Partners Pty Ltd
Address:
BOX 324 Hunter Region Mail Centre
NSW 2310
Fax: (02) 4960 9601

Relinquished By: Kasey Watts of ALS Newcastle 15/8/07 at 4pm

ALS Environmental

QUALITY CONTROL REPORT

Client	:	**DOUGLAS PARTNERS PTY LTD**	**Laboratory**	:	Environmental Division Brisbane	**Page**	: **1 of 4**
Contact	:	MR SCOTT MCFARLANE	**Contact**	:	Tim Kilmister		
Address	:	PO BOX 324 HUNTER REGION MAIL CENTRE AUSTRALIA 2310	**Address**	:	32 Shand Street Stafford QLD Australia 4053	**Work order**	: **EB0709130**
						Amendment No.	:
Project	:	Hexham Preliminary Geotechnica	**Quote number**	:	EN/020/07	**Date received**	: **16 Aug 2007**
Order number	:	67344				**Date issued**	: **24 Aug 2007**
C-O-C number	:	- Not provided -					
Site	:	- Not provided -					
E-mail	:	mcfarlanes@douglaspartners.com.au	**E-mail**	:	Services.Brisbane@alsenviro.com	**No. of samples**	
Telephone	:	49609600	**Telephone**	:	+61-7-3243 7222	**Received**	: 5
Facsimile	:	49609601	**Facsimile**	:	+61-7-3243 7218	**Analysed**	: 5

This final report for the ALSE work order reference EB0709130 supersedes any previous reports with this reference.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

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NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IED 17025

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Lea-Ellen Catt	Inorganics - NATA 825 (818 - Brisbane)

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** = *Limit of Reporting,* ***RPD*** = *Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: SOIL ***Laboratory Duplicates (DUP) Report***

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EA026 : Chromium Reducible Sulphur						
EA026 : Chromium Reducible Sulphur - (QC Lot: 474407)				**%**	**%**	**%**
EB0709130-001	14/12.4	Chromium Reducible Sulphur	0.02 %	0.65	0.65	0.0
EA029-A: pH Measurements						
EA029-A: pH Measurements - (QC Lot: 474408)				**pH Unit**	**pH Unit**	**%**
EB0709130-001	14/12.4	pH OX (23B)	0.1 pH Unit	2.3	2.3	0.0
EA029-A: pH Measurements - (QC Lot: 474409)				**pH Unit**	**pH Unit**	**%**
EB0709130-001	14/12.4	pH KCl (23A)	0.1 pH Unit	5.6	5.6	0.0
EA029-B: Acidity Trail						
EA029-B: Acidity Trail - (QC Lot: 474408)				**mole H+ / t**	**mole H+ / t**	**%**
EB0709130-001	14/12.4	Titratable Peroxide Acidity (23G)	2 mole H+ / t	359	355	1.1
EA029-B: Acidity Trail - (QC Lot: 474409)				**mole H+ / t**	**mole H+ / t**	**%**
EB0709130-001	14/12.4	Titratable Actual Acidity (23F)	2 mole H+ / t	6	5	18.2

ALS Environmental

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Flagged outliers on control limits for inorganics tests may be within the NEPM specified data quality objective of recoveries in the range of 70 to 130%. Where this occurs, no corrective action is taken. Abbreviations: LOR = Limit of reporting.

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	*Actual Results*		*Recovery Limits*	
			Spike concentration	*Spike Recovery*	*Dynamic Recovery Limits*	
Analyte name	*LOR*			*LCS*	*Low*	*High*
EA026 : Chromium Reducible Sulphur						
EA026 : Chromium Reducible Sulphur - (QC Lot: 474407)		%	%	%	%	%
Chromium Reducible Sulphur	0.02 %	----	0.21	100	73.1	129
	0.02 %	<0.02	----	----	----	----
EA029-A: pH Measurements						
EA029-A: pH Measurements - (QC Lot: 474408)		pH Unit	pH Unit	%	%	%
pH OX (23B)	0.1 pH Unit	<0.1	----	----	----	----
EA029-A: pH Measurements - (QC Lot: 474409)		pH Unit	pH Unit	%	%	%
pH KCl (23A)	0.1 pH Unit	<0.1	----	----	----	----
EA029-B: Acidity Trail						
EA029-B: Acidity Trail - (QC Lot: 474408)		mole H+ / t	mole H+ / t	%	%	%
Titratable Peroxide Acidity (23G)	2 mole H+ / t	<2	2	----	----	----
EA029-B: Acidity Trail - (QC Lot: 474409)		mole H+ / t	mole H+ / t	%	%	%
Titratable Actual Acidity (23F)	2 mole H+ / t	<2	----	----	----	----

ALS Environmental

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** *= Limit of Reporting,* ***RPD*** *= Relative Percent Difference.*

* Indicates failed QC

Matrix Spike (MS) Report

					Actual Results		*Recovery Limits*	
					Sample Result	*Spike Recovery*	*Static Limits*	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
- (QC Lot:)						%	%	%
					----			

l **No Matrix Spike (MS) carried out on this Work Order.**

ALS Environmental

INTERPRETIVE QUALITY CONTROL REPORT

Client	:	**DOUGLAS PARTNERS PTY LTD**	**Laboratory**	:	Environmental Division Brisbane	**Page**	: **1 of 5**
Contact	:	MR SCOTT MCFARLANE	**Contact**	:	Tim Kilmister		
Address	:	PO BOX 324 HUNTER REGION MAIL CENTRE AUSTRALIA 2310	**Address**	:	32 Shand Street Stafford QLD Australia 4053	**Work order**	: **EB0709130**
						Amendment No.	:
Project	:	Hexham Preliminary Geotechnica	**Quote number**	:	EN/020/07	**Date received**	: 16 Aug 2007
Order number	:	67344				**Date issued**	: 24 Aug 2007
C-O-C number	:	- Not provided -					
Site	:	- Not provided -					
E-mail	:	mcfarlanes@douglaspartners.com.au	**E-mail**	:	Services.Brisbane@alsenviro.com	**No. of samples**	
Telephone	:	49609600	**Telephone**	:	+61-7-3243 7222	**Received**	: 5
Facsimile	:	49609601	**Facsimile**	:	+61-7-3243 7218	**Analysed**	: 5

This Interpretive Quality Control Report was issued on 24 Aug 2007 for the ALS work order reference EB0709130 and supersedes any previous reports with this reference.
This report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Type Frequency Compliance
- Summary of all Quality Control Outliers
- Brief Method Summaries

Interpretive Quality Control Report - Analysis Holding Time

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the sample aliquot was taken. Elapsed time to analysis represents time from sampling where no extraction / digestion is involved or time from extraction / digestion where this is present. For composite samples, sampling date/time is taken as that of the oldest sample contributing to that composite. Sample date/time for laboratory produced leaches are taken from the completion date/time of the leaching process. Outliers for holding time are based on USEPA SW846, APHA, AS and NEPM (1999). Failed outliers, refer to the 'Summary of Outliers'.

Matrix Type: SOIL ***Analysis Holding Time and Preservation***

Method / **Container /** Client Sample ID(s)	**Date Sampled**	**Extraction / Preparation**			**Analysis**		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EA026: Chromium Reducible Sulphur							
Snap Lock Bag - frozen 14/12.4, 16/3.0-3.45, 27/1.5-1.95, 28/3.3, 30/0.4	**6 Aug 2007**	**16 Aug 2007**	5 Aug 2008	Pass	**20 Aug 2007**	18 Nov 2007	Pass
EA029-TAA: Suspension Peroxide Oxidation-Combined Acidity and Sulphate							
Snap Lock Bag - frozen 14/12.4, 16/3.0-3.45, 27/1.5-1.95, 28/3.3, 30/0.4	**6 Aug 2007**	**16 Aug 2007**	5 Aug 2008	Pass	**20 Aug 2007**	18 Nov 2007	Pass
EA029-TPA: Suspension Peroxide Oxidation-Combined Acidity and Sulphate							
Snap Lock Bag - frozen 14/12.4, 16/3.0-3.45, 27/1.5-1.95, 28/3.3, 30/0.4	**6 Aug 2007**	**16 Aug 2007**	5 Aug 2008	Pass	**20 Aug 2007**	18 Nov 2007	Pass

Interpretive Quality Control Report - Frequency of Quality Control Samples

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which this work order was processed. Actual rate should be greater than or equal to the expected rate.

Matrix Type: SOIL ***Frequency of Quality Control Samples***

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
EA026: Chromium Reducible Sulphur	1	5	**20.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EA029-TAA: Suspension Peroxide Oxidation-Combined Acidity and Sulphate	1	5	**20.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EA029-TPA: Suspension Peroxide Oxidation-Combined Acidity and Sulphate	1	5	**20.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
EA026: Chromium Reducible Sulphur	1	5	**20.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Method Blanks (MB)					
EA026: Chromium Reducible Sulphur	1	5	**20.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EA029-TAA: Suspension Peroxide Oxidation-Combined Acidity and Sulphate	1	5	**20.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EA029-TPA: Suspension Peroxide Oxidation-Combined Acidity and Sulphate	1	5	**20.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Interpretive Quality Control Report - Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged on the 'Quality Control Report'. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). Flagged outliers on control limits for inorganics tests may be within the NEPM specified data quality objective of recoveries in the range of 70 to 130%. Where this occurs, no corrective action is taken. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot.

Non-surrogates

- **For all matrices, no RPD recovery outliers occur for the duplicate analysis.**
- **For all matrices, no method blank result outliers occur.**
- **For all matrices, no laboratory spike recoveries breaches occur.**
- **For all matrices, no matrix spike recoveries breaches occur.**

Surrogates

- **For all matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time

The following report highlights outliers within this 'Interpretive Quality Control Report - Analysis Holding Time'.

- **No holding time outliers occur.**

Outliers : Frequency of Quality Control Samples

The following report highlights outliers within this 'Interpretive Quality Control Report - Frequency of Quality Control Samples'.

- **No frequency outliers occur.**

Method Reference Summary

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Matrix Type: SOIL ***Method Reference Summary***

Preparation Methods

EN020PR : Drying at 85 degrees, bagging and labelling (ASS) - In house

Analytical Methods

EA026 : Chromium Reducible Sulphur - Sullivan et al (1998) The CRS method converts reduced inorganic sulfur to H2S by CrCl2 solution ; the evolved H2S is trapped in a zinc acetate solution as ZnS which is quantified by iodometric titration.

EA029-TAA : Suspension Peroxide Oxidation-Combined Acidity and Sulphate - Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

EA029-TPA : Suspension Peroxide Oxidation-Combined Acidity and Sulphate - Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: **DOUGLAS PARTNERS PTY LTD**	*Laboratory*	: **Environmental Division Brisbane**	*Page*	: **1 of 4**
Contact	: **MR SCOTT MCFARLANE**	*Contact*	: **Tim Kilmister**	*Work Order*	: **EB0709130**
Address	: **PO BOX 324 HUNTER REGION MAIL CENTRE AUSTRALIA 2310**	*Address*	: **32 Shand Street Stafford QLD Australia 4053**		
E-mail	: **mcfarlanes@douglaspartners.com.au**	*E-mail*	: **Services.Brisbane@alsenviro.com**		
Telephone	: **49609600**	*Telephone*	: **+61-7-3243 7222**		
Facsimile	: **49609601**	*Facsimile*	: **+61-7-3243 7218**		
Project	: **Hexham Preliminary Geotechnica**	*Quote number*	: **EN/020/07**	*Date received*	: **16 Aug 2007**
Order number	: **67344**			*Date issued*	: **24 Aug 2007**
C-O-C number	: **- Not provided -**			*No. of samples*	- *Received* : **5**
Site	: **- Not provided -**				*Analysed* : **5**

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NATA Accredited Laboratory 825

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Accredited for compliance with ISO/IEC 17025.

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	*Position*	*Department*
Lea-Ellen Catt	**Laboratory Technician - Acid Sulphate Soils**	**Inorganics - NATA 825 (818 - Brisbane)**

ALS Environmental

Comments

This report for the ALSE reference EB0709130 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical Results for Samples Submitted**
- **Surrogate Recovery Data**

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID : 14/12.4	16/3.0-3.45	27/1.5-1.95	28/3.3	30/0.4
				Sample Matrix Type / Description : SOIL	SOIL	SOIL	SOIL	SOIL
				Sample Date / Time : 6 Aug 2007 15:00	6 Aug 2007 15:00	6 Aug 2007 15:00	6 Aug 2007 15:00	6 Aug 2007 15:00
				Laboratory Sample ID : EB0709130-001	EB0709130-002	EB0709130-003	EB0709130-004	EB0709130-005
EA026 : Chromium Reducible Sulphur								
Chromium Reducible Sulphur		0.02	%	0.65	0.08	<0.02	<0.02	0.04
EA029-A: pH Measurements								
pH KCl (23A)		0.1	pH Unit	5.6	6.8	5.5	5.9	5.4
pH OX (23B)		0.1	pH Unit	2.3	2.2	4.2	5.8	3.3
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)		2	mole H+ / t	6	<2	21	4	16
Titratable Peroxide Acidity (23G)		2	mole H+ / t	359	388	184	<2	230

ALS Environmental

Surrogate Control Limits

- **No surrogates present on this report.**

5180

Douglas Partners
Geotechnics · Environment · Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project Name: Hexham
Project No: 39798 DP Order No: 67339
DP Contact Person: Scott Macfarlane
Prior Storage: esky / fridge / shelved (circle)

To: SGS Australia PTY LTD
Unit 16/33 Maddox Street
ALEXANDRIA NSW 2015
Ph: (02) 8594 0400
Attn: Angela

	Sample ID	Date Sampled	Sample Type S-soil W-water	Lab ID	Analytes: TRH	BTEX	#Metals	PCB's	PAH's	OCP's	OPP's	Phenols	pH	Sulphate	Total Phosphorus	~~TCLP~~ Chloride	Notes
1	TP14/0.8	6/8/08	S		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
2	TP18/1.0	"	"		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	"Sample received labelled as TP18/0.9" (Angela 14/8/07)
3	TP28/0.1	"	"		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
4	TP28/1.0	"	"		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
5	TP29/0.4	"	"		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
6	D1	"	"		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
	PQL (S)		mg/kg														
	PQL (W)		mg/L														

SGS
Received 14/08/07
By Sam
Time 9am am/pm
Samples intact yes/no
Esky/Cooler Pack yes/no
5446

PQL = practical quantitation limit *As per Laboratory Method (Detection Limit)
# - Metals to Analyse (Please circle): As Cd Cr Cu Pb Zn Hg Ni Other
Date relinquished: 13/8/07
Total number of samples in container: 6
Results required by:
TAT (Circle): Standard 72 hr 48hr 24hr

SAMPLES RECEIVED
Please sign and date to acknowledge receipt of samples and return by fax
Signature: Sam
Date: 14/8/07 Lab Ref: 54461

Send results to:
Douglas Partners Pty Ltd
Address:
BOX 324 Hunter Region Mail Centre
NSW 2310
Fax: (02) 4960 9601

20 August 2007 **TEST REPORT**

Douglas Partners Pty Ltd
Box 324
Hunter Region Mail Centre
NSW 2310

Your Reference: 39798, Hexham
Report Number: 54461

Attention: Scott McFarlane

Dear Scott
The following samples were received from you on the date indicated.

Samples: Qty.	6 Soils
Date of Receipt of Samples:	14/08/07
Date of Receipt of Instructions:	14/08/07
Date Preliminary Report Emailed:	Not Issued

These samples were analysed in accordance with your written instructions.
A copy of the instructions is attached with the analytical report.

The results and associated quality control are contained in the following pages of this report.
Unless otherwise stated, solid samples are expressed on a dry weight basis (moisture has been supplied for your information only), air and liquid samples as received.

Should you have any queries regarding this report please contact the undersigned.

Yours faithfully
SGS ENVIRONMENTAL SERVICES

Ly Kim Ha
Senior Organic Chemist

Edward Ibrahim
Laboratory Services Manager

Alexandra Stenta
Key Account Representative

SGS Australia Pty Ltd | Environmental Services Unit 16, 33 Maddox Street, Alexandria Australia

BTEX in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-1 TP14/0.8 Soil 6/08/2007	54461-2 TP18/1.0 Soil 6/08/2007	54461-3 TP28/0.1 Soil 6/08/2007	54461-4 TP28/1.0 Soil 6/08/2007	54461-5 TP29/0.4 Soil 6/08/2007
Benzene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Total Xylenes	mg/kg	<1.5	<1.5	<1.5	<1.5	<1.5
BTEX Surrogate (%)	%	101	93	89	84	119

BTEX in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-6 D1 Soil 6/08/2007
Benzene	mg/kg	<0.5
Toluene	mg/kg	<0.5
Ethylbenzene	mg/kg	<0.5
Total Xylenes	mg/kg	<1.5
BTEX Surrogate (%)	%	90

TRH in soil with..C6-C9 by P/T						
Our Reference:	UNITS	54461-1	54461-2	54461-3	54461-4	54461-5
Your Reference	----------	TP14/0.8	TP18/1.0	TP28/0.1	TP28/1.0	TP29/0.4
Sample Type	----------	Soil	Soil	Soil	Soil	Soil
Date Sampled		6/08/2007	6/08/2007	6/08/2007	6/08/2007	6/08/2007
TRH C_6 - C_9 P&T	mg/kg	<20	<20	<20	<20	<20
TRH C_{10} - C_{14}	mg/kg	<20	<20	23	<20	110
TRH C_{15} - C_{28}	mg/kg	<50	100	290	<50	2,600
TRH C_{29} - C_{36}	mg/kg	<50	<50	170	<50	1,900

TRH in soil with..C6-C9 by P/T		
Our Reference:	UNITS	54461-6
Your Reference	----------	D1
Sample Type	----------	Soil
Date Sampled		6/08/2007
TRH C_6 - C_9 P&T	mg/kg	<20
TRH C_{10} - C_{14}	mg/kg	<20
TRH C_{15} - C_{28}	mg/kg	250
TRH C_{29} - C_{36}	mg/kg	170

PAHs in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-1 TP14/0.8 Soil 6/08/2007	54461-2 TP18/1.0 Soil 6/08/2007	54461-3 TP28/0.1 Soil 6/08/2007	54461-4 TP28/1.0 Soil 6/08/2007	54461-5 TP29/0.4 Soil 6/08/2007
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	1.0
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.4
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.1
Phenanthrene	mg/kg	0.2	0.5	0.6	0.1	3.5
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.6
Fluoranthene	mg/kg	0.2	0.1	0.3	<0.1	2.0
Pyrene	mg/kg	0.1	0.1	0.3	<0.1	2.4
Benzo[*a*]anthracene	mg/kg	<0.1	0.1	0.2	<0.1	0.8
Chrysene	mg/kg	<0.1	<0.1	0.2	<0.1	0.8
Benzo[*b,k*]fluoranthene	mg/kg	<0.2	<0.2	<0.2	<0.2	0.8
Benzo[*a*]pyrene	mg/kg	0.07	0.06	0.09	<0.05	0.62
Indeno[*123-cd*]pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.4
Dibenzo[*ah*]anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.1
Benzo[*ghi*]perylene	mg/kg	<0.1	<0.1	<0.1	<0.1	0.4
Total PAH's	mg/kg	<1.77	<1.96	<2.69	<1.55	<14.02
Nitrobenzene-d5	%	91	98	96	91	99
2-Fluorobiphenyl	%	90	96	96	89	97
p -Terphenyl-*d14*	%	101	108	109	104	105

PAHs in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-6 D1 Soil 6/08/2007
Naphthalene	mg/kg	<0.1
Acenaphthylene	mg/kg	<0.1
Acenaphthene	mg/kg	<0.1
Fluorene	mg/kg	<0.1
Phenanthrene	mg/kg	0.6
Anthracene	mg/kg	<0.1
Fluoranthene	mg/kg	0.3
Pyrene	mg/kg	0.3
Benzo[*a*]anthracene	mg/kg	0.2
Chrysene	mg/kg	0.2
Benzo[*b,k*]fluoranthene	mg/kg	<0.2
Benzo[*a*]pyrene	mg/kg	0.08
Indeno[*123-cd*]pyrene	mg/kg	<0.1
Dibenzo[*ah*]anthracene	mg/kg	<0.1
Benzo[*ghi*]perylene	mg/kg	<0.1
Total PAH's	mg/kg	<2.68
Nitrobenzene-d5	%	101
2-Fluorobiphenyl	%	101
p -Terphenyl-*d14*	%	112

OC Pesticides in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-1 TP14/0.8 Soil 6/08/2007	54461-2 TP18/1.0 Soil 6/08/2007	54461-3 TP28/0.1 Soil 6/08/2007	54461-4 TP28/1.0 Soil 6/08/2007	54461-5 TP29/0.4 Soil 6/08/2007
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-BHC (Lindane)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-Endosulfan	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
cis-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-Endosulfan	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
2,4,5,6-Tetrachloro-m-xylene *(Surrogate*	%	111	103	115	108	102

OC Pesticides in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-6 D1 Soil 6/08/2007
HCB	mg/kg	<0.1
alpha-BHC	mg/kg	<0.1
gamma-BHC (Lindane)	mg/kg	<0.1
Heptachlor	mg/kg	<0.1
Aldrin	mg/kg	<0.1
beta-BHC	mg/kg	<0.1
delta-BHC	mg/kg	<0.1
Heptachlor Epoxide	mg/kg	<0.1
o,p'-DDE	mg/kg	<0.1
alpha-Endosulfan	mg/kg	<0.1
trans-Chlordane	mg/kg	<0.1
cis-Chlordane	mg/kg	<0.1
trans-Nonachlor	mg/kg	<0.1
p,p'-DDE	mg/kg	<0.1
Dieldrin	mg/kg	<0.1
Endrin	mg/kg	<0.1
o,p'-DDD	mg/kg	<0.1
o,p'-DDT	mg/kg	<0.1
beta-Endosulfan	mg/kg	<0.1
p,p'-DDD	mg/kg	<0.1
p,p'-DDT	mg/kg	<0.1
Endosulfan Sulphate	mg/kg	<0.1
Endrin Aldehyde	mg/kg	<0.1
Methoxychlor	mg/kg	<0.1
Endrin Ketone	mg/kg	<0.1
2,4,5,6-Tetrachloro-m-xylene *(Surrogate*	%	106

OP Pesticides in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-1 TP14/0.8 Soil 6/08/2007	54461-2 TP18/1.0 Soil 6/08/2007	54461-3 TP28/0.1 Soil 6/08/2007	54461-4 TP28/1.0 Soil 6/08/2007	54461-5 TP29/0.4 Soil 6/08/2007
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Bromofos Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
OP_Surrogate 1	%	111	103	115	108	102

OP Pesticides in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-6 D1 Soil 6/08/2007
Chlorpyrifos	mg/kg	<0.1
Fenitrothion	mg/kg	<0.1
Bromofos Ethyl	mg/kg	<0.1
Ethion	mg/kg	<0.1
OP_Surrogate 1	%	106

PCBs in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-1 TP14/0.8 Soil 6/08/2007	54461-2 TP18/1.0 Soil 6/08/2007	54461-3 TP28/0.1 Soil 6/08/2007	54461-4 TP28/1.0 Soil 6/08/2007	54461-5 TP29/0.4 Soil 6/08/2007
Arochlor 1016	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arochlor 1221	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arochlor 1232	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arochlor 1242	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arochlor 1248	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arochlor 1254	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arochlor 1260	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arochlor 1262	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arochlor 1268	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total Positive PCB	mg/kg	<0.90	<0.90	<0.90	<0.90	<0.90
PCB_Surrogate 1	%	111	103	115	108	102

PCBs in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-6 D1 Soil 6/08/2007
Arochlor 1016	mg/kg	<0.1
Arochlor 1221	mg/kg	<0.1
Arochlor 1232	mg/kg	<0.1
Arochlor 1242	mg/kg	<0.1
Arochlor 1248	mg/kg	<0.1
Arochlor 1254	mg/kg	<0.1
Arochlor 1260	mg/kg	<0.1
Arochlor 1262	mg/kg	<0.1
Arochlor 1268	mg/kg	<0.1
Total Positive PCB	mg/kg	<0.90
PCB_Surrogate 1	%	106

Acid Extractable Metals in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-1 TP14/0.8 Soil 6/08/2007	54461-2 TP18/1.0 Soil 6/08/2007	54461-3 TP28/0.1 Soil 6/08/2007	54461-4 TP28/1.0 Soil 6/08/2007	54461-5 TP29/0.4 Soil 6/08/2007
Arsenic	mg/kg	<3	20	7	<3	<3
Cadmium	mg/kg	<0.1	0.3	0.3	<0.1	0.2
Chromium	mg/kg	2.1	2.2	8.0	3.5	4.0
Copper	mg/kg	5.9	17	18	5.0	6.7
Lead	mg/kg	15	16	20	5	23
Mercury	mg/kg	<0.05	0.13	0.06	<0.05	<0.05
Nickel	mg/kg	3.5	3.5	13	3.8	8.0
Zinc	mg/kg	24	33	140	110	81

Acid Extractable Metals in Soil Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-6 D1 Soil 6/08/2007
Arsenic	mg/kg	4
Cadmium	mg/kg	0.1
Chromium	mg/kg	14
Copper	mg/kg	11
Lead	mg/kg	9
Mercury	mg/kg	0.05
Nickel	mg/kg	13
Zinc	mg/kg	36

Inorganics Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-1 TP14/0.8 Soil 6/08/2007	54461-2 TP18/1.0 Soil 6/08/2007	54461-3 TP28/0.1 Soil 6/08/2007	54461-4 TP28/1.0 Soil 6/08/2007	54461-5 TP29/0.4 Soil 6/08/2007
pH 1:5 soil:water	pH Units	6.9	9.4	6.1	6.4	6.2
Sulphate, SO4 1:5 soil:water	mg/kg	270	210	21	27	250
Total Phosphorus	mg/kg	180	2,200	430	92	490
Chloride, Cl 1:5 soil:water	mg/kg	98	12	81	65	11

Inorganics Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-6 D1 Soil 6/08/2007
pH 1:5 soil:water	pH Units	7.1
Sulphate, SO4 1:5 soil:water	mg/kg	200
Total Phosphorus	mg/kg	360
Chloride, Cl 1:5 soil:water	mg/kg	580

Moisture Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-1 TP14/0.8 Soil 6/08/2007	54461-2 TP18/1.0 Soil 6/08/2007	54461-3 TP28/0.1 Soil 6/08/2007	54461-4 TP28/1.0 Soil 6/08/2007	54461-5 TP29/0.4 Soil 6/08/2007
Moisture	%	16	9	11	14	5

Moisture Our Reference: Your Reference Sample Type Date Sampled	UNITS ---------- ----------	54461-6 D1 Soil 6/08/2007
Moisture	%	23

Method ID	Methodology Summary
SEO-018	BTEX - Determination by purge and trap/ Gas Chromatography with MS Detection.
SEO-017	BTEX/TRH C6-C9 - Determination by Purge and Trap Gas Chromatography with Flame Ionisation Detection (FID) and Photo Ionisation Detection (PID). The surrogate spike used is aaa-trifluorotoluene.
SEO-020	TRH - Determination of Total Recoverable Hydrocarbons by gas chromatography following extraction with DCM/Acetone for solids and DCM for liquids.
SEO-030	PAHs by GC/MS - Determination of Polynuclear Aromatic Hydrocarbons (PAH's) by Gas Chromatography / Mass Spectrometry following extraction with dichloromethane or dichloromethane/acetone. The surrogate spike used is p-Terphenyl-d14.
SEO-005	OC/OP/PCB - Determination of a suite of Organchlorine Pesticides, Chlorinated Organo-phosphorus Pesticides and Polychlorinated Biphenyls (PCB's) by sonication extraction using dichloromethane for waters or acetone / hexane for soils followed by Gas Chromatographic separation with Electron Capture Detection (GC/ECD). The surrogate spike used is 2,4,5,6-Tetrachloro-m-xylene.
SEM-010	Metals - Determination of various metals by ICP-AES following aqua regia digest.
SEM-005	Mercury - Determination of Mercury by Cold Vapour Generation Atomic Absorption Spectroscopy.
AN101	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
SEI-038	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 20th ED, 4110-B.
AN002	Preparation of soils, sediments and sludges undergo analysis by either air drying, compositing, subsampling and 1:5 soil water extraction where required. Moisture content is determined by drying the sample at 105 ± 5°C.

QUALITY CONTROL BTEX in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Benzene	mg/kg	0.5	SEO-018	<0.5	54461-6	<0.5 || <0.5	LCS	76 || [N/T]
Toluene	mg/kg	0.5	SEO-018	<0.5	54461-6	<0.5 || <0.5	LCS	75 || [N/T]
Ethylbenzene	mg/kg	0.5	SEO-018	<0.5	54461-6	<0.5 || <0.5	LCS	79 || [N/T]
Total Xylenes	mg/kg	1.5	SEO-018	<1.5	54461-6	<1.5 || <1.5	LCS	82 || [N/T]
BTEX Surrogate (%)	%	0	SEO-018	92	54461-6	90 || 83 || RPD: 8	LCS	95 || [N/T]
QUALITY CONTROL TRH in soil with..C6-C9 by P/T	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
TRH C_6 - C_9 P&T	mg/kg	20	SEO-017	<20	54461-6	<20 || <20	LCS	92 || [N/T]
TRH C_{10} - C_{14}	mg/kg	20	SEO-020	<20	54461-6	<20 || <20	LCS	90 || [N/T]
TRH C_{15} - C_{28}	mg/kg	50	SEO-020	<50	54461-6	250 || 260 || RPD: 4	LCS	93 || [N/T]
TRH C_{29} - C_{36}	mg/kg	50	SEO-020	<50	54461-6	170 || 180 || RPD: 6	LCS	93 || [N/T]
QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Naphthalene	mg/kg	0.1	SEO-030	<0.1	54461-6	<0.1 || <0.1	LCS	88 || [N/T]
Acenaphthylene	mg/kg	0.1	SEO-030	<0.1	54461-6	<0.1 || <0.1	LCS	69 || [N/T]
Acenaphthene	mg/kg	0.1	SEO-030	<0.1	54461-6	<0.1 || <0.1	LCS	103 || [N/T]
Fluorene	mg/kg	0.1	SEO-030	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Phenanthrene	mg/kg	0.1	SEO-030	<0.1	54461-6	0.6 || 0.6 || RPD: 0	LCS	94 || [N/T]
Anthracene	mg/kg	0.1	SEO-030	<0.1	54461-6	<0.1 || <0.1	LCS	92 || [N/T]
Fluoranthene	mg/kg	0.1	SEO-030	<0.1	54461-6	0.3 || 0.3 || RPD: 0	LCS	91 || [N/T]
Pyrene	mg/kg	0.1	SEO-030	<0.1	54461-6	0.3 || 0.3 || RPD: 0	LCS	90 || [N/T]
Benzo[a]anthracene	mg/kg	0.1	SEO-030	<0.1	54461-6	0.2 || 0.2 || RPD: 0	[NR]	[NR]
Chrysene	mg/kg	0.1	SEO-030	<0.1	54461-6	0.2 || 0.2 || RPD: 0	[NR]	[NR]
Benzo[*b,k*]fluoranthene	mg/kg	0.2	SEO-030	<0.2	54461-6	<0.2 || <0.2	[NR]	[NR]
Benzo[a]pyrene	mg/kg	0.05	SEO-030	<0.05	54461-6	0.08 || 0.09 || RPD: 12	LCS	101 || [N/T]
Indeno[*123-cd*]pyrene	mg/kg	0.1	SEO-030	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Dibenzo[*ah*]anthracene	mg/kg	0.1	SEO-030	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Benzo[*ghi*]perylene	mg/kg	0.1	SEO-030	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Total PAH's	mg/kg	1.55	SEO-030	1.55	54461-6	<2.68 || <2.69	[NR]	[NR]
Nitrobenzene-d5	%	0	SEO-030	92	54461-6	101 || 100 || RPD: 1	LCS	88 || [N/T]
2-Fluorobiphenyl	%	0	SEO-030	93	54461-6	101 || 100 || RPD: 1	LCS	91 || [N/T]
p -Terphenyl-*d* 14	%	0	SEO-030	101	54461-6	112 || 110 || RPD: 2	LCS	101 || [N/T]

QUALITY CONTROL OC Pesticides in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
HCB	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
alpha-BHC	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
gamma-BHC (Lindane)	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Heptachlor	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	LCS	83 || [N/T]
Aldrin	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	LCS	83 || [N/T]
beta-BHC	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
delta-BHC	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	LCS	80 || [N/T]
Heptachlor Epoxide	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
o,p'-DDE	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
alpha-Endosulfan	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
trans-Chlordane	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
cis-Chlordane	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
trans-Nonachlor	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
p,p'-DDE	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Dieldrin	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	LCS	85 || [N/T]
Endrin	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	LCS	88 || [N/T]
o,p'-DDD	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
o,p'-DDT	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
beta-Endosulfan	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
p,p'-DDD	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
p,p'-DDT	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	LCS	86 || [N/T]
Endosulfan Sulphate	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Endrin Aldehyde	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Methoxychlor	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Endrin Ketone	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
2,4,5,6-Tetrachloro-m-xylene *(Surrogate*	%	0	SEO-005	97	54461-6	106 || 107 || RPD: 1	LCS	96 || [N/T]

QUALITY CONTROL OP Pesticides in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Chlorpyrifos	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	LCS	92 || [N/T]
Fenitrothion	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Bromofos Ethyl	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Ethion	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
OP_Surrogate 1	%	0	SEO-005	97	54461-6	106 || 107 || RPD: 1	LCS	96 || [N/T]
QUALITY CONTROL PCBs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Arochlor 1016	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Arochlor 1221	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Arochlor 1232	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Arochlor 1242	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Arochlor 1248	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Arochlor 1254	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Arochlor 1260	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	LCS	112 || [N/T]
Arochlor 1262	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Arochlor 1268	mg/kg	0.1	SEO-005	<0.1	54461-6	<0.1 || <0.1	[NR]	[NR]
Total Positive PCB	mg/kg	0.9	SEO-005	0.90	54461-6	<0.90 || <0.90	LCS	0.9 || [N/T]
PCB_Surrogate 1	%	0	SEO-005	97	54461-6	106 || 107 || RPD: 1	LCS	97 || [N/T]
QUALITY CONTROL Acid Extractable Metals in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Cadmium	mg/kg	0.1	SEM-010	<0.1	[NT]	[NT]	LCS	99 || [N/T]
Chromium	mg/kg	0.3	SEM-010	<0.3	[NT]	[NT]	LCS	97 || [N/T]
Copper	mg/kg	0.5	SEM-010	<0.5	[NT]	[NT]	LCS	100 || [N/T]
Lead	mg/kg	1	SEM-010	<1	[NT]	[NT]	LCS	99 || [N/T]
Mercury	mg/kg	0.05	SEM-005	<0.05	[NT]	[NT]	LCS	106 || [N/T]
Nickel	mg/kg	0.5	SEM-010	<0.5	[NT]	[NT]	LCS	99 || [N/T]
Zinc	mg/kg	0.3	SEM-010	<0.3	[NT]	[NT]	LCS	97 || [N/T]
QUALITY CONTROL Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
pH 1:5 soil:water	pH Units		AN101	[NT]	54461-1	6.9 || 6.8 || RPD: 1	[NR]	[NR]
Sulphate, SO4 1:5 soil:water	mg/kg	2	SEI-038	<2	54461-1	270 || 190 || RPD: 35	LCS	101 || [N/T]
Total Phosphorus	mg/kg	5	SEM-010	<5.0	54461-1	180 || [N/T]	LCS	105 || [N/T]
Chloride, Cl 1:5 soil:water	mg/kg	0.5	SEI-038	<0.5	54461-1	98 || 81 || RPD: 19	LCS	101 || [N/T]

QUALITY CONTROL Moisture	UNITS	PQL	METHOD	Blank
Moisture	%	1	AN002	<1

Result Codes

[INS]	:	Insufficient Sample for this test	[HBG]	:	Results not Reported due to High Background Interference
[NR]	:	Not Requested	*	:	Not part of NATA Accreditation
[NT]	:	Not tested	[N/A]	:	Not Applicable

Result Comments

Date Organics extraction commenced: 17/08/07
NATA Corporate Accreditation No. 2562, Site No 4354
Note: Test results are not corrected for recovery (excluding Dioxins/Furans* and PAH in XAD and PUF).
This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

Quality Control Protocol

Reagent Blank: Sample free reagents carried through the preparation/extraction/digestion procedure and analysed at the beginning of every sample batch analysis. For larger projects, a reagent blank is prepared and analysed with every 20 samples.
Duplicate: A separate portion of a sample being analysed which is treated the same as the other samples in the batch. A duplicate is prepared at least every 10 samples.
Matrix Spike Duplicates: Sample replicates spiked with identical concentrations of target analyte(s). The spiking occurs during the sample preparation and prior to the extraction/digestion procedure. They are used to document the precision and bias of a method in a given sample matrix. Where there is not enough sample available to prepare a spiked sample, another known soil/sand or water (or Milli-Q water) may be used. A duplicate spiked sample is prepared at least every 20 samples.
Surrogate Spike: Added to all samples requiring analysis for organics (where relevant) prior to extraction. Used to determine the extraction efficiency. They are organic compounds which are similar to the target analyte(s) in chemical composition and behaviour in the analytical process, but which are not normally found in environmental samples.
Internal Standard: Added to all samples requiring analysis for organics (where relevant) after the extraction process; the compounds serve to give a standard of retention time and response, which is invariant from run-to-run with the instruments.
Control Standards: Prepared from a source independent of the calibration standards. At least one control standard is included in each run to confirm calibration validity.
Additional QC Samples: A calibration standard and blank are run after every 20 samples of an instrumental analysis run to assess analytical drift.

SGS Environmental Services
Unit 16, 33 Maddox St. Alexandria NSW 2015
Telephone Number : (+61 2) 8594 0400
Fax Number : (+61 2) 8594 0499

SAMPLE RECEIPT CONFIRMATION

COMPANY	:	Douglas Partners Pty Ltd	FAX NO.	:	02 4960 9601
ATTENTION	:	Scott McFarlane	PAGES	:	1
FROM	:	Sample Receipt	DATE	:	15/08/07

This is to confirm that samples for Project **39798, Hexham** were received on **14/08/07** the results are expected to be ready on **21/08/2007** . Please quote SGS Reference: **54461** when making enquiries regarding this project. Please refer to below which details information about the integrity of the samples and other useful information.

Samples will be held for 1 month for water samples and 2 months for soil samples from date of receipt of samples, unless otherwise instructed.

Samples received in good order:	YES
Samples received in correct containers:	YES
Samples received without headspace:	YES
Sufficient quantity supplied:	YES
Upon receipt sample temperature:	Cool
Cooling Method:	Ice
Sample containers provided by:	SGS
Samples Clearly Labelled:	NO
Turnaround time requested:	Standard
Completed documentation received:	YES

Comments:

Sample id on COC "TP18/1.0" was received on glass jar labelled "TP18/0.9"
Terms and conditions are available from www.au.sgs.com

The signed chain of custody will be returned to you with the original report.

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
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Warabrook NSW 2304
PO Box 324
Hunter Region MC NSW 2310
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Fax (02) 4960 9601

Quality Assurance / Quality Control
Preliminary Geotechnical Investigation
Hexham

Quality Assurance (QA) was maintained by:

- Compliance with a Project Quality Plan written for the objectives of the study;
- Using qualified engineers to undertake the field supervision and sampling;
- Following the Douglas Partners Pty Ltd (DP) operating procedures for sampling, field testing and decontamination as presented in Table 1;
- Using NATA registered laboratories for sample testing, that generally utilise standard laboratory methods of the US EPA, the APHA and NSW EPA.

Table 1: Field Procedures

Abbreviation	Procedure Name
FPM LOG	Logging
FPM DECONT	Decontamination of Personnel and Equipment
FPM ENVID	Sample Identification, Handling, Transport and Storage of Contaminated Samples
FPM PIDETC	Operation of Field Analysers
FPM ENVSAMP	Sampling of Contaminated Soils

(from DP Field Procedures Manual)

Quality Control (QC) of the laboratory programme was achieved by the following means:

- Check replicate - a specific sample was split in the field, placed in separate containers and labelled with different sample numbers, and sent to the laboratory for analysis;
- Method blanks - the laboratory ran reagent blanks to confirm the equipment and standards used were uncontaminated;
- Laboratory replicates - the laboratory split samples internally and conducted tests on separate extracts;
- Laboratory spikes - samples were spiked by the laboratory with a known concentration of contaminants and subsequently tested for percent recovery;

DISCUSSION

A. Check Replicate

The Relative Percent Difference (RPD) between replicate results is used as a measure of laboratory reproducibility and is given by the following:

$$RPD = \frac{ABS(\text{Replicate result } 1 - \text{Replicate result } 2)}{(\text{Replicate result } 1 + \text{Replicate result } 2)/2} \times 100$$

The RPD can have a value between 0% and 200%. An RPD data quality objective of up to 50% is generally considered to be acceptable for organic analysis, and 35% for inorganics (i.e. Metals).

A summary of the results of the soil replicate QA/QC testing is provided in Table 2.

Table 2: Results of Quality Control Analysis

Analyte		Pit 28/0.1	D1	RPD (%)
Metals	As	7	4	55
	Cd	0.3	0.1	100
	Cr	8	14	55
	Cu	18	11	48
	Pb	20	9	76
	Hg	0.06	0.05	18
	Ni	13	13	0
	Zn	140	36	118
TRH	C_6 - C_9	<20	<20	N/A
	C_{10} - C_{14}	23	<20	N/A
	C_{15} - C_{28}	290	250	15
	C_{29} - C_{36}	170	170	0
BTEX	Benzene	<0.5	<0.5	N/A
	Toluene	<0.5	<0.5	N/A
	Ethyl Benzene	<0.5	<0.5	N/A
	Xylene	<1.5	<1.5	N/A
PAH	Total PAHs	1.69	1.68	1
	Benzo(a)pyrene	0.09	0.08	12
OCPs	Total OCPs	<PQL	<PQL	N/A
	Aldrin + Dieldrin	<PQL	<PQL	N/A
	Chlordane	<PQL	<PQL	N/A
	DDT	<PQL	<PQL	N/A
	Heptachlor	<PQL	<PQL	N/A
OPPs		<PQL	<PQL	N/A
PCBs		<PQL	<PQL	N/A
pH 1:5 soil:water		6.1	7.1	15
Sulphate, SO4		21	200	162
Total Phosphorus		430	360	18
Chloride, Cl		81	580	151

Notes to Table 2:

Results expressed in mg/kg on dry weight basis

PQL - Practical Quantitation Limit

N/A - Not Applicable

The average RPD's were generally within the acceptable limits. Some metals and nutrients in soil contained elevated RPD's (up to 162%). Slightly elevated RPD's were also found for some organic analytes. Elevated RPD's can be attributed to heterogeneity of the fill materials analysed, together with relatively low contaminant concentrations in soil for some analytes (ie. small differences in concentrations) resulting in high RPD's, The results of replicate analysis are therefore generally considered acceptable.

B. Method Blanks

All method blanks returned results lower than the laboratory detection limit, therefore are acceptable.

C. Laboratory Replicates

The average RPD for individual contaminants ranged from 0% to 35%, which is considered to be within acceptable limits.

D. Laboratory Spikes

Recoveries in the order of 70% to 130% are generally considered to be acceptable. The average percent recovery for individual organic contaminants ranged from 69% to 112% which is generally within the quality control objectives. The results should however be qualified and may slightly under-estimate or over-estimate contaminant concentrations in certain samples (i.e. biased low or high respectively).

Conclusions

In summary, it is noted that the magnitude of RPDs for field replicates (i.e. blind replicates) are generally higher than those for laboratory replicates. Field replicate results generally show greater variability than laboratory replicates, because they measure both field and laboratory reproducibility.

The accuracy and precision of the soil testing procedures, as inferred by the QA/QC data is generally considered to be of sufficient standard to allow the data reported to be used to interpret site contamination conditions.

Appendix E

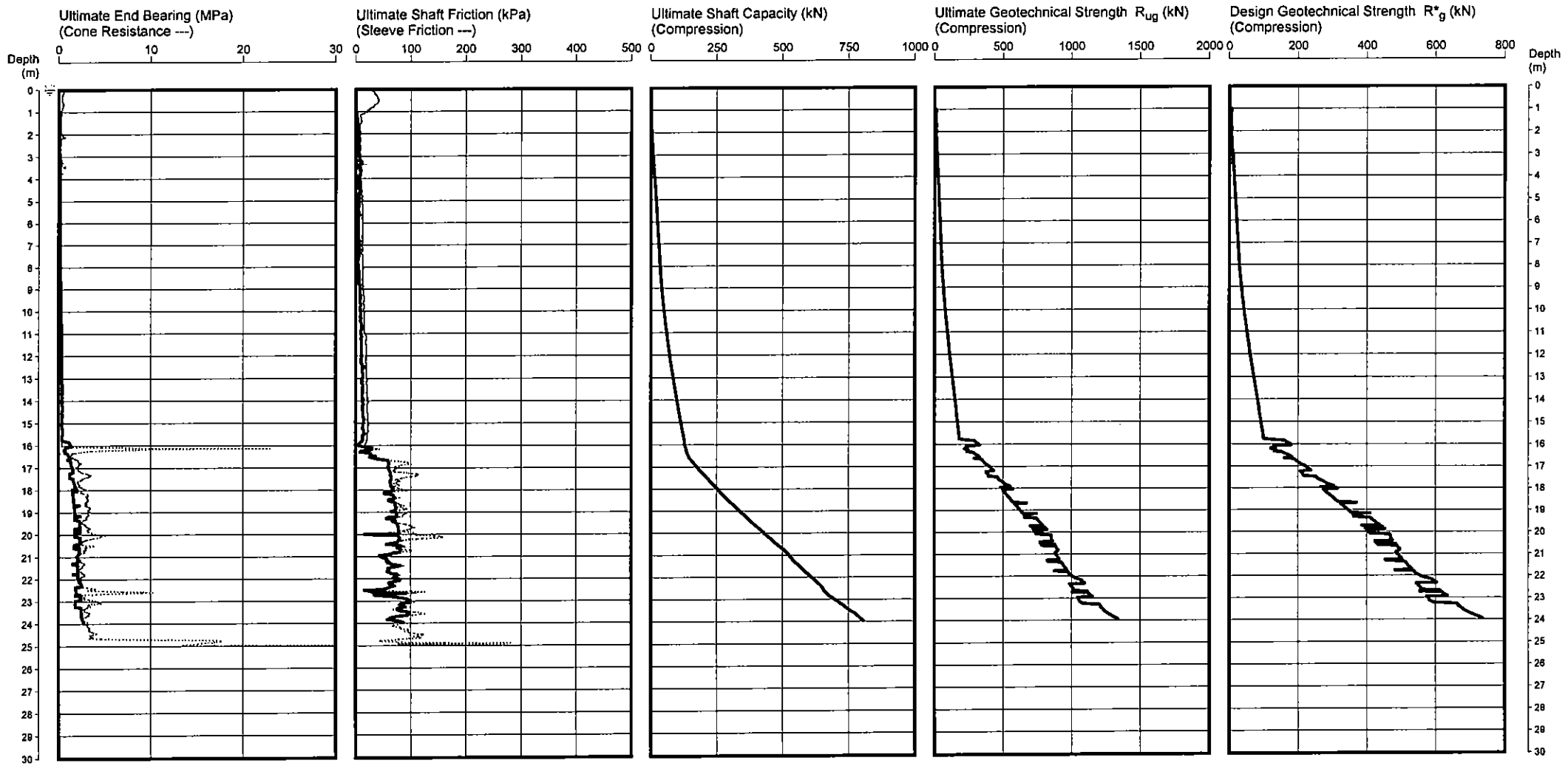
Pile Capacity Plots – CPT4 and CPT11

PILE CAPACITY ESTIMATE

PILE TYPE: Driven Timber S2 Hardwood
PILE SHAPE: Round Tapered
PILE SIZE: Toe Diameter = 0.25 Taper (mm/m) = 8.00
STRENGTH REDUCTION FACTOR ϕ_g: 0.55
CALCULATION METHOD: Dutch Method

PROJECT: PROPOSED MAINTENANCE FACILITY
LOCATION: WOODLANDS CLOSE, HEXHAM
CLIENT: QUEENSLAND RAIL

CPT 4
Page 1 of 1
DATE 20/08/2007
PROJECT No: 39798
SURFACE RL: 0.73 AHD



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date 11/07
Plotted
Checked

Water depth after test: 0.00m depth

File: P:\39798\Field\CP5 files\CPT04.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePile Version 5.6.1

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PILE CAPACITY ESTIMATE

PILE TYPE: Driven Concrete
PILE SHAPE: Square
PILE SIZE: Width = 0.35
STRENGTH REDUCTION FACTOR $\emptyset_g$: 0.55
CALCULATION METHOD: Dutch Method

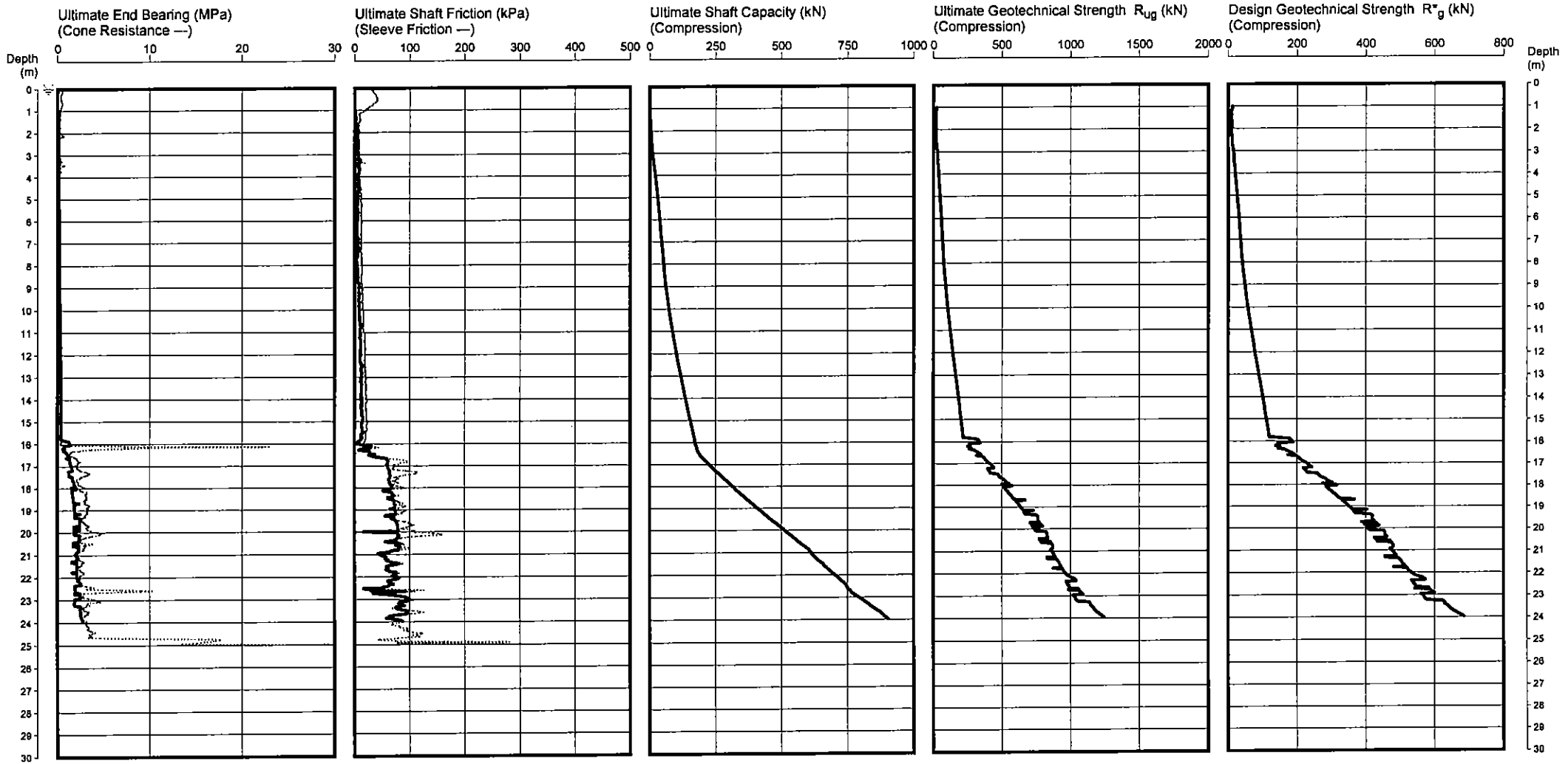
PROJECT: PROPOSED MAINTENANCE FACILITY

LOCATION: WOODLANDS CLOSE, HEXHAM

CLIENT: QUEENSLAND RAIL

CPT 4
Page 1 of 1

DATE 20/08/2007
PROJECT No: 39798
SURFACE RL: 0.73 AHD



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Date 11/07
Plotted
Checked

Water depth after test: 0.00m depth

File: P:\39798\Field\CP5 files\CPT04.CP5
Cone ID: IGS **Type:** 5 Piezocone

ConePile Version 5.6.1

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PILE CAPACITY ESTIMATE

PILE TYPE: Driven Concrete
PILE SHAPE: Square
PILE SIZE: Width = 0.35
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Dutch Method

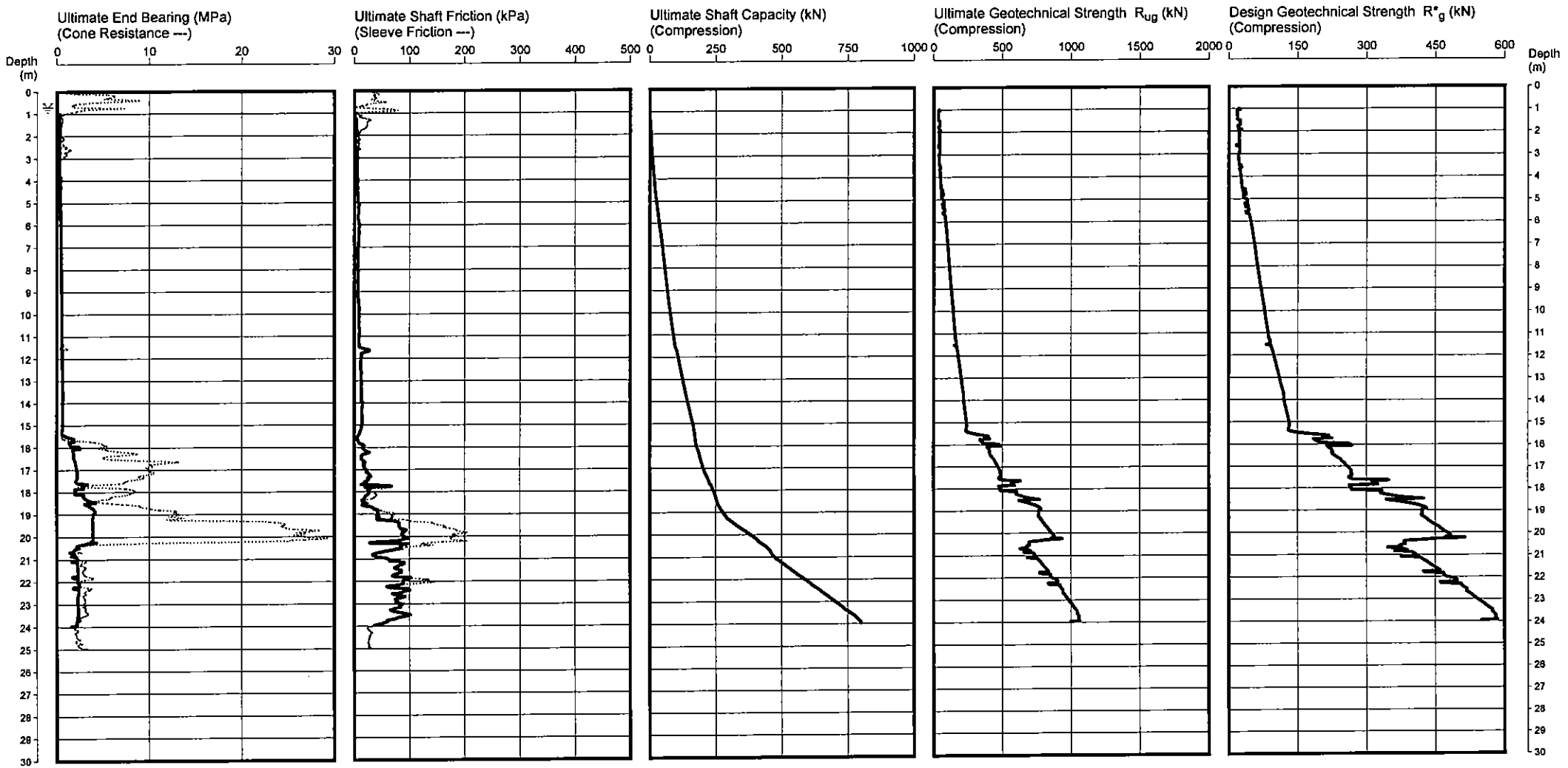
PROJECT: PROPOSED MAINTENANCE FACILITY

LOCATION: WOODLANDS CLOSE, HEXHAM

CLIENT: QUEENSLAND RAIL

CPT 11
Page 1 of 1

DATE 30/07/2007
PROJECT No: 39798
SURFACE RL: 1.53 AHD



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date 11/07
Plotted
Checked

Water depth after test: 0.70m depth

File: P:\39798\Field\CP5 files\CPT11.CP5
Cone ID: 400 **Type:** 2 Standard

ConePile Version 5.8.1

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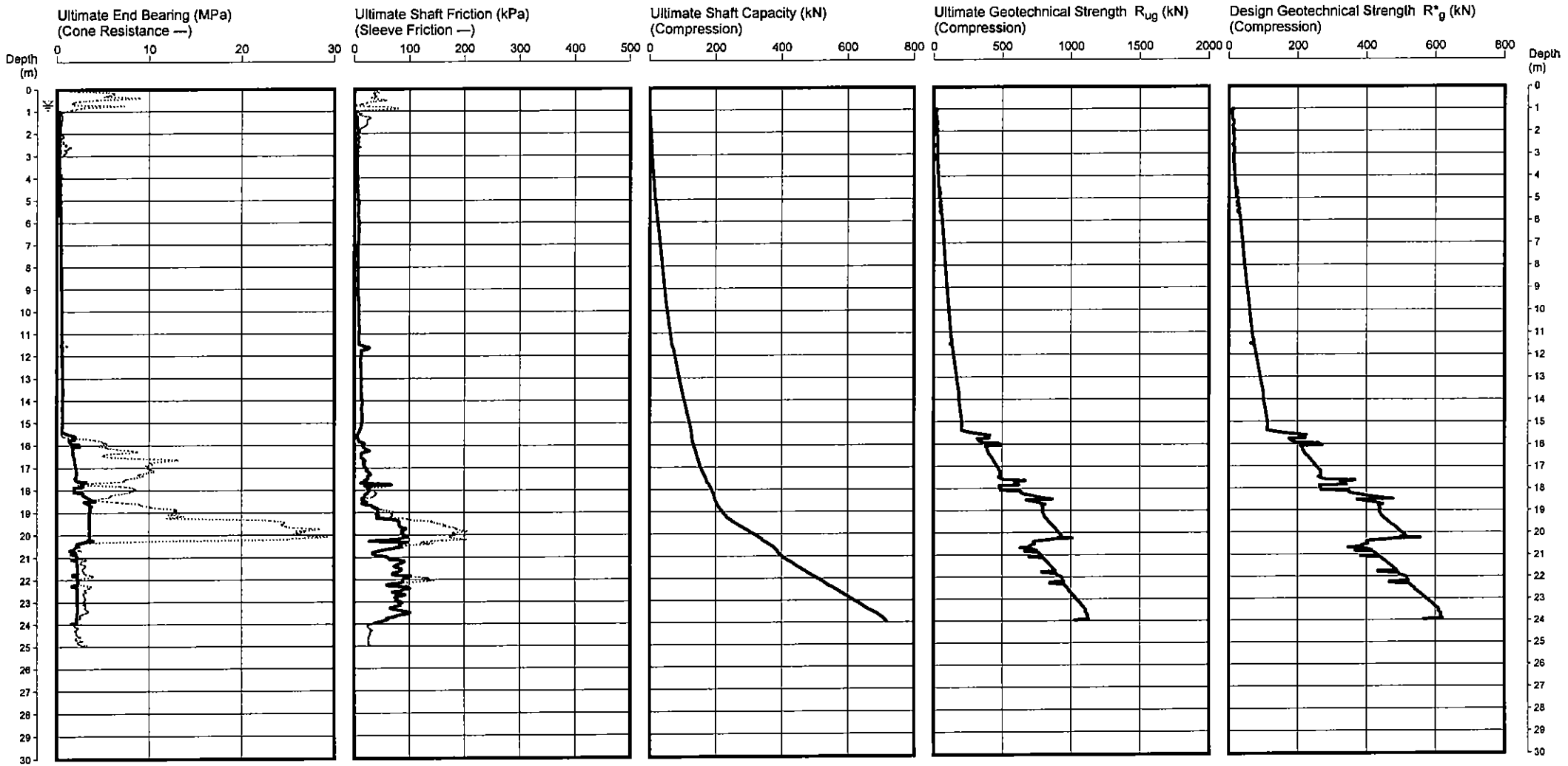
PILE CAPACITY ESTIMATE

PILE TYPE: Driven Timber S2 Hardwood
PILE SHAPE: Round Tapered
PILE SIZE: Toe Diameter = 0.25 Taper (mm/m) = 8.00
STRENGTH REDUCTION FACTOR $\emptyset_g$: 0.55
CALCULATION METHOD: Dutch Method

PROJECT: PROPOSED MAINTENANCE FACILITY
LOCATION: WOODLANDS CLOSE, HEXHAM
CLIENT: QUEENSLAND RAIL

CPT 11

DATE 30/07/2007
PROJECT No: 39798
SURFACE RL: 1.53 AHD



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date 11/07
Plotted
Checked

Water depth after test: 0.70m depth

File: P:\39798\Field\CP5 files\CPT11.CP5
Cone ID: 400 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
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Appendix F

Douglas Partners Report – Geotechnical Assessment

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Project 39798.08
15 May 2012
SAM:sm
P:\39798.08\Docs\39798.08 Appendix F.doc

Appendix F

Geotechnical Assessment of Embankment Settlement and Stability
Train Support Facility
Hexham

1. Introduction

This report presents the results of a geotechnical assessment for a proposed rail siding and provisioning and maintenance facility situated off Woodlands Close, Hexham. The work was undertaken at the request of QR National.

This report supersedes the report on the geotechnical assessment, ref 39798.01, 19 March 2008, prepared for Queensland Rail.

It is understood that the first stage of the development will include the construction of the following:

- Temporary provisioning and fuelling facility;
- Two new rail embankments from Ch 177241 m to Ch 179917 m.

At this stage, it is understood that the rail embankments will be constructed and allowed to settle for a period of about six months to one year. Following the initial settlement, the rail track and ballast will be installed and the subsequent settlement will be accommodated by periodic re-levelling of the rail track, as required.

The purpose of this assessment was to provide the following:

- Estimation of the initial settlement over a period of six months to one year based on the long section (cut and fill depths) provided;
- Estimation of the long term (residual) settlement following construction of the rail track;
- Stability analysis of the rail embankment.

This report was prepared on the basis of geotechnical data presented in the Report on Preliminary Geotechnical Investigation, ref 39798, October 2007 which is now superseded by the Report on Preliminary Geotechnical Investigation, ref 39798.08 May 2012.

2. Rail Embankment Loads

The formation levels of the proposed rail embankment were provided in a long-section by the client. The formation level along the majority of the rail siding is RL 2.65 AHD but reduces in elevation at each end of the alignment to tie into the Great Northern Railway (RL 1.4 m AHD southern end and 1.46 m AHD northern end).

It is understood that the rail level will be an additional 0.65 m above the formation level and that the proposed buildings will be at rail level (ie 3.3 AHD). The additional pressure associated with the ballast / rail is about 10 kPa to the top of the formation level; this load has been ignored in the analysis to account for some of the preconsolidation pressure of the underlying clays.

The load applied by the trains onto the formation has not been considered in this assessment as the load is considered as a transient load and will not stress the underlying compressible clays for sufficient time to allow significant consolidation. Cyclic creep from repeated load by the trains has also been ignored in the analysis. It is considered that strain associated with cyclic creep would be within the order of accuracy of the settlement estimates associated with consolidation of the underlying clays.

It has also been assumed that the existing filling associated with the former coal preparation plant has consolidated the underlying clays. The bulk of the filling has been in place for a period of greater than 30 years. There is a possibility that creep settlement may still be occurring but compared to the settlement associated with the remaining parts of the site, the residual settlements are likely to be minor. In this regard the strength of the underlying clays in areas where existing fill is situated show strength gain has occurred which confirms that primary settlement has also occurred.

The weight of the proposed filling embankment has been based on a compacted unit weight 20 kN/m^3.

The settlement along the rail embankment was estimated generally at 100 m intervals. It should be noted that the testing undertaken for the preliminary assessment was not undertaken at this frequency. The settlement analysis was based on interpolation between data points and is therefore considered approximate.

Based on the above, settlement analysis at each location along the rail embankment was based on the following relationships:

- Load on foundation = (Top of Formation level – Current Surface Level) x 20 kN/m^3.

3. Settlement of Unimproved Site

The settlements of an unimproved site (ie site not subject to ground improvement works) under the above loads were estimated for the centrelines of the rail embankment as indicated on the long-section provided by the client. The settlements were estimated using conventional 1-D consolidation theory, with soil compressibility values derived from CPT q_c values, and previous laboratory test results.

The settlement is caused by consolidation of the clay, which generally occurs in three phases:

- Initial undrained elastic settlement;
- Primary consolidation - a volume decrease associated with dissipation of load-induced excess pore water pressures, in low permeability soils (ie clays). This process can take some time, and the rate is very dependent on the length of the drainage path;
- Secondary consolidation - involving rearrangement of the soil particles, without excess pore pressure, and is less dependent on the magnitude of load; also referred to as creep.

There are differing opinions on when creep commences: at the same time as primary consolidation, at some point during primary consolidation, or following substantial completion of primary consolidation. The analyses in this report assume that creep commences at about 90% of primary consolidation.

One dimensional consolidation estimates from CPT data were based on correlations between cone tip resistance (q_c or q_t) and constrained modulus (M):

$M = \alpha.q_c = 1 / m_v$, where m_v is the coefficient of volume compressibility.

The following values of α were adopted (Refs 1 and 2):

Clay with q_c < 0.5 MPa: $\alpha = 3$
Clay with q_c > 0.5 MPa: $\alpha = 4$
Sand: $\alpha = 6$

The following consolidation parameters were also adopted and are based on previous laboratory test results at this site and adjacent sites.

Table 1: Summary of Adopted Soil Parameters

Property	Upper Silty Sandy Clay /Clayey Sand	Clay/Silty Clay	Clay
Bulk Density γ_b (kN/m^3)	18	17	17
Strength Ratio s_u/p'_o	0.20	0.25	0.25
Creep rate C_α(%)	1	1.5	1.5
c_v Before Preload (m^2/yr)	5	2.5	2.5

At each CPT location a time-settlement plot was determined for an unimproved site. Figure 1 shows the settlement estimates at 0.5 years and 1 year following placement of filling and are compared to the total estimated settlement over 25 years.

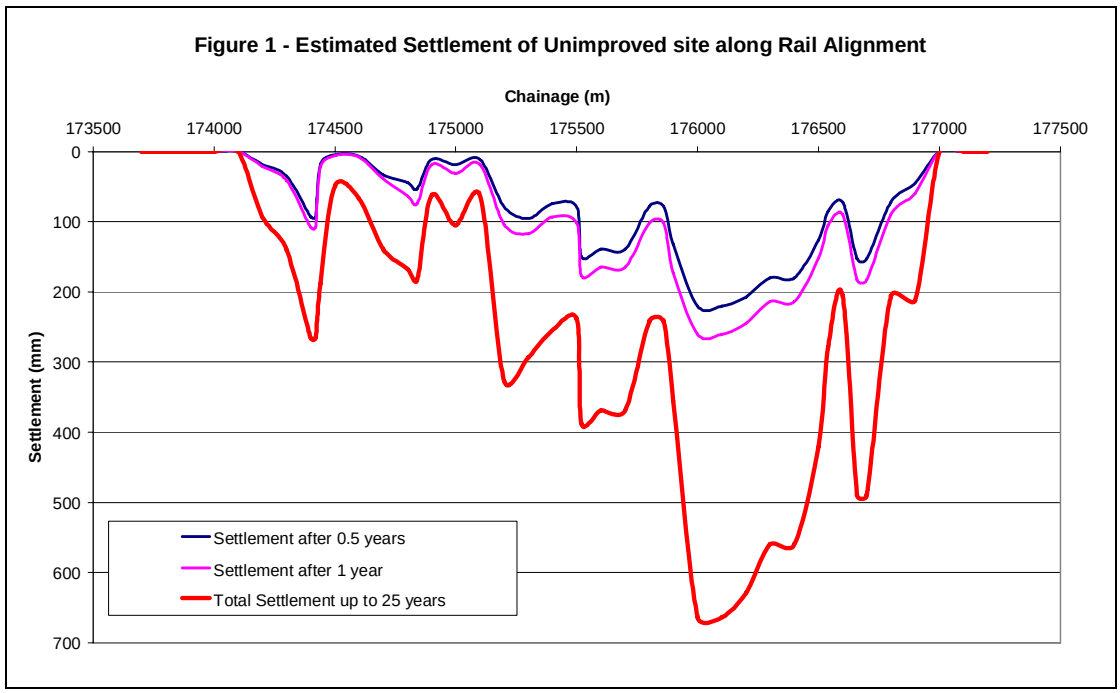
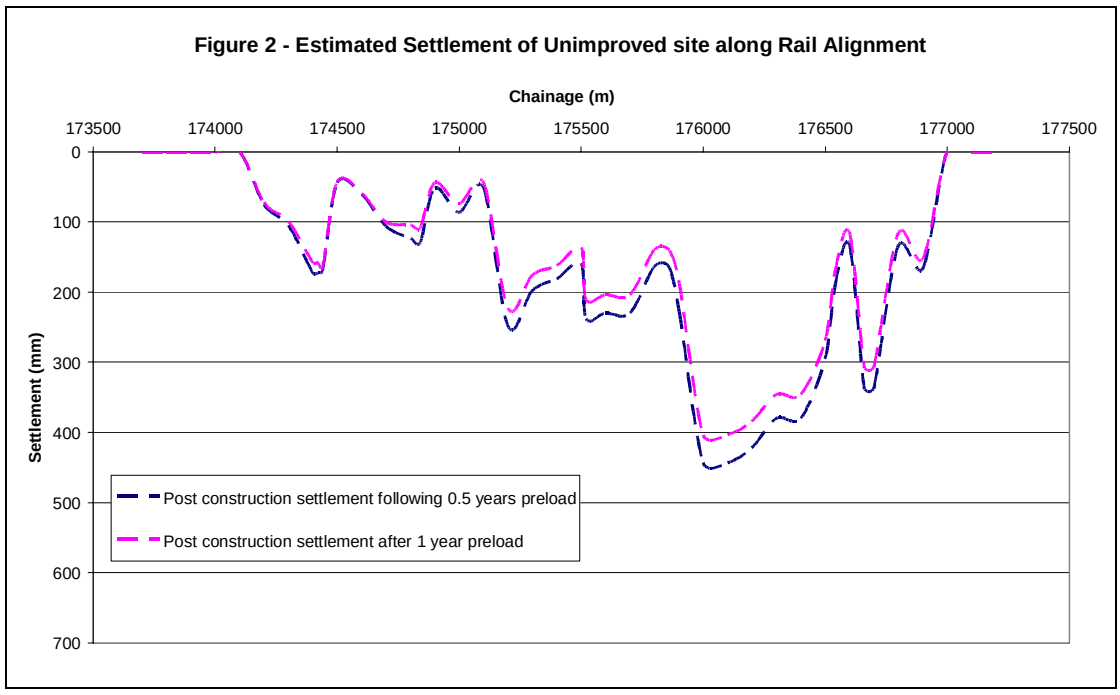


Figure 2 shows the post construction (residual) settlement of the rail embankment up to 25 years after the initial settlement



Based on the above plots, the largest expected settlement along the rail alignment will be between Ch 176000 m and 176700 m. This area correlates to the area where pre-existing filling has not been placed and the proposed fill height is greatest. This area is also situated in the area where the underlying clays are weaker in strength.

The magnitude and rates of settlements are estimates only. It is essential that the preload performance be monitored by geotechnical instrumentation installed prior to placing the fill and preload. These instruments would comprise settlement monitoring plates (SMP) installed on a regular grid. The SMPs would require survey levelling by registered surveyors at the time of installation and at selected time intervals during filling operations. SMPs generally provide valuable data on the magnitude and rate of settlement, which then help to refine post-construction settlement estimates.

4. Stability Assessment

The geometry of the embankment is controlled by the required height of the embankment, water level and the batter slopes required to provide acceptable factors of safety against slope instability.

The slope stability is controlled by the upper soft clay, which varies in strength and thickness across the site. For the purposes of the stability assessment, the stability of the rail embankment was assessed in the area where the clays were weakest and the height of the embankment is greatest (ie between Ch 176000 m and 176700 m).

The soil parameters adopted for initial conditions are presented in Table 2 below.

Table 2: Initial Soil Parameters used for Stability Analyses

Material	Bulk Density (kN/m^3)	Friction Ratio, ϕ (^{o})	Undrained Shear Strength, s_u (kPa)	Comments
Embankment Material	18	32	-	Fill material not known – assume granular fill
Upper Crust of Natural Material	18	-	25	Up to 1 m below ground
Lower Soft Clay	17	-	5	Greater than 1 m Strength increases with depth by 1.8 kPa/m

The geometry and load applied to the fill embankment was based on the following:

- Fill height – 2.0 m;
- Batter slope – 2.5 H:1V.

The slope stability assessment was undertaken using the program Slope/W Ver 2007.

The results of the analysis are shown in Figure 3 below and indicate that the factor of safety against slope failure during preload is 1.5 which is considered satisfactory for no load at crest.

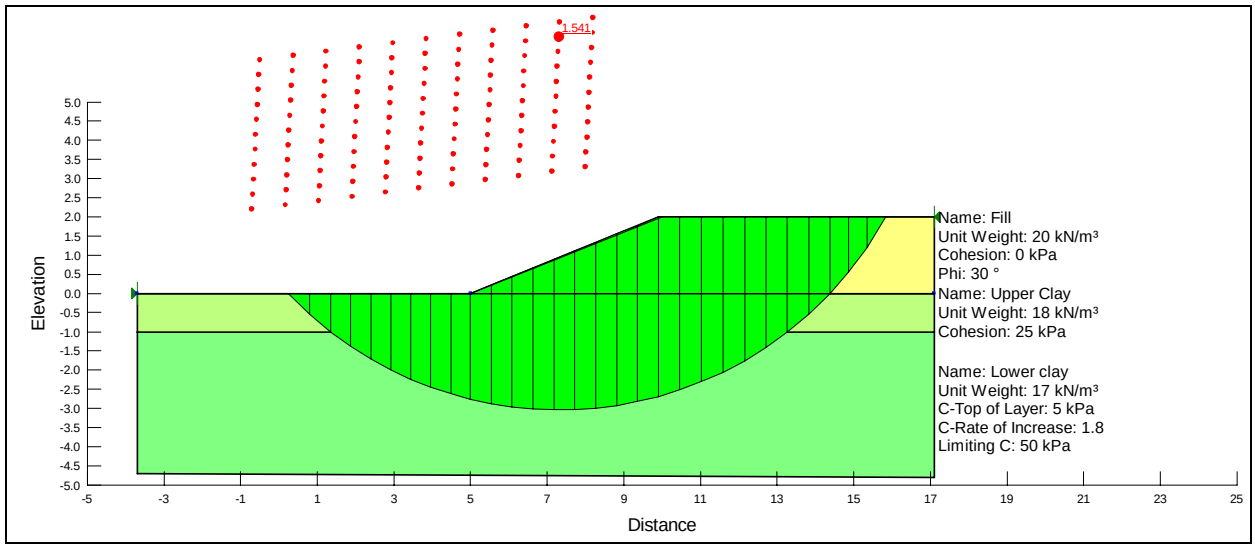


Figure 3: Results of Stability Analysis (no ground improvement, no load at crest)

The stability of the embankment following preload was estimated. The stability of the embankment (with train loads) will be a function of the amount of strength gain the underlying clays have achieved during the partial preload.

The consolidation and hence strength gain of the upper clay profile (critical for the stability assessment) was based on methods presented by Lambe & Whitman (1969) and the parameters presented in Table 1. Based on the results of the analysis, the degree of consolidation of the upper 3 m of soft clay after a period of 1 year was estimated to be about 50%.

The strength gain in the clay after full consolidation was calculated based on the following relationship between effective overburden stress and undrained shear strength:

$$s_u = 0.25\sigma_v'$$

Based on the above relationship and 50% strength gain within the soft clay after a period of 1 year, the strength of the upper 3 m of the soft clay due to a fill height of 2 m was estimated to be about 10 kPa.

The factor of safety was reassessed after a period of one year when the clays have partially consolidated and using a shear strength of 10 kPa. The analysis was also based on additional load applied at the crest of the embankment due to the load of a train. In this regard, without details on train loads, a value of 60 kPa (positioned at least 1 m from the shoulder of the embankment) was assumed in the analysis for the stress applied by the train loads onto the fill embankment.

The results of the stability analysis are presented in Figure 4 and indicate that the factor of safety following 1 year preload is about 1.3.

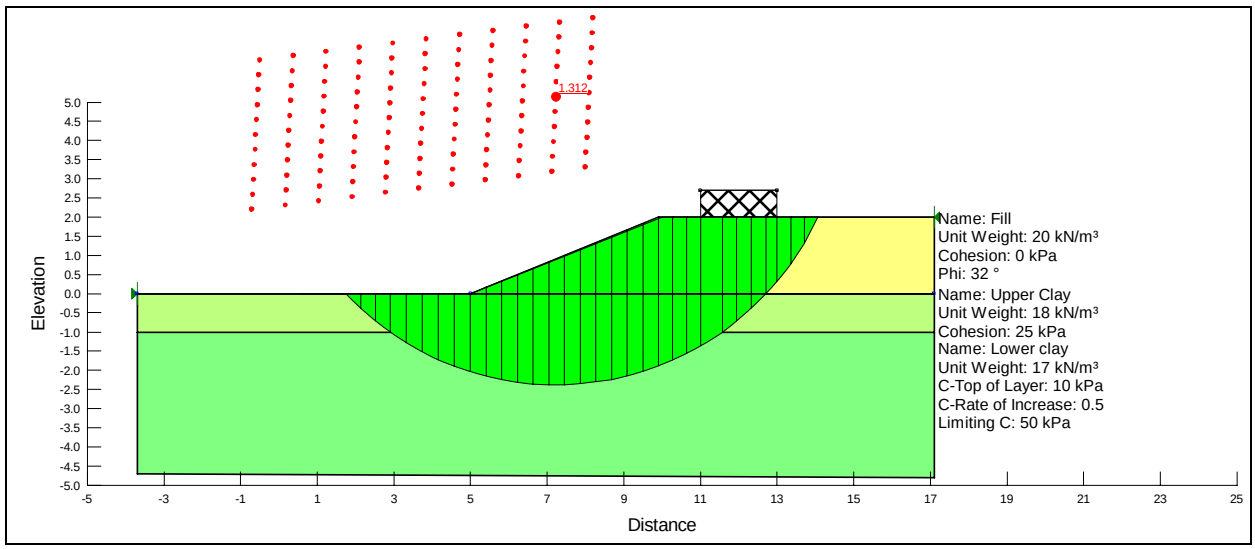


Figure 4: Results of Stability Analysis (following 1 year preload)

A factor of safety against slope failure of greater than 1.5 is generally considered the minimum acceptable for long term structures. The results of the above analysis suggest that a factor of safety of only 1.3 will be achievable following partial preload after 1 year and less if the preload is in place for a period of only 6 months. The factor of safety will increase over time to about 1.5 after the clay fully consolidates.

There are several options QR National can take with regard to the lower factor of safety; these are discussed below:

1. Do nothing – Accept the lower factor of safety and higher risk associated with slope instability until the upper clays have consolidated and sufficient strength gain has been achieved (ie about 5 to 8 years).
2. Placement of an additional 1 m to 2 m surcharge onto the fill embankment to increase the strength gain in the upper clays at the completion of partial preload and improve the long-term factor of safety. The short term factor of safety (ie during preload) will reduce to about 1.1 to 1.2 until strength gain is achieved. Careful monitoring of the fill embankment (via inclinometers) would be required to ensure slope failure does not occur during construction.
3. Install wick drains in the upper 5 m to 6 m of the clay profile to increase the consolidation rate and strength gain within the clay. The installation of wick drains will also aid with reducing long term settlement of the fill embankment. Further analysis would be required to optimise the depth and spacing of the wick drains if this option is considered.

4. Provide berm adjacent to rail embankment – Placement of a stabilising berm at the toe of the proposed embankment could be undertaken to improve the factor of safety against slope instability. The stabilising berm should be about 1 m high and 3 m wide at the toe of the embankment. The factor of safety against slope instability would increase to 1.4 in the short term which may be considered marginally acceptable.
5. Ground improvement options such as those presented in the DP report on the Preliminary Geotechnical Investigation, ref 39798.08 May 2012, ie deep soil mixing, stone columns or vacuum consolidation will increase the factor of safety against slope failure. Further analysis will be required if these options are considered.

The percentage of consolidation and thus strength gain can be gauged from pore pressure monitoring, however it is recommended that cone penetration testing be undertaken following preload, to confirm the predicted strength gain prior to allowing trains to use the rail embankment.

5. References

1. Lunne T, Robertson P K & Powell J J M (1997), "Cone Penetration Testing in Geotechnical Practice", Blackie Academic & Professional, First Edition 1997.
2. Jones S R (1995). "Engineering Properties of Alluvial Soils in Newcastle using Cone Penetration Testing", Proc Conference on Engineering Geology of the Newcastle-Gosford Region, The University of Newcastle, 5 - 7 February 1995, Australian Geomechanics Society.
3. Lambe, T W and Whitman, R V (1969) “Soil Mechanics”, Pub. John Wiley, New York.

Yours faithfully
Douglas Partners Pty Ltd Reviewed by

Scott McFarlane **John Harvey**
Senior Associate Principal

Appendix G

Douglas Partners Report – Geotechnical Investigation – Upgrade of Tarro Interchange

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Project 39798.08
17 May 2012
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Appendix G

Preliminary Geotechnical Investigation
Upgrade of Tarro Interchange
New England Highway, Tarro / Hexham

1. Introduction

This report presents the results of a geotechnical investigation for a proposed new road embankment between the Tarro interchange and Woodlands Close, Tarro, NSW. The work was carried out at the request of QR National.

It is understood that a new access road is proposed to connect the existing Tarro interchange with the QR National Train Support Facility (TSF).

A geotechnical investigation is required to assess subsurface conditions and to provide advice on the following:

- Settlement of the proposed embankment;
- Stability of the proposed embankment;
- Comments on ground improvement options to reduce construction time, instability of the batters and long-term settlement.

The investigation consisted of test bores and cone penetration tests (CPTs), in situ soil sampling and strength testing together with laboratory testing and engineering analysis. The results are presented in the report, together with geotechnical advice on design and construction.

The field investigations were undertaken along an alignment that has since been changed. This report is based on the testing results from the superseded alignment and, therefore, the comments are preliminary.

For the purpose of the investigation, the client supplied a current general arrangement plan, longitudinal and cross-sections of the proposed alignment (Ref ENG-0389-101 by Engenicom Pty Ltd / QR National) dated 26 April 2012.

2. Site Description

The site is located on the southern side of the New England Highway between Tarro and Hexham and covers the following areas:

Existing Tarro Interchange

The existing Tarro interchange comprised a concrete bridge spanning over the New England Highway with an earth-filled embankment on either end. The site of the geotechnical investigation is situated at the southern abutment (Figure 1). The earth filled embankment is about 8 m high and has grassed batters of between 2.5H:1V to 3H:1V. A row of semi mature trees is located at the eastern toe of the fill embankment.

The site was accessed via a temporary access road which comprised rubber tyres filled with gravel "Ecopave".

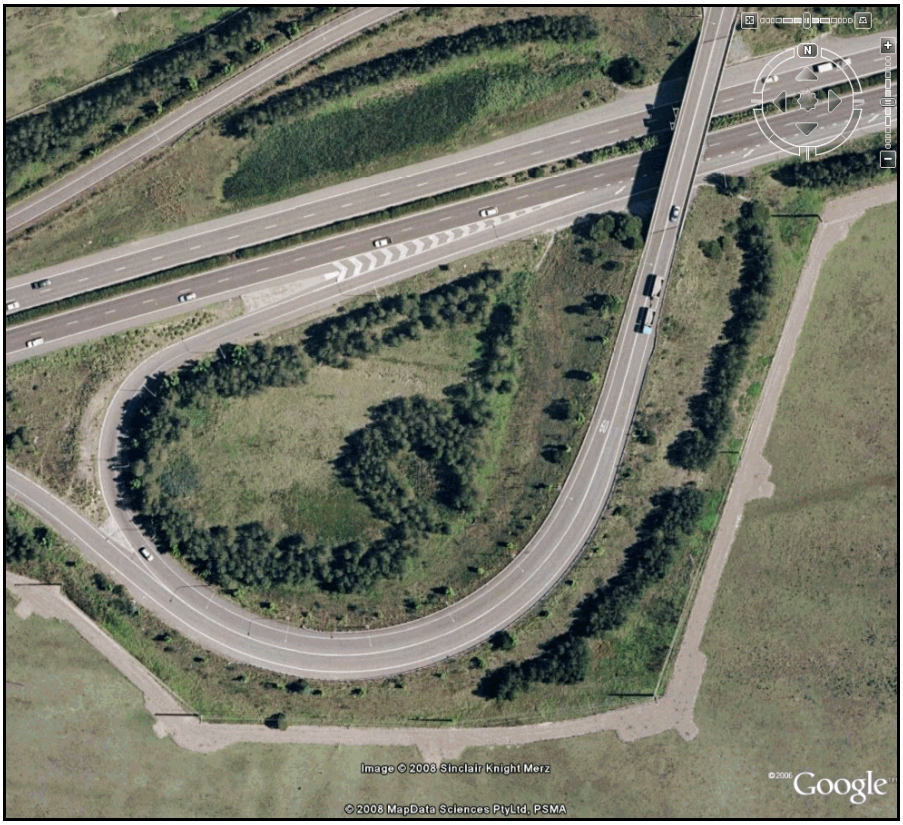


Figure 1: Southern Abutment of Tarro Interchange

Figure 2: Road leading off the southern embankment of the interchange Between Tarro Interchange and Woodlands Close

The area situated between the interchange and Woodlands Close comprises relatively flat grassed paddocks. The surface was saturated at the time of the investigation resulting in difficulties gaining access to test locations with rubber tyred vehicles. The Chichester pipeline bisects the access road in a north-south direction.

Figure 3: Area between gravel access road and the eastern side of the interchange embankment

Figure 4: Low lying grassed paddock between the Interchange and Woodlands Close (Old Maitland Road)

The 1:100000 scale Newcastle Coalfield Regional Geology map (Sheet 9321), published by the Department of Mineral Resources, indicates that the site is underlain by Quaternary Alluvium. The alluvium typically comprises unconsolidated sediments deposited in a fluvial or estuarine environment, and includes gravel, sand, silt and clay.

3. Field Work

3.1 Methods

General

The field work for the investigation was undertaken between 15 July 2007 and 18 July 2007, and comprised hand auger bores, drilling of bores and cone penetration tests (CPT).

The CPTs were set out at locations which were accessible to the truck mounted rig. Two additional CPTs were proposed but due to poor access, hand augers, together with hand shear vane and dynamic penetrometer testing were undertaken.

The tests were set out from existing site features such as boundary fences. The test locations are presented on Drawing 1-2, Appendix H. The position of the bores and pits were based on the development that was proposed in 2007.

An underground service locator was engaged to check test locations for potential underground services. The main services in the area included high pressure gas, Telstra, water (Chichester pipe line) and major optic (Telstra and Optus).

Cone Penetration Testing

A total of five CPTs were carried out to depths ranging from 2 m to 7.2 m, and were terminated upon.

The tests were carried out using a custom-built, truck-mounted CPT rig, with centrally located hydraulic rams. The cones were advanced at a constant rate of approximately 20 mm/second and a digital data acquisition system recorded cone tip resistance, friction sleeve resistance, inclination from vertical and encoded depth at measurement intervals of 20 mm.

Test Bores

A total of five bores (Bores 501 to 505) were drilled along Woodlands Close to assess the thickness of the existing pavement and subgrade conditions. The bores were drilled using a bobcat with 225 mm diameter auger attachment to depths of about 1.2 m.

Hand Augers

A total of eight hand-augur test bores (Bores 401, 404, 405 and 501b, to 505b) were drilled in areas where the drilling rig could not gain access due to wet and boggy conditions.

Bore 401 was drilled on the western site of the existing embankment at the Tarro interchange, Bores 404 and 405 were drilled within a grass paddock along the proposed road alignment between Woodlands Close and Tarro Interchange. Bores 501b to 505b were drilled near the toe of the existing road embankment along Woodlands Close

The bores were drilled to depths ranging between 1.2 m and 1.9 m.

3.2 Results

The subsurface conditions encountered are presented in detail in the attached borehole logs and CPT charts. The CPT charts show the measured parameters, together with an inferred strata description, based on published correlations. The charts and bores should be read in conjunction with the notes in Appendix A, which explain the descriptive terms and classification methods used in the logs.

The following is a summary of the subsurface conditions encountered in the bores / CPT. The summary of the subsurface conditions has been divided into two areas as presented below:

Woodlands Close (Bores 501 to 505 and 501b to 505b)

Bore 501 to 505 were drilled near the centre of Woodlands Close through the existing pavement.

The pavement profile along Woodlands Close generally comprised a spray seal wearing course overlying brown or black silty sandy gravel (basecourse) to depths of 0.18 m to 0.3 m. Clayey gravel comprising slag was encountered beneath the basecourse to depths of between 0.55 m and 0.8 m and was generally overlying natural clay or silty clay. Clay filling however, was encountered to 1.2 m depth at Bore 501.

Based on the results of the dynamic penetrometer and pocket penetrometer tests the underlying clay was firm to stiff to the depth of investigation (about 1.2 m). Some organics were encountered beneath the filling at Bores 501 and 505.

Bores 501b to 505b were drilled at the toe of the fill embankment along Woodlands Close.

Subsurface conditions in Bores 501b to 505b comprised topsoil to a depth of about 0.1 m overlying a firm to stiff clay / sandy clay which reduced in strength to generally firm below depths of about 0.4 m to 0.8 m at a similar level to the groundwater measurements. Soft clay was encountered in Bore 505b below depths of 1.6 m.

Groundwater was encountered in Bores 501b to 505b at depths of between 0.5 m to 0.9 m but the groundwater level rose to 0.28 m in Bore 502b after a period of about 15 minutes.

Proposed Embankment (Bore 401, 404 and 405, CPT 402, 403, 406, 407 and 407A)

The subsurface conditions at the bores and CPTs along the that was proposed in 2007 alignment comprised a thin layer of filling (CPT 402, 403, 406, 407 and 407A) to a depth of 0.3 m to 0.7 m. Topsoil was encountered in Bores 401, 404 and 405. The natural profile beneath the filling and topsoil comprised generally firm, firm to stiff or stiff clay to depths of between 1 m and 1.9 m. Very stiff to hard clay was encountered beneath the firm to stiff clay and continued to the depth of investigation where refusal was encountered at each location suggesting weathered bedrock. A summary of the results are presented in Table 1 below:

Table 1: Summary of Subsurface Conditions

Test Location	Depth of Filling / Topsoil (m)	Thickness of Firm to Stiff Clay (m)	Depth of CPT or DPT Refusal (m)	Groundwater Observations
Bore 401	Topsoil to 0.05 m	0.95	1.65	Not observed
CPT 402	Granular Filling to 0.4 m	1.2	4.78	Hole Collapse at surface
CPT 403	Granular filling to 0.4 m	0.8	7.22	0.5 m
Bore 404	Topsoil to 0.05 m	1.2	1.95	0.28 m
Bore 405	Topsoil to 0.05 m	1.4	1.95	0.4 m
CPT 406	Filling to 0.8 m	1.2	5.78	0.7 m
CPT 407	Filling to 0.3 m	1.5	2.0	0.2 m
CPT 407A	Filling to 0.4 m	1.2	2.16	0.2 m

The regional groundwater level is typically shallow relative to the natural ground surface. The data indicates that ground water levels are typically around 0 m to about 1 m below ground level. The groundwater measurements however may not represent a standing groundwater level as measurements are typically made upon the completion of testing and in low permeability soils there is insufficient time for water to enter the borehole, CPT hole prior to backfilling/collapse. In order to obtain accurate water levels, standpipes or piezometers installed in boreholes are required and should be monitored once levels have had sufficient time to stabilise.

Due to the above features, and with climatic variations, water levels within the site will be transient and also vary across the site.

4. Laboratory Results

Samples were submitted to the Douglas Partners Newcastle laboratory for California bearing ratio (CBR) and standard compaction testing. Detailed results are attached and are summarised in Table 2.

Table 2: Results of Laboratory Testing

Test Location	Depth (m)	Description	FMC (%)	MDD (t/m^3)	OMC (%)	CBR (%)
503b	0.2 - 0.5	Clay – Grey Brown	43.2	1.36	31.0	2.0
505	0.75 - 1.2	Clay – brown trace sand/gravel	59.1	1.27	36.5	6

Notes to Table 2:
FMC – Field Moisture Content
OMC – Optimum Moisture Content
MDD – Maximum Dry Density
CBR – California Bearing Ratio

Significant features to note with the laboratory testing is that field moisture contents are 12.2% (Bore 503B) and 22.6% (Bore 505) greater than optimum moisture content.

5. Comments

5.1 Road Embankment Loads

Analysis was carried out for the data obtained in 2007 for the road alignment proposed at that time. The analysis described in the following sections refers to the superseded alignment.

The finished surface level of the proposed road embankment was provided in a long-section by Engenicom. The surface level at the Tarro intersection is about RL 10.5 to 11 AHD and reduces in elevation to 1.8 AHD over a distance of about 200 m. From Ch 170 m to Ch 1580 the surface level of the finished road embankment is about RL 1.8 AHD (i.e. 0.6 m to 1.7 m above current ground levels).

The load applied by the vehicular loads onto the formation has not been considered in the settlement analysis as the load is considered as a transient load and will not stress the underlying compressible clays for sufficient time to allow significant consolidation. The traffic loads, however, have been considered in the short term stability analysis. A surcharge load of 20 kPa was adopted for the short term stability analysis.

The settlement along the road embankment was estimated generally at 40 m intervals between Ch 0 and Ch 200. The settlement analysis was based on interpolation between data points and is therefore considered approximate.

The weight of the proposed filling embankment has been based on a compacted unit weight 20 kN/m^3. The settlement analysis at each location along the road embankment was therefore determined as:
Load on foundation = (Finished Surface level – Current Surface Level) x 20 kN/m^3.

5.2 Settlement of Road Embankment

The settlement of an unimproved site under the above loads were estimated for the centrelines of the rail embankment as indicated on the long-section provided by the client. The settlements were estimated using conventional 1-D consolidation theory, with soil compressibility values derived from CPT q_c values, and previous laboratory test results. The layer thicknesses from the bores were also used in the analysis.

The settlement is caused by consolidation of the clay, which generally occurs in three phases:

- Initial undrained elastic settlement;
- Primary consolidation - a volume decrease associated with dissipation of load-induced excess pore water pressures, in low permeability soils (i.e. clays). This process can take some time, and the rate is very dependent on the length of the drainage path;
- Secondary consolidation - involving rearrangement of the soil particles, without excess pore pressure, and is less dependent on the magnitude of load; also referred to as creep. The stiffness of the clay that was encountered at each test location (Tests 401 to 405) suggests that secondary consolidation is likely to be minor.

One dimensional consolidation estimates from CPT data were based on correlations between cone tip resistance (q_c or q_t) and constrained modulus (M):

$M = \alpha.q_c = 1/m_v$, where m_v is the coefficient of volume compressibility.

The following values of α were adopted:

Clay with $q_c < 0.5$ MPa: $\alpha = 3$
Clay with $q_c > 0.5$ MPa: $\alpha = 4$
Sand: $\alpha = 6$

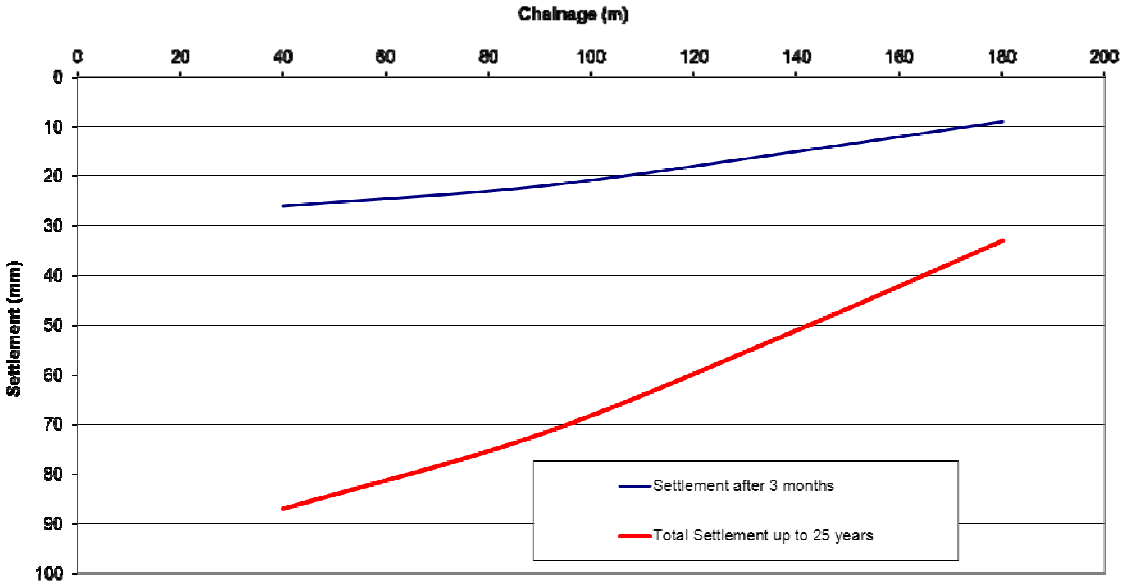
The following consolidation parameters were also adopted based on previous laboratory test results at this site and adjacent sites.

Table 3: Summary of Adopted Soil Parameters

Property	Clay – Firm to Stiff	Clay/Sandy Clay – Very Stiff to Hard
Bulk Density γ_b (kN/m^3)	17	21
Creep rate $C_{\alpha\varepsilon}$(%)	0.1	0.0
Coefficient of Vertical consolidation c_v (m^2/yr)	2.0	2.0

At each CPT location a time-settlement plot was determined for an unimproved site. Figure 1 shows the settlement estimates at 3 months and following placement of filling and are compared to the total estimated settlement over 25 years and the total post construction settlement following 3 months.

Figure 1 - Estimated Settlement of Unimproved site along Road Alignment



Based on the above plot, the largest expected settlement along the road embankment will be between Ch 35 m and 80 m. This area correlates to the area where the depth of proposed filling is greatest (about 10 m high) which would subject a load of about 200 kPa onto the foundation soils.

Based on thickness of clay encountered at Bore 401 and CPT 402/403, it is considered that the natural clay beneath the existing Tarro interchange has already consolidated due to the load applied by the existing embankment. Accordingly, any additional settlement of the existing embankment will only be associated with the placement of additional filling over the existing batters of the embankment. The thickness of the fill on the batters therefore reduces toward the centre of the existing embankment and therefore settlement will reduce.

Based on the results presented in Figure 1, it is expected that post construction settlements of up to 30 mm to 40 mm can be accommodated and ground improvement is unlikely to be required for the proposed road.

5.3 Stability of Road Embankment

The geometry of the embankment is controlled by the required height of the embankment, water level and the batter slopes required to provide acceptable factors of safety against slope instability. The slope stability is controlled by the upper firm or firm to stiff clay. For the purposes of the assessment, the stability of the road embankment was assessed in the area where the clays were weakest and the height of the embankment is greatest (i.e. between Ch 35 and 80 m).

The soil parameters adopted for initial conditions are presented in Table 4 below.

Table 4: Initial Soil Parameters used for Stability Analyses

Material	Bulk Density (kN/m^3)	Internal Friction ϕ (^{o})	Undrained Shear Strength, s_u (kPa)	Comments
Embankment Material	22	34^o	-	Fill material not known – assume granular fill such quarry overburden
Upper Firm to Stiff Clay	19	-	35	Up to 1.5 m below natural ground
Lower Hard Clay	21	-	400	Greater than 1.5 m

The geometry and load applied to the fill embankment was based on the following:

- Fill height – 10.0 m;
- Batter slope – 2.5 H:1V.

The slope stability assessment was undertaken using the program Slope/W Ver 2007.

The results of the analysis indicate that the factor of safety against slope failure is 1.40 which is slightly below the normally accepted factor of safety of 1.5 for long – term structures. The factor of safety increases to greater than 1.5 for embankment heights of less than 6 m.

The stability was reanalysed for a batter slope 3H:1V. The results of the analysis indicated a factor of safety of 1.6, as shown in Figure 2, which was considered acceptable.

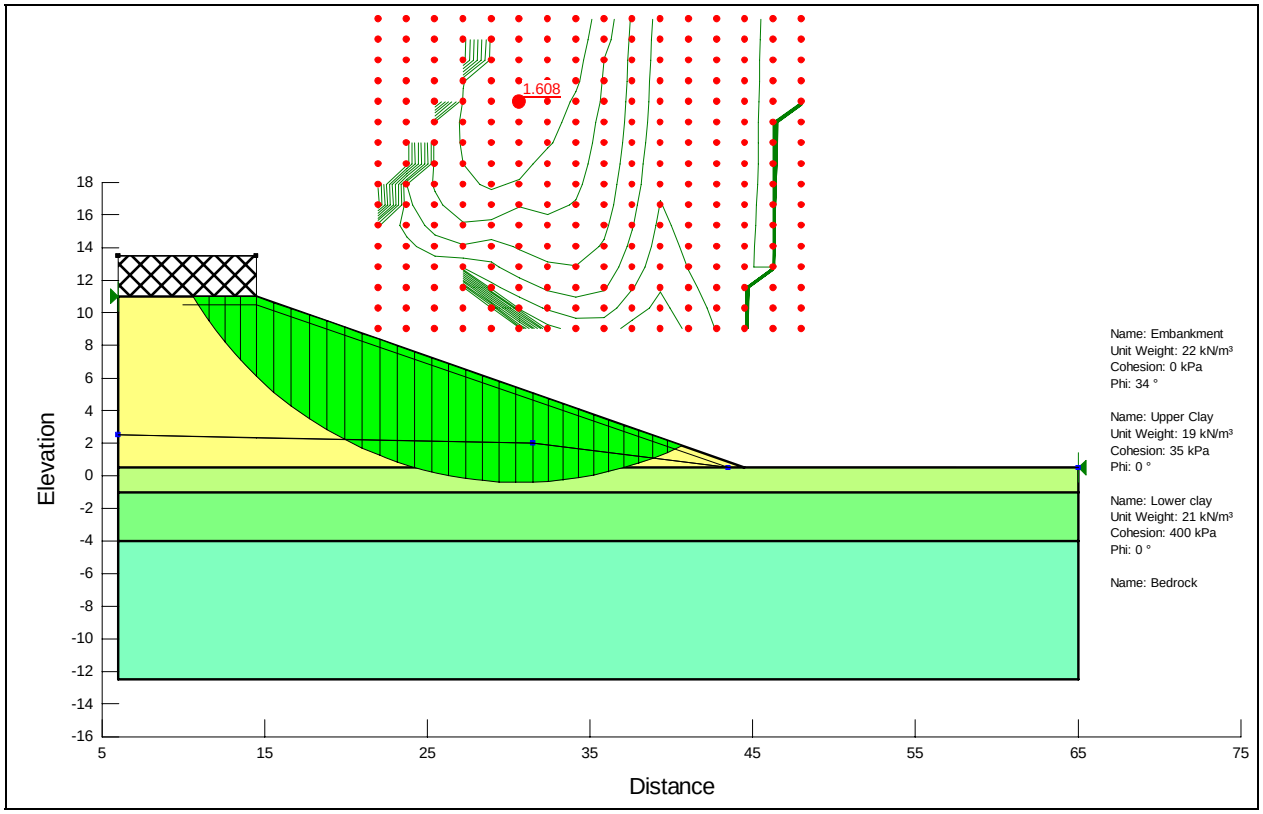


Figure 2: Results of Stability Analysis (3H:1V batters)

In summary, the results of the analysis indicate that for embankments greater than 6 m in height, the batter slope should be no steeper than 3H:1V and for embankments less than 6 m in height, batters should be no steeper than 2.5H:1V.

Yours faithfully
Douglas Partners Pty Ltd Reviewed by

Scott McFarlane **John Harvey**
Senior Associate Principal

Attachments: Borehole Lots (Bore 401, 404, 405, 501 to 505, 501b to 505b)
CPT Plots (CPT 402, 403, 406, 407 and 407A)
Results of Dynamic Penetrometer Tests
Laboratory Test Results

BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: 1.2m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 401
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.05	TOPSOIL: Generally comprising dark brown/black silty clay, M>Wp							
		CLAY: Stiff grey mottled orange clay, M>Wp		SV	0.5		Peak = 66kPa Residual = 4.5kPa		
1	1.0	SILTY CLAY/CLAYEY SILT: Very stiff light grey mottled orange silty clay/clayey silt, M<Wp		SV	1.05		Peak = 160kPa Residual = 12kPa		
	1.2	Bore discontinued at 1.2m, due to refusal							
2									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand tools
DRILLER: Foote/Cowan
LOGGED: Foote/Cowan
CASING: Nil

TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Interpolated from survey plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: 0.9m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 404
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.05	TOPSOIL: Soft dark brown silty clay topsoil, saturated, rootlets							
		CLAY: Stiff dark grey clay, some orange mottling (iron staining?), M>Wp		SV A	0.5		Peak=78kPa Residual=4kPa		
		From 0.8m, slightly sandy clay, grades to clay. Sand is fine to medium grained							
	1			SV	1.0		Peak=70kPa Residual=4kPa		
		From 1.2m, very stiff							
	1.9	Bore discontinued at 1.9m, due to refusal							
	2								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand tools **DRILLER:** Foote/Cowan **LOGGED:** Foote/Cowan **CASING:** Nil

TYPE OF BORING: Hand Auger

WATER OBSERVATIONS: Free groundwater observed at 0.08m

REMARKS: Interpolated from long-section

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: 0.8m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 405
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.05	TOPSOIL: Soft dark brown silty clay topsoil, saturated, rootlets							
		CLAY: Firm dark brown clay, M>Wp							
	0.3	CLAY: Stiff grey mottled orange (ferric staining?) clay, W_L>M>Wp						▼	
		From 0.5m, grey in colour		SV	0.5		Peak=78kPa Residual=3.4kPa		
	0.9	SANDY CLAY: Stiff grey sandy clay, sand is fine to medium grained, grades to slightly sandy clay, W_L>M>Wp		SV A	1.0		Peak=90kPa Residual=11kPa		
1	1.25	From 1.2m, brown in colour							1
		SHELLY CLAY: Stiff grey shelly clay, some patches of orange, fine grained clayey sand, W_L>M>Wp		A	1.3				
		From 1.4m, very stiff							
	1.8	Bore discontinued at 1.8m, due to refusal							
2									2

RIG: Hand tools **DRILLER:** Foote/Cowan **LOGGED:** Foote/Cowan **CASING:** Nil

TYPE OF BORING: Hand Auger

WATER OBSERVATIONS: Free groundwater observed at 0.4m

REMARKS: Interpolated from long-section

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 501
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
	0.03	FILLING - Spray seal							
		FILLING - Generally comprising brown silty sandy fine to medium grained subrounded gravel		A	0.1				
	0.18	FILLING - Generally comprising silty clayey gravel and slag		A	0.4				
	0.75	FILLING - Generally comprising clay, silty clay and gravel		A	0.8				1
	1.2	CLAY - Firm brown clay, organics M>Wp		A	1.2				
	1.25	Bore discontinued at 1.25m, limit of investigation							
	2								2

RIG: 247 Bobcat
DRILLER: J. Ahern
LOGGED: Benson
CASING: Nil

TYPE OF BORING: Solid Flight Auger - 200mm Ø
WATER OBSERVATIONS: No free groundwater observed
REMARKS: On centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 501b
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - Brown clay, trace silt with rootlets, M>Wp							
		CLAY - Firm brown clay, trace silt. M>Wp. Silt content decreasing with depth		A,pp	0.2		90-100 kPa		
		From 0.35m orange grey		A,pp	0.4		70-80 kPa		
				pp	0.55		60-90 kPa	▼	
	0.8	SANDY CLAY - Firm grey fine grained sandy clay, M>>Wp							
	1			A	1.0				1
	1.5	Bore discontinued at 1.5m, limit of investigation							
	2								2

5 10 15 20

RIG:
DRILLER: Benson
LOGGED: Benson
CASING: Nil

TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: Free groundwater observed at 0.77m
REMARKS: 13m south of centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 502
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
	0.03	FILLING - Spray seal							
		FILLING - Generally comprising brown silty sandy fine to medium grained subrounded gravel		A	0.2				
	0.26	FILLING - Generally comprising grey brown silty clayey fine grained gravel and slag (20-80mm)		A	0.4				
	0.65	CLAY - Soft to firm grey brown clay, trace silt, M>>Wp		A	0.8				
	1.2	Bore discontinued at 1.2m, limit of investigation							

RIG: 247 Bobcat **DRILLER:** J. Ahern **LOGGED:** Benson **CASING:** Nil
TYPE OF BORING: Solid Flight Auger - 200mm Ø
WATER OBSERVATIONS: No free groundwater observed
REMARKS: 0.5m north of centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 15/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 502b
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - Brown clay, trace silt, rootlets, M>Wp							
		CLAY - Firm, brown clay, M>Wp		A,pp	0.3		90-120 kPa		
		From 0.35m orange/grey		pp	0.5		50-90 kPa		
		From 0.65m mottled orange grey						▼	
	0.75	SANDY CLAY - Firm grey fine grained sandy clay, saturated		A	0.8				
	1.5	Bore discontinued at 1.5m, limit of investigation							

RIG:
DRILLER: Benson
LOGGED: Benson
CASING: Nil

TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: Free groundwater observed at 0.65m (0.28m by time packed up)
REMARKS: 14m south of centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 503
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.03	FILLING - Spray seal							
		FILLING - Generally comprising brown silty clayey sandy fine to coarse subrounded to subangular gravel		A	0.2				
	0.25	FILLING - Generally comprising slag (20-80mm) and silty sandy clayey fine to medium grained gravel		A	0.4				
	0.55	CLAY - Firm grey brown clay trace fine grained gravel, M>Wp		A	0.8				
	1.2	Bore discontinued at 1.2m, limit of investigation							

RIG: 247 Bobcat
DRILLER: J. Ahern
LOGGED: Benson
CASING: Nil

TYPE OF BORING: Solid Flight Auger - 200mm Ø
WATER OBSERVATIONS: No free groundwater observed
REMARKS: On centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 503b
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.2	TOPSOIL - Brown clay, trace silt, rootlets, M<Wp							
		CLAY - Firm to stiff grey brown clay, M>Wp		B,pp	0.2		100-150 kPa		
	0.55	CLAYEY SAND/SANDY CLAY - Firm orange/brown clayey sand/sandy clay, damp		A	0.5 0.8			▼	
	1.7	Bore discontinued at 1.7m, limit of investigation							

RIG:
DRILLER: Benson
LOGGED: Benson
CASING: Nil

TYPE OF BORING: Shovel to 0.5m. Hand Auger to TBD
WATER OBSERVATIONS: Free groundwater observed at 0.9m
REMARKS: 12m south of centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 17/7/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 504
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
	0.03	FILLING - Spray seal							
		FILLING - Generally comprising black silty sandy subrounded gravel		A	0.1				
	0.25	FILLING - Generally comprising silty clayey medium to coarse subrounded-angular gravel (slag) - clay content increasing with depth		A	0.4				
	0.8	CLAY - Firm brown clay, trace silt, M>Wp		A	0.9				1
	1.2	Bore discontinued at 1.2m, limit of investigation							
	1								
	2								2

RIG: 247 Bobcat **DRILLER:** J. Ahern **LOGGED:** Benson **CASING:** Nil

TYPE OF BORING: Solid Flight Auger - 200mm Ø

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Auger tip bolt snapped - 650mm - hole on centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/08

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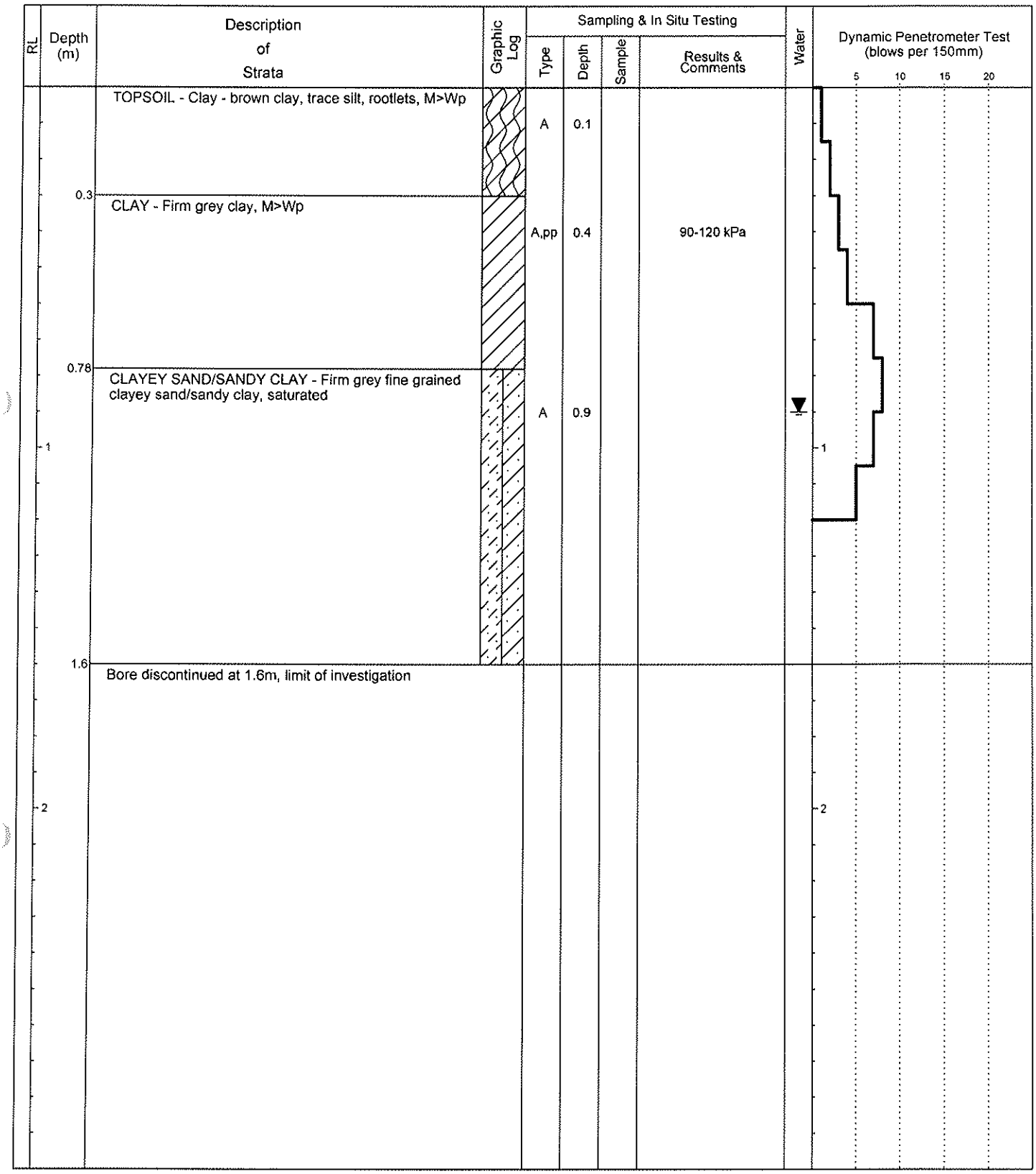
BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 504b
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1



RIG:
DRILLER: Benson
LOGGED: Benson
CASING: Nil

TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: Free groundwater observed at 0.9m
REMARKS: 14m south of centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/8/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 505
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.03	FILLING - Spray seal							
		FILLING - Generally comprising black silty gravel subrounded-angular		A	0.2				
	0.3	FILLING - Generally comprising brown/grey silty medium to coarse gravel (slag) - some coal		A	0.4				
	0.7	ORGANICS		A	0.7				
	0.75	CLAY - Soft brown clay trace silt, trace fine grained sand, trace fine grained gravel		B,pp	0.75		20-50 kPa		
	1.2	Bore discontinued at 1.2m, limit of investigation			1.2				

RIG: 247 Bobcat **DRILLER:** J. Ahern **LOGGED:** Benson **CASING:** Nil

TYPE OF BORING: Solid Flight Auger - 200mm Ø

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Approximately 500mm south of centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 16/08

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BOREHOLE LOG

CLIENT: Queensland Rail
PROJECT: Tarro Interchange - Option 3
LOCATION: New England Highway 1, Woodlands Close, Tarro/Hexham

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 505b
PROJECT No: 39798.03
DATE: 17 Jul 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL - Brown silty clay							
	0.1	CLAY - Firm brown silty clay, M>Wp, trace silt, trace sand		A,pp	0.2		100 kPa		
		From 0.5m mottled orange brown From 0.55m mottled orange/grey. Saturated from 0.55m		A	0.65			▼	
		From 0.8m grey-dark grey		pp	0.85		50-60 kPa		
	1	From 1.1m soft							1
	1.6	Bore discontinued at 1.6m, limit of investigation							
	2								2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG:
DRILLER: Benson
LOGGED: Benson
CASING: Nil

TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: Free groundwater observed at 0.6m
REMARKS: Approximately 11m south of centre line

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 10/08

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: TARRO INTERCHANGE

LOCATION: NEW ENGLAND HIGHWAY, TARRO/ HEXHAM

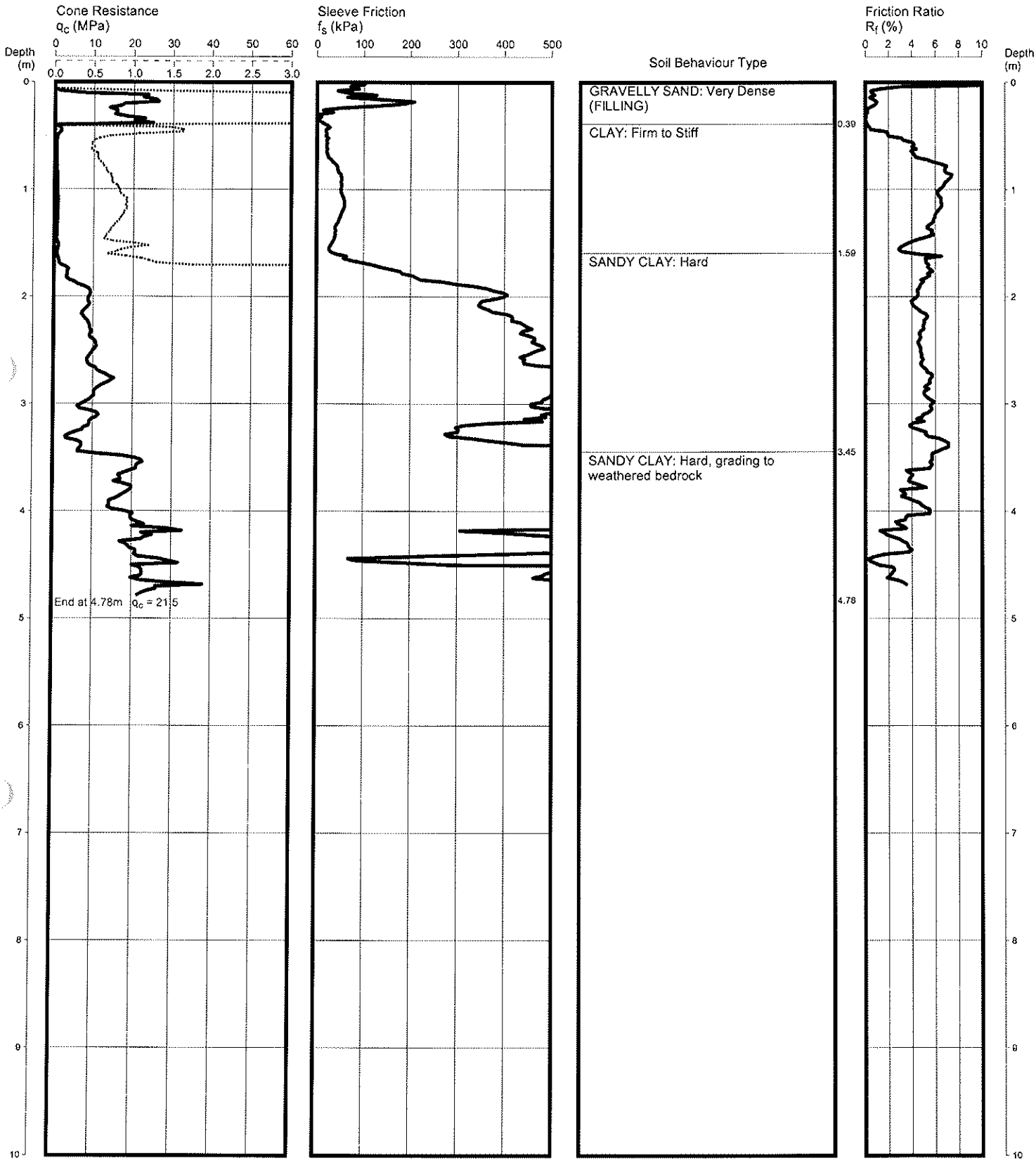
PROJECT No: 39798.03

CPT 402

Page 1 of 1

DATE 15/07/2008

SURFACE RL: 1.1



REMARKS: HOLE COLLAPSED AT 0.2m AFTER WITHDRAWAL OF RODS
SURFACE LEVEL INTERPOLATED FROM LONG-SECTION BY WPWATER LEVEL ASSUMED

Date Plotted 16/7/08
Checked

File: P:\39798.03\Field\39798402.CP5
Cone ID: 413 Type: 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: UPGRADE AT TARRO INTERCHANGE

LOCATION: NEW ENGLAND HIGHWAY, TARRO / HEXHAM

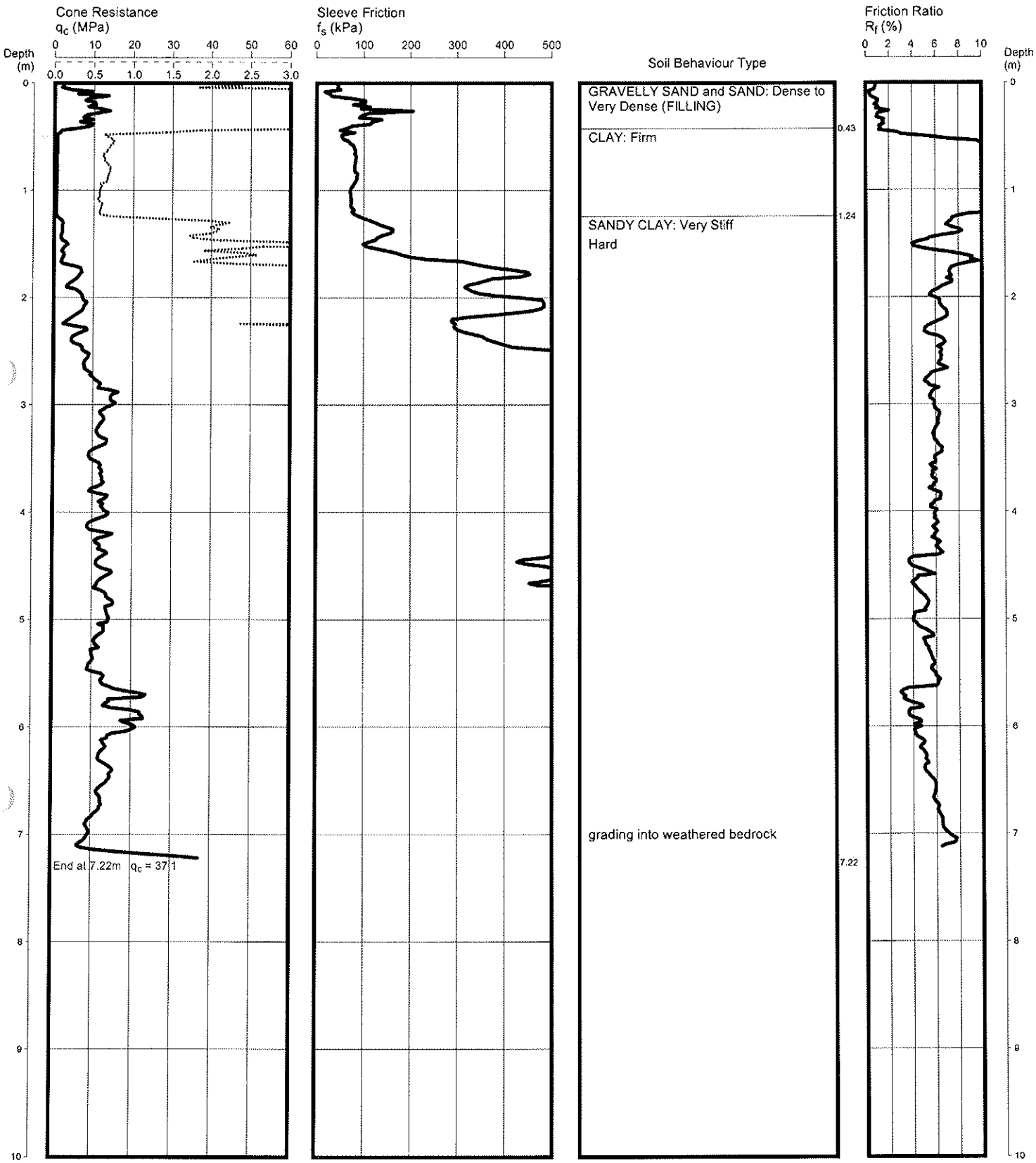
PROJECT No: 39798.03

CPT 403

Page 1 of 1

DATE 15/07/2008

SURFACE RL: 1.1



REMARKS: HOLE COLLAPSED AT 0.2 m AFTER WITHDRAWAL OF RODS
SURFACE LEVEL INTERPOLATED BY LONG-SECTION BY WPWATER LEVEL ASSUMED

Date Plotted 13/8/08
Checked

File: P:\39798.03\Field\39798403.CP5
Cone ID: CONE-HH3 Type: 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: TARRO INTERCHANGE

LOCATION: NEW ENGLAND HIGHWAY, TARRO / HEXHAM

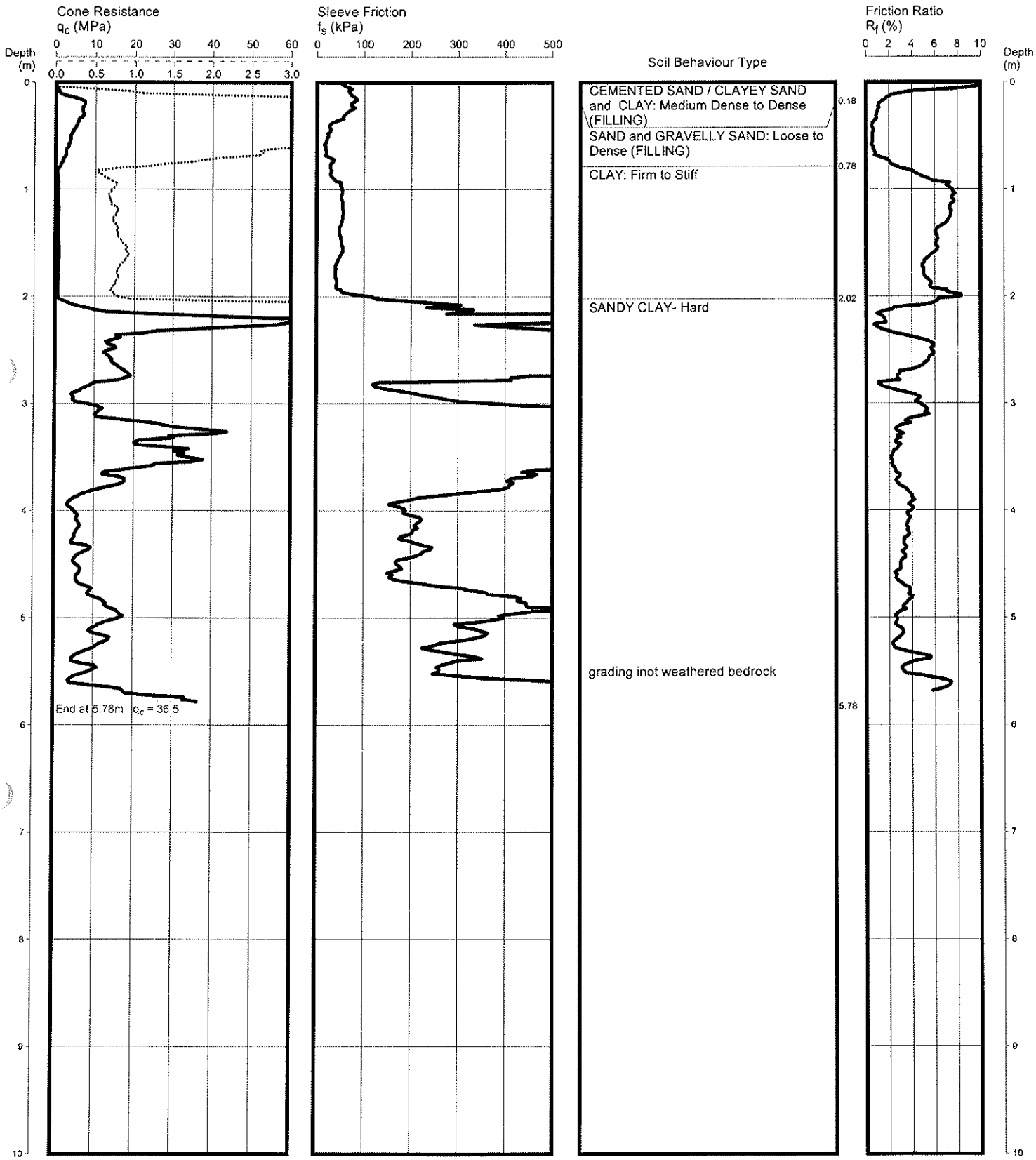
PROJECT No: 39798.03

CPT 406

Page 1 of 1

DATE 15/07/2008

SURFACE RL: 1.2 AHD



REMARKS: WATER DEPTH AT COMPLETION OF TEST:0.7m
SURFACE LEVEL INTERPOLATED FROM LONG-SECTION BY WP

Date Plotted 10/08
Checked

File: P:\39798.03\Field\39798406.CP5
Cone ID: CONE-HH3 Type: 2 Standard

ConePlot Version 5.6.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: TARRO INTERCHANGE

LOCATION: NEW ENGLAND HIGHWAY, TARRO / HEXHAM

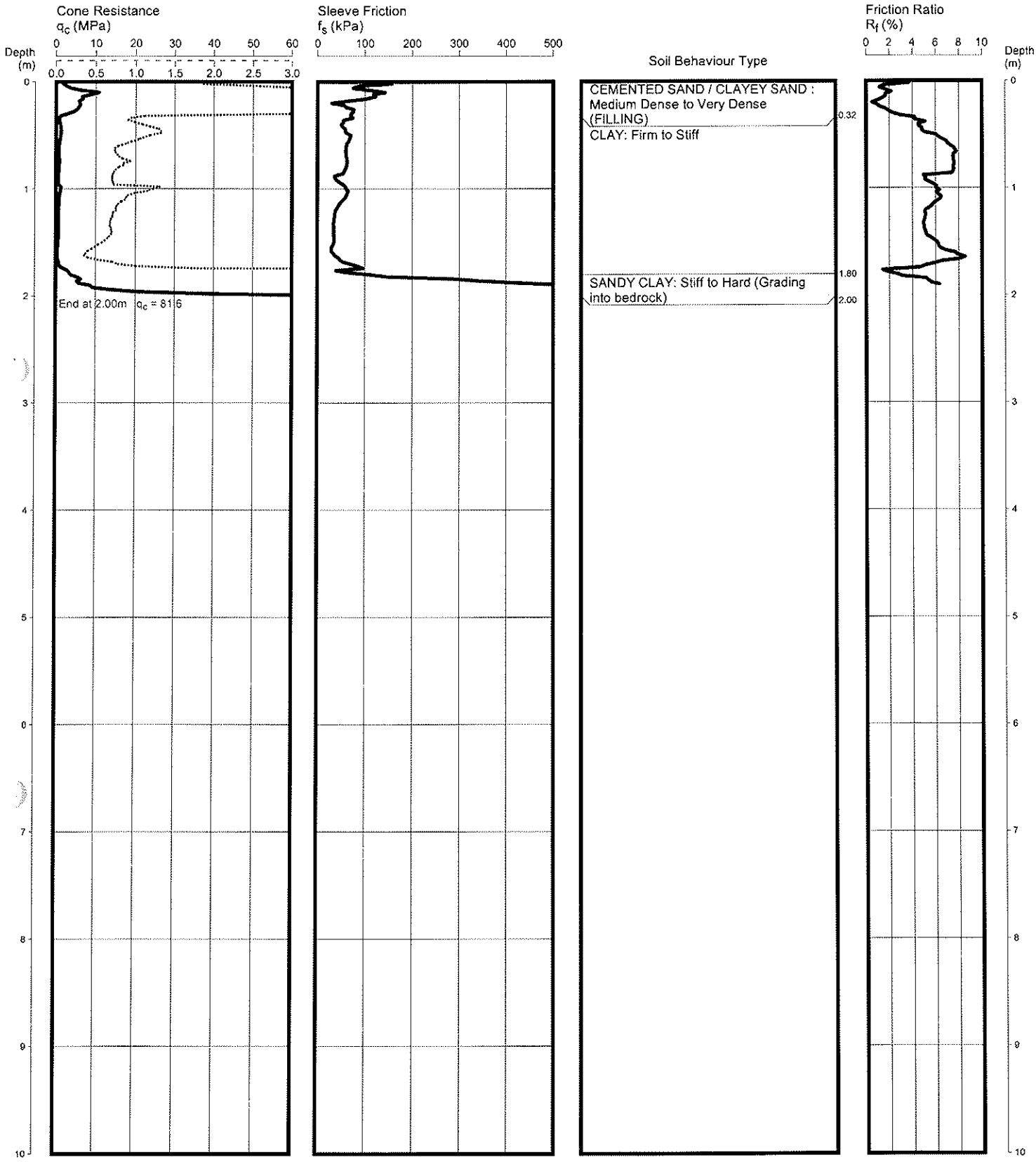
PROJECT No: 39798.03

CPT 407

Page 1 of 1

DATE 15/07/2008

SURFACE RL: 1.0 AHD



REMARKS: WATER DEPTH AT COMPLETION OF TESTING: 0.2 m
SURFACE LEVEL INTERPOLATED FROM LONG-SECTION BY WP

Date Plotted 30/7/08
Checked

File: P:\39798.03\Field\39798407.CP5
Cone ID: CONE-HH3 Type: 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: QUEENSLAND RAIL

PROJECT: HEXHAM RAIL FACILITY

LOCATION: NEW ENGLAND HIGHWAY, TARRO

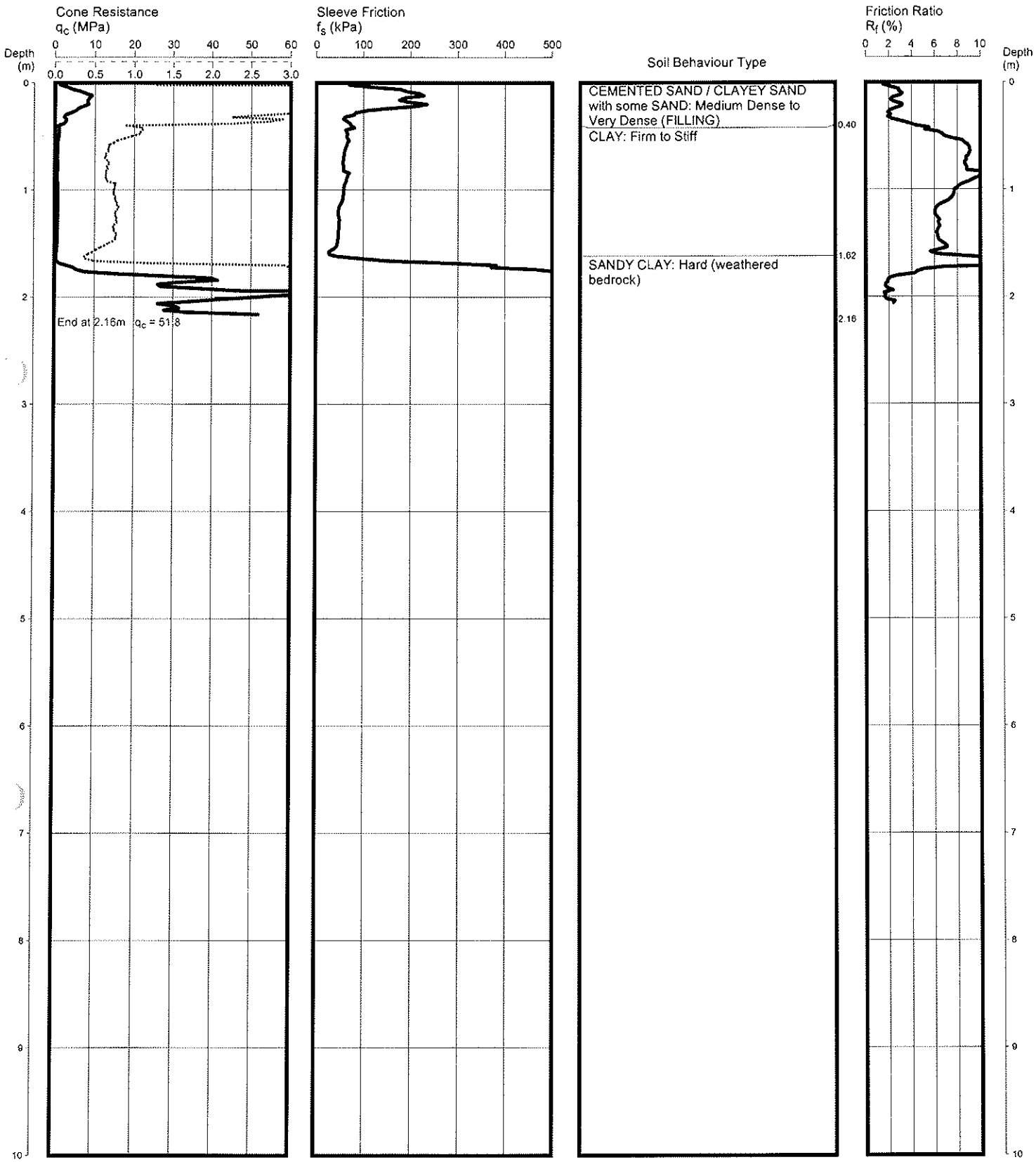
PROJECT No: 39798.03

CPT 407A

Page 1 of 1

DATE 15/07/2008

SURFACE RL: 1.1



REMARKS: HOLE COLLAPSED AT 0.2 m AFTER WITHDRAWAL OF RODS
SURFACE LEVEL INTERPOLATED FROM LONG-SECTION BY WPWATER LEVEL ASSUMED

Date Plotted 10/08

Checked

File: P:\39798.03\Field\39798407A.CP5
Cone ID: CONE-HH3 Type: 2 Standard

ConePlot Version 5.8.1

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RESULTS OF DYNAMIC PENETROMETER TESTS

CLIENT	Queensland Rail	DATE	18.07.08
PROJECT	Tarro Interchange – Option 3	PROJECT NO	39798.03
LOCATION	New England Highway/Woodlands Close, Tarro/Hexham	PAGE NO	Page 1 of 2

TEST LOCATIONS	401	404	405							
RL OF TEST										
DEPTH m	PENETRATION RESISTANCE BLOWS/150mm									
0.00 - 0.15	0	0	1							
0.15 - 0.30	1	2	1							
0.30 - 0.45	2	4	2							
0.45 - 0.60	3	6	5							
0.60 - 0.75	5	10	8							
0.75 - 0.90	8	13	11							
0.90 - 1.05	13	17	14							
1.05 - 1.20	21	18	14							
1.20 - 1.35	28	21	15							
1.35 - 1.50	31	24	21							
1.50 - 1.65	37	28	27							
1.65 - 1.80		30	31							
1.80 - 1.95		34	35							
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										

TEST METHOD AS 1289.6.3.2, CONE PENETROMETER ☑
AS 1289.6.3.3, FLAT END PENETROMETER ☐

TESTED BY: JMF
CHECKED BY:

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RESULTS OF DYNAMIC PENETROMETER TESTS

CLIENT	Queensland Rail	DATE	17/7/08
PROJECT	Tarro Interchange – Option 3	PROJECT NO	39798.03
LOCATION	New England Highway/Woodlands Close, Tarro/Hexham	PAGE NO	Page 2 of 2

TEST LOCATIONS	501	501b	502	502b	503	503b	504	504b	505	
RL OF TEST										
DEPTH m	PENETRATION RESISTANCE BLOWS/150mm									
0.00 - 0.15		2		2		3		1		
0.15 - 0.30		2		2		3		2		
0.30 - 0.45		4		5		6		3		
0.45 - 0.60		8		7		7		4		
0.60 - 0.75		9	2	9	2	10		7		
0.75 - 0.90	2	8	2	9	2	8		8	0	
0.90 - 1.05	7	10	1	10	3	8	2	7	0	
1.05 - 1.20	7	9	3	10	3	8	2	5	0	
1.20 - 1.35										
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										

TEST METHOD AS 1289.6.3.2, CONE PENETROMETER ☑
AS 1289.6.3.3, FLAT END PENETROMETER ☐

TESTED BY: IDB
CHECKED BY:

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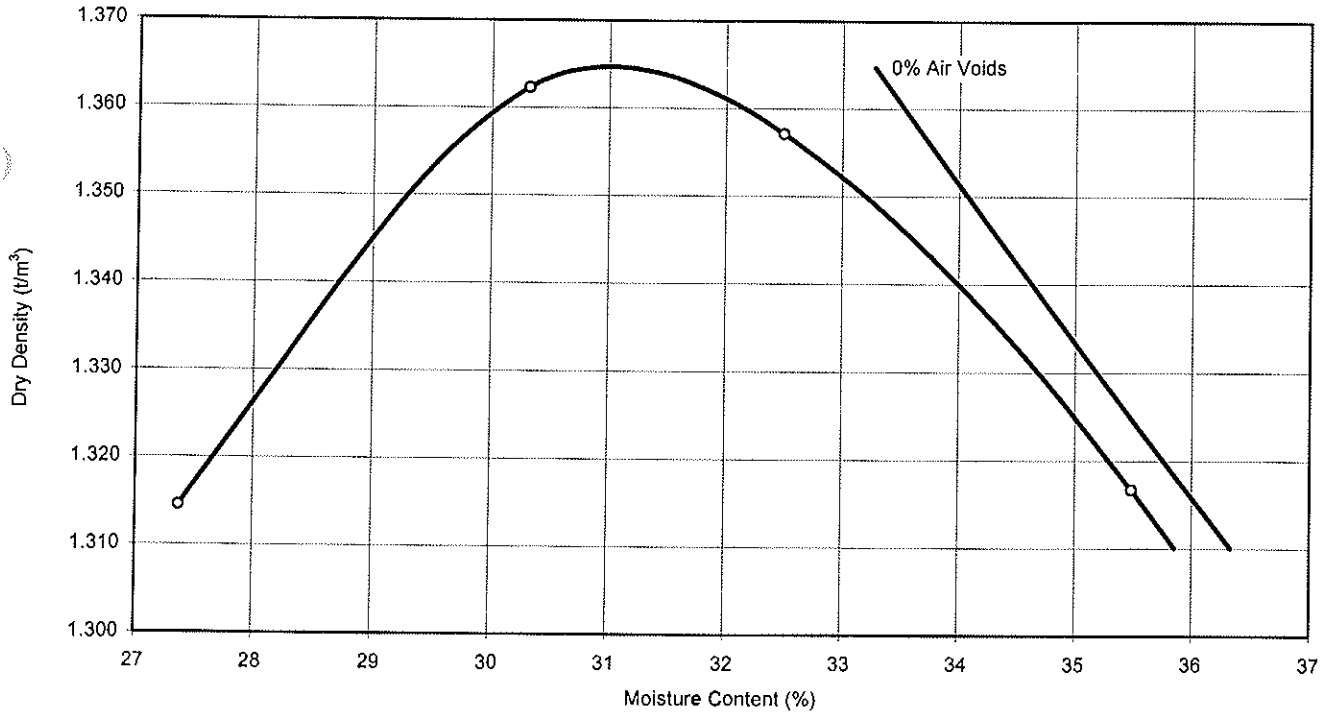
newcastle@douglaspartners.com.au

RESULTS OF COMPACTION TEST

Client :	Queensland Rail	**Project No. :**	39798.03
		Report No. :	N08-207
Project :	Proposed Tarro Interchange - Option 3	**Report Date :**	4/09/2008
Location :	Tarro/Hexham	**Date of Test:**	25/08/2008
		Page:	1 of 1



Sample Details **Location:** Bore 503B
Depth: 0.20-0.50m

Particles > 19mm: 0%

Description: CLAY - Grey/brown

Maximum Dry Density:	**1.36 t/m^3**
Optimum Moisture Content:	**31.0 %**

Remarks:

Test Methods: AS 1289.5.1.1-2003 (STD), AS 1289.2.1.1-2005

Sampling Methods: Sampled by DP engineers

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Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

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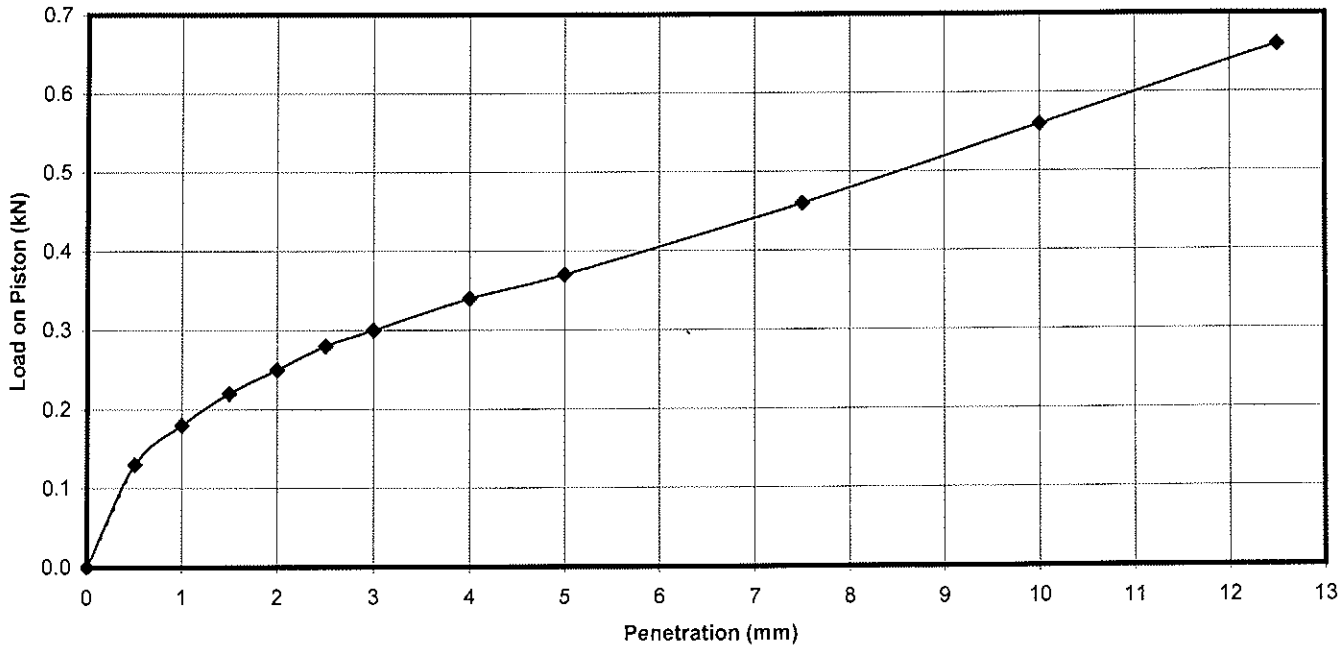
RESULT OF CALIFORNIA BEARING RATIO TEST

Client :	Queensland Rail	**Project No. :**	39798.03
		Report No. :	N08-207a
Project :	Proposed Tarro Interchange - Option 3	**Report Date :**	4/09/2008
		Date Sampled :	17/07/2008
Location :	Tarro/Hexham	**Date of Test:**	2/09/2008
Test Location :	Bore 503B		
Depth / Layer :	0.20-0.50m	**Page:**	1 of 1



Description: CLAY - Grey/brown

Test Method(s): AS 1289.6.1.1-1998, AS 1289.2.1.1-2005

Sampling Method(s): Sampled by DP engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 100% of STD OMC
SURCHARGE: 9 kg
SOAKING PERIOD: 4 days
SWELL: 3.1%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		31.0	1.36
After soaking		35.2	1.32
After test	Top 30mm of sample	43.8	-
	Remainder of sample	31.8	-
Field values		43.2	-
Standard Compaction		31.0	1.36

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	2.0
	5.0 mm	2.0

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Tested:	LB
Checked:	DM

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Laboratory Manager

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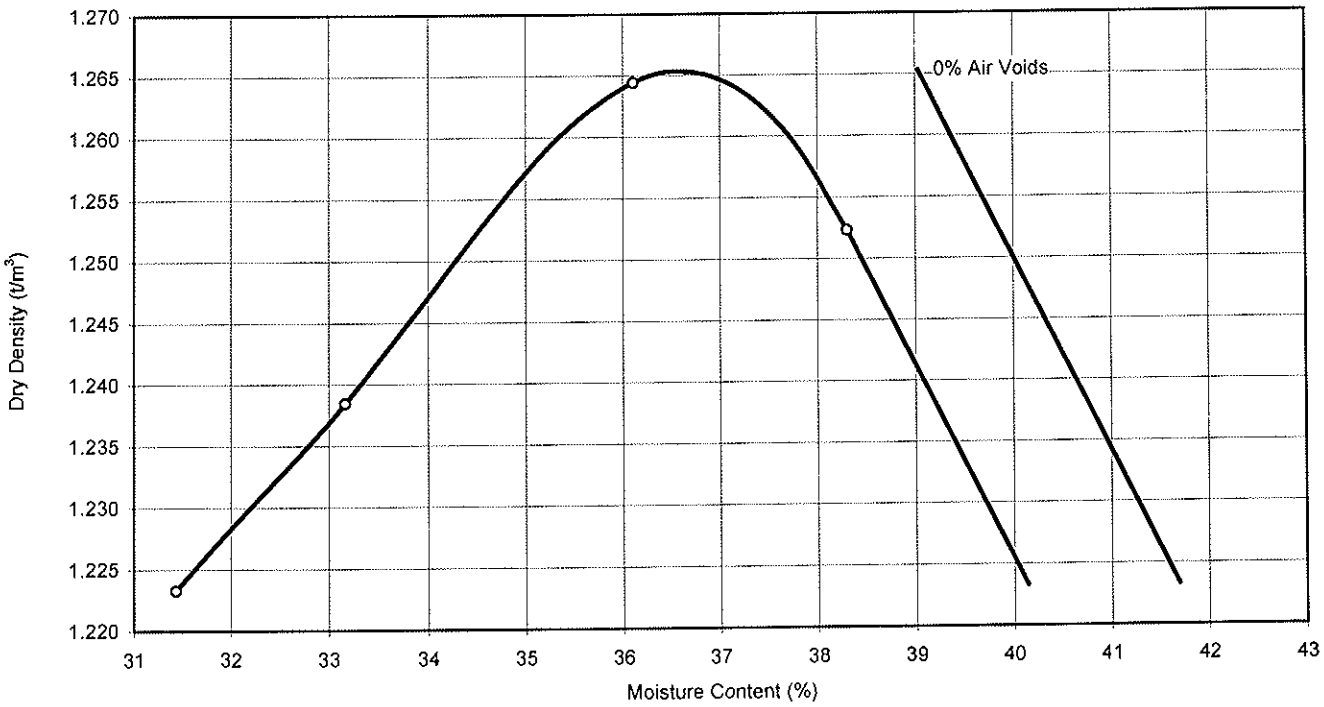
RESULTS OF COMPACTION TEST

Client :	Queensland Rail	**Project No. :**	39798.03
		Report No. :	N08-207b
Project :	Proposed Tarro Interchange - Option 3	**Report Date :**	4/09/2008
Location :	Tarro/Hexham	**Date of Test:**	25/08/2008
		Page:	1 of 1



Sample Details **Location:** Bore 505
Depth: 0.75-1.20m

Particles > 19mm: 0%

Description: CLAY - Brown, trace silt, sand and gravel

Maximum Dry Density:	**1.27 t/m^3**
Optimum Moisture Content:	**36.5 %**

Remarks:

Test Methods: AS 1289.5.1.1-2003 (STD), AS 1289.2.1.1-2005

Sampling Methods: Sampled by DP engineers

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Approved Signatory:

Tested:	DR
Checked:	DM

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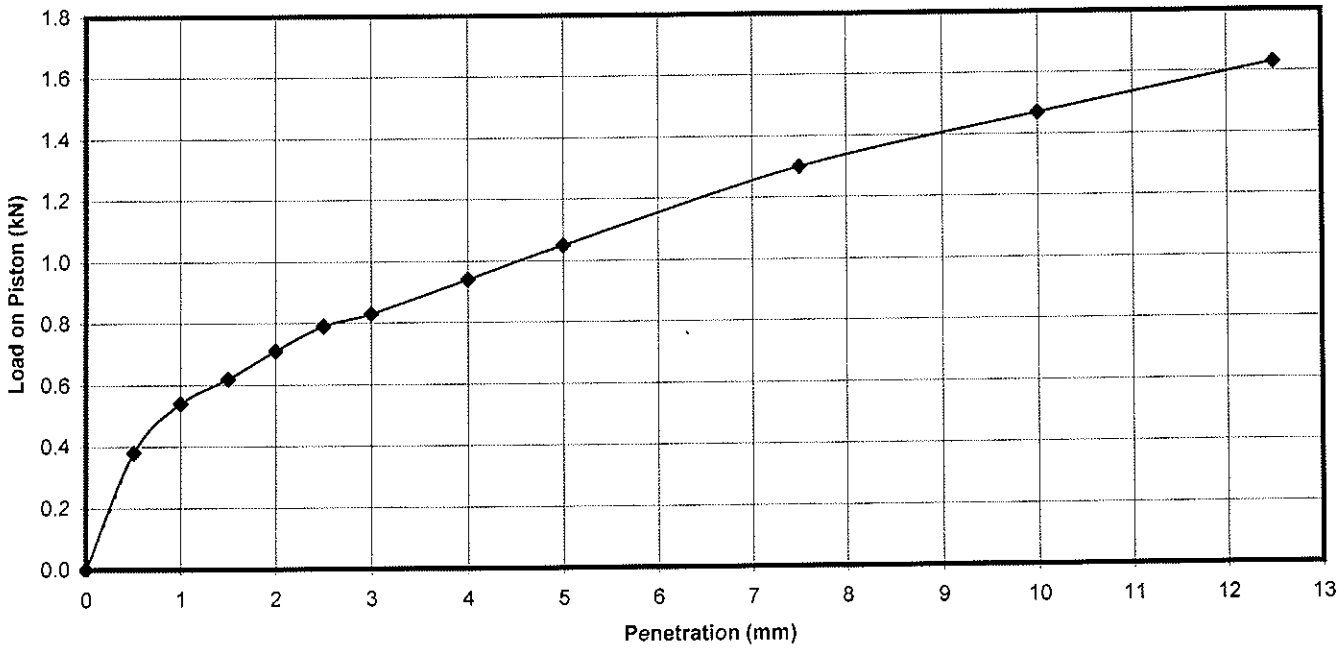
RESULT OF CALIFORNIA BEARING RATIO TEST

Client :	Queensland Rail	**Project No. :**	39798.03
		Report No. :	N08-207c
Project :	Proposed Tarro Interchange - Option 3	**Report Date :**	4/09/2008
		Date Sampled :	17/07/2008
Location :	Tarro/Hexham	**Date of Test:**	2/09/2008
Test Location :	Bore 505		
Depth / Layer :	0.75-1.20m	**Page:**	1 of 1



Description: CLAY - Brown, trace silt, sand and gravel

Test Method(s): AS 1289.6.1.1-1998, AS 1289.2.1.1-2005

Sampling Method(s): Sampled by DP engineers

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 101% of STD OMC
SURCHARGE: 9 kg
SOAKING PERIOD: 4 days
SWELL: 1.4%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		36.9	1.27
After soaking		40.9	1.26
After test	Top 30mm of sample	38.9	-
	Remainder of sample	36.9	-
Field values		59.1	-
Standard Compaction		36.5	1.27

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	6
	5.0 mm	5

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Approved Signatory:

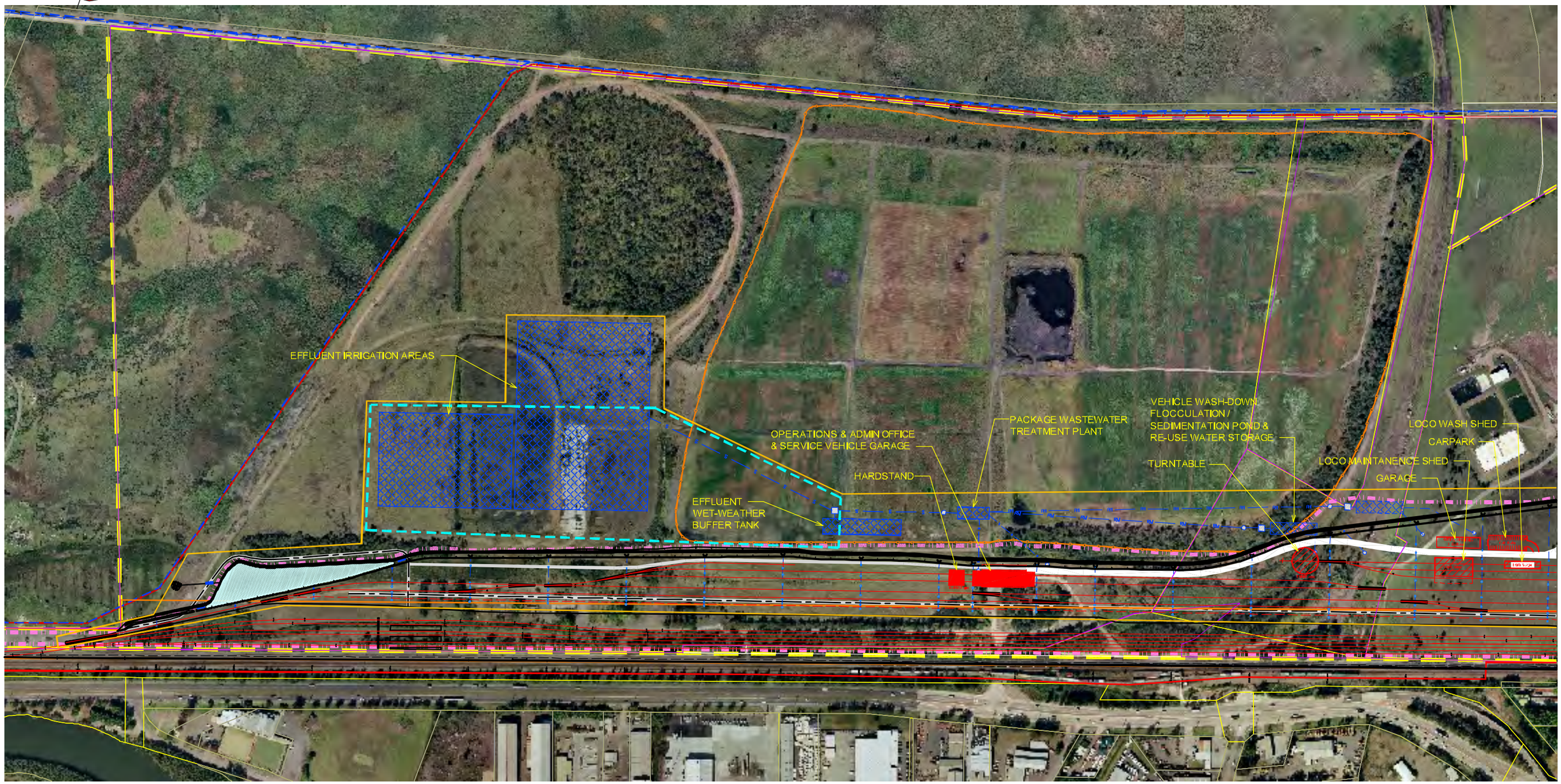
Tested:	LB
Checked:	DM

Dave Millard
Laboratory Manager

Appendix H

Figure 2 – Proposed Arrangement – Train Support Facility (WorleyParsons) (Sheet 1 of 2 and Sheet 2 of 2)
Drawing 1-1 – Location of Previous Investigations
Drawing 1-2 – Test Location Plan
Drawing 1- 3 – Section A-A
Areas of Disturbance Cut – Drawings 2216395-16-FIG-C0002 (GHD) – Rev 4 – 10 October 2012
Areas of Disturbance of Fill – Drawings 2216395-16-FIG-C0003 (GHD) – Rev 2 – 26 September 2012

FIGURE 2



LEGEND

- TRAIN SUPPORT FACILITY BOUNDARY
- PROPERTY BOUNDARY
- WATER RECYCLING & WASTEWATER TREATMENT SYSTEM
- HWC PROPOSED WATER MAIN
- EXISTING WATER MAIN
- PROPOSED ARTC RELIEF ROADS (TRACKS)
- TSF ROADS (TRACKS)
- STORMWATER DRAINAGE NETWORK
- COAL TAILINGS STOCKPILE EXTENTS
- PROPOSED CESS DRAIN
- PROPOSED WASTEWATER DRAINAGE LINE
- PROPOSED RISING MAIN

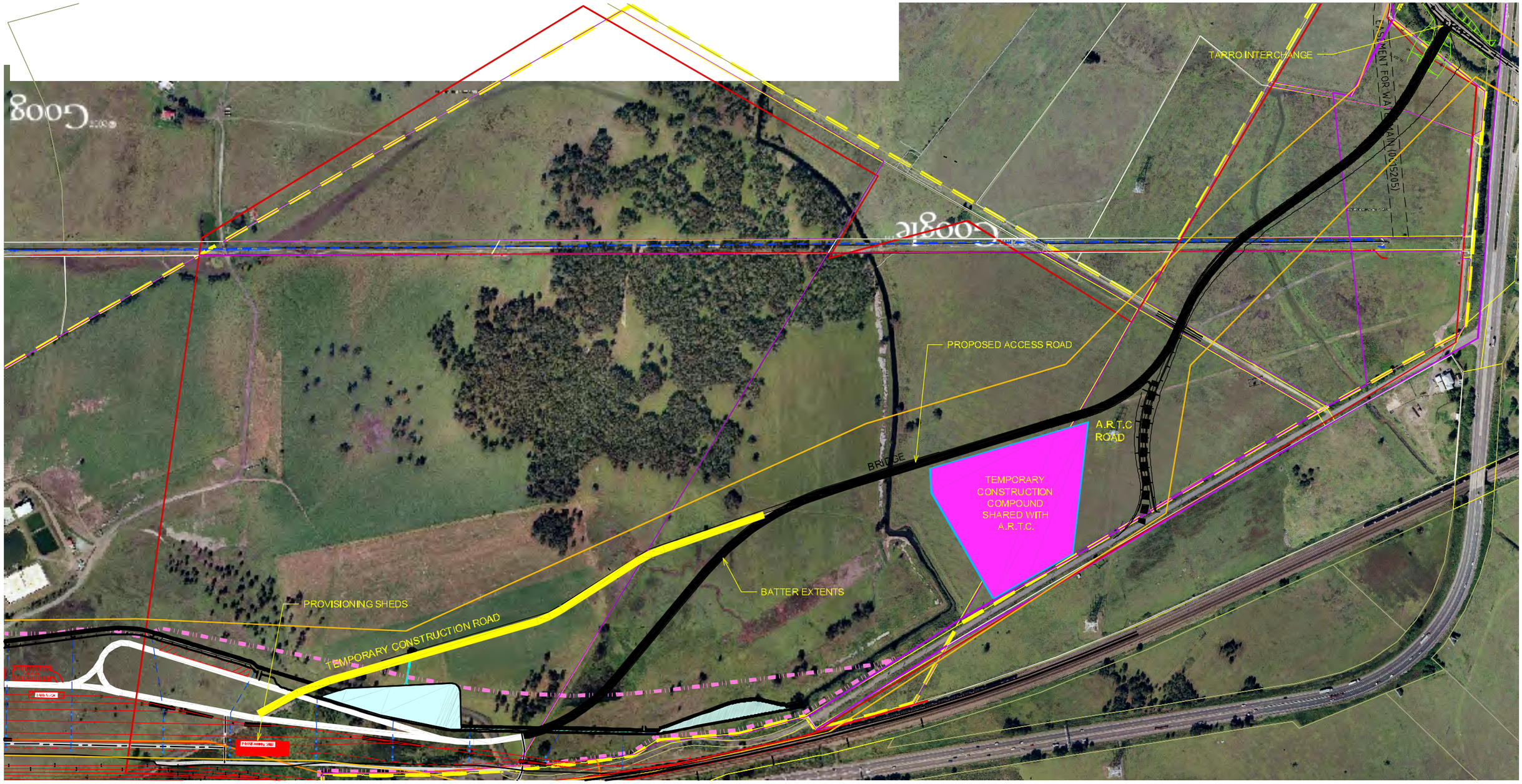
WorleyParsons
resources & energy

0 200m
1:5000

PROPOSED ARRANGEMENT TRAIN SUPPORT FACILITY SHEET 1 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 2-1_2-2_PROPOSED ARRANGEMENT.dwg 23/08/2012

FIGURE 2



LEGEND

- TRAIN SUPPORT FACILITY BOUNDARY
- PROPOSED CESS DRAIN
- PROPERTY BOUNDARY
- WATER RECYCLING & WASTEWATER TREATMENT SYSTEM
- TRUCK SHAKEDOWN AND WASHDOWN BAY (IF REQUIRED)

0 200m

1:5000

WorleyParsons
resources & energy

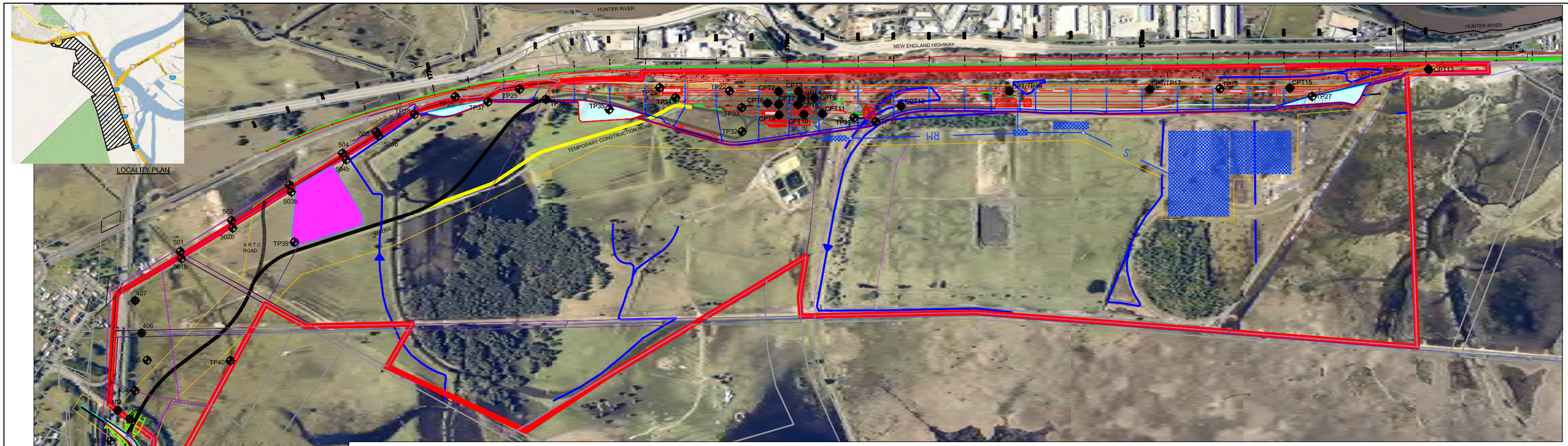
PROPOSED ARRANGEMENT
TRAIN SUPPORT FACILITY
SHEET 2 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 2-1_2-2_PROPOSED ARRANGEMENT.dwg 23/08/2012

DRAWING ADAPTED FROM iPLAN PLANNING PORTAL

Ref:P:/39798.08/Drawings/39798.08 Drawing 1-1

Douglas Partners Geotechnics | Environment | Groundwater	**Location of Previous Investigation Data** **Preliminary Geotechnical Investigation** **Proposed Train Support Facility** **Woodland Close, Hexham**	PROJECT No: 39798.08 DRAWING No: 1-1 REVISION: 1
	CLIENT: QR National	DATE: 14.05.2012



LEGEND

- Site Boundary
- Approximate Borehole Location (Project 39798 and 39798.03-October 2007)
- Approximate CPT Location (Project 39798-October 2007)
- Approximate Creek/Drainage Channels and Direction Flow
- Water Quality Control Pond
- Temporary Construction Compound
- Effluent Irrigation Areas

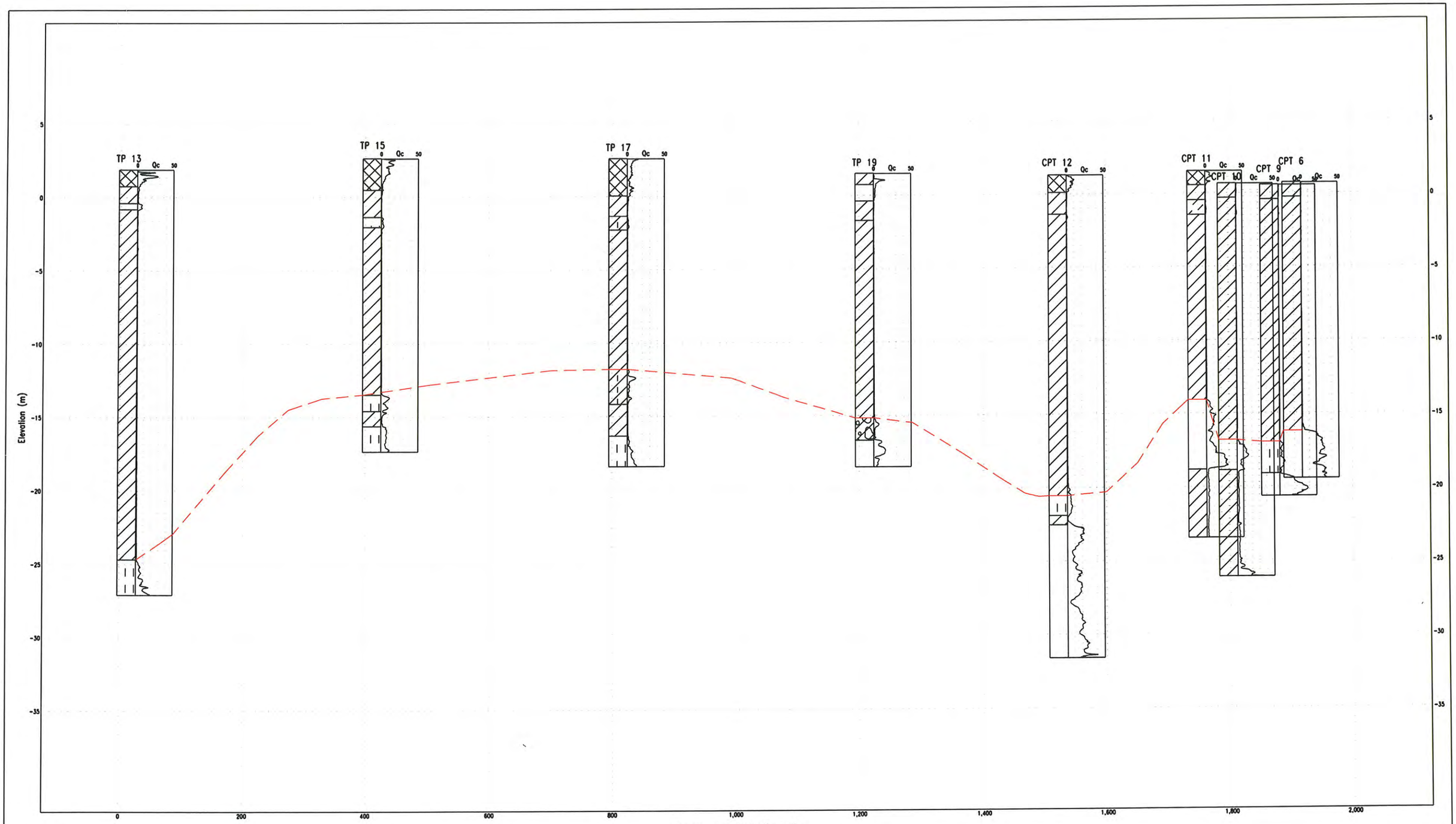
Drawing adapted from plan supplied by client, File Ref SKETCH120829 Site Masterplan-Final.dwg provided 30.08.2012 and NearMap Image dated 25 June 2011

0 50 100 150 200 300 400 500m

1:5000 @ A1

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: QR National		TITLE: Test Location Plan Proposed Train Support Facility Woodlands Close, Hexham	PROJECT No: 39798.08
OFFICE: Newcastle	DRAWN BY: PLH		DRAWING No: 1-2
SCALE: 1:5000@A1	DATE: 13.09.2012		REVISION: 1



LEGEND

- Filling
- Clay
- Silty Sand
- Sand
- Clayey Sand
- Silty Clay
- Clayey Gravel
- Q_c Cone Resistance (MPa)
- — — Approximate Base of Soft Clay Layer

NOTES:

1. Refer Drawing 1–2 "Test Location Plan" for location of section
2. Reference should be made to detailed CPTs for detailed descriptions
3. Layer boundaries have been estimated from discrete test locations and has involved interpolation between data points.

Ref:P:/39798.08/Drawings/39798.08 Drawing 1-3

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CLIENT: QR National		TITLE: **Geological Section A-A'**	PROJECT No: 39798.08
OFFICE: Newcastle	DRAWN BY: PLH	**Proposed Train Support Facility**	DRAWING No: 1-3
SCALE: As shown	DATE: 16.05.2012	**Woodlands Close, Hexham**	REVISION: 0

1:10,000 Paper Size A3

0 50 100 200 300 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Areas Of Disturbance Cut mm

- 300
- 800
- 1000
- 1500
- 1600
- 2600

- Cadastral Site Boundary
- Roads
- ARTC HRR Rail centrline
- QRN Rail Centreline

GHD

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QR National Pty
NSW Long Term Train Support Facility

Job Number 22-16395
Revision 4
Date 10 Oct 2012

Areas of Disturbance Cut

2216395-16-FIG-C0002

G:\22\16395\GIS\Maps\Deliverables\Internal\General\2216395-16-FIG-C0002(4).mxd

Data source: LPMA: DTDB - 2007; Nearmap: Aerials - 2012; Engenicom: Design Data - 2012. Created by:mabarnier

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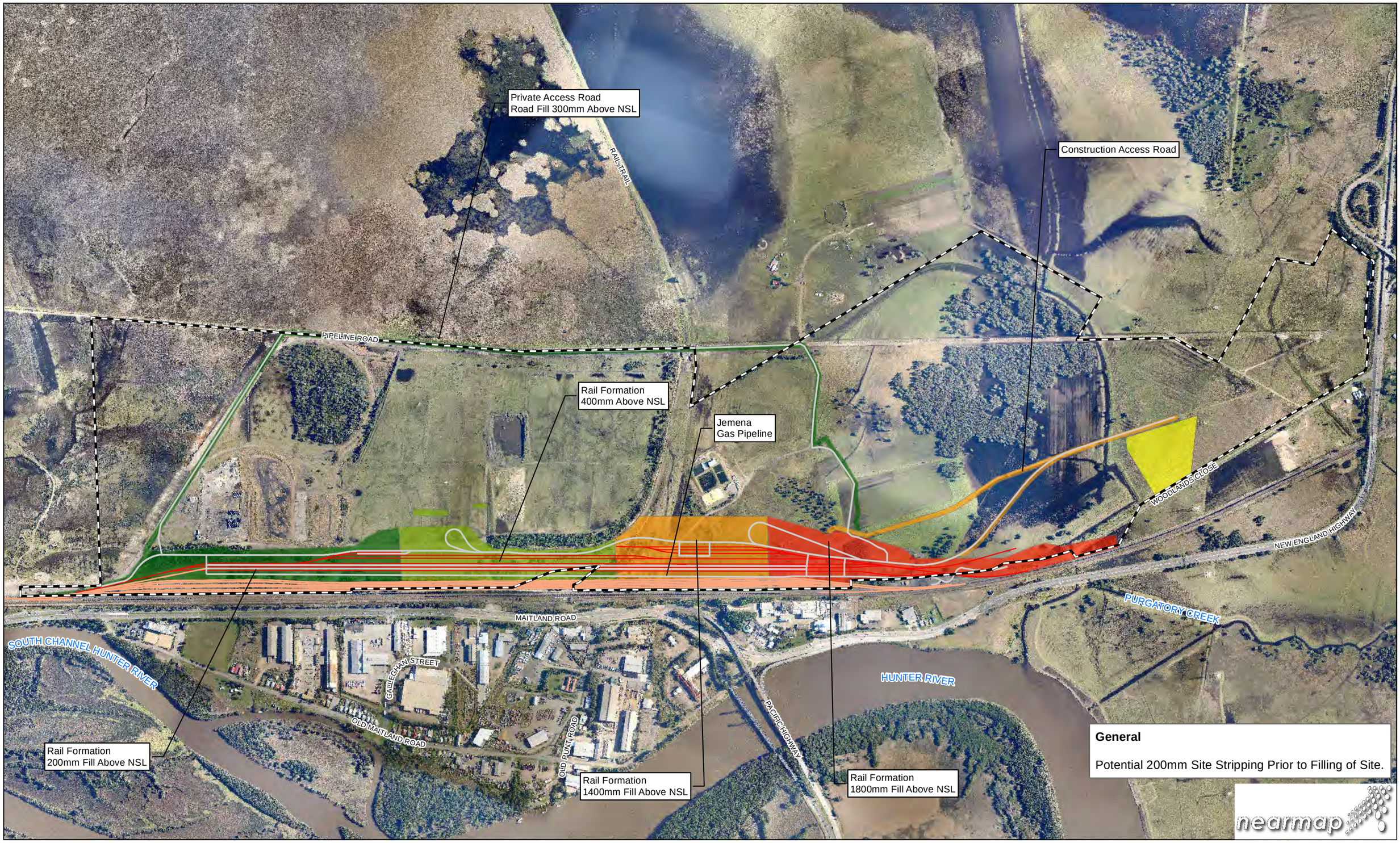

1:10,000 Paper Size A3

0 50 100 200 300 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Areas Of Disturbance Fill mm

- 0-200
- 200-400
- 500
- 1400
- 1800
- Cadastral Site Boundary
- Roads
- ARTC HRR Rail centrline
- QRN Rail Centreline

GHD

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QR National Pty Ltd
NSW Long Term Train Support Facility

Job Number	22-16395
Revision	2
Date	26 Sep 2012

Areas of Disturbance Fill

2216395-16-FIG-C0003

G:\22\16395\GIS\Maps\Deliverables\Internal\General\2216395-16-FIG-C0003(2).mxd

Data source: LPMA: DTDB - 2007; Nearmap: Aerial - 2012; Engenicom: Design Data - 2012. Created by:mabarnier

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