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Report

GLNG EIS Supplement

DMPF

Geotechnical Concept Design

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Prepared for

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1 Introduction

1.1 Background

This report presents the geotechnical concept design for the proposed DMPF at Laird Point.

The Laird Point site predominately comprises low lying terrain surrounded by a range of small hills to the north, south and east. To the west, the terrain is formed by intertidal mudflat separated from Port Curtis by a margin of mangroves.

Based on the dredging plan stated in Connell Wagner's report (Reference 27684-007-02-01, Revision 2, dated 10 December 2008), URS have estimated that 6,800,000 m^3 *in situ* material is to be dredged from the approach channel, swing basin and berth pocket for the GLNG Project. HR Wallingford (2009) has verified this figure. Maintenance dredging to maintain the channel, swing basin and berth will also be required over the life of the LNG facility operations.

During the dredging process the dredged slurry, a mixture of seawater and dredged materials, will be hydraulically transported to the facility. After suitable retention to achieve the relevant water quality criteria, the water will be returned to the marine environment.

HR Wallingford defined the general concept design layout and location for the Dredge Management Placement Facility (DMPF), which employs land-based confinement of dredged materials by a main embankment and saddle dams. URS have developed this concept into a conceptual design to capture and contain dredged materials and return associated seawater back to the marine environment.

1.2 Scope of Work

This report presents the geotechnical concept design for the DMPF including:

- Design criteria and concepts used for the concept design;
- Geotechnical site investigation and characterisation of site conditions;
- Preliminary conceptual design of the DMPF structures, including;
  - Concept design of the main embankment;
  - Concept design of the internal bunds;
  - Concept design of saddle dams; and
- Concept final landform design.

Site Conditions and Characterisation

2.1 Geotechnical Site Investigation

An initial geotechnical site investigation was carried out for the proposed Dredge Management Placement Facility (DMPF) to characterise the geological units and to assess the geotechnical engineering properties of the materials encountered. The results of the geotechnical site investigation were used as a key design input for the concept design of the main embankment, internal bunds, saddle dams and final landform.

2.1.1 Field Investigation

The sub surface conditions at the proposed DMPF site were investigated in early August 2009. The field investigation comprised nine geotechnical boreholes at key locations with six groundwater monitoring wells installed in selected boreholes. CPT soundings were conducted at 14 locations on the tidal mudflats. Twenty-two test pits were excavated with 10 on the tidal mudflats adjacent to cone penetration test (CPT) sounding locations. The locations of field investigation testing are presented in Figure 6.3 (Appendix A).

Geotechnical Boreholes

Nine geotechnical boreholes were drilled using a Hydropower Scout mounted on a Yanmar C60R rubber-track rig using mud rotary and triple tube NMLC coring techniques. Two wells were installed at each of saddle dams “A”, “B” and “E” in conjunction with the groundwater investigation. The target depths of the wells ranged from approximately 10 m to 30 m. Water levels measured in the wells varied from 4.9 m to 11.2 m below ground level with one well being dry. This translates to groundwater level ranging from 0.3 m to 1.1 m AHD. Three boreholes were drilled for geotechnical investigation only to assess the sub surface conditions, and ranged from 10 m to 1 5m depth.

The subsurface conditions encountered in the boreholes were logged by an URS engineering geologist and disturbed and undisturbed samples were collected for laboratory testing. The locations of the boreholes are presented in Figure 6.3 (Appendix A) and borehole logs are presented in Appendix B. Geotechnical boreholes were not attempted on the tidal mudflats due to concerns about stability and safety of the drill rig.

Test Pits

The test pits were excavated using a Daewoo 225LCV (30 tonne) excavator and were conducted in two parts. Ten test pits were excavated on the tidal mud flat area adjacent to CPT locations. Due to the low bearing capacity of the Very Soft Clay in the tidal mudflats access to the test locations was gained by using “swamp pads”. The swamp pads consisted of several logs approximately 11 m long chained together. These were then laid out onto the mud flat in front of the excavator. This provides a larger footing area for the excavator and enables movement with several pads laid out one after another. The test pits were used to collect samples for laboratory testing and to calibrate the CPT data. An additional 12 test pits were excavated across the site to depths of 5.0 m or less. The depth of test pit excavations was limited due to refusal on bedrock, collapse of the test pit or the target depth of 5.0 m and the average depth of test pits was 4.1 m. The subsurface conditions encountered in the test pits were logged by an URS geotechnical engineer and disturbed and undisturbed samples were collected for laboratory testing. The locations of the test pits are presented in Figure 6.3 (Appendix A) and test pit logs are presented in Appendix B.

Groundwater was encountered at approximately 1.0 m below ground level on the tidal mud flat areas, which agrees with the regional groundwater measurements. Groundwater was observed seeping into the test pits and collecting at the base of the excavation. There was no groundwater observed in test pits on the surrounding hills.

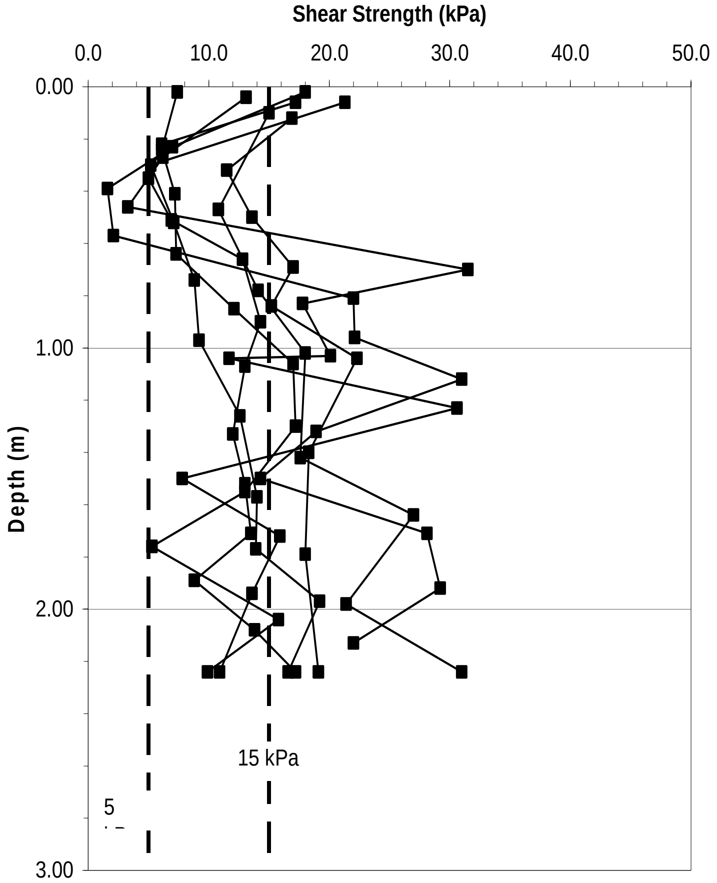
Cone Penetration Testing

Fourteen CPT tests were conducted on the tidal mud flat using a skid-mounted CPT rig. The Daewoo 225LCV excavator was used to transport the CPT rig to each of the testing locations using the swamp pads and to provide counter-weight resistance during the testing. The CPT rig used a C10CFIIP.G56 cone and tests were conducted to refusal with an average depth of 4.7 m and to a maximum depth of 7.8 m. The testing was supervised by a URS geotechnical engineer. The locations of the CPTs are presented in Figure 6.3 (Appendix A) and CPT logs are presented in Appendix B.

Shear Vane

Shear vane tests were conducted in seven locations on the tidal mud flat in general accordance with AS1289 6.2.1. Shear vane testing was conducted using an Edeco Pilcon hand shear vane. The 33 mm vane was used with 1.0 m extension rods to measure peak and residual shear strength readings up to 2.2 m below ground surface. The locations of the shear vane tests are presented in Figure 6.3 (Appendix A) and results are presented in Figure 2-1 below.

Figure 2-1 Shear Vane Results



2.2 Geotechnical Laboratory Testing

Laboratory testing was carried out by a NATA registered laboratory in Brisbane, QLD (Australian Geomechanical Laboratories) on selected disturbed and undisturbed samples to assess the engineering properties of the materials. The testing included the following:

- Moisture Content;
- Atterberg Limits;
- Linear Shrinkage;
- Particle Size Distribution;
- Emerson Class;
- Moisture Density Relationship;
- Direct Shear;
- Consolidated Undrained Triaxial; and
- Oedometer.

The results of laboratory testing are summarised in Figures 2-2 and 2-3 and in Tables 2-1, 2-2 and 2-3. These results are used in developing the site characterisation in Section 2.3. Detailed laboratory test report sheets are presented in Appendix C.

Figure 2-2 Atterberg Limits Results

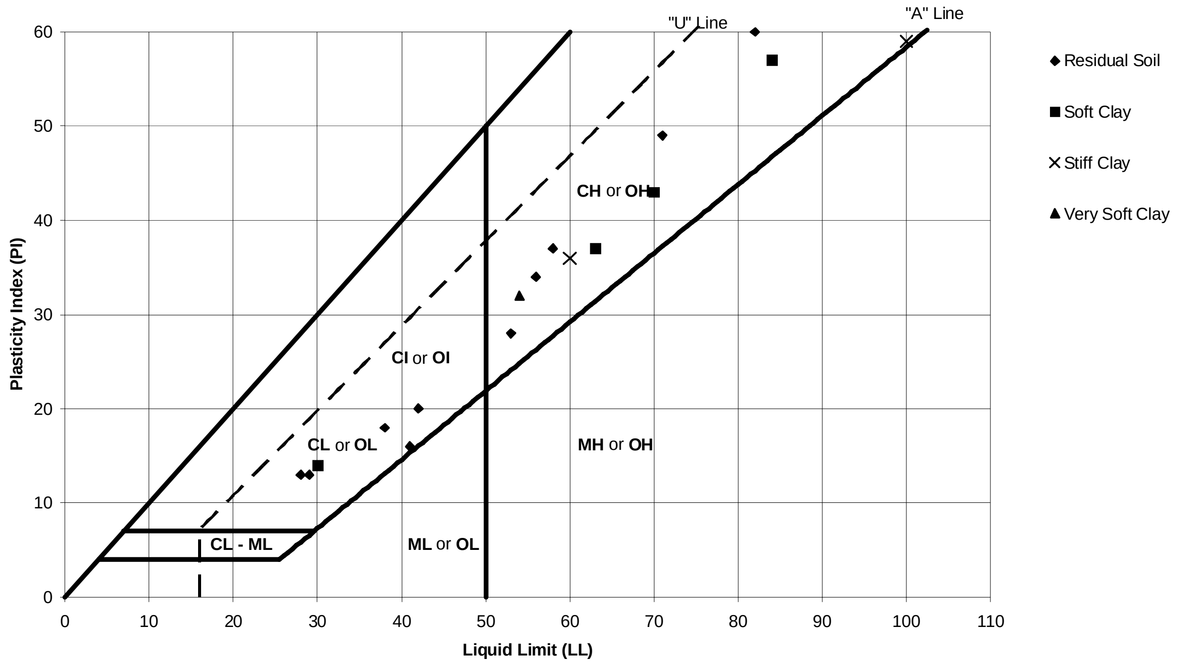


Figure 2-3 Particle Size Distribution Curves

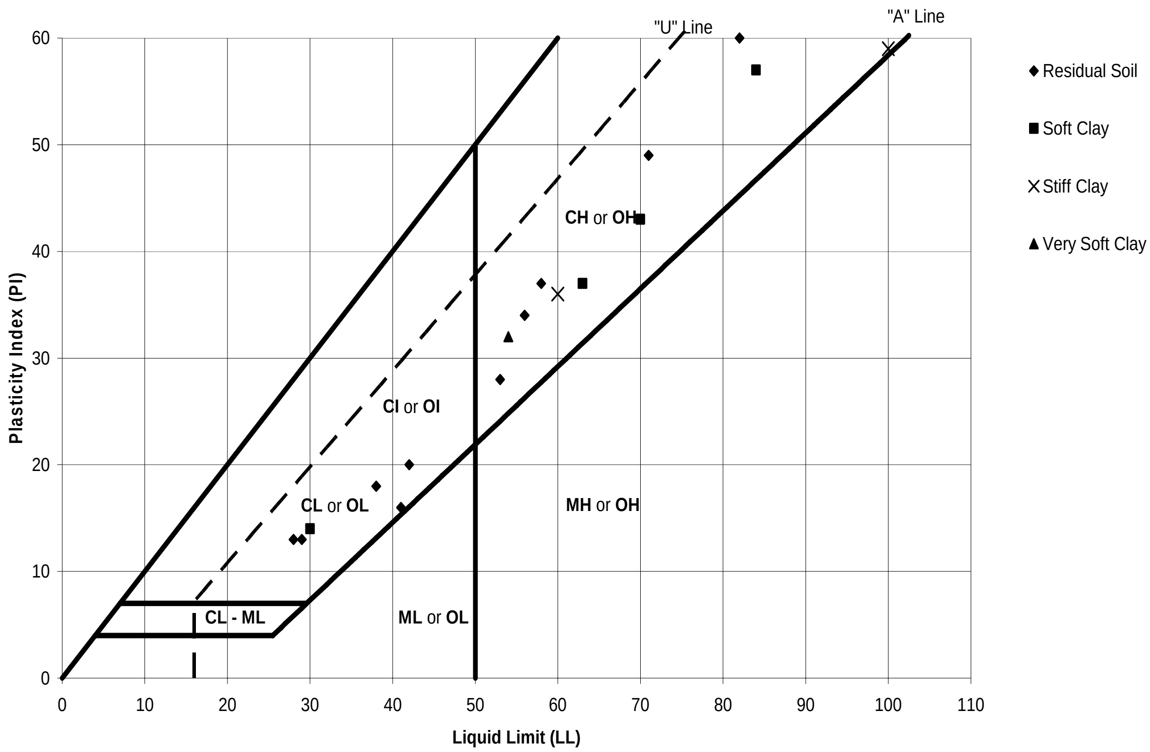


Table 2-1 Moisture Content, Emerson Class and Linear Shrinkage

Location No.	Depth (m)	Unit	Moisture Content (%)[1]	Emerson Class[2]	Linear Shrinkage (%)[3]
BH04	1.0	Residual Soil	8.4		
BH04	2.5	Residual Soil			4.5*
GW/BH2B	1.0	Residual Soil			17.0+
GW/BH2B	5.5	Residual Soil			13.5
New-TP02	1.5	Residual Soil	21.1	6	12.0*+
New-TP02	3.5	Residual Soil	15.7		
TP-BH03	4.0	Residual Soil		5	4.5*+
TP-CPT01	1.0	Soft Clay			4.5*+
TP-CPT012	0.5	Very Soft Clay			19.0+
TP-CPT012	1.0	Soft Cay			18.0+
TP-CPT012	1.5	Soft Clay			16

Location No.	Depth (m)	Unit	Moisture Content (%)[1]	Emerson Class[2]	Linear Shrinkage (%)[3]
TP-CPT012	2.0	Soft Clay			16.5
TP-CPT02	1.5	Soft Clay		6	
TP-CPT02	3.2	Stiff Clay			14.5+
TP-CPT04b	1.0	Soft Clay		2	17.5*+
TP-CPT05a	0.5	Very Soft Clay			10
TP-CPT05a	1.5	Soft Clay			21.5
TP02	1.5	Residual Soil			
TP03	3.0	Residual Soil			16.5+
TP04	0.3	Residual Soil	4.2		
TP04	4.0	Residual Soil			8
TP06	0.5	Residual Soil	12.6		
TP06a	0.5	Residual Soil			14.5+
TP06a	2.0	Residual Soil	12.6		
TP08	0.5	Residual Soil			20.0+
TP08	1.5	Residual Soil	16.4	2	
TP08	3.5	Residual Soil			7
TP09	2.0	Residual Soil	7.6	5	
TP10	2.5	Residual Soil	10.2		
TP11	1.0	Residual Soil	5.4		

Notes:

1. AS1289 2.1.1
2. AS1289 3.8.1, Tested with distilled water at 24ºC
3. AS1289 3.4.1, * Crumbling occurred, + Curling occurred

Table 2-2 Moisture Density Relationship and Direct Shear.

Location No.	Depth (m)	Unit	Maximum Dry Density (t/m^3)[1]	Optimum Moisture Content (%)[1]	Cohesion (kPa)[2]	Shear Angle (deg)[2]
New-TP02	1.5	Residual Soil	1.74	19.0		
TP-BH03	4.0	Residual Soil	2.13	8.4		
TP02	1.5	Residual Soil			19.0	25.8
TP08	1.5	Residual Soil	1.69	19.0		
TP09	2.0	Residual Soil	1.93	12.4		

Notes:

1. AS1289 5.1.1
2. AS1289 6.2.2 / KH 2 (Based on K. H. Head (1988) Manual of Laboratory Testing); Sample remoulded to a target of 95% of standard maximum dry density.

Table 2-3 Consolidated Undrained Triaxial and Oedometer.

Location No.	Unit	Depth (m)	Cc[1]	Cr[1]	Pc (kPa)[1]	e_0[1]	Cohesion C' (kPa)[2]	Angle of Shear Resistance φ' (deg)[2]
GW/BH2A	Residual Soil	1.5	0.11	0.09	-	0.608	60.7	12.9
TP-CPT05a	Soft Clay	1.5	1.09	0.16	18	2.301	4.1	15.5
TP-CPT05a	Soft Clay	3.5	0.81	0.14	37	2.278	20.4	12.6
TP-CPT12	Very Soft Clay	0.5	1.07	0.08	21	2.695	0.0	17.0
TP-CPT12	Soft Clay	1.0	1.14	0.13	25	2.272	1.4	18.0
TP-CPT12	Soft Clay	1.5	1.54	0.21	33	3.016	1.1	28.5
TP-CPT12	Soft Clay	2.0	1.57	0.20	19	3.198	0.0	23.5

Notes:

1. AS1289 6.6.1, undisturbed U75 sample
2. AS1289 6.4.2, undisturbed U75 sample

2.3 Site Subsurface Conditions

2.3.1 Regional Geology

The site is located approximately 500 m south of Laird Point on Curtis Island. The site geology is comprised of the Curtis Island Groups in the Wandilla Formation dated from the early Carboniferous (Sheet 9150, 1988).

The Wandilla Formation forms an approximately 10 km wide north-northwest trending belt comprising the majority of Curtis Island geology and extending south through Gladstone. The formation consists mainly of mudstone and arenite, and subordinate chert and minor limestone. The Wandilla Formation is seen on the site as argillite mudstone. The mudstone is typically characterised by Donchak and Holmes (1991) as dark grey and carbonaceous, weathering to cream and orange-brown tones. It varies from fissile to vaguely foliated, and from massive to thin-bedded or laminated. Cream sandy laminae are common and are characteristically lenticular and discontinuous. A phyllitic, micaceous sheen is locally developed on cleavage surfaces. In some areas, thin quartz veinlets as well as occasional thick veins penetrate parallel to the major foliation in the rocks.

2.3.2 Site Seismicity

The seismicity of the Gladstone region has been studied by the Queensland University Advanced Centre for Earthquake Studies (QUAKES). Seismic risk maps for the Gladstone region have also been developed by McCue *et al* (1993) and are reproduced in AS1170.4 and Gaull *et al* (1990). The Gladstone region lies on the northern edge of a seismicity belt that stretches between Brisbane and Gladstone.

The largest known earthquakes in Eastern Australia since European settlement include the Tasmanian Swarm [1883-1892] (Michel-Leiba, 1989) which had estimated magnitudes ranging from 6.2 to 6.6, and the Gladstone earthquake [1918] with a magnitude of 6.3.

Seismic parameters for DMPF site were interpolated from Gaull et al (1990) and AS 1170.4 1993. The peak ground acceleration (PGA) associated with the Operating Basis Earthquake (OBE) with a return period of 1 in 475 years was estimated to be 0.095 g for the DMPF site.

2.3.3 Site Characterisation

The DMPF site is comprised of two distinct geomorphological areas: (1) the tidal mud flat and (2) the surrounding hills. This is presented in the geotechnical sections Figure 6.4 and 6.5 in Appendix A.

Tidal mudflats are typically subject to changes in sea level resulting in a range of depositional environments from marine to estuarine. These environments are low energy resulting in accumulation of fine sediment (silts and clay). In addition, erosion transported Residual Soil from the surrounding hills and deposited additional sediment on the mudflats. This is seen on the surface where the ephemeral creeks deposited alluvial fans onto the tidal mudflats creating interbeds of sands and gravels. The tidal mud flat at the site is confined by the surrounding topography, which likely limits the depth of sediment accumulation.

2.3.4 Typical Profile

The tidal mudflats are generally comprised of a series of estuarine and marine clay layers overlaying the Residual Soil units seen in the surrounding topography.

The estuarine and marine clay units found in the tidal mudflats have been divided into three separate units:

1. Very Soft Clay;
2. Soft Clay; and
3. Stiff Clay.

Very Soft Clay

The Very Soft Clay was delineated using vane shear readings with typical undrained shear strength of 5 kPa. This was due to the very low tip resistance readings in the CPT results and lack of visual differences in the test pits. The Very Soft Clay is found from 0 m to 1.0 m below ground level and is generally described as low plasticity clay with some high plasticity clay and has a crust on the surface formed from continual wetting and drying. Moisture content ranges up to roughly 100 %.

Soft Clay

The Soft Clay unit was delineated using the interpreted CPT shear strength values (Figure 2-4). The base of the unit was defined by CPT shear strength increase above 100 kPa. The undrained shear strength for this unit is taken as 15 kPa. The Soft Clay unit is typically found from 0 m to 4.0 m below ground level with a thickness of up to 3.0 m and is generally described as low plasticity clay with some high plasticity clay. Moisture content ranges up to roughly 120 %.

Stiff Clay

The Stiff Clay unit was observed in the CPT soundings and in one test pit. It was been assumed that this unit continues with depth until the Residual Soil. The Residual Soil surface under the mudflats was interpreted by extrapolating the north-south and east-west topographic profiles below the mudflats. The Stiff Clay was described as low plasticity clay with some sand/gravel interbeds and was encountered at depths of 2.1 m to 4.5 m below ground level. The interpreted thickness of this unit, based on topographic extrapolations, is up to 1.6m. The undrained shear strength for this unit ranges above 100 kPa and increases with depth at a rate of roughly 50 kPa per metre to a limit of 200 kPa.

Residual Soil

The surrounding topography has a typical profile of 100 to 200 mm of topsoil overlying Residual Soil overlying bedrock. The Residual Soil is typically described as gravelly clay with some silt, sandy silt and clay. The observed thickness ranged from 8.5 m to greater than 30 m. It was generally described as being low to high plasticity with colour ranging from reddish brown to orangish white. The origin of the Residual Soil is extremely weathered bedrock.

Bedrock

Bedrock was encountered in three of the boreholes and ranged from 8.5 m to greater than 30 m below ground surface. Generally it was found in the eastern side of the DMPF site and was typically described as ‘high strength’ argillite with some greywacke and ranged from slightly to moderately weathered. The rock is slightly to highly fractured with RQD ranging from 0 to 89 %, averaging 47 %.

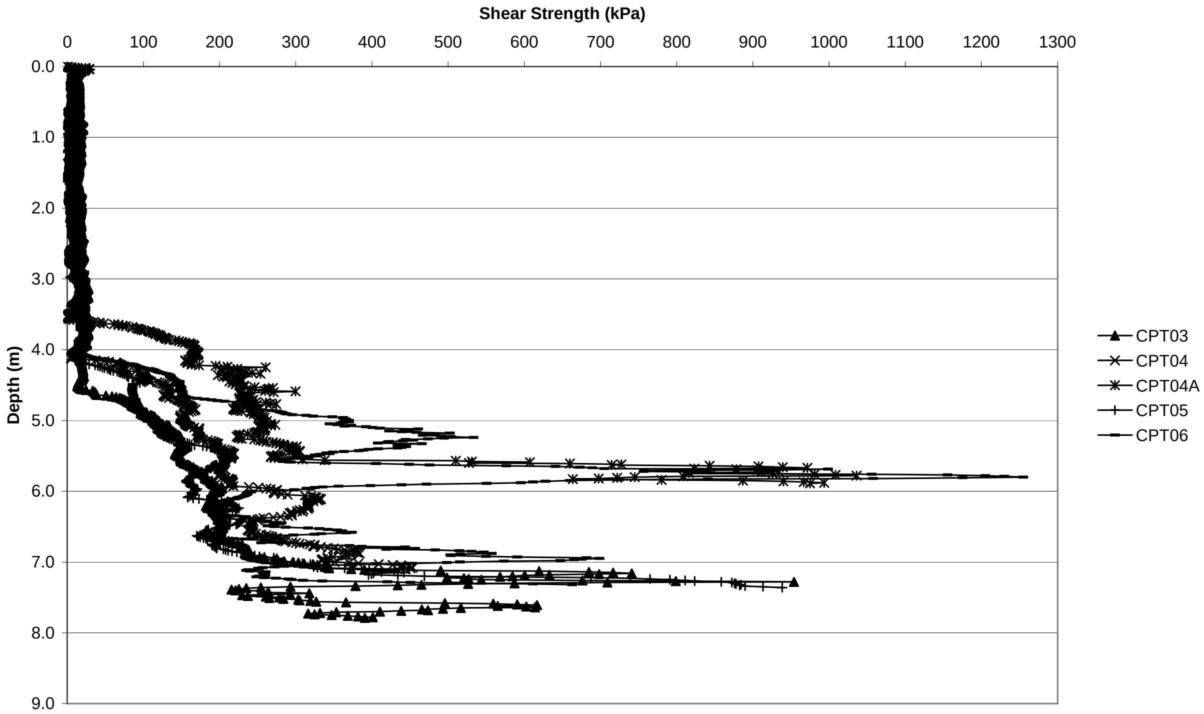
2.3.5 Undrained Shear Strength

Undrained shear strength of the clays was measured using the hand vane and CPT. T he hand vane shear results were used to calibrate the CPT data by estimating the cone bearing factor, N_K. Peak undrained shear strength for the seven shear vane tests is shown in Figure 2-1.

Residual shear strength was measured in the Very Soft and Soft Clay units using a shear vane. Generally, the results indicate these clays have sensitivity, S_t, of 2 to 3.

Pocket penetrometer readings taken in the Residual Soil indicate undrained shear strength greater than 225 kPa.

Figure 2-4 Interpreted CPT Shear Strength



2.3.6 Soil Dispersion

Emerson class tests were conducted to assess the dispersive properties of subsurface materials, with results ranging from 2 to 6 in the Soft Clay and 2 to 6 in the Residual Soil unit. This shows that both the Residual Soil and Soft Clay units are potentially highly dispersive and defensive design measures may be required to reduce erosion of constructed embankments. Emerson class tests are summarised in Table 2-1 with full laboratory report sheets in Appendix C.

2.3.7 Materials for Construction

The moisture content of the Residual Soil was found to be generally 2 % wet to 5 % dry of the optimum moisture content; moisture conditioning of the soil would typically be required before placement as earthfill material. Moisture density relationship tests are summarised in Table 2-2 with full laboratory report sheets in Appendix C.

A direct shear was run on remoulded Residual Soil to provide an estimate for use as engineered fill. This testing indicated effective cohesion of 19kPa and friction angle of 25.8 degrees, however conservative values of 12 kPa cohesion and 25 degrees friction have been selected. The results are summarised in Table 2-2, and laboratory report sheets in Appendix C.

DMPF Operations

3.1 Dredge Material Characterisation

A preliminary investigation into the dredge material was conducted as part of the URS Report: GLNG EIS Supplement Surface Water Assessment and Facility Design. This involved the collection of disturbed samples from eight boreholes drilled inside the proposed dredged approach channel and swing basin. For detailed information on borehole locations, establishment, equipment and drilling methodology please refer to URS Report: GLNG EIS Supplement Surface Water Assessment and Facility Design.

Laboratory testing of samples was carried out by a NATA registered laboratory in Sydney, NSW (Australian Soil Testing Pty Ltd) on disturbed samples in each lithologic unit encountered in the drilling program to assess the behaviour of the dredged material. The testing included the following:

- Soil classification;
- Sieve analysis; and
- Zone settlement tests.

The soil classification showed the dredged material varied from silty clay to gravelly sand and had between 5 and 94 % fines, averaging 41 % fines. Detailed descriptions of discrete soils layers encountered are provided in Table 3-1. These descriptions characterise the sediments as predominantly sand. The borehole locations are laid out parallel to the Curtis Island coastline along the proposed dredged approach channel and swing basin.

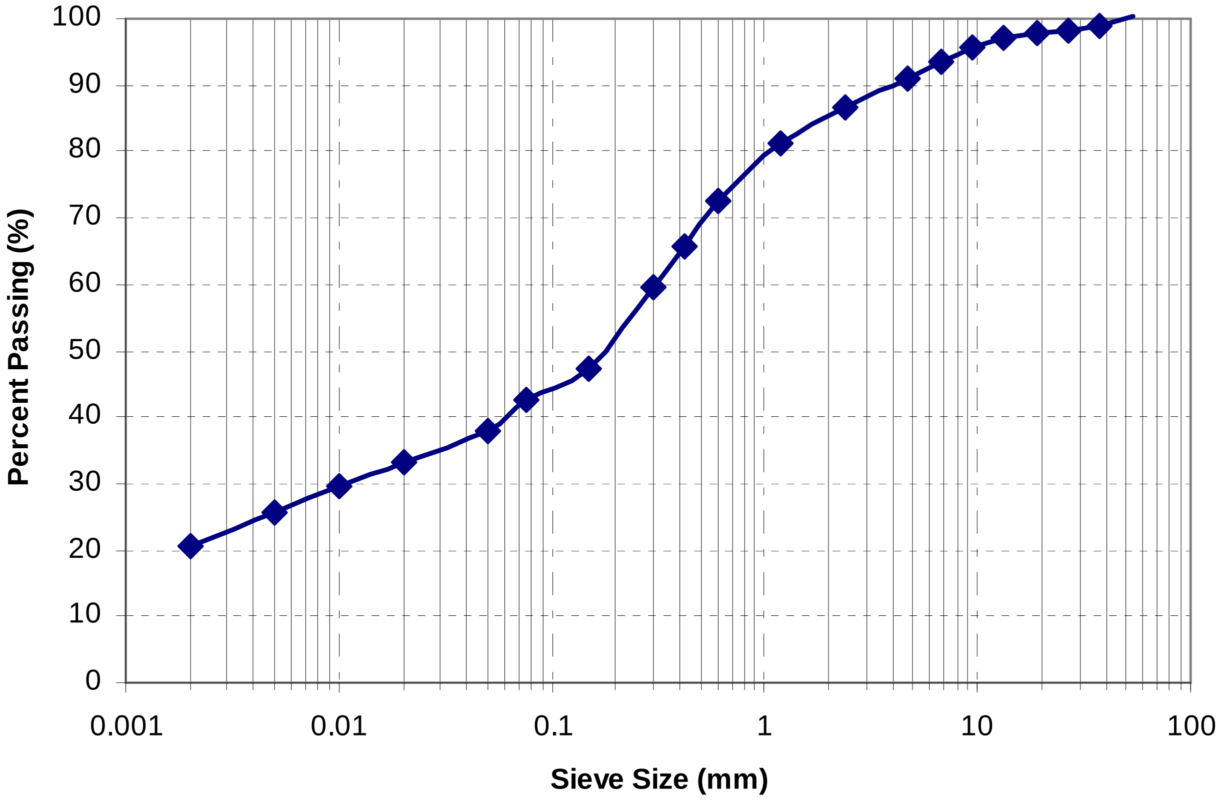
Table 3-1 Description of Discrete Soil Layers

Location	Depth (m)	Description
BH01A	0.0 - 1.0	SILTY SAND: grey, fine to coarse sand, some gravel (shells), some clay of low plasticity (Alluvial).
	1.0 - 2.1	SANDY CLAY: grey, medium plasticity, fine to coarse sand, some fine gravel (shells) (Alluvial).
	2.1 - 2.8	SANDY CLAY: grey, medium plasticity, fine to coarse sand, some fine gravel (Residual).
BH02A	0.0 - 1.0	SAND: brown, fine to coarse sand, trace of silt, trace of fine gravel (shells)
	1.0 - 2.75	SANDY CLAY/CLAYEY SAND: dark grey, medium plasticity, fine to coarse sand, some fine to medium gravel (Shells) (Alluvial).
	2.75 - 3.1	SANDY CLAY: brown & grey, medium plasticity, fine to medium sand (Residual).
BH04A	0.0 - 0.2	GRAVELLY (shells) SAND: grey, fine to coarse sand, some clay of low plasticity (Alluvial soil)
	0.2 - 0.5	SANDY CLAY: mottled yellow-brown and grey, medium plasticity, some fine to medium gravel (Residual soil)
	0.5 - 1.0	SILTY CLAY: mottled yellow-brown and grey. High plasticity, some fine to coarse sand (Residual soil)
BH07A	0.0 - 1.0	SANDY CLAY/CLAYEY SAND: grey, fine to coarse sand, low plasticity, some fine gravel shells present (Alluvium).
	2.0 - 2.8	SANDY GRAVEL: fine to coarse gravel, fine to coarse sand, some silt and clay of low plasticity (Alluvial).
	3.0 - 4.0	GRAVELLY SAND: brown, fine to coarse sand, fine to medium gravel, some silt (Alluvial).
BH08C	0.0 - 1.0	GRAVELLY SAND: grey, fine to coarse sand, fine to medium gravel, some silt (Alluvial).

Location	Depth (m)	Description
	3.0 - 4.0	SILTY SAND: grey, fine to coarse sand, some gravel (shells) some clay of low plasticity (Alluvial)
	4.75 - 5.6	SANDY CLAY: grey, medium plasticity, fine to coarse sand, with fine to medium gravel as shells (Alluvial).
BH13A	0.0 - 1.0	SAND: grey, fine to coarse, some clay of low plasticity, some gravel (shells) (Alluvial).
	6.0 - 7.0	SILTY SAND: grey, fine to coarse sand, some low plastic clay, some fine gravel (shells) (Alluvial).
	11.5 - 12	SANDY CLAY: grey, medium plasticity, fine to coarse sand, some gravel (shells) (Alluvial)
BH14A	0.0 - 1.0	CLAYEY SILT: grey, fine to coarse, low plasticity with shells (Alluvial).
	2.5 - 3.5	SANDY CLAY: dark grey, high plasticity, fine to coarse sand, some of fine gravel (Alluvial).
	6.0 - 7.0	GRAVELLY SANDY CLAY/SANDY GRAVEL: brown, fine to medium gravel, fine to coarse sand, some silt (Alluvial).
BH17A	0.0 – 0.3	SANDY CLAY/CLAYEY SAND: dark grey, medium plasticity, fine to coarse sand, some fine to medium gravel,(shells and rock)
	0.3 – 1.2	SILTY CLAY: brown, medium plasticity, some fine to coarse sand.
BH18A	2.0 - 3.0	SANDY CLAY/CLAYEY SAND: dark grey, medium plasticity, fine to coarse sand, some fine to medium gravel (shells and rock) (Alluvial).
	10.0 - 11.0	SILTY CLAY: brown, medium plasticity, some fine to coarse sand (Residual).
	11.1 - 11.5	SAND: grey, fine to coarse, some fine to medium gravel (shells), some low plastic clay (Alluvial).

Figure 3-1 provides an average particle size distribution for the dredge material.

Figure 3-1 Average Particle Size Distribution Curve



3.2 Dredge Material Delivery

Three dredging scenarios have been considered for the dredging program. The most likely scenario will involve a combination of cutter suction dredger (CSD) and trailer hopper suction dredger (TSHD). During the dredging process, *in situ* materials would be cut and hydraulically transported through pipelines and strategically discharged to the DMPF from various locations. Generally, the discharge locations would be moved around the periphery of the facility. The key component of the discharging operation is discharging from the main embankment in a manner that develops a suitable beach of coarse grained dredge material. This is required if upstream raises are to be achieved. The Dredging Contractor would take on the responsibility of delivering suitable beaching of coarse grained material through selective dredging and discharging techniques.

Concept Design Development

4.1 Design Criteria

Table 4-1 presents the criteria used to develop the conceptual design of the DMPF. The design criteria were developed with input from HR Wallingford, laboratory test data, the U.S. Army Corps of Engineers (USACE) Engineering Manual (EM) 1110-2-5027 and information gathered during site visits.

Table 4-1 Design Criteria

Item	Design Criteria Adopted	Source
Hazard Category of Embankments	Significant Hazard	ANCOLD (2003)
Hazard Category of Embankments	High Hazard	DERM – *Manual for Assessing Hazardous Categories and Hydraulic Performance of Dams Version 1.0*
Structural Life	20 years	Santos
Maximum height of embankments	No requirement	Santos
Site Selection	Laird Point	HR Wallingford & Santos
Dredged Material Disposal Method	Confined on-land disposal	HR Wallingford
Battery Limits	Queensland Gas Company (QGC) property boundary; Gas Transmission Pipeline Corridor (GTPC)	Santos
Proximity to shore	No requirement	Santos
Settlement (future land use)	No requirement	Santos
Water availability (for construction)	Barging from mainland (groundwater source not available)	Santos
Storage capacity	Provide storage volume to contain 6.8 million m^3 of in-situ dredged materials	HR Wallingford
Bulking Factor	1.4	HR Wallingford
Seepage	Allow facility seepage during service life	Santos
Dredging operation period	48.8 weeks	HR Wallingford
Freeboard	Minimum of 0.6m	USACE – Dredge Manual
Future use - Rehab	Provide rehab plan 5 yr prior to decommissioning	Santos
Future use - Industrial	Subject to GSDA provisions.	Santos
Drainage requirement	Free draining	Santos
Construction materials	Limited external sources for rock. On-site material use preferred.	Santos
Access	Via barge	Santos
Ponding depth	Minimum of 0.6 m	USACE – Dredge Manual
Length to width ratio to improve settlement efficiency	3:1	USACE – Dredge Manual
Rainfall	Highest rainfall event in 100 years commencing 1900 to 2000	Bureau of Meteorology

4.2 DMPF Design Concept

Based on the dredging plan stated in Connell Wagner's report (Reference 27684-007-02-01, Revision 2, dated 10 December 2008), URS have estimated 6,800,000 m^3 *in situ* material is to be dredged from the proposed marine shipping channel for the GLNG Project. HR Wallingford has verified this figure. During the dredging process the dredged slurry, a mixture of seawater and dredged materials, will be hydraulically transported to the facility. After suitable retention to achieve the water quality criteria, the water will be returned to the marine environment. Figure 6-1 shows the conceptual location of the DMPF.

HR Wallingford defined the general concept design layout and location for the DMPF, which employs land-based confinement of dredged materials by a main embankment and saddle dams. URS has developed into a conceptual design to capture and contain dredged materials and return associated seawater back to the marine environment. A system of internal cell structures and pipework has been developed to manage seawater to meet water quality criteria prior to release to the receiving environment. The general arrangement of the DMPF is shown in Figure 6-2. The facility is designed to operate by receiving dredge spoil material 20 hours per day with continuous effluent return to the sea (URS Report: GLNG EIS Supplement Surface Water Assessment and Facility Design). The subsurface and foundation conditions vary across the site and these are addressed in the concept designs.

The main embankment is needed to create confinement for the storage of dredged material. There are several options available to develop a design for the main embankment. URS have selected two embankment options that involve staged construction to optimise capital expenditure and compress the required lead time for facility preparation. The two staged embankment raise concepts explored were upstream and downstream raising. The remainder of facility confinement is provided using saddle dams at low points around the periphery of the facility.

In addition, internal bunds would be constructed to form the contiguous system of storage cells to facilitate settling of dredged material and allow water quality criteria to be achieved.

DMPF concept design also includes a spillway to allow safe discharge of storm water.

Outlet pipework is planned for discharge of effluent from the facility and for control of surface water.

4.3 Dam Hazard Classification

The Dam Hazard classification for the main embankment is 'high' based on the dam break criteria, as discussed in the GLNG DMPF Surface Water Assessment Report (Sections 4.2 and 4.3). Hence the criterion for design of the embankment offers the highest level of protection required by the current guidelines (*Manual for Assessing Hazard Categories and Hydraulic Performance of Dams v1.0, DERM*).

As the highest level of protection is required on the main embankment and hence the facility as a whole, it is not necessary to assess the surrounding perimeter embankments for dam hazard classification. This is because the design considerations and criteria being used for the spillway and DSA of the main embankment will either match or exceed guideline requirements for the perimeter embankments, which generally are expected to have significantly lesser consequences of failure.

4.4 Geotechnical Parameters

The site characterisation identified distinct geotechnical units and associated geotechnical properties. In addition, evaluation of the anticipated dredge materials has been made. The material properties used in concept design are generally based on interpretation of the results of these studies. In cases where data is not available typical values referenced in open literature have been adopted. For the open literature values adopted, parametric analyses were carried out to confirm the selection was reasonable and conservative.

The properties of each material used in concept design are summarised in Tables 4-2 and 4-3 and described as follows:

Embankment Earthfill: The embankment earthfill would be constructed using materials available from the site; the Residual Soil is likely to be a suitable source of earthfill material. The earthfill unit weight was estimated to be 20 kilo Newtons per cubic metre (kN/m^3), based on moisture-density relationship testing. Undrained shear strength of 100 kPa was selected for short-term stability. For long term-stability analysis, drained shear strength of 5 kPa and soil friction angle of 30 degrees were assumed. For seismic stability analysis, 20 % reduction of undrained shear strength to 80 kPa is adopted.

Very Soft Clay: The soil unit weight (17 kN/m^3) was estimated from the soil samples collected during the geotechnical investigation. Undrained shear strength of 5 kPa was estimated, based on shear vane and CPT results, for short-term stability analysis. For long-term stability analysis, drained shear strength of 0 kPa and soil friction angle of 15 degrees were selected from several laboratory testing results on soil samples collected during the geotechnical investigation; this is a conservative lower bound estimate. Compression index (Cc = 1.07) and recompression index (Cr = 0.08) values were interpreted from the laboratory testing results.

Soft Clay: The soil unit weight (17 kN/m^3) was estimated from the soil samples collected during the geotechnical site investigation. Undrained shear strength of 15 kPa was estimated, based on shear vane and CPT results, for short-term stability analysis. For long-term stability analysis, drained shear strength of 0 kPa and soil friction angle of 20 degrees were selected from several laboratory testing results on soil samples collected during the geotechnical investigation. Compression index (Cc = 1.23) and recompression index (Cr = 0.0168) values were interpreted from averaged laboratory testing results.

Stiff Clay: The soil unit weight (17 kN/m^3) was estimated using engineering judgement. Undrained shear strength of stiff soil was estimated using CPT. CPT results indicate undrained shear strength increases with depth at a rate of roughly from 50 kPa per metre from the upper contact of the unit. Undrained shear strength is limited to 200 kPa in our analyses. For long-term stability analysis, drained shear strength of 5 kPa and soil friction angle of 25 degrees were assumed from open literature. Due to the estimated over consolidated nature of the Stiff Clay, values of compression index (Cc = 0.6) and recompression index (Cr = 0.1) were estimated using a liquid limit relationship developed by Terzaghi and Peck (1967).

Rock Fill: Rock fills would likely be imported. The unit weight of the bedrock was assumed to be 21 kN/m^3. The friction angle of 38 degrees and the shear strength of 0 kPa were assumed for this material. The relatively low friction angle is due to anticipated minor contamination by clays.

Coarse Grained Dredged Material: Laboratory testing (particle size distribution) of dredged materials carried out by URS and Connell Wagner indicate a significant proportion of coarse grained material.

Based on this result, the dredged materials are divided into two general classifications: coarse grained and fine grained. The fine grained materials are considered not suitable for use in constructing embankments. For the coarse grained materials assumed in the design, conservative values have been assigned for unit weight and effective shear strength and friction angle: 17 kN/m^3; and 0 kPa and 27 degrees, respectively.

For seismic stability analysis, 20 % reduction of friction angle to 22 degrees is adopted (i.e. 0.2*tan27).

Residual Soils: The soil unit weight (19 kN/m^3) was estimated from site observation. Undrained shear strength of Residual Soil was assumed increasing from 100 kPa to 200 kPa at a linear rate of 50 kPa/m from the top of the layer. For long-term stability analysis, drained shear strength of 12 kPa and soil friction angle of 25 degrees were assumed. These assumptions are considered conservative.

Table 4-2 Summary of Geotechnical Parameters for Slope Stability Analyses

Type of materials	Unit weight (kN/m3)	Cohesion (kPa)	Friction angle, ϕ (deg)	Remark
Embankment Earthfill	20	100	-	Short-term stability analysis
		5	30	Long-term stability analysis
		80	-	Seismic analysis
Very Soft Clay	17	5	-	Short-term/Seismic stability analysis
		0	15	Long-term stability analysis
Soft Clay	17	15	-	Short-term/Seismic stability analysis
		0	20	Long-term stability analysis
Stiff Clay	17	Cu = 50 + 50 X Depth (Cu limited to 200 kPa)	-	Short-term stability analysis
		5	25	Long-term stability analysis
		Cu = 40 + 50 X Depth (Cu to be limited to 160 kPa)	-	Seismic analysis
Rock Fill	21	0	38	Long/Short-term/Seismic stability analysis
Coarse Grained Dredged Material	17	0	27	Long/Short-term stability analysis
		0	22	Seismic analysis
Residual Soils	19	Cu = 100 + 50 X Depth (Cu to be limited to 200 kPa)	-	Short-term stability analysis
		12	25	Long-term stability analysis
		Cu = 80 + 50 X Depth (Cu to be limited to 160 kPa)	-	Seismic analysis

4.5 Stability Analysis

Stability analyses were conducted to evaluate the stability of the main embankment, internal bunds and saddle dams throughout the design life. Geostudio (2007, Version 7.15) was used to evaluate slope stability of the main embankment, saddle dams, and internal bunds for several scenarios. The method of Morgenstern-Price was used in all cases to assess the stability via the critical surface search routine. The analyses were carried out on interim raise levels and the maximum cross-section of each structure.

Stability of each structure under the static and seismic loading conditions was analysed. Short-term and long-term stability analyses were performed under the static loading conditions. The short-term stability was a concern during the construction stage as the build-up of excess pore water pressure due to the construction works will negatively influence the stability of the structures. The short-term stability was analysed based on the undrained shear strength of the materials prior to the start of construction, which is shown in Table 4-2, taking no account of any increase in strength due to consolidation. The minimum acceptable factor of safety under short-term conditions is selected as 1.3. The long-term stability is conducted to assess the stability of the structure after the dredging works are complete. The minimum factor of safety under long-term conditions is selected as 1.5.

Stability of the structure under seismic loading conditions is assessed using a pseudo static approach. ANCOLD (1998) recommends the pseudo-static method used by the US Army Corp of Engineers (1984). Based on AS 1170.4, *Minimum Design Loads on Structures, Part 4: Earthquake Loads* the peak ground acceleration is roughly 0.095 g. The stability of the structure is considered acceptable if the pseudo-static factor of safety is greater than 1.0 or if seismic displacement is less than 0.5 m (USACE, 1984). Using this method, the peak ground acceleration adopted for the pseudo-static analysis is 0.0475 g with a 20 % reduction in undrained shear strength for the embankment and coarse-grained dredged materials.

A nominal surcharge load of 10 kPa was added to the crest of the main embankment, internal bunds and saddle dams to account for construction and maintenance loading by heavy equipment or materials.

4.6 Settlement Analyses

Foundation settlement is a phenomenon that occurs when load is applied to the ground (i.e. dredge spoil). The primary mechanism leading to settlement is consolidation of compressible soils under the applied load. Foundation settlement has to be considered for the final landform to maintain proper site drainage during the facility life. Settlement can also develop cracking and deformation of the main embankment during dredge placement operations. URS has undertaken settlement analyses to develop a DMPF design to tolerate conservative estimates of settlement.

Foundation settlement assessment was based on the geotechnical soil profile developed by site characterisation studies, as presented in Section 2, and engineering judgement. The method considers settlement under centre and edge of a rectangular loaded area using Boussinesq stress distribution and consolidation theory (Bowles, 1995). The stress increase coefficient (Is) at the centre of each layer is computed using Newmark integration of Boussinesq theory based on vertical depth below bottom of loaded area and position within the loaded area. The main embankment is considered an ‘edge’ and the middle of the completed facility is considered ‘centre’.

Averaged laboratory index values for compression (Cc) and recompression (Cr) measured from undisturbed samples of compressible soils from the Very Soft Clay and Soft Clay layers were used. The underlying Stiff Clay has undrained shear strength roughly 10 times greater than the Very Soft to Soft Clays, and as such the Stiff Clay is interpreted to be over consolidated. Index values for the Stiff Clay were estimated using a liquid limit relationship developed by Terzaghi and Peck (1967).

The rectangular dimension of dredged material above the compressible clay layers is 550 m by 500 m. The calculated maximum total settlement is about 4 m in the centre, and about 1.5 m at the edge (i.e. main embankment). The abutments of the main embankment are proposed on Residual Soil / weathered bedrock with a small amount of elastic settlement estimated. Differential settlement along the main embankment is estimated to be 1.5 m, the difference between the consolidation settlement at the mid-point on the embankment and zero settlement at the abutments (the abutment settlement taken as zero to estimate the maximum differential settlement). Taken over a distance of 275 m (midway), this translates to roughly 0.5 %.

The portion of main embankment foundation that transitions from clay to weathered bedrock is likely to experience some cracking. However this is not expected to be problematic due to the gradual thinning of compressible clay layers toward the edges of the mud flat to develop a gradual transition to weathered bedrock foundation conditions at the abutments.

Foundation settlement under the proposed saddle dams will largely be immediate settlement on the clayey unsaturated Residual Soil. This will take place during construction and is considered manageable.

Settlement of the internal bunds will be significant, which will require regular maintenance of the bunds to maintain required crest elevations.

Table 4-3 Foundation Settlement Parameters

Type of materials	**Unit weight (kN/m3)**	**OCR**	**e_0**	**Cc**	**Cr**
Very Soft Clay	17	1.0	2.695	1.07	0.08
Soft Clay	17	1.0	2.613	1.23	0.168
Stiff Clay	17	1.0	2.5	0.6	0.1

4.7 Main Embankment Concept Design

A 22 m high main embankment is planned to create partial confinement for the storage of dredged materials. The main embankment is proposed to be constructed over a mudflat area with abutments keyed into the Residual Soil / weathered bedrock. The embankment is conceived as a homogeneous earthfill embankment built on an improved foundation. The embankment earthfill would be sourced locally from the clayey Residual Soil deposits identified in the site characterisation. The low permeability of these clayey soils would serve to control seepage through the embankment. Construction of the embankment is envisaged in staged raises (upstream or downstream).

4.7.1 Foundation Preparation

The site characterisation work indicates that foundation soils below the main embankment consist of 4m of Very Soft to Soft Clay. As these units will compromise the constructability and stability of the main embankment, ground improvement of the foundation is required. With the consideration to cost, time and constructability, the soft to very soft soils have to be excavated and replaced with rockfill and engineered earthfill. The installation of continuous sheet pile wall is considered a requirement during the ground improvement work to limit seepage and control slumping of the excavation within the soft clays.

The upstream edge of the foundation treatment area is at risk of possible piping progressing from the rockfill through the clayey earthfill to the coarse grained dredge material. Piping can be controlled by installing a clay key into the Stiff Clay unit between the rockfill and the clayey earthfill.

The sequence of the foundation preparation is shown in Figures 6-6 and 6-7. The construction of the foundation preparation will be conducted progressively inwards from the abutments during low tide periods. It is expected that dewatering would be needed during the works.

Another issue to be considered for foundation preparation is the flooding of the mudflat during spring tides. It is proposed that an earthfill cofferdam (height to be determined to limit risk of inundation to an acceptable level) be constructed to cut-off seawater and prevent tidal flooding of the mudflat.

The ground improvement for foundation preparation is generally considered to extend beyond the footprint of the entire main embankment in order to prevent the possible localized failure around the toe. However, the stability analyses indicate that exact area of ground improvement for foundation preparation depends on the construction method (i.e. upstream versus downstream raises).

4.7.2 Conceptual Construction Sequence of Main Embankment

Construction of the main embankment would start after the completion of foundation preparation. Two options of constructing the main embankment are considered: upstream raise and downstream raise. Embankment raise methods influence cost, duration of work, and risks. These are explored in the following sections.

Upstream Raise Option

The concept of construction of main embankment by upstream raise method is depicted in Figures 6-8 and 6-9, which is briefly described as follows:

1. After the foundation preparation works are completed, the main embankment is to be built to RL 10 m AHD with an upstream batter of 1:5 (V:H) (sea side) and 1:3 (V:H) on the upstream side, using locally sourced earthfill materials;
2. Dredging work starts and coarse grained dredged materials are discharged to create a beach on the upstream batter to RL 7.9 m AHD;
3. Founded on coarse grained dredged materials, the main embankment is raised to RL14 m AHD using earthfill materials; and
4. This sequence of creating a beach of coarse grained dredged materials and 4 m embankment raises continues through Stage 3 and 4 to an ultimate embankment crest elevation at 22.0 m AHD.

Table 4-4 presents the summary of stability analyses and Appendix D shows the detailed results showing critical failure surface for each case.

Table 4-4 Summary of Stability Analyses for Upstream Raise Option

Case	Crest Elevation (m AHD)	FOS		Note
		Upstream Side	Downstream Side	
Stage 01	10	4.693	2.797	End of Construction – Undrained Analysis
Stage 02-1st Raise	14	2.922	2.760	End of Construction – Undrained Analysis
Stage 03-2nd Raise	18	2.289	2.139	End of Construction – Undrained Analysis
Stage 04-3rd Raise	22	5.427	1.734	End of Construction – Undrained Analysis
		3.840	1.634	Long-term condition – Drained Analysis
		1.013	2.208	Pseudo-Static Stability

The results of stability analyses indicate that the factor safety of the main embankment under static loading was greater than 1.5 for long-term condition and greater than 1.3 for short-term condition at the end of each stage of construction. The results of the pseudo-static stability analysis also indicate that the main embankment has a factor safety of 1, suggesting that the main embankment will not likely suffer significant deformations under design seismic loading. The high factor of safety in the static analyses is attributed to embankment configurations designed to control stability during the design seismic event. The embankment geometry can be optimised during detailed design to find a better balance between static and seismic scenarios.

Downstream Raise Option

The concept of construction of main embankment by downstream raise method is depicted in Figures 6-10 and 6-11, which is briefly described as follows:

1. After the foundation preparation works are completed, the main embankment is to be built to RL 10 m AHD with an upstream batter of 1:5 (V:H) (sea side) and 1:3 (V:H) on the downstream side using locally sourced earthfill materials. It is noted that the downstream raise options requires the construction of the main embankment from the inboard toe, which is different from the upstream raise option.
2. Construction of main embankment continues by raising the embankment in the downstream direction to RL 18 m AHD, followed again by a second raise to 22 m AHD.

Table 4-5 presents the summary of stability analyses and Appendix D shows the detailed results showing the critical surface for each case.

Table 4-5 Summary of Stability Analyses for Downstream Raise Option

Case	Crest Elevation (m AHD)	FOS		Note
		Upstream Side	Downstream Side	
Stage 01	10	4.130	3.727	End of Construction – Undrained Analysis
Stage 02-1st Raise	18	3.288	2.457	End of Construction – Undrained Analysis
Stage 03-2nd Raise	22	3.137	1.884	End of Construction – Undrained Analysis
		4.288	1.595	Long-term condition – Drained Analysis
		2.070	1.254	Pseudo-Static Stability

The results of stability analyses indicate that the factor safety of the main embankment under static loading was greater than 1.5 for long-term condition and greater than 1.3 for short-term condition at the end of each stage of construction. The results of the pseudo-static stability analysis also indicate that the main embankment has a factor safety of 1.0, suggesting that the main embankment will not likely suffer significant deformations under design seismic loading.

4.7.3 Recommended Conceptual Design of Main Embankment

Two design options, upstream raise and downstream raise, are feasible to construct the main embankment. The main embankment is the most critical structure in the DMPF. The benefit of two design options is having a fallback in case one option is found to be unfeasible during detailed design.

The main advantage of the upstream raise option is lower volume of construction materials. The use of coarse grained dredged materials to support the embankment raises reduces the volume of earthfill required. The volume of earthfill needed for construction of the main embankment using the downstream raise option is approximately 1,045,000 m^3, in contrast to only approximately 450,000 m^3 of earthfill materials for the upstream raise option. In addition, the amount of foundation preparation is reduced as foundation improvement is only required below the initial embankment at RL 10 m.

Disadvantages of the upstream raise option are that the construction works may encounter delays due to dredging works on the embankment, and the quality of the construction work is greatly dependent on coarse grained dredged materials achieving suitable shear strength. It is crucial that coarse grained dredged materials develop the required shear strength to support each subsequent raise.

Downstream raise of the main embankment does not rely on the shear strength of the dredged material. As a result, the construction process can proceed independently and quality of the construction work can more easily be controlled.

Piping risk for the main embankment can be managed by constructing a clay key during the foundation preparation. Piping through the homogeneous embankment is not considered likely because water is not stored against the embankment. Pore water would travel through a long seepage path through dredge material and clayey earthfill.

4.8 Internal Bunds Conceptual Design and Staging

In order to promote the particle settling in dredged slurry and achieve the effluent water discharge quality requirement, a continuously operating DMPF divided into several cells by internal bunds is proposed. As shown in Figure 6-12, the internal bunds are to be constructed to divide the facility into six cells. Each cell is to be connected to the neighbouring cell by an adjustable weir. Four or five cells would be operated in series to create necessary contaminant and migration pathways for improvement of effluent quality. The advantage of this operation is to allow drying and levelling of dredged materials in some cells while discharging of dredged materials takes place in other cells to create a continuous disposal process. The conceptual design of the cells and internal bunds will be verified during detailed design and would be the responsibility of the Dredging Contractor.

Two types of internal bunds are proposed: Type 1 constructed using engineered earthfill, and Type 2 constructed using coarse grained dredged materials.

Type 1 internal bunds would be battered to a gradient of 1:5 (V:H) on both sides. These would be built on original ground areas. Type 2 internal bunds would be built with 1:15 batters supported on dredged materials (fine or coarse). Generally, the Type 2 internal bunds are planned for dredged material areas that overlie the mudflats. This is because it is envisaged that bund construction on the fine grained dredged materials may not be feasible using heavy construction equipment.

As shown in Figures 6-13 through 6-16, both Type 1 or Type 2 internal bunds are envisaged to be constructed in three stages. This may change subject to the dredging contractor’s methodology but demonstrates a feasible approach which could be adopted:

1. Internal bunds not required during Stage One dredging operations;
2. Construct internal bunds to RL 14 m AHD after Stage One dredging is complete;
3. Disposal of dredged material into the cells continues to RL 11.9 m AHD;
4. Construct internal bunds to RL 18 m AHD;
5. Disposal of dredged material into the cells continues to RL 15.9 m AHD;
6. Construct internal bunds to RL 22 m AHD; and
7. Disposal of dredged material until facility is complete.

Table 4-6 presents the summary of stability analyses and Appendix D shows the detailed results showing the critical surface for each case.

Table 4-6 Summary of Stability Analyses for Internal Bunds

Case	Crest Elevation (m AHD)	FOS		Note
		Type I	Type II	
Stage 2	14	1.681	1.835	End of Construction – Undrained Analysis
Stage 3	18	1.681	1.963	End of Construction – Undrained Analysis
Stage 4	22	1.693	1.751	End of Construction – Undrained Analysis
		N/A	N/A	Pseudo-Static Stability

The results of stability analyses indicate that the factor safety of the internal bunds on both areas under static loading was greater than 1.5 for long-term condition and greater than 1.3 for short-term condition at the end of each stage of construction. Seismic stability is not applicable for the internal bunds because these are temporary structures and can easily be repaired.

4.8.1 Construction of Internal Bunds

It should be noted that careful detailed planning and design by the Dredging Contractor will be necessary in the construction of internal bunds, the logical sequence of dredging, selective disposal of dredging slurry, and discharge locations. These issues will be resolved during the detailed planning of the dredging program in conjunction with the Dredging Contractor and the regulatory authorities as necessary.

4.9 Saddle Dams Conceptual Design

The existence of natural topographical and landform constraints, such as low land areas, pipeline easements and property boundaries, require the use of saddle dams to achieve surface area, storage volume, and surface water management requirements.

Five saddle dams are proposed, each with the shoulder gradients of 1:3 (V:H). The general layout of saddle dams is indicated in Figure 6-2.

Locally sourced earthfill would be suitable to construct homogeneous embankments for the saddle dams. The conceptual construction sequence of saddle dams is shown in Figure 6-17, which is described as follows:

1. Saddle dams are constructed to RL 14 m AHD before the commencement of the dredging work.
2. Saddle dams are raised to RL 18 m AHD and RL 22 m AHD, respectively, as required during dredging works.

Geotechnical site investigation works indicated that saddle dams may be built on the original ground after vegetation is cleared and the thin topsoil layer is removed. Site characterisation work indicated the foundation conditions are typically similar among the five saddle dam locations. Figure 6-18 shows a typical saddle dam section and a table of embankment heights, ground levels and ultimate dam lengths. Saddle Dam 'E' is the highest embankment and was therefore selected for stability analyses.

Table 4-7 presents the summary of stability analyses and Appendix D shows detailed results showing the critical surface for each case.

Table 4-7 Summary of Stability Analyses for Saddle Dam 'E'

Case	Crest Elevation (m AHD)	FOS	Note
Stage 1	14	6.353	End of Construction – Undrained Analysis
Stage 2	18	4.389	End of Construction – Undrained Analysis
Stage 3	22	3.435	End of Construction – Undrained Analysis
		1.516	Long-term condition – Drained Analysis
		2.472	Pseudo-Static Stability

The results of stability analyses indicate that the factor safety of the saddle dams under static loading was greater than 1.5 for long-term condition and greater than 1.3 for short-term condition at the end of each stage of construction. The results of the pseudo-static stability analysis also indicate that the saddle dams have a factor safety of 1.0, suggesting that they will not likely suffer significant deformations under design seismic loading.

4.10 Spillway

Due to the expected similarity of the geotechnical conditions on both abutments the preferred location for this spillway will be on the southern abutment of the main embankment as site topography is more favourable, requiring significantly less earthworks. The spillway will still require significant excavation (approx. 210,000 m^3) of the abutment to provide the correct levels for the first spillway stage. The material won from these earthworks will be used in the construction of the main embankment.

The spillway will be raised three times in parallel with the embankment raise staging after the initial spillway has been constructed. Each raise will be 4 m in height and is proposed to be undertaken by excavation through natural ground.

Geotechnical investigations were not carried out in either of the abutments due to environmental access restrictions (significant felling of trees required). Boreholes drilled in saddle areas encountered deep deposits of clayey Residual Soil and some bedrock (below 25 m). However, the topography at the southern abutment is relatively steep (40 % grade), which implies harder and more resistant natural materials may be present. It should be anticipated that hard residual soils and bedrock are present.

A key consideration is the possible need to provide energy dissipation for the design flows downstream of the spillway crest if softer, less resistant materials are encountered. Concrete or rip rap armouring would be suitable for this purpose.

4.11 Effluent and Stormwater Drains

The DMPF requires a system of drains to manage surface water and to release effluent from the facility. Surface water contributing from the catchment areas upstream of Saddle Dams 'C' and 'D' would accumulate without adequate drainage. The concept is to provide stormwater drains placed on the existing ground surface leading to submarine outfalls. A similar concept is proposed for the effluent drain pipes to be laid out across the facility. The DMPF would bury the drains. Key design considerations are:

- Earth pressures;
- Lateral loads due to shifting dredge material; and
- Foundation settlement.

The conceptual layout shown in Figure 6-2 shows drains placed on firm ground away from the highly compressible clays found in the mudflats. This will greatly reduce settlement but will not eliminate it entirely. Elastic settlement of the Residual Soil is expected, but this could be managed by careful planning of layout to compensate for anticipated settlements.

Lateral loads would be countered by providing anchoring of pipes at suitable intervals.

The effluent drains are considered temporary works to be decommissioned after dredging. However, the stormwater drains are planned as permanent surface water management infrastructure. As such, extensive detail design works would be required to facilitate this concept. It is envisaged the stormwater drains would be enshrouded by natural filter materials to prevent clogging.

4.12 Construction

Construction of the DMPF requires consideration of access, site preparation, construction water, accommodation of workers, borrow areas and surface water management. Key design considerations are:

- Access to Curtis Island requires barging of heavy equipment, personnel, and some materials;
- Access tracks are required around the facility during construction;
- The site requires clearing, grubbing of vegetation and topsoil stripping in preparation for construction;
- Construction materials would generally be won from site, requiring the development of significant borrow areas;
- Temporary accommodation facilities may have to be constructed;
- Water for construction may have to be transported by barge to Curtis Island; and
- Earthworks for management of runoff and erosion would be required.

The most critical of these items is the sourcing of 'fresh' water (i.e. not seawater) for construction. Water is needed for dust suppression and earthworks. The amount of water required can be estimated from the earthfill quantity estimates. For the main embankment and saddle dams there are roughly 1,000,000 m^3 of earthfill needed. If moisture conditioning requires 2 % increase in soil moisture, this translates to roughly 50 mega litres of water required. If the soil turns out to be drier the demand for water goes up significantly. This estimate does not include water for dust suppression. Daily barge transport of water to Curtis Island would likely be required.

Final Landform

5.1 Landform Design

The DMPF will be constructed with dredge materials discharged from the periphery of the facility. The dredge material is estimated to deposit at a grade of roughly 1:50 (2 %). The final surface would drain toward the centre of the facility. The concept for rehabilitating the facility into a stable free-draining landform is to reshape the surface to promote controlled runoff and prevent ponding of water. Runoff from higher elevations around the periphery would be directed in a controlled manner along a network of surface drains toward the centre of the landform then to the spillway. The spillway would serve as a chute directing surface waters to the sea.

The surface drains would be designed to meet suitable ARI flood events and to resist erosion. Sediment traps and/or silt dams would be constructed to capture suspended sediment while vegetation is established. A range of options is available to provide erosion protection including a number of proprietary surface mat products, straw mulching or hydro-mulching. Figure 6-19 shows a conceptual layout of the final landform with indicative surface drainage and sediment traps.

Vegetation would be established across the surface of the final landform to promote natural regrowth and control erosion. Limited topsoil is available from the existing soil profile so additional treatment would be required, such as the addition of fertiliser and mulch, to promote vegetative growth across the rehabilitated surfaces.

Consolidation settlement of the dredged material and foundation is likely to occur for several years. However the rate of settlement will decrease over time. Several metres of settlement are estimated to occur primarily in areas above the mudflat, and lesser so toward the periphery. However, a significant portion of this settlement would likely occur during placement of the dredge spoil. Surface drainage would be designed to allow for changes in grade to maintain positive drainage.

The stormwater drains built to transfer under the facility stormwater captured from upstream catchments would also be used to drain vadose water percolating through the dredge material. The drains are envisaged as maintenance-free, comprised of rockfill encased in engineered filter materials.

5.2 Future Land Use

The final landform will be stable and free draining once rehabilitation works have been completed. However the nature of the dredge spoil and underlying soft clay foundation are potentially key constraints on future land use. Potential future land uses could include the following options:

1. Storage of dredge material produced by maintenance dredging of the channel, swing basin and berth pocket during the 20-year GLNG service life;
2. Native vegetation and habitat; and
3. Possible future commercial or industrial use.

The amount of dredge material produced by maintenance dredging is not known, but it is estimated to be a small percentage of the initial dredge operation. Segments of the internal bunds would remain intact (as shown in Figure 6-19) for intermittent storage of dredge material. After the 20-year service life it is anticipated that the maintenance dredge area at the site would be rehabilitated in a manner similar to the rest of the landform. Stormwater drainage would be provided via a spillway on the internal bund.

5 Final Landform

The viability of commercial or industrial use of the site would be dependent upon improvement of the natural very soft and soft clays existing in the mudflat and the nature of the dredge spoil landform produced at the end of the spoil disposal operation. Even without the DMPF the natural mudflat would require extensive foundation improvement works (as detailed in Section 4.7.1 for the main embankment) before commercial or industrial development could progress. Moreover, handling of the natural clays, which are PASS (potential acid sulphate soils), would require isolation in containment areas.

In comparison, the DMPF final landform would partly be built on improved foundation and the load of the dredge material would act as a surcharge to consolidate over time the natural very soft and soft clays. Although the landform would be highly variable owing to segregation of dredge material across the site, less PASS clays would be handled and these could be suitably contained in the DMPF.

Regardless of whether the site is in its natural state or as a DMPF, it is envisaged that development of the site for commercial or industrial purposes would require significant engineering works that could include:

1. Ground improvement by pre-loading or other ground improvement technologies. The cost and time required to achieve a suitable building platform using ground improvement would require further detailed evaluation.
2. Piled foundation support of structures which could be cost prohibitive.

Glossary

Abutment	That part of the valley side against which the dam is constructed
Alluvial	Sediments deposited by moving water
Arenite	A clean sandstone that is well sorted, contains little or no matrix material
Argillite	Weakly metamorphosed mudstone
Beach	The sloping area of coarse dredge material around a discharge point
Borehole	A hole drilled into the Earth to study the ground formation
Carbonaceous	Rich in carbon
Carboniferous	Geological era ranging from about 345 to about 280 million years ago
Catchment area	Area or land that drains into a single outlet and is separated from other catchments by a divide
Chert	A hard extremely dense sedimentary rock consisting of interlocking quarts grains
Coarse grained	Component of soil which greater than 0.075mm in size
Cone penetration test	A soil penetration test in which a steel cone of standard shape and size is pushed into the soil and the force required to advance the cone at a predetermined rate is recorded
Consolidation	The process whereby soil particles become more closely packed due to increased stress and release of excess pore water pressure
CPT	Cone Penetration Test
Critical failure surface	Failure surface with the lowest factor of safety
CSD	Cutter Suction Dredger
Deformation	Change in shape and/or size of a body
DERM	Department of Environment and Resource Management
Dispersive	Breaking down or separation of aggregates into single grains
Disturbed	Sample which is not in its in-situ condition
DMPF	Dredge Material Placement Facility
Downstream raise	Pertaining to a dam raise built on the downstream side of the existing dam structure
Drained analysis	Pertaining to slope stability, the analysis of conditions after excess pore water pressures in soil have dissipated
DSA	Design Storage Allowance
Earth pressure	Pressure that soil exerts
Earthfill	Engineered mineral soils placed to required specifications
Effluent	Discharge water from the internal cells

6 Glossary

EIS	Environmental Impact Statement
EM	Engineering Manual
Embankment	A structure established to contain waters or to protect their effects
Earthworks	Engineering works created through the moving of massive quantities of soil or unformed rock
Erosion	The wearing away of soil or rock caused by physical or chemical processes
Estuarine	Formed in an estuary
Excavation	Removal of soil for construction of structures
Final Landform	Final profile of the facility after decommissioning
Fine grained	The component of soil which less than 0.075mm in size
Foundation settlement	Subsidence due to elastic or consolidation effects caused by increase in effective stress
Geomorphological	Surface features differentiated by surface processes
GLNG	Gladstone Liquefied Natural Gas
GTPC	Gas Transmission Pipeline Corridor
Internal Bund	An embankment to separate the internal cells within the DMPF
Internal cell	Individual areas used for settling dredge material within the DMPF
Limestone	A sedimentary rock consisting chiefly of calcium carbonate, primarily in the form of calcite
Lithologic	The gross physical character of a rock or rock formation
LNG	Liquefied Natural Gas
Main embankment	Chief structure to hold back dredged material
Marine	Relating to the sea
Moisture conditioning	The process of altering soil water content to achieve optimum moisture content
Mudflat	Intertidal area
Mudstone	Sedimentary rock composed of clay and silts
OBE	Operating Basis Earthquake
PGA	Peak Ground Acceleration
Pseudo-static stability	Stability of the slope by assuming additional force due to seismic effect
Retention	Amount of time required for sediment to clear in water to an acceptable level
Saddle Dam	Dam at the low point of a ridge

6 Glossary

Seismic	Caused by an earthquake or vibration of the earth
Seismic displacement	Displacement caused by an earthquake
Shear strength	Maximum strength of soil at which point significant plastic deformation or yielding occurs due to an applied shear stress
Sheet piling	A steel structure (normally driven) that holds back soil or rock from a building, structure or area
Spillway	Structure to convey water over or around an embankment
SPT	Standard Penetration Test
Stability analysis	Analysis to study the potential failure of a soil slope
Subsurface	Below the ground surface
Surface water management	Management of water collecting on the ground or in a river, lake, wetland or ocean
Swamp pad	Series of logs chained together to enable an excavator to cross swampy ground
Test pit	Excavation into the ground to assess the subsurface
Tidal	Subject to tides
Topography	Surface shape and features
Topsoil	Upper portion of soil horizon that supports plant life
TSHD	Trailing Suction Hopper Dredger
Undisturbed	Sample which is in its in-situ condition
Undrained analysis	Analysis by assuming the pore water pressures, generated during the course of shearing the soil, are not able to dissipate rapidly
Upstream raise	Building a new dam on top of the slurries impounded during the previous stage of the dam crest
USACE	United States Army Corps of Engineers
Weathered rock	Rock that was undergone various degrees of physical and chemical degradation resulting in changes in colour, texture, composition, firmness or form
Well	Monitoring device used to measure groundwater levels and allow samples to be taken for analysis of groundwater quality
Weir	A small overflow-type dam commonly used to raise the level of a river or stream

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The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between 14 September and 23 October 2009 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

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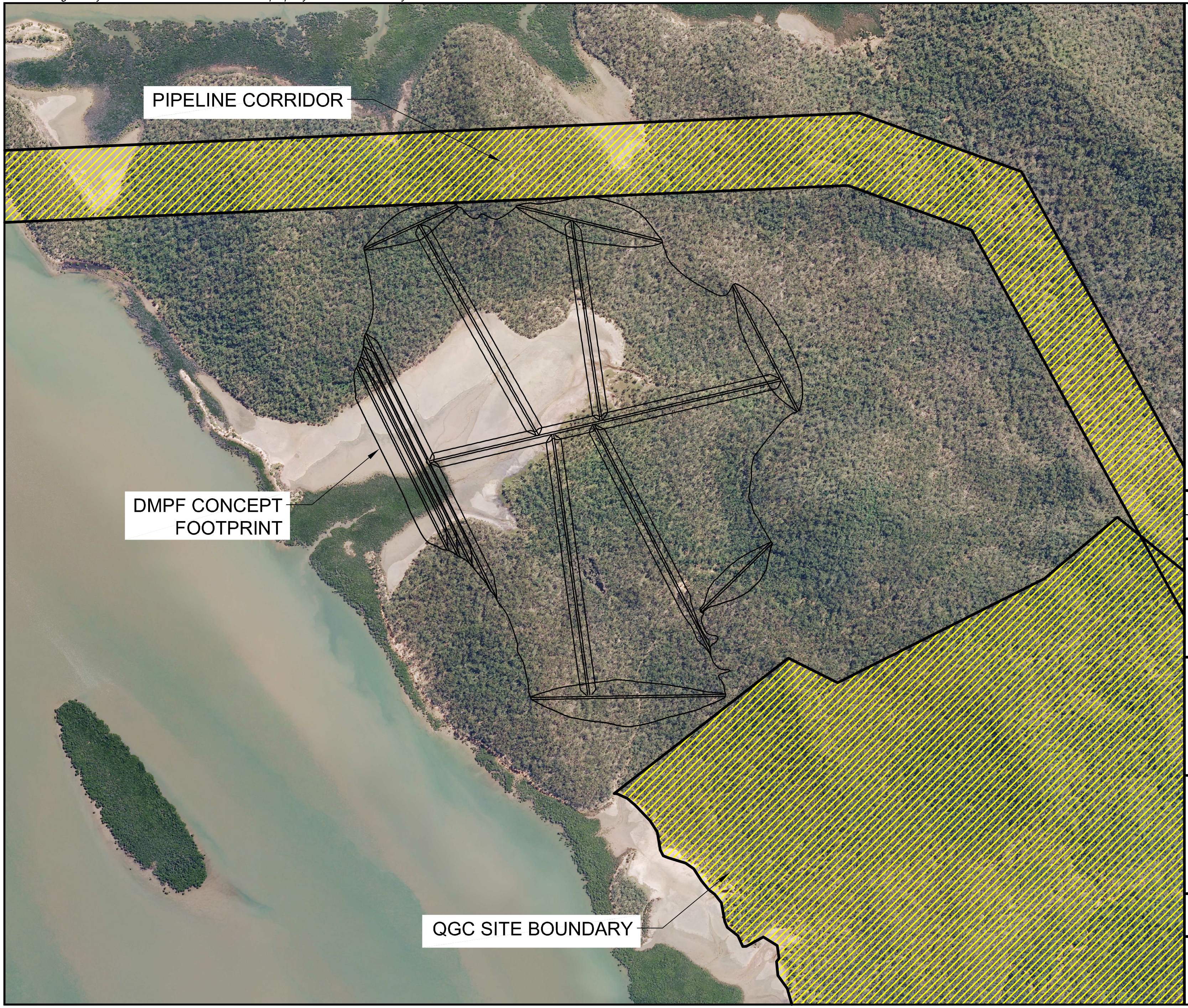
A

Appendix A Figures



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GEOTECHNICAL ASSESSMENT AND DESIGN

Title

LANDFORM CONSTRAINTS

Figure: **6-1** Rev. B A4

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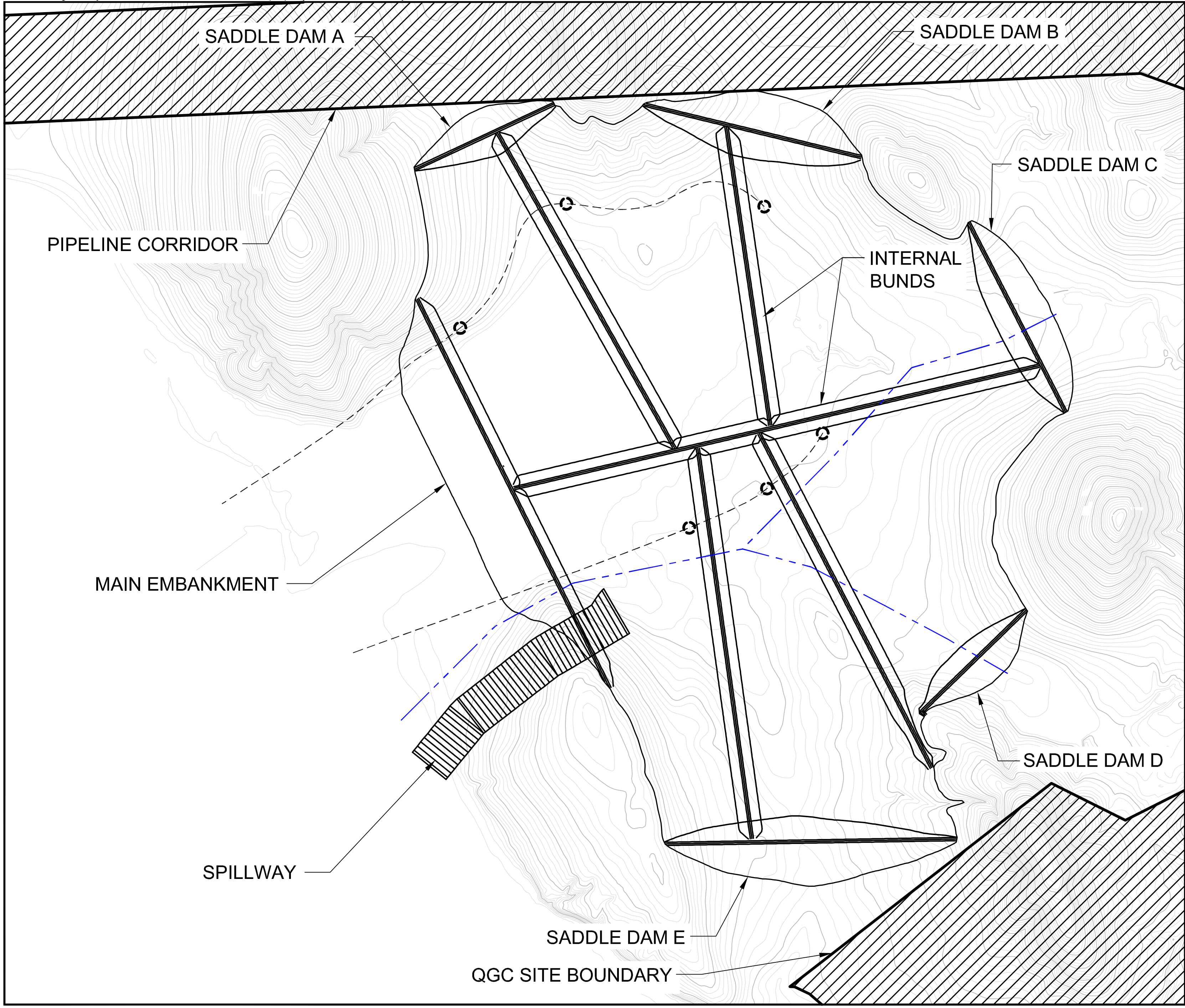

LEGEND

- SLUICE INTAKE
- EFFLUENT PIPELINE
- STORMWATER DRAIN

100 0 100

1 : 10 000 (A4)

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Title

GENERAL ARRANGEMENT

Figure: **6-2**

Rev. A

A4

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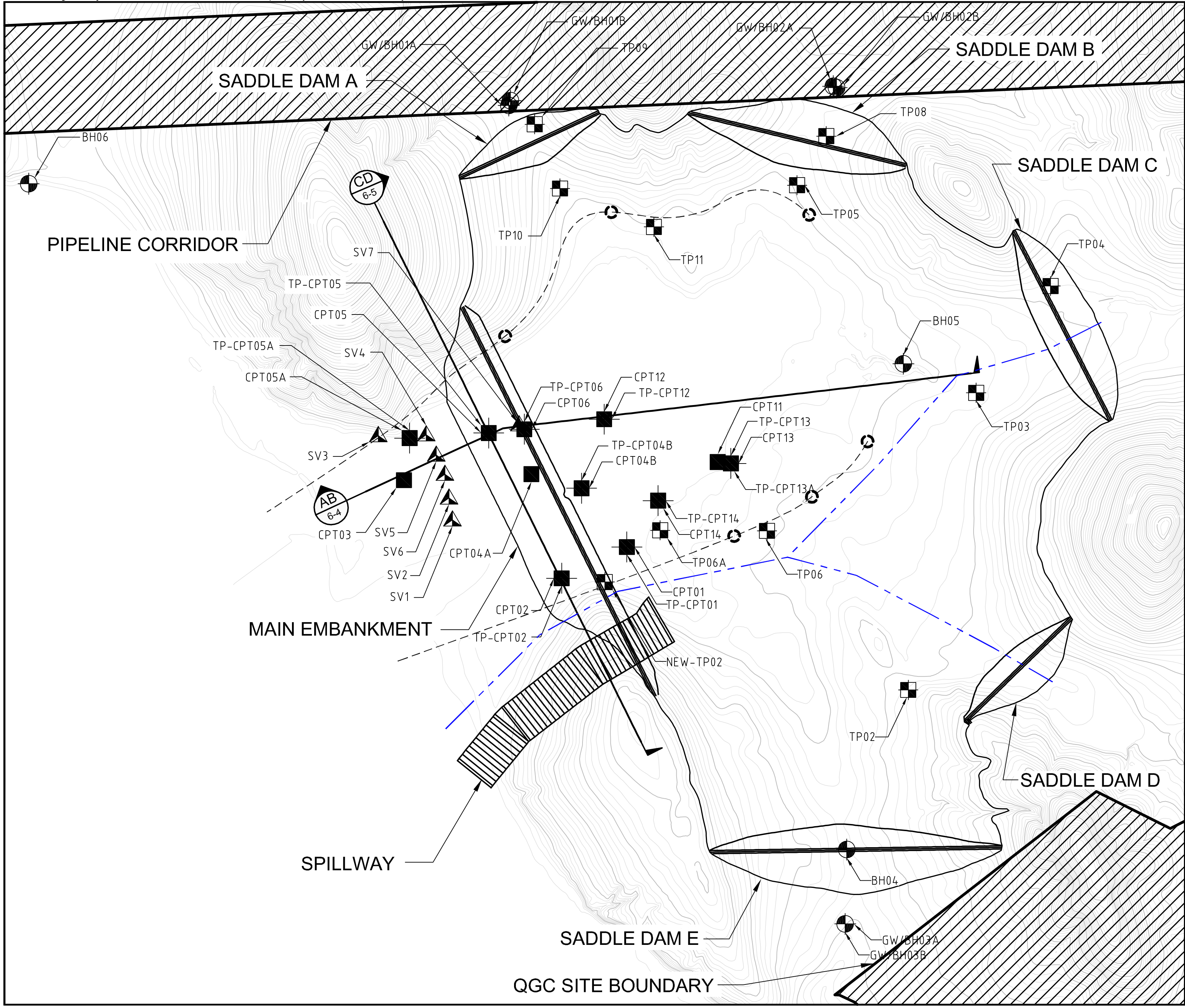

N
W E
S

LEGEND

- BOREHOLE
- GW BOREHOLE AND WELL
- TESTPIT
- TESTPIT AND CPT
- CPT
- SHEAR VANE
- SLUICE INTAKE
- EFFLUENT PIPELINE
- STORMWATER DRAIN

100 0 100
1 : 10 000 (A4)

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Title
GEOTECHNICAL SITE INVESTIGATION PLAN

Figure: **6-3** | Rev. A | A4

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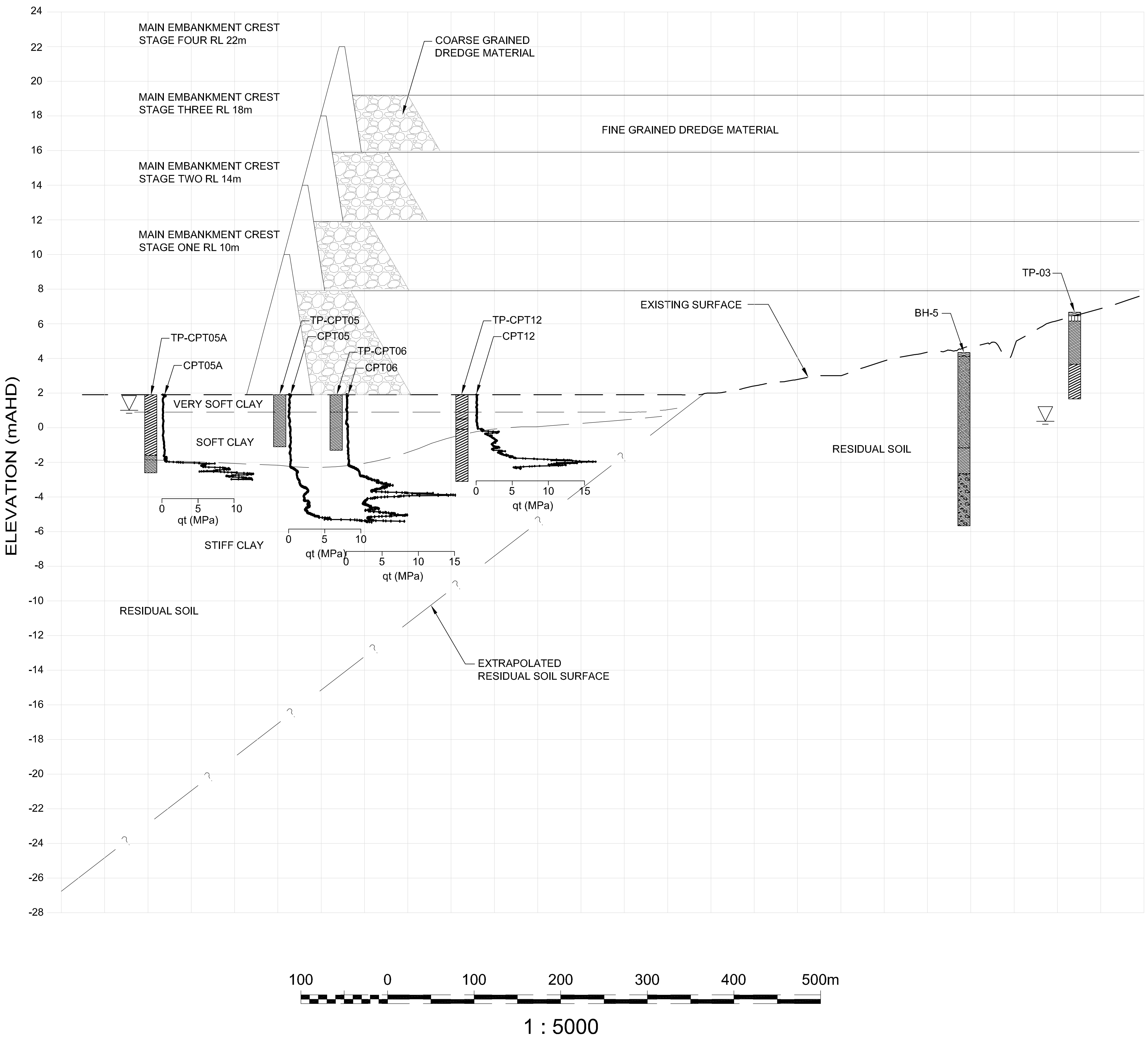

LEGEND:

GROUNDWATER LEVEL

LEGEND SOIL:

- TOPSOIL
- LOW PLASTICITY SANDY CLAY
- LOW PLASTICITY CLAY
- LOW PLASTICITY GRAVELLY CLAY
- HIGH PLASTICITY CLAY
- SILT

Source: 42626445

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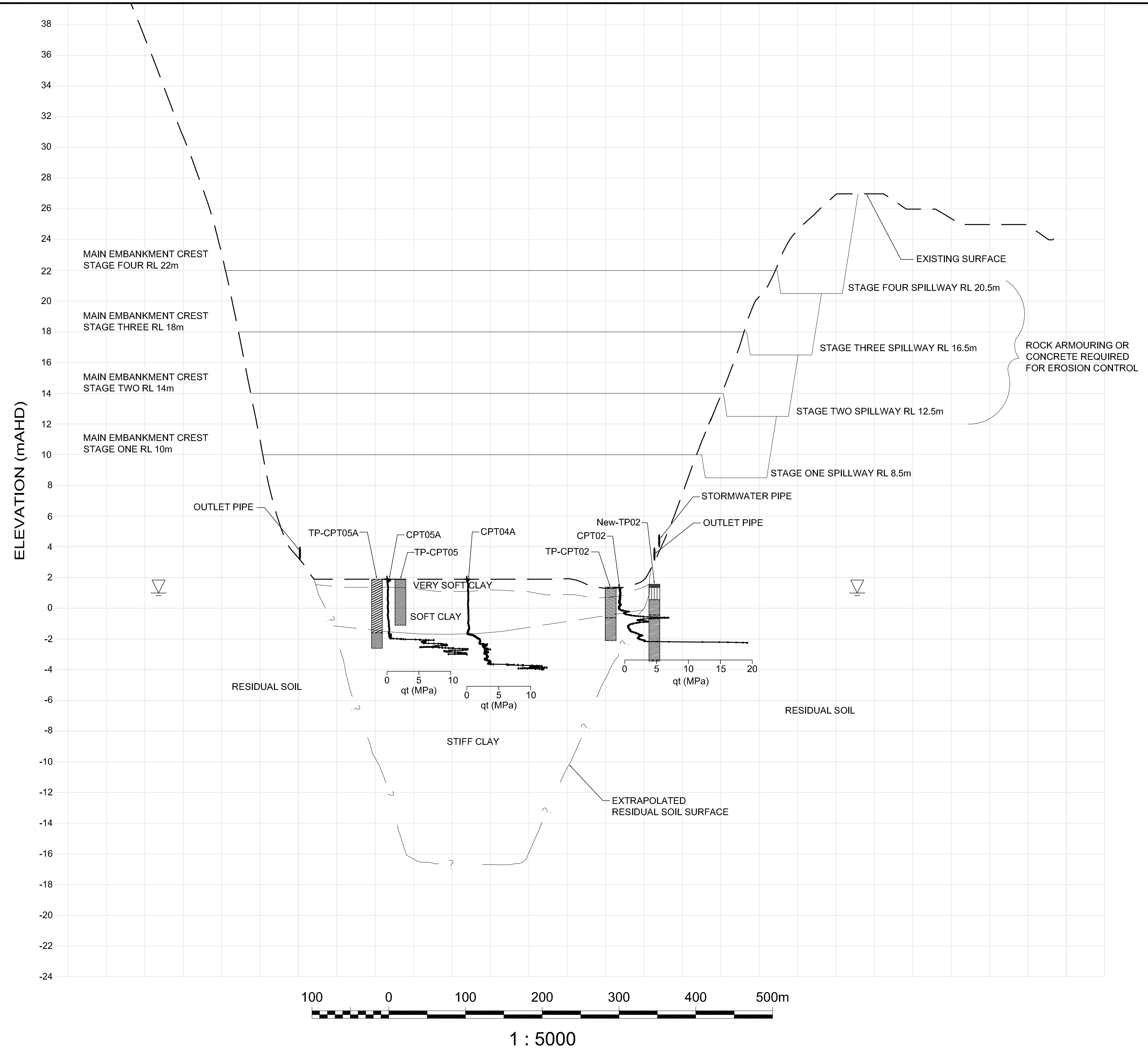
Title INDICATIVE GEOTECHNICAL SECTION AB

Figure: **6-4** Rev. A A3



LEGEND:

GROUNDWATER LEVEL

LEGEND SOIL:

TOPSOIL

LOW PLASTICITY SANDY CLAY

LOW PLASTICITY CLAY

LOW PLASTICITY GRAVELLY CLAY

HIGH PLASTICITY CLAY

SILT

Source: 42626445

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INDICATIVE GEOTECHNICAL SECTION CD

Figure: 6-5 | Rev. A | A3

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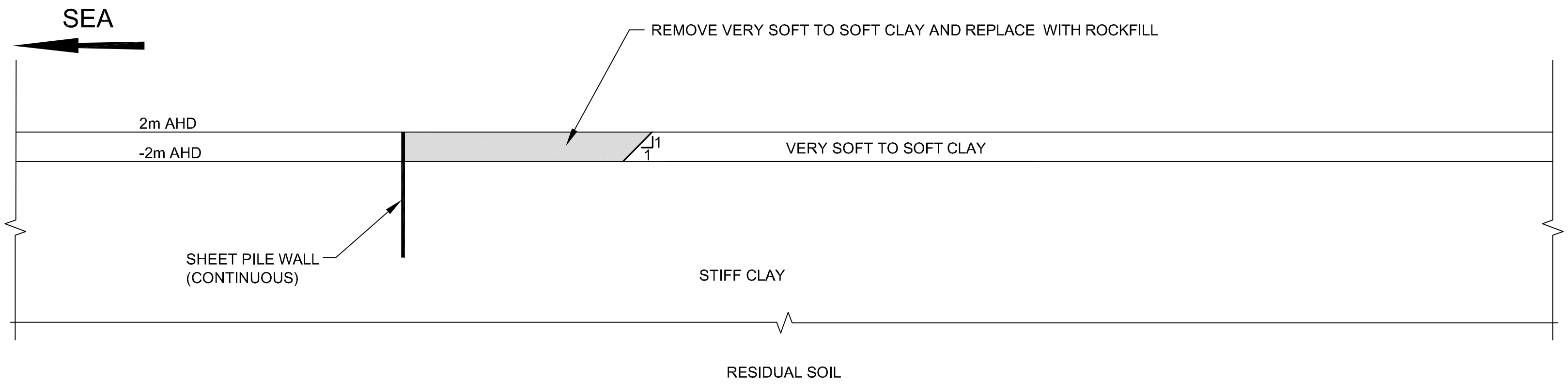

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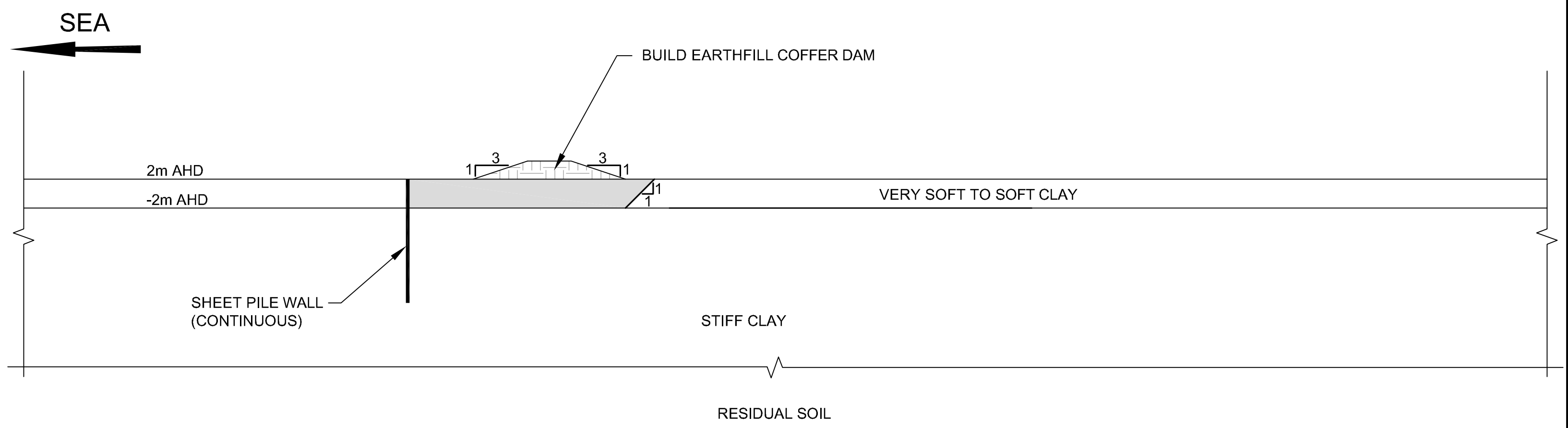

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GEOTECHNICAL ASSESSMENT AND DESIGN

Title
FOUNDATION PREPARATION FOR MAIN EMBANKMENT

Figure: **6-6** Rev. A A4

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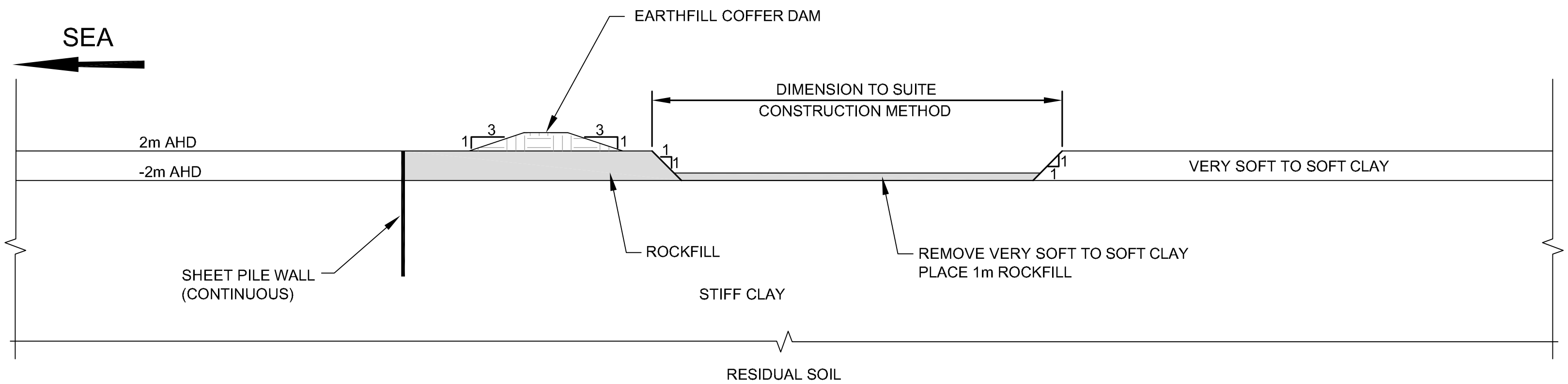

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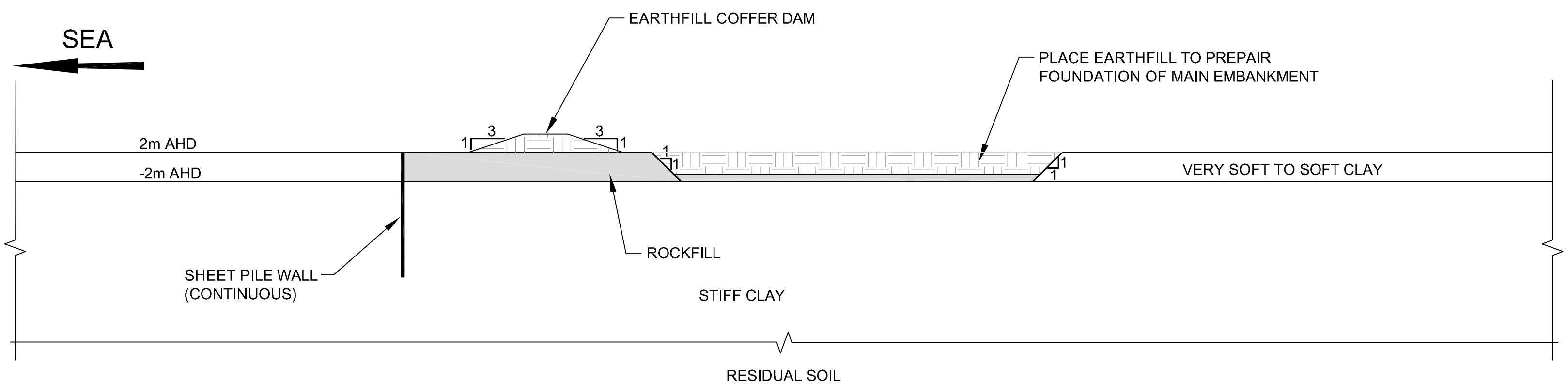
NOTE: DEWATERING REQUIRED TO CONTROL SEEPAGE INFLOWS



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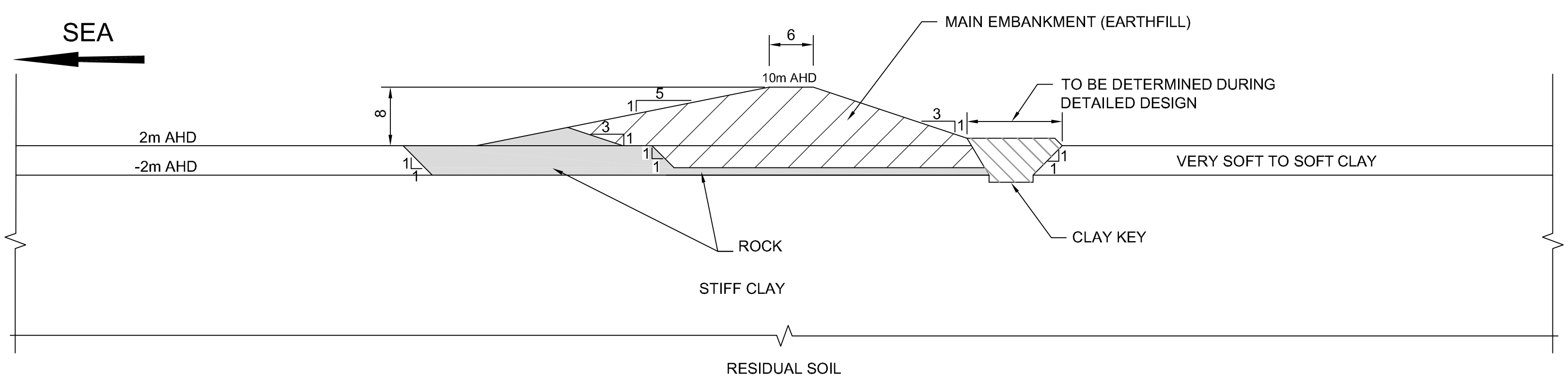
ENVIROMENTAL IMPACT STATEMENT
SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND
DESIGN

Title
FOUNDATION
PREPARATION FOR
MAIN EMBANKMENT

Figure: **6-7**

Rev. A

A4



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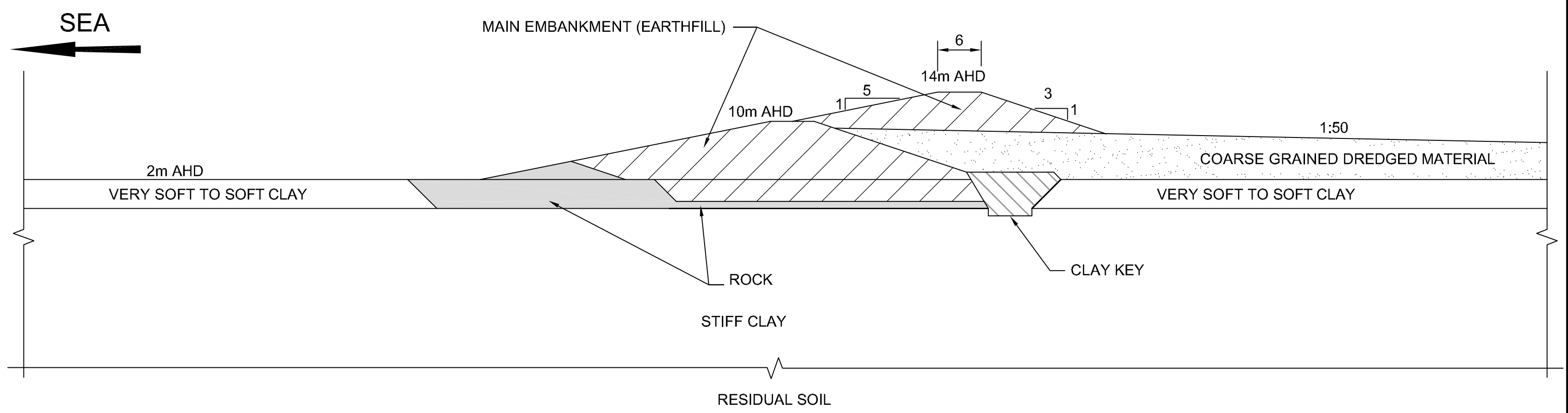

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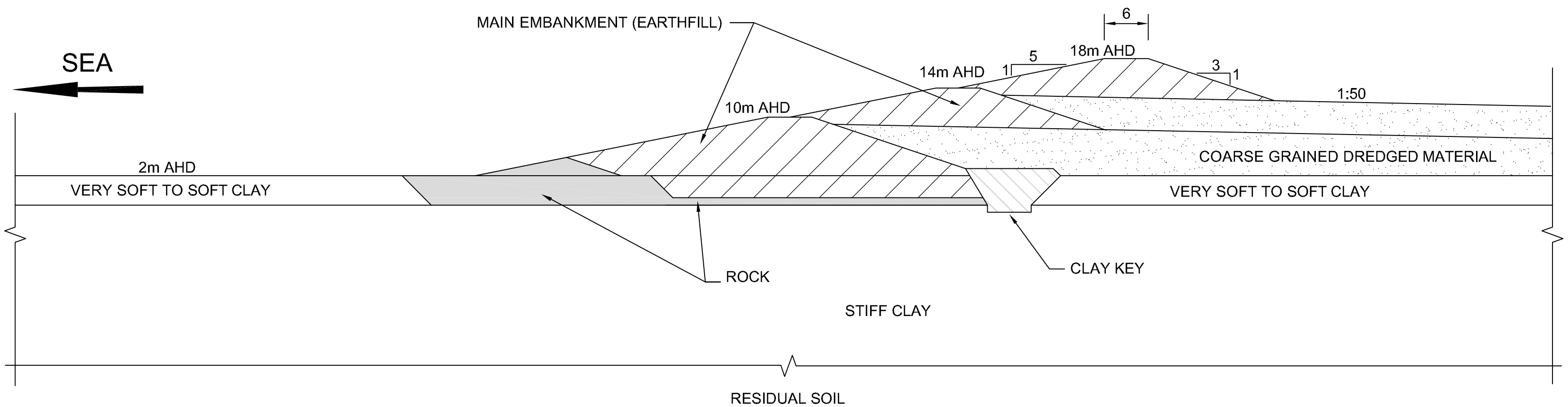
GEOTECHNICAL ASSESSMENT AND DESIGN

Title
MAIN EMBANKMENT UP-STREAM RAISE CONCEPT

Figure: **6-8**

Rev. B
A4

URS



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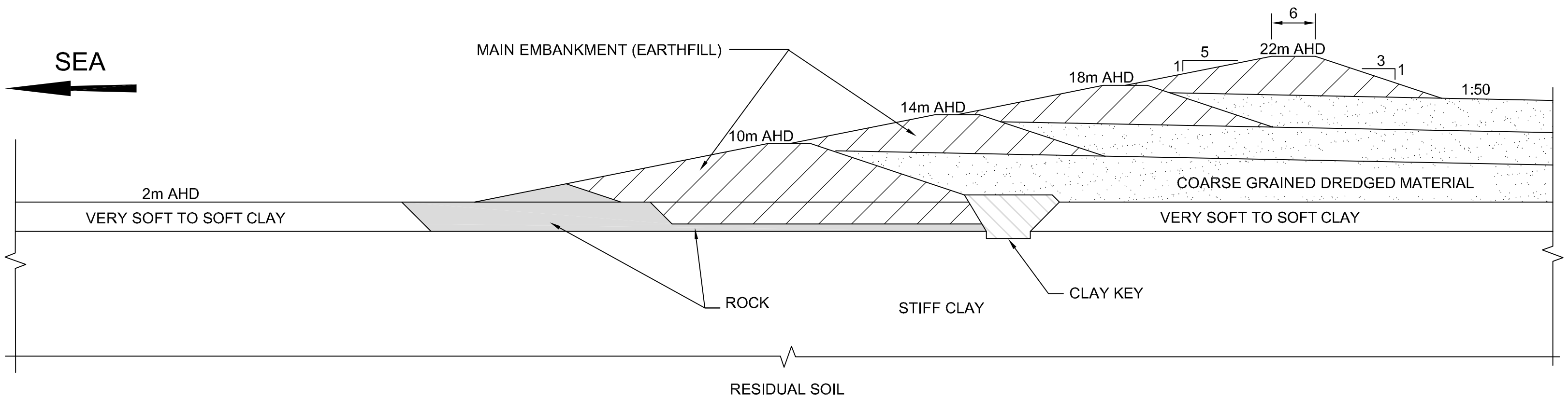

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SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND
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Title
MAIN EMBANKMENT UP-STREAM RAISE CONCEPT

Figure: **6-9** | Rev. B | A4

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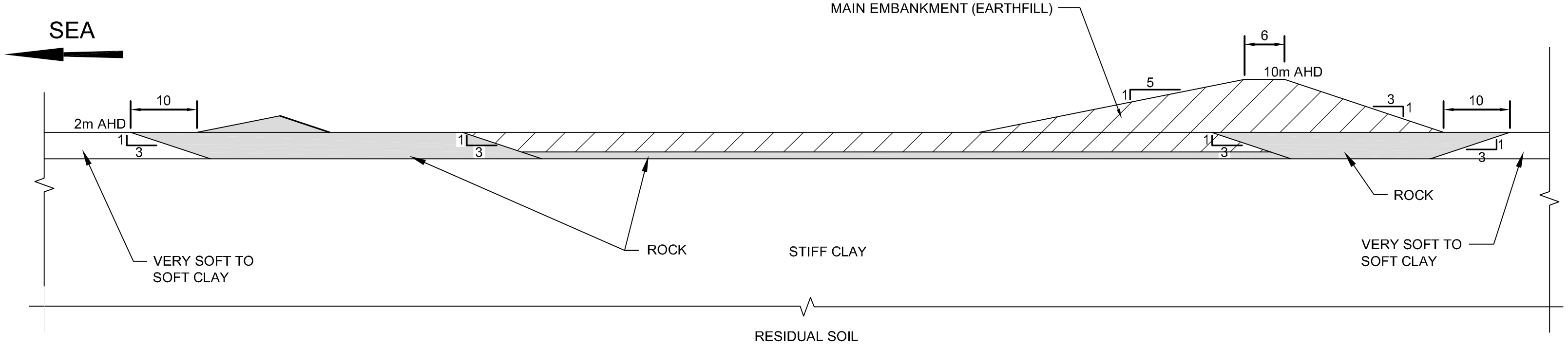

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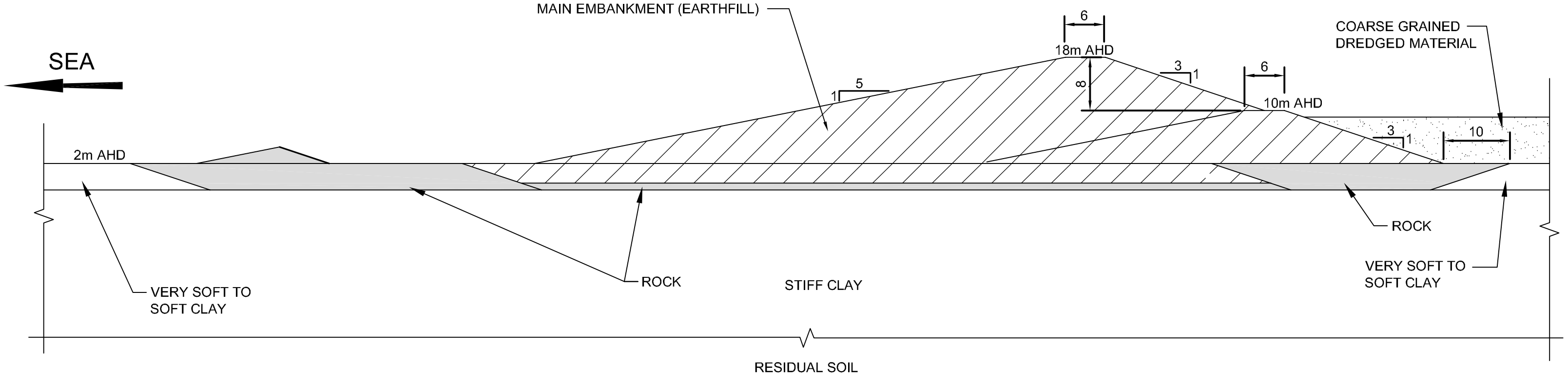

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Title
MAIN EMBANKMENT DOWN-STREAM RAISE CONCEPT

Figure: **6-10** Rev. A
A4

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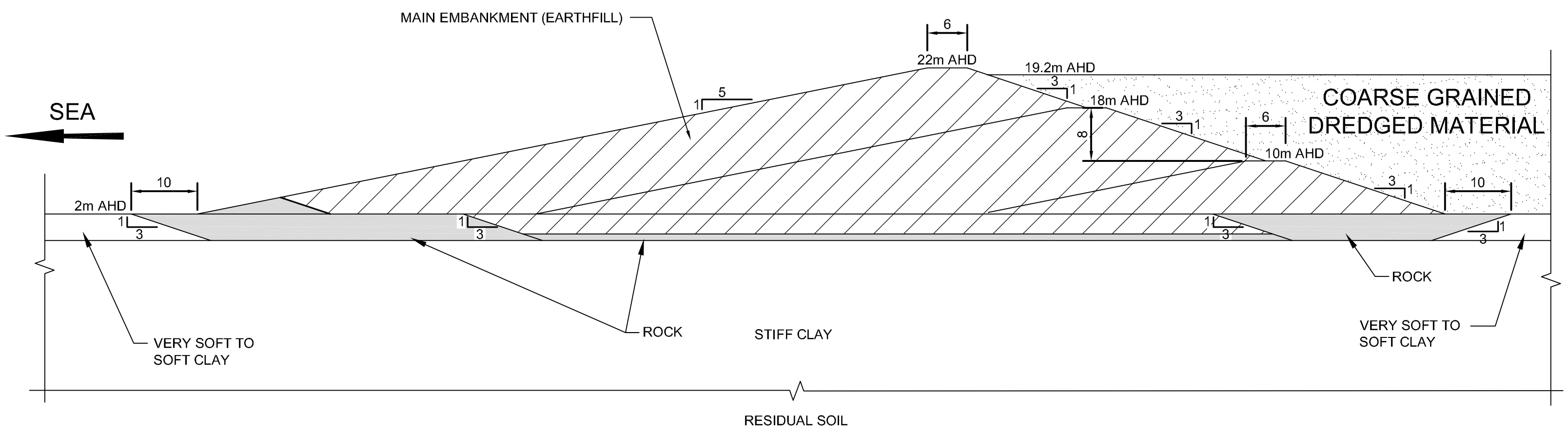

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ENVIROMENTAL IMPACT STATEMENT
SUPPLEMENT
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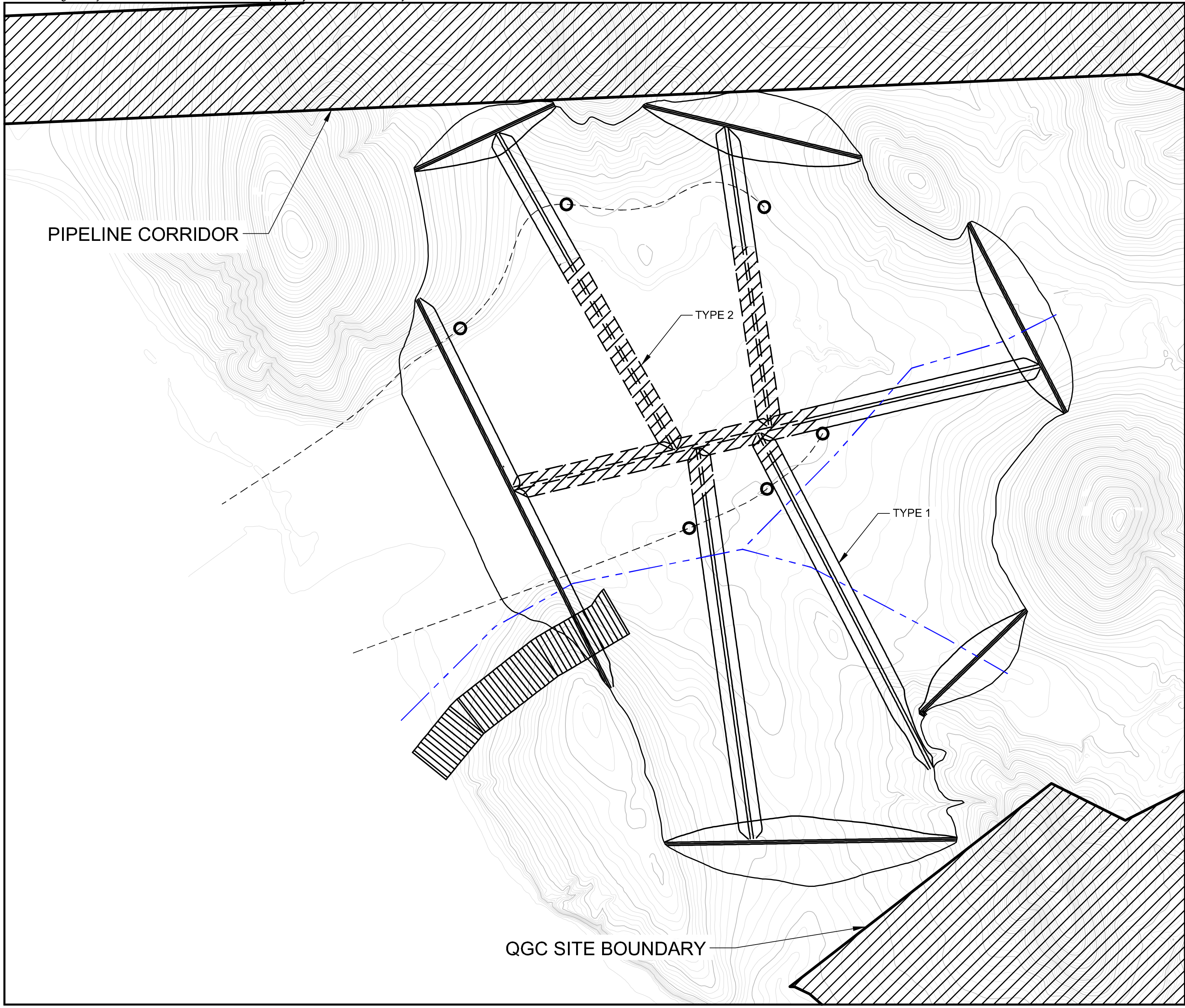
DESIGN

Title: MAIN EMBANKMENT
DOWN-STREAM
RAISE CONCEPT

Figure: **6-11** | Rev. A | A4

URS



LEGEND

- INTERNAL BUND TYPE 1
- INTERNAL BUND TYPE 2
- SLUICE INTAKE
- EFFLUENT PIPELINE
- STORMWATER DRAIN

100 0 100

1 : 10 000 (A4)

Source: 42626445

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ENVIROMENTAL IMPACT STATEMENT SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND DESIGN

Title
INTERNAL BUNDS CONCEPT LAYOUT

Figure: **6-12**

Rev. b

A4

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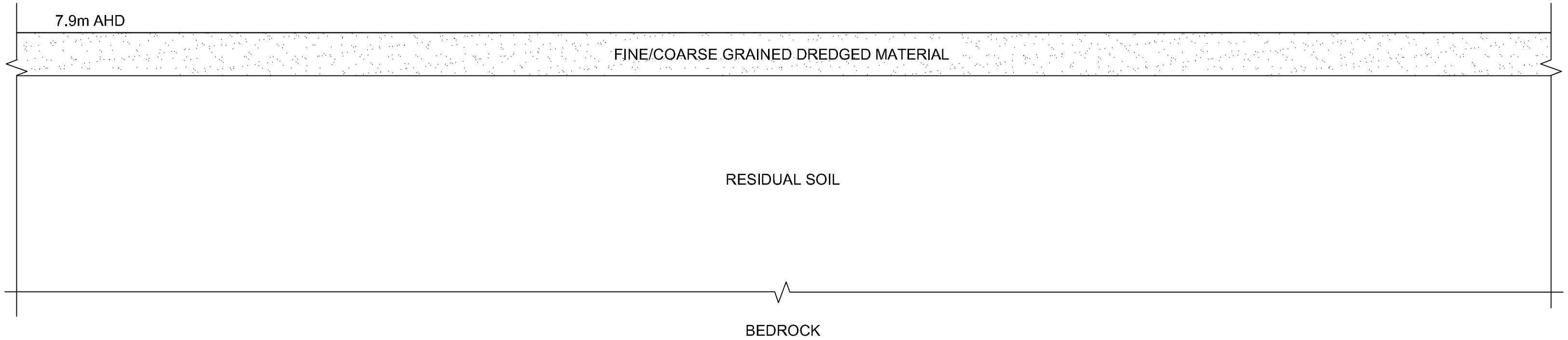

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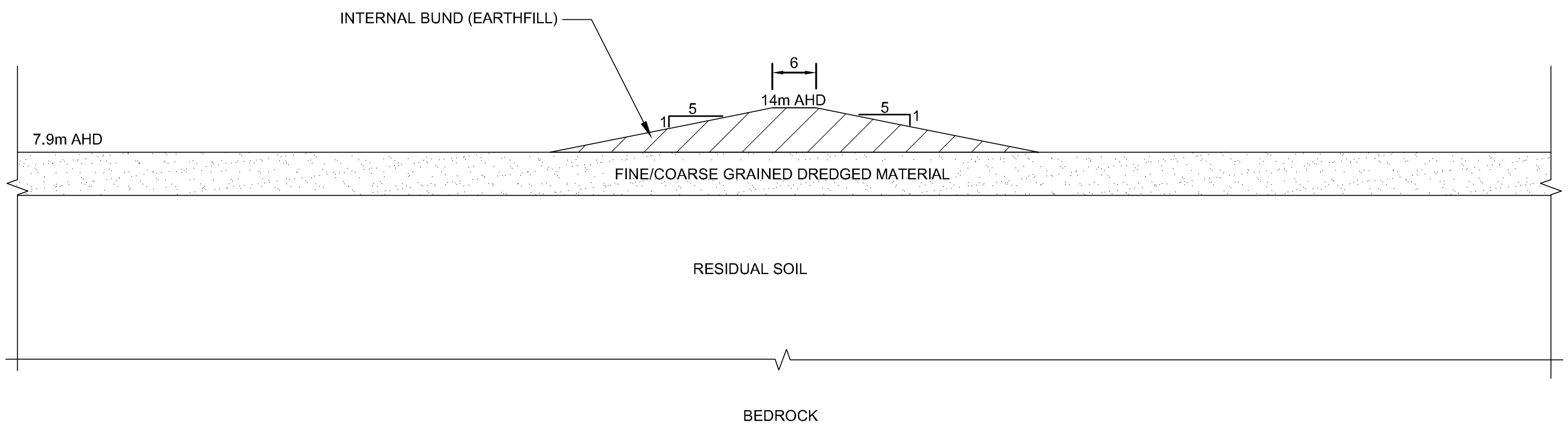

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Project
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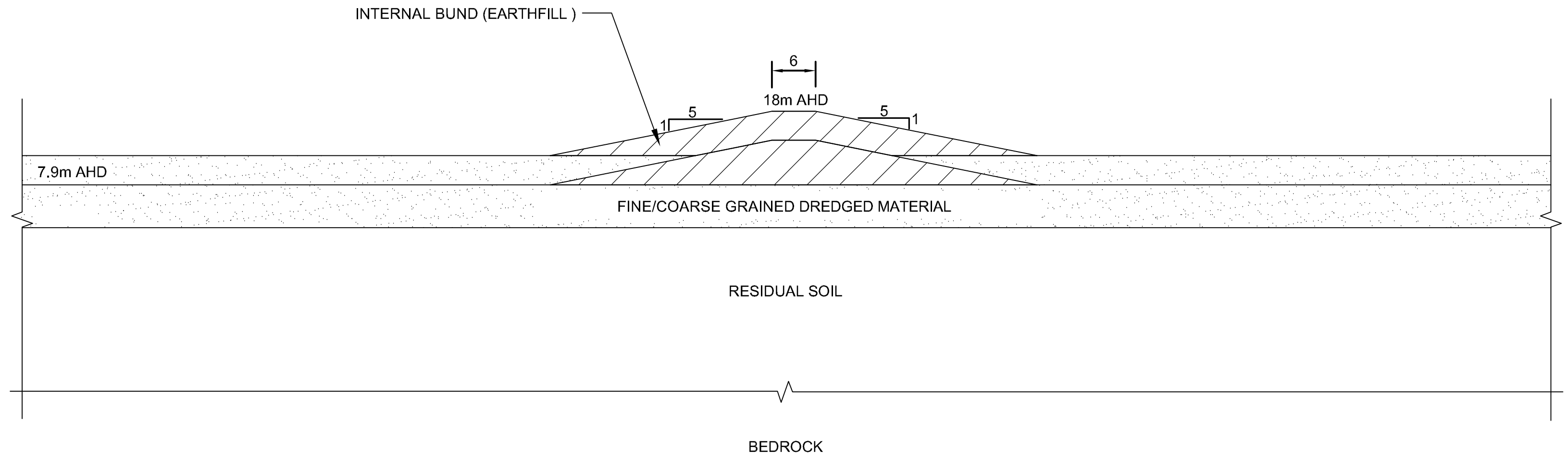
SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND
DESIGN

Title
INTERNAL BUNDS
TYPE 1 CONCEPTUAL
CONSTRUCTION
SEQUENCE

Figure: **6-13**

Rev. A
A4



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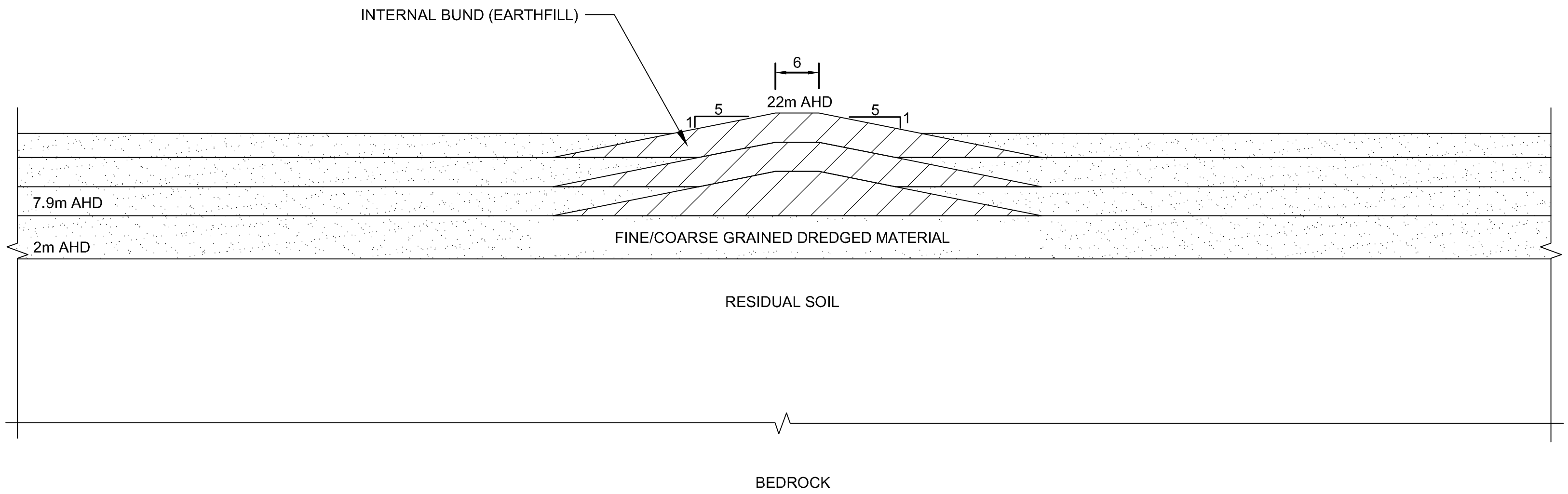

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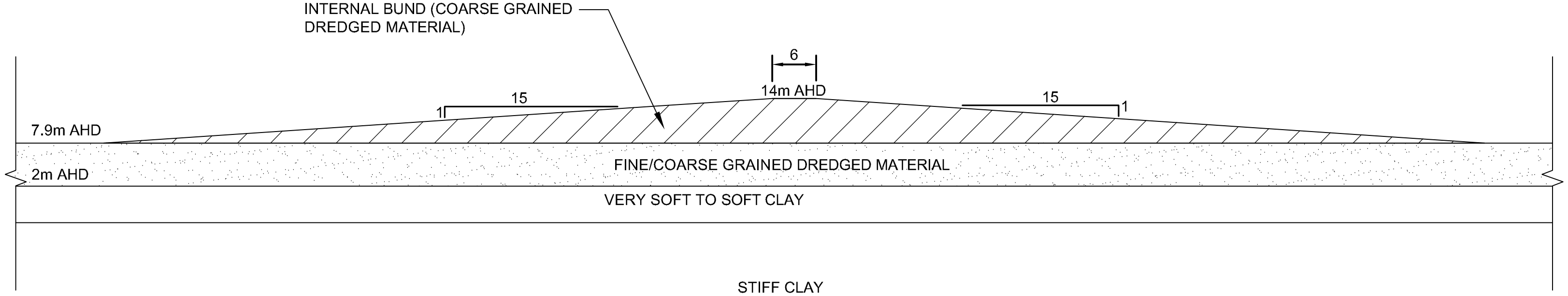
Project
GLADSTONE LNG PROJECT
ENVIROMENTAL IMPACT STATEMENT SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND DESIGN

Title
INTERNAL BUNDS TYPE 1 CONCEPTUAL CONSTRUCTION SEQUENCE

Figure: **6-14** | Rev. A | A4

STAGE 1
N.T.S.



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Project
GLADSTONE LNG PROJECT
ENVIROMENTAL IMPACT STATEMENT SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND DESIGN

Title
INTERNAL BUNDS TYPE 2 CONCEPTUAL CONSTRUCTION SEQUENCE

Figure: **6-15**
Rev. A
A4

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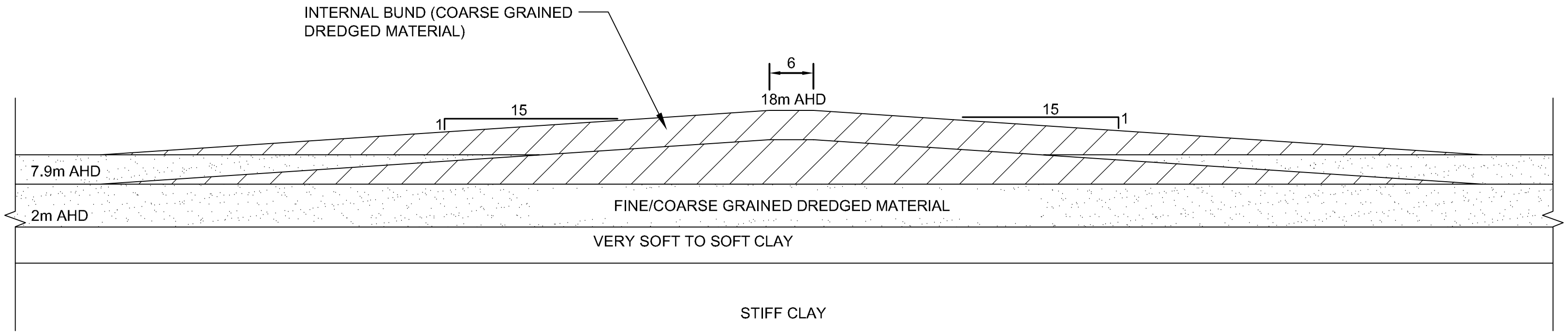
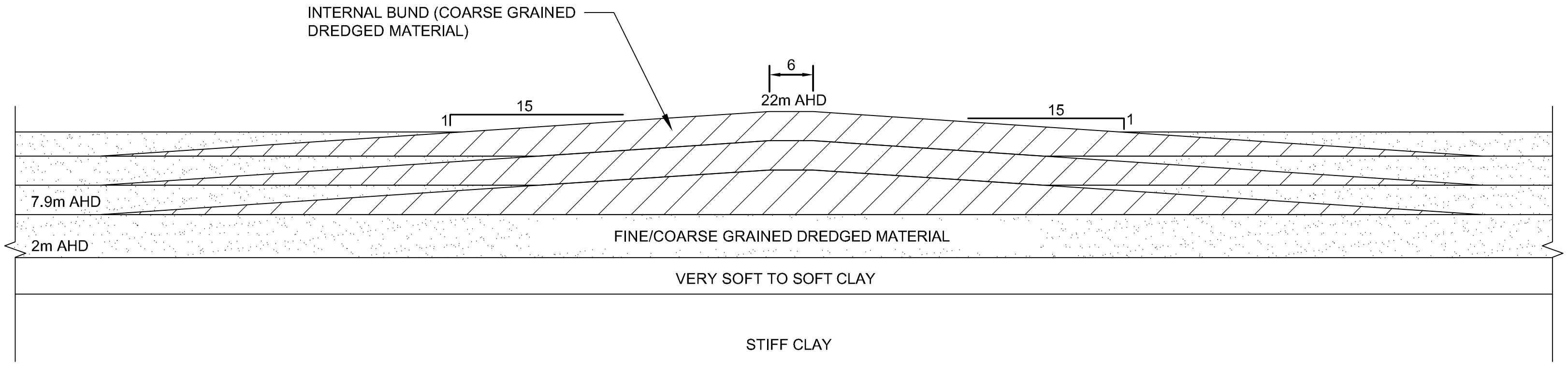


STAGE 3

N.T.S.



STAGE 4

N.T.S.

Source: 42626445

Drawn: TMA	Approved: JW	Date: 29/09/2009
Job No.: 4262 6444 /6220	File No.: 42626440-g-2104.dwg	

Client

LNG

Project

GLADSTONE LNG PROJECT
ENVIROMENTAL IMPACT STATEMENT SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND DESIGN

Title

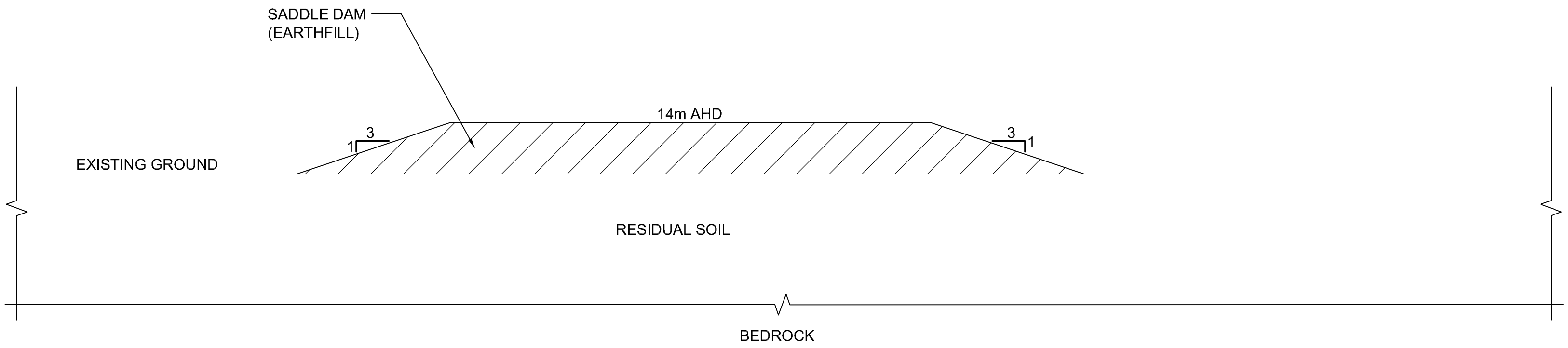
INTERNAL BUNDS TYPE 2 CONCEPTUAL CONSTRUCTION SEQUENCE

Figure: **6-16**

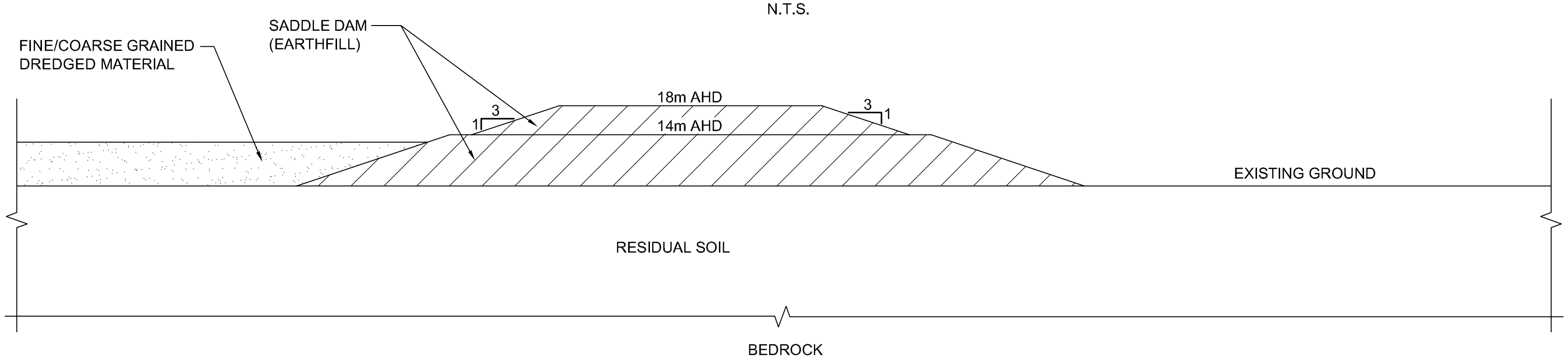
Rev. A

A4

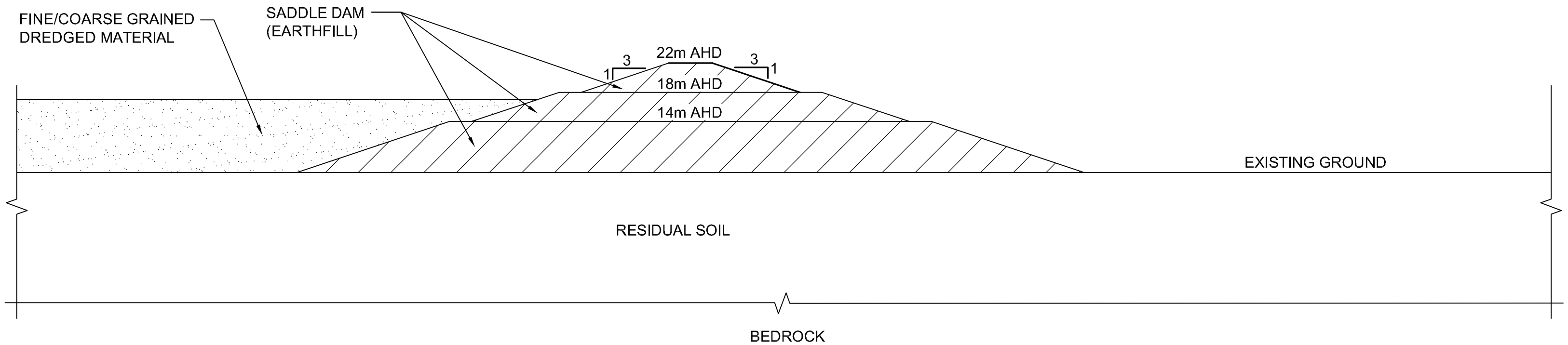
URS



STAGE 1
N.T.S.



STAGE 2
N.T.S.



STAGE 3
N.T.S.

Source: 42626445

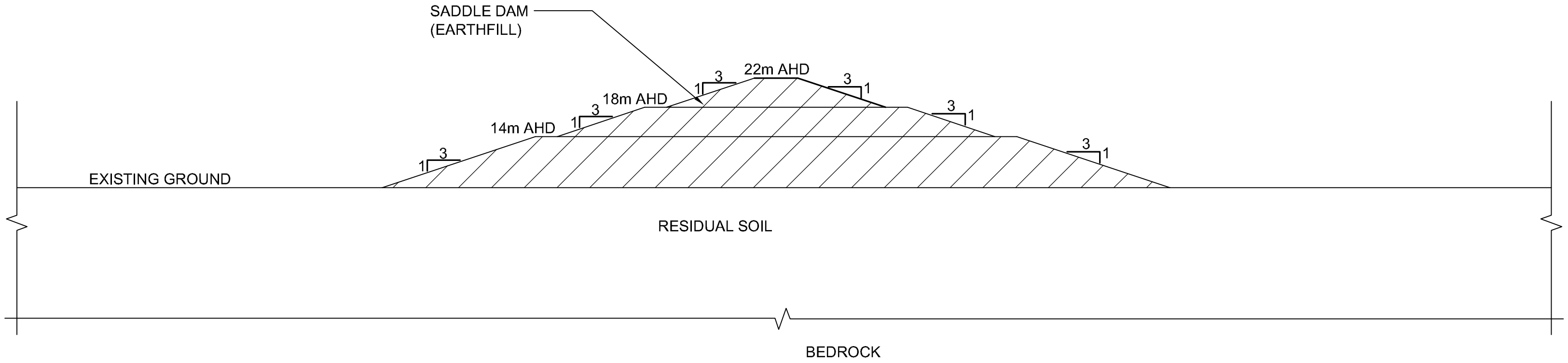
Drawn: TMA	Approved: JW	Date: 29/09/2009
Job No.: 4262 6444 /6220	File No.: 42626440-g-2100.dwg	

Client

Project
GLADSTONE LNG PROJECT
ENVIROMENTAL IMPACT STATEMENT
SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND
DESIGN

Title
SADDLE DAM
CONCEPTUAL
CONSTRUCTION
SEQUENCE

Figure: **6-17**
Rev. A
A4



SADDLE DAM	EXISTING GROUND (LEVEL mAHD)	HEIGHT OF SADDLE DAM (m)	LENGTH OF SADDLE DAM (m)
A	12.9	9.1	285
B	7.9	14.1	415
C	9.4	12.6	395
D	11.8	10.2	276
E	7.0	15.0	540

NOTE: APPROXIMATE LEVELS SHOWN

Source: 42626445

Drawn: TMA	Approved: JW	Date: 29/09/2009
Job No.: 4262 6444 /6220	File No.: 42626440-g-2101.dwg	

Client

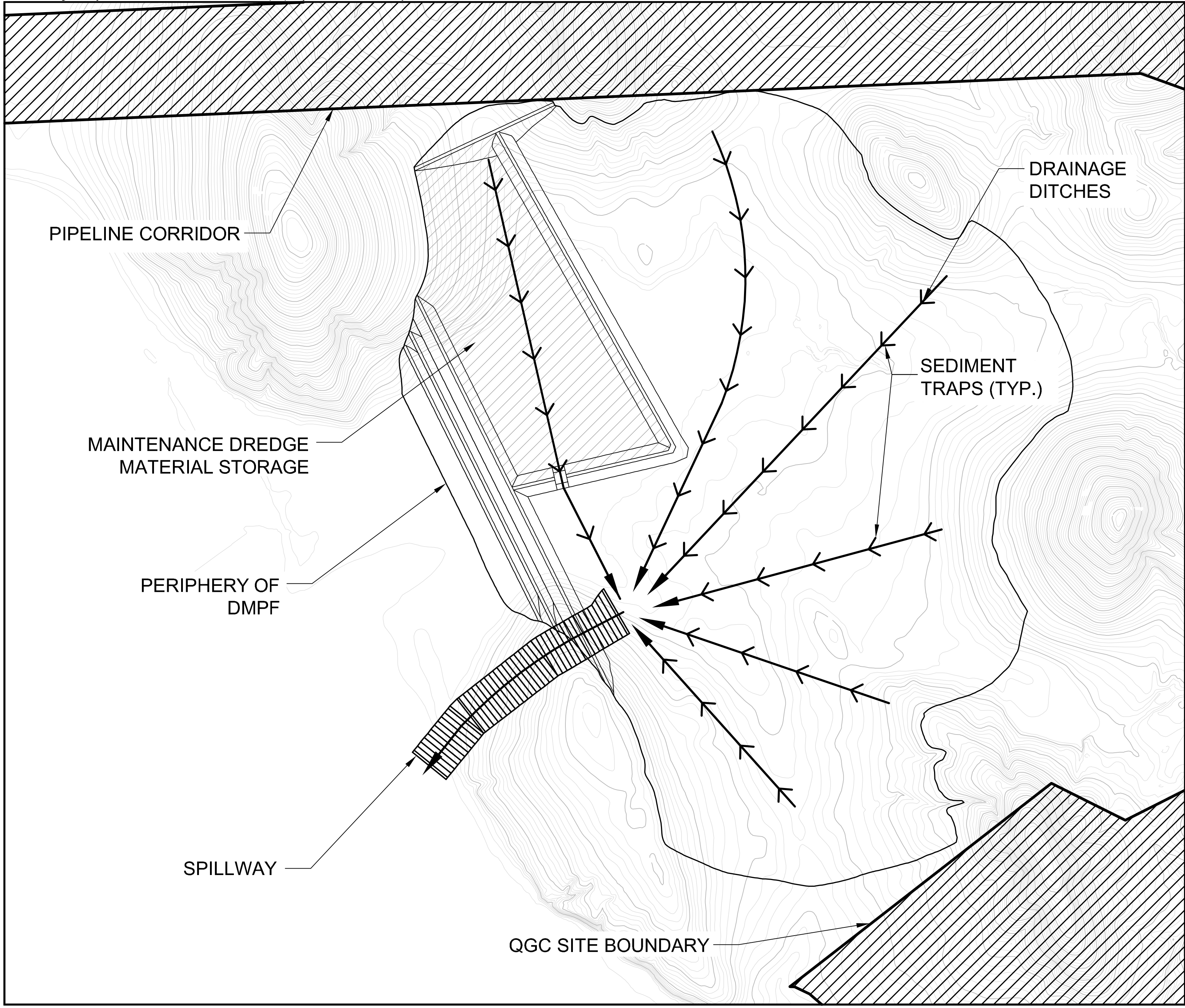
Project
GLADSTONE LNG PROJECT
ENVIROMENTAL IMPACT STATEMENT SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND DESIGN

Title
SADDLE DAM TYPICAL SECTION (ULTIMATE)

Figure: **6-18**

Rev. A

A4



N
W E
S

LEGEND

100 0 100

1 : 10 000 (A4)

Source: 42626445

Drawn: TMA	Approved: JW	Date: 10/11/2009
Job No.: 4262 6444	File No.: 42626440-g-2099.dwg	

Client

LNG

Project
GLADSTONE LNG PROJECT
ENVIROMENTAL IMPACT STATEMENT
SUPPLEMENT
GEOTECHNICAL ASSESSMENT AND
DESIGN

Title

CONCEPT LAYOUT OF FINAL LANDFORM

Figure: **6-19**

Rev. B

A4

URS

B

Appendix B Geotechnical Investigation

URS Australia Pty Ltd

Phone: (07) 3243 2111 Fax: (07) 3243 2199

Project No.: 42626445	Project Reference: GLNG EIS Supplement	Client: **Santos**	Sheet 1 of 3 **BH4**

Date(s) Drilled: **12/08/09 to 14/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **12.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **7.0 m**
Groundwater Depth: **Not Observed**	Location: **7371100 mN 315597 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Bentonite and cuttings**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	Type Number	SPT Blows per 150mm	SPT N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
7	0															
6	1									Silty CLAY with gravel (CL-ML); low plasticity, sub rounded to sub angular gravel, mottled brown, white and red, chert clasts, fine to medium gravel, moist, hard, (residual soil). MC:8.4%		15 21 22	43			BH4_1
5	2															
										CLAY with sand (CL); low plasticity, mottled brown and red, some iron staining, moist, hard, (residual soil). MC:13.9%, LL:29%, PL:16%, PI:13%, LS:4.5*%		20 17 20	37			BH4_2
4	3															
3	4									Sandy CLAY (CL); low plasticity, subangular gravel, sub rounded sand, orangish brown, grey gravel, hard, (residual soil).		30 / 95mm	95			BH4_3
2	5															
										Clayey GRAVEL (GC); fine to medium gravel, poorly graded, angular greywacke, dense, (residual soil).		30 / 80 mm	113			No Sample
1																

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd

Phone: (07) 3243 2111 Fax: (07) 3243 2199

Project No.: 42626445	Client:		
Project Reference: GLNG EIS Supplement	Santos		**BH4**

Date(s) Drilled: **12/08/09 to 14/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **12.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **7.0 m**
Groundwater Depth: **Not Observed**	Location: **7371100 mN 315597 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Bentonite and cuttings**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	SPT Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
1	6																
0	7										SPT		30 / 40 mm	225			No Sample
-1	8																
		1	4	94		13				Drilling method changed to NLMC coring due to mud rotory refusal. GREYWACKE, high strength, moderately weathered, grey, poorly developed, fine sand sized, highly fractured.							
-2	9								CORE LOSS	Core Loss							
		2	4	93		0				GREYWACKE, high strength, moderately weathered, grey, poorly developed, fine sand sized, highly fractured.							
		3	4	81		32											
-3	10								CORE LOSS	Core Loss							
		4	4	94		72				GREYWACKE, high strength, moderately weathered, grey, poorly developed, fine sand sized, highly fractured.							
-4	11	5	4	100		33											
		6	4	100		65				GREYWACKE, high strength, slightly weathered, grey, poorly developed, fine sand sized, highly fractured.							
-5																	

NOTES: Classification: Soil classification via AS 1726 - 1993

ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: Santos	Sheet 3 of 3 **BH4**

Date(s) Drilled: **12/08/09 to 14/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **12.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **7.0 m**
Groundwater Depth: **Not Observed**	Location: **7371100 mN 315597 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Bentonite and cuttings**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type Number	SPT Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
-5	12									CLAY (CL); low plasticity, greyish white, wet, soft, (residual soil).						
		7	4	100		0				GREYWACKE, high strength, moderately weathered, grey, poorly developed, fine sand sized, highly fractured.						
										Borehole terminated at 12.5m due to desired depth.						
-6	13															
-7	14															
-8	15															
-9	16															
-10	17															
-11																

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: Santos	Sheet 1 of 2 **BH5**

Date(s) Drilled: **14/08/09 to 15/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **10.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **4.3 m**
Groundwater Depth: **Not Observed**	Location: **7372001 mN 315702 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Bentonite and cuttings**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	0									Topsoil, brown, moist, roots.						
4																
3	1									Sandy CLAY with gravel (CL); low plasticity, orangish brown, angular greywacke gravel fragments, moist, hard, (residual soil).		20 19 23	42			BH5_1
2	2									Sandy CLAY with gravel (CI); medium plasticity, mottled greyish white and orange, angular greywacke gravel fragments, moist, very stiff, (residual soil).		8 10 13	23			BH5_2
1	3															
0	4															
-1	5									CLAY with gravel (CL); low plasticity, mottled yellow brown and light grey, some angular gravel fragments, moist, hard, (residual soil).		9 13 21	34			BH5_3

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: Santos	Sheet 2 of 2 **BH5**

Date(s) Drilled: **14/08/09 to 15/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **10.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **4.3 m**
Groundwater Depth: **Not Observed**	Location: **7372001 mN 315702 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Bentonite and cuttings**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	6																
-2																	
	7									Gravelly CLAY (CL); low plasticity, mottled white and orangish brown, angular fine greywacke gravel, moist, hard, (residual soil).			11 13 26	39			BH5_4
-3																	
	8																
-4										Gravelly CLAY (CL); low plasticity, greyish brown, angular greywacke gravel, moist, hard, (residual soil).			30 / 90 mm	100			BH5_5
	9																
-5																	
	10									Gravelly CLAY (CL); low plasticity, grey with brown, angular greywacke gravel, moist, hard, (residual soil). Borehole terminated at 10.04m at desired depth.			30 / 40 mm	225			BH5_6
-6																	
	11																
-7																	

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Phone: (07) 3243 2111 Fax: (07) 3243 2199

Project No.: 42626445	Project Reference: GLNG EIS Supplement	Client: **Santos**	Sheet 1 of 3 **BH6**

Date(s) Drilled: **15/08/09 to 15/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **15.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **2.2 m**
Groundwater Depth: **Not Observed**	Location: **7372335 mN 314079 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Bentonite and cuttings**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
2	0									SAND (SP); fine to medium sand, poorly graded, rounded, yellowish white, organics, wet, loose.							
1	1									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.			13 23 26	49			BH6_1
0	2									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.			16 30 30 / 80 mm	86			BH6_2
-1	3																
-2	4									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.			27 30 / 115 mm	78			BH6_3
-3	5									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.			28 30 / 125 mm	72			BH6_4

NOTES: Classification: Soil classification via AS 1726 - 1993

ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: Santos	Sheet 2 of 3 **BH6**

Date(s) Drilled: **15/08/09 to 15/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **15.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **2.2 m**
Groundwater Depth: **Not Observed**	Location: **7372335 mN 314079 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Bentonite and cuttings**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type / Number	SPT: Blows per 150mm	SPT: N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
-4	6															
-5	7									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.		30 30 / 100 mm	90			BH6_5
-6	8									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.		30 / 140 mm	64			BH6_6
-7	9															
-8	10									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.		30 / 140 mm	64			BH6_7
-9	11									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.		30 / 130 mm	69			BH6_8

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd
Phone: (07) 3243 2111 Fax: (07) 3243 2199

Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: **Santos**		**BH6**
Date(s) Drilled: **15/08/09 to 15/08/09**	Logged By: **RJT**	Checked By: **TWA**	
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **15.5**	
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **2.2 m**	
Groundwater Depth: **Not Observed**	Location: **7372335 mN 314079 mE**	Inclination from Horizontal/Bearing: **Verticle deg**	
Borehole Backfill: **Bentonite and cuttings**	Sampler Type: **SPT**	Hammer Data: **SPT**	

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
-10	12																
-11	13									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.			30 / 110 mm	81			BH6_9
-12	14																
-13	15									Sandy CLAY (CL); low plasticity, subrounded, very fine sand, brownish light grey, moist, hard.			26 27 30	57			BH6_10
										Borehole terminated at 15.45m at desired depth.							
-14	16																
-15	17																

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd

Phone: (07) 3243 2111 Fax: (07) 3243 2199

Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: **Santos**	Sheet 1 of 2	**GW/BH1A**

Date(s) Drilled: **05/08/09 to 06/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **10.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **12.4 m**
Groundwater Depth: **Not Observed**	Location: **7372480 mN 314970 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type Number	SPT: Blows per 150mm	SPT: N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	0									Topsoil, brown, moist, roots.						
12																
	1									Gravelly CLAY (CH); high plasticity, poorly graded, fine to coarse gravel, reddish brown, jasper and chert clasts, angular grains, dry, stiff, (residual soil).		11 16 21	37			GW/BH1A_1
11																
	2															
10										Gravelly CLAY (CH); high plasticity, poorly graded, fine to coarse gravel, some medium sand, chert clasts, angular grains, reddish brown, dry, stiff, (residual soil).		10 38 32 / 130 mm	70			GW/BH1A_2
	3															
9																
	4									Gravelly CLAY (CH); high plasticity, poorly graded, fine to coarse gravel, some medium sand, chert clasts, angular grains, reddish brown, dry, stiff, (residual soil).		32 / 140 mm	64			GW/BH1A_3
8																
	5															
7										Clayey GRAVEL (GC); poorly graded, medium to coarse gravel, trace sand, angular grains, chert and jasper clasts, brownish red, dense, (residual soil).		30 / 125 mm	72			GW/BH1A_4

NOTES: Classification: Soil classification via AS 1726 - 1993

ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: Santos	GW/BH1A

Date(s) Drilled: **05/08/09 to 06/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **10.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **12.4 m**
Groundwater Depth: **Not Observed**	Location: **7372480 mN 314970 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	6																
6										CLAY with trace gravel (CH); low plasticity, angular grains, white with red gravel, moist, stiff, (residual soil).			16 22 29	51			GW/BH1A_5
	7																
5																	
	8																
4										Sandy CLAY (CL); low plasticity, white with orange weathering, moist, hard, (residual soil).			30 / 120 mm	75			GW/BH1A_6
	9																
3																	
	10									CLAY with sand (CL); low plasticity, white with orange weathering, moist, firm, (residual soil).			5 8 21	29			GW/BH1A_7
2										Borehole terminated at 10.45m due to desired depth.							
	11																
1																	

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: **Santos**	Sheet 1 of 6 **GW/BH1B**

Date(s) Drilled: **06/08/09 to 07/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **30.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **12.2 m**
Groundwater Depth: **11.21m**	Location: **7372489 mN 314973 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	0									Topsoil, moist, brown, roots.						
12																
	1															
11																
	2															
10																
	3									CLAY with gravel (CL); low plasticity, mottled grey and red, trace angular coarse gravel fragments, some medium chert gravel, moist, stiff, (residual soil).		30 / 145 mm	62			GW/BH1B_1
9																
	4															
8																
	5															
7																
										CLAY (CL); low plasticity, mottled white and orange, trace angular unweathered gravel, moist, stiff, (residual soil).		13 27 34	61			GW/BH1B_2

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Project No.: 42626445	Client:
Project Reference: GLNG EIS Supplement	**Santos**

GW/BH1B

Date(s) Drilled: **06/08/09 to 07/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **30.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **12.2 m**
Groundwater Depth: **11.21m**	Location: **7372489 mN 314973 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type / Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
6	6										X	28 30 / 80 mm	113			GW/BH1B_8
5	7									Sandy CLAY with gravel (CL); low plasticity, mottled white and grey, fine sand to coarse gravel, some angular gravel, moist, hard, (residual soil).	X	30 / 75 mm	120			GW/BH1B_3
4	8									Gravelly CLAY (CL); low plasticity, greyish white, angular fine chert gravel, moist, hard, (residual soil).	X	30 / 90 mm	100			GW/BH1B_4
3	9															
2	10									Gravelly CLAY (CL); low plasticity, greyish white, angular fine chert gravel, moist, hard, (residual soil).	X	30 / 130 mm	69			GW/BH1B_5
1	11									Clayey SAND (SC); very fine sand, poorly graded, sub rounded, yellowish brown, moist, very dense, (residual soil).	X	24 30 / 100 mm	90			GW/BH1B_6

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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GW/BH1B

Project No.: 42626445	Project Reference: GLNG EIS Supplement	Client: Santos
Date(s) Drilled: 06/08/09 to 07/08/09	Logged By: RJT	Checked By: TWA
Drilling Method: Mud Rotory	Drill Bit Size/Type: 3 7/8" blade bit	Total Depth Drilled (m): 30.0
Drilling Rig Type: Hydrapower Scout on Yanmar C60R	Drilling Contractor: Drillsure	Relative Level: 12.2 m
Groundwater Depth: 11.21m	Location: 7372489 mN 314973 mE	Inclination from Horizontal/Bearing: Verticle deg
Borehole Backfill: Well Instalation	Sampler Type: SPT	Hammer Data: SPT

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	12																
0																	
	13									Sandy CLAY (CL); low plasticity, yellowish brown, subrounded fine sand, moist, very dense, (residual soil).			17 30 / 135 mm	67			GW/BH1B_7
-1																	
	14																
-2																	
	15																
-3																	
	16									Sandy CLAY (CL); low plasticity, white, sub rounded fine sand, moist, very dense, (residual soil).							
-4																	
	17																
-5																	

NOTES: Classification: Soil classification via AS 1726 - 1993

ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Date(s) Drilled: **06/08/09 to 07/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **30.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **12.2 m**
Groundwater Depth: **11.21m**	Location: **7372489 mN 314973 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	18									Sandy CLAY (CL); low plasticity, white, sub rounded fine sand, moist, very dense, (residual soil).							
-6																	
	19																
-7																	
	20																
-8																	
	21																
-9																	
	22																
-10																	
	23																
-11																	

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Date(s) Drilled: **06/08/09 to 07/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **30.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **12.2 m**
Groundwater Depth: **11.21m**	Location: **7372489 mN 314973 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	Type Number	SPT Blows per 150mm	SPT N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
-12	24															
-13	25									Gravelly CLAY (CL); low plasticity, mottled orangish brown and white, angular gravel fragments of fine to medium chert, moist, hard, (residual soil).		30 / 50 mm	180			GW/BH1B_10
-14	26															
-15	27															
-16	28															
-17	29									Clayey GRAVEL (GC); poorly graded, fine to medium gravel, angular to sub angular, grey, moist, very dense, (residual soil).		30 / 30 mm	300			GW/BH1B_11

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Project No.: **42626445**		Client: **Santos**	**GW/BH1B**
Project Reference: **GLNG EIS Supplement**			
Date(s) Drilled: **06/08/09 to 07/08/09**	Logged By: **RJT**	Checked By: **TWA**	
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **30.0**	
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **12.2 m**	
Groundwater Depth: **11.21m**	Location: **7372489 mN 314973 mE**	Inclination from Horizontal/Bearing: **Verticle deg**	
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT**	Hammer Data: **SPT**	

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	30									Borehole terminated at 30.0m due to desired depth.							
-18																	
	31																
-19																	
	32																
-20																	
	33																
-21																	
	34																
-22																	
	35																
-23																	

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Project No.: 42626445
Project Reference: GLNG EIS Supplement
Client: Santos

GW/BH2A

Date(s) Drilled: 07/08/09 to 07/08/09	Logged By: RJT	Checked By: TWA
Drilling Method: Mud Rotory	Drill Bit Size/Type: 3 7/8" blade bit	Total Depth Drilled (m): 10.1
Drilling Rig Type: Hydrapower Scout on Yanmar C60R	Drilling Contractor: Drillsure	Relative Level: 6.9 m
Groundwater Depth: 6.25m	Location: 7372516 mN 315573 mE	Inclination from Horizontal/Bearing: Verticle deg
Borehole Backfill: Well Instalation	Sampler Type: SPT & U75	Hammer Data: SPT

Relative Level (m)	Depth (m)	ROCK CORE (Run No., Box No., Recovery (%), Drilling Fluid Loss, R Q D (%), Drill Rate (m/min))	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type Number	SPT: Blows per 150mm	SPT: N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	0				Topsoil, brown, moist, roots.						
					Gravelly CLAY (CI); medium plasticity, greyish brown, angular chert gravel, moist, stiff, (residual soil).						
6	1				CLAY with gravel (CI); medium plasticity, brown, angular gravel compised of chert, moist, firm, (residual soil).	SPT	3, 2, 3	5			GW/BH24_1
					C'=60.7kPa, phi'=12.9º, Cc= 0.11, Cr= 0.09	U75					GW/BH2A_2
5	2										
					CLAY (CL); low plasticity, mottled brown and white, moist, stiff, (residual soil).	SPT	4, 6, 7	13			GW/BH2A_3
4	3										
3	4				Sandy CLAY with gravel (CH); high plasticity, grey, rounded to sub rounded chert gravel, moist, hard, (residual soil).	U75					GW/BH2A_4
2	5										
					Gravelly CLAY with sand (CL); low plasticity, mottled grey and orangish grey, angular chert gravel, moist, hard, (residual soil).	SPT	13, 15, 30	45			GW/BH2A_5
1											

NOTES: Classification: Soil classification via AS 1726 - 1993

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Project No.:	42626445	Client: Santos	Sheet 2 of 2
Project Reference:	GLNG EIS Supplement		**GW/BH2A**

Date(s) Drilled: **07/08/09 to 07/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **10.1**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **6.9 m**
Groundwater Depth: **6.25m**	Location: **7372516 mN 315573 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT & U75**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	6																
0	7									Clayey GRAVEL (GC); fine to medium chert gravel, angular, mottled whitish grey and brown, high plasticity, moist, very dense, (residual soil).	X		8 30 / 115 mm	38			GW/BH2A_6
-1	8																
										Clayey GRAVEL (GC); fine to medium chert gravel, angular, mottled whitish grey and brown, low plasticity, wet, very dense, (residual soil).	X		30 / 75 mm	30			GW/BH2A_7
-2	9																
-3	10									Clayey GRAVEL (GC); fine to medium chert gravel, angular, mottled whitish grey and brown, low plasticity, wet, very dense, (residual soil).	X		30 / 145 mm	30			GW/BH2A_8
										Borehole terminated at 10.145m due to desired depth.							
-4	11																
-5																	

NOTES: Classification: Soil classification via AS 1726 - 1993

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URS Australia Pty Ltd	Project No.: 42626445	Client:	Sheet 1 of 5
Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project Reference: GLNG EIS Supplement	Santos	**GW/BH2B**

Date(s) Drilled: **07/08/09 to 09/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **25.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **7.0 m**
Groundwater Depth: **6.4m**	Location: **7372513 mN 315578 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT & U75**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
7	0									Topsoil, brown, moist, roots.						
6	1									CLAY with gravel (CH); high plasticity, brown, angular fine gravel chert, moist, firm, (residual soil). MC:20.7%, LL:71%, PL:22%, PI:49%, LS:17.0+%	U75					GW/BH2B_1
5	2															
	2.5									CLAY (CL); low plasticity, mottled brown and white, moist, stiff, (residual soil).	SPT	6 10 12	22			GW/BH2B_2
4	3															
3	4									CLAY (CL); low plasticity, mottled brown and white, moist, stiff, (residual soil).	SPT	11 18 27	45			GW/BH2B_3
2	5															
	5.5									CLAY with Sand (CH); high plasticity, mottled orangish red and white, trace angular chert fine gravel, moist, hard, (residual soil). MC:21.2%, LL:53%, PL:25%, PI:28%, LS:13.5%	U75					GW/BH2B_4
1	6															

NOTES: Classification: Soil classification via AS 1726 - 1993

ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Date(s) Drilled: **07/08/09 to 09/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **25.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **7.0 m**
Groundwater Depth: **6.4m**	Location: **7372513 mN 315578 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT & U75**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	6																
0	7									Sandy CLAY with gravel (CL); low plasticity, mottled orangish red and white, trace angular chert fine gravel, moist, hard, (residual soil).			14 20 28	48			GW/BH2B_5
-1	8																
-2	9																
-3	10									Clayey SAND (SC); very fine sand, poorly graded, sub rounded, yellowish grey, low plasticity, very dense, (residual soil).			28 30 / 145 mm	62			GW/BH2B_6
-4	11																
-5																	

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Date(s) Drilled: **07/08/09 to 09/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **25.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **7.0 m**
Groundwater Depth: **6.4m**	Location: **7372513 mN 315578 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT & U75**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	12																
-6	13									Gravelly CLAY (CL); low plasticity, whitish grey, angular chert fine gravel, wet, very hard, (residual soil).	X		12 / 80mm	113			GW/BH2B_7
-7	14																
										ARGILITE, high strength, slightly weathered, dark and light grey, thinly layered, well developed, very fine grained, fractured.			8 / 0 mm	NA			GW/BH2B_8
-8	15	1	1	98		83											
-9	16	2	1	73		44											
										Gravelly CLAY with Sand (CL); low plasticity, orangish white, argilite gravel, fine to medium sand, fine to medium gravel, wet, soft, (residual soil).							
									CORE LOSS	Core Loss							
										ARGILITE, high strength, moderately weathered, dark and light grey, thinly layered, well developed, very fine grained, fractured.							
		3	1	98		23											
-10	17																
										Sandy CLAY with Gravel (CL); low plasticity, orangish white, argilite gravel, fine to medium sand, fine to medium gravel, wet, soft, (residual soil).							
										ARGILITE, high strength, slightly weathered, dark and light grey, thinly layered, well developed, very fine grained, fractured.							
-11		4	1	100		81											

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Date(s) Drilled: **07/08/09 to 09/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **25.0**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **7.0 m**
Groundwater Depth: **6.4m**	Location: **7372513 mN 315578 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT & U75**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type Number	SPT Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	18															
-12	19	5	1	100		89										
										ARGILITE, high strength, moderately weathered, dark and light grey, thinly layered, well developed, very fine grained, highly fractured.						
-13	20	6	1	74		44										
									CORE LOSS	Core Loss						
										ARGILITE, high strength, slightly weathered, dark and light grey, thinly layered, well developed, very fine grained, fractured.						
-14	21	7	2	100		81										
										ARGILITE, high strength, moderately weathered, dark and light grey, thinly layered, well developed, very fine grained, highly fractured, some quartz veins.						
-15	22	8	2	77		31										
-16	23	9	2	100		47										
										Gravelly CLAY with sand (CL); low plasticity, orangish white, argilite gravel, fine to medium sand, fine to medium gravel, wet, soft, (residual soil).						
										ARGILITE, high strength, slightly weathered, dark and light grey, thinly layered, well developed, very fine grained, fractured, some quartz veins.						
-17																

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Date(s) Drilled: 07/08/09 to 09/08/09	Logged By: RJT	Checked By: TWA
Drilling Method: Mud Rotory, NMLC Coring	Drill Bit Size/Type: 3 7/8"blade bit, NMLC	Total Depth Drilled (m): 25.0
Drilling Rig Type: Hydrapower Scout on Yanmar C60R	Drilling Contractor: Drillsure	Relative Level: 7.0 m
Groundwater Depth: 6.4m	Location: 7372513 mN 315578 mE	Inclination from Horizontal/Bearing: Verticle deg
Borehole Backfill: Well Instalation	Sampler Type: SPT & U75	Hammer Data: SPT

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	24	10	2	100		71										
-18	25									Borehole terminated at 25.0m due to desired depth.						
-19	26															
-20	27															
-21	28															
-22	29															
-23																

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS:PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: **Santos**	Sheet 1 of 2 **GW/BH3A**

Date(s) Drilled: **10/08/09 to 10/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **10.2**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **5.1 m**
Groundwater Depth: **4.895m**	Location: **7370962 mN 315594 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	Type / Number	SPT Blows per 150mm	SPT N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
5	0									Topsoil, brown, moist, roots.						
4	1									Gravelly CLAY (CL); low plasticity, reddish brown, subrounded to subangular chert, fine to medium gravel, moist, very stiff, (residual soil).		20 / 16 / 10	26			GW/BH3A_1
3	2									Gravelly CLAY (CL); low plasticity, orangish brown, angular, fine to medium gravel, moist, hard, (residual soil).		29 / 30 / 65 mm	138			GW/BH3A_5
										Gravelly CLAY (CL); low plasticity, mottled grey and reddish brown, subrounded to subangular, fine to medium chert and host rock, moist, very stiff, (residual soil).		8 / 11 / 17	28			GW/BH3A_2
2	3															
1	4									CLAY with sand (CL); low plasticity, grey, angular, fine to medium sand, moist, hard, (residual soil).		15 / 20 / 28	48			GW/BH3A_3
0	5															
										Gravelly CLAY (CL); low plasticity, whitish grey, angular, fine to medium gravel, moist, hard, (residual soil).		30 / 85 mm	106			GW/BH3A_4

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: **Santos**	**GW/BH3A**

Date(s) Drilled: **10/08/09 to 10/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory**	Drill Bit Size/Type: **3 7/8" blade bit**	Total Depth Drilled (m): **10.2**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **5.1 m**
Groundwater Depth: **4.895m**	Location: **7370962 mN 315594 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Well Instalation**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
-1	6																
-2	7									Gravelly CLAY (CL); low plasticity, orangish brown, angular, fine to medium gravel, moist, hard, (residual soil).							
-3	8									Clayey SAND (SC); fine to medium sand, subrounded, poorly graded, orangish brown, moist, very dense, (residual soil).			29 30 / 140 mm	64			GW/BH3A_6
-4	9																
-5	10									Sandy CLAY (CL); low plasticity, orangish brown, subrounded, moist, hard, (residual soil).			25 30 / 80 mm	113			GW/BH3A_7
										Borehole terminated at 10.23m at desired depth.							
-6	11																

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: Santos	Sheet 1 of 6 GW/BH3B

Date(s) Drilled: 11/08/09 to 12/08/09	Logged By: RJT	Checked By: TWA
Drilling Method: Mud Rotory, NMLC Coring	Drill Bit Size/Type: 3 7/8"blade bit, NMLC	Total Depth Drilled (m): 30.5
Drilling Rig Type: Hydrapower Scout on Yanmar C60R	Drilling Contractor: Drillsure	Relative Level: 5.1 m
Groundwater Depth: 5.25m	Location: 7370964 mN 315594 mE	Inclination from Horizontal/Bearing: Verticle deg
Borehole Backfill: Grout/Bentenite	Sampler Type: SPT	Hammer Data: SPT

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
5	0									Topsoil, brown, moist, roots.						
4	1									Gravelly CLAY (CL); low plasticity, mottled red and brown, angular gravel comprised of siltstone, moist, stiff, (residual soil).		11 9 8	17			GW/BH3B_1
3	2									Gravelly CLAY with sand (CI); medium plasticity, reddish brown, subrounded to subangular gravel, moist, hard, (residual soil). MC:10.3%, LL:42%, PL:22%, PI:20%		30 / 90 mm	100			GW/BH3B_2
2	3															
1	4									Sandy CLAY with gravel (CL); low plasticity, mottled white and red, moist, subangular gravel, hard, (residual soil).		30 / 140 mm	64			GW/BH3B_3
0	5									Sandy CLAY with gravel (CL); low plasticity, mottled white and red, sub angular to angular gravel, moist, hard, (residual soil).		30 / 90 mm	100			GW/BH3B_4

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd
Phone: (07) 3243 2111 Fax: (07) 3243 2199

Project No.: 42626445	Client: Santos		**GW/BH3B**
Project Reference: GLNG EIS Supplement			
Date(s) Drilled: 11/08/09 to 12/08/09	Logged By: RJT	Checked By: TWA	
Drilling Method: Mud Rotory, NMLC Coring	Drill Bit Size/Type: 3 7/8"blade bit, NMLC	Total Depth Drilled (m): 30.5	
Drilling Rig Type: Hydrapower Scout on Yanmar C60R	Drilling Contractor: Drillsure	Relative Level: 5.1 m	
Groundwater Depth: 5.25m	Location: 7370964 mN 315594 mE	Inclination from Horizontal/Bearing: Verticle deg	
Borehole Backfill: Grout/Bentenite	Sampler Type: SPT	Hammer Data: SPT	

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
	6																
-1																	
	7																
-2																	
	8																
-3																	
										Gravelly CLAY with sand (CL); low plasticity, orangish grey, angular gravel, coarse sand to medium gravel, moist, hard, (residual soil).	X		26 30 / 85 mm	106			GW/BH3B_6
	9																
-4																	
	10																
-5																	
	11																
-6																	
										CLAY (CL); low plasticity, mottled yellowish orange and brown, trace subrounded gravel, moist, hard, (residual soil).	X		23 30 / 100 mm	90			GW/BH3B_7

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: Santos	GW/BH3B

Date(s) Drilled: **11/08/09 to 12/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **30.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **5.1 m**
Groundwater Depth: **5.25m**	Location: **7370964 mN 315594 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Grout/Bentenite**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	Type	Number	SPT Blows per 150mm	SPT N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
-7	12																
-8	13																
-9	14									CLAY with sand (CL); low plasticity, mottled grey and orange, angular medium to coarse grained sand, moist, hard, (residual soil).	X		30 / 65 mm	138			GW/BH3B_8
-10	15																
-11	16																
-12	17									Gravelly CLAY (CL); low plasticity, greyish brown, angular to sub angular gravel, moist, hard, (residual soil).	X		30 / 90 mm	100			GW/BH3B_9

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: Santos	GW/BH3B

Date(s) Drilled: **11/08/09 to 12/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **30.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **5.1 m**
Groundwater Depth: **5.25m**	Location: **7370964 mN 315594 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Grout/Bentenite**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	Type Number	SPT Blows per 150mm	SPT N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
-13	18															
-14	19															
-15	20															
										CLAY with sand (CL); low plasticity, mottled brownish grey and orangish grey, angular to subangular medium to coarse sand, mudstone fragments, hard, (residual soil).		30 / 40 mm	225			GW/BH3B_10
-16	21															
-17	22															
-18	23															
										Clayey GRAVEL with sand (GC); fine to medium gravel, poorly graded, angular pieces of unweathered rock, low plasticity, very dense, (residual soil).		15 23 30 / 100	68			GW/BH3B_11

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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Phone: (07) 3243 2111 Fax: (07) 3243 2199

Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: **Santos**	**GW/BH3B**	
Date(s) Drilled: **11/08/09 to 12/08/09**	Logged By: **RJT**	Checked By: **TWA**	
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **30.5**	
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **5.1 m**	
Groundwater Depth: **5.25m**	Location: **7370964 mN 315594 mE**	Inclination from Horizontal/Bearing: **Verticle deg**	
Borehole Backfill: **Grout/Bentenite**	Sampler Type: **SPT**	Hammer Data: **SPT**	

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
-19	24																
-20	25																
										Washboring refusal swich to coring.							
-21	26									ARGILITE, high strength, slightly weathered, dark grey, thinly layered, very fine grained, highly fractured.							
		1	3	88		10											
-22	27								CORE LOSS	Core Loss							
										GREYWACKE, high strength, slightly weathered, dark grey, thinly layered, very fine grained, fractured, quartz veins.							
-23	28	2	3	100		74											
-24	29																
		3	3	98		55											

NOTES: Classification: Soil classification via AS 1726 - 1993
ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

URS Australia Pty Ltd Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445 Project Reference: GLNG EIS Supplement	Client: Santos	Sheet 6 of 6 **GW/BH3B**

Date(s) Drilled: **11/08/09 to 12/08/09**	Logged By: **RJT**	Checked By: **TWA**
Drilling Method: **Mud Rotory, NMLC Coring**	Drill Bit Size/Type: **3 7/8"blade bit, NMLC**	Total Depth Drilled (m): **30.5**
Drilling Rig Type: **Hydrapower Scout on Yanmar C60R**	Drilling Contractor: **Drillsure**	Relative Level: **5.1 m**
Groundwater Depth: **5.25m**	Location: **7370964 mN 315594 mE**	Inclination from Horizontal/Bearing: **Verticle deg**
Borehole Backfill: **Grout/Bentenite**	Sampler Type: **SPT**	Hammer Data: **SPT**

Relative Level (m)	Depth (m)	ROCK CORE: Run No.	Box No.	Recovery (%)	Drilling Fluid Loss	R Q D (%)	Drill Rate (m/min)	In-situ Testing	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	SPT: Blows per 150mm	N Value Blows/300mm	Recovery (m)	Water Content (%)	REMARKS
-25	30									Drilling continued using Rock Roller							
										Borehole terminated at 30.5m due to desired depth.							
-26	31																
-27	32																
-28	33																
-29	34																
-30	35																

NOTES: Classification: Soil classification via AS 1726 - 1993

ABBREVIATIONS: PP: Pocket Penetrometer LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index EC: Emerson Class k: Laboratory Permeability

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TEST PIT LOG New-TP02

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **17-8-09** Date Finished: **17-8-09**	Relative Level: **2.14 mAHD** Coordinates: **7371596 mN** **315148 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
2	Topsoil, brown, moist, roots.		0					
	SILT (ML); low plasticity, grey, with some vegetation and gravel, subangular gravel, moist, stiff, (residual soil).							BS 0.5m
1	CLAY (CH); medium plasticity, greyish brown, with some gravel, subangular gravel, moist, very stiff, (residual soil).		1					
	MC:21.1%, LL:56%, PL:22%, PI:34%, LS:12.0*+%, EC:6, MDD:1.74t/m^3, OMC:19%				>4.5			BS 1.5m
0	CLAY (CH); high plasticity, greyish brown, with some gravel, subangular gravel, moist, very stiff, (residual soil).		2					
-1			3					
	MC:15.7%				>4.5			BS 3.5m
-2			4					
-3	Test pit terminated at 5.0m due to target depth reached.		5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	X
Refusal	
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-02

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **16-8-09** Date Finished: **16-8-09**	Relative Level: **11.281 mAHD** Coordinates: **7371396 mN** **315711 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM²)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, brown, moist, roots.		0					
11	SILT (ML); low plasticity, red brown, with a trace of vegetation, moist, very stiff, (residual soil).							
	CLAY (CH); high plasticity, light yellow grey, with some gravel, subangular gravel, dry, hard				>4.5			BS 0.3m
10			1					
	C=19kPa, FA=25.8°							
9			2		>4.5			BS 2.5m
8			3					
7			4					
	Test pit terminated at 5.0m due to target depth reached.		5					
6								

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	X
Refusal	
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-03

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **16-8-09** Date Finished: **16-8-09**	Relative Level: **6.662 mAHD** Coordinates: **7371947 mN** **315837 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, brown, moist, roots.		0					
	SILT (ML): low plasticity, grey, some vegetation and gravel, subangular gravel, dry, firm, (residual soil).							
6	CLAY (CL): medium plasticity, red brown, with some gravel, subangular gravel, moist, very stiff, (residual soil).							BS 0.3m
			1					
5					>4.5			BS 1.5m
			2					
4								
	CLAY (CH): high plasticity, grey with mottled brown, with some gravel, subangular gravel, moist, hard, (residual soil). MC:15.6%, LL:58%, PL:21%, PI:37%, LS:16.5+%		3		>4.5			BS 3m
3								
			4					
2								
	Test pit terminated at 5.0m due to target depth reached.		5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	X
Refusal	
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-04

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **16-8-09** Date Finished: **16-8-09**	Relative Level: **10.915 mAHD** Coordinates: **7372145 mN** **315975 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, brown, moist, roots.		0					
	SILT (ML): low plasticity, grey, with some vegetation and gravel, subangular gravel, dry, firm, (residual soil). MC:4.2%							BS 0.3m
	CLAY (CI): medium plasticity, grey with mottled white, with a trace of gravel, subangular gravel, moist, stiff, (residual soil).							
10			1					
9			2					
					>4.5			BS 2.5m
8	CLAY (CI): medium plasticity, brownish white, with some gravel, subangular gravel, moist, stiff, (residual soil).		3					
7	MC:8.3%, LL:38%, PL:20%, PI:18%, LS:8%		4		>4.5			BS 4m
6	Test pit terminated at 5.0m due to target depth reached.		5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	X
Refusal	
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-05

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445	Project Reference: GLNG DMPF Geotech Assessment
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **16-8-09** Date Finished: **16-8-09**	Relative Level: **5.413 mAHD** Coordinates: **7372332 mN** **315505 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, brown, moist, roots.		0					
5	CLAY (CL): low plasticity, grey, with some vegetation and gravel, subangular gravel, dry, firm, (residual soil).							BS 0.5m
4	CLAY (CI): medium plasticity, yellowish brown, with some gravel, subangular gravel, moist, stiff, (residual soil).		1					
3			2					
2			3		>4.5			BS 3m
1			4					
0	Test pit terminated at 5.0m due to target depth reached.		5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	X
Refusal	
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-06

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **17-8-09** Date Finished: **17-8-09**	Relative Level: **4.634 mAHD** Coordinates: **7371691 mN** **315449 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, brown, moist, roots.		0					
	SILT (ML); low plasticity, light grey, with some vegetation and gravel, subangular gravel, moist, firm, (residual soil).				>4.5			BS 0.5m
4								
	CLAY (CI); medium plasticity, reddish brown, with some gravel, subangular gravel, moist, stiff, (residual soil).		1					
3								
			2					
2					>4.5			BS 2.5m
			3					
1								
			4					
0								
	Test pit terminated at 5.0m due to target depth reached.		5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	X
Refusal	
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-06a

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **17-8-09** Date Finished: **17-8-09**	Relative Level: **1.9 mAHD** Coordinates: **7371743 mN** **315246 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	CLAY (CH): high plasticity, dark grey, with some vegetation and gravel, subangular gravel, wet, soft, (Marine Clay).		0					
	MC:41.6%, LL:54%, PL:22%, PI:32%, LS:14.5+%							BS 0.5m
1			1					
	CLAY (CL): low plasticity, brown, with some gravel, subangular gravel, moist, stiff, (Marine Clay).							
0	MC:12.6%		2					BS 2m
-1			3					
	Test pit terminated at 3.5m due to excavator becoming unstable.							
-2			4					
-3			5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	☐
Flooding	☐
Caving/collapse	X

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-08

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **16-8-09** Date Finished: **16-8-09**	Relative Level: **8.633 mAHD** Coordinates: **7372423 mN** **315559 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, brown, moist, roots.		0					
8	CLAY (CH); high plasticity, light grey, with some vegetation and gravel, subangular gravel, moist, firm, (residual soil). LL:82%, PL:22%, PI:60%, LS:20.0+%							BS 0.5m
7	CLAY (CI); medium plasticity, dark grey, with some gravel, subangular gravel, moist, very stiff, (residual soil). MC:16.4%, EC:2, MDD:1.69t/m3, OMC:19%		1		>4.5			BS 1.5m
6 5 4	CLAY (CI); medium plasticity, reddish brown, with some gravel, subangular gravel, moist, very stiff, (residual soil). MC:12.3%, LL:41%, PL:25%, PI:16%, LS:7%		2 3 4		>4.5			BS 3.5m
	Test pit terminated at 5.0m due to target depth reached.		5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	X
Refusal	
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-09

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **16-8-09** Date Finished: **16-8-09**	Relative Level: **12.314 mAHD** Coordinates: **7372445 mN** **315018 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM²)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, brown, moist, roots.		0					
12	CLAY (CL): low plasticity, grey, with some vegetation and gravel, moist, firm, (residual soil).				>4.5			BS 0.3m
11	CLAY (CI): medium plasticity, reddish brown, with some gravel, moist, hard, (residual soil).		1					
10	MC:7.6%, EC:5, MDD:1.93t/m3, OMC:12.4%		2		>4.5			BS 2m
9			3					
8	Testpit terminated at 3.5m due to excavator refusal.		4					
7			5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	☒ X
Flooding	☐
Caving/collapse	☐

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-10

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **16-8-09** Date Finished: **16-8-09**	Relative Level: **6.393 mAHD** Coordinates: **7372326 mN** **315065 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, moist, brown, roots.		0					
6	SILT(ML): low plasticity, light grey, with some vegetation and gravel, subangular gravel, dry, firm, (residual soil).							BS 0.5m
5	CLAY (CH): high plasticity, reddish brown, with some gravel, subangular gravel, moist, hard, (residual soil).		1					
4	MC:10.2%		2		>4.5			BS 2.5m
3			3					
2	Test pit terminated at 4.0m due to excavator refusal.		4					
1			5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	X
Flooding	☐
Caving/collapse	☐

SAMPLE TYPE:

Bulk Sample	BS
Tube Sample	TS
Disturbed Sample	DS

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-11

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **16-8-09** Date Finished: **16-8-09**	Relative Level: **4.523 mAHD** Coordinates: **7372255 mN** **315239 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, brown, moist, roots.		0					
4	SILT (ML): low plasticity, light grey, with some vegetation and gravel, subangular gravel, moist, firm, (residual soil).				>4.5			BS 0.3m
3	CLAY (CL): low plasticity, reddish brown, with some gravel, with some sand, moist, stiff, (residual soil). MC:5.4%		1 2		>4.5			BS 1m
2 1 0	CLAY (CH): high plasticity, dark brown, with some gravel, subangular gravel, moist, very stiff, (residual soil).		3 4		>4.5			BS 3.5m
	Testpit terminated at 5.0m due to target depth reached.		5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	X
Refusal	
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-BH3

URS Australia Pty. Ltd. Phone: (07) 3243 2111 Fax: (07) 3243 2199

Project No.:	42626445
Project Reference:	GLNG DMPF Geotech Assessment
Excavator Contractor	Rayment Excavation
Excavator Type:	Daewoo 225LCV
Logged By:	WWD
Checked By:	TWA
Date Started:	16-8-09
Date Finished:	16-8-09
Relative Level:	10.384 mAHD
Coordinates:	7372359 mN 315118 mE
Permit No:	
Client:	Santos Ltd

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM²)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	Topsoil, brown, moist, roots.		0					
10	SILT (ML); medium plasticity, grey, with some gravel, subangular gravel, moist, firm, (residual soil).				>4.5			BS 0.5m
9	CLAY (CL); low plasticity, light brownish grey, with some gravel, subangular gravel, moist, stiff, (residual soil).		1					
8			2		>4.5			BS 2m
7			3					
6	CLAY (CL): low plasticity, reddish brown, with some gravel, subangular gravel, moist, stiff, (residual soil). LL:28%, PL:15%, PI:13%, LS:4.5*+%, EC:5, MDD:2.13t/m³ OMC:8.4%		4		>4.5			BS 4.5m
5	Test pit terminated at 5.0m due to target depth reached.		5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	X
Refusal	
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-CPT01

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445	Project Reference: GLNG DMPF Geotech Assessment
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **15-8-09** Date Finished: **15-8-09**	Relative Level: **1.912 mAHD** Coordinates: **7371661 mN** **315189 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	CLAY (CL): low plasticity, dark grey, with some vegetation and gravel, subangular gravel, moist, soft, (marine clay).		0					
1	MC:34.5%, LL:30%, PL:16%, PI:14%, LS:4.5*+%		1					BS 1m
	CLAY (CL): low plasticity, reddish brown, with some gravel, subangular gravel, moist, stiff, (marine clay).							
0			2					BS 2m
-1	Test pit terminated at 3.0m due to excavator refusal.		3					
-2			4					
-3			5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	X
Flooding	☐
Caving/collapse	☐

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-CPT02

URS Australia Pty. Ltd. Phone: (07) 3243 2111 Fax: (07) 3243 2199

Excavator Contractor: **Rayment Excavation**		Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **15-8-09** Date Finished: **15-8-09**	Relative Level: **1.349 mAHD** Coordinates: **7371603 mN** **315068 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
1, 0	CLAY (CL): low plasticity, dark grey, with some vegetation, wet, soft, (marine clay). C'=1.1kPa, phi'=28.5º		0, 1					BS 1.5m
-1, -2	CLAY (CH): high plasticity, reddish brown, with some gravel, subangular gravel, moist, very stiff, (marine clay). MC:20.9%, LL:60%, PL:24%, PI:36%, LS:14.5+%		2, 3					BS 3.2m
-3, -4	Test pit terminated at 3.5m due to excavator refusal.		4, 5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	X
Flooding	☐
Caving/collapse	☐

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-CPT04

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: 42626445	Project Reference: GLNG DMPF Geotech Assessment
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **14-8-09** Date Finished: **14-8-09**	Relative Level: **1.9 mAHD** Coordinates: **7371761 mN** **314868 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	CLAY (CI): medium plasticity, brownish grey, with some vegetation, moist, soft, (marine clay).		0					BS 0.5m
1	CLAY (CI): medium plasticity, dark grey, with some vegetation, with a trace of gravel, subangular gravel, wet, soft, (marine clay).		1					
0			2					BS 2m
-1			3					
-2			4					
	Test pit terminated at 4.0m due to test pit collapse.							
-3			5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	☐
Flooding	☐
Caving/collapse	X

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred
+: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability
FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-CPT04b

URS Australia Pty. Ltd.
Phone: (07) 3243 2111
Fax: (07) 3243 2199

Excavator Contractor: **Rayment Excavation**		Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **15-8-09** Date Finished: **15-8-09**	Relative Level: **1.9 mAHD** Coordinates: **7371770 mN** **315105 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	CLAY (CH); high plasticity, dark grey, with some vegetation, wet, soft, (marine clay).		0					
1	MC:57.2%, LL:63%, PL:26%, PI:37%, LS:17.5*+% EC:2		1					BS 1m
0			2					
-1	CLAY (CL); low plasticity, yellowish grey, with some gravel, subangular gravel, moist, firm, (marine clay).		3					BS 3.5m
-2	Test pit terminated at 4.0m due to test pit collapse.		4					
-3			5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	☐
Flooding	☐
Caving/collapse	X

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-CPT05

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **13-8-09** Date Finished: **13-8-09**	Relative Level: **1.9 mAHD** Coordinates: **7371873 mN** **314932 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	CLAY (CL): low plasticity, grey with mottled brown, with some vegetation, wet, soft, (marine clay).		0					
1			1					
0			2					
-1	Test pit terminated at 3.0m due to test pit collapse.		3					
-2			4					
-3			5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	
Refusal	
Flooding	
Caving/collapse	X

SAMPLE TYPE:

Bulk Sample	BS
Tube Sample	TS
Disturbed Sample	DS

NOTES: Soil classification via AS1726-1993
ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred
+: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability
FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-CPT05a

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **13-8-09** Date Finished: **13-8-09**	Relative Level: **1.9 mAHD** Coordinates: **7371863 mN** **314786 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
1 to -1.6	CLAY (CH): high plasticity, brownish grey, with some vegetation, wet, soft, (marine clay) LL:70%, PL:27%, PI:43%, LS:10% MC:73.4%, LL:94%, PL:30%, PI:64%, LS:21.5%, C'=4.1kPa, phi'=15.5º, Cc=1.09, Cr=0.16		0 to 3.5					
-1.6 to -2.6	CLAY (CL): low plasticity, dark grey, with some gravel and shells, sub-angular gravel, wet, firm, (marine clay). C'=20.4kPa, phi'=12.6º, Cc=0.81, Cr=0.14		3.5 to 4.5					
-3	Test pit terminated at 4.5m due to test pit collapse.		5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	☐
Flooding	☐
Caving/collapse	X

SAMPLE TYPE:

Bulk Sample	BS
Tube Sample	TS
Disturbed Sample	DS

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

Sheet 1 of 1

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TEST PIT LOG TP-CPT06

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **13-8-09** Date Finished: **13-8-09**	Relative Level: **1.9 mAHD** Coordinates: **7371880 mN** **314998 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
1, 0, -1	CLAY (CL); low plasticity, grey, with some vegetation, wet, very soft, (marine clay).		0–3.2					
-2, -3	Test pit terminated at 3.2m due to test pit collapse.		3.2–5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	
Refusal	
Flooding	
Caving/collapse	X

SAMPLE TYPE:

Bulk Sample	BS
Tube Sample	TS
Disturbed Sample	DS

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-CPT12

URS Australia Pty. Ltd. Phone: (07) 3243 2111 Fax: (07) 3243 2199

Excavator Contractor: **Rayment Excavation**		Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **12-8-09** Date Finished: **12-8-09**	Relative Level: **1.9 mAHD** Coordinates: **7371898 mN** **315147 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	CLAY (CH): high plasticity, grey, with some vegetation, moist, very soft, (marine clay). MC:91%, LL:90%, PL:28%, PI:62%, LS:19.0+%, C'=0kPa, phi'=17º, Cc=1.07, Cr=0.08 MC:67.9%, LL:84%, PL:27%, PI:57%, LS:18.0+%, C'=1.4kPa, phi'=18º, Cc=1.14, Cr=0.13		0					
1			1					
	CLAY (CH): high plasticity, grey, with some vegetation, wet, very soft, (marine clay). MC:94.9%, LL:100%, PL:34%, PI:66%, LS:16%, C'=1.1kPa, phi'=28.5º, Cc=1.54, Cr=0.21							
0								
	CLAY, high plasticity, poorly graded, greenish grey, with some poorly graded sub angular fine sand , moist, medium dense, (marine clay). MC:87.8%, LL:100%, PL:41%, PI:59%, LS:16.5%, C'=0kPa, phi'=23.5º, Cc= 1.57, Cr= 0.20		2					
-1			3					
-2			4					
-3			5					
	Test pit terminated at 5.0m due to test pit collapse.							

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	☐
Flooding	☐
Caving/collapse	X

SAMPLE TYPE:

Bulk Sample	BS
Tube Sample	TS
Disturbed Sample	DS

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-CPT13

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **11-8-09** Date Finished: **11-8-09**	Relative Level: **2.236 mAHD** Coordinates: **7371816 mN** **315382 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
2	CLAY (CL); low plasticity, brownish grey, with a trace of gravel, subangular gravel, moist, soft, (marine clay).		0					
1	CLAY (CL); Low plasticity, brown with light green, with some gravel, subangular gravel, moist, stiff, (marine clay).		1					
0	CLAY (CL); low plasticity, grey green, with some gravel, subangular gravel, moist, stiff, (marine clay).		2					
-1	Test pit terminated at 2.5m due to excavator refusal.		3					
-2			4					
-3			5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	
Refusal	X
Flooding	
Caving/collapse	

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

URS Australia Pty Ltd

TEST PIT LOG TP-CPT14

URS Australia Pty. Ltd.	Phone: (07) 3243 2111 Fax: (07) 3243 2199	Project No.: **42626445**	Project Reference: **GLNG DMPF Geotech Assessment**
Excavator Contractor **Rayment Excavation**			
Excavator Type: **Daewoo 225LCV**	Logged By: **WWD** Checked By: **TWA** Date Started: **16-8-09** Date Finished: **16-8-09**	Relative Level: **1.9 mAHD** Coordinates: **7371747 mN** **315247 mE** Permit No:	Client: **Santos Ltd**

REDUCED LEVEL (m RL)	DESCRIPTION OF STRATA	GRAPHIC LOG	DEPTH (m)	SHEAR VANE STRENGTH (kPa)	POCKET PENETROMETER (KG/CM^2)	DCPT (Blows/100mm)	SAMPLING AND OTHER TESTING	COMMENTS
	CLAY (CL); low plasticity, dark grey, with some vegetation, wet, soft, (marine clay).		0					
1			1					BS 1.5m
0	CLAY (CL); low plasticity, yellowish green, with some gravel, subangular gravel, moist, stiff, (marine clay).		2					BS 2.2m
	Test pit terminated at 2.5m due to excavator refusal.							
-1			3					
-2			4					
-3			5					

TEST PIT SECTION

TEST PIT TERMINATED AT:

Target Depth	☐
Refusal	X
Flooding	☐
Caving/collapse	☐

SAMPLE TYPE:

Bulk Sample	**BS**
Tube Sample	**TS**
Disturbed Sample	**DS**

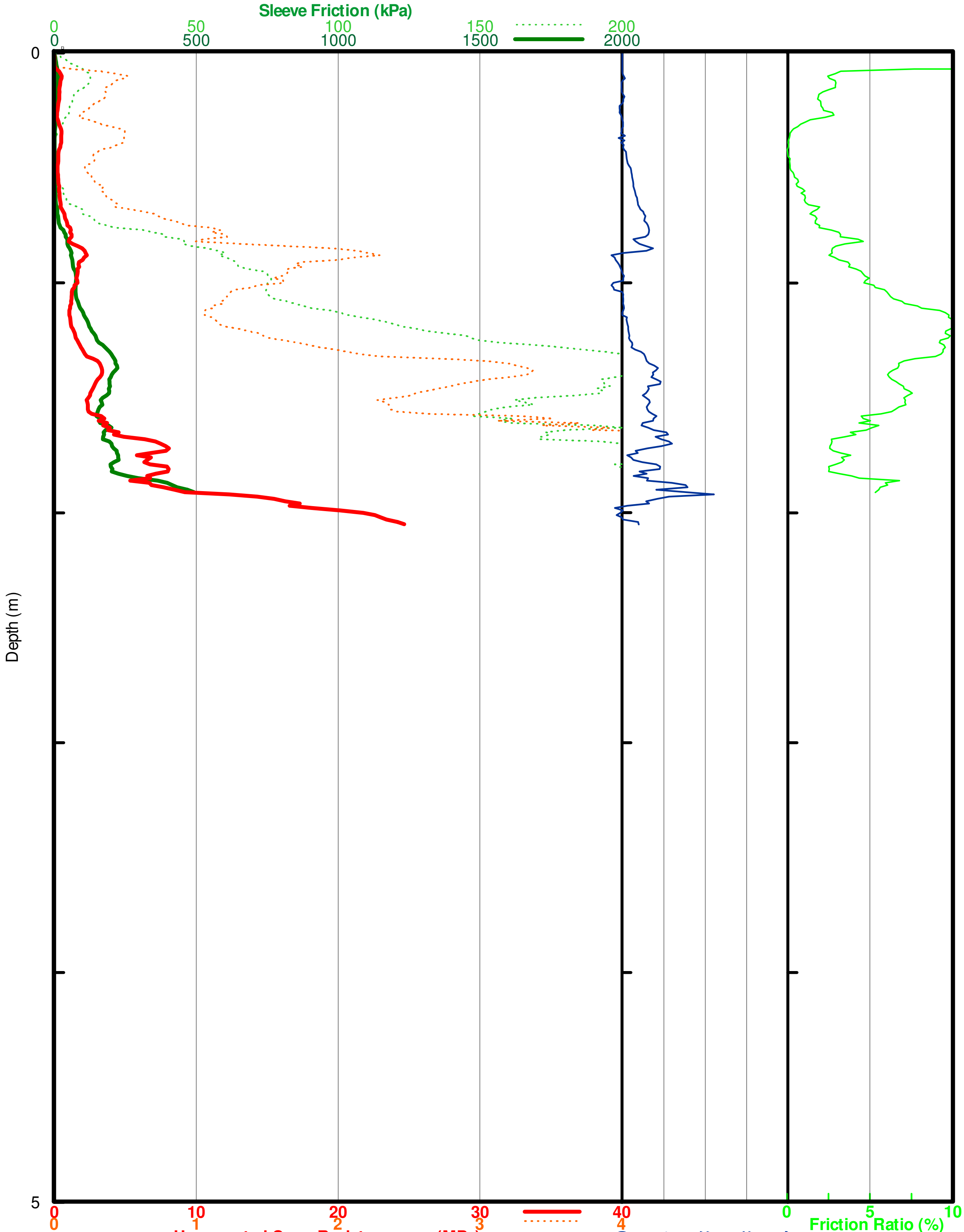
NOTES: Soil classification via AS1726-1993

ABBREVIATIONS: MC: Moisture Content LL: Liquid Limit PL:Plastic Limit PI: Plasticity Index LS: Linear Shrinkage *: Crumbling occurred +: Curling occurred EC: Emerson Class MDD: Maximum Dry Density OMC: Optimum Moisture Content k: Laboratory Permeability FA: Peak Friction Angle C: Cohesion

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT01



Job Number : G0908-103
Test Date : 15/08/2009
DGPS Position : 56K 0315189, 7371662
DGPS Format : GDA

Cone Number : C10CFIIP.G56
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

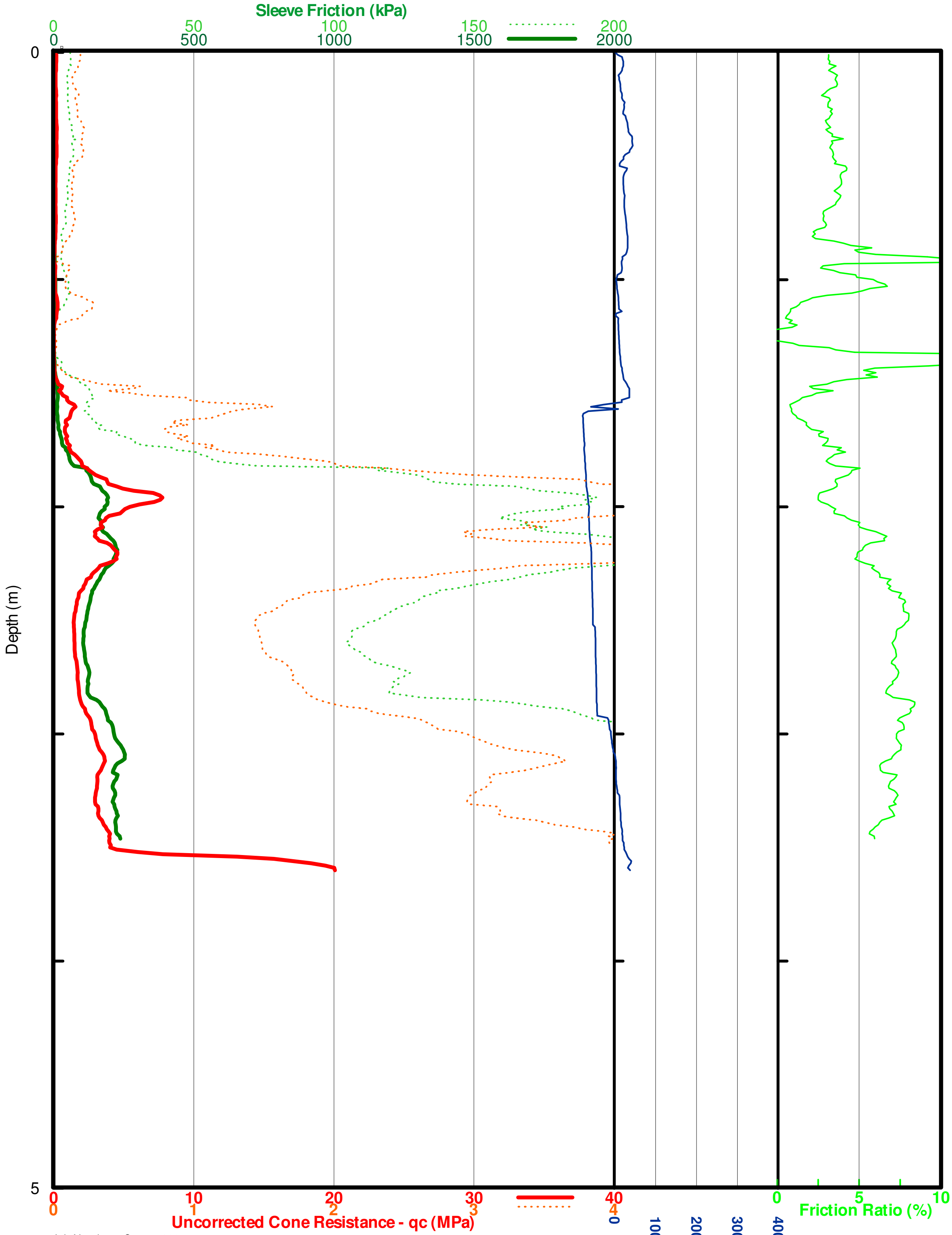
Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu
Geotech
Services
Pty Ltd
IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT02



Job Number : G0908-103
Test Date : 15/08/2009
DGPS Position : 56K 0315068, 7371603
DGPS Format : GDA

Cone Number : C10CFIIP.G56
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

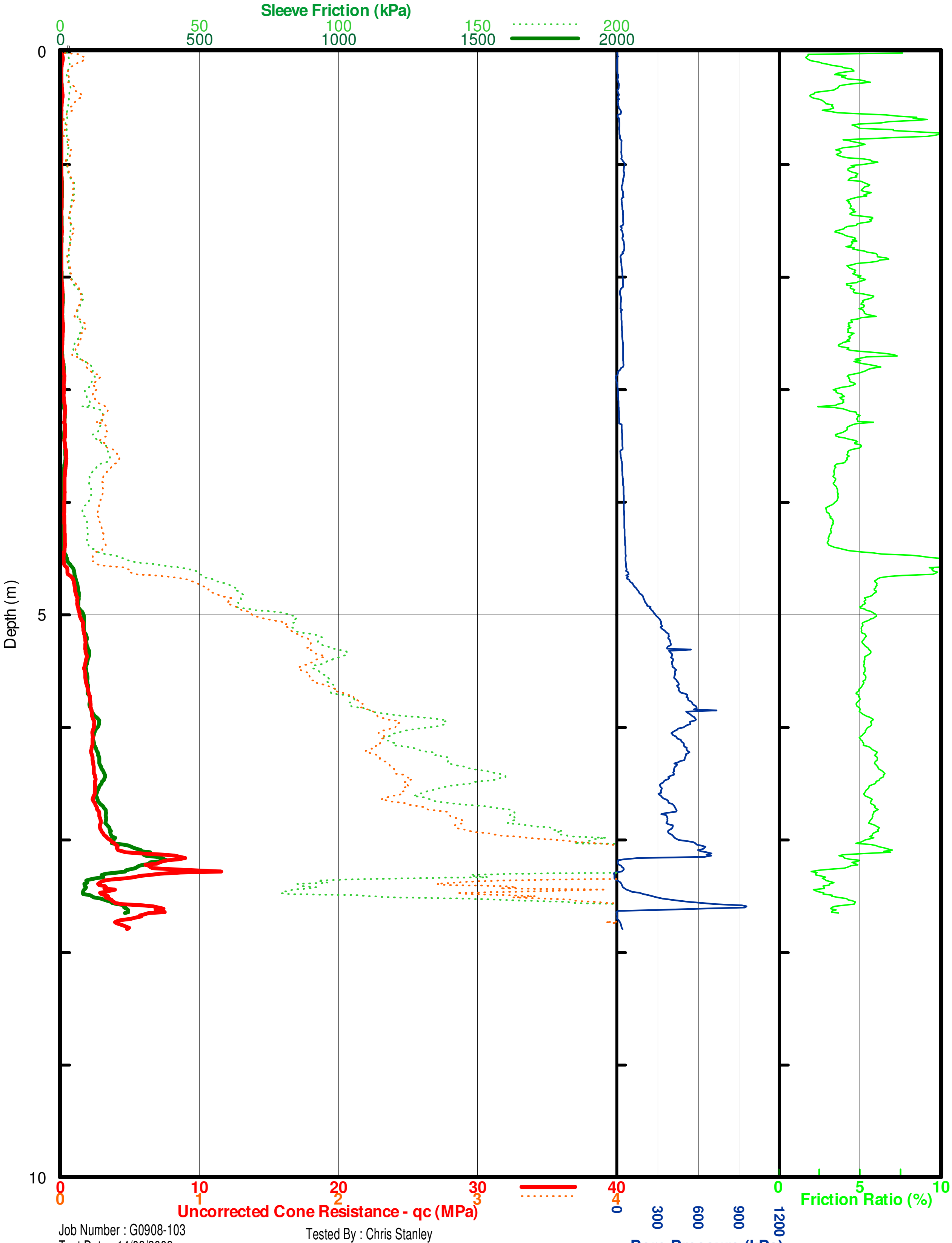
Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu Geotech Services Pty Ltd
IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT03



Job Number : G0908-103
Test Date : 14/08/2009
DGPS Position : 56K 0314776, 7371786
DGPS Format : GDA

Cone Number : C10CFIIP.E29
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

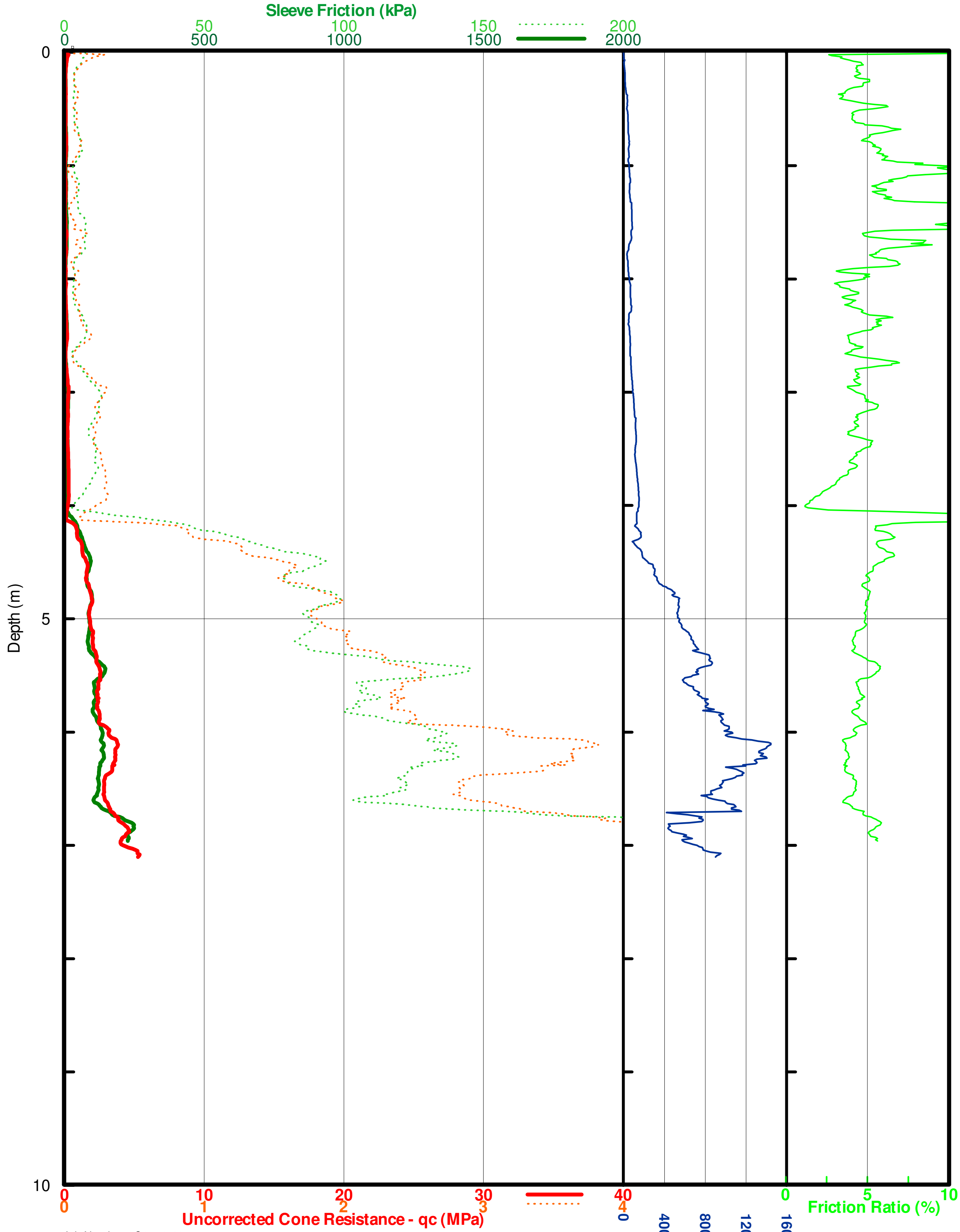
Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu Geotech Services Pty Ltd IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT04



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Test Date : 14/08/2009
DGPS Position : 56K 0314868, 7371761
DGPS Format : GDA

Cone Number : C10CFIIP.G56
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

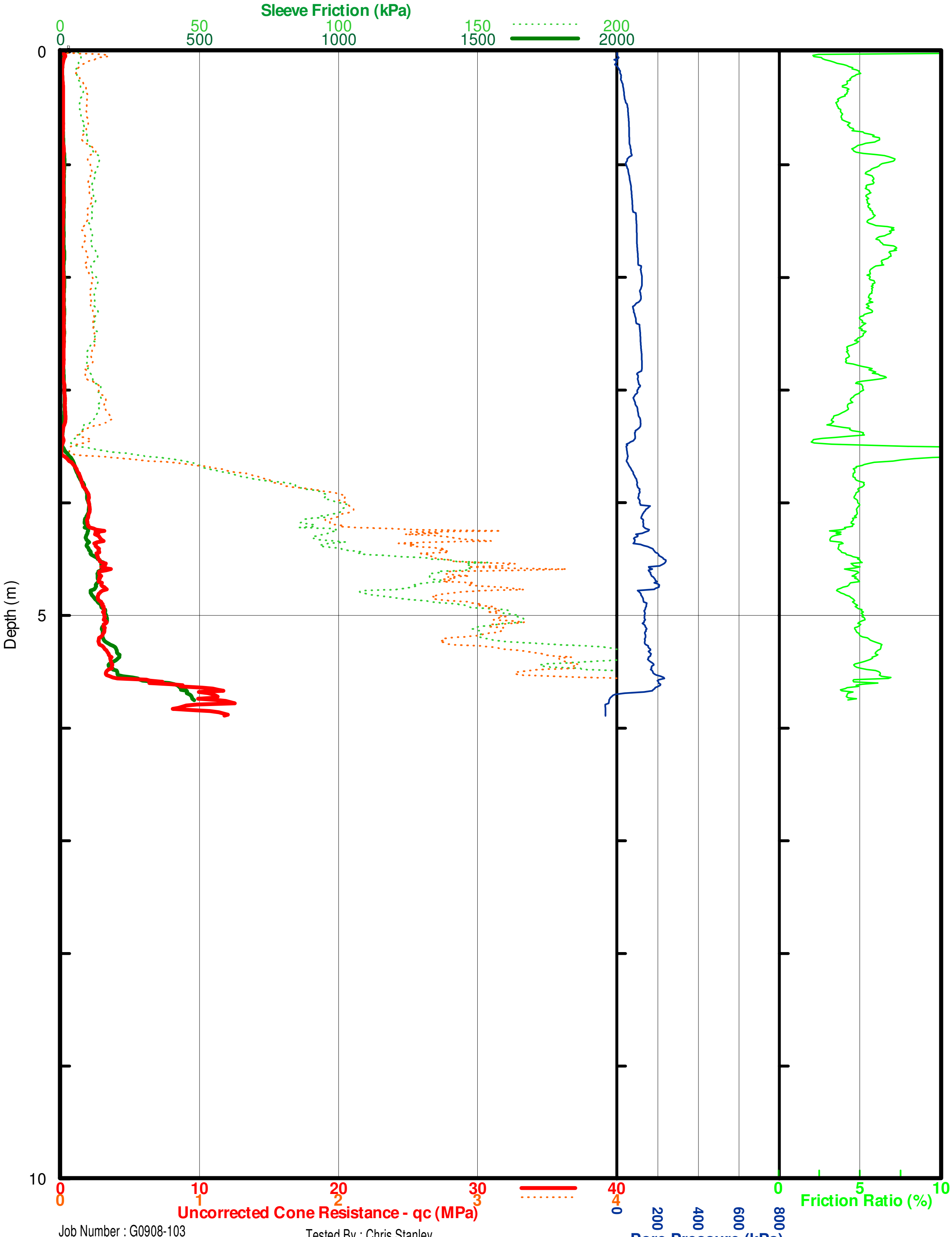
Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu Geotech Services Pty Ltd IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT04A



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Test Date : 14/08/2009
DGPS Position : 56K 0315011, 7371796
DGPS Format : GDA

Cone Number : C10CFIIP.E29
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

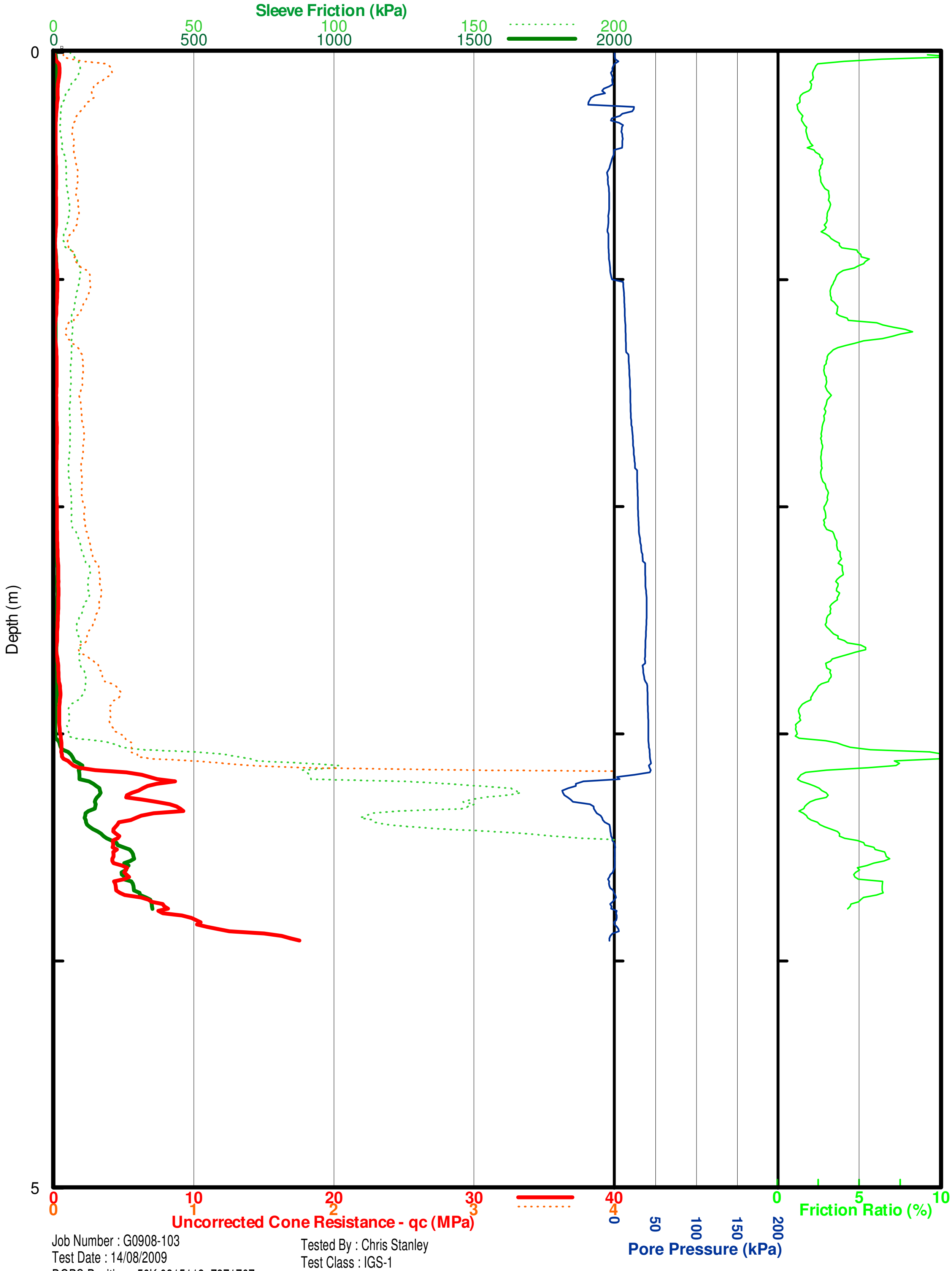
Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu Geotech Services Pty Ltd
IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT04B



Job Number : G0908-103
Test Date : 14/08/2009
DGPS Position : 56K 0315112, 7371767
DGPS Format : GDA

Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

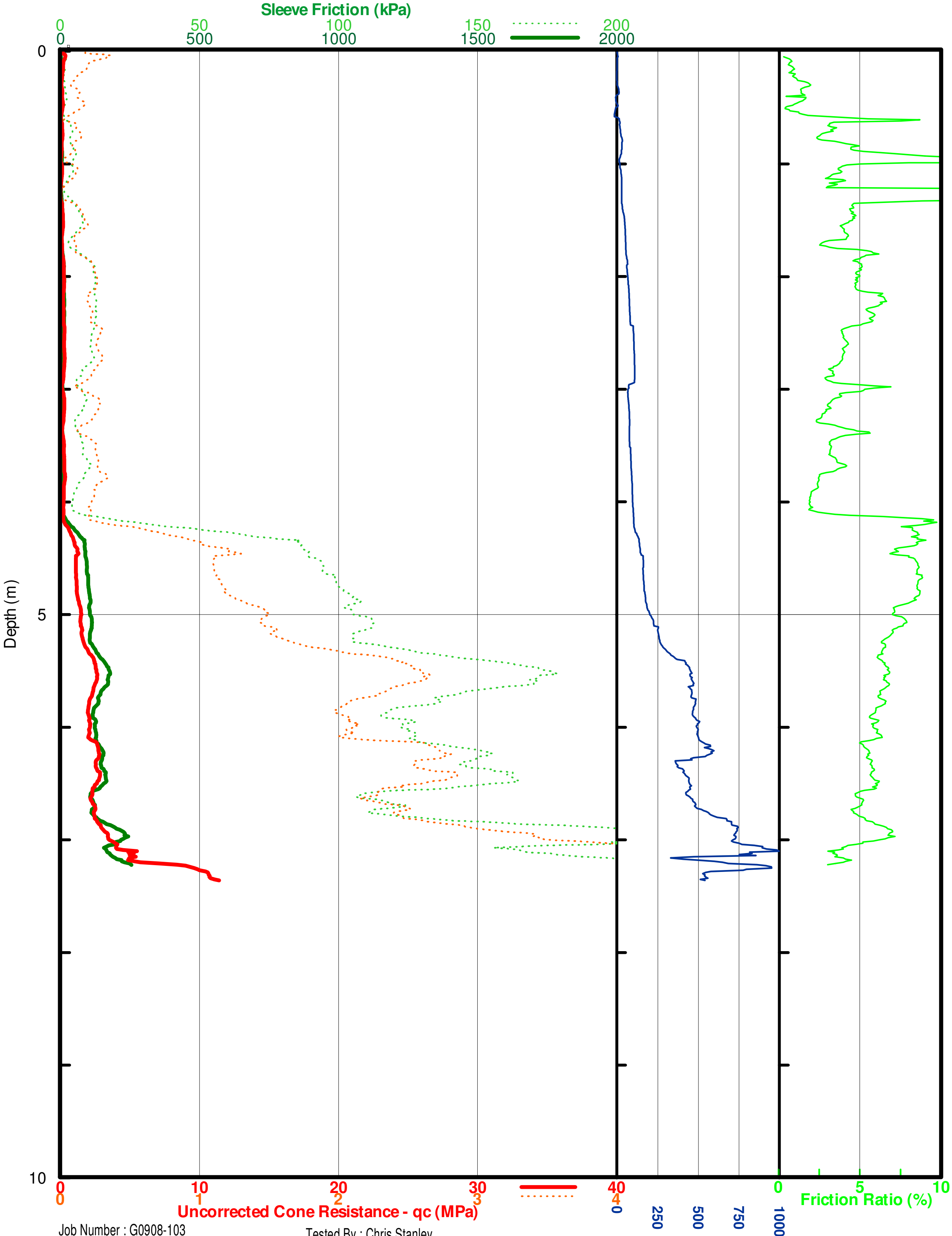
Cone Number : C10CFIIP.E29
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

Insitu Geotech Services Pty Ltd **IGS**

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT05



Job Number : G0908-103
Test Date : 13/08/2009
DGPS Position : 56K 0314932, 7371873
DGPS Format : GDA

Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

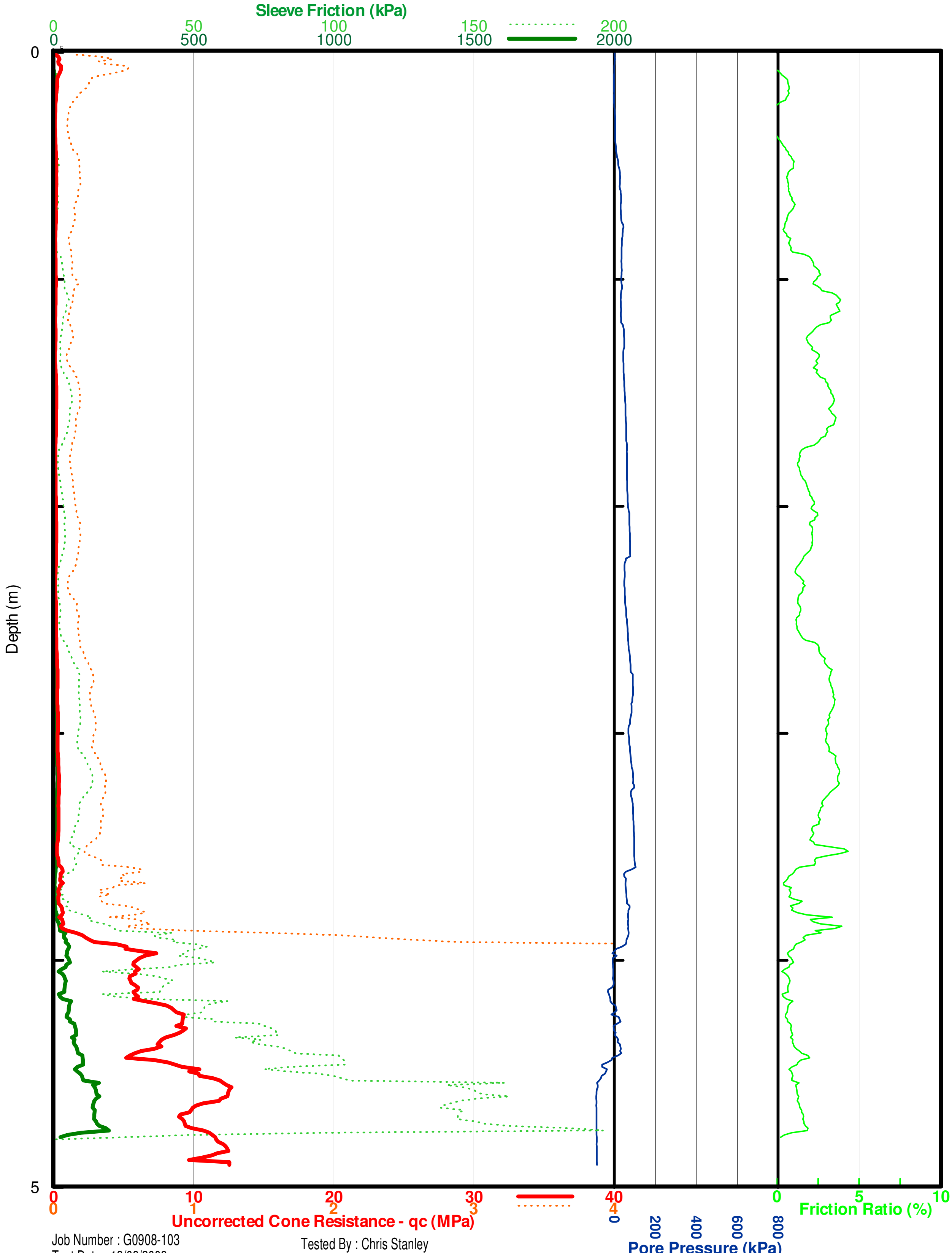
Cone Number : C10CFIIP.G56
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

Insitu Geotech Services Pty Ltd
IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT05A



Job Number : G0908-103
Test Date : 13/08/2009
DGPS Position : 56K 0314786, 7371863
DGPS Format : GDA

Cone Number : C10CFIIP.G56
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

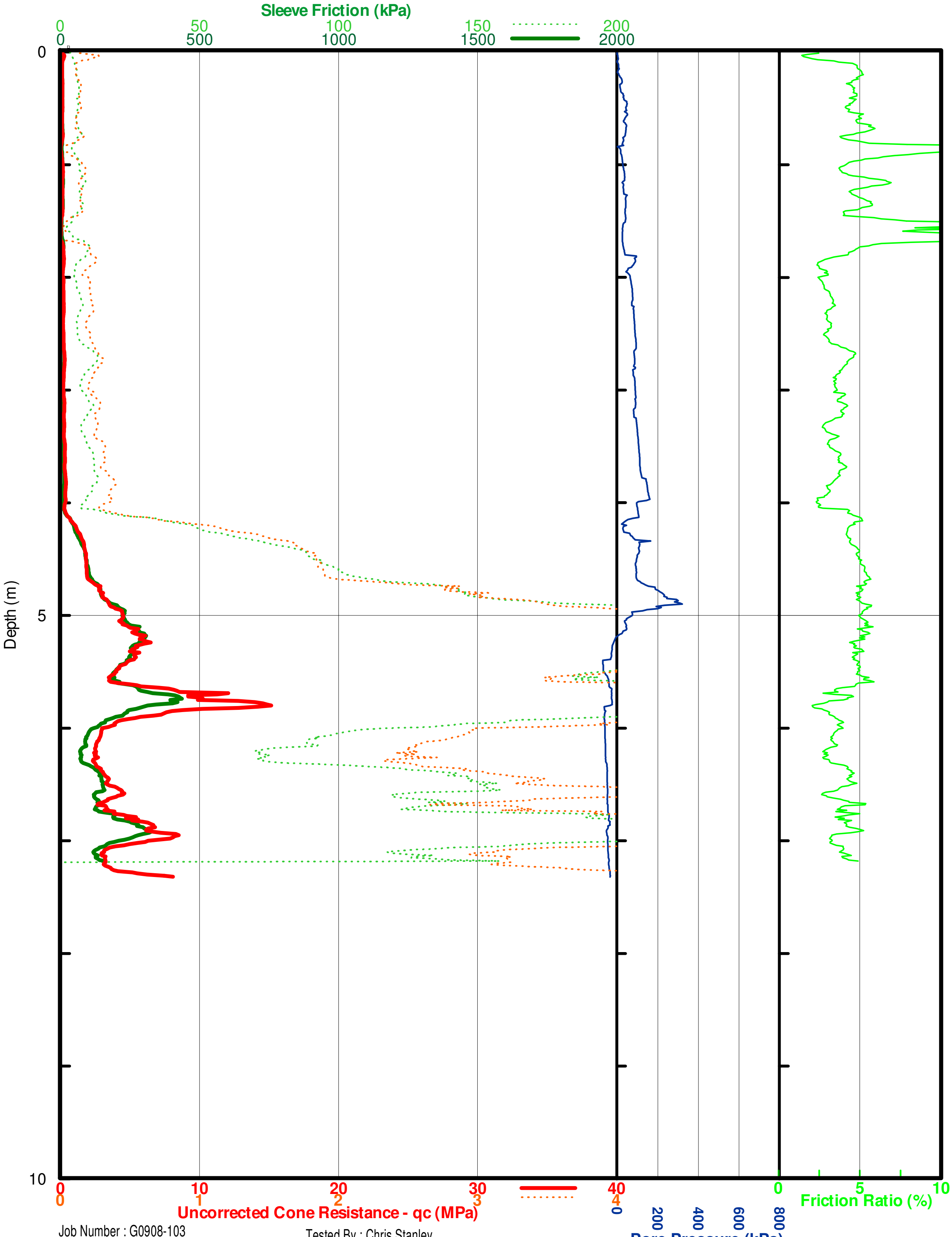
Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu Geotech Services Pty Ltd **IGS**

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT06



Job Number : G0908-103
Test Date : 13/08/2009
DGPS Position : 56K 0314998, 7371880
DGPS Format : GDA

Cone Number : C10CFIIP.E29
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

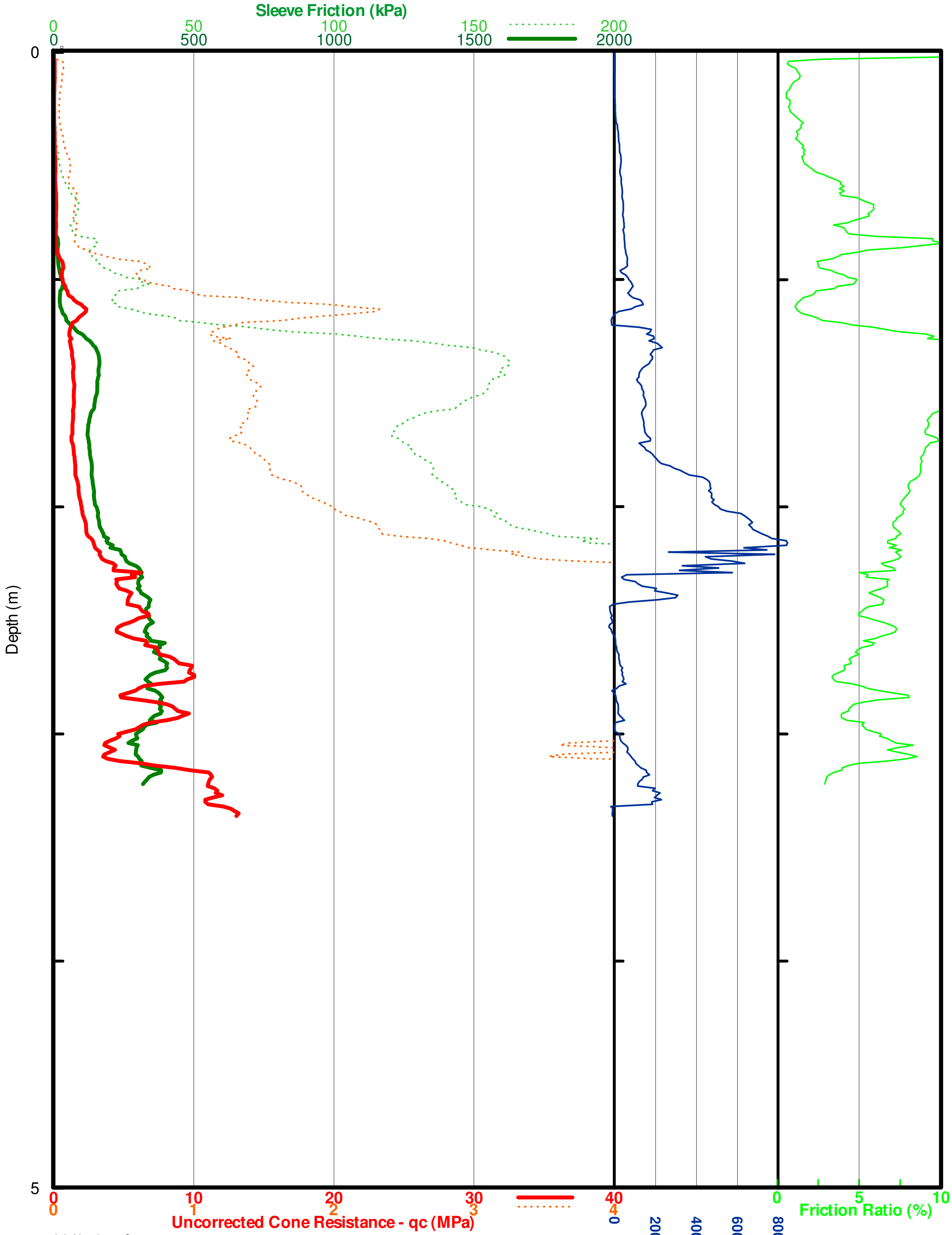
Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu Geotech Services Pty Ltd
IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT11



Job Number : G0908-103
Test Date : 12/08/2009
DGPS Position : 56K 0315358, 7371818
DGPS Format : GDA

Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

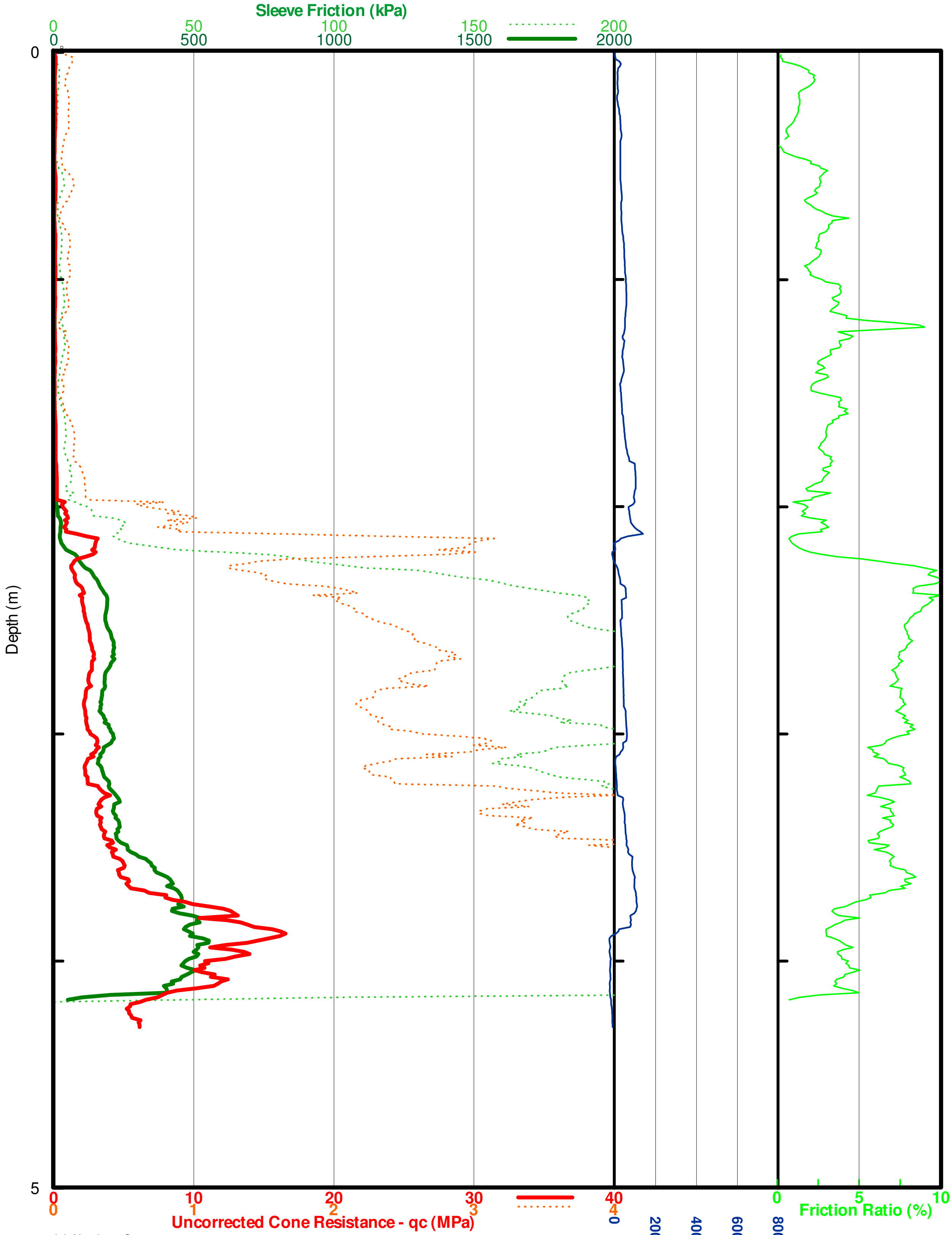
Cone Number : C10CFIIP.G56
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

Insitu Geotech Services Pty Ltd IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT12



Job Number : G0908-103
Test Date : 12/08/2009
DGPS Position : 56K 0315147, 7371898
DGPS Format : GDA

Cone Number : C10CFIIP.G56
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

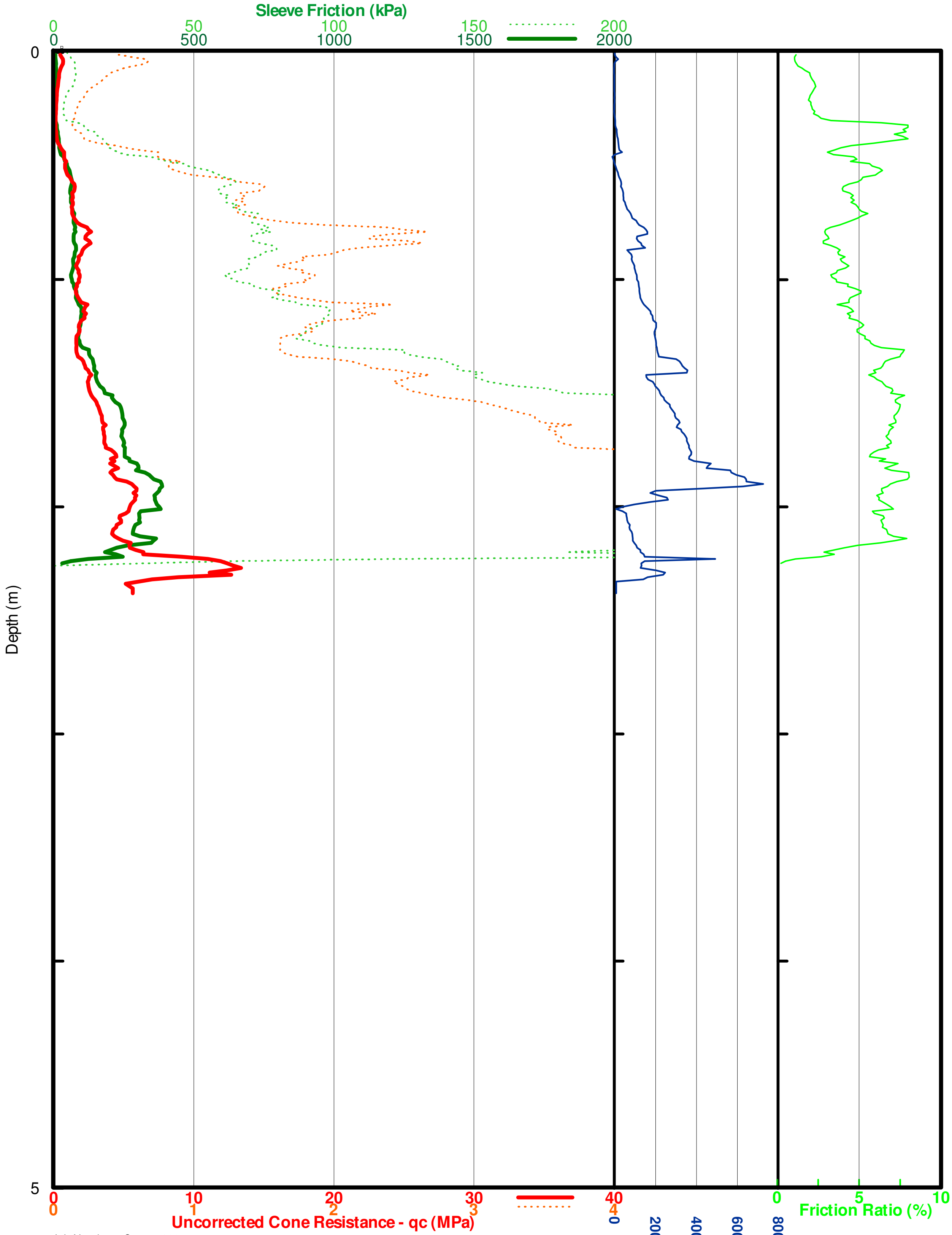
Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu Geotech Services Pty Ltd IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND, QLD

CPT13



Job Number : G0908-103
Test Date : 11/08/2009
DGPS Position : 56K 0315382, 7371816
DGPS Format : GDA

Cone Number : C10CFIIP.G56
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

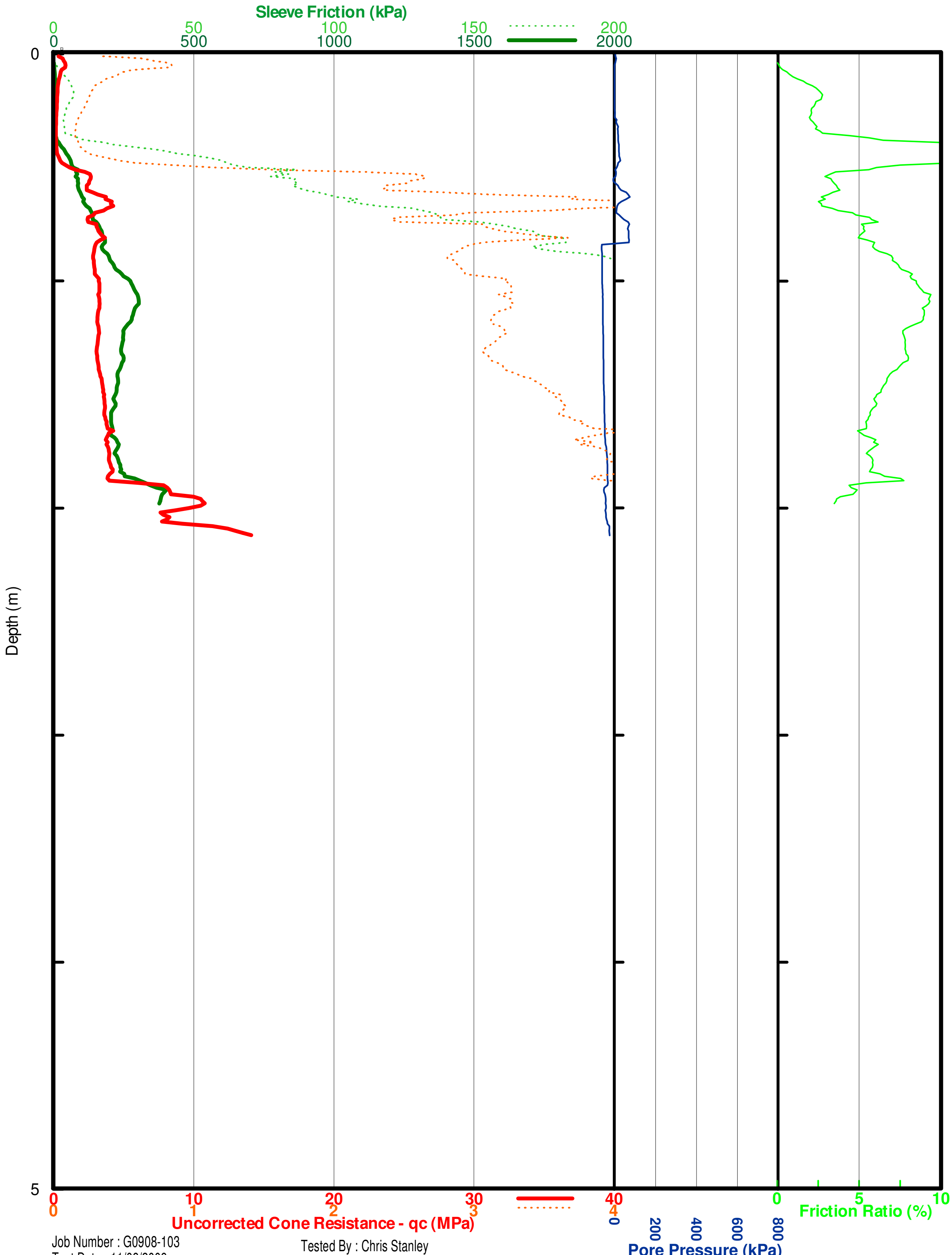
Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu Geotech Services Pty Ltd **IGS**

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT13A



Job Number : G0908-103
Test Date : 11/08/2009
DGPS Position : 56K 0315382, 7371816
DGPS Format : GDA

Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

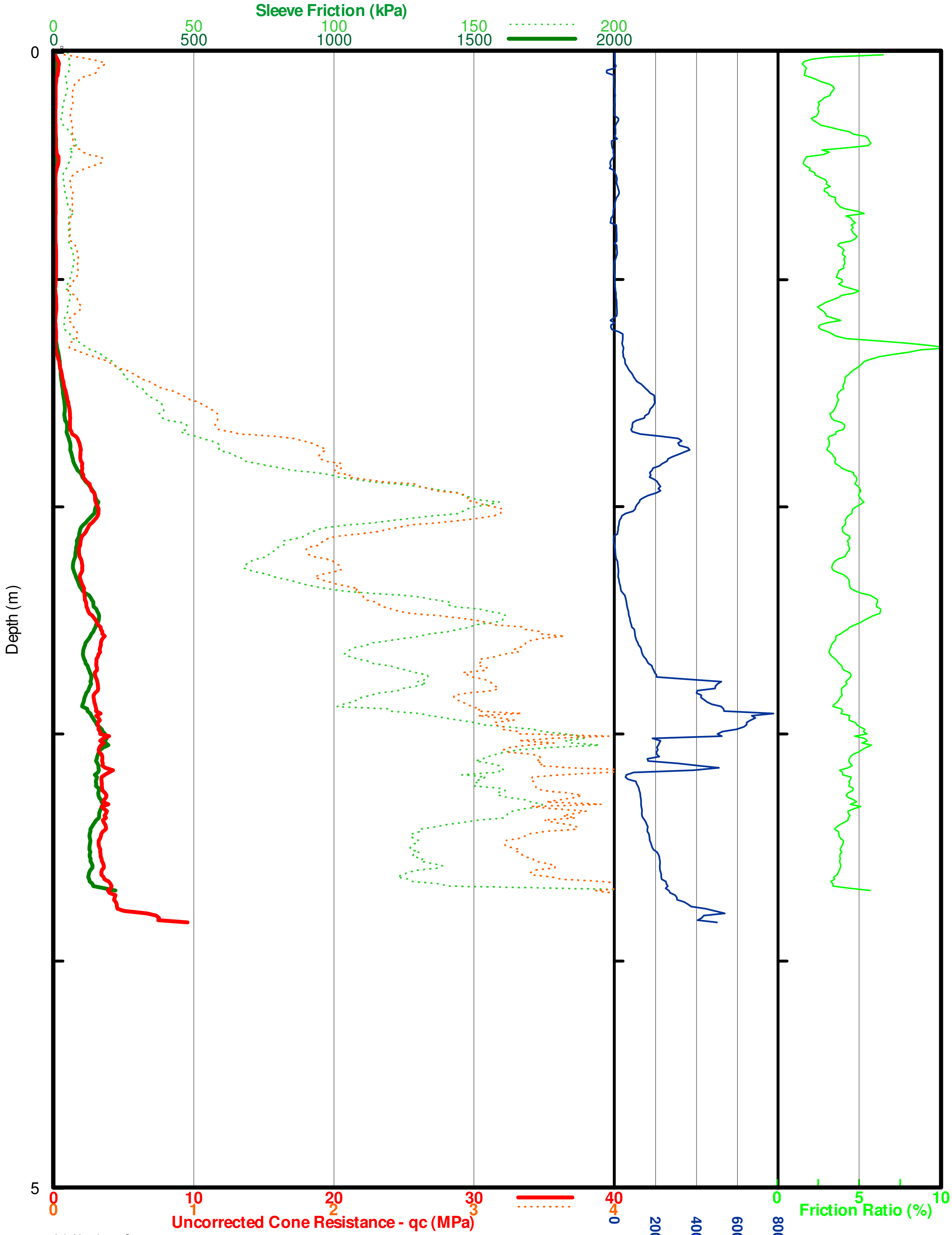
Cone Number : C10CFIIP.G56
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

Insitu Geotech Services Pty Ltd IGS

CONE PENETROMETER TEST RESULT

URS
GLNG
CURTIS ISLAND

CPT14



Job Number : G0908-103
Test Date : 15/08/2009
DGPS Position : 56K 0315247, 7371747
DGPS Format : GDA

Cone Number : C10CFIIP.E29
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

Tested By : Chris Stanley
Test Class : IGS-1
Checked By : Chris Stanley

Insitu Geotech Services Pty Ltd IGS

Appendix C Laboratory Results

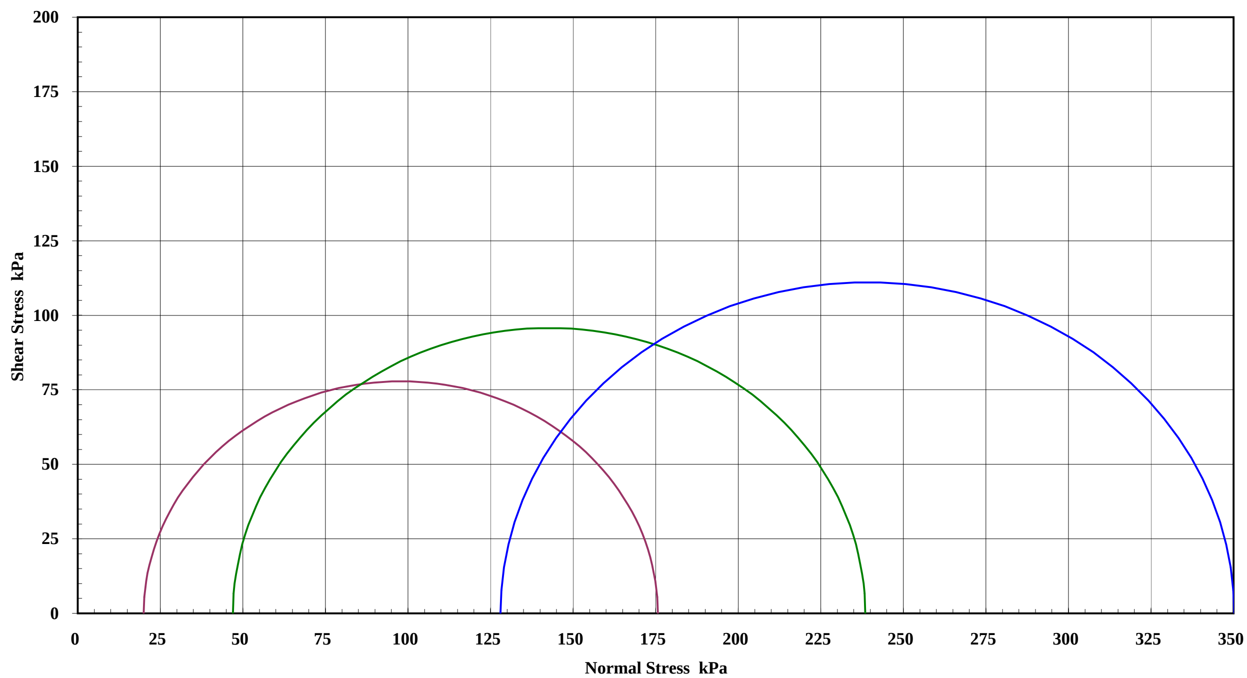
A.G. LABS
Australian Geomechanical Laboratories P/L
ABN: 25 065 630 506
Soil & Rock Testing
Postal: PO Box 3317 Newmarket Qld 4051
Address: 10/104 Newmarket Rd Windsor Qld 4030
(Phone) 07 3357 5535
(Fax) 07 3357 5531
windsor@aglabs.com.au

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080674-cu
Project:	GLNG EIS	**Test Date:**	3/09/2009
		Report Date:	8/09/2009
Client Id.:	GW/BH2A_2	**Depth (m):**	1.50
Description:	CLAY- brown		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	42.3	73.9	60.7
Angle of Shear Resistance Φ' (Degrees) :	23.5	9.2	12.9

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS / FAILURE DETAILS

Sample Details			Moisture Contents	Principal Effective Stresses σ'$_1$	σ'$_3$	Deviator Stress	Strain
Initial Height :	152.5	mm	Initial Moisture				
Initial Diameter :	72.1	mm	19.9 %	176 kPa	20 kPa	156 kPa	1.46 %
Wet Density :	2.05	t/m^3	Final Moisture	238 kPa	47 kPa	191 kPa	3.04 %
Dry Density :	1.71	t/m^3		350 kPa	128 kPa	222 kPa	5.65 %
Rate of Strain:	0.007	%/min	23.5 %				
B Response:	98	%					

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

NATA ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number 9926

This Document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards.

Authorised Signatory
J. Russell

A.G. LABS

Australian Geomechanical Laboratories P/L
ABN: 25 065 630 506

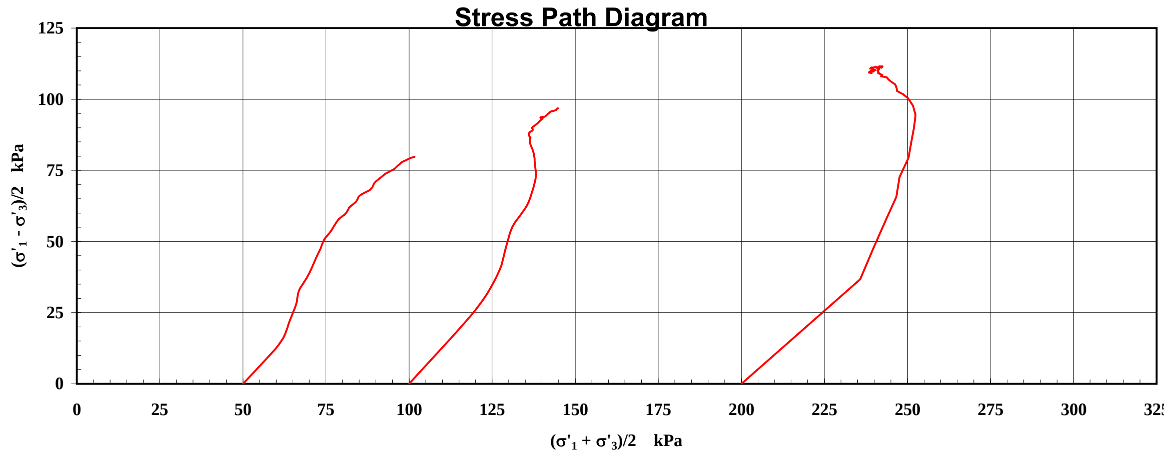
Soil & Rock Testing

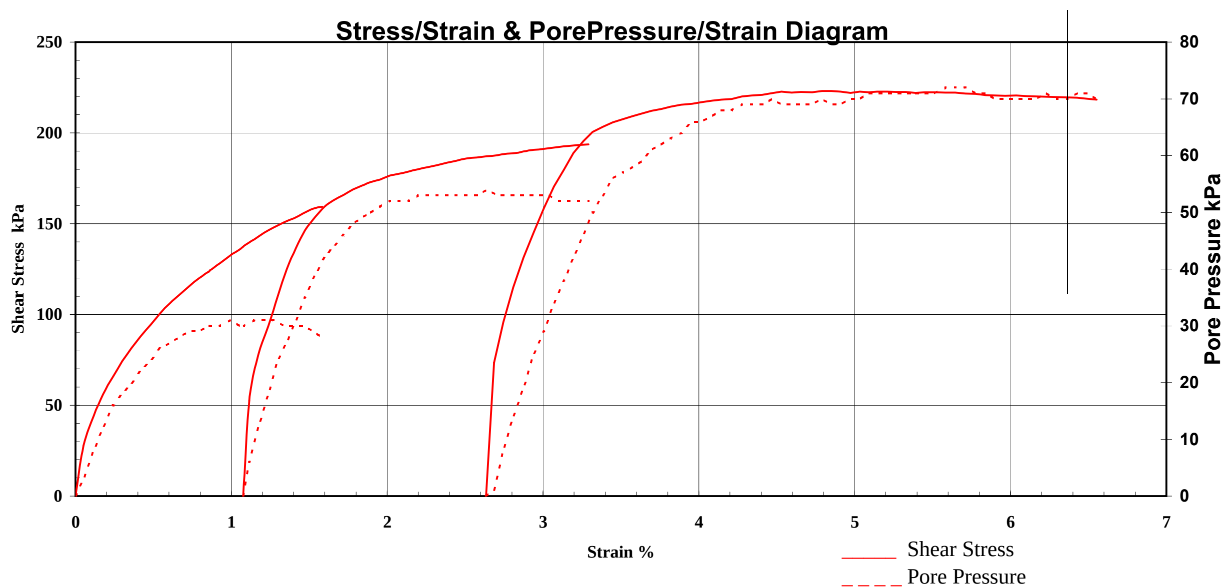
Postal: PO Box 3317 Newmarket Qld 4051
Address: 10/104 Newmarket Rd Windsor Qld 4030
(Phone) 07 3357 5535
(Fax) 07 3357 5531
windsor@aglabs.com.au

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080674-cu
Project:	GLNG EIS	**Test Date:**	3/09/2009
		Report Date:	8/09/2009
Client Id.:	GW/BH2A_2	**Depth (m):**	1.50
Description:	CLAY- brown		





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

This Document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards.

Authorised Signatory

J. Russell

NATA Accredited Laboratory Number 9926

A.G. LABS

Australian Geomechanical Laboratories P/L
ABN: 25 065 630 506

Soil & Rock Testing

Postal: PO Box 3317 Newmarket Qld 4051
Address: 10/104 Newmarket Rd Windsor Qld 4030
(Phone) 07 3357 5535
(Fax) 07 3357 5531
windsor@aglabs.com.au

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080674-cu
Project:	GLNG EIS	**Test Date:**	3/09/2009
		Report Date:	8/09/2009
Client Id.:	GW/BH2A_2	**Depth (m):**	1.50
Description:	CLAY- brown		

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number 9926

This Document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards.

Authorised Signatory

J. Russell

A.G. LABS

Australian Geomechanical Laboratories P/L
ABN: 25 065 630 506

Soil & Rock Testing

Postal: PO Box 3317 Newmarket Qld 4051
Address: 10/104 Newmarket Rd Windsor Qld 4030
(Phone) 07 3357 5535
(Fax) 07 3357 5531
windsor@aglabs.com.au

OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: URS Pty Ltd

Report No.: 9080674-OED

Project: GLNG EIS

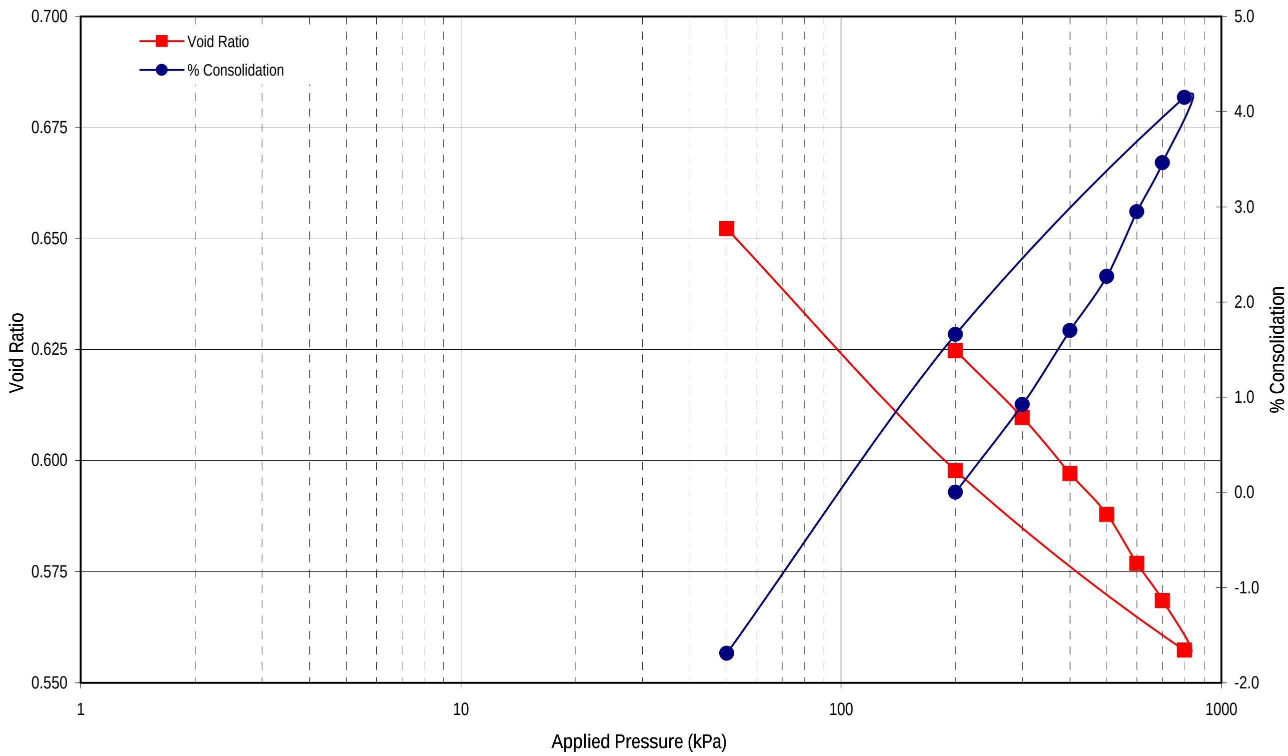
Test Date: 9/01/2009

Report Date: 22/09/2009

Client Id.: GW/BH2A_2

Depth (m): 1.5

Description: CLAY-brown



Load (kPa)	200-300	300-400	400-500	500-600	600-700	700-800	800-200	200-50				
Cc	0.085	0.101	0.095	0.139	0.125	0.192	0.067	0.090				
Cv (m^2/yr) t_{50}	0.36	0.34	0.16	0.11	0.15	0.23	0.16	0.05				
t_{90}	0.33	0.44	0.31	0.20	0.17	0.16	0.21	0.08				
Mv ($kPa^{-1}x10^{-3}$)	0.092	0.078	0.058	0.069	0.053	0.071	0.043	0.227				
C_a x 10^{-3}	0.6	1.6	0.5	0.5	2.3	2.7	2.5	7.0				
% Consolidation	0.9	1.7	2.3	2.9	3.5	4.1	1.7	-1.7				

Wet Density (t/m^3):	1.96	Initial Moisture (%):	23.9	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.54	Initial Voids Ratio:	0.608	Initial Degree of Saturation (%):	100.1
Undisturbed sample supplied by the client		Remarks:	Tested as received		Page 1 of 1

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Authorised Signatory

J. Russell

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ATTERBERG LIMITS TEST REPORT

TEST METHOD: AS1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client:	URS Pty Ltd	Report No.	9080676-al
Project:	GLNG EIS	Test Date:	03/09/09
		Report Date:	21/09/09

Client ID: GW/BH2B_1	Depth(m): 1.0	Sample No. 9080676	
Liquid Limit (%):	71	Linear Shrinkage (%):	17.0+
Plastic Limit (%):	22	Field Moisture Content (%):	20.7
Plasticity Index (%):	49		

Client ID: GW/BH2B_4	Depth(m): 5.5	Sample No. 9080677	
Liquid Limit (%):	53	Linear Shrinkage (%):	13.5
Plastic Limit (%):	25	Field Moisture Content (%):	21.2
Plasticity Index (%):	28		

Client ID: GW/BH3B_2	Depth(m): 2.5	Sample No. 9080679	
Liquid Limit (%):	42	Linear Shrinkage (%):	Insufficient Sample
Plastic Limit (%):	22	Field Moisture Content (%):	10.3
Plasticity Index (%):	20		

Client ID: BH4_2	Depth(m):2.5	Sample No.9080681	
Liquid Limit (%):	29	Linear Shrinkage (%):	4.5*
Plastic Limit (%):	16	Field Moisture Content (%):	13.9
Plasticity Index (%):	13		

Remarks: The sample/s were tested oven dried, dry sieved and in a 125 – 250mm mould.
*Crumbling occurred.
+Curling occurred

Sample/s supplied by the client

Authorised Signatory

J. Russell

Manager

Form Number:GT004-5

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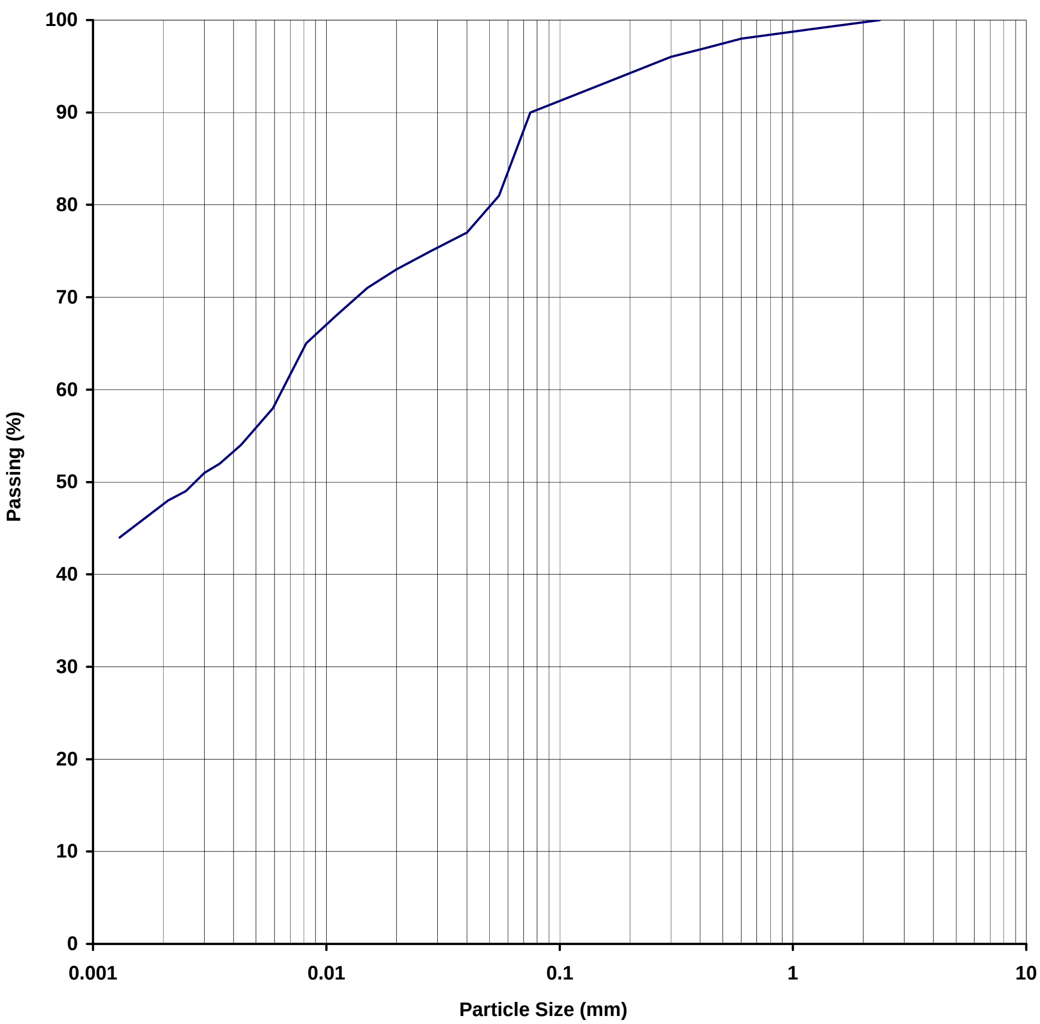
PARTICLE SIZE DISTRIBUTION

Test Method: AS 1289 3.6.3, 3.5.1

Client:	URS Pty Ltd	**Report No.:**	9080676-g
Project:	GLNG EIS	**Test Date:**	26,31/08/09
		Report Date:	22/09/2009
Client Id.:	GW/BH2B_1	**Depth (m):**	1

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	
19.0	
9.5	
4.75	
2.36	100
1.18	99
0.600	98
0.425	97
0.300	96
0.150	93
0.075	90
0.055	81
0.04	77
0.028	75
0.02	73
0.015	71
0.011	68
0.0082	65
0.0059	58
0.0043	54
0.0035	52
0.003	51
0.0025	49
0.0021	48
0.0013	44



Remarks:

Sample Moisture (%): 20.7

Soil Particle Density(t/m^3): 2.68

Sample/s supplied by the client

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PARTICLE SIZE DISTRIBUTION

Test Method: AS 1289 3.6.3, 3.5.1

Client: URS Pty Ltd

Report No.: 9080677-g

Project: GLNG EIS

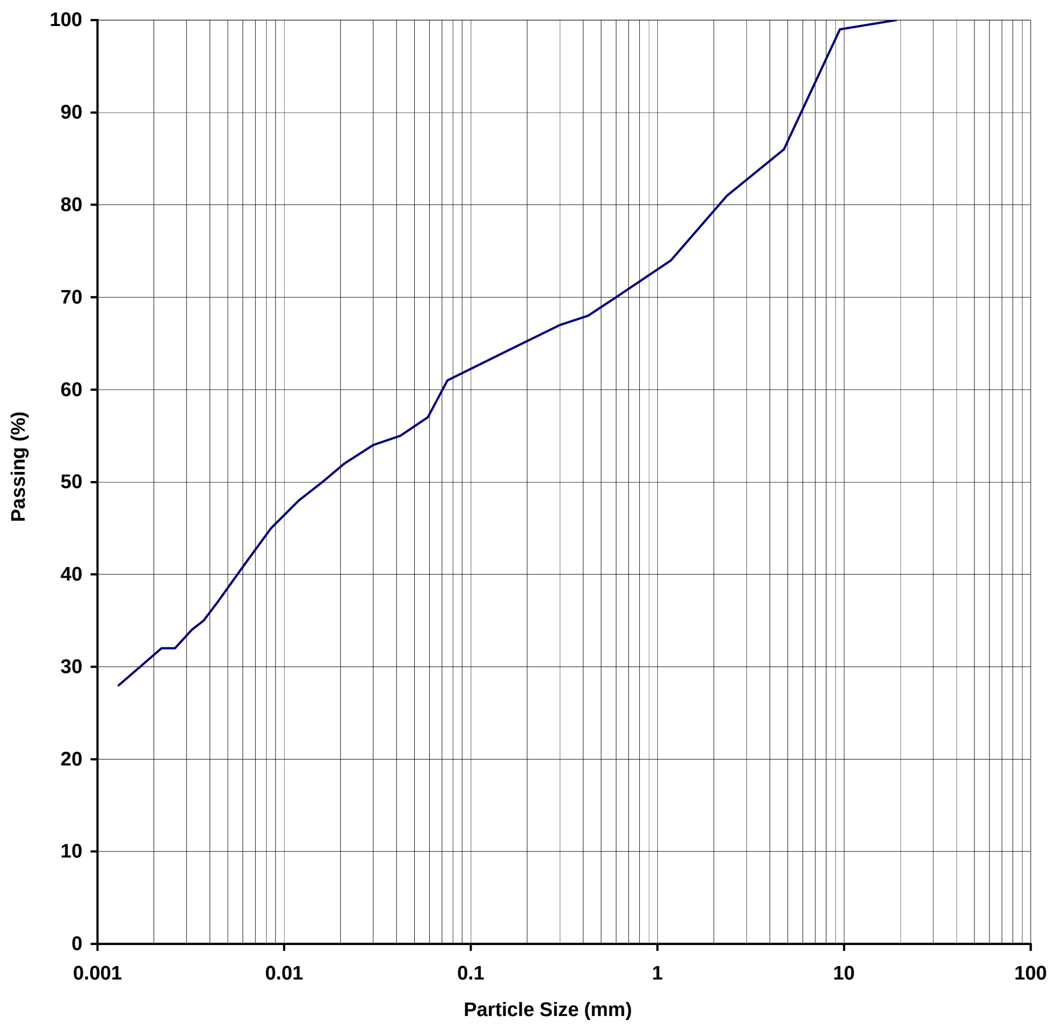
Test Date: 26/08,01/09/09

Report Date: 22/09/2009

Client Id.: GW/BH2B_4

Depth (m): 5.5

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	
19.0	100
9.5	99
4.75	86
2.36	81
1.18	74
0.600	70
0.425	68
0.300	67
0.150	64
0.075	61
0.059	57
0.042	55
0.03	54
0.021	52
0.016	50
0.012	48
0.0085	45
0.0061	41
0.0044	37
0.0037	35
0.0032	34
0.0026	32
0.0022	32
0.0013	28



Remarks:

Sample Moisture (%): 21.2

Soil Particle Density(t/m^3): 2.65

Sample/s supplied by the client

Authorised Signatory

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client:	URS Pty Ltd	Report No.	9080678-g
Project:	GLNG EIS	Test Date:	31/08,07/09/09
		Report Date:	22/09/2009

Sample No.	9080678	9080682	9080707
Client ID:	GW/BH3B_1	BH4_3	CPT5a_3
Depth (m):	1	4	3.5
Moisture (%)	14.6	10.8	35.5

AS SIEVE SIZE (mm)	**PERCENT PASSING**		
150			
75			
63			
53			
37.5			
26.5			
19	100	100	
9.5	84	85	
4.75	75	60	
2.36	69	44	100
1.18	66	35	99
0.6	63	28	99
0.425	61	25	98
0.3	60	22	98
0.15	57	16	98
0.075	55	13	97

Sample/s supplied by the client

Authorised Signatory

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MOISTURE CONTENT TEST REPORT

Test method: AS 1289 2.1.1

Client:	URS Pty Ltd	Report No.	9080680-mc
Project:	GLNG EIS	Test Date:	25/08/09
		Report Date:	21/09/09

Sample No.	9080680	9080684	9080686	9080688
Client ID:	BH4_1	TP4_1	TP6_1	TP6a_2
Depth (m):	1.0	0.3	0.5	2.0
Moisture Content (%)	8.4	4.2	12.6	12.6

Sample No.	9080693	9080694	9080698
Client ID:	TP10_2	TP11_2	New TP2_3
Depth (m):	2.5	1.0	3.5
Moisture Content (%)	10.2	5.4	15.7

Sample/s supplied by the client

Page: 1 of 1

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Form Number: GT003-5

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ATTERBERG LIMITS TEST REPORT

TEST METHOD: AS1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client:	URS Pty Ltd	Report No.	9080683-al
Project:	GLNG EIS	Test Date:	27/08/09
		Report Date:	21/09/09

Client ID: TP3_3	Depth(m): 3.0	Sample No. 9080683	
Liquid Limit (%):	58	Linear Shrinkage (%):	16.5+
Plastic Limit (%):	21	Field Moisture Content (%):	15.6
Plasticity Index (%):	37		

Client ID: TP4_3	Depth(m): 4.0	Sample No. 9080685	
Liquid Limit (%):	38	Linear Shrinkage (%):	8.0
Plastic Limit (%):	20	Field Moisture Content (%):	8.3
Plasticity Index (%):	18		

Client ID: TP6a_1	Depth(m): 0.5	Sample No. 9080687	
Liquid Limit (%):	54	Linear Shrinkage (%):	14.5+
Plastic Limit (%):	22	Field Moisture Content (%):	41.6
Plasticity Index (%):	32		

Client ID: TP8_1	Depth(m):0.5	Sample No.9080689	
Liquid Limit (%):	82	Linear Shrinkage (%):	20.0+
Plastic Limit (%):	22	Field Moisture Content (%):	-
Plasticity Index (%):	60		

Remarks: The sample/s were tested oven dried, dry sieved and in a 125 – 250mm mould.
*Crumbling occurred.
+Curling occurred

Sample/s supplied by the client

Authorised Signatory

J. Russell

Manager

Form Number:GT004-5

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Soil & Rock Testing

PARTICLE SIZE DISTRIBUTION

Test Method: AS 1289 3.6.3, 3.5.1

Client: URS Pty Ltd

Report No.: 9080683-g

Project: GLNG EIS

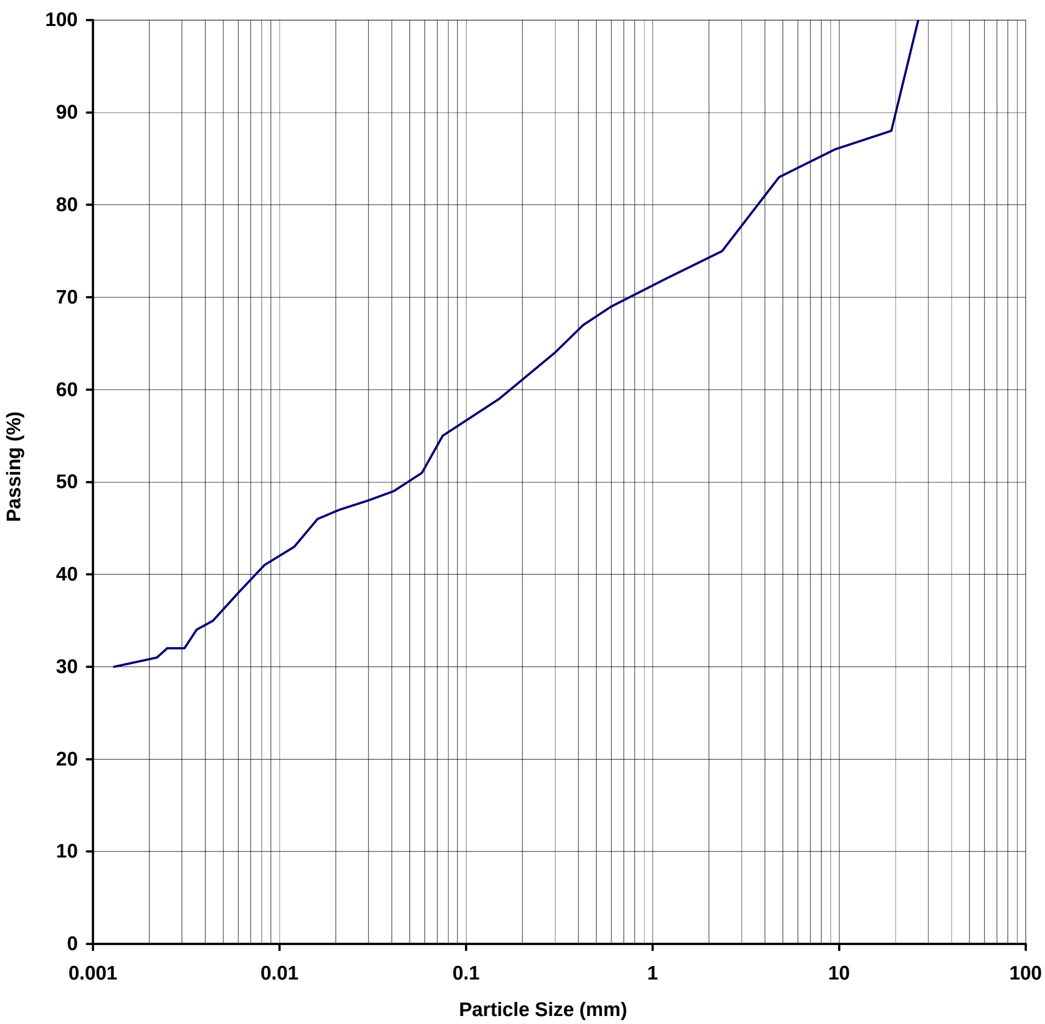
Test Date: 02,07/09/09

Report Date: 22/09/2009

Client Id.: TP3_3

Depth (m): 3

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	100
19.0	88
9.5	86
4.75	83
2.36	75
1.18	72
0.600	69
0.425	67
0.300	64
0.150	59
0.075	55
0.058	51
0.041	49
0.03	48
0.021	47
0.016	46
0.012	43
0.0083	41
0.006	38
0.0044	35
0.0036	34
0.0031	32
0.0025	32
0.0022	31
0.0013	30



Remarks:

Sample Moisture (%): 15.6

Soil Particle Density(t/m^3): 2.75

Sample/s supplied by the client

Authorised Signatory

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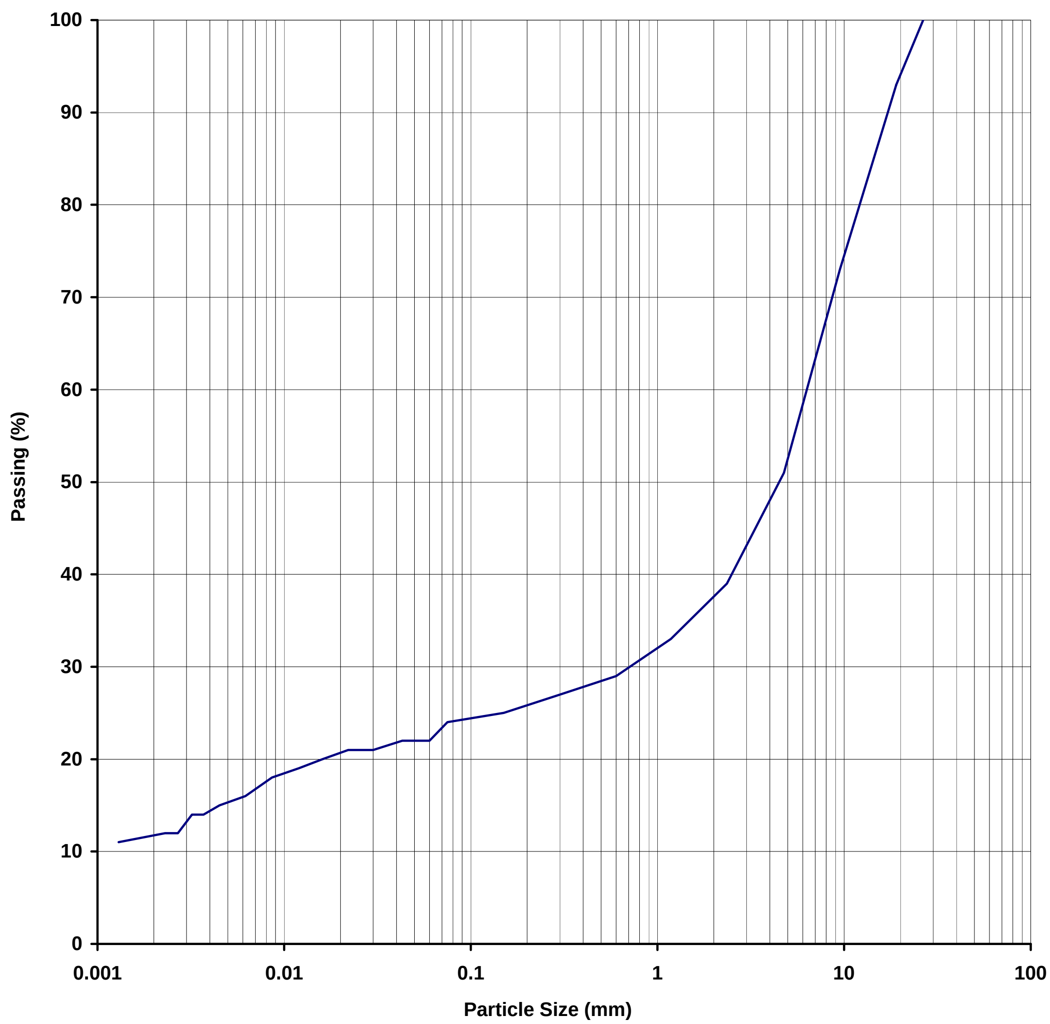
PARTICLE SIZE DISTRIBUTION

Test Method: AS 1289 3.6.3, 3.5.1

Client:	URS Pty Ltd	**Report No.:**	9080685-g
Project:	GLNG EIS	**Test Date:**	02,07/09/09
		Report Date:	22/09/2009
Client Id.:	TP4_3	**Depth (m):**	4

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	100
19.0	93
9.5	73
4.75	51
2.36	39
1.18	33
0.600	29
0.425	28
0.300	27
0.150	25
0.075	24
0.06	22
0.043	22
0.03	21
0.022	21
0.016	20
0.012	19
0.0086	18
0.0062	16
0.0045	15
0.0037	14
0.0032	14
0.0027	12
0.0023	12
0.0013	11



Remarks:

Sample Moisture (%): 8.3

Soil Particle Density(t/m^3): 2.68

Sample/s supplied by the client

Authorised Signatory

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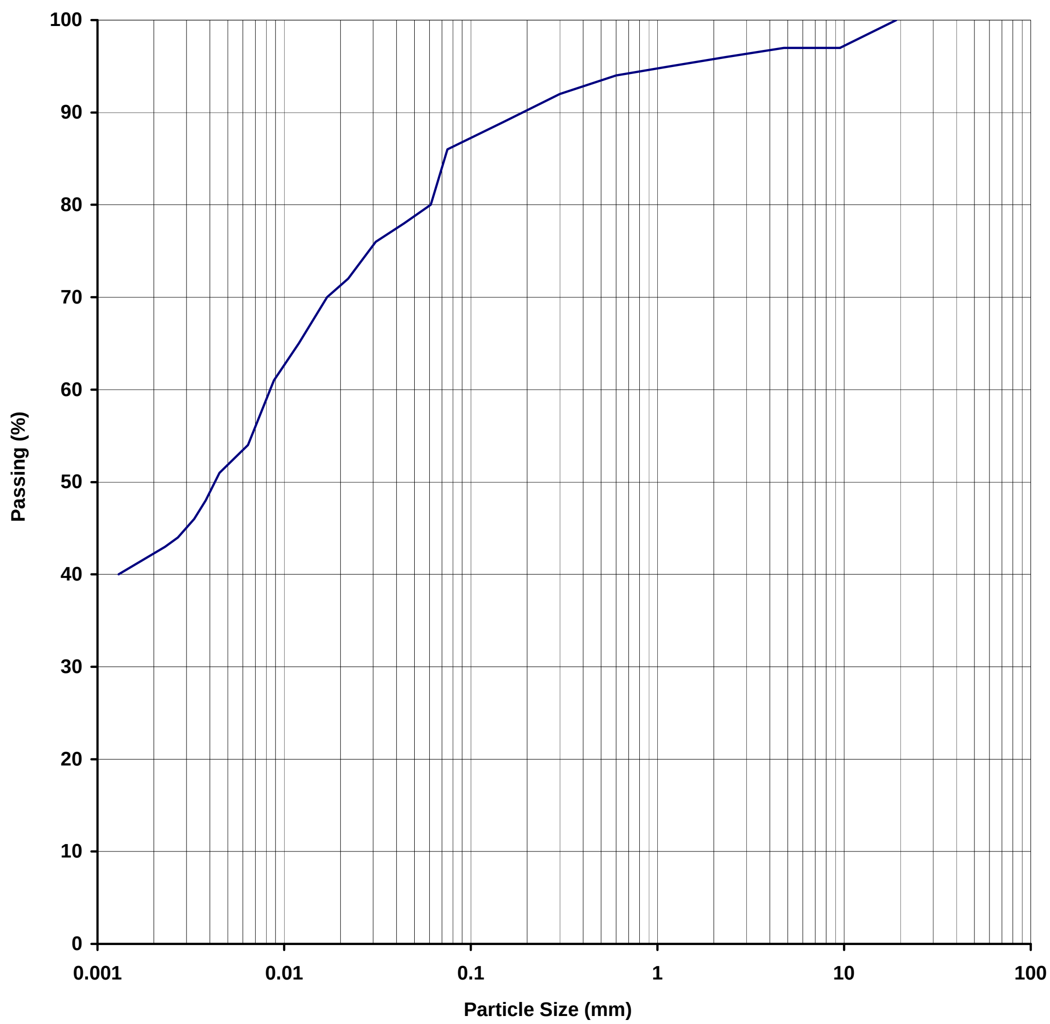
PARTICLE SIZE DISTRIBUTION

Test Method: AS 1289 3.6.3, 3.5.1

Client:	URS Pty Ltd	**Report No.:**	9080687-g
Project:	GLNG EIS	**Test Date:**	26,31/08,01/09/09
		Report Date:	22/09/2009
Client Id.:	TP6a_1	**Depth (m):**	0.5

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	
19.0	100
9.5	97
4.75	97
2.36	96
1.18	95
0.600	94
0.425	93
0.300	92
0.150	89
0.075	86
0.061	80
0.044	78
0.031	76
0.022	72
0.017	70
0.012	65
0.0088	61
0.0064	54
0.0045	51
0.0038	48
0.0033	46
0.0027	44
0.0023	43
0.0013	40



Remarks:

Sample Moisture (%): 41.6

Soil Particle Density(t/m^3): 2.60

Sample/s supplied by the client

Authorised Signatory

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client:	URS Pty Ltd	Report No.	9080690-em
Project:	GLNG EIS	Test Date:	01/09/09
		Report Date:	21/09/09

Sample No.	9080690	9080692	9080696	9080697	9080700
Client ID:	TP8_2	TP9_2	TP Near BH3_3	New TP2_2	CPT2_1
Depth (m):	1.5	2.0	4.0	1.5	1.5
Description:	Clay – brown	Gravelly Clay orange/red	Gravelly Clay brown	Clay red/brown	Clay – grey
Emerson Class No.:	2	5	5	6	6

Sample No.	9080703
Client ID:	CPT4b_1
Depth (m):	1.0
Description:	Clay – grey
Emerson Class No.:	2

Remarks: Tested with distilled water at 24^{o}C

Sample/s supplied by the client

Authorised Signatory

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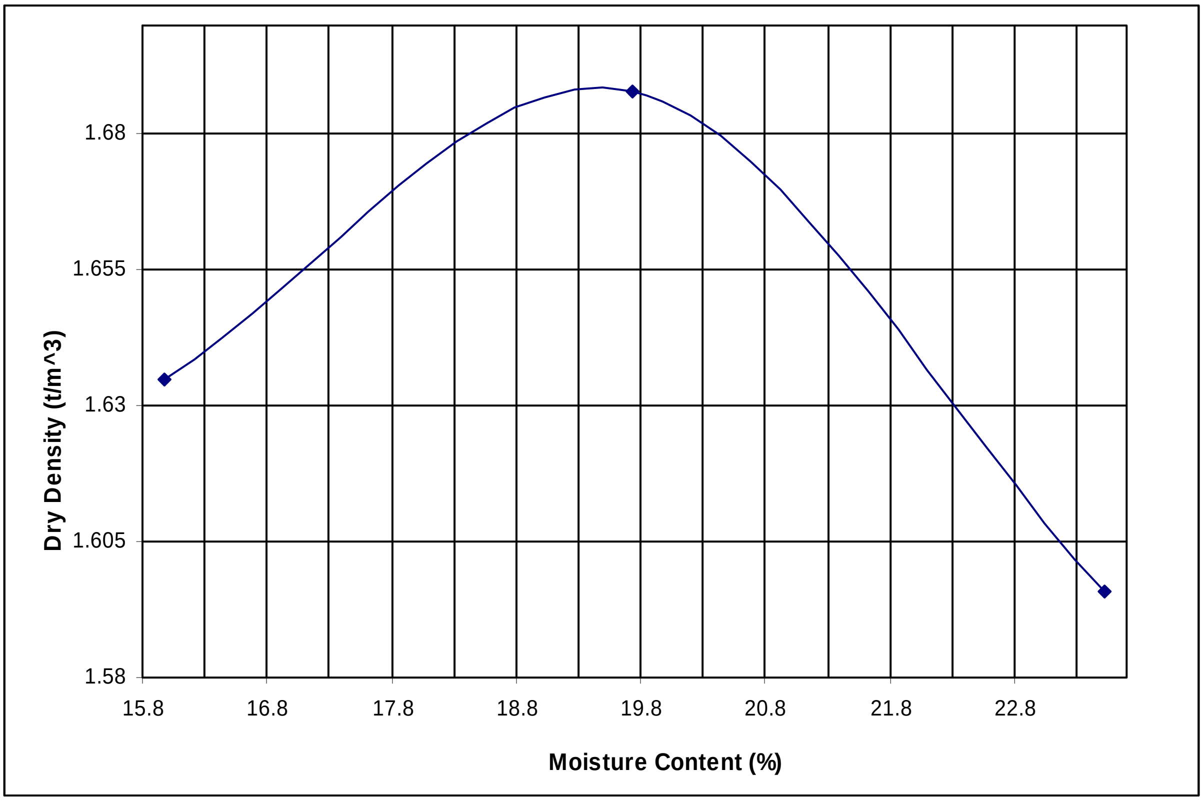
MOISTURE / DENSITY RELATIONSHIP TEST REPORT

Test Method: AS1289 5.1.1

Client: URS Pty Ltd	Report No. 9080690-mdd
Project: GLNG EIS	Test Date: 31/08/09 Report Date: 22/09/09
Client ID: TP8_2	Depth (m): 1.5

Description: Clay - brown



Maximum Dry Density (t/m^3):	**1.69**	**Optimum Moisture Content (%):**	**19.0**
Sample Moisture (%):	**16.4**	**Percentage of Oversize / Sieve Size (mm):**	**0/19**

Remarks: This is a computer generated plot so estimates may show some minor variations from the results summarised.

Sample/s supplied by the client

Authorised Signatory

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Manager

Form Number: GT013-5

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ATTERBERG LIMITS TEST REPORT

TEST METHOD: AS1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client: URS Pty Ltd	Report No. 9080691-al
Project: GLNG EIS	Test Date: 02/09/09 Report Date: 21/09/09

Client ID: TP8_3	Depth(m): 3.5	Sample No. 9080691	
Liquid Limit (%):	41	Linear Shrinkage (%):	7.0
Plastic Limit (%):	25	Field Moisture Content (%):	12.3
Plasticity Index (%):	16		

Client ID: TP near BH3_1	Depth(m): 0.5	Sample No. 9080695	
Liquid Limit (%):	23	Linear Shrinkage (%):	3.5*+
Plastic Limit (%):	15	Field Moisture Content (%):	4.6
Plasticity Index (%):	8		

Client ID: TP near BH3_3	Depth(m): 4.0	Sample No. 9080696	
Liquid Limit (%):	28	Linear Shrinkage (%):	4.5*+
Plastic Limit (%):	15	Field Moisture Content (%):	-
Plasticity Index (%):	13		

Client ID: New TP2_2	Depth(m):1.5	Sample No.9080697	
Liquid Limit (%):	56	Linear Shrinkage (%):	12.0*+
Plastic Limit (%):	22	Field Moisture Content (%):	21.1
Plasticity Index (%):	34		

Remarks: The sample/s were tested oven dried, dry sieved and in a 125 – 250mm mould.
*Crumbling occurred.
+Curling occurred

Sample/s supplied by the client

Authorised Signatory

J. Russell

Manager

N ATA Accredited Laboratory Number 9926
Form Number:GT004-5

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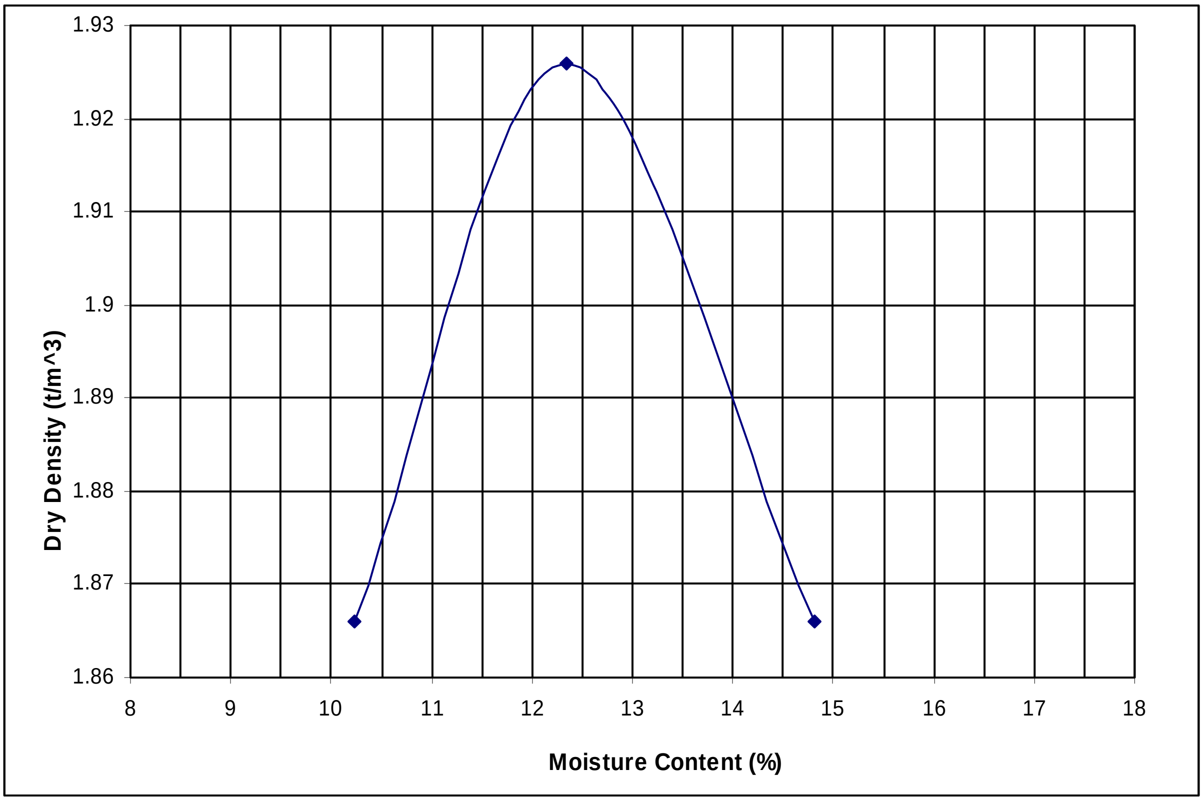
MOISTURE / DENSITY RELATIONSHIP TEST REPORT

Test Method: AS1289 5.1.1

Client:	URS Pty Ltd	Report No.	9080692-mdd
Project:	GLNG EIS	Test Date:	31/08/09
		Report Date:	22/09/09
Client ID: TP9_2		Depth (m): 2.0	
Description: Clay - red			



Maximum Dry Density (t/m^3):	**1.93**	**Optimum Moisture Content (%):**	**12.4**
Sample Moisture (%):	**7.6**	**Percentage of Oversize / Sieve Size (mm):**	**0/19**

Remarks: This is a computer generated plot so estimates may show some minor variations from the results summarised.

Sample/s supplied by the client

Authorised Signatory

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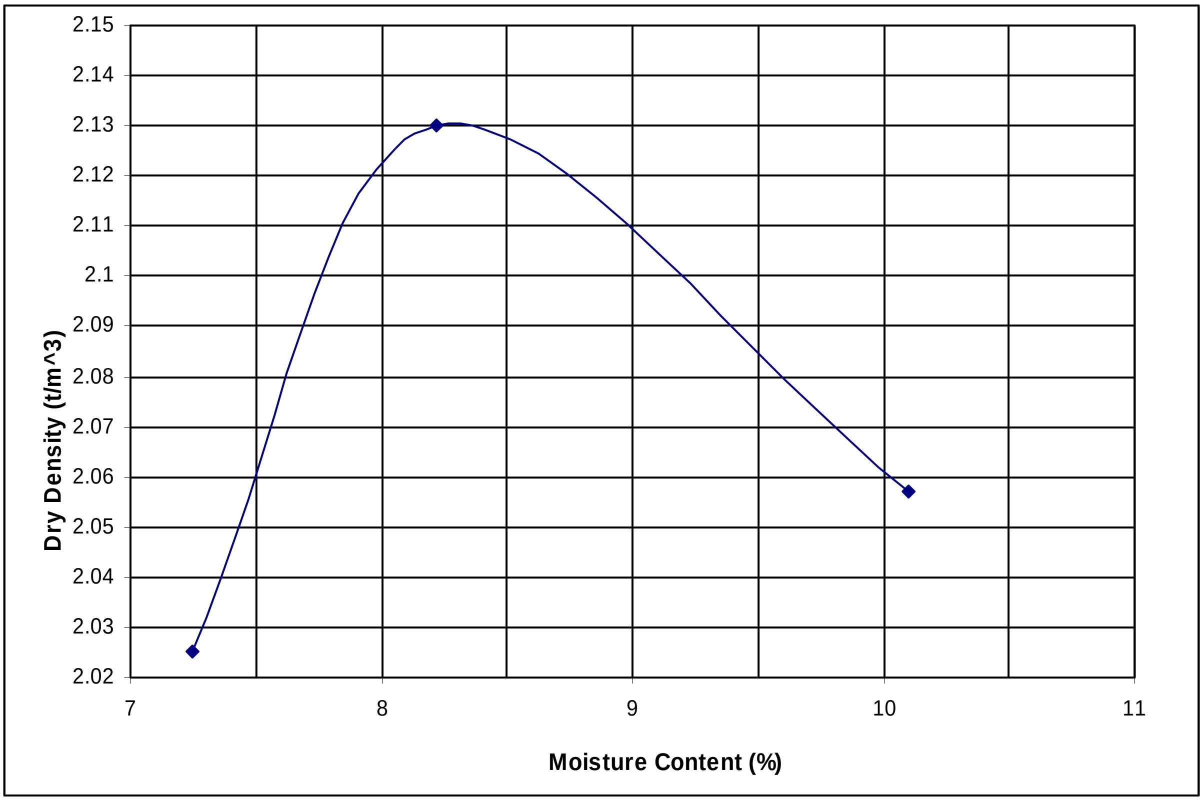
MOISTURE / DENSITY RELATIONSHIP TEST REPORT

Test Method: AS1289 5.1.1

Client: URS Pty Ltd	Report No. 9080696-mdd
Project: GLNG EIS	Test Date: 31/08/09 Report Date: 22/09/09
Client ID: TP Near BH3_3	Depth (m): 4.0
Description: Clay	



Maximum Dry Density (t/m^3):	**2.13**	**Optimum Moisture Content (%):**	**8.4**
Sample Moisture (%):		**Percentage of Oversize / Sieve Size (mm):**	**0/19**

Remarks: This is a computer generated plot so estimates may show some minor variations from the results summarised.

Sample/s supplied by the client

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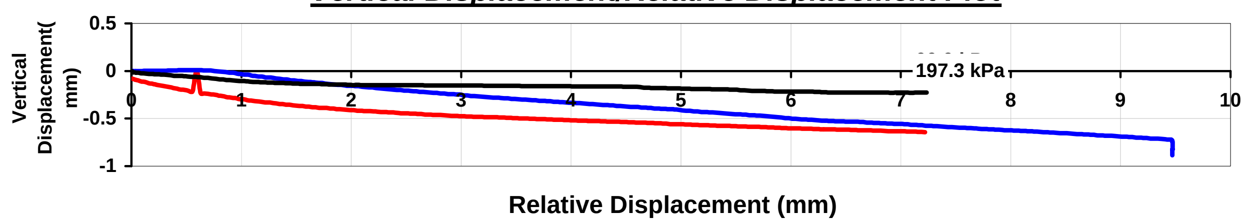
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

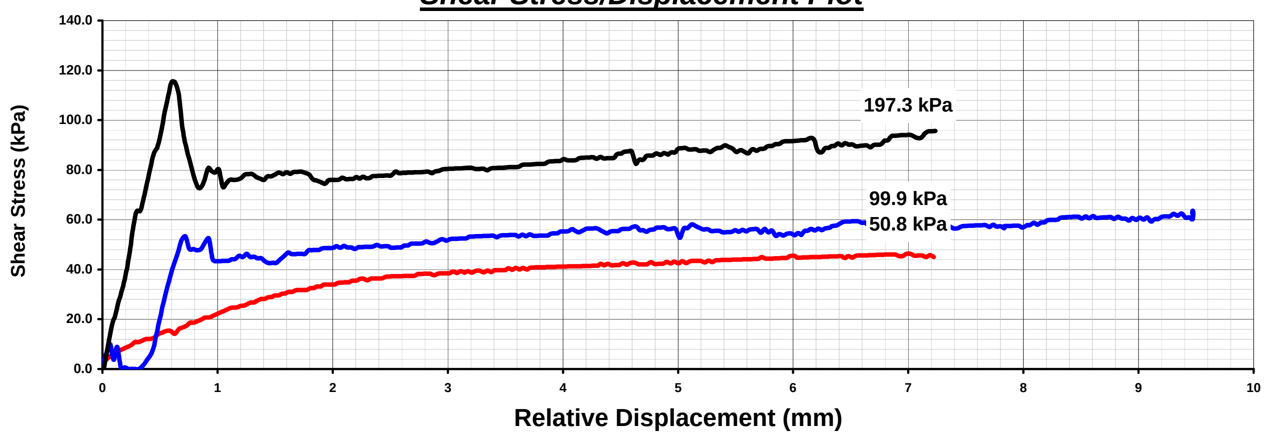
Client:	URS Pty Ltd	**Report No.:**	9080697-DS
Project:	GLNG EIS	**Test Date:**	17/09/2009
		Report Date:	25/09/2009
Client Id.:	TP2_2	**Depth (m):**	1.5
Description:	Clay - red brown	**Sample Type:**	Three Individual Specimens remoulded to a target of 95% of Standard Maximum Dry Density

Failure Criteria: **RESIDUAL @ 7 mm DISPLACEMENT**

Vertical Displacement/Relative Displacement Plot



Shear Stress/Displacement Plot



Specimen Dimensions(mm):	45*19	Normal Stress (kPa)		Shear Stress (kPa)
Rate of Strain(mm/min):	0.008	Stage 1	50.8	46.3
Initial Moisture Content(%):	19.3	Stage 2	99.9	56.5
Initial Wet Density(t/m3):	1.96;1.97;1.96	Stage 3	197.3	94.1

Remarks: Please review the results if the Cohesion is above 2 kPa when plotted with a line of best fit

Sample/s supplied by the client | Note: Graph not to scale |

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J. Russell

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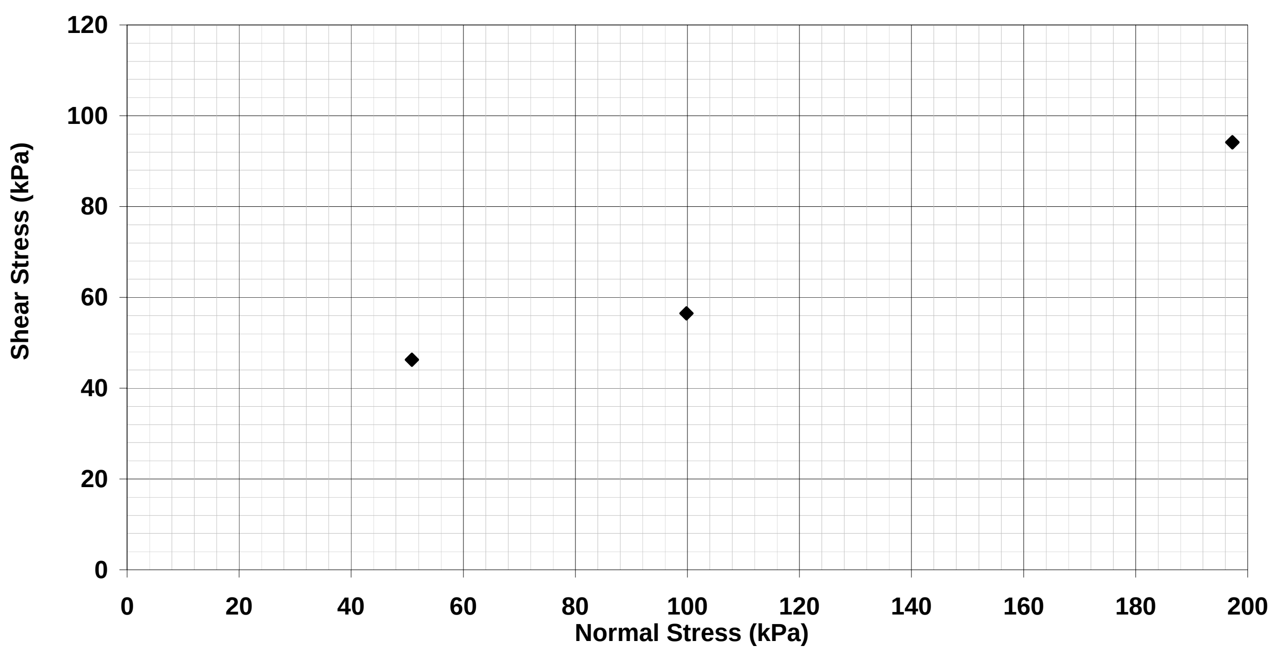
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client:	URS Pty Ltd	**Report No.:**	9080697-DS
Project:	GLNG EIS	**Test Date:**	17/09/2009
		Report Date:	25/09/2009
Client Id.:	TP2_2	**Depth (m):**	1.5
Description:	Clay - red brown	**Sample Type:**	Three Individual Specimens remoulded to a target of 95% of Standard Maximum Dry Density

Failure Criteria: **RESIDUAL @ 7 mm DISPLACEMENT**

Residual - Normal Stress v's Shear Stress



Shear Angle (deg).:	**18.8**	**Cohesion (kPa):**	**26**	**r: 0.994**

			Normal Stress (kPa)	Shear Stress (kPa)
Specimen Dimensions(mm):	45*19			
Rate of Strain(mm/min):	0.008	Stage 1	50.8	46.3
Initial Moisture Content(%):	19.3	Stage 2	99.9	56.5
Initial Wet Density(t/m3):	1.96;1.97;1.96	Stage 3	197.3	94.1

Remarks: Please review the results if the Cohesion is above 2 kPa when plotted with a line of best fit

Sample/s supplied by the client | Note: Graph not to scale |

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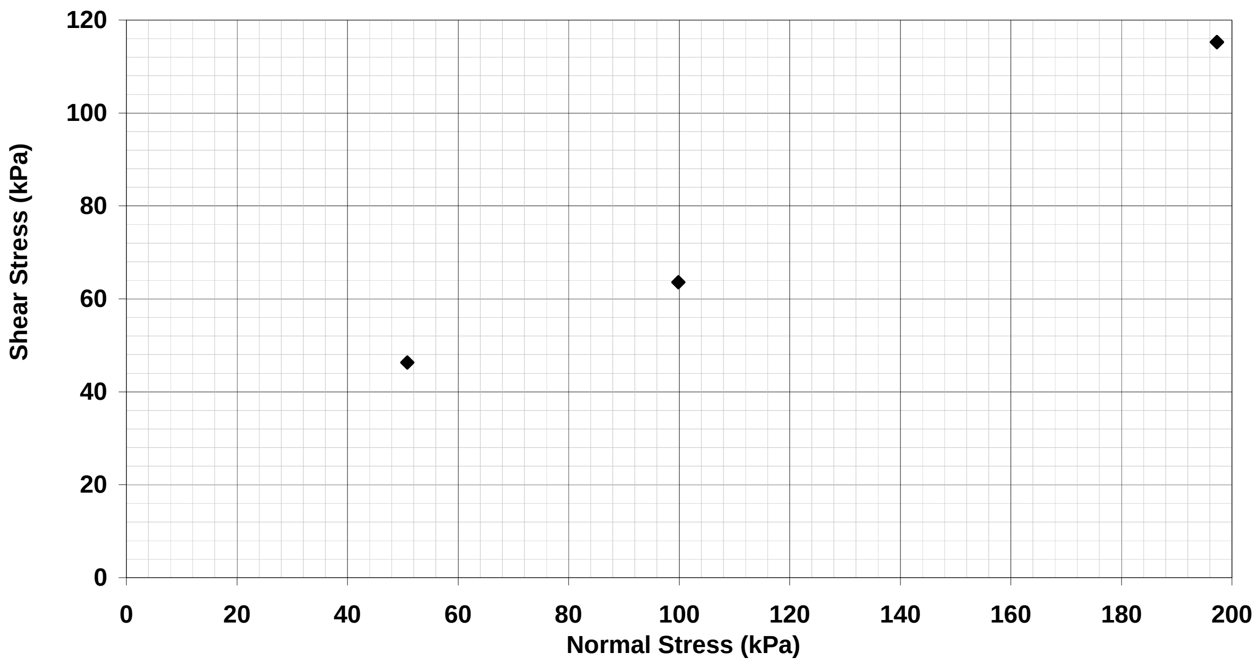
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client:	URS Pty Ltd	**Report No.:**	9080697-DS
Project:	GLNG EIS	**Test Date:**	17/09/2009
		Report Date:	25/09/2009
Client Id.:	TP2_2	**Depth (m):**	1.5
Description:	Clay - red brown	**Sample Type:**	Three Individual Specimens remoulded to a target of 95% of Standard Maximum Dry Density

Failure Criteria: **PEAK**



Shear Angle (deg).:	**25.8**	**Cohesion (kPa):**	**19**	**r:**	**0.997**

			Normal Stress (kPa)	Shear Stress (kPa)
Specimen Dimensions(mm):	45*19			
Rate of Strain(mm/min):	0.008	Stage 1	50.8	46.3
Initial Moisture Content(%):	19.3	Stage 2	99.9	63.6
Initial Wet Density(t/m3):	1.96;1.97;1.96	Stage 3	197.3	115.2

Remarks: Please review the results if the Cohesion is above 2 kPa when plotted with a line of best fit

Sample/s supplied by the client | Note: Graph not to scale |

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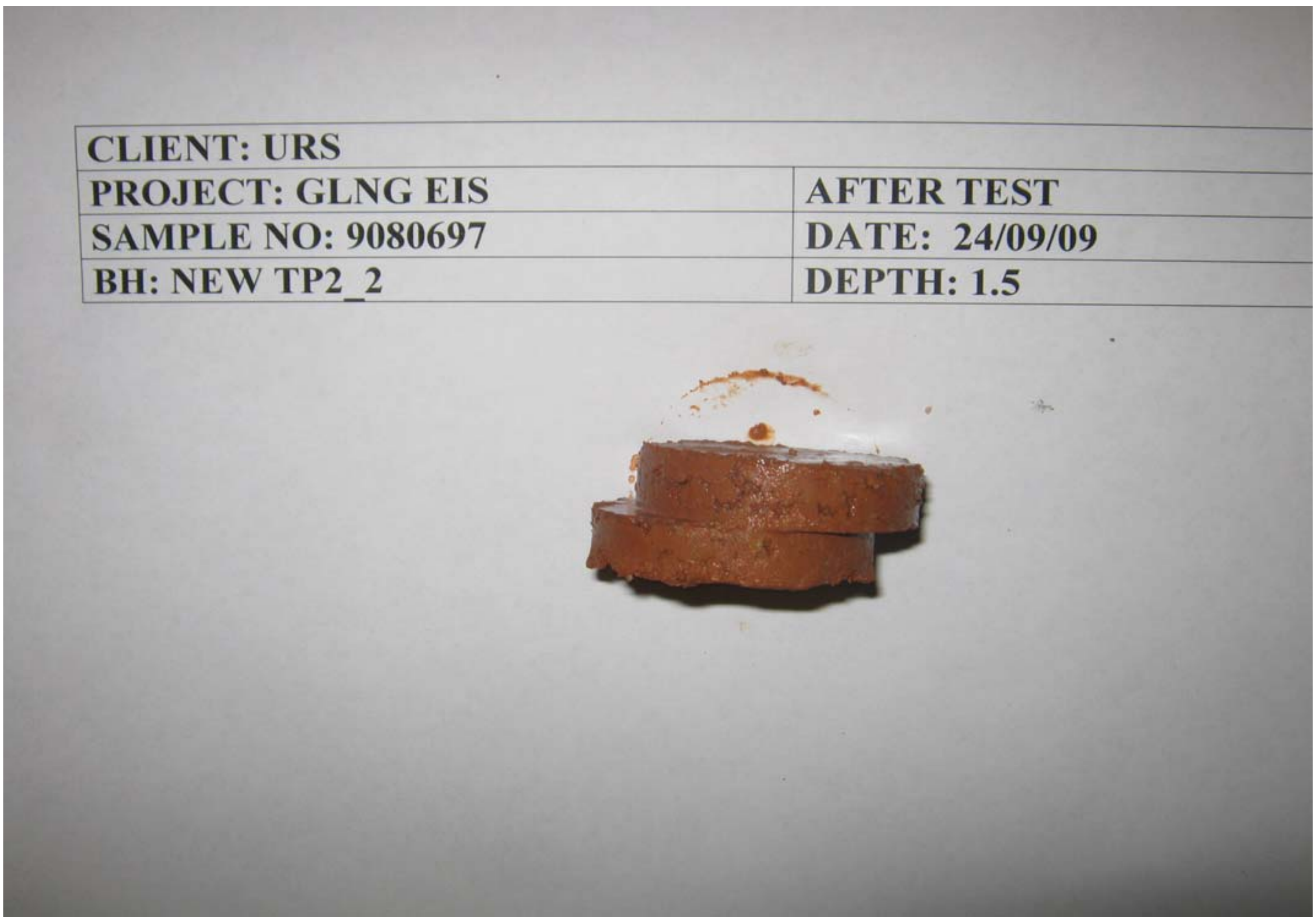
Soil & Rock Testing

DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client:	URS Pty Ltd	**Report No.:**	9080697-DS
Project:	GLNG EIS	**Test Date:**	17/09/2009
		Report Date:	25/09/2009
Client Id.:	TP2_2	**Depth (m):**	1.5
Description:	Clay - red brown	**Sample Type:**	Three Individual Specimens remoulded to a target of 95% of Standard Maximum Dry Density



Remarks: Please review the results if the Cohesion is above 2 kPa when plotted with a line of best fit

Sample/s supplied by the client

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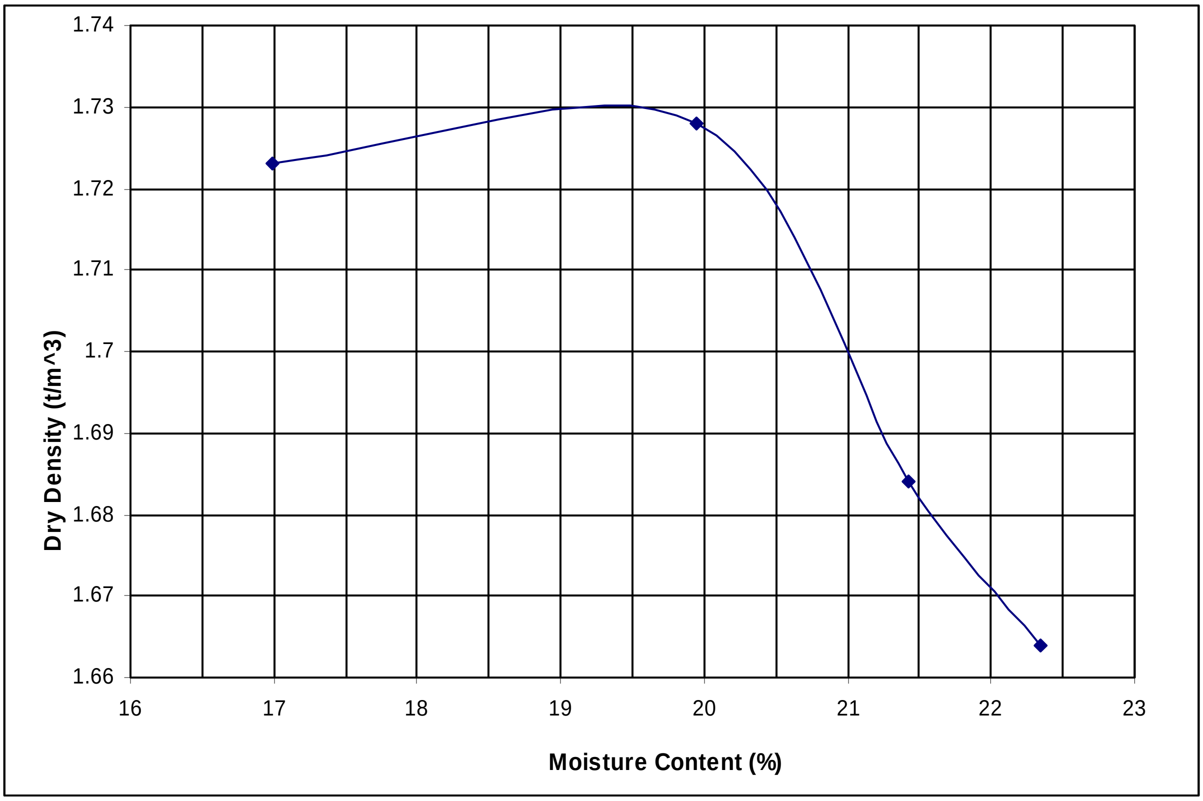
MOISTURE / DENSITY RELATIONSHIP TEST REPORT

Test Method: AS1289 5.1.1

Client: URS Pty Ltd	Report No. 9080697-mdd
Project: GLNG EIS	Test Date: 01/09/09 Report Date: 22/09/09
Client ID: New TP2_2	Depth (m): 1.5

Description: Clay



Maximum Dry Density (t/m^3):	**1.74**	**Optimum Moisture Content (%):**	**19.0**
Sample Moisture (%):	**21.1**	**Percentage of Oversize / Sieve Size (mm):**	**0/19**

Remarks: This is a computer generated plot so estimates may show some minor variations from the results summarised.

Sample/s supplied by the client

Form Number: GT013-5

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Manager

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ATTERBERG LIMITS TEST REPORT

TEST METHOD: AS1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client:	URS Pty Ltd	Report No.	9080699-al
Project:	GLNG EIS	Test Date:	10/09/09
		Report Date:	21/09/09

Client ID: CPT1_1	Depth(m): 1.0	Sample No. 9080699	
Liquid Limit (%):	30	Linear Shrinkage (%):	4.5*+
Plastic Limit (%):	16	Field Moisture Content (%):	34.5
Plasticity Index (%):	14		

Client ID: CPT2_2	Depth(m): 3.2	Sample No. 9080701	
Liquid Limit (%):	60	Linear Shrinkage (%):	14.5+
Plastic Limit (%):	24	Field Moisture Content (%):	20.9
Plasticity Index (%):	36		

Client ID: CPT4b_1	Depth(m): 1.0	Sample No. 9080703	
Liquid Limit (%):	63	Linear Shrinkage (%):	17.5*+
Plastic Limit (%):	26	Field Moisture Content (%):	57.2
Plasticity Index (%):	37		

Client ID: CPT5a_1	Depth(m):0.5	Sample No.9080705	
Liquid Limit (%):	70	Linear Shrinkage (%):	10.0
Plastic Limit (%):	27	Field Moisture Content (%):	-
Plasticity Index (%):	43		

Remarks: The sample/s were tested oven dried, dry sieved and in a 125 – 250mm mould.
*Crumbling occurred.
+Curling occurred

Sample/s supplied by the client

Authorised Signatory

J. Russell

Manager

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Form Number:GT004-5

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PARTICLE SIZE DISTRIBUTION

Test Method: AS 1289 3.6.3, 3.5.1

Client: URS Pty Ltd

Report No.: 9080701-g

Project: GLNG EIS

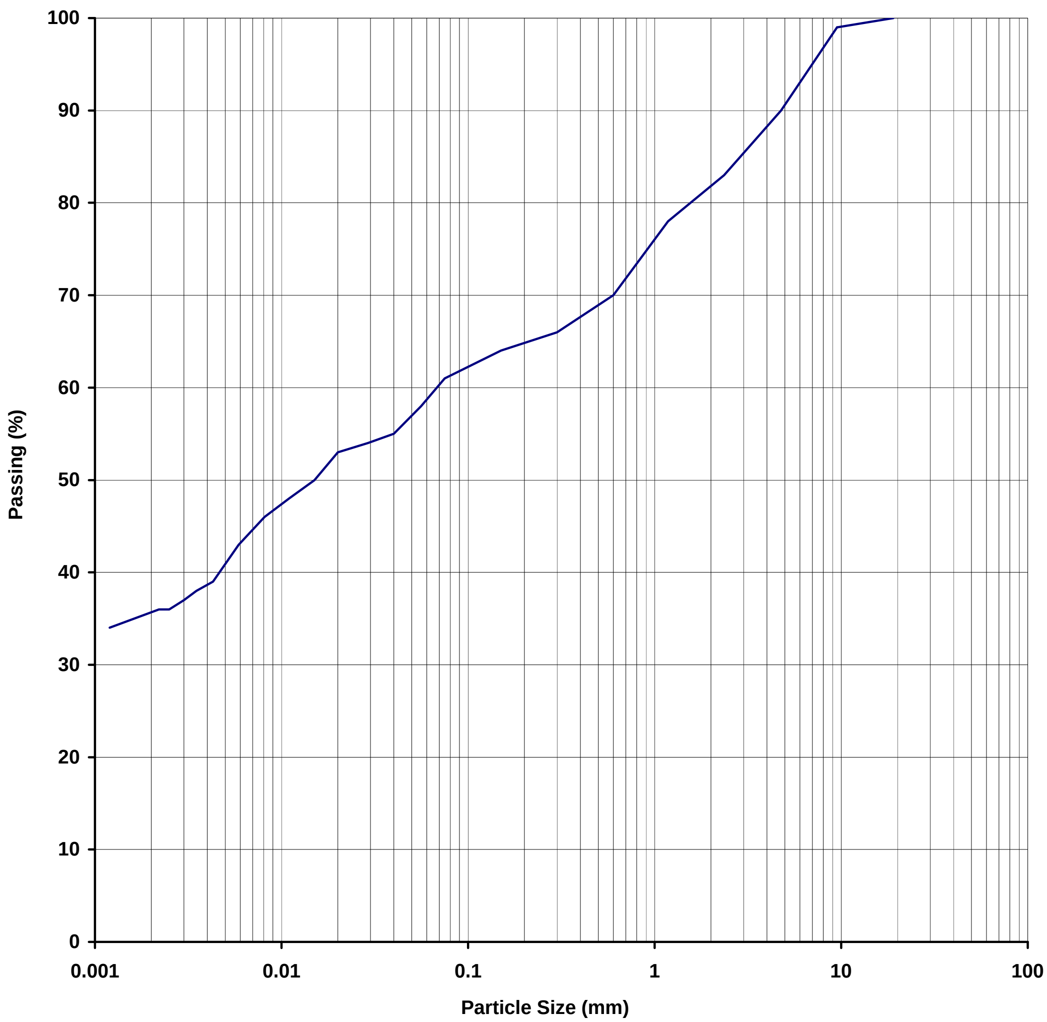
Test Date: 27/08,02/09/09

Report Date: 22/09/2009

Client Id.: CPT2_2

Depth (m): 3.2

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	
19.0	100
9.5	99
4.75	90
2.36	83
1.18	78
0.600	70
0.425	68
0.300	66
0.150	64
0.075	61
0.056	58
0.04	55
0.029	54
0.02	53
0.015	50
0.011	48
0.0081	46
0.0059	43
0.0043	39
0.0035	38
0.003	37
0.0025	36
0.0022	36
0.0012	34



Remarks:

Sample Moisture (%): 20.9

Soil Particle Density(t/m^3): 2.80

Sample/s supplied by the client

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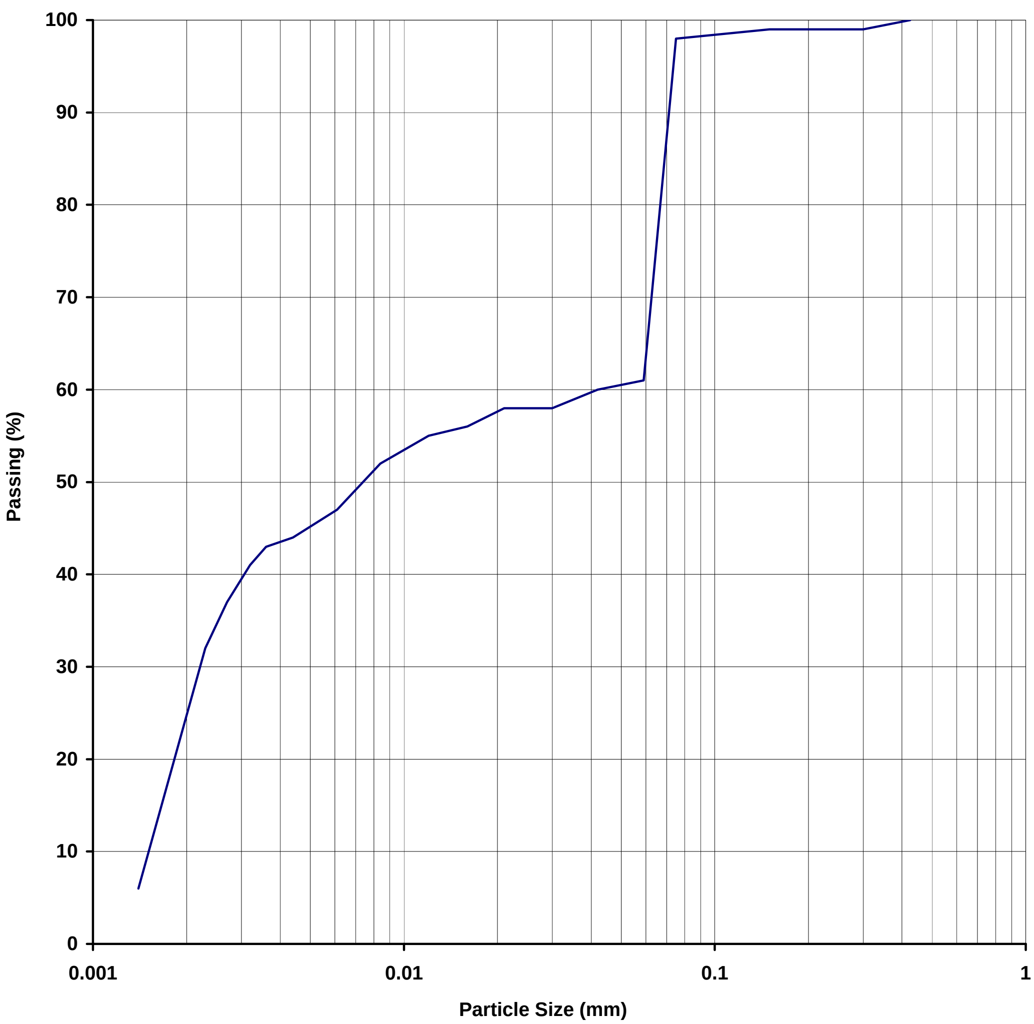
PARTICLE SIZE DISTRIBUTION

Test Method: AS 1289 3.6.3, 3.5.1

Client:	URS Pty Ltd	**Report No.:**	9080702-g
Project:	GLNG EIS	**Test Date:**	27/08,04,09/09/09
		Report Date:	22/09/2009
Client Id.:	CPT4_2	**Depth (m):**	2.0

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	
19.0	
9.5	
4.75	
2.36	
1.18	
0.600	
0.425	100
0.300	99
0.150	99
0.075	98
0.059	61
0.042	60
0.03	58
0.021	58
0.016	56
0.012	55
0.0084	52
0.0061	47
0.0044	44
0.0036	43
0.0032	41
0.0027	37
0.0023	32
0.0014	6



Remarks: Material flocculated
Sample Moisture (%): 57.2
Soil Particle Density(t/m^3): 2.70

Sample/s supplied by the client

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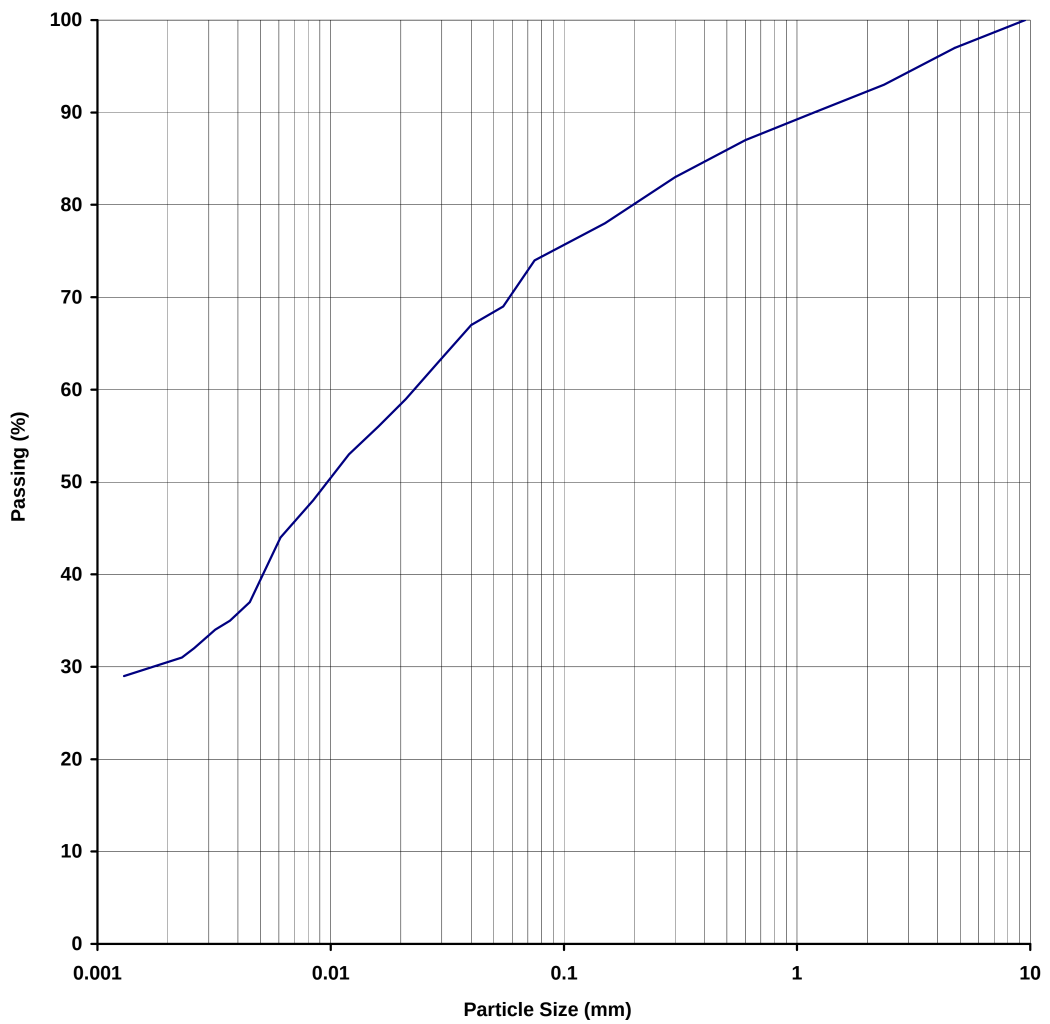
PARTICLE SIZE DISTRIBUTION

Test Method: AS 1289 3.6.3, 3.5.1

Client:	URS Pty Ltd	**Report No.:**	9080704-g
Project:	GLNG EIS	**Test Date:**	27/08,07/09/09
		Report Date:	22/09/2009
Client Id.:	CPT4b_2	**Depth (m):**	3.5

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	
19.0	
9.5	100
4.75	97
2.36	93
1.18	90
0.600	87
0.425	85
0.300	83
0.150	78
0.075	74
0.055	69
0.04	67
0.029	63
0.021	59
0.016	56
0.012	53
0.0084	48
0.0061	44
0.0045	37
0.0037	35
0.0032	34
0.0026	32
0.0023	31
0.0013	29



Remarks:

Sample Moisture (%): 17.5

Soil Particle Density(t/m^3): 2.68

Sample/s supplied by the client

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ATTERBERG LIMITS TEST REPORT

TEST METHOD: AS1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client:	URS Pty Ltd	Report No.	9080706-al
Project:	GLNG EIS	Test Date:	03,15/09/09
		Report Date:	21/09/09

Client ID: CPT5A_2	Depth(m): 1.5	Sample No. 9080706	
Liquid Limit (%):	94	Linear Shrinkage (%):	21.5
Plastic Limit (%):	30	Field Moisture Content (%):	73.4
Plasticity Index (%):	64		

Client ID: CPT12_1	Depth(m): 0.5	Sample No. 9080708	
Liquid Limit (%):	90	Linear Shrinkage (%):	19.0+
Plastic Limit (%):	28	Field Moisture Content (%):	91.0
Plasticity Index (%):	62		

Client ID: CPT12_2	Depth(m): 1.0	Sample No. 9080709	
Liquid Limit (%):	84	Linear Shrinkage (%):	18.0+
Plastic Limit (%):	27	Field Moisture Content (%):	67.9
Plasticity Index (%):	57		

Client ID: CPT12_3	Depth(m): 1.5	Sample No.9080710	
Liquid Limit (%):	100	Linear Shrinkage (%):	16.0
Plastic Limit (%):	34	Field Moisture Content (%):	94.9
Plasticity Index (%):	66		

Client ID: CPT12_4	Depth(m): 2.0	Sample No. 9080711	
Liquid Limit (%):	100	Linear Shrinkage (%):	16.5
Plastic Limit (%):	41	Field Moisture Content (%):	87.8
Plasticity Index (%):	59		

Remarks: The sample/s were tested in a natural state, wet sieved and in a 125 – 250mm mould.
*Crumbling occurred.
+Curling occurred.

Sample/s supplied by the client

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Form Number:GT004-5

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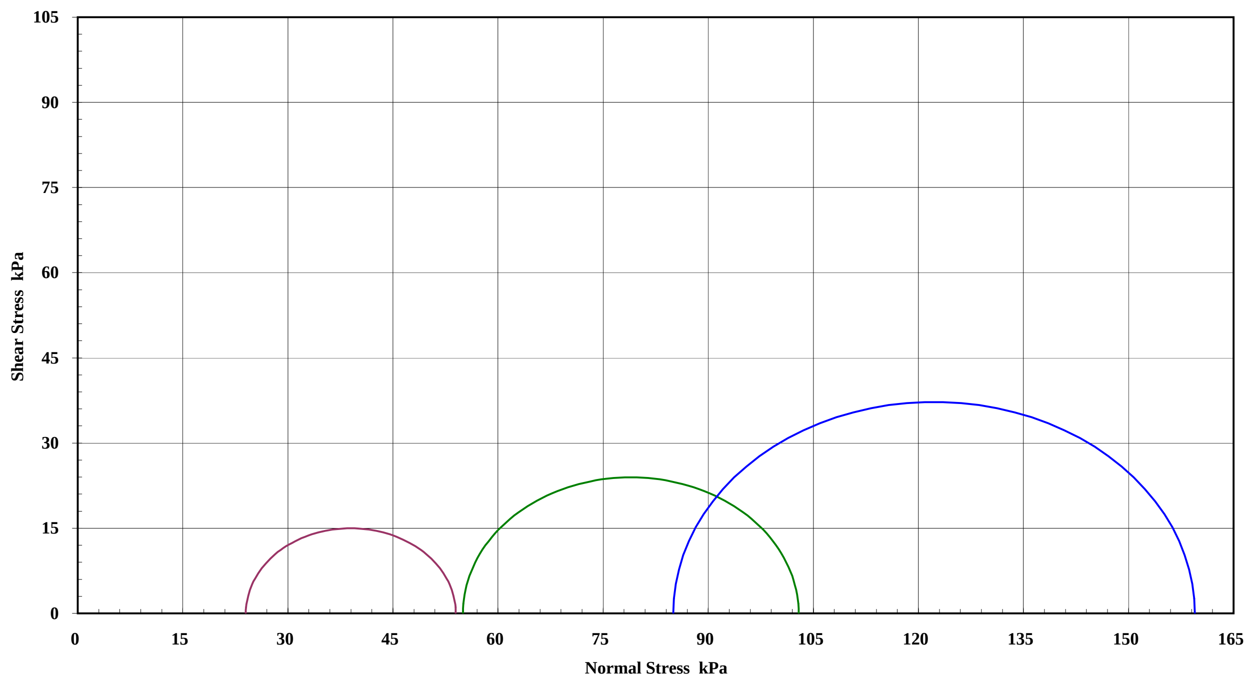
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080706-cu
Project:	GLNG EIS	**Test Date:**	2/09/2009
		Report Date:	14/09/2009
Client Id.:	CPT5A_2	**Depth (m):**	1.50
Description:	CLAY- grey		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	6.4	0	4.1
Angle of Shear Resistance Φ' (Degrees) :	13.0	17.8	15.5

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			Moisture Contents
Initial Height :	153.3	mm	Initial Moisture
Initial Diameter :	71.5	mm	73.4 %
Wet Density :	1.57	t/m^3	Final Moisture
Dry Density :	0.91	t/m^3	
Rate of Strain:	0.007	%/min	32.6 %
B Response:	98	%	

FAILURE DETAILS

Principal Effective Stresses σ'_1	Principal Effective Stresses σ'_3	Deviator Stress	Strain
54 kPa	24 kPa	30 kPa	1.90 %
103 kPa	55 kPa	48 kPa	6.17 %
159 kPa	85 kPa	74 kPa	15.95 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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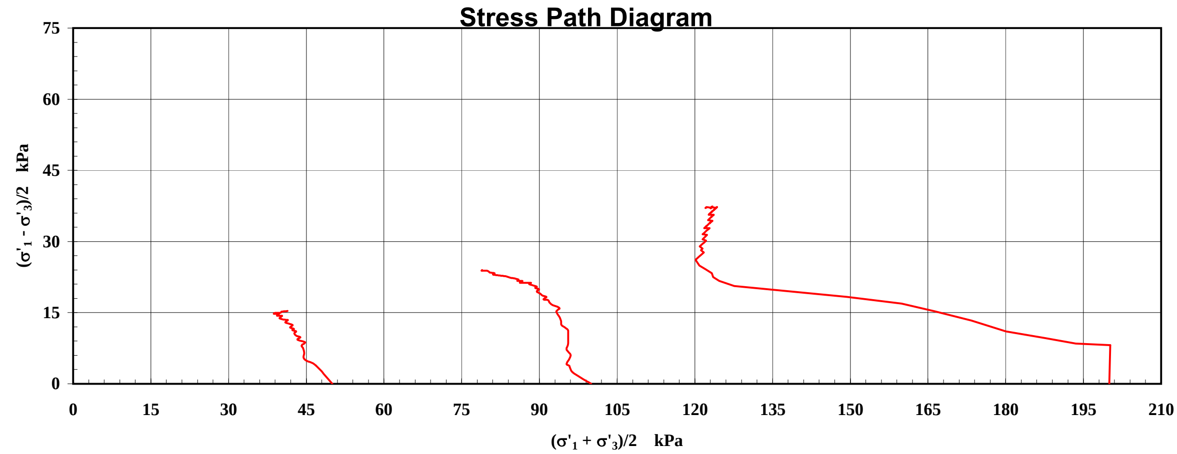
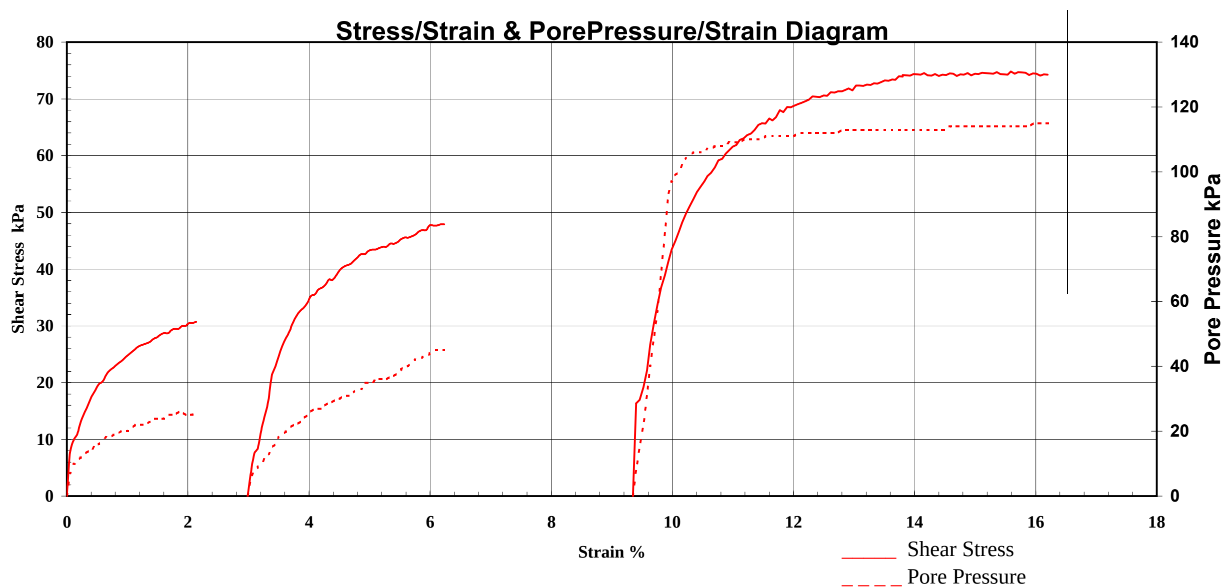
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080706-cu
Project:	GLNG EIS	**Test Date:**	2/09/2009
		Report Date:	14/09/2009
Client Id.:	CPT5A_2	**Depth (m):**	1.50
Description:	CLAY- grey		





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080706-cu
Project:	GLNG EIS	**Test Date:**	2/09/2009
		Report Date:	14/09/2009
Client Id.:	CPT5A_2	**Depth (m):**	1.50
Description:	CLAY- grey		

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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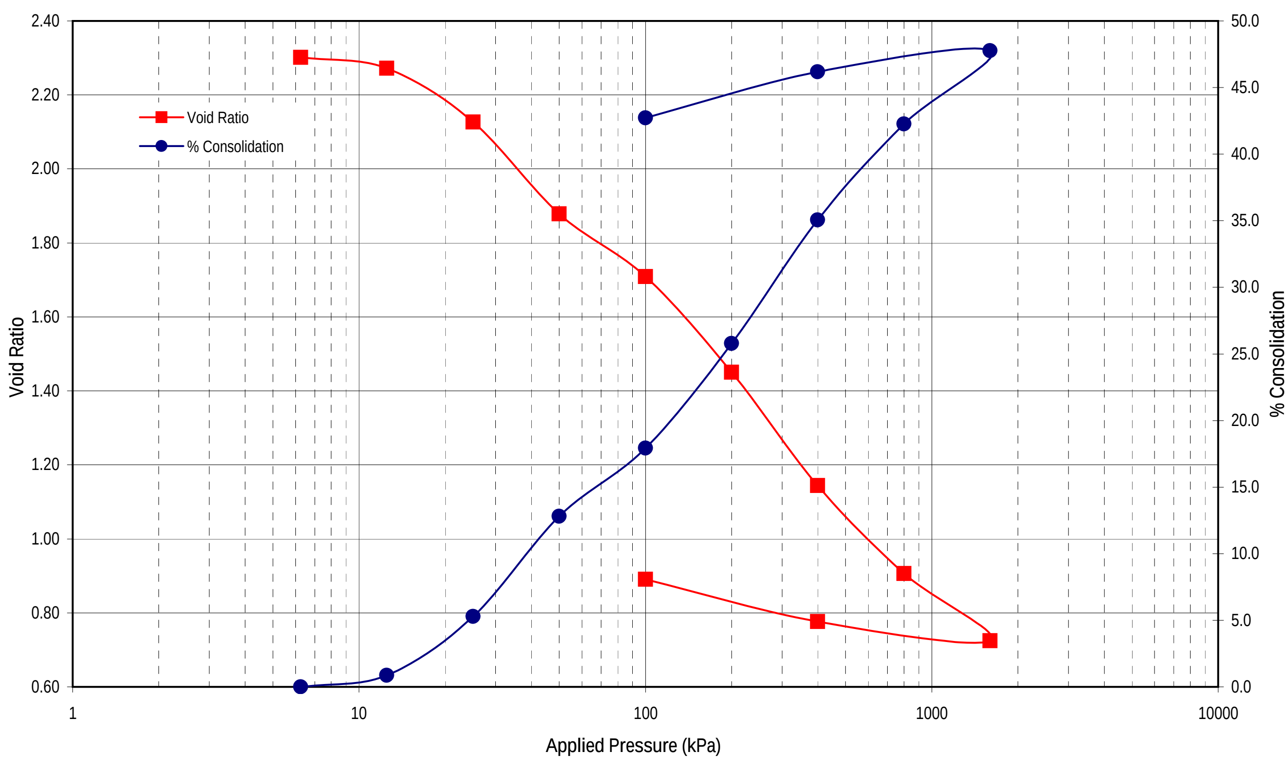
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	URS Pty Ltd	**Report No.:**	9080706-OED
Project:	GLNG EIS	**Test Date:**	9/01/2009
		Report Date:	22/09/2009
Client Id.:	CPT5A_2	**Depth (m):**	1.5

Description: CLAY-dark grey.



Load (kPa)	6.25-12.5	12.5-25	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100		
Cc	0.095	0.483	0.825	0.562	0.861	1.017	0.790	0.604	0.086	0.190		
Cv (m^2/yr) t_{50}	6.22	2.15	0.28	0.45	0.40	0.19	0.17	3.84	0.28	0.09		
t_{90}	2.33	0.86	0.27	1.05	0.51	0.24	0.23	2.41	0.47	0.14		
Mv ($kPa^{-1}x10^{-3}$)	1.393	3.556	3.179	1.175	0.956	0.625	0.277	0.119	0.025	0.215		
C_a x 10^{-3}	1.8	5.5	8.1	12.4	15.7	11.5	8.5	1.9	2.3	7.8		
% Consolidation	0.9	5.3	12.8	17.9	25.8	35.1	42.3	47.8	46.2	42.7		

Wet Density (t/m^3):	1.53	Initial Moisture (%):	100.8	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.56	Initial Voids Ratio:	2.301	Initial Degree of Saturation (%):	110.4
Undisturbed sample supplied by the client		Remarks:	Tested as received		Page 1 of 1

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Authorised Signatory

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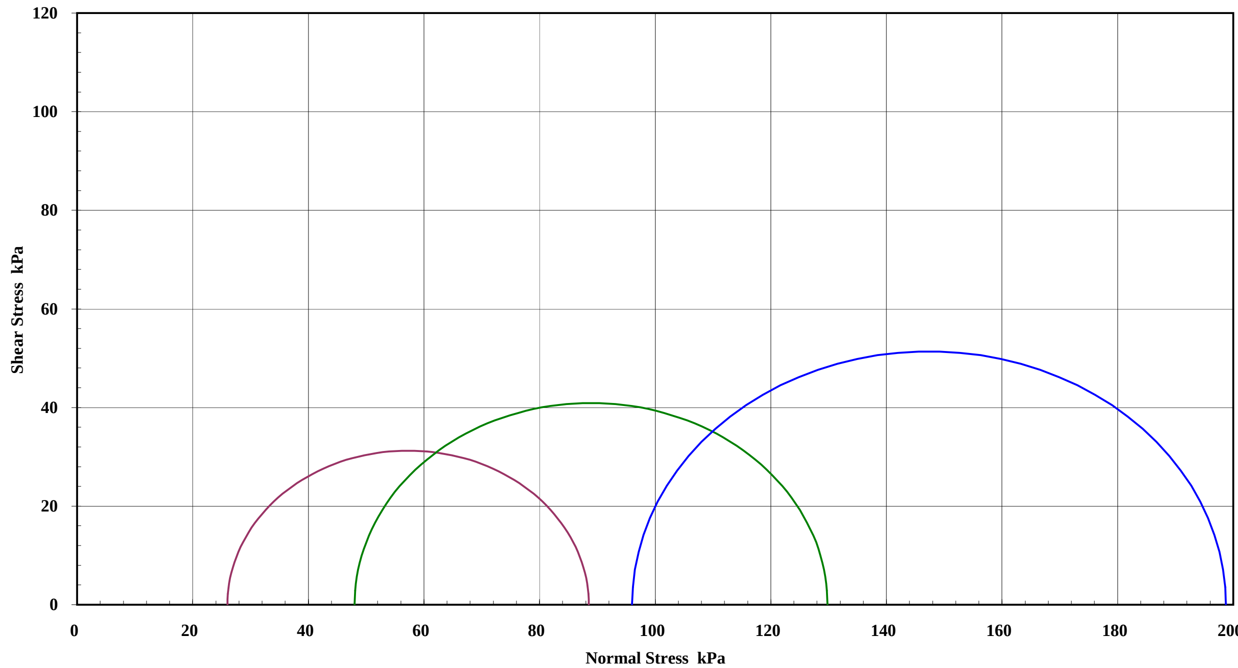
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080707-cu
Project:	GLNG EIS	**Test Date:**	12/09/2009
		Report Date:	18/09/2009
Client Id.:	CPT5A_3	**Depth (m):**	3.50
Description:	CLAY- dark grey		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	14.5	25.4	20.4
Angle of Shear Resistance **Φ'** (Degrees) :	17.8	10.3	12.6

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	123.4	mm	Initial Moisture
Initial Diameter :	72.0	mm	57.7 %
Wet Density :	1.58	t/m^3	Final Moisture
Dry Density :	1.00	t/m^3	
Rate of Strain:	0.010	%/min	35.5 %
B Response:	98	%	

FAILURE DETAILS

Principal Effective Stresses σ'_1	*Principal Effective Stresses* σ'_3	*Deviator Stress*	*Strain*
89 kPa	26 kPa	63 kPa	4.64 %
130 kPa	48 kPa	82 kPa	7.26 %
193 kPa	96 kPa	97 kPa	10.23 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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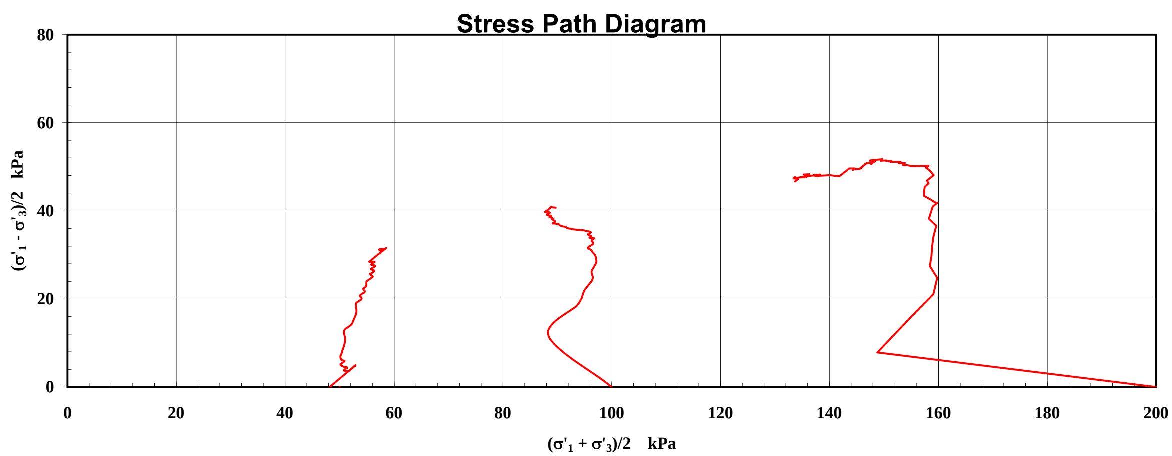
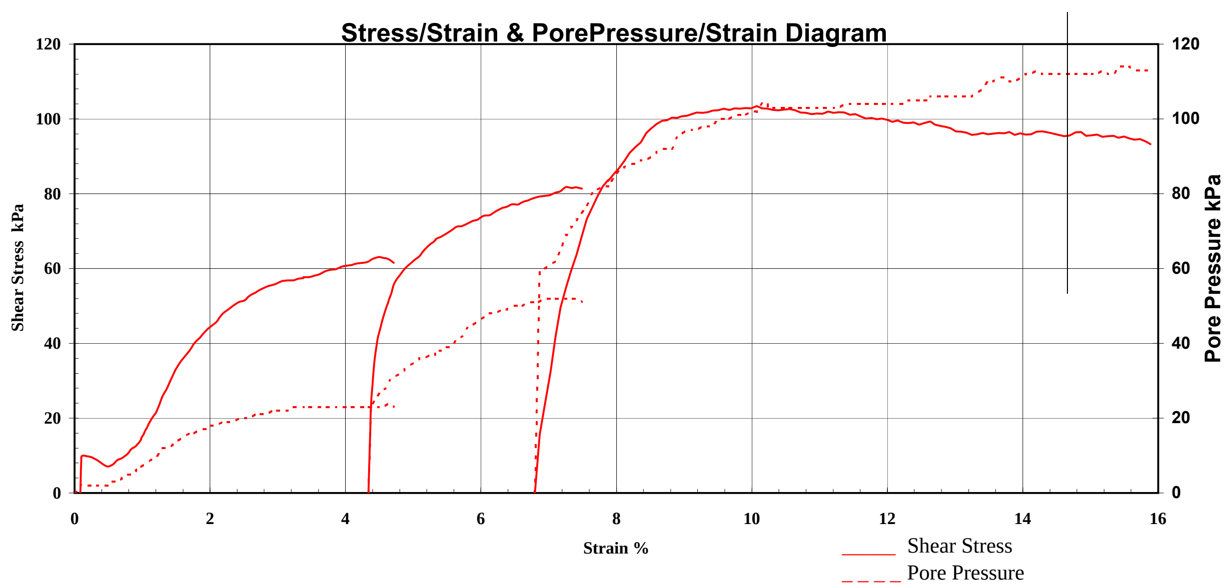
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080707-cu
Project:	GLNG EIS	**Test Date:**	12/09/2009
		Report Date:	18/09/2009
Client Id.:	CPT5A_3	**Depth (m):**	3.50
Description:	CLAY- dark grey		





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080707-cu
Project:	GLNG EIS	**Test Date:**	12/09/2009
		Report Date:	18/09/2009
Client Id.:	CPT5A_3	**Depth (m):**	3.50
Description:	CLAY- dark grey		

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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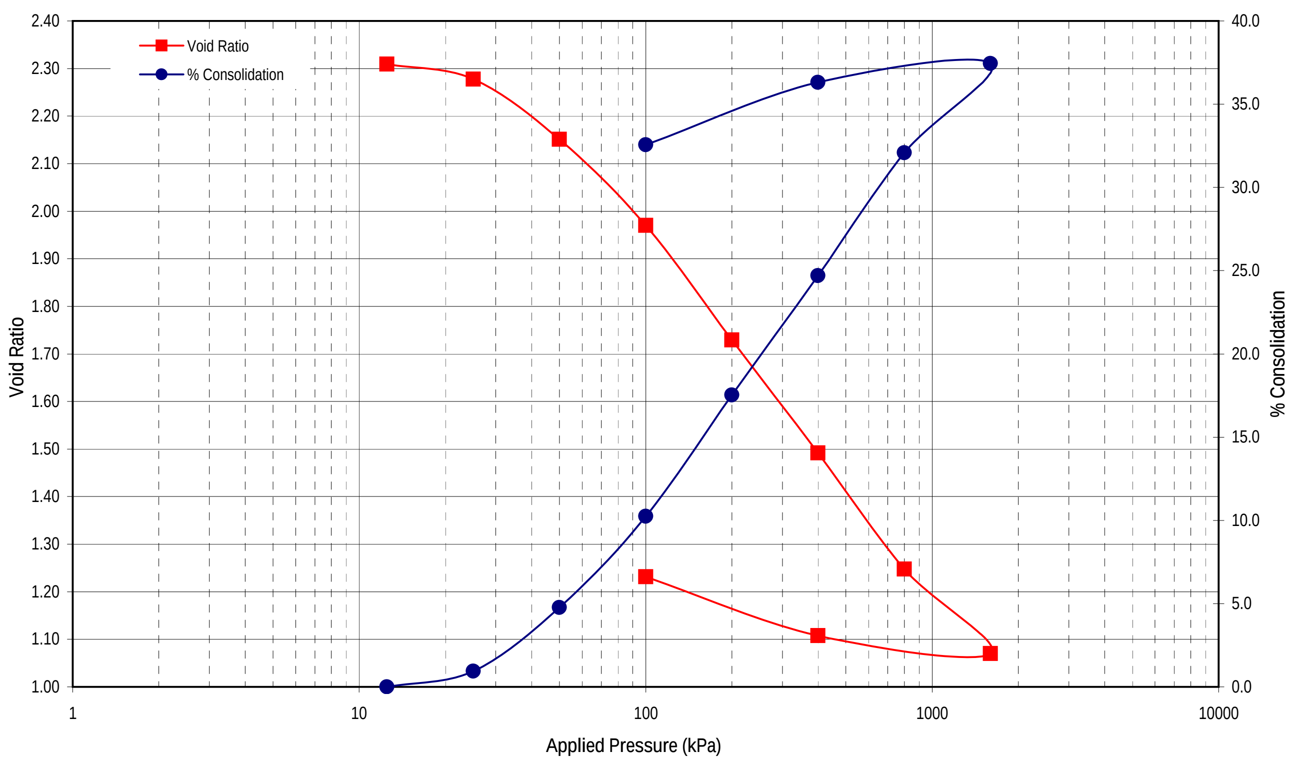
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	URS Pty Ltd	**Report No.:**	9080707-OED
Project:	GLNG EIS	**Test Date:**	9/02/2009
		Report Date:	22/09/2009
Client Id.:	CPT5A_3	**Depth (m):**	3.5

Description: CLAY-dark grey.



Load (kPa)	12.5-25	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100			
Cc	0.105	0.420	0.602	0.800	0.789	0.812	0.590	0.063	0.206			
Cv (m^2/yr) t_{50}	2.22	0.64	0.28	0.25	0.17	0.18	0.24	0.35	0.10			
t_{90}	1.86	0.54	0.43	0.31	0.25	0.25	0.23	0.44	0.15			
Mv ($kPa^{-1}x10^{-3}$)	0.761	1.543	1.150	0.811	0.435	0.245	0.099	0.015	0.196			
C_a x 10^{-3}	2.2	10.5	12.9	19.4	13.5	10.2	6.1	1.5	8.8			
% Consolidation	1.0	4.8	10.2	17.5	24.7	32.1	37.5	36.3	32.6			

Wet Density (t/m^3):	1.55	Initial Moisture (%):	88.0	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.70	Initial Voids Ratio:	2.278	Initial Degree of Saturation (%):	104.3
Undisturbed sample supplied by the client		Remarks:	Tested as received		Page 1 of 1

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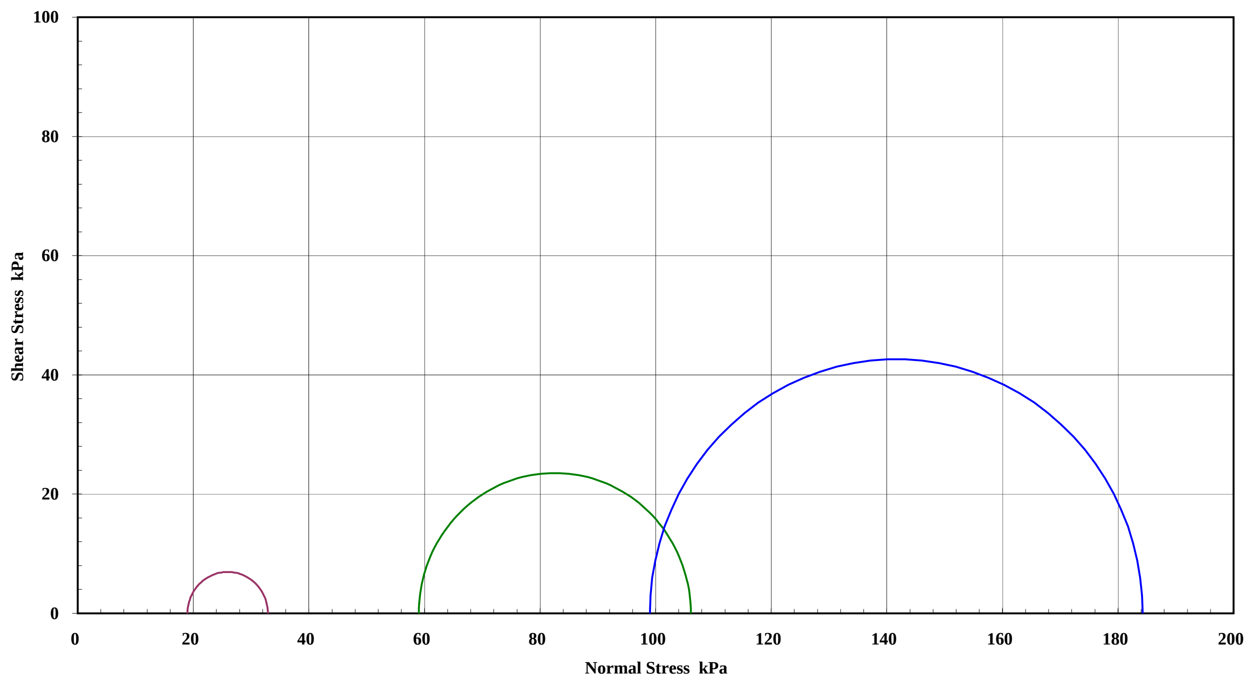
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080708-cu
Project:	GLNG EIS	**Test Date:**	29/08/2009
		Report Date:	4/09/2009
Client Id.:	CPT12-1	**Depth (m):**	0.5
Description:	CLAY- dark grey with organics		

Mohr Circle Diagram



Interpretation between stages : 1 to 2
Cohesion C' (kPa) : 0
Angle of Shear Resistance Φ' (Degrees) : 17

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS				FAILURE DETAILS			
Sample Details			*Moisture Contents*	*Principal Effective Stresses*		*Deviator Stress*	*Strain*
Initial Height :	131.5	mm	Initial Moisture	σ'_1	σ'_3		
Initial Diameter :	72.2	mm	91.0 %	33 kPa	19 kPa	14 kPa	2.14 %
Wet Density :	0.00	t/m^3	Final Moisture	106 kPa	59 kPa	47 kPa	9.47 %
Dry Density :	0.00	t/m^3		184 kPa	99 kPa	85 kPa	33.79 %
Rate of Strain:	0.006	%/min	49.4 %				
B Response:	98	%					

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Load frame malfunction Stage 3 run at 1.0mm/min

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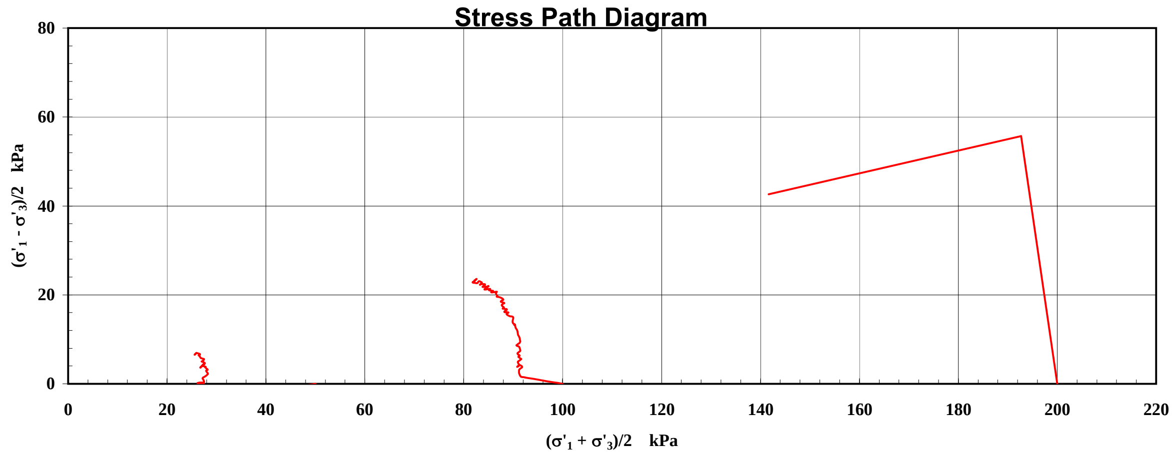
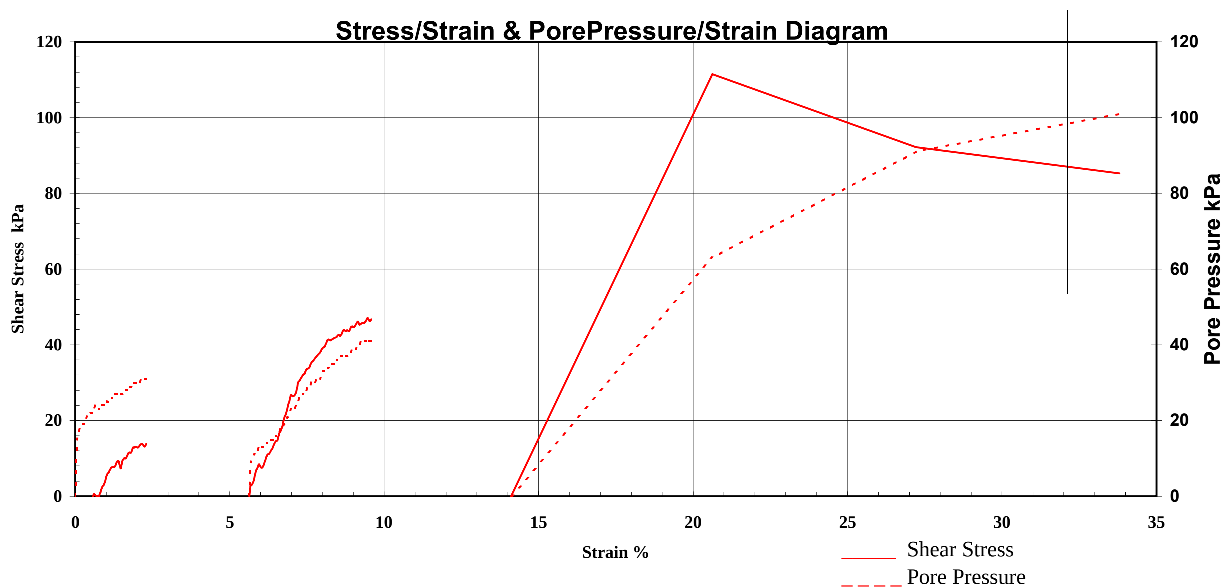
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080708-cu
Project:	GLNG EIS	**Test Date:**	29/08/2009
		Report Date:	4/09/2009
Client Id.:	CPT12-1	**Depth (m):**	0.5
Description:	CLAY- dark grey with organics		





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Load frame malfunction Stage 3 run at 1.0mm/min

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080708-cu
Project:	GLNG EIS	**Test Date:**	29/08/2009
		Report Date:	4/09/2009
Client Id.:	CPT12-1	**Depth (m):**	0.5
Description:	CLAY- dark grey with organics		

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Load frame malfunction Stage 3 run at 1.0mm/min

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OEDOMETER TEST REPORT

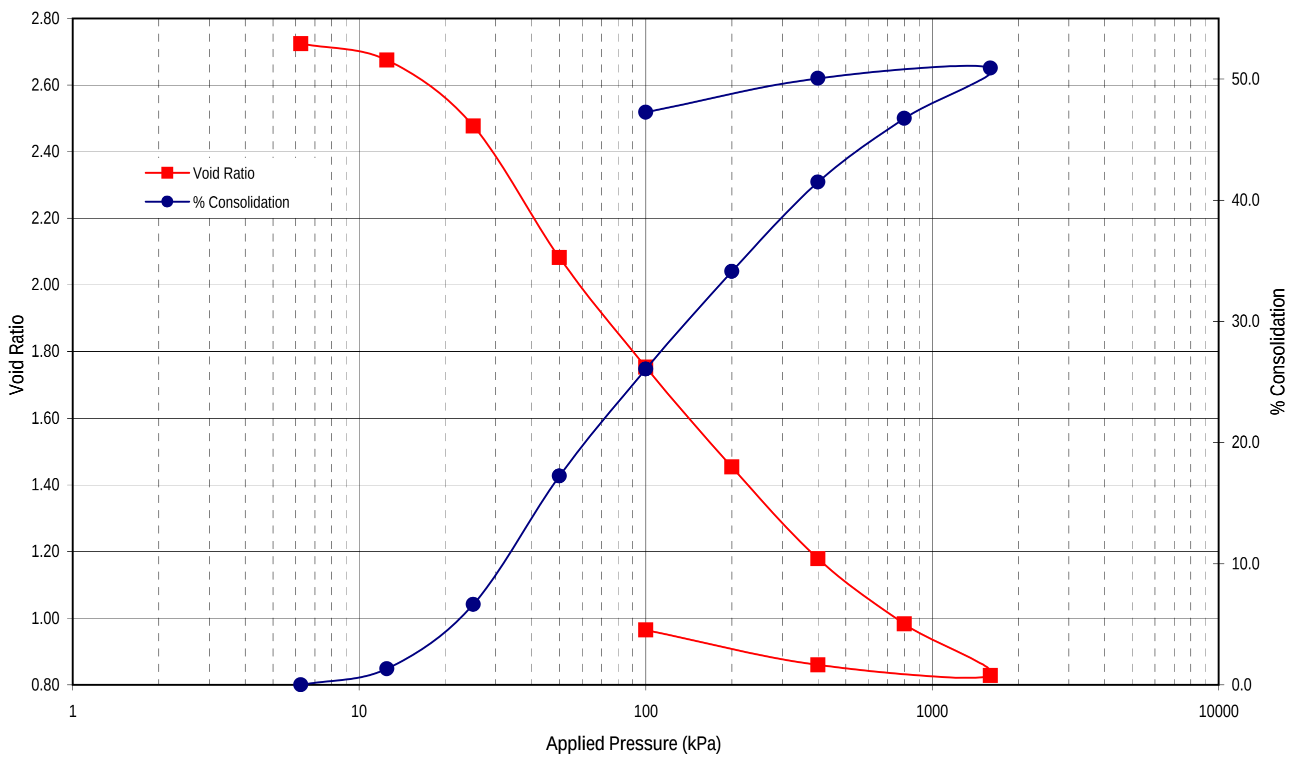
Test Method: AS1289.6.6.1, 3.5.1

Client: URS Pty Ltd
Report No.: 9080708-OED

Project: GLNG EIS
Test Date: 29/8/2009
Report Date: 22/09/2009

Client Id.: CPT12_1
Depth (m): 0.5

Description: CLAY-dark grey,marine organics present.



Load (kPa)	6.25-12.5	12.5-25	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100		
Cc	0.163	0.658	1.312	1.091	0.996	0.913	0.651	0.514	0.052	0.174		
Cv (m^2/yr) t_{50}	3.34	0.95	0.36	0.24	0.22	0.17	0.16	0.21	0.30	0.09		
t_{90}	1.54	0.37	0.41	0.30	0.25	0.25	0.27	0.29	0.40	0.17		
Mv ($kPa^{-1}x10^{-3}$)	2.102	4.313	4.545	2.131	1.089	0.560	0.225	0.098	0.014	0.188		
C_a x 10^{-3}	2.6	10.9	18.9	22.8	22.2	12.0	9.6	11.7	1.5	5.1		
% Consolidation	1.3	6.6	17.2	26.1	34.1	41.5	46.8	50.9	50.1	47.3		

Wet Density (t/m^3):	1.47	Initial Moisture (%):	103.8	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.68	Initial Voids Ratio:	2.695	Initial Degree of Saturation (%):	103.1
Undisturbed sample supplied by the client		Remarks:	Tested as received		Page 1 of 1

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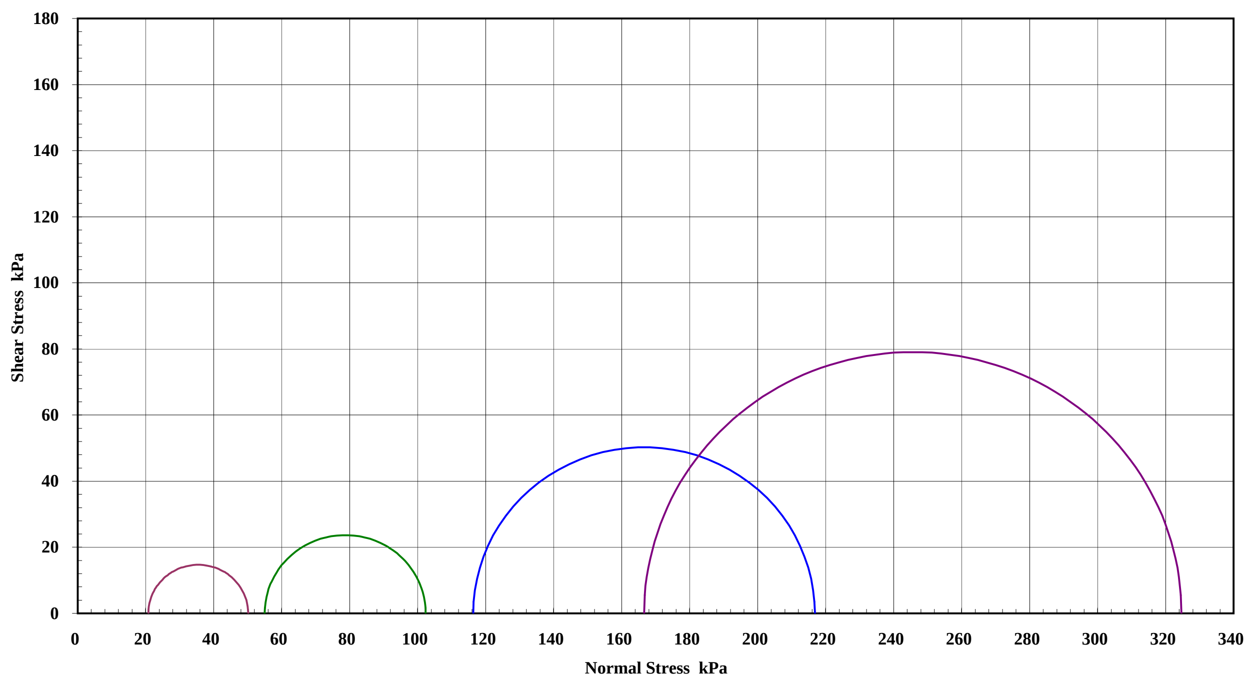
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080709-cu
Project:	GLNG EIS	**Test Date:**	28/08/2009
		Report Date:	4/09/2009
Client Id.:	CPT12-2	**Depth (m):**	1.0
Description:	CLAY- dark grey		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3	1 to 4
Cohesion C' (kPa) :	7.5	0.0	3.9	1.4
Angle of Shear Resistance Φ' (Degrees) :	12.0	17.6	16.0	18.0

Effective Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	152.8	mm	Initial Moisture
Initial Diameter :	72.0	mm	67.9 %
Wet Density :	1.55	t/m^3	Final Moisture
Dry Density :	0.92	t/m^3	
Rate of Strain:	0.007	%/min	41.4 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses σ'_1	*Principal Effective Stresses* σ'_3	*Deviator Stress*	*Strain*
50 kPa	21 kPa	29 kPa	1.87 %
102 kPa	55 kPa	47 kPa	6.99 %
217 kPa	117 kPa	100 kPa	12.97 %
325 kPa	167 kPa	158 kPa	17.88 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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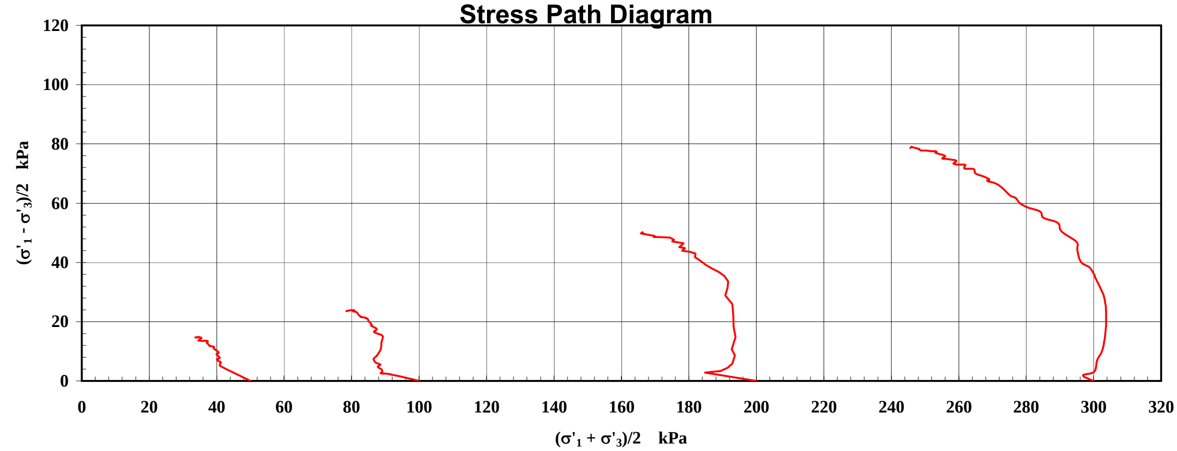
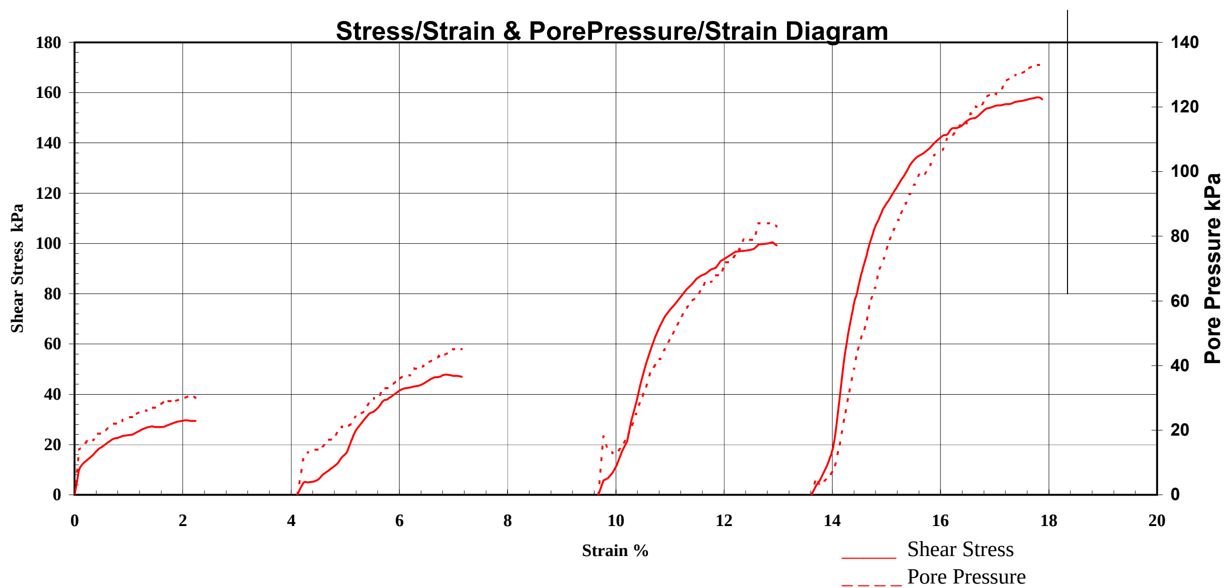
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080709-cu
Project:	GLNG EIS	**Test Date:**	28/08/2009
		Report Date:	4/09/2009
Client Id.:	CPT12-2	**Depth (m):**	1.0
Description:	CLAY- dark grey		





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080709-cu
Project:	GLNG EIS	**Test Date:**	28/08/2009
		Report Date:	4/09/2009
Client Id.:	CPT12-2	**Depth (m):**	1.0
Description:	CLAY- dark grey		

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: URS Pty Ltd

Report No.: 9080709-OED

Project: GLNG EIS

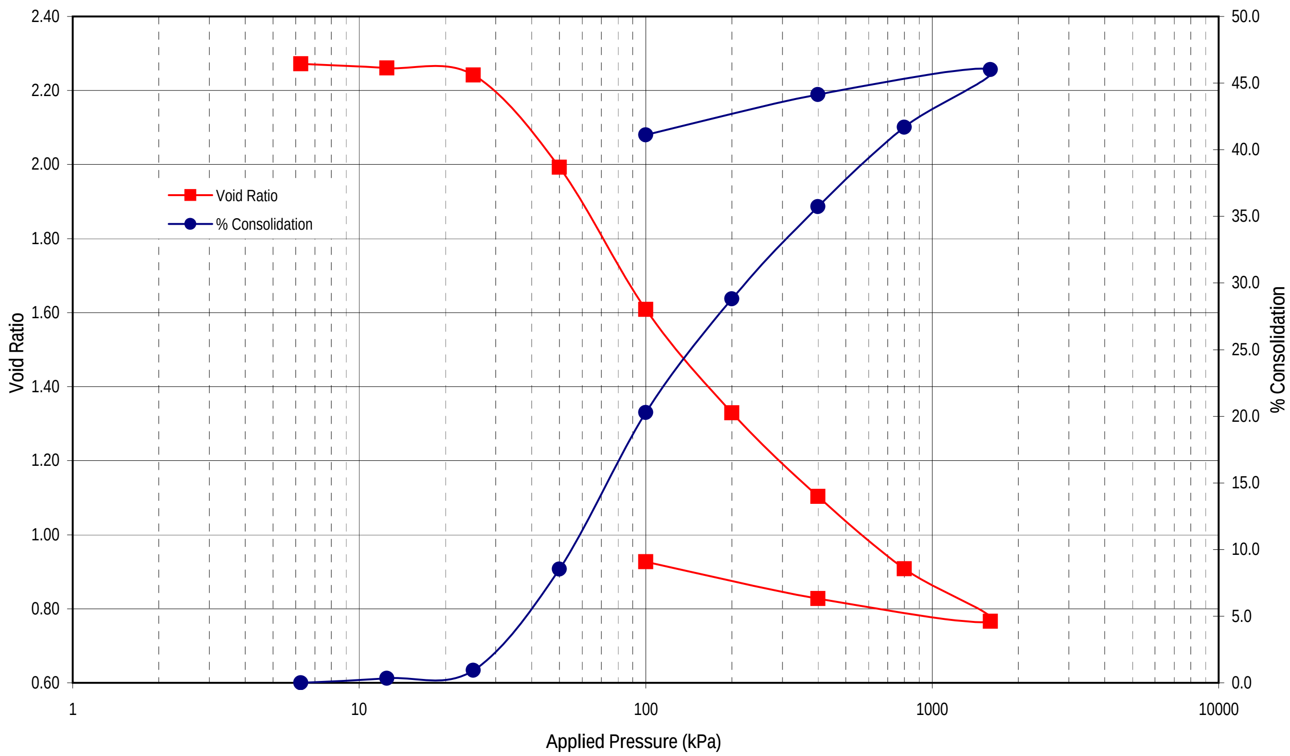
Test Date: 29/8/2009

Report Date: 22/09/2009

Client Id.: CPT12_2

Depth (m): 1

Description: CLAY-dark grey,organics present.



Load (kPa)	6.25-12.5	12.5-25	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100		
Cc	0.037	0.065	0.826	1.275	0.928	0.751	0.650	0.469	0.101	0.166		
Cv (m^2/yr) t_{50}	17.18	11.68	0.02	0.22	0.25	0.23	0.19	0.18	0.36	0.09		
t_{90}	3.87	4.18	0.03	0.27	0.29	0.29	0.24	0.26	0.47	0.13		
Mv (kPa^{-1}x10^{-3})	0.543	0.482	3.067	2.565	1.071	0.485	0.233	0.093	0.029	0.182		
C_a x 10^{-3}	0.5	1.2	21.2	16.9	18.0	16.8	9.3	7.6	3.3	7.0		
% Consolidation	0.3	0.9	8.5	20.3	28.8	35.7	41.7	46.0	44.1	41.1		

Wet Density (t/m^3):	1.54	Initial Moisture (%):	90.9	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.66	Initial Voids Ratio:	2.272	Initial Degree of Saturation (%):	106.1
Undisturbed sample supplied by the client		Remarks:	Tested as received		Page 1 of 1

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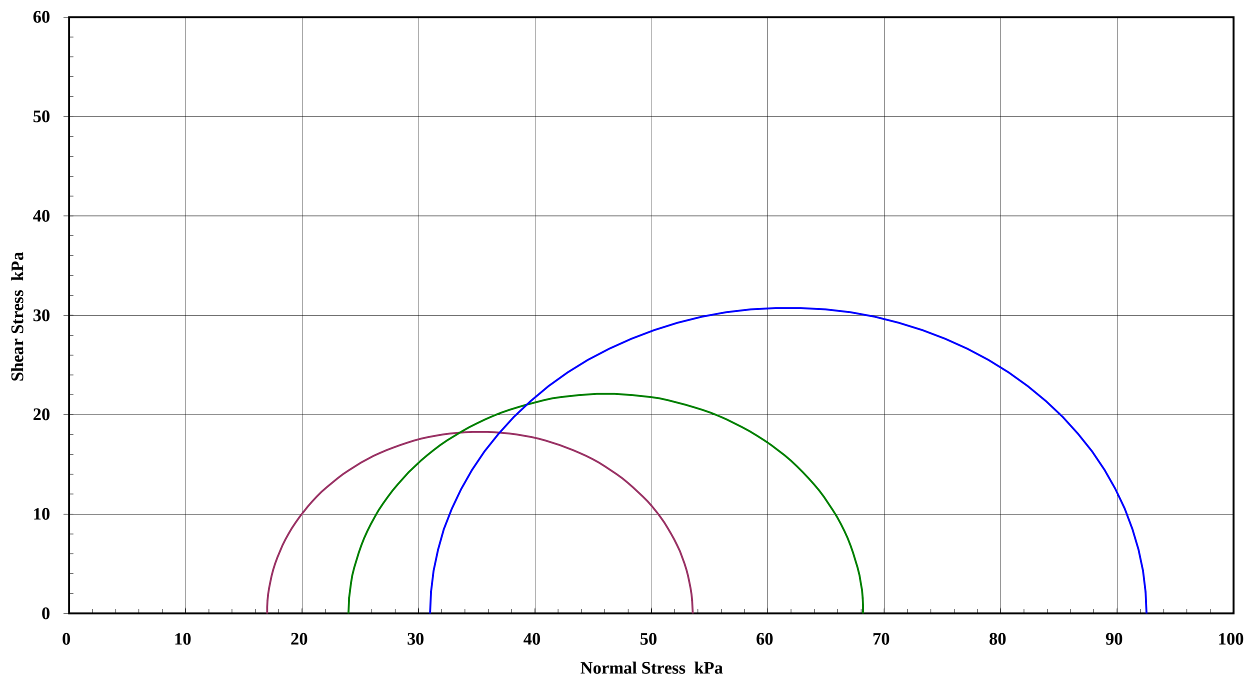
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080710-cu
Project:	GLNG EIS	**Test Date:**	7/09/2009
		Report Date:	14/09/2009
Client Id.:	CPT12_3	**Depth (m):**	1.50
Description:	CLAY- dark grey		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	1 to 3
Cohesion C' (kPa) :	6.2	1.1
Angle of Shear Resistance Φ' (Degrees) :	20.7	28.5

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS / ***FAILURE DETAILS***

Sample Details			*Moisture Contents*	*Principal Effective Stresses* σ'_1	σ'_3	*Deviator Stress*	*Strain*
Initial Height :	153.6	mm	Initial Moisture				
Initial Diameter :	72.1	mm	94.9 %	54 kPa	17 kPa	37 kPa	1.22 %
Wet Density :	1.46	t/m^3	Final Moisture	68 kPa	24 kPa	44 kPa	7.76 %
Dry Density :	0.75	t/m^3		93 kPa	31 kPa	62 kPa	16.34 %
Rate of Strain:	0.007	%/min	72.4 %				
B Response:	99	%					

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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NATA Accredited Laboratory Number 9926

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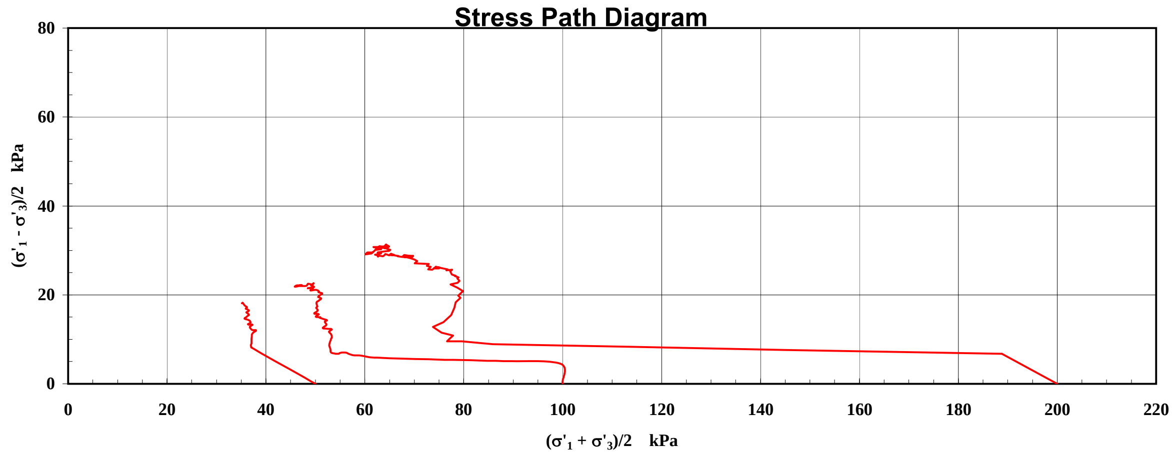
Authorised Signatory
J. Russell

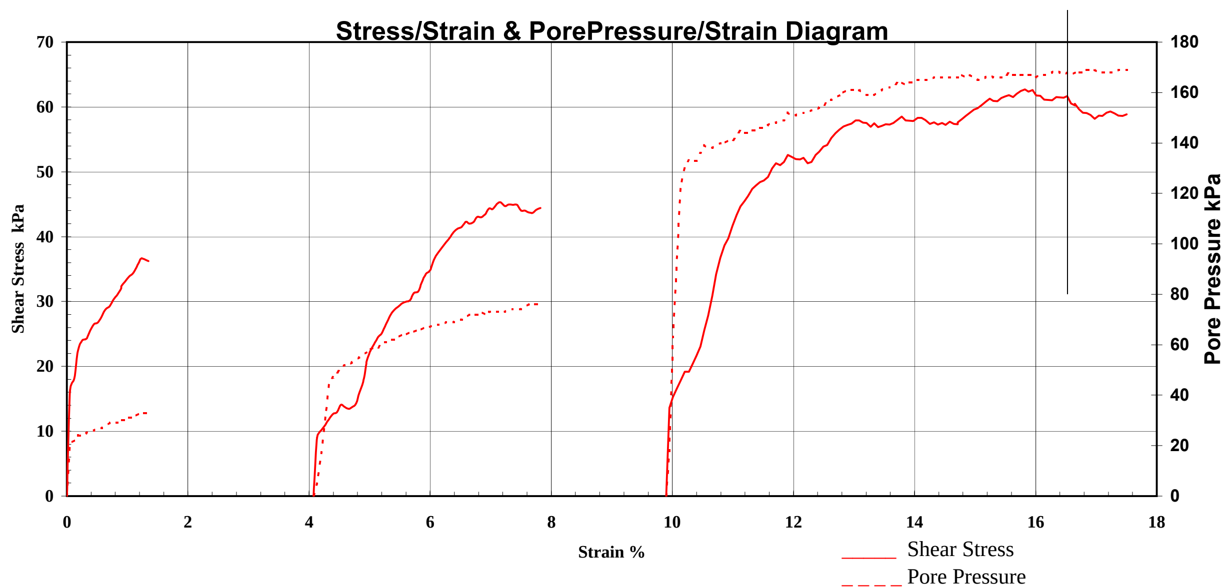
A.G. LABS
Australian Geomechanical Laboratories P/L
ABN: 25 065 630 506
Soil & Rock Testing
Postal: PO Box 3317 Newmarket Qld 4051
Address: 10/104 Newmarket Rd Windsor Qld 4030
(Phone) 07 3357 5535
(Fax) 07 3357 5531
windsor@aglabs.com.au

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080710-cu
Project:	GLNG EIS	**Test Date:**	7/09/2009
		Report Date:	14/09/2009
Client Id.:	CPT12_3	**Depth (m):**	1.50
Description:	CLAY- dark grey		





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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windsor@aglabs.com.au

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080710-cu
Project:	GLNG EIS	**Test Date:**	7/09/2009
		Report Date:	14/09/2009
Client Id.:	CPT12_3	**Depth (m):**	1.50
Description:	CLAY- dark grey		

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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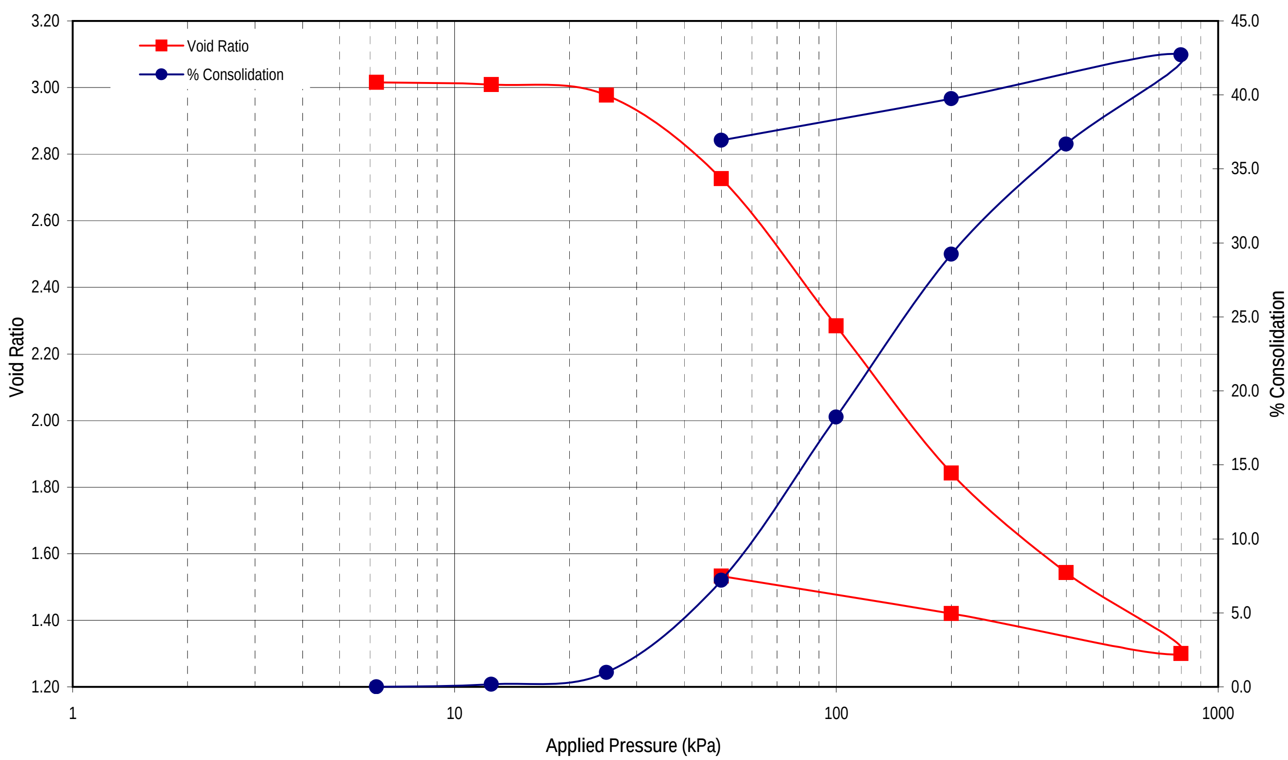
(Phone) 07 3357 5535
(Fax) 07 3357 5531
windsor@aglabs.com.au

OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	URS Pty Ltd	**Report No.:**	9080710-OED
Project:	GLNG EIS	**Test Date:**	9/02/2009
		Report Date:	22/09/2009
Client Id.:	CPT12_3	**Depth (m):**	1.5
Description:	CLAY-dark grey.		



Load (kPa)	6.25-12.5	12.5-25	25-50	50-100	100-200	200-400	400-800	800-200	200-50			
Cc	0.023	0.107	0.832	1.471	1.468	0.992	0.806	0.199	0.187			
Cv (m^2/yr) t_{50}	20.20	10.39	0.87	0.26	0.13	0.19	0.21	0.50	0.13			
t_{90}	4.57	12.96	0.78	0.35	0.94	0.30	0.31	0.73	0.20			
Mv ($kPa^{-1}x10^{-3}$)	0.270	0.642	2.518	2.377	1.346	0.526	0.239	0.087	0.311			
C_a x 10^{-3}	0.2	1.3	9.4	14.6	20.7	10.9	9.7	4.0	6.7			
% Consolidation	0.2	1.0	7.2	18.2	29.2	36.7	42.7	39.7	36.9			

Wet Density (t/m^3):	1.40	Initial Moisture (%):	106.1	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.74	Initial Voids Ratio:	3.016	Initial Degree of Saturation (%):	96.5
Undisturbed sample supplied by the client		Remarks:	Tested as received		Page 1 of 1

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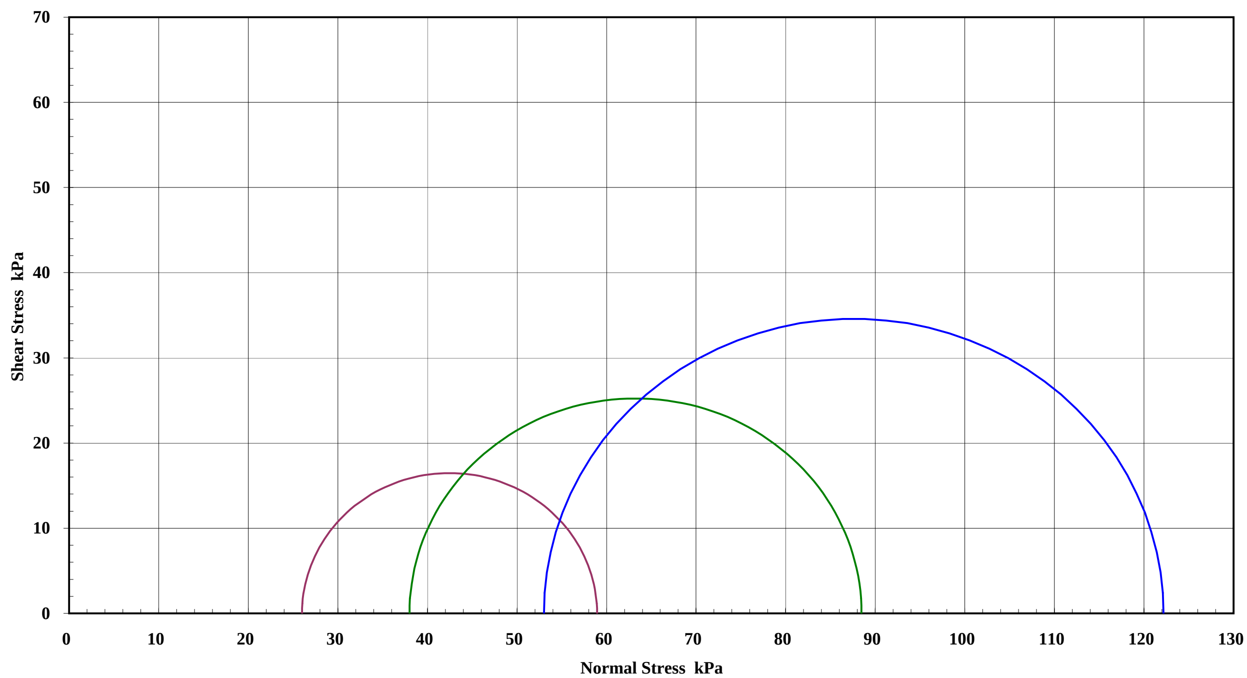
windsor@aglabs.com.au

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080711-cu
Project:	GLNG EIS	**Test Date:**	9/09/2009
		Report Date:	18/09/2009
Client Id.:	CPT12_4	**Depth (m):**	2.0
Description:	CLAY- dark grey		

Mohr Circle Diagram



	2 to 3	1 to 3
Interpretation between stages :	2 to 3	1 to 3
Cohesion C' (kPa) :	1.0	0.0
Angle of Shear Resistance Φ' (Degrees) :	22.6	23.5

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			Moisture Contents
Initial Height :	152.5	mm	Initial Moisture
Initial Diameter :	71.8	mm	87.8 %
Wet Density :	1.48	t/m^3	Final Moisture
Dry Density :	0.79	t/m^3	
Rate of Strain:	0.007	%/min	57.7 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses σ'_1	Principal Effective Stresses σ'_3	Deviator Stress	Strain
59 kPa	26 kPa	33 kPa	1.97 %
88 kPa	38 kPa	50 kPa	5.10 %
122 kPa	53 kPa	69 kPa	13.58 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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Authorised Signatory
James Russell
J. Russell

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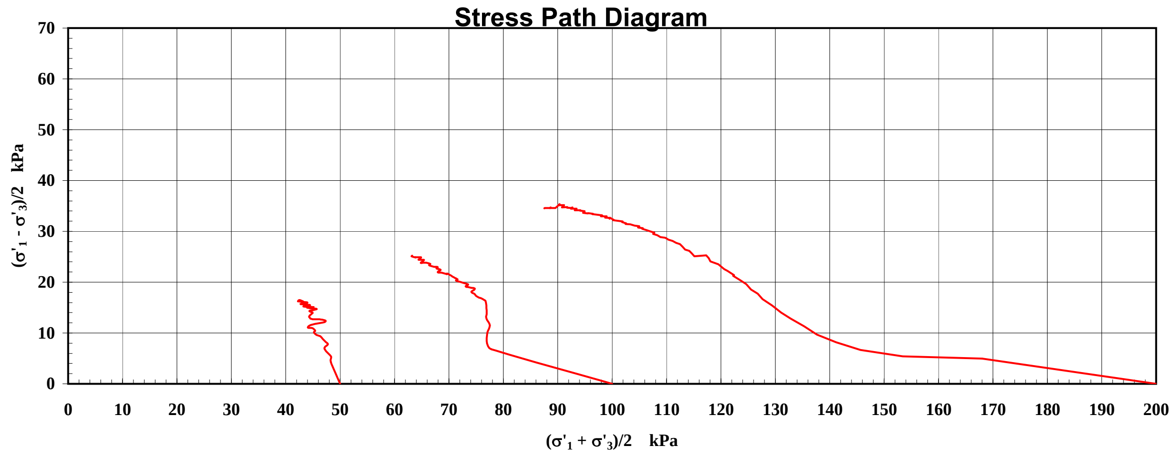
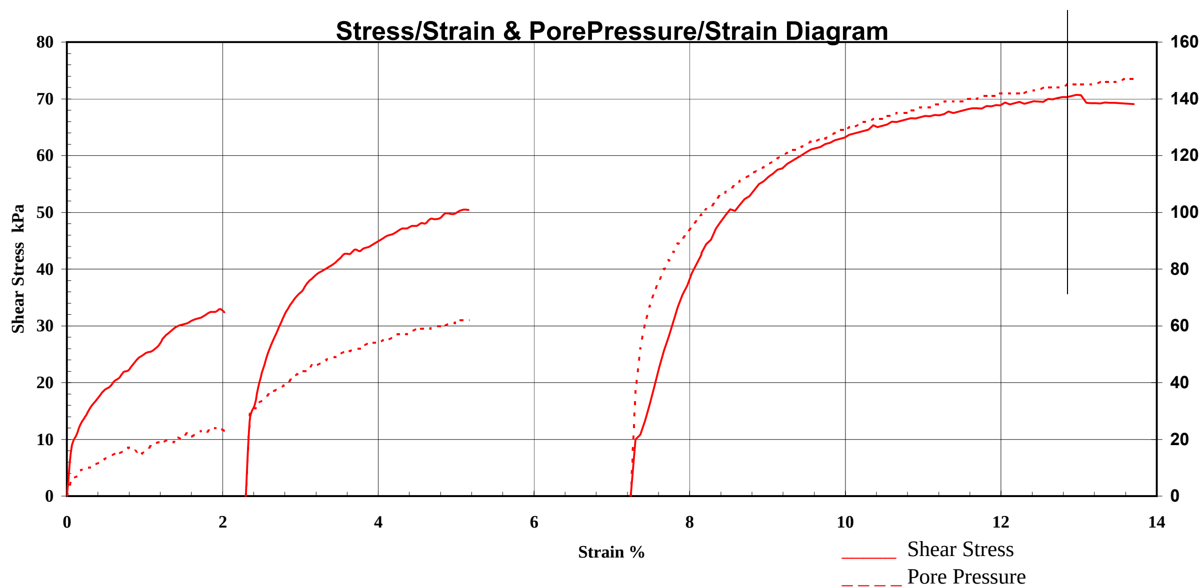
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080711-cu
Project:	GLNG EIS	**Test Date:**	9/09/2009
		Report Date:	18/09/2009
Client Id.:	CPT12_4	**Depth (m):**	2.0
Description:	CLAY- dark grey		





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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Number 9926

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	URS Pty Ltd	**Report No.:**	9080711-cu
Project:	GLNG EIS	**Test Date:**	9/09/2009
		Report Date:	18/09/2009
Client Id.:	CPT12_4	**Depth (m):**	2.0
Description:	CLAY- dark grey		

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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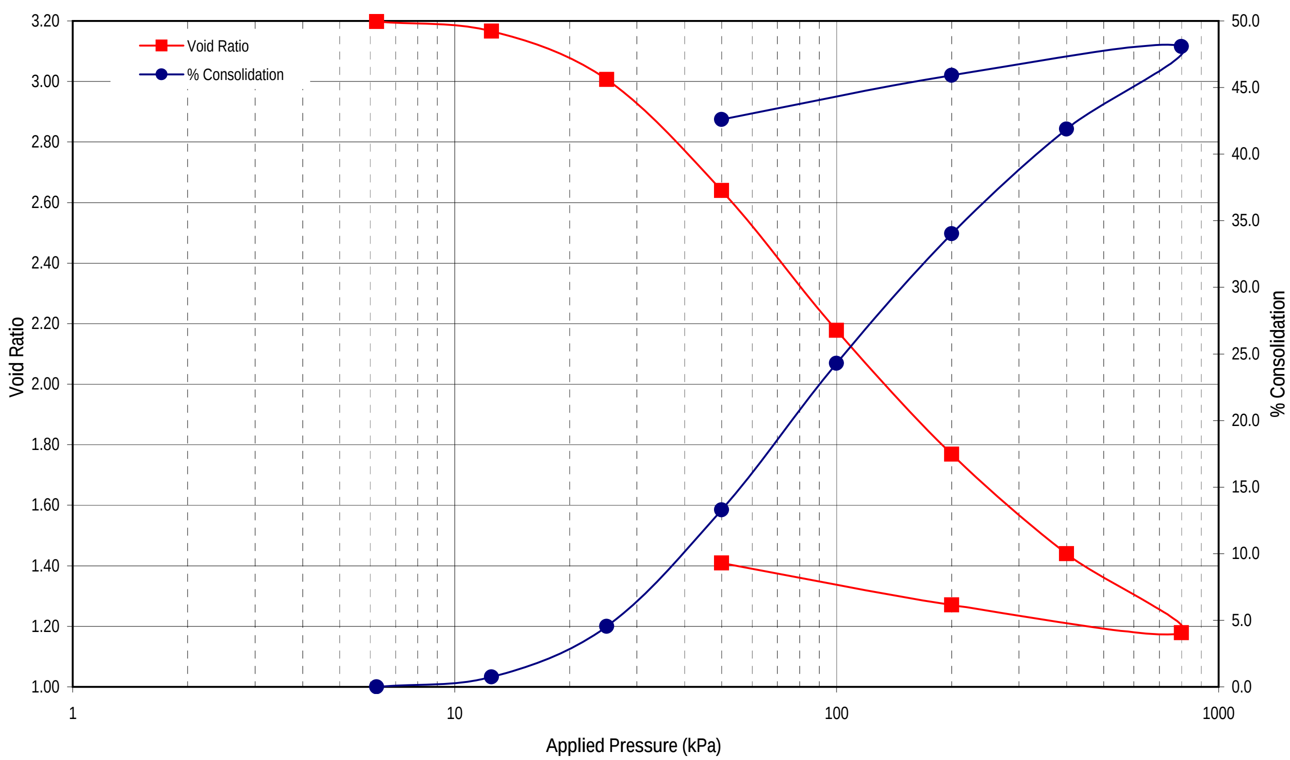
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	URS Pty Ltd	**Report No.:**	9080711-OED
Project:	GLNG EIS	**Test Date:**	17/9/2009
		Report Date:	30/09/2009
Client Id.:	CPT12_4	**Depth (m):**	2

Description: CLAY-dark grey,organics present.



Load (kPa)	6.25-12.5	12.5-25	25-50	50-100	100-200	200-400	400-800	800-200	200-50			
Cc	0.104	0.530	1.218	1.536	1.357	1.093	0.866	0.152	0.231			
Cv (m^2/yr) t_{50}	0.14	3.72	1.04	0.24	0.22	0.22	0.17	0.36	0.09			
t_{90}	2.96	1.13	2.16	0.42	0.30	0.26	0.25	0.89	0.13			
Mv ($kPa^{-1}x10^{-3}$)	1.193	3.066	3.660	2.541	1.286	0.594	0.267	0.070	0.407			
C_a x 10^{-3}	0.8	6.3	21.0	16.2	20.6	17.6	11.9	4.6	11.6			
% Consolidation	0.7	4.5	13.3	24.3	34.0	41.9	48.1	45.9	42.6			

Wet Density (t/m^3):	1.43	Initial Moisture (%):	121.3	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.72	Initial Voids Ratio:	3.198	Initial Degree of Saturation (%):	102.9
Undisturbed sample supplied by the client		Remarks:	Tested as received		Page 1 of 1

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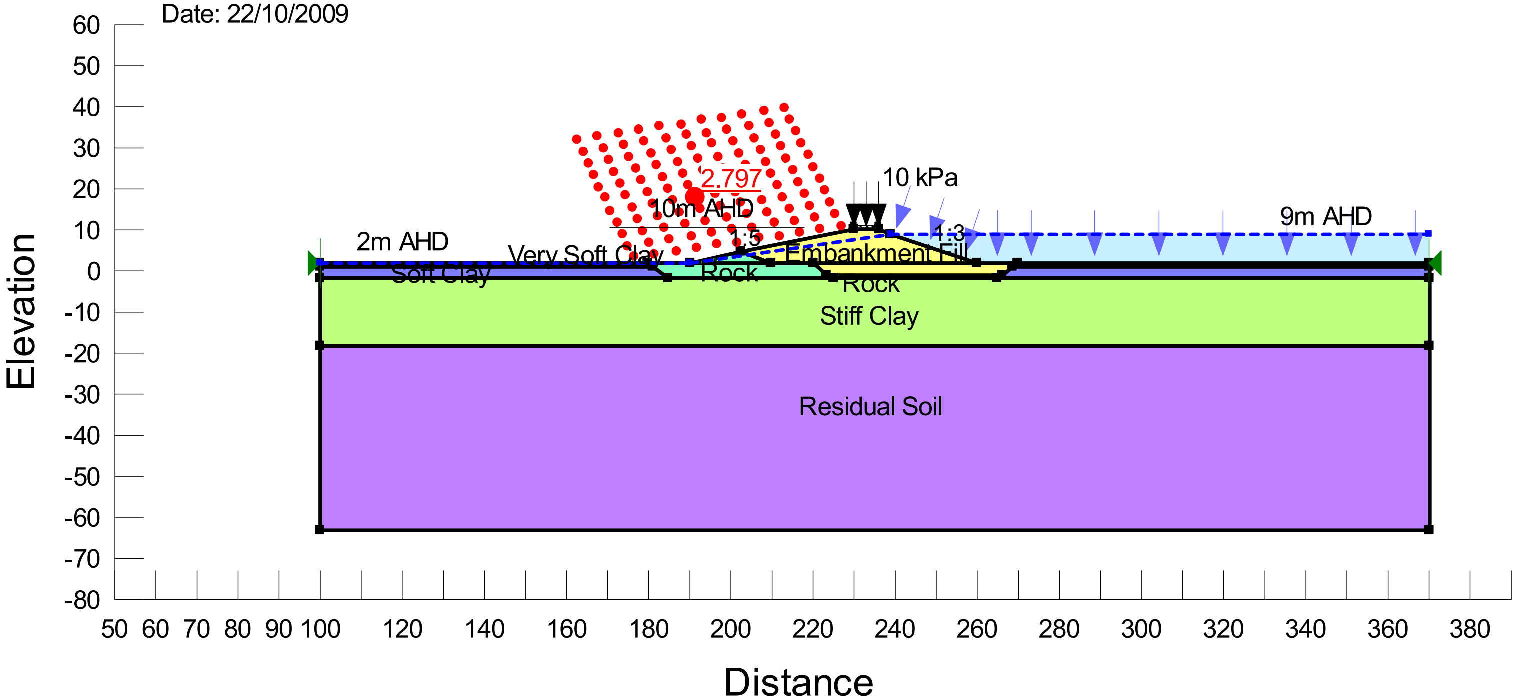
Authorised Signatory

J. Russell

Appendix D Geotechnical Analysis

UR_Raise01_Undrained_Downstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\UR\Undrained\
File Name: UR_Stage01-Undrained_rev 5.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

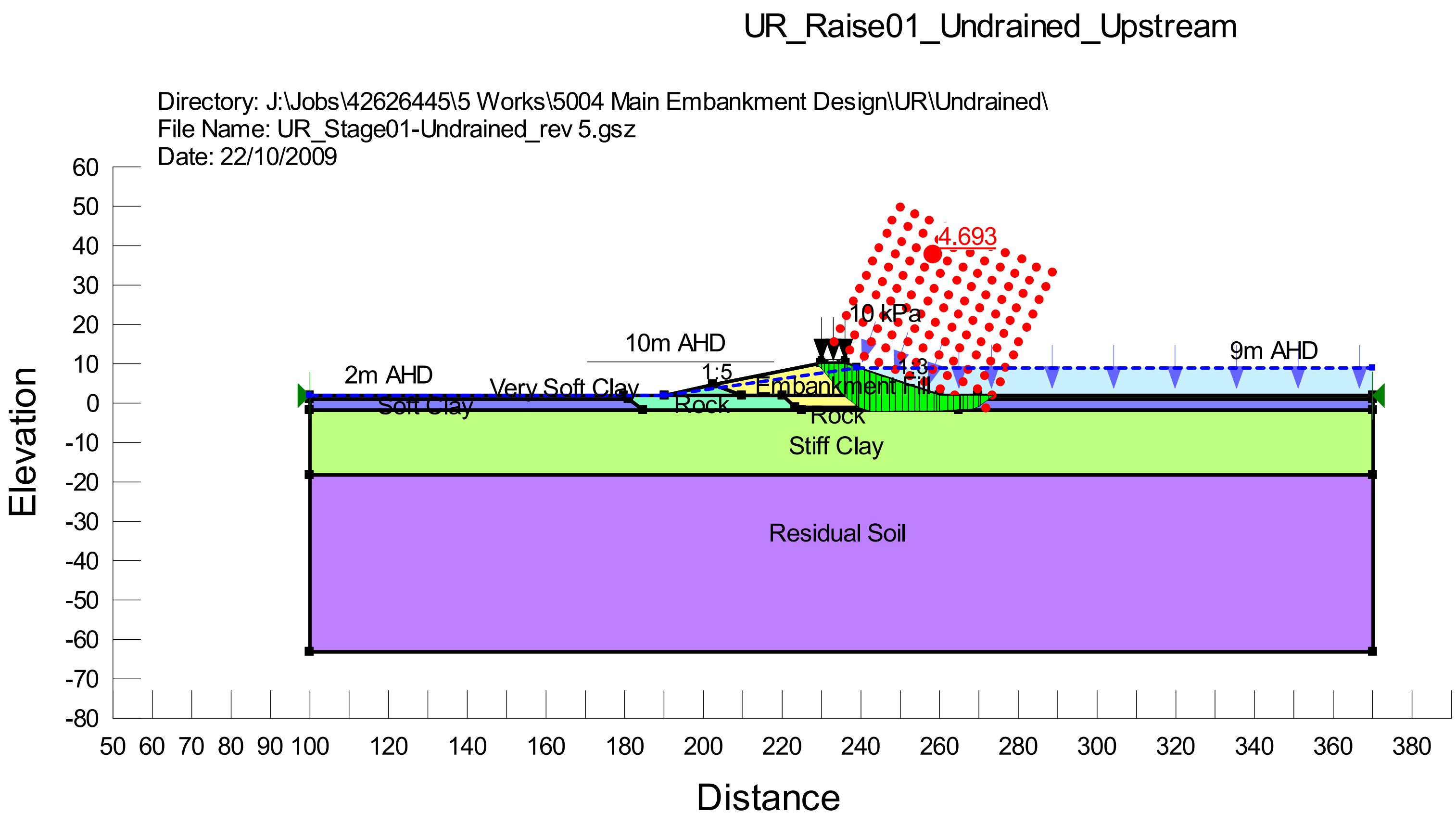
Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd** PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	TITLE Upstream Raise Stage 01 Short-term Stability
DESIGNED: **WW** APPROVED: **TWA** DRAWN: **WW** DATE: **10/2009** CHECKED: **TWA** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1** URS FIGURE **D-1**

J:\Jobs\42626176\6000 Deliverables\6002 Reports\Appendix D\New Coxon Creek Seepage and Stability_Final.ppt



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

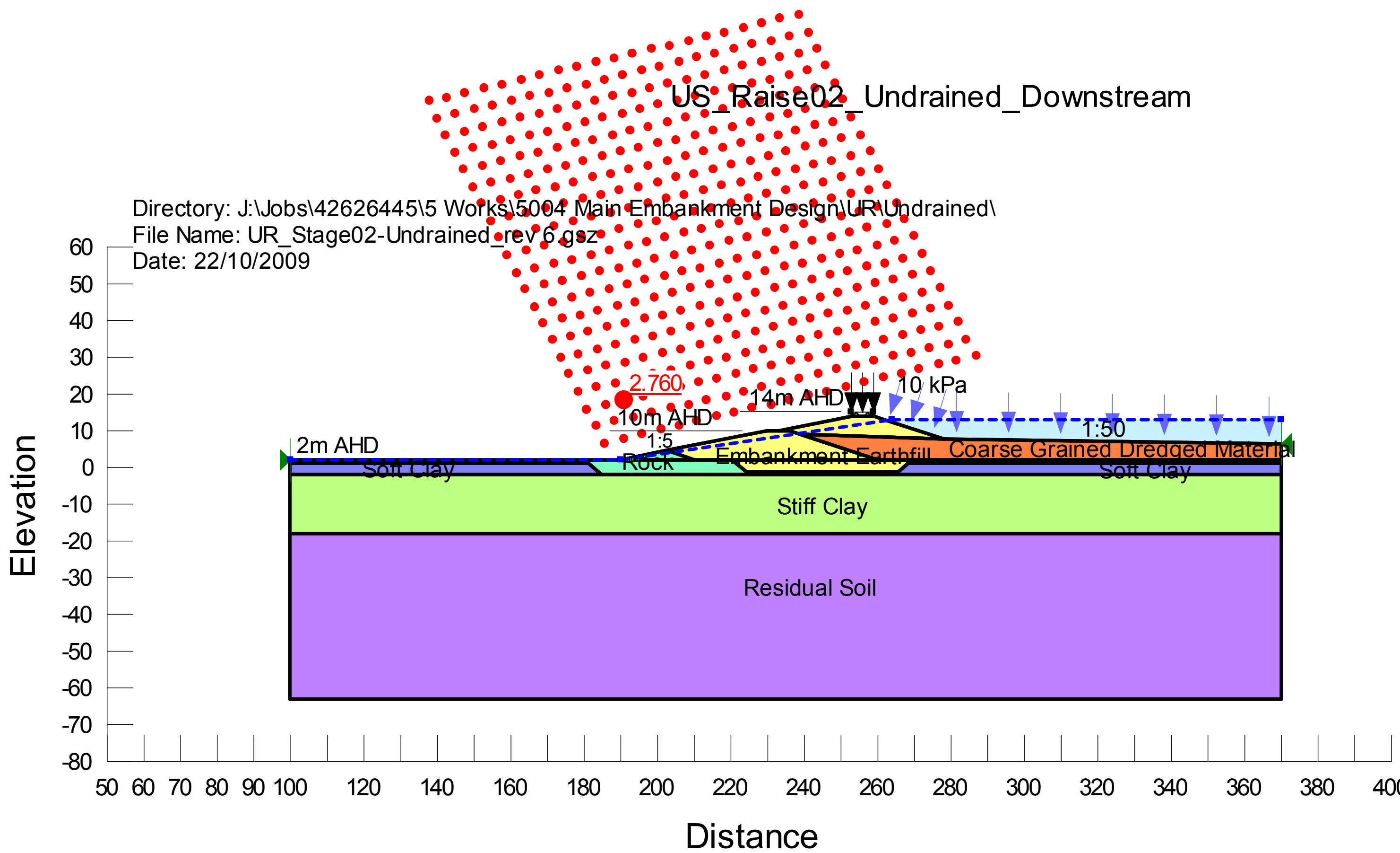
Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd**	TITLE Upstream Raise Stage 01 Short-term Stability
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA** APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1** — URS — FIGURE **D-2**



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Coarse Grained Dredged Material
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT
Santos Ltd

PROJECT
GLNG EIS Supplement Geotechnical Assessment and Design

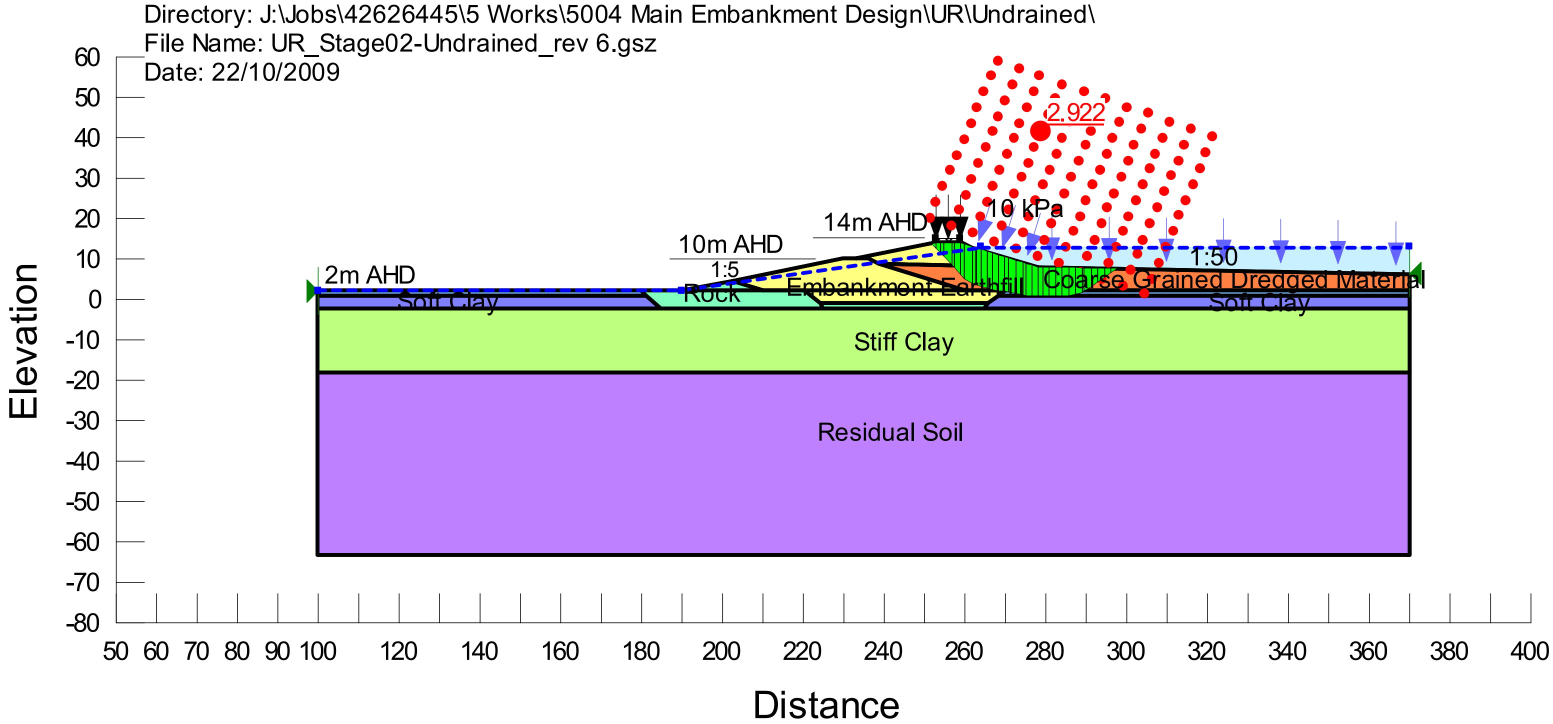
TITLE
Upstream Raise Stage 02
Short-term Stability

DESIGNED:	**WW**	APPROVED:	**TWA**	PROJECT:	**42626445**
DRAWN:	**WW**	DATE:	**10/2009**	FILE:	**05004**
CHECKED:	**TWA**	STATUS:	**FINAL**	REVISION:	**1**

URS

FIGURE
D-3

US_Raise02_Undrained_Upstream



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

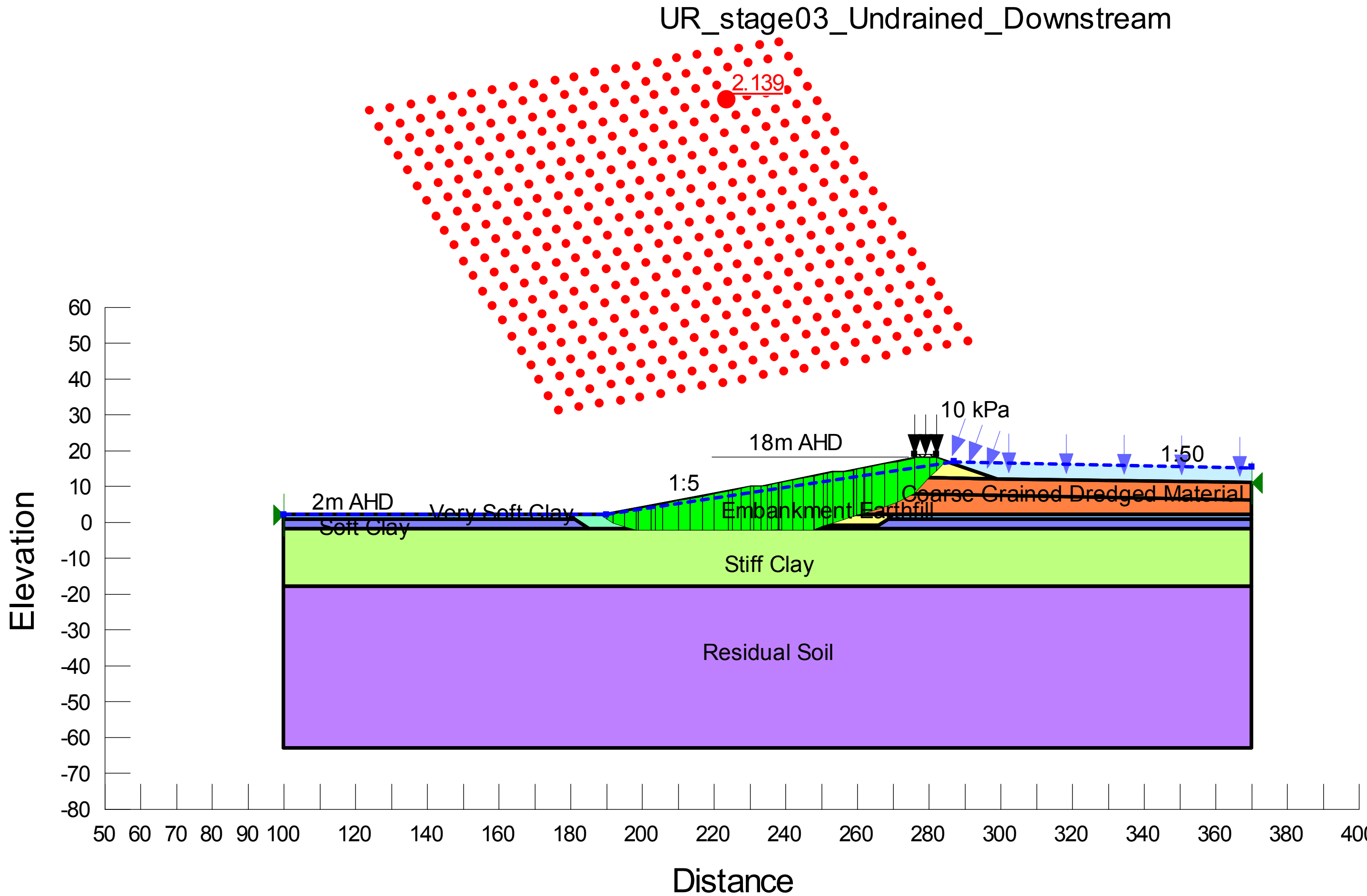
Name: Coarse Grained Dredged Material
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd** PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	TITLE Upstream Raise Stage 02 Short-term Stability
DESIGNED: **WW** APPROVED: **TWA** DRAWN: **WW** DATE: **10/2009** CHECKED: **TWA** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1** URS FIGURE **D-4**

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\UR\Undrained\
File Name: UR_Stage03-Undrained_rev 6.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Coarse Grained Dredged Materia
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT
Santos Ltd
PROJECT
GLNG EIS Supplement Geotechnical Assessment and Design

TITLE
Upstream Raise Stage 03
Short-term Stability

DESIGNED:	**WW**	APPROVED:	**TWA**
DRAWN:	**WW**	DATE:	**10/2009**
CHECKED:	**TWA**	STATUS:	**FINAL**

PROJECT: **42626445**
FILE: **05004**
REVISION: **1**

URS

FIGURE
D-5

UR_stage03_Undrained_Upstream

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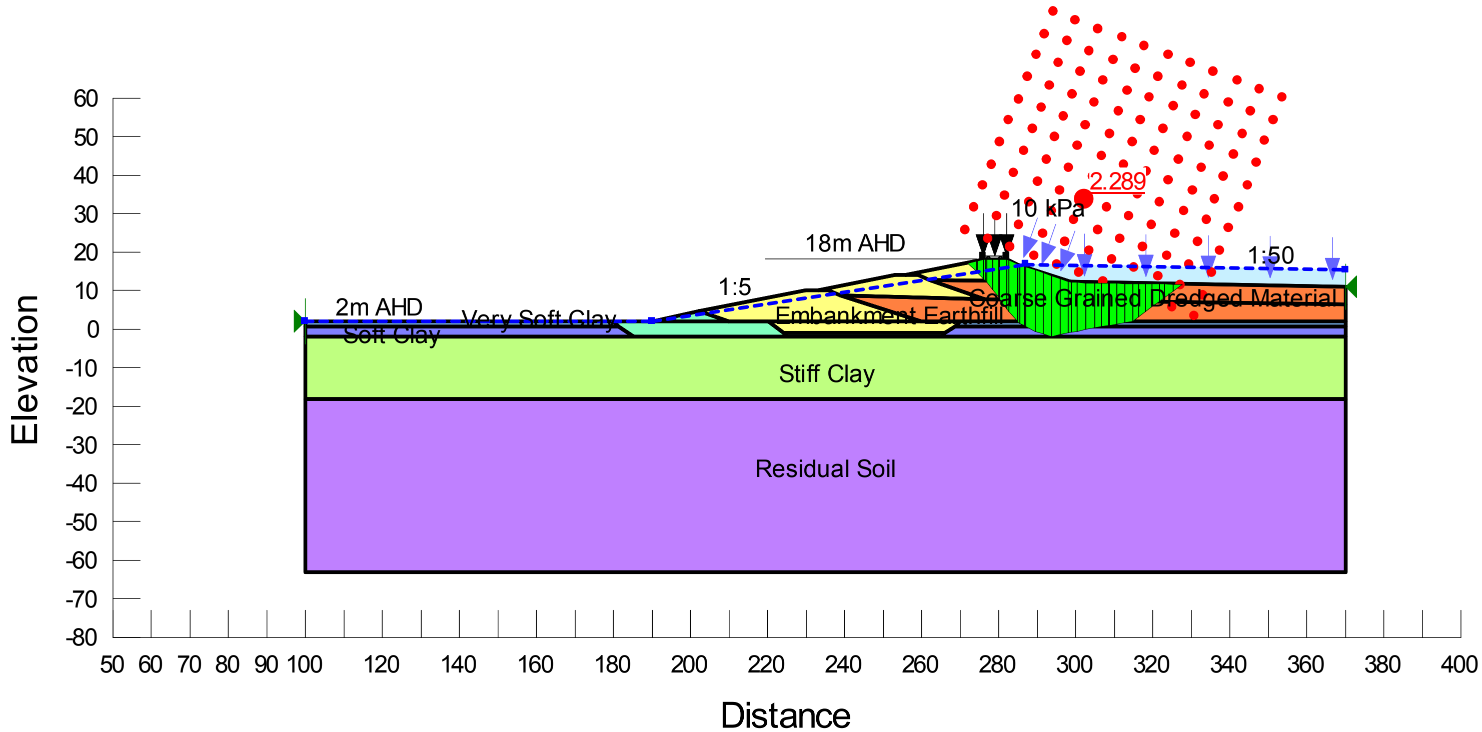
File Name: UR_Stage03-Undrained_rev 6.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Coarse Grained Dredged Materia
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

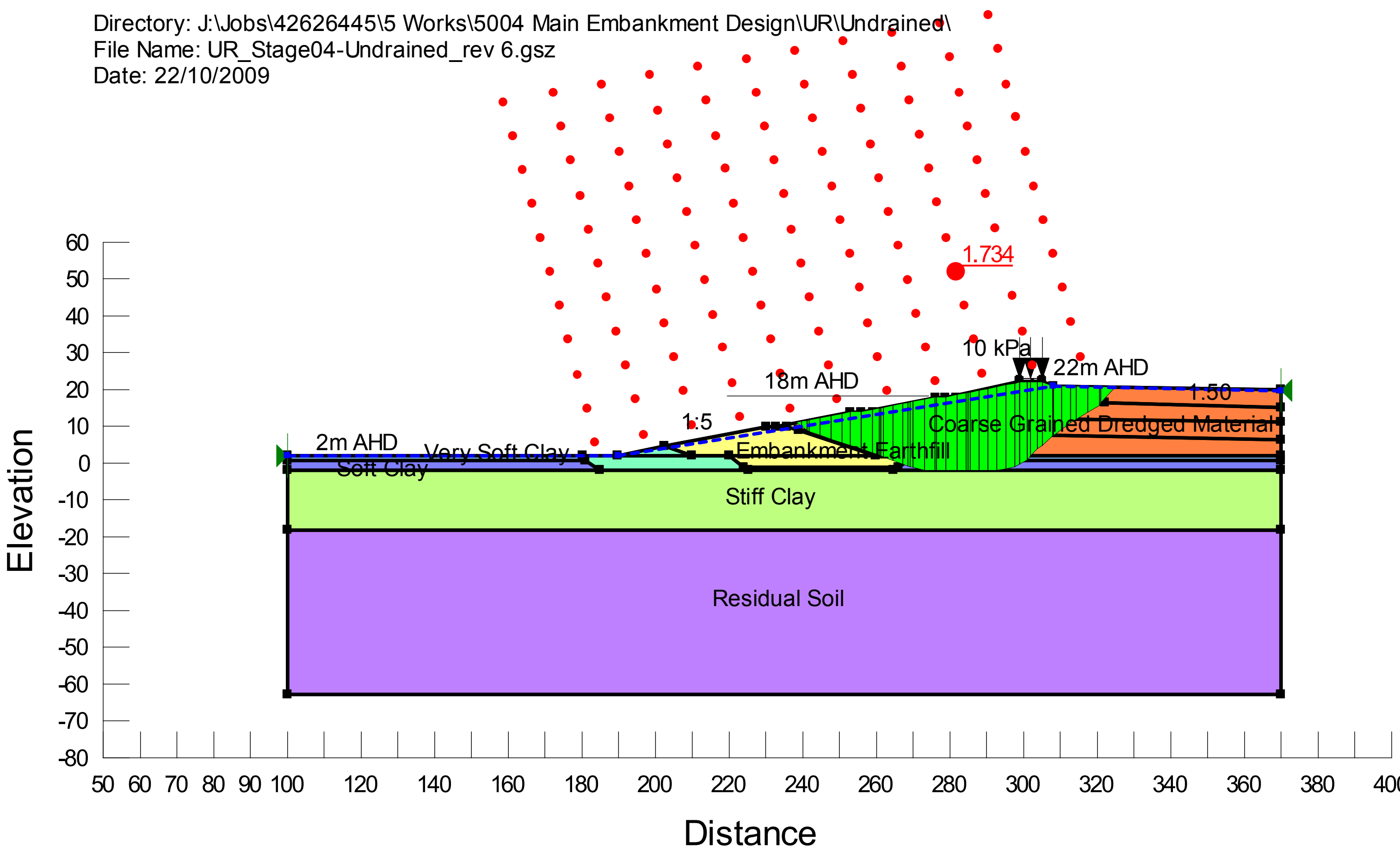
Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd** PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	TITLE Upstream Raise Stage 03 Short-term Stability
DESIGNED: **WW** APPROVED: **TWA** DRAWN: **WW** DATE: **10/2009** CHECKED: **TWA** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1** URS FIGURE **D-6**

J:\Jobs\42626176\6000 Deliverables\6002 Reports\Appendix D\New Coxon Creek Seepage and Stability_Final.ppt

UR_Raise04_Undrained_Downstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\UR\Undrained\
File Name: UR_Stage04-Undrained_rev 6.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Coarse Grained Dredged Material
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

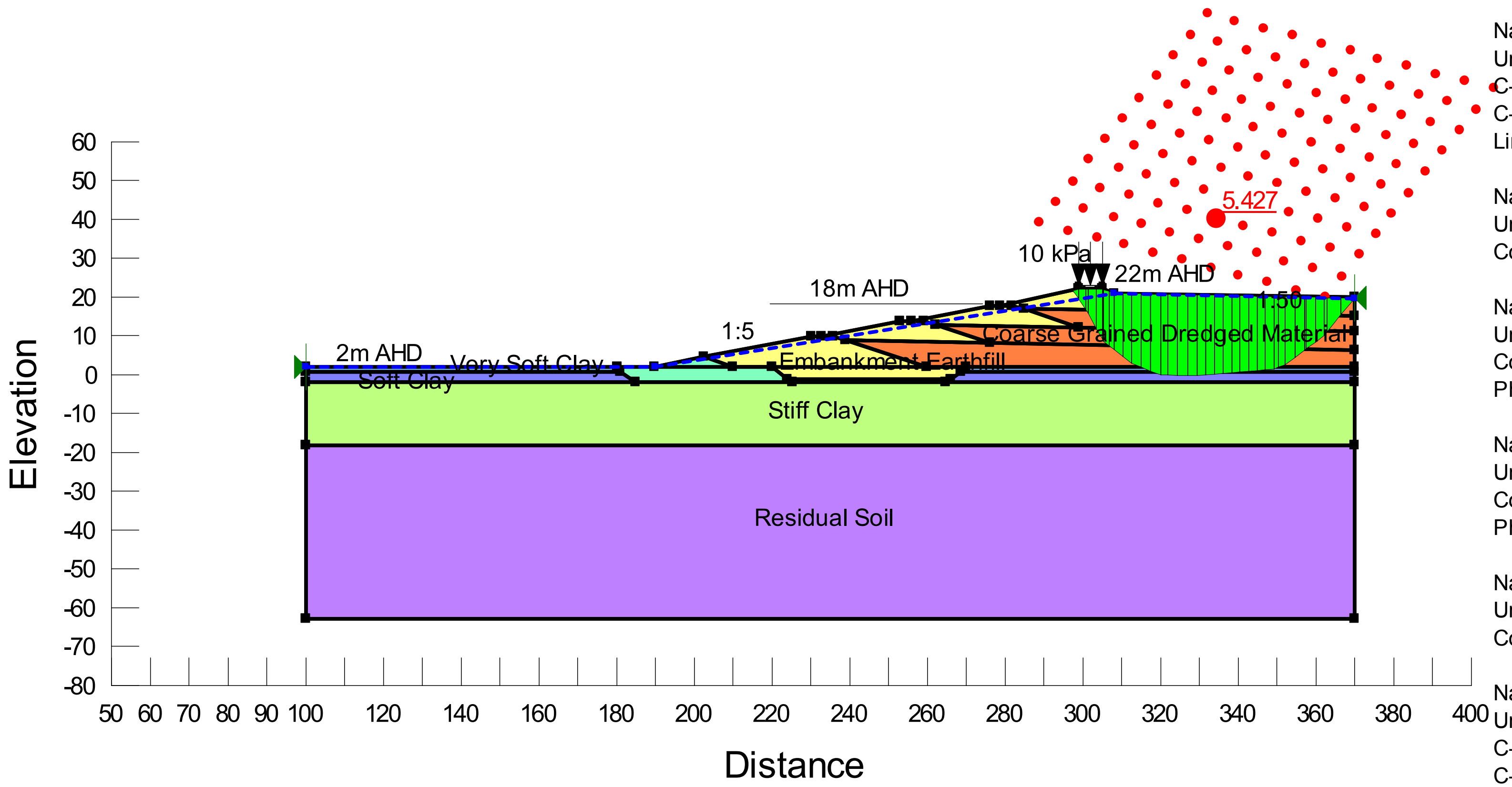
Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd** PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**		TITLE Upstream Raise Stage 04 Short-term Stability	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA**	APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1**	FIGURE **D-7**

UR_Raise04_Undrained_Upstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\UR\Undrained\
File Name: UR_Stage04-Undrained_rev 6.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Coarse Grained Dredged Material
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

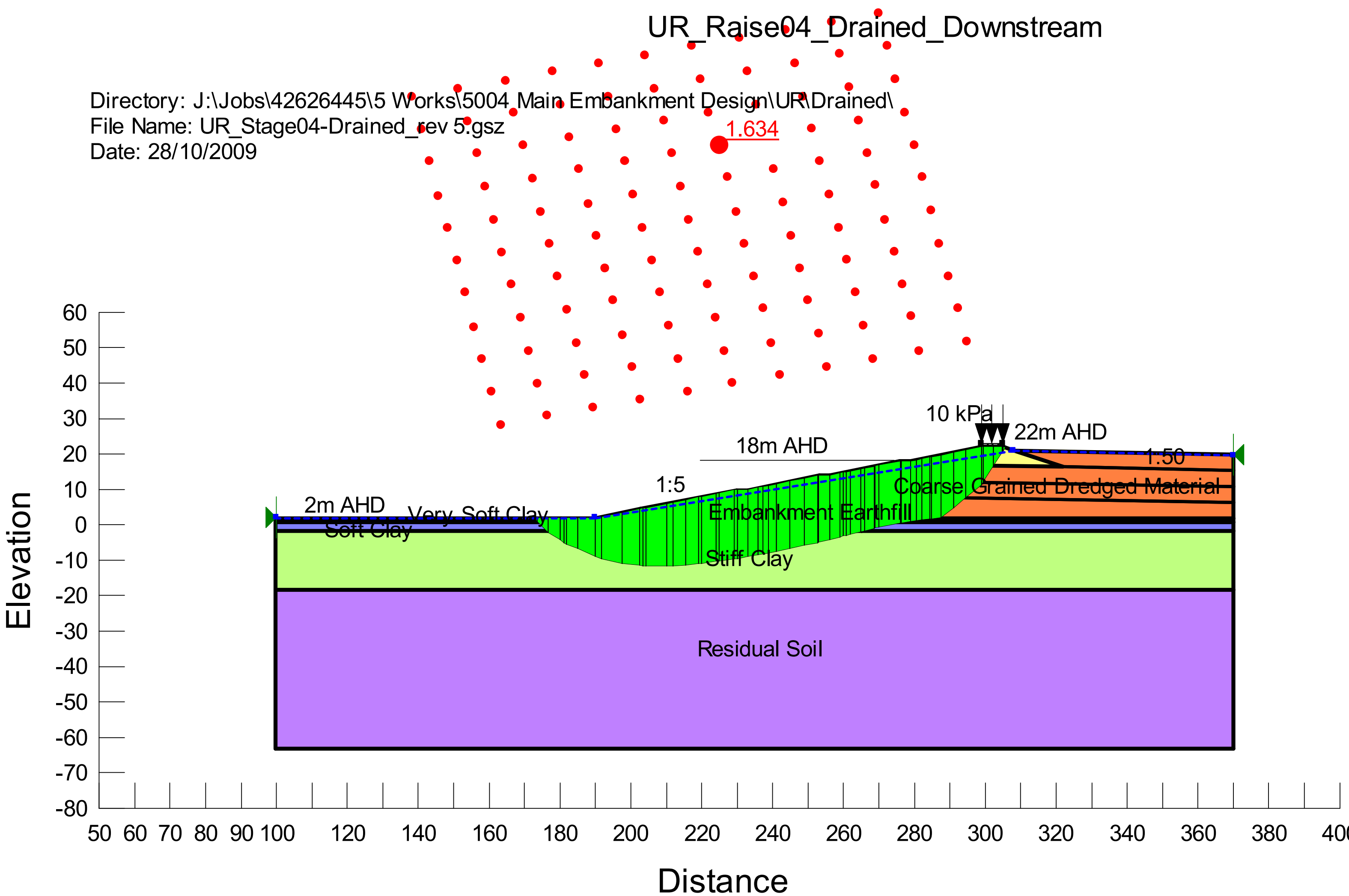
Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd**	TITLE
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	Upstream Raise Stage 04 Short-term Stability

DESIGNED:	**WW**	APPROVED:	**TWA**	PROJECT:	**42626445**
DRAWN:	**WW**	DATE:	**10/2009**	FILE:	**05004**
CHECKED:	**TWA**	STATUS:	**FINAL**	REVISION:	**1**

URS

FIGURE **D-8**



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °

Name: Stiff Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa
Phi: 25 °

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 20 °

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Coarse Grained Dredged Material
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 15 °

Name: Residual Soil
Unit Weight: 19 kN/m³
Cohesion: 12 kPa
Phi: 25 °

CLIENT
Santos Ltd

PROJECT
GLNG EIS Supplement Geotechnical Assessment and Design

TITLE
Upstream Raise Stage 04
Long-term Stability

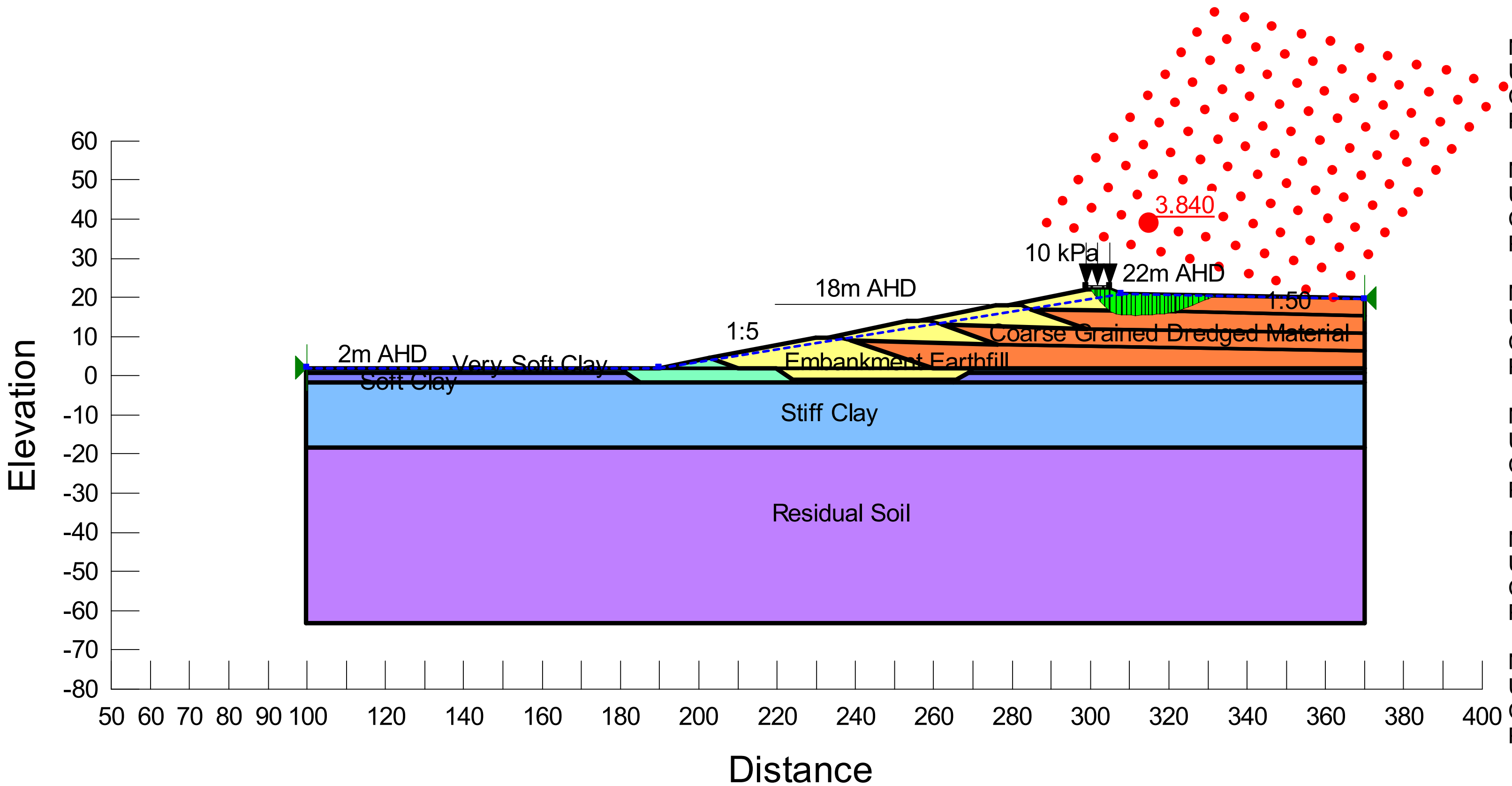
DESIGNED:	WW	APPROVED:	TWA	PROJECT:	42626445
DRAWN:	WW	DATE:	10/2009	FILE:	05004
CHECKED:	TWA	STATUS:	FINAL	REVISION:	1

URS

FIGURE
D-9

UR_Raise04_Drained_Upstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\UR\Drained\
File Name: UR_Stage04-Drained_rev 5.gsz
Date: 28/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 30 °

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 20 °

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Coarse Grained Dredged Material
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 15 °

Name: Residual Soil
Unit Weight: 19 kN/m³
Cohesion: 12 kPa
Phi: 25 °

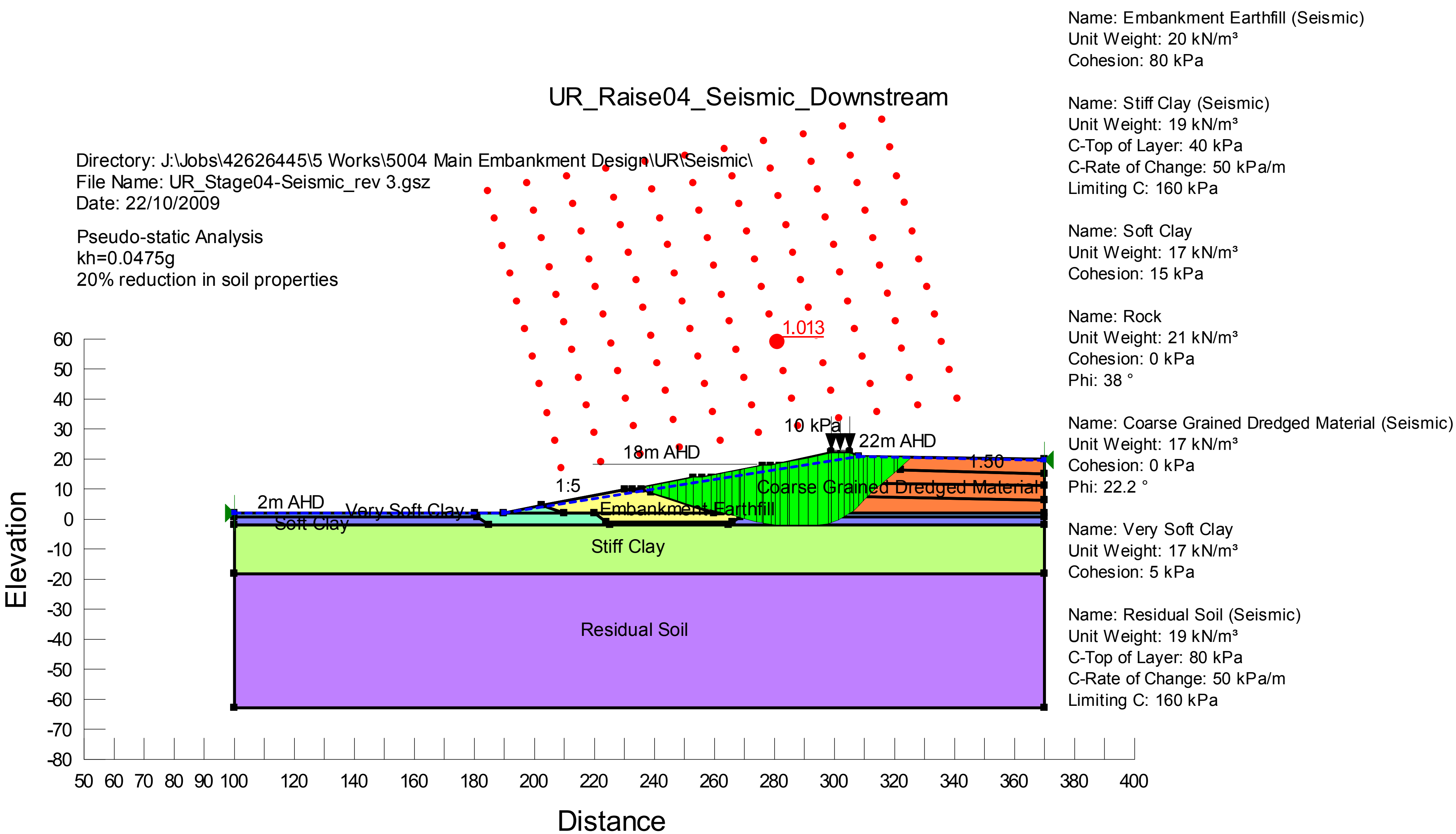
CLIENT
Santos Ltd
PROJECT
GLNG EIS Supplement Geotechnical Assessment and Design

TITLE
Upstream Raise Stage 04
Long-term Stability

DESIGNED:	**WW**	APPROVED:	**TWA**	PROJECT:	**42626445**
DRAWN:	**WW**	DATE:	**10/2009**	FILE:	**05004**
CHECKED:	**TWA**	STATUS:	**FINAL**	REVISION:	**1**

URS

FIGURE
D-10

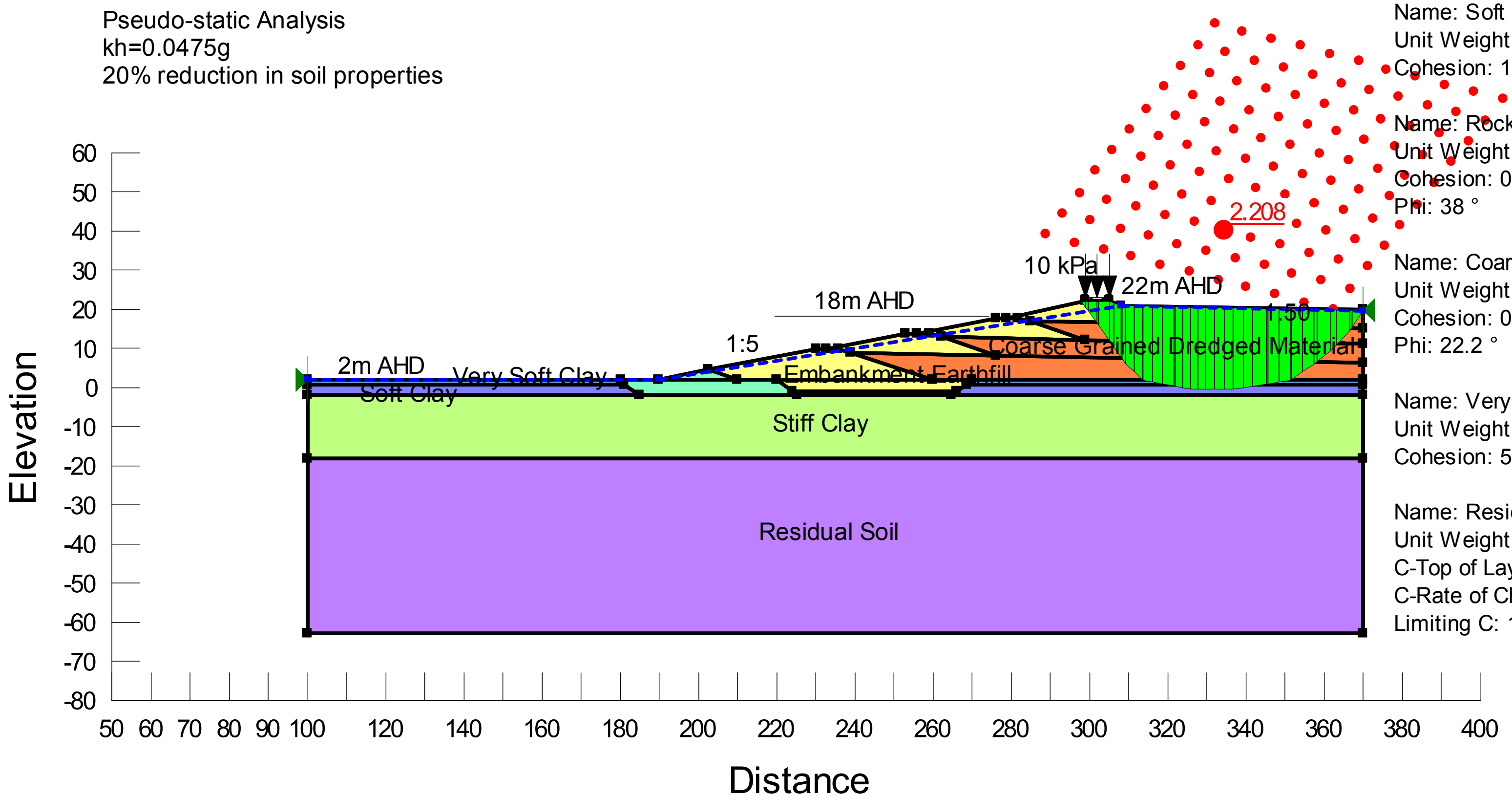


CLIENT **Santos Ltd** PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**		TITLE Upstream Raise Stage 04 Seismic Stability	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA**	APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1**	URS — FIGURE **D-11**

UR_Raise04_Seismic_Upstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\UR\Seismic\
File Name: UR_Stage04-Seismic_rev 3.gsz
Date: 22/10/2009

Pseudo-static Analysis
kh=0.0475g
20% reduction in soil properties



Name: Embankment Earthfill (Seismic)
Unit Weight: 20 kN/m³
Cohesion: 80 kPa

Name: Stiff Clay (Seismic)
Unit Weight: 19 kN/m³
C-Top of Layer: 40 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 160 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Coarse Grained Dredged Material (Seismic)
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 22.2 °

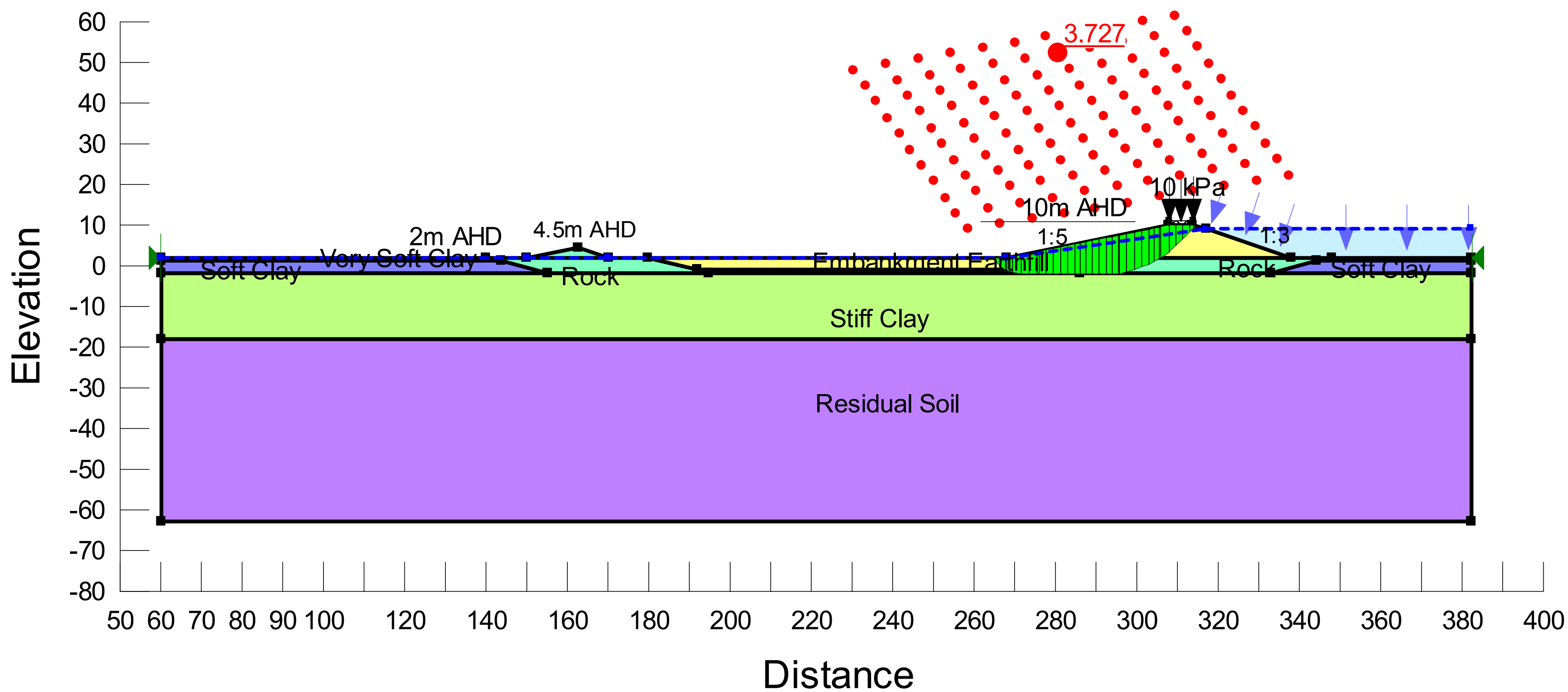
Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil (Seismic)
Unit Weight: 19 kN/m³
C-Top of Layer: 80 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 160 kPa

CLIENT **Santos Ltd**		TITLE	
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**		Upstream Raise Stage 04 Seismic Stability	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA**	APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1**	URS FIGURE **D-12**

DR_Raise01_Undrained_Downstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\DR\Undrained\
File Name: DR_Rasie01_Undrained_rev7.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

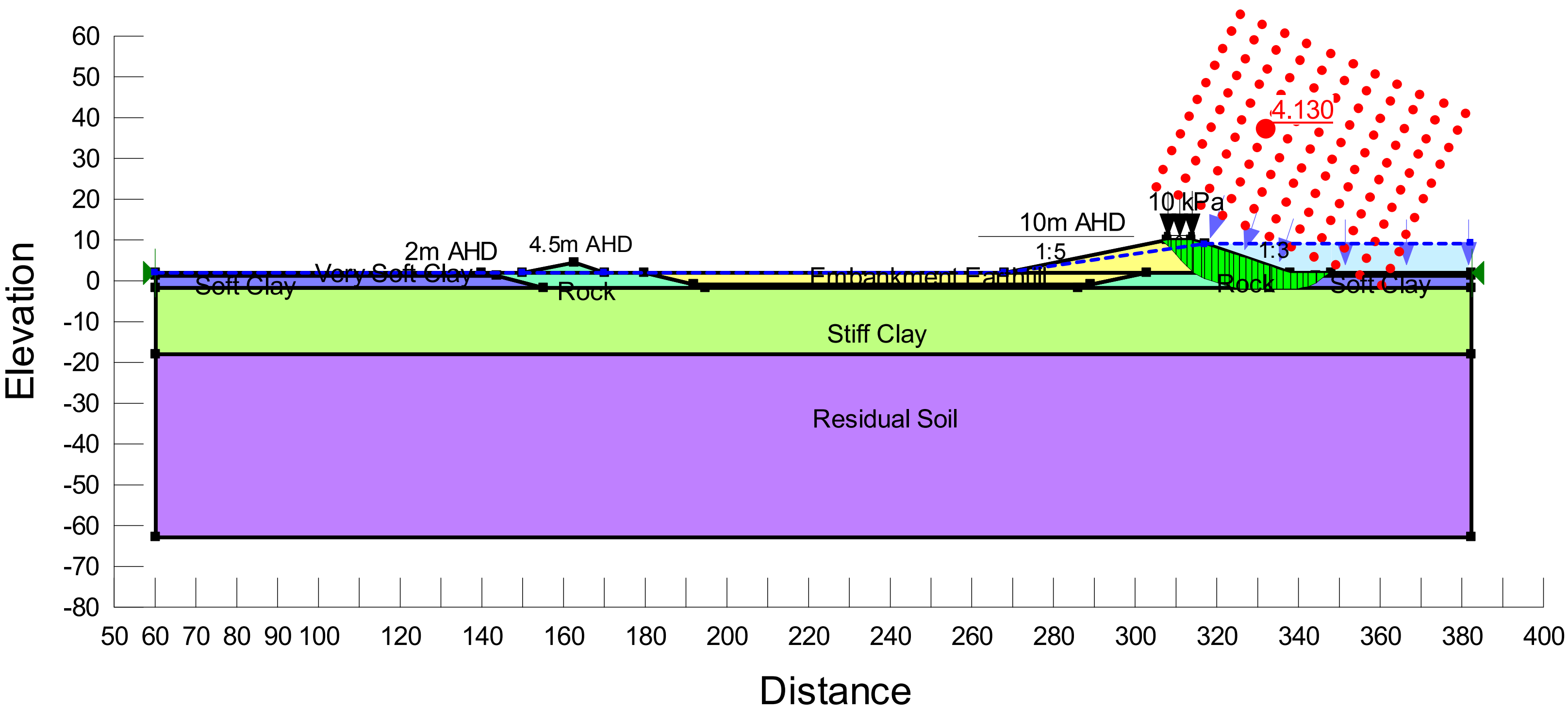
Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd** PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	TITLE Downstream Raise Stage 01 Short-term Stability	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA** APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1**	URS FIGURE **D-13**

DR_Raise01_Undrained_Upstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\DR\Undrained\
File Name: DR_Rasie01_Undrained_rev7.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

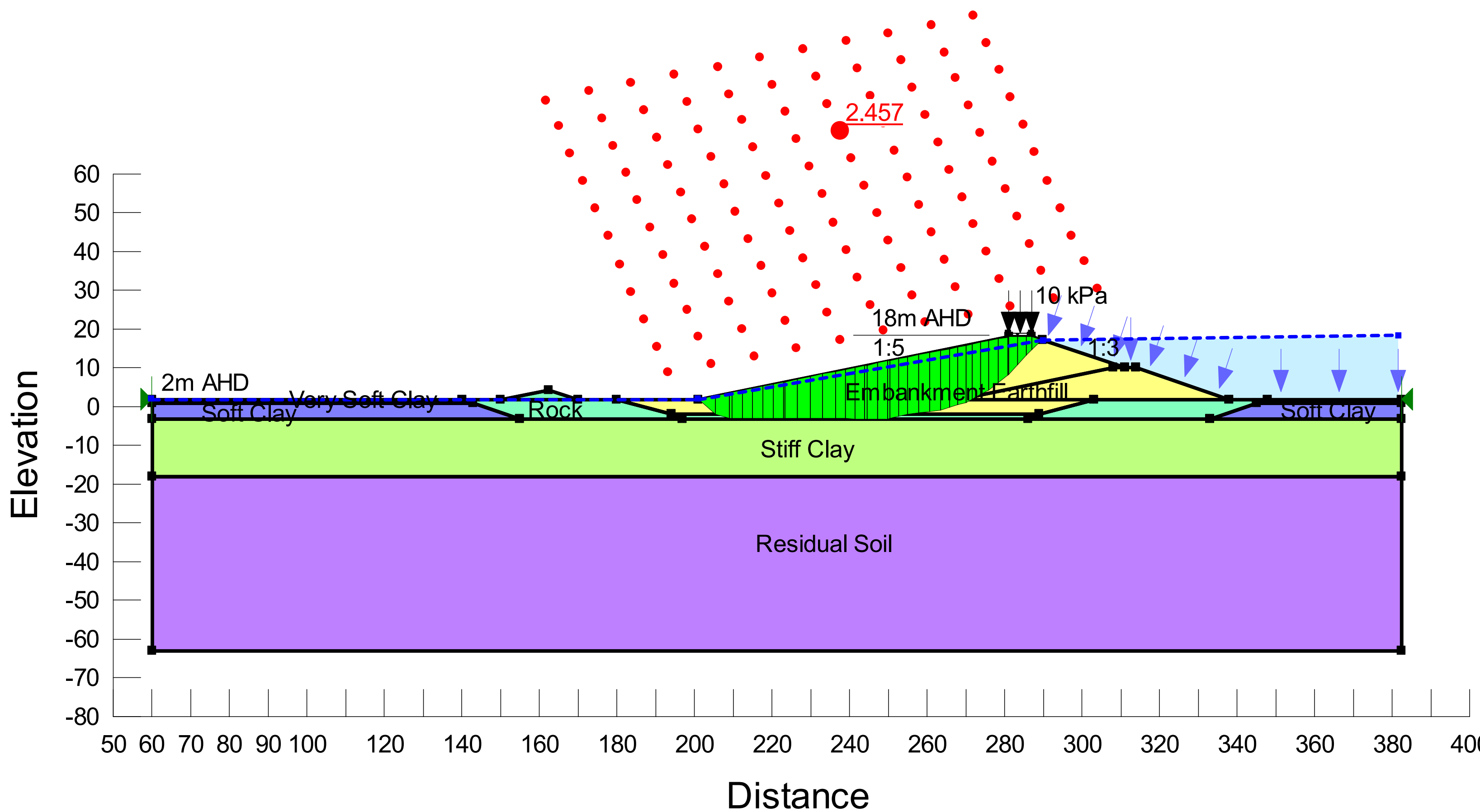
Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd**	TITLE Downstream Raise Stage 01 Short-term Stability
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA** APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1** URS FIGURE **D-14**

DR_Raise02_Undrained_Downstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\DR\Undrained\
File Name: DR_Raise02_Undrained_rev7.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

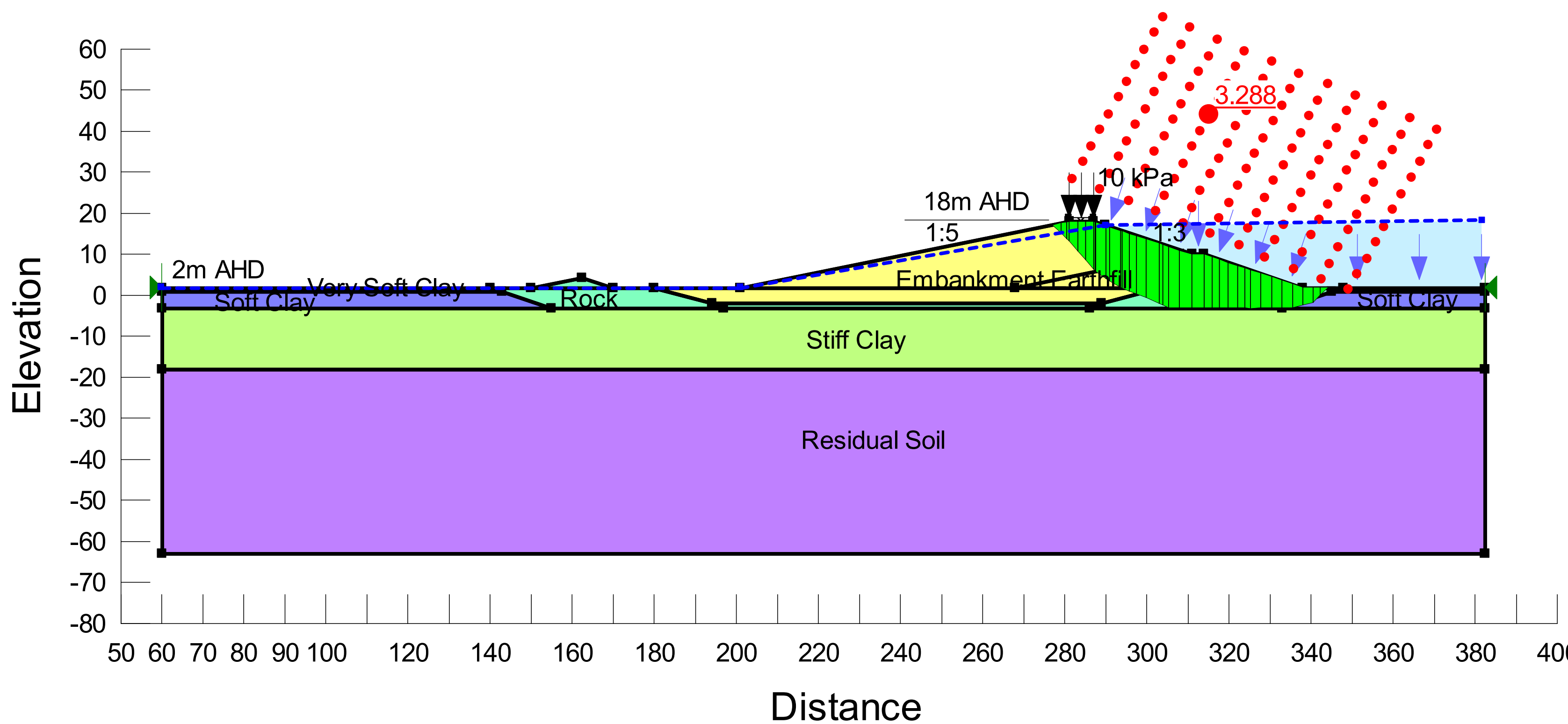
Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd**	TITLE Downstream Raise Stage 02 Short-term Stability
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA** APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1** — URS — FIGURE **D-15**

DR_Raise02_Undrained_Upstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\DR\Undrained\
File Name: DR_Raise02_Undrained_rev7.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT
Santos Ltd
PROJECT
GLNG EIS Supplement Geotechnical Assessment and Design

TITLE
Downstream Raise Stage 02
Short-term Stability

DESIGNED: **WW** APPROVED: **TWA**
DRAWN: **WW** DATE: **10/2009**
CHECKED: **TWA** STATUS: **FINAL**

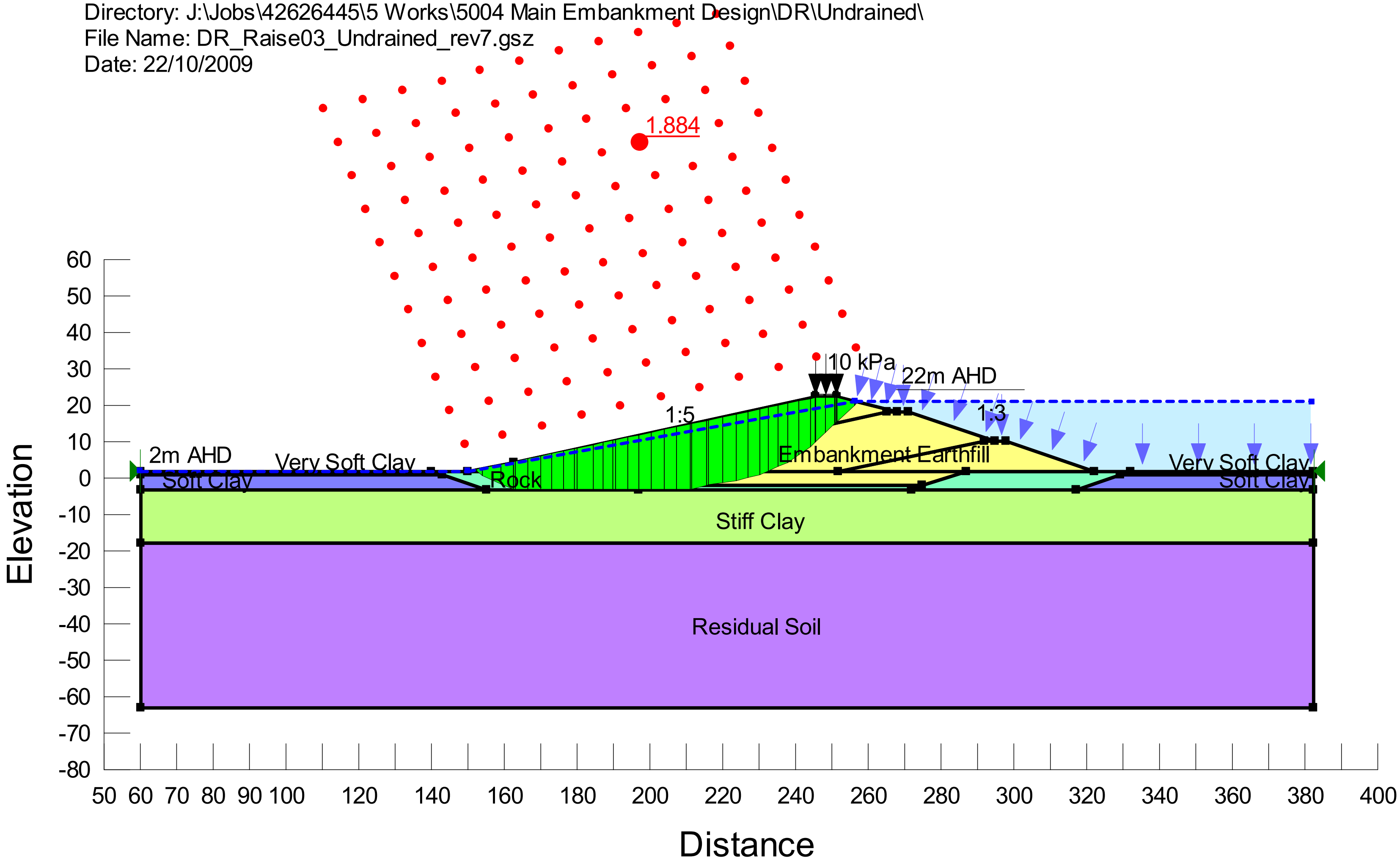
PROJECT: **42626445**
FILE: **05004**
REVISION: **1**

URS

FIGURE
D-16

DR_Raise03_Undrained_Downstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\DR\Undrained\
File Name: DR_Raise03_Undrained_rev7.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

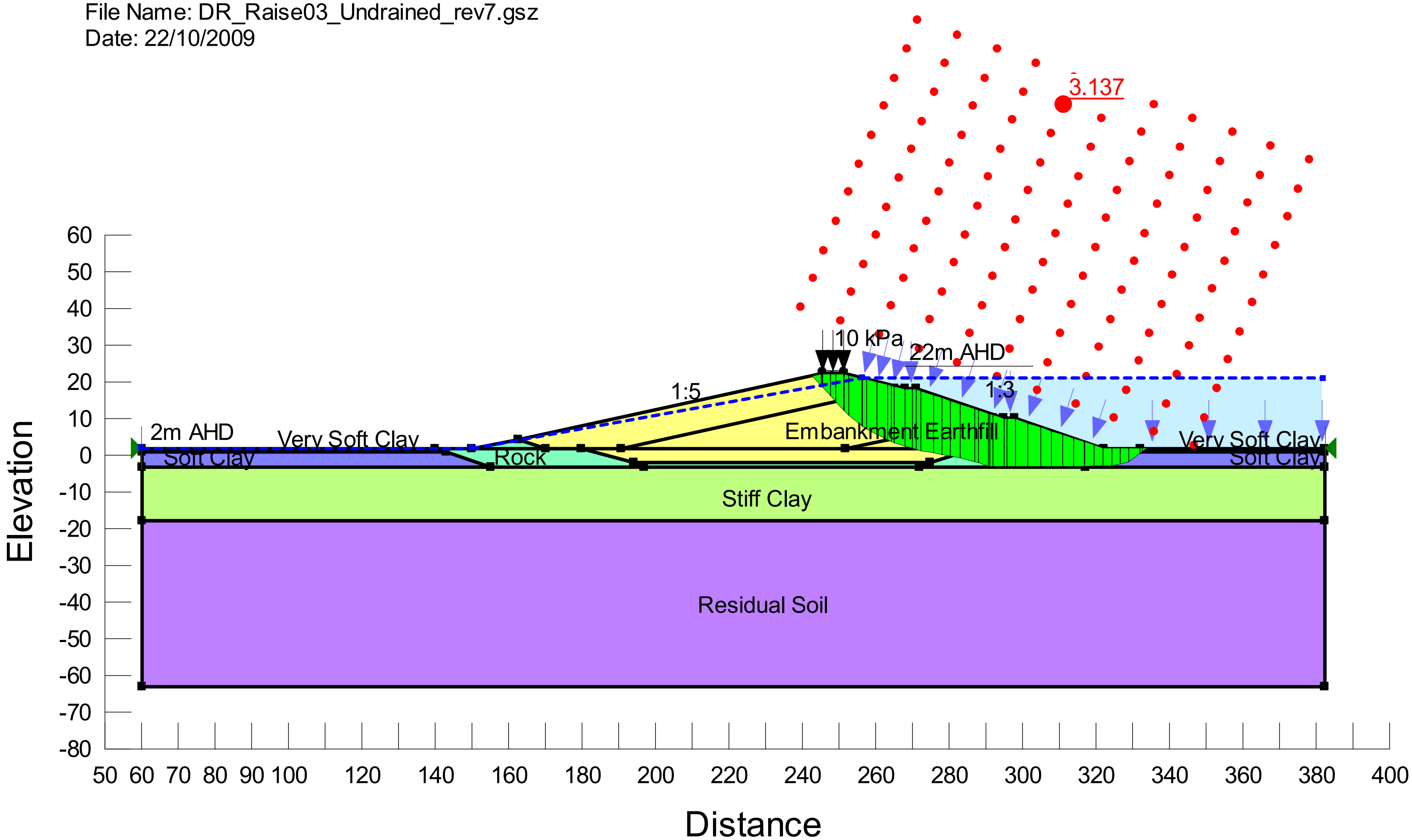
Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd**		TITLE Downstream Raise Stage 03 Short-term Stability	
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**			
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA**	APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1**	URS FIGURE **D-17**

DR_Raise03_Undrained_Upstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\DR\Undrained\
File Name: DR_Raise03_Undrained_rev7.gsz
Date: 22/10/2009



Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

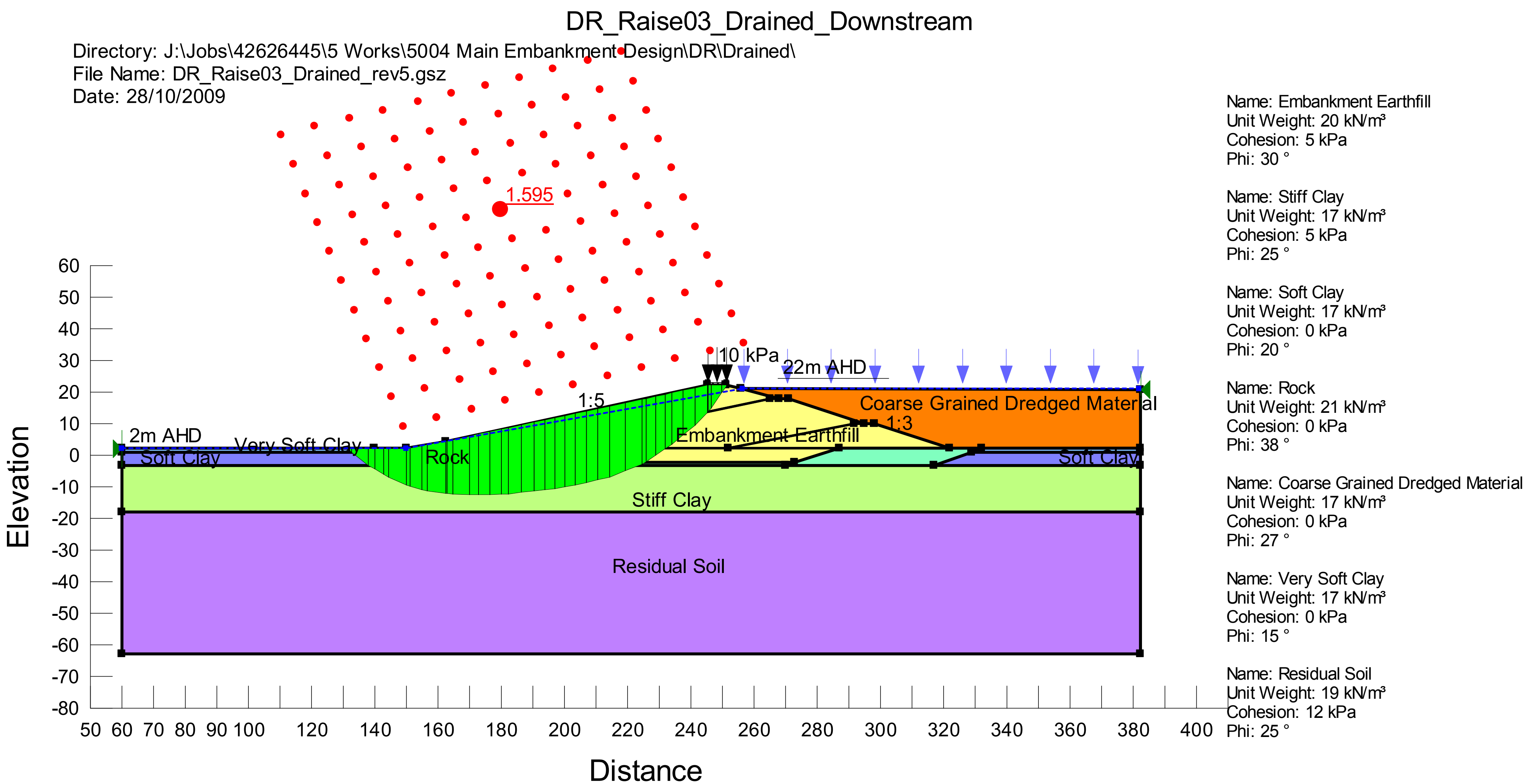
Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd**	TITLE Downstream Raise Stage 03 Short-term Stability
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA** APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1** URS FIGURE **D-18**



CLIENT
Santos Ltd
PROJECT
GLNG EIS Supplement Geotechnical Assessment and Design

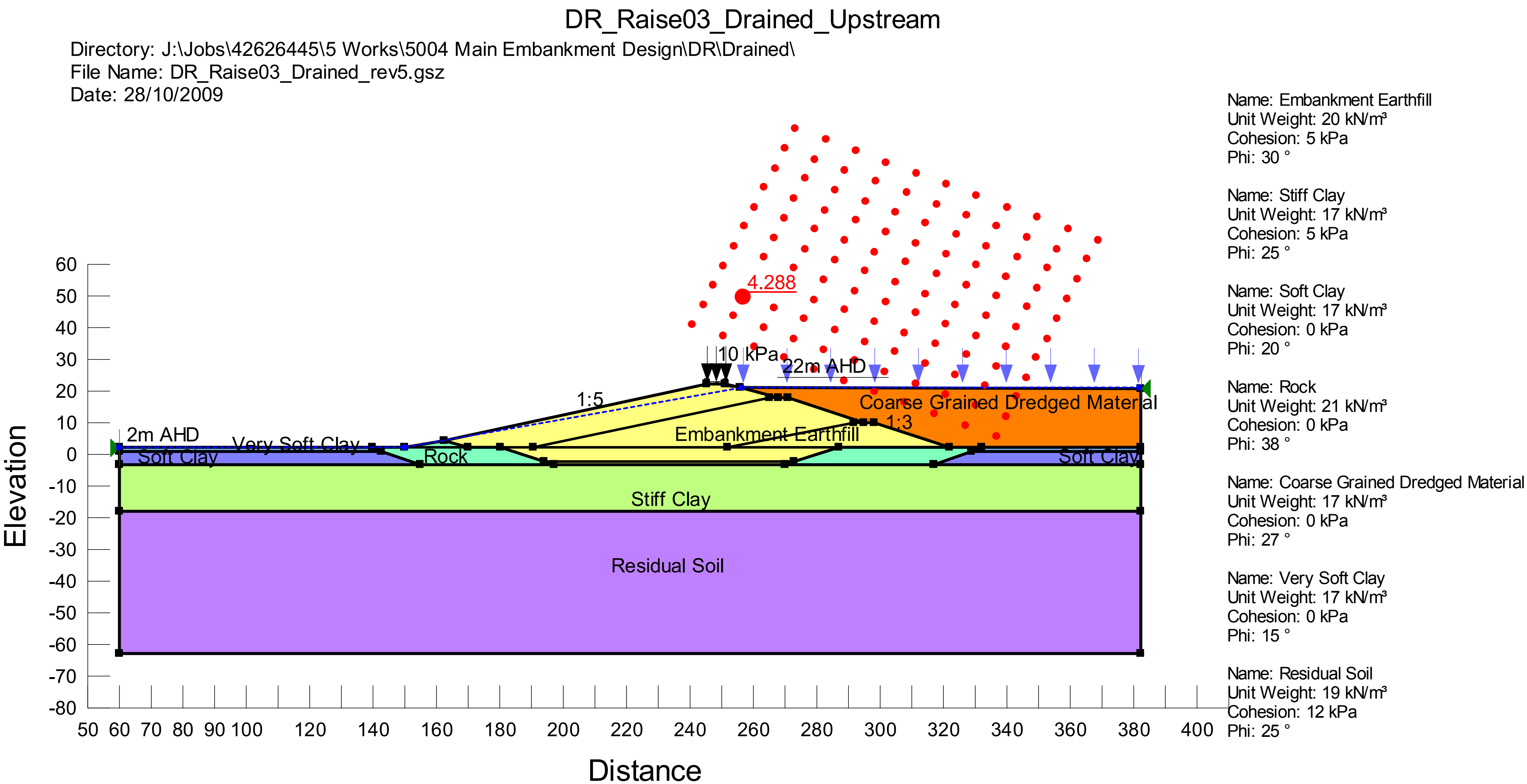
TITLE
Downstream Raise Stage 03
Long-term Stability

DESIGNED:	**WW**	APPROVED:	**TWA**
DRAWN:	**WW**	DATE:	**10/2009**
CHECKED:	**TWA**	STATUS:	**FINAL**

PROJECT:	**42626445**
FILE:	**05004**
REVISION:	**1**

URS

FIGURE
D-19



CLIENT **Santos Ltd**	TITLE
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	Downstream Raise Stage 03 Long-term Stability

DESIGNED:	**WW**	APPROVED:	**TWA**	PROJECT:	**42626445**
DRAWN:	**WW**	DATE:	**10/2009**	FILE:	**05004**
CHECKED:	**TWA**	STATUS:	**FINAL**	REVISION:	**1**

URS

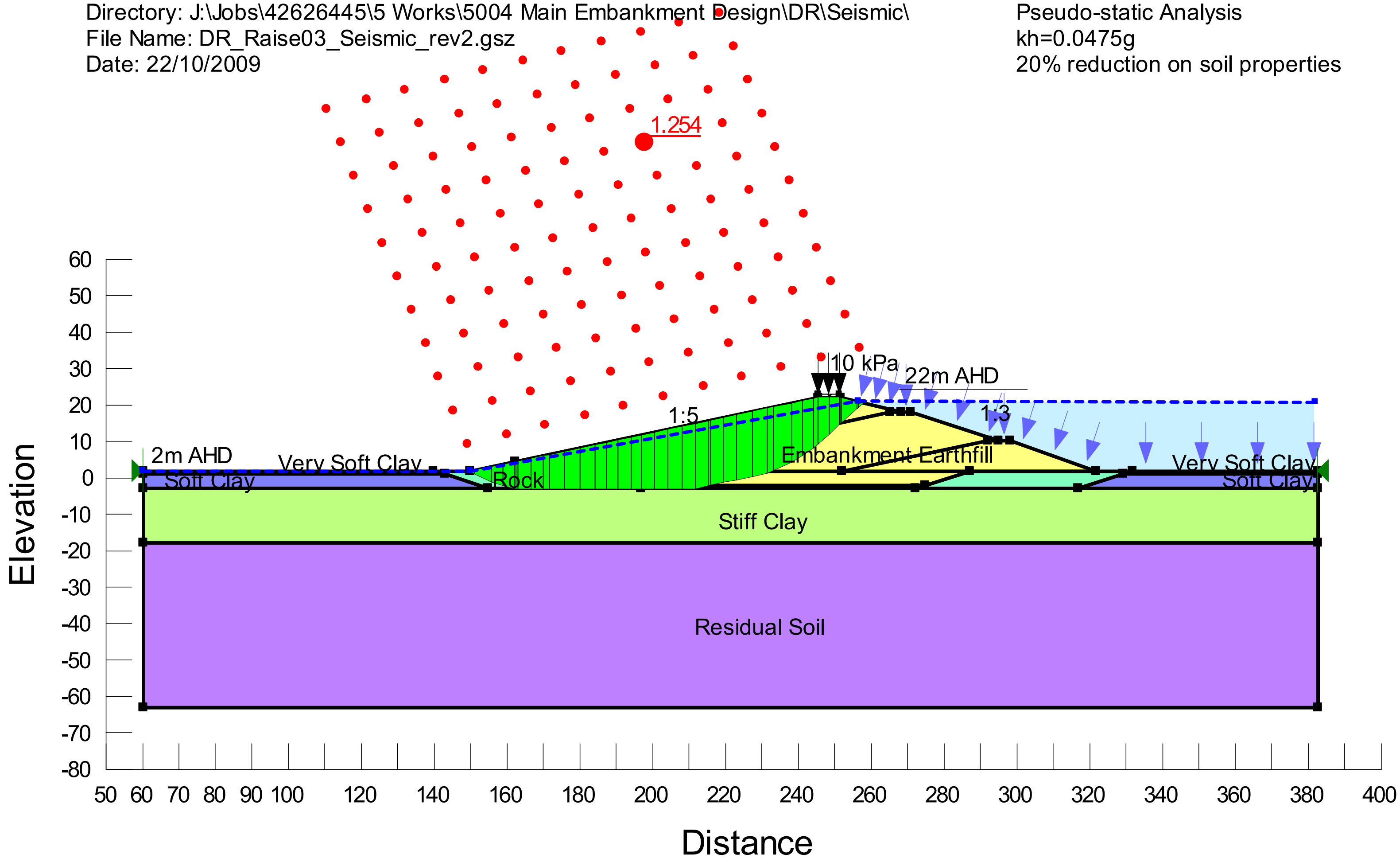
FIGURE **D-20**

J:\Jobs\42626176\6000 Deliverables\6002 Reports\Appendix D\New Coxon Creek Seepage and Stability_Final.ppt

DR_Raise03_Seismic_Downstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\DR\Seismic\
File Name: DR_Raise03_Seismic_rev2.gsz
Date: 22/10/2009

Pseudo-static Analysis
kh=0.0475g
20% reduction on soil properties



Name: Embankment Earthfill (Seismic)
Unit Weight: 20 kN/m³
Cohesion: 80 kPa

Name: Stiff Clay (Seismic)
Unit Weight: 17 kN/m³
C-Top of Layer: 40 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 160 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil (Seismic)
Unit Weight: 19 kN/m³
C-Top of Layer: 80 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 160 kPa

CLIENT
Santos Ltd
PROJECT
GLNG EIS Supplement Geotechnical Assessment and Design

TITLE
Downstream Raise Stage 03
Seismic Stability

DESIGNED:	**WW**	APPROVED:	**TWA**
DRAWN:	**WW**	DATE:	**10/2009**
CHECKED:	**TWA**	STATUS:	**FINAL**

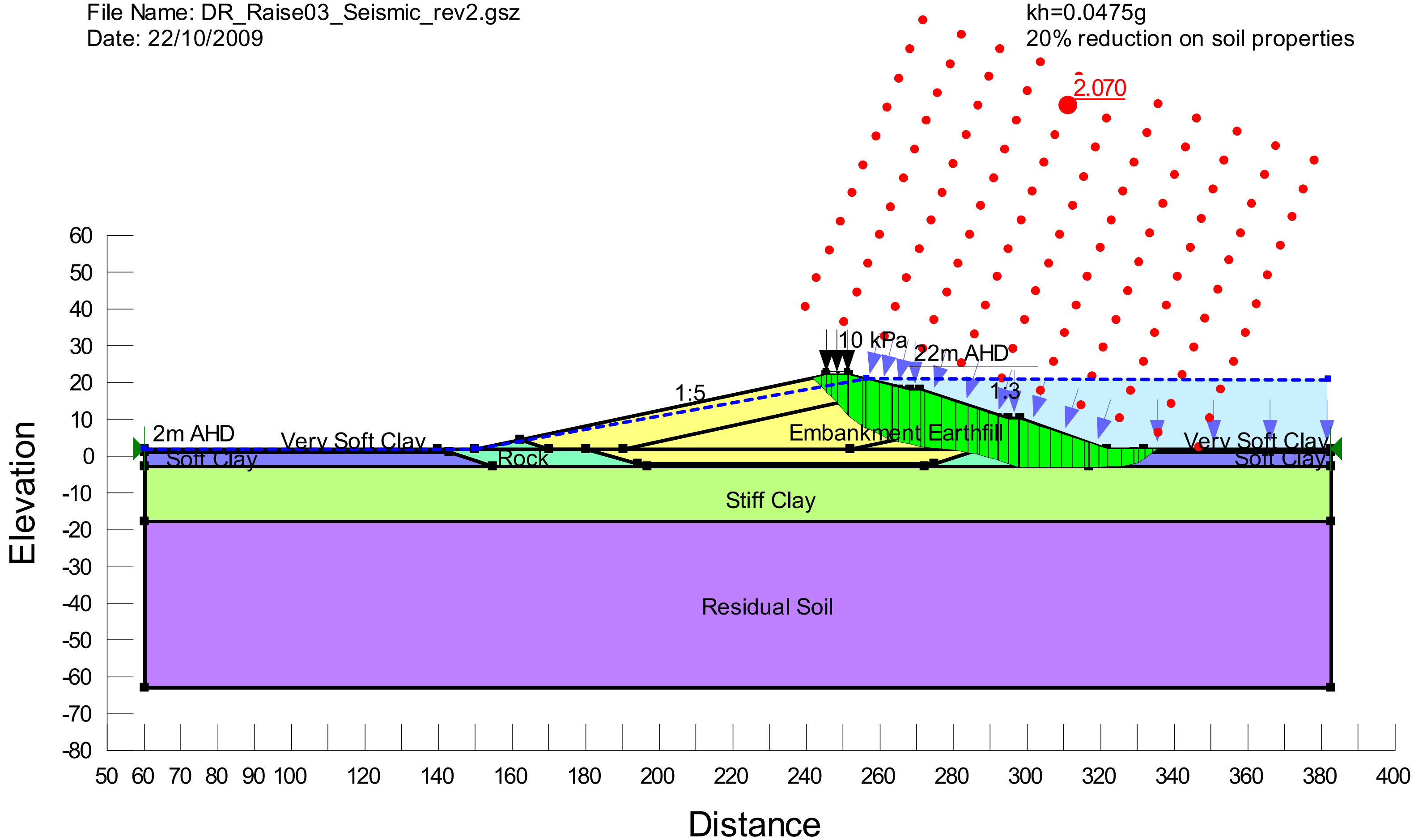
PROJECT: **42626445**
FILE: **05004**
REVISION: **1**

FIGURE
D-21

DR_Raise03_Seismic_Upstream

Directory: J:\Jobs\42626445\5 Works\5004 Main Embankment Design\DR\Seismic\
File Name: DR_Raise03_Seismic_rev2.gsz
Date: 22/10/2009

Pseudo-static Analysis
kh=0.0475g
20% reduction on soil properties



Name: Embankment Earthfill (Seismic)
Unit Weight: 20 kN/m³
Cohesion: 80 kPa

Name: Stiff Clay (Seismic)
Unit Weight: 17 kN/m³
C-Top of Layer: 40 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 160 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Rock
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 38 °

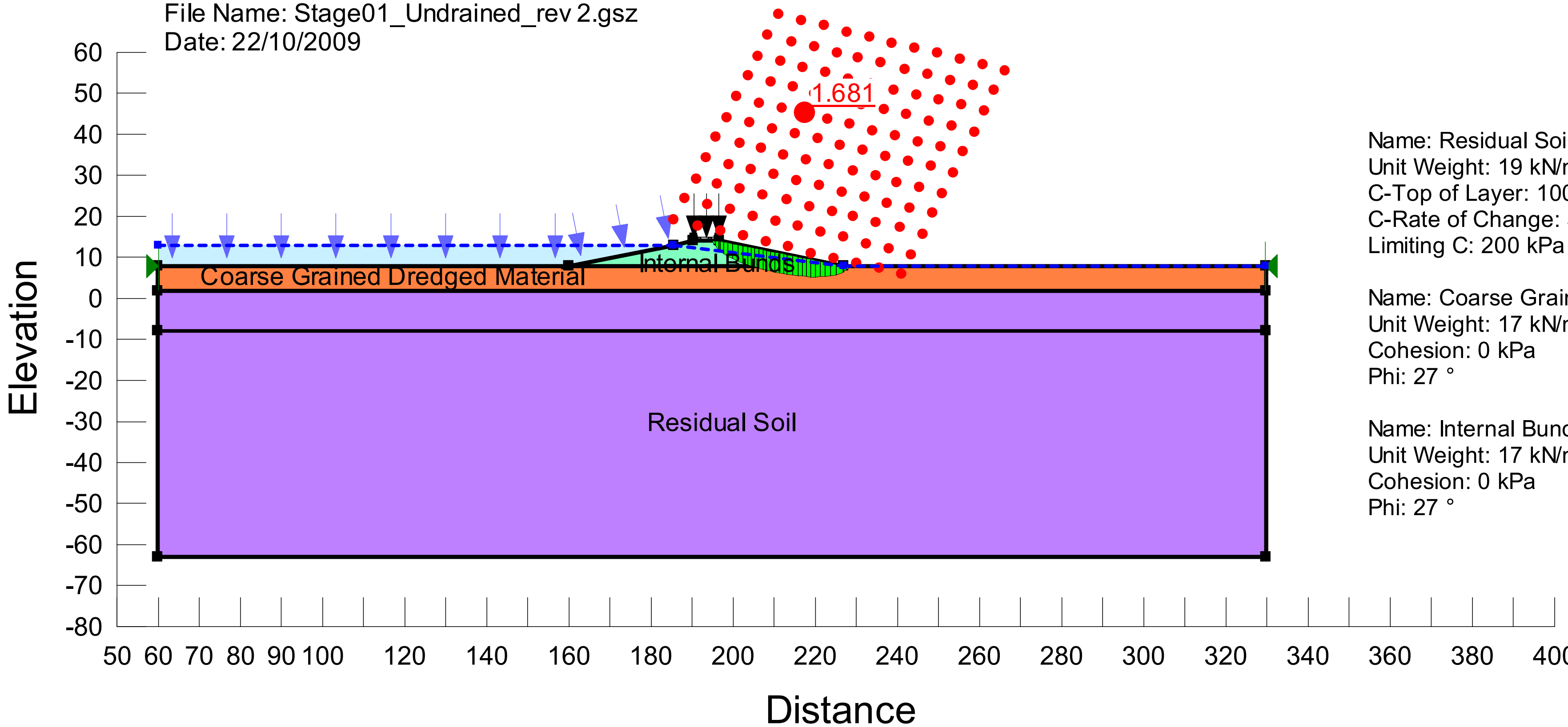
Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil (Seismic)
Unit Weight: 19 kN/m³
C-Top of Layer: 80 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 160 kPa

CLIENT **Santos Ltd** PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	TITLE Downstream Raise Stage 03 Seismic Stability	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA** APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1**	URS FIGURE **D-22**

Internal Bunds_Undrained_Stage01

Directory: J:\Jobs\42626445\5 Works\5005 Internal Bunds_Saddle Dams\Internal Bunds\part 1_GoodGround\
File Name: Stage01_Undrained_rev 2.gsz
Date: 22/10/2009



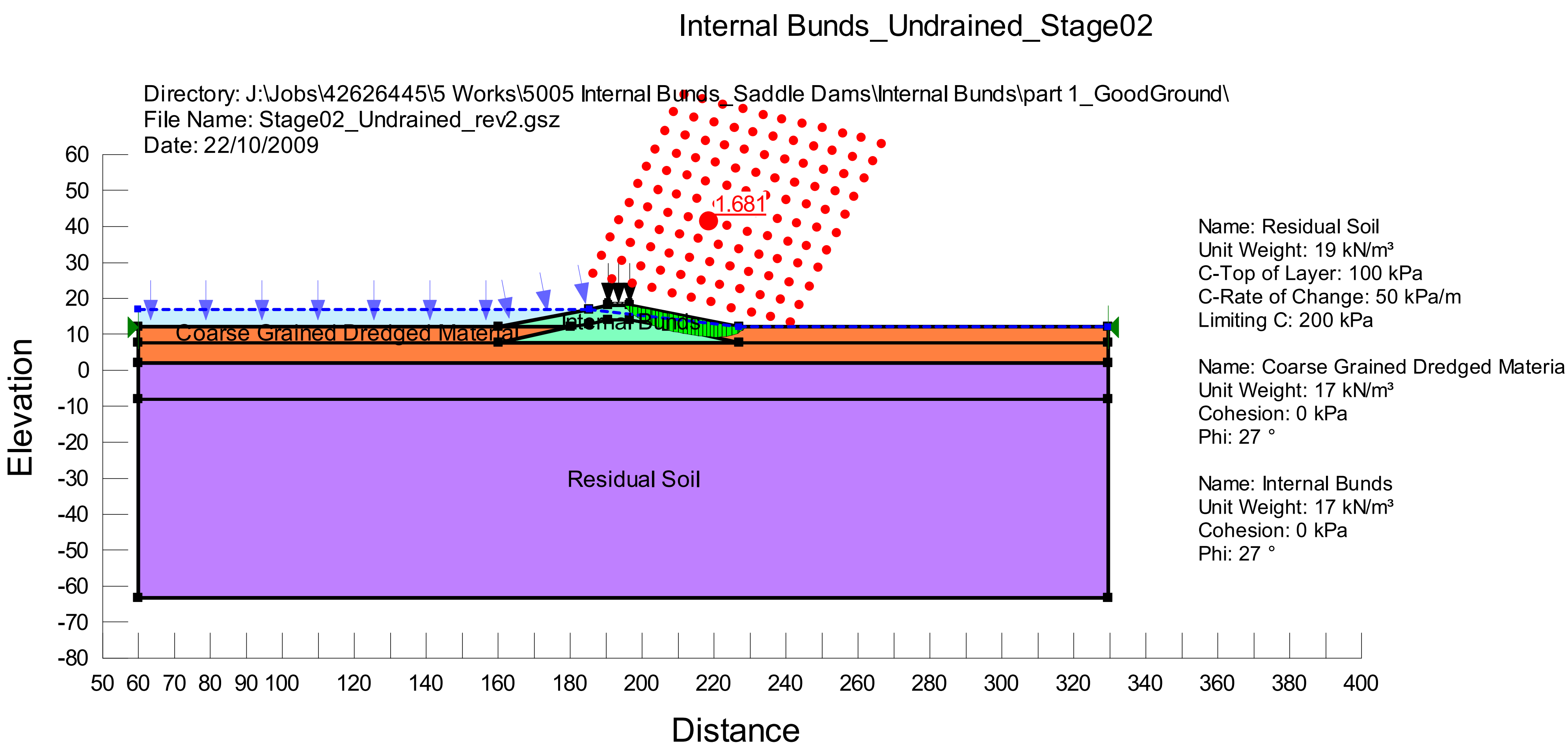
Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Coarse Grained Dredged Materia
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

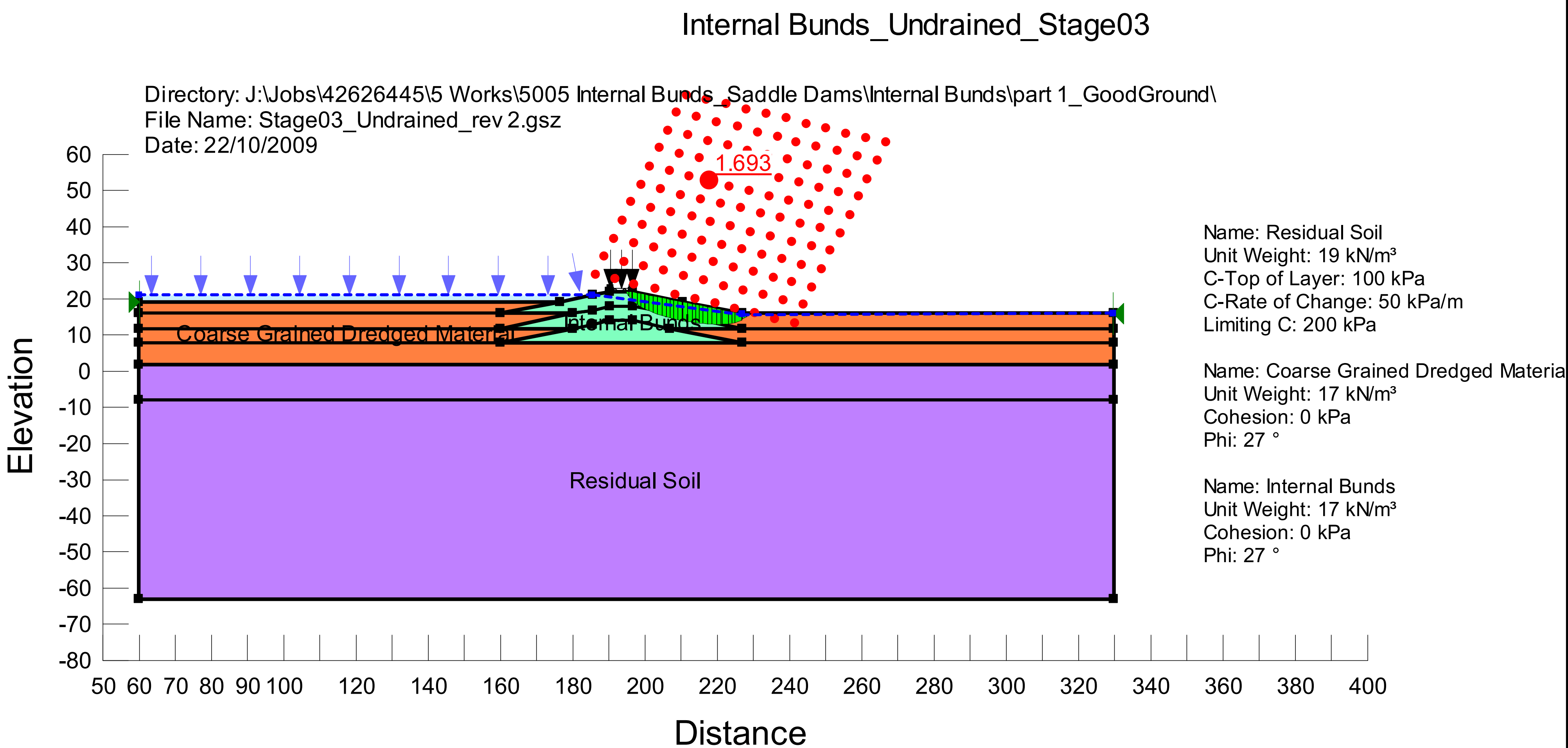
Name: Internal Bunds
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

CLIENT	TITLE
Santos Ltd	Type 1 Internal Bund Stage 01 Short-term Stability
PROJECT	
GLNG EIS Supplement Geotechnical Assessment and Design	

DESIGNED:	**WW**	APPROVED:	**TWA**	PROJECT:	**42626445**	FIGURE
DRAWN:	**WW**	DATE:	**10/2009**	FILE:	**05004**	**D-23**
CHECKED:	**TWA**	STATUS:	**FINAL**	REVISION:	**1**	



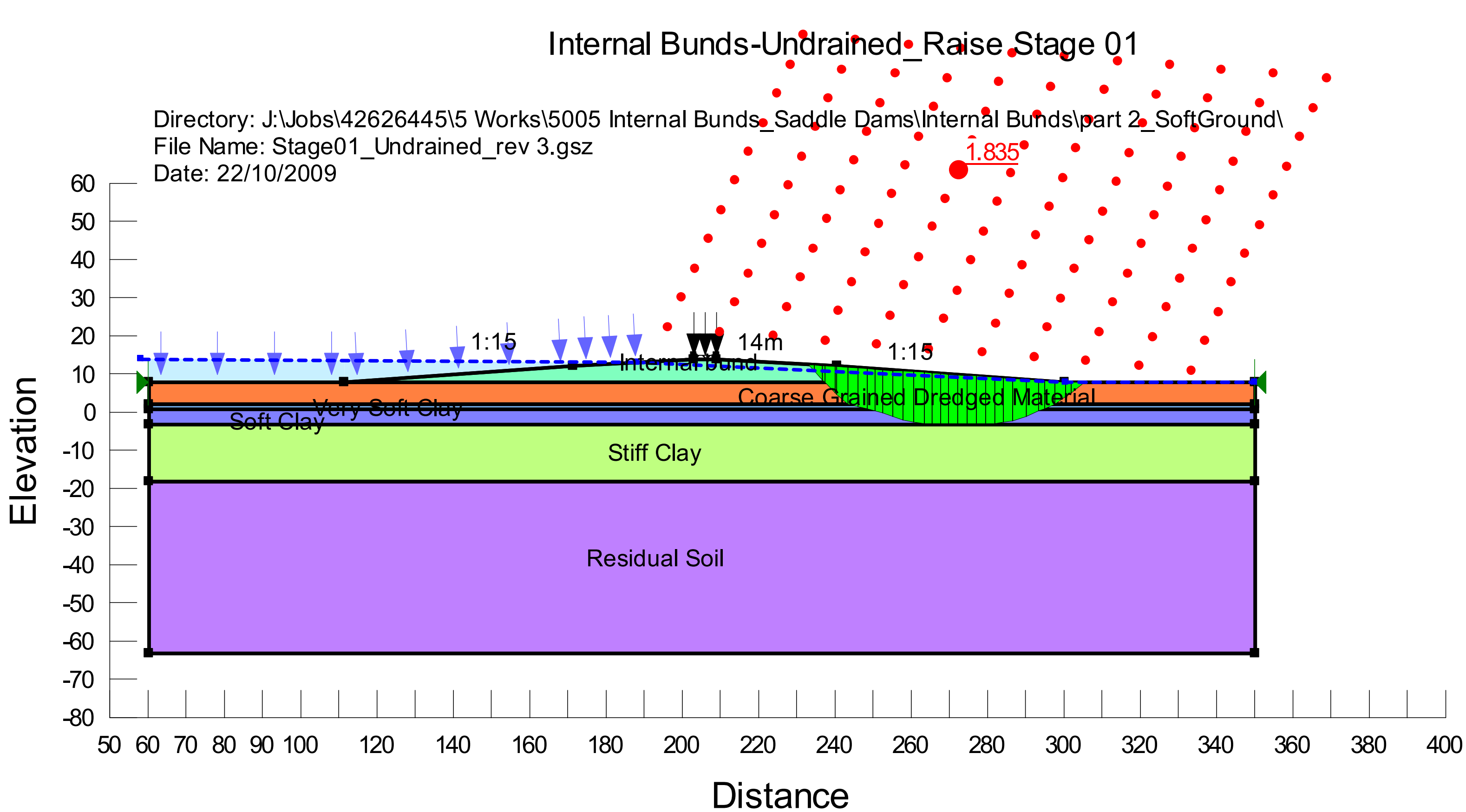
CLIENT **Santos Ltd**	TITLE Type 1 Internal Bund Stage 02 Short-term Stability
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA** APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1**
URS	FIGURE **D-24**



CLIENT	TITLE
Santos Ltd	Type 1 Internal Bund Stage 03 Short-term Stability
PROJECT: **GLNG EIS Supplement Geotechnical Assessment and Design**	

DESIGNED:	**WW**	APPROVED:	**TWA**	PROJECT:	**42626445**	FIGURE
DRAWN:	**WW**	DATE:	**10/2009**	FILE:	**05004**	**D-25**
CHECKED:	**TWA**	STATUS:	**FINAL**	REVISION:	**1**	

URS



Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

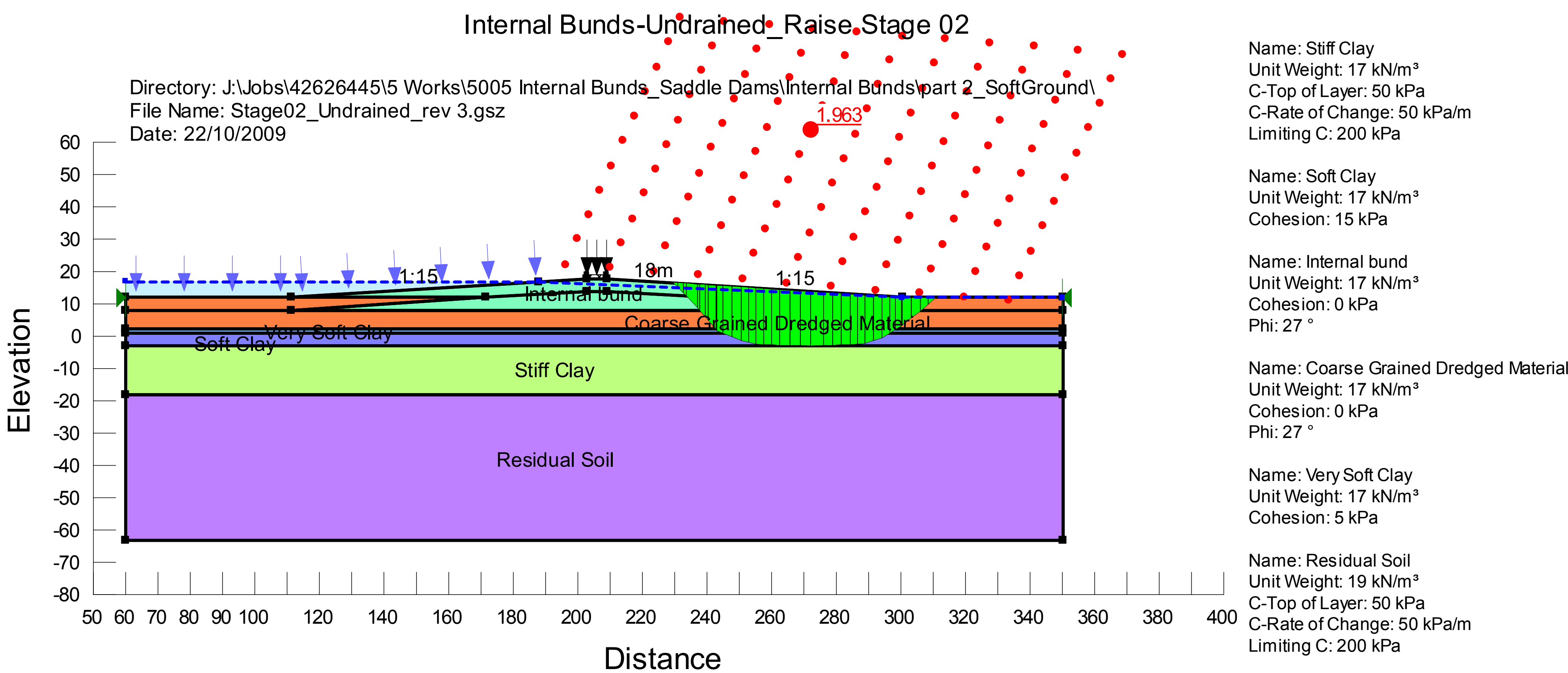
Name: Internal bund
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Coarse Grained Dredged Material
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd**	TITLE Type 2 Internal Bund Stage 01 Short-term Stability
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	
DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA** APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1** URS FIGURE **D-26**



CLIENT	TITLE
Santos Ltd	Type 2 Internal Bund Stage 02 Short-term Stability
PROJECT: **GLNG EIS Supplement Geotechnical Assessment and Design**	

DESIGNED:	**WW**	APPROVED:	**TWA**	PROJECT:	**42626445**	URS	FIGURE
DRAWN:	**WW**	DATE:	**10/2009**	FILE:	**05004**		**D-27**
CHECKED:	**TWA**	STATUS:	**FINAL**	REVISION:	**1**		

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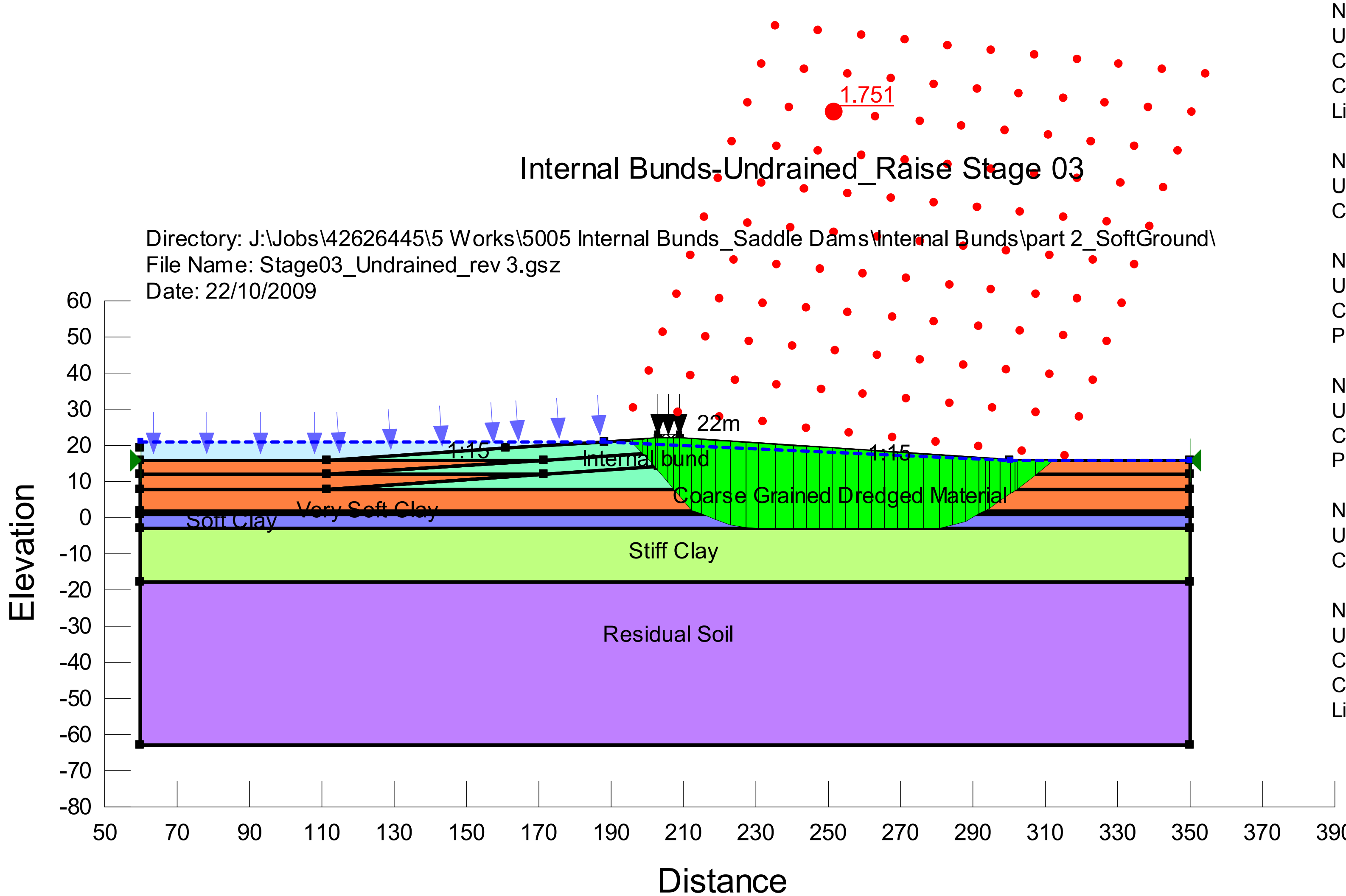

Name: Stiff Clay
Unit Weight: 17 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 15 kPa

Name: Internal bund
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Coarse Grained Dredged Material
Unit Weight: 17 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Very Soft Clay
Unit Weight: 17 kN/m³
Cohesion: 5 kPa

Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 50 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

CLIENT **Santos Ltd** PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	TITLE Type 2 Internal Bund Stage 03 Short-term Stability

DESIGNED: **WW** DRAWN: **WW** CHECKED: **TWA**
APPROVED: **TWA** DATE: **10/2009** STATUS: **FINAL**
PROJECT: **42626445** FILE: **05004** REVISION: **1**
FIGURE **D-28**

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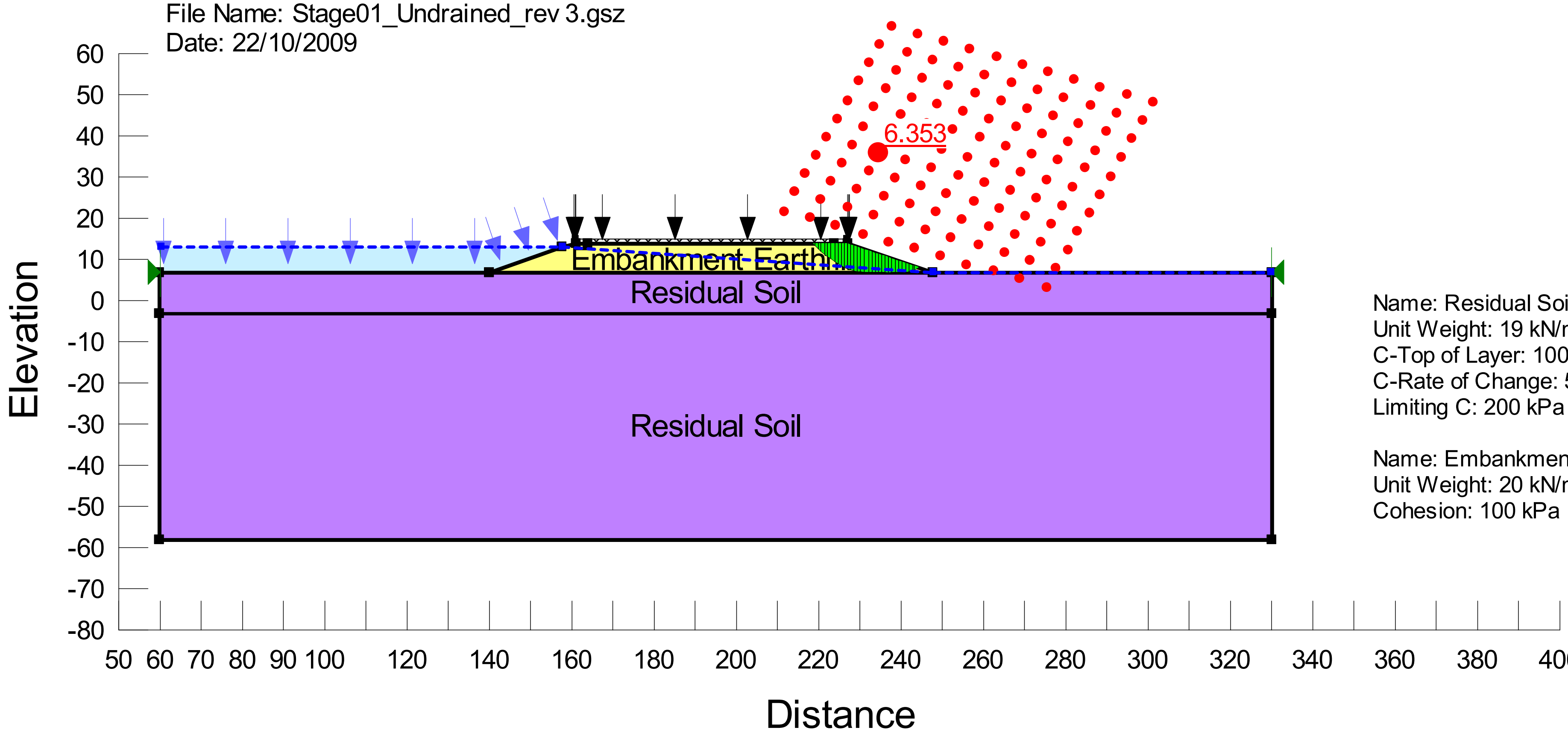
Saddle Dam_Undrained_Stage01

Directory: J:\Jobs\42626445\5 Works\5005 Internal Bunds_Saddle Dams\Saddle Dams\
File Name: Stage01_Undrained_rev 3.gsz
Date: 22/10/2009



Name: Residual Soil
Unit Weight: 19 kN/m³
C-Top of Layer: 100 kPa
C-Rate of Change: 50 kPa/m
Limiting C: 200 kPa

Name: Embankment Earthfill
Unit Weight: 20 kN/m³
Cohesion: 100 kPa

CLIENT **Santos Ltd**				TITLE Saddle Dam Stage 01 Short-term Stability	
PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**					
DESIGNED: **WW**	APPROVED: **TWA**	PROJECT: **42626445**		URS	FIGURE **D-29**
DRAWN: **WW**	DATE: **10/2009**	FILE: **05004**			
CHECKED: **TWA**	STATUS: **FINAL**	REVISION: **1**			

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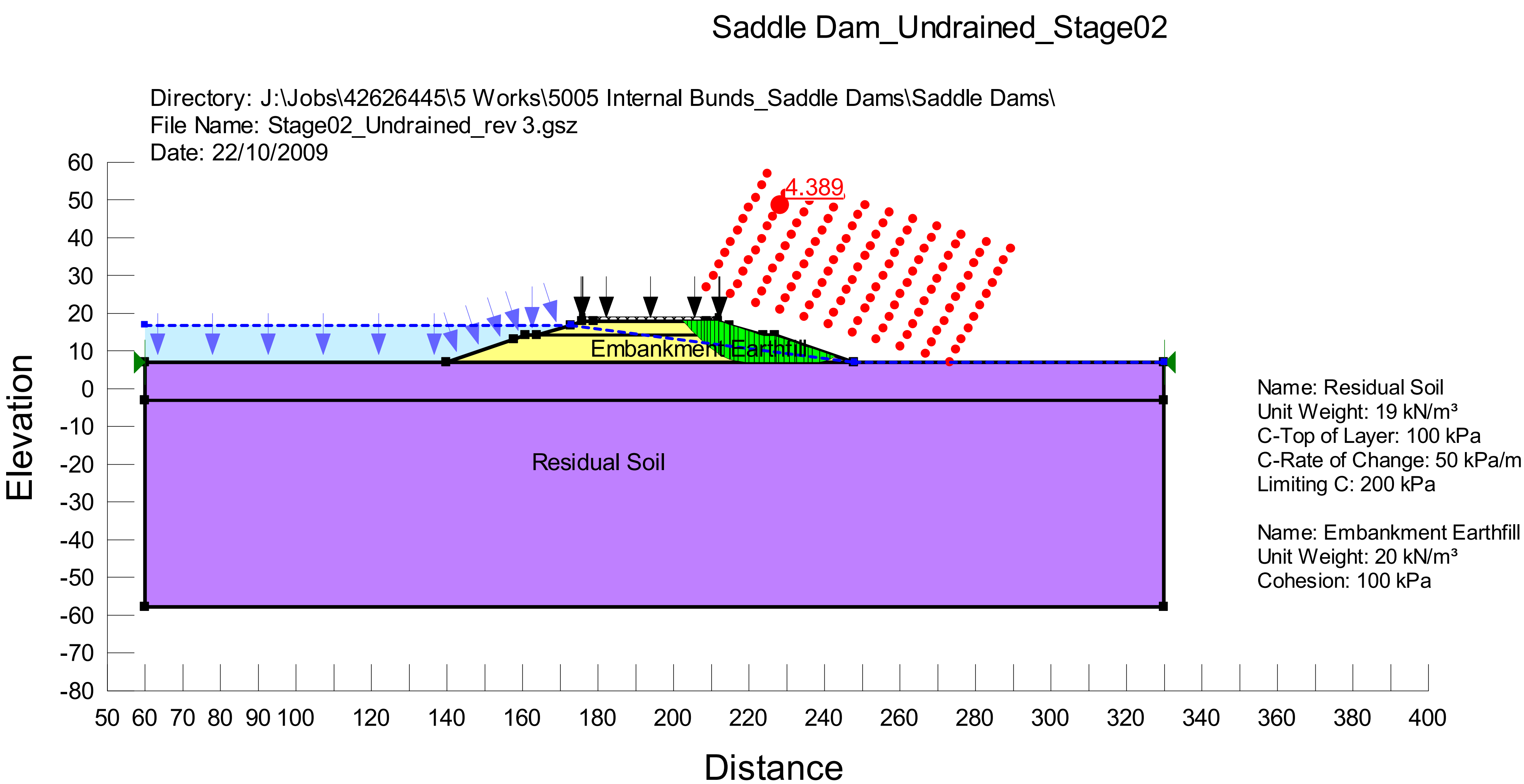

CLIENT **Santos Ltd** PROJECT **GLNG EIS Supplement Geotechnical Assessment and Design**	TITLE Saddle Dam Stage 02 Short-term Stability
DESIGNED: **WW** APPROVED: **TWA** DRAWN: **WW** DATE: **10/2009** CHECKED: **TWA** STATUS: **FINAL**	PROJECT: **42626445** FILE: **05004** REVISION: **1** URS FIGURE **D-30**

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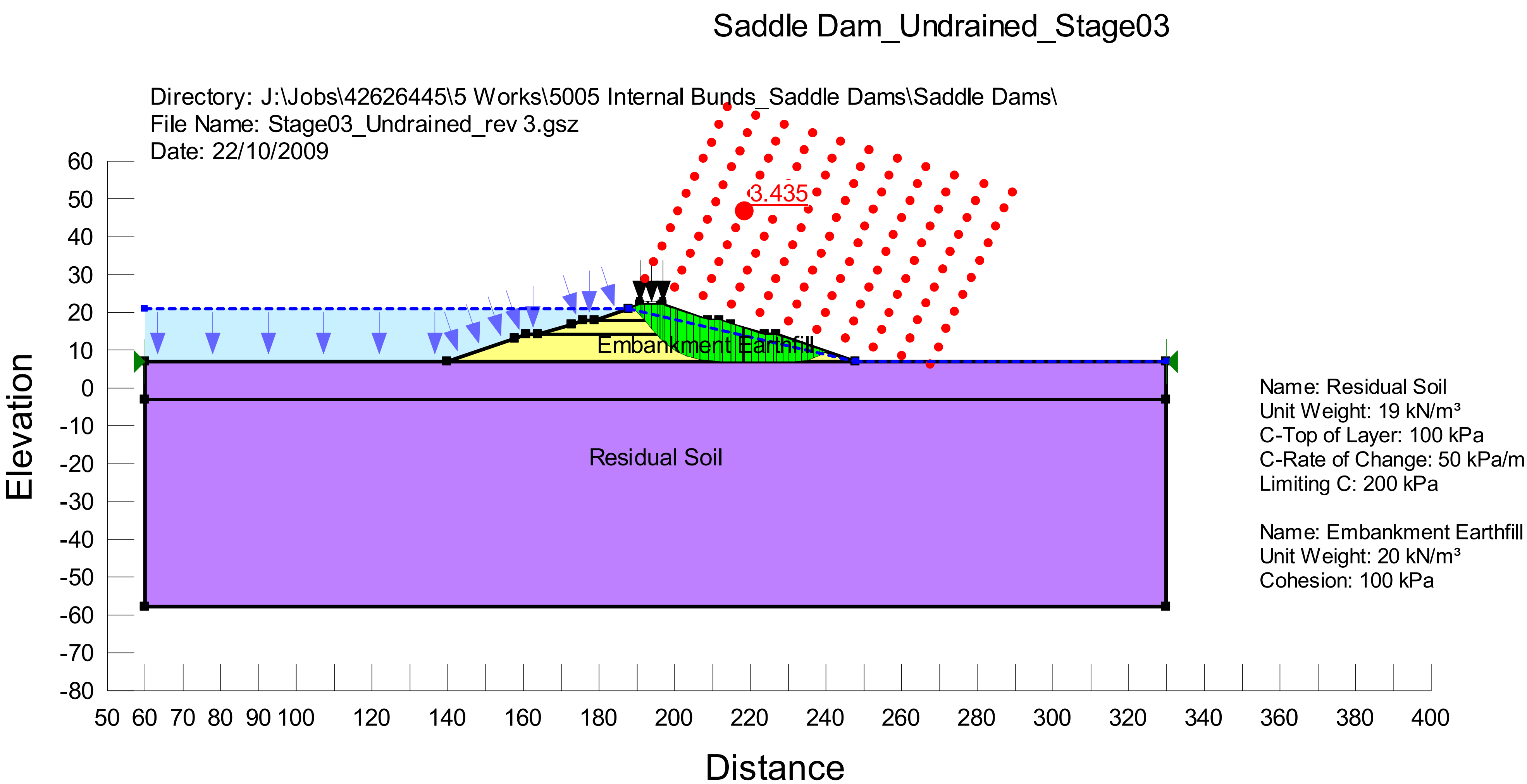

CLIENT
Santos Ltd

PROJECT
GLNG EIS Supplement Geotechnical Assessment and Design

TITLE
Saddle Dam Stage 03
Short-term Stability

DESIGNED: **WW**	APPROVED: **TWA**	PROJECT: **42626445**	FIGURE
DRAWN: **WW**	DATE: **10/2009**	FILE: **05004**	**D-31**
CHECKED: **TWA**	STATUS: **FINAL**	REVISION: **1**	

URS

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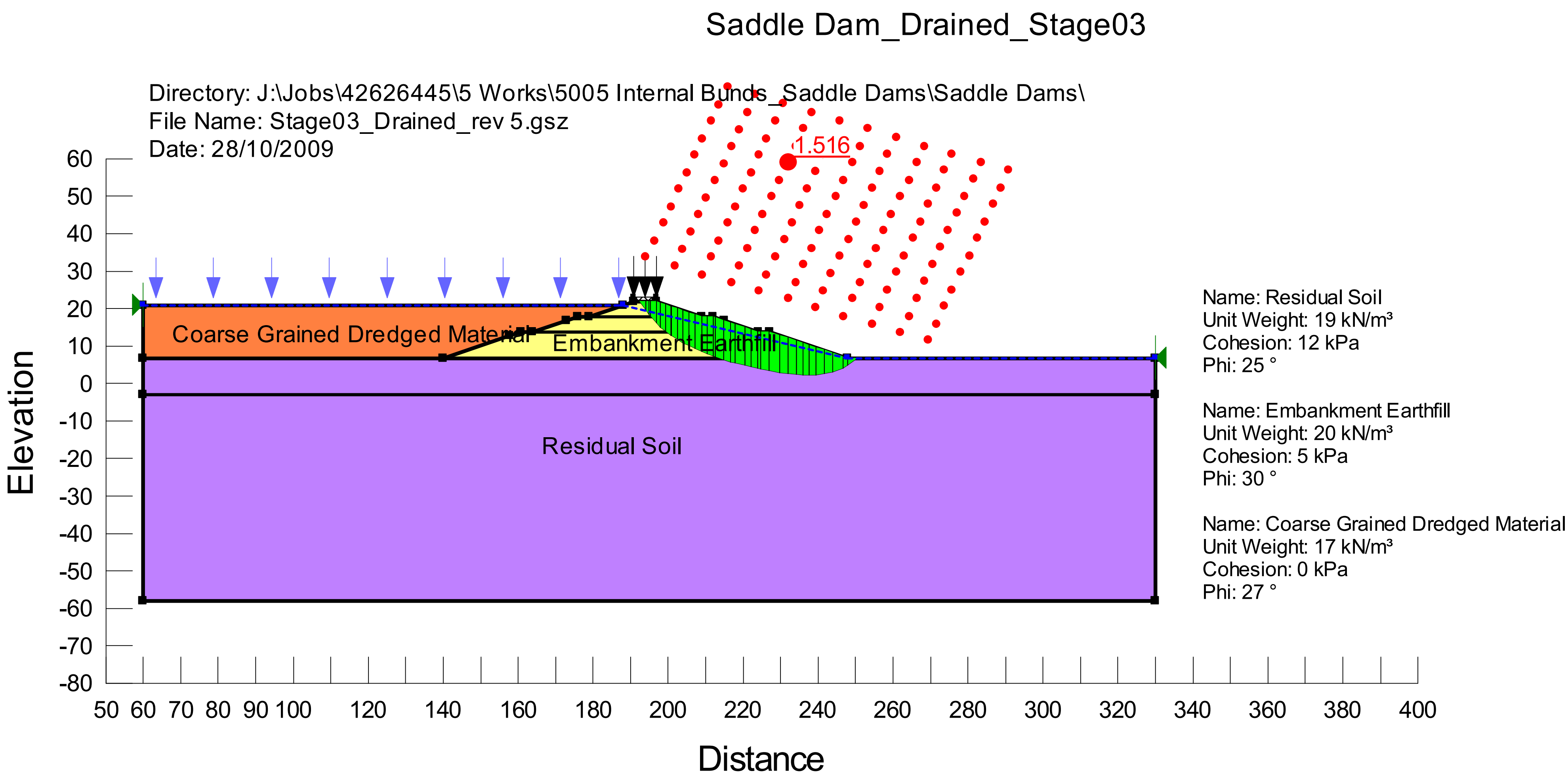

CLIENT	TITLE
Santos Ltd	Saddle Dam Stage 03 Long-term Stability
PROJECT	
GLNG EIS Supplement Geotechnical Assessment and Design	

DESIGNED:	**WW**	APPROVED:	**TWA**	PROJECT:	**42626445**	URS	FIGURE
DRAWN:	**WW**	DATE:	**10/2009**	FILE:	**05004**		**D-32**
CHECKED:	**TWA**	STATUS:	**FINAL**	REVISION:	**1**		

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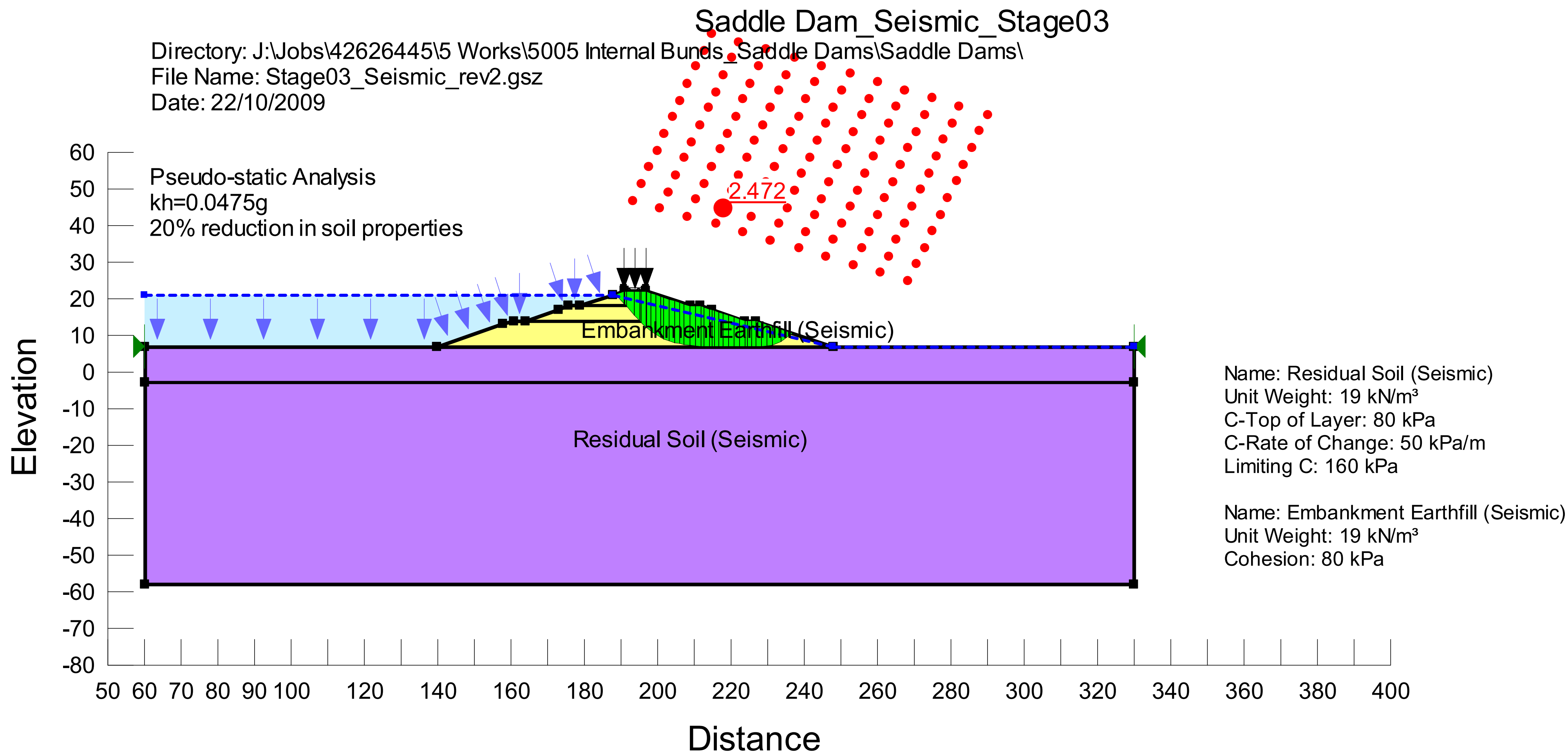

CLIENT	TITLE
Santos Ltd	Saddle Dam Stage 03 Seismic Stability
PROJECT	
GLNG EIS Supplement Geotechnical Assessment and Design	

DESIGNED:	**WW**	APPROVED:	**TWA**	PROJECT:	**42626445**	FIGURE
DRAWN:	**WW**	DATE:	**10/2009**	FILE:	**05004**	**D-33**
CHECKED:	**TWA**	STATUS:	**FINAL**	REVISION:	**1**	

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