

Our Ref: PSM4025-005L REV2

1 November 2021

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Attention: David Lousick

Dear David

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**RE: 13 ENDEAVOUR ROAD, CARINGBAH - PLANNING PROPOSAL STAGE  
RESULTS OF GEOTECHNICAL INVESTIGATION**

**1. Introduction**

This letter presents the results of the geotechnical investigation conducted at 13 Endeavour Road, Caringbah on 31 August and 1, 2 and 8 September 2020. The development is at Planning Proposal (PP) stage. This letter provides commentary regarding the suitability of the site with regards to the proposed development and provides PP stage geotechnical advice. The advice will need to be confirmed at detailed design stage.

The work has been conducted in accordance with PSM proposal (PSM4025-003L) dated 6 May 2020.

To assist with our investigation, we were provided with and reviewed the following documents:

- Survey plan of the site prepared by Land Partners (Ref. SY074865.000.1.4) dated 19 August 2020
- Geotechnical and Preliminary Contamination Investigation by Golder Associates (Ref. 98622179.D) dated August 1998
- A draft Urban Design Study prepared by SJB Urban (Ref. 6272 V02) dated 3 September 2020. A draft masterplan is presented in Appendix B.
- An Environmental Site Assessment prepared by AECOM (Ref. 60613064) dated 28 October 2019
- A Soil Quality Assessment by Consulting Earth Scientists (Ref. CES051003-TOY-01-F) dated 7 December 2005.

From the documents listed above, we understand the following about the proposed development:

- New buildings will be erected around the site ranging from 3 to 12 stories in height comprising above ground car parking, retail stores, offices, a hotel and an industrial development
- The existing warehouse will remain as part of the new development
- No basements are proposed for any of the structures
- New parking and recreation areas will be created on surface level around the site.

Construction details of the proposed development (eg. Earthworks, buildings loads, footings) are not clear to PSM at this stage.

Figure 1 presents the locality plan.

## 2. Geotechnical Investigation

PSM have completed a geotechnical investigation for the area. The aim of the investigation was to obtain information on areas not covered within the Golder Associates report dated August 1998.

### 2.1 Fieldwork

The fieldwork was undertaken on 31 August and 1, 2 and 8 September 2020 under the full-time supervision of a PSM geotechnical engineer who directed the testing locations for the Cone Penetrometer Testing (CPT). Prior to conducting CPTs, the test locations were scanned by an electronic services locator to ensure the locations were free from buried underground utilities. Where necessary, the locations were cored using concrete cutting techniques.

A total of fourteen (14) CPTs were undertaken under the direction of PSM. The CPTs were carried out using a 15-tonne truck-mounted rig. All CPTs were taken to refusal at a depth of between 3.63 m and 17.13 m. All testing locations were measured using a handheld GPS unit of accuracy +/- 5 m and measured relative to existing features on site. The results of the CPTs are presented in Appendix A. At the completion of the fieldwork, all testing locations were reinstated by backfilling with sand and using either quick set concrete mix or cold mix asphalt as required.

Figure 1 presents the investigation locations conducted by PSM described above and the investigation locations conducted by Golder Associates in 1998. Figures 3 and 4 present selected site photographs.

## 3. Ground Conditions

### 3.1 Geological Setting

The 1:100,000 Geological Map for Wollongong – Port Hacking indicates that the Site is located on:

- Organic-rich muddy, mostly “marine” sand (Qhf)
- Man-made fill. Dredged estuarine sand and mud, coal washing, industrial and household waste (mf)
- Medium to coarse-grained quartz sandstone, very minor shale and laminite lenses (Rh).

Inset 1 shows the boundary of the site with respect to the geological setting.



**Inset 1: Geological Map of the Site**

### 3.2 Site History

Aerial Imagery from Nearmap and the AECOM report indicate that the site was originally heavily vegetated and remained predominately undisturbed until 1961; subsequently:

- Between 1961 and 1965 the site was covered with fill material (likely to be covered by sand, clay and crushed sandstone)
- Between 1965 and 1972 vegetation re-emerged at the site
- Between 1972 and 1983 part of the vegetation was cleared
- Between 1983 and 1994 The majority of the buildings on site including the Toyota warehouse have been built
- Between 1994 and 2002 some carparks and an additional building in the northwest corner were constructed
- Between 2002 to present no major changes have occurred to the site.

### 3.3 Surface Conditions

The site is located on 13 Endeavour Road, Caringbah and is bounded by industrial properties to the north, Woolloomooloo Bay to the east, Solander Fields to the south and Captain Cook Drive to the west. The site is essentially flat. During the investigation, the following observations were made:

- The site contains existing buildings including a one storey warehouse
- The site surface contains paved areas including a hardstand area on the northern side of the warehouse
- The eastern and western sides of the site have predominantly landscaped surfaces with some trees, shrubs and grass
- Driveways to the site were encountered along Captain Cook Drive and Endeavour Road
- A bike track runs along the eastern boundary of the site.

Figure 1 presents the surface conditions of the site on 2 August 2020.

### 3.4 Subsurface Conditions

The subsurface conditions encountered within the test locations are summarised in Table 1. These units are consistent with those encountered in the Golder Report dated August 1998.

**Table 1 – Summary of Inferred Subsurface Conditions**

Inferred Unit	Inferred Top of unit depth below ground surface (m)	Description
TOPSOIL / PAVEMENT	0.0	Silty SAND; fine to medium grained sand, dark brown, dry to moist, loose to medium dense consistency. CONCRETE SLAB; approximately 190 to 220 mm thick ASPHALT; approximately 25 to 190 mm thick
EXISTING FILL	0.025 to 0.22	Clayey SAND to Gravelly SAND; fine to coarse grained, brown to dark grey, sub-angular gravels consisting primarily of sandstone, dry to wet, consistency ranges from loose to dense, contains wood, concrete, bricks, sandstone cobbles, building waste.
ALLUVIUM A	2.0 to 4.0	CLAY to Silty CLAY; dark brown and grey, very soft to firm consistency, wet, can contain organics.

Inferred Unit	Inferred Top of unit depth below ground surface (m)	Description
ALLUVIUM B	3.8 to 6.5	SAND to Silty SAND; pale brown and grey, medium dense to very dense consistency, wet, can contain lenses of very soft to firm clay.
ALLUVIUM C	3.8 to 12.6	SAND and CLAY mixtures; pale brown and grey, stiff to hard clay and medium dense to dense sand, wet.
BEDROCK	3.6 to 17.1	SANDSTONE; extremely to highly weathered and low strength up to 2 m depth overlying slightly weathered and medium to high strength sandstone.

Table 2 presents the approximate elevation of the top of the inferred geotechnical units encountered in the CPT investigation. Figure 2 presents a plan view of the elevation of the top of ALLUVIUM B unit and top of BEDROCK unit encountered.

**Table 2 – Elevations to Top of Inferred Geotechnical Units from PSM CPTs**

Test ID	Elevations of top of inferred geotechnical units (RL m AHD)						
	TOPSOIL / PAVEMENT	EXISTING FILL	ALLUVIUM A	ALLUVIUM B	ALLUVIUM C	BEDROCK	EOH <sup>1</sup>
CPT01	2.8	2.64	-0.2	-2.2	-5.5	-6.8	-6.8
CPT02	2.7	2.68	-0.1	-2.2	-5.4	-6.8	-6.8
CPT03	2.7	2.51	0.2	-2.8	N/E <sup>2</sup>	N/E <sup>2</sup>	-4.1 <sup>3</sup>
CPT04	2.6	2.42	0.1	-1.8	-5.2	-7.1	-7.1
CPT05	2.7	2.61	0.7	N/E <sup>2</sup>	-1.1	-2.7	-2.7
CPT06	2.8	2.66	0.7	N/E <sup>2</sup>	N/E <sup>2</sup>	-0.8	-0.8
CPT07	2.3	2.27	0.2	-3.1	-8.2	-9.1	-9.1
CPT08	2.2	2.19	-0.4	-3.1	-9.2	-10.6	-10.6
CPT09	4.3	4.1	1.1	-2.2	-8.3	-12.8	-12.8
CPT10	2.9	2.80	-0.3	-2.3	-9.5	-13.0	-13.0
CPT11	3.5	3.41	-0.4	-2.0	-8.9	-12.7	-12.7
CPT12	2.2	2.01	0.2	-1.6	-5.6	-12.3	-12.3
CPT13	2.4	2.18	0.4	-1.6	-4.6	-10.1	-10.1
CPT14	3.2	3.19	0.6	N/E <sup>2</sup>	-0.6	-2.4	-2.4

<sup>1</sup> EOH = End of Hole

<sup>2</sup> N/E = Not Encountered

<sup>3</sup> Refused in ALLUVIUM B

<sup>4</sup> Surface RLs estimated from survey plan

### 3.5 Groundwater

Groundwater was observed in the AECOM, Golders and Consultant Earth Scientist investigations in almost all boreholes. Groundwater is typically encountered between 1 m and 3 m below ground surface. These values are typically between 0.5 m AHD to 1.0 m AHD; however, some records show levels of 0.07 m AHD and 2.1 m AHD.



#### **4. Geotechnical Suitability of the Site for the Proposed Development**

At this stage, construction details of the proposed development (e.g. earthworks, buildings loads, footings) are not fully defined. However, we have considered the PP stage development and the inferred subsurface conditions at the site and provide the following opinion on the geotechnical suitability of the site for the proposed development:

- We consider that the site presents geotechnical conditions which are suitable for the proposed development subject to the detailed design of the structures being undertaken in accordance with the advice provided in Section 5.
- The multistorey residential buildings will need to be supported on piles founded on the BEDROCK unit or subject to detailed design in the ALLUVIUM B unit.
- Whilst the EXISTING FILL encountered during the various investigations has varying consistencies, these fills have been in place for over 50 years and have reportedly supported loaded slabs on grade and trafficked areas. On this basis, we consider they are likely to be able to continue to support such loading across the site, including new loads of up to 20 kPa with standard light commercial/industrial serviceability requirements. Any subgrade that is exposed to new loads should be inspected and proof-rolled under the direction of PSM. Subject to some near surface treatment, the surface is considered to be suitable for supporting on-grade carparks, roads and services and lightly loaded structures.
- The construction of basement structures, although not impossible, is not recommended as they would present major geotechnical challenges including:
  - Excavation in variable material including the EXISTING FILL unit and the ALLUVIUM A unit which comprises very soft to firm clays (i.e. mangrove muds). The presence of these units results in difficult excavation support
  - Excavation below the water table which would require tanking of the basements in the long term and temporary dewatering during excavation. The temporary dewatering could in turn result in drawdown effects resulting in compression of the very soft clays and settlement of services and structures in and around the excavations.

#### **5. Advice and Recommendations**

##### **5.1 General**

We have prepared the following advice and recommendations based on our geotechnical investigation and review on the documents provided. Should at any time the ground conditions be found to be different from that described in this letter, PSM should be contacted to revise this advice.

##### **5.2 Foundations**

###### **5.2.1 General**

The multi storey residential building shall be founded on piles supported on the BEDROCK unit or subject to the discussion below on piles targeting the ALLUVIUM B unit.

Smaller lightly loaded structures may be able to be supported on shallow footing founded on the EXISTING FILL unit prepared as follows:

- The location of the proposed structure shall be stripped of TOPSOIL and other loose material.
- The area shall be proof rolled in the presence of a PSM geotechnical engineer to confirm the advice regarding bearing capacity in this letter report.
- No structures shall be founded in the ALLUVIUM A unit.

### 5.2.2 Shallow Footings

Pad footings can be proportioned on the basis of an allowable bearing pressure (ABP) for centric vertical loads provided in Table 3. Further advice should be sought, if the footings are located adjacent to a batter or wall.

We note that an allowable bearing pressure (ABP) is not a soil property. It depends on many factors such as the size of the footings, the embedment depth, the load direction and eccentricity, the stiffness of the footing, the adopted factor of safety (FOS), as well as the soil properties. As footings get bigger or deeper the capacity increases rapidly, as the load gains eccentricity or becomes inclined, the capacity reduces rapidly.

Settlements in the EXISTING FILL unit or the ALLUVIUM units can be estimated using the elastic moduli provided in Table 3. When assessing the settlement of shallow footings, the designer needs to consider the additional ground settlement due to the total building load on both shallow and deeper units. The differential settlement due to building loads shall also be assessed. Any structures which are not piled to BEDROCK should consider the effect of settlement particularly arising from ALLUVIUM A. Differential settlements of pavements and non-piled structures will be proportional to the thickness of ALLUVIUM A.

Foundation conditions at the proposed shallow pad footings locations should be inspected by a suitably qualified geotechnical engineer prior to the pouring of concrete.

### 5.2.3 Piles

We envisage that piles would be founded within the BEDROCK unit. Targeting the ALLUVIUM B unit for a floating pile design is not recommended. There are risks associated with the uncertainty of the pile toe level, exact location and thickness of the ALLUVIUM B unit and settlements within the underlying variable ALLUVIUM C unit. If this option is considered, advice from a specialist pile contractor should be sought.

Piles should be designed in accordance with the requirements in AS 2159 (2009), Piling – Design and Installation. The parameters provided in Table 3 may be adopted in the design of piles founded in the BEDROCK unit.

The designer should note the following with regards to the pile design:

- The ABP may need to be confirmed by a geotechnical engineer through pile inspections prior to pouring concrete
- For piles founded on rock, under permanent load, the contribution of side adhesion from the soil units should be ignored
- Should large surface loads be applied the designers should be aware of and account for the potential for negative friction
- Deflection should be checked using the recommended elastic parameters in Table 3
- Where adjacent foundation details differ (e.g., pile and pad, differing loads or ground conditions), differential settlement should also be assessed.

The bearing capacities provided are contingent on piles or footings being vertically and centrally loaded. Further advice should be sought if the footings are not vertically centrally loaded. Should higher bearing capacities be required of the Bedrock, this may be available subject to further advice.

With regards to the pile design we recommend that:

- A geotechnical strength reduction factor,  $\phi_g = 0.60$  (AS2159 CL. 4.3.2) be adopted for a high redundancy system for an assessed average risk rating (ARR) between 2.5 and 3.0. This should be reviewed to suit the specific design and appropriate pile testing proposed by the structural designers in accord with the requirements of AS2159
- It may be possible to increase the pile reduction factors, if the details of the proposed pile installation procedures indicate a high level of quality control with regards to concrete placement, base cleanliness, etc.
- If a geotechnical strength reduction factor,  $\phi_g = 0.40$  is adopted then no pile testing will be required (AS2159 Clause 8.2.4 (b)).

**Table 3 – Foundation Parameters of Inferred Geotechnical Units**

Inferred Unit	Bulk Unit Weight (kN/m <sup>3</sup> )	Effective Strength Parameters		Ultimate Bearing Pressure under Vertical Centric Loading <sup>2</sup> (kPa)	Allowable Bearing Pressure under Vertical Centric Loading <sup>3</sup> (kPa)	Ultimate Shaft Adhesion (kPa)	Elastic Parameters	
		c' (kPa)	φ' (deg)				Young's Modulus (MPa)	Poisson's Ratio
EXISTING FILL	18	0	30	400 <sup>1</sup>	150 <sup>1</sup>	N.A.	10	0.3
ALLUVIUM A	16	0	25	N.A.	N.A.	N.A.	1	0.35
ALLUVIUM B	18	0	30	N.A.	N.A.	N.A.	50	0.3
ALLUVIUM C	18	0	30	N.A.	N.A.	N.A.	20	0.3
BEDROCK	24	N.A.	N.A.	4000 <sup>2</sup>	2000 <sup>3</sup>	250	200	0.25
BEDROCK (subject to further investigation at detailed design stage)	24	N.A.	N.A.	60,000 <sup>2</sup>	6,000 <sup>3</sup>	1500	900	0.25

Notes:

- <sup>1</sup> Minimum plan dimension of 1.0 m and a minimum embedment depth of 0.5 m and no less than 2 m of EXISTING FILL beneath the base of the footing.
- <sup>2</sup> Ultimate bearing pressure for bedrock assumes a settlement of approximately 5% of the least footing dimension for footings in rock.
- <sup>3</sup> Allowable bearing pressure assumes a settlement of approximately 1% of the least footing dimension for footings in rock.

Should there be any queries, please do not hesitate to contact the undersigned.

For and on behalf of  
**PELLS SULLIVAN MEYNINK**



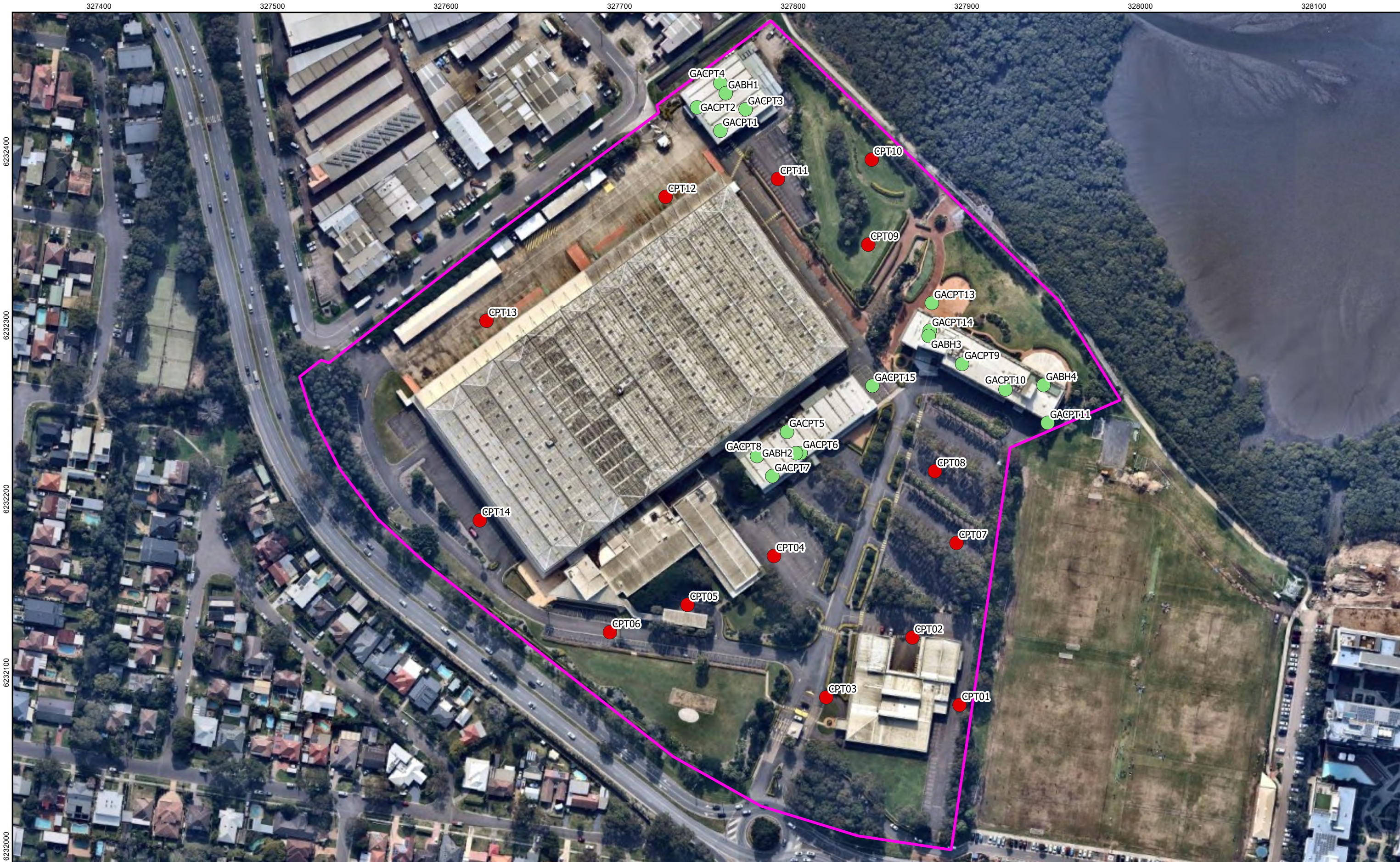
**MATIAS BRAGA**  
**GEOTECHNICAL ENGINEER**



**DAVID PICCOLO**  
**PRINCIPAL**

Encl.	Figure 1	Locality Plan (1 of 2)
	Figure 2	Locality Plan (2 of 2)
	Figure 3	Selected Site Photographs (1 of 2)
	Figure 4	Selected Site Photographs (2 of 2)
	Appendix A	CPT Results
	Appendix B	SJB Draft Masterplan





- Legend**
- Site Boundary
  - Golder Test Locations
  - PSM CPT Locations

**Notes:**

- Image obtained from Nearmap of the site conditions on 2 August 2020.
- Golder test locations obtained from Golder report (Ref. 98622179.D) dated August 1998.
- All test locations approximated using Land Partners survey plan (Ref. SY074865.000.1.4) dated 19 August 2020.

Scale 1:2,000

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Scale (m)

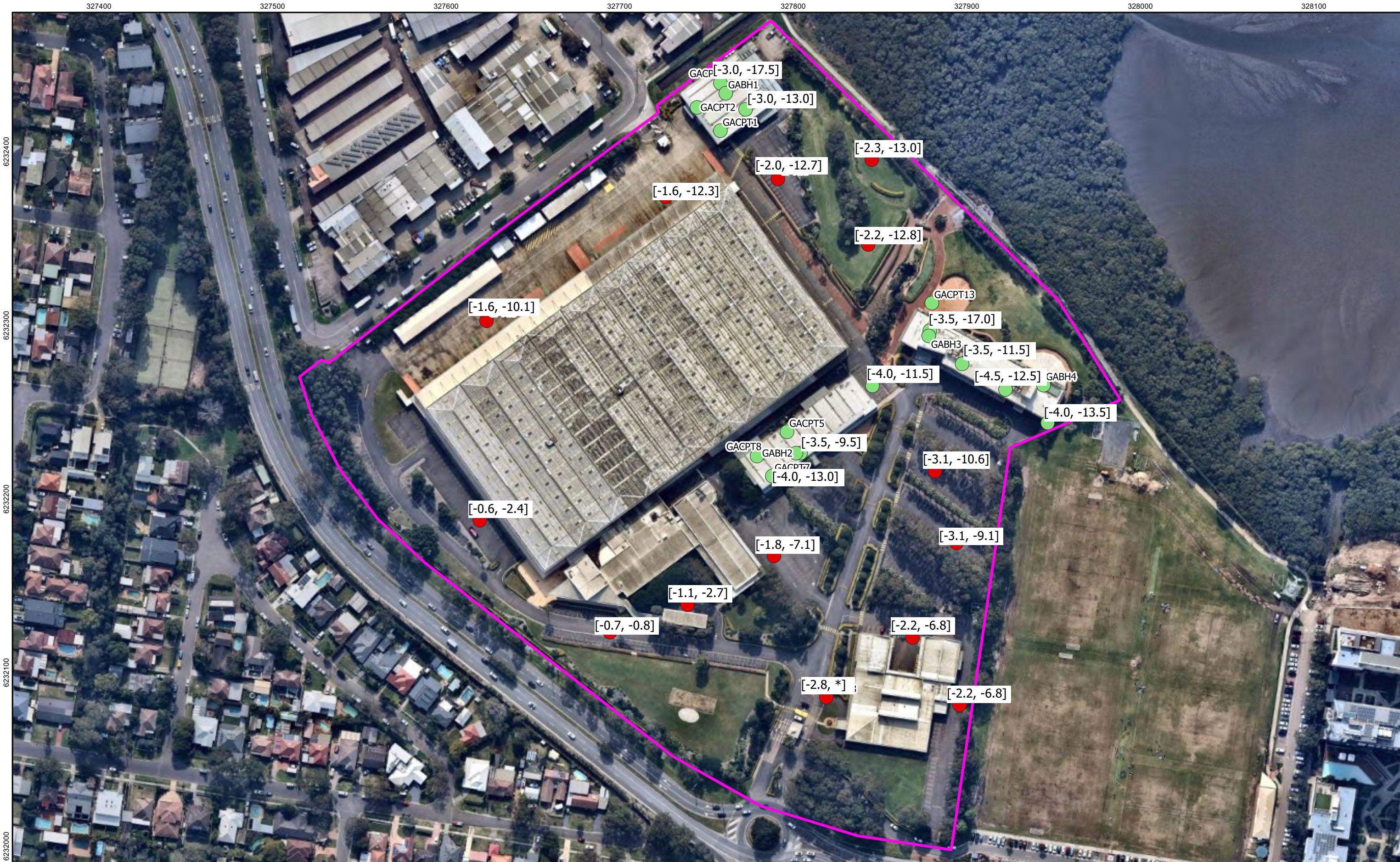
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13 Endeavour Road  
Caringbah, NSW

**GEOTECHNICAL INVESTIGATION  
LOCALITY PLAN (1 OF 2)**

PSM4025-005L	Figure 1
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**Legend**

- Site Boundary
- PSM CPT Locations
- Golder Test Locations


Notes:  
1. Values in brackets indicate [Top of ALLUVIUM B, Top of BEDROCK] in RL AHD (m).



Scale 1:2,000

0 20 40 60 80 100 m

Scale (m)

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	Date:	Paper Size:
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Caringbah, NSW

**GEOTECHNICAL INVESTIGATION  
LOCALITY PLAN (2 OF 2)**

PSM4025-005L	Figure 2
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Photo 1 - General site conditions along northern side of the site facing east (2/09/2020)



Photo 2 - General site conditions along southern side of the site facing east (1/09/2020)



<p>Aliro Group Pty Ltd 13 Endeavour Road Caringbah NSW</p>	
<p>GEOTECHNICAL INVESTIGATION SELECTED SITE PHOTOGRAPHS (1 of 2)</p>	
PSM4025-005L	FIGURE 3



Photo 3 - General site conditions along western side of the site facing north (1/09/2020)



Photo 4 - General site conditions along southern side of the site facing north (1/09/2020)



<p>Aliro Group Pty Ltd 13 Endeavour Road Caringbah NSW</p>	
<p>GEOTECHNICAL INVESTIGATION SELECTED SITE PHOTOGRAPHS (2 of 2)</p>	
PSM4025-005L	FIGURE 4

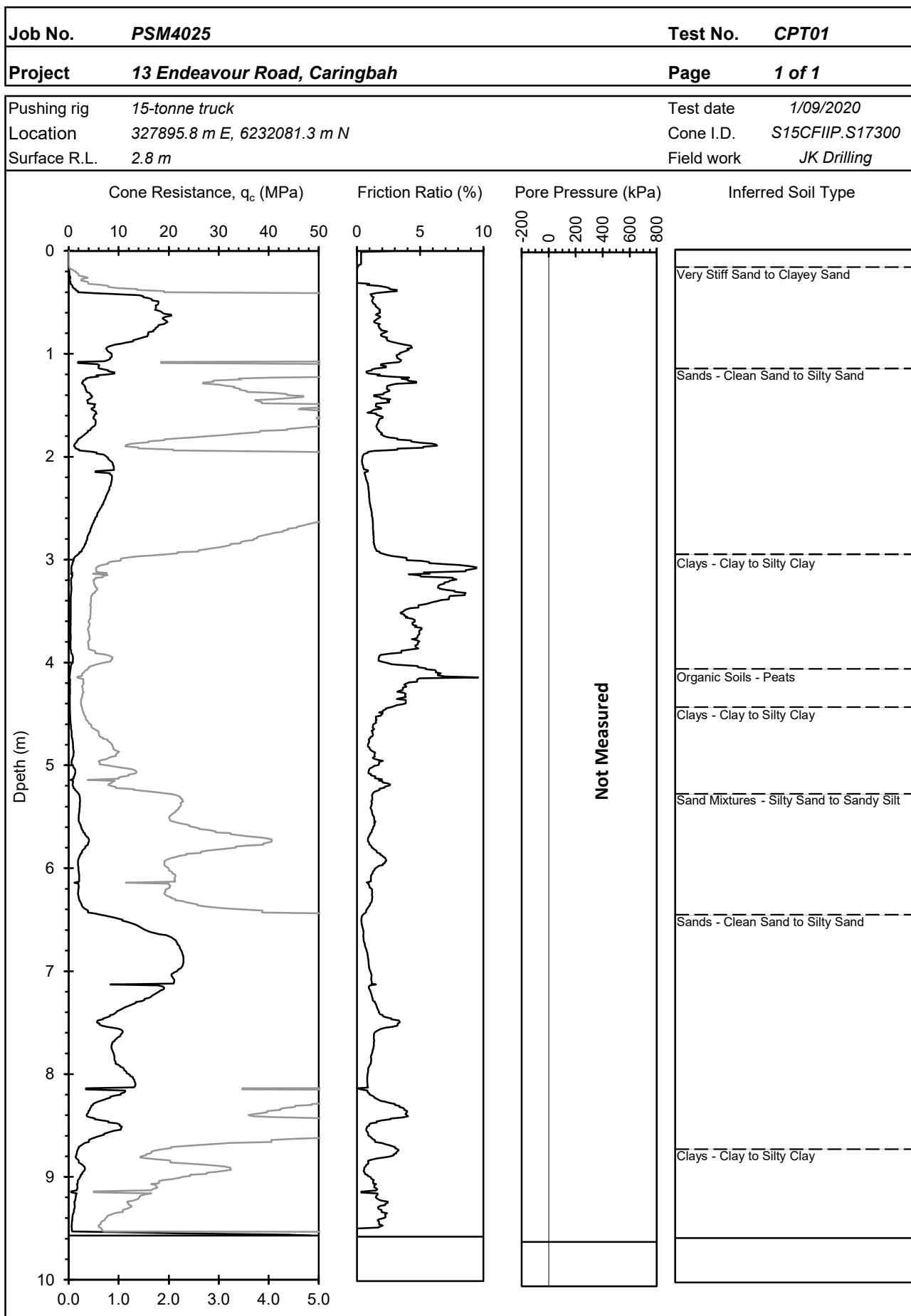


# **Appendix A**

## **CPT Results**

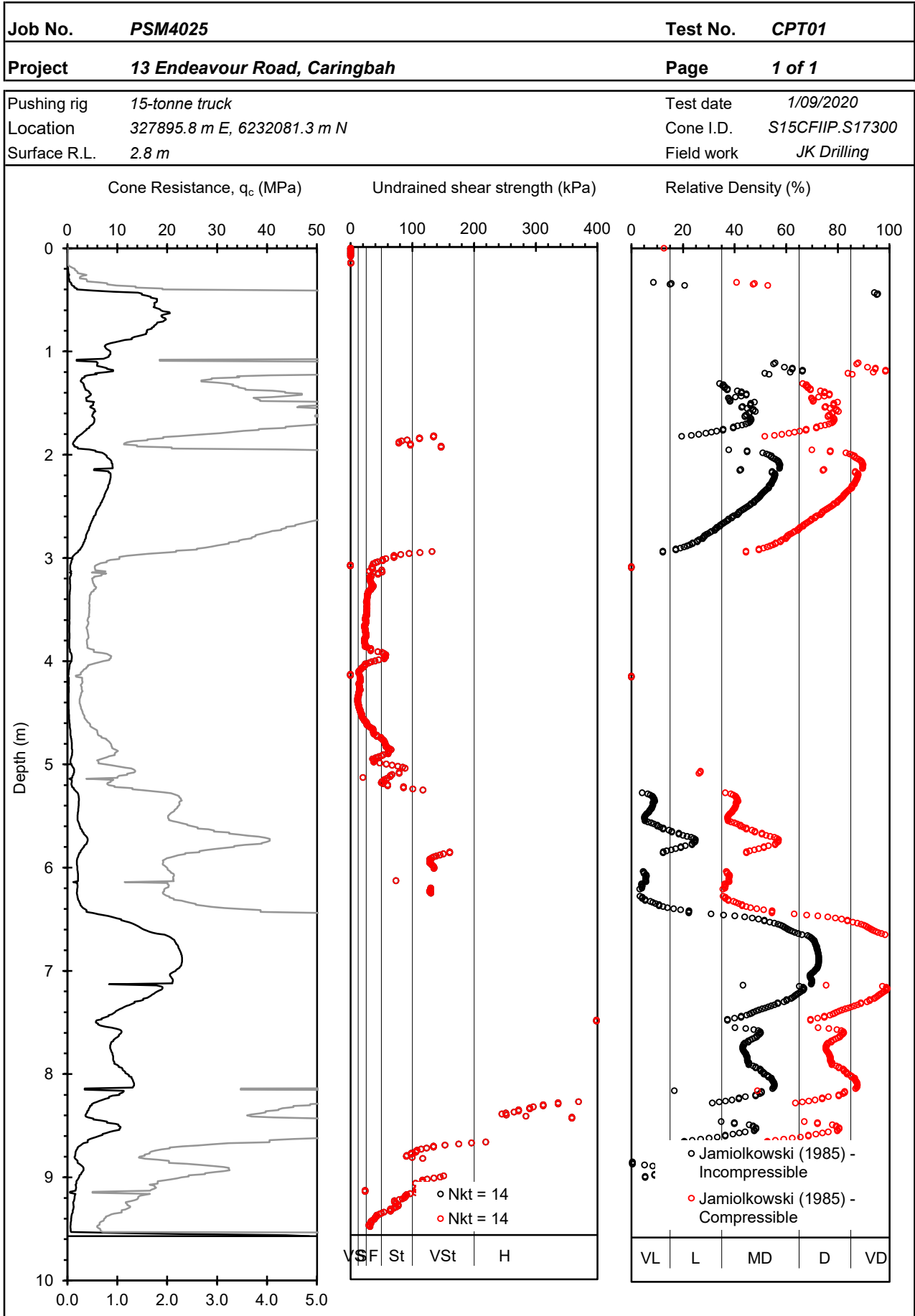


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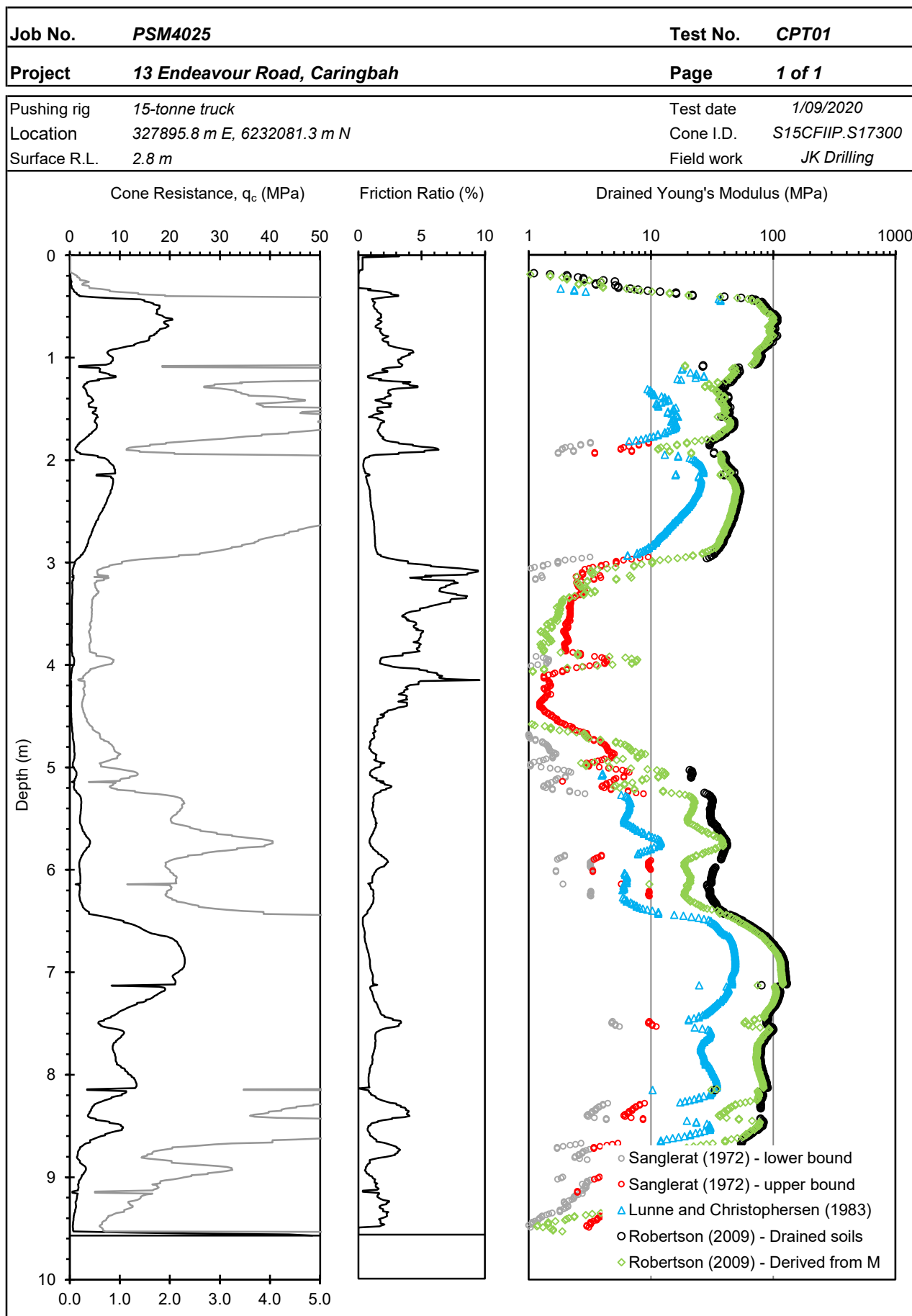


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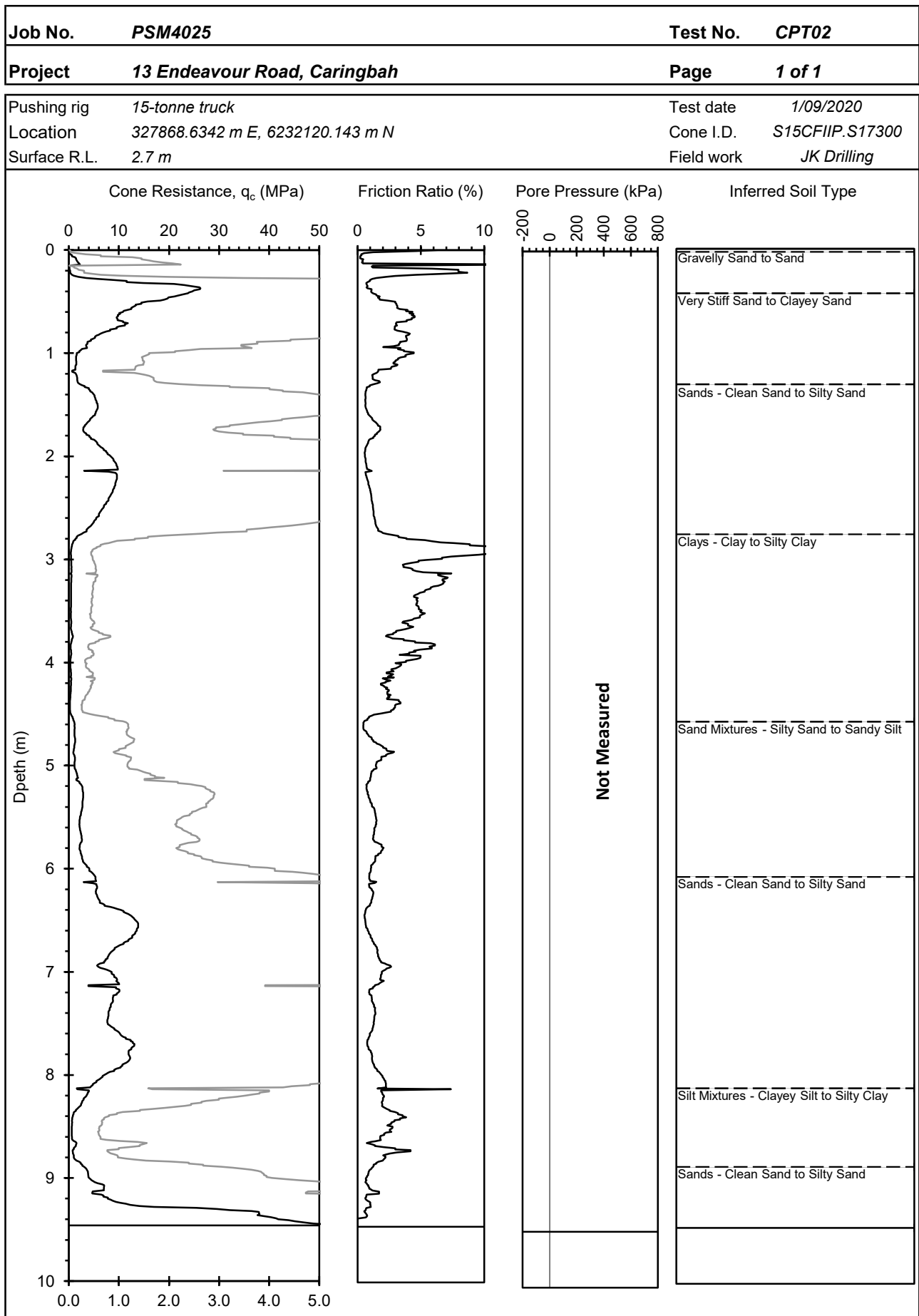


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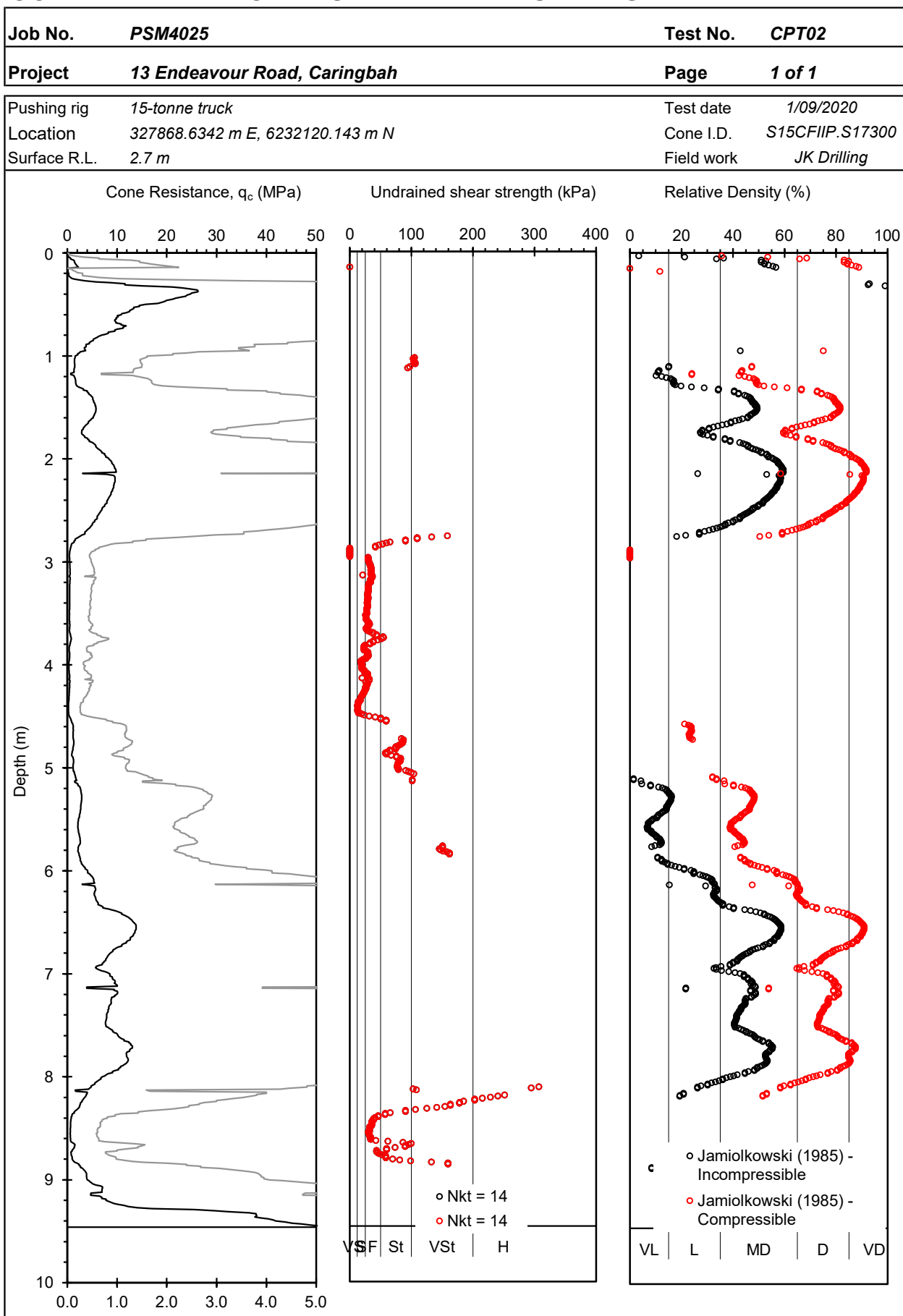


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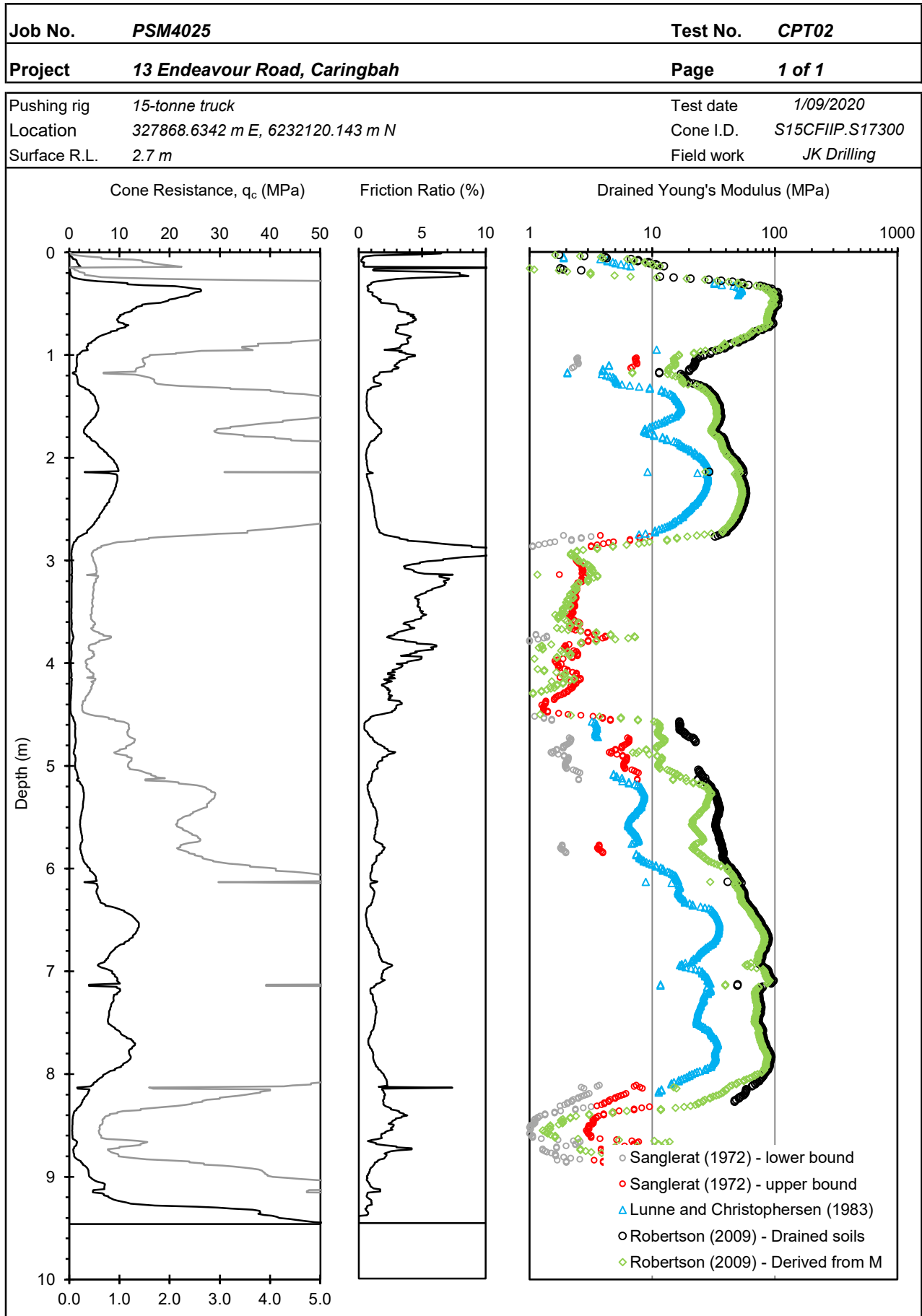


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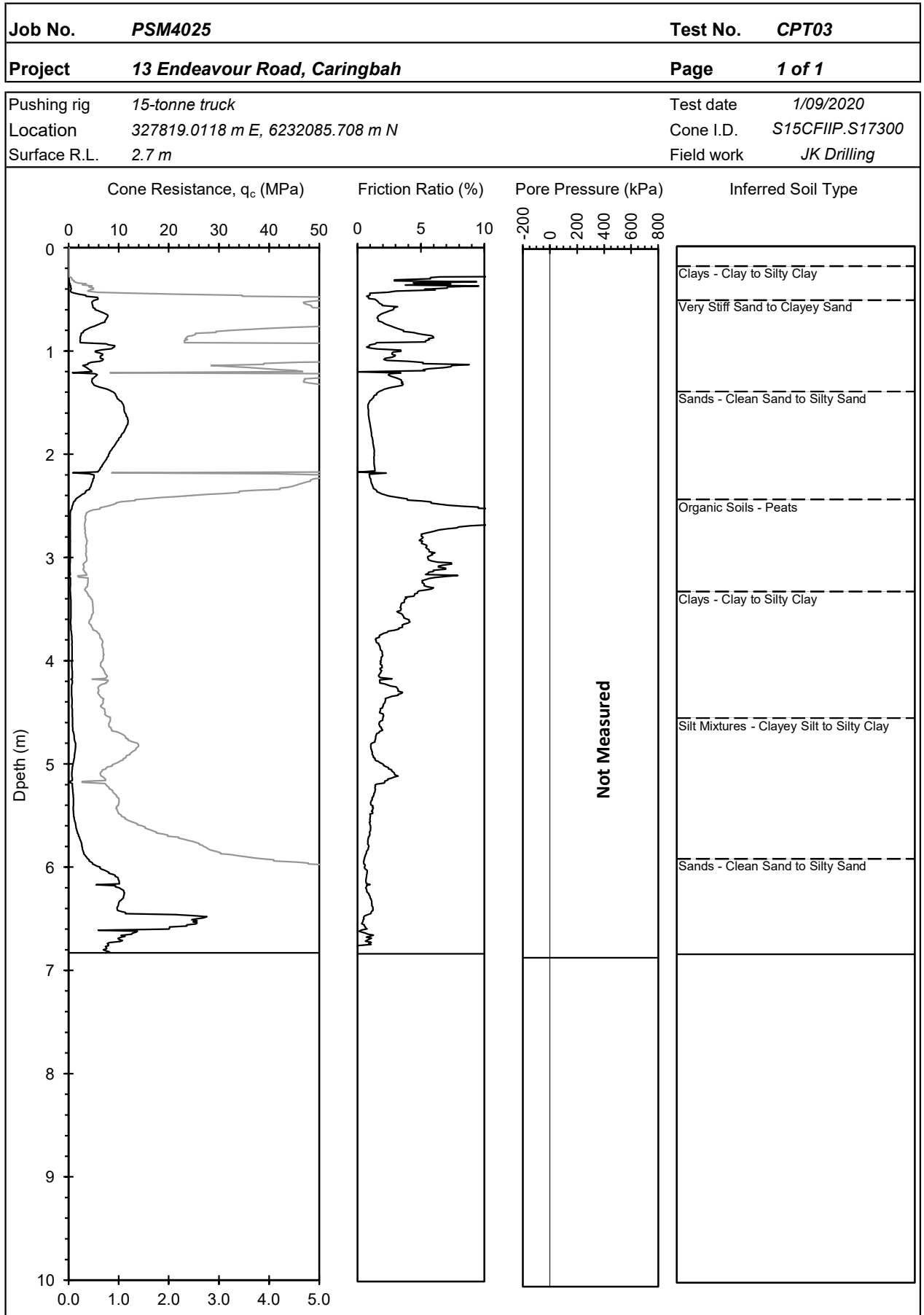
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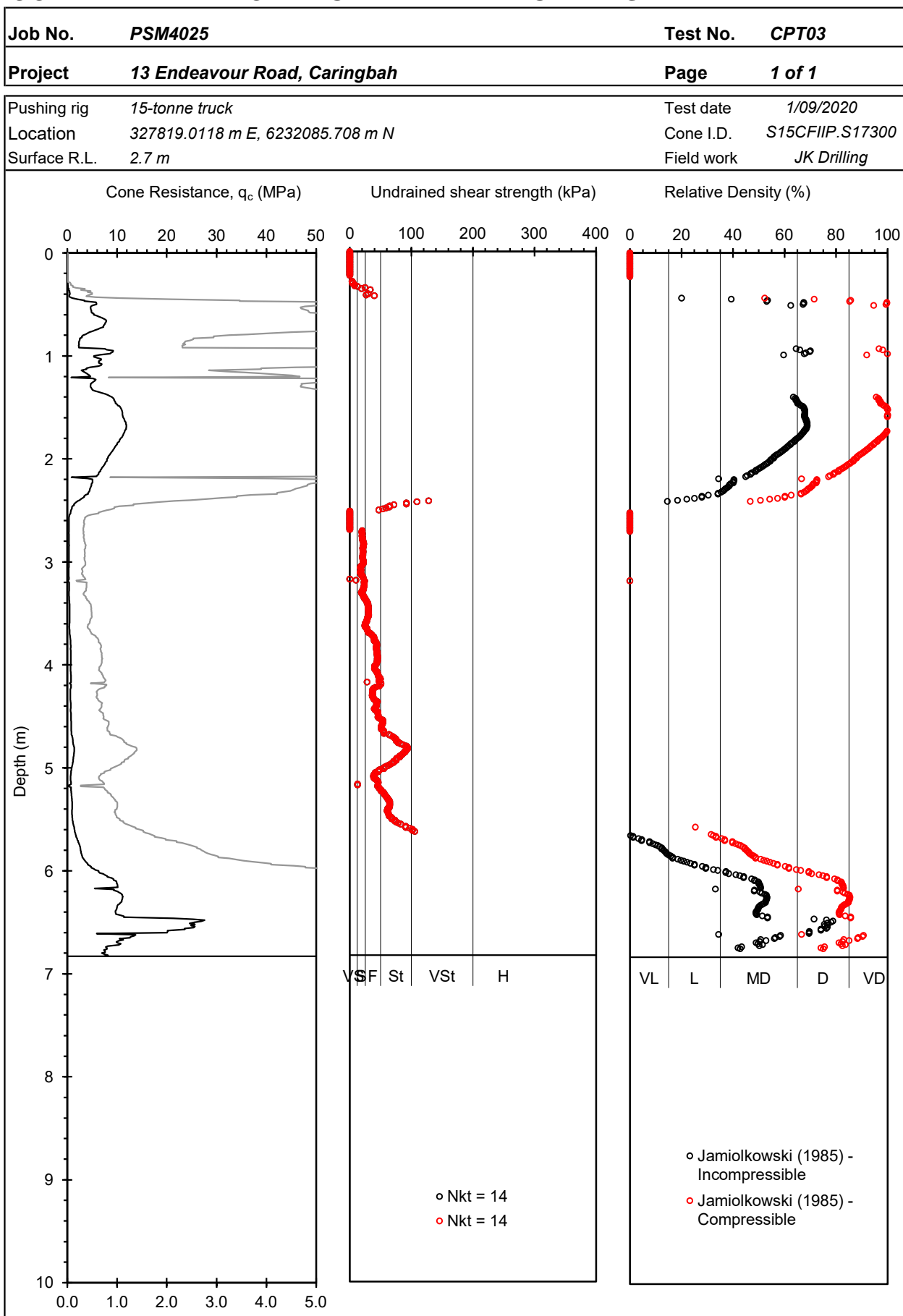


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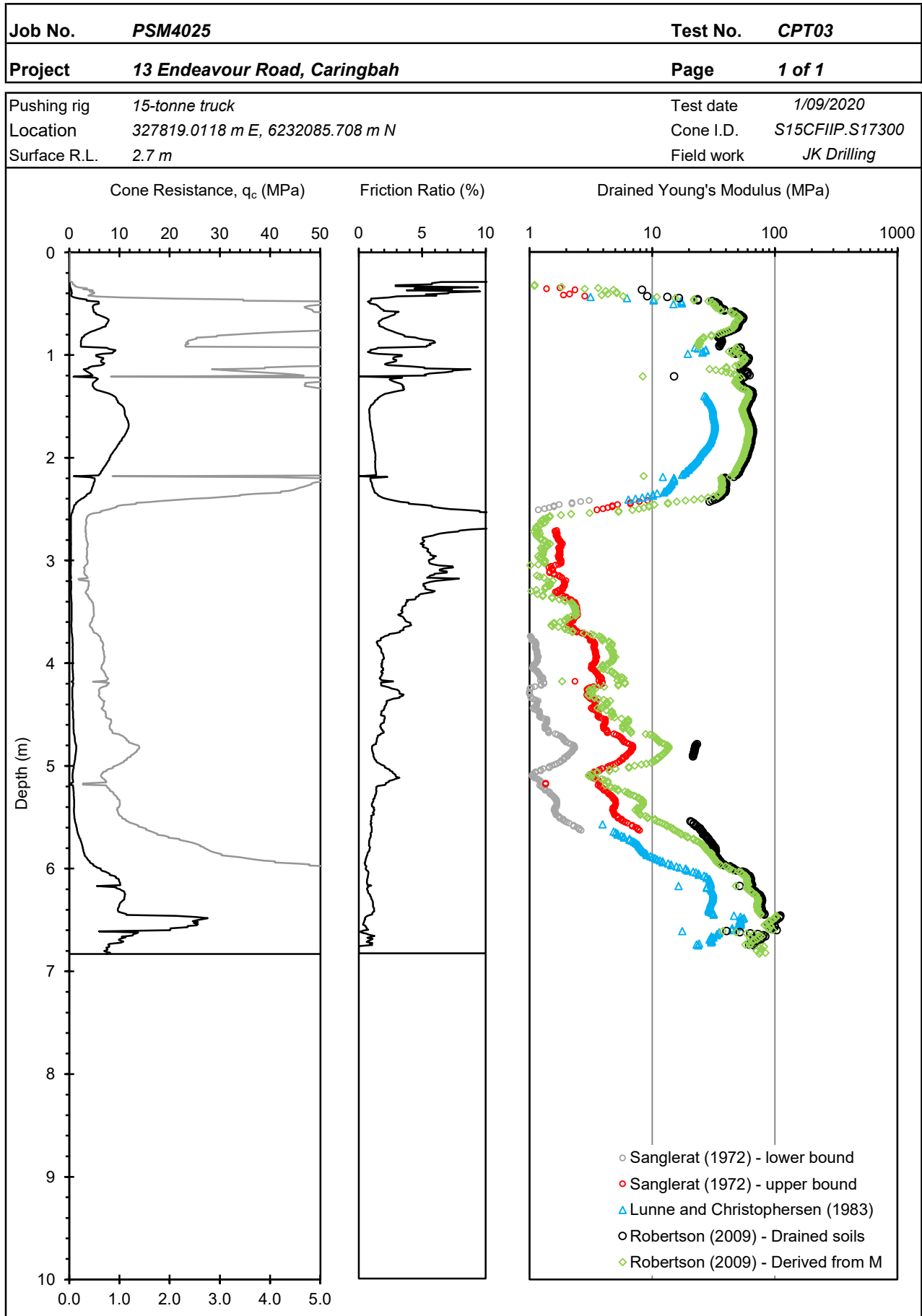


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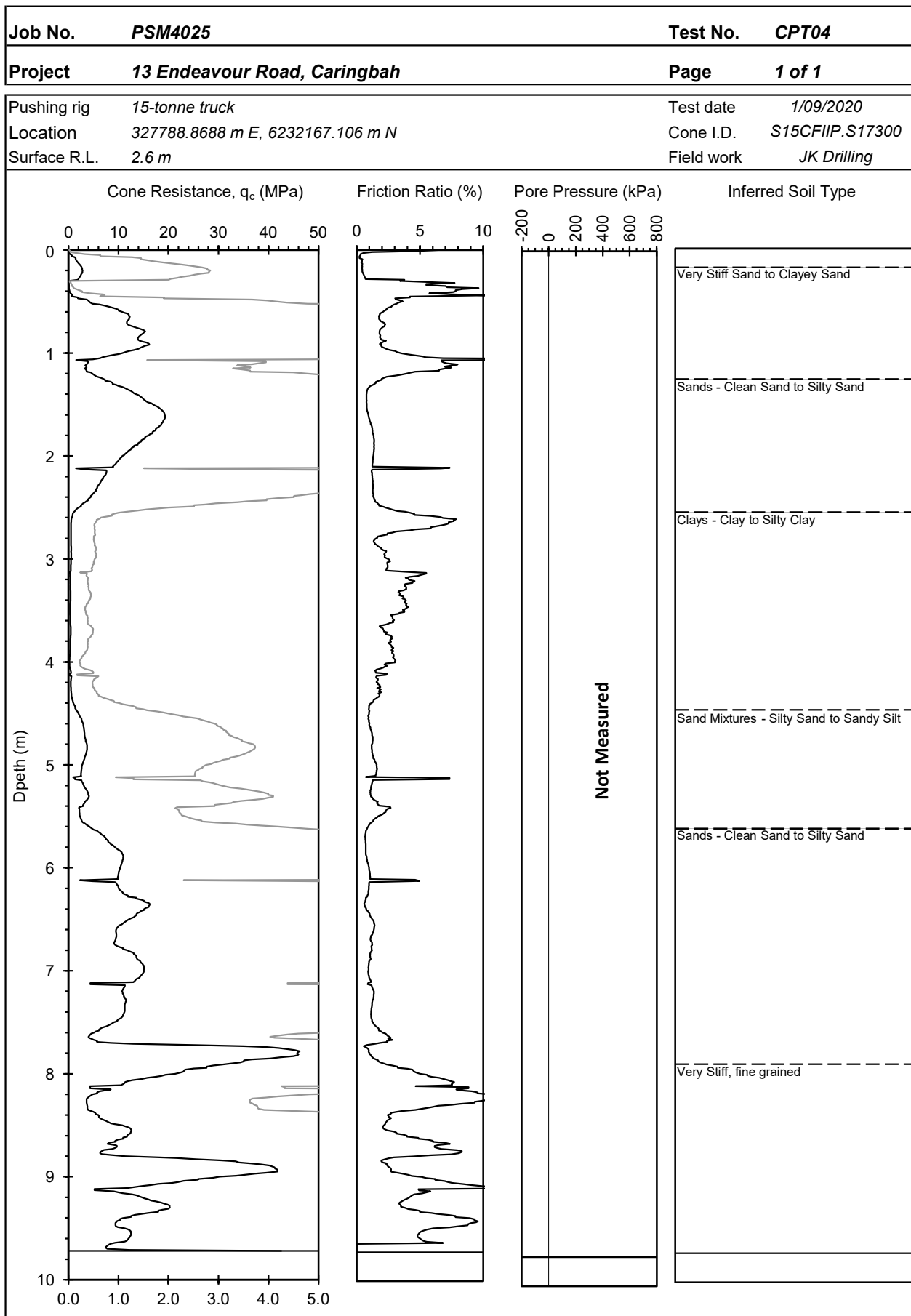


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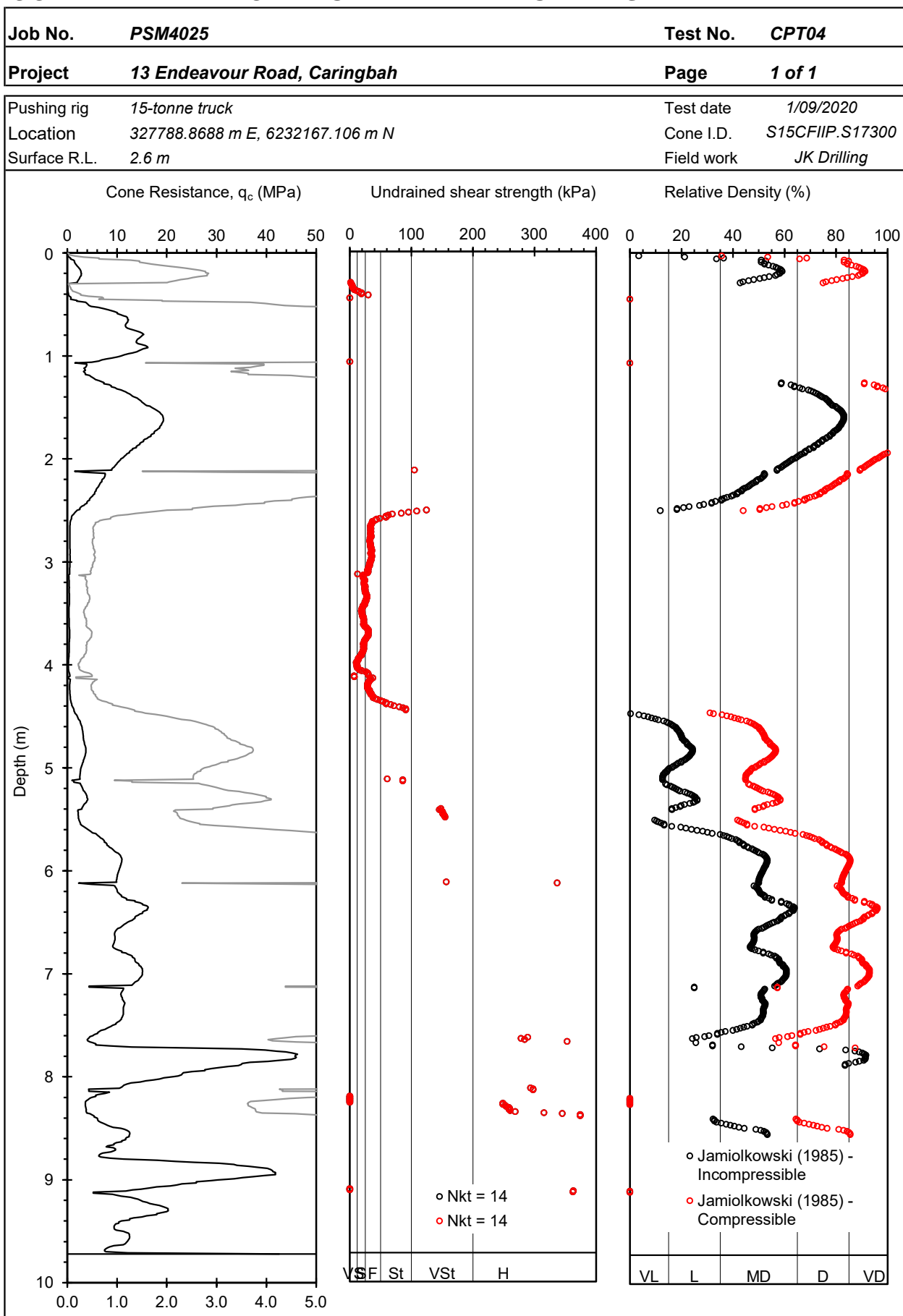


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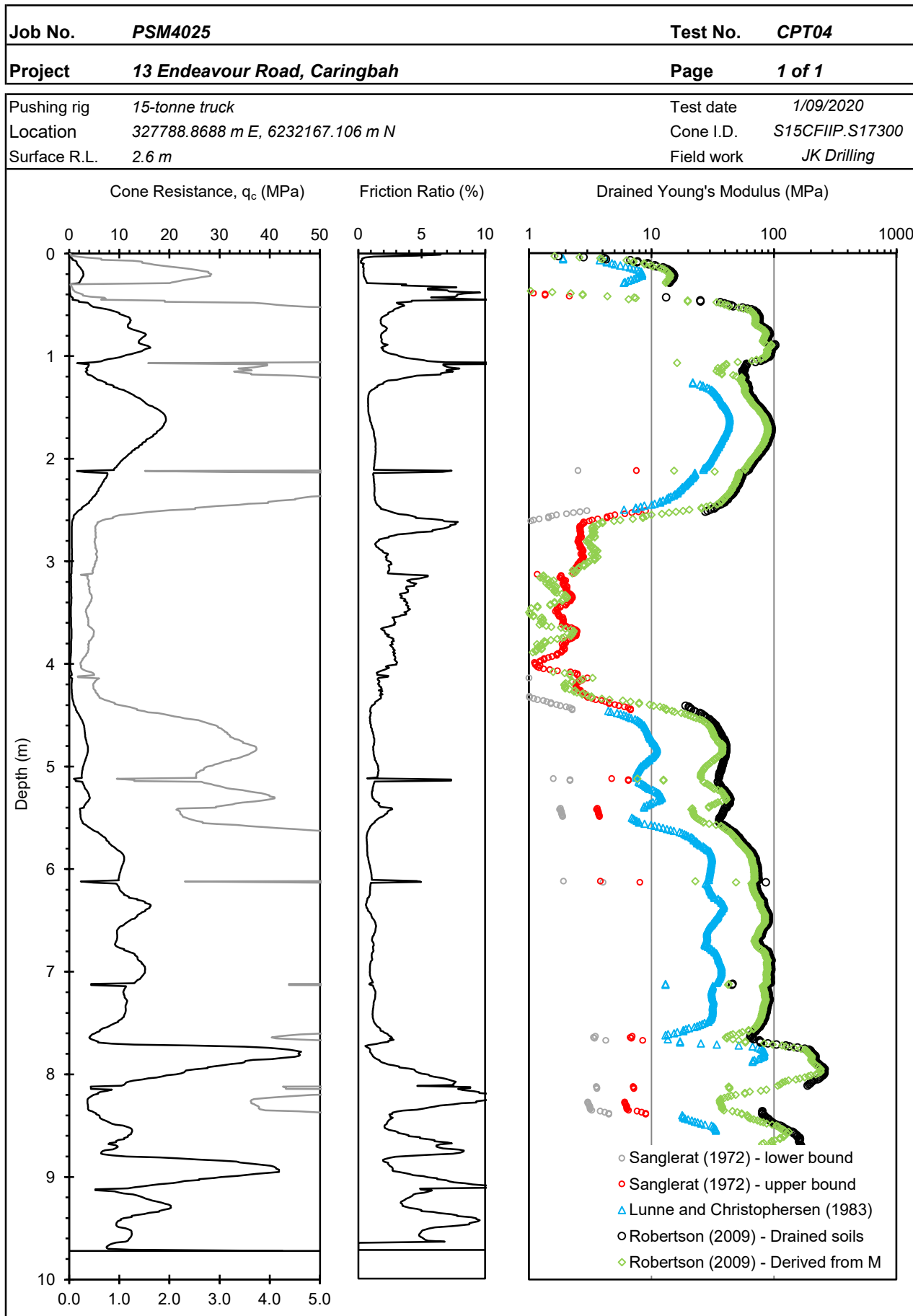


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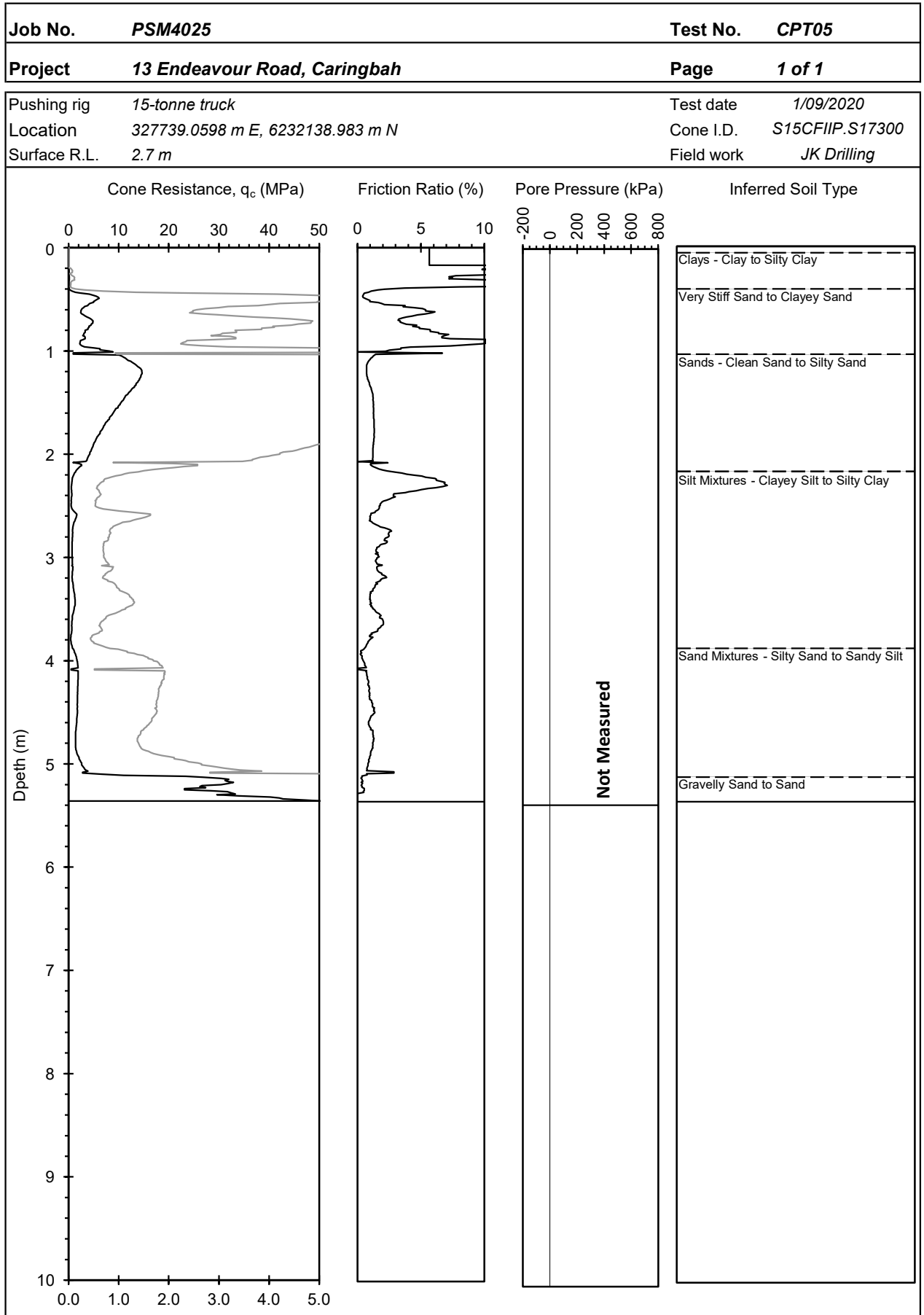


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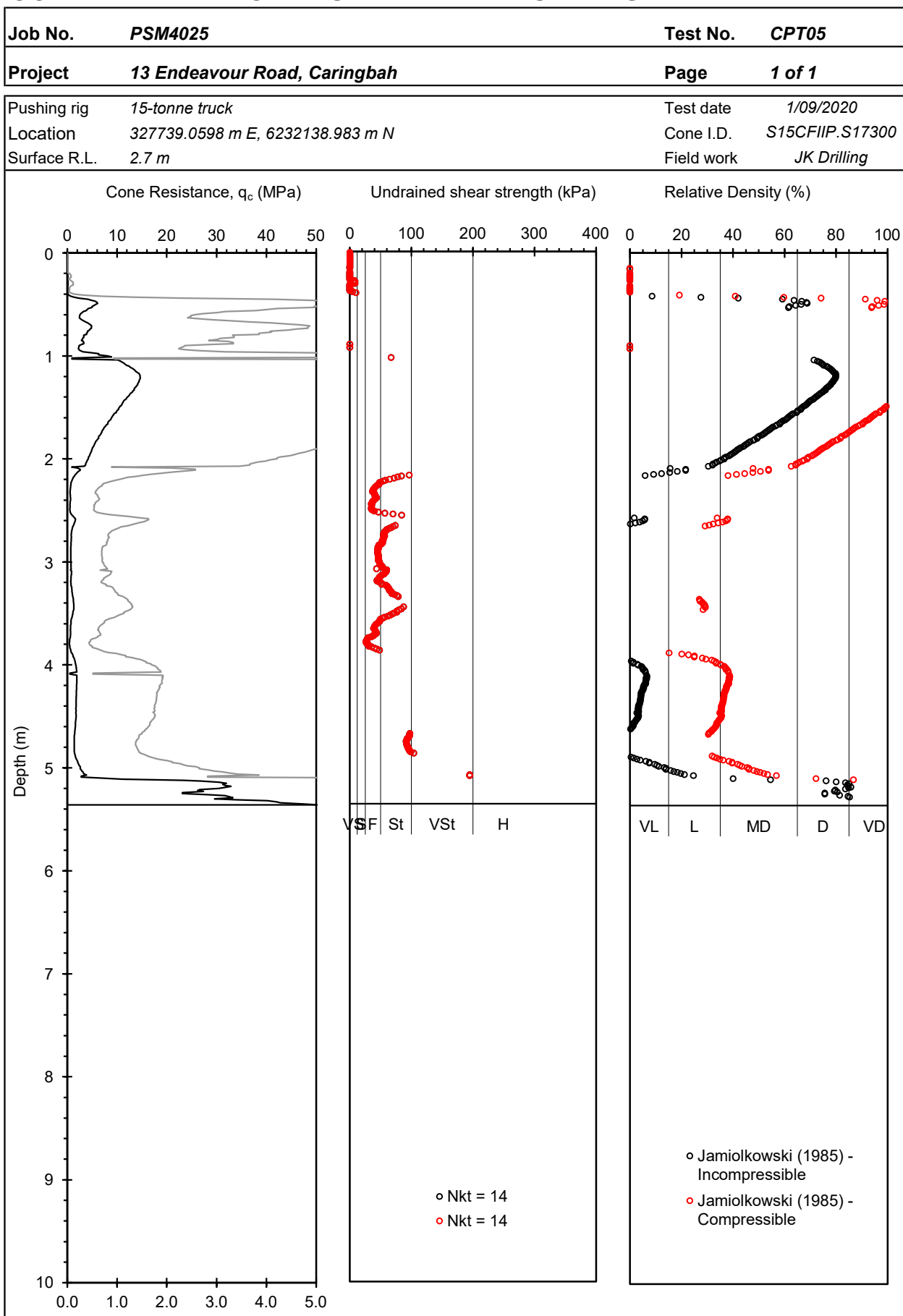
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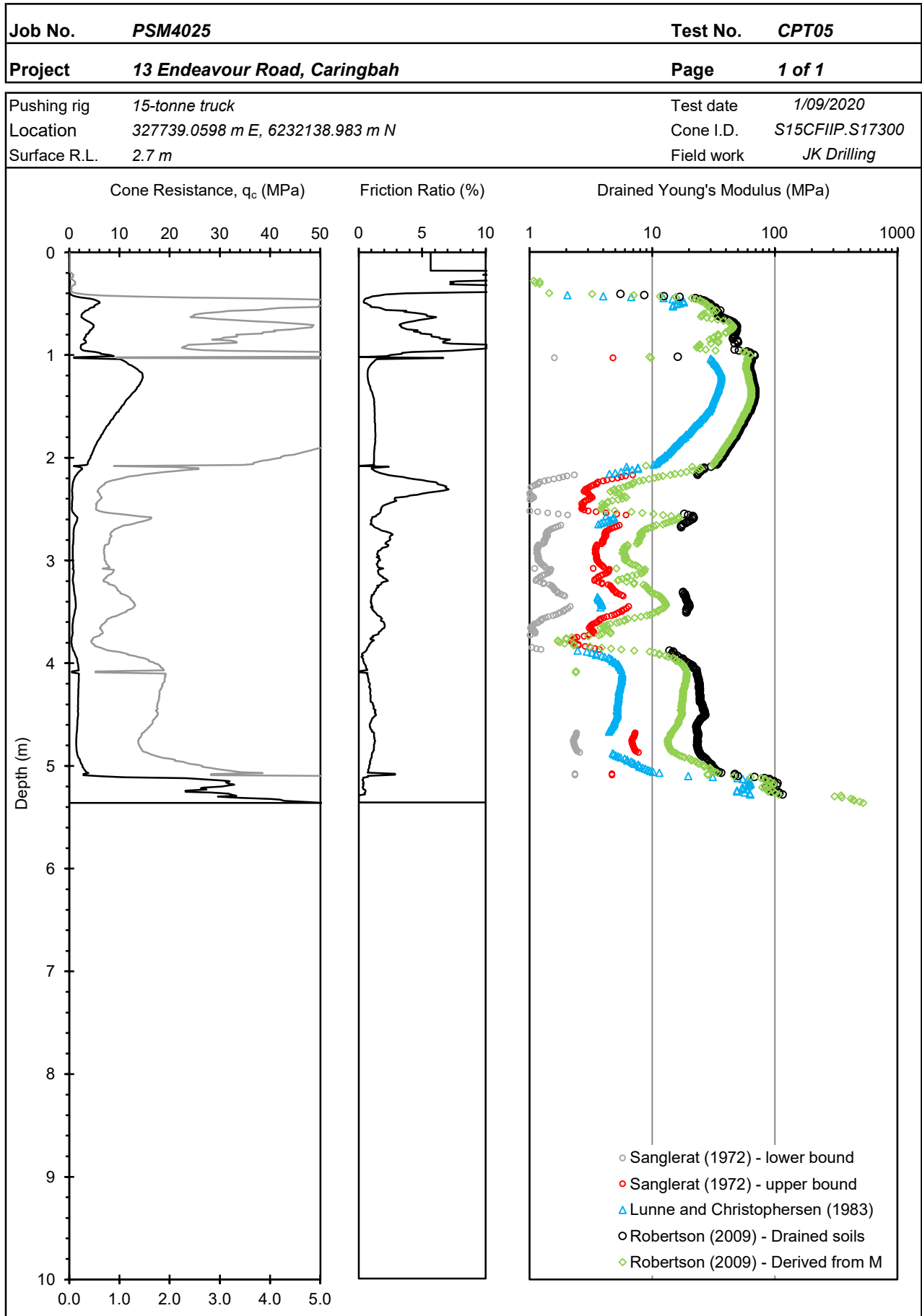


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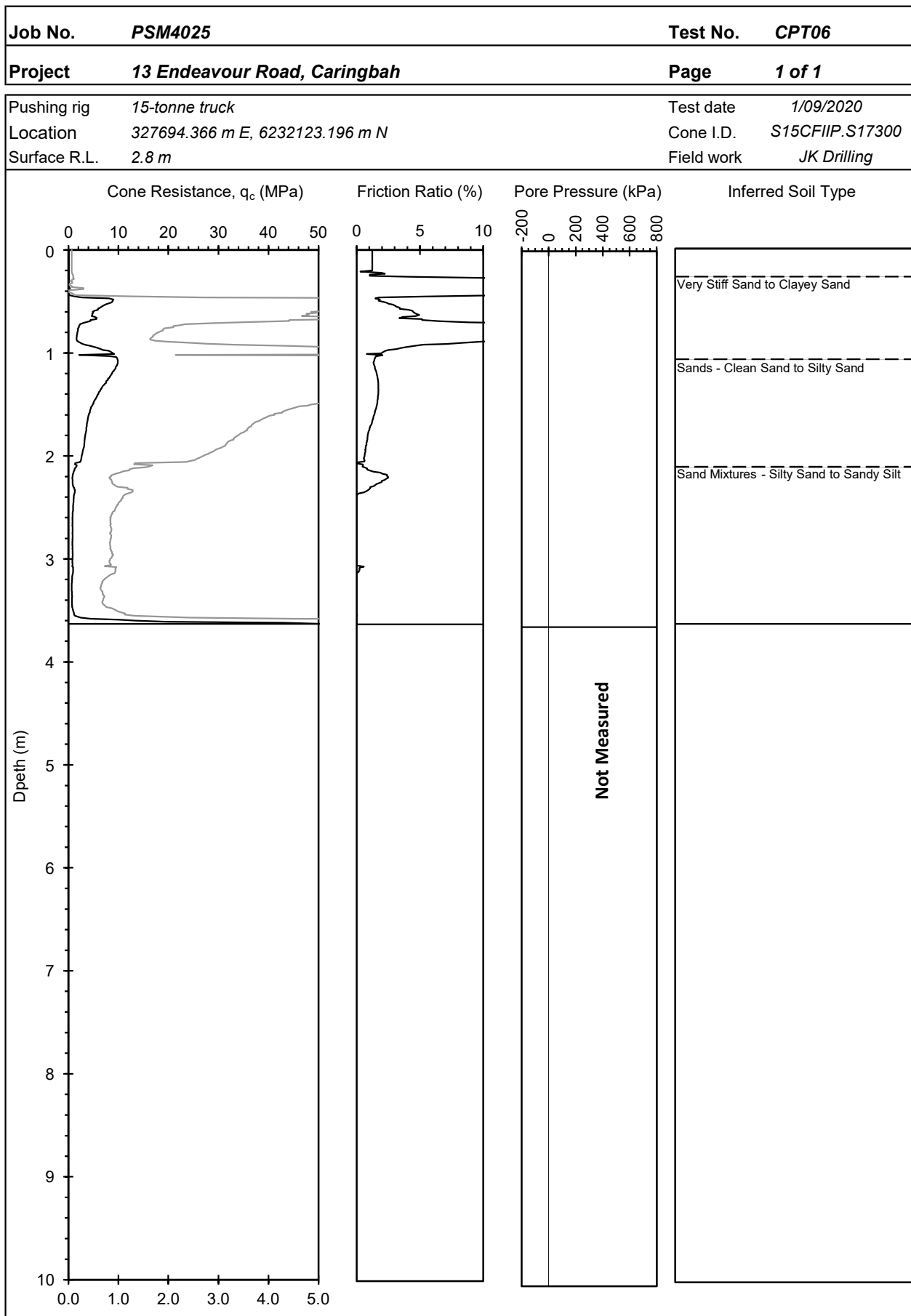


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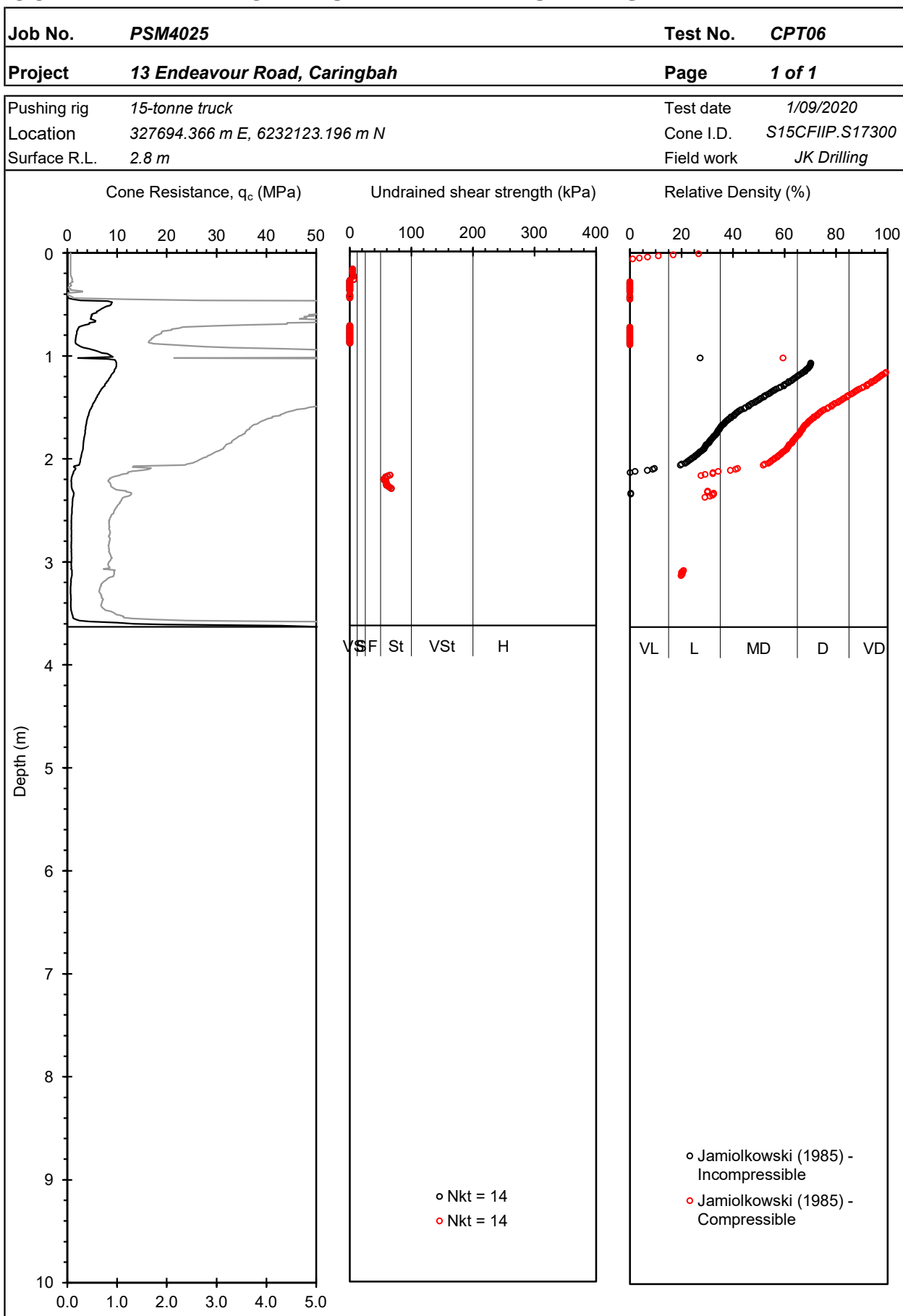


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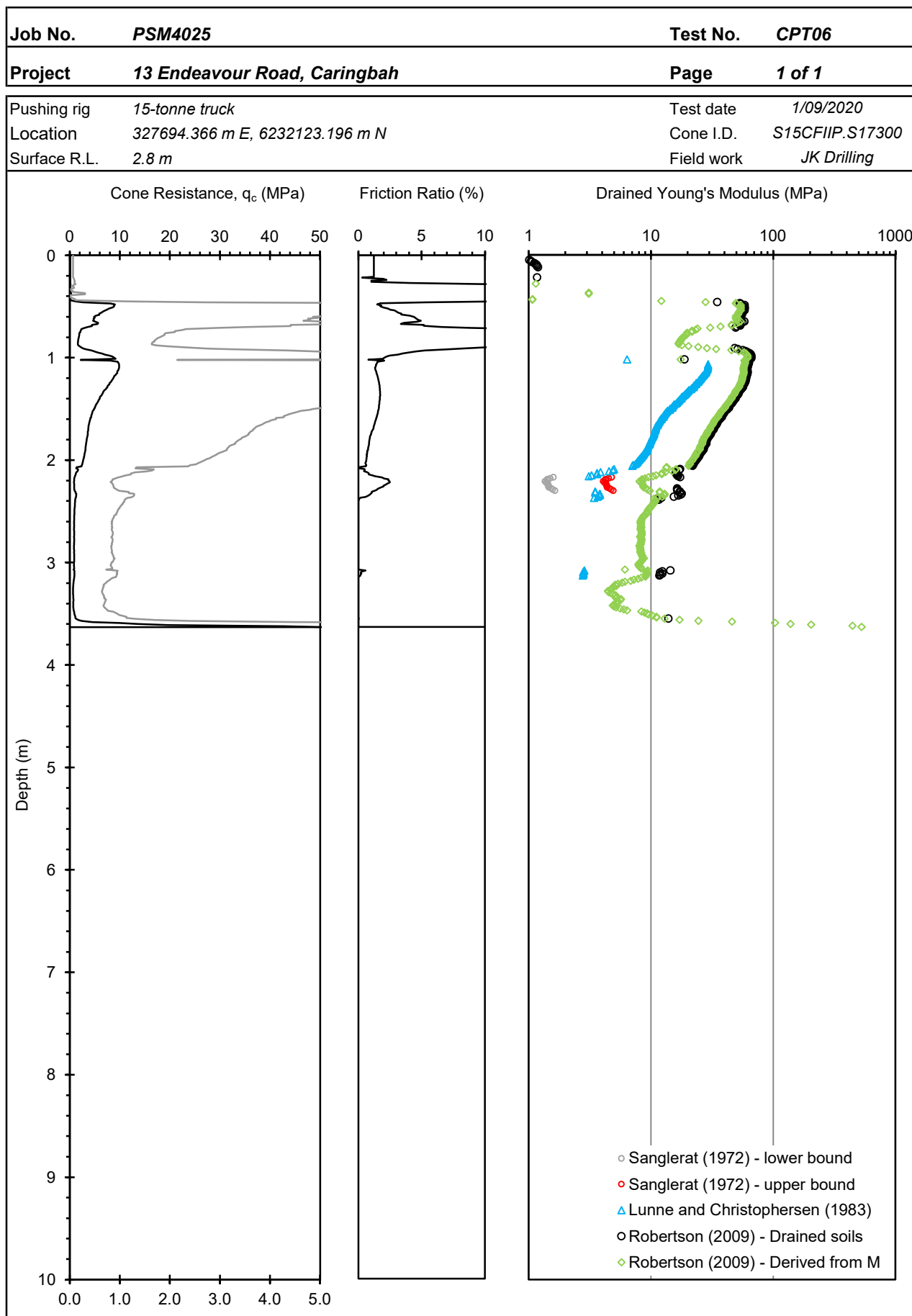


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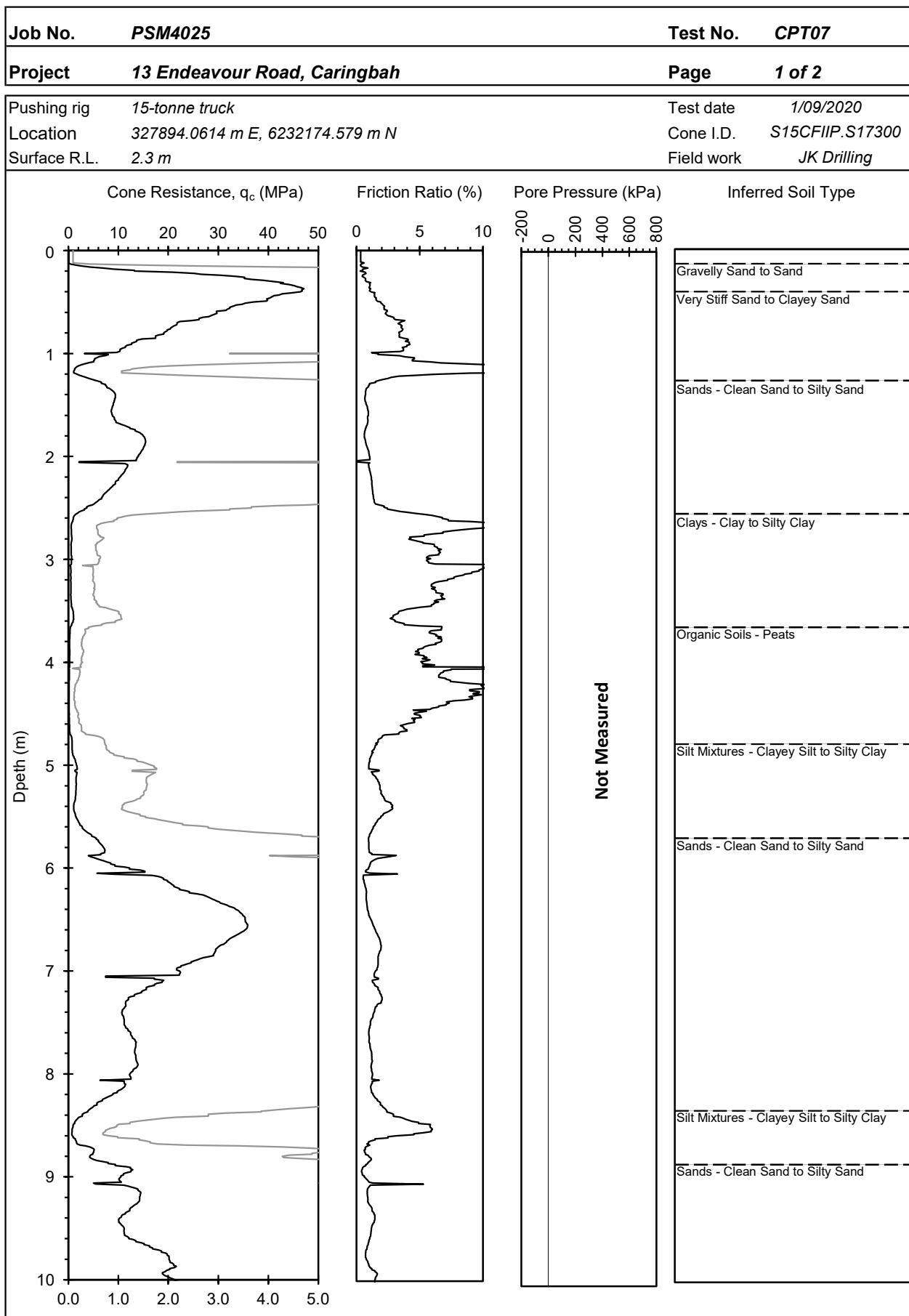


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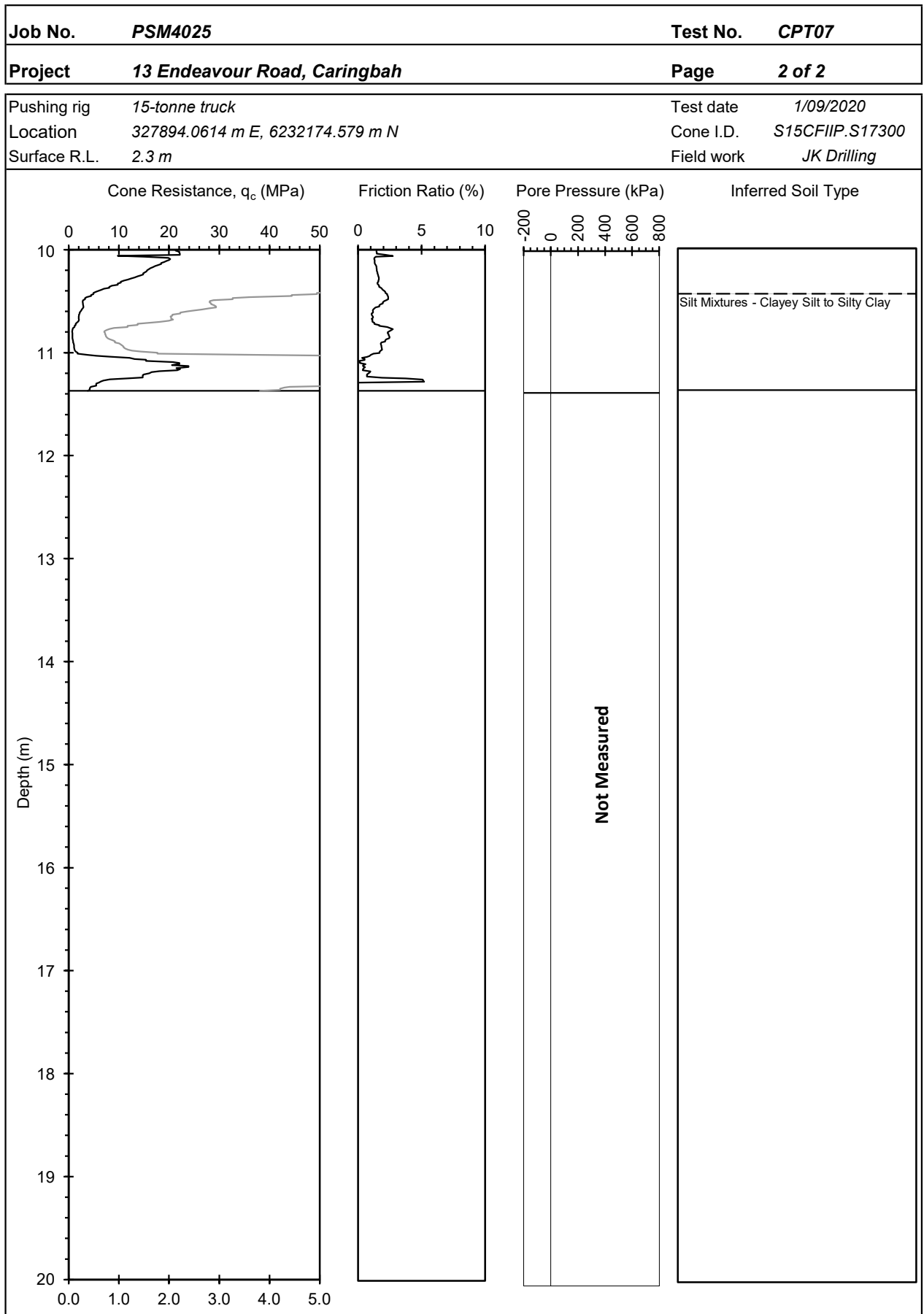


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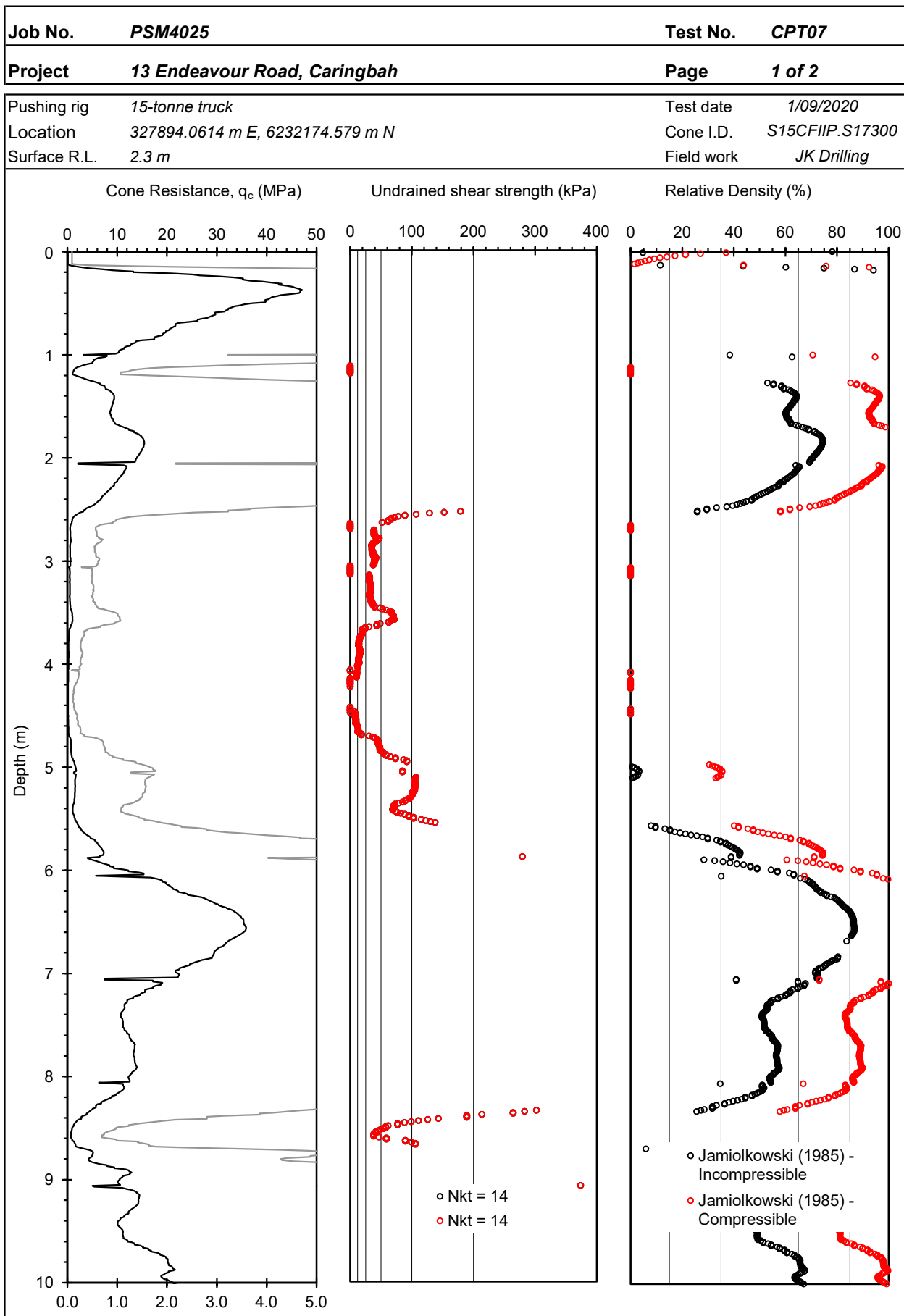
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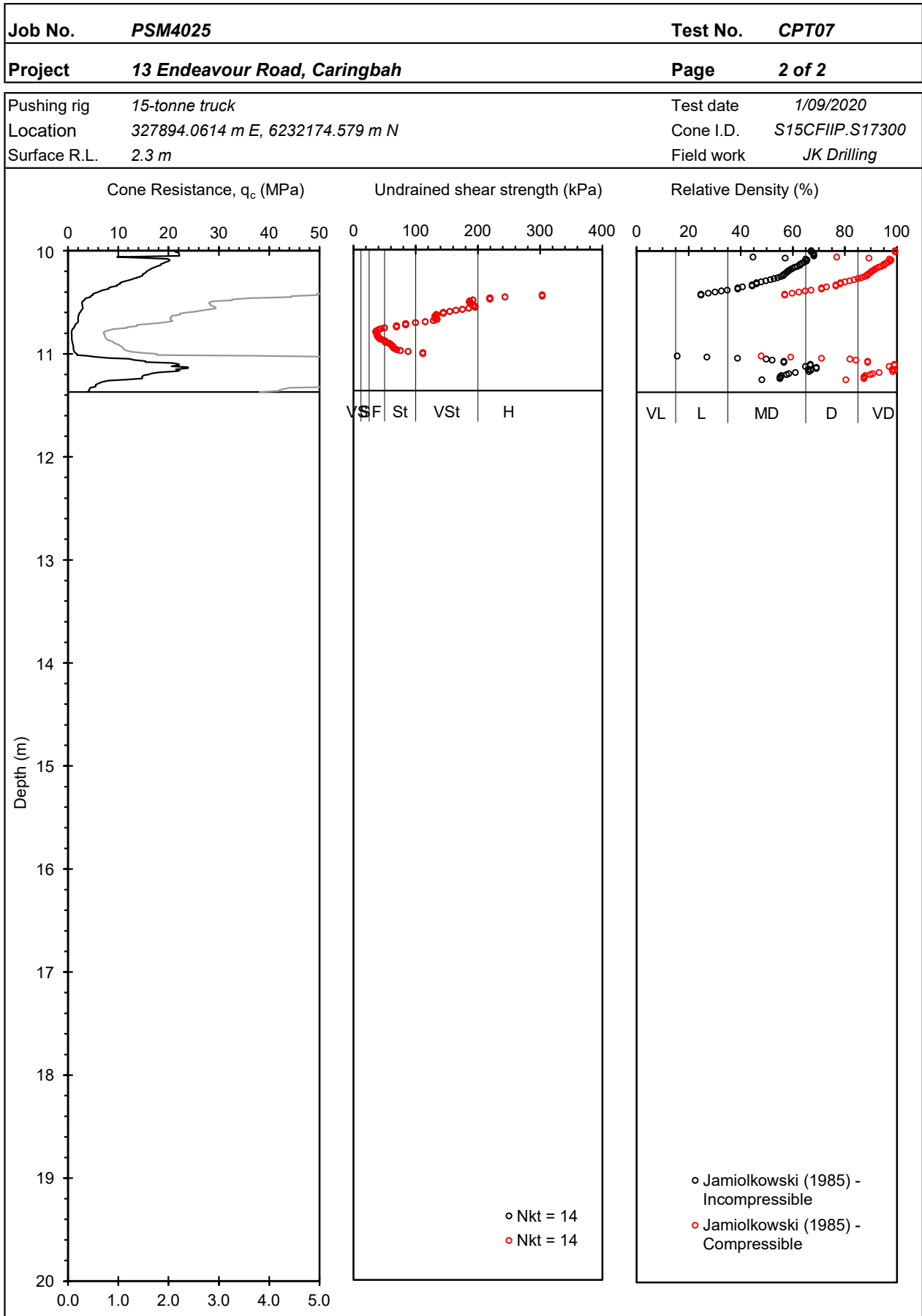


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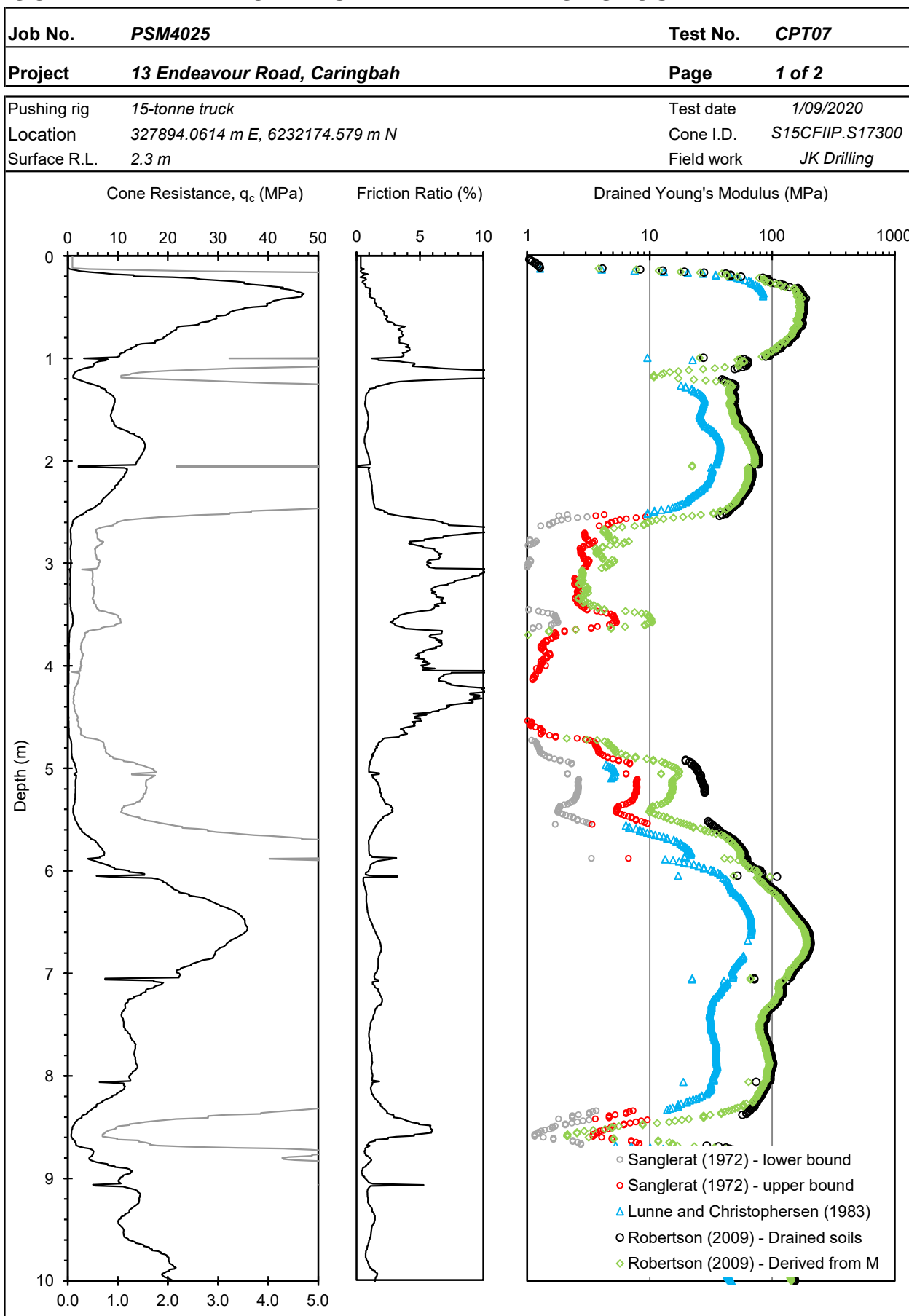


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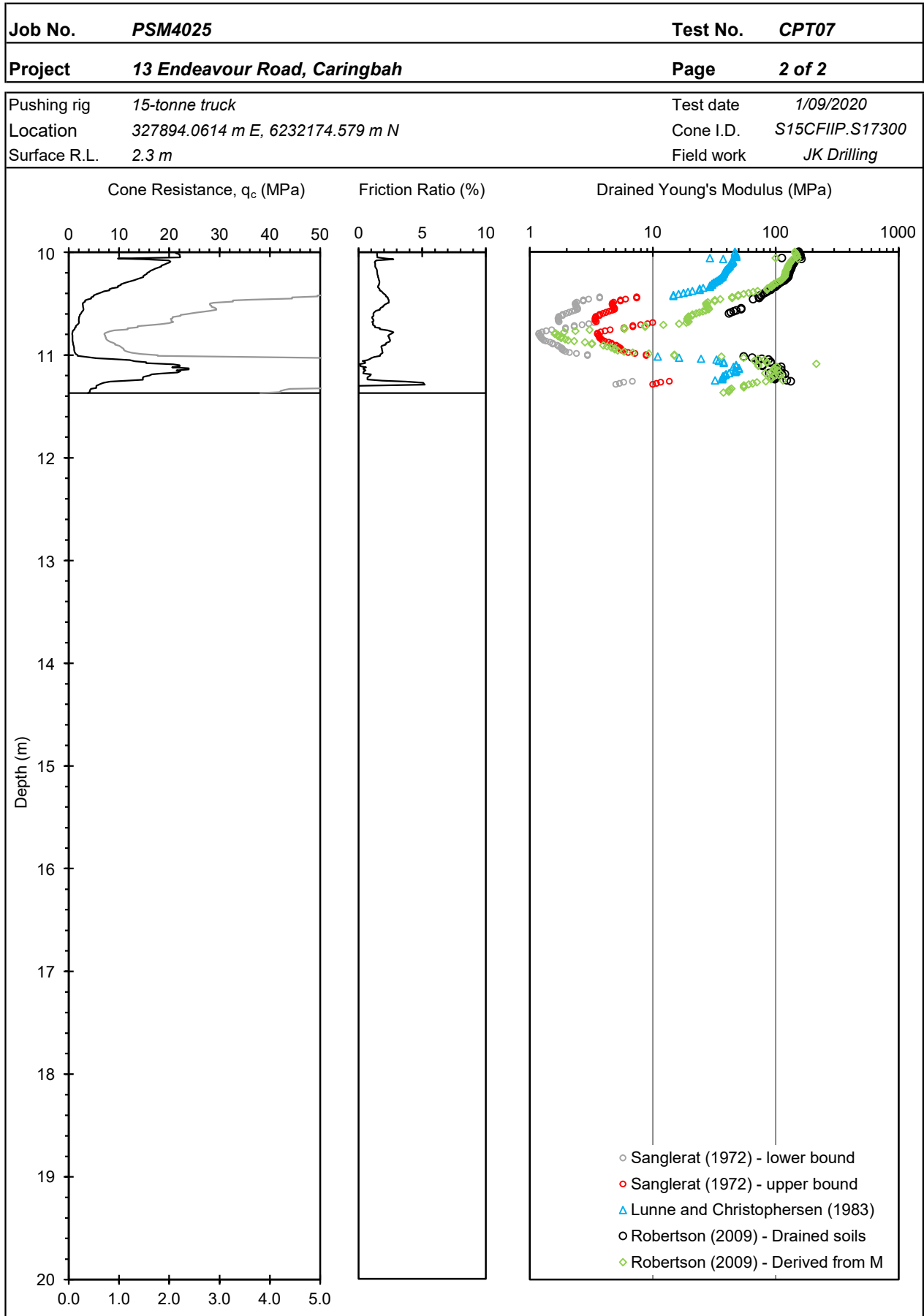


## CONE PENETRATION TEST - INFERRED MODULUS



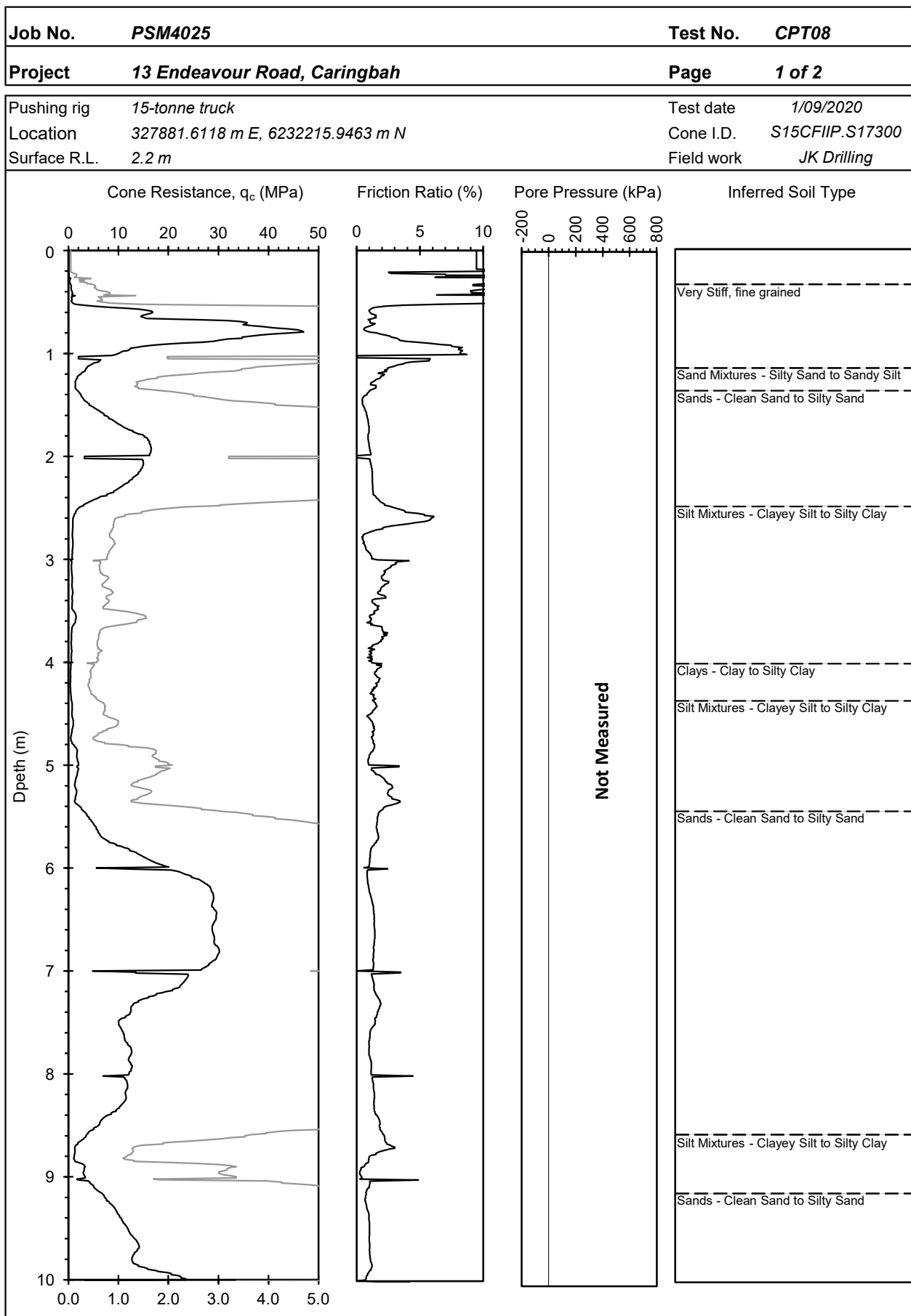


## CONE PENETRATION TEST - INFERRED MODULUS





## CONE PENETRATION TEST - INFERRED SOIL TYPE

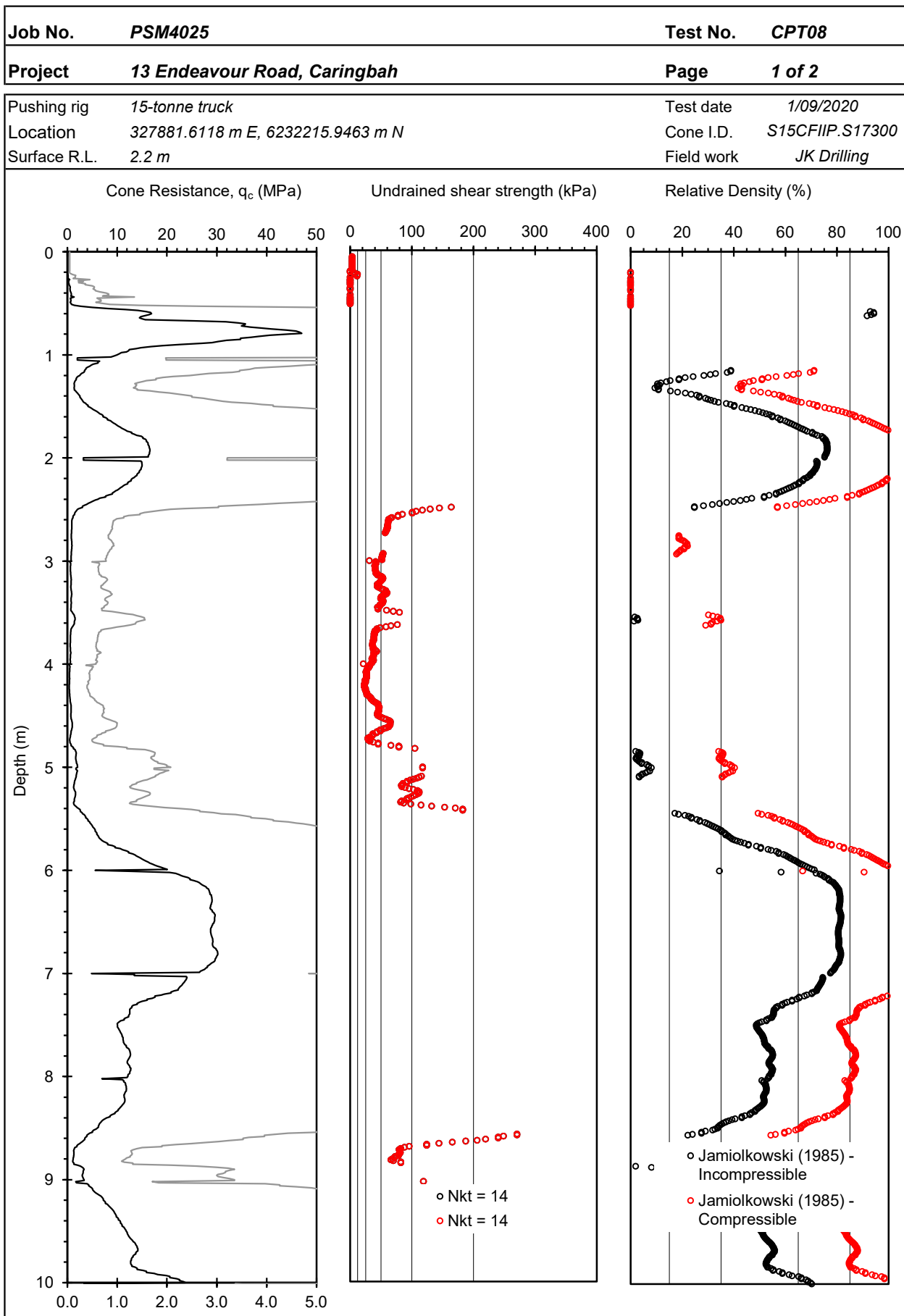




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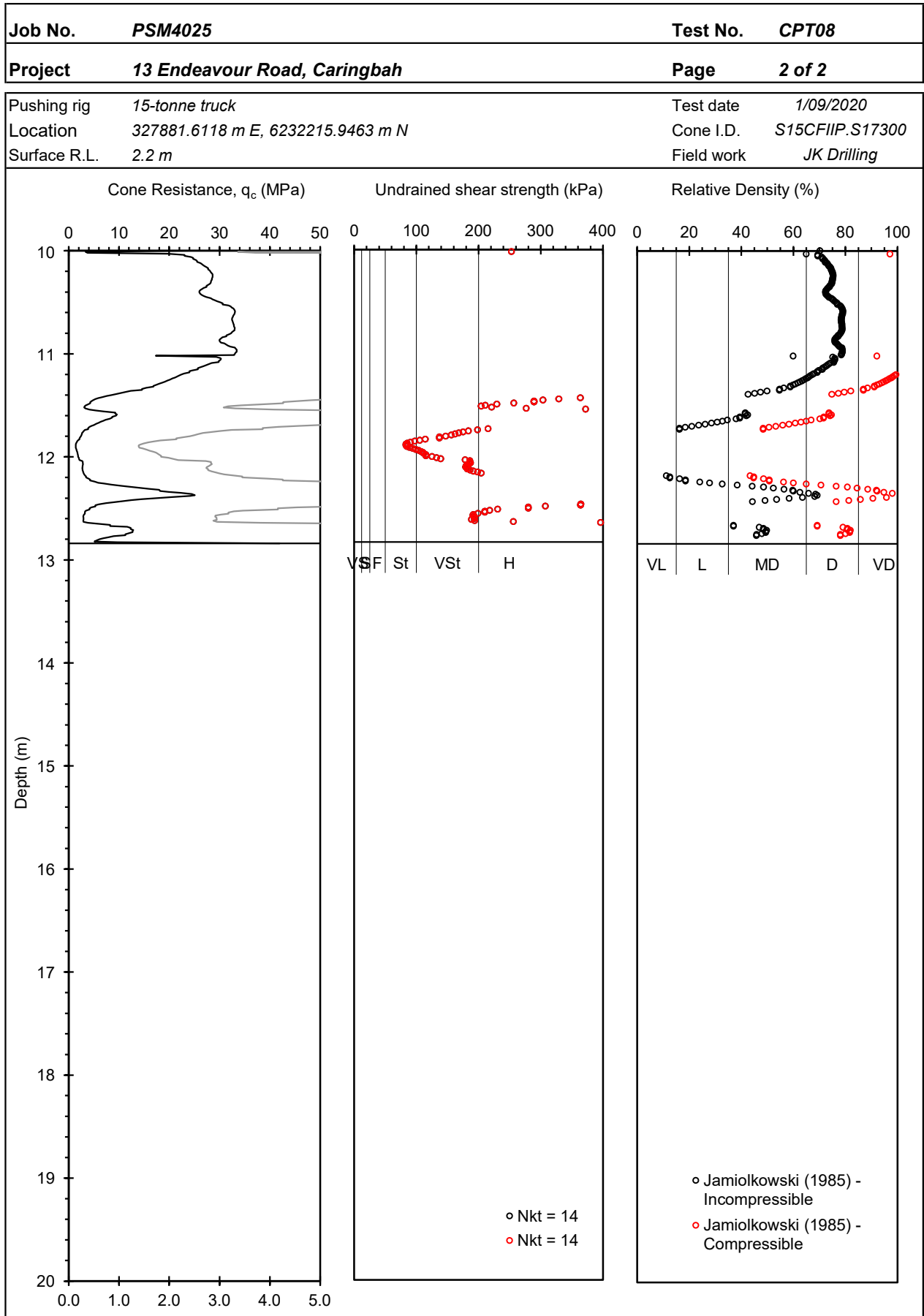


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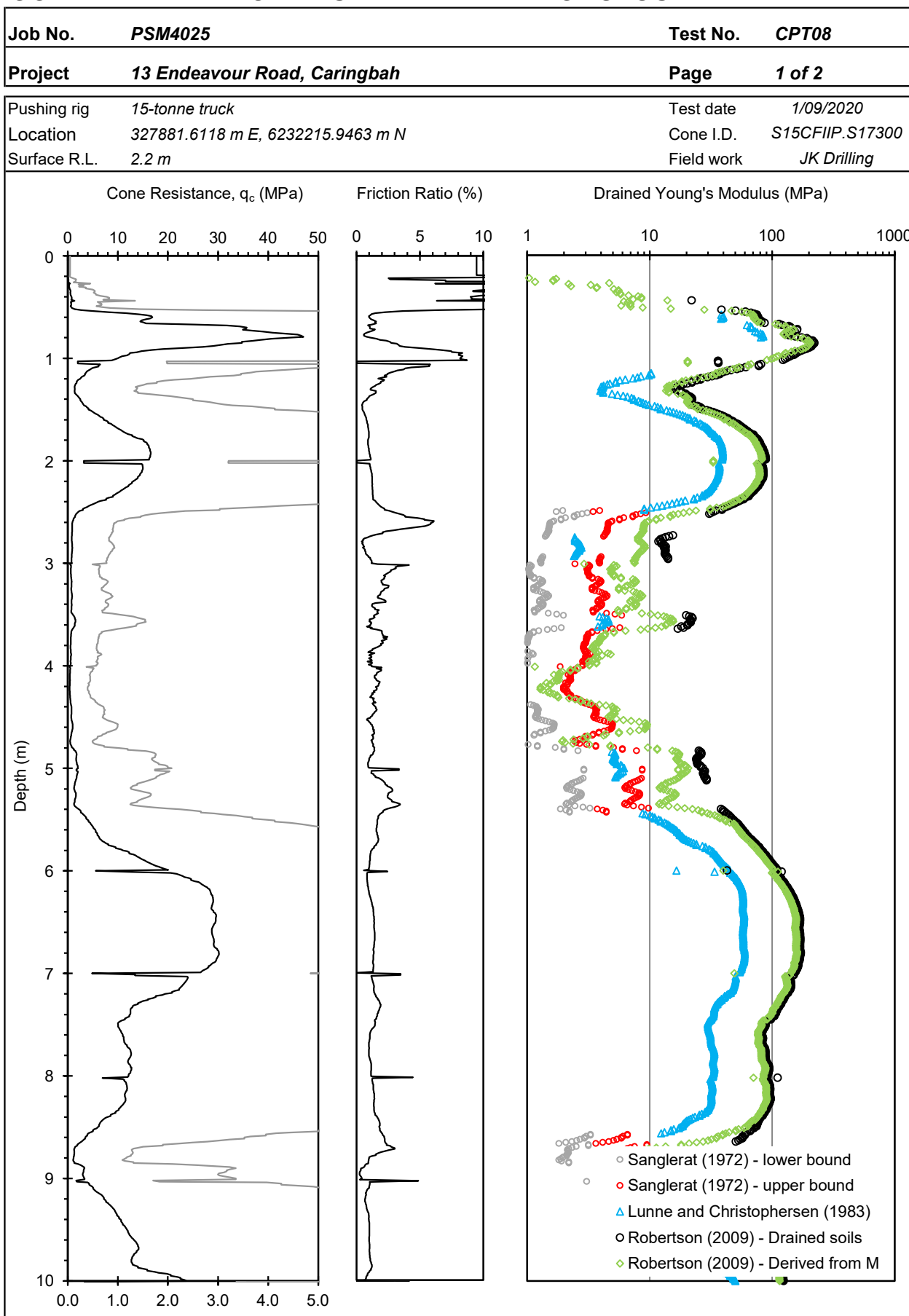
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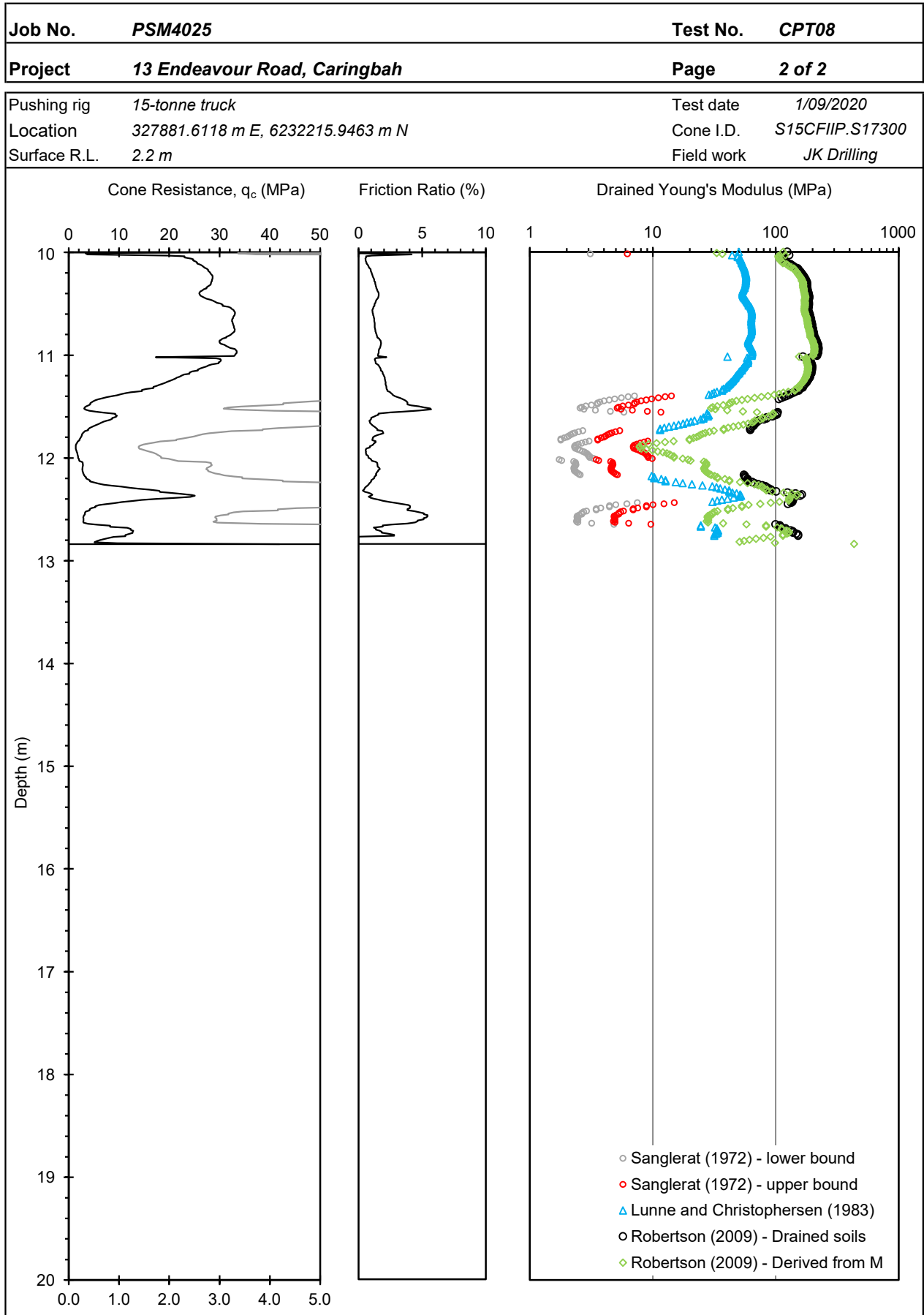


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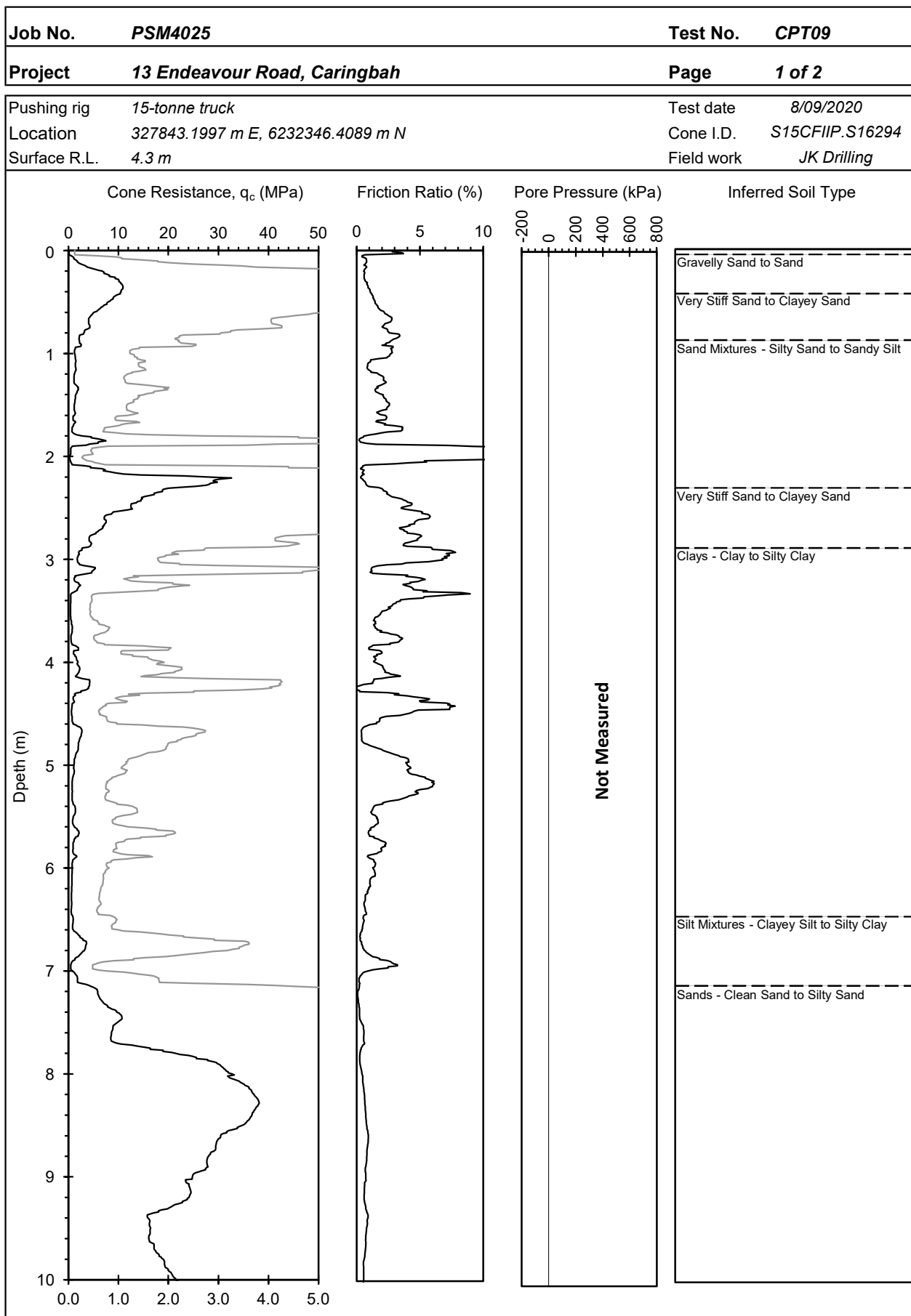


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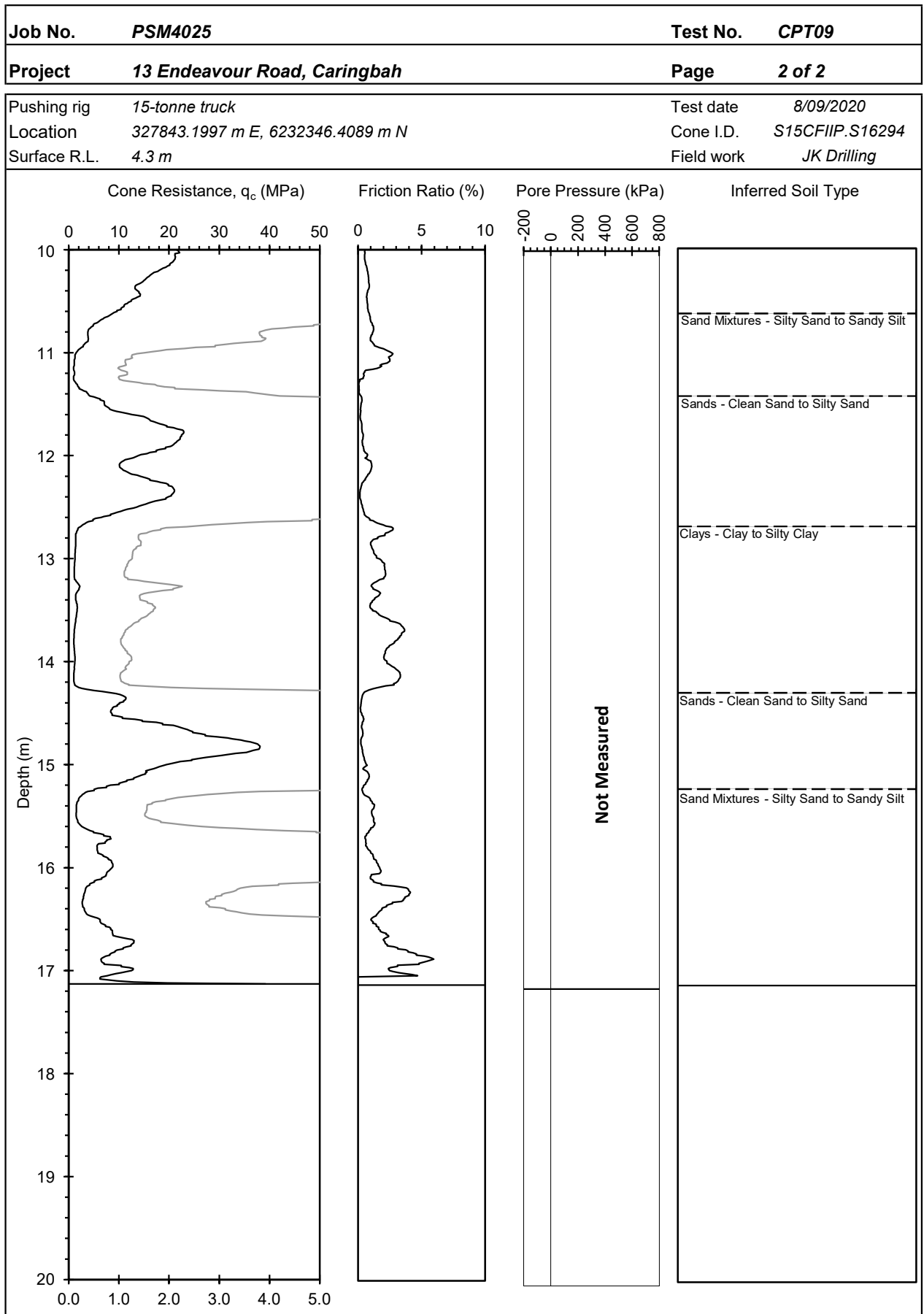


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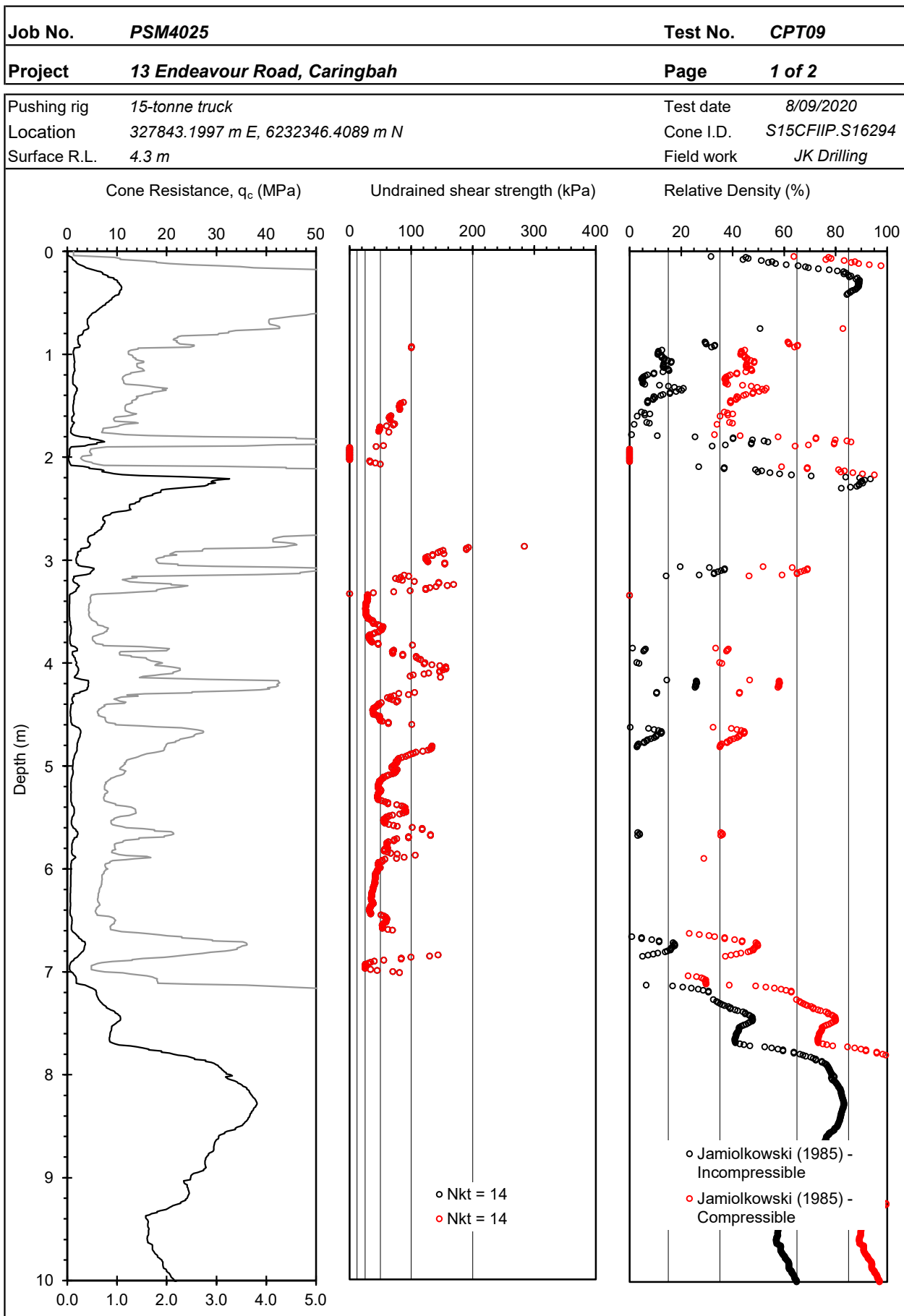


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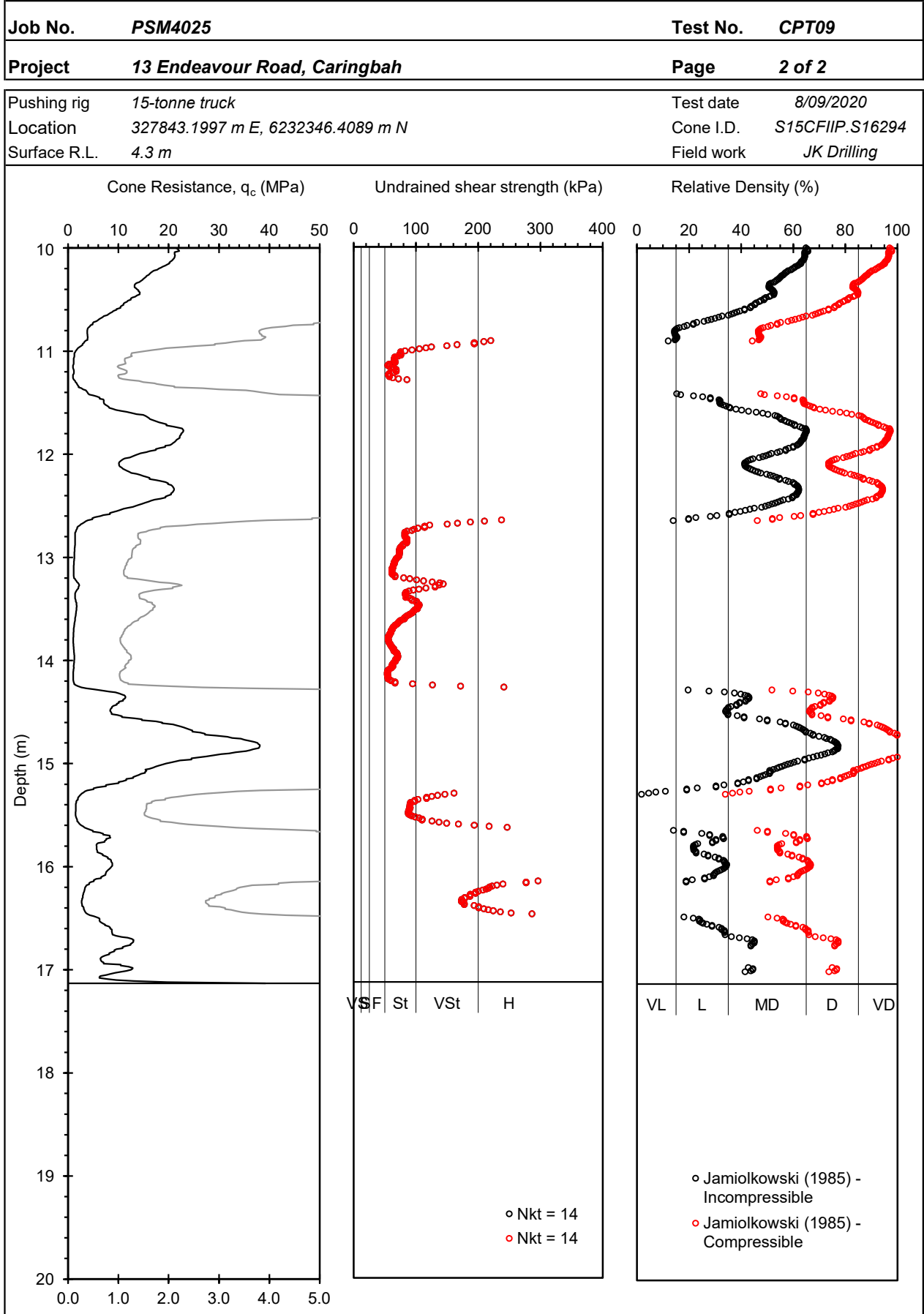


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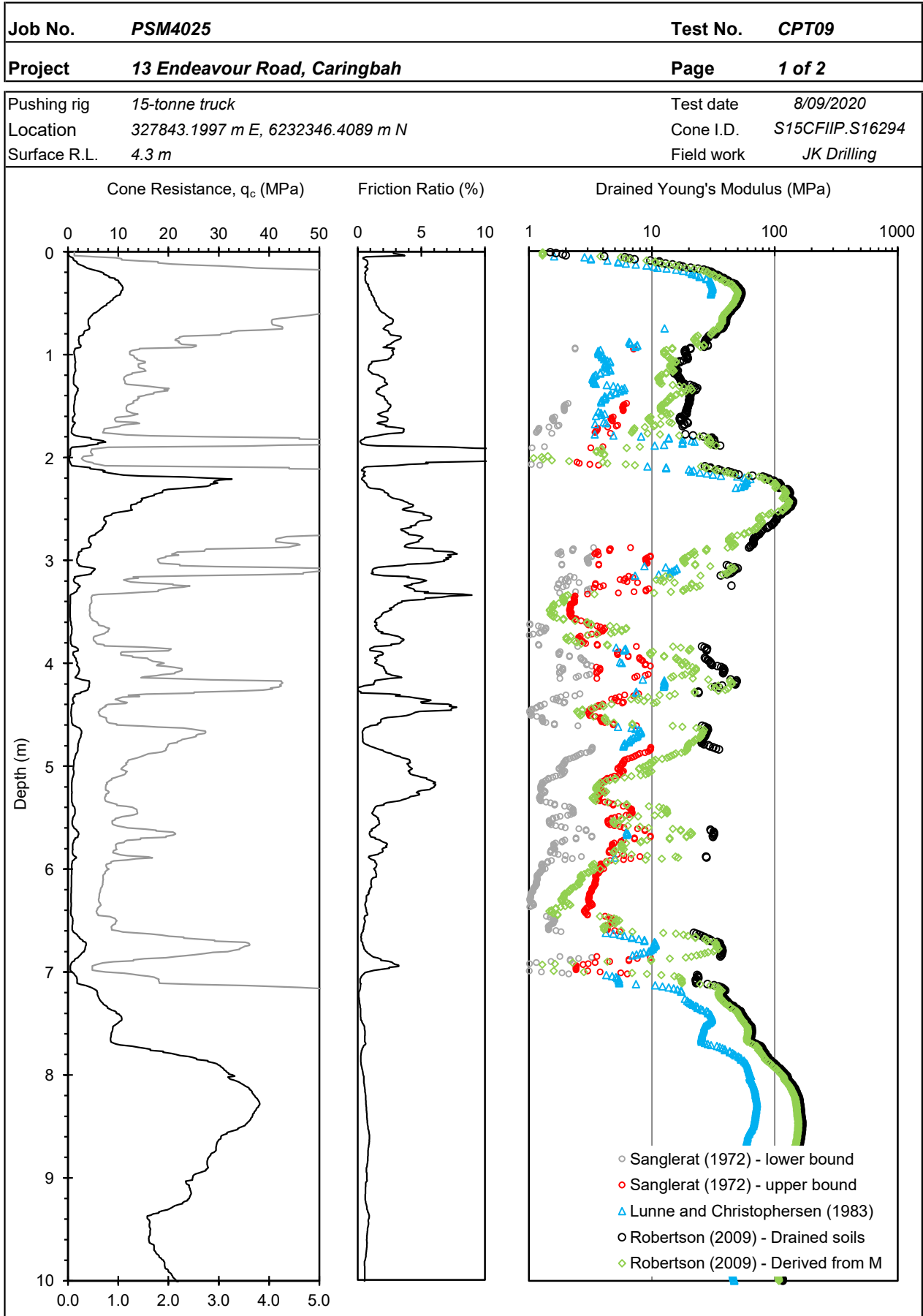


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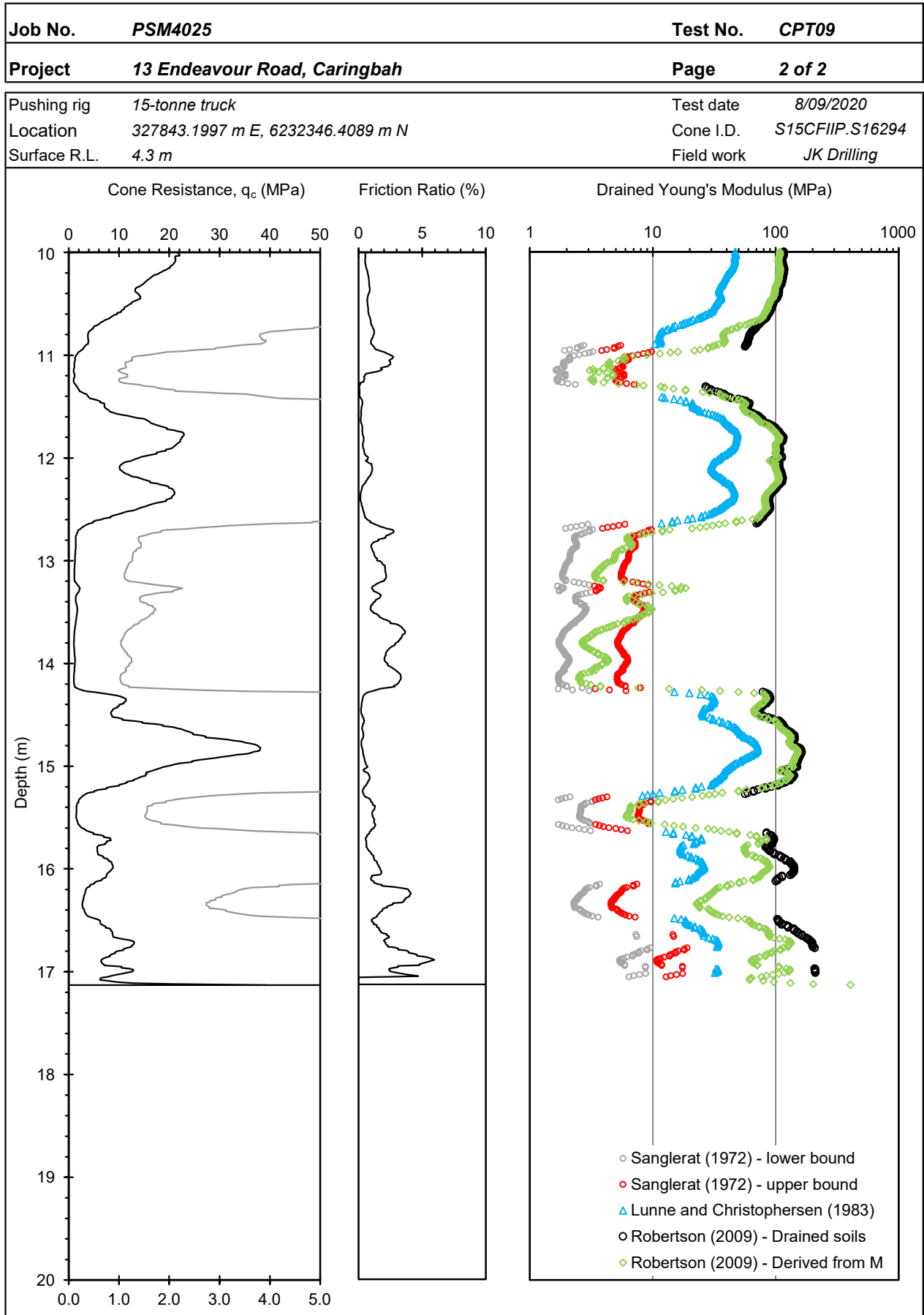


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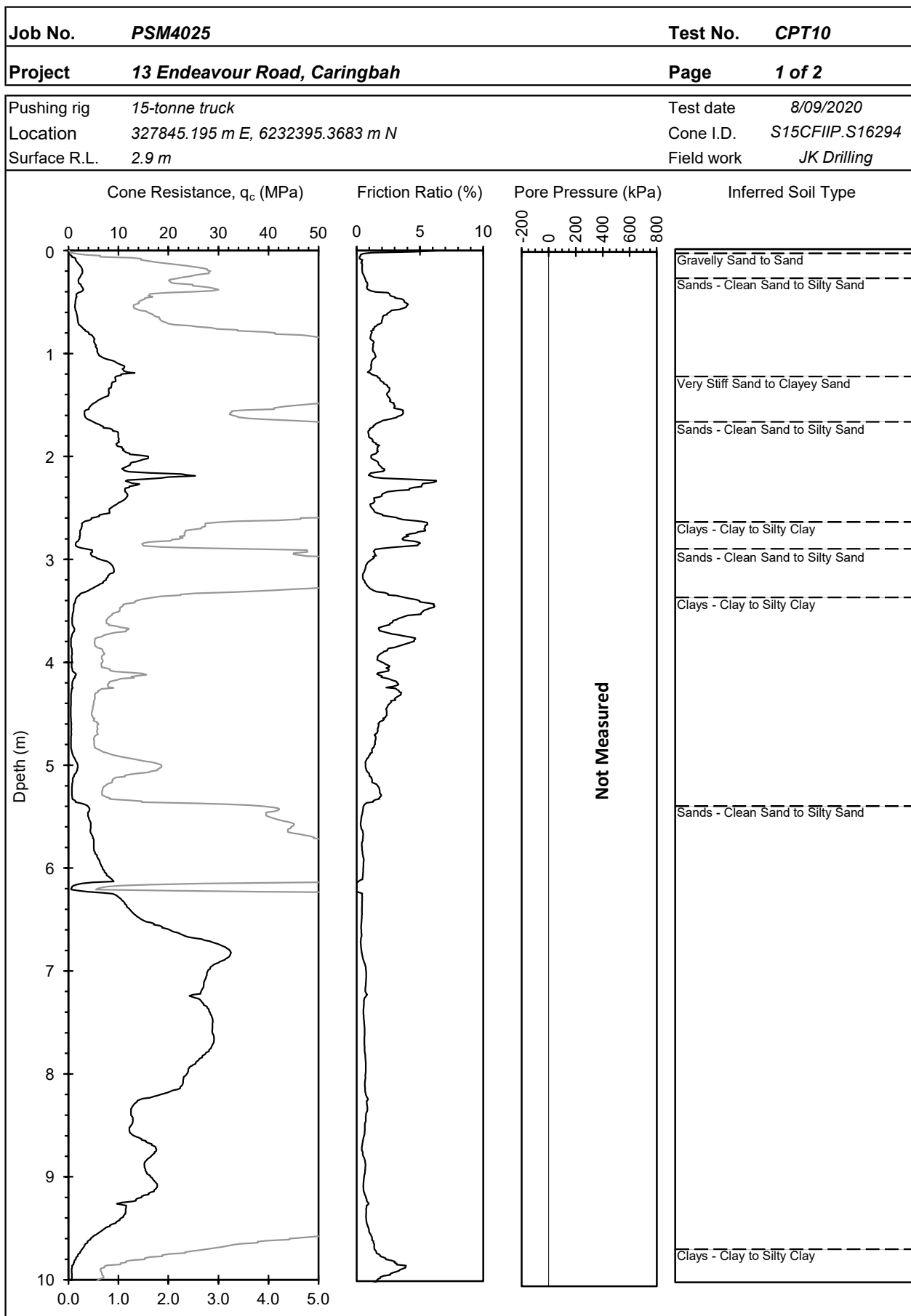
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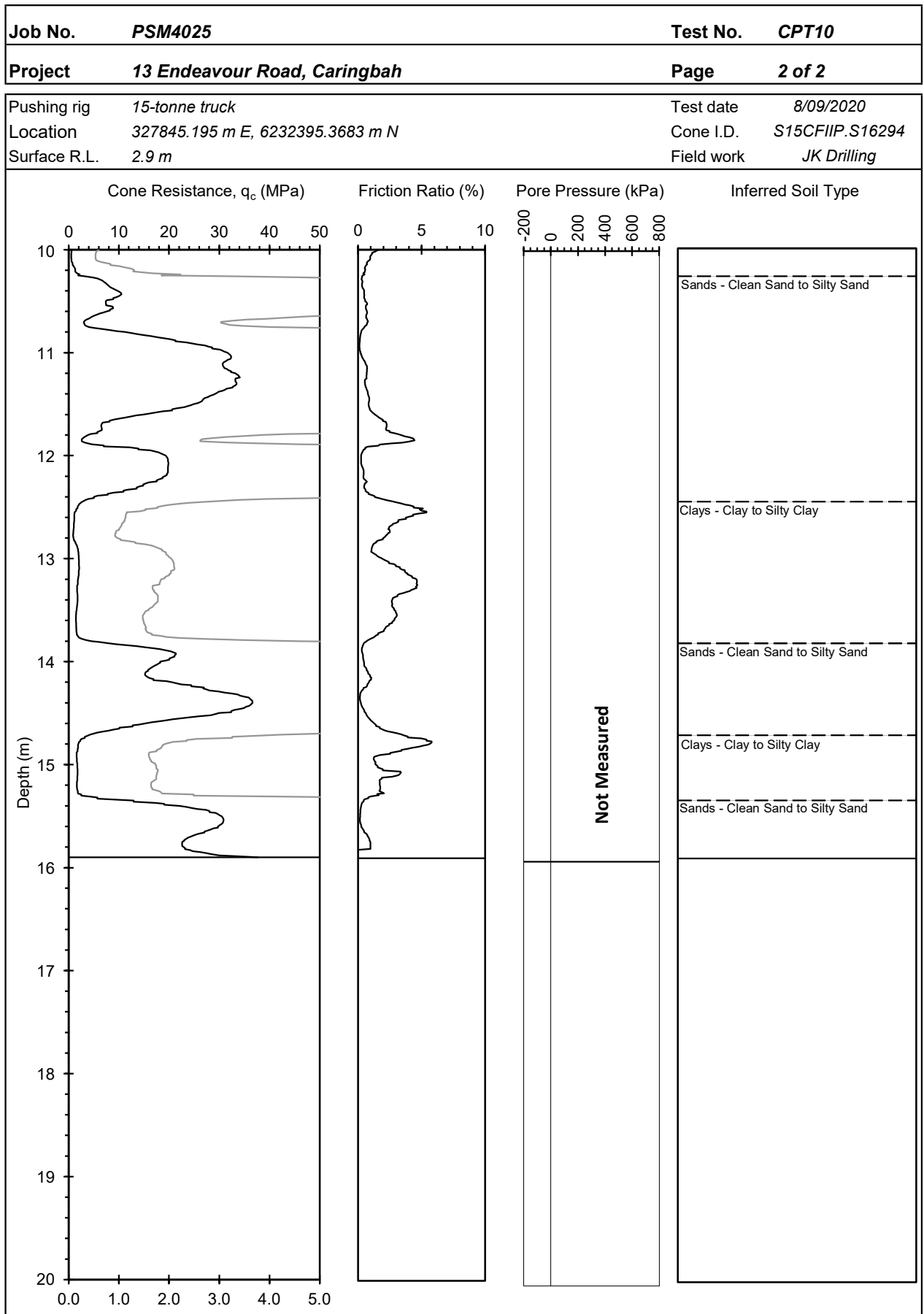


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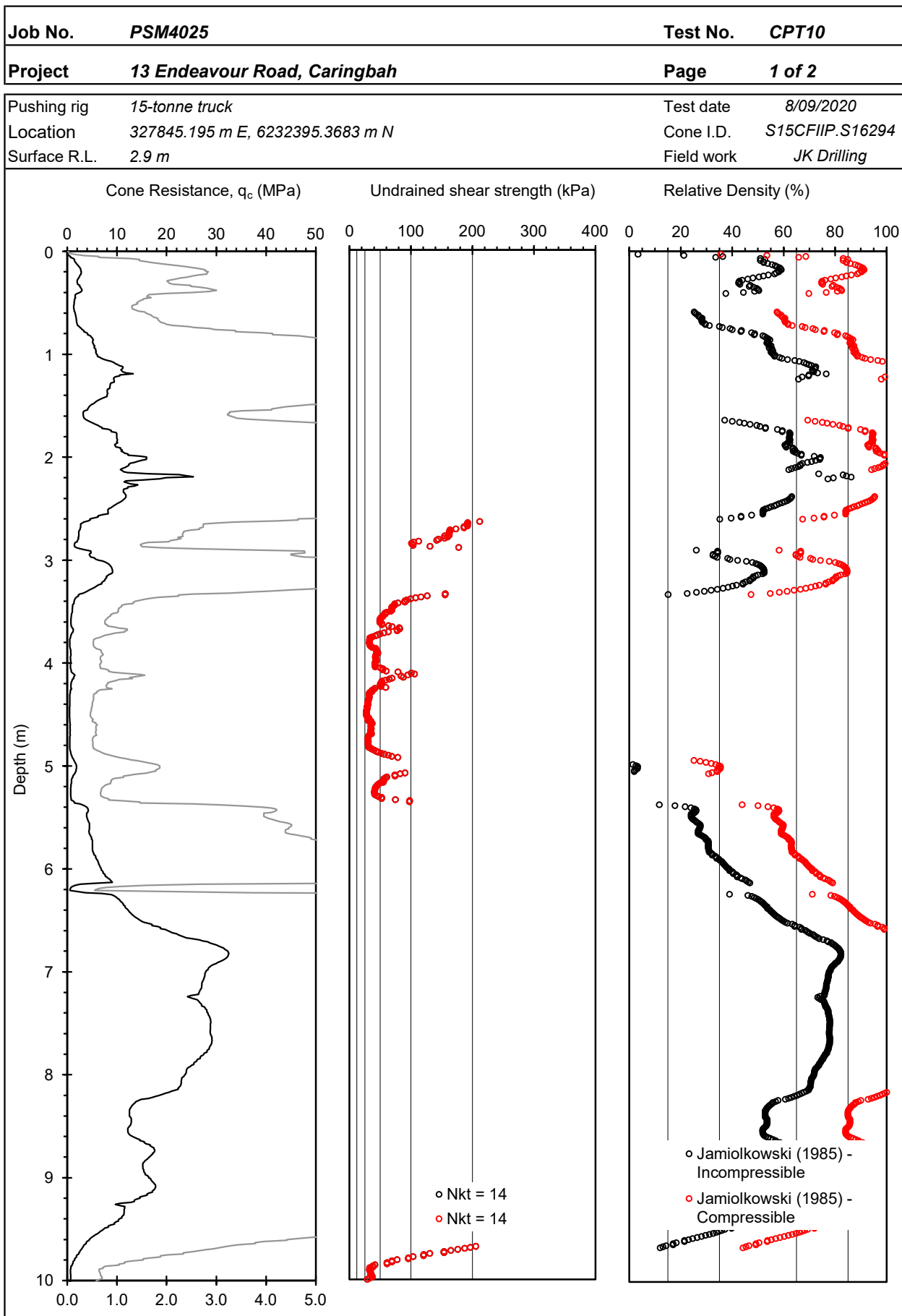


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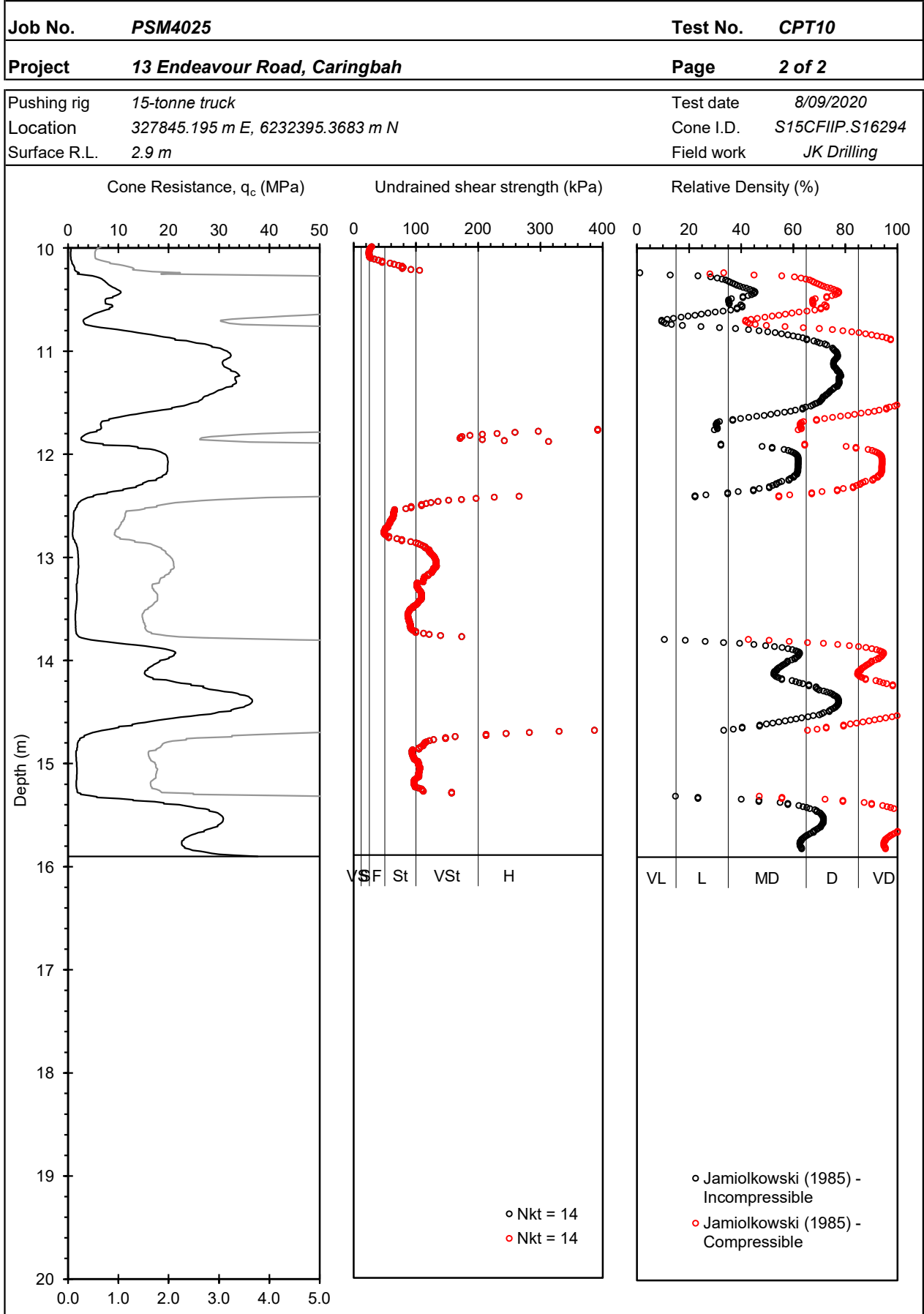


## CONE PENETRATION TEST - INFERRED STRENGTH





## CONE PENETRATION TEST - INFERRED STRENGTH

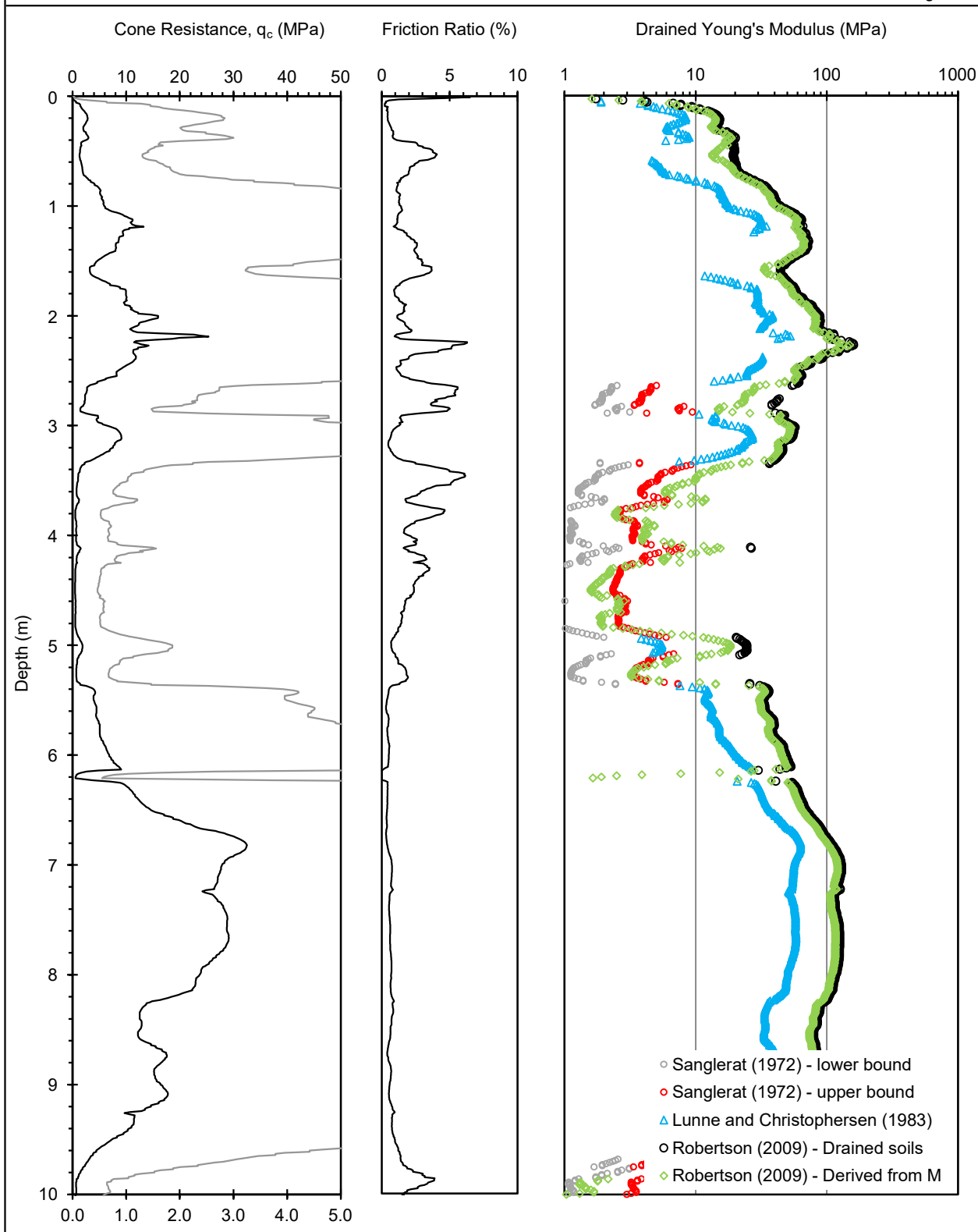




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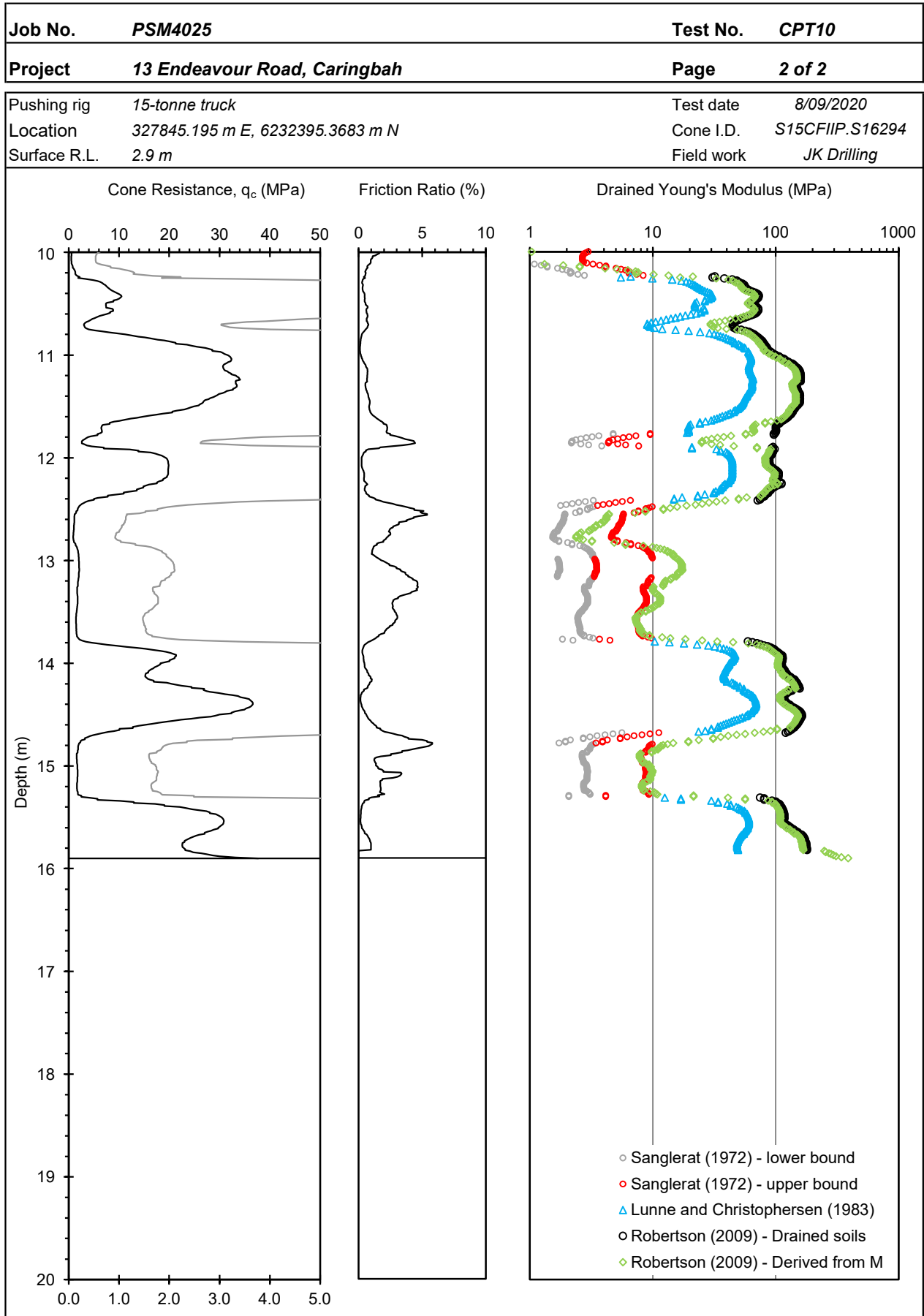
Job No.	PSM4025	Test No.	CPT10
Project	13 Endeavour Road, Caringbah	Page	1 of 2

Pushing rig	15-tonne truck	Test date	8/09/2020
Location	327845.195 m E, 6232395.3683 m N	Cone I.D.	S15CFIIP.S16294
Surface R.L.	2.9 m	Field work	JK Drilling



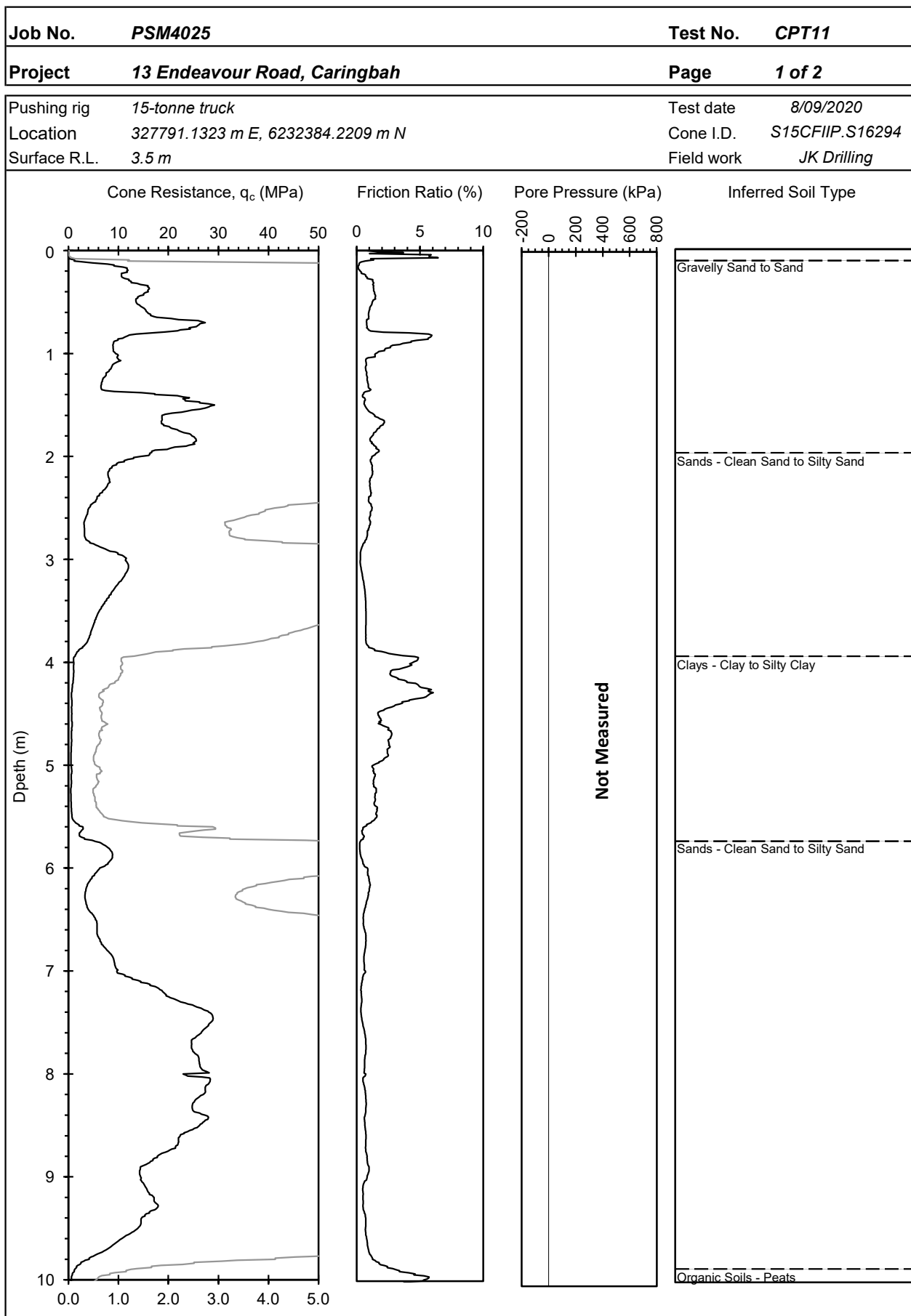


## CONE PENETRATION TEST - INFERRED MODULUS





## CONE PENETRATION TEST - INFERRED SOIL TYPE



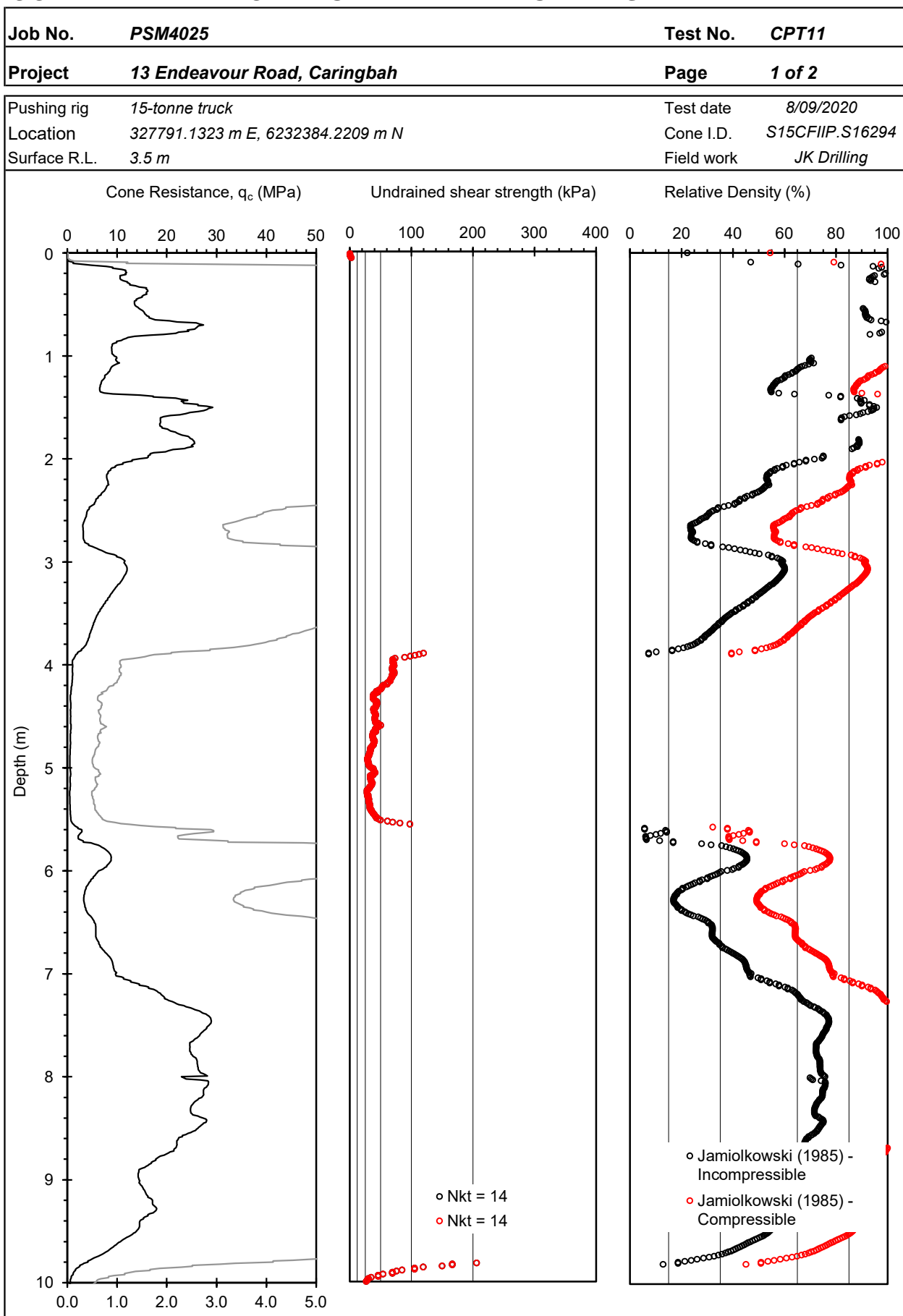


0.0    1.0    2.0    3.0    4.0    5.0



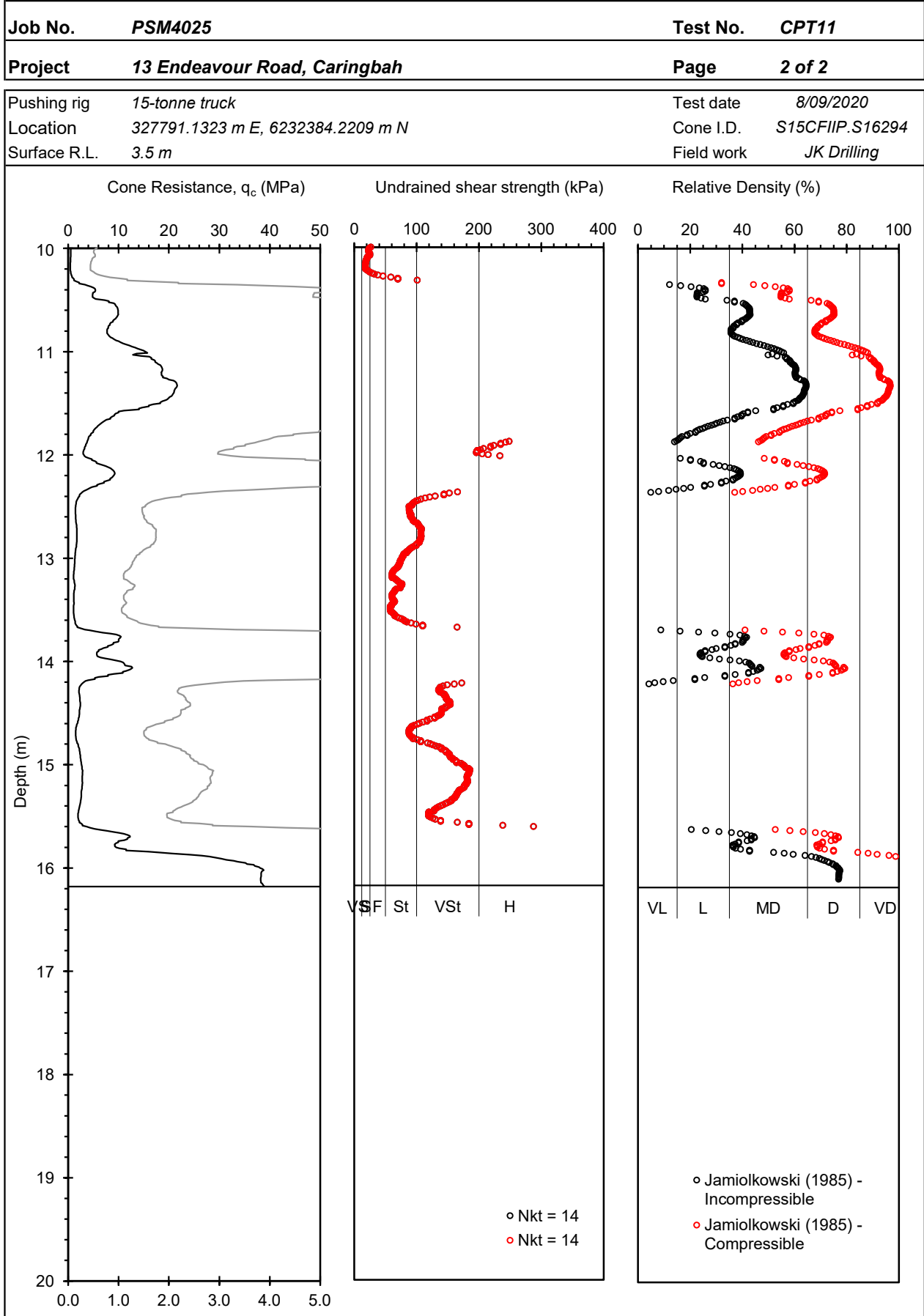


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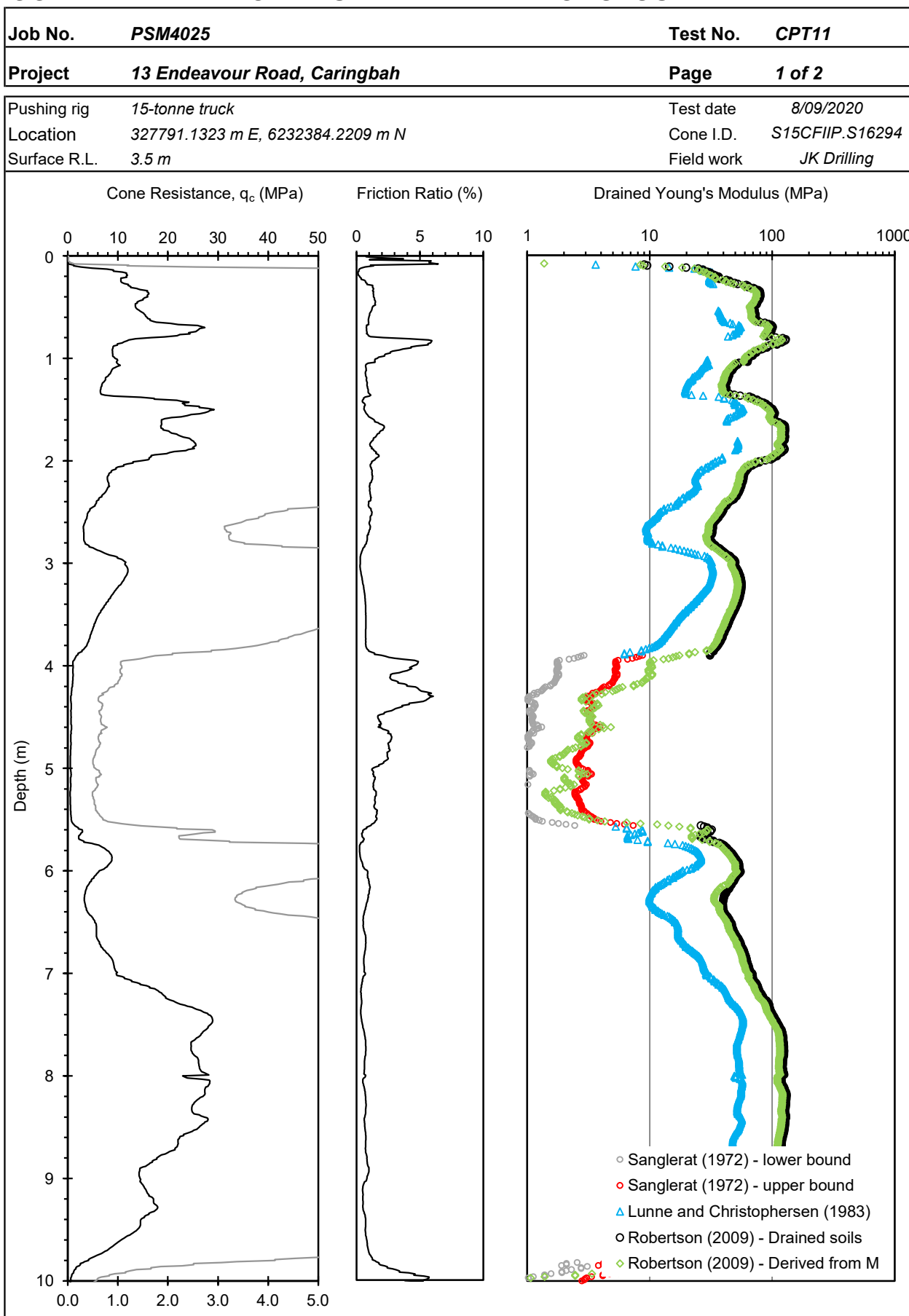


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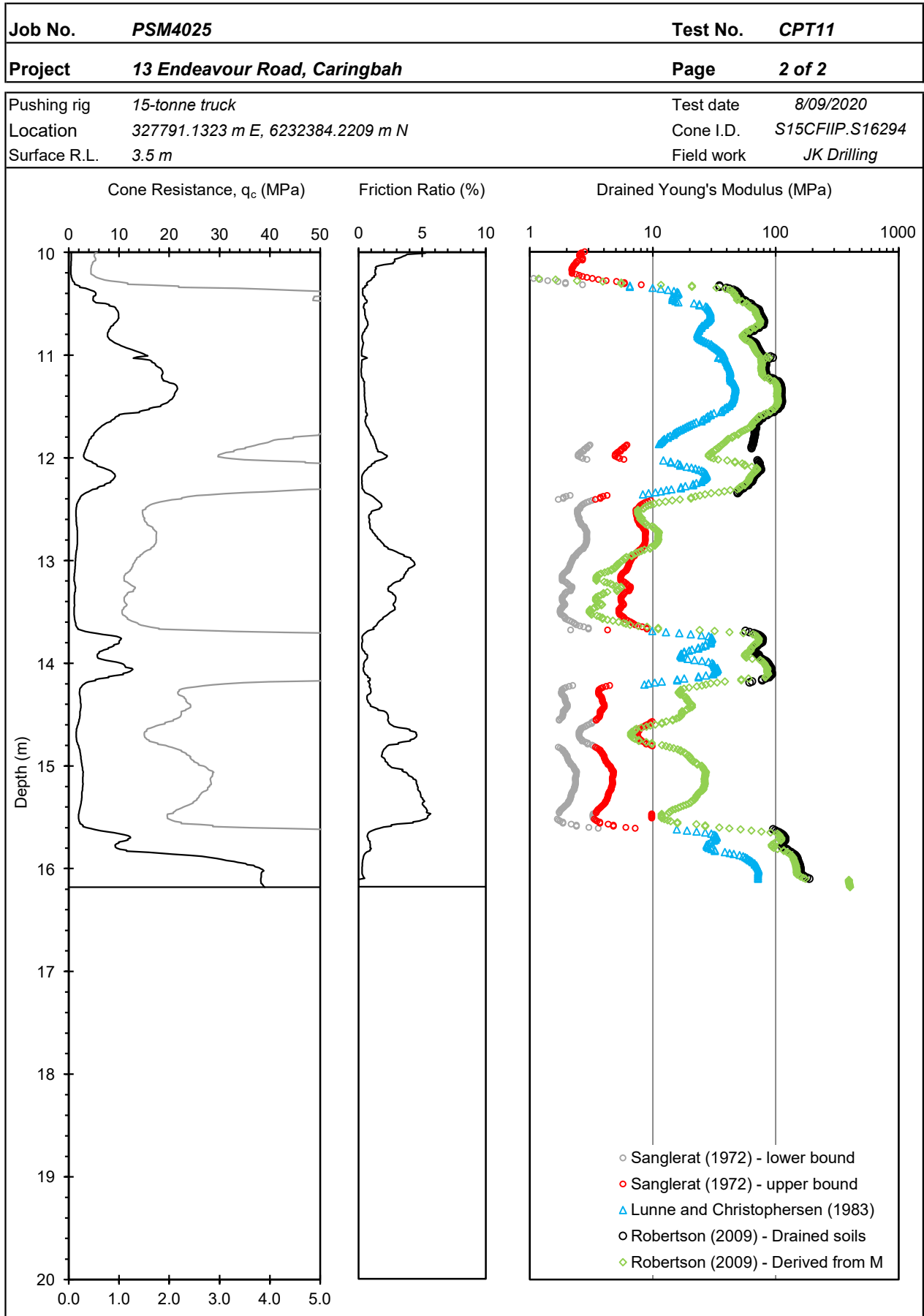


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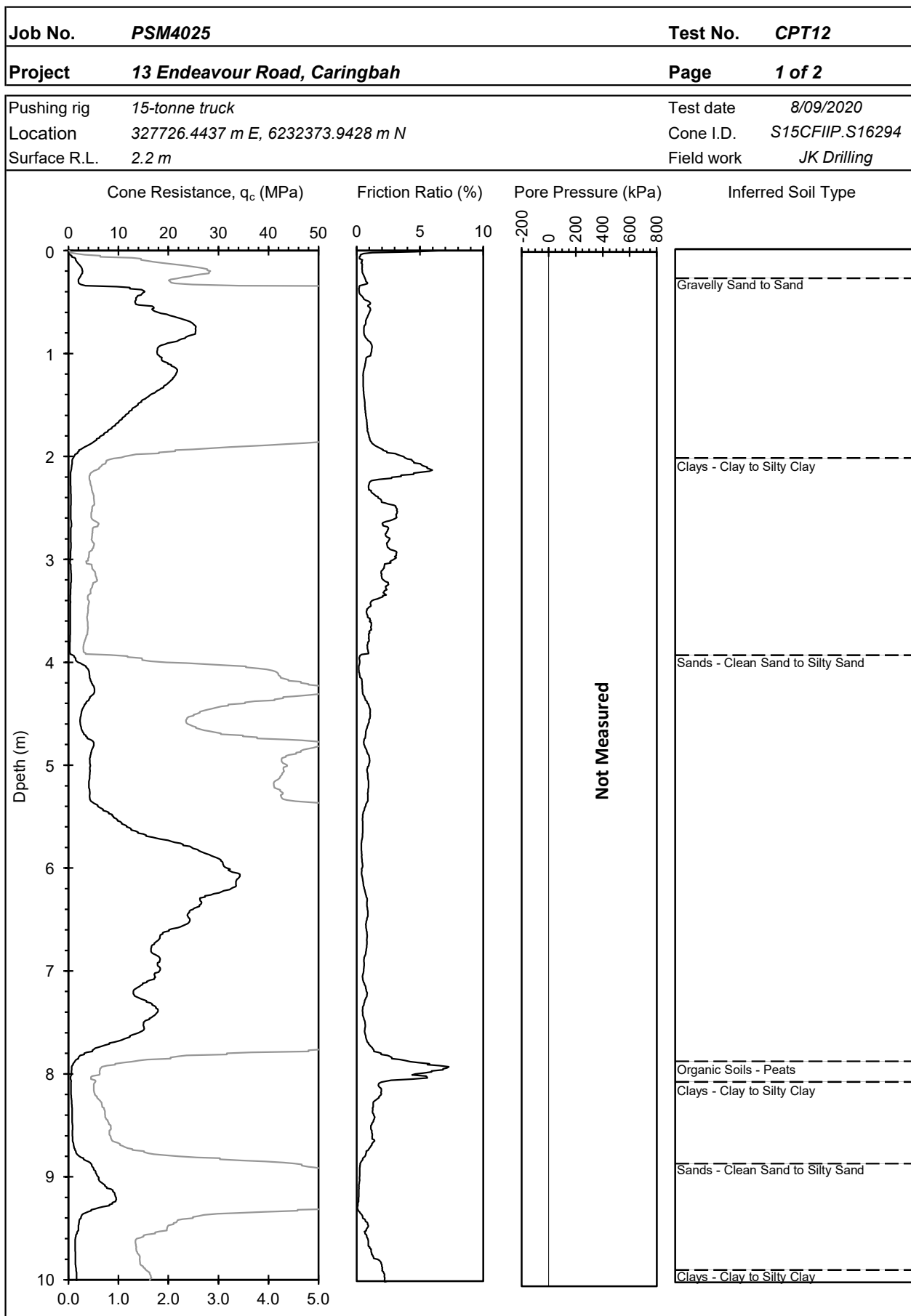


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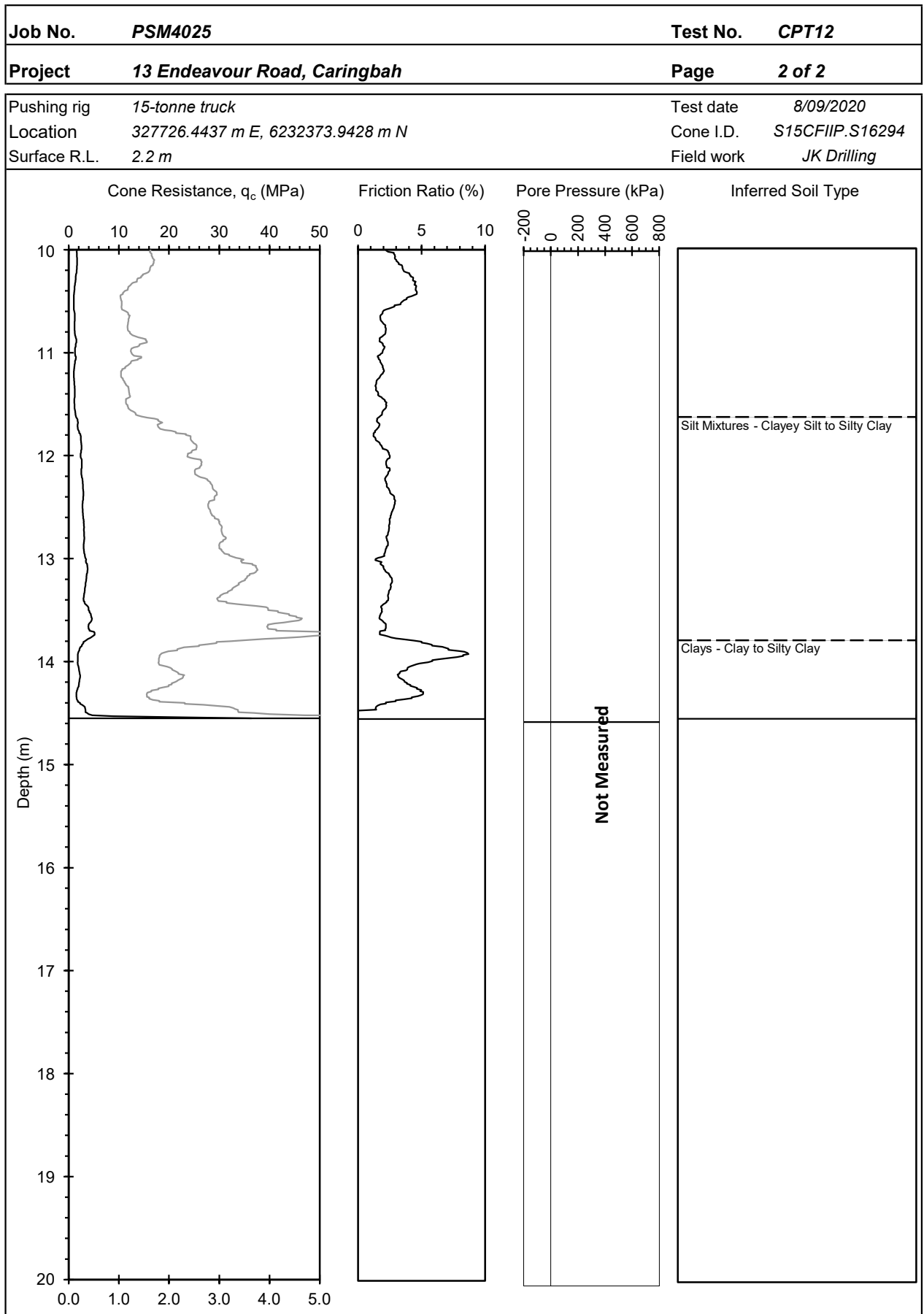


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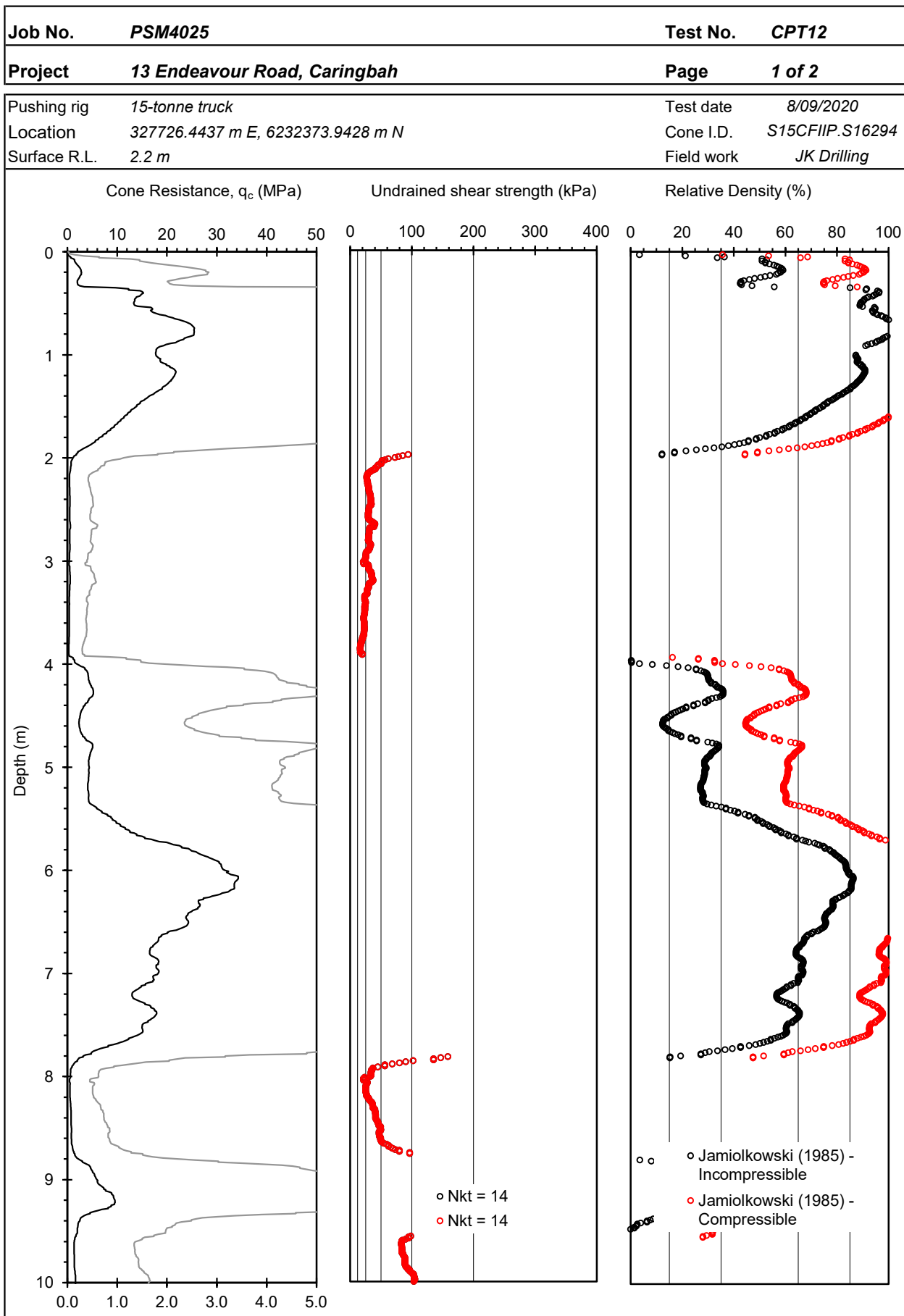


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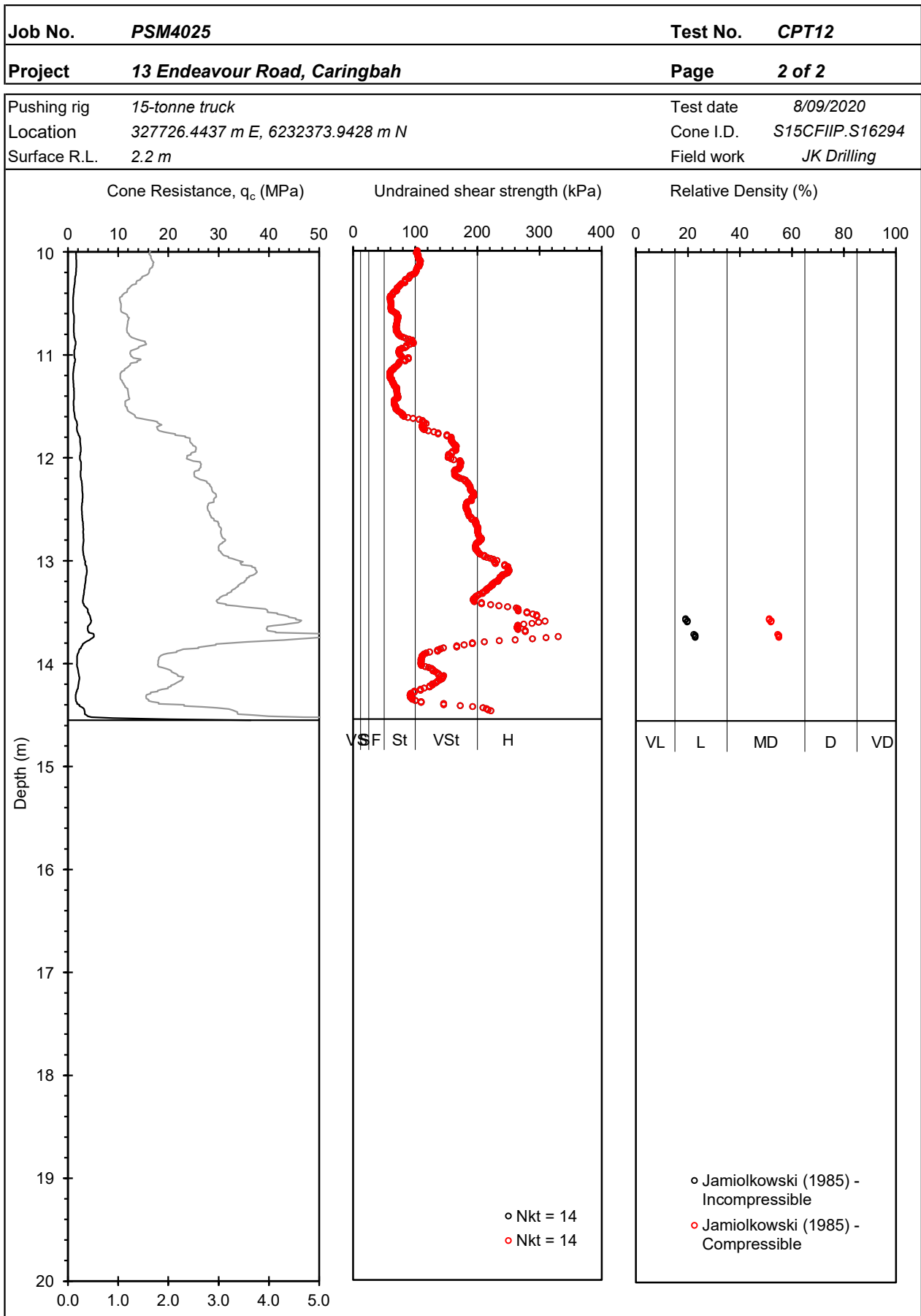


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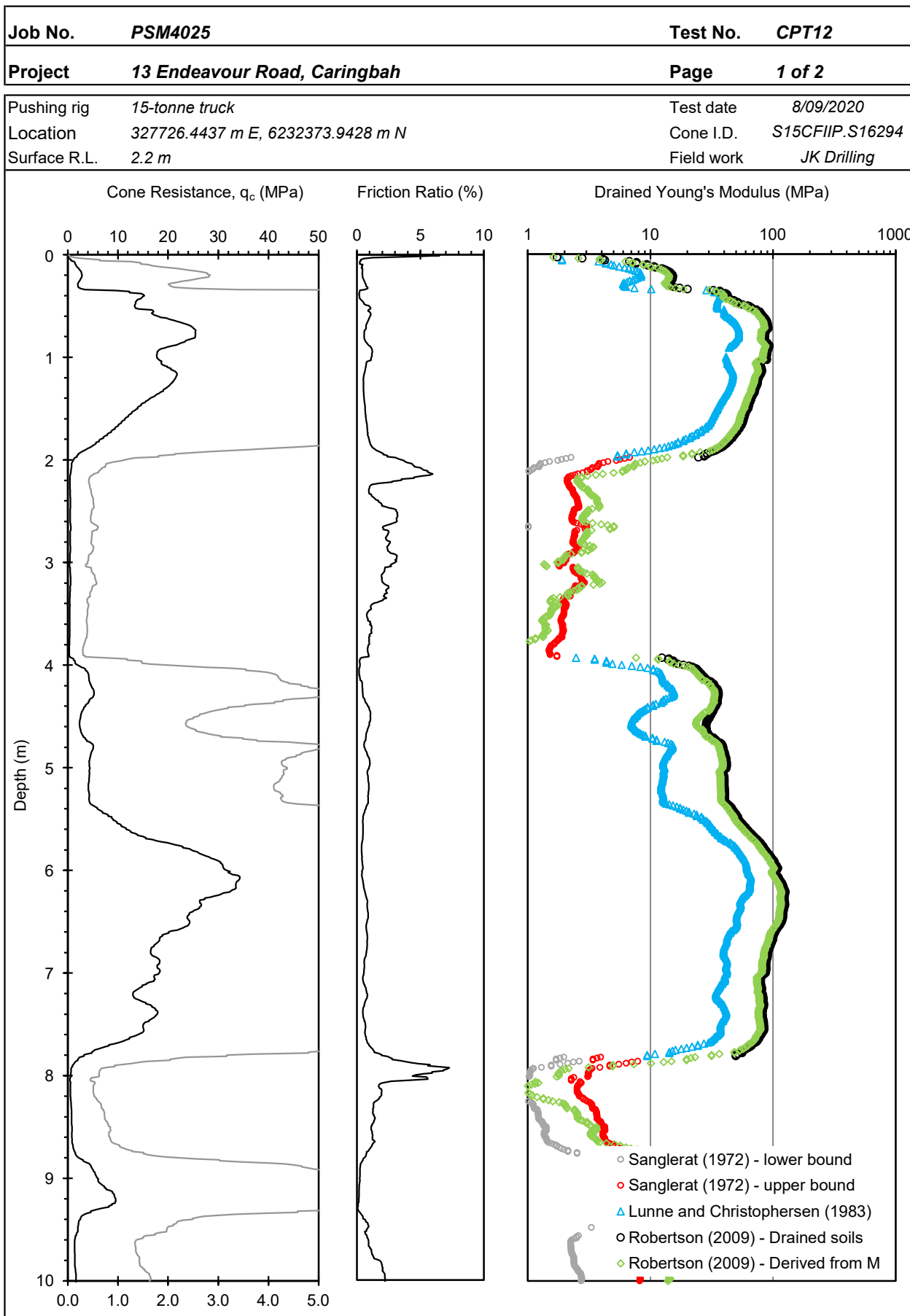
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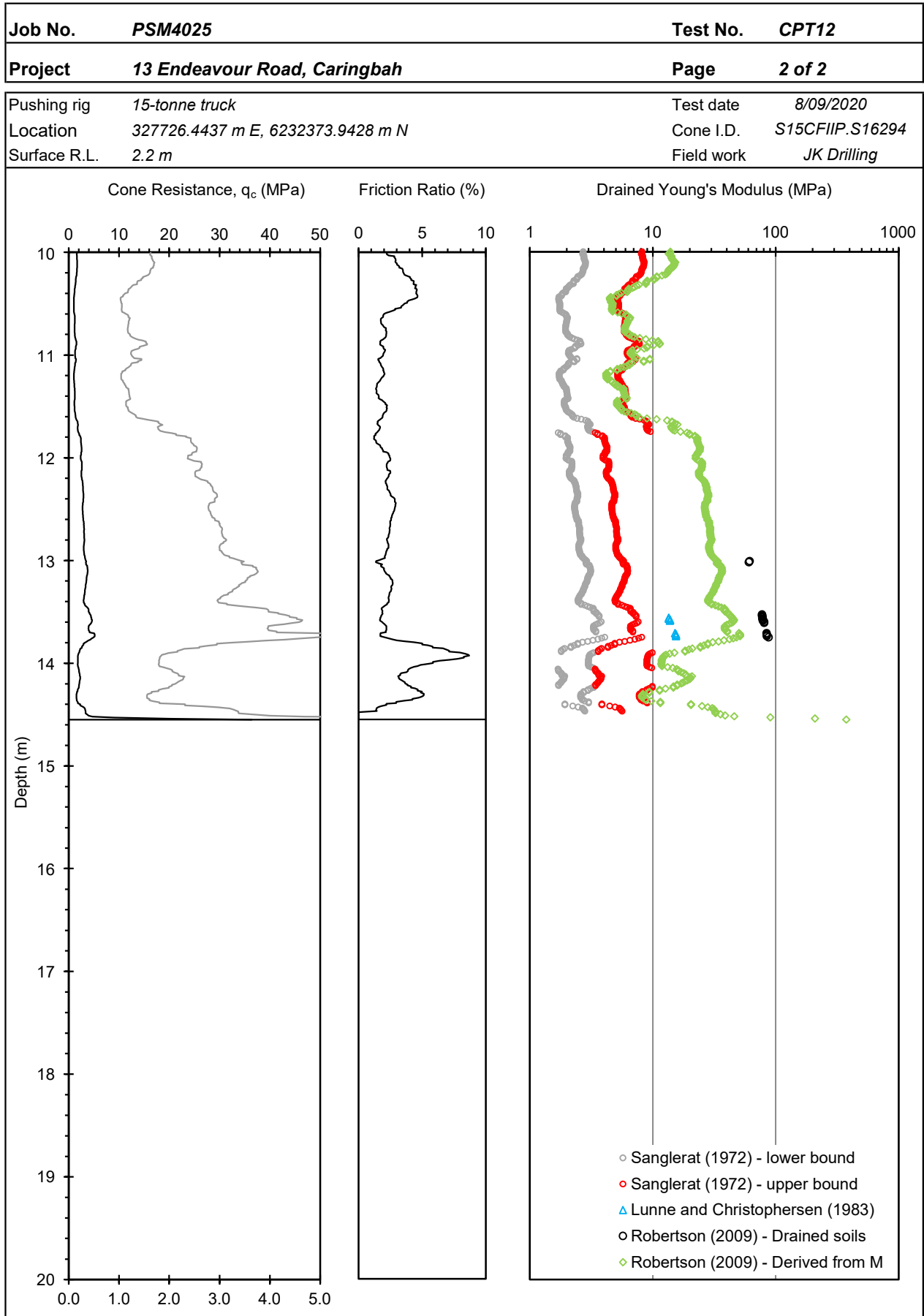


## CONE PENETRATION TEST - INFERRED MODULUS





## CONE PENETRATION TEST - INFERRED MODULUS

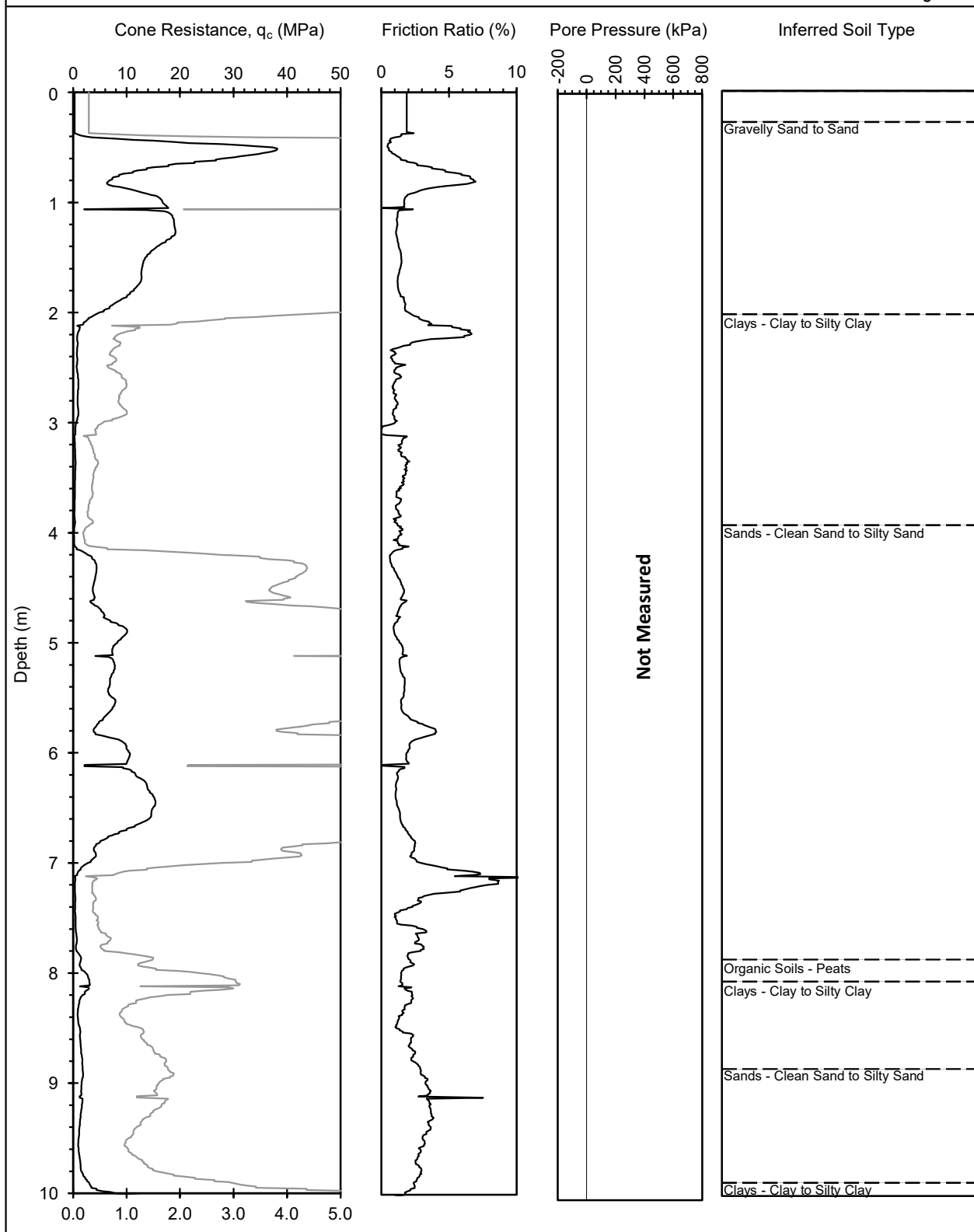




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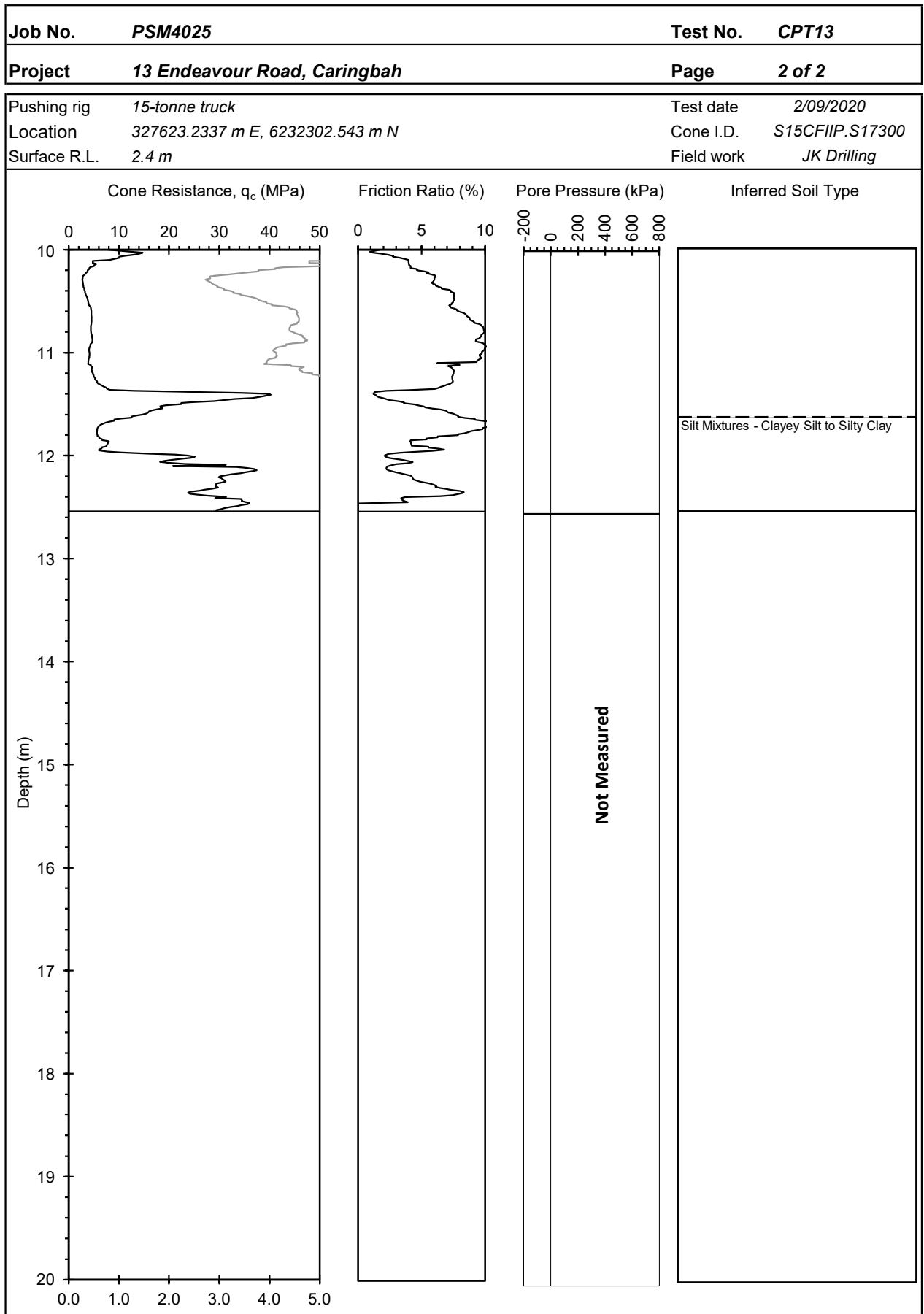
Job No.	PSM4025	Test No.	CPT13
Project	13 Endeavour Road, Caringbah	Page	1 of 2

Pushing rig	15-tonne truck	Test date	2/09/2020
Location	327623.2337 m E, 6232302.543 m N	Cone I.D.	S15CFIIP.S17300
Surface R.L.	2.4 m	Field work	JK Drilling



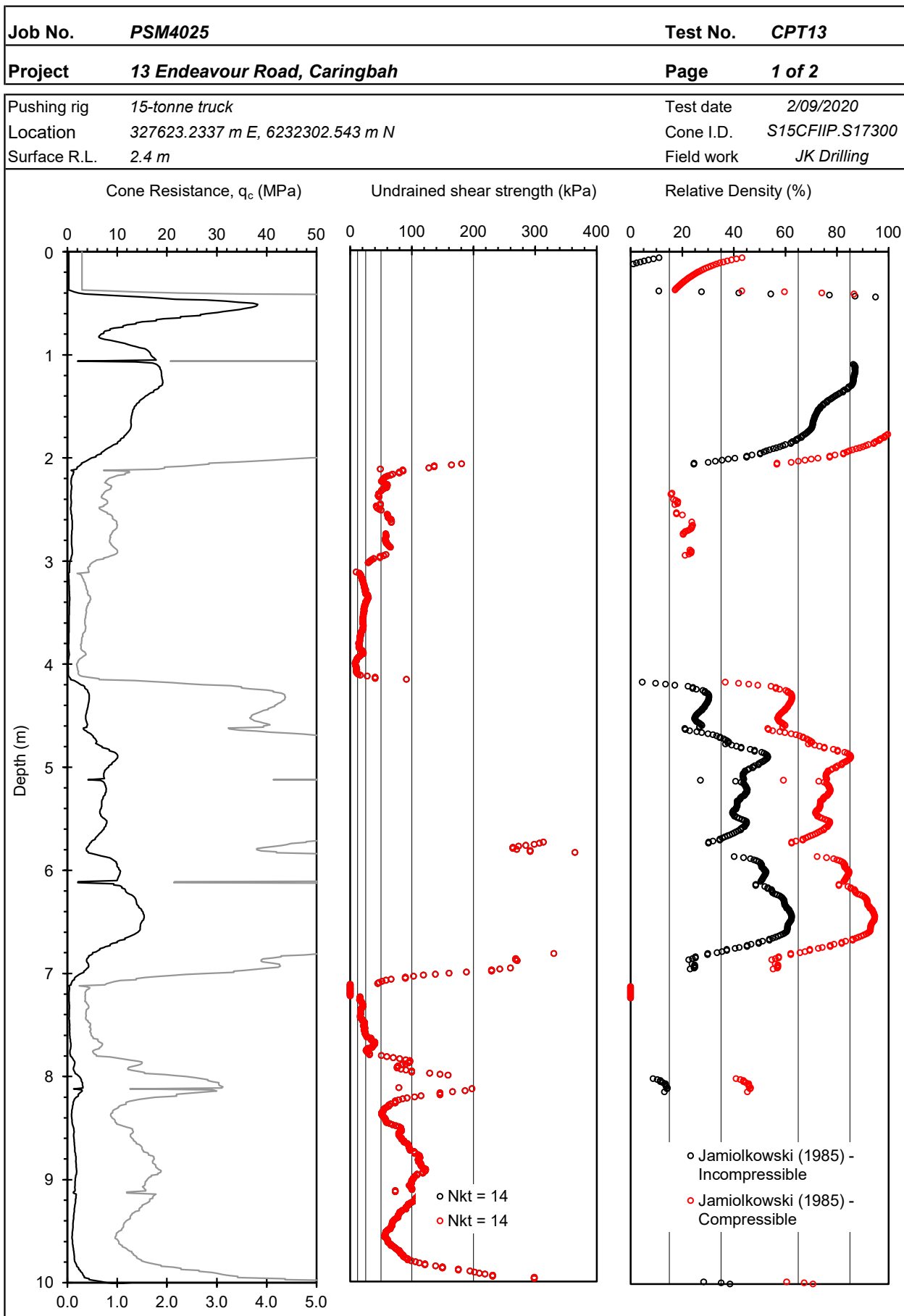


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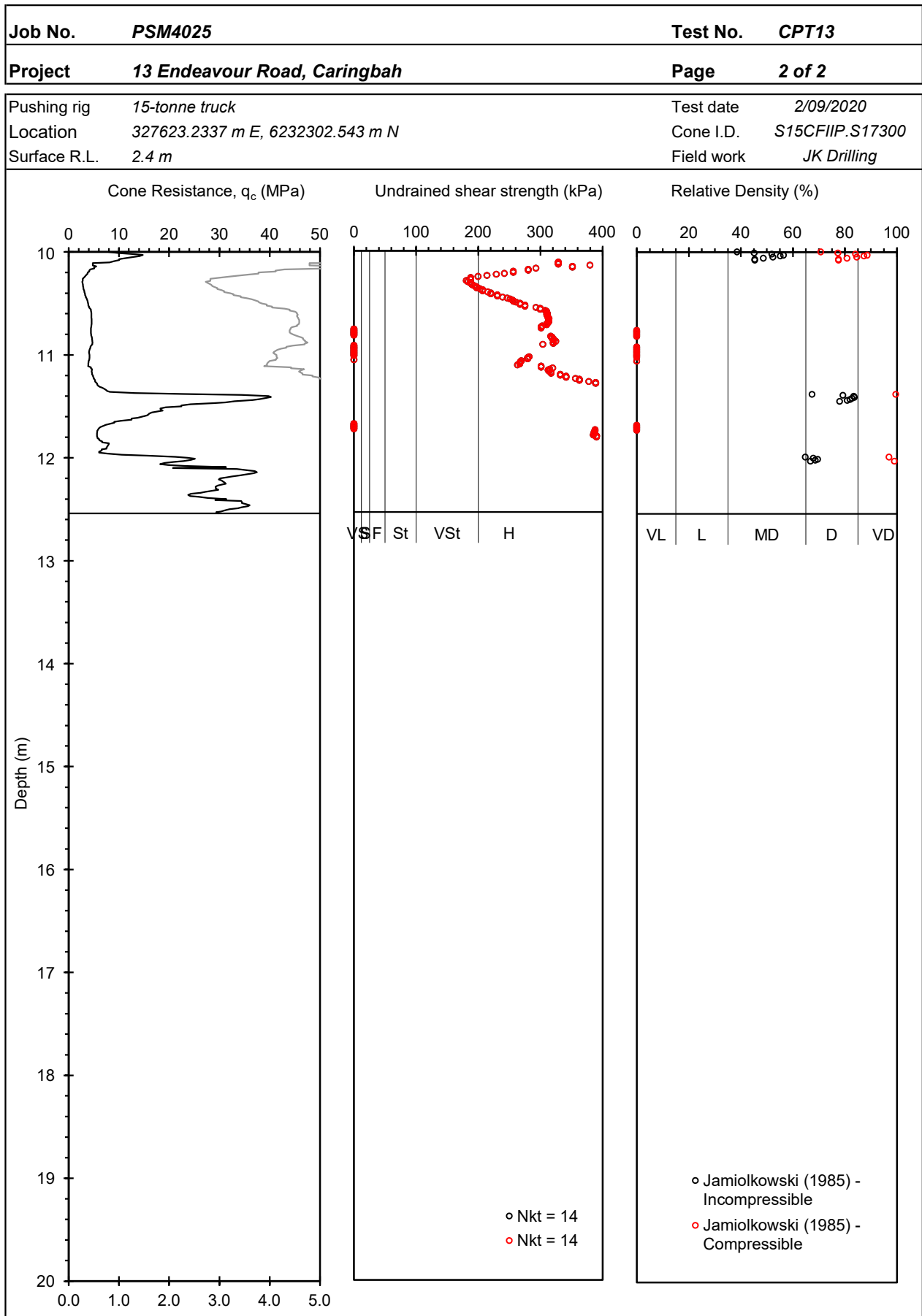


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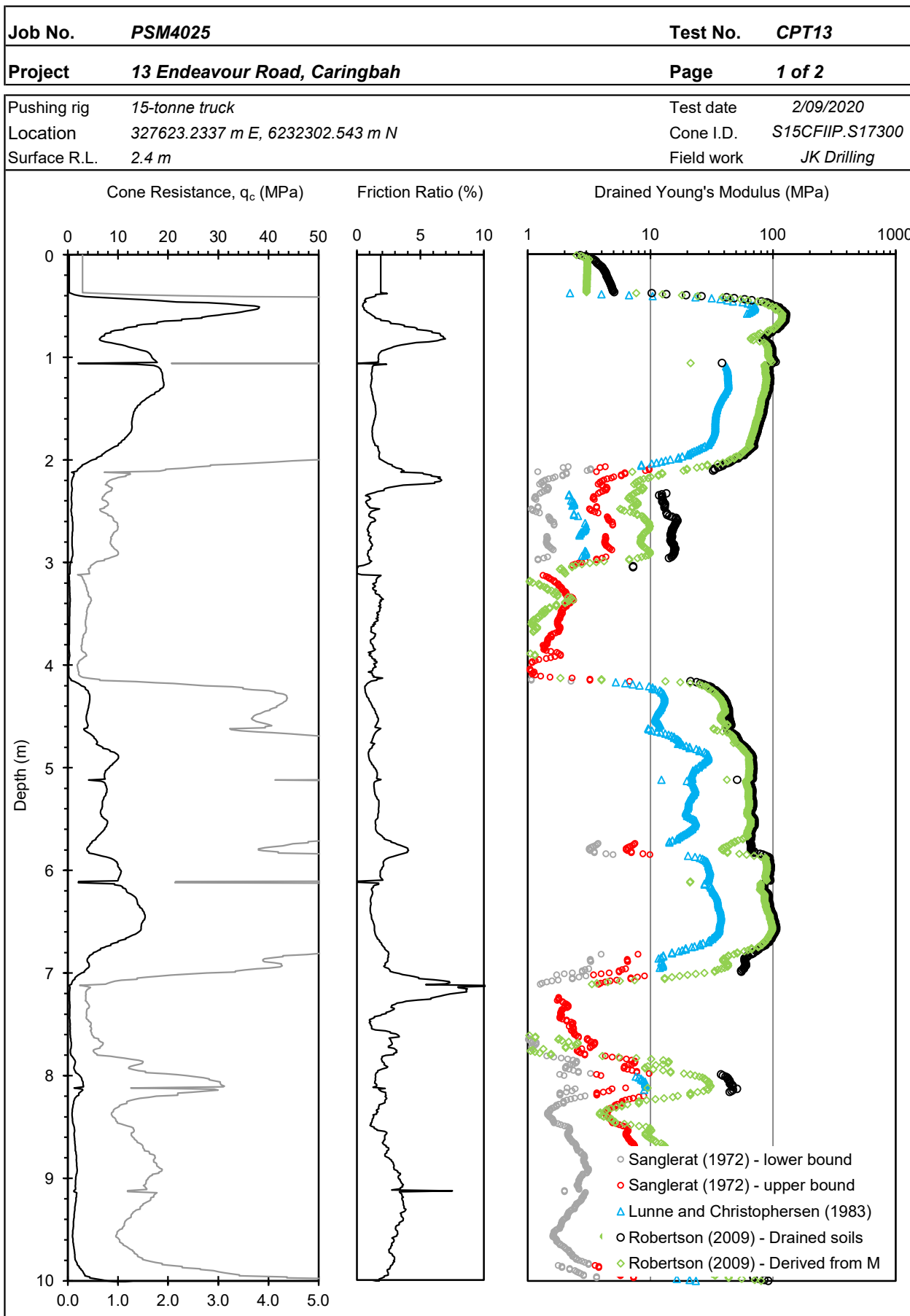
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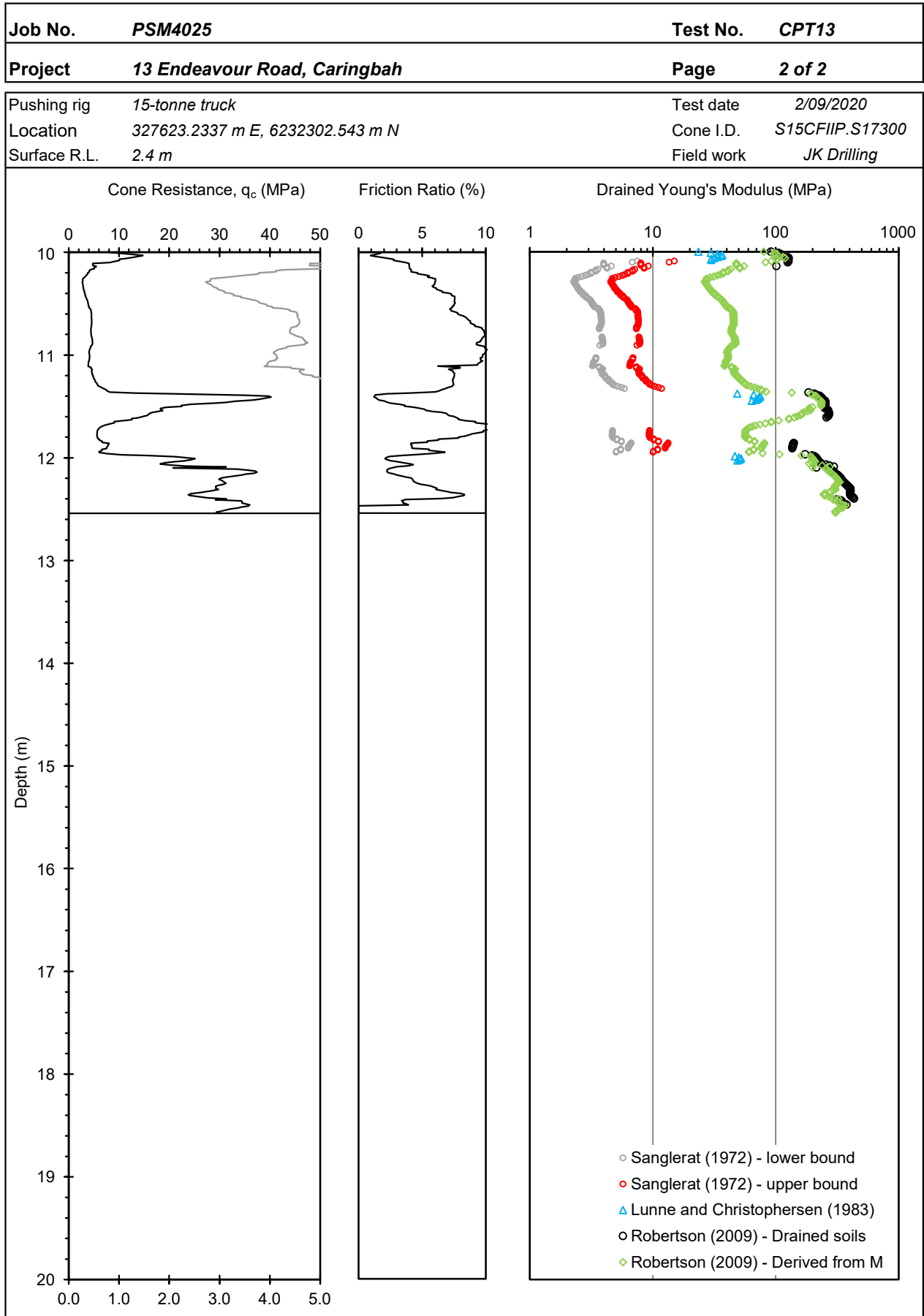


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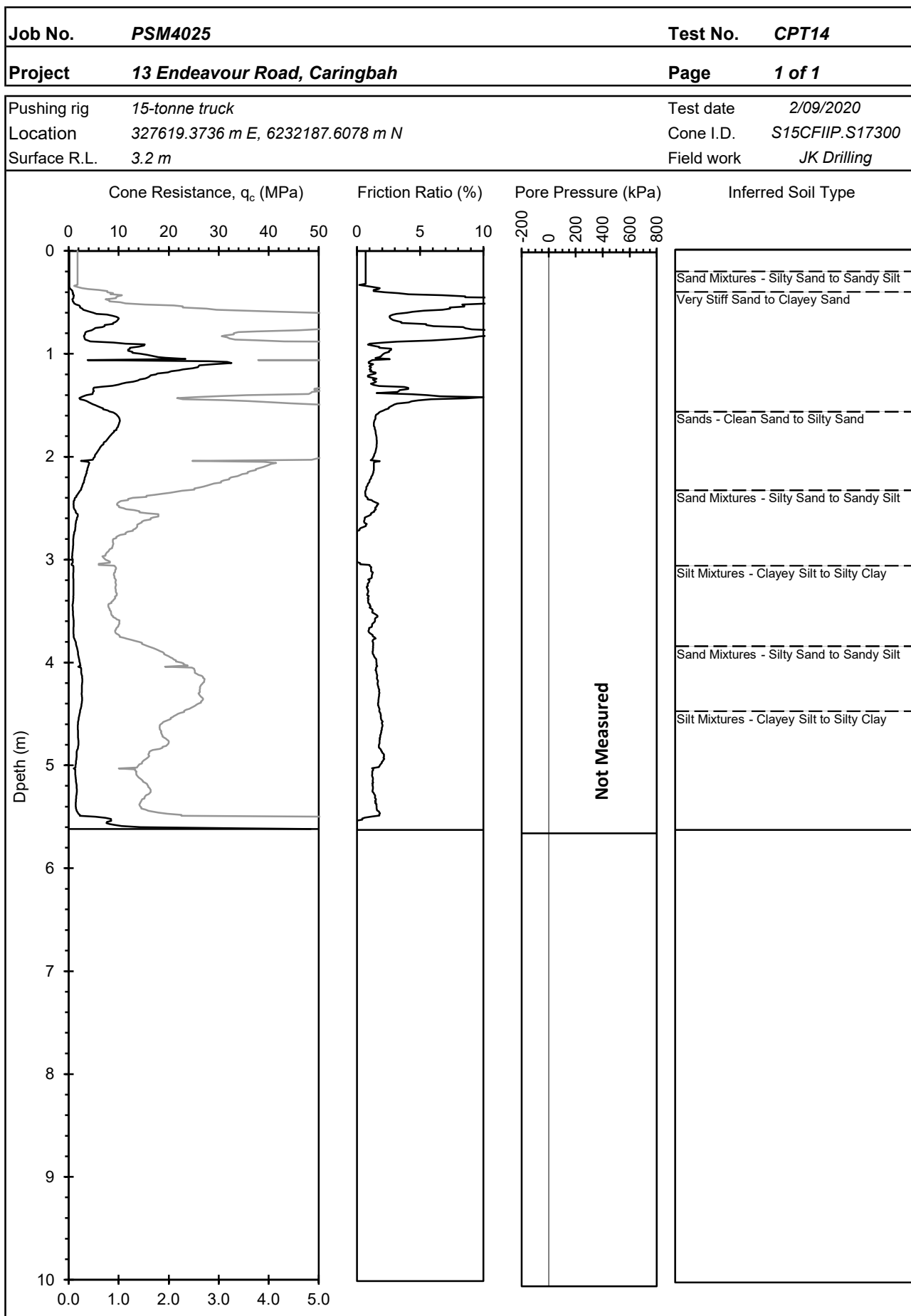


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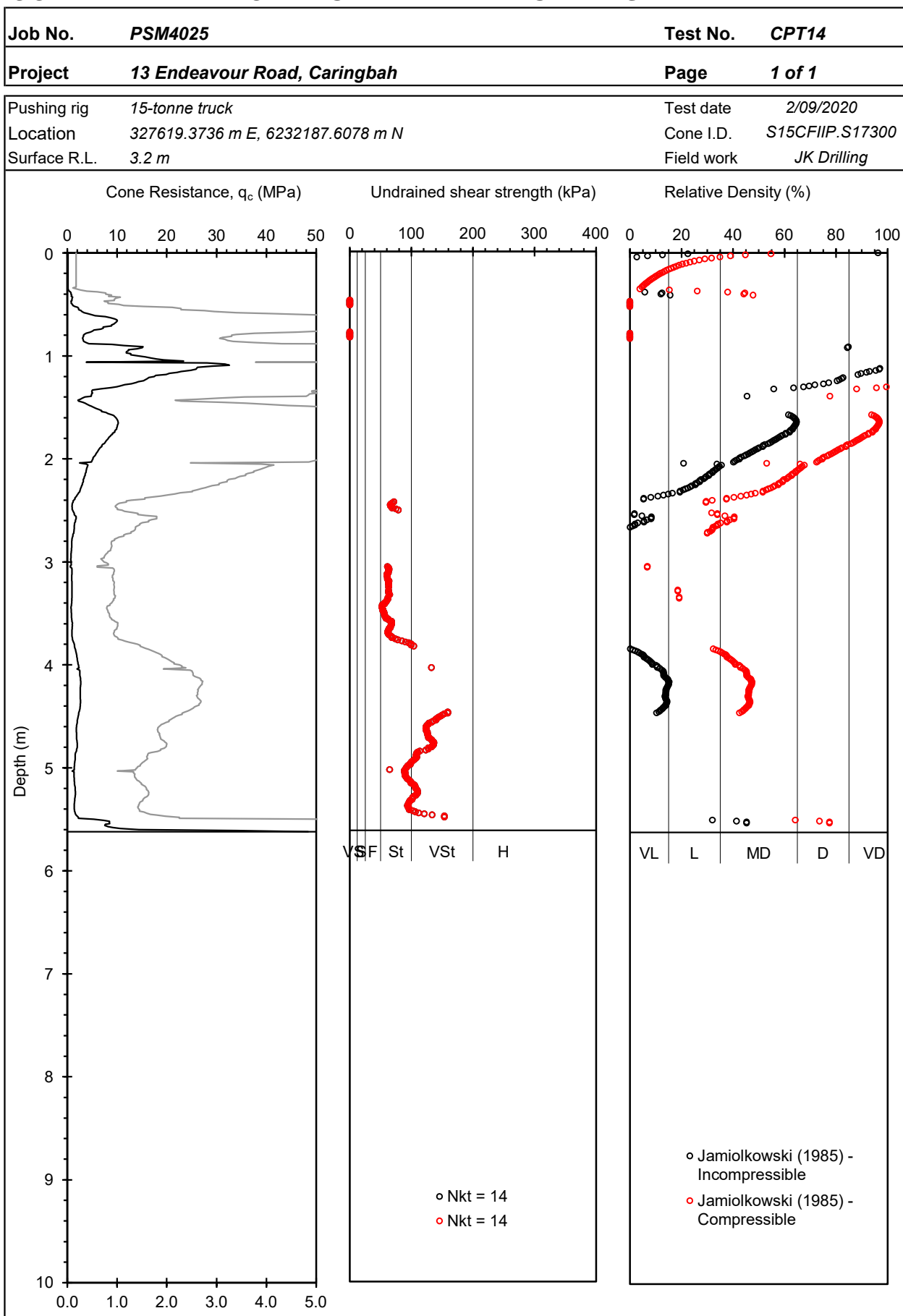


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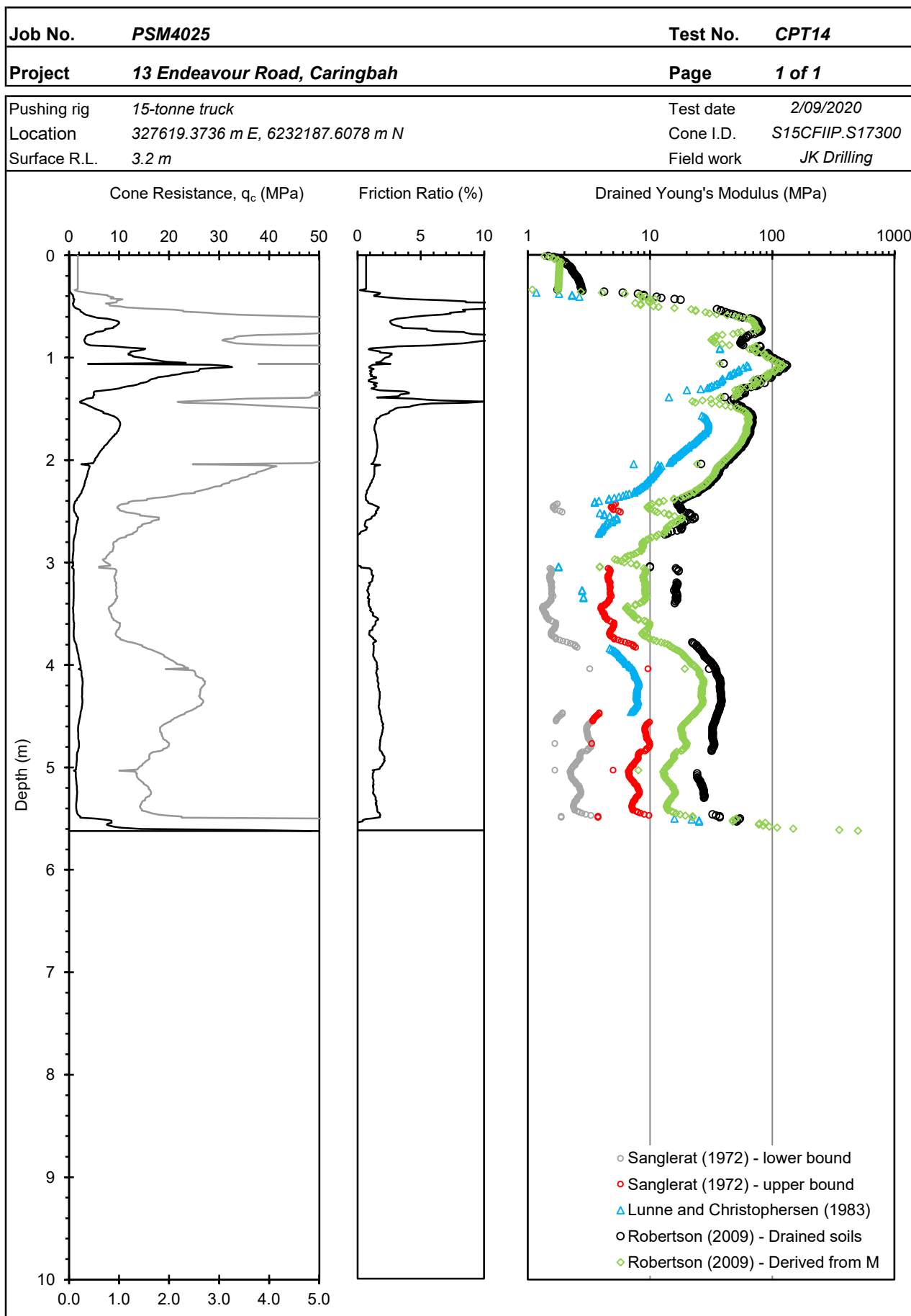


## CONE PENETRATION TEST - INFERRED STRENGTH





## CONE PENETRATION TEST - INFERRED MODULUS



## **Appendix B**

### **SJB Draft Masterplan**



Concept Masterplan

5.4 Indicative Masterplan

The indicative masterplan is structured around the extant built form and existing road network to allow the project to be staged and be flexible in its delivery.

A new plaza will be public open space to the wider context and provide community, and commercial functions - establishing a central place for gathering.

Internal vehicular circulation has been minimised to reduce conflicts with pedestrians but consideration has been made to ensure all buildings will have a safe and secure front door and car drop off area.

Commuter car parks will be housed within each of the buildings that are vertically sleeved by commercial uses at ground. In time, these will have the capacity to be converted to commercial floorspace as the future market demand dictates and demand for parking reduces.

Communal roof terraces will provide significant amount of amenity for workers with easy and accessible connections down to the more public ground plane that offers convenient and direct access to Solander Fields and the foreshore shared path.

Existing trees with notable retention value will be retained wherever possible - especially on the boundaries of the site and along Toyota Avenue with its strong tree'd and vegetated character.

KEY

- ① Pedestrian & Cycle Shared Path
- ② 40m Mean High Water Mark Setback
- ③ Bio-Swale / Overland Flow Path
- ④ Embellished Toyota Avenue
- ⑤ Private Shuttle Bus Drop Off Bay
- ⑥ New Open Space
- ⑦ Significant Stands of Existing Trees Retained
- ⑧ New Public Plaza
- ⑨ Potential New Public Bus Stops
- ⑩ Existing Main Warehouse Building Retained
- ⑪ Service Area
- ⑫ New Internal Service Road

