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AECOM

Via email only: ryan.newnham@aecom.com

12th July 2022

Our Ref.: 20227/LR_Rev1.01

Dear Ryan,

Re: Crown Trading Centre, Clayton Road, Hayes UB3 1DU

We are writing regarding the stability of canal wall at the above site.

Brief

The Soils Limited quotation (reference Q26041 Rev.2, dated 5th May 2022) set the scope of the site investigation at the wider site and of the assessment regarding the stability of the canal wall. This letter report deals with the Canal Wall stability only, as specified within the dedicated section of the above-mentioned quotation.

Competence

The report was prepared by Dr Valerio Tedesco MEng PhD ChIta CEng MICE RoGEP, with eighteen years experience as a geotechnical engineer in the assessment of earth retaining structures, slope stability, deep and shallow foundations, deep excavations in urban environment, seismic engineering, earth dams, embankments and lime stabilisation, etc.

General

The site was located at Crown Trading Centre (CTC), Clayton Road, Hayes UB3 1DU, OS grid ref. TQ 09450 79679. A site location plan has been included as Figure 1.

The 1:50,000 BGS map showed the site to be located upon the bedrock London Clay Formation with overlying superficial deposits of the Lynch Hill Gravel Member. The presence of thick Made Ground/remoulded material could be anticipated as backfilling to the canal wall.

A certain number of mature trees, of unidentified species, was noted at the top of the wall and some vegetation could be observed growing out of brick masonry cracks.

An engineering survey of wall conditions was produced by CDMS Sub Surface Engineering Ltd for ENGIE. The survey report was named Above and Below Water

Inspection of 109m Section of Canal Washwall and was dated June 2021. Soils Limited assumed full reliance on it, being accurate and complete.

The survey subdivided the wall into two parts based upon structure type. The wall was made up of bricks between chainage 0m (the northernmost point of the wall) and 50m and was replaced by a reinforced concrete wall between chainage 50m and 109m (the southernmost point of the wall).

The engineering survey by CDMS recorded several issues within the brick wall, the most evident of which are the presence of vegetation outgrowing from cracks and brick intercourses and the bulging of the top 21No. brick courses out of alignment and perpendicular between chainages 26m and 30m. The survey considered the damaged wall at high likelihood of collapse in the short-term.

Site Works

The investigation concerning the canal wall, undertaken by Soils Limited on 20th May 2022, with reporting, comprised 2No. windowless sampler boreholes (WS01 and WS02) and 2No. dynamic probes (DPC01 and DPC02), driven prior and adjacent to the corresponding windowless sampler boreholes, and a survey with Ground Penetration Radar (GPR). This was to be undertaken to provide details on the eventual presence of cable ties retaining the walls. A trial hole location plan is included as Figure 2.

The selection of test locations for both drilling and surveying was limited by the presence of storage sea-containers located very close to the edge of the canal wall. The site investigation, however, was carried out within two areas respectively representative of the brick wall and reinforced concrete wall sections.

Ground Conditions

The ground conditions encountered during the site investigation have been summarised in Table 1.

Made Ground (MG)

Table 1 – Summary of Ground Conditions

Strata	Epoch	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
MG	Anthropocene	GL	0.70[1] – 5.00[1]	Not proven[2]	Concrete slab/concrete cobbles overlying brown clayey sandy GRAVEL to gravelly CLAY over greyish brown and dark grey gravelly SAND with clinker, brick and concrete gravel.

Note: [1] Final depth of trial hole. [2] Base of strata not encountered.

It must be reminded that the above ground conditions referred to the soils immediately behind the canal wall and would not necessarily be representative of the conditions within the wider site, provided that Made Ground was only used for backfilling the rear of the canal wall.

The full windowless sampler borehole logs are provided in Appendix A.

Roots

Roots and rootlets were observed in windowless sampler borehole WS1 only to the final investigated depth of 0.70m bgl. Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

Groundwater

Groundwater was not encountered during the investigation within any of the windowless sampler boreholes. The water level in the canal was circa 2.0m lower than the site level and was understood not to fluctuate very significantly. The canal would be expected to be clay lined, provided that there is no evident linkage between the water level in the canal and the local groundwater.

Dynamic Probing

Three dynamic probes, super-heavy (DPSH), respectively identified as DPC1A, DPC1B and DPC1C were attempted at location DPC1 and one at location DPC2. Very limited penetration was achieved within DPC1A – DPC1C, ranging between 0.40m and 1.30m below ground level (bgl), due to the presence of obstructions. The final depth of dynamic probe DPC2 was 7.00m bgl.

The interpretation of dynamic probing logs within the Made Ground cannot be considered as sufficiently reliable to infer the final depth of Made Ground. However, it is likely that Made Ground at DPC2 persisted to the final investigated depth of 7.00m bgl.

The full dynamic probing logs are provided in Appendix A.

GPR Survey

A GPR survey was undertaken by Soils Limited at two areas respectively overlooking the brick and RC concrete canal wall sections and was presented in Appendix B.

The GPR survey did not detect any obvious linear objects behind the wall that could be representative of the presence of tiebacks. Although undetected metallic objects could be present deeper in the ground, beyond the depth investigated by the GPR, tiebacks are usually applied near the top of the wall to improve their effectiveness. The presence of cable ties at the back of the canal wall can therefore be considered unlikely at least within the two investigated areas.

The GPR Survey, however, identified areas characterised by changes in soil conditions, representing voids/soft soils/less compacted materials, at depths ranging between 0.15m and 3.00m bgl.

Conclusions on the Existing Wall and Overall Stability

The site investigation undertaken by Soils Limited revealed that the wall was backfilled with uncontrolled Made Ground, which could be inferred to depths in excess of 7.00m bgl from the results of dynamic probe DPC2. The composition of the Made Ground was variable and although predominantly granular, included cohesive horizons and voids/soft

soils/less compacted materials, therefore soil composition, sub-layer thickness and mechanical properties must be considered as unpredictable.

The presence of containers along the wall edge did not actually allow to undertake in situ tests at regular intervals and to collect sufficient data to define the mechanical behaviour of the Made Ground, which is always particularly complicated due to its intrinsic variability.

However, at present there are no visible signs of overall slope failure at the site, with sliding surfaces passing under the foundations of the canal wall.

The brick wall section showed evident signs of failure, such as localised bulging, loss of verticality and cracking. The unsuitability of the brick wall does not need any further demonstration. The failure was caused mainly by the action of tree roots, which locally increased the lateral forces acting on the wall and induced the bulging within the top 21No. brick courses and caused the development of cracks. The presence of loads applied near the edge of the wall, due to the presence of containers, and the degradation of the mortar, locally absent, also contributed to the failure within the brick wall. It must be noted that the eventual collapse of the wall could cause a lack of containment within the retained soil, which could then trigger localised sliding and an eventual retrogressive slope failure.

The conditions of the reinforced concrete wall were apparently less concerning due to the absence of evident signs of failure. However, the wall had been heavily surcharged by the stockpiling of containers close to the wall top. Some of the construction and expansion joints showed displacements, suggesting the presence of relative movements between adjacent wall sections, likely indicative of some level of sliding or tilting. In addition, shrubbery was recorded to grow up from cracks/openings within the wall (ref. Fig.37 and Fig.42A). This implies that other portions of the wall could be subjected to the action of tree roots, which could break the concrete in contact with the backfill and weaken the RC structure.

It must therefore be considered that the existing brickwork canal wall cannot be considered safe and must be replaced by a new one because already failed within the brick masonry portion and affected by the action of tree roots. The removal of trees, vegetation and roots would improve site conditions but would not fix the issues with the wall, which is beyond repair and would not provide a satisfactory factor of safety against overturning and both overall and internal sliding.

Regarding the RC wall it was not possible to fully investigate the condition or properties of this section due to limited access and further investigation will be required to determine if any remedial works will be required in this area.

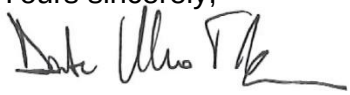
A series of options can be considered for replacing the existing brickwork canal wall and improving the level of safety at the site. However, it is understood the proposal is to install new sheet piles in front of the masonry wall (on the canal side). The new wall could also contribute to improving the factor of safety against overall stability.

The following attachments make up the remainder of this letter report.

Figure 1. Site Location Plan
Figure 2. Trial Hole Location Plan
Appendix A. Field Data
Appendix B. GPR Survey

Should you have any further questions please do not hesitate to contact the undersigned.

Yours sincerely,



Dr DV Tedesco MEng, PhD, ChIta, CEng MICE, RoGEP.
(dt@soilslimited.co.uk)
For and on behalf of Soils Limited.

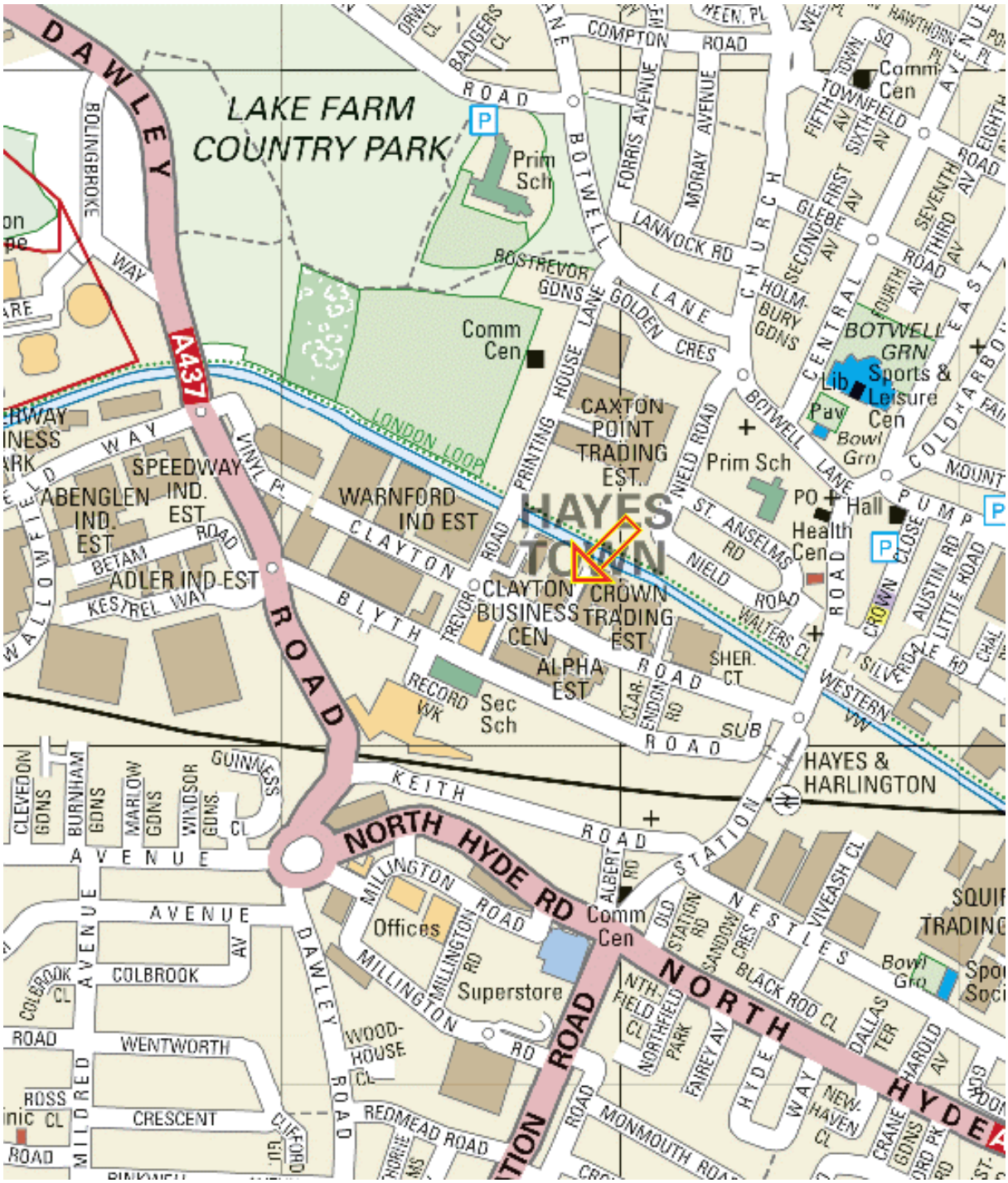


Figure 1 – Site Location Map

Job Number 20227	**Project** Crown Trading Centre, Clayton Road, Hayes UB3 1DU
Client AECOM	**Date** June 2022

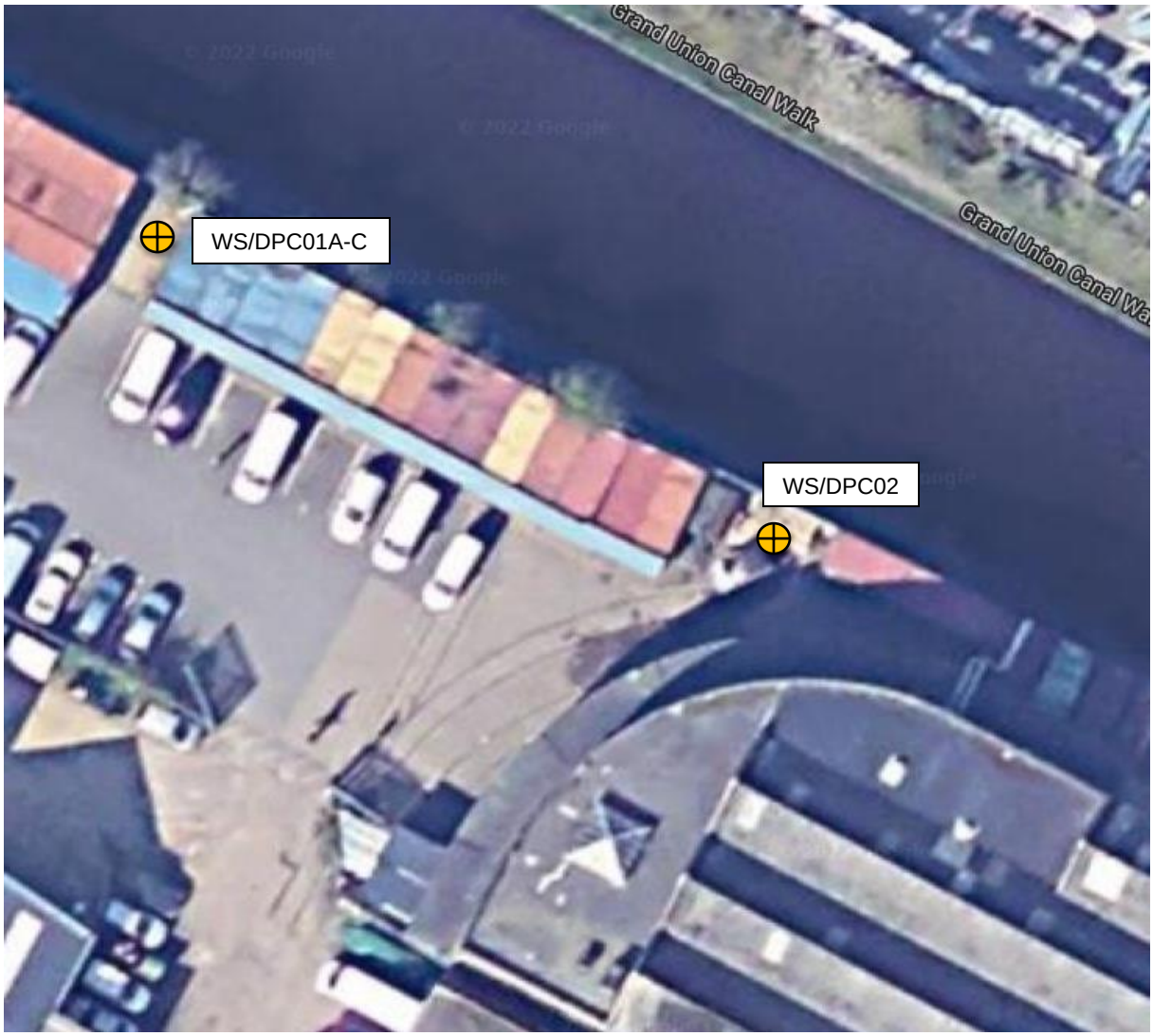


Figure 2. Trial Hole Location Plan

Job Number 20227	**Project** Crown Trading Centre, Clayton Road, Hayes UB3 1DU
Client AECOM	**Date** June 2022

Appendix A. Field Data

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Contract Name:		Client:			Hole ID:
Crown Trading Centre, Hayes, UB3 1DU		AECOM			**WSC01**
Contract Number:	Start and End Date:	Logged By:	Checked By:	Status:	Hole Type:
20227	20/05/22	GB	SB	FINAL	**WS**
Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
			Premier 1	08/06/2022	1:50

Weather: | Termination: Refused on obstruction | Sheet 1 of 1

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.20	ES			0.20		Broken cobble sized pieces of concrete.		
0.30	D			(0.50)		Dark brown mottled very dark grey slightly sandy silty GRAVEL. Gravel is angular to sub-rounded fine to coarse brick, clinker, sandstone, concrete, flint and rare cloth fragments. Occasional rootlets. (MADE GROUND)		
0.60	ES					*Cobble sized piece of concrete.*		
				0.70		End of Borehole at 0.70m		

1 2 3 4 5 6 7 8 9 10

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Remarks:
Rootlets observed to 0.7m bgl.

Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0	0.00	Groundwater not encountered.

Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.

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Contract Name:		Client:			Hole ID:
Crown Trading Centre, Hayes, UB3 1DU		AECOM			**WSC02**
Contract Number:	Start and End Date:	Logged By:	Checked By:	Status:	Hole Type:
20227	20/05/22	GB	SB	FINAL	**WS**
Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
			Premier 1	08/06/2022	1:50

Weather: | Termination: Hole complete | Sheet 1 of 1

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
				(0.50)		Concrete Slab		
				0.50		Brown slightly clayey sandy GRAVEL. Gravel is angular to rounded fine to coarse brick, clinker and sandstone. (MADE GROUND)		
0.60	ES							
0.80	ES							
0.90	D							
				(1.25)				
1.30	ES							
1.40	D							
				1.75		Firm light brown gravelly CLAY. Gravel is angular to rounded fine to coarse flint and clinker. (MADE GROUND)		
1.80	ES			2.00		Greyish brown and dark grey gravelly SAND. Gravel is angular to sub-rounded fine to coarse clinker, brick and flint. (MADE GROUND)		
1.90	D					*Mild hydrocarbon odour.*		
2.20	ES							
2.30	D							
2.70	ES							
2.80	D							
3.20	ES							
3.30	D							
				(3.00)				
3.70	ES					*Moderate hydrocarbon odour.*		
3.80	D							
4.20	ES							
4.30	D							
4.70	ES							
4.80	D							
				5.00		*Moderate hydrocarbon odour.*		
						End of Borehole at 5.00m		

1 2 3 4 5 6 7 8 9 10

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Remarks:
No rootlets observed.

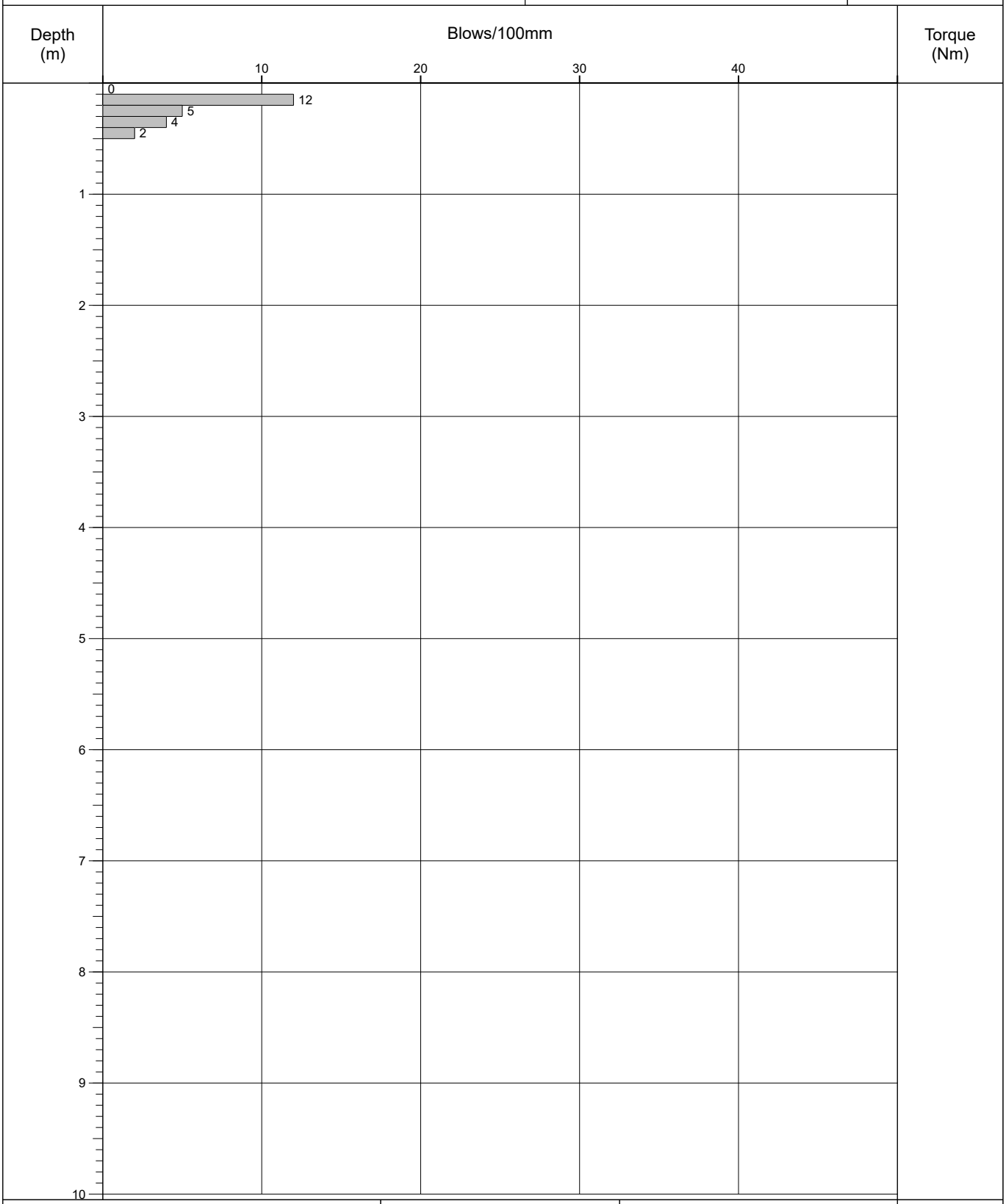
Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0	0.00	Groundwater not encountered,

Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.

Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk	**Probe Log**	Probe No. **DPC1A** Sheet 1 of 1

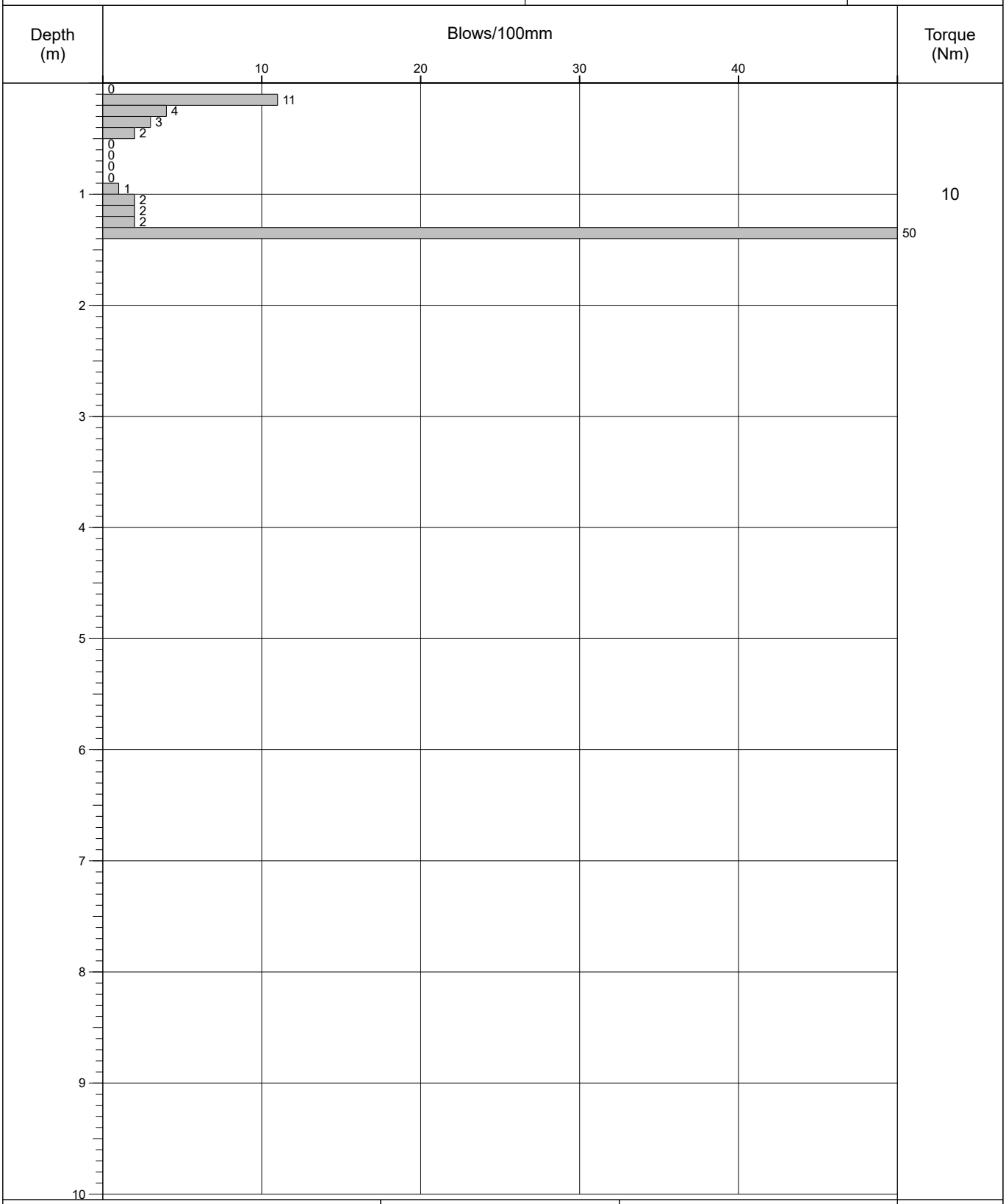
Project Name:	Crown Trading Centre, Hayes, UB3 1DU	Project No. 20227	Co-ords:	Hole Type DP
Location:	Crown Trading Centre, Hayes, Greater London, UB3 1DU		Level: m AOD	Scale 1:50
Client:	AECOM		Dates: 17/05/2022	Logged By



Remarks					
DPC01A driven prior and adjacent to WSC01	Fall Height	760mm	Cone Base Diameter	mm	AGS REGISTERED USER 2020
	Hammer Weight	64kg	Final Depth	0.4m	
	Probe Type	DPSH-B	Energy Ratio (Er)	92.96%	

Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk		**Probe Log**	Probe No. **DPC1B** Sheet 1 of 1

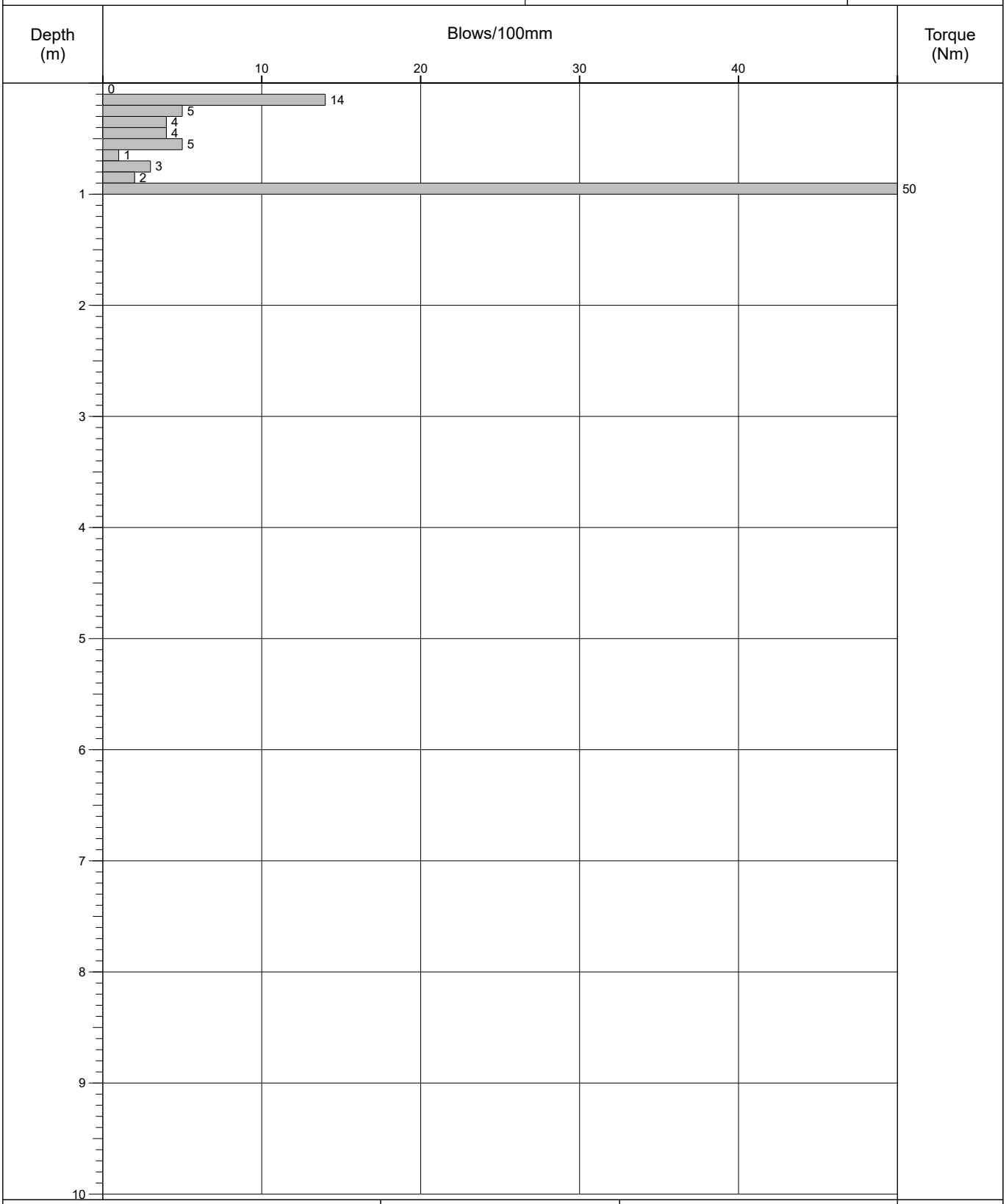
Project Name:	Crown Trading Centre, Hayes, UB3 1DU	Project No. 20227	Co-ords:	Hole Type DP
Location:	Crown Trading Centre, Hayes, Greater London, UB3 1DU		Level: m AOD	Scale 1:50
Client:	AECOM		Dates: 17/05/2022	Logged By



Remarks DPC01B driven prior and adjacent to WSC01	Fall Height	760mm	Cone Base Diameter	mm	AGS REGISTERED USER 2020
	Hammer Weight	64kg	Final Depth	1.3m	
	Probe Type	DPSH-B	Energy Ratio (Er)	92.96%	

Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk		**Probe Log**	Probe No. **DPC1C** Sheet 1 of 1

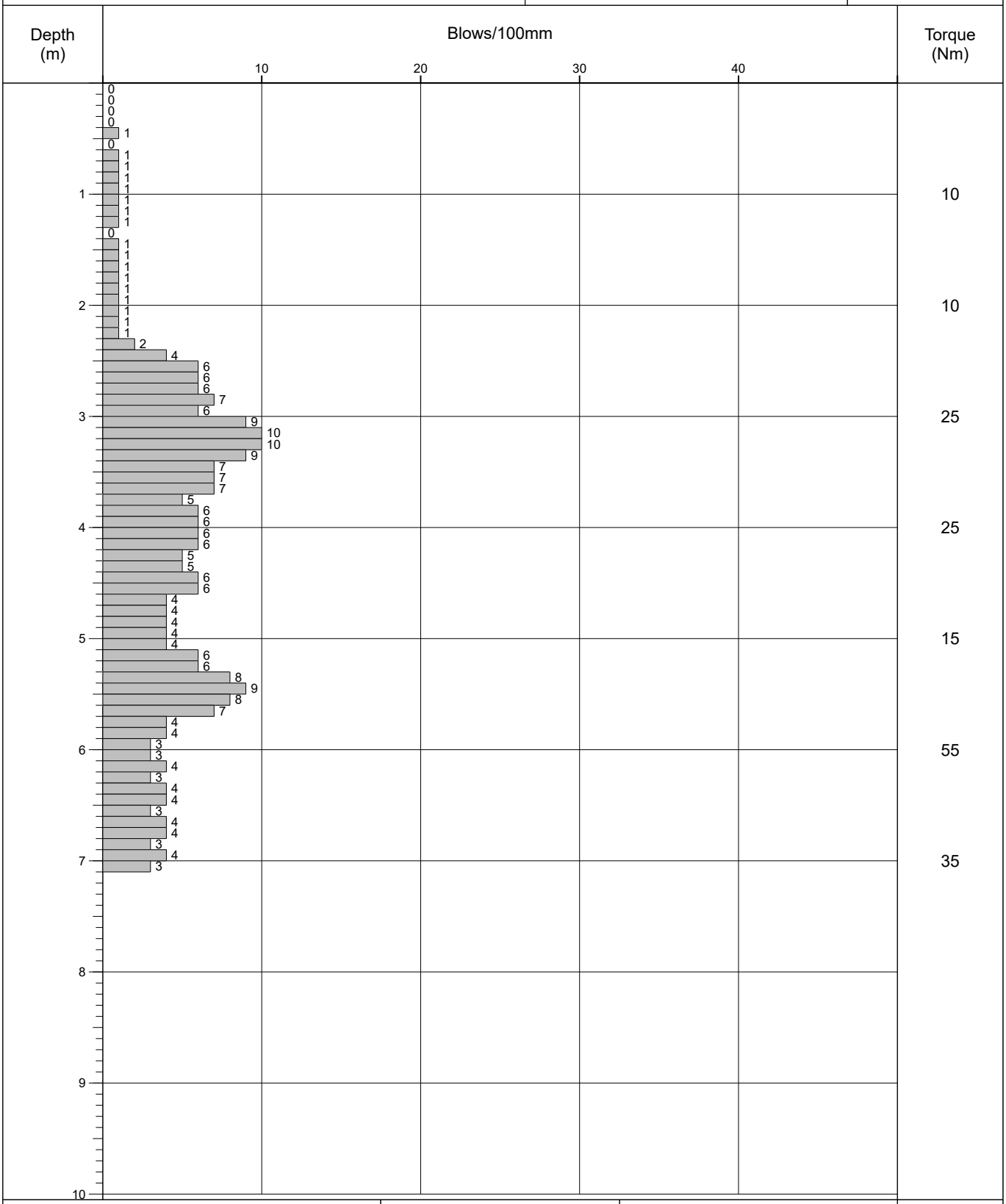
Project Name:	Crown Trading Centre, Hayes, UB3 1DU	Project No. 20227	Co-ords:	Hole Type DP
Location:	Crown Trading Centre, Hayes, Greater London, UB3 1DU		Level: m AOD	Scale 1:50
Client:	AECOM		Dates: 17/05/2022	Logged By



Remarks DPC01C driven prior and adjacent to WSC01	Fall Height	760mm	Cone Base Diameter	mm	AGS REGISTERED USER 2020
	Hammer Weight	64kg	Final Depth	0.9m	
	Probe Type	DPSH-B	Energy Ratio (Er)	92.96%	

Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk	**Probe Log**	Probe No. **DPC2** Sheet 1 of 1

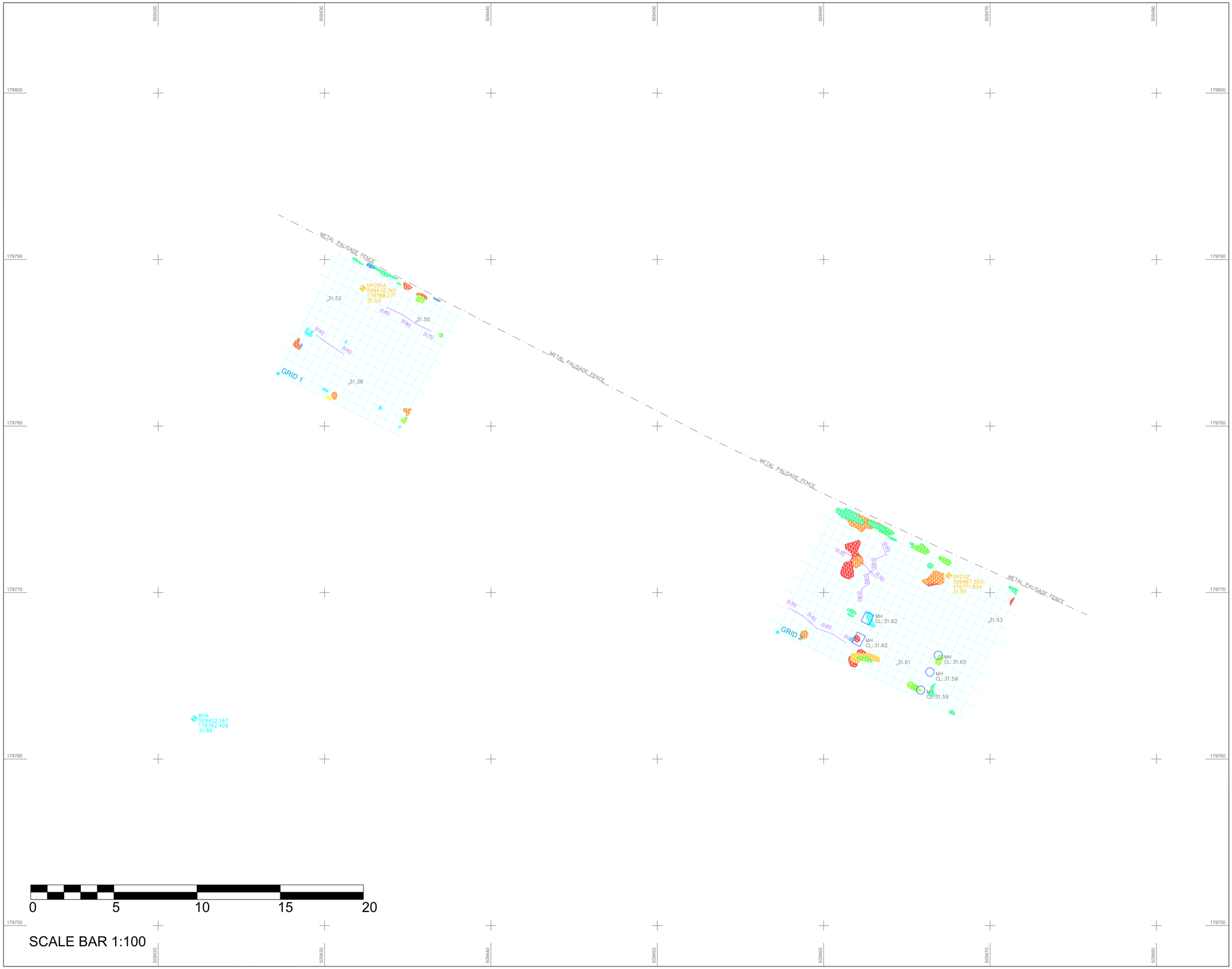
Project Name:	Crown Trading Centre, Hayes, UB3 1DU	Project No. 20227	Co-ords:	Hole Type DP
Location:	Crown Trading Centre, Hayes, Greater London, UB3 1DU		Level: m AOD	Scale 1:50
Client:	AECOM		Dates: 17/05/2022	Logged By



Remarks DPC02 driven prior and adjacent to WSC02	Fall Height	760mm	Cone Base Diameter	mm
	Hammer Weight	64kg	Final Depth	7m
	Probe Type	DPSH-B	Energy Ratio (Er)	92.96%

AGS REGISTERED USER 2020

Appendix B. GPR Survey



LEGEND (Utilities)

ELECTRICITY TRACE (UNDEFINED)	EL
BT CABLE	BT
CATV	CATV
SURFACE WATER DRAINAGE	SWD
FOUL WATER DRAINAGE	FWD
WATER PIPE	W
GAS PIPE	GAS
UNKNOWN UTILITY-METALIC	
SURVEY BOUNDARY	

LEGEND (GPR)

GPR trace (Unknown)

(0.60) GPR target depth

GPR Anomaly

Additional Information

Small voids, change in the ground condition or less compacted material.

WS3
577316.045
521809.048
54.64
Location Name
Easting
Northing
Elevation

GPR grid path
Grid number
GPR Grid zero point
GRID 27

0.15m b.g.l
0.25m b.g.l
0.50m b.g.l
0.75m b.g.l
1.00m b.g.l
1.25m b.g.l
1.50m b.g.l
1.75m b.g.l
2.00m b.g.l
2.25m b.g.l
2.50m b.g.l
2.75m b.g.l
3.00m b.g.l

Abbreviations

AC	ASSUMED CONNECTION	AR	ASSUMED ROUTE
BH	BORE HOLE	BT	BTITISH TELECOM COVER
BOX	UNIDEFIELD BOX	BOL	BOLLARD
BP	BOUNDARY POST	BS	BUS STOP
C	CABLE TV	CL	COVER LEVEL
CATV	CABLE TV COVER	CP	CONCRETE POST
DP	DEPTH	EL	ELECTRICITY PIT
ER	EARTH ROD	EOT	END OF TRACE
FH	FIRE HYFRANT	FB	FLOWER BED
FP	FOOTPATH	GV	GAS VALVE
GY	GULLY	GP	GATE POST
GPR	G.P.R TRACE	GB	GAS BOX
HV	HIGH VOLTAGE	IC	INSPECTION CHAMBER
IL	INVERT LEVEL	LP	LAMP COLUMN
LV	LOV VOLTAGE	MH	MANHOLE
MW	MONITORING WELL	ND	NO DEPTH
OH	OVERHEAD	CL	COVER LEVEL
OHW	OVERHEAD WIRES	PM	PARKING METER
PB	POST BOX	RE	RODDING EYE
RP	ROAD PIN	RWP	RAIN WATER PIPE
SI	SIGN POST	SVP	SOIL VENT PIPE
TCB	TELEPHONE CALL BOX	SP	SIGN POST
TOP	TOP OF FENCE LEVEL	TOW	TOP OF WALL LEVEL
TL	TRAFFIC LIGHT	TK	TOP OF KERB
UI	UNIDENTIFIED	UTS	UNABLE TO SURVEY
UTT	UNABLE TO TRACE	UTL	UNABLE TO LIFT
VP	VENT PIPE	WM	WATER METER
WS	WEAK SIGNAL	WP	WATER PIPE

SOILS LIMITED - Underground Services Disclaimer

The survey aims to map all existing utilities and subsurface structures and provide information on pipe size, material type, and drainage connectivity. However GPR surveying is limited by the following guidelines, and it may not be possible to accurately survey, define and locate all services and subsurface features.

-Existing record information showing underground services is often incomplete and unknown accuracy. Therefore it should be regarded only as an indication.

-In ideal conditions, these spatial accuracies for the underground utilities located and mapped are ±5% / 500mm for the RD8000 and +/-15% of depth for the GPR System. Variations within the subsurface may, however, alter this estimated accuracy.

-It is not always possible to trace the entire length of each underground service. Everything depends on Ground condition.

-Although all reasonable steps have been taken to locate all underground utilities, there is no guarantee that all will be shown in the drawing, as some above ground features may have obstructed the survey.

-Due to the attenuation of the radar signal with depth, locating is restricted, making identification of anomalies difficult with increasing depth.

-The depth penetration and quality of the data depend on the ground conditions on site. Weak data may be a result of areas with high conductivity. Also, highly reflective materials close to the surface. e.g. Wire fencing can mask anomalies.

-Unless otherwise stated, all services and subsurface structures shown in these drawings have been surveyed using approved detectors and the connections between manholes, if not traced, are assumed to be direct.

-Where supplied before survey commencement, we will use utility provider's information as a guide for location purposes. However, should we not be able to locate those guided services, we shall not be held responsible for the accuracy, or otherwise, of the location of that service, as issued by the utility provider. These will be shown as "Taken From Records" on the drawing and we are not liable for any loss that may arise due to the lack of accuracy in the guided information.

-Plan accuracies of the order of + or - 150mm may be achieved, but this figure will depend on the depth of the service below ground level. Where similar services run on proximity, separation may be impossible. Successful tracking of non-metallic pipes may be limited.

No guarantee can be given that all services have been shown. During locating Underground service, errors and omissions can occur, due to electrical fields and localized ground conditions.

The Contractor shall not rely on this information and shall take necessary steps to verify this information as required. It is the Contractor's responsibility to verify the location and presence on site of all existing underground services and whether live or isolated.

soils LIMITED

Head Office – London
Contact: Rob Higginson
Newton House,Tadworth,KT20 5SR
Tel: 01737 814221

Southern Office – Winchester
Contact: Craig Morrison
Winnall Close, SO23 0LB
Tel: 01737 814221

Web: soilslimited.co.uk

Site details

Address: Crown Trading Centre, Hayes

Postcode: UB3 1DU | City: Hayes

Client:

AECOM

GPR Survey

Scale	Sheet Size:	Sheet Number:	Date:
1:100	A1	1 of 1	28.05.2022

Project Number:	Rev:	Surveyed By:	Drawn By:	Approved By:
20227	1.0	BW	BW	SB