MER-110-020135	Department of Major Projects Project Hydrus	Issue: Issue 01
	Piling Report	Date: 29/04/2010

Project Hydrus,
Submission to West Berkshire Council,
Information on Piling

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APPROVALS

MER-110-020135	Department of Major Projects Project Hydrus	Issue: Issue 01
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Originator	Checked	Approved
Signature:	**Signature:**	**Signature:**
Date:	**Date:**	**Date:**
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1 INTRODUCTION

The project scope identifies the requirement for the use of 'piled foundations' for the tower crane bases and for the lightning protection system (LPS) masts.

This document has been prepared provide the information which has been requested for other AWE applications to demonstrate that the piled foundations do not pose an unacceptable risk to groundwater.

2 LOCAL CONDITIONS

2.1 LOCAL GEOLOGY

In order to assess the risk posed by the piling operations to groundwater information on the local geology has been drawn from Hydrus ground investigation reports, particularly the Atkins Geotechnical Interpretative Report[1]. The geology is summarised in the following cross sections taken from the Atkins report.

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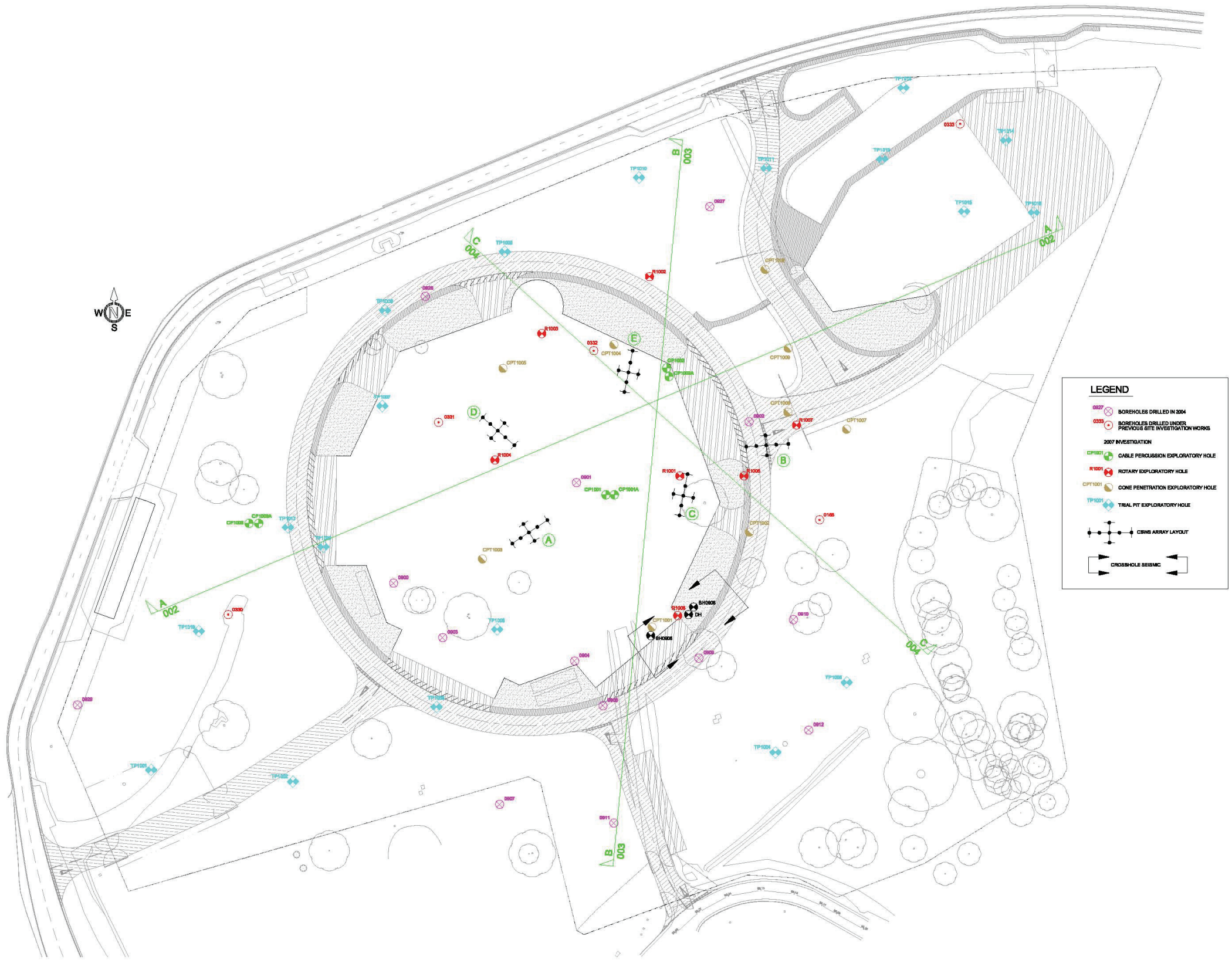
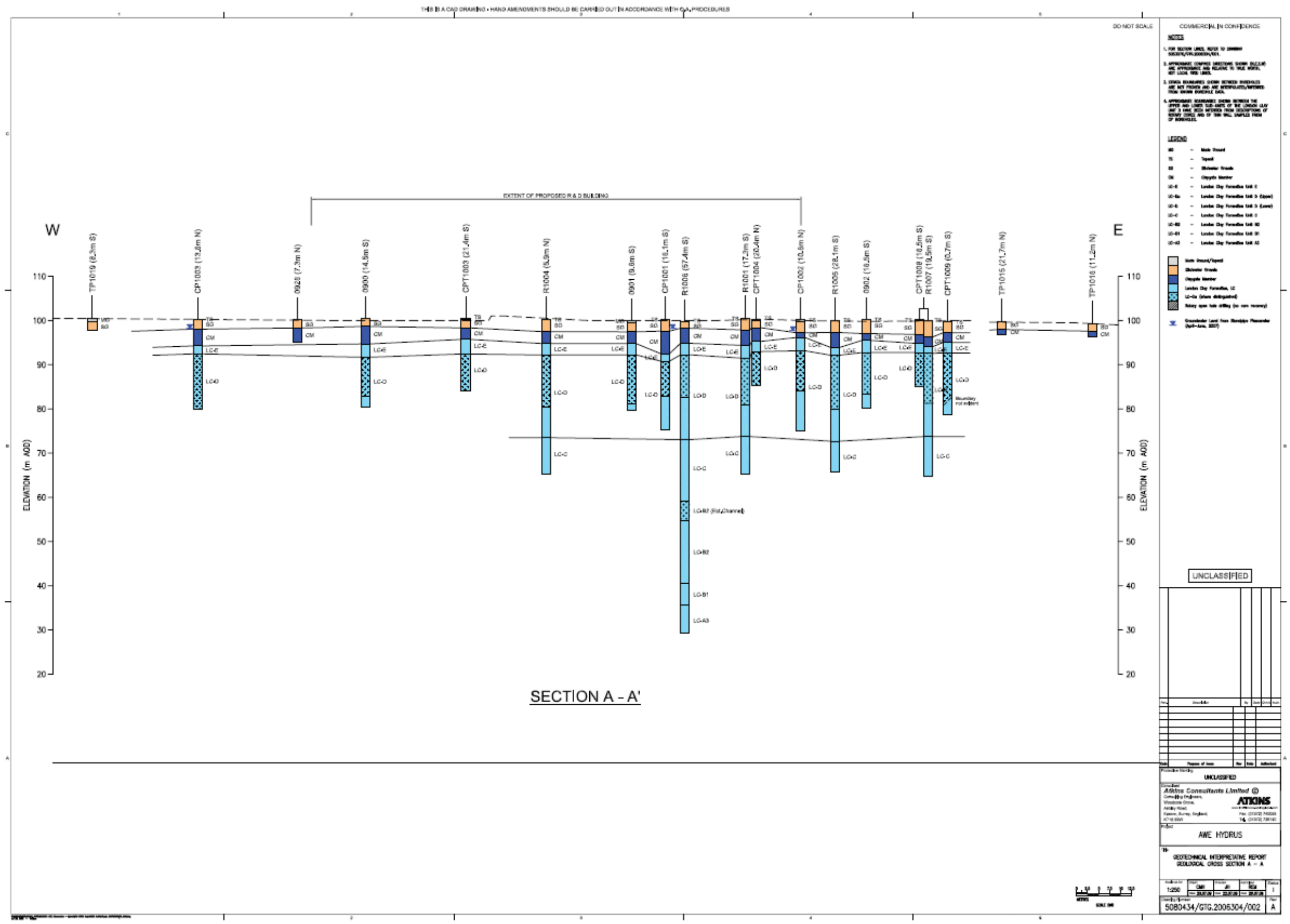
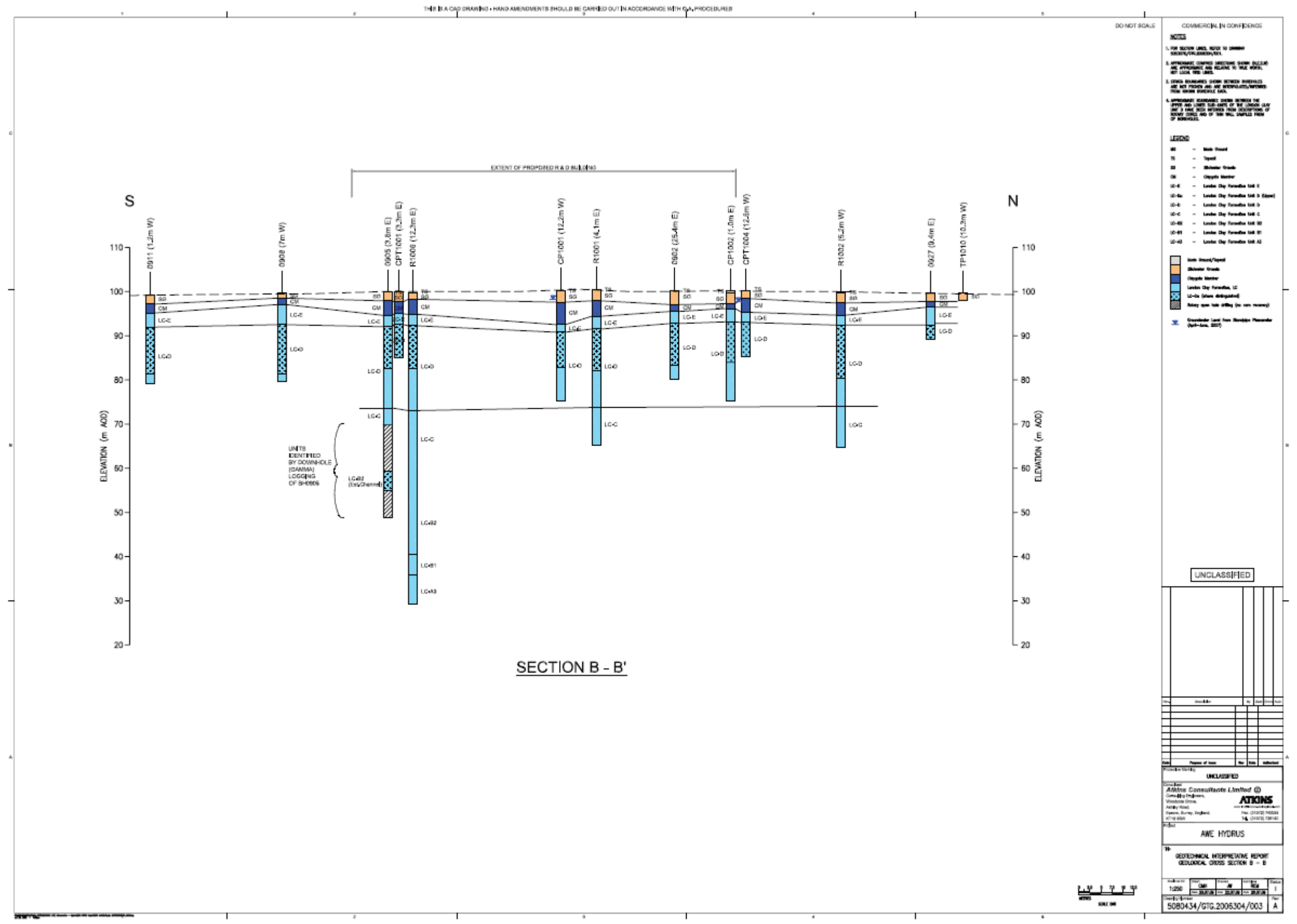



THIS IS A CAD DRAWING - HAND AMENDMENTS SHOULD BE CARRIED OUT IN ACCORDANCE WITH QA PROCEDURES
DO NOT SCALE
COMMERCIAL IN CONFIDENCE
EXTENT OF PROPOSED R & D BUILDING
W
E
ELEVATION (m AOD)
TP1019 (8.2m S)
CP1003 (13.6m N)
0928 (7.3m N)
0900 (14.5m S)
CPT1003 (21.4m S)
R1004 (5.9m N)
0901 (9.8m S)
CP1001 (16.1m S)
R1006 (57.4m S)
R1001 (17.3m S)
CPT1004 (20.4m N)
CP1002 (10.8m N)
R1005 (28.1m S)
0902 (16.8m S)
CPT1008 (16.2m S)
R1007 (19.5m S)
CPT1009 (0.7m S)
TP1015 (21.7m N)
TP1018 (11.2m N)
TS
SG
SD
CM
LC-E
LC-D
LC-C
LC-B2 (Flat Channel)
LC-B2
LC-B1
LC-A3
Boundary not evident
SECTION A - A'
LEGEND
Made Ground
Topsoil
Shelvoir Grade
Clayate Member
London Clay Formation, LC
LC-Cs (where distinguished)
Rotary open hole drilling (no core recovery)
UNCLASSIFIED
Atkins Consultants Limited
ATKINS
AWE HYDRUS
GEOTECHNICAL INTERPRETATIVE REPORT
GEOLOGICAL CROSS SECTION A – A'
1:250
5080434/GTG.2005304/002
A


THIS IS A CAD DRAWING - HAND AMENDMENTS SHOULD BE CARRIED OUT IN ACCORDANCE WITH QA PROCEDURES
DO NOT SCALE
COMMERCIAL IN CONFIDENCE
EXTENT OF PROPOSED R & D BUILDING
S
N
0911 (1.2m W)
0908 (7m W)
0905 (9.6m E)
CPT1001 (9.3m E)
R1008 (12.3m E)
CP1001 (12.2m W)
R1001 (4.1m E)
0902 (25.4m E)
CP1002 (1.0m E)
CPT1004 (12.6m W)
R1002 (5.2m W)
0927 (9.4m E)
TP1010 (10.3m W)
ELEVATION (m AOD)
110
100
90
80
70
60
50
40
30
20
TS
SG
GM
LC-E
LC-D
LC-C
LC-B2
LC-B1
LC-A3
UNITS IDENTIFIED BY DOWNHOLE (GAMMA) LOGGING OF BH0905
LC-B2 (Est)(Channel)
LEGEND
Made Ground/Topsoil
Shelvoir Grade
Claygate Member
London Clay Formation, LC
LC-Ca (where distinguished)
Rotary open hole drilling (no core recovery)
Groundwater Level from Standpipe Piezometer (April–June, 2007)
SECTION B - B'
UNCLASSIFIED
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AWE HYDRUS
GEOTECHNICAL INTERPRETATIVE REPORT
GEOLOGICAL CROSS SECTION B – B'
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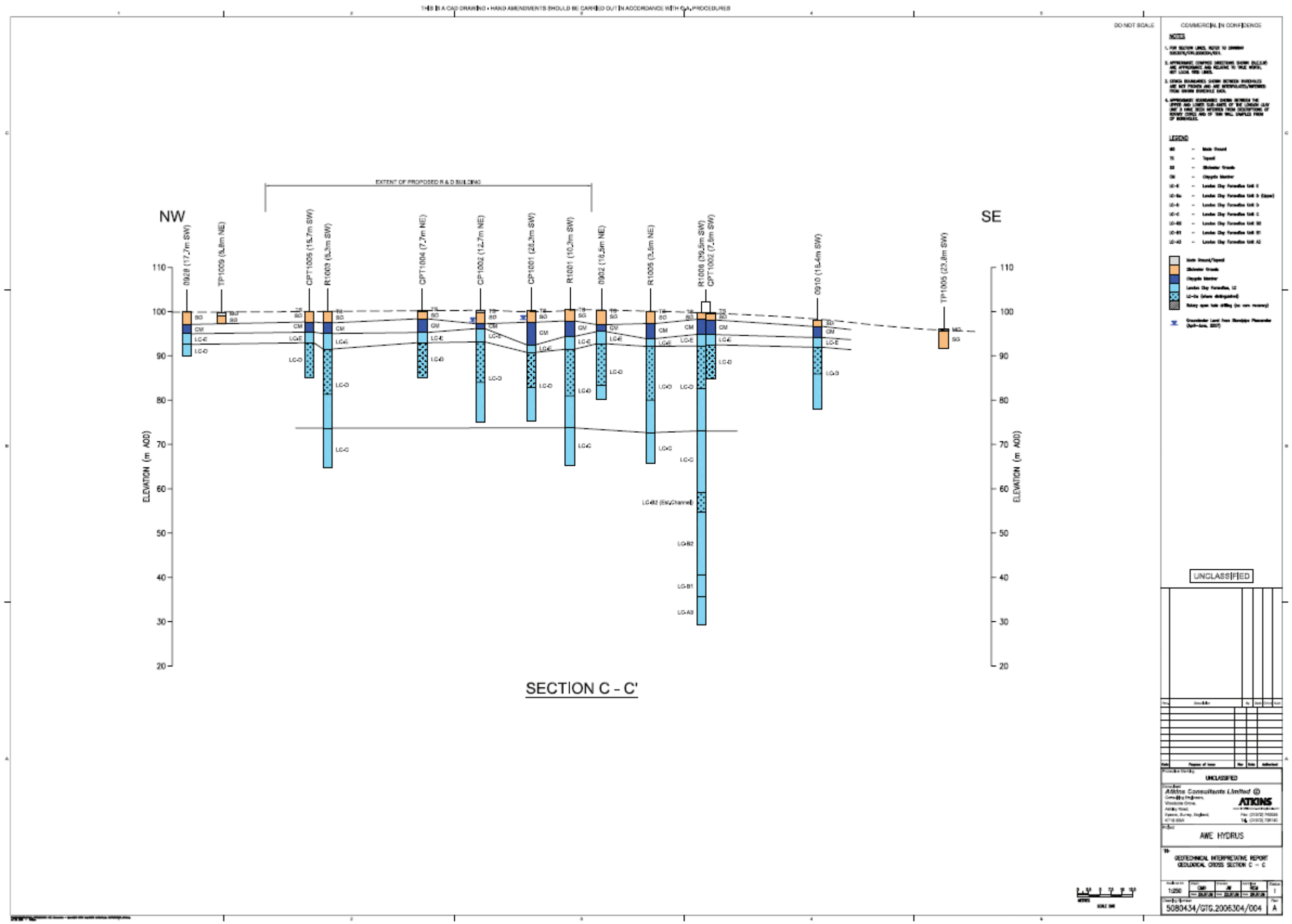
THIS IS A CAD DRAWING - HAND AMENDMENTS SHOULD BE CARRIED OUT IN ACCORDANCE WITH QA PROCEDURES
DO NOT SCALE
COMMERCIAL IN CONFIDENCE
EXTENT OF PROPOSED R & D BUILDING
NW
SE
0928 (17.7m SW)
TP1009 (9.8m NE)
CPT1005 (15.7m SW)
R1003 (9.3m SW)
CPT1004 (7.7m NE)
CPT1002 (12.7m NE)
CPT1001 (28.3m SW)
R1001 (10.2m SW)
0902 (18.5m NE)
R1008 (3.8m NE)
R1006 (39.5m SW)
CPT1002 (7.8m SW)
0910 (18.4m SW)
TP1005 (23.8m SW)
ELEVATION (m AOD)
SECTION C - C'
UNCLASSIFIED
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AWE HYDRUS
GEOTECHNICAL INTERPRETATIVE REPORT
GEOLOGICAL CROSS SECTION C - C'
5080434/GTG.2006304/004

2.2 LOCAL HYDROGEOLOGY

The following are excerpts from the Atkins Geotechnical Interpretative Report:

Examination of the borehole logs and the limited groundwater level data available indicates that there are likely to be two aquifer units at relatively shallow depth. These are a unit formed by the Silchester Gravels and Claygate Member and one formed by the upper part of Unit D of the London Clay.

On the basis of a number of dual installations, Golder concluded that flow was generally downward vertical flow from the Silchester Gravel into the underlying Claygate Member with some limited upward vertical flow in the vicinity of spring lines and ponds. It is apparent from the monitoring data that groundwater is generally flowing in a northerly direction in the vicinity of the Hydrus site. Contour plots prepared by Golder indicate that there may be a groundwater divide running approximately north south through the Hydrus site with flow to the west of this divide to the north west and flow to the east being to the north east.

The minor aquifers across the wider site are generally unconfined, and therefore it may be expected that levels will fluctuate seasonally and will respond to rainfall events relatively rapidly. The Golder study reported that the hydraulic gradient varied seasonally, associated with the relative groundwater level changes, although the pattern of groundwater heads and the principal flow direction does not change with the seasons.

The local nature of the Silchester Gravel is such that there are no data on its permeability available within the aquifer properties manual (British Geological Survey Technical Report WD/97/34 1997). However, site specific testing has previously been undertaken by Golder (2002)[2] elsewhere on the Aldermaston site and as part of the current investigation on both the Silchester Gravel and the London Clay.

Laboratory permeability testing was undertaken as part of the Golder assessment to determine both the horizontal and vertical permeability. The conclusions of these studies are shown in the table below.

Table 1. Permeability of the geological units at Aldermaston (Golder)

Geological Unit	**Horizontal permeability (m/s)**	**Vertical permeability (m/s)**
Silchester Gravel	10^{-5} to 10^{-6}	-
Claygate Member	10^{-5} to 10^{-6}	10^{-9}
London Clay (undifferentiated)	10^{-9} to 10^{-11}	10^{-11}

Site specific information is available in the form of infiltration values derived from a number of field soakaway tests (using TP1004, TP1005, TP1006, TP1007 and TP1010) during March and April 2007, conducted to facilitate the design of surface water management systems. The results of these tests are presented in the table below.

Table 2. Infiltration rates from soakaway tests

Trial Pit	Location	Test infiltration rates (f), (m/s)	Lowest infiltration rate (f) , (m/s)
TP1006	Main plateau area	2.8×10^{-5} , 2.5×10^{-5} and 1.9×10^{-5}	1.9×10^{-5}
TP1007	Main plateau area	3.8×10^{-5} and 4.8×10^{-5}	3.8×10^{-5}
TP1010	Main plateau area	1.1×10^{-5} and 6.1×10^{-6}	6.1×10^{-6}
TP1004	Southern valley	2.5×10^{-6} and 2.3×10^{-6}	2.3×10^{-6}
TP1005	Southern valley	1.9×10^{-6}	1.9×10^{-6}

It is noted that infiltration tests in trial pits are not strictly equivalent to borehole permeability tests, but the values are generally similar. They therefore provide additional confirmation that the previous results gathered by Golder are applicable for the Hydrus site. Particular attention is drawn to the value of approximately 10^{-4} m/s recorded in TP1006. The Silchester Gravel at this location appeared cleaner than that found in adjacent trial pits and could represent a higher permeability 'channel' running through the gravel stratum.

The Atkins Geotechnical Interpretative Report also highlights the presence of the following higher permeability band of the London Clay:

Unit D (Upper) is an unstructured very sandy silt/clay with zones of local fissuring. Bands and lenses of silt and sand appear to predominate in the upper 2 m and the lower 1 m of the deposit. In contrast with the other sub units of the London Clay present at this site, Unit D (Upper) contains a significantly low proportion of clay (typically 10 to 15%) and high sand content (13 to 45%).This will have a considerable effect on the behaviour and characteristics of the material. It is likely to have been susceptible to permafrost effects in the geological past, which will have changed its structure and fabric. As a result, the permeability, compressibility, swelling and shrinkage characteristics of this Unit will differ from the rest of the Formation.

In summary, there are two groundwater bodies which may be affected by the piling – the shallow aquifer and the upper part of Unit D of the London Clay.

3 PILING

A piled solution for the tower crane bases and Lighting Protection System (LPS) masts is a design requirement, and alternatives such as gravity foundations have been dismissed as inadequate.

3.1 PILING OPTIONS

The following options for pile installation exist,

- Bored piles; or
- Driven piles.

The installation of driven piles is likely to create significantly greater nuisance to neighbours and the surrounding AWE community than bored piles. This is due to the presence of cohesive clays (see Local Geology) which will require installation using percussive hammers or vibration to achieve the required embedment. This process will produce significant noise and transmit 'shockwaves' and vibration through the

ground. The AWE operations occurring adjacent to the site preclude such a nuisance being tolerable.

As such bored piling techniques have been selected for the tower crane base and LPS foundations.

The piles will be installed using Continuous Flight Auger (CFA) or bored techniques. The CFA/bored technique casts concrete against the shaft wall, forming a close bond between the concrete and the in-situ ground. Where piles are installed in cohesive material (such as London Clay encountered at the site) the design relies on the skin friction between the concrete pile and the shaft wall to bear the anticipated structural loadings – the skin friction therefore relies on a close bond between the concrete of the pile and the shaft edge.

3.2 PILE DETAILS

Tower Crane

The preliminary design details for the base piles are:

- 6 piles per tower crane (of which there will be 2)
- 600mm diameter concrete CFA/ bored piles
- Pile toe at approximately 15m below ground level
- With a pile cap dimensions of 5m by 5m and a thickness of 1.5m.

LPS

The LPS masts consist of the mast supported by 2 structural stays, the piles are distributed between the 3 points of contact, 4 below the base of the mast, 2 below the base of each structural stays. The preliminary design details for the base piles are:

- 8 piles per LPS mast (of which there will be 8)
- 600mm diameter concrete CFA/ bored piles
- Pile toe at approximately 15m below ground level
- The mast pile cap measures approximately 4.1m x 4.0m with a thickness of 1.4m. The pile caps under each of the structural stays measure 3m x 1.2m with a thickness of 1.4m.

Borehole information contained within the Atkins Geotechnical Interpretative Report was used to establish ground conditions in the areas which are to be subjected to piling.

This anticipated pile length will result in piles which penetrate into the upper part of Unit D of the London Clay.

3.3 PILING RISK ASSESSMENT

Risk Description	Likelihood	Severity	Hazard	Mitigation Measures	Residual Risk
Contamination of groundwater via pathway created by piling from ground level to the underlying aquifer	Medium	Medium	Medium	• Environmental controls will be enforced as defined in the Construction Environmental Management Plan MER-110-017361. • No significant soil contamination. • Groundwater form the Shallow Aquifer will be removed by dewatering. • The piles marginally penetrate into the Upper region Unit D of the London Clay which is more permeable than the rest of the formation. Unit D is **not** in hydraulic continuity with the underlying Chalk (a major aquifer from which AWE and the regional water utility company abstract), the vertical permeability of the London Clay formation is 10^{-11} m/s, and there is a thickness of approximately 60m of London Clay below the base of the piles, which will provide considerable protection to the Chalk. • The nature of the piles means that the concrete forms a close bond with the shaft wall, which must be maintained for the pile to function. This seal will prevent contamination from running down the side of the pile. • All the piles will have a pile cap cast on/over them further limiting the possibility of contamination entering the annulus around the pile. • The ground profile adjacent to the pile cap will be managed to prevent any contamination ponding.	Low
Disruption of groundwater flow due to piling.	Low	Low	Low	• The piles will not penetrate • None of the installed wells will form a continuous cut off wall through the aquifer.	Low
Contamination of aquifer through the	Medium	Medium	Medium	• Piles are created through the injection of concrete	Low

installation of piles.				into drilled boreholes. The bores can be lined where the ground is not self supporting or where there is significant groundwater flow which would wash out the concrete. • Where the piles penetrate more permeable strata the wet concrete will come into contact with groundwater and will form a matrix with the sands and silts around the pile. • Once the concrete has cured in the ground it is a non-active inert material and hence will not cause contamination. • Piles will remain in the ground on completion of the project, though the pile caps may be removed and any depression backfilled. No further construction activities will impact on the groundwater as a result of piling. • Concrete mixes will be designed to minimise leaching of cement from the concrete based on the ground and groundwater conditions of the site.	
Nuisance from pile installation process – CFA / boring piling.	Low	Low	Low	CFA piles are bored into the ground without percussive action and unless obstructions are encountered (requiring breaking out), will not cause appreciable noise. This method of piling will cause minimal vibration to the ground.	Low

4 CONCLUSION

The risk of groundwater contamination as a result of using piled foundations is mitigated through the proposals set out above. CFA / bored techniques create a continuous bond between the pile concrete and surrounding soil preventing any contamination path from the ground surface to the groundwater. Where wet concrete is introduced to the pile shaft the leaching of cement into the groundwater is minimised by the installation being mostly within clay strata, in granular material, where there is potential for groundwater flow, leaching will be minimised through the utilisation of appropriately designed concrete and where necessary cased piles. In the case of high groundwater piles may require casing during construction.

Once installed the concrete pile is cured, the concrete will be inert and remain in position. The location and design of the piles will not cause any impacts on groundwater flows.

REFERENCES

[1] Hydrus Geotechnical Interpretative Report, Issue 3.Atkins Job No. 5080434, Ref. HYDFEL3/56.24/REP/00113

[2] Hydrogeological characterisations of AWE Aldermaston, prepared by Golder Associates, April 2002 (Ref: 98524410.500, version B.0)